Training Course on Energy Storage Systems in Design and Grid Integration

Professional Development Training Course Outline

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

Course Introduction

Introduction

The rapid growth of renewable energy integration, smart grid technologies, and electric mobility has elevated the importance of Energy Storage Systems (ESS) in modern power systems. Training Course on Energy Storage Systems in Design and Grid Integration equips participants with the technical knowledge and practical tools to design, develop, and integrate a variety of energy storage technologies, including battery energy storage systems (BESS), thermal storage, flywheels, and hydrogen-based storage. The program emphasizes critical topics such as grid-scale energy storage, hybrid systems, and advanced control strategies, ensuring stable, reliable, and sustainable power delivery.

Through real-world case studies and global best practices, this course explores the application of ESS in frequency regulation, voltage support, load shifting, renewable firming, and black start capabilities. Participants will also learn how to evaluate system sizing, battery chemistries (e.g., Li-ion, flow batteries), lifecycle management, power electronics interfacing, and the impact of energy storage on decarbonization, resilience, and grid optimization. Ideal for energy engineers, utility planners, and project developers, this course offers a future-proof skillset aligned with emerging grid demands.

Programme Curriculum

Training Course on Energy Storage Systems in Design and Grid Integration

Introduction

As the global energy transition accelerates in 2026, the shift from "baseload" thinking to "flexibility" has made Energy Storage Systems (ESS) the backbone of the modern grid. With the increasing penetration of intermittent renewables like solar and wind, the challenge is no longer just generation, but the intelligent time-shifting of energy. This course provides a deep technical dive into Battery Energy Storage Systems (BESS), Long-Duration Energy Storage (LDES), and the engineering required for seamless grid integration. We move beyond simple storage to explore ancillary services, frequency regulation, and the deployment of Virtual Power Plants (VPP) in high-volatility environments.

Designing the grid requires a holistic understanding of thermal management, fire safety standards (NFPA 855), and power electronics optimization. This training bridges the gap between electrochemical potential and utility-scale application, focusing on the Levelized Cost of Storage (LCOS) and the transition toward solid-state and flow battery technologies. Whether you are a grid operator, a renewable developer, or an electrical engineer, this course equips you with the predictive modeling and control strategies necessary to stabilize the "grid of the future" while maximizing ROI through revenue stacking.

Course Objectives

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

1. Master ESS Sizing & Design: Optimize power-to-energy ratios for specific utility and C&I (Commercial & Industrial) applications.

2. Navigate Grid Interconnection: Streamline the technical process of connecting large-scale BESS to HV/MV substations.

3. Optimize Frequency & Voltage Regulation: Implement sub-second response strategies to maintain grid stability.

4. Analyze LCOS & Economic Viability: Use the Levelized Cost of Storage formula to evaluate project bankability.

5. Engineer Fire Safety & Thermal Systems: Apply 2026 global safety protocols to prevent thermal runaway and ensure site longevity.

6. Integrate Virtual Power Plants (VPPs): Leverage AI-driven dispatch to aggregate distributed energy resources (DERs).

7. Evaluate Long-Duration Storage (LDES): Explore pumped hydro, compressed air, and flow battery alternatives to Lithium-ion.

8. Understand Power Electronics: Master Bi-directional Inverter (PCS) functionality and grid-forming capabilities.

9. Implement Circular Economy Principles: Develop second-life battery strategies and end-of-life recycling frameworks.

10. Execute Black-Start Procedures: Design storage systems capable of restoring grid power during total system failures.

Course Modules

Module 1: The ESS Landscape & Technology Roadmap

- Classification of storage: Mechanical, Electrochemical, Thermal, and Chemical.
- The 2026 Lithium-ion market: LFP vs. NMC and the rise of **Sodium-ion**.
- Long-Duration Energy Storage (LDES) for multi-day resilience.
- Grid-scale vs. Distributed (Behind-the-Meter) storage trends.
- **Case Study:** The **Sere Wind Farm BESS** integration in South Africa—lessons in stabilizing variable wind.

Module 2: ESS Sizing & Engineering Design

- Defining requirements: Peak shaving, load leveling, and energy arbitrage.
- The relationship between **Depth of Discharge (DoD)** and cycle life.
- Calculating energy density and footprint requirements.
- Auxiliary power requirements (HVAC, lighting, and control systems).
- **Case Study:** Designing a hybrid storage system for a **mining operation in the DRC**.

Module 3: Electrochemical Performance & BMS

- **Battery Management System (BMS)** architecture: Monitoring SoC, SoH, and SoP.
- Cell balancing techniques and thermal monitoring.
- The chemistry of degradation: Calendar vs. Cycle aging.
- Advanced sensors for early gas detection and failure prevention.
- **Case Study:** Managing battery health in high-temperature environments for **Egyptian solar-plus-storage** parks.

Module 4: Power Electronics & Grid-Forming Inverters

- The role of the **Power Conversion System (PCS)** in AC/DC bi-directional flow.
- **Grid-following vs. Grid-forming** inverters for weak-grid stability.
- Managing Total Harmonic Distortion (THD) and reactive power support.
- Fast Frequency Response (FFR) and Synthetic Inertia.
- **Case Study:** Utilizing grid-forming inverters to stabilize the **mini-grids in rural Nigeria**.

Module 5: Grid Integration & Interconnection Standards

- Impact of ESS on short-circuit levels and protection coordination.
- Navigating the **IEEE 1547** and **IEC 62933** international standards.
- Step-up transformers and substation protection for BESS.
- Communication protocols: **Modbus, DNP3, and IEC 61850**.
- **Case Study:** Grid integration challenges of the **Kenyan Geothermal-BESS hybrid** pilot.

Module 6: Economic Modeling & Revenue Stacking

- Calculating the Levelized Cost of Storage ($LCOS$):
- Revenue Stacking: Combining arbitrage, FCR, and capacity market payments.
- Modeling CAPEX vs. Operational lifespan (Repowering strategies).
- Carbon credits and green financing for storage projects.
- **Case Study:** The commercial viability of **Zambia’s "Scaling Solar"** storage components under current PPA structures.

Module 7: Thermal Management & Fire Safety

- Active vs. Passive cooling: Liquid-cooled vs. Air-cooled systems.

- Mitigating **Thermal Runaway**: Propagation prevention and ventilation.
- Compliance with **NFPA 855** and **UL 9540A** fire testing standards.
- Fire suppression agents: Water-based vs. Clean agent systems.
- **Case Study:** Safety audit and fire suppression design for an urban BESS in **Nairobi's Business District**.

Module 8: Virtual Power Plants (VPP) & DERMS

- Aggregating distributed storage for grid-level participation.
- The role of **Cloud-based Control Systems** and IoT.
- Forecasting demand and supply using Machine Learning.
- Blockchain for peer-to-peer (P2P) energy trading via storage.
- **Case Study:** The **South African "VPP Pilot"**—aggregating residential solar batteries to mitigate load shedding.

Module 9: Long-Duration & Emerging Technologies

- **Flow Batteries (Vanadium, Zinc-Bromine):** Scalability for 8-24 hour storage.
- Green Hydrogen: Electrolyzers and fuel cells as seasonal storage.
- Gravity-based and Compressed Air Energy Storage (CAES).
- Mechanical flywheels for high-power, short-duration needs.
- **Case Study:** Exploring **Pumped Hydro Storage** expansion in the **Maghreb region** for seasonal balancing.

Module 10: Environmental Impact & Second-Life

- The "Cradle-to-Grave" lifecycle of battery minerals (Lithium, Cobalt).
- Repurposing EV batteries for stationary grid storage.
- Regulatory frameworks for battery recycling and hazardous waste.
- Environmental Social Governance (ESG) in the storage supply chain.
- **Case Study:** The **"Second-Life Africa" initiative**—converting old bus batteries into rural clinic power backups.

Training Methodology

· Instructor-led interactive lectures

· Hands-on exercises in program design and delivery

· Case studies and scenario-based simulations

· Group discussions and peer learning

· Role-playing exercises in outreach and communication

· Access to templates, outreach materials, and evaluation tools

Certification

Upon successful completion of this training, participants will be issued with a globally- recognized certificate.

Tailor-Made Course

We also offer tailor-made courses based on your needs.

Key Notes

a. The participant must be conversant with English.

b. Upon completion of training the participant will be issued with an Authorized Training Certificate

c. Course duration is flexible and the contents can be modified to fit any number of days.

d. The course fee includes facilitation training materials, 2 coffee breaks, buffet lunch and A Certificate upon successful completion of Training.

e. One-year post-training support Consultation and Coaching provided after the course.

f. Payment should be done at least a week before commence of the training, to Fineskill Training Center account, as indicated in the invoice so as to enable us prepare better for you.

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

Ready to enroll or request a customized program? Book online or contact us:

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