16/12/2013

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

1st stakeholders

Paul Van Tichelen

Brussels, DG Enterprise

5th of December 2013

Agenda

- 10:00-10:10 Welcome
- 10:10-10:20 Short presentation of participants
- 10:20:-10:40 Introduction to MEErP and the ErP directive
- 10:40-12:00 Presentation of draft Task reports 1-3
- 12:00-12:15 Presentation of first screening
- 12:15-12:30 Enquiry results
- 12:30-13:30 Break&lunch
- 13:30-14:00 Discussion on scope
- 14:30-15:00 Answers to questions received in writing before the meeting
- 15:00-15:30 Other Q&A
- 15:30-16:00 Further needs for data provision and/or enquiries
- 16:00 Closure

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, ..)
    - Karolien Peeters (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

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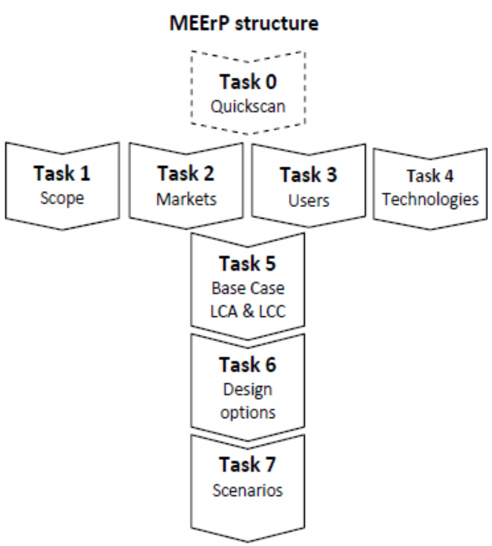
MEErP in a nutshell

- 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



Task 1 Scope

- **Identify relevant** Prodcom/ EN&ISO/ Labelling **categories > Stakeholder input!**
  - Define preliminary product scope, definition, primary ("functional unit“)
  - Define secondary performance parameters:
- Test **standards**, also **under development**
- Legislation
- First screening

Task 2 Market Data

- Generic economic data (.. Eurostat?)
- Market and Stock data
- Market trends
- Consumer expenditure base data
- Recommendations (.. Scope, barriers&opportunities)

Task 3 Users

- **System aspects:**
  - **use phase energy consumption .. Cable losses**
- **End of Life behaviour**
- **Local infrastructure (barriers & opportunities)**
- Recommendations

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Task 4 Technologies

- Technical product description
  - Existing products.. **Working towards 'Base Cases'** (=conscious abstraction of reality' ..has to fit with previous tasks & workable model)
  - Improvement options: **BAT&BNAT**
- **Production, distribution and end&of&life** > BOM > Ecoreport format&tool
- Recommendations

Task 5-7

- **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
- **Task 6: Design options**
  - .. Identify LLCC & BAT > target levels & benchmark values
  - .. Long term potential& system analysis
- Task 7: Scenarios
  - Policy analysis

Task 7 Scenarios

- Task 7: Scenarios
  - Policy analysis
  - Scenario analysis unit stock/sale & environmental
  - Impact analysis (socio) economic
  - Sensitivity Analysis
  - Summary

Note: MEErP 2011 is not an automatic law making procedure; the preparatory study is an analytical document at the responsibility of the contractor. Political and legislative choices, at the responsibility of the Commission, are indispensable in the follow up.

Planning (preliminary)

- 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**
- End May 2014 ■ 2nd stakeholder meeting on Draft Task 1-5
- Early Nov 2014 ■ 3rd stakeholder meeting on Draft Task 1-7
- End Feb 2015 ■ Publication Final Report Task 1-7

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Stakeholder meeting: Task 1

Paul Van Tichelen

Brussels, DG Enterprise

5th of December2013

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);
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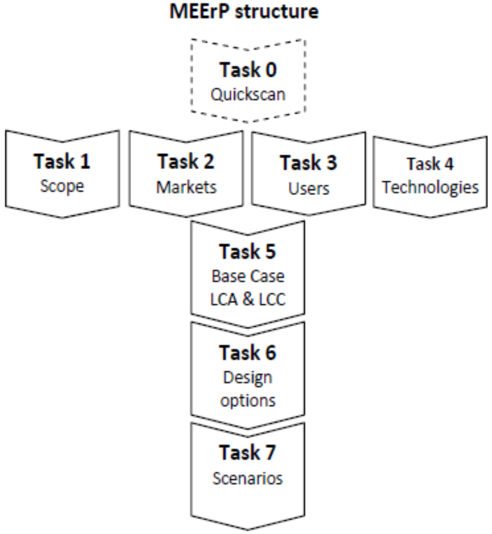

Task 1: Content

- “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

- Focus: “Installed power cables & wires **in** buildings”
  - Buildings:
    - Residential
    - Non-residential: Services & Industry
  - Power cables behind the electrical meter
  - Fixed wired; LV ($\leq$ 1000Vac)
- Excluded:
  - HV, MV & LV distribution (utility) cables, overhead, burried…
  - Data cables, special purpose cables,…
  - Electrical distribution board, installation materials, socket outlets …

- **SCOPE proposal: Losses in installed power cables & wires in buildings**

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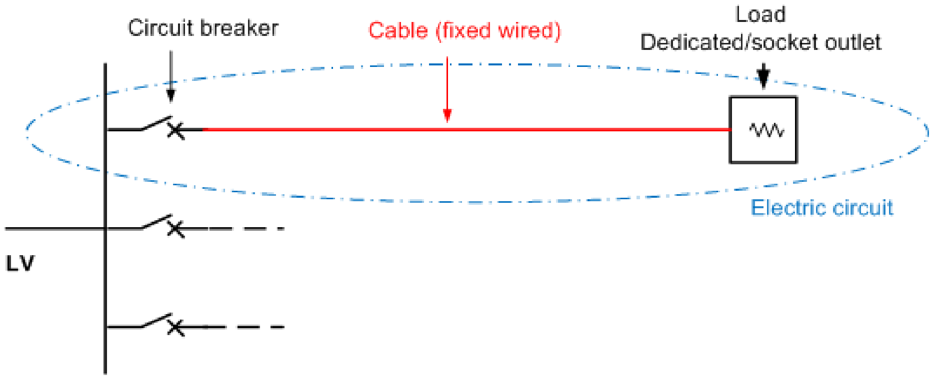
Task 1: Product scope

» **Electric circuit**



Task 1: Product categories

- Prodcom – NACE 27321380:
  - “Other electric conductors, for a voltage ≤ 1000V, not fitted with connectors”
    - Too broad: cords, flexible wires,… also included
- EN-, IEC-standards:
  - IEC 60228: “conductors of insulated cables”
    - Class-1(solid), -2(stranded),-5(flexible),-6(very flexible)
  - IEC 60227-1: PVC cables – 5 categories
  - IEC 60245-1: Rubber insulated cables – 5 categories
  - ….
- Other possibilities: categories according to
  - Field of application, composition of the cable….

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Most used LV cables in buildings

To be completed + country designation code

Designation	NYM-J cable (VDE) 60227IEC10 	H07 RN-F 	H07 V-U H07 V-R 	H05 V-K H07 V-K 	FR-N05 VV-U FR-N05 VV-R 
Use	For installation on or under the plaster In bricks and concrete	Protected mobile or fixed installation	Internal wiring or wiring fixed installation in trunking or conduit	Internal wiring or wiring fixed installation in trunking or conduit	Fixed installation on walls, empty construction compartments
Number of conductors	1 to 5	1 to 4	1	1	2 to 5
Conductor cross- section	2.5 to 25mm²	1.5 to 300mm²	Up to 400mm²	Up to 240mm²	1.5 to 6 mm²
Core	Strands of bare copper wires	Flexible copper	Rigid copper Solid (V-U) Stranded (V-R)	Flexible Copper	Rigid copper Solid (V-U) Stranded (V-R)
Insulation	PVC	Cross-linked elastomer	PVC	PVC	PVC
Sheath	PVC	Cross-linked elastomer	-	-	PVC
Nominal voltage	300/500V	450/750V	450/750V	H05: 300/500V H07: 450/750V	300/500V

Variants:

- **Low smoke, halogen free cables: e.g. H07** Z1**-K, H07 ZZ-F,….**
- **Armoured cables: e.g. FG7(O)RAR 0.6/1 kV, U 1000 RVFV, …**
- **Fire resistant cables: FTG100M1, SZ1-K,….**

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Task 1: Product performance parameter

- Primary product performance paramater or “Functional unit”:
  - **“Current-Carrying capacity” of the cable/conductor [Amperes]**
  - *“the maximum value of electric current which can be carried continuously by a conductor (a cable), under specified conditions without its steady-state temperature exceeding a specified value (see IEV 826-11-13)”*

- Secondary product performance parameters
  - Construction of the cable (see Task 2)
    - CSA, DC resistance, Rated voltage, insulation material, conductor material, number of cores, construction of the conductor….
  - Use of the cable (see Task 3)
    - Electrical installation: Supply param., installation method, Tamb…
    - Circuit level: dV, I load, I max, LF, Kf, PF, Kd…..

Task 1: Measurement & test standards

- Conductors & cables
  - EN13601 & -13602: Copper and copper alloys
  - **EN 60228**: Conductors of insulated cables
    - Class1,2,5,6; **Rdc max**; **measurement of resistance**, …
  - EN 50525-1: Low voltage energy cables
  - EN 50395: Electrical test methods for low voltage energy cables
- Electrical installation
  - **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** (segment)
  - IEC 60364-6: Low Voltage electrical installations - verification

Measurement of resistance (IEC 60228)

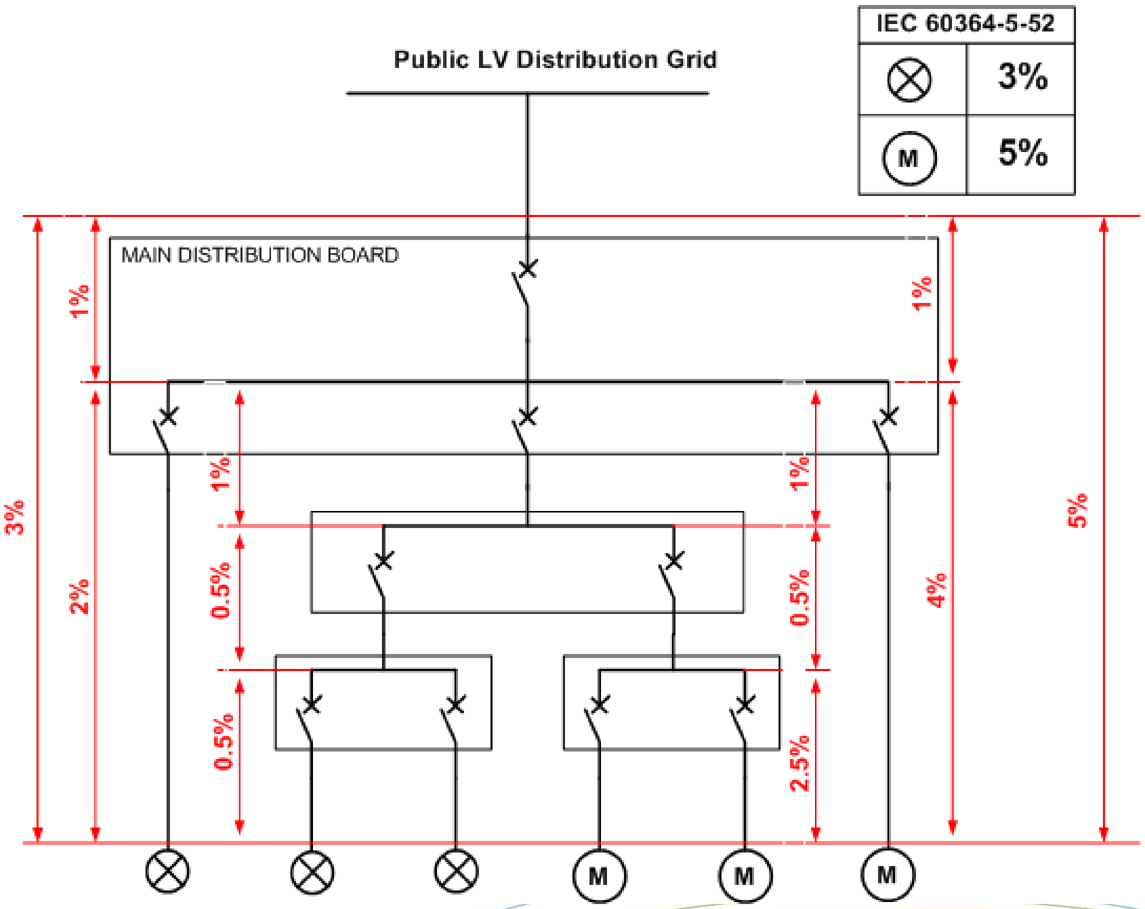
“The cable shall be kept in the test area for sufficient time to ensure that the conductor temperature has reached a level which permits an accurate determination of resistance using the correction factors provided.

Measure the d.c. resistance of the conductor(s), either on a complete length of cable or flexible cord or on a sample of cable or flexible cord of at least 1 m in length, at room temperature and record the temperature at which the measurement is made. Adjust the measured resistance by means of the correction factors given in Table A.1.

Calculate the resistance per kilometre length of cable from the length of the complete cable and not from the length of the individual core or wires”

Accuracy of the measurement equipment?

Max voltage drop (IEC 60364-5-52)



Legislation

- EU Directives applicable on LV cables
  - Low Voltage Directive (LVD, 2006/95/EC)
  - Restriction of Hazardous Substances in EEE (RoHs, 2002/95/EC)

  Conclusion: "**CE** " and/or "**HAR**" mark on the cable (see LVD guide)
  - Construction Product Regulation (EU) No 305/2011 (CPR)

    The publication of the standard for power cables and control and communication cables – cables for general applications in buildings with regard to the demands made on fire behaviour is not expected before 2014 (ZVEI)
  - **Other Directives applicable ??**
- Member state level
  - National wiring regulation rules
  - **Overview of national wiring regulations available ??**
- **Third country legislation ??**
- Voluntary initiatives: e.g. ELEKTRO+ (Ge), ACI (UK), **other ??**

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Task 1: First screening

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

Stakeholder meeting: Task1 first screening

Dominic Ectors

Brussels, DG Enterprise

5th of December2013

Objective

» The first product screening is a **preliminary analysis** that sets out the recommended scope for the subsequent Tasks. As the full study investigates the feasibility and appropriateness of Ecodesign and/or Energy Labelling measures, the first product screening entails an **initial assessment of the eligibility and appropriateness of the product group envisaged.**

Product application categories

Table 1-3: Application categories

	Sector	Residential			Services			Industry		
Circuit level 1	Application category id	1			2			3		
Circuit level 2	type of application	Lighting circuit	Socket-outlet circuit	Dedicated circuit	Lighting circuit	Socket-outlet circuit	Dedicated circuit	Lighting circuit	Socket-outlet circuit	Dedicated circuit
	Application category id	4	5	6	7	8	9	10	11	12

Preliminary analysis according to Working plan

Market and stock data for the first screening

Table 1-4: Sales of power cables (kTon Copper)

Annual Sales (kTons eq. Copper)	2000	2005	2010	2015	2020	2025	2030
Industry	226	245	241	253	266	279	293
Services	202	219	216	227	238	250	263
Residential	284	308	303	318	334	351	368
Total	712	772	760	798	838	880	924

Table 1-5: Stock of power cables (kTon of Copper)

Stock (kTons eq. Copper)	2000	2005	2010	2015	2020	2025	2030
Industry	5991	6102	6538	6951	7395	7453	7511
Services	4338	4419	4734	5033	5355	5397	5439
Residential	6886	7014	7515	7989	8500	8567	8633
Total	17215	17536	18788	19974	21250	21417	21583

Assumptions were:
30 kg of equivalent copper per electrical installation of a household.
Stock in non-residential buildings = 1.5 times the stock in residential buildings (based on copper wire and cable consumption statistics).

Cable loading data and loss

Table 1-6: Final affected energy demand, related to power cables[1]

FINAL ENERGY DEMAND - Reference Scenario	Unit	2010	2015	2020	2025	2030
Industry	TWh	1073	1152	1207	1279	1329
Services	TWh	775	832	872	924	960
Residential	TWh	950	1021	1069	1133	1177
Total Electricity	TWh	**2798**	**3005**	**3148**	**3336**	**3466**
Total Electricity	PJelec	10074	10818	11334	12011	12478
Total energy	PJ prim	25182	27045	28332	30024	31194

The calculated averaged energy loss in power cables for the sectors defined in the EGEMIN study was **2.04%.**

[1]Based upon projections made by EC regarding energy consumption in buildings

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Review of losses

Loss ratio = $\frac{\text{energy losses in the circuit cables}}{energy\ transported\ by\ those\ circuits}$

- Residential model: **less than 0.3%** (loss ratio on Iavg : 0.15%)
- Services model: **2.26%** (loss ratio on Iavg: 1.83%)
- Industry:
  - Assumptions: design based upon maximum voltage drop
    - 3% (6%) for lighting circuits, 5 % (8%) for other circuits, when supplied from public (private) voltage distribution (see Table 1-15).
    - high load factor;
    - dedicated circuits with a high distribution factor :
  - loss ratio between 1% and 8%.

Residential model

- Load factor α_c =Pavg/S (S: rated power circuit)
- Load Form factor Kf = Prms/Pavg
- 3500kWh -> 400 W -> 1.74 A (230V)
- 25 Kg Cu/100 m^2 (flat, 84 m^2)

Table 1-7: Residential model: parameters and calculated losses

Summary	Circuits					Installation
	RESL1	RESL2L	RESL2S	RESL2D	RESL2D	
Total circuit length (m)	30	34	40	17	17	
CSA (mm^2)	10	1.5	2.5	2.5	6	
Loaded cores	3	2	2	2	2	
Kd (distribution factor)	1.00	0.50	0.50	1.00	1.00	
α (load factor= Pavg/S)	0.03	0.01	0.02	0.01	0.01	
Kf (load form factor)	1.08	1.29	2.83	6.48	4.90	
PF (power factor)	0.90	0.90	0.90	0.90	0.90	
loss ratio on Imax (formula 3.5)	0.15%	0.02%	0.09%	0.21%	0.06%	0.24%
loss ratio on Iavg (formula 3.1)	0.12%	0.02%	0.03%	0.03%	0.01%	0.15%

Improvement potential by increasing CSA

Table 1-9: Impact on energy losses and copper usage (working plan)

Strategy	Energy loss	Loss reduction	Cu weight	Additional Cu
Base	2.04%	0.00%	100.0%	0.0%
S+1	1.42%	0.62%	141.6%	41.6%
S+2	1.02%	1.02%	197.7%	97.7%
Economic	0.75%	1.30%	274.2%	174.2%
Carbon	0.29%	1.76%	907.3%	807.3%

Table 1-10: Improvement scenario power cables (working plan)

Potential savings (starting measures in 2013)	Unit	2010	2015	2020	2025	2030
annual rate (refurbishment)		3%				
Stock of buildings - old standard installations		100%	100%	85%	70%	55%
Stock of buildings - new standard installations		0%	0%	15%	30%	45%
Improvement scenario - final energy consumption	PJprim/year	25182	27045	28277	29907	31012
Savings	PJprim/year	0	0	55	117	182
Total electricity savings	TWh/year	0	0	6	13	20

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Review improvement potential

Table 1-11 S+x scenario overview based upon CSA ratio

CSA	resistance reduction based upon CSA ratio (S+x)/S				
mm²	S+1	S+2	S+3	S+4	S+5
Minimum	17%	33%	48%	58%	67%
Maximum	40%	63%	76%	85%	91%
Average	27%	47%	61%	71%	78%
Average for CSA 1,5 till CSA 10	38%	61%	74%	83%	89%
Average for CSA 1,5 till CSA 25	36%	58%	72%	81%	86%

A reduction in losses from 2.04% to 0.75% (reduction of 1,3%) implies a resistance reduction of 63%. A scenario consisting of a combination of S+2 and S+3 strategies corresponds with such a resistance reduction.

Dual wiring: reducing the load by means of cables in parallel

Significant environmental impact & potential for improvement

Table 1-12: Overview annual savings in 2030

		Unit	Residential sector	Services sector	Industry sector	Total	Total without residential sector
Energy consumption		TWh/y	1177	960	1329	3466.00	2289
Loss ratio		%	0.3%	2.0%	2.0%		
Losses		TWh/y	3,531	19.2	26.58	49.31	45.78
Improvement scenario penetration in 2030		%	45%	45%	45%		
S+1 strategy minimum savings	17%	TWh/y	0.27	1.47	2.03	3.77	3.50
S+1 strategy maximum savings	40%	TWh/y	0.64	3.46	4.78	8.88	8.24
S+2 strategy minimum savings	33%	TWh/y	0.52	2.85	3.95	7.32	6.80
S+2 strategy maximum savings	63%	TWh/y	1.00	5.44	7.54	13.98	12.98

Conclusion

- Significant environmental impact : yearly losses of **45.78 TWh/y**
  - with residential buildings: 49.31 TWh/y
- Significant potential for improvement: **S+1: min 3.5 TWh/y – 8.24 TWh/y**
  - with residential buildings: 3.77 TWh/y – 8.88 TWh/y
- Significant potential for improvement: **S+2: min 6.8 TWh/y – 12.98 TWh/y**
  - with residential buildings: 7.32TWh/y – 13.98 TWh/y
- significant trade and sales volume:
  - ProdCom (includes more than LV power cable): in 2012 for the EU28 a production of 2128 kTon and a production value of 12300 million Euro. (divide by 3 = about 776 kTon working plan ?)

- Proposal: **to exclude residential buildings from study**

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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

5th of December2013

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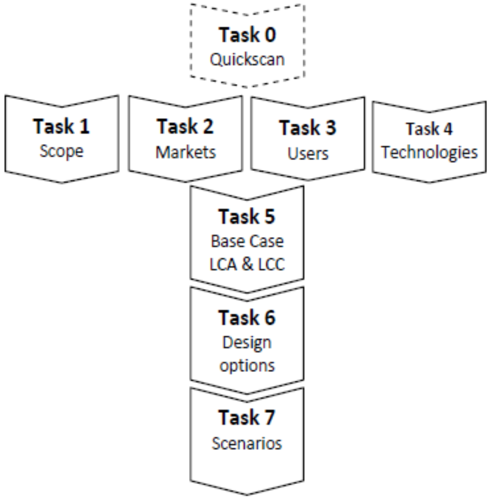
MEErP structure



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

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ProdCom data

Table 2-1: ProdCom data relevant NACE code

Prodcom Nace code	Description
27321380	Other electric conductors, for a voltage <= 1000 V, not fitted with connectors

Note: The ProdCom data include a broad range of electrical wires and cables, such as wires and cables for electrical installations inside and outside the buildings (e.g. LV distribution cables), wires and cables for data communication (coax cables are excluded), flexible cords, wires for internal wiring of control panels, instrumentation cables, elevator cable, and others. The category includes cables and wires with conductors made of copper, aluminium or any other material.

ProdCom data

Table 2-2: EU27 ProdCom data on NACE code 27321380

Year	Quantity in kTon				Value in million €			
	Production	Import	Export	Apparent EU consumption	Production	Import	Export	Apparent EU consumption
2007	1550				9300			
2008	2171				11648			
2009	1920				8400			
2010	2200				11100			
2011	2280				12600			
2012	2128				12300			

Table 2-3: Value per kg conductor based on ProdCom data (NACE code 27321380)

Year	Value in 1000 €	Quantity in Ton	€/kg
2007	9300000	1550000	6.00
2008	11647510	2171223	5.36
2009	8400000	1920000	4.38
2010	11100000	2200000	5.05
2011	12600000	2280000	5.53
2012	12300000	2128632	5.78
Average			**5.35**

Sales data from EU cable industry associations

- To verify the ProdCom data with recent data from stakeholders a questionnaire was sent to the cable manufacturers.
- **Extra responses are needed to** guarantee anonymity, stakeholders are still invited to use the enquiry form and to reply.

Sales of power cables in Europe according to working plan

Table 2-4: Sales of power cables (kTon Copper)

Annual Sales (kTons eq. Copper)	2000	2005	2010	2015	2020	2025	2030
Industry	226	245	241	253	266	279	293
Services	202	219	216	227	238	250	263
Residential	284	308	303	318	334	351	368
Total	712	772	760	798	838	880	924

Table 2 4 shows that annual sales of wiring, expressed as kilotons equivalent copper, is estimated to be some **760 kton in 2010**, and expected to increase to **924 kton in 2030**

CRU Wire and Cable Quarterly report

Table 2-5: kTons of conductor for Europe 2013f (source: CRU Wire and Cable Quarterly, Q3 2013)

000 tons conductor content by region (2013f)

Europe	Cu	Al
Bare Overhead Conductors	0	306
Insulated Cables	1828	531
Winding Wire	424	38
Subtotal	**2252**	**874**

Table 2-6: European consumption of wire & cable by type ('000 ton conductor independent of metal, 2013f) (source: CRU Wire and Cable Quarterly, Q3 2013)

Europe	
LV Energy	1073
Power Cable	1114
External Telecom	68
Internal/Data	218
Winding Wire	465
Sub-Total	**2938**

- LV Energy: all cable whose primary function is the transmission of energy and rated at below 1kVac;
- *Sales: 1073/3*4=1430kTon (Cu+Al, whole Europe, also LV distribution)* versus about 2200 kTon (EU27, ProdCom) *versus about 783 kTon copper WP (EU,2013)*

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Stock data according to working plan

Table 2-7: Total amount of copper installed in buildings

Stock (kTons eq. Copper)	2000	2005	2010	2015	2020	2025	2030
Industry	5991	6102	6538	6951	7395	7453	7511
Services	4338	4419	4734	5033	5355	5397	5439
Residential	6886	7014	7515	7989	8500	8567	8633
Total	17215	17536	18788	19974	21250	21417	21583

760kTon sales /18788 kTon stock = about 4% (new + replacement)
'replacement sales (rennovation)' > 25 years (1/0,04)??

Stock

- Power cable stock = building stock floor area x kg cable/m²
- Buildings (BPIE):
  - **24 billion m²** of useful floor space (industry floor space excluded?)
  - The residential stock : 75% of the building stock: 18 billion
- Buildings (Ecofys study):
  - non-residential building stock: 12.3566 – 13.2906 billion m²
  - industry building stock: 2.752 billion m²
- **29 – 139 kg/100m² depending on sector** (based upon CuIoU survey)
- Results in
  - Residential buildings: 5241 kTon versus 7515 kTon in working plan
  - Services buildings: 3250 kTon versus 4734 kTon in working plan
  - Industry buildings: 3825 kTon versus 6538 kTon in working plan

Example of office building

Table 2-14: Example of an real office building

Amount of Ligth circuits	**33**
Amount of Socket outlet circuits	62
Amount of Dedicated circuits	34
Amount of Main feeders	1
Amount of Sub feeders	11
Cu total (kg)	2851
Floorspace (m²)	3059
Cu (kg/100m²)	93

Distribution of power cables based upon CSA residential buildings

Table 2-15: Distribution of LV cables in the residential buildings[1]

CSA (mm²)	% Weight	% Length
1.5	23.4	27.5
2.5	38.9	40
4	6,6	4.9
6	9,3	5.7
10	6.1	<1

The total length of 1.5 +2.5 mm² cables counts for 67.5% of the total length of the installed cables in the residential sector.

[1] Source: CuIoU survey European Copper Institute

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Distribution of power cables based upon CSA non-residential buildings

Table 2-16: Distribution of LV cables in non-residential buildings[1]

CSA (mm²)	% Weight	% Length
1.5	2	15
2.5	13	58.6
4	2	4.9
6	3	5.1
10	3	3.2
16	3	2.4
25	4	2
35	6	1.9
50	5	1.2
70	11	1.8
95	12	1.4
120	9	0.9
150	6	0.4
185	13	0.8
240	7	0.4
300	0	0
400	3	0.1
500	0	0
600	0	0

The total length of 1.5 +2.5 mm² cables counts for 73.6% of the total length of the installed cables in the non-residential sector.

[1] Source: CuIoU survey European Copper Institute

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Sales rate and stock data summary

Table 2-18: Summary of growth rates

Sector	New Sales growth rate	Replacement sales growth rate
Residential	1% (BPIE)	0.59% (Heinze+BPIE)
Services	2.1% (Ecofys)	7.08% (Heinze+Ecofys)
Industry	3.1% (Ecofys)	7.08% (Heinze+Ecofys)

Table 2-19: Summary of stock data

Sector	Building floor area	Amount of Cu material per 100m² empirical
Unit	Million m²	kg/100m²
Residential	18000	29.1
Services	6000	54
Industry	2752	139

Source: BPIE, Ecofys study, Heinze study,

Market trends

- Power cables are a **mature** product and available in standardized sizes.
- There is a trend to use low smoke halogen free cables in buildings?

Product cost

- Product unit is (CSA [mm^2] x l [m] x N).
- Product cost
  - Average user price (2013) around **0.075 €/ (mm^2x m x 1 core)**.
  - Average (2005-2010) factory price (ProdCom) around **0.047 €/ mm^2 x m**.

Other costs

- **Installation costs**
  - **Stakeholders are invited to provide input on an approach, e.g. labour hours per m and labour cost per hour? Per mm² & m? In hours labour.**
- **Repair and Maintenance costs**
  - No repair, nor maintenance costs
- **Disposal costs/benefits**
  - The positive scrap value for the owner of the cable should be about 70% of the copper price.

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

Stakeholder meeting: Task 2

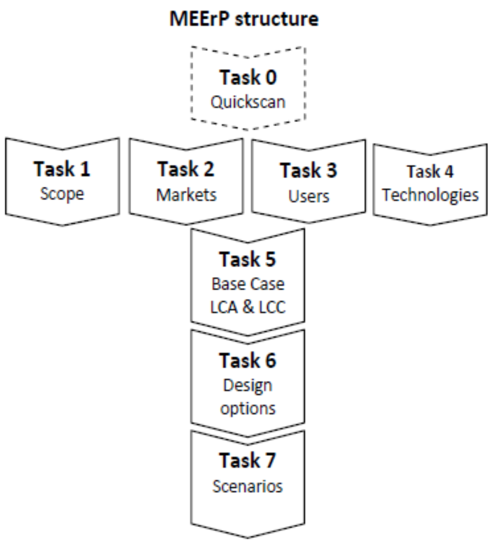
Paul Van Tichelen

Brussels, DG Enterprise

5th of December2013

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



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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
- **Systems aspects of the use phase for ErPs with indirect impact**
- **End of Life behaviour**
- Local infrastructure (barriers & opportunities), e.g. cable bending
- Recommendations

Product to systems approach

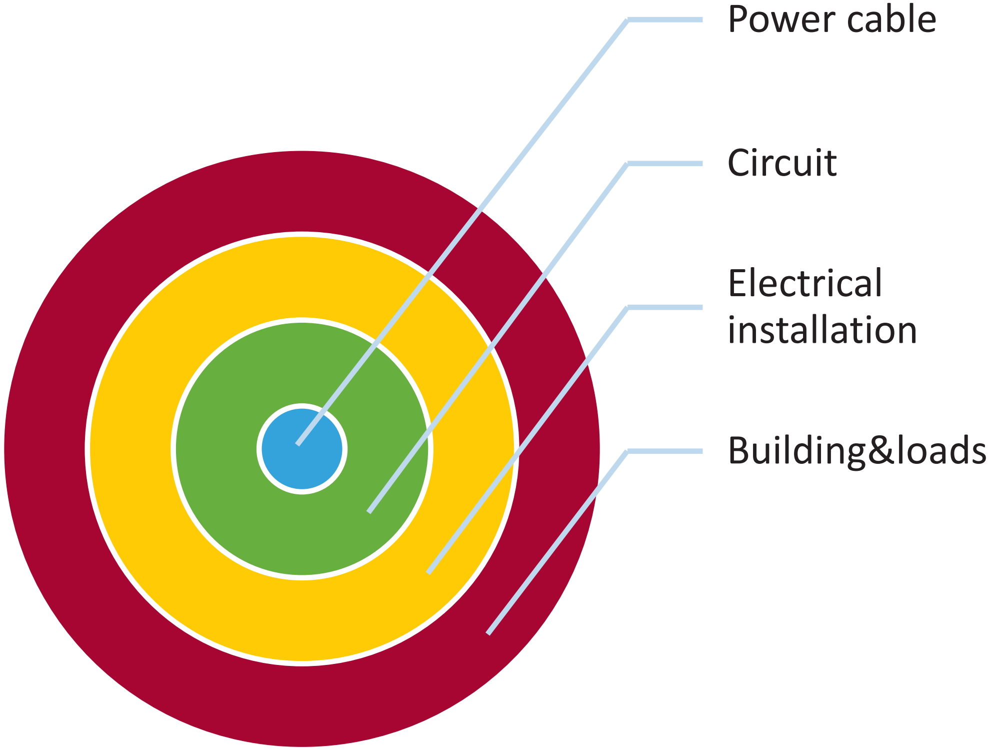

Figure 3-1: From strict product to systems approach

Loss parameters directly related to the cable itself

- R= ρ_t.l/A (Ohm) (formula 3.2)

- 3.1.2.1 Conductor material electrical resistance
- 3.1.2.2 **Cross-sectional area (CSA)**
- 3.1.2.3 Length of cable
- 3.1.2.4 Number of cores
- 3.1.2.5 Skin effect

CSA per circuit application type & sector

Table 3-2: Typical cable cross sectional areas depending on the circuit type

Sector	Circuit application type	CSA (mm²) min	CSA (mm²) ref	CSA (mm²) max
Residential	Distribution circuit	2.5	10	16
	Lighting circuit	1	1.5	2.5
	Socket-outlet circuit	1.5	2.5	6
	Dedicated circuit	2.5	4	6
Services	Distribution circuit	10	35	600
	Lighting circuit	1.5	1.5	2.5
	Socket-outlet circuit	1.5	2.5	6
	Dedicated circuit	2.5	35	95
Industry	Distribution circuit	25	95	600
	Lighting circuit	1.5	1.5	2.5
	Socket-outlet circuit	1.5	2.5	10
	Dedicated circuit	2.5	35	600

Own estimates

New input from stakeholder, not processed yet.

Other functional cable parameters not directly related to losses

- **Insulation material**
- Construction of the conductor

Insulation material

- The selection criteria of insulation material depends on electrical (rated voltage) and physical (temperature range, flexibility, flammability, chemical resistance,….) requirements of the application.
- The selection of insulation material is also influenced by building properties and function of the building (risk of fire, evacuation capability,..).

- **Conclusion:**
  - **To be decided whether this is relevant or not**.

Loss parameters directly related to the electrical circuit and network topology

- 3.1.4.1 Single phase or three phase circuit
- 3.1.4.2 Maximum voltage drop in a circuit
- 3.1.4.3 Overcurrent protection in a circuit
- 3.1.4.4 Circuit network topology
- 3.1.4.5 **Circuit length**
- 3.1.4.6 **Effect of load distribution**
- 3.1.4.7 **Effect of not simultaneous functioning of distributed loads**
- 3.1.4.8 Ambient temperature
- 3.1.4.9 Temperature effect caused by the ‘method of installation’
- 3.1.4.10 Single or three phase system
- 3.1.4.11 Number of distribution levels
- 3.1.4.12 Rated Diversity Factor DF at installation level

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Circuit length

» Based upon enquiry, but corrected (factor 1. 2 for branches in lighting circuits)

Table 3-6: Corrected (and rounded) average circuit length in meters

Sector	Circuit application type	Average length min (m)	Average length ref (m)	Average length max(m)
Residential	Distribution circuit	5	17	40
	Lighting circuit	12	21	3
	Socket-outlet circuit	5	20	50
	Dedicated circuit	5	17	40
Services	Distribution circuit	10	34	80
	Lighting circuit	14	38	72
	Socket-outlet circuit	10	31	65
	Dedicated circuit	10	34	80
Industry	Distribution circuit	15	72	200
	Lighting circuit	24	65	120
	Socket-outlet circuit	15	48	100
	Dedicated circuit	15	72	200

Effect of load distribution

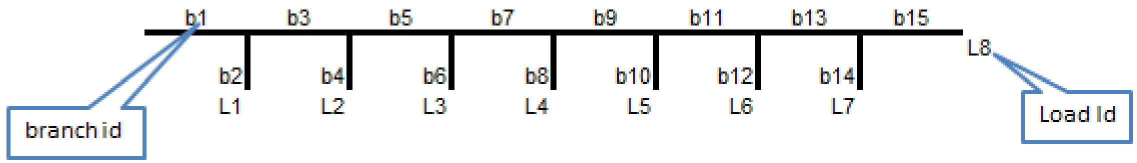

Table 3-7: Kd factors for circuits with minimum 1 to maximum 8 socket-outlets with equally distributed loads and cable segment lengths

	Number of socket-outlet							
	1	2	3	4	5	6	7	8
Kd	1	0,61	0,50	0,45	0,42	0,40	0,39	0,38

Table 3-9: Kd factor per circuit type

Sector	Circuit application type	Kd min	Kd avg	Kd max
Residential	Distribution circuit		1	
	Lighting circuit	0.38	0.5	1
	Socket-outlet circuit	0.38	0.5	0.9
	Dedicated circuit		1	
Services	Distribution circuit		1	
	Lighting circuit	0.38	0.5	1
	Socket-outlet circuit	0.38	0.5	0.9
	Dedicated circuit		1	
Industry	Distribution circuit		1	
	Lighting circuit	0.38	0.5	1
	Socket-outlet circuit	0.38	0.5	0.9
	Dedicated circuit		1	

Parameters related to the building and loading

- 3.1.5.1 **Load Factor (αc) and load form factor (Kf)**
- 3.1.5.2 **Power factor**
- 3.1.5.3 Impact of harmonics
- 3.1.5.4 Number of loaded conductors and impact of phase imbalance and harmonics

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

- Load factor α_c =Pavg/S (S: rated power circuit)
- Load Form factor Kf = Prms/Pavg

Table 3-12: Load form factor and load factors in the services sector

Services												
	Lighting circuit			Socket-outlet circuit			Dedicated circuit			Distribution circuit		
	Low	Ref	High	Low	Ref	High	Low	Ref	High	Low	Ref	High
Use factor	0.4	0.5	0.7	0.2	0.3	0.4	0.6	0.7	0.8	0.6	0.7	0.8
P2/P1 ratio	10%	20%	30%	10%	20%	30%	10%	20%	30%	10%	20%	30%
P1 (amplitude)	100	100	100	100	100	100	100	100	100	100	100	100
Period 1 (time)	50	60	70	50	60	70	70	80	90	70	80	90
P2 (amplitude)	10	20	30	10	20	30	10	20	30	10	20	30
Period 2 (time)	118	108	98	118	108	98	98	88	78	98	88	78
Period 1 + Period 2	168	168	168	168	168	168	168	168	168	168	168	168
Prms	55	62	68	55	62	68	65	71	76	65	71	76
Pavg	37	49	59	37	49	59	48	58	68	48	58	68
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
α_c	0.15	0.24	0.41	0.07	0.15	0.24	0.29	0.41	0.54	0.29	0.41	0.54
Kf . α_c	0.22	0.31	0.48	0.11	0.19	0.27	0.39	0.49	0.61	0.39	0.49	0.61

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

Table 3-14: Load factors (α_c) and load form factors (Kf) to be used in this study

		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
	α_c	0.02	0.05	0.10	0.00	0.04	0.10	0.01	0.02	0.05	0.03	0.06	0.22
	Kf . α_c	0.06	0.11	0.17	0.02	0.06	0.13	0.05	0.08	0.14	0.03	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
	α_c	0.15	0.24	0.41	0.07	0.15	0.24	0.29	0.41	0.54	0.29	0.41	0.54
	Kf . α_c	0.22	0.31	0.48	0.11	0.19	0.27	0.39	0.49	0.61	0.39	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
	α_c	0.23	0.34	0.54	0.12	0.27	0.46	0.46	0.61	0.76	0.46	0.61	0.76
	Kf . α_c	0.26	0.36	0.55	0.13	0.29	0.47	0.47	0.61	0.76	0.47	0.61	0.76

Power factor

- **Power factor**
  - Although the power factor will differ from circuit to circuit depending on the load type, it is proposed to use **PF = 0.9** when load profiles are used.

Formula 3.2 used for power losses in cables

$R_t = \rho_t . l/A \ (\Omega)$ (formula 3.2)

where,

- ρ_t= specific electrical resistance of the conductor at temperature t ($\Omega.mm^2/m$)
- l= length of the cable (meter)
  - **Length = circuit length x number of loaded conductors (2 or 3)**
- A= cross sectional area of the conductor (mm^2)
- ρ_t is the resistivity of conductors in normal service, taken equal to the resistivity at the temperature in normal service, i.e. **1,25 times** the resistivity at 20 °C, or 0,0225 $\Omega mm^2/m$ for copper and 0,036 $\Omega mm^2/m$ for aluminium; IEC 60364-5-52 annex G

Formula 3.5 used for power losses in cables

$E_{circuit}(y)$ [kWh] = $Kd \times R_t \times Imax^2 \times (\alpha_c \times Kf/PF)^2 \times 8760 / 1000$ (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
- Kf = Load form factor (=Prms/Pavg)
- PF = the power factor of the load served by the power cable

Systems aspects of the use phase for ErPs with indirect impact

- **Building space heating and cooling system**
  - Cable losses are dissipated in the form of heat energy and therefore contribute to so-called ‘internal heat gains’, this has and impact on the building heating and cooling requirements. The impact can be positive when heating is needed or negative when cooling is needed.

- **Conclusion:** because the impact can be positive or negative and it is not the primary function of the cable to contribute to the heating it is proposed to further **neglect** this effect in the study.

End-of-Life behaviour

- Assumptions made in this study (Stakeholders please provide input):
- Present fractions to recycling, re-use and disposal for copper:
  - **95%?, 0%, 5%?**
- Present fractions to recycling, re-use and disposal for aluminium:
  - **95%?, 0%, 5%?**
- Present fractions to recycling, re-use and disposal for insulation:
  - **50%?, 0%, 50%?**
- Present fraction of second hand use and refurbishment: **0%**
- Product use & stock life: **40 years?**
- Repair & maintenance practice: **not existing**
- Collection rate: **95 %?**
- Second hand use: **not existing**

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

Stakeholder meeting: questionnaire

Dominic Ectors

Brussels, DG Enterprise

5th of December2013

Questionnaire for installers

- http://www.erp4cables.net/node/6,
- questionnaire was sent to installers on the 30th of September, 2013 in the context of this study.
- 8 responses

1. Amount of nodes

» On average how many nodes/points (socket-outlet, light fixture, fixed connection,…) are there on an electric circuit (circuit after a circuit breaker) ?

Table 3-8: Average number of nodes per circuit application type

Sector	Circuit application type	Average number min (m)	Average number ref (m)	Average number max(m)
Residential	Distribution circuit			
	Lighting circuit	5	10.7	30
	Socket-outlet circuit	8	10.3	20
	Dedicated circuit	1	2	3
Services	Distribution circuit			
	Lighting circuit	6	13.8	25
	Socket-outlet circuit	5	6.6	8
	Dedicated circuit	1	2.2	5
Industry	Distribution circuit			
	Lighting circuit	4	14.6	28
	Socket-outlet circuit	2	5.7	18
	Dedicated circuit	1	1.9	5

2. Circuit length

Please estimate the average length of an electric circuit per sector?

Table 3-6: average circuit length in meters

Sector	Circuit application type	Average length min (m)	Average length ref (m)	Average length max(m)
Residential	Distribution circuit			
	Lighting circuit	10	18	30
	Socket-outlet circuit	5	20	50
	Dedicated circuit	5	17	40
Services	Distribution circuit			
	Lighting circuit	12	31	60
	Socket-outlet circuit	10	31	65
	Dedicated circuit	10	34	80
Industry	Distribution circuit			
	Lighting circuit	20	54	100
	Socket-outlet circuit	15	48	100
	Dedicated circuit	15	72	200

3. Aluminium inside buildings

- Do you use aluminium power cables for electrical installations inside buildings?
- Answers:
  - 5 x No, 3 x Yes
  - Comments:
    - Due to cost and practical reasons aluminium cables are often used in main circuits and also in consumer circuits with a significant load (> 32 A).
    - rarely, only large amperages over large distances

4. Designed by means of a calculation tool

- How many electrical installations, performed by your company, are designed by means of a maximum voltage drop and safety requirement calculation. Please indicate roughly in percentage (0 %, 25% , 50 %, 75% or 100 %).

	Residential	Services	Industry
No calculation	11%	5%	1%
Design based on rules of thumb or predefined tables	42%	26%	12%
Design calculated by means of software tool, taking into account voltage drop and safety requirements	46%	69%	88%

5. Energy losses estimation

- Do you think there are significant energy losses in low voltage power cables in indoor electrical installations? (<1 %, 1-3 %, > 3 %)
- Answers:
  - 1-3%: 6
  - 3% :2

6.Installation

- Who may perform an electrical installation in your country?
- Answers:
  - In the residential sector?
    - Anyone (no qualification): 1 (UK)
    - Qualified person/organisation: 7
    - No idea: 0
  - In the non-residential sector?
    - Anyone (no qualification): 0
    - Qualified person/organisation: 8
    - No idea: 0

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7.Certification

- Must an electrical installation be certified in your country?
- Answers:
  - In the residential sector?
    - Yes: 7
    - No: 1 (Norway)
  - In the non-residential sector?
    - Yes: 7
    - No: 1 (Norway)

8. Certifier

- Who may certify an electrical installation in your country? Only to be filled in when certification is obligatory.
- Answers
  - Anyone: 0
  - Qualified installer: 6 (5)
  - Independent (accredited) company: 2

9. National wiring code

- Please indicate the installation/national wiring code or standard used for electrical installations in your country?

- See Task 1: table 1-18

10. BMS

» Please indicate relatively (in percentage) per sector how many installations performed by your company include a home/building management system (BMS) or building automations and control system (BACS)?

	Residential	Services	Industry
Percentage of installations having a BMS or BACS	12%	54%	60%

Questionnaire for cable manufacturers

- questionnaire was sent to installers on the 30th of September, 2013 in the context of this study.
- Two questions:
  - 1. Indicate the annual EU27 (27 member states of European union in 2010) of sales for the year 2010 of power cables per cross cable section (CSA) and per number of cores. Please express in **kilometer** cable.
  - 2. Highlight the countries that are part of your market; which cable labelling standard is used in these countries; and the installation code/national wiring code for indoor installations (e.g. AREI code for Belgium, NFC 15-100 for France, ...)
- 2 responses
  - Too low to guarantee anonymity

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