Advanced Energy Storage Modeling in Renewable Energy Training Course

Professional Development Training Course Outline

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

Course Introduction

Advanced Energy Storage Modeling in Renewable Energy Training Course is designed to develop advanced expertise in battery energy storage systems (BESS), renewable energy integration, smart grid optimization, energy management systems (EMS), digital twin modeling, and predictive analytics. With the rapid growth of solar PV, wind energy, electric mobility, and distributed energy resources, professionals need advanced modeling capabilities to design efficient, reliable, and economically viable energy storage solutions. This course provides practical knowledge of battery modeling, electrochemical simulation, state-of-charge (SOC) estimation, state-of-health (SOH) prediction, degradation analysis, and AI-driven energy optimization.

The program combines advanced simulation tools, real-world case studies, data-driven modeling techniques, and renewable energy applications to prepare engineers, researchers, and energy professionals for the evolving clean energy transition. Participants will gain expertise in hybrid renewable energy systems, grid-scale storage design, lithium-ion battery technologies, flow batteries, energy forecasting, microgrid modeling, and sustainable energy management. Through hands-on learning and industry scenarios, this course builds the technical capability required to accelerate net-zero energy systems, renewable integration, and future-ready energy infrastructure.

Programme Curriculum

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Course Objectives

1. Develop advanced skills in energy storage system modeling and simulation for renewable energy applications.
2. Understand battery technologies, electrochemical behavior, and performance optimization strategies.
3. Master Battery Management System (BMS) modeling, SOC estimation, and SOH monitoring techniques.
4. Apply AI, machine learning, and predictive analytics for energy storage forecasting.
5. Design optimized Battery Energy Storage Systems (BESS) for solar, wind, and hybrid renewable projects.
6. Analyze battery degradation mechanisms and lifecycle performance improvement methods.
7. Learn advanced digital twin technologies for energy storage monitoring and optimization.
8. Develop expertise in microgrid energy storage modeling and smart grid integration.
9. Evaluate grid stability, frequency regulation, and renewable energy balancing solutions.
10. Apply simulation approaches for large-scale energy storage project development.
11. Understand energy economics, techno-economic analysis, and storage investment modeling.
12. Explore emerging technologies including solid-state batteries, hydrogen storage, and next-generation storage systems.
13. Build practical capabilities for implementing net-zero, resilient, and sustainable energy solutions.

Target Audience

1. Renewable Energy Engineers
2. Electrical and Power System Engineers
3. Battery Technology Specialists
4. Energy Storage System Designers
5. Solar and Wind Energy Professionals
6. Smart Grid Engineers
7. Research Scientists and Academics
8. Sustainability and Energy Consultants

Course Modules

Module 1: Fundamentals of Advanced Energy Storage Systems

- Overview of modern energy storage technologies and renewable integration.
- Classification of electrochemical, mechanical, thermal, and chemical storage systems.
- Energy storage role in grid modernization and decarbonization.
- Key performance parameters: capacity, efficiency, power density, and lifecycle.
- Introduction to advanced storage modeling frameworks.
- **Case Study:** Utility-scale lithium-ion battery deployment for renewable energy balancing.

Module 2: Battery Technologies and Advanced Performance Modeling

- Lithium-ion battery chemistry and operational characteristics.
- Modeling battery charging and discharging behavior.
- Battery equivalent circuit models and electrochemical models.
- Thermal behavior and temperature impact analysis.
- Performance optimization techniques.
- **Case Study:** Tesla Megapack battery optimization for renewable energy storage.

Module 3: Battery Management System (BMS) Modeling

- Architecture and functions of advanced BMS.
- SOC and SOH estimation algorithms.
- Battery protection and safety modeling.
- Real-time monitoring and diagnostics.
- Intelligent BMS using AI technologies.
- **Case Study:** EV battery management systems improving battery lifespan.

Module 4: State-of-Charge (SOC) and State-of-Health (SOH) Estimation

- Advanced SOC estimation methods.
- Kalman filtering and adaptive algorithms.
- Machine learning-based battery health prediction.
- Battery aging analysis.
- Reliability improvement strategies.
- **Case Study:** AI-based battery health monitoring in electric vehicle fleets.

Module 5: Battery Degradation and Lifecycle Modeling

- Battery aging mechanisms.
- Capacity fade and performance loss analysis.
- Cycle life prediction models.
- Degradation-aware energy management.
- Long-term storage reliability assessment.
- **Case Study:** Grid-scale storage lifecycle optimization projects.

Module 6: Renewable Energy Integration with Energy Storage

- Solar PV and wind energy storage modeling.
- Renewable intermittency management.
- Hybrid renewable energy systems.
- Energy smoothing and peak shaving strategies.
- Grid-connected storage applications.
- **Case Study:** Solar-plus-storage projects improving renewable reliability.

Module 7: Microgrid Energy Storage Modeling

- Microgrid architecture and operational strategies.
- Distributed energy resource integration.
- Islanding and resilience modeling.
- Energy dispatch optimization.
- Microgrid control strategies.
- **Case Study:** Remote community microgrid powered by renewable energy storage.

Module 8: Smart Grid and Grid-Scale Storage Applications

- Grid frequency regulation modeling.
- Demand response and load balancing.
- Ancillary service applications.
- Grid stability enhancement.
- Utility-scale storage planning.
- **Case Study:** Large battery storage systems supporting grid reliability.

Module 9: Digital Twin Modeling for Energy Storage Systems

- Digital twin concepts and applications.
- Real-time battery system monitoring.
- Predictive maintenance modeling.
- Data-driven storage optimization.
- Virtual testing environments.
- **Case Study:** Digital twin implementation for industrial energy assets.

Module 10: Artificial Intelligence and Machine Learning in Storage Modeling

- AI-based battery prediction models.
- Machine learning algorithms for energy forecasting.
- Deep learning applications.
- Predictive maintenance techniques.
- Automated energy optimization.
- **Case Study:** AI forecasting models improving renewable energy dispatch.

Module 11: Energy Storage Simulation Tools and Software

- Introduction to energy modeling platforms.
- Battery simulation workflows.
- Renewable energy system modeling.
- Data analysis and visualization techniques.
- Simulation validation methods.
- **Case Study:** Simulation-based design of hybrid renewable storage systems.

Module 12: Hybrid Energy Storage Systems

- Combining batteries with supercapacitors and hydrogen storage.
- Hybrid storage architecture design.
- Power and energy optimization.
- Control strategy development.
- Performance evaluation.

- **Case Study:** Hybrid storage solutions for renewable microgrids.

Module 13: Hydrogen Energy Storage Modeling

- Green hydrogen production and storage concepts.
- Electrolyzer modeling.
- Hydrogen fuel cell integration.
- Long-duration storage analysis.
- Renewable hydrogen applications.
- **Case Study:** Green hydrogen projects supporting energy transition.

Module 14: Techno-Economic Analysis of Energy Storage Projects

- Storage cost modeling.
- Levelized cost of storage (LCOS).
- Investment analysis.
- Revenue modeling for storage systems.
- Financial optimization strategies.
- **Case Study:** Economic assessment of utility-scale battery storage deployment.

Module 15: Future Trends in Advanced Energy Storage

- Solid-state battery technologies.
- Next-generation battery chemistry.
- AI-powered autonomous energy systems.
- Sustainable battery recycling.
- Future renewable energy storage strategies.
- **Case Study:** Emerging solid-state battery developments for future mobility and grid applications.

Training Methodology

- Interactive lectures and presentations.
- Group discussions and brainstorming sessions.
- Hands-on exercises using real-world datasets.
- Role-playing and scenario-based simulations.
- Analysis of case studies to bridge theory and practice.
- Peer-to-peer learning and networking.
- Expert-led Q&A sessions.
- Continuous feedback and personalized guidance.

Register as a group from 3 participants for a Discount

Send us an email: info@fineskilltrainingcenter.org or call *+254769199797*

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

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