



# Integration of renewable energy in Europe's power grid: The critical role of distribution transformers



## ABSTRACT

Europe's 2030 renewable energy goals, targeting 600 GW of solar PV and 480 GW of wind energy, rely on distribution transformers for grid stability and efficiency. This article highlights the role of transformers, challenges from supply shortages and regulations, and the need for

domestic production and workforce development to support Europe's climate goals.

## KEYWORDS:

distribution transformers, renewable energy, decarbonization, supply chain, digitalization, energy transition

## Europe aims for a 45% renewable energy share by 2030, with 600 GW of solar PV and 480 GW of wind energy, relying on distribution transformers to integrate renewable power into the grid

As Europe moves forward with ambitious renewable energy (RE) goals, including achieving a 45% renewable share in the energy mix by 2030, the role of distribution transformers has become central to realizing this transition. Major regional initiatives underscore the urgency of grid modernization and the integration of renewable energy sources. Key countries—Germany, France, and the United Kingdom—are at the forefront, aiming to lead Europe’s decarbonization through substantial targets for solar and wind installations by 2030. However, this transition is not without challenges, as the power grid must accommodate increased capacity and the variable nature of renewable power.

### Europe’s renewable energy targets and challenges

Europe aims to achieve a 45% renewable energy share by 2030, targeting 600 GW

of solar PV and 480 GW of wind energy. The IEA projects Europe will add 450 GW of renewable energy from 2024-2028, with over 70% from solar PV, led by distributed systems, and 26% from onshore wind projects.

Despite these ambitions, challenges in grid infrastructure and permitting processes create bottlenecks, particularly in wind energy deployment. Grid constraints, permitting delays, and funding challenges have slowed wind energy’s expansion, prompting calls for increased investment in the power grid and more streamlined permitting.

### Role of distribution transformers in integrating renewable energy sources

Distribution transformers are foundational to achieving Europe’s RE targets, as they facilitate efficient voltage regulation, load

balancing, and the overall stability of the grid. The integration of renewable sources introduces variability that requires precise management to ensure grid reliability. Distribution transformers enable this by addressing voltage fluctuations and harmonic distortions that may arise from intermittent renewable sources.

This critical role drives substantial investment in Europe’s power grid, with utilities prioritizing upgrading existing infrastructure to handle renewable loads. The Eco Design Directive further reinforces this push by requiring transformers to meet stringent efficiency standards, which lowers energy losses and optimizes resource use.

As renewable targets drive demand, distribution transformer technology is also evolving. Modern transformers now incorporate digitalization and data analytics to provide real-time insights, enabling remote monitoring, predictive maintenance, and efficiency gains. Eco-friendly materials, including ester fluids, are gaining traction due to their biodegradability and fire safety benefits, aligning with Europe’s goals for a reduced carbon footprint. With advanced sensors and analytics, transformers can seamlessly integrate with smart grid systems, enhancing Europe’s capacity to handle variable renewable energy flows.

### Supply shortages and implications for renewable energy projects

Despite advances and demand, Europe faces a growing shortage of distribution

**The distribution transformer shortage from supply chain issues and rising costs threatens Europe’s renewable projects, underscoring the need for greater domestic production and workforce development**

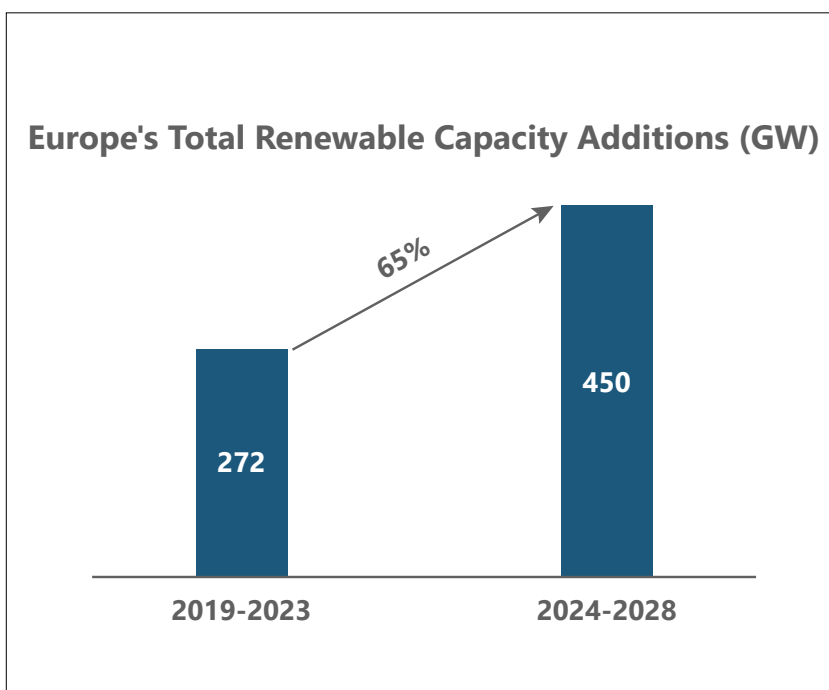


Figure 1. Europe’s Total Renewable Capacity Additions in GW. Source: IEA.

transformers, which poses a considerable threat to the timely implementation of renewable energy projects.

Ongoing supply chain disruptions and rising material costs have primarily driven the shortage. Factors such as the lingering effects of the pandemic, geopolitical tensions, and increased demand for raw materials have all contributed to these challenges. Consequently, manufacturers struggle to meet the escalating demand, leading to longer lead times for transformer production and delivery.

These constraints have a ripple effect, potentially stalling grid connections for new solar and wind installations and hindering Europe's progress toward its 2030 renewable energy targets. Consequently, solutions are urgently needed to expand production capacity and streamline supply chains for distribution transformers.

**As Europe continues its pursuit of ambitious renewable energy targets, the significance of distribution transformers becomes increasingly pronounced**

**Technological advancements in distribution transformers, including digitalization and eco-friendly materials, are essential for enhancing grid stability and efficiency and supporting increased renewable energy capacity**

### Regulatory and industry responses

The European Union is actively seeking solutions to the transformer shortage, but local manufacturers hesitate to invest in new production facilities due to uncertainty regarding regulations and targets beyond 2030. Although current order books are full until that year, long-term investment commitments remain elusive without clarity on goals for 2040. Furthermore, a lack of skilled labor and essential components, particularly the iron core used in transformers, exacerbates the issue.

To mitigate this shortage and maintain the stability of Europe's power grid, it is essential to increase domestic production capacity through government and industry partnerships that offer financial incentives, tax breaks, and grants for new manufacturing facilities. Additionally, investing in training programs and apprenticeships in electrical and technical fields can help build a skilled workforce to meet the growing demands of transformer production.

### Way forward

As Europe continues its pursuit of ambitious renewable energy targets, the significance of distribution transformers becomes increasingly pronounced. These transformers play a crucial role in facilitating the integration of renewable energy sources and maintaining grid stability and reliability amid the inherent challenges of variable power generation. The pressing need to address supply shortages and advance regulatory frameworks, such as the Eco Design Directive, cannot be underestimated. Europe can bolster its transformer manufacturing capabilities by emphasizing domestic production and investing in workforce development, thereby supporting its transition to a sustainable, low-carbon future. Successfully integrating renewable energy into Europe's power grid depends on overcoming these challenges, underscoring the necessity of strengthening the distribution transformer sector as a cornerstone for achieving climate neutrality by 2050.

### About PTR

With over a decade of experience in the Power Grid and New Energy sectors, PTR Inc. has evolved from a core market research firm into a comprehensive Strategic Growth Partner, empowering clients' transitions and growth in the energy landscape and E-mobility, particularly within the electrical infrastructure manufacturing space.

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