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Final report

LOT 32 / Ecodesign of Window Products TASK 5 – Environment & Economics (Base case LCA & LCC)

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SUMMARY

This report presents the outcomes of the TASK 5 Environmental analysis of the "ENER Lot 32" Ecodesign Preparatory study, performed by VHK and ift Rosenheim, in collaboration with VITO.

Chapter 1 and 2 give a brief introduction to the study background (Chapter 1 Preface) and overall methodology (Chapter 2 Introduction).

Chapter 3 presents the base cases that represent the (average of) windows that are placed on the EU market and according which the information in subsequent Chapters and TASKS is structured.

Chapter 4 gives an overview of the inputs to the environmental and economic analysis performed using the Ecoreport 2014 version. These inputs are based on the information presented in the preceding (and updated) TASKS 1-4.

Chapter 5 gives the results of the environmental analysis, or the impacts for the complete life cycle of individual products (base cases).

Chapter 6 gives the results of the economic analysis, or the life cycle costs for the complete life cycle of individual products (base cases).

Chapter 7 gives the result of the combined annual environmental impact and EU expenditure at EU level, of windows sold and used in the EU.

In the Annexes more detailed information on environmental impacts (Annex I) and purchase costs (Annex II) is provided.

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LIST OF ABBREVIATIONS & ACRONYMS

AP	Acidification Potential
BAT	Best Available Technology
BNAT	Best Not yet Available Technology
BOM	Bill of Materials
CA	Concerted Action
C&D	Construction and demolition waste
CENELEC	European Committee for Electro technical Standardization
CEN	European Committee for Normalisation
CPD	Construction Products Directive
CPR	Construction Products Regulation
EN	European Norm
EOL	End Of Life
EOTA	European Organisation for Technical Assessment of construction products
EP	Eutrophication Potential
EPBD	Energy Performance of Buildings Directive
EPD	Environmental Product Declaration
EPS	Expanded Polystyrene
ETAG	European Technical Approval Guidelines
EU	European Union
EuP	Energy using Products
ErP	Energy related Products
FDES	Fiches de Déclaration Environnementale et Sanitaire (French EPD system)
GWP	Global Warming Potential
HM	Heavy Metals
IAQ	Indoor Air Quality
JRC	Joint Research Centre
LCA	Life Cycle Assessment
LCC	Life Cycle Cost
MEErP	Methodology for Ecodesign of Energy related Products
MEEuP	Methodology for Ecodesign of Energy using Products
MEPS	Minimum Energy Performance Standard
MS	Member State
NEEAP	National Energy Efficiency Action Plan
NMVOC	Non Methane Volatile Organic Compound
NZEB	Nearly Zero Energy Building
ODP	Ozone Depletion Potential

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ODS	Ozone Depleting Substance
OEF	Organisational Environmental Footprint
PEF	Product Environmental Footprint
PEFCRs	Product Environmental Footprint Category Rules
PM	Particulate Matter
POP	Persistent Organic Pollutants
POCP	Photochemical Oxidant Creation Potential
PRODCOM	PRODuction COMmunautaire
RES	Renewable Energy Sources
RoHS	Restriction of the use of certain Hazardous Substances
CI/SfB	Construction Index/Samarbetskommitten for Byggnadsfrago
SME	Small and Medium sized Enterprise
TC	Technical Committee
TR	Technical Report
VITO	Flemish Institute for Technological Research
VOC	Volatile Organic Compounds

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[No items to list]

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CHAPTER 1 PREFACE

This report has been prepared by ift Rosenheim and Van Holsteijn en Kemna BV (VHK) in collaboration with the Flemish Institute for Technological Research (VITO), under the Multiple Framework Contract related to preparatory studies and related technical assistance on specific product groups (ENER/C3/2012-418-Lot 1), and in response to the Terms of Reference included in the Contract for the "Ecodesign study with regard to Windows".

The subject of this report falls under the general context of sustainable industrial policy which aims to foster the development of products with less environmental impacts.

Directive 2009/125/EC ("Ecodesign Directive") is the cornerstone of this approach as it establishes a framework for the setting of Ecodesign requirements for energy-related products (ErPs) with the aim of ensuring the free movement of these products within the internal market. Directive 2009/125/EC targets ErPs as these account for a large portion of the consumption of energy and natural resources, and a number of other environmental impacts, in the Community, in particular during their use phase.

Directive 2010/30/EC on the energy labelling of ErPs is complementary to the Ecodesign Directive as it requires (a.o.) information on the impact by these products on the use of essential resources to be provided to consumers at the point of sale.

Any measure prepared under these directives must be preceded by a study or assessment ('preparatory study') that sets out to collect evidence and stakeholder input, explore policy options and describe the recommended policy mix (ecodesign and/or labelling and/or self-regulation measures).

The product groups considered as priorities for such studies have been listed in the Working Plan 2012-2014 (established according article 16(1) of the Ecodesign Directive) and this list includes "windows". Therefore a preparatory study has been requested by the Commission.

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This preparatory study is to be executed according the Methodology for the Ecodesign of Energy-related Products (MEErP, 2011)[1] which identifies eight (1+7) tasks and shall allow stakeholder involvement. This report is the final report of Task 5 or “Environment & Economics (Base case LCA & LCC)” of the study.

[1] http://www.meerp.eu/ VHK BV, Netherlands and COWI, Belgium: Methodology Study Ecodesign of Energy-related Products, MEErP Methodology Report, under specific contract SI2.581529, Technical Assistance for the update of the Methodology for the Ecodesign of Energy-using products (MEEuP), within the framework service contract TREN/R1/350-2008 Lot 3, Final Report: 28/11/2011

CHAPTER 2 INTRODUCTION

2.1. METHODOLOGY FOR ECODESIGN PREPARATORY STUDIES

This chapter introduces the objective of Task 5 of the full preparatory study. A full preparatory study follows the methodology for ecodesign of energy-related products established in 2011 (MEErP 2011) which itself is a succession of the former methodology dealing with energy-using products (MEEuP 2005) developed in 2005 to contribute to the creation of a methodology allowing evaluating whether and to which extent various energy-using products fulfil certain criteria according to Annex I and/or II of the Ecodesign Directive that make them eligible for implementing measures.

The full preparatory study is executed according to seven tasks, as described below:

Task 1 – Scope (definitions, standards and legislation);

Task 2 – Markets (volumes and prices);

Task 3 – Users (product demand side);

Task 4 – Technologies (product supply side, includes both BAT and BNAT);

Task 5 – Environment & Economics (Base case LCA & LCC);

Task 6 – Design options;

Task 7 – Scenarios (Policy, scenario, and impact and sensitivity analysis).

The MEErP structure makes a clear split between:

- Tasks 1 to 4 (product definitions, standards and legislation; economic and market analysis; consumer behaviour and local infrastructure; technical analysis) that have a clear focus on data retrieval and initial analysis;
- Tasks 5 (assessment of base case), 6 (improvement potential) and 7 (policy, scenario, impact and sensitivity analysis) with a clear focus on modelling.

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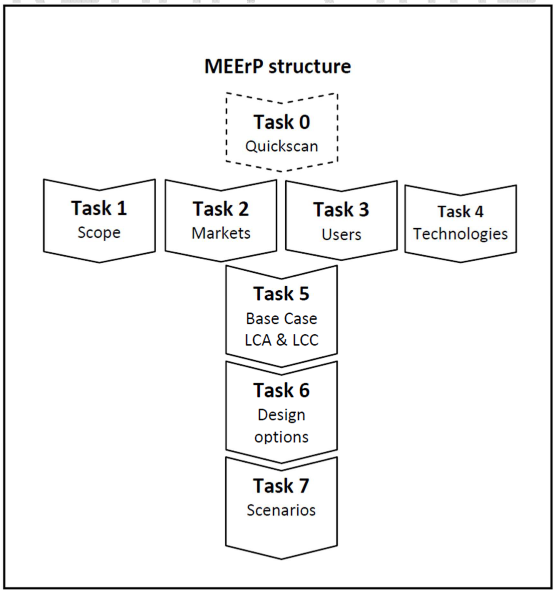
Figure 1 MEErP structure



An optional Task 0 quick scan or first product screening has been introduced in the 2011 methodology for those product groups that are characterised by a large variety of products covered by a generic product group description. It was carried out for this study as well. The findings of this Task 0 are incorporated in the Task 4 report.

Tasks 1 to 4 can be performed in parallel, whereas Task 5, 6 and 7 are sequential.

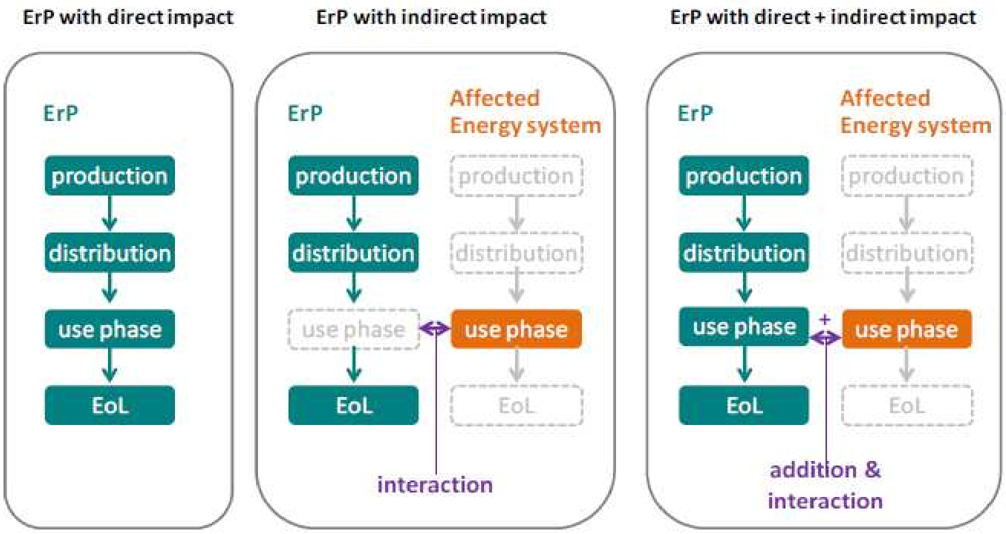
2.1.1. ENERGY RELATED PRODUCTS

The Directive 2009/125/EC defines an energy-related product as *"any good that has an impact on energy consumption during use which is placed on the market and/or put into service, and includes parts intended to be incorporated into energy-related products covered by this Directive, which are placed on the market and/or put into service as individual parts for end-users and of which the environmental performance can be assessed independently"*.

The impact on energy consumption during use of an energy-related product may take different forms and the MEErP methodology defined these as either direct and/or indirect impacts. The relevance of this lies in the analysis required and which should or should not include affected energy systems.

The MEErP introduced a grouping of energy related products into products with only direct impacts, only indirect impacts or both.

Figure 2 Three types of ErP (VHK, 2011)



Considering the above indicated grouping in MEErP of ErP products, windows are considered as an example of ErP with indirect impact.

2.2. MEERP – DETAILS OF WORK FOR TASK 5

The details of work for TASK 5 are described below. The TASK description is copied from MEErP 2011.

5 ENVIRONMENT & ECONOMICS

5.1 Product-specific inputs

Choose from the previous tasks the most appropriate information

From all tasks 1 to 4:

Definition of the base case(s) (from all previous Tasks 1 to 4)

with per Base Case

Task 1: The most appropriate test standard for performance and consumption data

Task 2: EU-27 annual unit sales 2010

EU-27 unit stock 2010

Purchase price. The installation costs (specify end-of-life disposal costs comprised in product price)

Repair and maintenance costs

Unitary rates for energy, water and/or other consumables

Discount, inflation, interest rates to be applied

Product service life

Task 3 Annual resources consumption (energy, water, consumables, from Task 3.1) and emissions caused during product life (from Task 3.2);

Product use & stock life, if appropriate (i.e. if deviates substantially from product service life)

As appropriate, multiplier(s) to transform standard test data to real-life consumption data

Average user demand/ load

Collection rate at end-of-life (per fraction if applicable)

Task4 Product weight and Bill-of-Materials (BOM), preferably in EcoReport format (from Task 4)

Primary scrap production during sheet metal manufacturing (avg. EU); [12]

Volume and weight of the packaged product avg. EU;

Selected EU scenario at end-of-life of materials flow for:

o Disposal (landfill, pyrolytic incineration);

o Thermal Recycling (non-hazardous incineration optimised for energy recovery);

o Re-use or materials recycling scenario.

5.2 Base Case Environmental Impact Assessment.

Using the EcoReport and the above inputs calculate emission/resources categories in MEErP format for

Raw Materials Use and Manufacturing;

Distribution;

Use phase;

End-of-Life Phase.

Furthermore, if more than one type of resource is used in the use phase, make a split-up between resources and their individual impacts.

5.3 Base Case Life Cycle Costs for consumer

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Combining the results from tasks 2 and 3 for the Real-Life Base Case determine the Life Cycle Costs

LCC = PP + PWF * OE + EoL, where LCC is Life Cycle Costs, PP is the purchase price, OE is the operating expense, PWF (Present Worth Factor) is PWF= {1 – 1/(1+ r) N }/r , in which N is the product life and r is the discount rate minus the growth rate of running cost components (e.g. energy, water rates) and EoL the End-of-Life costs

5.4 EU Totals

Aggregate the Real-Life Base Case environmental impact data and the Life Cycle Cost data (subtask 5.3 and 5.4) to EU-27 level, using stock and market data from task 2, indicating

5.4.1. The life cycle environmental impact and total LCC of the new products designed in 2010 or most recent year for which there are reliable date (this relates to a period of 2010 up to 2010+product life);

5.4.2 The annual (2010) impact of production, use and (estimated) disposal of the product group, both in terms of the annual environmental impacts and the annual monetary costs for consumers.

CHAPTER 3 BASE CASES

3.1. BASIS FOR IDENTIFYING BASE CASES

The MEErP 2011 states that Task 5 requires that one or more average EU product(s) or a representative product category has/have to be defined as the "Base case" for the whole of the EU27 has to be chosen. The environmental and Life Cycle Cost analyses will be based on this Base Case.

MEERP 2011 states: *"The Base Case is a conscious abstraction of reality, necessary for practical reasons. Having said that, the question if this abstraction leads to inadmissible conclusions for certain market segments will be addressed in the impact and sensitivity analysis".*

The description of the Base Case is the synthesis of the results of Tasks 1 to 4 and the point-of-reference for Tasks 6 (improvement potential) and 7 (policy, scenario, impact and sensitivity analysis).

With respect to former MEEuP 2005 there is no longer a distinction between a Standard Base case, i.e. using impact values (efficiency etc.) as published by industry in accordance with test standards, and a Real-Life Base case, i.e. using impact values as they occur in practice. Only the latter is required, where the analysts will use conversion factors to translate the values originating from test standards into values that have meaning for real-life energy consumption.

In Task 5, the economic (LCC) and environmental (LCA) assessment of the base case should be based on the ErP; only for the monetary running costs (the Operating Expense 'OE' in the LCC formula) and the environmental impacts in the use phase (as in EcoReport 2011) it should be based on the affected system characteristics, and more specifically only for the costs and impacts that are influenced by the ErP characteristics.

3.2. BASE CASES

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Although the MEErP allows identifying as base case the overall average EU window (the average of all windows placed on the EU market) this study task will instead identify base cases at a more detailed level to better reflect the differences in energy performance and allow easier calculation of life cycle costs of design options.

The windows placed on the EU market and present in the stock (installed base) will be a mix of the below defined window types. The calculation of energy characteristics of windows sales and stock is based on the energy characteristics of these 11 types and may include consideration of a solar shading device[2].

Table 1 Window base cases

No.	U_w in W/m^2K	g	Description
			FAÇADE WINDOWS
1	5.8	0.85	Single glazing; Frame: even no or bad thermal break
2	2.8	0.78	Double IGU; Standard frame (wood, PVC, Metal)
3	1.7	0.65	Double IGU with Low-e coating and argon filling; Standard frame (wood, PVC, Metal)
4	1.3	0.60	Double IGU with Low-e coating and argon filling; Standard frame (wood, PVC, Metal)
5	1.0	0.55	Triple IGU with Low-e coating and argon filling; Standard frame (wood, PVC, Metal)
6	0.8	0.60	Triple IGU with optimized Low-e coating and argon filling, thermally improved spacer; Improved frame (wood, PVC, Metal)
7	1.0	0.58	Single and Double IGU with Low-e coating and argon filling, thermally improved spacer; Coupled window(wood, PVC, Metal)

[2] All windows base cases are considered with and without a shutter having the following characteristics : ΔR = 0,17 $m^2.K/W$ and a Fc – value of 0,1

8	0.6	0.47	2 Double IGU with Low-e coating and argon filling, thermally improved spacer; Double window (wood, PVC, Metal)
9	2.8	0.35	Double IGU low g-value solar control ; Standard frame (wood, PVC, Metal)
10	1.3	0.35	Double IGU low g-value solar control with Low-e coating and argon filling; Standard frame (wood, PVC, Metal)
11	0.8	0.35	Triple IGU low g-value solar control with Low-e coating and argon filling, thermally improved spacer; Improved frame (wood, PVC, Metal)
			ROOF WINDOWS [3]
roof_3	1.7	0.60	Double IGU with Low-e coating and argon filling; Frame metal-PVC/PU or metal-wood
roof_4	1.1	0.50	Triple IGU with Low-e coating and argon filling; thermally improved spacer; Frame metal-PVC/PU or metal-wood
roof_5	0.9	0.50	Triple IGU with optimized Low-e coating and argon filling, thermally improved spacer; Frame metal-PVC/PU or metal-wood
roof_6	1.7	0.35	Double IGU with Low-e coating and argon filling and solar control glazing; Standard frame metal-PVC/PU or metal-wood

For the material characteristics they are the average of the windows sold in EU in 2011: 61% PVC, 20% wood and 19% aluminium (see TASK 2, Section 5.1.1).

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[3] U values for roof windows based on inclined (40º) installation

CHAPTER 4 PRODUCT SPECIFIC INPUTS

4.1. FROM TASK 1: PERFORMANCE STANDARDS

The window energy performance is based on the definition of the window and the test standards as described in the TASK 1 report.

The window performance parameters are as established by EN 14351-1, which gives values for the environmental parameters:

- overall window U-value U_w;
- solar energy transmittance, g-value;
- Class of air leakage, 1-4;
- Light transmission.

The (indirect) energy effect of windows is based on a calculation according to:

- ISO 18292
- EN ISO 13790 - simply hourly method.

The calculation requires inputs for the context of the window. These boundary conditions and the calculation method are explained in TASK 3 and TASK 7.

The shading performance parameters are established in the standards EN 13659 (shutters) and EN 13561 (awnings) and will provide values for:

- Thermal resistance ΔR
- Solar energy transmittance g_t

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The energy performance of windows (kWh/m^2*yr.) has been assessed using the simplified approach (based on these main window characteristics and appropriate ABC/XYZ values), as established in TASK 7.

4.2. FROM TASK 2: SALES AND STOCK OF WINDOWS

4.2.1. SALES AND STOCK

The stock of façade windows is estimated to be about 5.5 billion m^2 in year 2020 (or 3 million units of 1.23*1.48 m), divided over domestic (79%) and tertiary sector (21%). Window stock has been calculated on the basis of building floor area and a window-to-floor ratio of 20% for façade windows. The overall window area in stock is therefore primarily determined by assumptions regarding the floor area and the window-to-floor ratio. The sales in 2020 are some 202 million m2 (some 111 million units of 1.23*1.48 m) of which some 23% for the non-residential sector. Some 68% of the residential sales are for replacement, some 62% of the non-residential sales are for replacement.

For roof windows we assumed a sales share of not more than 10% of the façade windows and the window-to-roof ratio has been defined accordingly. This results in sales in year 2020 of around 8.8 million roof windows (size 1.14*1.4 m) and a stock of some 231 million units (of 1.14*1.4 m).

For more information on the sales and stock – please see the TASK 2 report.

4.2.2. PURCHASE PRICES AND OTHER ECONOMIC INFORMATION

The purchase prices have been established in the TASK 2 (Market) report and are repeated below.

Table 2 Purchase costs for façade windows

EU28	Uw (W/m2*K)	g (-)	Street price, incl. inst.+VAT
01_single	5.8	0.85	155
02_double IGU, standard	2.8	0.78	234
03_double IGU, lowE, argon	1.7	0.65	255
04_double IGU, lowE, argon, impr.	1.3	0.60	256
05_triple IGU, lowE, argon	1.0	0.55	299
06_triple IGU, lowE, argon, impr.	0.8	0.60	404
07_coupled	1.0	0.58	370
08_quadruple	0.6	0.47	510
09_as 02, solar	2.8	0.35	288
10_as 04, solar	1.3	0.35	299
11_as 06, solar	0.8	0.35	456

Table 3 Purchase costs for roof windows

No.	Description	Uw (W/m2*K)	g (-)	Street price in €/m^2 (including inst.+ VAT)
1	Single glazing; Frame: metal-wood, no or bad thermal break	5.8	0.85	Not available on the market
2	Double IGU; Standard frame (metal-wood or metal-PVC/PU, Metal)	2.8	0.78	only for inhabited rooms
3	Double IGU with Low-e coating and argon filling; Frame metal-PVC/PU or metal-wood	1.3	0.60	480
4	Triple IGU with Low-e coating and argon filling; thermally improved spacer; Frame metal-PVC/PU or metal-wood	1.0	0.50	708
5	Triple IGU with optimized Low-e coating and argon filling, thermally improved spacer; Frame metal-PVC/PU or metal-wood	0.8	0.50	913
6	Double IGU with Low-e coating and argon filling and solar control glazing; Standard frame metal-PVC/PU or metal-wood	1.3	0.35	578

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Energy rates are based on the MEErP 2011 with additions from Eurostat 2015 and result in EU average costs for fuels (gas) 0.07 euro/kWh of fuel, and for electricity (consumers) 0.17 euro/kWh electricity (residential prices).

The escalation rate for energy is set at 4%.

The discount rate is set at 4%, following rules for EU impact assessments.

The standard product service life is set at 40 years, although a sensitivity analysis of life cycle costs assuming other product lives has been added to the section on life cycle costs (TASK 6).

4.3. From Task 3: Use phase aspects

This section describes which energy performance is used for the calculation of the use phase impacts of the window base cases.

The following applies:

1. The use phase impacts are determined by the energy balance of the window. These have been described in TASK 7 and the related TASK 3. As the assessment is intended to describe as much as possible real-life impacts, the energy performance is based on the "average" estimated use of shutters. The energy performance (residential heating only) is based on the ABC values for 'single room' and for 'houses' defined per climate condition, whereby the latter is the average of high and low insulated houses (see also TASK 3 and TASK 7).

2. The analysis is limited to windows used in the residential sector. An analysis for the non-residential would be considered too subjective as regards the boundary conditions underlying the calculation of the energy performance.
3. The TASK 5 environmental analysis is limited to heating only, as the current implementation of the Ecoreport does not allow simultaneous calculation of impacts from cooling performance. In TASK 6 analysis of life cycle costs cooling performance will be taken into consideration.

The table below shows the inputs to the use phase, as used in TASK 3 as well.

Table 4 Façade window energy performance (heating)

	Facade window North	Central	South	Roof window North	Central	South
A	98	61	18	86	49	9
B	225	196	193	156	150	90
C (incl. correction)	0.04	0.04	0.05	0.04	0.04	0.04

Heating Performance (kWh/m2*yr.)	**North**	**Central**	**South**
01_single	563.2	316.9	12.8
02_double IGU, standard	194.6	90.5	-47.2
03_double IGU, lowE, argon	78.3	23.2	-54.7
04_double IGU, lowE, argon, impr.	47.5	6.0	-55.0
05_triple IGU, lowE, argon	26.3	-5.2	-53.6
06_triple IGU, lowE, argon, impr.	-1.0	-24.1	-63.9
07_coupled	21.6	-9.3	-57.6
08_quadruple	0.1	-18.4	-49.9
09_as 02, solar	262.4	149.5	10.9
10_as 04, solar	86.9	40.3	-21.2
11_as 06, solar	38.4	10.2	-30.1
roof_03	59.1	7.9	-24.8
roof_04	44.5	3.9	-21.1
roof_05	27.5	-5.8	-22.9
roof_06	86.4	34.2	-9.0

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The energy performance used for the Ecoreport calculations is presented in the bottom three columns (shown for average shutter use, correction for C applies).

The assessment of the environmental impacts of the heating performance assumes a heating system efficiency of 82.5%. This is higher than the average efficiency of the current stock heating system efficiency (closer to 60%) and more representative of the future stock heating efficiency (may be higher than 100%). The reason is that no indicator values are available for such low efficiency heating equipment. The assessment is therefore more indicative for the future impacts of windows, rather than that of the current stock of windows (energy consumption is underestimated).

The product life assumed is set at 40 years. The sensitivity analysis in TASK 6 contains an assessment of shorter and longer product life for life cycle costs.

4.4. From Task 4: Product life cycle

The Product life cycle impacts are calculated using the Ecoreport tool which is an element of the MEErP. The Ecoreport used is the 2013 version.

For calculating life cycle impacts one needs to establish a bill-of-materials related to the production phase, some inputs for the manufacturing and distribution phase. The use phase impacts are mainly related to the energy balance of the window assessed and the properties of the affected HVAC system and have been described in TASK 3 (see previous section). The end-of-life phase determines the settings for recycling and recovery of materials.

4.4.1. Production phase

→ **Façade windows**

The bill of materials is based on information from the Task 4 report.

The available bill of materials from Task 4 relates to a standard double glass (IGU) window, for PVC, aluminium and wooden frames. As several materials or processes applied to windows are not available in the Ecoreport tool, these are either added (wood, EPDM, silicone sealant), or not included in the assessment. For certain materials/processes, the omission is believed to be acceptable, as their significance is limited. This is for instance the case for the low-E coating (either silver or TiO2), the energy requirement is insignificant compared to that of the glass itself.

The Athena institute[4] described differences in windows with and without TiO2 or silver Low E coatings.

Table 5 Cradle-to-gate electricity requirements for manufacturing 1 m² window (kWh)

Input	Argon/Silver	Argon/Tin	Tin	Standard
Glass	3.36	3.36	3.36	3.36
Polysulfide kit	0.025	0.025	0.025	0.025
Aluminium frame	0.726	0.726	0.726	0.726
Argon gas	0.001	0.001		
TiO2	0.001	0.001	0.001	
Silver	0.004			
Filling powder	0.006	0.006	0.006	0.006
Window manufacturing	15	15	15	15
Total	19.1	19.1	19.1	19.1

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In order to calculate the bill-of-materials of other window types (single glazed or a double (coupled) window) mark-up factors have been applied to the standard IGU (glass factor) and the frame and hardware (frame/hardware factor). The table below shows the inputs as applied in the Ecoreport calculation.

Table 6 Bill-of-materials of base case façade windows

Type:		1 – single	2 – double	3 – double, lowE	4 – double, lowE, impr.	5 – triple	6 – triple, opt.	7 – coupled 1+2	8 – coupled 2+2	9 – double, solar (as 2)	10 – double, solar, lowE (as	11 – triple, solar (as 6)
Nr.		1	2	3	4	5	6	7	8	9	10	11
glass factor		0.5	1	1	1	1.5	1.5	1.5	2	1	1	1.5
frame/hardware factor		0.8	1	1	1	1.25	1.25	1.5	2	1	1	1.25
Material inputs (kg)	Eco Indicator #											
PVC	8	4.3	5.4	5.4	5.4	6.7	6.7	8.0	10.7	5.4	5.4	6.7

[4] Athena Institute, Life Cycle Inventory Analysis of Building Envelope Materials

PA 6.6 25%gf (thermal break / aluminium window)	12	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.2	0.2	0.3
PA 6.6 25%gf	12	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01
steel sheet zinc coated (reinforcement / PVC window)	22	4.0	5.0	5.0	5.0	6.3	6.3	7.5	10.1	5.0	5.0	6.3
steel (galvanized)	22	0.75	0.94	0.94	0.94	1.17	1.17	1.41	1.88	0.94	0.94	1.17
steel (screws /PVC window)	22	0.03	0.03	0.03	0.03	0.04	0.04	0.05	0.07	0.03	0.03	0.04
stainless steel	26	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01
Aluminium	27	1.4	1.8	1.8	1.8	2.2	2.2	2.7	3.5	1.8	1.8	2.2
aluminium (drainage profile / timber window)	27	0.04	0.05	0.05	0.05	0.07	0.07	0.08	0.11	0.05	0.05	0.07
aluminium (strand) cast	28	0.02	0.03	0.03	0.03	0.04	0.04	0.04	0.06	0.03	0.03	0.04
brass die cast	32	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.01
zinc (die cast)	33	0.13	0.16	0.16	0.16	0.20	0.20	0.24	0.32	0.16	0.16	0.20
powder coating (/aluminium window)	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
float glass	55	6.87	13.73	13.73	13.73	20.60	20.60	20.60	27.47	13.73	13.73	20.60
Wood	102	1.8	2.2	2.2	2.2	2.7	2.7	3.3	4.4	2.2	2.2	2.7
EPDM	103	0.62	0.77	0.77	0.77	0.96	0.96	1.15	1.54	0.77	0.77	0.96
silicone	104	0.04	0.05	0.05	0.05	0.07	0.07	0.08	0.11	0.05	0.05	0.07
Total mass (kg)		**20.2**	**30.4**	**30.4**	**30.4**	**41.4**	**41.4**	**45.6**	**60.7**	**30.4**	**30.4**	**41.4**
Additional PVC for roller shutter (per m^2)	8	3.02	3.02	3.02	3.02	3.02	3.02	3.02	3.02	3.02	3.02	3.02

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NOTE: the above shown average material composition relates to 1 m^2 of window and represents the (weighted) average of the windows using different frame materials (61% PVC, 19% aluminium and 20% wood) – see TASK 2, section 5.1.1.

The shutter (if applicable) adds some 3 kg PVC per m^2 window.

→ **Roof windows**

The bill-of-materials for roof windows has been based on publicly available EPD's from a major manufacturer. The values in the table below have been corrected to a window area of 1 m^2 (the data applied to a roof window of 1.14*1.40 and has been divided by 1.596). The values are a simple average of four types roof windows (wood or wood + PUR, various types of glazing) as no sales split-up data is available.

Table 7 Bill-of-materials of the base case roof window

Material type	Quantity (kg)
Insulating glass unit	17.4
wood	8.7
PUR	2.8
aluminium	2.1
other metals	1.8
plastics	1.3
PVC	0.0
PC	0.0

Material type	Quantity (kg)
PMMA	0.0
other materials	0.3
total	34.4

→ **Use of hazardous substances**

The possible presence of lead in PVC window profiles could not be modelled using the current version of the Ecoreport and is ignored in the environmental analysis as the European PVC industry is committed to a complete phase out of lead based stabilisers by the end of 2015. This means that by the time the eco-design study is finished there will be hardly any lead used in PVC windows.

The possible presence of Cr6+ in aluminium window frames could not be modelled using the current version of the Ecoreport. According information from the aluminium industry the process is well controlled, and almost all Cr6+ is converted in Cr3+. Hence, the coated Al profiles are not toxic and do not release any Cr6+ ions / substances. Cr6+ is a controlled substance and heavily regulated by other forms of legislation (REACH).

The wood preservation method based on boric acid (capsules for local treatment) could not be modelled using the current version of the Ecoreport. Nonetheless the environmental impacts of this substance are regarded negligible.

4.4.2. Manufacturing phase

The Ecoreport tool default value for primary scrap production during sheet metal manufacturing is applied (25%). This includes scrap created during production (extrusion) and assembly of windows using metal profiles.

The team decided to maintain the default value as no information was retrieved regarding the process scrap value. As metal is only a minor constituent of the total window mass, any error resulting from this is considered negligible.

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4.4.3. Distribution phase

For the distribution phase the Ecoreport requires as inputs the product volume (the weight is the sum of the bill-of-materials, some 15 to 30 kg, depending on window type, for 1m^2).

The product volume is assessed to be some 1.3*1.5*0.1m for a standard size window, which is 0.195 m3. For 1 m2 window this is then 0.11 m3. For roof windows the same was assumed.

Transportation distances are default values as established in Ecoreport.

4.4.4. Use phase

The use phase has been modelled on the basis of TASK 3 (and TASK 7) and not on the basis of TASK 4.

4.4.5. End-of-life phase

For the Ecoreport the information presented in TASK 4 Section 4.5 (End-of-Life) has led us to make the following assumptions regarding end-of-life of average windows. This applies to both façade and roof windows.

Table 8 End-of-life scenarios for windows, presented by material type[5]

MEERP #	Description	Bulk Plastics	TecPlastics	Ferro	Non-ferro	Coating	Electronics	"Misc.	Refrigerant	Mercury	Extra	Auxiliaries	TOTAL
	main material flow	PVC		Steel	Aluminium			Glass			Wood		
263	EoL mass fraction to re-use, in %	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0.0%
264	EoL mass fraction to (materials) recycling, in %	10%	10%	95%	95%	0%	0%	10%	0%	0%	0%	0%	30.2%
265	EoL mass fraction to (heat) recovery, in %	80%	80%	0%	0%	0%	0%	25%	0%	0%	80%	0%	34.2%
266	EoL mass fraction to non-recov. incineration, in %	10%	10%	5%	5%	100%	100%	0%	100%	100%	10%	100%	4.0%
267	EoL mass fraction to landfill/missing/fugitive, in %	0%	0%	0%	0%	0%	0%	65%	0%	0%	10%	0%	31.6%
268	TOTAL	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
269	EoL recyclability	avg	avg	avg	avg	avg	avg	avg	avg	avg	avg	avg	avg

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[5] Source: Own estimates based on data presented in TASK 3 and 4

CHAPTER 5 IMPACTS AT PRODUCT LEVEL

5.1. IMPACTS ACCORDING TO ECOREPORT

Using the inputs of the previous section, the impacts per window type have been calculated.

Emission and resource use have been expressed in categories according the MEErP format for

- Raw Materials Use and Manufacturing;
- Distribution;
- Use phase;
- End-of-Life Phase.

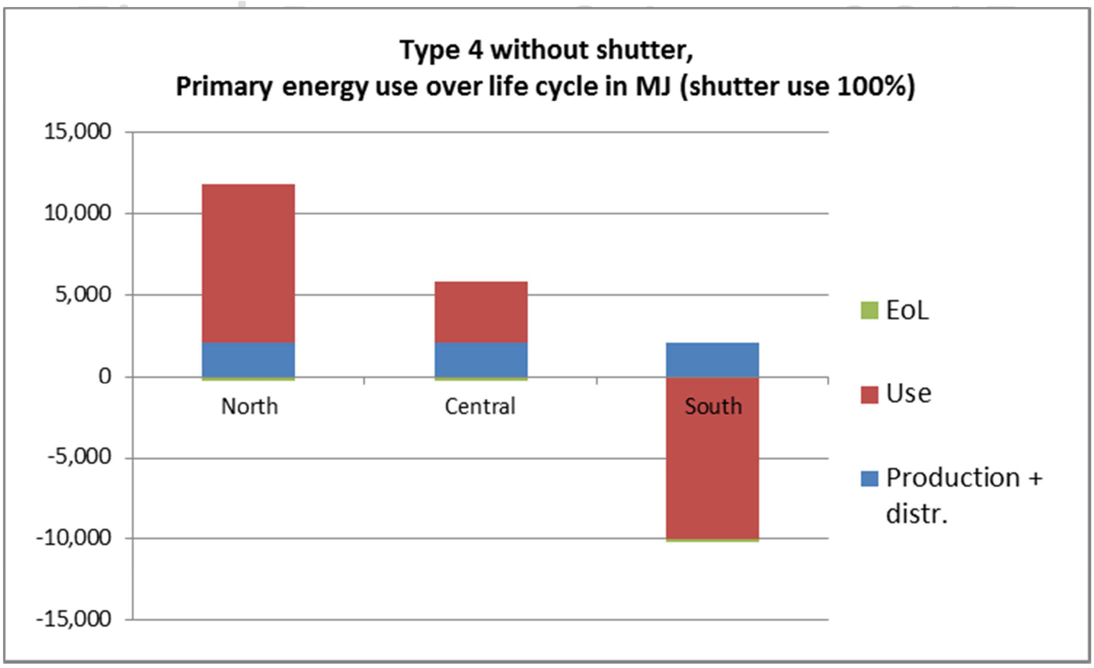
As stated the impacts on associated / related energy systems are limited to heating performance only.

→ **Façade windows**

The table below presents the outputs for the current market standard base case type 4 window (double glazing IGU) assuming a product life of 40 years, and an energy balance as explained in the previous sections, **without use of shutters**.

When considering the possible differences per climate condition, the distribution of energy impacts over 'production', 'use' and 'end-of-life' is as shown below.

Figure 3 Façade window energy compared over life cycle phase, per climate condition



Annex I presents the impacts for all 11 base cases (performance 'without shutters').

Table 9 Ecoreport facade window type 4, climate condition Central, without shutters

Life Cycle Impact (per unit) of Type 4: heating in zone Central, without shutters

Nr	Life cycle Impact per product:	Reference year	Author
0	Type 4: heating in zone Central, without shutters	2014	vhk, izm

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recov.	Stock	
	Materials	**unit**									
1	Bulk Plastics	g			**5,361**		**54**	542	4,874	0	**0**
2	TecPlastics	g			**218**		**2**	22	198	0	**0**
3	Ferro	g			**6,009**		**60**	303	5,766	0	**0**
4	Non-ferro	g			**2,025**		**20**	143	1,902	0	**0**
5	Coating	g			**0**		**0**	0	0	0	**0**
6	Electronics	g			**0**		**0**	0	0	0	**0**
7	Misc.	g			**13,733**		**137**	9,016	4,855	0	**0**
8	Extra	g			**3,021**		**0**	610	2,441	0	**-30**
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**
10	Refrigerant	g			**0**		**0**	0	0	0	**0**
	Total weight	g			**30,367**		**273**	10,636	20,034	0	**-30**
									see note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	MJ	1,515	371	**1,886**	**153**	**3,832**	20	-273		**5,617**
12	of which, electricity (in primary MJ)	MJ	254	219	**473**	**0**	**3**	0	-13		**462**
13	Water (process)	ltr	177	3	**180**	**0**	**2**	0	-1		**180**
14	Water (cooling)	ltr	380	99	479	0	4	0	60		543
15	Waste, non-haz./ landfill	g	11,591	1,440	**13,031**	**97**	**116**	27	-4,130		**9,141**
16	Waste, hazardous/ incinerated	g	35	0	**35**	**2**	**0**	0	4		**41**
	Emissions (Air)										
17	Greenhouse Gases in GWP100	kg CO2 eq.	58	21	**79**	**11**	**212**	0	-12		**289**
18	Acidification, emissions	g SO2 eq.	300	90	**390**	**32**	**64**	0	-53		**434**
19	Volatile Organic Compounds (VOC)	g	15	0	**16**	**2**	**3**	0	-4		**17**
20	Persistent Organic Pollutants (POP)	ng i-Teq	300	21	**321**	**1**	**3**	0	-96		**229**
21	Heavy Metals	mg Ni eq.	1,000	49	**1,049**	**5**	**10**	4	-244		**824**
22	PAHs	mg Ni eq.	178	0	**178**	**7**	**2**	0	-66		**121**
23	Particulate Matter (PM, dust)	g	65	14	**79**	**342**	**2**	0	-15		**408**
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	1,415	2	**1,417**	**0**	**14**	2	-345		**1,088**
25	Eutrophication	g PO4	3	0	**3**	**0**	**0**	0	0		**3**

When focusing solely on primary energy, the combined 11 base cases show the following impacts.

Table 10 Primary energy over life cycle all base cases

	Primary Energy							
	Without shutters (estimate for shutter use)				With shutters			
	Production + distr.	Use	EoL	Total	Production + distr.	Use	EoL	Total
01_single	1,574	55,861	-197	57,238	1,866	67,959	-159	69,666
02_double IGU, standard	2,038	16,734	-253	18,520	2,331	20,529	-214	22,646
03_double IGU, lowE, argon	2,038	4,610	-253	6,395	2,331	6,213	-214	8,329
04_double IGU,l owE, argon, impr.	2,038	1,531	-253	3,317	2,331	2,521	-214	4,638
05_triple IGU, lowE, argon	2,591	-532	-320	1,739	2,883	80	-281	2,682
06_triple IGU, lowE, argon, impr.	2,591	-4,173	-320	-1,902	2,883	-3,769	-281	-1,167
07_coupled	3,032	-1,326	-379	1,327	3,324	-714	-340	2,270
08_quadruple	4,025	-3,066	-505	454	4,317	-2,831	-467	1,020
09_as 02, solar	2,038	28,154	-253	29,940	2,331	31,949	-214	34,066

10_as 04, solar	2,038	8,171	-253	9,956	2,331	9,161	-214	11,278
11_as 06, solar	2,591	2,467	-320	4,738	2,883	2,871	-281	5,473

Figure 4: Primary energy over life cycle of all base cases (with very low optimal shutter use)

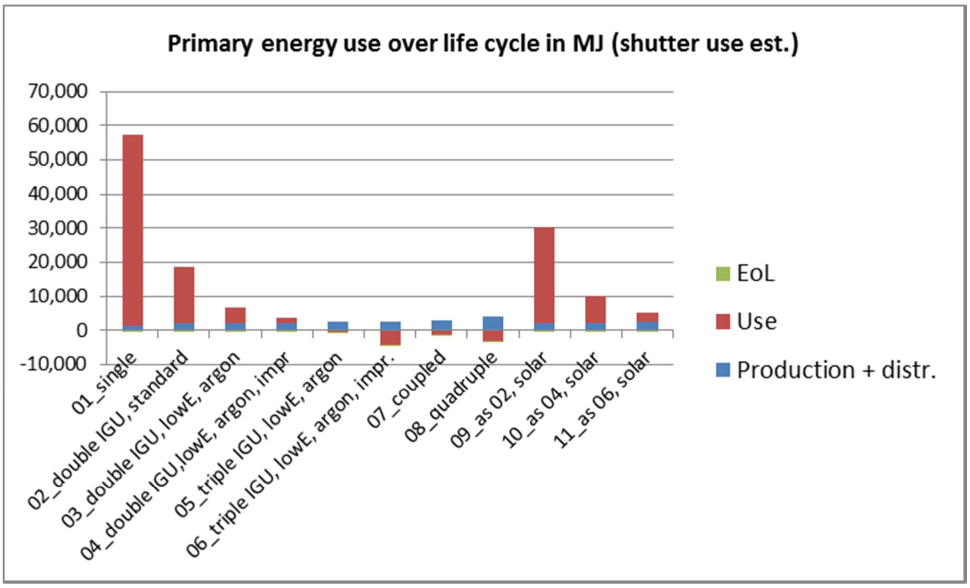
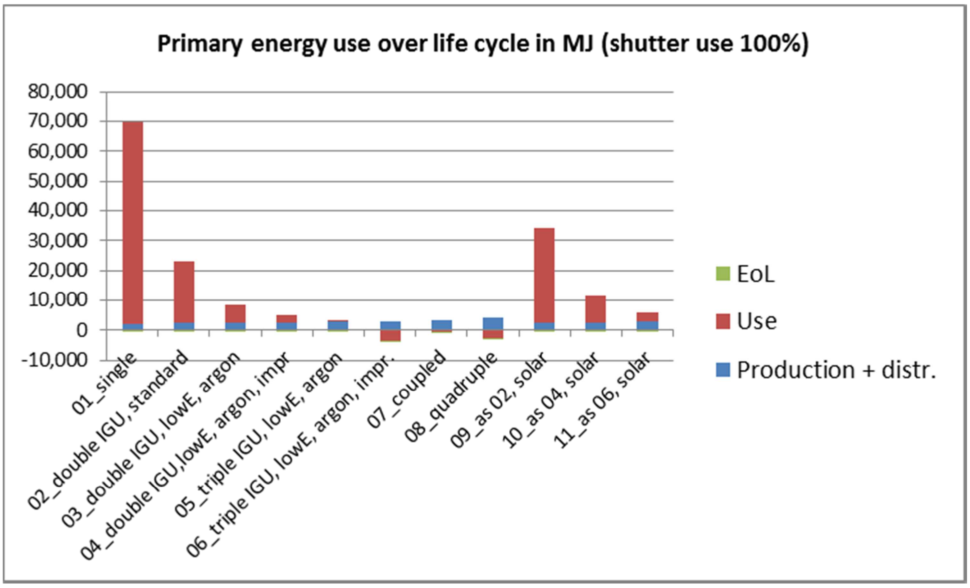


Figure 5: Primary energy over life cycle of all base cases (with 100% optimal shutter use)



The above information (details in Annex I) shows that for the simplest window (base case #1) the use phase represents some 96% of overall energy consumption.

For the more advanced windows (type 6, and 8) the energy embodied in the window even exceeds that of the use phase. This is to be expected, as because of the increased material input (from single to triple pane etc.) the use phase energy can be reduced in some cases to close to zero or even below zero (below zero means the window is a net supplier of energy, as calculated for type #6 and #8 for climate condition Central, with shutters).

Depending on the reference taken, the extra embodied energy can be recuperated by the energy saved in the use phase. This is the case for all windows type 2-11 when compared to type 1 (so extra embodied energy in production of double, triple and quadruple glazing is compensated by reduced energy in use phase) for the Central climate condition and boundary conditions as indicated in Task 3. Table 8 shows that even the change from type 4 to type 8 still results in recuperation of embodied energy.

For window base case #6 and #8 the use phase has even a negative (-5%, -6%) impact for energy.

→ **Roof windows**

The Ecoreport for the roof window type 3 (U_W 1.7, g 0.6) is shown below.

Figure 6: Ecoreport for roof window type 3, climate condition Central

Life Cycle Impact (per unit) of Type roof_03: heating in zone Central, without shutters

Nr	Life cycle Impact per product:	Reference year	Author
0	Type roof_03: heating in zone Central, without shutters	2014	vhk, izm

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE			TOTAL
	Resources Use and Emissions		Material	Manuf.	**Total**	BUTION		Disposal	Recov.	**Stock**	
	Materials	**unit**									
1	Bulk Plastics	g			**1,253**		**13**	253	1,013	0	**0**
2	TecPlastics	g			**5,576**		**56**	1,126	4,506	0	**0**
3	Ferro	g			**1,817**		**18**	18	1,817	0	**0**
4	Non-ferro	g			**2,130**		**21**	22	2,130	0	**0**
5	Coating	g			**0**		**0**	0	0	0	**0**
6	Electronics	g			**0**		**0**	0	0	0	**0**
7	Misc.	g			**17,450**		**174**	15,862	1,762	0	**0**
8	Extra	g			**8,991**		**0**	1,816	7,265	0	**-90**
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**
10	Refrigerant	g			**0**		**0**	0	0	0	**0**
	Total weight	g			**37,218**		**282**	19,098	18,493	0	**-90**
									see note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	MJ	2,766	351	**3,117**	**203**	**1,700**	45	-707		**4,358**
12	of which, electricity (in primary MJ)	MJ	341	209	**550**	**0**	**3**	0	-32		**522**
13	Water (process)	ltr	492	3	**495**	**0**	**5**	0	-85		**415**
14	Water (cooling)	ltr	1,756	96	1,852	0	18	0	-395		1,475
15	Waste, non-haz./ landfill	g	6,599	1,239	**7,838**	**119**	**66**	110	-2,119		**6,015**
16	Waste, hazardous/ incinerated	g	120	0	**120**	**2**	**1**	0	-26		**98**
	Emissions (Air)										
17	Greenhouse Gases in GWP100	kg CO2 eq.	48	20	**67**	**14**	**93**	0	-11		**164**
18	Acidification, emissions	g SO2 eq.	401	85	**486**	**42**	**31**	1	-103		**457**
19	Volatile Organic Compounds (VOC)	g	55	0	**55**	**3**	**2**	0	-15		**45**
20	Persistent Organic Pollutants (POP)	ng i-Teq	377	11	**388**	**1**	**4**	0	-112		**280**
21	Heavy Metals	mg Ni eq.	3,741	25	**3,766**	**6**	**37**	14	-1,048		**2,775**
22	PAHs	mg Ni eq.	318	0	**319**	**9**	**3**	0	-109		**222**
23	Particulate Matter (PM, dust)	g	87	13	**100**	**513**	**1**	1	-26		**589**
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	3,978	1	**3,979**	**0**	**40**	4	-1,113		**2,911**
25	Eutrophication	g PO4	18	0	**18**	**0**	**0**	1	-4		**16**

Some 39% of GER (or 57% of CO2 eq. emissions) are related to the use phase. As with façade windows, these values are even further reduced for better performing windows, as at a certain point the window can even become a building component introducing net energy gains.

5.2. Comparison to other window LCA (related) studies

In June 2004, the European Commission published a 325-page study[6], which reviewed 30 published assessments, concluded: *"For windows, one of the most important PVC applications, the available studies conclude that there is no "winner" in terms of a preferable material since most of the studies conclude that none of the materials has an overall advantage for the standard impact categories".*

In 2012, DG JRC IPTS published a technical background report for the European Commission in the light of revising GPP criteria for windows and doors[7]. This report states in Chapter 9, section 9.2.2.2 (p.78) the following:

The current GPP criteria include a number of requirements relating to materials used in windows and external doors. The EcoReport analysis and previous studies have shown that a particular frame material does not have an overall

[6] Life Cycle Assessment of PVC and of principal competing materials. European Commission, July 2004

[7] Green Public Procurement Windows and external doors Technical Background Report, Report for the European Commission – DG-Environment by JRC IPTS, 2012

environmental advantage over other frame materials, with higher and lower impacts identified across the impact categories, depending on the frame material type. It is therefore considered appropriate to include criteria in relation to different material types.

This study did not find reason to prefer one frame material type over another and instead proposed to set GPP requirements specific per material (presenting requirements for legally harvested wood, marking of plastics, GWP of filler gases, participation to take back schemes such as Vinyl2010, etc.).

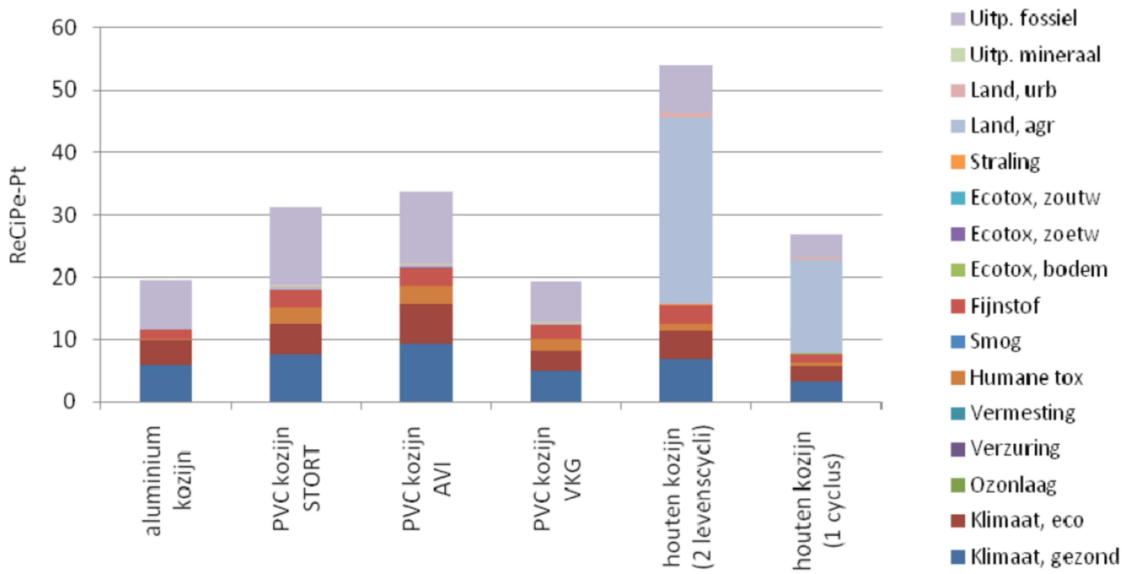
Other window related LCA studies consulted confirm the dominance of the use phase over the overall environmental impacts. Comparing such studies is however troublesome as the use phase values between studies cannot be compared due to differences in methods and inputs.

In 2010 the Dutch VKG commissioned a comparative study into PVC, aluminium and wood window frames (without consideration of the use phase, the windows are assumed to perform similarly). The study starting points have been:

- Aluminium is recycled at 94%, 6% is incinerated;
- PVC is either #1 landfilled, #2 incinerated with heat recovery, #3 recycled for 90% and 10% incinerated;
- Wood is incinerated. The life time is set at #1 half or #2 equal to PVC/aluminium frames.

The figure below shows the results: the life cycle impacts (according ReCiPe) for three window frame types: aluminium, PVC (landfill / incineration / recycling) and wood (2 life cycles or 1 life cycle compared to aluminium, PVC).

Figure 7: the life cycle impacts (according ReCiPe) for three window frame types



The higher scores of wood are mainly due to impacts related to land use, which are still relatively uncertain as impact category. If this impact category is ignored, the total impacts are comparable to aluminium and PVC.

CHAPTER 6 LIFE CYCLE COSTS AT PRODUCT LEVEL

The life cycle costs of all window base cases (at product level) are presented in TASK 6.
Costs at EU level are presented in this TASK 5 report Chapter 7 (next).

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CHAPTER 7 IMPACTS AND COSTS AT EU LEVEL

7.1. EU-28 LIFE CYCLE IMPACTS OF NEW PRODUCTS (PLACED ON MARKET IN 2010)

The table below shows the impacts over the life cycle of all windows sold in the EU-28, if the type 3a is considered the average window sold (Uw 1.7, g-value 0.65, based on calculation of average window for 2020). In reality the sales are a mix of window types 1-11 (see also TASK 7, explanation of Business-as-usual scenario).

Table 11 Life cycle impacts of new products (placed on market in 2010)

Nr	EU Impact of New Models sold reference year over their lifetime:	Date	Author
0		2014	vhk, izm

Nr	Life Cycle phases -->		PRODUCTION			DISTRI	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
	Materials	**unit**									
1	Bulk Plastics	kt			**1,072**		**11**	108	975	0	**0**
2	TecPlastics	kt			**44**		**0**	4	40	0	**0**
3	Ferro	kt			**1,202**		**12**	61	1,153	0	**0**
4	Non-ferro	kt			**405**		**4**	29	380	0	**0**
5	Coating	kt			**0**		**0**	0	0	0	**0**
6	Electronics	kt			**0**		**0**	0	0	0	**0**
7	Misc.	kt			**2,747**		**27**	1,803	971	0	**0**
8	Extra	kt			**604**		**0**	122	488	0	**-6**
9	Auxiliaries	kt			**0**		**0**	0	0	0	**0**
10	Refrigerant	kt			**0**		**0**	0	0	0	**0**
	Total weight	kt			**6,073.4**		**55**	2,127	4,007	0	**-6**
	Other Resources & Waste										
11	Total Energy (GER)	PJ							see note!		
12	of which, electricity (in primary PJ)	PJ						debet	credit		
13	Water (process)	mln. m3	303	74	**377**	**31**	**829**	4	-55	0	**1,186**
14	Water (cooling)	mln. m3	51	44	**95**	**0**	**1**	0	-3	0	**92**
15	Waste, non-haz./ landfill	kt	35	1	**36**	**0**	**0**	0	0	0	**36**
16	Waste, hazardous/ incinerated	kt	76	20	**96**	**0**	**1**	0	12	0	**109**
	Emissions (Air)		2,318	288	**2,606**	**19**	**23**	5	-826	0	**1,828**
17	Greenhouse Gases in GWP100	mt CO2 eq.	7	0	**7**	**0**	**0**	0	1	0	**8**
18	Acidification, emissions	kt SO2 eq.									
19	Volatile Organic Compounds (VOC)	kt									
20	Persistent Organic Pollutants (POP)	g i-Teq	12	4	**16**	**2**	**46**	0	-2	0	**61**

21	Heavy Metals	ton Ni eq.	60	18	**78**	**6**	**14**	0	-11	0	**88**
22	PAHs	ton Ni eq.	3	0	**3**	**0**	**1**	0	-1	0	**3**
23	Particulate Matter (PM, dust)	kt	60	4	**64**	**0**	**1**	0	-19	0	**46**
	Emissions (Water)		200	10	**210**	**1**	**2**	1	-49	0	**165**
24	Heavy Metals	ton Hg/20	36	0	**36**	**1**	**0**	0	-13	0	**24**
25	Eutrophication	kt PO4	13	3	**16**	**68**	**0**	0	-3	0	**82**

Note: Due to the setup of the Ecoreport, the energy consumption is not calculated correctly. The actual energy consumption is presented in TASK 3.

7.2. EU-28 ANNUAL IMPACTS OF WINDOWS SOLD, IN USE, DISPOSED IN 2010

The table below shows the impacts of one year of window use in the EU-28. It is the production impacts of one year of window sales and the energy impact of the stock of windows. The average stock window is in-between type 1 and 2, with an average U value of 3.4. The g-value shall be close to 0.8 on average.

Table 12 Annual impacts of windows sold, in use, disposed in 2010

Nr	EU Impact of Products in reference year (produced, in use, discarded)***	Date	Author
		2014	vhk, izm

	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	**Total**	BUTION		Disposal	Recycl.	**Stock**	
	Materials	**unit**									
1	Bulk Plastics	kt			**1,072**		**11**	108	975	0	**0**
2	TecPlastics	kt			**44**		**0**	4	40	0	**0**
3	Ferro	kt			**1,202**		**12**	61	1,153	0	**0**
4	Non-ferro	kt			**405**		**4**	29	380	0	**0**
5	Coating	kt			**0**		**0**	0	0	0	**0**
6	Electronics	kt			**0**		**0**	0	0	0	**0**
7	Misc.	kt			**2,747**		**27**	1,803	971	0	**0**
8	Extra	kt			**604**		**0**	122	488	0	**-6**
9	Auxiliaries	kt			**0**		**0**	0	0	0	**0**
10	Refrigerants	kt			**0**		**0**	0	0	0	**0**
	Total weight	kt			**6,073**		**55**	2,127	4,007	0	**-6**
	Other Resources & Waste										
8	Total Energy (GER)	PJ							see note!		
9	of which, electricity (in primary PJ)	PJ						debet	credit		
10	Water (process)	mln. m3	303	74	**377**	**31**	**549**	4	-55	0	**957**
11	Water (cooling)	mln. m3	51	44	**95**	**0**	**0**	0	-3	0	**95**
12	Waste, non-haz./ landfill	kt	35	1	**36**	**0**	**0**	0	0	0	**36**
13	Waste, hazardous/ incinerated	kt	76	20	**96**	**0**	**1**	0	12	0	**96**

	Emissions (Air)		2,318	288	**2,606**	**19**	**15**	5	-826	0	**2,641**
14	Greenhouse Gases in GWP100	Mt CO2 eq.	7	0	**7**	**0**	**0**	0	1	0	**7**
16	Acidification, emissions	kt SO2 eq.									
17	Volatile Organic Compounds (VOC)	kt									
18	Persistent Organic Pollutants (POP)	g i-Teq	12	4	**16**	**2**	**30**	0	-2	0	**48**
19	Heavy Metals	ton Ni eq.	60	18	**78**	**6**	**9**	0	-11	0	**94**
	PAHs	ton Ni eq.	3	0	**3**	**0**	**0**	0	-1	0	**4**
20	Particulate Matter (PM, dust)	kt	60	4	**64**	**0**	**0**	0	-19	0	**65**
			200	10	**210**	**1**	**1**	1	-49	0	**212**
	Emissions (Water)		36	0	**36**	**1**	**0**	0	-13	0	**37**
21	Heavy Metals	ton Hg/20	13	3	**16**	**68**	**0**	0	-3	0	**84**
22	Eutrophication	kt PO4									

Note: Due to the setup of the Ecoreport, the energy consumption is not calculated correctly. The actual energy consumption is presented in TASK 3.

The table below shows the overall environmental impacts of the EU stock in 2010

Table 13 Overall environmental impacts of the EU stock in 2010

Table . Summary Environmental Impacts EU-Stock 2011					
Main life cycle indicators	value	unit	%	EU totals	Reference
Materials					
Plastics	1.127	Mt	2.348%	48	Ref: Plastics Europe (demand by EU converters) [1]
Ferrous metals	1.214	Mt	0.589%	206	Ref: Iron & Steel Statistics Bureau [1]
Non-ferrous metals	0.409	Mt	2.045%	20	Ref: www.eaa.net et al. (Al 12,5+Cu 4,7 + Zn 0,8 + Pb 0,8 + Ni 0,3)
Other resources & waste					
Total Energy (GER)					see note above, stock energy is covered in Task 3
of which, electricity					
Water (process)*	36	mln.m3	0.015%	247,000	Ref: http://ec.europa.eu/environment/water/quantity/pdf/exec_summary.pdf [1]
Waste, non-haz./ landfill*	2.64	Mt	0.090%	2,947	Ref: http://epp.eurostat.ec.europa.eu/statistics_explained/index.php?title=File:Generation_of_waste,_total_arising_and_by_selected_economic_activities.
Waste, hazardous/ incinerated*	0.01	kton	0.008%	89	
Emissions (Air)					
Greenhouse Gases in GWP100	48	mt CO2eq.	0.95%	5,054	Ref: EEA3 (CO2 4187 + CH4 416 + N2O 374 + HFCs 63 + PFCs 4 + SF6 10)
Acidifying agents (AP)	94	kt SO2eq.	0.42%	22,432	Ref: EEA1 (Nox 11 151 + Sox 7 339 + NH3 3 876)
Volatile Org. Compounds (VOC)	4	kt	0.04%	8,951	Ref: EEA1
Persistent Org. Pollutants (POP)	65	g i-Teq.	2.93%	2,212	Ref: EEA1 (dioxins and furans only)

Heavy Metals (HM)	212	ton Ni eq.	3.59%	5,903	Ref: EEA1 (Cd 118 + Hg 89 + Pb 2157 t); EEA2 (As 337 + Ni 2843 t); CML (Cr 517 + Cu 589 + Zn 6510 t)
PAHs	37	ton Ni eq.	2.72%	1,369	Ref: EEA1
Particulate Matter (PM, dust)	84	kt	2.40%	3,522	Ref: EEA1 (1400 kt PM2,5 + 2122 kt PM10)
Emissions (Water)					
Heavy Metals (HM)	285	ton Hg/20	2.22%	12,853	Ref: CML (As 17+Cd 21,3 + Cr 271 + Cu 1690 + Pb 2260 + Hg 14,3 + Ni 551 t + Zn 11200 t)
Eutrophication (EP)	1	kt PO4	0.03%	900	Ref: EEA2 (Baltic 861 N/5,4 P + North Sea 761 N/14,4 P + Danube/Black Sea 270 N/ 14,2 P)
***=caution: low accuracy for production phase**					
EEA1, European Environmental Agency, National emissions reported to the Convention on Long-range Transboundary Air Pollution (LRTAP Convention), EU-27 (national territory), 2007. (extract Feb. 2011)					
EEA2, Source apportionment of nitrogen and phosphorus inputs into the aquatic environment, 2005. [Compare: CML value for EU-15, 1995 is 1 263 kt PO4 eq. based on 1 370 kt N and 224 kt P; no data for aquatic emissions BOD, COD, DOC, TOC reported]					
EEA3: EEA, Annual European Community greenhouse gas inventory 1990–2007 and inventory report 2009, Submission to the UNFCCC Secretariat, 2009. Total without LULUCF (Land-Use, Land-Use Change & Forestry)					
EC1, European Commission (DG ENV), Ambient air pollution by AS, CD and NI compounds, Position Paper, 2001. [data sources stem from ca. 1990, EU-15 recalculated by VHK to 2007, EU-27 using multiplier 1,3 for EU-expansion and 55% emission reduction (e.g. Cd) 1990-2007; data are roughly in line with CML]					
Eurostat, Energy Balance Sheets 2007-2008, European Commission, edition 2010. VHK, Energy analysis of energy sector to final end use electricity and fuels (excl. transport & feedstock), based on Eurostat, elsewhere in this report					
CML, Centrum voor Milieukunde Leiden, Characterisation and Normalisation factors (CML-IA xls file Nov. 2010; extract Feb. 2011); data for EU-15, 1995. Assumed that EU expansion to EU-17 and emission decrease 1995-2007 will balance.					
[1] from intermediate source: AEA, ENTR Lot 3 Sound and Imaging Equipment, preparatory Ecodesign study, Nov. 2010					

Note: Due to the setup of the Ecoreport, the energy consumption is not calculated correctly. The actual energy consumption is presented in TASK 3. TASK 3 also shows more correct GHG emission values.

7.3. LIFE CYCLE COSTS AND EXPENDITURE

EU expenditure (purchase costs, maintenance costs and energy costs) have been presented in TASK 3 and are further elaborated in TASK 7 Scenario's.

APPENDIX I - ECOREPORT BASE CASE 1-11

Nr	Life cycle Impact per product:	Reference year	Author
0	Type 1: heating in climate condition Central, without shutters	2014	vhk, izm

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE			TOTAL		
	Resources Use and Emissions		Material	Manuf.	**Total**	BUTION		Disposal	Recov.	**Stock**			
	Materials	**unit**											
1	Bulk Plastics	g			**4,289**		**43**	433	3,899	0	**0**		
2	TecPlastics	g			**174**		**2**	18	158	0	**0**		
3	Ferro	g			**4,807**		**48**	243	4,612	0	**0**		
4	Non-ferro	g			**1,620**		**16**	115	1,521	0	**0**		
5	Coating	g			**0**		**0**	0	0	0	**0**		
6	Electronics	g			**0**		**0**	0	0	0	**0**		
7	Misc.	g			**6,867**		**69**	4,508	2,427	0	**0**		
8	Extra	g			**2,417**		**0**	488	1,953	0	**-24**		
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**		
10	Refrigerant	g			**0**		**0**	0	0	0	**0**		
	Total weight	g			**20,174**		**178**	5,804	14,571	0	**-24**		
									see note!				
	Other Resources & Waste							debet	credit			% use phase	% EOL
11	Total Energy (GER)	MJ	1,145	296	**1,442**	**132**	**5,358**	13	-210		**6,735**	96%	-1%
12	of which, electricity (in primary MJ)	MJ	150	175	**325**	**0**	**2**	0	-5		**322**	1%	-1%

13	Water (process)	ltr	107	3	**110**	**0**	**1**	0	3		**114**		1%	2%
14	Water (cooling)	ltr	304	79	**383**	**0**	**3**	0	48		**434**		1%	8%
15	Waste, non-haz./ landfill	g	9,217	1,152	**10,369**	**88**	**92**	14	-3,297		**7,265**		1%	-46%
16	Waste, hazardous/ incinerated	g	27	0	**27**	**2**	**0**	0	4		**32**		1%	7%
	Emissions (Air)													
17	Greenhouse Gases in GWP100	kg CO2 eq.	43	17	**59**	**10**	**296**	0	-9		**356**		97%	-1%
18	Acidification, emissions	g SO2 eq.	228	72	**300**	**28**	**88**	0	-41		**376**		71%	-6%
19	Volatile Organic Compounds (VOC)	g	12	0	**12**	**2**	**4**	0	-3		**15**		65%	-12%
20	Persistent Organic Pollutants (POP)	ng i-Teq	240	17	**257**	**0**	**2**	0	-77		**183**		1%	-44%
21	Heavy Metals	mg Ni eq.	799	39	**838**	**4**	**8**	3	-195		**659**		1%	-37%
22	PAHs	mg Ni eq.	142	0	**142**	**6**	**2**	0	-53		**97**		2%	-61%
23	Particulate Matter (PM, dust)	g	52	11	**63**	**274**	**2**	0	-12		**327**		4%	-5%
	Emissions (Water)													
24	Heavy Metals	mg Hg/20	1,132	1	**1,133**	**0**	**11**	1	-276		**870**		1%	-39%
25	Eutrophication	g PO4	2	0	**2**	**0**	**0**	0	0		**2**		1%	5%

Nr	Life cycle Impact per product:	Reference year	Author
0	Type 2: heating in climate condition Central, without shutters	2014	vhk, izm

	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE			TOTAL		
	Resources Use and Emissions		Material	Manuf.	**Total**	BUTION		Disposal	Recov.	**Stock**			
	Materials	**unit**											
1	Bulk Plastics	g			**5,361**		**54**	542	4,874	0	**0**		
2	TecPlastics	g			**218**		**2**	22	198	0	**0**		
3	Ferro	g			**6,009**		**60**	303	5,766	0	**0**		
4	Non-ferro	g			**2,025**		**20**	143	1,902	0	**0**		
5	Coating	g			**0**		**0**	0	0	0	**0**		
6	Electronics	g			**0**		**0**	0	0	0	**0**		
7	Misc.	g			**13,733**		**137**	9,016	4,855	0	**0**		
8	Extra	g			**3,021**		**0**	610	2,441	0	**-30**		
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**		
10	Refrigerant	g			**0**		**0**	0	0	0	**0**		
	Total weight	g			**30,367**		**273**	10,636	20,034	0	**-30**		
									see note!				
	Other Resources & Waste							debet	credit			% use phase	% EOL
11	Total Energy (GER)	MJ	1,515	371	**1,886**	**153**	**4,960**	20	-273		**6,746**	87%	-3%
12	of which, electricity (in primary MJ)	MJ	254	219	**473**	**0**	**3**	0	-13		**462**	1%	-1%
13	Water (process)	ltr	177	3	**180**	**0**	**2**	0	-1		**180**	1%	2%
14	Water (cooling)	ltr	380	99	**479**	**0**	**4**	0	60		**543**	1%	8%
15	Waste, non-haz./ landfill	g	11,591	1,440	**13,031**	**97**	**116**	27	-4,130		**9,141**	1%	-46%
16	Waste, hazardous/ incinerated	g	35	0	**35**	**2**	**0**	0	4		**41**	1%	7%
	Emissions (Air)												
17	Greenhouse Gases in GWP100	kg CO2 eq.	58	21	**79**	**11**	**274**	0	-12		**352**	90%	-2%

18	Acidification, emissions	g SO2 eq.	300	90	**390**	**32**	**83**	0	-53		**453**		40%	-13%
19	Volatile Organic Compounds (VOC)	g	15	0	**16**	**2**	**4**	0	-4		**18**		34%	-23%
20	Persistent Organic Pollutants (POP)	ng i-Teq	300	21	**321**	**1**	**3**	0	-96		**229**		1%	-44%
21	Heavy Metals	mg Ni eq.	1,000	49	**1,049**	**5**	**10**	4	-244		**824**		1%	-37%
22	PAHs	mg Ni eq.	178	0	**178**	**7**	**2**	0	-66		**121**		2%	-61%
23	Particulate Matter (PM, dust)	g	65	14	**79**	**342**	**2**	0	-15		**409**		1%	-5%
	Emissions (Water)													
24	Heavy Metals	mg Hg/20	1,415	2	**1,417**	**0**	**14**	2	-345		**1,088**		1%	-39%
25	Eutrophication	g PO4	3	0	**3**	**0**	**0**	0	0		**3**		1%	5%

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Nr	Life cycle Impact per product:	Reference year	Author
0	Type 3: heating in climate condition Central, without shutters	2014	vhk, izm

	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE			TOTAL		
	Resources Use and Emissions		Material	Manuf.	**Total**	BUTION		Disposal	Recov.	**Stock**			
	Materials	**unit**											
1	Bulk Plastics	g			**5,361**		**54**	542	4,874	0	**0**		
2	TecPlastics	g			**218**		**2**	22	198	0	**0**		
3	Ferro	g			**6,009**		**60**	303	5,766	0	**0**		
4	Non-ferro	g			**2,025**		**20**	143	1,902	0	**0**		
5	Coating	g			**0**		**0**	0	0	0	**0**		
6	Electronics	g			**0**		**0**	0	0	0	**0**		
7	Misc.	g			**13,733**		**137**	9,016	4,855	0	**0**		
8	Extra	g			**3,021**		**0**	610	2,441	0	**-30**		
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**		
10	Refrigerant	g			**0**		**0**	0	0	0	**0**		
	Total weight	g			**30,367**		**273**	10,636	20,034	0	**-30**		
									see note!				
	Other Resources & Waste							debet	credit			% use phase	% EOL
11	Total Energy (GER)	MJ	1,515	371	**1,886**	**153**	**4,146**	20	-273		**5,932**	73%	-6%
12	of which, electricity (in primary MJ)	MJ	254	219	**473**	**0**	**3**	0	-13		**462**	1%	-1%
13	Water (process)	ltr	177	3	**180**	**0**	**2**	0	-1		**180**	1%	2%
14	Water (cooling)	ltr	380	99	**479**	**0**	**4**	0	60		**543**	1%	8%
15	Waste, non-haz./ landfill	g	11,591	1,440	**13,031**	**97**	**116**	27	-4,130		**9,141**	1%	-46%
16	Waste, hazardous/ incinerated	g	35	0	**35**	**2**	**0**	0	4		**41**	1%	7%
	Emissions (Air)												

17	Greenhouse Gases in GWP100	kg CO2 eq.	58	21	**79**	**11**	**229**	0	-12		**307**		78%	-5%
18	Acidification, emissions	g SO2 eq.	300	90	**390**	**32**	**70**	0	-53		**439**		21%	-16%
19	Volatile Organic Compounds (VOC)	g	15	0	**16**	**2**	**3**	0	-4		**17**		17%	-29%
20	Persistent Organic Pollutants (POP)	ng i-Teq	300	21	**321**	**1**	**3**	0	-96		**229**		1%	-44%
21	Heavy Metals	mg Ni eq.	1,000	49	**1,049**	**5**	**10**	4	-244		**824**		1%	-37%
22	PAHs	mg Ni eq.	178	0	**178**	**7**	**2**	0	-66		**121**		2%	-62%
23	Particulate Matter (PM, dust)	g	65	14	**79**	**342**	**2**	0	-15		**409**		1%	-5%
	Emissions (Water)													
24	Heavy Metals	mg Hg/20	1,415	2	**1,417**	**0**	**14**	2	-345		**1,088**		1%	-39%
25	Eutrophication	g PO4	3	0	**3**	**0**	**0**	0	0		**3**		1%	5%

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Nr	Life cycle Impact per product:	Reference year	Author
0	Type 4: heating in climate condition Central, without shutters	2014	vhk, izm

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recov.	Stock	
	Materials	**unit**									
1	Bulk Plastics	g			**5,361**		**54**	542	4,874	0	**0**
2	TecPlastics	g			**218**		**2**	22	198	0	**0**
3	Ferro	g			**6,009**		**60**	303	5,766	0	**0**
4	Non-ferro	g			**2,025**		**20**	143	1,902	0	**0**
5	Coating	g			**0**		**0**	0	0	0	**0**
6	Electronics	g			**0**		**0**	0	0	0	**0**
7	Misc.	g			**13,733**		**137**	9,016	4,855	0	**0**
8	Extra	g			**3,021**		**0**	610	2,441	0	**-30**
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**
10	Refrigerant	g			**0**		**0**	0	0	0	**0**
	Total weight	g			**30,367**		**273**	10,636	20,034	0	**-30**

see note!

Nr	**Other Resources & Waste**		Material	Manuf.	Total	DISTRIBUTION	USE	debet	credit		TOTAL	% use phase	% EOL
11	Total Energy (GER)	MJ	1,515	371	**1,886**	**153**	**3,832**	20	-273		**5,617**	62%	-9%
12	of which, electricity (in primary MJ)	MJ	254	219	**473**	**0**	**3**	0	-13		**462**	1%	-1%
13	Water (process)	ltr	177	3	**180**	**0**	**2**	0	-1		**180**	1%	2%
14	Water (cooling)	ltr	380	99	**479**	**0**	**4**	0	60		**543**	1%	8%
15	Waste, non-haz./ landfill	g	11,591	1,440	**13,031**	**97**	**116**	27	-4,130		**9,141**	1%	-46%
16	Waste, hazardous/ incinerated	g	35	0	**35**	**2**	**0**	0	4		**41**	1%	7%

Emissions (Air)

17	Greenhouse Gases in GWP100	kg CO2 eq.	58	21	**79**	**11**	**212**	0	-12		**289**		68%	-7%
18	Acidification, emissions	g SO2 eq.	300	90	**390**	**32**	**64**	0	-53		**434**		14%	-18%
19	Volatile Organic Compounds (VOC)	g	15	0	**16**	**2**	**3**	0	-4		**17**		12%	-31%
20	Persistent Organic Pollutants (POP)	ng i-Teq	300	21	**321**	**1**	**3**	0	-96		**229**		1%	-44%
21	Heavy Metals	mg Ni eq.	1,000	49	**1,049**	**5**	**10**	4	-244		**824**		1%	-37%
22	PAHs	mg Ni eq.	178	0	**178**	**7**	**2**	0	-66		**121**		2%	-62%
23	Particulate Matter (PM, dust)	g	65	14	**79**	**342**	**2**	0	-15		**408**		0%	-5%
	Emissions (Water)													
24	Heavy Metals	mg Hg/20	1,415	2	**1,417**	**0**	**14**	2	-345		**1,088**		1%	-39%
25	Eutrophication	g PO4	3	0	**3**	**0**	**0**	0	0		**3**		1%	5%

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Nr	Life cycle Impact per product:	Reference year	Author
0	Type 5: heating in climate condition Central, without shutters	2014	vhk, izm

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE			TOTAL		
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recov.	Stock			
	Materials	**unit**											
1	Bulk Plastics	g			**6,702**		**67**	677	6,092	0	**0**		
2	TecPlastics	g			**272**		**3**	27	247	0	**0**		
3	Ferro	g			**7,511**		**75**	379	7,207	0	**0**		
4	Non-ferro	g			**2,531**		**25**	179	2,377	0	**0**		
5	Coating	g			**0**		**0**	0	0	0	**0**		
6	Electronics	g			**0**		**0**	0	0	0	**0**		
7	Misc.	g			**20,600**		**206**	13,524	7,282	0	**0**		
8	Extra	g			**3,777**		**0**	763	3,052	0	**-38**		
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**		
10	Refrigerant	g			**0**		**0**	0	0	0	**0**		
	Total weight	g			**41,392**		**376**	15,549	26,257	0	**-38**		
									see note!				
	Other Resources & Waste							debet	credit			% use phase	% EOL
11	Total Energy (GER)	MJ	1,950	463	**2,413**	**178**	**3,520**	27	-347		**5,791**	42%	-13%
12	of which, electricity (in primary MJ)	MJ	362	273	**635**	**0**	**4**	0	-22		**617**	1%	-1%
13	Water (process)	ltr	249	4	**253**	**0**	**2**	0	-5		**251**	1%	2%
14	Water (cooling)	ltr	475	123	**598**	**0**	**5**	0	75		**678**	1%	8%
15	Waste, non-haz./ landfill	g	14,535	1,801	**16,335**	**108**	**145**	41	-5,167		**11,462**	1%	-46%
16	Waste, hazardous/ incinerated	g	44	0	**45**	**2**	**0**	0	5		**52**	1%	7%

Emissions (Air)

17	Greenhouse Gases in GWP100	kg CO2 eq.	75	26	**101**	**13**	**194**	0	-15		**293**		49%	-12%
18	Acidification, emissions	g SO2 eq.	386	113	**498**	**37**	**60**	1	-67		**529**		7%	-20%
19	Volatile Organic Compounds (VOC)	g	19	0	**19**	**3**	**3**	0	-5		**20**		6%	-33%
20	Persistent Organic Pollutants (POP)	ng i-Teq	375	26	**402**	**1**	**4**	0	-121		**286**		1%	-44%
21	Heavy Metals	mg Ni eq.	1,251	61	**1,312**	**5**	**13**	5	-305		**1,030**		1%	-37%
22	PAHs	mg Ni eq.	222	0	**223**	**8**	**2**	0	-83		**150**		2%	-62%
23	Particulate Matter (PM, dust)	g	82	17	**99**	**428**	**2**	1	-19		**510**		0%	-5%
	Emissions (Water)													
24	Heavy Metals	mg Hg/20	1,769	2	**1,771**	**0**	**18**	2	-431		**1,360**		1%	-39%
25	Eutrophication	g PO4	3	0	**3**	**0**	**0**	0	0		**4**		1%	5%

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Nr	Life cycle Impact per product:	Reference year	Author
0	Type 6: heating in climate condition Central, without shutters	2014	vhk, izm

	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE			TOTAL		
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recov.	Stock			
	Materials	**unit**											
1	Bulk Plastics	g			**6,702**		**67**	677	6,092	0	**0**		
2	TecPlastics	g			**272**		**3**	27	247	0	**0**		
3	Ferro	g			**7,511**		**75**	379	7,207	0	**0**		
4	Non-ferro	g			**2,531**		**25**	179	2,377	0	**0**		
5	Coating	g			**0**		**0**	0	0	0	**0**		
6	Electronics	g			**0**		**0**	0	0	0	**0**		
7	Misc.	g			**20,600**		**206**	13,524	7,282	0	**0**		
8	Extra	g			**3,777**		**0**	763	3,052	0	**-38**		
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**		
10	Refrigerant	g			**0**		**0**	0	0	0	**0**		
	Total weight	g			**41,392**		**376**	15,549	26,257	0	**-38**		
									see note!				
	Other Resources & Waste							debet	credit			% use phase	% EOL
11	Total Energy (GER)	MJ	1,950	463	**2,413**	**178**	**3,842**	27	-347		**6,113**	-5%	-24%
12	of which, electricity (in primary MJ)	MJ	362	273	**635**	**0**	**4**	0	-22		**617**	1%	-1%
13	Water (process)	ltr	249	4	**253**	**0**	**2**	0	-5		**251**	1%	2%
14	Water (cooling)	ltr	475	123	598	0	5	0	75		678	1%	8%
15	Waste, non-haz./ landfill	g	14,535	1,801	**16,335**	**108**	**145**	41	-5,167		**11,462**	1%	-46%
16	Waste, hazardous/ incinerated	g	44	0	**45**	**2**	**0**	0	5		**52**	1%	7%
	Emissions (Air)												

17	Greenhouse Gases in GWP100	kg CO2 eq.	75	26	**101**	**13**	**212**	0	-15		**310**		-7%	-25%
18	Acidification, emissions	g SO2 eq.	386	113	**498**	**37**	**65**	1	-67		**534**		0%	-21%
19	Volatile Organic Compounds (VOC)	g	19	0	**19**	**3**	**3**	0	-5		**20**		1%	-35%
20	Persistent Organic Pollutants (POP)	ng i-Teq	375	26	**402**	**1**	**4**	0	-121		**286**		1%	-44%
21	Heavy Metals	mg Ni eq.	1,251	61	**1,312**	**5**	**13**	5	-305		**1,030**		1%	-37%
22	PAHs	mg Ni eq.	222	0	**223**	**8**	**2**	0	-83		**150**		2%	-62%
23	Particulate Matter (PM, dust)	g	82	17	**99**	**428**	**2**	1	-19		**510**		0%	-5%
	Emissions (Water)													
24	Heavy Metals	mg Hg/20	1,769	2	**1,771**	**0**	**18**	2	-431		**1,360**		1%	-39%
25	Eutrophication	g PO4	3	0	**3**	**0**	**0**	0	0		**4**		1%	5%

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Nr	Life cycle Impact per product:	Reference year	Author
0	Type 7: heating in climate condition Central, without shutters	2014	vhk, izm

	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE			TOTAL		
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recov.	Stock			
	Materials	**unit**											
1	Bulk Plastics	g			**8,042**		**80**	812	7,310	0	**0**		
2	TecPlastics	g			**326**		**3**	33	297	0	**0**		
3	Ferro	g			**9,013**		**90**	455	8,648	0	**0**		
4	Non-ferro	g			**3,037**		**30**	215	2,853	0	**0**		
5	Coating	g			**0**		**0**	0	0	0	**0**		
6	Electronics	g			**0**		**0**	0	0	0	**0**		
7	Misc.	g			**20,600**		**206**	13,524	7,282	0	**0**		
8	Extra	g			**4,532**		**0**	915	3,662	0	**-45**		
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**		
10	Refrigerant	g			**0**		**0**	0	0	0	**0**		
	Total weight	g			**45,551**		**410**	15,954	30,052	0	**-45**		
									see note!				
	Other Resources & Waste							debet	credit			% use phase	% EOL
11	Total Energy (GER)	MJ	2,273	556	**2,828**	**203**	**3,715**	30	-409		**6,368**	33%	-15%
12	of which, electricity (in primary MJ)	MJ	381	328	**709**	**0**	**4**	0	-20		**693**	1%	-1%
13	Water (process)	ltr	265	5	**270**	**0**	**3**	0	-2		**270**	1%	2%
14	Water (cooling)	ltr	570	148	**718**	**0**	**6**	0	90		**814**	1%	8%
15	Waste, non-haz./ landfill	g	17,386	2,161	**19,547**	**119**	**174**	41	-6,195		**13,686**	1%	-47%
16	Waste, hazardous/ incinerated	g	52	0	**52**	**2**	**1**	0	6		**62**	1%	7%
	Emissions (Air)												

17	Greenhouse Gases in GWP100	kg CO2 eq.	87	31	**118**	**14**	**205**	0	-18		**319**		39%	-14%
18	Acidification, emissions	g SO2 eq.	450	135	**585**	**42**	**64**	1	-79		**613**		5%	-20%
19	Volatile Organic Compounds (VOC)	g	23	0	**23**	**3**	**3**	0	-6		**24**		5%	-34%
20	Persistent Organic Pollutants (POP)	ng i-Teq	450	32	**482**	**1**	**5**	0	-145		**343**		1%	-44%
21	Heavy Metals	mg Ni eq.	1,500	73	**1,573**	**6**	**15**	6	-366		**1,234**		1%	-37%
22	PAHs	mg Ni eq.	267	0	**267**	**9**	**3**	0	-99		**180**		2%	-62%
23	Particulate Matter (PM, dust)	g	98	21	**119**	**513**	**2**	1	-22		**612**		0%	-5%
	Emissions (Water)													
24	Heavy Metals	mg Hg/20	2,123	2	**2,125**	**0**	**21**	2	-517		**1,632**		1%	-39%
25	Eutrophication	g PO4	4	0	**4**	**0**	**0**	0	0		**4**		1%	5%

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Nr	Life cycle Impact per product:	Reference year	Author
0	Type 8: heating in climate condition Central, without shutters	2014	vhk, izm

	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE			TOTAL		
	Resources Use and Emissions		Material	Manuf.	**Total**	BUTION		Disposal	Recov.	**Stock**			
	Materials	**unit**											
1	Bulk Plastics	g			**10,723**		**107**	1,083	9,747	0	**0**		
2	TecPlastics	g			**435**		**4**	44	395	0	**0**		
3	Ferro	g			**12,018**		**120**	607	11,531	0	**0**		
4	Non-ferro	g			**4,049**		**40**	286	3,803	0	**0**		
5	Coating	g			**0**		**0**	0	0	0	**0**		
6	Electronics	g			**0**		**0**	0	0	0	**0**		
7	Misc.	g			**27,466**		**275**	18,032	9,709	0	**0**		
8	Extra	g			**6,043**		**0**	1,221	4,882	0	**-60**		
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**		
10	Refrigerant	g			**0**		**0**	0	0	0	**0**		
	Total weight	g			**60,734**		**547**	21,273	40,069	0	**-60**		
									see note!				
	Other Resources & Waste							debet	credit			% use phase	% EOL
11	Total Energy (GER)	MJ	3,030	741	**3,771**	**254**	**3,024**	40	-545		**6,544**	-6%	-24%
12	of which, electricity (in primary MJ)	MJ	508	437	**945**	**1**	**5**	0	-27		**924**	1%	-1%
13	Water (process)	ltr	353	6	**360**	**0**	**4**	0	-3		**361**	1%	2%
14	Water (cooling)	ltr	760	197	**957**	**0**	**8**	0	120		**1,085**	1%	8%
15	Waste, non-haz./ landfill	g	23,181	2,881	**26,062**	**142**	**232**	55	-8,259		**18,231**	1%	-47%
16	Waste, hazardous/ incinerated	g	70	0	**70**	**3**	**1**	0	9		**82**	1%	7%
	Emissions (Air)												

17	Greenhouse Gases in GWP100	kg CO2 eq.	115	42	**157**	**18**	**167**	0	-24		**317**		-9%	-25%
18	Acidification, emissions	g SO2 eq.	600	180	**781**	**52**	**54**	1	-106		**782**		0%	-21%
19	Volatile Organic Compounds (VOC)	g	31	0	**31**	**4**	**2**	0	-8		**30**		1%	-35%
20	Persistent Organic Pollutants (POP)	ng i-Teq	600	42	**643**	**1**	**6**	0	-193		**457**		1%	-44%
21	Heavy Metals	mg Ni eq.	2,000	98	**2,098**	**7**	**20**	7	-488		**1,645**		1%	-37%
22	PAHs	mg Ni eq.	356	0	**356**	**11**	**4**	0	-132		**239**		2%	-62%
23	Particulate Matter (PM, dust)	g	130	28	**158**	**684**	**2**	1	-30		**815**		0%	-5%
	Emissions (Water)													
24	Heavy Metals	mg Hg/20	2,830	3	**2,833**	**0**	**28**	3	-689		**2,176**		1%	-39%
25	Eutrophication	g PO4	5	0	**5**	**0**	**0**	0	0		**6**		1%	5%

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Nr	Life cycle Impact per product:	Reference year	Author
0	Type 9: heating in climate condition Central, without shutters	2014	vhk, izm

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE			TOTAL		
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recov.	Stock			
	Materials	**unit**											
1	Bulk Plastics	g			**5,361**		**54**	542	4,874	0	**0**		
2	TecPlastics	g			**218**		**2**	22	198	0	**0**		
3	Ferro	g			**6,009**		**60**	303	5,766	0	**0**		
4	Non-ferro	g			**2,025**		**20**	143	1,902	0	**0**		
5	Coating	g			**0**		**0**	0	0	0	**0**		
6	Electronics	g			**0**		**0**	0	0	0	**0**		
7	Misc.	g			**13,733**		**137**	9,016	4,855	0	**0**		
8	Extra	g			**3,021**		**0**	610	2,441	0	**-30**		
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**		
10	Refrigerant	g			**0**		**0**	0	0	0	**0**		
	Total weight	g			**30,367**		**273**	10,636	20,034	0	**-30**		
									see note!				
	Other Resources & Waste							debet	credit			% use phase	% EOL
11	Total Energy (GER)	MJ	1,515	371	**1,886**	**153**	**2,213**	20	-273		**3,999**	91%	-2%
12	of which, electricity (in primary MJ)	MJ	254	219	**473**	**0**	**3**	0	-13		**462**	1%	-1%
13	Water (process)	ltr	177	3	**180**	**0**	**2**	0	-1		**180**	1%	2%
14	Water (cooling)	ltr	380	99	**479**	**0**	**4**	0	60		**543**	1%	8%
15	Waste, non-haz./ landfill	g	11,591	1,440	**13,031**	**97**	**116**	27	-4,130		**9,141**	1%	-46%
16	Waste, hazardous/ incinerated	g	35	0	**35**	**2**	**0**	0	4		**41**	1%	7%
	Emissions (Air)												

17	Greenhouse Gases in GWP100	kg CO2 eq.	58	21	**79**	**11**	**122**	0	-12		**200**		93%	-2%
18	Acidification, emissions	g SO2 eq.	300	90	**390**	**32**	**38**	0	-53		**408**		50%	-10%
19	Volatile Organic Compounds (VOC)	g	15	0	**16**	**2**	**2**	0	-4		**16**		44%	-20%
20	Persistent Organic Pollutants (POP)	ng i-Teq	300	21	**321**	**1**	**3**	0	-96		**229**		1%	-44%
21	Heavy Metals	mg Ni eq.	1,000	49	**1,049**	**5**	**10**	4	-244		**824**		1%	-37%
22	PAHs	mg Ni eq.	178	0	**178**	**7**	**2**	0	-66		**121**		2%	-61%
23	Particulate Matter (PM, dust)	g	65	14	**79**	**342**	**1**	0	-15		**408**		2%	-5%
	Emissions (Water)													
24	Heavy Metals	mg Hg/20	1,415	2	**1,417**	**0**	**14**	2	-345		**1,088**		1%	-39%
25	Eutrophication	g PO4	3	0	**3**	**0**	**0**	0	0		**3**		1%	5%

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Nr	Life cycle Impact per product:	Reference year	Author
0	Type 10: heating in climate condition Central, without shutters	2014	vhk, izm

	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE			TOTAL		
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recov.	Stock			
	Materials	**unit**											
1	Bulk Plastics	g			**5,361**		**54**	542	4,874	0	**0**		
2	TecPlastics	g			**218**		**2**	22	198	0	**0**		
3	Ferro	g			**6,009**		**60**	303	5,766	0	**0**		
4	Non-ferro	g			**2,025**		**20**	143	1,902	0	**0**		
5	Coating	g			**0**		**0**	0	0	0	**0**		
6	Electronics	g			**0**		**0**	0	0	0	**0**		
7	Misc.	g			**13,733**		**137**	9,016	4,855	0	**0**		
8	Extra	g			**3,021**		**0**	610	2,441	0	**-30**		
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**		
10	Refrigerant	g			**0**		**0**	0	0	0	**0**		
	Total weight	g			**30,367**		**273**	10,636	20,034	0	**-30**		
									see note!				
	Other Resources & Waste							debet	credit			% use phase	% EOL
11	Total Energy (GER)	MJ	1,515	371	**1,886**	**153**	**2,234**	20	-273		**4,020**	77%	-5%
12	of which, electricity (in primary MJ)	MJ	254	219	**473**	**0**	**3**	0	-13		**462**	1%	-1%
13	Water (process)	ltr	177	3	**180**	**0**	**2**	0	-1		**180**	1%	2%
14	Water (cooling)	ltr	380	99	**479**	**0**	**4**	0	60		**543**	1%	8%
15	Waste, non-haz./ landfill	g	11,591	1,440	**13,031**	**97**	**116**	27	-4,130		**9,141**	1%	-46%
16	Waste, hazardous/ incinerated	g	35	0	**35**	**2**	**0**	0	4		**41**	1%	7%
	Emissions (Air)												

17	Greenhouse Gases in GWP100	kg CO2 eq.	58	21	**79**	**11**	**123**	0	-12		**201**		81%	-4%
18	Acidification, emissions	g SO2 eq.	300	90	**390**	**32**	**39**	0	-53		**409**		25%	-16%
19	Volatile Organic Compounds (VOC)	g	15	0	**16**	**2**	**2**	0	-4		**16**		20%	-28%
20	Persistent Organic Pollutants (POP)	ng i-Teq	300	21	**321**	**1**	**3**	0	-96		**229**		1%	-44%
21	Heavy Metals	mg Ni eq.	1,000	49	**1,049**	**5**	**10**	4	-244		**824**		1%	-37%
22	PAHs	mg Ni eq.	178	0	**178**	**7**	**2**	0	-66		**121**		2%	-61%
23	Particulate Matter (PM, dust)	g	65	14	**79**	**342**	**1**	0	-15		**408**		1%	-5%
	Emissions (Water)													
24	Heavy Metals	mg Hg/20	1,415	2	**1,417**	**0**	**14**	2	-345		**1,088**		1%	-39%
25	Eutrophication	g PO4	3	0	**3**	**0**	**0**	0	0		**3**		1%	5%

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Nr	Life cycle Impact per product:	Reference year	Author
0	Type 11: heating in climate condition Central, without shutters	2014	vhk, izm

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE			TOTAL		
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recov.	Stock			
	Materials	**unit**											
1	Bulk Plastics	g			**6,702**		**67**	677	6,092	0	**0**		
2	TecPlastics	g			**272**		**3**	27	247	0	**0**		
3	Ferro	g			**7,511**		**75**	379	7,207	0	**0**		
4	Non-ferro	g			**2,531**		**25**	179	2,377	0	**0**		
5	Coating	g			**0**		**0**	0	0	0	**0**		
6	Electronics	g			**0**		**0**	0	0	0	**0**		
7	Misc.	g			**20,600**		**206**	13,524	7,282	0	**0**		
8	Extra	g			**3,777**		**0**	763	3,052	0	**-38**		
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**		
10	Refrigerant	g			**0**		**0**	0	0	0	**0**		
	Total weight	g			**41,392**		**376**	15,549	26,257	0	**-38**		
									see note!				
	Other Resources & Waste							debet	credit			% use phase	% EOL
11	Total Energy (GER)	MJ	1,950	463	**2,413**	**178**	**2,245**	27	-347		**4,515**	52%	-11%
12	of which, electricity (in primary MJ)	MJ	362	273	**635**	**0**	**4**	0	-22		**617**	1%	-1%
13	Water (process)	ltr	249	4	**253**	**0**	**2**	0	-5		**251**	1%	2%
14	Water (cooling)	ltr	475	123	**598**	**0**	**5**	0	75		**678**	1%	8%
15	Waste, non-haz./ landfill	g	14,535	1,801	**16,335**	**108**	**145**	41	-5,167		**11,462**	1%	-46%
16	Waste, hazardous/ incinerated	g	44	0	**45**	**2**	**0**	0	5		**52**	1%	7%
	Emissions (Air)												

17	Greenhouse Gases in GWP100	kg CO2 eq.	75	26	**101**	**13**	**124**	0	-15		**222**		59%	-9%
18	Acidification, emissions	g SO2 eq.	386	113	**498**	**37**	**40**	1	-67		**508**		10%	-19%
19	Volatile Organic Compounds (VOC)	g	19	0	**19**	**3**	**2**	0	-5		**19**		8%	-32%
20	Persistent Organic Pollutants (POP)	ng i-Teq	375	26	**402**	**1**	**4**	0	-121		**286**		1%	-44%
21	Heavy Metals	mg Ni eq.	1,251	61	**1,312**	**5**	**13**	5	-305		**1,030**		1%	-37%
22	PAHs	mg Ni eq.	222	0	**223**	**8**	**2**	0	-83		**150**		2%	-62%
23	Particulate Matter (PM, dust)	g	82	17	**99**	**428**	**1**	1	-19		**510**		0%	-5%
	Emissions (Water)													
24	Heavy Metals	mg Hg/20	1,769	2	**1,771**	**0**	**18**	2	-431		**1,360**		1%	-39%
25	Eutrophication	g PO4	3	0	**3**	**0**	**0**	0	0		**4**		1%	5%

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