

GE
Grid Solutions

Utility & Industrial Substation Projects



imagination at work



Today's Environment

Substation and electrical infrastructure projects for utility and industrial customers face a number of challenges in today's environment. Increasing demand and workload peaks, NERC® and FERC® regulations, and an aging workforce and infrastructure serve as drivers for outsourcing these complex projects.

GE serves these needs with a comprehensive range of products and services for substation and electrical grid projects including:

- Control, protection, and monitoring hardware
- High voltage substation equipment
- System studies
- Engineering, project and site management, commissioning and testing

GE designs, procures, constructs and project manages electrical substations and network infrastructure projects for utility and industrial applications. Whether green field substations or upgrades and retrofits of existing substations, GE offers Engineered Equipment Packages (EEP), Engineer, Procure and Construct (EPC), and support services.

GE's Advantage

With more than a century of experience in the transmission and distribution industry, GE's projects team leverages their expertise to provide customers with a number of key benefits.

Extensive Experience

Deep domain knowledge and proven excellence to engineer, procure, and construct large, complex electrical projects resulting in increased customer confidence and reduced risk.

- Designed and implemented over 1,700 substation projects in the last 10 years
- Lead engineering and project management professionals average more than 20 years industry experience
- Experience completing large and complex projects valued over \$100M
- Unique capability to execute technically complex upgrade projects

Industry Leading Safety and On-Site Management Record

Rigorous, best-in-class quality and process standards provide and promote a safe and secure work environment. This ensures systematic project execution, on-time completion of deliverables and the highest level of on-site safety.

- Nearly 1.5 years of project site work without an OSHA recordable injury
- Comprehensive safety program focused on awareness, training and prevention

On-Time and On-Budget Delivery

Process rigor with seamless project execution and delivery, produce streamlined on-time and on-budget results.

- 99% on-time completion to in-service date
- Greater than 97% on-budget performance
- 50% fewer change orders than industry average resulting in improved price forecasting and total cost of ownership

Comprehensive Integration Capability

A full line of OEM equipment integrated via state-of-the-art 3D knowledge-based design tools provide optimized system designs.

- Pioneered the use of 3D interactive tools that incorporate GE design experience into repeatable knowledge-based system to drive efficiency, quality and speed
- Simplified and streamlined commercial offerings eliminate project and logistical complexities of multiple vendor projects

GE Project Types



Substation Upgrade Programs

- Transformer additions
- Transformer change-outs
- Breaker additions
- Breaker change-outs
- Ring bus expansions
- Protection & control/SCADA upgrades



Green Field Substations

- Utility
- Renewables
- Industrial



Experience and Capability

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 substation project, from the supply of an EEP to a full EPC system, is assigned an experienced and dedicated project team. With an average 20 years experience and access to industry leading project training, tools and processes, GE's project managers excel at execution, meeting on-time and on-budget customer requirements.

- Delivered over 1,700+ global projects in the last 10 years
- Global capability with proven project execution in more than 6 continents, including developed and developing countries and volatile environments
- Consistent core project management philosophy is applied to every project regardless of size, with a focus on cost, quality and time
- Experience delivering large and complex projects over \$100M
- Unique capability to execute technically complex upgrades
- Experience working with all major suppliers and OEMs
- Simplified, streamlined commercial offerings



Advanced Tools

GE's engineering teams have advanced internal design tools that provide customers with robust and proven designs, with a focus on quality and reliability. GE pioneered the use of 3D interactive tools to incorporate design experience into repeatable knowledge-based systems that help customers achieve shorter project cycle times with a standardized design.

- Data model based design incorporates 1,000 man-years of GE experience and expertise of substation design with integrated lessons learned
- Critical design elements validated against established quality checks and design rules
- Standard parts libraries, re-usable sub-assemblies
- Single line diagram, schematics, wiring, panels, physical and 3D



Quality Processes

GE's quality processes are fundamental to the complete life cycle of any project including requirements definition, product interfaces, project management methodology, engineering design and drawing reviews, supply chain technical and project (cost, schedule) quality, site management, and handover/punchlist compliance.

- All project and significant risks are reviewed and owned by senior leadership
- Comprehensive safety program



Project and Site Management

GE assigns a Project Manager to each project to act as a single point of contact to ensure that key project deliverables are satisfied. GE Project Managers have a proven track record and have successfully demonstrated their understanding of technical and commercial issues and effective decision-making. The Project Manager has overall responsibility for GE's project implementation and is the primary interface between the Customer's stakeholders and the GE project team. This resource is charged with providing solutions, and has the authority to access the necessary resources within GE to support the customer as required.

Additionally, GE assigns a Project Engineer to ensure the technical deliverables are satisfied. The Project Engineer will manage a multi-discipline design team consisting of protection engineers, designers,

civil engineers and drafters to meet the overall needs of the technical design. Our design teams understand the importance of satisfying utility/customer specifications while offering value added solutions to specific problems.

GE has a highly experienced staff of Site Managers with the background and knowledge to assist our customers with many types of construction requirements. The Site Manager is an effective communicator with the customer and all project members and support resources. With help from the GE support team, the Site Manager has full control over the coordination and scheduling from project mobilization to customer turnover.

Markets Served

GE provides projects ranging from the supply of an Engineered Equipment Package (EEP) to a full EPC system, and has the experience and capability to provide substation and electrical grid projects for a variety of applications. We serve a number of different market verticals including utility, renewables and heavy industrial.



Utility Transmission Substations

GE leads the North American industry in successful completion of sophisticated and critical electric transmission projects varying from 69kV to 500kV. Typical project types include:

- Greenfield substations
- Capacity upgrades
- Bay additions
- Transformer and circuit breaker change-outs
- Bus reconfiguration and expansion (BAAH, Ring Bus)
- SCADA and protection and control upgrades

GE offers a suite of services, system hardware and high voltage (HV) switchyard equipment and can tailor the scope based on the customers requirements. The suite of services that GE offers includes:

- System studies
- Civil, electrical and protection and control engineering
- Control buildings
- Panel assembly, onsite installation
- Testing of hardware communications and HV equipment

Building a greenfield substation or retrofitting existing substations is very challenging due to the complexities of integrating with existing infrastructure. GE addresses these challenges with their extensive industry knowledge and depth of expertise to help customers optimize their transmission systems during the planning/scoping phase of the project, avoiding unplanned outages during the construction and testing phase of the project.

Utility Distribution Substations

GE offers a wide variety of distribution substation solutions, varying from 12kV to 69kV, that incorporate the latest GE technologies and a modular design that allows for standardization and scalability to cover small, medium and large distribution substation upgrades. Typical project types include:

- Greenfield substations
- Transformer and circuit breaker change-outs
- SCADA and protection and control upgrades

GE offers a suite of services, system hardware and high voltage (HV) switchyard equipment and can tailor the scope based on the customers requirements. The suite of services that GE can offer include:

- Civil, electrical and protection and control engineering
- Control building and panel assembly
- Onsite installation
- Testing of hardware communications and HV equipment

Additionally, GE extends its expertise in the distribution substation space to include distribution automation. GE's unique portfolio of hardware and software solutions support advanced applications such as FDIR (fault detection, isolation, and restoration), VVC (volt/var control), and CVR (conservation voltage reduction). Our solution offerings can be networked with various communication technologies, and engineered to be either distributed or centralized in their control schemes.



Multiyear Upgrade Programs

GE provides multiyear programs to utilities and customers for a range of project types. A program approach is generally used for a group of projects that have a set criteria, common goals or anticipated results. For example, a customer may need to replace specific equipment or upgrade systems at multiple substations over an extended period of time. Typical project types can include:

- Protection and control hardware upgrades
- New or existing communications and SCADA upgrades
- Replacement of specific switchyard equipment, including transformer and circuit breaker change-outs



Industrial Substations

Reliability of service is of utmost importance to industrial customers, especially as it relates to the electrical service that keeps their process facilities running. With that in mind, GE's solution is specifically engineered to provide the highest reliability possible, including redundant service if required. GE also provides scheduled maintenance and service contracts to make sure that the substation is maintained properly to provide years of reliable service.

GE has extensive design and construction experience in building new or upgrading existing industrial substations, including:

- Oil & Gas
- LNG/Petrochemical
- Metals & Mining
- Steel/paper/cement

GE brings a wealth of experience to substation and electrical infrastructure projects and can help industrial customers address the complex engineering challenges of substation design, construction and the connection to the electrical infrastructure. For the industrial sector, GE's design teams have created modular substation designs that reduce cycle time, improve quality and improve project economics.

Renewable Substations (Wind & Solar)

GE provides Electrical Balance of Plant (EBoP) for wind and solar grid interconnect with a full line of solutions, products and services to support the development, design, installation and operations of renewable generation facilities. GE has designed and constructed nearly 10% of the wind generation connected to the North American grid.

GE has the experience to address site specific system configurations, standards and specifications to meet Point of Interconnect (POI) requirements.

GE's team of engineers has the capability to understand, analyze and provide solutions that are required by system operators for control, reactive compensation, harmonic filtering, metering, communications and SCADA.

Developers, Operator/Owners and General Contractors face similar challenges when it comes to managing the risks associated with scope, schedule and cost. GE's unique approach in organizing and planning the entire scope mitigates these risks and provides the optimal solution.

Utilizing innovative designs and technologies, GE's solutions are able to reduce system losses from the collection circuit through transformation and POI resulting in optimizing the annual energy production (AEP).

Specialized Technology Applications

Gas Insulated Switchgear Substations

GE provides Gas Insulated Switchgear (GIS) Substations ranging from 69kV to 500kV for utilities and industrial customers with a full complement of primary and secondary equipment, services and solutions to build and retrofit electrical infrastructure. GE's compact and modular design minimizes the installation footprint. This, along with a proven reduction in maintenance, provides for a lower total cost of ownership. GE designs and delivers technology solutions that provide among the highest level of performance and reliability to meet customer's operating requirements. Typical projects types include:

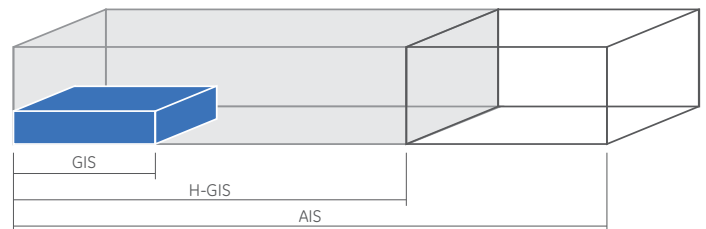
- Greenfield substations
- Expansions and upgrades
- Bus reconfigurations and expansions (Breaker and A Half (BAAH), Double Bus, Ring Bus)

GE's GIS design provides customers with a substation that is more efficient and more reliable, and easier to maintain and integrate. When reconfiguring existing electrical infrastructure or building a new substation, installing GIS provides flexibility due to its modular design and smaller installation footprint than traditional AIS design.

The GIS provides more operational data and control, leading to higher system availability and improved key performance indicators such as SAIDI, CAIDI and SAIFI compared to traditional AIS design.

GE provides the following for GIS substations:

- System studies
- Planning and outage management
- Civil , electrical and protection and control engineering
- Control building and panel assembly
- Onsite installation and testing of all hardware including communications



Spatial advantage of GIS technology



IEC 61850 Process Bus Solution

With the unique Multilin™ HardFiber Brick solution, GE offers customers an alternative to traditional copper wired substation designs that significantly reduces installation costs. This enabling technology creates a reliable high-speed network with the ability to connect and transmit data from the substation to an Advanced Distribution Management System (ADMS) or Energy Management System (EMS). The Multilin HardFiber Brick solution complies to the IEC® 61850 global industry standard.

GE provides hardware, engineering and design, system installation, commissioning, and testing for a full fiber substation solution, helping utilities achieve the following benefits:

- Reduced installation and commissioning labor – eliminate copper field wiring for an estimated 25-35% savings
- Data available beyond local site – digital input for asset management, operating systems, analytics
- Plug-and-play compatibility in the components – bricks, cables, marshalling cabinets, protocols

Operation and expandability benefits include:

- Reduced maintenance – eliminate energized wires in raceways and cable spaces
- Minimize ground current exposure
- Cycle time reduction
- Majority of field point to point checks eliminated
- Device and system self-monitoring reduces periodic testing
- Future upgrades are simplified – wiring limited to termination cabinets, design and relay configurations done offsite
- Digital data capture (status, conditions) available/integrated with traditional continuous data (voltage, current)



Modular Control Buildings

GE provides electric utility and industrial customers with Modular Control Buildings intended for use in transmission and distribution substations. The Modular Control Building is manufactured in a controlled environment. The Panels are wired and cabled to an intertie box that accepts the field cables from the switchyard equipment. The entire building and panels are pretested at the factory and shipped to site to be set on piers or a slab foundation.

Typical Building Size and Attributes include:

- 14' x 40', 14' x 49', 14' x 64', 14' x 98'
- Meets stringent seismic and high wind conditions
- Can include separate battery room, office or bathroom
- Set on pier or slab foundation
- Fire suppression systems
- Heat and HVAC

Key benefits include:

- 30% reduction in engineering versus conventional design resulting in shorter lead times
- 70% reduction in field wiring resulting in reduced costs and onsite construction time by 30%
- Reduced capital costs of new and rebuilt sites by 30%
- Operations and Maintenance reduced by 30%
- Traditions building size reduced by 25%
- SAT Site acceptance test reduced by 40%
- ECO certification by GE- reduce CO2 emission by 40%+, and travel by 140,000 miles, avoiding 190 tons of CO2 per year



For more information about
GE's Utility & Industrial Substation Projects visit
GEGridSolutions.com/PowerD/SubstationProjects



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