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COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT

Accompanying the document

Draft Commission Regulation implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to small, medium and large power transformers

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Acronym List

AC	Alternating Current
AF	(Transformer) Availability Factor
Al	Aluminium
AM	Amorphous Metal
AMDT	Amorphous Metal Distribution Transformer
AMT	Amorphous Metal Transformer
BAT	Best Available Technology
BAU	Business As Usual
BNAT	Best Not yet Available Technology
BOM	Bill of Materials
CENELEC	European Committee for Electrotechnical Standardization
CGO	Cold rolled Grain-Oriented Steel
Cu	Copper
DER	Distributed Energy Resources
DOE	US Department of Energy
DSO	Distribution System Operators
EN	European Norm
EP	Eutrophication Potential
ErP	Energy Related Products
EU	European Union
EuP	Energy using Products
GO	Grain Oriented
GWP	Global Warming Potential
HV	High Voltage
Hz	Hertz

IEC	The International Electrotechnical Commission
IEE	Intelligent Energy Europe
k	Kilo (10^3)
Kf	Load form factor
LCA	Life Cycle Assessment
LCC	Life Cycle Cost
LV	Low Voltage
MEEuP	Methodology for the Eco-design of Energy using Products
MEPS	Minimum Energy Performance Standard
MV	Medium Voltage
Paux	Auxiliary losses
PF	Power factor
Pk	Load losses at rated load
Po	No load losses
RES	Renewable Energy Sources
S	(transformer) apparent power
SEEDT	Strategy for development and diffusion of Energy Efficient Distribution Transformers
Si	Silicon
SME	small medium sized enterprise
TCO	Total Cost of Ownership
TOC	Total Operational Cost
TSO	Transmission System Operators
TWh	TeraWatt hours
V	Volt
VA	Volt-Ampere
VITO	Flemish Institute for Technological Research

VOC	Volatile Organic Compounds
WEEE	Waste Electrical and Electronic Equipment
Z	Short-circuit impedance
α	Load Factor

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The main challenge in the transformers' market is that technical solutions to reduce their energy consumption exist, but the market penetration of more efficient transformers is relatively low. The two main reasons for this low market penetration are an emphasis on initial purchase cost, to the detriment of lifecycle costs, and the fact that distribution losses (of which transformers are responsible for half of them) are ultimately charged to end-users by network operators. These two market deficiencies mutually reinforce each other over time. A number of national regulatory regimes[1] for electricity markets offer incentives for network loss reduction, but the targets are based on averages losses, not the real marginal losses avoided through more efficient equipment. The proposed ecodesign regulation should reinforce existing incentive schemes in national regulatory regimes and stimulate their introduction in those Member States where they are still not present.
What is this initiative expected to achieve?
The proposed Ecodesign Regulation is expected to gradually shift the market towards more energy efficient transformer models. It is expected that by 2025, some 16,2 TWh of energy will be saved annually, as well as 3,6 Mton of CO_2 emissions. Given that many jurisdictions around the world are setting minimum requirements for transformers, it is expected this regulation will help maintain the competitiveness of the EU's manufacturers of transformers by stimulating innovation and trade.
What is the value added of action at the EU level?
The proposed Ecodesign Regulation, together with the relevant CENELEC standard, will help consolidate the internal market for transformers and achieve efficiencies through larger production volumes. In the absence of an EU Regulation, manufacturers and utilities may be confronted with a proliferation of national regulations establishing disparate minimum performance requirements and increasing compliance costs.
B. Solutions
What legislative and non-legislative policy options have been considered? Is there a preferred choice or not? Why?
The following policy options have been considered: A – No EU action B – Adoption of existing foreign policy C – Self-regulation D – Energy Labelling only E1 - Strict Minimum Energy Performance Standards (MEPS) E2 - Intermediate Minimum Energy Performance Standards (MEPS)

[1] See for instance the RIIO model in the UK http://www.ofgem.gov.uk/Media/FactSheets/Documents1/re-wiringbritainfs.pdf

Options A (as baseline), E1 and E2 were retained for the quantitative assessment. The preferred choice is option E2 as it presents the best profile in terms of effectiveness, efficiency and coherence.

Who supports which option?

Transformer manufacturers' support the introduction of MEPS. In the short term, this represents a business opportunity as more efficient transformers attract higher purchasing prices. In the long term, building up know how in more efficient transformers may open up opportunities in export markets.

Most users of transformers, electricity companies and private industrial users, are not as supportive of the regulation as manufacturers, as they will have to incur higher initial prices for the gradual replacement of their installed base. However, this is investment will be very spread over time.

Environmental NGOs are supportive of the regulation as they put the emphasis on the expected energy and CO2 savings and are less concerned with the expected increases in purchasing prices.

C. Impacts of the preferred option

What are the benefits of the preferred option (if any, otherwise main ones)?

The introduction of MEPS in two Tiers, 2015 and 2020 is expected to bring minimum requirements in the EU internal market to a comparable level with those in the US and Japan. It will generate annual electricity savings of 16,2 TWh by 2025 and CO2 annual savings of 3,6 Mton. The regulation is expected to have a positive effect in the competitiveness of EU manufacturers and open up market opportunities elsewhere.

It is expected that in the long term the regulation will have an additional marginal contribution to decreasing electricity prices by reducing distribution losses and therefore demand.

What are the costs of the preferred option (if any, otherwise main ones)?

The proposed regulation will have an effect on the purchasing price of transformers. Making transformers more energy efficient requires more raw materials and labour and inevitably results in increasing their price. A precise assessment of the expected price increase has not been possible as manufacturers were not in a position to share key data which was considered to be commercially sensitive. The estimate of price increases allowed calculating a payback period of less than 9 years for a typical distribution transformer fulfilling the minimum requirements in Tier 1 (2015).

Some retraining in manufacturing facilities may be expected as manufacturers adapt their production lines to the minimum requirements set out for Tier1 (2015) and Tier 2 (2020).

How will businesses, SMEs and micro-enterprises be affected?

The transformers market is dominated by large international companies. Nevertheless, SMEs are also active in the production of transformers, especially for niche smaller industrial application transformers, where often orders are directly placed with manufacturers without going to public tender. It is estimated that there are around 50 SMEs active in production in the EU, often with only a few employees.

As the proposed regulation will not be forcing a technological shift in the market towards amorphous steel, where only one supplier worldwide currently exists, it is not expected to have a major impact on SMEs, which are active in conventional silicon steel technology.

Will there be significant impacts on national budgets and administrations?

No significant impact on national budgets and administration is expected.

Will there be other significant impacts?
No other significant are expected. The regulation is establishing minimum energy efficiency requirements for newly installed transformers, most of which are replacement units.
D. Follow up
When will the policy be reviewed?
The regulation is expected to be reviewed in 2018. Some of the issues that will be considered are the following: • The appropriateness of the levels for the specific Ecodesign requirements in Tier 2 (2020) • The availability of materials necessary to meet the requirements set out for Tier 2. • The possibility to cover other environmental impacts than energy in the use phase.

Lead DG: ENTR

Associated DG: ENER

Other involved services:

Agenda planning or WP reference: 2012/ENTR/026

1. POLICY CONTEXT

The Directive 2009/125/EC of the European Parliament and of the Council establishing a framework for the Commission to set ecodesign requirements for energy-related products[2] (hereafter referred to as the Ecodesign Directive) is to be implemented by the European Commission through regulations dealing with the product groups identified in the Ecodesign Working Plans. The Ecodesign Working Plan for 2009-2011[3] identified "transformers" as one of the ten priority product groups.

DG Enterprise has explored the possibility of setting Ecodesign requirements for this product group, which includes small, medium (also known as distribution) and large power transformers used in electricity distribution networks operating at a frequency of 50 Hz. Annex II includes the detail of the precise scope of the proposed regulation.

Following the usual practice in Ecodesign regulations, also the possibility of introducing a labelling system under the Energy Labelling Directive (2010/30/EU) of the European Parliament and of the Council has been explored.

The proposed ecodesign regulation also needs to be put in the context of wider Commission's policies such as the Europe 2020 flagship "A Resource -efficient Europe" and the Internal Energy Market[4] policy, which intends to gradually open up gas and electricity markets for the benefit of consumers.

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[2] OJ L 285, 31.10.2009.
[3] COM (2008) 660
[4] See Commission Communication Making the internal energy market work at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2012:0663:FIN:EN:PDF

2. PROCEDURAL ISSUES AND CONSULTATION OF INTERESTED PARTIES

2.1. Organisation and timing

No Ecodesign requirements within the framework of the Ecodesign Directive have so far been set on these products.

The proposed implementing measure is based on the Directive 2009/125/EC of the European Parliament and of the Council establishing a framework for the Commission, assisted by a regulatory committee to set Ecodesign requirements for energy-using products, in the following abbreviated as "Ecodesign Directive". An energy-related product, or a group of energy-related products, shall be covered by Ecodesign implementing measures, or by self-regulation (cf. criteria in Article 17), if the product represents significant sales volumes, while having a significant environmental impact and significant improvement potential (Article 15). The structure and content of an Ecodesign implementing measure shall follow the provisions of the Ecodesign Directive (Annex VII).

Article 16 provides the legal basis for the Commission to propose an implementing measure on this product category.

A preparatory study[5] was carried out from November 2009 to November 2011. It provided the European Commission with technical background supporting the design of ecodesign requirements following the methodology defined in Annex I and II of the Ecodesign Directive.

The consultation of stakeholders was organized first around the preparatory study, which included technical meetings on 6 July 2009, 19 May 2010 and 24 August 2010 in order to assist the Commission in analysing the likely impacts of the planned measures, and second around the Ecodesign Consultation Forum, as foreseen in Article 18 of the Directive, which was convened twice in April and November 2012 (see next section for details).

The impact assessment was launched in February 2012 and supported by an Interservice Steering Group (ISG) including CLIMA, COMP, ECFIN, ENTR, ENV, INFSO, LS, MARKT, RTD, SANCO, SG, TRADE. The ISG met on February the 23, July the 5th, November the 7th and assisted during all critical steps of the impact assessment, namely: drafting of the working document for stakeholder consultation and design of the impact assessment and policy options.

An Impact Assessment study for the product group "transformers" was carried out from March 2012 to February 2013 to provide the European Commission with technical and economic background supporting the proposed Ecodesign regulation.

2.2. Impact Assessment Board

[*Section to be completed further to the IAB meeting*].

[5] Preparatory Study for Eco-design Requirements of EuPs, Lot 2 Distribution and power transformers, available at: http://ecotransformer.org

2.3. Transparency of the consultation process

The opinions of stakeholders have been gathered throughout the process through numerous bilateral meetings and the Consultation Forum foreseen in the Ecodesign Directive. The preparatory study consulted manufacturers in three stakeholder meetings and registered stakeholders were granted access to the documents available on the project website http://ecotransformers.org

The following consultations were then held during the impact assessment process (more information about type of consultation, participants and topics is available in Annex I):

- The Ecodesign Consultation Forum, set up in accordance with Article 18 of the Ecodesign Directive, was consulted twice, on 19 April 2012 and 9 November 2012 with the participation of Member States, environmental NGOs, electricity distribution companies (represented by Eurelectric) and transformers manufacturers (represented by T&D Europe). The reason for convening the Consultation Forum twice was that the draft impact assessment study was able to refine a number of the assumptions made in the preparatory study and yielded different results for the lifecycle cost calculations. The working documents presenting the policy options were sent one month in advance of the meetings. All replies to the working document, as well as the minutes of the meeting are available on the CIRCABC website. The minutes of the Consultation Forum are also available in Annex I. The working document for the second Ecodesign Consultation Forum held on 9 November 2012 presented a high level of stringency for the proposed minimum requirements, based on the calculations made in the impact assessment study. The proposed requirements were found too onerous by the electricity companies, on the grounds that a number of peripheral costs associated with the installation of new, more efficient transformers that would be required by the proposed draft regulation, had not been taken into account in the economic modelling carried out in the referred study. Section 6.1 on Options E1 and E2 explains how this feedback was accomodated.
- An online stakeholder consultation to collect feedback on the proposed regulation, its modifications following the first Consultation Forum and its impacts was held from 5 October to 2 November 2012. A total of 74 replies from 20 different countries were received. A majority of stakeholders agreed that a regulation should be the preferred policy option. However, a number of stakeholders expressed similar concerns to those raised by electricity companies at the meeting of the Ecodesign Consultation Forum (see above) about the proposed level of stringency. Again, Section 6.1 on Options E1 and E2 explains how this feedback was acommodated. A summary of the results of the stakeholder consultation is available in Annex I. A full public online consultation has been considered neither appropriate nor proportionate given the technical nature of the proposal and the fact that transformers are not consumer products.
- Additional meetings were held with transformers' manufacturers and electricity distribution companies to discuss key issues of concern, including data analysis, timing and level of ambition of the proposed requirements in the regulatory proposal.
- The Council of European Energy Regulators (CEER) and the Regulatory Assistance Project (RAP)[6] have also been consulted and have provided valuable feedback.

[6] http://www.raponline.org/

2.4. Outcome of the consultation process

The general approach to setting minimum energy performance requirements through an Ecodesign regulation is supported by most Member States, environmental NGOs and the industry association for transformers' manufacturers (T&D Europe).

Electricity distribution companies (purchasers of transformers) have been, in general, more critical with the proposed Ecodesign regulation. Organized around the European association Eurelectric, these stakeholders have challenged the justification for the investment required to put into service more efficient transformers.

Some of the difficulties identified by the electricity distribution companies have to do with the fact that electricity prices and capital discount rates used in their procurement processes are different across Member States. These parameters are critical in the calculation of lifecycle cost and therefore in the justification of investment decisions. The spreads in the values used for these parameters by different companies can be quite considerable[7].

While private and state-owned companies can legitimately use whatever values they deem appropriate for such parameters as electricity price and discount rate in their calculation of loss capitalizations, from a public policy perspective, the study underpinning the impact assessment needs to use values that are widely accepted and consistent with other Commission's impact assessments. Given that the Ecodesign Directive is a piece of single market legislation, the calculations made in the impact assessment study could only use EU27 average electricity prices. Annex 3 explains how such an average price of electricity has been calculated. Furthermore, the discount rate for the cost-benefit analysis is fixed at 4% by the Commission's Impact Assessment Guidelines and both the preparatory study and the impact assessment study have respected this practice.

3. PROBLEM DEFINITION

Introduction

The main challenge in the transformers' market is that cost-efficient technical solutions to reduce their energy consumption exist, but the market penetration of more efficient transformers is relatively low. The two main reasons for this low market penetration are an emphasis on initial purchase cost, to the detriment of lifecycle costs, and the fact that distribution losses (of which transformers are responsible for half of them) are ultimately charged to end-users by network operators. These two market deficiencies mutually reinforce each other over time.

Transformers are procured by professional buyers who follow total cost of ownership (TCO) considerations to inform the required design specifications. This is almost always the case with large power transformers and often the case for distribution transformers. However, there

[7] See for instance SEED Selecting Energy Efficient Distribution Transformers
A Guide for Achieving Least-Cost Solutions (page 15) at
http://www.copperinfo.co.uk/transformers/downloads/seedt-guide.pdf

is a large margin for discretion in the valuation of network losses (which are a component of all TCO formulas) done by electricity companies and industrial users, which may result in the calculations not reflecting the true cost of these losses to society.

A number of national regulatory regimes[8] for electricity markets offer incentives to electricity companies for network loss reduction, but the targets are based on average losses calculated over a period of time, not on the real marginal losses which are actually avoided through more efficient equipment. The situation with such incentives is very patchy across the EU, with various types of heterogeneous schemes co-existing. Where no incentives are in place, the cost of losses in the distribution networks is simply passed onto final users. In general, it can be said that the existing structure of regulatory incentives for electricity companies in the EU does not always favour the purchasing of the most energy efficient models available in the market.

By introducing minimum efficiency requirements which are economically justified, the proposed Ecodesign regulation should reinforce existing incentive schemes in national regulatory regimes, stimulate their introduction in those Member States where they are still not present and foster their overall convergence. This point is elaborated further in section 3.3.1 on existing legislation.

The experience from other countries in regulating transformers shows that establishing minimum performance or efficiency requirements is likely to have a beneficial transformational effect on the market and achieve desirable policy objectives of energy conservation, reduction of greenhouse emissions and stimulation of technological innovation.

Assessment of the current market situation

Transformers convert electrical energy from one voltage to another. They are an essential part of the electricity network. After generation in power stations, electrical energy needs to be transported to the areas where it is consumed. This transport is more efficient at higher voltage (typically 220 kV up to 400 kV). Since the majority of electrical installations operate at lower voltages, the high voltage needs to be converted back close to the point of use. The main reason to step down voltage is to increase the safety for the end user and insulation material. The first step down is transformation to 33 -150 kV, and this is often the level at which power is supplied to major industrial customers. Distribution companies then transform power further down to the consumer mains voltage.

In this way, electrical energy passes through an average of four transformation stages before being consumed. A large number of transformers of different classes and sizes are needed in the transmission and distribution network, with a wide range of operating voltages. The last transformation step into the consumer mains voltage (400/230 V in Europe) is done by distribution transformers.

[8] See for instance the RIIO model in the UK http://www.ofgem.gov.uk/Media/FactSheets/Documents1/re-wiringbritainfs.pdf

Modern distribution transformers have typical efficiencies of 98 to 99% at half load. Large power transfomers are even more efficient, typically above 99%. This might seem to suggest a low improvement potential of their performance. However, due to the very large number of transformers in use in distribution systems, the total impact of small improvements could provide a significant contribution to reducing energy consumption and greenhouse gas emissions.

It is estimated that network losses attributable to power and distribution transformers represent 2,6% of total energy consumption in the EU27 in 2005[9]. This is a considerable figure in absolute terms (around 72 TWh/year) and is equivalent to the annual electricity generation of three medium size nuclear power plants.

Transformers run 24 hours/day, 365 days a year and have very long lifetimes, of typically between 25 and 40 years, so energy consumption clearly is the dominant factor in their environmental impact. The installation of inefficient products therefore has an adverse environmental impact for a long time, and low stock rotation means that any measure stimulating energy efficiency is likely to take a long time to reach its full potential and make a difference.

Actual lifetime of transformers is strongly influenced by the operating temperature and also by the type of insulation system used. The choice between the two dominant technologies (liquid-immersed and dry transformers) is actually dictated by fire hazards and ecological impact issues. The relative market share is approximately 80% for liquid-immersed (e.g.oil) and 20% for dry type.

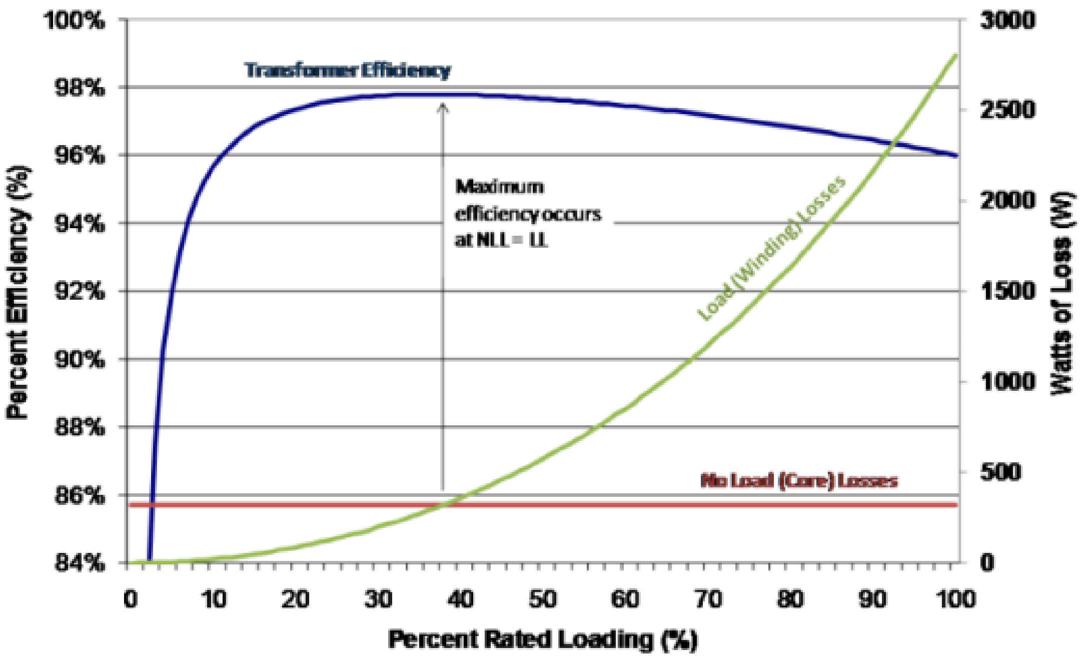


Figure 1 - Transformer efficiency and different losses for a 75 kVA oil immersed transformer (VITO & BIOIS, 2011).

[9] Ecodesign preparatory study on distribution and power transformers, VITO 2011

Transformer efficiency is mostly characterised by two factors: standing (magnetic) losses, which are constant independent of the level of load, and load dependent (resistive) losses (see Figure 1), both of which need to be characterised separately in order to give total losses over a wide range of loads.

As mentioned before, the traditional approach to the procurement of transformers is either simply considering the initial purchase cost or following a total cost of ownership approach. The total cost of ownership (TCO) analysis includes the purchase price of the transformer and the cost of load and no-load losses, what requires specifying a number of parameters, including the interest rate, the lifetime of the transformer and the price of electricity:

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

Where PP = purchase price

A = cost of no-load losses per Watt

P_0 = rated no-load losses

B = cost of load loses per Watt

P_k = rated load loss

The TCO calculation may provide similar results to the Life Cycle Cost calculation, if similar values for the key parameters are used. However, the large spread in the actual values used for these parameters by different utilities limits substantially the usefulness of the TCO approach for any regulatory purposes.

Furthermore, the cost of network distribution losses is passed onto consumers. Therefore, distribution system operators (DSOs), who are responsible for buying large numbers of transformers, often do not have strong incentives to realize the full saving potential of energy-efficient transformers for lack of adequate national regulatory incentives.

In medium and small industries using distribution transformers for their production facilities, the restricted capital availability and short term perspective also tend to favor low initial cost solutions over lifecycle considerations.

Other factors that may delay the uptake of efficient transformers include existing long term contracts for supplying equipment, products already held in storage as spares and the inertia to use previous design specifications. Decisions based on these criteria can be rational from the strict perspective of individual decision-makers, but may incur high societal costs in terms of energy consumption and CO2 emissions.

The EU transformers' manufacturing sector has been losing jobs and internal market share in recent years. Without a regulatory push to foster technological innovation, it is likely that this trend will continue and that the competitive position of EU transformers' manufacturers (e.g., in terms of export market share and innovative capacity) will deteriorate further.

An additional obstacle, which would be addressed as a consequence of an adoption of the proposed regulation, is the lack of adequate standards to measure the energy efficiency of small and large power transformers. This should be done under the auspices of the relevant Technical Committees of CENELEC.

To summarize the situation, an integrated framework to accelerate the use of energy-efficient transformers and to support a competitive European manufacturing sector for transformers is still not fully in place.

Grounds for a possible implementing measure

According to Article 15(1) of the Ecodesign Directive, a product shall be covered by an implementing measure or self-regulation if the criteria listed in Article 15(2) are met, namely:

(a) the energy using product shall "represent a significant volume of sales and trade, indicatively more than 200 000 units a year";

(b) it shall "have a significant environmental impact within the EU";

(c) it shall "present significant potential for improvement in terms of its environmental impact without entailing excessive costs, taking into account in particular:

  (i) the absence of other relevant EU legislation or failure of market forces to address the issue properly;

  (ii) a wide disparity in the environmental performance of energy using products available on the market with equivalent functionality."

The following sections (3.1 to 3.4) provide the justification on how the criteria listed above are met.

3.1. Baseline scenario

3.1.1. Market structure

The main European industry players for transformers are big international groups like ABB, Siemens, Areva, Schneider Electric, and some large/medium size companies like Cotradis, Efacec, Pauwels, SGB/Smit, Transfix and Ormazabal. Transformer manufacturers from outside the EU include General Electric, Hitachi (Japan) and Vijai (India).

Their respective material suppliers for winding wires are a multitude of European and non-European companies. For Grain Oriented electrical steel there are four 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).

In recent years, amorphous steel has appeared as an alternative material to grain oriented magnetic steel to build trasformers' cores. Amorphous steel transformers are manufactured in significant quantities in other parts of the world by American, Asian and Indian companies, such as Hitachi, Zhixin and Kotsons. In Europe, investment in amorphous steel transformers' equipment is still low, but it is likely to increase.

Transformers for industrial applications are most often sold and installed by SMEs in business-to-business markets and in some cases SMEs have service contracts with utilities for installation.

T&D Europe is the representative of the European Transformer Manufacturers, regrouping the Austrian, Belgian, British, French, German, Italian, Spanish, Portuguese, Netherlands and Turkish's national associations. Smaller industrial transformers are mainly produced by European SMEs for niche markets. The preparatory study estimated that there are around 50 SMEs active in production throughout the EU, which often have only a few employees.

3.1.2. Sales and stock

The EU statistics, as well as figures from the EU transformer industry (T&D Europe) show that the production/sales figures for distribution, industry and power transformers comply with the eligibility criterion from the Ecodesign Directive, this is, more than 200.000 units sold per year (see Table 1).

As a consequence, for the total figure of small, distribution and power transformers there should be no doubt that the eligibility criterion in the Directive is met, as annual sales is well above 200.000 units. Moreover, this is certainly the case when the "unit" is defined as the "functional unit" used in the preparatory study. Distribution transformers represent the largest share of both the stock and sales.

The population of distribution transformers in Europe is estimated to be around 3,6 million units, increasing to almost 4,7 million in 2025 (see Table 1 below). This estimated growth in stock may be partially explained because of the proliferation of distributed generation facilities, which need to be connected to the main distribution grid. On average, in recent years, about 140.000 distribution transformers (Medium Voltage/Low Voltage) have been sold annually in Europe and over 50.000 units for industrial use. Most MV/LV distribution transformers are liquid-immersed. For industry applications, oil-immersed transformers represent around 80% of the market.

The average rating of power transformers is about 100 MVA. This figure is reported as the average rating for power transformers by the sector organization (members of T&D Europe, 04/06/2009). This does not mean that this value corresponds to the most sold transformer, but it is in between the product range, and it is also the borderline between the so-called medium and large power transformers. In some reports from electricity network operators (France and Belgium) the average ratings of a power transformer seems to be higher, at about 180 MVA per unit.

Recent and accurate data on transformers' trade between the EU-27 and the rest of the word does not seem to be readily available. For the period 2004-2007, the number of imports outweighed the number of units produced inside the EU by a factor of 9. However, in monetary terms, the value of domestic production was far greater than the import value. This is explained by the fact that the cost of shipping large power transformers, by far the most expensive product subgroup, is enormous and they tend to be procured closer to their final installation sites. In any case, the EU-27 does not seem to be a net exporter of any type of transformer.

Table 1 - Summary of the market and stock data for 1990 – 2005 – 2020 (VITO & BIOIS, 2011).

Transformer type	Rated power	Stock			Replacement sales	Total sales		
		1990	2005	2020		1990	2005	2020
	KVA	*K units*	*K units*	*K units*	*% p.a.*	*units p.a.*	*units p.a.*	*units p.a.*
Smaller industrial transformers	16	750	750	750	10	75000	75000	75000
MV/LV (*) Distribution transformer	250	*2,714*	3,600	*4.459*	2,50	*119.438*	*140.400*	*173,891*
DER LV/MV (**) transformers	2000	*0,25*	20	*89*	4,00	*94*	*2,900*	*12,967*
Industry MV/LV oil transformer	630	*603*	800	*991*	4,00	*35.590*	*43,200*	*53,505*
Industry MV/LV (*) dry transformer	800	*128*	170	*211*	3,33	*6,708*	*8,047*	*9,966*
Power transformer	100000	*49*	64,35	*80*	3,33	*2,539*	*3,046*	*3,772*
Phase	100000	*0,49*	0,65	*0.81*	3,33	*26*	*31*	*38*

(*) MV/LV = Medium Voltage/Low Voltage
(**) LV/MV = Low Voltage/Medium Voltage
DER stands for distributed energy resources

3.1.3. Evolution of energy consumption and CO2 emissions in a BAU scenario

It has been estimated that for the year 2005, the annual electricity consumption of the installed base of transformers was of 85 TWh, with an associated 34 Mt of CO2 emissions[10]. The preparatory study has estimated for the year 2025 an installed base of almost 4,7 million transformers in the EU, leading to an annual electricity consumption of 120 TWh, corresponding to 28 Mt of CO2 emissions by that year, as shown in Figures 2 and 3.

[10] Average specific EU emissions for EU-27: EURELECTRIC (2010) Power Statistics – 2010 Edition – Synopsis. Brussels

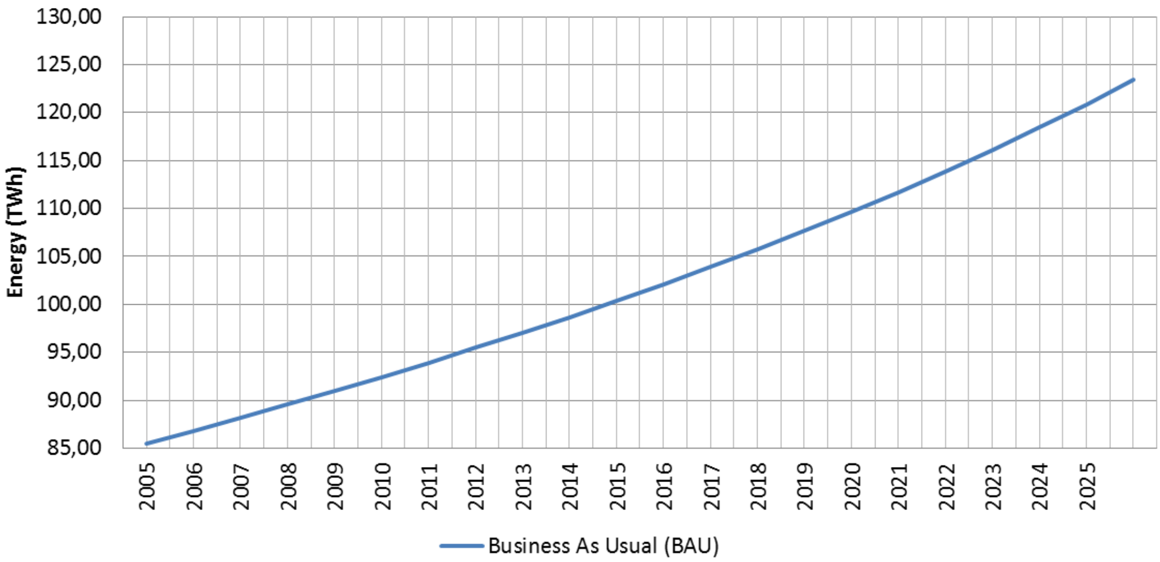


Figure 2 – Evolution of energy consumption of transformers to 2025 in a BAU scenario

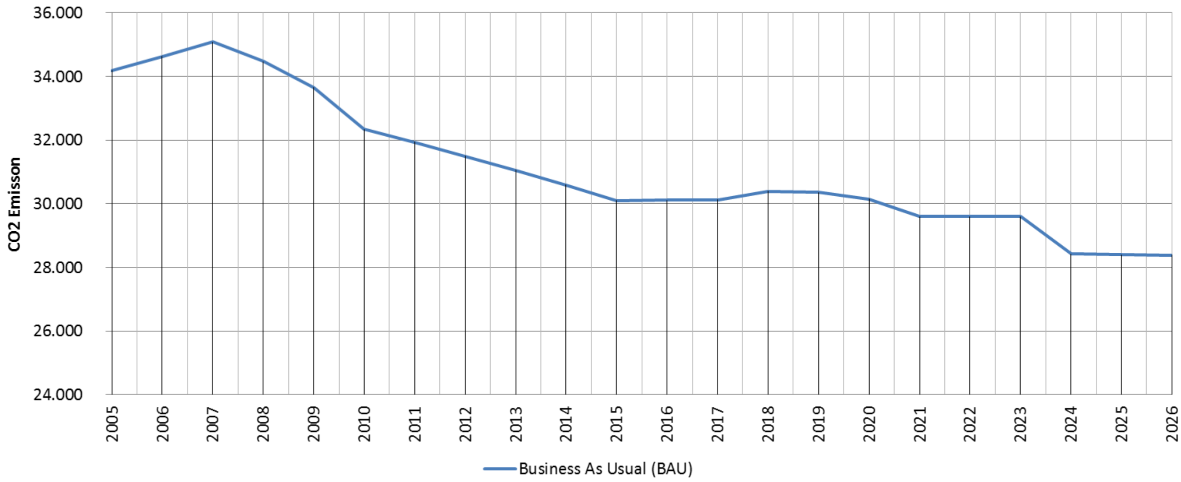


Figure 3 - Evolution of CO2 emissions of transformers to 2025 in a BAU scenario

The numbers for figures 2 and 3 have been calculated based on the market trends from the preparatory study, assuming typical lifetime usages and no reduction in electricity consumption that could be attributed to interventions at Member State or EU level.

The forecast for CO2 emissions in a BAU scenario actually shows a decrease due to the expected sharp reduction of the carbon intensity in electricity generation in the EU.

3.1.4. Environmental Impacts (Article 15(2)(b))

The environmental impact assessment carried out in the preparatory study showed that the use phase is by far the lifecycle stage with the highest impact, in terms of energy consumption, water consumption, greenhouse gases emissions and acidification. The production phase has a contribution to the following impacts: generation of non-hazardous waste, volatile organic compounds, persistent organic pollutants, polycyclic aromatic hydrocarbons emissions and eutrophication.

The large majority of transformers are recycled at the end of their lifecycle. There also exists a market for refurbished transformers. The end-of-life phase may have impacts due to the disposal of mineral oil. The content of PCBs (polychlorinated biphenyls) in mineral oils is regulated by the PCB/PCT EU Directive 96/59/EC and the Waste Framework Directive 2008/98/EC.

Energy consumption during the use phase was found to be, by far, the most significant impact, and therefore this IA analysis focuses on this impact, while other life cycle impacts have been left out of the scope of the proposed regulation, as they have not been found to be significant.

3.2. Improvement potential (Article 15 (2) (c))

The preparatory study examined improvement options of transformers considered as best available technology. The efficiency of transformers can be improved by using higher quality magnetic steel, but also by using copper instead of aluminum windings and by using circular limb cross-sections. Other possible improvements include the use of amorphous steel[11] or improved coatings between the laminations of conventional silicon steel.

The identified improvements prove to be, in general, economically superior and more energy efficient. All improvement options increase the final product price.

However, building more energy-efficient transformer most often implies adding extra raw materials, and therefore there are some additional impacts in terms of increased waste, particulate matter, eutrophication and embedded CO2. These extra impacts have found be almost negligible compared to the impact of energy consumption during the use phase.

The inclusion of extra materials (such as copper and magnetic steel) to make transformers more efficient also has a direct impact on first costs and renders their final price proportionally more sensitive to fluctuations in the price of such raw materials.

3.3. Existing legislation and failure of market forces to address the issue (point (i) of Article 15(2) (c)

3.3.1. Existing legislation

There is no existing legislation at the EU level that directly targets the reduction of energy consumption in transformers. However, power losses in transmission and distribution networks, of which transformers are part of, may account for up to 10-15% of the total amount of electricity produced in some Member States[12].

[11] Amorphous steel is already used to manufacture transformers in Japan (30% of the market) and the US (10% of the market). It offers lower resistivity to electricity and therefore allows reducing network losses further than with conventional magnetic steel. However, it has limitations in terms of achievable rated power ratings and currently there is only one large supplier of this material worldwide (Hitachi Metglas).

[12] Source : Treatment of losses by Network Operators – ERGEG Position Paper , available at http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_CONSULT/CLOSED%20PUBLIC%20CONSULTATIONS/ELECTRICITY/Treatment%20of%20Losses/CD/E08-ENM-04-03_Treatment-of-Losses_PC_2008-07-15.pdf

The costs associated to distribution losses are ultimately paid by final customers, as they are obliged to pay for an energy supply that includes the load of energy that is lost and therefore not consumed. The environmental impact of losses is borne by society as a whole, as a result of the emission of greenhouse gases associated with the additional power generation that is needed to cover losses.

At the Member State level, many National Regulating Authorities (NRAs) have designed incentive mechanisms to reward or penalize network operators whenever losses are below (or above) a target level during a given price control period. The treatment of losses differs significantly across Member States.

The European Regulators Group of Electricity & Gas (ERGEG) has performed an analysis[13] of such regulatory and incentive mechanisms at national level and found the following categorization:

- No regulatory or incentive mechanism in place
- Incentive-based regulatory model where the incentives for the network losses are equal to the incentives for any other costs
- Allowed rate of losses to include in tariffs capped to a maximum value in %[14]
- Incentive mechanism allowing the network operator to be rewarded (or penalized) if global network losses are higher (or lower) than a reference target value

This situation makes it difficult to establish benchmarks and perform comparative analyses of national mechanisms and ultimately hinders the effectiveness of regulatory incentive mechanisms.

Given the wide differences in national regulatory approaches to distribution losses, their expected interaction with the proposed EU Ecodesign regulation for transformers may be complex. There may be cases where network operators are required by the proposed regulation to make capital investments in efficient transformers which may go beyond what the NRA programmes are able to reward during a given price control period. A few utilities have raised this concern during the stakeholder consultations as a possible regulatory conflict.

However, from a life-cycle cost perspective (i.e., 25 to 40 years), such investments in more efficient transformers remain justified as they will help reduce total cost of ownership and generate wider socio-economic returns through lower electricity bills and lower greenhouse gas emissions.

3.3.2. Voluntary measures

No industry-led voluntary initiative that covers transformers has been identified during the preparatory study. No industry association has indicated any willingness to work on self-regulatory initiatives, as it seems that energy efficiency is not the main business consideration in the competitive procurement processes in which they are involved.

[13] idem

[14] For instance in Norway 40 % of the costs are passed through to consumer and 60 % of the allowed revenue is based on efficiency analysis

3.3.3. *Market failures*

As stated in the introduction to Chapter 3, the costs of distribution losses are passed on to consumers and therefore DSOs, who are responsible for purchasing a large number of distribution transformers, may only have a limited incentive to invest in more efficient designs. Furthermore, the external societal costs associated to the carbon emissions linked to network electricty losses does not seem to be included in the financial valuation of losses made by many TSOs and DSOs.

Therefore, existing regulatory incentives to procure efficient transformers are limited to reward mechanisms established by National Regulating Authorities (NRAs) in a few Member States (typically valid during price control periods of 5 years or so).

Private industrial users of transformers operating outside regulated retail electricity markets are by definition not subject to the referred incentives and tend to favour low initial cost solutions, which are not optimal from a lifecycle perspective.

It is therefore expected that the proposed regulation will complement existing regulatory incentives for reduction of distribution losses and trigger their introduction in those Member States where they are currently not present. Furthermore, it will force private industrial users to pay more attention to lifecyle costs over and above initial purchasing costs.

3.4. Legal basis for EU action

Article 16 of the Ecodesign Directive provides the legal basis for the Commission to adopt an implementing measure for this product category. The scrutiny of criteria enshrined in Article 15(2) of the Ecodesign Directive performed above shows that transformers qualify for the adoption of an implementing measure setting new ecodesign requirements.

Furthermore, a number of other jurisdictions around the world have been adopting MEPS (Minimum Energy Performance Standards) for transformers in recent years (US, Japan, Australia, China). Action at EU level is justified to bring the EU's market in line with the most progressive jurisdictions and also to reduce the burden of testing and product development on manufacturers compared with eventual separate measures in different Member States.

The envisaged regulation is fully coherent with other EU policies, and in particular it is to be seen as a contribution to decoupling economic growth from the use of resources, and in particular energy, an objective set out in the Europe 2020 strategy (COM(2010) 2020)[15] under the Resource efficient Europe flagship initiative.

3.5. Conclusion

The analysis performed above clearly indicates that there is currently a missed opportunity for significant energy savings (and consequently reductions in greenhouse gases emissions) to be achieved in this product group. For a number of reasons, utilities and industrial users are not

[15] Available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:2020:FIN:EN:PDF

always buying the most environmentally and economically optimal transformers, when their lifecycle impacts are considered.

Market forces alone are not expected to realize the potential savings identified, primarily due to the market and regulatory incentive structure currently in place. About two thirds (65%) of the respondents to the public consultation carried out prior to this impact assessment agreed to this assessment of the current market[16]. Only one third of the respondents, predictably mainly electricty network operators, were not in favour of establishing minimum mandatory requirements. Annex I.3 includes more detail about the results of the public consultation.

Therefore, action at EU level seems advisable, and it could give a sizeable contribution to the achievement of the Europe 2020 targets. The following chapters explain how a well-designed regulatory intervention can achieve this.

4. OBJECTIVES

The **general objective** is to develop a policy which corrects the identified market failures, and which:

- reduces energy consumption and related CO_2 emissions.
- promotes energy efficiency hence encouraging innovation and reducing energy dependence and contributing to the EU objective of saving 20% of the EU's energy consumption by 2020.

These should be achieved while maintaining a functioning internal market with a level playing field for producers and importers.

The **specific objectives** are:

- to facilitate removal of the poorest performing products from the market, where their life cycle cost disadvantages have proven insufficient to drive this.
- to set incentives for producers to further develop and market energy efficient technology and products.
- to complement existing national regulatory incentives for reducing distribution losses and stimulate their introduction where they are not present.
- to generate cost savings for end-users over the product's lifecycle.

The **operational objectives** are:

- to mobilize CENELEC to complete by 2013 appropriate measurement standards for energy performance and efficiency that complement the Regulation.
- to create, in the case of large power transformers, a framework for gathering information about energy efficiency that can reinforce the economic rationale for the minimum energy efficiency requirements envisaged for Tier 2.
- to achieve the objectives listed above without having a significant negative impact on functionality, safety, affordability of the product, nor on the industry's competitiveness and the administrative burden imposed on it as provided in Art. 15 of the Directive.

[16] A total of 74 respondents from 20 different countries replied to the public consultation, which took place between 5 October and 2 November 2012.

Chapter 5 describes the policy options that have been considered to meet these objectives.

5. POLICY OPTIONS

This Chapter describes the policy options that have been considered in the context of this impact assessment. It is important to state that the requirements first proposed in the preparatory study and in the working document presented at the Consultation Forum have been revised following substantial feedback from stakeholders.

5.1. Option A: No EU action

Currently there are no Ecodesign or energy efficiency requirements in force at EU level for transformers. Energy efficiency does not seem to be a driver in the transformers' market and effective incentives for network loss reductions set by National Regulatory Authorities are not in place in all Member States, neither are they mutually compatible.

The view from the Council of European Energy Regulators (CEER) is that an EU regulation that stimulates transformer efficiency through minimum mandatory requirements would help such national incentives converge and be established in those Member States where they are not in place. Furthermore, there are no such incentives for private industrial buyers of transformers, which represent around 20% of the market.

If no EU action is taken the situation described in Chapter 3 is likely to persist, and the energy saving potential identified in the preparatory study may not be fully realized.

Because of the long lifetime of transformers (25 to 40 years), the installation of inefficient products will have an adverse environmental impact over a long period of time.

In the absence of EU action, it is to be expected that Member States may want to take individual (non-harmonised) action on the energy efficiency of transformers. This possibility is further reinforced due to the rapid introduction of minimum requirements in third countries (e.g. Australia, Canada, USA). Such action would hamper the functioning of the internal market and lead to high administrative burdens and costs for manufacturers, in contradiction with the objectives of the Ecodesign Directive.

In the absence of a regulatory push, there is a risk of competitive disadvantage for EU manufacturers as other markets around the world move towards more energy efficient transformers, which may require adaptation of production lines and investment in technology.

The specific mandate of the Legislator (Article 15.1) would not be respected despite the fact that all the criteria of Article 15.2 setting the rationale for an implementing measure are met.

In the coming years, it is likely that electricity prices will increase significantly. The World Energy Outlook Report 2012 from the International Energy Agency quotes that "electricity prices are set to increase by 15% in real terms on average by 2035, driven by higher fuel prices, increased use of renewables and, in some regions, $CO2$ pricing"[17]. This only reinforces the need to stimulate the uptake of more energy efficient tranformers.

The option of no EU action is equivalent to the baseline scenario in chapter 3.1 and provides the reference for the other proposed options and thus the basis on which energy savings and other impacts are calculated.

[17] See http://www.worldenergyoutlook.org/media/weowebsite/2012/factsheets.pdf

5.2. Option B: Adoption of existing foreign policy

Energy efficiency requirements for distribution transformers already exist in a number of jurisdictions around the world. Some countries (Canada, Australia, New Zealand, Mexico) have based their minimum requirements on the US NEMA TP-1 standard. In 2007, the USA itself proposed new mandatory requirements for distribution transformers stricter than the previous TP-1, and which are roughly equivalent to the European AoBk[18] level.

In any case, comparison of international efficiency classes is not always obvious because of differences in electricity distribution systems. These differences are mainly: voltages, frequencies (50 Hz in Europe vs 60 Hz in the USA), definitions for apparent power of the transformer (input power versus output power) and load levels at which the efficiency of the transformer is measured. For these reasons, the adoption of efficiency requirements and associated measurement standards, as developed specifically for the US rulemaking on transformers, would be very complicated. This view is shared by most stakeholders, including manufacturers and electricity companies.

It is worth noting that most of the countries around the world which are adopting minimum efficiency requirements are doing so on the basis of minimum efficiency levels (percentages), which incorporate both load and no-load losses into a single values and therefore provide a degree of flexibility to manufacturers and operators as to how to achieve these values . On the other hand, this approach makes the verification of efficiency levels more challenging.

In Europe there is a strong tradition for specifying load and no-load losses separately. After a long discussion within the relevant standards setting body[19], stakeholders agreed to adopt a mixed approach for medium power transformers and opted for specyfing efficiency classes based on percentage values of a Peak Efficiency Index specifically developed for that purpose. Efficiency classes in the complementary standard for large power transformers are also based on minimum values of the Peak Efficiency Index. .

To conclude, the adoption of the US rulemaking(s) on medium power (distribution) transformers in its entirety into EU regulation is not technically possible. However the idea of specifying minimum efficiency values instead of absolute value of separate load and no-load losses has gained acceptance amongts stakeholders and the standardisation community and this is being reflected in Options E1 and E2, which propose setting Minimum Energy Performance Standards (MEPS).

5.3. Option C: Self-Regulation

So far no initiative for self-regulation on minimum energy requirements for transformers has been brought forward by the relevant industrial sector. Even though the transformers market is dominated by a relatively small number of players, there seems to be little inclination to engage in a self-regulatory initiative to improve their energy efficiency. This option is therefore unlikely to be effective to meet the Directive's objectives.

The specific mandate of the Legislator (Article 15.1) would not be met despite the fact that all criteria of Article 15.2 setting the rationale for an implementing measure are met. Therefore the option of a voluntary agreement is discarded from further analysis.

[18] A distribution transformer with levels of losses AoBk is considered the current benchmark by many manufacturers and electricity network operators in the EU. The current EN standard for transformers describes only one category of transformer (AoAk) more efficient than AoBk.

[19] Technical Committee 14 of CENELEC

5.4. Option D: Energy Labelling only

A labelling system that indicates the efficiency of transformers under specific load profiles is technically possible. There would be obvious difficulties in creating a labelling system for transformers, given the variability of losses depending upon application, but in most instances it would be possible to develop a labelling system that provides the user with appropriate guidance. The introduction of a labelling system would also provide a framework from which future minimum standards could be derived (if deemed appropriate). The framework could also be used for financial incentives associated with efficiency programmes, should they be required at a national level.

However, an energy label like the ones that have been developed for household appliances, with energy efficiency classification from A to G would not be appropriate, as professional buyers of transformers use complex loss capitalization formulas to determine what the optimal level of load and no-load losses is from their perspective.

Therefore, the most relevant information for buyers of transformers is the levels of load and no–load losses, measured according to existing standards. From this point of view, the categories of losses described in the relevant EN standard (AoAk, AoBk, BoBk, etc…) perform a similar role for professionals in the transformers market as the one energy labels do in a number of household appliance markets.

Such a product information requirement (indicating the levels of losses on the transformer's nameplate) is considered in Options E1 and E2 for an Ecodesign regulation, and could therefore avoid the need to adopt a separate regulation for Energy labelling. This also seems to be the preferred choice of most stakeholders, including manufacturers and electricity companies.

The option of Energy Labelling only is therefore discarded for the following reasons:

- A labelling scheme alone would not ensure that cost effective improvement potentials are realised for all products on the market, implying that the full energy and cost savings potential is not captured. A labelling scheme alone would not prevent the entering of low-efficiency transformers into the EU market as described in the section on market failures.
- The speed of the market transformation would be entirely determined by the voluntary take-up of labelled products. The market transformation due to the implementation of the labelling scheme will not be driven forward by the 'push' effect from Ecodesign requirements setting minimum energy performance levels.
- Due to the peculiarity of the transformers market in the EU (long tradition in specifying load and no losses separately), a well specified Ecodesign product information requirement could perform a similar role to an energy label, in a simpler manner.
- The specific mandate of the Legislator (Article 15.1) would not be met as all of the criteria listed in Article 15(2) giving grounds for an Ecodesign implementing measure are met.

Consequently there would be a high risk that with this option market transformation towards high-efficient transformers would take place only very slowly, with the corresponding detrimental impact on the environment and life cycle cost for end-users.

5.5. Options E1 (Strict MEPS) and E2 (Intermediate MEPS)

Options E1 and E2 aims at improving the environmental impact of transformers by defining maximum levels of load and no-load losses. The only difference between them is the initial level of stringency in the proposed MEPS (Minimum Energy Performance Standards) requirements.

The proposed MEPS requirements can be achieved by the manufacturers using existing technology (e.g. high grade commercially available silicon electrical steel, larger magnetic cores and increased cross-section of the conductors), with some adaptation of their existing manufacturing equipment.

Mandatory MEPS would require verification by market surveillance authorities. It is to be expected that a product is tested for energy losses not only for its conformity with Ecodesign requirements, but also for contractual requirements. The extra costs associated with the declaration of conformity of a transformer are therefore expected to be negligible, as the measurement of energy losses is already a standard contractual practice.

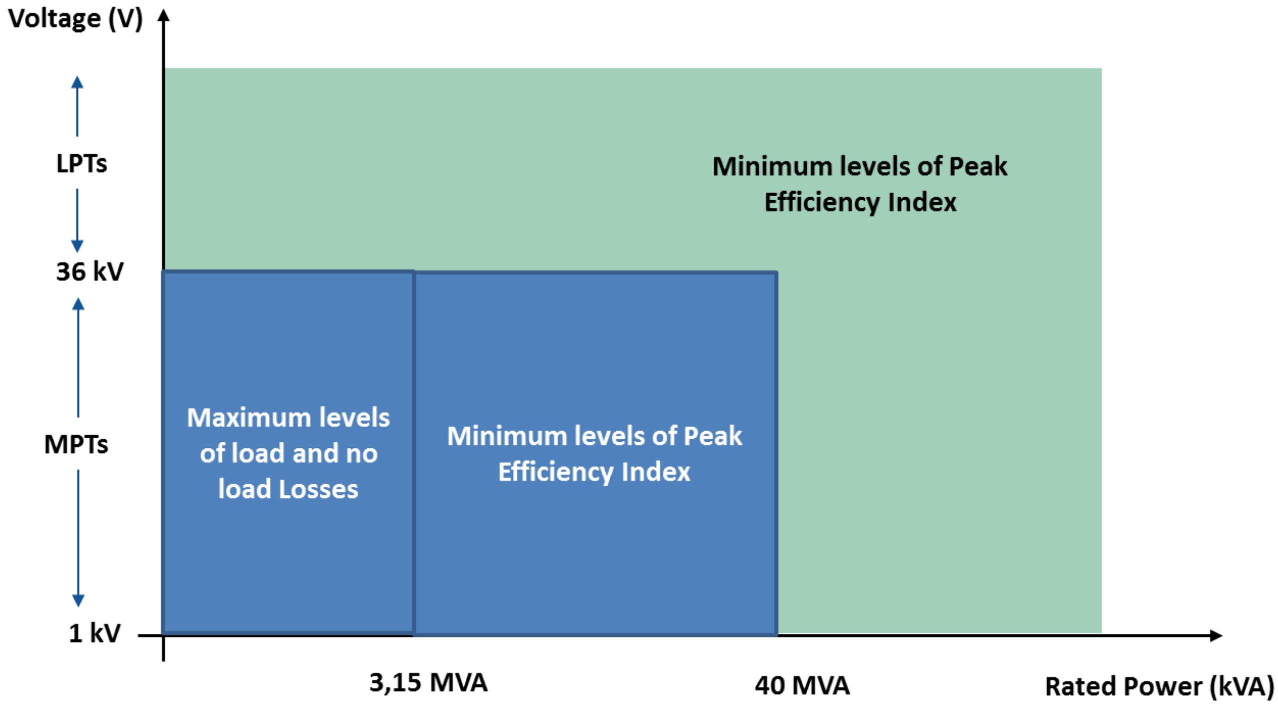
An Ecodesign Regulation setting MEPS on transformers would allow the specific mandate of the Legislator to be met.

For the purpose of comparative impact analysis, Options E1 and E2 are characterized as follows with respect to the BAT (Best Available Technology) option:

- Option E1 - Strict MEPS (Minimum Energy Performance Standards) - This option would include the setting of minimum requirements based on strict least lifecycle cost calculations (as indicated in Annex II of the Ecodesign Directive).
- Option E2 - Intermediate MEPS (Minimum Energy Performance Standards) - As the calculation of the least life cycle cost (see Annex IV) could not take into account certain installation costs associated with putting into service more efficient transformers, which can be quite onerous in specific cases, this option would be setting minimum requirements at a lower level of stringency than those in option E1 - Strict MEPS, so as to compensate for these additional costs.
- Best Available Technology (BAT) - This option would include the setting of minimum requirements based on what is technically possible with transformer models that embody BAT in the market. As some of the required technologies are not cost-effective within a reasonable payback period, this option is included for the purpose of the comparative analysis only.

Both Options E1 and E2 would be implemented through the introduction of requirements in two stages, Tier 1 in 2015 and Tier 2 in 2020.

The proposed Minimum Energy Performance Standards for medium and large power transformers consist of either maximum allowable values of load and no load losses or minimum efficiency values, depending on the rated power of the transformer. The graph below presents the same information visually.



Overview of the options

Table 2 present an overview of the different options.

	Not Retained	Retained	Earmarked for review
Option A: No EU action		✓ (as baseline)	
Option B: Adoption of existing foreign policy	✓		
Option C: Self-Regulation	✓		
Option D: Energy Labeling	✓		
Option E1 - Strict MEPS requirements		✓	
Option E2 - Intermediate MEPS requirements		✓	

Table 2. Summary of options for transformers

6. IMPACT ANALYSIS OF THE RETAINED OPTIONS

This section looks into the impacts of the retained policy options. They are assessed against the baseline scenario described in Chapter 3, which describes the expected impacts in case the Commission decides not to put forward any Ecodesign regulatory proposal.

Given that options B,C and D have been discarded in the previous section, this section looks into the impacts of options E1 and E2.

6.1. Options E1 - Strict MEPS and E2 - Intermediate MEPS

6.1.1. Economic impacts

The purpose of proposing an Ecodesign regulation with Minimum Energy Performance Requirements (MEPS) for transformers is to push the market in the EU towards more efficient designs, as installed units are gradually replaced at the end of their service life and new installations need to meet minimum performance requirements. This would help achieve the **policy objectives of energy conservation, reduction of greenhouse emissions and stimulation of technological innovation**.

More specifically, options E1 and E2 would achieve the following impacts:

- Ensure cost-effective reduction of transformers losses and related CO2 mitigation;
- Correct market failures and ensure proper functioning of the internal market;
- Decrease of the life-cycle cost of transformers for end-users without reducing the profit margins of manufacturers;

The starting point for impact analysis is the electricity (TWh) savings that would be achieved with Options E1 and E2 compared to the Business as Usual scenario. Transformer lifetime ranges from 20 to 40 years or more, and savings figures are provided until 2025. Due to the long life time of transformers, further savings will be achieved after 2025.

After the analysis of energy savings, an assessment of other environmental impacts, as well as other possible social impacts is made in the coming sections.

The preparatory study has shown that existing cost effective technical solutions allow for considerably lower electricity consumption levels than the current market average.

According to the Ecodesign Directive, the aim of the lifecycle analysis is to identify the least life-cycle cost (LLCC) points (see Annex IV for details of the calculation). A simulation of more than 1000 design options of the different types of transformers was carried out in the preparatory study using a simplified lifecycle cost analysis, which lays down the basis for the proposed Minimum Energy Performance Standards (MEPS) requirements.

Table 3 – Proposed MEPS for the different options considered

P0Pk	BAU	Strict MEPS 2015 Option E1	BAT	Intermediate MEPS 2015 Option E2	MEPS 2020 Options E1 and E2
Oil-immersed distribution transformers	D0Ck	A0-10% Ak	A0-20%Ak-20%	A0Ck ≤ 1000 kVA A0Ak > 1000 kVA	A0-10%Ak
Dry-type distribution transformers	C0Bk	A0-10% Ak	A0-20%Ak-20%	A0Ak	A0-10%Ak

Table 3 shows the proposed MEPS levels for Tier 1 (2015) and Tier 2 (2020) for different types of transformers. This terminoloy corresponds to the values of losses expressed in absolute terms (Watts) for a given rated power as indicated in the relevant EN measurement standard.

It needs to be explained that the analyses made in the preparatory study and in the impact assessment study was able to propose different levels of losses for distribution transformers used for different purposes (electricity distribution networks, industry and buildings).

The LLCC value for transformers used in electricity distribution networks occurs at lower levels of losses than for industry or building use, as the price of electricity before entering the distribution network is significantly lower than for industrial and residential users down the line. (See Annex III for the estimation of the price of electricity and Annex IV for the methodology to calculate lifecycle costs).

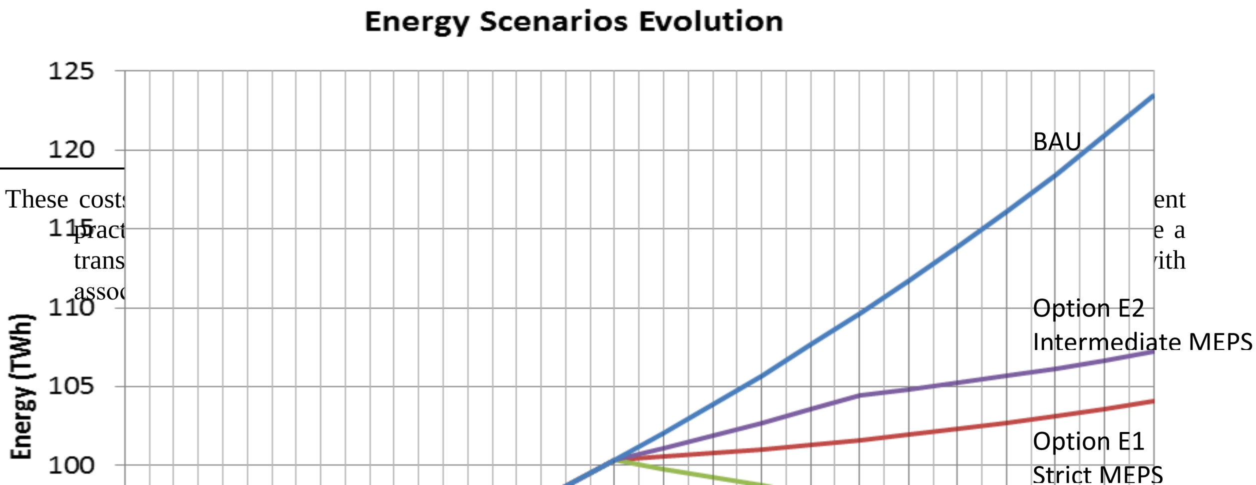
Distribution transformers used for different applications are inherently interchangeable. However, setting out minimum requirements based on intended use is a practice which has been avoided in all Ecodesign regulations so far. Therefore, although different MEPS could be proposed for different uses of the same transformer, which would still be economically justified, the proposed MEPS in the regulation are independent of the final intended use and are based on the least ambitious values found across different uses. This reduces somewhat the expected energy and C02 savings, but makes market monitoring easier and avoids potentially large loopholes.

The difference between Option E1 (Strict MEPS 2015) and Option E2 (Intermediate MEPS 2015) in Tier 1 is the level of stringency in the maximum allowed level of losses. While the MEPS in Option E1 are strictly based on the LLCC calculations of the impact assessment study, the MEPS in Option E2 are set a less stringent level to account for the fact that certain installation costs associated with the replacement of transformers at the end of their lifecycle could not be factored into the LLCC calculations[20].

The MEPS for Tier 2 in 2020 for Options E1 and E2 are set at the same level of stringency. The less stringent Option E2 therefore provides manufacturers more time to make the necessary adaptations to their productions lines and customers more time to plan their investments in more efficient transformers.

6.1.1.1 Energy savings

Figure 4 presents an overview of the evolution of the energy consumption of transformers in the different options considered.



[20] These cost ... ent pract ... e a trans ... ith assoc

Figure 4 – Evolution of the energy consumption of transformers in different options.

Figure 4 shows how the energy consumption levels should start to drop with the proposed MEPS set out for Tier 1 in 2015. These savings can be achieved by readily available technology based on conventional magnetic steel, which leads to a considerable reduction of the transformers life-cycle cost from the end-user perspective.

To be clear, the benefits of the expected saving will be distributed across stakeholders. How these benefits will accrue to different stakeholders (electricity companies, final users, etc…) will depend on the regulatory regime in place in each Member State. In general terms, the higher the percentage of distribution losses that electricity operators are allowed to pass through to consumers, the higher the savings in the electricity bills that may be expected.

In absolute terms, the estimated energy savings are larger in Option E1 (Strict MEPS in 2015) than in Option E2 (Intermediate MEPS). However, Option E1 requires a higher upfront investment from purchasers of transformers, as the level of stringency is initially higher. Against the background of the current financial and economic crises, stakeholders have expressed a preference for the initially less ambitious Option E2.

Table 4 shows the energy consumption of existing transformers (old stock) and of new purchases after 2015 and 2020 respectively, assuming that the proposed MEPS in Option E2 are adopted, as well as the expected annual savings.

Table 4 – Energy consumption of existing transformers and of new purchases up to 2025

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
BAU	102,08	103,87	105,72	107,64	109,63	111,70	113,85	116,09	118,42	120,87	123,43
Old Stock	97,11	93,81	90,45	87,02	83,53	79,88	76,15	72,35	68,47	64,51	60,47
LLCC	100,6	100,9	101,2	101,6	101,9	102,3	102,7	103,2	103,7	104,2	104,7
1StMEPS	3,99	8,07	12,24	16,52	20,90	20,90	20,90	20,90	20,90	20,90	20,90
2ndMEPS	0,00	0,00	0,00	0,00	0,00	4,04	8,18	12,43	16,79	21,27	25,88
Annual Savings Option E2	**0,98**	**1,99**	**3,03**	**4,10**	**5,20**	**6,88**	**8,61**	**10,41**	**12,26**	**14,19**	**16,19**
Annual Savings Option E1	**1,5**	**3**	**4,5**	**6,1**	**7,7**	**9,4**	**11,1**	**13**	**14,8**	**16,7**	**18,7**

6.1.1.2 Impact on manufacturers

Production costs

In general, manufacturing more efficient transformers requires using more raw material (magnetic steel, copper/aluminium, resin) and more labour to assemble larger units. This will have a direct impact on production costs. Feedback from manufacturers indicates that producing transformer models fulfulling the requirements proposed in Options E1 and E2 is possible with conventional technology and may require only minor changes to production lines. Informal feedback indicates that a number of manufacturers have already “discounted” the effect of the regulation and have adapted their production facilities to comply with the minimum requirements expected from the regulation.

A detailed assessment of the possible increase in the cost of transformers has not been possible, as the relevant manufacturer association was not in a position to share cost data, as this data is considered to be commercially sensitive information.

Cost of testing

Testing of load and no-load losses is routinely performed by manufacturers as part of their contracts with utilities and industrial clients. Widely accepted measurement standards are available in the EU for distribution transformers (under development for large power transformers). It is therefore not expected that the regulation will have a significant effect in increasing the cost of testing.

In this respect, no difference between Options E1 and E2 are to be expected.

Other compliance costs

In addition to the cost of testing, the administrative burden associated with the declaration of conformity imposed by the regulation would fall on manufacturers or economic operators placing transformers in the EU market. This compliance cost can be considered to be insignificant compared to the production costs, particularly for distribution and large power transformers.

Member States will be required to perform adequate market surveillance activities to ensure an effective enforcement of the regulation. Because of weight limitations, product inspections are expected to take place on-site at manufaturers' facilities rather than at final destinations. These inspections may incurr some costs for manufacturers, but these can be considered negligible compared to overall production costs.

In this respect, no difference between Options E1 and E2 are to be expected.

6.1.1.3 Product price increases

The MEPS requirements proposed in Options E1 and E2 will have an impact on the price of transformers, as more efficient transformers require more material and labour to be manufactured. The preparatory study made a number of assumptions on the price of different models of transformers in order to calculate their whole lifecycle costs (=initial purchasing cost + operating cost).

A detailed assessment of the possible increase in the price of transformers has not been possible either, as neither manufacturers nor utilities have shared any price data during the preparatory study, as this is considered to be commercially sensitive information. This is understandeable to a certain extent, as the transformers market is characterized by competitive tendering processes with few bidders.

Table 5 – Payback period for a typical distribution transformer

	Lifetime (years)	MEPS 2020 (Options E1 and E2)	Payback period(years)
		P0PK (Level of losses)	
Distribution transformer	40	A0-10%Ak	8,77

Nevertheless, the impact assessment study made an estimate of the payback period (see Table 5) for the investment required to purchase a typical transformer model fulfilling the level of stringency introduced by the Tier 2 MEPS in 2020 (which are the same in Options E1 and E2). A payback period of less than 9 years for a piece of equipment that is meant to have a service life of 40 years can be considered quite reasonable.

Direct stakeholder feedback has indicated that expected price increases for typical distribution transformers might be in the region of 15% to 25% for Tier 1 in Option E2 and in the region of 25% to 40% for Tier 2 in Option E2.

As most purchases of transformers are for replacement purposes, net price increases obviously depend on the efficiency level of the transformer which is due for replacement. As the procurement of transformers is very often done through competitive processeses, it may also happen that manufacturers' margins are eroded, making net price increases difficult to estimate.

In this respect, it is clear that those utilities and private users with the most efficient installed bases of transformers will be less likely to experience net price increases. In terms of the geographical distribution of price impact, generally speaking, utilities in the Scandinavian countries, Germany, Austria, UK and the Benelux countries are less likely to suffer price increases, while utilities in Southern and Eastern European Member States are more likely to suffer them.

6.1.1.4 Impact on users

It is expected that as a result of the market transformation towards more energy efficient transformers, utilities and private users will need to procure more expensive transformers, as the installed units are progressively due for replacement. In this respect, the difference between Options E1 and E2 is the initial level of stringency for Tier 1 in 2015, but the long term effect will be similar.

In the case of utilities, the impact of the proposed regulation on the final users of electricity needs to be considered. The proposed market intervention is based on a detailed life-cycle cost analysis that should bring wider economic benefit to network operators and consumers through lower network total operating costs.

Replacement sales for distribution transformers are expected to occur at a rate of 2.5% over the period 2005-2020, so any additional investment effort brought about by the proposed regulation will be spread over many years. In any case, transformers represent a small percentage (typically between 5% and 10%) of all electricity distribution costs[21]. These two considerations taken together lead to conclude that any direct impact on final electricity prices should in principle be negligible.

On the other hand, more efficient transformers start saving energy from their first day of operation, therefore helping reduce electricity bills for end-users. Additionally, improved network efficiency brings down the marginal cost of power generation through reduced demand and therefore contributes to lowering prices in wholesale electricity markets.

A precise quantification of the net effect of all the impacts described above has not been possible within the resources available for the preparation of the proposed regulation. Nevertheless, the impact assessment study has estimated that, in the medium to long term, it would be possible to save not only about 1% of all the electricity generated by introducing more efficient transformers, but also save a huge amount of investment in power generation and transmission (about 5000 MW of power generation and transmission could be avoided). This very large avoided cost of supplying wasted electricity should result in lower electricity prices for consumers and ultimately to make the EU economy more efficient.

With the available information, it seems reasonable to conclude that any net effect of the regulation will be in the direction of lowering final electricity prices and that this effect will become more pronounced over time, as efficient equipment is gradually amortised, while it continues to generate savings.

6.1.1.5 Impact on competitiveness, innovation and trade

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21 See for instance the Irish CER Decision Paper on Distribution System Operator Revenues at http://www.cer.ie/cerdocs/cer05138.pdf

The production of higher efficiency designs should lead to a more competitive EU transformer industry in world markets. The know-how gained in the manufacturing of more efficient transformers may open up market opportunities in third countries where energy efficiency might be a business driver.

As transformers are manufactured to be more energy efficient, the relative importance of the different production factors will change. More efficient transformers generally require more copper and magnetic steel and also more labour, but relatively less of the latter in comparative terms. As labour is generally cheaper in emerging markets (India, China) than in the EU (up to a factor of 10), the proposed regulation is likely to make European manufacturers relatively more competitive, as the importance of labour in the overall production costs decreases.

Adding extra materials is not the only way to achieve higher energy efficiency in transformers. Other innovative design options (e.g., core shapes or improvements in grain oriented magnetic steel) may be stimulated in order to achieve the same levels of efficiency, particularly in situations where space may be a design constraint.

The EU is already a net importer of transformers. As demand for more efficient transformers increases in world markets, it is to be expected that the proposed regulation should have a positive effect on trade, as EU manufacturers are more able to compete in third markets.

In this respect, the difference between Options E1 and E2 is the initial level of stringency for Tier 1 in 2015, but long term effects on competitiveness and innovation should be similar.

Table 6 provides a qualitative assessment of the expected impact of introducing mandatory MEPS on different aspects of the industry's competitiveness.

Table 6 - Competitiveness proofing screening table for Options E1 and E2

Cost and price competitiveness	Positive	Negative
Cost of inputs		Likely to increase
Cost of capital	No significant change expected	
Cost of labour	No significant change expected	
Other compliance costs (e.g. reporting obligations)		Minor compliance cost to prepare self-declarations
Cost of production, distribution, after-sales services		Distribution costs could rise because of larger products
Price of outputs (directly not through the cost, e.g. price controls)	Initial price increase expected, but Life-cyle cost (LLC) should go down	
Capacity to innovate		
Capacity to produce and bring R&D to the market	Should be stimulated in order to meet Tier 2 MEPS requirements	
Capacity for product innovation	Should be stimulated in order to meet Tier 2 MEPS requirements	

Capacity for process innovation (including distribution, marketing and after-sales services)	Cannot say	
Access to risk capital	Cannot say	
International competitiveness		
Market shares (single market)	Likely to increase	
Market shares (external markets)	Likely to increase	
Revealed comparative advantages	Products with higher added value	

6.1.1.6 Impact on SMEs

The transformers market is dominated by large international companies such as ABB, Siemens, Areva and Schneider Electric, and some medium size companies like SGB/Smits Pauwels, Cotradis or Ormazabal.

Nevertheless, SMEs are also active in the production of transformers, especially for niche smaller industrial application transformers, where often orders are directly placed with manufacturers without going to public tender. It is estimated that there are around 50 SMEs active in production in the EU, often with only a few employees.

As the proposed regulation will not be forcing a technological shift in the market towards amorphous steel, it is not expected to have a major impact on SMEs which are active in the production of transformers with conventional grain-oriented electrical steel. They will have to keep up with technological development in this material.

In this respect, no significant differences between Options E1 and E2 are to be expected.

6.1.2. Social impact

The production of higher efficiency designs should lead to a more competitive EU industry in world markets. Higher efficiency units are more expensive, leading to higher turnover and potentially higher profitability of the EU transformer industry. The transformer market is projected to evolve with a moderate to medium stock growth of 1.4 to 10.5% annually, depending on the type of transformer.

It seems strategic to foster the local manufacture of efficient transformers, as otherwise there is a the risk of losing competitiveness and market share to manufacturers in other major markets like the U.S., Australia, China, Canada, where regulations introducing minimum efficiency requirements are already in place and are transforming markets.

Of concern among stakeholders is the use of amorphous technology in the production of the transformer cores, of which there is currently no production capacity within Europe, although this situation may change if the demand picks up.

The proposed performance requirements for Tier 1 in 2015 and Tier 2 in 2020 are attainable with both conventional grain-oriented electrical steel technology, as well as with amorphous metal technology (required only to go beyond levels of losses of A0-20%), thus still allowing manufacturers a choice of technology to meet the requirements.

It may be expected that more specialised processes and manufacturing equipment may be needed to produce more efficient models in line with the proposed minimum requirements in Tier 1 and Tier 2. This could result in training requirements and a more skilled workforce.

In this respect, the difference between Options E1 and E2 is the initial level of stringency for Tier 1 in 2015, but long term effects on skills and the labour market should be similar.

6.1.3. Environmental impact

As stated in Section 2.1.2, the main environmental impact related to this product that falls within the scope of the regulation is its contribution to global warming through CO2 emissions. The accumulated electricity savings and the reduction of CO2 emissions obviously depend on the level of stringency of the adopted MEPS and on the timing of their introduction.

Figure 5 – Expected evolution of CO2 emissions in different options up to 2025

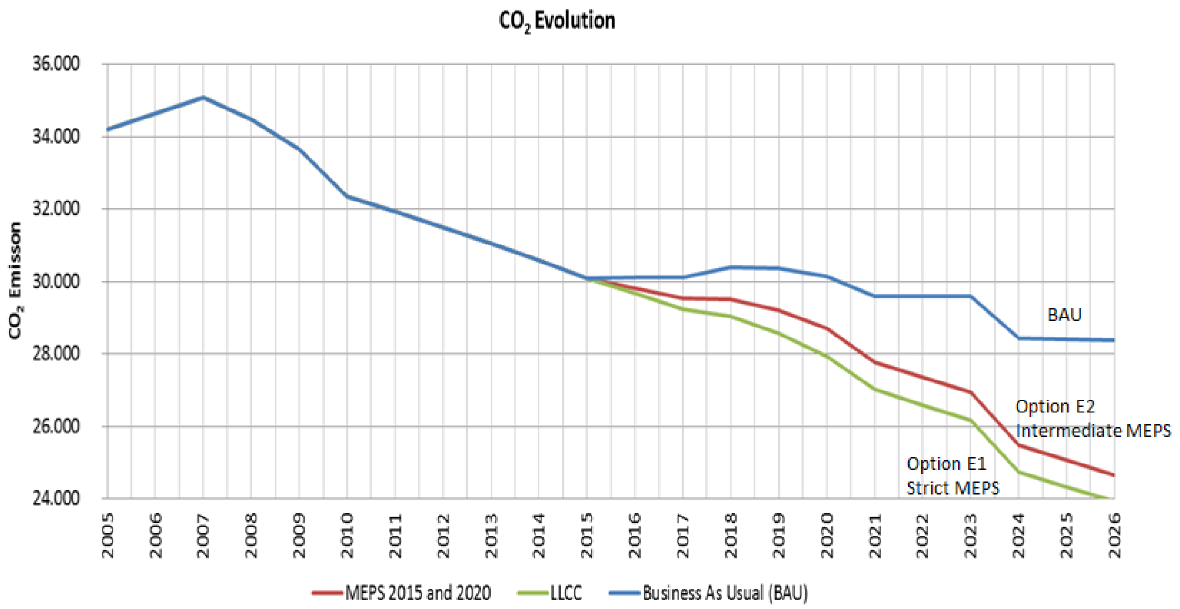


Figure 5 shows the expected evolution of CO2 emissions in the different scenarios under consideration. It needs to be highlighted that the BAU scenario shows a decrease in CO2 emissions in the absence of regulatory intervention. This is due to the expected progressive decarbonisation of the electricity generation in the EU.

Table 7 shows the expected CO2 emissions and CO2 savings due to existing transformers and new purchases up to 2025. The adoption of the minimum requirements in Option E1 would entail savings of 4,3 Mtons of CO2 by 2025 over the BAU scenario, while Option E2 would generate savings of 3,7 Mtons of CO2 by 2025.

CO2 (Mton)	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025

BAU	30,1	30,1	30,4	30,4	30,1	29,6	29,6	29,6	28,4	28,4	28,4
Old Stock	28,6	27,2	26,0	24,5	22,9	21,2	19,8	18,5	16,4	15,2	13,9
LLCC	1,1	2,1	3,2	4,2	5,2	6,1	7	8	8,6	9,4	10,3
1StMEPS	1,2	2,3	3,5	4,7	5,7	5,5	5,4	5,3	5,0	4,9	4,8
2ndMEPS						1,1	2,1	3,2	4,0	4,9	5,9
Annual Savings Option E2	0,3	0,6	0,9	1,2	1,4	1,8	2,2	2,7	2,9	3,3	3,7
Annual Savings Option E1	0,4	0,9	1,3	1,7	2,1	2,5	2,9	3,3	3,6	3,9	4,3

Table 7 – Expected CO2 emissions of existing transformers and new purchases up to 2025

7. COMPARING THE OPTIONS

Table 8 provides an overview of the quantified impacts for the different options.

Table 8 – Summary of quantified impacts

Option	Total energy consumption (2025, TWh)	Total energy savings (2025, TWh)	Total CO2 savings (Mton, 2025)	Monetized value of CO2 savings[22]	Costs for producers
Option A: No EU action	123,4	0	0	0	n/a
Option E1: Strict MEPS	104,7	18,7	4,3	64,5 M€	Could not be quantified
Option E2: Intermediate MEPS	107,2	16,2	3,7	55,5 M€	Could not be quantified

Then, each option has been scored in Table 9 according to the anticipated impacts of the policy, using three criteria: effectiveness, efficiency and coherence

Both Options E1 and E2 score well in terms of coherence with other neighbouring policies, such as the Energy Efficiency Directive and climate change policies. Option A is not expected to achieve any of the objectives associated with the proposed regulation.

In terms of effectiveness, both Options E1 and E2 score well, as they are expected to gradually transform the market towards more efficient models and generate substantial energy and C02 savings. In the long term, their effect is nearly indistinguishable, as they are proposing the same MEPS from 2020 onwards.

Option E2 scores slightly higher than Option E1 in terms of efficiency. The reason for this is the smoother introduction of MEPS in Tiers 1 and 2. Transformers are not bought off the

[22] :"Based on 15 euro/tonne average market value 2008-2012. Actual market value has fluctuated between 7 and 30 euro over this time. Source, the State of the European Carbon Market in 2012 COM(2012)652

shelf, but are manufactured to specification. The stricter Option E1 could have some disruptive effect in the market, as purchasers of transformers are likely to frontload orders ahead of the coming into force of the regulation, thus straining manufacturers' production capacity and their supply chains for input materials.

Option E2, by delaying the introduction of stricter requirements to 2020, is therefore expected to have a more gradual market transformation effect, but without the risks that could be associated with the more stringent Option E1. It is expected that, as manufacturers and purchasers of transformers have more time to adapt to stricter requirements in 2020, disruptive effects in the market should not

Overall, Option E2 presents the better profile in terms of effectiveness, efficiency and coherence and therefore it is the retained option.

Table 9 - Summary of policy option comparison

Option	Effectiveness to deliver on objectives	Efficiency	Coherence
Option A: No New EU action	0	0	0
Option E1: Strict Minimum Energy Performance Requirements (MEPS)	✓✓	✓✓	✓✓
Option E2: Intermediate Minimum Energy Performance Requirements (MEPS)	✓✓	✓✓✓	✓✓

Scoring key: ✓✓✓ = large positive, ✓✓ = sizable positive ✓ = small positive, 0 = neutral, × = small negative, ×× = large negative.

7.1 Timing and structure of the implementing measure

After consultation with the different stakeholders, the following dates have been considered for implementation of the regulation:

- Ecodesign information requirements from January 2015
- Tier 1 requirements from January 2015
- Tier 2 requirements from January 2020
- Review of the regulation in January 2018

The different product information requirements and minimum energy performance requirements are summarised in Table 10.

Table 10 – Overview of the different requirements in Tier 1 and Tier 2

	Tier 1 (2015)	Review (2018)	Tier 2 (2020)
Small power transformers (< 1kV)	Information requirement on losses	Consideration of introducing minimum requirements for Tier 2 (MEPS or efficiency (%))	Possibly MEPS or minimum efficiency (%) requirements
Medium-power transformers (distribution) (< 36 kV)	Information requirement on losses MEPS (Minimum Energy Performance Standards) requirements	Consideration of switching from MEPS to minimum efficiency (%) for Tier 2 Validation of requirements for Tier 2	Information requirement on losses Stricter MEPS or minimum efficiency (%) requirements
Special category pole-mounted transformers	Regulatory concessions due to weight limitations	Consider if regulatory concessions are still appropriate	Regulatory concessions due to weight limitations
Large power transformers (> 36 kV)	Information requirement on energy efficiency Minimum efficiency requirements	Validation of requirements for Tier 2	Information requirement on energy efficiency Stricter minimum efficiency requirements

Annex 2 includes more detail on the proposed scope of the regulation.

8. MONITORING AND EVALUATION

The main monitoring element will be the tests carried out for new product conformity. Products placed on the Community market have to comply with the requirements set by the proposed regulation, as expressed by the CE marking. Monitoring of the impacts is mainly done by market surveillance carried out by Member State authorities ensuring that the requirements are met.

The appropriateness of scope, definitions and concepts will be monitored by the ongoing dialogue with stakeholders and Member States at the Ecodesign Consultation Forum.

The main issues for consideration for the proposed mid-term review of the regulation include:

- The appropriateness of the levels for the specific Ecodesign requirements in Tier 2
- The possibility to switch minimum requirements from maximum levels of losses to efficiency levels (%) at a specific load factor, which would incorporate load and no-losses, thus providing more flexibility in the design.
- Look into the availability of materials necessary to meet the requirements set out for Tier 2.

- Consider the appropriateness of establishing minimum efficiency requirements for small transformers.
- Verify whether regulatory concessions made for pole-mounted transformers and for special combinations of winding voltages in the implementing measure are still appropriate.
- The possibility to cover other environmental impacts than energy in the use phase.

Taking into account the time necessary for collecting, analysing and complementing the data and experiences in order to properly assess technological progress, a review could be presented to the Consultation Forum no later than three years after entry into force of the regulation (as laid down in the implementing measure).

9. ANNEXES

Annex I: Consultations

I.1 Minutes of the Ecodesign Consultation Forum of 20 April 2012

MINUTES – CONSULTATION FORUM: Ecodesign ENTR Lot 2 – TRANSFORMERS

Brussels, 20 April 2012

Attendees/ Presentation

The list of attendees to the meeting and the Commission's presentation are available in circa as separate documents.

Introductions

Kirsi Ekroth-Manssila (KEM), acting Head of Unit, ENTR B.1, welcomed the Consultation Forum members and invitees to the meeting, and introduced the responsible Policy Officer for ENTR Lot 2, Cesar Santos Gil (CSG), and attending colleague, Michael Bennett (MJB).

Overall Agenda – Structuring of Discussion Points

CSG outlined the main purpose of the day: to inform attendees regarding the draft ecodesign regulation for small, distribution and power transformers, and to seek feedback.

Although transformers are efficient devices already, there seems to be wide consensus that an EU ecodesign regulation establishing minimum performance requirements would be beneficial for European industry, as well for society and the environment. The details of such a proposed regulation would be presented via a structured PowerPoint presentation, based on the previously-circulated draft ENTR Lot 2 regulation working document.

CSG thanked organisations for helpful contributions received prior to the Consultation Forum, and indicated a deadline of a further 4 weeks after today's Consultation Forum for additional comments to be submitted.

After an initial first round of short interventions on generic issues, the main areas of the draft document, and discussions points, would be organised according to the following structure:

- Scope of the proposed regulation & exceptions
- Definitions
- Ecodesign requirements for small transformers
- Requirements for distribution transformers
- Requirements for pole mounted transformers
- Requirements for power transformers (including a discussion on Total Cost of Ownership analyses)
- Product information requirements
- Standardisation needs
- Verification procedure
- Other issues & potential loopholes
- AOB

Generic Issues

(1) **Comment (Anthony Walsh, Irish Electricity Board/ Eurelectric):** Firstly, re. stakeholders invited to the Consultation Forum, the European Commission should explicitly consider inviting electricity utilities from Member States, plus Eurelectric. Secondly, have EU regulating bodies received the draft proposals on "Ecodesign ENTR Lot 2 – Transformers"? Thirdly, A. Walsh requests a period of more than four weeks to submit feedback, owing to the need for prior internal/ Member State-level discussions.

Answer, CSG: (i, ii) – Utilities are not formally members of the Ecodesign Consultation Forum, but this could and should be addressed as they are stakeholders with a legitimate interest in the ecodesign discussion on transformers. The Ecodesign Consultation membership was officially "frozen" at the status of 2007 (iii) It would be better to adhere to the four week deadline, wherever possible, in order to maintain the overall timeline for ENTR Lot 2.

Specific Issues – Addressed Slide by Slide

Re. Slide 7 – Proposed Exceptions to the Regulation

CSG opens the floor for comments.

(2) **Comment (Paul Jarman, National Grid, UK & Michel Sacotte, T&D Europe):** Autotransformers are a simple means of increasing energy efficiency overall. Where they could be used, they should be used, i.e., they should *not* be excluded.

(3) **Comment (Anthony Walsh, Irish Electricity Board/ Eurelectric):** On the distribution side, autotransformers are not normally used. Therefore, might it be useful to classify transformers according to use by "utilities" and "non-utilities"? Technical point: differences between a "line voltage restorer" (which compensates for very short duration "sags" in voltage) and an "autotransformer". The numbers of line voltage transformers are very low.

(4) **Comment (Angelo Baggini, University of Bergamo, Italy):** (i) Autotransformers should be included in the measure; (ii) Any exclusions might be better addressed regarding one element of either power **or** function.

(5) **Comment (Hans Paul Siderius, Netherlands):** (i) Supports above Italian comment, and would prefer the scope to be determined by kVA; (ii) Regarding material efficiency and resource efficiency aspects, the text should be amended to state that these issues are significant, but that they are dealt with by the functioning of the transformers market itself.

(6) **Comment (Anibal de Almeida, University of Coimbra, Portugal):** Supports (i) kVA approach; (ii) that autotransformers should not be excluded. Additionally, (iii) magnetic halogen lighting transformers should *not* be excluded.

Regarding Slide 8 (Proposed Ecodesign Requirements) & Slide 9 (Proposed Definitions)

(7) **Comment (Paul Jarman, National Grid, UK):** The use that a transformer is put to dramatically affects its power during its lifetime, re. "load", and "on/off" usage. Therefore, denoting definitions via "rating" vs. "type of use" might be problematic. Regarding standards bodies, definitions via "rating" only would be preferred.

(8) **Comment (both representatives from T&D Europe):** (i) For transformers in the range 1kVA to 20 kVA, it is relatively easy to define losses. The current relevant EN & ISO standards should be taken into consideration. (ii) For "large power transformers", these are more specialised machines; T&D Europe suggests mapping their use and place in the market. (iii) Re. recyclability, most transformers are close to 95% or even 100% recyclability, and they are indeed recycled. (iv) 16.5 Hz transformers should be considered (point raised by Sweden) - however, there is the need for a study regarding their volume and total impact**.**

(9) **Comment (Marie Baton (CLASP), & Simonetta Fumagalli (ENEA, Italy)):** Care needs to be exercised to avoid double-regulation with other applicable regulations, including Ecodesign (e.g., lighting transformers, and lamp control gear).

Summary (CSG): The overview conclusions seem to be to (i) exclude transformers of power <1kVA; (ii) Keep the list of function-driven exemptions as short as possible; (iii) Transformers are viewed as not being difficult to recycle - further comment on this would be appreciated from the Schneider Electric colleagues, in writing, from their experience.

Regarding Slide 8, and Energy Labelling

(10) **Comment (Hans Paul Siderius, NL, Stamatis Sivitos, ECOS & Roman Targosz):** All express the opinion that business-to-business labelling could be useful, to indicate Best Available Technologies (BAT), with regard to resource efficiency and recyclability as well as energy performance.

(11) **Comment (Michael Scholand, CLASP):** Labelling is probably not appropriate re. utilities transformers, but is useful for "supply side", e.g., supply to buildings, at customer level. Industry does perform labelling, in the form of "AO, BO, AK", etc, and suggests that for ENTR Lot 2 the consideration for this Consultation Forum is whether a definition of "better than AO" could be feasible.

(12) **Comment (T&D Europe, & Ireland):** For the larger transformer products, market aspects already ensure recycling. An investigation to examine where a useful "borderline" might be drawn could be useful, re. the larger transformers being recycled, vs. smaller transformers not being so successfully recycled.

Regarding Slide 9 (Proposed Definitions)

(13) **Comment (T&D Europe):** Re. pole mounted transformers, the power rating should be 50-315 kVA, because 50kVA is used in France for such transformers.

(14) **Comment (University of Bergamo, Italy):** Additional size grouping definitions could be usefully added, e.g., "medium power transformer", and "large/ very large power transformer". This comment was opposed by the National Grid (UK), on the grounds that all definitions should be aligned with standards.

(15) **Comment (Netherlands):** The European Commission should explicitly include to all relevant definitions in the Working Document, to assist consistency-checking.

(16) **Comment (ENEA, Italy?):** Three groups could be considered: <36kVA, >36kVA and "very high" (e.g., 1200kVA, etc).

CSG, Summary: There seem to be two classes of transformers: "Distribution", and "Large Power". Regarding the 36kVA boundary issue, CSG asks Sweden to submit comments in writing.

Regarding Slide 10 (Table with Proposed Ecodesign Requirements - Small Power Transformers)

(17) **Comment (NL & University of Bergamo):** Owing to non-linearity, from 64kVA upwards, *interpolation* instead of extrapolation should be required.

(18) Comment (T&D Europe): Suggest adding 80 kVA and 100 kVA extra categories to the table. Re. timeline, 2016 generally acceptable, but Tier 2 should be 2022, with respect to the changes needed to implement these requirements.

CSG, Summary – Small Power Transformers: (i) The table will be extended to cover the suggested two additional categories for 80kVA and 100kVA rating. (ii) DG ENTR would appreciate contributions from stakeholders re. "rounding up" of figures. (iii) Interpolation will be required, where necessary, rather than extrapolation.

Regarding Slide 11 (Table with Proposed Ecodesign Requirements – Distribution Transformers)

(19) **Comment (Anthony Walsh, Irish Electricity Board/ Eurelectric):** The "Total Cost of Ownership" model should be used, as kWh losses are proportional to the prices of the electricity in each Member State. If higher investment is necessary for transformers, other elements (e.g., circuits) may receive less investment. Loading patterns may change according to both transformer types, and an increased renewables component. In addition, the Tier 2 draft extra performance requirement of "-20%" in reality means that a specific type of technology is being specified, and that technology is presently largely available only outside the EU.

Re. loading put on transformers, if, in certain areas, there is a high load, then utilities would install a second transformer to cope with this higher load. The revised scenario would mean that the average load per individual transformer would be lower over its life.

(20) **Comment (Sweden):** The ambition should be set higher, namely that the present "Stage 2" should become "Stage 1". For stage 2 in 2018, SE is proposing losses of Ao(-40%) for all categories in Table 2.

(21) **Comment (Hitachi EU):** The values in the table can be achieved with technologies available today. The timing therefore seems to be too slow, echoing Sweden's comment. AOBk is needed, because the EU is lagging behind other regions, internationally, and the timelines proposed should be strict, because of the inevitable additional time (over 2 years) for implementation to take place, for each Tier of ambition.

(22) **Comment (T&D Europe):** (i) Disagrees with the above two comments, and asks that the draft 2014/2018 timetable be changed to 2014 (Tier 1)/ 2020 (Tier 2). (ii) Re. losses, Member State-specific frequencies should be taken into account. (iii) The *Load factor* rather than "load losses" is more relevant. (iv) AOBk implies that the mass of the transformers is increased, meaning more resources are required and so the price of the transformer is likely to increase – how does this affect the overall life cycle impacts, re. embedded energy in the additional metals?

(23) **Comment (CLASP Europe):** Would like AOAk to be in Tier 1. Asks why Stage 2 does not demand energy improvement regarding winding losses. CLASP contends that what the Irish Electricity Board is asking for, via an approach to regulation less based on Minimum Energy Performance Standards, is no better than the status quo, and may in fact be worse than the status quo.

(24) **Comment (University of Bergamo):** The "Total Cost of Ownership" (TCO) approach is not mutually exclusive to the approach defining maximum losses. Legislation could define level(s) of minimum losses. Then, a "TCO" approach could be applied by utilities above these minima.

(25) **Comment (Sweden):** (i) Ecodesign measures must put environmental and energy requirements on products. (ii) Future-thinking is important, because new transformers will be used in the grid typically for 40 years.

(26) **Question (Belgium Ministry**): The TCO approach is useful, but there will be potentially always missing information. Therefore, all variables need to be included in any "TCO" approach. How may this be handled? Also, what about market surveillance and legal measures?

(27) Summary, CSG: (i) The economic figures from the preparatory study will be further explored during the Impact Assessment phase now being commenced, for large power transformers as well as distribution transformers. (ii) The ecodesign aim is that proprietary technology should not be stipulated. (iii) Comments from other utilities, in addition to those from the Irish Electricity Board, are sought, to attempt to get a wider view from EU utilities. (iv)

It should be remembered that we are discussing product policy here. The Ecodesign process is not designed to mandate public or private utilities how to conduct their procurement process; therefore, it is important to identify and specify permitted maximum losses to manufacturers, where possible. (v) It seems that not all of the conclusions from the contractor of the preparatory study (VITO) are correct, re. the Bk/ Ck discussions. (vi) The level of ambition of a recently proposed US rulemaking at present is in the region of "AOCk", allowing for frequency variations and other differential parameters, etc. (vii) For Stage 1, from the discussions it seems that there is no consensus. However, for Stage 2, there appears to be consensus on "(Ao - 20%)Bk".

(28) **Comment (NL & CLASP):** Disagree with point (vii) above. This consensual conclusion is premature, and not ambitious enough.

Answer, CSG & KEM: (i) The aim is to define maxima and minima re. EU-wide parameters. (ii) NL and CLASP comments are carefully noted. (iii) There are four more weeks in which to submit comments, so nothing is finalised. (iv) The Impact Assessment is another stage where all the facts and submissions, plus additional enquiries, will be taken into account/ initiated.

LUNCH BREAK.

Regarding Slide 12 – Proposed Requirements for Pole-Mounted Transformers

CSG introduced Slide 12 with the overview question: Do we need a pole-mounted category? Is it a necessary sub-category?

(29) **Comment (T&D Europe):** Option 2 is preferred; Option 1 has too many detailed specifications. T&D will send comments in writing re. changes sought for Option 2 contents: amongst them is a request for a delay for Stage 2 from 2018 to 2020 (there are important numbers of these devices in France, and more time is needed for adaptation).

(30) **Comment (Anthony Walsh, Irish Electricity Board/ Eurelectric):** Option 2 is to be favoured. There are mass issues re. Option 1 in Ireland. Notes that 1.2 million poles are present in Ireland, of which 10% have transformers on them.

Emphasises that Ireland will still very much need pole-mounted transformers after 2018.

(31) **Comment (T&D Europe):** Invites Ireland to participate in the relevant CENELEC TC 14 Working Group, re. masses of pole mounted transformers.

(32) **Comment (NL):** Also favours Option 2, on the grounds of being as technology-neutral as possible.

(33) **Comment (CLASP, Polish Copper Promotion Centre, University of Bergamo):** CLASP can accept either Option 1 or Option 2, but comments that Option 2 losses should be stricter, as the requirements date from 1993. CLASP favours the Stage 2 phase-out of the subcategory for pole-mounted transformers. Polish CPC also backs stricter measures, citing stricter industry proposals from 5 years previously. University of Bergamo: the values in the table are now out of scope in the EU since April 2012, apart from the worst classes .

(34) **Comment (Sweden):** favours combining Table 2 (Slide 11) with Table 3, Option 2 (Slide 12).

(35) **Comment (Hitachi, & Anthony Walsh, Ireland):** Both seek clarification re. single-phase and three-phase pole mounted transformers.

CSG – clarification: ALL the values in Tab le 3 (Slide 12) refer to **three-phase** transformers.

(36) **Comment (CLASP):** Notes that the US Dept of Energy opted for an "LLCC" approach, and did not make a separate pole-mounted category for transformers. This should be examined within the Impact Assessment study for ENTR Lot 2.

(37) **Comment (Anthony Walsh, Ireland):** Contends that the (current/ voltage?) load is not the same in Ireland as it is in the USA; there are different wind speeds in Ireland, and different loading on power/ cables.

CSG – Summary re. Pole-Mounted Transformers/ Distribution Transformers

(38) Ambition to be stepped up, as noted by stakeholders.

(39) For single-phase transformers, a separate table may be needed.

Table 2 and Table 3 to be integrated; phasing out of pole-mounted category to be examined during the IA.

Regarding Slides 13 & 14, and Slides 15-19 – Power Transformers

(40) **Comment (T&D Europe):** A Position Paper has been sent to the Commission re. a "TOC" approach (Total Cost of Ownership). In 3-4 months, T&D Europe hopes to compile a "map" of utilities' behaviour and the real market situation of power transformers.

T&D Europe notes that the price of (electricity) energy varies considerably throughout the EU, and may be more volatile in some MSs (citing a smaller amount of volatility in FR, compared to IT & DE). Nordic countries have a "TOC" approach which is more heavily-weighted towards energy costs.

Manufacturers are very willing to promote energy saving in the EU via stricter standards, especially if this also ensures that jobs and technology development are maintained in the EU.

(41) **Comment (UK):** Option 2 is better, regarding minimum efficiency, based on TCO. This should be agreed with CENELEC. Prefers TCO **plus** a minimum energy efficiency standard.

(42) **Comment (SWE):** Favours either Option 1 or 2. A solution that Sweden would support is to set a price per kWh lost. This is set politically, in Sweden. This could be an interim solution re. Ecodesign requirements.

(43) **Comment (Hitachi):** Supports minimum efficiency measures. This could also be extended to distribution transformers.

(44) **Comment (Polish CPC):** Favours Option 2. However, does not agree with combining/ discussing together power transformers and distribution transformers., as a consensus on using maximum losses for distribution transformers is very close.

(45) **Comment (University of Bergamo):** Medium-sized transformers are more homogeneous. Large transformers are more heterogeneous. Thus, owing to this lack of mass-scale homogeneity, an approach similar to the Energy Performance of Buildings Directive might be useful, i.e., assess each site on its own merits.

(46) **Comment (CLASP):** Supports Option 2. Re. the role of CENELEC, comments that CENELEC's role should be re. the equation and method for energy efficiency, but not the level of efficiency stipulated in the ecodesign regulation.

CLASP supports the setting up of a Technical Committee/ Working Group, because in its opinion, much of the information sought is actually available within organisations – it just needs to be discussed meaningfully by relevant practitioners.

(47) **Comment (Oekopol):** Supports Option 2, but timing must not be delayed. Rejects Option 3.

(48) **Comment (UK):** Recommends examining the CENELEC and IEC available equations. Also recommends extending the provisions for large transformers to those which are <36kV, where loading makes this suitable/ necessary.

(49) **Comment (Anthony Walsh, Irish Electricity Board/ Eurelectric):** Notes the absence of distribution/ transmission stakeholders during today's discussions, and comments that some design parameters of the electricity networks could have important ramifications for transmission stakeholders. Another point is whether, and to what amount, the effects of a higher proportion of renewables in the grid might have to be evaluated, re. when excess electricity is available.

Summary – CSG:

(50) Cites the US use of load and non-load losses combined in a single formula for energy efficiency, so it must be possible to do it.

(51) Option 2 – to try, for large power transformers. Aiming for Autumn 2012 solution availability.

(52) Expert Group – to be convened, with limited numbers, and expert participants.

Regarding Slides 20-22 – Product Information Requirements, Standardisation Needs, Verification Procedure (Annex IV)

(53) **Comment (Sweden, UK):** Mineral oils in transformers, plus other fluids and gases. Need to be addressed, re. fire precautions also, and care must be exercised not to make technology-specific requirements in Ecodesign measures. UK: Care also is

needed re. definitions on declared losses, as opposed to measured losses or design losses..

(54) **Comment (DE, AT):** Re. market surveillance, there might be more of an issue re. "putting into service", rather than "placing on the market".

Summary, CSG: Notes that Special Small Powered Transformers are out of scope for specific ecodesign requirements, but are *in* scope re. product information requirements. This will be clarified in the draft regulation.

Notes that the "caution mark" is addressed to market surveillance authorities, as this is a subcategory product with different provisions in the regulation.

Asks for clarification from stakeholders re. "plates" where losses are indicated, vis-à-vis measured losses, and associated liabilities.

(55) **Comment (T&D Europe):** "Declared value" should instead be termed "Guaranteed value".

(56) **Comment (NL):** Re. B2B deals, "guaranteed value" is the term to be preferred, generally. However, in ecodesign, the terminology would be "declared value", for one individual transformer, rather than (e.g., in B2B contracts) the average performance over a batch.

(57) **Comment (University of Bergamo):** The parameter rated power should be included as a measured parameter in the verification procedure in order to avoid false declarations. A value of 5% is considered reasonable as a tolerance for all parameters

Summary – CSG: The phrase "on the nameplate" will be added to the sentence, re. Slide 22 specifications. Rated power will be included as a parameter and tolerances of 5% will be specified.

(58) **Comment (Anthony Walsh, Ireland):** Retrofitting – should be looked at, re. existing size constraints in, e.g., the nacelle of a wind turbine, or an existing substation.

(59) **Comment (NL):** Strong disagreement with the position of A.Walsh. Such potential exemptions could create loopholes, which would render the whole Ecodesign process meaningless for transformers. Such exemptions re. retrofitting taking into account site-specific requirements etc, should *only* be allowed re. historic, listed buildings. See, for example, the recent Air-conditioning Ecodesign Regulation, which did this.

(60) **Comment (Polish CPC):** As the rate of refurbishment of transformers is low, especially where transformers are aged over 20 years, a refurbishment maximum of 10 years could be considered.

(61) **Comment (UK, ?or UK National Grid?):** Notes that the time period between specification and construction for bespoke transformers can be over 1 year. Therefore, UK requests a period of "stability" of 3-5 years, re. regulations in which specifications can be made, re. losses and production requirements.

Second point (**UK, and Polish CPC**): "rated power" for larger transformers – care re. definitions are needed. In the UK, there is a "base rating", and an "emergency rating". This could be important in other MSs. "Emergency rating" is important re. over-loading, in certain instances, as required.

(62) **Comment (Oekopol):** Public procurement – GPP should link up with Ecodesign requirements, to ensure a coherent approach.

Summary – CSG: (i) Asks for responses by 18 May (ii) Reminds stakeholders that he will contact stakeholders re. their interest for participating in the Technical Group. (iii) Next Ecodesign Consultation Forum will be held in Autumn 2012, which will hopefully be able to take into account the recommendations of the Technical Group (point ii) by that time.

17.00: Close of meeting.

I.2 Minutes of the Ecodesign Consultation Forum of 09 November 2012

(DRAFT) MINUTES OF MEETING

Subject: Ecodesign Consultation Forum on ENTR Lots 2 and 3
Place and date: Borschette building, meeting room CCAB 3C, Brussels, 9.11.2012
Chair: Kirsi Ekroth-Manssila

1. Welcome and approval of the agenda

THE CHAIR welcomed the participants and explained the structure of the discussion in the morning part of the meeting. The order of the discussion points is different to what was distributed in the draft agenda.

THE CHAIR explained that there was limited time for discussion in the morning and that the Commission was seeking for feedback from stakeholders particularly on two main points. The first was the increased level of ambition of the draft regulation for medium power transformers with respect to the April version. The reason for this is that the impact assessment study has been able to refine the calculation of the life cycle cost minimum points for representative models and has performed a sensitivity analysis on load factors and electricity prices.

The second point was what to do with large power transformers. In the meeting in April, there was general agreement that the favored option was to aim at setting minimum energy efficiency requirements. Thanks to the work of the technical experts in the Technical Subgroup, it will be shown that there seems to be an agreement on how to calculate the peak energy efficiency of large power transformers. The next logical step is where to set the minimum peak efficiency levels without being too arbitrary. For this, data is needed, which is being collected both by CENELEC TC 14 and T&D Europe. After hearing what the state-of-play of this exercise is later on this morning, we will need to discuss how to proceed with this part of the regulation, based on a slide with options.

There was no objection to the proposed order for the discussion

2. Presentation of the findings of the draft Impact Assessment (IA) study- Professor Anibal Almeida, University of Coimbra

Professor Anibal Almeida (AA) started his presentation with the problem definition and explained that the market penetration of high efficient transformers could be higher and that this market has been traditionally characterized by an emphasis on first cost and reduced concerns with operating costs. He explained that the total losses of transformers in the distribution network are about 38TWh/year in EU-27 and the power transformer losses are 55TWh/year.

He then explained the scope of transformers covered by the study and what the base cases represented. He then explained some assumptions about the price of electricity and the evolution of the price of silicon steel and amorphous steel. He then talked about the different policy options considered in the IA study: baseline (BAU), self-regulation, energy labeling only, MEPS on transformers, and energy labeling + ecodesign requirements.

He went into the detail of the proposed MEPS for 2014 and 2019 and showed a slide with the levels of losses corresponding to different scenarios: BAU, LLCC, BAT, MEPS 2014 and MEPS 2019. He then concluded what the expected energy savings would be (16 TWh/year in 2025) for MEPS adopted in 2014 and 2019. The associated reduction in greenhouse gas emissions would be of 3,8 MTons of CO2.
Finally, he explained the sensitivity analysis performed on two of the key parameters, the price of electricity and the load factor. The calculations are quite robust to variations in these two parameters. He then presented a slide on the special category of pole-mounted transformers and explained that it is technically possible to build such transformers at AoAk levels, although this would make them larger and heavier. He said that the reinforcement of poles and related costs does not seem to be economically justified against the extra electricity wasted during their lifecycle.
Bram Soenen (BELGIUM) asked about the assumptions in the IA study on the average stock and lifetime use, and queried whether these were the same as in the preparatory study. BE also asked whether provisions for dual voltage transformers (e.g., 230V, 400V) in the draft regulation were supported by the IA study.
AA replied that the assumptions were similar to those in the preparatory study. The **Commission** replied that the provisions for dual voltage transformers were taken from the EN standard under preparation and were not supported by the IA study.
Anthony Walsh (ESB Networks and Eurelectric) reacted to the presentation by saying that calculations were not mature enough and the risk of investment in more efficient (and therefore more expensive) transformers would not pay off. He estimated the extra cost to EU utilities for small Distribution Transformers alone caused by the regulation at 500 million € per annum. According to his calculations, there will be an increase of 47% in the cost of a distribution transformer. He explained that the price of electricity used in the IA study is not correct as it includes DUOS And TUOS costs, typically 35%, which are fixed and unaffected by the savings in kWh and that it is the marginal cost of electricity that should be used in the calculations. Furthermore, he said that the price of electricity and the discount rate in the study are quite different from those used by utilities when they capitalize the cost of electricity losses. He also said that utilities have strong incentives from local regulators to decrease losses and that the proposed regulation would enter into conflict with these incentives.
AAlmeida agreed to review how the price of electricity was calculated and that there could also be some marginal impact on incremental new build costs from peak increases due to losses. He emphasized that not all electricity goes to final residential consumers, but that a good part goes to industrial consumers, which are charged a different price.
Anthony Walsh replied that the correct cost would be similar to that used for Power Transformers (AA used 5c/kWh) plus the extra cost of losses (typically an extra 2% from HV to MV). There could also be an amount for peak but this would depend on marginal T&D costs.
Patrick Lauzevis (ERDF) reacted to the presentation questioning how faults in pole-mounted transformers would be dealt with in cities if the proposed regulation does not foresee concessions for this type of transformers beyond 2019. He also explained that more efficient transformers would also be larger and that this would pose problems to make them fit into existing substation buildings.

DE made a question about whether the figures on the improvement potential were cumulative (85 TWh) or yearly. **AA** replied that the yearly savings by 2025 were expected to be 16 TWh.
Michel Sacotte (T&D Europe, Schneider Electric) explained that, as a transformer manufacturer, he was not sure whether it would be feasible to manufacture transformers with levels of losses of Ao-20%Ak-20%. He also said that the improvement of amorphous steel over silicon steel is not in the region of 70%, but rather 40% or 50%. He said that silicon steel still has a margin of improvement to go. He said that in his opinion, feasible levels of losses for Tier 2 would be in the region of Ao-15%Ak, without resorting to amorphous steel. **Klaus Giefer (Hitachi Metals Europe GmbH)** replied that the source for the figures on amorphous steel in the IA study is the US DoE and he thought they were correct.
DE reported that the expected increase in the size of transformers may represent a problem as there are likely to be size constraints in existing installations. He asked whether the associated costs and feasibility issues had been taken into account in the IA study.
Yvan Tits (Laborelec) made a point about the (lack of) availability of ground in many Belgian cities (to replace pole-mounted transformers) and explained that sometimes it is not possible not to use pole-mounted transformers.
Paul Jarman (UK National Grid) said that he found the level of losses for Tier 2 rather ambitious at AkAo-20% and he questioned whether a TCO approach would yield the same result for a transformer specification.
AAlmeida replied to some of the comments on pole-mounted transformers by saying that there is a trend towards relocating transformers on the ground as the reliability is higher than in poles.
Anthony Walsh explained that the reliability of the customers supply is determined by the large length of Overhead line, not the Transformer. Transformers in urban areas which are developed are moved onto the ground, but most transformers are in rural areas servicing only a few customers and it would be uneconomic to move them to ground – it would required land purchase, a foundation, two site visits and and an equi-potential zone – much more expensive.
Michael Scholand (CLASP) commented on the issue of pole-mounted transformers and said that weight does not need to be a problem for all transformer sizes, only for some kVA ratings. He said that manufacturers have design options to make lighter transformers for pole mounting. Optionally, poles can be reinforced to take heavier transformers. In the US rulemaking on distribution transformers of 2007, no allowances were finally made for pole-mounted transformers. Finally, he offered an alternative solution in using smaller kVA ratings for pole-mounting, using two smaller ones on a pole instead..
Giuliano Monizza (T&D Europe, ABB) reminded the Forum that utilities must guarantee certain levels of service and, naturally, they try to do this at the cheapest cost. He said that the discussion on the product must be linked to the discussion on the system (electricity network) and that if 1/3 of distribution transformers seem to be pole-mounted, the regulation must cope with this fact.
Roman Targosz (International Copper Institute) commented that the market transformation the regulation is trying to achieve is difficult. He observed that other economies around the world have been able to make the market transformation towards highly efficient transformers and the EU should not be an exception. He said that, that there are examples of countries (China and Australia) with a lot of rural areas around the world like

France with probably even more radial networks than in France. These countries regulated transformer efficiency but have not separated pole mounted transformers subcategory from distribution transformers category.
He also said that reliability and need for service restoration is not contradicting use of reasonably efficient transformers as reliability can be improved by more redundant schemes replacing simple radial supply.
He said that the impact from large power transformer is underestimated by investigations from Vito which was also repeated in presentation from Mr. Almeida. The underestimation comes from too low loading assumptions. Leonardo ENERGY estimates are that saving potential from large power transformers is about a half of this represented by distribution transformers. He explained that as a very rough check the operational efficiency of distribution transformers can be improved by about 0,8% while that of large power transformers by about 0,1 to 0,15% and that approximately 3-4 times more electricity passes through large power transformers (step up, transmission, primary distribution) than distribution transformers.
He also said the discount rate used in the IA study and in TCO calculations should not be the average cost of capital, but the Consumer Price Index (around 2,5% at the moment). Finally, he said that building transformers with losses levels of Ak-20%Ao-20% represents BNAT and should be feasible for Tier 2 in 2019.
Giuliano Monizza (T&D Europe, ABB) replied that one thing is the feasibility of building a product in a laboratory and something else is making it commercially with all the contractual implications this has.
Victoria Cox (AEA Technology) spoke on behalf of the consortium preparing the IA study and explained that, as contractors to the Commission, they had no choice but to use the social discount rate in the NPV calculations in the study, which is currently fixed by the Commission at 4%. She highlighted that strict adherence to the Commission’s Impact Assessment Guidance is essential for their study, and it will be peer reviewed by the Impact Assessment Board. She explained that the 4% rate represents the Social Rate of Time Preference and is composed of the pure rate of time preference and some factor for income growth over time. She also explained that it is possible that a declining discount rate can be used for sensitivity analysis for impacts extending beyond a 30 year period.

Anthony Walsh (ESB Networks and Eurelectric) commented that

(a) That it was incorrect in this instance to use a Social Discount Rate and that this issue had been covered in Australia in an economic analysis cited in the Eurelectric response. If applied it would mean that utility investments in loss reductions with yields of say 7% would be left undone and the money invested instead in transformers, which only gave a yield of 4%
(b) That if 4% were to be used it had to be used in the context allowed in the EU Guide to Cost Benefit Analysis, and this meant adjusting all the cash flows for risk using probability distributions, shadow prices etc, which is required when using what is essentially a risk free rate. He said that in such a large investments of more than €500m pa it was important to get things right.

Victoria Cox reiterated that the 4% rate was fixed by the Guidance, but asked that if Anthony (or anyone else) had any more data and evidence on costs (or benefits) to include within the IA analysis then this would be gratefully received.
Anthony Walsh: In regard to the discussion on the cost of taking down pole-mounted transformers and installation costs in substations due to extra size and weight, this discussion was only arising because such costs had not been taken into account in the calculations in the IA study.
Regis Lemaitre (ThyssenKrupp) commented on the impact of the proposed regulation on the Grain Oriented Steel market in the EU and asked the Commission to include in the IA study a forecast of the evolution of demand for this type of material, for the sake of transparency and free competition amongst suppliers.
Michel Sacotte (T&D Europe, Schneider Electric) reacted by saying that according to his information, the supply of magnetic steel necessary to meet the requirements of the regulation in Tier 1 should be guaranteed and that for Tier 2 he had conflicting information from his suppliers as to whether the supply of the right type of silicon steel would be guaranteed.

3. Explanation of the main changes made to the draft Ecodesign Regulation – Cesar Santos
The European Commission (Cesar Santos) went through the main changes that have been introduced in the regulation since the version circulated for the meeting in April**. A number of** recitals have been included in the draft, including one with guidance on the TCO approach for buyers of transformers, as this was thought to be useful. He explained what the current exceptions to the scope of the regulation are and asked stakeholders for help to complete the list if necessary.
He then explained that the definitions in the draft regulation had been fine-tuned and made more coherent. He commented on how the maximum levels of losses for medium power transformers allowed in the draft regulation had been reduced based on the findings of the IA study (both for dry type and liquid-immersed). He explained what concessions are being made for pole-mounted transformers in Tier 1 and that these concessions are supposed to disappear in Tier 2.
For large power transformers, he referred to the presentation to be made by Angelo Baggini after him, and he asked whether the agreement reached at the Technical Subgroup on how to measure their minimum peak efficiency was still valid. Based on this, the discussion on where to set minimum peak efficiency requirements would be more or less meaningful.
He went through the proposed product information requirements in the draft regulation and asked for validation of the benchmark levels proposed by the Commission.
Finally, he sketched out some options to move forward with the regulation, depending on the outcome of the discussion on large power transformers. Basically, a decision needs to be taken as to whether it is appropriate at this stage to detach the part of the regulation on large power transformers and to continue with a regulation for small and medium power transformers only.
Bram Soenen (Belgium) asked what the interpolation and extrapolation methods should be in the regulation for transformers' ratings not present in the different tables. He said that the requirements for Tier 2 should be feasible with Grain Oriented Silicon Steel. He pointed out that a definition of load factor is given in the regulation, but this does not seem to be used

anywhere in the rest of the document. He clarified that Belgium had not asked officially for regulatory concessions for pole-mounted transformers. He said that he would be sending a number of more detailed comments in writing.

The Commission (Cesar Santos) replied that, indeed, it had only been France who had officially requested such concessions for pole-mounted transformers, but that a Belgian utility (Eandis) has expressed in the meeting similar concerns to those from French utility ERDF. The Commission explained that interpolation and extrapolation methods in the regulation should be consistent with those in the relevant standard and that they would check about the load factor.

Anthony Walsh (ESB Networks and Eurelectric) asked why the Commission had chosen to change the regulation based on the findings of the IA study as opposed to the preparatory study. Furthermore, he said that if the regulation comes into force as it currently stands, it will amount to a cross-subsidy from those countries where the price of electricity is cheaper to those where it is more expensive. EU should be providing a subsidy if this is the case. He also asked who would be independently assessing the validity of the new proposals in the IA study and challenged the choice of 4% for the discount rate.

The Commission (Cesar Santos) replied that it had indeed chosen to amend the draft regulation based on the findings of the IA study, as it seems that the LLCC calculations are more accurate than in the preparatory study. He explained that DG Enterprise and its contractors have to take the 4% discount rate as a given and cannot depart from this Commission policy.

Michel Sacotte (T&D Europe, Schneider Electric) intervened to say that he found a level of losses of A0-15% more reasonable for Tier 2, and that in any case 2018 was too short for Tier 2 as manufacturers need time to invest in readjusting production facilities and train people. He asked for further concession for 160 kVA pole-mounted transformers (Co instead of Ao) and to change the level of load losses to Ck for transformers up to 630 kVA in Tier 1 and the no load losses to A0-15% for all ratings in Tier 2. He also said that some coefficients for dual voltage windings still need to be adjusted.

Flavio Mauri (ENEL, Italy) said that he some concerns about the regulation and that he will be sending comments, particularly related to Tier 2.

Stamatis Sivitos (ECOS) commended the Commission for having shared the IA study, as this is the first time this happens, and, in his opinion, this should become standard practice. He supported the bold ambition of the Commission’s document and said that the EU should not lag behind the US and Japan in the level of stringency for the energy efficiency of transformers. He supported the phasing out of concessions for pole-mounted transformers in Tier 2 and asked the Commission to stick to the calendar in the draft regulation for Tiers 1 and 2.

Michael Scholand (CLASP) commented that including the short-circuit impedance in the tables in the draft regulation was not necessary. He said that the exceptions for unusual combinations of windings in Tables 1.4 and 1.7 should not be the same for dry-type and liquid-immersed and that no correction factors should be necessary at all for liquid-immersed. He questioned the evidence to support the concessions for transformers equipped with tapping as specified in section b.3.1 of the draft regulation.

DE asked about small transformers and queried why the regulation was based on maximum levels of losses and not on efficiency and whether the scope was small transformers used in the electricity distribution networks, as there was some confusion in DE about this. **The Commission** replied that, indeed, the regulation was supposed to cover small transformers used in the distribution networks and that the regulation is based on maximum levels of losses, following the recommendation of the preparatory study, but that this would be verified.

Anthony Walsh (ESB Networks and Eurelectric) commented that the small transformers listed are isolations transformers which are typically used for building sites and have quite low load factors and wondered whether it is really worth regulating the copper losses as there is little load coincidence.

4. Presentation of the work done in the Technical Subgroup on Large Power Transformers – Angelo Baggini CENELEC TC 14

Angelo Baggini explained that the Technical Subgroup of the Ecodesign Consultation Forum on large power transformers and the Working Group 29 of CENELEC TC 14 had been working to find a way to characterize the energy efficiency of these transformers and thus to facilitate the task of specifying minimum requirements.

He said tha,t first of all, it is possible to specify a minimum peak efficiency (EPE) which takes into account the wide range of utilization factors, but not voltage and impedance. He said that it is not suitable to specify losses values because of the different ranges of voltages, impedances and utilization factors.

$$EPE = 1 - \frac{2(P_0 + P_{C0})}{S_R \sqrt{\frac{P_0 + P_{C0}}{P_K}}}$$

The proposed energy peak efficiency formula takes into account the no load losses, the electrical power required by the cooling system for load operation, the load losses corrected to reference temperature and the rated power of the transformer on which the load losses are based.

Furthermore, he explained that data on some 6580 transformers units had been collected in ten European countries through the CENELEC National Committees. Based on this empirical data distribution, he presented some fit-curves to guide the discussion on possible minimum requirements and drew the following conclusions:

- Setting a reasonable value of minimum EPE will be effective in improving the overall efficiency of the installed transformer population by eliminating transformers with poor efficiency purchased without using loss capitalization. The application of a high value of minimum peak efficiency would be uneconomic for a proportion of transformer.
- For transformers with unusual configurations, very severe size or weight limitations it may be impossible to meet the minimum efficiency requirement either technically or economically.
- In terms of number of units the bulk of power transformers with Um > 36 kV can be considered has having a rated power between 5 and 100 MVA.
- For large units above 100 MVA the economically achievable efficiency of a transformer is related to the technical parameters of the network, (impedance) and specific transport and installation constraints. Units above 100 MVA tend to be already state of the art as far as efficiency is concerned.

The proposal for a minimum energy peak efficiency consisted in two fitting curves, one log portion below 100 MVA and a linear continuation above this rating value. The impact of this proposal would be that, with the available data, 86% of installed transformers would comply in stage 1 and 80% would comply in stage 2. The associated energy savings would be of 3,68 TWh in Tier 1 and 4,5 TWh (not cumulative) in Tier 2. He proposed that further updating should not take place before 4 to 5 years.
Roman Targosz commented that the standardization of efficiency of large power transformers is not easy to understand. However the concept developed by Cenelec TC 14 to simplify all difficulties i.e. variety of design and applications, voltage and SC impedance levels, loading - has been very successful and brought the most significant turn in way of thinking about possible regulation. Thousand of records of data received by Cenelec after their European survey led, after a very well done analysis, to formulation of bold proposal which will be wasted if the conclusion is diluted or postponed.

Giuliano Monizza (T&D Europe) took the floor to react to the presentation by Angelo Baggini. As expressed in their position paper, T&D Europe considers the work done by the Technical Subgroup and CENELEC TC 14 a good basis for the discussion, but thinks it is not mature to regulate a market which has not been regulated before and where the typical lifetime of products is 40 years. It is probably not enough to fix one value of energy peak efficiency to specify a transformer design.
T&D Europe questioned that, although there are some interdependencies between EPE, loss evaluations, BIL, impedances, in regulating a rather complex group in the range of 5 -100 MVA, it might not be possible to set a minimum value that can be cost benefit analyzed at an impact assessment. It is not known how a manufacturer will design with the Po and Pk losses to match a minimum EPE value if a loss capitalization is not used. Loss capitalization must always be used to optimize LPTs.
T& D Europe believes that setting minimum energy efficiency requirements at this stage would lead to unrealistic choice of the transformers as well as uncertain investment by utilities, without reaching the desired EU energy efficiency targets. The industry association proposes to continue the work of the Technical Subgroup led by the Commission and with the involvement of a small group of technical and financial experts from the key stakeholders. The work of the Subgroup should yield results before one year.

5. Summary of the discussions and next steps

The Commission summarized the morning discussions by saying that there seems to be wide agreement about the way forward for medium power transformers, at least in the approach (maximum levels of losses), if not in the level of ambition.
For large power transformers, the situation probably requires more time. The implication of this may be that the regulation for medium power transformers may need to go ahead alone, while a separate regulation for large power transformers might need to be prepared when discussion is mature.
The Chair asked for written comments before 7 December to the e-mail address: ENTR-ecodesign@ec.europa.eu and thanked the participants for their contributions during the meeting.

I.3 Results of the public consultation via online survey (05.10.12 to 02.11.12)

Note: The public consultation exercise was based on a draft of the regulation with a level of ambition substantially higher then the one that is finally being proposed. This may help understand the reaction of manufacturers and users (utilities). The proposed regulation in no way requires manufacturers to resort to amorphous steel to meet the mandatory efficiency requirements.

A public stakeholder-consultation exercise, inviting the views of stakeholders on the Transformers went live on 5 October 2012 and lasted for four weeks. The survey included an assessment of policy options. A Consultation Forum also took place at the European Commission on 9 November 2012.

A majority of respondents were manufacturers of transformers and industry associations. A large number of manufacturers were apprehensive of loss regulation in transformers, citing the effect it would have on price. Furthermore, manufacturers were of the opinion that if the assumption that cost-effectiveness of efficient transformers sufficiently balances the higher initial investment, further regulation need not be necessary to incentivize their uptake.

With regard to the policy options under consideration, a majority agreed with the framework suggested in the Consultation Forum. However, a large majority of respondents disagreed with the stipulated loss levels mentioned stating that the levels were too stringent and would result in an impractical spike in costs.

A common thread among comments seemed to be concerned that the rise in costs would be too high to be counter-balanced by the savings that would be facilitated. Additionally, this would adversely affect the competitiveness of SMEs in the market, especially with limited availability of high-grade core material.

Besides economic considerations, several respondents felt that the auxiliary impacts in terms of noise increases, oil leakage and recyclability considerations of amorphous coil transformers had not been sufficiently addressed especially for areas with strict targets to be met.

Table 1. Consultation events and numbers of participants / respondents

Consultation event	No. of manufacturer and industry participants / respondents	No. of government, NGO or other participants / respondents	Topics and Aims
Consultation Forum - 19 April 2012, Brussels	3 reps from manufacturers, 4 from utilities	3 reps from environmental NGOs, 15 from national goverments	Discussion on draft working document covering small, medium and large power transformers
Consultation Forum - 9 November 2012, Brussels	3 reps from manufacturers, 4 from utilities	1 rep from environmental NGOs, 10 from national goverments, 2 from other stakeholders	Discussion on draft working document covering small, medium and large power transformers
Meeting with UK electricity operators – 11 April 2012, London	5 UK electricity operators		Dicusssion on various aspects of the drafat working document, including the level of ambition and the timing for the different tiers
Meeting with manufacturers of large power transformers on 2 March 2012, Paris	3 manufacturers		Discussion on how to measure energy performance and efficiency of medium and large power transformers
Meetings of the Consultation Forum Subgroup on large power transformers – 29 June 2012, 28 September 2012 and 12 April 2013	5 reps from manufacturers, 5 from utilities	1 rep from national governments, 3 from environmental NGOs	Discussion on how to measure energy efficiency for large power transformers and how to characterize possible minimum requirements
Public consultation via online survey, 05 October to 02 November 2012	74 responses from 20 different countries (manufacturers, parts suppliers, environmental NGOs, national authorities)		The consultation was based on a questionnaire detailing the main aspects of the proposed regulation, and inquiring about its impact on the market and SMEs active in it.

Annex II: Scope of the regulation

This Regulation establishes ecodesign requirements for the putting into service of transformers with a minimum power rating of 1 kVA used in 50Hz electricity transmission and distribution networks or for industrial applications.

This Regulation shall not apply to the following categories of transformers:

- Instrument transformers
- Transformers with high current rectifiers
- Transformers for furnace applications
- Transformers for offshore applications and floating offshore applications
- Transformers for emergency mobile installations
- Transformers and auto-transformers for 16.7 Hz railway feeding systems
- Auto-transformers for 50 Hz railway feeding system
- Earthing transformers
- Traction transformers on rolling stock
- Starting transformers
- Testing transformers
- Welding transformers
- Explosion-proof and underground mining transformers
- Transformers for deep water (submerged) applications

Definitions

Transformers are considered as energy related products within the meaning of Article 2 (1) of Directive 2009/125/EC.

For the purpose of this Regulation and its annexes, the definitions set out in Directive 2009/125/EC shall apply. The following definitions shall also apply.

(1) "Power transformer" means 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 alternating voltage and current usually of different values and at the same frequency for the purpose of transmitting electrical power.

(2) "General purpose small power transformer" means a power transformer with a highest voltage for equipment not exceeding 1 kV.

(3) "Medium power transformer" means a power transformer with a high voltage for equipment higher than 1 kV, but not exceeding 36 kV and a rated power equal or higher than 5 kVA.

(4) "Large power transformer" means a power transformer with a high voltage for equipment exceeding 36 kV and a rated power equal or higher than 5 kVA.

(5) "Liquid-immersed transformer" means a power transformer in which the magnetic circuit and windings are immersed in liquid.

(6) "Dry-type transformer" means a power transformer in which the magnetic circuit and windings are not immersed in an insulating liquid.

(7) "Pole mounted transformer" means a power transformer connected by open bushings suitable for outdoor service and designed to be mounted on the support structures of overhead power lines.

Annex III: Estimation of electricity prices for the modelling

For distribution transformers used in industry and buildings (BC2, BC3 and BC7), it is proposed to use the projected Eurostat average price of 0.13 €/kWh (Figure 39) for the industry sector for EU-27, estimated for 2019.

In the case of DER transformers (BC5 and BC6), it makes sense to use the average feed-in-tariff, which has been decreasing in the last 10 years. The value of 0.15 €/kWh will be used in this case. In the case of power transformers (BC4) the value 0.05 €/kWh will be used as suggested by T&D Europe (T&D Europe position on Power Transformers, April 2012).

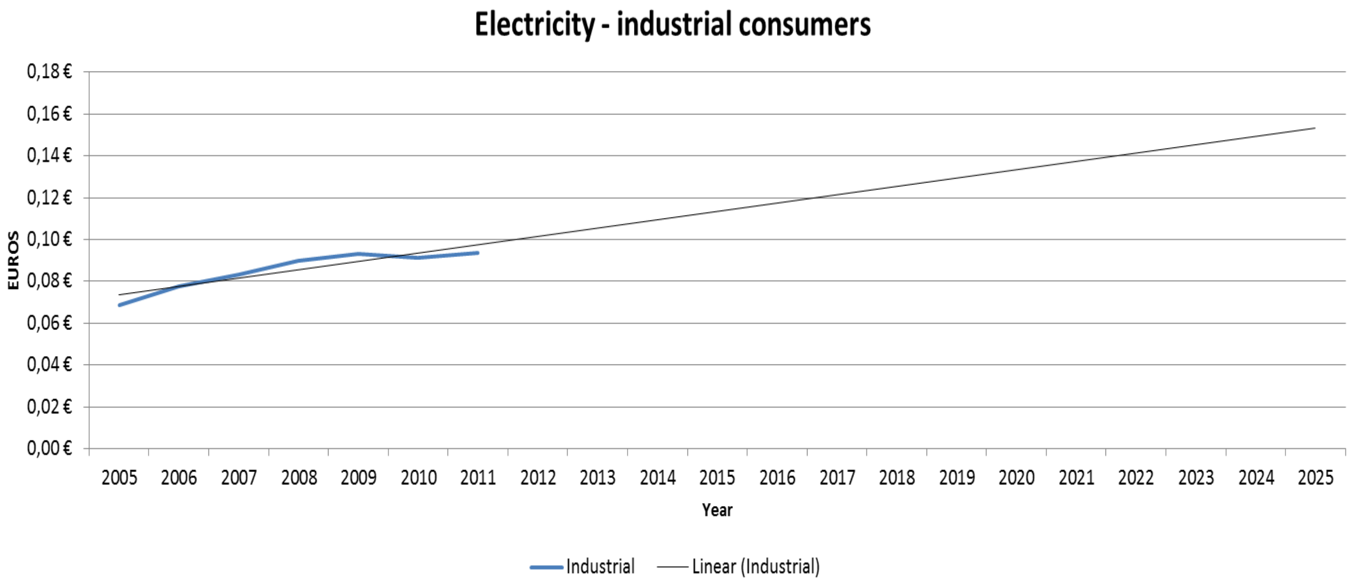


Figure 2 - Evolution of electricity price (€/kWh) in European Union (27 countries) in industry – (based on EUROSTAT data).

For the distribution transformers used by distribution utilities (BC1), the average price of the electricity in the distribution network, can be calculated as follows:

-Use of weighted average consumer electricity price taking into account the sector consumption (industry, services and residential sectors).

In the above mentioned conditions, the projected value for the average electricity price for 2019 is 0,146€/kWh, as explained in the following page.

-Applying a discount to deduct the typical DSO charges - a 40% deduction is used.

Therefore, 0,0876€/kWh is the base value used in the LLCC calculations for distribution transformers.

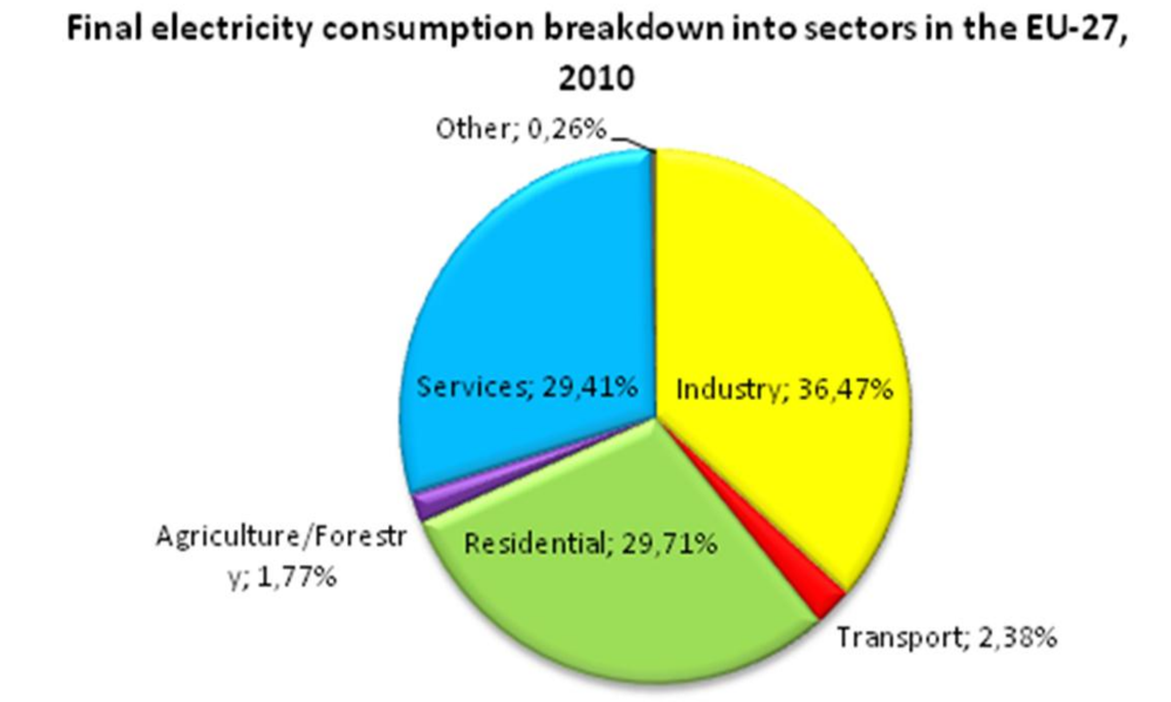


Figure 3-Final electricity consumption breakdown into different sectors in the EU-27, in 2010.

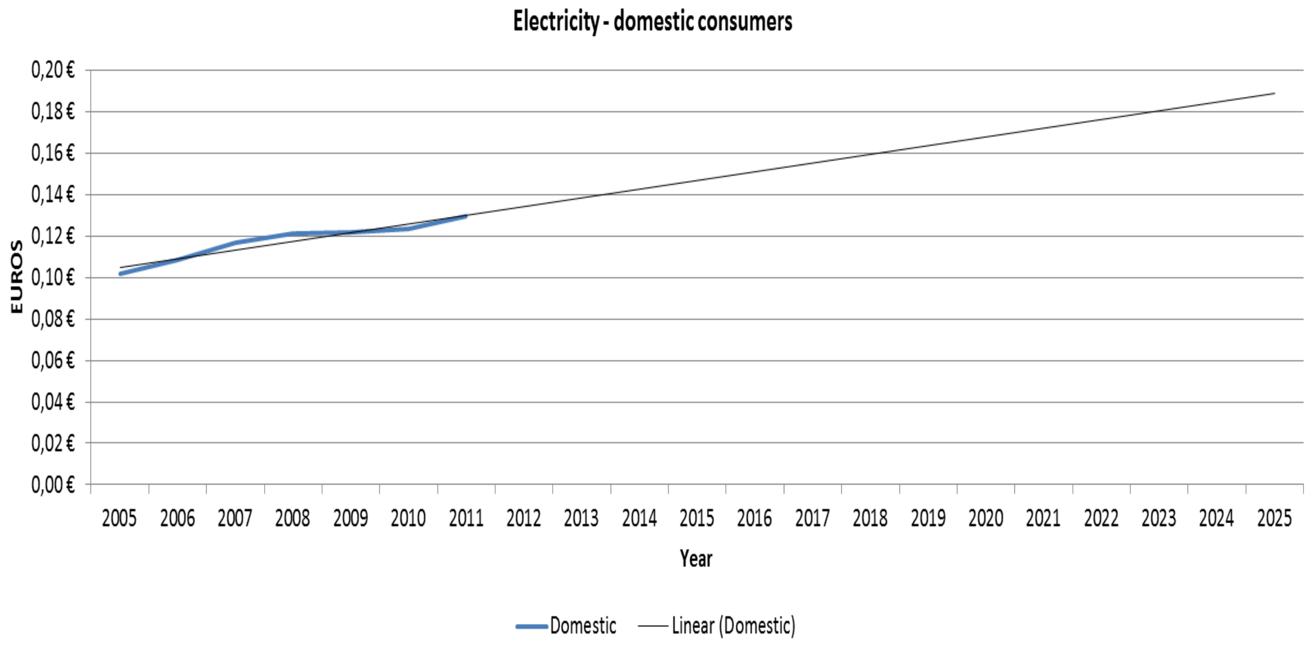


Figure 4-Evolution of electricity price (€/kWh) in European Union (27 countries) in domestic/residential sector – (based on EUROSTAT data).

For the services sector there is no available data from Eurostat about the evolution of electricity prices in the last years. However, is known that these prices are close to the average of the electricity prices of industry and domestic sectors, as shown in Figure 42.

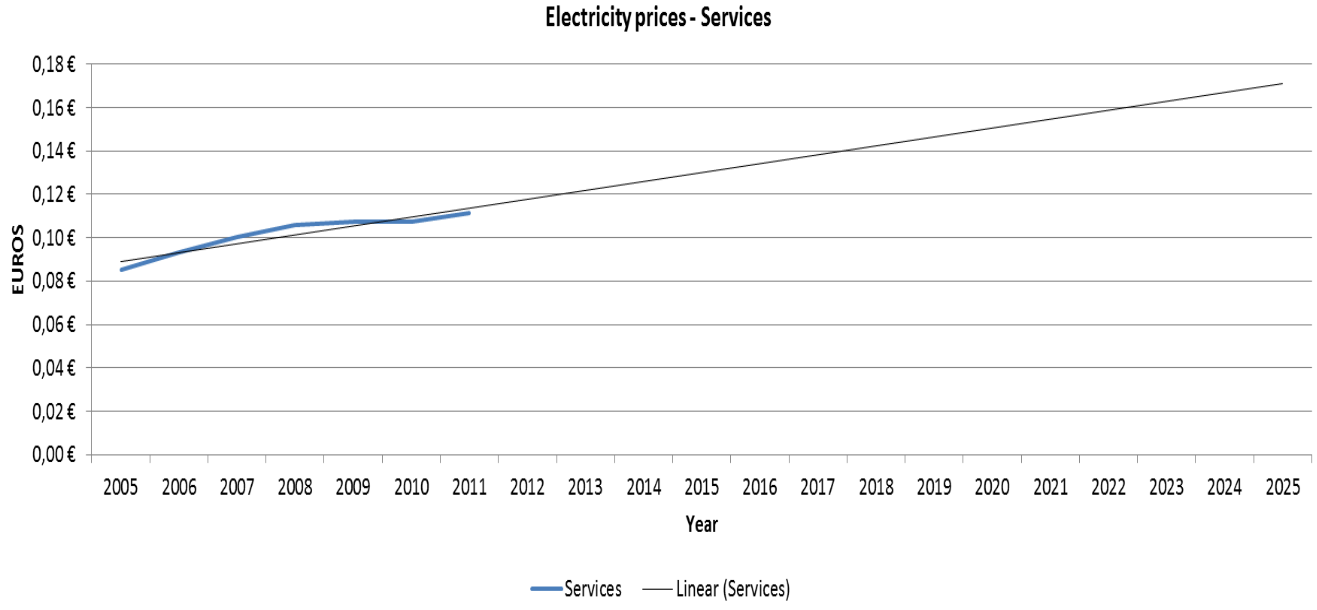


Figure 5-Evolution of electricity price (€/kWh) in European Union (27 countries) in services.

Taking into account the final electricity consumption breakdown in the EU-27 (Figure 40) and the electricity prices (industry and domestic) of last six years based on Eurostat data, it is possible to extrapolate a weighted electricity average price for the next few years.

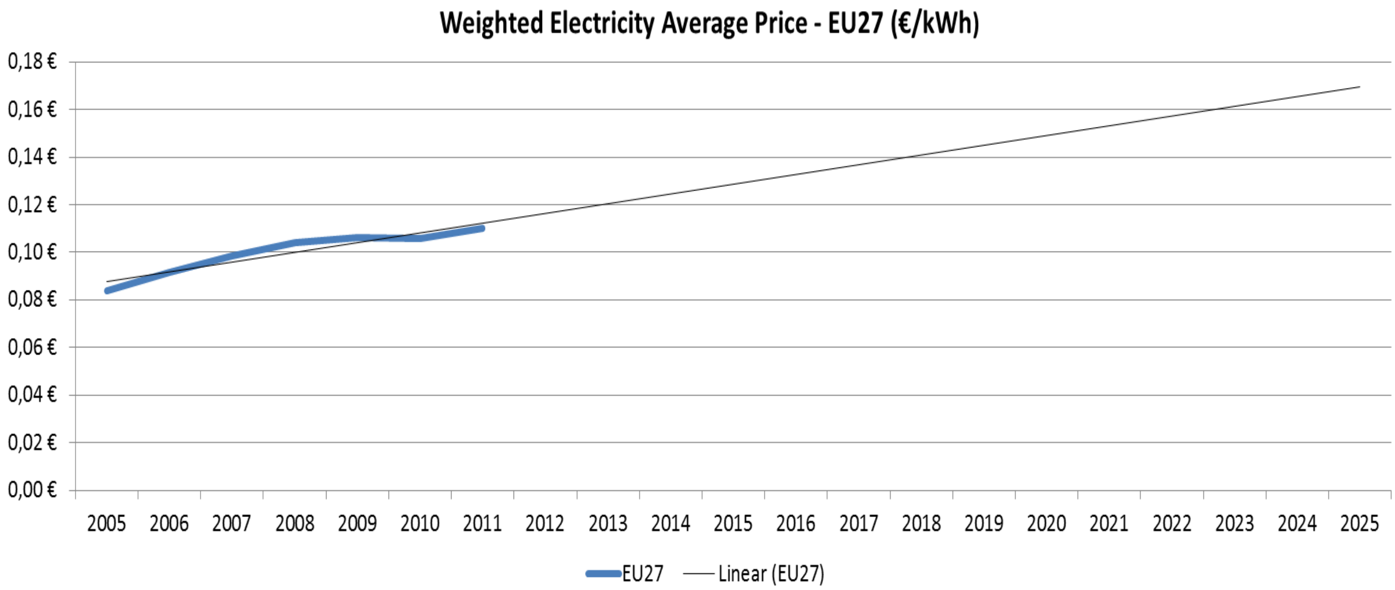


Figure 6- Evolution of Weighted Electricity Average price (€/kWh) in the distribution networks in the EU27

Annex IV Methodology used to calculate the lifecycle cost (LLC)

The methodology followed was based on a wide range of core and coil losses for each transformer analysed, including from the highest allowable level (usually Co and Ck) to a point beyond the most efficient levels (i.e., called Ao and Ak). The combinations of core and coil losses combine to create several combinations of Po and Pk. For each combination, the kWh/year consumed is calculated, along with the Life Cycle Cost (LCC) of those losses. Then, the cost of the transformer is calculated for each design based on the equation associated with a curve-fit of the Preparatory Study designs. Finally, with first cost and operating cost known, the respective LCC is calculated for the entire matrix of designs.

The following text discusses the steps involved in more detail.

Establish the Range of Losses: each of the base case transformers analysed has a range of losses that are given in the Preparatory Study. The spreadsheet starts with the least efficient design, which constitutes the baseline unit for analysis, and then extends out to lower maximum loss levels until the A0 and Ak levels are surpassed. Going beyond the A0, Ak level (A0-20% and Ak-20%) is important because it offers some insight into the economics of models slightly above the highest conventional levels considered in the Preparatory Study.

Calculate kWh/year consumption: given the known losses for the transformer (P0, Pk), it is known that the P0 losses will be occurring 8.760 hours per year, thus those can be deducted from the kWh/year total consumption reported in the Preparatory Study. The remaining kWh/year is then divided by Pk, and a constant is derived, which is a function of the transformer loading determined by VITO for the Preparatory Study.

Calculate purchase price of the transformer: each of the Preparatory Study designs is plotted on a graph showing purchase price over kWh/year of energy consumption. This metric is used for the X-axis because it takes into account both P0 and Pk, as well as the embedded assumptions about average loading. A curve is fit to those data, using either a 2nd or 3rd order polynomial or exponential equation, which is a function of the kWh/year losses. The equation is then multiplied by the different kWh/year calculated for each P0, Pk combination to estimate a price for each of the designs.

Calculate LCC of operating costs: the LCC of operating the transformer can be calculated by multiplying the different kWh/year calculated for each P0, Pk combination with the energy prices and adding to this result the purchase price of transformer.

Calculate the LCC relative to the baseline model and provide colour coding: the LCC is then derived by summing together the purchase price and the operating LCC, resulting in a total LCC for the transformer.

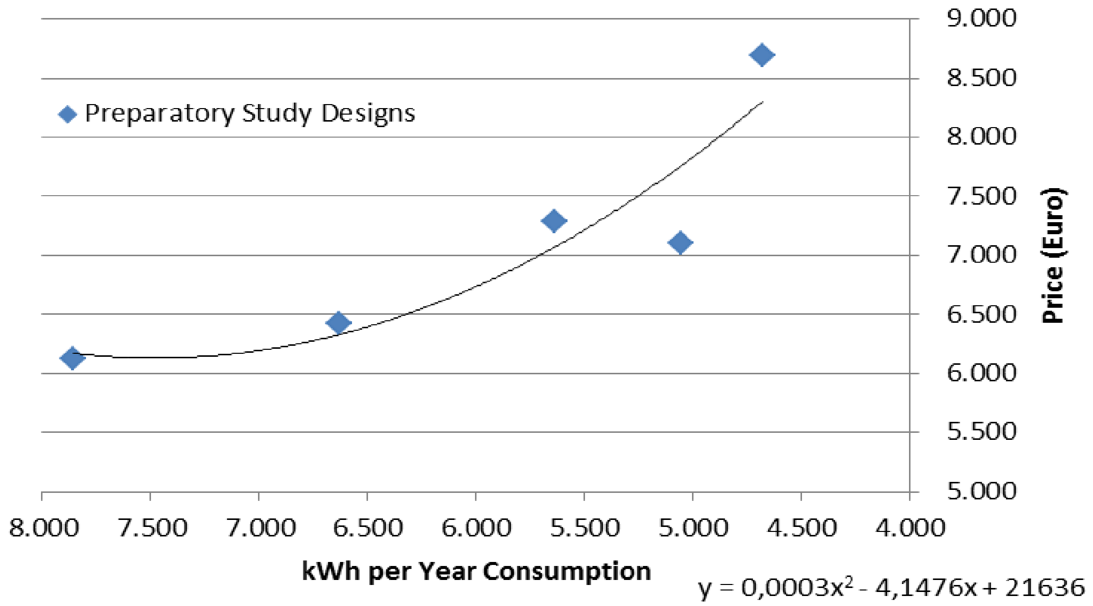
In order to perform these calculations for the base case models, there are certain key data points taken from the Preparatory Study that drive the whole simplified LCC model. The following key data points are given in Chapter 6 of the Preparatory Study for each base case unit and each of the more efficient designs prepared at that same kVA rating:

- Maximum watts of core loss (P0);

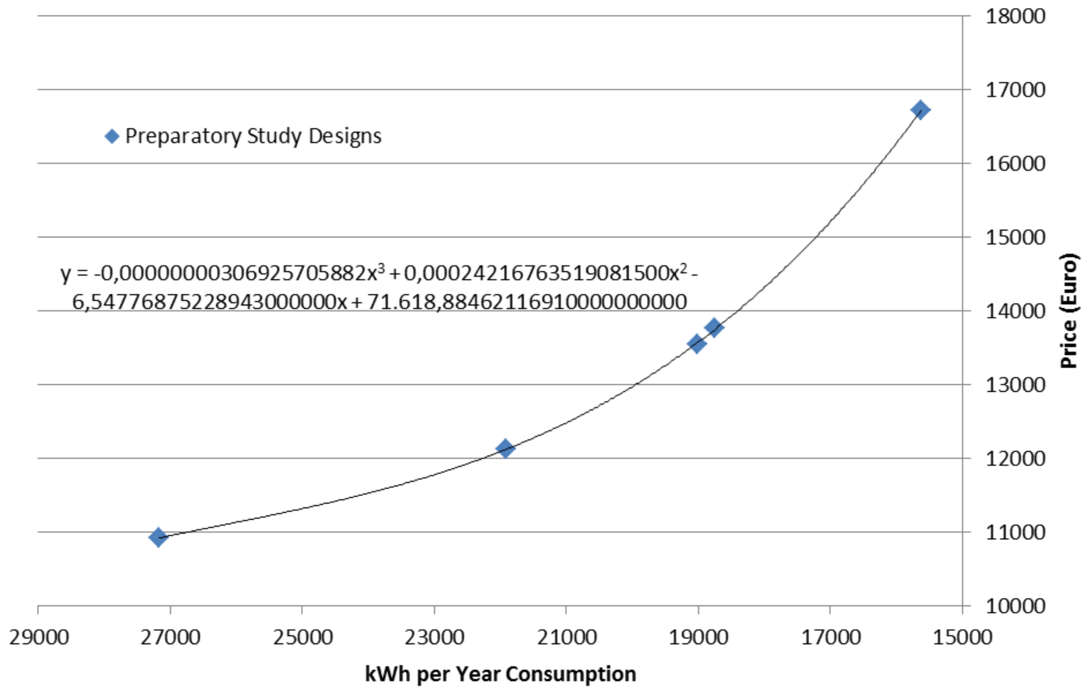
- Maximum watts of coil loss (Pk);
- Annual energy consumption from the transformer (kWh/year);
- Price of the transformer (Euro);
- Total electricity cost (Euro/year);
- LCC for the lifetime of the transformer.

Polynomial fit-curve overlays used to estimate the purchase price of each transformer design.

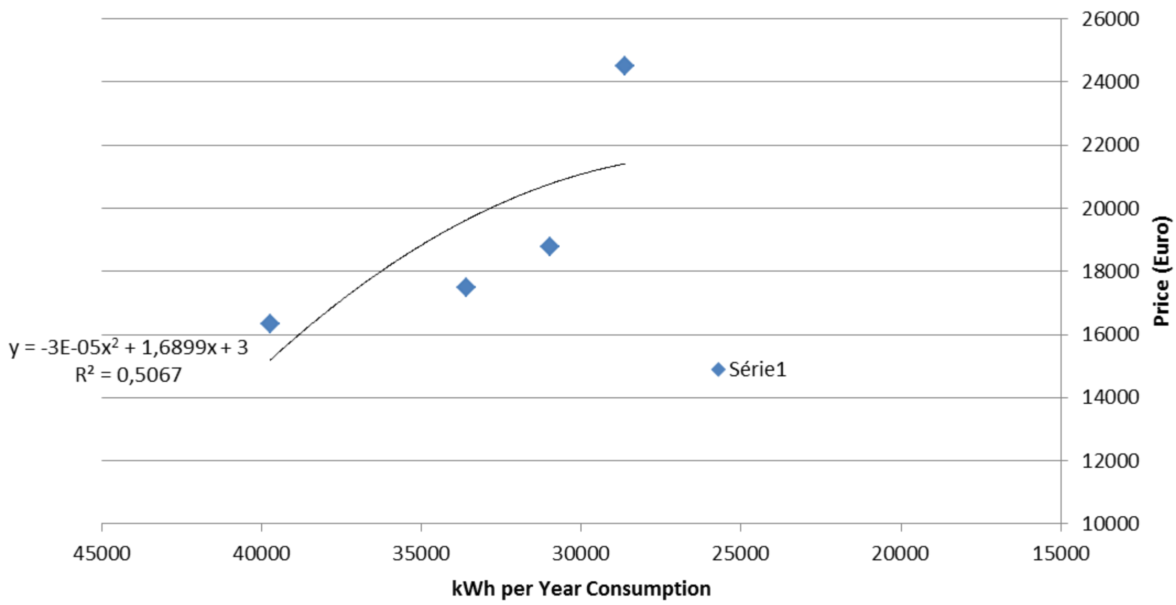
-BC1



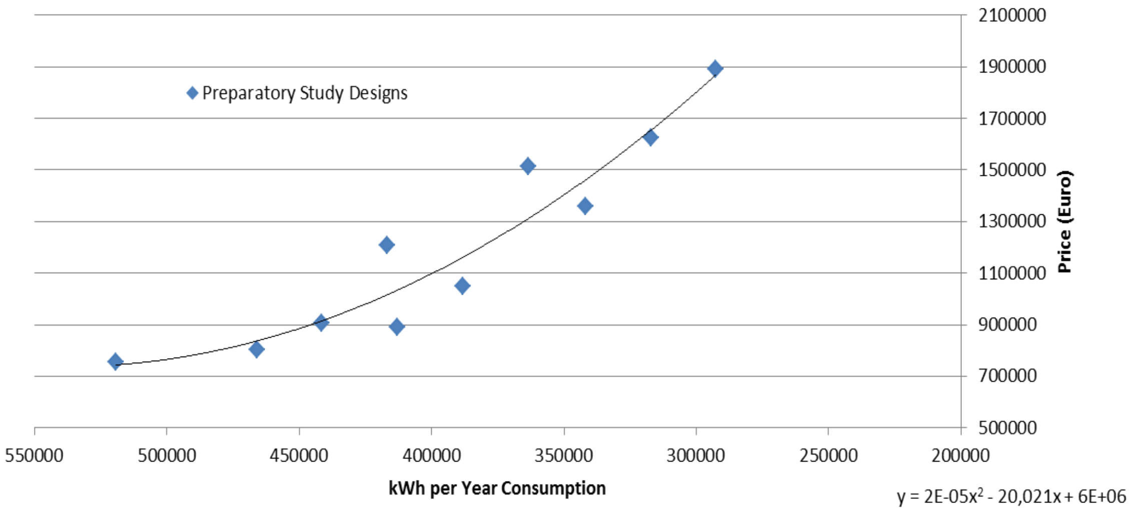
-BC2


Preparatory Study Designs
y = -0,00000000306925705882x³ + 0,00024216763519081500x² -
6,54776875228943000000x + 71.618,88462116910000000000
18000
17000
16000
15000
14000
13000
12000
11000
10000
Price (Euro)
29000
27000
25000
23000
21000
19000
17000
15000
kWh per Year Consumption

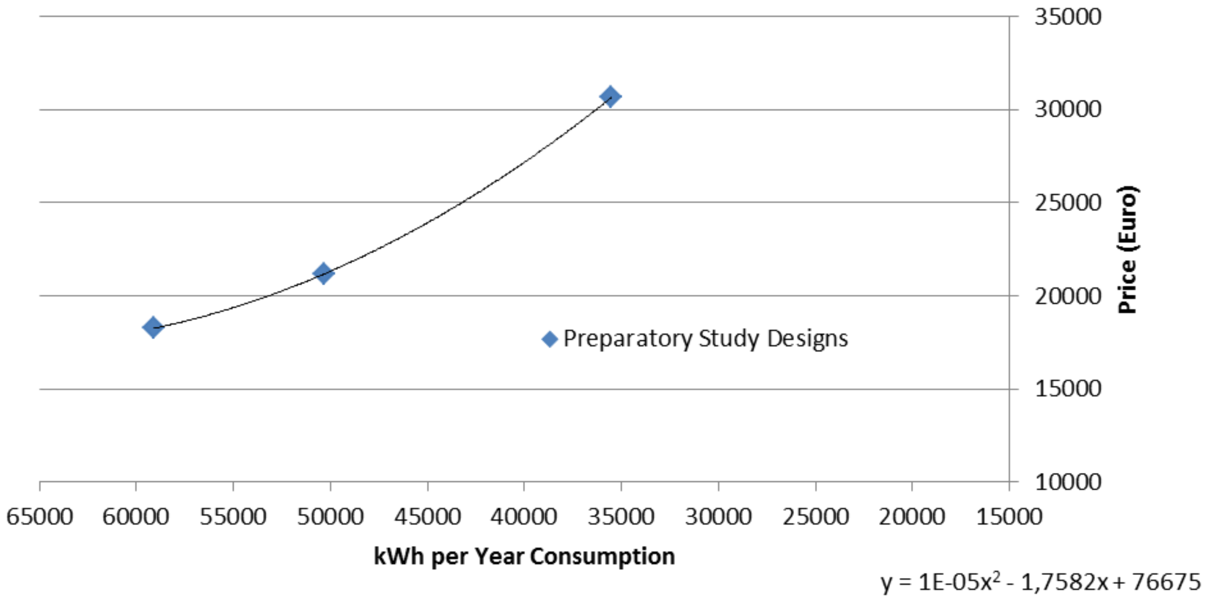
-BC3


26000
24000
22000
20000
18000
16000
14000
12000
10000
Price (Euro)
y = -3E-05x² + 1,6899x + 3
R² = 0,5067
Série1
45000
40000
35000
30000
25000
20000
15000
kWh per Year Consumption

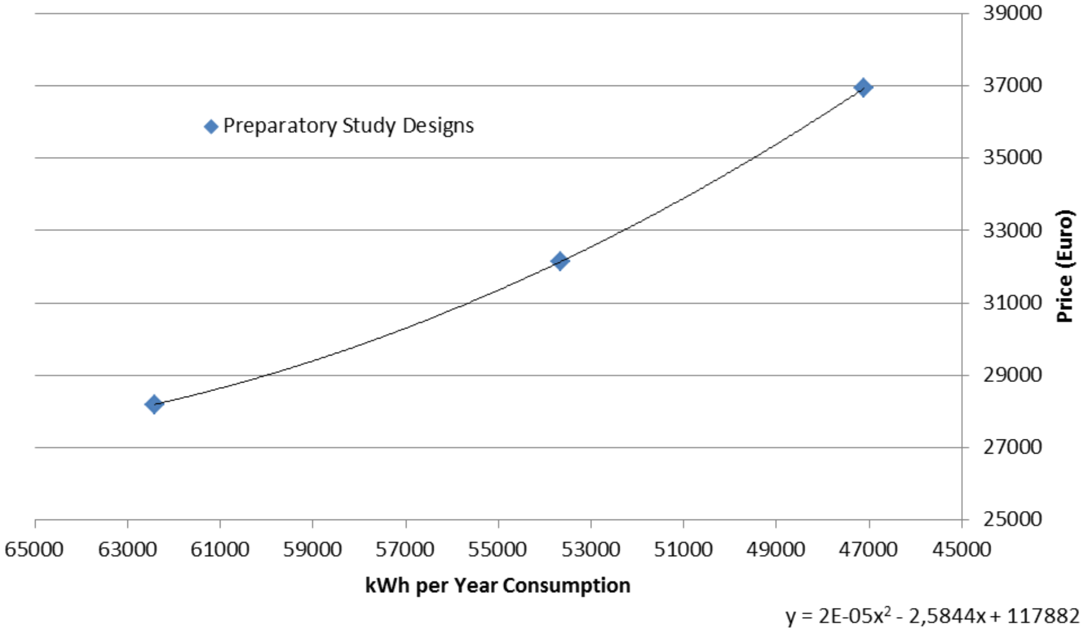
-BC4


Preparatory Study Designs
2100000
1900000
1700000
1500000
1300000
1100000
900000
700000
500000
Price (Euro)
550000
500000
450000
400000
350000
300000
250000
200000
kWh per Year Consumption
y = 2E-05x2 - 20,021x + 6E+06

-BC5

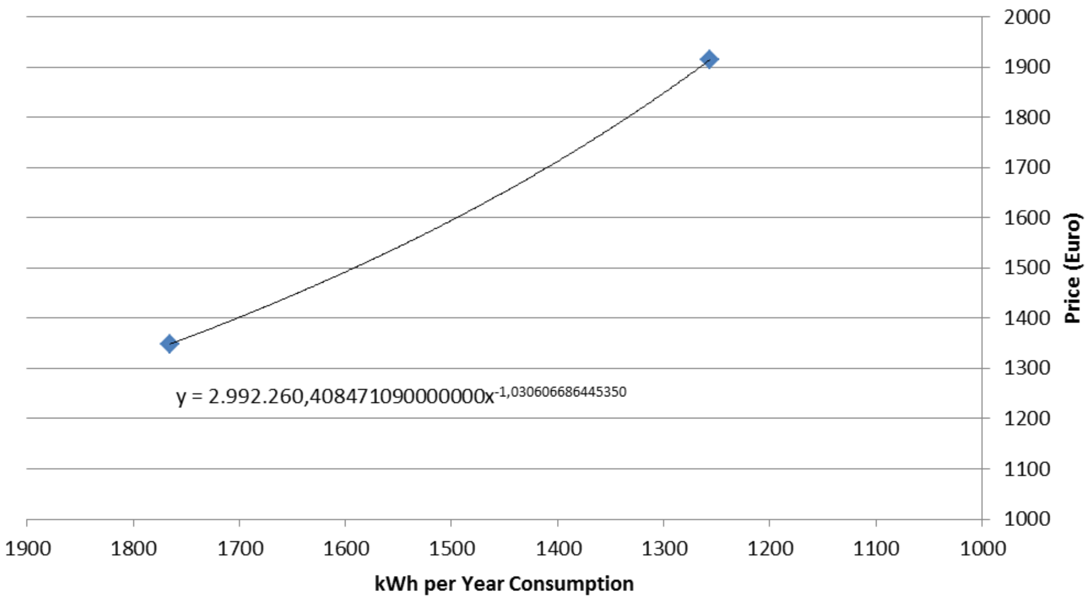

35000
30000
25000
20000
15000
10000
Price (Euro)
Preparatory Study Designs
65000
60000
55000
50000
45000
40000
35000
30000
25000
20000
15000
kWh per Year Consumption
y = 1E-05x2 - 1,7582x + 76675

-BC6



39000
37000
35000
33000
31000
29000
27000
25000
Preparatory Study Designs
Price (Euro)
65000
63000
61000
59000
57000
55000
53000
51000
49000
47000
45000
kWh per Year Consumption
y = 2E-05x² - 2,5844x + 117882

-BC7



2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
Price (Euro)
y = 2.992.260,408471090000000x-1,030606686445350
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
kWh per Year Consumption