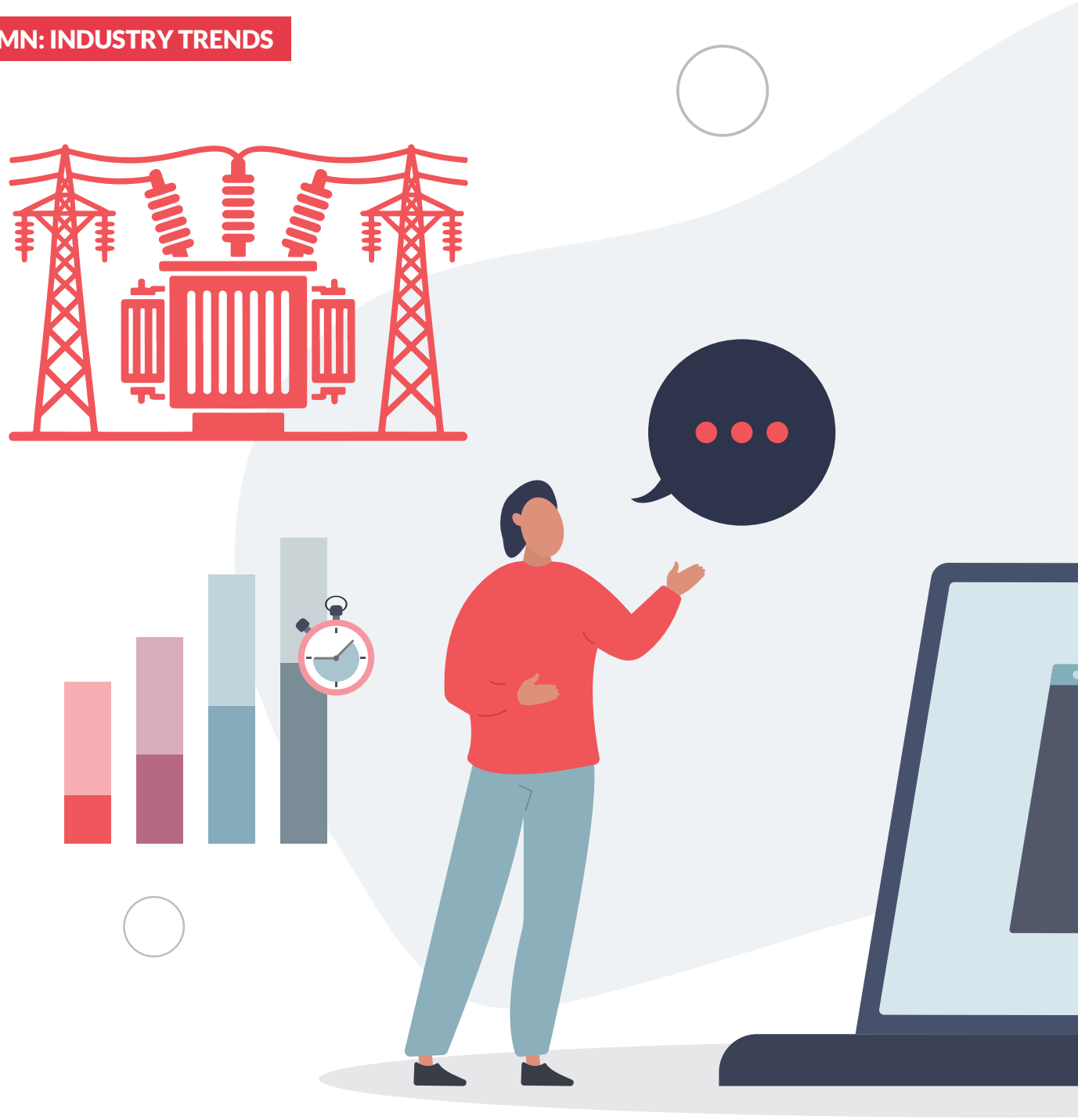
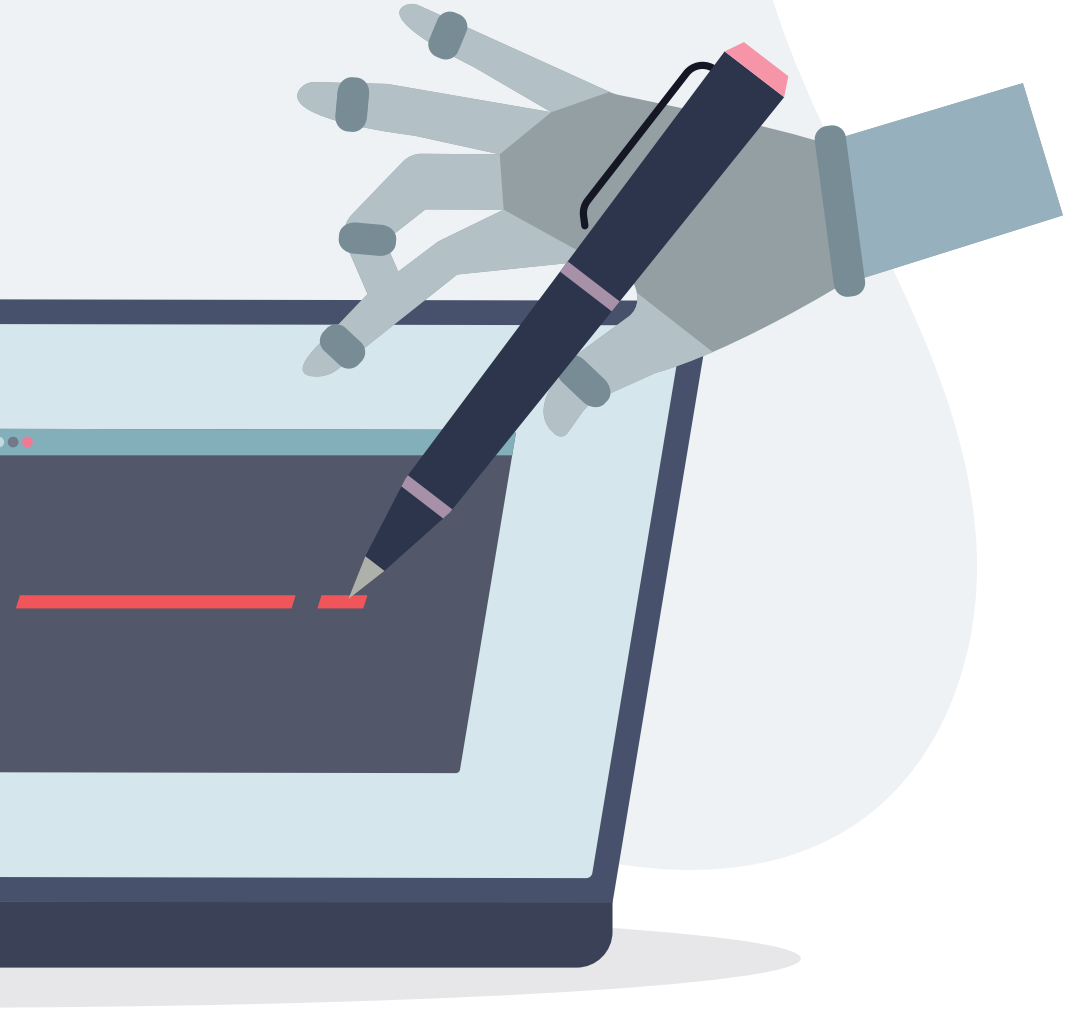


Diagnostics and monitoring applied to business

What transformer practice can teach us about a changing industry

Mladen Banovic

The mechanisms in business are different from the physics inside a transformer, but the information problem is comparable



ABSTRACT

The transformer industry has spent decades learning how to combine diagnostics and monitoring. In some cases, only one parameter, such as hydrogen, is selected for monitoring to provide an early warning. In other applications, tens of parameters are monitored because a broader view of condition is needed. The number of parameters is not the point. What matters is to know what each monitored parameter can tell us, what it cannot tell us and when a change deserves deeper diagnostic investigation. The same information challenge exists in business. Industry Navigator research has already built a deep diagnostic view of the transformer industry through studies conducted since 2018. The 2026 programme examines more than 260 variables across demand, capacity, lead times, supply chains, investment, workforce, complexity, resilience, and market visibility. Monitoring selected market indicators has a different purpose. It cannot replace this depth, but it can add the time dimension by showing how the market is changing between deeper examinations. Diagnostics explains the condition. Monitoring helps us recognise movement.

KEYWORDS:

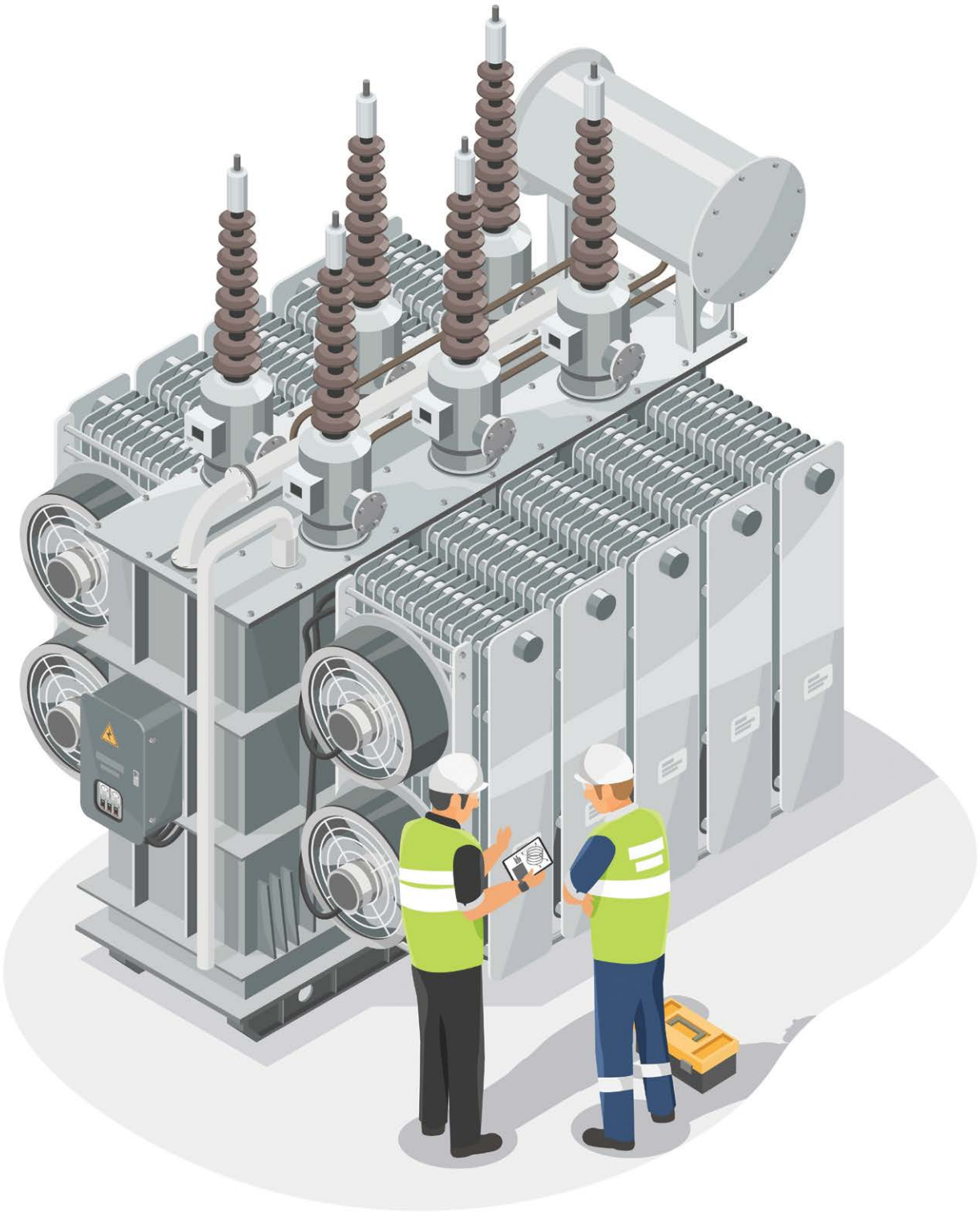
transformer industry; market intelligence; diagnostics; monitoring; Industry Navigator

In market discussions, we are often less disciplined and are tempted to let the most visible number become the explanation

1. Introduction

Most people in this industry would not make an important decision about a transformer from one measurement alone. There are exceptions, of course. In some cases, only a single parameter is selected for monitoring. Hydrogen monitoring is a good example. There are discussions about whether it is enough or not, but this is common practice. If the value or its trend starts to change, that may be enough to tell us that the transformer deserves attention. In other cases, tens of parameters may be monitored because the question we are trying to answer is more complex.

Suppose an online gas monitor shows a developing trend. We would normally look at the loading and operating history, consider whether other gases or temperatures have changed and decide



whether additional diagnostics are needed. The monitor does not have to explain the whole problem. Its first value may simply be that it tells us early enough that something is developing.

That timing can be extremely important. If the cause is identified while there is still time to intervene, a developing fault can sometimes be corrected before it becomes a failure. The result may be more than avoiding one outage. It can preserve years of useful transformer life and, in favourable cases, perhaps much longer.

The mechanisms in business are different from the physics inside a transformer, but the information problem is comparable. We still have to decide which business parameters or indicators matter, how much context is needed before drawing a conclusion, and whether we are looking at a stable condition or at the beginning of a change.

The transformer analogy is useful here. It is not about pretending that a market or industry behaves like an electrical asset. It is about applying the same discipline to information: understand what is being measured, avoid asking one measurement to answer a question it cannot answer, and pay attention to change while there is still time to act.

2. One number cannot tell the whole story

A monitored parameter does not have to diagnose the fault by itself. Its purpose may simply be to show that the condition has changed enough to justify a closer look. Hydrogen monitoring is commonly used in this way. There is debate about whether one gas is sufficient, and additional measurements are still needed for diagnosis.

The same applies when we look at a market. Take lead time. If a utility reports that it is now being quoted 24 months for a transformer, the number is significant, but it still does not explain the situation on its own. Is that normal for this transformer category? Is the project in North America or Asia? Is the restriction at the transformer factory, in components, engineering, testing or qualification? Is the quoted lead time similar to what other customers are seeing?

The value of such research comes from combining many answers and examining questions that cannot be resolved from a single indicator or survey result

This is why context and direction must be considered. A long lead time tells us that pressure exists, but it does not automatically identify the source of that pressure. Nor does a factory announcement tell us how much additional supply customers can actually use. A strong order book confirms that manufacturers are busy, but its meaning depends partly on how far ahead customers are ordering and what has happened to inventories and capacity reservations.

The practical consequence matters because the management response depends on the diagnosis. If the real restriction is a component, adding final assembly capacity will not remove it. If capacity exists elsewhere but the supplier is not qualified or the product cannot meet the required specification, then the issue is access rather than physical scarcity.

For transformers we are comfortable with this way of thinking. We routinely separate indication from diagnosis. In market discussions, we are often less disciplined and are tempted to let the most visible number become the explanation.

3. Building industry diagnostics

Diagnostics at industry level is not a new direction at all. Industry Navigator has been building the diagnostic side of the picture for years.

The research started in 2018 with transformer technology trends. In 2021 we widened the scope to technology and market trends, followed by sustainability in 2023. The 2024 programme went much deeper into investment, manufacturing capacity, lead times and supply-chain challenges. Workforce Challenges 2025 then examined the people, skills, knowledge, and organisational capability needed to support the expansion. The 2026 Critical Business Pillars research brings many of those subjects together and looks at how they interact.

There is also continuity in the way we think about information. In the 2024 report we used the example of driving with a navigation system. A good navigation system gives information that is difficult to assemble on our own, but nobody drives by looking only at the screen. We still watch the road, traffic, signs, and weather because the situation around us can change.

That analogy was originally used as a caution against relying on one source when making an important decision. Looking back, it also says something else. A detailed map and the traffic around us answer different questions. The map gives us structure and context. Observation tells us whether something has changed since the route was calculated.

The same philosophy runs through the research programme. Each study gives a deep examination of a particular dimension of the industry. Read together, they also show how the nature of the problem has changed. In 2024 the dominant issue was shortage and the first response to it. In 2025 we looked at whether the industry had enough people and knowledge to deliver the expansion. The 2026 research shows the system-level consequence: factory capacity, components, workforce, engineering, testing, complexity, and market access all have to develop together.

This is why I increasingly think of Industry Navigator as industry diagnostics. We are not only asking how high or low one result is. We compare groups, regions and product categories, connect questions that at first appear unrelated and test whether an obvious explanation still holds when the rest of the evidence is considered.

The underlying need can be real, but scarcity can change how that need becomes visible in the order book

4. What deep research can reveal

The 2026 programme is one of our broadest to date. It examines more than 260 variables across demand, capacity, lead times, supply-chain performance, investment, workforce, complexity, resilience, and the outlook towards 2030. The value of such research comes from combining many answers and examining questions that cannot be resolved from a single indicator or survey result.

Demand is a good example. If I look only at a full order book, it is easy to call everything in it demand. The research forces a more useful distinction. We can separate the underlying need for equipment from the timing with which that need enters the order book, and then look separately at the ability of the value chain to execute the projects.

Those are three different things. A transformer may be needed in 2029 and still be ordered years earlier because the buyer cannot risk losing a production slot. A company may increase inventory because it is protecting itself against continued scarcity. A utility may reserve capacity well before it would have done in a balanced market. The underlying need remains real, but scarcity changes when that need becomes visible in the order book.

This distinction becomes important when we try to interpret a turning market. Ordering behaviour can normalise faster than electricity demand or grid investment. If customers become more confident that they can secure transformers later, they may stop ordering so far ahead even though the projects themselves have not disappeared. Looking only at order intake, we could easily confuse a change in timing with a change in fundamentals.

Lead time gives another example. It is one of the most useful indicators of market pressure, but only if we are precise about what we mean. Distribution transformers, medium power transformers and large power transformers operate on very different timescales. Regional differences can be large enough to change the conclusion completely, and manufacturers may see improvement before end customers feel it.

This is exactly what deep research is good at. It can tell us not only that a number is high or low, but where, for whom and in combination with what other conditions. Monitoring selected market indicators cannot provide the same depth as a broad industry research programme, nor should we expect it to.

5. Capacity: One word, several realities

Capacity may be the clearest example of how easily one familiar word can hide several different realities. We hear regularly about a new factory, a new production line or a major expansion. While all of those announcements matter, none of them, on its own, tells us how much additional competitive supply has actually reached the market. Counting factories is not the same as measuring market capacity.

The 2026 research separates the path into several stages. Announced capacity is what a company plans to add. Installed capacity is what has physically been built. Ramped capacity is different again because commissioning a line is an event, while reaching stable output is a process. People have to be recruited and trained, production routines have to settle, suppliers have to keep pace and the testing organisation has to release the extra units reliably.

Even a well-ramped factory may still produce less than its nameplate potential if critical components, engineering resources, skilled labour or test capacity are limiting. Effective capacity provides a more realistic measure. It is the output that the surrounding value chain can actually support, rather than just what the factory could theoretically manufacture if everything else were available.

Then comes accessibility. A transformer can exist somewhere in the world and still be of little use to a particular customer if the manufacturer is not qualified, the design does not meet the specification, localisation or trade rules restrict access, or the relevant product is simply not offered in that market. Competitive capacity goes one step further. The source must not only be accessible; it has to make commercial sense at an acceptable combination of price, lead time, technical fit and contractual conditions.

This becomes especially important as supply chains regionalise. Global manufacturing capacity can rise while a particular market remains short. Product mix creates the same problem. Additional slots in one transformer category do not automatically help another category that requires different engineering, equipment, testing or supplier capability.

The distinction between announced, installed, ramped, effective, accessible, and competitive capacity is therefore more than terminology. Each stage answers a different business question. It also explains why two people can look at the same investment wave and reach very different conclusions about how quickly the shortage will ease.

6. Cross-checking indicators

A comprehensive transformer diagnostic assessment is performed at a particular point in time. We may combine offline tests, loading and operating history, inspection findings and expert judgement. Monitoring of one parameter, or even tens of selected parameters, does not replace that examination. It answers a different question.

Comprehensive industry research works in much the same way. Some questions need a broad sample, detailed segmentation, and enough time to understand how the results fit together. Workforce capability, supplier qualification, specification complexity, organisational maturity or long-term investment expectations do not become more useful simply because we measure them more often.

Counting factories is not the same as measuring market capacity

The 2026 research also lets us connect answers that would otherwise sit in separate charts. We can ask whether the investment areas respondents consider insufficient are the same areas they identify as future bottlenecks. We can compare regional expectations for new manufacturing capacity with regional workforce outlooks. We can find out whether a resilience measure reduces one risk but increases qualification, quality, or organisational load elsewhere.

This kind of triangulation is where the depth comes from. A result that looks obvious in isolation can become much more interesting once another variable changes its meaning. That is also why I would never want market monitoring to become a smaller, faster copy of the full research. The two have different jobs.

7. Recognising change

A market does not normally move from shortage to balance in one clean step. More often, the change begins in parts of the system while other parts still look exactly as they did before.

Imagine that underlying grid investment remains strong, but customers gradually stop ordering three years ahead because delivery times are no longer getting worse. Companies that built inventories during the shortage stop adding to them. At the same time, some of the new factories announced in previous years are finally reaching stable output. Revenue can still look excellent because manufacturers are delivering the old backlog, while new-order behaviour is already becoming less defensive.

If we watched revenue alone, we could conclude that nothing important had changed. If we looked only at one regional lead-time figure, we might reach the opposite conclusion. The more interesting question is whether several indicators that used to move together have started to separate. The first indication of a market turning point may be a pattern across several indicators, not one dramatic number.

The value of continuity becomes practical here. In transformer monitoring, early recognition gives us time to investigate and, where possible, intervene before the consequence becomes serious. In business, companies normally see changes in their own order intake early. The harder question is whether the same change is happening across the market, or only in their own books. Industry research and market monitoring can provide that wider context while there is still time to adjust investment timing, inventories, sourcing commitments or capacity plans.



The first indication of a market turning point may be a pattern across several indicators, not one dramatic number

None of this means that every small movement deserves a reaction. Transformers also produce normal variation, and so do markets. Monitoring only becomes useful when we understand which changes are meaningful in context. That brings us back to diagnostics.

8. What monitoring can tell us

Monitoring does not always mean using only a few parameters. In some cases, only a single parameter is selected for monitoring. In other applications many parameters are monitored together. The number itself is not the point. Monitoring is used to recognise change in the selected parameters, while diagnostic measurements and analysis are used when the cause needs to be understood.

The same logic works for market intelligence. One indicator may be particularly informative for one question, while another question may require several indicators to be read together. Lead time is a good candidate because it reflects the interaction of backlog, effective capacity, and market pressure, but it becomes much more useful when product category, region and position in the value chain are kept consistent.

An eighteen-month lead time means one thing if it has risen from twelve months and something very different if it has fallen from thirty. Eighteen months is not inherently good or bad without a reference. The level tells us where we are; the history tells us how we got there and which way we may be moving.

Other indicators can help answer different parts of the question. Ordering horizons and capacity reservation can show whether customers still feel forced to secure slots far in advance. Inventory behaviour can tell us whether companies are still building buffers or beginning to normalise them. On the supply side, the useful number is not how much capacity has been announced, but how much has moved far enough through the ramp-up process to affect actual availability.

How often an indicator should be monitored depends on how quickly it can change, how reliable the data are and what decision the information is meant to support. There is no reason to assume that more frequent automatically means better. Consistent definitions, comparable segments, and enough history to distinguish movement from noise are at least as important.



There is another reason deep research and monitoring belong together. A broad diagnostic study helps identify what is worth paying attention to. Without that background, it is very easy to monitor what is convenient to collect rather than what is genuinely informative.

9. From position to direction

In my previous column on research-based business insight, I focused on the question of where a company stands. A benchmark can show whether a problem is specific to one company or common across the market. It can help a procurement manager judge a supplier lead time or help management understand whether its own position is stronger or weaker than it appears.

Direction is a related, but different, question. A benchmark taken today can tell us that the market is tight. It cannot, by itself, tell us whether the pressure is increasing, stabilising, or beginning to ease. For that we need comparable observations over time. A benchmark tells us where we stand; monitoring helps us see whether the market is moving.

Companies also tend to have much better visibility of their own business than of the system around them. A transformer manufacturer can know its own backlog in great detail and still be uncertain about how quickly competitors are ramping new capacity. A utility knows its project pipeline, but not exactly when market-wide lead times will begin to normalise. A component supplier can see its direct orders without seeing how much inventory has accumulated elsewhere in the chain.

A wider market picture does not replace company information or judgement. It gives context that no single participant can assemble completely on its own.

The level tells us where we are; the history tells us how we got there and which way we may be moving

For critical transformers, diagnostics and monitoring are not alternatives - they are used together because they answer different questions

10. Conclusion

Through Industry Navigator, we have been developing a diagnostic view of the transformer industry since 2018, and each research cycle has added another layer. The latest programme brings more than 260 variables together to examine not only demand or capacity, but the relationships between demand, timing, execution, components, people, complexity, investment, and market access.

For critical transformers, diagnostics and monitoring are not alternatives. They are used together because they answer different questions. Diagnostics helps us understand condition and causes, while monitoring can show that something is changing and deserves closer attention. The same distinction is useful in business. Deep industry research helps us understand the market and the relationships behind it, while monitoring adds the time dimension by showing whether that wider market picture is beginning to move.

Further reading in Critical Business Pillars 2026

- Section 1: Market dynamics
- Section 2: Lead times, especially Lead time as an indicator
- Section 3: Capacity and effective output
- Section 11: Market visibility
- Section 14: Future risks, especially Turning-point mechanics
- Section 15: Industry Navigator 2024-2026

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Author



Mladen Banovic is Director and Editor-in-Chief at Merit Media Int. and has 27 years of technical and managerial experience in energy transmission. He has led the development of products and systems for power grids up to 1200 kV, including smart-grid, design, testing, diagnostic and monitoring applications. He holds PhD, MSc and BSc degrees in electrical engineering from the University of Zagreb and is an IEEE Senior Member and member of CIGRE and EASE.