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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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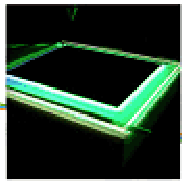
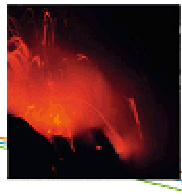
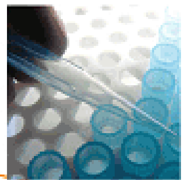

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EXECUTIVE SUMMARY

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 http://ec.europa.eu/enterprise/policies/sustainable-business/ecodesign/index_en.htm).

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

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-business/ecodesign/methodology/index_en.htm).

The tasks in the MEErP entail:
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 Best Available Technology (BAT) and Best Not Yet Available Technology (BNAT));
Task 5 – Environment & Economics (base case Life Cycle Assessment (LCA) & Life Cycle Costs (LCC));
Task 6 – Design options(improvement potential);
Task 7 – Scenarios (policy, scenario, impact and sensitivity analysis).
Tasks 1 to 4 can be performed in parallel, whereas 5, 6 and 7 are sequential.
Task 0 or a Quick-scan is optional to Task 1 for the case of large or inhomogeneous product groups, where it is recommended to carry out a first product screening. The objective is to re-group or narrow the product scope, as appropriate from an ecodesign point of view, for the subsequent analysis in tasks 2-7.

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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

Use of text background colours

Blue: draft text
Yellow: text requires attention to be commented
Green: text changed in the last update

CHAPTER 5 TASK 5: ENVIRONMENT & ECONOMICS

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

The aim of this section is to assess environmental and economic impacts of the different base cases. The assessment is based on the updated version 3.06 of the EcoReport Tool[1], as provided with the MEErP 2011 methodology.

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

Summary of Task 5:

Previous Task 4 identified improvement options at circuit level. In this Task nine base 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 base cases used the ‘median’ electrical circuit parameters from Task 3, such as load factor and cable length. The nine base cases used are:

- 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;
- 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 industry sector (BC1 up to and including BC8 are with copper conductors);
- Base case 9: base case 8 but with aluminium instead of copper.

The LCA and LCC showed that in most cases the use phase is dominant. This is due to the impact of electrical cable losses. As a consequence, there will be room left for economic energy savings in several of those base cases that will be analysed in detail in Task 6. The data of the nine base cases was also summed using EU-28 circuit level 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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showed an overestimation compared to EU-28 data on energy use. This means that the 'median' parameters for the base cases from Task 3 do not reflect 'average reference' parameters that can be used in a stock model in Task 7. Therefore corrections factors on those 'median' parameters were calculated that fit with total EU energy consumption. This also indicates that potentially a lot of circuits in the stock have a relative lower loading and/or longer circuit length and/or higher share of base cases with lower loading. This is also something to take into account in the sensitivity analysis (Task 6).

Table 5-21 indicates annual electricity consumption at EU-28 level of about 42 TWh. The tables in section 5.2 show that the use phase is responsible for the largest part of this electricity consumption, which is also confirmed by the 35 TWh electricity losses per year shown in

1 and

Table 5-24.

5.1 Product specific inputs

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

5.1.1 Identification of base cases

According to the MEErP methodology, base cases should reflect average EU products. 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 product.
For the identification of the base cases, four application types (power cable for use in 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 application sectors (services sector and industry sector) have been chosen. All base cases use cables with copper conductors, except for base case nine which is based upon cables with aluminium conductors.

The most appropriate base cases have been selected in accordance with the analysis presented in Tasks 2, 3 and 4 concerning the analysis of market and environmental and technical elements associated to products used across the EU.
Nine base cases have been identified to assess the environmental and economic impacts over the life cycle:

- Base case 1: A typical power cable for use in typical distribution circuit in the services sector (see Figure 5-1);
- Base case 2: A typical power cable for use in typical lighting circuit in the services sector;
- Base case 3: A typical power cable for use in typical socket-outlet circuit in the services sector;
- Base case 4: A typical power cable for use in typical dedicated circuit in the services sector (see Figure 5-1);
- Base case 5: A typical power cable for use in typical distribution circuit in the industry sector (see Figure 5-2);
- 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.

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	T	Bases cases definiton								
Base case id			BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8	BC9
Sector			Services sector	Services sector	Services sector	Services sector	Industry sector	Industry sector	Industry sector	Industry sector	Industry sector
Application circuit			Distribution circuit	Lighting circuit	Socket-outlet circuit	Dedicated circuit	Distribution circuit	Lighting circuit	Socket-outlet circuit	Dedicated circuit	Dedicated circuit
Transformer/Consumer	kVA	I	400	2.3	4	43	1250	2.3	4	108	108
Voltage	V	I	400	230	230	400	400	230	230	400	400
Load current Ib	A	I	577	10	16	62	1804	10	16	156	156
Cores		I	5	5	5	5	4	5	5	5	5
Conductor material		I	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Al
CSA	mm²	I	120	1.5	2.5	10	300	1.5	2.5	35	70
Installation Method (IEC 60364-5-52)		I	E	E	E	E	E	E	E	E	E
Current Carying Capacity cable (IEC 60364-5-52 / Table B52.12)	A	I	346	26	30	75	621	26	30	158	158
Cables in parallel //		I	2	1	1	1	4	1	1	1	1
Current-Carrying Capacity - total	A	I	692	26	30	75	2484	26	30	158	158
Reduction Factor (IEC 60364-5-52 / Table B52.17)		I	0.88	1	1	1	0.8	1	1	1	1
Current-Carrying Capacity cable - total - reducted	A	C	609	26	30	75	1987	26	30	158	158
Icircuit= Ir (circuit breaker setting)	A	I	577	10	16	62	1804	10	16	156	156
Single phase or 3-phase		I	3	1	1	3	3	1	1	3	3
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 number of conductors/cores of a cable has to be the same for each CSA. Therefore the cables in these base cases have always 5 cores. The BOM mentioned in Task 4 is based upon cables with 5 cores.

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 transformer[3] 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.

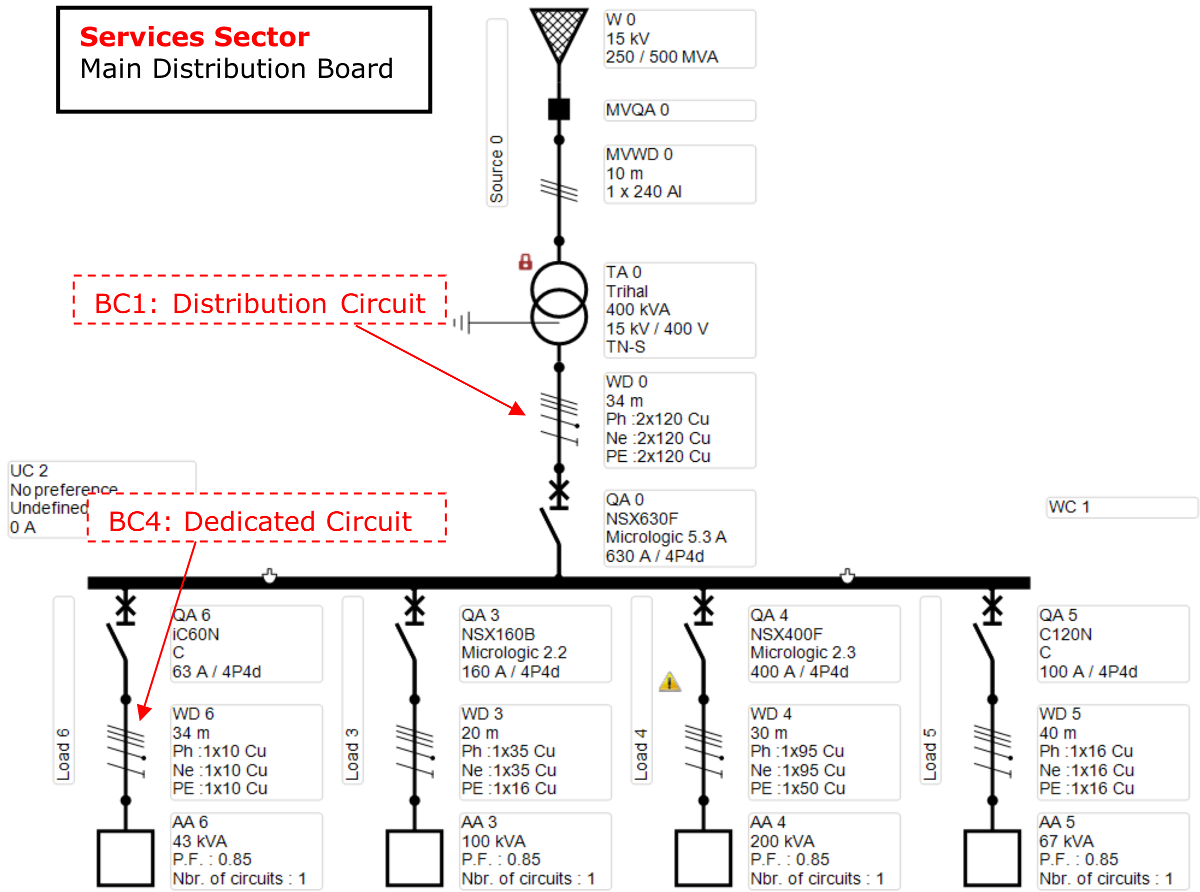

Figure 5-1 Services Sector - Base Cases 1 & 4

Base Case 2: Services sector - Lighting circuit

3G1.5 mm² and 5G1.5 mm² (two extra conductors for DALI protocol[2]) power cables are commonly used in lighting circuits in EU-28 countries. A 5G1.5 mm² is used in this base case. A circuit breaker of 10 A (or 16 A) can be used to protect the cable against overload and short circuit. The maximum power which can be transmitted over the cable is (230V*10A=) 2.3 kVA.

Base Case 3: Services sector – Socket-outlet circuit

A 3G2.5 mm² power cable is commonly used in socket-outlet circuits in EU-28 countries. A 5G2.5 mm² is used in this base case for reasons mentioned in the remarks above. A circuit breaker of 16 A (or 20 A) can be used to protect the cable against overload and short circuit. The maximum power which can be transmitted over the cable is (230V*16A=) 36.8 kVA.

Base Case 4: Services sector – Dedicated circuit

A dedicated circuit forms the connection between a main- or sub-distribution board and a dedicated consumer (see Figure 5-1). A 5G10 mm² cable is selected for the services

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

sector as a dedicated circuit cable. For the given cable length and cable section a load of 43 kVA can be connected to the 63 A circuit breaker in the distribution board.

Base Case 5: Industry sector – Distribution circuit

In general, transformers with a higher power rate are used in industry sector compared to the services sector. A 1250 kVA transformer is used in this BC as a common used transformer in industry[3].
The distribution circuit contains the main distribution circuit - this means the LV power cable and protective device - between the 1250 kVA MV/LV power transformer and the main LV distribution board (see Figure 5-2).

Four parallel cables of each 4 x 300 mm² are needed to transport the maximum power from the 1250 kVA transformer to the main distribution board at the given circuit length.

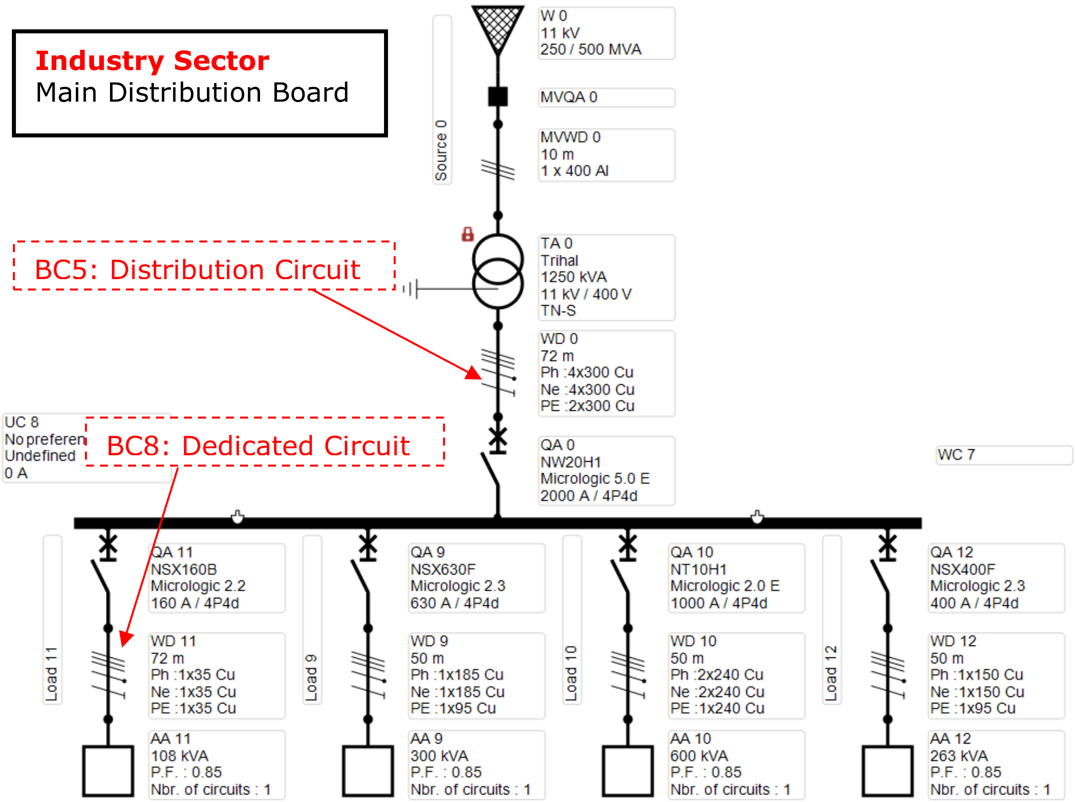

Figure 5-2 Industry Sector – Base Cases 5 & 8

Base Case 6: Industry sector – Lighting circuit
A circuit similar to base case 2, but with characteristics typical for the industry, as defined in Task 3.

[3] EU DG ENTR- Lot 2: Distribution and power transformers: http://www.eceee.org/ecodesign/products/distribution_power_transformers/Final_report_Feb2011

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.

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).

A frequently used LV power cable with the following specifications is selected as the reference cable:

- Conductor:
  - Material: Cu
  - Flexibility: Class 1 and 2
- Insulation material: XLPE (Cross-Linked Polyethylene)
- Sheath material: PVC (Polyvinyl Chloride)
- Voltage rating: 0.6/1 kV
- Single- and multicore
- Armoured: No
- Standard: IEC 60502-1

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
Sector			Services sector	Services sector	Services sector	Services sector	Industry sector	Industry sector	Industry sector	Industry sector	Industry sector
Application circuit			Distribution circuit	Lighting circuit	Socket-outlet circuit	Dedicated circuit	Distribution circuit	Lighting circuit	Socket-outlet circuit	Dedicated circuit	Dedicated circuit
BoM per meter cable											
CSA	**mm²**	**I**	120.00	1.50	2.50	10.00	300.00	1.50	2.50	35.00	70.00
Conductor material	g/m	**I**	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	**I**	478.79	79.39	88.56	129.78	820.05	79.39	88.56	210.34	399.11
Filler material	g/m	**I**	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	**C**	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	C	600.08	2.90	5.86	22.47	3,520.44	4.50	8.00	122.13	74.18
Insulation material	kg	C	26.82	0.94	1.35	2.22	147.86	1.45	1.84	7.84	14.88
Sheath material	kg	C	53.86	3.46	4.67	6.56	270.62	5.36	6.38	16.51	31.33
Filler material	kg	C	146.34	1.79	2.65	7.14	638.18	2.78	3.62	30.69	66.20
Total weight material	kg	C	827.10	9.09	14.54	38.40	4,577.10	14.09	19.84	177.17	186.59

In the EcoReport tool the following material components are selected, based on Table 4-1 of Task 4:

- Conductor material: Cu or Al (depending on the BC);
- Insulation material: 100% LDPE (According to the Europacable members, there is 3% silane based crosslinking compound in the XLPE insulation, however due to the limited list of materials in the EcoReport tool 100% LDPE is used for the calculations, also given the small share of crosslinking compound.) ;
- Sheath material, composed of:
  - 50% of the sheath material weight: PVC (not recycled)[4];
  - 25% of the sheath material weight: talcum filler as filler material in the sheath (According to the Europacable members, calcium carbonate filler is used, however in the EcoReport tool calcium carbonate cannot be chosen. Given that both talcum and calcium carbonate are mineral fillers that are used in plastic, talcum is used as a substitute.);
  - 25% of the sheath material weight: bitumen (As it is the closest to a plasticizer in the EcoReport tool.);
- Filler material: 100% talcum filler.

The material resource input for base case 1 in the Ecoreport tool is shown in Table 5-3 as an example.

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

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

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !
1	Conductor	600075.0	4-Non-ferro	30 - Cu wire
2	Insulation	268210	1-BlkPlastics	1-LDPE
3	Sheath - PVC	269317	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	T	BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8	BC9
CSA	mm²	I	120	1.5	2.5	10	300	1.5	2.5	35	70
Ficitious diameter	mm	I	39.96	7.56	8.64	13.50	55.90	7.56	8.64	22.95	31.32
PVC sheat tickness	mm	I	2.40	1.80	1.80	1.80	2.96	1.80	1.80	1.80	2.10
Cable outer diameter	mm	C	44.76	11.16	12.24	17.10	61.82	11.16	12.24	26.56	35.51
Drum Size		I	22	10	10	14	22	10	10	16	20
Max. cable length	m	I	842	2323	1952	2448	443	2323	1952	1326	1161
Drum Volume (formula 4.1)	m³	I	6.04	0.70	0.70	1.80	6.04	0.70	0.70	2.63	4.99
Drum spacing	m³	C	0.91	0.11	0.11	0.27	0.91	0.11	0.11	0.39	0.75
Correction factor (spacing)	%	I	15%	15%	15%	15%	15%	15%	15%	15%	15%
Drum Corrected Volume	m³	C	6.95	0.81	0.81	2.07	6.95	0.81	0.81	3.03	5.74
Drum Weight	kg	I	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	C	0.00825	0.00035	0.00041	0.00085	0.01568	0.00035	0.00041	0.00228	0.00494
Drum Weigth / meter cable	g/m	C	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
Sector			Services sector	Services sector	Services sector	Services sector	Industry sector	Industry sector	Industry sector	Industry sector	Industry sector
Application circuit			Distribution circuit	Lighting circuit	Socket-outlet circuit	Dedicated circuit	Distribution circuit	Lighting circuit	Socket-outlet circuit	Dedicated circuit	Dedicated circuit
Volume package											
Volume package per meter cable	m3	I	0.008250	0.000347	0.000412	0.000847	0.015680	0.000347	0.000412	0.002282	0.004945
Volume package per base case	m3	C	0.92811	0.01509	0.02177	0.04283	5.17450	0.02339	0.02969	0.17917	0.38816

5.1.4 Use phase

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

Table 5-6: Energy consumption per base case

Parameter	**Unit**	**T**					**Base cases**				
Base case id			**BC1**	**BC2**	**BC3**	**BC4**	**BC5**	**BC6**	**BC7**	**BC8**	**BC9**
Sector			**Services sector**	**Services sector**	**Services sector**	**Services sector**	**Industry sector**	**Industry sector**	**Industry sector**	**Industry sector**	**Industry sector**
Application circuit			**Distribution circuit**	**Lighting circuit**	**Socket-outlet circuit**	**Dedicated circuit**	**Distribution circuit**	**Lighting circuit**	**Socket-outlet circuit**	**Dedicated circuit**	**Dedicated circuit**
Loaded cores		I	6	2	2	3	12	2	2	3	3
Cables in parallel		I	2	1	1	1	4	1	1	1	1
Conductor material		I	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Cu	Al
In per cable	A	I	289	10	16	62	451	10	16	156	156
CSA	mm^2	I	120	1.5	2.5	10	300	1.5	2.5	35	70
Length of circuit	m	I	56	44	53	51	83	68	72	79	79
ρ_t	$\Omega.mm^2/m$	I	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	C	0.008	0.485	0.353	0.084	0.005	0.752	0.481	0.037	0.030
Kd		I	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
αc		I	0.41	0.24	0.15	0.41	0.57	0.34	0.27	0.61	0.61
Pf		I	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	C	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	C	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	C	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)		C	0.60%	0.49%	0.45%	1.40%	0.66%	0.87%	1.06%	1.94%	1.54%

5.1.5 End of Life (EoL)

Recycling of materials can avoid the extraction of raw materials and the production of 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 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. These recycling rates are considered comparable with the outcomes of the previous tasks and thus suitable for the current environmental analysis. Only the re-use of metals is set to 0% instead of 1% and recycling of metals is set to 95% instead of 94% (see section 3.3 in Task 3).

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 mm^2 till 4 mm^2, 0.2 mm^2 till 10 mm^2, 0.5 mm^2 till 16 mm^2 and so on. In the base case calculation the smallest connector, able to fit the cable, is selected.

Base case connector price = CP x CC x NC x NEN (formula 5.1)

Where:

CP: connector price for one wire;
CC: cores per cable;
NC: number of cables in the base case;
NEN: number of end-nodes in a base case.

This means that the connector price doubles when the amount of cables in a base case doubles. Also for base cases with a lot of end-nodes like the base cases for lighting circuits or socket circuits, the connector price will be a substantial part of the base case product price.

Larger connectors may also have an impact on the distribution boards. This is however not included in the base case product price, nor is the cost for potential larger ducts and the building space needed for this. The connector prices are listed in Task 2. Discounted prices are used.

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
Sector			Services sector	Services sector	Services sector	Services sector	Industry sector	Industry sector	Industry sector	Industry sector	Industry sector
Application circuit			Distribution circuit	Lighting circuit	Socket-outlet circuit	Dedicated circuit	Distribution circuit	Lighting circuit	Socket-outlet circuit	Dedicated circuit	Dedicated circuit
LCC data											
Year		I	2010	2010	2010	2010	2010	2010	2010	2010	2010
Electricity rate	€/kWh	I	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Product price for 1 meter cable	€	I	56.60	0.71	1.18	4.72	113.21	0.71	1.18	16.51	18.79
Price connectors	€	I	359.20	35.59	24.87	15.54	876.80	40.94	18.07	43.25	111.31
Bace case product price	€	C	6727.15	66.41	87.11	254.01	38235.44	88.70	102.97	1339.24	1586.41
Base case installation cost	€	I	693.23	78.65	98.45	137.78	3572.78	107.30	113.40	334.55	391.53
Product life	Year	I	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Product service life	Year	I	23.75	23.75	23.75	23.75	23.75	23.75	23.75	23.75	23.75

5.2 Base case environmental impact assessment (using EcoReport)

In this section, the EcoReport tool 2011 version 3.06 is used to calculate the outputs 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.

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

	Unit	Base cases: ecoreport input								
Base case id		**BC1**	**BC2**	**BC3**	**BC4**	**BC5**	**BC6**	**BC7**	**BC8**	**BC9**
CSA	mm^2	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	Al

5.2.1 Base case 1: distribution circuit in services sector

The environmental impacts related to the use of one BC1 circuit per year, calculated by 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	END-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**
									see 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	END-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**
									see 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	END-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**
									see 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.

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

	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	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**
									see 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

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.

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

	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	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**
									see 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**

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.

Table 5-14: Environmental impacts related to the use of one BC6 circuit per year

	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	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**
								see 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**

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	END-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**
									see 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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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.

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

	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	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**
									see note!		
	Other Resources & Waste							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**

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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	END-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**
									see 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

This section includes a calculation of the LCC for consumers using the new LCC 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.

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

	Unit	Life Cycle Costs per base case								
Base case id		BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8	BC9
Sector		Services sector	Services sector	Services sector	Services sector	Industry sector	Industry sector	Industry sector	Industry sector	Industry sector
Application circuit		Distribution circuit	Lighting circuit	Socket-outlet circuit	Dedicated circuit	Distribution circuit	Lighting circuit	Socket-outlet circuit	Dedicated circuit	Dedicated 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%

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 CO_2 stock price, societal damage of certain emissions, etc.

LCC for society have been calculated using the EcoReport tool. The results of this calculation are shown in Table 5-19 referred to the lifetime considered for each of the 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
Application circuit		Distribution circuit	Lighting circuit	Socket-outlet circuit	Dedicated circuit	Distribution circuit	Lighting circuit	Socket-outlet circuit	Dedicated circuit	Dedicated 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%

5.5 EU totals

Following the MEErP 2011 methodology, EU Totals have been calculated using the EcoReport tool in which environmental impacts and LCC outcomes have been aggregated according to stock and market data estimated in Task 2.
As explained in section 5.6, three reference parameters had to be corrected to fit EU-28 stock and EU-28 electricity consumption. These correction factors are applied in sections 5.5 and 5.6.

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 definiton								
Base case id			BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8	BC9
Sector			Services sector	Services sector	Services sector	Services sector	Industry sector	Industry sector	Industry sector	Industry sector	Industry sector
Application circuit			Distribution circuit	Lighting circuit	Socket-outlet circuit	Dedicated circuit	Distribution circuit	Lighting circuit	Socket-outlet circuit	Dedicated circuit	Dedicated 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	I	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	C	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
EU Stock (base case units)	mln. Units	C	1.75	38.82	51.26	13.38	0.39	24.15	27.17	3.23	3.23
Annual sales (base case units)	mln. Units	C	0.07	1.55	2.05	0.54	0.02	0.97	1.09	0.13	0.13
BC weightfactor of total stock		I	14.00%	1.50%	4.00%	4.00%	50.00%	4.00%	8.00%	14.50%	

5.5.2 Environmental impact at EU-28

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

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	
Application circuit		Distribution circuit	Lighting circuit	Socket-outlet circuit	Dedicated circuit	Distribution circuit	Lighting circuit	Socket-outlet 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	Total annual expenditure in the EU-28 per base case									Total (BC1-BC8)
Base case id	0	BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8	BC9	
Sector	0	Services sector	Services sector	Services sector	Services sector	Industry sector	Industry sector	Industry sector	Industry sector	Industry sector	
Application circuit	0	Distribution circuit	Lighting circuit	Socket-outlet circuit	Dedicated circuit	Distribution circuit	Lighting circuit	Socket-outlet circuit	Dedicated circuit	Dedicated 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

To verify the outcomes of the calculation some cross-checks were added.

There are two possible cross-checking methods with different starting assumptions for the calculation:

1. Fixed total stock/annual sales (figures in Task 2) -> EU-28 annual transported active energy is calculated
2. Fixed EU-28 energy consumption -> total stock/annual sales is calculated

In case of the first method, the amount of energy transported per BC multiplied by the number of BC units must be lower than the amount of electricity consumed in the EU-28 services and industry sector. The results of the first method (comparison between the amounts of energy transported with the total electricity consumption in Europe) are shown in Table 5-23.

In case of the second method the calculated annual replacement sales multiplied by the product life (= stock) should be about the same as the stock/annual sales figures mentioned in Task 2.
Table 5-24 shows the results when using the second method (fixed energy consumption).

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 all BC
Base case id			BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8	
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	%	I	100%	20%	20%	60%	100%	10%	15%	75%	
EU Stock (base case units)	mln. Units	I	1.75	38.82	51.26	13.38	0.39	24.15	27.17	3.23	
Number of buildings per sector (Task 2 Table 2-9)	mln Units	I	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	I	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	I	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	C	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	C	1,213	121	123	995	988	88	101	750	
Annual energy transported Eu-28 corrected with energy distribution factor	TWh	C	1,213	605	614	1,658	988	875	672	1,000	
Number of BC units (circuits) per building		C	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 all BC
Base case id			BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8	
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	I	904				1030				1934
Energy distribution factor	%	I	100%	20%	20%	60%	100%	10%	15%	75%	
Number of buildings per sector (Task 2 Table 2-9)	mln Units	I	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	I	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	C	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	C	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 transported per BC)	mln Units	C	1.31	58.02	75.54	7.29	0.40	28.41	41.61	3.32	215.90
BC stock (weight)	kTon	C	1443.07	310.02	815.24	301.62	2604.63	235.22	612.56	746.10	7068.48

NOTE: The EU-28 totals mentioned in the previous sections are based upon a fixed Cu stock for the reference year.

The cross-checks at EU level indicated that the outcome for the losses were too high. 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 'median' parameters were calculated that fit with total EU energy consumption. With the fitted parameters the total energy transported by the base cases equals the energy consumed at EU level, and the stock equals the stock figures in Task 3. To accomplish this, the following three reference parameters are corrected:

- The reference circuit length (Task 3) is multiplied by 1.84;
- The reference load factor (Task 3) is multiplied by 0.5;
- The weight distribution towards the circuits (Task 2) is altered (see Table 5-20).

This also indicates that potentially a lot of circuits in the stock have a relative lower loading and/or longer circuit length and/or higher share of bases case with lower loading. This is also something to take into account in the sensitivity analysis (Task 6).