Generators
2,500 to 80,000 kVA
Up to 22,000 Volts
GE has been setting the standard in generator manufacturing for over 130 years.
GE created and implemented the first fundamentals of large-scale electrical generation. Today we continue to deliver innovative power generation solutions to the world.

We continue to innovate with product quality
Generators are designed and manufactured to operate efficiently and reliably in challenging applications and severe environments where ease of maintenance is critical.

Standards and Certifications
We’ve designed rotating machines that comply with global standards and certifications, including but not limited to IEC, NEMA, API, CSA, Lloyds, DNV, ABS, ATEX, IEC ExN, and ExP. Zone 1 or 2 and Division 1 or 2 are also available. GE manufacturing facilities are ISO 9001 certified.

Applications
Power generation from gas and steam turbines, diesel and gas reciprocating engines, wind turbines, and hydro turbines.

Industries
- Oil & Gas
- Power and Energy
- Mining
- Marine
- Other Process Industries
Generator Products

4-Pole Synchronous Gas and Steam Turbine Applications

Our range of 4-pole generators provide a reliable product which is based on a modular construction concept utilizing the latest design and manufacturing techniques. All generators include Vacuum Pressure Impregnation (VPI) insulation systems (for both the stator and rotor components) and a unique vent stator technology for maximum heat dissipation.

Stators are either mounted in a box-frame with end-shield mounted bearings or in a base frame with pedestal bearings.

Up to 20 MW a laminated rotor is used. Above 20 MW bolted and unbolted solid pole rotors are used.

Reciprocating Engine Driven (Beta) Diesel and Gas Reciprocating Engine Applications

These generators are designed to withstand the rigours of marine and industrial applications but still take advantage of the insulating properties of the VPI technology present in gas turbine generators.

The speed range for these machines is very wide. The number of poles ranges from 6 to 22 in general. More poles can be added to these machines if required.

<table>
<thead>
<tr>
<th>Output Range</th>
<th>2,500 to 45,000 kVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>400 to 15,000 V</td>
</tr>
<tr>
<td>Frequency</td>
<td>50 Hz or 60 Hz</td>
</tr>
<tr>
<td>Cooling</td>
<td>Air or Water-Cooled</td>
</tr>
</tbody>
</table>

8-Pole Beta Generator

Output Range: 5,000 to 75,000 kVA
Voltage: Up to 15,000 V
Frequency: 50 Hz or 60 Hz
Cooling: Air or Water-Cooled
4-Pole Synchronous Gas and Steam Turbine Generator

Beta Diesel and Gas Turbine Generators
Generator Products

Reciprocating Engine Driven (Delta) Diesel and Gas Reciprocating Engine Applications

This design has the stator mounted into a base-frame with pedestal bearings to support the rotor. These are used in many applications from Prime and Emergency Power to Marine Power.

The speed range for these machines is very wide. The number of poles ranges from 6 to 22 in general. More poles can be added to these machines if required.

| Output Range | 2,500 to 45,000 kVA |
| Voltage      | 400 to 15,000 V     |
| Frequency    | 50 Hz or 60 Hz      |
| Cooling      | Air or Water-Cooled |

Wind Turbine Applications

Although these machines employ the same insulation systems as other generators, they tend to be more specifically designed for the application or project. The speed can range from 17 to 1800 RPM depending on the generator type required.

Permanent magnet generators with no gearbox are slow speed (as in the photo at bottom left.) This machine is a 6 MW machine weighing in at 100 tonnes.

A similarly rated machine working at 1800 RPM in a doubly-fed induction (DFIG) configuration would weigh between 10 and 12 tonnes.

Permanent Magnet Generators

| Output Range | 2,500 to 12,500 kVA |
| Voltage      | 690 to 14,400 V     |

Doubly Fed Induction Generators

| Output Range | 2,500 to 10,000 kVA |
| Voltage      | 690 to 15,000 V     |

The inside of a 14-pole Delta generator
Delta Diesel and Gas Turbine Generator

Wind Turbine Generator
Rotors

Laminated Pole

- Laminated cruciform assembly
- Wire-on-Edge field windings
- Coils wound directly on poles
- Cooling vee-block designs
- Advanced ventilation and fan designs

This rotor has a laminated cruciform assembly and a wire-on-edge field winding. Each pole face has a set of damper bars brazed to a copper segment at each end, and coil support bars to prevent the ends of the coils from moving in service. After winding and vacuum pressure impregnation treatment, the rotor assembly is shrunk on to the shaft to ensure a positive fit. The heating process is computer controlled with a number of thermocouples to ensure the rotor is not overheated to protect the insulation and other parts. The shaft material is either of a rolled bar or a carbon steel forging. The coils are of the wire type, wound directly onto the poles of the generator. The poles are insulated with Class F insulation and the coils are fully consolidated with epoxy resin.

Bolted Tip Solid Pole

- Class H winding technology
- Improved thermal performance
- Individual bladed fan designs

This rotor has solid poles and a strip-on-edge field winding. The shaft and pole bodies are produced from a single normalised carbon steel forging. After the field coils are fitted, steel pole tips or shoes are bolted to the pole bodies using steel pole screws. The coils are of a strip-on-edge construction with an inter-turn insulation of epoxy resin impregnated inorganic paper. This is cured under heat and pressure to make fully consolidated units with Class H performance. At intervals down each coil side, individual turns may be extended to improve cooling. Coils are assembled on epoxy bonded glass laminate washers. Each fully insulated coil unit is then mounted on its salient pole with a suitable restraining arrangement to ensure that it is held firmly against the pole during normal service conditions.
Integral Tip Solid Pole

The pole tips or shoes on this rotor are machined from the single rotor forging. All other features are the same as the bolted tip rotor. Solid poles hold a strip-on-edge field winding. These types of rotors are used in special 60 Hz applications or otherwise specified by customers requiring maximum durability.

Cylindrical Wound

- Class H winding technology
- Improved thermal performance
- Laminated core
- Distributed winding

This rotor is used in applications where a distributed winding is required. The rotor body is made from laminations with slots to take the windings. The windings are placed into slot-liners when inserted and wedged in at the surface, similar to stator winding technology. There are winding retaining rings at each end of the rotor to prevent movement.
Stators

Two Layer Lap Winding

- Low-loss lamination grade
- No core-pack welding
- Individual slot wedging
- Thermal vent technology
- Global VPI with rotate cure

The stator core assembly consists of varnished laminations of cold-rolled low-loss silicon steel, clamped between compression plates. The laminations are supplied in the finally annealed condition, and are insulated to reduce eddy current losses. The core is built around a central mandrel, to enhance the bore profile. There are radial ventilation ducts at intervals along the core length, formed by spacers welded to laminations, with similar assemblies at each end of the core to provide support for the teeth. The whole assembly is clamped under pressure within steel core bars welded to the compression plates.
Vacuum Pressure Impregnation (VPI)

Void free insulation is vital for the life of medium and high voltage insulation systems. The stator is heated in an oven to dry out any moisture. Then it is placed into a pressure vessel where the lid is vacuum sealed. Then resin, at varying temperature, is pumped into the chamber to fill all voids on the stator. After a period of time, dry air is pumped into the top of the vessel creating a “pressure blanket” over the resin, “pushing” it into all remaining voids. The pressure is then released and the stator is placed in an oven for the resin to cure. The stator is rotated during the curing process to ensure that the resin does not run-off and is even throughout.

Coil Windings

Stator coils are produced from annealed copper strips insulated with a number of layers of mica tape under armour finishing tapes. The coils are inserted into stator slots using protective liners to prevent damage and are firmly positioned with epoxy glass wedges. The end windings are then securely braced before the complete wound stator undergoes a VPI process.
Typical Enclosures

Open Vented Enclosure
ODP, WPI, WPII
IP00-44, ICOA1

Water to Air Enclosure
TEWAC, CACW
IP54-56, IC8A1W7

Duct Ventilated Enclosure
TEPV
IP22-44, IC3A7

Air to Air Enclosure
TEAAC, CACA
IP54-56, IC6A1A1
Analysis Tools

Finite Element
Modern analysis tools such as finite elements make predictions regarding performance more accurate. Before integrating the generator with an engine, we calculate all the natural frequencies of the machine in order to avoid exciting them.

Thermal and Structural
We analyze our generator designs to improve their ability to not run too hot or be susceptible to natural frequencies and resonances.

Torsional
By torsional analysis of the rotor, it is ensured that the shaft components perform well even under fault conditions.

Terminal Box Integrity
Through a particularly advanced mathematical simulation we can calculate the effects of an explosion in a terminal box due to an electrical fault. This allows us to optimize the integrity of the terminal box during a very rare fault condition.

Fluid Dynamics
By using computer fluid dynamics programs, we can more accurately calculate generator cooling and make continuous improvements.

Electromagnetic Field
By using electromagnetic field analysis, we can accurately calculate the flux distribution in generators. This allows us to better understand loss and efficiency details.
Training and Service

Generator Controls
The GEPC RVD Mk III system uses a Programmable Logic Controller (PLC) to perform all the control functions and fire a power stack for the excitation. These are generally part of a “turnkey” type system where many other controls functions are being supplied by GE. These systems are most common in large, utility-type generators.

Controls Training
GE can supply comprehensive training in controlling generators for small and large systems. Classroom or site-based courses can be tailored to suit all levels of required competency. Courses discuss the principles of synchronous machine control through design, operation, and fault finding of the excitation system.

- Product Familiarization
- Technology Awareness
- Installation and Commissioning of Generator Control and Protection Equipment
- Generator Control and Protection
- General Instrumentation
- Generator Interface with Prime Mover
- Maintenance and Inspection
- Monitoring and Trending
- Fault Diagnostics

Global Service Capability
GE’s full global service network delivers fast initial response and follow-up on all warranty and service issues including:

- Supply and retrofit of all our associated Automatic Voltage Regulator (AVR) products
- Installation, erection and commissioning of machines and their associated control and protection systems
- Refurbishment capability including upgrades, repairs, rewinds, and enhancements
- Customer training, both at our regional facilities and at customer’s site
- Troubleshooting and 24-hour call-out availability
- Lifetime care and maintenance packages, from basic annual inspection through to total risk ownership
Global Expertise

Few manufacturers can claim the depth and breadth of experience that GE has in building and delivering electrical and mechanical solutions for customers.

GE offers a complete portfolio of rotating machines.
- Motors from 0.75 to 100,000 kW (1 to 134,000 HP)
- Generators up to 80 MVA
- Low and medium voltage variable frequency drives

GE has the global resources and capabilities to enhance the performance and reliability of your machines.
- A highly experienced team of application and sales engineers
- Engineering support optimized for your application

GE is constantly innovating product technologies to meet and exceed customer expectations.
MAIN OFFICES

**Australia**, Botany
Tel: +61 (0) 2 8313 9980

**Brazil**, São Paulo
Tel: +55 11 3614 1930

**Canada**, Mississauga
Tel: +1 905 858 5100

**Chile**, Santiago
Tel: + 56 2 652 6500

**China**, Shanghai
Tel: +86 21 6198 2600

**France**, Massy
Tel: +33 1 77 31 20 00

**Germany**, Berlin
Tel: +49 30 7622 0

**India**, Chennai
Tel: +91 44 4968 0000

**Japan**, Tokyo
Tel: +81 3 5544 3852

**Russia**, Moscow
Tel: +7 495 981 13 13

**Singapore**
Tel: +65 6332 0940

**South Africa**, Midrand
Tel: +2711237 0000

**South Korea**, Busan
Tel: +82 51 710 9015

**UAE**, Dubai
Tel: +971 44296161

**UK**, Rugby
Tel: +44 1788 563 563

**USA**, Fort Wayne
Tel: +1 800 541 7191