GE
Grid Solutions

Electrical Balance of Plant Solutions for Power Generation

imagination at work

Today's Environment

Todays power plants, whether heavy duty gas turbines, a distributed mobile "power plant on wheels", or a remote wind farm, are becoming increasingly complex, especially when connecting different disparate systems seamlessly together. This is resulting in increasing industry challenges including:

Demand Management

Supplementing power to the grid for peak shaving or managing seasonal demands.

Constraint Management

Overcoming generation constraints with increasing demand.

Back-up Power

Supporting maintenance, overhauls, or outages at power plants.

Rural Demand

Population growth in large cities creating increase in electrification of rural areas.

Emergency Power

Support during natural disasters due to unpredictable global weather patterns as well as support in politically volatile regions of the world.

Regulatory Environment

Rapidly changing regulations, standards and impact on grid stability due to a variety of power generation sources on the grid.

Power Quality

Managing changed network load profiles, larger switched or dynamic loads, missing or overloaded interconnections.

Energy Savings

Reduce production cost through energy savings and increase process efficiency.

With one of the largest installed base of turbine generators in the world, coupled with more than a century of experience delivering innovative, high voltage solutions in generation, transmission, and distribution networks, GE helps utilities solve these challenges with its versatile and robust suite of solutions for Electrical Balance of Plant (EBoP) applications offering best-in-class manufactured products with engineering and installation services.

Providing a broad range of solutions to suit customer's specific EBoP requirements, GE's solutions are designed with scalability in mind to support a large scope of projects ranging from heavy duty turbine generation to hydro pump storage, renewable wind and solar applications.

GE provides simplified and streamlined commercial offerings for EBoP systems, providing customers with a single, "1-stop shop" approach eliminating project and logistical complexities of multiple vendor projects.

Partnering with customers to define the project scope and vision, along with shared success metrics, is GE's top priority in all Electrical Balance of Plant system implementations. Offering full system lifecycle support, from project conceptualization to post installation, GE ensures customers are supported for the long-term.

GE's EBoP System Offers Utilities:

Extensive Experience in Project Implementation & Integrated Equipment Manufacturing

Deep domain knowledge and manufacturing excellence in electrical equipment, technology, and project execution and project delivery integrating complex generation and electrical plant systems resulting in streamlined, on-time and on-budget execution.

- Fast-cycle execution capability for GE Distributed Power EBoP projects*
- 1500+ complex generation and transmission project implementations
- Executed nearly 10% of all wind farm integration projects in North America

* *Subject to configuration*

Industry Leading Design and Integration Tools

Completed plant and application reference designs to enable rapid technical and commercial responsiveness, combined with industry leading visualisation tools utilized for planning and design, resulting in increased reliability and accurate scoping, reduction of unnecessary cost and labor, and reduced commissioning cycle time.

- 99% record of on-time installation during project execution
- 50% fewer change orders than industry average resulting in better cost accuracy and reduced overall project cost

Impeccable Safety and On-Site Management Record

GE's rigorous and best-in-class quality and process standards provide and promote a safe and secure work environment ensuring systematic project execution, on-time completion of deliverables and the highest level of on-site safety.

- Over 3.6 million hours of on-site project implementation without a workplace accident

GE's Capabilities

GE's EBoP solutions work seamlessly across an extensive range of applications and power generation types ranging from distributed to renewables and hydro pump storage to thermal power, ensuring optimal performance and unprecedented reliability in delivering power from the source of generation out into the grid.

Offering an extensive range of full project lifecycle capabilities from studies, complete design, installation and commissioning for a complete Electrical Balance of Plant solution, GE ensures an integrated and reliable electrical system. With deep domain knowledge, an impeccable safety record and manufacturing excellence in electrical equipment, technology and complex project installations, GE delivers on-time and on-budget EBoP project execution.

Providing local project and engineering support in different languages, GE brings a wealth of international experience to its customers. GE 's dedicated, and highly-qualified, engineering teams drive consistency and local knowledge to ensure the needs and localized requirements of customers are achieved, addressing both business and technical objectives, ensuring project success.

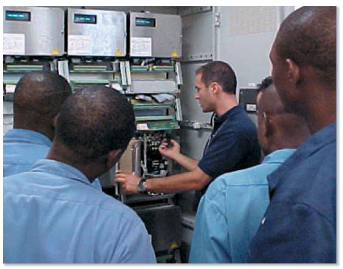
With more than a century of designing, developing and manufacturing products for the electrical grid, GE's manufacturing centers of excellence are located globally and are specialized, state-of-the-art facilities with ISO® 9001 certification.

Full Scope Capabilities

With experience gained from implementing more than 1,500 complex generation and transmission projects around the globe, GE can deliver Electrical Balance of Plant solutions that include GE equipment, fully engineered packages, as well as complete Engineering, Procurement and Construction (EPC) projects. GE manufactures electrical equipment and technology for complex generation and electrical plant systems, and provides a full scope of solutions from the generator terminals to the connection to the transmission grid.

Project Management and Control

The GE project team represents unsurpassed worldwide power system engineering capabilities, comprehensive system design expertise, and unequalled project management experience, provided within a defined and proven project management methodology and long history of highly successful projects. GE's core strengths in each of these areas enables the delivery of highly reliable solutions that fully meet customer's specific system requirements.



Engineering Services

GE's Engineering Services include comprehensive system analysis to develop an optimal and cost effective technology solution based on customer requirements. The scope of services include load flow analysis, project feasibility and justification reports, detailed protection and automation designs, and testing and commissioning plans. GE's engineering teams use industry leading visualization tools for planning and design, providing customers a robust and fully executed system with high quality and reliability.

Service and Warranty

GE is committed to outstanding customer service and has a global network of field engineering offices, maintenance facilities, and certified local partners to ensure faster, more competent responses to your service needs. GE provides an array of services from standard tests and evaluations to emergency repair services. A 24-hour, multi-lingual call center is available for all customers, and a "direct-to-field" option is available for mission critical installations. GE's service contracts and warranties are designed on a contract by contract basis to maximize the flexibility and value for our customers.

Power Generation Expertise

GE has one of the largest installed base of turbine generators in the world, coupled with over a century of experience delivering innovative, high voltage solutions in generation, transmission, and distribution networks. GE works collaboratively with customers to drive growth and progress, anticipate energy needs of the future, and power a cleaner and more productive world.

GE's Electrical Balance of Plant Offering Summary

GE's Electrical Balance of Plant systems cater to many types of project requirements including supplying equipment, engineered packages, and full engineering, procurement and construction (EPC) implementations.

GE designs and manufactures innovative, durable and robust electrical equipment for the complete energy value chain ranging from generation to transmission to distribution networks. GE has extensive project, application and industry experience as well as strong relationships in the energy sector, delivering complex integrations of generation and electrical plant systems resulting in streamlined execution delivering, on-time and on-budget projects.

GE's EBoP systems work seamlessly across a broad range of applications and power generation types including distributed power, renewable generation and thermal power.

Renewable Generation

Offering solutions for hydro, wind and solar renewable generation applications, the system is modular and scalable in design, integrating best-in-class GE components for a complete end to end system. The system is compromised of relays, meters, communication hardware, HMI to SCADA integration, and a pre-packaged control building connected to the substation. Furthermore GE can deliver a full engineered collector substation including Power Transformers and MV/HV Switchgear. The implemented solution reduces testing, commissioning and maintenance for customers.

Distributed Power

Providing proven, pre-defined, modular systems for distributed power generation applications, GE's solutions are designed for both scalability and flexibility and designed to meet utilities needs for distributed power including temporary and emergency power. GE's distributed power solution includes full end-to-end components from transformers and switchgear to protection and control and cabling systems.

Thermal Power

GE provides an integrated system with complete monitoring and control of the power plant for thermal power generation applications. This includes all electrical aspects of a plant from power generation, power quality, evacuation to switchyard control. The system is engineered using reference designs resulting in higher efficiency, flexibility, reliability and quicker return on investment.

Typical EBoP Components

Distributed Power AERO Trailer Mounted Example

	Power Train	Auxiliary Systems		High Voltage Substation	
Electrical	Motor Control Center	MV Switchgear	LV Switchgear	Step Up Transformer	Disconnect Switch
	MV Switchgear	Motor Control Center	Distribution Transformer	Busbar, HV protection	Breaker
	Generation Protection	Busbar/MV protection	Motor protection	Transformer Monitoring	Surge Arresters
	Power Control Module (PCM)	SCADA	Communications	Communications	Instrument Transformers
		Power Control Room (PCR)	MV Disconnect switch	SCADA	
Full Scope Engineering and Design – Electrical Systems					
Installation, Commissioning					

Electrical Balance of Plant for Distributed Power Applications

GE's Electrical Balance of Plant offering for temporary and emergency power is a scalable and flexible system that is modular and pre-designed with rapid cycle execution capabilities subject to customer readiness. The system includes elements of the power plant from the generator terminals to high voltage grid connection.

The EBoP system can be delivered as a fully engineered equipment package, a fully engineered, procured and constructed solution, or installed as individual components to meet customer's specific requirements.

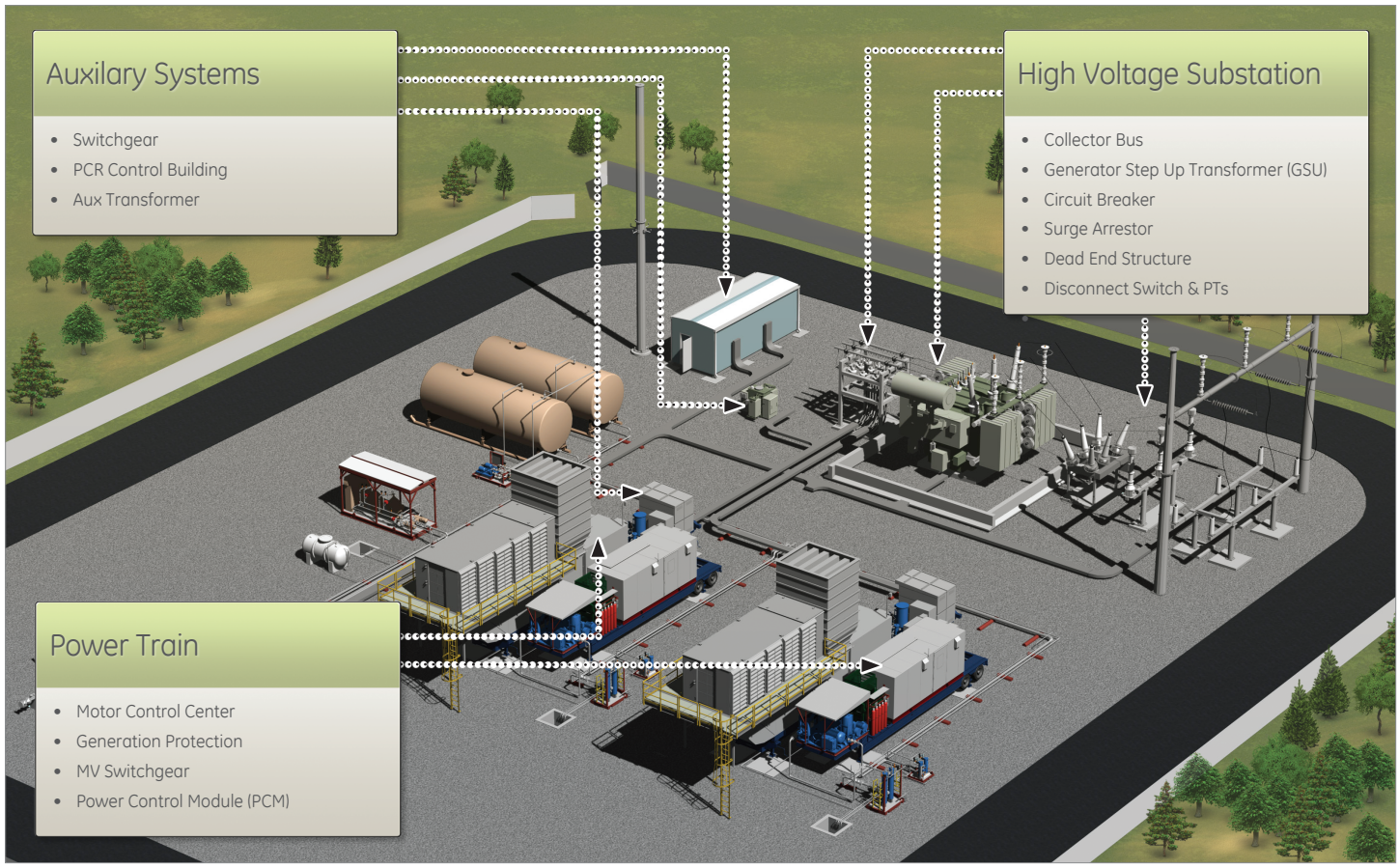
Major components of GE's solution include:

- Generator Step up Transformers
- Current and Voltage Transformers
- Gas Insulated Switchgear
- High Voltage Circuit Breakers (LT/DT)
- Air Insulated Switchgear (LT/DT/ Compact)
- Disconnect Switches
- HV Arresters, Insulators
- Protection & Control
- Networking Connectivity
- Systems Engineering
- Project Management
- Cabling Systems

Key Benefits

- Decreases project costs, such as engineering designs, due to modular and predesigned system
- Increases reliability with proven plant reference designs
- Minimizes inefficiencies and streamlines processes, delivering accurate scoping due to equipment and system studies
- Enables quicker return on investment facilitated by fast generation of electricity

Application Example for Distributed Power



Electrical Balance of Plant for Renewable Generation Applications

GE's Electrical Balance of Plant offering for wind and solar applications is modular and scalable in design and integrates best-in-class components for a flexible and standardized system meeting the specific requirements of both developers and utilities. The system includes the collector system, grid interconnection substations and the transmission line connection to the utilities electrical network.

Providing a broad range of products and services to meet customer's specific project requirements, GE's solutions range from high voltage switchyard equipment to systems hardware and design and engineering services. GE's engineering services capabilities include system studies, civil, electrical, protection and control engineering, control building and panel assembly and on-site installation and testing.

GE utilizes proprietary engineering tools to optimize the design and configuration of the collector circuits and provides turnkey SCADA solutions required for the integration of the power plant into the grid, including the HMI screens for providing status and controls with the option of remote control and diagnostics.

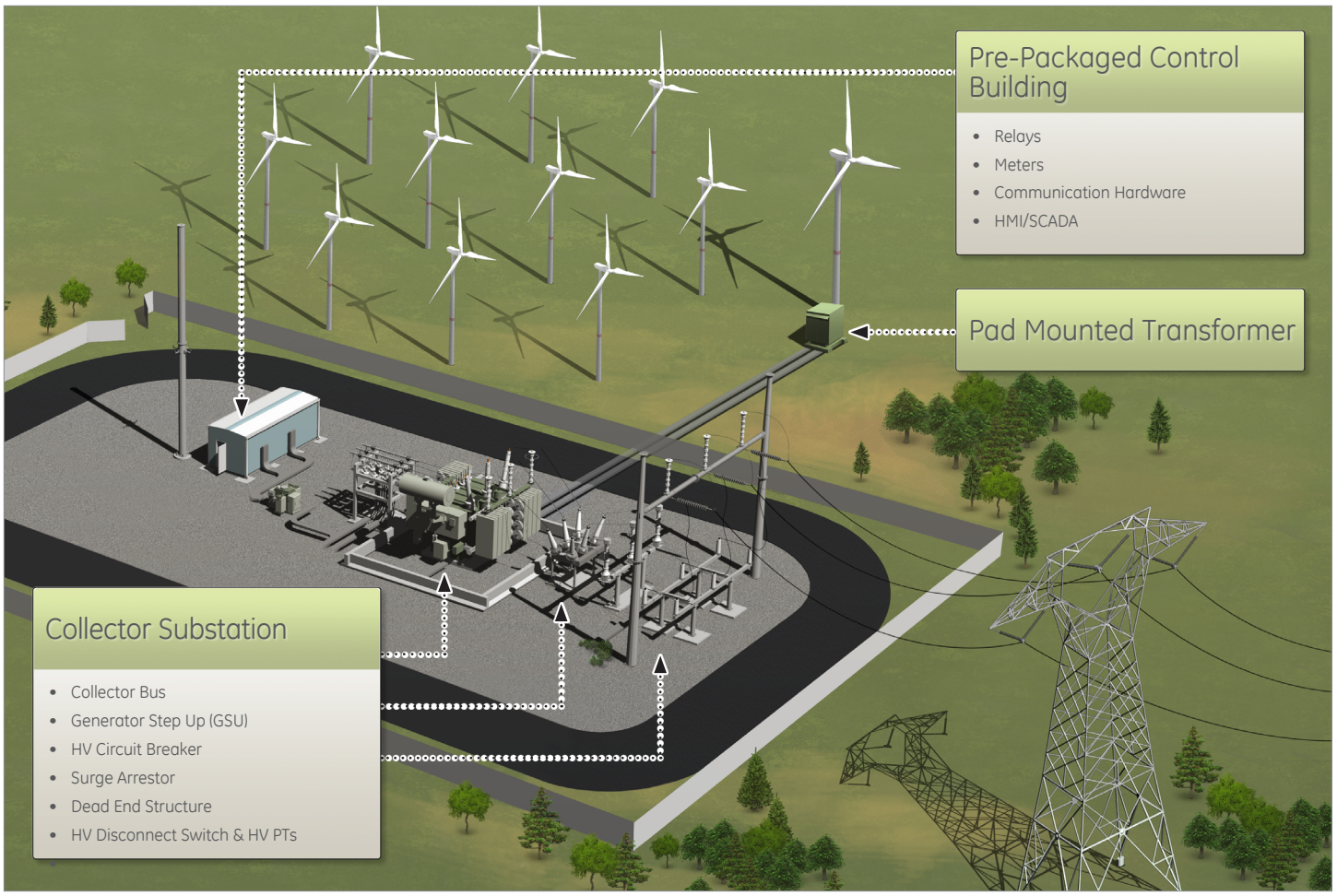
Major components of the solution include:

- Modular control building with protection, control, metering and communications panels
- Medium and High Voltage switchgear
- Capacitor banks
- GSU Power Transformer (generator step-up)
- Integrated SCADA system
- Optional monitoring and diagnostic systems for transformers and breakers

Key Benefits

- Minimizes inefficiencies and streamlines processes, due to system planning and studies
- Optimizes configuration of the substation consistent with customer requirements resulting from rigorous and accurate scoping
- Reduces costs, increases flexibility and provides standardization by utilizing industry leading design tools for ease-of-integration in design, procurement and installation
- Reduces testing, commissioning and maintenance actions, due to modular system design

Application Example for Wind Application



Electrical Balance of Plant for Thermal Power Applications

GE's Electrical Balance of Plant offering for thermal power uses a reference design and includes the electrical aspects of a power plant from power evacuation to control. The integrated system is scalable, flexible and is designed to respond to customer's requirements, whether as a fully engineered equipment package, a fully engineered, procured and constructed solution, or installed as individual components.

GE's solution can be tailored to meet project specific needs, compliance to codes and standards and local requirements. The GE solution brings together the vast GE Turbine fleet expertise coupled with the EBoP portfolio

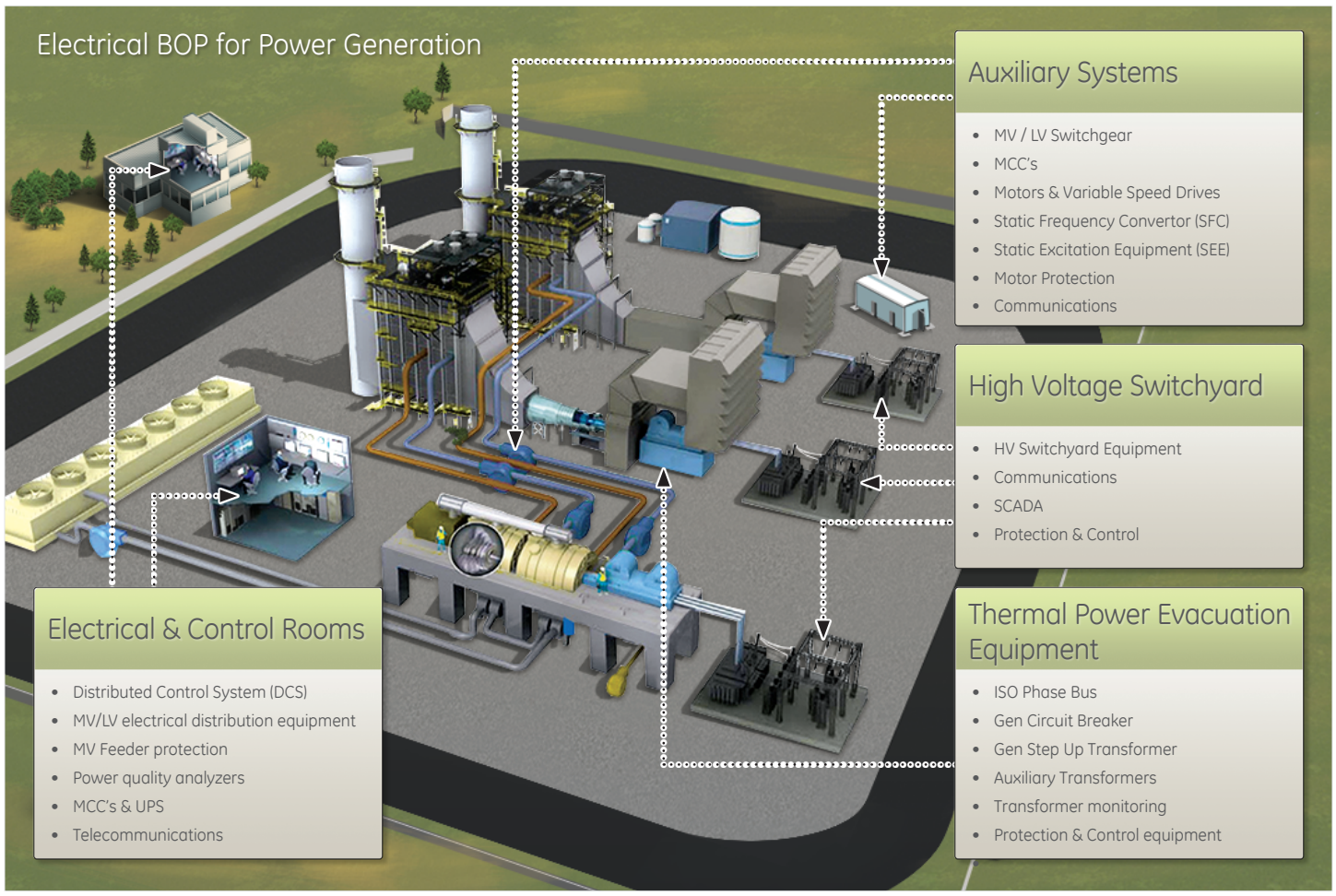
Major components of the solution include:

- High Voltage Equipment
- Medium and Low Voltage Electrical Equipment including Motors, Drives, Protection and Control Systems
- Monitoring and Diagnostic systems for starters/exciters, drive systems transformers, and motors
- Generator Protection
- Generator Step up Transformers
- Auxiliary Transformers
- Power Metering Systems
- Communications Systems
- Plant Control System
- Power Quality Systems

Key Benefits

- Faster return on investment facilitated by on time COD (Commercial on Date)
- High reliability enhanced by proven design, which is compliant with international standards
- Complete monitoring and control of power plant electrical systems enabling better visibility and maintenance
- Seamless installation and commissioning due to integrated system with optimized interfaces
- Increases visibility and maintenance due to complete monitoring and control of power plant electrical system
- Smoother project execution due to single coordinating design and construction entity assuring coordination among all designs and systems

Application Example for Thermal Plant Applications



GE's Electrical Balance of Plant Core Components

Complete Range of HV Primary Equipment

Transformers

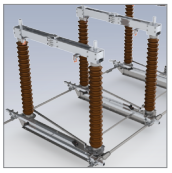
GE offers a wide range of transformer solutions for the utility, industrial, commercial, residential, and energy markets. These products and solutions feature flexible, reliable, and robust designs to support a wide range of applications.

Gas-insulated Substations

GE provides high performance, compact and flexible Gas-insulated substation (GIS) solutions for high voltage power transmission and distribution networks. Supporting a voltage range of 72.5 up to 800kV, GE has delivered more than 23,000 bays around the world.

Disconnect Switches

GE offers a flexible range of disconnect switches with voltage ratings from 72,5 up to 1,200 kV AC with all types of configuration i.e. center, double-side, vertical, pantograph and earthing switches. GE disconnect switches delivers the reliability and operational performance required by these critical assets.



Generator Circuit Breakers

GE provides generator circuit breaker solutions for installation in new power plants up to 1,500 MW or for refurbishment of existing ones. Both circuit breaker-only and combined solutions are available, and designed to customer needs

Circuit Breakers

GE offers a full range of Live and Dead Tank HV Circuit Breakers from 72,5 up to 800 kV. Based on proven technology, advanced manufacturing and testing capabilities, our circuit breaker suit a broad range of applications. GE offers also specific compact, hybrid switchgear modules for 123 to 170 kV AIS bays.

Instrument Transformers

GE's Instrument Transformers are designed to enable the protection of equipment and minimize the loss of product flow. This includes current and voltage transformers, test switches, control switches, lockout relays, three phase voltage monitors, ground fault detection systems, and power control components.

Surge Arrester/Insulators

GE provides lighting arresters/insulators to meet customers' system reliability requirements. Our products cover both IEEE and IEC markets from medium voltage (34.5kV) to ultra high voltage (1100kV), for both AC and DC application, and offer both porcelain and polymer housed products.

Integrated Intelligent Controls

Digital Substations

GE can deliver primary equipment with integrated digital communications. The Multilin™ HardFiber system digitizes analog signals from primary assets utilizing IEC 61850 communications, reducing total life costs of protection and control through labor and resource optimization. This factory-installed solution reduces the amount of labor-intensive, individually terminated copper wire connections with pre-terminated copper and fiber optic cables.

Electrical Protection & Control

GE uses substation hardened Multilin and MiCOM Agile protection and control relays to provide comprehensive protection, control, automation, and monitoring of primary substation equipment. With fast deterministic execution of programmable automation logic, extensive I/O options, and integrated peer-to-peer communications, Multilin and MiCOM Agile devices ensure optimized asset performance for maximum power system availability.

Transformer Monitoring & Diagnostics

GE offers a wide range of solutions that monitor, manage, detect and diagnose transformer issues to optimize substation assets. Online monitoring of transformer oil with composite gas or multiple gas Dissolved Gas Analysis (DGA), allows asset owners to be notified of developing conditions that could lead to unscheduled outages. Our advanced prognostics and proven modeling capture and analyze critical transformer data.

Industrial Strength Communications

GE's solution set of secure and ruggedized wireless devices, fiber optic multiplexers and Ethernet switches provide customers with a means to reduce the time and labor associated with substation construction and expansion. GE integrates a range of technologies, from cellular to private, and licensed to unlicensed, to support customer needs for secure private, public and hybrid communications networks.

Medium & Low Voltage Products

MV/LV Switchgear & Motor Control Centers

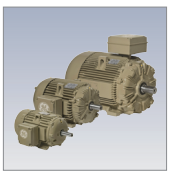
GE offers medium and low voltage switchgear and motor control centers which can meet the most demanding requirements for high current applications up to 6400A down to MCC applications for a few kW. GE's switchgear is suited to provide control and protection for cables, transformers, capacitors and motors.

Busways

GE offers a comprehensive range of busways designed to international standards, that address the requirement of the global market with outstanding levels of electrical installation performance.

Drives & Motors

GE offers a comprehensive range of drives and motors that comply with global standards. GE drives and motors are designed and manufactured to operate efficiently and reliably in challenging applications and severe environments where reliability and ease of maintenance is critical.



Variable Speed Drives

GE's Variable Speed Drives (VSD) solutions for auxiliary power plant systems such as pumps and fans adjust quickly to the required plant output and are designed to improve operational flexibility during low and peak demands. They can help to reduce production cost through energy savings and increase process efficiency.

Auxiliary Transformers

GE offers a wide range of auxiliary transformers, characterized by proven technology, application flexibility, lower installations costs, operating efficiency and environmental acceptability designed for use in most demanding and diverse environments and in all applications requiring reliable electrical power.

MV/LV Circuit Breakers

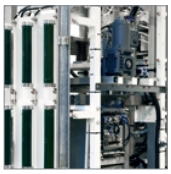
GE offers a wide range of MV/LV circuit breakers which can be applied in controlling and protecting electrical equipment in power plants and substations. All products conform to IEC 62271 standard and can be installed as a fixed or withdrawable application.

Solar Inverters

GE provides a complete range of central inverters based on a modular and compact approach, specifically designed for the solar industry. GE has extensive experience designing and installing more than 26 GW of converters for the renewable energy industry, and decades of experience in controls for a wide range of utility applications.

Static Frequency Convertor/Static Excitation Equipment

GE's static frequency converters (SFC) enable a soft starting system for gas turbines with generators running as motors, and help to enhance process performance. SEMIPOL compact units, a combination of a SEE and SFC offer space and cost saving design.



GE's Project Management and Execution

Based on years of global experience and several deployments across multiple applications and industries, GE has dedicated projects teams working in partnership with our customers to ensure successful system implementations.

Each Electrical Balance of Plant project, from the supply of an equipment only package, to an engineered equipment package (EEP), to a full Engineer, Procure, Construct (EPC) system, is assigned an experienced and dedicated project team.

With an average 24 years experience and access to industry leading project training tools, and processes, GE's project managers excel at project execution meeting on-time and on-budget customer requirements.

GE's engineering teams have advanced internal design tools that provide customers with the most robust and proven designs with a focus on quality and reliability.

GE's Energy Consulting works with customers to understand the overall system and project objectives. Through comprehensive analysis and studies the team develops the optimal, most cost effective technology solution based on customers requirements.

GE's Global Capabilities

Offering engineering excellence to design and deliver complete Electrical Balance of Plant projects, GE tailors its solutions to meet each customer's requirements and needs.

GE's dedicated engineering teams are located in regions around the world and bring a wealth of international experience to every project. Customers benefit from GE's local systems subject matter experts who are able to drive and comply with regional/local requirements ensuring customers business and technical objectives are met.

Post Installation Service

GE's commitment to customer satisfaction is a primary goal – just because the project is complete, our job is not done. A primary responsibility is continued support of the implemented system throughout its lifecycle.

GE has an extensive network of field engineering office locations and service centers around the world capable of responding immediately to urgent situations that may arise once the equipment is placed in service.

GE's Professional Services Process and Key Activities

GE's project management approach follows a well-established set of processes and procedures, that have resulted in high on-time delivery.

GE has the people, process and rigor that customers require for the planning and execution of complex projects, including defined processes for the definition, analysis, design, implementation and post service support that is required for successful projects. Below is an overview of GE's proven planning, execution and services methodology.

Definition	Analysis	Design	Implementation	Support & Services
				
• Customer System Planning and Studies • Load Flow Analysis • Transmission Planning Studies • Impact Studies • Initial Sub Synchronous Resonance (SSR) Planning • Reliability and Economic Analysis	• Project Feasibility and Justification • Preliminary System Requirements • Guide form Project Specification • Preliminary Schedule and Scope of Work • Business Case and Budgetary Estimates • Technical regulations and standards study • Quality plan	• Project management plan and detailed schedule • Detailed HV design • Detailed protection design • Detailed automation design • Project reviews • Testing and commissioning plans • Detailed documentation • Component contractor specifications • Customer communications	• Procurement • Complete safety and site execution plan • Site mobilization and construction • Customer Project Communication Plan • site testing and commissioning • Customer acceptance • Final Documentation	• Final Documentation and Training • Finalize Maintenance and Services Plan • Spares Verification and Planning • Formal Lessons Learned • Establishment of Warranty • Customer closeout • Customer feedback • Customer Support services option including analytics

GE's Manufacturing Centers Of Excellence

GE designs, manufactures and tests to the highest standards in the industry at its state-of-the-art manufacturing facilities. GE has an excellent track record in safety and is dedicated to the research, application and development of an extensive range of technology solutions for customers in the utility and energy industries.

Exceptional Quality and Reliability

- ANSI® and IEC® certified products available
- Third-party product certifications, including KEMA®, CESI® and other internationally recognized testing facilities
- Multiple checkpoints in the production, assembly and inspection process yield high quality products
- Secondary cross-inspections by certified technicians
- On-site GE quality engineers

Advanced Technology and Manufacturing

- State-of-the-art manufacturing facilities
- All manufacturing sites are ISO 9001 certified
- Robust product technology
- Advanced 3D platforms provides robust and reliably designed products
- Quality inspections for purchased and outsourced materials

GE's High Voltage Power Equipment is designed and manufactured in accordance with the Grid Solutions Sourcing Quality guidelines. Our design systems and manufacturing facilities are certified under the requirements of:

ISO 9001:2008, ISO14001:2004, OHSAS18001:2007

For more information about
GE's Electrical Balance of Plant Solutions visit

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