Navigating the transformer shortage: Strategies for procurement, life extension, and alternative solutions

How should energy industry professionals and other concerned parties react to the transformer shortage?

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ABSTRACT

A persistent transformer shortage is slowing grid upgrades, construction projects, and the transition to renewable energy. Rising demand, aging infrastructure, and long lead times mean that organizations must plan strategically to avoid costly delays. Practical approaches include targeting manufacturers' expanding capacity, timing procurement to minimize setbacks, extending transformer lifespans through maintenance and monitoring, and exploring retrofitting or refurbishment when new equipment is unavailable. Proactive action today can help safeguard operations and ensure reliability in the years ahead.

KEYWORDS:

transformer shortage, transformer demand, power infrastructure, transformer procurement

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1. Introduction

Many areas of the world are experiencing a transformer shortage, creating numerous challenges for power industry professionals, construction leaders, manufacturers, and others. Decision makers who rely on transformers in their industries or projects must respond proactively to reduce the possible effects and set accurate expectations. A well-developed strategy can give a leader an advantage over peers who do not have one. Which actions should a thoughtful plan include?

2. Understand which factors drive transformer demand

Supply chain shortages, extensive construction projects, and increased electricity demand are some of the factors that can make transformers harder to find, requiring ongoing strategy planning. However, the more decision makers understand the most common factors, the easier it will be to anticipate potential challenges and react in time.

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While working with the Department of Energy's Office of Electricity, researchers from the National Renewable Energy Laboratory examined aspects such as the number of US distribution transformer units, the number and capacity of the assets, the units' current age profiles, and how demand for distribution transformers might increase.

During that 2024 study, they found that annual new customers and the replacements of failed transformers drive distribution transformer demand, and capacity requirements could be 260% higher in 2050 than in 2021 [1]. The group also determined that transportation electrification, data center demand, and the increased need for step-up transformers within the wind and solar industries will cause much of the expected growth.

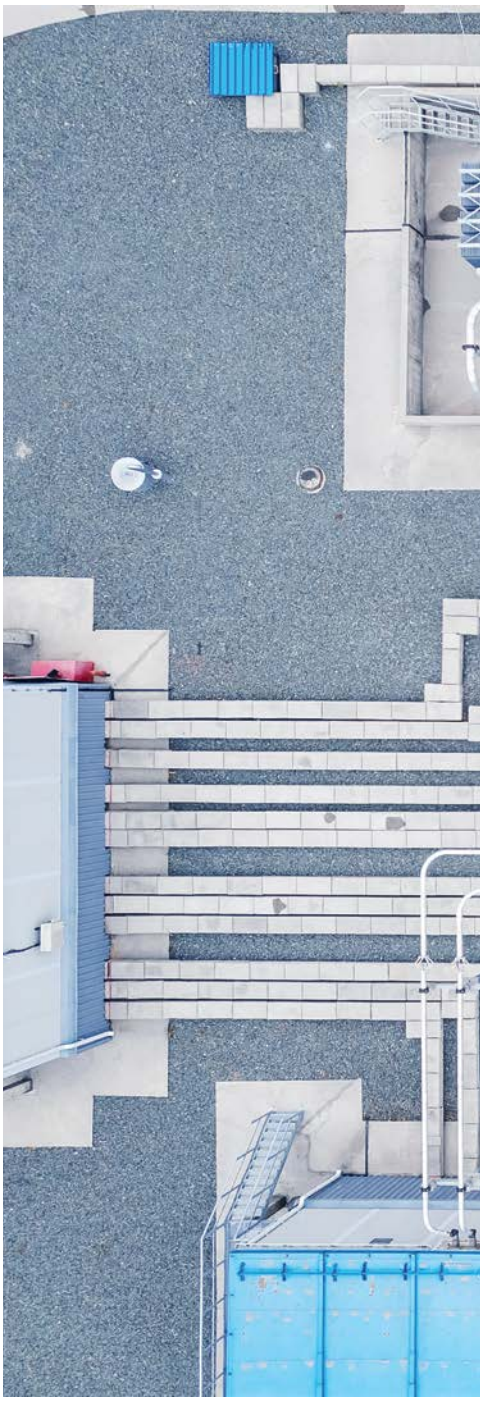
The research also revealed that transformers last much longer than their expected lifespans. Although 55% of in-service transformers are at least 33 years old, the professionals managing them must look for proactive solutions to procure replacements before failures occur. While the researchers found many transformers lasting several decades longer than expected, they believe the combination of aging infrastructure and demand increases will cause failures to occur more rapidly, especially after 2030.

Detailed inventories of a site's transformers, including their ages and maintenance records, will help leaders determine when to replace those assets or take other measures to prevent costly failures. These parties may also wish to categorize the equipment according to the urgency of replacement. That information could create a strategy that prevents downtime now and in the future.

3. Target manufacturers that are expanding operations

Once power industry decision makers have determined that they will need to procure more transformers soon, a solution is to focus on producers that have responded to the growing demand and pressing shortage by opening new factories or adding capacity to existing ones. Those manufacturers may be among the entities best positioned to offer the shortest lead times and widest selections for customers needing to replace their aging equipment.

In one example, Siemens Energy invested $149.8 million into a new North Carolina facility that will be its first large power transformer manufacturing site in the United States [2]. The company's data indicated that the lead time for large power transformers is up to five years, and US domestic suppliers can only meet 20% of the total required. Those factors encouraged the manufacturer's leaders to pursue this new site.

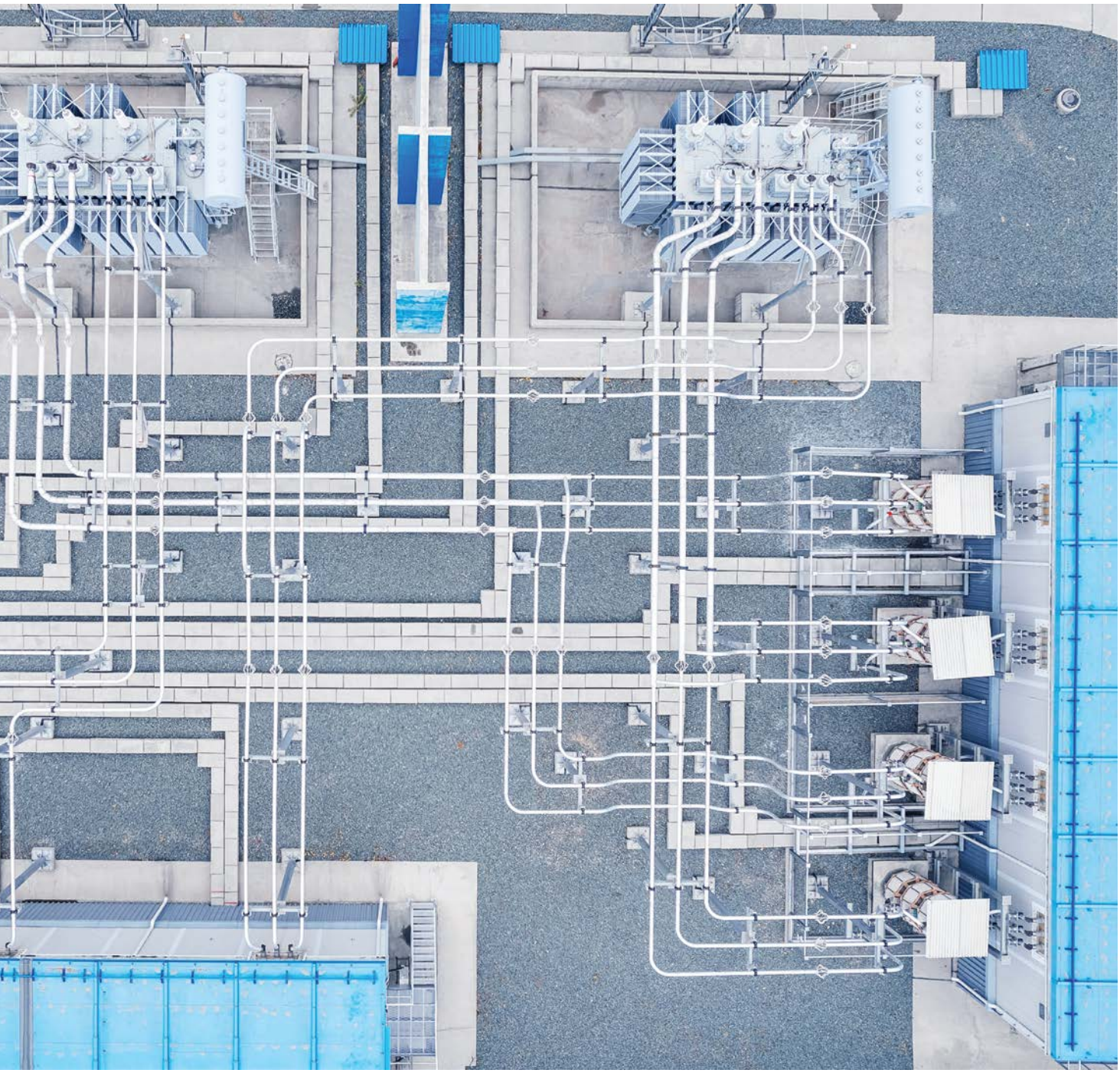


This investment strategy will also stimulate the state's economy, adding more than 500 permanent jobs across two cities and 285 temporary positions during the facility's construction. Although the location will initially produce 24 transformer units per year, that figure will increase to 57 at full capacity. Since Siemens custom-builds transformers for clients, and each is approximately the size of a school bus, it needs time to fill orders. However, this capability boost could point leaders in the right direction as they weigh the best options for meeting their procurement needs.

Although the global transformer market is not seasonally driven, severe weather is one aspect that could make them harder to source in some parts of the world

4. Influence procurement time frames when possible

Purchasing distribution transformers has a substantially shorter lead time compared to large power transformers because these assets are comparatively less complex and do not require as many materials as their counterparts. Buying them when demand is comparatively lower could also accelerate the associated time frames. Although the global



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transformer market is not seasonally driven, severe weather is one aspect that could make them harder to source in some parts of the world.

Some customers found that lead times were as high as 24 months during peak hurricane season [3]. These delays have challenged utility brand leaders. Although some have enough stocks to sustain them until newly ordered equipment becomes available, hurricane season has exacerbated difficulties, as strong storms can destroy transformers and poles.

Professionals attempting to secure new transformers should ideally engage with manufacturers outside of storm seasons or other events that could cause demand spikes. Then, even if those producers have longer-than-desired lead times, customers can show their interest and take the initial purchasing steps. They can simultaneously explore short-term opportunities, such as industrial transformer rentals. Although that strategy does not meet the needs of parties trying to repair or improve the grid, it could serve those who need transformers to meet particular site needs at mission-critical facilities.

One construction association founder and development entity partner revealed his procurement strategy by mentioning that his business paid the transformer installation bill for an 80-lot project immediately after receiving the invoice because he knew promptness would get him in the queue [4]. Even that preparedness meant that the developer's site did not receive its transformers until at least nine months after the location was ready for power. This example shows how the lead times are still lengthy when buyers do everything possible to shorten them, but the circumstances could be much worse for those who need transformers and are less proactive.

Researchers in New York are developing a connected system to alert transformer operators of transformer leakage reactance changes greater than 3%, allowing them to detect winding deformation

5. Establish an effective maintenance and lifetime extension strategy

Power industry players should also keep their existing transformers working for as long as possible by performing all maintenance as the manufacturer recommends. They can save money and time by preventing severe issues through periodic inspections and service appointments rather than only responding once failures occur. Electrical equipment needs regular, either time- or operations-based maintenance. The associated activities directly affect transformer performance, lifespan, and safe operations [5].

Keeping components performing well can reduce catastrophic failure and health and safety incidents, such as loss of life, shocks, and burns. These efforts can also prevent unexpected failures, especially if technicians notice them soon enough. Many problems are initially small, so the cost and ease of fixing them early are reasonable, but the risk of outages grows when people do not address unknown problems.

6. Introduce an online condition monitoring system

The introduction of an online monitoring system to track conditioning and health to prevent failures and identify the need for intervention can assist in ensuring continued operations. Many problems are more apparent over time, but humans do not typically notice them until they have already become severe. However, a connected system that monitors a transformer's real-time condition allows parties to detect issues sooner and have technicians investigate them before these matters become disruptive enough to cause failures.

Most commercially available solutions can alert people to temperature or noise-related changes and provide statistics to show how the transformer has performed over time. Reviewing those details could tell a site manager that something is wrong that deserves further attention or help them create a more effective maintenance strategy.

Predictive analytics algorithms also exist that can indicate which transformer components may fail soon if left unaddressed. That information gives the relevant parties enough time to order replacement parts and make other proactive decisions to prevent lengthy outages that disrupt operations.

Researchers in New York are developing a connected system to alert transformer operators of transformer leakage reactance changes greater than 3%, allowing them to detect winding deformation proactively.

In one example, groups in New York are developing a system that can remotely and continuously monitor a transformer's voltage and currents and calculate the leakage impedance based on those measurements. Operators will then get an alert when the transformer leakage reactance changes by more than 3% [6]. This enables electrical professionals to detect when forces and stresses from short-circuit events have caused a transformer's windings to deform.

This example shows how future dedicated platforms may allow remote, real-time monitoring of transformers and other critical assets. Such data could allow people to extend the life of that machinery while increasing its cost-effectiveness.

When the purchase of new transformers is not a solution that can happen quickly enough, people must think about their existing resources and how they could best use those to address pressing issues

7. Explore retrofitting opportunities

Sometimes, even once power industry leaders plan to procure the new transformers they need, the overall lead times are too long, requiring them to seek alternatives. Decision makers at Central Maine Power dealt with those circumstances when lead times for padmount transformers were well over a year. However, those delays prevented its employees from connecting new homes in their service area to electricity. The ongoing transformer demand and the construction activity prevented the residents from getting the desired underground power.

However, staff found a creative solution by contracting with a local shed builder who created dozens of wooden structures that became part of a retrofitting plan [7]. That strategy allowed the utility enterprise to retrofit the transformers it already had, updating that equipment to optimize its performance and efficiency. It installed 80 wooden transformer enclosures and even more fiberglass ones throughout Maine.

A company executive said the transformer shortage was the biggest problem it had experienced, but ingenuity and thinking outside the box allowed them to prevent the worst-case scenario with this strategy. If the business had not tackled the challenge before it worsened, it would have had to stop connecting customers, causing major delays. Authorities at Central Maine Power coupled this retrofitting approach with a refurbishment program targeting hundreds of unused or underutilized transformers, which crews have brought to a centralized facility for restoration.

When the purchase of new transformers is not a solution that can happen quickly enough, people must think about their existing resources and how they could best use those to address pressing issues. These real-life cases show the value of examining all possibilities to keep operations running and prevent customer disappointment.

Conclusion

Managing the transformer shortage is not easy, but these options for extending transformers' usable lives and being more proactive with procurement methods show there are viable possibilities to explore. Consulting with industry peers may also help with strategy development because it will reveal what others have tried and how well those efforts worked, allowing decision makers to focus on the most worthwhile actions and create timelines for implementing them.

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