



# EasyDry®: A new paradigm for transformer bushings

## The new age of paperless, oil-free, resin-impregnated synthetics

**T**he global transformer market is projected to grow at a compound annual growth rate of around 7 % until 2030. This robust growth rate is indicative of many industries' reliance on transformers. Additionally, this also points to the versatility of transformers due to their many applications.

Although transformers require substantial technical expertise to design and manufacture, a surface-level understanding of their overall usage is relatively common knowledge. However, within this well-known electromagnetic marvel lie many not-so-well-known components that make its functioning possible and effective. One such component is the transformer bushing. It is essentially used to connect the windings of a transformer to the external electrical system. This makes them vital to any electrical power system.

Today, the following transformer-bushing technologies have the majority share in the global market:

**Oil-impregnated paper (OIP):** The conventional oil-reliant bushing technology that has been a mainstay in the transformers market for over 100 years.

Traditional OIP bushings bring advantages in terms of thermal overload performance, size, and ability to serve the full power range ratings that the transformer industry requires.

**Resin-impregnated paper (RIP):** The dry-type bushing technology that has been on the rise since the 1970s.

The dry-type (oil-free) technology brings the benefits of very high operational safety, environmental friendliness due to the absence of oil, substantially lower maintenance efforts, and failure rate reduction by removing all liquids and related items, along with their associated potential issues and maintenance. All this brings an undisputed Total Cost of Ownership (TCO) advantage compared to OIP transformer bushings.

**Resin-impregnated synthetics (RIS):** A relatively new, paperless, dry-type bushing technology that has been introduced in the transformers industry since 2010.

Hitachi Energy introduced its dry bushing RIP technology to the transformer world about 5 decades ago. In 2020, it officially launched its latest modular RIP transformer bushing family, named AirRIP® flex, as well as AirRIP® flex AE, which is suitable for alternative transformer fluids, like ester fluids.

As the industry-leading bushing pioneer, Hitachi Energy invented the world's first paperless bushing technology that was

released under the flagship portfolio of EasyDry® in 2010.

Since then, our paperless bushing offering has evolved, and its voltage ratings have gradually increased to 245 kV, in compliance with various regional standards, like IEC and IEEE. Our installed base for paperless transformer bushings has been growing continuously, presently reaching more than 20,000 bushings that are successfully operating in all climatic regions of the world.

This new generation of paperless, dry-type bushings transformer allows us to push the boundaries in terms of:

- Rated voltage, up to 550 kV and 5000 A.
- Reduced maintenance while increasing reliability.
- Improved availability, reliability, and safety.
- Easy conversion to a pluggable bushing, enabled by **QuickConnect**.
- Superior productivity with our online product configurator **COMPAS** and all product documentation instantly downloadable.
- Extended bushing lifetime, by achieving a more homogeneous electric field distribution.

**Transformer bushing – it is essentially a component used to connect the windings of a transformer to the external electrical system**

## Hitachi Energy has further enhanced its capabilities of paperless transformer bushings manufacturing and is now introducing: EasyDry® up to 550 kV

Hitachi Energy has further enhanced its capabilities of paperless transformer bushings manufacturing and is now introducing: **EasyDry® up to 550 kV**. It is a breakthrough configurable bushing platform comprising paperless, oil-free / dry-type, pluggable (enabled by QuickConnect), and the highest seismic-resistant transformer bushing portfolio. This transformer bushing comes as a fully configurable portfolio with widely selectable designs for almost all transformer interfaces, thus offering an unprecedented possibility of customized paperless transformer bushings to the customers.

### A plethora of challenges

The transformer bushing industry is facing various challenges, each potentially impacting overall performance and reliability. It is a never-ending race and mission for the

transformer component industry to design value-added solutions for transformer manufacturers, operators, and service providers.

Surely, transferring and **distributing energy safely** is at the center of this industry's mission. Even though transformers are by far one of the most reliable apparatuses in the power industry, any contribution to avoid and minimize incidents or accidents and their consequences on people and equipment provides great hard and soft values to all players.

**Reliability and availability** are always a matter of concern, generating repair costs and losses in revenue when the transformer cannot perform as expected, leading to potential delays in the value chain.

Finally, one challenge affecting all of us is related to **CO<sub>2</sub> gas emissions** impacting

our planet's climate more and more. All value chain players in this industry must reduce their CO<sub>2</sub> emission footprint. The achievement of ambitious targets set by the governments is a real challenge for transformer operators and can only be achieved through changes and innovation.

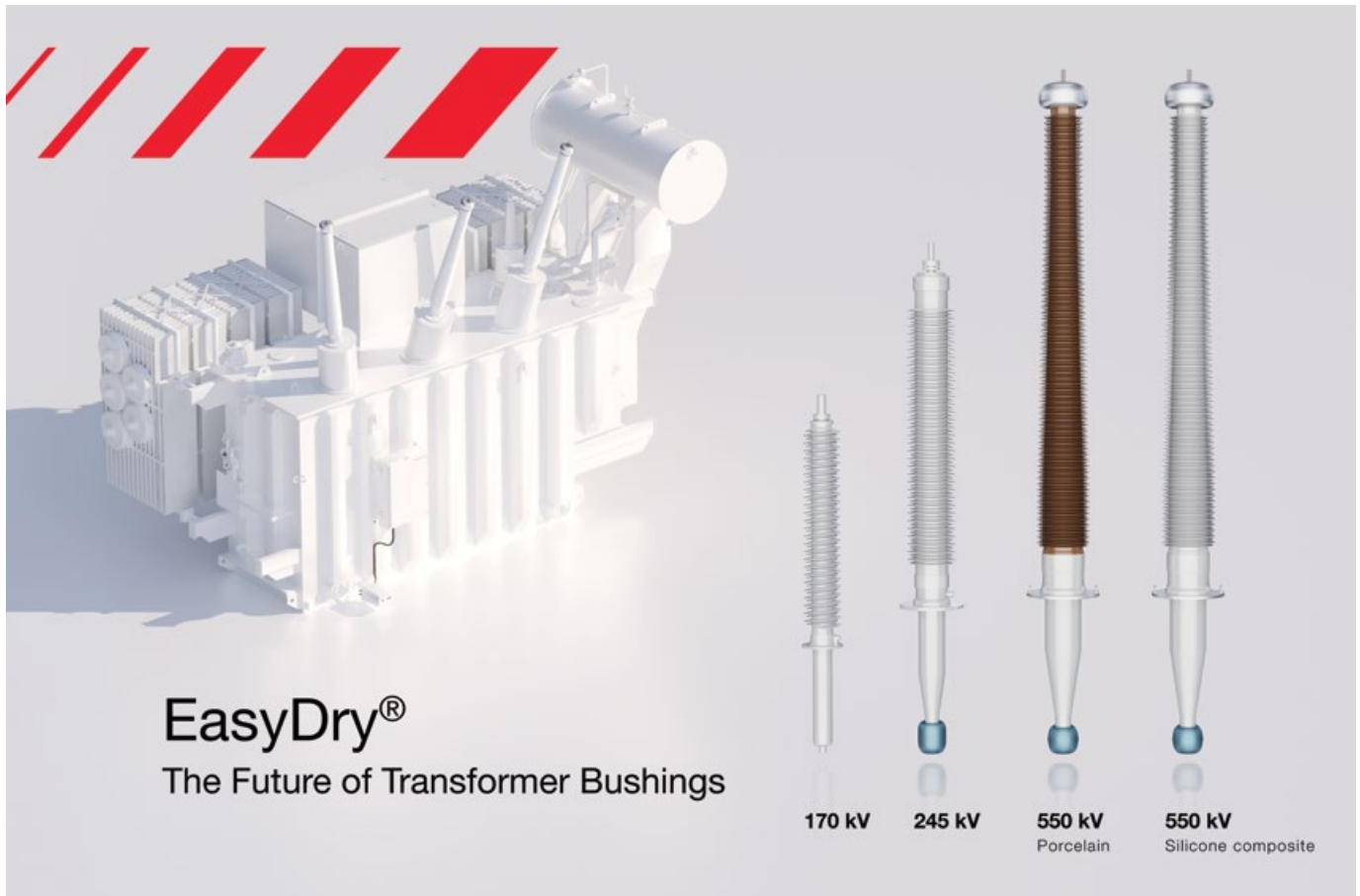
Specifically, when discussing how bushings technology can address those challenges, some key factors must be considered:

**Moisture ingress** needs to be continuously monitored to avoid transformer bushings failure. This is because moisture can seep into the bushing through the seal and, over time, cause continuous deterioration of the main insulation.

A second crucial factor that needs to be taken into consideration is the **aging** of the components. Since bushings are subjected to electrical and thermal stresses, they age and deteriorate over time. This leads to decreased insulation performance and an increased risk of failures.

Regular **maintenance** and proper **storage** can be crucial to guarantee uptime and reduce the possibility of breakdowns.





It should be noted, however, that the maintenance of bushings is often expensive and time-consuming.

Additionally, transformer bushings are often engineered and produced to order. This is impacting their overall **availability on the market**, limiting the possibility of purchasing them at any given time. This may result in a long lead time for new transformers and replacement projects.

Finally, to guarantee the overall **safety and reliability** of transformer operations, even if they operate in high-voltage environments, we need to be careful when evaluating possible risks. To prevent accidents during transformer and bushing operation, installation, maintenance, and repair process, appropriate safety protocols must be followed readily and with precision and discipline. Risk mitigation in the industry is also carried out via methods such as dry bushing.

While the above factors represent the most common and demanding challenges to the transformer bushing industry, we should also be aware of the most likely outcomes that arise out of those same

challenges. Factors such as cracks, leaks, and the loss of dielectric properties lead to failure and, ultimately, the inability to provide full functionality. This fact makes addressing these challenges head-on a clear priority, which can be accomplished by using new technologies.

### RIS: The key to future-ready transformers

Industry insiders are aware of the advantages that OIP brought into the bushing industry all those decades ago. We see these gains in terms of their ability to function well, size, and ratings, which meet the entire power range required by the transformer industry. It can be said that those advantages and characteristics were fundamental to the operation of transformers as we know them today.

However, oil-impregnated paper (OIP) also has quite a limitation that encourages and exacerbates the incumbent challenges in the transformer industry, including oil leakage risks, frequent and time-consuming maintenance, higher flammability, and lower explosion resistance in case of internal arc failure, as

well as moisture-related malfunctioning risks.

While some of these challenges can be mitigated by using resin-impregnated paper (RIP) technology, the potential moisture absorption associated with specific bushing storage procedures still requires special attention.

This is where resin-impregnated synthetics (RIS) step into the picture. Dry-type, paperless RIS technology carries with it the advantages of very high operational safety, environmental friendliness as a result of the absence of oil and paper, substantially reduced storage and maintenance efforts, and a reduced risk of failure.

In comparison to traditional bushings, RIS bushings offer several benefits, including the following:

- No risk of moisture absorption and ingress under the harshest service conditions
- Superior electrical loss factor
- Simplified long-term storage capabilities
- Improved aging performance — extended lifetime
- Reduced maintenance requirements

Hitachi Energy is making customers' life <b>Easy</b>				
EasyDry Features	A wide range of benefits			Values
Paper-free	Know-how from technology inventor of the paperless bushing technology (RIS)	Largest installed base of > 20'000 bushings in the field	More than 12 years field experience	Trusted and field proven bushing technology
	No moisture sensitivity No moisture uptake	Certified for operating temp -50°C		<b>Easy to operate</b> Maintenance free in harshest operating conditions
	Simple spare part storage No moisture sensitivity	No special long-term storage packing	No pre-conditioning	<b>Easy to store</b> Energize directly after storage
	More homogeneous electric field distribution	Improved condenser foil wrinkling	Superior accelerated aging test results vs. RIP	<b>Easy to operate</b> Extended lifetime
Liquid-free	Enhanced safety & resilience	No chance for oil getting into the environment	No risk in polluting the environment with oil leakages	<b>Easy to operate</b> Enhanced safety from risk of fire and more suitable installation in environmentally sensitive areas
		No chance for explosion and shattering	Lower fire load content	
	Items related to liquid removed	No risk of leakages or failures	Higher reliability, availability, less maintenance	<b>Easy to operate</b> Reduction in total cost of ownership (TCO)
Productivity increase	Simple bushings selection with online configurator "COMPAS"	Broad type test coverage by 3rd test institutes	Instant 3D models, outline drawings download	<b>Easy to select</b> Accelerate value creating process
	Fast initiation of online RFQs	Rapid quotation response		<b>Easy to purchase</b> Accelerate value creatin process
	Fast & convenient bushing installation/replacement and commissioning	No transformer oil drainage required	No special transformer socket requirements	<b>Easy to install</b> Pluggable bushing conversion with QuickConnect ≥245 kV
Global service support	World largest transformer service network with presence in more than 30 countries	Dedicated bushing analytics and digital monitoring solutions	24/7/365 availability	<b>Easy to service</b> Complete service support through the entire lifecycle
	Simple product customizations	Direct replacements of OIP bushings	Solutions for 3rd party bushing replacement	<b>Easy to upgrade</b> Seamless upgrades and replacements

## A new paradigm for bushings

As the industry-leading bushing pioneer, Hitachi Energy invented the world's first paperless bushing technology, released under the flagship portfolio of EasyDry® in 2010. Designed using the highly innovative RIS technology that was utilized for the first time, a synthetic material, EasyDry® is leakage-proof, resistant to moisture, and easy to install and operate. It employs paperless, non-hygroscopic insulation, resulting in low dielectric losses over its entire lifetime. Its external outdoor insulation with superior silicone rubber is self-cleaning, and it operates safely in extremely low temperatures, down to -55 °C. Paired with Hitachi's digital online monitoring solutions, the EasyDry® product family always contributes to optimal grid resilience.

Since its first release, our paperless bushing offering has evolved, and

it has reached the latest release, the 550 kV, in conformance with our global standards, such as those established by the IEC and the IEEE, as well as various regional standards. Our installed base for paperless bushings has been continuously expanding, reaching more than 20,000 bushings that

are successfully operating in various climatic regions around the world.

**EasyDry®: The future of safer, reliable, and sustainable transformer bushings**



### Author



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With over 25 years of experience at Hitachi Energy (formerly ABB), Jens holds a PhD in Chemistry from Queensland University of Technology, Australia, and a master's degree in Material Science from Osnabrück University, Germany. He has an impressive track record of over 40 international inventor patent applications and about 25 esteemed international journal contributions to his credit.