Contract N°. S12.515810 call ENTR/2008/039
Sustainable Industrial Policy – Building on the Ecodesign Directive – Energy-Using Product Group Analysis/1

Final Project Report

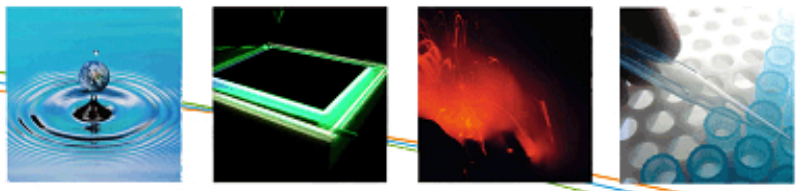
LOT 2: Distribution and power transformers

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2010/ETE/R/108

November 2010



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DISTRIBUTION LIST

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EXECUTIVE SUMMARY

VITO and BIOIS performed this study for preparing the implementation of the new Ecodesign or Energy Related Products (ERP) Directive (2009/125/EC) related to power and distribution transformers, on behalf of the European Commission (more info http://ec.europa.eu/enterprise/eco_design/index_en.htm).

This underlying report is the Project Report, serving an administrative purpose vis-à-vis the contract and providing more background on how the study was conceived and the process to arrive at the results. This report is complementary to the Final Report on Tasks 1-7 that also can be found on the project website www.ecotransformer.org.

This project report demonstrates that:

- All tasks listed in the MEEUP methodology were performed in close consultation with the stakeholders and the European Commission;
- The project website http://www.ecotransformer.org was created and maintained;
- Three stakeholder meetings were organised (see minutes of meetings in annexes);
- Three enquiries were organised (see Final Report on Tasks 1-7);
- Stakeholder comments and data were processed (see comments and answers in annexes).

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.

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CHAPTER 1 INTRODUCTION

This underlying report is the Project Report, serving an administrative purpose vis-à-vis the contract and providing more background on how the study was conceived and the process to arrive at the results. This report is complementary to the Final Report on Tasks 1-7 that also can be found on the project website www.ecotransformer.org.

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- Three stakeholder meetings were organised (see minutes of meetings in annexes);
- Three enquiries were organised (see Final Report on Tasks 1-7);
- Stakeholder comments and data were processed (see comments and answers in annexes).

CHAPTER 2 CONTACT WITH STAKEHOLDERS

2.1 Website

People could register as a stakeholder on the website and 225 stakeholders are registered. Registration was not necessary to download documents. Figure 2-1 contains an overview of registered stakeholders per category. Amongst others, four manufacturers of the so-called smaller industrial transformers are registered as well as the Chairman of related IEC TC 96. Other manufacturers are mainly related to power and distribution transformers as defined in Task 1.

01 Industry (Transformers manufacturer)	67
02 Industry (Transformer component manufacturer)	16
03 Industry (Transformer installation, repair, maintenance)	5
04 Industry (Electricity producer)	3
05 Industry (Electricity T&D)	9
06 Industry/business association	31
07 Environmental NGOs	4
08 Consumer NGOs	4
09 Institute, consultancy	46
10 Member State representative/agency	13
11 International agency/organisation	7
12 European Commission	2
13 Other	16
TOTAL	223

Figure 2-1: Registered stakeholder statistics

2.2 Stakeholder meetings

One stakeholder meeting was held in Brussels in the offices of the EC:

- 6th July 2009: First stakeholder meeting in Brussels discussing draft Tasks 1-3;

The minutes of this meeting can be found in ANNEX A. The presentations that were displayed during this meeting are included in ANNEX B.

- 19th May 2010: Second stakeholder meeting in Brussels discussing draft Tasks 4&5;

The minutes of this meeting can be found in ANNEXE I&F. The presentations that were displayed during this meeting are included in ANNEXES J&K.

- 24th August 2010: Final stakeholder meeting / workshop in Brussels discussing draft final Tasks 6 & 7.

The minutes of this meeting can be found in ANNEXES N, Q, R&S. The presentations that were displayed during this meeting are included in ANNEXES O&P.

2.3 Expert meetings and experts consultation

Several stakeholder expert meetings and expert consultations were held:

- 2 expert meetings were held with Orgalime (T&D Europe) on 17th March (Brussels) (Minutes in ANNEX C) and 4th June (Paris) (data included in the report);
- 2 dedicated expert meetings were held with Hitachi Transformers and/or Hitachi METGLAS discussing face-to-face technical information and performance of amorphous transformers (Antwerp 12/1/2010, Mol 3/3/2010) (production data included in the report);
- 1 expert meeting was organized with CG Power Systems (formerly Pauwels Transformers) (Mechelen, 5/2/2010) (included in enquiry data);
- One face to face meeting with the a smaller transformer manufacturer after the first stakeholder in Brussels (www.erea.com) (market data & standards on smaller transformers);
- 1 expert meeting with ERDF (Paris 4/5/2010) on transformer loading;
- One visit to an amorphous steel production plant was performed (Vacuumschmelze, Hanau, 8/10/2010)

2.4 Consultations in writing

2.4.1 Enquiries

In accordance with the project planning, BIO IS developed enquiries in order to obtain information from manufacturers and operators of transformers. The enquiries included questions designed to obtain input for the analyses to be completed in Tasks 4 and 6, as well as base technical information for Task 5. The enquiries were distributed to stakeholders via the website. A notification email was sent at the time of posting. In the event of questions or comments, BIO IS dealt with the concern directly by email or phone.

Four enquiries for distribution and power transformers are in ANNEXES D, E, M and T.

Smaller transformer manufacturers who registered on the website did receive an extra e-mail to seek confirmations on assumptions made in chapters 1-3 (see Annex H) (www.erea.com, http://www.trafomodern.com/, www.noratel.com, Chairman of IEC TC 96).

E-mail contact with the Chairman of IEC to note about the study and our requests for more information.

2.4.2 Consultation in writing on draft reports

Comments from stakeholders on draft chapters 1-3 before the first stakeholder meeting and the responses that were given by the project team can be found in Annex F.

After the Task 1-3 deadline, comments on behalf of the UK Market Transformation Programme were received, see comments and answer in Annex G.

Comments from stakeholders on draft chapters 1-5 before the second stakeholder meeting and the responses that were given by the project team can be found in Annexes F,G&L.

Comments from stakeholders on draft chapters 1-7 before the third stakeholder meeting and the responses that were given by the project team can be found in Annexes Q, R&S.

Comments from stakeholders on draft chapters 7 before the final deadline (29/9/2010) and the responses that were given by the project team can be found in Annex U.

CHAPTER 3 EXTRA INFORMATION SOURCES AND ANALYSIS TOOLS

Two dedicated calculation spreadsheet tools were elaborated:

- A first calculation spreadsheet that supports the first screening that includes all transformer energy related parameters was developed and is public available on the project website (www.ecotransformer.org). This is a useful tool that can easily be operated based on the reports and could support any other later scenarios or work.
- A second calculation spreadsheet containing a simplified analytic transformer model was developed in Task 5. It is described in Task 5 and will be available on the website. It allows assessing product optimization strategies without relying on confidential transformer manufacturer information.

Transformer load profiles were analysed. For the residential grid this could be done on publicly available information (see Task 3 report), in this process ERDF and ESB provided detailed information (see Task 3). For renewable information this was done using confidential information from Vito monitoring campaigns, only the calculated parameters can be disclosed. Also the IEE OFFSHOREGRID project was contacted but they could not provide direct usable information. The calculation is similar to the residential one, so anybody having new or future information will be able to calculate the impact of the loading profile (see Task 3 report).

The information on smaller transformers was obtained from catalogues, Vito is also user of these transformers for their research facilities and also information from the copper institute was received.

Several information was obtained from literature the references are included in the footnotes in the draft Task report.

CLASP provided a design report that was used for the Bill-of-Material and cost analysis of amorphous transformers (see Task 5 report).

ANNEX A MINUTES OF THE FIRST STAKEHOLDER MEETING

EuP Preparatory Study ENTR Lot 2: Distribution and Power Transformers

Minutes of the First Stakeholder Meeting

Place: European Commission
Berlaymont building, Brussels

Date / Time: July 6, 2009
10h-16h

Project contact:

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Agenda:

- Presentation of participants
- MEEuP methodology by BIO IS
- Task 1 by VITO
- Task 2 by VITO
- Task 3 by VITO
- Data needs and enquiry by VITO
- Planning & feedback on reports
- Any other business

Participants:

European Commission		
	Martin Eiffel	EC – DG ENTR
Lot 2 consortium		
	Paul Van Tichelen	VITO
	Liesbet Goovaerts	VITO
	Eefje Peeters	VITO
	Shailendra Mudgal	BIO Intelligence Service
	Benoît Tinetti	BIO Intelligence Service
	Alexander Thornton	BIO Intelligence Service
Stakeholders		
	Bastian Bach	ThyssenKrupp Steel AG
	Eric Coen	EREA NV
	Maya De Groot	Federal public service health, food chain safety and environment (Belgium)
	François-Xavier Dussart	GE
	Stefan Fassbinder	Deutsches Kupferinstitut
	Cinzia Formica	Orgalime
	Klaus Giefer	METGLAS® Transformer Products
	Michael Hastenrath	ThyssenKrupp Electrical Steel GmbH
	Michael Heinz	Sächsisch-Bayerische Starkstrom-Gerätebau
	Sigrid Jacobs	ArcelorMittal
	Elodie Jaussaud	RTE - CNER - SER
	Hans Lammert	ThyssenKrupp Electrical Steel GmbH
	Pierre Lucas	Orgalime
	Richard Mc Geehan	Hitachi
	Michel Sacotte	France Transfo

Hans-Paul Siderius	SenterNovem
Yukihiro Taniguchi	Hitachi
Frans Van Camp	ArcelorMittal

1. INTRODUCTION

Paul Van Tichelen (PVT) of VITO welcomed participants to the meeting and initiated introductions by all participants.

2. PRESENTATION ON MEEUP

Alexander Thornton (AT) of BIO Intelligence Service presented the methodology used in the study.

3. PRESENTATION ON PROGRESS OF TASK 1

PVT begins with a presentation of Task 1. Comments were made:

- **Definition of main Ecodesign parameters (slide 4)**

Maya De Groot (MdG) of federal public service health, food chain safety and environment: Is voltage considered an environmental hazard?

PVT: Safety hazards such as voltage and explosions are dealt with in other directives. However, safety issues should be added for completeness. It is important that the improvement options are safe as well.

Shailendra Mudgal (SM) of BIO Intelligence Service: It is important to discriminate between factors involved in the LCA and other hazards. Also, Ecodesign should not negatively affect the safety and functioning of products.

Martin Eiffel (ME) of the European Commission: We should define all relevant hazards, and then filter them for environmental ones. Non-environmental hazards cannot be included within the context of Ecodesign.

- **Definition – Scope (slide 6)**

SM: Smaller and specialty transformers may be out of the scope.

ME: The Commission intends to study all transformers including small and specialty. The goal is to have a full picture to know what to target as a first screening. This study will cover transformers similar to External Power Supply (EPS). The result of the study EPS did not cover transformers with regulation.

SM: Most stakeholders here represent larger transformers and those smaller are not present.

PVT: Better communication will have to be made to the other manufacturers, .

Eric Coen (EC) of EREA NV (manufacturer of smaller and specialty transformers): It is difficult to know the market as there are many transformers in housing and lighting. It is important to draw a line as there is the directive already for power supplies. Perhaps it is best to stop with power cutoff or function.

SM: The cutoff cannot be made based on power criteria because of the methodology of the Ecodesign studies. In addition, the data for EPS was very difficult to obtain.

Stefan Fassbinder (SF) of Deutsches Kupferinstitut: The definition of distribution transformers is from 16 kVA for single-phase and 35 kVA for 3-phase. I am surprised that the study wants to cover all types of transformers but I feel that it is feasible. I offer to provide a list of smaller transformer manufacturers.

PVT: For a study on all types of transformers, the study title is then misleading. It is essential to paint a complete picture with Task 1 and industry (Orgalime federation) is invited to submit information.

- **Verification of data in Definition – Scope (slide 8)**

PVT: Is the data with power transformers there 52 TWh of losses out of 3 100 TWh (1.5%)?

Elodie Jaussaud (EJ) of RTE – CNER – SER: In the transmission system, losses are 80% from the line and 15% from the transformers.

- **Test Standards (slide 10)**

SM: It is important to note that standards have a different connotation in Europe than in the US. In Europe, standards mean test standards while in the US, standards mean legislation.

ME: The European test standards result from the 3 accepted standards bodies in Europe. This study needs to identify standards gaps to avoid pitfalls in the future. Standards can be created if necessary.

PVT: For Ecodesign, maybe there will be no standards for negative health effects, but other parameters like voltage and efficiency which can be measured. Emphasis should be placed on performance and Ecodesign parameters. There is an open invitation to stakeholders to submit information and help identify gaps.

- **Existing legislation (slide 14)**

ME: It is important to first understand what exists in Europe, including extensions of Ecodesign, the introduction of incentives, and green public procurement. One can identify the level of incentives and other tools within each Member State. All instruments should be considered. It is important to see what has been done internationally, such as Minimum Energy Performance Standards (MEPS). Have any other parameters been considered?

4. PRESENTATION OF PROGRESS OF TASK 2

Liesbet Goovaerts (LG) of VITO continues with a presentation of task 2.

- **Energy efficiency (slide 25)**

Hans-Paul Siderius (HS) of SenterNovem: It seems according to the slide that transformers purchased today are less efficient than those bought earlier. The average no load losses increase with time according to the table.

PVT: The rating is also higher for newer transformers, so this is an incorrect interpretation of the data.

- **General questions/comments**

Sigrid Jacobs (SJ) of ArcelorMittal: There is also the possibility of using iron cobalt alloys which can go to rather high levels. These transformers are more compact. Has this been pursued in market data?

PVT: Transformer size has not been considered as a market parameter.

LG: This can be discussed later during Task 5 during research of best available and best not-yet available technology. The goal of Task 2 is to research what is commonly available now on the market.

5. PRESENTATION OF PROGRESS OF TASK 3

PVT and LG present the current status of Task 3.

6. PRESENTATION OF FOLLOWING ACTIONS AND PLANNING

PVT presents the future planning for after the meeting.

- **How to conduct commenting and receive input**

PVT: There are two options for the submission of input. Either stakeholders can comment on the chapters line by line, or they can fill out the enquiries that have been made.

Michel Sacotte (MS) of France Transfo: T&D Europe will meet and send unified comments on Tasks 1 – 3.

Cinzia Formica (CF) of Orgalime: Orgalime will try to find manufacturers of smaller transformers so that they can be included.

PVT: Most small- and medium-sized enterprises typically have low participation. It will be best to contact them directly. Also, in the next month the collection of data for tasks 4 and 5 will begin.

7. OPEN DISCUSSION

- **Weighting of environmental factors**

MdG: How will relative values on issues such as noise and other factors be given proper weight?

Benoît Tinetti (BT) of BIO Intelligence Service: The EcoReport tool will output the necessary environmental impacts. We do not combine or create a weighted average.

SM: We look for a correlation between factors, for example between electricity and global warming potential. Ecodesign looks for the most significant impacts. Noise is specific for this study and not part of the EcoReport. This must be discussed separately and will be analysed for Task 4.

PVT: A relative comparison will be made and perhaps certain environmental impacts will increase with the improvement options. Relative change is more important than absolute figures.

- **Submission of private information**

PVT: It is important to receive information that can be made public. We can speak privately as well on how to handle sensitive information.

SM: Non-disclosure agreements are possible. Data can be aggregated or averaged. Everything published will be verified prior to release.

- **Possibility of legislation**

ME: It is not set that there will be legislation. Perhaps there can be requirements, voluntary agreement, labelling, incentives, etc. The earlier stakeholders submit info and feedback, the greater influence they will have on the outcome. This meeting and the coming months are very crucial.

MS: T&D Europe is in favour of regulation. As a manufacturer, it is difficult to push a client to buy efficient products. The measurement of losses is difficult, and smaller companies could find ways to circumvent voluntary agreements.

- **Readability and consistency of figures**

SF: There is a problem of the readability of the figures. For example, the use of commas and periods to represent decimals in table 2.1 and 2.3 in Task 2.

PVT: This is due to computer parameters that are sometimes difficult to change. This problem will be improved upon in the future.

SM: This can be fixed by changing language settings of the computer.

SF: Also, the Excel language settings can be changed.

- **Scope and classification of study**

EC: It is very important to know where to stop with the small transformers, or to begin with some other kind of classification.

PVT: Originally the study was for distribution and power transformers, but the scope will be discussed further after the meeting. Classification of distribution and industrial transformers is already defined by standards.

HS: The scope should be based on functionality as opposed to technical characteristics. It is important to determine the lower limits of the scope so that there is no overlap or influence with other Ecodesign legislation.

MdG: I am surprised by the extension of the scope as this makes it a horizontal study.

ME: The European Commission does not want to differentiate based on who uses the transformer, including the small ones. The Commission wants a global overall picture.

- **Utility of DOE Transformer study**

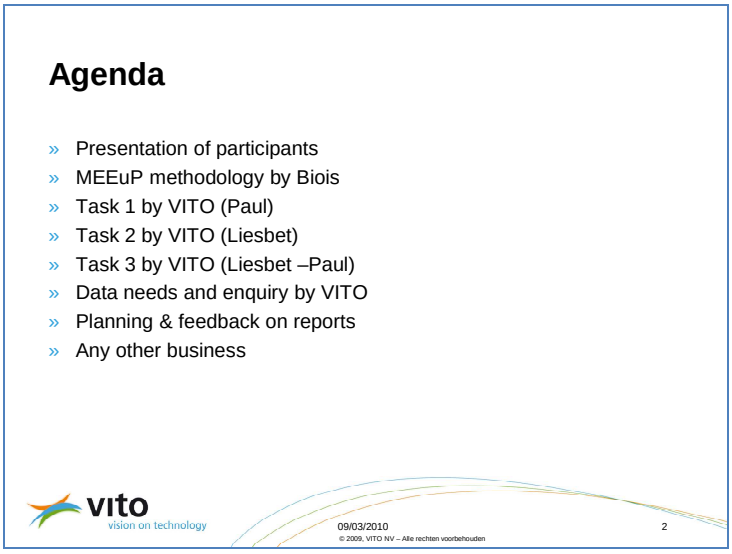
Frans Van Camp (FVC) of ArcelorMittal: The DOE did a study on transformers. How useful is this data for Europe?

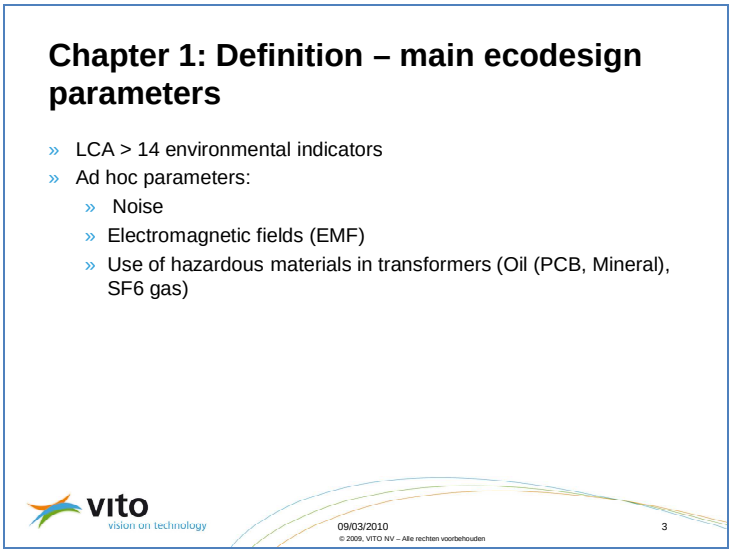
PVT: It is dangerous to transfer data because of the difference between the US and Europe in electrical system and economic parameters. The US study had a $6 million budget and lasted many years and contains therefore valuable information. It should be noted that US legislation is very different from that of the EU and includes formulas for economic optimisation and very specific test methods. It is subjective to economic parameter stability that are highly fluctuating. As a conclusion, it will be important in our study to conduct life-cycle analysis with correct interest and inflation assumptions as the product lifetime is long.

ME: The good ideas of the US study and legislation could be brought to the EU. Standards are very important.

ANNEX B MINUTES OF THE FIRST STAKEHOLDER MEETING PRESENTATIONS







Chapter 1: Definition – main ecodesign parameters

- LCA > 14 environmental indicators
- Ad hoc parameters:
  - Noise
  - Electromagnetic fields (EMF)
  - Use of hazardous materials in transformers (Oil (PCB, Mineral), SF6 gas)
- Energy Efficiency > load (Pk) and no load losses (Po) and Auxiliary Losses (Paux)
  - *Other?*

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Chapter 1: Definition – Categories

- Types of categories:
  - PRODCOM
  - rated power (S)
  - Technology
  - Type of service
  - *Any other?* Pole mount- oil (biodegradable-synthetic)

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Chapter 1: Definition – Scope

		Technology or functionality															
Name	Application	Oil	Dry	Gas	MV/LV	HV and/or MV	Phase change	LV/LV an to	LV/LV isolation (separation)	LV/SELV (control)	Cu winding	Alu winding	High SC impedance (>5%)	Am-steel core	Min kVA	Max kVA
MV/LV Distribution transformer	Distribution by DSO	99,99%	0,01%		100%						90%	10%		<50	50	2500
line voltage restorers	Distribution by DSO		100%					100%			xx				10	30
DER LV/MV transformers	Connecting DER by producer	20%	80%		100%						80%	20%	90%	0%	50	2500
Industry MV/LV oil transformer	Distribution by non DSO (industry, ..)	50%			100%						85%	15%			50	2500
Industry MV/LV dry transformer	Distribution by non DSO (industry, ..)		50%		100%						15%	85%	95%		50	4000
Power transfomer	Power by TSO (DSO)	100%		0%		99%					xx				5000	>
Phase	Power by TSO (DSO)	100%		0%			1%				xx				5000	>
Seperation/isolation transformer	Distribution by non DSO (industry, ..)		100%						xx		xx				1	63
Control transformer	Distribution by non DSO (industry, ..)		100%							xx	xx				0,04	2,5
Safety transformers	Industry application		100%							xx	xx				1	63
speciality transformers	Industry application	??	??		??	??					??	??	??	??	??	??

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Chapter 1: Definition – First impact screening

Name	Avg kVA	Stock 2005 (Kunits)	sales (units)	Pk Avg (sales 2005) Watt	PoAvg (sales 2005) Watt	Pk (Avg % load raw estimate)	Estimated TWh	Pk BAT Watt	Po BAT Watt	Pk (Avg % load raw estimate)	Estimated TWh
MV/LV Distribution transformer	250	3600	140400	3250	650	117	24	2350	300	84,835	12
line voltage restorers	25	??	??	??	??	??	??	??	??	??	??
DER LV/MV transformers	2000	20	2900	??	??	??	??	??	??	??	??
Industry MV/LV oil transformer	630	800	43200	6500	1300	1040	16	4600	600	166,06	5
Industry MV/LV dry transformer	800	170	8047	10000	2500	1600	6	6500	1600	234,65	3
Power transfomer	100000	64,4	1803	300000	80000	12000	52	300000	80000	12000	52
Phase	100000	0,65	17	300000	80000	12000	0	300000	80000	12000	1
Seperation/isolation transformer	25	??	??	??	??	??	??	??	??	??	??
Control transformer	1	??	??	??	??	??	??	??	??	??	??
Safety transformers	25	??	??	??	??	??	??	??	??	??	??
speciality transformers	??	??	??	??	??	??	??	??	??	??	??

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Chapter 1: Definition – Scope

- Background market&use data > Chapter 2&3
- Issues:
  - Power transformers: 52 TWh is about 1.5 % of 3100 TWh?
  - Smaller industrial transformers:
    - Smaller industrial transformers used in distribution:
      - Separating/isolating transformer
      - Control transformer (24 VAC)
  - Smaller industrial transformers used with industrial applications:
    - Safety transformers (lot 7)
    - Speciality transformers (welding, ..?)
- *Lack of data on smaller transformers? Improvement potential in transformer product? Improvement potential at system level (e.g. power electronic solutions)?*

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Chapter 1: Definition – Performance parameters

- Primary: Transformer rated power (S)
- Secondary energy efficiency related: No load losses (Po), Load losses (Pk), Auxiliary losses (Paux)
- Secondary application related: Load Factor (α = Pavg/S), Load form factor (Kf = =Prms/Pavg), Transformer availability factor (AF), Power factor (PF), K-factor.
- Secondary functional related: Short-circuit impedance, Rated voltage of the high-voltage winding (Vrms), Rated voltage of the low-voltage winding (Vrms), LwA dB (A), Vector group, Insulation temperature class, Protection class (IP), Fire behaviour class, Environmental class, Climate class.
- *Complete for the study?*
- *Functional Unit: proposal* 'Transformer rated power (S)' (correct in text)

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Standards – Test EN

- European (EN) Test Standards on Energy Use
  - EN 60076-1 (IEC 60076-1) 'Power transformers. General'
  - EN 50464 series under the general title "Three-phase oil-immersed distribution transformers 50Hz, from 50 kVA to 2500 kVA with highest voltage for equipment not exceeding 36kV"
- European (EN) Test Standards on other ecodesign parameters

Performance parameter or Ecodesign parameter	Standard	Status/notes	Gap identified
LwA dB (A): Sound power level of the transformer	IEC 600769-10??		?
EMF (electromagnetic field)	To complete		?
Hazardous substances PCB	To complete		?
Hazardous substances PCB	To complete		?
Hazardous substances PCB	To complete		?
ANY OTHER RELEVANT?			?
			?

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Chapter 1: Test Other&conclusion

- Input required: Sector, National, Third country
- Note: 'rated power' (S) definition differs IEC (EU) from IEEE (US)
- *Conclusion: There are no missing standards?*

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Chapter 1: Other relevant standards for the study – related to energy use or ecodesign parameters

- Table 1.6 (not in the right place in the text)
- EN 50464 series (oil filled distribution transformers)
  - four classes for the load losses (Ak to Dk) and five classes for no-load losses (A0 tot E0).
- HD 538.1 series (dry type distribution transformers)
  - Maximum level

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Chapter 1: Other relevant standards for the study

» To be completed:

Performance parameter or Ecodesign parameter	Standard	Status/notes	Gap identified
Short-circuit impedance	IEC 60076-1 (EN)		?
Rated voltage of the high-voltage winding (Vrms)	IEC 60076-1 (EN)		?
Rated voltage of the low-voltage winding (Vrms):	IEC 60076-1 (EN)		?
Insulation temperature class	IEC 60085 (EN)		?
Protection class (IP)	EN 60529		?
Fire behaviour class	IEC 60076-11 (Dry type transformers)		?
Environmental class	IEC 60076-11 (EN)		?
Climate class	IEC 60076-11 (EN)		?
ANY OTHER RELEVANT?			?

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Chapter 1: Existing legislation and agreements

» EU: Machinery (No), ROHS (No), WEEE (No), Directive 2004/40/EC on the minimum health and safety (system), Directive 89/106/EEC construction products (?), Directive 2005/32/EC on Eco-design (= study). *PCB ban?*
» Agreements EN: EN 50464 series, HD 538.1 series, SEEDT, *Any other?*
» Relevant Legislation at Member State level. *Any? PCB ban?*
» Third Country
  » Note:
    » European, most African and Asian: within 10% of 230 V at 50 Hz
    » Japan, North America and some parts of South America: 100 and 127 V at 60 Hz
  » Hence: grid different (size transformers), other losses

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Chapter 1: Third countries

» Many have MEPS for distribution transformers
» China has MEPS for power transformers (<31,5 MVA)
» Stakeholders are welcome to provide relevant input.
» Other smaller industry transformers?

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Chapter 2: Economic and Market Analysis

- Aim:
  - Generic economic data
  - Insights in past, recent and future stock and market
  - Additional parameters
  - Market trends
  - User expenditure data

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Chapter 2: Economic and Market Analysis

- **Generic economic data**
  - Europroms-Prodcom statistical data show:
    - LV dry industry largest market
    - MV oil industry second largest market
    - Distribution third largest market
    - Power smallest share
  - Market trend (market and growth) correlates with data literature and sector organisation, however not in number of units
  - Explanation:
    - Broader scope statistical data then literature (also small industrial transformers)
    - BUT, inconsistencies statistical data: more units imported, but greater monetary value produced?

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Chapter 2: Economic and Market Analysis

- Eurostat seems unreliable and not in line with figures other reports and sector data
  → other economic and market sources used

- Data retrieved from:
  - Literature
  - Sector organistion

  - Your input (especially on small transformers) and feedback!

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Chapter 2: Economic and Market Analysis

» **Economic data** retrieved till now: **STOCK**

Transformer type	Stock 1990 *K units*	Stock 2005 *K units*	Stock 2020 *K units*
MV/LV Distribution transformer (oil)	2 692	3 600	4 459
line voltage restorers	**?**	**?**	**?**
DER LV/MV transformers	0.25	20	90
Industry MV/LV oil transformer	598	800	991
Industry MV/LV dry transformer	127	170	211
Power transformer	48	64.35	80
Phase	0.49	0.65	0.81
Separation/isolation transformer (dry)	**?**	**?**	**?**
Control transformer (dry)	**?**	**?**	**?**
Safety transformers (dry)	**?**	**?**	**?**
Speciality transformer	**?**	**?**	**?**

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Chapter 2: Economic and Market Analysis

» **Economic data** retrieved till now: **MARKET** – estimated growth

» Sales new installation: estimation based on electricity consumption 1990-2005 and predictions for 2020 (=same method for STOCK 1990 and 2020)

» Replacement sales: estimation based on economic product life time

- » Distribution 40 years
- » Large industry oil 25 years
- » Large industry dry 30 years
- » Small industry dry 10 years
- » Power 70 years

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Chapter 2: Economic and Market Analysis

» **Economic data** retrieved till now: **MARKET** – estimated growth

Transformer type	New installed sales 1990-2005 *% p.a.*	New installed sales 2005-2020 *% p.a.*	Replacement sales *% p.a.*
MV/LV Distribution transformer (oil)	1.9	1.4	2.5
line voltage restorers	1.9	1.4	2.5
DER LV/MV transformers	34	10.5	4
Industry MV/LV oil transformer	1.9	1.4	4
Industry MV/LV dry transformer	1.9	1.4	3.3
Power transformer	1.9	1.4	1.4
Phase	1.9	1,4	1.4
Separation/isolation transformer (dry)	1.9	1.4	10
Control transformer (dry)	1.9	1.4	10
Safety transformers (dry)	1.9	1.4	10
Speciality transformer (?)	1.9	1.4	10

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Chapter 2: Economic and Market Analysis

» **Economic data** retrieved till now: **MARKET** – estimated figures

Transformer type	Total sales		
	1990	2005	2020
	units p.a.	*units p.a.*	*units p.a.*
MV/LV Distribution transformer (oil)	118 443	140 400	173 891
line voltage restorers	?	?	?
DER LV/MV transformers	95	2 900	13 050
Industry MV/LV oil transformer	35 294	43 200	53 505
Industry MV/LV dry transformer	6.652	8 047	9.966
Power transformer	1 588	1 802	2 232
Phase	16	18	23
Separation/isolation transformer (dry)	?	?	?
Control transformer (dry)	?	?	?
Safety transformers (dry)	?	?	?
Speciality transformer (?)	?	?	?

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Chapter 2: Economic and Market Analysis

» **Additional MEEuP market parameters**
- » Transformer design
- » Energy efficiency
- » Total inhabitants EU27
- » Electricity use EU27

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Chapter 2: Economic and Market Analysis

» **Additional MEEuP market parameters**
- » *Transformer design*
  - » Almost all transformers have Si-steel cores (0.0001% amorphous cores)
  - » 80-90% Cu windings and 10-20% Al windings

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Chapter 2: Economic and Market Analysis

- **Additional MEEuP market parameters**
  - *Energy efficiency*

Sector		*Average rating (kVA)*	*Average no-load loss (W)*	*Average load loss (W)*
MV/LV distribution oil	stock	250	650	3250
	sales	400	750	4600
Industry oil	stock	630	1300	6500
	sales	1000	1700	13000
Industry dry	stock	800	2500	10000
	sales	1250	2800	13100
Power	stock	100000	80000	300000
	sales	100000 ?	80000	300000
DER	stock	2000	?	?
	sales	2000	?	?
Small industrial transformers	stock	1-25	?	?
	sales	1-25	?	?

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Chapter 2: Economic and Market Analysis

- **Additional MEEuP market parameters**
  - Transformer design
  - Energy efficiency
  - *Total inhabitants EU27 from Eurostat*
  - *Electricity use EU27 per sector from Eurostat*

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Chapter 2: Economic and Market Analysis

- **Market trends**

- Trend to increase stock of residential distribution transformers
- Trend to increase stock of distribution transformers in decentralised renewable energy production
- Trend towards more power transformers in offshore farms
- Trend towards more power transformers used in EU interconnection lines

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Chapter 2: Economic and Market Analysis

- **Market trends**
- Duration of redesign cycle:
  - 3 to 12 months if production with same production lines
  - 3 to 5 years if production lines need to be changed

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Chapter 2: Economic and Market Analysis

- **User expenditure data**
  - Need for data → enquiry

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Chapter 3: User behaviour

- Aim:
  - Analysis of consumer behaviour: user information and barriers for eco-design
  - Analysis of real life situation:
    - real efficiency – energy use
    - harmonics and ambient temperature
    - end-of-life

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Chapter 3: User behaviour

- **User information - Potential barriers for eco-design measures**
  - Lack of awareness on environmental impact of transformers
  - Lack of users acceptance for higher cost and pay back time
  - Lack of information on energy efficiency
  - Lack on information on dimensional physical aspects
  - Other ?

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Chapter 3: User behaviour

- **Analysis of real life situation: real efficiency – energy use**
  - **Use phase**
    - **Real life efficiency → load profiles**
      - **Load profiles characterised by**
        - **load form factor**
        - **load factor**
        - **power factor**
        - **availability factor**

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Chapter 3: User behaviour

- **Analysis of real life situation: real efficiency – energy use**
  - **Use phase: load form, moad and power factor**

Application	Load form factor	Load factor	Power
Distribution	1.073	0.19	0.95
Industry	1.096	0.40	
Power	1.08	0.20	
DER (wind)	1.60	0.30	
Small transformers	1.096	0.40	

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Chapter 3: User behaviour

- Analysis of real life situation: real efficiency – energy use
  - Use phase: availibility factor

Application	AF (typ.)	AF (min.)	AF (max.)
distribution	1	1	1
industry	1	1	1
power	1	1	1
DER (wind)	1	0.5	1
small industry	0.25	0.12	1

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Chapter 3: User behaviour

- Analysis of real life situation: harmonics and ambient temperature
  - Harmonics : losses due to non-linear loads
    → use of highest efficiency transformers
  - Ambient temperature: resistance Cu and Al increases with ↗T°
    → load losses can increase/decrease

→ NOT taken into account as impact relative to chosen reference

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Chapter 3: User behaviour

- Analysis of real life situation: End-of-life
  - Repair:
    - rewind of transformer coils
    - Rebocking and reclambing of the coils
    - Repacement of ancillary equipment (fans, pumps, pressure relief,…)
  - Recyling and replacement

→ 99% dismanteled and recycled, others repaired

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Following actions

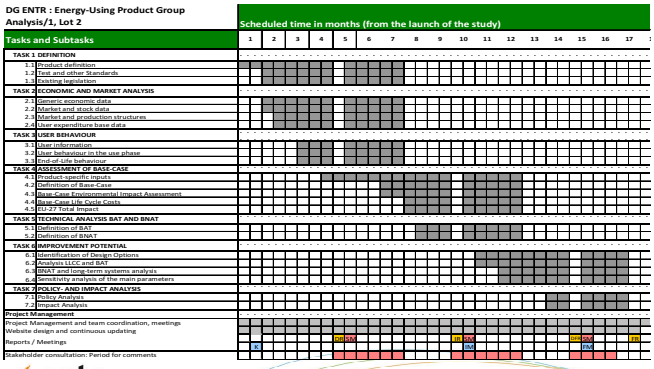
- Enquiry forms will be sent out
- Comments on the chapters 1-3 (next day small corrections with remark of the meeting)
- Comments on other chapters
- Data for chapter 4&5 (enquiries to industry)
- Deliverables and timing

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Planning



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Timing –target dates

Task	Draft for comment	Comment	Final
1	22/7	7/9	*30/9*
2	22/7	7/9	*30/9*
3	22/7	7/9	*30/9*
4	*10/11*	*15/12*	
5	*10/11*	*15/12*	
6			
7			30/6/10

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ANNEX C MINUTES OF MEETING WITH T&D EUROPE

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Mol, 26 march 2009

Meeting with Orgalime 17 March 2009 - main discussed issues

During our meeting on the EuP transformer project a few items were discussed on which we would like your confirmation:

- Industry will not be able to replace their transformers if the pay-back time is >20 years. This is only feasible for utility transformers because they calculate the pay back on a very long period..
- The price of steel anno 2009 is around € 3 per kg
- The price of amorphous steel is €3-4 per kg. . The price of standard steel was not stable, during the last 5 years, it has increased with a factor around of 2.5 since 2004. The price of amorphous steel depends on the price of Boron (B), one of the elements of amorphous steel;
- The use of amorphous steel will be necessary if the losses need to be reduced with 200% or more. Adjustment of the design of the transformer will only lead to 100-150% reduction of the losses.
- The replacement of steel cores by amorphous steel cores need to take into account:
  - The extra necessary capacity for the production of amorphous steel (knowing that 1 company may use 20 000 ton steel per year) The annual production of amorphous steel is around 80000T a year and not enough to supply the manufacturer of transformer.
  - The use of amorphous steel will require other tools and equipment
  - The use of amorphous steel will require an adjustment of the design of the core/winding
  - Reliability and sound are not totally mastered for the time being but could be if larger manufacturer produced this kind of transformers;
  - Currently companies are not ready to switch to amorphous cores (due to equipment and capacity). This will take min.at least 2 years.
- From 2010 all PCB containing liquid transformers must be replaced;
- The production capacity of transformer units is about 3% of the currently installed units. If you want to replace all transformers within 10 years this will require a substantial increase of the production capacity (about 200%). This will not only affect the manufacturers buth also the suppliers.
- The number of power transformer units is estimated at about 2000 units (this figure should be checked because it is only an assessment) sales per year, with about 10 companies who can produce this kind of large units. These transformer have already higher efficiencies than distribution transformers. However some power transformers may be over 50 years old, and could lead to high overall losses.

- T&D will provide the currently available data on sales, prices and market trends within 1 month
- T&D can provide data for the bill of materials for certain specified transformers. BIOIS and VITO will provide the specific cases.

- Next meeting will be on 4th of June in Brussels or Paris where we will discuss the first draft document.

T&D europe

The European Association of the Electricity Transmission and Distribution Equipment and Services Industry

Meeting between T&D Europe and Vito/Bio consultants on EuP preparatory study
17 March 2009 , 2pm /5pm, Diamant building ,Bld Reyers, 80, Brussels
MOM

Participants: for VITO Paul Van Tichelen; Eefje Peeters; Liesbet Goovaert; for Bio Benoit TINETTI and Alexander Thornton; for T&D Europe Michel Sacotte and Cinzia Formica

Presentation of participants

Mr Sacotte introduced T&D Europe and explained that it is a new association resulting from the merger of Capiel and Cotrel. T&D companies employ 200.000 people and represent a turn over €25 bn.

Mr Van Tichelen presented VITO (Flemish institute for technological research) which develops sustainable technologies in the area of energy, environment, materials and remote sensing. More than 500 persons work for VITO. The institute has already done EuP preparatory studies on lighting lots 8, 9, 19. The team working at the study on transformer will be composed of Paul, Liesbet, Eefje, Marcel (dealing with standards).

Mr Tinetti presented Bio which is specialists in the measurement environmental and health quality of products and services in France and Europe. Vito has an extensive experience with EuP preparatory studies and policy studies developed for the Commission on several topics.

The EuP functioning and methodology

Mr Tinetti explained how the EuP functions. The EuP applies to product categories which:

- represent a significant volume of products placed on the EU market (> 200.000 units/year),
- involve a significant environmental impact, and
- present a significant potential for improvement

A preparatory study, including or not the impact assessment is done by the consultants. A consultation Forum including Stakeholders, Commission and Member States meets regularly. On the base of the results of the study the Commission prepares a proposal which is sent to the Regulatory Committee for endorsement. If endorsed the Proposal is sent to the European Parliament for consultation. Scrutiny right can be used within 3 months from publication

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in the OJ. If the EP approves the Commission adopts the implementing measures. At the beginning of March implementing measures have been adopted for non efficient light bulbs http://europa.eu/rapid/pressReleasesAction.do?reference=IP/09/411&format=HTML&aged=0&language=EN&guiLanguage=en
and the Regulatory Committee has endorsed implementing measures for motors
http://europa.eu/rapid/pressReleasesAction.do?reference=IP/09/391&type=HTML&aged=0&language=EN&guiLanguage=en
The EuP referred only to energy using products, but now has been decided to include also the energy related products (not necessarily using directly energy). Bio is working with the European Commission at the working program for 2012 including energy related products.
For all lots of the EuP a methodology has been set up. The analysis is divided into an

- assessment of the present situation :
  1. definition,
  2. economic and market analysis,
  3. consumer behaviour
  4. assessment of base case.
- and in the evaluation of the development potential
  1. bat-bnat analyisis,
  2. improvement potential,
  3. macro analysis

After defining the product category, the related standards and the existing legislation; assessing the economic data available; defining the consumer behaviour, a **base case** must be defined. This is an average product /product category for all EU-27. On this base the all environmental and life cycle analysis will be built. It will be analysed the bill of material, the energy consumption, the end of life and the economic/market data.
The technical analysis of the BAT (best available technologies) and BNAT, technologies that require further R&D, will follow. This analysis will help to identify the **improvement potential**. The improvement potential will consist of different improvement options with different LCC. The BAT option with the LLCC (least life cycle cost) may be the solution. However a BNAT long term analysis and a **sensitivity analysis** of all parameters must be also carried out. At the end a policy and impact analysis will allow to summarise the outcomes of all previous phases. Suitable policy means to achieve the potential by using legislative or voluntary agreements will be proposed. It will be done a comparison of the BAT scenario vs. a Business-as-Usual scenario and a LLCC one. Impacts on consumers and industry will be pointed out.

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In the case of transformers the new technology could consist in the use of magnetic steel (amorphous core). However this may have many implications as the price of the raw material has multiplied by 2.5 since 2004 and it is not clear whether enough production of magnetic steel would be available. It is also to be considered that some machines may have to be replaced to use this new material. Energy efficiency and other environmental impacts will be considered not only in relation to the functioning of the transformers, but also to the production of the transformer. In so doing a better efficient new transformer could imply a higher use of energy due to the production process involving more energy using material. It is therefore needed a Bill of material to evaluate whether a technology is really bringing energy savings.
A change in the technology cannot be forced by the politicians if companies are not ready for it (eg: if only one company is ready to start a production on the base of a new technology and the others are not). It is important to consider that the EuP takes into account a normal life cycle approach as an accelerated replacement of products is not in its scope. The EuP therefore focus on new products and not on installed ones. For installed products apply the Energy Service directive
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:114:0064:0085:EN:PDF

T&D position on EuP

Since the beginning T&D Europe has supported the Commission intention to do a preparatory study on transformers to assess the capacity of the sector to improve energy efficiency. T&D Europe considers that the best way to realise the potential is to adopt bounding regulatory measures. Only in this way the replacement on the installed transformers would be faster. In fact on one hand the advantage of replacing an old transformer with a new more efficient is not so visible in the short term (the amortization of the investment is too long) and on the other hand the measurement of the losses of the transformers are difficult to do and may lead to distortions.

Timetable

The study on Transformers will be completed in around 1 an d ½ year (it should be finished by June 2010). The impact assessment that was not public until now may become public. The study is led by DG ENTR

- Before end of May a first draft report addressing task 1, 2 and 3 will be available.

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- T&D will have to comment on that in the following 2 weeks (last week of May, first week of June).
- On 23rd of June a stakeholder meeting is planned.
- Vito+Bio will prepare their answers to T&D comments during the two weeks before the meeting
- In general expert meeting (only Vito+Bio and T&D) can be set upon request.

Data required to T&D

The definition of the scope needs still some refining and can be discussed at the first stakeholder meeting in June. At the moment on request of the European Commission power transformer s are part of the study, even though they represent only about 2000 units per year (according to Mr Sacotte). It is important to clearly define the product scope following technical parameters. The consultants need existing data available about:

1. number of units, capacity and average efficiency of installed distribution and power transformers.
2. forecast referring to the possible increase of the number of units of power and distribution transformers by 2020
3. market trends, stocks and prices of transformers €/kVA
4. average of the rated power
5. best available technologies

Next steps

- Vito/Bio will send in a few days a questionnaire to T&D asking information as explained above.
- T&D will answer to the questions as soon as possible (by mid April)
- By end of May Vito/Bio will send to T&D Europe for comments his draft report covering task 1,2 and 3 of the methodology.
- Mr. Sacotte chairman of the task force energy efficiency of Transformers in T&D Europe will organise a meeting to analyse the report above mentioned. VITO/Bio will participate to the meeting

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ANNEX D FIRST ENQUIRY FOR MANUFACTURERS



Contact BIO Intelligence Service
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Alexander Thornton
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benoit.tinetti@biois.com
alexander.thornton@biois.com

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3. Confidentiality 3
4. Product case specific background information 4
4.1. Costs 4
4.2. Specifications 5
4.3. Use phase 7
4.4. End of Life 9
5. Best not-yet availabe technology (BNAT) 10
6. Bill of Materials (Excel sheet) 10
Modular Approach 10

1. INTRODUCTION

Directive 2005/32/EC establishes a framework for setting ecodesign requirements (e.g. energy efficiency) for a wide range of products and, thus, it is going to affect environmental and/or energy efficiency specifications of a variety of products sold in Europe in the future.

The ENTR Lot 2 preparatory study is the first step in considering whether and which ecodesign requirements could be set for power and distribution transformers falling into the scope of this study. To this end, technical and economic data is needed from stakeholders to ensure that that the study accurately reflects reality.

This questionnaire document is intended to structure your data input to reflect the current and future situation in the transformer market (EU) appropriately.

We are aware that for many aspects there might be no concrete data, but an expert's educated guess would be better than no data at all. Therefore, we encourage you to fill data gaps through **"educated guesses"**. However, in the case that you do not have access to the information asked, please **do not hesitate to skip questions and leave blank answers.**

Please respond to this document before 7 January, 2010.

Please contact webmaster@ecotransformer.com in the event of any questions.

Instructions: Please fill in data for at least **two products for each type and rating of transformer specified**: the first one considered an average representative of the transformer type, and the other one(s) an example of Best Available Technology (BAT) (e.g. very high efficiency).

For each product, please fill out a separate **questionnaire and associated spreadsheet** ("Lot 2 BOM Spreadsheet"), which can be downloaded at: http://www.ecotransformer.org/docs_unprotected/BOM.xls.

If you operate other types of transformers you consider to be relevant, please feel free to provide information about these as well.

2. CONTACT DETAILS

- Organisation: _____
- Name: _____
- Position/Department: _____
- Telephone: _____
- E-mail: _____

3. CONFIDENTIALITY

Please state explicitly if you would prefer to provide information only under terms of confidentiality. If you have already signed a non-disclosure agreement (NDA) with us, please skip this section.

Confidential data: No ☐ Yes ☐

Note: We ensure complete confidentiality; however, it is also possible to sign a NDA. Please do not hesitate to contact us for such an agreement.

4. PRODUCT CASE SPECIFIC BACKGROUND INFORMATION

In this section, we seek technical data related to the transformers you operate and identify as being representative of the five following transformer types (average product sold on the EU market today) within the scope of our study. Please provide information on transformers as similar as possible to the defined types:

Type (please tick)	Most typical rating S [kVA]	Typical no-load loss Po [W] at 75 °C	Typical load loss Pk [W] at 75 °C
☐ Type 1 MV/LV distribution oil-immersed	400	750 (D0)	4600 (Ck)
☐ Type 2 Industry oil-immersed	1000	1700 (E0)	10500 (Ck)
☐ Type 3 Industry dry-type	1250	2800	13100
☐ Type 4 Power transformer	100000	80000	300000
☐ Type 5 DER[1] transformer	2000	1760	16800

Model reference:

Transformer technology (reminder: please provide us data for one average product and at least one BAT):

☐ Average product

☐ Best Available Technology (BAT) (e.g. very high efficiency, very low noise, etc.)

If BAT, please shortly describe how it was achieved:

4.1. COSTS

We need different types of costs in order to evaluate the influence of the Ecodesign Directive on the cost of future products. We are aware that the cost is confidential data and we do not ask you to specify the "precise" cost of the specific transformer operated by your company. If you can provide an average market price for a similar

[1] Distributed Energy Resources (e.g. connecting wind turbines)

model, it will be sufficient for our analysis. **Individual cost data will be kept confidential. The data provided will only be presented publicly in aggregated form.**

(1) Approximate manufacturing cost for this type of transformer: euros

(2) Approximate buying price for this type of transformer (VAT included): euros

(3) Date of price (month/year): /

(4) Is the purchase price of the transformer determined by a contract indexed to the price of materials?

☐ Yes ☐ No

(5) Approximate installation cost: euros

(6) Estimated maintenance/repair costs: euros per (e.g. per year, per lifetime)

(7) Is end-of-life considered a positive gain or negative expense? Please quantify this gain or expense, if possible.

☐ Gain: euros ☐ Expense: euros

Please provide information on the proportion of the sale price that arises from the following:

- Distribution: %
- Production: %
- Sales margin: %
- Taxes: %
- Other (please specify:): %

4.2. SPECIFICATIONS

Please give the specifications for your product case (all major technical and design product characteristics):

(1) Insulation type:

☐ Oil-immersed ☐ Dry-type ☐ Other (specify):

If dry-type, basic impulse insulation level (BIL):

If oil-immersed, tank shape:

(2) Main characteristics:

Rated Power (IEC 60050): kVA

Voltages:

Primary (IEC 60076): V

Secondary(IEC 60076): V

Frequency(IEC 60076): Hz

Short-circuit impedance(IEC 60076): %

(3) Core design:

Configuration (e.g. wound core distributed gap, 5-leg):

Steel type:

(4) Conductor metal:

High Voltage metal type:

Low Voltage metal type:

Tap configuration (e.g. four 2½ percent, two above and two below the nominal):

(5) Classes:

Vector group (e.g. Dy1): (IEC)

Insulation temperature class (for dry-type only): (IEC 60085)

Protection class: (IP)

Fire behaviour class (for dry-type only): (IEC 60076-11)

Environmental class (for dry-type only): (IEC 60076-11)

Climate class: (IEC 60076-11)

(6) External dimensions:

Height: cm

Width: cm

Depth: cm

Gross weight: kg

Volume (packaged): m^3

(7) Please specify any other relevant specifications of the product, if not covered in the questions above:

(8) Do you think the current standards as specified in Task 1 provide sufficient methods for measurements and calculations of significant environmental impacts and ecodesign performance levels for significant environmental impacts of transformers ?

☐ Yes ☐ No

If no, please specify any gaps you identify for:

Performance standards (i.e. IEC 60076-1, IEC 60050, EN 50464):

Ecodesign standards (i.e. IEC vector group code, IEC 600769-10, EN 50413:2009):

Measurement and calculations methods standards (i.e. IEC standards series):

Safety standards (i.e. EN 60529, IEC 60076-11, IEC 60085):

Other standards:

4.3. USE PHASE

We are fully aware that the manufacturer may not be in possession of information regarding the use phase of the transformer but even estimations would be useful. Please provide data in accordance with the following standards: EN 60076 for power transformers, EN 50464 series for oil-immersed distribution transformers, HD 538.1 for dry-type distribution transformers. If other standards are used, please specify these in question 6 of this section.

(1) Please specify:

Load loss at 100% load (IEC 60076): kW (☐ at 75°C ☐ at 120 °C)

Temperature corrected load loss at 50% load (if available): kW

No-load loss (IEC 60076): kW

Auxiliary loss: kW (fans, pumps,...)

A-weighted sound power level: dB(A)

If the transformer uses BAT regarding sound level, please shortly describe how it was achieved:

Temperature Rise: °C

Ambient Temperature: °C

(2) Use of consumables/chemicals (e.g. oil, water, paint) for transformer use/maintenance/service

Material	Quantity (e.g. 100)	Unit (e.g. kg/yr)	Service interval (years)
		/	
		/	
		/	
		/	
		/	
		/	

(3) Please specify any other relevant data regarding the use phase, if not covered in the questions above (other standards):

4.4. END OF LIFE

We are fully aware that the manufacturer may not be in possession of information regarding the end of life of the transformer but even estimations would be useful.

(1) Do you take back transformers that have reached end-of-life?

☐ Yes ☐ No

If yes, please provide information on how end-of-life is managed:

If no, please provide information on who manages the end-of-life and how, to the best of your knowledge:

(2) Recycled waste: % (of the total transformer weight)

Incinerated waste: % (of the total transformer weight)

Waste to landfill: % (of the total transformer weight)

(3) Hazardous waste: % (of the total transformer weight)

(4) Cooling liquid (e.g. oil):

Type:

Quantity: kg

Cooling liquid recycled/reused: % (of the total cooling liquid weight)

Cooling liquid waste: % (of the total cooling liquid weight)

(5) Metal recycled/reused: % (of the total metal weight)

Metal waste: % (of the total metal weight)

(6) Plastics:

Re-use, closed loop recycling: % (of the total plastics weight)

Materials recycling: % (of the total plastics weight)

Thermal recycling: % (of the total plastics weight)

5. BEST NOT-YET AVAILABE TECHNOLOGY (BNAT)

Please inform us about ongoing technology developments and improvements that are not yet available on the market:

6. BILL OF MATERIALS (EXCEL SHEET)

We provide here an excel spreadsheet which will enable us to get the suitable inputs for a coherent application of the MEEuP methodology. Please note that this sheet is derived from the LCA tool used in the methodology but is very simplified in order to make it easier for you to fill. As a result, we would appreciate if you could provide **precisions on material types in the column "Details" whenever possible** in order to make our analysis more accurate.

If you prefer to provide BOM data separately because you might have it in another document, feel free to attach this data (but ensure that a link to weights is possible).

MODULAR APPROACH

To enable the identification of technical and environmental improvement potential the link between material/component and function/functionality is needed (at least on a confidential basis). We want to make your (internal) data acquisition as easy as possible, but in case your data basis is more detailed than requested by us (e.g. component weights on BOM level instead of aggregated data), we would like to ask you to share this data with us for a better understanding and future discussion on improvement potentials (data on BOM level will not be published in the project reports). Please split up the product declaration in the following modules:

- Coil/Windings
- Core
- Cooling/insulation system
- Tank/frame
- Cast compound
- Coatings
- Auxiliary equipment

- **Electric assembly:** Please, list all components and materials existing in the electric panel. Moreover, this module contains all cables, including the power cable.
- **Miscellaneous:** All materials/components relevant for your product but not being part of the above mentioned seven groups should be stated under miscellaneous (e.g. temperature display systems...).

Please feel free to add in the excel file any missing subcomponents for these modules.

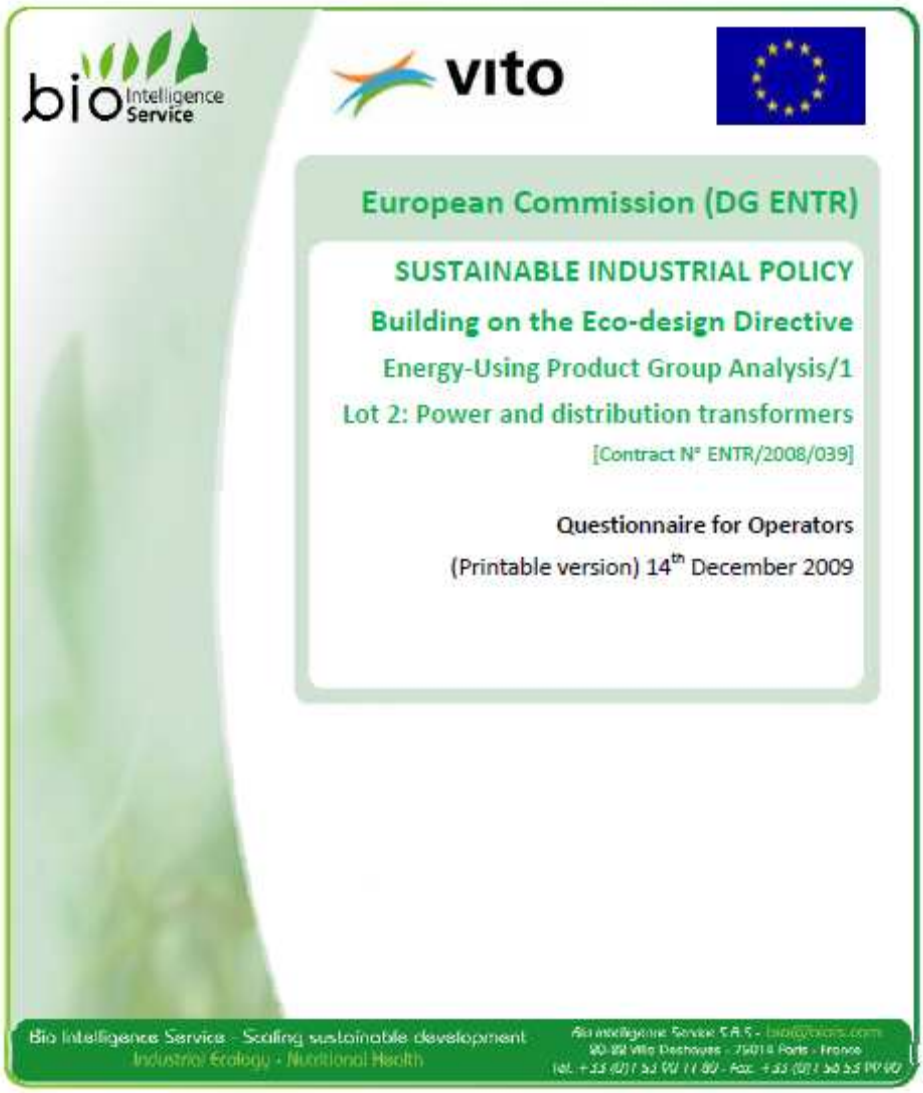
Download: http://www.ecotransformer.org/docs_unprotected/BOM.xls

Please send responses and inquiries to Alexander Thornton and Thibault Faninger at alexander.thornton@biois.com / thibault.faninger@biois.com

or by fax: + 33 1 56 53 99 90

For any questions, please contact us by telephone: + 33 1 53 90 11 80

ANNEX E FIRST ENQUIRY FOR OPERATORS



Contact BIO Intelligence Service
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benoit.tinetti@biois.com
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Contents

1. Introduction 3
2. Contact details 3
3. Confidentiality 3
4. Product case specific background information 4
4.1. Costs 5
4.2. Specifications 5
4.3. Use phase 7
4.4. End of Life 9

1. INTRODUCTION

Directive 2005/32/EC establishes a framework for setting ecodesign requirements (e.g. energy efficiency) for a wide range of products and, thus, it is going to affect environmental and/or energy efficiency specifications of a variety of products sold in Europe in the future.

The ENTR Lot 2 preparatory study is the first step in considering whether and which ecodesign requirements could be set for power and distribution transformers falling into the scope of this study. To this end, technical and economic data is needed from stakeholders to ensure that that the study accurately reflects reality.

This questionnaire document is intended to structure your data input to reflect the current and future situation in the transformer market (EU) appropriately.

We are aware that for many aspects there might be no concrete data, but an expert's educated guess would be better than no data at all. Therefore, we encourage you to fill data gaps through **"educated guesses"**. However, in the case that you do not have access to the information asked, please **do not hesitate to skip questions and leave blank answers.**

Please respond to this document before 7 January, 2010.

Please contact webmaster@ecotransformer.com in the event of any questions.

Instructions: Please fill in data for at least **two products for each type and rating of transformer specified**: the first one considered an average representative of the transformer type, and the other one(s) an example of Best Available Technology (BAT) (e.g. very high efficiency).

For each product, please fill out a separate questionnaire. If you operate other types of transformers you consider to be relevant, please feel free to provide information about these as well.

2. CONTACT DETAILS

- Organisation: _____
- Name: _____
- Position/Department: _____
- Telephone: _____
- E-mail: _____

3. CONFIDENTIALITY

Please state explicitly if you would prefer to provide information only under terms of confidentiality. If you have already signed a non-disclosure agreement (NDA) with us, please skip this section.

Confidential data: No ☐ Yes ☐

Note: We ensure complete confidentiality; however, it is also possible to sign a NDA. Please do not hesitate to contact us for such an agreement.

4. PRODUCT CASE SPECIFIC BACKGROUND INFORMATION

In this section, we seek technical data related to the transformers you operate and identify as being representative of the five following transformer types (average product sold on the EU market today) within the scope of our study. Please provide information on transformers as similar as possible to the defined types:

Type (please tick)	Most typical rating S [kVA]
☐ Type 1 MV/LV distribution oil-immersed	400
☐ Type 2 Industry oil-immersed	1000
☐ Type 3 Industry dry-type	1250
☐ Type 4 Power transformer	100000
☐ Type 5 DER[1] transformer	2000

Model reference:

Manufacturer and contact details:

Typical no-load loss (Po) at 75°C (IEC 60076): W

Typical load loss (Pk) at 75°C (IEC 60076): W

Transformer technology (reminder: please provide us data for one average product and at least one BAT):

☐ Average product

☐ Best Available Technology (BAT) (e.g. very high efficiency, very low noise, etc.)

If BAT, please shortly describe how it was achieved:

[1] Distributed Energy Resources (e.g. connecting wind turbines)

4.1. COSTS

We need different types of costs in order to evaluate the influence of the Ecodesign directive on the cost of future products. We are aware that the cost is confidential data and we do not ask you to specify the "precise" cost of the specific transformer operated by your company. If you can provide an average market price for a similar model, it will be sufficient for our analysis. **Individual cost data will be kept confidential. The data provided will only be presented publicly in aggregated form.**

(1) Approximate buying price for this type of transformer: euros

(2) Date of price (month/year): /

(3) Metal content of the transformer:

Metal (Cu, Al, steel...)	Quantity (kg)

Is the purchase price of the transformer determined by a contract indexed to the price of materials?

☐ Yes ☐ No

(4) Average installation cost (if done by the manufacturer): euros

(5) Average maintenance/repair costs: euros per (e.g. per year, per economic lifetime)

(6) Does end-of-life considered a positive gain or negative expense? Please quantify this gain or expense, if possible.

☐ Gain: euros ☐ Expense: euros

4.2. SPECIFICATIONS

Please give the specifications for your product case (all major technical and design product characteristics) to which you have access. We are aware that you may not be able to answer all the questions of this section which are related to the manufacturing.

(1) Insulation type:

☐ Oil-immersed ☐ Dry-type ☐ Other (specify):

If dry-type, basic impulse insulation level (BIL):

If oil-immersed, tank shape:

(2) Main characteristics:

Rated Power (IEC 60050): kVA

Voltages:

Primary (IEC 60076): V

Secondary (IEC 60076): V

Frequency (IEC 60076): Hz

Short-circuit Impedance (IEC 60076): %

(3) Core design:

Configuration (e.g. wound core distributed gap, 5-leg):

Steel type:

(4) Conductor metal:

High Voltage metal type:

Low Voltage metal type:

Tap configuration (e.g. four 2½ percent, two above and two below the nominal):

(5) Classes:

Vector group (e.g. Dy1): (IEC)

Insulation temperature class (for dry-type only): (IEC 60085)

Protection class: (IP)

Fire behaviour class (for dry-type only): (IEC 60076-11)

Environmental class (for dry-type only): (IEC 60076-11)

Climate class: (IEC 60076-11)

(6) External dimensions:

Height: cm

Width: cm

Depth: cm

Gross weight: kg

Volume (packaged): m^3

(7) Please specify any other relevant specifications of the product, if not covered in the questions above:

(8) Do you think the current standards as specified in Task 1 provide sufficient methods for measurements and calculations of significant environmental impacts and ecodesign performance levels for significant environmental impacts of transformers?

☐ Yes ☐ No

If no, please specify any gaps you identify for:

Performance standards (i.e. IEC 60076-1, IEC 60050, EN 50464):

Ecodesign standards (i.e. IEC vector group code, IEC 600769-10, EN 50413:2009):

Measurement and calculations methods standards (i.e. IEC standards series):

Safety standards (i.e. EN 60529, IEC 60076-11, IEC 60085):

Other standards:

4.3. USE PHASE

Please provide data in accordance with the following standards: EN 60076 for power transformers, EN 50464 series for oil-immersed distribution transformers, HD 538.1 for dry-type distribution transformers. If other standards are used, please specify these in question 6 of this section. Please provide any additional data available (real life conditions...) in question 6 of this section as well.

(1) Please specify:

Auxiliary loss: kW (fans, pumps, etc.)

A-weighted sound power level: dB(A)

If the transformer achieves BAT regarding sound level, please shortly describe how it was achieved:

Temperature Rise: °C

Ambient Temperature: °C

(2) Please list the average working hours of each component of the transformer (an educated approximate figure would be appreciated if data is not available):

Component	Hours per day (h/d)	On-mode electricity consumption per hour (kWh)	Max power (W)	Average Power (W)	Model reference of component
Fan(s)					
Pump(s)					
Other (please specify)					
Other (please specify)					
Other (please specify)					

(3) Use of consumables/chemicals (e.g. oil, water, paint) for transformer use/maintenance/service

Material	Quantity (e.g. 100)	Unit (e.g. kg/yr)	Service interval (years)
		/	
		/	
		/	
		/	
		/	
		/	

(4) Please specify any other relevant data regarding the use phase, if not covered in the questions above (e.g. other standards):

4.4. End of Life

(1) Do you manage the end-of-life of the transformer?

☐ Yes ☐ No

If yes, please provide information on how end-of-life is managed:

If no, please provide information on who manages it and how, to the best of your knowledge:

(2) Recycled waste: % (of the total transformer weight)

Incinerated waste: % (of the total transformer weight)

Waste to landfill: % (of the total transformer weight)

(3) Hazardous waste: % (of the total transformer weight)

(4) Cooling liquid (e.g. oil):

Type:

Quantity: kg

Cooling liquid recycled/reused: % (of the total cooling liquid weight)

Cooling liquid thermally recycled: % (of the total cooling liquid weight)

Cooling liquid waste: % (of the total cooling liquid weight)

(5) Metal:

Metal recycled/reused: % (of the total metal weight)

Metal waste: % (of the total metal weight)

(6) Plastics:

Re-use, closed loop recycling: % (of the total plastics weight)

Materials recycling: % (of the total plastics weight)

Thermal recycling: % (of the total plastics weight)

Please send responses and inquiries to Alexander Thornton and Thibault Faninger at alexander.thornton@biois.com / thibault.faninger@biois.com

or by fax: + 33 1 56 53 99 90

For any questions, please contact us by telephone: + 33 1 53 90 11 80

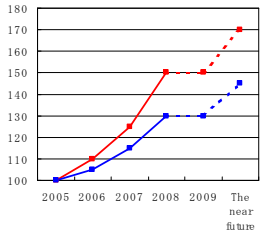
ANNEX F COMMENTS RECEIVED PRIOR TO THE SECOND STAKEHOLDER MEETING (TASKS 1-3)

Comments to the VITO and partners Draft Report						
Number / Ident Stakeh	**Cap**	**Page nr**	**Text extract**	**Comments**	**Alternative proposal (if availble)**	**VITO and partners Reply**
Task 1						
1. **ORG**	line 2	7		The category E0 misses on the second line to be in compliance with the standard		agreed
2. **ORG**	line 3 before the end of the page	11	Oil filled distribution transformers mostly contain Synthetic transformer oil if released	Replace Synthetic transformer oil by Mineral transformer oil		agreed
3. **ORG**	Add line 5	12		SF6 transformers are currently not used in Eu Only less than 100 units has been installed.		Agreed text adapted
4. **ORG**	lastline before the end of the page	12	They also occur in the windings and tanks.and metal parts Amongst others, stranded conductors are used to lower the eddy current loss.			agreed
5. **ORG**	1.54 in the middle of the page	17	Liquid filled transformers are smaller in size than dry-type units for the same power rating capacity and have lower losses due to their ~~better thermal dissipation characteristics~~ smaller dielectric distances			agreed
6. **ORG**	in the middle	17	~~Because of potential fire hazard, these transformers are used in outdoor applications (e.g. distribution transformers).~~ This purpose is not true and this sentence must be deleted			adopted

Comments to the VITO and partners Draft Report						
Number / Ident Stakeh	**Cap**	**Page nr**	**Text extract**	**Comments**	**Alternative proposal (if availble)**	**VITO and partners Reply**
7. **ORG**	before the end of the page (add and delete)	17	The third letter expresses the external cooling medium. The fourth letter identifies the circulation mechanism for external cooling medium. The following cooling methods exist: • ONAN: Oil Natural Air Natural • ONAF: Oil Natural Air Forced • OFAN: Oil Forced Air Natural • OFAF: Oil Forced Air Forced • OFWF: Oil Forced Water Forces Other combinations are also possible ~~(e.g. ONAN, ..)~~			Adapted
8. **ORG**	First sentence	18	In large power transformers (>25 MVA) gas-filled transformers are ~~also~~ exceptionally used.			adopted
9. **ORG**	3rd	18	Such a transformer is sometimes referred to as a gasinsulated~~(GIS)~~ transformer. GIS is used for switch gear and not for transformers (idem in page 12). GIS has to be deleted in the whole document.			adapted
10. **ORG**	Last line	24	Functional unit used for the LCA10 of Distribution transformer 16/20 MVA was 1 kVA of the system apparent power. Check if it really distribution transformer?			adapted
11. **ORG**	1.6	30	No			Added that Orgalimes agree it is complete
12. **ORG**	Table 1.6	30	EN 60726 is now obsolete has been cancelled. IEC document is 60076-12 is now available IEC 60729 is not applicable for the transformer			Deleted as proposed

Comments to the VITO and partners Draft Report						
Number / Ident Stakeh	**Cap**	**Page nr**	**Text extract**	**Comments**	**Alternative proposal (if availble)**	**VITO and partners Reply**
13. **SMA**	Last sentence	34	If any of the primary and/or the secondary voltage falls within LVD limits it is subject to LVD(stakeholders are invited to provide input). This sentence is not true. If any of the primary and/or the secondary voltage falls within LVD limits it is not subject to LVD(stakeholders are invited to provide input).	If any of the primary and/or the secondary voltage falls above LVD limits it is not subject to LVD		Under consideration
14. **SMA**		41	COMMENTS FROM SMA Figure 1-6. If we are comparing the best practices of the international standards, HD 428 A'A is neither a reference (it has been replaced by EN 50464, no longer a prEN), nor the best practice of that document. EN 50464 not is a line on the chart, because it covers from AoAk to EoDk, a very wide strip of the chart. The best eficiency practice on the real european market is BkBo with conventional materials, or BkAo using special laser treated magnetic steel (not available in quantities for a wide use). AoAk involves the use of great amounts of laser steel and copper, not a real alternative nowadays.	COMMENTS ORG I do not share the information given in this paragraph done by Spanish committee. In fact it is possible to manufacture transformers A0Ak with another quality of magnetic steels than laser and the source of purchasing of laser is more wide than Spanish committee believed;		More complete picture was supplied by Hitachi. In line with Orgalimes view
15. **SMA**		11		Environmental parameters. Noise: spectrum of noise between 100 and 2000 Hz of range (not only a 50 Hz noise)		Text adapted
16. **SMA**		12		Load losses (Pk) are function of the load factor. Their value at rated load is determined when the secondary circuit is short-circuited and		Text adapted

Comments to the VITO and partners Draft Report						
Number / Ident Stakeh	**Cap**	**Page nr**	**Text extract**	**Comments**	**Alternative proposal (if availble)**	**VITO and partners Reply**
17. SMA		20	COMMENTS FROM SMA Add a new category c) in 1.5.5 addressing "Small transformers used for consume products" (LV-LV or LV to DC). In this category should be contemplated all small transformers used for power supply units of appliances, electronic devices, UPS.... The number of these type of transformers is huge, and their efficiency is neither categorized nor controlled so it can be supposed to be very low. In the preliminary studies has been contemplated as a category with big energy savings potential, but in this stage seems to have disappeared of the scope of the study.	COMMENTS ORG For me that is an other story and it is outside TC14 and T&D scope.		This category has been added but with a clear reference of being out of T&D scope in line with Orgalimes point of view
18. **SMA**	Tables	21		Tables 1.2, 1.3 and following, should contemplate the c) category.		Under considaration
19. **SMA**	Tables	28		tables 1.4 and 1.5. Vito is asking to stakeholders to provide information about status and gaps. WG3 has not given any answer about this by the moment. We are not able to evaluate the relevance of this information, but if it's not relevant (as it seems to be empty until now) we propose to eliminate the columns; if it's relevant we must ask for clarification on this point, and answer it.		Will be noted in the text
20. **SMA**	1.8.3	36		In Spain, National Regulations ask for a minimum level of efficiency for Distribution Transformers (from 50 to 2500 kVA, up to 36 kV) for both, utilities and industrial users based on the lists of losses of EN50464. We have not knowledge about other countries with a minimum efficiency requirement legislation for industrial market.		Added
21. **HITT**	1.3	11	Noise	Noise level should be determined in accordance with installation environment. Japanese transformers for utility companies are regulated as <45dB in the rural areas, 50dB in other areas.		Added in section 1.8.4
22. **HITT**	1.3	11	EMF	Japanese utilities are now considering the regulation "<1000mG".		Added

Comments to the VITO and partners Draft Report						
Number / Ident Stakeh	**Cap**	**Page nr**	**Text extract**	**Comments**	**Alternative proposal (if availble)**	**VITO and partners Reply**
23. **HITT**	1.3	11	PCB	Disposal of transformer with Insulation oil containing PCB(>0.5ppm) is now carrying out up to 2016 in accordance with Legal act. Distribution equipment such as switches has been developed no to use SF6 Gas.		Noted
24. **HITT**	1.5.3	17	Rated Power	In Japan, Distribution transformers are categorized "Single phase (10,20,30kVA) Three phase (20,30kVA)"		Noted (far different from Europe)
25. **HITT**	1.5.4	17	Subcategories	Material prices are changed by movement of market. The cost of transformers is greatly influenced by the price of the material. Please see next slides. 		Not an issue of chapter 1
26. **HITT**	1.5.6	20	Category	Oil filled or dry type. Rated voltage(10or20or30kV).		Text added 'Please note that a more specific parameter is the MV or LV rated voltage.'
27. **HITT**	1.7.1.2	26-33	Specification	Please see next slides. Appendix A		Figure 1-6 with comparison was updated based on these slides

Comments to the VITO and partners Draft Report						
Number / Ident Stakeh	**Cap**	**Page nr**	**Text extract**	**Comments**	**Alternative proposal (if availble)**	**VITO and partners Reply**
28. **DEA**	General			Regarding the invitations to stakeholder input:Many are on the perhaps somewhat obscure application related minor transformers (applications, separation etc). I have absolutely no suggestion for how to get that in hand and wonder if anyone will.		Noted and taken into consideration in refining the scope
29. **DEA**		7	Power transformers (> 5 MVA) used in transmission are efficient for many decades (>99,8 %)	This goes for distribution transformers as well.		In theory yes but no such large distribution transformer was reported
		9	Modern distribution transformers are typically about 98-99% efficient at half load (SEEDT, 20083). This might suggest a low improvement potential to improve their environmental performance.	Po=0.1...0.2% er = 0.5...1% Would excpect higher even higher efficiency number		Noted
30. **DEA**		11	Transformers can produce a 50 Hz humming noise which might cause nuisance or discomfort, e.g. when installed in the basement of an apartment building.	100 Hz !		Adapted (see also SMA)
31. **DEA**		11	Please note that transformer noise is regulated in standards	Not in IEC600706. Assessment is. No limits.		Added no limits
32. **DEA**		11	Transformers produce extremely low frequency (ELF4) fields of 50 Hz.	Oil-in-tank, yes, depending on mode of installation (leads). Dry, propably not "extremely" low, would expect "significant", baseline to be defined for the appropriate use of adjectives.		Text is adapted as it was confusing
33. **DEA**		11	Some products in operation may still comprise polychlorinated biphenyls or PCBs, however it is not allowed anymore in new transformers.	Can't believe it. At least not in the TSO/DNO industry. Would it not be a criminal offense?		Text updated

Comments to the VITO and partners Draft Report						
Number / Ident Stakeh	**Cap**	**Page nr**	**Text extract**	**Comments**	**Alternative proposal (if availble)**	**VITO and partners Reply**
34. **DEA**		11	Oil filled distribution transformers mostly contain Synthetic transformer oil if released	Define "synthetic"? Mineral oil is normal, Nynäs Nitro is popular. Synthetic such as "Midol" only for special use e.g. water protection areas, I would have thought.		Updated (see also ORG comment)
35. **DEA**		11	the ground water. In this case Biodegradable insulating/coolant liquid	Modern installation often comprises bunding and controlled drainage.		added
36. **DEA**		12	biodegradable and not water pollutant and furthermore has a much higher flash point than the mineral oils traditionally used	But poorer cooling effect and hence causing larger volumes/more materials.		added
37. **DEA**		12	Some power transformers use Sulphur hexafluoride (SF6) gas and they are sometimes referred to as a gas-insulated transformer.	Which? I never saw that, only small volumes in bushings.		updated
38. **DEA**		12	It could be an environmental issue because its strong impact on global warming (1 SF6 = 23.600 CO2)	If going for SF6, look at switchgear first.		updated
39. **DEA**		13	Auxiliary losses (Paux): These losses are caused by using energy to run cooling fans or pumps which help to cool larger transformers	Stating orders of magnitude Po = 0.05..0.2% and er = 0.2...1%, highest for smallest distribution transformers, might be appropriate.	Larger deleted	(values are issue of later sections)
40. **DEA**		17	For any new subcategory defined hereafter new minimum and maximum rated values will have to be derived from related product standards and/or market data. Stakeholders please check minimum and maximum rated power in the concluding Table 1.2.	Would expect a slightly higher share of oil DER transformers (Siemens Wind Power). Where do the figures come from? Other than percentages within categories, would it be appropriate to establish total volumes e.g. in terms of installed units, ratings and losses, so as to provide a basis for prioritation?		

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41. **DEA**		17	However, many liquids used in transformers are flammable and some older types were toxic. Because of potential fire hazard, these transformers are used in outdoor applications (e.g. distribution transformers). The identification of the cooling method for oil cooled transformers is expressed by a fourletter	Please substantiate. Oil is not. PCB? Oil is definitely widely used indoor, too.	See ORG comment	adapted
42. **DEA**		17	ONAF: Oil Natural Air Forced · OFAN: Oil Forced Air Natural · OFAF: Oil Forced Air Forced · OFWF: Oil Forced Water Forces Other combinations are also possible (e.g. ONAN, ..)	which is the most common one, virtually all distribution transformers are ONAN. Note that synth oil is not "O" but "L" e.g. LNAN.	See ORG comment	adapted
43. **DEA**		17	Most common non liquid transformers are Dry-type transformers	The inherent quality of being non-liquid is being dry....		adapted
44. **DEA**		17	Dry-type transformers are more commonly used in indoor applications, e.g. smaller industrial transformers.	Rather large units. Dry-type industrial, airport, large building... would typically be 1000...2500 kVA. Wind turbines (3-4 MVA) not to be forgotten, today a quite large share of the market, I would expect.		adapted
45. **DEA**		18	In large power transformers (>25 MVA) gas-filled transformers are also used. It is a transformer whose magnetic circuit and windings are enclosed with an insulating gas. Sulphur	Where?	See ORG comment	adapted
46. **DEA**		18	Please note that this is a very different products group because standards are developed within IEC/TC 96 and the products are not made by distribution transformer manufacturers. .	? Who then? Is this product not old-fashioned, related to rural, too long LV lines? Worth mentioning voltage symmetrisers. zigzag winding for zero sequence voltage suppression?	Yes product is nearly obsolete	Added (issue of zigzag winding is part of other section)
47. **DEA**		18	Power transformers installed by TSO (DSO) refer to those transformers used between the generator and the distribution circuits and are usually rated at 5 to 500	By Generator (Producer), power plant owner.		adapted

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48. **DEA**		18	until the largest power plant (about 500 MVA).	1500 MVA.		adapted
49. **DEA**		19	Power transformers are operated by the TSO (Transmission System Operator). International standards are developed within IEC/TC 14. Sometimes these transformers are also referred as Transmission system	..and Generator.		added
50. **DEA**		19	Phase-shifting power transformers. Phase-shifting used in the high voltage grid with special vector groups to compensate for long transmission line electrical effects (phase lag) (e.g. those discussed by standard IEC 62032 on 'Guide for the application, specification, and testing of phase-shifting transformers').	No, control of active power flows in parallel systems "Quad Boosters".		adapted
51. **DEA**		20	Stakeholders are welcome to provide us more information on types of applications, volume and impact and improvement. It should also be assessed if the improvement potential is at transformer level or within the system or applicattion.	Would such units not be subject to analysis within the context of the applications to which they contribute?		added
52. **DEA**		20	Stakeholders please check of any other category is needed here (please consider especially ecodesign parameters).	Single phase: Insignificant volume. Pole mount, irrelevant, installation method (kiosk, indoor, pole mount.... has no significant impact as seen from an ecodesign perspective.		added

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53. **DEA**		22	*Table 1.3 Table with first impact screening on sales and impact per product cate*	Where does this come from? Distribution trf losses seem very high, even BAT load. Noise is more "H" -ish, Hazardous material, "L", because of installation methods and spill mitigation. Industry seem high when compared with Distribution. Would expect 10% 250 MVA		This come from later chapters. The EC requested to include it already in chapter 1. Suggestion for noise and hazardous material adapted.
54. **DEA**		23	Load form factor (Kf): the ratio of the root mean squared (rms) Power to the average Power (=Prms/Pavg)	? Would have thought average / peak consumption?		Easier to calculate as we can use the detailed synthetic load profiles (see chapter 3)
55. **DEA**		23	Transformer availability factor (AF) determines the availability of the transformer on a given instant of time (mostly on a yearly basis). · Power factor (PF): the ratio of the active power (kWatt) to the apparent power (kVA).	Relates to reliability, not use and efficiency.		Discussed more in chapter 3. It is not only about relaibility, e.g. transformer could be disconnected when there is no wind in a wind turbine.

<table>
<tr><th colspan="6">Comments to the VITO and partners Draft Report</th></tr>
<tr><th>Number / Ident

Stakeh</th><th>Cap</th><th>Page nr</th><th>Text extract</th><th>Comments</th><th>Alternative proposal (if availble)</th><th>VITO and partners Reply</th></tr>
<tr><td>56.

DEA</td><td></td><td>24</td><td>Insulation temperature class: The insulation temperature classes determines the
maximum operating temperature of the transformer. IEC 60085 defines six
temperature classes: A (105℃), E (120℃), B (130℃), F (155℃), H (180℃) and C
(220℃).
· Protection class (IP): provides a protect</td><td>Dry only.</td><td></td><td>Added</td></tr>
<tr><td>57.

DEA</td><td></td><td>28</td><td>Table 1.4 Relationship between ecodesign parameter and test stand
<table><tr><th>Performance parameter or Ecodesign parameter</th><th>Standard</th><th>Status/notes</th></tr><tr><td>LwA dB (A): Sound power level of the transformer</td><td>IEC 600769-10??</td><td></td></tr><tr><td>EMF (electromagnetic field)</td><td>To complete</td><td></td></tr><tr><td>Hazardous substances PCB</td><td>To complete</td><td></td></tr><tr><td>Hazardous substances PCB</td><td>To complete</td><td></td></tr><tr><td>Hazardous substances PCB</td><td>To complete</td><td></td></tr><tr><td>ANY OTHER RELEVANT?</td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr></table></td><td>Standards on materials would not relate to the transformer product as such.

There are IEC standards on oil for transformer use, but they are not of ecodesign relevance.</td><td></td><td>added</td></tr>
<tr><td>58.

DEA</td><td>1.7.1.3</td><td>28</td><td>No, the IEC standard is used.
(Stakeholders please comment)</td><td>Agree</td><td></td><td>noted</td></tr>
<tr><td>59.

DEA</td><td>1.7.1.4</td><td>28</td><td>No, the IEC standard is used.
(Stakeholders please comment)</td><td>Agree</td><td></td><td>noted</td></tr>
<tr><td>60.

DEA</td><td>1.7.1.6</td><td>29</td><td>When interpreting US data or countries data using IEEE standards one should be aware of the
difference in definition in rated power (S)(see 1.7.1.5).
Stakeholders please comment.</td><td>US IEEE/ANSI irrelevant, not used in the EU</td><td></td><td>added</td></tr>
</table>

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61. **DEA**	Table 1.5	30	To be completed (stakeho… are invit… provide input) / To be completed / To be completed	You got the important ones		noted
62. **DEA**		33	*Table 1.6 Relationship between performance or ecodesign parameter* **Performance parameter or Ecodesign parameter** / **Standard** / **Status/notes** *Short-circuit impedance* / IEC 60076-1 (EN) *Rated voltage of the high-voltage winding (Vrms)* / IEC 60076-1 (EN) *Rated voltage of the low-voltage winding (Vrms):* / IEC 60076-1 (EN) *Insulation temperature class* / IEC 60085 (EN) *Protection class (IP)* / EN 60529 *Fire behaviour class* / IEC 60076-11 (Dry type transformers) *Environmental class* / IEC 60076-11 (EN)	Dry		added
63. **DEA**		34	*Climate class* / IEC 60076-11 (EN) ANY OTHER RELEVANT?	No, goverened in general by IEC 60076		noted
64. **DEA**		34	***1.7.2.3 Other relevant EU 27 national (EN) Standards or se*** Stakeholders please inform if there are any relevant standards at natio ***1.7.2.4 Other relevant Third country Standards or sector p***	None in Denmark. Common user spec is DEFU but that is strictly based on IEC.		added

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65. **DEA**		35	they are exempted. If any of the primary and/or the secondary vo LVD limits it is subject to LVD(eholders are invited to provide in • List relevant ESRs and related standards potentially overlapping wi requirements (noise, emissions, etc.) To be completed. • Directive 98/37/EC on the approximation of the laws of the Member machinery. The machinery directive is not applicable for transformers be applicable on certain accessories (e.g. pumps) (eholders are i input). • Directive 2002/95/EC on Restriction of the use of certain Hazardo electrical and electronic equipment (RoHS). keholders are in input). • Directive 2002/96/EC on 'Waste Electrical and Electronic Equipmen applicable as transformers are not falling under the categories set out i • Directive 2004/40/EC on the minimum health and safety requireme exposure of workers to the risks arising from physical agents fields).This Directive lays down minimum requirements for the prote from risks to their health and safety arising or likely to arise fi electromagnetic fields (0 Hz to 300 GHz) during their work. This can the construction of the transformer station, however it is not relevan on its own. • Directive 89/106/EEC on the approximation of laws, regulations ar provisions of the Member States relating to construction products. there any measure on transformer products? (eholders are invited	It sure is and as such under the provisions of national implementations and regulations pertaining to electrical safety. Yes, definetely, but are we not a bit at the edge of the scope of this study now? Same comment. Have none.	Opposed to the view of ORG	added
66. **DEA**		36	**1.8.3 Legislation at Member State level** M erstates please indicate any relevant legislation here that is not leg ation. Also green procurement requirements or public tender requirements (e.g. adopted by the sector can be reported here if they have no European dimen	None.		noted

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67. **DEA**			Regarding the invitations to stakeholder input:Many are on the perhaps somewhat obscure application related minor transformers (applications, separation etc). I have absolutely no suggestion for how to get that in hand and wonder if anyone will.			noted

Number / Ident Stakeh	**Cap**	**Page nr**	**Text extract**	**Comments**	**Alternative proposal (if availble)**	**VITO and partners Reply**
Task 2						
1. **ORG**		9	DER LV/MV Transformers This line should be divided in 2 categories 1 line for immersed and 1 line for dry type; The rated power should be the same for the two lines;	Replacement by ageing of the transformer is 0% because is new application for DER application;		adapted
2. **ORG**	Last paragraph	29	In some cases, transformers are available with either low (4 %) or high (6 %) short-circuit impedance. As can be concluded from standard EN 50464-1 for the same class and rating losses are higher for transformers with higher short-circuit impedance.	Delete this paragraph because there is no correlation between impedance and other parameters. It is only a problem of design and protection of the network.		adapted

Number / Ident Stakeh	Cap	Page nr	Text extract	Comments	Alternative proposal (if availble)	VITO and partners Reply
3. ORG		35	.	In the map it misses certain countries as UK or Scandinavia (whole document)		The source of this figure is UCTE, which covers obly 24 countries, and does not include UK and Scandinavian countries.
4. ORG		37		The replacement of the currently installed most inefficient transformers probably will not be problem.		ok
5. ORG	2.3.5.1	37	COMMENTS FROM SMA - 3 months can be enough for producing one type of higher efficiency transformer, but for re-design and produce a whole range it will be necessary the full year.	COMMENTS ORG That is the point of view of Spanish committee but not the point of view of a lot of other competitor		This paragraph is adapted based on these comments, plus Hitachi metals and remarks T&D Europe
6. ORG	2.3.5.1	37	COMMENTS FROM SMA - These figures are considering that the increase of efficiency is achieved using the same conventional materials (i.e. up to BoBk). For higher efficiencies, AoBk or AoAk, laser treated steel should be used, and the limit of production capacity from the manufacturers shall block the effective "production" of these transformers until the production capacity be increased, estimated, three to five years.	COMMENTS ORG Not agreed, it is possible to do in an other ways,see my remark above		Not taken into account since other alternatives are provided by the stakeholders
7. ORG	2.3.5.2	37	COMMENTS FROM SMA Add to the list of problems to be solved: - AMDT cores manufacturing is not an open technology, but under patent. That will cause the market not being a free one, and not working along the usual open competition rules.	COMMENTS ORG This information in not true.		Not taken into account since contradictory information by othet stakeholders
8. ORG	2.3.5.2	37	COMMENTS FROM SMA - There is not experience of the behavior of AMDT technology for three phase transformers over 200 kVA neither over 15 kV, being values commonly used in Europe.	COMMENTS ORG An experimentation is lauched by my company on the network see CIRED article in Praga		Not taken into account condiering the information of T&D Europe

Number / Ident Stakeh	Cap	Page nr	Text extract	Comments	Alternative proposal (if availble)	VITO and partners Reply
9. **ORG**	2.3.5.2	37	COMMENTS FROM SMA - There is not demonstrated -and there are some concern about- that values of losses of AMDT do not increase during the life cycle.	COMMENTS ORG I do not share this point of view large background exist in India and other countries		Not taken into account considering comments from T&D Europe
10. **ORG**	2.3.5.2	37	COMMENTS FROM SMA - AMDT technology will increase noise pollution because of their higher noise levels.	COMMENTS ORG Must be checked ……		Will be checked
11. **ORG**	figure 2-13	39	COMMENTS FROM SMA According to this figure, the increment of price (base 2005) from DoCk to AoAk is around 33%. This value is not consistent with the data of page 14 of the presentation "Expert meeting T&D Europe 04-jun modified by MSrev1". In the presentation, the increasing from EoCk to BoCk is stated to be a 30%, so the increment of the SEETD figure should be much more higher, having the same three steps of better no-load losses, and in addition two steps more efficient in load losses. If WG3 T&D can't provide VITO with other information on increments of prices related to increments of efficiency, VITO will be forced to adopt the values of the study from SEETD, that is an player committed in the change of the existing technology towards AMDT. Not to give data about prices evolution related to more efficient transformers, can result in a study by VITO with not correct conclusions. If it's not possible to give price data, because of legal reasons, it should be possible to give price increases related to performance increases. National Associations can give national values of increasing, and WG3 can give VITO european averages of price increases.	COMMENTS ORG That is not the position of T&D		The examples from T&D Europe are also mentioned in the § 2.4.1

Number / Ident Stakeh	Cap	Page nr	Text extract	Comments	Alternative proposal (if availble)	VITO and partners Reply
12. ORG	2.4.2	41	COMMENTS FROM SMA - SEEDT study data of 3% increase price for "steel" (we understand GOES steel, otherwise is a non relevant data) does not match with COTREL commodity index for GOES 2005-2007 that is about 70% increase. - In the same paragraph, VITO stated that T&D Europe indicates a steel price of 1€ per kg and 3 to 3,5 for amorphous steel (year 2009) in the 17th March 2009 meeting. We understand again the "steel" refers to GOES. We think 1€ per kg is a mistake, because is not a market price for GOES in 2009, and there are not reference to these values in the minutes of the related meeting.	COMMENTS ORG At this time the price of the magnetic steel is around 3E/KG and it is between 3 and 4 for amorphous material		The T&D prices have been taken into account and correspond with the cotrel and DOE figures.
13. ORG		41		Information from T&D on prices to be added: T&D could not give price of transformer for legal reason (Eu competition rules) and VITO is invited to launch enquiries directly to the manufacturers.		deleted
14. ORG	Table 2.17	41		It misses M5 in the table of immersed transformers (M5 is the more common magnetic steels used to manufacture the transformers!)		Ok, however no price Price is estimated to be €3, is this correct???
15. SMA	First paragraph	30		The average energy efficiency should be 98.38% according figure 2-9		adapted
16. SMA	2.4.4	43		- Only the free-breathing transformers oil must be filtered. For hermetically sealed transformers is not a good practice.		ok
17. HITT	2.2.1.5	28	Life time	The average of transformer life cycle in Japan is 30 years. However, in the point of TOC, Life cycle which Japanese utilities define is 19 years.		included
18. HITT	2.3.5.2	37	More efficient transformer	The approach of Hitachi is as follows. Please see next slides.		Information not yet included, but will be taken into consideration

<table>
<tr><th>Number / Ident

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<tr><td>19.

HITT</td><td>2.3.6</td><td>38</td><td>Rated Power</td><td>Please see No4.</td><td></td><td>Information not yet included, but will be taken into consideration</td></tr>
<tr><td>20.

HITT</td><td>2.3.7</td><td>38</td><td>PCB</td><td>Please see No3.</td><td></td><td>Information not yet included, but will be taken into consideration</td></tr>
<tr><td>21.

HITT</td><td>2.4</td><td>41-42</td><td>Prices</td><td>Please see next slides.</td><td></td><td>Information not yet included, but will be taken into consideration</td></tr>
<tr><td>22.

HITM</td><td>Table 2 3</td><td>13</td><td>Table Error! No text of specified style in document.-1: Transformer market data within the EU-27, Prodcom data
<table>
<tr><th>Product Group
Prodcom / scope study</th><th>Year</th><th>Production (1000 units)</th><th>Production (million €)</th><th>Import (1000 units)</th><th>Import (million €)</th><th>Export (1000 units)</th><th>Export (million €)</th><th>Apparent Consumption (1000 units)</th><th>Apparent Consumption (million €)</th></tr>
<tr><td rowspan="5">31.10.41.30 LLP / Distribution oil (MV/LV)</td><td>1995*</td><td>525.85</td><td>418.11</td><td>270.77</td><td>14.91</td><td>175.21</td><td>68.71</td><td>621.40</td><td>364.31</td></tr>
<tr><td>2004</td><td>208.45</td><td>372.55</td><td>1096.39</td><td>34.38</td><td>115.30</td><td>72.91</td><td>1189.54</td><td>334.02</td></tr>
<tr><td>2005</td><td>207.69</td><td>436.97</td><td>541.48</td><td>35.47</td><td>53.26</td><td>79.13</td><td>695.91</td><td>393.31</td></tr>
<tr><td>2006</td><td>223.79</td><td>631.08</td><td>1082.33</td><td>54.24</td><td>101.98</td><td>90.62</td><td>1204.14</td><td>594.70</td></tr>
<tr><td>2007</td><td>230.89</td><td>796.94</td><td>1030.21</td><td>75.47</td><td>221.62</td><td>111.38</td><td>1039.48</td><td>761.02</td></tr>
<tr><td rowspan="5">31.10.41.53 LMLP / Industry oil (LV)</td><td>1995*</td><td>19.08</td><td>156.13</td><td>21.46</td><td>4.09</td><td>21.54</td><td>26.98</td><td>19.00</td><td>133.24</td></tr>
<tr><td>2004</td><td>19.72</td><td>182.97</td><td>8.11</td><td>20.44</td><td>6.08</td><td>27.01</td><td>21.75</td><td>176.41</td></tr>
<tr><td>2005</td><td>20.92</td><td>191.82</td><td>9.29</td><td>21.64</td><td>14.29</td><td>30.66</td><td>15.92</td><td>182.80</td></tr>
<tr><td>2006</td><td>26.55</td><td>292.96</td><td>47.82</td><td>24.53</td><td>17.16</td><td>37.37</td><td>57.21</td><td>280.11</td></tr>
<tr><td>2007</td><td>29.57</td><td>369.64</td><td>79.26</td><td>22.76</td><td>44.51</td><td>40.36</td><td>64.33</td><td>352.05</td></tr>
<tr><td rowspan="5">31.10.41.55 LMHP / Industry oil (MV)</td><td>1995*</td><td>3.39</td><td>138.82</td><td>3.12</td><td>4.89</td><td>22.51</td><td>36.92</td><td>-16.00</td><td>106.79</td></tr>
<tr><td>2004</td><td>4.54</td><td>213.02</td><td>823.24</td><td>32.52</td><td>8.77</td><td>45.32</td><td>819.01</td><td>200.22</td></tr>
<tr><td>2005</td><td>3.95</td><td>181.17</td><td>1222.44</td><td>23.95</td><td>12.08</td><td>39.07</td><td>1214.32</td><td>166.05</td></tr>
<tr><td>2006</td><td>5.39</td><td>231.24</td><td>1468.17</td><td>41.45</td><td>10.23</td><td>68.99</td><td>1463.32</td><td>203.70</td></tr>
<tr><td>2007</td><td>6.77</td><td>328.21</td><td>1423.65</td><td>50.64</td><td>25.30</td><td>72.09</td><td>1405.13</td><td>306.76</td></tr>
<tr><td rowspan="5">31.10.41.70 HP / Power oil</td><td>1995*</td><td>2.24</td><td>865.46</td><td>18.01</td><td>27.23</td><td>56.18</td><td>352.78</td><td>-36.93</td><td>539.92</td></tr>
<tr><td>2004</td><td>2.98</td><td>1009.22</td><td>63.11</td><td>36.57</td><td>212.56</td><td>427.36</td><td>-146.47</td><td>618.43</td></tr>
<tr><td>2005</td><td>3.38</td><td>1229.41</td><td>430.04</td><td>46.36</td><td>2.51</td><td>540.35</td><td>430.90</td><td>735.42</td></tr>
<tr><td>2006</td><td>3.79</td><td>1457.22</td><td>7.29</td><td>48.68</td><td>4.45</td><td>580.10</td><td>6.63</td><td>925.81</td></tr>
<tr><td>2007</td><td>4.64</td><td>2007.58</td><td>32.04</td><td>68.07</td><td>41.07</td><td>642.33</td><td>-4.28</td><td>1433.32</td></tr>
<tr><td rowspan="5">31.10.43.30 DLP / Industry dry (LV/LV)</td><td>1995*</td><td>5565.53</td><td>161.20</td><td>3289.82</td><td>25.34</td><td>864.06</td><td>83.09</td><td>7991.29</td><td>103.45</td></tr>
<tr><td>2004</td><td>307.55</td><td>216.90</td><td>3370.72</td><td>41.20</td><td>374.26</td><td>88.41</td><td>3304.01</td><td>169.69</td></tr>
<tr><td>2005</td><td>272.35</td><td>220.13</td><td>4071.17</td><td>31.74</td><td>411.41</td><td>79.59</td><td>3932.11</td><td>172.28</td></tr>
<tr><td>2006</td><td>899.84</td><td>800.00</td><td>3317.19</td><td>56.46</td><td>389.52</td><td>106.10</td><td>3827.50</td><td>750.36</td></tr>
<tr><td>2007</td><td>395.99</td><td>397.18</td><td>6151.42</td><td>71.81</td><td>690.73</td><td>139.67</td><td>5856.69</td><td>329.32</td></tr>
<tr><td rowspan="5">31.10.43.50 DHP / DER and industry dry (MV/LV)</td><td>1995*</td><td>28.35</td><td>350.65</td><td>1255.07</td><td>17.46</td><td>22.43</td><td>84.71</td><td>1260.99</td><td>283.39</td></tr>
<tr><td>2004</td><td>77.43</td><td>474.45</td><td>210.68</td><td>24.69</td><td>56.01</td><td>130.48</td><td>232.10</td><td>368.66</td></tr>
<tr><td>2005</td><td>93.51</td><td>538.51</td><td>198.06</td><td>39.84</td><td>123.05</td><td>141.98</td><td>168.52</td><td>436.37</td></tr>
<tr><td>2006</td><td>84.06</td><td>766.20</td><td>447.77</td><td>68.26</td><td>210.35</td><td>252.08</td><td>321.48</td><td>582.38</td></tr>
<tr><td>2007</td><td>123.75</td><td>804.64</td><td>848.29</td><td>72.23</td><td>194.00</td><td>335.81</td><td>778.04</td><td>541.06</td></tr>
</table>
Negative apparent consumption (not valid): due to inconsistencies between the quantity and value of imports and exports</td><td></td><td></td><td>???</td></tr>
<tr><td>23.

HITM</td><td>2.2.2.1</td><td>29-30</td><td>According to figures from T&D Europe (meeting 04 June 2009) currently all transformers have Si-steel cores. However the Italian utility ENEL has granted a substantial part of their last tender on distribution transformers to the amorphous technology. This will introduce a market share of 2,80% of amorphous distribution transformers (figure based on the replacement quantity of table 2-4 of this task). Other EU utilities (Enel, EDF,…) have some amorphous technology transformers in their grids for evaluation. ~~(only 0.0001% amorphous cores).~~ Most transformers have Cu windings (80-90%), and the rest (10-20%) have Al windings.</td><td></td><td></td><td>adapted</td></tr>
</table>

Number / Ident Stakeh	Cap	Page nr	Text extract	Comments	Alternative proposal (if availble)	VITO and partners Reply
24. HITM		35	Solar capacity should count for 8.7% of the total RES capacity in 2015 and above 10.5% in 2020. The average annual growth rate of solar capacity is foreseen to about 20% up to 2013 and 12% up to 2020.Paul: if you need data for solar inverters, made from amorphous material, please let me know. We have a major worldwide share for the AC reactor component.			adapted

Number / Ident Stakeh	Cap	Page nr	Text extract	Comments	Alternative proposal (if availble)	VITO and partners Reply
25. **HITM**	2.3.5.2	39-39	In the case of amorphous transformers , the time varies with the availability and lead time of the production equipment needed. The existing production equipment for coil manufacturing, coil/core assembly installations, active part assembly and the tanking may need some adjustment. Some specific installations like material cutting and annealing need to be added..~~frame will be much longer. If amorphous transformers will become the standard, several problems will have to be solved:~~ Lately improvements have been made in order to: – Meet the IEC standards, especially with regards to short circuit behavior. ~~Agreement of the transformer following EU specifications (short circuit). Only one or two manufacturers are today ready to manufacture such a transformer with successful tests.~~ – Develop designs that allow power ratings up to 5000 kVA for 5 leg oil transformers and 3000 kVA for 3 leg dry transformers. ~~Development of the rated power over 1000 kVA needs to be studied.~~ – The capacity of the manufacturers of amorphous steel was increased to supply a significant share of transformers to be installed. The current capacity of amorphous metal is on the same order of magnitude as total distribution electrical steel demand in the EU. ~~must be increased, with 5-20 times current capacity~~. – ~~Production lines of the transformers manufacturers should be changed for the magnetic core production and probably for the construction of the coil according to the design of the manufacturer~~. These ~~changes~~ improvements will allow the transformer manufacturers ~~take at least 3 to 5 years to be ready to manufacture at full capacity amorphous transformers. However, it will be probably possible to begin~~ to produce amorphous transformers within the next ~~in one~~ year in certain companies. Stakeholders are invited to provide input.			adapted

Number / Ident Stakeh	Cap	Page nr	Text extract	Comments	Alternative proposal (if availble)	VITO and partners Reply
26. **HITM**	2.3.6	39	The main industry players for this product group are big international groups like ~~producing transformers~~ ABB, Siemens, Areva ~~Areva, ABB~~, Schneider Electric, and some large/medium size companies like Cotradis, Efacec, Pauwels, SGB/Smit and Transfix.~~(France Transfo)~~, ~~Alstom~~, ~~Pauwels Transformers~~, ~~Siemens~~, ~~SMIT transformers~~, Transformer manufacturers from outside the EU include GE, Hitachi and Vijai. Their respective ~~as well as their~~ material suppliers for winding wires and foil are a multitude of European and non European companies and for electrical steel these concentrate on Thyssen Krupp Electrical Steel, AK Steel, Arcelor Mittal, ~~(Cumerio, Acelor Mittal, Corus, Alcoa,~~ Hitachi Metals (METGLAS), ~~ThyssenKrupp Steel AG ...).~~ and some suppliers from outside the EU ~~Orgalime~~ T&D Europe is the representative of the ~~National Associations of~~ European Transformer Manufacturers, regrouping the Austrian, Belgian, British, French, German, Italian, Spanish, Portugese and the Netherland's National Associations Nevertheless, SMEs are also active in transformer production, especially for niche smaller industrial applications transformers. Today, amorphous steel transformers are manufactured in significant quantities by Asian and Indian companies, such as Hitachi, Zhixin and Kotsons. In Europe investments in amorphous steel transformers equipment will accelerate, beginning in 2009. ~~o.a.: BEZ (SK), Hitachi and Hexaformer (S),~~ Transformers for industrial applications are most often sold and installed by SMEs in a B2B market and in some cases SMEs have service contracts with utilities for installation. They are not subject to any public tender. For utility sales, all calls for offers must be published in the European journal; common EU-wide rules apply for the granting of orders. Usually these tenders run for a delivery period of 2 years, with substantial volumes and cover the whole range of the possible transformer ratings. These tenders are subject to the utility's specification which can vary in transformer performance, rating and energy efficiency. Needless to say that there is no common energy efficiency specification EU wide yet.			adapted

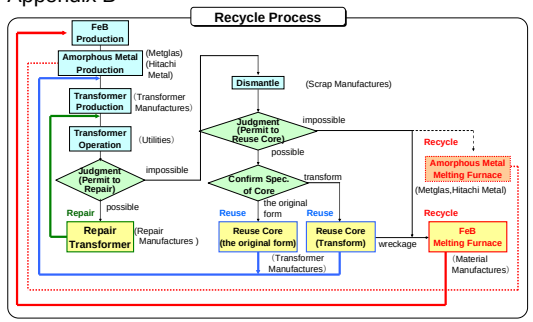
Number / Ident Stakeh	Cap	Page nr	Text extract	Comments	Alternative proposal (if availble)	VITO and partners Reply
27. **HITM**	2.4.2	43	From the previous section, it is clear that the transformer prices are strongly dependent on the transformer commodities prices. Cotrel, the transformer manufacturer association, published the following price indications. The graph shows that CRGO steel price level of 2007 being roughly 180% of the 2005 price level. Copper prices show an even higher level. ~~The SEEDT study referred to data of the German Federal Statistical Office which showed steel prices of 2007 being 103% of the 2005 price level, and copper prices being 164% of the 2005 price level.~~ These variable market trends on steel prices were confirmed by T&D Europe (meeting 17/03/2009).. Confirmed sources indicate that if the price for silicon steel were €3,50 to 4,00 per kg then amorphous material would be slightly lower,. ~~T&D Europe indicates a steel price of €1 per kg steel and €3-3.5 per kg amorphous steel (year 2009).~~ Paul: please see attached graph. The cotrel figures were changed to a new 100% base beginning 2009, thus not showing the huge increase during 2005-2009.			adapted
28. **HITM**	2.4.2	44	COTREL provides monthly 'Transformer Commodities Indices' that are used by the sector to index transformer prices. To be completed. Information from T&D on prices to be added Paul: I don't know what price levels to apply as there is no public data available. The only change we must bring is to emphasise that the amorphous figure is for FINISHED core.			adapted

Number / Ident Stakeh	Cap	Page nr	Text extract	Comments	Alternative proposal (if availble)	VITO and partners Reply
29. HITM	Table 2 17	44				adapted

Material	*2002-2006 average 5 year material price in €/kg*	*2002-2006 average 5 year marked up material price in €/kg*
Liquid immersed transformers		
M2 core steel	1.96	2.82
M3 core steel	1.79	2.58
M4 core steel	1.72	2.48
M6 core steel	1.55	2.23
mechanically-scribed core steel	2.75	3.95
amorphous core ~~fished core~~, ~~volume production~~	3.61	5.17
copper wire, formvar, round 10-20	4.36	6.30
copper wire, enamelled, round 7-10 flattened	4.42	6.37
copper wire, enamelled, rectangular sizes	4.73	6.82
aluminum wire. formvar. round 9-17	2.58	3.72
aluminum wire. formvar. round 7-10	2.62	3.77
copper strip. thickness range 0.020-0.045	4.54	6.55
copper strip. thickness range 0.030-0.060	4.41	6.35
aluminum strip. thickness range 0.020-0.045	2.87	4.14
aluminum strip. thickness range 0.045-0.080	2.82	4.07
kraft insulation paper with diamond adhesive	2.79	4.02
mineral oil	3.09	4.36
tank steel	0.74	1.08
Dry-type transformers		
domain refined core steel	2.14	3.11
M3 core steel	1.81	2.60
M4 core steel	1.72	2.48
M5 core steel	1.64	2.36
M6 core steel	1.60	2.31
M19 core steel (26 gauge)	1.03	1.49
M36 core steel (29 gauge)	0.95	1.35
M36 core steel (26 gauge)	0.86	1.25
M43 core steel (26 gauge)	0.81	1.18
rectangular copper wire 0.1 x 0.2. Nomex	4.85	6.99
rectangular aluminum wire 0.1 x 0.2. Nomex	3.48	5.03
copper strip. thickness range 0.20-0.045	5.05	7.28
aluminum strip. thickness range 0.20-0.045	2.87	4.14
Nomex insulation	30.64	44.16
Cequin insulation	18.70	26.95
impregnation (per liter)	3.71	5.22
winding combs	31.36	44.11
enclosure steel	15.99	23.07

Number / Ident Stakeh	Cap	Page nr	Text extract	Comments	Alternative proposal (if availble)	VITO and partners Reply

Number / Ident Stakeh	Cap	Page nr	Text extract	Comments	Alternative proposal (if availble)	VITO and partners Reply
Task 3						
30. **ORG**		9	C. Add a load and no-load losses class indicator on the name plate (e.g. EN 50464-1); Manufacturers are in favour to indicate the C proposal if class of efficiency transformer are defined in a standard			View of manufacturers is addes
31. **ORG**		9	More efficient transformers tend to be bigger in size and heavier in weight. However other technologies by changing raw material could not change the size and weight but could have an influence on the optimum of the price.	Add red sentence		???
32. **ORG**		20		Load factors for DER transformers For the future it is important to consider this category as a special category because this transformer is not continuously energised		Ok, will be consiedred
33. **ORG**		20		In the table 3.4 the figure of average load factor seems to be low		To be checked
34. **SMA**	3.2.1.1	11	- Distribution transformers for residential areas are very often sized by the installed total power of the load, multiplied by a simultaneity factor. - Correct sizing of a transformer is a non expensive tool for increase of the energy eficiency of the whole system.			Sentence added
35. **HITT**	3.1.3.1	8	Tr.&Network losses	Please see next slides.		Information not yet included, but will be taken into consideration
36. **HITT**	3.1.3.2	9	Pay back	Please see next slides.		Information not yet included, but will be taken into consideration
37. **HITT**	3.1.3.3	9	Information	"D" is best. In Japan,we use "Top runner label".		Information not yet included, but will be taken into consideration

Number / Ident Stakeh	Cap	Page nr	Text extract	Comments	Alternative proposal (if availble)	VITO and partners Reply
38. **HITT**	3.1.3.4	10	Size & weight	Please see next slides.		Information not yet included, but will be taken into consideration
39. **HITT**	3.2.1.1	**16-19**	Load profile	Please see attached paper. Appendix 1		Information not yet included, but will be taken into consideration
40. **HITT**	3.2.1.4	21	Harmonics	It is very difficult to define specification of harmonics. It might be significant, though. Please see attached paper. Appendix 2		Information not yet included, but will be taken into consideration
41. **HITT**	3.2.1.5	23	Temperature	It is significant.The efficiency when ambient temperature becomes high shall be defined .(For instance of US DOE, definition at 55K)		Information not yet included, but will be taken into consideration
42. **HITT**	3.2.3	24	Repair	High efficient transformer will be heavier and bigger in general. It is necessary to consider the conditions in transportation. We think that there are no influence in Frequency of repair and failure,spare parts.		Information not yet included, but will be taken into consideration
43. **HITT**	3.3	26	Recycle	In Japan,the ratio of transformer recycling is 99%. And, amorphous transformer recycling has been started already. Please see next slides. Appendix B 		Information not yet included, but will be taken into consideration

Number / Ident Stakeh	Cap	Page nr	Text extract	Comments	Alternative proposal (if availble)	VITO and partners Reply
44. **DEA**		8	***3.1.3.1 Lack of awareness on environmental impact of transformer and network losses*** End-users possibly do not assess their purchase nor evaluate the available technology o and related energy (and cost) saving potentials for their specific situation. In many cas new equipment is purchased when the old equipment fails and there is no time to anal detail the purchase decisio urchase decisions for transformers are often not made cycle cost or payback considerations. Utility distribution and transmission companies an elaborated procurement process (call for tender), and normally select the product pro best value for money i.e. a transformer that meets specifications at the lowest cost. The public procurement and eco-responsible purchase in private sector are important initiati be analysed.	In case of Scandinavian, UK and Gernan distribution/transmission markets and probably more, this paragraph is utterly incorrect in its entirety. Loss evaluation is almost always undertaken, stating iron and copper loss values EUR/kW, calculated from period, interest and cost of electricity.		Ok, this paragraphe is delete since users to take into account environmetal aspects in procurement process
45. **DEA**		9	Many utilities do not publish their inventories and network losses at the detail le transformers losses (ERGEG[1] (2008), (SEEDT (2008)), however network losses are simply accounted in the distribution cost. Making this detailed information public to t user or network client might increase awareness. Stakeholders please comment. ***3.1.3.2 Lack of user acceptance for higher cost and long pay back period*** Efficient transformers are often more expensive (see task 2). Purchasers search for the priced equipment t meets the facility's needs and do not necessarily accept or tak account long payback period. Industry will not be able to replace their transformers if the pay-back time is >20 years. only feasible for utility transformers because they calculate the pay back on a ver period. For smaller industrial transformers this might be even more the case, when transform not have significant annual operational hours.	If aiming to allege user misbehaviour, overdimensioning or excess installation in numbers would be more appropriate to look at. Even transformers with no installed reserve function often run at peak loads below 50% of their rated power. Leading to excess losses. No! Any attempt to justify a transformer replacement by loss savings is bound to fail, save if using extreme, politically dictated and fictitious energy prices.		This aspects is considered as user behaviour not user information Ok, taken into account

Number / Ident Stakeh	Cap	Page nr	Text extract	Comments	Alternative proposal (if availble)	VITO and partners Reply
46. **DEA**		9	***3.1.3.3 Lack of information on energy efficiency of existing transformers service*** Furthermore, operators will often not substitute transformers before they fail. Althoug may be aware of the losses, or maybe oversized older, less energy-efficient transformers not foreseen realistic to change them. In many cases the losses of existing transformers a exactly known, as they are not included on the transformer nameplate (picture will be add In order to avoid this situation in the future it could be recommended to include the loa no-load losses on the name plate, alternatively the classes as defined in EN 50464-1 f filled transformers. Options are: A. No information on transformer name plate; B. Add the load and no-load losses on the name plate; C. Add a load and no-load losses class indicator on the name plate (e.g. EN 50464 D. Add a separate energy efficiency label similar to household appliances. Stakeholders please comment	B is evident as routine tests are always made and figures are readily available at the time of delivery. No reason to compromise provision of exact and comprehensive facts in a durable manner.		added
47. **DEA**		10	***3.1.3.4 Possible barrier by lack on information on dimensional an physic constraints*** More efficient transformers tend to be bigger in size and heavier in weight. This could concern for retrofit applications, mining applications, telephone pole capacities, and installations where transformers have to comply with dimensional or physical constrain approximately 80% of transformers sold are for replacement installations (DOE, Sept 2007[2]), this issue of pre-existing space limit will cause problems. There might be a need to timely inform the user on this increased need for installation sp Stakeholders please comment	Don't think this to have a significant real-life impact. Never saw space constraints as a reason to choose a noisier and lossier transformer.		Ok, added
48. **DEA**		12	Considering both load and no-load losses, the transformer energy loss can be calculate following formula: $Etr(t) = Po + Pk \times [Load(t)/(S \times PF)]^2$ (formula 3.1)	We have a MWh / MW issue here. Replace Load(t) by load factor = Pavg/Ppeak and you are right.		adapted

<table>
<tr><th>Number / Ident

Stakeh</th><th>Cap</th><th>Page nr</th><th>Text extract</th><th>Comments</th><th>Alternative proposal (if availble)</th><th>VITO and partners Reply</th></tr>
<tr><td>49.

DEA</td><td></td><td>13</td><td>Figure 3-2: Total losses versus load factor (LF) for three 75 kVA transformer n
(NEEP, 1999[5])
In order to easily calculate the annual energy loss of the transformer from data files it is convenient to switch to time independent parameters and use the so-called RMS load (P or root-mean-square value of the load. The RMS load values can be easily computed fr data files, e.g. the Synthetic Load Profiles. In this case the annual energy loss (Etr(y)) fo is:
Etr(y) [kWh] = (Po[W] + Pk[W] × (α × Kf/PF)²) × 8760/1000 (formula 3.2)
Where,
Etr(y) = the energy used by the distribution transformer per year [kWh],
Po = no-load losses at rated load (see chapter 1),
Pk = the load losses at rated load (see chapter 1),
α = The load factor (Pavg/S) (see chapter 1),
Kf = Load form factor (=Prms/Pavg) (see chapter 1),
PF = the power factor of the load served by the transformer (see chapter 1).</td><td>Squaring Kf might be erroneous.
Scandinavian approach: Rather than squaring alpha*Kf, one computes a "loss load factor" from a squared load probability curve. Or, if not having that, eventually use "synthetic load probability curves" or Härlin's approximation

aLoss = (5a^2-a^3)/4

where a = Pavg/Pmax

Then

Eloss = (P0 + aLoss Pk *(Pmax/Sn/PF)^2)*8760</td><td></td><td>Added</td></tr>
<tr><td>50.

DEA</td><td></td><td>17</td><td>Table 3.1 Load form factors (Kf) to be used in this study
<table><tr><th>Application</th><th>Kf (= Prms/Pavg)</th><th>Profile used</th></tr><tr><td>Distribution</td><td>1.073</td><td>VDEW G0</td></tr><tr><td>Industry</td><td>1.096</td><td>VDEW H0</td></tr><tr><td>Power</td><td>1.08</td><td>Assumption</td></tr><tr><td>DER (wind)</td><td>1.60</td><td>Experimental data (Vito)</td></tr><tr><td>Small transformers</td><td>1.096</td><td>VDEW H0</td></tr></table>
e) Load Factor (α)</td><td>Attach Mathcad spreadsheet on typical Danish MV/LV and DER cases.</td><td></td><td>??</td></tr>
<tr><td>51.

DEA</td><td></td><td>21</td><td>Table 3.5 Proposed Availability Factors for this study
<table><tr><th>Application</th><th>AF (typ.)</th><th>AF (min.)</th><th>AF (max.)</th></tr><tr><td>distribution</td><td>1</td><td>1</td><td>1</td></tr><tr><td>industry</td><td>1</td><td>1</td><td>1</td></tr><tr><td>power</td><td>1</td><td>1</td><td>1</td></tr><tr><td>DER (wind)</td><td>1</td><td>0.5</td><td>1</td></tr><tr><td>small industry</td><td>0.25</td><td>0.12</td><td>1</td></tr></table></td><td>Approach to treatment of DER is too coarse. From turbine power curve and wind distribution, one deduces a power probability curve. See attached Mathcad spreadsheet.</td><td></td><td>??</td></tr>
</table>

<table>
<tr><th>Number / Ident

Stakeh</th><th>Cap</th><th>Page nr</th><th>Text extract</th><th>Comments</th><th>Alternative proposal (if availble)</th><th>VITO and partners Reply</th></tr>
<tr><td>52.

DEA</td><td></td><td>23</td><td>Amount of harmonics in a normal distribution grid.
Stakeholders are invited to provide input.

Conclusion:
It is proposed to not take this effect into account by a lack of data and it will not b
inefficient transformers in normal use.
Stakeholders please comment.</td><td>Is very modest. In Scandinavian countries, UK, DE and probably other, connection conditions impose limits to harmonic distortion emitted by users, limits taken from IEC 61000-3-6. THD >10% is for practical purposes only found in industrial applications.</td><td></td><td>This confirms conclusion to not take harmonics into account</td></tr>
<tr><td>53.

DEA</td><td></td><td>23</td><td>The copper and aluminium resistance increases with temperature, hence the load loss
increase or decrease with temperature.
The following formula is applicable for copper:

Pk = Pk x (235° + 75 °)/(235° + tm)

Where,
tm = is the measured temperature at the reference point
75 ° is the reference temperature at the reference point</td><td>Strange. The hotter the winding, the less the losses. Hard to beleive.</td><td></td><td>Ok, adapted</td></tr>
<tr><td>54.

DEA</td><td></td><td>24</td><td>rated temperature by only 6°C will halve the lifetime of the insulation (T.R. Blac
October 2007[15]).

The end-user behaviour, e.g. regularly overloading of the transformer, has a significant i
on the transformer life time. Therefore, a number of manufacturers give recommendatic
smart use of such transformers and "energy-saving tips" to end-users. Such strategies
reducing the losses and improving overall performance of transformers which can be ac
through better monitoring and maintenance practices.</td><td>In theory, yes, maybe. In practice: Local development make small units < 200 kVA obsolete. Corrosion, degradation, tightening/gaskets... Lighting direct strokes, other external causes. In-service fault due to insulation degradation rarely seen.</td><td></td><td>??</td></tr>
<tr><td>55.

DEA</td><td></td><td>24</td><td>Table 3.6 Typical repair and maintenance intervals for power transfo

<table><tr><th>source</th><th>Occurance per year</th></tr><tr><td>Major power transformer failure</td><td>0,00569</td></tr><tr><td>Minor power transformer failure</td><td>0,01138</td></tr><tr><td>Maintenance interval (if needed, e.g. oil)</td><td>0,1</td></tr><tr><td>Inspection interval (recommended)</td><td>0,5</td></tr></table></td><td>NORDEL and probably also UCTE publish good fault statistics.</td><td></td><td>To be checked</td></tr>
</table>

Number / Ident Stakeh	Cap	Page nr	Text extract	Comments	Alternative proposal (if availble)	VITO and partners Reply
56. DEA		25	**3.2.4 Economic product life (= actual time to disposal):** Lifetime is a crucial component of the life cycle cost (LCC) calculation. Transformer durable and have long working lives. For financial purposes, the amortisation period f investment in a transformer is often set at years. After that period, companies are no l motivated to invest in new, more efficient, transformers since the 10 year-old one bea cost and cannot be logically compared to the cost of a new investment. The average tech life of a transformer is 30 years or more; more than 10% of the European transformer fl 40 years old or more. This 10% of the transformer fleet contributes more than 20% of the no-load losses and more than 15% of load losses in European distribution companies. The minimum reasonable transformer lifetime in LCC calculations could be 20 year arguments mentioned above indicate that applying 30 years lifetime in industry commerce, and 40 years lifetime in electricity distribution companies can be justified as (SEEDT, 2008[13]).	20 Reinvestment and net present value approach more often used. Accounted asset value hopefully never a criterion for investment decisions.		ok
57. DEA		26	2. Replacement: Replacement with a new unit provides the benefits of an imp more energy efficient design but is very expensive. In Europe dismantlin incineration is mostly used, with the recovery/recycling of the metallic comp (copper, steel, aluminium). The contained oil will be either incinerated, or treate a solvent to extract the PCB. This PCB concentrate will be sent to a chemical co for conversion to hydrochloric acid. contamination of the transformer chemical methods is however little used because of the prevalence of incinerator are easy to transport in drums, and incinerate easily. New transformers will use PCB dielectric fluid or be designed without a liquid dielectric fluid (dr transformers) (UNEP, May 2002[19]). Furthermore, delivery times are also decreasing and are beginning to approach spans. Some utilities used to replace a transformer when the associated load re 100% of transformer nameplate capacity. Some utilities also used to repl transformer when its calendar age reached an arbitrary value of 30 to 35 years the extraordinary growth in power consumption during the late 1960's and many transformers were simply replaced with larger units. But today the con operation of aging transformers is crucial to the financial performance and eco viability of the electric utility. The transformer engineer and/or the asset mana regularly expected to make timely replacement decisions on aging transfo Transformer replacement is no longer a unilateral or arbitrary decision pr	PCB is not worth mentioning here, it is out of the market now. Happened in the eighties. Hardly in DK. Danish utilities tend accept overloading at peak. 120% would be considered acceptable for a unit with residental load.		Ok
58. DEA		26	Approximately 99% are recycled (source: T&D Europe (2009), the other are repaired o second hand. Stakeholders please comment	Would expect 100% recycling. What else to do with all that steel and copper?		ok

<table>
<tr><th>Number / Ident

Stakeh</th><th>Cap</th><th>Page nr</th><th>Text extract</th><th>Comments</th><th>Alternative proposal (if availble)</th><th>VITO and partners Reply</th></tr>
<tr><td colspan="7">Task 4</td></tr>
<tr><td>59.

ORG</td><td></td><td>Page 8</td><td>Page 8
<table><tr><td rowspan="2">Industry oil</td><td>stock</td><td>630</td><td>1300</td><td>6500</td></tr><tr><td>sales</td><td>1000</td><td>1700</td><td>13000</td></tr></table></td><td>Change by
<table><tr><td rowspan="2">Industry oil</td><td>stock</td><td>630</td><td>1300</td><td>6500</td></tr><tr><td>sales</td><td>1000</td><td>1700</td><td>10500</td></tr></table></td><td></td><td></td></tr>
<tr><td>60.
ORG</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Stakeholder identification:

ORG	Orgalime SE
SMA	Spanish Manufacturers Association
HITT	Hitachi Transformers
DEA	The Danish Energy Authority **H&H** HANSEN & HENNEBERG AS
HITM	Hitachi Metals

ANNEX G LATE COMMENTS AFTER THE SECOND STAKEHOLDER MEETING

Comments to the VITO and partners Draft Report						
Stakeholder	**Cap**	**Page nr**	**Text extract**	**Comments**	**Alternative proposal (if availble)**	**VITO and partners Reply**
Task 2						
61. **MTPUK**	Section 2, Summary	p. 8	'The term 'unit' could also be interpreted in relation to the functional unit 'kVA.' Need to explain rationale for this interpretation. Have previous studies defined 'units' in such a manner? Please provide details and references where appropriate.			**This sentence was deleted and reference is made to Task 1 where the functional unit is defined and explained.**
62. **MTPUK**	Table 2-1	p. 9	Should add a totals column so stakeholders can compare summary figures to T&D Europe figures in Table 2-4, Section 2.1.3.			**Ok**
63. **MTPUK**	Section 2.2.1.1	p. 19	It is unclear if the figures provided in Table 2-5, p. 19 are taken directly from the SEEDT study, or if they have been revised based on T&D Europe (sector organisation) data. Suggest clarification by explaining how information from T&D was used. If figures presented are from calculations, would be helpful to present original data from SEEDT study and original data from T&D Europe, along with explanation of how new figures were derived.			**This is explained in footnotes**
64. **MTPUK**	Section 2.2.1.1	p. 19	Currently, document headings are different from table headings despite referring to same product class. For example, headings in Table 2-5 state 'Distribution oil' while the document heading states 'MV/LV distribution,' despite referring to the same product. This can confuse a reader so suggest standardising the product class names, suggest doing so according to Table 2-2.			**Ok**

65. **MTPUK**	Section 2.2.1.1	p. 20	'In the assumption that the EU-27 households are connected on average with Imax of 33 A and has UF of 0.9 and SF of 0.7, this would require a total installed capacity of 1000GW.' Need to identify your rationale for choosing the above assumptions so stakeholders can judge if these are reasonable assumptions.			**Text has been updated to clarify the statement**
66. **MTPUK**	Section 2.2.1.1	p. 21	Figure 2-7 suggests it is possible to breakdown stock numbers in Table 2-6 further, so that an average rating can be calculated to compare with T&D Europe average transformer kVA ratings. Suggest doing so and comparing the two to ensure that appropriate average kVA ratings are used for the different product classifications.			**OK**
67. **MTPUK**	Section 2.2.1.1	p. 22	'Details power transformers' section states that 7500 GVA power transformers were installed in 2005. Suggest providing information source for the approx. 1200 GVA power transformers installed in SE and UK in 2005.			**Was already mentioned in one sentence, this is now further elaborated.**
68. **MTPUK**	Section 2.2.1.1	p. 22, 23	UCTE data provides information on power transformers installed in 2005, while T&D data provides information on power transformers installed in 2009. Suggest using this section to explain how stock figures for power transformers were derived for this report (Table 2-1 Summary of MEEUP Market parameters provides data for 1990, 2005, 2020			**T&D sales data are from 2005, meeting were we received info was in 2009 → this is adjusted to avoid this confusion**
69. **MTPUK**	Section 2.2.1.1	p.23	'Details DER transformers' section suggests the 'current [2009] installed capacity is estimated to amount about 20,000 units.' Suggest explaining how this figure was adjusted to create the figures presented in Table 2-1 Summary of MEEUP Market parameters, which provides data for 1990, 2005 and 2020.			**Current refers to 2005 as the reference year for 'recent' figures, to avoid the confusion current is replaced by 2005**

70. **MTPUK**	Section 2.2.1.1	p. 24	Figures of a case study in Poland and Czech Republic are used to estimate 1990 transformer stock based on the age of the stock in 2005. They are chosen because 'these countries have good transformers manufacturing tradition, they are considered to be representative for the general EU-25 population.' Suggest explaining further why these two countries are good candidates, as earlier Prodcom data presented (p.14) suggests that EU-27 imports of transformers far exceed production in 2004-07. So it seems that a representative country would have a mix of production and import of transformers and it isn't clear if Poland/Czech Republic demonstrate this.			**Indeed this is not a could rationale. We only had this kind of data from Poland and Czech Republic. It is now stated like that. This data is only to try to verify the calculated figures.**
71. **MTPUK**	Section 2.2.1.3	p. 25	Section title labelled as 'Market Data: 2004-2005.' Suggest re-naming to 'Sales Data: 2004-2005' as this seems a more descriptive heading.			**We keep the terminology as stated in the MEEuP methodology**
72. **MTPUK**	Section 2.2.1.3	p. 26	SEEDT sales figures in 2004 are 'much lower than those found in the Prodcom market statistics. Thus could be explained by the fact that the SEEDT data probably did not take into account the small (<25kVA) industrial transformers.' Suggest confirming this assumption with SEEDT.			**SEEDT does not take into account the small industrial tranfo's**
73. **MTPUK**	Section 2.2.1.3	p. 26	It is recommended that an explanation be given describing how 2009 T&D sales data were used to cross-reference 2004 SEEDT data in Table 2-8. Given that it is pointed out that Table 2-8 figures are lower than those found in Prodcom statistics, it is suggested to confirm why this is the case. This may not be relevant considering Prodcom statistics are viewed as not reliable.			**It is indicated with a footnote which data are from T&D and which from SEEDT. T&D data is sales data from 2005.**
74. **MTPUK**	Sections 2.2.2	p. 28-35	This section describes additional market parameters used to check and confirm market data. The authors of the report should re-visit this section to ensure they describe (in all instances) how the parameters listed are used to confirm market data.			**OK, see comment EC above**

75. **MTPUK**	Section 2.3.1	p. 35	This section states that distributed generation systems will 'play an important role in future electricity production' and provides a single statistic that in Belgium, 2005 figures indicate a growth of 700% compared to 2003. Suggest the provision of additional data to illustrate a more representative uptake of distributed generation system growth in the EU-25. Suggest using these data to present a projection of distributed generation growth (and associated growth in stock/sales of transformers) on an EU-25 level.			**Belgium was just mentioned as an example to indicate the trend of the DES growth. This is not further elaborated since DES growth projection on EU level not the key of the project.**
76. **MTPUK**	Section 2.3.2	p. 36	This section mentions the EU Directive to generate 22% electricity from renewable energy systems by 2020. The authors should consider the likelihood of the EU achieving the 22% by 2020 target and scale the projected impact on market figures accordingly. (Suggest incorporating feedback from industry bodies).			**This is not further elaborated since this is not the key of the project.**
77. **MTPUK**	Section 2.3.5	p. 37	The authors should consider including text that describes what potential impact increased production time for more efficient transformers would have on projected stock and sales data.			**This is not further elaborated since this is not the key of the project.**
78. **MTPUK**	Section 2.4.4	p. 39	This section does not indicate average annual maintenance costs. Presentation of these data and an indication of how they were derived would greatly improve this section.			**This data was not provided only the indication that there will be no difference with the current maintenance costs**
79. **MTPUK**	Section 2.4.1		This section effectively lays out the dependence of transformer prices on the commodities markets. However it does not indicate what future commodities prices or transformer prices the study will use in the Life Cycle Cost analysis or how they will be derived. Authors should consider improving their unit cost data.			**To calculate future prices inflation and interest rates are used, see §2.4.5. The EC provides this information.**

80. **MTPUK**			The remaining comments point out grammatical and spelling suggestions.			
81. **MTPUK**	Scope	p.7	Third para beginning 'Please note that this section currently only **includs**' should correct spelling to 'includes'			**Ok**
82. **MTPUK**	Section 2.2.1.2	p. 24	Para 3, 2nd line, 'To estimate the age of these transformers, figures **of** a case study…' should replace 'of' with 'from'.			**Ok**
83. **MTPUK**	2.2.1.3	p. 27	Para 1, last line, '**were** used' should read 'was used'			**Ok**
84. **MTPUK**	2.2.1.4	p. 27	Para 1, second line, **'which'** should be replaced with 'that'			**Ok**
85. **MTPUK**	2.2.1.4		'The following assumptions were made:' first bullet point **'This allows to calculate'** should read 'This allows one to calculate' or 'This allows the calculation of'...			**Ok**
86. **MTPUK**	2.3.1	p. 35	Para 2, last line states '…effect of the policy measures **has taken place.'** Should be replaced with '…effect of the policy measures will have taken place.'			**Ok**
87. **MTPUK**	2.3.2	p. 36	Para 1, last two lines state 'Variable renewable energy output inevitably requires to be supplemented by separate distribution.…' **Consider re-phrasing.**			**Ok**
88. **MTPUK**	2.3.3	p. 36	Para 1, line 2, 'Currently the largest wind turbine **deliver** up to...' should read 'Currently the largest wind turbine delivers up to…'			**Ok**

Comments to the VITO and partners Draft Report						
Stakeholder	**Cap**	**Page nr**	**Text extract**	**Comments**	**Alternative proposal (if availble)**	**VITO and partners Reply**
Task 3						
89. MTPUK	3.1.2	p. 8		Para 1, line 2, 'Lacks of user information…' should read 'Lack'.		OK
90. MTPUK	3.1.3.1	p. 9		The first para states, 'Many utilities do not publish their inventories and network losses at the detail level of transformer losses….Making this detailed information public to the end user or network client might increase awareness [of transformer losses].' Suggest explaining why this information is not reported. Is it a lack of information or is it a decision made by utilities? If it is a lack of information, it may not be possible to derive transformer losses. Suggest explaining how this information can be collected.		this section has been deleted in the meanwhile

91. MTPUK	3.1.3.2	p. 9		Last para states, 'Industry might also benefit from information on the residual value of the transformer after the depreciation time period due to the copper and steel scrap material price. A solution might be to provide information on the value of scrap material in relation to the product price.' Authors should consider if there is significantly more material in efficient transformers such that purchasers would re-think their decision to buy a less efficient transformer based on the end of life value of the extra material. Suggest listing examples of this, demonstrating the percentage of extra material in an efficient transformer versus a normal one and then placing a future value on it. (Discounting that value into today's terms could minimise any perceived benefit). Assume this will take place in future task reports.		This is the purpose of later tasks
92. MTPUK	3.1.3.3	p. 9		Para 2 presents options for providing purchasers information on name plates or by adding an energy efficiency label. It seems that use of an energy efficiency label or added details on the name plate could be beneficial as long as information provided is detailed enough to inform an educated purchaser (as mentioned in 3.1.1). It is not clear if this information would be placed on a specification sheet in addition to the name plate. Recommend placing it on the specification sheet as it is what most purchasers would review before purchasing.		OK
93. MTPUK	3.1.3.4	p. 10		Need to provide examples of how much bigger and heavier more efficient transformers are compared to their less efficient equivalent. Otherwise this statement seems speculative. This could be an important issue, but more information is needed.		see comment 2

94. MTPUK	3.2.1.1	p. 15		Para 1, last line, 'Please note that VDEW is curre' Suggest completing the word and sentence.		OK
95. MTPUK	3.2.1.1	p. 16		Heading 'Load form factor for DER Transformers (DER):' This sections presents an assumed load form factor of 1.60 for wind energy. Suggest explaining how this form factor was derived and provide references to the literature used so that stakeholders can understand the rationale.		Source data and complementary data was added. Due to confidentiality agreement the turbine manufacturer and location cannot be disclosed.
96. MTPUK	Table 3.1	p. 17		The load form factors provided here do not seem sufficient enough to extrapolate to all EU countries. Three of the values are provided by the German electricity organisation only, and are not cross-referenced with any other data. The load form factor for Power transformers does not even reference how the assumption was derived, nor was the experimental data (Vito) explained. Suggest inserting appropriate references and cross-referencing the load form factors with additional data.		The spreadsheet calculating can be made available on the website. A new reference is made to less accurate but EU 27
97. MTPUK	Table 3.2	p. 17		For transparency on input figures and factors used, suggest inserting the actual calculation used to arrive at the average load factors mentioned in the table.		OK

98. MTPUK	3.2.1.1	p. 18		First para refers to NEEP, an organisation based in the north-eastern United States and provides an RMS loading factor from one of their studies. If the study took place in the United States, suggest discussing how the different line voltage standards in the US (compared to the EU) affect performance and efficiency (Task 1, p. 37). Suggest commenting on how this may affect the RMS loading factors used in the EU.		It is obvious that the line voltage is not connected to the end use load profile which is related to the application energy needs, so we don't think any further comment is needed.
99. MTPUK	Table 3.3	p. 19		Similar to comment 7, suggest discussing how the different line voltage standards in Japan (compared to the EU) affect performance and efficiency. Suggest commenting on how this might affect RMS load factors used in the EU.		It is obvious that the line voltage is not connected to the end use load profile which is related to the application energy

100. MTPUK	Table 3.4	p. 20		The load factors to be used in this study are provided in Table 3.4. Suggest more information provided on how the distribution load factor was derived and the rationale behind it, as the factor calculated is 0.15 and the figure listed is 0.19. The DER (wind) factor was taken from the KEMA T&D Consulting report. Turbines examined in this report are rated at 750kW. Suggest identifying if this is the average sized turbine in the EU (seems small, as most commercial scale turbines are rated at 1MW or greater). Additional research could be done to identify how the load factor could change due to larger turbines.		It is obvious the transformer load profile is related to wind fluctuations and as far as known not to size. A detailed
101. MTPUK	3.2.1.2	p. 20		This section discusses power factors and states that 'typically domestic loads have power factors around 1, while industrial load will have lower power factors.' Bearing this point in mind, suggest the study explain why only one power factor has been proposed, considering that five different transformer applications are being examined.		The obvious reason is the lack of reliable data (if you have other evidence please provide it). Finally a sensitivity analysis needs to cover a range to see if it really matters (chapter 7). Mathematically the impact is identical to an increase in load factor.

102. MTPUK	3.2.1.3	p. 21		Para 1, line 1, 'The proposed Availability Factors for this study are in' should read 'The proposed Availability Factors for this study are in the table below.'		OK
103. MTPUK	Table 3.5	p. 21		Despite stating that transformers using DER (wind) applications will likely have a lower availability factors, the typical availability factor provided in Table 3.5 is 1. The minimum availability factor (0.5) could also be high. Suggest re-visiting this factor or explaining the rationale for using it as the majority of wind applications are not constantly energised.		A detailed technical analysis and discussion seems not appropriate here. Finally a sensitivity analysis needs to cover a range to see if it really matters (chapter 7).
104. MTPUK	3.2.1.4	p. 23		Conclusion: 'It is proposed to not take this effect into account by a lack of data and it will not benefit inefficient transformers in normal use.' This statement is unclear. Suggest re-phrasing. Section suggests that harmonics can represent 5% of load loss. Is this considered insignificant? Suggest listing the maximum potential load loss attributable to harmonics to provide a sense of the impact on energy efficiency.		Text is adapted. Suggestion cannot be done due to a lack of relevant data on harmonic content. If available provide it.

105. **MTPUK**	3.2.2	p. 24		This section does not explain if it will adjust transformer lifetimes based on estimating time operated above rated temperature. Suggest explaining if the study will or will not account for this factor.		the text now mentions that this factor is NOT taken into account

ANNEX H ENQUIRY FOR SMALLER INDUSTRIAL POWER TRANSFORMERS

Dear XXX,

We are currently performing an Eco-design study on distribution transformers on behalf of the EC (DG ENTR) (see also www.ecotransformer.org).
Herein we urgently seek more confirmation on assumption related to small industrial power transformers (between 1 and 63 kVA) for our) on which you are registed as stakeholders as it appeared to be hard to find reliable data.

Scope of smaller industrial power transformers is: isolation, separation or control transformers at 50 Hz with 230 VAC or 400 VAC primary, between 1 and 63 kVA.

Questions:
Complementary to Task 1 or Chapter 1 on standards:

A) Which measurement standard (EN ?) do you apply to measure load and no load losses?
   a. Standard EN …… b. there is no? c. no measurements are made?
B) Are there gaps or loopholes related to those standards?
   a. Yes? b. No?

Complementary to Task 2 or Chapter 2 on market data:

A) Size of 16 kVA was chosen after catalogue research that ranges up to 63 kVA, however more smaller transformers are present therefore 16 kVA was taken as reference. Is this realistic or not?

If not please correct: .. … kVA

B) This market is estimated at about 30000 units per year (anno 2005) with average rating of 16 kVA (typically three phase.
   FYI: How this was obtained:
   Assumed to be equivalent in turn over to halogen transformers and corrected upwards = 6000000 x 0.06 kVA/16 kVA x1.33 = 30000 units per year of typically 16 kVA
Is this realistic or not?

If not please correct: about …… units per year

C) At 16 KVA most transformers are rather 3 phase because much 3 phase equipment is on the market, agree or not?

Complementary to Task 3 or Chapter 3 on user behaviour:

D) For industrial transformers it is uncommon to include sound level data in catalogues. It is most likely that very low sound levels for transformers are not a source of concern in the industrial environment. Agree or not?

As we plan to release this chapters next week we would appreciate to have your reply by Friday 26/4, this will enable to take your opinion into account. Do not hesitate if you have any further question.
Thanks in advance,

Best regards,

ANNEX I MINUTES OF THE SECOND STAKEHOLDER MEETING

Ecodesign Preparatory Study ENTR Lot 2: Distribution and Power Transformers

Minutes of the Second Stakeholder Meeting

Place: European Commission
Centre Albert Borschette, Brussels

Date / Time: May 19, 2010
10h30 – 18h00

Project contact: **VITO**
Paul Van Tichelen (paul.vantichelen@vito.be)
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Tel: +33 1 53 90 11 80

Agenda:

10h15 – 10h45	Welcome and participants presentation (EC and Vito) Agenda Distribution of comments and proposed answers
10h45 – 11h00	Short presentation of MEEuP methodology and general scope of the study (BIO)
11h00 – 11h30	Chapters 1-3 in a nutshell with short discussion on approach for load profiles (Vito)
11h30 – 12h00	Gaps in standards and potential recommendations (Vito)
12h00 – 13h00	Presentation of Chapter 4 followed by a discussion on transformer price approach and selected comments and answers (BIO)
13h00 – 14h00	Lunch break

14h00 – 15h00	Presentation of Chapter 5 and selected comments and answers (Vito)
15h00 – 15h30	Needs for updated info related to Chapters 4 and 5
	Chapters 6 and 7 planning and approach
15h30 – 15h45	Coffee break
15h45 – 16h30	Other comments received and discussion (Vito)

The times of the agenda are the originally planned times, and do not reflect the reality of the events that occurred.

Annex: Stakeholders who read these minutes should also consult the powerpoint presentations of the meeting that are available on the project website.

Participants:

European Commission

ME	Martin Eifel	EC – DG ENTR

Lot 2 consortium

PVT	Paul Van Tichelen	VITO
MSt	Marcel Stevens	VITO
BT	Benoît Tinetti	BIO Intelligence Service
AT	Alexander Thornton	BIO Intelligence Service
TF	Thibault Faninger	BIO Intelligence Service

Stakeholders

MSa	Michel Sacotte	GIMELEC/T&D EUROPE/WG3
PL	Pierre Lucas	T&D Europe
CE	Christophe Elleau	EDF R&D
EC	Eric Coen	EREA nv
SJ	Sigrid Jacobs	ArcelorMittal
SF	Stefan Fassbinder	DKI
HDK	Hans De Keulenaer	European Copper Institute
CM	Chiara Margagliano	European Consulting Brussels
JG	Joachim Gerster	Vacuumschmelze

HL	Hans Lammert	ThyssenKrupp Electrical Steel GmbH
AS	Angélique Stopin	ThyssenKrupp Electrical Steel GmbH
AW	Anthony Walsh	ESB Networks/Eurelectric
HPS	Hans-Paul Siderius	NL Agency
MSc	Michael Scholand	CLASP/Navigant Consulting
RM	Richard McGeehan	Hitachi Ltd.
JH	Jesper Holmberg	Hitachi, Ltd.
VDF	Vance DeFelice	Hitachi Metals/Metglas
MDG	Maya DeGroot	federal public service health, food chain safety and environment

1. INTRODUCTION

Paul Van Tichelen (PVT) of VITO welcomed participants to the meeting and initiated introductions by all participants.

Martin Eiffel (ME) of the European Commission explains the meeting expectations:

- The study began 1.5 years ago. This is the second stakeholder meeting and there are two tasks remaining to be completed before the study ends in November. It is important to have comments from stakeholders.
- The EC wants a project report that answers all questions and addresses all concerns to have the necessary information for passage through the legislative process.
- There should be an emphasis on standardisation. We need to look for what exists and what might be needed related to test and measurement, as well as performance.
- There is a new ecodesign Directive (2009/125/EC) in which the product scope is extended to all energy-related products (ErP). For example, windows are an ErP. The update of the Directive has no impact on the current study and legislative process.
- The current working plan runs out in 2011 and a new one will take effect in 2012. A call for tender is currently out for the contract to create the new working plan.
- Article 21 of the new ecodesign Directive calls for an extensive review in 2012.

Anthony Walsh (AW) of ESB Networks/Eurelectric raises a question on the application of the Directive to ErP. Are cables and overhead lines included? Within a utility, an optimization is done to balance the losses in cables and transformers. Utilities look at capitalisation of energy efficiency over the entire system, rather than just one component. It is incorrect to minimise losses in transformers if greater gains can be made per capital in the system. He feels that the perspective of utilities is lacking within the present version of the study.

ME: All perspectives are welcome and will be taken into account. Cables as such are already covered under the original ecodesign Directive (2005). No one has yet come forward with a reason to focus on them.

Michel Sacotte (MSa) of GIMELEC/T&D EUROPE/WG3: The study of transformers is already very complicated; it should be remained focused on the transformer and not the system level aspect.

PVT: Agree. This is a horizontal discussion that is out of the scope of the study.

1. PRESENTATION ON MEEUP

Alexander Thornton (AT) of BIO Intelligence Service presents the methodology used in the study.

2. CHAPTERS 1-3

PVT makes a presentation on remaining issues within Chapters 1-3. It is essential particularly to receive information on the use phase.

AW: The load factor definition used in the study is not the one used by utilities. The difference comes from the load increasing over time.

PVT: Agreed. We will come back to this point.

Christophe Elleau (CE) of EDF: Dimensioning and weight are not included with performance parameters.

PVT: They are important but not related to the core functionality.

AW: Disagree. A transformer that is too big is unusable in certain contexts.

PVT: Information on amorphous transformer tests?

CE: When EDF tested Indian and Chinese products with the short-circuit test, they failed. However, the test specifications were satisfied by French products.

MSa: There is proof that at least one French and one German company have passed the short-circuit tests for amorphous transformers. It is technically possible to pass up to 1 MVA, and surely up to 400 kVA. There is a CIRED article for proof.

CE: Amorphous transformers are new for ERDF. Manufacturers in France were not informed, so the product was taken from the world market. There is a new field test program and manufacturers now know the needs of EDF.

AW: Why is there a problem with amorphous transformers and short circuit tests?

MSa: Short-circuit tests are one of the many requirements for reliability in Europe. The rectangular core of most amorphous transformer designs creates technical difficulties in this respect. As power increases, the difficulties increase.

AW: Is this a problem of manufacturing experience with amorphous material?

MSa: It is a question of design using amorphous material. The EU utilities are very serious about the short-circuit test and reproducible design is needed.

PVT: Can fuses or circuit breakers be used?

MSa: This is not possible as they are too slow. There are a few issues with amorphous transformers that need to be studied.

CE: Note that EDF shares the same specification with ENBW.

AW: There have been about 25 amorphous transformers in our system for the past 20 years in rural circuits that have lower short-circuit requirements without problem.

Vance DeFelice (VDF) of Hitachi Metals/Metglas: Amorphous transformers have no failures reported so far in Japan and the US and carry the same risk as any transformer.

MSa: The difference of standards from around the world needs to be studied.

Discussing raw material prices

Michael Scholand (MSc) of CLASP: Worked for seven years with the DOE transformer standards. The price table for that study was a five year material average price. There was a lot of fluctuation at the time. The marked up material price had to do with the manufacturers selling price of embedded material. Column two is not necessarily needed for the EU. The breakdown of markup is the following: 2.5% scrap and handling, 4% mitred scrap factor, 12.5% factory overhead, and 25% nonproduction markup.

AW: The numbers given for transformer stock are very confusing. It is better to increase the scope to 12 kVA which is utility size. Utilities should be asked for stock data.

PVT: It is hard to get good data. We would like the average rating and how many of them you have. (Note: Utilities are still invited to send data, which can be taken into account in chapters 6 and 7, as well as later impact assessments).

Discussing load factor

MSc: The DOE went through a long process to arrive at a 50% average load factor, used in association with specific load curves.

MSa: The price of transformers and load factor need to be accurately determined for this study to be finalised. Load factor data is needed for all countries. A new inquiry is encouraged as load factor is extremely important.

PVT: Agreed. We need stakeholders to provide data (Note: see also presentation, there might be confusion about the used definitions of load factors, as mentioned in the presentation this will be more documented in the updated chapters).

ME: On the basis of this report, the European Commission will take action. It is in the best interest of all stakeholders to provide data so a decision can be made on a solid basis.

AW: Eurelectric can be pushed to release data but one load factor is not sufficient. It is better to push for standardisation of capital losses across EU.

MSa: Yes but that is not the purpose of the study. Average load factor is needed for this study.

AW: Load factor is very unique in each location. Will ask EUrelectric for general factors.

CE: The problem with an average load factor is that when a utility constructs a grid, it considers not average but peak values (or worst case, see also powerpoint presentation on definitions). A better idea is to sum the total power installed, then obtain total no-load losses at the time. No-load losses are constant all year.

Discussing standards

MSa: Fire standards are generated by manufacturers. A technology dependent standard is set high and dry type was chosen to satisfy it. Liquid already has embedded energy and is inherently worse performing with respect to fire safety than dry types. No one tries to develop a liquid standard. An end user chooses a dry type transformer when considering safety and environment. However, liquid has lower level of losses. Vegetable oil is becoming more common, though fire performance remains the same.

Discussing energy labelling

PVT: Would it be a good idea to put the loss classes on the transformer nameplate?

AW: It would be better to indicate the losses values.

MSc: With efficiency you must always determine a loading point. No load and load loss info would be better.

MSa: Suggest a law to reduce losses rather than labelling. A working group to establish standards of energy efficiency was just launched. The first meeting will take place in autumn 2010. Goal is an energy efficiency standard in 2012.

Discussing performance tolerances

MSc: The DOE ended up creating standards for 5-6% tolerance which created higher quality products.

MSa: This is hard to achieve because of raw material standard deviation, testing tolerances, manufacturing process tolerances. 10% could be reduced to 7.5%, but not further.

AW: The utility expects a tolerance of less than 5%.

MSa: There is currently a 10% tolerance but penalties if the performance varies by more than 2%.

3. PRESENTATION ON TASK 4

Thibault Faninger (TF) of BIO Intelligence Service presents the results of Task 4.

Discussing EcoReport inputs

Sigrid Jacobs (SJ) of ArcelorMittal: Galvanized steel was used in the EcoReport for modelling core material but it is not precise enough.

MSc: same remark for the use of "cast iron" for the tank material.

TF: More appropriate materials were not available within the EcoReport. We are restricted to the use of the EcoReport.

SJ: Materials were added for the lot on motors, such as electrical steel. Will email with more information afterwards.

MSc: Support for expanded bill of materials.

AW: What country or continent is the steel being produced in? It is very geographic dependent.

TF: This is a general tool, and thus uses an EU average for inputs, including electricity generation.

ME: The EcoReport reflects an average. We cannot check where items are produced, but more focused on the design of products. It would not be possible to create regulations governing the supply chain.

Discussing transformer lifetime

AW: Product life of distribution transformers is more often 40-45 years because a transformer at partial load lasts longer.

Discussing 1 kVA transformers

AW: Where are the separation and isolation transformers used? Is this a unique situation?

Eric Coen (EC) of EREA nv: Separation and isolation transformers are commonly used outside of distribution in machinery.

PVT: There are many reasons for using them that are clearly explained in Chapter 1.

ME: The purpose of the study is to map all transformers, and thus they will remain within scope.

Discussing price of electricity

CE: The price of electricity should be 0.078 €/kWh.

AW: Is tax included in the price? The price varies depending upon which part of the transmission system it is in, as well as location.

PVT: A sensitivity analysis will be conducted to ensure robustness.

Discussing material cost of active part

MSa: 35% is very low but cannot give exact figures. Perhaps double that (look for utility revision formulas), definitely greater than 50%.

Discussing end of life

AW: Was cost of waste disposal taken into account?

TF: No true data was obtained so it was ignored. Data is welcome.

AW: For transformers constructed before 1990, it is a loss. For newer transformers, it is a gain.

4. PRESENTATION ON TASK 5

PVT presents the results of Task 5.

MSc: AK Steel makes carlite, an insulator that is better than glass and rivals amorphous transformer efficiency. Other steel coatings would be a useful improvement option.

Angélique Stopin (AS) of ThyssenKrupp Electrical Steel GmbH: ThyssenKrupp developed this and is also decreasing material thickness using new coatings. Will send info.

(info below provided 04/06/10 by AS)

The potentials for further loss improvements are related to the three loss components contributing to the total loss: hysteresis, eddy current and anomalous loss. Smoother surfaces (interface between insulation layer and steel matrix), new coatings with enhanced tension, sharper texture with improved grain structure (generating micrograins, controlling grain shape), optimized domain refining (decreasing of 90° closure domains), thinner gages (without destabilizing of secondary recrystallization) are the items on which each GOES producer works.

In the field of insulation coatings, most GO producers use the second generation coating "S2" (Carlite is the AK Steel designation), or "C5 over C2" according to international standards. This is a tension coating leading to tensile enhancement, resulting in core loss and magnetostriction reduction. It reduces compressive stress sensitivity of laminations, too.

A 3rd generation coating may consist of generating a smooth and particle free interface between surface and steel matrix and applying a DLC (diamond like carbon) insulation, but this technique is still under development.

The reduction of the thickness is a well known technique to decrease the core losses. Whereas CGO in thickness 0.18 mm is already available on the market from some limited GO producers, the development of HGO in thickness 0.18 mm is more challenging due to the more difficult control of secondary recrystallisation.

Discussing noise in amorphous transformers

MSa: The problem of noise in amorphous transformers is a lobby problem. For the same flux, an amorphous transformer probably gives 6-10 dB (A) more noise than a traditional transformer. For a traditional 400 kVA, noise is about 63 dB. If losses are reduced 10-20%, then noise is roughly 53 dB. An amorphous transformer will have a lower level of losses and about the same noise. Noise should not be the primary parameter in choosing technology.

AW: Specifying noise levels is economics. Sometimes this results in amorphous being uneconomical.

ME: A hypothetical regulation could be that a manufacturer must declare intention for use in order to allow for noisy transformers away from people.

CE: An amorphous Bk transformer cannot yet meet EDF specifications for noise, weight, and losses.

PVT: Is noise connected to the load factor?

MSa: Noise of the coil only contributes for greater than 10 MVA according to ISO 76-10.

AW: Core noise does not change depending upon load.

MSc: To minimise uncertainty, contract a third party that designs transformers. Optimized Program Service was used by the DOE and has the capability to provide an independent evaluation.

PVT: We use a simple spreadsheet and it is open for the manufacturers to verify it, moreover enquiry will be launched (see powerpoint presentation)

MSc: There are technical issues that complex software is needed to address.

MSa: It is better to have a simple example with simple data. An inquiry is the best way.

MSc: The relationship between cost and efficiency is the most important part of the study. A simple example is not sufficient. European manufacturers use there own design software.

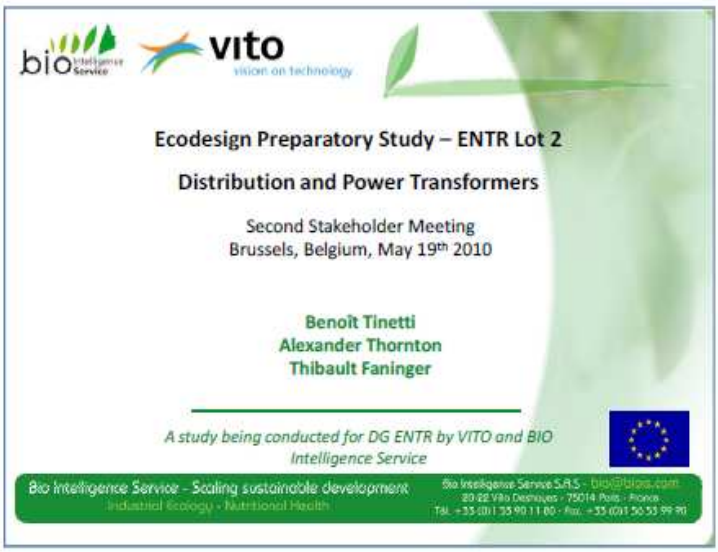
(Note added afterwards(PVT): in what does it differ from obtaining info from manufacturers as the DOE information is single source data and crucial design parameters were not disclosed? Moreover, European manufacturers have their own design software and do not rely on OPS so the outcomes might not be representative either.)

ME: The European Commission is actively looking to fill in gaps and loopholes in standards, as mentioned on p. 77 of the report. This will avoid a situation in regulatory committee when a standard is lacking. The European Commission calls all stakeholders to provide this information very soon.

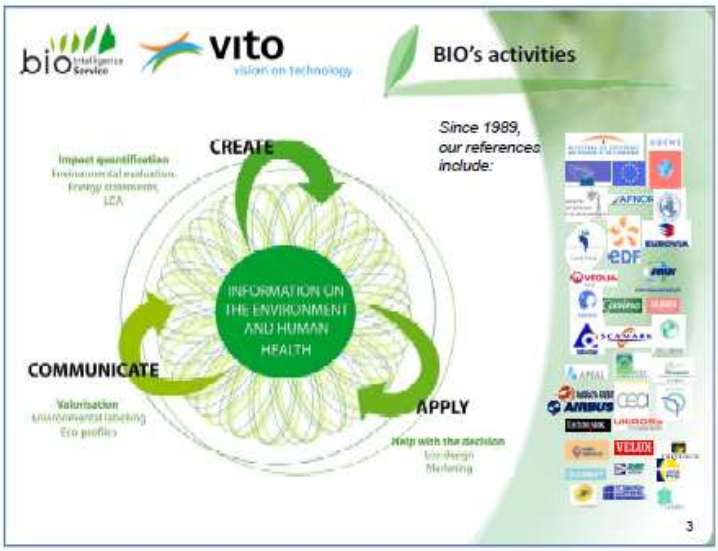
AW: The discount rate of 4% is not appropriate.

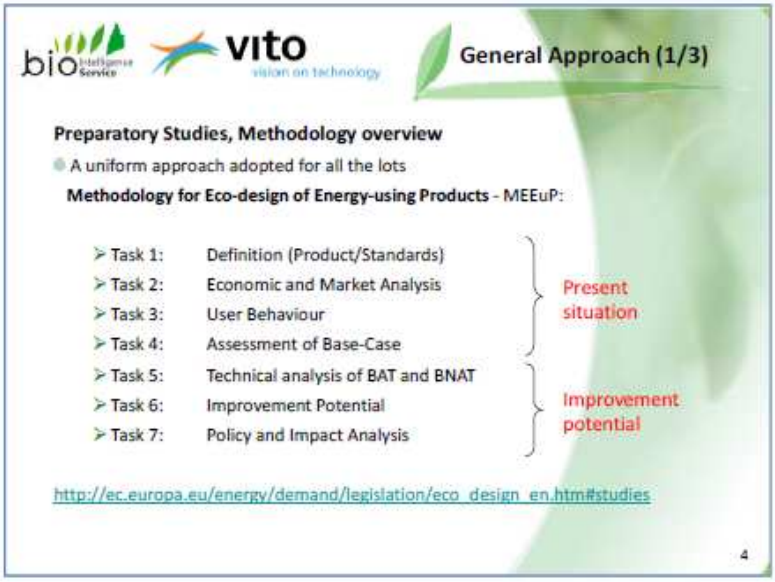
ME: The discount rate is standardised across European Commission studies and will remain at 4%.

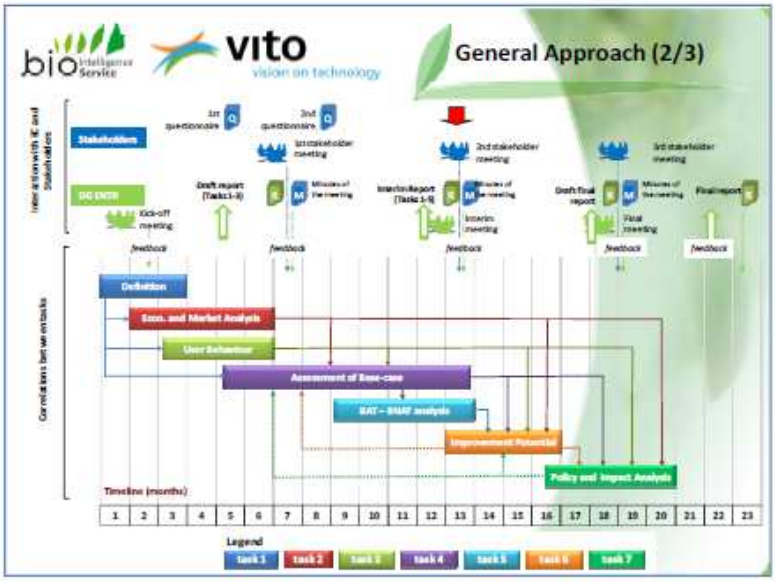
ANNEX J PRESENTATIONS OF THE SECOND STAKEHOLDER MEETING

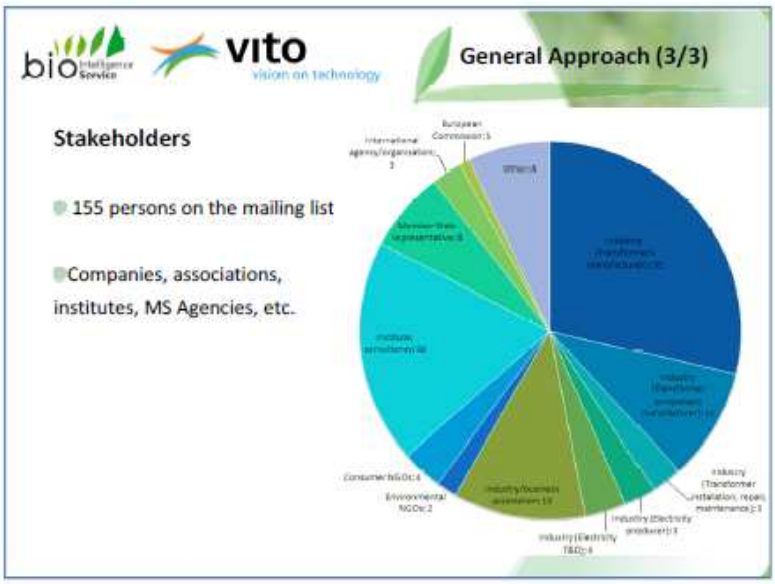






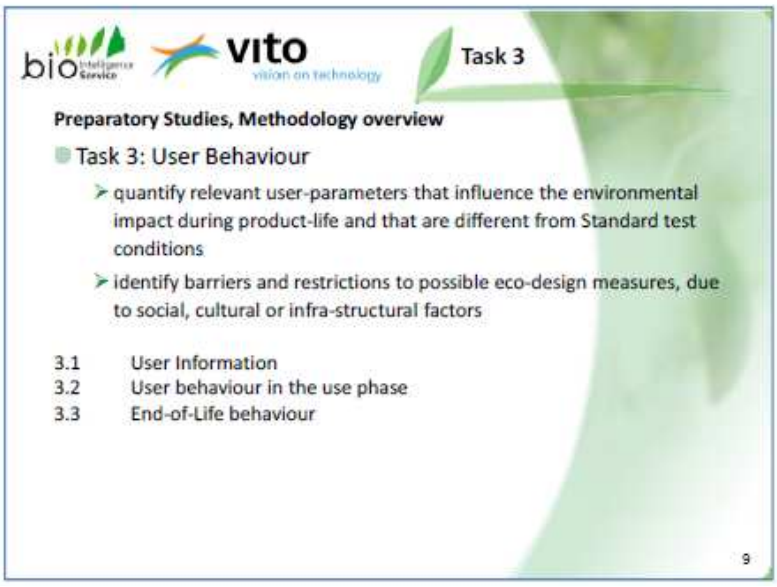

General Approach (1/3)
Preparatory Studies, Methodology overview
A uniform approach adopted for all the lots
Methodology for Eco-design of Energy-using Products - MEEuP:
Task 1: Definition (Product/Standards)
Task 2: Economic and Market Analysis
Task 3: User Behaviour
Task 4: Assessment of Base-Case
Task 5: Technical analysis of BAT and BNAT
Task 6: Improvement Potential
Task 7: Policy and Impact Analysis
Present situation
Improvement potential
http://ec.europa.eu/energy/demand/legislation/eco_design_en.htm#studies
4


General Approach (2/3)
Definition
Assessment of Base-case
Timeline (months)
Legend


General Approach (3/3)
Stakeholders
155 persons on the mailing list
Companies, associations, institutes, MS Agencies, etc.

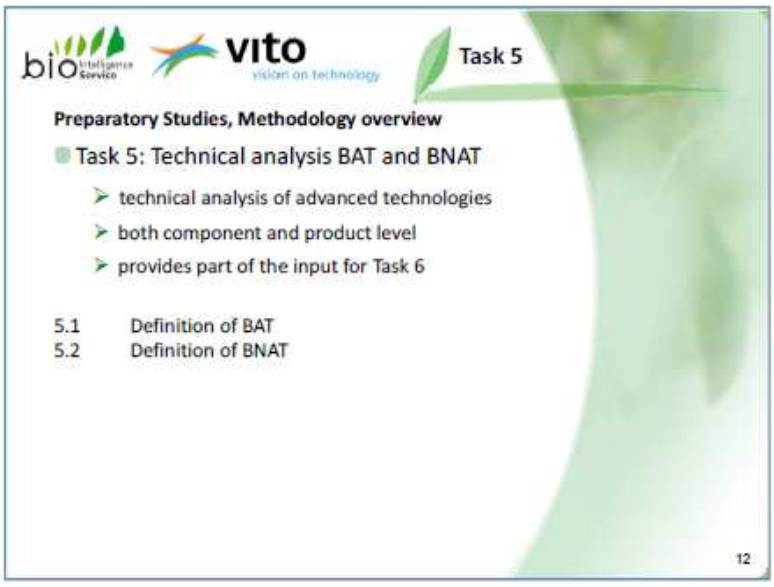

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Task 1
Preparatory Studies, Methodology overview
Task 1: Definition
define the product category and define the system boundaries of the 'playing field' for eco-design
identify the harmonised test standards and additional sector-specific procedures for product-testing
identify the existing relevant legislation, voluntary agreements, and labelling initiatives at the EU and MS level, as well as outside Europe
1.1 Product definition
1.2 Test and other Standards
1.3 Existing legislation (including labelling and voluntary programs)
7


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Task 2
Preparatory Studies, Methodology overview
Task 2: Economic and Market Analysis
place the product group within the total of EU industry and trade policy
provide market and cost inputs for the EU-wide environmental impact of the product group
provide insight in the latest market trends
provide a practical dataset of prices and rates to be used in a Life Cycle Cost (LCC) calculation
2.1 Generic economic data
2.2 Market and stock data
2.3 Market and production structures
2.4 User expenditure base data
8


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Task 3
Preparatory Studies, Methodology overview
Task 3: User Behaviour
quantify relevant user-parameters that influence the environmental impact during product-life and that are different from Standard test conditions
identify barriers and restrictions to possible eco-design measures, due to social, cultural or infra-structural factors
3.1 User Information
3.2 User behaviour in the use phase
3.3 End-of-Life behaviour
9


Task 4 (1/2)
Preparatory Studies, Methodology overview
Task 4: Assessment of Base-Case
general technical analysis of current products on the EU market
objective is to capture the market on the whole, both "good" and "bad" products
functional analysis of the system to which the product belongs, including a rough estimate of the overall impacts
building on the results of Tasks 1 – 3, and analysis of current products, "one or two average EU product(s)" or product category(ies) have to be defined as the "Base-case" for the whole of the EU-27
on these Base-Cases most of the environmental and Life Cycle Cost analyses will be built throughout the rest of the study
the Base-Case is a conscious abstraction of reality
10


Task 4 (2/2)
Preparatory Studies, Methodology overview
Use of the EcoReport tool
Results consist of environmental impacts assessments and economic analysis
4.1 Product specific inputs
4.2 Definition of Base-Case
4.3 Base-Case environmental impact assessment
4.4. Base-Case Life Cycle Cost
4.5 EU 27 total impact
11


Task 5
Preparatory Studies, Methodology overview
Task 5: Technical analysis BAT and BNAT
technical analysis of advanced technologies
both component and product level
provides part of the input for Task 6
5.1 Definition of BAT
5.2 Definition of BNAT
12

Next Steps

Preparatory Studies, Methodology overview

- Task 6: Improvement Potential
- Task 7: Policy and Impact Analysis

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Task 6 (1/2)

Preparatory Studies, Methodology overview

- Task 6: Improvement Potential
  - identify design options, their monetary consequences in terms of Life Cycle Cost for the consumer and their environmental costs and benefits
  - Life Cycle Costs: indicate whether design solutions might negatively or positively impact the total EU consumer's expenditure over the total product life (purchase, running costs, etc.)
  - pinpoint the solution with the Least Life Cycle Costs (LLCC) and the Best Available Technology (BAT)
  - robustness of the outcome

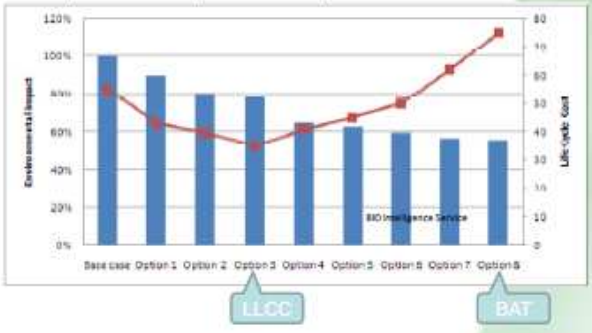
6.1 Identification of Design options
6.2 Analysis BAT and LLCC
6.3 BNAT and long-term systems analysis
6.4 Sensitivity Analysis of the main parameters

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Task 6 (2/2)

Preparatory Studies, Methodology overview

- Analysis of the improvement potential



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Task 7 (1/2)

Preparatory Studies, Methodology overview

- Task 7: Policy and Impact Analysis
  - summarise and total the outcomes of all previous tasks
  - look at suitable policy means to achieve the potential e.g. implementing LLCC as a minimum and BAT as a promotional target, using legislative or voluntary agreements, labeling and promotion
  - scenarios 1990 – 2025 quantifying the improvements that can be achieved vs. a Business-as-Usual scenario
  - impacts on consumers and industry

7.1. Policy analysis
7.2. Impact analysis

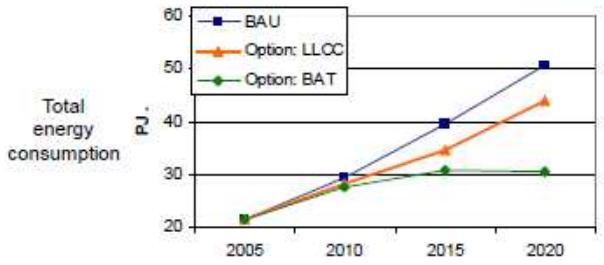
16

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Task 7 (2/2)

Preparatory Studies, Methodology overview

- Task 7: policy and Impact Analysis
  - example of scenarios



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Transition

- Back to Vito's presentation

Task 4 (1/20)

- Task 4: Assessment of Base-Cases
  - building on the results of Tasks 1 to 3, and analysis of current products
  - the Base-Case is a conscious abstraction of reality
  - use of Ecoreport: tool that has to be used within the MEEuP
  - sources of data: stakeholder enquiry (on the website) and literature
    The BCs inputs are aggregated data, supposed to average the EU market

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Task 4 (2/20)

- Definition of Base-Cases
  - BC 1 – Distribution transformer (400 kVA, P_0 750 W, P_k 4600 W, D_0C_k)
    Comment: add another BC: 160 kVA distribution transformer?
  - BC 2 – Industry transformer: oil-immersed (1 MVA, P_0 1700 W, P_k 10500 W, E_0C_k)
  - BC 3 – Industry transformer: dry-type (1.25 MVA, P_0 2800 W, P_k 13100 W)
  - BC 4 – Power transformer (100 MVA, P_0 80000 W, P_k 300000 W)
  - BC 5 – DER transformer: oil-immersed (2 MVA, P_0 1760 W, P_k 16800 W)
    Comment: is the rating power (2 MVA) representative?
  - BC 6 – DER transformer: dry-type (2 MVA, P_0 1760 W, P_k 16800 W)
  - BC 7 – Separation/isolation transformer (16 kVA, P_0 110 W, P_k 750 W)

20

Task 4 (3/30)

- EcoReport Inputs
  - Bill of Materials (BOM)

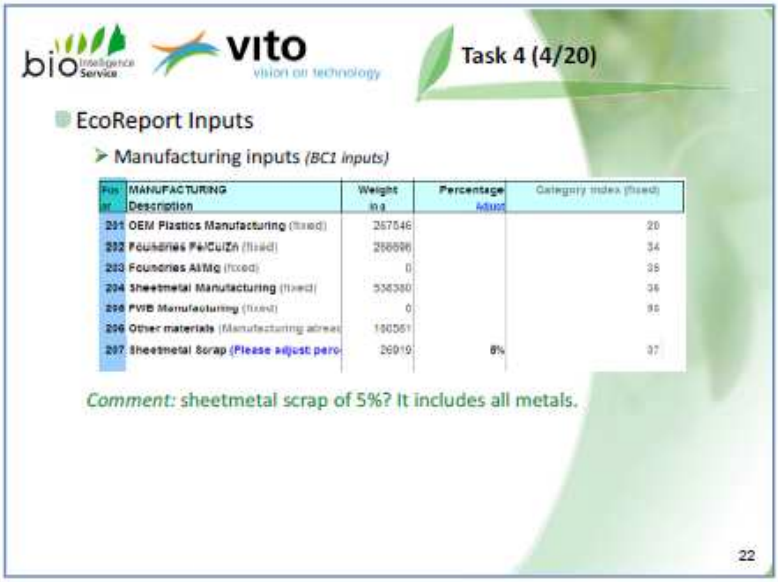
Comment:
initially, oil replacement was considered every 10-15 years. New calculations do not take it into account. Is that correct?

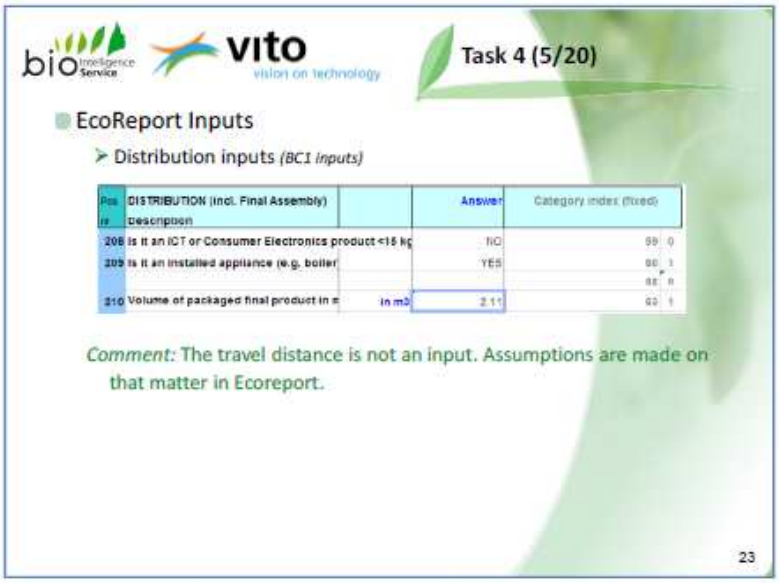
	Product name	Date	Author
1	BC1 - Distribution transformer		BIO

Assy nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click this cell	Material or Process select Category first !
1	CORE			
2	Core steel	466700.0	3-Ferro	21-St sheet galv.
3				
4	WINDINGS			
5	Aluminium wire	21440.0	4-Non-ferro	26-Al sheet/extrusion
6	Copper wire	144720.0	4-Non-ferro	29-Cu winding wire
7	Copper sheet	46240.0	4-Non-ferro	30-Cu tube/sheet
8				
9	TANK			
10	Cast iron	299000.0	3-Ferro	23-Cast iron
11				
13	INSULATION			
14	Paper	15000.0	7-Misc	57-Office paper
16	Ceramic	6019.4	7-Misc	58-Ceramics
17	Oil	743400.0	1-Bit/Plastics	4-Mineral Oil
18	Cardboard	3054.0	7-Misc	59-Cardboard
20				
21	OTHERS			
22	Plastics	2040.0	1-Bit/Plastics	1-HDPE
23	Wood	4364.0	7-Misc	60-Wood
24				
25	COATINGS	5700.0	5-Coating	38-powder coating

(BC1 BOM)

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Task 4 (4/20)
EcoReport Inputs
Manufacturing inputs (BC1 inputs)
Pos nr
MANUFACTURING Description
Weight in g
Percentage Adjust
Category index (fixed)
201 OEM Plastics Manufacturing (fixed) 267546 20
202 Foundries Fe/CuZn (fixed) 286696 34
203 Foundries Al/Mg (fixed) 0 35
204 Sheetmetal Manufacturing (fixed) 536380 34
205 PWB Manufacturing (fixed) 0 95
206 Other materials (Manufacturing adhesi 180561
207 Sheetmetal Scrap (Please adjust perc 26919 5% 37
Comment: sheetmetal scrap of 5%? It includes all metals.
22


Task 4 (5/20)
EcoReport Inputs
Distribution inputs (BC1 inputs)
Pos nr
DISTRIBUTION (incl. Final Assembly) Description
Answer
Category index (fixed)
208 Is it an ICT or Consumer Electronics product <15 kg NO 99 0
209 Is it an installed appliance (e.g. boiler YES 99 1
210 Volume of packaged final product in m 2.11 99 1
Comment: The travel distance is not an input. Assumptions are made on that matter in Ecoreport.
23


Task 4 (6/20)
EcoReport Inputs
Use phase inputs (BC1 inputs)
Pos nr
USE PHASE Description
unit
Subtotals
211 Product Life in years 35 years
Electricity
212 On-mode: Consumption per hour, cycle, setting, etc 8.426 kWh 8426.786135
213 On-mode: No. Of hours, cycles, settings, etc. / year 1 #
214 Standby-mode: Consumption per hour 0 kWh 0
215 Standby-mode: No. Of hours / year 0 #
216 Off-mode: Consumption per hour 0 kWh 0
217 Off-mode: No. Of hours / year 0 #
TOTAL over Product Life 294.90 MWh (=000 kWh)
Maintenance, Repairs, Service
225 No. of km over Product-Life 500 km / Product Life
226 Spare parts (fixed, 1% of product materials & manuf.) 12532 g
Comment: 500 km are assumed for the maintenance and repair services (not for installation). Realistic?
24

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Task 4 (7/20)

- EcoReport Inputs
  - Use phase inputs:

No consumables (water, oil,…)

Calculation of the electricity losses according to Formula 3.2:

$$Etr(y) = Af \times (P_o + P_k \quad (\alpha \quad K_y/PF)^2 + P_{aux}) \quad 8\,760/1\,000$$

where:

Etr(y) = the energy used by the distribution transformer per year [kWh],

Af = the availability factor,

P_o = no-load losses at rated load [W]

P_k = the load losses at rated load [W]

P_{aux} = the auxiliary losses

α = The load factor (P_{avg}/S)

K_y = Load form factor (P_{rms}/P_{avg})

PF = the power factor of the load served by the transformer

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Task 4 (8/20)

- EcoReport Inputs
  - Use phase inputs: influence of the use parameters

Typical transformer	Load factors (α)	Load form factors (Ky)	Power factor (PF)	Availability factor (Af)	Average Lifetime
MV/LV distribution oil	0.19	1.673	0.95	1	35
Industry oil	0.40	1.696		1	27.5
Industry dry	0.40	1.696		1	27.5
Power	0.20	1.08		1	40
DER (liquid-immersed and dry-type)	0.30	1.80		0.5 to 1	27.5
Separation/isolation	0.40	1.696		0.12 to 0.25	27.5

Comments:

- Af of DER transformers?
- Load factors too low for power transformers or other types?

Typical transformer	Annual losses according to Formula 3.2 [kWh]
MV/LV distribution oil	8 426
Industry oil	34 480
Industry dry	48 966
Power	826 658
DER (oil-immersed and dry-type) (Af=0.5)	26 494
Separation/isolation	284

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Task 4 (9/20)

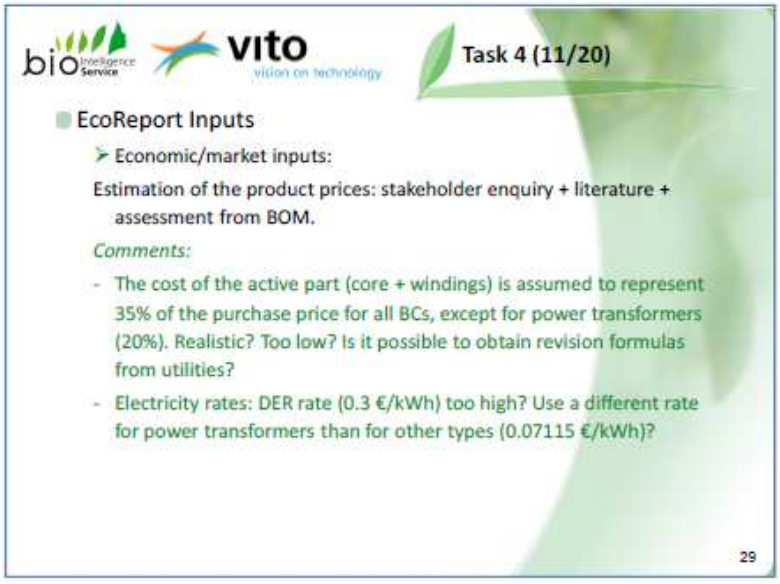
- EcoReport Inputs
  - End of life inputs *(BC1 inputs)*

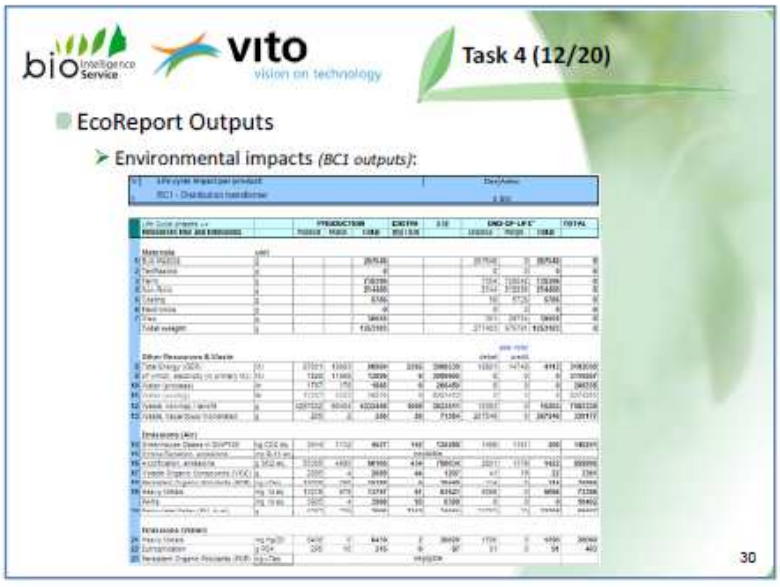
Pos	DISPOSAL & RECYCLING Description		unit	Substitute
	Substances released during Product Life and Landfill			
227	Refrigerant in the product (Click & select)	0	g	1-none
228	Percentage of fugitive & dumped refrigerant	0%		
229	Mercury (Hg) in the product	0	g Hg	
230	Percentage of fugitive & dumped mercury	0%		
	Disposal: Environmental Costs partly final product			
231	Landfill (fraction products not recovered) in g en %	125/92	1%	88 fixed
232	Incineration (plastics & PWB not re-used/recycled)	2675.19	g	91 fixed
233	Plastics: Re-use & Recycling ("cost"-side)	0	g	93 fixed
	Re-use, Recycling targets	in g	% of plastics (recover	
234	Plastics: Re-use, Closed-loop Recycling (please edit%)	0	0%	1
235	Plastics: Materials Recycling (please edit% only)	0	0%	4
236	Plastics: Thermal Recycling (please edit% only)	2675.48	100%	73
237	Electronics: PWB Easy to Disassemble ? (Click&select)	0	YES	99
238	Metals & TV Glass & Misc. (95% Recycling)	936359		fixed

Comment: in the UK, oil is recycled, not incinerated.

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Task 4 (10/20)
EcoReport Inputs
Economic/market inputs (BC1 inputs)
INPUTS FOR EU-Totals & economic Life Cycle Costs
Description
unit
A Product Life 15 years
B Annual sales 0.5884 mln Units/year
C EU Stock 3.6 mln Units
D Product price 0.888 Euro/unit
E Installation/acquisition costs (if any) 0 Euro/ unit
F Fuel rate (gas, oil, wood) 0 Euro/GJ
G Electricity rate 0.07115 Euro/kWh
H Water rate 0 Euro/m3
I Aux. 1: None 0 Euro/kg
J Aux. 2: None 0 Euro/kg
K Aux. 3: None 0 Euro/kg
L Repair & maintenance costs 0 Euro/ unit
M Discount rate (interest minus inflation) 4.0% %
N Present Worth Factor (PWF) (calculated automatically) 15.56 (years)
O Overall Improvement Ratio STOCK vs. NEW: Use Phase 1.00
28


Task 4 (11/20)
EcoReport Inputs
Economic/market inputs:
Estimation of the product prices: stakeholder enquiry + literature + assessment from BOM.
Comments:
- The cost of the active part (core + windings) is assumed to represent 35% of the purchase price for all BCs, except for power transformers (20%). Realistic? Too low? Is it possible to obtain revision formulas from utilities?
- Electricity rates: DER rate (0.3 €/kWh) too high? Use a different rate for power transformers than for other types (0.07115 €/kWh)?
29

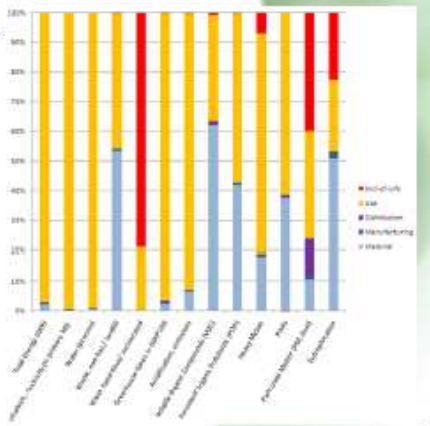

Task 4 (12/20)
EcoReport Outputs
Environmental impacts (BC1 outputs):
30

Task 4 (13/20)

- EcoReport Outputs
  - Environmental impacts: *(BC1 outputs)*

Predominance of the use phase in "Energy consumption", "GWP", "Acidification".

All BCs show similar profiles.



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Task 4 (14/20)

- EcoReport Outputs
  - Environmental impacts:

Mineral oil, wood and ceramics manually added to the EcoReport, based on Ecoinvent LCI.

Impacts of oil are apparently overestimated (feedback from DG JRC). It can have important impacts, especially on:

- Hazardous/incinerated waste (end-of-life)
- VOC (production phase)
- PAHs (production phase)
- PM (end-of-life)

Comment: Discussion on the manufacturing impacts of different grades of steel

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Task 4 (15/20)

- EcoReport Outputs
  - Environmental impacts (per product):

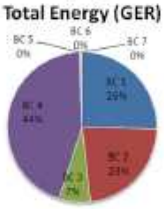
Base-case	Annual electricity losses during the use phase [kWh]	GWP during lifetime [ton CO_2 eq.]
BC1 - MV/LV distribution oil	8 426	140
BC2 - Industry oil	34 480	445
BC3 - Industry dry	48 966	631
BC4 - Power	836 658	15 770
BC5 - DER oil-immersed	26 494	353
BC6 - DER dry-type	26 494	361
BC7 - Separation/isolation	784	4

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Task 4 (16/20)

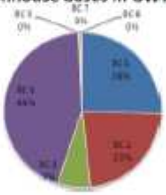
- EcoReport Outputs
  - Environmental impacts: shares of BCs in total impacts of the stocks per year

Total Energy (GER)



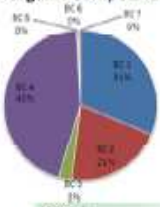
Total:
1224 PJ (of which 111.5 TWh of electricity)

Greenhouse Gases in GWP100



Total:
53.6 Mt CO_2 eq.

Volatile Organic Compounds (VOC)



Total:
2.81 kt

- *Comment:* The shares of power transformers decreased slightly with the removal of additional oil.

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Task 4 (17/20)

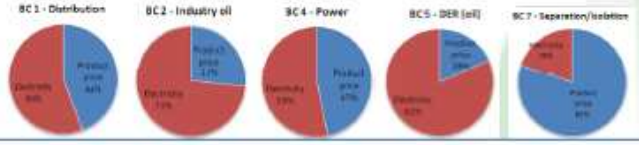
- EcoReport Outputs
  - Economic analysis:

The life cycle is obtained by adding the product price and the cost of the electricity losses during lifetime.

Except for BC7, the electricity cost represents an important share of the LCC.

Input	BC1 Distribution	BC2 Industry oil	BC3 Industry dry	BC4 Power	BC5 DER oil	BC6 DER dry	BC7 Separation /Isolation
Product price (€)	8 008	14 751	19 623	1 036 720	30 060	37 950	1 340
Electricity cost (€)	11 169	16 179	57 178	1 179 829	131 128	131 138	340
Life Cycle Cost (€)	20 077	55 226	77 101	2 214 948	161 188	169 088	1 681

Table 4-24: EcoReport inputs and outcomes of the LCC calculations of the seven base-cases



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Task 4 (18/20)

- EcoReport Outputs
  - Economic analysis:

$$TCO = PP + A*P_0 + B*P_k$$

With:
PP = Purchase Price
A = cost of no-load losses per Watt
P_0 = rated no-load loss
B = cost of load losses per Watt
P_k = rated load loss

$$A = \frac{(1+i)^n - 1}{i*(1+i)^n} * C_{kWh} * 8760 \qquad B = A*(\frac{I_L}{I_r})^2$$

With:
i = interest rate (%/year)
n = lifetime (years)
C_{kWh} = kWh price (€/kWh)
8760 = number of hours in a year (h/year)
I_L = loading current (A)
I_r = rated current (A)

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Task 4 (19/20)

- EcoReport Outputs
  - Economic analysis:

The EcoReport LCC and the TCO give the same results if we assume Kf=PF=1 in formula 3.2 to calculate the annual losses:

$$Etr(y) = Af \times (P_0 + P_k \quad (\alpha \quad K_f/PF)^2 + P_{aux}) \quad 8760/1000$$

By using the inputs parameters, acceptable differences (except for BC7):

Input	BC1 Distribution	BC2 Industry oil	BC3 Industry dry	BC4 Power	BC5 DER oil	BC6 DER dry	BC7 Separation /isolation
A [€/W]	11.63	10.28	10.28	12.34	43.36	43.36	10.28
B [€/W]	0.42	1.65	1.65	0.49	3.90	3.90	1.65
Purchase Price [€]	8 888	14 751	19 623	1 036 720	30 068	37 958	1 348
TCO [€]	16 985	49 507	69 967	2 171 661	171 931	179 821	3 713
EcoReport LCC [€]	20 077	55 225	77 101	2 214 948	161 198	169 088	1 681
Difference between EcoReport LCC and TCO	3.73%	11.03%	10.20%	1.00%	-6.21%	-5.97%	-31.72%

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Task 4 (20/20)

- EcoReport Outputs
  - Economic analysis: EU Totals

	BC1 Distribution	BC2 Industry oil	BC3 Industry dry	BC4 Power	BC5 DER oil	BC6 DER dry	BC7 Separation /isolation	TOTAL
EU-27 sales [units]	140 000	40 200	8 047	1 802	580	2 320	75 000	271 349
Share of the EU-27 sales	51.7%	15.9%	3.0%	0.7%	0.2%	0.9%	27.6%	100%
Product Price [mln €]	1 248	637	158	1 868	17	88	101	4 117
Electricity [mln €]	2 167	1 963	592	3 834	32	127	6	8 721
Total [mln €]	3 414	2 600	750	5 702	49	215	107	12 837

Table 4-29: Total Annual Consumer expenditure in EU-27 in 2007



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Contacts

Thank you for your kind attention!

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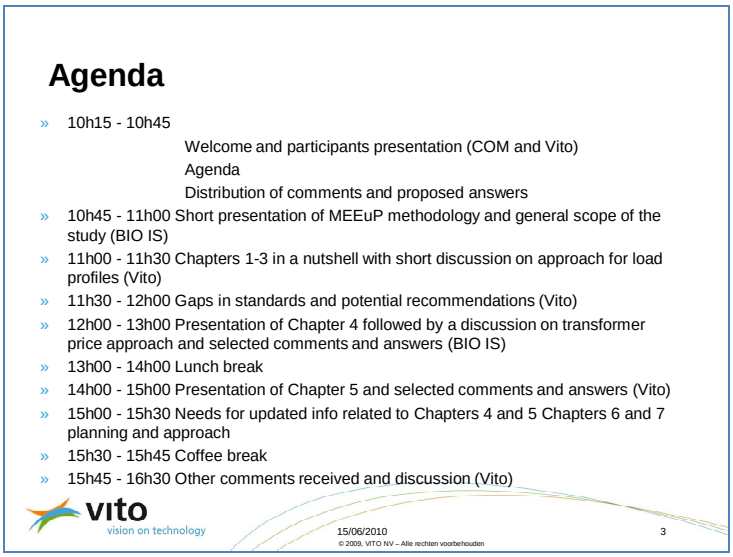
Tel: +33 1 53 90 11 80

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ANNEX K PRESENTATIONS OF THE SECOND STAKEHOLDER MEETING







Short presentation of MEEuP methodology and general scope

» see Bio IS presentation

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Chapters 1-3 in a nutshell with short discussion on approach for load profiles

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Chapter 1: Definition – main ecodesign parameters

» main ecodesign parameters:
  » LCA > 14 environmental indicators (MEEuP)
  » Ad hoc parameters: Noise (propose to use sound power (Lw) in dB(A)? = horizontal update),Electromagnetic fields (EMF), Use of hazardous materials in transformers
» Definition and scope:
  » Transformers were defined for use in the electrical transmission and distribution systems;
  » Also include ‘smaller industrial transformers’;
  » According to EN 60076-1 (IEC 60076-1), power transformers are in general terms considered as transformers (including auto-transformers) above 1 kVA single phase and 5 kVA poly phase, hence lower ratings will not be considered in this study;
  » Used segmentation see next slide

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Chapter 1 Scope: segmentation in this study

Study scope	Major subcategory name	Type of Service and Sector	Main Type of Technology used or Functionality: Oil cooled	Dry-type	Gas-filled	MV/LV	HV and/or MV	Phase changer	LV/LV	Copper winding	Aluminium winding	Amorphous steel core	S Min (kVA)	S Max (kVA)	S Avg (kVA)
y	MV/LV Distribution transformer	Distribution by DSO	85-95%	5-15%		100%				85%	10%	<5%	50	2500	250
y	line voltage restorers	Distribution by DSO		100%					yes	100%			50	630	75
y	DER LV/MV transformers	Connecting DER by producer	20%	80%		100%				80%	20%	3%	50	2500	2000
y	Industry MV/LV oil transformer	Distribution by non DSO (industry, ...)	50%			100%				85%	15%		50	2500	630
y	Industry MV/LV dry transformer	Distribution by non DSO (industry, ...)		50%		100%				15%	85%		50	4000	1000
y	Power transformer	Power by TSO (DSO)	100%		2%		98%			100%			5000	>	1E+05
y	Phase	Power by TSO (DSO)	100%		3%			1%		100%			5000	>	1E+05
y	Seperation/Isolation transformer	Distribution by non DSO (industry, ...)		100%						100%			1	63	16
y/n	Control transformer	Distribution by non DSO (industry, ...)		100%					yes	100%			0.04	2.5	1.6
n	Safety transformers	Specific ext. applications industry/domest.c		100%					yes	100%			0.04	0.25	0.05
n	specialty/consumer transformers	Specific int. application industry/domestic	NA	NA		NA	NA		yes	NA	NA	NA	NA	NA	NA
n	magnetic halogen transformers	Lighting all sections		100%					yes	100%			0.01	0.63	0.05

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Chapter 1: Definition – Performance parameters

- Primary: Transformer rated power (S)
- Secondary energy efficiency related: No load losses (Po), Load losses (Pk), Auxiliary losses (Paux)
- Secondary application related: Load Factor (α = Pavg/S), Load form factor (Kf = =Prms/Pavg), Transformer availability factor (AF), Power factor (PF), K-factor.
- Secondary functional related: Short-circuit impedance, Rated voltage of the high-voltage winding (Vrms), Rated voltage of the low-voltage winding (Vrms), LwA dB (A), Vector group, Insulation temperature class, Protection class (IP), Fire behaviour class, Environmental class, Climate class.
- *Functional Unit:* 'Transformer rated power (S)'

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Chapter 1 standards and legislation

- Standards (gaps and potential recommendations for updates will be discussed later)
- Various DSO/TSOs have MEPS and transformer specs.
  - will be updated ERDF trafo specs reference (norm.edf.fr) (section 1.7.1.6 but also section 3.2.1) (cross references between sections). To be discussed related to chapter 5, did any AMT passed ERDF tests related to short circuit? (note: load loss class on name plate)
- Legislation (overview has been updated), note:
  - Power transformer MEPS standard under development in China
  - EN 50541-1 on dry type transformers includes more ambitious levels compared to HD 538 (will be updated in report).
  - Many countries have adopted distribution transformer MEPS (frequently assume 50 % average load
  - Care is needed to interprete US results due to differences in grid topology, grid frequency and standards.

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Chapter 2: Economic and Market Analysis

- Aim: Generic economic data, insights in past, recent and future stock and market, additional parameters, market trends, user expenditure data (e.g. Electricity price, interest rate, ..).
- Has been updated with smaller transformer market data.
- To be corrected (from comments): transformer oil price, other prices Table 2-20? Marked up prices?
- To be considered later: window for electricity prices(power transformers electricity price discount, DER scenario?, ..).
- Power trafo's 2005 stock: 64000x100 MVA(T&D)-7500 GVA extrapolated (UCTE>ENTSOE- ?? MVA)!
- Total energy demand Eurostat 2005 (end use): 2763 TWh (or +8.1 % due to T&D losses 2986TWh?) which is average 315 GW (340GW) (5 % (6%?) of installed capacity only)
- = related to load factors –keeping in mind that the grid is meshed and redundant

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Chapter 2: Economic and Market Analysis

Transformer type	Rated Power S in *KVA*		Stock	Stock	Stock	Total sales		
			1990	2005	2020	1990	2005	2020
	stock	*sales*	*K units*	*K units*	*K units*	*Units p.a.*	*Units p.a.*	*units p.a.*
Smaller industrial transformers	16	16	750	750	750	75000	75000	75000
Distribution transformer (oil)	250	400	2692	3600	4459	118443	140400	173891
DER transformers oil immersed	2000	2000	0.25	20	90	85	2100	9450
DER transformers dry-type	2000	2000						
Industry oil transformer	630	1000	598	800	991	35294	43200	53505
Industry dry transformer	800	1250	127	170	211	6652	8047	9966
Power transformer	100000	100000	48	64.35	80	1588	1802	2232
Phase	100000	100000	0.49	0.65	0.81	16	18	23

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Chapter 3: User behaviour

- Aim:
  - Analysis of consumer behaviour: user information and barriers for eco-design
  - Analysis of real life situation: most important are load factors & life time
  - The loading profile parameters can be precisely calculated from excel load profile data (see website) (figures were added)
  - several (late) comments are related to perceived low transformer loading parameters (therefore they will be explained and discussed)

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Chapter 3: User behaviour

Typical transformer	Load factors (α)	Load form factors (Kf)	Power factor (Pf)	Availability factor (Af)	Average Lifetime
MV/LV distribution oil	0.19	1.073	0.95	1	35
Industry oil	0.40	1.096		1	27.5
Industry dry	0.40	1.096		1	27.5
Power	0.20	1.08		1	40
DER (liquid-immersed and dry-type)	0.30	1.60		0.5 to 1	27.5
Separation/isolation	0.40	1.096		0.12 to 0.25	27.5

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Chapter 3: User behaviour

- Proposal is to:
  - update with more explanation the used load profile parameters and add a comparison with equivalent time of peak load and flat load profiles.
  - add a small increase to annual energy use justified with DSO losses (+5 %) result in α =0.24 instead of 0.2??;
  - For power transformers Energyx4 was assumed due to different transformation steps in TSO grid? Could we assume Energyx5 or Energyx6??
  - TSO grid is meshed and redundant but AF =1 was assumed (always energized). It might be possible to assume AF <1 and increase α, this might have a slight impact on the outcome but is it realistic??

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Chapter 3: User behaviour

- This study should also have a match with realistic total impact scenarios, hence:
  - Care to modify parameters that do not match with EU annual energy consumption and product sales data;
  - Uncertainity is often related to use parameters (annual operating hours, loading, .., not only this study inefficient car owner might lobby low car use while efficient lighting sales might lobby high annual operational hours) .The study aim is to do this neutral;
- Stakeholders are often concerned about negative impact from outcomes of the general base case because of trivial cases. This is generally tackled by a so-called sensitivity analysis per product = chapter 7 (avoids excessive interference with scenarios).
  - Therefore the parameter window will be completed where needed with stakeholder comments (typ.), (min.), (avg.) > sensitivity analysis

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Chapter 3: User behaviour

Load factor (study, IEC 60050)	Pavg/S	0.19	Pk	1	kW
	hpy	8760			
Equivalent peak load factor	Ppeak/S	0.53			
	equivalent time of peak for load loss/hpy	0.20	EkSEEDT	492.1368	kWh
	equivalent time of peak for transformed E	0.36			
	equivalen time of peak for load loss		Ek'	311.5928	kWh
	control Prms/Pavg?				
	Ppeak²xtime	0.06			
	sqrt( )	0.24			
Load form factor (Kf = Prms/Pavg)	Kf = sqrt(Ppeak²xtime)/Pavg	1.26	Estudy	492.1368	kWh
		1.58	EkVito	492.1368	kWh
Load factor (utlity)	Pavg/Ppeak	0.36			

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Chapter 3: User behaviour

Load factor (study, IEC 60050)	Pavg/S	0.50	Pk	1	kW
	hpy	8760			
Equivalent peak load factor	Ppeak/S	0.50			
	equivalent time of peak for load loss/hpy	1.00	EkSEEDT	2190	kWh
	equivalent time of peak for transformed E	1.00			
	equivalen time of peak for load loss		Ek'	2190	kWh
	control Prms/Pavg?				
	Ppeak²xtime	0.25			
	sqrt( )	0.50			
Load form factor (Kf = Prms/Pavg)	Kf = sqrt(Ppeak²xtime)/Pavg	1.00	Estudy	2190	kWh
		1.00	EkVito	2190	kWh

assumed Kf=1

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Chapter 3: User behaviour

- Adding trends that might explain low load factors in residential grids:
  - Reliability and redundancy
  - no acceptance of peak overloads, fusing at rated power instead of peak load?
  - Fear for high peak loads on one hand but consumers get high power consumption capability (16-90 A single or 25-40 A three phase while average EU consumption is only about 2.2 A (500 W or 4380 kWh))
  - Caused by power fluctuations or load profile (Kf)
  - Redundancy in the grid to cope with cable failures (meshed with links) (espicially underground lines difficult to repair)
- Trends that might explain low load factors in power transformers:
  - Concern is reliability, the grid is meshed and redundant.
  - No active switching of transformers (.. to avoid voltage transients?)
  - Load profile (week-season-short labour weeks)

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Gaps in standards and potential recommendations: for discussion

- The IEC 60076-1 is the general generic standard for power transformers with European equivalent EN 60076-1, potential recommendations are:
  - issue 1: Is there a need to elaborate fire behaviour performance of liquid transformers similar to dry type transformers in elaborated in IEC 60076-11 taking new developments into account (see chapter 5)? indicate K level for natural ester (refer to IEC61100)? The behaviour of silicon transformer under fire had never been tested under standardisation condition and pressure in the tank could lead to special results
  - issue 2: similar to ERDF requirement could the efficiency class be required on the name plate within this standard series?
  - issue 3: CLASP remark on tolerance +10 % that might be too high. Could it be lower? Symmetric?
  - any other?

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Gaps in standards and potential recommendations: for discussion

- For oil filled distribution transformers, the European standard (EN 50464-1) includes efficiency classes
  - issue 1: could A0 be completed with AA0 (about A0/2)?
  - issue 2: could inefficient classes (E0, Dk) be deleted to attract less consumers? In the assumption of an implementing measure?
  - Any other?

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Gaps in standards and potential recommendations

- For dry transformers: HD 538 to be superseded by EN 50541-1 in 2010 includes more ambitious levels: issues similar to above ones
- EN-61158 series deal with smaller transformers but mainly from a safety perspective.

  issue 1: There is no standard formal to measure the load and no load losses. However they use in practice a similar method as distribution transformers (EN 60076-x series). Any opinion?
- There are no MEPS standards for these small industrial transformers. Any opinion?
- There are no MEPS defined for Power transformers (>5000 kVA) (China has a draft). (TSO use TCO and hence indirectly have MEPS)? European harmonised load and no load losses? electricity prices? TCO? Any opinion?

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Chapter 4: Assessment of Base-Case

» See Bio IS presentation.

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Chapter 5: Technical Analysis BAT and BNAT

» This task examines the improvement options of transformers considered as best available technologies, in an attempt to improve upon the base-cases

» Definitions:

  » Best" shall mean most effective in achieving a high level of environmental performance of the product

  » "Available" technology shall mean that developed on a scale which allows implementation for the relevant product, under economically and technically viable conditions (expected to be introduced at product level within at least 2-3 years), taking into consideration the costs and benefits, whether or not the technology is used or produced inside the Member States in question or the EU-27, as long as they are reasonably accessible to the product manufacturer

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Chapter 5: Technical Analysis BAT and BNAT

» BAT that was assumed to be part of common practice (no barriers)

  » Use of stranded rectangular wires or conductor foils

  » Use of stacked cores with laminated steel (Add new insulation material here – see CLASP remark).

  » Avoid that the flux to deviate from the grain direction in grain oriented silicon steel

  » Magnetic flux reduction in the core yokes compared to limbs

  » Avoiding stress in silicon steel cores

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Chapter 5: Technical Analysis BAT and BNAT

- BAT with indentified barriers for take-up
  - Use of copper compared to aluminium conductors (some corrections were needed see comments)
  - Use of a 'circular' limb core cross-section (terminology should change to 'Cruciform(?) or (?)' it is not exact a 'circle' but two dislocated circles or cross?) (however there should be no doubt that a circle is the most efficient way to contain a surface..)
  - Use of grain oriented silicon steel with lower losses
    - important note: update is needed (acronyms, EN designation, -DR -compatible with stress relief annealing –progress)(see comments)
    - AMT: Especially price quotes are needed related to Ck, Bk, Ak? Do current AMT transformers pass quality criteria of DSO related to noise and short circuit? More DSO experiences are needed?

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Chapter 5: Technical Analysis BAT and BNAT

- AMT ('Material'): Especially price quotes are needed related to Ck, Bk, Ak? Do current AMT transformers pass quality criteria of DSO related to noise and short circuit? More DSO experiences are needed?
- results AMT model (Ck matched with literature 360 kg Cu &573 kg steel) (full calculation spreadsheet available on the website – matched to literature data):

Pk	more conductor in % of reference	more core in % of reference
load loss class		
Ck	100%	100%
Bk	122%	100%
Ak	121%	120%

- note other ratio's conductor/core are possible. A spreadsheet tool is available.
- To discuss:
  - Update on BOM active part data in or out price enquiry?
  - Might be required to double check realism in prototype cost claims?
  - Especially price quotes are needed related to Ck, Bk, Ak?

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Chapter 5: Technical Analysis BAT and BNAT

- To discuss:
  - Update on BOM active part data in or out price enquiry?
  - Might be required to double check realism in prototype cost claims?
  - Especially price quotes are needed related to Ck, Bk, Ak?

Pk	more conductor in % of reference	more core in % of reference
load loss class		
Ck	100%	100%
Bk	122%	100%
Ak	121%	120%

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Chapter 5: Technical Analysis BAT and BNAT

- Use of transformers with silicon liquid or biodegradable natural esters instead of dry cast resign transformers

Characteristic	Natural ester	Silicon liquid	Mineral oil	dry/cast resign
Noise Level	+	+	+	-
Insulation Life	++	+	+	+/-
Recyclability	yes	yes	yes	difficult
Fire Safety	+	++	-	++
Fault Detection capability (DGA)	yes	yes	yes	difficult
Biodegradability	yes	no	no	no
Environmental hazard (leakage)	++	+	-	++
Price per liter	300-400%?	300-400%?	100%	120%

  - Table is not agreed. How to update? Enquiry? Common position of T&D with alternate table?
  - Update needed on fire behaviour IEC 60076? Other parameters?

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Chapter 5: Technical Analysis BAT and BNAT

- Reducing transformer noise
- Grouped BOM and cost impact on improvement options for base cases transformer types
  - various options: see text, do we simplified summary overview table here (e.g. DOE or others)?
  - data options:
    - analytic model (spreadsheet available and generated data);
    - other more detailed transformer design software;
    - catalogue data (smaller transfors);
    - Manufacturer enquiry?

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Chapter 5: Technical Analysis BAT and BNAT

- draft results analytic model (cost proportional to BOM) (note: designation will be changed to EN):

Si-steel	losses		Mass		Price	Transformer design parameters			
	P0	Pk	conductor	core		Bmax	Afe	J	h/w
grade	W	W	% of ref.	% of ref.	% of ref.	T	mm²	A/mm²	
M6	E0	Ck	100%	100%	100%	1.70	34200	2.44	1.35
M3	D0	Ck	100%	100%	110%	1.7	34200	2.44	1.35
HiB	C0	Bk	113%	102%	118%	1.70	34200	2.20	1.41
HiB-DR	B0	Ak	145%	127%	186%	1.5	40000	1.8	1.37
HiB-DR	A0	Bk	152%	108%	175%	1.50	34000	1.90	1.69
HiB-DR	A0	Ak	209%	108%	207%	1.5	32000	1.5	2.03

  - *Table 5-9: Analytic model result for a 1000 kVA oil filled distribution transformer (BC 2 in chapter 4) (TBC)*
  - *Is related to data already included in section 2.4.1 on transformer prices (DKI also provided a new estimate, see comments)*

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Chapter 5: Technical Analysis BAT and BNAT

- T&D Europe (meeting T&D Europe 04 July 2009):
  - class EoCk 100%
  - class CoCk 115%
  - class BoCk 130%
- ECI have been different from W. Irrek, www.wupperinst.de, closer to T&D. For 250 kVA:
  EoCk= 100%
  DoCk= 110%
  CoCk= 122%
  BoCk = 135%
  AoAk= 160%
- DOE is hard to compare because data is at 50 % load (see p. 123).

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Chapter 5: Technical Analysis BAT and BNAT

- Proposal for enquiry:
  - Price related to table of transformer efficiency classes = minimum > should allow price sensitivity analysis? Afterwards data will be aggregated including a price range?
  - As the BOM has little impact it is proposed to keep the calculated tables with the analytic model to project environmental impact with MEEuP. Any opinion on this? This significantly reduce work to submit enquiries and avoid manufacturers have to leak proprietary design information?
  - An option is also to request design parameters (see table). However manufacturers might prefer not to share this information. It might be less relevant but only allows Vito to double check the realism of certain claims. It is proposed that Vito keeps this option to request those data for claims that strongly deviate?

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Chapter 5: Technical Analysis BAT and BNAT

- **Existing technologies not further considered for BAT**
  - at system level (redundancies)
  - silver wires
  - particular core form (note: updated DR steel available that can be annealed – connected to GO steel)
- BNAT
  - more info was received in silicon steel and AM material development and text will be updated (see stakeholders comment)
  - System level worth mentioning but out the product scope (switching off transformers –heat recovery).

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Needs for updated info related to Chapters 4 and 5 Chapters 6 and 7 planning and approach

- Agree on the format of the enquiry (Today)
- Enquiry forms will be sent out (21/5??) >deadline (15/6)
- Updated chapters 1-3, 4&5 (16/6?)
- Draft chapter 6 release for comment(30/6)
- Draft chapter 7 release for comment (9/7)
- Proposals related to standards discussion. Also do we connect lower efficiency class transformers to max. volume and or weight to have later exceptions?
- Target for 3rd stakeholder meeting (from 10th of August?) (Alternative is week of 6/7 but with short deadlines for draft chapters 6&7?)

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Other comments received and discussion (Vito)

- See text distributed
- Thanks for participating and contributing with comments

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ANNEX L COMMENTS RECEIVED PRIOR TO THE SECOND STAKEHOLDER MEETING (TASKS 4&5) DEADLINE (8/5/2010)

Stakeholder	Section	Page	Comment	VITO and partners Reply
General (received after interim meeting comment deadline)				
TB TCS	General Comments		• Directive2005/32/EC on Eco-design - "energy using products directive". Do distribution or power transformers "use" energy? It could be argued that this directive is specifically aimed at end products which utilities would consider to be the "end-load". Transformers do not use energy, but consume energy in operating to pass load. If it is subsequently determined that transformers use energy and therefore the study is valid, then the study should also be extended to cables and cable systems where the highest losses in the power system tends to occur, and the highest usage of materials such as copper occurs. Transformers are often the easy target because they are discrete products.	There is no doubt that transformers fall firmly within the context and legal framework of the Ecodesign Directive. Other products, such as cables, could be investigated in the future. The EC welcomes suggestions and energy savings potentials of product groups to be studied.
			• The study covers distribution transformers and by asking around it would appear that this market is indeed above the 200,000 per annum threshold.	The study focuses on transformers as a product category in general, thus the 200 000 unit criteria is satisfied.
			• The study includes power transformers, but there is not the required annual requirement in excess of 200,000 per annum across Europe bracket to justify this.	The study focuses on transformers as a product category in general, thus the 200 000 unit criteria is satisfied.
			• Distribution transformers are often based on standard designs and include volume manufacture, but larger power transformers are generally bespoke designs and recent experience shows that the number of repeat manufactures tends to be very small. This significant difference justifies the removal of large power transformers from this study.	This was already argued in the beginning of the study but not accepted by the EC by grouping several types of transformers and unit can be interpreted as 'KVA', the directive does not specify that it is one product. (see section 2.1.4)

			• Distribution transformers are often based on standard designs and include volume manufacture, but larger power transformers are generally bespoke designs and recent experience shows that the number of repeat manufactures tends to be very small. This significant difference justifies the removal of large power transformers from this study.	
			• Document refers to TSO – transmission system operators, so this implies that this covers **all** transformers from smallest distribution up to highest voltage and top ratings. o Technology and manufacturing techniques although appearing to be similar are actually quite different for large power than for distribution. o Improvements in large power transformers are driven by cost reductions and the global market. o Large power transformers i.e. those installed by TSO's (including those at the upper end of DSO's requirements) **should not** be included in this document as the volume cannot exceed 200,000 units. Large manufacturers such as Smit produce 80 units per annum, if you then assume an average of 100 units per annum per manufacturer, then large power needs 2000 manufacturing factories to achieve the critical numbers. In fact there are probably no more than 100 factories operating globally. •	See previous comment (also section 2.1.4)
			• Document suggests that power transformers last longer than distribution transformers, but experience suggests the opposite is true.	This comment has also been made during the stakeholder meeting. If available, we would be glad to receive more precise figures for the lifetime of the different types of transformers. A differentiation between economic and technical lifetime may be noted.
			• Distribution units fall into two categories, oil filled and dry type. Dry type is almost solely supplied to the industrial market. The majority of oil filled units are supplied to the utility market. Utility markets are driven by regulatory	This is in line with the study. Both transformers are analysed.

			systems which given how much the utility can spend on transformers and how loss reduction can be rewarded. This is not the case for industrial units	
			• The document discounts single phase transformers as not generally used in Europe. This is true on the continent but not in the UK and Ireland. My experience would suggest that the UK and Ireland have a requirement for about 10,000 to 15,000 single phase distribution transformers per annum. •	Thanks for pointing out this. This is added to chapter 1 section 1.5.5
			• The whole document is based on core type transformers and does not recognise shell type designs. Shell type transformers are manufactured in Europe and are in use in many European countries.	This issue is treated in chapter 5 in the section dedicated to core form (5.1.3.3) when dealing with this level of technical details.
TB TCS			• The document states that SF6 gas is rarely used. This is not the case as Japan and Korea manufacture significant amounts – additionally one major UK utility is in the process of installing 275kV, 150 MVA units with associated 33/11 kV at 33.8 MVA units. SF6 installations will continue to grow and therefore this needs to be considered in this study but only **if** the study includes large power units.	Added (p. 37) .. seldom used *in Europe*. The study focus on major applications and cannot into account a single event. *Could you inform about the rationale for installing this transformer as SF6 is a high GWP?*
EURELECTRIC	General Comments		**Background;** Utilities have a commitment to Sustainability and seek to optimise the operation of their networks so as to achieve an economic minimisation of losses on the overall system. Network utilities in Europe are regulated so the societal costs of network operation are taken into account in the regulatory framework in which decisions are made, principally by the Regulator setting an overall cost of capital (WACC) so that sub-optimisation does not occur, and requiring that the utility	This is in line with section 3.2.1 but might been less clear. Therefore we suggest to add this in the title > 3.2.1 Procurement of transformers *based on Total Cost of Ownership taking transformer losses into account by utilities* *The text will add. The cost parameters A and B take full network losses into account including cable losses. Moreover those cost parameters for load and no-load cost can also take into account that peak load electricity is more expensive.*

			conduct sophisticated cost-benefit analyses of any proposed investments. These investment appraisals may then be reviewed by the Regulator to ensure that the expenditure has been wisely incurred. ESB Networks in particular have been using Total Cost of Ownership and incorporating losses into all investment appraisals and equipment purchase decisions for well over 30 years and have very sophisticated approaches in these areas, as do most other large utilities. In ESB Networks particular case this has resulted in high capitalisation rates for transformer losses and consequently low actual kWh losses, but all justified on an economic basis as providing the best return to the customer. **Utility Approach to losses:** Utilities seek to minimise the cost of losses over the full network, and to avoid any level of excessive expenditure in one area which would result in sub-optimal returns – in short, utilities will invest in reducing transformer losses up to the point where the next increment of investment in (say) Cables, would produce a better reduction in the cost of losses. It is important to note that there is no such thing as a 'particular' reasonable level of losses for all utilities – the optimum level will depend on existing network structure and the future opportunities to achieve reduced losses in an economic manner. An example of this would be where countries with dense urban networks using short cables will be seen to have much less losses than countries with mainly long Overhead networks and less urbanisation e.g. Germany with 5% losses and Ireland with 8%. Both Germany and Ireland could have the same approach to	

			reducing losses but the opportunities in Ireland to use dense cable networks will be less than in Germany and it would be uneconomic to try and reduce the losses on Irish Overhead Networks so that the German Loss level of 5% is achieved. Typically a utility will therefore use the WACC in investment appraisal to ensure that all investments at least achieve the WACC and that discretionary investments are done in the order that provides the greatest return above the WACC. This ensures that all necessary objectives are achieved in the most economic manner, and possibly that a surplus is available for investment in the next area with the best return. Obviously all investment appraisals are done on a Total Cost of Ownership basis. So for Transformers and other plant the utility estimates the cost of capitalised Load and No Load losses and adds the capitalized losses of the transformers to their Tendered Price in order to rank the Transformers offered in terms of TCO. Usually the winner is the Tenderer who can minimise losses as the cost of such minimisation at the margin is intellectual skill, but Transformers with low cost and higher losses could also win. The fact that these transformers will have higher losses is not an issue because the goal of the utility is to minimise losses on the system overall. Savings made in such areas simply allow extra expenditure in others – e.g. investment in reduced circuit loading may have a greater benefit than investment in reduced transformer losses. **The main point here is that the adoption by a utility of any legislated value Load/No Load loss levels will inherently be sub-optimal as it will not take into account the particular circumstances in that utility. The resulting over expenditure on such transformers will in turn mean that investments in other areas which would have resulted in a much greater impact on losses will be reduced, so that overall a sub-optimal result is achieved.**	

EURELECTRIC	General Comments		**Environmental issues:** A number of important changes in the current environment now need to be incorporated in any assessment of transformer losses but have not appeared in the report: **(a) Distributed Generation at LV:** If widespread distributed generation occurs then the loading on Distribution Transformers will decrease. This means that the load losses on the Distribution transformers will be so low that any investment in their minimisation could end up stranded. More correctly, the Load Factor and Trafo Utilization factor should take the impact of DER into account in assessing capitalization rates. **(b) Cost of Energy** Iron losses are constant and are capitalized at the Long Run Marginal cost per kWh. However as renewable resources increase, the LRMC will decrease, and again this needs to be taken into account e.g. Ireland has about 15% of electricity from Wind today and will have 40% by 2020. **(c) DER Transformers** Transformers for connecting renewable resources use the renewable resources themselves to provide the transformer losses. The marginal cost to the Renewable resource provider of providing these losses could be very low (e.g. no contract for kWh to be bought at a particular time) so that the DER producer may wish to buy the cheapest transformer possible, even with the highest	With regard to environmental impact please have to have a look at the MEEuP methdology, to which we are bound by contract with the European Commission. See related link on: http://www.ecotransformer.org/methodology_2.php

			costs, because the energy savings from a renewable generator are effectively zero in many circumstances. **(d) Loss Capitalisation:** The cost of capital for a utility relates to the low risk nature of the work carried out, so with little risk the WACC is also low, typically around 5%. To date this cost of Capital has also been used to capitalise transformer losses, and this has resulted in high capitalisation rates for Iron and Copper losses. However this is not necessarily a correct approach, as what is required is to assess the number of kWh used by the transformer and then cost this usage every hour for the lifetime of the transformer. As the cost per kWh is basically related to the price of oil, this is quite a risky calculation. Effectively this exercise is a futures contact in energy, normally considered a high risk exercise. The conclusion from this is that: (1) The normal utility WACC is too low and a higher rate would be more appropriate - possibly something closer to the Best New Entrant Generator cost of capital (2) A more sophisticated discounting calculation – possibly using Real Options as would be used in the oil industry would be more appropriate. **(e) CO2 Emissions from embedded materials:** The report attempts to assess the amount of embedded Co2 incurred in the production of the materials from which the transformer is made. For most CO2 Assessments what is actually measured and accounted for is the CO2	

			emissions in use, not what was incurred in the production value chain. If it is proposed that the embedded CO2emissions incurred in production are to be eaningfully included then the CO2 involved at allstages of production, from minimng to refining and assembly, in every country involved taking into account the transfport method used and the source of fuel used e.g. if hydro /nuclear used in refining then no CO2, whereas if Coal used then a lot of Co2. Such exercises are extremely complicated and generally impractical. A review of the environmental assessment methodology used should be considered. **Procurement:** An approach to Procurement which allows flexibility in the trial of new technologies whilst having regard to EU Tendering procedures should be considered. One such approach would be to tender for two options, one which had new technology e.g. Amorphous Core, and the other which used traditional technology Silicon Steel. This would provide relative prices and capitalised losses for both technologies so that the marginal cost of the reduced losses on Amorphous Core could be seen in relation to that using Silicon Steel. This would allow the Tender award to be split to the extent that the utility wished to encourage one technology to compete with the other for the future, even though strict application of capitalised losses should result in only one technology winning. The use of separate options means that all EU Procurement rules were adhered to (- within each separate option considered).	

			Approach within Report: The report is very comprehensive but is difficult to follow as it covers many different market segments together. So references to transformer efficiency are very relevant to appliances operating at fixed load but nearly irrelevant to utilities where the trafo loading varies widely over it's lifetime. It would be better for the user to separate the trafo markets segments as the losses produced and the scope for their economic reduction would be more apparent. Different approaches will be required for each segment – as explained above the usage of minimum transformer efficiencies in the utility sector would be both dysfunctional and unsustainable	
EURELECTRIC	General Comments		Similarly the section dealing wit the numbers of transformers is very confused – a reference to over 5m transformers of <16kVA suggests that this includes trafos in small household appliances. A better approach for the utility sector would be to simply write to the utilities and ask for details if their installed transformer capacity, Much of this information is already on the internet. Details of ESB Trafo installations is attached below:  esb_networks_summary_statistics.pdf	We will launch a new enquiry that could be useful for the sensitivity and impact analysis
EURELECTRIC	summary	VII	-average lifetime MV/LV distribution t/f stated as 35 years – probably more like make 50 to 60 for Distribution Trafos, 45-50 for Power Trafos.	We suggest to extend the range of life time in the related section in chapter 3 (useful for sensitivity analysis) and modified the power transformer life time to 30 years.
EURELECTRIC	summary	VII	Same table - very questionable to state that distribution t/f has load factor of 0.19 and that power t/f LF is 0.2. The definition of load factor (page 46) is not same as utility would use - (sum kwhr in year / peak kw x 8760 hrs) This one seems to refer to running at maximum capacity. On some work we did for DPCR	These data is fitted to the stock of transformers and energy use. We will contact to verify with more utilities and extend the table with minimum and maximum values in the related section in chapter 3.

			on distribution t/fs we looked at 85% nameplate as peak load and then 0.45 LF on that. so in their definition that is about 0.4 LF Also see repeat on table 3.1 page 130 In Ireland a Load Factor, Trafo Utilization Factor, A Factor and Loss Load factor would be used to compute the kWh used, with each of these factors varying with the size of the transformer used. Growth in load would also be assumed over the period and a capitalization factor used to provide an NPV and a Capitalization arte. e.g. For a 400kVA Trafo, 60% Utilization, Load Factor 0.53, A Factor 0.85 then the Loss Load Factor would be (0.85*0.53)*0.63 +(1-0.85)*0-.53 = 0.313 Usage in first year = 1kW * 8760*0.313 = 2,742kWh Cost at 0.542c/kWh = €148.7 Apply Growth Factor = 1.321 * €148.7= €196.3 Apply Cap Factor (25 years) = 11.65 * €196.3 = €2,288 Apply Trafo Util. Factor = 0.6* € 2,288 = €824 /kW of load is Capitalization rate. For Power Trafos the actual load profiles of the existing trafos in that particular location would be used with changes in load from Network Plans taken into account for the future.	
Task 1				
Dansh Energy Agency/AFHH/ EJ	EXECUTIVE SUMMARY	IV	"For smaller industrial transformers however a gap has been identified": Such transformers could have certain design parameters such as high impedance/low saturation voltage possibly compromising the relevance of a strict loss efficiency focus. Hence, these transformers should perhaps be seen as components of systems, energy efficiency assessment then to be undertaken at the system level.	**This is indeed important to keep in mind and a dedicated section will be introduced in chapter 3, a detailed analysis at system level is outside the scope of this study (moreover few data is available).**

PCPM / ECI		VI & 25	Replace “phase” with “phase shifter”	**To be considered in the final update**
PCPM / ECI		IX	“It has been found that transformers can be improved by using similar technology based on silicon steel transformers with the following options: - The use of copper compared to aluminium conductors” This (both silicon steel and copper) is nothing extraordinary	**Reworded to ‘explains’**
Dansh Energy Agency/AFHH/ EJ		IX	“The use of superconducting technology;” This is felt to be speculative. High-temperature superconductivity has been subject to research and demonstration projects since the mid eighties without any sign of significant breakthrough in any sector.	**Detail related to the section**
Dansh Energy Agency/AFHH/ EJ		IX	“The use of smart grid technology”: Yes, perhaps a few more words. What is done these days is mainly either permanent paralleling or single unit in, based in an overall loss efficiency rationale. Active switching, based in load measurement, rarely happens and is a good, obvious and easily implemented idea. Perhaps worth mentioning?: Smart Grid Technology is a very general and relevant topic, probably best addressed at an overall grid optimisation level, incorporating lines, SCADA and switchgear automation, moving focus from security of supply to loss efficiency, rather than in a context of transformer focus only. DSOs and TSOs face these days rigid availability focused standards/benchmarking, potentially leading to excessive use of no-load loss consumption in idling transformer/generator plant and inefficient operational network conditions. I.e. the view is: The topic is relevant in an ecodesign but perhaps not in a transformer context.	**Ok but included in the related section in chapter 5**

DKI / ECI	1.3	32	Another interpretation says that the findings of the 1998 study may as well have "social causes", since more educated and hence wealthier people will prefer different residential areas to live in than underneath HV lines (be it for health or just aesthetic reasons), while "lower class people" often do not have the choice and are at the same time those who take less care of their health (overweight, alcohol, tobacco) and have the professions with greater health impacts.	**Noted but considered less relevant for the final objective of this study.**
PCPM / ECI	Table 1-4	44	Power transformer losses appear exaggerated (again, what is a "power transformer"?). They are also largely oversized. At least some of them are (not so few)	**100 MVA was an average mixing with step up transformers at the power stations (most subsations have probably 30-60 MVA**
DKI / ECI	1.7.2.1	61	Here ("The EN 61558-x series deals with safety aspects of power transformers") the term "power transformer" is used adequately in the sense of www.electropedia.org, as opposed to voltage transformers and current transformers (for measurement purposes), while the usual reference throughout the document to "power transformers" as "transformers bigger than distribution transformers" is no standardized terminology	**Noted – suggested update to add at page 41 on scop: .. in the distribution context power transformer should be understood as power transformer to transform at EU27 grid frequency and voltage levels at least above power levels**
DKI / ECI	1.7.2.1	62	At low frequency we have two separate fields, a magnetic and an electric field. There is no "electromagnetic field of the transformer".	**We could not track this statement in the referred section.**
Dansh Energy Agency/AFHH/ EJ	1.9	75	"Some MEPS are in efficiency at 50 % load factor, in task 3 it will be shown that it is representative for industry transformers but not for the distribution transformers (20 % load factor)." –If 20% is valid, there is a strong reason to instigate a study on DSO user behaviour as this is a sign of overrating and excess no load losses.	**However the form factor KF also contributes (making the difference smaller) $Kf^2 = 1.08^2 = 1.16$ times!**
Federal Environment	1	general	It should be carefully looked at the definition of „power transformers", which is, e.g., in EN 61558-x series not just a	**Noted**

Agency, Germany (UBA)			transformer bigger than a distribution transformer (the usual, but not standardised terminology throughout the preparatory study), but a term to characterise transformers opposed to voltage transformers and current transformers. Therefore, a revised definition of „power transformer" will be needed.	**A more detailed update was done at page 41 on the scope.**
UBA	1.2		The description of the basic concept of a transformer and its components should still be extended, since this is an important basis for understanding improvement options, even if additional information can be found in Chapter 4.1.2.	**It was not the purpose of this section to enter in a technical analysis and this task is finalized since long, more technical details are in chapter 5.**
UBA	1.5.7.	42-45	Safety transformers, speciality transformers and magnetic halogen transformers have been excluded compared to the former Task 1-3 drafts. In addition, page 42 says that „LV/LV distribution autotransformers or line voltage restorers" should be excluded from the scope because of low number and outdated use, but Table 1-3 includes line voltage restorers („Y" for study scope). For control transformers, Tables 1-3, 1-4 and 1-5 give "Y/N" regarding the question if they are within the scope or not. **In general, the scope of a preparatory study and the following implementing measure should be defined as far as possible on technical parameters, like range of rated power, and on the basis of existing standards. To set exemptions should be avoided. This can be realised e.g. if for special functions, which cause that the products can not comply with energy efficiency requirements set for other subcategories of the product group, additional allowances are given. A low number of a product on the market cannot be a reason to exempt it, because this would create an unfair treatment of products. Furthermore the market development cannot be predicted for sure. If exemptions are absolutely necessary they need to be defined by referring to the technical specification, which is the reason for this exemption.**	**The transformers used in T&D are clearly defined in standards and primary LV with secondary LV is also a clear technical parameter, hence this risk of loopholes is perceived very low. Text and table will be made more clear.**

			We especially see no reason to exempt subcategories of the smaller transformers.	
UBA	1.6		Using „transformer rated power" as functional unit seems to be appropriate. For the calculation of no load losses, stray losses and extra losses should not be underestimated.	**Noted**
UBA	1.7		IEC 354 and IEC 904 seem to be missing.	**IEC 354 is outdated (= EN 60076 part 7) IEC 904 is related to solar and not to transformers?**
UBA	1.8.2	64	„SEEDT" is not an agreement at European Community level and not just a software and selection guide base, but a project which has developed proposals for adequate policy packages including MEPS and labelling for liquid-filled distribution transformers (Irrek, W.; et al. (2008): Policies and measures fostering energy-efficient distribution transformers, Report (final version of deliverable no. 6) from the EU-IEE project „Strategies for development and diffusion of energy-efficient distribution transformers (SEEDT)", Wuppertal et al.)	**Agreed and removed**
UBA	1.9	76	The conclusions make clear that there is no formal standard to measure the load and non-load losses of smaller industrial transformers. The contractors recommend closing this gap as soon as possible. We strongly support this recommendation. The contractors should communicate this need to the Commission separately to the preparatory study.	**Is ongoing.**
Hitachi Metals/Metglas	**general**	**several**	**Clearly separate Hitachi Ltd and Hitachi Metals/Metglas®**	**Adapted**
Hitachi Metals/Metglas		**67**	"As mentioned before the US standards has little relevance in this study." Not true- material prices are comparable, energy costs are becoming comparable and IEEE and IEC standards are not that	**Agreed therefore changed to '**material prices are comparable, energy costs are becoming comparable and IEEE and IEC standards are not

			different. Efficiencies at 60 Hz converted to 50 Hz are not that different for any reasonable assumptions.	that different'

Stakeholder	Section	Page	Comment	VITO and partners Reply
Task 2				
DKI / ECI			UCTE no longer exists. Now see www.entsoe.eu**.**	**replaced**
PCPM / ECI	Table 2-8	102	If the installed capacity of power transformers in EU is 2000 GW in EHV and HV + 1000GW in power plants, then 230 GW (8%) cannot be the market	**Table is about sales not stock**
ThyssenKrupp Electrical Steel (TKES)	**2.2.6.7**	**114**	**General Remark: We propose to use the commonly used product wordings and abbreviations: GO, CGO and HGO** **GO= Grain Oriented Electrical Steel** **[Note: Silicon steel is not exact, since it covers also Non-Grain Oriented Electrical Steels, which are different products for other applications than transformers. The name GO is also clearer than CRGO (=Cold Rolled GO) or GOES (=GO Electrical Steel), which mean the same.].** **CGO= Conventional Grain Oriented Electrical Steel** **HGO= High permeability Grain Oriented Electrical Steel (High permeability steel + domain refined high permeability steel). Note: The expression HIB is a product name of one Japanese GO producer. Better use HGO** **Facts regarding the GO Market**	**Adapted**

			During 2004-2008, global GO market grew strongly from 1500 kt/y to 2200 kt/y, due to a strong demand especially from emerging markets like China and India. The capacities of the global producers were fully used. In 2009, when demand slumped due to the economic and financial crisis, GO capacities were further increased mainly in China to worldwide 2500 kt/y. In the EU, the GO market was at 360 kt/y in 2008, with capacities of the 4 EU-suppliers of 420 kt/y. **With regard to High permeability Grain Oriented Electrical Steel (HGO), there are 8 suppliers worldwide, thereof two producers in the EU. The global HGO supply in 2009 was at nearly 700 kt/y, thereof 130 kt/y in the EU .** **Global GO demand is expected to grow to roughly 2700 kt/y in 2015; GO capacities will be further expanded to over 3000 kt/y worldwide, thereof 1000 kt/y for HGO. In the EU demand and supply are expected to grow moderately, with a stronger focus on HGO.**	
ThyssenKrupp Electrical Steel (TKES)	**2.3.7**	**117**	**For GO electrical steel there are 4 suppliers in the EU (ThyssenKrupp Electrical Steel, Orb Electrical Steels, ArcelorMittal Frydek Mistek, Stalprodukt) and 8 producers outside the EU (NLMK/Russia, Nippon Steel/JP, JFE/JP, AK Steel/USA, ATI/USA, Baosteel/CHN, Wisco/CHN, Anshan/CHN, Posco/S. Korea), ArcelorMittal Inox/Brazil)**	**Adapted**
ThyssenKrupp Electrical Steel (TKES)	**2.3.8**	**119**	**Remark: The 5% market share for AMDT refers to the market of distribution transformers** **Remark: The market share of amorphous metals on the global market of core materials (=GO + amorphous metals) is at 2,5%** **Remark to China: There are differences between manufacturers of amorphous materials, amorphous cores**	**Added** **Added** **See updates provided by other stakeholoders**

			and AMDT. Concerning manufacturers of amorphous materials, we don't know other producers besides Advanced Technology & Materials Co. Maybe the other companies (who?) produce amorphous materials for other applications.	
DKI / ECI		**122ff**	**The subscript k for short-circuit may be misleading and not widely understood because it relates to German "Kurzschluss" or Dutch "kort-sluiting", respectively. The international standard is probably sc for "short-circuit".**	**Hard to change and 'k'is used in EN 50464**
PCPM / ECI	**2.4.1**	**123**	**Our observations have been different from W. Irrek, www.wupperinst.de, closer to T&D. For 250 kVA: EoCk= 100% DoCk= 110% CoCk= 122% BoCk = 135% AoAk= 160%**	**Thanks. Added**
PCPM / ECI	**2.4.1**	**125**	**Commodities were on the absolute top ever by then**	**See below**
ThyssenKrupp Electrical Steel (TKES)	**2.4.2**	**125**	**Under the links below you find more updated GO price indices: From T&D Europe and ZVEI, the German Electrical and Electronic Manufacturers' Association You can see, that since end of 2009 GO prices are strongly decreasing. You should take the current development into account when comparing GO prices with amorphous metals. http://www.tdeurope.eu/en/raw-material/transformers-indices/current-month/ http://www.zvei.org/index.php?id=488 http://www.zvei.org/index.php?id=376**	**It will be added that 'In the current economic context (2009-2010) prices are subjective to strong fluctuations (with those references).**

UBA	2	general	The exact references for the data are not always given and should be completed. Data for distribution transformers seems to be available in more detail than data for other transformer types. In addition, data for line voltage restorers, separation/isolation transformers and control transformers seems to be missing.	**There is a section 2.2.1 explaining sources (they were not repeated to increase the readability of the report)**
UBA	2	general	Interaction transformer scenarios <-> electricity system scenarios: While the preparatory study contains data and information on the general development of the European electricity system (development of consumption, which in turn is partly dependent on the demographic and infrastructural development; development of electricity savings, which is partly dependent on the policies and measures in place; development of distributed generation) as well as on the expected development of sales until 2020, it neglects the interaction between both. This interaction should be explicitly modelled (cf., e.g., the transformer scenarios differentiated by two scenarios of the development of the electricity system, PRIMES TRENDS and PRIMES EE/RES, in Irrek et al. 2008, see above).	**We think that this would lead to beyond the scope discussions.**
UBA	2	general	Sales, sales growth and prices of transformers and transformer input materials (transformer commodity prices) can change a lot from one year to another. It remains unclear to which extent the short-term analysis of market trends, expenditures and prices in Chapter 2 will be used for calculating the expected developments until 2020. In particular, the prices for input materials (copper, steel, aluminium) can change a lot depending on the general economic and market situation in the world, regional and world-wide market concentration, capacities of manufacturers, etc. Therefore, Task 2 should carefully analyse, on which prices or price ranges the calculation of LLCC and thus the design of policies and measures should be based.	**Indeed the market is very volatile currently, but it is hard to take this on board and will remain uncertain anyhow. It should be tackled in the sensitivity analysis**

UBA	2	general	Important market information missing: Besides optimisation of windings and core design and the not yet feasible option of using superconducting technology, the most important technical options to reduce load and no load losses of distribution transformers are the application of improved cold rolled grain oriented (CGO) steel, with improved cutting technology and decreased lamination thickness of 0.23 mm, and the change from CGO steel technology with crystalline atomic structure to amorphous cores with non-crystalline anisotropic atomic structure (Targosz/Topalis/et al. 2008). However, there are only very few manufacturers of CGO steel and amorphous metals that can supply transformer manufacturers. Moreover, there are currently only very few manufacturers of amorphous transformers. Finally, switching production to very energy-efficient CGO steel transformers and particularly to amorphous transformers needs large investments, and will be very difficult for small and medium transformer manufacturers. Task 2 contains an analysis of market introduction of amorphous metal distribution transformers. However, with regard to the analysis of policy impacts in Task 7 it is absolutely necessary to analyse the current market structure and market concentration and the effort needed to switch production lines in much more detail, thereby differentiating between both the different transformer production processes and the different steel manufacturing processes. In particular, the problems in the market today to provide sufficient quantities of thin CGO steel at a competitive price due to only limited number of producers and limited capacities are neglected so far. Targosz, R.; Topalis, F..; et al. (2008): Analysis of existing situation of energy-efficient transformers - technical and non-technical solutions, Report (final version of deliverable no. 1) from the EU-IEE project „Strategies for development and diffusion of energy-efficient distribution transformers (SEEDT)“, Wroclaw, Athens, et al.	**CGO will be updated (see Thyssens comments).**

UBA	2	Tab 2-1, p. 83/84	Stock and sales data differ between sources. Sources for the data given in Table 2-1 are not given. It remains unclear why the data in this table has been selected and other information has been neglected. In particular, the data and assumptions for the development 2005 to 2020 should be explained well.	**This is a summary and should match one-to-one with tables in the text. It should be clear that replacement rate is equivalent to life time, e.g. replacement rate 10 % is equivalent to 10 years life time. We consider adding this in the text.**
UBA	2.2.3.2		An important market trend missing is the influence of regulation of electricity distribution and transmission companies on the choice of transformers, cost saving approaches, relocation of transformers and reduced redundancies in the electricity system.	**This is an issue of chapter 3 related to users but we will make a reference to chapter 3 in the section on trends (2.3).**
UBA	2.2.5		Since lifetime of transformers in practice partly even exceeds 40 to 50 years, and since exchange of existing stock will take a long time, it should be considered to extend the timeframe of calculations to the year 2050.	**Could be in the sensitivity analysis.**

Stakeholder	**Section**	**Page**	**Comment**	**VITO and partners Reply**
Task 3				
TB TCS	**General**		• Higher utilisation factors (e.g. sweating the assets) increases the costs of lost energy, lower losses can be obtained by operating at lower utilisation or transformers with larger than necessary conductors.	**Thanks. This should confirm the relative low load factors (Pavg/s) in section 3.2.2.1. This argument will be added to the text. We illustrated this with an example.**
TB TCS	**General**		• Equipment efficiency is stated at nameplate rating. There should be no reference to efficiency at any other load factor. Lower utilisations mean lower efficiencies. But this means the transformer can have an efficiency close to zero when it is off load. If higher efficiency in operation is the desired goal then	

			there needs to be a change to smaller rated but more transformers. In reality this needs a change in network design policy and is probably not a good idea in the longer term. **UK Utility Approach to Distribution and Medium Power Transformers** • Transformer losses are governed by the design of the transformer in accordance with the utility specified capitalisation formula as suggested. However, there is a focus on significant noise reduction in the specifications which aligns with the reduction in no load loss. • We have specified noise levels which we think the industry needs to meet and not what the manufacturer can produce. This in turn challenges the manufacturer to improve his products and find new solutions to achieve the required noise level. • No load loss is considered to be the most important as it is always consumed when the transformer is energised. Load loss is a factor of the load being consumed and as the transformer operates at 0.2 load factor, this means that the load loss is approximately 0.04 times the measured loss. If the load loss was 6 kW e.g. 500 kVA distribution unit, then the average load loss is then 240 W compared with a low value of no load loss for a similar transformer of 700 W.	
PCPM / ECI	**Table 3-1**	**130**	**This is much too low. Keep in mind that power transformers as understood in this study cover 3 steps of transformation, so the average load should be referred roughly to installed capacity divided by 3. We think this should be ~0.7. What is characteristic for some of these transformers is very high overload capacity, and this is probably the explanation why**	**See discussion in the meeting**

			power transformer designs may differ by factor of 4 or so	
PCPM / ECI	**3.2.2.1.3, formula 3.1**	**135**	**Fundamentally correct, but be careful; Ppeak is not the same as S, and no provision for RMS load here**	**Kf accounts for RMS load curve and PF to account for S**
PCPM / ECI	**3.2.2.1.3, formula 3.2**	**136**	**I think mathematically it is correct, however the concept of peak load is somehow bypassed?**	**No, it is included in Kf**
PCPM / ECI	**3.2.2.1.3, formula 3.3**	**136**	**Here it comes: Obviously Pmax = Ppeak?**	**Formula 3.2 is used**
Dansh Energy Agency/AFHH/ EJ	3.1.3.1	131	Industry –CAPEX focus and short horizon, yes. Suggest to add DER investors who often have have very short payback time targets. It might be so that in essence, only DSOs and TSOs demonstrate overall life cycle optimisation targets when purchasing transformers.	**added**
Dansh Energy Agency/AFHH/ EJ	3.2.2.1.4	139	For wind turbines, the shown “load profiles” are not normal practice. Instead, one derives an annual load profile from the wind turbine power curves i.e. kW output vs wind m/s and the local wind distribution for the development, modelled as a Weibull distribution. Typically, one arrives at load/loss efficient hours (i.e. hours multiplied with installed power/losses at peak equal to annual generation/energy losses) of onshore: 3500/3000 hours – offshore 4000/3500 hours.	**Is it possible to provide some in excel for inland and offshore?**
PCPM / ECI	**3.2.2.1.4 Table 3-2**	**140**	**Although we are not passionate with this formula we think this is close to reality. In SEEDT we got similar figures. For power we think or rather feel it should be less, like 1.05**	**1.05 instead of 1.073 will worsen the gap with a 50 % loading.. (stakeholder meeting discussion)**

PCPM / ECI	**3.2.2.1.4 Table 3-4, public sector**	**141**	**We think it could be over-interpretation here. We have not found any confirmation of this interpretation of average in Prophet**	**See discussion on stakeholder meeting**
PCPM / ECI	**3.2.2.1.4 Table 3-5**	**142**	**"Load factors for power transformers" – we think these are very arguable. Roughly if the installed capacity of power transformers is ~ distribution transformers and the load is of factor between 2 and 3 how could this be?**	**See discussion on stakeholder meeting**
UBA	3	general	Based on differentiation between relevant market actors in Irrek et al. (2008, see above) and on the existing scope of the preparatory study, it is recommended to differentiate between the following relevant market actors: - Electricity transmission companies, transmission system operators - Larger electricity distribution companies, distribution system operators - Smaller electricity distribution companies, distribution system operators - Owners of large industrial plants - Owners of small industrial plants or sites in the tertiary sector - Owners of small industrial transformers - Engineering firms, ESCOs, energy consultants and planners, who often have a large influence on decisions, particularly in small industrial plants and the tertiary sector	**These are late comments as chapter 3 is finalized since long time to take into account now. We keep this in mind for chapter 7.** **It is included in section 3.1.1**

			- Users that are not owners, e. g., shops or offices renting space in tertiary sector sites - Large transformer manufacturers - Small transformer manufacturers - Steel, copper and aluminium manufacturers. Policy options to be developed in Task 7 will have to take into account the differences in market position, incentives and disincentives, barriers and obstacles, capabilities and capacities, knowledge and decision processes of these different actor types in the transformer market chain. Therefore, this should be analysed in more detail and in sufficient differentiation in Task 3.	
UBA	3	130	The transformer lifetimes identified are reasonable. However, lifetimes should be differentiated according to the subcategories identified in Task 1. For example, Targosz/Topalis/et al. 2008 (see above) differentiated between lifetime of liquid-filled and dry-type transformers in industry, while the preparatory study has the same value for both. Moreover, it should be noted that application in practice can deviate from the lifetimes identified. In particular, in many cases, lifetime can exceed the one identified. This should be mentioned in the text	**It is suggested to add a window of lifetimes for the sensitivity analysis**
UBA	3.2.2.1.5	135ff., 140ff.	Empirical base for the identification of load factors is very limited and not very strong. Therefore, in Task 7, sensitivity analysis should be carried out with different load factors. For this, in Task 3, the possible ranges should be defined well. For the year 2005, the choice of load factors might be realistic on average. However, for a specific application, the load factor can differ a lot from the average. This becomes particularly relevant when defining MEPS and an energy labelling scheme, and when looking at the impact of these policies and measures on a specific	**See discussion in the stakeholder meeting**

			application in practice in Task 7. Also from this perspective, in Task 3, possible ranges of load factors in practice should be identified well. Moreover, the development of the distribution system will change in the future. For example, in Germany many distribution transformers will be relocated or abolished in the coming years, and the load factor might increase over time. Therefore, Task 3 should give information on the possible development of load factors over the timeframe of analysis. The low average load factor of power transformers is questionable. In some regions, an overload of transformers can even be assumed. In addition, if one takes into account that the installed capacity is similar to the capacity of distribution transformers, such a large difference between load factors of both transformer categories will not be feasible. At least, the data basis and arguments for this choice of this load factor for power transformers should be made more explicit.	
UBA	3.2.2.1.3	135	When setting the load factor in relation to the power of the transformer, it should be carefully differentiated between the rated power (named “S” in the preparatory study) and the maximum power of a transformer, which can deviate from the rated power substantially. There should be one single variable name for the maximum power, not using partly “Ppeak”, partly “Pmax”.	**Indeed this has been updated and probably also the cause of confusion about the load factor with stakeholders.**

Stakeholder	**Section**	**Page**	**Comment**	**VITO and partners Reply**
Task 4				
ThyssenKrupp	**4.1.2.1**	**153**	**Magnetic core: We propose some little changes in the figures**	

Electrical Steel (TKES)			**….They have a low carbon content (< 30 ppm to reduce losses) and are commonly alloyed with Silicon (content < 3,5%). ……Typical thickness is from 0,18mm to 0,35 mm.** **…Grain Oriented Electrical Steel (GO) is steel whose…..** **(Remark: CGO is the abbreviation only for conventional grades, see also 2.2.6.7)** **….Amorphous Steel… is considered as a Best Available Technology (BAT): Remark: BAT refers here only to one factor (no load losses) under special circumstances (low average transformer load) and only for special transformer types (DT). Regarding the disadvantages of amorphous materials in regard to noise levels, building size, cost, no stacked cores (see page 212) BAT is here not the right wording. Thus we propose to change the phrase: Amorphous Steel, which…..will be presented in detail in chapter 5 as an alternative core material with very low no-load losses**	**Will be integrated in the text** **This part will not be included: amorphous core is considered as a BAT, even if it cannot be implemented to every base-cases.** **Technical analysis has shown that it can achieve very low levels of losses compared to the technology used in the base-cases. The drawbacks of all types of BAT (not limited to amorphous) will be discussed in Task 5.**
T&D Europe	**4**	**150**	No load losses Po [W] at 75 ℃ : delete temperature for no load losses no influence of the temperature on the no load losses. The sentence should be No load losses Po [W] , and load losses Pk [W] at 75 ℃	**Will be integrated in the text**
T&D Europe	**4**	**151**	Idem for table 4/3 delete temperature for no load losses in the top of the table	**Will be integrated in the text**
T&D Europe	**4**	**151**	Table 4-4: Common scaling relationships in transformers (DOE, 200777): Formulas given in this table are untrue, if they are used in a large extrapolation over 10% and with similar technologies of coils and core and cooling.	**We are aware of that.** **Quotation from the report: "This approach was nonetheless only used for transformers with similar efficiency to the base-case."**

T&D Europe	4.1.2.1Coil/windings and insulation materials	**152**	The windings are made as concentric shells around the core or for shell type the core is around the coil.	**Will be integrated in the text**
T&D Europe	4.1.2.1 First sentence	**153**	The windings have to be insulated (normally coated by varnish or paper)	**Will be integrated in the text**
T&D Europe	4.1.2.1 tank /Frame	**154**	The tank has four purposes: it contains the oil in liquid-immersed transformers, protects the active part from the exterior environment allows the transmission of heat between active part and cooling devices and is a support structure for the accessories and control equipment.	**Will be integrated in the text**
T&D Europe	4.1.2.1 Cast compound	**154**	Porcelain or epoxy cast for distribution transformers are mainly used for bushings in oil-immersed transformers.	**Will be integrated in the text**
T&D Europe	4.1.2.1 Coatings	**154**	New IEC 60076-1 indicate to use ISO 12944 for corrosion protection definition	**Will be integrated in Chapter 1, if not already there.**
T&D Europe	4.1.2.2 EcoReport BOM	**155**	A very small quantity of silver is used in the contact on load tap changer and on special request for off circuit tap changer. Manufacturers of these accessories could indicates these quantities	**This material is considered negligible in the BOM, in comparison with the other quantities in a transformer.**
T&D Europe	4.1.4.1	**157**	Stakeholders are welcome to comment on the value of the availability factor (0.5) for DER transformers. Following information of the manufacturer DER transformers are supplied during 220 days per years with average load during theses days of 0,7. That means 0,5 seems to be correct.	**Thank you for this feedback.** **This input was estimated in chapter 3 and will be updated if additional information is**

				received.
T&D Europe	Table 4-8:	**157**	Load factor for large power transformers is to low. The value is 0,4 following transformer manufacturers point of views;	**This input was estimated in chapter 3 and will be updated if additional information is received.**
PCPM / ECI	Table 4-9	158	The results are these because the loading is assumed too low	**The loadings were estimated in chapter 3 and will be updated if additional information is received.**
T&D Europe	Table 4-9: Annual electricity losses of the seven base-cases	**158**	Manufacturers ask to clarify the results of the table 4.9 by use the formulas Etr(y) [kWh] = Af x (Po[W] + Pk[W] × (α × Kf/PF)2 + Paux) × 8 760/1 000 Or Etr(y) = Af x ((Pk x α2) + Po) x 8 760/1 000 With the data of Table 4-8: Usage parameters as defined in chapter 3 and 4.3	**We will expose intermediate results of the calculation in the table.**
T&D Europe	4.1.4.2	**158**	To complement stakeholders' price information, a simplified cost estimation based on the fact that the cost of the active part represents around 35% of the purchase price of a transformer81 (20% for power transformer) was used. Manufacturers believe that the value given in the text is false and too low. Revision formulas of the utilities could give better values.	**The estimations of the prices from the BOM will be made clearer in the report. However, an updated approach of the price estimation is still required and utilities will be contacted.**
T&D Europe	Table 4-10:	**159**	Oil price is widely false. For hermetically sealed distribution transformers there are no need for additional oil during the life of the transformer. For large power transformers before 30years additional oil represents only 10% of the volume. Sometimes after 30 years the oil may be changed.	**This price will be updated in chapter 2.**
T&D Europe	4.1.4.3	**159**	General remarks for noise level: It is important to precise if noise is sound power level or pressure level in all text. Example Page 30 this is not done	**All text will be checked and this information will be specified**

T&D Europe	4.1.4.3	**159**	42 to 71 dB(A) for Eo must be change by 42 to 66 dB(A) for Bo	**Will be integrated in the text**
T&D Europe	Table 4-10:	**159**	Table 4-10: The reference of magnetic steel has to be in compliance with the standard designation and not magnetic steel manufacturer's reference. Example:M5 is M 140-30P5 according to IEC 60404-8 This designation has to be changed in all documents for all references of magnetic steels.	**Will be integrated in the text**
T&D Europe	4.1.4.3	**159**	For dry-type transformers, the HD538 standard does not mention a related sound level. This standard is under revision with number EN 50541-1 This new standard will propose several lists of noise level and will be published end of 2010	**For chapter 1: Is it possible to have a copy?**
T&D Europe	Table 4-11:	**161**	Sheetmetal Scrap 5% : If scrap include tanks and core the scrap is more 7%	**This average value (5%) has been agreed during the meeting and will be kept.**
T&D Europe	Table 4-11:	161	Compliance between the table 4-11 and the text 4.1.5 related to the thermal cycling and material cycling	**The options presented in table 4-11 (100% thermal recycling) only refer to the oil. This misleading info will be completed.**
T&D Europe		162	The electricity rate was estimated at 0.07115 Euro/kWh in chapter 2 for all base-cases, except for DER transformers (BC 5 and 6) for which a rate of 0.3 Euro/KWh84 has been applied. The electricity rate should be different for the large power transformers and the others transformers.	**This will be taken account in chapter 3 if more inputs are provided.**
T&D Europe	Under table 4.12	163	The oil is changed every 12.5 years on average, for a transformer technical lifetime of 35 years (see chapter 2): the initial quantity of oil was thus multiplied by 2.8 in the Bill of Materials. See our previous remarks in page 159 table 4.10 according to the	**This will be corrected: we will now assume that the oil is not replaced during the whole**

			additional volume and change of oil ;	**lifetime (for all types of transformers)**
T&D Europe	Table 4-26:	190	Table should be revised according to the previous remarks done;	**It will be done.**
T&D Europe		197	Stakeholders and operators are welcome to comment on the financial benefits oftransformers recycling/selling at the end-of-life. Manufacturers indicate that there is a balance between the expenses and the incomes. No benefits on these operations;	**We understand that this is in accordance with the text.**
T&D Europe		**197**	Despite a small amount of power transformers in stock, these transformers are responsible for about half of the overall impacts due to power and distribution transformers in EU. Manufacturers are surprise by this conclusion and think that there is a mistake in assessment of the impact of large transformers. We think that this impact is widely smaller than half of the overall impact.	**We are also surprised but could not find any explanation.** **The stock of power transformers (GVA) is precisely known (UCTE) (ENSOE) and transported energy (Eurostat). Taking the base case transformer performance (as put forward by T&D) this leads to such a result.**
Dansh Energy Agency/AFHH/ EJ	4	148	"DER transformers: 2 MVA". A significant portion of the European wind turbines have higher ratings, 4 MVA is typical for offshore.	**After discussion during the meeting, this average rated power of 2MVA will be kept.**
Dansh Energy Agency/AFHH/ EJ	4.1.4.1	157	" Stakeholders are welcome to comment on the value of the availability factor (0.5) for DER transformers." 0.95 is more appropriate as outages are driven by generating plant availability. 0.95 is a typical wind turbine contractual value.	**The availability factors were estimated in chapter 3 and will be updated by Vito if additional information is received.**
Dansh Energy Agency/AFHH/ EJ	4.2	160	General comment, partly a repetition of above: It is suggested to emphasise that particular constraints are likely to apply to DER transformer units, especially offshore wind turbines where transformers as a matter of necessity will sit in the tower, making small dimensions utterly mandatory.	**While we agree that it is more accurate to assess the energy efficiency of an entire system rather than one component, DER plan energy efficiency is outside of the scope of the study and will not be assessed quantitatively. Particular considerations for transformers**

			As stated for smaller industry transformers: Energy efficiency should preferably be assessed for the complete DER plant rather than for a specific component. Emphasising that the assessment is to comprise the entire DER plant. For turbines, loss efficiency "power curves" are often stated at low voltage terminals, neglecting the transformer although it an inherent portion of the plant.	**used in these settings, such as size, shape, and weight will be mentioned.**
Dansh Energy Agency/AFHH/ EJ	4.2.1	161	"0.3 Euro/KWh (for BC 5 & 6)" is perhaps an extremely high figure. UK - £0.16/MWh; DK – DKK 1/MWh. Suggesting EUR 0.14 /MWh as more appropriate.	**We assume you meant 0.14 €/kWh?** **This information could be updated in chapter 2, if it is considered representative of the EU situation.**
Dansh Energy Agency/AFHH/ EJ	4 and 5	-	The message taken from the findings is that TSO/DSO practice of stating loss capitalisation factors in enquiries and assessing the optimal tender from CAPEX + net present value OPEX remains correct and appropriate. Substantiating the view that focusing on user behaviour could be at least as productive as maintaining a technology focus as done in 5) so as to enhance energy efficiency in a transformer context.	**The study only presents unbiased technical and economic information to allow policy makers to make informed decisions. No statements are intentionally made to prescribe "correct" or "appropriate" methods. Results of the political process after the preparatory study could indeed focus on either user behaviour or technology.**
UBA	4.1.2.	155	With regard to the environmental assessment of base cases, there are gaps particularly with regard to the environmental impact of different steel qualities. It can be assumed that there will be huge differences regarding the environmental impact of producing amorphous steel, CGO steel or other steel types – this should be considered even if the MEEuP Ecoreport does not allow to differentiate many types of steel.	**As exposed during the SH meeting, the tool that is being used within the MEEuP methodology does not include such levels of details in the database. However, if significant and required, such differences in the manufacturing impacts will be taken into account thanks to additional data.**
UBA	4.1.4.1	158	With regard to the annual losses presented in Table 4-9, it should be made more clear that these results strongly depend on the	**The sensitivity analysis will be done in chapter 6. The calculations will be made clearer.**

			loading assumed. Sensitivity analysis of different loadings would show how loading assumptions influence the choice of a product.	
UBA	4.2	160	The deviation from the scope defined in Task 1, i.e. the exclusion of line voltage restorers and phase-shifting transformers as well as control transformers from the base cases, is not explained in the study. With regard to the size of the transformers in the base cases, it should be considered to include a further base case of smaller MV/LV distribution transformers. Although there is a tendency to increased size, and 400 kVA will probably be a good choice for the average transformer, there are many transformers sold in the market of lower size (e.g., 160 kVA), with different characteristics. In addition, it should be carefully checked if the size of the industrial transformers is really an average figure (maybe slightly oversized). Moreover, for the analysis of impacts on the market, it is very important not only to present typical sizes of average products, but to give figures on the distribution of sizes within a base case category, e.g. the distribution of sizes of distribution transformers and industrial transformers.	**Task 1 will be completed regarding this matter.** **According to the discussion held during the Stakeholder meeting, it was decided to keep the power rating of the distribution base-case as such. The distribution of sizes of distribution and industrial transformers will be possibly be added in Chapter 2 if data available.**
CLASP	4.1.2.2	155	In this section, the EuP draft report notes “Because the EcoReport was initially designed as a simple and generic tool for Ecodesign preparatory studies, its database does not include some materials found in transformers such as: Different types of magnetic steel: cold rolled grain oriented, amorphous, etc.; oil (mineral or biodegradable); wood and Ceramic/Porcelain.” While some of these materials that are not in the EcoReport database are not substantial to the overall weight of the transformer, CLASP is concerned by the lack of specific information pertaining to the different types of magnetic steel, including grain oriented electrical steel and amorphous material. We are concerned with the assumption that “the differences of environmental impacts between the different types of steel are	**Same response to comment from UBA above (p155).** **Further information will be obtained but given the low influence of the manufacturing phase on the life cycle impacts and the compulsory EcoReport tool, we do not consider this as a priority.**

			expected to be negligible" and would prefer that further study be conducted on this issue. The manufacturing of electrical steel is energy-intensive, involving extended periods of high-temperature "baking" to enable large crystals to form in the metal, and then frequent and long rolling processes to flatten the steel and create the coils. CLASP understands that there is increasing embodied energy per kilogram of steel moving from a less efficient grade of steel to a more efficient grade. In an "Eco-sheet" published by Leonardo Energy on three 100kVA distribution transformers in 2006, 5two references may be of some assistance to the analytical team in conducting further analysis around the issue of a more accurate representation of magnetic steel in the EcoReport database: • The respective tools and models have been provided by PE Europe, Haupt- strasse 111-113, D-70771 Leinfelden-Echterdingen (Stuttgart), Germany, www.gabi-software.com • The original information of this environmental declaration sheet is taken from the results of the GABI4 i-report referring to the ecodesign toolbox 2005 (for information, contact Hans De Keulenaer, email hdk@eurocopper.org)	
CLASP	4.1.2.2	156	The report states "In the EcoReport spreadsheet, mineral oil was added as a 'plastic material'…" CLASP questions the decision to model mineral oil as a processed plastic. It would seem that there must be some alternative in the EcoReport database that is closer to transformer mineral oil that plastic material.	**Unfortunately not. However, the impacts are not the same as a plastic material and were manually added into the tool. This option enabled us to consider thermal recycling for mineral oil (only applicable to plastics in Ecoreport)**
CLASP	4.1.4.2	158	In the first paragraph of this section, last sentence, a statement is made about the percentage of the purchase price of a transformer that is represented by the materials used in construction. A footnote is added which cites a DOE study published in August 2002 as the source of this information. CLASP wishes to point out that DOE published a revised version of this analysis, including four different transformer designs (two liquid-immersed and two dry-type) with an accompanying detailed	**This will be updated thanks to the provided document, and also through the price enquiry to be launched after the stakeholder meeting.**

			bill of materials. These designs were published in the Engineering Chapter of DOE's Notice of Proposed Rulemaking (NOPR) in August 2006. Please see section 5.6 of the PDF found on this link: http://www1.eere.energy.gov/buildings/appliance_standards/commercial/pdfs/transformer_tsd/chapter_5.pdf	
CLASP	4.2	161	Table 4-11 presents modelling inputs are provided for a range of the EcoReport Sections. This is a minor point, but CLASP questions whether it is appropriate to use the same electricity rate for base case 1 (distribution transformer, 400 kVA), base case 2 (industry transformer: oil), base case 3 (industry transformer: dry), base case 4 (power transformer, 100 MVA) and base case 7 (separation/isolation transformer, 16 kVA). Losses on the transformers owned by the electric utility will generally be less than 0.07115 Euro/kWh, which is more in line with the electricity rates of an industrial end-user.	**This will be taken account in chapter 3 if more inputs are provided.**
CLASP	4.2	161	The last bullet on this page reads: "An average distance of 500 km over the product life was assumed." CLASP questions the basis for this assumption, as it seems that the travel distance might be higher. Given that a few transformer companies dominate the European market, their centralised production facilities will result in the need to ship transformers throughout the EU, by rail and road. CLASP notes that the US Department of Energy assumed a shipment distance of 1000 miles in its analysis of regulations on distribution transformers. See section 7.2 in the PDF found on this link: http://www1.eere.energy.gov/buildings/appliance_standards/commercial/pdfs/transformer_fr_tsd/chapter7.pdf	**This distance only refers to the maintenance and repair services during the use phase. Assumptions are made with the Ecoreport for the distribution phase (shipment).** **The current value was estimated correct during the stakeholder meeting.**
CLASP	4.2.2	163	Table 4-12 presents some of the modelling assumptions made when working to match transformer materials being assessed to the most appropriate material or process from the EcoReport database. As discussed in a comment earlier in this chapter, CLASP is	**Same response as above, we are aware of such problems but it is not considered as a priority for the time being.**

TB TCS			concerned about the use of "21-St sheet galv." as being representative of grain oriented electrical steel. CLASP is requesting that the analytical team contact the author of a 2006 life-cycle assessment on three transformers as well as the LCA consulting firm that supported that study. CLASP is concerned about the use of "23-Cast Iron" as being representative of the transformer tank. Rather than cast iron, transformer tanks are made out of low-carbon, rolled steel plate, ASTM A283 Grade C. These plates are welded together along the seams to form a sealed tank. Sometimes cooling fins, radiators, and other parts are added to the tanks. CLASP located an illustrated marketing brochure on transformer tanks which provides some technical data and other information about transformer tanks. This may be helpful in your review of this modelling assumption: http://www.ptd.siemens.ru/files/14765.pdf Tanks are shown as "cast iron". This is not correct. Tanks are generally manufactured from mild steel.	
Hitachi			Some layouts problems (tables not fully visible)	**Will be improved**
Hitachi			The BCs are below 25 kV (as defined in EN standards)	**Will be integrated in the text**
Hitachi			There is no scrap during amorphous material manufacturing.	**Will be included in chapter 6**
Eurelectric	4.1.2.2	154	CO2 impacts are dominated as they say be use phase (ie losses) however the COP2 impact will vary dramatically between countries due to generation mix - NB France Nuclear, German./ Danes Wind, Scandinavia hydro. Note also UK future low carbon gen targets and 35GW renewables by 2020..... From raw material impact - similar arguments - if we look at ENERGY impact from use of aluminium coils its high, but as a lot of Al comes from Canada and Norway where hydro significant the CO2 impact is	**As explained during the stakeholder meeting, the electricity mix has been assessed previously to define the methodology (it is common to all preparatory studies) and is not expected to be re-calculated.**

			low.....!	
Eurelectric	4.2.1	161	Distribution trafos bought in ESB are sealed for life. Power Trafos have their oil filtered but not replaced. What utilities are replacing transformer oil???	**This will be taken into account in the future: the oil is not considered to be changed over the whole lifetime.**
Eurelectric	4.3.1	171	In UK Oil is recycled, not incinerated.	**More details will be asked on this comment. Different end-of-life scenarios can of course be considered.**
TB TCS		160	400 kVA distribution transformer is not a main standard. 630 kVA would have been a better rating for this 100 MVA power transformer is much larger than most medium power and much smaller than most transmission size units. It would have been better to split this into two sections as IEC does i.e. up to 100 MVA and above 100 MVA with the smaller size around 60 MVA and the larger unit about 300 MVA.	**According to the discussion held during the Stakeholder meeting, it was decided to keep the power rating of the distribution and power base-cases as such. The distribution of sizes of distribution and industrial transformers will possibly be added in Chapter 2 if data available.**
TB TCS	4.1.4.3	159	The definitions imply sound level is measured in terms of sound power level, but this section would suggest that the noise level is discussed in terms of sound pressure level. The document needs to be consistent in terms of either sound power or sound pressure.	**The report will be harmonised regarding the sound parameter.**

Stakeholder	**Section**	**Page**	**Comment**	**VITO and partners Reply**

Task 5				
DKI / ECI	**5.1.2.1**	**203**	**The thermal coefficient of resistance of aluminium is 3770*10^{-6}**	**Agreed**
ThyssenKrupp Electrical Steel (TKES)	**Summary**	**199**	**Wording phrase 1: -The use High permeability Grain Oriented Electrical Steel (HGO)**	**Agreed**
ThyssenKrupp Electrical Steel (TKES)	**5.1.1.5**	**202**	**Remark: There is a new technique "Unicore", developed in Australia. Here domain refined material can be used without annealing. The Unicore technique is today accepted in more than 30 countries and is also being tested in the EU.** **http://www.aemcores.com.au/**	**Thanks for informing us, will be updated**
ThyssenKrupp Electrical Steel (TKES)	**5.1.2.3**	**206**	**Wording for product names (see also 2.2.6.7):** **1). GO - Grain Oriented Electrical Steel, 2). HGO - High permeability Grain Oriented Electrical Steel, 3). Domain Refined HGO** **Remark on Chapter "High permeability Steel", last 2 phrases (…..Later on other alloys based on MnSe…….due to lower magnetisation): In our view this statement is not confirmed.**	**Thanks for informing us, will be updated**
ThyssenKrupp Electrical Steel (TKES)	**5.1.2.3**	**207**	**Figure 5-6: See also attached documents "New developments in Manufacturing of GO Electrical Steel", where you can find data on core loss evolution.** **Grading and designation of GO: ….by core loss. The worldwide valid system is the IEC 60404-8-7. In Europe, the EN 10107, which is comparable to the IEC 60404-8-7, is**	**Thanks for informing us, will be updated**

			applicable. In business practise also the old system of the American Iron and Steel Institute (M-grades) is still used, however without technical relevance. **We propose not to use the M-Grades but the EN standard designation.** **Other grading systems (JIS, GOST) you can find in the attached TKES-product brochure**	
ThyssenKrupp Electrical Steel (TKES)	**5.1.2.3**	**208**	**Table 5-3: Remark: The values for CGO 0,18mm are not standardized in the EU** **Potential barriers:** **The M2 material…..its' application at 1.7 T is not specified in the EU. Remark: M2-material (= CGO 0,18mm) is mainly used in the US-Market (for single phase pole transformers), but rarely in the EU.** **...in hexagonal core form transformers, unless Unicore-technique is applied (see Comments on 5.1.1.5)**	**Agreed**
ThyssenKrupp Electrical Steel (TKES)	**5.1.2.4**	**211**	**General Remark: Is a comparison between a core (amorphous) and a core material (HGO-DR) reasonable?** **A typical value for HGO-DR at 1.7 T is 0.81 W/kg**	**Data corrected.** **The context should make the reader aware of the difference but we cannot avoid to put these materials next to each others (as many stakeholders are interested).**
ThyssenKrupp Electrical Steel (TKES)		**212**	**Bullet point 6: Due to their bigger size and construction as well as to the higher magnetostriction value of AM compared to GO these transformers tend to have higher noise levels.** **Noise is about 6% [6 db(A)?] higher than similar GO steel**	**Adapted (no figures are given).**

			transformers. **Remark: Giving Noise in % might be misleading, we would prefer a db or db(A) value. Is there any study/reference that can be cited for this value?**	
ThyssenKrupp Electrical Steel (TKES)	**5.1.2.6**	**215**	**The highest efficiency …….based on HGO-DR (instead of HIB-DR)**	**Agreed**
ThyssenKrupp Electrical Steel (TKES)	**5.2.2**	**221**	**R&D on silicon steel** **See attached documents, which are quotable: "New developments in Manufacturing GO Electrical Steel".**	**Section completed with info provided**
ThyssenKrupp Electrical Steel (TKES)	**5.2.4**	**222**	**2nd chapter: …would be about 30-45 kg. Remark: Do you mean ..-45 kg or ..-45 kg/MVA?**	**The reference is unclear and therefore it will be deleted. It has no impact on the study.**
T&D Europe	**5 Summary**	**198**	The use of copper compared to aluminium conductors: This sentence is true for certain ratio between the copper and the aluminium raw material price.	**It's a summary we avoided details**
T&D Europe	**5 Summary**	**198**	The use of a circular limb core cross-section: This untrue other form could be more efficient	**Reformulated to 'Cruciform'**
T&D Europe	**5 Summary**	**199**	The use of amorphous steel (significant lower core losses): Not possible to large power transformer	**Added**
T&D Europe	**5 Summary**	**199**	The use of transformers with silicon liquid: Untrue because the temperature of the losses and the environmental aspects.	**Synthetic esters added**

			Add synthetic ester	
T&D Europe	**5 Summary**	**199**	Increasing the cross section of the conductor and cross section of the core	**Agreed**
T&D Europe	**5 Summary**	**199**	The improvements options considered as Best Non Available Technologies concern: (add : Grain oriented magnetic steels	**Added (see Thyssens)**
T&D Europe	5.1.2.1	**202**	5.1.2.1 Use of copper compared to aluminium conductors: All manufacturers have the knowledge of the technologies to choose the most appropriate raw material for conductor (aluminium or copper) according to the level of losses and commonly achieved that. See CIRED n°108 of 2008	**This statement was added but we suggest to keep it in subsection 5.1.2 instead of 5.1.1 for the economic barrier**
T&D Europe		**202**	It is common to have copper in the high-voltage (HV) windings and aluminium at a lower current density in the low-voltage (LV) windings. Untrue is according to the technology of the manufacturer and the level of the losses	**Text adapted**
T&D Europe	5.1.2.1	**203**	Formula 5.3 and 5.4 should be used very carefully and are relevant only for the same technology.	**This statement was added**
T&D Europe	Table in the head of the page	**204**	Manufacturers hope to delete this table because this table is established with wrong assumptions.	**Table was deleted and reference to section 5.1.2.7 (it was indeed wrong and left there due to an administrative error)**
T&D Europe	Potential barriers for up-take	**204**	In dry type transformers aluminium has the same coefficient of expansion as cast resign, this might be needed for the robustness? Untrue, manufacturers choose resin coefficient expansion resin in compliance with the expansion of the copper and aluminium	**Adopted; This barrier has been deleted.**

T&D Europe	5.1.2.2 Use of a circular limb core cross-section	**204**	Core laminations are built up to form a limb or leg having as near as possible circularcross-section99 in order to obtain optimum use of space within the windings and reduce load losses (Pk) (Figure 5-2). Not true other shape could leads to better results;	**Has been reformulated to 'cruciform'.**
	5.1.2.2 Use of a circular limb core cross-section	**204**	In smaller industrial transformers (e.g. isolation/separation/control < 63 kVA) rectangular core cross-sections are used because it is not considered economical for such a small construction to assemble stepped core cross-sections.: They use other kind of section because there are no guaranty on the no load losses	**Please clarify and specify 'no guaranty'**
T&D Europe	Table 5-2: Filling for different shapes limb core cross sections	**205**	1-step or rectangular : Untrue the value of the cross section is 63,7% instead of 78%	**Maybe better to change the parameter to 'efficiency to surround a surface' instead of filling (see reference in text)? Should be adapted after agreement on terminology.** **(Lcirc/Lrect = 2phiDc/Dr² & phiDc²/4=Dr² .. ?)**
T&D Europe		**212**	Noise is about 6% higher than similar CGO steel transformers: It is important to define what is compared? (which level of losses…..). European manufacturers have the feeling that the difference of noise is much more important probably around 10db between amorphous transformers and the better level of losses with standard magnetic steels transformers (400KVA)	**Statement added to the text.**

T&D Europe	Grading and designation of grain-oriented steels	**207**	The most frequently used system that of the American Iron and Steel Institute (AISI), Not true in Eu where the most frequently used system is IEC and EN;	**Adapted**
T&D Europe	Potential barriers for up-take	**213**	Technical development are necessary in most of European company to fullfill completely European standard and IEC standard regarding ability to withstand short circuit tests	**Added**
T&D Europe	Potential barriers for up-take	**213**	It seems not possible to be in compliance with European standard and IEC standard for rated power above 1MVA	**Added**
T&D Europe	Potential barriers for up-take	**213**	Long time reliability for three phase transformers as demanded by European utilities is not demonstrated on European networks.	**Added**
T&D Europe	Potential barriers for up-take	**213**	It will be interesting to have the lower possible level of losses with standard magnetic steel to have a true comparison between the technology.	**See developments noted by Thyssens, it is an issue of BNAT section.**
T&D Europe	Table 5-6: Analytic model core and conductor material mass estimation	**214**	These value could be widely different depending on the manufacturer, the technology, the magnetic steels used and the price ratio between copper aluminium and magnetic steel;	**Discussed in the stakeholder meeting.** **An enquiry has been launched to the manufacturers.**

	(reference is:			
T&D Europe	Table 5-7: Scaling factors for obtaining other transformer data.	**214**	These value could be widely different depending on the manufacturer, the technology, the magnetic steels used and the price ratio between copper aluminium and magnetic steel	**Discussed in the stakeholder meeting.** **An enquiry has been launched to the manufacturers.**
T&D Europe	Table 5-8: Comparison of different types of transformer insulation medium	**215**	This table should be reviewed for the following reasons: Only dry type transformer have test defined by standard that prove their fire behaviour. In the head of the table it is necessary to indicate class F1. Silicon do not have the same fire safety than dry type transformers for the above reasons.	**Discussed in the stakeholder meeting.** **Table is removed. Text is updated. Recommendation for updated standards is added.**
T&D Europe	Table 5-8: Comparison of different types of transformer insulation medium	**215**	In the head of the table it would be useful to indicate K level for natural ester (refer to IEC61100).	**Discussed in the stakeholder meeting.** **Table is removed. Text is updated. Recommendation for updated standards is added.**
T&D Europe	Table 5-8: Comparison of different types of transformer insulation medium	**215**	In the head of the table it would be useful to indicate K level for Silicon (refer to IEC61100). The behaviour of silicon transformer under fire had never been tested under standardisation condition and pressure in the tank could lead to special results.	**Discussed in the stakeholder meeting.** **Table is removed. Text is updated. Recommendation for updated standards is added.**

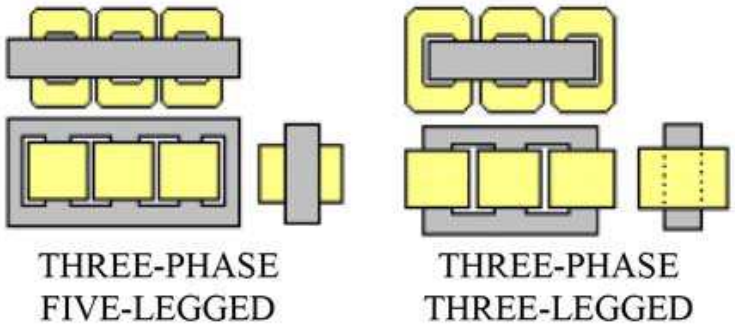
T&D Europe		**218**	Table 5-9: Analytic model result for a 1000 kVA oil filled distribution transformer (BC 2in chapter 4) (TBC). The trend given in this figure are true, but the absolute value seems to high	**Could be explained by the reference and particularities of manufacturing Indian reference (www.softbitonline.com)? We will consider a lower BC value and reference to chapter 4 and adapt the correction factor in the spreadsheet.**
T&D Europe			General point of view of the manufacturer: The results of the study are very important for the manufacturers. The choice of the technology will be probably done with parameters like load of the transformers, price of the transformers, and environmental behaviour of the transformer. It seems that it is very important to have a precise study before the final choice between the technologies regarding particularly the price of the different technologies.	**Agree: We hope to cope by this in a sensitivity analysis and incorporate more input on the price. See enquiry discussion at the stakeholder meeting. An enquiry has been launched to cover this problem.**
UBA	5	general	In general, the analysis of BAT and BNAT identifies all important aspects. However, for the analysis of LLCC and economic impacts on the markets, important information on costs and possible cost developments (e.g., decreasing prices for CGO or amorphous steel with increased capacities) is missing. It should be checked if all possibilities to improve windings and core design have been identified.	**See discussion on price enquiry at stakeholder meeting**
UBA	5.1.2.1		The use of copper is common. As far as we know, for transformer manufacturers, it is more important to look at the relation between market prices of copper and aluminium than on technical aspects when deciding on using copper or aluminium.	**See also T&D comments –rewording has been done.**
Hitachi Metals/Metglas		**198**	Rectangular coils around rectangular coils is as close to optimum as round coils around cruciform cores in the smaller sizes (<3000 kVA).	**Rewording of section will be done in consultation with T&D**
Hitachi Metals/Metglas		**203**	Aluminum transformers are optimized for aluminum, copper transformers are optimized for copper-they are never the same	**A more precise rewording has been done with T&D input**

			designs	
Hitachi Metals/Metglas		**209**	The diagram is duplicated sometimes without all of the gridlines	**Administrative error is corrected**
Hitachi Metals/Metglas		**212**	Decibel numbers are not linear.	**Indeed has been modified to dB(A) taking into account T&D comments.**
Hitachi Metals/Metglas		**213**	…maximum performance. Therefore the cores will undergo heat treatment at 340-360℃. The cycle consists in a heat up phase, soak time (1 hour) and cooling phase (no forced cooling) that can take up to 5 or 6 hours (according to core size and oven load).	**Adapted**
Hitachi Metals/Metglas		**216**	The Base Case used to compare transformers should reference M4 or M3 (world class SiFe) and not M6.	**The reader could easily consult Table 5-3. See also Thyssens comments**
Hitachi Metals/Metglas		**217**	not sure how this simple of a design routine can be predictable. One would need to vary dimensions to get an optimal design. Vary a set of dimensions for minimal cost at a given efficiency or minimal total evaluated cost using window height, window width, core build, core width, operating induction, or window height/window width, current density, core build, core width, operating induction. Core build and core width are replaced by iron circle in cruciform cores. Impedance must be constrained to get a viable design.	**An enquiry to manufacturers has been launched to get a better view on BAT.**
Hitachi Metals/Metglas		**222**	I squared R losses are usually over 90% of the load loss in distribution transformers.	**Text added**

Hitachi Metals/Metglas	**Table 5-5**		**The values for 1,55 T are wrong (check end of 5.1.2.4 remarks)**	**Please specify .. I couldn't find them?**
Hitachi Metals/Metglas	**5.1.2.4**		***3.1.1.1 Use of amorphous steel*** **Description of technology** Amorphous metal-based transformers (AMT) have been used for more than 25 years. Initial interest in their use in electrical power distribution systems stemmed from the first oil shock in the mid-1970s as improved energy-efficiency in power distribution systems was increasingly needed. This trend was maintained until energy costs started decreasing and electrical power supply deregulation was adopted in the US in the mid-1990s. The major reason for this trend reversal was the higher initial cost of the energy-efficient transformers. This, however, can be mitigated by lower maintenance costs for the energy-efficient devices over their lifetime. (Souk SMM18) and by savings in generation costs due to the higher efficiency. Amorphous metal atomic structure is random (hence, amorphous) unlike regular metals, which are crystalline. Typically, they are made by rapidly quenching liquid metal at a very high cooling rate of around one million K/s [1]. Due to their random atomic structure, they possess very unique properties. Iron-based amorphous metals are easy to magnetize, but because of their noncrystalline atomic structure, their physical characteristics are more like glass then metal. Typical chemical composition may be found in the Metglas® Material Safety Data Sheet of their 2605 SA1 Iron Based Alloy. Several properties of amorphous metal presented a challenge to the designer of distribution transformers unfamiliar with this material. The material is very thin, approximately 0.025mm (1 mil), almost 1/10th the thickness of conventional silicon iron material	**We will further check which more technical detail could be included in the text. (see blue)** **Please note that market data on AMT is included in chapter 2 and will not be repeated here.**

			used to make cores in present-day transformers. It also is very hard, having a Vicker's hardness of about 1000, some four to five times harder than silicon iron. Traditional cutting/punching tools, even with carbide tips, would wear out in a very short period. The material also is very (mechanical) stress sensitive and requires annealing under a magnetic field to achieve optimum performance. It has 20% lower magnetic saturation, resulting in increased core and, hence, transformer size. These were some of the engineering challenges in making transformers out of this material. Despite all these problems, the potential benefit of amorphous core transformers made the effort to develop them worthwhile [1]. (Epri) **Production Differences to stacked core** In Europe, distribution transformers use "stack core" construction where the core is formed by stacking laminations of steel. The AMT construction requires a wound construction and thus the two manufacturing processes differ in the following points: - core construction   Amorphous 3 leg core under construction Stacked core under construction The 'wound core' technology in case of the amorphous material needs field anneal in order to come to maximum performance.	

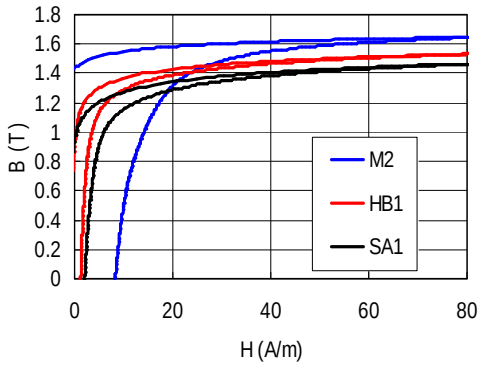
			Therefore the cores will undergo heat treatment at 340-360℃. The cycle consists in a heat up phase, soak time (1 hour) and cooling phase (no forced cooling) that can take up to 5 or 6 hours (according to core size and oven load). This will typically be followed by epoxying the top and bottom side for mechanical protection during handling. Once passed these two production steps particular to the amorphous material, the core is ready for assembly. - coil geometry 'Wound core' technology uses one width/core. This results in a rectangular cross section of the core. In order to assemble the active part, rectangular shaped coils have to be used. The main difference between oval shaped and rectangular coils are the forces during short circuit testing. However the unbalanced axial forces which can be nearly eliminated by using a sheet wound low voltage coil. Use of sheet wound LV coils in large rectangular coil transformers is almost universal. The low voltage coil then balances its current distribution to match the high voltage coil current distribution eliminating most of the axial force. - core/coil assembly Core-coil assembly is different in that the whole core is moved into the coil window(s) at one time. The core is opened up, pushed into the coil windows using sleeves that keep the laminations from getting caught on the inside of the coil window. The cores are stress sensitive-they need to hang off of the coils rather than having the coils hang off of the core. It is preferable to have the core joints at the bottom in a finished unit. The joint design particular to amorphous cores- there is one step more overlap than in a silicon iron core. - design requirements Special design requirements for amorphous cores apply. For the two typical design types shown below please take into account: Amorphous ribbon is available in widths of 142, 170 and 213.3 mm, multiple widths can be stacked side by side.	

			A design induction of 1.35T allows 110% overvoltage without saturation. At 85C core temperature (hotter than cores get in normal operation), 110% overvoltage is 7 VA/kg. The core space factor should be 84%. The core material density is 7,200 kg/m3. The cores should be supported from the coils.  THREE-PHASE FIVE-LEGGED THREE-PHASE THREE-LEGGED **Global activities & Capacities** After several years of use in the United States, other countries became interested and adopted AMT. The following section describes current AMT activities in different countries. ***Japan:*** Currently, there are at least four Japanese manufacturers offering AMTs commercially. It is estimated that Japan has over several hundred thousand units installed in the field and operating satis-factorily for over 18 years.(epri). Hitachi Metals, the parent company of Metglas, has an amorphous metal manufacturing facility in Japan. ***India:*** Currently India has the largest installed base, surpassing the United States. There are currently three manufacturers of AMTs in	

			India while others have already invested in AMT equipment and will begin production in 2010. ***China:*** There are two amorphous metal (AM) core manufacturers who supply cores to transformer manufacturers. There are now many (15+) manufacturers of AMTs in China. ***Taiwan:*** Taiwan Power is now a significant user of AMTs. There is an AM core manufacturer in Taiwan with a subsidiary in China since 2005, and three manufacturers of transformers are AMT suppliers. ***Bangladesh:*** There is one (1) manufacturer of AMTs in Bangladesh. ***Other Asian Countries:*** KEPCO in Korea and Meralco in the Philippines are now significant users of AMTs. Australia and Thailand have initiated adoption and are now purchasing small quantities of AMTs. ***South America:*** An Indian AMT company has started manufacturing AMTs in Brazil. In response to this market entry, an AM core manufacturer has emerged, supported by five (5) transformer manufacturers. These five (5) transformer manufacturers will source AM cores from this core manufacturer and produce AMTs. ***North America:*** The US Department of Energy (DoE) had passed a minimum performance efficiency standard (MEPS) that came into affect January 2010 and requires some of the highest mandatory efficiencies in the world. Several Canadian utilities have started evaluating this product and Mexican utilities, primarily CFE, have converted a significant portion of the demand to AMT's . One AM core manufacturer and one AMT manufacturer has emerged or is emerging in Canada	

			and Mexico has one (1) AMT manufacturer .Metglas®, subsidiary of Hitachi Metals has a manufacturing facility in South Carolina ***Europe:*** In Europe, distribution transformers use "stack core" construction where the core is formed by stacking laminations of steel. This manufacturing process doesn't lend itself to adopting AMTs because they require a "wound" construction. Thus, adoption of AMTs in Europe is somewhat slow. In addition, unlike many countries around the world, Europe has no mandatory standard on energy efficiency of distribution transformers. The two main documents which describe losses in transformers are: the European Standard EN 50464-1, which has superseded the harmonised document HD428 for oil cooled transformers, and the harmonised document HD538 for dry type transformers, which is still valid (or their various country equivalents, e.g., DIN, etc.). Data from these norms is given in the Annex. Despite the fact that there are no mandatory standards in Europe, there are some procurement procedures (internal standards of electricity distribution companies) which are highly demanding in Benelux, Germany, Austria, Switzerland and Scandinavia. Most of the electricity distribution companies in these countries buy transformers at AoBk (50464 standards). ENDESA in Spain purchases HD 428 CC' for 400 kVA units. EdF has introduced a certain purchasing policy which specifies no load losses between Co and Eo and load losses between Dk and Bk. The mix of losses is focused on low no-load losses for small ratings and low load losses for higher ratings. Also tolerance of losses has changed recently. More often utilities reduce the tolerance of losses to, e.g., 0% instead of 15%. Seedt guide However, several utilities have evaluated AMTs, and now ENEL in Italy and ENDESA in Spain have stepped up AMT purchases. Worldwide market share of AMTs is quite significant with about 3 million single phase units and a few hundred thousand three	

			phase units. It represents about 5% market share worldwide. Hitachi Metals/Metglas® is the worldwide biggest promoter of amorphous technology in distribution transformers, their capacity of amorphous ribbon was at the level of 50 000 tons/year in 2007 and 100 000 tons in 2010. Further similar capacity expansions are under evaluation. The 2010 yearly Hitachi Metals/Metglas® capacity exceeds 140.000 units of 400 kVA three phase transformers at Ao/2- Bk classification (EN 50464 Standard), which is equivalent of the European distribution transformers yearly market. Besides the top company, there are several companies which can manufacture amorphous materials in China.. Advanced Technology & Materials Co.,Ltd is listed on the Shenzhen Stock Exchange. It is planning a drastic increase in capital expenditure. (nomura) Lately it has been announced in the Chinese press that this manufacturer will have a 40.000 to capacity set up by the end of 2010. Amorphous transformers have not yet found their way into the European market. In 1997 about 161 amorphous transformers were installed in Europe. Recent analysis of these transformers in Belgium showed that there was not any core performance degradation after more than a decade. More recently, as already mentioned in chapter 2, the energy company ENDESA (Spain) started a pilot project with 20 units of amorphous core transformers (400 kVA). Other major European utilities are following this example. Outlook The situation described above has been changed considerably for the following three reasons: first is the recent energy cost increase and unreliable/unpredictable fossil fuel supply; second is the cost increase of raw materials for transformer cores and conductors. Especially noted is the recent price increase of conventional	

			transformer-core metals which historically have cost less than amorphous alloys. Third, the saturation magnetic inductions of Fe-based amorphous alloys have been increased, resulting in reduced transformer sizes requiring less material. In spite of the increased flux density in the core, core loss has decreased and transformer noise has been considerably reduced [1]. These factors have recently resulted in amorphous metal-based transformers which are cost competitive with the conventional transformers. Souk smm1 Technically important magnetic properties of the newly developed amorphous Fe-based alloy, Metglas® 2605HB1, are depicted in Fig. 1 in comparison with those of a commercially available Metglas® 2605SA1 material and commercial M2 grade silicon steel. M2 grade material was chosen as it is one of the most advanced silicon steels. The representative points such as B(80 A/m), remanence B_r and coercivity H_c are listed in Table I below  **Finished Core Test Values at 25 C (About Twice Single Strip Values)- 50 Hz** **1115 Potential barriers for up-take**	

<table>
<tr>
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<td>In the past AMT's were considered to be larger than traditional transformers, however, at higher efficiencies now be demanded around the world, this historic size differential has been greatly reduced or eliminated altogether. At higher efficiency levels such as in the US, first costs of AMT's can easily be below those of traditional transformers. Audible noise is an issue that must be managed with AMT's, however, the greated potential efficiencies and lowerlower greenhouse gas emissions that come with it may offset any slight increase in audible noise.
<table>
<tr><th>Physical/Technical</th><th>HB1</th><th>SA1</th><th>Silicon Steel</th></tr>
<tr><td>Weight (ratio)</td><td>1.17</td><td>1.23</td><td>1</td></tr>
<tr><td>Footprint (ratio)</td><td>1</td><td>1.11</td><td>1</td></tr>
<tr><td>No Load Loss (W)</td><td>215</td><td>215</td><td>665</td></tr>
<tr><td>Total Loss (W)*</td><td>1207</td><td>1207</td><td>1353</td></tr>
<tr><td>Audible Noise (dB)</td><td>55</td><td>58</td><td>53</td></tr>
</table>
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<td></td>
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<tr>
<td>CLASP</td>
<td>Summary</td>
<td>198-199</td>
<td>While all parts of the EuP study are important, CLASP feels that the Technical Analysis is among the most critical parts, as it provides input for the identification of the improvement potential and policy options considered in Chapters 6 and 7.
CLASP reviewed the bulleted list of improvement options at the bottom of page 198 and the top of 199 and has the following suggested things to add:
1. Please add "Transformer design variability" to the list, representing an improvement option centred around the adjustment and optimisation of core dimensions, magnetic flux, volts/turn, current density, impedance, etc. Modifications to a transformer design can be made without changing the core steel type or winding type – and yet can result in significant</td>
<td>1. title added

2. Thanks for informing us, will be updated and add details added to section 5.1.1.2

3. title added</td>
</tr>
</table>

			improvements in efficiency. This type of design trade-off is generally done today by computer software programmes, which model the operation of the transformer and adjust the dimensions and other variables to create a new, unique design specific to the customer's requirements, while taking into account current material prices. 2. Coatings between the laminations of conventional silicon steel. Most electrical steels are supplied with glass-type insulation coatings. Certain manufacturers have developed new coating technologies which can enhance the efficiency and performance of the electrical steels. AK Steel, for example, has introduced Carlite 3 insulation which provides a beneficial tensile stress that contributes to better magnetic properties and decreased stress sensitivity of the material. (see p.4 of the following PDF: http://www.aksteel.com/pdf/markets_products/electrical/Oriented_Bulletin.pdf) *3. Core construction techniques – fully-mitred, 7 step-lap construction and wound-core construction. In essence, core design the cruciform core you already have in your list) that improv magnetic pathway in the steel and minimise air gaps or flux tra against the grain of the oriented steel.*	
CLASP	5.1.1.1	199	In the discussion of wire, there is one additional technology option which is not discussed. Rectangular wires and foils have the best 'copper filling' per unit area in the core window, particularly when compared to round wire – however, some manufacturers have used "flattened" or "smashed" wire, which involves pulling a spool of round wire through two roller-compressors while winding the transformer on a lathe. This creates a wire that is flat on the top and bottom and round on the sides, and results in a better space factor than round wire (although still not as good as rectangular wire or foil).	**Thanks for informing us, updated**
CLASP	Chapter 5		Throughout this chapter, the word "resin" has been changed to "resign". Both are words, but they have very different meanings.	**Adapted**

			We suggest a global search and replace to make sure to change the word “resign” throughout this chapter (and potentially elsewhere in the document) to be “resin”.	
CLASP	5.1.1.5	202	A statement is made at the top of this page that the most efficient steel grade will not allow the transformer core/coil assembly to be annealed after assembly because it would eliminate the beneficial properties of the laser scribing. This statement is true of laser scribed material (see page 4 of the AK Steel brochure mentioned above – “Stress-relief annealing will nullify the beneficial effects of laser scribing domain refinement.”), but it is not true of a mechanically-scribed electrical steel. The US DOE conducted analysis of a core steel manufactured by Nippon Steel called “Orientcore HI-B-PM” (called ZDMH by DOE). This steel can withstand stress-relief annealing (up to approximately 800℃ in a non-oxidising atmosphere). A note about this steel should be added to this section. See detail in this Nippon Steel brochure: http://www.nsc.co.jp/en/product/sheet/pdf/DE304.pdf	**Indeed. See also Thyssens comments. Updated.**
CLASP	5.1.2.1	204	At the top of this page, a table is provided which summarises some of the design options for improving efficiency and the associated impact on no-load losses, load losses and cost. This table is adapted from the DOE publication of the same table in 2007, however it is unclear why several items that were in the table have been removed in this draft. The full table is provided here, and CLASP recommends that the table on page 204 be revised to include the complete list of measures that improve transformer efficiency. Also, there is no discussion before or after the table which helps the reader interpret what is being presented. The acronym “CSA” is used in the table, which if left undefined could be confusing (CSA = Cross Sectional Area, not Canadian Standards Association).	**This table is removed and did indeed not belong here.** **The Table you suggest will be included in the more relevant section 5.1.2.7**

3.1.1.2 [Editorial note: the table on p.204 doesn't have a caption "Table X.X….."]

Table 4.2.1 General Loss-Reduction Interventions for Distribution Transformers

Loss-Reduction Interventions		No-Load Losses	Load Losses	Effect on Price
Decrease Core Losses	Use lower-loss core materials	Lower	No Change*	Higher
	Decrease flux density by increasing core cross-sectional area	Lower	Higher	Higher
	Decrease flux density by decreasing volts/turn	Lower	Higher	Higher
	Decrease flux path length by decreasing conductor cross-sectional area	Lower	Higher	Lower
Decrease Coil Losses	Use lower-loss conductor materials	No Change	Lower	Higher
	Decrease current density by increasing conductor cross-sectional area	Higher	Lower	Higher
	Decrease current path length by decreasing core cross-sectional area	Higher	Lower	Lower
	Decrease current path length by increasing volts/turn	Higher	Lower	Lower

*Amorphous-core materials would result in higher load losses because flux density drops, requiring a larger core volume.

The following is a more detailed list of design options that were considered by the US Department of Energy in its analysis of distribution transformers. Several of these design options are already under review by the EuP Analytical Team, however we provide the complete list in the event that there are others below that are new. If you require further detail on any of these options, please do not hesitate to contact CLASP.

Conductor Materials – Aluminium, Copper and Alloys

Core Materials – Cold Rolled High Silicon Steel; Cold Rolled High Silicon Steel Domain Refined; Amorphous Material in Wound Core

			Design Dimensions – Flux Density; Current Density; Volts/Turn; Voltage Spacings, Frame/Coil Dimensions; Shape, Cooling Channels – Number and Location; Insulating Materials and Core Type (Shell or Core Form, either Stacked or Wound) Construction Techniques – Core Cutting, Core Stacking, Core Lapping or Butting of Joints; Coil Winding, LV-HV.	
CLASP	5.1.2.2	205	Table 5-2 misspells the word “cicular” twice. It should read “circular”.	**Should be adapted also taken other comments into accoutn**
CLASP	5.1.2.2	205	In the section labelled “Potential barriers for up-take”, in the context of a discussion on cruciform core construction, the first item listed indicates that the “price to cut and handle many widths of strips might be a barrier for silicon steel transformers.” The implication from this description is that this assembly process is done by hand, however this is not the case. Rather, there is a machine manufactured by a Germany company called “Georg” which completely automates the processing of core steel from a coil into a stacked, circular (or oval), mitred corner core. For more information, visit their homepage for transformers: http://www.georg.com/e/trafo/index.php These are expensive machines and are used by all the major transformer manufacturers. The Georg machine is very precise, managing all the different dimensions - widths, lengths, and angles – which it then stacks to build cores that look like this:	**Thanks for informing us, updated**

			 ***3.1.1.3 Thus, the "price to cut and handle" the different widths should not be seen as a barrier, this is actually a highly-automated process for manufacturers across Europe.***	
CLASP	5.1.2.3	205-206	Steel and windings are indeed the main two considerations for improving efficiency, however the insulating film between the core steel laminations can also improve overall core performance. AK Steel has developed and marketed a product called Carlite 3 and/or other insulating films between the steel laminations. (see p.4 of the following PDF for information on AK Steel's product: http://www.aksteel.com/pdf/markets_products/electrical/Oriented_Bulletin.pdf) Consider adding mention of Nippon Steel's mechanically scribed, deep domain refined steel Orientcore HI-B-PM (called ZDMH by DOE). Unlike the laser-scribed steel, the mechanically scribed steel can withstand stress-relief annealing (up to approximately 800℃ in a non-oxidising atmosphere). Thus, ZDMH ca n be used in a wound-core configuration and retain the low watts/kilogram benefits after being annealed. It would be advantageous to add a note about Orientcore HI-B-PM (ZDMH) steel to this section. For more information, please see detail in this Nippon Steel brochure: http://www.nsc.co.jp/en/product/sheet/pdf/DE304.pdf	**Thanks for informing us, updated**

CLASP	5.1.2.3	208	Table 5-3 provides a list of core steels that are available and considered in this analysis. It is suggested that a new row be added to this table for mechanically scribed steel, which will survive the annealing process: ZDMH 0.27mm 0.92 W/kg at 1.7T, 50Hz ZDMH 0.23mm 0.85 W/kg at 1.7T, 50Hz	**Added.**
CLASP	5.1.2.7	216	This section indicates that the analysts are considering working with a transformer design company which uses its own software to develop a cost-efficiency curve that can support the analysis in subsequent chapters of this study. As discussed in our comments on section 2.2.6.2 (p.107) above, CLASP supports this approach, and believes it will yield excellent results because the software modelling exercise can take advantage of many design options and efficiency improvements that may not be common in the market today and may be difficult to quantify or estimate for this study. By creating new designs and extracting calculated bills of material and electrical performance, a relationship between cost and efficiency can be developed. As discussed in our comments above, CLASP is aware of at least one company – Optimized Program Service – who is capable of designing six out of the seven base case transformers identified in this analysis (they design up to 2500 kVA, liquid-filled or dry-type). Please visit their website at: http://www.opsprograms.com/	**The analytic model is public available and will be aligned with real manufacturing data obtained by an enquiry.** **The preference is to use public available design data (which was not disclosed in the DOE study upon our knowledge). European manufacturers have there own design software, hence undisclosed design from one single consultancy service might not be representative.** **BTW:** **Available software and support is also available at www.rale.ch or www.softbitonline.com** (So they should be invited as well)**.**
CLASP	Chapter 5		Much of this chapter – particularly the second half – is incomplete, and simply presents tables, has headings with no text, or has statements highlighted in blue or yellow asking for comments or stakeholder input. CLASP requests that once the chapter is in a more complete condition, that stakeholders will be given a chance to review it again before it is finalised.	**There is a third stakeholder meeting and final processing later in the project.**

TB TCS			• I don't disagree with the views expressed on the desire to adopt only round winding designs. The consequence is simply put as a cost increase in the transformer. However, many manufacturers do not manufacture round windings for many reasons and they do not have the technology to manufacture round windings. Therefore a requirement to move to specific configurations may have the effect to drive some smaller manufacturers out of the market.	**Noted**
EURELECTRIC		199	**Hexaform trafo** mentioned for the first time yet amorphous mentioned in much more detail and much earlier. This requires rebalancing as it would appear that Hexaform 3 phase trafos are mor e competitive than amorphous core in the range 33-200kVA, and should be featured more prominently earlier.	**The Base Case in chapter 4 was 400 kVA, hence it is difficult to take it on board for the analysis.** **Note: text is added.**

Stakeholder identification:

TB TCS	Transformer Consultancy Services
EURELECTRIC	EURELECTRIC
CLASP	Collaborative Labeling and Appliance Standards Program
Dansh Energy Agency/AFHH/EJ	Dansh Energy Agency/AFHH/EJ
PCPM / ECI	European Copper Institute (Poland)
DKI / ECI	European Copper Institute (Germany)
UBA	Federal Environment Agency, Germany
Hitachi Metals/Metglas	Hitachi Metals/Metglas
ThyssenKrupp Electrical Steel (TKES)	ThyssenKrupp Electrical Steel GmbH
T&D Europe	The European Association of the Electricity Transmission and Distribution Equipment and Services Industry

ANNEX M SECOND ENQUIRY ON POWER AND DISTRIBUTION TRANSFORMERS

1. Reference price of the base-cases

Do you agree with the curent Base-Cases price?

Answer (select in drop-down menu):
If no, please provide a reference price you would suggest:

BC1	BC2	BC3	BC4	BC5	BC6	BC7
8.888 €	14.751 €	19.623 €	1.036.720 €	30.068 €	37.958 €	1.348 €
-	-	-	-	-	-	-

Reminder of the base-cases enquiry:
BC 1: Distribution transformer (400 kVA, P0=750 W, Pk=4 600 W)
BC 2: Oil-immersed industry transfromer (1 MVA, P0=1 700 W, Pk=10 500 W)
BC 3: Dry-type industry transformer (1.25 MVA, P0=2 800 W, Pk=13 100 W)
BC 4: Power transformer (100 MVA, P0=80 000 W, Pk=300 000 W)
BC 5: DER transformer oil-immersed (2 MVA, P0=3 100 W, Pk= 21 000 W)
(losses increased in comparison with the base case enquiry chapter 4)
BC 6: DER transformer dry-type (2 MVA, P0=4 000 W, Pk= 18 000 W)
(losses increased in comparison with the base case equiry chapter 4)
BC 7: Separation/isolation transfomer (16 kVA, P0=110 W, Pk=750 W)

2. Evolution of the prices

In the following section, please provide information on the evolution of the prices within the tables, in % (for instance, a 400 kVA COCk distribution transformer has a price of 115% of the reference price of the base-case), **assuming the price of the base-case represents 100%**. If you have suggested another price for the base-case than the current one given in the report, **please give this evolution based on your suggested price**. The green cells correspond to the base-cases transformers. Please do not fill in the grey cells.
If you are able to fill in the amorphous column, please also precise the level of no-load losses and noise.

BC 1 - Distribution transformer 400 kVA		E0	D0	C0	B0	A0	Amorphous
		930 W	750 W	610 W	520 W	430 W	?
		68 dB	63 dB	58 dB	53 dB	50 dB	?
Dk	6000 W						
Ck	4600 W		100%	?	?	?	?
Bk	3850 W				?	?	?
Ak	3250 W					?	?

BC 2 - Industry oil-immersed transformer 1 MVA		E0	D0	C0	B0	A0	Amorphous
		1700 W	1400 W	1100 W	940 W	770 W	?
		73 dB	68 dB	63 dB	58 dB	55 dB	?
Dk	13000 W						
Ck	10500 W	100%		?	?	?	?
Bk	9000 W				?	?	?
Ak	7600 W					?	?

BC 3 - Industry dry-type transformer 1.25 MVA		C0	B0	A0	Amorphous
		2800 W	2100 W	1800 W	?
		75 dB	67 dB	67 dB	?
Bk	13000 W	100%	?	?	?
Ak	11000 W			?	?

BC 4 - Power transformers 100 MVA (132/33kV) (double winding)		Po(kW)	Po(kW)	Po(kW)	Po(kW)	Po(kW)
		80	70	60	40	30
Pk(kW)(75°C)	390	?				
Pk(kW)(75°C)	300	100%		?	?	?
Pk(kW)(75°C)	275				?	?
Pk(kW)(75°C)	250					?

BC 5 - DER oil-immersed transformer 2 MVA		E0	D0	C0	B0	A0	Amorphous
		3100 W	2700 W	2100 W	1800 W	1450 W	?
		78 dB	73 dB	68 dB	63 dB	60 dB	?
Dk	26000 W						
Ck	21000 W	100%		?			?
Bk	18000 W						
Ak	15000 W					?	?

BC 6 - DER dry-type transformer 2 MVA		C0	B0	A0	Amorphous
		4000 W	3000 W	2600 W	?
		78 dB	70 dB	70 dB	?
Bk	18000 W	100%	?		?
Ak	16000 W			?	?

3. Evolution of the core and conductor weights

In the following section, please indicate the evolution of core and conductor weights, similarly to section 2, but in the format X%/Y%, where X refers to the core material and Y to the conductor material. The green cells correspond to the base-cases transformers. Please do not fill in the grey cells.
If you are able to fill in the amorphous column, please also precise the level of no-load losses and noise.

BC 1 - Distribution transformer 400 kVA		E0	D0	C0	B0	A0	Amorph
		930 W	750 W	610 W	520 W	430 W	?
		68 dB	63 dB	58 dB	53 dB	50 dB	?
Dk	6000 W						
Ck	4600 W		100%/100%	?		?	?
Bk	3850 W				?		
Ak	3250 W					?	?

BC 2 - Industry oil-immersed transformer 1 MVA		E0	D0	C0	B0	A0	Amorph
		1700 W	1400 W	1100 W	940 W	770 W	?
		73 dB	68 dB	63 dB	58 dB	55 dB	?
Dk	13000 W						
Ck	10500 W	100%/100%		?		?	?
Bk	9000 W				?		
Ak	7600 W					?	?

BC 3 - Industry dry-type transformer 1.25 MVA		C0	B0	A0	Amorphous
		2800 W	2100 W	1800 W	?
		75 dB	67 dB	67 dB	?
Bk	13000 W	100%/100%	?	?	?
Ak	11000 W			?	?

BC 4 - Power transformers 100 MVA (132/33kV)		Po(kW)	Po(kW)	Po(kW)	Po(kW)	Po(kW)
		80	70	60	40	30
Pk(kW)(75°C)	390					
Pk(kW)(75°C)	300	100%/100%		?		?
Pk(kW)(75°C)	275				?	
Pk(kW)(75°C)	250					?

BC 5 - DER oil-immersed transformer 2 MVA		E0	D0	C0	B0	A0	Amorph
		3100 W	2700 W	2100 W	1800 W	1450 W	?
		78 dB	73 dB	68 dB	63 dB	60 dB	?
Dk	26000 W						
Ck	21000 W	100%/100%		?			?
Bk	18000 W						
Ak	15000 W					?	?

BC 6 - DER dry-type transformer 2 MVA		C0	B0	A0	Amorphous
		4000 W	3000 W	2600 W	?
		78 dB	70 dB	70 dB	?
Bk	18000 W	100%/100%	?		?
Ak	16000 W			?	?

ANNEX N MINUTES OF THE THIRD STAKEHOLDER MEETING

Ecodesign Preparatory Study ENTR Lot 2: Distribution and Power Transformers

DRAFT Minutes of the Final Stakeholder Meeting

Place: European Commission
Centre Albert Borschette, Brussels

Date / Time: August 24, 2010
10h30 – 18h00

Project contact: **VITO**
Paul Van Tichelen (paul.vantichelen@vito.be)
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Agenda:

10h00 – 10h15	Welcome and participants presentation Agenda Distribution of comments and proposed answers
10h15 – 10h30	Short presentation of MEEuP methodology and general scope of the study (BIO)
10h30 – 11h30	Chapters 1-5 in a nutshell and main updates made after second stakeholder meeting (Vito)
11h30 – 12h30	Presentation of Chapter 6 followed by a discussion on selected comments and answers (BIO)
12h30 – 13h30	Lunch Break
13h30 – 14h30	Presentation of Chapter 7 followed by a discussion on selected comments and

	answer (Vito)
14h30 – 14h45	Data update and completion of power transformers MEPS (Vito)
14h45 – 15h15	Coffee break
15h15 – 15h45	Opportunity to come back to comments and answers as distributed in the beginning of the meeting (Vito, BIO)
15h45 – 16h00	Planning to completion of the study
16h00 – 16h30	Any other Business

The times of the agenda are the originally planned times, and do not reflect the reality of the events that occurred.

Annex: Stakeholders who read these minutes should also consult the powerpoint presentations of the meeting that are available on the project website.

Participants:

European Commission

ME	Martin Eifel	EC – DG ENTR

Lot 2 consortium

PVT	Paul Van Tichelen	VITO
MSt	Marcel Stevens	VITO
BT	Benoît Tinetti	BIO Intelligence Service
AT	Alexander Thornton	BIO Intelligence Service
TF	Thibault Faninger	BIO Intelligence Service

Stakeholders

MSa	Michel Sacotte	GIMELEC/T&D EUROPE/WG3
PL	Pierre Lucas	T&D Europe
CE	Christophe Elleau	EDF R&D
EC	Eric Coen	EREA
SJ	Sigrid Jacobs	ArcelorMittal
HL	Hans Lammert	ThyssenKrupp Electrical Steel GmbH
AJ	Andreas Jansen	ThyssenKrupp Electrical Steel GmbH
AW	Anthony Walsh	ESB Networks/Eurelectric

HPSi	Hans-Paul Siderius	NL Agency
AE	Anita Eide	CLASP
MSc	Michael Scholand	CLASP/Navigant Consulting
RM	Richard McGeehan	Hitachi Ltd.
JH	Jesper Holmberg	Hitachi Ltd.
KG	Klaus Giefer	Hitachi Metals/Metglas
JA	Jerry Allen	Hitachi Metals/Metglas
HPSa	Heinz Peter Sailler	EMB Wittlich
WH	Walter Hulshorst	ECON International
EB	Erik Bjernulf	Hexaformer
TO	Tetsuya Oishi	Mitsui & Co
LS	Laura Spengler	Ökopol/UBA
MH	Michael Heinz	SBG Neumark

1. INTRODUCTION

Paul Van Tichelen (PVT) of VITO welcomed participants to the meeting and initiated introductions by all participants.

Martin Eifel (ME) of the European Commission explains the meeting expectations:

- The study began in the beginning of 2009. Transformers are part of the first Working Plan of the Ecodesign Directive (2009-2012). This is the final stakeholder meeting and represents the last opportunity for stakeholders to provide valuable comments and points of view on the project. It is thus very important to get an active participation during this meeting. ME is attending as an observer.
- The study is expected to be finalised by mid-November. The report shall not be changed after this date.
- Based on the final version of the study, draft implementing measures may be written and brought to a consultation forum. After possible review of the draft, the document is then going through an Impact Assessment. The final steps before adoption by the Commission are the vote by the Committee (Member States representatives) and the scrutiny by the Parliament and the Council.
- Assuming this process follows a "common" evolution, the consultation forum may take place in spring 2011 and the potential measures could be adopted by the Commission in the spring of 2012 at the soonest.

ME suggested an update of the project website: latest versions of each task should be published on the top of pages for more convenience. BIO will adapt the website according to this suggestion.

1. PRESENTATION ON MEEUP

Alexander Thornton (AT) of BIO Intelligence Service presents the methodology used in the study.

2. CHAPTERS 1-5

PVT makes a presentation on remaining issues within Chapters 1-5. Latest updates of these tasks include[1]:

- A clearer definition of the "smaller transformers" in task 1
- A justification of the power rating chosen for the power transformers (100 MVA)
- A justification of the low load factors, which were checked thanks to utilities data.

Discussing the low load factors

Anthony Walsh (AW) of ESB Networks/Eurelectric supported the conclusion on the low load factors as when adding transformers in the EU networks, the loading on surrounding transformers is lowered because of the interconnections. In the US, this effect does not exist. Jerry Allen (JA) from Hitachi/Metglas specified that load factors in the US are actually as low as in the EU.

PVT also explained that the share of domestic consumption of electricity is still important. AW added that in Ireland, policies are pushing towards the use of electric heat pumps for building heating in order to reduce the carbon footprint of the country.

In task 4, the important losses due to power transformers make sense according to PVT. The category power transformer includes generation transformers. PVT gave the example of nuclear power plants that have flat loads, 3-4 weeks maintenance in a year and 2 or 3 power transformers, which results in a loading of 0.5. Walter Hulshorst (WH) does not agree as only one transformer is operated at the same time and the other transformers are only magnetised (no load losses occur but not load losses). This should not result in a loading as low as 0.5. Christophe Elleau (CE) from EDF ensured that in France, there is only one power transformer after the turbine.

AW said that wires and cables represent 4-5 times the losses in transformers. Of the 8% of losses on the electric network in Ireland, 6% occur on the distribution system and 2% on the transport system. He insisted that the optimisation should be done at a system level and that cables should also be considered for example. Utilities look at capitalisation of energy efficiency over the entire system, rather than just one component. It is incorrect to minimise losses in transformers if greater gains can be made per capital in the system. ME explained that the policy options should be compatible with this system approach and that the main objective of the Directive is to get rid of the worst products, and not to set every component of the system at a very high level. PVT added that there is no technical conflict to include more efficient transformers in the system. This issue had already been discussed during the second stakeholder meeting and is considered out of the scope of this project.

[1] Full presentations of the meeting are available on the project website : www.ecotransformer.org

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Discussing the price data of task 5

Michael Scholand (MSc) from CLASP/Navigant Consulting has prepared a short report made available to this working group and the project team, where some designs are presented to allow comparisons with current results of task 5. The designs are European, using stack core for silicon steel transformers and wound core designs for amorphous transformers.

Klaus Giefer (KG) argued that amorphous should not be presented as a new technology as it is 30 years old. JA added that amorphous transformers have already won bids for some transformers of the US Department of Energy (DoE).

PVT explained that the figures of the report are the selling prices, thus including the manufacturers' margin. Michel Sacotte (MSa) explained that knowhow is very important in transformer manufacturing in terms of cost reduction, which could justify the wide range of prices found. The margins of the manufacturers are usually similar.

MSc, CE, JA and MSa confirmed that the figures regarding the increase of prices and bill of material when increasing the efficiency of silicon steel transformers look correct (results are in line with CLASP report). MSa explained that manufacturers probably use different grades of steel to manufacture transformers with the same level of efficiency. It is difficult to assess the shares of every step of the production chain in the total costs of a given product. Production costs thus depend on the range of products manufactured by the company. However, for competitiveness reasons, purchases prices are similar amongst manufacturers. CE requested the project team to include tables with absolute figures of prices of material quantities, besides the tables with percentages. The report will be amended according to this request. The CLASP report details the different shares (raw material costs, factory overheads, labour, etc.).

Regarding the amorphous transformers tables, JA and KG claimed that the prices presented are too high. CLASP results are however in line with their market information. JA added that the production costs of amorphous transformers can even be lower than the production of silicon steel products. MSa does not agree with this point of view. He thinks the current amorphous tables are representative as prices proposed by manufacturers belong to the proposed range. He underlined the short circuit withstand parameters, for which amorphous designs are still currently not optimised.

KG is surprised as Hitachi market information does not fit with the proposed range. On the EU market, there are amorphous offers less expensive than silicon steel transformers. He expressed his disappointment regarding the non inclusion of the data Hitachi/Metglas provided.

PVT double checked what happened with the Hitachi/METGLAS data after this meeting. Data was received at 30th June after the deadline, a few days before the release of the chapters 1-5 updated with enquiry results (on July 6th) and related chapters 6&7 while these chapters were under EC revision. They will be investigated for the final update.

PVT explained that the table is not a long term pricing, but a snapshot. It is stated in the report that "prices could become equal" in the future. MSa added that the lower prices of silicon steel transformers might be explained by the important decrease of the magnetic steel price in the past two years.

KG insisted several times during the meeting that is it not realistic that silicon steel transformers have lower Life Cycle Costs (LCC) than amorphous transformers.

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3. PRESENTATION OF CLASP FINDINGS (BY MICHAEL SCHOLAND)

For the silicon steel designs, there is a very good correlation between the preparatory study results and CLASP findings. The slopes of price evolution vs. efficiency are similar.

Regarding amorphous, the slopes are still similar but the prices of the preparatory study are 44% higher than CLASP results because of an important shift for all levels of efficiency. CLASP results also show than stack silicon designs and wound amorphous designs superposes on these price vs. efficiency figures. Michael Heinz (MH) said that the CLASP results does not look realistic for European designs and MSa added that the impact of the short circuit withstand is very important. MSc answered that amorphous transformers up to 2.5 MVA are manufactured in Japan and in the US.

4. CHAPTER 6

About the improvement options proposed, CE said that all options, especially the most ambitious (A02Ak) are not currently feasible regarding size and weight constraints.

MSc expressed some concerns on the choice of materials used in the bill of materials. Galvanised steel is not representative of the electrical steel, but would be a better choice than cast iron for the tank composition. AT explained that the impacts of the manufacturing phase had been proven very low in comparison with the electricity losses but some updated might be done by the project team to have the most accurate results possible.

Discussing base-case 7

PVT exposed the situation of base-case 7 (small separation/isolation transformers): the Best Available Technology does not appear economically justified because of the low use rate of these transformers. MSc is surprised that only one improvement option is presented for this category of transformers. PVT justified this by the scarcity of data found: the applications of these transformers are very specific and quite rare with a low utilisation factor. JA raised the question of their inclusion into the study. This topic had already been discussed during the previous stakeholder meeting and ME reminded that this study is the first step of the process and its goal is to provide a full picture of the situation in order to make relevant policy decisions.

Note (see powerpoint presentation): base-case 7 is for LV/LV transformers (<1kV), not to be confused with MV/LV types.

Discussing alternative oils

The analysis of mineral oil vs. biodegradable esters was made assuming no leakage and spill over the lifetime, which explains why the environmental impacts are assessed similar in the end. AW claimed that the majority of the liquid used is mineral oil and silicon liquid is only a niche market. AT added that the functionality should then determine the choice of liquid, as stated in the report.

AW requests that the study mentions the switch in voltage possible in order to achieve electricity savings (e.g. 10 kV to 20 kV), as an improvement option. The project team explains that this seems out of the scope of the study to perform a detailed analysis. Some qualitative information is already included in the report (see section 6.3.4) just to pinpoint the existence of such possibility.

Discussing electricity tariffs

Also AW thinks the electricity tariffs should be revised. He stated the figures of 4.5-5 cents per kWh in Ireland and will provide further information. However, the project team has been using Eurostat data which is the advised tool in the framework of these preparatory studies.

Discussing LCC calculations

JA mentioned the fact that the Total Cost of Ownership (TCO) depends a lot on the A and B factors (capitalisation of no load and load losses). Different methodologies may give different results in the comparison of the improvement options with the base-cases. The project team will make clearer the assumptions regarding these calculations (e.g. correlation between A and B) and additional parameters might be introduced after further investigation. A & B will be more clearly exposed so that utilities can make a direct comparison of the results. KG reminded the importance of having realistic purchase prices in the LCC calculations. The current sensitivity analysis does not cover a range of prices of amorphous transformers compared to fixed silicon steel transformers prices.

Discussing availability factors of DER

AW thinks that the value of 1.25 is not correct (see section 6.4.2) for the factor of DER transformers. This value presented seems to be a stand-alone value, the actual value that has been used for calculations being 1.5. The project team will double check this. JA confirms that the availability factors for wind and solar power should be 1.5.

Checked (PVT): the sensitivity analysis should indeed be performed with the parameter set as presented in Table 5-6. The section needs to be updated accordingly.

Discussing the stock figures

The stock figures had been updated by the project team because of a difference in the average rating between stock transformers and sales transformers. The calculations will be made clearer in the updated version of the report.

5. CHAPTER 7

Discussing on subcategory in policy measures

On potential measures, MSa claimed that DER transformer should not be separated from other transformers regarding performance. For pole-mounted transformers, the weight limit is 550 kg in

France. This limit could be respected for 50 kVA and 100 kVA products, but not for 160 kVA when implementing improvement measures. CE explained that this limit is not due to the stability of the transformer in itself, but deals with security and procedures while installing the transformer on the pole.

AW explained that there are compact transformers sold in Japan that could be very useful for electric car integration into the network. He expects the demand for such products to grow and explains that situations might occur where you do not have several options available, especially the choice of energy efficiency. Thus, he does not want the potential regulations to limit and prevent him from buing such products for instance. PVT asked the question of the need for subcategory. MH does not think a subcategory is needed.

MSa said that pole-mounted transformers are used in France, Portugal, Italy and France and that these countries will have to keep this type of transformers in use. Erik Bjernulf (EB) from Hexaformer said they can manufacture compact transformers up to 200 kVA and he will double check the technical feasibility.

MSc exposed the situation of the US where three single phase transformers can be connected as a three phase transformer. MSa answered that this is not the European mentality and that utilities do not want to have a messy network. He underlined the fact that options need to be applicable in every MS and thinks a thorough study is required to estimate the limit of feasibility of pole-mounted transformers (in terms of weight and power rating). CE added that it also exists transformers with fuses inside the tank which make them heavier, and that these probably need a subcategory or derogation. MSa suggested an inquiry to be carried out in all the Member States. ME concluded that there could indeed be two different levels of requirement depending on the categories defined and the technical feasibility.

AW also suggested that in the evaluation of the cost/benefit justification of heavier low loss pole mounted transformers the costs associated with alterations to the pole design would have to be factored in – if a multiple pole structure was required this would add hugely to cost, and if pole mounting was not feasible due to weight limitations then the only option would be to use a Ground mounted substation instead. This would be even more expensive.

However if the ancillary costs of using low loss transformers are included in a TCO evaluation, this evaluation would result in levels of losses for pole mounting transformers which did not impose excessive costs.

Hans-Paul Siderius (HPSi)[2] is in favour of as few exemptions as possible. The pole mounted transformer above a certain capacity might be an acceptable exemption, but not the transformer for electric vehicles, according to him.

Discussing the policy targets

PVT explained that the objectives do not look ambitious enough. Comments have been made by the industry: the change would be more beneficial from an economic point of view if happening in one single step, instead of two (Tier 1 in 2013 and Tier 2 in 2015). MSa suggested the target of Tier 2 in 2014 to give stakeholders enough time to make required adaptations. HPSi[2] understands this vision

[2] Comments received after the meeting by email as the person had to leave before the end of the meeting.

from the industry but stresses that the requirements should be ambitious then, because this is the only opportunity to implement them.

JA and AW insisted that no requirements should be made on designs. The market will naturally adapt the best options. MSa specified that the best magnetic steel and copper would probably be required to achieve the current targets suggested (A0Ak for Tier 2).

PVT explained that new standards need to be defined with higher efficient levels. KG said that the no load losses of amorphous material are not mathematically A0 level divided by 2, but even less than that. MSa thinks that it is still too early to define better levels in the standards, which are defined for the sector and by the sector. He nevertheless agrees that a better list should be planned, with previous feasibility check.

HPSi[2] thinks that an energy label for transformers would be useful, especially when there is a lot of room for improvement above the minimum requirements. This would also enable commercial businesses to show in a simple way that they use the most efficient products.

Discussing the tolerance

MSa expressed his feelings that tolerance is a kind of "bad game" and there should be no tolerance from his point of view. Today, manufacturers are today available to adapt the quality of production very well (in the past, raw material quality was not as good). If a tolerance is set, they just aim at the product quality with the tolerance included. AW explained that in Ireland, a "fine" is paid by the manufacturer if the product does not respect the tolerance range. JA said that the problem by setting tolerance 0 is that you may discard acceptable products, slightly outside of the levels required. ME specified that the variations in measurement of quality may results from variations of products, repeatability and the methods used (instruments error, etc.). Manufacturers have to determine where parameters still cannot be 100% controlled and the tolerance assessment should be based on such analysis.

6. DATA UPDATE AND COMPLETION OF POWER TRANSFORMERS MEPS

MSa will push for further replies from manufacturers in T&D regarding the additional inquiry on power transformers. PVT suggested to simplify the analysis by excluding the autotransformers, assuming that these products are always more efficient and do not have important sales. MSc asked for the risk of any loophole is autotransformers are not regulated. According to PVT, there is no need for an exemption for autotransformers as they can have identical MEPS that they can meet more easily.

7. DISCUSSIONS ON REMAINING COMMENTS

Discussing the amorphous transformers prices

MSc said that the estimations of prices in the CLASP report are transparent, as well as the Bill of materials. PVT acknowledged the possibility to use these figures as reliable source of data.

AW specified that utilities do the TCO analysis the other way around: capitalisation of losses is set and transformers are designed according to these, rather than calculating directly A and B. In the current results, the capitalisation show too little variations in comparison with the variations of the purchase prices according to him.

Discussing the implementation of the amorphous option

ME claimed that the amorphous section should not be presented in a separate section but should be included with the other improvement options dealing with silicon steel. Immediate links between performance and the technology used should be clearly explained in the report.

According to AW, amorphous technology should be implemented for base-case 2 (1 MVA) as such transformers already exist in Japan. MSc agrees and does not think short circuit tests are a problem up to ratings of 2 MVA. CE answered that the short circuit issue also exists for silicon steel products and is not specific to amorphous transformers. MSa claimed that for T&D Europe, 1 MVA is the maximum power rating currently achievable with amorphous core.

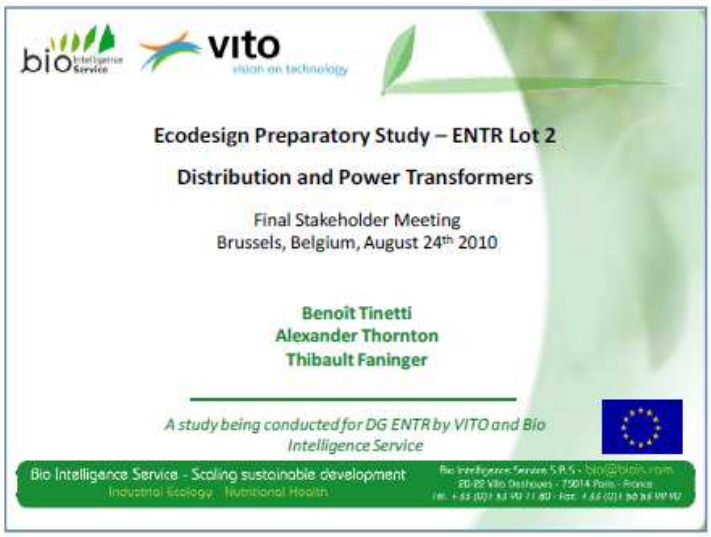
The project team will decide for which other base-cases amorphous cores should be implemented. MSc announced that CLASP will also write another report on the dry-type transformers, to complement the preparatory study.

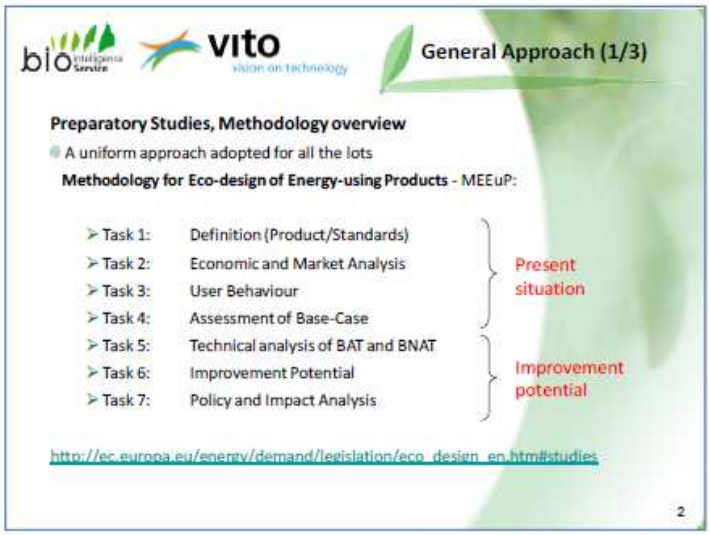
Discussing the smaller power transformers(<1kV or LV/LV)(Base-case 7)

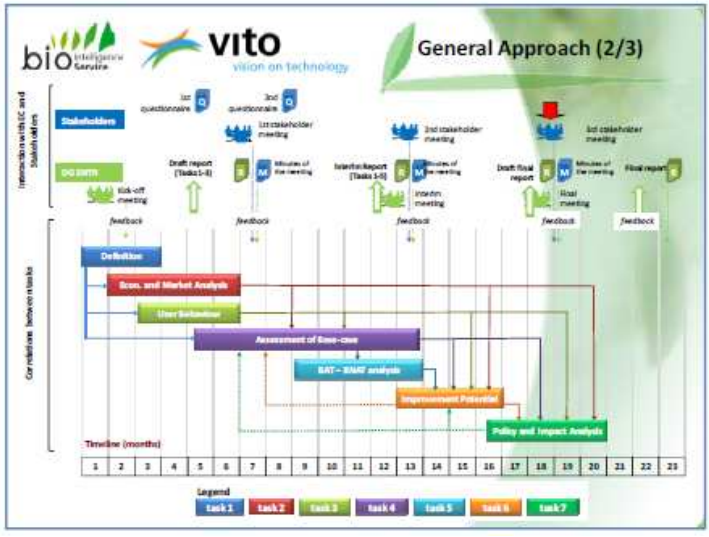
Eric Coen (EC) from EREA said that many small power transformers (from 1 to 200 kVA) are different (input voltages). Some are intended to be used in high ambient temperatures. Many parameters determine the construction of these transformers and it does not look realistic to specify one level of load loss level and no load loss level for all of them. Besides, users usually do not worry about losses in those smaller power transformers. He proposed to give up the idea of setting losses values, but rather force the manufacturers to indicate the losses (in catalogues), and to agree on methods to measure them. PVT thinks that the first step is to map more precisely the market as very few data is available. Moreover, these transformers have low global impacts.

JA suggested looking at the US standards where many different categories are specified but MSc replied that the applications and designs of these transformers are not the same in the EU.

ANNEX O PRESENTATIONS OF THE THIRD STAKEHOLDER MEETING



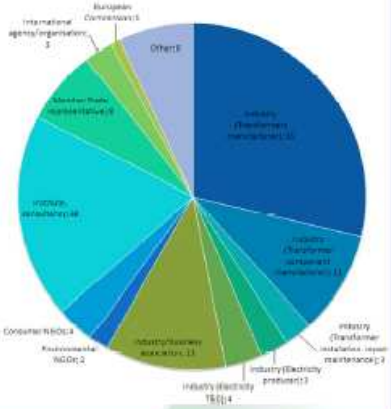




General Approach (3/3)

Stakeholders

- 155 persons on the mailing list
- Companies, associations, institutes, MS Agencies, etc.



Task 1

Preparatory Studies, Methodology overview

- Task 1: Definition
  - define the product category and define the system boundaries of the 'playing field' for eco-design
  - identify the harmonised test standards and additional sector-specific procedures for product-testing
  - identify the existing relevant legislation, voluntary agreements, and labelling initiatives at the EU and MS level, as well as outside Europe

1.1 Product definition
1.2 Test and other Standards
1.3 Existing legislation (including labelling and voluntary programs)

5

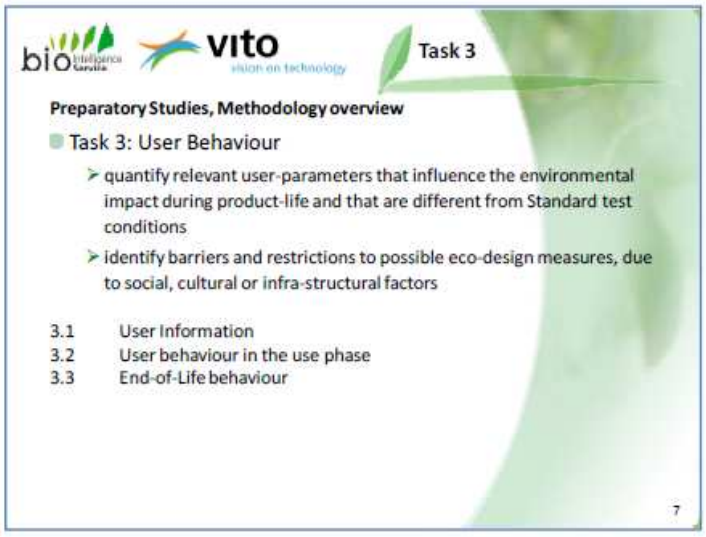
Task 2

Preparatory Studies, Methodology overview

- Task 2: Economic and Market Analysis
  - place the product group within the total of EU industry and trade policy
  - provide market and cost inputs for the EU-wide environmental impact of the product group
  - provide insight in the latest market trends
  - provide a practical dataset of prices and rates to be used in a Life Cycle Cost (LCC) calculation

2.1 Generic economic data
2.2 Market and stock data
2.3 Market and production structures
2.4 User expenditure base data

6


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Task 3
Preparatory Studies, Methodology overview
Task 3: User Behaviour
quantify relevant user-parameters that influence the environmental impact during product-life and that are different from Standard test conditions
identify barriers and restrictions to possible eco-design measures, due to social, cultural or infra-structural factors
3.1 User Information
3.2 User behaviour in the use phase
3.3 End-of-Life behaviour
7


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Task 4 (1/2)
Preparatory Studies, Methodology overview
Task 4: Assessment of Base-Case
general technical analysis of current products on the EU market
objective is to capture the market on the whole, both "good" and "bad" products
functional analysis of the system to which the product belongs, including a rough estimate of the overall impacts
building on the results of Tasks 1 – 3, and analysis of current products, "one or two average EU product(s)" or product category(ies) have to be defined as the "Base-case" for the whole of the EU-27
on these Base-Cases most of the environmental and Life Cycle Cost analyses will be built throughout the rest of the study
the Base-Case is a conscious abstraction of reality
8


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Task 4 (2/2)
Preparatory Studies, Methodology overview
Use of the EcoReport tool
Results consist of environmental impacts assessments and economic analysis
4.1 Product specific inputs
4.2 Definition of Base-Case
4.3 Base-Case environmental impact assessment
4.4. Base-Case Life Cycle Cost
4.5 EU 27 total impact
9

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Task 5

Preparatory Studies, Methodology overview

- Task 5: Technical analysis BAT and BNAT
  - technical analysis of advanced technologies
  - both component and product level
  - provides part of the input for Task 6

5.1 Definition of BAT
5.2 Definition of BNAT

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Task 6 (1/2)

Preparatory Studies, Methodology overview

- Task 6: Improvement Potential
  - identify design options, their monetary consequences in terms of Life Cycle Cost for the consumer and their environmental costs and benefits
  - Life Cycle Costs: indicate whether design solutions might negatively or positively impact the total EU consumer's expenditure over the total product life (purchase, running costs, etc.)
  - pinpoint the solution with the Least Life Cycle Costs (LLCC) and the Best Available Technology (BAT)
  - robustness of the outcome

6.1 Identification of Design options
6.2 Analysis BAT and LLCC
6.3 BNAT and long-term systems analysis
6.4 Sensitivity Analysis of the main parameters

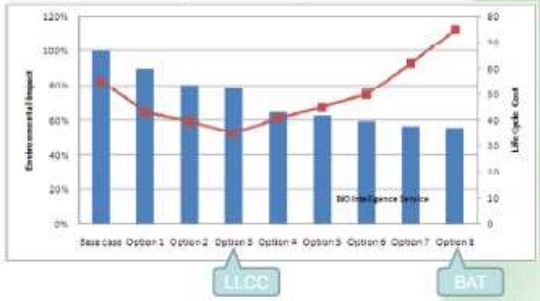
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Task 6 (2/2)

Preparatory Studies, Methodology overview

- Analysis of the improvement potential



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Task 7 (1/2)

Preparatory Studies, Methodology overview

- Task 7: Policy and Impact Analysis
  - summarise and total the outcomes of all previous tasks
  - look at suitable policy means to achieve the potential e.g. implementing LLCC as a minimum and BAT as a promotional target, using legislative or voluntary agreements, labeling and promotion
  - scenarios 1990 – 2025 quantifying the improvements that can be achieved vs. a Business-as-Usual scenario
  - impacts on consumers and industry

7.1. Policy analysis
7.2. Impact analysis

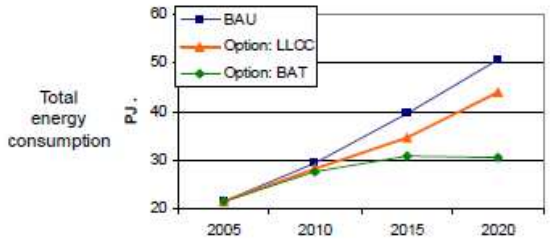
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Task 7 (2/2)

Preparatory Studies, Methodology overview

- Task 7: policy and Impact Analysis
  - example of scenarios



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Transition

- End


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Task 6
Task 6: Improvement Potential
– identify design options, their monetary consequences in terms of Life Cycle Cost for the consumer and their environmental costs and benefits
– Life Cycle Costs: indicate whether design solutions might negatively or positively impact the total EU consumer's expenditure over the total product life (purchase, running costs, etc.)
– pinpoint the solution with the Least Life Cycle Costs (LLCC) and the Best Available Technology (BAT)
– robustness of the outcome
• 6.1 Identification of Design options
• 6.2 Analysis BAT and LLCC
• 6.3 BNAT and long-term systems analysis
• 6.4 Sensitivity Analysis of the main parameters
16

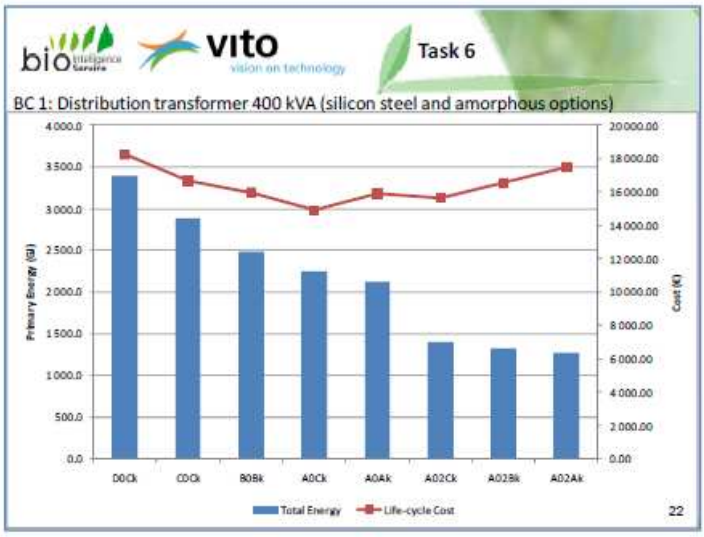

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Task 6
Improvement options
1. More material, higher grade steel, and replacing aluminium with copper windings
• General aggregations of data, no specific designs were used
2. Amorphous steel
• Only for BC1 (Distribution transformer 400 kVA) due to compliance with short circuit test (p. 223)
• Input received indicated that amorphous material exhibits different characteristics that put it in a separate class of improvement option
3. Replace mineral oil with natural esters
17

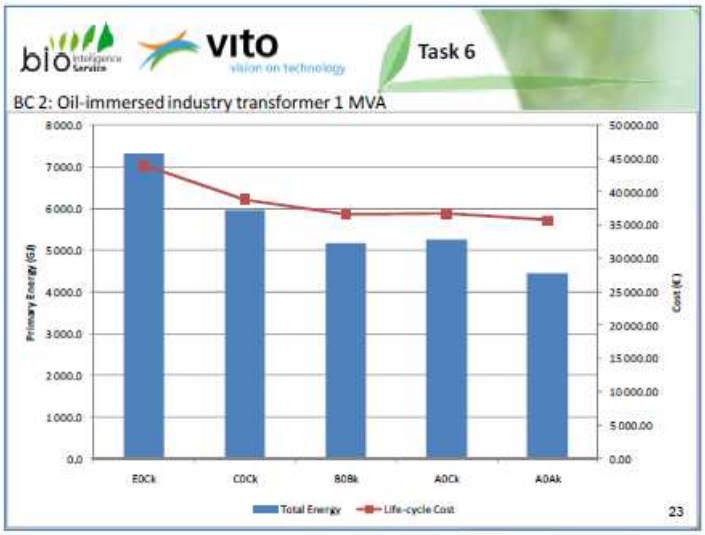

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Task 6
Improvement options (detailed information at end of slides)
1. Distribution 400 kVA: D0Ck, C0Ck, B0Bk, A0Ck, A0Ak, A02Ck, A02Bk, A02Ak
2. Oil industry 1 MVA: E0Ck, C0Ck, B0Bk, A0Ck, A0Ak
3. Dry industry 1.25 MVA: C0Bk, B0Bk, A0Bk, A0Ak
4. Power 100 MVA: 80-300, 60-300, 40-275, 30-300, 30-250
5. DER oil 2 MVA: E0Ck, C0Ck, A0Ak
6. DER dry 2 MVA: C0Bk, B0Bk, A0Ak
7. Separation/isolation 16 kVA: 110-750, 110-400
18

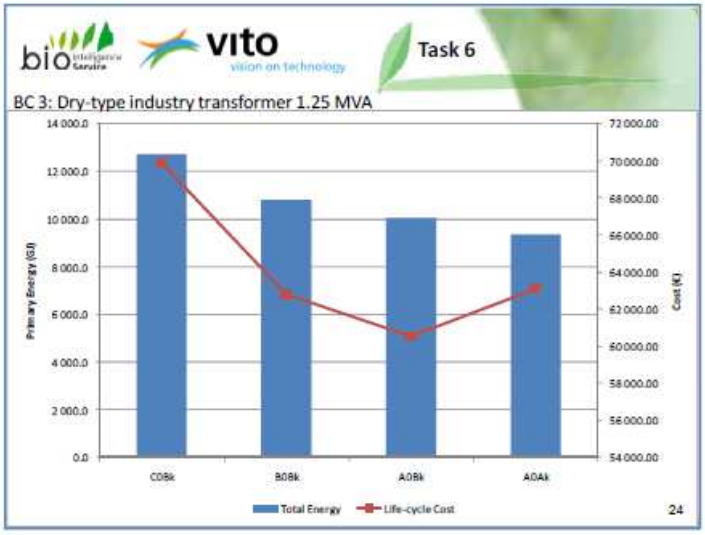

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Task 6
Major comments on input data
– New power inquiry
– Prices of improvement options
– Improvement options beyond A0Ak
– Segregating amorphous transformers from silicon steel options
– Amorphous transformers for use up to 3 MVA
– More accurate material selection in the EcoReport
19

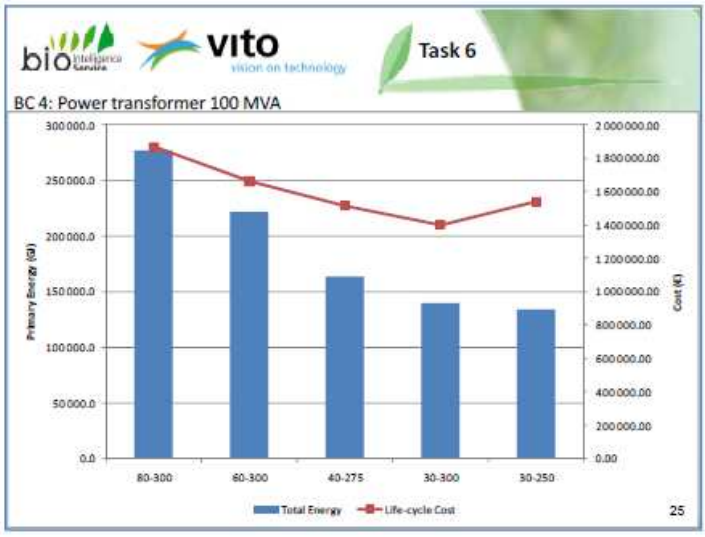

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Task 6
Data analysis submitted by Collaborative Labelling and Appliance Standards Program (CLASP)
20

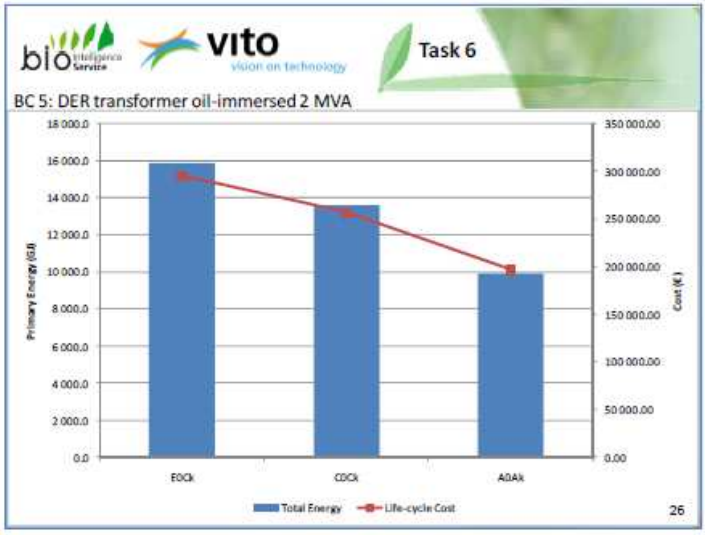

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Task 6
EcoReport results
21

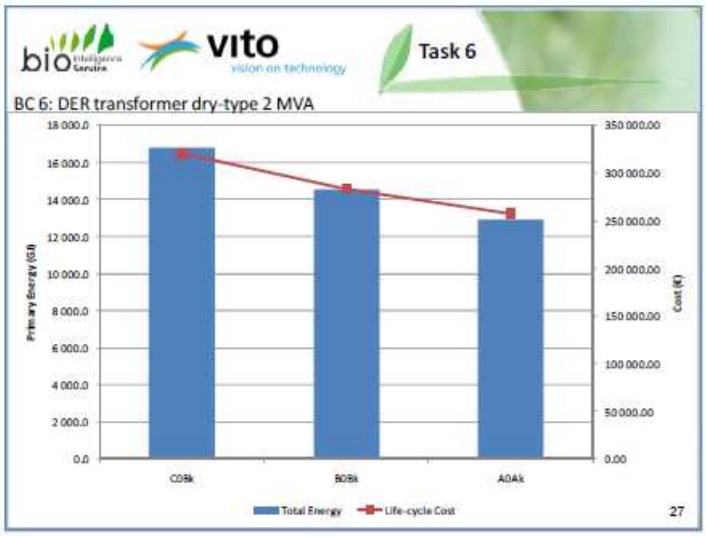

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Task 6
BC 1: Distribution transformer 400 kVA (silicon steel and amorphous options)
Primary Energy (GJ)
Cost (€)
D0Ck
C0Ck
B0Bk
A0Ck
A0Ak
A02Ck
A02Bk
A02Ak
Total Energy
Life-cycle Cost
22

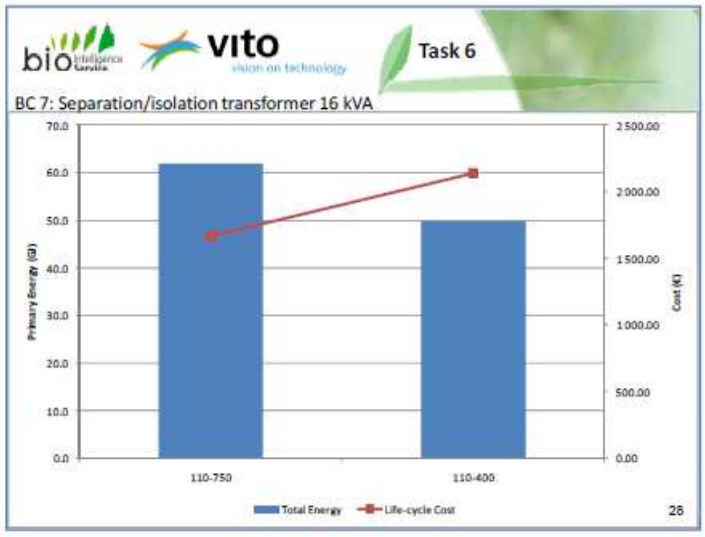

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Task 6
BC 2: Oil-immersed industry transformer 1 MVA
Primary Energy (GJ)
Cost (€)
E0Ck
C0Ck
B0Bk
A0Ck
A0Ak
Total Energy
Life-cycle Cost
23

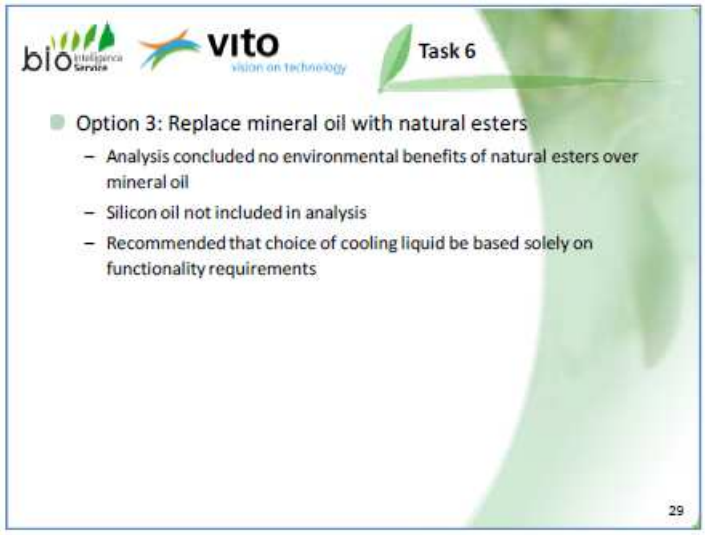

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Task 6
BC 3: Dry-type industry transformer 1.25 MVA
Primary Energy (GJ)
Cost (€)
C0Bk
B0Bk
A0Bk
A0Ak
Total Energy
Life-cycle Cost
24


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Task 6
BC 4: Power transformer 100 MVA
Primary Energy (GJ)
Cost (€)
80-300
60-300
40-275
30-300
30-250
Total Energy
Life-cycle Cost
25


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Task 6
BC 5: DER transformer oil-immersed 2 MVA
Primary Energy (GJ)
Cost (€)
E0Ck
C0Ck
A0Ak
Total Energy
Life-cycle Cost
26


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Task 6
BC 6: DER transformer dry-type 2 MVA
Primary Energy (GJ)
Cost (€)
C0Bk
B0Bk
A0Ak
Total Energy
Life-cycle Cost
27


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Task 6
BC 7: Separation/isolation transformer 16 kVA
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Primary Energy (GJ)
2 500.00
2 000.00
1 500.00
1 000.00
500.00
0.00
Cost (€)
110-750
110-400
Total Energy
Life-cycle Cost
28


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Task 6
Option 3: Replace mineral oil with natural esters
– Analysis concluded no environmental benefits of natural esters over mineral oil
– Silicon oil not included in analysis
– Recommended that choice of cooling liquid be based solely on functionality requirements
29


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Task 6
BNAT
– Expected impact for new material development on amorphous metals, silicon steel and microcrystalline steel
• Further price reductions and increased production capacity are expected
– Expected impact from using superconducting technology
• Low likelihood of implementation
– Expected impact from using smart grid technology and an increased share of Distributed Energy Resources (DER) on the grid
• Load factor affected, analysed in sensitivity analysis
– Expected impact from improvement options at system level by increasing the MV voltage and having dual or triple windings
• Savings possible, separate study necessary
30

Task 6

- Sensitivity analysis
  - Load factor
  - Load form factor (for DER transformers)
  - Lifetime
  - Electricity price
  - Transformer price
  - Discount rate
  - Installed stock

31

Task 6

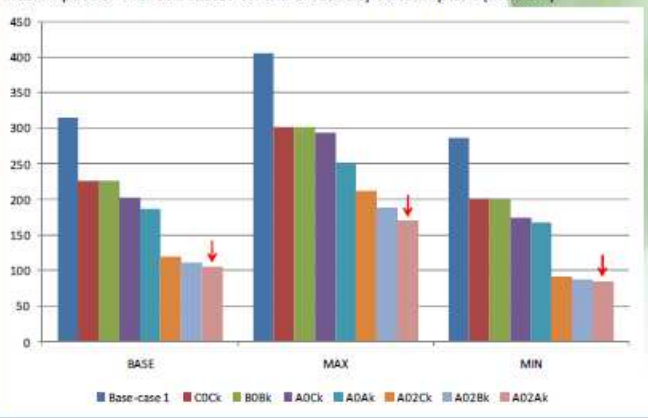
- Load factor

Application	Base	Min	Max
Distribution	0.15	0.10	0.25
Industry	0.30	0.10	0.60
Power	0.20	0.20	0.50
DER (wind)	0.25	0.20	0.30
Small industry	0.40	0.10	0.60

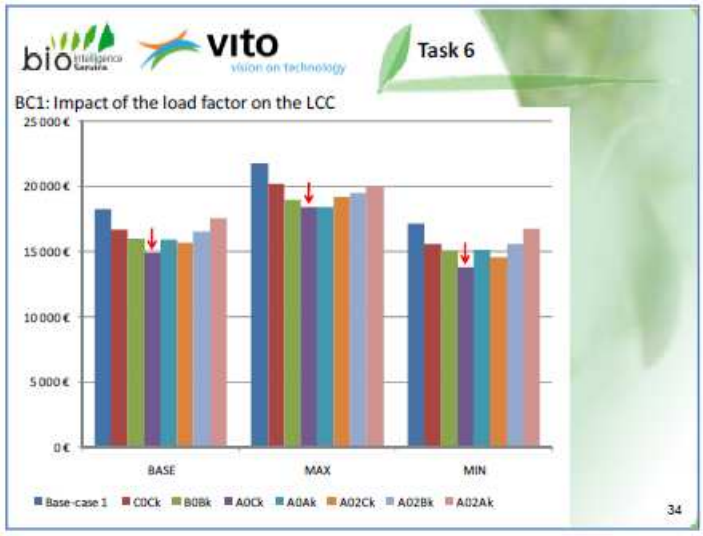
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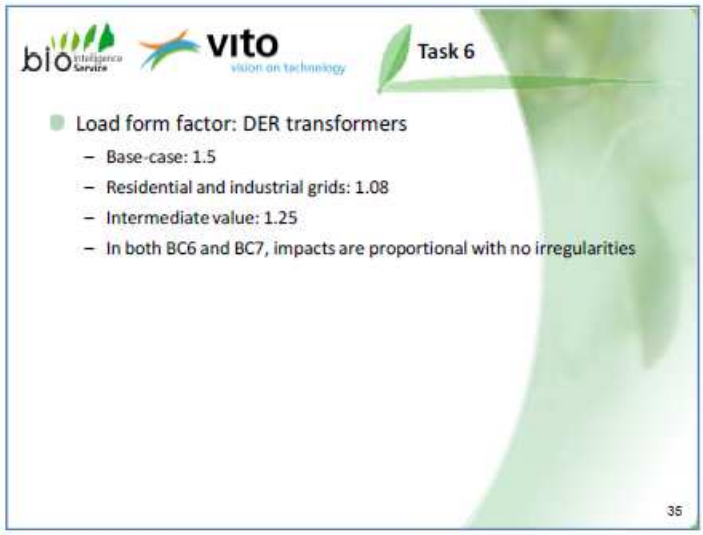
Task 6

BC1: Impact of the load factor on the electricity consumption (in MWh)



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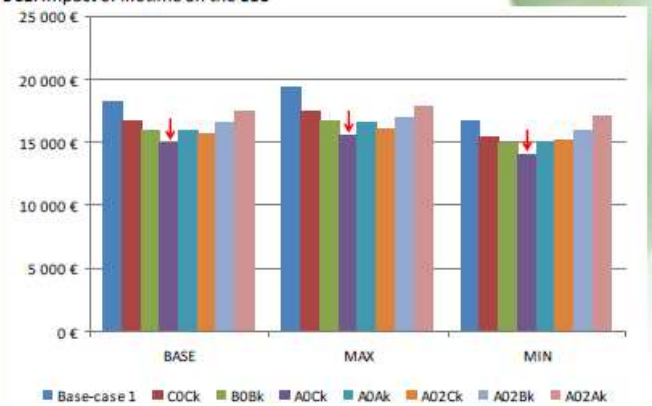

Task 6
BC1: Impact of the load factor on the LCC
25 000 €
20 000 €
15 000 €
10 000 €
5 000 €
0 €
BASE
MAX
MIN
Base-case 1
C0Ck
B0Bk
A0Ck
A0Ak
A02Ck
A02Bk
A02Ak
34


Task 6
Load form factor: DER transformers
Base-case: 1.5
Residential and industrial grids: 1.08
Intermediate value: 1.25
In both BC6 and BC7, impacts are proportional with no irregularities
35


Task 6
Lifetimes
Application | Base | Min | Max
Distribution | 40 | 30 | 50
Industry oil | 25 | 20 | 40
Industry dry | 30 | 20 | 35
Power | 30 | 25 | 35
DER (wind) | 25 | 20 | 30
Small industry | 10 | 10 | 20
36

Task 6

BC1: Impact of lifetime on the LCC



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Task 6

Electricity tariff and discount rate

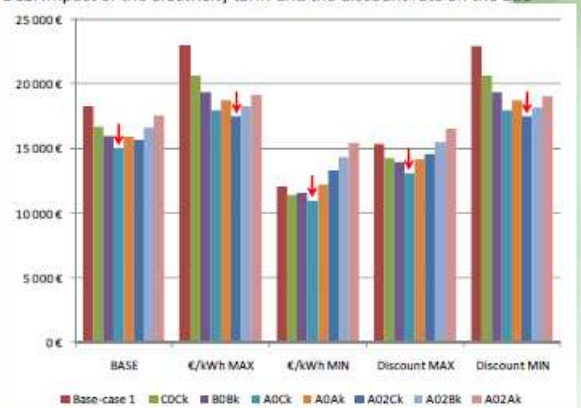
	Average (used in Task 4 and 6)	MIN	MAX
Electricity tariff, except for DER transformers (€/kWh)	0.078	0.038 (Estonia)	0.108 (Ireland)
Electricity tariff for DER transformers (€/kWh)*	0.4	0.2	0.3
Discount rate (%)	4	2	6

* Error noticed by stakeholder. Will be corrected in update.

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Task 6

BC1: Impact of the electricity tariff and the discount rate on the LCC



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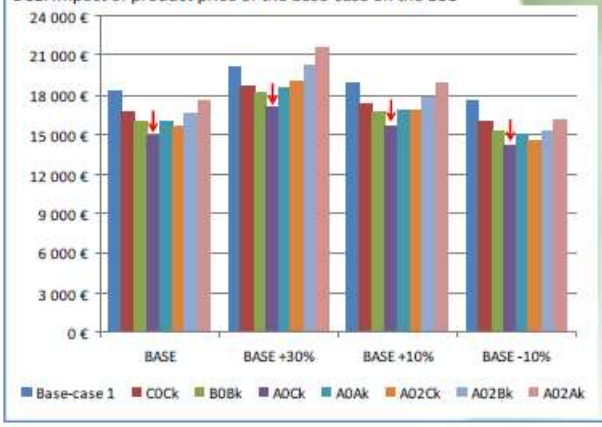
Task 6

- Price
  - Relative to base-case, -10%, +10%, +30%

40

Task 6

BC1: Impact of product price of the base-case on the LCC



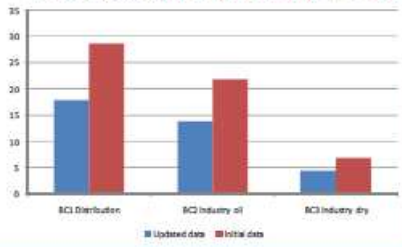
41

Task 6

- Installed stocks

EU stock (units)	BC1 Distribution	BC2 Industry oil	BC3 Industry dry
Updated data	2 250 000	504 000	108 800
Initial data	3 600 000	800 000	170 000

Electricity consumption (in TWh) of the EU stock



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Task 6

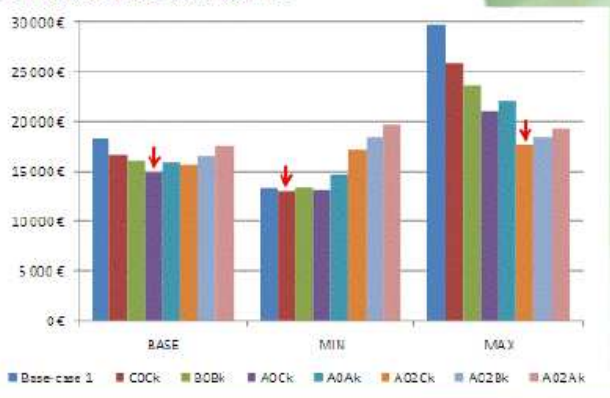
- Extreme scenario
  - MIN: One leading to the lowest reduction of the LCC compared to the base-case
  - MAX: One leading to the highest reduction of the LCC compared to the base-case

	Base	MIN	MAX
Load factor	0.15	0.25	0.1
Purchase price (€)	6 122	7 959	5 510
Lifetime (years)	40	30	50
Electricity tariff (€/kWh)	0.078	0.038	0.108
Discount rate	4%	6%	2%

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Task 6

BC1: Impact of extreme scenario on LCC



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Task 6

- Conclusions
  - Reductions in energy consumption generally correlate with lower life cycle cost
    - Most efficient corresponds with LLCC for BC2, BC5, BC6
    - Second most efficient is LLCC for BC1 (silicon), BC3, BC4
  - Sensitivity analysis shows that results not significantly dependent on assumptions made

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BC 1: Distribution transformer 400 kVA (silicon steel options)

		relative	absolute	relative	absolute	relative	absolute	relative	absolute
Core Steel (kg)	468.70	1.12	524.94	1.22	571.81	1.35	632.75	1.45	679.62
Aluminium wire (kg)	21.44	1.06	22.73	1.44	30.87	1.37	29.37	2.07	44.38
Copper wire (kg)	144.72	1.06	153.40	1.44	208.40	1.37	198.27	2.07	299.57
Copper sheet (kg)	48.24	1.06	51.13	1.44	69.47	1.37	66.09	2.07	99.86
Tank (cast iron) (kg)	266.70	1.10	293.68	1.29	343.78	1.36	361.71	1.64	438.61
Paper (kg)	16.00	1.10	17.61	1.29	20.62	1.36	21.70	1.64	26.31
Ceramic (kg)	6.02	1.10	6.63	1.29	7.76	1.36	8.16	1.64	9.90
Oil (kg)	265.50	1.10	292.36	1.29	342.24	1.36	360.09	1.64	436.64
Cardboard (kg)	3.65	1.10	4.02	1.29	4.71	1.36	4.96	1.64	6.01
Plastics (kg)	2.05	1.10	2.25	1.29	2.64	1.36	2.78	1.64	3.37
Wood (kg)	4.38	1.10	4.83	1.29	5.65	1.36	5.95	1.64	7.21
Paint (kg)	5.79	1.10	6.37	1.29	7.46	1.36	7.85	1.64	9.52
Silver (kg)	0.01	1.10	0.01	1.29	0.01	1.36	0.01	1.64	0.02
Total (kg)	1 253.19		1 379.98		1 615.43		1 699.68		2 060.99
Volume (m^3)	2.11	1.10	2.32	1.29	2.72	1.36	2.86	1.64	3.47
P_0 (W)	750.00		610.00		520.00		430.00		430.00
P_c (W)	4 600.00		4 600.00		3 850.00		4 600.00		3 250.00
Electricity losses (kWh/year)	7 858.72		6 632.32		5 633.80		5 055.52		4 677.31
Product price (€/unit)	6 122.05	1.05	6 428.15	1.19	7 285.24	1.16	7 101.58	1.42	8 693.31

BC 1: Distribution transformer 400 kVA (amorphous steel options)

	D0Ck	A02Ck		A02Bk		A02Ak	
		relative	absolute	relative	absolute	relative	absolute
Core Steel (kg)	468.70		560.00	1.00	560.00	1.20	672.00
Aluminium wire (kg)	21.44		0.00		0.00		0.00
Copper wire (kg)	144.72		360.00	1.22	439.20	1.21	435.60
Copper sheet (kg)	48.24		0.00		0.00		0.00
Tank (cast iron) (kg)	266.70	1.50	399.99	1.63	434.42	1.81	481.55
Paper (kg)	16.00	1.50	23.99	1.63	26.06	1.81	28.88
Ceramic (kg)	6.02	1.50	9.03	1.63	9.80	1.81	10.87
Oil (kg)	265.50	1.50	398.19	1.63	432.47	1.81	479.39
Cardboard (kg)	3.65	1.50	5.48	1.63	5.95	1.81	6.60
Plastics (kg)	2.05	1.50	3.07	1.63	3.33	1.81	3.69
Wood (kg)	4.38	1.50	6.58	1.63	7.14	1.81	7.92
Paint (kg)	5.79	1.50	8.68	1.63	9.43	1.81	10.45
Silver (kg)	0.01	1.50	0.01	1.63	0.01	1.81	0.02
Total (g)	1 253.19		1 775.02		1 927.82		2 136.97
Volume (m^3)	2.11	1.42	2.99	1.54	3.25	1.71	3.60
P_0 (W)	750.00		195.00		195.00		195.00
P_k (W)	4 600.00		4 600.00		3 850.00		3 250.00
Electricity losses (kWh/year)	7 858.72		2 996.92		2 786.80		2 618.71
Product price (€/unit)	6 122.05	1.80	11 019.69	2.00	12 244.10	2.20	13 468.52

BC 1: Distribution transformer 400 kVA (silicon steel options)

Load form factor (Kf)	1.073
Power factor (Pf)	0.9
Availability factor (Af)	1
Load factor (α)	0.15
Lifetime	40
Electricity rate (€/kWh)	0.078
Annual sales (m)	0.1404
EU stock (m)	2.25
Discount rate	4%

BC 2: Oil-immersed industry transformer 1 MVA (silicon steel options)

	E0Ck	C0Ck		B0Bk		A0Ck		A0Ak	
		relative	absolute	relative	absolute	relative	absolute	relative	absolute
Core Steel (kg)	882.20	1.14	1 005.71	1.21	1 067.46	1.27	1 120.39	1.48	1 305.66
Aluminium wire (kg)	64.32	1.16	74.61	1.63	104.84	1.54	99.05	2.23	143.43
Copper wire (kg)	364.48	1.16	422.80	1.63	594.10	1.54	561.30	2.23	812.79
Tank (cast iron) (kg)	601.69	1.15	689.86	1.35	810.70	1.36	817.28	1.73	1 038.10
Paper (kg)	25.86	1.15	29.65	1.35	34.85	1.36	35.13	1.73	44.62
Ceramic (kg)	5.28	1.15	6.06	1.35	7.12	1.36	7.18	1.73	9.12
Oil (kg)	493.90	1.15	566.28	1.35	665.47	1.36	670.87	1.73	852.13
Cardboard (kg)	8.92	1.15	10.23	1.35	12.02	1.36	12.12	1.73	15.40
Paint (kg)	4.46	1.15	5.11	1.35	6.01	1.36	6.05	1.73	7.69
Total (kg)	2 451.12		2 810.31		3 302.57		3 329.38		4 228.93
Volume (m^3)	3.20	1.15	3.67	1.35	4.31	1.36	4.35	1.73	5.52
P_0 (W)	1 700.00		1 100.00		940.00		770.00		770.00
P_k (W)	10 500.00		10 500.00		9 000.00		10 500.00		7 600.00
Electricity losses (kWh/year)	27 168.43		21 912.43		18 757.05		19 021.63		15 631.00
Product price (€/unit)	10 926.00	1.11	12 127.86	1.26	13 766.76	1.24	13 548.24	1.53	16 716.78

BC 2: Oil-immersed industry transformer 1 MVA (silicon steel options)

Load form factor (Kf)	1.096
Power factor (Pf)	0.9
Availability factor (Af)	1
Load factor (α)	0.3
Lifetime	25
Electricity rate (€/kWh)	0.078
Annual sales (m)	0.0432
EU stock (m)	0.504
Discount rate	4%

BC 3: Dry-type industry transformer 1.25 MVA (silicon steel options)

	C0Bk	B0Bk		A0Bk		A0Ak	
		relative	absolute	relative	absolute	relative	absolute
Core Steel (kg)	1 872.96	1.11	2 078.98	1.23	2 303.74	1.36	2 547.22
Aluminium wire (kg)	355.45	1.05	373.22	1.15	408.77	1.47	522.51
Copper wire (kg)	104.83	1.05	110.07	1.15	120.55	1.47	154.09
Tank (cast iron) (kg)	118.79	1.10	130.45	1.21	144.24	1.38	164.14
Resin (kg)	145.96	1.10	160.29	1.21	177.23	1.38	201.67
Ceramic (kg)	60.78	1.10	66.74	1.21	73.80	1.38	83.98
Paint (kg)	1.38	1.10	1.52	1.21	1.68	1.38	1.91
Plastics (kg)	16.12	1.10	17.70	1.21	19.57	1.38	22.27
Total (kg)	2 676.26		2 938.97		3 249.56		3 697.78
Volume (m³)	2.94	1.10	3.22	1.21	3.56	1.38	4.06
P_0 (W)	2 800.00		2 100.00		1 800.00		1 800.00
P_k (W)	13 000.00		13 000.00		13 000.00		11 000.00
Electricity losses (kWh/year)	39 727.39		33 595.39		30 967.39		28 629.02
Product price (€/unit)	16 333.07	1.07	17 476.38	1.15	18 783.03	1.50	24 499.60

BC 3: Dry-type industry transformer 1.25 MVA (silicon steel options)

Load form factor (Kf)	1.096
Power factor (Pf)	0.9
Availability factor (Af)	1
Load factor (α)	0.3
Lifetime	30
Electricity rate (€/kWh)	0.078
Annual sales (m)	0.008047
EU stock (m)	0.1088
Discount rate	4%

BC 4: Power transformer 100 MVA (silicon steel options)

	80-300	60-300		40-275		30-300		30-250	
		relative	absolute	relative	absolute	relative	absolute	relative	absolute
Core Steel (kg)	39 486.67	0.97	38 302.07	0.99	39 091.80	0.99	39 091.80	1.01	39 881.53
Copper wire (kg)	17 487.84	1.14	19 936.14	1.44	25 182.49	1.26	22 034.68	1.85	32 352.50
Copper sheet (kg)	1 204.75	1.14	1 373.42	1.44	1 734.84	1.26	1 517.99	1.85	2 228.79
Tank (cast iron) (kg)	11 307.00	1.02	11 585.37	1.13	12 828.71	1.08	12 174.80	1.28	14 471.67
Paper (kg)	504.54	1.02	516.96	1.13	572.44	1.08	543.26	1.28	645.75
Ceramic (kg)	472.33	1.02	483.95	1.13	535.89	1.08	508.58	1.28	604.52
Oil (kg)	26 848.48	1.02	27 509.49	1.13	30 461.80	1.08	28 909.08	1.28	34 363.00
Paint (kg)	391.72	1.02	401.36	1.13	444.44	1.08	421.78	1.28	501.36
Wood (kg)	2 672.74	1.02	2 738.54	1.13	3 032.44	1.08	2 877.87	1.28	3 420.80
Total (kg)	100 376.05		102 847.29		113 884.85		108 079.82		128 469.92
Volume (m^3)	188.76	1.02	193.41	1.13	214.16	1.08	203.25	1.28	241.59
P_o (W)	80 000.00		60 000.00		40 000.00		30 000.00		30 000.00
P_k (W)	300 000.00		300 000.00		275 000.00		300 000.00		250 000.00
Electricity losses (kWh/year)	852 172.80		676 972.80		489 158.40		414 172.80		388 944.00
Product price (€/unit)	719 850.72	1.04	748 644.75	1.19	856 622.36	1.17	842 225.34	1.41	1 014 989.52

BC 4: Power transformer 100 MVA (silicon steel options)

Load form factor (Kf)	1.08
Power factor (Pf)	0.9
Availability factor (Af)	1
Load factor (α)	0.2
Lifetime	30
Electricity rate (€/kWh)	0.078
Annual sales (m)	0.001802
EU stock (m)	0.06435
Discount rate	4%

BC 5: DER transformer oil-immersed 2 MVA (silicon steel options)

	E0Ck	C0Ck		A0Ak	
		relative	absolute	relative	absolute
Core Steel (kg)	1 715.47	1.06	1 818.40	1.18	2 024.25
Aluminium wire (kg)	190.44	1.11	211.38	2.21	420.86
Copper wire (kg)	542.74	1.11	602.44	2.21	1 199.46
Copper sheet (kg)	219.00	1.11	243.09	2.21	483.99
Tank (cast iron) (kg)	1 113.01	1.08	1 199.65	1.55	1 722.54
Paper (kg)	10.31	1.08	11.11	1.55	15.95
Oil (kg)	800.30	1.08	862.61	1.55	1 238.59
Cardboard (kg)	10.62	1.08	11.44	1.55	16.43
Nomex (kg)	21.69	1.08	23.38	1.55	33.56
Paint (kg)	4.32	1.08	4.66	1.55	6.69
Total (kg)	4 627.89		4 988.16		7 162.32
Volume (m^3)	4.02	1.08	4.33	1.55	6.21
P_o (W)	3 100.00		2 100.00		1 450.00
P_k (W)	21 000.00		21 000.00		15 000.00
Electricity losses (kWh/year)	59 093.50		50 333.50		35 514.50
Product price (€/unit)	18 248.38	1.16	21 168.12	1.68	30 657.28

BC 5: DER transformer oil-immersed 2 MVA (silicon steel options)

Load form factor (Kf)	1.5
Power factor (Pf)	0.9
Availability factor (Af)	1
Load factor (α)	0.25
Lifetime	25
Electricity rate (€/kWh)	0.3
Annual sales (m)	0.00042
EU stock (m)	0.004
Discount rate	4%

BC 6: DER transformer dry-type 2 MVA (silicon steel options)

	C0Bk	B0Bk		A0Ak	
		relative	absolute	relative	absolute
Core Steel (kg)	3 568.82	1.24	4 425.34	1.34	4 782.22
Aluminium wire (kg)	841.00	1.03	866.23	1.27	1 068.08
Tank (cast iron) (kg)	415.65	1.20	498.76	1.33	551.42
Resin (kg)	112.51	1.20	135.01	1.33	149.27
Ceramic (kg)	221.42	1.20	265.70	1.33	293.75
Plastics (kg)	59.90	1.20	71.88	1.33	79.47
Paint (kg)	5.56	1.20	6.67	1.33	7.37
Total (kg)	5 224.87		6 269.58		6 931.57
Volume (m^3)	4.26	1.20	5.12	1.33	5.66
P_0 (W)	4 000.00		3 000.00		2 600.00
P_k (W)	18 000.00		18 000.00		16 000.00
Electricity losses (kWh/year)	62 415.00		53 655.00		47 109.33
Product price (€/unit)	28 191.74	1.14	32 138.58	1.31	36 931.18

BC 6: DER transformer dry-type 2 MVA (silicon steel options)

Load form factor (Kf)	1.5
Power factor (Pf)	0.9
Availability factor (Af)	1
Load factor (α)	0.25
Lifetime	25
Electricity rate (€/kWh)	0.3
Annual sales (m)	0.00168
EU stock (m)	0.016
Discount rate	4%

BC 7: Separation/isolation transformer 16 kVA (silicon steel options)

	110-750	110-400	
		relative	absolute
Core Steel (kg)	50.00	1.10	55.00
Copper wire (kg)	35.00	1.57	54.95
Total (kg)	85.00		109.95
Volume (m^3)	0.04	1.29	0.05
P_0 (W)	110.00		110.00
P_k (W)	750.00		400.00
Electricity losses (kWh/year)	504.50		359.00
Product price (€/unit)	1 348.00	1.42	1 914.16

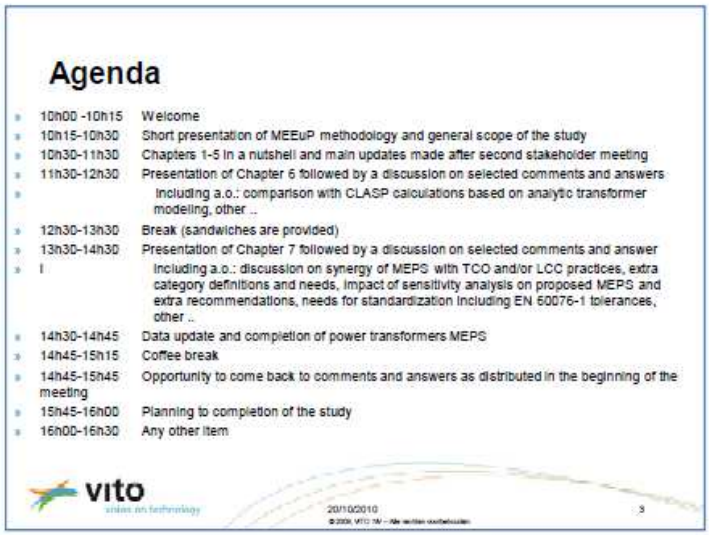
BC 7: Separation/isolation transformer 16 kVA (silicon steel options)

Load form factor (Kf)	1.096
Power factor (Pf)	0.9
Availability factor (Af)	0.2
Load factor (α)	0.4
Lifetime	10
Electricity rate (€/kWh)	0.078
Annual sales (m)	0.075
EU stock (m)	0.75
Discount rate	4%

ANNEX P PRESENTATIONS OF THE THRID STAKEHOLDER MEETING







Short presentation of MEEuP methodology and general scope

- see Bio IS presentation

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Chapters 1-5 in a nutshell with main updates

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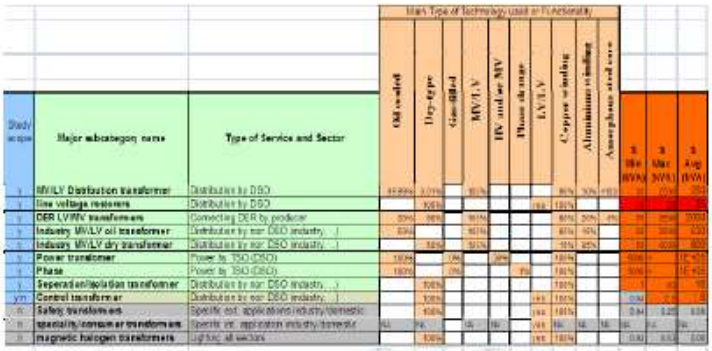
Chapter 1: Definition – main ecodesign parameters

- main ecodesign parameters:
- Definition and scope:
  - Transformers were defined for use in the electrical transmission and distribution systems;
  - Also include 'smaller industrial transformers' (<1kV);
  - pR EN 50451-1 with losses classes for dry type transformers added (still some extra tables needed) (released during the study) (depend on the high voltage winding);
  - BC3, BC6,BAT A0AK ..was fitted to those clases 22 kV type.
  - Used segmentation see next slide
  - Functional unit: 'Transformer rated power (S)'

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Chapter 1 Scope: segmentation in this study



Study scope	Major subcategory name	Type of Service and Sector
1	MV/LV Distribution transformer	Distribution by DSO
1	line voltage regulators	Distribution by DSO
1	DER LV/MV transformers	Connecting DER by producer
1	Industry MV/LV oil transformer	Distribution by own DSO industry, ..)
1	Industry MV/LV dry transformer	Distribution by own DSO industry, ..)
1	Power transformer	Power by TSO (DSO)
1	Phase	Power by TSO (DSO)
1	Seperation/isolation transformer	Distribution by own DSO industry, ..)
yn	Control transformer	Distribution by own DSO industry, ..)
n	Safety transformers	Specific ind. applications industry/domestic
n	specialty/consumer transformers	Specific ind. application industry/domestic
n	magnetic halogen transformers	Lighting, all sectors

Chapter 1: Standards

- Standards – this will be discussed again in chapter 7 to look for gaps and legislation from the viewpoint of future policy measures.
- For power transformers draft Chinese standard (only available).
- Power transfo update will be discussed later in the meeting

Chapter 2: Economic and Market Analysis

- Aim: Generic economic data, insights in past, recent and future stock and market, additional parameters, market trends, user expenditure data (e.g. Electricity price, interest rate, ..).
- Remark: the reference power transformer BC 4 as communicated by T&D matched close to grade 2. Nevertheless several remarks are received that many utilities procure far more efficient power transformers the last decades. 100 MVA has been chosen as in between the medium and large transformers to simplify the model, it is therefore not the most sold transformer.

Chapter 2: Economic and Market Analysis

Transformer type	Rated Power S in KVA		Stock	Stock	Stock	Total sales		
			1990	2005	2020	1990	2005	2020
	stock	sales	K units	K units	K units	Units p.a.	Units p.a.	units p.a.
Smaller industrial transformers	10	10	750	750	750	75000	75000	75000
Distribution transformer (oil)	250	400	2692	3600	4459	118443	140400	172841
DER transformers oil immersed	2000	2000	0.25	20	90	85	2100	9450
DER transformers dry-type	2000	2000						
Industry oil transformer	630	1000	598	800	991	35294	43200	53505
Industry dry transformer	800	1250	127	176	211	6652	8047	9966
Power transformer	100000	100000	48	64.25	80	1588	1802	2232
Phase	100000	100000	0.49	0.65	0.81	16	18	23

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Chapter 3: User behaviour

- Aim:
  - Analysis of consumer behaviour: user information and barriers for eco-design
  - Analysis of real life situation: most important are load factors, load form factor & life time
  - The loading profile parameters can be precisely calculated from excel load profile data (see website) (figures were added)
  - Further investigations done on loading (ERDF, ESB) but they seem to confirmed low(er) load factors for distribution.
  - The same for power transformers: more data was found that EU substations (e.g. OPERA FP7 grid data) have mainly double and redundant transformers (BTW: also HV and MV cabling is), which explains this.
  - Text and parameters were updated.

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Chapter 3: User behaviour

Typical transformer	*Load factors (α)*	*Load form factors (Kf)*	*Power factor (Pf)*	*Load factors eq. flat(α_{eq})*	*Availability factor (Af)*	*Average Lifetime*
MV/LV distribution oil	0.15	1.073	0.9	0.18	1	40
Industry oil	0.30	1.096		0.37	1	25
Industry dry	0.30	1.096		0.37	1	30
Power	0.20	1.08		0.24	1	30
DER (liquid-immersed and dry-type)	0.25	1.50		0.42	1	25
Separation/isolation	0.40	1.096		0.49	0.2	10

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Chapter 4: Assessment of the Base-Case

- Have been completely recalculated, taking into account:
  - updated use parameters from chapter 3.
  - updated prices that were the outcome of the enquiry launched after the second stakeholder meeting.
- Results and outcomes will be discussed together with chapter 6 on improvement options.
- In the enquiry launched within chapter 4 simplifications with regards to BOM data are introduced as this has little impact.
- Note: BC4 power transformers = 55.0 TWh (much)

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Chapter 5: Technical Analysis BAT and BNAT

- This task examines the improvement options of transformers considered as best available technologies, in an attempt to improve upon the base-cases
- Has been completed with input received.
- Main event was the launch of an manufacturers enquiry (see next slide).

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Chapter 5: Technical Analysis BAT and BNAT

- Grouped BOM and cost impact on improvement options for base cases transformer types are used
  - = combination of various techical options: see text
  - data sourcing options were:
    - analytic model (spreadsheet available and generated data);
    - other more detailed transformer design software = CLASP (Task 6);
    - catalogue data (smaller transfors);
    - >> Manufacturer enquiry = chosen
- Note: dry-types are coherent with the new draft standards (and manufacturing catalogues)!
- Power transformers, will be discussed later today at stakeholder meeting

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Chapter 5: Technical Analysis BAT and BNAT

Type	BC1 Distribution	BC2 Industry oil	BC3 Industry dry	BC4 Power	BC5 DER oil	BC6 DER dry	BC7 Separation /isolation
uct price (€)	6 122	10 926	16 333	719 851	18 248	28 192	1 348

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Chapter 5: Technical Analysis BAT and BNAT

Improvement options for BC 1: Distribution transformer 400 kVA

Relative price data:

BC 1 - Distribution transformer 400 kVA		E0	D0	C0	B0	A0
		930 W	750 W	610 W	520 W	430 W
		68 dB	63 dB	58 dB	53 dB	50 dB
Dk	6000 W					
Ck	4600 W		100%	105% ±1%	108% ±1%	116% ±4%
Bk	3850 W				119% ±3%	130% ±8%
Ak	3250 W					142% ±9%

Relative core mass % (top) and conductor mass % (bottom) data:

BC 1 - Distribution transformer 400 kVA		E0	D0	C0	B0	A0
		930 W	750 W	610 W	520 W	430 W
		68 dB	63 dB	58 dB	53 dB	50 dB
Dk	6000 W					
Ck	4600 W		100% 100%	112% ±6% 106% ±4%		135% ±13% 137% ±9%
Bk	3850 W				122% ±17% 144% ±14%	
Ak	3250 W					145% ±34% 207% ±53%

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Chapter 5: Technical Analysis BAT and BNAT -AMT

- AMT relative price data for a 400 kVA (BC 1) transformer compared to a D0Ck standard silicon steel transformer as found anno 2010
- prices could become equal (according to Hitachi-METGLAS)
- sources:manufacturers enquiry, prices from the Indian rule making process and a 1999 THERMIE project.
- Note: large differences (might be due to lack of sufficient EU sourcing)

	Reference D0Ck(Base Case)			Reference A0Ck		
	min.	ref.	max.	min.	ref.	max.
Ck	135%	180%	230%	116%	155%	198%
Bk	145%	200%	250%	125%	172%	216%
Ak	155%	220%	290%	134%	190%	250%

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note on latest version of chapters 1-5

- This should be V26
- After the release there has been a server error and some user might have downloaded the older version V11

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Chapter 7: Policy and impact analysis

- This task looks at suitable policy means
- draws up scenarios 2005–2025
- an estimate of the impact on users and industry

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Chapter 7: Proposed exact product definitions and scope for policy measures

- Three-phase oil-immersed distribution transformers 50 Hz
  - according to EN 50464-1 series
  - includes industry and DER (agree?)
  - subcategory needed when imposing A0AK?
    - i.e. 'very compact three-phase oil-immersed distribution transformers'
      - maybe two: light weight (≤100 kVA) (pole mount) & compact (≤630kVA)
      - technical parameters to define (weight & dimension)?
    - Not needed at all? All ways needed? Temporary need? They could be made with highest grade HGO-DR? if so, do we need more timing in the Tiers because of availability? A solution might be to have this only in Tier 1?
- Three-phase dry-type distribution transformers 50 Hz(prEN 50541-1)

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Chapter 7: Proposed exact product definitions and scope for policy measures

- Medium and Large power transformers (>5 MVA) used in 50 Hz electricity transmission with highest voltage for equipment exceeding 36 kV
- Smaller power transformers (≥ 1kVA & ≤100 kVA) designed for use in electricity 50 Hz distribution with high voltage winding (HV) for equipment not exceeding 1 kV
  - Impact is low, low use, many niche products&applications
  - Not yet measurement standard
    - general purpose vs special purpose
      - offers a backdoor > target documentation + marking
      - Acceptable?

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Chapter 7: MEPS

- Distribution oil:
  - ≤630 kVA A0Ck in Tier 2 (2015) > Tier 1 (2013) .. more ambition needed (several comments) e.g. 0.9A0Bk ?
  - >630 kVA A0Ak in Tier 2 (2015) > Tier 1 (2013) .. more 0.9A00,9Ak?
  - very compact .. needed? loophole fixed with installation reqs?
  - (add inter- and extrapolation)
  - Stakeholders, agree?
    - is it feasible
- fit wit standards?
- A more ambitious long term Tier 2 based on:
  - lower price assumptions:
    - AMT 0.5A0
    - 0.9 or 0.75A0
  - higher load factor assumptions:
    - more ambitious Ak or beyond

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Task 7: MEPS

- Dry-type distribution Transformers: A0Ak (2013)
  - but where are more ambitous levels in standard? Not found on the market yet
  - how to avoid distribution oil consumers move to those less efficient ones?
- Power transformers: separate discussion (need a review).
- Smaller industry transformers (<1kV): table & interpolation

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Chapter 7: Policy recommendations

- Towards TSOs & DSOs:
  - MEPS should coexist with TCO or LLC
  - If MEPs for TSOs or DSOs are above their TCO target it takes away money from other investments, e.g. cables, DER, ..? (see also impact)
  - Further harmonise TCO? (TCO error > in $B \geq 0.8Ax(\alpha xKf)^2/PF^2$)
- Towards DER:
- Towards private or public users (e.g. industry)
  - classes should not prevent to strive to improve
- Towards BNAT
- Standards: see other slide
- other (information, installation requirements?)
- Dual low voltage winding? (to lower losses in MV cables)

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Chapter 7: Policy recommendations & standards

- updating standards vs implementing measure and expected timing
- Needs:
  - IEC (EN) 60076-1: Tolerance: +/- 5%? +/- 7.5%? +0/-10%?
    - It was said that large tolerance is needed to cover full range also power? (might be more difficult to project losses due to lack of serial production?) Limit ≤ 5000 kVA? Limit to distribution transformers?
  - extra categories EN 50464-1 (oil), prEN50541-1
  - Is proposal to close gap smaller industrial transformers technical OK? Where to include?

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Chapter 7: Policy analysis

LLCC	2010	2013	2015
BC1	D0Dk	C0Ck	A0Ck
BC2	E0Ck	B0Bk	A0Ak
BC3	C0Bk	B0Bk	A0Bk
BC4	80-300	60-300	30-300
BC5	E0Ck	C0Ck	A0Ak
BC6	C0Bk	B0Bk	A0Ak
BC7	110-750	-	-

BAT	2010	2013	2015	2017
BC1	D0Dk	B0Bk	A0Ak	A02Ak
BC2	E0Ck	B0Bk	A0Ak	-
BC3	C0Bk	A0Bk	A0Ak	-
BC4	80-300	30-300	30-250	-
BC5	E0Ck	C0Ck	A0Ak	-
BC6	C0Bk	B0Bk	A0Ak	-
BC7	110-750	110-400	-	-

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Chapter 7: Policy analysis

- BAU:
  - 130.3 TWh/a in 2025
  - 1 721 TWh 2011-2025
- LLCC:
  - 101.7 TWh/a in 2025 (-21.9% BAU)
  - 1 556 TWh 2011-2025 (-9.6% BAU)

LLCC	2010	2013	2015
BC1	D0Dk	C0Ck	A0Ck
BC2	E0Ck	B0Bk	A0Ak
BC3	C0Bk	B0Bk	A0Bk
BC4	80-300	60-300	30-300
BC5	E0Ck	C0Ck	A0Ak
BC6	C0Bk	B0Bk	A0Ak
BC7	110-750	-	-

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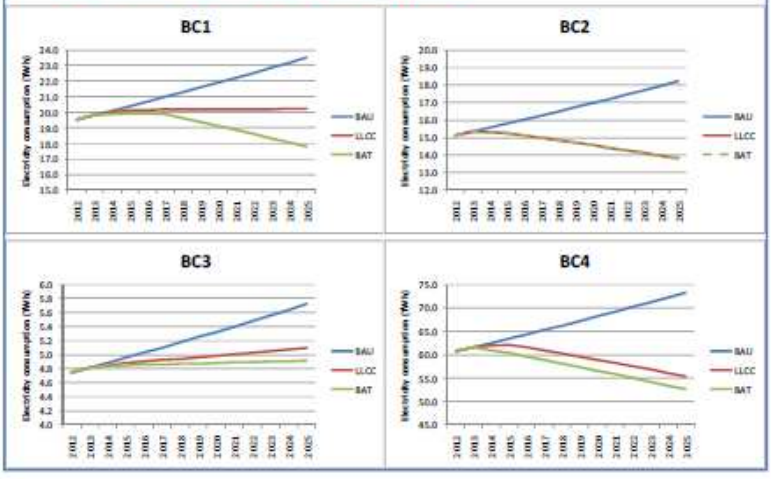
Chapter 7: Policy analysis

- BAU:
  - 130.3 TWh/a in 2025
  - 1 721 TWh 2011-2025
- BAT:
  - 96.2 TWh/a in 2025 (-26.2% BAU)
  - 1 515 TWh 2011-2025 (-12% BAU)

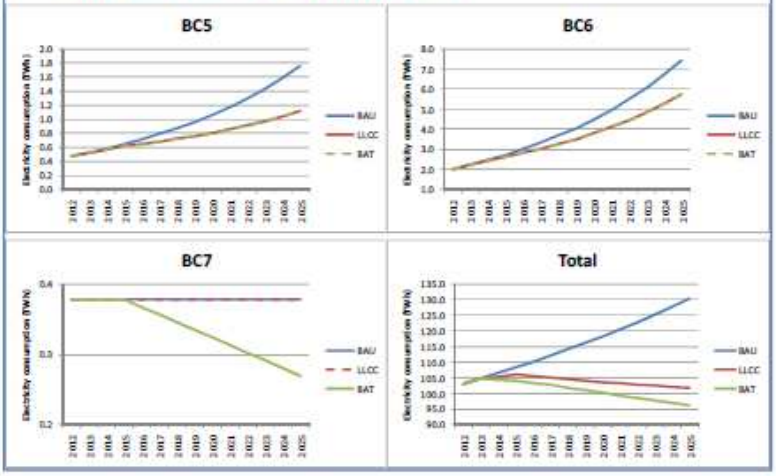
BAT	2010	2013	2015	2017
BC1	D0Dk	B0Bk	A0Ak	A02Ak
BC2	E0Ck	B0Bk	A0Ak	-
BC3	C0Bk	A0Bk	A0Ak	-
BC4	80-300	30-300	30-250	-
BC5	E0Ck	C0Ck	A0Ak	-
BC6	C0Bk	B0Bk	A0Ak	-
BC7	110-750	110-400	-	-

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Chapter 7: Policy analysis



Chapter 7: Policy analysis



Chapter 7: Impact Analysis (Biois)

- negative impact on the functionality .. increased volume and weight
- Monetary impact (calculated along scenarios)
- Impact on EU employment? Launch enquiry? Target steel manufacturers? Target transformer manufacturers
- Impact on the manufacturers and competitive situation of the market (mainly AMT issue, steel manufacturers, transformer manufacturers, but HGO-DR can also step up in current limits(?))
- TSO/DSO capital not available for other projects.. see also discussion on MEPS vs TCO
- Should not substitute TCO or LCC but coexist

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Data update and completion of power transformers MEPS

- power transformers comments are (see XXX):
  - BAT is not ambitous enough and in line with state of art
  - proposed policy measure based on corrected Chinese standard does makes no sense for EU
  - proposal to launch an enquiry to produce more realistic data to develop a policy measure
- history:
  - current base case 100 MVA Pk=300 kW &P0=80 kW
    - (source: proposed by T&D, in between chinese grades, P0 relative high, better compared to reference from literature 1976)
  - Apart from the Chinese standard there is no accepted reference classes or grades such as for oil filled transformers
- How to proceed:
  - Updated LCC sensitivity analysis chapter 6 on product range to see how 'Tiers &grades or grades' can be elaborated
  - Update the BC4 reference data (Pk, P0, price) + BAU .. which would result in less energy saving?

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comparison

Energy efficiency grades for 110kV three-phase oil-immersed double-winding non-excitng regulation transformer (Table 5 in standard)

	No-load loss (kW)					Load loss (kW) (75°C)				BAT	BAT	BCA	BCA	BAT (CLASP-SGB)	
capacity kVA	Grade 1	T	Grade 2	Grade 3	Grade 3+ = Grade 1 -40%	Grade 1	T	Grade 2	Grade 3	No load	load	No load	load	No load	load
6300	11.5	9.1	7.9	5.6	6.84	60.4	57	56.3	53.4	6.2	29				
8000	13.6	10.9	9.5	6.9	8.04	70.4	66.2	65.6	66.9	7.3	35				
10000	16.8	12.9	11.2	10.6	8.24	90.4	84.4	83.6	82.9	8.4	41.5				
12500	17.5	15.2	13.8	12.5	7.98	90.6	84.7	83.5	82.9	9.3	50				
16000	21.1	18.3	16	14.8	8.88	86.3	79	77.6	76.8	10	65				
20000	24.7	21.4	18.7	17.6	10.44	104.2	95.9	93.7	93.8	10.6	70				
25000	29.2	25.3	22.1	20.7	12.3	125.1	112.9	110.8	109.6	11.5	80			0	60
31500	34.3	30	26.2	24.5	14.58	149	136.5	134	132.7	12	100				
40000	41.3	35.8	31.2	29	17.4	176.8	160.1	157.1	155.6	13	110				
50000	49.2	42.9	37.8	34.7	20.82	217.5	196.1	195.4	193.8	19	120				
63000	58.3	50.8	44.1	41	24.6	262.1	240.1	235.7	234.3	23	140				
75000	66.1	57.6	50.1	46.5	27.9	311.4	285.8	280	277.9	26	160				
90000	76.2	66.1	57.7	53.6	32.16	378.4	338.4	332.3	330.5	30	185	72	270	13	180
120000	89	82.3	71.9	66.8	40.08	444.7	407.4	399.8	398	37	230				
150000	112.3	97.6	85	78.9	47.34	528.7	486.1	477.3	476.9	43.5	275				
180000	126	109.4	95.4	88.6	53.16	645.9	545.9	535.8	561.7	50	315			27.7	205

Enquiry: Market segmentation and typical reference prices

Table 1: Market segmentation for typical transformers and typical reference prices

Notes	Primary voltage (kV)	Secondary voltage (kV)	Rated power (MVA)	% market share	Typical No load losses (kW)	Typical Load losses (75°C, kW)	Price (€)
	70	10.5	80	?	?	?	?
	132	22	80	?	?	?	?
	132	22	100	?	?	?	?
	132	11	100	?	?	?	?
	132	33	100	?	?	?	?
base-case 4	132	33	100	?	80	300	100%
	170	22	100	?	?	?	?
	220	22	170	?	?	?	?
	345	132	350	?	?	?	?
	420	132	350	?	?	?	?
Most common type in your company	?	?	?	?	?	?	?

Enquiry: Market segmentation and typical reference prices

- Enquiry Tables:

Enquiry: relative price data for more efficient transformers (compared to base)

100 MVA (132/33 kV) ((no autotransformers -double winding)		Po(kW) 100%	Po(kW) 85%	Po(kW) 70%	Po(kW) 50%
Pk(kW)(75°C)	100%	100%	?	?	?
Pk(kW)(75°C)	85%		?	?	?
Pk(kW)(75°C)	70%				
Pk(kW)(75°C)	50%				

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How to proceed

- Updated LCC sensitivity analysis chapter 6 on product range to see how 'Tiers &grades or grades' can be elaborated?
- Update the BC4 reference data (Pk, P0, price) + BAU .. which would result in less energy saving?
- It's important to keep timing (input no later than 30/8).

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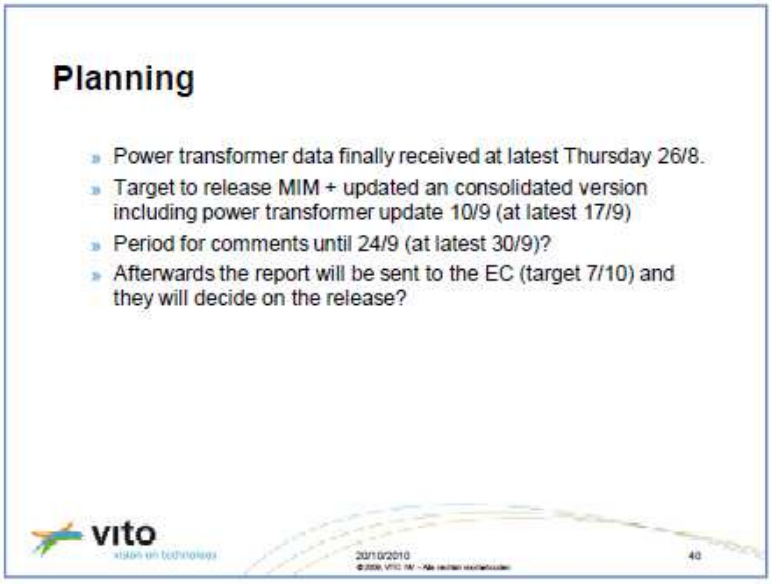
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Opportunity to come back to comments and answers as distributed in the beginning of the meeting

- Distribution and power transformers might be misleading as also smaller industrial transformer (high voltage winding < 1kV) are in scope
- ..

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Planning
» Power transformer data finally received at latest Thursday 26/8.
» Target to release MIM + updated an consolidated version including power transformer update 10/9 (at latest 17/9)
» Period for comments until 24/9 (at latest 30/9)?
» Afterwards the report will be sent to the EC (target 7/10) and they will decide on the release?
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Any other item and closing
» ?
» Thanks for participating and contributing with comments
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ANNEX Q: SOME REMAINING COMMENTS ON CHAPTERS 1-5 IN AUGUST 2010 (<15/8)

Stakeholder	Section	Page	Comment	Answer Vito and Biois
T&D Europe	2	127	Just a later information "COTREL" is replaced by "T&D Europe" in the last paragraph	Modified
T&D Europe Task 4	4.3.1	178	Explanation should be given about conversion factor from 3.31 TJ and (315MWh this value is ok)	OK, the text will be updated.
T&D Europe	5	208	Last sentence :Recovery of the waste…… it is available technology in UK and perhaps Sweden,…..Scandinavia?	Will be removed from the summary as it is less relevant indeed and not advanced technology neither under development (see related section)
T&D Europe	5.1.2.4	222	Add information just after the second paragraph :during the process due to the brittleness there are some risk of particles inside the active part of the transformers that could lead to dielectric breakdown	OK added in the third paragraph that discusses brittleness
T&D Europe	5.1.2.4	222	Last paragraph: Replace Curie by curing	This info was provided by METGLAS and is assumed to be correct. The Curie temperature of a ferromagnetic or a ferrimagnetic material is the reversible point above which it becomes paramagnetic. To be double checked

T&D Europe	**5.1.2.5**	**226**	**Price data paragraph:It is assumed that price…….are about 250% and 700% according to the kind of liquid.**	**Adapted**
T&D Europe	**5 Annex B**	**240**	**Reference price 8888€ is not taken into account in paragraph Task 6.1.1.1 as indicated in Task 5 in yellow on page 231. Similar comments from BC 2 to BC 6**	**Thanks for point this out. The text needs to be streamlined in relation to the reference prices that were found in the enquiry** **The reference prices that were the outcome of the enquiry will be added in annex C**
Hitachi Metals	**Chapter 2.3.8**		***North America:*** The United States has one of the largest installed bases and the longest operational experience. ~~Currently, AMTs are neither produced in this country nor being installed in any significant quantity~~. With the new DOE regulation in place the market for Amorphous Transformers re-surfaced in 2010, approching the levels of the mid 1990.	***Adapted***
Hitachi Metals / Metglas	2.3.8 Market introduction of Amorphous Metal Distribution Transformers (AMDT) ***North America:*** The United States has one of the largest installed bases and the longest operational experience. Currently, AMTs are neither produced in this country nor being installed	**120**	Hitachi Metals/Metglas would like to point out that the section on the US Market states that AMDT's are neither produced or are being installed in any significant quantity. While this was true a few years ago (if you do not include Mexico which as been making AMDT's since the mid 2000's), recent developments have resulted in a strong resurgence of AMDT's in the US with all major transformer makers producing AMDT's at some volume level and some also making their own AMDT cores using newly installed equipment. AMDT growth in the US market is currently very strong.	Adapted as suggested above

	in any significant quantity.			
ECI	**Chapter 3**		Thanks for this. In fact we are really impressed by amount and quality of work you have done. We still have doubts if 20% average loading for power transformers category is the right figure but as we have no other precise calculation we agree to rely on this.	Noted
Asia Energy Platform (AEP)	**2.2.6.9**	**117**	**Comments: In your recent report published on April 2010, you have referred to our advisor Mr. Jerry Li\'s earlier article regarding amorphous metal transformer deployment in China (ref. 44). We\'d like to inform you that the growth in China has been very significant since the article has been published. For 2010, the projected installation in China will be about 30,000,000KVA.**	**Text added**
Econ BV **Wuppertal Institute**	**Two remarks related to the use of EN 50541-1 new standard on dry-type transformers for vote**		**Answer related to this requests:** **FPrEN 50541-1 on dry type transformers has been released during the project and related info was also received along the project from T&D Europe and CENELEC TC14 members, the draft is now also public available for sale:** **http://www.vde-verlag.de/standards/1532075/vde-0532-241-din-en-50541-1-2010-01.html** **Base cases were based on T&D input on double checked on catalogue data, later on they closely fitted with the FPrEN 50541-1 classes (17.5 to 24 kV table).** **Chapter 1 included the below 12 kV table (p.58 table 1-6) was updated in parallel with the completion of chapter 6 that is based on the 17.5 to 24 kV table.** **Therefore the link is lost and it is unclear and confusing, therefore**	**As mentioned will need an update in all sections to refer to the standard and appropriate voltage**

			this will be fixed in the final update.	

ANNEX R: COMMENTS ON TASK 6 RECEIVED BEFORE THE THIRD STAKEHOLDER MEETING

Stakeholder	Section	Page	Comment	VITO and partners Reply
Task 6 (received before 17 Aug 2010)				
T&D Europe	6.1.1.4 BC4	12	Large representation of manufacturers in T&D Europe during this meeting said that 100MVA without indication of voltage is not relevant for Large power transformers because of the variety of the network in different countries like in UK 132KV, France 220KV, 63, 90, Belgium and Nederland 150KV Germany 110KV and 220 and in Spain 66KV,132, 220KV Greece 150KV. There are not typical transformers in EU for Large power transformers. Analysis without voltage is not relevant because the assessment of the price difference between losses depend of the voltage also.	A new inquiry to obtain information specifically on power transformers was sent out.
T&D Europe	6.1.2 Option 2	16	Check Table 16 and table 2 in page 10. Calculation in table 15 seems to be done according table 2….and probably well done.	Ok, thank you.
T&D Europe	6.1.3	16	Mineral oil and natural esters…. And Silicon?	There was little environmental information available on silicon fluids. The report will be updated to suggest further study by the EU.
T&D Europe	6.2.1.1.	17	Table 17 First column must be verified with table 4-29 page 201 in task 4 . Other columns must be also verified.	Not comparable. Table 17 is for one unit. Table 4-29 is for EU stock.

T&D Europe	6.3.5	53	Future demand for electricity could increase very quickly to the demand of electricity vehicle for example…. And therefore calculation has to be reviewed.	There is little consensus in the market trends of electric vehicles. Evaluating drastic system-level changes is external to the scope of the study.
T&D Europe	6.5	83	We partially agree the conclusion. It is not obvious in all tables that energy consumption is correlated with lower life cycle cost.	The project team thinks that the presentation is sufficiently clear.
Eurelectric (represented by ENA Consulting)	General		There are three initiatives followed: 1. Increase materials to reduce losses 2. Reduce losses by amorphous materials 3. Consideration of the use of natural esters instead of mineral oil The third is discounted as having no material benefit, whilst the second is limited solely to distribution transformers. That leaves material variation to reduce loss. Therefore the approach is no different from that taken by a manufacturer when designing a transformer based on how the customer specifies the value of the losses incurred.	No response necessary.
Eurelectric (represented by ENA Consulting)	General		The whole approach is statistical but we question the conclusions as many of the calculations in the document where sample checked do not appear to be accurate. There are no clear explanations as to where the numbers come from, they simply appear from nowhere!	Please be specific about which numbers are not referenced.

Eurelectric (represented by ENA Consulting)	General		There is also a suggestion that the operating voltage should simply be increased to save losses. This has been done before in the UK and there is minimal benefit. To increase the voltage significantly can mean a complete re-investment in infrastructure – something that just won't happen.	No response necessary.
Eurelectric (represented by ENA Consulting)	General		The data in the annex of sensitivity analysis has been examined for BC4 power transformers and the calculation for energy consumed in the life of the transformer appears to be incorrect. For example: If you assume a 30 year life, a no load loss of 60 kW, a load loss of 300 kW and a load factor of 0.2, the energy consumed in the life of the transformer is 31566 MWh. The document states 20309 MWh. This is a ratio of 1.55:1. For the 30 kW and 250 kW case, the calculated loss is 21,024 MWh and the document states 11668 MWhrs. This is a ratio of 1.80:1. So as the losses reduce, the energy saved increases by more than the simple calculation shows. The effect of this difference is to enhance the saving in the improvement suggested. The data suggests that this is not correct. A similar check has been made on the sensitivity to load factor which suggests that the life of the transformer is in reality variable from 15 years to over 19 years. Again the variation has an impact to make the improvement suggested appear better than it really is.	Thank you for pointing this out. Upon review, there may have been errors in the sensitivity analysis. These will be corrected for the next version.
Eurelectric (represented by	General		The document needs to be much more robust in terms of the detailed calculations made and formulae must be	Please cite specific examples.

ENA Consulting)			included to show how the values were obtained.	
Eurelectric (represented by ENA Consulting)	6.1.1	9	the assumption that the base case is the least efficient and that utilities today are procuring transformers on the basis of the base case condition. This is not true in that many UK utilities are procuring at much better than base case.	The text does not state that utilities procure transformers on the basis of the base-case condition. Rather, the data of the project team shows that the base-case represents the average current stock, not sales.
Eurelectric (represented by ENA Consulting)	6		Improvement tables – no explanation as to how these were arrived at. As they are very difficult to interpret an explanation is really needed to make sense of the content.	The improvement tables are explained in the paragraphs preceding.
Eurelectric (represented by ENA Consulting)	6.2.1.4	27	Table 21 – indicates a base case of 80 kW no load loss for BC4. This is excessive and is typical of no load losses from the 1960's. Current transformers at 100 MVA at transmission levels are around 50 kW no load loss. The correct figure would have the effect of making the savings predicted much less favourable. Therefore the conclusion must be that the analysis severely overstates the savings likely to be achieved.	A new inquiry to obtain information specifically on power transformers was sent out.
Eurelectric (represented by ENA Consulting)	6.4.7	78	Table 34 – base case purchase prices seem to be much lower than I would expect based on current market conditions. Higher prices have the effect of diluting the effectiveness of the savings.	Please provide any additional quantitative market data that you may have.
Eurelectric (represented by ENA Consulting)	6.2.4	47	Assumption is that natural esters and mineral oil are comparable. This is not yet fully proven. It is known that the thermal capacity of the ester is not as good as mineral oil which would mean an equivalent ester filled transformer will be larger. Likewise the dielectric	There was little information available on the environmental impacts cooling fluids. The study will be updated to suggest further study by the EU.

			properties of the ester have not been fully proven to be comparable with mineral oil.	
Eurelectric (represented by ENA Consulting)	6.4.1	53	Assumption of 50% maximum load factor in BC4 is not correct. Where utilities operate transformers in groups of more than 2, the load factor will increase. Four in the group means a load factor of 75%. With other applications, such as generator step up transformers, the maximum load factor is 100%. The assumption would appear to be based on all this type operating with two transformers sharing the load.	Please provide any additional quantitative market data that you may have.
Eurelectric (represented by ENA Consulting)	General		Base case lifetime for power transformer assumed to be 30 years and the maximum is 35 years. Experience shows that the actual average lifetime is nearer to 55 years, so these figures are simply wrong. If the study is correct, then no transformer will be on the system older than 1975. One UK company age profile shows about 65% installed before 1965!	Base-case lifetime was discussed in the previous meetings and previous inquiries. New lifetime information will not be integrated.
Federal Environment Agency (Germany)	6		As already promised by the preparatory study contractors in an email to Wuppertal Institute on 12 August 2010, the final update of the Task 1 report should include all relevant information needed to understand the categories of load losses and no-load losses of the Base Cases 3, 4, 6 and 7 in the Chapter 6 tables (these categories have not been explained yet in the published Task 1 draft report available on the website). In particular, it should include information on the categories taken from FprEN 50541-1, which has been released in the course of the preparatory study project.	Confirmed. Will be in the next updated in all chapters
Federal Environment	6.1	8	The reasons for the choice of the improvement options, load factors and product price assumptions should be	All inputs for the improvement options are related to the corresponding base-

Agency (Germany)			explained very well. Why have these options, load factors and prices finally been chosen as a basis for analysis and not others? [Annex C, mentioned on page 9, which might give some further explanation, could not be found.] In particular, At least the load factors for base cases 1 and 4 seem to be too low. And as already commented last time, for a specific application, the load factor can differ a lot from the average. This becomes particularly relevant when defining loss requirements and an energy labelling scheme, and when looking at the impact of such policies and measures on a specific application in practice in Task 7. Moreover, the development of the distribution system will change in the future. For example, in Germany many distribution transformers will be relocated or abolished in the coming years, and the load factor might increase over time. Therefore, the possible development of load factors over the timeframe of analysis should be taken into account. As the sensitivity analysis in Chapter 6.4 shows, a change in the load factor can lead to a different ranking of options with regard to the life cycle costs. This has to be taken into account for the comparison in Chapter 6.2.3 as well as for the loss requirements set in Chapter 7. Therefore, the choice of the load factors taken as a basis in Chapter 6.1 should be explained very well. In their response to stakeholder comments on the load factors chosen, the preparatory study contractors referred to the discussion at the stakeholder meeting. However, the minutes do not show any justification of the load factors taken here as a basis.	case. The rationale for choosing these inputs are based on stakeholder feedback, explained in Tasks 1-5.
Federal Environment	6.1		The relative product price increase of the amorphous steel improvement options compared to the base case is	Yes, this information is really the result

Agency (Germany)			questionable (probably too high). Is this really the result of the inquiry carried out in June 2010? The relation between product prices of amorphous and HGO steel transformers has to be taken into account for the comparison in Chapter 6.2.3 as well as for the loss requirements set in Chapter 7.	of the inquiry carried out in June 2010.
Federal Environment Agency (Germany)	6.4	p.53	Instead of carrying out sensitivity analyses related to general average changes in transformer prices, it is suggested to run - calculations related to changes in copper, aluminium and steel prices which have been very volatile during last years. In their response to stakeholder comments, the preparatory study contractors had promised to tackle this in the sensitivity analysis. - calculations taking into account different relations between amorphous steel and HGO steel prices or amorphous and HGO steel transformers, which will be particularly important and should be taken into account for the comparison in Chapter 6.2.3.	The sensitivity analysis was intended to be simple. A more detailed sensitivity analysis of the various price factors will not be included.
Federal Environment Agency (Germany)	6.2.3	42	The inclusion of a comparison between option 1 and 2 is appreciated. However, this comparison and its discussion in the text should be extended. The comparison presented is just a single result based on the very specific assumptions made. Table 26 shows that life cycle costs (LCC) of Ao2Ck are only slightly higher than LCC of AoCk. This is based on the assumption that the product price increase of AoCk compared to the base case is 116 % and the price increase of Ao2Ck is 180 %. If the price relation between amorphous steel and HGO steel prices only changed slightly so that the transformer	This study is not meant to examine how transformer prices change with time. Rather, it is meant to provide an idea about the energy savings and costs of more efficient transformers. It is up to the stakeholders to apply this information to their own tendering processes, if relevant.

			product price increase of A02Ck was only 160 %, Ao2Ck would be the LLCC option preferred instead of AoCk. In practice, different tendering procedures at different time can easily lead to such changes in product price. Moreover, there could be different learning curves and mass scale effects for the different transformer technologies and steel types, particularly considering that the amorphous transformer market might experience higher competition in the future, and different competition in the different transformer market segments related to different world-wide developments in general. Therefore, the sensitivity analyses should take into account different possible relations between amorphous and HGO steel transformers, and this should be discussed in Chapter 6.2.3 when the options are compared with each other.	
Federal Environment Agency (Germany)	6.5	83	The study concludes that the results of the sensitivity analysis would not be significantly dependent upon the assumptions made throughout the text. This conclusion is wrong and should be revised: The sensitivity analysis in Chapter 6.4 clearly shows that a variation in the load factor significantly alters the relation between LCC of improvement options. For example, while with max load factor assumptions, LCC for BC1 for AoCk and AoAk are approximately the same, they are clearly different with base case or minimum load factor assumptions. Another example: While with base case load factor assumptions, LCC for BC2 for AoCk and AoAk are nearly the same, they are higher for AoCk with max load factor assumption, and lower for AoCk with min load factor assumption. This is very important for the decision on implementing measures proposed in Chapter 7. Since in practice, load factors can differ, setting loss requirements at AoAk instead of AoCk can lead to significantly different LCC in practice, if load factors deviate from load factors	The conclusion was a general remark about the sensitivity of the results to varied parameters. Indeed, certain cases do show minor variation. However, the project team does not believe these examples to be significant.

			assumed here. If not only sensitivity analyses with respect to the general transformer price level but sensitivity analysis with regard to the relation between amorphous and HGO steel technology were carried out, significant changes in the relative order of improvement options could be observed.	
Hitachi Metals / Metglas	2.3.8 Market introduction of Amorphous Metal Distribution Transformers (AMDT) North America: The United States has one of the largest installed bases and the longest opera-tional experience. Currently, AMTs are neither produced in this country nor being installed in any significant quantity.	120	Hitachi Metals/Metglas would like to point out that the section on the US Market states that AMDT's are neither produced or are being installed in any significant quantity. While this was true a few years ago (if you do not include Mexico which as been making AMDT's since the mid 2000's), recent developments have resulted in a strong resurgence of AMDT's in the US with all major transformer makers producing AMDT's at some volume level and some also making their own AMDT cores using newly installed equipment. AMDT growth in the US market is currently very strong.	Please provide rough quantitative numbers or references to justify this comment.
Hitachi Metals / Metglas	6.1.1 Lastly, price increases are reflected with the relative values	9	- would the consultants disclose who answered to the questionnaire, or at least how many different DT manufacturers answered in order to determine if these answers are representative	No. It can only be said that not all manufacturers who replied the inquiry had AMT price data or said it was unreliable. Therefore also other data sources were added.

	supplied by stakeholders.			
Hitachi Metals / Metglas	6.1.1.1 Improvement options for BC 1: Distribution transformer 400 kVA	10	Why is the amorphous option treated separately- it should be included in this section? Amorphous Distribution Transformers are a commonly available product and should not be treated in a separate chapter. Hitachi Metals/Metglas is asking to include the amorphous improvement option in table 1. Pricing: this is not reflecting the market price today. In fact the AoCk product price (€7101,58/unit) given in this table is almost identical to the currently available 400 kVA unit with a BoCk rating. The price of an AoCk unit is €1000- 1500/unit higher than the BoCk unit (depending on the transformer manufacturer). Hitachi Metals/ Metglas is asking for a change of this figure. Why is the option AoBk missing? This option was asked to be included in the stakeholders inquiry and represents an important market share in Europe.	This section includes only improvement options with traditional technology. Section 6.2.3 compares all improvement options together. Product prices were aggregated from stakeholder input. As this has received many comments, this topic will be discussed during the stakeholder meeting.
Hitachi Metals / Metglas	6.1.1.2 Improvement options for BC 2: Oil-immersed industry transformer 1 MVA	11	same as above: why is the amorphous improvement option not included in this section and the following analysis?	Section 6.2.3 compares all improvement options together.

Hitachi Metals / Metglas	6.1.2 Option 2: Amorphous steel	15	General remark: what does Ao2 mean? Ao x 0,5? This is what we assume, please clarify, also in view of chapter 7.1.7. Hitachi Metals/Metglas will make a recommendation later in these remarks proposing a modified method of handling AMDT NLL category and replacing Ao2 with a more meaningful category to handle amorphous. see remark above: why is there a different section for Amorphous Distribution Transformers. They are commonly available and should not be treated separately. This leaves the impression that AMT are an 'exotic' product, which is not the case. In fact AMT are competing with conventional distribution transformers every day. Why is there only the BC 1 (400 kVA, oil filled) model represented? All stakeholders are aware of the fact that AMTs are being used up to 3 MVA today. In lack of response by the other stakeholders, why was the data of Hitachi Metals/Metglas not taken into consideration when answering the AMT inquiry? Hitachi Metals/Metglas is asking to add the BC2 into Table 3: BC2 improvement options input data- for direct comparison. Why is the AoBk combination listed here and not in BC 1 and BC 2. Hitachi Metals/ Metglas is requesting to add this combination in table 1 and 3 to better reflect the European requirements Where does the product price base for the DoCk solution	A02 means A0x0.5. This section includes only improvement options with traditional technology. Section 6.2.3 compares all improvement options together. See p. 223. 'It seems not possible to be in compliance with European standard and IEC standard for rated power above 1MVA (According to T&D Europe at stakeholder meeting).' (short circuit test) . Therefore did not make sense to include in enquiry related BAT. There is no A0Bk on page 15. Can you please clarify this comment? The price for BC1 is with traditional silicon steel, not AMT. Thus, the price came from aggregated stakeholder input.

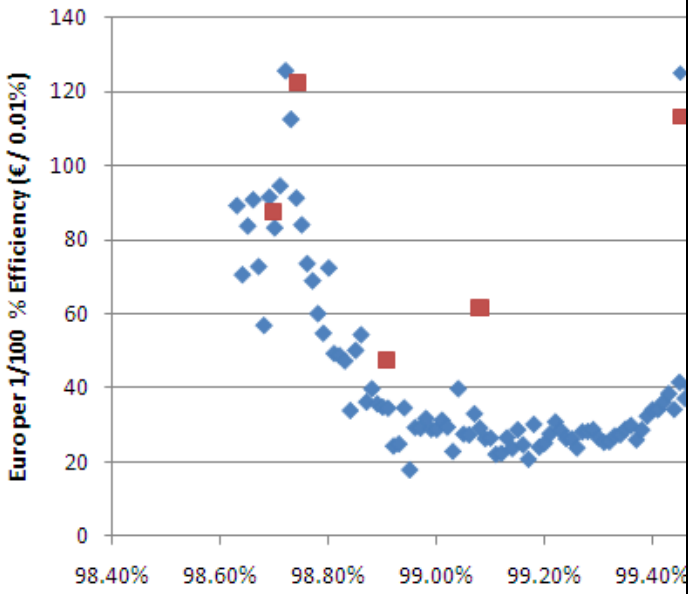
			come from? Amorphous Transformers cannot be designed with such bad performances on no load losses. The data Hitachi Metals/Metglas submitted was based on AM Ck. If this base is used, the AMDT cost for BC 1 was given with USD 7200/unit! Cost increase of 116% to come to an AMAk solution. We like to emphasize that we are talking about product costs- to every transformer manufacturer to add the respective margin, overhead etc. Hitachi Metals/Metglas is requesting to recalculate these figures.	
Hitachi Metals / Metglas	6.2.1.1 Improvement options for BC 1: Distribution transformer 400 kVA	17	Same remark as under point 6.1.1.1	See related answer.
Hitachi Metals / Metglas	6.2.1.2 Improvement options for BC 2: Oil-immersed industry transformer 1 MVA	21	Same remark as above	See related answer.
Hitachi Metals / Metglas	6.2.3 Option 1 and option 2	42	same remark as above: the pricing for AMT is not correct. Looking at the Ao2Bk combination LLC is € 16 546,47 and subtracting the electricity cost of € 4 302,37 the product	See related answer.

	compared		price is given with € 12 244,10 (like in table 15). This figure is NOT representing the market reality. Pricing for Ao2Bk units are given within a range of €7 800 to 10 400/unit (these manufacturers (2 European based and 1 Asia based cannot be disclosed). Subsequently the Ao2Ck solution leads to false results. Hitachi Metals/Metglas firmly believes that if the correct market prices for AMDT's are used, that the proper analysis will show that use of AMDT's will result in the lowest Life-Cycle-Cost. Hitachi Metals/Metglas is requesting to recalculate the figures as they bare mistakes. Why is the AoBk version not listed? Again top European utilities are asking for this. Hitachi Metals/Metglas is requesting to compare AoBk and Ao2Bk as this is the market trend today.	
CLASP-Europe	Task 6 general		Lack of transparency on the improved efficiency transformer designs. There is no information on the type of materials used (e.g., grade of core steel), the type of core (e.g., wound or stacked, cruciform, mitred), and no information on input or output voltage, BIL rating, impedance, etc. The Chapter refers readers to Annex C, but the Annex doesn't contain that information either. Does the Commission intend to publish its designs for public review?	The base-cases and improvement options do not correlate to specific designs, but rather to aggregated data that we have collected from stakeholders.
CLASP-Europe	Task 6 general		Transformer selling prices on certain energy-efficient designs are higher than we expected, particularly the A0Ak and amorphous designs. We conducted analysis of the cost per watt of savings per kVA of capacity and found some discrepancies.	Noted in this and the specific comments below. This will be a point of discussion during the stakeholder meeting.

CLASP-Europe	Task 6 general		The range of efficiencies contained in your design database is constrained by the design losses of EN 50464-1 and EN 50541. We believe that efficiency levels higher than A0Ak may be economically justified, however no designs were created or analysed because those maximum loss levels don't exist in EN 50464-1 or EN 50541.[1]	We provide amorphous transformers that exceed this standard. Depending upon data received, this may be included in the update.
CLASP-Europe	Task 6 general		The amorphous designs prepared for BC1 appear not to be optimised. They are less efficient and significantly more expensive than the conventional steel designs. Furthermore, it is unclear why the amorphous designs are presented separately from the conventional grain oriented electrical steel designs.	Noted, this will be discussed in the stakeholder meeting.
CLASP-Europe	Task 6 general		It is unclear why amorphous designs were only prepared for one of the seven base case units, where we understand they are being used in and can be used in any application under 3MVA, which encompasses 6 out of your 7 base case models (everything except BC4, 100 MVA)	See p. 223. 'It seems not possible to be in compliance with European standard and IEC standard for rated power above 1MVA (According to T&D Europe at stakeholder meeting).' (short circuit test) .Therefore should not be considered as BAT.
CLASP-Europe	Task 6 general		We are concerned about the accuracy of the findings from the life-cycle assessment, given the material substitutes selected for electrical core steel and tank steel. We hope the contractors will prioritise correcting this problem before finalising their analysis for the Commission.	It was determined in Task 4 that the material selection did not have a significant effect on the life-cycle impacts. Being restricted by the EcoReport, the results should not be taken as true life-cycle assessments,

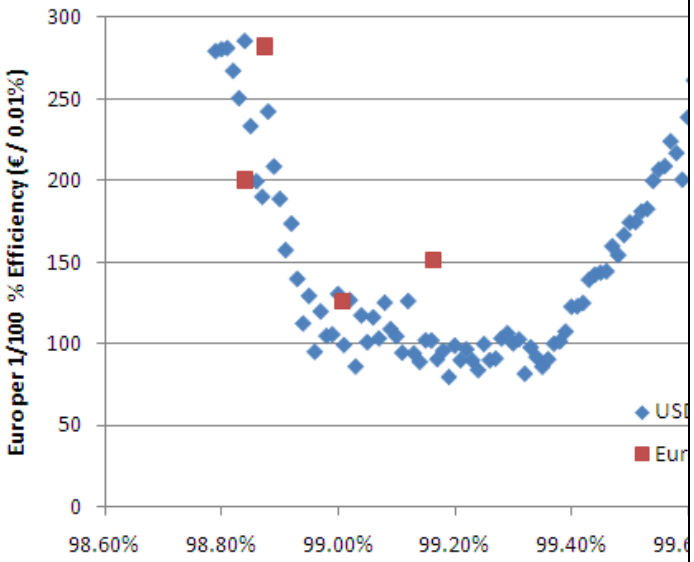
[1] In the Executive Summary for the Preparatory Study on page IV, the Preparatory Study agrees with CLASP's position, however we did not observe the publication of designs beyond A0Ak. The Preparatory Study Executive Summary states: "Also, the highest performance level (Ak, A0) defined in standards EN50464-1, HD 538.1 or FprEN50541-1 does not mean that significant lower losses can't be achieved with actual technology. This will also be evaluated in subsequent tasks."

				but more of an estimation.
CLASP-Europe	6.1.1	9	Reference is made to “Annexe C”, however there is no Annex C to Chapter 6. If appropriate, for clarification we’d suggest changing the text to clarify the Chapter to which the Annex is associated, such as “Annex C of Chapter 5”. Please search/replace throughout the Study.	Noted. The text will be updated.
CLASP-Europe	6.1.1.1	10	A helpful way to review the reasonableness of incremental increases in price and efficiency is to compare the slope of the cost-efficiency relationship to that of similar data. Although there are differences between the European and North American electrical distribution systems, the fundamental principles of transformer design and performance (including incremental material costs for efficiency gains) are consistent between the two networks. Using the US DOE’s published data, including the selling price, watts of core loss and watts of coil loss at 100% load for a transformer similar to BC1, a comparison can be drawn between the two cost-efficiency slopes. In order to make this comparison, the DOE data must have its full load percent efficiency calculated according to IEC 60076-01 (i.e., slightly different from North America’s IEEE C57.12) and the currency must be converted from USD to Euro (using a recent exchange rate of 1.32). Then, a slope of cost (in €) per unit of efficiency (in 1/100 of a percent efficiency) relative to the baseline unit can be calculated and compared. Conducting this calculation, a graph is presented below which compares BC1 (400 kVA oil) with DOE’s DL3 (500 kVA oil). From this graph, it appears that C0Ck, B0Bk and A0Ck are all reasonable and in alignment with expectations. However, the top-efficiency model for Europe, A0Ak appears to be over-priced by approximately	Thank you for this information. It will be discussed in the stakeholder meeting.

			€900. This particular model would fall into alignment with DOE's data if it were priced around €7800 rather than €8693.31. At the higher price, this transformer improves its efficiency over the D0Ck model at a cost of €61.59 per 0.01% improvement in efficiency. However, at the lower price point of €7800, the slope of that cost-efficiency line would change to €40.19 per 0.01% improvement – which is more consistent with DOE's findings. Please review the figure below.  In order to review the relationship between cost and efficiency in this analysis, CLASP is undertaking design work using a former ABB oil-immersed transformer design engineer with 25 years experience and design software from the US-based Optimised Programme Service. This analysis will include the 400 kVA oil-immersed transformer, in both silicon steel and amorphous material,	

			and the results will be shared with the Commission and its Contractors.	
CLASP-Europe	6.1.1.1	10	The European Standard EN 50464-1 does not exhaust the efficiency potential of conventional materials. The best unit presented in Table 1: BC 1 improvement options input data is based on A0Ak, which has Po of 430 watts and Pk of 3250 watts. Converting this unit to full-load efficiency (according to IEC 60076-1, where the input power is the rated kVA capacity of the transformer), it achieves an efficiency of 99.08%. This can then be compared to the full-load efficiency (also calculated according to IEC 60076-1 method) for DOE's 500 kVA oil-immersed transformer design database where over 2,900 designs are published, each with core losses (watts) and 100% rated load coil losses (watts). The efficiency of designs prepared by DOE with conventional electrical steels is significantly higher than the A0Ak design. DOE's unit achieves a maximum efficiency in its dataset of between 99.42% and 99.57% - much greater than 99.08% - and DOE was using the same conventional steels and winding material considered in the European analysis. CLASP is concerned that significant energy savings may not be realised because of the lack of ambition in EN 50464-1, and the fact that there is no consideration of design levels above A0Ak using conventional electrical steels for this base-case 400 kVA transformer. This is unusual because on page IV of the Executive Summary, the Preparatory Study states: "Also, the highest performance level (Ak, A0) defined in standards EN50464-1, HD 538.1 or FprEN50541-1 does not mean that significant lower losses can't be achieved with actual technology. This will also be evaluated in subsequent	Thank you for this information. It will be discussed in the stakeholder meeting.

			tasks." CLASP suggests that additional designs be prepared for this analysis with lower losses than A0, Ak, developing A0+ and Ak+ levels which will further assess maximum efficiency and minimum life-cycle cost.	
CLASP-Europe	6.1.1.1	10	The annual sales are given as 0.1404 million, the lifetime is given as 40 years and yet the EU stock is only 2.25 million. Assuming European electricity consumption has increased by 1.8% per year since 1970, the stock should be 4.1 million – nearly double the estimate in his section. Please clarify your stock calculation methodology – the energy savings potential of this regulation for these transformers may be understated.	The market data is taken from section 4.5.1. The project team will discuss internally to determine where an improved explanation of methodology should be placed.
CLASP-Europe	6.1.1.2	11	Conducting a similar comparison on BC2 as was done above on BC1, a comparison between the EU and US cost-efficiency slopes is presented below. This comparison involved calculating new values for DOE based on percent efficiency calculated according to IEC 60076-01 (i.e., slightly different from North America's IEEE C57.12) and a currency conversion from USD to Euro (using an exchange rate of 1.32). Then, a slope of cost (in €) per unit of efficiency (in 1/100 of a percent efficiency) relative to the baseline unit can be calculated and compared. Conducting this calculation, a graph is presented below which compares BC2 (1000 kVA oil) with DOE's DL5 (1500 kVA oil). From this graph, it appears that C0Ck, B0Bk and A0Ck are all reasonable and in alignment with expectations. However, the top-efficiency model for Europe, A0Ak appears to be over-priced by approximately €1500. This particular model would fall into alignment with DOE's data if it were priced around €15200 rather	Thank you for this information. It will be discussed in the stakeholder meeting.

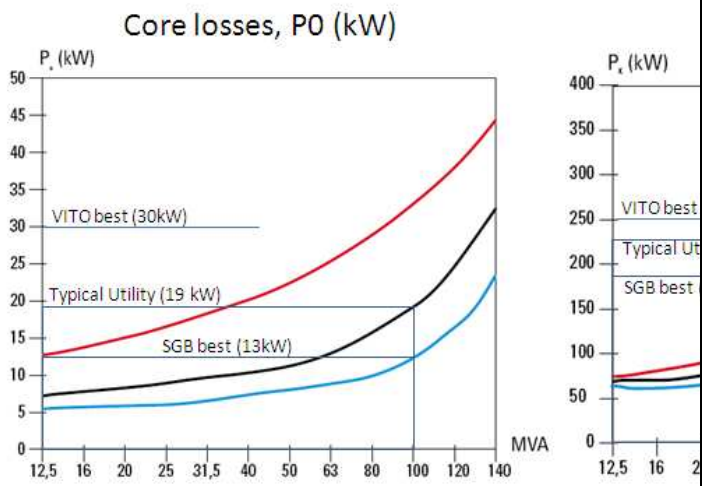
			than €16716.78. At the higher price, this transformer improves its efficiency over the D0Ck model at a cost of €151.20 per 0.01% improvement in efficiency. However, at the lower price point of €15200, the slope of that cost-efficiency line would change to €112.47 per 0.01% improvement – which is more consistent with DOE's findings. Please review the figure below.  In order to review the relationship between cost and efficiency in this analysis, CLASP is undertaking design work on this particular unit (BC2) as well as BC1. The analysis will include both silicon steel and amorphous material designs for BC2, and the results will be shared with the Commission and its Contractors.	
CLASP-Europe	6.1.1.2	11	The European Standard EN 50464-1 does not exhaust the efficiency potential of conventional materials. The	Thank you for this information. It will be

			best unit presented in Table 2: BC 2 improvement options input data is based on A0Ak, which has Po of 770 watts and Pk of 7600 watts. Converting this unit to full-load efficiency (according to IEC 60076-1, where the input power is the rated power of the transformer), the A0Ak is 99.16% efficient. This can then be compared to the full-load efficiency (also calculated according to IEC 60076-1 method) for DOE's 1500 kVA oil-immersed transformer design database where over 3,300 designs are published, each with core losses (watts) and full-load rated coil losses (watts). The percentage efficiency achieved by DOE with conventional electrical steels is significantly higher than the A0Ak design. DOE's unit achieves a maximum efficiency in its dataset of between 99.41% and 99.54% efficient using conventional electrical steels that are also considered in the European analysis. The European A0Ak design is only 99.16%. CLASP is concerned that significant energy savings may not be realised because of the lack of ambition in EN 50464-1, and the fact that there is no consideration of design levels above A0Ak using conventional electrical steels for this base-case 1000 kVA transformer. CLASP suggests that additional designs be prepared for this analysis, developing A0+ and Ak+ levels which will explore further the relationship between maximum efficiency and minimum life-cycle cost.	discussed in the stakeholder meeting.
CLASP-Europe	6.1.1.2	11	The annual sales are given as 0.0432 million, the lifetime is given as 25 years and yet the EU stock is only 0.504 million. Assuming European electricity consumption has increased by 1.8% per year since 1985, the stock should be 0.903 million – nearly double the estimate presented in this section. Please clarify your stock calculation methodology – the energy savings potential of this	The market data is taken from section 4.5.1. The project team will discuss internally to determine where an improved explanation of methodology should be placed.

			regulation for these transformers may be understated.	
CLASP-Europe	6.1.1.3	12	In the BC3 improvement options input data for a 1.25 MVA dry-type industry transformer the report presents Table 6 with some cost and performance data on four designs – a baseline and three improvement options. Unfortunately, for this model, and indeed all the others presented in Chapter 6, it is not clear what design work – including dimensions, materials and otherwise – are being applied to arrive at the target losses. This data is not provided in Chapter 5 Annex C, nor in the tables in Chapter 6. For instance, does the A0Ak design use domain-refined M3 steel in a cruciform seven-step mitre, or is it able to achieve this performance with a lower grade steel or less sophisticated core? This kind of transparency is important to understand whether the design options for conventional materials are being exhausted. Table 6 of section 6.1.1.3 has three sets of losses presented in the core (C0@2800W, B0 @ 2100W and A0@1800W), and it considers two levels for winding losses (Bk@13000W and Ak@11000W). The full-load efficiencies that correspond to these ratings are 98.74% for the base line, and then 98.79%, 98.82% and 98.98% for the three more efficient designs. CLASP suggests that additional designs be prepared for this analysis, developing A0+ and Ak+ levels which will explore further the relationship between maximum efficiency and minimum life-cycle cost. For this unit, perhaps a design could be prepared at A0+ of 1600W and an Ak+ of 9500W.	The base-cases and improvement options do not correlate to specific designs, but rather to aggregated data that we have collected from stakeholders.
CLASP-Europe	6.1.1.3	12	The annual sales are given as 0.008047 million, the lifetime is given as 30 years and yet the EU stock is only 0.1088 million. Assuming European electricity	The market data is taken from section 4.5.1. The project team will discuss internally to determine where an

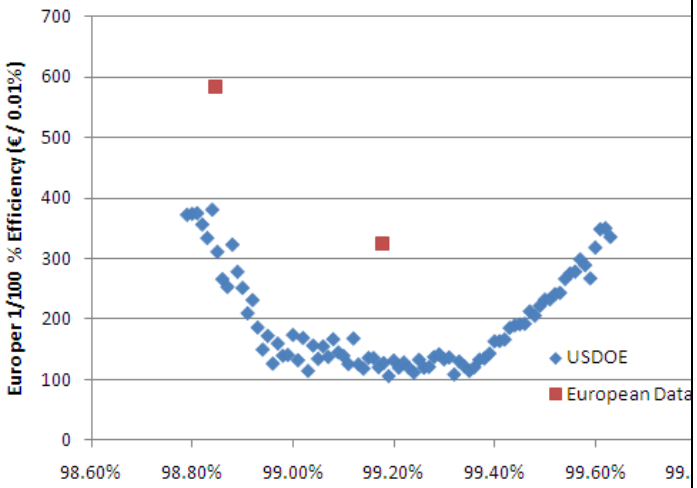
			consumption has increased by 1.8% per year since 1980, the stock should be 0.192 million – nearly double the estimate given in this section. Please clarify your stock calculation methodology – the energy savings potential of this regulation for these transformers may be understated.	improved explanation of methodology should be placed.
CLASP-Europe	6.1.1.4	12	In the BC4 improvement options input data for a 100 MVA power transformer, the report is ambiguous on the design work – including dimensions, materials and otherwise – that are being applied to arrive at the target losses. This data is not provided in Chapter 5 Annex C, nor in the tables in Chapter 6. For instance, does the 30-250 design use domain-refined M3 steel in a cruciform seven-step mitre, or is it able to achieve this performance with a lower grade steel or less sophisticated core? This kind of transparency is important to understand whether the design options for conventional materials are being exhausted. Table 7 of section 6.1.1.4 presents five designs, ranging in full-load efficiency from 99.62% efficient for the basecase having 80,000 watts of core losses and 300,000 watts of coil losses to 99.72% efficient for the best unit, having 30,000 watts of core losses and 250,000 watts of coil losses. CLASP reviewed industry literature on power transformers like the 100 MVA unit, and is concerned that the loss levels presented in the Preparatory Study are higher than is typically specified by an electric utility and are higher than could be manufactured in Europe. Consider the following graphs from SGB Starkstrom and SMIT Transformers2 that provide losses in accordance with	The base-cases and improvement options do not correlate to specific designs, but rather to aggregated data that we have collected from stakeholders. Thank you for this information. It will be discussed in the stakeholder meeting.

[2] Weblink for this marketing brochure: http://www.google.co.uk/url?sa=t&source=web&cd=2&ved=0CB4QFjAB&url=http%3A%2F%2Fwww.sgb-

			standards (red line), typical electric utility specification (black line) and values achievable by SGB (blue line).  We have super-imposed boxes and labels on these SGB graphs to facilitate interpretation of the core and coil losses for a 100 MVA transformer. In Chapter 6, the designs considered for the 100 MVA were 60kW-300kW, 40kW-275kW, 30kW-300kW and 30kW-250kW. From this graph, it is evident that the most ambitious combination of core and coil losses considered in Chapter 6 (30kW-250kW) has higher core and coil losses than the "typical" electric utility specification on the SGB graph. Rather than 30kW of core losses, SGB estimates that for a 100 MVA transformer, utilities typically specify 19kW and they are capable of manufacturing around 13kW. Rather than 250kW, SGB estimates that utilities typically specify around 225kW, and they're capable of manufacturing	

smit.pl%2Fdownload2.php%3Fnazwa%3DLeistung12S_engl_9_02.pdf%26katalog%3Dbroszury&rct=j&q=SGB%20Starkstrom%20100%20MVA&ei=8-tkTLu9FYqQjAf91JnNCw&usg=AFQjCNE0Y_wvc97PuzDH_bkbJiCs5d9pEw

			around 180kW. CLASP suggests that additional designs be prepared for this analysis, developing improved levels that will further explore the relationship between maximum losses and minimum life-cycle cost. For example, perhaps two additional designs could be prepared at 19kW-200kW (99.78% efficient), and at 13kW-180kW (99.81% efficient).	
CLASP-Europe	6.1.1.4	13	Unlike the previous three base case transformers, the lifetime, annual sales and EU stock estimates for this unit result in a higher estimate of EU stock than would be expected. The annual sales are given as 0.001802 million, the lifetime is given as 30 years and yet the EU stock is 0.06435 million. Assuming European electricity consumption has increased by 1.8% per year since 1980, the stock should be 0.0431 million – about 50% less than the estimate in Chapter 6. Please clarify your stock calculation methodology – the energy savings potential of this regulation for these transformers may be overstated, based on current sales volumes.	The market data is taken from section 4.5.1. The project team will discuss internally to determine where an improved explanation of methodology should be placed.
CLASP-Europe	6.1.1.5	13	Conducting a similar comparison on BC5 as was done above on BC1 and BC2, a comparison between the EU and US cost-efficiency slopes is presented below. This comparison involved calculating new values for DOE based on percent efficiency calculated according to IEC 60076-01 (i.e., slightly different from North America's IEEE C57.12) and a currency conversion from USD to Euro (using today's exchange rate of 1.32). Then, a slope of cost (in €) per unit of efficiency (in 1/100 of a percent efficiency) relative to the baseline unit can be calculated and compared. The graph below presents our findings, comparing BC5 (2000 kVA oil DER transformer) with DOE's DL5 (1500	Thank you for this information. It will be discussed in the stakeholder meeting.

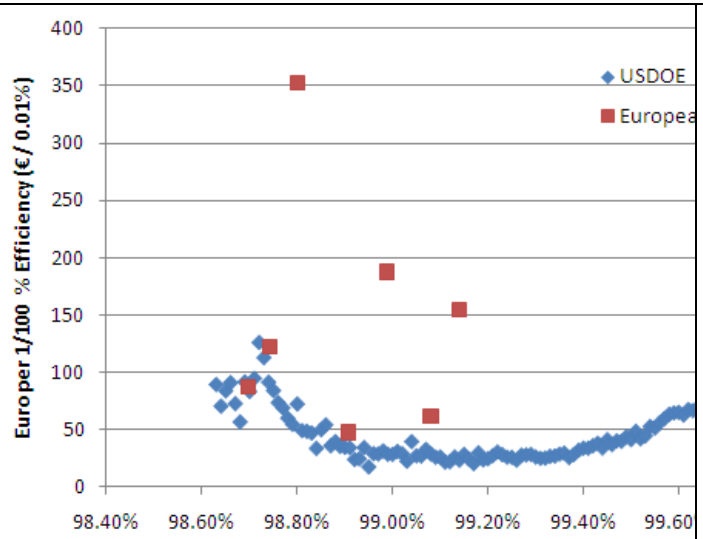
			kVA oil), adjusted by the ratio 2000/1500 to allow for scaling losses to the larger kVA rating. From this graph, it appears that C0Ck and A0Ak are both more expensive than would be expected. It is uncertain whether the reason for this apparent doubling of the cost per unit efficiency is due to other attributes of the transformer that make it able to operate as a DER transformer. This discrepancy requires further investigation.  In order to review the relationship between cost and efficiency in this analysis, CLASP is undertaking design work on this particular unit (BC5) as well as BC1 and BC2. The analysis will include both silicon steel and amorphous material designs for BC5, and the results will be shared with the Commission and its Contractors.	
CLASP-Europe	6.1.1.5	13	As discussed earlier, the European Standard EN 50464-1 does not exhaust the efficiency potential of conventional materials. The best unit presented in Table 9: BC 5	Thank you for this information. It will be discussed in the stakeholder meeting.

			improvement options input data is based on A0Ak, which has Po of 1450 watts and Pk of 15,000 watts. Converting this unit to full-load efficiency (according to IEC 60076-1, where the input power is the rated power of the transformer), the efficiency is calculated as 98.80%. This can then be compared to the full-load efficiency (also calculated according to IEC 60076-1 method) for DOE's 1500 kVA oil-immersed transformer design database where over 3,300 designs are published, each with core losses (watts) and 100% rated load coil losses (watts). The percentage efficiency achieved by DOE with conventional electrical steels is significantly higher than the A0Ak design. DOE's unit achieves a maximum efficiency in its dataset of between 99.41% and 99.54% for conventional electrical steels that are also discussed in the European analysis. It is unclear why the European design should reach its maximum at 98.80%. CLASP is concerned that significant energy savings may not be realised because of the lack of ambition in EN 50464-1, and the fact that there is no consideration of design levels above A0Ak using conventional electrical steels for this base-case 2000 kVA transformer. CLASP suggests that additional designs be prepared for this analysis, developing A0+ and Ak+ levels which will explore further the relationship between maximum efficiency and minimum life-cycle cost.	
CLASP-Europe	6.1.1.5	13-14	The annual sales are given as 0.00042 million, the lifetime is given as 25 years and yet the EU stock is only 0.004 million. Assuming European electricity consumption has increased by 1.8% per year since 1985, the stock should be 0.0088 million – more than double the estimate in this section of the report. Please clarify your stock calculation methodology – the energy savings potential of this	The market data is taken from section 4.5.1. The project team will discuss internally to determine where an improved explanation of methodology should be placed.

			regulation for these transformers may be understated.	
CLASP-Europe	6.1.1.6	14	In the BC6 improvement options input data for a 2 MVA dry-type DER transformer, the report presents Table 11 with some cost and performance data on three designs – a baseline and two improvement options. Unfortunately, for this model, and indeed all the others presented in Chapter 6, it is not clear what design work – including dimensions, materials and otherwise – are being applied to arrive at the target losses. This data is not provided in Chapter 5 Annex C, nor in the tables in Chapter 6. For instance, does the A0Ak design use domain-refined M3 steel in a cruciform seven-step mitre, or is it able to achieve this performance with a lower grade steel or less sophisticated core? This kind of transparency is important to understand whether the design options for conventional materials are being exhausted. Table 11 of section 6.1.1.6 has three sets of losses presented in the core (C0@4000W, B0@3000W and A0@2600W), and it considers two levels for winding losses (Bk@18,000W and Ak@16,000W). The full-load efficiencies that correspond to these ratings are 98.90% for the base line, and 98.95% and 99.07% for the two more efficient designs. CLASP suggests that additional designs be prepared for this analysis, developing A0+ and Ak+ levels which will explore further the relationship between maximum efficiency and minimum life-cycle cost. For this unit, perhaps a design could be prepared at A0+ of 2300W and an Ak+ of 14,500W which would correspond to an efficiency of 99.16%.	The base-cases and improvement options do not correlate to specific designs, but rather to aggregated data that we have collected from stakeholders. Thank you for this information. It will be discussed in the stakeholder meeting.
CLASP-Europe	6.1.1.6	14	The annual sales are given as 0.00168 million, the lifetime is given as 25 years and yet the EU stock is only 0.016 million. Assuming European electricity consumption has increased by 1.8% per year since 1985, the stock should	The market data is taken from section 4.5.1. The project team will discuss internally to determine where an improved explanation of methodology

			be 0.035 million – more than double the estimate in this section. Please clarify your stock calculation methodology – the energy savings potential of this regulation for these transformers may be understated.	should be placed.
CLASP-Europe	6.1.1.7	14-15	The analysis for this transformer seems to require further development. There is only one energy-efficient option presented in Table 13 for BC7 (16 kVA separation/isolation transformer), which offers no improvement over the base case in terms of core losses. At a minimum, two energy-efficiency designs should be presented, but ideally more – presenting a range of energy-efficiency options for reducing both core and coil losses.	The lack of improvement options is a result from a scarcity of data received. If you have further market and technical information, please supply it.
CLASP-Europe	6.1.1.7	15	The annual sales are given as 0.075 million, the lifetime is given as 10 years and the EU stock is 0.75 million. This estimate of stock appears reasonable for the shipments and number of years of service.	This base-case used the same methodology as the others, so any problems with calculations would be the same. The market data for all base-cases will be reviewed and updated if necessary.
CLASP-Europe	6.1.2	15	This section addresses amorphous material for one of the base case transformers, BC1. First, it is unclear why this section is separate from 6.1.1.1, which presents the cost and performance data of the same unit. Since 400 kVA oil-immersed transformers are also made using amorphous material, this section should be moved to become part of section 6.1.1.1. Second, it is unclear why amorphous material is only considered for one of the units being analysed, and not others. At a minimum this design option should be considered for BC2, the 1000 kVA oil-immersed and BC5, the 2000 kVA oil-immersed dry-type. In addition, wound-	Amorphous transformers are presented separately as many stakeholders suggested that they are a developing technology and not necessarily a one-to-one replacement for traditional silicon steel technologies. All improvement options for base-case 1 are compared in section 6.2.3. See p. 223. 'It seems not possible to be in compliance with European standard and IEC standard for rated

			core amorphous designs could be made for the cast-coil BC3, the 1250 kVA dry-type industry transformer and BC6, the 2000 kVA dry-type DER transformer. Furthermore, we know of no technical reason why amorphous material could not be used on BC7, the 16 kVA separation/isolation transformer. Therefore, the only unit which could not be made in amorphous material is BC4, the Power Transformer at 100 MVA. CLASP therefore suggests that the amorphous designs be expanded to transformers other than BC1, including specifically, BC2, BC3, BC5, BC6 and BC7 – and that these additional designs be incorporated into the relevant cost-efficiency tables of section 6.1.1. Third, the cost-efficiency results presented in Table 15 for the amorphous transformer designs appears to be problematic and does not represent cost-optimised designs for amorphous material at this kVA rating. The graph below is the same graph we provided on our comments in section 6.1.1.1 above, now updated to include the three amorphous designs in Table 15 – all of which are completely off the US DOE curve. Furthermore, the amorphous efficiencies are lower than amorphous designs developed by the US DOE for the similar kVA rating and in terms of cost, are multiples higher than the US data.	power above 1MVA (According to T&D Europe at stakeholder meeting).' (short circuit test). They aren't BAT. Thank you for this information. It will be discussed in the stakeholder meeting.

			 Surprisingly, the efficiency ratings of the amorphous transformers are lower than silicon steel for two of the three designs and the cost per increment of efficiency is double or triple that of the silicon steels. If this were indeed the case, we would expect amorphous material and all suppliers of amorphous material to be out of business. However, as we heard in the May 2010 stakeholder meeting and confirmed in subsequent research, the amorphous material market in transformers is growing, and manufacturers are adding production equipment to accommodate the unique processing requirements of this material. Thus, we can only conclude that the cost and design information presented in Table 15 for amorphous material is erroneous and misrepresentative of the market. CLASP therefore suggests that the Commission's contractor revisit these designs and develop (or adopt) some that are more in line with the market.	

			As stated earlier, in order to review the relationship between cost and efficiency in this analysis, CLASP is undertaking design work on this particular unit including amorphous designs in BC1. CLASP will share this report with the Commission and its consultants upon completion.	
CLASP-Europe	6.1.3	16	This section is titled "Option 3: Replace mineral oil with natural esters." This section is only two paragraphs long, and contains no analysis, nor any results. It is unclear what the purpose of this section is – for example, are the Commission's contractors considering natural esters as a one-for-one replacement of mineral oil in their designs? If so, then this issue requires some investigation and discussion in this section, namely whether natural esters and mineral oil share the same dielectric properties, lifetime properties and other performance characteristics.	Further analysis is conducted in section 6.2.4. There was little information available on the environmental impacts cooling fluids. The study will be updated to suggest further study by the EU.
CLASP-Europe	6.2	16	This section discusses the fact that the Commission's contractors are taking into account the "rebound effect" of more energy-efficient transformers. However, we do not think this is appropriate for this equipment, as transformers provide no direct service to the end-user. In other words, a transformer is a functional part of the T&D system, delivering electricity to homes and businesses. We cannot conceive of a scenario where an end-user will choose to run their lights longer or take hotter or longer showers because the transformers delivering the electricity are more efficient. We suggest that rebound effect be ignored in the analysis of transformers.	This section of text simply described the objectives of the section as outlined by the EC at the beginning of the study. Rebound effects are not analysed as they are not relevant.
CLASP-Europe	6.2.1.1	17-18	We do not support the findings of the analysis shown in Table 17, and reiterate our suggestion for a more accurate analysis by the Commission's contractors. These are critical findings, indicating where life-cycle indicators of	It was determined in Task 4 that the material selection did not have a significant effect on the life-cycle impacts. Being restricted by the

			various materials are higher or lower than the baseline, however they are not based on critical materials used in constructing transformers, and therefore are unreliable. With disappointment, we note that our comments submitted in May 2010 on Chapter 4 concerning the life-cycle assessment were not adopted. We commented that grain-oriented electrical steel was different from other types of steel, and that Leonardo Energy had published a study that investigated exactly this issue and this material. In VITO's response to our comment, it states that "we do not consider this as a priority" – and yet core steel is the most expensive part of a transformer, and is inextricably linked to its performance. We therefore re-iterate our concern about the accuracy of this life-cycle assessment, and suggest that the Commission's contractors review the "Eco-sheet" published by Leonardo Energy on three 100kVA distribution transformers in 2006,3 two references may be of some assistance to the analytical team in conducting further analysis around the issue of a more accurate representation of magnetic steel in the EcoReport database: The respective tools and models have been provided by PE Europe, Haupt- strasse 111-113, D-70771 Leinfelden-Echterdingen (Stuttgart), Germany, www.gabi-software.com • The original information of this environmental declaration sheet is taken from the results of the GABI4 i-report referring to the ecodesign toolbox 2005 (for information, contact Hans De Keulenaer, email hdk@eurocopper.org)	EcoReport, the results should not be taken as true life-cycle assessments, but more of an estimation.

[3] "Eco-sheet: 100 kVA distribution transformer designs with increasing efficiency", by Hans De Keulenaer published by Leonardo Energy; July 2006; email hdk@eurocopper.org

CLASP-Europe	6.2.1.1	17-18	Also relating to the findings presented in table 17, we are concerned about the use of "23-Cast Iron" as being representative of the transformer tank (as stated in the revised Chapter 4). Transformer tanks are made out of low-carbon, rolled steel plate, ASTM A283 Grade C, not cast iron. These plates are welded together along the seams to form a sealed tank. Sometimes cooling fins, radiators, and other parts are added to the tanks. We found an illustrated marketing brochure on transformer tanks which provides some technical data and other information about transformer tanks. This may be helpful in your review of this modelling assumption: http://www.ptd.siemens.ru/files/14765.pdf CLASP made this same comment in May 2010, both in our written comments on Chapters 1-5 and at the stakeholder meeting. We note with regret that the Commission's contractors' response to our comment is "we are aware of such problems but it is not considered as a priority for the time being." However, the findings are being presented here as factual and correct, without any caveats or explanations surrounding the assumptions made, the errors these assumptions have introduced and the limited accuracy of the results. Policy makers are intended to review these tables and make decisions. This issue is troubling for us, and we are struggling to understand why this analysis is not a priority for the Commission's contractors.	It was determined in Task 4 that the material selection did not have a significant effect on the life-cycle impacts. Being restricted by the EcoReport, the results should not be taken as true life-cycle assessments, but more of an estimation.
CLASP-Europe	6.2.1.1	19	In Figure 2, the most efficient design for BC1 (A0Ak) is shown to have a higher total ownership cost because its product price is incrementally larger than the operational cost savings associated with the more efficient design. As discussed in our comments on section 6.1.1.1, we believe that this design is over-priced by approximately €900,	Thank you for this information. It will be discussed in the stakeholder meeting.

			which would make it virtually the same (within €100) of the A0Ck design. If indeed, the actual design is over-priced by €1000 or slightly more, then the A0Ak design would attain the status of lowest life-cycle cost of ownership. In addition, why are the amorphous design options not included in this analysis? As discussed earlier, CLASP is conducting its own design work to review this particular base case model, and we look forward to providing that report to the Commission and its contractors.	
CLASP-Europe	6.2.1.1	20	Paragraph on "Eutrophication" contains the statement "The results are exposed in Table 18." Please replace the word "exposed" with "presented". The term 'presented' is a better term for expressing the presentation of results. N.B., we suggest that the Commission's contractors conduct a key word search on the term "exposed" as this isn't the only place in Chapter 6 where this revision is needed.	Thank you, this will be updated.
CLASP-Europe	6.2.1.1	20-21	Table 18 provides "Normalisation of some impact categories for base case 1 option 1 results", however it is unclear from the table or the text what has been used to normalise these impact categories. Some clarifying text or additional data labels would be helpful. Note that we suggest incorporating this clarification throughout this section of Chapter 6, although we will only raise it here relating to Table 18.	Improved explanatory text will be added in the next version.
CLASP-Europe	6.2.1.2	21-22	Table 19 presents the life-cycle assessment impacts of the various design options associated with BC2. As discussed above on Table 17, we do not support these findings because our original comments in May 2010	It was determined in Task 4 that the material selection did not have a significant effect on the life-cycle impacts. Being restricted by the

			suggesting that the Commission's contractors use grain oriented electrical steel, tank steel and other materials germane to transformers when doing the life-cycle assessment was not considered a priority. These findings require revision, and/or a statement about their accuracy. Thus, relating to Table 19, please see both of our comments above associated with Table 17 in section 6.2.1.1.	EcoReport, the results should not be taken as true life-cycle assessments, but more of an estimation.
CLASP-Europe	6.2.1.2	22-24	In Figure 5, the most efficient design for BC2 (A0Ak) is shown to have the lowest life-cycle cost. As discussed in our comments on section 6.1.1.2, we believe that this design is over-priced by approximately €1500, which would make it even more attractive a design option. If this revision is made to section 6.1.1.2, then the figures in section 6.2.1.2 will require updating. It is unclear to us why amorphous design options are not included in this analysis. Please clarify and/or add amorphous designs. As discussed earlier, CLASP is conducting its own design work to review this particular base case model, and we look forward to providing that report to the Commission and its contractors.	Thank you for this information. It will be discussed in the stakeholder meeting.
CLASP-Europe	6.2.1.3	24-25	Table 20 presents the life-cycle assessment impacts of the various design options associated with BC3. As discussed above on Table 17, we do not support these findings because our original comments in May 2010 suggesting that the Commission's contractors use grain oriented electrical steel, tank steel and other materials germane to transformers when doing the life-cycle assessment was not considered a priority. These findings require revision, and/or a statement about their accuracy. Thus, relating to Table 20, please see both of our	It was determined in Task 4 that the material selection did not have a significant effect on the life-cycle impacts. Being restricted by the EcoReport, the results should not be taken as true life-cycle assessments, but more of an estimation.

			comments above associated with Table 17 in section 6.2.1.1.	
CLASP-Europe	6.2.1.3	26-27	In Figures 7, 8 and 9, the labels on the bars do not correspond to Table 20, nor to the designs presented in section 6.1.1.3. Please correct these to be C0Bk, B0Bk, A0Bk and A0Ak.	Thank you. This will be updated.
CLASP-Europe	6.2.1.4	27-28	Table 21 presents the life-cycle assessment impacts of the various design options associated with BC4. As discussed above on Table 17, we do not support these findings because our original comments in May 2010 suggesting that the Commission's contractors use grain oriented electrical steel, tank steel and other materials germane to transformers when doing the life-cycle assessment was not considered a priority. These findings require revision, and/or a statement about their accuracy. Thus, relating to Table 21, please see both of our comments above associated with Table 17 in section 6.2.1.1.	It was determined in Task 4 that the material selection did not have a significant effect on the life-cycle impacts. Being restricted by the EcoReport, the results should not be taken as true life-cycle assessments, but more of an estimation.
CLASP-Europe	6.2.1.5	30-31	Table 22 presents the life-cycle assessment impacts of the various design options associated with BC5. As discussed above on Table 17, we do not support these findings because our original comments in May 2010 suggesting that the Commission's contractors use grain oriented electrical steel, tank steel and other materials germane to transformers when doing the life-cycle assessment was not considered a priority. These findings require revision, and/or a statement about their accuracy. Thus, relating to Table 22, please see both of our comments above associated with Table 17 in section 6.2.1.1.	It was determined in Task 4 that the material selection did not have a significant effect on the life-cycle impacts. Being restricted by the EcoReport, the results should not be taken as true life-cycle assessments, but more of an estimation.

CLASP-Europe	6.2.1.5	31-33	In Table 22 and Figures 13 to 15, the most efficient design for BC5 (A0Ak) is shown to have the lowest life-cycle cost. As discussed in our comments on section 6.1.1.5, we believe that this design may be over-priced, and we are concerned that there may be a design option more efficient than A0Ak which has lower life-cycle costs. We therefore suggest that further analysis be conducted on BC5 at efficiency levels higher than A0Ak, perhaps the values suggested in our comment above on 6.1.1.5 for A0+ and Ak+. It is unclear to us why amorphous design options are not included in this analysis on BC5. Please clarify and/or add amorphous designs. As discussed earlier, CLASP is conducting its own design work to review this particular base case model, and we look forward to providing that report to the Commission.	Thank you for this information. It will be discussed in the stakeholder meeting.
CLASP-Europe	6.2.1.6	33-34	Table 23 presents the life-cycle assessment impacts of the various design options associated with BC6. As discussed above on Table 17, we do not support these findings because our original comments in May 2010 suggesting that the Commission's contractors use grain oriented electrical steel, tank steel and other materials germane to transformers when doing the life-cycle assessment was not considered a priority. These findings require revision, and/or a statement about their accuracy. Thus, relating to Table 23, please see both of our comments above associated with Table 17 in section 6.2.1.1.	It was determined in Task 4 that the material selection did not have a significant effect on the life-cycle impacts. Being restricted by the EcoReport, the results should not be taken as true life-cycle assessments, but more of an estimation.
CLASP-Europe	6.2.1.6	31-33	In Table 23 and Figures 16 to 18, the most efficient design for BC5 (A0Ak) is shown to have the lowest life-cycle cost. As discussed in our comments on section 6.1.1.6, we are	Thank you for this information. It will be discussed in the stakeholder meeting.

			concerned that there may be a design option more efficient than A0Ak which has lower life-cycle costs. We therefore suggest that further analysis be conducted on BC6 at efficiency levels higher than A0Ak, perhaps the values suggested in our comment above on 6.1.1.6 for A0+ and Ak+. It is unclear to us why amorphous design options are not included in this analysis on BC6. Please clarify and/or add amorphous designs.	
CLASP-Europe	6.2.1.7	36-37	Table 24 reflects the baseline and one energy-efficient design option prepared for BC7. We believe this is too few, and suggest that further designs be prepared and analysed for BC7 (see comment on 6.1.1.7). It is unclear to us why amorphous design options are not included in this analysis. Please clarify and/or add amorphous designs.	The lack of improvement options is a result from a scarcity of data received. If you have further market and technical information, please supply it.
CLASP-Europe	6.2.1.7	38	We reject the notion that the market is already using lowest life-cycle cost transformer as our experience with this market does not reach this same conclusion. As stated earlier in these comments, we suggest that greater transparency around the energy-efficient designs be provided – Annex C and the tables in Chapter 6 do not provide adequate information to assess the reasonableness of these findings. We reiterate our suggestion for further design options for BC7, as this one design is not satisfactory. It is unclear to us why amorphous design options are not included in this analysis on BC7. Please clarify and/or add amorphous designs.	The data available to the project team gave these results. The lack of improvement options is a result from a scarcity of data received. If you have further market and technical information, please supply it.

CLASP-Europe	6.2.2	39	We suggest that the amorphous designs on BC1 be added to the discussion in section 6.2.1.1 on BC1. We do not understand why these results are presented separately from the analysis of conventional material. We note again that we do not believe these to be optimised amorphous designs, after comparing these draft findings to the published designs prepared by the US Department of Energy. We suggest that amorphous designs be prepared for BC2, BC3, BC5, BC6 and BC7 and that these designs be incorporated into sections 6.2.1.2, 6.2.1.3, 6.2.1.5, 6.2.1.6 and 6.2.1.7 respectively.	This section includes only improvement options with traditional technology. Section 6.2.3 compares all improvement options together.
CLASP-Europe	6.2.3	42-44	This section becomes redundant if you address the comment on sections 6.2.1.1 and 6.2.2 to combine the conventional steel and amorphous analysis in the first instance. This would reduce repetition in the Chapter and present the findings in an appropriate manner for stakeholders.	The project team will discuss internally about possibly restructuring the document.
CLASP-Europe	6.3	51-52	This section on best not available technologies would benefit from adding discussion on: 1. Larger kVA ratings of hexaformer designs (perhaps this technology also deserves discussion in the Best Available Technology sections of Chapter 6)? Please see the following page: http://www.hexaformer.com/Oil-insulated-3-phase-transformers.htm 2. The potential for oil-immersed hexaformer designs with a wound amorphous core – this combination of design options would represent a premium-efficiency transformer. We are aware of the fact that a prototype amorphous-	Indeed it is a good suggestion to add a section related to BNAT in 6.3: including larger AMT types and hexaformer types. On solid state technology transformers: Solid state convertors have inherent voltage drops and losses created by semiconductors, They also suffer from low efficiency at low loads, a.o. due to control circuits losses (e.g. as know

			hexaformer has been constructed, although it has not yet been commercialised. 3. Solid-state technology transformers – this design option, likely to start initially at smaller kVA ratings, has the potential to resolve some of the problems associated with distribution transformers. It can mitigate power quality problems, converting loads to sinusoidal and unity power factor, improving the efficiency of the grid. It can mitigate secondary faults, readily supply dc offset loads, and offer very low no-load losses. These products do not utilize mineral oil and thus are potentially more environmentally friendly, and are based on a technology (power electronics) where component costs are falling.	from PV convertors). PV convertors have typically 92-95 % full load efficiency and 99 % is rare and only achieved by transformerless types (not of use). Please provide more information if any evidence of this solution is available? If significant, It should be included in chapter 5.
CLASP-Europe	6.4.4	69	It appears that Table 32 may have the electricity tariff for DER Transformers swapped. The average used in BC5 and BC6 is €0.30/kWh and the MAX level used in the sensitivity should be €0.40/kWh. Note too, what are “Task 4 and Task 6” – do you mean instead “BC5 and BC6”?	Thank you, this will be updated.
ThyssenKrupp	Task 6 general		To ensure comparability, we propose to indicate the core steel grades (e.g. GO M095-27P or Amorphous SA1) and the working induction used in the various model calculations	Unfortunately, we do not have information at this level of detail and thus we cannot include this data.
ThyssenKrupp	6.1.2	15	Table 15: In the columns "relative" some values refer on A02Ck, but other to D0Ck (maybe wrong formula)	Thank you for noticing this. Explanatory text will be added.
ThyssenKrupp	6.1.2 and 6.2.2	15 and	Table 15/25: The transformer type (single or three	I do not understand this comment – this information was not indicated for any of the improvement options. The

		39	phase?) and the power rating (400kVA?) is missing here	options are assumed to have similar characteristics as their respective base-case.

ANNEX S: COMMENTS ON TASK 7 RECEIVED BEFORE THE THIRD STAKEHOLDER MEETING

ID	Stakeholder	Section	Page	Comment	Vito and Biois reply
Task 7					
1	**T&D Europe**	**7**	**Title**	**The title do not include the small transformers that are not part of distribution and power transformers. A definition of small transformers is needed and this topic should have a special part in an other document.**	The term “power transformers” covers the small transformers in question according to IEC standards. Normally the titles are not changed.
2	**T&D Europe**	**7.1.1.1**	**7**	**The minimum of rated is not acceptable. The minimum must be 50KVA because most of all pole mounted transformers and some cabin transformers are with this kind of rated power. Utilities in France, Portugal in Spain…… operate with these rated power.** **For Oil distribution transformers (ODT) the maximum rated power should be 3,15MVA to be in compliance with dry type transformers.**	According to our interpretation 100 kVA is the maximum for the compact or pole mount category, please explain? To be discussed in the stakeholder meeting. Will be extended to 3.15 MVA (note EN 50464-1 should be extended as well including inter- and extrapolation)
3	**T&D Europe**	**7.1.1.1**	**7**	In yellow in document. Very compact three phase oil distribution transformer is not understood by manufacturers. In any case transformers between 50KVA and 630KVA must be in the same categories. These transformers should have some restrictions in terms of dimensions and size. Dimensions are for compact substation and weight are for pole mounted transformers at least between 50KVA and 160KVA; Stakeholders’ suggestions are welcome to define the maximum size and weight related to transformer rating: For pole mounted transformers the maximum weight is 550KG in France for cranes	The weight limitation of 550kg in France appears to be for crane capacity reasons which doesn't seem valid for the functioning of the transformer itself. To be explained and discussed in the stakeholder meeting.

				reasons. WAITING FOR DATA FROM SPAIN AND PORTUGAL Limits of dimensions are according to the utilities requirements.	
4	**T&D Europe**	**7.1.1.3**	**8**	**Definition for large power transformers is not correct. We propose two new categories: MPT(Medium power transformers) transformers which are between 3,15MVA up to 30MVA and an other large power transformers which is above 30MVA. Large and Medium power transformers are used not only for transmission purpose but for other application like primary distribution, generation… title has to be taking into account these applications.**	We suggest to use 'Medium and Large power transformers'. The borderline between medium- and large is unclear, e.g. comment 18 suggests 100 MVA. In principle it should not matter.
5	**T&D Europe**	**7.1.1.4**	**8**	**Title :Limits must be changed 100KVA must be replaced by 50KVA**	Not agreed: this is not for so-called distribution transformers and they exist in 63 kVA. To clarify text was modified to: '..with highest- voltage winding (HV) for equipment not exceeding 1 kV
6	**T&D Europe**	**7.1.2.1**	**10**	**This paragraph has to be review for a better understanding. Minimum rated power must be better identified by positive ways. The minimum rated power must be 50KVA.**	Definition and necessity to be discussed in the stakeholder meeting.
7	**T&D Europe**	**7.1.2.1**	**10**	**Each time series of transformers changes that represent an amount of expenses for manufacturers for prototypes and agreement. Therefore manufacturers don't want to change each 3years the level of losses of the transformers. Therefore manufacturers request to have directly the final level of losses.** **That means 2013 50KVA <=rated power <=630KVA 2013 A0Ck**	**Agreed**

				That means 2013 >630KVA 2013 A0Ak	
8	**T&D Europe**	**7.1.2.1**	**10**	**The second part of this paragraph "The proposed loss limiting requirement…… to dry type transformers" is not applicable to distribution transformers and must be deleted**	**OK**
9	**T&D Europe**	**7.1.2.3**	**10**	**Large power 110KV and 100MVA are not enough representative for European market and that leads to mistake in the conclusion. European manufacturers have decided to transmit to VITO a form to launch a new enquiry regarding rules (losses, cost and rated voltage).**	**Enquiry was launched and will be discussed in the stakeholder meeting**
10	**T&D Europe**	***7.1.13.2***	**24**	**Manufacturers prefers to change in one time to the final level of losses to avoid useless expenses**	**See also remark 7.**
11	**T&D Europe**	***7.1.13.4***	**38**	**Precision has to be given to indicate if LLCC is present time core technology (stack core)**	**The data used in the improvement options does not dictate a specific design (please read version V26), but rather an average that can be reached with various manufacturers using different design options.**
12	**T&D Europe**	***7.2.3***	**46**	**To move to amorphous transformers manufacturers have the needs of several years because all machines for core must be changed and winding machines should be modified. Invest to achieve such modification are important and difficult for smaller manufacturers.** **Supplier of amorphous have needs of time to increase quantities manufactured.**	**Text added**

13					
14	**ENA consulting**	***7***	**All**	**OBSERVATIONS ON APPROACH** It would appear that the whole approach is based solely on the reduction of losses in the transformer. It seems strange therefore that in previous comments referring to cables that nothing is being proposed for cable or line losses which are much more dominant that transformer losses in terms of overall loss in the system. Recent experience has shown that asset replacement with new units having losses at the high end of current technology will still result in a reduction in losses overall. However, as markets can be set up such that the asset owner does not really pay for the losses, there needs to be more coordinated thinking in how this will impact in Member States. Regulatory price controls will need to reflect the European wide situation if utilities are forced to procure higher cost assets for little or no return. No-load loss reduction can be achieved by improving the core steel quality or the introduction of amorphous cores (lower end distribution only). Load losses can be reduced by using larger conductors. None of this is new! It has all been done before. What is being proposed is to introduce maximum loss figures into the standards which will force the utilities to procure more efficient transformers. However, utilities that apply TCO or LLCC to their procurement are often likely to be procuring at these lower proposed losses already. If the losses are enshrined in the standard this will also remove any incentive for manufacturers to move forward with even more efficient designs in the future. Fixed losses can also remove the	The focus is indeed on transformers, nevertheless a cable related issue was taken into account. On impact a new section (7.2.4) will be added that procurer higher cost transformers might reduce capital available for other investments (cables, ..). This item will be explained. It is indeed important, especially for TSOs, that seeking more efficient transformers by applying TCO or LLCC is not abandoned. Therefore a dedicated section 7.2.5 will be added as well. There should be no conflict, see also comments 50 and 51.

				ability of a utility to negotiate a lower cost solution as the manufacturer can insist on supplying what the standard permits. This solution is really only applicable for the industrial market. We are concerned that forced standardisation in this area may actually hinder the ability of utilities to reduce their cost of ownership, and may indeed cause increases in costs. We do not disagree with the objectives to reduce energy consumption overall, but this is better done by introducing incentives for better R&D and design changes via commercial and specified requirements rather than standardisation. Recent UK experience demonstrates that the required levels of losses can be obtained by means other than through standardisation.	
15	**ENA consulting**	***7.1.1***	**All**	• UK Utilities apply LLCC and or TCO to all distribution and power transformer procurement as a matter of good business practice. • Concept of BAT or BNAT should be considered to be a matter for the manufacturer to offer as the lowest lifetime cost. • Modifying a standard to include loss figures is a retrograde step as this stops utilities driving losses lower to achieve even lower LLCC's as the manufacturers would always claim/decide to work to the standard. We do not disagree with the concept, but the LLCC's for different utilities will be different depending on their business situation, e.g. required	• See previous remark. A section will be added and the issue will be discussed at the stakeholder meeting • Table 7-1 will be discussed at the meeting as well. It needs to be replaced by a European more ambitious table. (see also other stakeholder comments).

				Rate of Return on Investment, cost of capital, design of system etc. • Standardisation of losses has been attempted before in the UK and it did not work because different partners in the procurement consortium had different key requirements and this ended up being counter-productive. It can also fall foul of national competition legislation as it requires competitors to "collude" with the design (and therefore the price) of major assets. • Transformer no load losses as obtainable in standard UK practice has been consistently at the lower end of all the figures quoted in table 7-1 for many years. This has been achieved by active capitalisation of losses policy driven by the utility	
16	**ENA consulting**	***7.1.1***		**For a 90 MVA transformer load loss figures in Table 7 are very close and will make little difference across the grades. E.g. grade 2 is 322.3kW and grade 1 is only 319.2 kW. Where the load factor is 0.2, this means the reduction to grade 1 saves only 3.1 x 0.2 kW or 0.6 kW. This is less than the variations in capitalisation formula and much less than the loss tolerance in IEC 60076-1 and therefore not worth considering. It is much more important to consider load losses in conjunction with the intended applications which only the purchaser can know fully about.** **The no load losses in table 7-1 in grade 1+ are consistent with what has been achieved regularly by one UK DSO/TSO over the last decade. If this is then intended to save energy, then the grade 1 + is not low enough.** **The approach should not be to detail maximum losses. It**	Table 7-1 will be discussed at the meeting as well. It needs to be replaced by a European more ambitious table. (see also other stakeholder comments).

				should be to specify target losses and introduce some other control mechanism for excessive losses. Otherwise the manufacturer would simply supply the maximum losses permitted, thereby simplifying his own processes and giving him more profit. (This has been done in the UK with noise levels). It should be a case of specifying what is needed and not what the manufacturer can do at the moment, otherwise there is no incentive for the manufacturer to invest in further R&D.	
17	**ENA consulting**	***7.1.1.1***		**DER transformers have been lumped together with distribution transformers, but this is not the case in the standards – IEC 60076-16 is about to be issued specifically to deal with the special nature of DER transformers. The load cycle on these devices is also significantly different from distribution transformers.**	The study discrimated DER transformers (BC 5 and 6). The need for discrimination DER transformers will be discussed in the meeting and IEC 60076-16 will be added and investigated if this include loss limits.
18	**ENA consulting**	***7.1.1.3***		**Definition of large power transformer – this is incorrect as the definition of a large power transformer is above 100 MVA as per IEC 60076-7. Above 5 MVA and less than 100 MVA is defined in the same standard as a medium power transformer**	**See comment 4, text modified to 'Medium and Large power transformers..**
19	**ENA consulting**	***7.1.1.4***		**This size of transformer is defined as a distribution transformer in IEC 60076-1.**	To clarify text was modified to: '..with highest- voltage winding (HV) for equipment not exceeding 1 kV to discriminate from so-called distribution transformers.
20	**ENA consulting**	***7.1.3.1***		**We disagree with the conclusion that low efficiency transformers have been procured by TSO's. Typical loss figures for a 90 MVA 132/33 kV standard transformer purchased by one Utility in the UK in the last few years are no load loss**	Text will be updated. It differs from DSO and indeed several have procured for more efficient transformers compared to grade 1 in

				29.5 kW, load loss 315 kW (i.e. as proposed for 2015 even including a 5% tolerance on load loss!). Without any tolerances, these figures are both well below the best values quoted in table 7-1 and are the values obtained by good application of capitalisation formulae	the Chinese standards for decades.
21	**ENA consulting**	***7.1.3.1***		**TSO's and DSO's have monopolies and can pass on all investment costs to the end user. From the UK perspective this statement is not true. Costs passed on to the end user are based on regulatory price controls and are based on "use of system" charging. This can mean rising costs but income from the use of system being reduced!**	**Text will be modified to: ..could .. which might not offer the proper incentive, however there exist regulatory price control mechanisms that might reduce profit when grid losses increase.** **This is not EU27 wide policy, please look at comment 60.** **Please refer to TSOs that made financial losses due to this?**
22	**ENA consulting**	***7.1.3.1***		**- total cost of ownership may well be increased in the longer term by adopting the most efficient loss categories. This is wholly dependent on load profiles, utilisation and seasonal demand fluctuations etc; only the sourcing utility can really determine the optimum mix and therefore the true cost of ownership**	**Text need to be modified. Indeed the load profile must be neutralized when comparing A and B. In the study $B = Ax(\alpha xKf)^2/PF^2$.** **Would result in $B \geq 0.8Ax(\alpha xKf)^2/PF^2$ and making available the load profile parameters assumptions (α,Kf,PF)?** **To be discussed.**
23	**ENA consulting**	***7.1.6***		**need for a new standard for industrial transformers – this is not**	**Not agreed by the manufacturers,**

				required as these transformers are covered by the IEC 60076 series at the moment. What is needed is a change to the capitalisation approach for this type of transformer where the first cost is always the dominant factor due to the way these units are procured and installed.	**should not be mixed with so called distribution transformers? .. industrial transformers with high voltage winding below 1 kV.**
24	**ENA consulting**	***7.1.6***		**Therefore, un update of the IEC 60076-11 standard for oil filled transformers is needed taking new developments and test results into account - IEC 60076-11 is the standard for dry type transformers and not for oil filled**	**Text will be updated and provide more clarification** Therefore, an update of the IEC 60076-11 standard to include oil filled transformers is needed or a new one dedicated to dry type transformers can be developed.
25	**ENA consulting**	***7.1.7***		**need to reduce tolerance on loss measurement in IEC 60076-1. This has been called for by a number of European experts during the recent revision of IEC 60076-1 and has been rejected for a number of reasons, mainly linked to the use of this standard for all transformers up to the largest voltages of 1200 kV and 2000 MVA and higher where manufacturing tolerances cannot be so closely controlled. The new version of IEC 60076-1 is scheduled for publication towards the end of 2010 and will not be due for revision until around 2015. What is needed is a separate document for distribution transformers which can then be used to separate the requirements of the standard for the different types of product. This has been recognised in the IEC community but as yet there has been no volunteer to lead such a modification. This is also recognised by many utilities by the application of a "no positive tolerance" clause in their specifications which effectively resets this tolerance to +0%!**	**Noted and to be discussed in the stakeholder meeting** **Good suggestion for 'no positive tolerance' or +0%**
26	**ENA consulting**	***7.1.7***		**addition of efficiency class to transformer rating plate in IEC 60076-1. This document is about to be re-issued with a new version. Future changers would need to be incorporated in the**	**Noted and text added**

				next review scheduled most likely for 2015 or 2016	
27	**ENA consulting**	***7.1.9***		**If the transformer is at end of life, it is reasonable to assume that all the ancillary components will also be at end of life and therefore re-use is not really an option.**	**Yes.**
28	**ENA consulting**	***7.1.10***		**The addition of a third winding to increase voltage and reduce loss. This is not really practical in general terms as the investment to increase voltages would be determined by the need to re-lay a huge amount of cable. Where cables are capable of being uprated to a higher operating voltage, most utilities have schemes in place to adopt "dual ratio" transformers**	**In this configuration there are no double windings, it is only a matter of reconfigurating windings from parallel to series. Hence there are no extra losses, cost increase is due to some extra terminals and wiring.**
29	**ENA consulting**	***7.1.13.1***		**BAU in the UK utility sector would most likely comply with the proposed lowest losses. Does this imply that the rest of Europe has been less attentive to the capitalisation process?**	**The data available to the project team is for the EU-27. There will obviously be some variations between countries.**
30	**ENA consulting**	***7.1.13.4***		**Figure 7-6 BC4 graph – This does not reflect the UK utility situation where the BAU case is lower than the LLCC (see earlier examples) and the BAT cases for three phase distribution and transmission class transformers.**	**The data available to the project team is for the EU-27. There will obviously be some variations between countries.**
31	**ENA consulting**	***7.2.3***		**A strategy of encouraging amorphous core development will almost certainly mean European manufacturers will lose out to the existing manufacturers of this technology from the USA, Japan and Asia. This will mean further dependence on overseas suppliers and a reduction (potentially significant) in the European manufacturing base. This is not the right strategy for an integrated approach from the EC.**	**Noted. Text will be updated. This might be for steel manufacturers but isn't de facto the case for transformer manufacturing.**
32	**Hitachi Metals / Metglas**	Chapter 7 Summary For several standards,	**6**	The categories proposed to handle amorphous are not appropriate for amorphous. Ao is based on a silicon steel standard and using a fraction of Ao for amorphous will not	The is a close fit between this proposal for AA0 or A0+ with 0.5A0, e.g.: 90/2, 145/2, 210/2

<table>
<tr>
<td></td>
<td></td>
<td>updates are recommended, especially to add two extra no load losses categories (0.75A0, 0.5A0) in standard EN50464-1 to cover BAT developments of amorphous transformers</td>
<td></td>
<td>result in values appropriate for amorphous. Hitachi Metals/Metglas recommends that one new category is added (perhaps called AAo or Ao+). It is hereby proposed that this standard would have the following NLL values:

Table 1 – proposed AAo NLL

<table>
<tr><th></th><th colspan="2">Recommendation</th></tr>
<tr><th></th><th>4%</th><th>6%</th></tr>
<tr><td></td><td>S15 - 8%</td><td>S15 - 15%</td></tr>
<tr><td>Power</td><td>P0</td><td>P0</td></tr>
<tr><td>kVA</td><td>W</td><td>W</td></tr>
<tr><td>Power</td><td>SH15-8%</td><td>SH15-15%</td></tr>
<tr><td>50</td><td>40</td><td></td></tr>
<tr><td>100</td><td>69</td><td></td></tr>
<tr><td>160</td><td>92</td><td></td></tr>
<tr><td>250</td><td>129</td><td></td></tr>
<tr><td>315</td><td>156</td><td></td></tr>
<tr><td>400</td><td>184</td><td></td></tr>
<tr><td>500</td><td>221</td><td></td></tr>
<tr><td>630</td><td>294</td><td>272</td></tr>
<tr><td>800</td><td></td><td>323</td></tr>
<tr><td>1000</td><td></td><td>383</td></tr>
<tr><td>1250</td><td></td><td>451</td></tr>
<tr><td>1600</td><td></td><td>536</td></tr>
<tr><td>2000</td><td></td><td>638</td></tr>
<tr><td>2500</td><td></td><td>765</td></tr>
</table>

These values are based on the current Chinese standard S15 which is only applicable to amorphous. In China, amorphous transformer makers routinely exceed the S15 standard and it is common for Chinese power supply bureaus to ask for some % below S15 in their tenders. Metglas analysis shows that the values in Table 1 would be achievable by European transformer makers. The reason that the proposed values go from S15-8% for 4% short circuit impedance to S15-15% for 6% is that the Chinese standard is entirely based on 4%.</td>
<td>matches closely 40, 69, 92,..

The proposal with 0.5A0 would round off values in line with the existing standards and current measurement tolerances.

Therefore at least 0.5A0 should be added. The 0.75A0 could serve other developments with silicon steel.</td>
</tr>
</table>

33	**Hitachi Metals / Metglas**	7.1.2.1 Proposed maximum load and no-load losses requirements for Oil-immersed distribution transformers The proposed maximum load and no-load losses requirements for Oil-immersed distribution transformers not being so-called 'very compact Three-phase oil-immersed distribution transformers (≤100 kVA)' is: - ≤630 kVA C0Ck in Tier 1 (2013) and A0Ck in Tier 2 (2015) - >630 kVA B0Bk in Tier 1 (2013) and A0Ak in Tier 2 (2015)	**10**	This Tier 1 requirement seems very low. In an international comparison Europe would rank well below the US, Japan, China and India.	Noted. There is another proposal to directly implement Tier 2 (comment 7).

34	**Hitachi Metals / Metglas**	7.1.3.2 Policy recommendations towards distribution transformers operated by Transmission System operators (TSO) The identified BAT (A0Ak) should serve as a reference and at least the LLCC should be implemented.	**13**	Where does this result come from? A and B factors: what do these assumptions mean exactly? If the difference between A and B factor is limited to 15%, this would mean a load factor of 90%. Hitachi Metals/Metglas is requesting more explanations.	Indeed this should be corrected (see comment 22).
35	**Hitachi Metals / Metglas**	7.1.7 Needs for standards to be updated It is therefore recommended to extend the classes up to 0.5xA0 and also include an intermediate class 0.75xA0, e.g. called AA0 and AAA0.	**16**	Please see earlier comments	Noted
36	**Hitachi Metals / Metglas**	**7.1.13.1/2/3**	**19/31**	7.1.13.1/2/3 All scenarios have a very inefficient entry point. Hitachi Metals/Metglas believes that, if the correct (market) prices are used for AMDT's, AMDT's will easily become the lowest LLCC. BAT conclusions may also be altered by using correct AMDT prices.	**The scenarios were conducted using the market data available to the project team. Updates to this data will be discussed in the stakeholder meeting.**

37	**CLASP**	**7 All**		**Thank you for the opportunity to review draft Chapters 6 and 7 of the EuP Study: Lot 2 Distribution and Power Transformers. Overall, we are impressed with the quality of the work prepared, its readability and presentation. We do however have a range of comments on both chapters which we prepared for your consideration. In the pages that follow, we provide detailed comments on these chapters using the template provided on your website. I summarise our main issues below:** **• The text would benefit from further clarity on scope of coverage / regulatory applicability, particularly for "very compact" subcategory exemptions and kVA ratings not included in the scope of covered products (e.g., between 2500 and 5000 kVA for oil-immersed and between 3150 and 5000 kVA for dry-type).** **• The schedule phasing in regulations and the regulations themselves are not ambitious, with certain levels cost-justified in 2010 only being adopted in 2015.** **• Large power transformers appear to have very weak standard levels under consideration, far higher than "typical utility" losses for the 100 MVA rating according to SGB Starkstrom. CLASP proposes an alternative table of efficiency values, based on this industry data.** **• The chapter would benefit from clarification of how to treat non-standard kVA ratings (i.e., kVA ratings that fall between two standard numbers in a table).** **• We continue to believe a lower tolerance on manufacturing losses is possible, given advances in the last two decades in steel, core-cutting equipment, annealing furnaces and other production engineering. We suggest 5% instead of the IEC 60076's 10% from 1993 (or earlier).**	**Noted these priorities**

38					
39	**CLASP-Europe**	**7.1.1.1**	**7**	**We support the use of EN 50464-1 to define covered products, as it becomes immediately clear to manufacturers whether a transformer would be covered or not. We note that in this instance, three-phase oil-immersed distribution transformers would be covered, spanning from 50 kVA to 2500 kVA with the highest voltage not exceeding 36 kV. This encompasses transformers represented by BC1, BC2 and BC5.** **We are concerned that in the second paragraph of this section, the contractors introduce discussion of "very compact" three-phase oil-immersed distribution transformers and state that this group might need different and less stringent losses. This issue has not been previously discussed in Chapters 1 through 6, nor have the Commission's contractors investigated how upgrading materials and changing core constructions can reduce volume while also improving efficiency. CLASP is concerned about the last minute introduction of this issue because of the lack of analysis and the uncertainty behind:** **a) how would "very compact" be defined from an application perspective? This is important to prevent this class from being exploited as a loop-hole, undermining the energy savings potential.** **b) how much would the Commission relax the stringency on losses?** **These are critical questions which have not been explored or discussed in any previous chapter, but are simply stated as fact in the policy and impact analysis chapter. In order to better understand regulatory levels and impacts on size, we suggest that this subject be investigated and presented in one of the chapters of the Preparatory Study. In addition, we are aware that by upgrading materials and changing core shapes, it**	**This point will be discussed in the stakeholder meeting.**

				is possible (to a point) to reduce size while increasing efficiency, and thus we would suggest some analysis around this issue before simply stating that all space-constrained transformers should have a lower level. This may not be justified, as more compact alternatives may exist.	
40	**CLASP-Europe**	**7.1.1.2**	**7-8**	**We support the use of EN 50541-1 to define covered products as covered product is very clear. We note that this group encompasses "Three-phase dry-type distribution transformers 50 Hz, from 100 to 3150 kVA, with the highest voltage for equipment not exceeding 36 kV." We note (and agree) that no subcategories are required for dry-type transformers, and that all would be subject to the same regulatory level.**	**Noted**
41	**CLASP-Europe**	**7.1.1.3**	**8**	**This section discusses 'large power transformers (>5 MVA) used in 50 Hz electricity transmission.' The definition provided (i.e., "a static piece of apparatus with two or more windings which, by electromagnetic induction, transforms a system of alternating voltage and current into another system of voltage and current usually of different values and at the same frequency for the purpose of transmitting electrical power") is based on the International Electrotechnical Vocabulary (IEV) and does not define any kVA ratings.** **We are concerned by the use of the MVA rating in brackets: "(>5 MVA)" as this is a constraint which appears to leave certain ratings, such as between 2500 and 5000 kVA for oil-immersed and between 3150 and 5000 kVA for dry-type transformers without coverage under EcoDesign. CLASP wishes to ensure maximum possible coverage of large kVA oil-immersed and dry-type transformers, and we are concerned that the scope of coverage identified in 7.1.1.3 is unclear and may be incomplete.** **We suggest that in establishing the definitions addressing scope of coverage in sections 7.1.1.1, 7.1.1.2, 7.1.1.3 and 7.1.1.4 that VITO work to establish clear definitions that encompass**	**Will be discussed in the stakeholder meeting. Medium and large power transformers are not such a big market (few 1000) and an extra enquiry was launched to seek more information and extend and optimize requirements.**

				the complete set of transformers originally envisioned in Chapter 1 of the preparatory study. We are concerned that through the use of specific industry standards, the identification of explicit kVA ratings and voltage ranges, there will be products that are inadvertently excluded from any future regulation which will distort the market, undermine the Ecodesign Directive objectives and forego the opportunity for energy savings. We therefore suggest that VITO add a table to summarise the coverage of this table, much like was done in Table 1-3 of Chapter 1, to establish the roadmap between the broad scope discussed in Chapter 1 and the explicit definitions being proposed in Chapter 7.	
42	**CLASP-Europe**	**7.1.1.4**	**9**	**We support the focus on efforts to define special purpose transformers with well defined target applications in order to avoid loopholes, however we are unclear on what VITO considers to be 'special purpose' beyond the explicit mention of welding transformers and guitar amplifier transformers. We suggest that more development of this section be applied in order to clarify the transformers that would be subject to any exclusion from the regulation. We would then suggest an opportunity to review those special applications, the definitions for them, the rationale behind granting them the exclusion and the approach the Commission will follow to ensure that these exclusions don't develop into loop holes.**	**Scope discussed in the stakeholder meeting, any suggestion are welcome.** **It remains a niche market which is hard to map. Figuring out the last potential loophole in this area might unduly delay other regulation. The product group of smaller industrial transformers had a low estimated impact on energy consumption.**
43	**CLASP-Europe**	**7.1.2.1**	**10**	**This section addresses maximum losses for oil-immersed distribution transformers, which represent a very large share of the European transformer market. The draft document proposes the following schedule for transformers that are not subject to space constraints:** **≤630 kVA C0Ck in Tier 1 (2013) and A0Ck in Tier 2 (2015)**	**Agreed to review Tier 1 with Tier 2 targets. See also other stakeholder comments.** **The main reason for not going beyond classes A0Ak was that neither in manufacturers**

				>630 kVA B0Bk in Tier 1 (2013) and A0Ak in Tier 2 (2015) **CLASP is very disappointed that levels which are economically justified in 2010 must wait for five years to be introduced to the market. There is no discussion or explanation in this section as to why these levels are selected, or why they are being proposed on this schedule. Furthermore, as discussed in our comments on Chapter 6, we believe the 400 kVA oil-immersed unit at A0Ak is overpriced, which causes the minimum life-cycle cost to fall at the level proposed here of A0Ck in Tier 2. And, for the 1000 kVA oil-immersed transformer, we expressed concern that A0Ak was not ambitious enough in terms of losses, stating A0+ and Ak+ levels should be developed and analysed to see if they are more cost-effective than A0Ak.** **CLASP suggests that the Tier 1 (2013) level be A0Ak for all oil-immersed transformers (≤630 kVA and >630 kVA) under EN50464-1 and that the Tier 2 (2015) level be defined at a level more ambitious than A0Ak. For example, A0+Ak+ levels could be developed by deducting 50% of the difference in losses A0 and B0 from A0 to create A0+ and deducting 50% of the difference in losses between Ak and Bk from Ak to create Ak+. The table of efficiency values would look as follows:**	**catalogues neither in DSO literature evidence could be found that such transformers are sold or installed, hence it is not 'BAT'.** **Noted:** - **a proposal for a softer A0+ close to 0.9A0.** - **For larger transformer >630 kVA a second Tier 0.9Ak could be an option. Taking into account that it is technical feasible but not a current product on the market yet.**

				<table><tr><th>No Load Losses P0 Rated Power</th><th>Tier 1 (2013) A0 (watts)</th><th>Tier 2 (2015) A0+ (watts)</th><th>Impedance (%)</th></tr><tr><td>50</td><td>90</td><td>80</td><td rowspan="8">4%</td></tr><tr><td>100</td><td>145</td><td>128</td></tr><tr><td>160</td><td>210</td><td>185</td></tr><tr><td>250</td><td>300</td><td>270</td></tr><tr><td>315</td><td>360</td><td>320</td></tr><tr><td>400</td><td>430</td><td>385</td></tr><tr><td>500</td><td>510</td><td>460</td></tr><tr><td>630</td><td>600</td><td>535</td></tr><tr><td>630</td><td>560</td><td>500</td><td rowspan="8">6%</td></tr><tr><td>800</td><td>650</td><td>575</td></tr><tr><td>1000</td><td>770</td><td>685</td></tr><tr><td>1250</td><td>950</td><td>850</td></tr><tr><td>1600</td><td>1,200</td><td>1,075</td></tr><tr><td>2000</td><td>1,450</td><td>1,275</td></tr><tr><td>2500</td><td>1,750</td><td>1,550</td></tr><tr><th>Load Losses Pk(W) Rated Power</th><th>Tier 1 (2013) Ak (watts)</th><th>Tier 2 (2015) Ak+ (watts)</th><th>Impedance (%)</th></tr><tr><td>50</td><td>750</td><td>688</td><td rowspan="8">4%</td></tr><tr><td>100</td><td>1,250</td><td>1,138</td></tr><tr><td>160</td><td>1,700</td><td>1,550</td></tr><tr><td>250</td><td>2,350</td><td>2,150</td></tr><tr><td>315</td><td>2,800</td><td>2,575</td></tr><tr><td>400</td><td>3,250</td><td>2,950</td></tr><tr><td>500</td><td>3,900</td><td>3,550</td></tr><tr><td>630</td><td>4,600</td><td>4,200</td></tr><tr><td>630</td><td>4,800</td><td>4,400</td><td rowspan="8">6%</td></tr><tr><td>800</td><td>6,000</td><td>5,500</td></tr><tr><td>1000</td><td>7,600</td><td>6,900</td></tr><tr><td>1250</td><td>9,500</td><td>8,750</td></tr><tr><td>1600</td><td>12,000</td><td>11,000</td></tr><tr><td>2000</td><td>15,000</td><td>13,500</td></tr><tr><td>2500</td><td>18,500</td><td>16,750</td></tr></table>	
44	**CLASP-Europe**	**7.1.2.1**	**10**	**This section proposes to constrain 'very compact' (i.e., space-constrained) three-phase oil-immersed distribution transformers to be less than or equal to 100 kVA.** **While we welcome the restriction of this sub-category to a**	**Noted** **Scope and range will be discussed in the meeting.**

				partial range of rated power (kVA) levels, we remain concerned about how this subcategory will be defined. For example, would it apply to every oil-immersed transformer of 100 kVA or less? We remain very concerned about the lack of clarity around defining 'very compact' transformers. **We note that the loss-limiting requirement presented for 'very compact' transformers would be the use of copper conductor (instead of aluminium) and the use of domain-refined grain-oriented electrical steel with a performance of 0.96 Watt per kg at 1.7 Tesla at 50 Hz. We support the concept of a materials design standard alternative, as it should result in very compact designs – however, we have the following comments:** **1) The domain refined material you have selected at 0.96 Watt is not the best performing domain-refined electrical steel, and there are better materials that can achieve 0.85W/kg (from Thyssen-Krupp) and 0.90W/kg from AK Steel. We suggest this better domain-refined steel because it will not only save more energy, but it will enable construction of more compact designs. In addition, the higher cost of the material would deter manufacturers from using this subcategory as a loop-hole.** **2) In addition to requiring copper and domain-refined core steel, for clarity of design we would also suggest requiring seven-step mitred construction, as this will ensure the core design benefits from use of the high-quality core material in an optimal way.** **3) We are concerned about how the Commission would enforce this regulation in practice. We would welcome further clarification on how this requirement would be enforced, given that this subcategory of transformer may be commonly applied in some member states, depending on their particular distribution network. It would be very unfortunate to later learn that companies**	**About the material loss 0.96W/kg: this allows some competition and mechanical scribed material that might be needed for some particular core forms that annealing.**

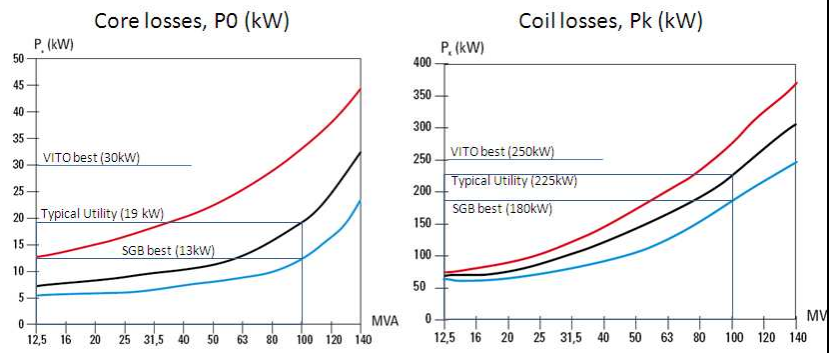
				that comply with the regulation have lost business to less scrupulous companies who supplied transformers that failed to meet these requirements, gambling on the fact that there is little probability of being discovered to be non-compliant.	
45	**CLASP-Europe**	**7.1.2.2**	**10**	**The opening sentence is unclear: "When drafting those requirements the risk for mitigation from oil-immersed to dry type transformers needs to be considered." We are unsure what is being stated here, we thought you might mean the following: "When drafting the dry-type distribution transformer requirements, the risk of dry-type transformers being substituted for oil-immersed transformers needs to be considered."** **If this is indeed the intended statement, then we share your concern on this point, as you rightly point out in this section, the losses of an A0Ak oil-immersed are much smaller (430W core, 2800W coil) than an A0Ak dry-type (700W core, 4500W coil), and if the standard on dry-type is weak, it could trigger a migration to dry-type – with near doubling of transformer losses, completely undermining the objectives of the Ecodesign Directive.** **CLASP therefore supports the adoption of the A0Ak regulation for dry-type transformers from Tier 1 (2013) to avoid loopholes. Furthermore, we refer back to our comments on Chapter 6 for the 1.25MVA dry-type transformer (BC3) where we suggested that additional designs be prepared for this analysis, developing A0+ and Ak+ levels which will explore further the relationship between maximum efficiency and minimum life-cycle cost. For the 1.25MVA unit, we suggested a design at A0+ of 1600W and an Ak+ of 9500W. We would suggest that A0+Ak+ levels be adopted for Tier 2 (2015) which are calculated by deducting 50% of the difference in losses A0 and B0 from A0 to create A0+ and deducting 50% of the difference in losses between Ak and Bk from Ak to create Ak+. Then, Tier 2 (2015)**	**Agreed text was incomplete.** **Will be reformulated as suggested.** **Suggestion for additional levels noted but the draft standard is currently for voting and a short term revision might be unlikely.**

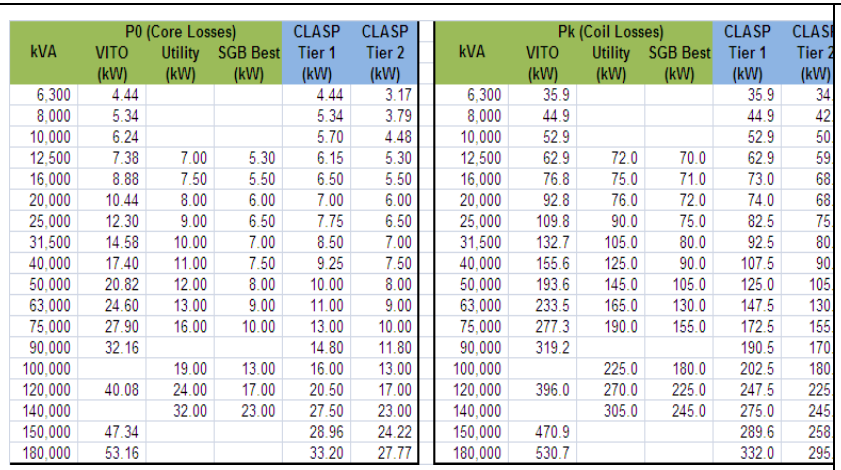
<table>
<tr><td></td><td></td><td></td><td></td><td>can adopt A0+Ak+.

As an example of how this would work, the following table presents our suggestion for 12kV dry-type transformers with 6% impedance voltage:

<table>
<tr><th>kV</th><th>kVA</th><th>Tier 1 (2013) Ak (watts)</th><th>Tier 2 (2015) Ak+ (watts)</th><th>Tier 1 (2013) A0 (watts)</th><th>Tier 2 (201 A0+ (watts)</th></tr>
<tr><td rowspan="12">12</td><td>100</td><td>1,800</td><td>1,700</td><td>260</td><td>2</td></tr>
<tr><td>160</td><td>2,600</td><td>2,550</td><td>350</td><td>3</td></tr>
<tr><td>250</td><td>3,400</td><td>3,350</td><td>500</td><td>4</td></tr>
<tr><td>400</td><td>4,500</td><td>4,300</td><td>700</td><td>6</td></tr>
<tr><td>630</td><td>7,100</td><td>7,000</td><td>1,000</td><td>9</td></tr>
<tr><td>800</td><td>8,000</td><td>7,500</td><td>1,100</td><td>1,0</td></tr>
<tr><td>1000</td><td>9,000</td><td>8,500</td><td>1,300</td><td>1,2</td></tr>
<tr><td>1250</td><td>11,000</td><td>10,500</td><td>1,500</td><td>1,3</td></tr>
<tr><td>1600</td><td>13,000</td><td>12,250</td><td>1,800</td><td>1,6</td></tr>
<tr><td>2000</td><td>15,500</td><td>14,250</td><td>2,200</td><td>2,0</td></tr>
<tr><td>2500</td><td>18,500</td><td>17,250</td><td>2,600</td><td>2,3</td></tr>
<tr><td>3150</td><td>22,000</td><td>20,000</td><td>3,150</td><td>2,8</td></tr>
</table>
</td><td></td></tr>
<tr><td>46</td><td>CLASP-Europe</td><td>7.1.2.3</td><td>11</td><td>As discussed in Chapter 6, we are concerned that the proposed levels for Large Power Transformers are not ambitious enough, and simply scaling the Chinese table core losses without further adjustment is problematic.

Consider the following graphs from SGB Starkstrom and SMIT Transformers that provide losses in accordance with standards (red line), typical electric utility specification (black line) and values achievable by SGB (blue line).</td><td>Agreed. Also T&D insisted to review this and an enquiry is ongoing to fill this gap.</td></tr>
</table>

				 **We have super-imposed boxes and labels on these SGB graphs to facilitate interpretation of the core and coil losses for a 100 MVA transformer. In Chapter 6, the designs considered for the 100 MVA were 60kW-300kW, 40kW-275kW, 30kW-300kW and 30kW-250kW. From this graph, it is evident that the most ambitious combination of core and coil losses considered in Chapter 6 has higher core and coil losses than the "typical" electric utility specification on the SGB graph. Rather than 30kW of core losses, SGB estimates that utilities typically specify 19kW and they are capable of manufacturing around 13kW. Rather than 250kW, SGB estimates that utilities typically specify around 225kW, and they're capable of manufacturing around 180kW.** **CLASP suggests that the levels for the Large Power Transformers be set at the midpoint between the Typical Utility and SGB Best lines in the graphs above for Tier 1 (2013). Then, Tier 2 (2015) could be the SGB Best line. To cover the kVA ratings that are not included in the SGB plot, CLASP proposes adopting the VITO recommendation or uses the 0.75 scaling rule to determine maximum losses from the SGB curves. The following table presents CLASP's suggestion for Tier 1 and Tier 2 maximum losses for this Large Power Transformers.**	

					
47	**CLASP-Europe**	**7.1.2.4**	**12**	**Table 7-2 presents maximum losses for a limited number of kVA ratings for smaller LV/LV 50 Hz transformers. The section then states that certain 'special purpose' (not defined) smaller LV/LV transformers that are unable to satisfy the maximum loss requirements in Table 7-2 should meet the following design requirements – use rectangular copper wire and core steel with maximum losses of 0.80 W/kg at 1.5 Tesla at 50 Hz.** **CLASP supports this approach, except the core steel should have maximum losses of 0.73 W/kg at 1.5 Tesla at 50 Hz (1.10 W/kg at 1.7T at 50Hz).**	**Noted**
48	**CLASP-Europe**	**7.1.2.1 - .4**	**7-12**	**Throughout this section, it would be helpful if VITO included discussion around how the Commission intends to handle non-typical kVA ratings, such as those not appearing in the tables. This is a minor point, but it should be agreed whether transformers between two ratings would be held to the maximum losses of the rating above or below the non-typical kVA rating, or have their maximum losses of the non-typical kVA based on linear interpolation between the kVA ratings**	**Noted.** **Linear inter- and extrapolation should indeed be added to avoid loopholes.**

kVA	P0 (Core Losses) VITO (kW)	Utility (kW)	SGB Best (kW)	CLASP Tier 1 (kW)	CLASP Tier 2 (kW)
6,300	4.44			4.44	3.17
8,000	5.34			5.34	3.79
10,000	6.24			5.70	4.48
12,500	7.38	7.00	5.30	6.15	5.30
16,000	8.88	7.50	5.50	6.50	5.50
20,000	10.44	8.00	6.00	7.00	6.00
25,000	12.30	9.00	6.50	7.75	6.50
31,500	14.58	10.00	7.00	8.50	7.00
40,000	17.40	11.00	7.50	9.25	7.50
50,000	20.82	12.00	8.00	10.00	8.00
63,000	24.60	13.00	9.00	11.00	9.00
75,000	27.90	16.00	10.00	13.00	10.00
90,000	32.16			14.80	11.80
100,000		19.00	13.00	16.00	13.00
120,000	40.08	24.00	17.00	20.50	17.00
140,000		32.00	23.00	27.50	23.00
150,000	47.34			28.96	24.22
180,000	53.16			33.20	27.77

kVA	Pk (Coil Losses) VITO (kW)	Utility (kW)	SGB Best (kW)	CLASP Tier 1 (kW)	CLASP Tier 2 (kW)
6,300	35.9			35.9	34
8,000	44.9			44.9	42
10,000	52.9			52.9	50
12,500	62.9	72.0	70.0	62.9	59
16,000	76.8	75.0	71.0	73.0	68
20,000	92.8	76.0	72.0	74.0	68
25,000	109.8	90.0	75.0	82.5	75
31,500	132.7	105.0	80.0	92.5	80
40,000	155.6	125.0	90.0	107.5	90
50,000	193.6	145.0	105.0	125.0	105
63,000	233.5	165.0	130.0	147.5	130
75,000	277.3	190.0	155.0	172.5	155
90,000	319.2			190.5	170
100,000		225.0	180.0	202.5	180
120,000	396.0	270.0	225.0	247.5	225
140,000		305.0	245.0	275.0	245
150,000	470.9			289.6	258
180,000	530.7			332.0	295

				immediately above and below it. CLASP would support this latter option – linear interpolation for non-typical kVA ratings.	
49	**CLASP-Europe**	**7.1.3.1**	**12**	**The discussion on policy measures for TSOs is helpful, and responsible TSOs should continue to use total cost of ownership based on high valuation of losses. CLASP strongly feels that this should not be seen as an alternative to a regulation on maximum losses for power transformers. As discussed in our comments on section 7.1.2.3 above, there exists potential to improve efficiency and achieve the objectives of the EcoDesign Directive through the adoption of these regulations. Progressive TSOs will continue to purchase at or below these levels of losses, and the regulation will ensure that a minimum performance level is achieved.**	**Agreed it there should be no conflict with TCO and MEPS (topic of stakeholder meeting as there might be disagreement amongst stakeholders see comment 15)**
50	**CLASP-Europe**	**7.1.3.2**	**13**	**This section contains three suggestions for incentivising DSOs to adopt more energy-efficient practices. CLASP supports the measures presented, but again strongly feels that this should not be seen as an alternative to a regulation on maximum losses for power transformers. Progressive DSOs will continue to purchase at or below these levels of losses, and the regulation will ensure that a minimum performance level is achieved.** **The second paragraph of this section discusses other legislation that "TSOs" are subject to. Should this say "DSOs" or was this paragraph intended to be inserted into section 7.1.3.1?**	**Agreed it there should be no conflict with TCO and MEPS (topic of stakeholder meeting as there might be disagreement amongst stakeholders see comment 15)**
51	**CLASP-Europe**	**7.1.3.3**	**14**	**CLASP shares the concern expressed in this section that some DER investors may be looking for short payback periods that are not in alignment with the life-cycle (+20 years) of a transformer. In these instances, inefficient transformers will be installed and operated over their full life-time with negative environmental consequences.**	**Noted**

				CLASP fully supports the recommendation to have the meter installed such that it incorporates losses from the transformer, as the transformer is a critical component of the DER system. Furthermore, transformers remain energised even when the wind is not blowing or the sun is not shining, thus the transformers will run the meters backwards, consuming power from the grid. CLASP agrees that Renewable Energy Certificate Systems should only be given for electricity generated by the renewable energy resource, and is concerned with inaccuracies that may be introduced through having the meter installed on the wrong side and a correction calculation applied for losses above the BAT level (A0Ak). By installing the meter on the correct side of the transformer and accounting for those losses, the DER system will benefit from accurately tracking energy generation and all losses will be relevant.	
52	**CLASP-Europe**	**7.1.3.4**	**14**	**In this section, the BAT levels (A0Ak) are identified as easily being drafted into procurement specifications, however CLASP has two concerns:** **1) CLASP strongly feels that this should not be seen as an alternative to a regulation on maximum losses for these transformers. An EU-27 regulation will ensure that all equipment purchases, not only those for large public buildings and certain industrial sectors, will achieve a certain minimum performance level. More progressive consumers can always purchase higher, but the Ecodesign Directive would ensure a maximum level on losses that no one would exceed.** **2) For several of the Basecase transformers analysed, the A0Ak level was found not to be ambitious, and that other more efficient levels exist in the market. There may be more efficient, cost-optimised levels for certain Basecase transformers (e.g., A0+ and Ak+).** **CLASP supports the concept of accelerated depreciation of**	**Agreed and we add a statement to support this concern.**

				energy-efficient capital assets as a method for promoting efficiency. This is a win-win for society and business.	
53	**CLASP-Europe**	**7.1.5**	**15**	**Other options that may be included in this section include:** **1. Higher-flux amorphous material, to enable a reduction in the size of amorphous cores and thus a reduction in associated winding losses.** **2. Thinner steel laminations in Georg and other transformer core steel processing machines. Presently, 0.23mm (0.009 inches) is the thinnest lamination used, but thinner steels – such as 0.18mm (0.007 inches) are manufactured and could further reduce core losses.** **3. Improved coatings between steel laminations that will reduce sound while enhancing electrical performance (i.e., reducing losses).**	**Thanks for reminding, will be added.**
54	**CLASP-Europe**	**7.1.7**	**16**	**CLASP welcomes and fully supports the recommendations in this section to develop extra no-load and load loss classes that exceed the A0 and Ak levels already published in EN 50464-1 and EN50541-1.** **CLASP appreciates the acknowledgement of its comment from the second stakeholder meeting relating to the fact that the loss tolerance specified in IEC 60076-1 may be excessive. IEC 60076-1 states that the maximum allowable tolerance on the total losses (sum of the load and no-load losses) is +10% of the total losses. CLASP believes the level could be less than +7.5%, given the improvements in core steel processing, core handling equipment, annealing furnaces, winding equipment, insulation and other variables that had previously necessitated the +10% tolerance. CLASP believes that 5% should be the maximum allowable tolerance level, based on data supplied to the US Department of Commerce's National Institute of Standards and Testing, who supported the development of the**	**Tolerance issue will be discussed in the stakeholder meeting. See comment 25 and suggestion for no positive tolerance (or +0%) that is often used.**

				US DOE's test method, compliance certification and enforcement procedures. See the NIST Technical Note 1456: http://www1.eere.energy.gov/buildings/appliance_standards/commercial/pdfs/technical_note_1456.pdf	
55	**CLASP-Europe**	**7.1.8**	**16**	**CLASP strongly supports the recommendation to report the load and no-load losses on products that are included in the regulation. This label should be mandatory as it will be the first means of an enforcement officer to ensure compliance, and will also enable customers to verify they have received equipment of the quality and calliper they expect. It is more important to have the actual wattages included, as the particular efficiency classes are subject to change year-on-year, and having wattages leaves the option for customers to purchase above the minimum efficiency class levels.**	**noted**
56	**CLASP-Europe**	**7.1.13**	**17-19**	**Table 7-4 presents sales, replaced and stock for the seven basecase units, however as discussed in our comments on Chapter 6, we believe the starting stock is too low for several of these units. This projection from 2005 to 2025 is helpful, but if it is starting with a installed stock that is off by a factor of two or more, the error will only be compounded in this forecast, and the energy savings estimate from the regulation will be more severely underreported. We look forward to the review and revision to the stock calculations in Chapter 6 and the updating of this and other tables in Chapter 7.**	**The market data is taken from section 4.5.1. The project team will discuss internally to determine where an improved explanation of methodology should be placed.**
57	**CLASP-Europe**	**7.1.13.4**	**38**	**CLASP notes that Table 7-12 presents the energy savings estimate from the previously discussed lowest life-cycle cost and the best available technology scenarios. Considering the time period of 2011 to 2025, the table reports a reduction of between 9.6% and 12% for the LCC and BAT scenarios. This represents 165.5 to 206.2 TWh of savings over this time period, or 75.8 to 94.5 $MtCO_2$ equivalent savings. CLASP agrees that**	**Noted.**

				this does represent a significant savings potential, and through the incorporation of our comments on Chapters 6 and 7, we hope to see that increase slightly to reflect the increased ambition on some critical units, such as the oil-immersed large power transformers.	
58	**CLASP-Europe**	**7.2.1**	**46**	**In the context of the discussion on potential negative impacts of larger and heavier energy-efficient transformers, it deserves mention that adding more core steel and lowering the flux density is not the only way to make a more energy-efficient transformer. It should be noted that through the use of premium conventional core steels, including domain-refined and mechanically scribed grain-oriented electrical steels with very thin laminations and improved coatings between the laminations, lower losses can be achieved in a smaller volume.**	**Will be added and part of the stakeholder meeting discussion**
59	**CLASP-Europe**	**7.2.3**	**46-47**	**CLASP strongly objects to the statement contained in this section which reads:** **"Therefore, the following elements could be taken into account when deciding on maximum transformer losses:** **- Raising the no-load requirements above class A0 (EN 50464-1) would phase out Domain Refined High-permeability steel production and associated production of steel and transformers.** **- A fast raise to class A0 (EN 50464-1) would require high amounts of Domain Refined High-permeability steel production and could disturb the market as well."** **We believe that both of these statements are invalid, as we have demonstrated in our comparison with US data in Chapter 6. Indeed, in the US, transformers operate at 60Hz, so achieving higher efficiency is more difficult because the frequency is higher - however using conventional steels and conventional construction methods and windings, the US was able to develop optimised designs that exceeded the efficiency levels presented in Chapter 6. Thus, raising no-load**	**See also T&D comment 24.** **Text will be modified to 'far' above class A0, as indeed a small step 0.9A0 might also be possible.**

				requirements above class A0 will not phase out grain-oriented electrical steels. Furthermore, VITO should conduct a global study of core steel requirements, production volumes and availability before concluding that a fast rise would "disturb" the market. The US market and its suppliers were able to achieve a similar shift in just over two years, going from no regulation to efficiency levels that exceed the equivalent of A0.	
60	UBA	7.1		In general, the policy analysis should differentiate between the following relevant market actors: - Electricity transmission companies, transmission system operators - Larger electricity distribution companies, distribution system operators - Smaller electricity distribution companies, distribution system operators - Owners of large industrial plants - Owners of small industrial plants or sites in the tertiary sector - Owners of small industrial transformers - Engineering firms, ESCOs, energy consultants and planners, who often have a large influence on decisions, particularly in small industrial plants and the tertiary sector - Users that are not owners, e.g., shops or offices renting space in tertiary sector sites - Large transformer manufacturers - Small transformer manufacturers	The modelling and analysis is already sophisticated and based on the MEEuP methodology to achieve fast and significant results. In order to perform more fine grained analysis by policy makers a tool will be made available.

				- Steel, copper and aluminium manufacturers. Policy options to be developed in Task 7 will have to take into account the differences in market position, incentives and disincentives, barriers and obstacles, capabilities and capacities, knowledge and decision processes of these different actor types in the transformer market chain. Therefore, this should be analysed in more detail and in sufficient differentiation. For example, ➢ With regard to electricity distribution and transmission companies, removing disincentives and including incentives in regulatory schemes should be the main activity to be combined with the loss requirements proposed here. ➢ In addition to the loss requirements proposed here, clearly visible information required on the nameplate of a transformer, a labelling scheme like one of the three options proposed by the EU SEEDT project, information, motivation and qualification, the inclusion of transformer issues into energy advice and audit programmes as well as the provision of a toolkit for buyers (including the calculation tool provided by the SEEDT project) particularly address those market actors who lack of information and knowledge or who tend to follow traditional purchasing routines which do not lead to least-cost solutions. These are particularly small and medium industry and commerce, but also some smaller electricity distribution companies, engineering firms, ESCOs, energy consultants and planners. Only few larger companies in industry and in the electricity sector will need such information and qualification. ➢ It should be analysed, if market surveillance in the case of transformers or certain transformer types could be more difficult than for other energy-related products and which provisions could overcome possible obstacles (e.g. possibilities for the respective public authorities to join tests run by buyers). ➢ Manufacturers and their suppliers will have to comply with loss	

				requirements and the labelling scheme required, and might make use of available information and toolkits in their marketing activities. These market actors are directly addressed by R&D funding. ➢ All market actors can implement demonstration or pilot projects together with manufacturers (and their suppliers), but probably larger companies will particularly be prepared to make use of respective R&D support provided.	
61	UBA	7.1.1.1		Exemptions with less stringent loss requirements for “very compact three-phase oil-immersed distribution transformers” or any limitation of kVA within this category does not seem to be justified.	Will be discussed in the stakeholder meeting
62	UBA	7.1.2		It is appreciated that ambitious transformer load and no-load losses requirements have been proposed which go partly even a little bit beyond what had been proposed within the EU SEEDT project, and which will therefore lead to larger electricity savings and CO_2 emissions reductions than calculated in the EU SEEDT project.	Noted
63	UBA	7.1.3		A detailed analysis of the incentives and barriers for electricity distribution and transmission companies to invest into LLCC transformer technology, to follow LCC saving approaches, to improve location of transformers and to reduce redundancies in the electricity system is missing here (and in Chapter 3; in their response to stakeholder comments, the preparatory study contractors have suggested to make at least a reference to this topic in Chapter 3, but this should be extended to better understand the problem of the relation between setting loss requirements and regulation of grid companies). Why is this important for the policies and measures proposed in Chapter 7? In some countries within the EU-27, the situation currently is as follows: While there is a bidding for the electricity price for grid	Will be added as a suggestion but it is heavily related to assessing cost for rewiring the grid and beyond the scope of transformers. Cost figures for rewiring are very local and would form a hard basis to formulate a EU wide policy. Following text ‘In some countries within the EU-27 ..’ will be added as it nuances comment 21 related to the UK

				losses, there is no incentive for distribution and transmission companies to reduce the quantity of grid losses. Costs of grid losses are always fully paid by the electricity end-users in these countries. If now an implementing measure requires lower losses, the end-user will have to pay less. But lower losses can only be achieved by higher investment costs, which need to be accepted by the regulator as eligible costs. Therefore, it should be analysed, if changes in the internal market directive for the electricity market, or at least changes in the national laws and ordinances on the regulation of electricity distribution and transmission companies are necessary, in order to safeguard, that there are no barriers to invest into the more efficient transformer technology.	.
	UBA	7.1.7		There is clearly the need to update existing standards, particularly EN 50464-1, in order to take BAT and BNAT options sufficiently into account (cf., e.g., the additional categories proposed for the labelling scheme proposed by the EU SEEDT project).	Noted
1	UBA	7.1.8		Cf. also the information, motivation and qualification activities proposed by the EU SEEDT project, particularly activities to be carried out on Member State level.	A reference to information actions will be made in section 7.1.3
2	UBA	7.1.13		Growth of sales assumed is questionable, particularly for BC 2 and 3, but also for the other base cases. What are the assumptions behind, and why have these figures been finally selected for the impact analysis?	**The market data is taken from section 4.5.1. The project team will discuss internally to determine where an improved explanation of methodology should be placed.**
3	UBA	7.1.13 and 7.2		In contrast to the opinion of the preparatory study contractors in their response to stakeholder comments, we think that relevant interactions between transformer scenarios and scenarios of the general development of the electricity system should be explicitly modelled within Task 7 and would not be beyond the scope of	The extent of modelling that is suggested is out of the scope of this study.

				discussions. While the preparatory study contains data and information on the general development of the European electricity system (development of consumption, which in turn is partly dependent on the demographic and infrastructural development; development of electricity savings, which is partly dependent on the policies and measures in place; development of distributed generation) as well as on the expected development of sales of transformers until 2020, it neglects the interaction between both. This interaction should be explicitly modelled (cf., e.g., the transformer scenarios differentiated by two scenarios of the development of the electricity system, PRIMES TRENDS and PRIMES EE/RES, as in Irrek et al. 2008 within the context of the EU SEEDT study).	
4	UBA	7.2.1		Any larger negative impact of the loss requirements proposed here on transformers mounted on exiting poles or installed within existing buildings with limited space cannot be expected. Possible negative impacts and constraints regarding the investment into amorphous transformers have already been sufficiently discussed in Chapters 5.1.2.4 and 5.1.2.6 of the draft preparatory study report of April/May 2010.	Will be discussed. All evidence is welcome.
5	UBA	7.2.3		Regarding the impact on the manufacturers and competitive situation in the market, it has to be noted that there is a typical the chicken or the egg causality dilemma in the transformer market: On the one hand, without any visible increase in demand for energy-efficient transformers, European manufacturers will not invest into HGO or amorphous transformer production plants. On the other hand, if an implementing measure creates this demand, the existing production capacity will not be sufficient to satisfy demand. Therefore, what is recommended is a clear strategic plan for an implementing measure and further policies and measures in this context, with visible tiers for the European manufacturers clearly showing what will happen, so that investment into production	Dilemma will be added.

				facilities can be better planned and an increase into energy efficiency can be achieved.	
				Received after the deadline the day before the meeting 23/8/2010 (Answered after the meeting in the extend possible	
	Eurelectric	7.1.2.1		The proposal to set particular levels of losses for transformers is economically incorrect, but to go further and state and prescribe the resistivity of the material and the level of core losses is completely unwarranted. There are two reasons why it is unwarranted: (a) the transformer designer may be able use other materials in a more clever manner to achieve the target required e.g. Hexaform design (b) Competition is restricted when the materials from which the transformer can be made are set by fiat. This issue is potentially very serious. The description of the losses required in transformers up to 100kVA is very unclear – if <=100kVA is in question why is the restriction described as *"-<= 630kVA C0Ck in Tier 1 (2013) and A0Ck in Tier 2 (20145).* " This section needs to be clarified.	Section is reviewed completely
		Section 7.1.2.3		Setting levels of Load and No Load loss for 110kV transformers requires rather more justification than is provided here. The costs of HV transformers is very high and extra costs – which may be extremely high, particularly in cases where	This was discussed in the meeting and will be reviewed. (New enquiry was launched and will

				the electrical design dictates the shape of the transformer and this conflicts with the losses requirements so that the design is expensive to produce. It is worrying that such a proposal is made – apparently based on copying a proposed Draft Chinese standard and then simply multiplying Grade 1 by an arbitrary correction factor of 0.6 simply because Grade 1 wasn't ambitious enough. **It isn't a question of ambition or reaching a very high target – it's providing society with the best balance of cost and benefits.**	be included in the latest update)-
		Section 7.1.3.1		This section contains many sweeping statements whose justification would require quite detailed analysis by energy market economists. It is stated that 'electricity prices in the past could have been too low and they could now be different' – this is correct the price of electricity could indeed be either higher or lower than it was in the past. 'Therefore it can be recommended that authorities put forward European long term electricity indexed prices (e.g. 0.08 €/kWh) and interest rates to be used ' – how will the authorities know the future price of electricity which is dependent on the price of oil, or the interest rate to be used ? The answer is that they can't – even the markets will only price commodities for a very limited period ahead. Trying to use an artificially high rate for electricity to justify low loss transformers is bad economics and would only rive dysfunctional investments. Instead of getting the wrong answered some of the time the wrong answer would be	Indeed there was an error related to TCO recommendations (see other stakeholders comments). Based on those and other related comments the TCO recommendation has completely be reviewed. BTW: Apart from the used electricity price used, that was agreed in the beginning of the project. The rationale will be repeated on the update.

				obtained all of the time. From an economist point of view this would not seem to be a strong proposal. Next it is proposed to limit the differentiation between the cost of no load losses (A) and load losses (B) to *'e.g. <=20% 'on* the basis that '*Significantly lower no load prices fit in an electricity park with a high share of nuclear energy for the base load and fossil fuels for peak loads might have been used in the past, however this is outdated with a higher share of renewable energy currently'.* The reason for the difference in the capitalisation rates of the A and B factors is that the kWh used by Iron losses are 24/7 whereas most of the Copper losses occur for a short time at peak. So Iron losses account for a every large number of kWh and Copper losses for a much smaller number. Secondly the copper losses tend to be larger at peak time when they occur so they have more of an effect on peak demand requirements and could be associated with a demand charge (- although to date this has not appeared in this project). Taking both of these impacts into account the capitalisation rates for Copper losses are €670/kW and for Iron losses are €6,700 per kW for a typical 15-50kVA transformer. So the price of electricity has nothing to do with the relative capitalisation rates for iron and copper losses, and the suggestion that capitalisation rates which differ by a factor of 10 would be set to within 20% of each other is somewhat unusual.	

				It s then suggested that because TSO's '*use a much lower electricity price compared to DSO's because of the top down large scale electricity production and distribution. This might be debatable in the future as well when a high share of DER is integrated in the electrical grid. Thus it is recommended to limit this differentiation in-between electricity prices used in large power transformers compared to Distribution transformers (e.g. <15%)*' Aging there is a lack of understanding as to how the price of electricity is derived and what it means. The price of electricity is set by a market and is intended to signal the value of the product in such a way that decisions taken are related to the societal value of the product, as signalled by the information in the price. So electricity at the Distribution level is more expensive than at the Transmission level because there is greater investment in network infrastructure on the Distribution system than on the Transmission system, and because the losses in transporting a unit down to the Transmission system are greater – say 2% losses on Transmission and a further 6% in the Distribution system. So if there was sufficient DER perhaps you could end up with a situation where there was a much generation at Distribution as at Transmission and loads were served at LV from local generation. However in such a case the transformers would be carrying little load and there would be no justification in having low loss transformers as there were no losses to save! Also, it would-be at least 20 – 40 years before this situation was achieved (if it was) so that in the meantime transformers would still have to be bought on the basis of	

				existing electricity prices at the Transmission and Distribution levels. Finally there is the statement that as TSOs and DSO's are monopolies they can pass the cost son to customers so that no financial incentives are needed. Furthermore they can issue bonds to raise funds for the extra costs with Govt backing for the bonds. The bottom line here is that society is paying directly for these extra costs and these cost should only be inflicted on society if the benefit they confer is greater than what society could otherwise achieve with these funds. Reality is that TSO and DSO's are regulated monopolise and any cost increases have to be agreed by the regulator. The Regulator is precluded from agreeing extra costs that are not justified in a Regulatory Impact assessment which is subject to public scrutiny. The public include large energy users as well as economists who publicity challenge increases and required a detailed economic justification for same.	
		Section 7.1.3.2		As above but now suggesting that the DSO could get Tax benefits for using efficient transformers. As the DSO is a regulated monopoly this is just another way of taking the money from the customer directly, but less transparently, as at least in the monopoly such transfers would have to be justified	See above reply
		Section 7.1.3.3		Meter on HV customers are always installed on the LV side – not practical to install metering at say 110kV or 220kV when al that is required is to install it at the lower voltage side and calculate loss. The losses incurred are charged to the DER.	Thanks for informing. Text added 'In this case, it is recommended to include the calculated losses and charge them to

				The short time frames are due to the higher discount rate used by DER's who are generators. Generator BNE WACC is about 15% so 7 year payback – this is economically rational. In theory the DER could auction the savings in losses produced by installing a more efficient trafo and then transfer the extra units saved to the purchaser	the DER owner.'
		Section 7.1.3.4		Replacing high loss transformers with low loss transformers before the end of their economic life is not justified on economic grounds.	Is a case by case decision, should be compared with other means of EU to reach 20/20/20 targets.
		Section 7.1.10		Use of Dual Ratio trafos depends on having a clear policy on Voltage updating – otherwise you end up with a Dual Ratio trafo which is in situ for 25 years before uprating takes place	Indeed Text added, note the copper is used anyhow its only a matter of reconfiguring the windings.
		Section 7.2 Impact Analysis		**`….ecodesign requirements should not entail excessive costs nor undermine the competitiveness of European enterprises…** **This is clearly not the case with the proposal as outlined. They are not economically justified and increase costs for no clear benefit, in ways which are clearly non-optimal.** **It can be expected that the costs of these measures will cause significant complaints by business to Regulators and Governments, and that the argues in favour of the proposals are weak.** **The only argument for low loss equipment is that where all items of plant and all investments are made on the basis of Total Cost of ownership, including an assessment of the losses as part of the investment**	A new related section has been added.

				costs.	
		Section 7.2.3		**The impact on manufacturers may be more significant than expected on low loss trafos , as the value of losses is high and so technologies such as the latest generation from Hitachi could knock out all other forms.** **Also, if the justification for using low loss transformers is losses saving and the environment then the manufactures should be expected to meet this requirement, whether the manufacturers are in Europe or elsewhere.**	Related comments were also received from T&D Europe and section has been updated.

ANNEX T ENQUIRY ON POWER TRANSFORMERS

Table 1 breaks down the power transformer market by primary and secondary voltage. Please fill in the missing data marked by a ? with data for the most common it is acceptable to use estimations if you do not have concrete data. There is a line for an additional transformer should you wish to add one. Note that these are not transformers.

Table 1: Market segmentation for typical transformers and typical reference prices

Notes	Primary voltage (kV)	Secondary voltage (kV)	Rated power (MVA)	% market share	Typical No load losses (kW)	Typical Load losses (75℃, kW)	Price (€
	70	15,6	50	?	?	?	?
	132	22	50	?	?	?	?
	132	22	100	?	?	?	?
	132	11	100	?	?	?	?
	132	33	100	?	?	?	?
base-case 4	132	33	100	?	80	300	100%
	170	22	100	?	?	?	?
	220	22	170	?	?	?	?
	345	132	350	?	?	?	?
	425	132	350	?	?	?	?
Most common type in your company	?	?	?	?	?	?	?

Table 2 asks for relative price data for more efficient transformers. Please fill in the cells marked with a ? with a percentage representing the relative cost of efficient transformers compared to the base. There is an additional block for an additional transformer should you wish to add one.

Table 2: Price evolution compared to typical no load and load losses as defined in table 1

50 MVA (70/15.6 kV) (no autotransformers - double winding)		Po(kW) 100%	Po(kW) 85%	Po(kW) 70%	Po(kW) 50%
Pk(kW)(75°C)	100%	100%	?	?	?
Pk(kW)(75°C)	85%		?	?	?
Pk(kW)(75°C)	70%				
Pk(kW)(75°C)	50%				

100 MVA (132/22 kV) ((no autotransformers -double winding)		Po(kW) 100%	Po(kW) 85%	Po(kW) 70%	Po(kW) 50%
Pk(kW)(75°C)	100%	100%	?	?	?
Pk(kW)(75°C)	85%		?	?	?
Pk(kW)(75°C)	70%				
Pk(kW)(75°C)	50%				

100 MVA (132/33 kV) ((no autotransformers -double winding)		Po(kW) 100%	Po(kW) 85%	Po(kW) 70%	Po(kW) 50%
Pk(kW)(75°C)	100%	100%	?	?	?
Pk(kW)(75°C)	85%		?	?	?
Pk(kW)(75°C)	70%				
Pk(kW)(75°C)	50%				

170 MVA (220/22kV) ((no autotransformers -double winding)		Po(kW) 100%	Po(kW) 85%	Po(kW) 70%	Po(kW) 50%
Pk(kW)(75°C)	100%	100%	?	?	?
Pk(kW)(75°C)	85%		?	?	?
Pk(kW)(75°C)	70%				
Pk(kW)(75°C)	50%				

350 MVA (425/132 kV) ((no autotransformers -double winding)		Po(kW) 100%	Po(kW) 85%	Po(kW) 70%	Po(kW) 50%
Pk(kW)(75°C)	100%	100%	?	?	?
Pk(kW)(75°C)	85%		?	?	?
Pk(kW)(75°C)	70%				
Pk(kW)(75°C)	50%				

Most common type in your company		Po(kW) 100%	Po(kW) 85%	Po(kW) 70%	Po(kW) 50%
Pk(kW)(75°C)	100%	100%	?	?	?
Pk(kW)(75°C)	85%		?	?	?
Pk(kW)(75°C)	70%				
Pk(kW)(75°C)	50%				

ANNEX U COMMENTS RECEIVED AFTER THE THIRD STAKEHOLDER MEETING (<29/9/2010)

ID	Stakeholder	Section	Page	Comment	Answer Vito&Biois
1	**UK Market Transformation Programme (MTP)**	7.1.1.1	p. 331	Proposed new sub-category for 3 phase oil-immersed distribution transformers (50Hz). Specifically for 'light weight pole mounted transformers rated 100-160kVA with a maximum of 550kg and not having minimum load classes A0Ck'. 550kg for the max weight of a 'light weight pole mounted transformer' seems high, suggest confirming this.	This was confirmed by T&D Europe (see stakeholder meeting) (is ERDF spec). Might be even not enough (see Eurelectric comment 132).
2	**UK Market Transformation Programme (MTP)**	7.1.1.4	p.332	Proposed new sub-category for smaller power transformers. Specifically for 'general purpose smaller power transformers suitable for distribution (50Hz) (≤1kV) and 'special purpose smaller power transformers (50Hz) (≤1kV) Suggest definition of 'special purpose' be more strictly defined beyond providing the guitar amplifier example.	Machine tools has been added
3	**UK Market Transformation Programme (MTP)**	7.1.2.4	p. 334-5	Suggested MEPs for smaller power transformers are provided in Table 7-2. However stakeholders mentioned the need to require efficiency information reporting and develop a harmonised standard for smaller power transformers before developing minimum energy performance standards (MEPs) and suggest MEPs should be more moderated (e.g. x2). Suggest the x2 levels are substantiated further. How can more 'moderate' levels be justified if there is no efficiency information and harmonised standard already available?	Indeed. Should be reformulated. Table 7-2 is for consideration only.
4	**UK Market Transformati**	7.1.4.1	p. 336	Transmission System Operators (TSO) and Distribution System Operators (DSOs) already use a total cost of ownership (TCO) calculations. However there is no harmonised system and factors used can vary. It is proposed to create a	TCO should not supersede the MEPS (no realistic

	on Programme (MTP)			harmonised TCO system alongside MEPs. Suggest including a discussion on how these two policies might interact. Will they complement each other or create conflicts? Will one supersede the other?	way to check that the harmonised TCO is used if this would be the case). It should be used an additional tool to go beyond the MEPS and the MEPS should be compulsory for every product and situation. This has been made clearer in the report.
5	**UK Market Transformation Programme (MTP)**	7.1.4.1	p. 337	'Grid losses are not limited to transformer losses but also consist of load losses of the cables and theft or unbilled electricity. Currently TSOs/DSOs report on grid losses as a whole; it is recommended to ask them detailed information.' Suggest being more specific here. Is this proposed to be a mandatory policy suggestion or a voluntary one? Seems like this should be mandatory so that a more accurate baseline of electricity losses due to power and distribution transformers can be created.	Text added in the beginning of section 7.1.4.1 to give more guidance about the context and level of detail:'These are recommendations that are outside the scope of ERP Directive (2009/125/EC), hence they should be considered as suggestions that will need further elaboration and investigation in the context of other legislation.' recommendation is made on the mandatory or

					optional aspect of this proposal. It will be up to the EC to assess the feasibility of such a measure, in collaboration with relevant stakeholders.
6	**UK Market Transformation Programme (MTP)**	7.1.4.2	p.337	DSOs are already subjected to other legislation, in particular the Energy Services Directive (2006/32/EC).....some member states have incorporated distribution transformers in the National Energy Efficiency Action Plan (NEEAP) to be developed by Member States.' Task report 7 doesn't discuss in any detail the feasibility of integrating its policy recommendations with these existing measures. Suggest exploring in detail the feasibility of implementing the harmonised TCO approach (Comment 4), the tax benefit approach and the public procurement approach into the existing policies named above.	A reference is made to chapter 3, which includes a detailed TCO approach. Of course there are many TCO alternatives currently in use and there is nothing wrong with them as such. Therefore there is no need to analyse them in detail. Text has been updated to stress the general weaknesses of all TCO or LCC approaches.
7	**UK Market Transformation**	7.1.4.3	p. 338	Regarding policy recommendations for distributed energy resource (DER) plants, 'there are two potential reasons why those DER investors might have little interest in efficient transformers...'	CLASP shares this concern that DER investors

	Programme (MTP)			Both reasons provided seem speculative. Are they backed up by discussions with stakeholders or modelling? Please state so. If not, suggest confirming with stakeholders or conducting some analysis to back up the claims.	might have little interest in efficient transformers (comment 106). Also DEA commented this in previous revisions. Reference to related section in chapter 3 added. This issue is not a new finding and returns in almost any extra investments in energy efficient equipment (see other ERP (EuP) directive studies).
8	**UK Market Transformation Programme (MTP)**	7.2.2	p. 371	2nd para, 'However, it is not expected that these investments would provide a significant burden or barrier to implementation.' It's assumed that this statement is with reference to the LLCC scenario, but it's worth explicitly stating this.	This statement is indeed valid for the LLCC scenario but it is not limited to this. It also applies to a more general situation where more efficient transformers are sold, whatever the level of

					losses chosen. Text has been modified to make this clearer.
9	**UK Market Transformation Programme (MTP)**	7.2.3	p. 371	'When deciding on MEPs, T&D Europe insists on one Tier to avoid excessive administrative work. Nevertheless... or else introduce a second more ambitious tier.' What are the MEPs associated with a second, more ambitious Tier now that Tier 2 in the original draft of Task 7 has basically become Tier 1 in the revised draft Task 7? It seems that excessive administrative work is not a sufficient reason not to have two tiers, especially if significant electricity savings can be met with less cost. For example, BAT technology would be quite expensive, but is there an in-between MEPs level that is cost effective and would be well suited for a new Tier 2?	A second Tier should be considered when more evidence is available about the availability and cost of the identified improvement options related to amorphous transformers.
10	**UK Market Transformation Programme (MTP)**	7.2.3	p. 372	'Currently there is no significant European production of amorphous steel.....it is likely that much of this equipment (core and/or transformer) will be imported from Asia instead of produced in the EU.' Suggest providing an indication of the value of amorphous steel production in the EU if MEPs requiring amorphous steel were passed. Suggest indicating how this could impact EU steel manufacturing, and whether or not this market transformation would negatively impact EU steel manufacturers.	Those details are included in chapter 2.. Reference to chapter 2 added in the text.
11					
12	T&DEurope	**7.1.1.1**	**330**	Extend the rated power of immersed transformer up to 3150KVA instead 2500KVA at the next revision.	Agreed reformulated
13	**T&DEurope**	**7.1.1.1**	**331**	Last sentence of paragraph 7.1.1.1.:Should be deleted because the pole are not build to support 2 or transformers as in other countries. It is also a contraction in the sentence; When size or weight matters, it is also possible to install two or more smaller transformers.	Text modified but: .. installed on two or more poles.

14	**T&DEurope**	**7.1.1.4**	**331**	Change the title that is confusing: “with high voltage winding (HV) “ has to be replaced by “with higher voltage winding”	High-voltage winding, is IEV 421-03-03 vocabulary But for explanation will be added in text (the winding having the highest rated voltage). Title also modified to clarify
15	**T&DEurope**	**7.1.2.1**	**333**	Very compact categories is not defined. And any way the minimum rated power for distribution transformer is 50KVA. And not 100KVA; Utilities have needs of 50KVA in Italia and in France for pole mounted transformers. We propose to modify this sentence : The proposed maximum load and no-load losses requirements for oil-immersed distribution transformers not being so-called _very compact Three-phase oil-immersed distribution transformers (≤100 kVA)‘ is: By : The proposed maximum load and no-load losses requirements for cabins oil-immersed distribution transformers are : The losses and no load losses for pole mounted are defined after.	100 kVA transformers are light weight due to their rating and it has been reported that they ca achieve A0Ck. However a note has been added to clarify this.
16	**T&DEurope**	**7.1.2.1**	**333**	The minimum rated power for pole mounted is 50KVA and not 100KVA that mean the following sentence must be changed The proposed loss limiting requirement for _Light weight pole mounted transformers with rating between **50** -160 kVA with a maximum of 550 kg and not having minimum load classes A0Ck‘ is:	The rationale for the 100 kVA was: Note: there are also 50 kVA pole mounted transformers but they are light weight due to their low rating(S) and

					can be constructed with class A0Ck .
l	**T&DEurope**	**7.1.2.1**	**333**	End of paragraph: The way in which the magnetic steel is defined is confusing. We prefer to have a reference to standardisation and we propose to replace this sentence *These transformers shall only use low loss core material with maximum specific core losses below 0.72 Watt per kg at 1.5 Tesla and 50 Hz (e.g. Domain Refined High-permeability steel or amorphous steel).* By *These transformers shall only use low loss core material with quality of magnetic steel given losses less or equal than M095-27P defined by EN10107 (<=0,95 at 1,7 at 50HZ) see table 5.3 page 223*	Agreed
18	**T&DEurope**	**7.1.2.3**	**333**	Table indicated in ANNEX D aggregated results…. Would be taken in this way for the next standard/ For typical no load losses: Manufacturers agreed to take average value as guaranties for the future regulation: Example: 70KV/15,6KV 50MVA Typical no load losses =21KW For typical load losses at 75℃ the manufacturers p ropose to have the average value minus 10% for the future regulation: Example 70KV/15,6KV 50MVA Typical load losses =162KW	-10% noted Agreed: Table will be used in chapter 7 as recommendations for a standard.
19	**T&DEurope**	***7.1.3.***	**336**	***Change the minimum rated power in the title and accordingly change this sentence*** ***7.1.3.4 Proposed Generic Eco-design requirements on the supply of information for 'Light weight pole mounted transformers with rating between 100 -160 kVA with a maximum of 550 kg and not having minimum load classes A0Ck'*** ***By*** ***7.1.3.4 Proposed Generic Eco-design requirements on the supply of information for 'Light weight pole mounted transformers with rating between 50 -160 kVA with a maximum of 550 kg and not having minimum load classes A0Ck'***	Not agreed but note added for the rationale. Note: there are also 50 kVA pole mounted transformers but they are light weight due to their low rating(S) and can be constructed with class A0Ck

20	**T&DEurope**	***7.1.3.***	**336**	Change this sentence using normative reference: 3. The core losses at 1.5 T and 50 Hz clearly marked on the product name plate in Watt per kg. By *These transformers shall only use low loss core material with quality of magnetic steel given losses less or equal than M095-27P defined by EN10107 (<=0,95 at 1,7 at 50HZ) see table 5.3 page 223*	Text modified: The normative reference to the core clearly marked on the product name plate in Watt per kg.
21	**T&DEurope**	***7.1.3.***	**336**	Reference of no load losses has to given at 1,7T and not at 1,5 and the sentence as tob be modified The product documentation should include a core loss (50 Hz, 1,7T) material type reference to facilitate market surveillance at any moment. For silicon core steel this could be deducted from the EN 10107 grading, i.e. M0XX (see chapter 5).	1.7T cannot be achieved for amorphous material. Therefore both alternatives will be added.
22	**T&DEurope**	***7.1.3.***	**336**	Add a sentence for pole mounted where the weight is not limited 5 When the maximum weight is not limited the level of no load losses and losses shall be A0Ck	Text added
23	**T&DEurope**	***7.1.6.***	**339**	**Need for a formal standard to measure the load and no load losses for smaller industrial transformers with high voltage winding below 1 kV:** **Has been changed to avoid confusing:** **Need for a formal standard to measure the load and no load losses for smaller industrial transformers with higher voltage winding below 1 kV:**	See comment 14. Text was added to clarify. Note: The high-voltage winding is defined according to the IEV 421-03-03 vocabulary as the winding having the highest rated voltage.

24	**T&DEurope**	***7.1.6.***	**339**	Interest of Dry type transformers are not only fire behaviour but also the fact there are no possibility of cold and hot pollution. The behaviour of silicon transformer during fire scenario could degenerate into spreading of liquid and extend the fire outside the transformer	
25	**T&DEurope**	***7.1.7***	**340**	To avoid confusion with the text we propose to modify the sentence below The maximum allowable tolerance on the total losses (sum of the load and no-load losses) is +10% of the total losses (IEC 60076-1). This was discussed in the final stakeholder meeting (24/08/2010) and the best option is to allow a +0% or zero tolerance for exceeding the specified losses. By The maximum allowable tolerance on the total losses (sum of the load and no-load losses) is +10% of the total losses (IEC 60076-1). This was discussed in the final stakeholder meeting (24/08/2010) and the best option is to allow a +0% or zero tolerance for exceeding no load losses and load losses separately	Agreed
26	**T&DEurope**	***7.1.7***	**340**	**Difficulties to interpreted efficiency class and modify the following sentence: Recommendation to include the values of the losses or the efficiency class of the transformer on the rating plate of the transformer in IEC 60076-1/ 7.1:** By **Recommendation to include the values of the losses of the transformer on the rating plate of the transformer in IEC 60076-1/ 7.1:**	Agreed
27	**T&DEurope**	***7.1.9***	**341**	We have to give all information concerning a technology and change the below sentence : Due to the potential from oil-immersed to less efficient dry type transformers as explained in sections 7.1.2.1 and 7.1.2.2, additional installation for dry-type transformers are also advisable. It is recommended to limit the use of dry type transformers only to industrial sites with a high risk of fire hazard, e.g. only to be installed after approval of the local fire station. By	Thanks. Text added.

				Due to the potential from oil-immersed to less efficient dry type transformers as explained in sections 7.1.2.1 and 7.1.2.2, additional installation for dry-type transformers are also advisable. It is recommended to use of dry type transformers only to industrial sites with a high risk of fire hazard and risk of cold pollution and hot pollution are not acceptable, e.g. only to be installed after approval of the local fire station.	
28	**T&DEurope**	***7.1.10***	**341**	Manufacturers have the capacity to change all transformers on the park in a period between 5 and 10 years; The plan to change should consider replacing the oldest transformers first to get the best saving for the environment.	This cannot be modelled in the tool as products are defined by average performance categories but it will be mentioned in the text that it is a relevant approach in real life.
29	**T&DEurope**	***7.1.11***	**341**	Title policy analysis already exist is 7.1 and we suggest to replace by an other title like Scenario analysis.	The title will be changed to "Policy Scenario analysis"
30	**T&DEurope**	***7.1.11***	**341**	Section indicated 2.2.5 are false and should be replaced by 2.2.6.2	The reference has been corrected to "table 2-10 section 2.2.5"
31	**T&DEurope**	***7.1.11.2***	**348**	***7.1.11.2 LLCC has to be replaced by 7.1.11.2 Scenario with LLCC***	Agreed
32	**T&DEurope**	***7.1.11.2***	**348**	***Change the first sentence*** The least life-cycle cost scenario assumes that minimum performance requirements implement all LLCC options, as calculated in Task 6. The requirements are implemented in one phase in 2013, as shown in Table 7-6. By This scenario assumes that minimum performance requirements implement all LLCC options, as calculated in Task 6. The requirements are implemented in one phase in 2013, as shown in	Agreed

				Table 7-6.	
33	**T&DEurope**	***7.1.11.3***	**304**	***7.1.11.3 BAT change the title 7.1.11.3Scenario with BAT***	Agreed
34	**T&DEurope**	***7.1.11.3***	**304**	***Change the first sentence*** The best available technology scenario assumes that minimum performance requirements implement all BAT options, as calculated in Task 6. The requirements are implemented in one phase the first in 2013 as shown in Table 7-8. By This scenario assumes that minimum performance requirements implement all BAT options, as calculated in Task 6. The requirements are implemented in one phase the first in 2013 as shown in Table 7-8.	Agreed
35	**T&DEurope**	***7.1.11.3***	**304**	***General remarks with the money b€***	Explained in text that it is billion euros in the short scale (10 E+9 Euros)
36	**T&DEurope**	***7.2.3***	**372**	Modified this sentence : There is currently no significant European production of amorphous steel and suppliers need time to increase quantities manufactured. There is currently no European production of amorphous steel and suppliers need time to start with manufacturing.	Not agreed There is one: Vacuumschmelze.
37	**T&DEurope**	***7.2.3***	**372**	General remarks: amorphous transformers should be replaced in the draft by amorphous core transformers.	corrected
38	**T&DEurope**	***Annex A***	**375**	IEC 60726 doesn't exit and have replaced by 60076-11	Agreed
39					
40	**CLASP**			Thank you for the opportunity to review and comment on the draft final Chapters 1 through 7 of the ErP Study: Lot 2 Distribution and Power Transformers. These comments were prepared by CLASP Europe, are supported by ECOS, the European Environmental Citizens' Organisation for Standardisation, on behalf of EU environmental NGOs and by eceee, the European Council for an Energy Efficient	Response from Vito and Biois on how these comments chapter 1-3

				Economy. In the pages that follow, we provide detailed comments on each of the chapters using the template that was provided on the website. Some of the key issues are identified here: Chapter 1 • Generally, we found that comments we submitted in May 2010 were not incorporated or responded to by the study consultants. We reviewed your revised chapter and are submitting those comments that we consider necessary and appropriate. • CLASP is concerned that drafting the regulation with a tolerance for total transformer losses of +10% (EN 50541-1) would adopt flexibility that is outdated and potentially excessive, and would undermine the objectives of the ErP process. Chapter 2 • Similar to Chapter 1, there are several comments we submitted in May 2010 that are still necessary and appropriate. • Energy-efficient transformers should have longer operating lives and lower maintenance costs, and these benefits should be taken into consideration in the analysis. Chapter 3 • Similar to Chapter 1, there are several comments we submitted in May 2010 that are still necessary and appropriate. • The load factors for MV/LV Distribution, Power Transformers and Industrial Transformers are all too low, and need to be increased. CLASP recommends Industrial Transformers have a 0.55 loading factor; 400 kVA distribution transformer have a 0.35 to 0.50 loading factor and 100 MVA power transformer have a 0.55 to 0.65 loading factor. Chapter 4 • Very minor comments.	were treated lately and partly overlooked, the main reason is: • **12 th May 2010** was a extended deadline for CLASP on request related to feedback request on chapter 4-5. • the chapters 2-3 comments deadline was before the **22th of July 2 2009** but no CLASP comments were received by then. In the priorities set for the 19/5/2010 stakeholder meeting this comments were briefly reviewed and the key points discussed at the meeting (load factor, market statistics) (see also minutes of meeting).

				Chapter 5 • Very minor comments. Chapter 6 • Some of the amorphous designs are overpriced, relative to the CLASP report submitted. Other base case designs which could consider amorphous design options do not. • CLASP remains concerned that the loading factor is incorrect (i.e., too low) for several base case transformers and that the installed stock estimates are understating the EU stock. • Two of the base case transformers considered have very few more efficient designs considered – one has two options over the baseline and another has just one more efficient option. We believe more are needed to improve the analysis. Chapter 7 • The coverage should be improved to ensure there are no unintended loop-holes, and "very compact" subcategory for certain pole-mounted transformers should be analysed before being granted. • The preparatory study needs to propose 2 tiers and not just one. Having one tier does not send a long-term message to industry that they should make more aggressive savings in a dynamic way. Furthermore, it fails to reward front runners because they need to wait for the revision before assessing whether it makes economic sense to put more efficient products on the market above the MEPS levels. Large power transformers appear to have very weak standard levels under consideration, far higher than "typical utility" losses for the 100 MVA rating according to SGB Starkstrom. CLASP is concerned that the baseline design for this rating is incorrect and does not constitute what is typically being purchased by a utility	CLASP should understand that those comments cannot be taken into account anymore when they conflict or overrule other stakeholders input, Such an approach would open the door for endless delays and disable timely policy decision making. We respect however the very important CLASP contribution on chapter 5-7 and it the integrity of the organisation., Therefore we will review them carefully and take them into account as far as possible (see above limitations).
41					
42	CLASP Europe	1	n/a	There is an editorial error. The pages are not numbered. Page numbering starts mid-way through Chapter 2 on page 97. We have numbered backwards from that	Indeed. Missing page numbers

				point in the document and use those page numbers in our comments on this chapter.	will be inserted
43	CLASP Europe	1.1	36	There is an editorial error. The paragraph under the figure states: "(1 TWh = 109 kWh)" It is generally understood that 1 TWh = 1 000 000 000 kWh, or 10^9 kWh where the number 9 is a superscript, indicating ten to the ninth power.	Adapted
44	CLASP Europe	1.3	39	There is a numerical and editorial error. Sulphur hexafluoride (SF6) gas is said to have an impact on global warming that is approximately 24 times that of CO_2 – it reads: "(1 SF6 = 23.600 CO2)". The potency multiple is not 23.6, but rather is twenty-three thousand nine-hundred times. Standard convention elsewhere in the Preparatory Study marks the thousands place with a space. Thus for consistency and clarity, we recommend revising the parenthetical statement to read: "(1 SF6 = 23 600 CO2)", or for absolute clarity, perhaps the phrase "(one molecule of SF6 is twenty-three thousand nine-hundred times as potent a greenhouse gas as one molecule of CO2)". Reference for this potency multiple is the UNFCCC: http://unfccc.int/ghg_data/items/3825.php	Adapted
45	CLASP Europe	1.5.7	51	Table 1-2 is a very helpful overview of the covered products. CLASP supports the scope of this study, however when defining the scope of coverage, the Commission should not feel compelled to have numeric thresholds (e.g., minimum 50 kVA) which may induce manufacturers to introduce a 45 kVA not subject to the regulation. KVA ranges are helpful for illustrative purposes but CLASP would recommend scopes of coverage be defined by entire classes of transformers used for T&D rather than subsets of or specific kVA ratings within those classes.	Loopholes will be discussed in chapter 7. Below 50 kVA is uncommom (e;g. Germany connects a single house default with 3x63A (40 kVA)) Nevertheless the scope has been extended to 25 kVA to avoid borderline cases. Note: also EN 50464 starts only at 50 kVA. Lower ratings are not an

					expected trend.
46	CLASP Europe	1.6	54	In the section titled “Proposed secondary functional transformer performance parameters related to energy efficiency and connected to the transformer itself:” the third bullet addresses “Auxiliary losses”. This list should also include fuses, circuit breakers, lightning arrestors, and other auxiliary features that may be specified by a utility and which consume power.	Not agreed They have no impact on losses and are not default components of transformers
47	[Editorial]	1.6	55	Under the bullet “Climate Class” the word “witch” should be “which”	Adapted
48	CLASP Europe	1.7.1.2.1	63	Second paragraph on this page states: “Table 1 of the standard [EN 50541-1] defines tolerances for the transformer performance parameters. The maximum allowable tolerance for the total transformer losses (sum of the no-load loss and the load loss) is +10%. This means that in worst case the real transformer losses could be 10% higher than the losses specified by the transformer manufacturer.” CLASP kindly requests that the Commission review this tolerance before adopting it (as was done for non-directional lamps in EC 244/2009, Annex III). CLASP finds that having such a large tolerance of losses is excessive. According to our experts, these large tolerance levels stem from the day when materials, production methods and testing methods weren't as consistent as they are now. The steady improvement in calculation and optimisation engines for transformer design has also played a significant part in removing the necessity for such large tolerances from the transformer. Should the Commission adopt such an excessive tolerance on losses, the regulation would create several problems: 1) It allows products of a lower efficiency to be sold into the market, undermining the objectives of the ErP regulation and foregoing potential energy and carbon emission savings. 2) It makes regulation enforcement more difficult, as an individual transformer may test below the regulation (i.e., not in compliance), but the manufacturer state that this unit is part of a batch that on average met the regulation. From a practical point of view, once sold into the market, locating those other transformers from the same batch and testing them would be extremely difficult. 3) It fails to protect consumers who would otherwise be purchasing a transformer at a performance level that was analysed and cost-justified from a total cost of ownership	See comment nr 25

				perspective by the European Commission and its analytical team. 4) A tolerance of 10 percent would not take into account significant improvements made in quality control by electrical steel suppliers and transformer manufacturers alike, many of which are certified by the International Standards Organisation (ISO) for quality control. While 10% additional losses may have been appropriate in the 1980's, in reality the real variance today is less than 5%. For all of these reasons, especially the improvement in materials, production, testing and calculation methods, the Commission should halve the tolerance limit to 5%.	
49	[Editorial]	1.7.1.2.1	64	The heading for the second table is in a very small font, and in the heading itself, it appears that P(W) is missing its subscript (P_0(W)) and U is missing its subscript (Um).	Adapted
50	CLASP Europe	1.8.4	76-79	The distribution transformer energy efficiency regulations for the United States are not portrayed correctly. This issue was commented on in our May comments, but the issues were not addressed. There are three problems with how the US regulations are portrayed that we commented on previously. These issues should be corrected before this Preparatory Study is finalised containing these errors: 1. It is implied that the two tables of efficiency values on page 77 are the MEPS levels for the United States, which they are not.[4] 2. The two tables presenting the MEPS for the United States are not correct, they refer to a proposed TSL2 level, which was not what DOE adopted for distribution transformers in October 2007. 3. The section omits a table of efficiency values for low-voltage (primary voltage ≤600V) dry-type distribution transformers. These transformers are covered and regulated by DOE, and were added as part of the Energy Policy Act of 2005 rather than by the DOE Final Rule in 2007. To address the first point, immediately following the first paragraph on page 77, which ends with "...would come into effect in 2016." we suggest you insert the sentence and three tables that follow below:	

[4] The term "MAX-TECH" represents the 'maximum technologically' feasible design for each of the kVA ratings considered. In other words, if cost were no object, what's the highest efficiency level that could be achieved? That is what these two tables represent, and thus they represent the upper limit of efficiency values considered by the US Department of Energy in that rulemaking completed in October 2007.

The US has three tables of efficiency values for distribution transformers. The first two tables below present the MEPS levels that were adopted for liquid-immersed and medium-voltage dry-type transformers by the US Department of Energy in October 2007. The third table presents the MEPS levels that were adopted by the US Congress for low-voltage dry-type transformers as part of the Energy Policy Act of 2005. As discussed above, all of these efficiency levels are presently under review at DOE as part of an active regulatory review programme.

Table 1. US DOE Minimum Efficiency Levels for Regulation of Liquid-Immersed Distribution Transformers

Single-phase		Three-phase	
kVA	Efficiency (%)	kVA	Efficiency (%)
10	98.62	15	98.36
15	98.76	30	98.62
25	98.91	45	98.76
37.5	99.01	75	98.91
50	99.08	112.5	99.01
75	99.17	150	99.08
100	99.23	225	99.17
167	99.25	300	99.23
250	99.32	500	99.25
333	99.36	750	99.32
500	99.42	1000	99.36
667	99.46	1500	99.42
833	99.49	2000	99.46
		2500	99.49

Note: All efficiency values are at 50 percent of nameplate-rated load, determined according to the DOE Test-Procedure. 10 CFR Part 431, Subpart K, Appendix A.

Table 2. US DOE Minimum Efficiency Levels for Regulation of Medium-Voltage Dry-Type Distribution Transformers (60Hz operation)

kVA	Single Phase Efficiency (%)			kVA	Three Phase Efficiency (%)		
	20–45kV BIL	46–95kV BIL	≥96kV BIL		20–45kV BIL	46–95kV BIL	≥96kV BIL
15	98.10	97.86		15	97.50	97.18	
25	98.33	98.12		30	97.90	97.63	
37.5	98.49	98.30		45	98. 0	97.86	
50	98.60	98.42		75	98.33	98.12	
75	98.73	98.57	98.53	112.	98.49	98.30	

				5			
100	98.8	98.67	98.63	150	98.60	8.42	
167	98.96	98.83	98.80	225	98 73	98.57	98.53
250	99.07	98.95	98.91	300	98.82	98.67	98.63
333	99.14	99.03	98.99	500	98.96	98.83	98.80
500	99.22	99.12	99.09	750	99.07	98.95	98.91
667	99.27	99.18	99.15	1,000	99.14	99.03	98.99
833	99.31	99.23	99.20	1,500	99.22	99.12	99.09
-				2,000	99.27	99.18	99.15
-				2,500	99.31	99.23	99.20

Note: BIL means basic impulse insulation level. All efficiency values are at 50 percent of nameplate rated load, determined according to the DOE Test-Procedure. 10 CFR Part 431, Subpart K, Appendix A.

Table 3. US DOE Minimum Efficiency Levels for Low-Voltage Dry-Type Distribution Transformers (60Hz operation)

Single-phase		Three-phase	
kVA	**Efficiency (%)**	**kVA**	**Efficiency (%)**
10	97.7	15	97.0
15	98.0	30	97.5
25	98.2	45	97.7
37.5	98.3	75	98.0
50	98.5	112.5	98.2
75	98.6	150	98.3
100	98.7	225	98.5
167	98.8	300	98.6
250	98.9	500	98.7
333	97.7	750	98.8
		1000	98.9

Note: All efficiency values are at 35 percent of nameplate-rated load, determined according to the DOE Test-Procedure. 10 CFR Part 431, Subpart K, Appendix A.

	CLASP Europe	1.8.4	77	To address the second problem identified with the characterisation of the US regulations on transformers, specifically the characterisation of the Max-Tech tables, there are two recommendations – first, there needs to be an explanation of what "max-tech" is because this is not clear and secondly, the tables are not the correct ones – these are draft tables that were later revised by DOE. To address the issue, we suggest you replace the sentence "The tables below show the MAX-TECH LEVELS for liquid-insulated transformers and dry-type transformers:" with the following text and subsequent tables that follow below.	

The Department considered a wide spectrum of efficiency values, from baseline efficiency levels through to the maximum technologically feasible ("Max Tech") levels. The "Max Tech" level represents the transformer designs that would exist if cost were no object and all design efforts were focused solely on having the highest possible efficiency level. In other words, the max tech levels represent the upper limit of efficiency values considered by the US Department of Energy in the final rule it published in October 2007. The tables below present the max tech values considered by DOE in that final rule:

Table 1. USDOE Maximum Technologically Feasible Levels for Liquid-Immersed Distribution Transformers (60Hz operation)

Single-phase		Three-phase	
kVA	**Efficiency (%)**	**kVA**	**Efficiency (%)**
10	99.32	15	99.31
15	99.39	30	99.42
25	99.46	45	99.47
37.5	99.51	75	99.54
50	99.59	112.5	99.58
75	99.59	150	99.61
100	99.62	225	99.65
167	99.66	300	99.67
250	99.70	500	99.71
333	99.72	750	99.66
500	99.75	1000	99.68
667	99.77	1500	99.71
833	99.78	2000	99.73
		2500	99.74

Note: All efficiency values are at 50 percent of nameplate-rated load, determined according to the DOE Test-Procedure. 10 CFR Part 431, Subpart K, Appendix A.

Table 2. USDOE Maximum Technologically Feasible Levels for Medium-Voltage Dry-Type Distribution Transformers (60Hz operation)

kVA	Single Phase Efficiency (%)	kVA	Three Phase Efficiency (%)

	20–45kV BIL	46–95kV BIL	≥96kV BIL		20–45kV BIL	46–95kV BIL	≥ 6kV BIL
15	99.05	98.54		15	98.75	98.08	
25	99.17	98.71		30	98.95	98.38	
37.5	99.25	98. 4		45	99.05	98.54	
50	9.30	98.92		75	99.17	98.71	
75	99. 7	99.02	99.22	112.5	99.25	98.84	
100	99.41	99.09	99.28	150	99.3	9 .92	
167	99.48	99.20	99.36	225	99.3	99.02	99.22
250	99.42	99.42	99.42	300	99.41	99.09	99.28
333	99.46	99.46	99.46	500	99.48	99.20	99.36
500	99.51	99.51	99.52	750	99.42	99.42	99.42
667	99.54	99.54	99.55	1,000	99.46	99.46	99.46
833	99.57	99.57	99.57	1,500	99.51	99.51	99.52
-				2,000	99.54	99.54	99.55
-				2,500	99.57	99.57	99.57

Note: BIL means basic impulse insulation level. All efficiency values are at 50 percent of nameplate rated load, determined according to the DOE Test-Procedure. 10 CFR Part 431, Subpart K, Appendix A.

51	CLASP Europe	1.8.4	77-79	To address the third problem with the portrayal of the US regulations on transformers, specifically the presentation of TSL2 on pages 77 through 79, we recommend that you delete the tables and the text associated with them. These were draft proposed tables that DOE later revised, and thus including these tables could mislead stakeholders. Thus, we recommend deleting the following: • Paragraph at the very bottom of page 77 that starts with "The tables below show the proposed efficiency levels...." • Table on page 78 • Table on page 79	

				Please retain the paragraph starting “It should be noted that the efficiencies listed in the DOE tables...” and all the text that follows after that paragraph, because it is still applicable.	
52	CLASP Europe	1.8.4	79-81	There are three minor problems with the text about the Canadian national programme: • The CSA Standard “C802.3-00” should be “C802.3-01” • The abbreviation for Natural Resources Canada should be “NRCan” (not “NR-Can”) • Canada consists of provinces, not states – thus the statement “…shipped across state borders” should be “…shipped across provincial borders”	Adapted
53	CLASP Europe	1.8.4	80	The Table presented in the Canadian section is incorrect, as Canada is now changing its standard to be closer to that of the US. In June 2010, NRCan issued a bulletin that presents the efficiency tables, the schedule and the definitions / exclusions. Information on all of these topics can be found electronically at the following link: http://oee.nrcan.gc.ca/regulations/bulletin/drytype-transformers-june-2010.cfm?attr=0	Table is changed recently (after finishing chapter 1). We will include the link.
54	CLASP Europe	1.8.4	82-83	The text and presentation of the Japanese Top Runner programme is incorrect. The authors keep referring to “efficiency” when what the programme shows in the table (1-8) is maximum watts (sum of NLL and LL). The sentence immediately before Table 1-8 states “Efficiencies for different products are described…(see Table 1-7)”. This sentence should read – “The maximum watts of loss (sum of no load and load losses) under the Top Runner programme for different models of transformer are described by equations (see Table 1-8).” Table 1-8 should have the fourth column label changed from “Formula for calculating efficiency” to read “Formula for calculating maximum watts” For clarity, the title of Table 1-8 should be changed from “Types of distribution transformers in Japan” to “Maximum watts of losses for different types of distribution transformers in Japan’s Top Runner programme” For more information, the authors may wish to review the following PDF (in English) about the Japanese Top Runner transformer programme: http://www.eccj.or.jp/top_runner/pdf/tr_transformers_summary.pdf	Adapted

55	CLASP Europe	Summary, but also pertains to lifetime discussion throughout Chapter 2.	91	The text states: “There is little maintenance schedules for transformers (annual checks for dust build-up, vermin infestation, and accident or light[n]ing damage) and it can be assumed that these repair and maintenance costs will not change with increased efficiency.” [editorial note: “lighting” should be “lightning”] CLASP believes that energy-efficient transformers would have lower maintenance costs and longer operating lives than standard transformers. These benefits, in addition to the energy savings, are due to the lower operating temperature which will reduce degradation of the mineral oil and the winding insulation. By reducing waste heat (and associated hot-spots in the windings), energy-efficient transformers will have longer service lives with lower maintenance costs. CLASP wishes to bring to the attention of the report authors a comment that was submitted to the US Department of Energy’s transformer rulemaking dated October 14, 2006. This comment (#119) was prepared by Professor Markus Zahn of the Massachusetts Institute of Technology, an expert in transformer insulation. Professor Zahn commented that transformer lifetime is directly proportional to operating temperature. He cited the following equation from IEEE Standard C57.100-1999: $$LIFE = Exp[\frac{15000}{Temp + 273} - 27.064]$$ Where: LIFE=transformer life in hours (8760 hours=1 year) and Temp=hottest-spot temperature in ℃. He concludes that transformers designed to higher efficiency levels will have significantly longer service lifetimes than the base line. While this work was conducted in the US (i.e., 60Hz), the same principal should apply in Europe. CLASP kindly requests that the Commission’s contractors explore this issue and consider longer service lifetimes in their economic analysis of transformer MEPS levels. CLASP also kindly requests that the Commission’s contractors investigate maintenance savings associated with more efficient transformers due to a reduction in oil degradation (from lower thermal stress).	We assume your statement is related to distribution transformers. Could indeed be less but can have no impact on the study because these cost are so low maintenance cost are not accounted. The study is about new transformers and they are nowadays sold mainentenance free. When referring to your reference: there is no confirmation that efficient transformers are designed with lower hottest-spot temperature or overrated thermal insulation. Note also: The hot spot does not correlate with lightning damage, neither short circuit

					damage nor mechanical damage or dust built up. Therefore your statement is arguable. When timely received could have been discussed with other stakeholders. Nevertheless, will have no (or little) impact.
56	CLASP Europe	2.1.2.1	97	The X-axis in Figure 2-1 and Figure 2-2 is illegible.	Fixed in the new version
57	CLASP Europe	2.2.3.2	111 - 113	CLASP attempted to reproduce VITO's inventory stock estimates using the same market growth assumptions. In all cases, CLASP found stock estimates presented by VITO are too low. CLASP is concerned about this finding, as it would mean that the energy savings potential from this analysis is understated. CLASP had raised this concern with the Commission in its August comments, however neither the methodology nor the findings were revised. CLASP is submitting this comment again, and for complete transparency is also providing separately an Excel spreadsheet to enable the Commission's contractors to conduct a detailed review of the year-on-year shipment methodology followed by CLASP. Our concern is that the methodology used by the Commission's contractors is a mathematical approximation based on a single equation (on page 112 of the preparatory study), whereas our approach calculates year-on-year stock and then sums the total stock based on the given lifetime of the transformers. CLASP wishes to emphasise that all of its calculations presented here are using the same input assumptions as presented by the Commission's contractors. CLASP is willing and prepared to engage in discussion with the Commission's contractors to help understand these differences	Not agreed. Could be interesting to claim higher savings later in (an issue for the impact assessment). I reviewed you spreadsheet. The key difference between yours and ours is that: • CLASP growth rate is reflected to the previous year

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<td>and assist with the correction of this critical part of the analysis.

This table presents the summary of our findings comparing the VITO Stock model with our stock models. In all cases, the VITO model was lower than our estimate, from between 7% to 155%.

<table>
<tr><th>Transformer type</th><th>VITO Stock 2020</th><th>CLASP Stock 2020</th><th>Difference (%)</th></tr>
<tr><td>MV/LV Distribution transformer</td><td>4,458,751</td><td>4,780,761</td><td>7%</td></tr>
<tr><td>DER LV/MV transformers</td><td>89,426</td><td>227,784</td><td>155%</td></tr>
<tr><td>Industry MV/LV oil transformer</td><td>990,834</td><td>1,193,576</td><td>20%</td></tr>
<tr><td>Industry MV/LV dry transformer</td><td>210,552</td><td>238,421</td><td>13%</td></tr>
<tr><td>Power transfomer</td><td>79,700</td><td>98,189</td><td>23%</td></tr>
<tr><td>Phase</td><td>805</td><td>992</td><td>23%</td></tr>
<tr><td>Total</td><td>5,830,068</td><td>6,539,723</td><td>12%</td></tr>
</table>
</td>
<td>sales.

• Vito (Chapter 2) is reflected to the previous stock.

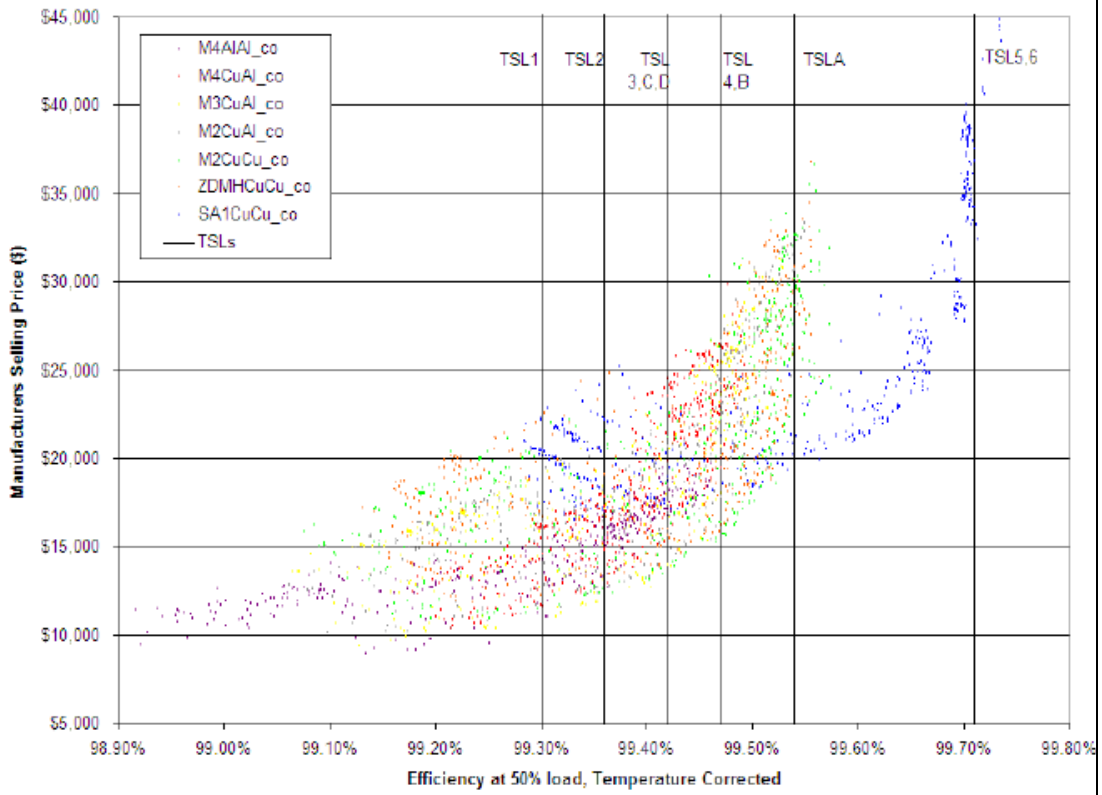
As a conclusion: Vito applied the ‘New installed sales’ on the past stock and not on the sales (as intended).

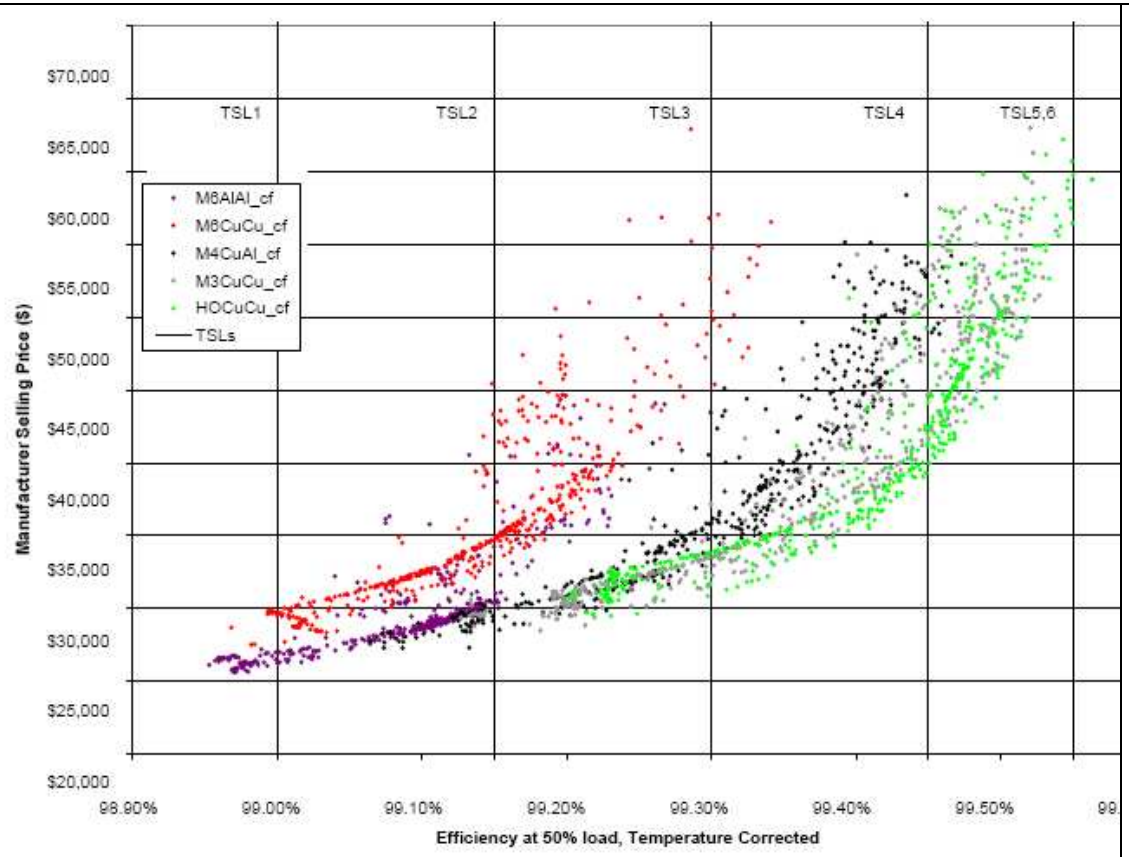
Another difference is that CLASP inflated the 2005 reference values.

BTW: Keep in mind that we received this comment substantially after the deadline (see comment 40) and that modifying stock figures now would result in a substantial amount of modifications of results and high risk of errors.</td>
</tr>
<tr>
<td>58</td>
<td>[Editorial]</td>
<td>2.2.4</td>
<td>112</td>
<td>The grammar in the third bullet from the top requires clarification to express the point. We are unsure what this bullet is trying to say. Currently, it reads:</td>
<td>Text updated</td>
</tr>
</table>

				"Above 5 kVA industrial users are reluctant to use three phase system as industrial equipment above 3 KVA often three phase in order to avoid unbalance in the electrical grid. Therefore a three phase 16 kVA transformer is considered more typical compared to single phase." Please review this bullet so the point it is making comes across clearly.	
59	[Editorial]	2.2.4	113	Near the top of the page, replace the word "poor" with "a minor", so it reads: "…this compensates each other and will have a minor impact on the further analysis."	Adapted
60	CLASP Europe	2.2.6.1	113	Please see opening comment above for Chapter 2 (noted above against page 91). CLASP Europe believes that energy-efficient transformers have longer operating lives, and this factor should be considered in the study being conducted by the Commission's contractors.	Not agreed, see comment 55.
61	CLASP Europe	2.3.7, 2.3.8	118	Spelling: "Amorhous" → "amorphous" (note the lower case 'a' and insertion of letter 'p')	No such section anymore (comment outdated?)
62	CLASP Europe	2.3.8	125	CLASP doesn't believe that the paragraph on Europe accurately depicts the market for amorphous transformers in Europe, which is a global leader in wind and solar energy. For instance, the paragraph on Europe fails to mention ABB's opening of a new transformer manufacturing plant in Brilon, Germany in March 2010. This facility specialises in the manufacturing of a cast-coil dry-type transformer that operate on an amorphous core. See: http://www.abb.com/cawp/seitp202/fb0fc8bb128af642c12576e9001d139e.aspx Also, for information on ABB's EcoDry cast-coil amorphous transformers, see this link: http://www05.abb.com/global/scot/scot252.nsf/veritydisplay/09242f48d062bf14852576e100212d3e/$File/1LAB000191_EcoDry_Transformer_Eng.pdf	Thanks for informing us about the opening of the plant(text is always outdated, reports dates from 2009). Added Noted, however:: The no load performance does not approach the BAT for the dry type as referred in chapter 5.

					Hence no reason for update. BTW:It is very unlikely that ABB would provide the essential data to perform the study because they were contacted several times but not provided any cooperation (directly or indirectly).
63	CLASP Europe	2.4.1	133	Figure 2-17 presents the 2001 DOE draft cost-efficiency curve for a 50 kVA single-phase oil-filled distribution transformer. DOE conducted and published two subsequent analyses on that unit. DOE also published analysis on larger liquid-filled transformers that may be more relevant to those being considered in this analysis. It is suggested that Figure 2-17 be removed as it was a draft analysis that DOE later revised (thus it does not represent the DOE's current position on the cost/efficiency relationship of this particular transformer), and it is suggested that one or both of the following figures be inserted instead. • 1500 kVA three-phase 60Hz liquid-immersed. Primary: 24940GrdY/14400 Volts (125kV BIL); Secondary: 480Y/277 Volts; T Rise: 65°C; Ambient: 20℃; Terminal Configuration: ANSI/IEEE C57.12.26, Loop Feed; Winding Configuration: Lo-Hi; Core: Wound core distributed gap, 5leg; Taps: Four 2½ percent, two above and two below the nominal; Impedance Range: 4.5-7.0%. (called "Design Line 5" below) • 2000 kVA three-phase 60Hz dry-type (open ventilated construction). Primary: 12470 Volts at 60 Hz (125 kV BIL); Secondary: 480Y/277 Volts; T Rise: 150℃; Ambient: 20℃; Winding Configuration: Lo-Hi; Core: Stacked, cruciform, mitered joint; Taps: Four 2½ percent, two above and two below the nominal; Impedance Range: 4.0–7.0%. (called "Design Line 13" below)	OK Thanks Added 1500 kVA

				Following below are screen captures from the DOE 2007 Technical Support Document, Chapter 5. The slope of a line describing the lowest points along the curve is indicative of the changing cost and efficiency relationship for these two representative models.	
64				 **Figure 5.5.5 Engineering Analysis Results, 2002-2006 Average Material Prices, Design Li**	

65				 **Figure 5.5.10 Engineering Analysis Results, 2002-2006 Average Material Prices, Design I**	
66	CLASP Europe	2.4.4	136	The text states: "It can be assumed that these repair and maintenance costs will not change with increased efficiency." As stated in its first comment on chapter 2 (referenced to a similar statement in the text on page 83), CLASP believes that energy-efficient transformers would have lower maintenance costs and longer operating lives than standard transformers. These benefits, in addition to the energy savings, are due to the lower operating temperature which will reduce degradation of	Text changed to '.. significant..4' See also reply in comment 55. Note: In general not agreed and should

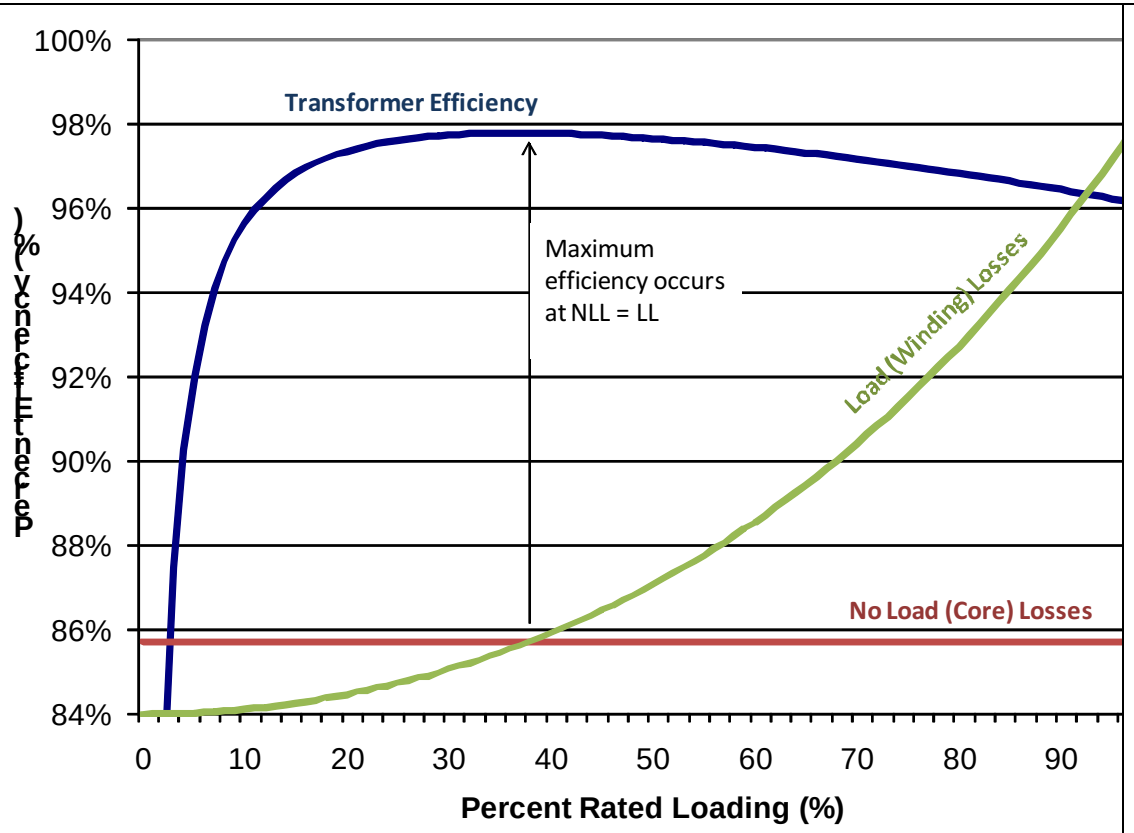
				the mineral oil and the winding insulation. By reducing waste heat (and associated hot-spots in the windings), energy-efficient transformers will have longer service lives with lower maintenance costs. Please see earlier comment for more detail. CLASP also kindly requests that the Commission's contractors investigate maintenance savings associated with more efficient transformers due to a reduction in oil degradation (from lower thermal degradation of the insulation).	have be timely brought up in the stakeholder meeting and discussed herein (see comment 40) .
67	CLASP Europe	Summary	140	Table 3-1 presents a summary of the main findings related to loading for the various transformers being analysed and covered in this study. CLASP finds that the "load factors" assumed for MV/LV distribution oil (0.19) and Power transformers (0.20) to be too low. This would imply that on average, utilities purchase and install transformers with a four-fold margin of safety. In reality, this is untrue as utilities have very good data on load profiles throughout their T&D grid and this loading point would imply poorly planned and underutilised assets. As the individual electric demand profiles aggregate, the load profiles become more predictable and well understood. By the time the demand profile has reached the size of a substation or indeed, a power transformer, there are literally thousands of users contributing to the loading, and thus 0.20 is too low. Later in CLASP's comments on this chapter, we identify what we think may be the cause of the calculated load factor being so low. CLASP believes that the loading on a 400 kVA distribution transformer would be between 0.35 and 0.50 and that the load factor on a 100 MVA power transformer would be between 0.55 and 0.65. CLASP provides some references / rationale for these estimates.	Not agreed This has been discussed in the last 2 stakeholder meetings. CLASP does not seem to understand the European installation practices and the two definitions that circulate about "load factors". The value currently used was obtained on very accurate factual data (ERDF (F complete), ESB (IE complete)) and confirmed by general statistics. Those two stakeholders cooperated after the second stakeholder

					meetings and provided us with the most accurate data on stock and transformed energy. Therefore this data is used. Some text was added in a new attempt to explain this low load factor (Pavg/S) being low: - A low load factor for residential such not be a surprise when looking to potential fluctuation in loading compared to the average power. The average domestic power in EU27 is only estimated at 413 Watt from 795 Twh used by 210.5 M households (Table 2-17, 2-15). This average power is much lower compared to the power comsumption of many home appliances, e.g.:

					cooking 500-9000 Watt, lighting 60-1000 Watt, TV 50-500 Watt, ICT 50-300 Watt, washing&drying 500-2000 Watt, ... Also the power factor should not be overlooked (see 3.2.1.2). Moreover new residential developments would rather upscale because more types of appliances are used, heating and cooling might rely more on heat pumps and electrical vehicles might be used. This is also reflected in the main fuse in households: 1x40 A(typically B), 1x90A(typically F), 3x63A (typically D) corresponding to residential power limits ranging from 10 kVA to 43 kVA. When a group of households connected to a transformer

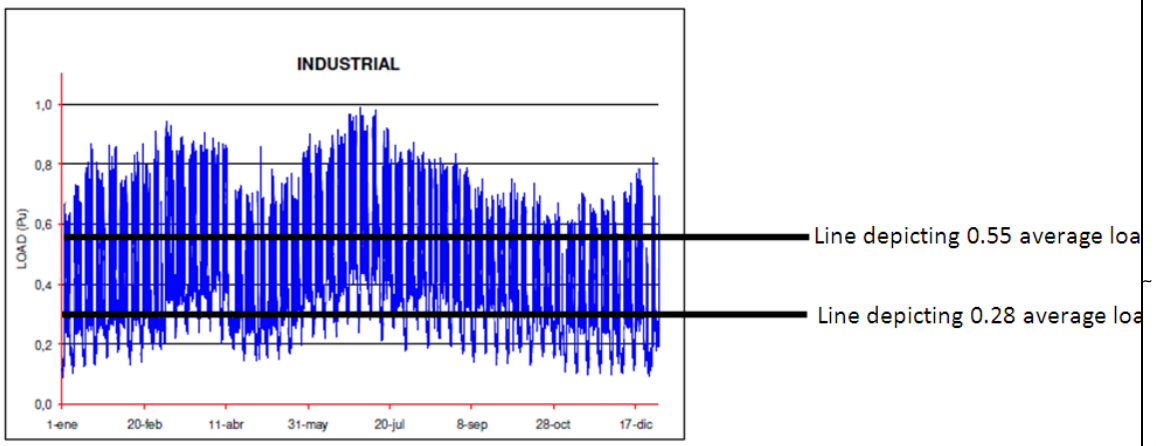
					simulatiously cooks, washes, lights its house, watches TV and uses some multimedia equipment clearly the average could be far above 413 Watt (e.g. 3000 Watt). Such an event can occur: e.g. match of the national football team. Therefore transformers are dimensioned at such events and load factors (Pavg/S) are correspondingly low (e.g. x0.15). See also how transformer rating is typically at its installation in section 2.2.2.1.
68	CLASP Europe	3.1.3.2	142	The title of the section is repeated immediately under the section heading number and title. The phrase “Lack of information on energy efficiency of existing transformers in service” immediately under the bold heading should be deleted.	Thanks, corrected.
69	CLASP Europe	3.2.1.1.2	145 - 146	In this section, the report authors discuss the impact of load profile on transformer efficiency. This is a well understood point. However, it is important to recall from a design perspective that every transformer has its optimum efficiency at the point where the watts of no load losses are equal to the watts load losses. At that loading point, the transformer will be at its peak	Thanks, added.

				efficiency, the “apex” of its efficiency curve. If that apex moves to a very low loading point – such as 15% loading, then the design software will create a design with a very large core cross sectional area and low magnetic flux. This will increase load losses (at the expense of no-load losses) and create a curve that is efficient at low loading points but which drops (significantly) in efficiency at high loading points. Similarly, if the apex of the efficiency curve (where NLL=LL) occurs at a significantly high point – such as 85% of rated nameplate, then the transformer will have very poor performance at the lower loading points. CLASP is providing the following graph of a typical 75 kVA three-phase open-ventilated low-voltage dry-type distribution transformer for VITO to incorporate into this section. This illustration may help to clarify the point about loading and the link to losses.	

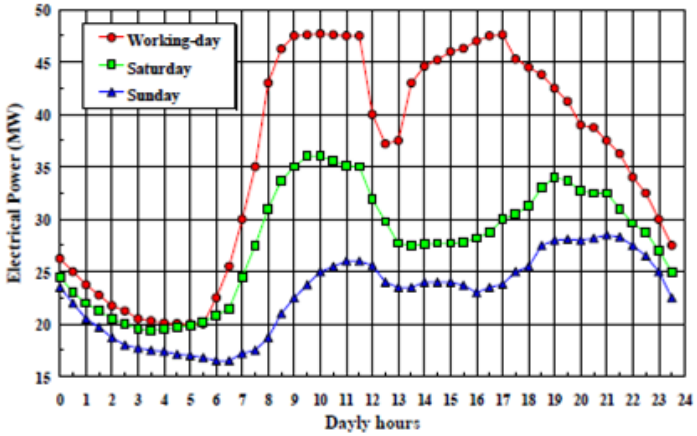
70					
71	[Editorial]	3.2.1.1.3	147	Change “know” to “known” in the following sentence: “Because the load profiles are not always known, some stakeholders…”	Corrected
72	[Editorial]	3.2.1.1.4	148	Format – consider revising scale of units presented on Y-axis of Figure 3-2. This graph is difficult to interpret with the units selected on this axis.	
73	CLASP Europe	3.2.1.1.5	151	CLASP is concerned that the Load Factors presented in this study are too low. We understand that the load factor unit used in this analysis is (Pavg/S rating), and we are not confusing it with the more commonly used average loading elsewhere in the industry. And while it is true that	Yes, but. As explained previously this value was

				the utility load factor would be slightly higher than that calculated in the preparatory study, the difference between these two values is numerically very small and certainly would not account for the very large differences between measured data on various transformer installations and the load factors being used in this preparatory study.	obtained after very detailed an robust data provided by cooperating stakeholders (ERDF, ESB). In our approach the load factor is still increased before calculation (Power factor (Pf), Load form factor (Kf)). While distribution is low, industry is rather high. More text is added to explain the findings.
74	CLASP Europe	3.2.1.1.5	151	Table 3-3 presents the numerical derivation of the average load factors (a) for distribution and industry transformers. Note that the Average load factor shown for Distribution transformers is incorrect – the table presents 0.15, but using the equation immediately under Table 3-3, the value should be 0.20. Average Load Factor = (annual demand in MWh / hours per year) / installed MVA Distribution = (1,553,000,000 / 8760) / 893,913 = 0.19832 ~ 0.20 It should be noted that the incorrect result of 0.15 is spread throughout this report, thus a search on this value should be conducted to ensure it is updated. However, even incorporating this mathematical correction, CLASP believes these load factors to be too low. It appears that there may be a problem with the methodology used to calculate	Corrected (should be 0.20 indeed). Comment, literature might use other definitions of load factors (Pavg/Ppeak) instead of Pavg/S. The issue of the load factor has sufficiently be

				the “Average load factor.” In the current approach, the annual demand in electricity (MWh) is divided by hours per year, the quotient is then divided by the installed MVA – however, CLASP does not believe it appropriate to divide by the entire installed capacity MVA. Rather, the annual demand of electricity (TWh) will pass through more than one transformer as it moves from generation to end-use. Indeed, the ErP study makes this point in Chapter 1 (page 35), where it states that “electrical energy passes through an average of four transformation stages before being consumed.” Thus, when calculating the average load factor based on annual demand of electricity, the installed capacity of transformers (MVA) will change the voltage of the same unit of electricity more than once. This needs to be accounted for, reducing the denominator (installed capacity of transformers) and thereby increasing the average loading. Table 3-3 needs to have an adjustment made to increase the average loading factor (a), since the electricity consumed will pass through multiple transformers in series rather than in parallel as it moves through the system. Two additional comments – (1) higher capacity (kVA) transformers (e.g., power transformers) will tend to have higher average loading factors than smaller capacity distribution transformers because they aggregate together multiple end-user load profiles and thus have more predictable loading profiles; and (2) industrial applications may experience fewer electrical transformation stages due to the fact that some industrial applications are operated at higher end-use voltages. CLASP researched data on loading of distribution, power and industrial transformers. Here are some findings: 1. The “Handbook of Electrical Installation Practice”, Fourth Edition, Edited by Geoffrey Stokes, Blackwell Publishing, 2003 contains a statement on page 330: “In the UK the average industrial load factor on a transformer is probably between 50-60%...” This range of loading levels seems more reasonable than the 0.40 proposed in Table 3-5 on page 154. 2. Further supporting an industrial transformer loading at a higher point, CLASP identified a Leonardo Energy publication, “Distribution transformer efficiency in a liberalized market” (http://www.leonardo-energy.org/webfm_send/504). On page 3 of this report is a figure depicting a typical load profile for a transformer in the industrial sector (see below). In Table 3-3 of the preparatory study, the average load factor for an industrial transformer is given as 0.28. CLASP believes this is much lower than reality. Perhaps a more reasonable loading point given these estimates would be 0.55 for industrial transformers.	discussed in two stakeholder meetings. A higher load factor is still covered in the sensitivity analysis. An extra example is added in an attempt to explain industry or commercial load factors: - Office lighting have typical annual operating hours ranging from 2000-2500 hours per year which should be equivalent to a load factor (Pavg/S) = 2250h/8760h = 26 %. However there is always some extra marging for extra loads (elevator, more ICT,..) and at the time of purchase one would allways rather select one step larger (e.g. 400 kVA instead of 250 kVA), that might explain

				 3. Another Leonardo Energy publication, "Potential for global energy savings from high efficiency distribution transformers" (February 2005) provides an estimate of the RMS load factor for various sectors, based on a questionnaire sent to 290 users in Japan. The findings are presented in Table 3-4 on page 153 of the draft ErP report. The top line in that table is for the "Electric Industry", which is presumably an electric utility transformer, which has a daily RMS average (including daytime and night time) of 0.43. Although this is for Japan rather than Europe, it is indicative of our concern that the 0.19 and 0.20 load factors being considered for distribution and power transformers in Europe is unusually low. 4. A paper[5] titled "Comparative life cycle assessment among MV metal-enclosed switchgears for HV/MV distribution substations" contains a load profile on page 3 of two 25MVA transformers of a HV/MV distribution substation. The figure below shows the loading profiles for a typical weekday, Saturday and Sunday. The combined capacity of these two transformers is 50MVA, approximately half the 100MVA transformer that is considered the representative unit in the analysis. CLASP entered the point values for each of the three lines, then converted them into an annual average based on 5 days per week of the red-line and one each per week of the green and blue lines. An RMS average was then calculated and it was found to be 69	above value of 15.9 %. Please note that in our approach also the power factor will be added afterwards and the designers do this as well. The SEEDT IEE Europe study (2008) used an average load of 18.86 % (including the power factor), which is very close to this study (Table 3-1 αe = 0.18).

[5] Fiorangelo Petroni, Lorenzo Sartore, Enzo and Antonio Sena of ENEL-Distribuzione and Renza Berti, Michele de Nigris and Pierpaolo Girardi of CESI. Comparative life cycle assessment among MV metal-enclosed switchgears for HV/MV distribution substations. Paper presented at CIRED, the 17th International Conference on Electricity Distribution Barcelona, 12-15 May 2003 link: http://www.cired.be/CIRED03/reports/R%201-67.pdf

				percent of the MVA rated nameplate for these two transformers.  *Fig.2 - A typical dayly load curve of a two 25 MVA transformers HV/MV distribution substation.* Average annual RMS loading is 34.5 MW. Convert to RMS average of nameplate by (34.5/50) = **69%**. CLASP believes that having correct loading factors is critical to this analysis because these assumptions will drive the economic analysis behind the efficiency levels considered. CLASP requests that the analytical team review their assumptions for the distribution, industry and power transformers in the light of these data; recommending the following: • Industrial Transformers: 0.55 loading factor • 400 kVA distribution transformer: between 0.35 and 0.50 loading factor and • 100 MVA power transformer: between 0.55 and 0.65 loading factor.	
75	CLASP Europe	3.2.1.1.5	151	The bullet at the bottom of this page identifies a small study conducted by the Cadmus Group for NEEP in 1999, which found the loading factors of certain transformers in office buildings to be between 14.1% and 17.6% of nameplate loading. CLASP recommends deleting this bullet from the chapter because these transformers do not exist in Europe, thus the RMS loading in a foreign country with different electrical distribution practices and voltages in commercial buildings is not relevant. Furthermore, the findings from this study need to be interpreted with caution as there are confounding factors that influenced the findings which may not be	Not agreed as it matches close with the sample based on office lighting that has been added (see comment 74).

				immediately apparent: 1. The study focused on low-voltage dry-type transformers, typically with primary voltages of 480V and secondaries of 120/240V. These are small, open-ventilated dry-type transformers that are typically installed on every floor of a commercial building in the US to supply plug loads and other electrical requirements, such as lighting. These transformers are not used in commercial buildings in Europe. 2. The Cadmus study metered the transformers for only two weeks each - it did not gather data for a full year. Seasonal variation (i.e., winter vs. summer) was not reported, nor was the level of occupancy in the sections of these metered buildings. This sample bias is of concern because these are all new buildings (less than 10 years old) and it is unclear whether they were fully occupied. Occupancy has a direct correlation to levels of consumption. 3. The capacity specification of transformers in commercial buildings is governed by the U.S. National Electrical Code, which has certain capacity requirements for the number of electrical plug points supplied on any given floor. These excess transformer capacity requirements are designed to prevent fires, and thus typically specify overcapacity in terms of kVA rating.	
76					
77	CLASP Europe	4	165	We note that there is a slight difference in the EU-27 Sales Figures between Table 4-2 on p.165 and Table 2-1 on page 93. The BC5 and BC6 sales figures in Table 4-2 do not sum to the total figures for DER transformers in Table 2-1. And for that reason, the total sales are also different.	We think the DER sales match between the two tables: 580 units for BC 5 and 2320 units for BC 6 (table 4-2) sum to 2900 (table 2-1). However the last category in table 2-1 (phase transformer) has not been taken on board for the rest of the study

					which is why there is a very minor difference in the total sales (31 units).
78	CLASP Europe	4	n/a	Thanks to the Team for accommodating our comments and preparing more refined materials for the life cycle assessment of transformers.	Thanks to CLASP for providing comments on advice on this topic!
79	CLASP Europe	5.1.2.2	220	Table 5-2 misspells the word “cicular” twice. It should read “circular”.	corrected
80	CLASP Europe	5.1.2.3	223	Table 5-3 provides a list of core steels that are available and considered in this analysis. A new row should be added to this table so that the beneficial properties of ZDMH (mechanically scribed domain refined electrical steel) can be compared to the other steels in the table. Here is the data to insert to the table: ZDMH 0.27mm 0.92 W/kg at 1.7T, 50Hz ZDMH 0.23mm 0.85 W/kg at 1.7T, 50Hz Here is the source of this performance data: http://www.nsc.co.jp/en/product/sheet/pdf/DE304.pdf	Thanks, added.
81	CLASP Europe	6.1.1.1	247	Table 6-1 presents the improvement options for the 400 kVA utility distribution transformer. CLASP is generally satisfied with the conventional steel designs, however we are concerned that the relative pricing used for all of the amorphous designs is too high. Our design report submitted to the Commission in August 2010 provided relative pricing values that were lower than those being used in the VITO report. BC1: Distribution Transformer 400 kVA Design VITO CLASP A0+Ck* 1.41 1.29	Indeed we have increased to prices to streamline them relative to the silicon steel prices from the enquiry. This gives indeed about +10 % higher price that

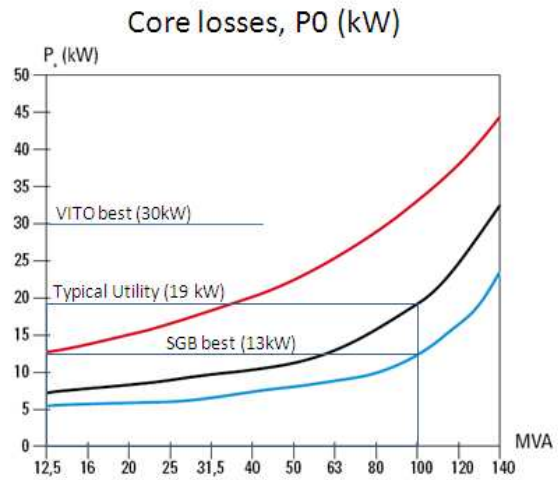
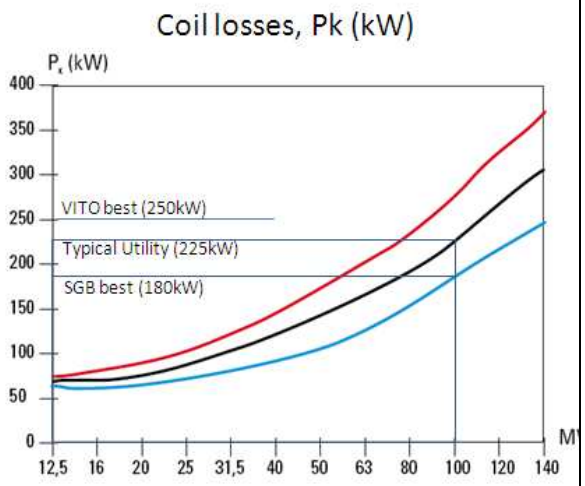
				A0+Bk* 1.64 1.50 A0+Ak* 1.75 1.60 A0+Ak+* 2.11 1.93 We are concerned that the prices of the amorphous designs have been increased relative to the report we submitted in August, and there is no explanation as to the rationale for the increase. The difference in price represents between €730 and €1100 for these four designs. We kindly request that the original CLASP price estimates be used for these four amorphous designs without modification.	can be explained as CLASP silicon steel designs were less optimal compared to those of those obtained in chapter 4 by enquiry. This allows a more equal comparison with chapter 4 silicon steel base case design. It does not impact the conclusions of chapter 6, as even with the +10 % the LCC is beneficial.
82	CLASP Europe	6.1.1.1	248	Table 6-2 presents some improvement option constants for BC1. We need to point out that the load factor used in this table is incorrect. Firstly, 0.15 is the value that was mistakenly calculated in Chapter 3 (see our comment on section 3.2.1.1.5 on page 151). Secondly, we believe even the corrected figure of 0.20 for load factor is too low as it is incorrect to divide by the total installed MVA, as the same quantity of electricity will pass through multiple transformers in its journey from generating source to end-use.	See comment 67. Has been discussed with CLASP by phone and the low power seems now to be accepted.
83	CLASP Europe	6.1.1.1	248	Table 6-2 presents sales and stock estimates for this particular representative transformer unit. As discussed in our earlier comments associated with section 2.2.3.2 (p.111-113), CLASP attempted to reproduce the stock estimates based on the sales and electricity growth rates used in this report. However, we found that the stock estimates presented were consistently	See comment 57. Vito and Biois think that our approach is consistent and sufficient to model

				understated in the preparatory study. CLASP therefore does not support the EU stock estimate of 2.25 million presented in Table 6-2. We believe this estimate is understated, as we calculated 3.67 million installed stock in 2005 and 4.78 million in 2020. Since CLASP's model is taking into account the adjusted new sales due to the shift from 250kVA to 400kVA, we are concerned that your stock estimate is significantly understating the EU stock.	the scenarios at this stage of policy assessment.
84	CLASP Europe	6.1.1.2	249	Table 6-3 presents the improvement options for the 1000 kVA industry transformer. CLASP is generally satisfied with the conventional steel designs, however we are concerned that the relative pricing used for all of the amorphous designs is too high. Our design report submitted to the Commission in August 2010 provided relative pricing values that were lower than those being used in the VITO report. BC2: Industry Oil Transformer 1000 kVA Design VITO CLASP A0+Ck* 1.73 1.68 A0+Bk* 1.91 1.85 A0+Ak* 2.06 1.99 A0+Ak+* 2.62 2.54 We are concerned that the prices of the amorphous designs have been increased relative to the report we submitted, and there is no explanation as to the rationale for the increase. The difference in price represents between €550 and €870 for these four designs. We kindly request that the original CLASP price estimates be used for these four amorphous designs without modification.	See comment 81
85	CLASP Europe	6.1.1.2	250	Table 6-4 presents some improvement option constants for BC2. CLASP has reviewed the load factor, and we believe that 0.3 is too low for an oil-filled industrial transformer. As we commented in Chapter 3, the loading for this transformer should be 0.55 of the rated kVA of the transformer.	See comment 67. Has been discussed with CLASP by phone and the low power seems now to be accepted.

86	CLASP Europe	6.1.1.2	250	Table 6-4 presents sales and stock estimates for this particular representative transformer unit. As discussed in our earlier comments associated with section 2.2.3.2 (p.111-113), CLASP attempted to reproduce the stock estimates based on the sales and electricity growth rates used in this report. However, we found that the stock estimates presented were consistently understated in the preparatory study. CLASP therefore does not support the EU stock estimate of 0.504 million presented in Table 6-4. We believe this estimate is understated, as we calculated 0.80 million installed stock in 2005 and 1.19 million in 2020. Since CLASP's model is taking into account the adjusted new sales due to the shift from 630kVA to 1000kVA, we are concerned that your stock estimate is significantly understating the EU stock.	See comment 57. Vito and Biois think that our approach is consistent and sufficient to model the scenarios at this stage of policy assessment.
87	CLASP Europe	6.1.1.3	250	Table 6-5 presents improvement option constants for BC3. CLASP is pleased to see that the preparatory study is now considering an amorphous design for this 1250 kVA dry-type transformer. CLASP intends to submit a dry-type report to the Commission in January 2011 which will provide design details on dry-type amorphous designs for this unit.	Noted
88	CLASP Europe	6.1.1.3	251	Table 6-6 presents some improvement option constants for BC3. CLASP has reviewed the load factor, and we believe that 0.3 is too low for a dry-type industrial transformer. As we commented in Chapter 3, the loading for this transformer should be 0.55 of the rated kVA of the transformer.	See comment 67. Has been discussed with CLASP by phone and the low power seems now to be accepted.
89	CLASP Europe	6.1.1.3	251	Table 6-6 presents sales and stock estimates for this particular representative transformer unit. As discussed in our earlier comments associated with section 2.2.3.2 (p.111-113), CLASP attempted to reproduce the stock estimates based on the sales and electricity growth rates used in this report. However, we found that the stock estimates presented were consistently	See comment 57. Vito and Biois think that our

				understated in the preparatory study. CLASP therefore does not support the EU stock estimate of 0.1088 million presented in Table 6-4. We believe this estimate is understated, as we calculated 0.17 million installed stock in 2005 and 0.24 million in 2020. Since CLASP's model is taking into account the adjusted new sales due to the shift from 800kVA to 1250kVA, we are concerned that your stock estimate is significantly understating the EU stock.	approach is consistent and sufficient to model the scenarios at this stage of policy assessment.
90	CLASP Europe	6.1.1.3	252 - 253	Table 6-7 and 6-8 present the revised range of designs for 100 MVA, 132/33 kV Power Transformer designs. CLASP reviewed industry literature on power transformers like the 100 MVA unit, and is concerned that the loss levels presented in this Preparatory Study are too high and do not reflect what is typically used by utilities in Europe. This is potentially very problematic because if the baseline unit is incorrect (i.e., not "typical"), then the analysis will artificially presume that more efficient models are more expensive than others, when these more efficient models are already the "typical" models used by utilities in Europe. Consider the following graphs from SGB Starkstrom and SMIT Transformers[6] that provide losses in accordance with standards (red line), typical electric utility specification (black line) and values achievable by SGB (blue line). Values of losses associated with the black lines in these graphs should be the base case typical unit – and clearly, these values are substantially more efficient than what is being used in the preparatory study as typical.	We are aware of the promotional leaflet of SGB, however: - A complementary inquiry on power transformers was carried out on stakeholders request after the final meeting and the definition of the base case was modified in accordance with the results of this inquiry.

[6] Weblink for this marketing brochure: http://www.google.co.uk/url?sa=t&source=web&cd=2&ved=0CB4QFjAB&url=http%3A%2F%2Fwww.sgb-smit.pl%2Fdownload2.php%3Fnazwa%3DLeistung12S_engl_9_02.pdf%26katalog%3Dbroszury&rct=j&q=SGB%20Starkstrom%20100%20MVA&ei=8-tkTLu9FYqQjAf91JnNCw&usg=AFQjCNE0Y_wvc97PuzDH_bkbJiCs5d9pEw

				  We have super-imposed boxes and labels on these SGB graphs to facilitate interpretation of the core and coil losses for a 100 MVA transformer. In Chapter 6, the base case design considered for the 100 MVA were 41kW core losses and 326kW of coil losses. That particular design is significantly higher than anything contemplated by these curves published by SGB Starkstrom and SMIT Transformers. From our perspective, it appears that the Commission's contractors are simply accepting industry data without doing any validating research by trying to consult with consumers of these transformers (i.e., utilities) to understand what the typical losses are for these units. VITO considers nine possible designs that are an improvement over this apparent artificial base case model. The highest performing unit is 20 kW of core losses and 228 kW of coil losses. CLASP is concerned again that this is not ambitious enough, as the SGB Starkstrom and SMIT Transformers literature indicates that 19kW of core and 225kW of coil losses is a "typical utility" specification. In Table 6-8, the closest design to this one is the 20-228 design, and it is shown to be 2.50 times higher in relative cost than the baseline. If SGB Starkstrom and SMIT Transformer call this the "typical utility" transformer, then this design should be set as 1.00 times the relative price and designs with lower losses than this one should be considered. For example, the very best SGB model shown in this graph is 13-180kW. In Tables 6-7 and 6-8, VITO does not offer a 100 MVA design with core losses below 20kW, nor one having winding	- SGB was contacted to provide additional information (1/2011) but no reply was received, neither at the third stakeholder meeting in (9/2010) on which SGB was present. - Our base case is in line with the performance required by the most recent German DIN 42508 standard (2009) (80 MVA –Po< 41kW-Pk<250kW). The German grid being known for its efficiency (see reference connected to Table 2-16). - The promotional

				losses below 225kW. Both are substantially higher than the SGB transformers. CLASP therefore concludes that the Power Transformer design results presented in this chapter are not representative of the typical transformers purchased by utilities. We do not support these findings and kindly request that BC4 (Power Transformer 100 MVA) be re-done with input from other parties such as electric utilities.	leaflet from SGB does not say that core and coil losses might compromise each other. - In the enquiry there were no answers from Germany (SGB?) confirming the best solutions mentioned in the enquiry. - As can be conducted from figure 6-12 existing improvement options did not yet lead to a lower LCC so far more optimisation won't either.
91	CLASP Europe	6.1.1.4	254	Table 6-9 presents some improvement option constants for BC4. CLASP has reviewed the load factor, and we believe that 0.2 is too low for a 100 MVA Power Transformer. As we commented in Chapter 3, the loading for this transformer should be 0.55 and 0.65 of the rated nameplate capacity of the transformer.	See comment 67. Has been discussed with CLASP by phone and the low power seems now to be

					accepted.
92	CLASP Europe	6.1.1.4	254	Table 6-9 presents sales and stock estimates for this particular representative transformer unit. As discussed in our earlier comments associated with section 2.2.3.2 (p.111-113), CLASP attempted to reproduce the stock estimates based on the sales and electricity growth rates used in this report. However, we found that the stock estimates presented were consistently understated in the preparatory study. CLASP therefore does not support the EU stock estimate of 0.064 million presented in Table 6-9. We believe this estimate is understated if it is meant to represent the stock in 2020, as we calculated 0.98 million units installed stock in 2020. If this estimate does represent 2020, then we are concerned that your stock estimate is significantly understating the EU stock.	See comment 57. Vito and Biois think that our approach is consistent and sufficient to model the scenarios at this stage of policy assessment.
93	CLASP Europe	6.1.1.5	255	Table 6-10 presents the improvement options for the 2000 kVA DER oil-immersed transformer. CLASP reviewed the conventional steel and amorphous designs, and we are generally satisfied that they are representative of what these units would cost. The relative costing of these designs is perfectly consistent with the CLASP design report submitted to the Commission in August 2010.	Thanks for your complementary information on this
94	CLASP Europe	6.1.1.6	256	CLASP fails to understand why there are only two lower loss designs considered for this 2000 kVA dry-type DER transformer. At a minimum, an amorphous design should also be included, as it was considered for BC5, the 2000 kVA oil-immersed DER transformer. Additional designs are needed, both in conventional grain-oriented electrical steel, domain-refined grain-oriented electrical steel and amorphous metal. Given the relative importance of this particular transformer, CLASP fails to understand why so little analytical effort has been invested in understanding the relationship between cost and efficiency, and the potential to for higher efficiency levels. We kindly request that additional designs be prepared and shared with stakeholders for review.	Agreed that the improvement options in BC 6 are currently weak. After discussion with CLASP the conclusion was that: - For BC 6, a switch to BC 5

					filled with biodegradable oil seems to be the best option. - The extra price and impacts for this will be assessed. - Mentioned that ABB announced starting production (2010) of up to 2500 kVA dry type amorphous transformers, so sooner or later data and products will be available (see comment 62).
95	CLASP Europe	6.1.1.7	257	CLASP is concerned that only one lower loss designs was prepared for this 16 kVA dry-type separation / isolation transformer. At a minimum, an amorphous design should also be included, and ideally some additional conventional grain-oriented electrical steel and domain-refined grain-oriented electrical steel. CLASP kindly requests that additional analytical effort be invested in understanding the relationship between cost and efficiency for this unit. We kindly request that these additional designs be prepared and shared with stakeholders for review.	Only one improvement design was prepared for this type of transformer because of lack of BAT data and minor

					importance of the product category. This study is about BAT as defined in chapter 5, could only be mentioned as BNAT. The purpose is not engineering of new products. Note: - Those transformers are mostly dry type. Making them from amorphous material isn't due to noise problems. - AMT will take more volume and one is limited to few sizes of preformed cores (see chapter 5). - it would require new production lines.. - Hence a business case for this product remains doubtful.

<table>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>96</td><td>CLASP Europe</td><td>6.2</td><td>258 - 295</td><td>CLASP notes that the LLCC designs identified throughout this section will likely change as the loading assumption and design costs change, according to our previous comments. We therefore kindly request that the revised LLCC designs selected be published for comment after our comments on Chapters 1 through 6 are addressed.</td><td>No changes of the values of the loading factors and design costs were made.

Their influence are however analysed in detail in the sensitivity analysis in section 6.4 (e.g.. see figure 6-23).</td></tr>
<tr><td>97</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>98</td><td>CLASP Europe</td><td>7.1.1</td><td>330</td><td>CLASP wishes to express its concern over transformer coverage, and whether the definitions presented in this section of the preparatory study would result in complete coverage of power and distribution transformers, or if it would result in some subset of those units with pockets of models that are not covered or regulated. These pockets may then become the high volume models, undermining the intention of the regulation. The table below summarises our understanding of the sections within 7.1.1:

<table>
<tr><th>Section</th><th>Application</th><th>Type</th><th>Phases</th><th>Rating Range</th><th></th><th>Max Voltage</th><th>Industry Standard</th></tr>
<tr><td>7.1.1.1</td><td>Distribution</td><td>Oil</td><td>Three</td><td>50 kVA</td><td>3150 kVA</td><td><36kV</td><td>EN 50464-1 Series 2007</td></tr>
<tr><td>7.1.1.2</td><td>Distribution</td><td>Dry</td><td>Three</td><td>100 kVA</td><td>3150 kVA</td><td><36kV</td><td>EN 50464-1 Series</td></tr>
<tr><td>7.1.1.3</td><td>Power</td><td>Oil</td><td>Three</td><td>>5000 kVA</td><td>no limit</td><td>>36kV</td><td></td></tr>
<tr><td>7.1.1.4</td><td>Smaller</td><td>Dry</td><td>Three?</td><td>1 kVA</td><td>100 kVA</td><td><1kV</td><td>Separating, Isolating, Contro</td></tr>
<tr><td></td><td>General Purpose</td><td>Dry</td><td>Single?</td><td>not defined</td><td></td><td><1 kV</td><td></td></tr>
</table>

As presented, it appears that oil-immersed transformers between 3150 and 5000 kVA are not covered, nor are any ratings below 50 kVA on the oil-immersed side. In addition, the voltage</td><td>See comment 45</td></tr>
</table>

				range can be a constraint on the oil-immersed side, with no small units at high voltage and no large units a lower voltages. For the dry-transformers, there is uncertainty in coverage, including a lack of specificity. Dry-type units above 3150 kVA would not be covered, nor would smaller units (<100 kVA) with voltages above 1kV. All of these product definitions have constraints in coverage, and CLASP is concerned that loop-holes will be inadvertently created through this numerical approach to defining the scope of covered products. CLASP therefore wishes to emphasize its earlier comment that scopes of coverage be more qualitative, that the quantitative aspects of coverage should be indicative as much as possible, but not limiting or constraining coverage. Furthermore, to ensure complete coverage, discussion of the comparisons with definitions should be compared with manufacturers' product catalogues to provide an independent verification on comprehensive coverage.	
99	CLASP Europe	7.1.1.1	330 - 331	CLASP wishes to express its concern over the "Proposed new subcategory needed for MEPS" at the top of page 331. Here, the preparatory study introduces – for the first time – the concept of "very compact" three-phase oil-immersed distribution transformers and state that this group might need different and less stringent losses. While we appreciate the use of the conditional verb 'might', we are equally concerned that there has been no analysis in the preparatory study of pole transformer sizes, weights and losses. This issue is simply dropped into Chapter 7 without any analysis to show that the Commission's contractors have explored different ways of making pole-mounted transformers more efficient, and whether – through the use of better core steel – designs can actually increase in efficiency while decreasing in weight. Indeed, this issue should be kept in mind, but proposing to create a new subcategory and suggesting that different and less stringent loss requirements are needed is problematic. Once an appropriate level is selected, designs of pole-mounted units should be prepared using various core steels and copper windings to determine what the weight would be. If it is possible to achieve the efficiency regulations without exceeding the maximum pole-mounted weight limit, then no special treatment is warranted.	We think that the impact on weight is sufficiently explained in chapter 5, because this is independent of the rating of the BC1 (sufficient abstraction can be made). The only difference is the way MEPS are proposed (which we think is adequate and no negative T&D reactions were received°.

100	CLASP Europe	7.1.1.1	331	Relating to the previous comment, although CLASP is calling for a detailed and technical review prior to establishment of any new subcategory of oil-immersed distribution transformer, CLASP wishes to draw the contractor's attention to two parts of the proposed definition that may be problematic: "Light weight pole mounted transformers with rating between 100-160 kVA with a maximum of 550 kg and not having minimum load classes A0Ck." Our concerns are as follows: 1. "maximum of 550 kg" should be "minimum of 550 kg" since this subcategory is about heavy transformers which exceed a certain maximum threshold 2. "and not having minimum load classes A0Ck" does not make any grammatical sense. Furthermore, in the absence of any design and weight analysis, we do not see how this specific combination of A0Ck losses can be proposed. We recommend deleting this phrase from the definition.	Difficult to understand your concern. Text was changed due to other stakeholder comments, nevertheless it is about light weight transformers with an upper limit in weight.
101	CLASP-Europe	7.1.2.1	333	CLASP is disappointed with the proposed design of A0Ck for this group of transformers. We are disappointed that only one tier is proposed, and we kindly request further clarification on the level proposed, including how it would apply to all covered kVA ratings. We were pleased to learn that the Amorphous designs were identified as the LLCC. CLASP does not support the adoption of an alternative standard for pole-mounted oil-immersed transformers without analysis to determine if this measure is appropriate. The preparatory study needs to propose 2 tiers and not just one. Having one tier does not send a long-term message to industry that they should make more aggressive savings in a dynamic way. Furthermore, it fails to reward front runners because they need to wait for the revision before assessing whether it makes economic sense to put more efficient products on the market above the MEPS levels.	Text was updated to align with the scenarios and the mentioned impact in later sections.
102	CLASP Europe	7.1.2.3	334	CLASP suggests that the levels for the Large Power Transformers be set at the midpoint between the Typical Utility and SGB Best lines in the graphs above for Tier 1 (2013). Then, Tier 2 (2015) could be the SGB Best line. To cover the kVA ratings that are not included in the SGB plot, CLASP proposes adopting the VITO recommendation or uses the 0.75 scaling rule to	Remark: SGB is a member from ZVEI who filled in an enquiry.

determine maximum losses from the SGB curves. The following table presents CLASP's suggestion for Tier 1 and Tier 2 maximum losses for this Large Power Transformers.

	P0 (Core Losses)			CLASP	CLASP
kVA	VITO (kW)	Utility (kW)	SGB Best (kW)	Tier 1 (kW)	Tier 2 (kW)
6,300	4.44			4.44	3.17
8,000	5.34			5.34	3.79
10,000	6.24			5.70	4.48
12,500	7.38	7.00	5.30	6.15	5.30
16,000	8.88	7.50	5.50	6.50	5.50
20,000	10.44	8.00	6.00	7.00	6.00
25,000	12.30	9.00	6.50	7.75	6.50
31,500	14.58	10.00	7.00	8.50	7.00
40,000	17.40	11.00	7.50	9.25	7.50
50,000	20.82	12.00	8.00	10.00	8.00
63,000	24.60	13.00	9.00	11.00	9.00
75,000	27.90	16.00	10.00	13.00	10.00
90,000	32.16			14.80	11.80
100,000		19.00	13.00	16.00	13.00
120,000	40.08	24.00	17.00	20.50	17.00
140,000		32.00	23.00	27.50	23.00
150,000	47.34			28.96	24.22
180,000	53.16			33.20	27.77

	Pk (Coil Losses)			CLASP	CLA
kVA	VITO (kW)	Utility (kW)	SGB Best (kW)	Tier 1 (kW)	Tie (k
6,300	35.9			35.9	
8,000	44.9			44.9	
10,000	52.9			52.9	
12,500	62.9	72.0	70.0	62.9	
16,000	76.8	75.0	71.0	73.0	
20,000	92.8	76.0	72.0	74.0	
25,000	109.8	90.0	75.0	82.5	
31,500	132.7	105.0	80.0	92.5	
40,000	155.6	125.0	90.0	107.5	
50,000	193.6	145.0	105.0	125.0	1
63,000	233.5	165.0	130.0	147.5	1
75,000	277.3	190.0	155.0	172.5	1
90,000	319.2			190.5	1
100,000		225.0	180.0	202.5	1
120,000	396.0	270.0	225.0	247.5	2
140,000		305.0	245.0	275.0	2
150,000	470.9			289.6	2
180,000	530.7			332.0	2

Unfortunately they did not fill in even the 50 % over BC improvement (Annex D).

Therefore we also lacked data to check the LLCC and.

Even less ambitious improvement options showed not to be economic (Figure 6-64).

Therefore the CLASP proposed Tiers cannot be part of ErP legislation.

Please have also a look at the Table of the DIN standard for power transformers (Chapter 1) and the analytic model (website).

The SGB promotional leaflet can therefore only serve to add in the proposal as BAT

					target.
103	CLASP Europe	7.1.2.1 - .4	333 - 334	Throughout this section, it would be helpful if VITO included discussion around how the Commission intends to handle non-typical kVA ratings, such as those not appearing in the tables. It should be agreed whether transformers between two ratings would be held to the maximum losses of the rating above or below the non-typical kVA rating, or have their maximum losses of the non-typical kVA based on linear interpolation between the kVA ratings immediately above and below it. CLASP would support this latter option – linear interpolation for non-typical kVA ratings.	Thanks for pointing out this, proposed is: Loss limits for ratings that fall in between ratings defined in the standard should be obtained by linear interpolation and ratings outside should be linear extrapolated.
104	CLASP Europe	7.1.4.1	336 -7	The discussion on policy measures for TSOs is helpful, and responsible TSOs should continue to use total cost of ownership based on high valuation of losses. CLASP strongly feels that this should not be seen as an alternative to a regulation on maximum losses for power transformers.	The project team agrees with this view and it will be made clearer in the report that the regulation would/could not be superseded by TCO.

105	CLASP Europe	7.1.4.2	337	This section contains three suggestions for incentivising DSOs to adopt more energy-efficient practices. CLASP supports the measures presented, but again strongly feels that this should not be seen as an alternative to a regulation on maximum losses for power transformers. Progressive DSOs will continue to purchase at or below these levels of losses, and the regulation will ensure that a minimum performance level is achieved. The second paragraph of this section discusses other legislation that "TSOs" are subject to. Should this say "DSOs" or was this paragraph intended to be inserted into section 7.1.3.1?	See response to previous comment This has been corrected
106	CLASP Europe	7.1.4.3	338	CLASP shares the concern expressed in this section that some DER investors may be looking for short payback periods that are not in alignment with the life-cycle (+20 years) of a transformer. In these instances, inefficient transformers will be installed and operated over their full life-time with negative environmental consequences. CLASP fully supports the recommendation to have the meter installed such that it measures losses from the transformer, as the transformer is a critical component of the DER system.	Thank you for your support
107	CLASP Europe	7.1.4.4	338	In this section, the BAT levels (A0Ak) are identified as easily being drafted into procurement specifications, however CLASP has two concerns: 3) CLASP strongly feels that this should not be seen as an alternative to a regulation on maximum losses for these transformers. An EU level regulation will ensure that all equipment purchases, not only those for large public buildings and certain industrial sectors, will achieve a certain minimum performance level. More progressive consumers can always purchase higher, but the Ecodesign Regulation would also ensure a maximum level on losses that no one would exceed. 4) For several of the Basecase transformers analysed, the A0Ak level was found not to be ambitious, and that other more efficient levels exist in the market. There may be more efficient, cost-optimised levels for certain Basecase transformers (e.g., A0+ and Ak+). CLASP supports the concept of accelerated depreciation of energy-efficient capital assets as a method for promoting efficiency. This is a win-win for society and business.	1. We agree with this point and the text states "Note that classes A0Ak should not serve as an alternative for the proposed regulation neither prevent that more ambitious targets could be set"

					2. Current barriers to most ambitious targets have been explained and the need for a Tier 2 to be set later is stressed in the report. Text was updated accordingly.
108	CLASP Europe	7.1.7	340	CLASP welcomes and fully supports the recommendations in this section to develop extra no-load and load loss classes that exceed the A0 and Ak levels already published in EN 50464-1 and EN50541-1. CLASP appreciates the acknowledgement of its comment from the discussion at the final stakeholder meeting relating to the fact that the loss tolerance specified in IEC 60076-1 may be excessive. IEC 60076-1 states that the maximum allowable tolerance on the total losses (sum of the load and no-load losses) is 10% of the total losses. This large tolerance levels come from the day when materials, production methods and testing methods weren't as consistent as they are now. CLASP's experts believe the level could be less than 5%, given the improvements in core steel processing, core handling equipment, annealing furnaces, winding equipment, insulation and other variables that had previously necessitated the 10% tolerance. CLASP believes that at most 5% be the maximum allowable tolerance on losses. CLASP is also aware that several utilities in Europe are not adopting a zero percent tolerance with manufacturers, meaning that the unit has no flexibility to have losses that are higher than the guaranteed level. If manufacturers are already working to that requirement in the market, then we consider it reasonable that any regulation would adopt a similar requirement – i.e., 0%.	Agreed See Also other stakeholder comments (T&D Europe).
109	CLASP Europe	7.2.3	371	CLASP is surprised that T&D Europe "insists on one Tier to avoid excessive administrative work", citing reprinting catalogues as the chief reason. CLASP disagrees with this recommendation and encourages the Commission to consider a two tier regulation, providing sufficient lead time on the second tier to allow for manufacturers – both large and small – to do the necessary research, designs and capital equipment investments to be ready for a higher second tier standard.	See comment 107. Text has been updated.

				CLASP and its consortium partners prefer the two tier level because it generally enables energy savings to be realised sooner, and it enables the Commission to adapt a more ambitious level in the second tier. Furthermore, it maximises the energy savings potential that can be realised for the analytical effort invested by the Commission into this product, and it provides sufficient lead time for manufacturers to prepare for manufacturing at these higher efficiency levels.	
110	CLASP Europe	7.2.3	372	CLASP kindly requests a revision to the statement below which reads: "Therefore, the following elements could be taken into account when deciding on maximum transformer losses: - Raising the no-load requirements above class A0 (EN 50464-1) would phase out Domain Refined High-permeability steel production and associated production of steel and transformers. - A fast raise to class A0 (EN 50464-1) would require high amounts of Domain Refined High-permeability steel production and could disturb the market as well." We believe that both of these statements are invalid: 1. It is possible to have domain-refined high permeability steel designs with no-load losses lower than class A0. These old efficiency classes (D0, C0, B0, A0) do not represent the maximum technologically feasible with modern, highly efficient core steel. In fact, CLASP believes the analysis would benefit from not restricting the range of designs to the P0, Pk loss categories, and instead allowing more flexibility around the range of losses, including silicon steels with losses lower than A0. 2. VITO makes a subjective statement that a fast rise to class A0 will disturb the market, however the report does not contain any analysis in support of that statement. This unsubstantiated statement is threatening at best and misleading at worst, and does nothing to further the purpose of the preparatory study. We propose revising this statement quoted above from page 372 to instead read as follows: "Therefore, when considering measures around maximum allowable transformer losses, policy makers should take into account: - Raising the no-load requirements above class A0 (EN 50464-1) would enable both high-quality domain refined high-permeability silicon steel and amorphous material to be used in transformer designs. - A rapid rise to class A0 (EN 50464-1) will stimulate the market for higher-quality	It was said 'far above' instead of 'above class A0..'. Agreed that the statement about the fast raise should be withdrawn (because it showed to be technical possible to design class A0 without HGO-DR). Agreed to add: - A rapid rise to class A0 (EN 50464-1) will stimulate the market for higher-quality domain refined high-permeability silicon steels, and

				domain refined high-permeability silicon steels, and may require steel suppliers to invest in their production capabilities."	may require steel suppliers to invest in their production capabilitie s."
111					
112	**ThyssenKrupp Electrical Steel (TKES)**	**5.1.2.3**	**222**	**Correction:** **There is also mechanically-scribed Domain refined electrical steel available. Furthermore there is a new technique "Unicore", developed in Australia, where Domain refined material can be used even <u>without annealing</u>. The Unicore technique is today accepted in more than 30 countries and is also being tested in the EU.**	Corrected
113	**ThyssenKrupp Electrical Steel (TKES)**	**6.1.1.1**	**247**	**Remark:** **In the "relative" columns of A0+Ck*, A0+Bk*, A0+Ak* and A0+Ak+*, the entries for Core steel, Aluminium wire and Copper wire are missing.** **(same situation on p249, p250, p255).**	Indeed because amorphous transformers use a different design. These quantities were not estimated from the initial BOM of the base case but were described in task 5 in absolute values only. The relative values are indicated only when they

					were used to calculate the absolute data.
114	**ThyssenKrupp Electrical Steel (TKES)**	**7.1.2.1**	**333**	**Correction:** **However, this can only be achieved with amorphous transformer technology and with HGO-DR material. (Remark: A0+ requirements can theoretically also be achieved with HGO-DR material by modifying the transformer design and -geometry - although this might be less economical)**	Corrected
115	**ThyssenKrupp Electrical Steel (TKES)**	**7.1.5**	**339**	**Remark on R&D:** **The amorphous technology has been established for 30 years. Therefore it must be recommended that technical development should be driven by market demand, like for silicon steel (equal treatment).**	Corrected in the text
116	**ThyssenKrupp Electrical Steel (TKES)**	**7.1.7**	**340**	**Remark:** **An extension of class A0 would phase out all distribution transformers with silicon core. Also a fast raise to class A0 is not achievable, since there is currently not enough HGO-DR-production available.**	The improvement options presented show that A0Ak levels could be achieved without amorphous technology. The project team believes that the manufacturing capacity will be able to follow the demand, if relevant

					tiers are set
117	**ThyssenKrupp Electrical Steel (TKES)**	**7.2.3**	**372**	**Correction:** - **There is currently no European production of amorphous strips for transformers. (Remark: The word significant is incorrect). Needed quantities must be imported from USA or from ASIA.** - **Over 100 manufacturers are active in China alone and a quarter of them are able to produce amorphous cores. (Remark: The word strips is incorrect. Amorphous strips are the basic material for amorphous cores. They are only produced by Hitachi Metals and eventually by AT&M worldwide)**	Text updated accordingly.
118					
119	Dansh Energy Agency/AFHH/LAH	Introduction		The following comments are given on behalf of the The Danish Energy Authority by Laurits Hansen who has taken over the DEA stakeholder work earlier done by Erik Jørgensen. Given the opportunity we want to thank the contractor group and the Commissions representative for their efforts and for the well done study to found a good base for eco-design requirements. We want, however, to give a few comments on Chapter 7 as follows:	
120		7.1.1.1 7.1.1.2 7.1.1.3 7.1.2.3 7.1.4.1		General comments addressing the list of sections: The MEPS policy for Distribution- and power transformers should be used in the tender specifications that take load and no-load losses into account when assessing the Total Cost of Ownership (TCO). The capitalisation factors for no-load losses and load losses started in the invitation to tender	The use of TCO should not supersede the MEPS. From the view of the project team, every product should have to respect the MEPS. Meanwhile

		7.1.4.4		shall be used as a basis for the tender. If the no-load losses or load losses deviate more than + 15% from the losses stated in the tender, the buyer reserves the right to reject the transformer. If the capitalised value of the total losses exceeds the calculated value based on the tender, a reduction corresponding to the excess value vill be made in the puchase. It is therefore important to state the capitalisation factors for no-load losses and load losses based on the MEPS I the tender.	the use of a harmonised TCO could be promoted to enable a fair comparison between the MEPS compliant products.
121		7.1.1.4 - 7.1.2.1 7.1.2.2 - 7.1.2.4 7.1.3.1 - 7.1.3.2 7.1.3.3 - 7.1.3.4 7.1.4.1 - 7.1.4.2		As general comments addressing the list of sections DEA is agree with the text.	Noted
122		7.1.4.3		Energy efficiency should preferably be assessed for the complete DER plant (wind) rather than for a specific component. Emphasising that the assessment is to comprise the entire DER plant. For turbines, loss efficiency “power curves” are often stated at low voltage terminals, neglecting the transformer although it is an inherent portion of the plant.	It will be emphasized in the text, even if the scope of this specific study is the transformer (a complete system analysis of a plant is not feasible in this context).
123		7.1.4.4		As general comments addressing the list of sections DEA is agree with the text.	Noted

124		7.1.5		Smart Grid Technology is a very general and relevant topic, probably best addressed at an overall grid optimisation level, incorporating lines, SCADA and switchgear automation, moving focus from security of supply to loss and efficiency, rather than in a context of transformer focus only. DSOs and TSOs face these days rigid availability focused standards/benchmarking, potentially leading to excessive use of no-load loss consumption in idling transformer/generator plant and inefficient operational network conditions. I.e. the view is: The topic is relevant in an eco-design but perhaps not in a transformer context. It is also important to restrict the impact of harmonic from no-linear load from the industries.	Thanks for point out, added: DSOs and TSOs are currently focused on availability with connecting standards and benchmarking. This has potentially lead to excessive use of no-load loss consumption in idling transformers and generator plant. This is also reflected in the low load factors found (chapter 3). Restricting harmonics from loads is outside the scope of this study
125		7.1.6 - 7.1.7 7.1.8 - 7.1.9		As general comments addressing the list of sections DEA is agree with the text.	

		7.1.10			
126		7.1.11. – 7.2.7		For making a coming policy (based on the policy analysis) work on the European market it is important that the implementing measures reflect a clear strategic plan, with visible tiers for the European manufacturers clearly showing what will happen, so that investment into production facilities can be better planned and an increase in energy efficiency can be achieved.	
127					
128	**Eurelectric (ESB-Anthony Walsh)**	General		The critical points for the utilities are as follows: The first of these is **that Utilities should, as an alternative to MEPS, be able to use Capitalized losses and Total Cost of Ownership in their selection of transformers**. This is covered in Section 7.1.4.1 but in an unclear manner – reference is made to TSO transformers when the TSO owns no electrical assets – these are owned by the Distribution and Transmission Asset Owners. The second is that **the economic evaluation by the utilities uses Total Cost of Ownership (TCO)**, which is best practice for Sustainability and which is also economically correct. The TCO model used in the report is oversimplified and confined to Initial costs and Capitalized losses, whereas **the utilities use a much more detailed and sophisticated form, also including maintenance, installation costs, logistic costs, re-use and disposal costs etc.** This more detailed approach avoids the problems highlighted in the report where some pole mounted transformers could be so heavy they couldn't fit on the pole, or some ground mounted transformers would be so large that they wouldn't fit in the substation, as so the cost of the installation would rule out such anomalies. **These points need to be clear and feature more prominently in the report.** As an Impact Assessment is the next stage in the process if this Report is approved, the above changes are necessary conditions for any economic Impact Assessment to be positive.	Nothing will prevent the utilities to use the TCO (on the contrary), but the purpose of the MEPS is to phase out products which would anyway not be chosen with the TCO (because economically inferior on the long term). Therefore, utilities should not be worried about that even if a more simplistic approach was used in this study (the maintenance, installation and re-use costs were considered in the study but their influence on the difference

					between the base case and the improvement options costs has been estimated negligible compared to the one of the losses).
129	**Eurelectric**				
130				**<u>P 329</u>** ***Summary …'Because of weight limitations, it might be that some pole mounted transformers can technically not satisfy the proposed maximum loss requirements. For these transformers and alternative requirement on core loss alone (W/kg) was proposed. These transformers could also benefit from strict installation requirements in Member States*****.** There are two problems with the above: (a) W/kg was one of the proposals but not the only one suggested at the meeting. In fact W/kg is too specific and one of the meeting discussions centred on the need to avoid prescribing solutions, as had been the case in the draft being discussed where, for example, only Copper windings were to be allowed in such transformers. In this case the use of W/kg could mean that transformer designs such as Hexaform, which reduce losses through a different configuration of the cores would not be allowed as a solution, only the use of steel with a W/kg below a certain level. So the prescription of the solution in such a manner is not optimal. (b) Extra costs for using heavy Transformers	On (a) Not agreed. Manufacturers do not have problems with that. Hexaform can use HGO-DRM (mechanical scribed) (see chapter 5) On (b) It is true that the specific case of the pole mounted transformers have not been subject of a specific cost analysis, including their installation costs. However, the project team believes that the

				- ESB use pole mounted transformers up to 200kVA as was mentioned at the meeting, yet the limit set is 160KVA - Furthermore it was pointed out that the cost/benefit analysis of using some arbitrary requirement for pole mounted transformers had to take into account the extra costs associated with the installation of such transformers, as the current cost/benefit analyses only take transformer costs into account. If a four pole double A arrangement is needed to mount an excessively heavy pole mounted transformer this is clearly not justifiable economically or environmentally, yet would not be catered for in the current analysis. Again this point was raised at the meeting – using capitalised costs for losses and a Total Cost of Ownership approach is necessary to indicate the correct solution. Similarly, 200kVA+ pavement mounted transformers for Electric Vehicles may be the only solution to reinforce networks for Electric Vehicles where city centre sites are unavailable at any reasonable price. In order to minimise the size of these transformers they are inherently high loss types, as a compromise must be made on size. However they are facilitating the introduction of EV's which has a much greater impact on energy efficiency and CO2 reductions. The treatment of losses in such pavement mounted transformers is also a special case which is not mentioned in the document.	possible increase in weight (but it is not even always the case!) and thus in installation cost that might be due to a better efficiency will not counterbalance the economic savings due to reduced electric losses during the lifetime.
131	**Eurelectric**			**P329** ***It is important that TCO and MEPS can coexist but not replace each other.*** This is unclear – fundamentally a TCO could result in a decision to use transformers with losses above or below MEPS, and it would be incorrect to use MEPS in such cases. The above example on pole mounted transformers is a case in point – if the cost of meeting MEPS is above the losses levels in a break even TCO, then it is clearly incorrect to use a MEPS figure which can be shown to give an uneconomic answer.	The project does not share this point of view. TCO should not supersede MEPS in any case. If MEPS are set, they should be respected for every

				be:	Perhaps the wording is unclear and an acceptable alternative could ***'Where TCO with capitalised losses is used by a Utility it will be acceptable as an alternative to MEPS.'***	transformer sold. The use of TCO to optimise the purchase amongst the transformers respecting the MEPS would be of course encouraged.
132	**Eurelectric**				**<u>P331</u>** ***Because of functional limitations in weight the following sub-category needs to be adopted: 'Light weight pole mounted transformers with rating between 100 – 160kVA with a maximum of 550 kg and not having minimum load classes A0Ck;. These might need different and less stringent losses requirements proposed with functional requirements (see Section 7.1.2)*** Why is the limit at 160kVA when utilities e.g. ESB, use pole mounted trafos up to 200kVA? The alternative to using a pole mounted trafo is to use a ground mounted substation which is considerably more expensive, requires purchase and protection of a plot of land i.e. a site, and that the existing overhead network is undergrounded so as to bring it into the ground mounted substation?	Why: The IEC standard rating series is 160-250-400. Agreed to extend the range from 160 kVA to 200 kVA
133	**Eurelectric**				**<u>P331</u>** ***The item was discussed during the final stakeholder meeting (25/8/2010) and the conclusion was that no special subcategory is needed for DER transformers because the technical differences do not conflict efficiency****. …* ***…During the same meeting , it was also concluded that there is no need for other new particular subcategories with higher ratings above 160kVA (e.g. very compact). When size of weight matters, it is also possible to install two or more smaller transformers.*** Firstly, it is not clear what the clause '*because the technical*	Text is reformulated. Not agreed with your view that losses are not important within a wind farm because of being renewable as this energy could be used

					differences do not conflict efficiency.' actually means – this may be just a matter of language but needs to be clarified. In any case the discussion at the last meeting focused on the need for DER transformers to actually have a separate category, because, as had been pointed out in correspondence, the DER Transformer is part of an overall energy system. It is the overall system that should be optimised, and that in the case of say a windfarm, the losses in a transformer are immaterial to the windfarm owner and society because the losses are supplied from renewable sources which may have no other use e.g. in many cases the actual Windfarm output is slightly restricted by the connection capacity, and amounts beyond the connection capacity cannot be exported. In relation to the conclusion that categories above 160kVA were not required **this is an incorrect statement of what occurred at the meeting** where attention was drawn to another two specific categories: (a) Pole mounted transformers of 200kVA which are already in wide use within ESB Networks (b) Sidewalk mounted transformers as already used in Tokyo up to 200kVA which have a very compact size which does not require a site within a building – typically 0.6m wide, 1m long and 1.2m high. These transformers were also available if required in 300kVA sizes. ESB proposed to use these for network reinforcement in City Centre areas for supply to Electric Vehicles. The small size of these trafos means that the iron and copper content is limited and accordingly they run at higher temperature and losses than other units. The cost of the alternative would be to buy a site for a substation in a city centre area which would be exceedingly expensive, and if any cost benefit analysis was done between this and using pavement mounted substations, the high costs of the low loss	elsewhere. Agreed to extend to 200 kVA (for EU countries). Not agreed to allow inefficient transformers newly being installed for Electric Vehicle charging Argument: One car does not charges at 300 kVA but typically at 4.6 kWatt only.

				option would make it prohibitively expensive. So these options should be included as a special case – they would automatically be available if TCO were used as a basis for decision making, which indicates the inflexibility of the MEPS process for utilities and the possibility of uneconomic decisions being made. Finally the suggestion that two transformers could be used instead of one in order to keep within the MEPS losses requirements is clearly dysfunctional – using two transformers to do the job of one slightly larger one will use double the material and have significantly greater losses – this makes no technical or financial sense, and should be omitted from the report.	
134	**Eurelectric**			**P 331 7.1.1.3** … ***no exception is needed ..*** If the transformer is associated with a windfarm or other DER then an exception is clearly required as explained earlier	Was not agreed by the transformer manufacturers at the stakeholder meeting, hence unneeded.
135	**Eurelectric**			**P 332** ***Note on voltage transformers or autotransformers:*** In order to reduce voltage drop and losses in Finland a practice has been adopted whereby the output 230V/400V from existing transformers is boosted to near 1000V and then stepped back down to 230V/400V at the customers premises. Has note been taken of these requirements in framing this rule? Is there a danger that heavier transformers may pose difficulties as the type of pole used for Domestic LV supplies will not be as strong as an MV trafo pole designed or much heavier trafos?	Thanks for pointing out. No problems with weight should be expected as those transformers are by construction more light weight (common primary and

					secondary winding and less need for insulation).
136	**Eurelectric**			**<u>P 333 &.1.2.1</u>** ***The proposed loss limiting requirement for 'Light weight pole mounted transformers with rating between 100- 160kVA with maximum of 550kg and not having load classes A0Ck ' is:*** ***- These transformers shall only use low loss core material with maximum specific core losses below 0.72 W/kg at 1.5T and 50Hz (e.g. Domain refined High Permeability steel or amorphous steel).*** Again, at the meeting it was agreed that requiring specific design requirements was not the appropriate way to implement such requirements, and whilst the original requirement to require that only copper should be used in such transformers has been removed, the requirement for 0.72W/kg remains. Such directions are not appropriate as they limit the technical solutions available e.g. a Hexaform transformer with lower losses overall than 0.72W/kg but make with steel above 0.72 W/kg would not be allowed. Similarly if there were considerable financial savings to be made by using material slightly above 0.72W/kg the this is also not allowed. **<u>Again these problems all arise from the avoidance of the use of a TCO methodology.</u>**	Was not agreed (see Minutes of Meeting). Moreover we currently see no alternative. Please also look at the other stakeholder comments including those of T&D Europe (comment 17), who do not oppose this approach.
137	**Eurelectric**			**<u>P334 7.1.2.3</u>** ***It is proposed to elaborate load and no-load loss class requirements for different ratings and voltage levels of the HV winding This could be done similar to the proposed***	This approach is used in Germany as well

					draft power transformer standard in China… the most efficient Grade 1 is not ambitious enough for no-load losses to reflect the European market) ***Such a table is currently under elaboration and an updated Draft will be added in the final version of this report.*** What is the economic basis of the Chinese standard and where is the cost/benefit analysis of the proposed changes? Has the impact of changes in impedance on the shape of the transformer core and hence on the cost of meeting these requirements been included? In particular how do such changes impact of the high frequency transient response of the transformers, as changes in the sizes/shapes also impact on capacitance ? Where have these factors been included in the analysis? As HV transformers are a highly specialised topic where the expertise is confined to a handful of utilities and manufacturers and where actual performance in the field of manufactured units is a significant indicator of a successful design, it is surprising that these proposals can be advanced with such confidence.	(see DIN 42508 standard in reference). The manufacturers see how to progress base on annex D (see T&D comment 18).
138	**Eurelectric**				**P336 7.1.4.1 *Policy recommendations towards power transformers operated by Transmission System operators (TSO)*** **<u>This is a very significant part of the report and needs careful wording</u>.** **The use of the Term 'Transmission System Operator (TSO)' is <u>incorrect</u> as the Transmission System Operator has no electrical assets – they just operate the Transmission assets owned by other entities such as the Transmission Asset Owner e.g. in Ireland Eirgrid is the TSO and ESB Networks is the TAO, who owns, maintains and purchases all the**	Corrected

				Transmission Assets operated by the TSO. **In addition, in numeric terms about 95% of all the transformers in every country are Distribution Transformers, operated by the Distribution System Operator (DSO)and owned by the Distribution Asset Owner (DAO).** So for clarity the title of this section should be amended as follows: ***7.1.4.1 Policy recommendations towards power transformers owned by the Distribution and Transmission Asset Owners.)***	
139	**Eurelectric**			**P*336 The electricity price used is a result of public tendering and the privileged position of TSO's often result in low electricity prices . The consequence of this approach is that unique energy saving possibilities exist in the electrical grid itself but is overlooked due to this business model. For example installing Renewables might cost 0.07 to 0.4 euro/kWh compared to energy savings overlooked on a 0.04 euro/kWh cost assessment.*** Firstly, the assumption that the electricity price used is a result of public tendering is certainly incorrect in the case of ESB Networks and probably for other utilities also. In the ESB Networks case the cost of electricity used in assessing losses is a combination of the expected long term marginal cost of a kWh of electricity, made up of the long term marginal cost of the energy component and the long term marginal cost of the associated increase in capital investment in network and generation required to feed this KW of losses. Using a tendered price of electricity at any one point in time would be clearly incorrect as the value of the losses saved reflect the expected price of electricity over the lifetime of the	P 336 This has been corrected to "The electricity price used is often a result of public tendering" Text has been reformulated to made the point pore clear. There is nothing wrong with TCO itself.

				losses saving, which is 25 years. However as NPV is used to capitalise the losses the price accuracy is most critical in early years, which simplifies the calculation somewhat. ESB Networks view is that the cost of losses in electrical plant is a real cost to the business and must be managed in the same way as any similar cost, with any investment to save money by minimising losses compared with alternative loss reduction options via the use of a common discount factor for losses in all Investment Appraisals. In the last sentence it is not quite clear what is meant, possibly that the marginal cost of kWh from renewable electricity should be used instead of the actual marginal cost of electricity, and that this would mean that the cost of electricity used in losses calculations could be up to 40c/kWh instead of 4 c/kWh based on the energy component of a typical kWh. This would clearly be an inappropriate approach for a number of reasons: (a) The price per kWh of Renewables reflects a large subsidy to encourage the introduction of the Renewables, with the price of a kWh from Renewables substantially greater than the cost of a kWh from conventional sources. This is an introductory offer and will not be maintained long term. Furthermore, the introduction of a kWh in losses saving will not result in a saving of 40C/KWH from Renewables unless a decision is taken to actually reduce the amount of Renewables allowed generate on the system as losses are reduced? – this does not seem likely as the function of renewable feed in tariffs is to increase Renewables connected and these tariffs are structured so that they apply to whoever connects in a period i.e. not possible to substitute one with the other (b) kWh from Renewables are not the same as kWh from Losses savings as renewable kWh come with additional benefits that justify a higher price, such as controllability, reactive power	Stakeholders (non TSO, DSO) are concerned that this does not disclose the load and no load losses of the transformers and there is no insight if economic parameters are used that result in them. Agreed more investigation might be needed. Text in the beginning added 'These are recommendations that are outside the scope of ERP Directive (2009/125/EC), hence they should be considered as suggestions that will need further elaboration and investigation in the context of other legislation.'

				control and availability at levels that are independent of the load. So in view of the above factors it is clear that the appropriate price for the kWh value of losses is the Long Run Marginal Cost, taking energy and cost of peak capacity into account. Similarly in the proposal that : ***2. To agree on a harmonized virtual price that is between the average market price (euro/kWh) and the average EU27 cost of Renewables (euro/KWh) e.g. (0.08 euro/kWh)*** is economically erroneous. The value of losses saved on any particular network depends on the value of the electricity supplying these losses, and also on the capital cost impact on infrastructure. These costs vary significantly between countries and to use an average will result in dysfunctional investments which provide a poor return to customers and society. So if electricity is dear then losses should be valued more highly than if cheap, and if peak capacity is limited losses savings carry a higher benefit than if lightly loaded. Accordingly the price of the kWh used carries the economic signals that drive investment in the correct direction, and moving to some sort of average would destroy these price signalling benefits. Furthermore an average of prices would be an average of fairly meaningless figures, some of which include historic costs, taxes etc which did not reflect economic drivers. Publication of the A& B capitalisation rates for the trafos is probably not a significant issue as these are provided with the Tender, and if the EU want to investigate how these are arrived at all that is required is that the utility maintain a record of the methodology for inspection by the EU. The EU can decide whether to inspect or not by looking at A & B factors for what might be expected to be similar utilities. Publication of further data would not be worthwhile as it would be of little interest or relevance to the public, and could only	

				be interpreted with the assistance of the utility. There may also be commercial issues surrounding the data that is confidential, especially of Marginal costs are used, as these could reflect the future expected connection of generation plant or the utilities own infrastructure investment plans, and this would be market sensitive. Capitalisation of losses on lines as suggested is correct in part – all utility investments in network should include capitalized losses – otherwise sub-optimisation of investment expenditure would occur. This IS ESB Networks policy since before well 1980.	
140	**Eurelectric**			**P 337** ***Therefore it makes sense to economically balance investments in grid loss reduction or efficiency with the high cost of Renewables. The above harmonized virtual price can do. Such a method will provide fairer opportunities for more energy efficient T&D equipment providers comparer to renewable equipment providers (e.g. wind turbines).*** As discussed earlier, this is not an economically correct	Text has been completely reformulated to make the point more clear.
141	**Eurelectric**			**P337** ***TSO's and DSO's have monopolies and could pass on all investment costs to the end user which might not offer the proper incentive, However there exist regulatory price control mechanisms that might reduce profit when grid losses increase,. TSOP/DSO's can emit bones to finance such operations , the government could back these bonds in case there is a lack of confidence.*** TSO's and DSO's are REGULATED monopolies and can only pass on to customers whatever costs are permitted by their REGULATORS. Any incentives/disincentives are handled by the Regulator in the Price Control structure. No references should be made to how the utilities should raise finance as it is outside the scope of the report and is a very specialised area, both in terms of finance and economics.	Thanks for this useful input. Text will be added. Any incentives or disincentives are handled by the Regulator in the Price Control Structure. This is a very specialised area and basically outside the scope of this study, however only brief suggestions are given for further study.

142	**Eurelectric**			**<u>P 337</u> *An incentive might be that EU27 regulators benchmark grid losses and required DSO's/TSO's procure above benchmark grid losses with renewable energy. This is also useful to reduce load losses in power lines.*** This proposal should be omitted unless it is backed up with a complete economic analysis. Furthermore any benchmarking of grid losses between EU27 countries is very misleading and would lead to undesired consequences. This is because the appropriate level of losses that is economically optimal varies by country and type of networks e.g. if the network is predominantly cable the losses will be low, if Overhead line they will be higher. Reducing losses significantly in one type of network may require low investment, in another very high investment. So the appropriate levels of losses depends on the marginal cost of reducing losses, which will vary over time and between countries. Having utilities purchase losses from renewable sources is also inappropriate as this equates renewable kWh with kWh saved from losses – as pointed out above they are not comparable. Furthermore, if DNO's were to purchase losses in the market this gives rise to significant costs, and energy trading risks. In countries where DNO's are required to purchase losses on the market the DNO is the largest customer in the market , creating other potential conflicts of interest.	Text added in the beginning of section 7.1.4.1 to give more guidance about the context and level of detail: 'These are recommendations that are outside the scope of ERP Directive (2009/125/EC), hence they should be considered as suggestions that will need further elaboration and investigation in the context of other legislation.' Note: the text says also 'might'.
143	**Eurelectric**			***P338 7.1.4.3 2. It has been reported that in some cases the electricity meter I s placed at the Low Voltage winding , hence neglecting the transformer losses,. In this case it is recommended to include the calculated losses and charge them to the DER owner.*** It is normal practice at voltages above about 50kV to meter on the LV side of the transformer, as the cost and accuracy of the Voltage	Thanks for the info. Text added.

					Transformers for voltages above 50kV is high, and at higher voltages the VT's are not sufficiently accurate. Such metering normally allows the loss levels on the transformers to be inputted, and the actual transformer losses are then calculated and added/subtracted from the power measurements on the LV side as appropriate. In Ireland the actual increase or decrease in losses on the network caused by the presence of the DER unit is assessed and added /subtracted from the DER unit's output.	
144	**Eurelectric**				**<u>P339</u> *Needs and requirements for harmonized standards to be developed*** It is sufficient to say that standards should be harmonized. It is not clear why the change proposed is mentioned – the issue it purports to solve is too simple to justify a change in standard. Again, Transformer standards are very sophisticated and any detailed proposed changes require a sophisticated understanding of the transformer and it's engineering.	Title is changed to be more clear. Note: It is to keep a track record for the EC. Agreed it should pass the experts from the technical committees of the standard. Some of them participated in the stakeholder meeting.
145	**Eurelectric**				**<u>P340</u> *Add two extra no-load classes in standard EN 50464-1*** - where is the cost –benefit analysis that justifies this change?	It is to map future developments not and is not related to a cost benefit analysis.
146	**Eurelectric**				**P340 *…to avoid mitigation from oil-immersed transformers to dry-type transformers'***	Thanks for this input

				This change is not required as there is no likelihood that anyone would move from oil immersed trafos to dry type simply because of losses. Dry type usually used where there is a fire risk that is deemed unacceptable. The room that the dry type goes into is considerably larger than the substation used by oil types, and furthermore, as dry types run hotter, air conditioning./ventilation is also required. The initial costs of dry type as well as the logistics are significantly higher than for oil types, as they are larger and heavier. The issue of losses is not a consideration in the choice between dry type and oil immersed.	Text added
147	**Eurelectric**			***<u>P 340</u> '…include value of losses or the efficiency class… on the rating plate'*** This is a good idea, but having the no load and the load losses noted directly is more meaningful than putting in the efficiency type, as such codings can change over time, and any efficiency rating is dependent on loading etc, whereas straightforward 'No load' and 'Load' losses are always directly meaningful and can be adjusted for al loadings	In line with all other stakeholder comments. Agreed and adapted
148	**Eurelectric**			***<u>P340</u> 7.1.8 …requirement for a dual or triple primary winding on oil immersed distribution transformers with highest voltage for equipment not exceeding 16kV*** This was discussed at the last meeting but the explanation may not have been fully understood. Migrating a system from say 10kV operation to 20kV can be one of the most cost effective investments that any utility can make on Overhead network – ESB Networks have spent about €3b+ in carrying out such a conversion whilst doing rMV refurbishment, and this expenditure was analysed and cost justified to the Irish regulator (CER) and their consultants in exhaustive detail to ensure that it was economic. However in the absence of firm plans for such conversion adding in extra windings will only increase cost due to complexity, with possibly a minor increase in losses due to restrictions on the shape	Thanks for this information. Text is partially added and modified

				of the core. Furthermore there is absolutely no justification in applying this requirement to equipment 'not exceeding 16kV' – the equipment must also be rated at 24kV so as to facilitate it's operation at 20KV nominal later on. So in summary, if conversion from a lower MV voltage such as 6-12kV, the goal is to jump to the highest voltage class feasible – which is 24kV, and in such cases using Dual ratio transformers is easily justified. Requiring Dual ratio transformers when such conversion plans are not in sight is a waste of money. Normally utilities would have decisions on voltage conversion strategies made about 10-20 years ahead of the conversion, so the requirements should be clear.	
149	**Eurelectric**			**<u>P341</u> *Suggestions for additional installation requirements*** ***..Member States limit the use of them to transformers installed on existing poles.*** ***… use of Dry Type transformers only to industrial sites with a high risk of fire hazard e.g. only to be installed after approval of the local fire station.*** The issue of losses on Overhead Pole Mounted Trafos has been covered earlier. The material cost of a trafo on a pole is about €1.7k with €1k installation. The material cost of the alternative is about €25kplus installation costs of about €2k, legal costs of about €2k and other costs of providing UG cable. The installation also takes longer and the impedance mismatch between cable and line now means extra lightning protection is required.	As you mentioned it, the TCO takes into account capitalized costs and the project team believes the savings due to lower losses will not be

					As explained at the meeting the Total Cost of Ownership includes the costs of all items relevant to the investment – including installation costs, retirement costs, capitalized losses, equipment costs, maintenance costs etc. Any TCO on the above would clearly indicate that the limitations proposed are inappropriate, uneconomic and not justified by any cost-benefit analysis. In regards to the issue on Dry Type transformers the first point that struck me was that the greatest use of Dry Type Transformers is in Commercial , not Industrial premises, as Industrial customers are happy to maintain oil equipment whereas Commercial/Retail units do not have such skills and opt for low maintenance Dry types. So limiting to 'industrial' is inappropriate. The earlier remarks above about how users would not use Dry Type unless they have to outlined above also applies. Finally, the issue of obtaining the ***'approval of the local fire station'*** is totally inappropriate and in contravention of Health And Safety legislation, where the onus is on the user (e.g. utility) to carry out the necessary risk assessment and comply with all national and EU legislation. The local fire station will not have this level of expertise, and would be ill advised to attempt to provide it, especially as they would then be assuming legal liability for such advice. Any attempt by a user/utility to attempt to bypass their responsibilities in such a manner is undesirable.	counterbalanced by the higher initial investment. Corrected in text
150	**Eurelectric**				**P371 7.2.1** ***… It might be easy to install two more efficient transformers instead..'*** Covered earlier, but for emphasis, the losses and material usage of using two transformers would be greater than using one larger transformer that was less efficient. Secondly, there is no cost-benefit analysis that can ever support this proposal. In the remainder of this section there is mention of other types of	See earlier anwers. Proposal is extended to 200 kVA The proposed

				steel, but not of their availability of their impact on price. The issue of Volume and Weight not being functional requirements of the trafo is incorrect – limits are usually placed in specs because these influence transportations cost – i.e. how many can fit on a truck by size/weight, and what equipment is needed to install them compared to existing trafos. In Ireland there are legal restrictions on the size of MV installations, which cannot be more than 11m3, and this is critical for ESB Networks. Similarly noise requirements are absolutely critical and in achieving these operation at lower teslas levels are required – with Amorphous this means the trafo must be larger and heavier.	MEPs with low core loss steel will lead to silent and compact transformers and should solve the issue. Should be kept in sight that no larger transformers are in use . BTW: See other stakeholder comments .. text was modified to '.. on two or more poles.
151	**Eurelectric**			**P 371 7.2.2 *Monetary Impact*** ***..investments will need to be made…. Will be returned with slightly higher product priced for more efficient models'*** **This might be correct, but what is not covered is the fact that utilities are not confined to buying transformers on the European market, and that the differential in TCO between transformers is very small, as the market is competitive.** **This means that if European amorphous core trafos are more expensive than ones made in Canada or Taiwan or India, or China, then European manufacturers will lose out if their costs increase.**	The situation is the same today, customers can still buy products from all around the world which means that the EU companies also have to be competitive today, like they will have to be in the future whatever the transformers sold.

152	**Eurelectric**			**P371 7.2.3 Impact on manufacturers and competitive situation in the Market** The EU can seek to protect local manufacturers but as transformers etc are covered under GATT it can be like trying to hold back the tide. Transformers compete in a global market. The rules can be bent to try and help EU manufacturers, but this is pointless if this then makes EU manufacturers similar in price but more expensive than ones abroad.	This is a valuable suggestion and was added.
153	**Eurelectric**				
154	**Eurelectric**			**Response on Lot 2 Chapters 6 & 7** **General:** The earlier comments in Appendix 1 , submitted for the meeting og 19/5/2010 seem to have been read but not fully understood, based on the comments presented. **The most important overall comment is that in attenpting to set loss levels for transformers alone, the result will be be a sub-optimal allocation of losses by the utilities. The only optimal way of reducing losses in a utility is to capitalise the losses in all Network invetsmnet decisions so that losses are reduced optimally across the full network.** **As losses occur in all parts of the network the economically correct, and sustainable, approach is to spend money on each part of the network in proportion to the losses that can be saved for that level of expenditure, This way every Euro spent should produce a similar savings in kWh losses, and when declining returns are achieved in one area the finanlcial resources aree used in other areas which produce a better return in loss reduction.** **This is best achieved by capitalising the losses at the one discount rate in**	The comments have been understood and this has already been discussed during the final stakeholder meeting. The scope and the methodology of the study are precisely defined and carrying out a complete system analysis is not feasible in this context.

				all areas of utility investment, as is already the practice in many utilities e.g. ESB in Ireland. **However picking one area such as transformers and setting losse levels for this component is inherently incorrect, as it will not allow an optimal investment strategy to reduce losses – inevitably too much money will be spent in this one area compared to other areas such as overloaded lines. This is simply because only one section of the loss value chain is being examined.** **Furthermore attenpting to set values for Europe when every European country has different networks, different loads and different losses ensures that the values selected must be non-optimal.** **It is surprising that such an approach is being used in this project as it would certainly not pass the regulatory impact assessment required to be undertaken by EU Regulators when instituting change – it is simply not in line with accepted economic planning..** The feedback on earlier comments in the Comments on Stakehodler repsonses states: *'The cost parameters A nad B take full network losses into account including cable losses'* This is completely incorrect and indicates a fundamental misunderstanding – the point being that the A and B figures could never take full network losses into account	
155	**Eurelectric**			In appendix the previous comments as provided on the stakeholder meeting were added. Two selected are repeated hereafter to stress some differences that were talked in the final review but sometimes still lead to confusion among stakeholders.	
156	**Eurelectric**	Selected older comment		P124 LF is used as a designation of Loss Factor and l_f for Load Factor. This is not the normal nomenclature and leads to confusion. LF is Loss Factor and LLF is Loss Load Factor which is caluclated from the Load factor emopirically using formula (1-0.85)*LF + 0.85*LF^2	See also comment 157

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