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

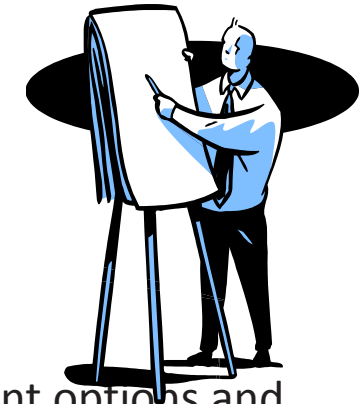
3rd stakeholder meeting

Paul Van Tichelen

Brussels, DG Enterprise

13 November 2014

Agenda



- 10:00-10:10 Welcome
- 10:10-10:20 Short presentation of participants
- 10:20:-11:20 Tasks 1-3 in a nutshell, incl. latest enquiry input
- 11:20-12:30 Task 4-6, based on updated input incl. improvement options and sensitivity analysis
- 12:30-13:30 Break & lunch
- 13:30-14:00 Draft Task 7 on policy options including discussion
- 14:00-14:20 Draft Task 7 on need for updated and/or new standards, including discussion
- 14:20-14:50 Draft Task 7 on 2025 scenarios
- 14:50-15:20 Draft Task 7 on impact including discussion and stakeholders position input
- 15:20-15:30 Any other business
- 15:30-15:40 Planning stakeholder feedback and finalization

EC policy officer & VITO Study Team

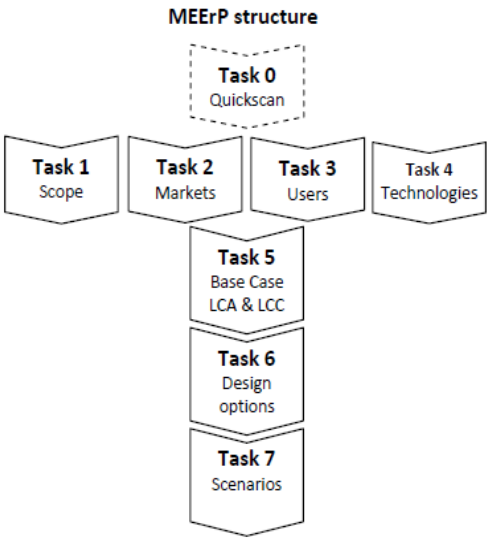
- EC policy officer: Cesar Santos
- VITO Preparotory Study Team:
  - Arnoud Lust: Contract Manager: Arnoud Lust (FC ENTR/29/PP/FC Lot 2) and FC DG ENER Lot 1
  - Main author power cables study&coordinator: Paul Van Tichelen
  - Co-authors:
    - Dominic Ectors (market and use data, ..)
    - Marcel Stevens (technical standards, ..)
    - Wai Chung Lam (LCA, MEErP and scenarios, ..)
  - Administrative contacts:
    - Magalie Wellens +32 14 33 58 04
    - Katrien Bultynck +32 14 33 59 96
  - Website: Karel Styns (webmaster).

Introduction ErP Directive

- Background is the Ecodesign Directive 2009/125/EC:
  - Framework Directive
  - binding requirements through 'Implementing Measures' (EC Regulation ..)
  - For products but it is possible to introduce information requirements for components and sub-assemblies
  - Product groups are first identified in a Working Plan, such as power cables in the 2nd working plan year 2012-2014
  - **A preparatory study provides the necessary information to prepare for the next phases in the policy process, a.o.: impact assessment, the consultation forum, ..)**
  - Approach of preparatory study is well defined in the Methodology for the Ecodesign of Energy-related Products (MEErP)
  - Further info: http://ec.europa.eu/enterprise/policies/sustainable-business/ecodesign/index_en.htm

MEErP in a nutshell

- Tasks in MEErP (chapters in final report):
- Task 1 - Scope (definitions, standards and legislation, first screening);
- Task 2 – Markets (volumes and prices);
- Task 3 – Users (product demand side);
- Task 4 - Technologies (product supply side, includes both BAT and BNAT);
- Task 5 – Environment & Economics (Base case LCA & LCC);
- Task 6 – Design options;
- Task 7 – Scenarios (Policy, scenario, impact and sensitivit
- Tasks 1 to 4 can be performed in parallel



Planning

- 28 Jun 2013 ■Project kick-off meeting with EC
- July 2013 ■Launch website www.erp4cables.net
- Aug 2013 ■ Launch first series of enquiries to registered stakeholders
- 5 dec 2013 ■ 1st stakeholder meeting on Draft Task 1-3
- 3 June 2014 ■ 2nd stakeholder meeting on Draft Task 1-5
- **13 Nov 2014 ■ 3rd stakeholder meeting on Draft Task 1-7**
- End Feb 2015 ■ Publication Final Report Task 1-7

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

Stakeholder meeting: Task 1

Paul Van Tichelen

Brussels, DG Enterprise

3rd of June2014

Task 1: Content

- “Product scope” of the study
- Product categories based on
  - Prodcom
  - EN- or ISO-standards
  - Other product-specific categories
- Definitions & Terminolgy
- Primary & secondary product performance parameters
- Product Standards & Legislation
  - EU level
  - Member state level
- First screening

Task 1: Product scope

- **SCOPE: 'losses in installed power cables in electric circuits in buildings after the meter' taking into account the electrical installation as a system.**

  Out of the scope:

  - Losses in circuit breakers;
  - Losses or inefficiency in the loads connected to the circuit;
  - Losses due to poor connections ;
  - Utility cables for transmission (HV) and distribution (MV,LV) of electrical energy;
  - Power cables for Nuclear power;
  - Power cables for hazardous locations (in ATEX zones);
  - Cables used for power plants such as PV, Wind, ….;
  - Outdoor cables: Cables used in process installations (e.g. chemical and petrochemical plants), railway cables,..;
  - Cables for mobile applications: (electric) cars, ships, metro, …
  - Busbar Trunking systems;

Task 1: Product performance parameter

- Primary product(cicuit) performance paramater or “Functional unit”:
  - **Cable: “Current-Carrying capacity” of the cable/conductor [Amperes]**
  - **Circuit: > In: is rated current for the circuit and is determined by the protective device (safety fuses or circuit breakers) of the circuit;**
- Secondary:
  - CSA, LF, Kf, cos θ, L, ..

Task 1: Measurement & test standards

- Conductors & cables
  - EN13601 & -13602: Copper and copper alloys
  - **EN 60228**: Conductors of insulated cables
    - Class1,2,5,6; Links **'Nominal CSA with Rdc max',** …
  - EN 50525-1: Low voltage energy cables
  - EN 50395: Electrical test methods for low voltage energy cables

Task 1: Measurement & test standards

- Electrical installation:
  - **(IEC)HD 60364-5-52**: LV electrical installations – … wiring systems
    - Correction factors, methods of installation, **dV max**, ….
  - IEC 60287-1-1: Calculation of current rating & losses -100% load factor
  - **IEC 60287-3-2**: Calculation of current rating – **Economic optimization single cable segment – not for distributed loads**
  - IEC 60364-6: Low Voltage electrical installations – verification
  - **IEC 60364-8-1 / FprHD 60364-8-1: 2013: Low voltage electrical installation - Part 8-1: Energy efficiency – DRAFT version:**
    - **Reduction of energy losses in wiring:**
      - **Reducing the voltage drop. Reference to IEC 60364-5-52;**
      - **Increasing the cross sectional area. Reference to IEC 60287-3-2;**
      - **Power factor correction to improve the power factor of the load circuit;**
      - **Reduction of harmonic currents at the load level.**
    - **Qualitative but not quantitative ?**

Task 1: First screening

- **Note: these values are updated in later chapters!**
- Focus in taks 3-6 on service and industry sector

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

Stakeholder meeting: Task 2

Paul Van Tichelen

Brussels, DG Enterprise

3rd of June 2014

Content

- 2.1 Generic economic data
- 2.2 Market and stock data
  - 2.2.1 Sales data
  - 2.2.2 Stock data
- 2.3 Market trends
- 2.4 Consumer expenditure base data
- 2.5 Recommendations

Market and stock data: summary

Sector	Product life	Service life	Vacancy	Stock growth rate	Demolition rate	Replace-ment sales rate	New sales rate	Total sales rate	Stock (Reference year: 2010)	
Unit	Year	Year	%	% p.a.	% p.a.	% p.a.	% p.a.	% p.a.	kTon Cu	%
Residential sector	64.00	60.80	5%	0.90%	0.10%	1.18%	0.90%	2.08%	5241	43%
Services sector	25.00	23.75	5%	1.90%	0.20%	3.20%	1.90%	5.10%	3250	26%
Industry sector	25.00	23.75	5%	2.90%	0.20%	2.80%	2.90%	5.70%	3825	31%
Total sector (weighted)	41.60	39.52	5%	1.79%	0.16%	2.22%	1.79%	4.00%	12316	100%

Product/circuit cost

- Cost of circuit:
  - Cable cost (CSA [mm²] x l [m] x N) an average discounted cable price of 0.09434 €/ (mm². m).
  - Connector cost
  - Installation times per cable type
  - Average hourly rate (23,7 euro/h)

Minimum wire size	Maximum wire size	CSA	Connector price	Discounted connector price
mm^2	mm^2	mm^2	€	€
0.14	4	1	0.87	0.54
0.14	4	1.5	0.87	0.54
0.14	4	2.5	0.87	0.54
0.14	4	4	0.87	0.54
0.2	10	6	1.61	0.97
0.2	10	10	1.61	0.97
0.5	16	16	2.11	1.25
1.5	25	25	2.11	1.07
1.5	50	35	4.85	2.84
1.5	50	50	4.85	2.84
16	70	70	11.79	7.31
25	95	95	22.11	13.71
35	150	120	28.96	17.96
35	150	150	28.96	17.96
70	240	185	35.36	21.92
70	240	240	35.36	21.92
		300	44.20	27.40
		400	58.93	36.53
		500	73.67	45.67
		630	92.82	57.54

Cu based cables		
Section	Installation time per meter	Installation time for the cable ends
mm2	Min	Min
1	1.75	5
1.5	2.45	7
2.5	3.15	9
4	3.85	12
6	5.25	12
10	5.95	15
16	7	17
25	8.75	20.4
35	9.8	25.5
50	10.5	30.6
70	11.9	36
95	12.6	45
120	14	45
150	15.75	60
185	17.5	60
240	21	85
300	24.5	120
400	28	200
500	35	360
630	42	480

Copper long-term availability

- Many comments received:
- Update needed, tekst added in 2.4.1 on ‘purchase price’ should fit in 2.4.1.1 ‘copper long term availability’ (both will be integrated).
- Main change: copper is not considered as critical raw material, references added to other EU studies that focus in this topic, e.g.:
  - http://ec.europa.eu/enterprise/policies/raw-materials/critical/index_en.htm

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

Stakeholder meeting: Task 3

Paul Van Tichelen

Brussels, DG Enterprise

3rd of June 2014

Task 3 Users

- **Systems aspects of the use phase for ErPs with direct impact**
  - Definition of the User and context
  - Loss parameters directly related to the cable itself
  - Other functional cable parameters not directly related to losses
  - Loss parameters directly related to the electrical circuit and network topology
  - Parameters related to the building and loading
  - Formulas used for power losses in cables
- **End of Life behaviour**
- **Local infrastructure (barriers & opportunities), e.g. cable bending**
- **Recommendations**

CSA, parameter

Table·3—2:·Minimum·and·maximum·cable·cross-sectional·areas·per·circuit·type¶

▪Sector¤	Circuit·application· type¤	CSA·(mm²)·min¤	CSA¶(mm²)¶max¤	¤
▪Residential¤	Distribution· circuit¤	6¤	16¤	¤
	Lighting· circuit¤	1¤	2.5¤	¤
	Socket-outlet· circuit¤	1.5¤	6¤	¤
	Dedicated·circuit¤	2.5¤	6¤	¤
▪Services¤	Distribution· circuit¤	10¤	600¤	¤
	Lighting· circuit¤	1.5¤	2.5¤	¤
	Socket-outlet· circuit¤	1.5¤	6¤	¤
	Dedicated·circuit¤	2.5¤	95¤	¤
▪Industry¤	Distribution· circuit¤	25¤	600¤	¤
	Lighting· circuit¤	1.5¤	2.5¤	¤
	Socket-outlet· circuit¤	1.5¤	10¤	¤
	Dedicated·circuit¤	2.5¤	600¤	¤

Circuit length, parameter (from questionnaire)

Table 3—4: Average circuit length in meters according questionnaire[5]

Sector	Circuit application type	Average length min (m)	Average length ref (m)	Average length max (m)
Residential	Distribution circuit	15	21	54
	Lighting circuit	10	20	60
	Socket-outlet circuit	5	24	100
	Dedicated circuit	5	18	80
Services	Distribution circuit	20	56	200
	Lighting circuit	12	44	240
	Socket-outlet circuit	10	53	300
	Dedicated circuit	10	51	300
Industry	Distribution circuit	30	83	240
	Lighting circuit	20	68	340
	Socket-outlet circuit	15	72	500
	Dedicated circuit	15	79	400
CorrectionFactor		1	1	2

Load factors (α_c) and load form factors (Kf)

		Lighting circuit			Socket-outlet circuit			Dedicated circuit			Distribution circuit		
		Low	Ref	High	Low	Ref	High	Low	Ref	High	Low	Ref	High
Residential sector	Kf	3.12	2.11	1.67	4.38	1.74	1.34	4.61	3.99	3.12	1.24	1.14	1.08
	αc	0.01	0.05	0.10	0.00	0.04	0.10	0.01	0.02	0.05	0.01	0.06	0.22
	Kf . αc	0.03	0.11	0.17	0.01	0.06	0.13	0.02	0.08	0.14	0.02	0.07	0.23
Services sector	Kf	1.50	1.27	1.16	1.50	1.27	1.16	1.37	1.21	1.13	1.37	1.21	1.13
	αc	0.07	0.24	0.41	0.04	0.15	0.24	0.14	0.41	0.54	0.14	0.41	0.54
	Kf . αc	0.11	0.31	0.48	0.06	0.19	0.27	0.20	0.49	0.61	0.20	0.49	0.61
Industry sector	Kf	1.11	1.06	1.03	1.11	1.06	1.03	1.03	1.01	1.00	1.05	1.02	1.01
	αc	0.12	0.34	0.54	0.06	0.27	0.46	0.23	0.61	0.76	0.22	0.57	0.72
	Kf . αc	0.13	0.36	0.55	0.06	0.29	0.47	0.24	0.61	0.76	0.23	0.58	0.72
αc correction factor		0.5	1	1	0.5	1	1	0.5	1	1	0.5	1	1

End of life parameters

- More info added on recycling
- source: kept similar with the MEErP default values also used in other ErP Ecodesigns studies

	Bulk Plastics	TecPlastics	Ferro	Non-ferro	Coating	Electronics	Misc. , excluding refrigant & Hg	refrigerant	Hg (mercury), **in mg/unit**	Extra	Auxiliaries
EoL mass fraction to re-use, in %	1%	1%	1%	0%	1%	**1%**	1%	1%	1%	1%	**5%**
EoL mass fraction to (materials) recycling, in %	29%	**29%**	94%	95%	94%	**50%**	**64%**	**30%**	**39%**	**60%**	**30%**
EoL mass fraction to (heat) recovery, in %	15%	**15%**	0%			**0%**	**1%**	**0%**	**0%**	**0%**	**10%**
EoL mass fraction to non-recov. incineration, in %	22%	**22%**	0%			**30%**	**5%**	**5%**	**5%**	**10%**	**10%**
EoL mass fraction to landfill/missing/fugitive, in %	33%	**33%**	5%			**19%**	**29%**	**64%**	**55%**	**29%**	**45%**

Product life times

	short product life		Reference		long product life	
Sector	Replace-ment rate	Product life	Replace-ment rate	Product life	Replace-ment rate	Product life
Unit	%	year	%	year	%	year
Residential sector	2.10%	40	1.18%	64	0.80%	84
Services sector	7.08%	13	3.20%	25	1.70%	40
Industry sector	7.08%	12	2.80%	25	1.37%	40

Formula 3.5 used for power losses in cables

$E_{circuit,(y)}$ [kVAh] = Kd . Rt . I_{max}^2 . (α_c . Kf)^2 . 8760 / 1000 (formula 3.5)

where,

- Kd = the distribution factor
- R_t = cable resistance at temperature t (see formula 3.2)
- Imax = the maximum rated current of the cable
- α_c = The corrected load factor (circuit level-distributed)
- Kf = Load form factor (=Prms/Pavg)
- PF = the power factor of the load served by the power cable

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

Stakeholder meeting: Task 4

Dominic Ectors

Brussels, DG Enterprise

13 November 2014

Task 4: Technologies

- BAT
  - Product level (power cable)
  - System level (electrical installation/-circuit)
- BNAT
  - Product level (power cable)
  - System level (electrical installation/-circuit)
- Production, distrubition and End of Live (Task 3)
- Improvement options & recommendations

Task 4: Technologies - BNAT

- BNAT at Product level (power cable)
  - ?

- BNAT at System level (electrical installation/-circuit)
  - Energy efficiency at appliance level
  - Building and home automation
  - Peak reduction control systems
  - DC power distribution in commercial buildings

Task 4: Technologies - BNAT

- DC power distribution in commercial buildings, as for instance promoted by the EMerge Alliance.
- This system will use 380 VDC/24VDC instead of 110 or 230 VAC
- The rationale is that cable insulation is related to the peak voltage(Vpeak). In AC systems peak voltage is Vrms.√2 = 325 Vpeak. In DC systems the peak voltage is equivalent to the VDC. As a consequence an identical cable with identical insulation would need **less current in DC** (e;g.: 325VDC, 1A, 325 VA) compared to AC (e.g. 230 Vrms, 1.41A, 325 W) and will therefore reduce the cable losses.
- Such a switch from AC to DC is **complex** as it requires another concept of power distribution with different converters, protection switches, distribution transformers, etc. Therefore it will not be considered as a viable BAT improvement option.

Task 4: Production, distribution and End of Live

- Section on Power Cable Manufacturing added
- Bill of Material Cu adapted
  - Using 5(4) cores (or 4 x 1 core)
  - Pricing based upon EURO/mm^2.m
- Bill of Material added for Al cable
- Cable composition added (from stakeholder)

Cable Part	Composition	% in weight
PVC sheath	PVC resin	45
	Ca Carbonate filler	25
	Plasticizer (DIDP)	25
	Lubricant, stabilizer and others	5
XLPE insulation	LDPE	97
	Crosslinking compound (Silane based)	3

Task 4: Distribution

- Not changed

Task 4: Improvement options & Recommendations

Option Name	Description
At cable level	
Low loss cable as a product	No BNAT technologies are available at cable level that could reduce the energy losses in an economical feasible manner. Labelling information on the cable about energy losses is not an improvement option and can be implemented by the scenarios mentioned in "at circuit level" part.
At circuit level (system level)	
S+x	Using, for a particular circuit and load, a cable with a larger CSA (S+x) than necessary (according current standards and regulation) will result in a lower cable resistance R, and thus lower energy losses. The CSA increments are conform the current, standardized CSA values (no new CSA values are considered).
2S	By installing, for a particular circuit and load, instead of one cable with a particular CSA_x one or more cables in parallel with the same CSA (or even smaller CSA than the original foreseen CSA_x) the losses in the circuit can be reduced.
Topology	Keeping the topology in mind when designing the electrical system of a building can reduce the energy losses in the circuits. For instance, to keep losses to a minimum, the main distribution transformers and switchboards are to be located to keep the distances (circuit lengths) to main loads to a minimum. The building's use, construction and space availability has to be taken into account to obtain the best position. One such method to determine the best position is the barycentre method[9].

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

Stakeholder meeting: Task 5

Dominic Ectors

Brussels, DG Enterprise

13 November 2014

Task 5: aim

- **Task 5: Environment Economics**
  - Base Case Environmental Impact Assessment(EcoReport Tool)
  - Base Case Life Cycle Costs for consumer
  - Base Case Life Cycle Costs for society
  - EU wide impact

- to assess environmental and economic impacts of the different base cases.
- based upon EcoReport Tool version 3.06 , as provided with the MEErP 2011 methodology.

Task 5 content (1)

- 5.1 Product-specific inputs
  - 5.1.1 Identification of base cases
  - 5.1.2 Manufacturing of the product: Bill Of Materials
  - 5.1.3 Distribution phase: volume of packaged product
  - 5.1.4 Use phase
  - 5.1.5 End of Life (EoL)
  - 5.1.6 Life Cycle Cost Inputs
- 5.2 Base case environmental impact assessment (using EcoReport)
- 5.3 Base case Life Cycle Cost for consumer
- 5.4 Base case Life Cycle Costs for society

Task 5 content (2)

- 5.5 EU totals
  - 5.5.1 Stock specific inputs
  - 5.5.2 Environmental impact at EU-28
  - 5.5.3 Economic assessment at EU-28
- 5.6 Cross checks

5.1 Product-specific inputs
5.1.1 Identification of base cases

- Services sector
  - Base case 1: typical distribution circuit
  - Base case 2: typical lighting circuit
  - Base case 3: typical socket-outlet
  - Base case 4: typical dedicated circuit
- Industry sector
  - Base case 5: typical distribution circuit
  - Base case 6: typical lighting circuit
  - Base case 7: typical socket-outlet
  - Base case 8: typical dedicated circuit
- Industry sector
  - Base case 9: The same base case as base case 8, but instead of copper the cable conductors are of aluminium.

5.1.2 Bill Of Materials: base cases

- Conductor material: Cu or Al
- Insulation material: 100% LDPE (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)
- Sheath material, composed of:
  - 50% of the sheath material weight: PVC (not recycled);
  - 25% of the sheath material weight: talcum filler as filler material in the sheath (talcum filler in EcoReport tool instead of calcium carbonate)
  - 25% of the sheath material weight: bitumen (As it is the closest to a plasticizer in the EcoReport tool);
- Filler material: 100% talcum filler.

5.1.2 Bill Of Materials: base cases

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 Categoryfirst !
1	Conductor	600075.0	4- Non- ferro	30 - Cu wire
2	Insulation	26821.0	1- Blk Plastics	1- LDPE
3	Sheath - PVC	26931.7	1- Blk Plastics	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

- Not changed, except there are 9 bases cases

5.1.4 Use phase

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%

$E_{circuit,}(y)$ [kVAh] = Kd . R_t . $I_{circuit}^2$. $(\alpha . Kf)^2$. 8760 / 1000 (formula 3.5)

$E_{active}(y)$ [kWh] = $\sqrt{3}$. V . $I_{circuit}$. α . Kf . PF . 8760 / 1000 (1-,3-phase) (formula 3.6)

Loss ratio = $E_{circuit}(y)$/ $E_{active}(y)$ (formula 3.7)

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5.1.5 End of Life (EoL)

- Not changed compared to previous version
  - Defaults values of the EcoReport have been used for recycling rates of the materials
  - 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)
- Remark Europacable: do not agree on 5% waste/landfill

5.1.6 Life Cycle Cost Inputs

	Unit		Bases cases definiton								
Base case id			BC1	BC2	BC3			BC6	BC7	BC8	BC9
Sector			Services sector	Services sector	Services sector	sector	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
Base 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

To be checked

Product life 25 instead of 14 years

Added connector cost, per node

Cost per meter + ends (per node)

Discounted product prices excl. VAT, based upon EURO/mm^2.m

5.2 BASE CASE ENVIRONMENTAL IMPACT ASSESSMENT (USING ECOREPORT)

EcoReport tool: input summary

Is split up in different components in EcoReport tool

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
Base 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

Added

Including connector cost

5.3 BASE CASE LIFE CYCLE COST FOR CONSUMER

Base Case Life Cycle Cost for consumer

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%

Including connector cost

Cost per meter + ends (per node)

Running costs discounted to their Net Present Value

5.5 EU TOTALS

EU totals: stock specific input

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%	

three reference parameters had to be corrected to fit EU-28 stock and EU-28 electricity consumption: see cross-checks

Environmental impact at EU-28 (annual)

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	2.18	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

42 TWh, including production, distribution, use and EoL phase.

Economic assessment at EU-28 (annual)

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

Cross-checks: correction

- 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. 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.
- 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).

Cross-checks: correction

- 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 taken into account in the sensitivity analysis (Task 6).

Cross checks: fixed stock (sales, lifetime)

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	

Cross checks: fixed EU-28 electricity consumption

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

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14/11/2014

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

Stakeholder meeting: Task 6 - design options

Dominic Ectors

Brussels, DG Enterprise

13 November 2014

6.1 Identification of design options and assessment of their impacts

Table 6-1: Design options

			Unit	T	Base 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
Design option	Description	Parameter											
BAU	Business As Usual	CSA	mm^2	I	120	1.5	2.5	10	300	1.5	2.5	35	70
D1	S+1	CSA	mm^2	I	150	2.5	4	16	400	2.5	4	50	95
D2	S+2	CSA	mm^2	I	185	4	6	25	500	4	6	70	120
D3	S+3	CSA	mm^2	I	240	6	10	35	630	6	10	95	150
D4	2S	Cables in parallel multiplicator		I	2	2	2	2	2	2	2	2	2

6.2 Improvement of Ecoreport Impact indicators

» 6.2.1 Impact per parameter

Table 6-3: Electricity

		Unit	of which, electricity (in primary MJ)								
	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
BAU	of which, electricity (in primary MJ)	MJ	1791182	6668	4845	445443	7202865	13662	17050	1932280	1534557
D1	of which, electricity (in primary MJ)	MJ	1435369	4091	3161	278676	5412938	8336	10838	1352990	1131613
D2	of which, electricity (in primary MJ)	MJ	1167395	2667	2255	178767	4323256	5381	7426	967408	897418
D3	of which, electricity (in primary MJ)	MJ	904406	1899	1586	128076	3438519	3775	4774	714232	718966
D4	of which, electricity (in primary MJ)	MJ	904390	3575	2761	223341	3642788	7204	8987	967858	770833
D1	Versus BAU	%	-20%	-39%	-35%	-37%	-25%	-39%	-36%	-30%	-26%
D2		%	-35%	-60%	-53%	-60%	-40%	-61%	-56%	-50%	-42%
D3		%	-50%	-72%	-67%	-71%	-52%	-72%	-72%	-63%	-53%
D4		%	-50%	-46%	-43%	-50%	-49%	-47%	-47%	-50%	-50%

Impact (GWP)

Table 6-7: Greenhouse Gases in GWP100

		Unit	Greenhouse Gases in GWP100								
	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
BAU	Greenhouse Gases in GWP100	kg CO2 eq.	79307	318	257	19145	323619	630	793	83067	66202
D1	Greenhouse Gases in GWP100	kg CO2 eq.	64811	217	203	12088	252258	417	552	58554	49201
D2	Greenhouse Gases in GWP100	kg CO2 eq.	54234	171	187	7921	209279	314	438	42424	39463
D3	Greenhouse Gases in GWP100	kg CO2 eq.	44283	157	203	5859	177825	275	385	32031	32088
D4	Greenhouse Gases in GWP100	kg CO2 eq.	44292	210	209	9785	187796	392	505	42475	34289
D1	Versus BAU	%	-18%	-32%	-21%	-37%	-22%	-34%	-30%	-30%	-26%
D2		%	-32%	-46%	-27%	-59%	-35%	-50%	-45%	-49%	-40%
D3		%	-44%	-50%	-21%	-69%	-45%	-56%	-51%	-61%	-52%
D4		%	-44%	-34%	-18%	-49%	-42%	-38%	-36%	-49%	-48%

Impact (Heavy metals)

Table 6-11: Heavy Metals to air

		Unit	Heavy Metals								
	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
BAU	Heavy Metals	mg Ni eq.	39033	178	264	5299	195517	307	464	23809	15736
D1	Heavy Metals	mg Ni eq.	40661	220	371	4082	218338	358	570	19779	11734
D2	Heavy Metals	mg Ni eq.	44042	307	525	3776	248225	486	758	18313	9440
D3	Heavy Metals	mg Ni eq.	50959	435	845	4046	292396	679	1178	18789	7721
D4	Heavy Metals	mg Ni eq.	50984	253	453	3842	282202	406	669	18324	8229
D1	Versus BAU	%	4%	23%	40%	-23%	12%	17%	23%	-17%	-25%
D2		%	13%	72%	99%	-29%	27%	58%	63%	-23%	-40%
D3		%	31%	144%	220%	-24%	50%	121%	154%	-21%	-51%
D4		%	31%	42%	71%	-27%	44%	32%	44%	-23%	-48%

Circuits with a low load factor have relatively a high increase of heavy metals

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Impact (GWP) per life cycle phase, relative

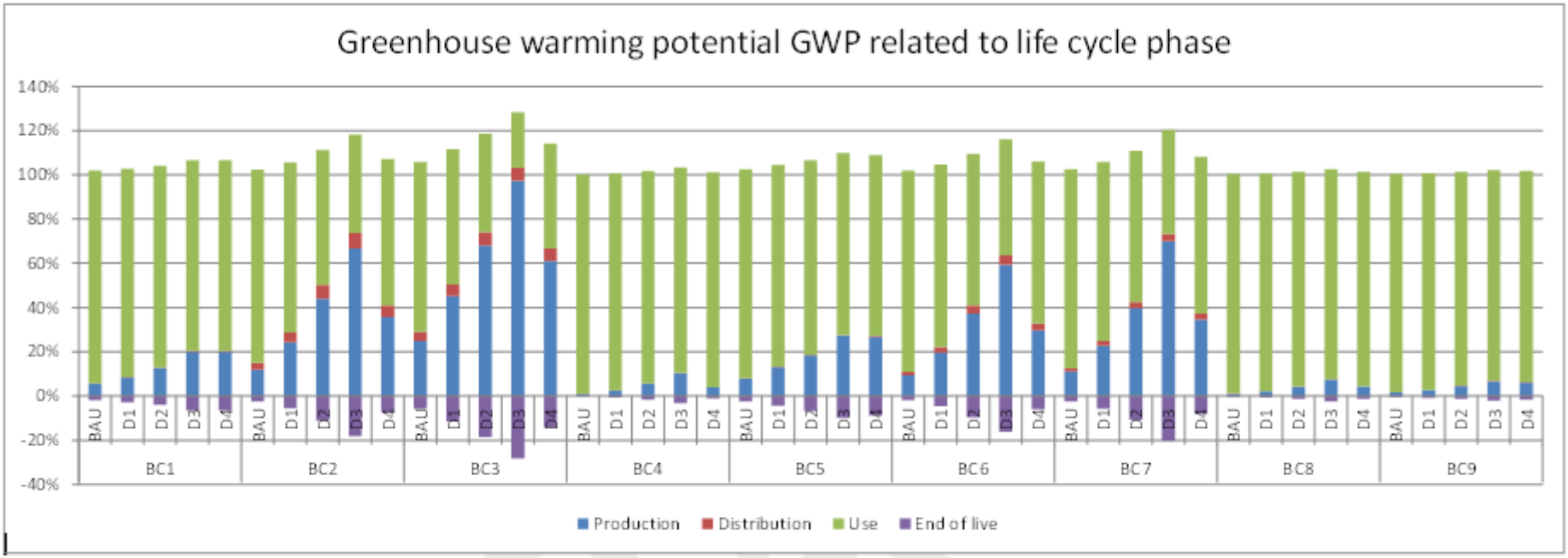


Figure 6-1 Greenhouse Gases (in detail, each phase relative to total) in GWP100

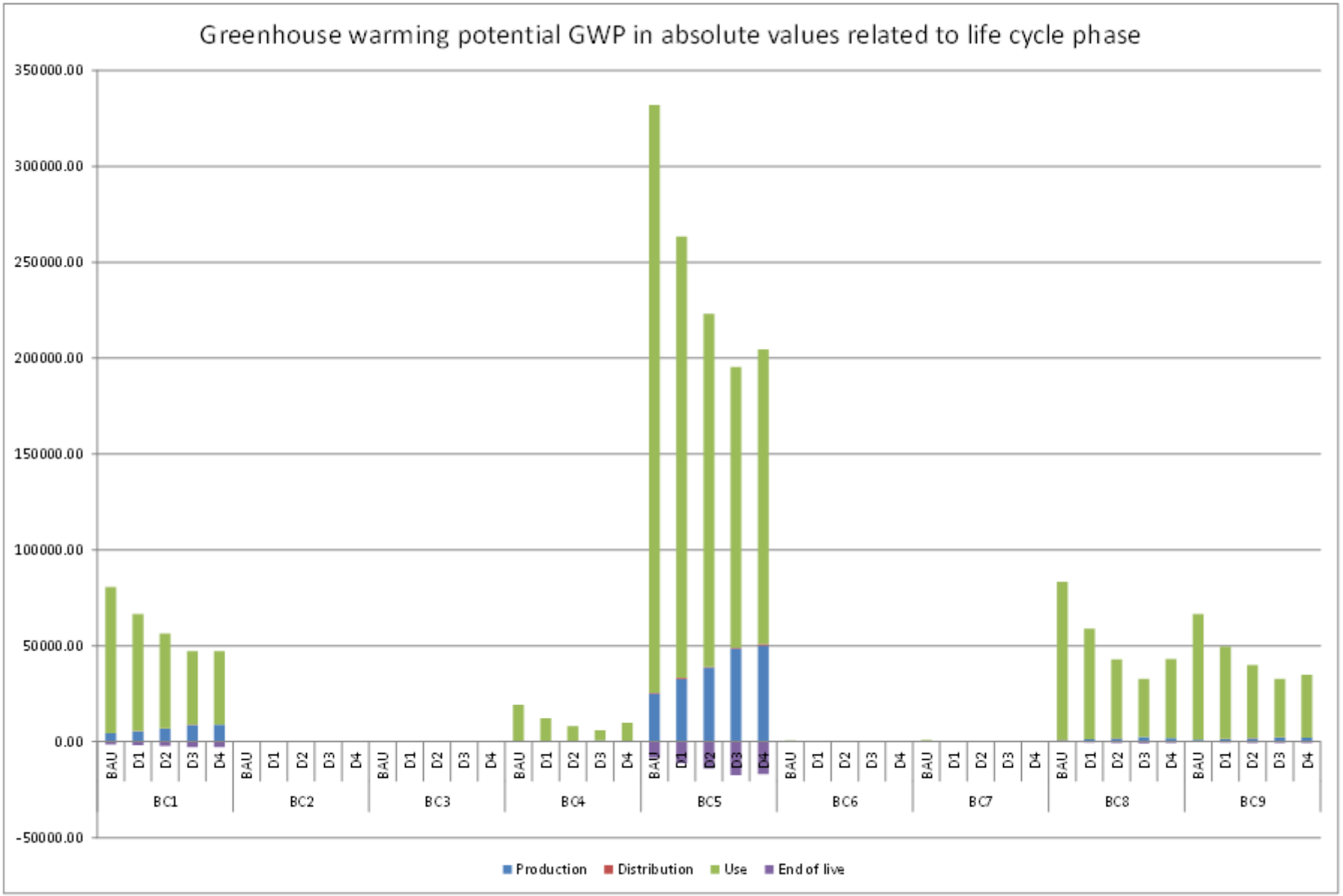


Figure 6-2 Greenhouse Gases in absolute values (in detail, each phase relative to total) in GWP100

Greenhouse gas: Environmental payback period

Table 6-19: Greenhouse Gases: environmental payback period in years

	Unit	Greenhouse Gases: payback period								
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 lifetime	years	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
D1	years	1.80	3.45	9.61	0.35	2.59	2.59	3.61	0.34	0.46
D2	years	2.30	5.58	14.07	0.56	2.76	4.20	5.28	0.52	0.66
D3	years	2.94	8.24	23.07	0.76	3.67	6.19	8.64	0.73	0.79
D4	years	2.95	7.00	16.71	0.51	4.17	5.26	6.27	0.55	0.83

6.2.3 Conclusion on EcoReport tool impact parameters

Table 6-20: best performing design option per parameter and base case

	Best performing design option per parameter and 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
Other resources and waiste									
Total Energy (GER)	D3	D3	D2	D3	D3	D3	D3	D3	D3
of which, electricity (in primary MJ)	D4	D3	D3	D3	D3	D3	D3	D3	D3
Water (process)	BAU	BAU	BAU	BAU	BAU	BAU	BAU	BAU	BAU
Waste, non-haz./ landfill	D3	D3	D2	D3	D3	D3	D3	D3	D3
Emissions (air)									
Waste, hazardous/ incinerated	D3	D3	D3	D3	D3	D3	D3	D3	D3
Greenhouse Gases in GWP100	D3	D3	D2	D3	D3	D3	D3	D3	D3
Acidification, emissions	D2	D1	BAU	D3	D1	D1	D1	D3	D3
Volatile Organic Compounds (VOC)	D3	D3	D3	D3	D3	D3	D3	D3	D3
Persistent Organic Pollutants (POP)	D2	D1	BAU	D3	D1	D1	D1	D3	D3
Heavy Metals	BAU	BAU	BAU	D2	BAU	BAU	BAU	D2	D3
PAHs	D1	BAU	BAU	D3	D1	D1	BAU	D3	BAU
Particulate Matter (PM, dust)	BAU	BAU	BAU	D3	BAU	BAU	BAU	D3	D1
Emissions (water)									
Heavy Metals	BAU	BAU	BAU	BAU	BAU	BAU	BAU	BAU	D3
Eutrophication	D3	D1	BAU	D3	D2	D1	D1	D3	D3

6.3 Impact on Life Cycle Cost

		Unit	Life Cycle Costs per base case per year								
	Base case id		BC1	BC2	BC3	BC4	BC5	BC6			
	Sector		Services sector	Services sector	Services sector	Services 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
BAU	Product price	€	6727.15	66.41	87.11	254.01	38235.44	88.70	102.97	1339.24	1586.41
	Installation cost	€	693.23	78.65	98.45	137.78	3572.78	107.30	113.40	334.55	391.53
	Electricity cost	€	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
D1	Product price	€	8319.14	86.96	124.45	401.55	50980.59	120.54	153.92	1894.67	2210.69
	Installation cost	€	794.69	101.12	123.98	161.27	4281.80	137.96	141.25	362.39	422.59
	Electricity cost	€	18375.19	50.23	37.15	3578.46	69235.30	103.54	134.62	17391.50	14524.89
	Total	€	27489.02	238.31	285.57	4141.29	124497.69	362.04	429.79	19648.56	17158.17
	Purchase price compared to BAU		+23%	+30%	+34%	+44%	+32%	+32%	+36%	+35%	+33%
	Total cost compared to BAU		-10%	+4%	+17%	-32%	-7%	-2%	-0%	-26%	-21%
	SPP	years	9.22	32.11	70.52	1.99	14.57	22.63	24.39	1.96	3.16
D2	Product price	€	10255.66	117.77	194.15	613.30	63725.73	168.30	236.31	2703.30	2802.23
	Installation cost	€	872.46	128.81	153.16	200.52	6225.20	174.61	181.07	412.30	463.83
	Electricity cost	€	14898.80	31.40	24.76	2290.22	55388.24	64.71	89.75	12422.50	11498.87
	Total	€	26026.91	277.98	372.07	3104.03	125539.17	407.62	507.12	15538.10	14764.93
	Purchase price compared to BAU		+50%	+70%	+87%	+108%	+67%	+75%	+93%	+86%	+65%
	Total cost compared to BAU		-14%	+22%	+52%	-49%	-7%	+11%	+17%	-41%	-32%
	SPP	years	11.49	48.50	116.64	3.07	19.05	34.05	39.99	2.90	3.92
D3	Product price	€	13174.30	187.36	293.73	880.09	80294.42	264.75	372.16	3726.47	3434.42
	Installation cost	€	1067.49	152.89	178.68	227.98	7773.60	211.94	208.92	444.83	532.44
	Electricity cost	€	11484.49	20.98	14.86	1635.87	43958.92	43.14	53.85	9153.42	9199.10
	Total	€	25726.28	361.19	487.27	2743.89	132026.94	519.84	634.92	13324.72	13165.95
	Purchase price compared to BAU		+92%	+135%	+155%	+183%	+111%	+143%	+169%	+149%	+101%
	Total cost compared to BAU		-15%	+58%	+99%	-55%	-2%	+41%	+47%	-50%	-39%
	SPP	years	14.85	77.72	160.89	4.38	23.92	54.22	56.44	3.98	4.73
D4	Product price	€	13454.30	132.82	174.21	508.02	76470.88	177.39	205.95	2678.48	3172.83
	Installation cost	€	1386.45	157.30	196.91	275.56	7145.55	214.60	226.81	669.10	783.05
	Electricity cost	€	11484.49	41.86	29.72	2862.77	46156.87	86.28	107.70	12422.50	9856.17
	Total	€	26325.24	331.98	400.84	3646.34	129773.30	478.28	540.45	15770.08	13812.06
	Purchase price compared to BAU		+100%	+100%	+100%	+100%	+100%	+100%	+100%	+100%	+100%
	Total cost compared to BAU						-3%	+30%	+25%	-41%	-36%
	SPP						22.64	56.79	50.23	3.37	5.02

Very low Simple Payback Period (SPP)

Very high Simple Payback Period (SPP)

6.4 Analysis of BAT and LLCC

Table 6-22: LLCC and BAT per base case

		Unit	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
BAU	Total Energy (GER)	MJ	1844983	7289	5803	447921	7509255	14563	18316	1943151	1547287
D1	Total Energy (GER)	MJ	1502325	4900	4464	282332	5815923	9530	12574	1367955	1148097
D2	Total Energy (GER)	MJ	1250532	3760	3990	184289	4800293	7015	9753	988460	918571
D3	Total Energy (GER)	MJ	1011499	3351	4168	135517	4036890	5964	8255	742897	744630
D4	Total Energy (GER)	MJ	1011881	4706	4566	228186	4255457	8896	11408	989490	796183
BAU	LCC	€	30389.36	228.78	244.99	6117.33	134121.95	368.57	431.77	26518.79	21690.29
D1	LCC	€	27489.02	238.31	285.57	4141.29	124497.69	362.04	429.79	19648.56	17158.17
D2	LCC	€	26026.91	277.98	372.07	3104.03	125339.17	407.62	507.12	15538.10	14764.93
D3	LCC	€	25726.28	361.19	487.27	2743.89	132026.94	519.84	634.92	13324.72	13165.95
D4	LCC	€	26325.24	331.98	400.84	3646.34	129773.30	478.28	540.45	15770.08	13812.06
BAT			D3	D3	D2	D3	D3	D3	D3	D8	D3
LLCC			D3	BAU	BAU	D3	D1	D1	D1	D8	D3

6.5 Long term potential (BNAT) & systems analysis

- 380 VDC systems replacing 230 VAC

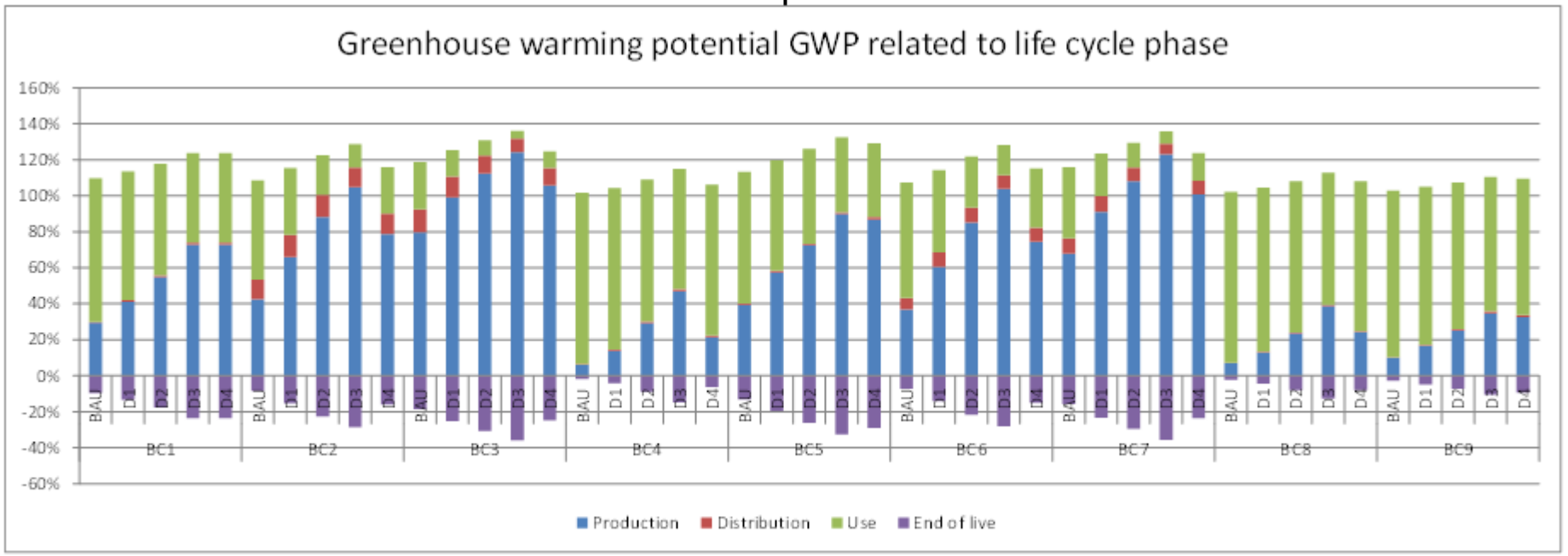
6.6 Sensitivity analysis

- **6.6.1 Sensitivity to circuit loading**
  - the load factor;
  - load form factor;
  - Kd factor;
  - number of nodes per circuit.
- **6.6.2 Sensitivity to length of the circuits**
- **6.6.3 Sensitivity to product lifetime**

6.6.1 Sensitivity to circuit loading

Table 6-32: design option sensitivity to circuit use (load)

	BAT - load sensitivity			LLCC - load sensitivity		
	low	ref	high	low	ref	high
BC1	D3	D3	D3	BAU	D3	D3
BC2	D1	D3	D3	BAU	BAU	D1
BC3	BAU	D2	D3	BAU	BAU	BAU
BC4	D3	D3	D3	D1	D3	D3
BC5	D3	D3	D3	BAU	D1	D4
BC6	D2	D3	D3	BAU	D1	D1
BC7	BAU	D3	D3	BAU	D1	D1
BC8	D3	D3	D3	D1	D3	D3
BC9	D3	D3	D3	D1	D3	D3



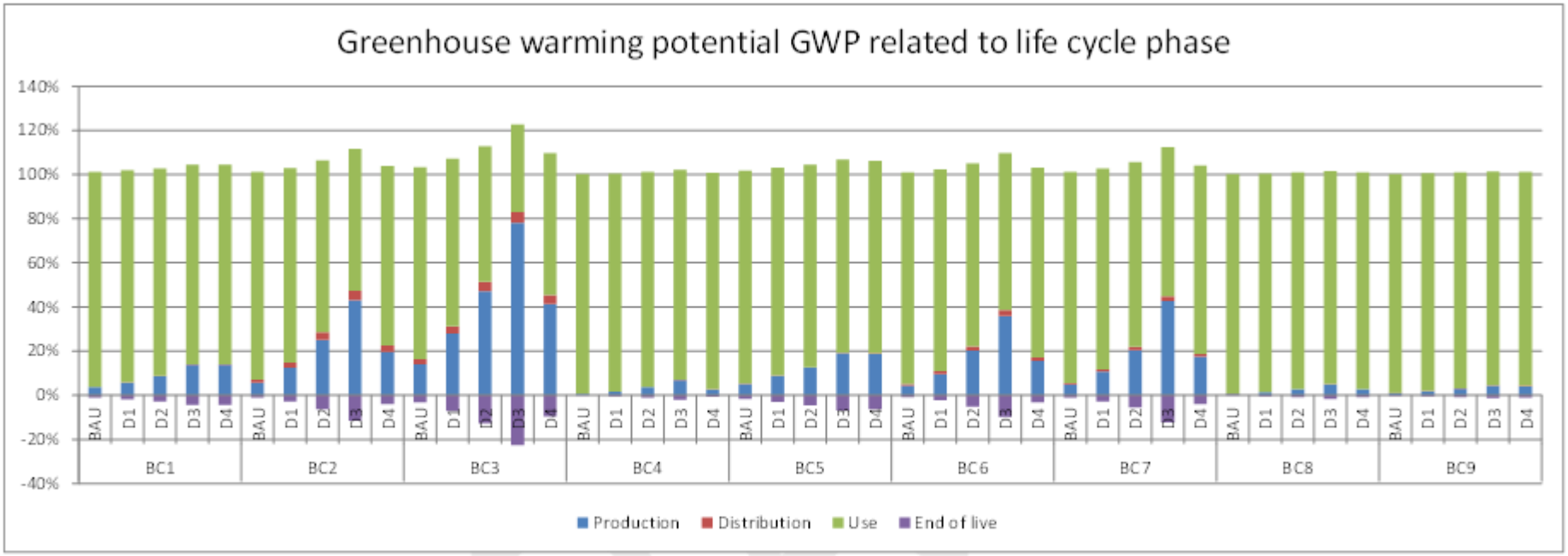


Figure 6-23 Greenhouse Gases (in detail, relative of each phase to total) in GWP100 for the 'high values'

6.6.2 Sensitivity to length of the circuits

Table 6-42: design option sensitivity to circuit length

	BAT - length sensitivity			LLCC - length sensitivity		
	low	ref	high	low	ref	high
BC1	D3	D3	D3	D3	D3	D3
BC2	D3	D3	D3	BAU	BAU	BAU
BC3	D2	D2	D2	BAU	BAU	BAU
BC4	D3	D3	D3	D3	D3	D3
BC5	D3	D3	D3	D1	D1	D1
BC6	D3	D3	D3	BAU	D1	D1
BC7	D3	D3	D3	BAU	D1	D1
BC8	D3	D3	D3	D3	D3	D3
BC9	D3	D3	D3	D3	D3	D3

6.6.3 Sensitivity to product lifetime

Table 6-43: Life time parameters per sector

	short product life		Reference		long product life	
Sector	Replace-ment rate	Product life	Replace-ment rate	Product life	Replace-ment rate	Product life
Unit	%	year	%	year	%	year
Residential sector	2.10%	40	1.18%	64	0.80%	84
Services sector	7.08%	13	3.20%	25	1.70%	40
Industry sector	7.08%	12	2.80%	25	1.37%	40

6.6.3 Sensitivity to product lifetime

Table 6-53: Design option sensitivity to product lifetime

	BAT - lifetime sensitivity			LLCC - lifetime sensitivity		
	low	ref	high	low	ref	high
BC1	D3	D3	D3	D1	D3	D3
BC2	D3	D3	D3	BAU	BAU	D1
BC3	D1	D2	D3	BAU	BAU	BAU
BC4	D3	D3	D3	D3	D3	D3
BC5	D3	D3	D3	BAU	D1	D4
BC6	D3	D3	D3	BAU	D1	D1
BC7	D3	D3	D3	BAU	D1	D1
BC8	D3	D3	D3	D3	D3	D3
BC9	D3	D3	D3	D3	D3	D3

vito
vision on technology

14/11/2014

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

Stakeholder meeting: Task 7 - scenarios

Paul Van Tichelen - Dominic Ectors

Brussels, DG Enterprise

13 November 2014

Task 7 structure

- **Stakeholders position – to be provided**
- Policy options
- Scenarios
- Socio-economic Impact
- Sensitivity analysis

Policy options- at product level?

- generic ecodesign requirements on information? (increase awareness
  - E.g. maximum DC ohmic resistance per kilometer at 20°C
  - E.g. on websites and/or packages:
    - Cable losses per kilometer @ 50, 100 % load
    - Tracking data of real measured ohmic resistance? (quality control data)
- Scope:
  - IEC 60502-1: Power cables with extruded insulation and their accessories for rated voltages from 1kV up to 30 kV. Remark: restricted to cables with a rated voltage U0/U (Um) of 0.6/1 (1.2kV)
  - EN 50525-1 Electric cables: LV energy cables of rated voltages up to and including 450/750 (U0/u) Remark: restricted to EN50525 cables for fixed wiring

Policy option at product level and/or circuit level

- Are electrical circuits in building products?
  - No? > elements or components of a building and so far were not considered as ‘products’ in European legislation
  - not satisfy the minimum volume of sales requirement of article 15 (5) of the ErP regulation (2009/125/EC
  - cannot be moved or relocated and the ‘free movement of goods’ is therefore irrelevant
  - Currently don’t belong to the product categories of the CE product marking directive (93/68/EEC).
- Therefore other policy proposals are included

Policy options at circuit/installation level - scope

- Scope
  - "installed Low Voltage power cables in buildings after the meter"
    - Suggest to focus, e.g.:
      - circuits between the transformer(s) and the main distribution board of the building, after the meter;
      - Electric circuits between the main distribution board and the secondary distribution boards;
      - Dedicated electric circuits from the main and secondary distribution boards to electrical consumers with a high load factor (large number of operating hours per year) (e.g. HVAC components and servers).

Policy options – Specific requirements to increase CSA

- Require LCC (economic optimisation)
  - IEC 60287-3-2 Electric cables – Calculation of the current – part 3-2: sections on operating conditions – Economic optimization of power cable size?
  - Web tool or software tool?
  - Introduction of an extra correction factor based on the load factor of the electric consumer. HD 60364-5-52:2011 (IEC 60364-5-52:2009) defines two correction factors to determine the maximum allowable current-carrying capacity of an electric circuit (apart from method of installation & ambient temperature)?
  - Inclusion in the EPB Directive (2010/31/EU)?
    - updated prIEC 60364-8-1 (EE in electrical installations), updatedEN15603, and a new standard EN15XXX?

Policy options – Generic requirements to increase CSA

- Before installation:
  - Information: ref., the design current (Ib), rated current of the circuit (In), L, estimated load factor, Kf or equivalent hours of peak load?
  - Note: updated prIEC 60364-8-1? Align with IEC 60287-3-2 on economic optimization method?
- After installation:
  - Measure & indicate resistance
  - Add label with parameters
  - Note: updated prIEC 60364-8-1?
- In BACS (Building Automation and Control Systems)
  - the load factor (LF) and load form factor (Kf) and/or equivalent or equivalent time of peak load
  - include monitoring functions in standard EN 15232 (2007)?

7.2 .1 Scenario definition

Scenario	BC1	BC2	BC3	BC4	BC5	BC6	BC7	BC8
BAU	BAU	BAU	BAU	BAU	BAU	BAU	BAU	BAU
BAT	D3	D3	D2	D3	D3	D3	D3	D3
LLCC	D3	BAU	BAU	D3	D1	D1	D1	D3
IV	D1	BAU	BAU	D1	D1	BAU	BAU	D1

- Circuits are not products !!!
- Scenarios **not** based upon ecodesign measures !!!!!
- Gives an indication if **all** circuits in services and industry are considered
- 'Improved' circuits replace BAU circuits at replacement rate (product life)
- Correction factors in T5 are used! Meaning low load, long circuits.

7.2.2.1 Main input parameters for the analysis

Discount rate	4.0%
Inflation rate	2.0%
Energy Escalation rate	4.0%
Electricity rate (€/kWh)	0.11
Stock growth rate services sector	1.9%
Stock growth rate industry sector	2.9%
Sales growth rate services sector	3.2%
Sales growth rate industry sector	2.8%
Product lifetime services sector (years)	25
Product lifetime industry sector (years)	25

Table 7-5: Main input parameters

7.2.2.2 Stock

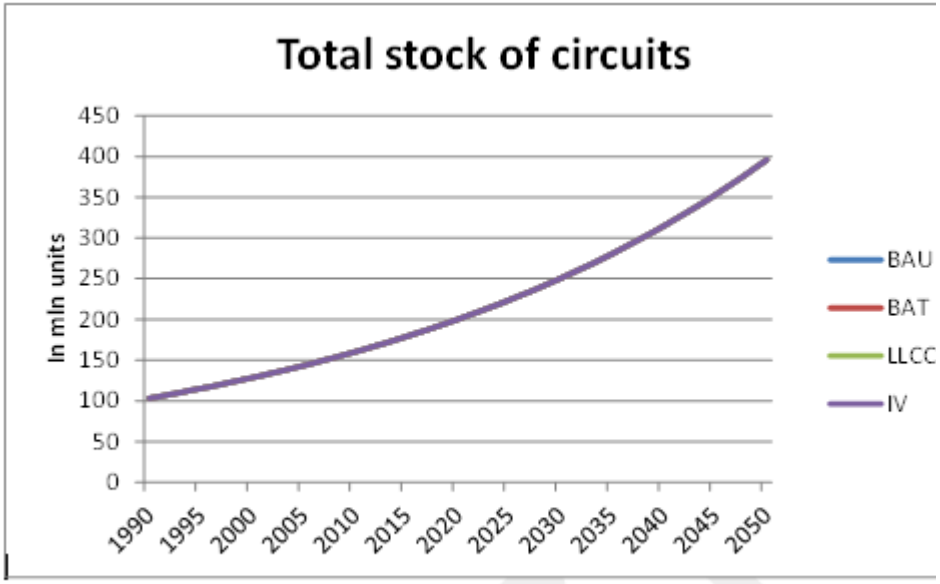


Figure 7-1: Total stock of circuits (in circuit units)

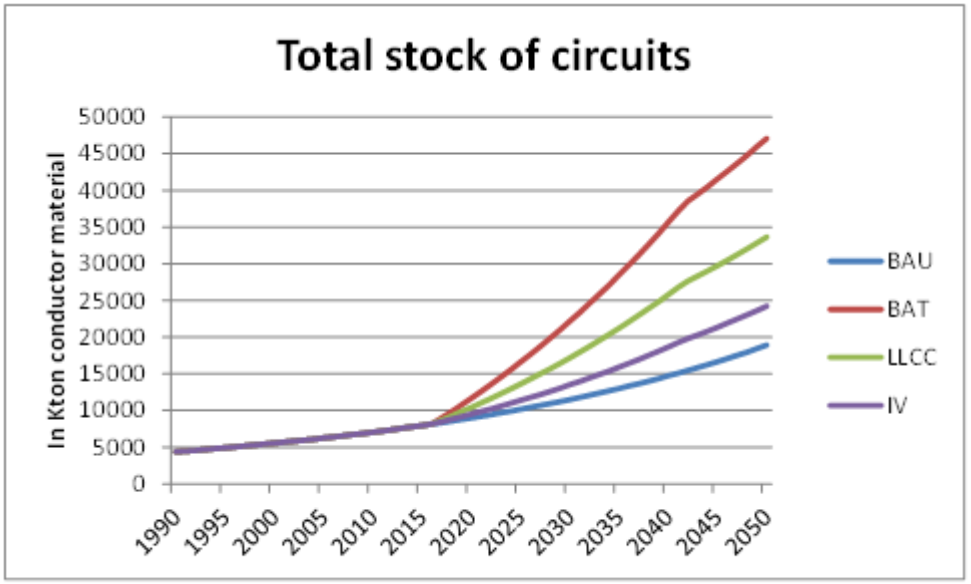


Figure 7-2: Total stock of circuits (in Kton conductor material)

Eurostat EU electricity consumption

Table 2-12 EU28 annual final consumption of electricity by industry and households/services in TWh[16]

	Final annual energy consumption in TWh											
Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Industry	1075	1081	1089	1120	1133	1131	1142	1119	966	1030	1037	1008
Households	744	753	787	798	806	818	810	820	820	845	803	828
Services	703	716	741	763	780	822	837	864	867	904	885	898

-0,74% annual growth rate in the industry

+2,0 up to +2,5% annual growth rate in services

- In this model is:

  electricity consumption growth = stock growth

=> Stock growth for industry: 0% ??

7.2.2.3 Annual sales of circuits

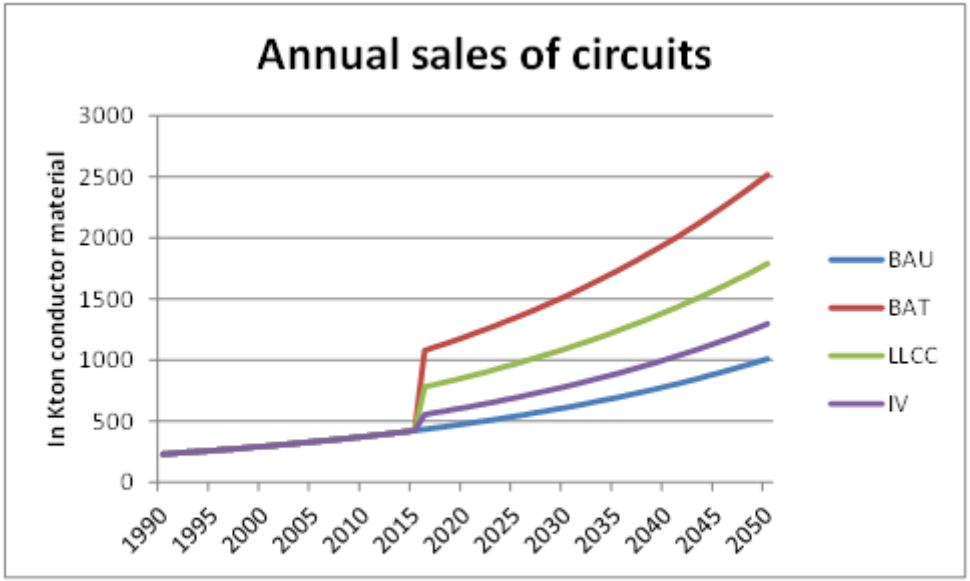
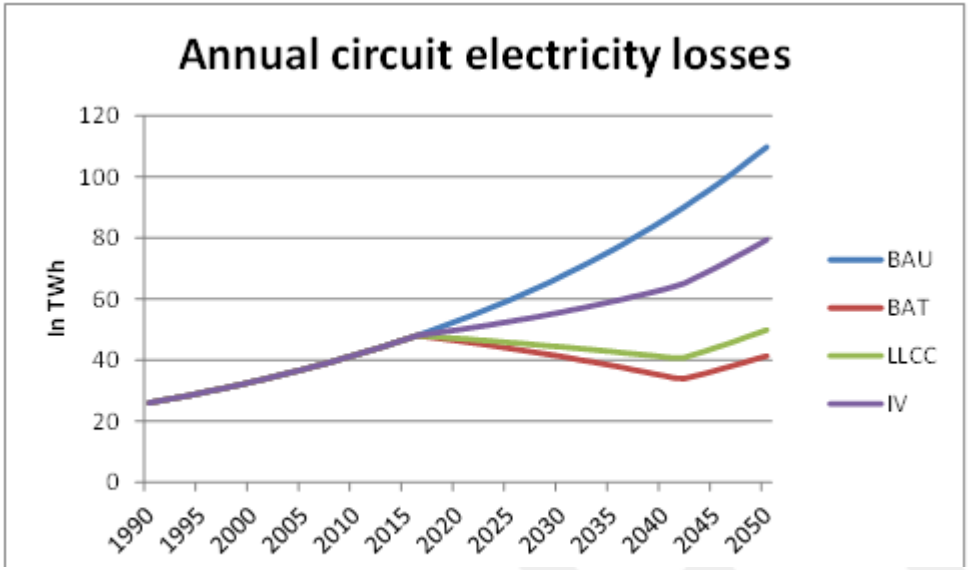


Figure 7-8: Annual sales of circuits (in Kton conductor material)

7.2.2.4 Annual demand of electricity due to losses in circuits



	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	26.02	29.24	32.88	36.99	41.65	46.91	52.88	59.64	67.30	75.99	85.85	97.05	109.77
BAT	26.02	29.24	32.88	36.99	41.65	46.91	46.30	43.89	41.20	38.20	34.86	36.55	41.38
LLCC	26.02	29.24	32.88	36.99	41.65	46.91	47.08	45.77	44.33	42.77	41.06	44.01	49.92
IV	26.02	29.24	32.88	36.99	41.65	46.91	49.95	52.62	55.68	59.17	63.17	70.17	79.42
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	-6.58	-15.75	-26.10	-37.79	-50.99	-60.50	-68.39
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	-5.80	-13.87	-22.97	-33.22	-44.79	-53.04	-59.86
IV	0.00	0.00	0.00	0.00	0.00	0.00	-2.93	-7.02	-11.62	-16.82	-22.68	-26.88	-30.36
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-12.4%	-26.4%	-38.8%	-49.7%	-59.4%	-62.3%	-62.3%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-11.0%	-23.3%	-34.1%	-43.7%	-52.2%	-54.6%	-54.5%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-5.5%	-11.8%	-17.3%	-22.1%	-26.4%	-27.7%	-27.7%

Table 7-16: Annual circuit electricity losses (in TWh/yr)

7.2.2.5 Annual emissions of CO_2 eq.

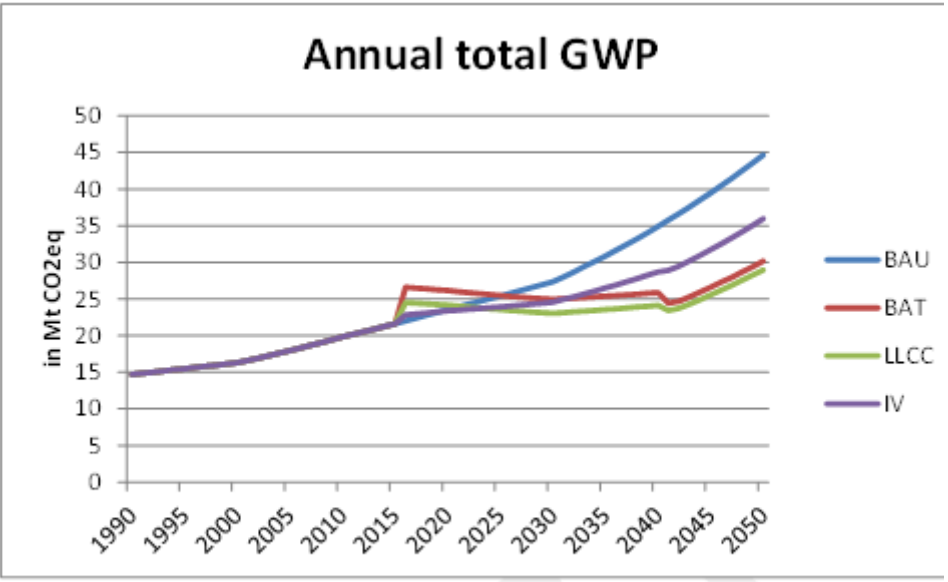


Figure 7-15: Annual total GWP (in Mt CO_2 eq.)

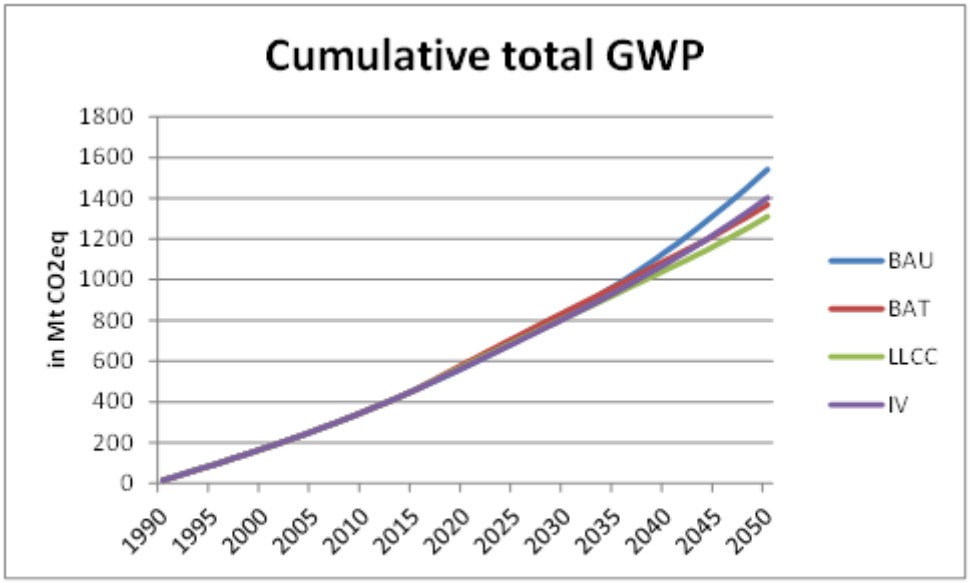
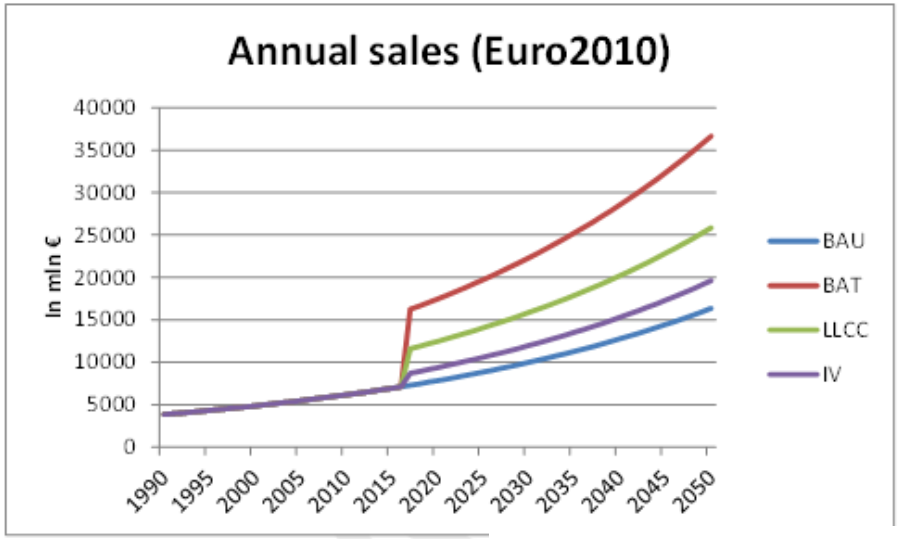


Figure 7-16: Cumulative GWP (in Mt CO_2 eq.)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	14.71	90.66	170.57	256.99	352.30	456.74	570.69	694.07	826.89	974.06	1140.33	1328.32	1540.96
BAT	14.71	90.66	170.57	256.99	352.30	456.74	588.64	717.36	843.14	969.17	1097.53	1224.59	1368.11
LLCC	14.71	90.66	170.57	256.99	352.30	456.74	578.51	697.48	813.72	930.48	1049.99	1171.98	1309.81
IV	14.71	90.66	170.57	256.99	352.30	456.74	572.31	690.86	812.42	940.99	1080.03	1231.31	1402.38
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	17.96	23.29	16.25	-4.89	-42.80	-103.73	-172.85
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	7.82	3.41	-13.17	-43.57	-90.34	-156.34	-231.15
IV	0.00	0.00	0.00	0.00	0.00	0.00	1.62	-3.20	-14.47	-33.06	-60.30	-97.01	-138.59
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+3.1%	+3.4%	+2.0%	-0.5%	-3.8%	-7.8%	-11.2%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+1.4%	+0.5%	-1.6%	-4.5%	-7.9%	-11.8%	-15.0%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.3%	-0.5%	-1.8%	-3.4%	-5.3%	-7.3%	-9.0%

Table 7-21: Cumulative GWP (in Mt CO_2 eq.)

7.3 Socio-economic impact analysis
7.3.1 Annual expenditure



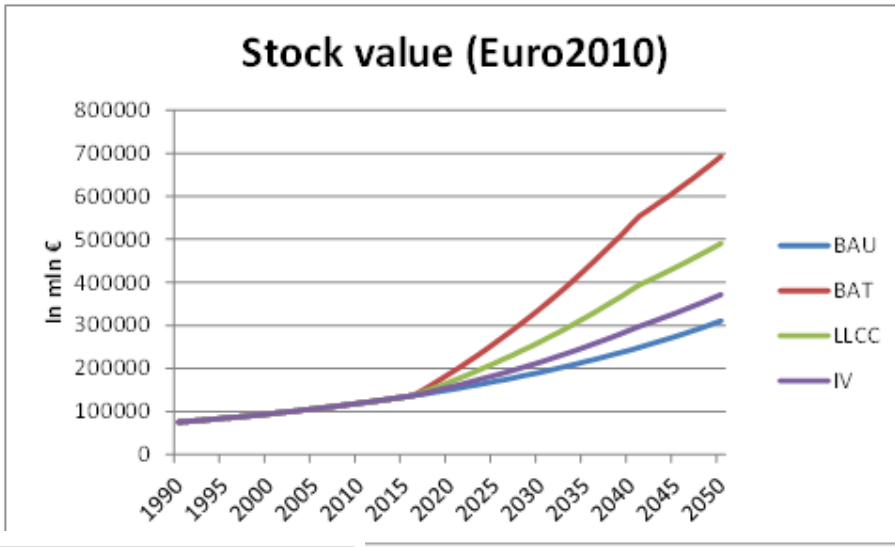


Figure 7-17: Annual sal

Stock value (in mln. euro)

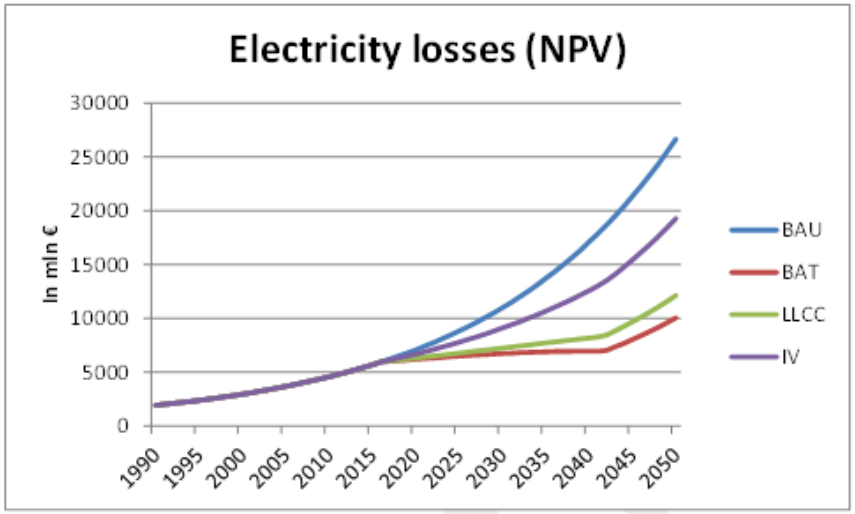


Figure 7-19: Annual expenditure due to electricity losses (in mln. euro)

7.3.2 Impact on workforce

- can lead to significant job creation within EU28 in the sector of local electrical contracting, local engineering.
- Stakeholders: please provide input and figures if possible

7.3.3 Any other relevant impact ?

- Impact on the market structure, size of the companies, role and responsibility …

7.4 Sensitivity analysis
7.4.1 sensitivity case 1

Discount rate	4.0%
Inflation rate	2.0%
Energy Escalation rate	4.0%
Electricity rate (€/kWh)	0.11
Stock growth rate services sector	1.0%
Stock growth rate industry sector	1.0%
Sales growth rate services sector	1.7%
Sales growth rate industry sector	1.4%
Product lifetime services sector (years)	40
Product lifetime industry sector (years)	40

Table 7-25: Sensitivity case 1 - Main input parameters

7.4.1.1 Stock

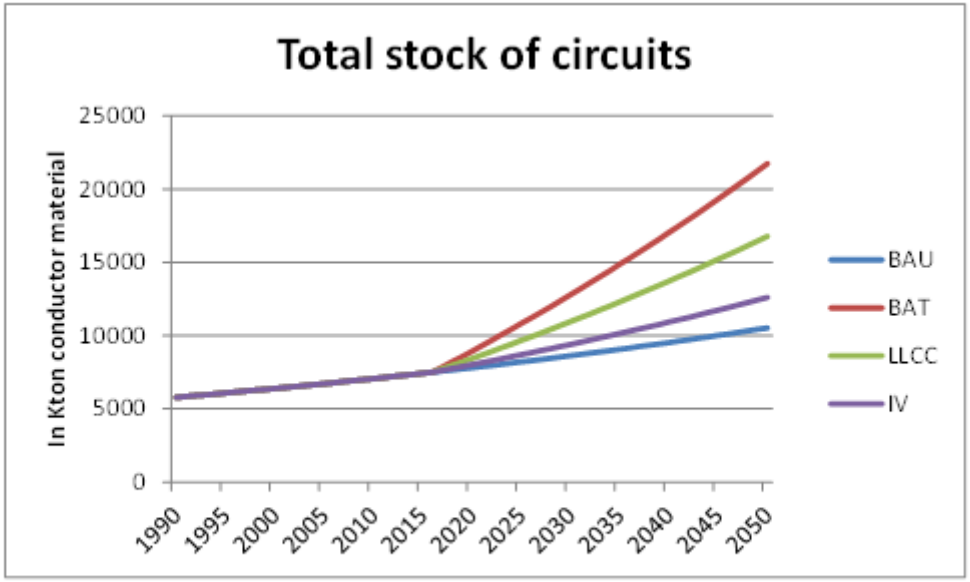
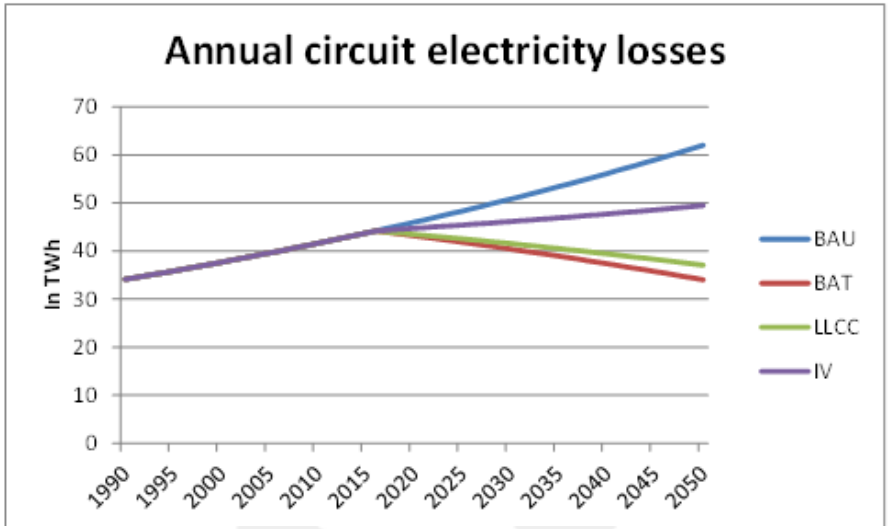


Figure 7-21: Sensitivity case 1 - Total stock of circuits (in Kton conductor material)

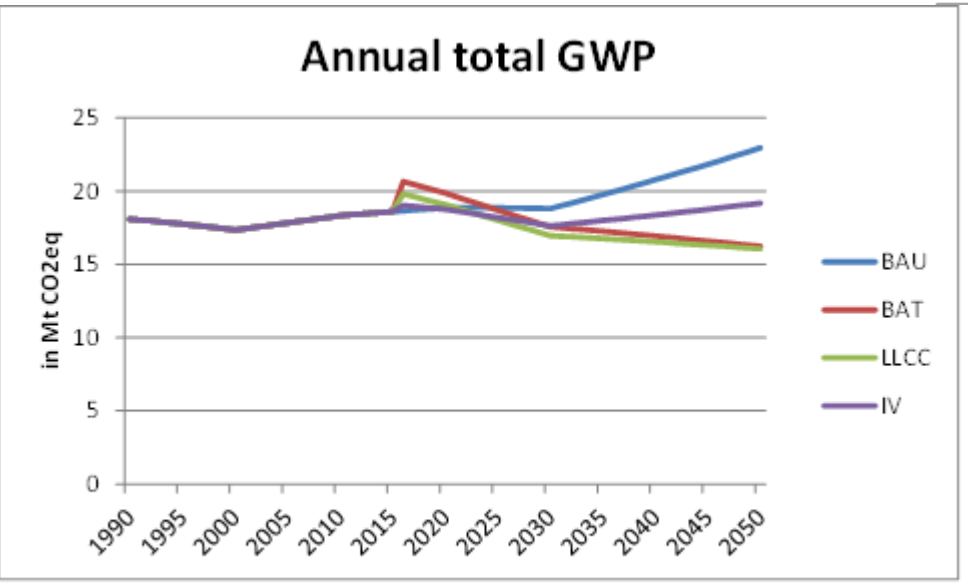
7.4.1.3 Annual demand of electricity due to losses in circuits



	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	34.13	35.87	37.70	39.63	41.65	43.77	46.01	48.35	50.82	53.41	56.14	59.00	62.01
BAT	34.13	35.87	37.70	39.63	41.65	43.77	43.18	41.84	40.42	38.94	37.38	35.74	34.02
LLCC	34.13	35.87	37.70	39.63	41.65	43.77	43.49	42.55	41.56	40.52	39.43	38.28	37.07
IV	34.13	35.87	37.70	39.63	41.65	43.77	44.74	45.43	46.16	46.92	47.72	48.57	49.45
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	-2.82	-6.51	-10.39	-14.47	-18.76	-23.26	-27.99
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	-2.52	-5.80	-9.26	-12.89	-16.71	-20.72	-24.94
IV	0.00	0.00	0.00	0.00	0.00	0.00	-1.27	-2.92	-4.66	-6.49	-8.41	-10.43	-12.56
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-6.1%	-13.5%	-20.5%	-27.1%	-33.4%	-39.4%	-45.1%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-5.5%	-12.0%	-18.2%	-24.1%	-29.8%	-35.1%	-40.2%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-2.8%	-6.0%	-9.2%	-12.2%	-15.0%	-17.7%	-20.2%

Table 7-36: Sensitivity case 1 - Annual circuit electricity losses (in TWh/yr)

GWP



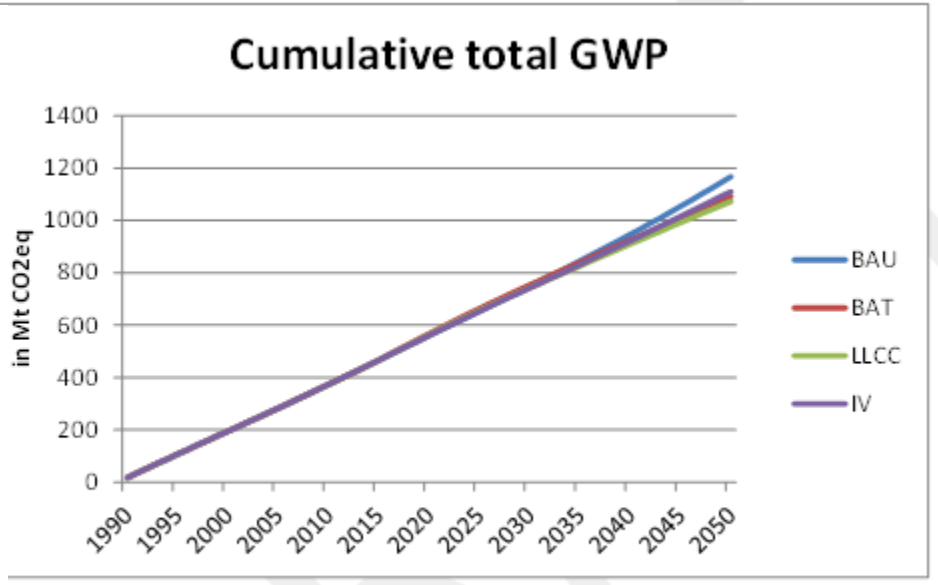


Figure 7-34: Sensitivity case 1 - Annu

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	18.09	107.57	195.15	283.32	373.96	466.42	560.22	654.53	748.67	845.54	947.34	1054.35	1166.81
BAT	18.09	107.57	195.15	283.32	373.96	466.42	567.72	663.53	753.61	840.51	925.82	1009.45	1091.31
LLCC	18.09	107.57	195.15	283.32	373.96	466.42	563.63	655.83	742.73	826.92	910.03	992.01	1072.80
IV	18.09	107.57	195.15	283.32	373.96	466.42	560.84	652.95	742.24	831.46	922.52	1015.53	1110.57
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	7.50	9.01	4.94	-5.02	-21.53	-44.90	-75.50
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	3.41	1.31	-5.93	-18.61	-37.31	-62.34	-94.01
IV	0.00	0.00	0.00	0.00	0.00	0.00	0.63	-1.58	-6.43	-14.08	-24.82	-38.82	-56.24
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+1.3%	+1.4%	+0.7%	-0.6%	-2.3%	-4.3%	-6.5%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.6%	+0.2%	-0.8%	-2.2%	-3.9%	-5.9%	-8.1%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.1%	-0.2%	-0.9%	-1.7%	-2.6%	-3.7%	-4.8%

Table 7-41: Sensitivity case 1 - Cumulative GWP (in Mt CO_2 eq.)

7.4.2 sensitivity case 2

Discount rate	2.5%
Inflation rate	1.0%
Energy Escalation rate	4.0%
Electricity rate (€/kWh)	0.11
Stock growth rate services sector	1.9%
Stock growth rate industry sector	2.9%
Sales growth rate services sector	3.2%
Sales growth rate industry sector	2.8%
Product lifetime services sector (years)	25
Product lifetime industry sector (years)	25

Table 7-45: Sensitivity case 2 - Main input parameters

7.4.2.1 *Annual expenditure due to electricity losses*

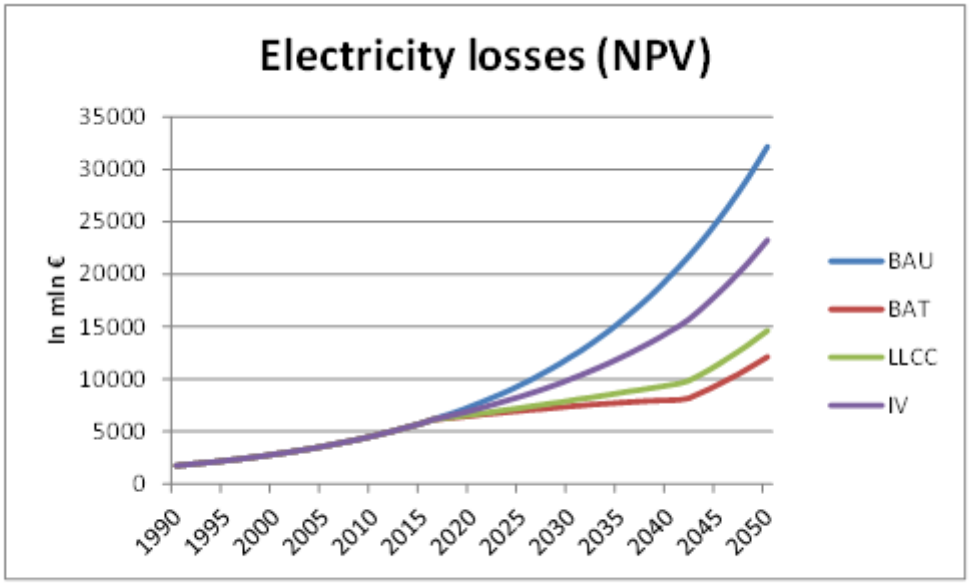


Figure 7-41: Sensitivity case 2 - Annual expenditure due to electricity losses (in mln. euro)

7.4.3 sensitivity case 3

Discount rate	4.0%
Inflation rate	2.0%
Energy Escalation rate	1.0%
Electricity rate (€/kWh)	0.11
Stock growth rate services sector	1.9%
Stock growth rate industry sector	2.9%
Sales growth rate services sector	3.2%
Sales growth rate industry sector	2.8%
Product lifetime services sector (years)	25
Product lifetime industry sector (years)	25

Table 7-49: Sensitivity case 3 - Main input parameters

7.4.3 Annual expenditure due to electricity losses

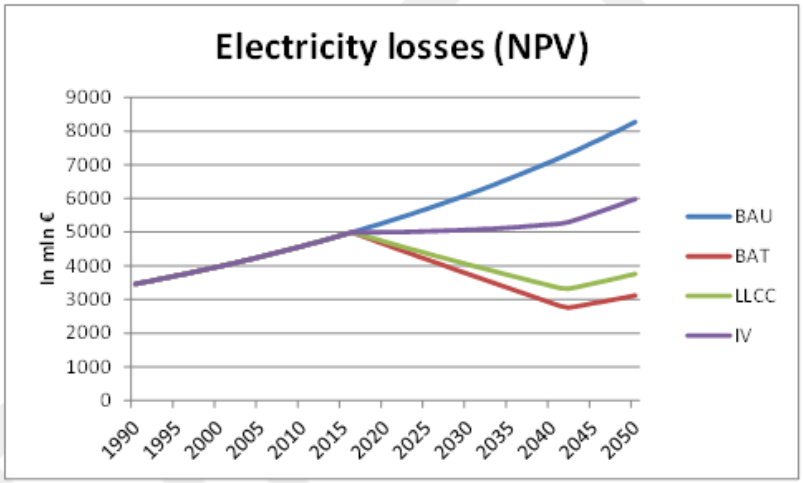


Figure 7-42: Sensitivity case 3 - Annual expenditure due to electricity losses (in mln.

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
BAU	3458.97	3707.40	3976.03	4266.66	4581.27	4922.00	5291.23	5691.54	6125.75	6596.98	7108.62	7664.40	8268.39
BAT	3458.97	3707.40	3976.03	4266.66	4581.27	4922.00	4632.92	4188.65	3750.34	3316.64	2886.19	2886.53	3117.06
LLCC	3458.97	3707.40	3976.03	4266.66	4581.27	4922.00	4710.84	4367.70	4035.23	3712.78	3399.70	3475.88	3759.89
IV	3458.97	3707.40	3976.03	4266.66	4581.27	4922.00	4997.75	5021.88	5067.88	5136.91	5230.31	5541.47	5981.73
Absolute difference to BAU													
BAT	0.00	0.00	0.00	0.00	0.00	0.00	-658.32	-1502.89	-2375.42	-3280.35	-4222.43	-4777.86	-5151.33
LLCC	0.00	0.00	0.00	0.00	0.00	0.00	-580.40	-1323.84	-2090.52	-2884.20	-3708.92	-4188.51	-4508.50
IV	0.00	0.00	0.00	0.00	0.00	0.00	-293.49	-669.66	-1057.87	-1460.07	-1878.31	-2122.93	-2286.66
Relative difference to BAU													
BAT	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-12.4%	-26.4%	-38.8%	-49.7%	-59.4%	-62.3%	-62.3%
LLCC	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-11.0%	-23.3%	-34.1%	-43.7%	-52.2%	-54.6%	-54.5%
IV	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	+0.0%	-5.5%	-11.8%	-17.3%	-22.1%	-26.4%	-27.7%	-27.7%

Table 7-50: Sensitivity case 3 - Annual expenditure due to electricity losses (in mln. euro)