U.S. DEPARTMENT of ENERGY | Federal Energy Management Program

Battery Energy Storage Systems: Considerations for Implementation

T02-S03, August 5th, 2025

FEMP Summer CAMP (Courses Aligned with Mission Priorities)

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Pacific Northwest National Laboratory

Agenda

1. What is a BESS?
2. Applications
    - Strategies for sizing a BESS
    - What drives capital cost
3. O&M
4. Example projects
5. Q&A

Session Learning Outcomes

1. Understand how battery energy storage systems can support diverse use cases as standalone systems or within microgrids.
2. Recognize how technical needs influence BESS capital cost and investment.
3. Recognize how O&M impacts vary by mission and location for BESS deployments.
4. Identify key technical and design strategies for properly sizing a BESS.

Alexandra Goodson

Global Product Marketing Manager

ABB

What is BESS?

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Battery Energy Storage Systems (BESS)

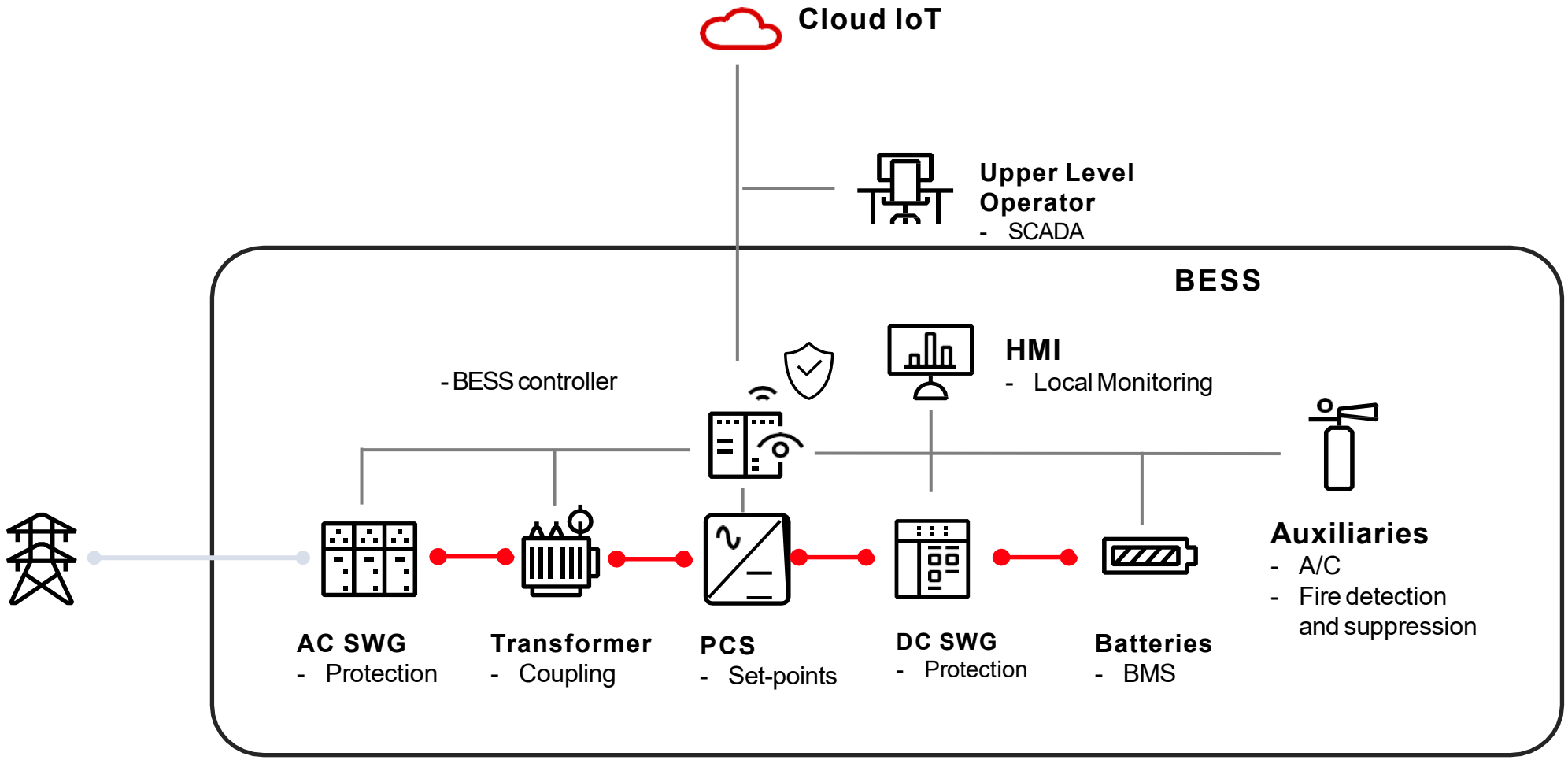
BESS Sample Picture

What are Battery Energy Storage Systems (BESS)?

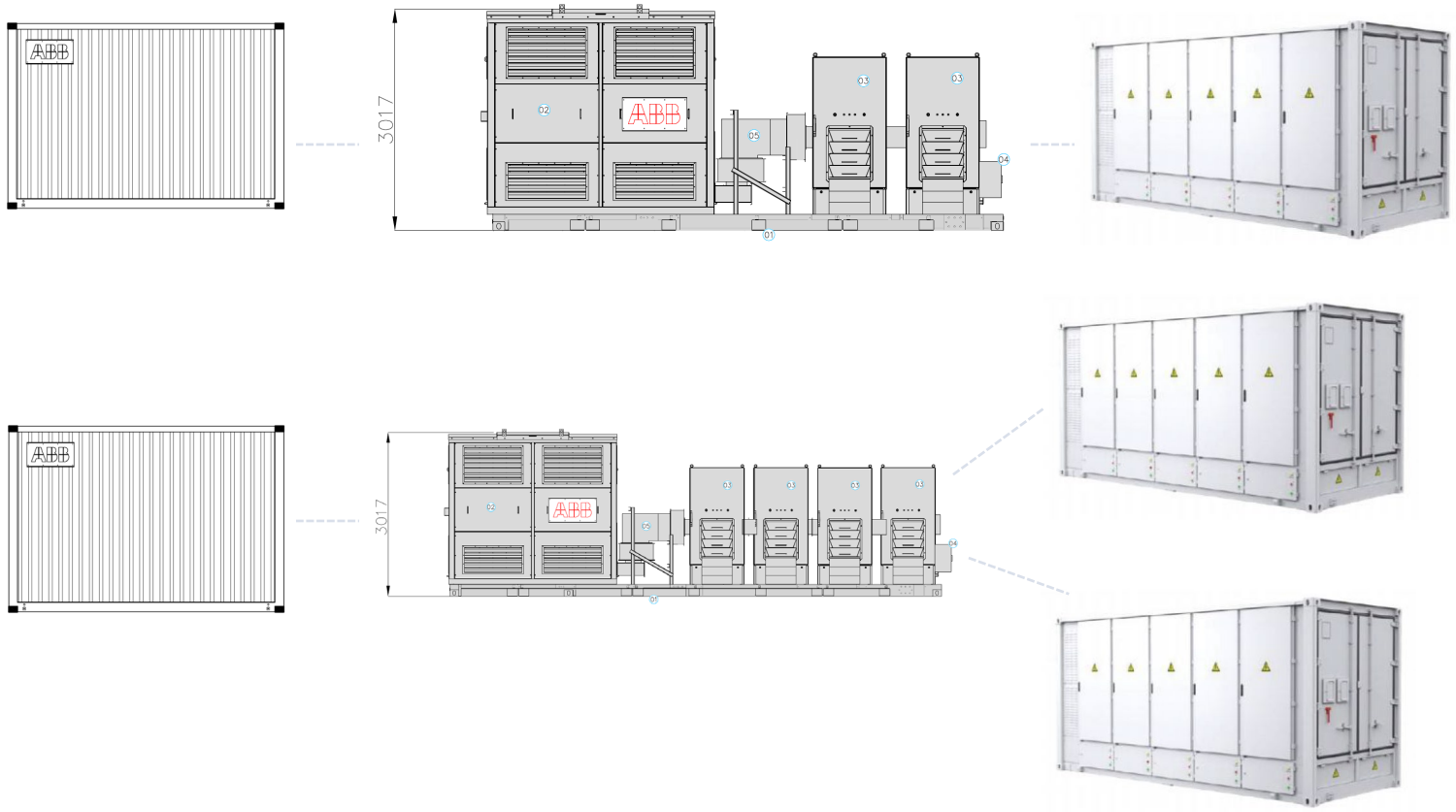
A Battery Energy Storage System (BESS), is the industry's generic reference name for a collection of equipment that comprise a system to store energy in batteries and use the energy later when it is advantageous.

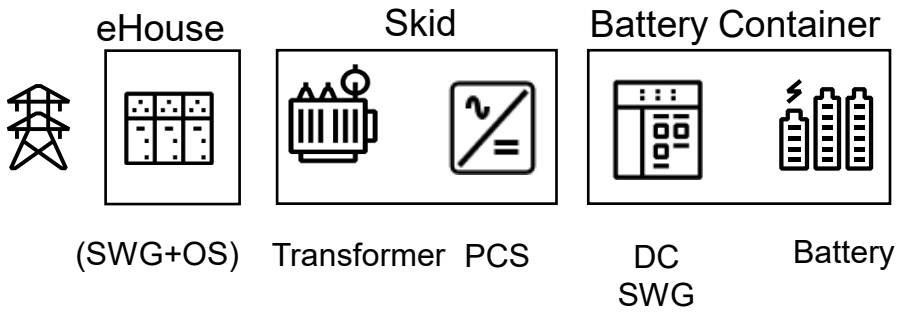
A typical system is comprised of batteries, a battery management system, an inverter, switchgear, transformer, protection and a control system.

Single Line Diagram



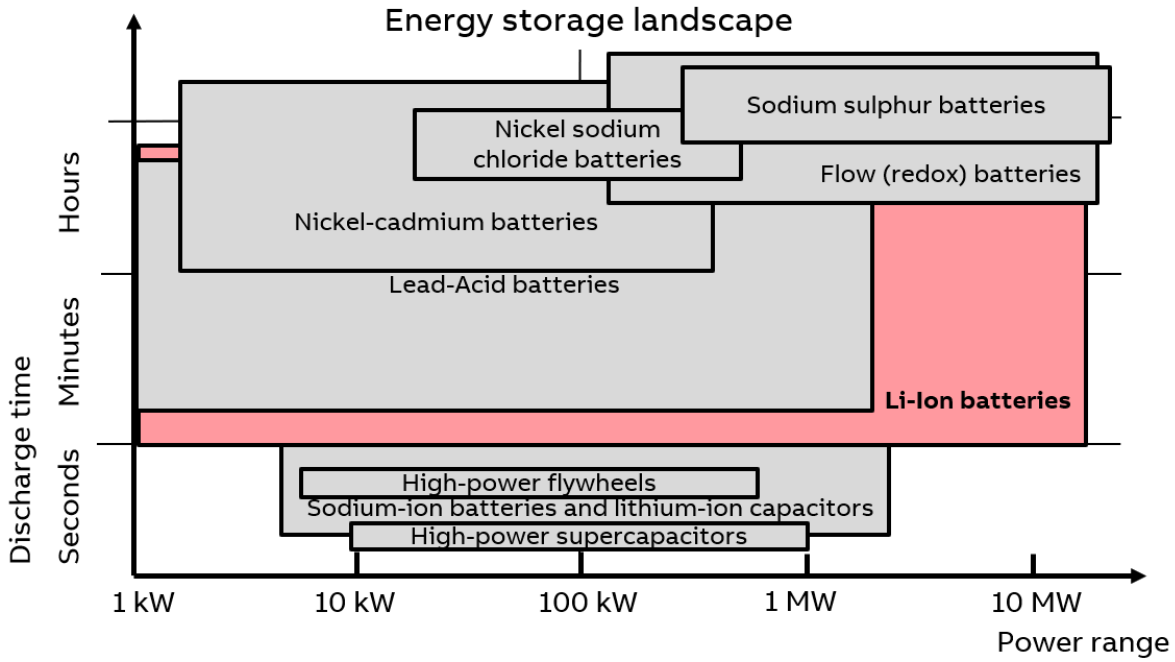
2.7 MW / 3.4 MWh vs 5.4 MW / 7.8 MWh





Types of Technologies Used for Energy Storage

Energy storage landscape



Lithium-Ion batteries main strengths

- One battery does not work for all applications.
- Lithium-ion is a very versatile product family with many various chemistries.
- Their benefits such as higher energy density and power efficiency, superior cycle-life, and longer calendar life make this technology one of the most interesting for various industries, in particular for Energy Storage Solutions.
- Main lithium-ion batteries used for BESS are the Lithium iron phosphate (LFP) and the Nickel Manganese Cobalt (NMC).

Applications

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Energy Storage Solutions

Value propositions

- Facilitate integration of renewables
- Leverage time of day generation pricing
- Support EV penetration with smart charging management and synchronization
- Increase distributed generation
- Provide back-up functionality to ensure power availability in case of grid outage
- Reduce dependency on diesel generators and CO2 emissions
- Generate revenue through participation in wholesale energy markets
- Optimize electricity consumption to reduce electricity bill
- Defer investment for grid upgrades
- Ensure reliable operation of the grid
- Provide power quality support

Energy Storage Solutions

Applications

- Energy shifting
- Peak shaving
- Frequency regulation, reserve and response
- Capacity firming
- Spinning reserve

May also be referred to as:

- Synchronized charging for e-mobility
- Renewable's integration
- Voltage control
- Islanding
- Black start
- Synthetic inertia dynamic response
- Forming a microgrid

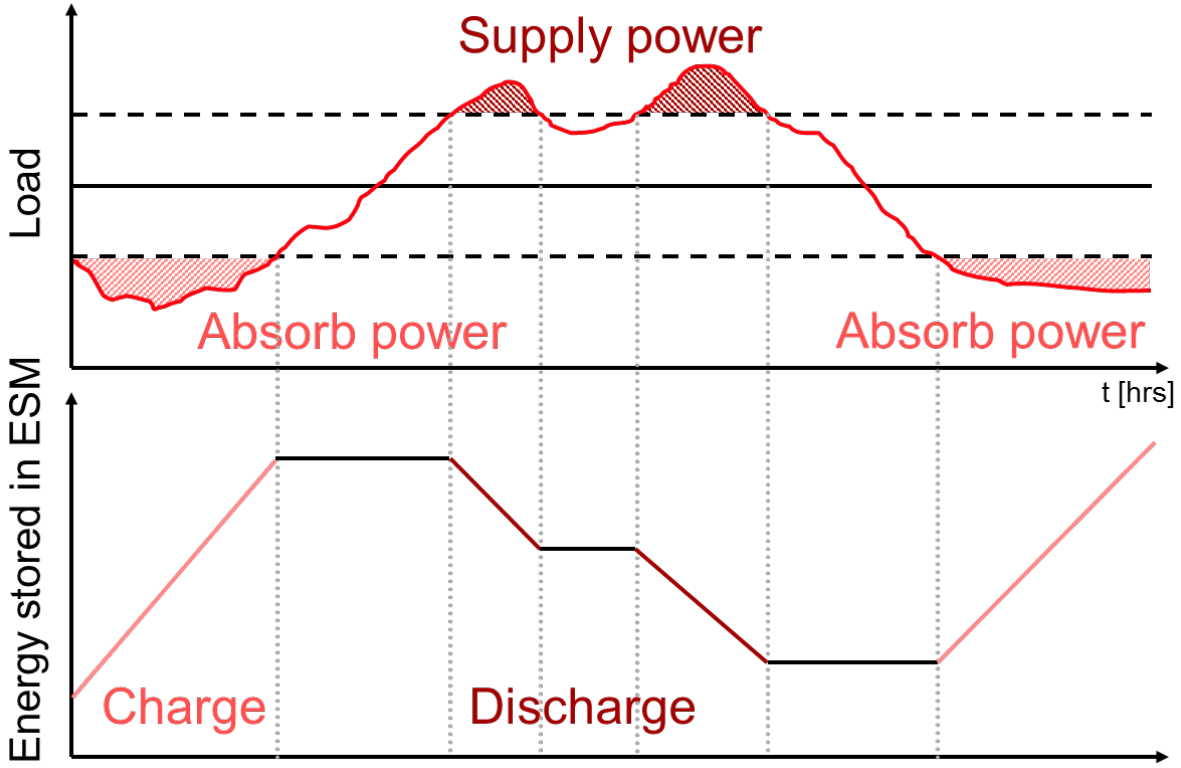
Energy Storage Solutions
Applications and Benefits

Energy shifting

Energy shifting involves storing electricity for use at a later, pre-specified time. Typically, these times are during periods of high demand on the grid. The stored energy is used to reduce the load on the grid while continuing to meet customer demands. In addition, energy shifting can be used to arbitrage electricity rates for C&I customers.

Benefits

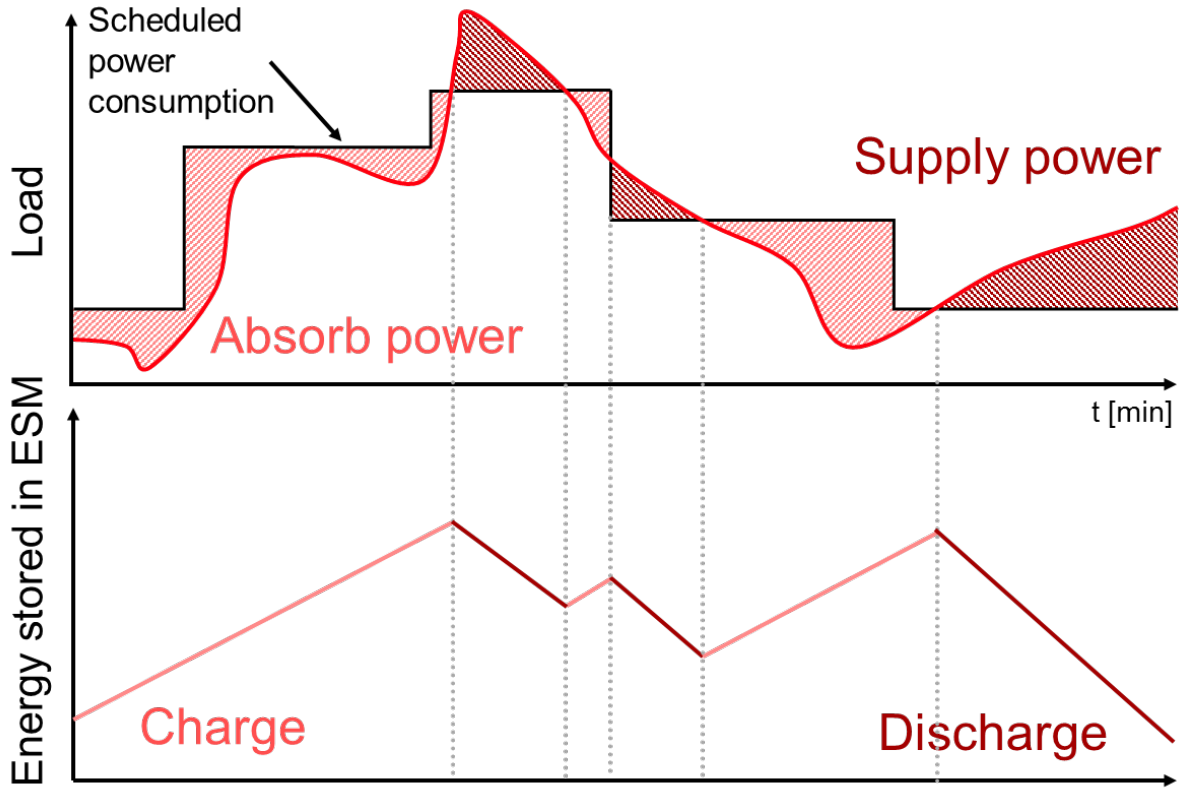
- Facilitate integration of renewables
- Leverage time of day generation pricing
- Optimize electricity consumption to reduce electricity bill
- Defer investment for grid upgrades
- Provide power quality support



Energy Storage Solutions
Applications and Benefits

Peak Shaving

Peak shaving is similar to energy shifting but is used for the purpose of reducing peak demand for economy of operation. Peak shaving installations are often owned by the electricity consumer, rather than by the utility. The goal is to avoid demand charges (power fees) and the installation of capacity to supply the peaks of a highly variable load.



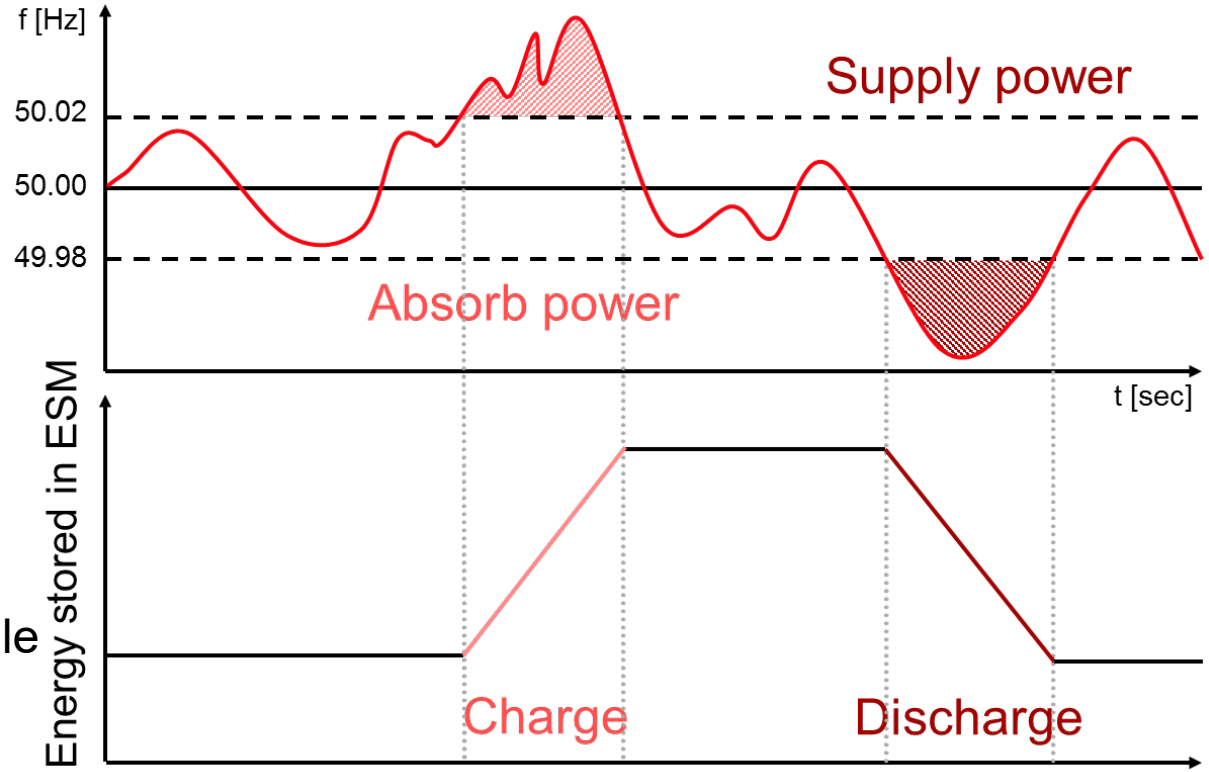
Benefits

- Optimize electricity consumption to reduce electricity bill
- Defer investment for grid upgrades
- Provide power quality support

Energy Storage Solutions
Applications and Benefits

Frequency Regulation, Reserve, And Response

The energy storage system is charged or discharged in response to an increase or decrease, respectively, of grid frequency. This approach to frequency regulation (fast frequency response) is a particularly attractive option due to its rapid response time and emission-free operation.



Benefits

- Generate revenue through participation in wholesale energy markets
- Facilitate integration of renewables
- Ensure reliable operation of the grid
- Provide power quality support

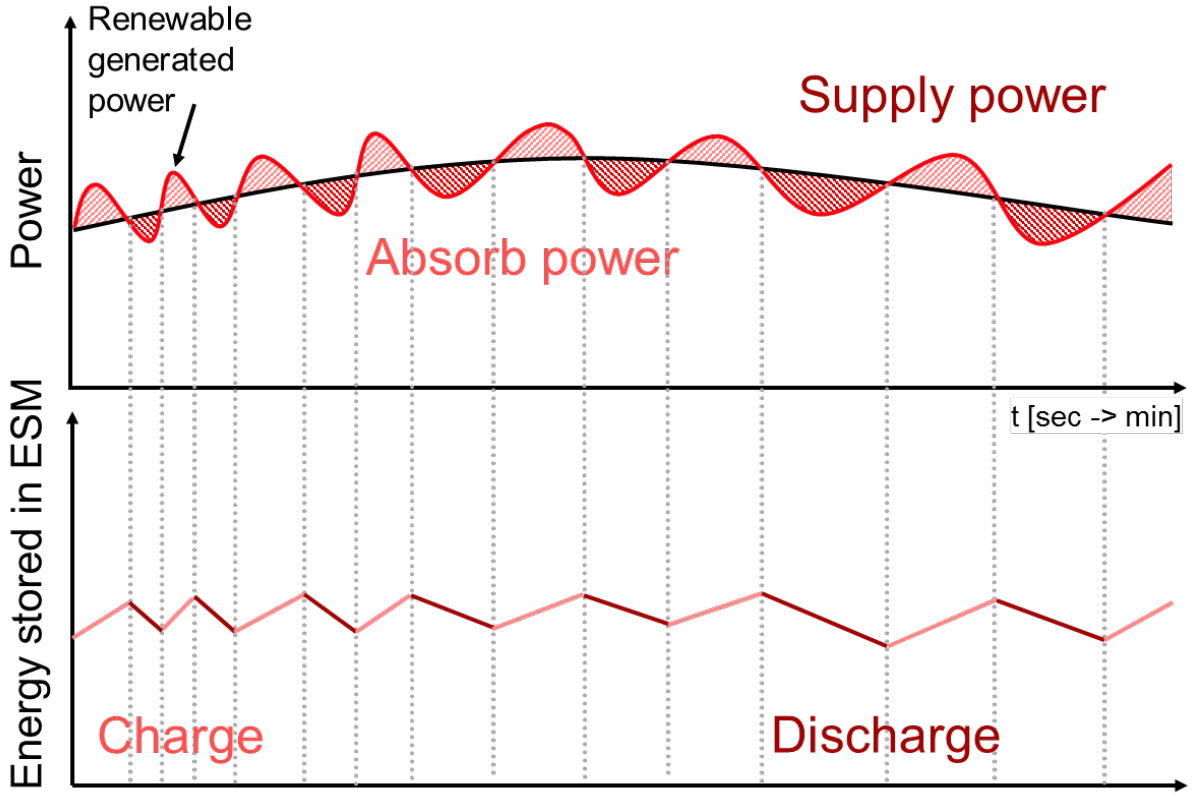
Energy Storage Solutions
Applications and Benefits

Capacity Firming

The variable, intermittent power output from a renewable power plant, such as wind or solar, can be maintained at a committed level for a period of time. The energy storage system smooths the output and controls the ramp rate (MW/min or kW/min) to eliminate rapid voltage and power swings on the electrical grid.

Benefits

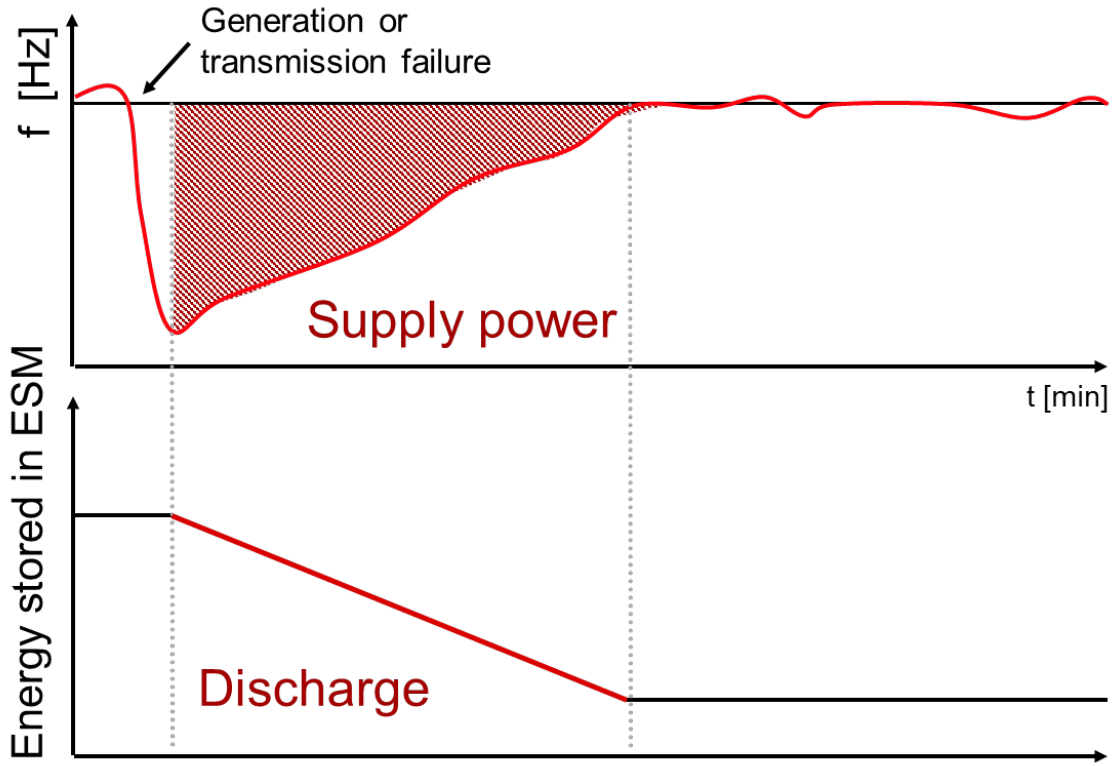
- Facilitate integration of renewables
- Increase distributed generation
- Provide power quality support



Energy Storage Solutions
Applications and Benefits

Spinning Reserve

Energy storage systems can respond within milliseconds and supply power to maintain network continuity while the back-up generator is started and brought online. This enables generators to work at optimum power output, without the need to keep idle capacity for spinning reserves. This eliminates the need to have back-up generators running idle. To provide effective spinning reserve, the Energy Storage is maintained at a level of charge ready to respond to a power failure.



Benefits

- Minimizes the impacts from power outages
- Reduces need for generation sources to be online and ready to use (lower O&M costs as well as emissions)
- Acts as a back-up power source

O&M

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O&M

System component	Preventive maintenance intervals
Distribution board	Once a year
Energy storage inverter	Once a year
Battery system	Battery status and condition is continuously monitored by BMS
Air conditioner unit	Every 6 months
Fire suppression system	Once a year, in case local regulation does not define different

Example Projects

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BESS Reference Case

Microgrid – Military Base

Contractor/end user: Confidential

Year of commissioning: 2025

Country: IT

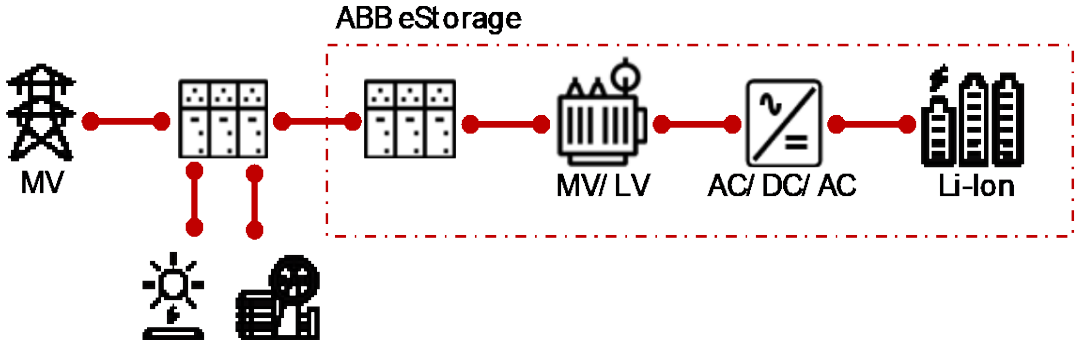
Segment: C&I

Customer Challenges

- Increase **sustainability** and reduce emissions
- Provide clean generation and **back up power** in case of grid outage
- Increase **renewable penetration**

Key Success Factors

- **Microgrid** Control system.
- Ability to operate in **grid forming mode**
- Compliance with **CEI016** IT grid code



BESS Reference Case

Microgrid – Military Base

Contractor/end user: Confidential

Year of commissioning: 2025

Country: IT

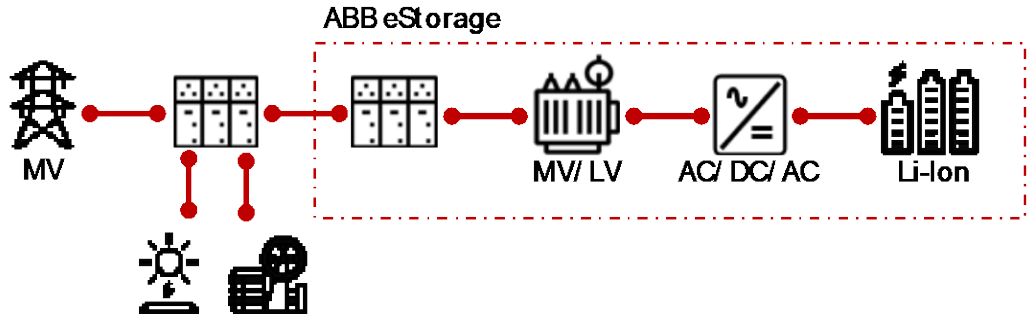
Segment: C&I

ABB Solution

- Supply of ABB **eStorage BESS 3000kW/4800kWh**
- Complete Networking, Monitoring and Control of the solution via **ABB eStorage OS** Energy Management System and **ABB Optimax**
- Main applications: Back-up Power, Microgrid Energy Optimization

Customer Benefits

- **Zero emissions** back-up power source
- **Colocated multi-application** system
- Microgrid **management** by ABB



BESS Reference Case

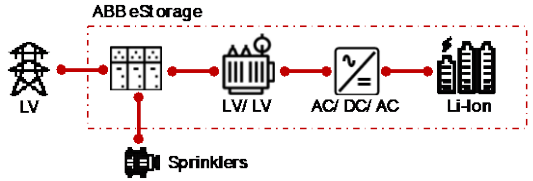
NetZero Sara Kulturhus

Contractor/end user: Skellefteå Kraft

Year of commissioning: 2021

Country: SE

Segment: C&I



Customer Challenges

- **Net-zero** commercial building
- **Critical power** application: fire-fighting sprinkler system
- Fire-fighting system compliant to local safety regulations

Key Success Factors

- **Predesigned and pretested** solution.
- Integration with sprinkler and building management system.

ABB Solution

- Supply of ABB **eStorage BESS 500kW/500kWh**
- Complete Networking, Monitoring and Control of the solution via **ABB eStorage OS** Energy Management System and **ABB Optimax**
- Main applications: Back-up Power, Peak-shaving

Customer Benefits

- **Zero emissions** back-up power source
- **Multi-application** system
- **Integration** with building management system

BESS Reference Case

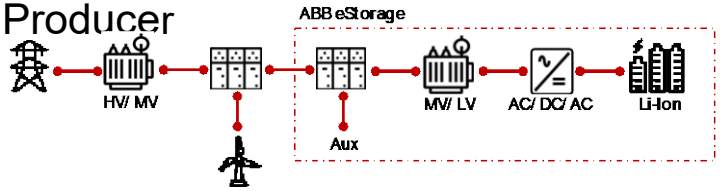
Ecotricity Alveston Wind Farm

Contractor/end user: Ecotricity

Year of commissioning: 2023/2024

Country: UK

Segment: Utility Independent Power Producer



Customer Challenges

- BESS **colocation** with existing wind farm
- Integration with customer Smart Grid platform

Key Success Factors

- **G99** compliant system at high-voltage connection
- Product Packaging
- Existing customer **relationship**

ABB Solution

- Supply of ABB **eStorage BESS 10MW/24MWh**
- Complete Networking, Monitoring and Control of the solution via **ABB eStorage OS** Energy Management System.
- Main applications: Frequency Regulation and Voltage Control

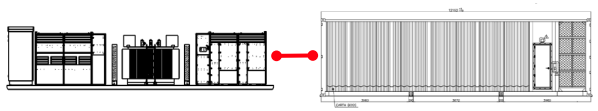
Customer Benefits

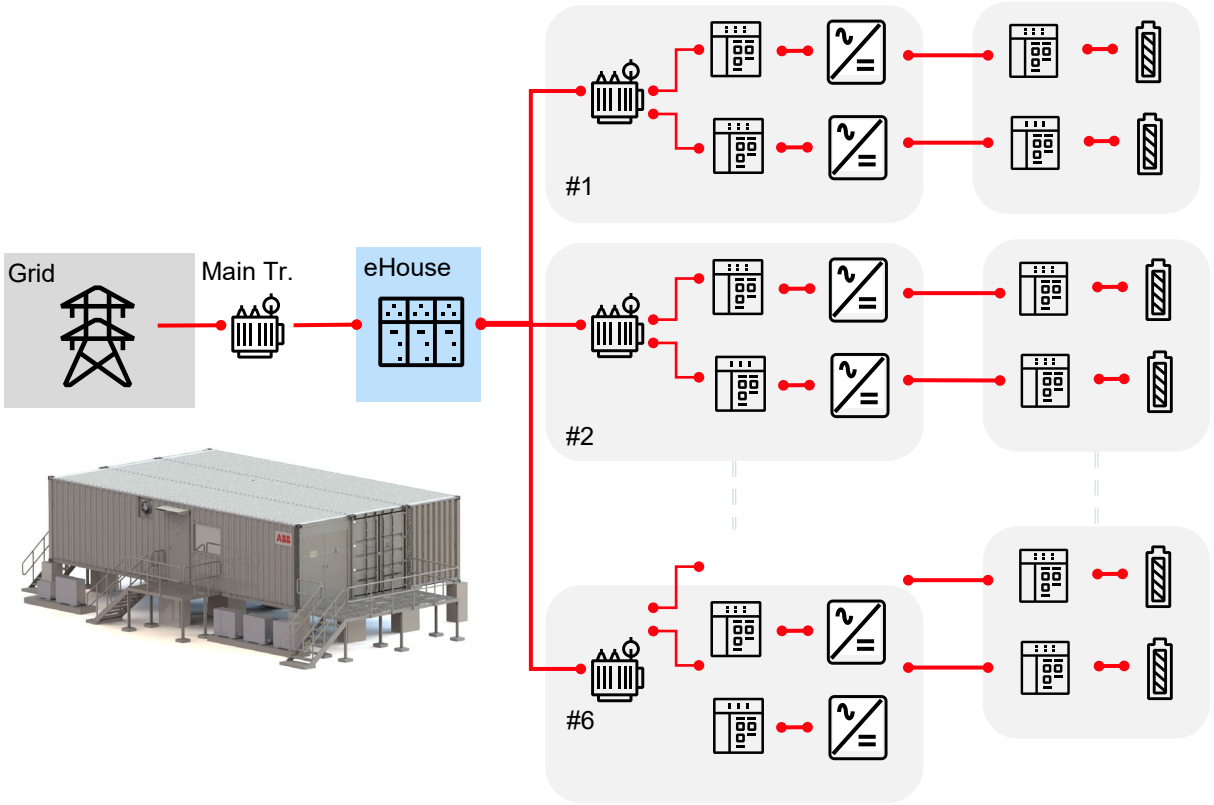
- **Reduced** engineering time and deployment to site
- Full **compatibility** with existing customer infrastructure
- High **availability** for maximum remuneration scheme

eStorage Max

Reference Case 20MW/20MWh – Frequency Regulation

Single Line Diagram





BOM

- Modular design to meet the customer requirement
- Pre-engineered solution reduce engineering time

ESS	Block type (Skid + eHouse 40ft)
Application	Frequency Regulation
Power	20MW at POI (grid connection point)
Energy	20MWh, 1C at POI
Dist. Transformer	3 winding, 13.8/0.69kV, 4.5MVA
Main Transformer	13.8/230kV, 27MVA
Grid connection Voltage	230kV
HVAC	20RT
Fire Fighting	NOVEC

eStorage MAX – Plant Layout

Reference Case 20MW/20MWh – Frequency Regulation

1. Battery Enclosure
2. Converter Skid
3. eHouse
4. Power Transformer
5. HV Switchyard

Questions?

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