Flow Battery Technologies Training Course

Professional Development Training Course Outline

Category	Renewable Energy	**Duration**	5 Days
Base Fee	$1,500 USD	**Delivery Mode**	Online / On-site Hybrid

Course Introduction

Flow Battery Technologies Training Course provides a practical and future-focused understanding of redox flow batteries (RFBs), long-duration energy storage (LDES), grid-scale energy storage, and the evolving global energy transition. As renewable power generation from solar PV and wind expands, the ability to store electricity reliably for extended periods is becoming critical for grid flexibility, energy resilience, renewable integration, peak shaving, load shifting, microgrids, and energy security. This course examines the science, engineering, design, operation, economics, and commercialization of flow batteries, with particular attention to vanadium redox flow batteries (VRFBs), zinc-bromine flow batteries, iron-based flow batteries, and emerging organic and hybrid flow battery technologies. Participants will explore how scalable energy storage can address intermittency, congestion, frequency regulation, capacity adequacy, and decarbonization challenges across utility, industrial, commercial, and renewable-energy applications.

Through hands-on learning, technical case studies, system-design exercises, technology comparisons, and real-world project analysis, participants develop the skills needed to evaluate and deploy flow battery systems. The program connects electrochemical fundamentals with practical topics such as stack architecture, membranes, electrolytes, pumps, power conversion systems (PCS), battery management systems (BMS), energy management systems (EMS), safety, degradation, lifecycle performance, levelized cost of storage (LCOS), bankability, project finance, and techno-economic analysis. Participants will also examine current market trends including long-duration energy storage, renewable firming, grid modernization, energy-as-a-service, hybrid renewable-storage systems, digital energy management, and net-zero strategies. By the end of the course, learners will be equipped to make informed technology-selection, design, procurement, operational, and investment decisions involving next-generation flow battery energy storage systems.

Programme Curriculum

Flow Battery Technologies Training Course

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Course Objectives

1. Understand the fundamentals, chemistry, architecture, and operating principles of flow battery technologies.
2. Compare VRFB, zinc-bromine, iron, organic, and hybrid flow batteries for different applications.
3. Analyze electrolyte chemistry, ion transport, membranes, electrodes, stacks, and cell performance.
4. Evaluate energy density, power density, round-trip efficiency, response time, degradation, and cycle life.
5. Design preliminary grid-scale and long-duration energy storage (LDES) configurations.
6. Assess flow batteries for renewable integration, solar-plus-storage, wind firming, and microgrid applications.
7. Apply battery management systems (BMS), energy management systems (EMS), monitoring, controls, and digitalization concepts.
8. Identify thermal management, electrolyte management, operational, fire, chemical, and electrical safety requirements.
9. Perform techno-economic analysis, LCOS evaluation, lifecycle costing, and total cost of ownership (TCO) assessments.
10. Evaluate degradation, reliability, maintainability, availability, and lifecycle performance.
11. Develop strategies for peak shaving, load shifting, frequency regulation, capacity support, and grid resilience.
12. Examine commercialization, supply chains, bankability, project development, procurement, and market opportunities.

13. Apply knowledge through real-world case studies, system-design challenges, and energy-storage project assessments.

Target Audience

1. Energy storage engineers and battery technology specialists.
2. Renewable energy engineers working with solar, wind, and hybrid systems.
3. Electrical, chemical, mechanical, and process engineers.
4. Utility, grid, and transmission/distribution professionals.
5. Energy project developers, EPC contractors, and system integrators.
6. Energy consultants, analysts, investors, and technical due-diligence teams.
7. Operations, maintenance, asset-management, and energy-management professionals.
8. Researchers, academics, policymakers, and clean-energy entrepreneurs.

Course Modules

Module 1: Flow Battery Fundamentals and Energy Storage Landscape

- Evolution of electrochemical energy storage and the role of flow batteries in the energy transition.
- Core principles of redox reactions, electrochemical cells, electrolytes, and ion exchange.
- Key differences between flow batteries, lithium-ion batteries, pumped hydro, compressed-air, and thermal storage.
- Understanding power versus energy scalability, duration, efficiency, and operational flexibility.
- Case Study: Selecting an energy-storage technology for a renewable-energy project requiring 8–12 hours of storage.

Module 2: Flow Battery Chemistry and Major Technologies

- Detailed study of vanadium redox flow batteries (VRFBs) and vanadium electrolyte chemistry.
- Zinc-bromine, iron-flow, organic, polysulfide, and hybrid flow battery technologies.
- Electrolyte composition, concentration, solubility, stability, and electrochemical performance.
- Technology trade-offs involving energy density, materials availability, efficiency, cost, and lifecycle.
- Case Study: Comparing VRFB versus zinc-bromine for a utility-scale renewable-storage application.

Module 3: Cell, Stack, and System Architecture

- Design principles of cells, membranes, electrodes, bipolar plates, flow frames, and stacks.
- Hydraulic architecture including pumps, pipes, valves, tanks, sensors, and electrolyte circulation.
- Stack scaling from laboratory cells to MW-scale energy-storage systems.
- Integration of power conversion systems (PCS), BMS, EMS, controls, and grid interfaces.
- Case Study: Conceptual design of a 10 MW / 80 MWh flow battery system for renewable-energy firming.

Module 4: Performance, Efficiency, Degradation, and Reliability

- Key performance indicators: round-trip efficiency, voltage efficiency, coulombic efficiency, power density, and energy density.
- Understanding capacity fade, electrolyte imbalance, crossover, membrane degradation, and electrode aging.
- Testing methodologies for cycle life, durability, efficiency, reliability, and availability.
- Predictive maintenance and condition monitoring for long-duration storage assets.
- Case Study: Diagnosing performance deterioration in a VRFB caused by electrolyte imbalance and membrane-related losses.

Module 5: Applications, Grid Integration, and Renewable Energy

- Flow batteries for solar-plus-storage, wind firming, microgrids, and renewable-energy integration.
- Applications in peak shaving, load shifting, frequency regulation, capacity support, and grid resilience.
- Integration with smart grids, distributed energy resources (DERs), and hybrid energy-storage systems.
- Designing storage duration according to grid needs, renewable profiles, demand curves, and market signals.
- Case Study: Using long-duration flow storage to reduce solar curtailment and improve evening peak supply.

Module 6: Safety, Operations, Maintenance, and Digital Energy Management

- Electrical, chemical, hydraulic, electrolyte, and operational safety considerations.
- Storage-tank management, leak detection, ventilation, containment, and emergency response.
- BMS, EMS, SCADA, IoT sensors, remote monitoring, analytics, and digital twins.
- Preventive and predictive operations and maintenance (O&M) strategies.
- Case Study: Developing an O&M and safety plan for a multi-megawatt flow battery installation.

Module 7: Economics, Project Development, and Commercialization

- CAPEX, OPEX, LCOS, TCO, revenue stacking, and lifecycle economics for flow batteries.
- Techno-economic comparison with lithium-ion and other long-duration energy-storage technologies.
- Procurement, vendor evaluation, EPC contracting, warranties, performance guarantees, and bankability.
- Business models including energy-as-a-service, capacity markets, ancillary services, and renewable-storage PPAs.
- Case Study: Performing a preliminary LCOS and investment assessment for a utility-scale flow battery project.

Module 8: Future Trends, Innovation, and Strategic Deployment

- Emerging organic flow batteries, iron-based chemistries, advanced membranes, and low-cost electrolytes.
- Innovation in materials science, manufacturing, automation, AI-enabled monitoring, and digital optimization.
- The role of flow batteries in net-zero strategies, grid modernization, energy security, and decarbonization.
- Future opportunities in LDES markets, renewable-heavy grids, industrial energy systems, and emerging economies.
- Case Study: Developing a strategic roadmap for deploying next-generation flow battery systems across a renewable-energy portfolio.

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
21 Sep 2026	25 Sep 2026	Online	$1,000
21 Sep 2026	25 Sep 2026	Physical	$1,500
21 Sep 2026	25 Sep 2026	Physical	$0
21 Sep 2026	25 Sep 2026	Physical	$0
21 Sep 2026	25 Sep 2026	Physical	$0
21 Sep 2026	25 Sep 2026	Physical	$0
21 Sep 2026	25 Sep 2026	Physical	$0
21 Sep 2026	25 Sep 2026	Physical	$0

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