International Copper Association Europe

Revision of Ecodesign Regulation for Transformers

International Copper Association Europe position

October 2024

The EU Green Deal targets carbon neutrality by 2050. Making this happen requires a drastic reduction in final energy consumption, as enshrined in the Energy Efficiency Directive. Recently, strategic considerations such as the availability of raw materials and green technologies have gained weight in the energy transition debate. The EU has established the Critical Raw Materials Act and the Net Zero Industry Act with the aim to protect the sovereignty of the EU in these two crucial areas.

In this context, **Ecodesign plays a key role, as it has the power to shape the landscape for critical raw materials and external dependencies**. By implementing ambitious energy efficiency standards for products, it can avoid the installation of power generation assets that come at a high cost in terms of critical raw material use and technological dependency. At a stroke, such measures help reduce final energy consumption, as requested by the EED.

In this context, **ICA Europe asks for a comprehensive evaluation of a potential introduction of Tier 3**, taking the above arguments as a guiding principle, while considering the following evidence:

1) Transformers < 3150 kVA can further reduce load and no-load losses by 10% (similar step as Tier 2 vs Tier 1) without requiring the use of amorphous steel. Free choice of material is preserved, and no new import dependency is installed.
2) Introducing Tier 3 efficiency is estimated to save 1.8 TWh/year of electricity at EU scale, which avoids the use of 1.35 Mton of material in generation assets, a figure that more than compensates the extra amount of material needed in Tier 3 transformers.
3) Tier 3 is not more costly than Tier 2 on an average total cost of ownership basis.
4) The transformer supply chain has cyclic behaviour. The current market bottlenecks are expected to be temporary, with a return to normal from 2027 onwards. According to a publicly available survey, 75% of manufacturers are investing in new capacity and have plans for further expansion in the years to come.
5) Existing regulatory concessions can address situations where installation costs are disproportionate, even though some updates on the concrete implementation of this clause may still be needed.
6) The extra amount of material needed in Tier 3 transformers can be fully recovered at the end of life of liquid-filled transformers. As for dry type transformers, design-for-recycling requirements would be needed to improve its circularity.

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Ecodesign has the power to shape the landscape for critical raw materials and external dependencies

A lack of investment at the level of energy-using devices, in terms of material use, cost-efficient financing, and technology, will ultimately create an additional need for such investments in power generation assets. In the case of power transformers, the two scenarios are compared as follows.

	More ambitious energy efficiency Ecodesign policies	**Less ambitious energy efficiency Ecodesign policies**
Energy Efficiency Directive	Supports the achievement of EED Targets.	Missed opportunity to contribute to EED targets.
Critical Raw Materials Act	Transformers use steel and copper (which are both well below the supply risk threshold of CRMs) and aluminium (just slightly above the supply risk threshold)	Wind generators usually use rare earths (permanent magnets) which rank the highest in supply risk among all CRMs.
Net Zero Industry Act	There is a well-established EU supply chain for transformers.	EU reliance on 3rd countries for the supply of PV panels is very high.

Lacking ambition and action at Ecodesign level leads to the unwanted effect of an increased dependency on foreign technologies and critical raw materials at the level of power generation.

1. Tier 3 MEPS for medium power transformers is feasible without amorphous steel

A modelling exercise has been carried out by ICA Europe (see 2023 ICA Europe position[1] and this press article[2]). In this exercise, Tier 3 has been set at Tier 2 minus 10 percentage points (i.e. A0-20%, Ak-10%), which represents the same efficiency gain as the transition from Tier 1 to Tier 2. Such Tier 3 level can be reached using conventional steel grades (M070), without any resort to amorphous steel.

[1] https://internationalcopper.org/wp-content/uploads/2023/10/Revision-of-Ecodesign-Regulation-for-Transformers.pdf

[2] https://transformers-magazine.com/magazine/improving-energy-and-material-efficiency-in-distribution-transformers/

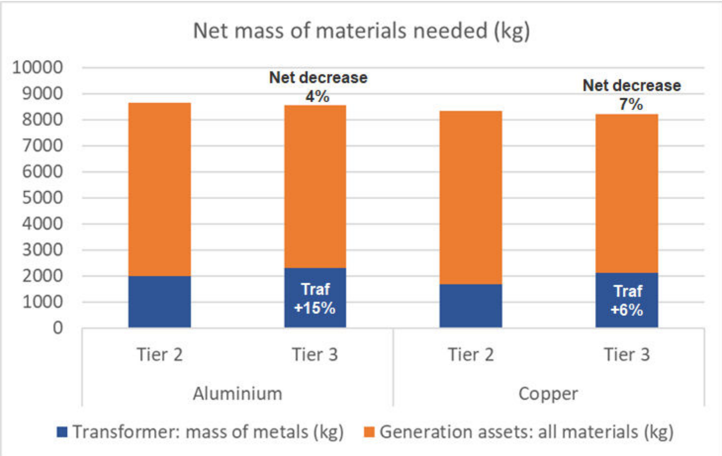
2. The energy savings potential is significant and doesn't involve an excessive use of raw materials

The additional savings potential of Tier 3 compared to Tier 2 has been estimated at 1.8 TWh/year[3], which deserves full consideration in the context of Ecodesign and Energy Efficiency Directive.

In the manufacturing phase, additional materials are needed to produce Tier 3 transformers compared to Tier 2. Indeed, weight increases with 120 to 440 kg depending on the starting and final designs (a 630 kVA transformer has been selected as the most representative size for this exercise).

In the use phase, Tier 3 transformers save electricity, which translates into avoided generation facilities (mainly onshore wind, solar and offshore wind). In total, savings per transformer are estimated at about 900 kWh/year, which translates into 670 kg of avoided materials in generation assets[4].

As it can be seen, a Tier 3 transformer delivers net material savings of 230 kg to 550 kg compared to its Tier 2 counterpart. This translates into 0.4 to 1.1 Mton of materials saved at EU scale. The use phase dominates the mass balance (as it is also the case for costs, see next section).



% relative to a Tier 2 unit with aluminium windings

In the end-of-life phase, liquid-filled medium-power transformers have a high degree of circularity. A full value chain for recovery and recycling is well established for this transformer technology. The additional materials used in Tier 3 compared to Tier 2 are not consumed, they can be considered as simply borrowed until the next investment cycle.

3. Tier 3 is not more costly than Tier 2 on a total cost of ownership basis

The same lifecycle approach as above is applied to costs.

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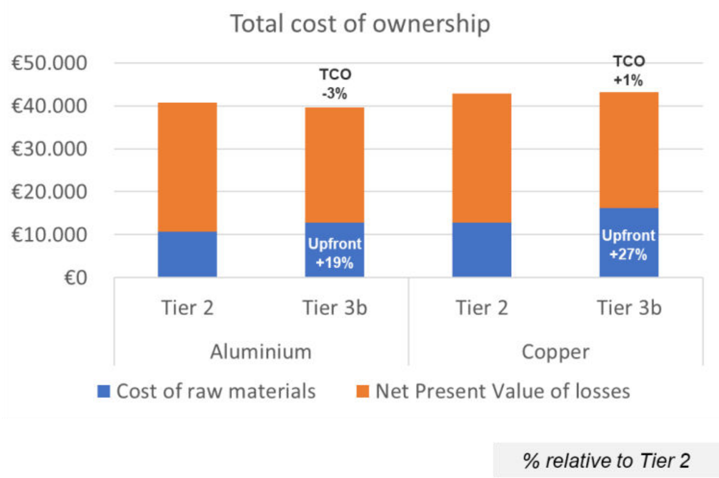
[3] Considering the fleet of transformers and the annual replacement rates as previously modelled in the Ecodesign preparatory studies

[4] Source: the U.S. Department of Energy (DOE) Renewable Energy Materials Properties Database (REMPD): https://www.nrel.gov/wind/materials-database.html. REMPD is a consolidated repository for data on the materials used in wind and solar plants. The database lists the type and amount of material required per megawatt (MW) of generation capacity and provides information about each material and its sources.

In the manufacturing phase, additional materials are needed to produce Tier 3 transformers compared to Tier 2, which leads to higher upfront costs.

In the use phase, Tier 3 transformers save electricity, which translates into a reduced cost of losses.

The net present value of the extra investment and the operational savings over the lifetime of the transformer is computed, which results in a comparable average total cost of ownership for the Tier 3 scenario compared to Tier 2.



The end-of-life phase is not considered in our analysis, though the materials contained in end-of-life transformers have an economic value.

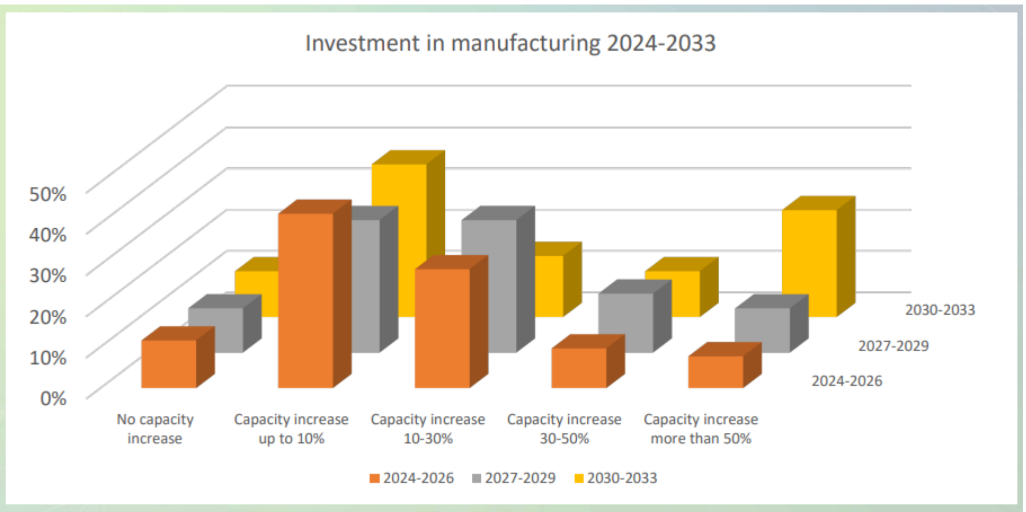
4. The supply chain is investing in capacity expansion, current delays are expected to significantly improve from 2027 onwards

The increased demand for transformers due to fleet renewal and electrification has strained the market. However, regulation wise, the situation that matters is not the current one but the one in the years to come, once the revision of regulation enters into force.

Transformers Magazine has carried out a comprehensive survey[5] over a representative sample of manufacturers and value chain companies, finding that:

- more than 75% of respondents are investing in manufacturing capacity;

[5] https://transformers-magazine.com/files/26_Mladen-Banovic_TM-IN-2024.pdf



- delays are expected to significantly improve from 2027 onwards.

5. Existing regulatory concessions can address situations where installation costs are disproportionate

Tier 3 MEPS generally increases the weight and size of the transformer (apart from situations where aluminium winding designs can be shifted to copper winding designs, in which case weight and size are reduced, thanks to the higher conductivity of copper). This can, in some cases, trigger collateral investments, potentially leading to excessive costs which don't justify the adoption of Tier 3 designs.

This can indeed be the case for some brownfields, but much less so for greenfields. Even in brownfields, due to the current electrification trends, an upgrade of the substation will be required anyway in many cases.

This question merits an analysis to quantify the percentage of situations where size and weight constraints actually lead to disproportionate additional costs. And in those particular situations, the existing concessions for cases where installation costs are disproportionate can still be applied (Annex I-3 of (EU) 2019/1783 regulation). Some practicalities in the implementation of this clause may still need a clarification (role of the user in determining the situations that lead to excessive installation costs).

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6. Materials can be recovered at the end-of-life, design-for-recycling requirements are necessary

Liquid-filled medium-power transformers have a high degree of circularity at end-of-life[6]. About 75% of the material can enter an entirely circular process, either re-used for a similar application or recycled into the same material (1st degree recycling). Almost 100% of the metals are recovered for either 1st degree (as is the case of copper) or 2nd degree recycling. As a result, the additional materials used in Tier 3 compared to Tier 2 can be considered as simply borrowed until the next investment cycle.

However, cast-resin dry type transformers pose a major difficulty to recycling, because the windings are over moulded with resin. Separation is complex, energy consuming, and not economically viable within the EU. As a result, coils covered with cast resin are sold along with other electromechanical scrap for export outside the EU, where a generally low-paid workforce separates the resin from the metal coils in semi-automated processes.

This situation calls for a regulatory intervention, to make dry transformers easier and more economical to recycle. Technology options exist to cope with such requirements (such as shifting from cast resin to silicon rubber or alternative materials easier to dismantle).

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The energy efficiency of power transformers is already high, and further improvements will always pose challenges. But an even bigger challenge is the decarbonisation of EU power generation, with all the critical raw materials, land use and EU import dependency it brings about. A restrained position at the level of energy efficiency in consumption, will increase the pressure upstream in the electricity system.

About the European Copper Institute

The European Copper Institute (ECI) is the leading advocate for the copper industry in Europe and the European arm of the International Copper Association (ICA). Our members mine, smelt, refine and recycle copper for use across the economy, in the electricity system, buildings, transport and industry.

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[6] References:

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