

The electrical grid stands as a marvel of modern engineering, intricately designed to transmit power from various sources to end users across vast distances. It tirelessly supplies electricity to buildings, industries, schools, and households, ensuring uninterrupted service around the clock, every day of the year. One of the challenges is the aging grid infrastructure such as transformers—critical components of the power grid. That’s why [DOE is partnering with industry](#) and other stakeholders to ensure that our nation’s grid is reliable, resilient, secure, and affordable while meeting all the demands of the 21st century.



Distribution line with transformer

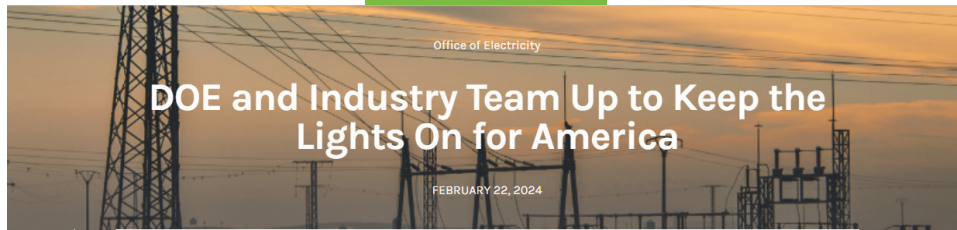
Challenges to Today’s Grid

Much of our modern grid still relies on century old engineering principles and decades old infrastructure that must meet today’s grid demands—this includes an unprecedented scale of deployment of renewable generation sources; emerging increase in load demand including new demand for electricity in the transportation sector; and increasing distributed generation (such as solar) that delivers electricity not only to consumers but also back to the grid. Today’s grid also provides never before seen opportunities for consumers to participate in the electricity market, and more.

These new demands put additional pressure on equipment and systems that brings electricity directly to homes and businesses. That includes electrical transformers, the fundamental building blocks of the electric grid. Large power transformers make it possible to transport electric energy over long distances—from where it is produced to where it consumed—and distribution transformers bring electricity to every home, business, or factory.

These distribution transformers present a special challenge. Transformers are ripe for innovation; the transformer design is based on the engineering principles of the 1800s when the electric power industry developed around the alternating current (AC) transformer. It’s long past time for transformer advancements, driven by the researchers and the electric utility industry.

Transformers are one the most basic grid components that are critical for grid operation. As the nation’s commitment to clean energy continues to grow, we need to make sure that transformers can support all these new demands. We need to accelerate innovations in transformer designs, and we have a unique role at the



Department of Energy to help the utility industry and manufacturers to advance transformers and the supply chain to ensure a resilient and reliable grid.



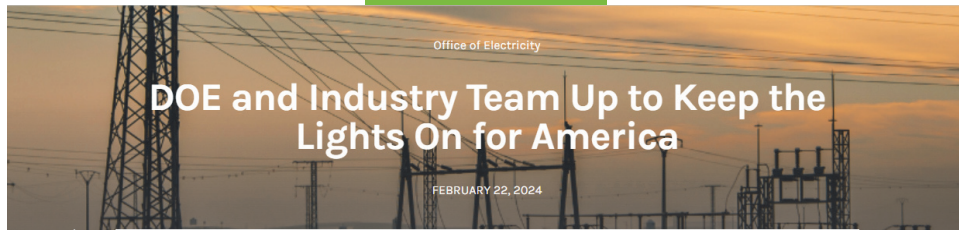
A truck hauls a transformer from EM's [West Valley Demonstration Project](#) to a recycling facility. Funds from recycling are used to offset the site's cleanup costs.

Addressing Transformer Supply Chains

On top of the new demands on distribution transformers are supply chain challenges for the transformers and their raw materials. It is crucial to ensure a robust supply chain. The lead times for transformer orders, particularly distribution transformers, increased from three to six months in 2019 to 12 to 30 months in 2023. The Covid-19 era revealed stresses on the supply chain for things all of us took for granted, including the equipment that makes up America's power grid. These stresses were due in part to pent-up post-pandemic demand; difficulty recruiting, training, and retaining a skilled workforce; component supply chain challenges; and materials shortages (grain-oriented electrical steel, aluminum, and copper). Yet this era also spurred innovation in transformer design, which can support increased productivity in manufacturing.

Government/Industry Partnerships Create Opportunities

This opportunity is being addressed by DOE's unique convening power. To address supply chain challenges, DOE leaders are engaged with utilities, manufacturers, and other stakeholders. This includes DOE partnership with



the Electricity Subsector Coordinating Council (ESCC) to form a Supply Chain Tiger Team of DOE offices, power associations, and a distribution transformer manufacturer.

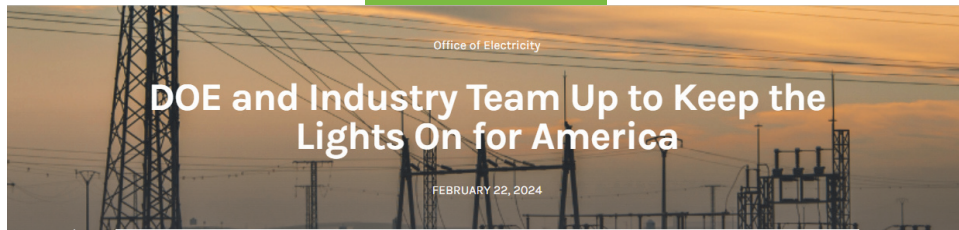
The team identified distribution transformers as the most crucial supply chain constraint facing the power system today. Utility trade members reported that between 2020 and 2022, average lead times to purchase distribution transformers across the electric industry and all voltage classes rose a whopping 443%! These same orders that previously took two to four months to fulfill now take 22 to 33 months. This severely limits utilities' ability to make repairs, order replacements, and connect new customers—all of which threatens reliability and resilience.



Crews at H Canyon at the Savannah River Site remove an old transformer to make room for new equipment needed for an electrolytic dissolver.

DOE convenes distribution transformers interoperability industry subgroup

In March 2023, DOE convened the industry workshop led by the Office of Electricity with participation from multiple industry stakeholders. The workshop attendees concluded that determined that one contributing factor to the longer distribution transformer production times is the lack of the consistent transformer specifications across the utilities. DOE identified over 80,000 different distribution transformer varieties nationwide. Many are legacy specifications that utilities could modify if they would accept more universal transformer designs and standard accessories included with the distribution transformers. To identify key interoperability opportunities



that would be acceptable to utilities and help with reducing production times, DOE convened the OE-led distribution transformer industry subgroup, which includes a diverse set of utility participants and transformer manufacturers.

These opportunities include creating standard definitions and specifications; OE is uniquely positioned to bring together its partners in the utility and manufacturing sectors to agree on core transformer designs, the impact of critical components, and component interchangeability. All these efforts to remove manufacturing bottlenecks and increase transformers production and help to ensure grid reliability.

Next Steps

Whether it's initiating innovation in transformer designs through recently announced [FITT](#) funding, continuing the work of the OE-led distribution transformer industry subgroup, or advancing research, development, and demonstration for the 21st Century grid, DOE is collaborating with industry to drive the change necessary to ensure a reliable grid.

Partnerships between DOE and the electric utility industry are the key to modernizing our nation's power grid. The insight that our utility partners share will continue to advance transformers and other critical grid components. DOE is there to help the industry and to use our convening power and the national labs to ensure that electric grid keeps up with demands of the future and is reliable, resilient, secure, and affordable for all.



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