

Pushing sustainability for transformers



How do you evaluate how green the energy infrastructure we need to build is?

Industry collaboration: To get ahead on the path to net zero, it's not just electricity generation we need to decarbonize; energy infrastructure itself needs to become greener. That's particularly true for transformers. Yet, to this day, there is no established standard to evaluate their sustainability. Not for much longer. Working groups at DNV and CIGRE are developing a framework to define a robust sustainability standard and, with it, best practices to reduce transformers' environmental impacts.

Today, when we look at the world's energy infrastructure, we see a lot of "more": more solar panels, wind turbines, transmission lines, substations, transformers, grid control stations, energy storage facilities—you name it.

One key driver is the global need to decarbonize electricity, enabling decentralized energy generation. However, transitioning to a green future requires more than sustainable energy sources. The energy infrastructure itself needs

to become more environmentally friendly. That means a more sustainable use phase, end-of-life management, and a greener supply chain for that infrastructure, i.e., raw materials and manufacturing. But how do you evaluate how green the energy infrastructure we need to build is? Just relying on a manufacturer's self-assessment is not sufficient. We need a solution.

Evaluating a transformer's sustainability

A prime example is power transformers. With the global grid expected to double in size by 2040, hundreds of thousands of new power transformers for the TSO grid will have to be in-

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stalled, resulting in the use of millions of tons of steel and copper and a large carbon footprint.

Given these numbers, we must ensure transformers are as green as possible from cradle to grave and, ideally, back to cradle again. However, to do that, we need standards to evaluate sustainable practices. It's in everybody's interest. "Customers not only want to know how green a transformer is," said Marcel Hilgers, Vice President at thys-

senkrupp Electrical Steel. "They also want to be sure they can trust those numbers."

Today, we don't have standards to define what makes a transformer "greener". Merely examining the transformer's operational carbon footprint is insufficient, as it neglects its embodied carbon, supply chain, environmental impact, and social and economic factors. To illustrate this, the embodied carbon of a 300 MVA transformer is estimated to be the equivalent of approx. 3.5 t of CO₂e per ton transformer; of that, 91% accounts for materials and just 9% for manufacturing and transportation.

Stakeholders need to work together

This has to change, and not just because we must keep anthropogenic global warming under 1.5° centigrade. It's also good business. In its most recent report on World Energy Investment,

the International Energy Agency (IEA) estimates total energy investments to exceed \$3 trillion in 2024, with \$2 trillion expected to go toward clean technologies. This also means that today, investors and customers take a company's sustainability into account before making substantial business decisions. These decisions would be easier if they could consider not just an asset's (such as a transformer's) performance but also its supply chain.

To remedy the situation, standardizing transformers' Life Cycle Assessments (LCAs), defined by different Key Performance Indicators (KPIs), is necessary. This will help manufacturers, customers, and regulatory entities reliably compare and assess transformers and identify best practices to reduce environmental impacts. However, stakeholders must work together to usher in such a new, robust standard.

Providing a basis for more effective communication

Luckily, efforts are underway to enhance sustainability transparency through standardization. At the 2022 Transformer Magazine conference, Siemens Energy Grid Technologies co-initiated the Joint Industry Project (JIP) with DNV to develop a standardized transformer LCA with industry partners (OEMs, suppliers, and customers). The result is a soon-to-be-published report, Recommended Practice for Power Transformer Sustainability. "It's all about making faster advancements towards sustainability goals with high-quality solutions," said Mohammad Shah, Team

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The report provides a basis for more effective communication and consultation with and between power transformer stakeholders on sustainability parameters, terminology, data quality, and life cycle assessment. Influential aspects (e.g., recyclability, load factors,

carbon intensity of the network, etc.) are also included. For example, it provides procedures for suppliers to assess the carbon footprint of raw materials such as steel or copper.

Making real-world impact

The report also suggests scenarios to reduce data variation, providing a more straightforward path towards stan-

dardization. For example, future data quality assessment should be based on EN 15804, a European environmental product declaration (EPD) standard. While this standard mainly applies to the construction business, it also applies to the energy industry’s solution business and the products it uses.

In addition, the report suggests rules to ensure the harmonization and re-



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liability of using mass balancing in materials environmental accounting and declarations across a global supply chain and minimize the risk of double counting and general greenwashing. For example, emission credits should be created annually, and EPDs for a grey product line should not include emissions reductions sold through a green product line. Finally, the report also focuses on the end-of-life process to bring the industry closer to a holistic cradle-to-cradle approach and prepare circularity in the HV industry.

In the future, all this should enhance the tendering process, enabling more accurate comparisons and informed decision-making. “It was a no-brainer to participate in this working group,” said Dr. Ghazi Kablouti, Global Portfolio Sustainability Leader at Hitachi Energy Transformers. “We need to drive the required changes across the value chain and collaborate with our partners on making real-world impact.”

Happy to welcome new members

The DNV Industry recommendation is now being continued at [CIGRE](#)

(Council on Large Electric Systems) in a Joint Working Group A2 / C3: [LCA for Transformers](#) led by Myles Margot, Senior Key Expert for Grid Technologies at Siemens Energy. The goal is to go beyond DNV’s JIP report in understanding and unpacking the entire life cycle and establish standardized evaluations, scoring systems, and KPIs of the transformers’ environmental impact. The group started its work in 2024 and is happy to welcome new members, as only the collective expertise of stakeholders will create the best comprehensive and practical framework possible.

Yet, the CIGRE working group is not expected to finish a report for approximately another two years. In the meantime – aside from joining the CIGRE group – what can you do? As an example (and for orientation), let’s look at how Siemens Energy has improved its transformers’ environmental footprint through sustainable and circular practices.

Self-assessments are not enough

As it is, Siemens Energy’s transformers are fairly sustainable. They feature a compact design built to last up to 40 years, using CO₂-reduced materials,

e.g., [bluemint® Steel](#) by thyssenkrupp for [Amprion’s Ultranet](#) Project. Over 95% of our transformers’ total weight can be fully recycled end of life; we can also design transformers fully to scrap. Regarding manufacturing, Siemens Energy is committed to becoming climate-neutral in its operations by 2030, shifting to 100% green electricity, preventing processes that emit greenhouse gases, and reducing energy consumption overall. The transformers have high-performance efficiency. Finally, their expected lifetime fulfills the [EU’s EcoDesign Directive](#) at a minimum and can easily exceed it.

And yet, as laudable as this effort may be, self-assessments won’t be enough in the future. Take, for example, the EcoDesign Directive. In the near future, it will expand its scope, e.g., require digital product passports and focus not just on performance but also on material efficiency, durability, environmental footprint, etc. For that, we need a robust standard as soon as possible. Once we have it, it will not only provide a reliable basis for comparison and evaluation for manufacturers, customers, and regulatory entities. It will help us identify best practices to reduce transformers’ environmental impacts. That’s what it is about in the end – cutting emissions on the way to net zero.

Author



Christina Iosifidou is the Head of Sustainability Grid Technologies at Siemens Energy. In this role, she drives the decarbonization of products, solutions and services across the value chain. She holds a Masters degree in business engineering from the Technical University of Berlin. She started her career at Siemens Energy as PLM for Large Power Transformers, where she later worked as Global Innovation Sales Manager

and gained valuable experiences in Austria and Brazil too. She strongly believes that decarbonization is not a choice; it is a must to protect our planet for future generations. Achieving net zero is possible only by joining hands together, and for this goal, she involves all the relevant stakeholders to discuss strategies and, most importantly, to act.