

GREENER

ABB transformers for renewable applications

As wind and solar power penetration reaches new dimensions, ABB's global transformer experience, grid solutions portfolio and digital technologies position it perfectly to supply transformers for renewable electricity grids.

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Wind and solar are the fastest-growing sources of electric power today for a few simple reasons: They are renewable energy sources that do not produce greenhouse gases or other emissions; the "fuel" is free and essentially infinite in supply; and as technology matures, equipment costs continue to drop [1] →1-2.

As one of the largest independent suppliers of electrical components, as well as a power technology leader, ABB helps renewable energy customers along the complete value chain to generate, connect, monitor and control power as well as to maintain and optimize their systems.

Solar applications – the latest transformer technology

ABB transformers provide customized products for solar inverter manufacturers and solar farm developers for both indoor containerized inverter stations and outdoor inverter solutions. As the global technology leader for transformers, ABB offers a deep knowledge of inverter configurations, real operating conditions and specific customer requirements. This knowledge helps ABB customers understand the implications of equipment load cycles and thus optimize their balance of systems. This deeper understanding increases their competitiveness in a market that is extremely dynamic and price-driven.

Dry-type transformers for solar

ABB dry-type transformers are a dependable asset in any solar project, ensuring the highest product reliability with the broadest service and production footprint in the market. These transformers can help harness the power of the sun in any location and under virtually any conditions - from central inverters at 1,000 V DC for high efficiency in Japan to multi-winding solutions for 1,500 V DC up to 4.6 MVA inside a conventional high cube container for installation and logistics savings. The design adaptability of ABB dry transformers allows owners to integrate the transformer inside the inverter, thus taking the containerized concept to the next level.

Higher-temperature products, like ABB's hi-T Plus concept with upgraded insulation, can allow further cost efficiency in a solar project. Owners can optimize the rated power for multiple ambient temperatures without footprint or weight changes, granting inverter standardization and economy of scale. An upcoming proliferation of utility string inverters will entail a further expansion of compact, safe and virtually maintenance-free dry-type transformers, as MV applications will be integrated into compact substations of up to 5 MW each →3. String solutions from ABB involve a simplification of transformer design requirements and further cost savings while increasing the available power inside conventional, easy-to-ship containers.



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— 01 As costs tumble and climate change awareness increases, growth in solar generation and wind power is far outstripping other forms of energy generation.

— 02 Indexed electricity generation by fuel (2001-21). The share of renewables in global electricity generation is expected to increase from over 23 percent in 2015 to 28 percent in 2021 as renewable power output is anticipated to grow much faster than global power from coal, natural gas and overall electricity generation [1].

Liquid-filled transformers for solar

With market constraints in mind, ABB has developed liquid-filled distribution transformers for the solar industry that pair with various solar inverter sizes. These "fit-for-purpose" transformers are designed to optimize the performance, reliability and return on investment of any solar installation. From residential rooftops to commercial and industrial applications and utility-grade power plants, ABB's fit-for-purpose solar distribution transformers are specifically matched to different solar inverter sizes and their applications. Streamlined quotation and manufacturing processes shorten lead times so aggressive customer timelines can be met →4.

ABB has also developed MultiSOLAR, a transformer that can connect up to six inverters in solar plants with a central inverter. This is an efficient and compact solution that can be containerized up to 6 MVA and allows owners to minimize logistic and operational costs.

Energy-efficient designs based on different inverter sizes, and power and voltage ratings, meet all current regulations and standards worldwide. Liquid-filled transformers can be manufactured and tested with mineral oil, synthetic-ester or natural-ester fluids, based on customer requirements.

ABB works closely with equipment owners to optimize designs, not only for the transformer but also for the total cost of ownership of the entire site. This includes ease of installation and full integration. ABB has a global network of factories and expertise, so transformer design and production can take place close to most customers.

The ABB fit-for-purpose approach perfectly matches the modern solar industry's challenges, such as longer times for funding approvals and shorter times for project execution, and pressure to reduce system and project costs.

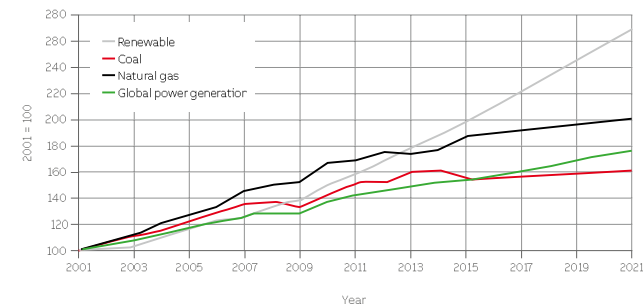
Wind applications - The latest transformer technology

Wind applications can take advantage of a variety of ABB transformers, both liquid-filled and dry:

Dry-type transformers for wind

ABB dry-type transformers provide customized solutions for turbine manufacturers and wind farm developers that can be used in power generation or distribution. As the global technology leader, ABB offers the broadest experience, with a deep knowledge of drivetrain interfaces and real operating conditions that lead to compact and optimized options for up to 8 MVA and E3 certification for such applications. With more than 32 GW worldwide capacity added by transformers delivered since 1998 to more than 55 countries, ABB is truly enabling the power of wind.

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Dry transformers are suitable for installation inside the wind turbine, either on the ground floor, at a first level or in the most demanding location, the nacelle →5. In all cases, the design implements a vibration-proof configuration according to IEC 60068-2-6/59 and EN 600. The design also includes a class H insulation system to minimize the footprint and prevent continuous overloads from aging the transformers.

Liquid-filled transformers for wind

ABB has a portfolio of liquid-filled distribution transformers for the wind energy sector. These transformers cover all applications from onshore pad-mount or ground-mount to offshore tower- or nacelle-mounted versions.

Within the portfolio, ABB can supply different liquids like mineral oil and ester liquids (both synthetic and natural). Should the requirement be for an onshore padmount, or a very complex offshore in-tower solution, ABB provides a tried and tested cooling design to meet any specific requirements.

With over 5,000 liquid-filled transformers in service in the wind energy industry, ABB has class-leading experience in the field. Designs give appropriate consideration to all the industry-specific characteristics such as harmonics, vibration, voltage spikes, load cycle, short-circuit strengths, etc., giving the purchaser assurance that the design will perform the tasks required while in service.

WindSTAR – the world's largest offshore wind turbine transformer

Increasing competitiveness in offshore and onshore wind projects is mainly driven by the increasing power output of the wind turbines. Today, the current maximum power output of an individual unit of around 9 MW is expected to rise to 12-14 MW by the year 2020. To accommodate higher offshore power densities and to reduce the levelized cost of energy (LCoE), wind farm collection grids are moving from 33 kV up to 66 kV.



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By 2020, 65 percent of the new installations in northern Europe will operate at 66 kV. This boost in voltage level will significantly reduce losses, make generation systems more efficient, deliver life cycle benefits and enable major efficiency gains.

In mid-2017, ABB announced its latest innovation in transformer technology with the introduction of the 66 kV WindSTAR transformer. WindSTAR's modular design can adapt to specific customer requirements and makes installation and commissioning easier than ever before →6-7.

Space is valuable and restricted inside wind turbines and WindSTAR's design is lightweight with a minimal footprint. Forced oil and forced water cooling methods are used to remove heat from the transformer while making the transformer assembly more compact.

The WindSTAR design is as safe, robust and reliable as possible to minimize the costs of repair and maintenance that are generally high in offshore locations. The transformer uses high-temperature insulation paper and an environmentally friendly and high-flashpoint ester. Ester fluids demonstrate a much-reduced risk of fire initiation and propagation, not to mention outstanding self-extinguishing and biodegradability properties.

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03 Dry-type transformers can be used to remove the risk of fires or spills.

04 Liquid-filled distribution transformers are a proven solution with quicker lead times.

05 Dry-type transformer placed in nacelle for wind application.

06 ABB's WindSTAR – The world's largest offshore wind turbine transformer.

07 WindSTAR characteristics.

Reference

[1] International Energy Agency, "Energy Snapshot: Indexed electricity generation by fuel (2001-21)." Available: <https://www.iea.org/newsroom/energysnapshots/indexed-electricity-generation-by-fuel-2001--2021.html>



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WindSTAR can cope with the rough and exceedingly variable conditions out at sea. The design has been extensively tested against vibration and short circuits, and for further robustness, the transformer's tank has been hermetically sealed by a welded-on cover.

WindSTAR offers a best-in-class solution to withstand sudden variable loading and is available for both 36 and 72.5 kV class applications. Both products are compliant with international standards and regulations for wind turbine transformers. Low overall system losses and improved LCoE ensure a low total cost of ownership.

When it entered service in 2014, the Vestas V164 had the largest installed capacity of any wind turbine. In 2017, the 9 MW version of the V164 set a one-day production record of 216 MWh. It is for power levels such as these that the WindSTAR has been conceived and 128 units of the 33 kV version and 16 units of the 66 kV version have already been delivered to five offshore wind farms in the UK and Germany. Now, more than 70 66 kV units are in the pipeline, with powers ranging from 11 MVA to 14 MVA.

Building a sustainable future

ABB also offers transformer solutions for collection stations (offshore platform and onshore) and integration of remote renewable energy sources into the grid with powerful ultrahigh-voltage DC and AC transformers.

ABB's global transformer experience, grid solutions portfolio and digital technologies uniquely position the company to support the complete transformer life cycle. With 40 dedicated transformer service centers, nine service workshops and thousands of team members, ABB helps its customers provide a stronger, smarter and greener grid. ●

High voltage	33 kV	66 kV
KV class	36 kV	72.5 kV
Rated power	> 10 MVA	> 10 MVA
Cooling	KFWF	KFWF
Insulation liquid	Ester	Ester
Insulation material	High-temperature class	High-temperature class
Tapping range	+/- 2 x 2.5%	+/- 2 x 2.5%
Low voltage	> 400 V	> 400 V
Frequency	50 or 60 Hz	50 or 60 Hz

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