

Contract N°. Specific contract 185/PP/ENT/IMA/12/1110333 implementing FC ENTR/29/PP/FC Lot 2

Report

Preparatory Studies for Product Group in the Ecodesign Working Plan 2012-2014: Lot 8- Power Cables

DRAFT Task 5 report - Environment & Economics (base case Life Cycle Assessment & Life Cycle Costs) (2nd version)



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1 **EXECUTIVE SUMMARY**

VITO is performing the preparatory study for the new upcoming eco-design directive for
 Energy-related Products (ErP) related to power cables, on behalf of the European
 Commission (more info <u>http://ec.europa.eu/enterprise/policies/sustainable-</u>
 <u>business/ecodesign/index en.htm</u>).

6

7 In order to improve the efficient use of resources and reduce the environmental 8 impacts of energy-related products the European Parliament and the Council have 9 adopted Directive 2009/125/EC (recast of Directive 2005/32/EC) establishing a 10 framework for the setting Ecodesign requirements (e.g. energy efficiency) for energyrelated products in the residential, tertiary, and industrial sectors. It prevents disparate 11 12 national legislations on the environmental performance of these products from 13 becoming obstacles to the intra-EU trade and contributes to sustainable development 14 by increasing energy efficiency and the level of protection of the environment, taking 15 into account the whole life cycle cost. This should benefit both businesses and 16 consumers, by enhancing product quality and environmental protection and by facilitating free movement of goods across the EU. It is also possible to introduce 17 18 binding information requirements for components and sub-assemblies.

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The MEErP methodology (Methodology for the Eco-design of Energy-related Products) allows the evaluation of whether and to which extent various energy-related products fulfil the criteria established by the ErP Directive for which implementing measures might be considered. The MEErP model translates product specific information, covering all stages of the life of the product, into environmental impacts (more info http://ec.europa.eu/enterprise/policies/sustainable-

- 26 <u>business/ecodesign/methodology/index_en.htm</u>).
 27
- 28 The tasks in the MEErP entail:
- 29 Task 1 Scope (definitions, standards and legislation);
- 30 Task 2 Markets (volumes and prices);
- 31 Task 3 Users (product demand side);

32 Task 4 - Technologies (product supply side, includes both Best Available Technology

33 (BAT) and Best Not Yet Available Technology (BNAT));

Task 5 – Environment & Economics (base case Life Cycle Assessment (LCA) & Life Cycle
 Costs (LCC));

- 36 Task 6 Design options(improvement potential);
- 37 Task 7 Scenarios (policy, scenario, impact and sensitivity analysis).
- 38 Tasks 1 to 4 can be performed in parallel, whereas 5, 6 and 7 are sequential.
- 39 Task 0 or a Quick-scan is optional to Task 1 for the case of large or inhomogeneous
- 40 product groups, where it is recommended to carry out a first product screening. The 41 objective is to re-group or narrow the product scope, as appropriate from an ecodesign
- 42 point of view, for the subsequent analysis in tasks 2-7.
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1 LIST OF ACRONYMS

- α_c corrected or circuit Load Factor
- BAT Best Available Technology
- BC Base Case
- BNAT Best Not (Yet) Available Technology
- BOM Bill Of Materials
- CSA conductor Cross-Sectional Area
- Cu Copper
- EC European Commission
- EOL End Of Life
- Kd Distribution factor
- Kf Load Form Factor
- LCA (environmental) Life Cycle Assessment
- LCC Life Cycle Costs
- LV Low Voltage
- MV Medium Voltage
- Pf Power Factor
- PVC PolyVinyl Chloride
- ρ conductor resistivity
- R Resistance
- TBC To Be Confirmed
- TBD To Be Defined
- VITO Flemish institute for Technological Research
- XLPE Cross-Linked PolyEthylene
- 2 3
- 3 4
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Use of text background colours

- 10
- 11 Blue: draft text
- 12 Yellow: text requires attention to be commented
- 13 **Green:** text changed in the last update

CHAPTER **TASK 5: ENVIRONMENT & ECONOMICS** 5 1

2 The objective of Task 5 is to define one or two average EU product(s) or to choose a 3 representative product category as the 'Base Case' (BC) for the whole of the EU-28. 4 Throughout the rest of the study, most of the environmental and Life Cycle Cost (LCC) 5 analyses will be built on this BC. The BC is a conscious abstraction of reality, necessary 6 for practical reasons (e.g. budget and time). The question if this abstraction leads to 7 inadmissible conclusions for certain market segments will be addressed in the impact and sensitivity analysis. The description of the BC is the synthesis of the results of 8 9 Tasks 1 to 4 and the point of reference for Tasks 6 (improvement potential) and 7 10 (impact analysis).

11 The aim of this section is to assess environmental and economic impacts of the 12 different base cases. The assessment is based on the updated version 3.06 of the 13 EcoReport Tool¹, as provided with the MEErP 2011 methodology.

14 Remark: Further in this study the word 'power cables' will be used as a general term for 15 single core or multi-core LV power cables in buildings, unless otherwise stated.

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Summary of Task 5:

Previous Task 4 identified improvement options at circuit level. In this Task nine base 20 21 cases were selected that represent typical electrical circuits in line with the market structure and data described in Task 2. For the initial LCA and LCC calculation, these 22 23 base cases used the 'median' electrical circuit parameters from Task 3, such as load 24 factor and cable length. The nine base cases used are: 25

- Base case 1: distribution circuit in the services sector;
- Base case 2: lighting circuit in the services sector;
- Base case 3: socket-outlet circuit in the services sector;
- Base case 4: dedicated circuit in the services sector; 28 29
 - Base case 5: distribution circuit in the industry sector;
 - Base case 6: lighting circuit in the industry sector;
 - Base case 7: socket-outlet circuit in the industry sector;
 - Base case 8: dedicated circuit in the industrv sector (BC1 up to and including BC8 are with copper conductors);
 - Base case 9: base case 8 but with aluminium instead of copper.

35 The LCA and LCC showed that in most cases the use phase is dominant. This is due to 36 the impact of electrical cable losses. As a consequence, there will be room left for 37 economic energy savings in several of those base cases that will be analysed in detail in 38 Task 6. The data of the nine base cases was also summed using EU-28 circuit level 39 stock data and cross-checked with total EU-28 data on electricity use from Task 2. This

¹ Legal notice of EcoReport tool

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1	showed an overestimation compared to EU-28 data on energy use. This means that the
2	'median' parameters for the base cases from Task 3 do not reflect 'average reference'
3	parameters that can be used in a stock model in Task 7. Therefore corrections factors
4	on those 'median' parameters were calculated that fit with total EU energy
5	consumption. This also indicates that potentially a lot of circuits in the stock have a
6	relative lower loading and/or longer circuit length and/or higher share of base cases
7	with lower loading. This is also something to take into account in the sensitivity analysis
8	(Task 6).
9	Table 5-21 indicates annual electricity consumption at EU-28 level of about 42 TWh.
10	The tables in section 5.2 show that the use phase is responsible for the largest part of
11	this electricity consumption, which is also confirmed by the 35 TWh electricity losses
10	

12 per year shown in

1 and

Table 5-24.

3

4 **5.1 Product specific inputs**

5 This section collects all relevant quantitative BC information from previous tasks for the 6 modelling exercise in the rest of Task 5. The input parameters are defined in previous 7 tasks. In these tasks, a parameter may have a low/minimum, average/reference or 8 high/maximum value. For the calculation in Task 5 the average/reference value of each 9 parameter is used as input.

10

11 **5.1.1 Identification of base cases**

12 According to the MEErP methodology, base cases should reflect average EU products. 13 Different products of similar functionalities, Bill Of Materials (BOM), technologies and efficiency can be compiled into a single BC, thus it does not always represent a real 14 15 product. For the identification of the base cases, four application types (power cable for use in 16 17 distribution circuit, power cable for use in lighting circuit, power cable for use in socket-outlet circuit, and power cable for use in dedicated circuit) and two different 18 application sectors (services sector and industry sector) have been chosen. All base 19 cases use cables with copper conductors, except for base case nine which is based upon 20 21 cables with aluminium conductors. 22 23 The most appropriate base cases have been selected in accordance with the analysis 24 presented in Tasks 2, 3 and 4 concerning the analysis of market and environmental and technical elements associated to products used across the EU. 25 Nine base cases have been identified to assess the environmental and economic 26 27 impacts over the life cycle: Base case 1: A typical power cable for use in typical distribution circuit in the 28 29 services sector (see Figure 5-1); Base case 2: A typical power cable for use in typical lighting circuit in the 30 services sector; 31 Base case 3: A typical power cable for use in typical socket-outlet circuit in the 32 33 services sector; 34 Base case 4: A typical power cable for use in typical dedicated circuit in the 35 services sector (see Figure 5-1); Base case 5: A typical power cable for use in typical distribution circuit in the 36 industry sector (see Figure 5-2); 37

- Base case 6: A typical power cable for use in typical lighting circuit in the industry sector;
- Base case 7: A typical power cable for use in typical socket-outlet circuit in the industry sector;
- Base case 8: A typical power cable for use in typical dedicated circuit in the
 industry sector (see Figure 5-2);
- Base case 9: The same base case as base case 8, but instead of copper the
 cable conductors are of aluminium.
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The characteristics of each BC are summarised in Table 5-1. These characteristics are relevant because they have an impact on the energy consumption and the BoM. The bases cases are explained more in detail in the next paragraphs.

Table 5-1: Base case identification

	Unit	т				Bases cases	definiton				
Base case id			BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8	BC9
			Services	Services	Services	Services	Industry	Industry	Industry	Industry	Industry
Sector			sector	sector	sector	sector	sector	sector	sector	sector	sector
					Socket-				Socket-		
			Distribution	Lighting	outlet	Dedicated	Distribution	Lighting	outlet	Dedicated	Dedicated
Application circuit			circuit	circuit	circuit	circuit	circuit	circuit	circuit	circuit	circuit
Transformer/Consumer	kVA	I	400	2.3	4	43	1250	2.3	4	108	108
Voltage	v	Ι	400	230	230	400	400	230	230	400	400
Load current lb	Α	1	577	10	16	62	1804	10	16	156	156
Cores			5	5	5	5	4	5	5	5	5
Conductor material		1	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	AI
CSA	mm²	1	120	1.5	2.5	10	300	1.5	2.5	35	70
Installation Method (IEC 60364-			-	-	-	-	_	-	-	-	-
5-52)		-	E	E	E	E	E	E	E	E	E
Current Carving Canacity cable											
(IEC 60364-5-52 / Table B52 12)	Δ		346	26	30	75	621	26	30	158	158
Cables in parallel //	<u>^</u>	i.	2	1	1	1	4	1	1	130	130
Current-Carrying Capacity -			-	-	-	-		1	1	-	-
total	Α	1	692	26	30	75	2484	26	30	158	158
Reduction Factor (IEC 60364-5-											
52 / Table B52.17)		1	0.88	1	1	1	0.8	1	1	1	1
Current-Carrying Capacity											
cable - total - reducted	А	с	609	26	30	75	1987	26	30	158	158
lcircuit= Ir (circuit breaker											
setting)	Α	Т	577	10	16	62	1804	10	16	156	156
Single phase or 3-phase		Т	3	1	1	3	3	1	1	3	3
In per cable		Т	289	10	16	62	451	10	16	156	156
Circuit length	m	Т	56.25	43.56	52.78	50.56	82.50	67.50	72.00	78.50	78.50
In per cable I 289 10 16 62 451 10 16 156 156 Circuit length m I 56.25 43.56 52.78 50.56 82.50 67.50 72.00 78.50 78.50 Remarks: • The circuits are 100% loaded. For each circuit the required CSA according to IEC 60364-5-52 is determined and checked with a commercial calculation tool. • Installation Method E means cables arranged in a single layer on a perforated horizontal or vertical cable tray system (IEC 60364-5-52). • Cable sizing is done according to the circuit breaker setting (Ir) and not according to the circuit breaker rating (In). For instance in base case 2 a 630 A (=In) circuit breaker will be used with Ir set at 609A. • To make transitions between design options in later chapters possible, the											
Therefore	the	C	ables i	n thes	e base	cases	have	always	5 cor	res. Th	e BON
mentioned	l in T	Tas	sk 4 is t	based u	pon ca	bles wit	h 5 cor	es.			

- Base Case 1: Services sector Distribution circuit

This base case includes the main distribution circuit - this means the LV power cable and protective device - between the 400 kVA MV/LV power transformer and the main LV distribution board (see Figure 5-1). In services sector smaller transformers are used compared to the industry. A 400 kVA transformer³ is assumed as a common used transformer in services sector. Two parallel cables of each 5G120 mm² are needed to transport the maximum power

from the 400 kVA transformer to the main distribution board at the given circuit length.





² DALI protocol is an open digital lighting standard: IEC 62386



³ EU DG ENTR- Lot 2: Distribution and power transformers:

http://www.eceee.org/ecodesign/products/distribution_power_transformers/Final_report_Feb201

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Base Case 7: Industry sector – Socket-outlet circuit

A circuit similar to base case 3, but with characteristics typical for the industry as defined in Task 3.

Base Case 8: Industry sector – Dedicated circuit

A 5G35 mm² cable is selected for the industry sector as a dedicated circuit cable. For the given cable length and cable section a load of 108 kVA can be connected to the 160 A circuit breaker in the distribution board (Figure 5-2).

Base Case 9: Industry sector – Dedicated

The same base case as base case 8, but with the difference that the cable conductors are of aluminium instead of copper. The aluminium cable with the smallest CSA complying with the requested current requirements is selected. In this case it means that a 5x35mm² copper based cable is replaced by a 5x70 mm² aluminium based cable. The selection is verified by means of an electrical installation design engineering tool.

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19 **5.1.2** Manufacturing of the product: Bill Of Materials

The manufacturing phase includes the extraction and processing of the required materials and the following steps necessary to produce and assembly one product. The MEErP 2011 EcoReport tool contains a fixed list of materials and processes for which materials and energy indicators are provided (see for instance the 'Material Code in EcoReport tool' reported in Table 5-9).

- 25
- A frequently used LV power cable with the following specifications is selected as the reference cable:
- 28 Conductor: 29 ∘ Mate
 - Material: Cu
 - Flexibility: Class 1 and 2
- Insulation material: XLPE (Cross-Linked Polyethylene)
- 32 Sheath material: PVC (Polyvinyl Chloride)
- Voltage rating: 0.6/1 kV
 - Single- and multicore
- Armoured: No
 - Standard: IEC 60502-1

36 37

34

30

38 The BOM of this preparatory study has been selected according to information included

in Task 2 and Task 4. An overview of the BOM per BC is shown in Table 5-2.

Table 5-2: Bill Of Materials per base case

	Unit					Bases cases	definiton				
Base case id			BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8	BC9
			Services	Services	Services	Services	Industry	Industry	Industry	Industry	Industry
Sector			sector	sector	sector	sector	sector	sector	sector	sector	sector
					Socket-				Socket-		
			Distribution	Lighting	outlet	Dedicated	Distribution	Lighting	outlet	Dedicated	Dedicated
Application circuit			circuit	circuit	circuit	circuit	circuit	circuit	circuit	circuit	circuit
BoM per meter cable											
CSA	mm²	Ι	120.00	1.50	2.50	10.00	300.00	1.50	2.50	35.00	70.00
Conductor material	g/m	Т	5,334.00	66.68	111.13	444.50	10,668.00	66.68	111.13	1,555.75	945.00
Insulation material	g/m	I	238.41	21.47	25.56	43.97	448.07	21.47	25.56	99.92	189.62
Sheath material	g/m	Ι	478.79	79.39	88.56	129.78	820.05	79.39	88.56	210.34	399.11
Filler material	g/m	Ι	1,300.81	41.21	50.26	141.25	1,933.88	41.21	50.26	390.98	843.27
Total weight material	g/m	С	7,352.00	208.75	275.50	759.50	13,870.00	208.75	275.50	2,257.00	2,377.00
BoM per base case											
Conductor material	kg	С	600.08	2.90	5.86	22.47	3,520.44	4.50	8.00	122.13	74.18
Insulation material	kg	С	26.82	0.94	1.35	2.22	147.86	1.45	1.84	7.84	14.88
Sheath material	kg	С	53.86	3.46	4.67	6.56	270.62	5.36	6.38	16.51	31.33
Filler material	kg	С	146.34	1.79	2.65	7.14	638.18	2.78	3.62	30.69	66.20
Total weight material	kg	С	827.10	9.09	14.54	38.40	4,577.10	14.09	19.84	177.17	186.59

2 3

4	
5	In the EcoReport tool the following material components are selected, based on Table
6	4-1 of Task 4:
7	 Conductor material: Cu or AI (depending on the BC);
8	• Insulation material: 100% LDPE (According to the Europacable members, there
9	is 3% silane based crosslinking compound in the XLPE insulation, however due
10	to the limited list of materials in the EcoReport tool 100% LDPE is used for the
11	calculations, also given the small share of crosslinking compound.);
12	 Sheath material, composed of:
13	\circ 50% of the sheath material weight: PVC (not recycled) ⁴ ;
14	\circ 25% of the sheath material weight: talcum filler as filler material in the
15	sheath (According to the Europacable members, calcium carbonate filler
16	is used, however in the EcoReport tool calcium carbonate cannot be
17	chosen. Given that both talcum and calcium carbonate are mineral fillers
18	that are used in plastic, talcum is used as a substitute.);
19	\circ 25% of the sheath material weight: bitumen (As it is the closest to a
20	plasticizer in the EcoReport tool.);
21	Filler material: 100% talcum filler.
22	
23	The material resource input for base case 1 in the Ecoreport tool is shown in Table 5-3
24	as an example.

⁴ See minutes of second stakeholder meeting http://www.erp4cables.net/sites/erp4cables.net/files/attachments/Minutes%20stakeholder%20m eeting%20MEErP%20Power%20Cables_20140603_final.pdf

Table 5-3: Material resource input for base case 1

Pos	MATERIALS Extraction & Production	Weight	Category	Material or Process
nr	Description of component	in g	Click &select	select Category first !
			1000	
1	Conductor	600075.0	4-Non-ferro	30 - Cu wire
2	Insulation	26821.0	1-BlkPlastics	1-LDPE
3	Sheath - PVC	26931.7	1-BlkPlastics	8 - PVC
4	Sheath - Filler	13465.8	2-TecPlastics	18 - Talcum filler
5	Sheath - plasticizer	13465.8	7-Misc.	56 - Bitumen
6	Filler material	146340.7	2-TecPlastics	18 - Talcum filler

5.1.3 Distribution phase: volume of packaged product

This phase includes the distribution of the packaged product. The volume of the packaged product (power cable) depends on the length of cable. For a certain cable section, the appropriate drum is selected. If multiple drum sizes (drum numbers) are available, the average drum size has been selected. The volume of this drum is then multiplied by length of cable of the BC (= circuit length x number of parallel cables) divided by the maximum length of cable on this drum. Drum characteristics are listed in Task 4. The calculation is shown in Table 5-4. An estimated spacing correction factor of 15% has been chosen for the extra space between drums during transport needed for handling. The EcoReport input is shown in Table 5-5.

Table 5-4: Calculation of volume of packaged base case per meter cable

	Unit	Т	BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8	BC9
CSA	mm²	L.	120	1.5	2.5	10	300	1.5	2.5	35	70
Ficitious diameter	mm	Ι	39.96	7.56	8.64	13.50	55.90	7.56	8.64	22.95	31.32
PVC sheat tickness	mm	Ι	2.40	1.80	1.80	1.80	2.96	1.80	1.80	1.80	2.10
Cable outer diameter	mm	С	44.76	11.16	12.24	17.10	61.82	11.16	12.24	26.56	35.51
Drum Size		Ι	22	10	10	14	22	10	10	16	20
Max. cable length	m	Τ	842	2323	1952	2448	443	2323	1952	1326	1161
Drum Volume (formula 4.1)	m³	T	6.04	0.70	0.70	1.80	6.04	0.70	0.70	2.63	4.99
Drum spacing	m³	С	0.91	0.11	0.11	0.27	0.91	0.11	0.11	0.39	0.75
Correction factor (spacing)	%	1	15%	15%	15%	15%	15%	15%	15%	15%	15%
Drum Corrected Volume	m³	С	6.95	0.81	0.81	2.07	6.95	0.81	0.81	3.03	5.74
Drum Weight	kg	Ι	450.00	50.00	50.00	125.00	450.00	50.00	50.00	175.00	330.00
Drum corrected volume / meter cable	m³/m	С	0.00825	0.00035	0.00041	0.00085	0.01568	0.00035	0.00041	0.00228	0.00494
Drum Weigth / meter cable	g/m	С	534.4	21.5	25.6	51.1	1015.8	21.5	25.6	132.0	284.2

Table 5-5: EcoReport input: volume of packaged base case

	Unit					Bases cases	definiton				
Base case id			BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8	BC9
			Services	Services	Services	Services	Industry	Industry	Industry	Industry	Industry
Sector			sector	sector	sector	sector	sector	sector	sector	sector	sector
					Socket-				Socket-		
			Distribution	Lighting	outlet	Dedicated	Distribution	Lighting	outlet	Dedicated	Dedicated
Application circuit			circuit	circuit	circuit	circuit	circuit	circuit	circuit	circuit	circuit
Volume package											
Volume package per meter											
cable	m3	Т	0.008250	0.000347	0.000412	0.000847	0.015680	0.000347	0.000412	0.002282	0.004945
Volume package per base case	m3	С	0.92811	0.01509	0.02177	0.04283	5.17450	0.02339	0.02969	0.17917	0.38816

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4 **5.1.4 Use phase**

5 The use phase considers the amount of energy resources demanded during the lifetime 6 of power cables. In this study, the amount of energy loss due to the resistance of the 7 power cable is regarded as the energy consumption of the power cable. The calculated 8 result of the energy consumption value per BC and the input parameters for this 9 calculation are listed in Table 5-6. Average consumption of energy per BC has been 10 calculated based on parameters, models and formulas described in Task 2 and Task 3.

12

Table 5-6: Energy consumption per base case

Parameter	Unit	т				Base cases					
Base case id			BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8	BC9
			Services	Services	Services	Services	Industry	Industry	Industry	Industry	Industry
Sector			sector	sector	sector	sector	sector	sector	sector	sector	sector
					Socket-				Socket-		
			Distributio	Lighting	outlet	Dedicated	Distributio	Lighting	outlet	Dedicated	Dedicated
Application circuit			n circuit	circuit	circuit	circuit	n circuit	circuit	circuit	circuit	circuit
Loaded cores		Ι	6	2	2	3	12	2	2	3	3
Cables in parallel		Т	2	1	1	1	4	1	1	1	1
Conductor material		Т	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Al
In per cable	А	Т	289	10	16	62	451	10	16	156	156
CSA	mm²	Т	120	1.5	2.5	10	300	1.5	2.5	35	70
Length of circuit	m	Т	56	44	53	51	83	68	72	79	79
	Ω.m										
ρ t	m²/m	Т	0.0167	0.0167	0.0167	0.0167	0.0167	0.0167	0.0167	0.0167	0.0265
R (formula 3.2) per wire	Ω	С	0.008	0.485	0.353	0.084	0.005	0.752	0.481	0.037	0.030
Кd		Ι	1.00	0.37	0.40	1.00	1.00	0.37	0.44	1.00	1.00
Kf		I	1.21	1.27	1.27	1.21	1.02	1.06	1.06	1.01	1.01
ας		Ι	0.41	0.24	0.15	0.41	0.57	0.34	0.27	0.61	0.61
Pf		Т	0.80	1.00	0.80	0.80	0.80	1.00	0.80	0.80	0.80
Annual energy loss (formula 3.5)											
per loaded core	kWh	С	1392.06	15.22	10.81	694.00	2797.39	31.38	39.16	3011.51	2389.38
Annual energy loss (formula 3.5)											
per BC	kWh	С	8352.36	30.44	21.61	2082.01	33568.63	62.75	78.33	9034.54	7168.13
Annual energy transported											
(formula 3.6) per BC	kVAh	С	1,383,543	6,233	4,787	148,731	5,121,230	7,249	7,423	465,153	465,153
Energy loss ratio (formula 3.7)		С	0.60%	0.49%	0.45%	1.40%	0.66%	0.87%	1.06%	1.94%	1.54%

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1 **5.1.5 End of Life (EoL)**

2 Recycling of materials can avoid the extraction of raw materials and the production of 3 virgin materials, which is modelled in the EcoReport tool as credits (avoided impacts), i.e. negative impacts. Defaults values of the EcoReport have been used for recycling 4 5 rates of the materials, except for ferro and non-ferro materials. For instance, default values for the recycling rate of metals and plastics are 94% and 29% respectively. 6 7 These recycling rates are considered comparable with the outcomes of the previous 8 tasks and thus suitable for the current environmental analysis. Only the re-use of 9 metals is set to 0% instead of 1% and recycling of metals is set to 95% instead of 94% 10 (see section 3.3 in Task 3).

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12 **5.1.6 Life Cycle Cost inputs**

Average market data and consumer expenditure data have been estimated in Task 2. These have been summarized in Table 5-7 and form the data input for carrying out the economic assessment of the base cases. As mentioned in Task 3, there are no repair and maintenance costs for installed power cables.

Because altering the cable size can have an impact on the price of the used connectors, the connector price is included in the base case product price. Connectors usually serve a range of cable sizes, for instance from 0.14 mm² till 4 mm², 0.2 mm² till 10 mm², 0.5 mm² till 16 mm² and so on. In the base case calculation the smallest connector, able to fit the cable, is selected.

22 Base case connector price = $CP \times CC \times NC \times NEN$ 23 (formula 5.1) 24 25 Where: 26 CP: connector price for one wire; 27 CC: cores per cable; 28 NC: number of cables in the base case; 29 NEN: number of end-nodes in a base case. 30 This means that the connector price doubles when the amount of cables in a base case 31 doubles. Also for base cases with a lot of end-nodes like the base cases for lighting 32 circuits or socket circuits, the connector price will be a substantial part of the base case 33 product price. 34 Larger connectors may also have an impact on the distribution boards. This is however 35 not included in the base case product price, nor is the cost for potential larger ducts 36 37 and the building space needed for this. The connector prices are listed in Task 2. Discounted prices are used. 38 39 40

Table 5-7: LCC input parameter per base case

	Unit					Bases cases	definiton				
Base case id			BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8	BC9
			Services	Services	Services	Services	Industry	Industry	Industry	Industry	Industry
Sector			sector	sector	sector	sector	sector	sector	sector	sector	sector
					Socket-				Socket-		
			Distribution	Lighting	outlet	Dedicated	Distribution	Lighting	outlet	Dedicated	Dedicated
Application circuit			circuit	circuit	circuit	circuit	circuit	circuit	circuit	circuit	circuit
LCC data											
Year		Ι	2010	2010	2010	2010	2010	2010	2010	2010	2010
Electricity rate	€/kWh	Ι	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Product price for 1 meter cable	€	Т	56.60	0.71	1.18	4.72	113.21	0.71	1.18	16.51	18.79
Price connectors	€	Ι	359.20	35.59	24.87	15.54	876.80	40.94	18.07	43.25	111.31
Bace case product price	€	С	6727.15	66.41	87.11	254.01	38235.44	88.70	102.97	1339.24	1586.41
Base case installation cost	€	Ι	693.23	78.65	98.45	137.78	3572.78	107.30	113.40	334.55	391.53
Product life	Year	Ι	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Product service life	Year	Ι	23.75	23.75	23.75	23.75	23.75	23.75	23.75	23.75	23.75

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4 5.2 Base case environmental impact assessment (using EcoReport)

5 In this section, the EcoReport tool 2011 version 3.06 is used to calculate the outputs 6 per environmental indicator and 'cradle-to-grave' stages of a product life.

A summary of all input parameters values used in the EcoReport tool is listed in Table
 5-8. For parameters not mentioned in Table 5-8, the default parameters of the
 EcoReport tool are used.

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Table 5-8: EcoReport tool input parameters per base case

	Unit	Base cases: ecoreport input BC1 BC2 BC3 BC4 BC5 BC6 BC7 BC8 BC9									
Base case id		BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8	BC9	
CSA	mm²	120	1.5	2.5	10	300	1.5	2.5	35	70	
Conductor material	g	600075.0	2904.1	5864.9	22471.9	3520440.0	4500.6	8001.0	122126.4	74182.5	
Insulation material	g	26821.0	935.3	1349.2	2223.0	147862.8	1449.5	1840.7	7.8	14.9	
Sheath material	g	53863.3	3458.1	4673.7	6561.1	270615.7	5359.1	6376.0	16512.0	31330.4	
Filler material	g	146340.7	1794.8	2652.4	7140.9	638181.6	2781.4	3618.4	30692.3	66196.7	
Annual energy loss (formula 3.5) per BC	kWh	8352.36	30.44	21.61	2082.01	33568.63	62.75	78.33	9034.54	7168.13	
Volume	m3	0.93	0.02	0.02	0.04	5.17	0.02	0.03	0.18	0.39	
Product life	Year	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	
Product service life	Year	23.75	23.75	23.75	23.75	23.75	23.75	23.75	23.75	23.75	
Bace case product price	€	6727.15	66.41	87.11	254.01	38235.44	88.70	102.97	1339.24	1586.41	
Annual sales (base case units)	mln. Units	0.13	2.86	3.77	0.98	0.03	1.78	2.00	0.24	0.24	
EU Stock (base case units)	mln. Units	3.23	71.43	94.32	24.62	0.71	44.44	49.99	5.94	5.94	
Base case installation cost	€	693.23	78.65	98.45	137.78	3572.78	107.30	113.40	334.55	391.53	
Electricity rate	€/kWh	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	
EoL mass fraction to re-use, non- Ferro material	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Conductor material		Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	ΔΙ	

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5.2.1 Base case 1: distribution circuit in services sector

15 The environmental impacts related to the use of one BC1 circuit per year, calculated by

16 means of the EcoReport tool, are shown in Table 5-9.

Table 5-9: Environmental impacts related to the use of one BC1 circuit per year

	Life Cycle phases>			PRODUCTION		DISTRI-	USE	EN	D-OF-LIFE	*	TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
	Materials	unit	*			,		.			*
1	Bulk Plastics	g			2,150		22	1,194	977	0	0
2	TecPlastics	g			6,392		64	3,551	2,905	0	0
3	Ferro	g			0		0	0	0	0	0
4	Non-ferro	g			24,003		240	1,212	23,031	0	0
5	Coating	g			0		0	0	0	0	0
6	Electronics	g			0		0	0	0	0	0
7	Misc.	g			539		5	185	359	0	0
8	Extra	g			0		0	0	0	0	0
9	Auxiliaries	g			0		0	0	0	0	0
10	Refrigerant	g			0		0	0	0	0	0
	Total weight	g			33,084		331	6,142	27,272	0	0
								S	ee note!		
	Other Resources & Waste	,						debet	credit		
11	Total Energy (GER)	MJ	3,033	349	3,382	49	71,443	18	-1,092		73,799
12	of which, electricity (in primary MJ)	MJ	26	210	236	0	71,413	0	-2		71,647
13	Water (process)	ltr	19	3	22	0	0	0	-2		20
14	Water (cooling)	ltr	115	99	214	0	3,175	0	-9		3,380
15	Waste, non-haz./landfill	g	448	1,093	1,542	27	36,806	15	-127		38,263
16	Waste, hazardous/incinerated	g	17	0	17	1	1,127	0	-3		1,141
	Emissions (Air)										
17	Greenhouse Gases in GWP100	kg CO2 eq.	157	19	177	3	3,050	0	-58		3,172
18	Acidification, emissions	g SO2 eq.	7,057	83	7,140	10	13,560	4	-2,670		18,043
19	Volatile Organic Compounds (VOC)	g	5	0	5	1	1,595	0	-1		1,600
20	Persistent Organic Pollutants (POP)	ng i-Teq	90	0	90	0	168	0	-34		224
21	Heavy Metals	mg Ni eq.	1,327	0	1,327	1	735	1	-504		1,561
22	PAHs	mg Ni eq.	133	0	133	2	168	0	-50		253
23	Particulate Matter (PM, dust)	g	212	13	225	127	288	5	-63		581
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	2,264	0	2,264	0	330	1	-859		1,736
25	Eutrophication	g PO4	4	0	4	0	14	0	-1		17

5.2.2 Base case 2: lighting circuit in services sector

- The environmental impacts related to the use of one BC2 circuit per year, calculated by means of the EcoReport tool, are shown in Table 5-10.

Table 5-10: Environmental impacts related to the use of one BC2 circuit per year

	Life Cycle phases>			PRODUCTION		DISTRI-	USE	EN	D-OF-LIFE	*	TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
	Materials	unit				······		······			
1	Bulk Plastics	g			107		1	59	48	0	0
2	TecPlastics	g			106		1	59	48	0	0
3	Ferro	g			0		0	0	0	0	0
4	Non-ferro	g			116		1	6	111	0	0
5	Coating	g			0		0	0	0	0	0
6	Electronics	g			0		0	0	0	0	0
7	Misc.	g			35		0	12	23	0	0
8	Extra	g			0		0	0	0	0	0
9	Auxiliaries	g			0		0	0	0	0	0
10	Refrigerant	g			0		0	0	0	0	0
	Total weight	g			364		4	136	231	0	0
								S	ee note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	MJ	23	9	32	5	261	0	-6		292
12	of which, electricity (in primary MJ)	MJ	1	5	7	0	260	0	0		267
13	Water (process)	ltr	1	0	1	0	0	0	0		1
14	Water (cooling)	ltr	6	2	8	0	12	0	0		20
15	Waste, non-haz./landfill	g	8	27	36	5	134	1	-1		174
16	Waste, hazardous/incinerated	g	1	0	1	0	4	0	0		5
	Emissions (Air)										
17	Greenhouse Gases in GWP100	kg CO2 eq.	1	0	2	0	11	0	0		13
18	Acidification, emissions	g SO2 eq.	36	2	38	1	50	0	-13		75
19	Volatile Organic Compounds (VOC)	g	0	0	0	0	6	0	0		6
20	Persistent Organic Pollutants (POP)	ng i-Teq	0	0	0	0	1	0	0		1
21	Heavy Metals	mg Ni eq.	7	0	7	0	3	0	-3		7
22	PAHs	mg Ni eq.	1	0	1	0	1	0	0		1
23	Particulate Matter (PM, dust)	g	10	0	10	2	1	0	-3		11
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	11	0	11	0	1	0	-4		8
25	Eutrophication	g PO4	0	0	0	0	0	0	0		0

5.2.3 Base case 3: socket-outlet circuit in services sector

The environmental impacts related to the use of one BC3 circuit per year, calculated by means of the EcoReport tool, are shown in Table 5-11.

Table 5-11: Environmental impacts related to the use of one BC3 circuit per year

	Life Cycle phases>			PRODUCTION		DISTRI-	USE	EN	D-OF-LIFE	*	TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
									· · · · · · · · · · · · · · · · · · ·		
	Materials	unit				······		÷			
1	Bulk Plastics	g			147		1	82	67	0	0
2	TecPlastics	g			153		2	85	69	0	0
3	Ferro	g			0		0	0	0	0	0
4	Non-ferro	g			235		2	12	225	0	0
5	Coating	g			0		0	0	0	0	0
6	Electronics	g			0		0	0	0	0	0
7	Misc.	g			47		0	16	31	0	0
8	Extra	g			0		0	0	0	0	0
9	Auxiliaries	g			0		0	0	0	0	0
10	Refrigerant	g			0		0	0	0	0	0
	Total weight	g			582		6	195	393	0	0
								S	ee note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	MJ	41	12	53	5	185	1	-12		232
12	of which, electricity (in primary MJ)	MJ	2	7	9	0	185	0	0		194
13	Water (process)	ltr	1	0	2	0	0	0	0		1
14	Water (cooling)	ltr	8	3	12	0	8	0	-1		19
15	Waste, non-haz./landfill	g	12	38	51	5	95	1	-2		150
16	Waste, hazardous/incinerated	g	1	0	1	0	3	0	0		4
	Emissions (Air)	~~~~~~	,			······		······			
17	Greenhouse Gases in GWP100	kg CO2 eq.	2	1	3	0	8	0	-1		10
18	Acidification, emissions	g SO2 eq.	71	3	74	1	36	0	-26		84
19	Volatile Organic Compounds (VOC)	g	0	0	0	0	4	0	0		4
20	Persistent Organic Pollutants (POP)	ng i-Teq	1	0	1	0	0	0	0		1
21	Heavy Metals	mg Ni eq.	13	0	13	0	2	0	-5		11
22	PAHs	mg Ni eq.	1	0	1	0	0	0	0		1
23	Particulate Matter (PM, dust)	g	13	0	14	3	1	0	-4		14
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	23	0	23	0	1	0	-8		15
25	Eutrophication	g PO4	0	0	0	0	0	0	0		0

5.2.4 Base case 4: dedicated circuit in services sector

The environmental impacts related to the use of one BC4 circuit per year, calculated by
means of the EcoReport tool, are shown in Table 5-12.
6

Table 5-12: Environmental impacts related to the use of one BC4 circuit per year

	Life Cycle phases>			PRODUCTION		DISTRI-	USE	EN	D-OF-LIFE	*	TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
	Materials	unit				······					
1	Bulk Plastics	g			220		2	122	100	0	0
2	TecPlastics	g			351		4	195	160	0	0
3	Ferro	g			0		0	0	0	0	0
4	Non-ferro	g			899		9	45	862	0	0
5	Coating	g			0		0	0	0	0	0
6	Electronics	g			0		0	0	0	0	0
7	Misc.	g			66		1	23	44	0	0
8	Extra	g			0		0	0	0	0	0
9	Auxiliaries	g			0		0	0	0	0	0
10	Refrigerant	g			0		0	0	0	0	0
	Total weight	g			1,536		15	385	1,166	0	0
								S	ee note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	MJ	126	23	149	6	17,802	1	-42		17,917
12	of which, electricity (in primary MJ)	MJ	3	14	17	0	17,801	0	0		17,818
13	Water (process)	ltr	2	0	2	0	0	0	0		2
14	Water (cooling)	ltr	12	7	19	0	791	0	-1		809
15	Waste, non-haz./landfill	g	26	73	99	5	9,174	1	-5		9,274
16	Waste, hazardous/incinerated	g	1	0	1	0	281	0	0		282
	Emissions (Air)										
17	Greenhouse Gases in GWP100	kg CO2 eq.	6	1	8	0	760	0	-2		766
18	Acidification, emissions	g SO2 eq.	266	6	272	1	3,365	0	-100		3,539
19	Volatile Organic Compounds (VOC)	g	1	0	1	0	398	0	0		398
20	Persistent Organic Pollutants (POP)	ng i-Teq	3	0	3	0	42	0	-1		44
21	Heavy Metals	mg Ni eq.	50	0	50	0	180	0	-19		212
22	PAHs	mg Ni eq.	5	0	5	0	42	0	-2		45
23	Particulate Matter (PM, dust)	g	20	1	21	6	71	1	-6		93
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	85	0	85	0	77	0	-32		131
25	Eutrophication	g PO4	0	0	0	0	3	0	0		4

5.2.5 Base case 5: distribution circuit in industry sector 1

- The environmental impacts related to the use of one BC5 circuit per year, calculated by means of the EcoReport tool, are shown in Table 5-13. 2
- 3

Table 5-13: Environmental impacts related to the use of one BC5 circuit per year

	Life Cycle phases>			PRODUCTION		DISTRI-	USE	EN	D-OF-LIFE	*	TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
		-	-								
	Materials	unit	******			· · · · · · · · · · · · · · · · · · ·			******		~
1	Bulk Plastics	g			11,327		113	6,292	5,148	0	0
2	TecPlastics	g			28,233		282	15,684	12,832	0	0
3	Ferro	g			0		0	0	0	0	0
4	Non-ferro	g			140,818		1,408	7,111	###########	0	0
5	Coating	g			0		0	0	0	0	0
6	Electronics	g			0		0	0	0	0	0
7	Misc.	g			2,706		27	929	1,804	0	0
8	Extra	g			0		0	0	0	0	0
9	Auxiliaries	g			0		0	0	0	0	0
10	Refrigerant	g			0		0	0	0	0	0
	Total weight	g			183,084		1,831	30,016	#############	0	0
								S	ee note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	MJ	17,595	1,616	19,211	253	287,188	98	-6,380		300,370
12	of which, electricity (in primary MJ)	MJ	139	973	1,112	1	287,013	0	-11		288,115
13	Water (process)	ltr	97	15	111	0	1	0	-11		101
14	Water (cooling)	ltr	602	459	1,061	0	12,762	0	-47		13,775
15	Waste, non-haz./landfill	g	2,500	5,064	7,564	128	147,932	78	-728		154,974
16	Waste, hazardous/incinerated	g	91	0	91	3	4,529	0	-18		4,605
	Emissions (Air)										
17	Greenhouse Gases in GWP100	kg CO2 eq.	915	90	1,005	16	12,261	0	-337		12,945
18	Acidification, emissions	g SO2 eq.	41,354	387	41,741	49	54,627	21	-15,658		80,781
19	Volatile Organic Compounds (VOC)	g	26	0	26	4	6,410	0	-7		6,434
20	Persistent Organic Pollutants (POP)	ng i-Teq	528	0	528	1	675	0	-201		1,004
21	Heavy Metals	mg Ni eq.	7,779	0	7,779	7	2,980	8	-2,953		7,821
22	PAHs	mg Ni eq.	777	0	777	9	677	0	-291		1,173
23	Particulate Matter (PM, dust)	g	1,124	60	1,183	708	1,159	24	-341		2,734
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	13,278	0	13,278	0	1,368	4	-5,040		9,611
25	Eutrophication	g PO4	24	1	25	0	54	1	-9		72
						***************************************		d'accourte a constant a	***************************************		

1 5.2.6 Base case 6: lighting circuit in industry sector

- The environmental impacts related to the use of one BC6 circuit per year, calculated by
 means of the EcoReport tool, are shown in Table 5-14.
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Table 5-14: Environmental impacts related to the use of one BC6 circuit per year

	Life Cycle phases>			PRODUCTION		DISTRI-	USE	EN	D-OF-LIFE	*	TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
	Materials	unit	,			······					,
1	Bulk Plastics	g			165		2	92	75	0	0
2	TecPlastics	g			165		2	92	75	0	0
3	Ferro	g			0		0	0	0	0	0
4	Non-ferro	g			180		2	9	173	0	0
5	Coating	g			0		0	0	0	0	0
6	Electronics	g			0		0	0	0	0	0
7	Misc.	g			54		1	18	36	0	0
8	Extra	g			0		0	0	0	0	0
9	Auxiliaries	g			0		0	0	0	0	0
10	Refrigerant	g			0		0	0	0	0	0
	Total weight	g			564		6	211	358	0	0
								S	ee note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	MJ	36	13	49	6	537	1	-10		583
12	of which, electricity (in primary MJ)	MJ	2	8	10	0	537	0	0		546
13	Water (process)	ltr	2	0	2	0	0	0	0		2
14	Water (cooling)	ltr	9	4	13	0	24	0	-1		36
15	Waste, non-haz./landfill	g	13	42	55	5	277	1	-2		336
16	Waste, hazardous/incinerated	g	1	0	1	0	8	0	0		9
	Emissions (Air)										
17	Greenhouse Gases in GWP100	kg CO2 eq.	2	1	2	0	23	0	0		25
18	Acidification, emissions	g SO2 eq.	55	3	59	1	102	0	-20		141
19	Volatile Organic Compounds (VOC)	g	0	0	0	0	12	0	0		12
20	Persistent Organic Pollutants (POP)	ng i-Teq	1	0	1	0	1	0	0		2
21	Heavy Metals	mg Ni eq.	10	0	10	0	6	0	-4		12
22	PAHs	mg Ni eq.	1	0	1	0	1	0	0		2
23	Particulate Matter (PM, dust)	g	15	0	15	3	2	0	-4		17
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	17	0	17	0	2	0	-7		13
25	Eutrophication	g PO4	0	0	0	0	0	0	0		0
				***************************************		***************************************		*******			

1 5.2.7 Base case 7: socket-outlet circuit in industry sector

The environmental impacts related to the use of one BC7 circuit per year, calculated by
means of the EcoReport tool, are shown in Table 5-15.

Table 5-15: Environmental impacts related to the use of one BC7 circuit per year

	Life Cycle phases>			PRODUCTION		DISTRI-	USE	EN	D-OF-LIFE	*	TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
				· · · · ·							
	Materials	unit				,					*
1	Bulk Plastics	g			201		2	112	91	0	0
2	TecPlastics	g			208		2	116	95	0	0
3	Ferro	g			0		0	0	0	0	0
4	Non-ferro	g			320		3	16	307	0	0
5	Coating	g			0		0	0	0	0	0
6	Electronics	g			0		0	0	0	0	0
7	Misc.	g			64		1	22	43	0	0
8	Extra	g			0		0	0	0	0	0
9	Auxiliaries	g			0		0	0	0	0	0
10	Refrigerant	g			0		0	0	0	0	0
	Total weight	g			793		8	266	536	0	0
								S	ee note!		
	Other Resources & Waste	·						debet	credit		
11	Total Energy (GER)	MJ	55	17	72	6	670	1	-16		733
12	of which, electricity (in primary MJ)	MJ	2	10	12	0	670	0	0		682
13	Water (process)	ltr	2	0	2	0	0	0	0		2
14	Water (cooling)	ltr	11	5	16	0	30	0	-1		45
15	Waste, non-haz./landfill	g	17	52	69	5	345	1	-3		418
16	Waste, hazardous/incinerated	g	1	0	1	0	11	0	0		12
	Emissions (Air)					,,				,	,
17	Greenhouse Gases in GWP100	kg CO2 eq.	3	1	3	0	29	0	-1		32
18	Acidification, emissions	g SO2 eq.	97	4	101	1	127	0	-36		194
19	Volatile Organic Compounds (VOC)	g	1	0	1	0	15	0	0		15
20	Persistent Organic Pollutants (POP)	ng i-Teq	1	0	1	0	2	0	0		2
21	Heavy Metals	mg Ni eq.	18	0	18	0	7	0	-7		19
22	PAHs	mg Ni eq.	2	0	2	0	2	0	-1		3
23	Particulate Matter (PM, dust)	g	18	1	18	4	3	1	-5		21
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	31	0	31	0	3	0	-12		22
25	Eutrophication	g PO4	0	0	0	0	0	0	0		0

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1 5.2.8 Base case 8: dedicated circuit in industry sector

The environmental impacts related to the use of one BC8 circuit per year, calculated by
means of the EcoReport tool, are shown in Table 5-16.

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Table 5-16: Environmental impacts related to the use of one BC8 circuit per year

	Life Cycle phases>			PRODUCTION		DISTRI-	USE	EN	D-OF-LIFE	*	TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
		-									
	Materials	unit	*								*****
1	Bulk Plastics	g			331		3	184	150	0	0
2	TecPlastics	g			1,393		14	774	633	0	0
3	Ferro	g			0		0	0	0	0	0
4	Non-ferro	g			4,885		49	247	4,687	0	0
5	Coating	g			0		0	0	0	0	0
6	Electronics	g			0		0	0	0	0	0
7	Misc.	g			165		2	57	110	0	0
8	Extra	g			0		0	0	0	0	0
9	Auxiliaries	g			0		0	0	0	0	0
10	Refrigerant	g			0		0	0	0	0	0
	Total weight	g			6,774		68	1,261	5,581	0	0
								S	ee note!		
	Other Resources & Waste					ļ		debet	credit		~~~~~~
11	Total Energy (GER)	MJ	610	70	681	13	77,251	3	-222		77,726
12	of which, electricity (in primary MJ)	MJ	4	42	46	0	77,245	0	0		77,291
13	Water (process)	ltr	5	1	5	0	0	0	-1		5
14	Water (cooling)	ltr	20	20	40	0	3,433	0	-2		3,472
15	Waste, non-haz./landfill	g	90	221	310	9	39,808	3	-26		40,104
16	Waste, hazardous/incinerated	g	3	0	3	0	1,219	0	-1		1,221
	Emissions (Air)										
17	Greenhouse Gases in GWP100	kg CO2 eq.	32	4	36	1	3,298	0	-12		3,323
18	Acidification, emissions	g SO2 eq.	1,437	17	1,454	3	14,605	1	-543		15,519
19	Volatile Organic Compounds (VOC)	g	1	0	1	0	1,725	0	0		1,726
20	Persistent Organic Pollutants (POP)	ng i-Teq	18	0	18	0	180	0	-7		192
21	Heavy Metals	mg Ni eq.	271	0	271	0	784	0	-103		952
22	PAHs	mg Ni eq.	27	0	27	0	181	0	-10		198
23	Particulate Matter (PM, dust)	g	58	3	60	25	310	1	-17		379
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	461	0	461	0	337	0	-175		624
25	Eutrophication	g PO4	1	0	1	0	15	0	0		15

1 5.2.9 Base case 9: aluminium based dedicated circuit in industry sector

The environmental impacts related to the use of one BC9 circuit per year, calculated by
means of the EcoReport tool, are shown in Table 5-17.

Table 5-17: Environmental impacts related to the use of one BC9 circuit per year

	Life Cycle phases>			PRODUCTION		DISTRI-	USE	EN	D-OF-LIFE	*	TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
	Materials	unit				~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~					
1	Bulk Plastics	g			627		6	348	285	0	0
2	TecPlastics	g			2,961		30	1,645	1,346	0	0
3	Ferro	g			0		0	0	0	0	0
4	Non-ferro	g			2,967		30	150	2,847	0	0
5	Coating	g			0		0	0	0	0	0
6	Electronics	g			0		0	0	0	0	0
7	Misc.	g			313		3	108	209	0	0
8	Extra	g			0		0	0	0	0	0
9	Auxiliaries	g			0		0	0	0	0	0
10	Refrigerant	g			0		0	0	0	0	0
	Total weight	g			6,869		69	2,251	4,687	0	0
								S	ee note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	MJ	652	147	799	23	61,294	5	-229		61,891
12	of which, electricity (in primary MJ)	MJ	7	88	95	0	61,288	0	-1		61,382
13	Water (process)	ltr	9	1	10	0	0	0	-1		9
14	Water (cooling)	ltr	39	42	81	0	2,724	0	-3		2,802
15	Waste, non-haz./landfill	g	1,127	459	1,587	14	31,595	16	-412		32,799
16	Waste, hazardous/incinerated	g	3	0	3	0	967	0	0		970
	Emissions (Air)										
17	Greenhouse Gases in GWP100	kg CO2 eq.	34	8	42	2	2,616	0	-12		2,648
18	Acidification, emissions	g SO2 eq.	219	35	254	5	11,579	0	-78		11,759
19	Volatile Organic Compounds (VOC)	g	3	0	3	0	1,369	0	-1		1,371
20	Persistent Organic Pollutants (POP)	ng i-Teq	15	0	15	0	143	0	-6		153
21	Heavy Metals	mg Ni eq.	14	0	14	1	620	0	-5		629
22	PAHs	mg Ni eq.	288	0	288	1	146	0	-109		326
23	Particulate Matter (PM, dust)	g	133	5	139	53	246	3	-41		400
	******			***************************************							
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	107	0	107	0	265	0	-40		332
25	Eutrophication	g PO4	0	0	0	0	12	0	0		12
				······		***************************************		······································			

5.3 Base case Life Cycle Cost for consumer

2 This section includes a calculation of the LCC for consumers using the new LCC3 equations available in the MEErP methodology including the escalation rate.

LCC have been calculated using the EcoReport tool based upon the economic input
parameters shown in Table 5-7. The results of this calculation are shown in Table 5-18
referred to the lifetime considered for each of the base cases. Product price, installation
costs and energy (electricity) costs during the whole life cycle have been considered.

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Table 5-18: Life Cycle Costs for consumer per base case

	Unit		Life Cycle Costs per base case BC1 BC2 BC3 BC4 BC5 BC6 BC7 BC8 BC9											
Base case id		BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8	BC9				
		Services	Services	Services	Services	Industry	Industry	Industry	Industry	Industry				
Sector		sector	sector	sector	sector	sector	sector	sector	sector	sector				
				Socket-				Socket-						
		Distributio	Lighting	outlet	Dedicated	Distributio	Lighting	outlet	Dedicated	Dedicated				
Application circuit		n circuit	circuit	circuit	circuit	n circuit	circuit	circuit	circuit	circuit				
Product price	€	6727.15	66.41	87.11	254.01	38235.44	88.70	102.97	1339.24	1586.41				
Installation/ acquisition costs														
(if any)	€	693.23	78.65	98.45	137.78	3572.78	107.30	113.40	334.55	391.53				
Electricity	€	22968.99	83.72	59.43	5725.54	92313.73	172.57	215.40	24845.00	19712.35				
Total	€	30389.36	228.78	244.99	6117.33	134121.95	368.57	431.77	26518.79	21690.29				
Product price	%	22%	29%	36%	4%	29%	24%	24%	5%	7%				
Installation/ acquisition costs														
(if any)	%	2%	34%	40%	2%	3%	29%	26%	1%	2%				
Electricity	%	76%	37%	24%	94%	69%	47%	50%	94%	91%				
Total	%	100%	100%	100%	100%	100%	100%	100%	100%	100%				

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13 **5.4 Base case Life Cycle Costs for society**

This section includes a calculation of the LCC for society as described in the MEErP methodology, following the extended LCC equations with CO₂ stock price, societal damage of certain emissions, etc.

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18 LCC for society have been calculated using the EcoReport tool. The results of this 19 calculation are shown in Table 5-19 referred to the lifetime considered for each of the 20 base cases.

Table 5-19: Life Cycle Costs for society per base case

	Unit		Life Cycle Costs per base case								
Base case id		BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8	BC9	
Sector		sector	sector	sector	sector	sector	sector	sector	sector	sector	
				Socket-				Socket-			
		Distributio	Lighting	outlet	Dedicated	Distributio	Lighting	outlet	Dedicated	Dedicated	
Application circuit		n circuit	circuit	circuit	circuit	n circuit	circuit	circuit	circuit	circuit	
Product price	€	6727.15	66.41	87.11	254.01	38235.44	88.70	102.97	1339.24	1586.41	
Installation/ acquisition											
costs (if any)	€	693.23	78.65	98.45	137.78	3572.78	107.30	113.40	334.55	391.53	
Electricity	€	22968.99	83.72	59.43	5725.54	92313.73	172.57	215.40	24845.00	19712.35	
External damages total, of							-				
which	€	6448.68	32.62	41.64	1115.20	30155.54	57.97	80.57	4906.73	3702.13	
- production PPext	€	6448.68	32.62	41.64	1115.20	30155.54	57.97	80.57	4906.73	3702.13	
- lifetime operating expense											
N*OEext	€	4101.38	15.01	10.78	1018.93	16513.54	30.87	38.59	4421.96	3506.93	
- end-of-life OELext	€	618.55	4.00	7.35	24.60	3613.25	6.20	10.03	127.57	41.35	
Total	€	36838.04	261.40	286.63	7232.53	164277.49	426.54	512.34	31425.52	25392.42	
Product price	%	18%	25%	30%	4%	23%	21%	20%	4%	6%	
Installation/ acquisition											
costs (if any)	%	2%	30%	34%	2%	2%	25%	22%	1%	2%	
Electricity	%	62%	32%	21%	79%	56%	40%	42%	79%	78%	
which	%	18%	12%	15%	15%	18%	14%	16%	16%	15%	
Total	%	100%	100%	100%	100%	100%	100%	100%	100%	100%	

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4 **5.5 EU totals**

5 Following the MEErP 2011 methodology, EU Totals have been calculated using the

6 EcoReport tool in which environmental impacts and LCC outcomes have been

7 aggregated according to stock and market data estimated in Task 2.

8 As explained in section 5.6, three reference parameters had to be corrected to fit EU-28

- 9 stock and EU-28 electricity consumption. These correction factors are applied in
- 10 sections 5.5 and 5.6.

1 5.5.1 Stock specific inputs

Table 5-20 shows the stock input parameters per BC. The nine base cases are assumed to represent the installed stock in the EU-28.

Table 5-20: Stock input parameters per base case

	Unit					Bases cases de	efiniton				
Base case id			BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8	BC9
			Services	Services	Services	Services	Industry	Industry	Industry	Industry	Industry
Sector			sector	sector	sector	sector	sector	sector	sector	sector	sector
			Distribution	Lighting	Socket-outlet	Dedicated	Distribution	Lighting	Socket-outlet	Dedicated	Dedicated
Application circuit			circuit	circuit	circuit	circuit	circuit	circuit	circuit	circuit	circuit
Stock and sales data (fixed total stock)											
Year			2010	2010	2010	2010	2010	2010	2010	2010	2010
EU Stock per base case cable (Conductor weight)	kg	Ι	1.94E+09	2.07E+08	5.53E+08	5.53E+08	2.50E+09	2.00E+08	4.00E+08	7.25E+08	4.40E+08
EU Stock (units of 1 cable)	m	С	3.63E+08	3.11E+09	4.98E+09	1.24E+09	2.34E+08	3.00E+09	3.60E+09	4.66E+08	4.66E+08
	mln.										
EU Stock (base case units)	Units	С	1.75	38.82	51.26	13.38	0.39	24.15	27.17	3.23	3.23
	mln.										
Annual sales (base case units)	Units	С	0.07	1.55	2.05	0.54	0.02	0.97	1.09	0.13	0.13
BC weightfactor of total stock		Ι	14.00%	1.50%	4.00%	4.00%	50.00%	4.00%	8.00%	14.50%	

1 5.5.2 Environmental impact at EU-28

2 The total annual impacts from the EU stock of products are presented in Table 5-21.

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Table 5-21: EU-28 total annual environmental impacts from the installed stock

	Unit					Environmental					
Base case id		BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8	BC9	Total (BC1-BC8)
Sector		Services sector	Services sector	Services sector	Services sector	Industry sector	Industry sector	Industry sector	Industry sector	Industry sector	
		Distribution		Socket-outlet		Distribution		Socket-outlet			
Application circuit		circuit	Lighting circuit	circuit	Dedicated circuit	circuit	Lighting circuit	circuit	Dedicated circuit	Dedicated circuit	
Materials											
Plastics	Mt	0.028	0.015	0.029	0.014	0.028	0.015	0.021	0.010	0.022	0.16
Ferrous metals	Mt	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00
Non-ferrous metals	Mt	0.078	0.008	0.022	0.022	0.101	0.008	0.016	0.029	0.018	0.29
Other resources & waste											
Total Energy (GER)	PJ	71.80	7.41	9.94	119.13	67.59	8.64	12.64	124.82	100.65	421.96
of which, electricity	TWh	6.82	0.60	0.61	12.86	6.05	0.75	1.05	13.44	10.70	42.16
Water (process)*	mln.m3	0.07	0.08	0.15	0.06	0.08	0.08	0.11	0.03	0.06	0.67
Waste, non-haz./ landfill*	Mt	0.04	0.01	0.01	0.06	0.03	0.01	0.01	0.06	0.06	0.22
Waste, hazardous/ incinerated*	kton	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Emissions (Air)											
Greenhouse Gases in GWP100	mt CO2eq.	3.17	0.33	0.46	5.12	3.02	0.38	0.57	5.37	4.35	18.43
Acidifying agents (AP)	kt SO2eq.	34.76	3.70	7.98	28.57	40.12	3.85	6.80	31.53	19.63	157.29
Volatile Org. Compounds (VOC)	kt	1.37	0.13	0.14	2.59	1.22	0.16	0.23	2.70	2.16	8.55
Persistent Org. Pollutants (POP)	g i-Teq.	0.44	0.04	0.10	0.35	0.50	0.05	0.08	0.39	0.31	1.95
Heavy Metals (HM)	ton Ni eq.	4.94	0.54	1.33	2.42	6.13	0.54	1.02	2.85	1.05	19.76
PAHs	ton Ni eq.	0.58	0.07	0.15	0.40	0.69	0.07	0.12	0.45	1.96	2.53
Particulate Matter (PM, dust)	kt	1.39	0.88	1.59	1.13	1.57	0.85	1.17	0.99	1.53	9.56
Emissions (Water)											
Heavy Metals (HM)	ton Hg/20	7.64	0.84	2.17	2.62	9.76	0.81	1.59	3.29	1.05	28.72
Eutrophication (EP)	kt PO4	0.03	0.00	0.01	0.03	0.03	0.01	0.01	0.03	0.02	0.14

Note: the total electricity consumption in TWh in the above table includes the electricity consumption during all phases of the life cycle, and must be higher than the energy losses values (energy consumption in use phase) listed in section 5.6.

5.5.3 Economic assessment at EU-28

Table 5-22 shows the total annual expenditure in Europe, due to the stock of products currently installed in the EU-28.

Table 5-22: Total annual expenditure in the EU-28 per base case

	Unit			Tota	annual exper	diture in the E	U-28 per base	case			Fotal (BC1-BC8)
Base case id	0	BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8	BC9	
		Services	Services	Services	Services	Industry	Industry	Industry	Industry	Industry	
Sector	0	sector	sector	sector	sector	sector	sector	sector	sector	sector	
		Distribution	Lighting	Socket-outlet	Dedicated	Distribution	Lighting	Socket-outlet	Dedicated	Dedicated	
Application circuit	0	circuit	circuit	circuit	circuit	circuit	circuit	circuit	circuit	circuit	
Product price	mln.€	847.05	143.33	285.81	243.13	1074.73	124.44	189.43	313.33	364.64	3221.25
Installation/ acquisition costs (if any)	mln.€	85.28	177.12	314.98	127.14	96.57	156.67	205.04	76.12	88.51	1238.92
Electricity	mln.€	741.11	59.81	56.06	1409.45	655.56	76.69	107.69	1474.92	1170.22	4581.27
Total	mln.€	1673.44	380.25	656.85	1779.73	1826.85	357.80	502.15	1864.36	1623.37	9041.43
Product price	%	26%	4%	9%	8%	33%	4%	6%	10%	11%	100%
Installation/ acquisition costs (if any)	%	7%	14%	25%	10%	8%	13%	17%	6%	7%	100%
Electricity	%	16%	1%	1%	31%	14%	2%	2%	32%	26%	100%
Total	%	19%	4%	7%	20%	20%	4%	6%	21%	18%	100%

5.6 Cross-checks on EU-28 impact

2 3	To verify the outcomes of the calculation some cross-checks were added.
4	There are two possible cross-checking methods with different starting assumptions for
5	the calculation:
6	1. Fixed total stock/annual sales (figures in Task 2) -> EU-28 annual transported
7	active energy is calculated
8	2. Fixed EU-28 energy consumption -> total stock/annual sales is calculated
9	
10	In case of the first method, the amount of energy transported per BC multiplied by the
11	number of BC units must be lower than the amount of electricity consumed in the EU-
12	28 services and industry sector. The results of the first method (comparison between
13	the amounts of energy transported with the total electricity consumption in Europe) are
14	shown in Table 5-23
15	Shown in rable 5 25.
10	
16	
17	In case of the second method the calculated annual replacement sales multiplied by the
18	product life (= stock) should be about the same as the stock/annual sales figures
19	mentioned in Task 2.
20	Table 5-24 shows the results when using the second method (fixed energy
21	consumption).
22	
~~ \\	In both mothods the losses in the base cases are calculated and should be equal.
23	In both methods the losses in the base cases are calculated and should be equal.

Table 5-23: EU-28 totals check: first method

	Unit T Base cases							Total over			
Base case id			BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8	all BC
Sector			Services	Services	Services	Services	Industry	Industry	Industry	Industry	
Application circuit			Distribution	Lighting	Socket-	Dedicated	Distribution	Lighting	Socket-	Dedicated	
Method 1: fixed stock	kg	I									7.08E+09
Energy distribution factor	%	- 1	100%	20%	20%	60%	100%	10%	15%	75%	
	mln.										
EU Stock (base case units)	Units	1	1.75	38.82	51.26	13.38	0.39	24.15	27.17	3.23	
	mln										
Number of buildings per sector (Task 2 Table 2-9)	Units	1	11.41	11.41	11.41	11.41	2.58	2.58	2.58	2.58	
Annual energy loss (formula 3.5) per BC	kWh	Т	3842.09	14.00	9.94	957.73	15441.57	28.87	36.03	4155.89	
Annual energy transported (formula 3.6) per BC	kVAh	Ι	691,772	3,117	2,394	74,365	2,560,615	3,625	3,712	232,577	
Checks										-	
Annual energy loss Eu-28 (=BC loss * #BC units)	TWh	С	6.74	0.54	0.51	12.81	5.96	0.70	0.98	13.41	34.91
Annual energy transported Eu-28 (=BC annual											
energy transport * #BC units)	TWh	С	1,213	121	123	995	988	88	101	750	
Annual energy transported Eu-28 corrected with											
energy distribution factor	TWh	С	1,213	605	614	1,658	988	875	672	1,000	
Number of BC units (circuits) per building		С	0.2	3.4	4.5	1.2	0.1	9.4	10.5	1.3	

Table 5-24: EU-28 totals check: second method

	Unit					Base	cases				Total over
Base case id			BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8	all BC
Sector			Services	Services	Services	Services	Industry	Industry	Industry	Industry	
Application circuit			Distribution	Lighting	Socket-	Dedicated	Distribution	Lighting	Socket-	Dedicated	
Method 2: fixed EU-28 energy consumption	TWh	Ι		90	04			10)30		1934
Energy distribution factor	%	Ι	100%	20%	20%	60%	100%	10%	15%	75%	
	mln										
Number of buildings per sector (Task 2 Table 2-9)	Units	Т	11.41	11.41	11.41	11.41	2.58	2.58	2.58	2.58	
Annual energy transported (formula 3.6) per BC	kVAh	Ι	691,772	3,117	2,394	74,365	2,560,615	3,625	3,712	232,577	
EU28 energy consumption (distributed via energy											
distribution factor)	TWh	С	904.12	180.82	180.82	542.47	1029.62	102.96	154.44	772.21	1933.74
Checks											
Annual energy loss Eu-28 (=BC loss * #BC units)	TWh	С	5.02	0.81	0.75	6.99	6.21	0.82	1.50	13.80	35.90
BC stock (= EU-28 energy consumption / energy	mln										
transported per BC)	Units	С	1.31	58.02	75.54	7.29	0.40	28.41	41.61	3.32	215.90
BC stock (weight)	kTon	С	1443.07	310.02	815.24	301.62	2604.63	235.22	612.56	746.10	7068.48

1	
2	NOTE: The EU-28 totals mentioned in the previous sections are based upon a fixed Cu
3	stock for the reference year.
4	
5	The cross-checks at EU level indicated that the outcome for the losses were too high.
6	The bases cases as such, although abstract cases, are not representative for the
/	average total stock and losses in Europe. Therefore corrections factors on those
8	median' parameters were calculated that fit with total EU energy consumption. With
9	concurred at EU lovel, and the stock equals the stock figures in Task 3. To accomplish
11	this the following three reference parameters are corrected.
12	• The reference circuit length (Task 3) is multiplied by 1.84:
13	• The reference load factor (Task 3) is multiplied by 0.5:
14	• The weight distribution towards the circuits (Task 2) is altered (see Table 5-20).
15	
16	This also indicates that potentially a lot of circuits in the stock have a relative lower
17	loading and/or longer circuit length and/or higher share of bases case with lower
18	loading. This is also something to take into account in the sensitivity analysis (Task 6).
19	
20	
21	
22	