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EeBGuide

Operational guidance for Life Cycle Assessment studies of the Energy Efficient Buildings Initiative

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What is EeBGuide?

The European research project "EeBGuide" develops metrics and guidance for the preparation of Life Cycle Assessment (LCA) studies for energy-efficient buildings and building products. Ongoing research under the framework of the Energy Efficient Building European Initiative creates technologies for an energy-efficient Europe. LCA is used to assess the environmental benefits of new technologies. The EeBGuide manuals and guidance will support LCA practitioners to obtain comparative results in their work.

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Executive Summary

Operational guidance for Life Cycle Assessment studies of the Energy Efficient Buildings Initiative (EeBGuide) is a European Commission funded project aiming to produce expert guidance for conducting Life Cycle Assessment (LCA) studies for energy-efficient buildings and building products under the framework of Energy-efficient Building European Initiative (E2B EI). The EeBGuide guidance document will provide a common methodology supporting reliable assessment and comparison of new efficient buildings and products. It will support LCA practitioners in industry and research.

In order to ensure acceptance by LCA practitioners, the EeBGuide was developed with a strong focus on applicability. Therefore, different case studies were conducted: usual building product, EeB product, new buildings (simple and complex) and existing buildings. The results enabled to show the applicability of the EeBGuide.

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1. Introduction

For each case study, main results are given according to the life cycle stages defined in EN 15804 / EN 15978. For building LCA, results are presented by contributors e.g. building products, operational energy use, operational water use etc. More detailed information can be found in the LCA report for each case study (see the additional documents).

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2. Summary of case study results: common product

For a tufted textile floor covering, the production stage is evidently the most important contributor to the life cycle environmental profile, specifically for Global Warming, Acidification, Eutrophication, Photochemical ozone creation, Ozone depletion and Abiotic fossils depletion potentials as well as for the consumption of Primary Energy (see Table 1 and Table 2).

The manufacturing of this product is energy intensive as it is produced over a series of steps involving tufting, primary backing, shearing, back coating, cutting and packaging, as well as other sub-stages happening for each manufacturing step. Most of these stages and sub-stages are carried out by machine and thus require electricity and thermal energy to function. Furthermore, impacts associated with the production and transport of raw materials result in a high contribution to the production stage.

Regardless of which end of life route is selected, the relative contribution from production remains high, whilst the contributions from the use stage become more evident when a lower impact end of life route is selected. This can be better seen at Figure 1 when selecting reuse of product in a cement kiln as this end of life route decreases the environmental impacts of this stage, making the use of electricity for maintenance more evident.

The carpet produces emissions during its use and it also needs to be maintained. These contribute to the majority of the following environmental indicators:

- Stratospheric ozone layer depletion resulting mostly from emissions generated during the production of the detergent needed to wet clean the carpet and those from electricity generation needed to vacuum the carpet and treat the water used and wastewater generated from wet cleaning it;
- Abiotic resource depletion (elements) resulting from electricity generation and detergent production;
- Net consumption of fresh water needed mostly for wet cleaning the carpet.

When comparing different disposal routes, the contribution to end of life is offset when the carpet is sent to incineration by the benefits over its system boundary, and even more when sent for recycling/energy recovery at a cement kiln by creating less environmental impacts and by presenting higher benefits over the system boundary (see Table 1 and Table 2).

All in all, the results may be used to assist planners and architects to promote the practice of reuse of this type of products in the cement industry as an alternative fuel. Furthermore, from the results more investigations on alternative materials and energy fuels during the production of the product can be undertaken to reduce the impact of the product's overall life cycle.

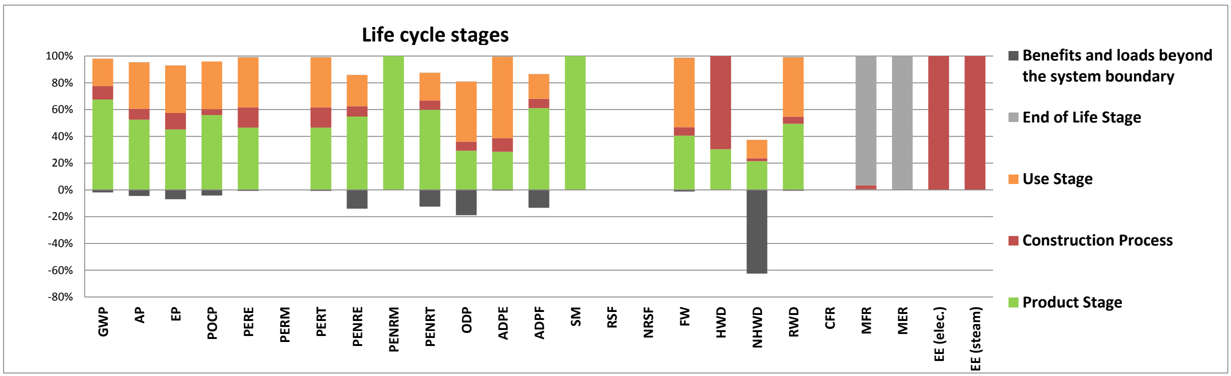
Table 1. Overview of the product LCA results for installed tufted textile floor covering (A1-B7)

Overview over the product LCA results			Installed tufted textile floor covering								
RSL 10 years			Global warming potential	Acidification Potential	Eutrophication Potential	Photochemical Ozone Creation Potential	Total use of renewable primary energy	Total use of non-renewable primary energy	Depletion potential of the stratospheric ozone layer	Abiotic Resource Depletion Potential for elements	Abiotic Resource Depletion Potential of fossil fuels
			GWP	AP	EP	POCP	PERT	PENRT	ODP	ADPE	ADPF
			[kg CO_2-equiv./m^2_{NFA}*a]	[kg SO_2-equiv./m^2_{NFA}*a]	[kg PO_4^{-3} - equiv. /m^2_{NFA}*a]	[kg C_2H_4-equiv./m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	kg CFC11-equiv./m^2_{NFA}*a	[kg Sb-Equiv. /m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]
Product Stage	A1 A2 A3	Raw Materials Supply Transport Manufacturing	0,97	1,99E-03	2,50E-04	2,95E-04	0,56	18,99	1,07E-08	2,51E-07	17,84
Construction Process	A4	Transport	8,32E-03	3,80E-05	8,79E-06	-1,37E-05	4,50E-03	0,12	3,08E-12	3,28E-10	0,11
	A5	Construction- Installation process	0,14	2,72E-04	5,90E-05	3,69E-05	0,18	2,06	2,44E-09	8,91E-08	1,91
Use Stage	B1	Use	3,14E-04	0,00	0,00	1,11E-05	0,00	0,00	0,00	0,00	0,00
	B2	Maintenance	0,29	1,31E-03	1,96E-04	1,77E-04	0,45	6,56	1,63E-08	5,36E-07	5,41
	B3	Repair	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	B4	Replacement	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	B5	Refurbishment	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	B6	Operational Energy Use	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	B7	Operational Water Use	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Table 2. Overview of the product LCA results for installed tufted textile floor covering (C1-D)

Overview over the product LCA results			Installed tufted textile floor covering (End of Life scenarios)								
RSL 10 years			Global warming potential	Acidification Potential	Eutrophication Potential	Photochemical Ozone Creation Potential	Total use of renewable primary energy	Total use of non-renewable primary energy	Depletion potential of the stratospheric ozone layer	Abiotic Resource Depletion Potential for elements	Abiotic Resource Depletion Potential of fossil fuels
			GWP	AP	EP	POCP	PERT	PENRT	ODP	ADPE	ADPF
			[kg CO_2-equiv./m^2_{NFA}*a]	[kg SO_2-equiv./m^2_{NFA}*a]	[kg PO_4^{-3} - equiv. /m^2_{NFA}*a]	[kg C_2H_4-equiv./m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	g CFC11-equiv./m^2_{NFA}*	[kg Sb-Equiv. /m^2_{NFA}*a	[MJ/m^2_{NFA}*a]
End of Life Stage (Landfill)	C1	Deconstruction	n.a. - manual deconstruction	n.a. - manual deconstruction	n.a. - manual deconstruction	n.a. - manual deconstruction	n.a. - manual deconstruction	n.a. - manual deconstruction	n.a. - manual deconstruction	n.a. - manual deconstruction	n.a. - manual deconstruction
	C2	Transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	C3	Waste process for reuse, recovery or/ and recycling	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	C4	Disposal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benefits and loads beyond the system boundary (Landfill)	D	Reuse-Recovery-Recyclingpotential	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
End of Life Stage (Incineration)	C1	Deconstruction	n.a. - manual deconstruction	n.a. - manual deconstruction	n.a. - manual deconstruction	n.a. - manual deconstruction	n.a. - manual deconstruction	n.a. - manual deconstruction	n.a. - manual deconstruction	n.a. - manual deconstruction	n.a. - manual deconstruction
	C2	Transport	4.66E-04	2.13E-06	4.92E-07	-7.70E-07	2.52E-04	6.46E-03	1.73E-13	1.84E-11	6.44E-03
	C3	Waste process for reuse, recovery or/ and recycling	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	C4	Disposal	0.38	2.49E-04	6.53E-05	1.78E-05	1.46E-02	0.32	3.25E-11	7.14E-08	0.30
Benefits and loads beyond the system boundary (Incineration)	D	Reuse-Recovery-Recyclingpotential	-1.23E-01	-1.81E-04	-1.60E-05	-2.00E-05	-6.89E-02	-2.03E+00	-1.75E-09	-5.71E-09	-1.87E+00
End of Life Stage (Reuse in kiln)	C1	Deconstruction	n.a. - manual deconstruction	n.a. - manual deconstruction	n.a. - manual deconstruction	n.a. - manual deconstruction	n.a. - manual deconstruction	n.a. - manual deconstruction	n.a. - manual deconstruction	n.a. - manual deconstruction	n.a. - manual deconstruction
	C2	Transport	4.66E-04	2.13E-06	4.92E-07	-7.70E-07	2.52E-04	6.46E-03	1.73E-13	1.84E-11	6.44E-03
	C3	Waste process for reuse, recovery or/ and recycling	1.36E-03	5.79E-06	3.11E-07	3.52E-07	3.46E-03	2.37E-02	8.87E-11	1.11E-10	1.55E-02
	C4	Disposal	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Benefits and loads beyond the system boundary (Reuse in kiln)	D	Reuse-Recovery-Recyclingpotential	-2.62E-02	-1.71E-04	-3.84E-05	-2.13E-05	-9.32E-03	-3.93E+00	-6.89E-09	-4.38E-09	-3.91E+00

Figure 1. . Share of main contributors to total product LCA results: Reuse of product in a cement kiln



3. Summary of case study results: EeB product

All in all the more functions the developed components fulfil, the higher is the influence of the production phase on the overall results for the total life cycle, as necessary amounts of material and energy for manufacturing processes increase. Component 3.1 is such an example, as it functions as e.g. shading device, substitutes a standard façade part and generates heat for heating and cooling purpose. In general, the results of the Life Cycle Assessment are significantly influenced by the assumptions made for the operation phase. Especially the environmental indicators total, renewable and non-renewable primary energy demand are strongly determined by the operation phase, independently from the component regarded at. The results for the renewable primary energy demand are highly determined by the net gains of solar primary energy which the components deliver to a potential target building. Furthermore, auxiliary electricity additionally accounts for small parts of the renewable primary energy demand. The results presented should serve for a first estimation on the assessment of the operation phase. Besides, the results for the assessment of the conventional energy generation versus alternative energy generation with the developed components are presented for one possibility of conventional energy generation. The results may differ, if other conventional scenarios are regarded at (e.g. heat generation with a wooden chip boiler or district heating). A comparison of conventional and alternative energy generation for the total life cycle (production, use, End-of-Life) only makes sense, if additional functionality of the new developed components is included for the conventional scenario. This is the case, if e.g. a potential target building is regarded at, too. Especially recycling processes for metals and glass have a high influence on reducing the environmental impacts from production and operation within the End-of-Life phase (see Figure 2 for the share of EoL (without operational energy use).

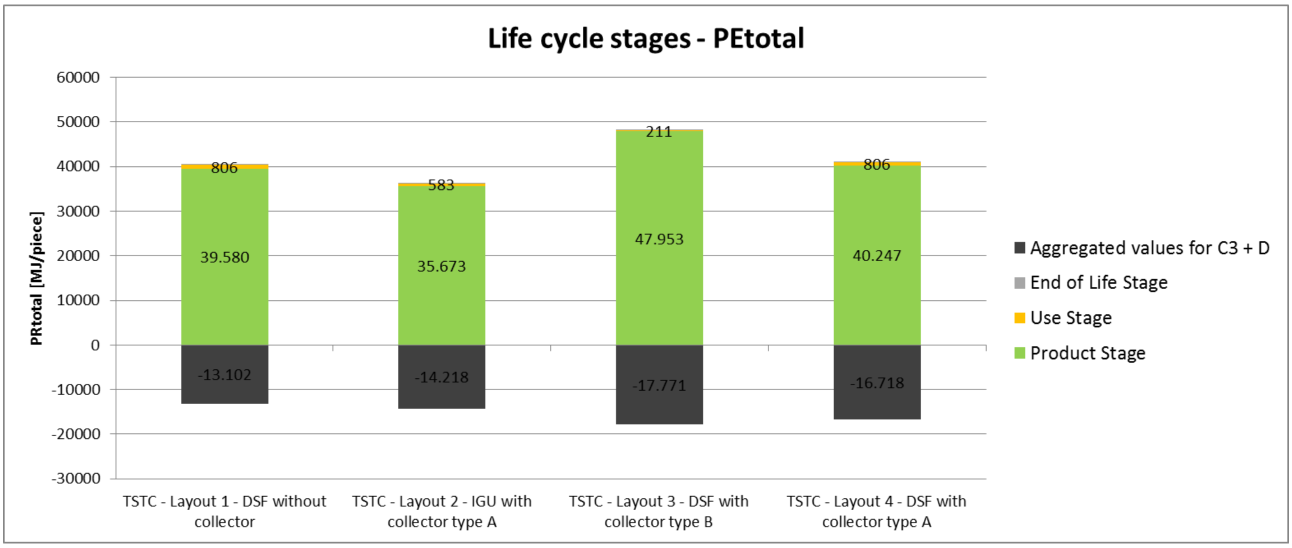


Figure 2: Overview of the product LCA results (without operational energy use) for alternative

They lower the partly very high impacts of the production phase up to 50%. The assessment results for all components seem to pretend that it is reasonable to apply the respective component while building retrofitting actions for reducing the Global Warming Potential and the use of fossil primary energy within the operation phase. Component 3.1, 3.2, 3.3 and 3.5 show in addition a good potential for increasing the renewable share of the primary energy demand while operation, as additional renewable primary energy from solar sources can be used. For component 3.3 the module efficiency is of importance to be able to reduce solar losses and to be able to use a high fraction of solar renewable primary energy while operation. For component 3.1, 3.2 and 3.5 the degree of collector efficiency and actual relieved heat or cold within the building are of interest, when talking about and increased use of renewable primary energy. The operation phase is based on specific assumptions which presume a virtual potential target building, where the component is applied. Furthermore, the results obtained for the operation phase are location-dependent. In that way, the results may be used to assist e.g. planers and architects within the building design phase for choosing environmental beneficial solutions and to promote the use of renewable energies within high-rise buildings.

Table 3. Overview of the product LCA results for alternative „TSTC layout 1"

Overview over the product LCA results			**TSTC - Layout 1 - DSF without collector (for all locations)**						
20 years			**1. Global warming potential**	**2. Acidification Potential**	**3. Eutrophication Potential**	**4. Photochemical Ozone Creation Potential**	**5. Total use of renewable primary energy**	**6. Total use of non-renewable primary energy**	**7. Depletion potential of the stratospheric ozone layer**
			GWP	AP	EP	POCP	PERE	PENRE	ODP
			[kg CO_2-equiv./piece]	[kg SO_2-equiv./piece]	[kg PO_4^{-3} - equiv. /piece]	[kg C_2H_4-equiv./piece]	[MJ/piece]	[MJ/m²$_{piece}$]	[kg CFC11-equiv./pi
Product Stage	A1 A2 A3	Raw Materials Supply Transport Manufacturing	2.305,24	14,14	0,69	1,12	5.332,60	34.247,84	1,86E-04
Construction Process	A4	Transport	--	--	--	--	--	--	--
	A5	Construction-Installation process (not considered)	--	--	--	--	--	--	--
Use Stage	B1	Use (not considered)	--	--	--	--	--	--	--
	B2	Maintenance (including Production, impacts for EoL, credits for EoL)	46,22	2,32E-01	1,01E-02	2,25E-02	140,59	665,43	4,38E-06
	B3	Repair	--	--	--	--	--	--	--
	B4	Replacement	--	--	--	--	--	--	--
	B5	Refurbishment	--	--	--	--	--	--	--
	B6	Operational Energy Use (no impacts)	--	--	--	--	--	--	--
	B7	Operational Water Use (not considered)	--	--	--	--	--	--	--
End of Life Stage	C1	Deconstruction (not considered)	--	--	--	--	--	--	--
	C2	Transport	7,88	4,86E-02	8,40E-03	3,95E-03	0,15	111,32	1,50E-08
	C3	Waste process for reuse, recovery or/ and recycling (can not be reported separately for incineration or recycling processes --> please see "Aggregated values for C3 + D")	--	--	--	--	--	--	--

4. Summary of case study results: new buildings

- **Summary of case study results for the simple new building**

Description of the building

The new building is a two-storey single-family house located in the mid-west of France and occupied all year per 5 persons. It is composed of 5 rooms, a living-room, a separate kitchen and 2 bathrooms. The structure is made of cellular concrete, heat is provided by thermal heat pump, solar thermal panels with additional electrical heating system permit to produce hot water.

Scope and objectives of the study

The objective of the study is to perform a stand alone, complete LCA of the building, in order to analyze main contributors of total environmental impacts and to identify possible way of optimization and related margin of improvement.

Methodological aspects and main assumption

ELODIE software has been used to perform the assessment. Main EEBguide provisions have been followed in order to perform the LCA. In particular, recommendations for the system boundaries according to the expected level of detail of the study (complete) have been followed. Mandatory and main optional component and process for each life stage have been taken into account. The baseline scenario of the analysis considers a reference study period of 50 years. No refurbishment of the building has been considered. Used LCA data are, for the most part, EPD extracted from the INIES database.

Main results

The application of the operational guidance permit to point out the building LCA impacts and to draw the following conclusions:

The contribution of products and equipments is predominant for some important indicator of environmental impacts as GWP, Non Hazardous Waste

Operational energy use is, for its part, the main accountant for non-renewable and renewable primary energy and radioactive waste. It is also a significant contributor to ADP and GWP.

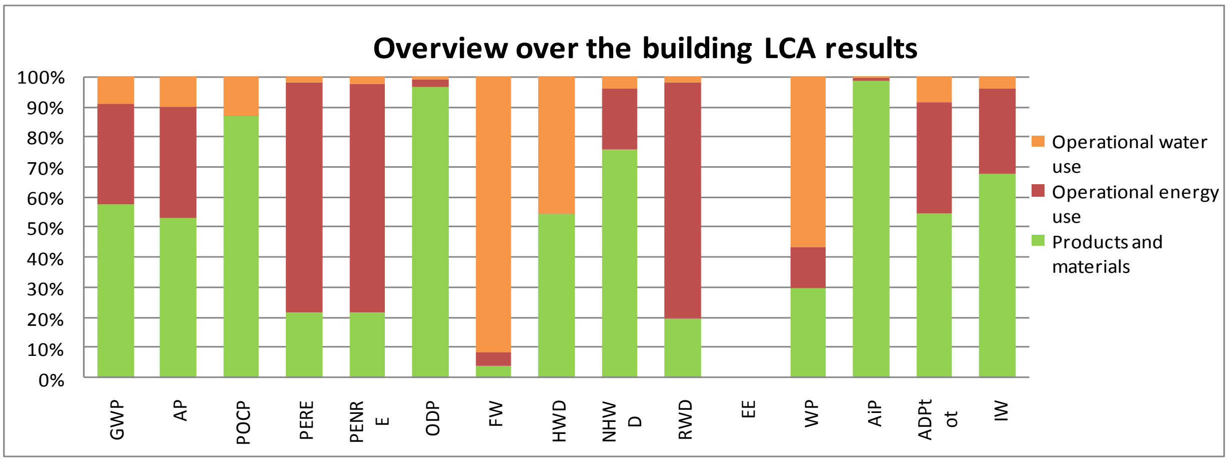


Figure 3: Overview of the product LCA results (without operational energy use) for alternative

Operational water use is the main accountant for the indicator net fresh water use whereas the contribution of product and operational energy use is slightly significant.

Finally, one of the main levers for this house in term of diminution of environmental impacts appears to be the contributor products and equipment. Indeed, building related uses are somehow already optimized. However we can't conclude about the influence of non-building related uses as they represent conventional scenario defined with the help of statistical data.

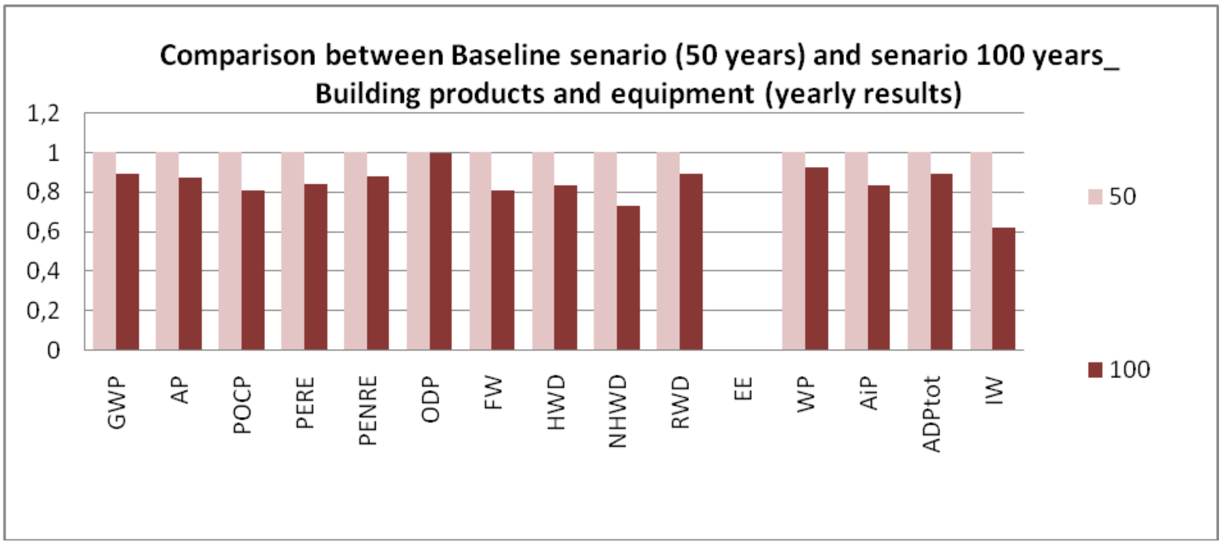


Figure 4: Overview of the product LCA results (without operational energy use) for alternative

The study was performed for a baseline scenario considering a reference study period (RSP) of 50 years and also for a RSP of 100 years. Total LCA results expressed per year of operation are slightly modified by this modification for most indicators. But some important differences can be seen if we focus on the contributor products and equipment, for example the quantity of inert waste is, for scenario "100 years", reduced down to 40%.

However the methodology taken into account in the study to extend the service life of the building might not be appropriate as it consider only more replacement of component. Recommendations of the guidance document propose to develop scenario for refurbishment (see module B, aspect *B- 16 "Refurbishment for screening, simplified and complete LCA").* For example, scenario for energy efficiency improvement could be drawn up considering higher thermal expectations and for example better equipment efficiency for the use of water. However, projections to consider future scenario are still difficult to make through a confident way.

- **<u>Summary of case study results for the complex new building</u>**

The study is a stand alone, complete LCA. The building consists of a main office building comprising a ground floor and 7 levels above it and an adjacent structure constituted of a two level car park. The objective of the study is to quantify the environmental impacts throughout the life cycle of the office building and more specifically:

- To identify the contribution of products and building materials to the overall environmental impact of the building and compare it to the impacts associated with the use phase of the building (e.g. consumption of water and electricity);

- To analyze the results and identify key issues among the building products used with respect to the different environmental impacts.

Results have shown that energy consumption during the use phase, and in particular lighting, ventilation, and to a lesser extent, cooling appear as the main contributors to total primary energy. The load bearing structure, flooring and lifts contributes significantly to the total primary energy impact, while the consumption of water during the use phase remain, at present, and for this indicator, negligible.

Due to the high thermal performance of building and the nature of energy inputs, unlike a more "standard" building, the building studied uses higher quantities of total primary energy for lighting and ventilation that for heating. The amount of total primary energy consumed by the cooling system (15 MJ / m² of floor area / year) is also much higher than that of heating (about twice time).

For GWP, the most important contribution is from products and building materials, which represents 72% of the total impacts (being 10.4 eq. Kg CO_2/m²/year). The second most important contribution is from energy consumption during the use phase (lighting, heating and cooling, ventilation and auxiliaries) that emits the equivalent of 3.8 eq. kg CO_2/m²/year. Finally, the contributor of water consumption is again negligible since it generates only 2% of the impact "climate change" assigned to the building. It should be noted that the balance of the contributor "products and building materials" is mainly induced by the energy context of French electricity production (the French electricity mix, including imports, has a low CO_2 content, but generate higher radioactive wastes).

An additional scenario, based on a 100 years RSP (compared to 50 years for the baseline scenario) has been developed. They differ by the number of replacement of the components and energy and water use during use phase.

As data collection was done before the publication of EN 15804 and EN 15978, the study does not entirely comply with these standards, notably with respect to the system boundaries of the modules (for instance modules B1 and B5 could not be determined). Furthermore, most of the inputs data for the production phase (production of building materials) are aggregated data from existing EPDs. Because of this, it was difficult to adapt these data to the format and requirements of EN standards and EeBGuide.

5. Summary of case study results: existing buildings

- Case study results for existing buildings: light retrofit

A simplified LCA case study has applied to estimate the potential environmental benefits derived from the improvement of the thermal insulation of the façade of a block of apartments situated in a popular district in Terrassa (Barcelona, Spain). This building was constructed in 1970 as part of the social housing development of the Spanish public administration. In 2010, the Catalan government implemented a plan for refurbish the whole district in order to improve the comfort of the inhabitants. Among other actions, the thermal insulation of the external walls of different buildings was accomplished, adding thermal insulation materials to the existing brick façades with a cavity wall. With the aim of not disturbing the current tenants of the apartments, the intervention was light and the insulation material (expanded polystyrene) was added as an external layer.

During the process, data related to the energy consumption and waste generation of the refurbishment works were collected by the Catalan Agency for Dwelings (Agència Catalana de l'Habitatge). In addition, data on use of operation energy has also being included in the assessment.

A reduction of circa 24% of the energy demand for heating and cooling was estimated. According to the LCA results, this reduction may generate a reduction of the impact categories (circa 10%). It has to be noted that the Abiotic Depletion category do not follow that trend, as it is more related to the consumption of non renewable materials, as the ones used for the refurbishment of the building.

ELODIE software has been used to perform the assessment. Main EeBguide provisions have been followed in order to perform the LCA. In particular, recommendations for the system boundaries for existing buildings have been taken into account. The baseline scenario of the analysis considers a reference study period of 50 years. Used LCA data are, for the most part, EPD extracted from the INIES database and in the case of energy carriers from GaBi database.

The simplified LCA study carried out has allowed identifying the % in which the environmental impacts of the existing buildings have been reduced due to the improvement of the thermal insulation of its façade.

This study is considered as a starting point as it may be improve including the end of life of the building, as well as some of the processes omitted in this first iteration (such as the management of waste produced during the rehabilitation work or the production of additional products used).

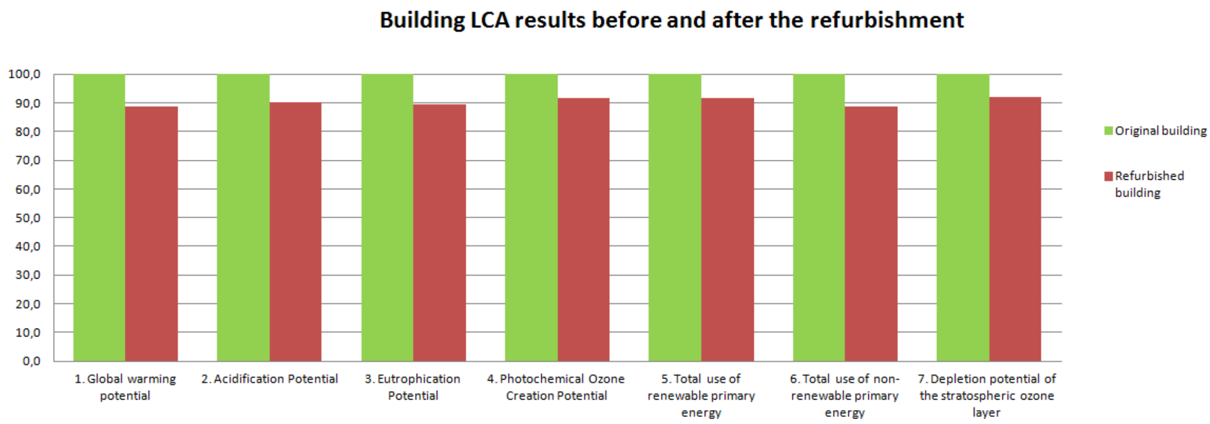


Figure 5: Overview of the building LCA results before and after the light refurbishment

- Case study results for existing buildings: substantial retrofit

A simplified LCA case study has applied to estimate the potential environmental benefits derived from the improvement of the refurbishment of the entire envelope (i.e. façades, roof and windows) of a block of apartments situated in a popular district in Donostia (Spain). This building was constructed in 1963. In 2011, the owners decided to carry out a substantial retrofit of the envelope in order to improve their comfort and reduce the energy demand (and therefore consumption).

For this simplified LCA study it has been considered the addition of 8 cm of insulation materials in walls and roof, as well as the substitution of the existing windows (single-glazing) by double-glazing. Mineral wool and XPS was added to the existing brick façades with a cavity wall and roof. With the aim of disturbing as less as possible the current tenants of the apartments, the insulation material was added as an external layer.

A significant reduction of circa 60% of the energy demand for heating was estimated. According to the LCA results, this reduction of the energy consumption may generate a substantial reduction of the Global Warming Potential and the Photochemical Ozone Creation Potential (circa 30% in both cases). However, the consumption of materials for the refurbishment also entails a greater Eutrophication Potential, Depletion of the Ozone Layer and Abiotic Resources Depletion.

GaBi software (v.5) has been used to perform the assessment. Main EeBguide provisions have been followed in order to perform the LCA. In particular, recommendations for the system boundaries for existing buildings have been taken into account. The baseline scenario of the analysis considers a reference study period of 50 years. Used LCA data are, for the most part, datasets extracted from GaBi database.

A simplified LCA study allows identifying the outcomes, in terms of environmental impact, of a refurbishment operation. In addition, it may help to compare different construction options and select those with a best benefit/cost ratio. So, LCA may be useful in decision making process, combined with other tools providing information about the economic and social benefits of the operation.

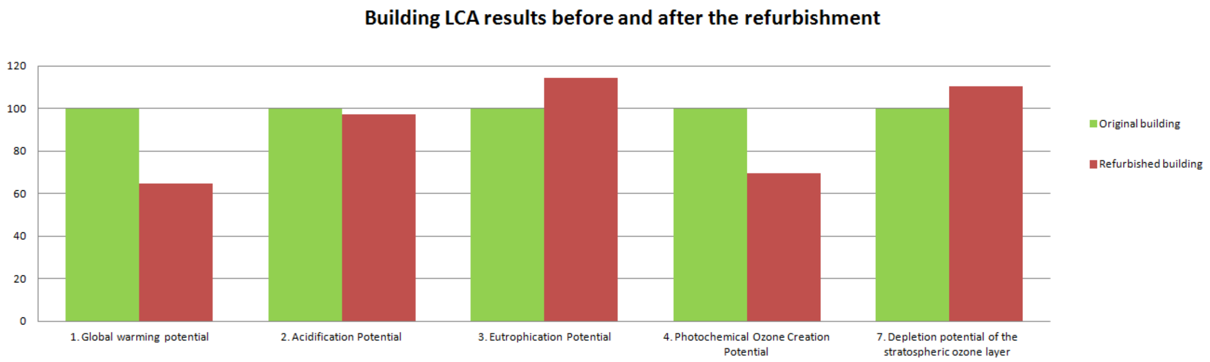


Figure 6: Overview of the building LCA results before and after the substantial refurbishment

6. LCA reports

For each case study, LCA reports according to EeBGuide provisions and guidance were done. The results are presented in separate documents.

7. LCA reviews

For each case study, reviews according to EeBGuide provisions and guidance were done. The results are presented in separate documents.

8. Conclusion

These case studies have reported useful and interesting results. Applying the guidance document is currently possible. The distinction of the 3 study types enables to ease the LCA studies though with the available data and software, some case studies are in between e.g. a simplified and a complete LCA. More case studies would be needed in the future to more comprehensively implement the guidance document in practice.

Literature

FprEN 15978: Sustainability of construction works – Sustainability assessment of buildings – calculation method. CEN - European Committee for Standardization. Brussels: CEN – CENELEC 2010.

FprEN 15804: Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products. CEN - European Committee for Standardization. Brussels: CEN – CENELEC 2011.

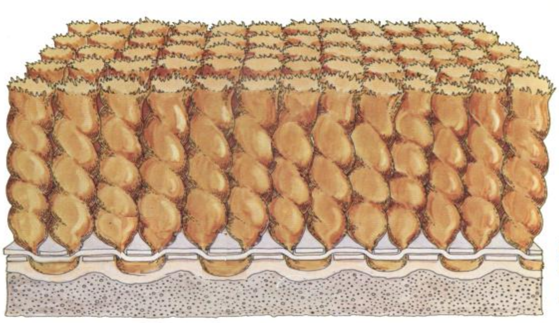
European Commission - Joint Research Centre - Institute for Environment and Sustainability (Ed.): ILCD handbook. General guide for life cycle assessment: detailed guidance. First edition. Luxembourg: Publications Office of the European Union 2010. ISBN: 978-92-79-19092-6.

Additional documents

All the information of the case study results, LCA report and LCA review can be accessed from the following documents attached to this deliverable:

- LCA reports on the common product (for screening, simplified and complete)
- LCA report on the EeB product
- LCA report on the simple new building
- LCA report on the complex new building
- LCA report on the existing building light refurbishment
- LCA report on the existing building substantial refurbishment

- LCA review on the common product
- LCA review on the EeB product
- LCA review on the simple new building
- LCA review on the complex new building
- LCA review on the existing building light refurbishment
- LCA review on the existing building substantial refurbishment



Background Report for Products

Screening LCA of manufactured tufted textile floorcovering (based on information provided by the Association of Environmentally Friendly Carpets - Gemeinschaft Umweltfreundlicher Teppichboden, GUT)

Basic assessment information

General information

Name of the product:	Tufted carpet with textile fabric backing
Date of the assessment:	4th of September, 2012
Name, role and affiliation of assessor:	Larisa Maya Altamira, Consultant at PE International
Name, role and affiliation of reviewer:	Peter Shonfield, Technical Director at PE International
Review type	Internal review
Date of the verification	26th of September, 2012
Client of the study:	GUT - Gemeinschaft umweltfreundlicher Teppichboden e.V., Schönebergstr. 2, 52068 Aachen, Germany GUT
Authors of the study:	PE International - Hauptstraße 111-113, 70771 Leinfelden-Echterdingen, Germany

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Nomenclature

Abbreviation	Explanation
ADP	Abiotic Depletion Potential
ADPE	Abiotic Resource Depletion Potential for elements
ADPF	Abiotic Resource Depletion Potential of fossil fuels
AP	Acidification Potential
BLBSB	Benefits and Loads Beyond the System Boundary
CML	Centrum voor Milieukunde, Leiden (NL)
CRU	Components for re-use
EE	Exported energy per energy carrier
EP	Eutrophication Potential
EPD	Environmental Product Declaration
FW	Use of net fresh water
GWP	Global Warming Potential
HWD	Hazardous waste disposed
IBU	Institut Bauen und Umwelt e.V.
MER	Materials for energy recovery
MFR	Materials for recycling
NRSF	Use of non-renewable secondary fuels
NHWD	Non hazardous waste disposed
ODP	Ozone Layer Depletion Potential
PENRE	Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials
PENRM	Use of non-renewable primary energy resources used as raw materials
PENRT	Total use of non-renewable primary energy resources
PERE	Use of renewable primary energy excluding renewable primary energy resources used as raw materials
PERM	Use of renewable primary energy resources used as raw materials
PERT	Total use of renewable primary energy resources
PCR	Product Category Rules
POCP	Photochemical Ozone Creation Potential
RSF	Use of renewable secondary fuels

RSL	Reference Service Life
RWD	Radioactive waste disposed
SM	Use of secondary material

9. Scope

This document is the background report for the life cycle assessment (LCA) results of the product. The study has been conducted in accordance with the provisions and guidelines of EeBGuide.

10. Content, structure and accessibility of the background report

The background report provides the systematic and comprehensive summary of the project documentation supporting the verification of an EeBGuide compliant product LCA. The project report shall record that both the LCA based information and the additional information meet the requirements of EeBGuide of the Energy-efficient Building Initiative. It will be/was made available to the verifier with the requirements on confidentiality stated in ISO 14025.

This background report contains important data and information for the data as required by the European Standard **Erreur ! Source du renvoi introuvable.** on Environmental Product Declarations (EPD's) of construction products. Special attention has been paid to transparently demonstrate how the data and accompanying information have been collected and how these are related to the declared LCA results.

11. General aspects in the background report

This LCA study was performed jointly by the Association of Environmentally Friendly Carpets (GUT) and PE International and has been conducted according to the requirements of the European Standard **Erreur ! Source du renvoi introuvable.**. Further details can be found in the table "General Information".

12. Goal/ Purpose of the study

GUT is a European association whose aim is to continuously improve all environmental and consumer protection aspects throughout the life cycle of textile floor coverings. Amongst other activities GUT compiles life cycle information from their members to produce EPD's.

GUT had already carried out the LCA of the product assessed in this study to gather data for an EPD. The data assessed is from a German manufacturer whose name cannot be disclosed due to confidentiality terms. According to GUT, this is a representative product of its type in the European market.

The aim of this study is to provide an overview of the carbon footprint of the manufactured product and compare this with its embodied energy (both renewable and non-renewable). This is intended as a first screening assessment of the product's manufacture for internal communication and to support the product design process, therefore the use and end of life stages are not considered.

PE International used GUT's data with the aim to exemplify how the guidelines of EeBGuide can be used to meet the aims of the study. The guidelines are referred at the "EeGBuide Guidance Document, Part A: PRODUCTS" (Wittstock et al., 2012).

The table "Goal/ Purpose of the study" summarises key points regarding the purpose of the study.

Table 1: Goal/ Purpose of the study

Goal/ Purpose of the study			
	Level of complexity	☑	Screening
		☐	Simplified
		☐	Complete
	related study objective	☐	Comparative assertion
		☑	Stand alone LCA
	object of assertion	☑	Product
	communication purpose	☑	Internal
		☐	External
		☐	For customer to customer
		☐	Publication

13. Scope of the study

Declared / functional unit

The declared unit in this study is 1 m^2 of manufactured packed tufted textile floor covering, which is equal to a reference flow of 2 kg of manufactured product and 40 g of packaging material.

Table 2: Declared unit

Functional unit		
	Declared unit:	1 m^2 of manufactured packed tufted textile floor covering
	Product group:	Floor coverings
	Function in the building:	The product complies with the use class 33 according to EN 1307, meaning that they are suitable for use in areas with high traffic and can be used both in the private and the commercial sector
	Reference service life	not applicable
	Other services provided within the building	none

The function of the product is to protect the floor and maintain an acceptable visual and tactile quality over 10 years under heavy use conditions in commercial buildings. It can also be used in residential buildings. However, the service life is outside the scope of this study.

Declaration of construction products classes

The following table describes the product in more detail:

Table 3: Technical description of product

Technical description of the product		
	Name of the PCR and describe the declaration type (if you follow any):	PCR 2011, Part A+B Institut Bauen und Umwelt e.V., Königswinter (pub.): Product Category Rules for Construction Products from the range of Environmental Product Declarations of Institut Bauen und Umwelt (IBU), Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Background Report, 2011-09 Part B: Requirements on the EPD for floor coverings, 2011-06
	Main important materials:	Polyamide 6 (PA6), polyester (PES), polypropylene (PP), limestone, latex, aluminiumhydroxide
	Statement on ability for recycling/reuse:	The carpet product can be used as secondary material and secondary fuel in cement kilns, substituting substantial inorganic material that remains in the clinker (mostly chalk & aluminum hydroxide) and original fuel needed for the kilns (hard coal, lignite and petroleum coal) - Source: Environmental Data of the German Cement Industry 2008, VDZ eV, Research Institute of Cement industry
	Description of the product:	Tufted carpet as rolls having a surface pile of 100% solution-dyed polyamide 6, a pre-coat & lamination made of limestone, latex and aluminiumhydroxide, a non-woven primary backing made of PES/PA6, and a textile fabric backing made of Polypropylene
	Designated application:	According to the use class 33 as defined in EN 1307 this product can be used in all commercial areas which require heavy use. According to the standard, this floor covering can be also used in other lower classes (i.e. in residential areas).

The technical specifications of the product are shown in Table 15 and its composition the next table.

Table 4: Technical specifications of the product

Information on basic construction data					
basic requirements (table 4):	fulfilled		type of carpet:	1	
type of manufacture (ref 1):	pile carpet acc. EN 1307 - tufted				
type of surface (ref 2):	loop pile - loop pile like - patterned				
primary backing (ref 3):	spunbond - PET				
secondary backing (ref 4):	textile backing - woven				
pile fibre composition:	100% PA6				
total carpet weight:	2.000	[g/m²]	surface pile mass:	410	[g/m²]
total carpet thickness:	5,1	[mm]	surface pile thickness:	2,5	[mm]
thickness of backing:	2,6	[mm]	surface pile density:	0,164	[g/cm³]
density of backing:	0,612	[g/cm³]	number of tufts:	1.580	[1/dm²]

Table 5: Product composition

Product composition	Unit per m^2	Amount per m^2 (dry)
PA6 solution dyed	g	**650**
Primary backing total	g	**100**
Share of PES	%	76
Share of PA6	%	24
Pre-coat total	g	**640**
Share of limestone	%	65
Share of aluminium hydroxide	%	14.3
Share of latex	%	20
Share of acrylate binding agent	%	0.06
Share of tenside	%	0.20
Share of antistatic agent	%	0.43
Share of carbon black	%	0.01
Lamination total	g	**550**
Share of limestone	%	70
Share of latex	%	29.9
Share of acrylate binding agent	%	0.07
Share of tenside	%	0.03
PP textile fabric total	g	**60**
Total weight	g	**2000**

System boundaries

The system boundaries of the product LCA follow the modular design defined by /**Erreur ! Source du renvoi introuvable.**/.

The next table summarizes the included life cycle stages.

Table 6: Included lifecycle stages

Included modules				
Product Stage	☑	A1	Raw Materials Supply
	☑	A2	Transport
	☑	A3	Manufacturing
Construction Process	☐	A4	Transport
	☐	A5	Construction- Installation process
Use Stage	☐	B1	Use
	☐	B2	Maintenance
	☐	B3	Repair
	☐	B4	Replacement
	☐	B5	Refurbishment
	☐	B6	Operational Energy Use
	☐	B7	Operational Water Use
End of Life Stage	☐	C1	Deconstruction
	☐	C2	Transport
	☐	C3	Waste process for reuse,
	☐	C4	Disposal
Benefits and loads beyond the	☐	D	Reuse- Recovery- Recycling potential

The following chapters describe the modules that are within the scope of this study. The modules included are in line with the requirements for a screening LCA study according to the following table:

Table 7: Definitions for the different study types

Screening - Simplified - Complete

according to SBA Common Metrics Framework 2009 and EeBGuide adaptations

M	**mandatory**
O relevance?	**optional because of minor relevance**
O data?	**optional due to potentially missing data**

	Study type	Before use stage				
		Raw Materials Supply	Transport (to factory)	Manufactoring	Transport (to construction site)	Construction-Installation process
		A1	A2	A3	A4	A5
Product	Screening	O data?	Optional Generic data for foreground system Generic data for background system		O data?	O data?
	Simplified	M	Specific data for foreground system Generic data for background system		O data?	O data?
	Complete	M	Specific data for foreground system Generic data for background system		M	

Screening - Simplified - Complete

according to SBA Common Metrics Framework 2009 and EeBGuide adaptations

M

O relevance?

O data?

	Study type	Use stage						
		Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use
		B1	B2	B3	B4	B5	B6	B7
Product	Screening	O data?	O data?	O data?	O data?	O data?	O data? Estimations or literature specific when focus on it	O data?
	Simplified	O data?	O data?	O data?	O data?	O data?	O data? Literature or specific energy use	O data?
	Complete	M	M	O data?	M	M	M Literature or specific energy use	M

Screening - Simplified - Complete

according to SBA Common Metrics Framework 2009 and EeBGuide adaptations

M

O relevance?

O data?

	Study type	End of Life				Benefits beyond boundary
		Deconstruction C1	Transport (to disposal) C2	Waste process for reuse, recovery or/ and recycling C3	Disposal C4	Reuse-/ Recovery- /Recyclingpotential D
Product	Screening	O data?	O data?	O data?	Generic EoL data sets	O data? Generic LCA data sets for reuse-/ recovery-/ recycling potential
	Simplified	O data?	O data?	M	Specific or generic LCA data for EOL processes	M Specific or generic LCA data for reuse-/ recovery- / recycling potential
	Complete	M	M	M	Specific or generic LCA data for EOL processes	M Specific or generic LCA data for reuse-/ recovery- / recycling potential

A1-A3, Product stage, information modules

The product stage includes:

- A1, raw material extraction and processing of the next carpet's materials:
  - Polyamide 6 (PA6),
  - Polyester (PES),
  - Polypropylene (PP),
  - Limestone,
  - Latex,
  - Aluminium Hydroxide,

  and the next packaging materials:
  - Cardboard (primary and secondary), and,
  - Polyethylene film.

- A2, transport of the materials to the manufacturing site,

- A3, manufacturing, including:
  - Tufting,
  - Textile fabric backing,
  - Cutting edges, and,

- o Packaging.

These including provision of all materials, products and energy, packaging processing and its transport, as well as waste processing up to the end-of waste state or disposal of final residues during the product stage.

The calorific value used to represent recycled cardboard as packaging material was represented by the value of cardboard made of virgin fibres (primary cardboard), because the recycled cardboard goes into the system without basic material stress so no alterations to the cardboard composition are happening.

The following flowchart represents the system boundaries for the product stage:

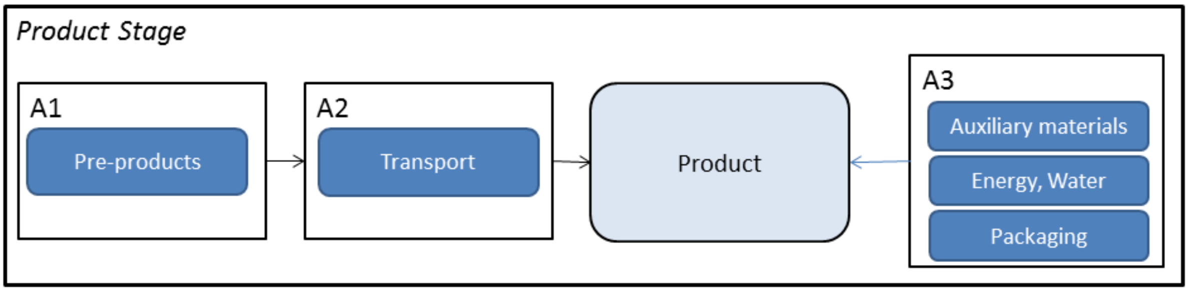


Figure 7: Schematic representation of the LCA system boundaries for the production module (A1-A3)

Table 8: Information on Module A1-A3

Module A1-A3	The following processes are omitted:	☑	A- 02 "Transport of staff in the supply of raw materials "
		☐	A- 03 "Transport to the manufacturer"
	Explain deviations from provision in the guidance document		
	Explained in the next statement		
	The following deviations from EeBGuide guidance document on data requirements occurred **(Only for "Complete Assessment")**:		* Infrastructure machinery & capital equipment were not included in the foreground system as this was neglected under the cut-off criteria; for the background system it was included for energy generation systems according to the GaBi Database SP20 and Ecoinvent 2.2 * Packaging waste from manufacturing was not modelled because it represents only 0.1% of the total mass through the Life Cycle
	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:		GaBi Database Service Pack 20 (SP20) and Ecoinvent 2.2 have been used as background data and their data quality assessment can be found in the documentation of these databases.

Electric energy mix

The selection of the background data for the electricity generation is in line with EeBGuide. European average (EU-27) data was used for the pre-processing of supplied PA6 and PES to the German manufacturer, whilst German average data was used for tufting and shearing. This was taken from GaBi 5 database Service Pack 20 [PE International, 2011] which is ILCD compliant.

For the European average electricity generation, data from 2008 official statistics on national energy carrier mixes, efficiencies, net losses and consumption were used. For the German average electricity generation, data from 2008 official statistics was included on average national specific electricity mix including main producers as well as imports energy carrier mixes, efficiencies, net losses and consumption.

The data sources for the complete system are consistent and details can be found in GaBi 5 documentation [Frischknecht et al., 2007]. The key emissions e.g. carbon dioxide, sulphur dioxide, nitrogen oxide, etc., of the power plants are based on measured operating data taken from national statistics. All other emissions from the power plants are based on literature data and/or calculated via energy carrier composition in combination with literature-based combustion models. Infrastructure data are from literature. The data on the energy carrier supply chain is based on statistics with country/region-specific transport distances, as well as industry and literature data on the inventory of exploration and extraction. Refinery data are also based on statistical data and measurements of major refineries as well as literature data. LCI modelling is fully consistent with the ILCD guidelines.

CO_2-Certificates

No CO_2-certificates are considered in this study.

Description of the system boundary in the background report

The definition of the system boundaries meets the requirements of EeBGuide.

Criteria for the exclusion of inputs and outputs

The application of the cut-off criteria for the exclusion of inputs and outputs follows the EN 15804 standard. Data gaps may be filled using conservative assumptions with average or generic data. Any assumptions for such choices shall be documented.

In case of insufficient input data or data gaps for a unit process, the cut-off criteria shall be:

- 1% of renewable and non-renewable primary energy usage and 1% of the total mass input of that unit process, and,
- the total of neglected input flows per module, e.g. per module A1-3, A4-5, B1-5, B6-7, C1-4 and D shall be a maximum of 5% of energy usage and mass.

Particular care should be taken to include material and energy flows known to have the potential to cause significant emissions into air and water or soil related to the environmental indicators of this standard.

Conservative assumptions in combination with plausibility considerations and expert judgement can be used to demonstrate compliance with these criteria.

In this particular study, the production and use of dyes in the manufacturing of this product were excluded on the basis that their input to the PA6 yarn is less than 1%.

Packaging waste was not considered because it constitutes less than 0.1% of the total mass of the packaging.

Infrastructure machinery & capital equipment were not included in the foreground system as these are typically excluded when assessing these type of products since they are insignificant in terms of mass and energy consumption and in terms of their contribution to the potential environmental impacts.

14. Life cycle inventory analysis

Data collection and calculation procedures

Data collection followed the guidance provided in /**Erreur ! Source du renvoi introuvable.**/, clause 4.3.2. The calculation procedures described in /**Erreur ! Source du renvoi introuvable.**/ were applied consistently throughout the study.

According to the definition of scope of the study, all relevant inputs and outputs related to the products or product systems were identified and quantified.

Developing product level scenarios

There were no scenarios assessed as as the goal of this study is to provide an overview of the environmental impact potentials of the product during its production stage.

Selection of data/ background data

As a general rule, specific data or average data derived from specific production processes shall be the first choice as a basis for calculating a product LCA.

For life cycle modelling of the considered product the GaBi 5 Software-System and Databases for Life Cycle Engineering was used. All relevant background datasets were taken from GaBi 5 database Service Pack 20 (PE International, 2011) and Ecoinvent 2.2 database (Frischknecht et al., 2007) and provided by PE International and the Swiss Centre for Life Cycle Inventories.

The applied foreground datasets are based on 1 year averaged data from 2010 and have either European or country specific average coverage. The data sets for the background system are based on 1 year averaged data from a range of years varying from 2000 to 2011.

Data/ background data quality requirements

The requirements for data quality and background data correspond to the specifications of EeBGuide.

The datasets are complete and conform to the system boundaries and the criteria for the exclusion of inputs and outputs. All datasets are specific to the product system model to the extent possible, and when this is not the case they are generic and representing the technology and region assessed.

Specific information about their age, technologies and regions represented cannot be disclosed due to confidentiality terms between GUT and the manufacturer. However, these should be included when assessing construction products according to this guidance. In this particular case, this information has been reviewed by an external verifier before producing the Environmental Product Declaration in terms of data quality and representativeness.

The foreground system data have been assessed in terms of quality and representativeness by an external critical review (Klöpffer W. and Hischier R., 2004).

The background data complies with data quality and representativeness requirements according to GaBi 5 database Service Pack 20 and Ecoinvent 2.2 database.

Allocation

In the present study no allocation has been required.

In modules A1, A2 and A3 electricity and thermal energy is recovered from the incineration of manufacturing waste from PA6 from spinning/colouring and from cutting the edges of the carpet. This recovered energy was subtracted from the input electricity based on the European electricity grid and the input thermal energy from natural gas (EU-27), in this way reflecting the NET energy consumption.

15. Life cycle inventory analysis and life cycle impact assessment

The results of the screening LCA are represented in the following tables. The inventory analysis indicators to be declared and the impact assessment are in accordance with EN 15804.

Indicators for the life cycle inventory analysis according to EN 15804

Only the energy related LCI indicators stated in the EN 15804 were assessed in this screening study. They describe the use of renewable and non-renewable primary energy.

Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ, net calorific value
Use of renewable primary energy resources used as raw materials	MJ, net calorific value
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ, net calorific value
Use of non renewable primary energy excluding non renewable primary energy resources used as raw materials	MJ, net calorific value
Use of non renewable primary energy resources used as raw materials	MJ, net calorific value
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ, net calorific value

Indicators for the life cycle impact assessment according to EN 15804

The only impact assessment category considered in this study is Global Warming Potential. This is calculated using characterisation factors from CML (Institute of Environmental Sciences Faculty of Science University of Leiden, Netherlands) referring to the EN 15804 standard:

Global warming potential (GWP);	kg CO_2-equiv.

The results from the impact assessment are only relative statements which give no information about the endpoint of the impact category assessed, overstepping of threshold values, safety margins or risk.

Summary of assessed environmental indicators

The table below illustrates the environmental indicators assessed in this study.

Table 9: Used environmental indicators

Used indicators	Selected	Indicator
	☑	1. Global warming potential
	☐	2. Acidification Potential
	☐	3. Eutrophication Potential
	☐	4. Photochemical Ozone Creation Potential
	☑	5. Total use of renewable primary energy
	☑	6. Total use of non-renewable primary energy
	☐	7. Depletion potential of the stratospheric ozone layer
	☐	8. Abiotic Resource Depletion Potential for elements
	☐	9. Abiotic Resource Depletion Potential of fossil fuels
	☐	10. Secondary Materials
	☐	11. Secondary fuels - renewable
	☐	12. Secondary fuels – non renewable
	☐	13. Net Fresh Water
	☐	14. Hazardous Waste
	☐	15. Non Hazardous Waste
	☐	16. Radioactive Waste
	☐	17. Components for Re-Use
	☐	18. Materials for Recycling
	☐	19. Materials for Energy Recovery
	☐	20. Exported Energy
	☑	Use of renewable primary energy excluding raw materials
	☑	Use of renewable primary energy as raw materials
	☑	Use of non-renewable primary energy excluding raw materials
	☑	Use of non-renewable primary energy as raw materials

Description of the screening LCA

No scenario analyses were carried out for this screening study.

The following table illustrates the parameters used in the Baseline scenario assessed.

Table 10: Description of the parameters for the assessed scenario

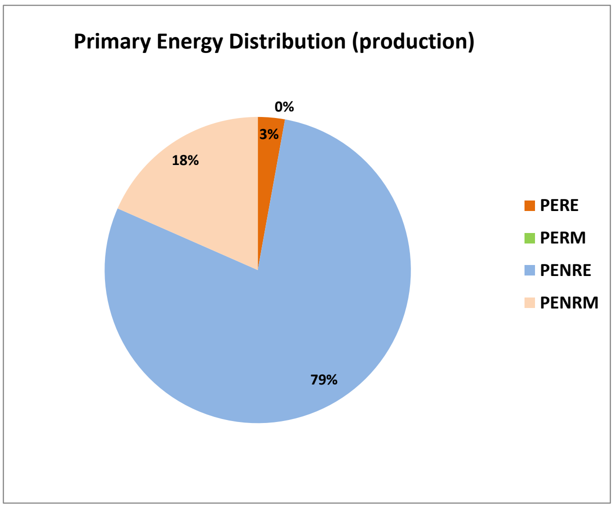
Baseline scenario	Parameter	Value
	G- 05 "Reference study period"	not applicable
	G- 09 "Future technical developments and innovation"	No innovation to be considered, current technologies to be used
	G- 11 "Accounting for carbon storage / carbon sequestration"	Biogenic carbon storage/emissions are not considered
	B- 11 "Modelling of water use"	Net water consumption only, water scarcity is not considered
	C- 02 "End of Life (EOL) scenarios "	not applicable

Results of the screening LCA

Table 11: Overview over the screening LCA results

Overview over the product LCA results							
1 year	1. Global warming potential	2. Use of renewable primary energy excluding raw materials	3. Use of renewable primary energy as raw materials	4. Total use of renewable primary energy	5. Use of non-renewable primary energy excluding raw materials	6. Use of non-renewable primary energy as raw materials	7. Total use of non-renewable primary energy
	GWP	PERE	PERM	PERT	PENRE	PENRM	PENRT
	[kg CO_2-equiv./m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]
Product Stage	0.97	0.56	0.00	0.56	15.39	3.60	18.99

Figure 8: Share of primary energy demand over the production stage



Interpretation of the results of the assessed scenario

The manufacturing of this product is energy intensive as it follows a series of steps involving tufting, primary backing, shearing, back coating, cutting and packaging, as well as other sub-stages for each manufacturing step. Most of these stages and sub-stages are carried out by machine and thus require electricity and thermal energy to function. Furthermore, many of the raw materials need to be pre-processed and transported to the manufacturing site, which increase the energy demand.

The results show that most of the global warming potential is related to the use of non-renewable primary energy excluding raw materials and to a lower degree to the production of raw materials. This indeed shows that the production stage of the carpet is strongly related to the use of electricity and thermal energy from fossil fuels, and in a lower extent to the use of non-renewable raw materials. The use of renewable energy is relatively minor and is only related to packaging cardboard as the only source of renewable raw materials used.

16. Conclusion

The study results show that most of the potential for improving the design of the carpet relate to the manufacturing of the product and not on the raw materials used. In particular, it is shown that increasing the use of renewable sources of electricity and thermal energy for manufacturing could improve the environmental performance of the carpet. However, it is important to remember that some renewable sources of energy also release Greenhouse Gas emissions so their Global Warming Potential should be evaluated when considering switching to renewable energy sources at the manufacturing.

Finally, switching to more renewable raw materials could also lead to a more "environmentally friendly" carpet, but caution should be taken that these changes do not negatively impact product quality (i.e. resulting in a reduced service life) or shift burdens to other life cycle stages.

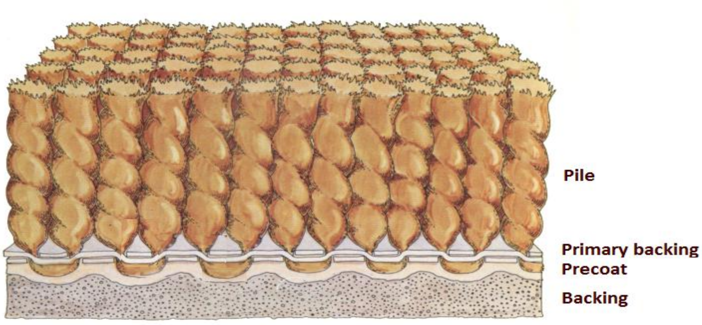
17. References

Gemeinschaft Umweltfreundlicher Teppichboden - GUT (2006)	Ökologische Bilanzierung von Teppichböden, Teil 2, Vom Fabriktor bis zur Bahre
Wittstock et al. (2012)	EeBGuide Guidance Document, Part A: PRODUCTS, "Operational guidance for Life Cycle Assessment studies of the Energy Efficient Buildings Initiative"
EN 15804: 2012	Sustainability of construction works – Environmental Product Declarations – Core rules for the product category of construction products
PE International (2011)	GaBi 5 dataset documentation for the software-system and databases, LBP, University of Stuttgart and PE INTERNATIONAL AG, Leinfelden-Echterdingen, 2011 (http://documentation.gabi-software.com/)
Frischknecht et al. (2007)	Overview and Methodology. Final report ecoinvent data v2.0, No.1. Swiss Centre for Life Cycle Inventories, Dübendorf, CH.
Joint Research Centre (JRC), European Commission (2010)	General guide for Life Cycle Assessment – Detailed guidance
Klöpffer and Hischier (2004)	Ökologische Bilanzierung von Teppichböden. Kritische Prüfung nach EN DIN 14040

Documentation of additional information

Documentation for the calculation of the reference service life (RSL)

The documentation of the RSL is not required for the EPD of the company since the entire life cycle is not declared. The RSL of 10 years is optionally specified.



Background Report for Products

Simplified LCA of manufactured tufted textile floorcovering (based on information provided by the Association of Environmentally Friendly Carpets e.V. - Gemeinschaft Umweltfreundlicher Teppichboden, GUT)

Basic assessment information

General information

Name of the product:	Tufted carpet with textile fabric backing
Date of the assessment:	4th of September, 2012
Name, role and affiliation of assessor:	Larisa Maya Altamira, Consultant at PE International
Name, role and affiliation of reviewer:	Peter Shonfield, Technical Director at PE International
Review type	Internal review
Date of the verification	26th of September, 2012
Client of the study:	GUT - Gemeinschaft umweltfreundlicher Teppichboden e.V., Schönebergstr. 2, 52068 Aachen, Germany GUT
Authors of the study:	PE International - Hauptstraße 111-113, 70771 Leinfelden-Echterdingen, Germany

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Nomenclature

Abbreviation	Explanation
ADP	Abiotic Depletion Potential
ADPE	Abiotic Resource Depletion Potential for elements
ADPF	Abiotic Resource Depletion Potential of fossil fuels
AP	Acidification Potential
BLBSB	Benefits and Loads Beyond the System Boundary
CML	Centrum voor Milieukunde, Leiden (NL)
CRU	Components for recycling
EE	Exported energy per energy carrier
EP	Eutrophication Potential
EPD	Environmental Product Declaration
FW	Use of net fresh water
GWP	Global Warming Potential
HWD	Hazardous waste disposed
IBU	Institut Bauen und Umwelt e.V.
MER	Materials for energy recovery
MFR	Materials for recycling
NRSF	Use of non-renewable secondary fuels
NHWD	Non hazardous waste disposed
ODP	Ozone Layer Depletion Potential
PENRE	Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials
PENRM	Use of non-renewable primary energy resources used as raw materials
PENRT	Total use of non-renewable primary energy resources
PERE	Use of renewable primary energy excluding renewable primary energy resources used as raw materials
PERM	Use of renewable primary energy resources used as raw materials
PERT	Total use of renewable primary energy resources
PCR	Product Category Rules
POCP	Photochemical Ozone Creation Potential
RSF	Use of renewable secondary fuels

RSL	Reference Service Life
RWD	Radioactive waste disposed
SM	Use of secondary material

18. Scope

This document is the background report for the life cycle assessment (LCA) results of the product. The study has been conducted in accordance with the provisions and guidelines of EeBGuide.

19. Content, structure and accessibility of the background report

This background report provides the systematic and comprehensive summary of the project documentation supporting the verification of an EeBGuide compliant product LCA. Both the LCA based information and the additional information meet the requirements of EeBGuide of the Energy-efficient Building Initiative. It will be made available to the verifier with the requirements for confidentiality stated in ISO 14025.

This background report contains important data and information for the data as required by the European Standard **Erreur ! Source du renvoi introuvable.** on Environmental Product Declarations (EPD's) of construction products. Special attention has been paid to transparently demonstrate how the data and accompanying information have been collected and how these are related to the declared LCA results.

20. General aspects in the background report

This LCA study was performed jointly by the Association of Environmentally Friendly Carpets (GUT) and PE International and has been conducted according to the requirements of the European Standard **Erreur ! Source du renvoi introuvable.**. Further details can be found in the table "General Information".

21. Goal/ Purpose of the study

GUT is a European association whose aim is to improve continuously all environmental and consumer protection aspects throughout the life cycle of textiles floor coverings. Amongst other activities, GUT compiles life cycle information from their members to produce EPD.

GUT had already carried out the LCA of the product assessed in this study, to gather data for an EPD. The data assessed is from a German manufacturer whose name cannot be disclosed due to confidentiality terms. According to GUT, this is a representative product of its type in the European market.

The aim of this study is to provide environmental information about the production and end of life of a tufted textile floor covering (i.e. carpet) used commercially in the European market under extensive traffic conditions. This is to support the development of an Environmental Product Fact Sheet, which is meant to aid the decision process on the selection of items for the interior design of an office or residential building. End of life data are included to assess the consequences when disposing the product. Installation, use and maintenance are excluded since they are completely dependent on how and where the carpet is installed.

PE International used GUT's data with the aim to exemplify how the guidelines of EeBGuide can be used to meet the aims of the study. The guidelines are referred at the "EeGBuide Guidance Document, Part A: PRODUCTS" (Wittstock et al., 2012).

The table "Goal/ Purpose of the study" summarizes key points regarding the aim of the study.

Table 12: Goal/ Purpose of the study

Goal/ Purpose of the study			
	Level of complexity	☐	Screening
		☑	Simplified
		☐	Complete
	Related study objective	☐	Comparative assertion
		☑	Stand alone LCA
	Object of assertion	☑	Product
	Communication purpose	☐	Internal
		☑	External
		☐	For customer to customer
		☐	Publication

22. Scope of the study

Declared / functional unit

The declared unit in this study is 1 m^2 of manufactured tufted textile floor covering, which is equal to a reference flow of 2 kg of manufactured product and 40 g of packaging material.

Table 13: Functional unit

Functional unit		
	Declared unit:	1 m^2 of manufactured tufted textile floor covering, including information about its disposal at the End of Life
	Product group:	Floor coverings
	Function in the building:	The product complies with the use class 33 according to EN 1307, meaning that they are suitable for use in areas with high traffic and can be used both in the private and the commercial sector
	Reference service life	not applicable
	Other services provided within the building	none

The function of the product is to protect the floor and maintain an acceptable visual and tactile quality over 10 years under heavy use conditions in commercial buildings. It can also be used in residential buildings. However, the service life is outside the scope of this study.

Declaration of construction products classes

The following table describes the product into more detail:

Table 14: Technical description of product

Technical description of the product		
	Name of the PCR and describe the declaration type (if you follow any):	PCR 2011, Part A+B Institut Bauen und Umwelt e.V., Königswinter (pub.): Product Category Rules for Construction Products from the range of Environmental Product Declarations of Institut Bauen und Umwelt (IBU), Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Background Report, 2011-09 Part B: Requirements on the EPD for floor coverings, 2011-06
	Main important materials:	Polyamide 6 (PA6), polyester (PES), polypropylene (PP), limestone, latex, aluminiumhydroxide
	Statement on ability for recycling/reuse:	The carpet product can be used as secondary material and secondary fuel in cement kilns, substituting substantial inorganic material that remains in the clinker (mostly chalk & aluminum hydroxide) and original fuel needed for the kilns (hard coal, lignite and petroleum coal) - Source: Environmental Data of the German Cement Industry 2008, VDZ eV, Research Institute of Cement industry
	Description of the product:	Tufted carpet as rolls having a surface pile of 100% solution-dyed polyamide 6, a pre-coat & lamination made of limestone, latex and aluminiumhydroxide, a non-woven primary backing made of PES/PA6, and a textile fabric backing made of Polypropylene
	Designated application:	According to the use class 33 as defined in EN 1307 this product can be used in all commercial areas which require heavy use. According to the standard, this floor covering can be also used in other lower classes (i.e. in residential areas).

The technical specifications of the product are shown in Table 15 and its composition in the next table.

Table 15: Technical specifications of the product

Information on basic construction data					
basic requirements (table 4):	fulfilled		type of carpet:	1	
type of manufacture (ref 1):	pile carpet acc. EN 1307 - tufted				
type of surface (ref 2):	loop pile - loop pile like - patterned				
primary backing (ref 3):	spunbond - PET				
secondary backing (ref 4):	textile backing - woven				
pile fibre composition:	100% PA6				
total carpet weight:	2.000	[g/m²]	surface pile mass:	410	[g/m²]
total carpet thickness:	5,1	[mm]	surface pile thickness:	2,5	[mm]
thickness of backing:	2,6	[mm]	surface pile density:	0,164	[g/cm³]
density of backing:	0,612	[g/cm³]	number of tufts:	1.580	[1/dm²]

Table 16: Product composition

Product composition	Unit per m^2	Amount per m^2 (dry)
PA6 solution dyed	g	**650**
Primary backing total	g	**100**
Share of PES	%	76
Share of PA6	%	24
Pre-coat total	g	**640**
Share of limestone	%	65
Share of aluminium hydroxide	%	14.3
Share of latex	%	20
Share of acrylate binding agent	%	0.06
Share of tenside	%	0.20
Share of antistatic agent	%	0.43
Share of carbon black	%	0.01
Lamination total	g	**550**
Share of limestone	%	70
Share of latex	%	29.9
Share of acrylate binding agent	%	0.07
Share of tenside	%	0.03
PP textile fabric total	g	**60**
Total weight	g	**2000**

System boundaries

The system boundaries of the product LCA follow the modular design defined by /**Erreur ! Source du renvoi introuvable.**/.

The next table summarizes the included life cycle stages.

Table 17: Included lifecycle stages

Simplified Life Cycle Assessment

Included modules				
	Product Stage	☑	A1	Raw Materials Supply
		☑	A2	Transport
		☑	A3	Manufacturing
	Construction Process	☐	A4	Transport
		☐	A5	Construction- Installation process
	Use Stage	☐	B1	Use
		☐	B2	Maintenance
		☐	B3	Repair
		☐	B4	Replacement
		☐	B5	Refurbishment
		☐	B6	Operational Energy Use
		☐	B7	Operational Water Use
	End of Life Stage	☐	C1	Deconstruction
		☐	C2	Transport
		☑	C3	Waste process for reuse,
		☑	C4	Disposal
	Benefits and loads beyond the	☑	D	Reuse- Recovery- Recycling potential

The following chapters describe the modules that are within the scope of this study. The modules included are in line with the requirements for a simplified LCA study according to the following table:

Table 18: Definitions for the different study types

Screening - Simplified - Complete

according to SBA Common Metrics Framework 2009 and EeBGuide adaptations

M	**mandatory**
O relevance?	**optional because of minor relevance**
O data?	**optional due to potentially missing data**

	Study type	Before use stage				
		Raw Materials Supply	Transport (to factory)	Manufactoring	Transport (to construction site)	Construction-Installation process
		A1	A2	A3	A4	A5
Product	Screening	O data?	Optional Generic data for foreground system Generic data for background system		O data?	O data?
Product	Simplified	M	Specific data for foreground system Generic data for background system		O data?	O data?
Product	Complete	M	Specific data for foreground system Generic data for background system		M	

Simplified Life Cycle Assessment

Screening - Simplified - Complete

according to SBA Common Metrics Framework 2009 and EeBGuide adaptations

M

O relevance?

O data?

	Study type	Use stage						
		Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use
		B1	B2	B3	B4	B5	B6	B7
Product	Screening	O data?	O data?	O data?	O data?	O data?	O data? Estimations or literature specific when focus on it	O data?
	Simplified	O data?	O data?	O data?	O data?	O data?	O data? Literature or specific energy use	O data?
	Complete	M	M	O data?	M	M	M Literature or specific energy use	M

Screening - Simplified - Complete

according to SBA Common Metrics Framework 2009 and EeBGuide adaptations

M

O relevance?

O data?

	Study type	End of Life				Benefits beyond boundary
		Deconstruction	Transport (to disposal)	Waste process for reuse, recovery or/ and recycling	Disposal	Reuse-/ Recovery- /Recyclingpotential
		C1	C2	C3	C4	D
Product	Screening	O data?	O data?	O data? Generic EoL data sets		O data? Generic LCA data sets for reuse-/ recovery-/ recycling potential
Product	Simplified	O data?	O data?	M Specific or generic LCA data for EOL processes		M Specific or generic LCA data for reuse-/ recovery- / recycling potential
Product	Complete	M	M	M Specific or generic LCA data for EOL processes		M Specific or generic LCA data for reuse-/ recovery- / recycling potential

A1-A3, Product stage, information modules

The product stage includes:

- A1, raw material extraction and processing of the next carpet's materials:
  - Polyamide 6 (PA6),
  - Polyester (PES),
  - Polypropylene (PP),
  - Limestone,
  - Latex,
  - Aluminium Hydroxide,

  and the next packaging materials:
  - Cardboard (primary and secondary), and,
  - Polyethylene film.
- A2, transport of the materials to the manufacturing site,
- A3, manufacturing, including:

- Tufting,
- Textile fabric backing,
- Cutting edges, and,
- Packaging.

These including provision of all materials, products and energy, packaging processing and its transport, as well as waste processing up to the end-of waste state or disposal of final residues during the product stage.

The calorific value used to represent recycled cardboard as packaging material was represented by the value of cardboard made of virgin fibres (primary cardboard), because the recycled cardboard goes into the system without basic material stress so no alterations to the cardboard composition are happening.

The following flowchart represents the system boundaries for the product stage:

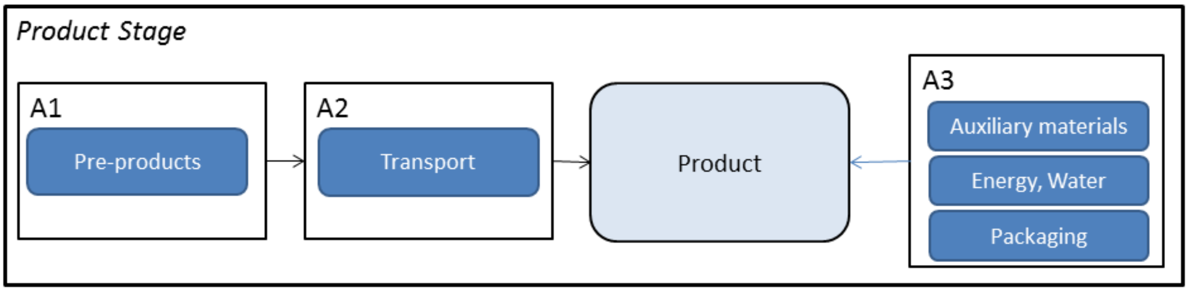


Figure 9: Schematic representation of the LCA system boundaries for the production module (A1-A3)

Table 19: Information on Module A1-A3

Module A1-A3	The following processes are omitted:	☑	A- 02 "Transport of staff in the supply of raw materials "
		☐	A- 03 "Transport to the manufacturer"
	Explain deviations from provision in the guidance document		
	Explained in the next statement		
	The following deviations from EeBGuide guidance document on data requirements occurred **(Only for "Complete Assessment")**:	* Infrastructure machinery & capital equipment were not included in the foreground system as this was neglected under the cut-off criteria; for the background system it was included for energy generation systems according to the GaBi Database SP20 and Ecoinvent 2.2 * Packaging waste from manufacturing was not modelled because it represents only 0.1% of the total mass through the Life Cycle	
	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	GaBi Database Service Pack 20 (SP20) and Ecoinvent 2.2 have been used as background data and their data quality assessment can be found in the documentation of these databases.	

C1-C4 End-of-life stage, information modules

The end of life of the carpet has been modelled to assess the consequences when disposing it. Three end of life scenarios have been assessed which represent the disposal routes of the carpet according to GUT (2006):

- 100 % landfill assuming it is disposed with commercial waste and including pre-treatment of waste and leachate treatment;
  100% incineration based on its composition represented by the same technology applied for municipal waste, assuming the carpet would be mixed with this before disposal;
- 100% recycling/energy recovery in a cement kiln, which is a common practice in Europe to send construction products for recycling at their end of life. Emissions were not included as these belong to the cement industry's product system on the basis that the kiln's emissions do not depend on the specific fuel used (German Research Institute of Cement industry, 2008). Therefore, the burden for the complete cement production stays in the following product system.

Modules C1: de-construction, demolition, and C2: transport to waste processing, are not included in this assessment as they are associated with the use stage which is outside the scope of this study. The end of life considers:

- C3, waste processing for reuse, recovery and/or recycling;
- C4, disposal,

including provision of all materials, products and related energy and water use.

The following flowchart represents the system boundaries for the End-of-life stage:

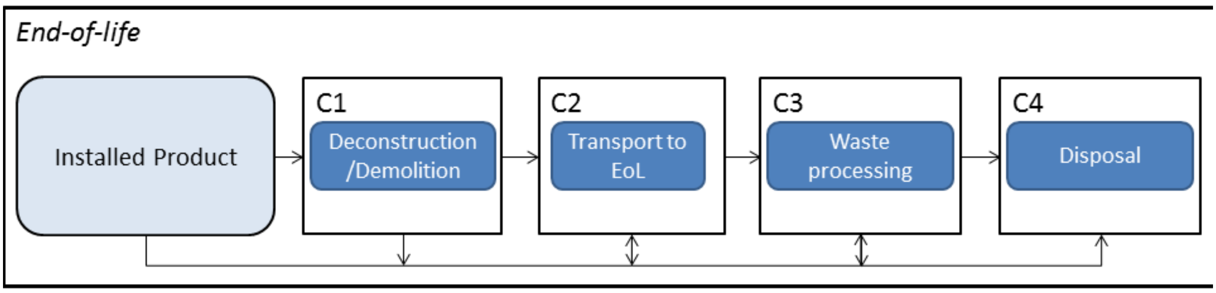


Figure 10: Schematic representation of the LCA system boundaries for the end of life stage (C1-C4)

Table 20: Information on Module C1-C4

Module C1-C4		
	The following processes are omitted: Explain deviations from provision in the guidance document	☑ C- 05 "Transport distances (to landfill, to incineration, to recy-cling)"
	none	
	Other processes omitted:	none
	The following deviations from EN 15804 on data requirements occurred **(Just for "Complete Assessment")**:	none
	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	GaBi Database Service Pack 20 (SP20) and Ecoinvent 2.2 have been used as background data and their data quality assessment can be found in the documentation of these databases.

D Benefits and loads beyond the system boundary, information module

The benefits of Module D including reuse and recovery were calculated as follows:

- The landfill of the carpet was modelled based on country average data for Austria, Belgium, Denmark, Finland, France, Germany, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom, with an average of 25% of the produced gas used to substitute electricity production;

- For the energy recovered from incineration, average calorific values from the carpet composition were used.

- For the recycling/energy recovery of the carpet in the cement kiln, its inorganic portion (chalk and aluminium hydroxide) is incorporated into the cement clinker as process additive substituting 90 of chalk and 10% of aluminium hydroxide, whilst the organic part is used to replace coal, lignite and petrol coke used in a cement kiln as a secondary fuels with a heating value of 32.2 MJ/kg (German Research Institute of Cement industry, 2008). On this basis, the calorific values for the substituted fuels were taken from the German Federal Ministry of Economics and Technology and these were used for calculating the substitution of coal (30 MJ/kg), lignite (9.15 MJ/kg), and petroleum coke (31.5 MJ/kg). The proportion of coal/lignite/petroleum coke substituted were 33.2/55/11.8% respectively according to GUT (2006).

The following flowchart represents the system boundaries for benefits/loads beyond the system boundary:

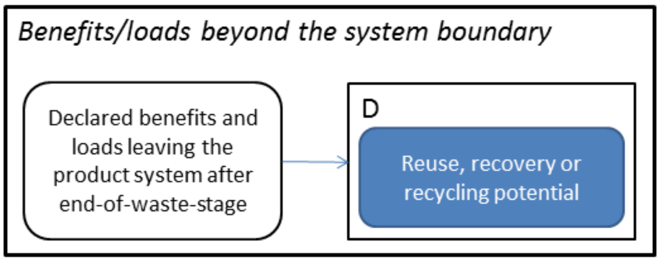


Figure 11: Schematic representation of the LCA system boundaries for the benefits and loads beyond the product system boundary in module D

Table 21: Information on Module D

Module D	The following processes are omitted:	☑ D- 02 "Reuse - water consumption"
	Explain deviations from provision in the guidance document	
	none	
	Other processes omitted:	none
	The following deviations from EN 15804 on data requirements occurred **(Just for "Complete Assessment")**:	none
	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	GaBi Database Service Pack 20 (SP20) and Ecoinvent 2.2 have been used as background data and their data quality assessment can be found in the documentation of these databases.

Electric energy mix

The selection of the background data for the electricity generation is in line with EeBGuide. European average (EU-27) and German average data were used. This was taken from GaBi 5 database Service Pack 20 [PE International, 2011] which is ILCD compliant.

For the European average electricity generation, data from 2008 official statistics on national energy carrier mixes, efficiencies, net losses and consumption were used. For the German average electricity generation, data from 2008 official statistics was included on average national specific electricity mix including main producers as well as imports energy carrier mixes, efficiencies, net losses and consumption.

The data sources for the complete system are consistent and details can be found in GaBi 5 documentation [Frischknecht et al.,2007]. The key emissions e.g. carbon dioxide, sulphur dioxide, nitrogen oxide, etc., of the power plants are based on measured operating data taken from national statistics. All other emissions from the power plants are based on literature data and/or calculated via energy carrier composition in combination with literature-based combustion models. Infrastructure data are from literature. The data on the energy carrier supply chain is based on statistics with country/region-specific transport distances, as well as industry and literature data on the inventory of exploration and extraction. Refinery data are also based on statistical data and measurements of major refineries as well as literature data. LCI modelling is fully consistent with the ILCD guidelines.

CO_2-Certificates

No CO_2-certificates are considered in this study.

Description of the system boundary in the background report

The definition of the system boundaries meets the requirements of EeBGuide.

Criteria for the exclusion of inputs and outputs

The application of the cut-off criteria for the exclusion of inputs and outputs follows the EN 15804 standard. Data gaps may be filled using conservative assumptions with average or generic data. Any assumptions for such choices shall be documented.

In case of insufficient input data or data gaps for a unit process, the cut-off criteria shall be:

- 1% of renewable and non-renewable primary energy usage and 1% of the total mass input of that unit process, and,
- the total of neglected input flows per module, e.g. per module A1-3, A4-5, B1-5, B6-7, C1-4 and D shall be a maximum of 5% of energy usage and mass.

Particular care should be taken to include material and energy flows known to have the potential to cause significant emissions into air and water or soil related to the environmental indicators of this standard.

Conservative assumptions in combination with plausibility considerations and expert judgment can be used to demonstrate compliance with these criteria.

In this particular study, the production and use of dyes in the manufacturing of this product were excluded on the basis that their input to the PA6 yarn is less than 1%.

Packaging waste was not considered because it constitutes less than 0.1% of the total mass of packaging.

Infrastructure machinery & capital equipment were not included in the foreground system as these are typically excluded when assessing these type of products since they are insignificant in terms of mass and energy consumption and in terms of their contribution to the potential environmental impacts.

23. Life cycle inventory analysis

Data collection and calculation procedures

Data collection follows the guidance provided in /**Erreur ! Source du renvoi introuvable.**/, clause 4.3.2. The calculation procedures described in /**Erreur ! Source du renvoi introuvable.**/ are applied consistently throughout the study.

According to the definition of scope of the study, all relevant inputs and outputs related to the products or product systems are identified and quantified.

Developing product level scenarios

Except for the required modules A1 to A3, which describe the product stage, the data for the disposal routes and benefits beyond the system boundaries are based on assumptions and described as scenarios.

For modules C3, C4 and D, three different end of life scenarios were modelled:

- Baseline scenario: 100% of the carpet sent to landfill within Europe,
- Scenario 1: 100% of the carpet sent to incineration within Europe, and,
- Scenario 2: 100% of the carpet sent to a cement producer for recycling/energy recovery as secondary material/fuel within the kiln.

All combustion processes in the incineration and kiln processes were credited with energy recovery in module D as well as the methane gas combustion from landfill.

For the use of the carpet in the cement kiln, a 100% use rate was modelled since this is the usual practice within Germany.

Selection of data/ background data

As a general rule, specific data or average data derived from specific production processes shall be the first choice as a basis for calculating a product LCA.

For life cycle modelling of the considered product the GaBi 5, Software-System and Databases for Life Cycle Engineering was used. All relevant background datasets were taken from GaBi 5 database Service Pack 20 (PE International, 2011) and Ecoinvent 2.2 database (Frischknecht et al., 2007) and provided by PE International and the Swiss Centre for Life Cycle Inventories.

The applied foreground datasets are based on 1 year averaged data from 2010 and have either European or country specific average coverage. The data sets for the background system are based on 1 year averaged data from a range of years varying from 2000 to 2011.

Data/ background data quality requirements

The requirements for data quality and background data correspond to the specifications of EeBGuide.

The datasets are complete and conform to the system boundaries and the criteria for the exclusion of inputs and outputs. All datasets are specific to the product system model to the extent possible, and when this is not the case they are generic and representing the technology and region assessed.

Specific information about their age, technologies and regions represented cannot be disclosed due to confidentiality terms of GUT with the German manufacturer. However, these should be included when assessing construction products according to this guidance. In this particular case, this information has been reviewed by an external verifier before producing the Environmental Product Declaration in terms of data quality and representativeness.

The foreground system data have been assessed in terms of quality and representativeness by an external critical review (Klöpffer W. and Hischier R., 2004).

The background data complies with data quality and representativeness requirements according to GaBi 5 database Service Pack 20 and Ecoinvent 2.2 database.

Allocation

In the present study no allocation has been required.

In modules A1, A2 and A3 electricity and thermal energy is recovered from the incineration of manufacturing waste from PA6 from spinning/colouring and from cutting the edges of the carpet. This recovered energy was subtracted from the input electricity based on the European electricity grid and the input thermal energy from natural gas (EU-27), in this way reflecting the NET energy consumption.

Substitution of the average European electricity grid and thermal energy from natural gas (EU-27) were modelled for the incineration of the carpet at its end of life, and substitution of the average European electricity grid (EU-27) was modelled for the landfilling of the carpet.

Substitution of European average virgin marginal materials (chalk and aluminium hydroxide) was modelled for the use of the carpet’s inorganic elements in a cement kiln, and substitution of German average virgin marginal materials (coal, lignite and petroleum coke) was modelled for the use of the carpet’s combustible components.

24. Life cycle inventory analysis and life cycle impact assessment

The results of the simplified LCA are represented in the following tables. The inventory analysis indicators to be declared and the impact assessment are in accordance with EN 15804.

Indicators for the life cycle inventory analysis according to EN 15804

The following environmental indicators apply data are derived from the LCI. They describe the use of renewable and non-renewable material resources, renewable and non-renewable primary energy and water.

Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ, net calorific value
Use of renewable primary energy resources used as raw materials	MJ, net calorific value
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ, net calorific value
Use of non renewable primary energy excluding non renewable primary energy resources used as raw materials	MJ, net calorific value
Use of non renewable primary energy resources used as raw materials	MJ, net calorific value
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ, net calorific value
Use of secondary material	kg
Use of renewable secondary fuels	MJ, net calorific value
Use of non-renewable secondary fuels	MJ, net calorific value
Use of net fresh water	m^3

The indicators describing waste categories and other material flows are output flows derived from the LCI.

Other environmental information describing waste categories is described next:

Hazardous waste disposed	kg
Non hazardous waste disposed	kg
Radioactive waste disposed	kg

Other environmental information describing output flows is described next:

Components for recycling	kg
Materials for recycling	kg

Materials for energy recovery	kg
Exported energy as thermal energy	MJ per energy carrier
Exported energy as electrical energy	MJ per energy carrier

Indicators for the life cycle impact assessment according to EN 15804

The following environmental impact categories have been assessed based on characterisation factors from CML (Institute of Environmental Sciences Faculty of Science University of Leiden, Netherlands) referring to the EN 15804 standard:

Global warming potential (GWP);	kg CO_2-equiv.
Depletion potential of the stratospheric ozone layer (ODP);	kg CFC 11- equiv
Acidification potential of soil and water, (AP);	kg SO_2 - equiv
Eutrophication potential (EP);	kg $(PO_4)^{3-}$ - equiv
Formation potential of tropospheric ozone (POCP);	kg Ethene - equiv
Abiotic depletion potential (ADP-elements) for non-fossil resources	kg Sb - equiv
Abiotic depletion potential (ADP-fossil fuels) for fossil resources	MJ, net calorific value

The results from the impact assessment are only relative statements which give no information about the endpoint of the impact categories, overstepping of threshold values, safety margins or risk.

Summary of assessed environmental indicators

The table below illustrates the environmental indicators assessed in this study.

Table 22: Used environmental indicators

Used indicators	☑	1. Global warming potential
	☑	2. Acidification Potential
	☑	3. Eutrophication Potential
	☑	4. Photochemical Ozone Creation Potential
	☑	5. Total use of renewable primary energy
	☑	6. Total use of non-renewable primary energy
	☑	7. Depletion potential of the stratospheric ozone layer
	☑	8. Abiotic Resource Depletion Potential for elements
	☑	9. Abiotic Resource Depletion Potential of fossil fuels
	☑	10. Secondary Materials
	☑	11. Secondary fuels - renewable
	☑	12. Secondary fuels – non renewable
	☑	13. Net Fresh Water
	☑	14. Hazardous Waste
	☑	15. Non Hazardous Waste
	☑	16. Radioactive Waste
	☑	17. Components for Re-Use
	☑	18. Materials for Recycling
	☑	19. Materials for Energy Recovery
	☑	20. Exported Energy
	☑	Use of renewable primary energy excluding raw materials
	☑	Use of renewable primary energy as raw materials
	☑	Use of non-renewable primary energy excluding raw material
	☑	Use of non-renewable primary energy as raw materials

Description of the Baseline scenario

The following table illustrates the parameters used in the Baseline scenario, which is represented by landfilling the carpet at its end of life.

Table 23: Description of the parameter Baseline scenario

Baseline scenario	G- 05 “Reference study period”	not applicable, use stage not considered
	G- 09 “Future technical developments and innovation”	No innovation to be considered, current technologies to be used
	G- 11 “Accounting for carbon storage / carbon sequestration”	Biogenic carbon storage/emissions are not considered
	B- 11 “Modelling of water use”	Net water consumption only, water scarcity is not considered
	C- 02 “End of Life (EOL) scenarios “	100% landfill

The next section shows the detailed results for the Baseline scenario.

Results: Baseline Scenario

Table 24: Overview of the LCA results – Baseline scenario (part A)

Overview over the product LCA results								
1 year	1. Global warming potential	2. Acidification Potential	3. Eutrophication Potential	4. Photochemical Ozone Creation Potential	5. Use of renewable primary energy excluding raw materials	6. Use of renewable primary energy as raw materials	7. Total use of renewable primary energy	8. Use of non-renewable primary energy excluding raw materials
	GWP	AP	EP	POCP	PERE	PERM	PERT	PENRE
	[kg CO_2-equiv./m²$_{NFA}$*a]	[kg SO_2-equiv./m²$_{NFA}$*a]	[kg PO_4^{-3} - equiv. /m²$_{NFA}$*a]	[kg C_2H_4-equiv./m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]
Product Stage	0.97	1.99E-03	2.50E-04	2.95E-04	0.56	0.00	0.56	15.39
End of Life Stage	0.25	5.47E-05	2.57E-04	6.59E-05	7.24E-03	0.00	7.24E-03	0.16
Benefits and loads beyond the system boundary	-1.14E-02	-4.88E-05	-2.62E-06	-2.97E-06	-2.92E-02	0.00	-2.92E-02	-2.00E-01

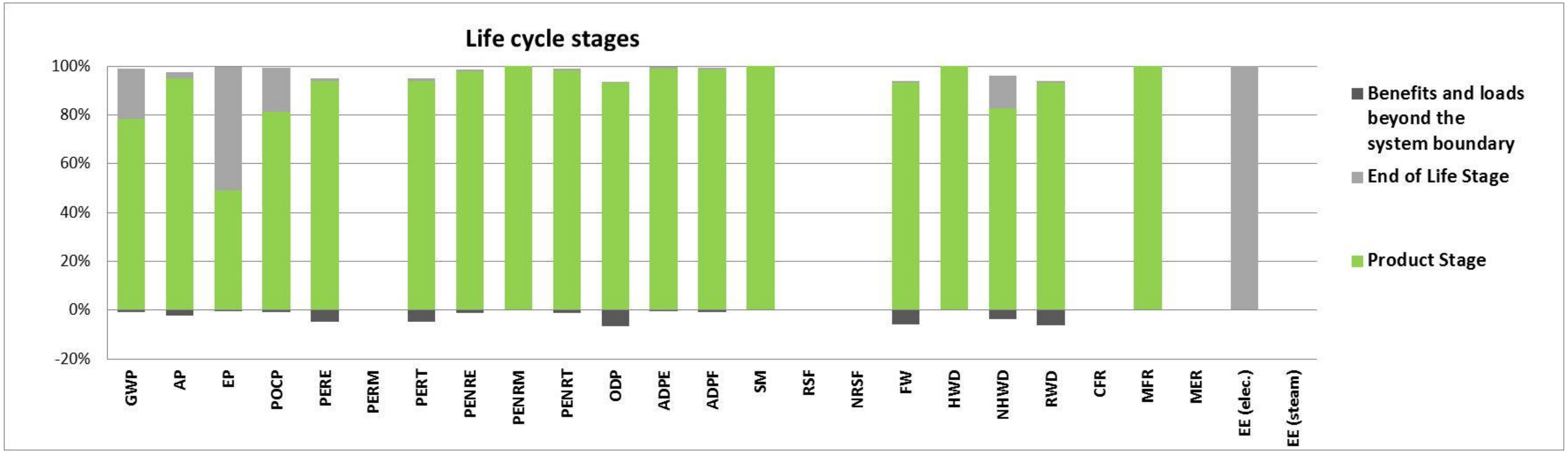
Table 25: Overview of the LCA results – Baseline scenario (part B)

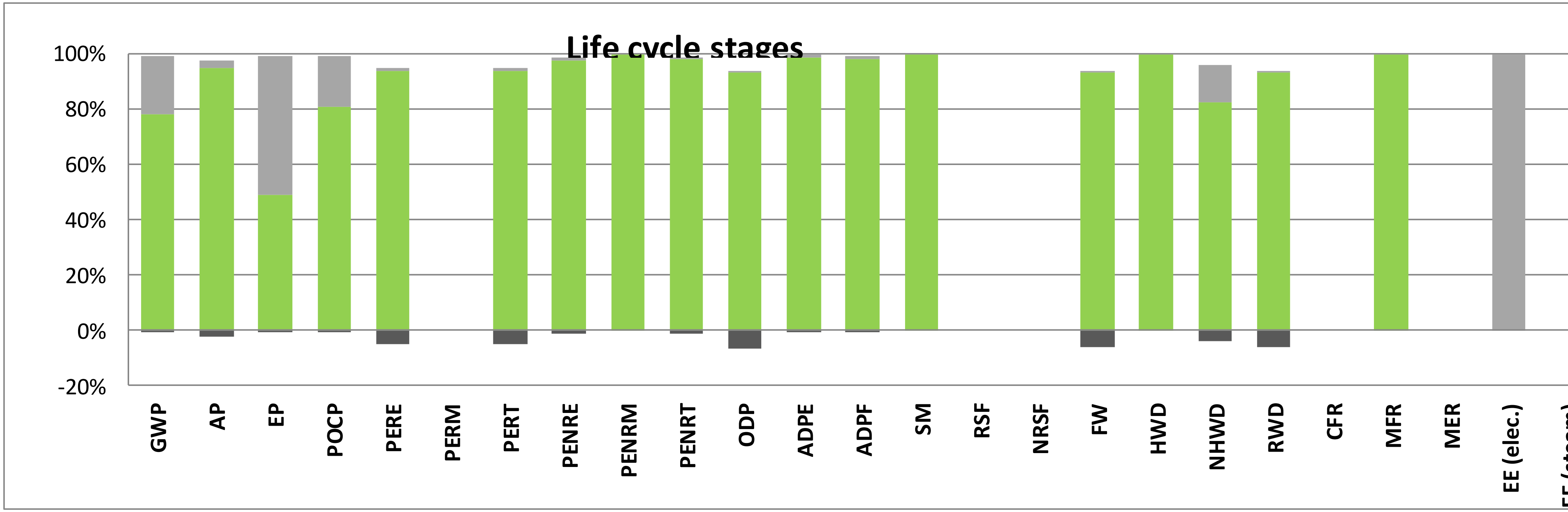
Overview over the product LCA results								
1 year	9. Use of non-renewable primary energy as raw materials	10. Total use of non renewable primary energy	11. Depletion potential of the stratospheric ozone layer	12. Abiotic Resource Depletion Potential for elements	13. Abiotic Resource Depletion Potential of fossil fuels	14. Secondary Materials	15. Secondary fuels - renewable	16. Secondary fuels – non renewable
	PENRM	PENRT	ODP	ADPE	ADPF	SM	RSF	NRSF
	[MJ/m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]	[kg CFC11-equiv./m²$_{NFA}$*a]	[kg Sb-Equiv. /m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]	[kg /m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]
Product Stage	3.60	18.99	1.07E-08	2.51E-07	17.84	2.60E-03	0.00	0.00
End of Life Stage	0.00	0.16	3.60E-11	2.06E-09	0.15	0.00	0.00	0.00
Benefits and loads beyond the system boundary	0.00	-2.00E-01	-7.48E-10	-9.39E-10	-1.30E-01	0.00	0.00	0.00

Table 26: Overview of the LCA results – Baseline scenario (part C)

Overview over the product LCA results									
1 year	17. Net Fresh Water	18. Hazardous Waste	19. Non Hazardous Waste	20. Radioactive Waste	21. Components for Re-Use	22. Materials for Recycling	23. Materials for Energy Recovery	24. Exported Energy - electricity	25. Exported Energy - steam
	FW	HWD	NHWD	RWD	CFR	MFR	MER	EE (elec.)	EE (steam)
	[m³/m²$_{NFA}$*a]	[kg /m²$_{NFA}$*a]	[kg /m²$_{NFA}$*a]	[kg /m²$_{NFA}$*a]	[kg /m²$_{NFA}$*a]	[kg /m²$_{NFA}$*a]	[kg /m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]
Product Stage	0.65	1.09E-03	0.93	4.30E-04	0.00	3.90E-04	0.00	0.00	0.00
End of Life Stage	5.62E-03	0.00	0.15	2.79E-06	0.00	0.00	0.00	8.43E-02	0.00
Benefits and loads beyond the system boundary	-4.16E-02	0.00	-4.28E-02	-2.86E-05	0.00	0.00	0.00	0.00	0.00

Figure 12: Results Indicators - life cycle stages Baseline scenario




Life cycle stages
100%
80%
60%
40%
20%
0%
-20%
GWP
AP
EP
POCP
PERE
PERM
PERT
PENRE
PENRM
PENRT
ODP
ADPE
ADPF
SM
RSF
NRSF
FW
HWD
NHWD
RWD
CFR
MFR
MER
EE (elec.)

Interpretation of the results for the Baseline Scenario

The results show that the end of life contributes to a relatively minor extent for most of the assessed indicators, with the exception of eutrophication, global warming photochemical ozone creation potentials, non-hazardous waste and exported energy as electricity. The benefits and loads beyond the system boundary are also relatively minor compared to the production's environmental profile.

The predominance of the production stage is due to an energy intensive manufacturing process that comprises a series of steps involving tufting, primary backing, shearing, back coating, cutting and packaging, as well as other sub-stages for each manufacturing step. Most of these stages and sub-stages are carried out by machine and thus require electricity and thermal energy to function. Furthermore, many of the raw materials need to be pre-processed and transported to the manufacturing site, so the demand of energy, fossil fuels and secondary materials for the packaging as well as the interaction of these supply processes with the environment make for this predominance.

The major contribution to eutrophication potential from the end of life stage is due to landfill emissions to soil and fresh water, mainly from ammonia/ammonium and phosphorus, which are by-products from the anaerobic degradation of the organic fraction of municipal solid waste. Its contribution to global warming potential is mainly due to methane which occur also by the anaerobic/aerobic degradation of the organic fraction of the waste, and its contribution to photochemical ozone creation potential by methane & carbon monoxide emissions. The exported electricity is generated from capturing about 28% of the landfill methane emissions. It is important to mention that the carpet's organic fraction may be lower than that of municipal solid waste, so the values of these indicators may be overestimated.

25. Scenarios

Description of the parameters for Scenario 1

In the following table the parameters of this scenario, focused on incineration at end of life are described.

Table 27: Description of Scenario 1

Scenario 1	G- 05 "Reference study period"	not applicable, use stage not considered
	G- 09 "Future technical developments and innovation"	No innovation to be considered, current technologies to be used
	G- 11 "Accounting for carbon storage / carbon sequestration"	Biogenic carbon storage/emissions are not considered
	B- 11 "Modelling of water use"	Net water consumption only, water scarcity is not considered
	C- 02 "End of Life (EOL) scenarios"	100% incineration
	[further variation]	not applicable

The next section shows the detailed results for the Scenario 1.

Results for Scenario 1

The following tables and figures show the results of the scenario.

Table 28: Overview of the LCA results – Scenario 1 (part A)

Overview over the product LCA results								
1 year	1. Global warming potential	2. Acidification Potential	3. Eutrophication Potential	4. Photochemical Ozone Creation Potential	5. Use of renewable primary energy excluding raw materials	6. Use of renewable primary energy as raw materials	7. Total use of renewable primary energy	8. Use of non-renewable primary energy excluding raw materials
	GWP	AP	EP	POCP	PERN	PERM	PERT	PENRE
	[kg CO_2-equiv./m^2_{NFA}*a]	[kg SO_2-equiv./m^2_{NFA}*a]	[kg PO_4^{-3} - equiv. /m^2_{NFA}*a]	[kg C_2H_4-equiv./m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]
Product Stage	0.97	1.99E-03	2.50E-04	2.95E-04	0.56	0.00	0.56	15.39
End of Life Stage	0.38	2.49E-04	6.53E-05	1.78E-05	1.46E-02	0.00	1.46E-02	0.32
Benefits and loads beyond the system boundary	-1.23E-01	-1.81E-04	-1.60E-05	-2.00E-05	-6.89E-02	0.00	-6.89E-02	-2.00E+00

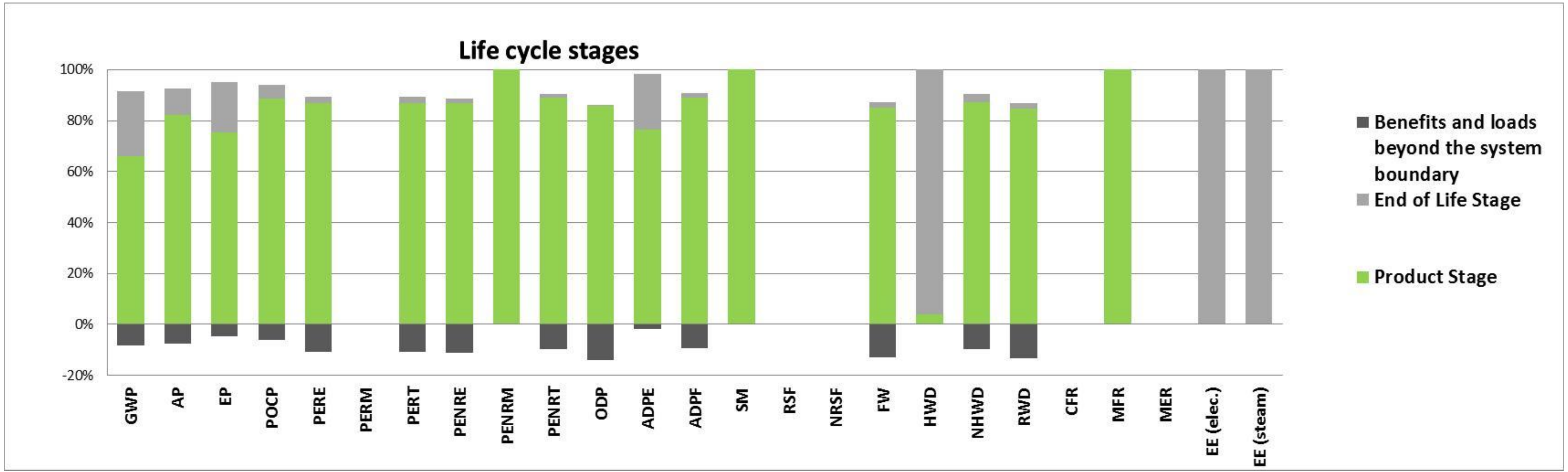
Table 29: Overview of the LCA results – Scenario 1 (part B)

Overview over the product LCA results								
1 year	9. Use of non-renewable primary energy as raw materials	10. Total use of non-renewable primary energy	11. Depletion potential of the stratospheric ozone layer	12. Abiotic Resource Depletion Potential for elements	13. Abiotic Resource Depletion Potential of fossil fuels	14. Secondary Materials	15. Secondary fuels - renewable	16. Secondary fuels – non renewable
	PENRM	PENRT	ODP	ADPE	ADPF	SM	RSF	NRSF
	[MJ/m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[kg CFC11-equiv./m^2_{NFA}*a]	[kg Sb-Equiv. /m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]
Product Stage	3.60	18.99	1.07E-08	2.51E-07	17.84	2.60E-03	0.00	0.00
End of Life Stage	0.00	0.32	3.25E-11	7.14E-08	0.30	0.00	0.00	0.00
Benefits and loads beyond the system boundary	0.00	-2.03E+00	-1.75E-09	-5.71E-09	-1.87E+00	0.00	0.00	0.00

Table 30: Overview of the LCA results – Scenario 1 (part C)

Overview over the product LCA results									
1 year	**17. Net Fresh Water**	**18. Hazardous Waste**	**19. Non Hazardous Waste**	**20. Radioactive Waste**	**21. Components for Re-Use**	**22. Materials for Recycling**	**23. Materials for Energy Recovery**	**24. Exported Energy - electricity**	**25. Exported Energy - steam**
	FW	HWD	NHWD	RWD	CFR	MFR	MER	EE (elec.)	EE (steam)
	[m^3/m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]
Product Stage	0.65	1.09E-03	0.93	4.30E-04	0.00	3.90E-04	0.00	0.00	0.00
End of Life Stage	1.54E-02	2.67E-02	3.66E-02	9.71E-06	0.00	0.00	0.00	0.18	1.22
Benefits and loads beyond the system boundary	-9.81E-02	0.00	-1.01E-01	-6.72E-05	0.00	0.00	0.00	0.00	0.00

Figure 13: Results Indicators - life cycle stages Scenario 1



Interpretation of the results for Scenario 1

in general, the results of this scenario show that when the carpet is sent to incineration at the end of life, this life cycle stage contributes to a greater proportion of the environmental impact categories and indicators than when it is sent to landfill, but it also shows more benefits beyond the system boundary. The contributions to eutrophication and photochemical ozone creation potentials and to non-hazardous waste are, however, reduced from those when the end of life route is 100% landfill.

All the other impact categories present higher values when incinerating the carpet rather than landfilling it due to combustion emissions from the incineration process. However, the electrical and thermal energy recovered during incineration also mean that higher values are seen for benefits and loads beyond the system boundary. The energy balance burdens the product system more than it credits for global warming, acidification, eutrophication and abiotic depletion (elements) potentials, but it credits more than burdens for primary energy demand (renewable & non-renewable), abiotic depletion (fossils) potential, net freshwater consumption and the generation of non-hazardous and radioactive waste. Furthermore, there is more exported electricity and steam generated from incineration than for landfill.

Description of the parameters for Scenario 2

Table 31: Description of Scenario 2

Scenario 2	G- 05 "Reference study period"	not applicable, use stage not considered
	G- 09 "Future technical developments and innovation"	No innovation to be considered, current technologies to be used
	G- 11 "Accounting for carbon storage / carbon sequestration"	Biogenic carbon storage/emissions are not considered
	B- 11 "Modelling of water use"	Net water consumption only, water scarcity is not considered
	C- 02 "End of Life (EOL) scenarios "	100% reuse in a cement kiln
	[further variation]	not applicable

The next section shows the detailed results for the Scenario 2.

Results for Scenario 2

Table 32: Overview of the LCA results – Scenario 2 (part A)

Overview over the product LCA results								
1 year	1. Global warming potential	2. Acidification Potential	3. Eutrophication Potential	4. Photochemical Ozone Creation Potential	5. Use of renewable primary energy excluding raw materials	6. Use of renewable primary energy as raw materials	7. Total use of renewable primary energy	8. Use of non-renewable primary energy excluding raw materials
	GWP	AP	EP	POCP	PERE	PERM	PERT	PENRE
	[kg CO_2-equiv./m$^2_{NFA}$*a]	[kg SO_2-equiv./m$^2_{NFA}$*a]	[kg PO_4^{-3} - equiv. /m$^2_{NFA}$*a]	[kg C_2H_4-equiv./m$^2_{NFA}$*a]	[MJ/m$^2_{NFA}$*a]	[MJ/m$^2_{NFA}$*a]	[MJ/m$^2_{NFA}$*a]	[MJ/m$^2_{NFA}$*a]
Product Stage	0.97	1.99E-03	2.50E-04	2.95E-04	0.56	0.00	0.56	15.39
End of Life Stage	1.36E-03	5.79E-06	3.11E-07	3.52E-07	3.46E-03	0.00	3.46E-03	2.37E-02
Benefits and loads beyond the system boundary	-2.62E-02	-1.71E-04	-3.84E-05	-2.13E-05	-9.32E-03	0.00	-9.32E-03	-3.93E+00

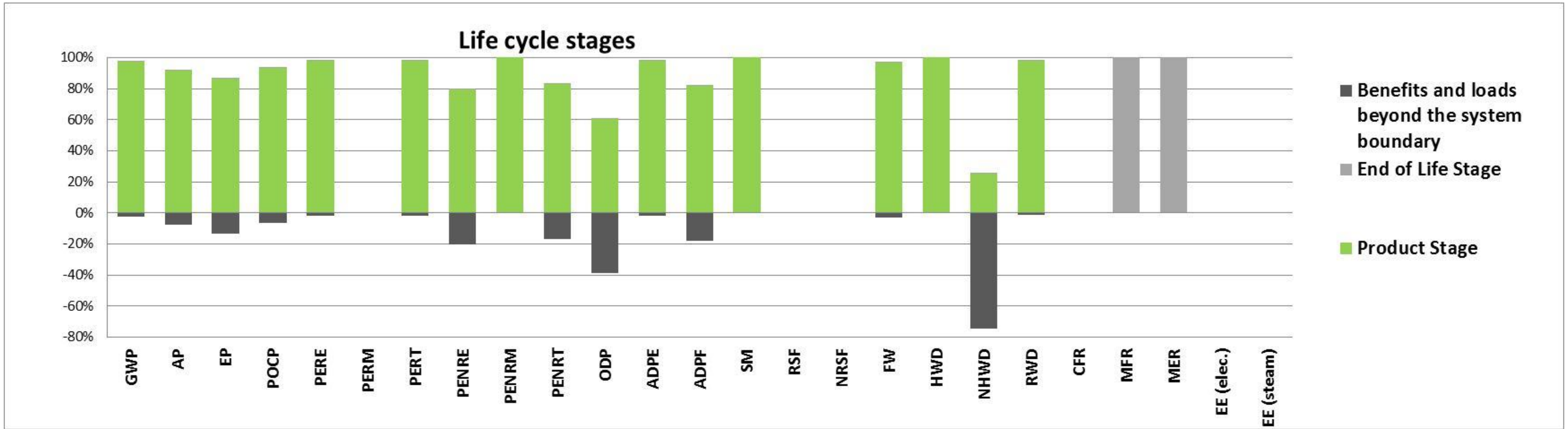
Table 33: Overview of the LCA results – Scenario 2 (part B)

Overview over the product LCA results								
1 year	9. Use of non-renewable primary energy as raw materials	10. Total use of non-renewable primary energy	11. Depletion potential of the stratospheric ozone layer	12. Abiotic Resource Depletion Potential for elements	13. Abiotic Resource Depletion Potential of fossil fuels	14. Secondary Materials	15. Secondary fuels - renewable	16. Secondary fuels – non renewable
	PENRM	PENRT	ODP	ADPE	ADPF	SM	RSF	NRSF
	[MJ/m$^2_{NFA}$*a]	[MJ/m$^2_{NFA}$*a]	[kg CFC11-equiv./m$^2_{NFA}$*a]	[kg Sb-Equiv. /m$^2_{NFA}$*a]	[MJ/m$^2_{NFA}$*a]	[kg /m$^2_{NFA}$*a]	[MJ/m$^2_{NFA}$*a]	[MJ/m$^2_{NFA}$*a]
Product Stage	3.60	18.99	1.07E-08	2.51E-07	17.84	2.60E-03	0.00	0.00
End of Life Stage	0.00	2.37E-02	8.87E-11	1.11E-10	1.55E-02	0.00	0.00	0.00
Benefits and loads beyond the system boundary	0.00	-3.93E+00	-6.89E-09	-4.38E-09	-3.91E+00	0.00	0.00	0.00

Table 34: Overview of the LCA results – Scenario 2 (part C)

Overview over the product LCA results									
1 year	17. Net Fresh Water	18. Hazardous Waste	19. Non Hazardous Waste	20. Radioactive Waste	21. Components for Re-Use	22. Materials for Recycling	23. Materials for Energy Recovery	24. Exported Energy - electricity	25. Exported Energy - steam
	FW	HWD	NHWD	RWD	CFR	MFR	MER	EE (elec.)	EE (steam)
	$[m^3/m^2_{NFA}*a]$	$[kg/m^2_{NFA}*a]$	$[kg/m^2_{NFA}*a]$	$[kg/m^2_{NFA}*a]$	$[kg/m^2_{NFA}*a]$	$[kg/m^2_{NFA}*a]$	$[kg/m^2_{NFA}*a]$	$[MJ/m^2_{NFA}*a]$	$[MJ/m^2_{NFA}*a]$
Product Stage	0.65	1.09E-03	0.93	4.30E-04	0.00	3.90E-04	0.00	0.00	0.00
End of Life Stage	4.94E-03	0.00	5.07E-03	3.39E-06	0.00	9.00E-02	0.11	0.00	0.00
Benefits and loads beyond the system boundary	-1.84E-02	0.00	-2.71E+00	-5.80E-06	0.00	0.00	0.00	0.00	0.00

Figure 14: Results Indicators - life cycle stages Scenario 2



Interpretation of the results for Scenario 2

The overall results of this scenario show some remarkable differences compared to those from the previous scenarios.

The contribution from the end of life stage to all indicators is reduced with the exception of materials for recycling and materials for energy recovery (where a high value is considered desirable). About 45% of the carpet's mass substitutes inorganic materials that are typically used as cement additives and the other 55% is used for combustion in the cement kiln. There is no exported energy as the carpet generates alternatives for materials rather than for energy utilization.

The benefits and loads beyond the system boundary are even higher than those at scenario 1. These are more evident by avoiding:

- **a.** the use of fossil fuels,
- **b.** the emissions which create the depletion of the stratospheric ozone layer,
- **c.** the generation of stockpile/overburden non-hazardous waste.

These result from using the carpet as secondary fuel/material at the cement kiln thus avoiding the use of hard coal, lignite and petroleum coke as energy fuels and calcium carbonate and aluminium hydroxide as cement additives.

26. Conclusion

Environmental data on the carpet's production and three end of life scenarios has been generated that is EN 15804 compliant and can be used to create Environmental Product Fact Sheets.

When comparing the environmental profile of the production of the tufted textile floor covering (i.e. carpet) to that of its End of Life, it is observed that the production stage dominates in most of the indicators assessed.

However, when comparing different disposal routes, the contribution to end of life is offset when the carpet is sent to incineration by the benefits over its system boundary, and even more when sent for recycling/energy recovery at a cement kiln by creating less environmental impacts and by presenting higher benefits over the system boundary.

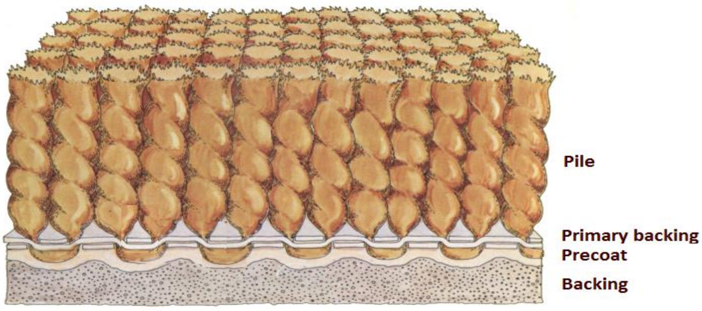
When considering this product on the selection of items for the interior design of an office or residential building, attention should be placed on how it will be disposed of at end of life. In general, the use of the product as a secondary fuel/material in cement kilns will yield the best environmental performance. Regardless of the end of life choice, the manufacturing stage is dominant for most indicators assessed, therefore attention should still be focused on reducing impacts in this life cycle stage.

27. References

Gemeinschaft Umweltfreundlicher Teppichboden - GUT (2006)	Ökologische Bilanzierung von Teppichböden, Teil 2, Vom Fabriktor bis zur Bahre
Wittstock et al. (2012)	EeBGuide Guidance Document, Part A: PRODUCTS, "Operational guidance for Life Cycle Assessment studies of the Energy Efficient Buildings Initiative"
EN 15804: 2012	Sustainability of construction works – Environmental Product Declarations – Core rules for the product category of construction products
PE International (2011)	GaBi 5 dataset documentation for the software-system and databases, LBP, University of Stuttgart and PE INTERNATIONAL AG, Leinfelden-Echterdingen, 2011 (http://documentation.gabi-software.com/)
Frischknecht et al. (2007)	Overview and Methodology. Final report ecoinvent data v2.0, No.1. Swiss Centre for Life Cycle Inventories, Dübendorf, CH.
Joint Research Centre (JRC), European Commission (2010)	General guide for Life Cycle Assessment – Detailed guidance
Klöpffer and Hischier (2004)	Ökologische Bilanzierung von Teppichböden. Kritische Prüfung nach EN DIN 14040
German Research Institute of Cement Industry (2008)	Environmental Data of the German Cement Industry. Concrete: Environmental profiles of cement and concrete. Manufacture, use and alternative materials.

Documentation for the calculation of the reference service life (RSL)

The documentation of the RSL is not required for the EPD of the company since the entire life cycle is not declared. The RSL of 10 years is optionally specified.



Background Report for Products

Complete LCA of installed tufted textile floorcovering (based on information provided by the Association of Environmentally Friendly Carpets e.V. - Gemeinschaft Umweltfreundlicher Teppichboden, GUT)

Basic assessment information

General information

Name of the product:	Tufted carpet with textile fabric backing
Date of the assessment:	4th of September, 2012
Name, role and affiliation of assessor:	Larisa Maya Altamira, Consultant at PE International
Name, role and affiliation of reviewer:	Peter Shonfield, Technical Director at PE International
Review type	Internal review
Date of the verification	26th of September, 2012
Client of the study:	GUT - Gemeinschaft umweltfreundlicher Teppichboden e.V., Schönebergstr. 2, 52068 Aachen, Germany GUT
Authors of the study:	PE International - Hauptstraße 111-113, 70771 Leinfelden-Echterdingen, Germany

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Nomenclature

Abbreviation	Explanation
ADP	Abiotic Depletion Potential
ADPE	Abiotic Resource Depletion Potential for elements
ADPF	Abiotic Resource Depletion Potential of fossil fuels
AP	Acidification Potential
BLBSB	Benefits and Loads Beyond the System Boundary
CML	Centrum voor Milieukunde, Leiden (NL)
CRU	Components for re-use
EE	Exported energy per energy carrier
EP	Eutrophication Potential
EPD	Environmental Product Declaration
FW	Use of net fresh water
GWP	Global Warming Potential
HWD	Hazardous waste disposed
IBU	Institut Bauen und Umwelt e.V.
MER	Materials for energy recovery
MFR	Materials for recycling
NRSF	Use of non-renewable secondary fuels
NHWD	Non hazardous waste disposed
ODP	Ozone Layer Depletion Potential
PENRE	Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials
PENRM	Use of non-renewable primary energy resources used as raw materials
PENRT	Total use of non-renewable primary energy resources
PERE	Use of renewable primary energy excluding renewable primary energy resources used as raw materials
PERM	Use of renewable primary energy resources used as raw materials
PERT	Total use of renewable primary energy resources
PCR	Product Category Rules
POCP	Photochemical Ozone Creation Potential
RSF	Use of renewable secondary fuels

RSL	Reference Service Life
RWD	Radioactive waste disposed
SM	Use of secondary material

28. Scope

This document is the background report for the life cycle assessment (LCA) results of the product. The study has been conducted in accordance with the provisions and guidelines of EeBGuide.

29. Content, structure and accessibility of the background report

This background report provides the systematic and comprehensive summary of the project documentation supporting the verification of an EeBGuide compliant product LCA. Both the LCA based information and the additional information meet the requirements of EeBGuide of the Energy-efficient Building Initiative. It will be made available to the verifier with the requirements for confidentiality stated in ISO 14025.

This background report contains important data and information for the data as required by the European Standard **Erreur ! Source du renvoi introuvable.** on construction product Environmental Product Declarations (EPD). Special attention has been paid to transparently demonstrate how the data and accompanying information have been collected and how these are related to the declared LCA results. Documentation of the reference service life (RSL) was not disclosed due to confidentiality terms. For further information please refer to GUT (2006).

30. General aspects in the background report

This LCA study was performed jointly by the Association of Environmentally Friendly Carpets (GUT) and PE International and has been conducted according to the requirements of the European Standard **Erreur ! Source du renvoi introuvable.**. Further details can be found in the table "General Information".

31. Goal/ Purpose of the study

GUT is a European association whose aim is to improve continuously all environmental and consumer protection aspects throughout the life cycle of textiles floor coverings. Amongst other activities, GUT compiles life cycle information from their members to produce EPD.

GUT had already carried out the LCA of the product assessed in this study, to gather data for an Environmental Product Declaration (EPD). The data assessed is from a German manufacturer whose name cannot be disclosed due to confidentiality terms. According to GUT, this is representative product of its type in the European market.

The aim of this study is to identify the environmental hotspots of a tufted textile floor covering (i.e. carpet) used commercially in the European market under extensive traffic conditions through its entire life cycle. The results of this study will be used internally to discuss about future potential areas of improvement thorough the supply chain of the product.

PE International used GUT's data with the aim to exemplify how the guidelines of EeBGuide can be used to meet the aims of the study. The guidelines are referred at the "EeGBuide Guidance Document, Part A: PRODUCTS" (Wittstock et al., 2012).

The table "Goal/ Purpose of the study" summarizes key points regarding the aim of the study.

Table 35: Goal/ Purpose of the study

Goal/ Purpose of the study			
	Level of complexity	☐	Screening
		☐	Simplified
		☑	Complete
	Related study objective	☐	Comparative assertion
		☑	Stand alone LCA
	Object of assertion	☑	Product
	Communication purpose	☑	Internal
		☐	External
		☐	For customer to customer
		☐	Publication

32. Scope of the study

Declared / functional unit

The functional unit in this study is 1 m^2 of installed tufted textile floor covering for a lifetime period of 10 years. This equals to a reference flow of 2 kg of manufactured product plus additional 180 g accounting for 9% of installation waste, and 40 g of packaging material.

Table 36: Functional unit

Functional unit		
	Functional/declared unit:	1 m^2 of installed tufted textile floor covering over a life time period of 10 years
	Product group:	Floor coverings
	Function in the building:	The product complies with the use class 33 according to EN 1307, meaning that they are suitable for use in areas with high traffic and can be used both in the private and the commercial sector
	Reference service life	10 years
	Other services provided within the building	none

The function of the product is to protect the floor and a maintain an acceptable visual and tactile quality over 10 years under heavy use conditions in commercial buildings. It can also be used in residential buildings.

Declaration of construction products classes

The following table describes the product in more detail:

Table 37: Technical description of product

Technical description of the product		
	Name of the PCR and describe the declaration type (if you follow any):	PCR 2011, Part A+B Institut Bauen und Umwelt e.V., Königswinter (pub.): Product Category Rules for Construction Products from the range of Environmental Product Declarations of Institut Bauen und Umwelt (IBU), Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Background Report, 2011-09 Part B: Requirements on the EPD for floor coverings, 2011-06
	Main important materials:	Polyamide 6 (PA6), polyester (PES), polypropylene (PP), limestone, latex, aluminiumhydroxide
	Statement on ability for recycling/reuse:	The carpet product can be used as secondary material in cement kilns, substituting substantial inorganic material that remains in the clinker (mostly chalk & aluminum hydroxide) and original fuel needed for the kilns (hard coal, lignite and petroleum coal) - Source: Environmental Data of the German Cement Industry 2008, VDZ eV, Research Institute of Cement industry
	Description of the product:	Tufted carpet as rolls having a surface pile of 100% solution-dyed polyamide 6, a pre-coat & lamination made of limestone, latex and aluminiumhydroxide, a non-woven primary backing made of PES/PA6, and a textile fabric backing made of Polypropylene
	Designated application:	According to the use class 33 as defined in EN 1307 this product can be used in all commercial areas which require heavy use. According to the standard, this floor covering can be also used in other lower classes (i.e. in residential areas).

The technical specifications of the product are shown in Table 15 and its composition in the next table.

Table 38: Technical specifications of the product

Information on basic construction data					
basic requirements (table 4):	fulfilled		type of carpet:	1	
type of manufacture (ref 1):	pile carpet acc. EN 1307 - tufted				
type of surface (ref 2):	loop pile - loop pile like - patterned				
primary backing (ref 3):	spunbond - PET				
secondary backing (ref 4):	textile backing - woven				
pile fibre composition:	100% PA6				
total carpet weight:	2.000	[g/m²]	surface pile mass:	410	[g/m²]
total carpet thickness:	5,1	[mm]	surface pile thickness:	2,5	[mm]
thickness of backing:	2,6	[mm]	surface pile density:	0,164	[g/cm³]
density of backing:	0,612	[g/cm³]	number of tufts:	1.580	[1/dm²]

Table 39: Product composition

Product composition	Unit per m^2	Amount per m^2 (dry)
PA6 solution dyed	g	**650**
Primary backing total	g	**100**
Share of PES	%	76
Share of PA6	%	24
Pre-coat total	g	**640**
Share of limestone	%	65
Share of aluminium hydroxide	%	14.3
Share of latex	%	20
Share of acrylate binding agent	%	0.06
Share of tenside	%	0.20
Share of antistatic agent	%	0.43
Share of carbon black	%	0.01
Lamination total	g	**550**
Share of limestone	%	70
Share of latex	%	29.9
Share of acrylate binding agent	%	0.07
Share of tenside	%	0.03
PP textile fabric total	g	**60**
Total weight	g	**2000**

System boundaries

The system boundaries of the product LCA follow the modular design defined by /**Erreur ! Source du renvoi introuvable.**/.

The next table summarizes the included life cycle stages.

Table 40: Included lifecycle stages

Stage	Module	Description
Product Stage	A1	Raw Materials Supply
	A2	Transport
	A3	Manufacturing
Construction Process	A4	Transport
	A5	Construction- Installation process
Use Stage	B1	Use
	B2	Maintenance
	B3	Repair
	B4	Replacement
	B5	Refurbishment
	B6	Operational Energy Use
	B7	Operational Water Use
End of Life Stage	C1	Deconstruction
	C2	Transport
	C3	Waste process for reuse,
	C4	Disposal
Benefits and loads	D	Reuse- Recovery- Recycling potential

The modules B3: Repair, B4: Replacement, B5: Refurbishment, B6: Operational Energy Use and B7: Operational Water Use are not relevant for this product, thus have been excluded from this assessment.

The following chapters describe the modules that are within the scope of this study. The modules included are in line with the requirements for a complete LCA study according to the following table:

Table 41: Definitions for the different study types

Screening - Simplified - Complete

according to SBA Common Metrics Framework 2009 and EeBGuide adaptations

M	**mandatory**
O relevance?	**optional because of minor relevance**
O data?	**optional due to potentially missing data**

	Study type	Before use stage				
		Raw Materials Supply	Transport (to factory)	Manufactoring	Transport (to construction site)	Construction-Installation process
		A1	A2	A3	A4	A5
Product	Screening	O data?	Optional Generic data for foreground system Generic data for background system		O data?	O data?
	Simplified	M	Specific data for foreground system Generic data for background system		O data?	O data?
	Complete	M	Specific data for foreground system Generic data for background system		M	

Screening - Simplified - Complete

according to SBA Common Metrics Framework 2009 and EeBGuide adaptations

M

O relevance?

O data?

	Study type	Use stage						
		Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use
		B1	B2	B3	B4	B5	B6	B7
Product	Screening	O data?	O data?	O data?	O data?	O data?	O data? Estimations or literature specific when focus on it	O data?
	Simplified	O data?	O data?	O data?	O data?	O data?	O data? Literature or specific energy use	O data?
	Complete	M	M	O data?	M	M	M Literature or specific energy use	M

Screening - Simplified - Complete

according to SBA Common Metrics Framework 2009 and EeBGuide adaptations

M

O relevance?

O data?

	Study type	End of Life				Benefits beyond boundary
		Deconstruction	Transport (to disposal)	Waste process for reuse, recovery or/ and recycling	Disposal	Reuse-/ Recovery- /Recyclingpotential
		C1	C2	C3	C4	D
Product	Screening	O data?	O data?	O data? Generic EoL data sets		O data? Generic LCA data sets for reuse-/ recovery-/ recycling potential
Product	Simplified	O data?	O data?	M Specific or generic LCA data for EOL processes		M Specific or generic LCA data for reuse-/ recovery- / recycling potential
Product	Complete	M	M	M Specific or generic LCA data for EOL processes		M Specific or generic LCA data for reuse-/ recovery- / recycling potential

A1-A3, Product stage, information modules

The product stage includes:

- A1, raw material extraction and processing of the next carpet's materials:
  - Polyamide 6 (PA6),
  - Polyester (PES),
  - Polypropylene (PP),
  - Limestone,
  - Latex,
  - Aluminium Hydroxide,

  and the next packaging materials:
  - Cardboard (primary and secondary), and,
  - Polyethylene film.

- A2, transport of the materials to the manufacturing site,

- A3, manufacturing, including:

- o Tufting,
- o Textile fabric backing,
- o Cutting edges, and,
- o Packaging.

These including provision of all materials, products and energy, packaging processing and its transport, as well as waste processing up to the end-of waste state or disposal of final residues during the product stage.

The calorific value used to represent recycled cardboard as packaging material was represented by the value of cardboard made of virgin fibres (primary cardboard), because the recycled cardboard goes into the system without basic material stress so no alterations to the cardboard composition are happening.

The following flowchart represents the system boundaries for the product stage:

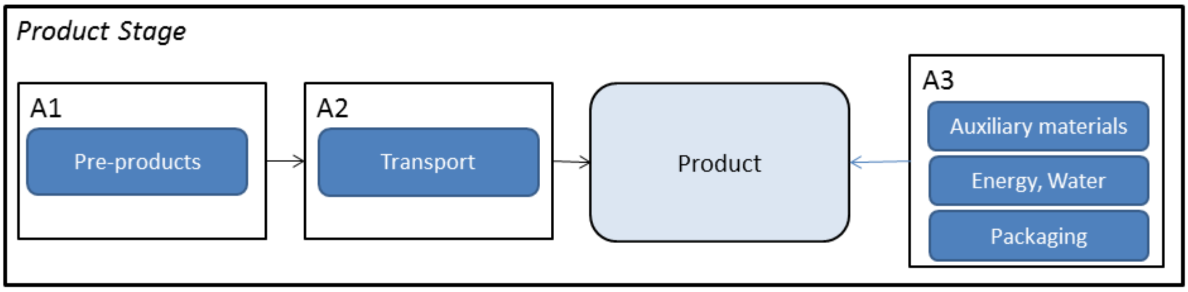

Figure 15: Schematic representation of the LCA system boundaries for the production module (A1-A3)

Table 42: Information on Modules A1-A3

Module A1-A3	The following processes are omitted:	☑	A- 02 "Transport of staff in the supply of raw materials "
		☐	A- 03 "Transport to the manufacturer"
	Explain deviations from provision in the guidance document		
	Explained in the next comment boxes		
	The following deviations from EeBGuide guidance document on data requirements occurred **(Only for "Complete Assessment")**:	* Infrastructure machinery & capital equipment were not included in the foreground system as this was neglected under the cut-off criteria; for the background system it was included for energy generation systems according to the GaBi Database SP20 and Ecoinvent 2.2 * Packaging waste from manufacturing was not modelled because it represents only 0.1% of the total mass through the Life Cycle	
	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	GaBi Database Service Pack 20 (SP20) and Ecoinvent 2.2 have been used as background data and their data quality assessment can be found in the documentation of these databases.	

A4-A5, Construction process stage, information modules

The construction process stage includes:

- A4, transport of the manufactured packed product and the assistants to the construction site;
- A5, installation into the building by laying, fixing and bonding including the production and transport of an additional 9% of the product to replace installation waste, production and use of fixing and adhesive agents, transport and disposal of installation waste (incineration excl. credits) and packaging waste (recycling).

These include also the provision of all materials, products and energy, as well as waste processing up to the end-of-waste state or disposal of final residues during the construction process stage.

700 km have been assumed as the transport distance to the construction site based on Western European delivery distance, using a mix of 20-26t payload trucks from EURO 0 to 5 and an average diesel consumption of 29.4 l/km and utilization rate of 85% including empty trips (GUT, 2006).

Credits from the incineration process were not included because the energy conversion efficiency from incineration is <60%.

The following flowchart represents the system boundaries for the construction process stage:

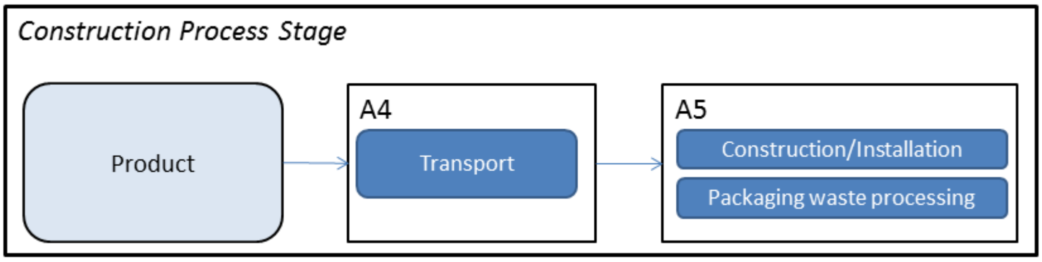

Figure 16: Schematic representation of the LCA system boundaries for the construction process stage (A4-A5)

Table 43: Information on Modules A4-A5

Module A4-A5	The following processes are omitted:	☐	A- 04 "Transports - consideration in complete LCAs"
		☐	A- 05 "Offcuts"
		☐	A- 06 "Transport of the construction worker"
	Explain deviations from provision in the guidance document		
	none		
	The following deviations from EeBGuide guidance document on data requirements occurred **(Only for "Complete Assessment")**:	none	
	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	GaBi Database Service Pack 20 (SP20) and Ecoinvent 2.2 have been used as background data and their data quality assessment can be found in the documentation of these databases.	

B1-B5, Use stage, information modules related to the building fabric

The use stage, related to the use of the construction product in the building includes:

- B1, which includes the interior air emissions by the textile floor covering during the reference service life,
- B2, maintenance, represented by vacuuming and wet cleaning,

including provision and transport of all materials, products and related energy and water use, as well as waste processing up to the end-of-waste state or disposal of final residues during this part of the use stage. These information modules also include all impacts and aspects related to the losses during this part of the use stage (i.e. production, transport, and waste processing and disposal of the lost products and materials).

B3, repair, B4, replacement, and B5, refurbishment, are not considered in this study as the product does not require these services by normal use during its lifetime (GUT, 2006).

In terms of "Release of dangerous substances to soil and water during the use stage", no direct emissions were included, only indirect emissions from maintenance at the wastewater treatment plant, electricity generation and detergent production.

Electricity consumption during vacuuming was based on a frequency of 4 times a week and a cleaning time of 0.05 min/m^2, water and detergent consumption for the reference service life were calculated as 0.03 m^3 of water and 0.06 kg of detergent. All these data were taken from GUT (2006.

The following flowchart represents the system boundaries for the use stage related to the building fabric:

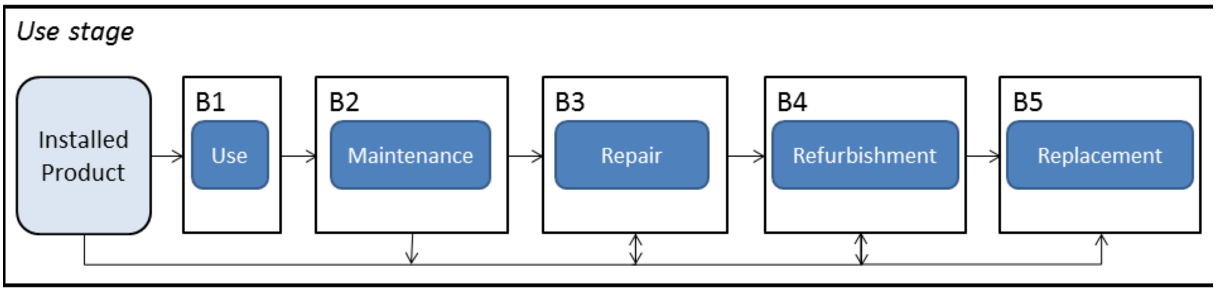

Figure 17: Schematic representation of the LCA system boundaries for the use stage (modules related to the building fabric B1-B5)

Table 44: Information on Modules B1-B5

Module B1-B5	The following processes are omitted:	☑ B- 03 "Release of dangerous substances to soil and water during the use stage"
	Explain deviations from provision in the guidance document	none
	Other processes omitted:	* No repairs were included since the product does not require it
	The following deviations from EN 15804 on data requirements occurred **(Just for "Complete Assessment")**:	none
	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	GaBi Database Service Pack 20 (SP20) and Ecoinvent 2.2 have been used as background data and their data quality assessment can be found in the documentation of these databases.

C1-C4 End-of-life stage, information modules

The end of life of the carpet has been modelled to assess the consequences when disposing it. Three end of life scenarios have been assessed which represent the disposal routes of the carpet according to GUT (2006):

- 100 % landfill assuming it is disposed with commercial waste and including pre-treatment of waste and leachate treatment;
- 100% incineration based on its composition represented by the same technology applied for municipal waste, assuming the carpet would be mixed with this before disposal;
- 100% recycling/energy recovery in a cement kiln, which is a common practice in Europe to send construction products for recycling at their end of life. Emissions were not included as these belong to the cement industry's product system on the basis that the kiln's emissions do not depend on the specific fuel used (German Research Institute of Cement industry, 2008).. Therefore, the burden for the complete cement production stays in the following product system.

Modules C1: de-construction, demolition, and C2: transport to waste processing, are not included in this assessment as they are associated with the use stage which is outside the scope of this study. The end of life considers:

- C3, waste processing for reuse, recovery and/or recycling;
- C4, disposal,

including provision of all materials, products and related energy and water use.

The following flowchart represents the system boundaries for the end of life stage:

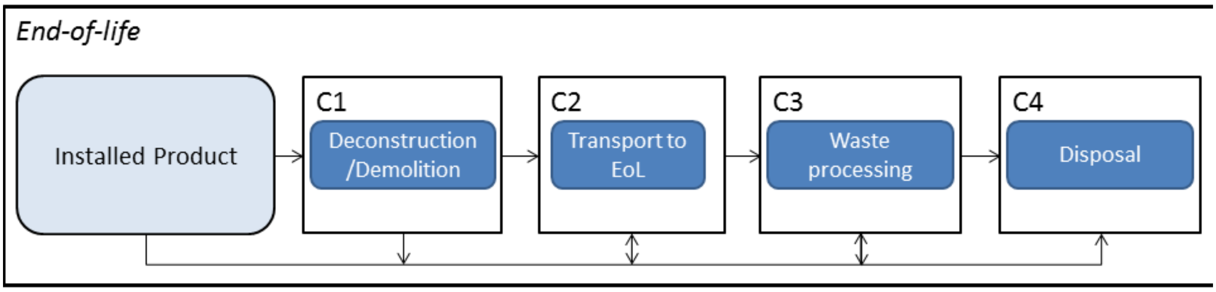

Figure 18: Schematic representation of the LCA system boundaries for the end of life stage (C1-C4)

Table 45: Information on Modules C1-C4

Module C1-C4	The following processes are omitted:	☐	C- 05 "Transport distances (to landfill, to incineration, to recy-cling)"
	Explain deviations from provision in the guidance document		
	none		
	Other processes omitted:	none	
	The following deviations from EN 15804 on data requirements occurred **(Just for "Complete Assessment")**:	none	
	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	GaBi Database Service Pack 20 (SP20) and Ecoinvent 2.2 have been used as background data and their data quality assessment can be found in the documentation of these databases.	

D Benefits and loads beyond the system boundary, information module

The benefits of Module D including reuse and recovery were calculated as follows:

- The landfill of the carpet was modelled based on country average data for Austria, Belgium, Denmark, Finland, France, Germany, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom, with an average of 25% of the produced gas used to substitute electricity production;

- For the energy recovered from incineration, average calorific values from the carpet composition were used.

- For the recycling/energy recovery of the carpet in the cement kiln, its inorganic portion (chalk and aluminium hydroxide) is incorporated into the cement clinker as process additive substituting 90 of chalk and 10% of aluminium hydroxide, whilst the organic part is used to replace coal, lignite and petrol coke used in a cement kiln as a secondary fuels with a heating value of 32.2 MJ/kg (German Research Institute of Cement industry, 2008). On this basis, the calorific values for the substituted fuels were taken from the German Federal Ministry of Economics and Technology and these were used for calculating the substitution of coal (30 MJ/kg), lignite (9.15 MJ/kg), and petroleum coke (31.5 MJ/kg). The proportion of coal/lignite/petroleum coke substituted were 33.2/55/11.8% respectively according to GUT (2006).

The following flowchart represents the system boundaries for benefits/loads beyond the system boundary:

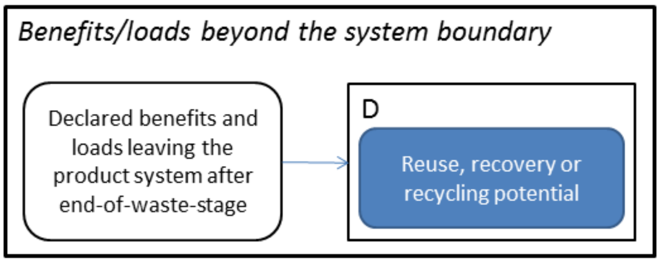

Figure 19: Schematic representation of the LCA system boundaries for the benefits and loads beyond the product system boundary in module D

Table 46: Information on Module D

Module D	The following processes are omitted:	☐ D- 02 "Reuse - water consumption"
	Explain deviations from provision in the guidance document	
	none	
	Other processes omitted:	none
	The following deviations from EN 15804 on data requirements occurred **(Just for "Complete Assessment")**:	none
	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	GaBi Database Service Pack 20 (SP20) and Ecoinvent 2.2 have been used as background data and their data quality assessment can be found in the documentation of these databases.

Electric energy mix

The selection of the background data for the electricity generation is in line with EeBGuide. European average (EU-27) and German average data were used. This was taken from GaBi 5 database Service Pack 20 [PE International, 2011] which is ILCD compliant.

For the European average electricity generation, data from 2008 official statistics on national energy carrier mixes, efficiencies, net losses and consumption were used. For the German average electricity generation, data from 2008 official statistics was included on average national specific electricity mix including main producers as well as imports energy carrier mixes, efficiencies, net losses and consumption.

The data sources for the complete system are consistent and details can be found in GaBi 5 documentation [Frischknecht et al.,2007]. The key emissions e.g. carbon dioxide, sulphur dioxide, nitrogen oxide, etc., of the power plants are based on measured operating data taken from national statistics. All other emissions from the power plants are based on literature data and/or calculated via energy carrier composition in combination with literature-based combustion models. Infrastructure data are from literature. The data on the energy carrier supply chain is based on statistics with country/region-specific transport distances, as well as industry and literature data on the inventory of exploration and extraction. Refinery data are also based on statistical data and measurements of major refineries as well as literature data. LCI modelling is fully consistent with the ILCD guidelines.

CO_2-Certificates

No CO_2-certificates are considered in this study.

Description of the system boundary in the background report

The definition of the system boundaries meets the requirements of EeBGuide.

Criteria for the exclusion of inputs and outputs

The application of the cut-off criteria for the exclusion of inputs and outputs follows the EN 15804 standard. Data gaps may be filled by conservative assumptions with average or generic data. Any assumptions for such choices shall be documented.

In case of insufficient input data or data gaps for a unit process, the cut-off criteria shall be:

- 1% of renewable and non-renewable primary energy usage and 1% of the total ass input of that unit process, and,
- the total of neglected input flows per module, e.g. per module A1-3, A4-5, B1-5, B6-7, C1-4 and D shall be a maximum of 5% of energy usage and mass.

Particular care should be taken to include material and energy flows known to have the potential to cause significant emissions into air and water or soil related to the environmental indicators of this standard.

Conservative assumptions in combination with plausibility considerations and expert judgment can be used to demonstrate compliance with these criteria.

In this particular study, the production and use of dyes in the manufacturing of this product were excluded on the basis that their input to the PA6 yarn is less than 1%.

Packaging waste was not considered because it constitutes less than 0.1% of the total mass of the packaging.

Infrastructure machinery & capital equipment were not included in the foreground system as these are typically excluded when assessing these types of products since they are insignificant in terms of mass and energy consumption and in terms of their contribution to the potential environmental impacts.

33. Life cycle inventory analysis

Data collection and calculation procedures

Data collection follows the guidance provided in /**Erreur ! Source du renvoi introuvable.**/, clause 4.3.2. The calculation procedures described in /**Erreur ! Source du renvoi introuvable.**/ are applied consistently throughout the study.

According to the definition of scope of the study, all relevant inputs and outputs related to the products or product systems are identified and quantified.

Developing product level scenarios

Except for the required modules A1 to A3, which describe the product stage, the data for the disposal routes and benefits beyond the system boundaries are based on assumptions and described as scenarios.

For modules C3, C4 and D, three different end-of-life scenarios were modelled:

- Baseline scenario: 100% of the carpet sent to landfill within Europe,
- Scenario 1: 100% of the carpet sent to incineration within Europe, and,
- Scenario 2: 100% of the carpet sent to a cement producer for recycling/energy recovery as secondary material/fuel within the kiln.

All combustion processes in the incineration and kiln processes were credited with energy recovery in module D as well as the methane gas combustion from landfill.

For the use of the carpet in the cement kiln, a 100% use rate was modelled since this is the usual practice within Germany.

Selection of data/ background data

As a general rule, specific data or average data derived from specific production processes shall be the first choice as a basis for calculating a product LCA.

For life cycle modelling of the considered product the GaBi 5, Software-System and Databases for Life Cycle Engineering was used. All relevant background datasets were taken from GaBi 5 database Service Pack 20 (PE International, 2011) and Ecoinvent 2.2 database (Frischknecht et al., 2007) and provided by PE International and the Swiss Centre for Life Cycle Inventories.

The applied foreground datasets are based on 1 year averaged data from 2010 and have either European or country specific average coverage. The data sets for the background system are based on 1 year averaged data from a range of years varying from 2000 to 2011.

Data/ background data quality requirements

The requirements for data quality and background data correspond to the specifications of EeBGuide.

The datasets are complete and conform to the system boundaries and the criteria for the exclusion of inputs and outputs. All datasets are specific to the product system model to the extent possible, and when this is not the case they are generic and representing the technology and region assessed.

Specific information about their age, technologies and regions represented cannot be disclosed due to confidentiality terms of GUT with the German manufacturer. However, these should be included when assessing construction products according to this guidance. In this particular case, this information has been reviewed by an external verifier before producing the Environmental Product Declaration in terms of data quality and representativeness.

The foreground system data have been assessed in terms of quality and representativeness by an external critical review (Klöpffer W. and Hischier R., 2004).

The background data complies with data quality and representativeness requirements according to GaBi 5 database Service Pack 20 and Ecoinvent 2.2 database.

Allocation

In the present study no allocation has been required.

In modules A1, A2 and A3 electricity and thermal energy is recovered from the incineration of manufacturing waste from PA6 from spinning/colouring and from cutting the edges of the carpet. This recovered energy was subtracted from the input electricity based on the European electricity grid and the input thermal energy from natural gas (EU-27), in this way reflecting the NET energy consumption.

Substitution of the average European electricity grid and thermal energy from natural gas (EU-27) were modelled for the incineration of the carpet at its end of life, and substitution of the average European electricity grid (EU-27) was modelled for the landfilling of the carpet.

Substitution of European average virgin marginal materials (chalk and aluminium hydroxide) was modelled for the use of the carpet’s inorganic elements in a cement kiln, and substitution of German average virgin marginal materials (coal, lignite and petroleum coke) was modelled for the use of the carpet’s combustible components.

34. Life cycle inventory analysis and life cycle impact assessment

The results of the LCA for all modules A1 to D are represented in the following tables. The inventory analysis indicators to be declared and the impact assessment are in accordance with EN 15804.

Indicators for the life cycle inventory analysis according to EN 15804

The following environmental indicators are derived from the LCI. They describe the use of renewable and non-renewable material resources, renewable and non-renewable primary energy and water.

Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ, net calorific value
Use of renewable primary energy resources used as raw materials	MJ, net calorific value
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ, net calorific value
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	MJ, net calorific value
Use of non-renewable primary energy resources used as raw materials	MJ, net calorific value
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ, net calorific value
Use of secondary material	kg
Use of renewable secondary fuels	MJ, net calorific value
Use of non-renewable secondary fuels	MJ, net calorific value
Use of net fresh water	m^3

The indicators describing waste categories and other material flows are output flows derived from the LCI.

Other environmental information describing waste categories is described next:

Hazardous waste disposed	kg
Non hazardous waste disposed	kg
Radioactive waste disposed	kg

Other environmental information describing output flows is described next:

Components for re-use	kg
Materials for recycling	kg

Materials for energy recovery	kg
Exported energy as thermal energy	MJ per energy carrier
Exported energy as electrical energy	MJ per energy carrier

Indicators for the life cycle impact assessment according to EN 15804

The following environmental impact categories have been assessed based on characterisation factors from CML (Institute of Environmental Sciences Faculty of Science University of Leiden, Netherlands) referring to the EN 15804 standard:

Global warming potential (GWP);	kg CO_2-equiv.
Depletion potential of the stratospheric ozone layer (ODP);	kg CFC 11- equiv
Acidification potential of soil and water, (AP);	kg SO_2 - equiv
Eutrophication potential (EP);	kg $(PO_4)^{3-}$ - equiv
Formation potential of tropospheric ozone (POCP);	kg Ethene - equiv
Abiotic depletion potential (ADP-elements) for non-fossil resources	kg Sb - equiv
Abiotic depletion potential (ADP-fossil fuels) for fossil resources	MJ, net calorific value

The results from the impact assessment are only relative statements which give no information about the endpoint of the impact categories, overstepping of threshold values, safety margins or risk.

Summary of assessed environmental indicators

The table below illustrates the environmental indicators assessed in this study.

Table 47: Used environmental indicators

Used indicators	☑	1. Global warming potential
	☑	2. Acidification Potential
	☑	3. Eutrophication Potential
	☑	4. Photochemical Ozone Creation Potential
	☑	5. Total use of renewable primary energy
	☑	6. Total use of non-renewable primary energy
	☑	7. Depletion potential of the stratospheric ozone layer
	☑	8. Abiotic Resource Depletion Potential for elements
	☑	9. Abiotic Resource Depletion Potential of fossil fuels
	☑	10. Secondary Materials
	☑	11. Secondary fuels - renewable
	☑	12. Secondary fuels – non renewable
	☑	13. Net Fresh Water
	☑	14. Hazardous Waste
	☑	15. Non Hazardous Waste
	☑	16. Radioactive Waste
	☑	17. Components for Re-Use
	☑	18. Materials for Recycling
	☑	19. Materials for Energy Recovery
	☑	20. Exported Energy
	☑	Use of renewable primary energy excluding raw materials
	☑	Use of renewable primary energy as raw materials
	☑	Use of non-renewable primary energy excluding raw material
	☑	Use of non-renewable primary energy as raw materials

Description of the Baseline scenario

The following table illustrates the parameters used in the Baseline scenario, which is represented by landfilling the carpet at its end of life.

Table 48: Description of the Baseline scenario

Baseline scenario	G- 05 "Reference study period"	The lifetime of the textile floor covering depends strongly on the proper installation and following of the instructions for use provided by the manufacturer according to the use class. In this case the reference life is of 10 years, guaranteeing a proper functional and visual quality.
	G- 09 "Future technical developments and innovation"	No innovation to be considered, current technologies to be used
	G- 11 "Accounting for carbon storage / carbon sequestration"	Biogenic carbon storage/emissions are not considered
	B- 11 "Modelling of water use"	Net water consumption only, water scarcity is not considered
	C- 02 "End of Life (EOL) scenarios"	100% Landfill

The next section shows the detailed results for the Baseline scenario.

Results Baseline Scenario

Table 49: Overview of the LCA results – Baseline scenario (part A)

Overview over the product LCA results							
1 year	1. Global warming potential	2. Acidification Potential	3. Eutrophication Potential	4. Photochemical Ozone Creation Potential	5. Use of renewable primary energy excluding raw materials	6. Use of renewable primary energy as raw materials	7. Total use of renewable primary energy
	GWP	AP	EP	POCP	PERE	PERM	PERT
	[kg CO_2-equiv./m²$_{NFA}$*a]	[kg SO_2-equiv./m²$_{NFA}$*a]	[kg PO_4^{-3} - equiv. /m²$_{NFA}$*a]	[kg C_2H_4-equiv./m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]
Product Stage	0.97	1.99E-03	2.50E-04	2.95E-04	0.56	0.00	0.56
Construction Process	0.14	3.10E-04	6.78E-05	2.31E-05	0.18	0.00	0.18
Use Stage	0.29	1.31E-03	1.96E-04	1.88E-04	0.45	0.00	0.45
End of Life Stage	0.25	5.68E-05	2.57E-04	6.51E-05	7.49E-03	0.00	7.49E-03
Benefits and loads beyond the system boundary	-1.14E-02	-4.88E-05	-2.62E-06	-2.97E-06	-2.92E-02	0.00	-2.92E-02

Table 50: Overview of the LCA results – Baseline scenario (part B)

Overview over the product LCA results									
1 year	8. Use of non-renewable primary energy excluding raw materials	9. Use of non-renewable primary energy as raw materials	10. Total use of non-renewable primary energy	11. Depletion potential of the stratospheric ozone layer	12. Abiotic Resource Depletion Potential for elements	13. Abiotic Resource Depletion Potential of fossil fuels	14. Secondary Materials	15. Secondary fuels - renewable	16. Secondary fuels – non renewable
	PENRE	PENRM	PENRT	ODP	ADPE	ADPF	SM	RSF	NRSF
	[MJ/m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]	[kg CFC11-equiv./m²$_{NFA}$*a]	[kg Sb-Equiv. /m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]	[kg /m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]
Product Stage	15.39	3.60	18.99	1.07E-08	2.51E-07	17.84	2.60E-03	0.00	0.00
Construction Process	2.18	0.00	2.18	2.45E-09	8.94E-08	2.03	0.00	0.00	0.00
Use Stage	6.56	0.00	6.56	1.63E-08	5.36E-07	5.41	0.00	0.00	0.00
End of Life Stage	0.16	0.00	0.16	3.62E-11	2.08E-09	0.16	0.00	0.00	0.00
Benefits and loads beyond the system boundary	-2.00E-01	0.00	-2.00E-01	-7.48E-10	-9.39E-10	-1.30E-01	0.00	0.00	0.00

Table 51: Overview of the LCA results – Baseline scenario (part C)

Overview over the product LCA results									
1 year	17. Net Fresh Water	18. Hazardous Waste	19. Non Hazardous Waste	20. Radioactive Waste	21. Components for Re-Use	22. Materials for Recycling	23. Materials for Energy Recovery	24. Exported Energy - electricity	25. Exported Energy - steam
	FW	HWD	NHWD	RWD	CFR	MFR	MER	EE (elec.)	EE (steam)
	$[m^3/m^2_{NFA}*a]$	$[kg/m^2_{NFA}*a]$	$[kg/m^2_{NFA}*a]$	$[kg/m^2_{NFA}*a]$	$[kg/m^2_{NFA}*a]$	$[kg/m^2_{NFA}*a]$	$[kg/m^2_{NFA}*a]$	$[MJ/m^2_{NFA}*a]$	$[MJ/m^2_{NFA}*a]$
Product Stage	0.65	1.09E-03	0.93	4.30E-04	0.00	3.90E-04	0.00	0.00	0.00
Construction Process	0.10	2.50E-03	9.95E-02	4.57E-05	0.00	2.80E-03	0.00	2.32E-02	0.13
Use Stage	0.83	0.00	0.59	3.86E-04	0.00	0.00	0.00	0.00	0.00
End of Life Stage	5.65E-03	0.00	0.15	2.80E-06	0.00	0.00	0.00	8.43E-02	0.00
Benefits and loads beyond the system boundary	-4.16E-02	0.00	-4.28E-02	-2.86E-05	0.00	0.00	0.00	0.00	0.00

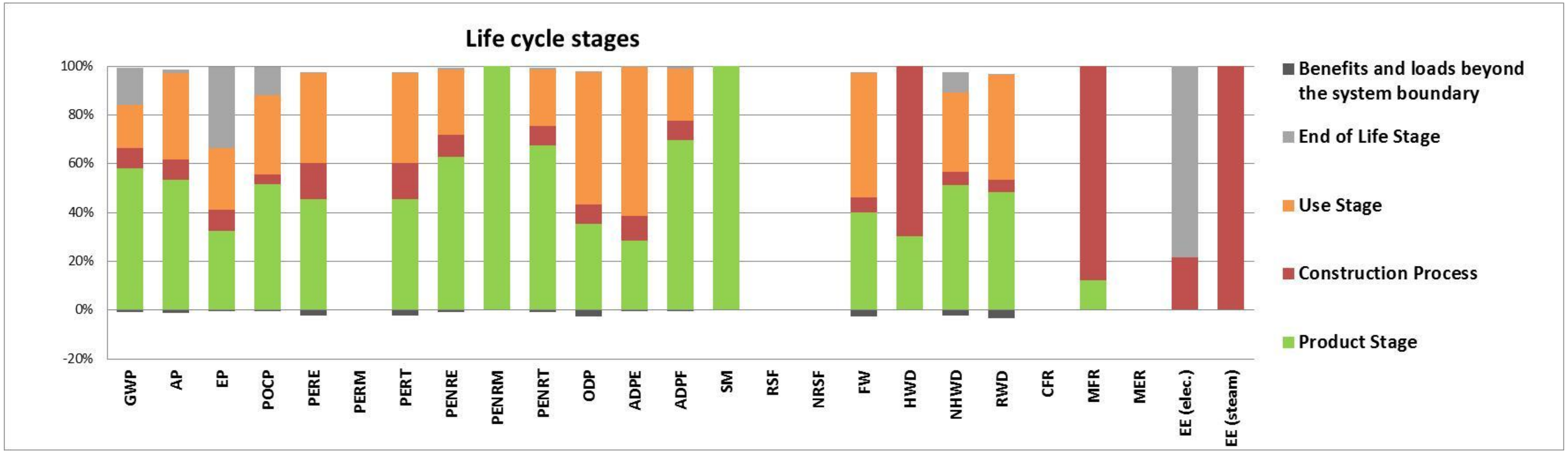

Figure 20: Results Indicators - life cycle stages Baseline scenario

Interpretation of the results for the Baseline Scenario

The results show that the manufacturing stage plays an important relative contribution to the overall cradle-to-grave assessment for many indicators. This is most clearly seen for:

- Global warming potential,
- Acidification potential,
- Photochemical ozone creation potential,
- Use of renewable and non-renewable primary energy,
- Abiotic depletion potential of fossil fuels,
- Use of secondary materials,
- Generation of non-hazardous waste,
- Generation of radioactive waste.

The manufacturing of this product is energy intensive as it is produced over a series of steps involving tufting, primary backing, shearing, back coating, cutting and packaging, as well as other sub-stages happening for each manufacturing step. Most of these stages and sub-stages are carried out by machine and thus require electricity and thermal energy to function.

The manufacturing impacts along with impacts associated with the production of and transport of raw materials result in a high overall contribution of the production stage to the total life cycle impacts.

The installation and construction processes account for the majority of the hazardous waste generated from incinerating the carpet offcuts and some of the packaging material, and these same steps also account for the majority of the exported energy generated as steam. The paper/cardboard fractions of the packaging are sent for recycling, and that is what makes most of the contribution to materials for recycling.

The carpet produces emissions during its use and it also needs to be maintained. These contribute to the majority of the following environmental indicators:

- Stratospheric ozone layer depletion resulting mostly from emissions generated during the production of the detergent needed to wet clean the carpet and those from electricity generation needed to vacuum the carpet and treat the water used and wastewater generated from wet cleaning it;
- Abiotic resource depletion (elements) resulting from electricity generation and detergent production;
- Net consumption of fresh water needed mostly for wet cleaning the carpet.

The end of life does not play an important role in the environmental profile of the carpet, except for the exported energy in the form of electricity generated from the landfill's methane emissions at its end of use. Smaller contributions to global warming and eutrophication potentials come mostly from the landfill, and to a minor extent from its transportation to the disposal site.

The benefits and loads beyond the system boundary are rather small when the carpet is sent to landfill.

35. Scenarios

Description of the parameters for Scenario 1

In the following table the parameters of this scenario, focused on incineration at end of life, are described.

Table 52: Description of Scenario 1

Scenario 1	G- 05 "Reference study period"	The lifetime of the textile floor covering depends strongly on the proper installation and following of the instructions for use provided by the manufacturer according to the use class. In this case the reference life is of 10 years, guaranteeing a proper functional and visual quality.
	G- 09 "Future technical developments and innovation"	No innovation to be considered, current technologies to be used
	G- 11 "Accounting for carbon storage / carbon sequestration"	Biogenic carbon storage/emissions are not considered
	B- 11 "Modelling of water use"	Net water consumption only, water scarcity is not considered
	C- 02 "End of Life (EOL) scenarios"	100% incineration
	[further variation]	not applicable

The next section shows the detailed results for the Scenario 1.

Results for Scenario 1

The following tables and figures show the results of the scenario.

Table 53: Overview of the LCA results – Scenario 1 (part A)

Overview over the product LCA results							
1 year	1. Global warming potential	2. Acidification Potential	3. Eutrophication Potential	4. Photochemical Ozone Creation Potential	5. Use of renewable primary energy excluding raw materials	6. Use of renewable primary energy as raw materials	7. Total use of renewable primary energy
	GWP	AP	EP	POCP	PERN	PERM	PERT
	[kg CO_2-equiv./m^2_{NFA}*a]	[kg SO_2-equiv./m^2_{NFA}*a]	[kg PO_4^{-3} - equiv. /m^2_{NFA}*a]	[kg C_2H_4-equiv./m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]
Product Stage	0.97	1.99E-03	2.50E-04	2.95E-04	0.56	0.00	0.56
Construction Process	0.14	3.10E-04	6.78E-05	2.31E-05	0.18	0.00	0.18
Use Stage	0.29	1.31E-03	1.96E-04	1.88E-04	0.45	0.00	0.45
End of Life Stage	0.38	2.51E-04	6.58E-05	1.70E-05	1.48E-02	0.00	1.48E-02
Benefits and loads beyond the system boundary	-1.23E-01	-1.81E-04	-1.60E-05	-2.00E-05	-6.89E-02	0.00	-6.89E-02

Table 54: Overview of the LCA results – Scenario 1 (part B)

Overview over the product LCA results									
1 year	8. Use of non-renewable primary energy excluding raw materials	9. Use of non-renewable primary energy as raw materials	10. Total use of non-renewable primary energy	11. Depletion potential of the stratospheric ozone layer	12. Abiotic Resource Depletion Potential for elements	13. Abiotic Resource Depletion Potential of fossil fuels	14. Secondary Materials	15. Secondary fuels - renewable	16. Secondary fuels – non renewable
	PENRE	PENRM	PENRT	ODP	ADPE	ADPF	SM	RSF	NRSF
	[MJ/m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[kg CFC11-equiv./m^2_{NFA}*a	[kg Sb-Equiv. /m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]
Product Stage	15.39	3.60	18.99	1.07E-08	2.51E-07	17.84	2.60E-03	0.00	0.00
Construction Process	2.18	0.00	2.18	2.45E-09	8.94E-08	2.03	0.00	0.00	0.00
Use Stage	6.56	0.00	6.56	1.63E-08	5.36E-07	5.41	0.00	0.00	0.00
End of Life Stage	0.33	0.00	0.33	3.27E-11	7.14E-08	0.31	0.00	0.00	0.00
Benefits and loads beyond the system boundary	-2.00E+00	0.00	-2.03E+00	-1.75E-09	-5.71E-09	-1.87E+00	0.00	0.00	0.00

Table 55: Overview of the LCA results – Scenario 1 (part C)

Overview over the product LCA results									
1 year	17. Net Fresh Water	18. Hazardous Waste	19. Non Hazardous Waste	20. Radioactive Waste	21. Components for Re-Use	22. Materials for Recycling	23. Materials for Energy Recovery	24. Exported Energy - electricity	25. Exported Energy - steam
	FW	HWD	NHWD	RWD	CFR	MFR	MER	EE (elec.)	EE (steam)
	[m^3/m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]
Product Stage	0.65	1.09E-03	0.93	4.30E-04	0.00	3.90E-04	0.00	0.00	0.00
Construction Process	0.10	2.50E-03	9.95E-02	4.57E-05	0.00	2.80E-03	0.00	2.32E-02	0.13
Use Stage	0.83	0.00	0.59	3.86E-04	0.00	0.00	0.00	0.00	0.00
End of Life Stage	1.54E-02	2.67E-02	3.66E-02	9.72E-06	0.00	0.00	0.00	0.18	1.22
Benefits and loads beyond the system boundary	-9.81E-02	0.00	-1.01E-01	-6.72E-05	0.00	0.00	0.00	0.00	0.00

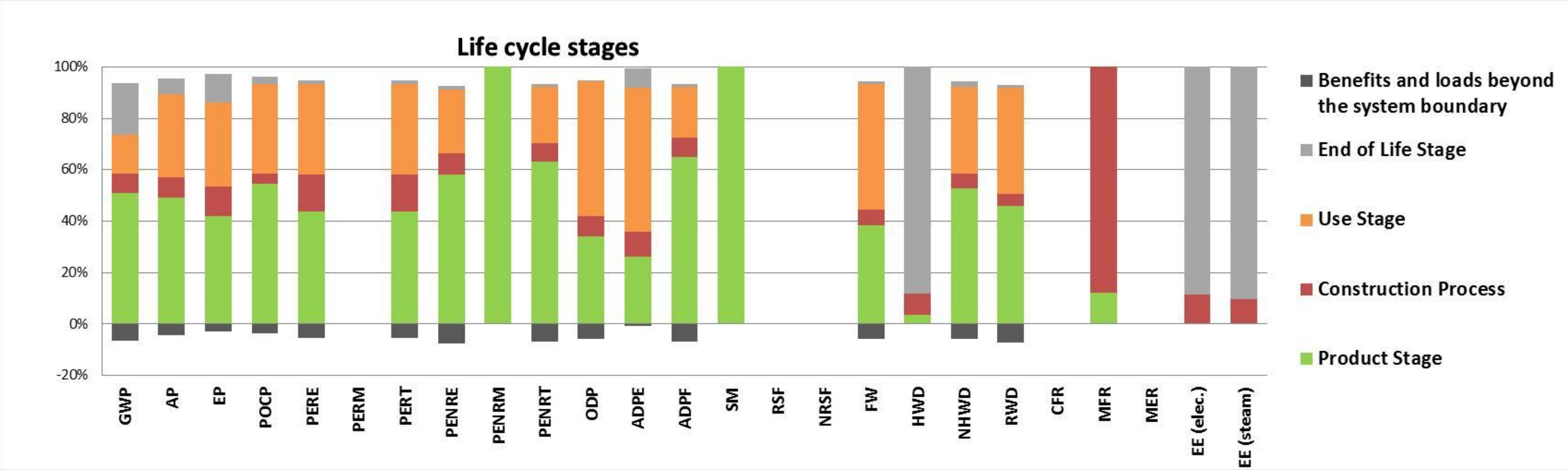

Figure 21: Results Indicators - life cycle stages Scenario 1

Interpretation of the results for Scenario 1

The overall results of this scenario do not show significant differences compared to those from the baseline scenario, where the assessment considered the carpet being sent to landfill at its end of life.

The greatest differences occur for:

- eutrophication potential where the contribution from incineration at the carpet's end of life are rather lower than those from landfill;
- generation of hazardous waste, where most of the hazardous waste is generated by that same incineration process that results in reduced eutrophication potential,
- generation of exported energy as electricity, where more is produced by the incineration process at the end of life rather and less occurs over the construction/installation of the carpet.

In general it is seen that the end of life plays a more significant role than for the baseline scenario.

The benefits and loads beyond the system boundary are higher for most of the environmental indicators although they still remain low in relation to contributions from the other stages.

Description of the parameters for Scenario 2

In the following table the parameters of this scenario, focused on using the carpet as a secondary fuel/material in a cement kiln at its end of life, are described.

Table 56: Description of Scenario 2

Scenario 2	G- 05 "Reference study period"	The lifetime of the textile floor covering depends strongly on the proper installation and following of the instructions for use provided by the manufacturer according to the use class. In this case the reference life is of 10 years, guaranteeing a proper functional and visual quality.
	G- 09 "Future technical developments and innovation"	No innovation to be considered, current technologies to be used
	G- 11 "Accounting for carbon storage / carbon sequestration"	Biogenic carbon storage/emissions are not considered
	B- 11 "Modelling of water use"	Net water consumption only, water scarcity is not considered
	C- 02 "End of Life (EOL) scenarios"	100% reuse in a cement kiln
	[further variation]	not applicable

The next section shows the detailed results for the Scenario 2.

Results for Scenario 2

Table 57: Overview of the LCA results – Scenario 2 (part A)

Overview over the product LCA results								
1 year	1. Global warming potential	2. Acidification Potential	3. Eutrophication Potential	4. Photochemical Ozone Creation Potential	5. Use of renewable primary energy excluding raw materials	6. Use of renewable primary energy as raw materials	7. Total use of renewable primary energy	8. Use of non-renewable primary energy excluding raw materials
	GWP	AP	EP	POCP	PERE	PERM	PERT	PENRE
	[kg CO_2-equiv./m²$_{NFA}$*a]	[kg SO_2-equiv./m²$_{NFA}$*a]	[kg PO_4^{-3} - equiv. /m²$_{NFA}$*a]	[kg C_2H_4-equiv./m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]
Product Stage	0.97	1.99E-03	2.50E-04	2.95E-04	0.56	0.00	0.56	15.39
Construction Process	0.14	3.10E-04	6.78E-05	2.31E-05	0.18	0.00	0.18	2.18
Use Stage	0.29	1.31E-03	1.96E-04	1.88E-04	0.45	0.00	0.45	6.56
End of Life Stage	1.82E-03	7.91E-06	8.03E-07	-4.18E-07	3.71E-03	0.00	3.71E-03	3.02E-02
Benefits and loads beyond the system boundary	-2.62E-02	-1.71E-04	-3.84E-05	-2.13E-05	-9.32E-03	0.00	-9.32E-03	-3.93E+00

Table 58: Overview of the LCA results – Scenario 2 (part B)

Overview over the product LCA results								
1 year	9. Use of non-renewable primary energy as raw materials	10. Total use of non-renewable primary energy	11. Depletion potential of the stratospheric ozone layer	12. Abiotic Resource Depletion Potential for elements	13. Abiotic Resource Depletion Potential of fossil fuels	14. Secondary Materials	15. Secondary fuels - renewable	16. Secondary fuels – non renewable
	PENRM	PENRT	ODP	ADPE	ADPF	SM	RSF	NRSF
	[MJ/m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]	[kg CFC11-equiv./m²$_{NFA}$*a]	[kg Sb-Equiv. /m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]	[kg /m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]
Product Stage	3.60	18.99	1.07E-08	2.51E-07	17.84	2.60E-03	0.00	0.00
Construction Process	0.00	2.18	2.45E-09	8.94E-08	2.03	0.00	0.00	0.00
Use Stage	0.00	6.56	1.63E-08	5.36E-07	5.41	0.00	0.00	0.00
End of Life Stage	0.00	3.02E-02	8.88E-11	1.30E-10	2.19E-02	0.00	0.00	0.00
Benefits and loads beyond the system boundary	0.00	-3.93E+00	-6.89E-09	-4.38E-09	-3.91E+00	0.00	0.00	0.00

Table 59: Overview of the LCA results – Scenario 2 (part C)

Overview over the product LCA results									
1 year	17. Net Fresh Water	18. Hazardous Waste	19. Non Hazardous Waste	20. Radioactive Waste	21. Components for Re-Use	22. Materials for Recycling	23. Materials for Energy Recovery	24. Exported Energy - electricity	25. Exported Energy - steam
	FW	HWD	NHWD	RWD	CFR	MFR	MER	EE (elec.)	EE (steam)
	[m³/m²$_{NFA}$*a]	[kg /m²$_{NFA}$*a]	[kg /m²$_{NFA}$*a]	[kg /m²$_{NFA}$*a]	[kg /m²$_{NFA}$*a]	[kg /m²$_{NFA}$*a]	[kg /m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]
Product Stage	0.65	1.09E-03	0.93	4.30E-04	0.00	3.90E-04	0.00	0.00	0.00
Construction Process	0.10	2.50E-03	9.95E-02	4.57E-05	0.00	2.80E-03	0.00	2.32E-02	0.13
Use Stage	0.83	0.00	0.59	3.86E-04	0.00	0.00	0.00	0.00	0.00
End of Life Stage	4.96E-03	0.00	5.10E-03	3.40E-06	0.00	9.00E-02	0.11	0.00	0.00
Benefits and loads beyond the system boundary	-1.84E-02	0.00	-2.71E+00	-5.80E-06	0.00	0.00	0.00	0.00	0.00

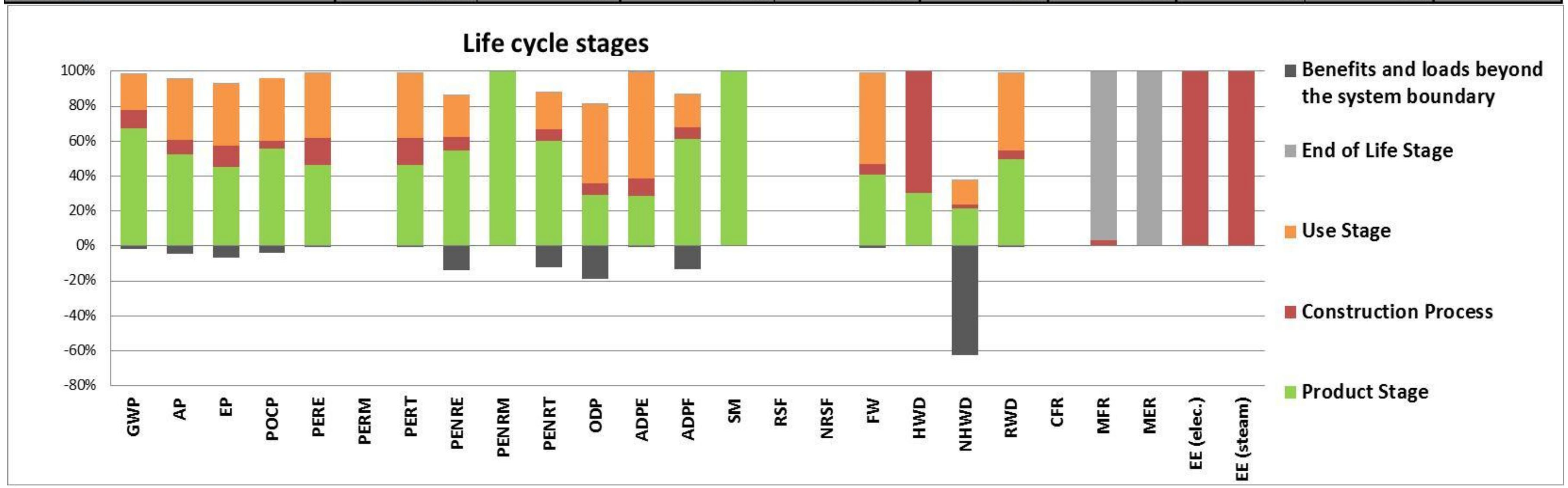

Figure 22: Results Indicators - life cycle stages Scenario 2

Interpretation of the results for Scenario 2

The overall results of this scenario show some significant differences compared to those from the baseline scenario and scenario 1.

The contribution from the end of life stage to all indicators is reduced almost entirely except for materials for recycling and materials for energy recovery (where a high value is considered desirable). This is because about 45% of the carpet's mass substitutes for inorganic materials that are typically used as cement additives and the other 55% is used for combustion in the cement kiln. Due to the lower impacts caused by the carpet's end of life, the contribution of the use stage becomes more evident whilst that of the production stage remains as important as in the other two scenarios.

The benefits and loads beyond the system boundary are even higher than those at scenario 1. These are more evident by avoiding:

- **d.** the use of fossil fuels,
- **e.** the emissions which create the depletion of the stratospheric ozone layer,
- **f.** the generation of stockpile/overburden non-hazardous waste,

These result from using the carpet as secondary fuel/material at the cement kiln thus avoiding the use of hard coal, lignite and petroleum coke as energy fuels and calcium carbonate and aluminium hydroxide as cement additives.

36. Conclusion

The production stage in all scenarios is evidently the most important contributor to the life cycle environmental profile of the carpet. Regardless of which end of life route is selected, the relative contribution from production remains high, whilst the contributions from the use stage become more evident when a lower impact end of life route is selected.

By incinerating the carpet there are no substantial differences other than the generation of more exported energy as electricity (this does bring reductions to several environmental impact categories but these are not great compared to the rest of the life cycle impacts). However, the greatest benefits are created by sending the carpet for use as secondary fuel/material at cement kilns. This end of life route results in the carpet having a better environmental profile in most of the indicators assessed, especially for the use of non-renewable primary energy, the use of fossil fuels, and the generation of non-hazardous waste and stratospheric ozone depleting emissions.

37. References

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Frischknecht et al. (2007)	Overview and Methodology. Final report ecoinvent data v2.0, No.1. Swiss Centre for Life Cycle Inventories, Dübendorf, CH.
Joint Research Centre (JRC), European Commission (2010)	General guide for Life Cycle Assessment – Detailed guidance
Klöpffer and Hischier (2004)	Ökologische Bilanzierung von Teppichböden. Kritische Prüfung nach EN DIN 14040
German Research Institute of Cement Industry (2008)	Environmental Data of the German Cement Industry. Concrete: Environmental profiles of cement and concrete. Manufacture, use and alternative materials.

Documentation for the calculation of the reference service life (RSL)

The RSL of textile floor coverings is usually 10 years according to the guidelines "useful life of components" by the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR). For more information, refer to GUT (2006).

Background Report for Products

LCA of the products

General information

Name of the product:	Transparent Solar Thermal Collector (TSTC)
Date of the assessment:	28.08.2012
name and qualification of the assessor:	Katrin Lenz (Scientific Researcher at the Dept. GaBi, LBP)
name and qualification of the reviewer:	CSTB
Review type	*project internal review*
Date of the verification	*to be specified after review*
Client of the study:	*European Commission, European research project "EeBGuide" and "Cost-Effective"*
Authors of the study:	*University of Stuttgart, Chair for Building Physics (LBP), Dept. Life Cycle Engineering (GaBi)*

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Nomenclature

Abbreviation	Explanation
ADP	Abiotic Depletion Potential
ADPE	Abiotic Resource Depletion Potential for elements
ADPF	Abiotic Resource Depletion Potential of fossil fuels
AP	Acidification Potential
BLBSB	Benefits and Loads Beyond the System Boundary
CML	Centrum voor Milieukunde, Leiden (NL)
CRU	Components for re-use
EE	Exported energy per energy carrier
EP	Eutrophication Potential
EPD	Environmental Product Declaration
FW	Use of net fresh water
GWP	Global Warming Potential
HWD	Hazardous waste disposed
IBU	Institut Bauen und Umwelt e.V.
MER	Materials for energy recovery
MFR	Materials for recycling
NRSF	Use of non-renewable secondary fuels
NHWD	Non hazardous waste disposed
ODP	Ozone Layer Depletion Potential
PENRE	Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials
PENRM	Use of non-renewable primary energy resources used as raw materials
PENRT	Total use of non-renewable primary energy resources
PERE	Use of renewable primary energy excluding renewable primary energy resources used as raw materials
PERM	Use of renewable primary energy resources used as raw materials
PERT	Total use of renewable primary energy resources
PCR	Product Category Rules
POCP	Photochemical Ozone Creation Potential

RSF	Use of renewable secondary fuels
RSL	Reference Service Life
RWD	Radioactive waste disposed
SM	Use of secondary material

38. Scope

This document is the background report for the report on the life cycle assessment results of the product "TSTC". The study conducted, follows the provisions and guidelines of EeBGuide.

39. Content, structure and accessibility of the background report

The background report provides the systematic and comprehensive summary of the project documentation supporting the verification of an EeBGuide compliant product LCA. The project report records both the LCA based information and the additional information which meet the requirements of EeBGuide of the Energy- efficient Building Initiative. It will be made available to the verifier with the requirements on confidentiality stated in ISO 14025.

The background report contains any important data and information for the product as required by the European Standard. Special attention is paid to transparently demonstrate how the data and information are declared in the results for the LCA study, and how the reference RSL has been established.

40. General aspects in the background report

The present LCA study is performed by an internal practitioner and has been conducted according to the requirements of the European Standard EN 15804. The background report will be sent to verification as mentioned. Further details can be found in the table "General Information".

41. Goal/ Purpose of the study

In general, the aim of this study is the calculation and interpretation of the LCA results for the product "TSTC" in different layouts. Table 60 illustrates important points regarding the purpose of the study.

Table 60: Goal/ Purpose of the study

Goal/ Purpose of the study			
	Level of complexity	☐	Screening
		☑	Simplified
		☐	Complete
	related study objective	☐	Comparative assertion
		☑	Stand alone LCA
	object of assertion	☑	Product
	communication purpose	☑	internal
		☑	external
		☐	for costumer to costumer
		☐	publication
		☑	*Within Deliverable D4.1.3 of European Research project "Cost-Effective" and Deliverable (Case study) D4.1 of European research project "EeBGuide"*

The purpose of the study can be further specified as the TSTC, as window element with integrated absorber/collector, shall be assessed in different layouts (see also section 25) and for different façade integration. Basis for the assessment is a window element without absorber/collector (see also section 0 to 0). The main purpose of the assessment is not a comparative assertion declaring the environmental advantages of the different layouts when compared against each other. The purpose of the study shall be seen as a single assessment of different options for the TSTC.

The target groups are the project consortia of the European projects “EeBGuide” and “Cost-Effective”, as well as publication within certain project reports (as mentioned above). For the publication within Cost-Effective, no critical review according to ISO 14040/14044 has been conducted. For the publication of the present study a project internal review will be performed by one of the project partners of “EeBGuide”.

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42. Scope of the study

Declared / functional unit

The declaration refers to the declared/functional unit of [1 piece] of the TSTC covering 5,625m² of façade area (with below mentioned characteristics) producing a certain amount of thermal energy over 20 years (location dependent).

Table 61: Functional unit

Functional unit		
	Reference unit:	*1 piece, covering 5,625 m² of facade area; Width = 3750 mm x height = 1500 mm x depth = 300 mm; Absorber area = 1,88 m² (collector type A) & 4,48 m² (collector type B); location dependant thermal energy production (see also description of scnearios)*
	product group:	*energy-generating (energy efficient), facade integrated component; ErP (window element with integrated collector)*
	Function in the building:	*window element with thermal insulation & shading & daylight supply collector element with heat production (energy generation) for solar heating and cooling purpose within a building*
	required service life	*20 years (according to Manufacturer)*
	Other services provided within the building (shops…)	*see also "Function in the building"*

The functional unit allows for comparison of different layouts for the TSTC. Due to important differences, e.g. significant variations in components characteristics (technical layout, façade integration), it is challenging to define a common function (and a resulting functional unit) which fits to all assessed layouts. In that way, a comparison between the components shall not be performed as it should be based e.g. on same functional units or requires a critical review according to ISO 14040/14044.

Some of the functions which need to be considered for deriving a functional unit are:

- the generation or saving of thermal energy,
- the reduced use of fossil energy for the building supply due to substitution with renewable energy,
- the reduction of thermal energy consumption from the public grid (e.g. district heat),
- making the building more independent from the supply by conventional heat generation (e.g. boilers) or
- supporting the building energy efficiency by thermal insulation as well as shading functionality or daylight supply.

Therefore, the results for each layout of the TSTC are separately related to a functional unit:

Layout	Functional unit
1	1 piece, covering 5,625 [m²] façade area over 20 years
2 to 4	1 piece, covering 5,625 [m²] façade area over 20 years → *for production, use (without module B6), End-of-Life* Enhanced with: location-dependent generated thermal energy in [kWh] per 1 piece over 20 years → *for only module B6*

Declaration of construction products classes

Table 62 describes the product into more detail:

Table 62: Technical description of product

Technical description of the product

Name of the PCR and describe the declaration type (if you follow any):	*no declaration type followed; but study in accordance with EeBGuide*
main important materials:	*Aluminum, steel, glass (float, laminated & coated), stone wool, plastics (e.g. sealings)*
Statement on ability for recycling:	*Metals are recycled (Aluminum, steel, copper) assuming collection rates which reduce credits (konservative assumption); Mineral construction wastes are only dumped not recycled*
Desription of the product:	*Transparent Solar Thermal Collector for window integration (TSTC) consisting of a window element and an absorber element; window element as single skin facade and as double skin facade solution; absorber element as semi-transparent plate collector (type A) and as lamella collector (type B);* *all elements of the 4 assessed systems are described below:*
Designated application:	*Facade integration in high-rise buldings as single skin or double skin facade solution; prior on facade sides which are well exposed to the sun (e.g. South, South-West)*

System I *Regular DSF without collector*	**System II** *TSTC type A in IGU*	**System III** *TSTC type B in DSF*	**System IV** *TSTC type A in DSF*
Façade element	Façade element	Façade element	Façade element
Single glazing unit & IGU	IGU	Single glazing unit & IGU	Single glazing unit & IGU
Blinds with motor	Blinds with motor	Motor	Blinds with motor
--	Plate collector	Lamella collector	Plate collector

The TSTC is integrated in the façade and available in two types:

- Type A: a semi-transparent plate collector (either embedded in an insulating glazing unit (IGU) for a single skin façade or embedded within the façade cavity for the double skin façade (DSF)),
- Type B: a lamella collector (embedded within the façade for the double skin facade cavity).

For the assessment of both collector types, four different systems will be analyzed (see above).

System boundaries

The system boundaries of the product LCA follow the modular design defined by EN 15804. The following chapters describe the modules which are within the scope of this study. The modules included are in-line with the following table:

Table 63: Definitions for the different study types

Screening - Simplified - Complete

according to SBA Common Metrics Framework 2009 and EeBGuide adaptations

M	**mandatory**
$O_{relevance?}$	**optional because of minor relevance**
$O_{data?}$	**optional due to potentially missing data**

	Study type	Before use stage				
		Raw Materials Supply	Transport (to factory)	Manufactoring	Transport (to construction site)	Construction-Installation process
		A1	A2	A3	A4	A5
Product	Screening	$O_{data?}$ Optional Generic data for foreground system Generic data for background system			$O_{data?}$	$O_{data?}$
	Simplified	M Specific data for foreground system Generic data for background system			$O_{data?}$	$O_{data?}$
	Complete	M Specific data for foreground system Generic data for background system			M	

Screening - Simplified - Complete
according to SBA Common Metrics Framework 2009 and EeBGuide adaptations

M

O relevance?

O data?

Study type		Use stage						
		Use B1	Maintenance B2	Repair B3	Replacement B4	Refurbishment B5	Operational Energy Use B6	Operational Water Use B7
Product	Screening	O data?	O data?	O data?	O data?	O data?	O data? Estimations or literature specific when focus on it	O data?
	Simplified	O data?	O data?	O data?	O data?	O data?	O data? Literature or specific energy use	O data?
	Complete	M	M	O data?	M	M	M Literature or specific energy use	M

Screening - Simplified - Complete
according to SBA Common Metrics Framework 2009 and EeBGuide adaptations

M

O relevance?

O data?

Study type		End of Life				Benefits beyond boundary
		Deconstruction C1	Transport (to disposal) C2	Waste process for reuse, recovery or/ and recycling C3	Disposal C4	Reuse-/ Recovery- /Recyclingpote ntial D
Product	Screening	O data?	O data?	O data? Generic EoL data sets		O data? Generic LCA data sets for reuse-/ recovery-/ recycling potential
	Simplified	O data?	O data?	M Specific or generic LCA data for EOL processes		M Specific or generic LCA data for reuse-/ recovery- / recycling potential
	Complete	M	M	M Specific or generic LCA data for EOL processes		M Specific or generic LCA data for reuse-/ recovery- / recycling potential

Following life cycle stages are excluded: A4 – Transport to construction site, A 5 – Construction – Installation process, B1 – Use, B3 – Repair ,B4 – replacement, B5 – Refurbishment, B7 – Operational Water Use, C1 – Deconstruction.

A1-A3, Product stage, information modules

The product stage includes:

- A1, raw material extraction and processing, processing of secondary material input (e.g. recycling processes),
- A2, transport to the manufacturer,
- A3, manufacturing,

Including provision of all materials, products and energy, packaging processing and its transport, as well as waste processing up to the end-of waste state or disposal of final residues during the product stage.

The following flowchart represents the system boundaries for the product stage:

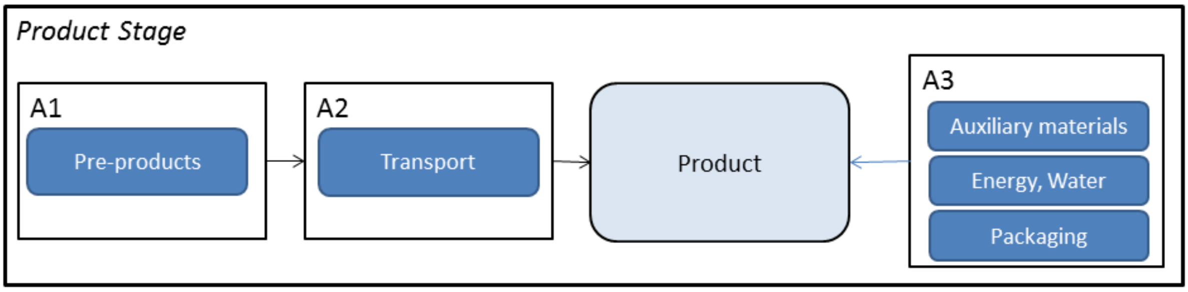


Figure 23: schematic representation of the LCA system boundaries for the production module (A1-A3)

In general, following assumptions have been made for modules A1 to A3:

- Transport processes are included with an average European transport distance of 293 km according to Baitz [3] and EeBGuide;
- Use of an average truck, diesel driven, Euro 3 and with a total capacity of 20 – 26 t (17,3 t payload capacity);
- Due to partly missing product specific information on single elements of the TSTC (as they are mainly bought from suppliers), and the uncertainty of assumptions taken (e.g. coating processes or laminated glass production), a security factor for the environmental results within the production phase in the amount of 10% is applied;
- For information on the coating process, please see 0 – “Assumptions on the coating process”.

Table 60 gives further information on Module A1 to A3.

Table 64: Module A1-A3

Module A1-A3	The following processes are omitted:		
		☑	A- 02 "Transport of staff in the supply of raw materials "
		☐	A- 03 "Transport to the manufacturer"
	Explain deviations from provision in the guidance document		
	A-02 is excluded, as simplified study according to EeBGuide and no special focus on that topic A-03 is included; Due to the use of partly generic LCA data (e.g. from the GaBi 4.4 database), missing product specific information on single elements (as they are mainly bought from suppliers), and the uncertainty of assumptions taken (e.g. for the coating processes), a security factor for the environmental results within the production phase in the amount of 10% is applied (conservative assumption)		
	The following deviations from EeBGuide guidance document on data requirements occurred **(Only for "Complete Assessment")**:	*It was not possible to use only ELCD data and/or ESUCO data;* *1st choice: ready-to-use European data or Global data from ESUCO or ELCD or GaBi 4 database* *2nd choice: ready-to-use German data from GaBi database* *3rd choice: where no ready-to-use datasets available --> new modelled according to best available technology (BAT) by using data sets of quality from 1st or 2nd choice*	
	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	*The coating process for glazing was estimated with manufacturer data and respective background data as described above.*	

A4-A5, Construction process stage, information modules

The construction process stage includes:

- A4, transport to the construction site;
- A5, installation into the building;

Including provision of all materials, products and energy, as well as waste processing up to the end-of-waste state or disposal of final residues during the construction process stage. These information modules also include all impacts and aspects related to any losses during this construction process stage (i.e. production, transport, and waste processing and disposal of the lost products and materials).

The following flowchart represents the system boundaries for the construction process stage:

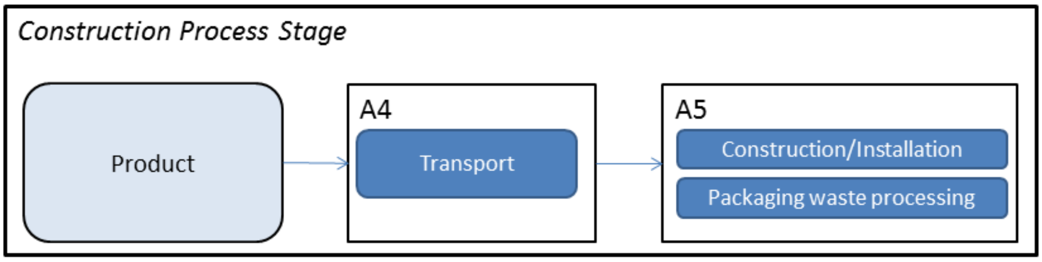


Figure 24: schematic representation of the LCA system boundaries for the construction process stage (A4-A5)

Table 65: Module A4-A5

Module A4-A5			
Module A4-A5	The following processes are omitted:	☑	A- 04 "Transports - consideration in complete LCAs"
		☑	A- 05 "Offcuts"
		☑	A- 06 "Transport of the construction worker"
	Explain deviations from provision in the guidance document		
	A4 to A5 completely excluded as simplified study according to EeBGuide and no special focus on that topic; Facade inetgration processes for the component are not considered		
	The following deviations from EN 15804 on data requirements occurred **(Just for "Complete Assessment")**:	*not applicable*	
	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	*not applicable*	

B1-B5, Use stage, information modules related to product use

The use stage, related to the building fabric includes:

- B1, use or application of the installed product;

- B2, maintenance;
- B3, repair;
- B4, replacement;
- B5, refurbishment.

Including provision and transport of all materials, products and related energy and water use, as well as waste processing up to the end-of-waste state or disposal of final residues during this part of the use stage. These information modules also include all impacts and aspects related to the losses during this part of the use stage (i.e. production, transport, and waste processing and disposal of the lost products and materials).

The following flowchart represents the system boundaries for the use stage related to the building fabric:

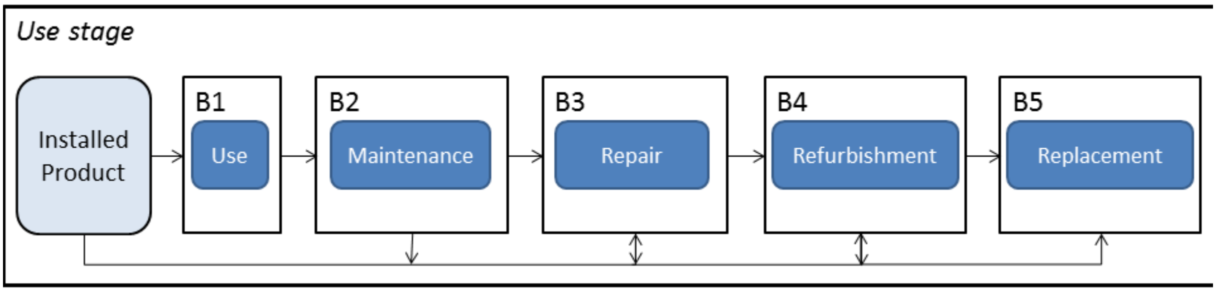


Figure 25: schematic representation of the LCA system boundaries for the use stage (modules related to the building fabric B1-B5)

For maintenance activities an exchange rate is calculated, indicating how often single elements need to be replaced. The exchange rate is calculated as:

Exchange rate = (Time period of consideration / Reference service life of element) – 1 [-]

The exchange rate is multiplied with the respective amount of necessary materials and energies for new production. On the other hand, maintenance activities incorporate transferring the exchanged amounts of materials to a specific End-of-Life scenario. The assumed End-of-Life scenarios are modeled in accordance with the description for the End-of-Life in module C. Transport is accounted for both production and End-of-Life following the same boundaries as described within module A1 to A3.

Table 66 gives further information on module B1 to B5.

Table 66: Module B1-B5

Module B1-B5	The following processes are omitted:	☑ ☐ B- 03 "Release of dangerous substances to soil and water during
	Explain deviations from provision in the guidance document	
	B-03 omitted, as simplified study according to EeBGuide and no special focus on that topic; Energetic performance (e.g. kWh of thermal an electrical final energy demand) of a reference building where the component is applied cannot be taken into account & cannot be assumed	
	The following processes are omitted:	*Cleaning activities, Repair activities*
	The following deviations from EN 15804 on data requirements occurred **(Just for "Complete Assessment")**:	*not applicable*
	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	*none*

B6-B7, Use stage, information modules related to the operation of the product

The use stage related to the operation of the building includes:

- B6, operational energy use (e.g. operation of heating system and other building related installed services);
- B7, operational water use;

These information modules include provision and transport of all materials, products, as well as energy and water provisions, waste processing up to the end-of-waste state or disposal of final residues during this part of the use stage.

The following flowchart represents the system boundaries for the use stage related to the operation of the building:

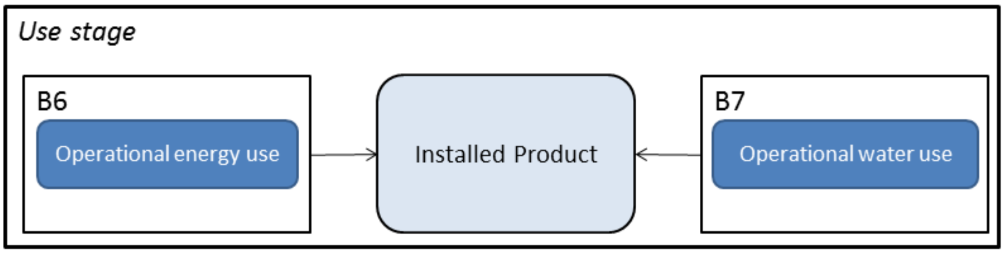


Figure 26: schematic representation of the LCA system boundaries for the use stage (modules related to the operation of the building)

Table 67 gives further information on module B6 to B7 with regard to data requirements.

Table 67: Module B6-B7

Module B6-B7	The following processes are omitted:	☑	B- 10 "Accounting of different types of waste water treatment"
	Explain deviations from provision in the guidance document		
	B-10 is omitted, as simplified study according to EeBGuide and no special focus on that topic		
	The following deviations from EN 15804 on data requirements occurred **(Just for "Complete Assessment")**:	*not applicable*	
	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	*none*	

For the present study only module B6 is taken into account by an estimation on auxiliary energy (e.g. electricity) for operating the TSTC in layout 2 to 4. Calculation on the collector output (produced thermal energy) is mainly based on the collector efficiency, the solar irradiation and the absorber/collector area. The produced thermal heat is assumed to be used for solar thermal heating and cooling purpose. Therefore, a separate heating and cooling efficiency, as well as the COP of the underlying HVAC system are estimated and considered. The energy production is only regarded under consideration of applying the TSTC only on the South façade.

In general, the heating and cooling efficiency (used heat/cold within the building in relation to produced heat/cold by the TSTC) will have a significant influence on the obtained results for necessary auxiliary energy. The efficiency depends e.g. on the relation between available façade area to actual façade area covered by the TSTC. The lower the efficiency, the higher is the need for storage or the heat/cold has to be released unused. Therefore, this

information will be mainly based on results of energetic simulations within WP4.1 respectively shall be kept in mind, when talking about the results for the operation phase.
For a first estimation on environmental impacts that are connected to the operation of the components, a potential target building and its potential HVAC layout, including their efficiencies, are assumed to be known (see also details in respective Annexes). The performance of the TSTC (e.g. collector efficiency) is based on component specific simulations. The performance of the HVAC system (heating and cooling) is based on expert judgement with respective project partners of "Cost-Effective".

For details on the calculation of auxiliary energy please see 0 as well as section 0.

C1-C4 End-of-life stage, information modules

The end-of-life stage includes:

- C1, de-construction, demolition:
- C2, transport to waste processing;
- C3, waste processing for reuse, recovery and/or recycling;
- C4, disposal

including provision and all transports, provision of all materials, products and related energy and water use.

The following flowchart represents the system boundaries for the End-of-life stage:

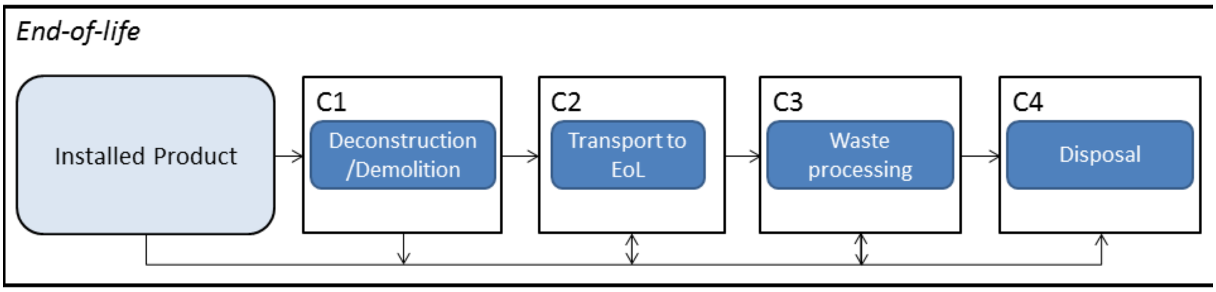


Figure 27: schematic representation of the LCA system boundaries for the End-of-life stage (C1-C4)

Following simplifications have been assumed for the End-of-Life processes:

- Only material recycling is included.
- Coatings and paintings are neglected for thermal incineration, recovery or recycling, to avoid that amounts of materials for the End-of-Life are artificially expanded.
- The recycling of special coatings and coated glass is a partly unresolved issue. As the technology of solar coatings in general is a very young one, and as no serial technologies exist to retrieve especially the coating layers and coating materials, only glass recycling processes are accounted for. Some research activities deal currently with the development of hydro metallurgical processes for recovering metal coating layers. As they are not yet applied practical, the End-of-Life of such coating layers is not considered so far.
- Transport is included in accordance with the production phase (Module A1 to A3).

Table 68 illustrates furthermore the assumptions made for module C1 to C4 with regard to data requirements.

Table 68: Module C1-C4

Module C1-C4	The following processes are omitted:	☐ C- 05 "Transport distances (to landfill, to incineration, to recy-cling)"
	Explain deviations from provision in the guidance document	C-05 is included and reported seperately
	The following processes are omitted:	*Losses are accounted for: powder coating and desiccants (window element) --> are not accounted for recycling, disposal or recovery to avoid that amounts of materials for the End-of-Life are artificially increased*
	The following deviations from EN 15804 on data requirements occurred **(Just for "Complete Assessment")**:	*not applicable*
	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	*- aluminium & steel are recycled by using datasets representing their "recycling potential" (where credits as well as impacts for recovery are included as aggreagted values)* *- PVB foil & sealing compounds & thermal breaks are incinerated by using respective incineration processes (where credits as well as impacts for incineration are included as aggreagted values)* *- stone wool & glass are disposed in a construction waste dumping represented by a Euroepan average dataset*

Metals are used in so called "incomplete loops" meaning that both metal scrap and primary material are input to the metal production processes. Furthermore, the recycling process itself is a non-dissipative process. The concept of "recycling potential" (as used for End-of-Life processes for meatls) is based on the idea that the process of metal recycling avoids the use of primary material for production and therefore results in environmental credits. It states how many environmental burdens may be avoided in relation to a new production of the material (avoidance of primary metal production).

D Benefits and loads beyond the system boundary, information module

Module D includes reuse, recovery and/or recycling potentials.

The following flowchart represents the system boundaries for benefits/loads beyond the system boundary:

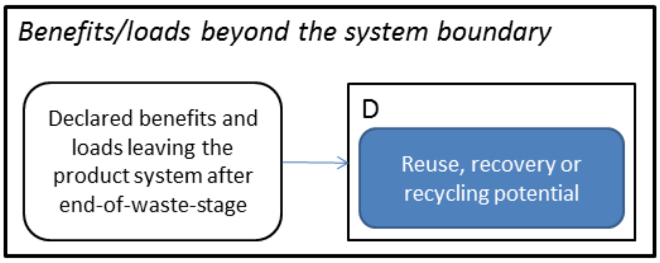


Figure 28: schematic representation of the LCA system boundaries for the benefits and loads beyond the product system boundary in module D

Table 69 illustrates furthermore the assumptions made for module D with regard to data requirements.

Table 69: Module D

Module D	The following processes are omitted:	☑ D- 02 "Reuse - water consumption"
	Explain deviations from provision in the guidance document	D-02 is omitted, as simplified study according to EeBGuide and no special focus on that topic
	The following processes are omitted:	*Avoided use of conventional produced heat and cold within a building which is substituted by solar produced heat from the TSTC (credits) for layout 2 to 4 --> reported seperately within "Mdule B6" as a 1st approximation for different climates by only taking into account the auxiliary energy (electricity) --> credits are only regarded at for renewbale primary energy as credits for other environmental impact categories or indicators depend on the conventional produced heat and cold that is substituted*
	The following deviations from EN 15804 on data requirements occurred **(Just for "Complete Assessment")**:	*not applicable*
	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	*none*

Due to the aggregation of credits and environmental burdens for metal recycling and thermal incineration processes, a separation of results for module D and module C3 is not possible.

Overview over the included Life cycle stages

The table summarizes the included lifecycle stages.

Figure 29: Included lifecycle stages

Included modules	Stage	Included	Module	Description
	Product Stage	☑	A1	Raw Materials Supply
		☑	A2	Transport
		☑	A3	Manufacturing
	Construction Process	☐	A4	Transport
		☐	A5	Construction- Installation process
	Use Stage	☐	B1	Use
		☑	B2	Maintenance
		☐	B3	Repair
		☐	B4	Replacement
		☐	B5	Refurbishment
		☑	B6	Operational Energy Use
		☐	B7	Operational Water Use
	End of Life Stage	☐	C1	Deconstruction
		☑	C2	Transport
		☑	C3	Waste process for reuse,
		☑	C4	Disposal
	Benefits and loads	☑	D	Reuse- Recovery- Recyclingpotential

Electric energy mix

The selection of the background data for the electricity generation is in line with EeBGuide.

The following ELCD data set is used:

- **Power: EU-27 Power grid mix (ESUCO data base)**

For further details please see also 0 or consult the documentation for the data set.

CO_2-Certificates

No CO_2-certificates are considered in this study.

Description of the system boundary

The definition of the system boundaries meets the requirements for a simplified product LCA study of EeBGuide.

Criteria for the exclusion of inputs and outputs

For the End-of-Life processes following processes are excluded:

- Coatings and paintings are neglected for thermal incineration, recovery or recycling, to avoid that amounts of materials for the End-of-Life are artificially expanded.
- Only glass recycling processes are accounted for e.g. coated or laminated glass.

43. Life cycle inventory analysis

Data collection and calculation procedures

Data collection follows the guidance provided in ISO 14044, clause 4.3.2. The calculation procedures described in ISO 14044 are applied consistently throughout the study.

According to the definition of scope of the study, all relevant inputs and outputs related to the TSTC are identified and quantified.

More details on the models and unit processes are illustrated in chapter 6.6.

Developing product level scenarios

Scenarios describe different layouts of the TSTC and therefore result in different LCI results for all life cycle stages. The scenarios (layouts) are described within section 0, section 0 and section 0.

Table 70 gives an overview on the material based LCI for all assessed systems [4].

Table 70: Overview on material based input data for all systems

Element	Reference	Material	Unit	Amount			
				System I w/o collector	System II Collector type A	System III Collector type B	System IV Collector type A
Facade	1 facade element with unit size: H x W x D = 3750mm x 1500mm x 300mm	Aluminum	kg	95	94	95	95
		Galvanized Steel / Stainless Steel		7	14	7	7
		Stone wool		4	10	4	4
		Polyamide		1,125	1,275	1,125	1,125
		Glass fibres		0,375	0,425	0,375	0,375
		Sealing compounds (e.g. silicone)		13	9	13	13
Glazing		Floatglass (e.g. pure, laminated or coated)	kg	335,85	251,27	335,85	335,85
		Plastics (e.g. PP)		0,3	1	0,3	0,3
		Sealing compounds & Desiccant (e.g. silicone, butyl, silica)		2,8	10,1	2,8	2,8
inds and Mot		Aluminum	kg	10,05	6,55	2,05	6,55
		Copper		0,45	0,45	0,45	0,45
		Plastics (e.g. PVC)		0,5	0,5	0,5	0,5
Absorber	1 collector per 1 facade element Collector size: Type A H x W = 1250mm x 1500mm covering 1,88m² of facade area per collector unit	Aluminum	kg	--	10,00	45,00	10,00
		Steel		--	2,00	12,00	2,00
		Coating (e.g. Chrome- & Siliciumoxide)	m²	--	1,88	4,48	1,88
		Polyefine	kg	--	0,10	0,50	0,10

A detailed description of the scenario(s) can be found in chapter 25.

In general, the information provided on the baseline scenario for all life cycle stages included are valid and applied for all assessed systems in the same way.

Selection of data/ background data

As a general rule, specific data derived from specific production processes or average data derived from specific production processes shall be the first choice as a basis for calculating a product LCA.

For life cycle modeling of the considered component, service or product, GaBi 4.4 software [1] is used. All relevant background datasets are taken from GaBi 4.4 database, the ELCD database or the ESUCO database [5]. The datasets from the GaBi 4.4 database and the ESUCO database are documented. For each data set a specific documentation is given within the software. The ELCD datasets are documented as well and can be looked up at the respective JRC website. The applied data sets are representative for the years between 2002 - 2012 and have a global, European and national coverage (please see also 0 – documentation of used data sets).

Data/ background data quality requirements

The requirements for data quality and background data correspond in general to the specifications of EeBGuide. Excluded from this specification is the use of some outdated ELCD data which only refer to a time period up to 2010. As the data sets can be still found on the JRC website and as no respective actual ESUCO or GaBi 4.4 dataset could be found, the data is used however.

For the LCA, existing datasets from the GaBi 4.4 database (e.g. respective ELCD or ESUCO data sets) and newly modelled datasets are used. Those newly modelled ones are based on information received from the project partners (e.g. information on the coating process). Whenever possible, processes or datasets representing European Union averages (EU-27, EU-25, EU-15) are used. If those are not available, datasets with global covering or for Germany are applied. Another approach chosen for the application of ready-to-use LCA datasets (as first choice of data to be used) of the GaBi 4 database is as follows: Where no appropriate data sets for e.g. manufacturing processes or material specific data is available, assumptions are made by using data sets reflecting best available technologies (BAT) and best available materials (respectively state-of-the-art data sets).

The GaBi 4.4 database contains life cycle inventory data obtained by long-term research over the past 20 years and is based on primary industry data. The database is part of the largest internally consistent LCA databases family on the market today, containing over 4,500 ready-to-use Life Cycle Inventory (LCI) profiles. Industries represented are e.g. building and construction, chemicals and materials, electronics and ICT, energy and utilities, industrial products, metals and mining or plastics. All LCI datasets are generated in compliance with the ISO 14044, ISO 14064 and ISO 14025 standards.

The data sets are based on 1 year averaged data. The time period over which inputs to and outputs from the system is accounted for is 100 years from the year for which the data set is deemed representative. The technological background of the collected data reflects the physical reality of the declared product / product group. The datasets are complete and conform to the system boundaries and the criteria for the exclusion of inputs and outputs.

For life cycle modeling of the TSTC the software GaBi 4.4 for Life Cycle Engineering, developed by PE International AG is used. All relevant background datasets are taken from the ELCD, the ESUCO and the GaBi 4.4 database and provided by the company PE International AG. The last revision of the used data sets took place less than 5 years ago (GaBi 4.4 data sets) and more than 10 years ago (ELCD data set).

Allocations

In the present study no foreground system allocation has been made. Detailed explanations on allocation procedures for the background system can be found in the documentation of the used datasets. In principle/Mainly following allocation methods have been used for the background (in compliance with ISO 14040/14044):

- Market value,
- Mass,
- Net calorific value,
- Exergy.

Co-product allocation

No allocation rules are considered.

Allocation of multi-Input processes

No multi-input allocation rules are considered.

Allocation procedure of reuse, recycling and recovery

The following allocation procedure for reuse, recycling and recovery are considered, according to the documentation within used datasets: [1], [5]

- Market value,
- Net calorific value,
- Exergy.

Used data sets for assessment are documented within 0. For further details please see respective data set specific documentation.

Description of the allocation processes

The application of allocation rules meets the requirements of the EeBGuide.

Description of the unit processes

The modeling of the unit processes reported for the LCA are documented in a transparent way and respecting the confidentiality of the data present in the background report, as for example:

- The allocation of corporate data to data sets from LCA programs
- The assignment of process data to the subsections of the life cycle in the LCA

Used unit processes (data sets for assessment) are documented in a tabular format within 0.

44. Life cycle inventory analysis and life cycle impact assessment

The results of the LCA for all modules A1 to D are represented in the following tables. The inventory analysis indicators to be declared and the impact assessment are in accordance with EN 15804.

For the Life Cycle Impact Assessment, the characterization model CML2001 from November 2007 [2] of the Center for Milieukunde in Leiden (the Netherlands) will be used. The results of the analysis will be presented for each layout of the TSTC separately. The results will not be weighted or grouped. The results are furthermore not intended for comparison purpose between single layouts. The consideration of module B6 (for layout 2 to 4) is based on qualitative assumptions discussed with experts of the project consortium of "Cost-effective". A critical review is not carried out.

Indicators for the life cycle inventory analysis according to EN 15804

The following environmental indicators apply data based on the LCI. They describe the use of renewable and non-renewable material resources, renewable and non-renewable primary energy and water.

Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ, net calorific value
Use of renewable primary energy resources used as raw materials	MJ, net calorific value
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ, net calorific value
Use of non renewable primary energy excluding non renewable primary energy resources used as raw materials	MJ, net calorific value
Use of non renewable primary energy resources used as raw materials	MJ, net calorific value
Total use of non renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ, net calorific value
Use of secondary material	kg
Use of renewable secondary fuels	MJ, net calorific value
Use of non renewable secondary fuels	MJ, net calorific value
Use of net fresh water	m³

The indicators describing waste categories and other material flows are output flows derived from LCI.

Other environmental information describing waste categories is described next:

Hazardous waste disposed	kg
Non hazardous waste disposed	kg
Radioactive waste disposed	kg

Other environmental information describing output flows is described next:

Components for re-use	kg
Materials for recycling	kg
Materials for energy recovery	kg
Exported energy	MJ per energy carrier

Indicators for the life cycle impact assessment according to EN 15804

The following information on environmental impacts is expressed with the impact category parameters of LCIA using characterisation factors

Global warming potential (GWP);	kg CO_2-equiv.
Depletion potential of the stratospheric ozone layer (ODP);	kg CFC 11- equiv
Acidification potential of soil and water, (AP);	kg SO_2 - equiv
Eutrophication potential (EP);	kg $(PO_4)^{3-}$ - equiv
Formation potential of tropospheric ozone (POCP);	kg Ethene - equiv
Abiotic depletion potential (ADP-elements) for non-fossil resources	kg Sb - equiv
Abiotic depletion potential (ADP-fossil fuels) for fossil resources	MJ, net calorific value

In fact, the results from the impact assessment are only relative statements which give no information about the endpoint of the impact categories, overstepping of threshold values, safety margins or risk.

Used environmental indicators "Baseline Scenario"

The table below illustrates the used environmental indicators.

Figure 30: Used environmental indicators

Used indicators	☑	1. Global warming potential
	☑	2. Acidification Potential
	☑	3. Eutrophication Potential
	☑	4. Photochemical Ozone Creation Potential
	☑	5. Total use of renewable primary energy
	☑	6. Total use of non-renewable primary energy
	☑	7. Depletion potential of the stratospheric ozone layer
	☐	8. Abiotic Resource Depletion Potential for elements
	☐	9. Abiotic Resource Depletion Potential of fossil fuels
	☐	10. Secondary Materials
	☐	11. Secondary fuels - renewable
	☐	12. Secondary fuels – non renewable
	☐	13. Net Fresh Water
	☐	14. Hazardous Waste
	☐	15. Non Hazardous Waste
	☐	16. Radioactive Waste
	☐	17. Components for Re-Use
	☐	18. Materials for Recycling
	☐	19. Materials for Energy Recovery
	☐	20. Exported Energy
	☐	additional indicator
	☐	additional indicator
	☐	additional indicator
	☐	additional indicator

Description of the Baseline scenario

The following table illustrates the parameters used in the Baseline scenario.

Table 71: Description of the parameter “Baseline scenario”

Baseline scenario	G- 05 “Reference study period”	*20 years*
	G- 09 “Future technical developments and innovation”	*No innovation to be considered, current technologies to be used*
	G- 09 “Accounting for carbon storage / carbon sequestration”	*Not applicable, as no carbon storage is not considered*
	B- 11 “Modelling of water use”	*Not applicable, as no water use is not considered*
	Baseline "System"	*System 1 = Layout 1* *Layout 1 = regular double skin facade without any collector*

Results “Baseline Scenario”

Table 72: Overview over the product LCA results (Layout 1)

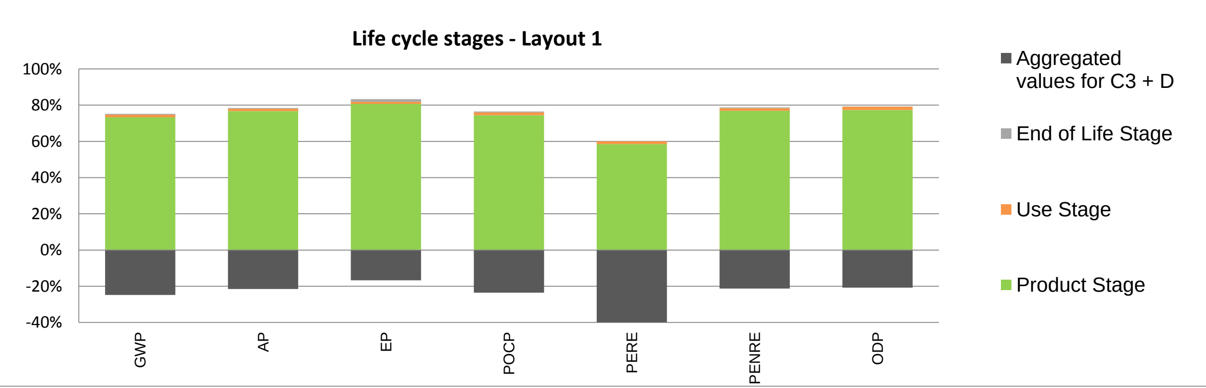
Overview over the product LCA results			TSTC - Layout 1 - DSF without collector (for all locations)						
20 years			1. Global warming potential	2. Acidification Potential	3. Eutrophication Potential	4. Photochemical Ozone Creation Potential	5. Total use of renewable primary energy	6. Total use of non-renewable primary energy	7. Depletion potential of the stratospheric ozone layer
			GWP	AP	EP	POCP	PERE	PENRE	ODP
			[kg CO_2-equiv./piece]	[kg SO_2-equiv./piece]	[kg PO_4^{-3} - equiv. /piece]	[kg C_2H_4-equiv./piece]	[MJ/piece]	[MJ/m²$_{piece}$]	[kg CFC11-equiv./piece]
Product Stage	A1 A2 A3	Raw Materials Supply Transport Manufacturing	2.305,24	14,14	0,69	1,12	5.332,60	34.247,84	1,86E-04
Construction Process	A4	Transport	--	--	--	--	--	--	--
	A5	Construction- Installation process (not considered)	--	--	--	--	--	--	--
Use Stage	B1	Use (not considered)	--	--	--	--	--	--	--
	B2	Maintenance (including Production, impacts for EoL, credits for EoL)	46,22	2,32E-01	1,01E-02	2,25E-02	140,59	665,43	4,38E-06
	B3	Repair	--	--	--	--	--	--	--
	B4	Replacement	--	--	--	--	--	--	--
	B5	Refurbishment	--	--	--	--	--	--	--
	B6	Operational Energy Use (no impacts)	--	--	--	--	--	--	--
	B7	Operational Water Use (not considered)	--	--	--	--	--	--	--
End of Life Stage	C1	Deconstruction (not considered)	--	--	--	--	--	--	--
	C2	Transport	7,88	4,86E-02	8,40E-03	3,95E-03	0,15	111,32	1,50E-08
	C3	Waste process for reuse, recovery or/ and recycling (can not be reported separately for incineration or recycling processes --> please see "Aggregated values for C3 + D")	--	--	--	--	--	--	--
	C4	Disposal	6,28	2,61E-02	3,24E-03	3,22E-03	2,61	52,02	1,03E-07
Benefits and loads beyond the system boundary	D	Reuse- Recovery- (can not be reported separately for incineration or recycling processes --> please see "Aggregated values for C3 + D")	--	--	--	--	--	--	--
Aggregated values for C3 + D		Incineration processes	17,12	-3,50E-02	-3,22E-03	-3,22E-03	-7,54	-544,48	-1,48E-06
		Recycling processes	-797,22	-3,93	-1,40E-01	-3,50E-01	-3.627,15	-8.922,68	-4,84E-05

Figure 31: Results Indicators - life cycle stages (Layout 1)

Overview over the product LCA results	TSTC - Layout 1 - DSF without collector (for all locations)						
20 years	1. Global warming potential	2. Acidification Potential	3. Eutrophication Potential	4. Photochemical Ozone Creation Potential	5. Total use of renewable primary energy	6. Total use of non-renewable primary energy	7. Depletion potential of the stratospheric ozone layer
	GWP	AP	EP	POCP	PERE	PENRE	ODP
	[kg CO_2-equiv./piece]	[kg SO_2-equiv./piece]	[kg PO_4^{-3} - equiv. /piece]	[kg C_2H_4-equiv./piece]	[MJ/piece]	[MJ/piece]	[kg CFC11-equiv./piece]
Product Stage	2.305,24	14,14	0,69	1,12	5.332,60	34.247,84	1,86E-04
Construction Process	--	--	--	--	--	--	--
Use Stage	46,22	2,32E-01	1,01E-02	2,25E-02	140,59	665,43	4,38E-06
End of Life Stage	14,16	7,47E-02	1,16E-02	7,17E-03	2,76	163,34	1,18E-07
Benefits and loads beyond the system boundary	--	--	--	--	--	--	--
Aggregated values for C3 + D	-780,09	-3,97	-1,43E-01	-3,53E-01	-3.634,70	-9.467,16	-4,99E-05

Results "Baseline Scenario"

Figure 32: Results Indicators - life cycle stages (Layout 1)



For the results of the production stage (module A1 to A3), a security factor of 10% on the original results is applied.

The results of the impact assessment for the life cycle phases show similar characteristics for all impact categories:

- The environmental impacts throughout the life cycle are determined by the production and the End-of-Life phase.
- Façade profiles (aluminium) contribute with 50% to 70%, the glazing unit (glass) with 20% to 25% to the total impacts for production.
- The End-of-Life phase is determined by aluminium recycling with 95% of overall credits. Respective credits lower the overall impacts for the life cycle up to one third of the impacts caused by production.
- Maintenance activities are almost irrelevant, independently from the system regarded at.

Thermal energy production is not regarded at (module B6) as no absorber is included within the window element. Therefore, no results for the operation phase are presented.

Interpretation of the results "Baseline Scenario"

Energy-intensive materials contribute mainly to the impacts for the total life cycle.

Hot spots which can be identified (for the production and end-of-life stage) are:

- Façade profiles made from aluminum,
- Glazing,
- Absorber made from aluminum and with PVD coating process.

Main improvement potentials should analyze lowering the material amounts necessary for façade profiles and the glazing.

A sensitivity analysis on different production processes was not within the scope of the study but might be conducted for future assessment, if the manufacturer of the TSTC is able to provide information on alternative production processes.

45. Scenario

Used environmental indicators "Scenario"

The table below illustrates the used environmental indicators.

Figure 33: Used environmental indicators

Used indicators		
	☑	1. Global warming potential
	☑	2. Acidification Potential
	☑	3. Eutrophication Potential
	☑	4. Photochemical Ozone Creation Potential
	☑	5. Total use of renewable primary energy
	☑	6. Total use of non-renewable primary energy
	☑	7. Depletion potential of the stratospheric ozone layer
	☐	8. Abiotic Resource Depletion Potential for elements
	☐	9. Abiotic Resource Depletion Potential of fossil fuels
	☐	10. Secondary Materials
	☐	11. Secondary fuels - renewable
	☐	12. Secondary fuels – non renewable
	☐	13. Net Fresh Water
	☐	14. Hazardous Waste
	☐	15. Non Hazardous Waste
	☐	16. Radioactive Waste
	☐	17. Components for Re-Use
	☐	18. Materials for Recycling
	☐	19. Materials for Energy Recovery
	☐	20. Exported Energy
	☐	additional indicator
	☐	additional indicator
	☐	additional indicator
	☐	additional indicator

Description of the parameters "Scenarios"

For the scenarios, also module B6 (operational energy use) is regarded at and accounted for separately. With regard to EN 15978 and the consideration of imported or exported energy case 1 of Annex B (clause B2.1) is valid for the use of the TSTC.

The TSTC produces thermal energy which is directly used within the building and 100% transferred to the building HVAC system (imported energy) to cover the building final energy demand. As it is not possible, at this stage of evaluation, to assume a final target building and to give an estimate on how much of the final thermal energy demand may be covered by the TSTC (if applied in that building), no considerations on the performance of the target building are yet possible. The only information that can be estimated is the thermal energy production by collector type and location, which later can be used to substitute e.g. conventional energy supply in a target building or to calculate the reduced impacts from a reduced conventional energy supply depending on the energy carrier (e.g. via a gas condensing boiler).

Table 73: Overview on imported energy „Scenarios"

Energy imported/ exported		
	Description on thermal and electrical energy imported/ exported:	*only thermal energy produced within a reference building assumed in three different locations (Frankfurt - DE, Stockholm - SE, Madrid - ES); energy is assumed to be imported to the building and to be used directly in the building*
	Imported thermal energy [kWh/a] (from the viewpoint of a potential target building)	*depending on the location and collector type (assuming an average collector efficiency of 20%) for 20 years and per 1 element* *Collector type A:* *- Frankfurt (DE) = 6.121 kWh* *- Stockholm (SE) = 7.106 kWh* *- Madrid (ES) = 9.129 kWh* *Collector type B (higher absorber surface area):* *- Frankfurt (DE) = 14.587 kWh* *- Stockholm (SE) = 16.934 kWh* *- Madrid (ES) = 21.755 kWh*
	Imported electrical energy [kWh/a]	*none*
	Exported thermal energy [kWh/a]	*none*
	Exported electrical energy [kWh/a]	*none*

In a first estimation on the impacts for module B6 (operational energy use), the following assumptions for the assessment have been made:

- Calculation of collector output (produced thermal energy) for each location and each collector type,
- Allocation of the collector output for heating and cooling purpose to the heating and cooling system (location dependent),
- Calculation of the amount of heat for heating/cooling purpose which effectively can be used within the heating/cooling system (location dependent),
- Based on this amount, calculation of auxiliary energy (electricity) for heating/cooling purpose.

For details please refer to Table 81 and its following calculations.

In the following table the varied parameters of the scenarios are described.

Table 74: Description of the parameter "Scenarios"

Scenario	G- 05 "Reference study period"	*Reference study period always set to 20 years, as the baseline scenario*
	G- 09 "Future technical developments and innovation"	*Not applicable, as no future innovation is not considered*
	G- 09 "Accounting for carbon storage / carbon	*Not applicable, as no carbon storage is not considered*
	B- 11 "Modelling of water use"	*Not applicable, as no water use is not considered*
	"Layout (Systems)"	*see also: description of the component --> 2 different solutions of facade integration (single skin & double skin facade solution) --> 2 different layouts of the collector (plate collector & lamella collector) 4 different systems for assessment: Layout 1 = regular double skin facade without any collector Layout 2 = collector type A in insulating glazing unit (single skin facade solution) Layout 3 = collector type B in double skin facade Layout 4 = collector type A in double skin facade System 2 to 4 assume an average collector efficiency of 20%, meaning that effectively 20% of the total incoming solar irradiation can be used to produce solar thermal heat*
	"Location"	*3 different locations have been choosen for a first estimation on the building operation and a yearly sum of total irradiation on vertical South-façade in [kWh/m² * a]: Central Europe - Frankfurt (DE) - 814 kWh/m² * a North Europe - Stockholm (SE) - 945 kWh/m² * a South Europe - Madrid (ES) - 1214 kWh/m² * a The produced heat of the collector is assumed to be used within the different climates as follows: Central Europe - 50% for heating - 50% for cooling North Europe - 75% for heating - 25% for cooling South Europe - 25 % for heating - 75% for cooling*
	"HVAC efficiency of reference building"	*HVAC efficiencies (for the HVAC system where the solar thermal produced heat is fed into) have been estimated in a potential reference building as follows: Central Europe - 90% for heating - 80% for cooling (best case) North Europe - 90% for heating - 80% for cooling (best case) South Europe - 80% for heating - 90% for cooling (best case) --> meaning, that 90% /80% of the total produced heat can be effectively used within the HVAC system for heating/cooling purpose COP for the the heating is assumed with 1; COP for cooling is assumed with 0,7 (heat as cooling source with losses)*

Results “Scenario”

The following tables and figures show the results of the scenarios.

Table 75: Overview over the product LCA results (Layout 2)

Overview over the product LCA results (without Module B6)			TSTC - Layout 2 - IGU with collector type A (for all locations)						
20 years			1. Global warming potential	2. Acidification Potential	3. Eutrophication Potential	4. Photochemical Ozone Creation Potential	5. Total use of renewable primary energy	6. Total use of non-renewable primary energy	7. Depletion potential of the stratospheric ozone layer
			GWP	AP	EP	POCP	PERE	PENRE	ODP
			[kg CO_2-equiv./piece]	[kg SO_2-equiv./piece]	[kg PO_4^{-3} - equiv. /piece]	[kg C_2H_4-equiv./piece]	[MJ/piece]	[MJ/m^2_{piece}]	[kg CFC11-equiv./piece]
Product Stage	A1 A2 A3	Raw Materials Supply Transport Manufacturing	2.086,24	12,78	0,59	1,01	5.725,12	29.948,15	1,79E-04
Construction Process	A4	Transport	--	--	--	--	--	--	--
	A5	Construction- Installation process (not considered)	--	--	--	--	--	--	--
Use Stage	B1	Use (not considered)	--	--	--	--	--	--	--
	B2	Maintenance (including Production, impacts for EoL, credits for EoL)	33,89	1,75E-01	7,28E-03	1,76E-02	101,39	481,46	3,00E-06
	B3	Repair	--	--	--	--	--	--	--
	B4	Replacement	--	--	--	--	--	--	--
	B5	Refurbishment	--	--	--	--	--	--	--
	B6	Operational Energy Use	Please see additonal table "TSTC - Module B6 - operational energy use only - collector type A and B"						
	B7	Operational Water Use (not considered)	--	--	--	--	--	--	--
End of Life Stage	C1	Deconstruction (not considered)	--	--	--	--	--	--	--
	C2	Transport	7,52	4,64E-02	8,01E-03	3,76E-03	0,14	106,14	1,43E-08
	C3	Waste process for reuse, recovery or/ and recycling (can not be reported separately for incineration or recycling processes --> please see "Aggregated values for C3 + D")	--	--	--	--	--	--	--
	C4	Disposal	5,53	2,30E-02	2,86E-03	2,84E-03	2,30	45,84	7,90E-08
Benefits and loads beyond the system boundary	D	Reuse- Recovery- (can not be reported separately for incineration or recycling processes --> please see "Aggregated values for C3 + D")	--	--	--	--	--	--	--
Aggregated values for C3 + D		Incineration processes	19,06	-3,86E-02	-3,61E-03	-3,60E-03	-8,44	-614,96	-1,67E-06
		Recycling processes	-870,96	-4,19	-1,53E-01	-3,76E-01	-3.882,70	-9.711,61	-5,08E-05

Table 76: Results Indicators - life cycle stages (Layout 2)

Overview over the product LCA results (without Module B6)	TSTC - Layout 2 - IGU with collector type A (for all locations)						
20 years	1. Global warming potential	2. Acidification Potential	3. Eutrophication Potential	4. Photochemical Ozone Creation Potential	5. Total use of renewable primary energy	6. Total use of non-renewable primary energy	7. Depletion potential of the stratospheric ozone layer
	GWP	AP	EP	POCP	PERE	PENRE	ODP
	[kg CO_2-equiv./piece]	[kg SO_2-equiv./piece]	[kg PO_4^{-3} - equiv. /piece]	[kg C_2H_4-equiv./piece]	[MJ/piece]	[MJ/piece]	[kg CFC11-equiv./piece]
Product Stage	2.086,24	12,78	0,59	1,01	5.725,12	29.948,15	1,79E-04
Construction Process	--	--	--	--	--	--	--
Use Stage	33,89	0,17	0,01	1,76E-02	101,39	481,46	3,00E-06
End of Life Stage	13,05	0,07	0,01	6,60E-03	2,44	151,99	9,33E-08
Benefits and loads beyond the system boundary	--	--	--	--	--	--	--
Aggregated values for C3 + D	-851,89	-4,23	-0,16	-0,38	-3.891,14	-10.326,57	-5,25E-05

Figure 34: Results Indicators - life cycle stages (Layout 2)

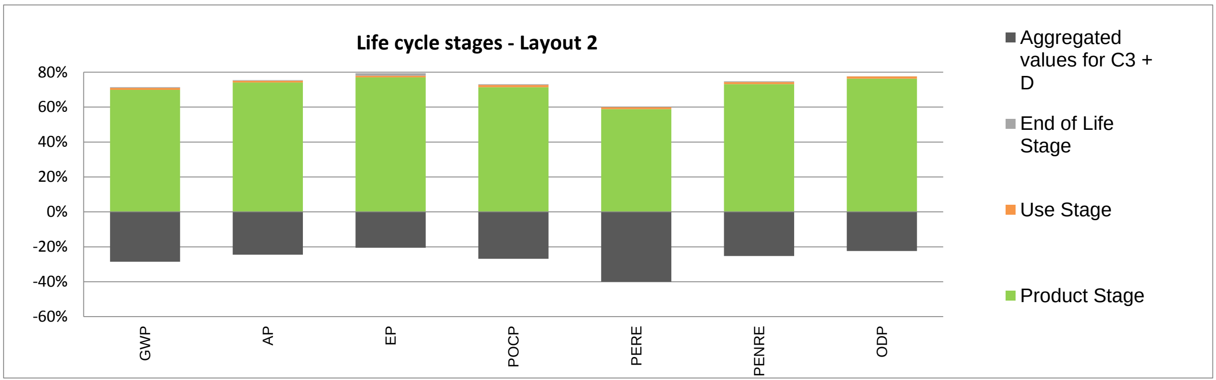


Table 77: Overview over the product LCA results (Layout 3)

Overview over the product LCA results (without Module B6)			TSTC - Layout 3 - DSF with collector type B (for all locations)						
20 years			1. Global warming potential	2. Acidification Potential	3. Eutrophication Potential	4. Photochemical Ozone Creation Potential	5. Total use of renewable primary energy	6. Total use of non-renewable primary energy	7. Depletion potential of the stratospheric ozone layer
			GWP	AP	EP	POCP	PERE	PENRE	ODP
			[kg CO_2-equiv./piece]	[kg SO_2-equiv./piece]	[kg PO_4^{-3} - equiv. /piece]	[kg C_2H_4-equiv./piece]	[MJ/piece]	[MJ/m^2_{piece}]	[kg CFC11-equiv./piece]
Product Stage	A1 A2 A3	Raw Materials Supply Transport Manufacturing	2.787,21	16,20	0,77	1,26	7.264,16	40.689,03	2,41E-04
Construction Process	A4	Transport	--	--	--	--	--	--	--
	A5	Construction- Installation process (not considered)	--	--	--	--	--	--	--
Use Stage	B1	Use (not considered)	--	--	--	--	--	--	--
	B2	Maintenance	13,34	7,95E-02	2,57E-03	9,33E-03	36,05	174,85	6,93E-07
	B3	Repair	--	--	--	--	--	--	--
	B4	Replacement	--	--	--	--	--	--	--
	B5	Refurbishment	--	--	--	--	--	--	--
	B6	Operational Energy Use	Please see additonal table "TSTC - Module B6 - operational energy use only - collector type A and B"						
	B7	Operational Water Use (not considered)	--	--	--	--	--	--	--
End of Life Stage	C1	Deconstruction (not considered)	--	--	--	--	--	--	--
	C2	Transport	9,23	5,70E-02	9,82E-03	4,64E-03	0,18	134,29	1,81E-08
	C3	Waste process for reuse, recovery or/ and recycling (can not be reported separately for incineration or recycling processes --> please see "Aggregated values for C3 + D")	--	--	--	--	--	--	--
	C4	Disposal	7,20	2,99E-02	3,72E-03	3,70E-03	2,99	59,63	1,03E-07
Benefits and loads beyond the system boundary	D	Reuse- Recovery- (can not be reported separately for incineration or recycling processes --> please see "Aggregated values for C3 + D")	--	--	--	--	--	--	--
Aggregated values for C3 + D		Incineration processes	17,12	-3,50E-02	-3,22E-03	-3,22E-03	-7,54	-544,48	-1,48E-06
		Recycling processes	-1.102,06	-5,32	-0,19	-0,19	-4.924,95	-12.293,89	-6,46E-05

Table 78: Results Indicators - life cycle stages (Layout 3)

Overview over the product LCA results (without Module B6)	TSTC - Layout 3 - DSF with collector type B (for all locations)						
20 years	1. Global warming potential	2. Acidification Potential	3. Eutrophication Potential	4. Photochemical Ozone Creation Potential	5. Total use of renewable primary energy	6. Total use of non-renewable primary energy	7. Depletion potential of the stratospheric ozone layer
	GWP	AP	EP	POCP	PERE	PENRE	ODP
	[kg CO_2-equiv./piece]	[kg SO_2-equiv./piece]	[kg PO_4^{-3} - equiv. /piece]	[kg C_2H_4-equiv./piece]	[MJ/piece]	[MJ/piece]	[kg CFC11-equiv./piece]
Product Stage	2.787,21	16,20	0,77	1,26	7.264,16	40.689,03	2,41E-04
Construction Process	--	--	--	--	--	--	--
Use Stage	13,34	0,08	2,57E-03	9,33E-03	36,05	174,85	6,93E-07
End of Life Stage	16,43	0,09	1,35E-02	8,33E-03	3,17	193,92	1,21E-07
Benefits and loads beyond the system boundary	--	--	--	--	--	--	--
Aggregated values for C3 + D	-1.084,93	-5,35	-0,20	-0,20	-4.932,49	-12.838,36	-6,61E-05

Figure 35: Results Indicators - life cycle stages (Layout 3)

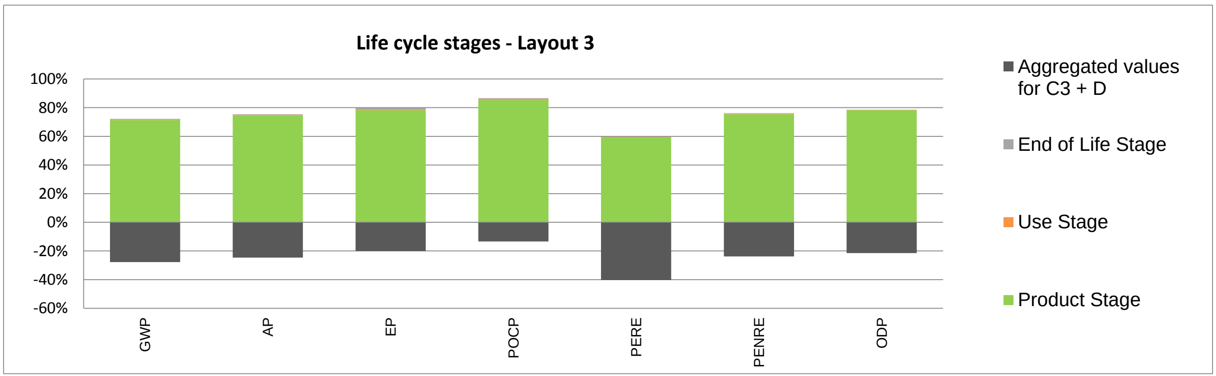


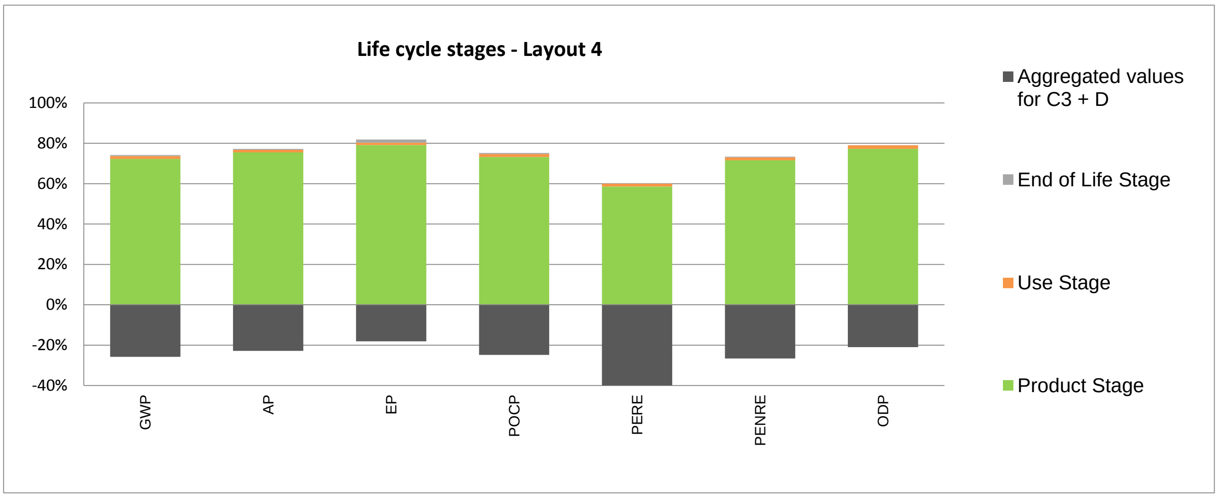
Table 79: Overview over the product LCA results (Layout 4)

Overview over the product LCA results (without Module B6)			TSTC - Layout 4 - DSF with collector type A (for all locations)						
20 years			1. Global warming potential	2. Acidification Potential	3. Eutrophication Potential	4. Photochemical Ozone Creation Potential	5. Total use of renewable primary energy	6. Total use of non-renewable primary energy	7. Depletion potential of the stratospheric ozone layer
			GWP	AP	EP	POCP	PERE	PENRE	ODP
			[kg CO_2-equiv./piece]	[kg SO_2-equiv./piece]	[kg PO_4^{-3} - equiv. /piece]	[kg C_2H_4-equiv./piece]	[MJ/piece]	[MJ/m^2_{piece}]	[kg CFC11-equiv./piece]
Product Stage	A1 A2 A3	Raw Materials Supply Transport Manufacturing	2.344,12	14,02	0,67	1,11	5687,57	34559,21	1,95E-04
Construction Process	A4	Transport	--	--	--	--	--	--	--
	A5	Construction- Installation process (not considered)	--	--	--	--	--	--	--
Use Stage	B1	Use (not considered)	--	--	--	--	--	--	--
	B2	Maintenance	46,22	0,23	1,01E-02	2,25E-02	140,59	665,43	4,38E-06
	B3	Repair	--	--	--	--	--	--	--
	B4	Replacement	--	--	--	--	--	--	--
	B5	Refurbishment	--	--	--	--	--	--	--
	B6	Operational Energy Use	Please see additonal table "TSTC - Module B6 - operational energy use only - collector type A and B"						
	B7	Operational Water Use (not considered)	--	--	--	--	--	--	--
End of Life Stage	C1	Deconstruction (not considered)	--	--	--	--	--	--	--
	C2	Transport	8,66	0,05	9,21E-03	4,35E-03	0,17	125,10	1,68E-08
	C3	Waste process for reuse, recovery or/ and recycling (can not be reported separately for incineration or recycling processes --> please see "Aggregated values for C3 + D")	--	--	--	--	--	--	--
	C4	Disposal	7,20	0,03	3,72E-03	3,70E-03	2,99	59,63	1,03E-07
Benefits and loads beyond the system boundary	D	Reuse- Recovery- (can not be reported separately for incineration or recycling processes --> please see "Aggregated values for C3 + D")	--	--	--	--	--	--	--
Aggregated values for C3 + D		Incineration processes	17,12	-0,03	-3,22E-03	-3,22E-03	-7,54	-544,48	-1,48E-06
		Recycling processes	-854,24	-4,20	-0,15	-0,37	-3872,28	-12293,89	-5,15E-05

Table 80: Results Indicators - life cycle stages (Layout 4)

Overview over the product LCA results (without Module B6)	TSTC - Layout 4 - DSF with collector type A (for all locations)						
20 years	1. Global warming potential	2. Acidification Potential	3. Eutrophication Potential	4. Photochemical Ozone Creation Potential	5. Total use of renewable primary energy	6. Total use of non-renewable primary energy	7. Depletion potential of the stratospheric ozone layer
	GWP	AP	EP	POCP	PERE	PENRE	ODP
	[kg CO_2-equiv./piece]	[kg SO_2-equiv./piece]	[kg PO_4^{-3} - equiv. /piece]	[kg C_2H_4-equiv./piece]	[MJ/piece]	[MJ/piece]	[kg CFC11-equiv./piece]
Product Stage	2.344,12	14,02	0,67	1,11	5.687,57	34.559,21	1,95E-04
Construction Process	--	--	--	--	--	--	--
Use Stage	46,22	0,23	0,01	0,02	140,59	665,43	4,38E-06
End of Life Stage	15,86	0,08	0,01	0,01	3,16	184,73	1,20E-07
Benefits and loads beyond the system boundary	--	--	--	--	--	--	--
Aggregated values for C3 + D	-837,12	-4,23	-0,15	-0,38	-3.879,82	-12.838,36	-5,30E-05

Figure 36: Results Indicators - life cycle stages (Layout 4)



For the results of the production stage (module A1 to A3), a security factor of 10% on the original results is applied.

The results of the impact assessment for the life cycle phases of layout 2 to 4 show similar characteristics for all impact categories:

- The environmental impacts throughout the life cycle are determined by the production and the End-of-Life phase when all systems are regarded at.
- Façade profiles (aluminium) contribute with 50% to 85%, the glazing unit with 20% to 25% and the absorber with 7% (collector type A) to 25% (collector type B) to the total impacts for production.
- The End-of-Life phase is determined by aluminium recycling with 90%. Respective credits lower the overall impacts for the total life cycle up to one third of the impacts caused by production.
- Maintenance activities are almost irrelevant, independently from the system regarded at.

Details and results on the assessment of the operation phase (module B6), are provided within following tables (Table 81 to Table 85) and figures (Figure 34 to Figure 36).

Calculation of produced thermal energy (component operation) [4]

$$Out_{coll} = \eta_{coll} \, (x) \, I \, (x) \, A_{coll} \, (x) \, t$$

Out_{coll}	Collector output (produced thermal energy) in [kWh]
η_{coll}	Collector efficiency in [%], determined via TRNSYS simulations
I	Solar irradiation in [kWh/m² * a] as yearly sum of horizontal irradiation (from TRNSYS simulation programme)
A_{coll}	Collector area (absorber area) in [m²]
t	Time period of consideration in [a]

Table 81 illustrates the calculated solar thermal heat production for both collector types and different locations.

Table 81: Overview on solar heat production (imported energy) for different collector types and different locations [4]

Solar heat production for different locations

Collector type A = semi-transparent plate collector (either embedded in an insulating glazing unit or within the façade cavity for the double skin façade)
Collector Type B = a lamella collector (embedded within the a double skin facade cavity)

		Frankfurt (DE)		Stockholm (SE)		Madrid (ES)	
Collector type	-	A	B	A	B	A	B
Absorber surface area	m²	1,88	4,48	1,88	4,48	1,88	4,48
Solar irradiation	kWh/(m² * a)	814	814	945	945	1214	1214
Collector efficiency	%	20	20	20	20	20	20
Time period of consideration	a	20	20	20	20	20	20
Total solar primary energy income - Total solar renewable primary energy for 20 years	kWh	30.606	72.934	35.532	84.672	45.646	108.774
	MJ	110.183	262.564	127.915	304.819	164.327	391.588
Solar primary energy losses due to collector efficiency	kWh	24.485	58.348	28.426	67.738	36.517	87.020
	MJ	88.146	210.051	102.332	243.855	131.462	313.270
Solar heat produced from renewable primary energy - Gross gains for renewable primary energy (to the building HVAC system)	**kWh**	**6.121**	**14.587**	**7.106**	**16.934**	**9.129**	**21.755**
	MJ	**22.037**	**52.513**	**25.583**	**60.964**	**32.865**	**78.318**

For the calculation of auxiliary energy (power grid mix = electricity) [4]

The following assumptions have been made to calculate auxiliary energy and respective environmental impacts:

- Auxiliary energy necessary = value of 5% for heating
- Auxiliary energy necessary = value of 10% for cooling

Following auxiliary energy consumption (module B6) is assumed for a time period of consideration of 20 years:

		for 20 years							Delivered to HVAC system		From delivered to HVAC system		Electricity			
Location	Collector type	Solar thermal energy production [kWh]	Used for heating [%]	Used for cooling [%]	Share for heating [kWh]	Share for cooling [kWh]	Heating efficiency [%]	Cooling efficiency [%]	Share for heating [kWh]	Share for cooling [kWh]	Share Aux. Energy "Heat" [%]	Share Aux. Energy "Cold" [%]	Aux. Energy "Heat" [kWh]	Aux. Energy "Cold" [kWh]	Aux. Energy "Heat" [MJ]	Aux. Energy "Cold" [MJ]
Frankfurt	A	6.121	50	50	3.061	3.061	90	80	2.755	2.449	5	10	138	245	496	881
	B	14.587	50	50	7.293	7.293	90	80	6.564	5.835	5	10	328	583	1.182	2.101
Stockholm	A	7.106	75	25	5.330	1.777	90	80	4.797	1.421	5	10	240	142	863	512
	B	16.934	75	25	12.701	4.234	90	80	11.431	3.387	5	10	572	339	2.058	1.219
Madrid	A	9.129	25	75	2.282	6.847	80	90	1.826	6.162	5	10	91	616	329	2.218
	B	21.755	25	75	5.439	16.316	80	90	4.351	14.685	5	10	218	1.468	783	5.286

Table 82: Overview over the product LCA results (Module B6, layout 2 to 4) – results per piece

Overview over the product LCA results			**TSTC - Module B6 - operational energy use only** **Share of solar produced heat from collector that is used within HVAC system (best case):** **Heating = 0,9 (Frankfurt & Stockholm); Heating = 0,8 (Madrid)** **Cooling = 0,8 (Frankfurt & Stockholm); Cooling = 0,9 (Madrid)** **Auxiliary electricity:** **Heating = 5% of solar produced heat used within heating system** **Cooling = 10% of solar produced heat used within cooling system**						
20 years			**1. Global warming potential**	**2. Acidification Potential**	**3. Eutrophication Potential**	**4. Photochemical Ozone Creation Potential**	**5. Total use of renewable primary energy**	**6. Total use of non-renewable primary energy**	**7. Depletion potential of the stratospheric ozone layer**
			GWP	AP	EP	POCP	PERE	PENRE	ODP
			[kg CO_2-equiv./piece]	[kg SO_2-equiv./piece]	[kg PO_4^{-3} - equiv. /piece]	[kg C_2H_4-equiv./piece]	[MJ/piece]	[MJ/piece]	[kg CFC11-equiv./piece]
Frankfurt	B6	Operational Energy Use - Total (Collector Type A)	221,81	1,5705	0,0570	0,0863	327	4.249	5,15E-05
	B6	Operational Energy Use - Total (Collector Type B)	528,57	3,7425	0,1358	0,2058	780	10.125	1,23E-04
Stockholm	B6	Operational Energy Use - Total (Collector Type A)	221,46	1,5680	0,0569	0,0862	327	4.242	5,14E-05
	B6	Operational Energy Use - Total (Collector Type B)	527,73	3,7365	0,1355	0,2054	779	10.109	1,23E-04
Madrid	B6	Operational Energy Use - Total (Collector Type A)	410,20	2,9044	0,1054	0,1597	606	7.857	9,52E-05
	B6	Operational Energy Use - Total (Collector Type B)	977,51	6,9211	0,2511	0,3805	1.443	18.724	2,27E-04

The results of the impact assessment for collector type A and B for module B6 show similar characteristics for all locations assessed:

- Collector type B with higher absorber surface area and a higher generation of heat compared to collector type A, has higher impacts within the operation phase in all locations due to higher use of auxiliary energy.
- Impacts for the operation phase are caused by auxiliary electricity needed to provide heat and cold for the building. The share of impacts by electricity for heating is about 40% and for cooling 60%.

Table 83: Overview over the product LCA results (Module B6, layout 2 to 4) – results per m² façade area covered, per kWh solar thermal energy produced and year

Results per 1m² facade area covered and per 1 kWh of thermal energy production per year:

Facade area covered:	5,625 m²	1 element (TSTC)
Energy produced:	6.121 kWh	Frankfurt
(Collector Type A)	7.106 kWh	Stockholm
	9.129 kWh	Madrid
Energy produced:	14.587 kWh	Frankfurt
(Collector Type A)	16.934 kWh	Stockholm
	21.755 kWh	Madrid
Energy production for:	20 years	

Overview over the product LCA results			**TSTC - Module B6 - operational energy use only** **Share of solar produced heat from collector that is used within HVAC system (best case):** **Heating = 0,9 (Frankfurt & Stockholm); Heating = 0,8 (Madrid)** **Cooling = 0,8 (Frankfurt & Stockholm); Cooling = 0,9 (Madrid)** **COP Heating System = 1** **COP Cooling System = 0,7** **Auxiliary electricity:** **Heating = 5% of solar produced heat used within heating system** **Cooling = 10% of solar produced heat used within cooling system**						
20 years			**1. Global warming potential**	**2. Acidification Potential**	**3. Eutrophication Potential**	**4. Photochemical Ozone Creation Potential**	**5. Total use of renewable primary energy**	**6. Total use of non-renewable primary energy**	**7. Depletion potential of the stratospheric ozone layer**
			GWP	AP	EP	POCP	PERE	PENRE	ODP
			[kg CO_2-equiv./m² * kWh * a]	[kg SO_2-equiv./m² * kWh * a]	[kg PO_4^{-3} - equiv. /m² * kWh * a]	[kg C_2H_4-equiv./m² * kWh * a]	[MJ/m² * kWh * a]	[MJ/m² * kWh * a]	[kg CFC11-equiv./m² * kWh *a]
Frankfurt	B6	Operational Energy Use - Total (Collector Type A)	3,22E-04	2,28E-06	8,27E-08	1,25E-07	4,76E-04	6,17E-03	7,48E-11
	B6	Operational Energy Use - Total (Collector Type B)	3,22E-04	2,28E-06	8,27E-08	1,25E-07	4,75E-04	6,17E-03	7,48E-11
Stockholm	B6	Operational Energy Use - Total (Collector Type A)	2,77E-04	1,96E-06	7,11E-08	1,08E-07	4,09E-04	5,31E-03	6,43E-11
	B6	Operational Energy Use - Total (Collector Type B)	2,77E-04	1,96E-06	7,11E-08	1,08E-07	4,09E-04	5,31E-03	6,43E-11
Madrid	B6	Operational Energy Use - Total (Collector Type A)	3,99E-04	2,83E-06	1,03E-07	1,55E-07	5,90E-04	7,65E-03	9,27E-11
	B6	Operational Energy Use - Total (Collector Type B)	3,99E-04	2,83E-06	1,03E-07	1,55E-07	5,90E-04	7,65E-03	9,27E-11

Table 84: Overview over the product LCA results (Credits for module B6, layout 2 to 4) – results per piece

Overview over the product LCA results			**TSTC - Module B6 - Credits for solar heat production**						
20 years			**1. Global warming potential**	**2. Acidification Potential**	**3. Eutrophication Potential**	**4. Photochemical Ozone Creation Potential**	**5. Total use of renewable primary energy**	**6. Total use of non-renewable primary energy**	**7. Depletion potential of the stratospheric ozone layer**
			GWP	AP	EP	POCP	PERE	PENRE	ODP
			[kg CO_2-equiv./piece]	[kg SO_2-equiv./piece]	[kg PO_4^{-3} - equiv. /piece]	[kg C_2H_4-equiv./piece]	[MJ/piece]	[MJ/piece]	[kg CFC11-equiv./piece]
Frankfurt	B6	Solar heat production - Total (Collector Type A)	--	--	--	--	22.036	--	--
		Accounted credits for solar heat production (Collector Type A)	none, as this depends on the conventional heating and cooling supply that may be substituted via using the TSTC				-22.036	none, as this depends on the conventional heating and cooling supply that may be substituted via using the TSTC	
	B6	Operational Energy Use - Total (Collector Type B)	--	--	--	--	52.513	--	--
		Accounted credits for solar heat production (Collector Type B)	none, as this depends on the conventional heating and cooling supply that may be substituted via using the TSTC				-52.513	none, as this depends on the conventional heating and cooling supply that may be substituted via using the TSTC	
Stockholm	B6	Solar heat production - Total (Collector Type A)	--	--	--	--	25.582	--	--
		Accounted credits for solar heat production (Collector Type A)	none, as this depends on the conventional heating and cooling supply that may be substituted via using the TSTC				-25.582	none, as this depends on the conventional heating and cooling supply that may be substituted via using the TSTC	
	B6	Operational Energy Use - Total (Collector Type B)	--	--	--	--	60.962	--	--
		Accounted credits for solar heat production (Collector Type B)	none, as this depends on the conventional heating and cooling supply that may be substituted via using the TSTC				-60.962	none, as this depends on the conventional heating and cooling supply that may be substituted via using the TSTC	
Madrid	B6	Solar heat production - Total (Collector Type A)	--	--	--	--	32.864	--	--
		Accounted credits for solar heat production (Collector Type A)	none, as this depends on the conventional heating and cooling supply that may be substituted via using the TSTC				-32.864	none, as this depends on the conventional heating and cooling supply that may be substituted via using the TSTC	
	B6	Operational Energy Use - Total (Collector Type B)	--	--	--	--	78.318	--	--
		Accounted credits for solar heat production (Collector Type B)	none, as this depends on the conventional heating and cooling supply that may be substituted via using the TSTC				-78.318	none, as this depends on the conventional heating and cooling supply that may be substituted via using the TSTC	

Table 85: Overview over the product LCA results (Credits for module B6, layout 2 to 4) – results per m² façade area covered, per kWh solar thermal energy produced and year

Results per 1m² facade area covered and per 1 kWh of thermal energy production per year:

Overview over the product LCA results			TSTC - Module B6 - Credits for solar heat production						
20 years			1. Global warming potential	2. Acidification Potential	3. Eutrophication Potential	4. Photochemical Ozone Creation Potential	5. Total use of renewable primary energy	6. Total use of non-renewable primary energy	7. Depletion potential of the stratospheric ozone layer
			GWP	AP	EP	POCP	PERE	PENRE	ODP
			[kg CO_2-equiv./m² * kWh * a]	[kg SO_2-equiv./m² * kWh * a]	[kg PO_4^{-3} - equiv. /m² * kWh * a]	[kg C_2H_4-equiv./m² * kWh * a]	[MJ/m² * kWh * a]	[MJ/m² * kWh * a]	[kg CFC11-equiv./m² * kWh *a]
Frankfurt	B6	Solar heat production - Total (Collector Type A)	--	--	--	--	3,20E-02	--	--
		Accounted credits for solar heat production (Collector Type A)	none, as this depends on the conventional heating and cooling supply that may be substituted via using the TSTC				-3,20E-02	none, as this depends on the conventional heating and cooling supply that may be substituted via using the TSTC	
	B6	Operational Energy Use - Total (Collector Type B)	--	--	--	--	3,20E-02	--	--
		Accounted credits for solar heat production (Collector Type B)	none, as this depends on the conventional heating and cooling supply that may be substituted via using the TSTC				-3,20E-02	none, as this depends on the conventional heating and cooling supply that may be substituted via using the TSTC	
Stockholm	B6	Solar heat production - Total (Collector Type A)	--	--	--	--	3,20E-02	--	--
		Accounted credits for solar heat production (Collector Type A)	none, as this depends on the conventional heating and cooling supply that may be substituted via using the TSTC				-3,20E-02	none, as this depends on the conventional heating and cooling supply that may be substituted via using the TSTC	
	B6	Operational Energy Use - Total (Collector Type B)	--	--	--	--	3,20E-02	--	--
		Accounted credits for solar heat production (Collector Type B)	none, as this depends on the conventional heating and cooling supply that may be substituted via using the TSTC				-3,20E-02	none, as this depends on the conventional heating and cooling supply that may be substituted via using the TSTC	
Madrid	B6	Solar heat production - Total (Collector Type A)	--	--	--	--	3,20E-02	--	--
		Accounted credits for solar heat production (Collector Type A)	none, as this depends on the conventional heating and cooling supply that may be substituted via using the TSTC				-3,20E-02	none, as this depends on the conventional heating and cooling supply that may be substituted via using the TSTC	
	B6	Operational Energy Use - Total (Collector Type B)	--	--	--	--	3,20E-02	--	--
		Accounted credits for solar heat production (Collector Type B)	none, as this depends on the conventional heating and cooling supply that may be substituted via using the TSTC				-3,20E-02	none, as this depends on the conventional heating and cooling supply that may be substituted via using the TSTC	

Interpretation of the results "Scenario"

Hot spots which can be identified (for the production and end-of-life stage) are:

- Façade profiles made from aluminum,
- Glazing,
- Absorber made from aluminum and with PVD coating process.

Main improvement potentials should analyze lowering the material amounts necessary for façade profile production and glazing.

A sensitivity analysis on different production processes was not within the scope of the study but might be conducted for future assessment, if the manufacturer of the TSTC is able to provide information on alternative production processes or alternative materials.

With regard to thermal energy production and the assessment of auxiliary energy:

- A first approximation has been conducted which is based on specific numbers for the efficiency of the HVAC system of a building with which the TSTC might interact.
- The higher the share of produced solar heat that is used within a potential building, the higher the use of auxiliary energy and the higher the connected environmental impacts. Therefore, the results are linear dependent on the amount of solar irradiation which is available in a certain location.
- Credits for renewable energy production with regard to the environmental indicator renewable primary energy may reach values between 22.000 and 78.000 MJ per piece and per 20 years, depending on the location and collector type.

For future assessment, it is advisable to include the component in realistic energetic simulations for a target building by varying:

- The façade side on which the TSTC is applied (every side has different effective solar irradiation),
- The amount of façade area covered by the TSTC and therefore the energy production for the building,
- HVAC elements for heating and cooling, as well as their efficiencies,
- Different conventional energy carriers (e.g. oil, gas, wood, ..) which are substituted as solar produced heat is used instead.

Only in this way a reliable result for the environmental influence of the component on the building performance (especially for building operation) can be obtained or information on e.g. energy payback times can be given.

46. Conclusion

Several facts have to be kept in mind when analysing the results presented in this report:

- The level of detail for the received information for the different elements of the TSTC differs partly, due to the fact that some of the single elements are bought and not self-manufactured by component developer. The TSTC still represent a prototype.
- Qualified and specific assumptions have been made for displaying the operation phase. The assumptions serve for a first estimation on the calculation of potential credits for renewable energy production in different locations. In future, calculations on the building operation shall be based on energetic simulations by taking into account a target building, its specific HVAC system and efficiencies as well as its respective final energy demand.
- Due to the novelty of the TSTC some environmental processes or data were not ready available in the GaBi 4 database and had to be modelled based on specific estimations and assumptions.
- For the End-of-Life phase partly no respective End-of-Life routes could be applied. Especially for the processing of coatings only very few technologies exist, which could not yet be addressed adequately. On the other hand, information on the coating process itself had to be based on assumptions when no specific information on the coating process was available. These assumptions can have a significant influence on the results for the production phase, if they are adapted when specific information is available.
- In general, conservative assumptions were made, wherever no information is available, in order to ensure that the environmental impacts are not affected by giving to high credits (e.g. for the End-of-Life phase) or that environmental effects are underestimated.
- Especially recycling processes for metals and glass have a high influence on reducing the environmental impacts from production and operation within the End-of-Life phase. They lower the partly very high impacts of the production phase up to 50%.

A comparison of conventional and alternative energy generation (in e.g. future scenarios) for the total life cycle (production, use, End-of-Life) only makes sense, if additional functionality (thermal energy production) of the layout 2 to 4 is included for the baseline scenario (layout 1). This is the case, if e.g. a potential target building is regarded at, assuming a specific conventional energy supply (e.g. via gas condensing boiler) which may be avoided by using the TSTC in layout 2, 3 or 4.

The assessment of the TSTC in combination with a potential target building for application shall be conducted to address further questions, such as:

- What is the environmental performance of the component when applied within a building?
- What share of heat, cold or electricity still has to be covered by conventional technologies?
- And how does this affect the environmental results obtained and the component performance?

In that way, the results may be used to assist e.g. planers and architects within the building design phase for choosing environmental beneficial solutions (e.g. the application of the TSTC) and to promote the use of renewable energies within high-rise buildings.

47. References

[1] PE, LBP. GaBi 4, Software-System and Database for Life Cycle Engineering, Copyright, TM, Stuttgart, Echterdingen, Germany, 1992-2010.

[2] Leiden University, Institute of environmental science (CML): CML (2007) - CML's impact assessment methods and characterization factors.

[3] Baitz, M.: Erstellung eines Modells zur Simulierung umweltrelevanter Auswirkungen von Transportprozessen unter Einfluss des Vertriebssystems, des Bedarfs, und des Transportmittels. Studienarbeit. Institut für Kunststoffprüfung und Kunststoffkunde (IKP). Universität Stuttgart (1998).

[4] Resource- and Cost-effective integration of renewables in existing high-rise buildings (Cost-Effective): D4.1.3 Report on the assessment of the environmental impacts of different integrated concepts – LCA of new developed components. Internal project report. European Seventh Framework Program (FP7).

[5] German Sustainable Building Council (DGNB e. V.): European Sustainable Construction Database (ESUCO), Stuttgart, 2012.

Documentation of additional information

Laboratory results and scenario-related information

The product LCA is based on the following documents/ evidence:

- Manufacturer information provided by project partners of European project "Cost-Effective"
- TRNSYs simulations (for component operation) from project partners of the European project "Cost-Effective"
- Deliverable 4.1.3 "LCA Report on the assessment of the environmental impacts of different integrated concepts - LCA of new developed components" → not yet public available
- Annex 1 of Deliverable 4.1.3, including partly confidential information on the layout, amounts for material inputs etc. → not public available

Documentation for the calculation of the reference service life (RSL) [4]

The RSL are declared in accordance with EN 15804, chapter 6.3.3, as information is provided by manufacturer. It refers to the technical and functional performance of the product within a building. The overall RSL for the TSTC is provided with 20 years. For different elements of the TSTC the RSL are provided within Table 86.

Table 86: Overview on RSL for different elements of the assessed systems

Element	Reference service life [a]
TSTC Type A and B (in general) – absorber, including piping	20
Façade profiles and metallic fixings	> 50
Façade insulation	30
Façade sealing	20
Glazing with spacer, desiccant and sealing	20
Blinds and motor	10

Assumptions for the coating process (LCI input data) [4]

PVD coating layers:

- chromium oxide (CrOx estimated with a “Ferro chrome mix) as cermet for absorption and silicon oxide (SiOx estimated with “Silicious sand) as antireflective coating;
- cermet consists of three layers with increasing oxygen content.
- target exploitation = 80% (target recovery = 20%; recycled for the production of new metal targets);
- material yield PVD process = almost 100% (almost all triggered metal atoms will be deposited);

The necessary auxiliary electricity is calculated as follows:

- Resulting electricity consumption = 4,8 $kWh/m^2{}_{\text{coated area}}$
- Corona power (generator) = 0,024 $kWh/m^2{}_{\text{coated area}}$

Documentation on used data sets

Case study EeBGuide: energy-efficient product - Documentation on used data sets

		1	2	3	4	5	6	1	2	3	4	5
	Data set name	Age (Date)	Geography	Technology	Source	Comments	ESUCO Dataset	Age (Date)	Geography	Technology	Source	Comments
Transport	Truck, Euro 3, 20-26t total cap., 17,3t payload	2005 - 2012	Global	technology mix	ELCD / PE-GaBi		EU: 9.3.01 Transport, truck (up to 26 t total cap.)	2005 - 2012	EU	technology mix	PE	ELCD dataset is not available any more on ELCD website, but is choosen instead of ESUCO datset, as documentation within GaBi 4.4 is better
Energy supply and auxiliary materials	Diesel	2003 - 2012	EU-15	consumption mix, at refinery	ELCD / PE-GaBi		no corresponding data set					as ESUCO dataset is used --> Diesel input is not necessary anymore, as already included within ESUCO dataset
	Power grid mix	2002 - 2010	EU-27	consumption mix, at consumer	ELCD / PE-GaBi		EU: 9.2.05 Power grid mix	2002 - 2010	EU	1kV - 60kV	ELCD/PE	original ELCD EU-27 Power grid mix, and not the ESUCO mix is choosen, as better documentation is available
	Compressed air 7 bar (low power consumption)	2002 - 2010	Global	production mix, at plant	ELCD / PE-GaBi		no corresponding data set					
	Lubricants	2003 - 2012	EU-15	consumption mix, at refinery	PE							
	Potable water from groundwater	2005 - 2012	DE	consumption mix, at refinery	PE							
	Detergent (fatty acid sulfonate derivate)	2005 - 2012	Global	production mix, at producer	PE							
	Thermal energy from natural gas	2002 - 2012	EU-25	consumption mix, at consumer	ELCD / PE-GaBi		EU: 9.2.01 Thermal energy from natural gas	2002 - 2012	EU	consumption mix, at consumer	PE	ESUCO dataset is choosen as ELCD datset is not anymore available on the ELCD Website

Case study EeBGuide: energy-efficient product - Documentation on used data sets

		1	2	3	4	5	6	1	2	3	4	5
	Data set name	Age (Date)	Geography	Technology	Source	Comments	ESUCO Dataset	Age (Date)	Geography	Technology	Source	Comments
Processing	Steel sheet stamping and bending (5% loss)	2005 - 2012	Global	technology mix	PE		no corresponding data set					
	Polyamide 6.6 GF injection moulded part (0,02 - 0,2kg)	2005 - 2012	DE	technology mix	PE							
	Powder coating of metal	2012	DE	technology mix	PE		EU: 4.7.03 Powder coating of metal	2006 - 2012	EU	at producer	PE	instead of German dataset
	Plastic extrusion profile (unspecific)	2012	Global	technology mix	PE		no corresponding data set					
	Diverse processes for laminated glass: Glass washing and drying; lamination initial bond; Autoclave; PVB Cutting; waste laminated glass disposal; Edge grinding; Monolythic laminated glass	2008 - ??	RER	technology mix	self-modelled with GaBi	Estimation for process of glass lamination						
	Aluminum extrusion profile	2002 - 2012	RER	production mix, at producer	PE		no corresponding data sets for processing, buit ready to use data sets for different metal sheets (see "Materials and products")					
	Aluminum sheet	2002 - 2012	RER	production mix, at producer	PE							
	Copper wire (0.06mm)	2012	DE	technology mix	PE							
	Welding seam 1m	2012	Global	technology mix	PE							

Case study EeBGuide: energy-efficient product - Documentation on used data sets

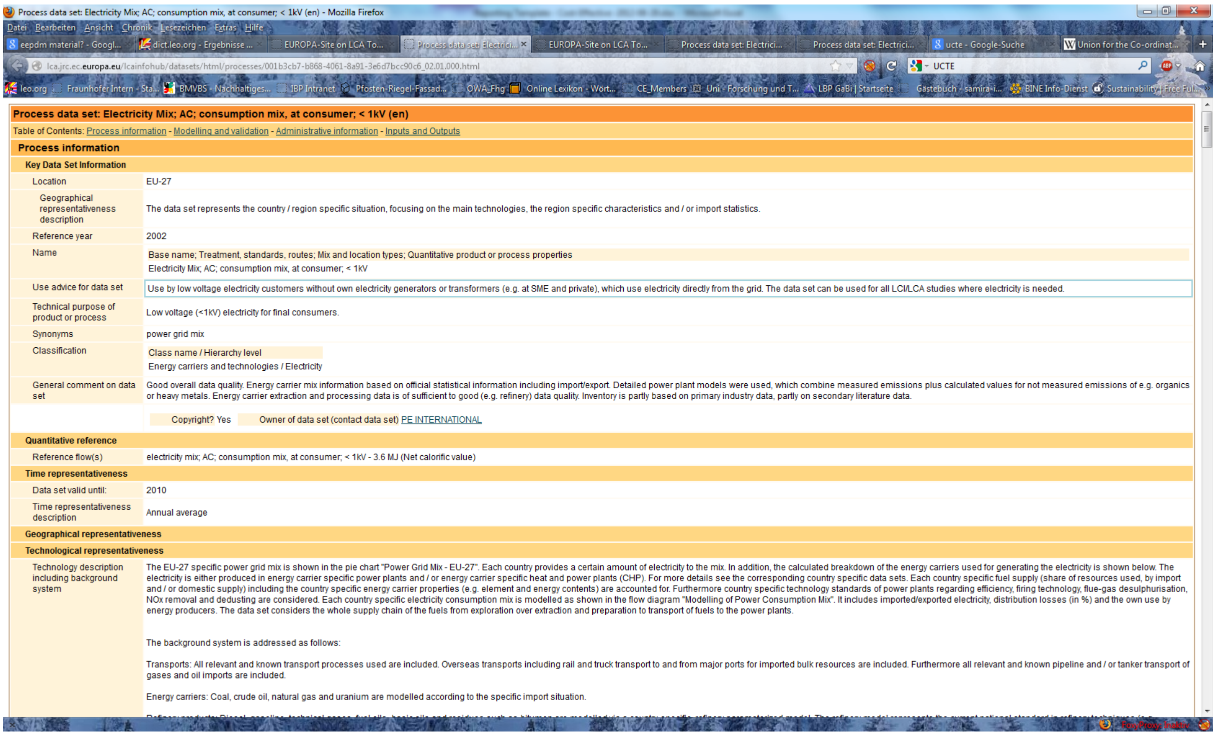
		1	2	3	4	5	6	1	2	3	4	5
	Data set name	Age (Date)	Geography	Technology	Source	Comments	ESUCO Dataset	Age (Date)	Geography	Technology	Source	Comments
Materials and intermediates	DE: Stone wool - Rockwool PE	2006 - 2012	DE	production mix, at plant	PE		DE: 2.01 Mineral wool (fasade insulation)	2004 - 2012	DE DE	production mix, at producer	PE PE	German data set is choosen, as ESUCO only refers to German dataset
	Aluminum sheet mix	2002 - 2012	RER	technology mix	PE		EU: 4.3.01 Aluminium sheet	2005 - 2012	EU	production mix, at producer	PE	ESUCO data set choosen, as data set is new from age
	Nylon 6.6 GF30 compound (PA 6.6 GF30)	1996 - 2006	RER	technology mix	ELCD /Plastics Europe							
	Glass fibres	2012	DE	technology mix	PE		no corresponding data set					
	Aluminum ingot mix	2002 - 2012	RER	consumption mix, at consumer	PE							
	Steel sheet	2004 - 2012	DE	technology mix	PE		DE: 4.2.01 Stainless steel sheet EU: 4.1.04 Steel plate	2005 - 2012 2007 - 2015	DE EU	n.n. blast furnace route	PE Wordsteel	German stainless steel sheet is choosen, as higher impacts per kg (as conservative assumption)
	Silicone sealing compound	2006 - 2012	DE	technology mix	PE		DE: 6.7 Silicone sealing compound	2006 - 2012	DE	technology mix	PE	ESUCO dataset = German dataset
	Rubber sealing compound	2005 - 2012	DE	technology mix	PE		DE: 7.3.01 EPDM sealings for aluminium profile (thermally separated)	2005 - 2012	DE	technology mix	PE	
	Steel cold rolled	2004 - 2012	DE	technology mix	PE		EU: 4.1.04 Steel cold rolled coil	2007 - 2015	EU	blast furnace route	wordlsteel	
	Silica sand (flour)	2005 - 2012	DE	production mix, at producer	PE		no corresponding data set					
	Polypropylene granulate (PP)	2005 - 2012	DE	production mix, at producer	PE							
	Joint sealing tape butyl	2012	DE	producer	PE		EU: 6.7 Acrylate sealing compound	2008 - 2012	EU	technology mix	PE	ESUCO data set choosen
	Polyvinyl butyral (PVB)	2005 - 2012	DE	production mix, at producer	PE							
	Float Glass (according to BAT Feb2007)	2007 - ??	n.n.	BAT Feb2007	self-modelled with GaBi							
	Tin	200 - 2012	ID	production mix, at producer	PE	process of TiO Coating						
	Polypropylene granulate (PP)	2005 - 2012	DE	production mix, at producer	PE							
	Polyvinylchloride granulate mix (S-PVC)	2005 - 2012	DE	production mix, at producer	PE							
	Copper mix	2002 - 2012	Global	consumption mix, at consumer	PE		no corresponding data set					
	Polyethylene cross-linked (PEXa)	2005 - 2012	DE	production mix, at producer	PE							
	Steel cast part alloyed	2005 - 2012	DE	production mix, at producer	PE							
	Ferro chrome mix	2000 - 2012	DE	consumption mix, at consumer	PE	Estimation of process for						
	Siliceous sand (grain size 0/2)	2005 - 2012	DE	production mix, at producer	PE	Estimation of process for						
	Steel billet	2004 - 2012	DE	production mix, at producer	PE			2005 - 2012 2007 - 2015				

Case study EeBGuide: energy-efficient product - Documentation on used data sets

		1	2	3	4	5	6	1	2	3	4	5
	Data set name	Age (Date)	Geography	Technology	Source	Comments	ESUCO Dataset	Age (Date)	Geography	Technology	Source	Comments
End-of-Life	Wastewater treatment (contains low organic load)	2005 - 2012	DE	production mix, at producer	PE		no corresponding data set					
	Cullet Recycling (Glas)	2008 - ??	DE		self-modelled with GaBi	Estimation for process of glass lamination						
	Aluminum sheet Recycling	2004 - 2012	DE	Recycling potential	PE		EU: 4.8 Recycling potential aluminium (sheet and profiles)	2004 - 2012	EU	Recycling potential	PE	ESUCO dataset is choosen as European average
	Stainless steel sheet recycling	2012	DE	Recycling potential	PE		EU: 4.8 Recycling potential stainless steel sheet	2004 - 2012	EU	potential	PE	
	Copper sheet bare/Surface threated	2012	DE	Recycling potential	PE		EU: 4.8 Recycling potential copper sheet	2007 - 2012	EU	potential	PE	
	Plastic, incineration in MWI incl. credit	2005 - 2012	DE	End of Life, incineration	PE		EU: 6.8 Plastic, incineration in MWI incl. Credit	2005 - 2012	EU	End of Life, incineration	PE	
	Construction waste dumping	2005 - 2012	DE	technology mix, disposal	PE		EU: 9.5.02 Landfill construction waste	2005 - 2012	EU	technology mix	PE	
	Polybutadiene (PB)	2005 - 2012	RER	incinerated in municipal waste incinerator	ELCD / PE-GaBi		EU: 6.8 Plastic, incineration in MWI incl. credit	2005 - 2012	EU	End of Life, incineration	PE	ESUCO data set is choosen, as ELCD data set is not anymore available on ELCD website

Documentation on used ELCD data sets

http://lca.jrc.ec.europa.eu/lcainfohub/datasetArea.vm



Process data set: Electricity Mix; AC; consumption mix, at consumer; < 1kV (en) - Mozilla Firefox

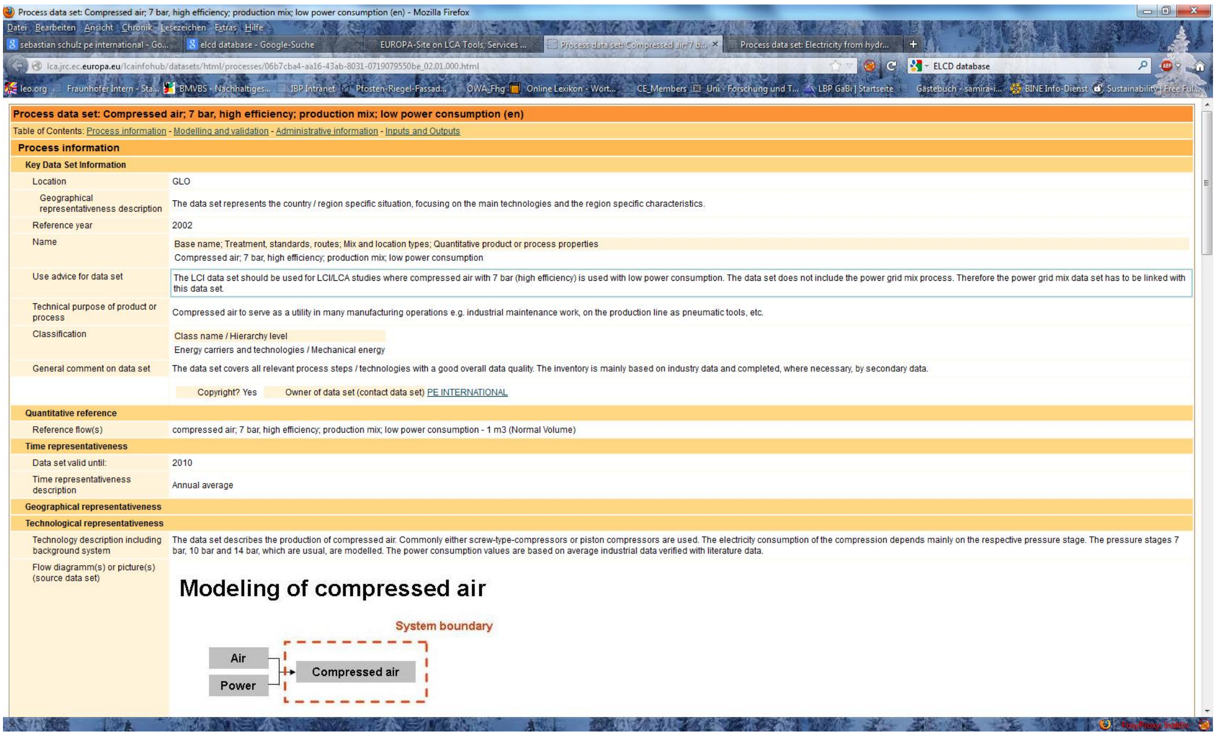
lca.jrc.ec.europa.eu/lcainfohub/datasets/html/processes/001b3cb7-b868-4061-8a91-3e6d7bcc90c6_02.01.000.html

Process data set: Electricity Mix; AC; consumption mix, at consumer; < 1kV (en)

Table of Contents: Process information - Modelling and validation - Administrative information - Inputs and Outputs

Process information

Key Data Set Information	
Location	EU-27
Geographical representativeness description	The data set represents the country / region specific situation, focusing on the main technologies, the region specific characteristics and / or import statistics.
Reference year	2002
Name	Base name; Treatment, standards, routes; Mix and location types; Quantitative product or process properties Electricity Mix; AC; consumption mix, at consumer; < 1kV
Use advice for data set	Use by low voltage electricity customers without own electricity generators or transformers (e.g. at SME and private), which use electricity directly from the grid. The data set can be used for all LCI/LCA studies where electricity is needed.
Technical purpose of product or process	Low voltage (<1kV) electricity for final consumers.
Synonyms	power grid mix
Classification	Class name / Hierarchy level Energy carriers and technologies / Electricity
General comment on data set	Good overall data quality. Energy carrier mix information based on official statistical information including import/export. Detailed power plant models were used, which combine measured emissions plus calculated values for not measured emissions of e.g. organics or heavy metals. Energy carrier extraction and processing data is of sufficient to good (e.g. refinery) data quality. Inventory is partly based on primary industry data, partly on secondary literature data.
	Copyright? Yes Owner of data set (contact data set) PE INTERNATIONAL
Quantitative reference	
Reference flow(s)	electricity mix; AC; consumption mix, at consumer; < 1kV - 3.6 MJ (Net calorific value)
Time representativeness	
Data set valid until:	2010
Time representativeness description	Annual average
Geographical representativeness	
Technological representativeness	
Technology description including background system	The EU-27 specific power grid mix is shown in the pie chart "Power Grid Mix - EU-27". Each country provides a certain amount of electricity to the mix. In addition, the calculated breakdown of the energy carriers used for generating the electricity is shown below. The electricity is either produced in energy carrier specific power plants and / or energy carrier specific heat and power plants (CHP). For more details see the corresponding country specific data sets. Each country specific fuel supply (share of resources used, by import and / or domestic supply) including the country specific energy carrier properties (e.g. element and energy contents) are accounted for. Furthermore country specific technology standards of power plants regarding efficiency, firing technology, flue-gas desulphurisation, NOx removal and dedusting are considered. Each country specific electricity consumption mix is modelled as shown in the flow diagram "Modelling of Power Consumption Mix". It includes imported/exported electricity, distribution losses (in %) and the own use by energy producers. The data set considers the whole supply chain of the fuels from exploration over extraction and preparation to transport of fuels to the power plants. The background system is addressed as follows: Transports: All relevant and known transport processes used are included. Overseas transports including rail and truck transport to and from major ports for imported bulk resources are included. Furthermore all relevant and known pipeline and / or tanker transport of gases and oil imports are included. Energy carriers: Coal, crude oil, natural gas and uranium are modelled according to the specific import situation.



Process data set: Compressed air; 7 bar, high efficiency; production mix; low power consumption (en) - Mozilla Firefox

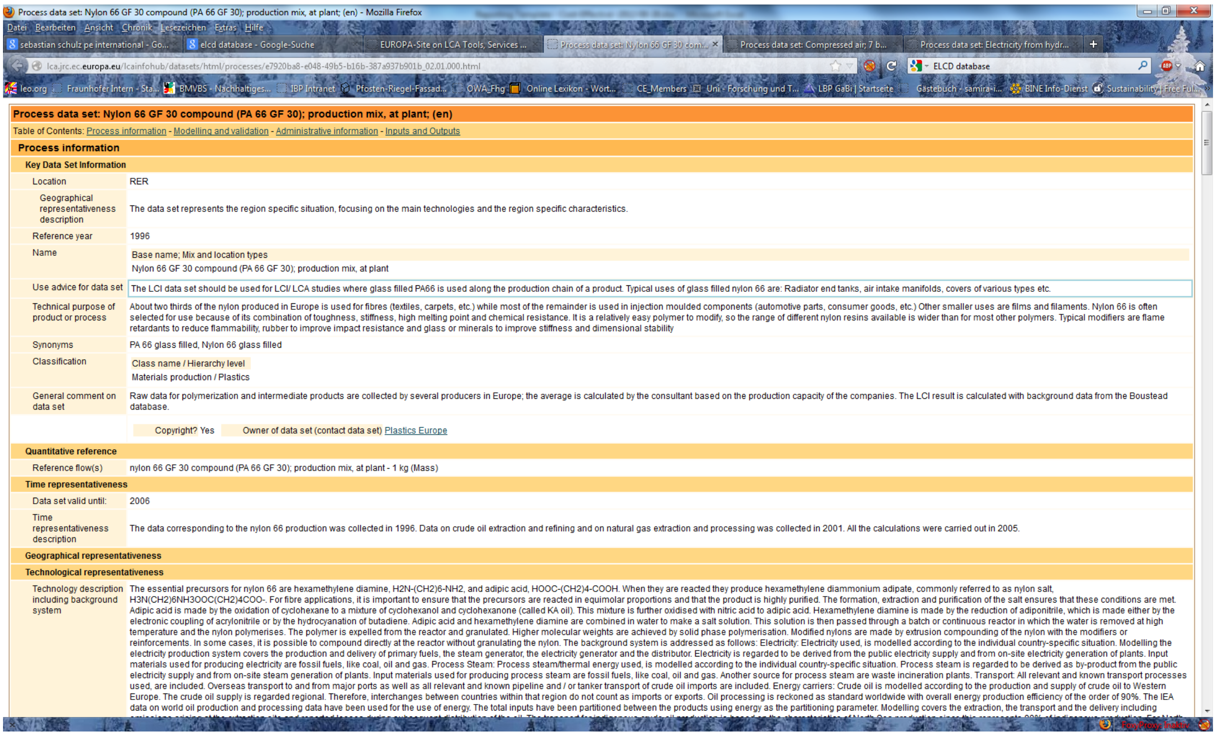
lca.jrc.ec.europa.eu/lcainfohub/datasets/html/processes/06b7cba4-aa16-43ab-8031-0719079550be_02.01.000.html

Process data set: Compressed air; 7 bar, high efficiency; production mix; low power consumption (en)

Table of Contents: Process information - Modelling and validation - Administrative information - Inputs and Outputs

Process information

Key Data Set Information	
Location	GLO
Geographical representativeness description	The data set represents the country / region specific situation, focusing on the main technologies and the region specific characteristics.
Reference year	2002
Name	Base name; Treatment, standards, routes; Mix and location types; Quantitative product or process properties Compressed air; 7 bar, high efficiency; production mix; low power consumption
Use advice for data set	The LCI data set should be used for LCI/LCA studies where compressed air with 7 bar (high efficiency) is used with low power consumption. The data set does not include the power grid mix process. Therefore the power grid mix data set has to be linked with this data set.
Technical purpose of product or process	Compressed air to serve as a utility in many manufacturing operations e.g. industrial maintenance work, on the production line as pneumatic tools, etc.
Classification	Class name / Hierarchy level Energy carriers and technologies / Mechanical energy
General comment on data set	The data set covers all relevant process steps / technologies with a good overall data quality. The inventory is mainly based on industry data and completed, where necessary, by secondary data.
	Copyright? Yes Owner of data set (contact data set) PE INTERNATIONAL
Quantitative reference	
Reference flow(s)	compressed air; 7 bar, high efficiency; production mix; low power consumption - 1 m3 (Normal Volume)
Time representativeness	
Data set valid until:	2010
Time representativeness description	Annual average
Geographical representativeness	
Technological representativeness	
Technology description including background system	The data set describes the production of compressed air. Commonly either screw-type-compressors or piston compressors are used. The electricity consumption of the compression depends mainly on the respective pressure stage. The pressure stages 7 bar, 10 bar and 14 bar, which are usual, are modelled. The power consumption values are based on average industrial data verified with literature data.
Flow diagramm(s) or picture(s) (source data set)	Modeling of compressed air System boundary Air Power Compressed air

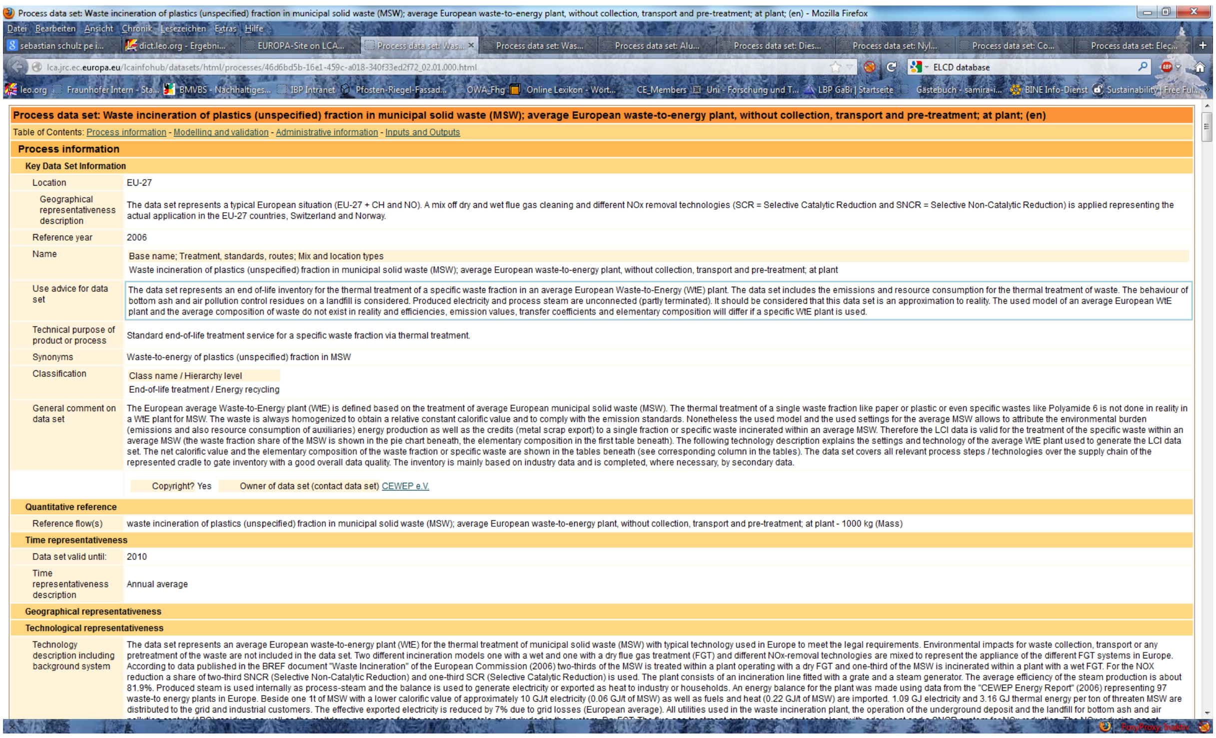


Process data set: Nylon 66 GF 30 compound (PA 66 GF 30); production mix, at plant; (en)

Table of Contents: Process information - Modelling and validation - Administrative information - Inputs and Outputs

Process information

Key Data Set Information	
Location	RER
Geographical representativeness description	The data set represents the region specific situation, focusing on the main technologies and the region specific characteristics.
Reference year	1996
Name	Base name; Mix and location types Nylon 66 GF 30 compound (PA 66 GF 30); production mix, at plant
Use advice for data set	The LCI data set should be used for LCI/ LCA studies where glass filled PA66 is used along the production chain of a product. Typical uses of glass filled nylon 66 are: Radiator end tanks, air intake manifolds, covers of various types etc.
Technical purpose of product or process	About two thirds of the nylon produced in Europe is used for fibres (textiles, carpets, etc.) while most of the remainder is used in injection moulded components (automotive parts, consumer goods, etc.) Other smaller uses are films and filaments. Nylon 66 is often selected for use because of its combination of toughness, stiffness, high melting point and chemical resistance. It is a relatively easy polymer to modify, so the range of different nylon resins available is wider than for most other polymers. Typical modifiers are flame retardants to reduce flammability, rubber to improve impact resistance and glass or minerals to improve stiffness and dimensional stability
Synonyms	PA 66 glass filled, Nylon 66 glass filled
Classification	Class name / Hierarchy level Materials production / Plastics
General comment on data set	Raw data for polymerization and intermediate products are collected by several producers in Europe; the average is calculated by the consultant based on the production capacity of the companies. The LCI result is calculated with background data from the Boustead database.
	Copyright? Yes Owner of data set (contact data set) Plastics Europe
Quantitative reference	
Reference flow(s)	nylon 66 GF 30 compound (PA 66 GF 30); production mix, at plant - 1 kg (Mass)
Time representativeness	
Data set valid until:	2006
Time representativeness description	The data corresponding to the nylon 66 production was collected in 1996. Data on crude oil extraction and refining and on natural gas extraction and processing was collected in 2001. All the calculations were carried out in 2005.
Geographical representativeness	
Technological representativeness	
Technology description including background system	The essential precursors for nylon 66 are hexamethylene diamine, H2N-(CH2)6-NH2, and adipic acid, HOOC-(CH2)4-COOH. When they are reacted they produce hexamethylene diammonium adipate, commonly referred to as nylon salt, H3N(CH2)6NH3OOC(CH2)4COO-. For fibre applications, it is important to ensure that the precursors are reacted in equimolar proportions and that the product is highly purified. The formation, extraction and purification of the salt ensures that these conditions are met. Adipic acid is made by the oxidation of cyclohexane to a mixture of cyclohexanol and cyclohexanone (called KA oil). This mixture is further oxidised with nitric acid to adipic acid. Hexamethylene diamine is made by the reduction of adiponitrile, which is made either by the electronic coupling of acrylonitrile or by the hydrocyanation of butadiene. Adipic acid and hexamethylene diamine are combined in water to make a salt solution. This solution is then passed through a batch or continuous reactor in which the water is removed at high temperature and the nylon polymerises. The polymer is expelled from the reactor and granulated. Higher molecular weights are achieved by solid phase polymerisation. Modified nylons are made by extrusion compounding of the nylon with the modifiers or reinforcements. In some cases, it is possible to compound directly at the reactor without granulating the nylon. The background system is addressed as follows: Electricity: Electricity used, is modelled according to the individual country-specific situation. Modelling the electricity production system covers the production and delivery of primary fuels, the steam generator, the electricity generator and the distributor. Electricity is regarded to be derived from the public electricity supply and from on-site electricity generation of plants. Input materials used for producing electricity are fossil fuels, like coal, oil and gas. Process Steam: Process steam/thermal energy used, is modelled according to the individual country-specific situation. Process steam is regarded to be derived as by-product from the public electricity supply and from on-site steam generation of plants. Input materials used for producing process steam are fossil fuels, like coal, oil and gas. Another source for process steam are waste incineration plants. Transport: All relevant and known transport processes used, are included. Overseas transport to and from major ports as well as all relevant and known pipeline and / or tanker transport of crude oil imports are included. Energy carriers: Crude oil is modelled according to the production and supply of crude oil to Western Europe. The crude oil supply is regarded regional. Therefore, interchanges between countries within that region do not count as imports or exports. Oil processing is reckoned as standard worldwide with overall energy production efficiency of the order of 90%. The IEA data on world oil production and processing data have been used for the use of energy. The total inputs have been partitioned between the products using energy as the partitioning parameter. Modelling covers the extraction, the transport and the delivery including



Process data set: Waste incineration of plastics (unspecified) fraction in municipal solid waste (MSW); average European waste-to-energy plant, without collection, transport and pre-treatment; at plant; (en)

Table of Contents: Process information - Modelling and validation - Administrative information - Inputs and Outputs

Process information

Key Data Set Information	
Location	EU-27
Geographical representativeness description	The data set represents a typical European situation (EU-27 + CH and NO). A mix off dry and wet flue gas cleaning and different NOx removal technologies (SCR = Selective Catalytic Reduction and SNCR = Selective Non-Catalytic Reduction) is applied representing the actual application in the EU-27 countries, Switzerland and Norway.
Reference year	2006
Name	Base name; Treatment, standards, routes; Mix and location types Waste incineration of plastics (unspecified) fraction in municipal solid waste (MSW); average European waste-to-energy plant, without collection, transport and pre-treatment; at plant
Use advice for data set	The data set represents an end of-life inventory for the thermal treatment of a specific waste fraction in an average European Waste-to-Energy (WtE) plant. The data set includes the emissions and resource consumption for the thermal treatment of waste. The behaviour of bottom ash and air pollution control residues on a landfill is considered. Produced electricity and process steam are unconnected (partly terminated). It should be considered that this data set is an approximation to reality. The used model of an average European WtE plant and the average composition of waste do not exist in reality and efficiencies, emission values, transfer coefficients and elementary composition will differ if a specific WtE plant is used.
Technical purpose of product or process	Standard end-of-life treatment service for a specific waste fraction via thermal treatment.
Synonyms	Waste-to-energy of plastics (unspecified) fraction in MSW
Classification	Class name / Hierarchy level End-of-life treatment / Energy recycling
General comment on data set	The European average Waste-to-Energy plant (WtE) is defined based on the treatment of average European municipal solid waste (MSW). The thermal treatment of a single waste fraction like paper or plastic or even specific wastes like Polyamide 6 is not done in reality in a WtE plant for MSW. The waste is always homogenized to obtain a relative constant calorific value and to comply with the emission standards. Nonetheless the used model and the used settings for the average MSW allows to attribute the environmental burden (emissions and also resource consumption of auxiliaries) energy production as well as the credits (metal scrap export) to a single fraction or specific waste incinerated within an average MSW. Therefore the LCI data is valid for the treatment of the specific waste within an average MSW (the waste fraction share of the MSW is shown in the pie chart beneath, the elementary composition in the first table beneath). The following technology description explains the settings and technology of the average WtE plant used to generate the LCI data set. The net calorific value and the elementary composition of the waste fraction or specific waste are shown in the tables beneath (see corresponding column in the tables). The data set covers all relevant process steps / technologies over the supply chain of the represented cradle to gate inventory with a good overall data quality. The inventory is mainly based on industry data and is completed, where necessary, by secondary data.
	Copyright? Yes Owner of data set (contact data set) CEWEP e.V.
Quantitative reference	
Reference flow(s)	waste incineration of plastics (unspecified) fraction in municipal solid waste (MSW); average European waste-to-energy plant, without collection, transport and pre-treatment; at plant - 1000 kg (Mass)
Time representativeness	
Data set valid until:	2010
Time representativeness description	Annual average
Geographical representativeness	
Technological representativeness	
Technology description including background system	The data set represents an average European waste-to-energy plant (WtE) for the thermal treatment of municipal solid waste (MSW) with typical technology used in Europe to meet the legal requirements. Environmental impacts for waste collection, transport or any pretreatment of the waste are not included in the data set. Two different incineration models one with a wet and one with a dry flue gas treatment (FGT) and different NOx-removal technologies are mixed to represent the appliance of the different FGT systems in Europe. According to data published in the BREF document "Waste Incineration" of the European Commission (2006) two-thirds of the MSW is treated within a plant operating with a dry FGT and one-third of the MSW is incinerated within a plant with a wet FGT. For the NOX reduction a share of two-third SNCR (Selective Non-Catalytic Reduction) and one-third SCR (Selective Catalytic Reduction) is used. The plant consists of an incineration line fitted with a grate and a steam generator. The average efficiency of the steam production is about 81.9%. Produced steam is used internally as process-steam and the balance is used to generate electricity or exported as heat to industry or households. An energy balance for the plant was made using data from the "CEWEP Energy Report" (2006) representing 97 waste-to energy plants in Europe. Beside one 1t of MSW with a lower calorific value of approximately 10 GJ/t electricity (0.06 GJ/t of MSW) as well as fuels and heat (0.22 GJ/t of MSW) are imported. 1.09 GJ electricity and 3.16 GJ thermal energy per ton of threaten MSW are distributed to the grid and industrial customers. The effective exported electricity is reduced by 7% due to grid losses (European average). All utilities used in the waste incineration plant, the operation of the underground deposit and the landfill for bottom ash and air

EeBGuide Background Report for Buildings

Building LCA of an individual house

Basic facts

General information		
	Name of the building:	« Maison ERICLOR »
	Date of the assessment:	04/07/2012
	Address of the building:	Le hameau des Vallées, 37230 Luynes, France
	Name and qualification of the assessor:	Alexandra Lebert, Engineer, CSTB Boris Bosdevigie, Engineer, CSTB
	Name and qualification of the reviewer:	ESCI (Spain)
	Review type	*project internal review*
	Date of the verification	*To be specified after review*
	Client of the study:	*M. Didier CLEMOT, Maison de Qualité, 27, rue d'Athènes, 75009 Paris*
	Authors of the study:	*Centre Scientifique et Technique du Bâtiment*

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Nomenclature

Abbreviation	Explanation
AIP	Air Pollution
ADP	Abiotic Depletion Potential
ADPE	Abiotic Resource Depletion Potential for elements
ADPF	Abiotic Resource Depletion Potential of fossil fuels
AP	Acidification Potential
BLBSB	Benefits and Loads Beyond the System Boundary
CML	Centrum voor Milieukunde, Leiden (NL)
CRU	Components for re-use
CSTB	Centre Scientifique et Technique du Bâtiment
EE	Exported energy per energy carrier
EP	Eutrophication Potential
EPD	Environmental Product Declaration
FDES	French EPD (Environmental and Sanitary Product Declaration)
FW	Use of net fresh water
GWP	Global Warming Potential
HWD	Hazardous waste disposed
IBU	Institut Bauen und Umwelt e.V.
MER	Materials for energy recovery
MFR	Materials for recycling
NRSF	Use of non-renewable secondary fuels
NHWD	Non hazardous waste disposed
NFA	Net Floor Area
ODP	Ozone Layer Depletion Potential
PENRE	Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials
PENRM	Use of non-renewable primary energy resources used as raw materials
PENRT	Total use of non-renewable primary energy resources
PEP	Profil Environmental Produit
PERE	Use of renewable primary energy excluding renewable primary

	energy resources used as raw materials
PERM	Use of renewable primary energy resources used as raw materials
PERT	Total use of renewable primary energy resources
PCR	Product Category Rules
POCP	Photochemical Ozone Creation Potential
RSF	Use of renewable secondary fuels
RSL	Reference Service Life
RWD	Radioactive waste disposed
SM	Use of secondary material
WP	Water Pollution
IW	Inert Waste

48. Scope

This document is the background report for the report on the life cycle assessment results of a building. The study conducted, follows the provisions and guidelines of EeBGuide.

49. Content, structure and accessibility of the background report

The background report provides the systematic and comprehensive summary of the project documentation supporting the verification of a building LCA. The project report shall record that the LCA based information meets the requirements of EeBGuide of the Energy- efficient Building Initiative. It will be/was made available to the verifier with the requirements on confidentiality stated in ISO 14025.

The background report contains any important data and information required by the European standard EN 15978. Special attention is paid to a transparent documentation.

50. General aspects in the background report

The present LCA study of the company is performed by the practitioner stated and has been conducted according to the requirements of the European Standard EN 15978. The background report was sent/will be sent to verification as mentioned. Further details can be found in the table "General Information".

51. Goal/Purpose of the study

The aim of this study is the calculation and interpretation of the LCA results of the building. The table "Goal/ Purpose of the study" illustrates important points regarding the purpose of the study.

Table 87: Goal/ Purpose of the study

Goal/ Purpose of the study

Level of complexity	☐	Screening
	☐	Simplified
	☑	Complete
related study objective	☐	Comparative assertion
	☑	Stand alone LCA
object of assertion	☑	New building
	☐	Existing building
communication purpose	☐	internal
	☑	external
	☐	for costumer to costumer
	☐	publication
	☑	

The LCA analysis was undertaken in the context of a French pilot project (called HQE performance project) concerning the assessment of the environmental performance of about 80 residential and non residential buildings allowed us to establish first reference values indicator per indicator through a statistical analysis.

The main assumption and guidance for the assessment of each building are given in the appendix "Annex_report_LCA_HQE Performance guidance document", enclosed with this report. Main rules for the calculation are based on the French standard on environmental performances of buildings XP P01-020-03 [3].

52. Scope of the study

Declared / Functional equivalent

The following points have to be defined with regards to the functional equivalent:

Table 88: Functional equivalent

Functional equivalent	Reference unit:	m² NFA (french living area)
	Type of Building:	Single-familiy house
	number of tennants:	A number of 5 occupants is considered for the study
	Required service life:	100 years
	Other services provided within the building (shops…):	no other services

Object of the assessment is an entire building including all infrastructures located on the building site.

Note: The reference study period considered for the study is admitted to be equal to the required service life. Actually, the required service life corresponds here to a reference service life estimated for French individual houses.

Technical building information

The following table describes the building into more detail:

Table 89: Technical description of the building

Technical description of the building		
	Year of comissioning:	*2008*
	Year and type of refurbishment:	*No refurbishment*
	Structural type:	*Cellular concrete structure*
	Number of storeys:	*Two storeys house*
	Net Floor Area [m²]:	*113 (SHAB in French)*
	Gross Floor Area [m²]:	*129 (SHON in French)*
	Calculated electrical end energy demand [kWh/(m²*a)]:	*The total electrical end energy demand for building related uses is estimated to 50 kWh/(m²*a) of primary energy*
	Calculated thermal end energy demand [kWh/(m²*a)]:	*0*
	Energy calculation methodology:	*French national thermal regulation method 2005 ThCE [1]*
	Important materials for supporting structure, insulation, windows:	*Cellular concrete, woodwork roof , roofing slat,*
	Type of facade:	*concrete block masonry*
	Energy supply system and energy transfer system (short description; name renewable components, if used):	*Heating system production: Thermal heat pump on external air;* *Heating system transmission: Heat floor for first floor and warmers for rooms located on the second floor* *Hot water production system: solar thermal sysem whith additional electrical heating system;* *Ventilation without heat recovery*
	Number and description of underground levels (parking areas, other)	*No underground levels*

	Information about external features (garden, fountain, pools, etc…)	*None*

Table 90: Technical description of all operational areas

Technical description of all operational areas	Operational Area1:	*"operational areas" for the house are: 5 rooms, 1 kitchen, 1 living room, 2 bathrooms*
	Usage Operational Area1:	*residence*
	Design number of building occupants Operational Area1:	*The number of occupant considered for the study is 5 persons*
	Design occupancy schedule Operational Area1:	*The house is considered to be used 12 month per year, different senario are defined for the occupancy regarding the use of each room (conventional senario defined according to Th-C-E method [1])*
	Heating, cooling and ventilation system and hot water service system Operational Area1:	*Technical systems defined above (see chapter 5.2) are applicable for each room. Heating systems are heat floor for first floor and warmer for second floor.*
	Lighting system Operational Area1:	*Ligthing system is not specified, conventional power ratio for lighting is considered taking into account occupancy schedule and conventional ratio for access to natural lighting as defined by Th-C-E method [1]*
	Power and communication systems operational Area1:	*none*

Information about the surrounding environment

The following table brings information about the local context:

Table 91: Description of the local context

Description of the local context	Information on climate (HDD and CDD, climate severity index...)	*HDD18°C = 2238 (CDD not considered since no cooling needs for the house) French climatic zone H2b*
	Urban context (down town, suburbs, countryside…)	*Countryside*
	Geological constraints (seismic context, load bearing capcity, slopes of the building site…)	*no geological constraints (no supplementary information regarding the quality of the soil to build a house…)*
	Accoustics constraints (indicator of noise exposure)	*no major noise exposure*
	Specific urban rules (eg. Plot ratio…)	*no information*
	Architectural constraints	*no information*
	Other constraint of the surrounding environment	*none*

System boundaries

The system boundary of the building LCA follows the modular design defined by EN 15978. The following chapters describe the modules which are within the scope of this study. The modules included are in-line with the following table:

Table 92: Definitions for the different study types

Screening - Simplified - Complete

according to SBA Common Metrics Framework 2009 and EeBGuide adaptations

M	**mandatory**
O relevance?	**optional because of minor relevance**
O data?	**optional due to potentially missing data**

	Study type	**Before use stage**				
		Raw Materials Supply	Transport (to factory)	Manufactoring	Transport (to construction site)	Construction-Installation process
		A1	A2	A3	A4	A5
Building	Screening	M	**Calculation rules based on data on major sub-structure (e.g. statistical data such as kWh/m² for primary energy) or generic LCA of building elements/products/materials** such as Roof; Load- bearing structure; Exterior and basement walls; Windows; Floor slabs; Foundation; Floor Finishes/ Coverings		O relevance?	O data?
Building	Screening	O data?	**Calculation rules based on data on statistical data such as kWh/m² for primary energy for the following equipment:** Refrigeration/ Coolants; Decorative wall finishes/ coatings (e.g. wallpaper, paints); Doors; Heating/ Cooling/ Lighning Equipment and any power-generating equipment (e.g. wind turbines/ PV/ solar heating) Equipment for internal transport (e.g. lifts, escalators); water and sewerage systems; electrical distribution system			
Building	Simplified	M	**Calculation rules based on data on major sub-structure (e.g. statistical data such as kWh/m² for primary energy) or generic LCA/average EPD of building elements/products/materials** such as Roof; Load- bearing structure; Exterior and basement walls; Windows; Floor slabs; Foundation; Floor Finishes/ Coverings;		O relevance?	O data?
Building	Simplified	O data?	**Calculation rules based on data on statistical data such as kWh/m² for primary energy for the following equipment:** Refrigeration/ Coolants; Decorative wall finishes/ coatings (e.g. wallpaper, paints); Doors; Heating/ Cooling/ Lighning Equipment and any power-generating equipment (e.g. wind turbines/ PV/ solar heating) Equipment for internal transport (e.g. lifts, escalators); water and sewerage systems; electrical distribution system			
Building	Complete	M	**Calculation rules based on data on major building elements/products/materials based on specific EPD (both group of manufacturer's or single manufacturer declaration) else average LCA data:** Roof; Load- bearing structure; Exterior and basement walls; Windows; Floor slabs; Foundation; Floor Finishes/ Coverings; Refrigeration/ Coolants; Decorative wall finishes/ coatings (e.g. wallpaper, paints); Doors; Heating/ Cooling/ Lighning Equipment and any power-generating equipment (e.g. wind turbines/ PV/ solar heating) Equipment for internal transport (e.g. lifts, escalators); water and sewerage systems; electrical distribution system		M	M

Screening - Simplified - Complete

according to SBA Common Metrics Framework 2009 and EeBGuide adaptations

M

O relevance?

O data?

	Study type	Use stage						
		Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use
		B1	B2	B3	B4	B5	B6	B7
Building	Screening	O relevance?	O relevance?	O data?	O data?	O relevance?	M **Calculation rules based on the expected performance target for the building** (e.g. energy label target or reference levels set by national regulation) calculated at least for building related uses covered by the EPBD (heating, cooling and air conditioning, ventilation, domestic hot water, lightning and auxiliary energy used for pumps, control and automation).	M **Calculation rules based on statistical data** for both building and non building related water equipment
Building	Simplified	O relevance?	O relevance?	O data?	M	O relevance?	M **Calculation rules based on Dynamic Thermal Simulation or national calculation methodology** for building related uses (heating, cooling and air conditioning, ventilation, heating for provision of domestic hot water, lightning) M **Calculation rules based on EPA-NR for comparative assessments** (heating, cooling and airconditioning) (Internal transport, computer and IT equipment, refrigerators, washing machines, dishwashers, dryers, other small power devices)	M **Calculation rules based on top-down approach** by taking into the economic (by water saving devices e.g. dual flash toilet system) or extra consumption measures for both building and non building related water equipment
Building	Complete	M	M		M	M	M **Calculation rules based on Dynamic Thermal Simulation, National calculation methodology or EPA-NR for comparative assessment** for building related uses and non building related (heating, cooling and air conditioning, ventilation, heating for provision of domestic hot water, lightning, Internal transport, computer and IT equipment, refrigerators, washing machines, dishwashers, dryers, other small power devices) (heating, cooling and air conditioning, ventilation, heating for provision of domestic hot water, lightning)	M **Calculation rules based on bottom-up approach** for both building and non building related water equipment such as urinals, WCs, taps, baths,showers, greywater/ rainwater systems dishwashers, washing machines, water softeners, wase disposal units

Screening - Simplified - Complete
according to SBA Common Metrics Framework 2009 and EeBGuide adaptations

M

O relevance?

O data?

	Study type	End of Life				Benefits beyond boundary
		Deconstruction	Transport (to disposal)	Waste process for reuse, recovery or/ and recycling	Disposal	Reuse-/ Recovery- /Recyclingpotential
		C1	C2	C3	C4	D
Building	Screening	O relevance?	O relevance?	O data? Generic LCA data for EOL processes O data? Generic LCA data for EOL processes		O data? Generic LCA data for reuse-/ recovery- / recycling potential O data? Generic LCA data for reuse-/ recovery- / recycling potential
	Simplified	O relevance? **Calculation rules based on a materials impact ratio (i.e. 3% for GWP in case of concrete)**	O relevance?	M Specific or generic LCA data for EOL processes O data? Specific or generic LCA data for EOL processes		M Specific or generic LCA data for reuse-/ recovery- / recycling potential O data? Specific or generic LCA data for reuse-/ recovery- / recycling potential
	Complete	M **Calculation rules based on the energy, materials and related emissions**	M	M Specific or generic LCA data for EOL processes		M Specific or generic LCA data for reuse- / recovery- / recycling potential

Overview over the included Life cycle stages

The table summarizes the included Lifecycle stages.

Included lifecycle stages				
	Product Stage	☑	A1	Raw Materials Supply
		☑	A2	Transport
		☑	A3	Manufacturing
	Construction Process	☑	A4	Transport
		☑	A5	Construction- Installation process*
	Use Stage	☐	B1	Use
		☑	B2	Maintenance
		☑	B3	Repair
		☑	B4	Replacement
		☐	B5	Refurbishment
		☑	B6	Operational Energy Use
		☑	B7	Operational Water Use
	End of Life Stage	☑	C1	Deconstruction*
		☑	C2	Transport
		☑	C3	Waste process for reuse, recovery or/ and recycling
		☑	C4	Disposal
	Benefits and loads beyond the system boundary	☐	D	Reuse- Recovery- Recyclingpotential

Table 93: Included lifecycle stages

** Module A5 Construction and installation process and C1 Deconstruction are partially given into the French EPD (FDES), no other process are taken into account.*

The analysis of building LCA results is completed by the evaluation of processes or product (i.e. contributors) that might contribute for several life stages. For example, products and materials are responsible for impacts at several life stages: the analysis of LCA results "stage per stage" does not permit to figure out the whole contribution of products in total LCA results.

The following scheme presents some main building contributors and their contribution at each building life stage.

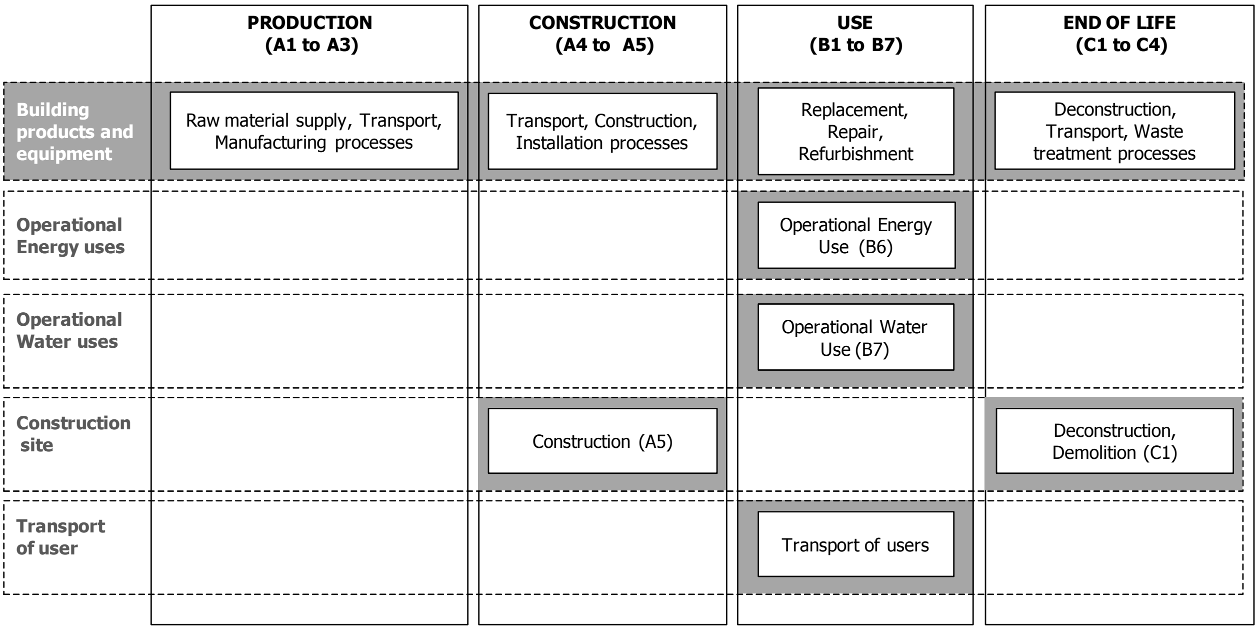


Figure 0: schematic representation of contributors and related life-cycle stages

The contributor "construction site" can be interpreted as an independent contributor as it may encompass any processes needed for the construction of the building that is not specific to one building component in particular and thus not included in EPDs of products and equipment.. The following process can be included:

- Water and energy consumption relative to cantonments site

- Provision of heavy equipment (cranes fixed, ...)

- Water consumption except cantonments

- Energy consumption except cantonments

- Consumption of construction equipment for earthmoving, drilling wells, disposal of land and demolition (electricity, fuel and / or consumables)

- The amount of cut and fill leaving or entering the field.

For this study, the contributors for construction site and the transport of users are not included.

The following sections (0 and 0) provide an overview of the included processes for each contributor considered in the study.

Overview over the included products and equipments

Table 94: Descriptions of products and equipments considered into the study

Keys for recommendation of component to be included regarding the study type.	0	Optional (because of minor relevance or due to missing data)
	M	Mandatory

Considered products and equipments

		Included	Not existing	Screening	Simplified	Complete
1. External works	Onsite network (water, gaz, sewers, heat...)	☑	☐	0	0	M
	Vats and tanks, water retention...	☐	☑	0	0	M
	Parkings and covered surface	☑	☐	0	0	M
2. Foundations - infrastructure	Foundations -Load-bearing structure	☑	☐	M	M	M
	Wall basement	☑	☐	M	M	M
3. Exterior walls - vertical structure	Exterior walls	☑	☐	M	M	M
	Structural vertical elements	☑	☐	M	M	M
	Stairs, pedestrian ramps	☑	☐	0	0	M
	External surface coating, facing, painting	☑	☐	M	M	M
4. Floor - horizontal structure	Floor structure and slabs	☑	☐	M	M	M
5. Roof	Covering and tightness elements	☑	☐	M	M	M
	Roof framework	☑	☐	M	M	M
6. Interior walls	Paritionning walls and internal doors	☑	☐	0	0	M
	Suspended ceilling	☐	☑	0	0	M
7. Windows and joinery work	Windows and joinery work	☑	☐	M	M	M
	Doors	☑	☐	0	0	M
8. Interior finishes	Floor finishes and covering, screeds	☑	☐	M	M	M
	Paintings, wallpaper, decorative products	☑	☐	0	0	M

Considered products and equipments	9. HVAC	Heating - Ventilation - Cooling - Domestic hot water system	☑	☐	0	0	M
	10. Sanitary facilities	Toilet (bowl and sets hunting), Urinals, Shower trays, plumbing...	☑	☐	0	0	M
	11. Electricity and communication network	Electricity wiring and equipment (high and low voltage)	☑	☐	0	0	M
		Communication network and equipment	☑	☐	0	0	M
	12. Safety equipments	Fire safety system, intrusion detection system...	☐	☑	0	0	M
	13. Lighting	General interior lighting and control systems...	☑	☐	0	0	M
	14. Lifts	Elevator, escalator, dumbwaiters...	☐	☑	0	0	M
	15. Electricity generating units	Photovoltaic systems including inverters...	☐	☑	0	0	M

The detail of building product and equipment for each class is given in the appendix D.

Overview over the included operational uses

Table 95: Descriptions of operational energy uses considered into the study

Considered operational energy uses				Comments
	Building related uses	Heating	☑	
		Air conditioning	☑	
		Domestic hot water	☑	
		Ventilation	☑	
		Lighting	☑	
		Auxiliary (pumps, control and automation)	☑	
		Building integrated systems (eg. Lifts, shutters, safety equipments…)	☐	No information
	Non building related uses	To specify (e.g. plug-in appliances, dishwachers, TV…)	☑	Consumption of user appliances are derived from french statistical data and calculated according to the surface NFA of the house.

Table 96: Descriptions of operational water uses considered into the study

Considered operational water uses	Building-related water consuming processes	Drinking water	☑	
		Water for sanitation	☑	
		Domestic hot water	☑	
		Irrigation of associated landscape areas	☐	
		water for heating, cooling, ventilation and humidification	☐	No information on HVAC system consumption
		Cleaning of interior or exterior spaces	☑	Interior spaces
		Other specific water use of building-integrated systems e.g. fountains, swimming pools...	☐	No other integrated systems
	Non building-related uses	To specify...	☐	Washing machines and dishwashers

A1-A3, Product stage, information modules

The product stage includes:

- **A1, raw material extraction and processing, processing of secondary material input (e.g. recycling processes),**
- **A2, transport to the manufacturer,**
- **A3, manufacturing,**

Including provision of all materials, products and energy, packaging processing and its transport, as well as waste processing up to the end-of-waste state or disposal of final residues during the product stage.

The following flowchart represents the system boundaries for the product stage:

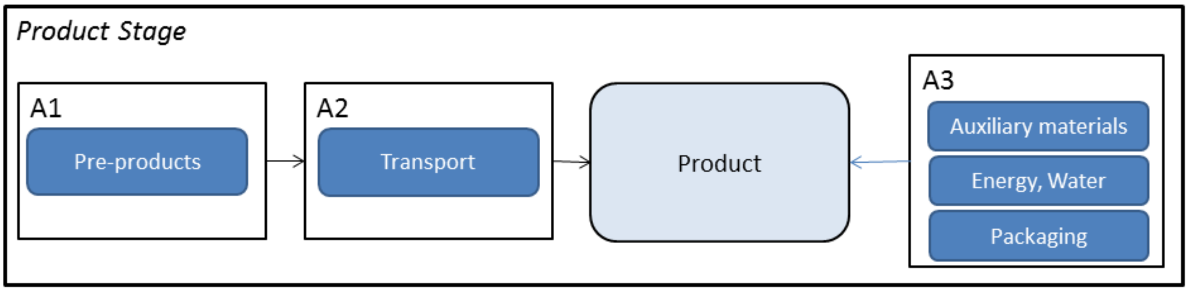


Figure 52-1: schematic representation of the LCA system boundaries for the production module (A1-A3)

Table 97: Module A1-A3

Module A1-A3	The following processes are omitted:	*The following flows have been excluded from the system boundaries: - Manufacture of the production tool and transportation systems for the construction site (machines, trucks, etc.).*
	The following deviations from EN 15978 on data requirements occurred:	*Deviation with regards to EN 15804:* *•Most of the building products data used are cradle to grave EPDs from INIES (called "FDES" in France) with aggregated results.* *•Cut of rule of most inputs is based on NF P01-010 [2] (French core PCR for construction products), i.e. 2% by mass of the reference flow instead of 5 % but without cut-off rules for energy inputs. The electrical equipment data are calculated based on PEP (Product Environmental Profile) that uses à 5% cut of rule for material inputs (PCR "PEP Eco-passeport").* *•When no EPDs were available, generic LCA data from ELODIE database have been used.* *These are extrapolated from the Ecoinvent database 2.0.* *For these data, the cradle-to-gate LCA data [module A1-A3] were taken into account as well as a default scenario to estimate the gate to grave impacts (transport, on-site implementation, use, end-of-life).* *As a result, the representativeness of these data is assumed to be limited for the French context.*
	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	*•Overall modeling based on preliminary project metrics and not on implemented building metrics - minor differences might occurs • Overall inputs data are representative of the French context (temporal, technological & geographical).*

A4-A5, Construction process stage, information modules

The construction process stage includes:

- A4, transport to the construction site;
- A5, installation into the building;

Including provision of all materials, products and energy, as well as waste processing up to the end-of-waste state or disposal of final residues during the construction process stage. These information modules also include all impacts and aspects related to any losses during this construction process stage (i.e. production, transport, and waste processing and disposal of the lost products and materials).

The following flowchart represents the system boundaries for the construction process stage:

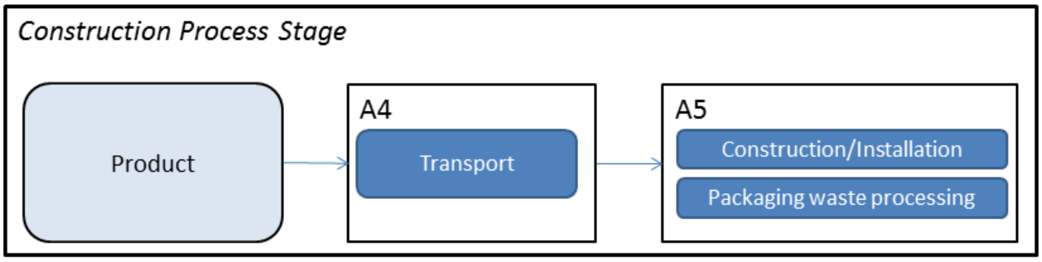


Figure 52-2: schematic representation of the LCA system boundaries for the construction process stage (A4-A5)

Table 98: Module A4-A5

Module A4-A5	The following processes are omitted:	*Depreciation of constructions equipment and vehicles.* *Employee transport and additional flow related to construction phase not included in EPDs (e.g. digging for foundations).*
	The following deviations from EN 15978 on data requirements occurred:	*No major deviation from EN 15978*

	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	*Inputs data used are mostly cradle to grave EPDs with aggregated results* *Transport of materials from production site to construction site is defined considering most representative senario (specific to products or materials).* *Data for construction and installation processing are considered in french EPDs however, the following process are not considered:* *- Water and energy consumption for the construction of cantonments* *- Amortization/ depretiation of heavy equipment (fixed cranes, ...).* *- Water consumption outside cantonments* *- Energy consumption outside cantonments* *- Consumption of construction equipment for earthmoving, drilling wells, disposal of land and demolition (electricity, fuel and / or consumables)* *- Quantity of cut and fill leaving or entering the field.* *Overall inputs data are representative of the French context (temporal, technological & geographical).*

B1-B5, Use stage, information modules related to the building fabric

The use stage, related to the building fabric includes:

- B1, use or application of the installed product;
- B2, maintenance;
- B3, repair;
- B4, replacement;
- B5, refurbishment.

Including provision and transport of all materials, products and related energy and water use, as well as waste processing up to the end-of-waste state or disposal of final residues during this part of the use stage. These information modules also include all impacts and aspects related to the losses during this part of the use stage (i.e. production, transport, and waste processing and disposal of the lost products and materials).

The following flowchart represents the system boundaries for the use stage related to the building fabric:

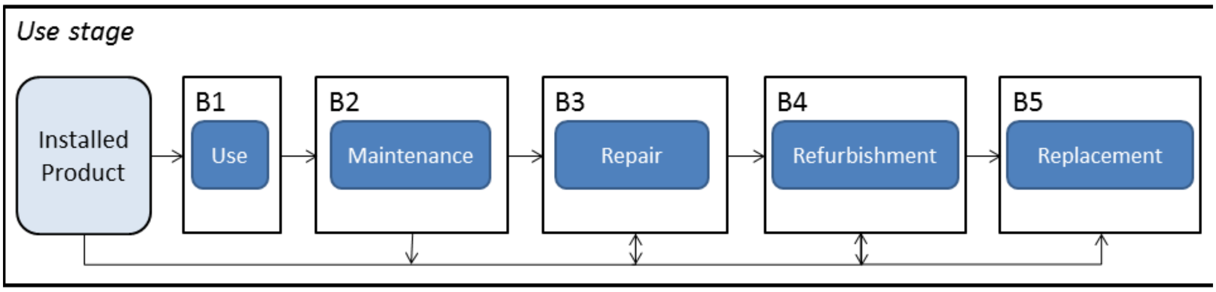


Figure 52-3: schematic representation of the LCA system boundaries for the use stage (modules related to the building fabric B1-B5)

Table 99: Module B1-B5

Module B1-B5	The following processes are omitted:	*Inputs data do not include emissions during use phase (B1)* *No scenario for refurbishment and repair considered, (modules B3 and B4 are not accounted in this study)*
	The following deviations from EN 15978 on data requirements occurred:	*No major deviation from EN 15978*
	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	*Replacements are considered in whole number cycle.*

B6-B7, Use stage, information modules related to the operation of the building

The use stage related to the operation of the building includes:

- B6, operational energy use (e.g. operation of heating system and other building related installed services);
- B7, operational water use;

These information modules include provision and transport of all materials, products, as well as energy and water provisions, waste processing up to the end-of-waste state or disposal of final residues during this part of the use stage.

The following flowchart represents the system boundaries for the use stage related to the operation of the building:

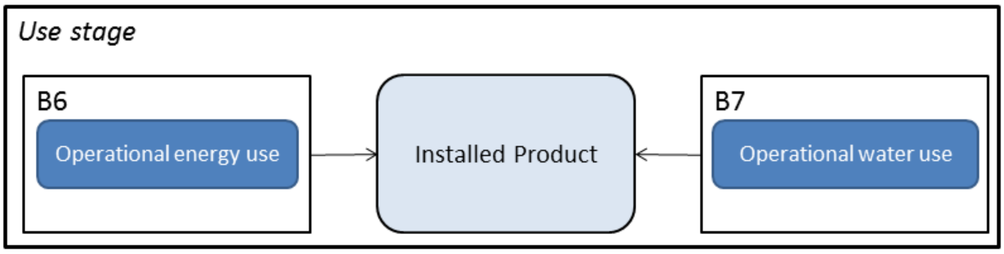


Figure 52-4: schematic representation of the LCA system boundaries for the use stage (modules related to the operation of the building)

Table 100: Module B6

Module B6	The following processes are omitted:	*None*
	The following deviations from EN 15978 on data requirements occurred:	*Energy uses taken into account fr the study are:* *- Building related uses as defined within EPBD* *- Non-building related uses corresponding to occupant plug-in appliances.* *Statistical data representative of the French context has been considered for Non building related uses.*

	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	*LCA data from ELODIE database has been used for each energy carriers. These are extrapolated from the Ecoinvent database 2.0.*

Table 101: Module B7

Module B7	The following processes are omitted:	*None*
	The following deviations from EN 15978 on data requirements occurred:	*Water consumption have been considered for the following uses:* *- Cleaning of interior spaces;* *- Showers and bath;* *- Flushing for sanitary;* *- sink;* *- washing machines and dishwashers.*
	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	*Amount of water has been calculated taking into account the characteristics of each water consumption device (e.g. 6L flushing system), the use factor (use frequency), and the number of occupants.* *Water consumption for cleaning of interior spaces has been calculated with the help of ratio per m² of NFA.* *No water consumption has been considered for watering of Landscape.* *Water outputs (sewages) are considered equal to water inputs (fresh water).* *LCA data from ELODIE database have been used for water input (including upstream processes) and output (including treatment processes).*

C1-C4 End-of-life stage, information modules

The end-of-life stage includes:

- C1, de-construction, demolition:
- C2, transport to waste processing;
- C3, waste processing for reuse, recovery and/or recycling;
- C4, disposal

including provision and all transports, provision of all materials, products and related energy and water use.

The following flowchart represents the system boundaries for the End-of-life stage:

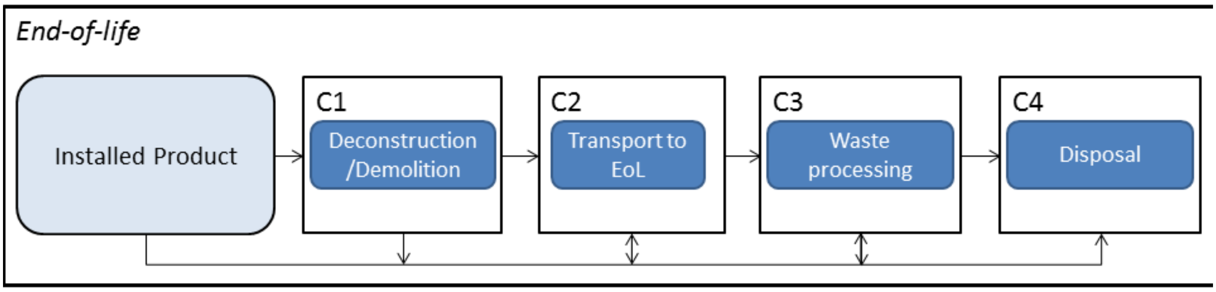


Figure 52-5: schematic representation of the LCA system boundaries for the End-of-life stage (C1-C4)

Table 102: Module C1-C4

Module C1-C4	The following processes are omitted:	*• Depreciation of demolition equipment and vehicles. • Employee transport and additional flow related to deconstruction phase not included in EPDs.*
	The following deviations from EN 15978 on data requirements occurred:	*Deviation with regards to EN 15804: •Most of the building products data used are cradle to grave EPDs from INIES (called "FDES" in France) with aggregated results. •Cut of rule of most inputs is based on NF P01-010 (French core PCR for construction products [2]), i.e. 2% by mass of the reference flow instead of 5 % but without cut-off rules for energy inputs. The electrical equipment data are calculated based on PEP (Product Environmental Profile) that uses à 5% cut of rule for material inputs (PCR "PEP Eco-passeport"). •When no EPDs were available, generic LCA data from ELODIE database have been used. These are extrapolated from the Ecoinvent database 2.0. For these data, the cradle-to-gate LCA data [module A1-A3] were taken into account as well as a default scenario to estimate the gate to grave impacts (transport, on-site implementation, use,*

		end-of-life). *As a result, the representativeness of these data is assumed to be limited for the French context [2].*
	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	

D Benefits and loads beyond the system boundary, information module

Module D includes reuse, recovery and/or recycling potentials.

The following flowchart represents the system boundaries for benefits/loads beyond the system boundary:

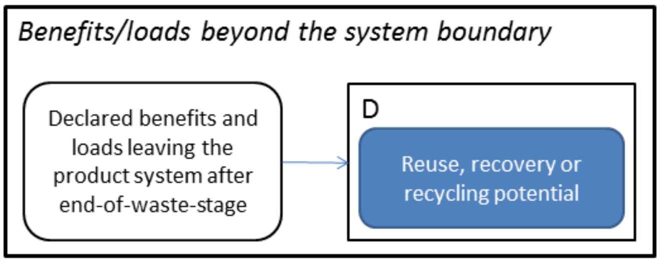


Figure 52-6: schematic representation of the LCA system boundaries for the benefits and loads beyond the product system boundary in module D

Table 103: Module D

Module D	The following processes are omitted:	*No information considered for module D*
	The following deviations from EN 15978 on data requirements occurred **(Just for "Complete Assessment")**:	*No information considered for module D*
	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	*No information considered for module D*

Energy imported/ Exported

The following table describes the imported/ exported energy.

Table 104: Energy imported/ exported

Energy imported/ exported	Description on thermal and electrical energy:	*No thermal energy exported;* *No electrical energy exported.*
	Imported thermal energy [kWh/a]	*0*
	Imported electrical energy [kWh/a]	*6414 kWh of final energy*
	Exported thermal energy [kWh/a]	*0*
	Exported electrical energy [kWh/a]	*0*

Description of the system boundary in the background report

The definition of the system boundaries meets the requirements of EeBGuide.

Criteria for the exclusion of inputs and outputs

LCA data

The definition of the cut-off rules for building products EPDs (cf. core PCR for construction products NF P01-010 standard [2]), electrical equipment EPDs (cf. PCR "PEP Eco-passeport). For Ecoinvent data, no cut-off rules have been applied.

Physical building description data (components)

All the available information in the quantity take-off has been taken into account (cf. the datasets results from the ELODIE software).

53. Life cycle inventory analysis

Data collection and calculation procedures

Data collection follows the guidance provided in ISO 14044, clause 4.3.2. The calculation procedures described in ISO 14044 are applied consistently throughout the study.

According to the definition of the scope of the study, all relevant inputs and outputs related to the building are identified and quantified.

Developing building level scenarios

Except from the base scenarios mentioned in EeBGuide, following scenarios for the different life cycle stages were defined:

A detailed description of the scenario(s) can be found in chapter 25.

Selection of data/ background data

As a general rule, specific data derived from specific production processes or average data derived from specific production processes shall be the first choice as a basis for calculating a building LCA. For life cycle modeling of the building, the software ELODIE is used. All relevant background datasets are taken from INIES (French EPD database) and ELODIE database. The datasets from the INIES database are documented online (www.inies.fr). The applied data sets are representative for the French context. The last revision of the used data sets took place less than 5 years ago.

Most of the inputs data used are cradle to grave EPDs with aggregated results.

•Cut of rule of most inputs is based on NF P01-010 [2] , i.e. 2% by mass of the reference flow instead of 5 % but without requirements for energy inputs. Some material inputs are calculated from PEP (Product Environmental Profile) that uses à 5% cut of rule for material inputs.

•For some cases, generic LCA data from ELODIE database have been used instead of EPDs from INIES. These are extrapolated from the Ecoinvent database 2.0.

For these data, the cradle-to-gate LCA data [module A1-A3] were taken into account as well as a default scenario* to estimate the gate to grave impacts (transport, on-site implementation, use, end-of-life).

As a result, the representativeness of these data is assumed to be limited for the French context [2].

Data/ background data quality requirements

The requirements for data quality and background data correspond to the specifications of EeBGuide.

Allocations

In the present study no allocation at the building scale (for module B6) has been made.

54. Life cycle inventory analysis and life cycle impact assessment

The results of the LCA for all modules A1 to D are represented in the following tables. The inventory analysis indicators to be declared and the impact assessment are in accordance with EN 15978.

Indicators for the life cycle inventory analysis according to EN 15978 "Baseline Scenario"

The following environmental indicators apply data based on the LCI. They describe the use of renewable and non-renewable material resources, renewable and non-renewable primary energy and water.

Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ, net calorific value
Use of renewable primary energy resources used as raw materials	MJ, net calorific value
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ, net calorific value
Use of non renewable primary energy excluding non renewable primary energy resources used as raw materials	MJ, net calorific value
Use of non renewable primary energy resources used as raw materials	MJ, net calorific value
Total use of non renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ, net calorific value
Use of secondary material	kg
Use of renewable secondary fuels	MJ, net calorific value
Use of non renewable secondary fuels	MJ, net calorific value
Use of net fresh water	m^3

The parameters describing waste categories and other material flows are output flows derived from LCI.
Other environmental information describing waste categories is described next:

Hazardous waste disposed	kg
Non hazardous waste disposed	kg
Radioactive waste disposed	kg

Other environmental information describing output flows is described next:

Components for re-use	kg
Materials for recycling	kg
Materials for energy recovery	kg
Exported energy	MJ per energy carrier

Indicators for the life cycle impact assessment according to EN 15978 "Baseline Scenario"

The following information on environmental impacts is expressed with the impact category parameters of LCIA using characterisation factors

Global warming potential (GWP);	kg CO_2-equiv.
Depletion potential of the stratospheric ozone layer (ODP);	kg CFC 11- equiv
Acidification potential of soil and water, (AP);	kg SO_2 - equiv
Eutrophication potential (EP);	kg $(PO_4)^{3-}$ - equiv
Formation potential of tropospheric ozone (POCP);	kg Ethene - equiv
Abiotic depletion potential (ADP-elements) for non-fossil resources	kg Sb - equiv
Abiotic depletion potential (ADP-fossil fuels) for fossil resources	MJ, net calorific value

In fact, the results from the impact assessment are only relative statements which give no information about the endpoint of the impact categories, overstepping of threshold values, safety margins or risk.

Used environmental indicators "Baseline Scenario"

The table below illustrates the used environmental indicators.

Figure 54-1 : Used environmental indicators

Used Indicators			
	☑	1. Global warming potential	GWP
	☑	2. Acidification Potential	AP
	☐	3. Eutrophication Potential	EP
	☑	4. Photochemical Ozone Creation Potential	POCP
	☑	5. Total use of renewable primary energy	PERE
	☑	6. Total use of non-renewable primary energy	PENRE
	☑	7. Depletion potential of the stratospheric ozone layer	ODP
	☐	8. Abiotic Resource Depletion Potential for elements	ADPE
	☐	9. Abiotic Resource Depletion Potential of fossil fuels	ADPF
	☐	10. Secondary Materials	SM
	☐	11. Secondary fuels - renewable	RSF
	☐	12. Secondary fuels – non renewable	NRSF
	☑	13. Net Fresh Water	FW
	☑	14. Hazardous Waste	HWD
	☑	15. Non Hazardous Waste	NHWD
	☑	16. Radioactive Waste	RWD
	☐	17. Components for Re-Use	CFR
	☐	18. Materials for Recycling	MFR
	☐	19. Materials for Energy Recovery	MER
	☑	20. Exported Energy	EE
	☑	additional indicator : Water Polluton	WP
	☑	additional indicator : Air Poluttion	AP
	☑	additional indicator : ADP total (element + fossil fuels)	ADPtot
	☑	additional indicator : Inert Waste	IW

It shall be noticed that the additional indicator Inert Waste (IW) is also included in the indicator Non-Hazardous waste. In French standardization, PCR for products [2] and standard for environmental performance of buildings [3] demand that inert and non-hazardous waste be separated. For the study, both indicators are summed in indicator NHWD. The indicator Inert waste is kept in order to provide an additional information. They are written in red in the following tables of results.

Parameters Baseline scenario

Following table illustrates the parameters used in the Baseline scenario.

Table 105: Description of the parameter Baseline scenario

Baseline scenario	G- 08 "Reference study period"	50 years
	G- 10 "Future technical developments and innovation"	No innovation to be considered, current technologies to be used
	G- 12 "Accounting for carbon storage / carbon sequestration"	Carbon storage is not considered
	G- 25 "Water consumption as a new impact category"	Not scarcity of water considered
	B- 03 "Transport of people"	No transport of people considered
	B- 14 "Replacement frequency"	Replacement in whole number cycles
	B- 20 "Electricity consumption in dynamic LCA data"	Annual average data sets for electricity
	B- 25 "Operational energy demand – Consideration of user behavior for stand-alone or comparative LCA of new buildings"	No user behavior considered

Results "Baseline Scenario"

Table 106: Overview over the building LCA results_Baseline scenario

Overview over the building LCA results (1/2)															
50 years	GWP	AP	POCP	PERE	PENRE	ODP	FW	HWD	NHWD	RWD	EE	WP	AP	ADPtot	IW
	[kg CO_2-equiv./m²$_{NFA}$*a]	[kg SO_2-equiv./m²$_{NFA}$*a]	[kg C_2H_4-equiv./m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]	[kg CFC11-equiv./m²$_{NFA}$*a]	[m³/m²$_{NFA}$*a]	[kg /m²$_{NFA}$*a]	[kg /m²$_{NFA}$*a]	[kg /m²$_{NFA}$*a]	[MJ/m²$_{NFA}$*a]	[m³/m²$_{NFA}$*a]	[m³/m²$_{NFA}$*a]	[kg Sb-Equiv. /m²$_{NFA}$*a]	[kg /m²$_{NFA}$*a]
Total LCA results	**1,30E+01**	**7,12E-02**	**2,32E-03**	**2,48E+01**	**1,53E+02**	**1,17E-05**	**2,02E+03**	**1,15E+00**	**3,42E+01**	**5,58E-03**		**1,78E+03**	**3,32E+04**	**7,74E-02**	**2,41E+01**
Products and materials	7,45E+00	3,77E-02	2,02E-03	5,31E+00	3,30E+01	1,13E-05	8,26E+01	6,27E-01	2,59E+01	1,08E-03		5,33E+02	3,27E+04	4,22E-02	1,63E+01
Operational energy use	4,37E+00	2,64E-02	1,39E-06	1,91E+01	1,16E+02	3,32E-07	8,30E+01	4,17E-04	6,88E+00	4,40E-03		2,43E+02	3,29E+02	2,87E-02	6,80E+00
Operational water use	1,16E+00	7,17E-03	2,96E-04	4,82E-01	3,86E+00	7,97E-08	1,86E+03	5,21E-01	1,37E+00	9,46E-05		1,01E+03	1,26E+02	6,45E-03	9,92E-01

Figure 54-2: Results Indicators – Share of main contributors to total building LCA results _ Baseline scenario

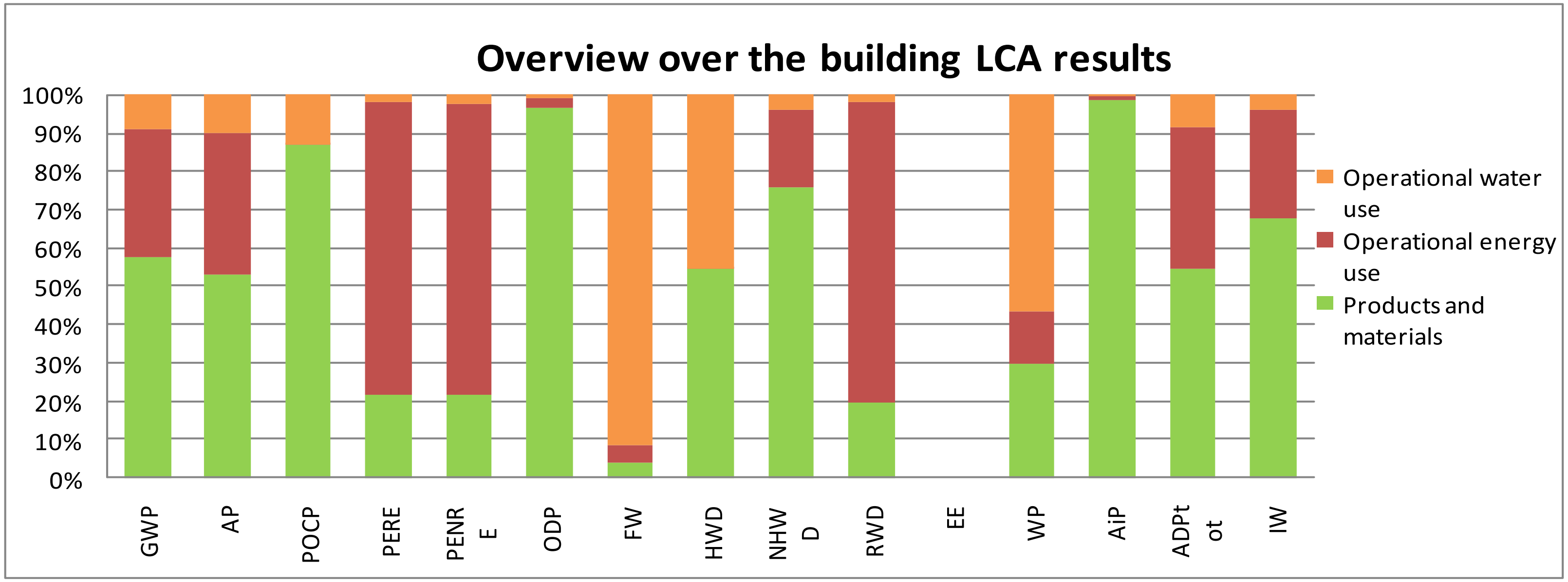
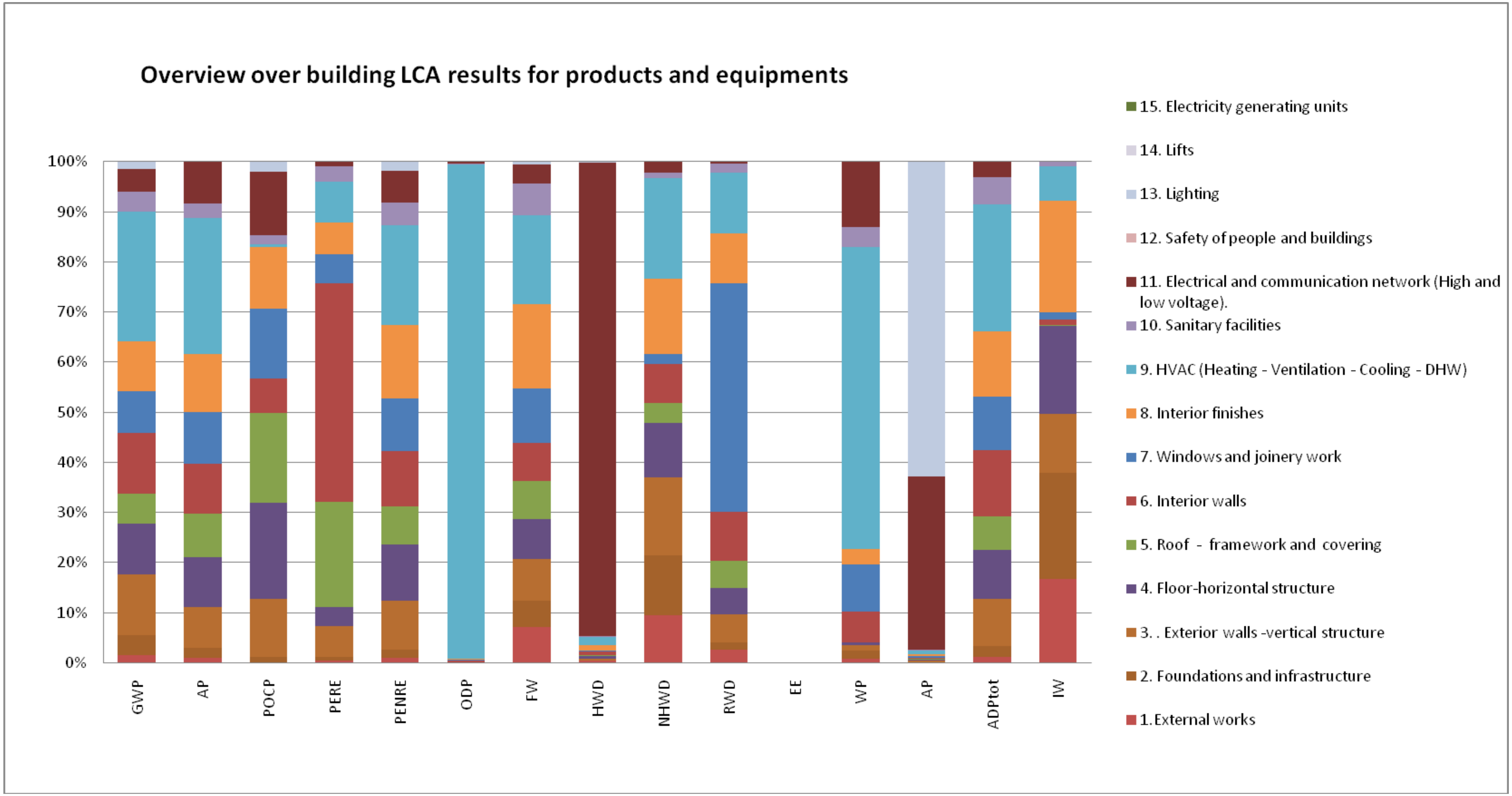


Table 107: Overview over the building LCA results for products and equipment_Baseline scenario

Overview over the product LCA results														
	GWP	AP	POCP	PERE	PENRE	ODP	FW	HWD	NHWD	RWD	WP	AP	ADPtot	IW
100 years	[kg CO_2-equiv./m^2_{NFA}*a]	[kg SO_2-equiv./m^2_{NFA}*a]	[kg C_2H_4-equiv./m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[kg CFC11-equiv./m^2_{NFA}*a]	[m^3/m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[m^3/m^2_{NFA}*a]	[m^3/m^2_{NFA}*a]	[kg Sb-Equiv. /m^2_{NFA}*a]	[kg /m^2_{NFA}*a]
1.External works	1,06E-01	3,45E-02	2,04E+00	2,73E+01	4,02E-07	4,73E+02	1,79E-01	1,78E+02	2,45E-03	0,00E+00	3,93E+02	1,31E+03	4,47E-02	1,70E+02
2. Foundations and infrastructure	2,62E-01	6,59E-02	3,18E+00	4,95E+01	7,62E-07	3,46E+02	8,11E-03	2,26E+02	1,49E-03	0,00E+00	8,35E+02	2,04E+03	7,77E-02	2,14E+02
3. . Exterior walls - vertical structure	8,05E-01	2,64E-01	2,76E+01	2,82E+02	3,17E-07	5,54E+02	2,15E-01	2,96E+02	5,30E-03	0,00E+00	4,73E+02	6,30E+03	3,57E-01	1,21E+02
4. Floor-horizontal structure	6,73E-01	3,31E-01	1,65E+01	3,27E+02	1,72E-07	5,36E+02	2,62E-01	2,05E+02	5,12E-03	0,00E+00	2,99E+02	5,94E+03	3,70E-01	1,77E+02
5. Roof - framework and covering	3,99E-01	2,87E-01	9,43E+01	2,18E+02	0,00E+00	5,12E+02	1,75E-01	7,46E+01	5,25E-03	0,00E+00	2,23E+01	4,74E+03	2,48E-01	2,86E+00
6. Interior walls	8,04E-01	3,28E-01	1,95E+02	3,25E+02	3,42E-06	5,04E+02	3,28E-01	1,47E+02	9,50E-03	0,00E+00	3,04E+03	7,12E+03	4,99E-01	9,58E+00
7. Windows and joinery work	5,55E-01	3,38E-01	2,61E+01	3,03E+02	1,16E-06	7,25E+02	1,16E-01	3,75E+01	4,38E-02	0,00E+00	4,61E+03	8,11E+03	4,03E-01	1,57E+01
8. Interior finishes	6,62E-01	3,82E-01	2,84E+01	4,24E+02	2,69E-06	1,12E+03	5,38E-01	2,85E+02	9,60E-03	0,00E+00	1,50E+03	1,06E+04	4,93E-01	2,26E+02
9. HVAC (Heating - Ventilation - Cooling - DHW)	1,72E+00	8,96E-01	3,58E+01	5,78E+02	1,11E-03	1,18E+03	8,58E-01	3,79E+02	1,18E-02	0,00E+00	2,97E+04	2,14E+04	9,53E-01	6,84E+01
10. Sanitary facilities	2,59E-01	9,63E-02	1,41E+01	1,36E+02	1,94E-06	4,18E+02	1,40E-01	1,91E+01	1,75E-03	0,00E+00	1,99E+03	2,83E+03	2,08E-01	9,86E+00
11. Electrical and communication network (High and low voltage).	3,08E-01	2,76E-01	4,23E+00	1,81E+02	4,13E-06	2,57E+02	4,94E+01	4,18E+01	3,09E-04	0,00E+00	6,40E+03	9,45E+05	1,15E-01	6,09E-01
12. Safety of people and buildings	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
13. Lighting	9,59E-02	4,92E-05	0,00E+00	5,50E+01	1,02E-06	3,46E+01	1,44E-01	0,00E+00	0,00E+00	0,00E+00	2,13E+00	1,72E+06	0,00E+00	0,00E+00
14. Lifts	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
15. Electricity generating units	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Figure 54-3: Building LCA results of contributor products and equipment_ Overview of the share of family products and systems



Interpretation of the results "Baseline Scenario"

General analysis

First of all, the analysis of the LCA results will not focus on the indicator POCP and ODP because of the lack of consistency and homogeneity among the calculation method used in different LCA data of the study.

If we look at

Figure 54-2 representing the share of total building LCA results per contributors, the following aspects can be noticed:

The contribution of **products and equipment** on total results is above **55%** for the following indicators:

- Global warming potential (**GWP**);
- Non hazardous Waste (**NHWD**);

The same contributor is also accountant up to **50%** of for the following indicators:

- Total abiotic resource depletion (ADPtot);
- Hazardous Waste to disposal (HWD and NHWD);
- Acidification Potential (AP).

We can notice that **the global trend is similar for indicator GWP, AP and ADPtot**. Indeed, products and materials are responsible for nearly half of the total building impacts. Operational energy use is then the second most important contributor and, at last, operational water use contributes for less than 10%.

Products and equipment are also the main accountant for the indicator "Non hazardous waste" (NHWD). This facts is can be interpreted as a logical results as it include all inert wastes ending up from the building deconstruction. However, indicator dangerous waste (DG) seems as much influenced by materials and products as by operational water consumption.

Concerning the indicator Air Pollution, products and equipment seems definitely the main accountant for the considered impact. However, these results should be considered with caution as it will be discussed further.

The contribution of **operational energy use** on total results is **above 75%** for the following indicator:

- Non renewable primary energy (NRPE);
- Renewable primary Energy (RPE);
- Radioactive Waste (RWD).

Considering that the house is mainly heated with the help of a heat pump that consume electricity and that domestic hot water production is ensured by solar system, these results are easily predicable and understandable.

Then, as it was said before, operational energy use is accountant for a big part (nearly 40%) of indicators of environmental impact GWP, Acidification Potential (AP) and Abiotic ressouce Depletion (ADPtot).

Operational water use is the main accountant for Net fresh Water consumption and Water pollution. This contributor is also responsible for a major part in indicator Hazardous waste to disposal. This last observation shall be taken with caution because of methodological issues about classification of waste from sewage treatment plants.

Specific analysis for the contributor products and equipment

If we look at indicator Non-renewable primary energy consumption and GWP, the trend for both indicators appears to be very similar. **The main accountants seem to be the HVAC equipments and building structure (horizontal and vertical)**. We can also notice the significance of interior finishes that can be compared to the contribution of exterior walls and vertical structure. A brief analysis of sensibility has underline that one of the main contributors might be the floor flexible coating.

HVAC equipment seems to be also responsible for a high contribution to the indicator water pollution.

Windows and joinery work is, for its part, the main responsible for radioactive waste if we consider only results of products and equipment. The use of specific EPDs related to the French context can be an obvious hypothesis to understand this result as the major part of the electricity used in France comes from nuclear sources.

Another important observation is the contribution of electrical systems and network to the indicator Hazardous waste to disposal. This result is to take with caution as very few data are currently available for these types of systems, then it is difficult to verify the consistency and the reliability of the LCA results.

The indicator Air pollution appears to be mainly related to Lighting systems and Electrical communication network. However, this result shall be taken with caution as accounting methods for electrical and devices LCA data appear not to be homogeneous with accounting methods of LCA data used for other building products.

Note: The content of each class of building products and equipment is available in 0.

55. Scenario 100 years

Used environmental indicators "Scenario 100 years"

Used environmental indicators for "Scenario 100 years" are identical to "Baseline scenario".

Description of the parameters "Scenario 100 years"

For "scenario 100 years", all impacts are calculated for 100 years of operation (compared to 50 years for the "Baseline scenario").

The two analyses are, in consequence, not based on the same reference study period. No scenario for refurbishment of the building has been considered. Replacement of building component during the operational stage is calculated according to French standard on environmental performance assessment of building [XP P01-020-3].

Scenario "100 years"	G- 08 "Reference study period"	**100 years**
	G- 10 "Future technical developments and innovation"	No innovation to be considered, current technologies to be used
	G- 12 "Accounting for carbon storage / carbon sequestration"	Carbon storage is not considered
	G- 25 "Water consumption as a new impact category"	Not scarcity of water considered
	B- 03 "Transport of people"	No transport of people considered
	B- 14 "Replacement frequency"	Replacement in whole number cycles
	B- 20 "Electricity consumption in dynamic LCA data"	Annual average data sets for electricity
	B- 25 "Operational energy demand – Consideration of user behavior for stand-alone or comparative LCA of new buildings"	No user behavior considered

Comparison between baseline scenario and "Scenario 100 years"

The following tables and figures show the differences estimated according to the variation of the reference study period.

Table 108: Overview over the building LCA results_comparison between baseline scenario and scenario 100 years

	Reference study period	1. Global warming potential	2. Acidification Potential	4. Photochemical Ozone Creation Potential	5. Total use of renewable primary energy	6. Total use of non-renewable primary energy	7. Depletion potential of the stratospheric ozone layer	13.Net Fresh Water	14.Hazardous Waste	15.Non Hazardous Waste	16.Radioactive Waste	20.Exported Energy	21. Water pollution	22.Air pollution	23.ADP (element +fossil fuels)	24.Inert Waste
	RSP	GWP	AP	POCP	PERE	PENRE	ODP	FW	HWD	NHWD	RWD	EE	WP	AiP	ADPtot	IW
	years	[kg CO_2-equiv./m^2_{NFA}*a]	[kg SO_2-equiv./m^2_{NFA}*a]	[kg C_2H_4-equiv./m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[kg CFC11-equiv./m^2_{NFA}*a]	[m^3/m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[m^3/m^2_{NFA}*a]	[m^3/m^2_{NFA}*a]	[kg Sb-Equiv. /m^2_{NFA}*a]	[kg /m^2_{NFA}*a]
Total LCA results	**50**	1,30E+01	7,12E-02	2,32E-03	2,48E+01	1,53E+02	1,17E-05	2,02E+03	1,15E+00	3,42E+01	5,58E-03		1,78E+03	3,32E+04	7,74E-02	2,41E+01
	100	1,22E+01	6,65E-02	1,93E-03	2,40E+01	1,49E+02	1,17E-05	2,01E+03	1,04E+00	2,71E+01	5,46E-03		1,74E+03	2,78E+04	7,29E-02	1,79E+01
	%	-6%	-7%	-16%	-3%	-3%	0%	-1%	-9%	-21%	-2%		-2%	-16%	-6%	-26%
Products and materials	**50**	7,45E+00	3,77E-02	2,02E-03	5,31E+00	3,30E+01	1,13E-05	8,26E+01	6,27E-01	2,59E+01	1,08E-03		5,33E+02	3,27E+04	4,22E-02	1,63E+01
	100	6,65E+00	3,30E-02	1,64E-03	4,47E+00	2,91E+01	1,12E-05	6,66E+01	5,23E-01	1,89E+01	9,64E-04		4,92E+02	2,73E+04	3,77E-02	1,01E+01
	%	-11%	-12%	-19%	-16%	-12%	0%	-19%	-16%	-27%	-11%		-8%	-17%	-11%	**-38%**

Scenario 100 years

Figure 55-1: Comparison between baseline scenario and scenario 100 years_ total building LCA results

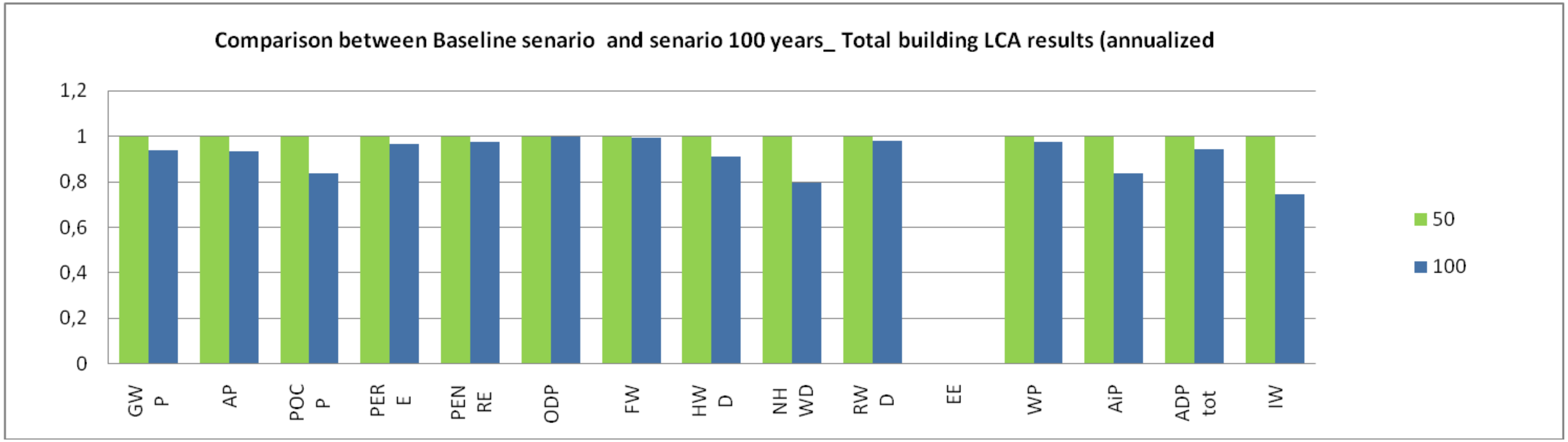
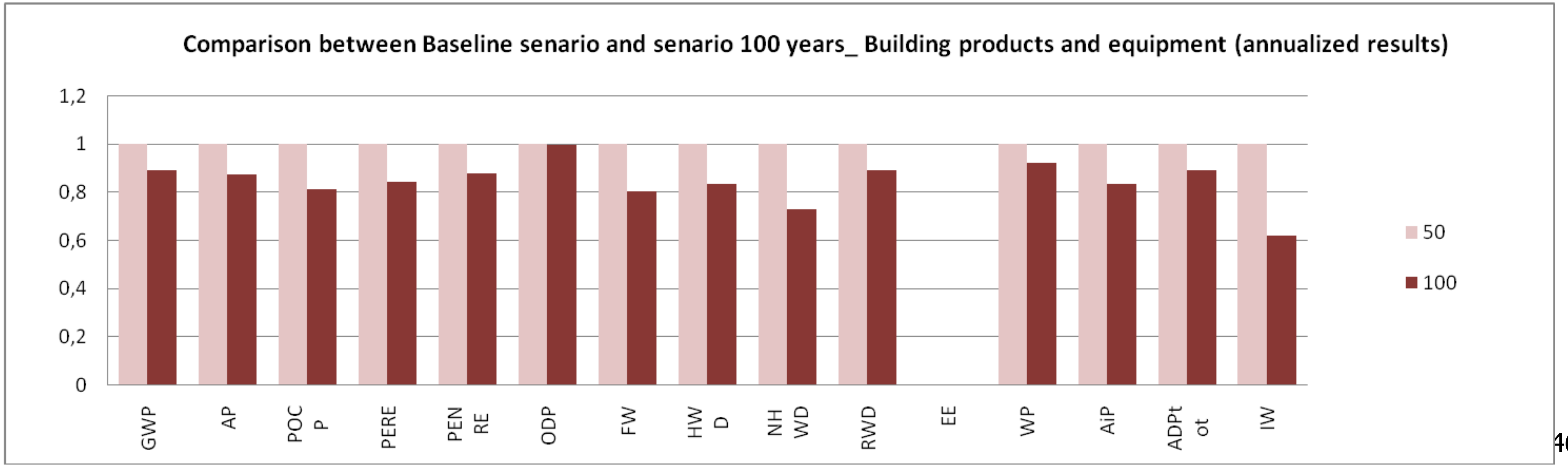


Figure 55-2: Comparison between baseline scenario and scenario 100 years_ LCA results for products and equipment



Interpretation of the results "Scenario 100 years"

The analysis made for a RSP of 100 years permit to estimate the differences when considering that the operational stage of the building is extended from 50 to 100 years.

Results are annualized per year of service life, this operation end up to spread impacts related to the contributor products and materials over the years of operation. Results for the contributor energy uses and water uses for the operational stage are not modified by the change of RSP as they consider yearly calculation. The hypothesis made here is that the performances of the systems are considered to be constant all along the building service life (whatever the chosen reference study period).

56. Conclusion

Main lessons from the Life cycle assessment of the building permit to draw the following conclusions:

The contribution of products and equipments is predominant for some important indicator of environmental impacts as GWP, Non Hazardous Waste and very significant for other ones like Abiotic resources depletion potential, Hazardous Waste to disposal (HWD and Acidification Potential (AP).

Concerning products and equipment, it is important to note that some elements that are usually not included into the scope of the assessment of building are finally impacting significantly specific indicators. For example, the interior finishes significantly influence the indicator primary energy, in the same way, electrical devices is predominant regarding the indicator Dangerous waste. Some analysis of the background data for these elements may need to be undertaken in order to ensure the reliability of the results.

Operational energy use is, for its part, the main accountant for non-renewable and renewable primary energy and radioactive waste and a significant contributor to ADP and GWP.

Operational water use is the main accountant for the indicator net fresh water use, where the contribution of product and operational energy use also appear to be significant.

These results show to some extent that one of the main levers for this house in term of diminution of environmental impacts appears to be the contributor products and equipment. Indeed, the operational energy uses are somehow already optimized (concerning building related uses only).

Moreover it has been shown that the modification of the reference study period from 50 years to 100 years, influence significantly annualized results for the contributor product and equipment (e.g. variation up to 40% for inert waste) but in a less significant way the total annualized results except for (i.e. less than 10% of differences for most indicators but up to 20% for Inert and Non-hazardous waste). It is however important to note that these results are closely related to the chosen method concerning replacement of products and component and moreover that no refurbishment scenario of the building is considered to extend the service life of the building from 50 to 100 years.

57. References

[1] Th-CE methods define the rules for the calculation of the energy performance of buildings according to the French thermal regulation 2005. http://www.rt-batiment.fr/

[2] AFNOR. Qualité environnementale des produits de construction, Déclaration environnementale et sanitaire des produits de construction, NF P01-010. Décembre 2004

[3] AFNOR. Définition et méthodes de calcul des indicateurs environnementaux pour l'évaluation de la qualité environnementale d'un bâtiment, XP P01-020-3, AFNOR, 2009

Documentation of components, materials and surfaces

Building products and equipment									
Product Classification	**Component**	**Quantity**	**unit**	**RSL**	**ESL (practitioner estimate)**	**Type of LCA data and source of the database**	**name of the LCA or EPD Data**	**Date of the LCA data**	**Date of last update**
1. External works	Driveway - stones	11600	k	100	100	ELODIE LCA data	* Gravel		16/07/2012 16:07
	Perimeter fence	0	k	100	50	ELODIE LCA data	* Steel reinforcement		06/09/2011 15:08
	Terrace ok	2.52	m3	100	100	ELODIE LCA data	* Reinforced concrete for the paving of a house		06/09/2011 15:08
	Drainage					No Environmental Data Assigned			
	Faucets					No Environmental Data Assigned			
	Gutter	0.087	unit	100	100	ELODIE LCA data	* Manhole Concrete (CERIB amended by CSTB)		27/09/2011 15:38
	Stormwater - Regards concrete	0.032	unit	100	100	ELODIE LCA data	* Manhole Concrete (CERIB amended by CSTB)		27/09/2011 15:38
	Stormwater - Connection					No Environmental Data Assigned			
	Stormwater - Lift					No Environmental Data Assigned			
	Linear EP					No Environmental Data Assigned			

	Public networks connecting - Polyethylene	2.4	k	30	30	Sheet ELODIE user	High density polyethylene (Adrian)		
	Connecting public networks - Holders for EDF and GDF					No Environmental Data Assigned			
	Connecting public networks - Holders for PTT					No Environmental Data Assigned			
	Sprinkler package pit					No Environmental Data Assigned			
	Connecting public networks - Holders for bell					No Environmental Data Assigned			
	Connecting public networks - Pipe network for TAE					No Environmental Data Assigned			
	Network crawl					No Environmental Data Assigned			
	PVC for sanitary water distribution					No Environmental Data Assigned			
	PAC liaison / nurse	14	ms	100	100	EPD available INIES	Copper tube for water supply and sanitary hot or cold heating in a dwelling	02/03/2009	17/04/2012 08:17
	Descent gutters ok	4.856	ms	100	100	EPD available INIES	Standing seam VMZINC	26/09/2009	29/08/2011 14:46
	Gutters ok	6.3396	ms	100	100	EPD available INIES	Standing seam VMZINC	26/09/2009	29/08/2011 14:46
2. Foundations and infrastructure	Basement ok	32.82	ms	100	100	EPD available INIES	Masonry wall of concrete blocks	25/11/2004	25/10/2011 10:15
	Base - tight ok leveled					No Environmental Data Assigned			

	Concrete blinding ok	1.55	m3	100	100	ELODIE LCA data	* Concrete cleanliness dosed at 150 kg/m3 cement type CEM2		06/09/2011 15:09
	Foundations - Footings and pads ok	6.84	m3	100	100	ELODIE LCA data	* Reinforced concrete for the foundations of a house		06/09/2011 15:08
3. Exterior walls-vertical structure	Stairs ok	0.146	ms	100	100	EPD available INIES	Traditional wood frame (oak and softwood)	04/10/2009	13/05/2012 22:31
	Walls - Poles stiffeners ok	1.1183	m3	100	100	ELODIE LCA data	* Reinforced concrete poles for a house or building type small group (with formwork)		06/09/2011 15:09
	Walls - Lintels rights ok	0.416	m3	100	100	ELODIE LCA data	* Reinforced concrete beams for a home or building type small collective		06/09/2011 15:09
	Elevations and floor DRC ok	119.96	ms	100	100	EPD available INIES	Masonry wall of concrete blocks 25 cm thick cell	31/03/2008	14/06/2012 10:12
	Isolated post ok	0.186	m3	100	100	ELODIE LCA data	* Reinforced concrete poles for a house or building type small group (with formwork)		06/09/2011 15:09
	+ Siporex stucco?	332.15	ms	50	50	EPD available INIES	Stucco mortar mineral	28/05/2007	02/05/2012 14:15
	Coated gerbière ok	1.6	ms	50	50	EPD available INIES	Stucco mortar mineral	28/05/2007	02/05/2012 14:15
	Windowsills **	0.136	m3	100	100	ELODIE LCA data	_ * Concrete assayed 300kg/m3 cement type CEM1		12/07/2012 08:23

	Insulating partitions type 3: dubbing walls	80.774	ms	50	50	EPD available INIES	Pane of glass wool 32 GR NU 100 mm thick	04/11/2008	29/08/2011 08:29
	Ok partition type 3	161.49	ms	50	50	EPD available INIES	PLATE BA13 PLACODUR	###########	16/07/2010 14:24
	Vapor barrier ok	202.65	ms	30	30	Sheet ELODIE user	VD internal vapor barrier: Vario Km Duplex (ISOVER product)		14/06/2012 09:03
	Isolation CVR	5.35	ms	50	50	EPD available INIES	Pane of glass wool 25mm Cleantec	03/09/2008	05/09/2011 09:53
4. Floor-horizontal structure	Beams DRC ok	0.396	m3	100	100	ELODIE LCA data	* Reinforced concrete beams for a home or building type small collective		06/09/2011 15:09
	Ground floor ok	94.624	ms	100	100	EPD available INIES	Low floor concrete crawl XF1 C25/30 CEM II concrete beams and interjoist PSE	19/06/2008	18/06/2012 16:11
	Chaining floor	128	k	100	100	ELODIE LCA data	* Steel reinforcement		06/09/2011 15:08
	Floor floor ok	91.124	ms	100	100	EPD available INIES	Low floor concrete crawl XF1 C25/30 CEM II concrete beams and interjoist PSE	19/06/2008	18/06/2012 16:11
	Total periphery low floor - ok Planelle	1.624	ms	100	100	EPD available INIES	Masonry wall of concrete blocks 25 cm thick cell	31/03/2008	14/06/2012 10:12
	Reinforcement for slab fireplace **	0.09	m3	100	100	ELODIE LCA data	* Reinforced concrete for the paving of a house		06/09/2011 15:08

	Insulating ground floor + floor ok	81.38	ms	50	50	EPD available INIES	Polyurethane Insulation Panel Efisol Support MF 60 mm screed TMS	12/07/2009	15/04/2010 16:06
	Ceiling insulation ok	121.91	ms	50	50	EPD available INIES	Pane of glass wool IBR COATED KRAFT thickness 240 mm	05/11/2008	29/08/2011 08:31
5. Roof	Elements and roofing sloping ok	166.87	ms	60	60	EPD available INIES	Slate Fibre-Cement Kergoat Natura Relief	15/01/2007	22/12/2011 16:44
	Flashing?	1.1089	ms	100	100	EPD available INIES	Standing seam VMZINC	26/09/2009	29/08/2011 14:46
	PVC box?	16.4	ms	30	30	EPD available INIES	PVC profiles and decorative interior and exterior	15/01/2007	18/12/2009 19:35
	Ridge ok	3.522	ms	100	100	EPD available INIES	Standing seam VMZINC	26/09/2009	29/08/2011 14:46
	Polythene membrane likened to rainscreen roof underlayment (model type HDPE Tyvek - DUPONT)	8.87	ms	30	30	Sheet ELODIE user	VD internal screen of sub-type roof TYVEK Polyethylene high density 63 g / m² HDPE film		14/06/2012 09:05
	Frame farmhouses ok	1.781	ms	100	100	EPD available INIES	Traditional wood frame (oak and softwood)	04/10/2009	13/05/2012 22:31
	Ok battens	1.138	ms	100	100	EPD available INIES	Traditional wood frame (oak and softwood)	04/10/2009	13/05/2012 22:31
	Ok rafters	0.17	ms	100	100	EPD available INIES	Traditional wood frame (oak and softwood)	04/10/2009	13/05/2012 22:31

	Oak timbers console + dormer + velux Trimmers	0.31	ms	100	100	EPD available INIES	Traditional wood frame (oak and softwood)	04/10/2009	13/05/2012 22:31
6. Interior walls	Isorupteurs	4.57	ms	50	50	EPD available INIES	Knauf Insulation panel Therm Sol TH35 80mm NC	20/04/2008	03/10/2011 10:25
	Partition type 1 ok	205.71	ms	50	50	EPD available INIES	Plasterboard KHD BA13	26/04/2008	06/10/2011 08:36
	Metal strips of metal rail + angle + steel frame	281.3	k	30	50	ELODIE LCA data	VD calculated by Pierre: Stainless Steel		27/09/2011 16:09
	Partition type 2 BA13 hard ok	42.972	ms	50	50	EPD available INIES	Plasterboard KHD BA13	26/04/2008	06/10/2011 08:36
	Type 2 insulating walls ok	21.486	ms	50	50	EPD available INIES	Pane of glass wool 32 GR NU 100 mm thick	04/11/2008	29/08/2011 08:29
	Recovery and ceiling attic crawl	106.79	ms	50	50	EPD available INIES	Plasterboard KHD BA13	26/04/2008	06/10/2011 08:36
	Bathroom waterproof					No Environmental Data Assigned			
	Postformed style doors	15.12	ms	30	30	ELODIE LCA data	* Wooden Interior Door		27/09/2011 15:43
	Ok hatch VS	0.36	ms	50	50	EPD available INIES	MDF (Medium Density Fiber) Standard or Fibreboard standard obtained by dry For use in wet thicknesses 12, 18, 19, 20, 22, 25mm	01/07/2009	04/05/2012 16:40
	Cupboards	0	ms	30	30	ELODIE LCA data	* Wooden Interior Door		27/09/2011 15:43

7. Windows and joinery works	Shutters gerbière ok	1.72	ms	30	30	ELODIE LCA data	_ * Component PVC		12/07/2012 08:29
	Ok windows shutters	11.395	ms	30	30	ELODIE LCA data	_ * Component PVC		12/07/2012 08:29
	Velux blinds ok	1.1934	ms	30	30	ELODIE LCA data	_ * Component PVC		12/07/2012 08:29
	Thresholds and doors doors **	0.054	m3	100	100	ELODIE LCA data	_ * Concrete assayed 300kg/m3 cement type CEM1		12/07/2012 08:23
	Windows	13.685	ms	30	30	EPD available INIES	Windows and doors PVC Double Glazing A	16/01/2007	18/12/2009 19:35
	Cellar window security bars					No Environmental Data Assigned			
	Velux	1.1934	ms	30	30	ELODIE LCA data	* Aluminum Window		27/09/2011 15:43
	Dress velux					No Environmental Data Assigned			
	Ok mortises	0	ms	30	30	EPD available INIES	PVC profiles and decorative interior and exterior	15/01/2007	18/12/2009 19:35
	Hats policeman					No Environmental Data Assigned			
	Gateway ok	1.935	ms	30	30	EPD available INIES	PVC profiles and decorative interior and exterior	15/01/2007	18/12/2009 19:35
	Garage door ok	4.8	ms	30	30	ELODIE LCA data	* Garage Door		27/09/2011 15:43
	Insulated door ok	1.89	ms	30	30	ELODIE LCA data	* Wooden Exterior Door		27/09/2011 15:43

	Chests VR	0.62	ms	100	100	EPD available INIES	Masonry wall of concrete blocks 25 cm thick cell	31/03/2008	14/06/2012 10:12
8. Interior finishes	Gypsum plaster ceiling ok	76.212	ms	50	50	EPD available INIES	Knauf Plasterboard Cleaneo ® 4	13/04/2008	10/10/2011 08:30
	Leveling screed	55.99	ms	50	50	EPD available INIES	Levelling mortar soil	28/05/2007	17/04/2012 18:29
	Screed ravoirage ok	2.5208	m3	100	100	ELODIE LCA data	* Concrete cleanliness dosed at 150 kg/m3 cement type CEM2		06/09/2011 15:09
	Screed **	3.151	m3	100	100	ELODIE LCA data	_ * Concrete assayed 300kg/m3 cement type CEM1		12/07/2012 08:23
	Paint interior walls and ceilings	416.17	ms	30	30	EPD available INIES	Mural AQUARYL ECO	01/09/2008	02/03/2012 08:54
	Floor covering soft ok	55.99	ms	21	21	EPD available INIES	Homogeneous vinyl flooring	25/11/2004	07/03/2012 17:55
	Ok fir baseboards	4.3024	ms	50	50	ELODIE LCA data	_ * Solid wood parquet reported gross		12/07/2012 09:03
	Tile floor ok	72.47	ms	50	50	EPD available INIES	PORCELAIN STONEWARE PORCELAIN TILE DESVRES 9 mm thick	####### ####	24/12/2010 17:28
	Skirting tile ok	15.024	ms	50	50	EPD available INIES	PORCELAIN STONEWARE PORCELAIN TILE DESVRES 9 mm thick	####### ####	24/12/2010 17:28
	Faience ok	12	ms	50	50	EPD available INIES	PORCELAIN STONEWARE PORCELAIN TILE DESVRES 9 mm thick	####### ####	24/12/2010 17:28
	Dividing joint					No Environmental Data Assigned			

	Base - Plaster basement ok	27.853	ms	60	60	EPD available INIES	Monolayer asphalt	30/11/2009	25/04/2012 15:44
	Lining Rasis ok					No Environmental Data Assigned			
	Fermaflex ok	1.715	ms	50	50	EPD available INIES	ADHESIVE Bostik	###########	10/11/2011 18:00
9. HVAC	Ventilation chimney					No Environmental Data Assigned			
	Heating radiators	80	ms	100	100	EPD available INIES	Copper tube for water supply and sanitary hot or cold heating in a dwelling	02/03/2009	17/04/2012 08:17
	PEX pipes	333	M	100	100	Sheet ELODIE user	Multilayer tube for 20x2.5 cancalisations EF / ECS	###########	27/07/2011 09:00
	Bushel fireplace ok	8.05	ms	50	50	EPD available INIES	Concrete flue	19/04/2005	27/09/2011 09:21
	CAP	0.65	unit	50	50	ELODIE LCA data	* CAP geothermal eau-glycolée/eau 10kW on sensors buried vertical		27/09/2011 15:58
	+ Solar balloon	A	unit	25	25	ELODIE LCA data	* Complete solar system for DHW production MI - glazed		27/09/2011 15:58
	Steel radiators	114.4	k	100	50	ELODIE LCA data	* Steel reinforcement		06/09/2011 15:08
	Towel	36	k	100	50	ELODIE LCA data	* Steel reinforcement		06/09/2011 15:08
	VMC					No Environmental Data Assigned			
	Hood and exits SL					No Environmental Data Assigned			

	Ventilation VS					No Environmental Data Assigned			
10. Sanitary facilities	Kitchen Sink	A	unit	21	21	EPD available INIES	Glazed ceramic sink of size 120 x 60 cm (2 tanks and a drip), without fittings	####### ####	22/10/2010 16:31
	Basins	2	unit	21	21	EPD available INIES	Porcelain sink and 60 cm column without plumbing or drain	####### ####	22/10/2010 16:39
	Shower	A	unit	21	21	EPD available INIES	Showertray glazed stoneware dimensions of 80 x 80 cm without the inserts,	####### ####	22/10/2010 18:29
	Bathtub	A	unit	21	21	EPD available INIES	Acrylic bathtub dimensions of 170 x 70cm and taps his feet without	####### ####	22/10/2010 15:26
	WC	2	unit	21	21	EPD available INIES	Pack toilet (bowl and tank) in porcelain with a mechanism and seat	####### ####	22/10/2010 18:04
	Shower door					No Environmental Data Assigned			
	Washstand					No Environmental Data Assigned			
	Shower guard					No Environmental Data Assigned			
	Fittings					No Environmental Data Assigned			

	Health food	70	ms	50	50	EPD available INIES	SYSTEM'O pipes for carrying out distribution of hot water and cold water.	###########	05/06/2012 09:21
	Disposal of sanitary items					No Environmental Data Assigned			
	Connecting decompression WC					No Environmental Data Assigned			
11. Electricity and communication equipment	Regulating heating	A	unit	10	10	ELODIE LCA data	PEP Heating control for room thermostat + + Trim Plate and Support - Program Céliane		27/09/2011 16:00
	Micro-device protection circuit breakers	3	unit	21	21	ELODIE LCA data	PEP Modular C60 circuit breaker 1 pole		27/09/2011 16:01
	Power supply					No Environmental Data Assigned			
	Outlets	46	unit	21	21	ELODIE LCA data	PEP 2P + E 16A 250V 10-terminal automatic + + Trim Plate - Series Initia		27/09/2011 16:03
	Equipotential					No Environmental Data Assigned			
	General gate array distribution	A	unit	21	21	ELODIE LCA data	PEP door cabinet for 18 gamma		27/09/2011 16:03
	Bell	A	unit	10	10	ELODIE LCA data	PEP Ring LIDO 8V		27/09/2011 16:04
	EDF breaker	A	unit	21	21	ELODIE LCA data	PEP circuit breaker connection		27/09/2011 16:01
	General picture of distribution	A	unit	21	21	ELODIE LCA data	PEP Gamma Distribution Box 18		27/09/2011 16:00

	Taken PTT	7	unit	21	21	ELODIE LCA data	PEP Telephone Outlet + + Trim Plate and Support - Program Céliane		27/09/2011 16:04
	Line thermostat					No Environmental Data Assigned			
	Blow point emergency stop	A	unit	10	10	ELODIE LCA data	PEP Button "punch" emergency stop		27/09/2011 16:00
	External floodlighting					No Environmental Data Assigned			
	Programming clock					No Environmental Data Assigned			
	TV sockets	8	unit	21	21	ELODIE LCA data	PEP TV socket + + Trim Plate and Support - Program Céliane		27/09/2011 16:04
	Table communication	A	unit	21	21	ELODIE LCA data	PIP box of semi-communication with telephone / TV TN401		27/09/2011 16:00
	Remote control switches	2	unit	21	21	ELODIE LCA data	PEEP Pushbutton unipolar or bipolar		27/09/2011 16:04
	Electric cables	103.28	M	21	21	ELODIE LCA data	ECOINVENT - three phase power cable		27/09/2011 15:39
	Chutes	0	unit	21	21	ELODIE LCA data	PEP installation trunking for distribution boxes 13 gamma and 18 gamma		27/09/2011 16:01
13. Lighting	RCCBs	4	unit	21	21	ELODIE LCA data	PEP bipolar differential switch		27/09/2011 16:01
	Two-way switch	14	unit	21	21	ELODIE LCA data	PEP-way switch 10AX Terminal + Automatic Plate - Space Series		27/09/2011 16:02

	Simple ignition switch	13	unit	21	21	ELODIE LCA data	Push button switch PEP 6A O + F + terminal automatic plate - Space Series		27/09/2011 16:02
	Power Bar breakers	A	unit	21	21	ELODIE LCA data	PIP Power Bar differential switches terminal offset		27/09/2011 15:59
	Bright spots: incomplete!	116	unit	21	21	ELODIE LCA data	PIP box DCL embedding drywall - Program Batibox		27/09/2011 15:59

EeBGuide Background Report for Buildings

LCA of a new office building

Basic facts

Name of the building:	"Office Building A"
Date of the assessment:	December 2010
Address of the building:	*Confidential*
name and qualification of the assessor:	Alexandra LEBERT, Jessia FEDOLLIERE and Manuel BAZZANA, Research Engineers.
name and qualification of the reviewer:	ESCI (Spain)
Review type	*project internal review*
Date of the verification	*To be specified after review*
Client of the study:	*Confidential*
Authors of the study:	*Centre Scientifique et Technique du Bâtiment* CSTB le futur en construction

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Nomenclature

Abbreviation	Explanation
ADP	Abiotic Depletion Potential
ADPE	Abiotic Resource Depletion Potential for elements
ADPF	Abiotic Resource Depletion Potential of fossil fuels
AP	Acidification Potential
BLBSB	Benefits and Loads Beyond the System Boundary
CML	Centrum voor Milieukunde, Leiden (NL)
CRU	Components for re-use
CSTB	Centre scientifique et technique du Bâtiment
EE	Exported energy per energy carrier
EP	Eutrophication Potential
EPD	Environmental Product Declaration
FW	Use of net fresh water
GWP	Global Warming Potential
HWD	Hazardous waste disposed
IBU	Institut Bauen und Umwelt e.V.
MER	Materials for energy recovery
MFR	Materials for recycling
NRSF	Use of non-renewable secondary fuels
NHWD	Non hazardous waste disposed
ODP	Ozone Layer Depletion Potential
PENRE	Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials
PENRM	Use of non-renewable primary energy resources used as raw materials
PENRT	Total use of non-renewable primary energy resources
PERE	Use of renewable primary energy excluding renewable primary energy resources used as raw materials
PERM	Use of renewable primary energy resources used as raw materials
PERT	Total use of renewable primary energy resources
PCR	Product Category Rules

POCP	Photochemical Ozone Creation Potential
RSF	Use of renewable secondary fuels
RSL	Reference Service Life
RT	French Thermal Regulation
RWD	Radioactive waste disposed
SM	Use of secondary material

58. Scope

This document is the background report for the report on the life cycle assessment results of an office building located in Metz, France. The study conducted, follows the provisions and guidelines of EeBGuide.

59. Content, structure and accessibility of the background report

The background report provides the systematic and comprehensive summary of the project documentation supporting the verification of a building LCA. The project report shall record that the LCA based information meets the requirements of EeBGuide of the Energy- efficient Building Initiative. It will be made available to the verifier with the requirements on confidentiality stated in ISO 14025.

The background report contains any important data and information required by the European standard EN 15978. Special attention is paid to a transparent documentation.

60. General aspects in the background report

The present LCA study of the company is performed by the practitioner stated and has been conducted according to the requirements of the European Standard **Erreur ! Source du renvoi introuvable.**. The background report will be sent to verification as mentioned. Further details can be found in the table "General Information".

61. Goal/Purpose of the study

The objective of the study is to quantify the environmental impacts throughout the life cycle of the office building and more specifically:

- To identify the contribution of products and building materials to the overall environmental impact of the building and compare it to the impacts associated with the use phase of the building (e.g. consumption of water and electricity);

- To analyze the results and identify key issues among the building products used with respect to the different environmental impacts.

Table 109: Goal/ Purpose of the study

Goal/ Purpose of the study			
	Level of complexity	☐	Screening
		☐	Simplified
		☑	Complete
	related study objective	☐	Comparative assertion
		☑	Stand alone LCA
	object of assertion	☑	New building
		☐	Existing building
	communication purpose	☐	internal
		☐	external
		☑	for costumer to costumer
		☐	publication
		☐	[name different communication purpose]

62. Scope of the study

Declared / functional equivalent

The following points have to be defined with regards to the functional unit:

"Function as office building, over a period of 50 years, with a typology of commercial building on 5500 sqm of floor area. The building also provides support for commercial activities on 150 m² of floor area and offers 78 parking spaces underground. "

Table 110: Functional equivalent

Functional equivalent	Reference unit:	m² NFA (living area)
	Type of Building:	Office building with underground parking space
	number of tennants:	378
	Required service life:	50 years
	Other services provided within the building:	The building support for commercial activities on 150 m² of floor area. Two underground levels are allocated to car parks

Object of the assessment is the entire building without infrastructure (e.g. roads) and surrounding structures (e.g. park). The assessed building is described with main components, materials and surfaces.

Technical description of the building

Extract from the descriptive of the building:

The project is located in the southern part of the City of Metz [...]. It consists of a main office building comprising a ground floor and 7 levels above it and an adjacent structure constituted of a two level car park. The first level of the car park is semi-underground and each level comprises 39 parking spaces.

The building surface is approximately 5700m², with 5500 m² dedicated to office space and 150 m² occupied by business located in the western part of the ground floor.

The number of occupant was calculated with a ratio of one person per 14 square meters of office floor area. This leads to a maximum of 55 people a standard level and 48 people for the penthouse level 7.

Additional information:

- Energy performance target: "BBC" label (French low energy label);
- Environmental performance target: "HQE NF bâtiment tertiaire";
- The low-energy building has an external thermal insulation;
- Heating and hot water provided by the district heating system of Metz city;
- Ventilation is provided by controlled mechanical ventilation (double flow).

The following table describes the building into more detail:

Table 111: Technical description of building

Technical description of the building	Year of comissioning:	*2013 (expected)*
	Year and type of refurbishment:	*No refurbishment expected for the study*
	Structural type:	*Concrete load- bearing structure*
	Number of storeys:	*8*
	Net Floor Area [m²]:	*9180*
	Gross Floor Area [m²]:	*5700*
	Calculated electrical end energy demand [kWh/(m²*a)]:	*The total electrical end energy demand for building related uses is estimated to 33 kWh/(m²*a) of primary energy*
	Calculated thermal end energy demand [kWh/(m²*a)]:	*7*

	Energy calculation methodology:	*French national thermal regulation 2005, calculation method ThCE [1]*
	Important materials for supporting structure, insulation, windows:	*concrete, structural steel, mineral wool, double glazing*
	Type of facade:	*Curtain wall*
	Energy supply system and energy transfer system (short description; name renewable components, if used):	*Central heating and cooling connected to urban Heating and Cooling (gas and coal production unit)*
	Number and description of underground levels (parking areas, other)	*2 underground level*
	Information about external features (garden, fountain, pools, etc…)	*None*

Table 112: Technical description of all operational areas

Technical description of all operational areas	Operational Area1:	*Complete building*
	Usage Operational Area1:	*Office and commercial activities*
	Design number of building occupants Operational Area1:	*378*
	Design occupancy schedule Operational Area1:	*The office building is considered to be occupied 220 days a year (hourly schedule is defined according conventional office of Th-CE method [1])*

	Heating, cooling and ventilation system and hot water service system Operational Area1:	*Central heating and cooling connected to urban Heating and Cooling (gas and coal production unit). Ventilation: controlled mechanical ventilation (double flow). Heating of hot sanitary water production excluded from the study.*
	Lighting system Operational Area1:	*Offices: T5 luminaires with electronic ballast (with dimming function). Common parts : 2*18w Downlight lunimaire and autonomous security lighting.*
	Power and communication systems Operational Area1:	*not specified*

Information about the surrounding environment

The following table brings information about the local context:

Table 113: Description of the local context

Description of the local context	Information on climate (HDD and CDD, climate severity index...)	*HDD (18°C) =2797 (french climatic zone according to RT2005 h1b)*
	Urban context (down town, suburbs, countryside…)	*City center, Office and commercial area*
	Geological constraints (seismic context, load bearing capcity, slopes of the building site…)	*no geological constraints (no supplementary information regarding the quality of the soil to build a house…)*
	Accoustics constraints (indicator of noise exposure)	*no information*
	Specific urban rules (eg. Plot ratio…)	*no information*

	Architectural constraints	*no information*
	Other constraint of the surrounding environment	*none*

System boundaries

The system boundary of the building LCA follows the modular design defined by EN 15978. The following chapters describe the modules which are within the scope of this study. The modules included are in-line with the following table:

Table 114: Definitions for the different study types

Screening - Simplified - Complete

according to SBA Common Metrics Framework 2009 and EeBGuide adaptations

M	**mandatory**
O relevance?	**optional because of minor relevance**
O data?	**optional due to potentially missing data**

	Study type	**Before use stage**				
		Raw Materials Supply	Transport (to factory)	Manufacturing	Transport (to construction site)	Construction-Installation process
		A1	A2	A3	A4	A5
Building	Screening	M — **Calculation rules based on data on major sub-structure (e.g. statistical data such as kWh/m² for primary energy) or generic LCA of building elements/products/materials** such as Roof; Load- bearing structure; Exterior and basement walls; Windows; Floor slabs; Foundation; Floor Finishes/ Coverings			O relevance?	O data?
		O data? — **Calculation rules based on data on statistical data such as kWh/m² for primary energy for the following equipment:** Refrigeration/ Coolants; Decorative wall finishes/ coatings (e.g. wallpaper, paints); Doors; Heating/ Cooling/ Lighning Equipment and any power-generating equipment (e.g. wind turbines/ PV/ solar heating) Equipment for internal transport (e.g. lifts, escalators); water and sewerage systems; electrical distribution system				
	Simplified	M — **Calculation rules based on data on major sub-structure (e.g. statistical data such as kWh/m² for primary energy) or generic LCA/average EPD of building elements/products/materials** such as Roof; Load- bearing structure; Exterior and basement walls; Windows; Floor slabs; Foundation; Floor Finishes/ Coverings;			O relevance?	O data?
		O data? — **Calculation rules based on data on statistical data such as kWh/m² for primary energy for the following equipment:** Refrigeration/ Coolants; Decorative wall finishes/ coatings (e.g. wallpaper, paints); Doors; Heating/ Cooling/ Lighning Equipment and any power-generating equipment (e.g. wind turbines/ PV/ solar heating) Equipment for internal transport (e.g. lifts, escalators); water and sewerage systems; electrical distribution system				
	Complete	M — **Calculation rules based on data on major building elements/products/materials based on specific EPD (both group of manufacturer's or single manufacturer declaration) else average LCA data:** Roof; Load- bearing structure; Exterior and basement walls; Windows; Floor slabs; Foundation; Floor Finishes/ Coverings; Refrigeration/ Coolants; Decorative wall finishes/ coatings (e.g. wallpaper, paints); Doors; Heating/ Cooling/ Lighning Equipment and any power-generating equipment (e.g. wind turbines/ PV/ solar heating) Equipment for internal transport (e.g. lifts, escalators); water and sewerage systems; electrical distribution system			M	M

Screening - Simplified - Complete

according to SBA Common Metrics Framework 2009 and EeBGuide adaptations

M

O relevance?

O data?

	Study type	Use stage						
		Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use
		B1	B2	B3	B4	B5	B6	B7
Building	Screening	O relevance?	O relevance?	O data?	O data?	O relevance?	M **Calculation rules based on the expected performance target for the building** (e.g. energy label target or reference levels set by national regulation) calculated at least for building related uses covered by the EPBD (heating, cooling and air conditioning, ventilation, domestic hot water, lightning and auxiliary energy used for pumps, control and automation).	M **Calculation rules based on statistical data** for both building and non building related water equipment
Building	Simplified	O relevance?	O relevance?	O data?	M	O relevance?	M **Calculation rules based on Dynamic Thermal Simulation or national calculation methodology** for building related uses (heating, cooling and air conditioning, ventilation, heating for provision of domestic hot water, lightning) M **Calculation rules based on EPA-NR for comparative assessments** (heating, cooling and airconditioning) (Internal transport, computer and IT equipment, refrigerators, washing machines, dishwashers, dryers, other small power devices)	M **Calculation rules based on top-down approach** by taking into the economic (by water saving devices e.g. dual flash toilet system) or extra consumption measures for both building and non building related water equipment
Building	Complete	M	M		M	M	M **Calculation rules based on Dynamic Thermal Simulation, National calculation methodology or EPA-NR for comparative assessment** for building related uses and non building related (heating, cooling and air conditioning, ventilation, heating for provision of domestic hot water, lightning, Internal transport, computer and IT equipment, refrigerators, washing machines, dishwashers, dryers, other small power devices) (heating, cooling and air conditioning, ventilation, heating for provision of domestic hot water, lightning)	M **Calculation rules based on bottom-up approach** for both building and non building related water equipment such as urinals, WCs, taps, baths,showers, greywater/ rainwater systems dishwashers, washing machines, water softeners, wase disposal units

Screening - Simplified - Complete

according to SBA Common Metrics Framework 2009 and EeBGuide adaptations

M

O relevance?

O data?

	Study type	End of Life				Benefits beyond boundary
		Deconstruction	Transport (to disposal)	Waste process for reuse, recovery or/ and recycling	Disposal	Reuse-/ Recovery- /Recyclingpote ntial
		C1	C2	C3	C4	D
Building	Screening	O relevance?	O relevance?	O data? Generic LCA data for EOL processes		O data? Generic LCA data for reuse-/ recovery- / recyc-ling potential
				O data? Generic LCA data for EOL processes		O data? Generic LCA data for reuse-/ recovery- / recyc-ling potential
	Simplified	O relevance? **Calculation rules based on a materials impact ratio (i.e. 3% for GWP in case of concrete)**	O relevance?	M Specific or generic LCA data for EOL processes		M Specific or generic LCA data for reuse-/ recovery- / recycling potential
				O data? Specific or generic LCA data for EOL processes		O data? Specific or generic LCA data for reuse-/ recovery- / recycling potential
	Complete	M **Calculation rules based on the energy, materials and related emissions**	M	M Specific or generic LCA data for EOL processes		M Specific or generic LCA data for reuse- / recovery- / recycling potential

Overview over the included Life cycle stages

The table summarizes the included Lifecycle stages.

Table 115: Included lifecycle stages

Included lifecycle stages		Included	Module	Description
	Product Stage	☑	A1	Raw Materials Supply
		☑	A2	Transport
		☑	A3	Manufacturing
	Construction Process	☑	A4	Transport
		☑	A5	Construction- Installation process
	Use Stage	☐	B1	Use
		☑	B2	Maintenance
		☑	B3	Repair
		☑	B4	Replacement
		☐	B5	Refurbishment
		☑	B6	Operational Energy Use
		☑	B7	Operational Water Use
	End of Life Stage	☑	C1	Deconstruction
		☑	C2	Transport
		☑	C3	Waste process for reuse, recovery or/ and recycling
		☑	C4	Disposal
	Benefits and loads beyond the system boundary	☐	D	Reuse- Recovery- Recyclingpotential

Overview over the included products and equipments

Table 116: Descriptions of products and equipments considered into the study

			Included	Not existing	Screening	Simplified	Complete
Considered products and equipments	1. External works	On-plot network (water, gaz, sewers, heat…)	☑	☐	**0**	**0**	**M**
		Vats and tanks, water retention…	☐	☑	**0**	**0**	**M**
		Parkings and covered surface	☑	☐	**0**	**0**	**M**
	2. Foundations - infrastructure	Foundations -Load-bearing structure	☑	☐	**M**	**M**	**M**
		Wall basement	☑	☐	**M**	**M**	**M**
	3. Exterior walls - vertical structure	Exterior walls	☑	☐	**M**	**M**	**M**
		Structural vertical elements	☑	☐	**M**	**M**	**M**
		Stairs, pedestrian ramps	☑	☐	**0**	**0**	**M**
		External surface coating, facing, painting	☑	☐	**M**	**M**	**M**
	4. Floor - horizontal structure	Floor structure and slabs	☑	☐	**M**	**M**	**M**
	5. Roof	Covering and tightness elements	☑	☐	**M**	**M**	**M**
		Roof framework	☑	☐	**M**	**M**	**M**
	6. Interior walls	Paritionning walls and internal doors	☑	☐	**0**	**0**	**M**
		Suspended ceilling	☐	☑	**0**	**0**	**M**
	7. Windows and joinery work	Windows and joinery work	☑	☐	**M**	**M**	**M**
		Doors	☑	☐	**0**	**0**	**M**
	8. Interior finishes	Floor finishes and covering, screeds	☑	☐	**M**	**M**	**M**
		Paintings, wallpaper, decorative products	☑	☐	**0**	**0**	**M**

Considered products and equipments						
9. HVAC	Heating - Ventilation - Cooling - Domestic hot water system	☐	☐	0	0	M
10. Sanitary facilities	Toilet (bowl and sets hunting), Urinals, Shower trays, plumbing...	☑	☐	0	0	M
11. Electricity and communication network	Electricity wiring and equipment (high and low voltage)	☑	☐	0	0	M
	Communication network and equipment	☑	☐	0	0	M
12. Safety equipments	Fire safety system, intrusion detection system...	☑	☐	0	0	M
13. Lighting	General interior lighting and control systems...	☑	☐	0	0	M
14. Lifts	Elevator, escalator, dumbwaiters...	☑	☐	0	0	M
15. Electricity generating units	Photovoltaic systems including inverters...	☐	☑	0	0	M

Overview over the included operational uses

Table 117: Descriptions of operational energy uses considered into the study

				Comments
Considered operational energy uses	**Building related uses**	Heating	☑	
		Air conditioning	☑	
		Domestic hot water	☑	
		Ventilation	☑	
		Lighting	☑	
		Auxiliary (pumps, control and automation)	☑	
		Building integrated systems (eg. Lifts, shutters, safety equipments...)	☐	No information
	Non building related uses	To specify (e.g. plug-in appliances, dishwachers, TV...)	☐	no plug-in appliances considered for the study

Table 118: Descriptions of operational water uses considered into the study

Considered operational water uses	**Building-related water-consuming processes**	Drinking water	☑	
		Water for sanitation	☑	
		Domestic hot water	☐	
		Irrigation of associated landscape areas	☐	
		water for heating, cooling, ventilation and humidification	☐	No information on HVAC system about water consumption
		Cleaning of interior or exterior spaces	☑	Cleanning of interior spaces calculated according to ratio
		Other specific water use of building-integrated systems e.g. fountains, swimming pools…	☐	No other integrated systems
	Non building-related uses	To specify…	☐	Washing machines and dishwashers

A1-A3, Product stage, information modules

Table 119: Module A1-A3

Module A1-A3	The following processes are omitted:	*The following flows have been excluded from the system boundaries: - workshop lighting, heating and cleaning; - Administration departments; - Employee transport; - Manufacture of the production tool and transportation systems (machines, trucks, etc.).*
	The following deviations from EN 15978 on data requirements occurred **(Just for "Complete Assessment")**:	*Deviation with regards to EN 15804: •Most of the inputs data used are cradle to grave EPDs with aggregated results. •Cut of rule of most inputs is based on NF P01-010, i.e. 2% by mass of the reference flow instead of 5 % but without requirements for energy inputs. Some material inputs are calculated from PEP (Product Environmental Profile) that uses à 5% cut of rule for material inputs. • Some missing data for material inputs have been generated directly by CSTB because of lack of EPD. For these data, A1 to A3 module have been taken into account with a penalizing scenario, consequently the reliability and representativeness of these data is limited.*
	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	*•Overall modeling based on preliminary project metrics and not on implemented building metrics - minor differences might occurs • Overall inputs data are representative of the French context (temporal, technological & geographical).*

A4-A5, Construction process stage, information modules

Table 120: Module A4-A5

Module A4-A5	The following processes are omitted:	*Depreciation of constructions equipment and vehicles. Employee transport and additional flow related to construction phase not included in EPDs (e.g. digging for foundations).*
	The following deviations from EN 15978 on data requirements occurred **(Just for "Complete Assessment")**:	*No major deviation from EN 15978*
	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	*Inputs data used are mostly cradle to grave EPDs with aggregated results Transport of materials from production site to construction site is defined considering most representative scenario (specific to products or materials). Overall inputs data are representative of the French context (temporal, technological & geographical).*

B1-B5, Use stage, information modules related to the building fabric

Table 121: Module B1-B5

Module B1-B5	The following processes are omitted:	*Inputs data do not include emissions during use phase (B1) No scenario for refurbishment considered, (module B5 is not accounted in this study)*
	The following deviations from EN 15978 on data requirements occurred **(Just for "Complete Assessment")**:	*No major deviation from EN 15978*
	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	

B6-B7, Use stage, information modules related to the operation of the building

Standard XP P01-020-3 recommends developing the analysis for the following environmental contributions:

- Energy consumption related to lighting, heating, production of domestic hot water, ventilation, cooling and associated auxiliary;
- Other consumption related to the frame;
- Energy consumption related to the activity;
- Consumption of products and building materials;
- Production of wastes related to the activity and waste management (including liquid wastes);
- Consumption of materials related to the activity;

- Transportation of users.

The Technical Annex[1] of HQE Performance label from June 2010 specifies whether each of the following contributors is mandatory or optional:

Contributor	Level of consideration
Energy consumption covered by the French thermal regulation	Mandatory
Other energy consumption related to the frame	Optional
Energy consumption related to the activity *	Optional
Consumption of products and building materials	Mandatory
Construction phase (excluding the contribution from construction products) **	Mandatory
Water consumption	Mandatory
Production of wastes related to activity and waste management *	Optional
Liquid waste (excluding waste related to activity)	Mandatory
Consumption of materials related to the activity *	Optional
Transportation of users	Optional
* If one of these contributors is calculated, the others shall be calculated too to keep the study consistent. ** This contributor is not mentioned in standard XP P01-020-3 because it was normally covered by the contributor 4.	

Table 122 Mandatory and optional contributors

[1] This document was under development at the time the present study was conducted.

Regarding the assessment of energy consumption covered by the French thermal regulation (RT), the contribution of domestic hot water (DHW) has not been considered as its assessment is not compulsory for an office building.

The version v1.0.026 (November 2010) of the ELODIE building LCA software allowed to consider three families of contributors: construction products, water consumption and energy as indicated in the following figure.

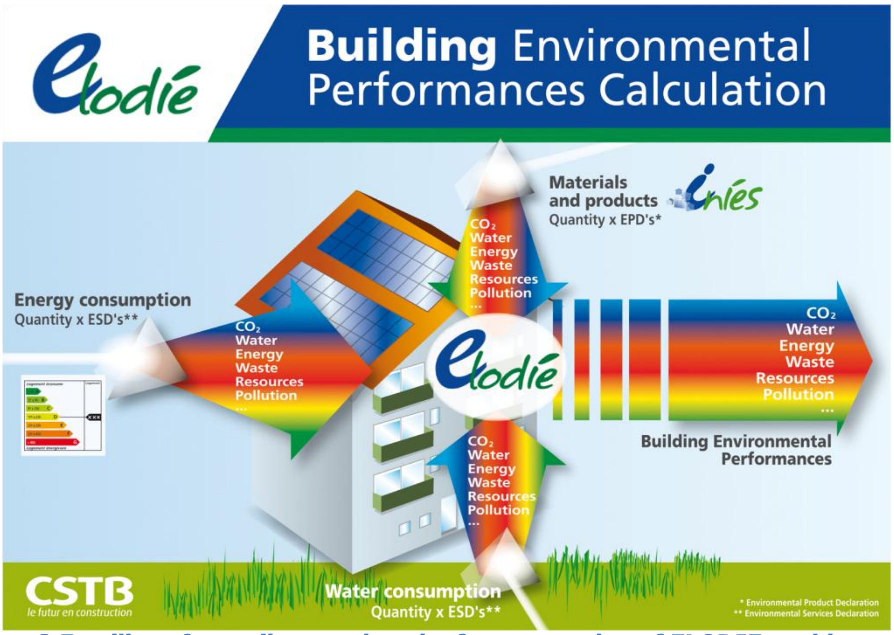


Figure 3 Families of contributors that the former version of ELODIE could manage

The general rules of the standard XP P01-020-3 were applied for the definitions of the system boundaries.

Because of the rules proposed by the standard and the availability of data for this project, the following contributors are included in this study:

- **Consumption of energy-related uses (French thermal regulation);**
- **Consumption of products and building materials;**
- **Water consumption and management of liquid waste.**

Table 123: Module B6

Module B6	The following processes are omitted:	*Energy inputs for production of hot sanitary water.*
	The following deviations from EN 15978 on data requirements occurred **(Just for "Complete Assessment")**:	*• The following energy uses have been included: lighting; heating and cooling; ventilation; auxiliaries.*
	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	*Energy demand calculated according to French Thermal Regulation calculation method (THCE - RT2005).* *• Energy inputs for heating and cooling provided by a Central heating and cooling connected to urban Heating and Cooling (gas and coal production unit).* *• Electricity inputs modeled with French average electric mix.*

Table 124: Module B7

Module B7	The following processes are omitted:	*All water inputs except cleaning.*
	The following deviations from EN 15978 on data requirements occurred **(Just for "Complete Assessment")**:	*Water consumption have been considered for the following uses:* *- Cleaning of interior spaces;* *- Sanitary taps.*
	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	*Amount of water has been calculated taking into account daily ratio per person.* *Water consumption for cleaning of interior spaces has been calculated with the help of ratio per m² of NFA.* *No water consumption has been considered for watering of green spaces.* *Water outputs (sewages) are considered equal to water inputs (fresh water).* *LCA data from ELODIE database have been used for iwater input and output: production of water and waste treatment representative of the European context.*

C1-C4 End-of-life stage, information modules

The end-of-life stage includes:

- C1, de-construction, demolition:
- C2, transport to waste processing;
- C3, waste processing for reuse, recovery and/or recycling;
- C4, disposal

Including: all transports, provision of all materials, products and related energy and water use.

The following flowchart represents the system boundaries for the End-of-life stage:

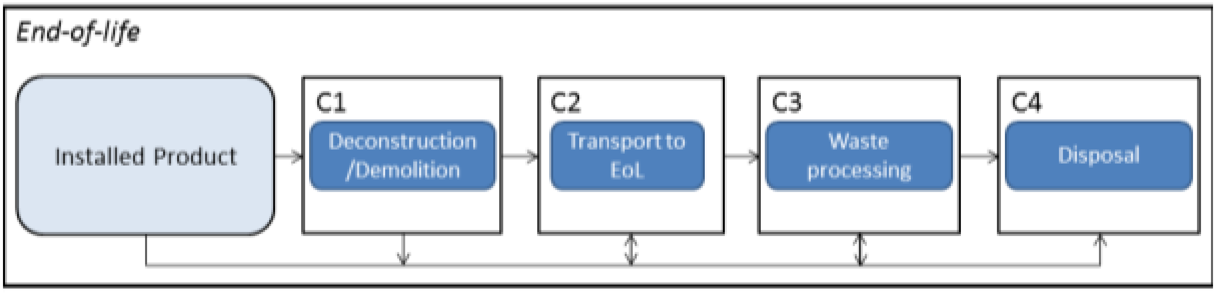


Figure 4: schematic representation of the LCA system boundaries for the End-of-life stage (C1-C4)

Table 125: Module C1-C4

Module C1-C4	The following processes are omitted:	*• Depreciation of demolition equipment and vehicles. • Employee transport and additional flow related to deconstruction phase not included in EPDs.*
	The following deviations from EN 15978 on data requirements occurred **(Just for "Complete Assessment")**:	*Most of the inputs data used are cradle to grave EPDs with aggregated results. • Cut of rule of most inputs is based on NF P01-010, i.e. 2% by mass of the reference flow instead of 5 % but without requirements for energy inputs. Some material inputs are calculated from PEP (Product Environmental Profile) that uses à 5% cut of rule for material inputs. • For some cases, generic LCA data from ELODIE database have been used instead of EPDs from INIES. These are extrapolated from the Ecoinvent database 2.0. For these data, the cradle-to-gate LCA data [module A1-A3] were taken into account as well as a default scenario* to estimate the gate to grave impacts (transport, on-site implementation, use, end-of-life). As a result, the representativeness of these data is assumed to be limited for the French context [2].*
	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	*Overall inputs data are representative of the French context (temporal, technological & geographical).*

D Benefits and loads beyond the system boundary, information module

Module D includes reuse, recovery and/or recycling potentials.

The following flowchart represents the system boundaries for benefits/loads beyond the system boundary:

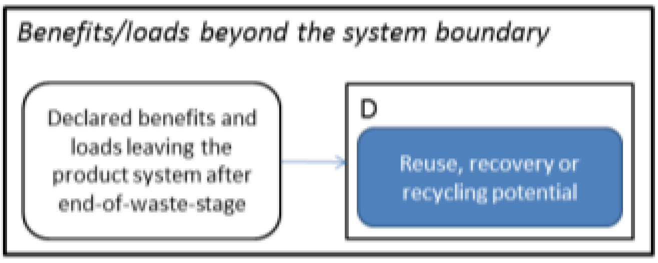


Figure 5. schematic representation of the LCA system boundaries for the benefits and loads beyond the product system boundary in module D

Table 126: Module D

Module D	The following processes are omitted:	*No information considered for module D*
	The following deviations from EN 15978 on data requirements occurred **(Just for "Complete Assessment")**:	*No information considered for module D*
	The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	*No information considered for module D*

Energy imported/ Exported

The following table describes the imported/ exported energy.

Table 127: Energy imported/ exported

Energy imported/ exported	Description on thermal and electrical energy:	*No thermal energy exported;* *No electrical energy exported.*
	Imported thermal energy [kWh/a]	*39 843*
	Imported electrical energy [kWh/a]	*110 252*
	Exported thermal energy [kWh/a]	-
	Exported electrical energy [kWh/a]	-

Description of the system boundary in the background report

The definition of the system boundaries meets the general requirements of EeBGuide.

63. Life cycle inventory analysis

Data collection and calculation procedures

Data collection follows the guidance provided in 14044, clause 4.3.2. The calculation procedures described in 14044 are applied consistently throughout the study.

According to the definition of the scope of the study, all relevant inputs and outputs related to the building are identified and quantified.

Selection of data/ background data/ background data quality requirements

As a general rule, specific data derived from specific production processes or average data derived from specific production processes shall be the first choice as a basis for calculating a building LCA.

For life cycle modeling of the building, ELODIE is used. All relevant background datasets are taken from INIES and ELODIE database. The datasets from the INIES database are documented online (www.inies.fr). The applied data sets are representative for the French context. The last revision of the used data sets took place less than 5 years ago.

Most of the inputs data used are cradle to grave EPDs with aggregated results.

•Cut of rule of most inputs is based on NF P01-010, i.e. 2% by mass of the reference flow instead of 5 % but without requirements for energy inputs. Some material inputs are calculated from PEP (Product Environmental Profile) that uses à 5% cut of rule for material inputs.

•For some cases, generic LCA data from ELODIE database have been used instead of EPDs from INIES.

These are extrapolated from the Ecoinvent database 2.0.

For these data, the cradle-to-gate LCA data [module A1-A3] were taken into account as well as a default scenario* to estimate the gate to grave impacts (transport, on-site implementation, use, end-of-life).

As a result, the representativeness of these data is assumed to be limited for the French context [2].

Allocations

In the present study no allocation has been made. Detailed explanations can be found in the chapters below.

64. Life cycle inventory analysis and life cycle impact assessment

The results of the LCA for all modules A1 to D are represented in the following tables. The inventory analysis indicators to be declared and the impact assessment are in accordance with EN 15978.

Indicators for the life cycle inventory analysis according to EN 15978 "Baseline Scenario"

The following environmental indicators apply data based on the LCI. They describe the use of renewable and non-renewable material resources, renewable and non-renewable primary energy and water.

Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ, net calorific value
Use of renewable primary energy resources used as raw materials	MJ, net calorific value
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ, net calorific value
Use of non renewable primary energy excluding non renewable primary energy resources used as raw materials	MJ, net calorific value
Use of non renewable primary energy resources used as raw materials	MJ, net calorific value
Total use of non renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ, net calorific value
Use of secondary material	kg
Use of renewable secondary fuels	MJ, net calorific value
Use of non renewable secondary fuels	MJ, net calorific value
Use of net fresh water	m^3

The parameters describing waste categories and other material flows are output flows derived from LCI.
Other environmental information describing waste categories is described next:

Hazardous waste disposed	kg
Non hazardous waste disposed	kg
Radioactive waste disposed	kg

Other environmental information describing output flows is described next:

Components for re-use	kg
Materials for recycling	kg
Materials for energy recovery	kg
Exported energy	MJ per energy carrier

Indicators for the life cycle impact assessment according to EN 15978 "Baseline Scenario"

The following information on environmental impacts is expressed with the impact category parameters of LCIA using characterisation factors

Global warming potential (GWP);	kg CO_2-equiv.
Depletion potential of the stratospheric ozone layer (ODP);	kg CFC 11- equiv
Acidification potential of soil and water, (AP);	kg SO_2 - equiv
Eutrophication potential (EP);	kg $(PO_4)^{3-}$ - equiv
Formation potential of tropospheric ozone (POCP);	kg Ethene - equiv
Abiotic depletion potential (ADP-elements) for non-fossil resources	kg Sb - equiv
Abiotic depletion potential (ADP-fossil fuels) for fossil resources	MJ, net calorific value

In fact, the results from the impact assessment are only relative statements which give no information about the endpoint of the impact categories, overstepping of threshold values, safety margins or risk.

Used environmental indicators "Baseline Scenario"

The table below illustrates the used environmental indicators.

Figure 6: Used environmental indicators

Used indicators

☑	1. Global warming potential	GWP
☑	2. Acidification Potential	AP
☐	3. Eutrophication Potential	EP
☑	4. Photochemical Ozone Creation Potential	POCP
☑	5. Total use of renewable primary energy	PERE
☑	6. Total use of non-renewable primary energy	PENRE
☑	7. Depletion potential of the stratospheric ozone layer	ODP
☐	8. Abiotic Resource Depletion Potential for elements	ADPE
☐	9. Abiotic Resource Depletion Potential of fossil fuels	ADPF
☐	10. Secondary Materials	SM
☐	11. Secondary fuels - renewable	RSF
☐	12. Secondary fuels – non renewable	NRSF
☑	13. Net Fresh Water	FW
☑	14. Hazardous Waste	HWD
☑	15. Non Hazardous Waste	NHWD
☑	16. Radioactive Waste	RWD
☐	17. Components for Re-Use	CFR
☐	18. Materials for Recycling	MFR
☐	19. Materials for Energy Recovery	MER
☑	20. Exported Energy	EE
☑	additional indicator : Water Polluton	WP
☑	additional indicator : Air Poluttion	AP
☑	additional indicator : ADP total (element + fossil fuels)	ADPtot
☑	additional indicator : Inert Waste	IW

Parameters Baseline scenario

Following table illustrates the parameters used in the Baseline scenario.

Table 128: Description of the parameter Baseline scenario

Baseline scenario	G- 08 "Reference study period"	50 years
	G- 10 "Future technical developments and innovation"	No innovation or prospective scenario considered (current technologies are used)
	G- 12 "Accounting for carbon storage / carbon sequestration"	Carbon storage is not considered, end-life carbone sequestration depend on senario defined for each EPD
	G- 25 "Water consumption"	Not scarcity of water to be considered
	A- 03 "Transportation of products to the construction site" – screening and simplified LCA"	Considered, transport distances vary depending on input data (EPD).
	A- 04 "Transportation of products to the construction site – Complete LCA"	Considered, transport distances vary depending on input data (EPD).
	B- 03 "Transport of people"	No transport of people to be considered
	B- 14 "Replacement frequency"	Replacement in whole number cycles
	B- 20 "Electricity consumption in dynamic LCA data"	Annual average data sets for electricity
	B- 25 "Operational energy demand – Consideration of user behavior for stand-alone or comparative LCA of new buildings"	No user behavior to be considered

Results "Baseline Scenario"

Table 129: Overview over the building LCA results

Overview over the building LCA results														
50 years	1. Global warming potential	2. Acidification Potential	4. Photochemical Ozone Creation Potential	5. Total use of renewable primary energy	6. Total use of non-renewable primary energy	7. Depletion potential of the stratospheric ozone layer	13.Net Fresh Water	14.Hazardous Waste	15.Non Hazardous Waste	16.Radioactive Waste	21. Water pollution	22.Air pollution	23.ADP (element+fossil fuels)	24.Inert Waste
	GWP	AP	POCP	PERE	PENRE	ODP	FW	HWD	NHWD	RWD	WP	AP	ADPtot	IW
	[kg CO_2-equiv./m^2_{NFA}*a]	[kg SO_2-equiv./m^2_{NFA}*a]	[kg C_2H_4-equiv./m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[kg CFC11-equiv./m^2_{NFA}*a]	[m^3/m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[m^3/m^2_{NFA}*a]	[m^3/m^2_{NFA}*a]	[kg Sb-Equiv. /m^2_{NFA}*a]	[kg /m^2_{NFA}*a]
Total LCA results	1,45E+01	5,14E-02	1,53E-03	5,41E+00	1,02E+02	4,55E-07	7,26E+02	1,74E-01	5,61E+01	2,93E-03	1,25E+03	6,46E+04	8,89E-02	4,49E+01
Products and materials	1,04E+01	3,49E-02	1,45E-03	2,63E+00	3,56E+01	2,57E-07	1,59E+02	2,72E-02	5,23E+01	6,89E-04	8,45E+02	6,44E+04	6,07E-02	4,12E+01
Operational energy use	3,77E+00	1,44E-02	8,33E-07	2,65E+00	6,55E+01	1,75E-07	4,21E+01	2,10E-04	3,47E+00	2,22E-03	1,25E+02	1,86E+02	2,63E-02	3,43E+00
Operational water use	3,27E-01	2,02E-03	8,35E-05	1,36E-01	1,09E+00	2,25E-08	5,24E+02	1,47E-01	3,86E-01	2,67E-05	2,85E+02	3,55E+01	1,82E-03	2,80E-01

Figure 7: Results Indicators – Share of main contributors to total building LCA results

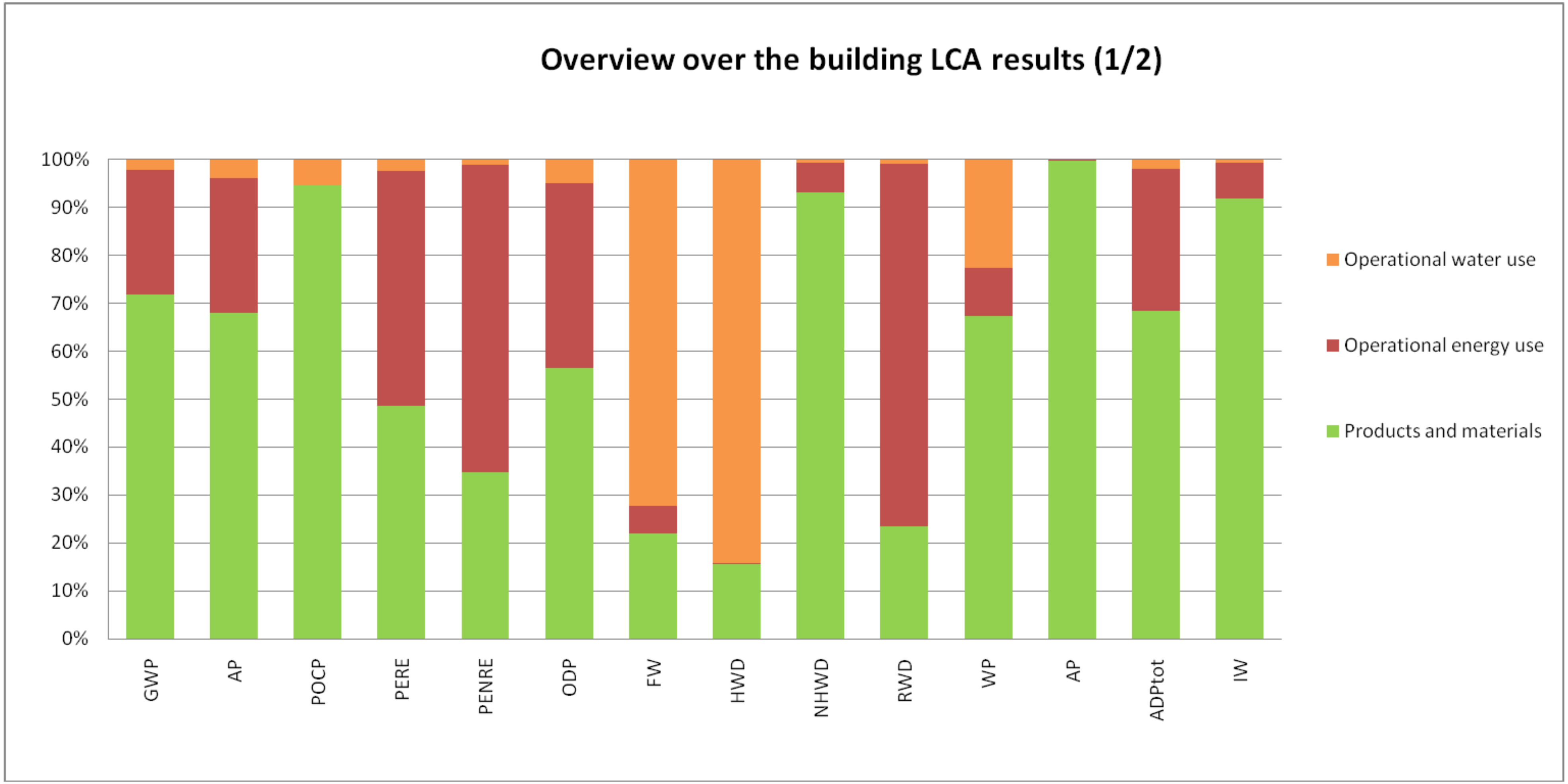
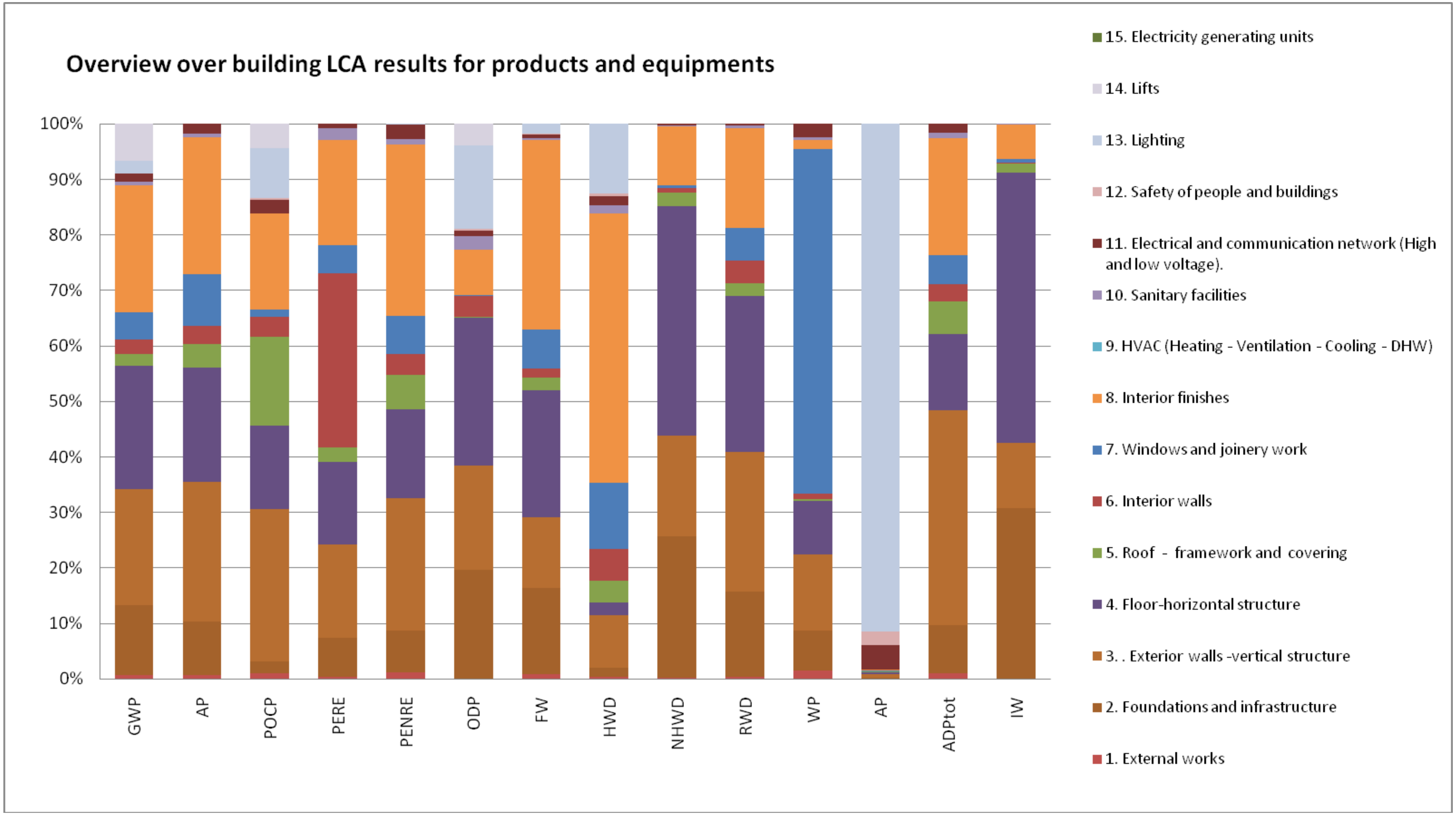


Table 130 : Overview over the product LCA results

Overview over the product LCA results														
50 years	GWP	AP	POCP	PERE	PENRE	ODP	FW	HWD	NHWD	RWD	WP	AP	ADPtot	IW
	[kg CO_2-equiv./m^2_{NFA}*a]	[kg SO_2-equiv./m^2_{NFA}*a]	[kg C_2H_4-equiv./m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[kg CFC11-equiv./m^2_{NFA}*a]	[m^3/m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[m^3/m^2_{NFA}*a]	[m^3/m^2_{NFA}*a]	[kg Sb-Equiv. /m^2_{NFA}*a]	[kg /m^2_{NFA}*a]
1. External works	6,71E-02	2,62E-04	1,50E-05	1,16E-02	4,33E-01	1,88E-10	1,29E+00	1,20E-04	7,93E-02	3,15E-06	1,27E+01	6,43E+00	6,09E-04	5,46E-02
2. Foundations and infrastructure	1,32E+00	3,36E-03	3,14E-05	1,84E-01	2,69E+00	5,05E-08	2,48E+01	4,31E-04	1,34E+01	1,06E-04	6,11E+01	1,07E+02	5,24E-03	1,26E+01
3. . Exterior walls - vertical structure	2,19E+00	8,77E-03	3,97E-04	4,44E-01	8,47E+00	4,82E-08	2,04E+01	2,57E-03	9,48E+00	1,73E-04	1,17E+02	4,57E+02	2,35E-02	4,89E+00
4. Floor- horizontal structure	2,33E+00	7,18E-03	2,19E-04	3,89E-01	5,68E+00	6,86E-08	3,62E+01	6,35E-04	2,16E+01	1,94E-04	8,03E+01	2,26E+02	8,32E-03	2,00E+01
5. Roof - framework and covering	2,13E-01	1,50E-03	2,31E-04	6,83E-02	2,22E+00	2,99E-10	3,77E+00	1,06E-03	1,28E+00	1,63E-05	2,73E+00	4,77E+01	3,59E-03	7,00E-01
6. Interior walls	2,83E-01	1,16E-03	5,07E-05	8,25E-01	1,33E+00	9,76E-09	2,72E+00	1,54E-03	4,17E-01	2,80E-05	8,55E+00	4,96E+01	1,88E-03	6,44E-02
7. Windows and joinery work	5,05E-01	3,26E-03	1,92E-05	1,35E-01	2,44E+00	1,90E-10	1,09E+01	3,26E-03	3,10E-01	4,01E-05	5,25E+02	4,60E+01	3,24E-03	2,31E-01
8. Interior finishes	2,39E+00	8,59E-03	2,51E-04	4,96E-01	1,09E+01	2,10E-08	5,46E+01	1,32E-02	5,54E+00	1,24E-04	1,46E+01	1,22E+02	1,27E-02	2,60E+00
9. HVAC (Heating - Ventilation - Cooling - DHW)	1,30E-04	5,28E-07	1,67E-08	4,28E-05	5,12E-04	0,00E+00	1,90E-03	8,91E-08	8,51E-06	2,79E-09	9,03E-06	1,85E-02	7,08E-07	3,98E-08
10. Sanitary facilities	7,88E-02	2,44E-04	3,08E-08	5,83E-02	3,94E-01	6,35E-09	4,37E-01	4,28E-04	6,31E-02	3,69E-06	3,16E+00	9,02E+00	6,40E-04	3,13E-02

11. Electrical and communication network (High and low voltage).	1,39E-01	6,16E-04	3,73E-05	2,05E-02	9,01E-01	2,60E-09	1,16E+00	4,33E-04	1,50E-01	2,04E-06	2,08E+01	2,81E+03	9,46E-04	2,67E-03
12. Safety of people and buildings	6,67E-03	4,12E-08	2,77E-06	0,00E+00	3,39E-02	8,53E-10	7,83E-02	1,20E-04	0,00E+00	0,00E+00	8,25E-04	1,65E+03	0,00E+00	0,00E+00
13. Lighting	2,36E-01	1,74E-06	1,32E-04	0,00E+00	2,44E-02	3,86E-08	2,89E+00	3,44E-03	0,00E+00	0,00E+00	1,54E-01	5,89E+04	0,00E+00	0,00E+00
14. Lifts	7,01E-01	3,07E-06	6,32E-05	0,00E+00	0,00E+00	9,87E-09	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
15. Electricity generating units	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Figure 8: Results Indicators – Overview over building LCA results for products and equipment



Interpretation of the results "Baseline Scenario"

Only a limited set of aspects are considered in this part, namely:

- Total Primary Energy Consumption,
- Climate Change,

Comments on the Total Primary Energy Consumption indicator:

The impact in terms of total primary energy consumption (i.e. including renewable and non renewable) rises, for this building to 107 MJ (i.e. 28.3 kWh) per square meter per year.

The energy contributors defined in the French thermal regulation (i.e. Heating, cooling, hot sanitary water production, ventilation, auxiliaries and lighting) are the main contributors to total primary energy consumption, with about 63% of the total. In absolute terms, this is equivalent to 68 MJ per square meter per year.

Products and building materials, with a contribution of 38 MJ per square meter per year, represent an average of 36% of the impacts, or 1.6 less than the total primary energy consumed by energy contributors during the use phase.

Consumption of Non renewable primary energy turned out, for this building, to be very close to those corresponding to the Total primary energy consumption. In total, the building consumes 102 MJ of non-renewable Primary energy per square meter per year.

Key aspects:

→ Given the assumptions made and the boundaries chosen for this study, energy consumption during the use phase, and in particular lighting, ventilation, and to a lesser extent, cooling appear as the main contributors to total primary energy. It would be interesting to compare these results to other energy consumption related to the use phase that are not included in the present study (e.g. other equipments such as computers).

→ Reflections on reducing the impacts attributable to products and building materials should be conducted, including:

- Nature of the structure (selection of system which generates a very important use of concrete and steel)
- Choice of the flooring. The flooring system account for 16% of the impacts from the materials due to low service life (important number of replacement) and important impacts related to production.
- The impacts of lifts (16% of the impacts from the materials).

→ The impacts generated by the consumption of water remain, at present, and for this indicator, negligible and are therefore not crucial for improving the environmental performance of the building.

Due to the high thermal performance of building and the nature of energy inputs, unlike a more "standard" building, the building studied uses higher quantities of total primary energy for lighting and ventilation that for heating. The amount of total primary energy consumed by the cooling system (15 MJ / m² of floor area / year) is also much higher than that of heating (about twice time).

Here, the specific energy consumption (operating of elevators and office equipment: computers, printers, copiers ...) were not included in the frontier of the study. However, for thermally efficient buildings, it seems essential to consider these contributors if we want to improve the overall energy performance.

Comments on the GWP indicator

For this indicator, the most important contribution is from products and building materials, which represents 72% of the total impacts (being 10.4 eq. Kg CO_2/m²/year).

The second most important contribution is from energy consumption during the use phase (lighting, heating and cooling, ventilation and auxiliaries) that emits the equivalent of 3.8 eq. kg CO_2/m²/year. Finally, the contributor of water consumption is again negligible since it generates only 2% of the impact "climate change" assigned to the building.

It should be noted that the balance of the contributor "products and building materials" is mainly induced by the energy context of French electricity production (the French electricity mix, including imports, has a low CO_2 content, but generate higher radioactive wastes).

Key aspects:

→ The biggest contributor is the set products and building materials, and in particular the structural elements, which represent, by themselves, 40 % of the impacts generated.

→ Within the structural elements, some components were identified as strong contributors: Steel, Floor slabs, tiles, concrete sails, and foundations. These elements generate a greater impact than all the use phase energy consumption considered for this study.

→ The main conclusions from the analysis of products and building materials are generally identical to those obtained for the indicators of energy consumption.

→ Among the use phase energy consumption contributors, the main contributor now corresponds to the heating, because of the low CO_2 content of French electricity (Energy inputs for heating and cooling are provided by a Central heating and cooling system connected to urban Heating and Cooling distribution system (gas and coal production unit).

→ The impacts generated by the consumption of water remain the lowest for this indicator.

Comments on other indicators

→ **Comments on the Water Consumption indicator**

The water consumption indicator represents water used (whatever the source: drinking water, river, wells, etc.) throughout the life cycle of the building. In this study, water consumption is clearly and primarily related to water consumption of building occupants. They represent about 524 L / sq.m. / year, contributing to 72% of overall indicator.

→ **Comments on the Non dangerous waste indicator**

The biggest contribution is from products and building materials, which generates the equivalent of 52.3 kg of disposed waste / sq.m. / year, are represents 93% of generated impacts. Among them, structural elements represent 69% of the overall impacts impact, infrastructure 9% and flexible floor coverings 5%.

65. Scenario 100 years

Used environmental indicators "Scenario 100 years"

Environmental indicators used for "Scenario 50 years" are identical to "Baseline scenario".

Description of the parameters "Scenario 100 years"

For scenario "100 years" All impacts are calculated for a 100 years period of operation (compared to 50 years for the "Baseline scenario").

The two analyses are, in consequence, not based on the same reference study period. No scenario for refurbishment of the building has been included in the study. They both differ by the number of replacement of the components and energy and water use during use phase. Replacement of building component during the operational stage is calculated according to French standard on environmental performance assessment of building [XP P01-020-3].

Comparison between baseline scenario and "Scenario 100 years"

The following tables and figures show the differences estimated according to the variation of the reference study period.

Table 131: Overview over the building LCA results_comparison between baseline scenario and scenario 100 years

Overview over the building LCA results															
	Reference study period	1. Global warming potential	2. Acidification Potential	4. Photochemical Ozone Creation Potential	5. Total use of renewable primary energy	6. Total use of non-renewable primary energy	7. Depletion potential of the stratospheric ozone layer	13.Net Fresh Water	14.Hazardous Waste	15.Non Hazardous Waste	16.Radioactive Waste	21. Water pollution	22.Air pollution	23.ADP (element+fossil fuels)	24.Inert Waste
	RSP	GWP	AP	POCP	PERE	PENRE	ODP	FW	HWD	NHWD	RWD	WP	AiP	ADPtot	IW
	years	[kg CO_2-equiv./m^2_{NFA}*a]	[kg SO_2-equiv./m^2_{NFA}*a]	[kg C_2H_4-equiv./m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[kg CFC11-equiv./m^2_{NFA}*a]	[m^3/m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[kg /m^2_{NFA}*a]	[m^3/m^2_{NFA}*a]	[m^3/m^2_{NFA}*a]	[kg Sb-Equiv. /m^2_{NFA}*a]	[kg /m^2_{NFA}*a]
Total LCA results	**50**	1,45E+01	5,14E-02	1,53E-03	5,41E+00	1,02E+02	4,55E-07	7,26E+02	1,74E-01	5,61E+01	2,93E-03	1,25E+03	6,46E+04	8,89E-02	4,49E+01
	100	1,16E+01	4,26E-02	1,27E-03	4,96E+00	9,41E+01	3,66E-07	6,83E+02	1,80E-01	3,28E+01	2,70E-03	1,12E+03	6,36E+04	7,09E-02	2,51E+01
	%	-20%	-17%	-17%	-8%	-8%	-20%	-6%	3%	-41%	-8%	-11%	-2%	-20%	-44%
Products and materials	**50**	1,04E+01	3,49E-02	1,45E-03	2,63E+00	3,56E+01	2,57E-07	1,59E+02	2,72E-02	5,23E+01	6,89E-04	8,45E+02	6,44E+04	6,07E-02	4,12E+01
	100	7,52E+00	2,62E-02	1,19E-03	2,18E+00	2,75E+01	1,68E-07	1,17E+02	3,31E-02	2,90E+01	4,58E-04	7,06E+02	6,34E+04	4,28E-02	2,14E+01
	%	-28%	-25%	-18%	-17%	-23%	-35%	-27%	22%	-45%	-34%	-16%	-2%	-30%	-48%

Figure 9: Comparison between baseline scenario and scenario 100 years_ total building LCA results

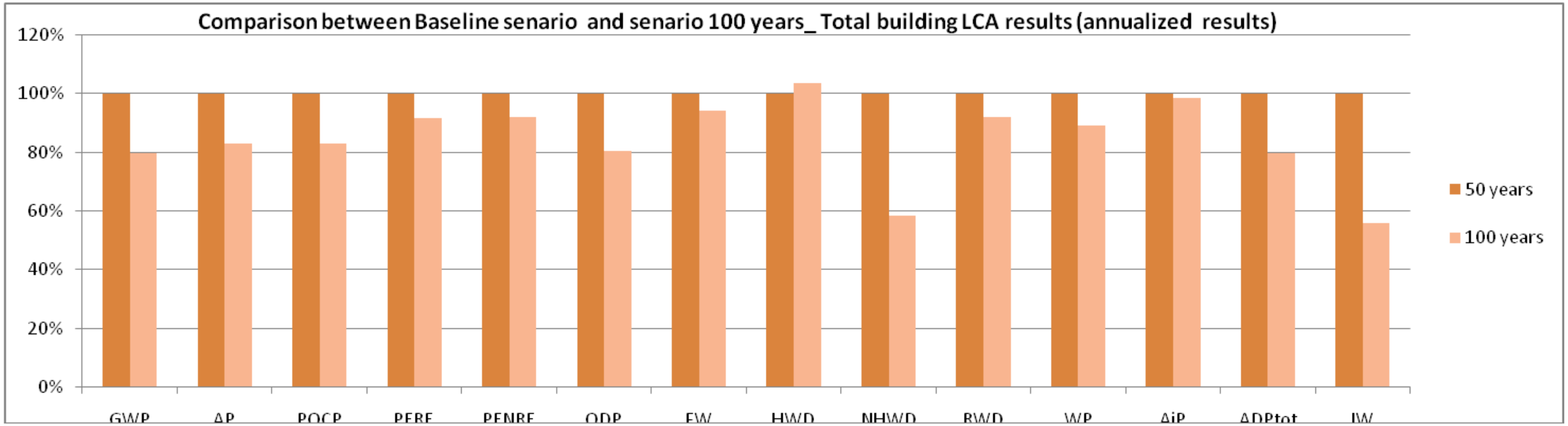
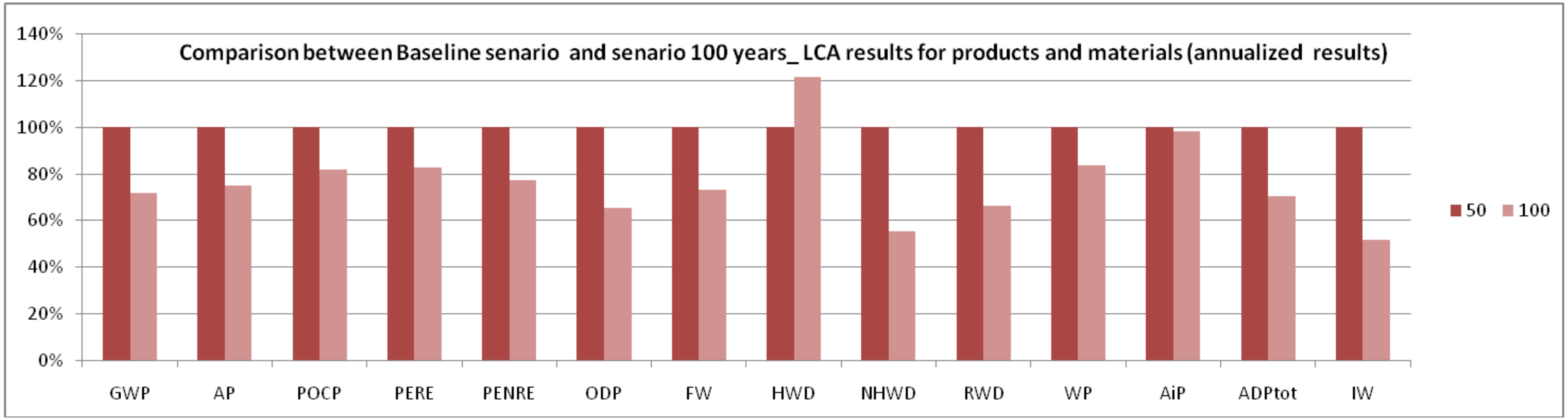


Figure 10: Comparison between baseline scenario and scenario 100 years_ LCA results for products and equipment



Interpretation of the results "Scenario 100 years"

This comparison allowed estimating the differences that arise from choosing a different reference study period.

As results are annualized, impacts related to the products and materials contributor are spread over the years of operation. Overall impacts of the 100 year scenario are naturally higher due to product replacement and others aspects of the use phase, but annualized results of the 100 year scenario are lower for most of the indicators as contribution from the production phase are divided by two compared to the 50 years scenario.

Results for the contributor energy uses and water uses for the operational stage are not modified by the change of RSP as they consider a yearly calculation. The hypothesis made here is that the performances of the systems are considered to be constant all along the building service life (whatever the chosen references study period).

66. Conclusion

This study has enabled a diagnosis of the environmental impacts arising from the building, indicator by indicator and contributor by contributor. The mains limitations were the availability of environmental data, which led us, among other things, to make several assumptions and approximations.

Indicators for "Total Primary Energy Consumption", "Nonrenewable Primary energy consumption" and "Radioactive waste", the energy consumption during the use phase appears to be the main contributors to the impacts. In particular, although efforts have been made to reduce energy consumption associated with lighting, the study showed that it remains the strongest contributor, followed closely by the ventilation and cooling. However, a comparison with similar work lead us to believe that there are limited options if one wants to minimize impacts related to lighting and ventilation.

With regard to products and building materials, they represent the main contributors to the indicators GWP, Non-hazardous waste and Inert waste. For the indicators "Total Primary Energy Consumption", "Nonrenewable Primary energy consumption," "Water consumption", "Hazardous Waste" and "Radioactive waste", they also appear strongly impacting.

EeBGuide Background Report for Buildings

LCA of the building Can Jofresa (Barcelona, Spain)

Name of the building:	Torre 9 - Can Jofresa
Date of the assessment:	22.08.2012
Address of the building:	*c/Montblanc, Torre 9, Can Jofresa, Terrassa (Barcelona, Spain)*
name and qualification of the assessor:	Cristina Gazulla Santos, PhD
name and qualification of the reviewer:	
Review type	*External review*
Date of the verification	
Client of the study:	*EeBGuide Project & Agència Catalana de l'Habitatge (Generalitat de Catalunya)*
Authors of the study:	*Cristina Gazulla, UNESCO Chair in Life Cycle and Climate Change Anna Mestre i Massa i Marta Arrufí Franch, Agència de l'Habitatge de Catalunya, Generalitat de Catalunya*

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Nomenclature

Abbreviation	Explanation
ADP	Abiotic Depletion Potential
ADPE	Abiotic Resource Depletion Potential for elements
ADPF	Abiotic Resource Depletion Potential of fossil fuels
AP	Acidification Potential
BLBSB	Benefits and Loads Beyond the System Boundary
BREEAM	BRE Environmental Assessment Method
CML	Centrum voor Milieukunde, Leiden (NL)
CPD	Construction Products Directive
CRU	Components for re-use
DGNB	Deutsche Gesellschaft für Nachhaltiges Bauen
	(German Sustainable Building Council)
ECO	European Construction product Organisation
EE	Exported energy per energy carrier
EP	Eutrophication Potential
EPD	Environmental Product Declaration
ESL	Estimated service life
FW	Use of net fresh water
GWP	Global Warming Potential
HQE	Haute qualite�much environmentale
	(French Sustainable Building Council)
HWD	Hazardous waste disposed
IBU	Institut Bauen und Umwelt e.V.
ILCD	International Reference Life Cycle Data System
LCA	Life Cycle Assessment

LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment
LCC	Life Cycle Costing
MER	Materials for energy recovery
MFR	Materials for recycling
NRSF	Use of non-renewable secondary fuels
NHWD	Non-hazardous waste disposed
ODP	Ozone Layer Depletion Potential
PCM	Phase changing material
PENRE	Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials
PENRM	Use of non-renewable primary energy resources used as raw materials
PENRT	Total use of non-renewable primary energy resources
PERE	Use of renewable primary energy excluding renewable primary energy resources used as raw materials
PERM	Use of renewable primary energy resources used as raw materials
PERT	Total use of renewable primary energy resources
PCR	Product Category Rules
POCP	Photochemical Ozone Creation Potential
ReqSL	Required Service Life
RSF	Use of renewable secondary fuels
RSL	Reference Service Life
RSP	Reference Study Period
RWD	Radioactive waste disposed
SM	Use of secondary material

67. Scope

This document is the background report for the report on the life cycle assessment results of a building. The study conducted, follows the provisions and guidelines of EeBGuide.

68. Content, structure and accessibility of the background report

The background report provides the systematic and comprehensive summary of the project documentation supporting the verification of a building LCA. The project report shall record that the LCA based information meets the requirements of EeBGuide of the Energy- efficient Building Initiative. It was made available to the verifier with the requirements on confidentiality stated in ISO 14025.

The background report contains any important data and information required by the European standard EN 15978. Special attention is paid to a transparent documentation.

69. General aspects in the background report

The present LCA study of the company is performed by the practitioner stated and has been conducted according to the requirements of the European Standard **Erreur ! Source du renvoi introuvable.**. The background report was sent to verification as mentioned. Further details can be found in the table "General Information".

70. Goal/Purpose of the study

The aim of this study is the calculation and interpretation of the LCA results of the building. The table "Goal/ Purpose of the study" illustrates important points regarding the purpose of the study.

Table 132: Goal/ Purpose of the study

Level of complexity	☐	Screening
	☑	Simplified
	☐	Complete
related study objective	☐	Comparative assertion
	☑	Stand alone LCA
object of assertion	☐	New building
	☑	Existing building
communication purpose	☐	internal
	☐	external
	☐	for costumer to costumer
	☐	publication
	☑	*Case study of the EeBGuide project*

71. Scope of the study

Declared / functional equivalent

The following points have to be defined with regards to the functional unit:

Table 133: Functional unit

Declared Functional unit:	*6125 m² NFA of dwelling per year*
Type of Building:	*dwelling (social housing)*
number of tennants:	*162*
required service life:	*50*
Other services provided within the building (shops...):	*[no other services]*

Object of the assessment is an entire building. Infrastructures located on the building site may also be included. Infrastructures not located on the building site like roads and surrounding structures (e.g. park) may not be included. The assessed building is described with **main** components, materials and surfaces.

Technical description of the building

The following table describes the building into more detail:

Table 134: Technical description of building

Year of comissioning:	*1975*
Year and type of refurbishment:	*2010-2011; improvement of the thermal insulation of the facade (4000 m²)*
Structural type:	*Reinforced concrete load- bearing structure*
Number of storeys:	*Ground floor + 15*
Net Floor Area [m²]:	*6125 m²*
Gross Floor Area [m²]:	*n.a.*
Calculated electrical end energy demand [kWh/(m²*a)]:	*12.3 kWh/(m²*a) [Real consumption before rehabilitation]* *11.3 kWh/(m²*a) [Estimation of the consumption after rehabilitation]*
Calculated thermal end energy demand [kWh/(m²*a)] (energy wich is used to supply heating needs)	*72.3 kWh/(m²*a) [Real consumption before rehabilitation]* *63.4 kWh/(m²*a) [Estimation of the consumption after rehabilitation]*
Energy calculation methodology:	*Before rehabilitation: Direct electricity meter reading (for a whole year, 2009). Using statistically represantitive data for Spanish dwellings, heating, air-conditioning, domestic hot water and lighting consumptions have been derived.* *After rehabilitation: Basich method for the certification of existing buildings - CE3X. Using the tool, the % of reduction for heating and air-conditioning consumptions has been calculated, then applied to the real data before rehabilitation.*
Considered energy uses	*Heating, air-conditionning, domestic hot water, lighting*
Most important materials for supporting structure, insulation, windows:	*Reinforced concrete, brick, wood windows, cavity wall*
Type of facade:	*Before rehabilitation: Brick façade with a cavity wall* *After rehabilitation: Brick façada with a cavity wall and expanded polystyrene (EPS)*
Energy supply system and energy transfer system (short description; name renewable components, if used):	*Individual and different systems in each dwelling (heater, heating system, heat pumps, air conditioner units...)*
Number and description of underground levels	*none*
Information about external features	*none*

Table 135: Technical description of all operational areas

Operational Area1:	*Apartments*
Usage Operational Area1:	*60 apartments distributed in 15 floors and with two possible net floor areas: 68.60 m² or 88.60 m²*
Design number of building occupants Operational Area1:	*162 (2.7 people * 60 apartments)*
Design occupancy schedule Operational Area1:	*24 h per day, 365 days per year (dwellings)*
Heating, cooling and ventilation system and hot water service system Operational Area1:	*Individual and different systems in each dwelling (heater, heating system, heat pumps, air conditioner units...). Ventilation system is not available.*
Lighting system Operational Area1:	*Different in each dwelling, but based on light-bulbs and fluorescent lights*
Power and communication systems Operational Area1:	*n.a.*

Information about the surrounding environment

The following table brings information about the local context:

Table 136: Description of the local context

Information on climate (HDD and CDD, climate severity index...)	*HDD18°C = 1435; CDD = 138*
Urban context (down town, suburbs, countryside...)	*Suburbs*
Geological constraints (seismic context, load bearing capcity, slopes of the building site...)	*none*
Accoustics constraints	*n.a.*
Specific urban rules	*n.a.*
Architectural constraints	*n.a.*
Other constraint of the surrounding environment	*n.a.*

System boundaries

The system boundary of the building LCA follows the modular design defined by /**Erreur ! Source du renvoi introuvable.**/. The following chapters describe the modules which are within the scope of this study. The modules included are in-line with the following table:

Table 137: Definitions for the different study types

Screening - Simplified - Complete

according to SBA Common Metrics Framework 2009 and EeBGuide adaptations

M	**mandatory**
Orelevance?	**optional because of minor relevance**
Odata?	**optional due to potentially missing data**

	Study type	Before use stage				
		Raw Materials Supply	Transport (to factory)	Manufactoring	Transport (to construction site)	Construction-Installation process
		A1	A2	A3	A4	A5
Building	Screening	M — **Calculation rules based on data on major sub-structure (e.g. statistical data such as kWh/m² for primary energy) or generic LCA of building elements/products/materials** such as Roof; Load- bearing structure; Exterior and basement walls; Windows; Floor slabs; Foundation; Floor Finishes/ Coverings			Orelevance?	Odata?
Building	Screening	Odata? — **Calculation rules based on data on statistical data such as kWh/m² for primary energy for the following equipment:** Refrigeration/ Coolants; Decorative wall finishes/ coatings (e.g. wallpaper, paints); Doors; Heating/ Cooling/ Lighning Equipment and any power-generating equipment (e.g. wind turbines/ PV/ solar heating) Equipment for internal transport (e.g. lifts, escalators); water and sewerage systems; electrical distribution system				
Building	Simplified	M — **Calculation rules based on data on major sub-structure (e.g. statistical data such as kWh/m² for primary energy) or generic LCA/average EPD of building elements/products/materials** such as Roof; Load- bearing structure; Exterior and basement walls; Windows; Floor slabs; Foundation; Floor Finishes/ Coverings;			Orelevance?	Odata?
Building	Simplified	Odata? — **Calculation rules based on data on statistical data such as kWh/m² for primary energy for the following equipment:** Refrigeration/ Coolants; Decorative wall finishes/ coatings (e.g. wallpaper, paints); Doors; Heating/ Cooling/ Lighning Equipment and any power-generating equipment (e.g. wind turbines/ PV/ solar heating) Equipment for internal transport (e.g. lifts, escalators); water and sewerage systems; electrical distribution system				
Building	Complete	M — **Calculation rules based on data on major building elements/products/materials based on specific EPD (both group of manufacturer's or single manufacturer declaration) else average LCA data:** Roof; Load- bearing structure; Exterior and basement walls; Windows; Floor slabs; Foundation; Floor Finishes/ Coverings; Refrigeration/ Coolants; Decorative wall finishes/ coatings (e.g. wallpaper, paints); Doors; Heating/ Cooling/ Lighning Equipment and any power-generating equipment (e.g. wind turbines/ PV/ solar heating) Equipment for internal transport (e.g. lifts, escalators); water and sewerage systems; electrical distribution system			M	M

Screening - Simplified - Complete

according to SBA Common Metrics Framework 2009 and EeBGuide adaptations

M

O relevance?

O data?

	Study type	Use stage						
		Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use
		B1	B2	B3	B4	B5	B6	B7
Building	Screening	O relevance?	O relevance?	O data?	O data?	O relevance?	M **Calculation rules based on the expected performance target for the building** (e.g. energy label target or reference levels set by national regulation) calculated at least for building related uses covered by the EPBD (heating, cooling and air conditioning, ventilation, domestic hot water, lightning and auxiliary energy used for pumps, control and automation).	M **Calculation rules based on statistical data** for both building and non building related water equipment
	Simplified	O relevance?	O relevance?	O data?	M	O relevance?	M **Calculation rules based on Dynamic Thermal Simulation or national calculation methodology** for building related uses (heating, cooling and air conditioning, ventilation, heating for provision of domestic hot water, lightning) M **Calculation rules based on EPA-NR for comparative assessments** (heating, cooling and airconditioning) (Internal transport, computer and IT equipment, refrigerators, washing machines, dishwashers, dryers, other small power devices)	M **Calculation rules based on top-down approach** by taking into the economic (by water saving devices e.g. dual flash toilet system) or extra consumption measures for both building and non building related water equipment
	Complete	M	M		M	M	M **Calculation rules based on Dynamic Thermal Simulation, National calculation methodology or EPA-NR for comparative assessment** for building related uses and non building related (heating, cooling and air conditioning, ventilation, heating for provision of domestic hot water, lightning, Internal transport, computer and IT equipment, refrigerators, washing machines, dishwashers, dryers, other small power devices) (heating, cooling and air conditioning, ventilation, heating for provision of domestic hot water, lightning)	M **Calculation rules based on bottom-up approach** for both building and non building related water equipment such as urinals, WCs, taps, baths,showers, greywater/ rainwater systems dishwashers, washing machines, water softeners, wase disposal units

Screening - Simplified - Complete

according to SBA Common Metrics Framework 2009 and EeBGuide adaptations

M

O relevance?

O data?

	Study type	End of Life				Benefits beyond boundary
		Deconstruction	Transport (to disposal)	Waste process for reuse, recovery or/ and recycling	Disposal	Reuse-/ Recovery- /Recyclingpotential
		C1	C2	C3	C4	D
Building	Screening	O relevance?	O relevance?	O data? Generic LCA data for EOL processes		O data? Generic LCA data for reuse-/ recovery- / recycling potential
				O data? Generic LCA data for EOL processes		O data? Generic LCA data for reuse-/ recovery- / recycling potential
	Simplified	O relevance? **Calculation rules based on a materials impact ratio (i.e. 3% for GWP in case of concrete)**	O relevance?	M Specific or generic LCA data for EOL processes		M Specific or generic LCA data for reuse-/ recovery- / recycling potential
				O data? Specific or generic LCA data for EOL processes		O data? Specific or generic LCA data for reuse-/ recovery- / recycling potential
	Complete	M **Calculation rules based on the energy, materials and related emissions**	M	M Specific or generic LCA data for EOL processes		M Specific or generic LCA data for reuse- / recovery- / recycling potential

Following chapters describe and explained only those modules included within the study.

The environmental impacts of a building may be breakdown according to different contributors such as the energy and water uses as well as the building products and equipment. These contributors need adequate calculation rules. The following figure presents the main contributors of a building and where they happen in the life cycle stages of a building according or EN 15978. For example, building products and technical equipment are responsible of the impacts all along the life cycle stages while the operational water uses only refers to the use phase (module B).

	PRODUCT stage (A1 to A3)	**CONSTRUCTION PROCESS stage (A4 to A5)**	**USE stage (B1 to B7)**	**END OF LIFE stage (C1 to C4)**
Building products and equipment	Raw material supply, Transport, Manufacturing	Transport, Construction installation processes	Use, Maintenance, Repair, Replacement, Refurbishment	De-construction, Transport, Waste processing, disposal
Operational Energy uses			Operational Energy Use (B6)	
Operational Water uses			Operational Water Use (B7)	
Construction site		Construction installation process (A5)		De-construction, Demolition (C1)
Transport of users			Transport of users	

Figure 11: Schematic representation of contributors and related life cycle stages

Overview over the included Life cycle stages

For an existing building, the system boundary should include all stages representing the remaining service life and the end of life stage of the building. As the façade of the existing building under assessment has been recently refurbished, it has been possible to include B5 module, as well as B6. However, the end of life stage could not been assessed as the complete list and quantification of the building's materials and components remains unknown.

The table summarizes the included Lifecycle stages.

Table 138: Included lifecycle stages

Product Stage	☐	A1	Raw Materials Supply
	☐	A2	Transport
	☐	A3	Manufacturing
Construction Process	☐	A4	Transport
	☑	A5	Construction- Installation process
Use Stage	☐	B1	Use
	☐	B2	Maintenance
	☐	B3	Repair
	☐	B4	Replacement
	☑	B5	Refurbishment
	☑	B6	Operational Energy Use
	☐	B7	Operational Water Use
End of Life Stage	☐	C1	Deconstruction
	☐	C2	Transport
	☐	C3	Waste process for reuse, recovery or/ and recycling
	☐	C4	Disposal
Benefits and loads beyond the system	☐	D	Reuse- Recovery- Recycling potential

Overview of the included products and equipments

As the system under study is an existing building, only materials used in the refurbishment of the façade have been included in the assessment (within module B5 – Refurbishment).

Overview of the included operational energy and water uses

The following table describes the considered energy uses. Water use has not been assessed.

Table 139: Descriptions of operational energy uses considered into the study

Building related uses	Heating	☑
	Air conditioning (Cooling and humidification/de-humidification)	☑
	Domestic hot water	☑
	Ventilation	☐
	Lighting	☑
	Auxiliary (pumps, control and automation)	☐
	Building integrated systems (eg. Lifts, shutters, automated gate, lighting for parkings…)	☐
Non building related uses	To specify (e.g. plug-in appliances, dishwachers, TV…)	☐

B5, Use stage, information modules related to the refurbishment of the building

Within the use stage, module B5 relates to the refurbishment of the building. A rehabilitation operation consists of a deconstruction (removal of products to change) and a reconstruction operation (adding new products to replace discarded ones). The energy consumption of the refurbishment process as well as the production of the main materials used (EPX and mortar) have been included in this module.

B6-B7, Use stage, information modules related to the operation of the building

The use stage related to the operation of the building includes:

- B6, operational energy use (e.g. operation of heating system and other building related installed services);
- B7, operational water use;

These information modules include provision and transport of all materials, products, as well as energy and water provisions, waste processing up to the end-of-waste state or disposal of final residues during this part of the use stage.

The following flowchart represents the system boundaries for the use stage related to the operation of the building:

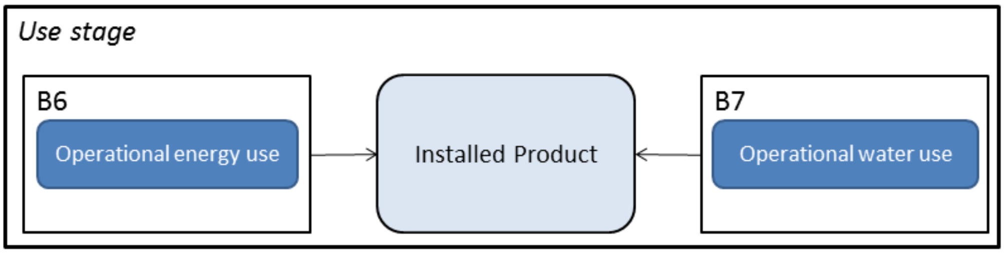


Figure 71-12: schematic representation of the LCA system boundaries for the use stage (modules related to the operation of the building)

Table 140: Module B6

The following processes are omitted:	*Energy consumption for heating, cooling, lighting and domestic hot water uses have been included. Other operation energy consumptions have been omitted.*
The following deviations from EN 15978 on data requirements occurred **(Just for "Complete Assessment")**:	
The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	*Average datasets representing the current situation in Spain have been used (e.g. electricity grid mix production, natural gas production, etc.)*

Energy imported/ Exported

The following table describes the imported/ exported energy.

Table 141: Energy imported/ exported

Description on thermal and electrical energy:	*No energy is produced on site.*
Imported thermal energy [kWh/a]	*All the thermal energy used in the building is imported (72,337.5 kWh/a before rehabilitation, 69,212.5 kWh/a after rehabilitation)*
Imported electrical energy [kWh/a]	*All the electricity used in the building is imported (442,837.5 kWh/a before rehabilitation, 388.325 kWh/a after rehabilitation)*
Exported thermal energy [kWh/a]	*none*
Exported electrical energy [kWh/a]	*none*

Description of the system boundary in the background report

The definition of the system boundaries meets the requirements of EeBGuide.

Criteria for the exclusion of inputs and outputs

As explained before, only the modules B5 and B6 have been included in the study. Relevant material and energy inputs and outputs have been included.

Waste management of rehabilitation work has been omitted, as it is considered to be irrelevant in the context of the system boundary analyzed.

72. Life cycle inventory analysis

Data collection and calculation procedures

Data collection follows the guidance provided in **Erreur ! Source du renvoi introuvable.**, clause 4.3.2. The calculation procedures described in **Erreur ! Source du renvoi introuvable.** are applied consistently throughout the study.

According to the definition of the scope of the study, all relevant inputs and outputs related to the building are identified and quantified.

Table 142: Inventory data for B5 Refurbishment module

Input	Amount (unit)	Description	Source
Electricity	880 (kWh)	Total electricity consumption by all the different machinery used in the removal of the outer layer of the former façade and the installation of an external layer of EPX using mortar.	Estimation taking into account the power of the different machinery and equipment used and their time of use.
Construction products	129 tn of arid 30 tn of mortar 3,624 m^2 of EPX 1.8 tn of acrylic paint	Main construction products used in the refurbishment of the façade.	Project description (ADIGSA, 2010)

Table 143: Inventory data for B6 Operational energy use

Input	BEFORE REFURB. kWh/m^2/year	AFTER REFURB. kWh/m^2/year	Source

Electricity - heating	3.1	2.4	Before rehabilitation: Direct electricity meter reading (for a whole year, 2009). Using statistically representative data for Spanish dwellings (IDAE, 2011), heating, air-conditioning, domestic hot water and lighting consumptions have been derived. After rehabilitation: Basic method for the certification of existing buildings - CE3X. Using the tool, the % of reduction for heating and air-conditioning consumptions has been calculated, then applied to real data before rehabilitation.
Electricity – cooling	1.0	0.7	
Electricity - lighting	5.0	5.0	
Electricity – domestic hot water	3.2	3.2	
Natural gas - heating	37.6	28.7	
Natural gas – domestic hot water	34.7	34.7	

Selection of data/ background data

As a general rule, specific data derived from specific production processes or average data derived from specific production processes shall be the first choice as a basis for calculating a building LCA.

For life cycle modeling of the building, Elodie software is used. All relevant background datasets are taken from Elodie (construction materials production) and GaBi 5.0 (for Spanish electricity mix and production of thermal energy from natural gas) databases. The datasets used are documented in Elodie and GaBi documentation. The applied data sets are representative for the year 2008 in the case of energy-carriers and 2010 or 2011 for the building materials used in the refurbishment, and have a national coverage.

Data/ background data quality requirements

The requirements for data quality and background data correspond to the specifications of EeBGuide.

For life cycle modeling of the considered building the software Elodie developed by the CSTB is used. In order to complement some background data about the production of electricity and thermal energy from natural gas within the Spanish production conditions, data from the GaBi Database (version 5) from PE International have been used. In both cases, the last revision of the used data sets took place less than 5 years ago.

Annex A provides more detail about the sources of the data used.

Allocations

In the present study **no** allocation has been made.

73. Life cycle inventory analysis and life cycle impact assessment

The results of the LCA for module B are represented in the following tables. The inventory analysis indicators to be declared and the impact assessment are in accordance with EN 15978, despite not all LCI indicators have been included due to the lack of data.

Indicators for the life cycle inventory analysis according to EN 15978 "Baseline Scenario"

The following environmental indicators apply data based on the LCI.

Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ, net calorific value
Use of renewable primary energy resources used as raw materials	MJ, net calorific value
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ, net calorific value

Indicators for the life cycle impact assessment according to EN 15978 "Baseline Scenario"

The following information on environmental impacts is expressed with the impact category parameters of LCIA using characterisation factors

Global warming potential (GWP);	kg CO_2-equiv.
Depletion potential of the stratospheric ozone layer (ODP);	kg CFC 11- equiv
Acidification potential of soil and water, (AP);	kg SO_2 - equiv
Eutrophication potential (EP);	kg $(PO_4)^{3-}$ - equiv
Formation potential of tropospheric ozone (POCP);	kg Ethene - equiv
Abiotic depletion potential (ADP-elements) for non-fossil resources	kg Sb - equiv

In fact, the results from the impact assessment are only relative statements which give no information about the endpoint of the impact categories, overstepping of threshold values, safety margins or risk.

Used environmental indicators “Baseline Scenario”

The table below illustrates the used environmental indicators.

Figure 13: Used environmental indicators

- [x] 1. Global warming potential
- [x] 2. Acidification Potential
- [x] 3. Eutrophication Potential
- [x] 4. Photochemical Ozone Creation Potential
- [x] 5. Total use of renewable primary energy
- [x] 6. Total use of non-renewable primary energy
- [x] 7. Depletion potential of the stratospheric ozone layer
- [x] 8. Abiotic Resource Depletion Potential for elements
- [ ] 9. Abiotic Resource Depletion Potential of fossil fuels
- [ ] 10. Secondary Materials
- [ ] 11. Secondary fuels - renewable
- [ ] 12. Secondary fuels – non renewable
- [ ] 13. Net Fresh Water
- [ ] 14. Hazardous Waste
- [ ] 15. Non Hazardous Waste
- [ ] 16. Radioactive Waste
- [ ] 17. Components for Re-Use
- [ ] 18. Materials for Recycling
- [ ] 19. Materials for Energy Recovery
- [ ] 20. Exported Energy
- [ ] additional indicator
- [ ] additional indicator
- [ ] additional indicator
- [ ] additional indicator

Parameters Baseline scenario

Following table illustrates the parameters used in the Baseline scenario.

Table 144: Description of the parameter Baseline scenario

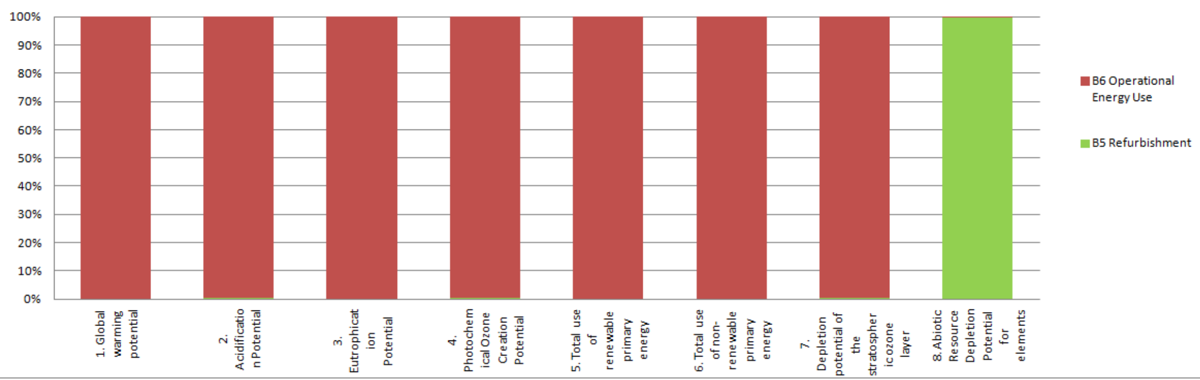
G- 08 "Reference study period"	50 years
G- 10 "Future technical developments and innovation"	No innovation to be considered, current technologies to be used
G- 12 "Accounting for carbon storage / carbon sequestration"	Carbon storage is not considered
G- 25 "Water consumption"	Not scarcity of water to be considered
B- 03 "Transport of people"	No transport of people to be considered
B- 13 "Replacement frequency"	Replacement in whole number cycles
B- 20 "Electricity consumption in dynamic LCA data"	Annual average data sets for electricity
B- 25 "Operational energy demand – Consideration of user behavior for stand-alone or comparative LCA of new buildings"	No user behavior to be considered

Results "Baseline Scenario"

Table 145: Overview over the building LCA results

	1. Global warming potential	2. Acidification Potential	3. Eutrophication Potential	4. Photochemical Ozone Creation Potential	5. Total use of renewable primary	6. Total use of non-renewable primary	7. Depletion potential of the stratospheric ozone layer	8. Abiotic Resource Depletion Potential for elements
B5 Refurbishment	2,11E-04	1,21E-04	3,31E-07	6,70E-05	1,30E-01	1,27E-01	2,73E-03	2,11E-04
B6 Operational Energy Use	2,32E+01	4,42E-02	2,75E-03	3,24E-03	5,75E+00	1,13E+02	1,78E-07	8,01E-07

Figure 14: Results Indicators - life cycle modules assessed

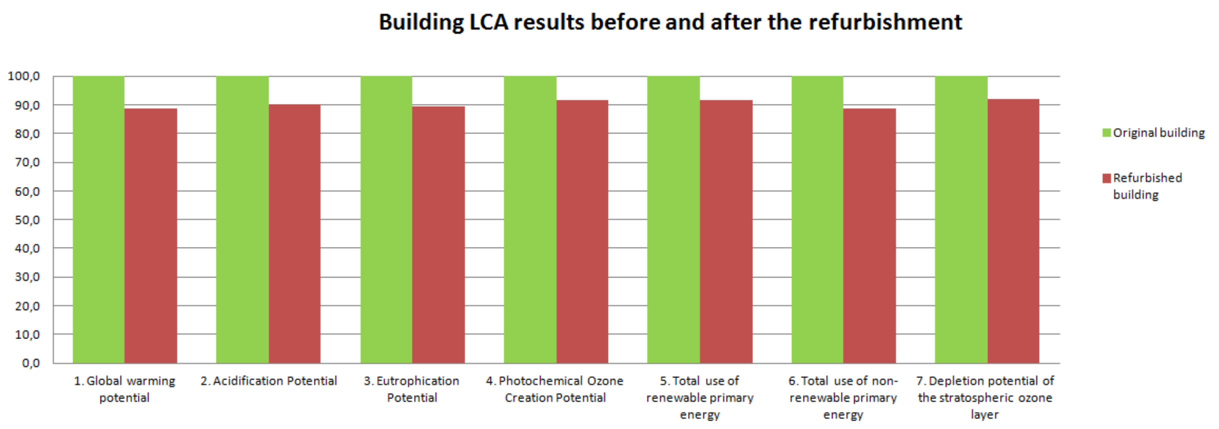


As expected, the module B6 has a higher environmental impact than module B5, due to the major energy consumption. In the case of the Abiotic Depletion, the use of non-renewable materials for the rehabilitation of the façade of the building is the reason explaining a major contribution of the Refurbishment module.

Interpretation of the results "Baseline Scenario"

The reduction of the energy consumption for heating and cooling uses derived from the improvement of the thermal insulation of the building's façade may generate a reduction of the impact categories (circa 10%). It has to be noted that the Abiotic Depletion category do not follow that trend, as it is more related to the consumption of non renewable materials, as the ones used for the refurbishment of the building.

Figure 15: Comparison of results before and after the refurbishment



74. Conclusion

The simplified LCA study carried out has allowed identifying the % in which the environmental impacts of the existing buildings have been reduced due to the improvement of the thermal insulation of its façade.

This study is considered as a starting point as it may be improve including the end of life of the building, as well as some of the processes omitted in this first iteration (such as the management of waste produced during the rehabilitation work or the production of additional products used).

75. References

(ADIGSA, 2010) Adigsa, empresa pública. Generalitat de Catalunya. Projecte d’Aïllament de Façanes. Fase 1. Can Jofres. 2010.

(IDAE, 2011) Intituto para la Diversificación y Ahorro Energéticos (IDAE). Análisis del consumo energético del sector residencial en España. 16 de julio de 2011.

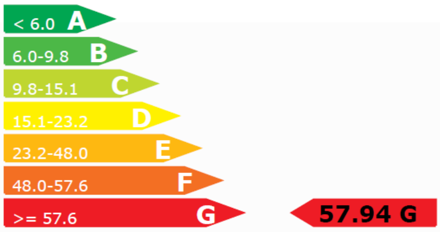
Documentation of components, materials and surfaces

Components/ Surfaces/ materials	LCA data set for production	Lifcycle stage	Total Amount	Service life
Mortar	*Mortier de jointoiement à base de ciment pour carreaux et dalles cerámiques (FDES, 2011)*	*B5*	*30 tn*	*50 years*
Arid	*Gravier (Elodie Database, 2012)*	*B5*	*129 tn*	*100 years*
EPS	*Isolation des murs par l'extérieur cellomur 20 (FDES, 2010)*	*B5*	*3,624 m2*	*50 years*
Acrylic paint	*FDES Enduits extérieurs de peinture en pâte (FDES, 2011)*	*B5*	*1.8 tn*	*30 years*
Electricity	*Electricity grid mix ES (GaBi Database, 2008)*	*B6*	*3,459 MWh*	*-*
Thermal energy from natural gas	*Thermal energy from natural gas ES (GaBi Database, 2008)*	*B6*	*19,425 MWh*	*-*

EPBD calculation or results from dynamic simulations

CALIFICACIÓN ENERGÉTICA DEL EDIFICIO EXISTENTE

Indicador kgCO2/m2



	kWh/m2	Clase	kWh/año
Demanda calefacción	136.033	G	833202.125
Demanda refrigeración	0.0	No calificable	0.0
	kgCO2/m2	**Clase**	**kgCO2/año**
Emisiones CO2 calefacción	52.639	G	322413.875
Emisiones CO2 refrigeración	0.0	No calificable	0.0
Emisiones CO2 ACS	5.296	F	32438.0
Emisiones CO2 anuales	57.935	G	354851.875

El consumo de energía y sus emisiones de dióxido de carbono son las obtenidas por el procedimiento CE3X, para condiciones normales de funcionamiento y ocupación.
El consumo real de energía del edificio y sus emisiones de dióxido de carbono dependerán de las condiciones de operación y funcionamiento del edificio y de las condiciones climáticas, entre otros factores.
En el proceso de calificación energética no se han tenido en cuenta las pérdidas térmicas en los circuitos de distribución. El aislamiento de dichos circuitos puede conllevar ahorros energéticos

Ahorros en emisiones de CO2

	Ahorros en emisiones de CO2 desglosados				
	Calefacción (%)	Refrigeración (%)	ACS (%)	Contribuciones energéticas	Clase
Aillament façana ext	32.8	0	0.0	0.0	E
Bomba calor (calefaccio)	60.1	0	0.0	0.0	E
combi bdc façana	73.2	0	0.0	0.0	D

EeBGuide Background Report for Buildings

LCA of the building Amara (Donostia, Spain)

Name of the building:	Building Amara
Date of the assessment:	7.09.2012
Address of the building:	Calle Isabel II, 21-23-25, barrio Amara, Donostia (Spain)
name and qualification of the assessor:	Cristina Gazulla Santos, PhD
name and qualification of the reviewer:	
Review type	*External review*
Date of the verification	
Client of the study:	*EeBGuide Project & Tecnalia*
Authors of the study:	*Cristina Gazulla, UNESCO Chair in Life Cycle and Climate Change* *Xabat Oregi Isasi and Patxi Hernández, TECNALIA*

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Nomenclature

Abbreviation	Explanation
ADP	Abiotic Depletion Potential
ADPE	Abiotic Resource Depletion Potential for elements
ADPF	Abiotic Resource Depletion Potential of fossil fuels
AP	Acidification Potential
BLBSB	Benefits and Loads Beyond the System Boundary
BREEAM	BRE Environmental Assessment Method
CML	Centrum voor Milieukunde, Leiden (NL)
CPD	Construction Products Directive
CRU	Components for re-use
DGNB	Deutsche Gesellschaft für Nachhaltiges Bauen
	(German Sustainable Building Council)
ECO	European Construction product Organisation
EE	Exported energy per energy carrier
EP	Eutrophication Potential
EPD	Environmental Product Declaration
ESL	Estimated service life
FW	Use of net fresh water
GWP	Global Warming Potential
HQE	Haute qualite�much environmentale
	(French Sustainable Building Council)
HWD	Hazardous waste disposed
IBU	Institut Bauen und Umwelt e.V.
ILCD	International Reference Life Cycle Data System
LCA	Life Cycle Assessment

LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment
LCC	Life Cycle Costing
MER	Materials for energy recovery
MFR	Materials for recycling
NRSF	Use of non-renewable secondary fuels
NHWD	Non-hazardous waste disposed
ODP	Ozone Layer Depletion Potential
PCM	Phase changing material
PENRE	Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials
PENRM	Use of non-renewable primary energy resources used as raw materials
PENRT	Total use of non-renewable primary energy resources
PERE	Use of renewable primary energy excluding renewable primary energy resources used as raw materials
PERM	Use of renewable primary energy resources used as raw materials
PERT	Total use of renewable primary energy resources
PCR	Product Category Rules
POCP	Photochemical Ozone Creation Potential
ReqSL	Required Service Life
RSF	Use of renewable secondary fuels
RSL	Reference Service Life
RSP	Reference Study Period
RWD	Radioactive waste disposed
SM	Use of secondary material

76. Scope

This document is the background report for the report on the life cycle assessment results of a building. The study conducted, follows the provisions and guidelines of EeBGuide.

77. Content, structure and accessibility of the background report

The background report provides the systematic and comprehensive summary of the project documentation supporting the verification of a building LCA. The project report shall record that the LCA based information meets the requirements of EeBGuide of the Energy- efficient Building Initiative. It was made available to the verifier with the requirements on confidentiality stated in ISO 14025.

The background report contains any important data and information required by the European standard EN 15978. Special attention is paid to a transparent documentation.

78. General aspects in the background report

The present LCA study of the company is performed by the practitioner stated and has been conducted according to the requirements of the European Standard **Erreur ! Source du renvoi introuvable.**. The background report was sent to verification as mentioned. Further details can be found in the table "General Information".

79. Goal/Purpose of the study

The aim of this study is the calculation and interpretation of the LCA results of the building. The table "Goal/ Purpose of the study" illustrates important points regarding the purpose of the study.

Table 146: Goal/ Purpose of the study

Level of complexity	☐	Screening
	☑	Simplified
	☐	Complete
related study objective	☐	Comparative assertion
	☑	Stand alone LCA
object of assertion	☐	New building
	☑	Existing building
communication purpose	☐	internal
	☐	external
	☐	for costumer to costumer
	☐	publication
	☑	*Case study of the EeBGuide project*

80. Scope of the study

Declared / functional equivalent

The following points have to be defined with regards to the functional unit:

Table 147: Functional unit

Reference unit	*1m² NFA per year*
Type of Building:	*Mainly dweling combined with commercial area at the ground floor. The attic (under the roof) is used for storage.*
number of tennants:	*257 approx.*
required service life:	*50 years*
Other services provided within the building (shops...):	*There are shops in the ground floor*

Object of the assessment is an entire building. Infrastructures located on the building site may also be included. Infrastructures not located on the building site like roads and surrounding structures (e.g. park) may not be included. The assessed building is described with **main** components, materials and surfaces.

Technical description of the building

The following table describes the building into more detail:

Table 148: Technical description of building

Year of comissioning:	*1963*
Year and type of refurbishment:	*2011-12; improvement of the thermal insulation of the envelope (walls, +8cm of mineral wool/XPS, roof +8cm of mineral wool + glazing, double/tripple glazing) (5767 m² in total)*
Structural type:	*Reinforced concrete load- bearing structure*
Number of storeys:	*Ground floor (shops) + 8 floors (dwelings) + attic (storage) (9 in total)*
Net Floor Area [m²]:	*8574 m²*
Gross Floor Area [m²]:	*9040 m²*
Calculated electrical end energy demand [kWh/(m²*a)]:	*14.20 kWh/(m²*a)*
Calculated thermal end energy demand [kWh/(m²*a)] (energy wich is used to supply heating needs)	*Before refurbishment: 80.62 kWh/(m²*a)* *After refurbishment: 33.65 kWh/(m²*a)*
Energy calculation methodology:	*EnergyPlus*
Considered energy uses	*heating, domestic hot water, lighting*
Most important materials for supporting structure, insulation, windows:	*Reinforced concrete (structure), Cavity brick wall (façade), Ceramic tile (roof), single glazing; no insulation before refurbishment.*
Type of facade:	*Before rehabilitation: Brick façade with a cavity wall; single glazing* *After rehabilitation: Brick façade with a cavity wall and expanded polystyrene (EPS); double glazing*
Energy supply system and energy transfer system (short description; name renewable components, if used):	*Combination of central (natural gas) and invididual (electrical) heating systems.*
Number and description of underground levels	-
Information about external features	-

Table 149: Technical description of all operational areas

Operational Area1:	*Dwelings: 108 apartments (12 per floor) with different area and orientation.*
Usage Operational Area1:	*Dwelings*
Design number of building occupants Operational Area1:	*257 approx (0.03 pax/m2)*
Design occupancy schedule Operational Area1:	*1) Weekdays: From 24 to 7h: 100% occupancy; from 7 to 15 h: 25%, from 15 to 24 h: 25% 2) Weekends: 100%*
Heating, cooling and ventilation system and hot water service system Operational Area1:	*Domestic electric heaters*
Lighting system Operational Area1:	*Different in each dwelling, but based on light-bulbs and fluorescent lights*
Power and communication systems Operational Area1:	-

Information about the surrounding environment

The following table brings information about the local context:

Table 150: Description of the local context

Information on climate (HDD and CDD, climate severity index...)	*HDD18°C = 1435; CDD = 318*
Urban context (down town, suburbs, countryside...)	*Suburbs*
Geological constraints (seismic context, load bearing capcity, slopes of the building site...)	*n.a.*
Accoustics constraints	*n.a.*
Specific urban rules	*n.a.*
Architectural constraints	*n.a.*
Other constraint of the surrounding environment	*The building is located between 4 other buildings which, due to their proximity, project shadows especially in the side walls. As a result, the sunlight capture is low.*

System boundaries

The system boundary of the building LCA follows the modular design defined by /**Erreur ! Source du renvoi introuvable.**/. The following chapters describe the modules which are within the scope of this study. The modules included are in-line with the following table:

Table 151: Definitions for the different study types

Screening - Simplified - Complete

according to SBA Common Metrics Framework 2009 and EeBGuide adaptations

M	**mandatory**
O relevance?	**optional because of minor relevance**
O data?	**optional due to potentially missing data**

<table>
<tr><th></th><th>Study type</th><th colspan="5">Before use stage</th></tr>
<tr><td></td><td></td><td>Raw Materials Supply
A1</td><td>Transport (to factory)
A2</td><td>Manufactoring
A3</td><td>Transport (to construction site)
A4</td><td>Construction- Installation process
A5</td></tr>
<tr><td rowspan="6">Building</td><td rowspan="2">Screening</td><td>M</td><td colspan="2">Calculation rules based on data on major sub-structure (e.g. statistical data such as kWh/m² for primary energy) or generic LCA of building elements/products/materials such as Roof; Load- bearing structure; Exterior and basement walls; Windows; Floor slabs; Foundation; Floor Finishes/ Coverings</td><td rowspan="2">O relevance?</td><td rowspan="2">O data?</td></tr>
<tr><td>O data?</td><td colspan="2">Calculation rules based on data on statistical data such as kWh/m² for primary energy for the following equipment: Refrigeration/ Coolants; Decorative wall finishes/ coatings (e.g. wallpaper, paints); Doors; Heating/ Cooling/ Lighning Equipment and any power-generating equipment (e.g. wind turbines/ PV/ solar heating) Equipment for internal transport (e.g. lifts, escalators); water and sewerage systems; electrical distribution system</td></tr>
<tr><td rowspan="2">Simplified</td><td>M</td><td colspan="2">Calculation rules based on data on major sub-structure (e.g. statistical data such as kWh/m² for primary energy) or generic LCA/average EPD of building elements/products/materials such as Roof; Load- bearing structure; Exterior and basement walls; Windows; Floor slabs; Foundation; Floor Finishes/ Coverings;</td><td rowspan="2">O relevance?</td><td rowspan="2">O data?</td></tr>
<tr><td>O data?</td><td colspan="2">Calculation rules based on data on statistical data such as kWh/m² for primary energy for the following equipment: Refrigeration/ Coolants; Decorative wall finishes/ coatings (e.g. wallpaper, paints); Doors; Heating/ Cooling/ Lighning Equipment and any power-generating equipment (e.g. wind turbines/ PV/ solar heating) Equipment for internal transport (e.g. lifts, escalators); water and sewerage systems; electrical distribution system</td></tr>
<tr><td>Complete</td><td>M</td><td colspan="2">Calculation rules based on data on major building elements/products/materials based on specific EPD (both group of manufacturer's or single manufacturer declaration) else average LCA data: Roof; Load- bearing structure; Exterior and basement walls; Windows; Floor slabs; Foundation; Floor Finishes/ Coverings; Refrigeration/ Coolants; Decorative wall finishes/ coatings (e.g. wallpaper, paints); Doors; Heating/ Cooling/ Lighning Equipment and any power-generating equipment (e.g. wind turbines/ PV/ solar heating) Equipment for internal transport (e.g. lifts, escalators); water and sewerage systems; electrical distribution system</td><td>M</td><td>M</td></tr>
</table>

Screening - Simplified - Complete

according to SBA Common Metrics Framework 2009 and EeBGuide adaptations

M

O relevance?

O data?

	Study type	Use stage						
		Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use
		B1	B2	B3	B4	B5	B6	B7
Building	Screening	O relevance?	O relevance?	O data?	O data?	O relevance?	M **Calculation rules based on the expected performance target for the building** (e.g. energy label target or reference levels set by national regulation) calculated at least for building related uses covered by the EPBD (heating, cooling and air conditioning, ventilation, domestic hot water, lightning and auxiliary energy used for pumps, control and automation).	M **Calculation rules based on statistical data** for both building and non building related water equipment
	Simplified	O relevance?	O relevance?	O data?	M	O relevance?	M **Calculation rules based on Dynamic Thermal Simulation or national calculation methodology** for building related uses (heating, cooling and air conditioning, ventilation, heating for provision of domestic hot water, lightning) M **Calculation rules based on EPA-NR for comparative assessments** (heating, cooling and airconditioning) (Internal transport, computer and IT equipment, refrigerators, washing machines, dishwashers, dryers, other small power devices)	M **Calculation rules based on top-down approach** by taking into the economic (by water saving devices e.g. dual flash toilet system) or extra consumption measures for both building and non building related water equipment
	Complete	M	M		M	M	M **Calculation rules based on Dynamic Thermal Simulation, National calculation methodology or EPA-NR for comparative assessment** for building related uses and non building related (heating, cooling and air conditioning, ventilation, heating for provision of domestic hot water, lightning, Internal transport, computer and IT equipment, refrigerators, washing machines, dishwashers, dryers, other small power devices) (heating, cooling and air conditioning, ventilation, heating for provision of domestic hot water, lightning)	M **Calculation rules based on bottom-up approach** for both building and non building related water equipment such as urinals, WCs, taps, baths,showers, greywater/ rainwater systems dishwashers, washing machines, water softeners, wase disposal units

Screening - Simplified - Complete

according to SBA Common Metrics Framework 2009 and EeBGuide adaptations

M

O relevance?

O data?

	Study type	End of Life				Benefits beyond boundary
		Deconstruction	Transport (to disposal)	Waste process for reuse, recovery or/ and recycling	Disposal	Reuse-/ Recovery- /Recyclingpotential
		C1	C2	C3	C4	D
Building	Screening	O relevance?	O relevance?	O data? Generic LCA data for EOL processes O data? Generic LCA data for EOL processes		O data? Generic LCA data for reuse-/ recovery- / recycling potential O data? Generic LCA data for reuse-/ recovery- / recycling potential
Building	Simplified	O relevance? **Calculation rules based on a materials impact ratio (i.e. 3% for GWP in case of concrete)**	O relevance?	M Specific or generic LCA data for EOL processes O data? Specific or generic LCA data for EOL processes		M Specific or generic LCA data for reuse-/ recovery- / recycling potential O data? Specific or generic LCA data for reuse-/ recovery- / recycling potential
Building	Complete	M **Calculation rules based on the energy, materials and related emissions**	M	M Specific or generic LCA data for EOL processes		M Specific or generic LCA data for reuse- / recovery- / recycling potential

Following chapters describe and explained only those modules included within the study.

The environmental impacts of a building may be breakdown according to different contributors such as the energy and water uses as well as the building products and equipment. These contributors need adequate calculation rules. The following figure presents the main contributors of a building and where they happen in the life cycle stages of a building according or EN 15978. For example, building products and technical equipment are responsible of the impacts all along the life cycle stages while the operational water uses only refers to the use phase (module B).

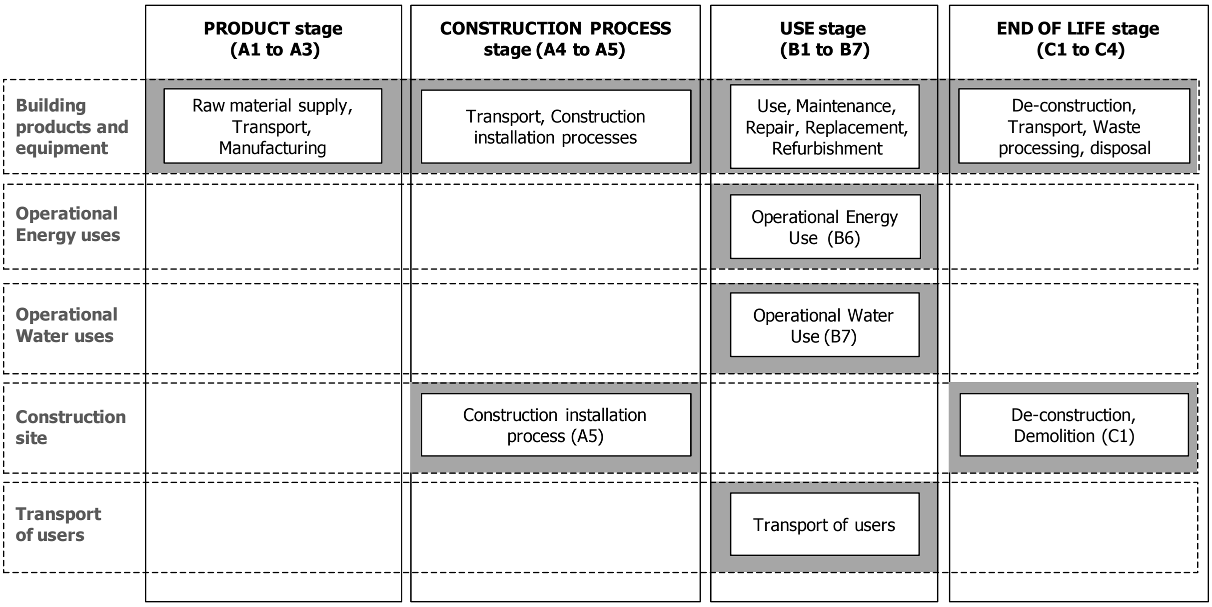


Figure 17: Schematic representation of contributors and related life cycle stages

Overview over the included Life cycle stages

For an existing building, the system boundary should include all stages representing the remaining service life and the end of life stage of the building. As the complete envelope of the existing building under assessment has been recently refurbished (including external walls, roof and windows), it has been possible to include B5 module, as well as B6. In additional, modules C2 and C4 have also been included, but it has to be noted that only refer to the materials added during the refurbishment.

The table summarizes the included Lifecycle stages.

Table 152: Included lifecycle stages

Product Stage	☐	A1	Raw Materials Supply
	☐	A2	Transport
	☐	A3	Manufacturing
Construction Process	☐	A4	Transport
	☐	A5	Construction- Installation process
Use Stage	☐	B1	Use
	☐	B2	Maintenance
	☐	B3	Repair
	☐	B4	Replacement
	☑	B5	Refurbishment
	☑	B6	Operational Energy Use
	☐	B7	Operational Water Use
End of Life Stage	☐	C1	Deconstruction
	☑	C2	Transport
	☐	C3	Waste process for reuse, recovery or/ and recycling
	☑	C4	Disposal
Benefits and loads beyond the system boundary	☐	D	Reuse- Recovery- Recyclingpotential

Overview of the included products and equipments

As the system under study is an existing building, only materials used in the refurbishment of the façade have been included in the assessment (within module B5 – Refurbishment).

Overview of the included operational energy and water uses

The following table describes the considered energy uses. Water use has not been assessed.

Table 153: Descriptions of operational energy uses considered into the study

Building related uses	Heating	☑
	Air conditioning (Cooling and humidification/de-humidification)	☐
	Domestic hot water	☑
	Ventilation	☐
	Lighting	☑
	Auxiliary (pumps, control and autom	☐
	Building integrated systems (eg. Lifts, shutters, automated gate, lighting for parkings...)	☐
Non building related uses	To specify (e.g. plug-in appliances, dishwachers, TV...)	☐

B5, Use stage, information modules related to the refurbishment of the building

Within the use stage, module B5 relates to the refurbishment of the building. A rehabilitation operation consists of a deconstruction (removal of products to change) and a reconstruction operation (adding new products to replace discarded ones). The production of the main materials used (insulation materials, ceramics and aluminum profiles, as well as double-glazing windows) have been included in this module. Due to the lack of data, it has not been possible to include the energy consumption associated with the installation of these materials into the building.

B6-B7, Use stage, information modules related to the operation of the building

The use stage related to the operation of the building includes:

- B6, operational energy use (e.g. operation of heating system and other building related installed services);
- B7, operational water use;

These information modules include provision and transport of all materials, products, as well as energy and water provisions, waste processing up to the end-of-waste state or disposal of final residues during this part of the use stage.

The following flowchart represents the system boundaries for the use stage related to the operation of the building:

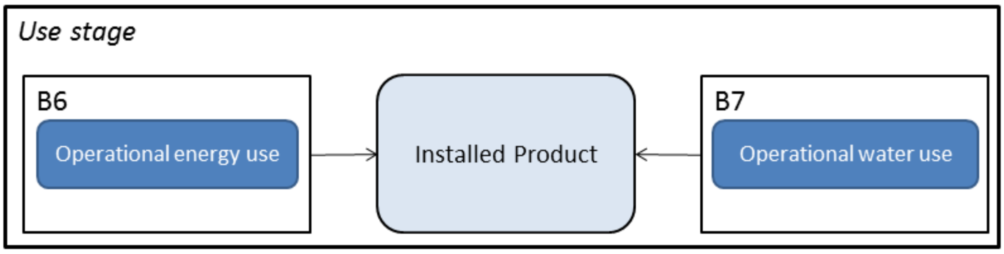


Figure 80-18: schematic representation of the LCA system boundaries for the use stage (modules related to the operation of the building)

Table 154: Module B6

The following processes are omitted:	*Energy consumption for heating, lighting and domestic hot water uses have been included. Other operation energy consumptions have been omitted.*
The following deviations from EN 15978 on data requirements occurred **(Just for "Complete Assessment")**:	
The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	*Average datasets representing the current situation in Spain have been used (e.g. electricity grid mix production, natural gas production, etc.)*

Energy imported/ Exported

The following table describes the imported/ exported energy.

Table 155: Energy imported/ exported

Description of thermal and electrical energy:	*No energy is produced on site.*
Imported thermal energy [kWh/a]	*All the thermal energy used in the building is imported (691,217 kWh/a before rehabilitation, 288,559 kWh/a after rehabilitation)*
Imported electrical energy [kWh/a]	*All the electricity used in the building is imported (121,399 kWh/a before rehabilitation, 121,399 kWh/a after rehabilitation)*
Exported thermal energy [kWh/a]	*none*
Exported electrical energy [kWh/a]	*none*

C1-C4 End-of-life stage, information modules

The end-of-life stage includes:

- C1, de-construction, demolition:
- C2, transport to waste processing;
- C3, waste processing for reuse, recovery and/or recycling;
- C4, disposal

including provision and all transports, provision of all materials, products and related energy and water use.

The following flowchart represents the system boundaries for the End-of-life stage:

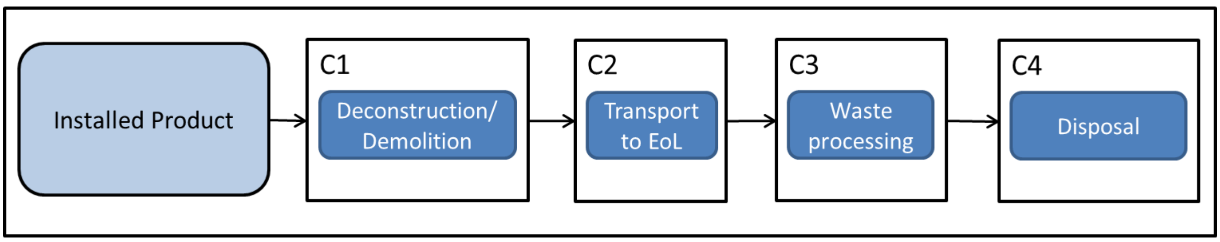


Figure 80-19: schematic representation of the LCA system boundaries for the End-of-life stage (C1-C4)

Table 156: Module C1-C4

The following processes are omitted:	*C1 and C3 have been omitted.*
The following deviations from EN 15978 on data requirements occurred **(Just for "Complete Assessment"):**	
The following assumptions about other relevant background data, important for the representation of the system boundaries, were considered:	*Average national datasets used for background data*

Description of the system boundary in the background report

The definition of the system boundaries meets the requirements of EeBGuide.

Criteria for the exclusion of inputs and outputs

As explained before, modules B5, B6, C2 and C4 have been included in the study. Relevant material and energy inputs and outputs have been included.

81. Life cycle inventory analysis

Data collection and calculation procedures

Data collection follows the guidance provided in **Erreur ! Source du renvoi introuvable.**, clause 4.3.2. The calculation procedures described in **Erreur ! Source du renvoi introuvable.** are applied consistently throughout the study.

According to the definition of the scope of the study, all relevant inputs and outputs related to the building are identified and quantified.

Table 157: Inventory data for B5 Refurbishment module

Input	Amount (unit)	Description	Source
Construction products	10,369 kg mineral wool (façade) 3,940 kg mineral wool (roof) 9,258 kg XPS (façade) 10,082 kg aluminum (façade) 123,440 kg ceramic façade panels 22,922 kg double glazing 7,250 aluminum frame (windows)	Main construction products used in the refurbishment of the façade (including windows) and the roof.	Oregi X, 2012
Waste	26,239 removed windows	Products removed (single-glazing windows)	Oregi X, 2012

Table 158: Inventory data for B6 Operational energy use

Input	BEFORE REFURB. $kWh/m^2/year$	AFTER REFURB. $kWh/m^2/year$	Source
Electricity - lighting	14.20	14.20	Oregi X, 2012

Natural gas - heating	80.62	33.65	(simulation using EnergyPlus)
Natural gas – domestic hot water	13.94	13.94	

Selection of data/ background data

As a general rule, specific data derived from specific production processes or average data derived from specific production processes shall be the first choice as a basis for calculating a building LCA.

For life cycle modeling of the building, GaBi software is used. All relevant background datasets are taken from GaBi 5.0 databases. The datasets used are documented in GaBi documentation. The applied data sets are representative for the year 2008 in the case of energy-carriers and 2008 or 2010 for the building materials used in the refurbishment. Energy carriers have a Spanish coverage, whereas in the case of building materials data from Germany have been used.

Data/ background data quality requirements

The requirements for data quality and background data correspond to the specifications of EeBGuide.

For life cycle modeling of the considered building the software GaBi developed by PE International/LBP is used. Data from the GaBi Database (version 5) from PE International have been used. In such case, the last revision of the used data sets took place less than 5 years ago.

Annex A provides more detail about the sources of the data used.

Allocations

In the present study **no** allocation has been made.

82. Life cycle inventory analysis and life cycle impact assessment

The results of the LCA for modules B and C are represented in the following tables. The inventory analysis indicators to be declared and the impact assessment are in accordance with EN 15978, despite not all LCI indicators have been included due to the lack of data.

Indicators for the life cycle inventory analysis according to EN 15978 "Baseline Scenario"

The following environmental indicators apply data based on the LCI.

Use of renewable primary energy resources used as raw materials	MJ, net calorific value
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ, net calorific value

Indicators for the life cycle impact assessment according to EN 15978 "Baseline Scenario"

The following information on environmental impacts is expressed with the impact category parameters of LCIA using characterisation factors

Global warming potential (GWP);	kg CO_2-equiv.
Depletion potential of the stratospheric ozone layer (ODP);	kg CFC 11- equiv
Acidification potential of soil and water, (AP);	kg SO_2 - equiv
Eutrophication potential (EP);	kg $(PO_4)^{3-}$ - equiv
Formation potential of tropospheric ozone (POCP);	kg Ethene - equiv
Abiotic depletion potential (ADP-elements) for non-fossil resources	kg Sb - equiv

In fact, the results from the impact assessment are only relative statements which give no information about the endpoint of the impact categories, overstepping of threshold values, safety margins or risk.

Used environmental indicators “Baseline Scenario”

The table below illustrates the used environmental indicators.

Figure 20: Used environmental indicators

☑	1. Global warming potential
☑	2. Acidification Potential
☑	3. Eutrophication Potential
☑	4. Photochemical Ozone Creation Potential
☑	5. Total use of renewable primary energy
☑	6. Total use of non-renewable primary energy
☐	7. Use of renewable primary energy excluding renewable primary energy resources used as raw materials
☐	8. Use of renewable primary energy resources used as raw materials
☐	9. Use of non renewable primary energy excluding non renewable primary energy resources used as raw materials
☐	10. Use of non renewable primary energy resources used as raw materials
☑	11. Depletion potential of the stratospheric ozone layer
☑	12. Abiotic Resource Depletion Potential for elements
☑	13. Abiotic Resource Depletion Potential of fossil fuels
☐	14. Secondary Materials
☐	15. Secondary fuels - renewable
☐	16. Secondary fuels – non renewable
☐	17. Net Fresh Water
☐	18. Hazardous Waste
☐	19. Non Hazardous Waste
☐	20. Radioactive Waste
☐	21. Components for Re-Use
☐	22. Materials for Recycling
☐	23. Materials for Energy Recovery
☐	24. Exported Energy
☐	additional indicator
☐	additional indicator
☐	additional indicator
☐	additional indicator

Parameters Baseline scenario

Following table illustrates the parameters used in the Baseline scenario.

Table 159: Description of the parameter Baseline scenario

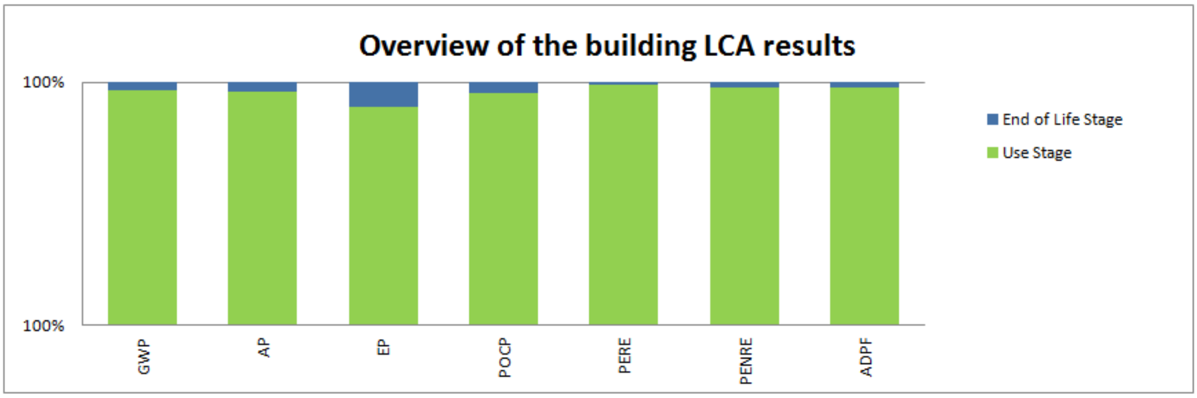
G- 08 "Reference study period"	50 years
G- 10 "Future technical developments and innovation"	No innovation to be considered, current technologies to be used
G- 12 "Accounting for carbon storage / carbon sequestration"	Carbon storage is not considered
G- 25 "Water consumption"	Not scarcity of water to be considered
B- 03 "Transport of people"	No transport of people to be considered
B- 13 "Replacement frequency"	Replacement in whole number cycles
B- 20 "Electricity consumption in dynamic LCA data"	Annual average data sets for electricity
B- 25 "Operational energy demand – Consideration of user behavior for stand-alone or comparative LCA of new buildings"	No user behavior to be considered

Results "Baseline Scenario"

Table 160: Overview over the building LCA results

Overview over the building LCA results							
	1. Global warming potential	**2. Acidification Potential**	**3. Eutrophication Potential**	**4. Photochemical Ozone Creation Potential**	**5. Total use of renewable primary energy**	**6. Total use of non-renewable primary energy**	**9. Abiotic Resource Depletion Potential of fossil fuels**
	GWP	AP	EP	POCP	PERE	PENRE	ADPF
	[kg CO_2-equiv./m^2_{NFA}*a]	[kg SO_2-equiv./m^2_{NFA}*a]	kg PO_4^{-3} - equiv. /m^2_{NFA}*a	[kg C_2H_4-equiv./m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]	[MJ/m^2_{NFA}*a]
Use Stage	18,82	0,05	0,00	0,01	28,71	323,17	265,40
End of Life Stage	0,00	0,00	0,00	0,00	0,00	0,01	0,01

Figure 21: Results Indicators - life cycle modules assessed

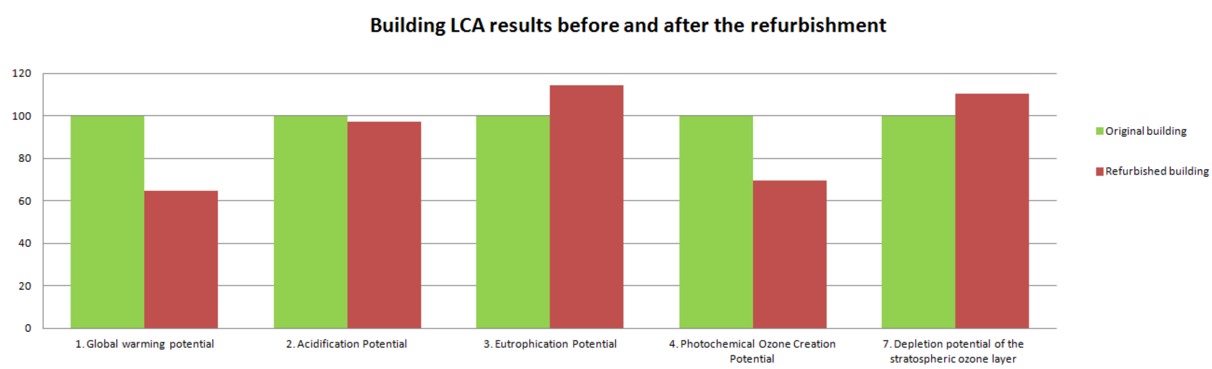


As expected, the use phase has a higher environmental impact than end of life, due to the major energy consumption.

Interpretation of the results “Baseline Scenario”

The reduction of the energy consumption for heating derived from the improvement of the thermal insulation of the building’s façade may generate a substantial reduction of the Global Warming Potential and the Photochemical Ozone Creation Potential (circa 30% in both cases). However, the consumption of materials for the refurbishment also entails a greater Eutrophication Potential, Depletion of the Ozone Layer and Abiotic Resources Depletion.

Figure 22: Comparison of results before and after the refurbishment



83. Conclusion

A simplified LCA study allows identifying the outcomes, in terms of environmental impact, of a refurbishment operation. In addition, it may help to compare different construction options and select those with a best benefit/cost ratio. So, LCA may be useful in decision making process, combined with other tools providing information about the economic and social benefits of the operation.

84. References

(OREGI X, 2012) Oregi Isasi, Xabat. Rehabilitación de edificios residenciales hacia consume casi cero. Máster de Investigación en Eficiencia Energética y Sostenibilidad en Industria, Transporte, Edificación y Urbanismo. Universidad del País Vasco, 2012.

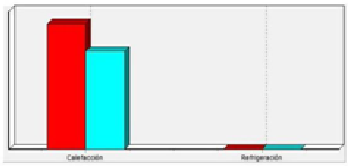
Components/ Surfaces/ materials	LCA data set for production	Lifcycle stage	Total Amount	Service life
Mineral wool	*DE: Mineral wool (facades) PE (2010)*	*B5*	*14.31 tn*	*50 years*
XPS	*DE: Extruded polystyrene (XPS) PE (2010)*	*B5*	*9.30 tn*	*50 years*
Aluminum profile	*DE: aluminium extrusion profile PE (2010)*	*B5*	*10.10 tn*	*50 years*
Ceramic panel	*DE: ceramic façade panels – NBK Ceramic PE (2008)*	*B5*	*123.44 tn*	*50 years*
Aluminum frame	*DE: Aluminium wing profile, powder coated PE (2010)*	*B5*	*7.25 tn*	*50 years*
Double-glazing	*DE: Double glazing unit PE (2010)*	*B5*	*22.92 tn*	*50 years*
Electricity	*ES: electricity grid mix (production mix) PE (2008)*	*B6*	*121,399 kWh*	-
Thermal energy from natural gas	*ES: thermal energy from natural gas PE (2008)*	*B6*	*691,217 kWh (before refurbishment) 288,559 kWh (after refurbishment)*	-
Waste transport	*RER: Articulated lorry (40t) incl. fuel ELCD (2005)*	*B5, C2*	*1,312 tnkm*	-
Waste disposal	*DE: landfill for inert matter (construction waste) (2010)*	*B5, C4*	*26.23 tn*	-

EPBD calculation or results from dynamic simulations

2. CONFORMIDAD CON LA REGLAMENTACIÓN

El edificio descrito en este informe NO CUMPLE con la reglamentación establecida por el código técnico de la edificación, en su documento básico HE1.

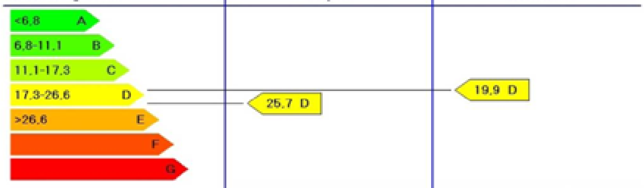
	Calefacción	Refrigeración
% de la demanda de Referencia	128,1	0
Proporción relativa calefacción refrigeración	100,0	0,0



En el caso de edificios de viviendas el cumplimiento indicado anteriormente no incluye la comprobación de la transmitancia límite de 1,2 W/m²K establecida para las particiones interiores que separan las unidades de uso con sistema de calefacción previsto en el proyecto, con las zonas comunes del edificio no calefactadas.

Fecha: 09/06/2010 Ref: 2A98499A5FD7A3 Página: 1

Certificación Energética de Edificios Indicador kgCO2/m²	Edificio Objeto	Edificio Referencia



	Clase	kWh/m²	kWh/año	Clase	kWh/m²	kWh/año
Demanda calefacción	D	65,2	589654,6	D	50,9	460328,5
Demanda refrigeración	-	-	-	-	-	-
	Clase	kgCO2/m²	kgCO2/año	Clase	kgCO2/m²	kgCO2/año
Emisiones CO2 calefacción	D	17,0	153744,3	D	16,3	147413,7
Emisiones CO2 refrigeración	-	-	-	-	-	-
Emisiones CO2 ACS	E	8,7	78680,9	D	3,6	32557,6
Emisiones CO2 totales			232425,2			179971,3

Datos para la etiqueta de eficiencia energética

	Edificio Objeto		Edificio Referencia	
	por metro cuadrado	anual	por metro cuadrado	anual
Consumo energía final (kWh)	96,8	875190,2	84,8	766972,1
Consumo energía primaria (kWh)	119,2	1077595,3	88,5	800633,6
Emisiones CO2 (kgCO2)	25,7	232425,2	19,9	179971,3

Certificación Energética de Edificios Indicador kgCO2/m²	Edificio Objeto			Edificio Referencia		

	Clase	kWh/m²	kWh/año	Clase	kWh/m²	kWh/año
Demanda calefacción	C	25,6	231520,8	D	50,7	458519,8
Demanda refrigeración	-	-	-	-	-	-
	Clase	kgCO2/m²	kgCO2/año	Clase	kgCO2/m²	kgCO2/año
Emisiones CO2 calefacción	B	7,2	65115,2	D	16,2	146509,3
Emisiones CO2 refrigeración	-	-	-	-	-	-
Emisiones CO2 ACS	B	2,7	24418,2	D	3,6	32557,6
Emisiones CO2 totales			89533,4			179066,9

Datos para la etiqueta de eficiencia energética

	Edificio Objeto		Edificio Referencia	
	por metro cuadrado	anual	por metro cuadrado	anual
Consumo energía final (kWh)	48,5	439016,9	84,6	764853,8
Consumo energía primaria (kWh)	49,1	443846,1	88,3	798335,4
Emisiones CO2 (kgCO2)	9,9	89533,4	19,8	179066,9

EeBGuide Reviewer statement (common PRODUCTS)

SEVENTH FRAMEWO PROGRAMME

Date:	30-oct-12
Assessor:	Larisa Maya Altamira, Consultant, PE International
Case Study:	Complete LCA of installed tufted textile floorcovering
Type of the study:	Complete
Reviewer:	Peter Shonfield, Technical Director, PE International
Statement of the reviewer	"I hereby certify that I was not part of the LCA study"

Review Overview

- The LCA study meets EeBGuide provisions
- The LCA study requires minor amendments to meet EeBGuide provisions
- The LCA study requires major amendments to meet EeBGuide provisions

Basic Review

Identify if the study is compliant with the individual provisions given for the relevant aspects

Goal and Scope definition	
Does the LCA study properly fits in any of the three study types defined in EeBGuide? If deviation, are there any explanations/reasons?	
Description of the project	
Description of main parts/ systems/ processes	Due to data confidentiality very limited information is available on production processes (inputs/outputs).
Included life cycle stages	
Choice of Indicators	
Allocation rules	
Cut offs	
Life Cycle Inventory Analysis	
Is the Life Cycle Inventory Analysis done in accordance with EeBGuide provisions?	Underlying LCA model was not checked as part of this review but the study has previously undergone external critical review
Life Cycle Impact Assessment	
Is the Life Cycle Impact Assessment done in accordance with EeBGuide provisions?	Underlying LCA model was not checked as part of this review but the study has previously undergone external critical review
Interpretation	
Is the interpretation of the results done in accordance with EeBGuide provisions?	
Reporting	
Is the documentation of the LCA report compliant with the EeBGuide reporting templates?	

Detailed Review

Note for Reviewers: *Please mark with an 1, 0 or -1 each column according to the rules defined*	
✔	*Type 1: Assessor evaluation accepted and confirmed by Reviewer*
!	*Type 0: Assessor evaluation needs correction; lack of documentation/evidence: see comments*
✘	*Type -1: Assessor evaluation technically incorrect; reevaluation needed: see comments*

	Fulfillment	Comments
Goal definition		
Is the goal of the study compliant with EeBGuide provisions?	✔	
Is the type of study described?	✔	
Is the audience of the study described?	✔	
Are the skills of the audience concerned?	✔	
Is the application or the context of the study described?	✔	
Is the LCA study compliant with ISO, CEN standards (e.g. ISO 14040-44, EN 15804 / EN 15978)	✔	
Is the LCA study compliant with EeBGuide study type? If not, is there a reason for the deviation?	✔	
Is the decision context (situation A, B, C according to the ILCD Handbook) justified? If not, are the choices made relevant?	✔	
Scope definition		
General aspects		
Is the scope definition compliant with EeBGuide provisions?	✔	
[If applicable] is the declared unit explained?	✔	
[If applicable] is the functional unit explained?	n/a	
[If applicable] is the functional equivalent clearly defined especially for comparative studies?	n/a	
Is the definition of system boundaries consistent?	✔	
Are the boundaries of the life cycle clearly presented (e.g. following the modularity principles of CEN TC 350 with modules A, B, C, D)?	✔	
Are the cut-off rules compliant with EeBGuide rules?	✔	
Is the treatment of infrastructure for background and foreground data consistent according to EeBGuide rules?	✔	
Is the transport of goods (e.g. raw materials) accounted for? Are the scenario clearly stated and justified for every life cycle stage?	!	Lack of documentation for raw material transport due to data confidentiality
[If applicable] are the biogenic CO2 accounting rules clearly justified?	n/a	
Are the allocation rules of e.g. coproduction processes, reuse, recycling, recovery aspects clearly justified?	✔	
Are the mass of by-products without burden allocated (recycled matter) justified? Is the end-of-waste status clearly documented for background and foreground data?	n/a	
Life cycle stages scope definition		
For the included life cycle stages, are the scenario documented and relevant (e.g. for modules A4, A5, B1, B2, B3, B4, B5, B6, B7)?	✔	
[If applicable] is the reference service life justified?	✔	
For module C, are the EoL scenarios consistent according to EeBGuide provisions?	✔	
Are the boundaries between "module C - End of life" and "module D" clearly differentiated?	✔	
Life Cycle Inventory Analysis		
Background database / software		
Is the used background database documented?	✔	
Is information given on LCA calculation process (e.g. LCA software used)?	✔	
Data collection for each life cycle stage		
Is the choice between background and foreground data justified and consistent according to the goal of the study?	✔	
Is the collection of specific data from company/manufacturer (e.g. for the gate-to-gate stage) consistent with EeBGuide provisions?	✔	

Data representativeness for each life cycle stage

Is the technological, geographical, time-related representativeness always mentioned for background and foreground data?	!	Mentioned in the report but only limited data available due to confidentiality of original study
Are the generic data amended to take into account the context of the study?	!	Limited data available due to confidentiality of original study
For the specific data, are the production sites surveyed mentioned?	!	Limited data available due to confidentiality of original study
For the LCA data derived from expert judgment, are the sources identified?	!	Limited data available due to confidentiality of original study
For the specific foreground data, are the sources identified (laboratory data etc.)	!	Limited data available due to confidentiality of original study

Plausibility of values for cumulative LCI results

[If applicable] is the mass balance between the reference flow and the generated wastes for cradle to grave data (e.g. EPD) consistent?	!	Results seem plausible although the underlying model was not reviewed. However, this has already undergone a critical review by a third party, hence assumed to be correct.
[If applicable] is the mass of non energy resources used coherent with the reference flow	!	Results seem plausible although the underlying model was not reviewed. However, this has already undergone a critical review by a third party, hence assumed to be correct.
[If applicable] CO and CO2 emissions coherent with the mass of fossil energetic resources	!	Results seem plausible although the underlying model was not reviewed. However, this has already undergone a critical review by a third party, hence assumed to be correct.
Are the energy indicators coherent between them? (e.g. check of the sum of non renewable and renewable parts or between feedstock and fuel parts)	!	Results seem plausible although the underlying model was not reviewed. However, this has already undergone a critical review by a third party, hence assumed to be correct.
[If applicable] is the energy indicators coherent with the energy resources used?	!	Results seem plausible although the underlying model was not reviewed. However, this has already undergone a critical review by a third party, hence assumed to be correct.

Life Cycle Impact Assessment

Translating LCI flows to LCIA indicators

Are the rules to calculate the LCIA indicators from the LCI clearly stated and justified?	✔	

Environmental indicators

Are the used indicators compliant with EeBGuide rules?	✔	
Are the used indicators consistent regarding the study type?	✔	

Interpretation of the results

Environmental indicators results

Are the results justified (contribution of processes to any environmental indicators)?	✔	

Plausibility of product LCA results per life cycle stage

Module A1-A3 (Production)	!	Results seem plausible although the underlying model was not reviewed. However, this has already undergone a critical review by a third party, hence assumed to be correct.
Module A4-A5 (Construction processes)	!	Results seem plausible although the underlying model was not reviewed. However, this has already undergone a critical review by a third party, hence assumed to be correct.
Module B (Use)	!	Results seem plausible although the underlying model was not reviewed. However, this has already undergone a critical review by a third party, hence assumed to be correct.
Module C (End of life)	!	Results seem plausible although the underlying model was not reviewed. However, this has already undergone a critical review by a third party, hence assumed to be correct.
Module D (Benefits and load beyond the system boundary)	!	Results seem plausible although the underlying model was not reviewed. However, this has already undergone a critical review by a third party, hence assumed to be correct.

Sensitivity/Uncertainty analysis

[If applicable] is a sensitivity or an uncertainty analysis done?	✔	Different end of life scenarios are considered
If it is an uncertainty analysis, is the analysis qualitative or quantitative?	✔	A quantitative assessment has been carried out
Is the precise tool or method mentioned (ex: scenario analysis, Monte Carlo simulation, etc.)?	✔	Scenario analysis has been used
For comparative assertion, are the results robust enough to claim an environmental superiority? Are the goal, scope and inventory analysis compliant with ILCD and EeBGuide provisions?	n/a	

Reporting of the results

Are the auhors of the study mentioned in the LCA report?	✔	
Is the documentation of the LCA report compliant with the EeBGuide reporting templates?	✔	
Are the results potentially reproducible by a third party?	!	Limited availabity of primary data in report due to confidentiality means that the report alone will not be sufficient to reproduce the results.

EeBGuide Reviewer statement (EeB PRODUCTS)

Date:	31/10/2012
Assessor:	Katrin LENTZ
Case Study:	Transparent Solar Thermal Collector
Type of the study:	Stand alone LCA
Reviewer:	Sébastien LASVAUX
Statement of the reviewer	"I hereby certify that I was not part of the LCA study"

Review results

The LCA study meets EeBGuide provisions	X
The LCA study requires minor amendments to meet EeBGuide provisions	
The LCA study requires major amendments to meet EeBGuide provisions	

Short Review

Identify if the study is compliant with the individual provisions given for the relevant aspects

Goal and Scope definition	X	See the detailed review for more information
Does the LCA study properly fits in any of the three study types defined in EeBGuide? If deviation, are there any explanations/reasons?		
Description of the project		
Description of main parts/ systems/ processes		
Included life cycle stages		
Choice of Indicators		
Allocation rules		
Cut offs		
Life Cycle Inventory Analysis	X	See the detailed review for more information
Is the Life Cycle Inventory Analysis done in accordance with EeBGuide provisions?		
Life Cycle Impact Assessment	X	See the detailed review for more information
Is the Life Cycle Impact Assessment done in accordance with EeBGuide provisions?		
Interpretation	X	See the detailed review for more information
Is the interpretation of the results done in accordance with EeBGuide provisions?		
Reporting	X	See the detailed review for more information
Is the documentation of the LCA report compliant with the EeBGuide reporting templates?		

Detailed Review

Note for Reviewers: ***Please mark with an 1, 0 or -1 each column according to the rules defined***
✔ *Type 1: Assessor evaluation accepted and confirmed by Reviewer* ! *Type 0: Assessor evaluation needs correction; lack of documentation/evidence: see comments* ✖ *Type -1: Assessor evaluation technically incorrect; reevaluation needed: see comments*

Goal definition

	Fulfillment	Comments
Is the goal of the study compliant with EeBGuide provisions?	✔	
Is the type of study described?	✔	
Is the audience of the study described?	✔	
Are the skills of the audience concerned?	✔	
Is the application or the context of the study described?	✔	
Is the LCA study compliant with ISO, CEN standards (e.g. ISO 14040-44, EN 15804 / EN 15978)	✔	
Is the LCA study compliant with EeBGuide study type? If not, is there a reason for the deviation?	✔	Simplified LCA definition in EeBGuide is flexible in terms of life cycle stages included and number/type of indicators. Some justifications would be needed why e.g. module A4 (transport to the site) is excluded
Is the decision context (situation A, B, C according to the ILCD Handbook) justified? If not, are the choices made relevant?	!	Situation A (attributional LCA) is assumed though not explicitely mentionned neither justified in the EeBGuide LCA report.

Scope definition

General aspects

	Fulfillment	Comments
Is the scope definition compliant with EeBGuide provisions?	✔	The comparison of the components can be done under specific conditions as mentionned in the LCA report. However, the sentence "the comparison between the components shall not be performed (…) requires a critical review according to ISO 14040/14044" is confusing as "comparison" and "comparative assertions" terms are not clearly distinguished.
[If applicable] is the declared unit explained?	N/A	
[If applicable] is the functional unit explained?	✔	The functions described for the layouts are confusing as they are more consequences to the function "energy producer" of the collector.
[If applicable] are the behavior for the use of the product clearly explained?	!	Information not found in the EeGuide LCA report
[If applicable] is the domain of application of the product clearly stated?	✔	Mentionned in Table 3 ("designed application")
[If applicable] are the values of the technical performances of the product justified?	!	Information not found in the EeGuide LCA report
[If applicable] is the product compliant with other regulations e.g. REACH, or the accounting of dangerous substances emissions during the use phase?	!	Information not found in the EeGuide LCA report, but this criteria is assumed to be not applicable here? A feedback from the assessor would be needed.
[If applicable] is the functional equivalent clearly defined especially for comparative studies?	N/A	Not applicable here as the study is only looking at stand alone LCA results of products
Is the definition of system boundaries consistent?	✔	The definition of system boundaries follows the simplified LCA study type though it would have been nice to see why some of the stages were neglected i.e. due to minor relevance (assuming previous works have demonstrated it) or no relevance (e.g. there is no impact for e.g. A5 module due to process/installation of the product done by the worker without any machine/tools) or due to missing data (e.g. no data available for A4 stage). For instance, a generic transport distance is assumed for module A2 (293 km). I do not see much effort in taking into account for A4 as well? It would be still a simplified LCA but using default values enable to not systematically neglect life cycle aspect/stage.
Are the boundaries of the life cycle clearly presented (e.g. following the modularity principles of CEN TC 350 with modules A, B, C, D)?	✔	
Are the cut-off rules compliant with EeBGuide rules?	!	The cut-off rules are not clear as the information from the background data are not provided and as the neglected elements due to the lack of information from the suppliers. Section 5.4 should be more documented, was it the cut-off rules? Is it a mass cut-off rule?
Is the treatment of infrastructure for background and foreground data consistent according to EeBGuide rules?	!	The section "6.4 Data / background data quality requirements" is not that explicit. Especially sentence like "The datasets are complete and conform to (…) the criteria for the exclusion of inputs and outputs"is not much detailed.
Is the transport of goods (e.g. raw materials) accounted for? Are the scenario clearly stated and justified for every life cycle stage?	✔	Generally speaking, the transport of goods are compliant with EeBGuide provisions for the simplified LCA study type. However, the reviewer has some minor comments to consider for a revised study. The transport of raw materials is included for A2 stage but the transport the site (module A4) is neglected. This can be justified by the EeBGuide suggestions for the simplified LCA. However, the use of an averaged transport distance for all raw materials in A2 questions why this average distance was not considered for module A4. Simplified LCA aims at easing the LCA and not automatically neglecting the stages wihtout any justification.
[If applicable] are the biogenic CO2 accounting rules clearly justified?	N/A	No biomass raw materials so assumed to be a non relevant criteria in this case

Are the allocation rules of e.g. coproduction processes, reuse, recycling, recovery aspects clearly justified?	✔	
Are the mass of by-products without burden allocated (recycled matter) justified? Is the end-of-waste status clearly documented for background and foreground data?	!	Not enough information but it's only an issue for the data provider. So, it would be needed for this critieria to check the assumptions used in GaBi, ESUCO and ELCD (end-of-waste status).

Life cycle stages scope definition

For the included life cycle stages, are the scenario documented and relevant (e.g. for modules A4, A5, B1, B2, B3, B4, B5, B6, B7)?	✔	
[If applicable] is the reference service life justified?	!	The service life was chosen "according the to manufacturer". It is a first basis for the justification of the RSL but it would need to be more explained in terms of forseeable maintenance (refer to EeBGuide aspect "Distinction between B2, B3, B4, B5 modules".
For module C, are the EoL scenarios consistent according to EeBGuide provisions?	✔	
Are the boundaries between "module C - End of life" and "module D" clearly differentiated?	!	Aggregated datasets, not fuly described. As the reviewer do not have access to the background reports / datasets from GaBi, the boundaries cannot be checked.

Life Cycle Inventory Analysis

Background database / software

Is the used background database documented?	✔	
Is information given on LCA calculation process (e.g. LCA software used)?	✔	

Data collection for each life cycle stage

Is the choice between background and foreground data (or primary vs. secondary data) justified and consistent according to the goal of the study?	✔	Data handling seems consistent for the goal of the study
Is the collection of specific data from company/manufacturer (e.g. for the gate-to-gate stage) consistent with EeBGuide provisions?	✔	No data collection was conducted. Only the use of generic data from GaBi, ESUCO and ELCD were used. It is mentionned that specific data (i.e. industry based) were used though they do not clearly state that they refer to the producer of this specific product (TCSC).

Data representativeness for each life cycle stage

Is the technological, geographical, time-related representativeness always mentioned for background and foreground data?	✔	It is not mentionned in the EeBGuide LCA report but the statement in section 6.4 mentions that such information can be retrieved from the GaBi datasets. It is mentionned the updates took less than "5 years ago" except for ELCD datasets (up to 10 years).
Are the generic data amended to take into account the context of the study?	!	Not enough information / Not detailed (either not relevant or not possible according to the data / software used).
For the specific data, are the production sites surveyed mentioned?	N/A	Check needed of the background data / database reports
For the LCA data derived from expert judgment, are the sources identified?	N/A	Check needed of the background data / database reports
For the specific foreground data, are the sources identified (laboratory data etc.)	N/A	Check needed of the background data / database reports

Data representativeness for the production stage (modules A1-A3)

Are the rules to link input materials to a LCA data clearly presented?	!	Within section 6.2, the table 11 gives an overview of the materials input. However, there is some lack of precisions e.g. "aluminium" -> the quantity for each alternative is given but we do not have the information of the LCA data linked to each material. For example, it would be useful to know the LCA data associated to each material and see possible deviation. Concerning the LCA data for metals, the recycled content considered in production would be needed (is it a World, EU average?) as well as the EoL recycled rate.

Plausibility of values for cumulative LCI results

[If applicable] is the mass balance between the reference flow and the generated wastes for cradle to grave data (e.g. EPD) consistent?	!	Only mid-point categories provided, no input or output flows provided such as wastes.
[If applicable] is the mass of non energy resources used coherent with the reference flow	N/A	No LCI was provided as part of the results so this criteria cannot be checked
[If applicable] CO and CO2 emissions coherent with the mass of fossil energetic resources	N/A	No LCI was provided as part of the results so this criteria cannot be checked
Are the energy indicators coherent between them? (e.g. check of the sum of non renewable and renewable parts or between feedstock and fuel parts)	N/A	No energy indicators provided
[If applicable] is the energy indicators coherent with the energy resources used?	N/A	Not enough available information

Life Cycle Impact Assessment

Translating LCI flows to LCIA indicators

Are the rules to calculate the LCIA indicators from the LCI clearly stated and justified?	!	No detailed references to existing LCIA methods (e.g. CML version 4.1) was provided. It is however highly needed as first each method (e.g. CML 2001) has several updates and as the EN 15804 does not provide yet the list of characterisation factors.

Environmental indicators

Are the used indicators compliant with EeBGuide rules?	✓	For a simplified LCA, a set of indicators more consistent than for a screening LCA should be selected. In this case, the baseline impact categories from EN 15804 were selected except for the ADP. In addition, the study uses PENRE and PERE indicators. As the choice of indicators is nor regulated in EeBGuide, it would be useful that the assessor justifies more his choice e.g. to prevent from pollution transfer between included impact categories and not included ones.
Are the used indicators consistent regarding the study type?	✓	See above

Interpretation of the results

Environmental indicators results

Are the results justified (contribution of processes to any environmental indicators)?	✓	

Plausibility of product LCA results per life cycle stage

Module A1-A3 (Production)	✓	The 10% security factor should be discussed in the final results as the production stage is the most signifcant stage. How reliable is the 10% factor compared to the "real impact"? Is the transport distances significant or not in the production stage? If not, then the use of a default value can be justified...
Module A4-A5 (Construction processes)	N/A	
Module B (Use)	✓	
Module C (End of life)	!	
Module D (Benefits and load beyond the system boundary)	!	Plausibility of results for modules C and D would be easier to check if the modules are breakdown and if background information concerning e.g. the recycling rates is provided. Is the recycling potential the same whatever the application of the steel/aluminium?

Sensitivity/Uncertainty analysis

[If applicable] is a sensitivity or an uncertainty analysis done?	N/A	No sensitivity/uncertainty analyses conducted as not within the scope of the study
If it is an uncertainty analysis, is the analysis qualitative or quantitative?	N/A	No sensitivity/uncertainty analyses conducted as not within the scope of the study
Is the precise tool or method mentioned (ex: scenario analysis, Monte Carlo simulation, etc.)?	N/A	No sensitivity/uncertainty analyses conducted as not within the scope of the study
For comparative assertion, are the results robust enough to claim an environmental superiority? Are the goal, scope and inventory analysis compliant with ILCD and EeBGuide provisions?	N/A	No sensitivity/uncertainty analyses conducted as not within the scope of the study

Reporting of the results

Are the parties of the study mentioned in the LCA report (commisionner, author of the study and critical reviewer)?	✓	
Is the documentation of the LCA report compliant with the EeBGuide reporting templates?	✓	
Are the results potentially reproducible by a third party?	✓	

EeBGuide Reviewer statement (New simple BUILDING)

Date:	30/10/2012
Assessor:	Alexandra Lebert, Engineer, CSTB & Boris Bosdevigie, Engineer, CSTB
Case Study:	Mison ERICLOR
Type of the study:	Complete
Reviewer:	Cristina Gazulla, ESCI
Statement of the reviewer	"I hereby certify that I was not part of the LCA study"

Review results

The LCA study meets EeBGuide provisions	X
The LCA study requires minor amendments to meet EeBGuide provisions	
The LCA study requires major amendments to meet EeBGuide provisions	

Short Review

Identify if the study is compliant with the individual provisions given for the relevant aspects

Goal and Scope definition		
Does the LCA study properly fits in any of the three study types defined in EeBGuide? If deviation, are there any explanations/reasons?	100%	HVAC system not included
Description of the project	100%	
Description of main parts/ systems/ processes	100%	
Included life cycle stages	100%	
Choice of Indicators	100%	Indicadors used in the HQE Performance label
Allocation rules	100%	No allocation is used
Cut offs	100%	Based on NF P01-010, 2% by mass of the reference flow instead of 5 % but without requirements for energy inputs.
Life Cycle Inventory Analysis		
Is the Life Cycle Inventory Analysis done in accordance with EeBGuide provisions?	100%	
Life Cycle Impact Assessment		
Is the Life Cycle Impact Assessment done in accordance with EeBGuide provisions?	50%	Total results are provided, but results are not displayed per each life cycle stage/module
Interpretation		
Is the interpretation of the results done in accordance with EeBGuide provisions?	100%	
Reporting		
Is the documentation of the LCA report compliant with the EeBGuide reporting templates?	100%	

Detailed Review

***Note for Reviewers:* Please mark with an 1, 0 or -1 each column according to the rules defined**	
✔	*Type 1: Assessor evaluation accepted and confirmed by Reviewer*
!	*Type 0: Assessor evaluation needs correction; lack of documentation/evidence: see comments*
✖	*Type -1: Assessor evaluation technically incorrect; reevaluation needed: see comments*

Goal definition

	Fulfillment	Comments
Is the goal of the study compliant with EeBGuide provisions?	✔	
Is the type of study described?	✔	
Is the audience of the study described?	✔	
Are the skills of the audience concerned?	✔	
Is the application or the context of the study described?	✔	
Is the LCA study compliant with ISO, CEN standards (e.g. ISO 14040-44, EN 15804 / EN 15978)	!	The study does not fully compliant with ISO 14044 (interpretation) nor 15804 (impact categories)
Is the LCA study compliant with EeBGuide study type? If not, is there a reason for the deviation?	✔	
Is the decision context (situation A, B, C according to the ILCD Handbook) justified? If not, are the choices made relevant?	✔	Not necessary to make a deviation. Life cyce assessment of a building => Situation A modelling

Scope definition

	Fulfillment	Comments
General aspects		
Is the scope definition compliant with EeBGuide provisions?	✔	
Is the object of assessment cleakry described?	✔	
Is the functional equivalent clearly defined especially for comparative studies?	✔	Specified; no comparative assertion
Are the calculation rules of surface areas (e.g. Gross Floor Area - GFA) explained?	!	
Is the reference study period clearly defined? Is there any deviation to the recommmended RSP for the baseline scenario of EeBGuide? If yes, is it justified?	✔	
Is the definition of system boundaries consistent according to EeBGuide provisions?	✔	
Are the boundaries of the life cycle clearly presented (e.g. following the modularity principles of CEN TC 350 with modules A, B, C, D)?	✔	
Are the cut-off rules compliant with EeBGuide provisions/study types (if relevant)?	✔	No cut off rules; inclusion of the building parts mentioned in the EeBGuide study types
Is the treatment of infrastructure for background and foreground data consistent according to EeBGuide rules?	✔	
Is the transport of goods (e.g. raw materials) accounted for? Are the scenario clearly stated and justified for every life cycle stage where transport occurs?	✔	
[If applicable] are the biogenic CO2 accounting rules clearly justified?	✔	No accounting for biogenic carbon
Are the allocation rules of e.g. coproduction processes, reuse, recycling, recovery aspects clearly justified?	✔	no allocation.
Are the mass of by-products without burden allocated (recycled matter) justified? Is the end-of-waste status clearly documented for background and foreground data?	✔	no by-product
For the included life cycle stages, are the scenario documented (e.g. for modules A4, A5, B1, B2, B3, B4, B5, B6, B7, C1, C2, C3, C4)?	✔	
Scope definition for the contributor "building product and technical equipment"		
Are the level of completeness (e.g. calculation rules and included building products and technical equipment) appropriate regarding the EeBGuide study type?	✔	
For cradle-to-gate data, are the scenarios for gate-to-grave stages documented according to EeBGuide study types?	✔	
For cradle-to-grave data (alreay defined prior to the case study), are the scenarios relevant for the building under study? If not, are the data adapted?	✔	
[If applicable] is the reference service life justified and coherent for each building product or technical equipment?	✔	
For module C, are the EoL scenarios consistent according to EeBGuide provisions?	✔	
Are the boundaries between "module C - End of life" and "module D" clearly differentiated?	✔	Module D not considered
Scope definition for the contributor "operational energy use"		
Are the level of completeness (e.g. calculation rules and included energy uses) appropriate regarding the EeBGuide study type?	✔	
[If applicable] Are energy consumption values consitent according to the energy performance target defined in the project?	✔	no energy target is defined in the project.
[If applicable] are the allocations of exported renewable produced on-site justified? Is it compliant to EeBGuide rules?	✔	no allocation.
Scope definition for the contributor "operational water use"		
Are the level of completeness (e.g. calculation rules and included water uses) appropriate regarding the EeBGuide study type?	✔	
Scope definition for the other contributors (construction site, deconstruction activities, transport of the users of the building if included)		
Is the choice of LCA, EPD data consistent according to the study type?	✔	
Are the completeness (e.g. calculation rules) appropriate regarding the study type?	✔	

Life Cycle Inventory Analysis

Background database / software

Is the database (compiling LCA or EPD data for products and processes) used for the building LCA study documented?	✔	FDES, Ecoinvent datasets
Are the used data critically reviewed (e.g. for generic LCA) or verified by third party (e.g. for EPD)?	!	Some of the EPDs may be not verified by third party
Is the building LCA software described/referenced?	✔	ELODIE

LCI for the contributor "building product and technical equipment"

Is the choice of LCA, EPD data consistent according to the study type?	✔	
Is the use of building physical description data consistent (with the project documentation ?	✔	
Can densities/ weight areas etc. be checked?	✔	
Can areas and volumes be checked?	✔	
Can details and drawings be checked?	✔	
Are the hypotheses for the calculation of quantities (according to the appropriate functional unit) provided?	✔	Not needed

LCI for the contributor "operational energy use"

Is the choice of LCA, EPD data consistent according to the study type (in terms of technological, geographical and time-related representativeness, completeness and reliability) ?	✔	
[Cross-check] Are the materials from the building description data consistent to the ones used as a basis for the energy calculations?	✔	

LCI for the contributor "operational water use"

Is the choice of LCA, EPD data consistent according to the study type (in terms of technological, geographical and time-related representativeness, completeness and reliability) ?	✔	
[Plausibility check] Are the quantities of water use per person plausible compared to average values? (eg. in France, residential use of drinking water is around 40m3/pers/year).	✔	

LCI for other contributors (construction site, deconstruction activities, transport of the users of the building if included)

Is the choice of LCA, EPD data consistent according to the study type (in terms of technological, geographical and time-related representativeness, completeness and reliability) ?	✔	

Life Cycle Impact Assessment

Translating LCI flows to LCIA indicators

Are the rules to calculate the LCIA indicators from the LCI clearly stated and justified?	✔	Based on NF P01-010

Environmental indicators

Are the used indicators compliant with EeBGuide general provisions?	✔	
Are the used indicators consistent regarding the EeBGuide study type?	✔	

Interpretation of the results

Environmental indicators results

Are the results justified (contribution of processes to any environmental indicators)?	✔	

Plausibility of the results per life cycle stage of the building LCA

Module A1-A3 (Production)	✔	
Module A4-A5 (Construction processes)	✔	
Module B (Use)	✔	B1 and B5 not included
Module C (End of life)	✔	
Module D (Benefits and load beyond the system boundary)	✔	not included

Plausibility of the results for the following contributors of the building LCA

Building products and technical equipment (modules A, B, C)	✔	
Operational energy use (module B6)	✔	
Operational water use (module B7)	✔	
Construction site (module A5)	✔	
Deconstruction activities (module C1)	✔	not included in ELODIE so far
Transport of the users of the building (not covered by EN 15978)	✔	not included

Sensitivity/Uncertainty analysis

[If applicable] is a sensitivity or an uncertainty analysis done?	✔	no sensitivity analysis was conducted, but not necessary.
If it is an uncertainty analysis, is the analysis qualitative or quantitative?	✔	see above
Is the precise tool or method mentioned (ex: scenario analysis, Monte Carlo simulation, etc.)?	✔	see above
For comparative assertion, are the results robust enough to claim an environmental superiority? Are the goal, scope and inventory analysis compliant with ILCD and EeBGuide provisions?	✔	no comparative assertion

Normalisation of impacts

[If applicable] is a normalisation step conducted (e.g. comparison of the results with reference values for the same type of buildings)?	✔	no normalization was conducted.

Reporting of the results

Are the auhors of the study mentioned in the LCA report?	✔	
Is the documentation of the LCA report compliant with the EeBGuide reporting templates?	✔	
Are the results potentially reproducible by a third party?	✔	

EeBGuide Reviewer statement (New complex BUILDING)

SEVENTH FRAMEWO PROGRAMME

Date:	30/10/2012
Assessor:	Alexandra LEBERT, Jessia FEDOLLIERE and Manuel BAZZANA, Research Engineers.
Case Study:	Office building A
Type of the study:	Complete
Reviewer:	Cristina Gazulla, ESCI
Statement of the reviewer	"I hereby certify that I was not part of the LCA study"

Review results

The LCA study meets EeBGuide provisions	X
The LCA study requires minor amendments to meet EeBGuide provisions	
The LCA study requires major amendments to meet EeBGuide provisions	

Short Review

Identify if the study is compliant with the individual provisions given for the relevant aspects

Goal and Scope definition		
Does the LCA study properly fits in any of the three study types defined in EeBGuide? If deviation, are there any explanations/reasons?	100%	HVAC system not included
Description of the project	100%	
Description of main parts/ systems/ processes	100%	
Included life cycle stages	100%	
Choice of Indicators	100%	Indicators used in the HQE Performance label
Allocation rules	100%	No allocation is used
Cut offs	100%	Based on NF P01-010, 2% by mass of the reference flow instead of 5 % but without requirements for energy inputs.
Life Cycle Inventory Analysis		
Is the Life Cycle Inventory Analysis done in accordance with EeBGuide provisions?	100%	
Life Cycle Impact Assessment		
Is the Life Cycle Impact Assessment done in accordance with EeBGuide provisions?	50%	Total results are provided, but results are not displayed per each life cycle stage/module
Interpretation		
Is the interpretation of the results done in accordance with EeBGuide provisions?	100%	
Reporting		
Is the documentation of the LCA report compliant with the EeBGuide reporting templates?	100%	

Detailed Review

Note for Reviewers: Please mark with an 1, 0 or -1 each column according to the rules defined	
✓	*Type 1: Assessor evaluation accepted and confirmed by Reviewer*
!	*Type 0: Assessor evaluation needs correction; lack of documentation/evidence: see comments*
✗	*Type -1: Assessor evaluation technically incorrect; reevaluation needed: see comments*

Goal definition

	Fulfillment	Comments
Is the goal of the study compliant with EeBGuide provisions?	✓	
Is the type of study described?	✓	
Is the audience of the study described?	✓	
Are the skills of the audience concerned?	✓	
Is the application or the context of the study described?	✓	
Is the LCA study compliant with ISO, CEN standards (e.g. ISO 14040-44, EN 15804 / EN 15978)	!	The study does not fully compliant with ISO 14044 (interpretation) nor 15804 (impact categories)
Is the LCA study compliant with EeBGuide study type? If not, is there a reason for the deviation?	✓	
Is the decision context (situation A, B, C according to the ILCD Handbook) justified? If not, are the choices made relevant?	✓	Not necessary to make a deviation. Life cyce assessment of a building => Situation A modelling

Scope definition

	Fulfillment	Comments
General aspects		
Is the scope definition compliant with EeBGuide provisions?	✓	
Is the object of assessment cleалry described?	✓	
Is the functional equivalent clearly defined especially for comparative studies?	✓	Specified; no comparative assertion
Are the calculation rules of surface areas (e.g. Gross Floor Area - GFA) explained?	!	
Is the reference study period clearly defined? Is there any deviation to the recommmended RSP for the baseline scenario of EeBGuide? If yes, is it justified?	✓	
Is the definition of system boundaries consistent according to EeBGuide provisions?	✓	
Are the boundaries of the life cycle clearly presented (e.g. following the modularity principles of CEN TC 350 with modules A, B, C, D)?	✓	
Are the cut-off rules compliant with EeBGuide provisions/study types (if relevant)?	✓	No cut off rules; inclusion of the building parts mentioned in the EeBGuide study types
Is the treatment of infrastructure for background and foreground data consistent according to EeBGuide rules?	✓	
Is the transport of goods (e.g. raw materials) accounted for? Are the scenario clearly stated and justified for every life cycle stage where transport occurs?	✓	
[If applicable] are the biogenic CO2 accounting rules clearly justified?	✓	No accounting for biogenic carbon
Are the allocation rules of e.g. coproduction processes, reuse, recycling, recovery aspects clearly justified?	✓	no allocation.
Are the mass of by-products without burden allocated (recycled matter) justified? Is the end-of-waste status clearly documented for background and foreground data?	✓	no by-product
For the included life cycle stages, are the scenario documented (e.g. for modules A4, A5, B1, B2, B3, B4, B5, B6, B7, C1, C2, C3, C4)?	✓	
Scope definition for the contributor "building product and technical equipment"		
Are the level of completeness (e.g. calculation rules and included building products and technical equipment) appropriate regarding the EeBGuide study type?	✓	
For cradle-to-gate data, are the scenarios for gate-to-grave stages documented according to EeBGuide study types?	✓	
For cradle-to-grave data (alreay defined prior to the case study), are the scenarios relevant for the building under study? If not, are the data adapted?	✓	
[If applicable] is the reference service life justified and coherent for each building product or technical equipment?	✓	
For module C, are the EoL scenarios consistent according to EeBGuide provisions?	✓	
Are the boundaries between "module C - End of life" and "module D" clearly differentiated?	✓	Module D not considered
Scope definition for the contributor "operational energy use"		
Are the level of completeness (e.g. calculation rules and included energy uses) appropriate regarding the EeBGuide study type?	✓	
[If applicable] Are energy consumption values consitent according to the energy performance target defined in the project?	✓	no energy target is defined in the project.
[If applicable] are the allocations of exported renewable produced on-site justified? Is it compliant to EeBGuide rules?	✓	no allocation.
Scope definition for the contributor "operational water use"		
Are the level of completeness (e.g. calculation rules and included water uses) appropriate regarding the EeBGuide study type?	✓	
Scope definition for the other contributors (construction site, deconstruction activities, transport of the users of the building if included)		
Is the choice of LCA, EPD data consistent according to the study type?	✓	
Are the completeness (e.g. calculation rules) appropriate regarding the study type?	✓	

Life Cycle Inventory Analysis

Background database / software

Is the database (compiling LCA or EPD data for products and processes) used for the building LCA study documented?	✓	FDES, Ecoinvent datasets
Are the used data critically reviewed (e.g. for generic LCA) or verified by third party (e.g. for EPD)?	!	Some of the EPDs may be not verified by third party
Is the building LCA software described/referenced?	✓	ELODIE

LCI for the contributor "building product and technical equipment"

Is the choice of LCA, EPD data consistent according to the study type?	✓	
Is the use of building physical description data consistent (with the project documentation ?	✓	
Can densities/ weight areas etc. be checked?	✓	
Can areas and volumes be checked?	✓	
Can details and drawings be checked?	✓	
Are the hypotheses for the calculation of quantities (according to the appropriate functional unit) provided?	✓	Not needed

LCI for the contributor "operational energy use"

Is the choice of LCA, EPD data consistent according to the study type (in terms of technological, geographical and time-related representativeness, completeness and reliability) ?	✓	
[Cross-check] Are the materials from the building description data consistent to the ones used as a basis for the energy calculations?	✓	

LCI for the contributor "operational water use"

Is the choice of LCA, EPD data consistent according to the study type (in terms of technological, geographical and time-related representativeness, completeness and reliability) ?	✓	
[Plausibility check] Are the quantities of water use per person plausible compared to average values? (eg. in France, residential use of drinking water is around 40m3/pers/year).	✓	

LCI for other contributors (construction site, deconstruction activities, transport of the users of the building if included)

Is the choice of LCA, EPD data consistent according to the study type (in terms of technological, geographical and time-related representativeness, completeness and reliability) ?	✓	

Life Cycle Impact Assessment

Translating LCI flows to LCIA indicators

Are the rules to calculate the LCIA indicators from the LCI clearly stated and justified?	✓	Based on NF P01-010

Environmental indicators

Are the used indicators compliant with EeBGuide general provisions?	✓	
Are the used indicators consistent regarding the EeBGuide study type?	✓	

Interpretation of the results

Environmental indicators results

Are the results justified (contribution of processes to any environmental indicators)?	✓	

Plausibility of the results per life cycle stage of the building LCA

Module A1-A3 (Production)	✓	
Module A4-A5 (Construction processes)	✓	
Module B (Use)	✓	B1 and B5 not included
Module C (End of life)	✓	
Module D (Benefits and load beyond the system boundary)	✓	not included

Plausibility of the results for the following contributors of the building LCA

Building products and technical equipment (modules A, B, C)	✓	
Operational energy use (module B6)	✓	
Operational water use (module B7)	✓	
Construction site (module A5)	✓	
Deconstruction activities (module C1)	✓	not included in ELODIE so far
Transport of the users of the building (not covered by EN 15978)	✓	not included

Sensitivity/Uncertainty analysis

[If applicable] is a sensitivity or an uncertainty analysis done?	✓	no sensitivity analysis was conducted, but not necessary.
If it is an uncertainty analysis, is the analysis qualitative or quantitative?	✓	see above
Is the precise tool or method mentioned (ex: scenario analysis, Monte Carlo simulation, etc.)?	✓	see above
For comparative assertion, are the results robust enough to claim an environmental superiority? Are the goal, scope and inventory analysis compliant with ILCD and EeBGuide provisions?	✓	no comparative assertion

Normalisation of impacts

[If applicable] is a normalisation step conducted (e.g. comparison of the results with reference values for the same type of buildings)?	✓	no normalization was conducted.

Reporting of the results

Are the auhors of the study mentioned in the LCA report?	✓	
Is the documentation of the LCA report compliant with the EeBGuide reporting templates?	✓	
Are the results potentially reproducible by a third party?	✓	

EeBGuide Reviewer statement (Existing BUILDING 1)

Date:	16/10/2012
Assessor:	Cristina Gazulla Santos
Case Study:	LCA of the building Can Jofresa (Barcelona, Spain)
Type of the study:	Simplified existing building LCA
Reviewer:	Johannes Gantner
Statement of the reviewer	"I hereby certify that I was not part of the LCA study"

Review results

The LCA study meets EeBGuide provisions	100%
The LCA study requires minor amendments to meet EeBGuide provisions	
The LCA study requires major amendments to meet EeBGuide provisions	

Short Review

Identify if the study is compliant with the individual provisions given for the relevant aspects

Goal and Scope definition		
Does the LCA study properly fits in any of the three study types defined in EeBGuide? If deviation, are there any explanations/reasons?	100%	The study fits the requirements of a "Simplified LCA" study with minor adjustments (A1-A3) due to object of assessment (existing building)
Description of the project	100%	detailed description with additional information
Description of main parts/ systems/ processes	100%	detailed description with additional information
Included life cycle stages	100%	Due to the fact that the focus is on existing buildings, the lifecycle stages A1-A3 were omitted
Choice of Indicators	100%	The proposed indicators Primary Energy (renewable and non renewable), as well as GWP were used. Several other indicators often used in building labelling schemes like DGNB were provided in addition.
Allocation rules	100%	no allocation is used
Cut offs	100%	
Life Cycle Inventory Analysis		
Is the Life Cycle Inventory Analysis done in accordance with EeBGuide provisions?	100%	
Life Cycle Impact Assessment		
Is the Life Cycle Impact Assessment done in accordance with EeBGuide provisions?	100%	CML was used for the used datasets.
Interpretation		
Is the interpretation of the results done in accordance with EeBGuide provisions?	100%	
Reporting		
Is the documentation of the LCA report compliant with the EeBGuide reporting templates?	100%	

Detailed Review

***Note for Reviewers:* Please mark with an 1, 0 or -1 each column according to the rules defined**	
✔	*Type 1: Assessor evaluation accepted and confirmed by Reviewer*
!	*Type 0: Assessor evaluation needs correction; lack of documentation/evidence: see comments*
✖	*Type -1: Assessor evaluation technically incorrect; reevaluation needed: see comments*

Goal definition

	Fulfillment	Comments
Is the goal of the study compliant with EeBGuide provisions?	✔	LCA assessment of an existing building
Is the type of study described?	✔	Simplified existing building LCA study
Is the audience of the study described?	✔	EeBGuide consortium, Public
Are the skills of the audience concerned?	✔	
Is the application or the context of the study described?	✔	
Is the LCA study compliant with ISO, CEN standards (e.g. ISO 14040-44, EN 15804 / EN 15978)	✔	
Is the LCA study compliant with EeBGuide study type? If not, is there a reason for the deviation?	✔	
Is the decision context (situation A, B, C according to the ILCD Handbook) justified? If not, are the choices made relevant?	✔	Not necessary to make a deviation. Refurbishment of one specific existing building => Situation A modelling

Scope definition

	Fulfillment	Comments
General aspects		
Is the scope definition compliant with EeBGuide provisions?	✔	
Is the object of assessment clealry described?	✔	
Is the functional equivalent clearly defined especially for comparative studies?	✔	Specified; no comparative assertion
Are the calculation rules of surface areas (e.g. Gross Floor Area - GFA) explained?	✖	
Is the reference study period clearly defined? Is there any deviation to the recommmended RSP for the baseline scenario of EeBGuide? If yes, is it justified?	✔	
Is the definition of system boundaries consistent according to EeBGuide provisions?	✔	
Are the boundaries of the life cycle clearly presented (e.g. following the modularity principles of CEN TC 350 with modules A, B, C, D)?	✔	
Are the cut-off rules compliant with EeBGuide provisions/study types (if relevant)?	✔	No cut off rules; inclusion of the building parts mentioned in the EeBGuide study types
Is the treatment of infrastructure for background and foreground data consistent according to EeBGuide rules?	✔	
Is the transport of goods (e.g. raw materials) accounted for? Are the scenario clearly stated and justified for every life cycle stage where transport occurs?	✔	Accounted for. Besides the transport to construction site
[If applicable] are the biogenic CO2 accounting rules clearly justified?	✔	No accounting for biogenic carbon
Are the allocation rules of e.g. coproduction processes, reuse, recycling, recovery aspects clearly justified?	✔	no allocation.
Are the mass of by-products without burden allocated (recycled matter) justified? Is the end-of-waste status clearly documented for background and foreground data?	✔	no by-product
For the included life cycle stages, are the scenario documented (e.g. for modules A4, A5, B1, B2, B3, B4, B5, B6, B7, C1, C2, C3, C4)?	✔	
Scope definition for the contributor "building product and technical equipment"		
Are the level of completeness (e.g. calculation rules and included building products and technical equipment) appropriate regarding the EeBGuide study type?	✔	
For cradle-to-gate data, are the scenarios for gate-to-grave stages documented according to EeBGuide study types?	✔	
For cradle-to-grave data (alreay defined prior to the case study), are the scenarios relevant for the building under study? If not, are the data adapted?	✔	
[If applicable] is the reference service life justified and coherent for each building product or technical equipment?	✔	
For module C, are the EoL scenarios consistent according to EeBGuide provisions?	✔	
Are the boundaries between "module C - End of life" and "module D" clearly differentiated?	✔	not considered
Scope definition for the contributor "operational energy use"		
Are the level of completeness (e.g. calculation rules and included energy uses) appropriate regarding the EeBGuide study type?	✔	
[If applicable] Are energy consumption values consitent according to the energy performance target defined in the project?	✔	no energy target is defined in the project.
[If applicable] are the allocations of exported renewable produced on-site justified? Is it compliant to EeBGuide rules?	✔	no allocation.
Scope definition for the contributor "operational water use"		
Are the level of completeness (e.g. calculation rules and included water uses) appropriate regarding the EeBGuide study type?	✔	water was not considered in the study.
Scope definition for the other contributors (construction site, deconstruction activities, transport of the users of the building if included)		
Is the choice of LCA, EPD data consistent according to the study type?	✔	
Are the completeness (e.g. calculation rules) appropriate regarding the study type?	✔	

Life Cycle Inventory Analysis

Background database / software

Is the database (compiling LCA or EPD data for products and processes) used for the building LCA study documented?	✔	FDES, GABI datasets
Are the used data critically reviewed (e.g. for generic LCA) or verified by third party (e.g. for EPD)?	!	GABI datasets were not critically reviewed.
Is the building LCA software described/referenced?	✔	ELODIE

LCI for the contributor "building product and technical equipment"

Is the choice of LCA, EPD data consistent according to the study type?	✔	
Is the use of building physical description data consistent (with the project documentation ?	✔	
Can densities/ weight areas etc. be checked?	✔	
Can areas and volumes be checked?	✔	
Can details and drawings be checked?	✔	
Are the hypotheses for the calculation of quantities (according to the appropriate fonctional unit) provided?	✔	Not needed

LCI for the contributor "operational energy use"

Is the choice of LCA, EPD data consistent according to the study type (in terms of technological, geographical and time-related representativeness, completeness and reliability) ?	✔	
[Cross-check] Are the materials from the building description data consistent to the ones used as a basis for the energy calculations?	✔	

LCI for the contributor "operational water use"

Is the choice of LCA, EPD data consistent according to the study type (in terms of technological, geographical and time-related representativeness, completeness and reliability) ?	✔	not concidered
[Plausibility check] Are the quantities of water use per person plausible compared to average values? (eg. in France, residential use of drinking water is around 40m3/pers/year).	✔	not concidered

LCI for other contributors (construction site, deconstruction activities, transport of the users of the building if included)

Is the choice of LCA, EPD data consistent according to the study type (in terms of technological, geographical and time-related representativeness, completeness and reliability) ?	✔	

Life Cycle Impact Assessment

Translating LCI flows to LCIA indicators

Are the rules to calculate the LCIA indicators from the LCI clearly stated and justified?	✔	CML

Environmental indicators

Are the used indicators compliant with EeBGuide general provisions?	✔	
Are the used indicators consistent regarding the EeBGuide study type?	✔	

Interpretation of the results

Environmental indicators results

Are the results justified (contribution of processes to any environmental indicators)?	✔	

Plausibility of the results per life cycle stage of the building LCA

Module A1-A3 (Production)	✔	not included
Module A4-A5 (Construction processes)	✔	A4 not included
Module B (Use)	✔	
Module C (End of life)	✔	not included
Module D (Benefits and load beyond the system boundary)	✔	not included

Plausibility of the results for the following contributors of the building LCA

Building products and technical equipment (modules A, B, C)	✔	
Operational energy use (module B6)	✔	
Operational water use (module B7)	✔	not included
Construction site (module A5)	✔	
Deconstruction activities (module C1)	✔	not included in ELODIE so far
Transport of the users of the building (not covered by EN 15978)	✔	not included

Sensitivity/Uncertainty analysis

[If applicable] is a sensitivity or an uncertainty analysis done?	✔	no sensitivity analysis was conducted, but not necessary.
If it is an uncertainty analysis, is the analysis qualitative or quantitative?	✔	see above
Is the precise tool or method mentioned (ex: scenario analysis, Monte Carlo simulation, etc.)?	✔	see above
For comparative assertion, are the results robust enough to claim an environmental superiority? Are the goal, scope and inventory analysis compliant with ILCD and EeBGuide provisions?	✔	no comparative assertion

Normalisation of impacts

[If applicable] is a normalisation step conducted (e.g. comparison of the results with reference values for the same type of buildings)?	✔	no normalization was conducted.

Reporting of the results

Are the auhors of the study mentioned in the LCA report?	✔	
Is the documentation of the LCA report compliant with the EeBGuide reporting templates?	✔	
Are the results potentially reproducible by a third party?	✔	

EeBGuide Reviewer statement (Existing BUILDING 2)

Date:	07/11/2012
Assessor:	Cristina Gazulla Santos
Case Study:	LCA of the building Amara (Donostia, Spain)
Type of the study:	Simplified existing building LCA
Reviewer:	Johannes Gantner
Statement of the reviewer	"I hereby certify that I was not part of the LCA study"

Review results

The LCA study meets EeBGuide provisions	100%
The LCA study requires minor amendments to meet EeBGuide provisions	
The LCA study requires major amendments to meet EeBGuide provisions	

Short Review

Identify if the study is compliant with the individual provisions given for the relevant aspects

Goal and Scope definition		
Does the LCA study properly fits in any of the three study types defined in EeBGuide? If deviation, are there any explanations/reasons?	100%	The study fits the requirements of a "Simplified LCA" study with minor adjustments (A1-A3) due to object of assessment (existing building)
Description of the project	100%	detailed description with additional information
Description of main parts/ systems/ processes	100%	detailed description with additional information
Included life cycle stages	100%	Due to the fact that the focus is on existing buildings, the lifecycle stages A1-A3 were omitted
Choice of Indicators	100%	The proposed indicators Primary Energy (renewable and non renewable), as well as GWP were used. Several other indicators often used in building labelling schemes like DGNB were provided in addition.
Allocation rules	100%	no allocation is used
Cut offs	100%	
Life Cycle Inventory Analysis		
Is the Life Cycle Inventory Analysis done in accordance with EeBGuide provisions?	100%	
Life Cycle Impact Assessment		
Is the Life Cycle Impact Assessment done in accordance with EeBGuide provisions?	100%	
Interpretation		
Is the interpretation of the results done in accordance with EeBGuide provisions?	100%	
Reporting		
Is the documentation of the LCA report compliant with the EeBGuide reporting templates?	100%	

Detailed Review

Note for Reviewers: ***Please mark with an 1, 0 or -1 each column according to the rules defined***

✔	*Type 1: Assessor evaluation accepted and confirmed by Reviewer*
!	*Type 0: Assessor evaluation needs correction; lack of documentation/evidence: see comments*
✘	*Type -1: Assessor evaluation technically incorrect; reevaluation needed: see comments*

	Fulfillment	Comments
Goal definition		
Is the goal of the study compliant with EeBGuide provisions?	✔	LCA assessment of an existing building
Is the type of study described?	✔	Simplified existing building LCA study
Is the audience of the study described?	✔	EeBGuide consortium, Public
Are the skills of the audience concerned?	✔	
Is the application or the context of the study described?	✔	
Is the LCA study compliant with ISO, CEN standards (e.g. ISO 14040-44, EN 15804 / EN 15978)	✔	
Is the LCA study compliant with EeBGuide study type? If not, is there a reason for the deviation?	✔	Focus on refurbishment (lifecycle stages A1- A3 are omitted)
Is the decision context (situation A, B, C according to the ILCD Handbook) justified? If not, are the choices made relevant?	✔	Not necessary to make a deviation. Refurbishment of one specific existing building => Situation A modelling
Scope definition		
General aspects		
Is the scope definition compliant with EeBGuide provisions?	✔	
Is the object of assessment clealry described?	✔	
Is the functional equivalent clearly defined especially for comparative studies?	✔	Specified; no comparative assertion
Are the calculation rules of surface areas (e.g. Gross Floor Area - GFA) explained?	✘	
Is the reference study period clearly defined? Is there any deviation to the recommmended RSP for the baseline scenario of EeBGuide? If yes, is it justified?	✔	
Is the definition of system boundaries consistent according to EeBGuide provisions?	✔	
Are the boundaries of the life cycle clearly presented (e.g. following the modularity principles of CEN TC 350 with modules A, B, C, D)?	✔	
Are the cut-off rules compliant with EeBGuide provisions/study types (if relevant)?	✔	No cut off rules; inclusion of the building parts mentioned in the EeBGuide study types
Is the treatment of infrastructure for background and foreground data consistent according to EeBGuide rules?	✔	
Is the transport of goods (e.g. raw materials) accounted for? Are the scenario clearly stated and justified for every life cycle stage where transport occurs?	✔	Accounted for. Besides the transport to constructiion site
[If applicable] are the biogenic CO2 accounting rules clearly justified?	✔	No accounting for biogenic carbon
Are the allocation rules of e.g. coproduction processes, reuse, recycling, recovery aspects clearly justified?	✔	no allocation.
Are the mass of by-products without burden allocated (recycled matter) justified? Is the end-of-waste status clearly documented for background and foreground data?	✔	no by-product
For the included life cycle stages, are the scenario documented (e.g. for modules A4, A5, B1, B2, B3, B4, B5, B6, B7, C1, C2, C3, C4)?	✔	
Scope definition for the contributor "building product and technical equipment"		
Are the level of completeness (e.g. calculation rules and included building products and technical equipment) appropriate regarding the EeBGuide study type?	✔	
For cradle-to-gate data, are the scenarios for gate-to-grave stages documented according to EeBGuide study types?	✔	
For cradle-to-grave data (alreay defined prior to the case study), are the scenarios relevant for the building under study? If not, are the data adapted?	✔	
[If applicable] is the reference service life justified and coherent for each building product or technical equipment?	✔	
For module C, are the EoL scenarios consistent according to EeBGuide provisions?	✔	
Are the boundaries between "module C - End of life" and "module D" clearly differentiated?	✔	not considered
Scope definition for the contributor "operational energy use"		
Are the level of completeness (e.g. calculation rules and included energy uses) appropriate regarding the EeBGuide study type?	✔	
[If applicable] Are energy consumption values consitent according to the energy performance target defined in the project?	✔	no energy target is defined in the project.
[If applicable] are the allocations of exported renewable produced on-site justified? Is it compliant to EeBGuide rules?	✔	no allocation.
Scope definition for the contributor "operational water use"		
Are the level of completeness (e.g. calculation rules and included water uses) appropriate regarding the EeBGuide study type?	✔	water was not considered in the study.
Scope definition for the other contributors (construction site, deconstruction activities, transport of the users of the building if included)		
Is the choice of LCA, EPD data consistent according to the study type?	✔	
Are the completeness (e.g. calculation rules) appropriate regarding the study type?	✔	

Life Cycle Inventory Analysis

Background database / software

Is the database (compiling LCA or EPD data for products and processes) used for the building LCA study documented?	✓	GABI datasets
Are the used data critically reviewed (e.g. for generic LCA) or verified by third party (e.g. for EPD)?	!	not all GABI datasets were not critically reviewed.
Is the building LCA software described/referenced?	✓	GaBi

LCI for the contributor "building product and technical equipment"

Is the choice of LCA, EPD data consistent according to the study type?	✓	
Is the use of building physical description data consistent (with the project documentation ?	✓	
Can densities/ weight areas etc. be checked?	✓	
Can areas and volumes be checked?	✓	
Can details and drawings be checked?	✓	
Are the hypotheses for the calculation of quantities (according to the appropriate fonctional unit) provided?	✓	Not needed

LCI for the contributor "operational energy use"

Is the choice of LCA, EPD data consistent according to the study type (in terms of technological, geographical and time-related representativeness, completeness and reliability) ?	✓	
[Cross-check] Are the materials from the building description data consistent to the ones used as a basis for the energy calculations?	✓	

LCI for the contributor "operational water use"

Is the choice of LCA, EPD data consistent according to the study type (in terms of technological, geographical and time-related representativeness, completeness and reliability) ?	✓	not concidered
[Plausibility check] Are the quantities of water use per person plausible compared to average values? (eg. in France, residential use of drinking water is around 40m3/pers/year).	✓	not concidered

LCI for other contributors (construction site, deconstruction activities, transport of the users of the building if included)

Is the choice of LCA, EPD data consistent according to the study type (in terms of technological, geographical and time-related representativeness, completeness and reliability) ?	✓	

Life Cycle Impact Assessment

Translating LCI flows to LCIA indicators

Are the rules to calculate the LCIA indicators from the LCI clearly stated and justified?	✓	CML

Environmental indicators

Are the used indicators compliant with EeBGuide general provisions?	✓	
Are the used indicators consistent regarding the EeBGuide study type?	✓	

Interpretation of the results

Environmental indicators results

Are the results justified (contribution of processes to any environmental indicators)?	✓	

Plausibility of the results per life cycle stage of the building LCA

Module A1-A3 (Production)	✓	not included
Module A4-A5 (Construction processes)	✓	not included
Module B (Use)	✓	
Module C (End of life)	✓	not included
Module D (Benefits and load beyond the system boundary)	✓	not included

Plausibility of the results for the following contributors of the building LCA

Building products and technical equipment (modules A, B, C)	✓	
Operational energy use (module B6)	✓	
Operational water use (module B7)	✓	not included
Construction site (module A5)	✓	not included
Deconstruction activities (module C1)	✓	not included
Transport of the users of the building (not covered by EN 15978)	✓	not included

Sensitivity/Uncertainty analysis

[If applicable] is a sensitivity or an uncertainty analysis done?	✓	no sensitivity analysis was conducted, but not necessary.
If it is an uncertainty analysis, is the analysis qualitative or quantitative?	✓	see above
Is the precise tool or method mentioned (ex: scenario analysis, Monte Carlo simulation, etc.)?	✓	see above
For comparative assertion, are the results robust enough to claim an environmental superiority? Are the goal, scope and inventory analysis compliant with ILCD and EeBGuide provisions?	✓	no comparative assertion

Normalisation of impacts

[If applicable] is a normalisation step conducted (e.g. comparison of the results with reference values for the same type of buildings)?	✓	no normalization was conducted.

Reporting of the results

Are the auhors of the study mentioned in the LCA report?	✓	
Is the documentation of the LCA report compliant with the EeBGuide reporting templates?	✓	
Are the results potentially reproducible by a third party?	✓	