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From reactors to grids: Engineering the nuclear backbone

Interview with Diego Hernandez, Global Segment Leader for Nuclear applications at Hitachi Energy Transformers

The global energy system is undergoing a profound transformation, with decarbonization, electrification, and energy security shaping long-term strategies for governments and industries alike.

Amidst this shift, nuclear power has re-emerged at the center of the conversation. Once considered a legacy technology, nuclear power is now widely acknowledged as a critical component in achieving net-zero targets, ensuring grid stability, and supporting industrial decarbonization through applications such as hydrogen production.

Within this context, Hitachi Energy has reinforced its strategic role as a trusted technology partner for the nuclear sector, recently launching a transformers portfolio dedicated to nuclear applications.

In this interview, Diego Hernandez Frisari, Industry Network Leader (INL) for Transformers Business at Hitachi Energy, shares his views on the crucial role of nuclear power and the transformer technologies required to support the demanding requirements of this application.

Hello Diego, great to have you here. While setting the stage for our discussion, you have emphasized that after a long period, nuclear energy is once again in the spotlight. Now seen as a cornerstone of the global energy transition and is often described as entering a new renaissance.

How do you see this momentum shaping the global energy landscape?

We are indeed living through what can be described as a nuclear renaissance, and it's quite remarkable if we think about the trajectory of the industry over the last decades. After years of underinvestment and stagnation, nuclear is now being recognized once again as indispensable for reaching climate goals, ensuring a secure baseload supply, and complementing intermittent renewable generation.

The drivers behind this momentum are multiple. First, there's a strong policy push: many governments are extending the lifetime of existing nuclear plants and restarting projects that had been shelved. Second, new technologies such as small modular reactors (SMRs) and advanced reactors are expanding the potential uses of nuclear power, including flexible generation, industrial heat, and even hydrogen production. Third, we cannot underestimate the societal need for resilience - events in recent years have shown us how fragile energy supply chains can be, and nuclear power offers stability over the long term.

For the energy landscape, this means nuclear will no longer be seen as a niche option, but as a mainstream, complementary pillar alongside renewables and storage. The renaissance is not only about new reactors, but also about creating an integrated ecosystem where nuclear power plays a strategic role in decarbonizing multiple sectors beyond electricity.

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INTERVIEW

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Where does Hitachi Energy stand in this nuclear renaissance, and how can its transformer technology contribute?

Hitachi Energy has a deep and long-standing relationship with the nuclear sector. For decades, we have been delivering products and services to nuclear facilities across the world, supporting some of the most demanding operating environments. This experience gives us a strong foundation to address the new wave of nuclear projects with confidence and proven expertise.

Our Transformers Business contributes in a very tangible way: transformers are the backbone of electrical systems in nuclear plants. They ensure the safe and reliable flow of power from generators to the grid, as well as within the plant itself to support auxiliary and safety systems. Reliability is not optional: it's mission-critical, because any failure could impact safety and availability. That's why transformers for nuclear are not just products; they are strategic assets that must perform flawlessly over very long lifetimes.

In today's renaissance, our role is twofold. First, we continue to support the existing transformer fleet, which is undergoing lifetime extensions, uprates, and digital upgrades. Second, we are preparing for new builds and next-generation reactors, which come with new technical requirements and expectations for sustainability and digital integration. Our strategy is to bring nuclear-specific solutions, backed by a global service footprint, which enable operators to meet their objectives with confidence.

Hitachi Energy recently unveiled a new dedicated transformers portfolio for nuclear applications called TXellence. Could you tell us more about it?

The launch of TXellence was a very important milestone for us because it formalizes something we have been doing for many years - developing transform-

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ers specifically designed for nuclear environments - into a clear and dedicated portfolio.

TXellence includes generator step-up transformers, station service transformers, and auxiliary transformers, together with the associated services, all tailored to the specific needs of nuclear plants. The portfolio integrates decades of design knowledge, advanced insulation systems, enhanced cooling technologies, and resilience features against seismic and environmental stresses. What makes it distinctive is that these solutions are engineered not only to meet but to exceed the stringent standards of nuclear applications.

Our latest edition of the company flagship event, "Energy & Transformer Days" was the right stage to introduce TXellence to the market. It allowed us to showcase not just the technical capabilities but also the philosophy behind this dedicated portfolio: a promise of excellence in every aspect, from engineering and manufacturing to testing, service, and lifecycle support. The feedback from industry partners has been very positive, as they see the value in having a portfolio explicitly dedicated to nuclear, rather than adapting generic solutions.

How does TXellence enhance Hitachi Energy's value proposition in such a demanding industry?

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First, *heritage and expertise*: we have decades of experience with nuclear operators globally, and this is not something that can be improvised. That expertise translates into trust and a proven track record.

Second, *engineering and testing rigor*: every transformer in the TXellence portfolio is designed and validated against nuclear-specific requirements, which go far beyond conventional standards. This includes seismic withstand, fire safety, long service life under challenging operating profiles, and redundant safety measures.

Third, *lifecycle partnership*: we recognize that nuclear assets operate for 40, 60, or even 80 years. Our approach is holistic, we don't just deliver transformers, we

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deliver lifecycle solutions that include digital monitoring, predictive maintenance, modernization, and service support across decades. This ensures operators can maximize reliability while optimizing costs over the full life of the plant.

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Can you give us some insights about what kind of transformers technologies are part of this dedicated portfolio? And what makes them special?

That's a great question because it really gets to the heart of what makes TXellence unique. First of all, it's important to remember that there are different types of transformers in a nuclear power plant, each playing a very specific role.

On one hand, you have **auxiliary transformers**, which provide the critical internal power needed to run the plant's systems safely and efficiently. This is where our **RESIBLOC dry-type transformers** make a big difference. They offer a combination of fire safety, mechanical robustness, and reliability that is ideally suited to nuclear applications. RESIBLOC technology provides enhanced resilience against short circuits and environmental stresses, making them a trusted solution for auxiliary power inside nuclear facilities.

On the other hand, you have **generator step-up transformers (GSUs)**, and these are truly different pieces of equipment. They are massive units that connect the generator to the transmission grid, and they must handle enormous amounts of power reliably and safely. In North America, for example, we see large three-phase GSUs ranging from 800 to 1200 MVA, with extremely high currents. Designing these requires mastering every aspect of transformer technology: from insulation and cooling systems to mechanical robustness and, critically, *compactness*, so that these "big boys" can actually be transported and installed at the site.

In Europe, by contrast, single-phase GSUs are more common, and here again, Hitachi Energy's breadth and depth of portfolio come into play. We have the capability to design both core-type and shell-type transformers, and we can propose the most suitable configuration depending on the grid requirements, the nuclear operator's specifications, and the practical constraints of the site.

Another crucial element is the **life extension of nuclear plants**. Many reactors are being extended to operate up to 80 years, which means transformers need to be replaced at some point. But in a nuclear plant, you don't have unlimited time, replacements have to be done within the very short window of a refueling outage. That means the new transformer must match the original dimensions, clearances, and mechanical arrangement so it can be installed seamlessly without modifying the plant. This

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is where our engineering and project experience are invaluable; we know how to design replacements that fit perfectly, while at the same time upgrading the technology and reliability.

We also have practical examples of innovations co-created with customers that illustrate our approach. Take our **TXpand™ solution**, developed with Hydro-Québec for transmission applications. We adapted and applied this technology to the nuclear segment for EDF in France, where we now have dozens of units in service. This is a perfect example of how innovation developed in one domain can be tailored and proven for the highly demanding nuclear environment.

What makes this journey particularly meaningful is the way we've leveraged cross-sector expertise to meet the nuclear sector's unique challenges. TXpand™ was originally designed to enhance safety and resilience in grid applications, but through close collaboration with EDF, we refined its mechanical robustness, fire safety features, and installation adaptability to align with nuclear standards.

These units are now operating in some of the most critical environments, demonstrating not only technical excellence but also the power of **partnership-driven innovation**. It's a testament to how our engineering rigor and customer intimacy allow us to translate proven technologies into nuclear-grade solutions — reliably, safely, and at scale.

Talking about the transformer's applications, what is the difference between a large nuclear reactors and Small Modular Reactors?

That's a very relevant question, because while the nuclear industry often gets spoken about as a single segment, the technical requirements can be quite different.

For **large nuclear reactors**, the focus is on very high-capacity transformers, especially generator step-up transformers, which must handle massive power outputs, often in the range of several hundred to over a thousand MVA. These are large, highly customized units that require advanced cooling, insulation, and mechanical design, as well as careful planning for transport and installation. They are essentially bespoke assets, built to match the specific requirements of each plant.

By contrast, **small modular reactors** (SMRs) bring an entirely different philosophy. The key element here is *modularization and standardization*, the ability to replicate designs, simplify interfaces, and streamline construction so that projects can be deployed faster and at scale. That translates directly into transformer requirements: instead of one or two massive GSUs, SMRs rely on a series of smaller, standardized transformers that are easier to manufacture, transport, and install. This makes them more modular, flexible, and cost-efficient.

Transformers for SMRs must therefore be designed with repeatability, compactness, and ease of integration in mind. They need to support shorter construction schedules and allow plug-and-play installation, consistent with the SMR concept itself. And because SMRs are often envisioned not just for electricity generation but also for industrial heat, hydrogen, or district heating, transformer solutions must be versatile enough to serve different applications and operating profiles.

At Hitachi Energy, we see this as a natural extension of our portfolio. With TXellence, we can provide both the large, bespoke GSUs required for conventional reactors and the standardized, modular transformers that will make SMRs viable at scale. In both cases, our commitment is the same: reliability, safety, and lifecycle support.

Looking ahead, what are the future paths for the nuclear segment, and how will Hitachi Energy continue to support it?

The future of the nuclear segment is both exciting and complex. We see several key directions.

First, *lifetime extension of the current fleet*: many existing reactors will continue to operate for decades, and this creates a demand for modernization, digital upgrades, and replacement of critical equipment like transformers.

Second, *deployment of new large-scale plants*: while SMRs get a lot of attention, we should not forget that many countries are still pursuing large gigawatt-scale reactors as part of their decarbonization strategies.

Third, *the rise of SMRs and advanced reactors*: these bring new operating profiles, more modular construction, and potentially new business models. They will require transformers that are more compact, flexible, and digitally integrated.

Finally, integration into broader decarbonization ecosystems: nuclear power will not only provide electricity, but also heat and hydrogen. This requires new electrical architectures, new connections, and new supporting infrastructure.

Hitachi Energy will continue to support all these paths by investing in R&D, developing digital and sustainable technologies, and strengthening our partnerships with utilities, OEMs, and EPCs. With TXellence, we have positioned ourselves to be not just a supplier, but a long-term partner for the nuclear journey — *ensuring that transformers are never a point of weakness, but a pillar of reliability in the clean energy system of the future.*