Training Course on High Voltage DC (HVDC) Transmission Systems

Professional Development Training Course Outline

Category	Engineering	**Duration**	10 Days
Base Fee	$3,000 USD	**Delivery Mode**	Online / On-site Hybrid

Course Introduction

Introduction

High Voltage Direct Current (HVDC) transmission is revolutionizing the way power is delivered over long distances and across borders. As the demand for renewable integration, grid interconnection, and energy efficiency grows, HVDC systems offer unmatched benefits in bulk power transmission, lower losses, and voltage control. Training Course on High Voltage DC (HVDC) Transmission Systems explores the core principles, technologies, control mechanisms, and applications of HVDC—from classic line-commutated converters (LCC) to next-generation voltage-source converters (VSC).

Participants will gain a deep understanding of converter station design, system modeling, power electronics, and dynamic control strategies essential for planning, operating, and maintaining HVDC systems. Emphasis is placed on real-world case studies, hands-on simulations, and the role of HVDC in supporting smart grid development, offshore wind farms, and cross-border power trading. Through this course, energy professionals will be equipped to lead projects in grid modernization, resilience, and global energy connectivity.

Programme Curriculum

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Course Objectives

- Understand the fundamentals of HVDC systems and their advantages
- Differentiate between LCC and VSC technologies
- Design HVDC converter stations and components
- Analyze control and protection schemes in HVDC systems
- Model HVDC links using simulation tools (e.g., PSCAD, MATLAB)
- Evaluate the role of HVDC in renewable energy integration
- Understand hybrid AC/DC grid architectures
- Identify harmonics, filtering, and mitigation techniques
- Assess transient and dynamic stability impacts of HVDC
- Explore offshore HVDC applications (e.g., wind power)
- Study real-world HVDC projects and challenges
- Gain insights into maintenance and asset management of HVDC systems
- Understand environmental and economic considerations of HVDC deployment.

Organizational Benefits

- Access to specialized HVDC technical skills
- Enhanced planning and execution of HVDC projects
- Improved grid reliability through advanced control systems
- Efficient long-distance power transmission capabilities
- Reduced transmission losses and improved voltage stability
- Better integration of renewables and offshore resources
- Competitive advantage in cross-border energy markets
- Reduction in environmental and right-of-way impacts
- Risk mitigation through trained personnel in protection and fault analysis
- Strengthened engineering capacity for utility and infrastructure projects.

Target Participants

- Power system engineers and planners
- Transmission and distribution (T&D) professionals
- Electrical utility managers

Renewable energy developers

Substation and protection engineers

Energy project consultants

Power electronics specialists

Grid modernization and smart grid team

Course Outline

Module 1: Introduction to HVDC Technology

1. History and evolution of HVDC
2. AC vs. DC transmission: Key differences
3. Applications and use cases of HVDC
4. Types of HVDC systems (monopole, bipole, back-to-back)
5. Case Study: Itaipu HVDC System – Brazil-Paraguay

Module 2: Components of HVDC Systems

1. Converter stations
2. Converter transformers
3. Smoothing reactors and filters
4. Grounding electrodes
5. Case Study: ABB's Ultranet HVDC Technology

Module 3: Line Commutated Converters (LCC)

1. Operation principles
2. 6-pulse vs. 12-pulse converters
3. Commutation failure analysis
4. Harmonics and filtering
5. Case Study: China’s Xiangjiaba–Shanghai ±800 kV Project

Module 4: Voltage Source Converters (VSC)

1. Modular Multilevel Converter (MMC) architecture
2. Benefits of VSC over LCC
3. Pulse Width Modulation (PWM)
4. VSC for offshore wind integration
5. Case Study: BorWin1 Offshore Wind HVDC

Module 5: HVDC Control and Protection

1. Current and voltage control modes
2. Fault detection and clearing strategies
3. DC circuit breakers
4. Hierarchical control architecture
5. Case Study: Control Scheme of INELFE France-Spain HVDC

Module 6: Modeling and Simulation of HVDC Systems

1. Using PSCAD for HVDC simulation
2. MATLAB/Simulink modeling
3. Dynamic vs. steady-state analysis
4. System behavior under faults
5. Case Study: Simulation of Bipolar HVDC in PSCAD

Module 7: Integration of Renewables with HVDC

1. Offshore wind HVDC systems
2. Grid code compliance for HVDC-connected renewables
3. Power flow and voltage control

4. Inertia and frequency stability considerations
5. Case Study: DolWin1 Integration in the North Sea

Module 8: HVDC in Smart Grids and Supergrids

1. Role in future energy systems
2. AC/DC hybrid grids
3. HVDC hubs and interconnectors
4. Market-based dispatch and control
5. Case Study: EuroAsia Interconnector

Module 9: Harmonics and Filtering

1. Harmonic generation in HVDC converters
2. Passive vs. active filters
3. Design of harmonic filters
4. Impact on nearby AC systems
5. Case Study: Harmonic Mitigation at Hokkaido–Honshu Link

Module 10: Thermal and Electrical Design Considerations

1. HVDC cable types (overhead, submarine)
2. Insulation coordination
3. Heat dissipation in power electronics
4. Electrical stress and aging
5. Case Study: Submarine HVDC Cable Failures and Lessons

Module 11: Environmental and Economic Aspects

1. Environmental impact assessments
2. Right-of-way and land use
3. Cost-benefit analysis of HVDC vs AC
4. Carbon footprint and energy savings
5. Case Study: Sustainability of NordLink HVDC Project

Module 12: Asset Management and Maintenance

1. Condition monitoring systems
2. Predictive and preventive maintenance
3. Spare parts and diagnostics
4. Lifecycle management of HVDC assets
5. Case Study: Maintenance Practices of Cahora Bassa HVDC

Module 13: HVDC Commissioning and Testing

1. Pre-commissioning activities
2. Functional and performance testing
3. Interface testing with AC grid
4. Dynamic commissioning trials
5. Case Study: Testing Protocols in INELFE HVDC

Module 14: Protection and Grounding in HVDC Systems

1. Grounding electrode design
2. Protection coordination
3. Overvoltage protection
4. Fault ride-through mechanisms

5.Upcoming Scheduled Sessions

Start Date	End Date	Location	Price
23 Nov 2026	04 Dec 2026	Online	$2,000
23 Nov 2026	04 Dec 2026	Physical	$3,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$9,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$12,000

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