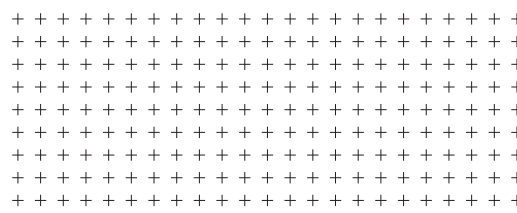




# The State of Ester Filled Transformers in Europe's Transformer Market: An Overview and Outlook

by **Aleena Ahmad**  
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Technology has taken huge leaps in the previous decades and the advancements have benefitted all spheres of life with the biggest impact on economic development. In the recent years, however, there has been a growing concern about the environmental impact of certain technological advances with effects becoming more and more pronounced through rising temperatures, floods, droughts and more. As the world tackles the growing problem of

climate change, there is an urgent need for shift in our processes to make them more sustainable. Electrical industry is also playing its role in this transition. Among other green initiatives and directives, the development of SF<sub>6</sub> alternatives in switchgear and vegetable ester oil as an insulation fluid for transformers, and their slow but increasing adoption by utilities and manufacturers, is a step in the right direction.



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of ester oils over mineral oil as an insulating fluid across different parameters.

Ester has an improved environmental footprint owing to biodegradability. This means that the cost of the clean-up procedure and spill prevention mechanisms that is associated with the use of mineral oil is considerably reduced. In case of a spill or breakdown, ester fluid will not contaminate the surrounding environment as is the case with mineral oil. Mineral oil oxidizes readily, leaving behind sludge precipitates that give rise to the need for periodic cleaning and maintenance, but ester is resistant to oxidation degradation, which is another added advantage.

With mineral oil, fire safety is a concern because temperature of the oil rises with transformer loading. Ester fluid has almost twice the

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### Ester Fluids vs. Mineral Oil as an Insulating Fluid

Ester fluid is derived from 100% renewable vegetable oil or inorganic feedstock. It was originally developed in 1996 as an alternative to polychlorinated biphenyl (PCBs) and high molecular weight hydrocarbons but has gradually become the fluid of choice for transformer insulation and an environmentally friendly alternative to mineral oil due to its properties. Table 1 compares the properties of natural and synthetic esters with mineral oil indicating the advantages

fire point making it relatively better than mineral oil in that aspect. This reduced risk of fire in turn lowers the need for fire protection equipment and fire safety systems. Since ester oil has a high fire and flash point, it can perform better in higher temperatures and has better loading capabilities as well. Ability to withstand higher temperatures means that ester has a longer life span than mineral oil. Life cycle expansion in turn directly relates to cost and maintenance optimization.

## Despite its advantages over other transformer fluids, initial capex for ester can still be up to 20% higher than for mineral oil.

### Cost of Ownership and Current Applications

Despite ester having the above stated advantages, its initial capex can still be up to 20% higher than for mineral oil, which can be a concern for companies adopting this technology. It should be noted, however, that this high capital cost is compensated by the lower maintenance costs and longer life spans in the long term.

Although most of the discussions around ester filled transformers focus on replacing mineral oil

transformers, these transformers are also gradually replacing dry type transformers because of their enhanced fire safety and ecofriendly properties. In addition to this, ester is not only being adopted for new installations, but existing oil immersed transformers that have reached their end of life or are overloaded are being retro-filled with ester fluids to improve grid reliability and stability until replacements can be carried out.

Globally, more and more electric utilities are installing ester filled transformers to complement the

efforts that are being made to make their operations more environmentally sustainable and to achieve the ambitious climate goals being set out by their respective countries. Europe has a well-developed grid infrastructure and is in the position to take the lead in this regard, which it has been taking with numerous laws and initiatives in place.

For instance, UK has announced that it intends to achieve 65% clean energy by 2030 and zero carbon emissions by 2050. Similarly, Germany plans to reduce its emissions by 65% by 2030 as compared to the 1990 level and 88% by 2040. France's current law states that it will decrease emissions by 40% by 2030 as compared to the 1990 level. Talking about the entire region, EU claims that the bloc will reduce its carbon emission by 55% by 2030 and become climate neutral by 2050.

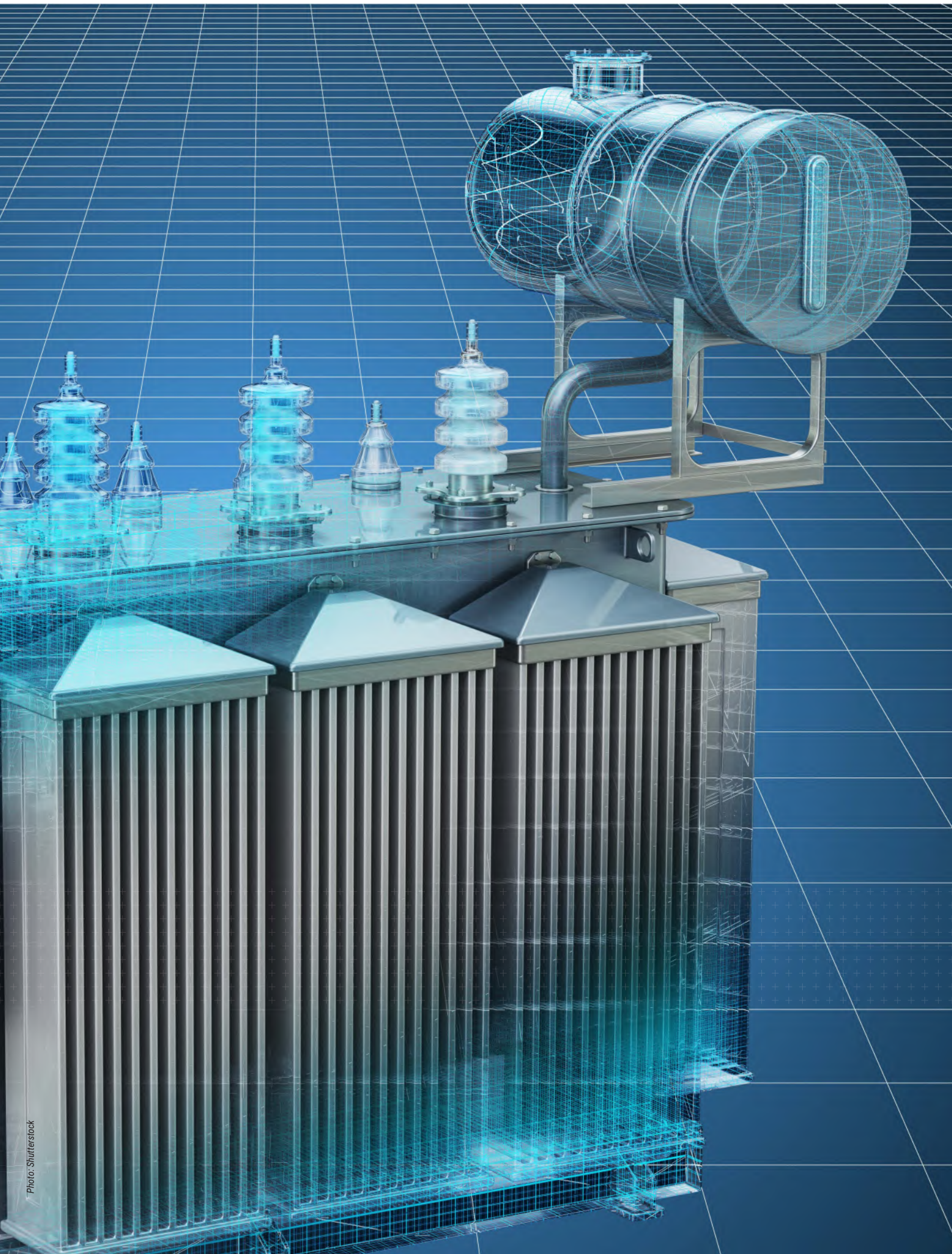
There are several green initiatives being adopted by European utilities that include the decarbonization of economy: an initiative by Endesa, a Spanish DSO, to develop 23 renewable hydrogen projects; Green Finance Framework by the Norwegian DSO Elvia plans on adding new hydro and wind power infrastructure to increase renewable capacity in the system; and Fluvius in Belgium plans to install EV charging infrastructure to facilitate the penetration of zero-emission vehicles.

Adoption of ester filled transformers is in line with the direction that the utilities in Europe are taking to achieve environmental sustainability. The increase in renewable power generation and the penetration of electric vehicles has given rise to a lot of gaps in the distribution grid with areas for improvement in the existing infrastructure as well as potential for expansions and additions to cater with this increased and dynamic load. The renewable installed capacity has grown with a CAGR of 5.4% from 2015-2020. With regards to EVs, Europe accounted for 30% of the global electric vehicle passenger fleet which amounts to approximately 3.1 million electric vehicles.

Property	Mineral Oil	Natural Ester	Synthetic Ester
Fire Point	180°C	360°C	310°C
Flash Point	160°C	330°C	260°C
Biodegradability	No	Ultimately	Readily
Toxicity	Toxic	Non-Toxic	Less Toxic
Viscosity	12	37	29
Thermal Aging	Good	Better	Best

Table 1. Comparison of ester oils vs mineral oil properties

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## State of Adoption in Europe

Europe has always been keen at adopting and manufacturing latest technologies and the same is being observed when it comes to the environment friendly and sustainable insulation fluid for transformers. Some of the top OEM markets for ester filled transformers in the region are Turkey, Poland, and Switzerland. UK, Germany, and France are some of the user markets in the region with ester oil transformers constituting a growing percentage of the total installed base of distribution transformers.

According to Power Technology Research, in Europe, the ester filled transformer market capacity accounts for about 1.29% of the total installed base, with UK, Netherlands and Spain being the top countries adopting ester fluid (Figure 1).

Although the percentage of installed ester filled transformers is low, this number is expected to rise in the future as countries race towards achieving their 2030 climate goals. UK, however, is breaking away from the generally slow adoption rate observed in the region with a comparatively higher percentage of ester filled transformers. Some utilities in the UK are exclusively installing ester filled transformers and others are using ester to retro-fill existing mineral oil transformers that have reached their end of life. Furthermore, ester filled transformers are being installed in historical buildings to ensure safety, prevent fire risk and to avoid fire suppression costs. Another observation is that utilities are more inclined towards adopting synthetic ester in comparison to natural ester since the former can be tailored to specific needs of the customers. Another statistic of importance is that utilities are adopting ester oil transformers in underground substations where the risk of mineral oil fires in transformers is higher than outdoors. 86.65% of the total installed base of ester filled transformers is installed indoors and underground.

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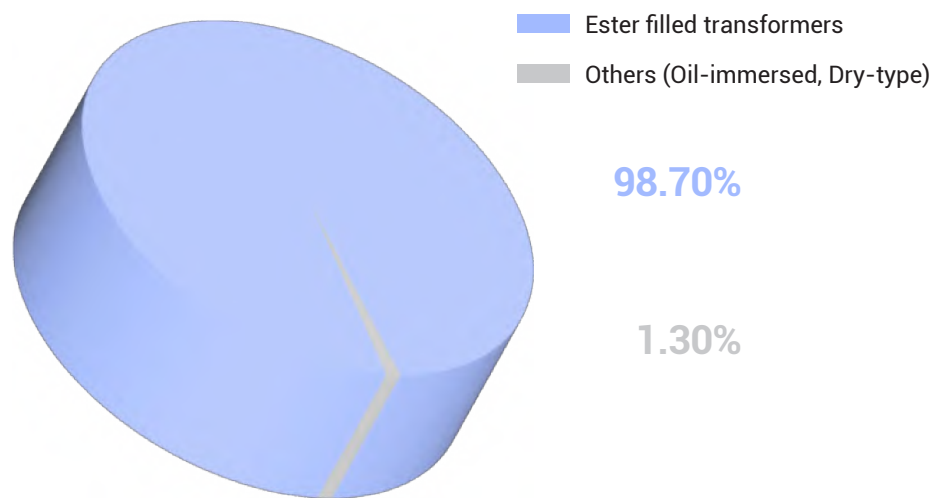


Figure 1. Ester filled transformers penetration in Europe

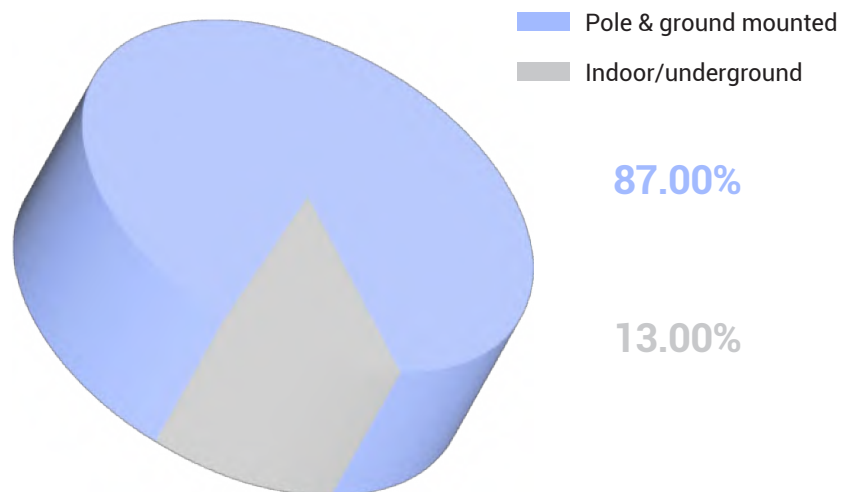



Figure 2. Segmentation of ester filled transformers by installation type

Utilities are more inclined towards adopting synthetic ester than natural ester since the former can be tailored to specific needs of the customer.



### Future Outlook

Looking ahead, according to Power Technology Research, the penetration of ester insulated transformers will continue to increase, especially in Western Europe. Even though the installed base of these transformers is quite low at the moment with some utilities even reporting no ester insulated transformers in their grid, their market is expected to grow in the future. This increase is directly tied to utilities upgrading their infrastructure to incorporate the additional renewable power generation and install new charging facilities for the growing market of electric vehicles, which will consequently result in a rise of the installed base of distribution transformers, especially sustainable options like ester filled transformers.

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