Introduction to Energy Storage Solutions

ELDS – Packaging and Solutions

ABB

Agenda

→ The future of energy

→ Introduction to Energy Storage

→ Integrated solutions

→ Digital, M&D and cloud connections

→ ELDS Packaging and Solutions Portfolio

The future of energy

Megatrends: The 3D's for the Grid

Making customers active elements of the system, though it requires coordination

Key technologies:

- Energy efficiency
- Solar and Wind integration
- Microgrids
- Demand response

Critical to long-term carbon goals with more renewable penetration and electrification of the transportation

Key technologies:

- Renewable generation
- Electric vehicles
- Vehicle to grid/home, Smart charging

Allowing real-time automated communication and operation of the system

Key technologies:

- Network technologies (smart meters, remote control and operation, smart sensors...)
- Behind the meter (IoT, optimization and aggregation platforms, smart products, machine learning...)

Megatrends Challenges

Renewable Grid impact:

- Generation often not aligned with demand
- Variability of the generation
- Loss of grid inertia due to power electronics devices
- Grid stability

E-Mobility Grid impact:

- Increasing number of EV's and longer ranges and faster charging times leading to high peak power demands hard to forecast
- Grid upgrade not always feasible
- More substations close to public making safety a key factor

Distributed assets:

- Need for interconnection to manage generation and demand
- Optimization to increase efficiency
- Cybersecurity of paramount importance

Our Contribution

Adapting to the future of energy with a digitally enabled Battery Energy Storage System

01.

Decentralization

Battery Energy Storage

- Postponing investments on grid upgrades
- Enabling different business models

02.

Decarbonization

Battery Energy storage

- Balancing the increasing peak demands due to e-mobility
- Supporting the variability in renewables

03.

Digitalization

Monitoring and diagnostics

- Increasing asset health, reliability and safety

Artificial Intelligence

- Providing an optimal operation of the energy storage for increased battery lifetime and ROI

Introduction to energy storage

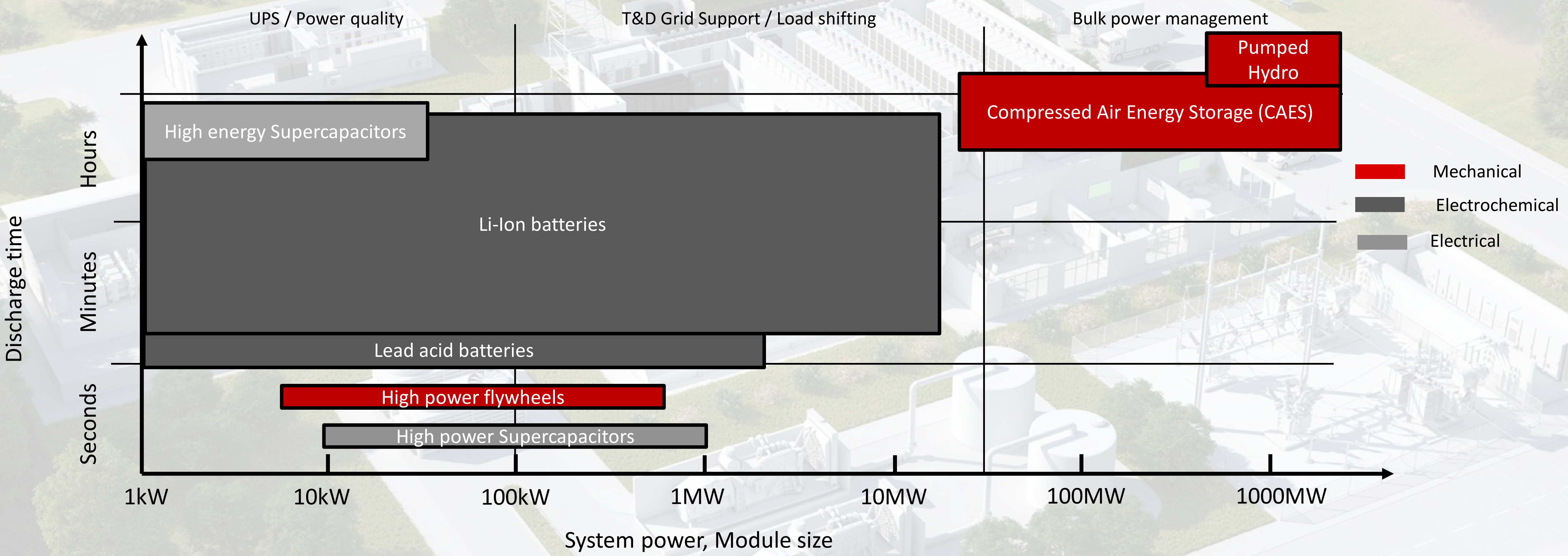
Energy storage and the grid

How can energy storage act as the key to balancing renewable generation with growing demand

Benefits of introducing energy storage to the grid

- Reduces the variability of renewable energy production by providing a buffer
- Can store renewable generation peaks for use during demand peaks when they do not align
- Immediate demand peak response without increasing generation to reduce stress on grid equipment
- Providing infrastructure support for volatile electric vehicle charging
- Potential to decrease or eliminate the power fees related to short time peak loads

Types of technologies used for energy storage



Where and how each technology is used in the energy value chain

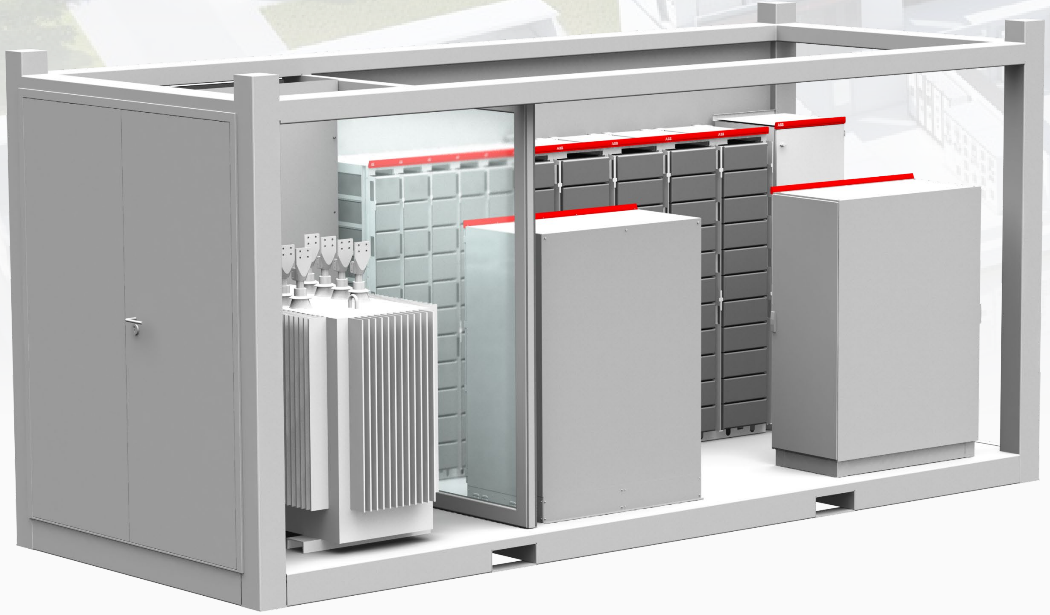
Types and application

Segment	**Generation**	**Transmission**	**Distribution**		**End Users**		
App	Centralized storage	Renewable integration	T&D network storage	Distributed energy storage	Industrial back-up & power quality	Residential & commercial	Electromobility
Type	Pumped hydro, CAES, batteries	CAES, batteries	Thermal storage, batteries			Batteries, flywheels, FC, SMES	E-mobility
Purpose	Large centralized storage for ancillary services and energy shifting	Large centralized / decentralized storage for time-shifting renewable generation aligning peak with demand	Energy storage, both stationary and portable at T&D network to support grid stability	Energy storage at distribution network to provide small scale energy generation and energy management	Back-up or high quaility power for commercial and industriaal consumers with demand peak management	Small scale storage for residential and commercial use to provide back-up power and peaking capacity and/or reduce energy costs	Small scale storage for electrification of transportation to provide back-up power and peaking capacity

Battery Energy Storage Systems (BESS)

What is 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.

Often renewable energy sources are combined with a BESS to store the renewable energy during peak production time and then the energy is used when it is needed.

Common control options available for energy storage

Control mode for those solutions with storage incorporated

Algorithms typically implemented:

- Peak shaving
- Synchronized charging for e-mobility
- Renewables integration/smoothing
- Frequency regulation (slave configuration)
- Voltage control
- Load shifting
- Time scheduled charge/discharge
- Islanding

Energy Storage Solutions

Applications

Load leveling

- Load shifting from high peak demand to off-peak period
- Reduces distribution congestion and losses
- Postponement of investments in grid upgrades

Peak shaving

- Flattens demand peaks thereby reducing peak demand charges
- Independency of the grid capacity during peak demand – power available from batteries when it is most needed
- Reduce the operational costs

Frequency regulation

- Increases reliable operation of the grid
- Supporting decentralized microgrids
- Reduces the need for additional generation facilities (expensive to operate and maintain)

Capacity firming

- Increases renewable penetration and reliability of the grid
- Supports the frequency and voltage of the grid even when the demand and Solar / Wind generation fluctuates
- Enables grid code compliance

Power quality

- Protects downstream loads against short-duration events
- Reactive power compensation and load factor improvement
- Balance the currents between phases

Spinning reserve

- Minimizes the impacts from power outages
- Backup power for critical loads
- Reduces need for generation sources to be online and ready to use (lower O&M costs as well as emissions)

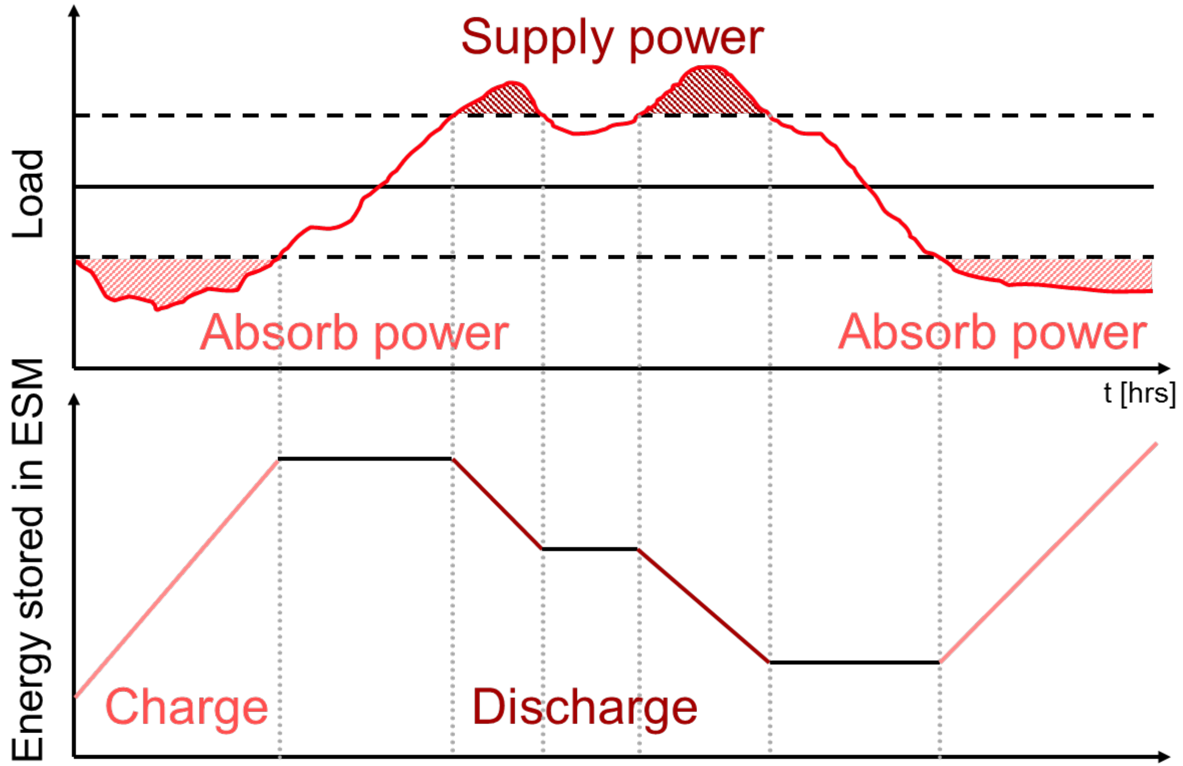
Energy Storage Solutions

Applications and benefits

Load leveling

Load leveling involves storing power during periods of light loading on the system and delivering it during periods of high demand. During these periods of high peak demand the Energy Storage supplies power, reducing the load on distribution grid and less economical peak-generating facilities.

Generation load is shifted from high peak demand to off-peak period



Benefit

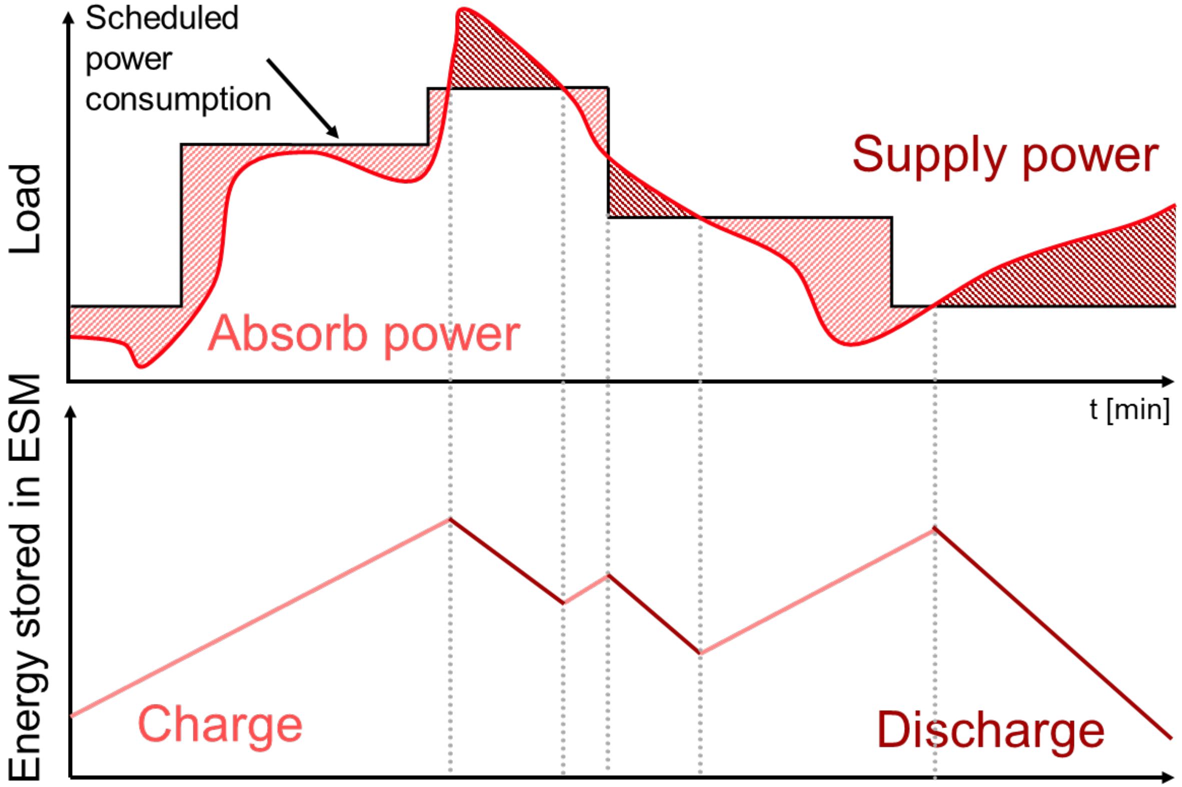
- Postponement of investments in grid upgrades or in new generating capacity
- Reduce T&D congestion
- Renewables time shifting

Energy Storage Solutions

Applications and benefits

Peak shaving

Peak shaving is similar to load leveling 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.



Benefit

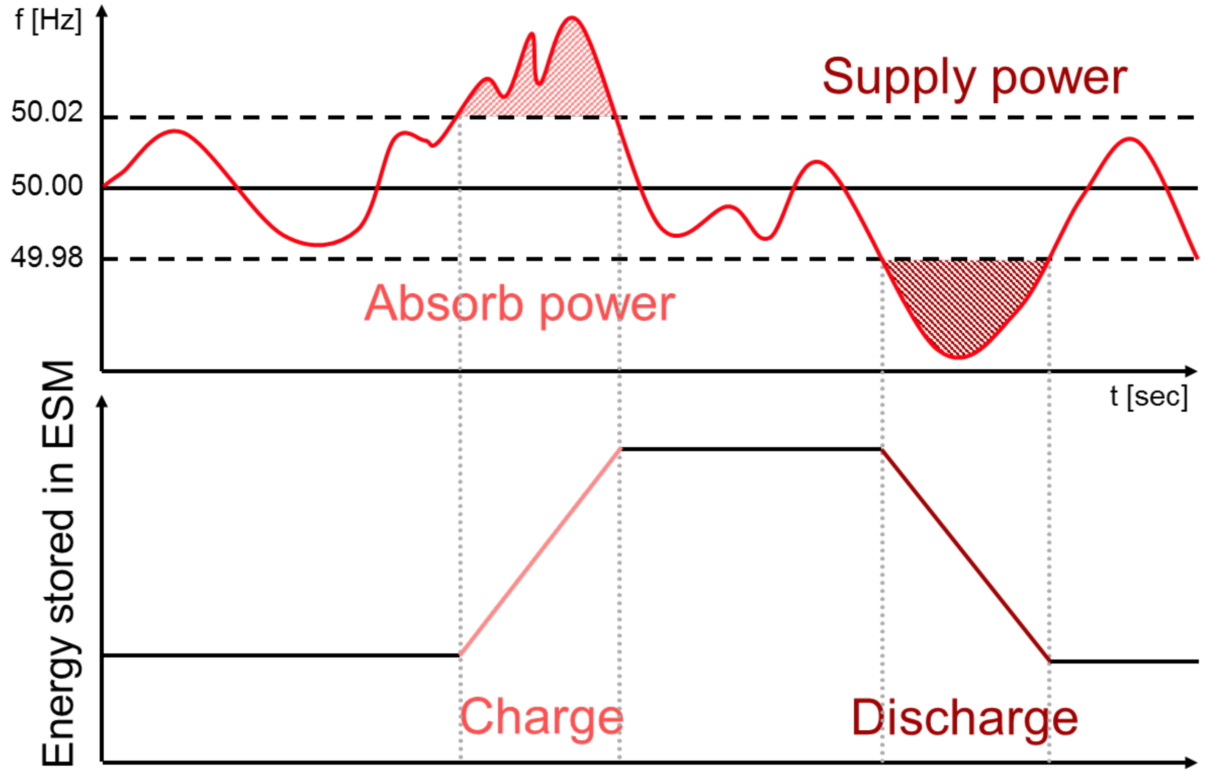
- Customers can save on their utility bills by reducing peak demand charges
- Utilities can reduce the operational costs meeting peak demand

Energy Storage Solutions

Applications and benefits

Frequency regulation

The Energy Storage 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.



Benefit

- Increases reliable operation of the grid
- Reduces the need for additional generation facilities (expensive to operate and maintain)

Energy Storage Solutions

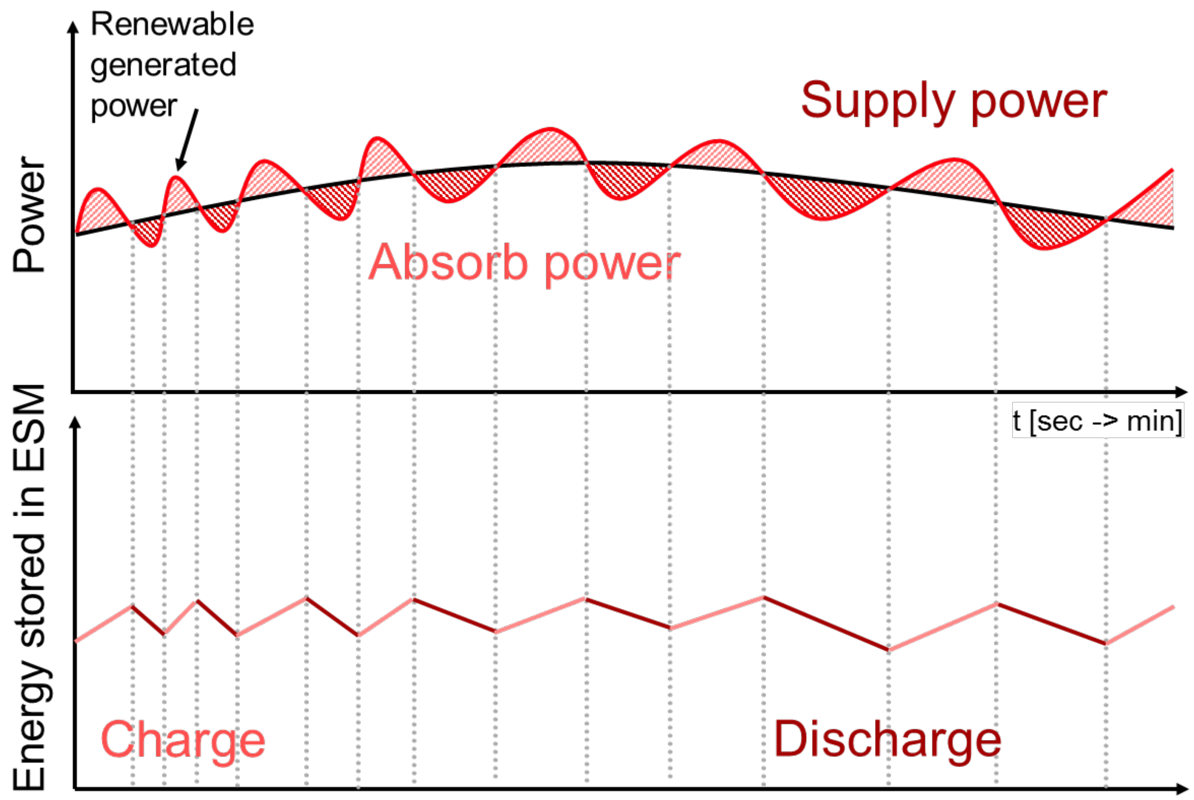
Applications and benefits

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 smoothens the output and controls the ramp rate (MW/min or kW/min) to eliminate rapid voltage and power swings on the electrical grid.

Benefit

- Increases reliability of the grid
- Improves efficiency of the renewable plant
- Enable grid code compliance



Energy Storage Solutions

Applications and benefits

Power quality

In power quality applications, an Energy Storage helps protect downstream loads against short-duration events that affect the quality of power delivered.

Energy storage with reactive power capability can provide and frequency and voltage support and respond quickly to voltage control signals.

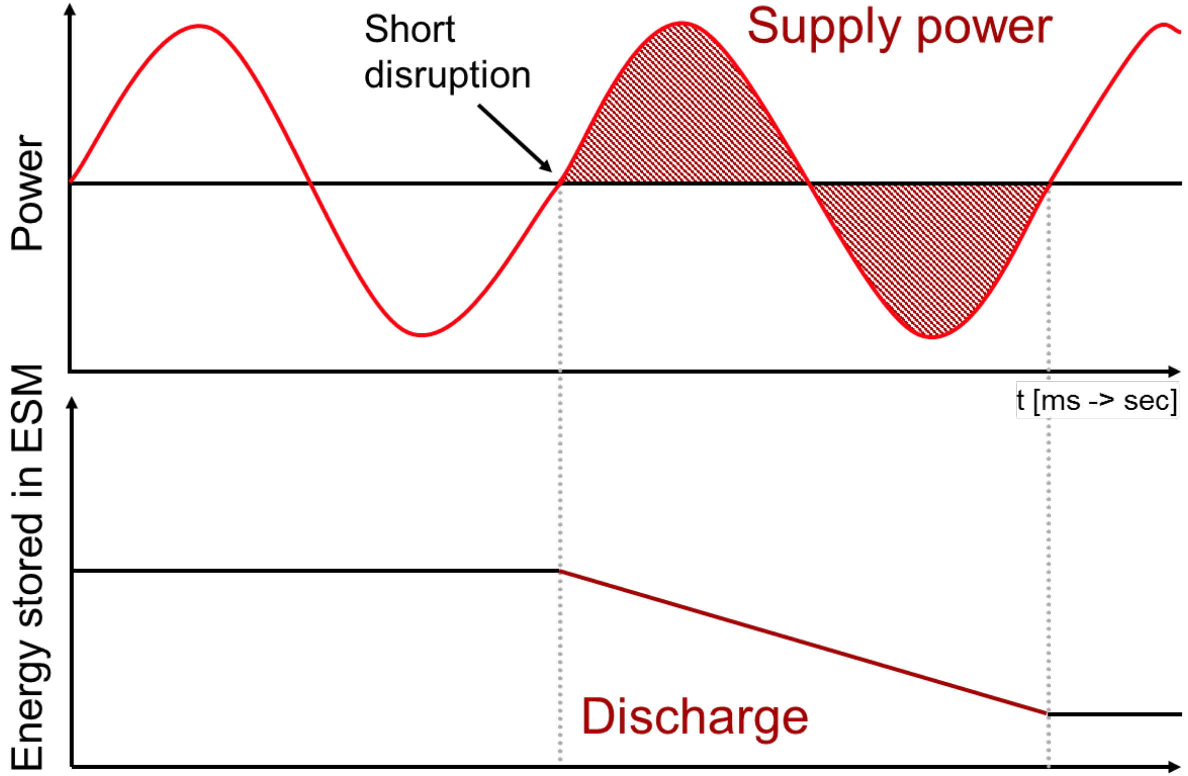
Benefit

Protected bus:

– Ensures high quality supply electricity to loads under gird instabilities

Grid services:

– During grid stability conditions, the Energy Storage can perform all other anciallary services



Energy Storage Solutions

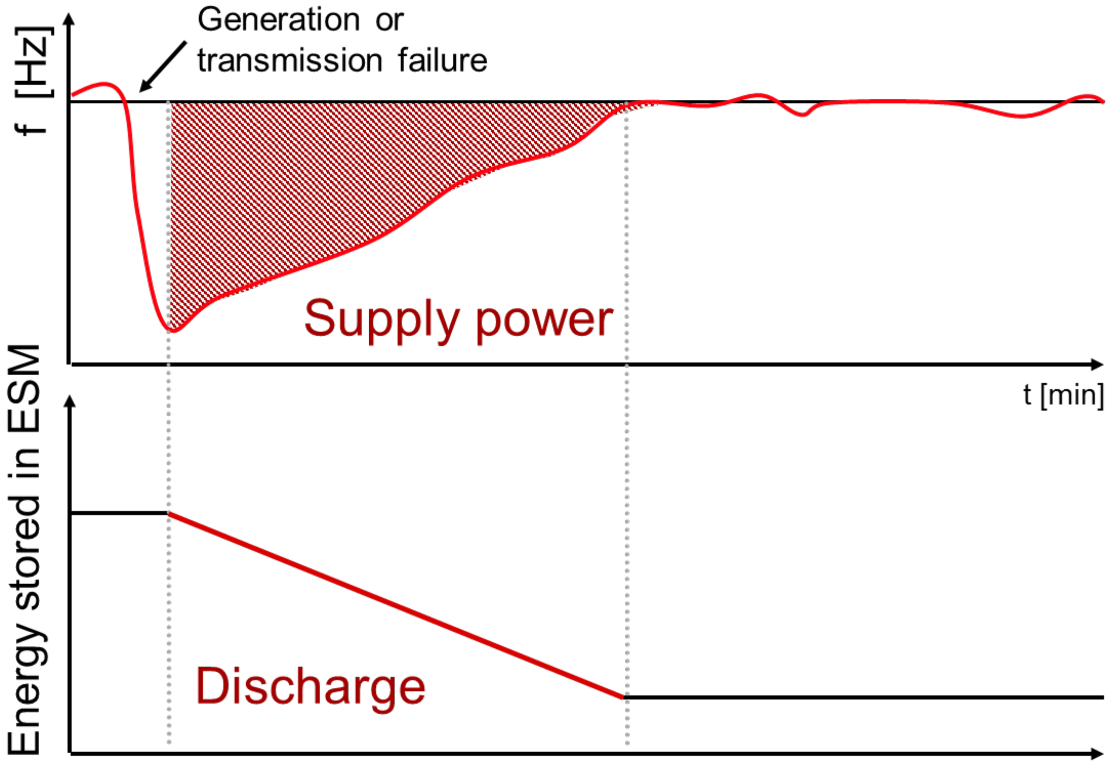
Applications and benefits

Spinning reserve

Energy Storage 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.

Benefit

- 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



Energy Storage Solutions

Applications and benefits

Benefits across multiple applications

Applications	Industrial, commercial and residential	Renewable integrators	Transmission and distribution operators	Power stations
Load leveling	✓	✓	✓	✓
Peak shaving	✓		✓	
Frequency regulation		✓	✓	✓
Ramp rate control / Capacity firming		✓		
Power quality	✓	✓	✓	
Spinning reserves / backup power	✓		✓	✓

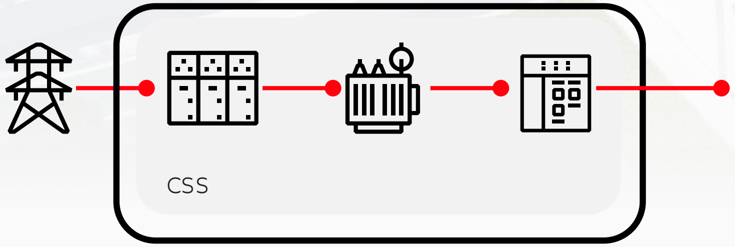
– Users may benefit from multiple applications of their energy storage
  - Residential / commercial users integrating Energy Storage to their solar for load leveling, and frequency regulation can also benefit from the availability of backup power
  - Utilities can benefit from frequency regulation to back-up power or other possible ancillary services
– Energy Storage can also offer different applications during the different times of the day
  - Capacity stored for renewables ramp rate can be used as backup power when there is no sun
– Commercial payback will increase from the combination of applications and benefits

Integrated solutions

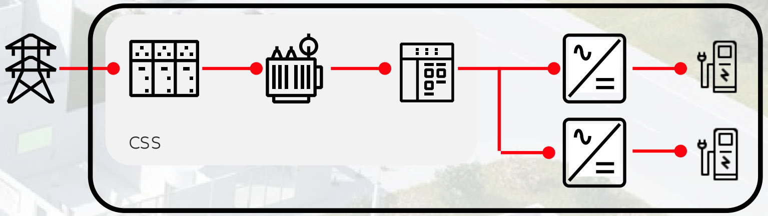
ABB Packaging & Solutions

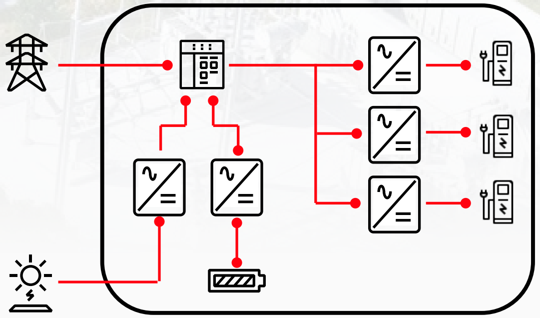
Adaptation of products to respond to the energy transition

Historically: Secondary Substation (CSS)



Present and future: eHouse/CSS+e-Mobility+Storage+PV





Moving from single products (CSS) to integrated solutions (CSS+eM+Storage+Renewable)

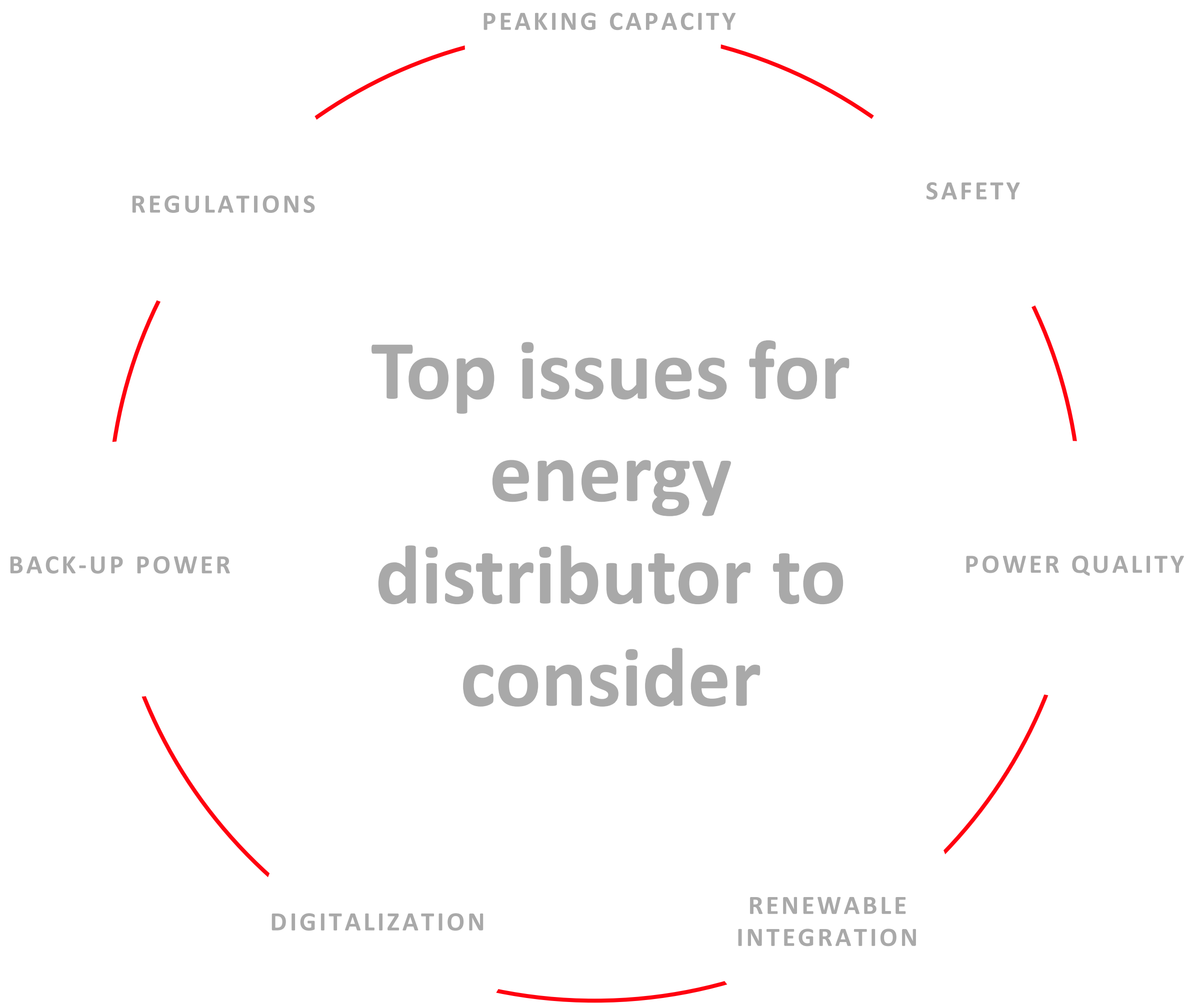
Integrated solution value propositions

How do solutions preemptively address the challenges of the future grid

Reliable & safe	New Infrastructure solutions require a high level of safety for equipment and personnel due to the increase in proximity to public areas
Reduced contracting time	Reduce overall project time with a quicker bid process, reduced negotiation time and single contract thus making us more prepared to meet upcoming growth demands
Single point of contact	A lead project manager can manage manufacturing approval documentation across all line items and coordinate all project deliveries, streamlining the process further
Cost effective	Fast installation needed on site leading to factory tested assembled solution. Will allow solution penetration into markets without engineering abilities
Reduced schedule risk	System engineering, system testing and site preparation to be eliminated or minimized
Digitalization	All packages to be enabled for smart sensing and communication through internet-based management and data history. Remote access and diagnostics to minimize downtime and enable efficient maintenance plans.

Distributor key challenges

- **Peaking capacity**: Especially an issue for roadside and highways where people will be charging at peak times in the morning and evenings
- **Safety**: E-mobility and Utility charging apparatus is often located right next to the medium-voltage products making safety an even higher priority
- **Power quality**: E-mobility charging is hard to forecast causing unpredictable loads
- **Renewable generation**: Often missaligned with demand
- **Digitalization**: Increased number of distributed assets means intelligence, communication, and analytics are even more important
- **Back-up power**: Storage is a key enabler even when grid-outages occur
- **Regulations**: In some locations it does not currently allow the energy distributor to operate as generator. Wide adoption is needed



Market shift

Adapting the portfolio to support the energy transition with safe, smart and sustainable electrification

01.

Safe and reliable electrification

Increase safety against internal faults for medium voltage connected substations to make safer for public spaces and service personnel. Battery fire safety is of paramount importance

02.

Integrated solutions

New concepts with new technologies to generate more value through solutions and increase target audience

03.

Digitalization

Smart algorithms for future smart grids

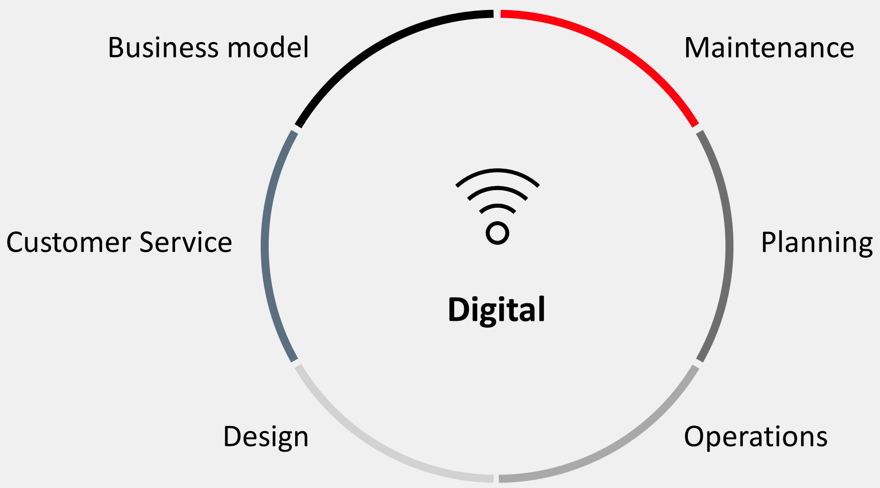
Monitoring and diagnostics for asset health and increase reliability

Communication between different distributed assets is essential


Digital,
cloud solutions,
monitoring & diagnostics

Digitalization
Disruptors and opportunities

Impacting all business functions



Fast technological change

- Increased and faster computing power for less money, increased connectivity and inexpensive data storage is facilitating rapid change
- Devices such as sensors, mobile devices, robotics, additive mfg coupled with software advances including artificial intelligence (AI), virtual reality (VR) and augmented reality (AR) are changing the way equipment is designed, operated and maintained
- Technical advances in solar power, wind energy, battery storage and carbon neutral initiatives including e-mobility pave the way for improved performance and lower operating costs
- We are experiencing disruptive business models enabled by these technology changes that transform many industries
- The time is now to leverage these opportunities to improve the competitive position and consider additional business models

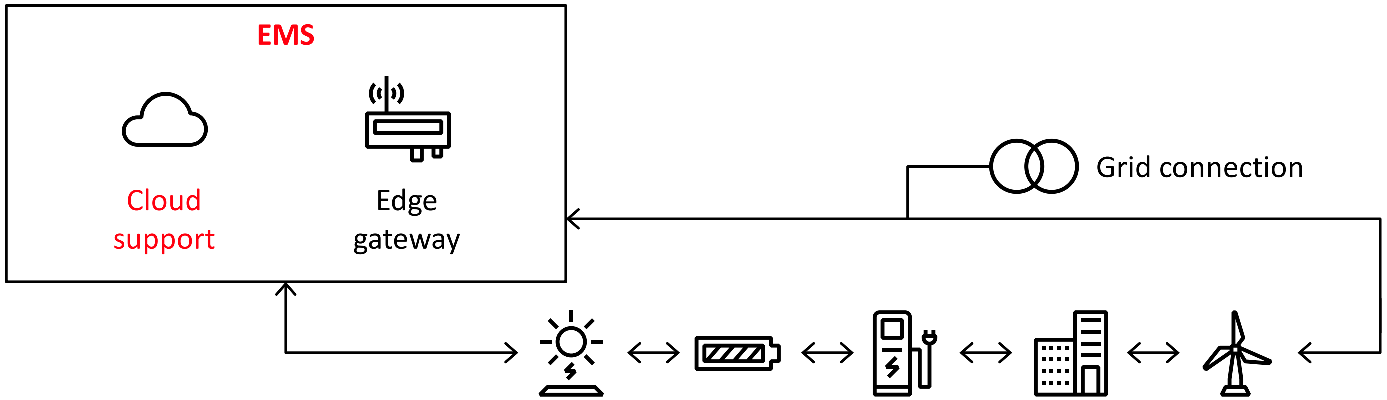
Energy management, monitoring and diagnostics

On-premise, edge and cloud solutions

ABB Ability™ Platform		Private Cloud Platform
Cloud, Analytics, Artificial Intelligence, Cybersecurity, Gateway & Hybrid	And/Or	Cloud, Reports, Proprietary algorithms, Planning

Digital enabled solution:

- Integration of Renewable + Storage + EV
- Cloud based EMS
- Grid support
- Substation Automation
- Multi-Energy Optimization



Smart and Connected Products

Hardware

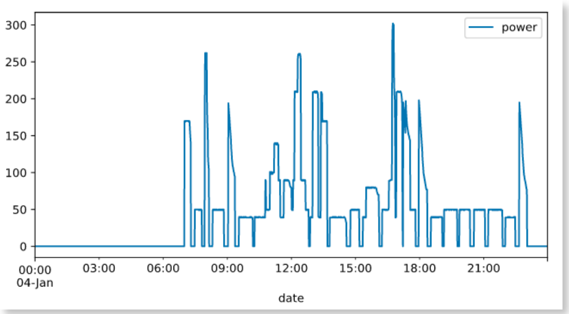
Digital Assets

Electrical Infrastructure

Machine Learning for Energy Prediction

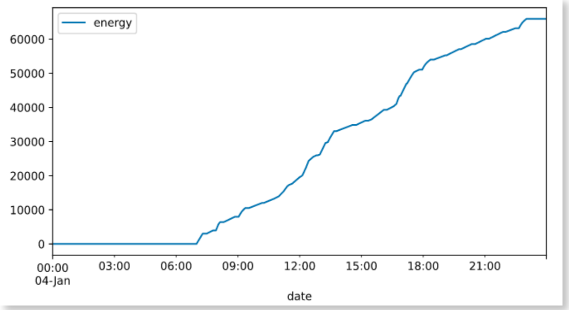
Artificial Intelligence as added value

Original power profile (true data)



$$E = \int P dt$$

Calculated energy demand



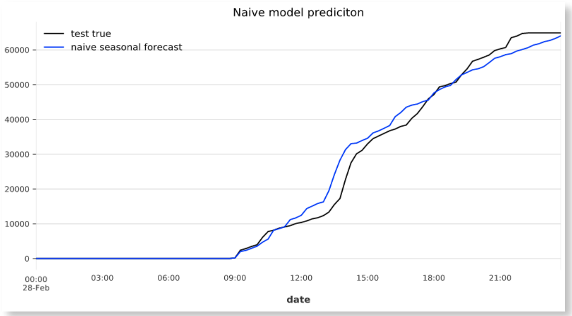
Calculated **energy** by summing up power over time

Key factor for

training and making predictions

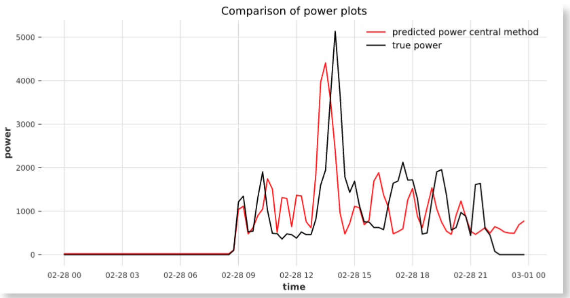
(machine learning)

Predicted energy profile



$$P = \frac{dE}{dt}$$

Predicted power profile



Calculate **power** by calculating changes in **energy over time**

ACCURATE PREDICTIONS

MACHINE LEARNING

AGILE

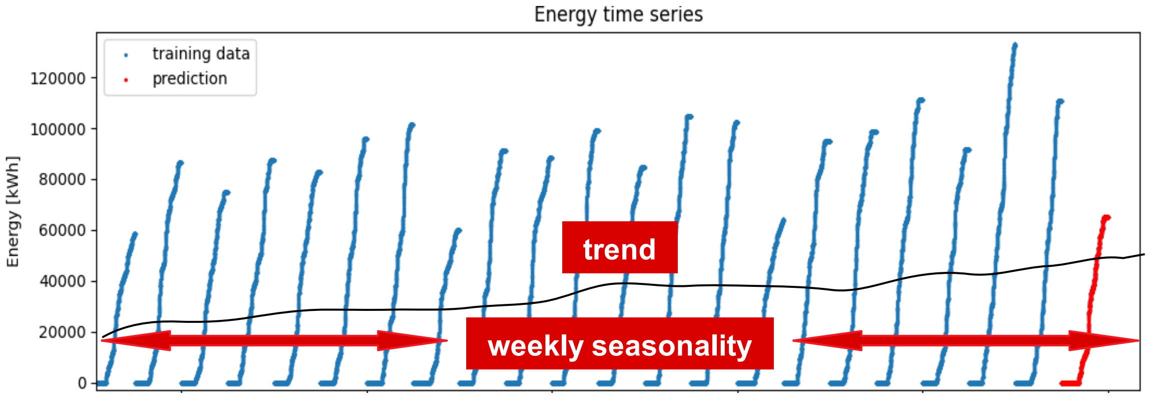
Energy forecasting
Real prediction

Objectives:

- predict energy consumption for the next 24h
- investigate data seasonality (daily, weekly, monthly, yearly)
- investigate holiday effect (country-specific holidays, seasonal events)
- multivariate time series forecasting by adding weather data
- verify correlation between them

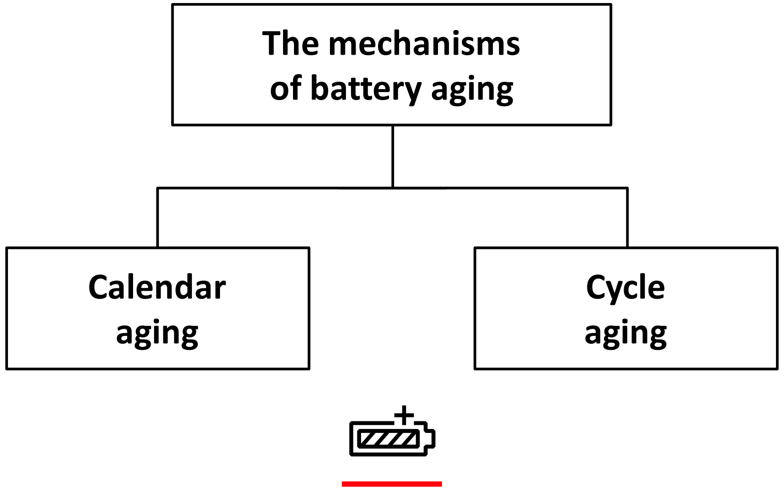
Challenges:

- resample high-resolution data (resolution = 1min) with minimizing information loss
- feed long-term sequences into machine learning or statistical models (e.g. monthly sequences)
- model extreme events (anomaly detection e.g. failures, volcano,...)



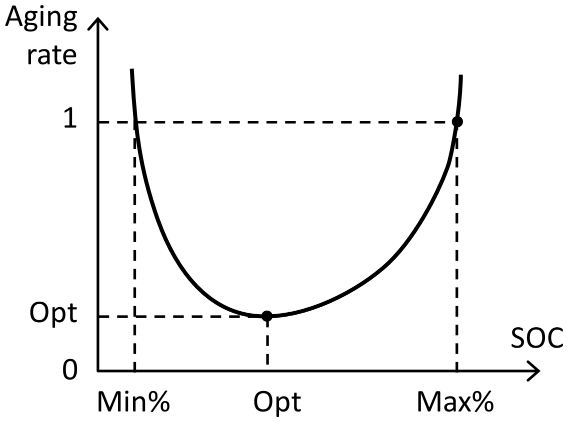
Battery Aging

Prediction and increase of battery's lifetime based on operation under optimal conditions



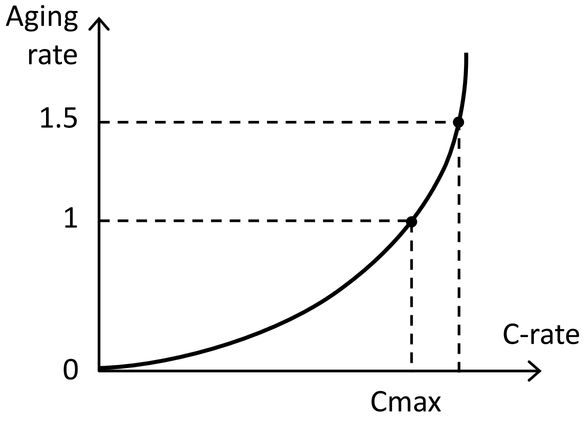
Calendar Aging

SoC impact
on battery health



Cycle Aging

C-rate impact
on battery health



Total aging optimized for both calendar and cycling aging:

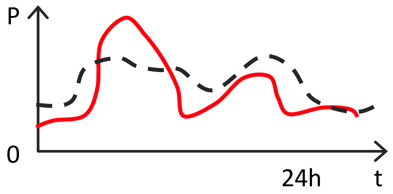
Total Aging = f(calendar, cycle)

BESS energy storage capacity optimization

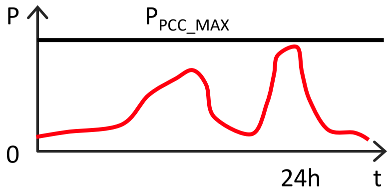
Leveraging the SOC for an optimal performance

Input Data Section

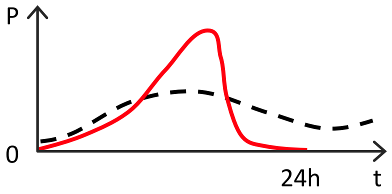
Load profiles (prediction based on historical data)



Power limit in PCC

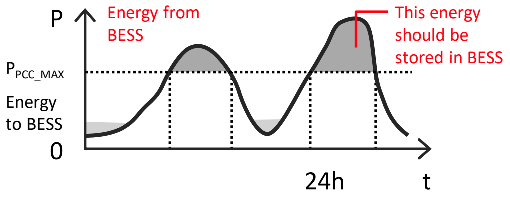


Renewable Energy Forecasting

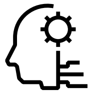


Battery pack parameters

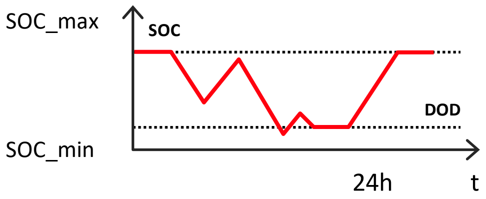
Estimation of load profile at PCC, best periods for charging or discharging the BESS, energy required to be stored in BESS



Prediction of BESS charging and discharging periods



Analysis of the battery conditions for assumed capacity and SOC at the adopted operation schedule

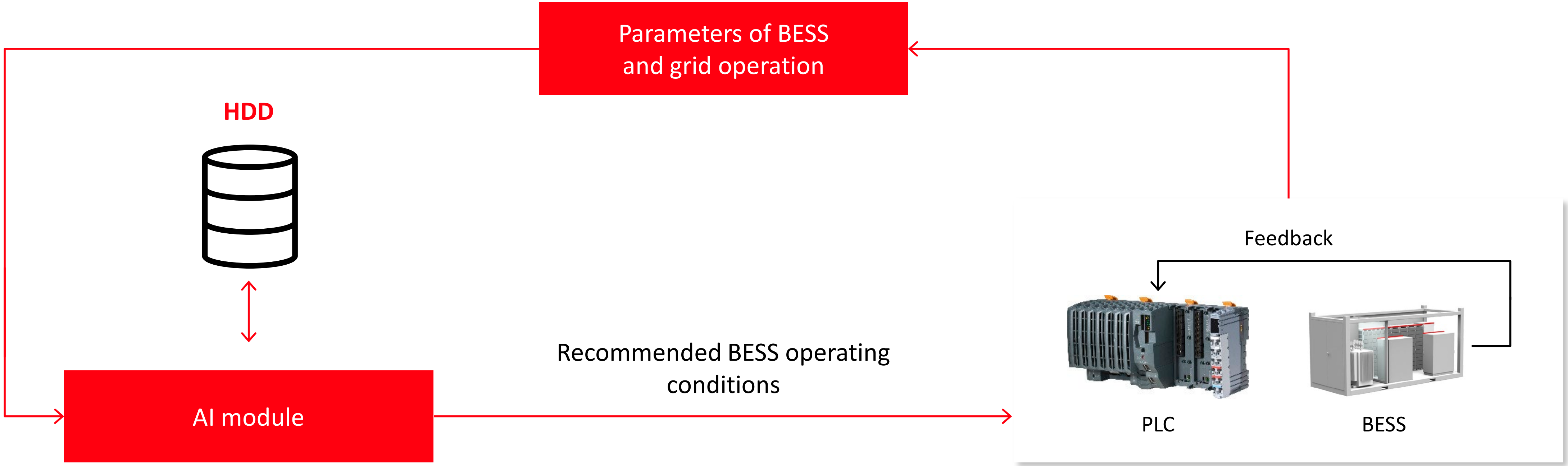


BESS operating recommendations

Capacity calculations

Control Flow Chart

AI module impact on BESS operation



Offline prediction – memory functionality added, reference setpoints value for each day based on historical data analysis

Online control - control loop without memory - real time execution (doesn’t know about future and past)

Conclusions

AI will be a game changer for the Energy Storage

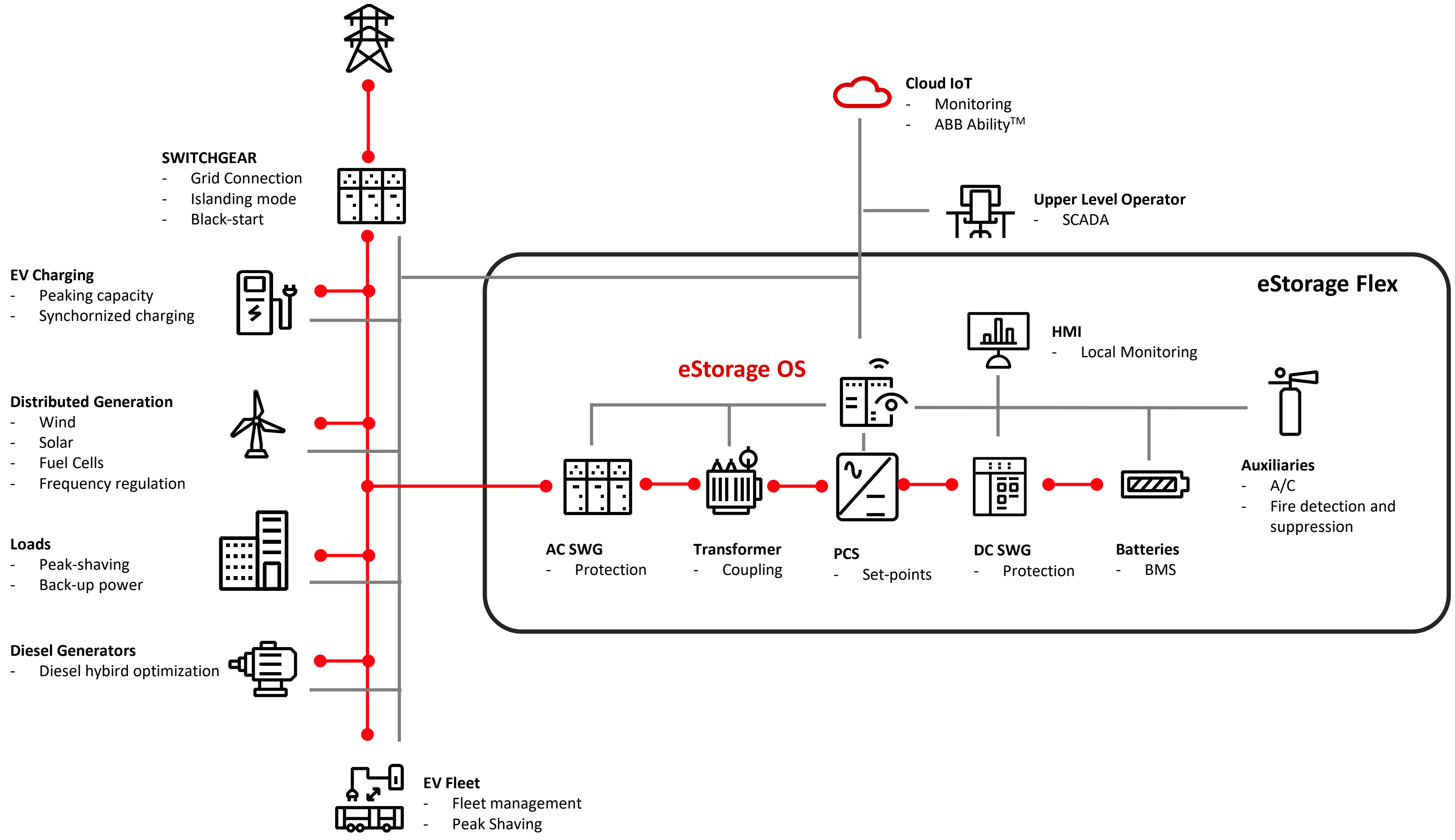
Benefits of Artificial Intelligence in Energy Storage

- More accurate energy flow predictions based on machine learning from PV generation to demand
- Supports the dimensioning of battery energy storage for an optimal investment with limited oversizing
- Lifetime increase due to optimal cycling of the batteries reducing the cycling aging
- Better preventive maintenance increasing the reliability of the system

ROI **Reliability**

ELDS Packaging and Solutions Energy Storage Portfolio

Portfolio Applications

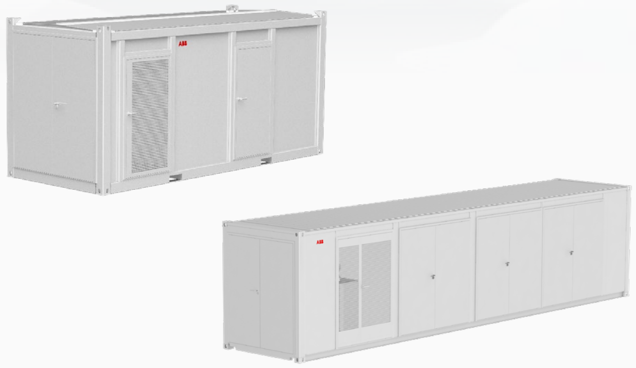


eStorage

Product Portfolio

FLEX

Productized medium-scale storage with integrated grid connection equipment in ISO look (20ft, 40ft)

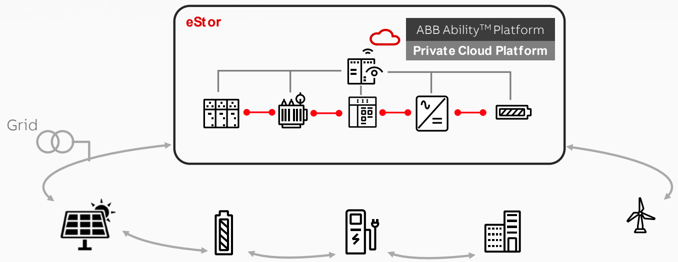


MAX

Productized and scalable energy storage comprised of skidded grid connection equipment and ISO look energy storage

OS

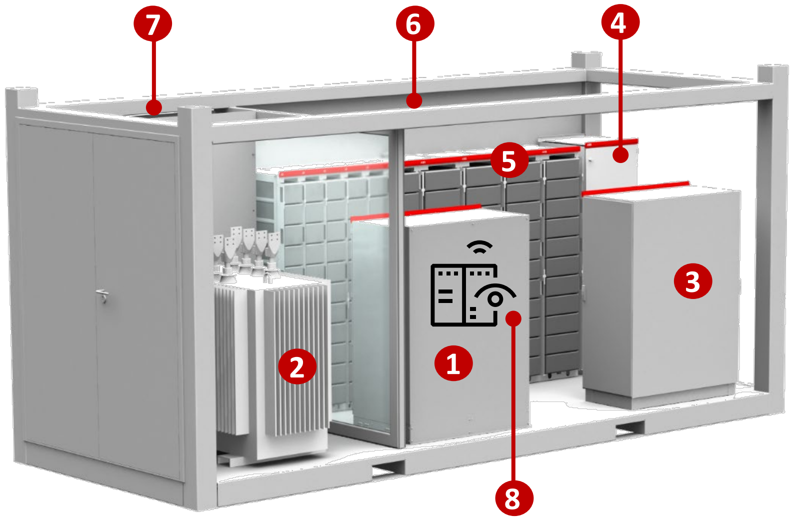
Standard or highly-customizable Energy Management System for the whole eStorage family



* eStorage trade-mark process ongoing.

eStorage Flex

All integrated and productized Energy Storage



1. AC Switchgear
2. Transformer
3. Power conversion
4. DC Switchgear
5. Battery Racks
6. Fire Suppresion
7. HVAC
8. eStorage OS

Plug-and-play: Provides all required batteries, power conversion, coupling transformer, safety features, cooling, and protection and controls.

Factory tested: Factory built solution integrates comprehensive safety features that bring extensive quality control for the highest level of safety and reduce risk by over 90%

Pre-engineered: Designed with careful equipment selection, catering for a long lifespan in all conditions including asset health and management for longest longevity

Digitally enabled: Critical power operations digitally controlled for fastest response time with embedded energy management algorythms and microgrid controller available

eStorage Flex 20 FACT SHEET

Technical data

1200Vdc

Description	eStorage Flex 20-550	eStorage Flex 20-660
Electrical specifications		
Maximum Outputpower (S)[1]	500kVA	500kVA
Typical Outputpower (P)[1,2]	450kW	450kW
Installed Energy	550kWh	650kWh
Max C-rate	<1C	<1C
Nominal voltage	400Vac, 480Vac	400Vac, 480Vac
Frequency	50/60Hz	50/60Hz
Power factor range	4-quadrant, 0 to 1	4-quadrant, 0 to 1
Connection method	3-phase	3-phase
DC voltage range	800-1200Vdc	800-1200Vdc
Equipment		
Enclosure	ABB EcoFlex	ABB EcoFlex
Inverter operations modes	VSI Vf, CSI PQ, Islanding, Black-start	VSI Vf, CSI PQ, Islanding, Black-start
Battery chemistry	NMC	NMC
Transformer type	Oil-filled, dry-type	Oil-filled, dry-type

eStorage Flex 40 FACT SHEET

Technical data

1200Vdc

Description	eStorage Flex-40-770	eStorage Flex-40-880	eStorage Flex-40-1100	eStorage Flex-40-1210
Electrical specifications				
Maximum Output power (S) [1]	1000kVA	1000kVA	1300kVA	1300kVA
Typical Output power (P) [1,2]	730kW	830kW	1050kW	1150kW
Installed Energy	770kWh	880kWh	1110kWh	1210kWh
Max C-rate	<1C	<1C	<1C	<1C
Nominal voltage	LV: up to 690Vac MV: up to 40.5kV	LV: up to 690Vac MV: up to 40.5kV	LV: up to 690Vac MV: up to 40.5kV	LV: up to 690Vac MV: up to 40.5kV
Frequency	50/60Hz	50/60Hz	50/60Hz	50/60Hz
Power factor range	4-quadrant, 0 to 1	4-quadrant, 0 to 1	4-quadrant, 0 to 1	4-quadrant, 0 to 1
Connection method	3-phase	3-phase	3-phase	3-phase
DC Voltage range	800-1200Vdc	800-1200Vdc	800-1200Vdc	800-1200Vdc
Equipment				
Enclosure	ABB EcoFlex	ABB EcoFlex	ABB EcoFlex	ABB EcoFlex
Inverter operations modes	VSI Vf, CSI PQ, Islanding, Black-start	VSI Vf, CSI PQ, Islanding, Black-start	VSI Vf, CSI PQ, Islanding, Black-start	VSI Vf, CSI PQ, Islanding, Black-start
Battery chemistry	NMC	NMC	NMC	NMC
Transformer type	Oil-filled, dry-type	Oil-filled, dry-type	Oil-filled, dry-type	Oil-filled, dry-type

eStorage Flex 40 FACT SHEET

Technical data

1500Vdc

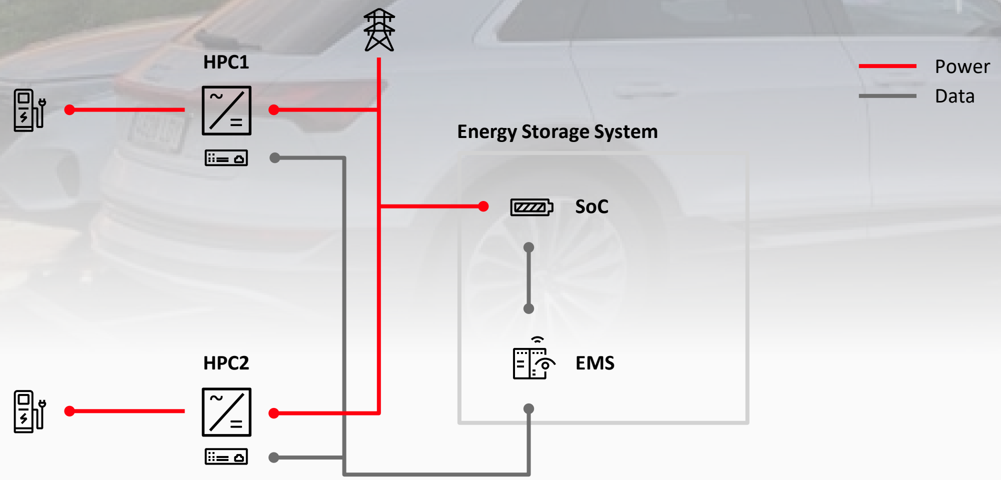
Description	eStorage Flex-40-1035	eStorage Flex-40-1380	eStorage Flex-40-1725	eStorage Flex-40-2070
Electrical specifications				
Maximum Output power (S) [1]	1000kVA	1500kVA	1500kVA	1500kVA
Typical Output power (P) [1,2]	950kW	1300kW	1300kW	1300kW
Installed Energy	1035kWh	1380kWh	1725kWh	2070kWh
Max C-rate	<1C	<1C	<1C	<1C
Nominal voltage	LV: up to 690Vac MV: up to 40.5kV	LV: up to 690Vac MV: up to 40.5kV	LV: up to 690Vac MV: up to 40.5kV	LV: up to 690Vac MV: up to 40.5kV
Frequency	50/60Hz	50/60Hz	50/60Hz	50/60Hz
Power factor range	4-quadrant, 0 to 1	4-quadrant, 0 to 1	4-quadrant, 0 to 1	4-quadrant, 0 to 1
Connection method	3-phase	3-phase	3-phase	3-phase
DC Voltage range	1100-1465Vdc	1100-1465Vdc	1100-1465Vdc	1100-1465Vdc
Equipment				
Enclosure	ABB EcoFlex	ABB EcoFlex	ABB EcoFlex	ABB EcoFlex
Inverter operations modes	VSI Vf, CSI PQ, Islanding, Black-start	VSI Vf, CSI PQ, Islanding, Black-start	VSI Vf, CSI PQ, Islanding, Black-start	VSI Vf, CSI PQ, Islanding, Black-start
Battery chemistry	NMC	NMC	NMC	NMC
Transformer type	Oil-filled, dry-type	Oil-filled, dry-type	Oil-filled, dry-type	Oil-filled, dry-type

eStorage Flex

Reference case - Energy Storage to support EV charging

Block diagram of the Energy Storage

- 10 × eStorage Flex-20 with 500 kW / 500 kWh power for several sites within Europe and the UK
- Peak shaving application for an EV charging infrastructure
- Solution complying with EN50549-1-2 2019



eStorage Flex-20 Integrated Energy Storage

ABB CSS

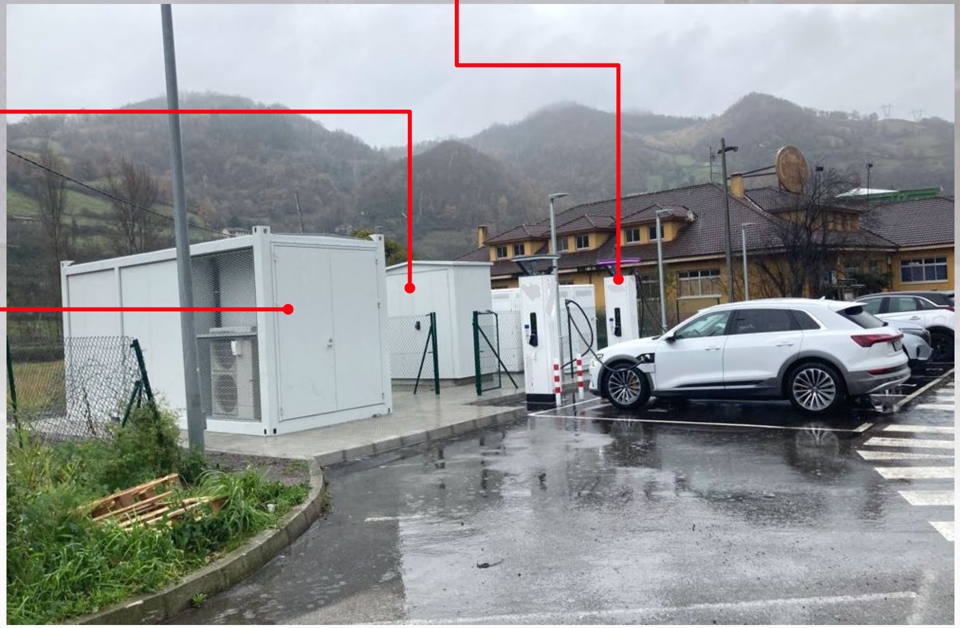
ABB UniPack-G Compact Secondary Substation featuring the ABB EVSS site controller and low-voltage distribution

HP Chargers

ABB Terra HP chargers up to 350 kW DC, cloud connected

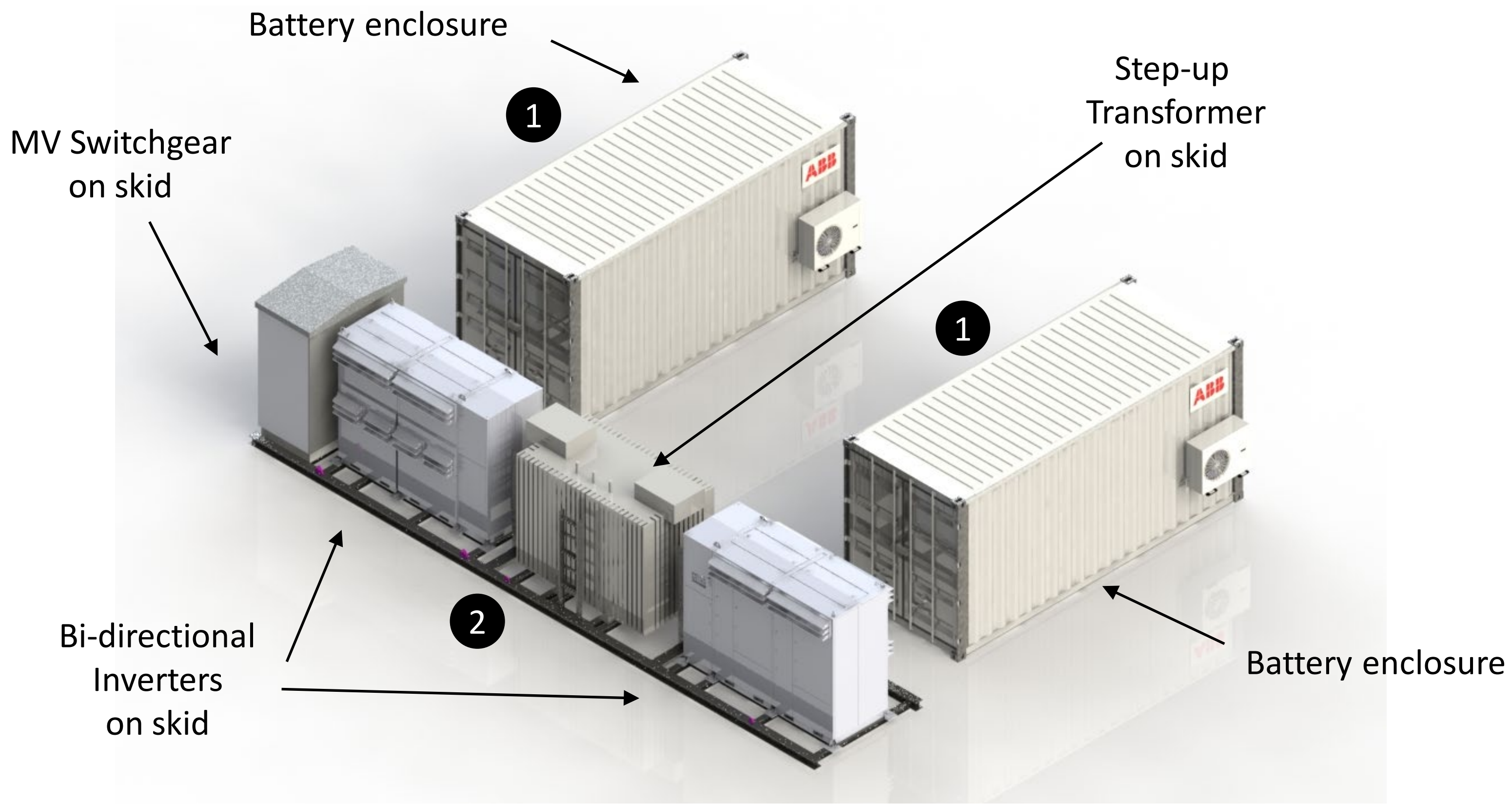
Energy Storage

ABB eStorage Flex-20 featuring ABB eStorage OS, cloud connected



eStorage Max

From modular solution design to real installation

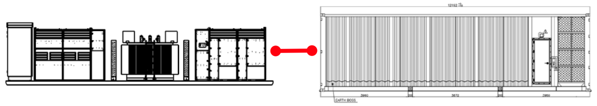


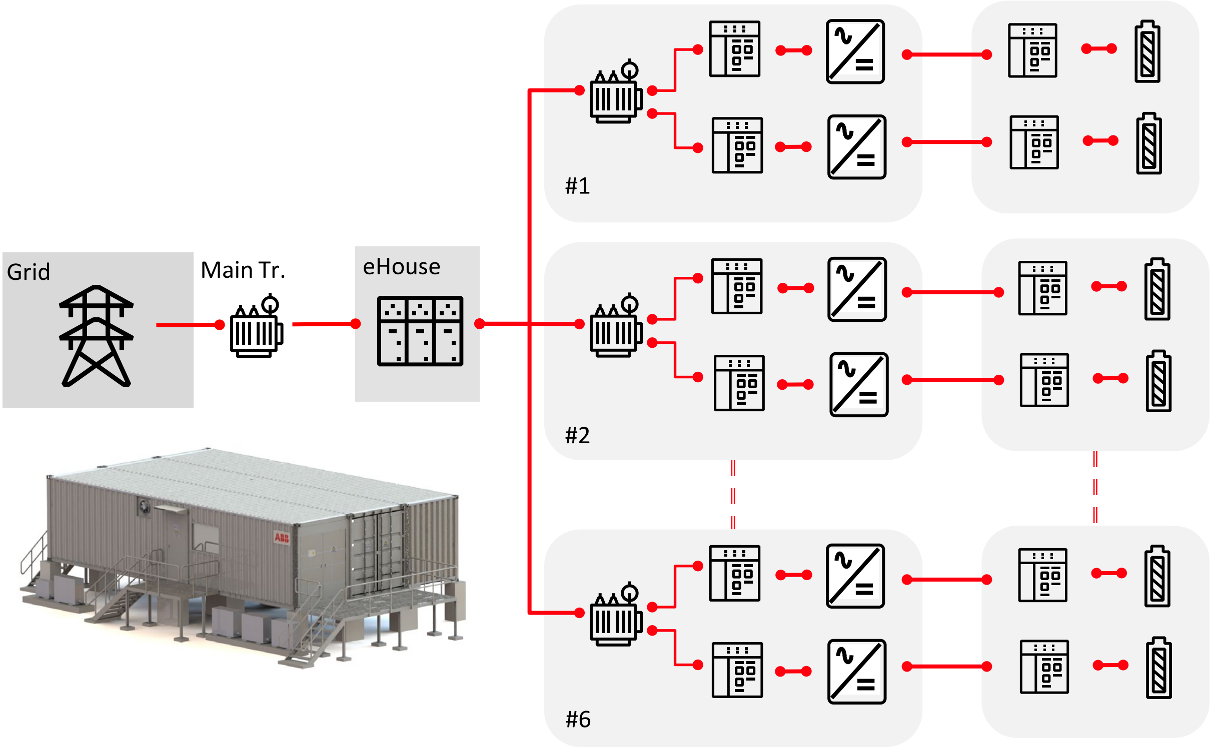
Alternative designs

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

ESM	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 – Electrical Room

Reference case 20MW/20MWh – Frequency Regulation

3 x 12192 x 2438W x 2896H mm EcoFlex modules

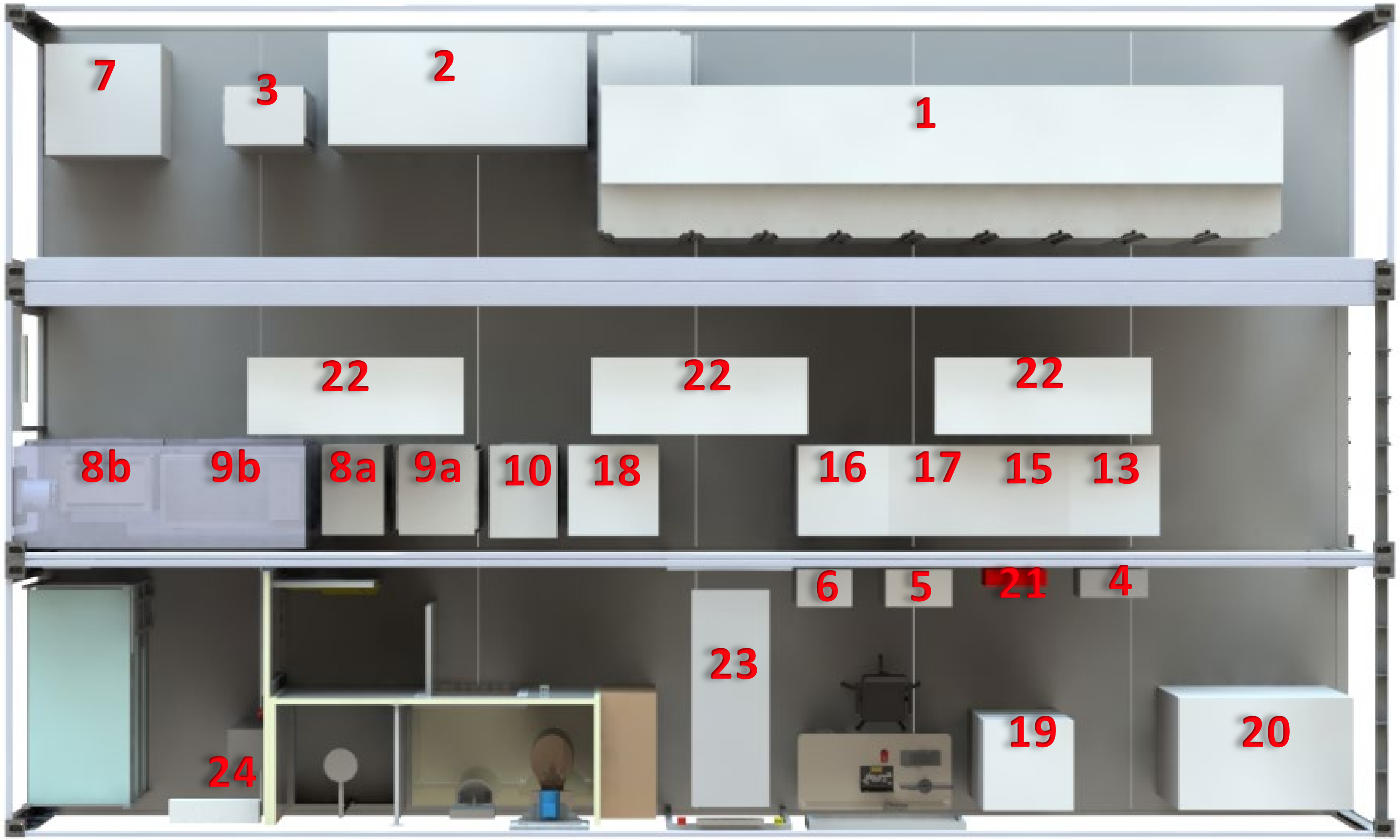
1. Switchgear module
2. Auxiliary Module
3. Office module

EcoFlex eHouse Solution advantages

- Equipment are installed and pre-tested on Fabrication Yard
- Minimize site works
- Standard design
- Easy to transport and install

eStorage Max – Electrical Room

Reference case 20MW/20MWh – Frequency Regulation



ITEM	DESCRIPTION
1	ABB 17.5kV ZS1 MV Switchgear
2	LV Switchgear
3	AC Panel A - Equipment Loads
4	AC Panel B - eHouse Loads
5	125VDC Panel
6	48VDC Panel
7	Auxiliary Transformer
08a	230VAC/10kVA UPS
08b	Battery Rack for 230VAC System
09a	460V-125VDC Rectifier Battery Charger
09b	Battery Rack for 125VDC System
10	460V-48VDC Rectifier with Battery & Battery Charger
13	6kV NGCCP Feeder Protection Panel Main 1 & 2 (Line Protection Panel 1 & 2)
15	Breaker Fail Protection Panel 1
16	Transformer Protection Panel 1
17	69kV/13.8kV Transformer Panel Main 1 (Transformer Protection Panel 2)
18	NDME
19	Telecom Panel - Fox 615
20	Control & Server Panel
21	Fire Alarm Panel
22	HVAC - ACU 1 (Indoor Unit)
23	HVAC - ACU 2 (Indoor Unit)
24	HVAC - ACU 3 (Indoor Unit)
28	Battery Room Exhaust Fan
29	Comfort Room Exhaust Fan

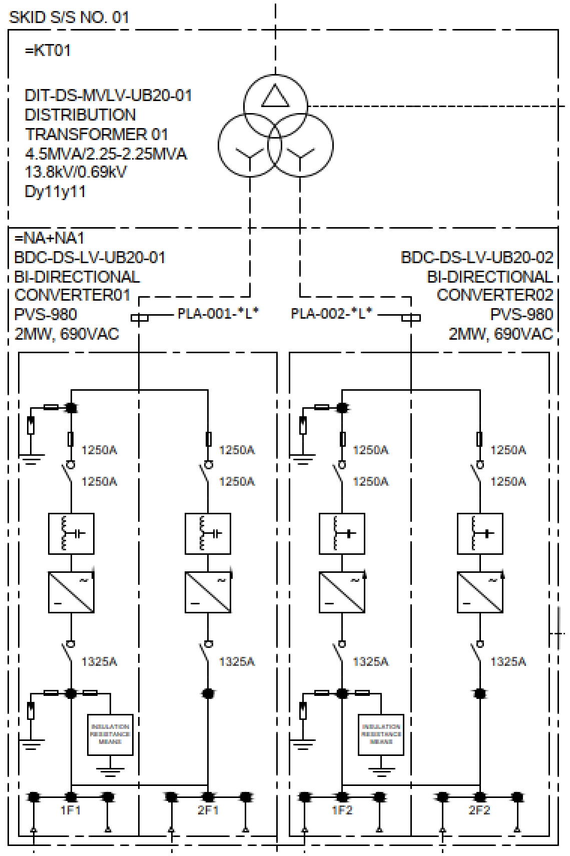
25	HVAC - ACU 1 (Outdoor Unit)
26	HVAC - ACU 2 (Outdoor Unit)
27	HVAC - ACU 3 (Outdoor Unit)

eStorage Max – Electrical Room

Reference case 20MW/20MWh – Frequency Regulation

eStorage Max – Skid with Transformer and Converter

Reference case 20MW/20MWh – Frequency Regulation



eStorage Max – Battery Enclosure

Reference case 20MW/20MWh – Frequency Regulation

Battery Enclosure Dimension

12,192L x 2,438W x 3.5H mm

Major Components

HVAC

Fire suppression system

- Aerosol

Fire Alarm system

- FA panel & Smoke detectors

DC Panel

AC Panel

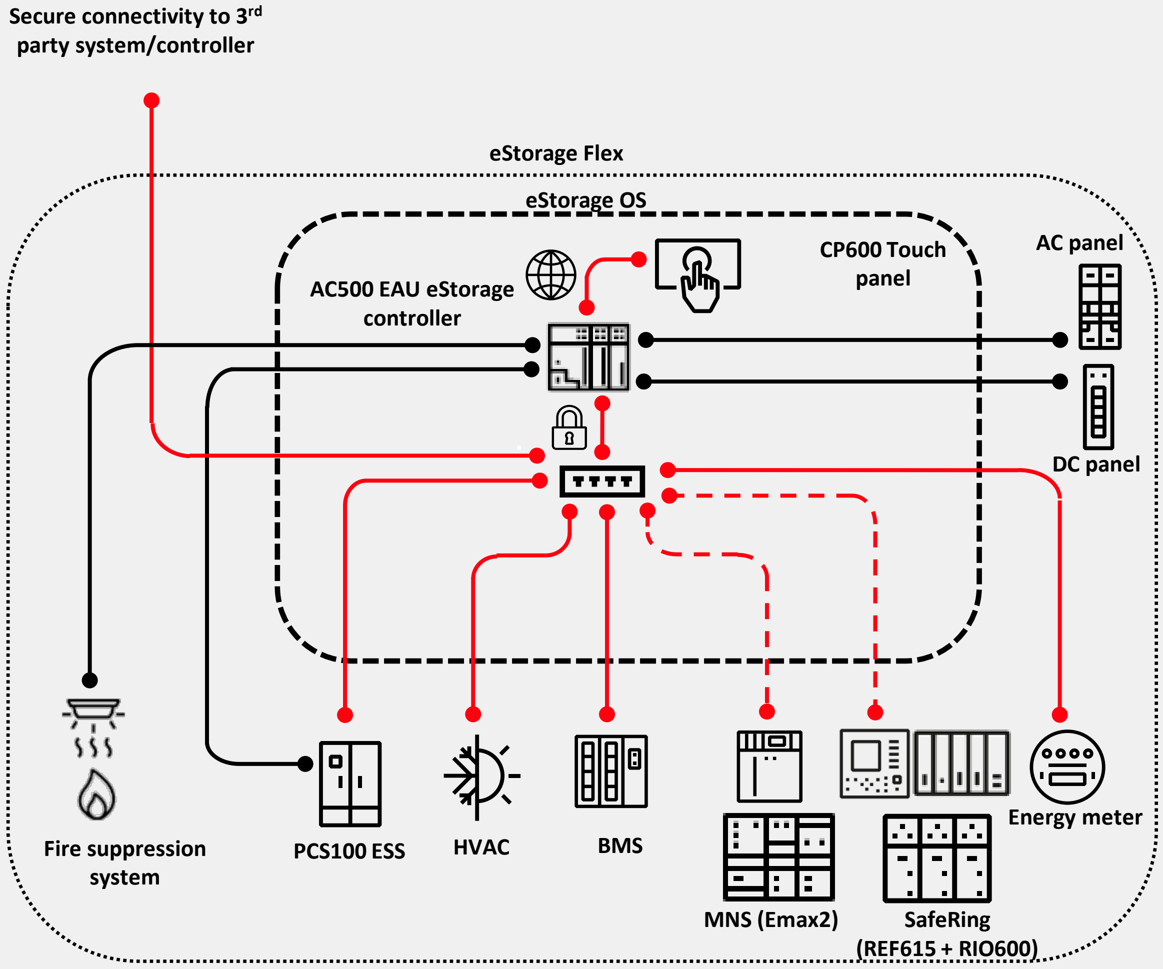
eStorage MAX – Plant Layout

Reference case 20MW/20MWh – Frequency Regulation

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

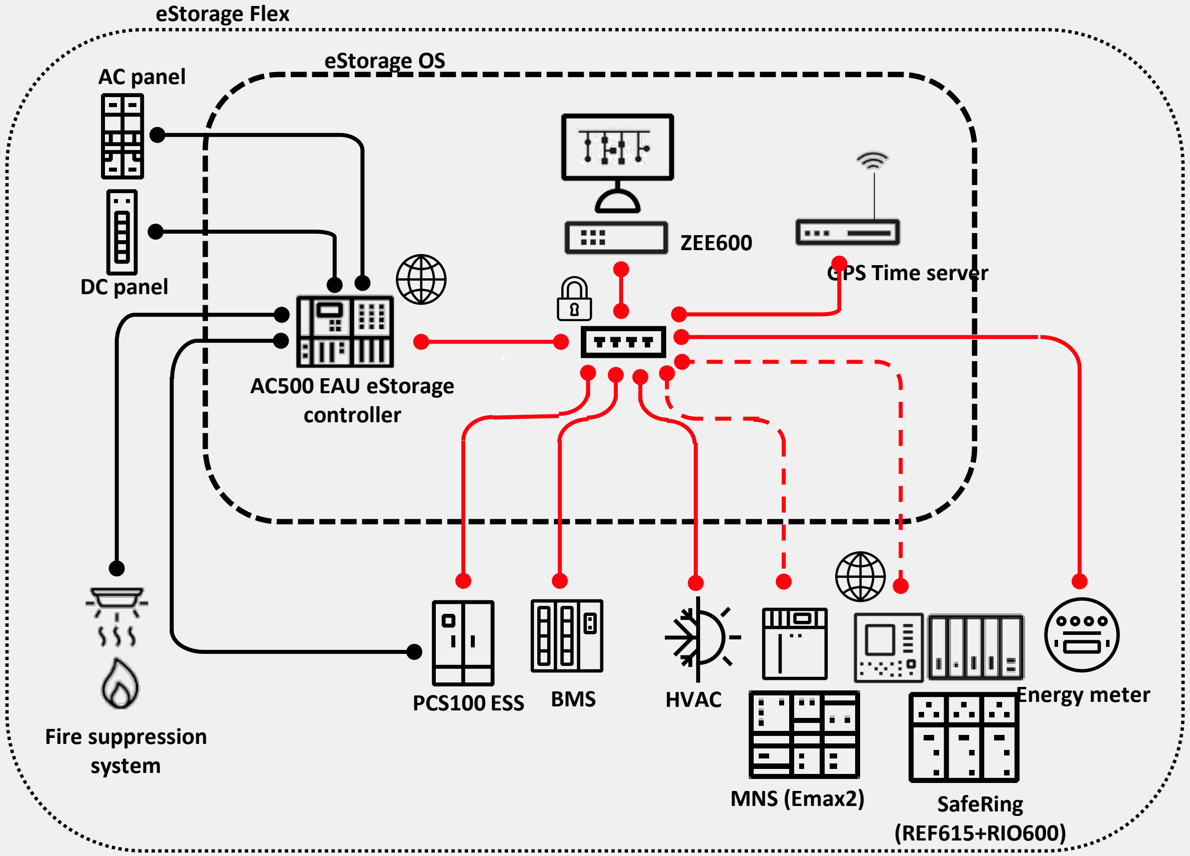
eStorage OS
Stage 1

Fieldbus connectivity with integrated monitoring and protection for external control.



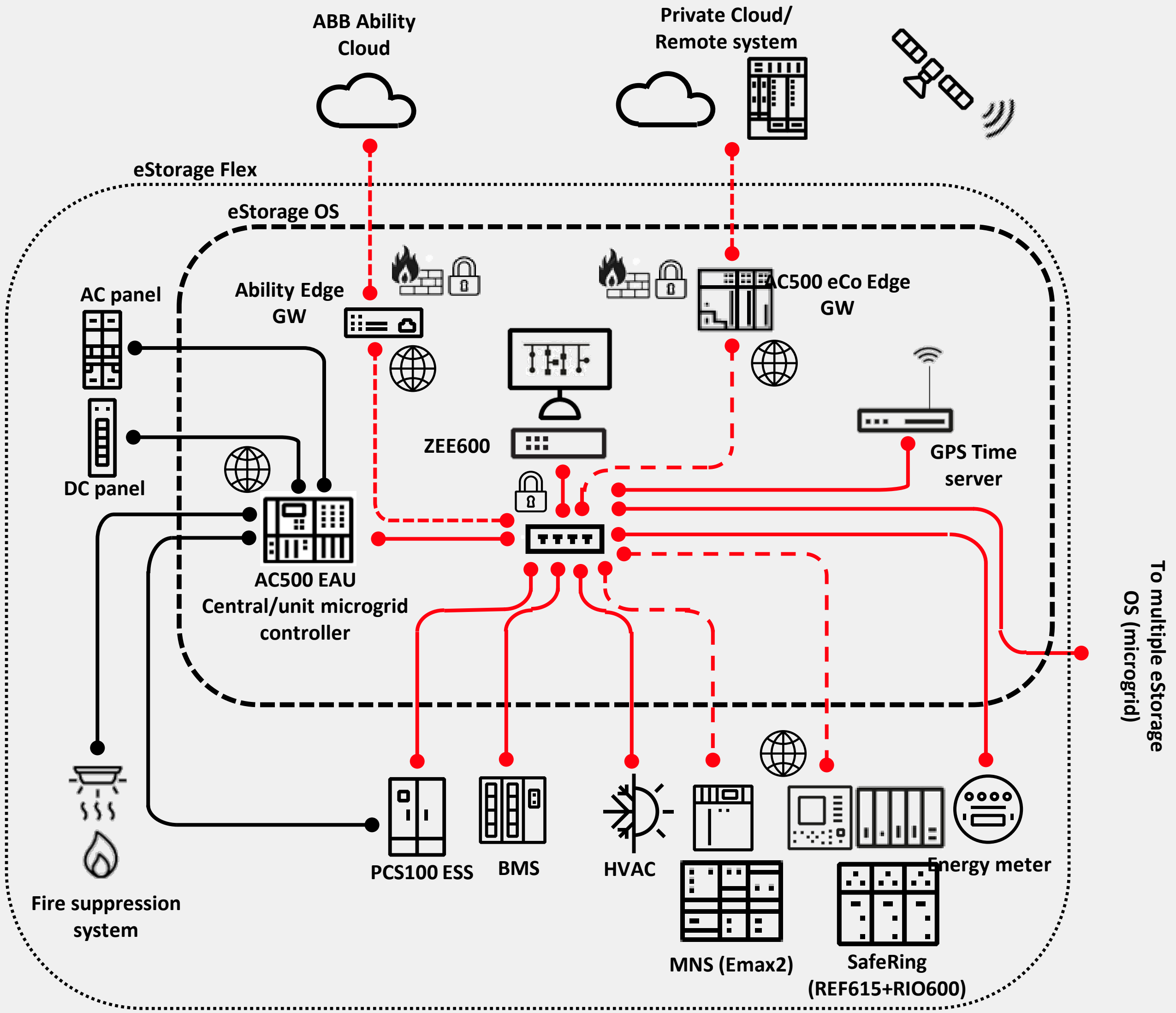
eStorage OS
Stage 2

On-premise energy management system with integrated HMI and smart algorythms for optimal performance.



eStorage OS
Stage 3

On-premise energy management system with advanced cloud connectivity and microgrid possibilities.



eStorage OS

Stage 4 - Microgrid

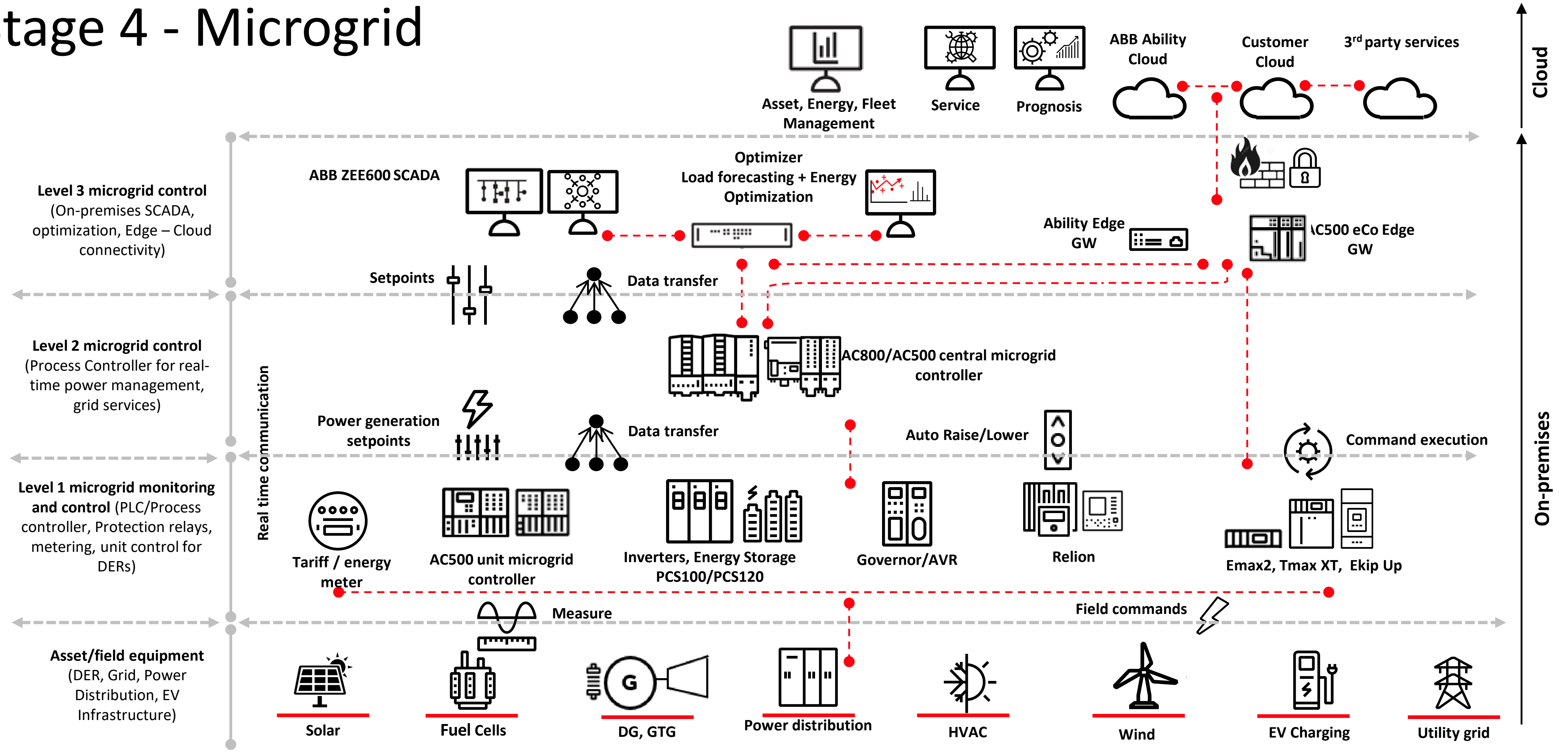


ABB Energy Storage Solutions

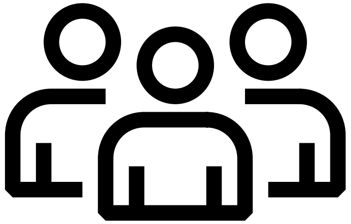
Your task – our mission

Customer Requirements

- Speed, Speed, Speed – TIME TO MARKET!
- Short delivery times and on time
- Require low risk solutions
- Minimize site activities and related risks
- Need strong coordination by one vendor (ABB ☺).

ABB Packaging and Solutions

- One focal point of execution
- Manage, coordinate and facilitate tenders and project execution.
- Reduce risk on-site by pre-fabricated and/or pre-engineered solutions.
- Site management, installation and commissioning
- Reduce client´s overall CAPEX through risk limitation and by taking wider responsibilities.



Solutions architects
– expert support

Global Support Organization

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ABB