# EXPLANATORY MEMORANDUM TO

## COMMISSION REGULATION (EU) No ……/……

**of** XXX

**amending 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**

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# 1. CONTEXT OF THE PROPOSAL

## 1.1. Introduction and general objectives of the proposal

This explanatory memorandum aims to give background to the proposal for a review by the European Commission of Ecodesign Commission Regulation (EU) 548/2014[1], as amended by Commission Regulation (EU) 2019/1783 on the ecodesign of small, medium and large power transformer.

The EU has longstanding objectives to increase energy efficiency and to reduce its greenhouse gas emissions. These go along with other objectives to reduce its environmental impacts. In December 2019, the Commission presented the European Green Deal[2] to strengthen these objectives and as the cornerstone of its strategy to fulfil the United Nation's 2030 Agenda for Sustainable Development[3]. In September 2020, it presented a Climate Target Plan (CTP) for 2030[4], showing the need for a higher contribution of energy efficiency and renewable energy to achieve a net 55 % GHG emission reduction most cost-effectively, in line with the Paris Agreement. The Commission followed this by proposing the "Fit for 55" package[5] of legislative proposals aiming to achieve the necessary cut in GHG emissions.

One pillar of the CTP and subsequently the 'Fit for 55' package is energy efficiency. In this context, the ecodesign and energy labelling rules for products arise as important instruments to realise EU's energy and decarbonisation objectives.

Another pillar of the European Green Deal is a more circular economy. The new Circular Economy Action Plan[6] sets out steps to work towards this. It aims to reduce product environmental impacts for example through promoting longer product lives, greater resource efficiency and enhancing recycling and recycled content.

Reducing energy use and promoting the circular economy are also important for reducing the EU's energy import dependence and improving energy security, aspects that are particularly relevant in the current context of continuous increase of energy prices and recent geopolitical events. On 18 May 2022, the Commission published its "REPowerEU Plan" Communication[7] aimed at rapidly reducing EU dependence on Russian fossil fuels.

The Ecodesign Directive[8] aims to address market barriers to the uptake of more energy efficient and sustainable products by setting performance requirements to remove the worst performing products from the EU's internal market. Being set at EU level, they have mitigated the risk of industry facing multiple, different national rules. The energy

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[1] 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, OJ L 152, 22.5.2014, p. 1–15

[2] The European Green Deal, COM(2019) 640 final.

[3] Transforming our world: the 2030 Agenda for Sustainable Development.

[4] Stepping up Europe's 2030 climate ambition. Investing in a climate-neutral future for the benefit of our people, COM/2020/562 final.

[5] 'Fit for 55': delivering the EU's 2030 Climate Target on the way to climate neutrality, COM(2021) 550 final.

[6] Circular Economy Action Plan for a more competitive Europe, COM(2020) 98.

[7] REPowerEU Plan, COM(2022) 230 final.

[8] 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. OJ L 285, 31.10.2009, p.10.

assessments aim to ensure that the minimum requirements are set at the level of Least Life cycle Consumer Cost.

The Ecodesign and Energy Labelling Working Plan 2022-2024[9] incorporated the review of small, medium and large power transformers and, as in the previous plan, identified ecodesign measures' potential to contribute to circular economy and, in general, environmental objectives.

### 1.2. Product scope

Commission Regulation (EU) 548/2014, amended by Regulation (EU) 2019/1783, sets minimum energy efficiency and information requirements for the 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.

A medium power transformer is defined by the Regulation as a power transformer with all windings having rated power lower than or equal to 3,150 kVA, and highest voltage for equipment greater than 1,1 kV and lower than or equal to 36 kV. A large power transformer is defined by the Regulation as a power transformer with at least one winding having either rated power greater than 3,150 kVA or highest voltage for equipment greater than 36 kV. A medium power pole-mounted transformer is a power transformer with a rated power of up to 400 kVA suitable for outdoor service and specifically designed to be mounted on the support structures of overhead power lines.

The energy efficiency requirements set for medium and large power transformers are dependent on the type of power transformer (there are no energy efficiency requirements for small power transformers). The measurements that are used to determine energy performance are the minimum peak efficiency index (PEI) or the maximum allowed load and no-load losses. The efficiency metric used is dependent on the type and size of the transformer. Medium power transformers (dry and liquid type) as well as liquid immersed medium power pole mounted transformers have to comply with maximum load or no-load losses, whereas large power transformers (dry and liquid immersed) comply with minimum PEI values.

In 2019 a review was conducted of (EU) No 548/2014 with the scope of this to consider if the industry was ready to move onto the more stringent tier 2 efficiency requirements. It also made certain amendments to the previous regulation, such as updating definitions. The review study[10] determined that the industry should continue to have to meet tier 1 requirements until 2021, at which point the performance requirements should be uplifted to the tier 2 values.

Power transformers excluded from the scope are those designed for the following specific applications: instrument transformers; transformers specifically designed and intended to provide a DC power supply to electronic or rectifier loads; transformers specifically designed to be directly connected to a furnace; transformers specifically designed to be installed on fixed or floating offshore platforms, offshore wind turbines or on board ships

[9] Ecodesign and Energy Labelling Working Plan 2022-2024, C(2022) 2026.

[10] https://transformers.vito.be/sites/transformers.vito.be/files/attachments/ec_dg_growth_lot2_Transformer_Jul2017b.pdf

and all kinds of vessels; transformers specifically designed to provide for a situation limited in time when the normal power supply is interrupted due to either an unplanned occurrence or a station refurbishment; transformers connected to an AC or DC contact line used in fixed installations for railway applications; earthing or grounding transformers specifically designed to be connected in a power system to provide a neutral connection for earthing; traction transformers specifically designed to be mounted on rolling stock; starting transformers, specifically designed for starting three-phase induction motors; testing transformers; welding transformers; transformers specifically designed for explosion-proof applications; transformers specifically designed for deep water applications; medium Voltage (MV) to medium voltage (MV) interface transformers up to 5 MVA; medium and large power transformers specifically designed to contribute to the safety of nuclear installations; and three-phase medium power transformers with a power rating below 5 kVA.

The review clause of the Regulation stipulates that the Commission shall review the Regulation in the light of technological progress within four years after their entry into force. The review study[11] is meant to inform the Commission and, if necessary, supply the necessary elements for a revision of the Regulation.

### 1.3. Key impacts

The total annual EU primary energy consumption of the stock for 400 kVA distribution transformers currently in scope of the Regulation is 170,468 TJ/a. This is projected to be around 194,479 TJ/a in 2030.

The total EU Resource use (minerals and metals) of the stock for 400 kVA distribution transformers currently in scope of regulation is 0.008 MT Sb eq./a[12]. This is projected to be around 0.012 MT Sb eq./a in 2030.

### 1.4. Standardisation aspects

The review study focused on seeking extensive feedback from stakeholders pertaining to amendments to various aspects of the current regulation, such as updating definitions when and if needed. Concerning the definitions of the product in scope to the Regulation, no feedback was provided throughout the study expressing stakeholder confusion regarding the definitions for small, medium and large power transformers that define the scope of the regulation. Towards the completion of the review study one stakeholder mentioned that IEC 60076-1 standard is undergoing a revision and suggested updates to the definitions for small, medium and large power transformers as indicated in the table below. The feedback also suggested renaming the product classes as Class A, Class B and Class C transformers respectively. While this feedback is critical, it is important to understand that the IEC 60076-1 standard is still undergoing a revision and the date it will be finalised is still unknown leaving room for further updates to these definitions. These proposed definitions may also lead to inconsistencies with the way the current regulation defines the scope and associated performance requirements. For example, what is currently a medium power transformer in the regulation would technically become a small power transformer. Since the current regulation states that small power transformers are not required to meet Tier 1 & Tier 2 MEPS, transformers which are <= 3150 kVA would be

[11] https://eco-transformers-review.eu/about/index.html

[12] MT Sb eq./a is equivalents of million tonnes of antimony (kg Sb eq)

affected by this new definition. Lastly, the terminology changes from small, medium and large power transformers to Class A, Class B and Class C respectively would create further confusion among stakeholders if the regulation simply renamed the product classes but did not revise the ratings. As such, no updates were proposed to the existing definitions.

| | Current Regulatory Definition | Proposed Definition under draft revised IEC 60076-1 |
|---|---|---|
| Small power transformer | Small power transformer means a power transformer with a highest voltage for equipment not exceeding 1,1 kV | Power transformer with a highest rated power of any winding <= 3150 kVA three phase, or <= 1050 kVA single phase |
| Medium power transformer | Medium power transformer means a power transformer with all windings having rated power lower than or equal to 3150 kVA, and highest voltage for equipment greater than 1,1 kV and lower than or equal to 36 kV | Power transformer with a highest rated power of any winding > 3150 kVA but <= 31.5 MVA three phase or >1050 kVA but less than 10.5 MVA single phase |
| Large power transformer | Large power transformer means a power transformer with at least one winding having either rated power greater than 3150 kVA or highest voltage for equipment greater than 36 kV | Power transformer with a highest rated power of any winding > 31.5 MVA three phase or > 10.5MVA single phase |

## 2. METHODOLOGY AND CONSULTATIONS

The proposal in the draft Working Document follows a review study for the European Commission[13] that investigated specific issues mentioned in the review clause of the regulation (Phase 1) and an update of the legacy preparatory study (Phase 2).

The review article requires the *Commission to review the requirements in the light of technological progress*, meaning whether the ecodesign requirements and limits can be introduced and/or set at a more ambitious level.

### 2.1. Review Scope (Phase 1)

Listed below are the items set out in Article 7 of Regulation 2019/1783:

[13] Contractor is ICF. Review study for EC, DG GROW.

a. the extent to which requirements set out for Tier 2 have been cost-effective and the appropriateness to introduce stricter Tier 3 requirements;
b. the appropriateness of the concessions introduced for medium and large power transformers in cases where installation costs would have been disproportionate. In particular, the analysis should investigate concessions in concrete cases (e.g. manufacturers, electricity companies, market surveillance authorities) and determine their appropriateness;
c. the possibility of utilising the PEI calculation for losses alongside the losses in absolute values for medium power transformers;
d. d) the possibility to adopt a technology-neutral approach to the minimum requirements set out for liquid-immersed, dry-type and, possibly, electronic transformers;
e. the appropriateness of setting minimum performance requirements for small power transformers;
f. the appropriateness of the exemptions for transformers in offshore applications;
g. the appropriateness of the concessions for pole-mounted transformers and for special combinations of winding voltages for medium power transformers;
h. the possibility and appropriateness of covering environmental impacts other than energy in the use phase, such as noise and material efficiency

Further items of interest were:

i. material efficiency aspects;
j. an analysis of the standards, and of their relevance for regulatory purposes;
k. technological, market and regulatory evolutions affecting environmental performance;
l. ecodesign (or similar) requirements for power transformers in other jurisdictions, in particular the US and Japan and in comparison to current ecodesign requirements for Tier 2.
m. strengthening potential of the existing MEPS and the potential of introducing material efficiency requirements (MMPS);
n. impact of rising electricity prices on current and potentially stricter ecodesign requirements.
o. existing methodologies for assessing technoeconomic aspects of ecodesign for power transformers (especially in terms of technology neutrality, circularity, MEPS and MMPS), as well as for the assessment of the costs for replacement/installation of transformers, based on the principles laid down in Regulation 2019/17834.
p. functional categorisation of power transformers (including conventional transformers, overload transformers and fire performant transformers and any others that the contractor may suggest).
q. a techno-economic analysis on the relevance and feasibility of requirements (in particular for low-to-medium and medium-to-high voltage transformers) related to design features aimed to increase the efficiency and lifetime of transformers when working with reversed power flows (due, for instance, to electricity from renewable energy sources injected in the grid at lower voltage levels).

### 2.2. Study methodology and consultations

Answers to the questions from Phase 1 are integrated at appropriate places in the reporting for the update of the preparatory study (Phase 2), which follows the MEErP methodology and includes:

Task 1 – Scope
Task 2 – Markets
Task 3 – Users
Task 4 – Technologies
Task 5 – Environment & Economics
Task 6 – Design Options
Task 7 – Scenarios

Phases 1 and 2 were delivered in sequence and entailed, amongst others, two online stakeholder consultation meetings (held in September 2023 and January 2024), bilateral meetings and extensive desk research by the consultants. The draft reports can be found on the project website: www.eco-transformers-review.eu.

The newly published version of the EcoReport tool (2024) was used for the analysis and preparation of deliverables under Tasks 5-7.

The review study is in its final stages, with updated task reports 1-7 published on the study website following receipt, analysis and actioning where appropriate of stakeholder feedback.

# 3. MEASURES

This section discusses the background to the draft Working Document presented at the Consultation Forum 30 September 2024, referring to the preliminary results from the review study Phase 1 and 2.

## 3.1. Measures not taken forward

This section presents the measures analysed but ultimately not taken forward into a revised or amended regulation and explains the reasons for this.

### *3.1.1. Tier 3 Efficiency Requirements*

Although it is technically feasible to reach higher efficiency values, this is done by using more materials. This increases the weight and size of the transformers, which can have complications such as increasing installation costs if it cannot fit into an existing substation. Furthermore, increasing energy efficiency standards would increase the costs and delays that the transformer supply chain currently experiences.

For medium sized transformers, reaching a Tier 3 performance requirement would require the use of amorphous steel cores. Since no country in the EU currently manufactures amorphous steel this is a difficult material to source. The infrastructure and supply chains for manufacturing with amorphous steel are still not established. Furthermore, amorphous steel is more expensive than regular steel, especially when operating at low saturation levels to mitigate excessive noise. This leads to the production of pricier transformers. Therefore, it was recommended not to increase the energy efficiency threshold above the current Tier 2.

### *3.1.2. Small power transformers energy efficiency metric*

After discussions with members of the TC 14[14] it was understood that it is not the intention of this TC to include small power transformers within its scope. As a result, there is currently no energy efficiency testing method present for small power transformers, since TC 14 only covers transformers > 1000 V. It was also mentioned that it was not the intention of TC 14 to cover small power transformers, because all small power transformers are to be covered by TC 96.

Therefore, it was not recommended to take this small power transformer energy efficiency metric forward because of the lack of a standard containing a methodology for testing small power transformer efficiency. The study team is aware of TC 96 which covers small power transformers < 1000 V. However, this series of standards (IEC 61558) does not provide a testing methodology for the efficiency of small power transformers.

### *3.1.3. PEI usage for medium power transformers*

It was recommended to keep absolute values of losses for medium power transformers, without utilising the Peak Efficiency Index (PEI) parameter.

Medium power transformers affect the EU-27 grid losses to a significant extent, due to them making up one of the largest market shares in the EU out of the existing transformer types. Using only PEI may give several combinations of no-load loss (P0) and load loss (Pk) with different optimum equivalent load factor (kPEI). Hence, the absolute value of losses for medium power transformers was recommended. However, out of several combinations of P0 and Pk, only one might be compliant with losses in absolute numbers as set out in the regulation. Absolute values of losses are also important for market standardisation.

### *3.1.4. Offshore transformer exemption and concessions*

It is recommended that existing exemptions are kept. Transformers used within the nacelle have more than double the capacity on average than those used for onshore wind turbines. Without exemptions, compliant transformers would struggle to fit into the nacelle, resulting in the nacelle and overall turbine needing to be bigger. Onshore turbines are smaller on average, more accessible, and cheaper to maintain and install, and hence a like-for-life comparison between onshore and offshore turbines is not deemed appropriate. It was recommended that these exemptions are kept, but are worth reviewing in future as the market share grows. Transformers used on platforms are larger, more efficient transformers and if the existing concessions were to change it would require an increased amount of structural material, making costs very high and increasing the environmental impact when considering the additional steel. Increasing regulatory pressure on offshore transformers may also be seen as a barrier to develop offshore wind resources, inhibiting renewable energy policies.

[14] TC14 – IEC Technical Committee 14

### *3.1.5. Pole-mounted transformer exemption*

It was recommended that these concessions are kept for like-for-life replacements. The cost for replacements is estimated to be significantly more than what would be saved from a more efficient transformer due to the pole being likely to not be able to withstand a heavier transformer.

### *3.1.6. Concessions to medium power transformers with special combinations of winding voltages*

Concessions for these are deemed necessary due to larger, more efficient transformers often being unable to fit into the same space that the original transformer was in, increasing installation costs by 10-20%. The concessions allow for the gradual conversion of the grid to a higher voltage in an economically favourable way, as well as for effectively handling intermittent power sources for the growing renewable energy sector.

### *3.1.7. Technology neutral and functional categorisation*

Since the regulation currently aligns its power transformer definition with that provided in EN/ISO 60076-1:2011, which is also harmonised with IEC 60076-1:2011, it is likely that any update that is made to the definition in the upcoming amendment of IEC 60076-1 will be adopted by the regulation. However, because the revised IEC standard will not be published until after the results of this study are published the regulation should not adopt a new – still not finalised and not published - definition. Thus, from an Ecodesign perspective, it is recommended not to change the definition of power transformers at this point. The regulation should only align with the definitions provided by the standard once these have officially been published. This will also mean that the current reference temperatures used by the regulation for oil-immersed transformers will continue to be used until the IEC 60076-1:2011 standard is updated. As a result, no action is to be taken on this matter during this review study.

### *3.1.8. Noise as a measure for Ecodesign*

It was recommended not to include noise as a measure for Ecodesign. The increase in efficiency from Ecodesign is already having an effect on reducing the noise of transformers. Additionally, there are separate standards and regulations from national and local governments which provide a maximum noise requirement. Furthermore, transformers with more efficient amorphous steel cores are much louder than ones with grain-oriented steel cores, making noise a potentially conflicting metric to include. Stakeholders have also indicated that noise testing would provide an additional charge for testing at certified laboratories.

### *3.1.9. Temperature and climate considerations*

It was recommended not to make further requirements in the Ecodesign regulation with regards to temperature and climate adaptation. This is due to the IEC and CENELEC standards already providing temperature requirements. IEC 60076-1 already states the operating ranges for transformers. IEC 60076-2 also sets out the cooling measures, temperature rise limits and the corresponding verifications tests. For dry-type transformer, IEC 60076-11

defines climate classes, covering transformer storage down to -60ºC and transformer energization down to -50ºC. Furthermore, the PEI methodology for large power transformers also considers the cooling systems operation within the test procedure. Mandating temperature operating ranges for transformers may be counterproductive, as it may go against the existing standards and would not allow utilities the flexibility to adapt to changing climate conditions.

## 3.2. Measures considered

This section presents the measures analysed and considered for a revised or amended regulation.

### *3.2.1. Replacing mineral oil with ester*

This measure considered the effects of replacing mineral oil with esters. Esters can perform at higher temperatures and are environmentally safer. The usage of esters increases the lifetime of assets, diminishes environmental concerns in case of leaks, and improves fire safety considerations.

### *3.2.2. Recovering and regenerating Replacing mineral oil with ester*

This measure would improve the sustainability of the mineral oil used with transformers by considering if the recovery and regeneration of oil can be encouraged. Mineral oil captured within the transformer enclosure can be cleaned and regenerated to be reused in a transformer. Currently, transformers with oil are bunded, such that if there is ever a leak, the oil is captured within the transformer enclosure and does not spread to the local environment. Stakeholders have indicated that 5% of transformer failures are due to poor oil quality. Thus, encouraging the recovery and regeneration of the captured oil to virgin oil quality may positively impact on reducing the overall number of failures.

## 3.3. Measures Taken Forward

The Life Cycle Cost (LCC) of replacing mineral oil with esters (i.e. Design Option 1) and the recovery and regeneration of used mineral oil from power transformers (i.e. Design Option 2) were calculated using the MEErP tool 2024. The LCC for both the design options is greater than the Base Case.

For Design Option 1, the LCC[15]is greater than the Base Case because there is an increase in the lifetime of the transformer and an increase in cost due to esters. Also, the availability and supply chain of esters also has to be factored in.

For Design Option 2, the LCC[16]is greater than the Base Case because the recovery and regeneration of mineral oil will increase the cost of the transformer by around 6%. Also, the responsibility of recovery and regeneration of mineral oil has also to be factored in.

In considering the practical implementation possibilities of replacing mineral oil with esters it would not be feasible to implement a ban, within the scope of the Ecodesign Framework 2009/125/EC, of mineral oil, based on the findings of the review study. Therefore, this measure will be taken forward as a proposed information requirement only. The

[15] non normalised per year i.e. LCC for Design Option 1 is calculated for 53.2 years of operational lifetime. The operational lifetime for the Base Case is 40 years.

[16] non normalised per year i.e. LCC for Design Option 2 is calculated for 40 years of operational lifetime and 6% increase in cost of transformer. The operational lifetime for the Base Case is 40 years.

information requirement would require manufacturers to specify if their transformer can be operated using esters.

It would be desirable to encourage the recovery and regeneration of used mineral oil from power transformers. However, similarly to the replacement of mineral oil with esters, it is difficult to consider practically how the Ecodesign Framework 2009/125/EC can be used to implement this measure, in particular due to the fact that it affects the end-of-life of a component.

## 4. BUDGETARY IMPLICATIONS

The legal format of Commission (Delegated) Regulations does not require transpositions into national legislation, saving administrative costs at Member State level.

## 5. ADDITIONAL INFORMATION

Note that this review concerns secondary acts, which follow the subsidiarity and proportionality report in the primary act. A specific discussion of these two aspects is not required.

The proposed Regulation concerns an EEA matter and should therefore extend to the European Economic Area.