Deliverable 3.7:

Best practice and experiences of both MSAs and industry regarding testing of transformers

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About the INTAS project

The aim of the INTAS project is to provide technical and cooperative support, as well as capacity building activities, to Market Surveillance Authorities (MSAs). The need for the INTAS project arises from the difficulty that MSAs and market actors face in establishing and verifying compliance with energy performance requirements for large industrial products subject to requirements of the Ecodesign Directive, specifically fans and industrial fans. Therefore, the project aims to:

- Support European Member State MSAs deliver compliance for large products (specifically for fans and large fans);
- Support industry to be sure of what their obligations are under the Ecodesign Directive and to deliver compliance in a manner that will be broadly accepted by MSAs;
- Foster a common European approach to the delivery and verification of compliance for these products.

List of project partners:

WIP Renewable Energies	Europe
European Environmental Citizens' Organisation for Standardisation	Europe
European Copper Institute	Europe
Engineering Consulting and Design	Europe
Waide Strategic Efficiency	Europe
Austrian Energy Agency	Austria
Federal Public Service Health, Foodchain, Safety and Environment	Belgium
SEVEn Energy Efficiency Center	Czech Republic
Danish Technological Institute	Denmark
Finnish Safety and Chemicals Agency	Finland
The Polish Foundation for Energy	Poland
Directorate General of Energy and Geology	Portugal
Romanian Regulatory Authority for Energy	Romania
Foundation for the Promotion of Industrial Innovation	Spain
Italian National Agency for New Technologies, Energy and Sustainable Economic Development	Italy
Food and Economic Safety Authority	Portugal

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Executive Summary

This report considers best practice and experiences of both MSAs and industry regarding conformity verification of large power transformers. Specifically, it presents the Ecodesign requirements pertaining to large power transformers (LPTs) and discusses factors relevant to their conformity verification and related market surveillance. It sets out the conformity assessment requirements, the legal framework that governs market surveillance, the different ways authorised market surveillance authorities (MSAs) can conduct conformity verification market surveillance and summarises their experiences to date with regard to large power transformers.

It also describes the business practices employed in the procurement, production, approval, supply and installation of LPTs that have a bearing on the viability of different market surveillance approaches and analyses the implications of these factors on the prospective approaches that MSAs may opt to use to conduct conformity verification.

It is found that the standard Ecodesign market surveillance conformity verification approach based on selecting a product for 3rd party verification testing is not very well adapted to LPTs because:

- LPTs are customised made-to-order products that are procured under private B2B commercial arrangements and hence they are not produced in series, are not ordinarily available at a manufacturers premises for sampling, and are not advertised – which means that MSAs cannot employ usual market research methods to establish whether a product is placed on the market or not

- Even when it is established that a product is placed on the market, conducting 3rd party testing once a product has left the factory premises is very costly to conduct and is liable to be disruptive and costly (in terms of lost operational value) to the business who had procured the product

By contrast market surveillance conformity verification based on witnessing factory acceptance tests, which is permitted under the Ecodesign regulation applying to transformers, is much less costly and disruptive; however, it also presents challenges due to:

- the difficulty of an MSA knowing that a product order has been placed and hence being able to request a witness test

- challenges MSAs face in securing expert 3rd party technical assistance to conduct this form of conformity verification

- the potential for manipulation of test results

- possible limits on the legal powers that can be exercised in the event an MSA rejects a product following a witness test.

Prospective alternative approaches including 3rd party testing prior to commissioning (i.e. putting into service on site), in situ testing and conformity verification of environmental management systems are also considered but are found to be unviable, or too immature to be used at present without further development.

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TRANSFORMERS FANS

Overall it is found that key areas need to be improved to enable effective conformity verification for these products or there is a risk that MSAs may feel obliged to assess conformity in ways that will produce legally defensible results with high integrity but that risk incurring significant costs to themselves and to the businesses at each end of the supply chain.

A key fundamental need, that requires robust action, is to ensure that mechanisms are put in place to maximise the likelihood that an MSA will be informed that a transformer will be placed on the market and put into service. To this end, Ecodesign MSAs are strongly encouraged to establish relationships with the following entities:

- all enterprises likely to procure large and medium power transformers – most, notably electricity generators, TSOs, DSOs and large industrial enterprises
- the conformity assessment bodies responsible for certifying the electrical safety of a transformer and granting it a license to be operated.

so that they are informed when products are placed on the market and put into service.

1. Introduction

The material presented in this report aims to simplify and improve relations between national authorities, manufacturers and end users of products. Whilst some Member State authorities have better working knowledge and relations with particular industries, others lack expertise and experience. The activities conducted for this task seek to better inform MSAs and manufacturers about each others' needs and build an understanding of how and when large and medium power transformers are produced, particularly looking at how customised and unique products are procured and delivered.

Specifically, for manufacturers this task aims to:

- increase understanding of the regulatory process and how they can influence this process
- increase understanding of the formation and application of harmonised standards
- increase understanding of the needs for the MSA and their rights and responsibility to conduct monitoring, verification, and enforcement actions
- increase understanding of the 'level playing field'.

While for MSAs it aims to:

- increase understanding of the administrative burden of market surveillance checks on industry and how this can be reduced through agreed upon inspection methods
- increase understanding of the nature of commissioning and purchasing large units, particularly unique and custom-built units
- increase understanding of transportation and logistical issues with large products.

The material it presents was assembled through a process of extensive consultation with both MSAs and businesses involved in the supply of large transformers. It also benefited from the experience of project partners, as well as input received from the INTAS national focal points.

As with the INTAS project in general the subject of the investigation is focused on large and medium power transformers, and especially those products which are customised i.e. are made to order and not as part of a series. The sub-categories based on size are summarized in Figure 1 below.

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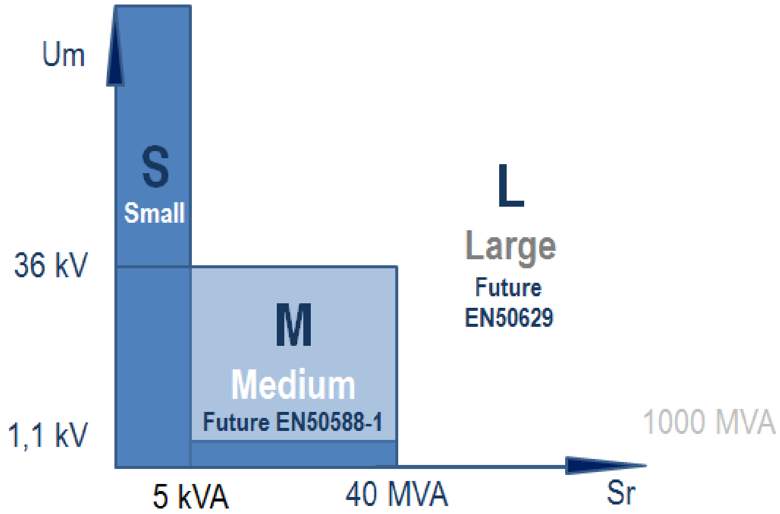

Figure 1. Power transformer categories recognised in EU Regulation 548/2014

2. Ecodesign regulatory requirements and standardisation

2.1 New Approach Directives and the Ecodesign Directive

The relationship between standardization and legislation at European level has been developed in accordance with the so-called 'New Approach' to technical harmonization and standards, which was introduced in 1985.

According to the New Approach:

- the European Union adopts legislation (EU Directives) that define essential requirements - in relation to safety and other aspects of public interest - which should be satisfied by products and services being sold in the Single Market
- the European Commission issues standardization requests (Mandates) to the European Standardization Organizations (CEN, CENELEC and ETSI), which are responsible for preparing technical standards and specifications that facilitate compliance with these essential requirements
- public authorities must recognize that all products manufactured (and services provided) in accordance with harmonized standards are presumed to conform to the essential requirements as defined by the relevant EU legislation
- European Standards remain voluntary and there is no legal obligation to apply them. Any producer (or service provider) who chooses not to follow a harmonized standard is obliged to prove that their products (or services) conform to the essential requirements
- around 25% of European Standards published by CEN have been developed in response to standardization requests (Mandates) issued by the European Commission
- business, consumers and other stakeholders benefit from the ongoing cooperation between the European regulatory authorities (i.e. the EU institutions and EFTA) and the European Standardization System, which can be seen as a kind of public-private partnership.

Nonetheless, when businesses make use of harmonized standards, they benefit from a 'presumption of conformity' with the requirements set out in the relevant European legislation. This means that they can sell their products or services throughout the Single Market – reaching a potential 600 million consumers in at least 34 countries. Meanwhile, when European Standards are correctly applied, consumers benefit from safe and environmentally-friendly products and services.

The Ecodesign Directive is one of a suite of so called “New approach directives” that are all produced in line with the approach described above. Table 1 presents a complete listing of these Directives.

Table 1. New Approach Directives or Regulations and Related Standards

Reference of directive/regulation	Subject of directive/regulation	Info about directive/regulation	Info on European standards	Harmonised standards cited in the Official Journal
2000/9/EC	Cableway installations	▶	▶	▶
(EC) 1907/2006	Chemical substances (REACH)	▶	▶	▶
89/106/EEC	Construction products (CPD)	▶	▶	▶
(EU) 305/2011	Construction products (CPR)	▶	-	▶
(EC) 1223/2009	Cosmetics	▶	▶	▶
92/42/EEC	Ecodesign – hot-water boilers	▶	▶	▶
2010/30/EU	Ecodesign and energy labelling	▶	-	▶
2009/125/EC	Ecodesign and energy labelling	▶	-	▶
(EC) 1221/2009	Eco-management and audit scheme (EMAS)	▶	-	▶
2014/30/EU	Electromagnetic compatibility (EMC)	▶	-	▶
2014/34/EU	Equipment for explosive atmospheres (ATEX)	▶	-	▶
2014/28/EU	Explosives for civil uses	▶	-	▶
2009/142/EC	Gas appliances (GAD)	▶	▶	▶
2014/28/EU	Inspection of pesticide application equipment	▶	-	▶
2014/33/EU	Lifts	▶	-	▶
2014/35/EU	Low Voltage (LVD)	▶	-	▶
2006/42/EC	Machinery (MD)	▶	▶	▶
2014/32/EU	Measuring instruments (MID)	▶	-	▶
93/42/EEC	Medical devices (MDD)	▶	▶	▶
90/385/EEC	Medical devices: active implantable	▶	▶	▶
98/79/EC	Medical devices: in vitro diagnostic	▶	▶	▶
(EC) 765/2008	New legislative framework (NLF)	▶	-	▶
2014/31/EU	Non-automatic weighing instruments (NAWI)	▶	-	▶
94/62/EC	Packaging and packaging waste	▶	▶	▶
89/686/EEC	Personal protective equipment (PPE)	▶	▶	▶
2014/68/EU	Pressure equipment (PED)	▶	-	▶
2013/29/EU	Pyrotechnic articles	▶	-	▶
2014/53/EU	Radio and	▶	-	▶

	telecommunications terminal equipment (RTTE)			

Reference of directive/regulation	Subject of directive/regulation	Info about directive/regulation	Info on European standards	Harmonised standards cited in the Official Journal
2008/57/EC	Rail system: interoperability	▶	▶	▶
2013/53/EU	Recreational craft	▶	-	▶
2011/65/EU	Restriction of the use of certain hazardous substances (RoHS)	▶	-	▶
2014/29/EU	Simple Pressure Vessels	▶	-	▶
2009/48/EC	Toys safety	▶	▶	▶

How to read the table

Directive number	▶	texts of directives and regulations available on the website of the European Union (*)
Information about directive	▶	information on directives and regulations available on the website of the European Commission's Enterprise Directorate-General
Info on European standards	▶	information on standards and standards activities available on the websites of the European Standards Organisations
Harmonised standards cited in the Official Journal	▶	lists of references of harmonised standards published in the Official Journal of the European Union, are available on the website of the European Commission's Entreprise Directorate-General

(*)The text of the corresponding directives are available in all official Community languages at **http://eur-lex.europa.eu** on the EUR-Lex site. For legal purposes, please refer to the texts published in the 'Official Journal of the European Union'. Only European Union legislation published in the paper editions of the Official Journal is deemed authentic.

Source: www.newapproach.org/directives/directiveList.asp

2.1.1 Ecodesign of Energy Related Products Directive

The Ecodesign Directive 2009/125/EC[1] of the European Parliament established a framework for the setting of eco-design requirements for energy-related products. Its goal is to encourage manufacturers to design products with the environmental impacts in mind throughout their entire life cycle. Published in the Official Journal of the European Union (L 285 31.10.2009), this framework directive defines the principles, conditions and criteria for setting environmental requirements for energy-related appliances. The Directive also sets out the process and governance by which Ecodesign measures of either a mandatory or voluntary nature can be established for energy-related products within the EU.

The production, distribution, use and end-of-life management of consumer products and commercial equipment is associated with a number of environmental impacts. However, it is estimated that on average over 80% of all product-related environmental impacts are determined during the design phase of a product. Taking this into consideration, the Ecodesign Directive aims to improve the environmental performance of products throughout their full life-cycle by systematically considering environmental aspects early in the product design phase.

[1] DIRECTIVE 2009/125/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products (recast)

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Ecodesign requirements are established under the Directive through a set of implementing measures which are published as product specific regulations or as negotiated voluntary agreements with industry. The measures set minimum requirements that aim to reduce the environmental impact of products, including the energy consumption throughout their entire life cycle. The Ecodesign measures help to remove the worst performing products from the market and hence provide market “push”.

This is complemented by energy labelling and eco-labels that provide information on the relative energy and environmental performance of products and hence provide market “pull”. Collectively, the Ecodesign and labelling policies work to create a continuous market transformation effect towards products with lower energy and environmental impacts. Additional the EU and individual EU Member States also deploy policy instruments to encourage green public procurement, raise user awareness of how to save energy and provide incentives for lower energy and environmental impact behaviour. Collectively these policies constitute a so called integrated product policy (IPP) which the Commission intends will accelerate the market shift toward improving the environmental performance of products and appliances.

Ecodesign implementing measures are not set for all energy-related products. Rather, they are established in the cases where there is a significant volume of trade within the EU’s internal market, the product has a substantial environmental impact and there is a clear improvement potential. In the case of energy-performance the guiding principle applied in the Ecodesign Directive is that minimum requirements should be set at the energy performance level which results in the least life cycle cost to the average EU end-user over the product lifecycle. Ecodesign differs from the minimum energy performance standards or Top Runner requirements set in many other economies as it is not confined acting upon energy consumption in the use phase. Instead it also encompasses energy in the production stage and all environmental impacts of products. Ecodesign implementing measures may therefore set requirements addressing many other environmental factors than just the energy in use phase, albeit that this is often the most important and the greatest focus of regulatory effort.

Implementing measures that establish mandatory minimum performance requirements are considered when no valid self-regulatory initiative has been taken by industry. Self-regulation by industry, including voluntary and unilateral commitments, may produce quick progress, due to rapid and cost-effective implementation, and allows flexible and appropriate adaptation to technological solutions and market sensitivities. Thus, when appropriate criteria have been met the Commission has been willing to accept a negotiated agreement with industry in place of establishing a mandatory regulation.

The priority products to be considered for implementing measures under the Directive are put forward in a series of Working Plans.

The different stages in the process of developing Ecodesign and energy labelling implementing measures are summarised in Figure 2.

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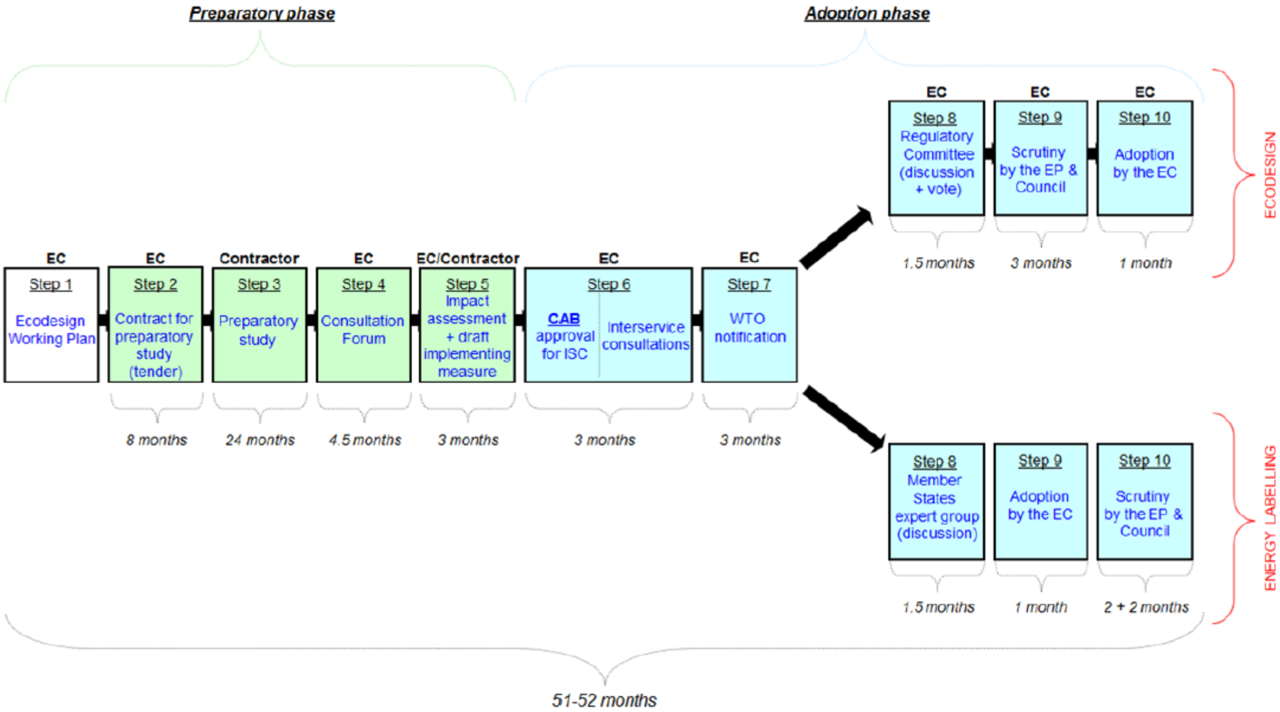

Figure 2. Diagram showing stages and timescales for Ecodesign and energy labelling regulations (source: http://www.energylabelevaluation.eu/eu/home/welcome)

Each implementing measure is preceded by a preparatory study and an impact assessment conducted by external experts and the Commission with the aim of identifying cost-effective solutions to improve the overall environmental performance of products and incorporates participatory and delegated decision-making processes. Implementing measures are eventually adopted by the Commission under the regulatory procedure with scrutiny, meaning the European Parliament and Council have veto authority.

Methodology for Ecodesign of Energy-related Products

The aim of the underlying Methodology study for Ecodesign of Energy-related Products (MEErP)[2] is to evaluate whether and to which extent various energy-related products fulfil certain criteria that make them eligible for implementing measures under the Ecodesign Directive (2009/125/EC). These criteria are specified in Article 15 and Annexes I and II of the Directive. The Commission is required, when preparing a draft implementing measure, to conduct a series of analyses and assessments referred to as a "preparatory study".

The generic process flow diagram depicted in Figure 2 shows the various tasks which are conducted over a timeline of approximately two years. The analytical teams conducting the research on these products and equipment may modify the task structure slightly, as appropriate for products and their respective stakeholder groups.

[2] Methodology for Ecodesign of Energy-related Products, MEErP 2011, Methodology Report; COWI Belgium sprl -in association with- Van Holsteijn en Kemna B.V. (VHK), Brussels/Delft, November 2011.

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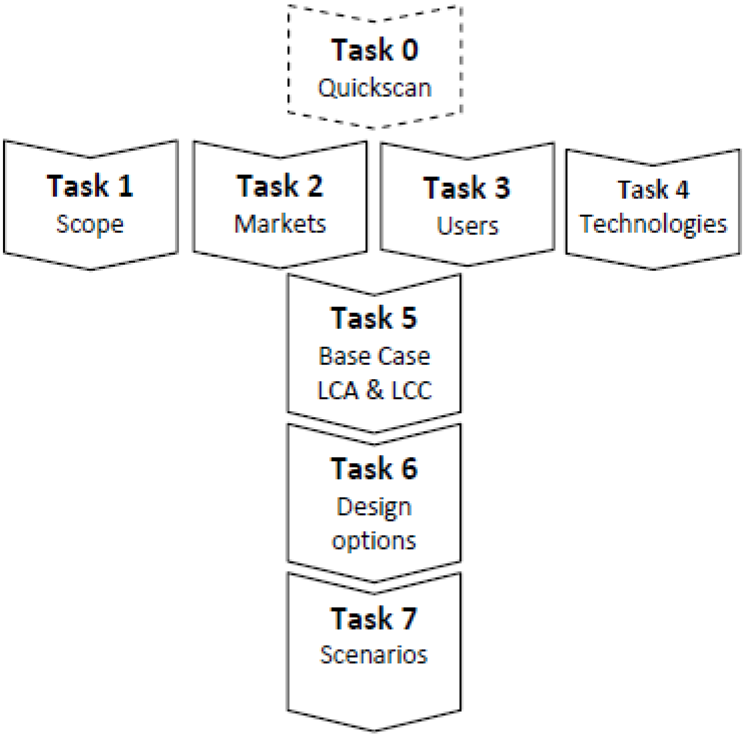

Figure 3. Methodology flow diagram for analysis of products under the Ecodesign Directive

Task 0 is an optional step that may be conducted on large or diverse product groups, where it would be advantageous to conduct a first product screening, considering environmental impacts and potential for improvement of those products following Article 15 of the Ecodesign Directive. The purpose of Task 0 is to re-group or narrow the scope, to enable the subsequent analysis to be manageable.

Task 1 discusses the scope of the product being considered, including the product category and system boundaries. This task includes a review of any implementing legislation or measures that may apply to the product, including both the EU and any pre-existing national legislation in the Member States. The task also looks at the test standards and metrics used for measuring performance. Finally, it provides a brief review of the international context, looking at measures that may have been adopted on the same product or equipment in other economies.

Task 2 focuses on quantifying the European market for the product, including the total EU industry and trade. The task seeks to provide insight into the latest trends in the market, including any product design innovations that are being implemented. The task also seeks to provide a set of baseline prices and cost-related information that can be used in subsequent analyses such as the life-cycle cost assessment. The analyst team will use both data from the EU's PRODCOM database for more generic trade and production data that are consistent with official statistics, as well as specialist market data sources to generate sales and stock data from industry sources.

Task 3 looks at how the product is used, to try and identify any barriers or restrictions that may prevent Ecodesign measures from being applied due to social, cultural or other factors. This task also seeks to quantify the typical and important end-user parameters that influence the environmental impacts over the life of the product which can be different from the quantification of the test standards in Task 1.

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Task 4 involves conducting a general analysis of products currently on the European market and provide general input for the base-case (Task 5) and potential improvement options (Task 6). This task takes into consideration the full range of reporting, from current products through to best available technology (BAT) and best not yet available technology (BNAT).

Task 5 seeks to establish a representative category that is considered the “base-case” for the whole European market. This base-case becomes the reference against which the environmental and economic analyses will be conducted in subsequent parts of the study. The base-case is an abstraction of reality, and is limited to one case for practical reasons. The base-case is derived from the synthesis of the information gathered through Tasks 1 to 4, and becomes the baseline against which Task 6 (improvement potential) and Task 7 (policy, scenario and impact analysis) are applied.

Task 6 considers the design options that can be applied to reduce environmental impacts, and the associated cost implications. The assessment of these options is carried out through a life-cycle cost assessment, to determine whether the design options may have a positive or negative impact on the cost of ownership. This cost takes into account the purchase and running cost, and disposal costs, if applicable. The minimum life-cycle cost option is the target value, and the Best Available Technology (BAT) represents a medium-term target level. The Best Not Available Technology (BNAT) offers a long-term potential level, i.e. is an assessment of the performance that could be expected by advanced future technologies that are not yet commercialised but are conceptually viable, and helps to define the full range of measures that could be considered.

Task 7, the final part of the preparatory study, summarises and considers the outcomes of all previous tasks, looking at appropriate policy measures for the product or equipment. This task prepares scenarios that quantify the improvements that can be achieved against a business-as-usual scenario and compares the outcomes in the context of European environmental targets, including CO2 emissions reductions. This Task considers the impact on consumers (first cost) and industry (increased costs, employment, profitability, competitiveness) as discussed in Annex II of the Ecodesign Directive. Finally, this task includes a sensitivity analysis which is applied to the primary parameters it uses to study the robustness of the results, varying some of those key inputs.

In following the MEErP methodology, there is a distinction drawn between Tasks 1 through 4, which are primarily about data retrieval and the initial analysis and Tasks 5 through 7 which are more about modelling and developing policy options for consideration. Ideally, after reading Tasks 1 through 4, policy makers and stakeholders should have enough understanding to discuss the issues and have an understanding of any issues or constraints. Tasks 5 through 7 provide analysis of which requirements could be established for Ecodesign. This is the first step in the process of considering Ecodesign measures for products.

Throughout the preparatory study stakeholders are asked to contribute data and opinions to make the results more robust and fit for purpose. Draft reports of the different tasks are generally published on a dedicated product-specific web site. The studies generally include two or three stakeholder meetings, open to all, to present results and gather feedback.

Following the publication of the preparatory study report, the Commission prepares a first draft of the implementing measure which is called a “working document”. In conjunction with the working document, the Commission prepares an Impact Assessment which is primarily an internal document but is published at the end of the process with the final implementing measure (if one is adopted). The working document undergoes review and comment through bilateral stakeholder consultations and in one or more Consultation Forum meetings. The Consultation Forum[3] is a group of experts consisting of business organisations, environmental groups, consumer organisations and Member State representatives.

Implementing measures are ultimately approved by Cabinet through an Inter Service Consultation and are voted on by the Ecodesign Regulatory Committee, made up of representatives from the Member States. Finally, they undergo approval by the European Parliament and Council, and are published in the Official Journal of the European Union (OJEU).

2.1.2 Ecodesign Directive requirements on Member States

The Ecodesign Directive contains a range of different requirements and instructions for Member States, manufacturers and other stakeholders involved in the process. Table 2 presents the requirements placed on Member States associated with market surveillance and penalties within the Ecodesign Directive.

Table 2. Select requirements of Member States specified in the Ecodesign Directive

Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of Ecodesign requirements for energy-related products	
Article 3	Placing on the market and/or putting into service 1. Member States shall take all appropriate measures to ensure that products covered by implementing measures may be placed on the market and/or put into service only if they comply with those measures and bear the CE marking in accordance with Article 5. 2. Member States shall designate the authorities responsible for market surveillance. They shall arrange for such authorities to have and use the necessary powers to take the appropriate measures incumbent upon them under this Directive. Member States shall define the tasks, powers and organisational arrangements of the competent authorities which shall be entitled to: (a) organise appropriate checks on product compliance, on an adequate scale, and oblige the manufacturer or its authorised representative to recall non-compliant products from the market in accordance with Article 7; (b) require the parties concerned to provide all necessary information, as specified in the implementing measures; (c) take samples of products and subject them to compliance checks. 3. Member States shall keep the Commission informed about the results of the market surveillance, and where appropriate, the Commission shall pass on such information to the other Member States. 4. Member States shall ensure that consumers and other interested parties are given an opportunity to submit observations on product compliance to the competent authorities.
Article 20	Penalties The Member States shall lay down the rules applicable to infringements of the national provisions adopted pursuant to this Directive and shall take all measures necessary to ensure that they are implemented. The penalties provided for shall be effective, proportionate and dissuasive, taking into account the extent of non-compliance and the number of units of non-complying products placed on the Community market. The Member States shall notify those provisions to the Commission by 20 November 2010 and shall notify it without delay of any subsequent amendment affecting them.

[3] See http://ec.europa.eu/energy/efficiency/ecodesign/forum_en.htm

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Collectively the first two sections of Article 3 place an obligation on Member States to develop and mandate a body responsible for product energy efficiency market surveillance and compliance and for that body to carry out compliance testing of a sample of products on the market. The size and frequency of the sample to be tested is left open to the Member State authorities to determine although the provisions in Article 3(1) imply that these should be sufficient to ensure that products placed on the market do comply with EU energy efficiency regulations.

Article 3(3) requires that Member States communicate with the Commission about the work they're conducting on market surveillance and Article 3(4) directs Member States to provide a mechanism by which consumers and other interested parties are able to provide their observations on product compliance to the designated competent authority in that Member State.

Article 20 of the Directive places an obligation on each Member State to establish the procedures and penalties to be followed in the event of non-compliance. While the nature of these is left open for the Member States to determine the Directive requires that the penalty shall be "effective, proportionate and dissuasive" and takes into account the degree of compliance observed in the market.

2.1.3 Conformity assessment under Ecodesign

Article 8 of the Ecodesign Directive specifies the following requirements with regard to conformity assessment:

> 1. Before placing a product covered by implementing measures on the market and/or putting such a product into service, the manufacturer or its authorised representative shall ensure that an assessment of the product's conformity with all the relevant requirements of the applicable implementing measure is carried out.
>
> 2. The conformity assessment procedures shall be specified by the implementing measures and shall leave to manufacturers the choice between the internal design control set out in Annex IV *(see below)* to this Directive and the management system set out in Annex V *(see below)* to this Directive. Where duly justified and proportionate to the risk, the conformity assessment procedure shall be specified among relevant modules as described in Annex II to Decision No 768/2008/EC[4].
>
> Where a Member State has strong indications of probable non-compliance of a product, that Member State shall as soon as possible publish a substantiated assessment of the product's compliance which may be conducted by a competent body in order to allow, if appropriate, for timely corrective action.
>
> Where a product covered by implementing measures is designed by an organisation registered in accordance with Regulation (EC) No 761/2001 of the European Parliament and of the Council of 19 March 2001 allowing voluntary participation by organisations in a Community eco-management and audit scheme (EMAS) (1) and the design function is included within the scope of that registration, the management system of that organisation shall be presumed to comply with the requirements of Annex V to this Directive.

[4] DECISION No 768/2008/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 9 July 2008 on a common framework for the marketing of products, and repealing Council Decision 93/465/EEC

If a product covered by implementing measures is designed by an organisation having a management system which includes the product design function and which is implemented in accordance with harmonised standards, the reference numbers of which have been published in the Official Journal of the European Union, that management system shall be presumed to comply with the corresponding requirements of Annex V.

3. After placing a product covered by implementing measures on the market and/or putting it into service, the manufacturer or its authorised representative shall keep relevant documents relating to the conformity assessment performed and declarations of conformity issued available for inspection by Member States for a period of 10 years after the last of that product has been manufactured.

The relevant documents shall be made available within 10 days of receipt of a request by the competent authority of a Member State.

4. Documents relating to the conformity assessment and the EC declaration of conformity referred to in Article 5 shall be drawn up in one of the official languages of the institutions of the European Union.

Annex IV

Internal design control

(referred to in Article 8(2))

1. This Annex describes the procedure whereby the manufacturer or its authorised representative who carries out the obligations laid down in point 2 ensures and declares that the product satisfies the relevant requirements of the applicable implementing measure. The EC declaration of conformity may cover one or more products and must be kept by the manufacturer.

2. A technical documentation file making possible an assessment of the conformity of the product with the requirements of the applicable implementing measure must be compiled by the manufacturer.

The documentation must contain, in particular:

(a) a general description of the product and of its intended use;

(b) the results of relevant environmental assessment studies carried out by the manufacturer, and/or references to environmental assessment literature or case studies, which are used by the manufacturer in evaluating, documenting and determining product design solutions;

(c) the ecological profile, where required by the implementing measure;

(d) elements of the product design specification relating to environmental design aspects of the product;

(e) a list of the appropriate standards referred to in Article 10, applied in full or in part, and a description of the solutions adopted to meet the requirements of the applicable implementing measure where the standards referred to in Article 10 have not been applied or where those standards do not cover entirely the requirements of the applicable implementing measure;

(f) a copy of the information concerning the environmental design aspects of the product provided in accordance with the requirements specified in Annex I, Part 2; and

(g) the results of measurements on the ecodesign requirements carried out, including details of the conformity of these measurements as compared with the ecodesign requirements set out in the applicable implementing measure.

3. The manufacturer must take all measures necessary to ensure that the product is manufactured in compliance with the design specifications referred to in point 2 and with the requirements of the measure which apply to it.

ANNEX V

Management system for assessing conformity

(referred to in Article 8(2))

1. This Annex describes the procedure whereby the manufacturer who satisfies the obligations of point 2 ensures and declares that the product satisfies the requirements of the applicable implementing measure. The EC declaration of conformity may cover one or more products and must be kept by the manufacturer.

2. A management system may be used for the conformity assessment of a product provided that the manufacturer implements the environmental elements specified in point 3.

3. Environmental elements of the management system

This point specifies the elements of a management system and the procedures by which the manufacturer can demonstrate that the product complies with the requirements of the applicable implementing measure.

3.1. The environmental product performance policy

The manufacturer must be able to demonstrate conformity with the requirements of the applicable implementing measure. The manufacturer must also be able to provide a framework for setting and reviewing environmental product performance objectives and indicators with a view to improving the overall environmental product performance.

All the measures adopted by the manufacturer to improve the overall environmental performance of, and to establish the ecological profile of, a product, if required by the implementing measure, through design and manufacturing, must be documented in a systematic and orderly manner in the form of written procedures and instructions.

These procedures and instructions must contain, in particular, an adequate description of:

(a) the list of documents that must be prepared to demonstrate the product's conformity, and, if relevant, that have to be made available;

(b) the environmental product performance objectives and indicators and the organisational structure, responsibilities, powers of the management and the allocation of resources with regard to their implementation and maintenance;

(c) the checks and tests to be carried out after manufacture to verify product performance against environmental performance indicators;

(d) the procedures for controlling the required documentation and ensuring that it is kept up-to-date; and

(e) the method of verifying the implementation and effectiveness of the environmental elements of the management system.

3.2. Planning

The manufacturer must establish and maintain:

(a) procedures for establishing the ecological profile of the product;

(b) environmental product performance objectives and indicators, which consider technological options, taking

into account technical and economic requirements; and

(c) a programme for achieving these objectives.

3.3. Implementation and documentation

3.3.1. The documentation concerning the management system must, in particular, comply with the following:

(a) responsibilities and authorities must be defined and documented in order to ensure effective environmental product performance and reporting on its operation for review and improvement;

(b) documents must be established indicating the design control and verification techniques implemented and processes and systematic measures used when designing the product; and

(c) the manufacturer must establish and maintain information to describe the core environmental elements of the management system and the procedures for controlling all documents required.

3.3.2. The documentation concerning the product must contain, in particular:

(a) a general description of the product and of its intended use;

(b) the results of relevant environmental assessment studies carried out by the manufacturer, and/or references to environmental assessment literature or case studies, which are used by the manufacturer in evaluating, documenting and determining product design solutions;

(c) the ecological profile, where required by the implementing measure;

(d) documents describing the results of measurements on the ecodesign requirements carried out including details of the conformity of these measurements as compared with the ecodesign requirements set out in the applicable implementing measure;

(e) the manufacturer must establish specifications indicating, in particular, standards which have been applied; where standards referred to in Article 10 are not applied or where they do not cover entirely the requirements of the relevant implementing measure, the means used to ensure compliance; and

(f) copy of the information concerning the environmental design aspects of the product provided in accordance with the requirements specified in Annex I, Part 2.

3.4. Checking and corrective action

3.4.1. The manufacturer must:

(a) take all measures necessary to ensure that the product is manufactured in compliance with its design specification and with the requirements of the implementing measure which applies to it;

(b) establish and maintain procedures to investigate and respond to non-conformity, and implement changes in the documented procedures resulting from corrective action; and

(c) carry out at least every three years a full internal audit of the management system with regard to its environmental elements.

Thus, the Ecodesign Directive establishes that the conformity assessment procedures shall be specified by the implementing measures (e.g. Regulation No 548/2104 in the case of power transformers – see section 2.2 and Appendix A) and shall leave to manufacturers the choice of conformity pathway between the internal design control set out in Annex IV and the management system set out in Annex V.

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2.2 Regulation No 548/2014 on Ecodesign of transformers

2.2.1 Regulation No 548/2014

Commission Regulation (EU) No 548/2014 establishes Ecodesign requirements for transformers. In the case of medium and large power transformers (M/LPT) these include Minimum Peak Efficiency Index (PEI) requirements, and mandatory product information requirements.

The full regulation is presented in Annex A.

2.2.2 Review and revision process

Every Ecodesign regulation stipulates a maximum period within which the regulation much be reviewed and potentially revised in accordance with the overarching process specified in the Directive. In the case of Regulation (EU) No 548/2014 for power transformers article 7 states:

> No later than three years after the entry into force, the Commission shall review this Regulation in the light of technological progress and present the results of this review to the Consultation Forum. Specifically, the review will assess, at least, the following issues:
>
> — the possibility to set out minimum values of the Peak Efficiency Index for all medium power transformers, including those with a rated power below 3 150 kVA,
>
> — the possibility to separate the losses associated to the core transformer from those associated with other components performing voltage regulation functions, where this is the case,
>
> — the appropriateness of establishing minimum performance requirements for single-phase power transformers, as well as for small power transformers,
>
> — whether concessions made for pole-mounted transformers and for special combinations of winding voltages for medium power transformers are still appropriate,
>
> — the possibility of covering environmental impacts other than energy in the use phase.

A preparatory study to support this review was launched in September 2016 and concluded in July 2017, see https://transformers.vito.be/. This review examined the above issues as well as whether, or not, the Tier 2 requirements were still appropriate. The preparatory study was conducted by VITO, Waide Strategic Efficiency and TNO and included extensive consultation with stakeholders including representatives of the transformer manufacturing sector.

At the time of writing (March 2018) the DG Grow has prepared a draft revision of Regulation No 548/2014 and has submitted it for inter-service consultation within the Commission. If a common text is subsequently agreed across the Commission the expectation is that it will be discussed by the Ecodesign Regulatory Committee perhaps as soon as May 2018.

Assuming that this process results in a revised version of the regulation being published in the months ahead it will also include an article specifying a maximum date wherein a subsequent review must occur, and thus there is an opportunity for stakeholders, including industrial actors, to engage with future regulatory review processes.

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2.2.3 Conformity assessment

The conformity assessment requirements set out in Regulation No 548/2014 leave it open to transformer manufacturers whether or not they will opt for the internal design control set out in Annex IV and the management system set out in Annex V.

2.3 Standardisation

2.3.1 Harmonised Standards

All New Approach Directives, such as the Ecodesign Directive, make use of harmonised standards to provide the technical and performance measurement basis for the requirements specified in the Directives.

A harmonised standard is a European standard developed by a recognised European Standards Organisation: CEN, CENELEC, or ETSI. It is created following a request from the European Commission to one of these organisations. Manufacturers, other economic operators, or conformity assessment bodies can use harmonised standards to demonstrate that products, services, or processes comply with relevant EU legislation.

The references of harmonised standards must be published in the Official Journal of the European Union. Details of harmonised standards applying to all New Approach Directives are provided here:

http://ec.europa.eu/growth/single-market/european-standards/harmonised-standards/

Details of harmonised standards applying to all the Ecodesign Directive regulations are provided here:

https://ec.europa.eu/growth/single-market/european-standards/harmonised-standards/ecodesign_en

2.3.2 European Standards bodies: CENELEC, CEN and ETSI

The European Union has three pan-European standardization bodies that are the direct corollary of the international standardization bodies: ISO (CEN), IEC (CENELEC) and ITU (ETSI). The mandate of these bodies was expanded in 1991 to facilitate the development of the European Single Market, and standards adopted through them automatically become national standards in EU and EFTA member countries.

European standardization is organized by and for the stakeholders concerned based on national representation (the European Committee for Standardization (CEN) and the European Committee for Electrotechnical Standardization (CENELEC)) and direct participation (the European Telecommunications Standards Institute (ETSI)), and is founded on the principles recognized by the World Trade Organization (WTO) in the field of standardization, namely coherence, transparency, openness, consensus, voluntary application, independence from special interests and efficiency ('the founding principles'). In accordance with the founding principles, it is important that all relevant interested parties, including public authorities and small and medium-sized enterprises (SMEs), are appropriately involved in the national and European standardization process. National standardization bodies should also encourage and facilitate the participation of stakeholders.

European standards play a very important role within the internal market, for instance through the use of harmonized standards in the presumption of conformity of products to be made available on the market with the essential requirements relating to those products laid down in the relevant Union harmonization legislation. Those requirements should be precisely defined in order to avoid misinterpretation on the part of the European standardization organizations.

Within the Union, national standards are adopted by national standardization bodies which could lead to conflicting standards and technical impediments in the internal market. Therefore, it is necessary for the internal market and for the effectiveness of standardization within the Union to confirm the existing regular exchange of information between the national standardization bodies, the European standardization organizations and the Commission, about their current and future standardization activities as well as the standstill principle applicable to the national standardization bodies within the framework of the European standardization organizations which provides for the withdrawal of national standards after the publication of a new European standard. The national standardization bodies and European standardization organizations should also observe the provisions on exchange of information in Annex 3 to the Agreement on Technical Barriers to Trade.

2.3.3 Regulatory basis for standardisation and representation of societal interests

Certain regulations govern the operation of the European standards bodies and their relationship with the European Commission and the National Standards Bodies. The most recent is: REGULATION (EU) No 1025/2012 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 25 October 2012 on *European standardization, amending Council Directives 89/686/EEC and 93/15/EEC and Directives 94/9/EC, 94/25/EC, 95/16/EC, 97/23/EC, 98/34/EC, 2004/22/EC, 2007/23/EC, 2009/23/EC and 2009/105/EC of the European Parliament and of the Council and repealing Council Decision 87/95/EEC and Decision No 1673/2006/EC of the European Parliament and of the Council*.

European standardisation bodies are mandated to ensure there is a representation of societal interests and societal stakeholders in European standardization activities. In practice thus refers to the activities of organizations and parties representing interests of greater societal relevance, for instance environmental, consumer interests or employee interests. However, the representation of social interests and social stakeholders in European standardization activities refers particularly to the activities of organizations and parties representing employees and workers' basic rights, for instance trade unions. The obligation of the European standardization organizations to encourage and facilitate representation and effective participation of all relevant stakeholders does not entail any voting rights for these stakeholders unless such voting rights are prescribed by the internal rules of procedure of the European standardization organizations.

In order to speed up the decision-making process, national standardization bodies and European standardization organizations are required to facilitate accessible information on their activities through the promotion of the use of information and communication technologies (ICT) in their respective standardization systems, for example by providing to all relevant stakeholders an easy-to-use online consultation mechanism for the submission of comments on draft standards and by organising virtual meetings, including by means of web conferencing or video conferencing, of technical committees.

Due to the importance of standardization as a tool to support Union legislation and policies and in order to avoid ex-post objections to and modifications of harmonized standards, it is important that public authorities participate in standardization at all stages of the development of those standards where they may be involved and especially in the areas covered by Union harmonization legislation for products.

Standards should take into account environmental impacts throughout the life cycle of products and services. Important and publicly available tools for evaluating such impacts throughout the life cycle have been developed by the Commission’s Joint Research Centre (JRC). The JRC is expected to play an active role in the European standardization system.

The viability of the cooperation between the Commission and the European standardization system depends on careful planning of future requests for the development of standards. REGULATION (EU) No 1025/2012 recognises that this could be improved, in particular through the input of interested parties, including national market surveillance authorities, by introducing mechanisms for collecting opinions and facilitating the exchange of information among all interested parties. Since Directive 98/34/EC already provides for the possibility of the European Commission to request the European standardization organizations to develop European standards, it was deemed appropriate to put in place an improved and more transparent planning process within an annual work programme, which should contain an overview of all requests for standards which the Commission intends to submit to European standardization organizations. It was further deemed necessary to ensure a high level of cooperation between the European standardization organizations and the European stakeholder organizations receiving Union financing. This in accordance with the Regulation and the Commission’s establishment of its annual Union work programme for standardization.

REGULATION (EU) No 1025/2012 establishes a committee to manage its implementation. Before bringing a matter regarding requests for European standards or European standardization deliverables, or objections to a harmonized standard before this committee, the Commission should consult experts of the Member States, for instance through the involvement of committees set up by the corresponding Union legislation or by other forms of consultation of sectoral experts, where such committees do not exist.

Several directives harmonising the conditions for the marketing of products specify that the Commission may request the adoption, by the European standardization organizations, of harmonized standards on the basis of which conformity with the applicable essential requirements is presumed.

Decision No 1673/2006/EC establishes the rules concerning the contribution of the Union to the financing of European standardization in order to ensure that European standards and other European standardization deliverables are developed and revised in support of the objectives, legislation and policies of the Union. It was deemed appropriate, for the purpose of administrative and budgetary simplification, to incorporate the provisions of that Decision into Regulation 1025/2012 and to use wherever possible the least burdensome procedures.

In order to achieve the main objectives of the Regulation and to facilitate speedy decision-making procedures as well as reducing the overall development time for standards, use should be made as far as possible of the procedural measures provided for in Regulation (EU) No 182/2011, which enables the chair of the relevant committee to lay down a time limit within which the committee should deliver its opinion, according to the urgency of the matter. Moreover, where justified, it should be possible for the opinion of the committee to be obtained by written procedure, and silence on the part of the committee member should be regarded as tacit agreement.

During the preparation of a harmonized standard or after its approval, national standardization bodies shall not take any action which could prejudice the harmonization intended and, in particular, shall not publish in the field in question a new or revised national standard which is not completely in line with an existing harmonized standard. After publication of a new harmonized standard, all conflicting national standards shall be withdrawn within a reasonable deadline.

CENELEC is the standardisation body responsible for developing performance standards, including harmonised standards, for power transformers. Details of its mandate and how it functions are presented in Appendix B, while section 2.3.3. indicates the relevant standards for power transformers.

2.3.4 European Standards applying to the Ecodesign assessment of transformers

The harmonised standards that apply to the energy performance of transformers are shown in Table 3.

Table 3. Harmonised standards for power transformers used in the Ecodesign Directive

ESO body	Reference and title of the standard (and reference document)	First publication OJ	Reference of superseded standard	Date of cessation of presumption of conformity of superseded standard
Cenelec	EN 50588-1:2015 Medium power transformers 50 Hz, with highest voltage for equipment not exceeding 36 kV - Part 1: General requirements	11/09/2015		
	EN 50588-1:2015/A1:2016	This is the first publication	See footnote 1	23/05/2019
Cenelec	EN 50629:2015 Energy performance of large power transformers (Um > 36 kV or Sr ≥ 40 MVA)	11/09/2015		
	EN 50629:2015/A1:2016	This is the first publication	See footnote 1	23/05/2019

[1] https://ec.europa.eu/growth/single-market/european-standards/harmonised-standards/ecodesign/transformers_en#Note%203

These standards are developed by the CENELEC Technical Committee CLC/TC 14. The scope of this committee is:

“Standardization in the field of power transformers, tap-changers and reactors for use in power generation, transmission and distribution. Generally, these transformers have power ratings above 1 kVA single phase and 5 kVA polyphase with a higher voltage winding of 1 000 V or more, however the scope includes lower voltage transformers and regulators used in power delivery applications. Excluded: - Instrument transformers - Testing transformers - Traction transformers mounted on rolling stock - Welding transformers - Transformers for applications covered by TC 96.”

Details of this committee including its membership, workplan and current standardisation projects can be viewed at: https://www.cenelec.eu/dyn/www/f?p=104:7:1253190300432701::::FSP_ORG_ID:1257153

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3. Ecodesign market surveillance and conformity assessment and verification in EU Member States

Under the New Approach Directives the responsibility and authority to conduct market surveillance for conformity with the Directives resides with the EU Member States.

3.1 EU conformity legislation

3.1.1 Compliance and conformity assessment responsibilities

Member States are responsible for market surveillance under the Ecodesign Directive. The national market surveillance authorities must monitor products covered by implementing regulations and placed on the market and/or put into service. These products must bear the CE mark which symbolises the conformity of the product with the applicable Community requirements, regardless of whether these address safety, health, energy-efficiency or other environmental requirements as set out in the applicable product legislation. As mentioned previously, Article 3 of the Ecodesign Directive states that authorities are entitled (1) to organise appropriate checks on compliance with the implementing regulations, (2) to oblige the manufacturer to recall non-compliant products from the market, (3) to require the provision of all necessary information and (4) to take samples of products and subject them to compliance tests.

The Ecodesign Directive stipulates that the conformity assessment procedures shall be specified by the implementing measures. The adopted measures leave to manufacturers the choice between the internal design control and the management system for conformity (self-certification, detailed in technical documentation accompanying the product). Decision No 768/2008/EC on a common framework for the marketing of products defines a full set of conformity assessment procedures, from self-certification with supervised product checks to third party certification (i.e., modules A-H), which the Commission may use in further mandatory measures.

Essentially, the European system is a self-declaration system wherein products which carry the CE mark must comply with all EU legal requirements including for truthful labelling and energy declarations. The Ecodesign Regulations are directly binding in all Member States, and the manufacturers or importers are legally liable for the compliance of their products.

3.1.2 Ecodesign legal frameworks at the Member State level

Table 4 indicates the law used by each EU or EEA Member State to transpose the Ecodesign Directive into national legislation.

Table 4. National Ecodesign legislation by EU and EEA Member State

Country	Form of national legislation under which the Ecodesign Directive is implemented
Austria	Electrical Engineering Legislation
Belgium	Environmental Law
Bulgaria	Technical Requirements towards Products Act (TRPA)
Croatia	NA
Cyprus	Ecodesign requirements for energy-using products law
Czech Republic	Commercial Law (Energy Act and Energy Management Act)
Denmark	Energy Law
Estonia	Energy Efficiency of Equipment Act
Finland	Act on Ecodesign and Energy Labelling of Products
France	General Environment Law
Germany	Commercial Law
Greece	Presidential Decree 32/2010
Hungary	Consumer Protection Law
Iceland	Law amending law no. 72/1994, labelling and disclosure requirements relating to household appliances energy use
Ireland	European Communities Act 1972
Italy	General Law No. 201
Latvia	Environmental Law
Lithuania	Technical Regulation on establishing a framework for the setting of Ecodesign requirements for energy using products
Luxembourg	Product Surveillance Legislation
Malta	Product Safety Act
The Netherlands	Dutch Law of Environmental Governance
Norway	NA
Poland	Energy Law
Portugal	Consumer Protection Law
Romania	Judgement on Ecodesign Requirements for Energy Using Products and Amending, Supplementing and Repeal of Laws
Slovakia	Acts within Conformity Assessment Law
Slovenia	Energy Law
Spain	Royal Decree 1369/2007, of 19 October on the establishment of Ecodesign requirements for energy-using products
Sweden	Law 2008:112 on Ecodesign.
United Kingdom	Energy Conservation Law

As is evident from this table Member States have used different types of primary legislation to transpose the Directive such that four countries used environmental law, two commercial law, four consumer protection/product safety law, four energy laws, two general law and the remainder laws specifically established for the Ecodesign Directive.

It is unclear whether the nature of primary law used to transpose the directive has any significant implications for the effectiveness of market surveillance and compliance activities, although, it is the case that the nature and magnitude of non-compliance penalties may be constrained by the nature of the primary legislation used for transposition.

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3.2 Organisation of conformity verification at MS level

3.2.1 Compliance institutions and structures

The majority of the countries where officials were interviewed had clearly defined the roles of the institutions and stakeholders involved in monitoring, verification and enforcement (MV&E). The capacity of those institutions to fulfil their functions, however, varied considerably between countries. Broadly speaking, a central government department (often a ministry) is responsible for the transposition of the legislation; a delegated government department sitting beneath the ministry (often referred to as the market surveillance authority) is responsible for compliance activities such as reviewing technical documentation and in most cases the instigation and management of enforcement proceedings; while testing is generally carried out by accredited laboratories under instruction from the market surveillance authority. Figure 4 shows a typical arrangement, but many other configurations are also found among the different countries.

In some federally organised countries (e.g. Germany and Spain) all legal and compliance responsibilities except transposition are delegated to regional state level government.

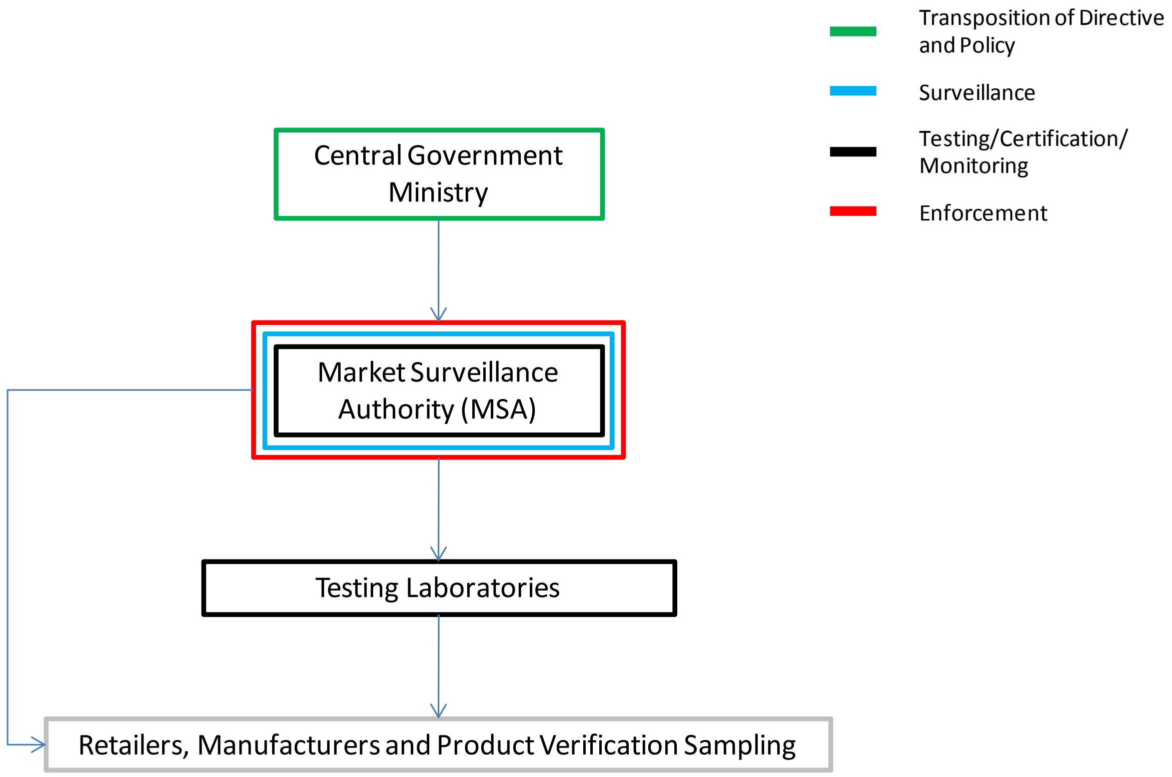

Figure 4. Typical institutional arrangement for market surveillance and conformity verification activities under the Ecodesign Directive

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Figure 5 below illustrates the types of institutions responsible for the various activities relating to the Ecodesign Directive: transposition; surveillance, verification testing and enforcement; where the frequency of the institutional type used for the specific MV&E function across the various EU/EEA Member States is expressed as a percentage of the total.

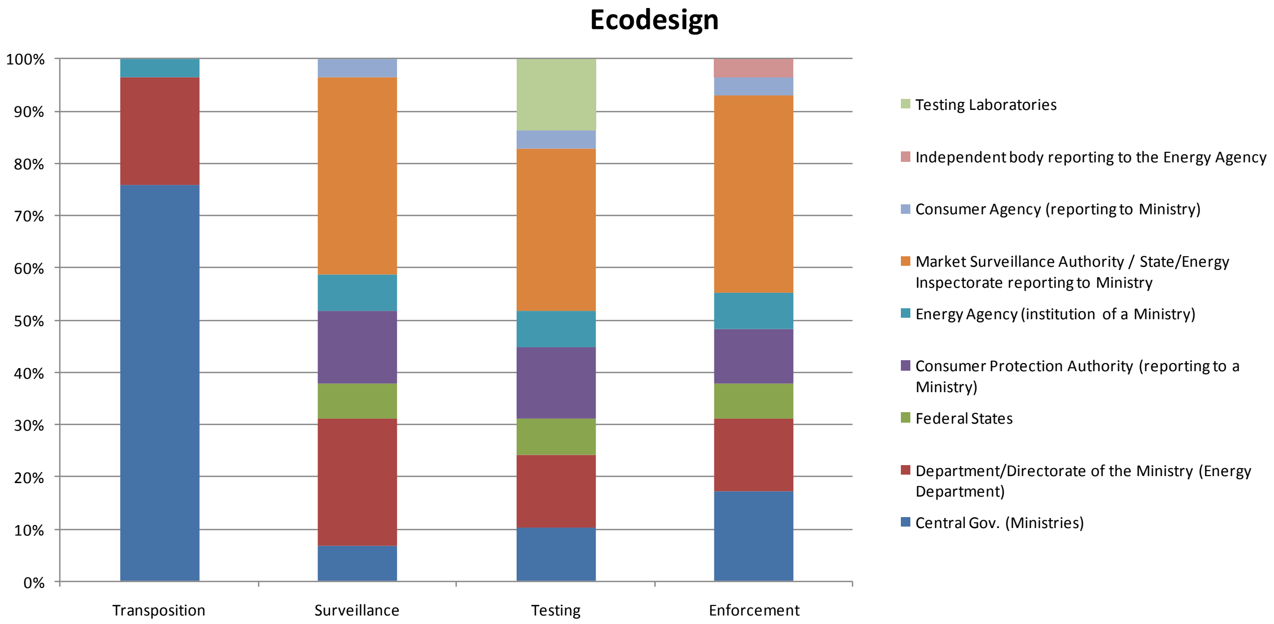

Figure 5. Institutions responsible for MV&E activities for Ecodesign

3.2.2 Energy performance testing agencies and their capabilities

Energy performance verification testing is contingent on the availability of competent accredited laboratories. One or more accredited test lab exists in Europe for each of the energy performance tests required under the Ecodesign Directives, however, no single lab provides testing for all the product types and many countries do not have access to nationally based test facilities. In general, there are far more labs available to test the energy performance of domestic appliances and equipment than there are for some of the less common or more challenging types of industrial and commercial equipment types, thus availability of 3rd party test labs could be a significant constraint to compliance testing for some types of products addressed under the Ecodesign Directive. This is especially the case where there is no or limited previous history of commercial 3rd party energy performance conformity, certification or verification-testing for the product type concerned. Some member states and their MSAs have forged cooperative alliances to overcome these limitations and to share testing facility resources. A good example of this is the cooperation between the MSAs of Nordic countries.

Information on EU testing capacity for power transformers is compiled in INTAS deliverable D2.2.

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3.2.3 Accreditation

MSAs are only likely to instigate compliance conformity verification testing if the results can be legally enforced. In practice this means that the standard procedure is to use accredited 3rd party test laboratories for this purpose. The accreditation of all European testing laboratories is conducted in accordance with European Regulation 765/2008 - *Setting out the requirements for accreditation and market surveillance relating to the marketing of products* and with ISO 17025 - *General requirements for the competence of testing and calibration laboratories*.

Each EU and EEA Member State has a designated national accreditation agency and these adhere to common standards and procedures within the auspices of the European Accreditation cooperative scheme which operates within the broader International Laboratory Accreditation Council (ILAC).

To be accredited to conduct Ecodesign performance verification testing the test facilities need to be accredited for each performance test relevant to the conformity verification of the specific-product type i.e. to conduct a test for each relevant harmonised standard for that product type.

3.2.4 Energy performance verification testing and levels of non-compliance

Since the introduction of the Ecodesign Directive the number of conformity verification tests conducted at the behest of MSAs is reported to have risen considerably over time. Currently it is thought that well over a 1000 such tests are done each year, but the actual figures are not in the public domain. Not surprisingly non-conformity levels tend to be higher when such testing is first initiated and then is frequently found to decline in subsequent years. This tendency can be attributed to two effects. Firstly, whenever a product is first subject to Ecodesign requirements there can be a process for both the suppliers and the MSAs to familiarise themselves with the conformity requirements. This means there can be a lag in the private sector putting into place the necessary modifications to ensure their products comply and to conduct conformity assessment to verify this. Secondly, once MSAs begin to undertake their own conformity verification testing they begin to identify non-compliant products and implement remedial measures to bring the sector into line.

In the case of power transformers, the regulatory requirements are relatively new and most MSAs are still developing their conformity verification approaches, thus there has only been very limited verification testing at the behest of MSAs. It is thus too soon to report on the levels of non-compliance being found.

3.2.4.1 Private sector challenge testing

In additional to officially mandated compliance verification testing private sector testing, including challenge-testing by manufacturers of competitor products, has occurred in some countries and product-type sectors. MSAs take such “whistleblowing” reports quite seriously and will often use them to trigger their own investigations. It is not known whether testing of competitor’s products is undertaken by transformer suppliers but it is most likely to either be for smaller distribution transformers, or for products in situ. In situ testing of transformers is technically viable using mobile test equipment and may occur when faults are detected with a product that has been put into service.

3.2.5 Cooperation between EU Member States

Although responsibility for ensuring compliance with EU product Ecodesign regulations resides with each Member State's MSA(s) there is scope to improve effectiveness and reduce costs via cooperative compliance actions among Member States and MSAs. In particular the efficiency of compliance enforcement efforts will benefit from:

- cooperative information exchange on compliance activities, levels and procedures
- mutual sharing and recognition of test results across EU/EEA Member States to avoid duplicative testing
- mapping of accredited test labs and facilitated access to labs within other EU/EEA Member States
- measures to enhance the reliability of compliance verification testing such as round-robin testing[5].

In recognition of this the European Commission established the Administrative Co-operation Working Group (ADCO) for the Energy Labelling and Ecodesign directives, which is a group that acts as a forum for discussion and information sharing, chaired on a rotating basis by the Members States. The ADCO is generally attended by the market surveillance authority of the Member State and most of the Member States report that they attend the sessions.

Another working group related to MV&E is the E^{n}R Labelling and Ecodesign Working Group[6]. This group is currently chaired by the UK Energy Savings Trust and establishes cooperation and information sharing in its members, amongst other tasks. There are 22 member agencies for E^{n}R.

Most EU and EEA Member States report that they exchange general information on Ecodesign compliance with other countries. The forums where this exchange occurs include:

- ADCO
- through the course of EU sponsored projects, such as those run by under the auspices of the H2020 programme
- E^{n}R Club – Labelling and Ecodesign Working Group
- regional fora and dialogues (reported to be the case for Eastern EU countries, the Baltic States and Scandinavian countries)
- IEA 4E Implementing Agreement (Efficient Electrical End-use Equipment)
- informal bilateral exchanges
- workshops.

[5] Round-robin testing refers to the situation where the same product samples are tested in multiple test labs in order to see the variance in testing procedures and results and minimise differences.
[6] http://www.enr-network.org/labelling-and-ecodesign.html

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Some examples of existing information sharing and cooperation between Member States follow below.

- The Belgium authorities reported that informal bilateral exchanges occur with other countries, such as France and the Netherlands.

- The regulation adopted in France does not explicitly state that there should be collaboration between Member States, however, it is reported to occur in practice.

- In Germany, cooperation and information exchanges are reported to be necessary to achieve efficiencies and cost-effective testing of the more complex products. The MSAs have suggested that were the testing laboratories across Europe which specialise in certain product groups to be mutually recognised they could be used by the whole of EU (via the principle of mutual recognition). Due to the federal structure of the German administration, representatives interviewed from the central and regional governments confirmed satisfaction at the exchange of information at Member State level and with the role of the German Bundesministerium für Wirtschaft und Technologie in sharing information and creating platforms for permanent information transfer and exchange of experiences in order to accomplish harmonised implementation among the German States.

- In Greece, the Hellenic Accreditation System S.A. and test laboratory Labor S.A. indicated that Greece seeks to provide open communication of results with laboratories and other enforcement authorities from other countries. It is in fact, a pre-requisite in the Greek accreditation process for laboratories to ensure they have the necessary provisions to provide open communication of test results in order to achieve accreditation.

- Through the participation of Dutch MSA authorities in the ADCO, the Netherlands is helping to stimulate pan-EU cooperation by running an intranet that facilitates data sharing; this assists other countries with their compliance activities and helps in creating a more level playing field across Europe. Testing laboratories do not generally share test results within the Netherlands unless the testing forms part of a programme. There is some pooling of testing resources and “Round-Robin Testing” where test laboratories conduct tests on the same models to ensure accuracy between laboratories (N.B. this is required by the testing laboratory standard ISO 17025).

- Spain is reported to have shared energy performance verification tests on products with enforcement authorities from other countries. These activities are reported to assist with coordination and cooperation between countries and enforcement agencies monitoring the markets.

- MSAs in the Nordic countries report they cooperate so that the verification tests which models undergo are similar regardless of the country they are tested in and so their constituent parts are not adversely influenced by a difference in the supply chain.

- The UK market surveillance authorities report they are participating in voluntary and informal efforts with EU partners to collaborate on the findings and share data on the monitoring and verification of the Ecodesign Directive. The UK recognises that through the sharing of data, the costs of market monitoring and verification testing can be reduced, and the effectiveness of policing the market can increase.

- The CIRCABC database[7] has been identified as an efficient tool to share information between countries.
- In a similar vein, the ICSMS (Information Communication System for Market Surveillance)[8] tool has been created at the behest of the European Commission and is used to share product health and safety market surveillance data and information between MSAs. ICSMS is reported to be the most comprehensive Europe-wide database of consumer and professional products, which have been tested as non-compliant by market surveillance authorities. It aims to promote co-operation between its members and facilitate their MV&E tasks. It gathers test results and relevant product data on thousands of products and lists authorities in all EU/EEA countries for 22 Directives. Initially these only addressed health and safety issues but more recently the Ecodesign Directive has been added to the list of directives included in the database and it is now possible for EEA Member States to share product non-compliance information via this route. Data sharing under this cooperative arrangement, which is part financed by the European Union, is managed via a secure internet database and can readily incorporate energy performance compliance data.

3.2.6 Ecodesign market surveillance experience for transformers

As mentioned previously MSAs are only just embarking on conducting Ecodesign market surveillance activities for power transformers. Nonetheless, from those that have the following findings are reported by one MSA:

- for smaller transformers Market Surveillance (MS) could be done the ”normal way” i.e. via verification testing at a 3rd party laboratory, if necessary
- for larger transformers i.e. those which are engineered-to-order MS must be done at the premises of manufacture with the help of their measuring devices. The MSA or its representative has the possibility to be present during the verification procedure
- there are only a few independent laboratories for testing transformers within the EU
- most experts in transformer technology are working for enterprises.
- One MSA operative has suggested that products with a rated capacity of up to 3150 kVA can use self-certification as “normal”, but that those above 3150 kVA are Engineered-to-Order (ETO) and will need a different approach for conformity verification and potentially conformity assessment.

[7] CIRCABC is an extranet tool, developed under the European Commission IDA programme, and tuned towards the needs of Public Administration. It enables a given community (e.g. committee, working group, project group etc.) geographically spread across Europe (and beyond) to maintain a private space on the Internet where they can share information, documents, participate in discussion fora and benefit from various other functionalities. http://circa.europa.eu

[8] https://www.icsms.org

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4. Ecodesign conformity verification for transformers – business practice and MSA issues

This chapter discusses business practices that are relevant to market surveillance and conformity verification for power transformers. It begins by considering business practices, supply chain considerations and factory acceptance testing. It then explores the experiences of MSAs in conducting Ecodesign market surveillance conformity verification for transformer and examines the implications this has on the most appropriate means of conducting such assessments, through the examination of market surveillance approaches. The intention is to inform MSAs of how businesses currently procure and deliver products and the implications that MSA activities may have on their business, and equally to inform business of the realities confronting MSAs. The hope is that by clearly laying out the issues that it will help identify the most promising approaches towards conducting market surveillance conformity verification and help build consensus on how best to address this need.

4.1 Business practices to establish product performance

4.1.1 Business to business procurement practice

An extensive consultation with transformer manufacturers has established that the clients for large power transformers are predominantly utilities, especially electricity Generators and Transmission System Operators who need very high voltage step-up and/or step-down power transformers. In some cases industrial clients may also procure such products. The process for procuring the products entails the client either issuing a call to tender directly, or appointing an EPC (electrical engineering performance consultancy) to manage the procurement and installation process on their behalf. This means that there can be more than one party involved in procuring and installing the product.

For high value electro-technical products such as large power transformers the team working on behalf of the final client will include a number of product approval stages in the procurement process. These may include detailed design reviews and factory acceptance testing, both of which are described below.

4.1.2 Detailed design review

A design review is a milestone within a product development process whereby a design is evaluated against its requirements in order to verify the outcomes of previous activities and identify issues before committing to - and if need to be re-prioritise - further work. The ultimate design review, if successful, therefore triggers the product launch or product release.

In the case of large customised power transformers a detailed design review may be requested by the client, or the EPC operating on behalf of the final client. The review would then be conducted by technical experts engaged by the client/EPC and who are external to the transformer manufacturer's design team.

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The design review process could entail any combination of:

- physical tests
- engineering simulations
- physical inspections (e.g. a walk-through assessment)

which are conducted in order to evaluate a design against its requirements. As transformer performance can be characterised with a reasonable degree of accuracy through software simulations that capture the essential physical laws of electromagnetism and link them to readily definable input design parameters, there is a widespread use of such simulation tools when conducting the design review assessments. The bill of materials (BOM) is a fundamental input to such software, albeit there are still uncertainties caused by variations in nominally identical materials e.g. it is reported that variations in the electromagnetic performance of nominally identical grades of electrical steel can result in a certain level of variability of actual designs against the simulated values.

Timing of design reviews

Most formalised systems engineering processes recognise that the cost of correcting a fault increases as it progresses through the development process. Additional effort spent in the early stages of development to discover and correct errors is therefore likely to be worthwhile. Design reviews are example of such an effort. Therefore, a number of design reviews may be carried out, for example to evaluate the design against different sets of criteria (consistency, usability, ease of localisation, environmental) or during various stages of the design process.

4.1.3 Factory acceptance testing

The general purpose of a Factory Acceptance Test (FAT) is to ensure that a new piece of equipment is 'fit for purpose' before releasing the equipment for delivery to site for installation. After agreeing a quality control plan with an equipment supplier as part of contract negotiations, the Factory Acceptance Test is the most significant activity within the overall plan. Once equipment has passed a factory acceptance test, it is ready for shipment to site to be installed.

Typical inspection activities during a factory acceptance test could include a review of the following:

- quality inspection plans
- general arrangement drawings
- bill of material records
- sub-component supply records
- fabrication records
- equipment critical dimensional checks
- welding qualifications and test piece records
- non-destructive testing records
- calibration records of measuring equipment
- suitability of the design for the application
- control and instrumentation systems

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- condition-based monitoring tools and systems
- packing list
- packaging plans
- shipment insurance policies.

Some ‘spot checks and re-measurements’ of critical dimensions would normally be expected and witness-checked (if practical) to confirm the equipment suppliers’ dimensional records are reliable. In addition, a variety of physical inspections of the finished equipment would take place to review elements of the quality documentation.

Particular attention is required for tolerance-fit items to ensure typical industry standards have been followed and that a manufacturer has followed its own internal procedures.

In some cases the capability of the manufacturing facilities being used is investigated to understand quality control procedures and typical tolerance capability of the machinery being used to manufacture components.

In practice commercial contractual arrangements are such that FATs are undertaken for all large power transformer orders. While they may not include all the steps set out above at a minimum they will involve witness testing of the transformers performance, including its energy performance in accordance with the EU’s harmonised test standards. These tests will be conducted at the manufacturers premises.

4.2 Supply chain considerations

This section considers the supply chain issues that are likely to affect the choice of the most viable market surveillance process.

4.2.1 Actors involved

At its simplest there are two businesses involved in the procurement and placing on the market of a large power transformer (LPT), the manufacturer and the business that placed the order. The business placing the order may be the same as the one that will take delivery of, put into service and use the LPT. If this is the case they will have all the required competences in house. Very often though, the final client will hire one or more intermediaries to act on their behalf. Most commonly these are the EPC (electrical engineering performance consultancies) mentioned in section 4.1.1.

It is also possible, but very rare, that the client placing the order is not acting directly on behalf of the business that will ultimately use the product. For example, a power project development company may procure a LPT as part of say a renewable power generation project that they intend to develop on behalf of a final client who they will ultimately sell the assets to, including the LPT.

Nonetheless, despite these complexities the final destination of the LPT (i.e. the place where it will enter into service) will always be known when the order to manufacture the LPT is placed. In practice no project developer will take the risk of placing such an order if they have not already secured the approval of the final client. This means there are no business circumstance when LPTs are bought by an intermediary and stored for any significant time prior to shipping to the final destination. This is important because it means that the MSA with authority for the region where the LPT will eventually be installed is knowable at the moment the order is placed. This means that in theory the MSA *could* be notified at that stage that a transformer is about to be manufactured that is intended to be installed in the region for which they have authority.

Once the LPT leaves the factory it is then considered to be in a state of having been placed on the market, however, it will need to be freighted to its destination, installed and commissioned before it is put into service. The freightage process will involve using the services of one or more haulage company and in the event that a product is shipped will include interaction with port authorities. If a hard trade border is being crossed then customs authorities will also be concerned.

Once the LPT arrives at site contractors will take delivery and undertake its installation and commissioning. As a final step before it is allowed to be put into service a conformity assessment body with responsibility for electrical safety will conduct a mandatory safety check prior to issuance of an operational permit , see INTAS Deliverable 3.5.

4.2.2 Freightage of large power transformers

Once the LPT has undergone its FAT and is approved by the client or their representative, it will be transported to the place where it is due to be installed. Most commonly this will involve shipping a product and often road freightage. Typically, the LPT will be freighted in one piece except for separate crates containing connectors and various ancillary parts. This means that once the LPT has left the factory it requires a degree of reassembly before it can be operated and tested, including if it is to be tested by a 3rd party. Very occasionally for the largest of LPT's it is possible that they may be shipped in two major parts, as well as crates containing the ancillary parts. This is a very rare occurrence, however.

4.2.2.1 Transportation on roads

For regular road transport in Europe vehicles must comply with certain rules with regards to weights and dimensions for road safety reasons and to avoid damaging roads, bridges and tunnels. This is regulated by Directive (EU) 2015/719 and limited to 40 tonnes (incl. trailer), 2.6 meter width, 4 meter height (incl. trailer) and 12 meter length. These limits are designed to allow the transport of standard containers according to the international standard ISO 668, but these are insufficient for large power transformers. Consequently, regular road transport can only be used for smaller power transformers such as distribution transformers.

For larger and heavier products, special road transports have to be used (Figure) and limits which apply to these depend on local circumstances and permits that vary from one Member State to another. The Ecodesign Preparatory Study to review the requirements for Regulation No. 548/2014 investigated the degree of commonality in such requirements but found there was very little. For example, in Norway the limits for special road transport limits are 10 m long, 3,7 m in width, 4,5 m in height and a maximum weight of 250 tonnes while Italy reported limits of 18,75 m long, 2,55m in width and 4 m height without any weight limits. Therefore, road haulage of any power transformer is likely to encounter transportation limits at some point. When products are being moved in accordance to such limits they often have to notify and seek approval from the local road network authorities, so in principal these authorities could also inform Ecodesign MSAs when such approval is sought for a large power transformer. This could help alert the MSA to the imminent installation of an LPT.

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Figure 6. Exceptional road transport of a transformer (source: Scheuerle-Nicolas catalogue[9])

4.2.2.2 Transportation on railways

As is the case for road transport railways also have transportation dimension and weight limits (e.g. Figure and Table). They are not harmonised across Europe nor within any given country because they can depend on the local railway infrastructure such as bridges.

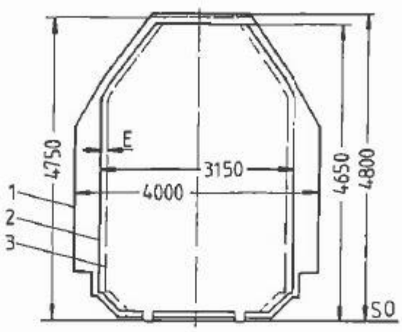

Bild 6.3: Begrenzung beim Schienentransport gemäß der Eisenbahn-Bau- und Betriebsvorschrift

1 Umgrenzung des lichten Raumes (Regellichtraum)
2 Begrenzung II für Fahrzeuge (Lademaß)
3 eingeschränktes Lademaß (E Einschränkung durch Auswanderung in Kurven)
SO Schienenoberkante

Figure 7. Dimensional limits for railroad transport in Germany (source: Deutsche Bahn)

[9] Available from https://www.scheuerle.com/

Table 5. Dimension and weight limits for railway transport in France.

Caractéristiques du convoi	1 ère catégorie	2 ième catégorie	3 ième catégorie
Longueur	L ≤ 20 m	20 m < L ≤ 25 m	L > 25 m
Largeur	l ≤ 3 m	3 m < l ≤ 4 m	l > 4 m
Masse	M ≤ 48 t	48 t < M ≤ 72 t	M > 72 t

4.2.3 Supply chain timing

The process of procuring large power transformers, from the acceptance of a tender through to the manufacture, delivery and installation of a product will usually take several months to conclude. According to transformer manufacturers interviewed they will make arrangements regarding the date of the FAT with the client's representatives at least 6 weeks in advance of the date of the FAT. Once a FAT has been approved by the client transportation to site will usually occur shortly afterwards. The time taken to deliver the product obviously depends on the distance to be travelled and modes of transport required. Once at the site the installation and commissioning of the LPT can take quite varying lengths of time depending on the site conditions, the stage the overall project is at and the readiness of the contractors managing the project. The process of requesting and expediting an official safety check immediately prior to putting the transformer into service is understood to be quite efficient in most Member States but no information with regard to the typical times taken has been made available to this project.

4.3 Country level experience

4.3.1 MS conformity verification experience for transformers

Regulation No. 548/2014 is a relatively new Ecodesign requirement, only being adopted in 2014 and with its Tier 1 efficiency requirements only coming into effect in mid-2015. In consequence, there has been very limited experience among EU MSAs in conducting Ecodesign conformity assessment for this product group thus far although several are reported to be planning such actions.

The Ecodesign conformity verification approach undertaken by MSAs involves:

- identifying which products are on the market
- screening for risks of non-compliance
- selecting products for conformity verification actions
- conducting conformity verification actions.

The screening process is optional and is discussed in more depth in INTAS Deliverable 3.8.

The conformity verification actions include:

- checking the CE marking
- document inspection
- rating plate inspection
- conformity verification testing.

The conduct of document and rating plate inspections is discussed in INTAS Deliverable 3.2.

In a case of performing an inspection, an MSA will review the product for the presence of the CE mark and will ask for technical documentation – including a declaration of conformity and test reports (showing the results of performance measurements which the Ecodesign requirements specify the product must respect) to verify the product's compliance. The results of measurements are part of the modules described in Annex IV and Annex V, of Ecodesign Directive 2009/125/EC.

A product will always fail the conformity verification if its technical documentation and/or rating plate are found not to conform to the requirements; however, assuming that they do the next step would be to select some products for conformity verification testing. The methods available to do this are discussed in the next sub section 4.3.2.

4.3.2 MS conformity assessment models for power transformers

The conventional approach used for conformity verification testing of the large majority of products subject to Ecodesign requirements is illustrated in Figure 8. This approach ensures legally enforceable outcomes and for standard products e.g. consumer products and small/medium sized commercial and or industrial products manufactured as part of a series and advertised in catalogues (on line or printed) it is straightforward to identify products which have been placed on the market, is affordable to conduct verification testing, and does not entail undue disruption of the supply chain and hence costs and inconvenience for product procurers.

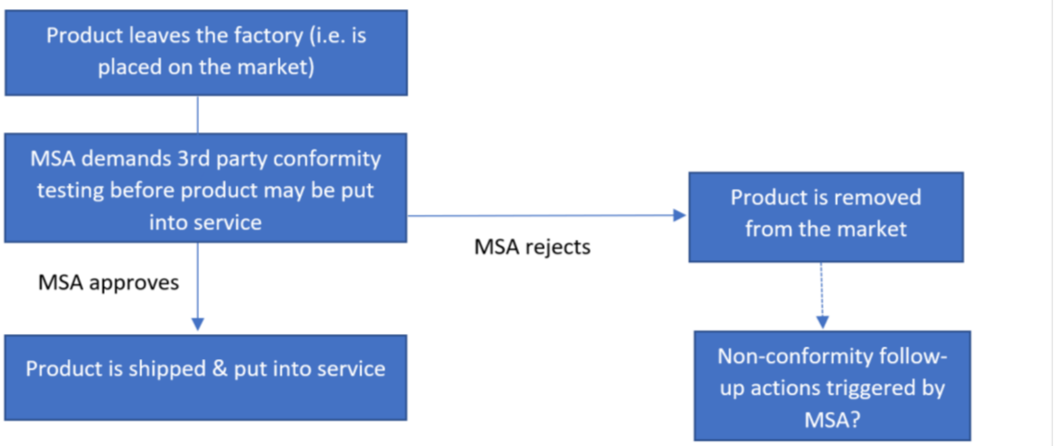

Figure 8. Conventional Ecodesign market surveillance conformity verification testing approach

4.3.2.1 Situation applying to large power transformers

Conventional conformity verification approach

For large power transformers, however, the situation is different. In this case the products are made to order under B2B procurement processes that are invisible to the MSA. Products are not placed in catalogues and are not produced in series, which means that they are not advertised (and hence neither are their technical characteristics) and thus MSA's cannot follow conventional market surveillance practices to determine when they have been placed on the market. In addition, even if the MSA can establish when a product has been placed on the market there are major difficulties and burdens to be addressed, as follows.

As the product has already left the factory premises once it has been placed on the market the MSA can either select the product for verification testing when it is in transit, or when it has arrived at the place of installation prior to being put into service. The former is only likely to be viable if the product is passing through customs controls, which does not happen if the product is being transported within a country or a fully frictionless border such as occurs within the Schengen signatories. The latter case would require the MSA to take the product off-site and would cause significant inconvenience and costs to the final client who may have scheduled major business operations based on the delivery date of the product agreed with the supplier.

Thus, if the conventional conformity verification approach is used for large power transformers is has the following characteristics.

Advantages:

a) the conformity verification tests are fully legally enforceable.

Weaknesses:

a) the MSA needs to be able to intercede before the product is put into service, but will have considerable challenges in knowing that the product is being placed on the market

b) high 3rd party testing costs

c) significant costs (from delay and lost service) incurred by the client for the product.

The first weakness listed above means that MSAs would only be able to intercede if they knew the product has been, or is imminently, being placed on the market and for B2B transactions involving one off customized products that process is not currently visible to MSAs. In practice, then this means that the most likely point where MSAs would be able to intervene are at customs borders (e.g. docks) or once the transformer has arrived at site – especially if they have been notified by the Conformity Assessment Body (CAB) managing electrical safety checks.

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Witness testing conformity verification approach

To provide an additional option the requirements with regard to the verification procedure for market surveillance purposes specified in the power transformer Ecodesign regulation anticipated that there might be a need for MSAs to conduct witness testing of product conformity at the manufacturer's premises prior to the product being placed into service. Specifically, Annex III of Regulation No. 548/2014 states that:

> "Given the weight and size limitations in the transportation of medium and large power transformers, Member States authorities may decide to undertake the verification procedure at the premises of manufacturers, before they are put into service in their final destination".

Figure 9 below illustrates the witness testing approach and the text beneath it summarises its strengths and weaknesses. Overall, the principal benefits of MSAs doing conformity verification via witness testing at the manufacturer's premises are that it avoids placing a burden onto the manufacturer and client because the manufacturer and MSA can arrange for the witness test to be carried out when the standard factory acceptance test is being conducted. Because such FATs are already standard commercial practice for large customized power transformers there is negligible extra burden incurred from MSAs sending a witness to the test. This also means that the only costs incurred by the MSA are solely those involved with arranging to have an expert witness be present at the test, and hence will be considerably less expensive than conducting 3rd party verification testing, which requires test lab and logistics costs to be covered as well as insurance costs for loss or damage (which could be considerable for such valuable products). FAT witness testing thus allows more MSA conformity verification to be done at less cost.

On the downside, the MSA needs to be able to intercede before the product is definitively placed on the market, which, at a minimum, requires knowledge that an order has been placed but also requires cooperation from the producer. If the MSA is from the same country as the manufacturer then they may be able to oblige the producer to inform them when an order has been placed so that they can arrange a witness test should they choose to. If it is not, then they need to find other means of knowing when an order has been placed and hence being able to request a witness test. In addition, witness tests are unlikely to be so robust from an MSA conformity verification perspective as 3rd party testing. The MSA would be reliant on finding a technically qualified independent expert to witness the test. Then the expert has to be technically capable of not only ensuring that the test facilities and test equipment are capable of doing the test correctly, are properly calibrated and set-up and that the factory testing staff are following correct procedures, but also of ensuring that there is no manipulation taking place during the testing or reporting of the results. Furthermore, the fact that the tests are not conducted in an accredited 3rd party test lab may render the outcome less legally enforceable. Even more so because under the current wording in the Ecodesign regulation it is unclear whether a product that undergoes Ecodesign witness testing on a manufacturer's premises has yet been placed on the market. In practice, if an MSA were to find that a FAT witness test was unacceptable they could certainly threaten the producer with immediate 3rd party verification testing if they attempted to ship the product without having made modifications and passed a 2nd witness test.

As these 3rd party test costs would be charged to the producer, and the MSA would certainly notify the client of the failed witness test, it is highly unlikely that the producer would attempt to place the product on the market without it being approved by both the MSA and the client (especially, given that it is a made to order customized product). However, this is probably as far as the sanctions imposed by the MSA could go due to the difficulty of independently demonstrating non-compliance. Nonetheless, the threat of a lost order and significant stranded assets is still a powerful deterrent.

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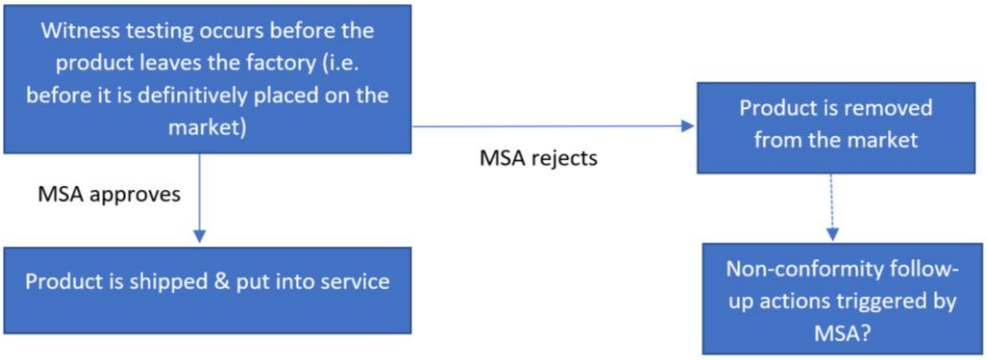

Figure 9. Ecodesign conformity verification through witness testing at place of manufacture approach

Advantages:

a) much cheaper than 3rd party testing and not limited by availability of testing facilities

b) minimises delays and inconvenience for both manufacturer and client.

Weaknesses:

a) the MSA needs to be able to intercede before the product is definitively placed on the market, which, at a minimum, requires knowledge that an order has been placed but also requires cooperation from the producer to access their facilities

b) sanctions in event of non-conformity may not be legally enforceable other than prohibiting the product from being placed on the EEA market

c) testing is not fully independent, which may permit some manipulation

d) testing facilities are not necessarily/ likely to be accredited

e) other lab competences, such as proper calibration and procedures, would need to be confirmed.

Conformity verification testing when putting into service approach

Given the inherent problems of knowing when a large customized transformer is being placed on the market a 3rd conformity verification testing option is to conduct testing when the product is being put into service.

In principle there are two sub-options that could be applied. One is illustrated in Figure 10 and involves the product being taken from the site where it is due to be put into service and subjected to 3rd party verification testing.

The other is shown in Figure 11 and concerns the product being tested in situ. In theory, it would also be possible to arrange to have a product tested after it has been put into service (by either of the above methods) but this would require it to be taken out of service and would disrupt the service it is providing. In the case of large power transformers which are mostly used for electricity transmission networks this could be a prohibitively disruptive and costly exercise for the transformer client and may even be subject to legal challenge; therefore, this is not considered any further.

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The only advantage that 3rd party testing when putting into service offers over 3rd party testing when placing on the market is that it is potentially much more straightforward for the Ecodesign MSA to be informed that the product exists and is already placed on the market. All it would require is agreement with the electrical safety CAB to inform the MSA that a product has been placed on the market and to inform them of the date of the electrical safety inspection test. The downside is that were an MSA to intervene to require 3rd party testing once a product has arrived at site then they risk imposing unscheduled delays on the client, while the product is removed and sent for testing, which may incur significant operational costs to the client.

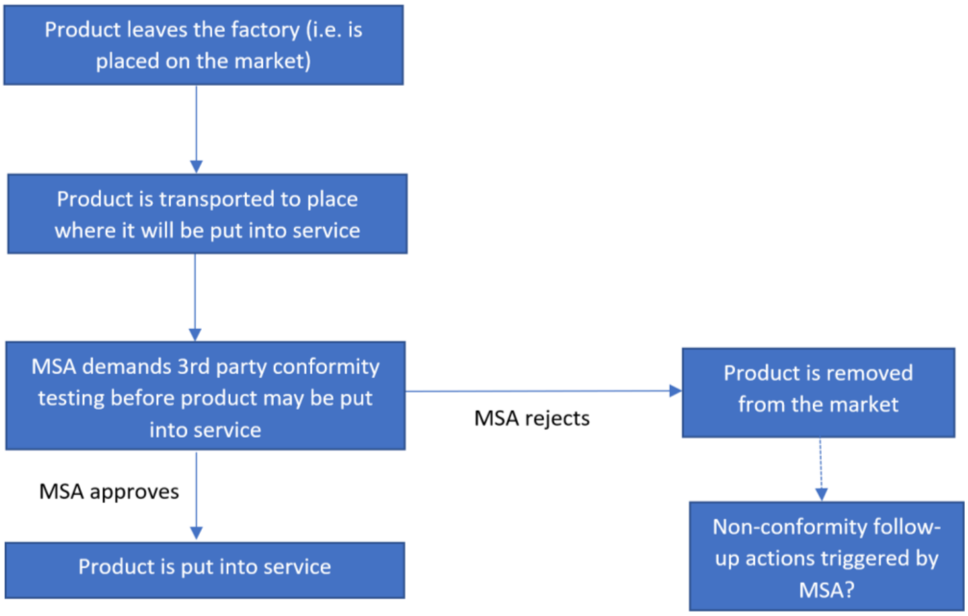

Figure 10. Ecodesign conformity verification via 3rd party testing when putting into service

Advantages:

a) the conformity verification tests are fully legally enforceable

b) knowledge of when the product is placed on the market is not required; only of when it is being put into service (which can be provided by the electrical safety CAB and others)

Weaknesses:

a) the MSA needs to know the product is being put into service to intercede (note, this is not as onerous as knowing the product is being placed on the market)

b) high 3rd party testing costs

c) significant costs (from delay and lost service) incurred by client while product undergoes third party testing.

In principle, in situ testing when a product is due to be put into service overcomes the problem of the high burden of 3rd party testing on the client. In situ testing can be done by mobile testing equipment and is quick to set up and conduct, thus there is only a minor delay incurred before a compliant product could be put into service, which is a major benefit. However, in situ energy performance testing cannot fully conform to the current harmonized standard, thus it does not result in a legally enforceable outcome. Rather, at present were a power transformer to fail an in situ performance test the MSA could inform the client, who would then potentially have the option to not accept the product until the supplier has been able to demonstrate that it does comply with the regulations and stated energy performance (note, this is likely to depend on the nature of the contractual arrangement between the client and the supplier). The MSA could also chose to use failure of an in situ test as a trigger for legally enforceable 3rd party testing; however, as this latter step would add an additional testing cost layer and would also result in operational delays and costs for the client, the MSA may only choose to pursue this course if they are quite confident that the product would also fail the 3rd party test and that legal measures could then be taken.

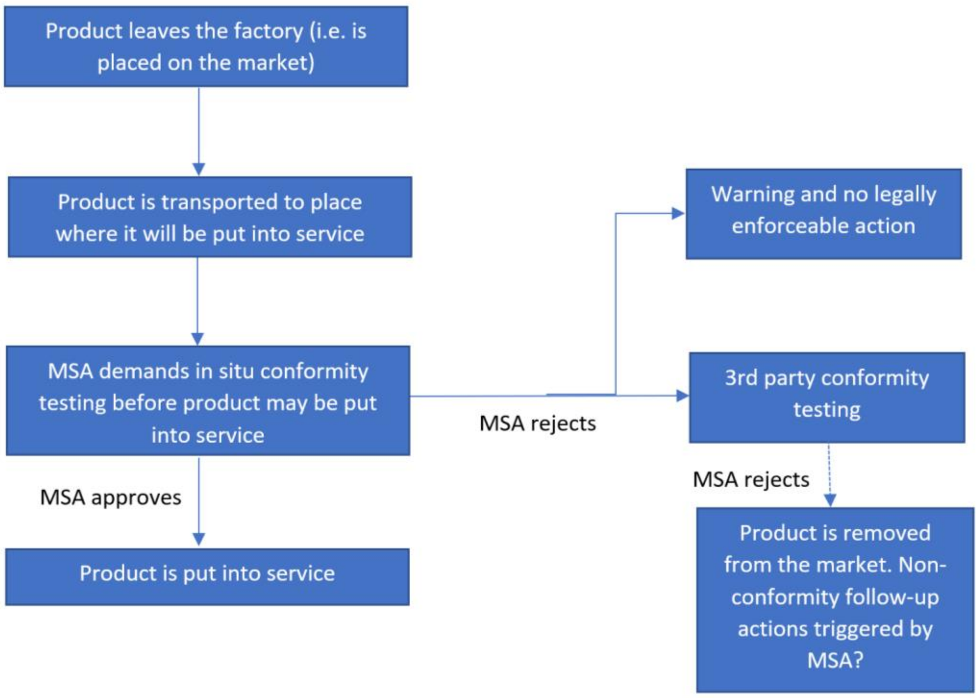

Figure 11. Ecodesign conformity verification via in situ testing when putting into service

Advantages:

a) knowledge of when the product is placed on the market is not required; only of when it is being put into service (which can be provided by the electrical safety CAB and others)

b) the conformity verification tests are fully legally enforceable if a product that fails the in situ test is subsequently sent for 3rd party testing

c) even if legally enforceable 3rd party testing is not conducted (which would likely be at the supplier's expense if still found to be non-compliant) the MSA could inform the client and leave it with them as to how to proceed

d) availability of 3rd party test facilities capable of testing the product are not needed

e) the client will only incur a short (it can be negligible i.e. a few hours) delay before the product can be put into service providing it complies.

Weaknesses:

a) the MSA needs to know the product is being put into service to intercede (note, this is not as onerous as knowing the product is being placed on the market)

b) high in-situ testing costs

c) in situ testing facilities may not be available

d) high 3rd party testing costs could still be incurred in the event there is a need for a legally enforceable conformity verification ruling

e) significant costs (from delay and lost service) incurred by client for product if 3rd party testing is required.

4.3.3 Assessing regulatory scope and managing exemptions

In general, MSAs have reported no difficulties in determining whether a power transformer is within scope of the regulation 548/2014 or not. It is usually a straightforward matter to determine the rating characteristics and hence whether the regulations are applicable to the product and what specific requirements apply. However, there is one aspect that is liable to be more challenging.

Regulation 548/2014 includes an exemption for

> 'large power transformers which are like-for-like replacements in the same physical location/installation for existing large power transformers, where this replacement cannot be achieved without entailing disproportionate costs associated to their transportation and/or installation'

In practice, no MSA has yet reported this exemption being applied[10] so the process of determining eligibility remains untested. There has been speculation that this could change once Tier 2 requirements come into effect in 2021 as some of the improvement options to reduce transformer losses can increase transformer size and weight and therefore it might become more difficult to transport the largest power transformers after Tier 2 requirements come into effect.

4.3.4 Auditing a manufacturer's management system

As reported in section 2.1 one conformity verification option permitted under the Ecodesign Directive is auditing a manufacturer's (environmental) management system (see Art. 8 and Annex V of Ecodesign Directive 2009/125/EC).

> Where a product covered by implementing measures is designed by an organisation registered in accordance with Regulation (EC) No 761/2001 of the European Parliament and of the Council of 19 March 2001 allowing voluntary participation by organisations in a Community eco-management and audit scheme (EMAS) (1) and the design function is included within the scope of that registration, the management system of that organisation shall be presumed to comply with the requirements of Annex V to this Directive.

[10] MSAs have been questioned on this through the conduct of this project and also under the Regulation 548/2014 review Preparatory Study.

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> If a product covered by implementing measures is designed by an organisation having a management system which includes the product design function and which is implemented in accordance with harmonised standards, the reference numbers of which have been published in the Official Journal of the European Union, that management system shall be presumed to comply with the corresponding requirements of Annex V.

Thus far, no MSA is known to have conducted such an audit, however, at least one is reported to be in the process of trialling this option. Views among MSAs currently seem to vary about the potential efficacy and viability of such an approach. Some have speculated that were manufacturers to have secured accreditation issued by a NAB (National Accreditation Body) for the Ecodesign performance tests that this could be used as evidence of conformity. However, they have also noted that while accreditation puts demands on the independence of the organization performing the testing (i.e. they have to satisfy the procedures and competences set out in ISO 17025) that implementing this within Ecodesign conformity assessment would require a change in the verification process under the Ecodesign Directive, as currently verification is done by the manufacturer without any demands on accreditation (third party verification).

Other MSAs have noted that control or audit of quality systems at a manufacturer's premises is a competence of a conformity assessment body conducted in accordance with designated conformity procedure modules. The distinction is that market surveillance addresses activities carried out and measures taken by public authorities to ensure that products comply with requirements set out in the relevant Community harmonization legislation, while a conformity body is a body that performs conformity assessment activities including calibration, testing, certification and inspection according to article 2 (13) and (17) of the Regulation 765/2008/EC.

Yet other MSAs have questioned the degree to which such audits can demonstrate that products produced at the audited site will be in conformity with the relevant Ecodesign regulation.

5. Conclusions and recommendations

5.1 Summary of findings

The material assembled in the main body of the report has described the business practices employed in the procurement, production, approval, supply and installation of LPTs that have a bearing on the viability of different market surveillance approaches and has analysed the implications of these factors on the prospective approaches that MSAs may opt to use to conduct effective Ecodesign conformity verification.

It is found that the standard Ecodesign market surveillance conformity verification approach based on selecting a product for 3rd party verification testing is not very well adapted to LPTs because:

- LPTs are customised made-to-order products that are procured under private B2B commercial arrangements and hence they are not produced in series, are not ordinarily available at a manufacturers premises for sampling, and are not advertised – which means that MSAs cannot employ usual market research methods to establish whether a product is placed on the market or not, and to sample and test the product

- even when it is established that a product is placed on the market, conducting 3rd party testing once a product has left the factory premises is very costly to conduct and is liable to be disruptive and costly (in terms of lost operational value) to the business who has procured the product.

By contrast, market surveillance conformity verification based on witnessing factory acceptance tests, which is permitted under the Ecodesign regulation applying to transformers, is much less costly and disruptive; however, it also presents challenges due to:

- the difficulty of an MSA knowing that a product order has been placed and hence being able to request a witness test

- challenges MSAs face in securing expert 3rd party technical assistance to conduct this form of conformity verification

- the potential for manipulation of test results

- possible limits on the legal powers that can be exercised in the event an MSA rejects a product following a witness test.

Prospective alternative approaches including 3rd party testing prior to commissioning (i.e. putting into service on site), in situ testing and conformity verification of environmental management systems are also considered but are found to be unviable, or too immature to be used at present without further development.

Overall it is found that key areas need to be improved to enable effective conformity verification for these products or there is a risk that MSAs may feel obliged to assess conformity in ways that will produce legally defensible results with high integrity but that risk incurring significant costs to themselves and to the businesses at each end of the supply chain.

5.2 Recommendations

It is proposed that MSA conformity verification approaches be structured to take the findings of this report into account when considering the different prospective verification testing pathways.

A key fundamental need, that requires robust action, is to ensure that mechanisms are put in place to maximise the likelihood that an MSA will be informed that a transformer will be placed on the market and put into service. To this end, Ecodesign MSAs are strongly encouraged to establish relationships with the following entities:

- any manufacturers of large power transformers
- all enterprises likely to procure large and medium power transformers – most, notably electricity generators, TSOs, DSOs and large industrial enterprises
- the conformity assessment bodies responsible for certifying the electrical safety of a transformer and granting it a license to be operated.

For the former, they should establish an agreement that they will inform the MSA once they have placed an order for a power transformer and share the main details concerning the type of product and main characteristics, the supplier including contact details, the expected dates of completion, the factory acceptance test and delivery.

For the latter, they should secure an agreement that they will systematically inform the MSA once they have received a request to conduct a safety assessment of a new power transformer and share the main details concerning the type of product and its characteristics, the enterprise who is having the product installed including the location of where it will be put into service and their contact details, the supplier including contact details, the expected dates of the safety test and of putting into service.

In addition, it is also advisable that the MSA makes an agreement with the principal ports, rail terminals, customs authorities –for imports to the Single Market- and the authorities charged with granting approval for large loads to be moved via road haulage to ensure they are notified whenever a large or medium power transformer shipment come to their notice.

In this way MSAs can close the information gap that currently makes it difficult for them to conduct market surveillance and conformity verification for these products.

If MSAs are informed when the order for the power transformer is first placed then they have the option of seeking to conduct conformity verification via FAT witness testing at the place of manufacture (presuming it is the same Member State as the place of installation). Otherwise, any conformity verification testing would need to occur while the product is in transit or is poised to be put into to service. The possibility that MSAs may choose to do this if market actors have not chosen to inform them soon enough for a witness test to be conducted should serve as a deterrent against this behaviour, as it risks incurring significant lost service (downtime) costs to the product procurer. Note, the option to test in transit is true whether the product is manufactured within the EEA or not and hence helps to address any potential asymmetry of treatment that might create an unlevel playing field based on the location of the supplier.

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While witness of factory acceptance tests addresses many of the most important deficiencies in the other market surveillance verification testing approaches, in that it is the most affordable and the least disruptive and costly to suppliers, it still requires improvement to be made fully viable. The most important needs are:

- to properly document ways that cheating in FATs could occur and to devise strategies to overcome them
- to ensure there is a competent independent 3rd party inspectorate community available for MSAs to hire
- to establish minimum qualification criteria for the supplier's test facilities and test procedures.

It may also be necessary to explore means of allowing external measurement equipment to be used in a manufacturers lab.

Appendix A: Regulation No. 548/2014

II

(Non-legislative acts)

REGULATIONS

COMMISSION REGULATION (EU) No 548/2014

of 21 May 2014

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

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products ([1]), and in particular Article 15 (1) thereof,

After consulting the Ecodesign Consultation Forum,

Whereas:

(1) The Commission has carried out a preparatory study that analysed the environmental and economic aspects of transformers. The study was developed together with stakeholders and interested parties from the Union and the results have been have made publicly available. Transformers are considered as energy related products within the meaning of Article 2(1) of Directive 2009/125/EC.

(2) The study showed that energy in the use phase is the most significant environmental aspect that can be addressed through product design. Significant amounts of raw materials (copper, iron, resin, aluminium) are used in the manufacturing of transformers, but market mechanisms seem to be ensuring an adequate end-of-life treatment, and therefore it is not necessary to establish related ecodesign requirements.

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(3) Ecodesign requirements set out in Annex I apply to products placed on the market or put into service wherever they are installed. Therefore such requirements cannot be made dependant on the application in which the product is used.

(4) Transformers are usually purchased under framework agreements. In this context, purchase refers to the act of contracting with the manufacturer for the delivery of a given volume of transformers. The contract is deemed to have come into force on the date of signature by the parties.

(5) Certain categories of transformers should not be covered by this Regulation, due to their specific function,. The energy consumption and saving potential of such transformers is negligible compared to other transformers.

(6) Regulatory concessions are granted because of the weight limitations for mounting transformers on utility poles. In order to avoid misuse of transformers specifically manufactured for pole-mounted operation, they should include a visible display 'For pole-mounted operation only', so as to facilitate the work of national market surveillance authorities.

(7) Ecodesign requirements for the energy performance/efficiency of medium power transformers and for the energy efficiency of large power transformers should be set with a view to harmonising ecodesign requirements for these devices throughout the Union. Such requirements would also contribute to the efficient functioning of the internal market and to improving Member States' environmental performance.

(8) Establishment of ecodesign requirements for medium and large power transformers is also necessary to increase the market penetration of technologies and design options improving their energy performance or efficiency. Total losses of the transformers fleet in the EU27 in 2008 amounted to 93,4 TWh per year. The cost-effective improvement potential through more efficient design has been estimated in about 16,2 TWh per year in 2025, which corresponds to 3,7 Mt of CO_2 emissions.

(9) It is necessary to provide for a staged entry into force of the ecodesign requirements in order to provide an appropriate timeframe for manufacturers to redesign their products. Time limits for the implementation of those requirements should be set taking into account impacts on the costs for manufacturers, in particular small and medium size enterprises, while ensuring timely achievement of the policy objectives.

(10) To allow an effective implementation of the regulation, National Regulating Authorities are strongly advised to take account of the effect of minimum efficiency requirements on the initial cost of the transformer and to allow for the installation of more efficient transformers than the regulation requires, whenever these are economically justified on a whole life cycle basis, including an adequate evaluation of losses reduction.

(11) To facilitate compliance checks, manufacturers should be asked to provide information in the technical documentation referred to in Annexes IV and V to Directive 2009/125/EC.

(12) The measures provided for in this Regulation are in accordance with the opinion of the Committee established by Article 19(1) of Directive 2009/125/EC,

([1]) OJ L 285, 31.10.2009, p. 10. Regulatory concessions are granted to transformers equipped with equipment capable of performing voltage regulation functions to integrate distributed generation from renewable sources into the distribution grid. Such concessions should gradually be phased out as this emerging technology matures and measurement standards become available to separate the losses associated to the core transformer from those associated to the equipment performing additional functions.

HAS ADOPTED THIS REGULATION:

Article 1

Subject matter and scope

1. This Regulation establishes ecodesign requirements for placing on the market or putting into service power transformers with a minimum power rating of 1 kVA used in 50 Hz electricity transmission and distribution networks or for industrial applications. The Regulation is only applicable to transformers purchased after the entry into force of the Regulation.

2. This Regulation shall not apply to transformers specifically designed and used for the following applications:

— instrument transformers, specifically designed to supply measuring instruments, meters, relays and other similar apparatus,

— transformers with low-voltage windings specifically designed for use with rectifiers to provide a DC supply,

— transformers specifically designed to be directly connected to a furnace,

— transformers specifically designed for offshore applications and floating offshore applications,

— transformers specially designed for emergency installations,

— transformers and auto-transformers specifically designed for railway feeding systems,

— earthing or grounding transformers, this is, three-phase transformers intended to provide a neutral point for system grounding purposes,

— traction transformers mounted on rolling stock, this is, transformers connected to an AC or DC contact line, directly or through a converter, used in fixed installations of railway applications,

— starting transformers, specifically designed for starting three-phase induction motors so as to eliminate supply voltage dips,

— testing transformers, specifically designed to be used in a circuit to produce a specific voltage or current for the purpose of testing electrical equipment,

— welding transformers, specifically designed for use in arc welding equipment or resistance welding equipment,

— transformers specifically designed for explosion-proof and underground mining applications ([1]),

— transformers specifically designed for deep water (submerged) applications,

— medium Voltage (MV) to Medium Voltage (MV) interface transformers up to 5 MVA,

— large power transformers where it is demonstrated that for a particular application, technically feasible alternatives are not available to meet the minimum efficiency requirements set out by this Regulation,

— large power transformers which are like for like replacements in the same physical location/installation for existing large power transformers, where this replacement cannot be achieved without entailing disproportionate costs associated to their transportation and/or installation,

except as regards the product information requirements and technical documentation set out in Annex I, points 3 and 4.

Article 2

Definitions

For the purpose of this Regulation and its annexes the following definitions shall 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) 'Small power transformer' means a power transformer with a highest voltage for equipment not exceeding 1,1 kV.

(3) 'Medium power transformer' means a power transformer with a highest voltage for equipment higher than 1,1 kV, but not exceeding 36 kV and a rated power equal to or higher than 5 kVA but lower than 40 MVA.

(4) 'Large power transformer' means a power transformer with a highest voltage for equipment exceeding 36 kV and a rated power equal or higher than 5 kVA, or a rated power equal to or higher than 40 MVA regardless of the highest voltage for equipment.

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(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) 'Medium power pole mounted transformer' means a power transformer with a rated power of up to 315 kVA suitable for outdoor service and designed to be mounted on the support structures of overhead power lines.

(8) 'Voltage Regulation Distribution Transformer' means a medium power transformer equipped with additional components, inside or outside of the transformer tank, to automatically control the input or output voltage of the transformer for on-load voltage regulation purposes.

(9) 'Winding' refers to the assembly of turns forming an electrical circuit associated with one of the voltages assigned to the transformer.

(10) 'Rated voltage of a winding' (U_r) is the voltage assigned to be applied, or developed at no-load, between the terminals of an untapped winding, or of a tapped winding connected on the principal tapping.

(11) 'High-voltage winding' refers to the winding having the highest rated voltage.

(12) 'Highest voltage for equipment' (U_m) applicable to a transformer winding is the highest r.m.s phase-to-phase voltage in a three-phase system for which a transformer winding is designed in respect of its insulation.

(13) 'Rated power' (S_r) is a conventional value of apparent power assigned to a winding which, together with the rated voltage of the winding, determines its rated current.

(14) 'Load loss' (P_k) means the absorbed active power at rated frequency and reference temperature associated with a pair of windings when the rated current (tapping current) is flowing through the line terminal(s) of one of the windings and the terminals of the other windings are in short-circuit with any winding fitted with tappings connected to its principal tapping, while further windings, if existing, are open-circuited.

(15) 'No load loss' (P_o) means the active power absorbed at rated frequency when the transformer is energised and the secondary circuit is open. The applied voltage is the rated voltage, and if the energized winding is fitted with a tapping, it is connected to its principal tapping.

(16) 'Peak Efficiency Index' (PEI) means the maximum value of the ratio of the transmitted apparent power of a transformer minus the electrical losses to the transmitted apparent power of the transformer.

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(1) Equipment intended for use in potentially explosive atmospheres is covered by Directive 94/9/EC of the European Parliament and of the Council (OJ L 100, 19.4.1994, p. 1).

Article 3

Eco-design requirements

Small power transformers, medium power transformers and large power transformer shall meet the ecodesign require- ments set out in Annex I.

Article 4

Conformity Assessment

Conformity assessment shall be carried out applying the internal design control procedure set out in Annex IV to Direct- ive 2009/125/EC or the management system procedure set out in Annex V to that Directive.

Article 5

Verification procedure for market surveillance purposes

When performing the market surveillance checks referred to in Directive 2009/125/EC, Article 3(2), Member State authorities shall apply the verification procedure set out in Annex III to this Regulation.

Article 6

Indicative Benchmarks

The indicative benchmarks for the best-performing transformers technologically possible at the time of adoption of this Regulation are identified in Annex IV.

Article 7

Review

No later than three years after the entry into force, the Commission shall review this Regulation in the light of technological progress and present the results of this review to the Consultation Forum. Specifically, the review will assess, at least, the following issues:

— the possibility to set out minimum values of the Peak Efficiency Index for all medium power transformers, including those with a rated power below 3 150 kVA,

— the possibility to separate the losses associated to the core transformer from those associated with other components performing voltage regulation functions, where this is the case,

— the appropriateness of establishing minimum performance requirements for single-phase power transformers, as well as for small power transformers,

— whether concessions made for pole-mounted transformers and for special combinations of winding voltages for medium power transformers are still appropriate,

— the possibility of covering environmental impacts other than energy in the use phase.

Article 8

Entry into force

The Regulation shall enter into force on the 20th day following its publication in the *Official Journal of the European Union*.

This Regulation shall be binding in its entirety and directly applicable in all Member States. Done at Brussels, 21 May 2014.

For the Commission
The President
José Manuel BARROSO

ANNEX I

Ecodesign requirements

1. Minimum energy performance or efficiency requirements for medium power transformers

Medium power transformers shall comply with the maximum allowed load and no-load losses or the Peak Efficiency Index (PEI) values set out in Tables I.1 to I.5, excluding medium power pole-mounted transformers, which shall comply with the maximum allowed load and no load losses values set out in Table I.6.

Requirements for three-phase medium power transformers with rated power ≤ 3 150 kVA

Table I.1: Maximum load and no-load losses (in W) for three-phase **liquid-immersed** medium power transformers with one winding with $U_m \leq 24$ kV and the other one with $U_m \leq 1,1$ kV

	Tier 1 (from 1 July 2015)		Tier 2 (from 1 July 2021)	
Rated Power (kVA)	Maximum load losses P_k (W) (*)	Maximum no-load losses P_o (W) (*)	Maximum load losses P_k (W) (*)	Maximum no-load losses P_o (W) (*)
≤ 25	C_k (900)	A_o (70)	A_k (600)	A_o – 10 % (63)
50	C_k (1 100)	A_o (90)	A_k (750)	A_o – 10 % (81)
100	C_k (1 750)	A_o (145)	A_k (1 250)	A_o – 10 % (130)
160	C_k (2 350)	A_o (210)	A_k (1 750)	A_o – 10 % (189)
250	C_k (3 250)	A_o (300)	A_k (2 350)	A_o – 10 % (270)
315	C_k (3 900)	A_o (360)	A_k (2 800)	A_o – 10 % (324)
400	C_k (4 600)	A_o (430)	A_k (3 250)	A_o – 10 % (387)
500	C_k (5 500)	A_o (510)	A_k (3 900)	A_o – 10 % (459)
630	C_k (6 500)	A_o (600)	A_k (4 600)	A_o – 10 % (540)
800	C_k (8 400)	A_o (650)	A_k (6 000)	A_o – 10 % (585)
1 000	C_k (10 500)	A_o (770)	A_k (7 600)	A_o – 10 % (693)
1 250	B_k (11 000)	A_o (950)	A_k (9 500)	A_o – 10 % (855)
1 600	B_k (14 000)	A_o (1 200)	A_k (12 000)	A_o – 10 % (1080)
2 000	B_k (18 000)	A_o (1 450)	A_k (15 000)	A_o – 10 % (1 305)
2 500	B_k (22 000)	A_o (1 750)	A_k (18 500)	A_o – 10 % (1 575)
3 150	B_k (27 500)	A_o (2 200)	A_k (23 000)	A_o – 10 % (1 980)

(*) Maximum losses for kVA ratings that fall in between the ratings given in Table I.1 shall be obtained by linear interpolation.

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Table I.2: Maximum load and no-load losses (in W) for three –phase **dry-type** medium power transformers with one winding with $U_m \leq$ 24 kV and the other one with $U_m \leq$ 1,1 kV.

	Tier 1 (1 July 2015)		Tier 2 (1 July 2021)	
Rated Power (kVA)	Maximum load losses P_k (W) (*)	Maximum no-load losses P_o (W) (*)	Maximum load losses P_k (W) (*)	Maximum no-load losses P_o (W) (*)
≤ 50	B_k (1 700)	A_o (200)	A_k (1 500)	A_o – 10 % (180)
100	B_k (2 050)	A_o (280)	A_k (1 800)	A_o – 10 % (252)
160	B_k (2 900)	A_o (400)	A_k (2 600)	A_o – 10 % (360)
250	B_k (3 800)	A_o (520)	A_k (3 400)	A_o – 10 % (468)
400	B_k (5 500)	A_o (750)	A_k (4 500)	A_o – 10 % (675)
630	B_k (7 600)	A_o (1 100)	A_k (7 100)	A_o – 10 % (990)
800	A_k (8 000)	A_o (1 300)	A_k (8 000)	A_o – 10 % (1 170)
1 000	A_k (9 000)	A_o (1 550)	A_k (9 000)	A_o – 10 % (1 395)
1 250	A_k (11 000)	A_o (1 800)	A_k (11 000)	A_o – 10 % (1 620)
1 600	A_k (13 000)	A_o (2 200)	A_k (13 000)	A_o – 10 % (1 980)
2 000	A_k (16 000)	A_o (2 600)	A_k (16 000)	A_o – 10 % (2 340)
2 500	A_k (19 000)	A_o (3 100)	A_k (19 000)	A_o – 10 % (2 790)
3 150	A_k (22 000)	A_o (3 800)	A_k (22 000)	A_o – 10 % (3 420)

(*) Maximum losses for kVA ratings that fall in between the ratings given in Table I.2 shall be obtained by linear interpolation.

Table I.3: Correction of load and no load losses in case of other combinations of winding voltages or dual voltage in one or both windings (rated power ≤ 3 150 kVA)

One winding with $U_m \leq 24$ kV and the other with $U_m > 1,1$ kV	The maximum allowable losses in Tables I.1 and I.2 shall be increased by 10 % for no load losses and by 10 % for load losses
One winding with $U_m = 36$ kV and the other with $U_m \leq 1,1$ kV	The maximum allowable losses in Tables I.1 and I.2 shall be increased by 15 % for no load losses and by 10 % for load losses
One winding with $U_m = 36$ kV and the other with $U_m > 1,1$ kV	The maximum allowable losses indicated in Tables I.1 and I.2 shall be increased by 20 % for no load losses and by 15 % for load losses

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Case of dual voltage on one winding	In case of transformers with one high-voltage winding and two voltages available from a tapped low-voltage winding, losses shall be calculated based on the higher voltage of the low-voltage winding and shall be in compliance with the maximum allowable losses in Tables I.1 and 1.2. The maximum available power on the lower voltage of the low-voltage winding on such transformers shall be limited to 0,85 of the rated power assigned to the low-voltage winding at its higher voltage.
	In case of transformers with one low-voltage winding with two voltages available from a tapped high-voltage winding, losses shall be calculated based on the higher voltage of the high-voltage winding and shall be in compliance with the maximum allowable losses in Tables I.1 and I.2., The maximum available power on the lower voltage of the high-voltage winding on such transformer shall be limited to 0,85 of the rated power assigned to the high-voltage winding at its higher voltage.
	If the full nominal power is available regardless of the combination of voltages, the levels of losses indicated in Tables I.1 and I.2 can be increased by 15 % for no load losses and by 10 % for load losses.
Case of dual voltage on both windings	The maximum allowable losses in Tables I.1 and I.2 can be increased by 20 % for no load losses and by 20 % for load losses for transformers with dual voltage on both windings. The level of losses is given for the highest possible rated power and on the basis that the rated power is the same regardless of the combination of voltages.

Requirements for medium power transformers with rated power > 3 150 kVA

Table I.4: Minimum Peak Efficiency Index (PEI) values for **liquid immersed** medium power transformers

Rated Power (kVA)	Tier 1 (1 July 2015)	Tier 2 (1 July 2021)
	Minimum Peak Efficiency Index (%)	
$3\,150 < S_r \leq 4\,000$	99,465	99,532
5 000	99,483	99,548
6 300	99,510	99,571
8 000	99,535	99,593
10 000	99,560	99,615
12 500	99,588	99,640
16 000	99,615	99,663
20 000	99,639	99,684
25 000	99,657	99,700
31 500	99,671	99,712
40 000	99,684	99,724

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Minimum PEI values for kVA ratings that fall in between the ratings given in Table I.4 shall be calculated by linear interpolation.

Table I.5: Minimum Peak Efficiency Index (PEI) values for **dry type** medium power transformers

Rated Power (kVA)	Tier 1 (1 July 2015)	Tier 2 (1 July 2021)
	Minimum Peak Efficiency Index (%)	
3 150 < S_r ≤ 4 000	99,348	99,382
5 000	99,354	99,387
6 300	99,356	99,389
8 000	99,357	99,390
≥ 10 000	99,357	99,390

Minimum PEI values for kVA ratings that fall in between the ratings given in Table I.5 shall be calculated by linear interpolation.

Requirements for medium power transformers with rated power ≤ 3 150 kVA equipped with tapping connections suitable for operation while being energised or on-load for voltage adaptation purposes. Voltage Regulation Distribution Transformers are included in this category.

The maximum allowable levels of losses set out in Tables I.1 and I.2 shall be increased by 20 % for no load losses and 5 % for load losses in Tier 1 and by 10 % for no load losses in Tier 2.

Requirements for medium power pole-mounted transformers

The levels of load and no load losses indicated in Tables I.1 and I.2 are not applicable to liquid immersed pole-mounted transformers with power ratings between 25 kVA and 315 kVA. For these specific models of medium power pole- mounted transformers, the maximum levels of allowable losses are set out in Table I.6.

Table I.6: Maximum load and no-load losses (in W) for medium power liquid immersed pole-mounted transformers

	Tier 1 (1 July 2015)		Tier 2 (1 July 2021)	
Rated Power (kVA)	Maximum load losses (in W) (*)	Maximum no-load losses (in W) (*)	Maximum load losses (in W) (*)	Maximum no-load losses (in W) (*)
25	C_k (900)	A_o (70)	B_k (725)	A_o (70)
50	C_k (1 100)	A_o (90)	B_k (875)	A_o (90)
100	C_k (1 750)	A_o (145)	B_k (1 475)	A_o (145)
160	C_k + 32 % (3 102)	C_o (300)	C_k + 32 % (3 102)	C_o – 10 % (270)

	Tier 1 (1 July 2015)		Tier 2 (1 July 2021)	
Rated Power (kVA)	Maximum load losses (in W) (*)	Maximum no-load losses (in W) (*)	Maximum load losses (in W) (*)	Maximum no-load losses (in W) (*)
200	C_k (2 750)	C_o (356)	B_k (2 333)	B_o (310)
250	C_k (3 250)	C_o (425)	B_k (2 750)	B_o (360)
315	C_k (3 900)	C_o (520)	B_k (3 250)	B_o (440)

(*) Maximum allowable losses for kVA ratings that fall in between the ratings given in Table I.6 shall be obtained by linear interpolation.

Minimum energy efficiency requirements for large power transformers

The minimum efficiency requirements for large power transformers are set out in Tables I.7 and I.8. Table I.7: Minimum Peak Efficiency Index requirements for liquid immersed large power transformers

Rated Power (MVA)	Tier 1 (1 July 2015)	Tier 2 (1 July 2021)
	Minimum Peak Efficiency Index (%)	
≤ 4	99,465	99,532
5	99,483	99,548
6,3	99,510	99,571
8	99,535	99,593
10	99,560	99,615
12,5	99,588	99,640
16	99,615	99,663
20	99,639	99,684
25	99,657	99,700
31,5	99,671	99,712
40	99,684	99,724
50	99,696	99,734
63	99,709	99,745
80	99,723	99,758
≥ 100	99,737	99,770

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Minimum PEI values for MVA ratings that fall in between the ratings given in Table I.7 shall be calculated by linear interpolation.

Table I.8: Minimum Peak Efficiency Index requirements for dry-type large power transformers

Rated Power (MVA)	Tier 1 (1 July 2015)	Tier 2 (1 July 2021)
	Minimum Peak Efficiency Index (%)	
≤ 4	99,158	99,225
5	99,200	99,265
6,3	99,242	99,303
8	99,298	99,356
10	99,330	99,385
12,5	99,370	99,422
16	99,416	99,464
20	99,468	99,513
25	99,521	99,564
31,5	99,551	99,592
40	99,567	99,607
50	99,585	99,623
≥ 63	99,590	99,626

Minimum PEI values for MVA ratings that fall in between the ratings given in Table I.8 shall be calculated by linear interpolation.

Product information requirements

From 1 July 2015, the following product information requirements for transformers included in the scope of this Regulation (Article 1) shall be included in any related product documentation, including free access websites of manufacturers:

(a) information on rated power, load loss and no-load loss and the electrical power of any cooling system required at no load;
(b) for medium power (where applicable) and large power transformers, the value of the Peak Efficiency Index and the power at which it occurs;

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(c) for dual voltage transformers, the maximum rated power at the lower voltage, according to Table I.3;

(d) information on the weight of all the main components of a power transformer (including at least the conductor, the nature of the conductor and the core material);

(e) For medium power pole mounted transformers, a visible display 'For pole-mounted operation only'.

The information under a); c) and d) shall also be included on the rating plate of the power transformers.

Technical documentation

The following information shall be included in the technical documentation of power transformers:

(a) manufacturer's name and address;

(b) model identifier, the alphanumeric code to distinguish one model from other models of the same manufacturer;

(c) the information required under point 3.

If (parts of) the technical documentation is based upon (parts of) the technical documentation of another model, the model identifier of that model shall be provided and the technical documentation shall provide the details of how the information is derived from the technical documentation of the other model, e.g. on calculations or extrapolations, including the tests undertaken by the manufacturer to verify the calculations or extrapolations undertaken.

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ANNEX II

Measurement and calculation methods

Measurement method

For the purpose of compliance with the requirements of this Regulation, measurements shall be made using a reliable, accurate and reproducible measurement procedure, which takes into account the generally recognised state of the art measurement methods, including methods set out in documents the reference numbers of which have been published for that purpose in the *Official Journal of the European Union*.

Calculation methods

The methodology for calculating the Peak Efficiency Index (PEI) for medium and large power transformers is based on the ratio of the transmitted apparent power of a transformer minus the electrical losses to the transmitted apparent power of the transformer.

$$PEI = 1 - \frac{2(P_0 + P_{c0})}{S_r\sqrt{\frac{P_0+P_{c0}}{P_k}}}$$

Where:

P_0 is the no load losses measure at rated voltage and rated frequency, on the rated tap P_{c0} is the electrical power required by the cooling system for no load operation

P_k is the measured load loss at rated current and rated frequency on the rated tap corrected to the reference temperature S_r is the rated power of the transformer or autotransformer on which P_k is based

ANNEX III

Verification procedure[11]

When performing the market surveillance checks referred to in Article 3(2) of Directive 2009/125/EC, the authorities of the Member States shall apply the following verification procedure for the requirements set out in Annex I.

(1) Member States authorities shall test one single unit per model;

(2) The model shall be considered to comply with the applicable requirements set out in Annex I of this Regulation if the values in the technical documentation comply with the requirements set out in Annex I, and if the measured parameters meet the requirements set out in Annex I within the verification tolerances indicated in the Table of this Annex;

(3) If the results referred to in point 2 are not achieved, the model shall be considered not to comply with this Regulation. The Member States authorities shall provide all relevant information, including the test results if applicable, to the authorities of the other Member States and the Commission within one month of the decision being taken on the non-compliance of the model.

Member States authorities shall use the measurement methods and calculation methods set out in Annex II.

Given the weight and size limitations in the transportation of medium and large power transformers, Member States authorities may decide to undertake the verification procedure at the premises of manufacturers, before they are put into service in their final destination.

The verification tolerances set out in this Annex relate only to the verification of the measured parameters by Member States authorities and shall not be used by the manufacturer or importer as an allowed tolerance to establish the values in the technical documentation.

Table

Measured parameter	Verification tolerances
Load losses	The measured value shall not be greater than the declared value by more than 5 %.
No load losses	The measured value shall not be greater than the declared value by more than 5 %.
The electrical power required by the cooling system for no load operation	The measured value shall not be greater than the declared value by more than 5 %.

[11] Note, these requirements are now replaced by Annex XIX of Regulation COMMISSION REGULATION (EU) 2016/2282 of 30 November 2016 amending Regulations … No 548/2014 … with regard to the use of tolerances in verification procedures specifies the tolerances to be deployed in Ecodesign verification testing for power transformers

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ANNEX IV

Indicative Benchmarks

At the time of adoption of this Regulation, the best available technology on the market for medium power transformers was identified as follows:

(a) Liquid-immersed medium power transformers: A_o – 20 %, A_k – 20 %

(b) Dry-type medium power transformers: A_o – 20 %, A_k – 20 %

(c) Medium power transformers with amorphous steel core: A_o – 50 %, A_k – 50 %

The availability of material to manufacture transformers with amorphous steel core needs further development, before such values of losses can be considered to become minimum requirements in the future.

Appendix B: CENELEC

European Committee for Electrotechnical Standardization (CENELEC)

Website: http://www.cenelec.eu/

CENELEC is the European Committee for Electrotechnical Standardization and is responsible for standardization in the electrotechnical engineering field and hence is the body that prepares energy performance standards for transformers.

CENELEC prepares voluntary standards, which help facilitate trade between countries, create new markets, cut compliance costs and support the development of a Single European Market.

CENELEC creates market access at European level but also at international level, adopting international standards wherever possible, through its close collaboration with the International Electrotechnical Commission (IEC), under the Dresden Agreement.

In an ever more global economy, CENELEC fosters innovation and competitiveness, making technology available industry-wide through the production of voluntary standards.

Through the work of its members together with its experts, the industry federations and consumers, European Standards are created in order to encourage technological development, to ensure interoperability and to guarantee the safety and health of consumers and provide environmental protection.

Designated as a European Standards Organization by the European Commission, CENELEC is a non-profit technical organization set up under Belgian law. It was created in 1973 as a result of the merger of two previous European organizations: CENELCOM and CENEL.

Membership

CENELEC is an association comprised of Members who are the National Electrotechnical Committees of European Countries. At the beginning of 2013, CENELEC membership encompassed 33 countries. In addition, 13 National Committees from Eastern Europe, the Balkans, Northern Africa and the Middle East participate in the work of CENELEC as Affiliates. CENELEC concludes also cooperation agreements with European associations and federations to which it gives the status of 'cooperating partners'. It also offers a special partnership status to countries outside Europe called Partner Standardization Body (PSB). Since 2009, CENELEC developed the concept of Techncial Liaison Partnership for organizations active in rapidly evolving and innovative market segments.

The 33 current CENELEC members are national organizations entrusted with electrotechnical standardization, recognized both at National and European level as being able to represent all standardization interests in their country. Only one organization per country may be member of CENELEC.

CENELEC members have been working together in the interests of European harmonization creating both standards requested by the market and harmonized standards in support of European legislation and which have helped to shape the European Internal Market. Their commitment to implement all European Standards identically at national level and to withdraw any conflicting standard guarantees continued harmonization of the market.

The CENELEC Members have voting rights in the General Assembly of CENELEC and they provide delegations to the Technical Board, which defines the work programme.

The process of accession to CENELEC membership must be considered by CENELEC as well as by the candidate member as one of the important steps towards the full participation of the concerned countries in the European Internal Market.

The CENELEC General Assembly of June 2011 has adopted in conjunction with the CEN General Assembly the CEN–CENELEC Guide 20 “Guide on membership criteria of CEN & CENELEC” which is the Reference Document describing the criteria for membership to be fulfilled by all national CENELEC Members at any time.

The candidate organizations have to meet the criteria set out in details in the CEN–CENELEC Guide 20 and their fulfilment are assessed by independent auditors.

Vision and mission

According to CENELEC ‘It is our vision to enhance European innovation and competitiveness through excellence in electrotechnical standardisation.

CENELEC’s mission is to prepare voluntary electrotechnical standards that help develop the Single European Market/European Economic Area for electrical and electronic goods and services removing barriers to trade, creating new markets and cutting compliance costs.

CENELEC and its National Committees (NCs) work jointly in the interest of European harmonisation, creating both standards requested by the market and harmonised standards in support of European legislation.

The standardisation system aims to increase market potential, encourage technological development and guarantee the safety and health of consumers and workers, as well as contribute to a greener world.

Participation

‘*The standardisation process* – European Standards (ENs are based on a consensus, which reflects the economic and social interests of 33 CENELEC Member countries channelled through their National Electrotechnical Committees (NCs). Most standards are initiated by industry. Other standardisation projects can come from consumers, Small and Medium sized Enterprises (SMEs) or associations, or even European legislators. Besides European Standards, CENELEC products other reference documents, which can be developed quickly and easily: Technical Specifications, Technical Reports and Workshop Agreements.

Who participates – Standards are driven by business, and drafted by technical experts in the field. In building European consensus, industry, trade federations, public authorities, academia and NGO representatives are invited to contribute to the standardisation process. It is this open participation, which accounts for the strength of European standardisation.

How to participate - The route for participating in the development of European Standards is through national members (NSBs/NCs). They send balanced delegations to represent the concerned interests in a standardisation project. European trade associations and interest groups – representing environmentalists, consumers, trade unions, as well as small and medium sized enterprises, amongst others – also have the opportunity to contribute to the development of a standard.

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Why participate – Participation in the process allows a stakeholder to anticipate changes to standards in his sector as well as have a say in the content. A manufacturer wishing to participate in the CENELEC process contacts his NC, either directly or through a trade association. Through the National Committee, the manufacturer can become involved in a national mirror committee, which is responsible for developing the national position on a particular standard and presenting this position to the relevant CENELEC Technical Body. It may also be possible to become a member of the national delegation of the CENELEC Technical Body, or to be nominated to serve as a technical expert in one of the Working Groups.'

European Standards Organisations (ESOs) – CENELEC is a European regional standards organisation that together with its sister organisations CEN, the European Committee for Standardisation, and European Telecommunications Standards Institute (ETSI), compose the so called and known European Standards Organisations (ESOs) that are officially recognised by the European Commission and act as a European platform through which European Standards are developed.

In the European Union, only standards developed by CEN, CENELEC and ETSI are recognised as 'European Standards'. Hence, CENELEC closely cooperates with CEN and ETSI; working jointly in the interest of European harmonisation, creating both standards requested by the market and harmonised standards in support of European legislation.

Global partners – Besides its dedication and commitment to international standardisation through its membership and the Dresden agreements, CENELEC as European regional standardisation body has always been open for cooperation/collaboration with other standardisation bodies worldwide, since it clearly acknowledges the importance of the European Standards it develops for trade and welfare inside as well as outside the European Economic Area.

CENELEC recognises that the cooperation/collaboration with third country National Standardisation Bodies (NSBs) or with regional standardisation bodies may take several shapes depending on their links with Europe, their wish to participate in technical activities and their interest in the results of the European Standardisation process. In that respect CENELEC proposes four different models of cooperation:

For National Standard Bodies in third countries the concepts of:

- Affiliation;
- Standardisation Partnership (PSB);
- Cooperation Agreement.
- For the regional grouping of those NSBs:
- Memorandum of Understanding (MoU).

See also - http://www.cenelec.eu/aboutcenelec/whoweare/globalpartners/index.html

CENELEC Members (National Committees) - The 33 current CENELEC members are national organisations entrusted with electrotechnical standardisation recognised both at National and European level as being able to represent all standardisation interests in their country. Only one organisation per country may be member of CENELEC.

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CENELEC members have been working together in the interests of European harmonisation creating both standards requested by the market and harmonised standards in support of European legislation and which have helped to shape the European Internal Market. Their commitment to implement all European Standards identically at national level and to withdraw any conflicting standard guarantees continued harmonisation of the market.

The CENELEC Members have voting rights in the General Assembly of CENELEC and they provide delegations to the Technical Board, which defines the work programme.

The process of accession to CENELEC membership must be considered by CENELEC as well as by the candidate member as one of the important steps towards the full participation of the concerned countries in the European Internal Market.

Affiliates – The EU enlargement process brings us in contact with new neighbours. In this context, a Commission Communication (COM(2003) 104 final of 2003-03-11) "Wider Europe-Neighbourhood: A new Framework for Relations with our Eastern and Southern Neighbours" highlights the political and economical importance of enhancing the relations with Russia, with the Western Newly Independent States (Ukraine, Moldova, Belarus) and the southern Mediterranean (Algeria, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, Palestinian Authority, Syria, Tunisia).

The European Neighbourhood policy was extended to also include the countries of the Southern Caucasus with whom Bulgaria, Romania, and new Member Turkey share either a maritime or land border (ie Armenia, Azerbaijan and Georgia). These countries are included to the to the European Neighbourhood Policy and can benefit from the status of Affiliation to CENELEC.

Affiliation with CENELEC is available to a National Standards Body, which is:

- Recognised as the only National Electrotechnical Committee from a EU neighbouring country;
- Member or associate member of the IEC;
- Registered in the IEC List of Standardisation Bodies having notified acceptance of the WTO Code of Good Practice for the Preparation, Adoption and Application of Standards.

Committee Structure:

CENELEC Management Committees –

- AG – General Assembly – the AG is the supreme authority of CENELEC, where all statutory and general policy decisions are taken. The Ordinary Meetings take place annually, normally, in June and should be attended by a delegation of up to five representatives of each CENELEC Member, led by a Head of Delegation. The CA members are expected to attend the AG meetings. They should report to the AG on the activities that have been performed during the past twelve months in their respective field of responsibility;
- BT – Technical Board – the General Assembly has delegated the management of the technical standardisation work to the Technical Board (BT). As stipulated in the CEN/CENELEC Internal Regulations – Part 2, the latter is responsible for controlling the standards programme and promoting its speedy implementation by the CEN-CENELEC Management Centre (CCMC) as well as by the

Technical Committees and other bodies. BT meets three times a year. The CENELEC President chairs the meetings, but if he is not available, a Vice President will stand in for him. This rule implies the mandatory presence of two CENELEC Officers. The participation of more CA members in BT should be avoided. The CEN-CENELEC Management Centre (CCMC) holds the BT secretariat. BT members are Permanent Delegates – one representative of each National Electrotechnical Committee, appointed on a long term/permanent basis – who have decision rights, and observers of indentified cooperating partners, CEN, ETSI, IEC, the European Commission and EFTA;

- CA – Administration Board – The Administration Board (CA) has the broadest powers to manage and administer the association's business. Execution of the decisions made by the General Assembly (AG) is entrusted by it to the Administrative Board.

Number of Committees:

See also - http://www.cenelec.eu/dyn/www/f?p=104:6:1116981891070109

Committee Rules and Regulations:

CENELEC Products – CENELEC concentrates most of its work on 2 major deliverables: The European Standard (EN) and the Harmonisation Document (HD). These two documents are referred to commonly as 'standards' and must be implemented in all CENELEC member countries, who must also withdraw any conflicting standard.

There are a few differences in the implementation process of ENs and HDs. Basically, the EN must be transposed as it is, not adding or deleting anything. The process of HDs is a bit more flexible. It is the technical content that must be transposed, no matter the wording or how many documents are made of it. In addition to these two major deliverables, CENELEC also produces and approves documents with a different objective and target.

See also - http://www.cenelec.eu/standardsdevelopment/ourproducts/index.html

Governance and Organisation:

Governing Structure – see also http://www.cenelec.eu/dyn/www/f?p=WEB:123:696551064879647

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List of abbreviations

ADCO – Administrative Co-operation Working Group

CAB – Conformity Assessment Body

EEA – European Economic Area

EPC – Engineering/Electrical Performance Contractor

ESO – European Standardisation Organisation

EU – European Union

LPT – Large Power Transformer

MS – Member State

MSA – Market Surveillance Authority

MV&E – Monitoring Verification & Enforcement

PEI – Peak Efficiency Index

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about the INTAS project activities
and all of its results
are published on:

www.INTAS-testing.eu

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