# Digital Substation Automation with IEC 61850 Protocols Training Course



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4100 € (Per Person)

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## Course Introduction / Overview:

The global energy landscape is undergoing a profound transformation, with digital substations emerging as the nerve center of the modern smart grid. This course provides a comprehensive exploration of digital substation architecture and the pivotal IEC 61850 standard that enables it. Moving beyond legacy systems, participants will delve into the principles of substation automation, protection, and control facilitated by seamless, high-speed digital communication. We will dissect the core components, from Intelligent Electronic Devices (IEDs) to the Process and Station Buses, ensuring a robust understanding of the entire ecosystem. As highlighted by industry pioneers like Dr. Alex Apostolov, the successful implementation of IEC 61850 is not merely a technical upgrade but a paradigm shift in how power systems are designed, operated, and maintained. This training, inspired by foundational texts such as "Control and Automation of Electric Power Distribution Systems", is designed to bridge the knowledge gap between traditional substation engineering and the new digital frontier. BIG BEN Training Center has developed this program to empower professionals with the practical skills and strategic insights needed to lead digital substation projects, from initial design and configuration to testing and cybersecurity hardening, ensuring reliability and efficiency for the grid of the future.

## Target Audience / This training course is suitable for:

- Electrical Engineers.
- Substation Design and Engineering Professionals.
- Protection and Control Engineers.
- SCADA and Automation Specialists.
- Power System Planners and Consultants.
- Commissioning and Testing Engineers.
- Asset Management Professionals.
- System Integrators and Technicians.
- Operations and Maintenance Personnel.
- IT/OT Convergence Specialists.

## Target Sectors and Industries:

- Electric Power Utilities (Generation, Transmission, and Distribution).
- Renewable Energy Project Developers (Solar, Wind).
- Heavy Industrial Plants with High-Voltage Substations.
- Railway and Transportation Electrification sectors.
- Oil and Gas Sector Power Infrastructure.
- Data Center Power Management Teams.
- Engineering, Procurement, and Construction (EPC) Companies.
- Governmental and Regulatory Bodies overseeing energy infrastructure.

## Target Organizations Departments:

- Engineering and Design Departments.
- Protection, Automation, and Control Departments.
- Substation Operations and Maintenance Teams.
- Asset Management and Planning Divisions.
- SCADA and Telecommunications Departments.
- Information Technology (IT) and Operational Technology (OT) Security Teams.
- Grid Modernization and Smart Grid Project Teams.
- Technical Training and Development Departments.

## Course Offerings:

By the end of this course, the participants will have able to:

- Analyze the fundamental architecture of a digital substation and its advantages over conventional designs.
- Interpret the structure and data models of the IEC 61850 standard.
- Differentiate between the roles of the Station Bus and the Process Bus.
- Configure GOOSE messaging for high-speed peer-to-peer communication.
- Implement Sampled Measured Values (SMV) for digital instrument transformer integration.
- Develop and manage Substation Configuration Language (SCL) files for system engineering.
- Evaluate testing and commissioning strategies for IEC 61850-based systems.
- Identify cybersecurity vulnerabilities within digital substations and apply mitigation techniques.
- Plan the migration from a conventional to a digital substation environment.
- Assess the impact of digital substations on overall grid reliability and performance.

## Course Methodology:

The training methodology at BIG BEN Training Center is designed to be immersive, practical, and highly interactive, ensuring that participants not only learn the theory but can also apply it confidently. Our approach moves beyond traditional lectures to foster a dynamic learning environment. The course is built upon a foundation of expert-led presentations that break down complex topics like IEC 61850 data modeling and SCL engineering into understandable segments. These sessions are heavily supplemented with real-world case studies, showcasing successful digital substation implementations as well as lessons learned from challenging projects. A significant portion of the training is dedicated to collaborative group exercises and workshops where participants will work together to solve design, configuration, and troubleshooting problems. This teamwork fosters peer-to-peer learning and a deeper understanding of the material. Interactive Q&A sessions are encouraged throughout the course to address specific challenges and queries from participants. We utilize simulation concepts and practical examples to demonstrate the flow of GOOSE and SMV messages, providing a virtual hands-on experience. This blended approach ensures that attendees leave with both the strategic knowledge and the practical skills required to excel in the field of digital substation automation.

## Course Agenda (Course Units):

### Unit One: Introduction to Digital Substations and IEC 61850

- Fundamentals of Substation Automation (SA).
- Comparing Conventional and Digital Substation Architectures.
- Key benefits of Digital Substations: Safety, Cost, and Footprint.
- An Overview of the IEC 61850 Standard Series.
- The Philosophy and Core Principles of IEC 61850.
- Understanding the Station Bus and Process Bus Concepts.
- Introduction to Intelligent Electronic Devices (IEDs).

### Unit Two: IEC 61850 Data Modeling and Communication

- The Object-Oriented Data Model of IEC 61850.
- Logical Nodes, Data Objects, and Data Attributes.
- Common Data Classes (CDCs) and their functions.
- Abstract Communication Service Interface (ACSI).
- Specific Communication Service Mapping (SCSM).
- Manufacturing Message Specification (MMS) for vertical communication.
- Client-Server interactions and reporting schemes.

### Unit Three: Real-Time Communication with GOOSE and SMV

- Generic Object-Oriented Substation Events (GOOSE).
- Principles of GOOSE messaging for protection and interlocking.
- Configuring GOOSE datasets, control blocks, and timing parameters.
- Understanding Sampled Measured Values (SMV).
- The role of Merging Units (MUs) and Process Bus.
- IEC 61850-9-2 LE protocol for digital instrument transformers.
- Time synchronization principles using PTP (IEEE 1588).

## Unit Four: Engineering and Configuration with SCL

- The Substation Configuration Language (SCL) framework.
- System Specification Description (SSD) files.
- IED Capability Description (ICD) files.
- Substation Configuration Description (SCD) files.
- Instantiated IED Description (IID) and Configured IED Description (CID) files.
- The top-down vs. bottom-up engineering workflow.
- Using System Configuration Tools for project integration.

## Unit Five: Testing, Cybersecurity, and Future Trends

- Testing and Commissioning Methodologies for Digital Substations.
- Factory Acceptance Testing (FAT) and Site Acceptance Testing (SAT).
- Introduction to IEC 62351 for Substation Cybersecurity.
- Identifying and mitigating cyber risks in IEC 61850 networks.
- Network architecture considerations for security and redundancy (PRP/HSR).
- The role of Digital Twins in substation lifecycle management.
- Future outlook: IEC 61850 in DER integration and wide-area monitoring.

# FAQ:

### Qualifications required for registering to this course?

There are no requirements.

### How long is each daily session, and what is the total number of training hours for the course?

This training course spans five days, with daily sessions ranging between 4 to 5 hours, including breaks and interactive activities, bringing the total duration to 20 - 25 training hours.

## Something to think about:

As digital substations become more interconnected with enterprise IT systems, how can we effectively bridge the cultural and technical gap between OT and IT teams to ensure holistic cybersecurity?

## What unique qualities does this course offer compared to other courses?

This course distinguishes itself by offering a holistic, lifecycle-oriented perspective on digital substations, rather than focusing narrowly on the IEC 61850 protocol alone. While other programs may cover the technical syntax of the standard, our curriculum emphasizes the practical application within the entire engineering workflow, from initial system specification using SCL to final commissioning and cybersecurity hardening. We place a strong emphasis on the "why" behind the technology, exploring the strategic business drivers and operational benefits that justify the transition to digital. The content is structured to build a bridge between the worlds of protection engineering, automation, and networking, acknowledging that a successful digital substation project requires a multidisciplinary skillset. Furthermore, the course directly addresses the most pressing real-world challenges, including interoperability issues between different vendor IEDs, effective testing strategies in a digital environment, and the critical importance of cybersecurity as defined by standards like IEC 62351. Participants will gain not just technical proficiency but a strategic framework for planning, executing, and maintaining secure and efficient digital substation assets, making this a uniquely comprehensive and forward-looking educational experience.