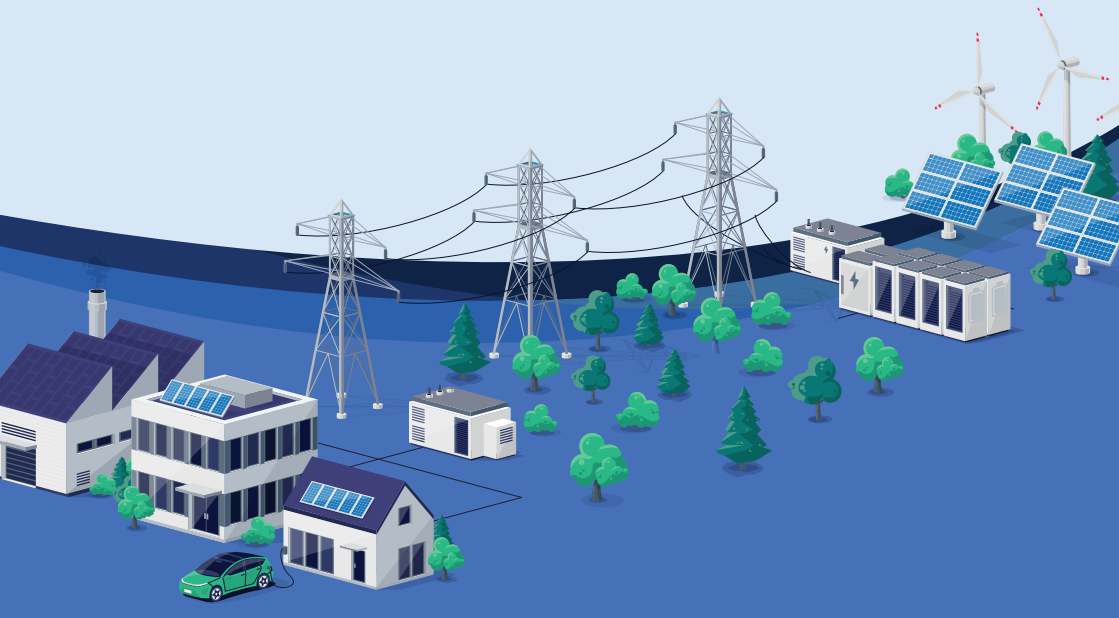
TRANSFORMERS MAGAZINE'S
INDUSTRY NAVIGATOR

# INVESTMENTS 2024
## OUTLOOK TO 2033

DR. MLADEN BANOVIC | ANTO BANOVIC



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# Investments 2024 - Outlook to 2033

## Transformers Magazine's Industry Navigator Report

Mladen Banovic | Anto Banovic

# Investments 2024 - Outlook to 2033

**Transformers Magazine's Industry Navigator Report**

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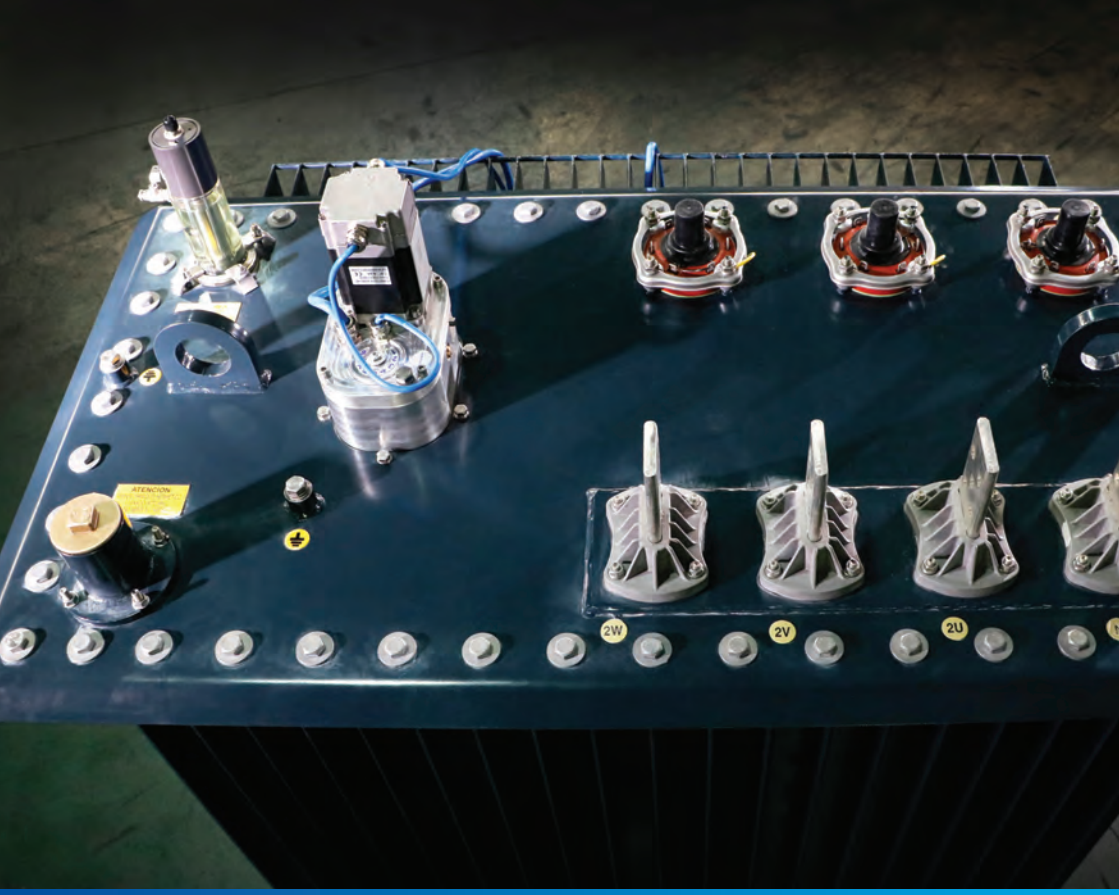


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## Credit

We would like to give credit and express our appreciation to all peers whose useful suggestions during the preparation of this research helped improve its quality. A big thanks to everyone who contributed, especially to:

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Hitachi Energy

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The main purpose of the data presented in this document is to inform decision-makers about the likely scenarios in relation to their decisions. The information presented in this document is not a guarantee that any particular scenario will occur or is likely to occur.

The original data in this research were collected from participants who voluntarily and freely participated in this public research. The researcher had no influence on the selection of participants or their responses, nor could he verify the accuracy of the responses. Various analyses were carried out on the original data and the results of these analyses are presented in this document. *Some of the responses obtained may contain inaccuracies or may be untrue and, as such, may cause inaccuracies or errors in the final results.*

Participants had free access to the survey and their responses were taken into account when processing the data obtained. The number of participants and the number of individual responses were not controlled by any category or attribute, so the results of individual analyses may not be equally representative.

If this survey was carried out with different participants, they might give different answers. In such a case, the results and conclusions may differ to some extent.

If several related people with the same preferences participated in this survey, the 'weight' of those preferences would be increased. In such a case, some of the data in this document may be biased.

Extensive analyses have been carried out with the utmost care in the processing of the data collected; however, it is not possible to guarantee that no errors have been made in the process which would result in the data presented in this document being inaccurate.

Analyses have been carried out on the basis of the data provided by the participants when they took part in this survey. Even if the same participants took part in this survey at a different time, they may give different answers, in which case the results and conclusions may be different.

For the reasons given above, and for other possible reasons that are unknown to the researcher at the time of writing, we recommend that important decisions are not made solely on the basis of the data presented in this document. In the same way that, when driving a car with the aid of a navigation system, one does not rely solely on the information provided by the system, but also observes the traffic flow, road signs, weather conditions, etc., we would also *recommend using other sources of information and, in this case, carrying out additional surveys to verify one's assumptions*.

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## SUSTAINABILITY AT SGB-SMIT

The energy sector plays a key role in the sustainability transition. A clear sign of this is the closing of several centralized power plants and the rapid increase of decentralized renewables for example wind (on- and offshore) and solar.

Being part of the energy sector, the SGB-SMIT Group carries a big responsibility regarding sustainability. Being aware of this, we integrate sustainability by focusing our strategy on Environment, Social and Governance (ESG). This is implemented in our GREEN awareness program which stands for Governance, Responsibility, Equality, Employees and Net Zero. Responsibility and Net Zero cover the Environment Pillar. For the Social Pillar we run an Equality and Employees Program that includes diversity, inclusion, health & safety, good working conditions, trainings and relationships based on trust. Additionally, within our Governance Pillar we are focusing on business ethics, compliance, code of conduct and data security.

Design for circularity, high efficiency and sustainability are the environmental trends influencing our product and service. Lower losses, lower noise (no-load and load), CO2 footprint and product lifetime are important environmental aspects related to these topics. Our suppliers have responded proactively by adjusting their portfolio with more sustainable products such as bio oils and CO2-reduced steel. This is a crucial factor, as over 90% of the emissions generated in connection with the manufacturing of our transformers are caused by the so called up-and downstream activities in Scope 3 of the Green House Gas (GHG) Protocol.

SGB-SMIT is committed to the Sustainable Development Goals (SDGs) for 2030 and the European Regulatory Framework to reach a circular economy by 2050. Our sustainability target is to be 90% carbon neutral of own activities (Scope 1 and 2) by 2030 and 100% by 2035. For all activities (Scope 1, 2 and 3) we aim to be carbon neutral by 2050.

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**14** OPERATIONAL SITES

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# FOREWORDS

Transformers Magazine's Industry Navigator continues to serve as a vital, independent guide to our sector. It validates and highlights emerging trends in the global transformer industry, covering a wide range of issues from investment perspectives, the challenge of limited production capacity in the face of surging demand, and the ongoing issue of labour shortages. It addresses forward-looking issues, such as the industry's approach to sustainability, adjustments to inventory policies, the simplification of complex specifications and other critical issues. The global transformer community will benefit greatly from the findings of this latest Industry Navigator report.

For over a decade, Transformers Magazine has been recognised as a respected, independent voice in the transformer industry, providing analyses that are valued worldwide.

Jean Sanchez, PhD | Transformer Engineer at EDF, France
Executive Editor of Transformers Magazine

This in-depth report from Transformers Magazine, an independent entity with deep industry connections, draws on the collective insights of a significant segment of the industry. It skilfully identifies and addresses areas for improvement to bridge the gap between ambitious goals and current conditions. The study highlights key challenges, including the need to improve sustainability practices, reduce lead times, increase production capacities, improve operational longevity, and implement reliable monitoring systems, all while maintaining cost effectiveness. Individuals at all levels of expertise can uncover valuable strategies for future investments and find effective solutions for balancing conflicting objectives.

Marius Grisaru | Transformer Expert at Transformers Academy, Israel
Transformers Magazine Columnist

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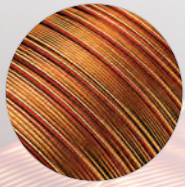

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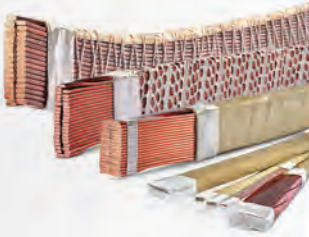

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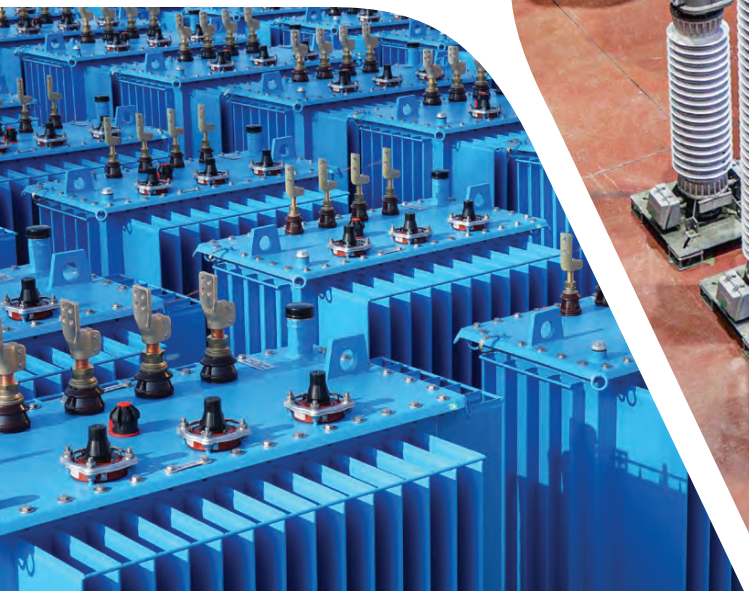
KONČAR

Inspired by challenge



We are here to support the energy transition
1.25 billion people are counting on it

The energy transition – away from fossil fuel to renewable sources – will be humanity's greatest journey this century. We're doing what we can to support increased electrification. For example, we now offer a premium re-refined transformer oil that meets the most stringent requirements. That way, electricity providers can keep cooling their transformers with future-friendly oil. Which is good news both for power companies and electricity consumers worldwide.

NYNAS

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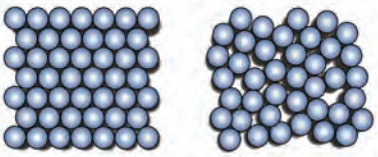
1 The disordered structure of Amorphous steel and the ordered crystalline structure of regular grain-oriented steel



1a Crystalline material 1b Amorphous material

Amorphous alloy is a new type of soft magnetic material, these material offer, in short, excellent magnetic characteristics and economy in production costs. In fact, the advent of Fe-B-Si amorphous metal alloys in the mid-1980s has been the most important advancement in materials for distribution transformers in the second half of the 20th century.

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## Amorphous VS CRGO

| Terms | No-load Loss (W) | load Loss (W) |
|---|---|---|
| SST | 2410 | 21,200*0.3² |
| AMT | 900 | 21,200*0.3² |
| Annual Saving (kW·h) | 13,227 kW·h | 30% load rate |
| 30 years Saving (kW·h) | 396,828 kW·h | 30% load rate |

**A 2500 kVA AMT can reduce $CO_2$ emissions by about 381,000 KG in 30 years**

# EXECUTIVE SUMMARY

The energy transition is stimulating massive investment in power grids, which is driving demand for power equipment, including transformers. Manufacturers with orders stretching years into the future are challenged to increase production capacity, but the uncertainty lies in future demand. Utilities, faced with longer lead times and full production capacities, are considering relaxing specifications to ensure transformer supply. Material availability and price volatility add to these challenges.

Transformers Magazine, as the independent voice of the industry with extensive experience in conducting complex research projects[1], has worked with partners including leading utilities, transformer manufacturers and material and component suppliers to investigate the major challenges facing the industry, in particular the shortage of transformers and skilled labour, as well as future trends in the industry. Unique and precious insights resulting from the research will enable corporate management and those responsible for investments, sustainability, business and technology development to prepare well in advance for market developments that would otherwise be difficult to predict. This information is valuable not only to gain insight into your customers' priorities, but also to understand the steps you need to take to improve your market position and maximise your competitiveness.

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1 Other publicly available reports from Transformers Magazine include:

- Trends in Transformers Technology, 2018;
- Technology and Market Trends, 2021; and
- Trends in Sustainability in 2023.

The accuracy of the research results is proven and has been used as a basis for strategic decision making, but also very often for sales, marketing, business and technology development purposes, etc.

The research covers the entire value chain: transformers, materials and components, manufacturing, operations, etc., and provides answers to 57 key questions on investments, supply chain challenges, sustainability, etc.

The research and report cover the following areas:
- Investments in new transformers in the grids (6 questions)
- Lead time for new transformers (6 questions)
- Key supply chain challenges (14 questions)
- Investments in manufacturing capacities (9 questions)
- Sustainability (8 questions)
- Future trends (9 questions)
- Business outlook (5 questions)

This research provides answers to many relevant questions. Some of them are:
- What are the investment plans for new transformers and manufacturing capacities until 2033?
- What is the expected lead time until 2033?
- What are the main procurement issues and what are preferred approaches?
- Which materials and components pose the greatest supply risk to transformer manufacturing?
- Are companies adopting procurement planning activities and identifying new suppliers?
- Are companies considering acquiring key suppliers to ensure priority supply?
- What is the preferred contracting period related to transformer procurement?
- What will be the key evaluation criteria for transformer procurement decisions?
- What are the changes in requirements for key components inventory?
- What are the main reasons for the price increases?
- Is there an increase in sustainability requirements?
- What are the main barriers to sustainability initiatives?
- What will be the priority for utilities to maintain operability? etc.

# OBJECTIVE

The energy transition, which refers to the global shift from fossil-based systems of energy production and consumption to renewable energy sources such as wind, solar, and hydro, is stimulating massive investment in power grids. Such investments dramatically increase the demand for power equipment, including transformers.

Most transformer manufacturers have orders for the next two to three years or even longer, although the situation is not the same all over the world. High demand challenges the management to invest in new manufacturing capacities, but the challenge is to find the right level of investment as future demand is uncertain.

On the other hand, power utilities are struggling because the lead times are getting longer and there is less interest in bidding as most factories have reached capacity, as mentioned above.

The energy transition is stimulating massive investment in power grids, dramatically increasing the demand for power equipment, including transformers.

Thirdly, the availability of materials and their price volatility further complicates the market situation.

Finding solutions is possible if you have a good insight into the current and future trends. That is why Transformers Magazine, as the independent voice of the industry with extensive experience in conducting complex research projects, has worked with partners including leading utilities, transformer manufacturers and material and component suppliers to conduct research on the major challenges facing the industry, in particular the shortage of

transformers and skilled labour, as well as future trends in the industry.

The aim is that the unique and precious insights resulting from the research will enable corporate management and those responsible for investments, sustainability, business and technology development to prepare well in advance for market developments that would otherwise be difficult to predict. Such information is valuable for gaining insight into your customers' priorities, but also for understanding the steps you need to take to improve your market position and maximise your competitiveness.

That is why we have designed and conducted research that covers the entire value chain: transformers, materials and components, manufacturing, operations, etc. It consists of 57 key questions on investments, supply chain challenges, sustainability, etc. to provide the most accurate and unbiased insights to anyone interested in this field.

The research and report cover the following areas:
- Investments in new transformers in the grids (6 questions)
- Lead time for new transformers (6 questions)
- Key supply chain challenges (14 questions)
- Investments in manufacturing capacities (9 questions)
- Sustainability (8 questions)
- Future trends (9 questions)
- Business outlook (5 questions)

# RESPONSE

In this research, we collected 253 responses from at least 19 countries and 5 continents (only about 1/5 of respondents provided information on their country of residence, while the rest did not provide this information). Having a sufficient number of responses provides an opportunity for various analyses.

The vast majority of respondents (87%) are employed, 11% are self-employed, and 2% are students (Fig. 1). For comparison, the employment status of respondents from the previous report published in 2023 is shown on the Fig. 2.

Having a sufficient number of responses in the research provides an opportunity for various analyses

Regarding respondents' work experience in the field of transformers, 38% have more than 20 years of experience, 39% have between 10 and 20 years of experience, 14% have between 3 and 10 years of experience, and 9% have less than 3 years of experience (Fig. 3). Work experience of the 2023 report respondents is shown on the Fig. 4

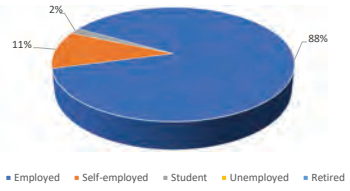


Figure 1. Respondents' employment status, report 2024

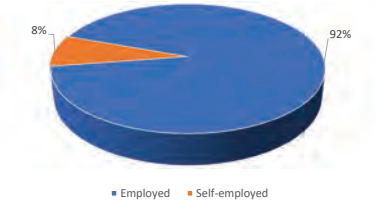


Figure 2. Respondents' employment status, report 2023

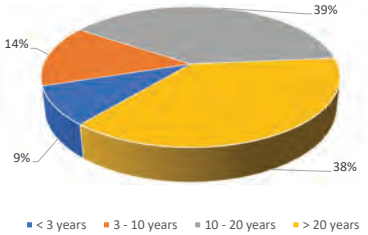


Figure 3. Respondents' work experience, report 2024

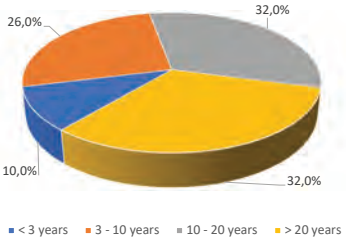


Figure 4. Respondents' work experience, report 2023

The highest number of respondents (45%) are in the age group of 50 years or older, 32% of respondents are between the ages of 40 and 49, 16% are between the ages of 30 and 39, and 7% are between 20 and 29 years of age.

In terms of influence in their current work position, 45% of the respondents stated that they have influence beyond the scope of their work (42% in the 2023 report), 41% have influence within their projects or teams (44% in the 2023 report), while 14% have influence only on their own work (same in the 2023 report).

The distribution of primary responsibility among the respondents is as follows: 14% refers to engineering (same in the 2023 report), 11% to corporate/executive management (16% in the 2023 report), 7% to business development (16% in the 2023 report), 7% to research and development (10% in the 2023 report), 11% to consulting/advising (2% in the 2023 report), etc., Fig. 5 and Fig. 6.

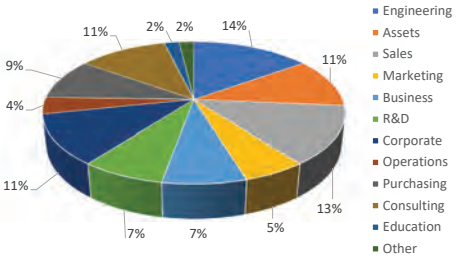


Figure 5. Respondents' primary responsibility, research 2024

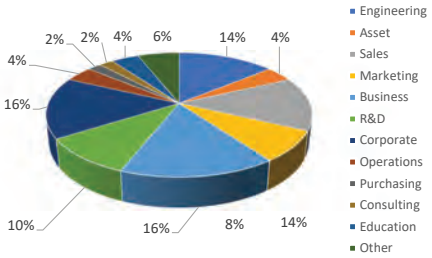


Figure 6. Respondents' primary responsibility, report 2023

The profile of respondents in this research, in terms of their employment status, age, influence, and other relevant attributes, is similar to the profile of respondents in research conducted in 2022. Therefore, the results of these two reports can be compared, where it is appropriate to compare results.

The results of the previous reports (from 2018, 2021, and 2022) have proven to be reliable. E.g., after the 2018 research, we experienced severe turbulences during the pandemic, and despite this, the findings were later confirmed as accurate. Also, results from 2021 and 2023 report were validated.

Given the above and the similarity of the profile of respondents in these research projects, the actual results of the report can be considered sufficiently credible.

The goal of this research was to cover the entire value chain or at least its major parts, and it was achieved, considering that the respondents' organisations include manufacturers of transformers, consultants, service companies, manufacturers of components, materials and equipment for transformers, utilities, agents/distributors and others.

# ANALYTICS

Collected results were analysed and key answers were identified based on the percentage of votes or ranking, and the overall results are presented in this report.

In addition, it is possible to analyse responses with respect to attributes of the respondents' profiles. If you are doing business with transformer OEMs, it is necessary that you have the results based only on their responses.

Collected results were analysed and key answers were identified based on the percentage of votes or ranking

If your business depends on decisions made by engineering and procurement people, which is often the case, you need to check those responses and analyse them.

We can also analyse relations between responses. For example, what are the differences in priorities between specific groups of respondents? In this way you can get a much deeper understanding of priorities, requirements and correlations related to your interest precisely.

Specific analyses can be made on request.

# SUMMARY OF RESULTS

This section summarises the most significant results of each area covered by this research. However, for each question, it is important to consider the entire ranking list to understand the relationships between priorities and to consider these factors in the strategic decision-making process and in the implementation of investment strategy, business development strategy, sustainability strategy, etc.

## Investments in new transformers in the grids

The aim of this section was to analyse historical and present trends in investment in new transformers, together with projections of MVA capacity up to 2033 and the expected number of units up to 2026

The overall results show that most respondents (between 32% and 35%) expect investment to increase by between 10% and 30%.

Most respondents expect investment to grow between 10% and 30%

## Lead time for new transformers

The objective of this section was to examine past and current trends in lead times for the procurement of new transformers, as well as expectations for lead times up to 2033, and to determine the optimal lead time.

Prior to the pandemic, until 2020, the typical lead time for the procurement of new transformers was up to 1 year.

However, during the pandemic period from 2020 to 2023, the typical lead time increased to 1-2 years. Projections suggest a further increase in lead times to 2-3 years by 2026, after which they are expected to stabilise in the 1-2 year range.

Lead times are expected to be 2-3 years until 2026

The maximum acceptable lead time that is considered reasonable within the industry standards, is identified as up to 2 years.

## Key supply chain challenges

This section aims to deepen our understanding of various problems in the supply chain, preferred sourcing strategies, risk management approaches, preferred contracting periods, planning methodologies, inventory policies, supply chain compliance practices, etc.

The increasing demand for electricity grid capacity is significantly influencing the need for new transformers, highlighting the central role of transformer procurement in addressing supply chain challenges.

**The primary sourcing challenge is to secure the necessary raw materials and components.**

To manage the risks of transformer procurement associated with long lead times, many are opting for long-term framework contracts with price flexibility.

A notable preference among respondents is for local or regional sourcing or sourcing from specific regions, with over 60% favouring this approach. When it comes to period for transformer procurement, the majority (51%) tends towards 1-2 years.

There's a clear trend towards earlier procurement planning, with almost 90% of respondents initiating orders at least a year in advance - a strategy that suggests that **a significant proportion of demand is coming from earlier ordering**.

In addition, **around --% of respondents said they had adjusted their inventory strategies, opting to increase stock levels by at least --%, which is another reason for the increase in demand**.

A significant --% are looking for new suppliers, indicating a dynamic market and a continuing search for better sourcing options.

**The most critical risk to transformer manufacturing today is the availability of ----------.**

Rising raw material costs are the main reason for price increases.

Quality remains the number one consideration in sourcing decisions, underlining its importance over other factors in the transformer sourcing process.

The main sourcing issue is the availability of raw materials and components

## Investments in manufacturing capacities

This section was intended to investigate the manufacturing investment trends and identify constraints until 2033, including insourcing and outsourcing strategies and the issue of skills shortages.

The majority of respondents reported investment plans to increase manufacturing capacity by up to --% by 2026. This is expected to increase to --% by 2030, before slowing a --% growth rate by 2033. **These investment plans are in alignment with the anticipated lead times for purchasing new transformers**.

The most pronounced barrier to expanding manufacturing capacity is the shortage of available staff. This is highlighted by the fact that **--% of respondents disclosed their companies have underutilised capacity, primarily due to labour shortages**. This underlines the significant impact of staffing issues on manufacturing operations.

In addition, nearly --% respondents are considering the strategic acquisition of key suppliers as a means of mitigating these challenges and enhancing their manufacturing capabilities. This indicates a strategic shift towards vertical integration or closer collaboration with suppliers to ensure stability and growth in manufacturing capacities.

## Sustainability

The goal of this section was to explore several key areas related to sustainable transformers: the perception of green or more sustainable transformer, the presence and evaluation of sustainability requirements in tender processes, barriers to sustainability initiatives, strategies to improve sustainability, and approaches to improve circularity within the industry.

Transformers with reduced losses have the best perception as a green or more sustainable transformer, a stance that remained consistent in both the 2021 as well as in 2023 report. With regard to the integration of sustainability criteria in tenders, findings indicate that such requirements are specified in around -- % of cases. However, the weight given to sustainability is typically less than -- % and is expected to increase to between -- % and -- % in the foreseeable future.

**The most significant barrier to sustainability is the lack of ---- ----- ----- tools**, and the development of a standard is seen as the most critical step to improve sustainability in this sector. In addressing the transformer shortage, the adoption of material saving techniques and methods emerges as the most important circularity practice. These approaches not only contribute to sustainability, but also ensure the resilience of the industry by reducing supply chain vulnerabilities.

## Future trends

The primary objective of this section was to explore the critical aspects of procuring of new transformers in the foreseeable future, the importance of innovation, the prevailing preference for transformer ownership, strategies for maintaining grid operability, the importance of transformer-related services, etc.

Improving sustainability will be a key consideration when procuring new transformers. Innovation should focus on ensuring reliability, optimising the design to cost, and minimising losses. When it comes to transformer ownership, there is a clear preference for direct ownership over other alternatives.

**For utility companies, there is a strong recommendation to prioritize the ------- -- --- ------ --- -------- -- --- -------- ----- -- - strategy to maintain grid operability**. This is essential for adapting to evolving energy demands and integrating renewable energy sources efficiently.

It was observed that a considerable number of respondents acknowledge the widespread implementation of online monitoring technologies in the grids to which they supply products or services. These t echnologies a re instrumental in improving the reliability and efficiency of grid operations by providing real-time data on transformer performance.

In addition, load factors are expected to increase significantly, according to more than half of the respondents. This forecast underlines the need for transformers that can handle higher capacities and stresses, making the case for continued investment in transformer innovation and maintenance even more compelling.

Reliability, optimisation of design to cost, and low losses will be priorities for innovation

## Business outlook

The main objective of this section was to analyse expected revenue growth up to 2026 and to identify the transformer applications that are expected to see the most significant growth.

Most respondents expect their company's revenue to grow by ---- -- %. Among the various applications, those related to **renewables and distribution transformers are predicted to experience the most significant growth over the next 5 years**.

# CONCLUSION

The research meticulously examined 57 pertinent questions and collected responses from a wide range of stakeholders across the global transformer market in a systematic and unbiased manner. The selection of stakeholders was carefully considered to ensure that a wide range of influential voices were heard, providing a robust foundation for meaningful analysis. This thorough approach has enabled us to derive actionable insights that provide a strong basis for strategic decision-making across a wide range of scenarios.

The findings presented in this report indicate several key insights:

- A substantial portion of the increase in demand is attributed to ---------- ---------- ---------.
- Strategies to ------- -------- ---------- are another significant factor contributing to the increase in demand.
- The principal challenge in sourcing is the limited ---------- -- ---------- --- -------- ----- --, which has a direct impact on price escalation.
- Shortage of --------- -------- limits some industrial capacity.
- There is a noticeable correlation between anticipated investments in manufacturing capacity expansion and the expected lead time dynamics.

In instances where the findings outlined in this report do not provide sufficient clarity for decision making, they can still be used as preliminary guidance. These insights can pave the way for more in-depth analyses and encourage the conduct of additional, targeted investigations to refine understanding and strategic direction.

Results presented in this report represent a solid basis for making good strategic decisions in a large number of cases

# OVERALL RESULTS

This section presents the overall results of 57 critical strategic questions relating to investments, supply chain management, sustainability, future trends, etc. The responses to each question are presented in a list format, with the corresponding percentage or score derived from the collective input of all participants. The higher the score result, the higher the priority of that option in the question. The option with the highest score or percentage will be ranked as 1. Options with lower scores or percentages will be ranked as 2, 3, etc.

To facilitate comparison with the results of additional analyses, we've maintained the order of responses as they originally appeared in the research.

Such additional analyses can be carried out by segregating data according to specific criteria and contrasting the results. For example, results of responses from transformer manufacturers can be compared with the results of responses from end users. Results for developed countries can be compared with the results for developing countries, and so on.

Maintaining a consistent order of responses facilitates comparisons across these nuanced analyses, despite potential differences in rankings.
Various additional analyses are available on request.

Detailed results are available in the full version of the report...

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> Transformers Magazine's Industry Navigator continues to serve as a vital, independent guide to our sector. It validates and highlights emerging trends in the global transformer industry, covering a wide range of issues from investment perspectives, the challenge of limited production capacity in the face of surging demand, and the ongoing issue of labour shortages. It addresses forward-looking issues, such as the industry's approach to sustainability, adjustments to inventory policies, the simplification of complex specifications and other critical issues. The global transformer community will benefit greatly from the findings of this latest Industry Navigator report.
>
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