Transforming transformer testing

Key Strategies for the Industry in the Age of Energy Transition, Sustainability, and Digitalization

ABSTRACT

In an era characterized by energy transition, sustainability, and digitalization, the world is experiencing a profound transformation. For the power transformer industry, this new landscape presents both exciting opportunities and formidable challenges. As we navigate this changing terrain, it is essential to explore why testing solutions for the energy grid of tomorrow are crucial. At HAEFELY, we recognize our role in shaping the next generation and are committed to addressing this critical question. We perceive a paradigm shift in the world of testing.

KEYWORDS:

sustainability, energy transition, renewable energy, EcoDesign directive, digitalization, testing

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Electronic Power Supply 1500 kVA

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Sustainability: A transformative force in the transformer industry

Sustainability has never been a more compelling imperative. One of the most significant shifts we are witnessing is the transition to renewable energy sources, particularly solar and wind power. This evolution is revolutionizing the transformer business. In the past, a 1 GW power generation system typically required two large power transformers. However, today, for a 1 GW wind power generation system, we need 200 small power transformers, and for solar power generation, the number escalates to 600 small power transformers. These transformers serve critical roles in an increasingly inaccessible and mission-critical environment. Consequently, they undergo more intensive and deeper testing than traditional standards demand. In summary, the industry must produce more transformers, subjected to more demanding tests, to meet the requirements of sustainable energy generation and distribution.

Transformer losses and EcoDesign Directive: A regulatory shift

The EcoDesign Directive in the European Union has significantly strengthened the regulations surrounding transformer losses, with a particular focus on no-load losses. This change stems from the intermittent on-and-off cycles of transformers in networks with wind and solar energy generation, a deviation from the traditional continuous electricity generation. The no-load loss of transformers now plays a pivotal role in reducing CO_2 emissions.

In light of these transformative forces, transformer test engineers face the challenge of reconciling speed and accuracy, often considered contradictory objectives. As these trends reshape the testing landscape, the need for testing solutions in the energy grid of the future becomes increasingly evident. So, what key strategies and approaches are required to thrive in the face of unprecedented change? The answer lies in embracing digitization.

Embracing digitization: The path forward

It is paramount for the industry to acknowledge the changing landscape and embrace digitization. Transforming traditional test systems into state-of-the-art digital solutions is no longer optional; it's a necessity to stay ahead of the impending wave of change. The impact extends to all players in the transformer market, from large corporations to family-owned businesses. Those who act swiftly will lead the charge.

At HAEFELY, we have observed this trend reflected in the increasing number of "new buyers" on our reference list for our Distribution Transformer Test System (DTTS).

Digitalization: Game-changing advancements in transformer testing

Digitalization is not just an upgrade; it's a revolution in transformer testing. Upgrading from traditional Motor – Generator hardware to state-of-the-art solutions, such as electronic power supply (EPS), brings a plethora of advantages:

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1. Compact hardware: EPS offers an optimized kW/kg and kW/m³ ratio, generating no vibration. Its design allows for easy transportation and factory relocation.

2. Maintenance-free: Electronic power supply technology is virtually maintenance-free, with no moving parts apart from the cooling fan.

3. Ease of service: Standardized hardware and online monitoring make service efficient and spare parts readily available worldwide.

4. Safety: The EPS integrates advanced safety features, reacting intelligently to various situations, including voltage and current trip detection. It holds SIL3 certification, one of the highest safety levels in the industry.

5. Redundancy: EPS units can be used in parallel, providing increased power for testing. This flexibility allows for various test configurations, including parallel testing or testing larger transformers.

6. Decoupled power supply: The EPS provides decoupling from the mains voltage, frequency, distortion, and asymmetry, ensuring a clear separation between the test system and the workshop.

7. Compatibility with partial discharge measurement: Electronic power supply technology, coupled with filtering options, enables precise partial discharge measurements with minimal background noise.

8. Variable frequency: The ability to vary the frequency from 16⅔ to 200 Hz allows for versatile testing, including applied voltage tests, loss measurements at 50 Hz and 60 Hz, and induced voltage tests at any frequency.

9. Advanced control software: Real-time feedback loops ensure voltage symmetry and a reduced total harmonic distortion, enhancing accuracy.

10. Full working range: EPS technology is fully compatible with inductive and capacitive loads, simplifying testing.

Real-time feedback and transformative impact

One of the most significant advancements lies in the real-time feedback loop, connecting measurements taken on the transformer's bushing to the electronic power supply. This ingenious algorithm works wonders, minimizing total harmonic distortion (THD) to levels below 1% in the majority of cases. It doesn't stop there; this algorithm also addresses issues related to symmetry and has the remarkable ability to counterbalance unsymmetrical loads. In a real-world case study, the activation of this real-time algorithm led to a remarkable 3% reduction in no-load loss readings. The implications are truly astounding when one considers the feats that such sophisticated software can achieve on a multi-megawatt power supply. This innovation represents a game-changing leap in transformer testing technology, delivering precision and efficiency beyond what was previously imaginable.

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Modularity and flexibility: Meeting market demands

Amid the dynamic nature of the market, it's essential to adapt swiftly and remain open to future evolution. Timely delivery and flexibility are key considerations for any investment in today's transformer testing landscape. This state-of-the-art EPS presents a fully standardized and modular system. Each EPS unit, offering 540 kVA, can be conveniently stacked together to meet the power requirements for testing. This user-friendly approach offers numerous advantages. Systems can be upgraded on-site to accommodate increased power demands, all while maintaining standardized components, which facilitates faster delivery and streamlined spare part management. In the case of a large system, if one EPS unit encounters issues, the remaining units ensure the system's continuous operation. Additionally, it's possible to run two medium-sized test systems in parallel to test two medium-size transformers and combine their power for testing large power transformers. This adaptability positions EPS as a powerful hardware for navigating the evolving testing landscape.

Global view with safety features

The EPS comes equipped with software that not only monitors but also drives the entire test laboratory, even including third-party components. It continuously senses the state of every switch, interlock door, and takes measurements from the EPS, capacitive compensation bank, and

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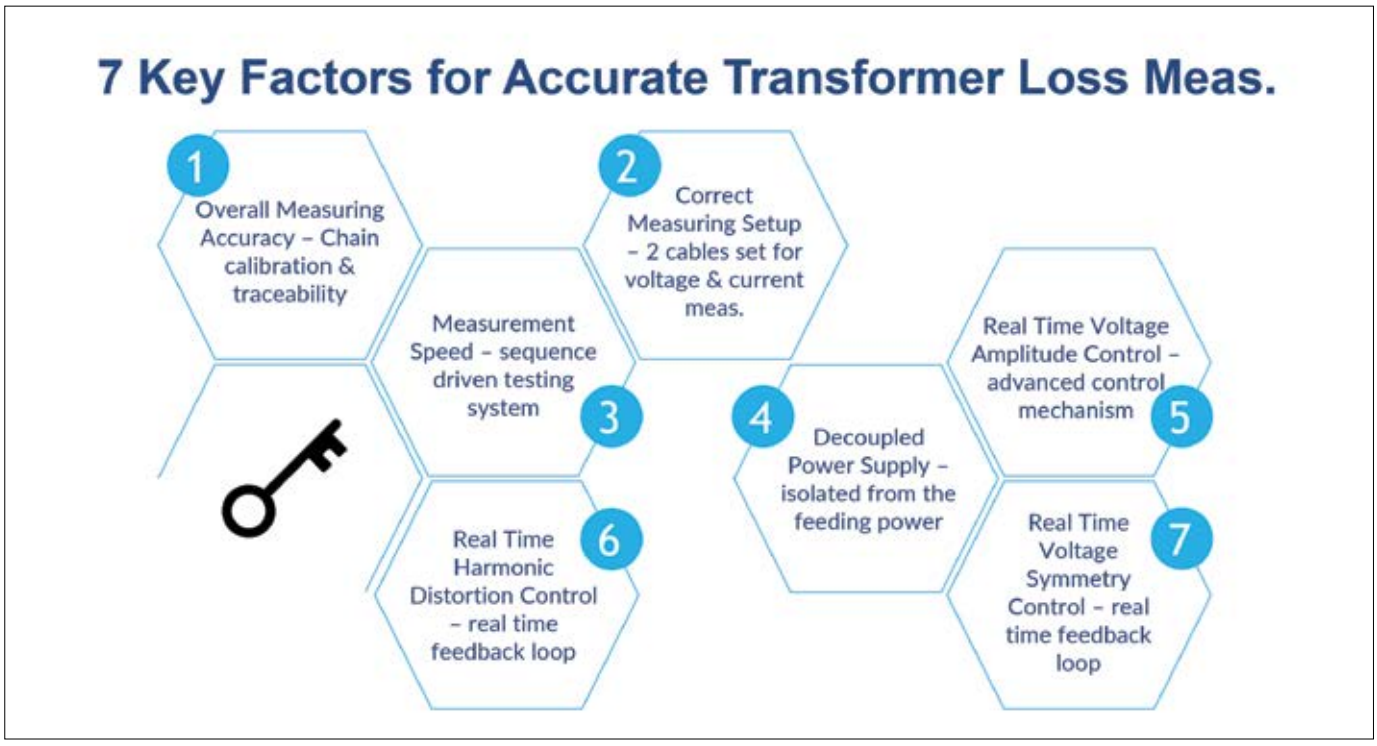

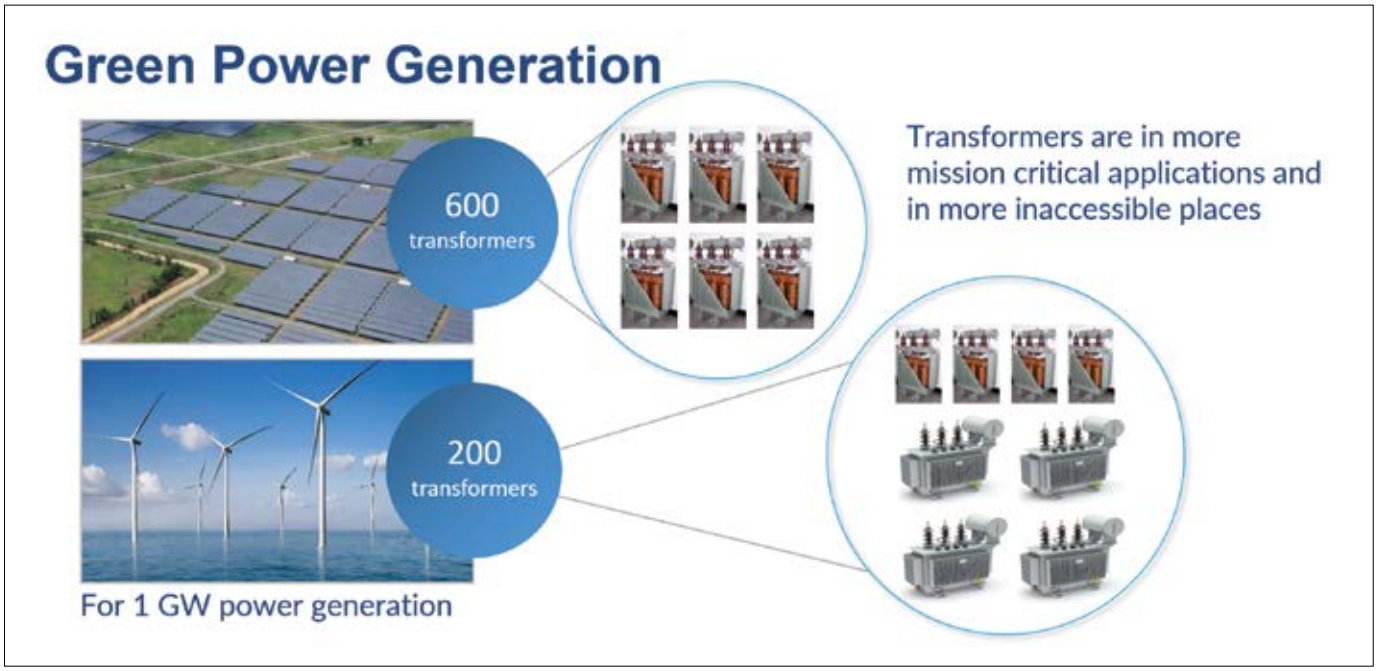

step-up transformer. This top-tier software incorporates advanced features such as voltage and current trip detection and flash detection, significantly enhancing safety throughout the system and the entire factory. In the event of a malfunction or an unforeseen situation, the system immediately switches off, entering a secure state. Instances of capacitive compensation banks failing due to operator errors or over-stress are not uncommon. However, with this software, such catastrophic scenarios can be predicted and avoided, earning it a SIL 3 safety certificate.

These advancements make a compelling case for EPS technology and its transformative potential in transformer testing.

Balancing speed and precision in transformer testing

In the world of transformer testing, where we confront the challenge of balancing speed and precision, we're equipped with a robust toolbox that significantly simplifies the life of a test engineer. This toolbox includes transformative elements such as a transformer database, automated hardware configuration, streamlined test sequence setup, automated measurements, and standardized result calculations based on industry standards and pass-or-fail criteria. It also seamlessly generates test reports, accelerating the testing process. For instance, with our DTTS, cycle times as short as 7 minutes per transformer are attainable, depending on the system configuration – a remarkable feat compared to the bygone era when measurements were meticulously handwritten in notebooks.

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These digital tools not only enable us to expedite the testing process without compromising measurement accuracy but also play a pivotal role in upholding the integrity of our Quality Management procedures. Each step in the process is meticulously defined, ensuring that every transformer undergoes testing in a standardized manner, regardless of the operator. Additionally, traceability is effortlessly maintained, as the system offers a fully calibrated setup and a comprehensive test report database. This powerful combination of speed and precision is the driving force behind our transformation in the testing landscape, guaranteeing consistency and excellence in every test.

The new era is here, and for the industry to prosper in the face of unparalleled transformation, it must enthusiastically adopt these innovations.

Author

Frédéric Dollinger, Area Sales & Marketing Manager at HAEFELY, shared his groundbreaking insights on "Transforming Transformer Testing" at the Transformers Magazine Sustainability and Digitalization 2023 conference in Dubrovnik, Croatia. With over a decade of experience in the transformer industry, he is passionate about pioneering cutting-edge solutions that revolutionize the efficiency and accuracy of transformer testing. A frequent speaker at industry events, he actively travels the globe, sharing his expertise with customers and collaborating on projects.