GE
Grid Solutions

Power Transformers and Reactors

Imagination at work

Today's Environment

Growth in the world's population and economy, will result in a substantial increase in energy demand over the coming years. The International Energy Agency (IEA)[1] estimates that $20 trillion will need to be invested in power and grid technologies, over the next 25 years, to keep up with demand. According to a 2015 IEA report[2], renewable energy will represent the largest single source of electricity growth over the next five years - rising to a 26 % share of global generation.

Integrating renewable energy sources into the grid can conflict with Utilities' existing modernization and optimization plans. Utilities face increasing challenges of reliability, safety, power quality and economics when planning substations and choosing switchgear.

Additionally, power systems are interconnected and highly complex networks which are susceptible to instabilities. Managing and maintaining today's complex grid pose many challenges, including:

- Increasing grid efficiency and resilience without adequate funding to invest in new capital equipment.
- Expertise to manage the grid is rapidly diminishing due to the lack of skilled, technical resources in the workplace.

Overall, utitilies are under intense scrutinity, by both regulatory agencies and the public, to prevent catastrophic power system failures today and in the future.

References
1. https://www.iea.org/bookshop/700-World_Energy_Outlook_2015
2. https://www.iea.org/bookshop/708-Medium-Term_Renewable_Energy_Market_Report_2015

Generator transformers
100 MVA 275/13,2/13,2 kV
for AGL, Hallet power plant (Australia)

The Right Transformer for the Right Application

GE offers utilities advanced solutions to improve grid stability and increase efficiency of transmission infrastructure.

From low to ultra-high voltage; small to extra-large power ratings; standard to the most complex designs; GE has the right solution for every application.

Conventional Power Transformers
From 5 MVA up to 1500 MVA & 765 kV

- Small & medium power transformers
- Large power transformers
- Generator step-up transformers
- Autotransformers

Oil-Immersed Reactors
Up to 250 Mvar & 765 kV / 2640 Mvar

- Shunt reactors
- Series reactors
- Earthing reactors
- Smoothing reactors

Special Transformers for Transmission Networks
Up to 2750 MVA & 800 kV

- HVDC converter transformers
- Phase-shifting transformers (PST)
- Transformers for static var compensator (SVC)

Special Transformers for Electro-intensive Industries
Up to 140 kA DC / 300 MVA

- Rectifier transformers
- Electrical arc furnace transformers

Special Transformers

- Trackside feeder transformers
- Autotransformers & boosters
- Distribution transformers

Power Transformer Bushings

- Resin-impregnated paper (RIP) up to 245 kV
- Oil-impregnated paper (OIP) up to 1200 kV
- Hybrid DC converter bushings up to 800 kV DC
- Resin-bonded paper (RBP) up to 36 kV, 45 kA
- SF_6-insulated up to 800 kV

The GE Advantage

With extensive experience delivering up to 800 kV and 2750 MVA in major power networks worldwide, GE is one of the world leaders in power transformers and reactors. As a pioneer in the field, GE's expertise extends to all types of applications from power generation and transmission to electro-intensive industrial and railway applications.

A World Leader in Transformers for 100+ Years

GE has dedicated facilities for manufacturing power transformers on four continents, with a current production capacity of more than 170,000 MVA. This global manufacturing footprint, coupled with efficient technology transfer programs, enables us to offer high quality tailored solutions for a wide variety of applications and geographical locations.

Intensive research into new products and solutions drives our process of continuous improvement. As a technological leader, GE actively participates in internationally recognized workgroups and conferences.

Manufacturing of a 1125 MVA 330/275/33 kV autotransformer for Middle Ridge s/s (Australia)

Broad Technical Expertise Built on Strong R&D

Innovative solutions for evolutive transformers and reactors

GE, a world leader in innovation, invests, both financially and with human resources, in research and development (R&D). Research and development drive our innovative designs, manufacturing and continuous product improvement.

GE's team of senior R&D engineers address issues such as partial discharge monitoring and diagnostics, transformer modelling, transient behavior, frequency response analysis and dielectric system development for the validation of innovative insulating structures for up to 1200 kV AC and 800 kV DC.

GE's R&D engineering continuously builds on its expertise with experience in the field and with the technical committees of major international standards bodies such as the CIGRE, IEC and IEEE.

Guaranteed Global Quality

Customers can expect the same excellent quality from all GE's transformer facilities. All GE design and manufacturing sites are guided by the same design quality and production rules, complemented by standardized design software and manufacturing tools, and equipped with the most modern, high-performance testing equipment available. When a transformer leaves a GE factory, customers know that every step has been taken to ensure its quality, reliability and performance.

Manufacturing Excellence

GE's quality management program exceeds the latest ISO 9001 certification. With a dedicated central technical management team, the highest expertise is implemented in all our factories to ensure the same world-class level of quality in all our power transformer facilities.

GE has a long track record of power transformers of different designs that have successfully gone through short-circuit testing. Most of GE's transformers and reactors have long surpassed their life expectancy are still in service. The design quality as well as the manufacturing processes and controls have been validated over time.

GE's facilities for research and development and manufacturing are based in the Brazil, China, Germany, India, Indonesia, Turkey and the United Kingdom.

Rigorous Testing

Routine tests, type tests and special tests are performed according to the latest IEC, IEEE, GOST and DL standards. Per customer requirements, in addition to the tests performed in our factories, special tests such as short circuit withstand can also be performed on GE's power transformers and reactors in world class laboratories such as KEMA and CESI. The following comprehensive tests are performed on GE's power transformers and reactors in our facilities:

- Measurement of winding resistance, voltage ratio and phase displacement check, short-circuit impedance, load loss, no-load loss and current
- Dielectric performance tests including LI, LIC, LIN, SI, AV, LTAC, IVW, IVP, AuxW or LIMT
- Measurement of DC insulation resistance, dissipation factor (tanδ), dissolved gases in dielectric liquid
- Temperature rise test, determination of sound level, power consumption of fans and pumps
- Special tests like winding hot-spot temperature rise, transient voltage transfer characteristics, zero-sequence impedance, vacuum and pressure deflection, vacuum tightness
- Tests on on-load tap changers, where appropriate, leakage tests and pressure tests, tightness tests
- Check of core and frame insulation, determination of capacitances windings-to-earth and between windings
- Check of external coating and tank suitability for transport

Advanced Production System

The Advanced Production System (APS), is the framework for contemporary manufacturing excellence in all GE sites. It is based on lean tools for continous improvement of safety, quality, cost and delivery. APS brings together a wide range of best practices and standards in seven domains such as Basics, Environmental, Health & Safety (EHS), Supply Chain, Project Delivery, Manufacturing and Quality & Leadership to create and sustain world class manufacturing excellence.

Quality from Concept to Commissioning

With proven designs, advanced testing methods and standardized processes, GE ensures that high quality transformers are produced, delivered and installed.

To further ensure a high level of quality, and per customer requirements, GE regularly submits transformers and reactors for special third-party testing.

With over 100 years of experience, our expert service teams are fully qualified to handle, transport and install power transformers. From the conception to commissioning, GE ensures the overall reliability of transformer installations with a local expertise across the globe. Dedicated teams of GE service engineers manage erection, commissioning, on-site final testing and energizing.

Integration of Renewable Energy into the Grid

Green Power Transformers Eco-efficient and Innovative

GE offers a sustainable range of green eco-efficient power transformers, from 10 to 500 MVA and up to 550 kV.

GE creates and delivers customer-valued network solutions for an energy-efficient future. Our environmentally-friendly solutions are aimed at meeting major energy challenges of today and tomorrow: energy efficiency, market efficiency, grid reliability and environmental concerns.

GE Green Power Transformers offer significant environmental benefits, including better product performance, covering the three phases of the product life cycle:

- **Manufacturing:** reduced consumption of natural resources
- **Operation**: lower CO_2 emissions, limitation of environmental-risks, noise reduction, space savings and energy efficiency
- **End of life:** recyling capabilities of products

GE's Green Power Transformers provide environmentally-friendly options with solutions to today's eco-management challenges. Green power transformers offer decreased life-cycle costs, require minimal maintenance and have a long service lifetime.

GE's Green Power Transformers are designed with the following specifications:

- Filled with natural ester instead of mineral oil
- Hermetically-sealed tank design, equipped with patented expandable radiators and vacuum type tap changer
- Innovative technologies to reduce acoustic energy transferred and optimized design of the active part
- Optimized low loss levels
- Solvent-free paint
- Online MS 3000 monitoring system
- Resin-Impregnated Paper (RIP) bushings with composite insulators
- Cooling unit with speed-controllable EC fans

Increased Safety

With a Green Power Transformer, fire safety is improved considerably. GE's Green transformers increase security for operators and others in close proximity.

Natural ester has a fire point above 350 °C, which is more than twice as high as mineral oil. This leads to the advantage of less expenditures for fire walls and sprinkler and consequently save space for installation. These transformers are practically self-extinguishing in case of the unlikely event of fire.

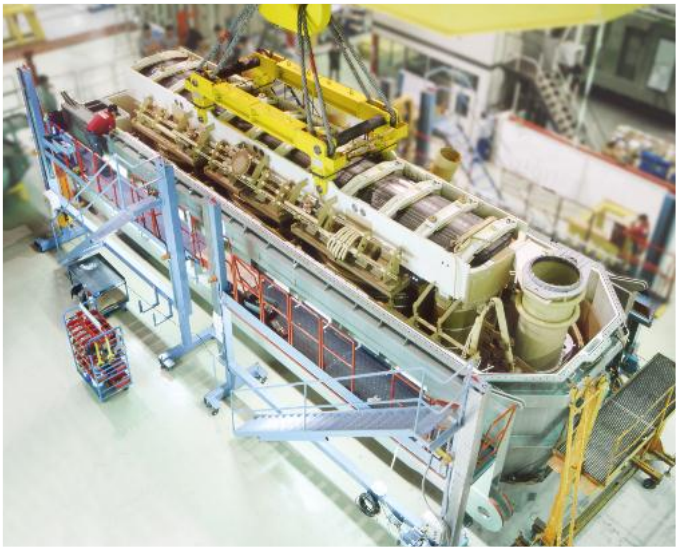
Connecting Renewable Energy

The technical development, construction, commissioning and operation of high-voltage systems for offshore projects means leaving behind familiar and moderate onshore conditions and facing the harsh and aggressive offshore climate. In recent years GE has gathered a high level of experience in delivering various offshore projects. Due to their low environmental risks and maintenance needs, GE's green transformers are especially suitable for installation on offshore platforms.

MAKING THE DIFFERENCE

We also offer a wide variety of transformers for various renewable energy applications - onshore and offshore, wind or solar energy. Small power transformers are utilized in the wind turbines while medium and large power transformers are utilized on the offshore platform or onshore wind/solar farm to connect the energy to the grid.

Conventional Power Transformers



Active part of a 1100 MVA 400 kV generator transformer during tanking

340 MVA 400 kV generator transformer

Generator Step-up Transformers

Generator transformers require very specific expertise, production equipment and testing capabilities, as high voltages and rated power are often required.

A generator transformer is an essential element of all nuclear, thermal or hydraulic power stations. Generator transformers are step-up transformers with delta-connected low voltage (LV) windings energized by the generator, while star-connected high voltage (HV) windings feed the transmission lines. Due to load rejection, switching operations, and generator over excitation, generator transformers are often affected by large voltage swings.

To operate properly, generator transformers must have the ability to withstand overloads by appropriately adjusting the winding gradients and maintaining cooling capacity. Controlling the magnetic field inside the tank is also essential to avoid overheating due to high-rated currents. GE's generator transformers are designed to solve these operational challenges and more. Our generator transformers are designed, manufactured, tested and delivered for versatile power stations applications all over the world.

Hermetic

The low maintenance transformer
Up to 250 MVA and up to 245 kV

GE's field-proven hermetically-sealed power transformer was designed without an oil conservator two decades ago. These transformers are highly reliable and have a long service life.

The innovative design of the radiators does not require an oil expansion vessel eliminating the chance of ambient humidity in the oil. In addition, the use of a vacuum type on-load tap changer (OLTC) eliminates contact erosion consequently increasing service life. With minimal oil and OLTC aging rate, the Hermetic does only require very low maintenance over its service life, speeding up the return on your investment.

MAKING THE DIFFERENCE

Single-phase autotransformers 500 MVA 765/400/20 kV in operation since the early 80's for EDELCA (Venezuela)

Interconnection Transformers

The most common transformers in networks, the interconnection transformers (step-up or step-down), connect AC networks or systems of different voltages to allow power exchange between them. They must be designed to handle the specified requirements of each transformer unit.

These transformers offer galvanic insulation between primary and secondary networks and can be designed as 3-phase or single-phase banks, depending on the end-user priorities and transportation constraints. They are also often designed to offer a wide voltage regulation range, by incorporating either an on-load or a no-load tap changer.

GE's conventional transformers are adaptable to specific site conditions. The design, rating of windings and configuration will be adapted to the customer specific needs. GE's customized solution can incorporate all specific physical constraints such as transport limitations.

According to power and voltage ratings and especially the constructive design, conventional power transformers can be classified as:

- Small and medium power transformers: While those with the lowest ratings can share some design characteristics of large-size distribution transformers, GE's medium power transformer offer covers a wide range that stretches up to 245 kV and 100 MVA.
- Large power transformers: As a world-class specialist in the highest ranges of power transformers, GE has supplied interconnection transformers up to the level of 765 kV AC - at that time the world's highest in commercial operation - as well as several units above both 300 MVA and 500 kV.

Autotransformers

When compared with interconnection transformers of equivalent power flow, the autotransformer presents a lighter and more economically optimized solution when the voltage ratio is between 1 and 2. However, autotransformers have connected windings hence there is no galvanic insulation between the interconnected systems.

Autotransformers have one of the most complex designs. The internal dielectric stress distribution requires in-depth knowledge of the electrical characteristics of these special transformers. Designs for constant flux regulation at high voltages or booster schemes are part of the GE expertise. For many years, we have supplied very high-rated autotransformers, such as single-phase units up to 500 MVA and with voltages up to 765 kV for networks all over the world.

240 MVA 400 kV autotransformer for RTE (France)

Oil-immersed Reactors

110 Mvar, 765 kV single-phase shunt reactor for Hydro Quebec. Chamouchouane s/s (Canada)

Shunt Reactors

Shunt reactors increase grid stability and maintain economically acceptable levels of insulation on networks with long transmission lines between power plants and consumption areas, especially low loaded or buried lines.

Shunt reactors compensate the capacitive load of energy transmission lines and are adequate solutions for:

- Maintaining an acceptable voltage level, regardless of load
- Limiting transient overvoltages induced by switching or sudden load decreases
- Decreasing line losses by capacitive current reduction

GE has expertise and experience delivering shunt reactors with air-gap cores and magnetic circuits. GE's shunt reactors have low vibration and noise levels. The optimized design of these shunt reactors provides magnetic field distribution allowing safe operation.

GE designs and delivers single-phase or 3-phase shunt reactors based on customer requirements. Globally, GE has delivered single-phase units up to 110 Mvar for 800 kV and 125 Mvar for 400 kV as well as 250 Mvar, 275 kV 3-phase units all currently in operation.

AC saturated reactors, a special type of shunt reactors, were devised to provide system voltage stabilization in situations where large and rapid load fluctuations cause unacceptable voltage flicker. They are typically used to counteract the effects of arc furnace, rolling mill and mine winder loads. They may also be used on transmission lines where a sudden loss of load may result in a dangerously high line voltage. Saturated reactors respond extremely quickly and automatically to a voltage disturbance.

Variable Shunt Reactors

Power Compensation made flexible

GE's variable shunt reactors, an innovative product, is equipped with tapped windings and on-load tap changer (OLTC).

Unlike common shunt reactors, variable shunt reactors are able to provide an adjustable Mvar output. For example, 160 Mvar to 250 Mvar at 420 kV or other special required regulation ranges. These variable shunt reactors are 3-phase units, oil-immersed and designed for outdoor use.

Variable shunt reactors are connected to the end of a high voltage line or to a substation busbar to provide a flexible solution to the changing infrastructure of today's electrical systems due to the integration of renewable power sources.

MAKING THE DIFFERENCE

Series Reactors

Series reactors are used in line series connections as current limiting devices to reduce fault currents to required levels. They can be single-phase or 3-phase and configured as unshielded, magnetically shielded or non-magnetically shielded.

The design of core/coil clamping system is essential to effective operation of series reactors. Expertise is required to contain phenomena presented by stray magnetic fields in extremely large ratings. GE has a wide range of experience in various applications of series reactors with throughput ratings over 2000 Mvar.

Earthing Reactors and Transformers

Neutral earthing reactors connect the neutral point of power transformers to ground through an impedance, in order to limit the short-circuit current and the increase of voltage in the healthy phases.

When the neutral point is not accessible in the transformer (e.g. delta connection), an artificial neutral can be created by an earthing transformer. An earthing transformer has a zig-zag winding and is connected between the main transformer and the reactor.

GE provides both earthing reactors and transformers to meet our customers needs.

Smoothing Reactors for HVDC

Smoothing reactors, in HVDC transmission application, are used to reduce the flow of harmonic currents and transient overcurrents in DC systems based on two functions:

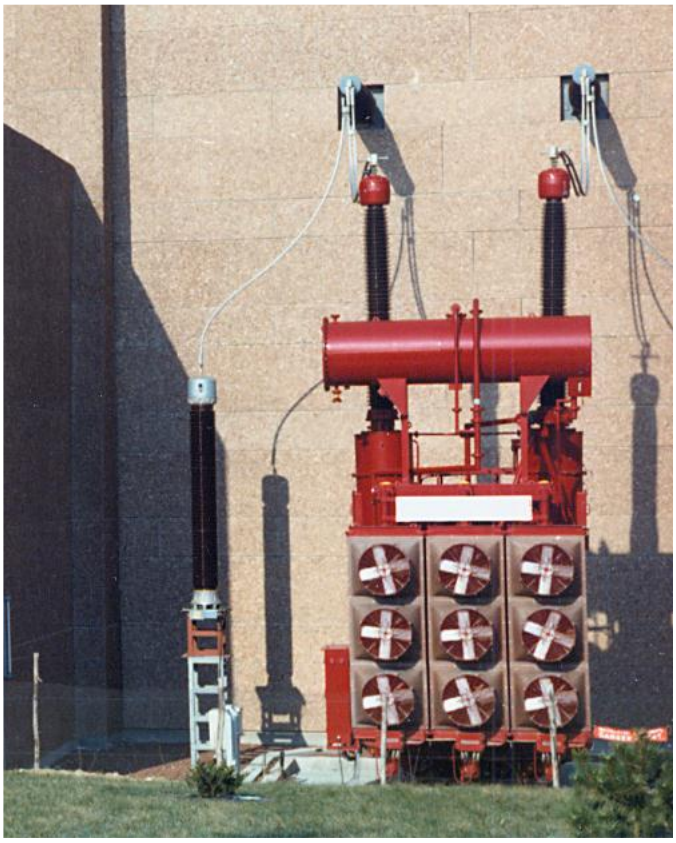
- Compensate voltage ripple at the 12-pulse converter bridge
- Decrease the short-circuit current in the DC link

Utilizing the same insulation design principles as our transformers, GE's oil-filled smoothing reactors are designed to offer a low level of electromagnetic radiation outside the tank. To protect the environment and equipment (like motors, relays and switchgear), our smoothing reactors are designed with a magnetic shield on the internal wall of the tank to minimize magnetic flux density effects.

Similar to HVDC converter transformers, GE's smoothing reactors can withstand short-circuit stresses. The clamping structure of the active part is reinforced in order to conform with these requirements.

2640 Mvar

The record throughput rating of a 400 kV 3-phase series reactor with low-noise design manufactured by GE for National Grid Co., UK (photo: active part)



Smoothing reactor with rated current 1850 A, 270 kV for IFA 2000 HVDC link France/England

Special Transformers for Transmission Networks

HVDC converter transformer 600 kV DC for Rio Madeira, Brazil

HVDC Converter Transformers

High Voltage Direct Current (HVDC) systems allow energy transmission over long distances and provide solutions for the interconnection of networks with different characteristics and frequencies.

The HVDC converter transformer, a vital element of these systems, transforms the AC supply voltage from a 3-phase network to the required converter bridge input voltage and compensates for voltage drop through on-load tap changers.

Direct voltage components superimposed on the AC parameters appear during service and factory testing and impose high levels of stress on the valve windings and components connected to the rectifier bridge. The design and manufacture of HVDC converter transformers require a significantly high degree of technical expertise and competence.

The high harmonic content of the load current also demands a very specific knowledge of thermal design. GE's experts have HVDC converter transformers successfully installed globally: Europe, India, Canada, the Middle East and South America.

In 2009, GE was awarded an order for a ± 600 kV DC bi-pole for the Rio Madeira project in Brazil. This was, at the time, the world's longest power transmission line, with a total length of 2,375 km. This project was followed by the ± 800 kV DC 3000 MW bi-pole stations for the Champa/Kurukshetra project in India. GE supplied the Ultra-High Voltage DC (UHVDC) converter transformers for all the converter stations, establishing our position as a world leader in complex HVDC converter transformer manufacturing.

HVDC converter transformer 350 kV DC for Lower Churchill, Canada

800 kV DC

GE's full-scale 800 kV UHVDC transformer model was successfully tested in July 2010 and validated in compliance with the applicable IEC standards.

This achievement is the result of 40+ years of experience and a focused Research & Development program in the field of HVDC power transformers, marking a further step towards 800 kV DC transmission.

GE's experts have mastered the analysis of complex phenomena to design and manufacture the safest transformers for our customers.

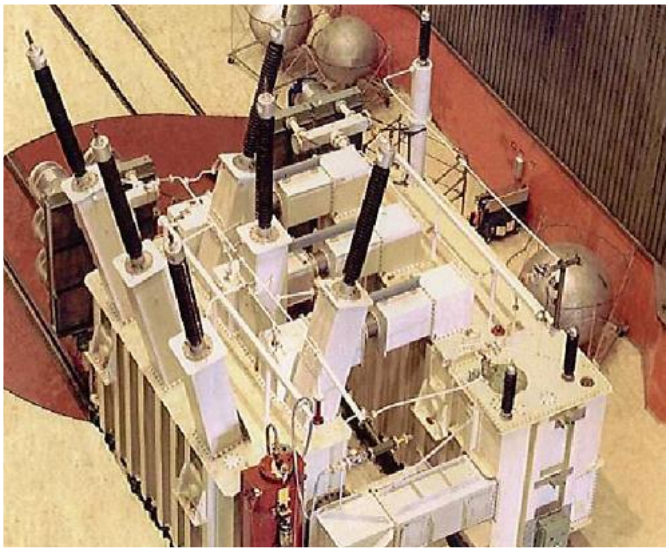
Phase-Shifting Transformers (PST)

There are several connection points in today's high voltage network systems which require the control of energy flow. Traditional voltage regulation that do not iclude phase-shifting is no longer sufficient. Hence, phase-angle regulation is increasingly becoming a necessity. Phase-shifting transformers (PST) are used to provide such regulation.

Phase-shifting transformers are divided in two families:
1. PST with one active part (single core) or
2. PST with two active parts (dual core).

A PST with one active part permits independent phase angle and voltage regulation and is suitable for a low voltage and power levels. For higher power and voltages, a PST with two active parts is ideal. PSTs are often used in special cases where design criteria varies by customer based on individual network specifications and requirements. Since these transformers are heavy units with large ratings, manufacturing limits and transportation constraints are important to consider.

GE has extensive experience delivering PSTs. For example, in Europe, GE delivered constant-modulus type, phase-shifting transformers with two active parts offering no-load phase-shifting angles of +/-21.4°, for a voltage level of 225 kV with rated power of 312 MVA and +/-10° regulation for a 400 kV voltage level with rated power of 1180 MVA.



312 MVA 225 kV two-tanks, dual-core phase-shifting transformer

Quadrature Boosters

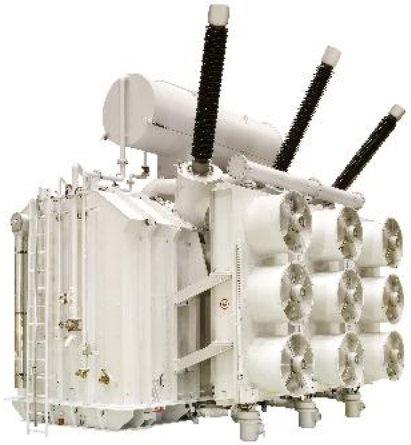
A variant of the dual-core PST, the quadrature booster (QB), offer an economical solution when limited phase-shifting angles are required with voltage variations. Since 1997, GE has supplied nine QB transformers to UK's National Grid Co., with power ratings up to 2750 MVA.

Quadrature Booster 2750 MVA 400/80 kV
for National Grid Co. plc. High Marnham (UK)

Transformers for SVC

Static Var Compensators (SVC) transformers are used to connect SVC equipment to transmission lines. These transformers combine the complexity induced by DC components - even if moderate - with high levels of harmonic and rated currents.

GE's SVC transformers provide a flexible solution to improve power system efficiency and control the reactive power balance of the network. Mastery of insulation structures, thermal behavior and magnetic field distribution are all part of the GE's SVC transformer expertise.



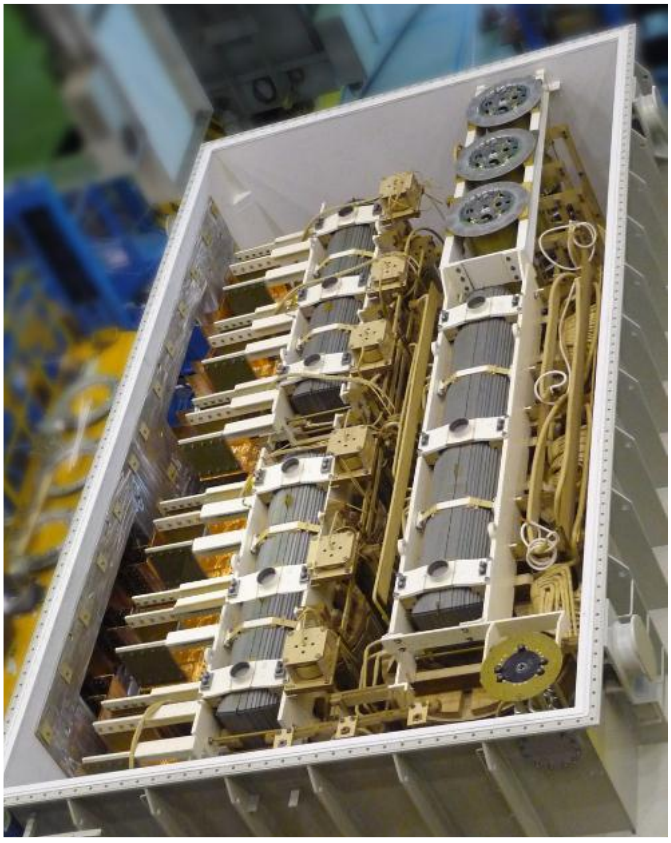
250 MVA 225 kV SVC transformer for RTE, France

Special Transformers for Electro-intensive Industries

Rectifier Transformers

Rectifier transformers supply very high currents required for industrial applications such as electrolysis processes for aluminum and electrochemical processes for zinc, copper and chlorine.

For over 35 years, GE has supplied rectifier transformers to more than 80 industrial projects all over the world. GE's unique skills and experience provide solutions to any industrial process from new installations to refurbishments. Rectifier transformer combinations can be made with all active parts grouped in one or two tanks, with the regulating (auto) transformer and its tap changer in one tank and the rectifier transformer assembled in the other.



Active parts of a combined rectifier transformer to be housed in a common tank

Electrical Arc Furnace (EAF) Transformers

With more than four decades of proven expertise, GE is one of the indisputable leaders in extra-high power EAF transformers. The quality and performance of our products are field-tested every day at steel production sites around the world.

Arc furnace transformers deliver high currents over a wide range of voltages. While power ratings between 10 and 300 MVA and secondary currents of more than 100 kA are quite common, our EAF transformers are designed to adapt to the extreme thermal, mechanical and dielectric constraints of the furnace load cycles.

To improve the efficiency of the service currents and maintain system's stability, furnace series reactors may be also added. These series reactors can be housed in the same EAF transformer tank.

300 MVA

GE delivered the world's highest-rated electrical arc furnace (EAF) power transformer for MMK/Atakas

265 MVA EAF transformer with on-load tap changer and two 77 Mvar EAF series reactors for Colakoglu (Turkey)

Special Transformers

Trackside Feeder Transformers for Railways

GE's trackside transformers are key components for railways, supplying power to electric rolling-stock that use single-phase AC networks (see scheme below).

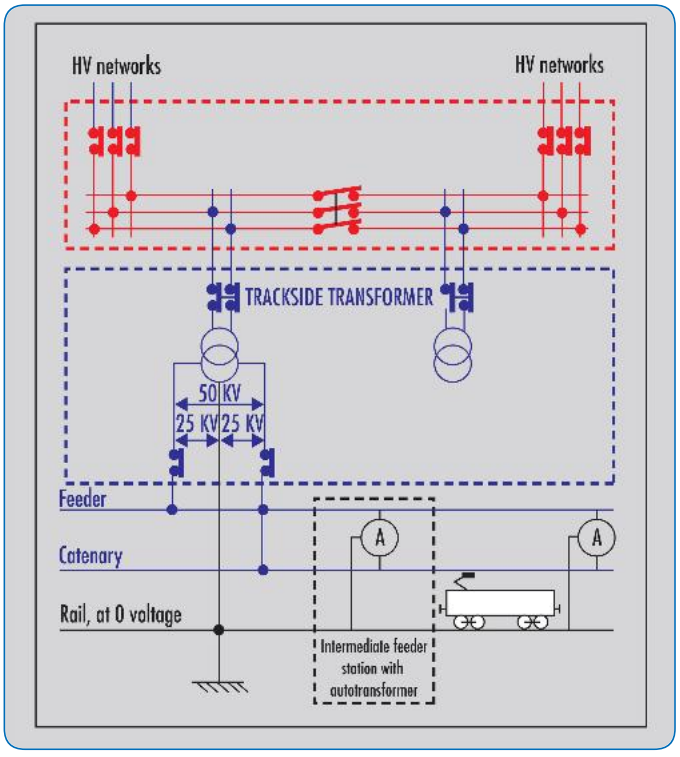
These transformers are designed to withstand high mechanical and electrical stresses due to fluctuating load current and frequent short-circuit conditions created by passing trains. Our trackside feeder transformers can reach up to 60 MVA rated power and with the HV connected to 220 kV or even 400 kV networks for high-speed train supplies.

"Hermetic" transformers (see page 6) are especially suitable for these uses and have proven their performance for years on some of the most demanding European railways.

15 MVA 120/17.25 kV hermetic-type trackside transformer for Deutsche Bahn (Germany)

Autotransformers and Boosters for Catenary

To improve transmission efficiency and system regulation while reducing earth current and electromagnetic interferences, catenary feeding systems use booster transformers or autotransformers (in addition to trackside power transformers) at regular intervals along the track. These schemes are extensively used for high-speed trains, typically for those of the French TGV (Train à Grande Vitesse or high speed train).



25 kV feeder system with a 220 kV / 2x25 kV trackside transformer and autotransformer for SNCF TGV lines (France)

Autotransformers in SNCF railways (France)

Distribution Transformers

GE provides a broad array of distribution transformers to support a variety of applications. Our product lines include pole- and pad-mounted, single-phase and three-phase solutions, as well as primary and secondary substation transformers, cast coil transformers, network transformers and voltage regulators.

Optional Features for Advanced Systems Capabilities

With over 40 years of experience and more than 50,000 installed units, GE's high-quality M&D equipment and software support users in early detection of faults avoiding unplanned outages, and maximizing asset reliability. Our solutions enable intelligent operational decision making on condition-based asset lifecycle managent (ALM) and asset performance management (APM) strategies. GE's broad range of M&D products is well established in the marketplace today. Below are some of products in our portfolio:

Hydran – Single Gas DGA Monitoring

Like the other Dissolved Gas Analysis (DGA) equipment, the Hydran is a compact permanently mounted on-line transformer monitoring device that will alert personnel to developing fault conditions. These Hydrogen only or "composite gas" devices used for DGA provide easy to install, cost effective monitoring with remote alarm and data communication capabilities, all packaged within a small direct valve mountable unit.

Kelman – Multi-gas DGA Monitoring & Diagnostics

Capable of delivering up to 9 individual gas measurements plus moisture with laboratory matching accuracy, these devices raise alarms and provide detailed remote diagnostics of fault present. A range of 3, 5 and 9 gas models are available supporting Modbus, DNP3 and IEC 61850 communication protocols.

Intellix BMT 330 – Online Bushing Monitoring

Utilizing bushing tapping points with custom fitted adapters, these devices replace offline testing with continuous condition monitoring of up to 6 bushings - providing percentage changes in Capacitance and Power Factor. They also warn about the presence of any electrical Partial Discharge (PD) within the transformer.

Transport X2 – Portable DGA

Often referred to as a "lab in a box", this fully portable seven gas DGA analyser weighs less than 9 kg (20 lb) and delivers a full DGA diagnostic of an oil sample in about 30 minutes. This portable DGA comes with a built-in diagnostics, local HMI and printer eliminating the need for an external laptop. These DGAs are an ideal fast response tool for field crews and a great companion to GE's suite of Hydran devices.

MS 3000 – Holistic Condition Monitoring System

The MS 3000 is an "Expert system" based on GE's extensive transformer manufacturing and domain knowledge that provides information, alarms, diagnostics and suggested next steps. This flexible system aggregates data from a wide range of sensors installed on various transformer components. This tool is also used to perform smart cooling control and monitor dynamic loading. When combined with a DGA monitor, it enables holistic coverage of transformer failure modes. The MS 3000 significantly increases the ability to detect and analyze potential transformer problems allowing operators to make better technical and operational decisions.

Perception – Transformer Monitoring Software

This powerful software collates data from all GE's Monitoring and Diagnostic (M&D) devices and provides a range of trending, analysis and diagnostics based on international standards. The "Enhanced Perception Fleet" version provides an easy to understand overview of transformer fleet with more advanced analytics, reporting, health indexing and fleet ranking. Fully interoperable with GE's wider ALM service and APM software solutions, Perception is a proven tool for asset managers, SMEs and operational personnel.

Transformer Maintenance and Upgrade Services

Power transformers constitute a large capital expenditure and are one of the most critical components in electrical systems.
Over the equipment long lifecycle, operators must optimize the availability, reliability and safety of transformers, and avoid accelerated irrecoverable ageing of its insulation system. GE provides advanced maintenance strategies to help customers minimize unplanned outages and major failures and to adapt transformers to evolving operation conditions.

GE's Field Services engineers located close to customer sites, leverage our extensive in-house field service, product design and R&D expertise. Customers benefit from a local infrastructure including on-site mobile workshops, advanced testing capabilities, dedicated refurbishment facilities, and oil laboratories.

Asset lifecycle Management Services

Site Inspection and Tests

- Visual inspection, functional checks and electrical tests including non intrusive advanced measurement such as infrared thermography
- Standard protocol for condition data collection
- Data checks and first hand diagnostics
- Internal inspections for critical assets

Oil Analysis

- A broad range of tests can be performed including dissolved gas analysis (DGA), oil quality and ageing markers
- Customized oil analysis plan

Diagnostics & Recommendations

- Transformer condition assessments, diagnostics
- Root Cause Analysis
- Expert recommendations for operation and maintenance
- Substation and transformer fleet digital management
- Online monitoring consulting services for data analysis and alarm management

Modernization and Upgrade

Providing Custom Engineered Solutions

- Life-extension program
- Thermal & cooling upgrade for uprating and life time extension
- Voltage regulation upgrade to new needs
- Oil preservation system upgrade
- Bushing replacement and upgrade
- Online monitoring retrofit

Preventive Maintenance and Repair

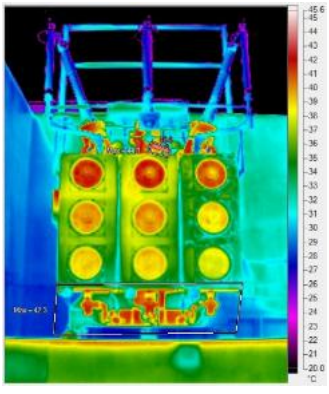
Maximizing Lifecycle Performance

- 24/7 technical support
- Repair or replacement of defective or obsolete parts and accessories including tap changers
- Major repair of active part up to complete rewind
- Treatment of corrosion points and oil leakages
- Oil processing, treatment and drying or replacement
- Complete regasketing
- Spare parts management

Assembly and Disassembly Services

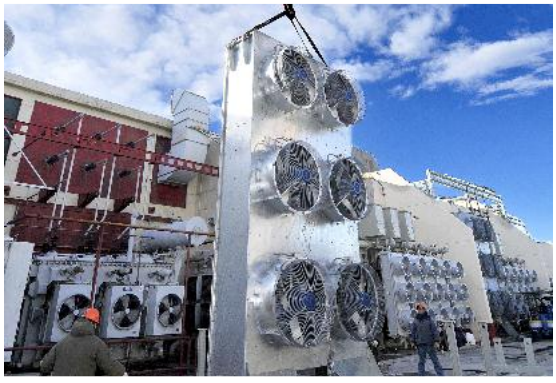
For Installation and Relocation

- Full relocation services
- Erection and commissioning
- Decommissioning solutions



Infra-red thermal scan performed during site inspection. Hot spots accuratly identified.

Cooling upgrade designed and implemented to match new operation conditions



Imagination at work

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