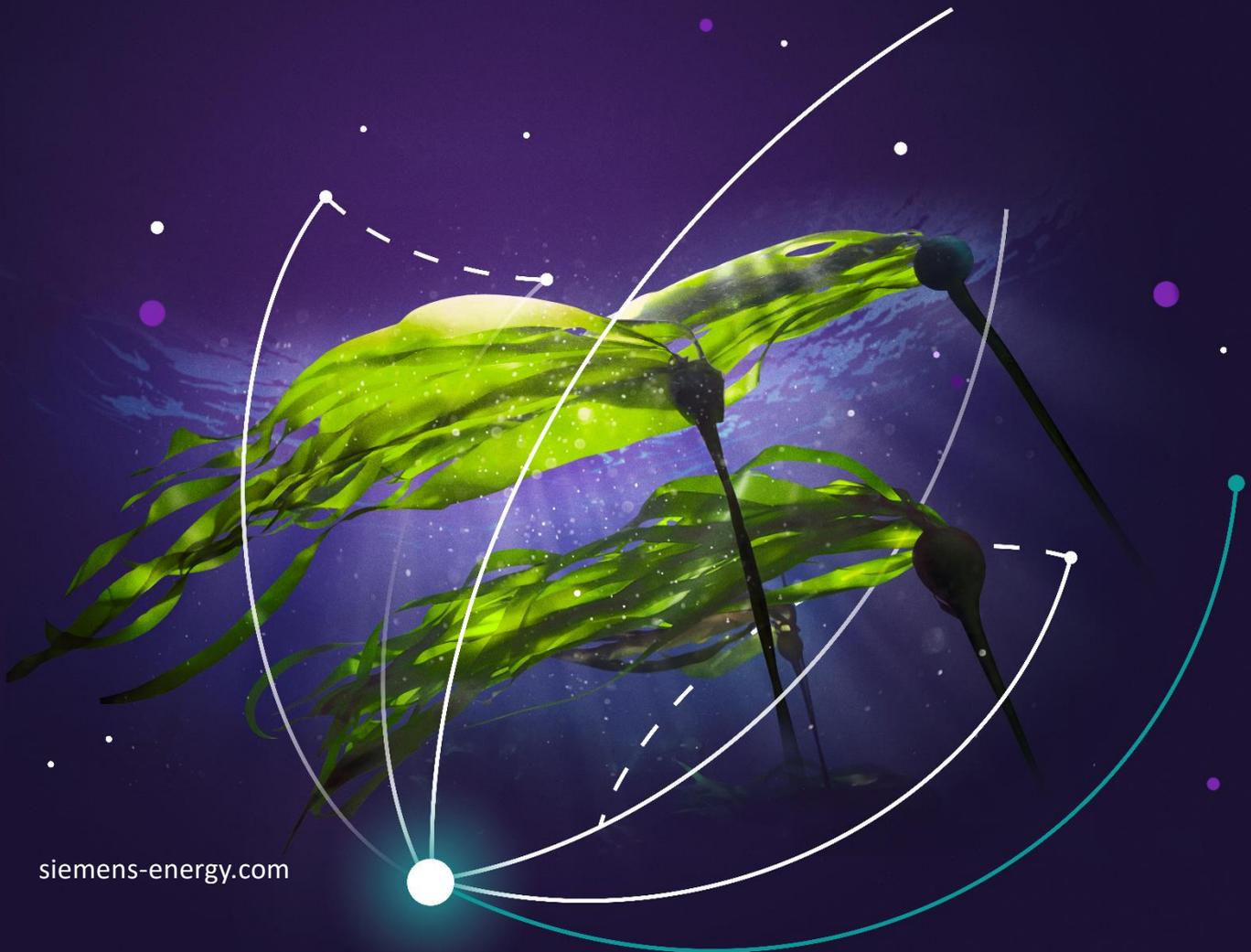


# Trusted partner in the energy transition

Be more eco-friendly, waste less energy  
with Siemens Energy transformers



# Our world is changing – and so are we

Climate change and the increasing electrification of energy systems worldwide pose major challenges for our planet. Studies show that the global energy demand could increase by up to 25% by 2040 - with greenhouse gas emissions rising at the same time. Consequently, manufacturers like Siemens Energy Transmission face three central challenges: first, supporting the grid expansion for reliable transmission and distribution of the above mentioned rising power demand. Second, reducing our customers' carbon footprint by providing environmentally friendly products, and third, coping with the increasing fluctuations in the grid resulting from the rising infeed of renewable energy resources. These challenges lead to the questions: How can we provide our customers with climate-friendly, reliable, and affordable solutions to meet the growing electricity demand? How can we help to successfully implement a decarbonization journey that benefits our customers and society? At Siemens Energy, we support our customers in the transition to a more sustainable world with our innovative technologies, extensive experience, and an ambitious strategy to drive the decarbonization of global energy systems.

Today, more than 1/6 of the world's electricity is generated with Siemens Energy products. As one of the biggest players in the energy landscape, we are focused on and committed to sustainable growth. Therefore, decarbonizing our business activities along the entire value chain is an important step in our journey to energize society even more sustainably in the future. This includes our supply chain, our operations, and our product portfolio. A key element of the Siemens Energy sustainability program is the goal of becoming climate-neutral by 2030. To achieve this, we will switch to 100% green energy consumption by 2023 and invest in our own operations.

Looking at our portfolio, power transformers are a key element for the success of the energy transition. How can power transformers contribute towards a green energy landscape and which product features make them more sustainable?

## Did you know?

Today, more than 40% of our Power Transformers are GSUs manufactured for renewable energy sources – with GSUs for conventional energy sources representing less than 5% of our production volume.

## Power transformers are a key element within the energy value chain towards a successful energy transition

Siemens Energy power transformers are leading the path towards sustainable energy systems. Driven by the need to reduce CO<sub>2</sub> emissions, the energy landscape and therefore transmission infrastructure is rapidly changing. According to the IEA, the need for transmission expansion in the next decade is 80% higher than in the last decade. The increasing amount of renewable energy infeed leads to rising fluctuations and decentralization of generated power. Consequently, there is a great demand for technologies that address the increasing complexity of electrical networks. Products like phase-shifting transformers and variable shunt reactors protect powerlines from overloads, provide active power flow control and compensate reactive power losses. Additionally, the transition to renewable energy sources like solar and wind is enabled by our step-up power transformers with efficiency ratings that exceed global regulations.

As part of our Siemens Energy targets, all power transformer plants will use 100% green electricity by 2023, with more than 80% of electricity already coming from renewable sources today. Furthermore, various sustainability initiatives are being implemented within our factory network in order to decrease the carbon footprint, protect the local environment and reduce the material consumption and waste production.

### Siemens Energy Sustainability Key Figures FY21

0.27

Mt CO<sub>2</sub>e emissions in Scope 1 + 2



1.369

Mt CO<sub>2</sub>e emissions in Scope 3 downstream



0.473

Mt CO<sub>2</sub>e emissions/€ PVO in Scope 3 upstream



76%

Share of green electricity



21%

Women in top leadership positions



0.49

TRIR for employees



### Siemens Energy Sustainability Targets

Climate neutral by 2030

28% reduction by 2030 (base 2019)

30% reduction by 2030 (base 2018)

100% by 2023

25% by 2025  
30% by 2030

Zero harm

## A green factory network – the start of sustainability

### Saving tons of CO<sub>2</sub> emissions by reusing insulation oil

The insulation oil is an integral part of every power transformer and is subject to several aging and degradation processes. As a result, the formation of polar components often prevented insulation oil from being reused in the past. A team at the Siemens Energy power transformer factory in Jundiaí, Brazil has invented an innovative oil purification process that removes these polar components, restoring the insulation oil to its original state and making it reusable. The purification and reutilization of more than 300.000 liters of oil each year reduces CO<sub>2</sub> emissions by 770 tons in Brazil alone. Several Siemens Energy power transformer factories around the world have already implemented this insulation oil purification process, further decreasing the carbon footprint of our manufacturing network.

Picture 1 Oil purification in our factory in Jundiaí, Brazil



### Promoting e-mobility at power transformer factories

The Siemens Energy power transformer factories in Nuremberg, Germany and Weiz, Austria invested in electrical charging stations on the factory premises. By electrifying our own fleet and encouraging our employees to switch to electrical vehicles as well, we are pushing towards sustainable mobility. In addition, our factories are consequently switching to 100% electric construction machines and vehicles such as cranes and forklifts in all power transformer factories, further reducing operational emissions.

### Generating green energy with rooftop solar panels

A total of 3,230 photovoltaic panels were installed at the top of four buildings of the Siemens Energy factory in Zagreb, Croatia. Regular electricity generation from the installed panels started in June 2018. The power station has a total capacity of 1 MW, covering more than 17% of the factories electricity consumption and resulting in an annual reduction of 415 tons of CO<sub>2</sub> emissions. This is just one of many measures to reduce CO<sub>2</sub> emissions by generating green energy for our own operations. We are implementing decarbonization measures in all power transformer factories.

But our journey towards a sustainable future doesn't end with decarbonization. By reducing water consumption and creating large green areas at our sites, Siemens Energy preserves the local environment and biodiversity. At the same time, the automation of lighting and heating systems reduces our power consumption. And by reusing or eliminating packaging materials altogether, we reduce production-related waste. While we optimize and decarbonize the manufacturing of power transformers with state-of-the-art technologies and innovations, our power transformers are also contributing to sustainability themselves, by enabling the feed-in of renewable energies and displaying special ecological features.



Picture 2 Photovoltaic panels on the roof of our factory in Zagreb, Croatia

## Technologies, that make power transformers sustainable

### Highly efficient products ensure low losses

In many cases, transformation losses during the lifetime represent the biggest contributor to CO<sub>2</sub> emissions of power transformers. To ensure that the total CO<sub>2</sub> emissions are reduced, all our power transformers are built in accordance with the local energy efficiency regulations. And by considering an optimal balance between transformer losses and weight induced CO<sub>2</sub> emissions, Siemens Energy offers solutions with optimized efficiency ratings, further minimizing the carbon footprint of our products. To quickly compare transformers with different efficiency ratings and identify the most ecological and economical solution, we recommend our customers to use our peak efficiency index calculator.

The utilization of losses through heat recovery can further maximize the overall efficiency of a transformer. Our experience with heat recovery applications helps our customers to make good use of transformation losses up to the highest power ratings. The usable temperature ranges for heat recovery can be extended by using heat pumps or alternative insulating liquids such as esters.



Picture 3 Power transformer with ester insulation and heat exchanging device in the test field

### Safety and environmental protection through alternative insulation liquids

Traditionally, power transformers are filled with non-biodegradable mineral oils. In order to achieve a higher safety level and to comply with regulations regarding impact on the environment, Siemens Energy offers proven equipment with appropriate designs for transformers filled with alternative insulation liquids. Biodegradable mineral oil made from biowaste has similar properties to conventional mineral oil, but results in a smaller carbon footprint. An even smaller carbon footprint can be achieved with biodegradable natural ester, which captures CO<sub>2</sub> from the atmosphere and comes with the added benefit of a higher flash point. The unique properties of ester enable operation at higher temperatures or can increase the power transformer's lifetime. At the other end of the temperature spectrum, synthetic ester

allows cold starting at very low temperatures and offers several end-of-life options, including regeneration and full recycling. By using biodegradable insulation liquids, such as esters, harmful effects on ground water and the surrounding area are prevented.



Picture 4 World's first 400MVA, 420kV transformer filled with natural Ester for Kupferzell, TransnetBW

Siemens Energy has more than 15 years of extensive experience in ester technologies and has mastered the corresponding challenges of power transformer design. The world's biggest transformer filled with natural ester with a rating of 400MVA, 420kV was built in our transformer factory in Nuremberg and shows the excellent combination of environmental technical expertise and a design tailored to customer requirements.

All the environmentally friendly properties of our transformers are summarized in our Pretact EcoSafeT program and can also be combined with special safety functions, like a rupture safe tank design. The Pretact EcoSafeT™ fire safe substation concept sets new standards for substations in terms of environment, health and safety. The innovative design concept enables the environment-friendly integration of power transformers and other technologies into the transmission landscape, combined with the highest grade of operational reliability.

### Did you know?

More than 95% of a power transformer can be recycled after its lifetime – which often exceeds 30 years.

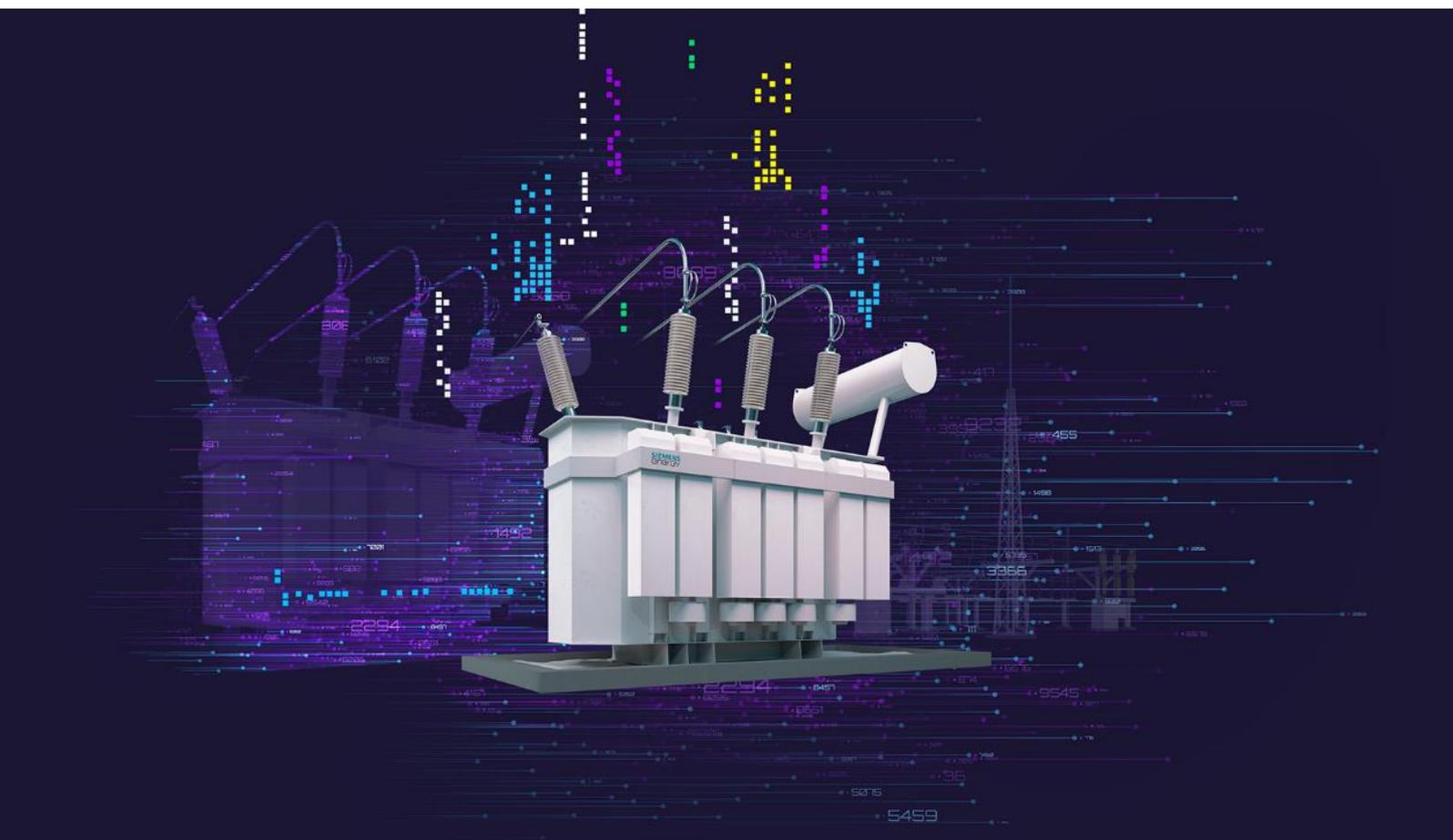
### Advancing the grid with digitalized transformers

Sensformer™ Advanced and Sensformer™ Edge add a digital layer of operational transparency to power transformers which supports operators in managing the growing grid complexity. A distinctive feature of both Sensformer versions is the digital twin technology, a virtual replication of the specific power transformer, based on its design and operational parameters. The digital twin not only provides real-time information about the transformer's performance and condition, but also allows the simulation and evaluation of load scenarios in advance. It can be used for three scenarios: simulating any load and ambient temperature cycle for 24 hours into the future, determining permissible overload with defined boundary conditions and automatically calculating the relative aging of the transformer. Sensformer™ Advanced and Sensformer™ Edge provide the necessary information and analysis to optimize operations. Furthermore, they can help to extend transformer lifetimes and to increase grid loading, thus representing a sustainable and innovative approach to meet the increasing power demand with grid operators' existing fleets.

### Siemens Energy is actively shaping the Energy Market

In addition to the numerous factory measures that we have already implemented to reduce CO<sub>2</sub> emission in production and the many features which make our power transformers more sustainable, many other sustainability initiatives will follow in the future. By issuing certified Life Cycle Assessments and Environmental Product Declarations for each transformer, according to respective norms, we are expanding environmental transparency. And by providing a transformer-specific raw material passport to our customers, we will further contribute to the transparency regarding the CO<sub>2</sub> emission of our products along the value chain in the near future.

Establishing a strong circular economy plays a key role in making our transformers more sustainable. We not only ensure that the materials we use comply with international standards, but also push for a sustainable change in the market landscape by encouraging our suppliers to use an increasing percentage of recycled materials with lower CO<sub>2</sub> emissions. Another important factor in a circular economy is end-of-life recyclability. By working with recycling partners, we ensure that the amount of recycled materials at the end of our transformers' life is maximized while living up to our responsibility to create an ecologic and economic circular economy.



**Published by**

Siemens Energy Global GmbH & Co. KG  
Transmission  
Freyeslebenstr. 1  
91058 Erlangen  
Germany

For more information, please visit our website:  
[siemens-energy.com](https://www.siemens-energy.com)

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**For the U.S. published by**

Siemens Energy, Inc  
Transmission  
8841 Wadford Drive  
Raleigh, NC 27616  
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