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

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This study was done for preparing the implementation of the Ecodesign or Energy Related Products (EED) Directive (2009/125/EC) related to power cables on behalf of the European Commission DG ENTR unit B1. The information provided herein can serve to prepare for subsequent phases, including conducting an impact assessment on policy options, to prepare a paper for the Consultation Forum and finally draft regulation for the Regulatory Committee or other policy instruments. Those phases are to be carried out by the European Commission. This study also discusses other policy instruments compared to the EED.
In a multi stakeholder consultation, a number of groups and experts provided comments on a preliminary draft of this report. The report was then revised, benefiting from stakeholder perspectives and input. The views expressed in the report remain those of the authors, and do not necessarily reflect the views of the European Commission or the individuals and organisations that participated in the consultation. A list of stakeholders that participated in this consultation and further information on project meetings and comments can be found in a project report that is published complementary to this report.

The study follows the European Commission’s MEErP methodology and consists of seven Tasks:
Task 1 - Scope (definitions, standards and legislation);
Task 2 – Markets (volumes and prices);
Task 3 – Users (product demand side);
Task 4 - Technologies (product supply side, includes both Best Available Technology (BAT) and Best Not Yet Available Technology (BNAT));
Task 5 – Environment & Economics (base case Life Cycle Assessment (LCA) & Life Cycle Costs (LCC));
Task 6 – Design options(improvement potential);
Task 7 – Scenarios (Policy, scenario, impact and sensitivity analysis).
Tasks 1 to 4 can be performed in parallel, whereas 5, 6 and 7 are sequential.
Task 0 or a Quick-scan is optional to Task 1 for the case of large or inhomogeneous product groups to re-group or narrow the product scope, as appropriate from an ecodesign point of view.

Together with this study MEErP EcoReports of task 5 and 6 are provided and an excel tool designed for task 7.

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The findings in Task order are the following:

Task 1&0:
The scope of the study is: 'losses in installed power cables in electric circuits in buildings after the meter' taking into account the electrical installation as a system', the power cable being the product put into service by the electrical installer in a circuit of an electrical installation in a building. The electrical installation including loads are taken into account at system level, this is explained in more detail in chapter 3. Amongst others it means that the installation will be analysed at the level needed related to cable losses.
More in detail, the scope defined is losses in installed power cables in buildings that covers low voltage power cables for fixed wiring used in indoor electrical installations in non-residential buildings and initially also in residential buildings. The first screening estimated losses in the services and industry sector about 2% while losses in the residential sector seems to be much lower (<0.3%). This is because circuits in residential buildings are in general much shorter and have relative low loading. The assessment is about business as usual in new installed circuits according to the current standards. Some stakeholders pointed out that in some member states old residential installation still might have inefficient electric circuits but promoting renovation in residential houses but this cannot be addressed by the EDD. Therefore the focus in the subsequent tasks is on the services and industry sector circuits. Losses in installed power cables in buildings are directly related to the loading.
The primary functional performance parameter of the cable is 'current-carrying capacity' and for electric circuits it is the rated current.

Relevant standards, definitions, regulations, voluntary agreements and commercial agreements on EU, MS and 3rd country level are part of this task report. Important secondary performance parameters are the 'Nominal Cross-Sectional Area (CSA)' and its corresponding 'maximum DC resistance at 20°C (R20)', which are defined in standard IEC/EN 60228. Cable Nominal Cross-Sectional Areas (CSA) are harmonized in this standard and increase stepwise (1-1.5-2-4-6-.. mm²). For the performance electrical installation codes play an important role and they can differ per member state. Important performance standards are IEC 60287-3-2 on the Economic optimization of power cable size and IEC/EN 60364-8-1 on Energy efficiency in Low voltage electrical installation.

Task 2:
Input parameters for a stock and sales model were collected. Therefore the stock or stock growth rate of power cables in buildings is linked to the stock and stock growth rate of buildings respectively. The stock, stock growth rate, replacement, and demolition rates for power cables were deduced from the corresponding building parameters. Absolute stock and sales were estimated based upon these figures and verified with PRODCOM data. The input from stakeholders regarding product lifetime is taken into account.
The results can be found in Table 1: Summary of cable stock, growth and sales. These values will be used in the Tasks 5 up to and including 7.

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Table 1: Summary of cable stock, growth and sales

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%

Installation times, cable and connector prices are defined in this chapter along with energy and financial rates. For copper power cables this study uses an average discounted cable price of 0.09434 €/ (mm². m).
The input market stock, sales and growth data was not directly available and as explained in the respective sections the deduced and projected data has a certain degree of uncertainty, therefore a complementary sensitivity analysis and cross checks are performed in Tasks 4 to 7.

Task 3:
The use of the power cable is mainly defined by the characteristics of the circuit, the load distribution in the building and the power consumption profile of the connected loads.
The most important parameters for the circuit characteristics are the average circuit length in meters and minimum and maximum cable cross sectional areas (CSA) in mm² per circuit type.
The most important parameters related to the power consumption profile of the loads are: load factor, load form factor and power factor.
There is a big spreading in these parameters and 'the European average electric circuit' is not directly defined neither existing. This might introduce a large degree of uncertainty in later tasks and therefore ranges of data are included which allow complementary sensitivity analysis in Tasks 6 and 7.

A typical product lifetime in the service and industry sector is about 25 years. Due to the high scrap value of copper, recycling of cables is common business and the MEErP defaults value of 95 % will be used.

On user behaviour the stakeholder questionnaires[1] also revealed that:

- Electro-installers are unaware of the losses in circuits;
- In practice, calculation of losses is not performed when designing an installation. Mostly only voltage drop and safety restrictions are taken into account;
- The responsibility regarding the budget for the investment and the budget for operating expenses is in most cases split and linked to different departments. As a result no economic Life Cycle Cost (LCC) evaluation is performed and the installation with the lowest investment costs is often selected;

[1] This questionnaire was sent to installers on the 30th of September, 2013 in the context of this study. A second questionnaire was sent on the 7th of July, 2014. The results were combined. See "Preparatory Studies for Product Group in the Ecodesign Working Plan 2012-2014:Lot 8 - Power Cables Project report".

- Tenders do not include a requirement to perform LCC calculations in the offer.

Task 4:
At the product level of the power cable itself, there are no improvement options identified related to energy efficiency because every cable cross sectional area (CSA) on the market has a certain load and cable length to fit with.
At circuit level (system level) two improvement options are identified, the first is installing a cable with a larger CSA ('S+x') and the second is installing one or more cables in parallel with the same CSA ('2S'). This task also includes the necessary product data for subsequent life cycle impact modelling which is primarily based on its Bill-of-Material (BOM). A larger CSA will increase the BOM and therefore this environmental impact will be modelled in later Tasks with the MEErP Ecoreport tool.

Task 5:
Previous Task 4 identified improvement options at circuit level. In this Task nine so-called base cases (BC) were selected that represent typical electric circuits in line with the market structure and data described in Task 2. Base Cases according to MEErP are abstractions from reality that serve for modelling purposes. These base cases used the 'median' electric circuit parameters from Task 3, such as load factor and cable length. The nine base cases used are:

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

The environmental impact analysis and LCC obtained with the MEErP tool showed that in most cases the use phase, because of electrical cable losses, is dominant. As a consequence, there will be room left for economic energy savings in several of those base cases that will be analysed in detail in Task 6. The data of the nine base cases was also summed using EU-28 circuit level stock data and cross-checked with total EU-28 data on electricity use from Task 2. This showed an overestimation compared to EU-28 data on energy use. This means that the 'median' parameters for the base cases from Task 3 do not reflect 'average reference' parameters that can be used in a stock model in Task 7. Therefore corrections factors on those 'median' parameters were calculated that fit with total EU energy consumption. This also indicates that potentially a lot of circuits in the stock have a relative lower loading and/or longer circuit length and/or higher share of base cases with lower loading.
The annual electricity loss in cables in the service and industry sector at EU-28 level was estimated about 42 TWh which fits with cross checks in the report.

Some cable insulation additives did not match one-to-one with the limited set of materials available in the MEErP Ecoreport tool, therefore alternative materials were chosen and a small sensitivity analysis showed that this has limited impact on the outcomes.

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Task 6:
The previous Task 5 identified the use phase as the most important and hence reducing cables losses are the way forward to improve environmental impact. Reducing cable losses in installed cables can easily be done by decreasing the cable resistance and by increasing the copper cross-sectional area (CSA). The methods identified to increase the CSA were installing a cable with a larger CSA ('S+x') and/or installing more cables in parallel with the same CSA ('2S').
Three design options (D1, D2, D3) were calculated with stepwise increased CSA(S+1, S+2, S+3). Another design option (D4) calculated two cables in parallel. These are the four design improvement options that are applied to the nine defined base cases in Task 5.
This task concluded that those design options have a positive impact on almost any of the environment parameters generated with the MEErP EcoReport tool. In summary all the parameters including Global Warming Potential (GWP) improved, except impact from 'water (process)', 'heavy metals (emissions in water and air)' and 'Particulate Matter (PM)'. The defined base cases, representing the so-called lighting and socket-outlet circuits, performed relative less. In particular the parameters Polycyclic Aromatic Hydrocarbons (PAHs), PM and Eutrophication increased in several 'improvement' options. Therefore policy measures from Task 7 are defined carefully not imposing an increased CSA for any circuit disregarding their loading.
Based on input from previous tasks, LCC has also been calculated for all options and the LLCC improvement options were identified. In is important to note that for base cases, representing circuits with a low load, the Least Life Cycle Cost (LLCC) option is 'Business As Usual' (BAU), hence no economic improvement potential is identified. All other defined base cases (1, 3-9) showed economic justified improvement potential. The explanation for these differences is related to the variations in the loading behind the defined base cases.

Finally also a sensitivity analysis has been done on the circuit loading parameters, circuit length, product lifetime and product price. The sensitivity analysis showed that the best design option considering BAT and LCC varies depending on the assumptions made for the parameters.

It should be noted that depending on the local situation shifting to a particular design option may not be technical feasible, because it often requires more space for the cable installation which is not always available. In practice not all improvement options can be realized because the impact of the design options on accessories (ducting systems, trunking systems, junction boxes, etc.) and on the building space that are left out of the quantitative analysis.

Task 7:
The proposed policy options in this task take into account the findings from previous tasks.

From Task 1 it was proposed to focus on 'losses in installed power cables in buildings', the power cable being the product put into service by the electrical installer in a circuit of an electrical installation in a building. As a consequence proposed policy measures focus on the power cables itself and/or the installed power cables in electric circuits in buildings. Therefore, there is also no policy option proposed to set minimum requirements on the cable cross-sectional area (CSA), because they have their economic justified function in circuits with low loading and/or other applications such as machinery. The proposed policy measures at product level are therefore only generic on the provision of information related to cable losses, e.g. cable loss information but also a proposal proposal for cable sizing tools to be provided with placing on the market of cables. By consequence most policy measures are formulated at electric circuit or system level, which is not directly in the 'product' scope of the Ecodesign of Energy Related Products Directive (2009/125/EC). The rationale for this is included in Task 7 nevertheless it should be noted that in principle nothing has been found to preclude as such to consider 'installed electric power circuits' as products and installers as their manufacturers, therefore it remains a policy option to be decided

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by the EC. The policy options are mostly related to upgraded standardization, labelling and/or electrical installation codes. There is a proposal for specific ecodesign requirements to increase CSA and lower cable losses during design of the installation. There are also proposals for generic information requirements on the provision of information losses before and after commissioning of the electric circuit. Finally also specific requirements for monitoring of cable losses with BACS during operation of the building (Building Automation and Control Systems) are formulated. Related to standardisation it is important to support, maintain and upgrade the standard IEC 60634-8-1 / HD 60634-8-1:2015 – Low voltage electrical installations energy efficiency. Task 7 also discusses pros, cons and timing of the proposed policy measures. The task also explains why no other specific ecodesign requirements on the type of cable insulation and/or conductor material are proposed.

This task also calculates different scenarios on energy use and cost with a sensitivity analysis on key parameters like discount rate, inflation rate, energy escalation rate, product lifetime, stock growth rate and product price. In a Business-as-Usual (BAU) scenario the energy losses in power cables in the industry and service sector in 2025 are forecasted at 56.67 TWh, which would be about 2.5 % of the transported electricity in 2025. In an ultimate scenario assuming full impact from 2017 for all proposed policy measures based on the least life cycle cost option these losses could be reduced up to -7.60 TWh in 2025. Various other scenarios are calculated taking into account different policy options, gradual timing of measures and partial impact. Afterwards a sensitivity analysis is done on the key parameters that have an impact on these scenarios. This is useful because the policy scenarios are based on new sales and replacement sales of power cables and this is related to the EU28 economic growth which might be optimistic in this study. For example, the sensitivity analysis showed that a longer product life and lower stock growth has a significant impact on all outcomes. A tool complementary to this study for calculating scenarios with their costs and benefits has been provided to the EC.

It is expected that the proposed measures will have a positive impact on the labour for installers, cable manufacturers and distributors.

The complete final report is available at: http://erp4cables.net/node/6