Battery Energy Storage for Hybrid Microgrid Applications

Energy & Digital World (EDW) 2024, Knowledge Session 2.3.1, 13:30-14:30

PU Jianjiang, Bambang Prihambodo, Alexander Pradana

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Hitachi Energy

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Our Local Presence – We are here to support

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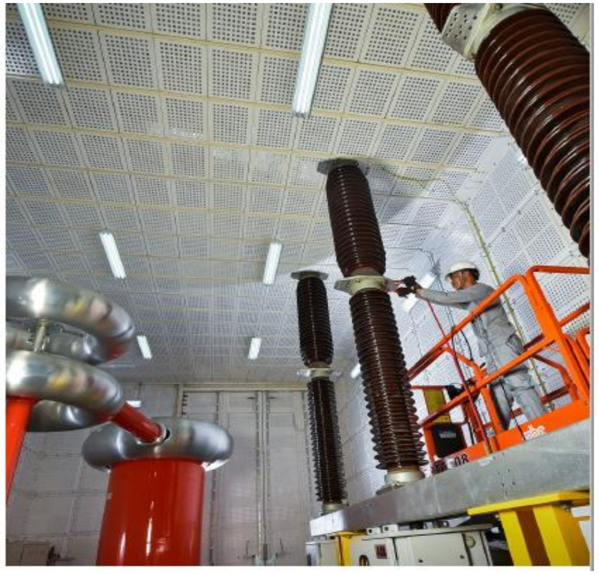

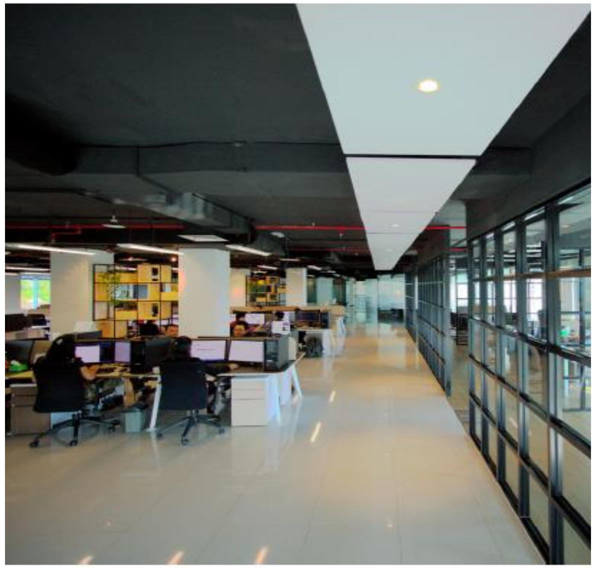

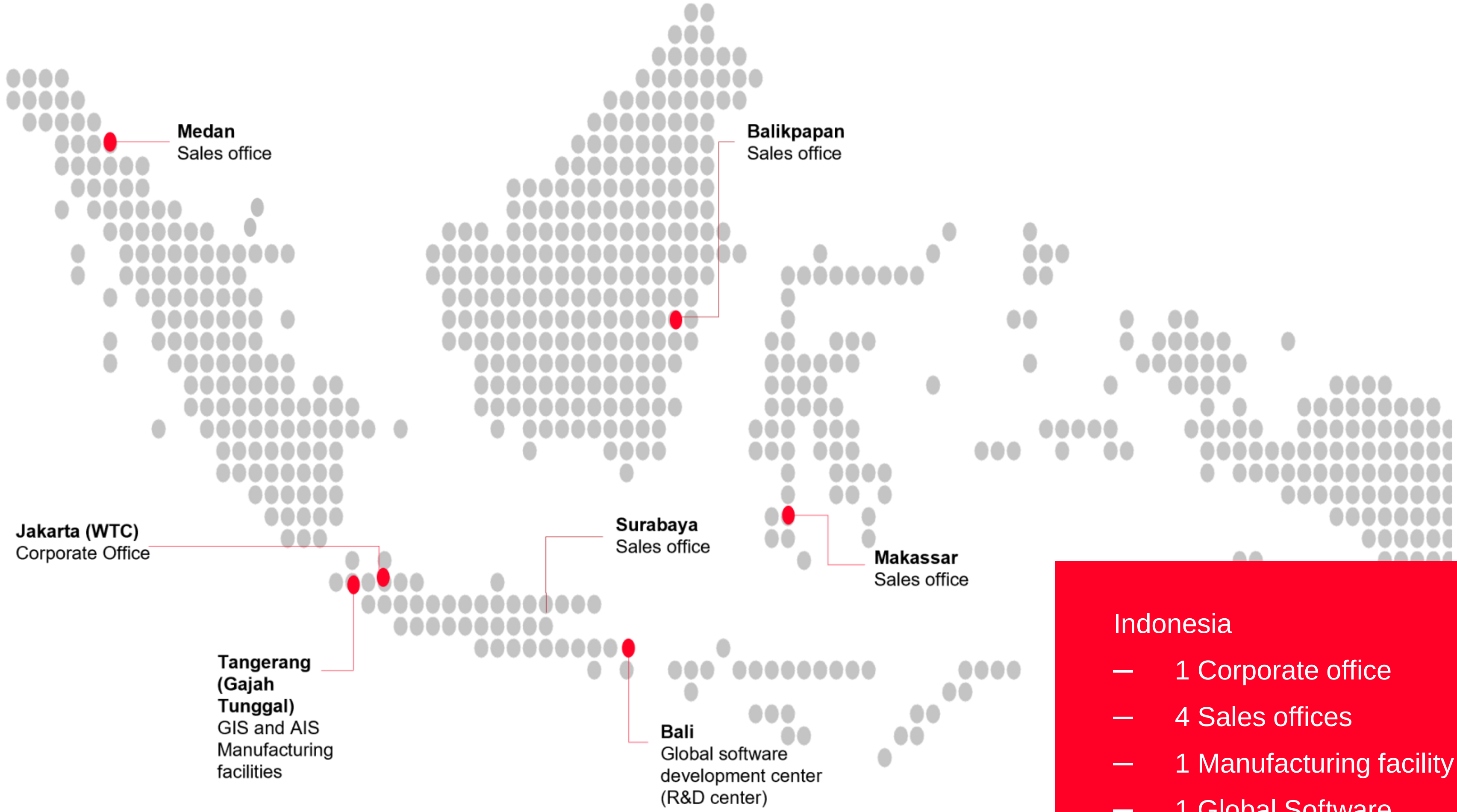

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Indonesia

- 1 Corporate office
- 4 Sales offices
- 1 Manufacturing facility
- 1 Global Software Development Center
- >300 Employees
- Large Installed base

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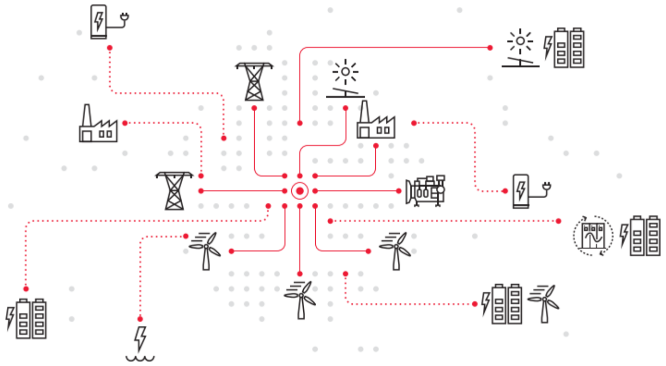
Converging Megatrends

MEGATREND 1
Decarbonization
According to McKinsey and Co., more than 70 countries have committed to net-zero targets[1] and more than 5,200 companies have mobilized efforts to support the United Nations' Race to Zero campaign[2].

MEGATREND 2
Decentralization
Adoption of distributed energy resources (DERs), such as wind and photovoltaic (PV) generation plants, requires fundamental shifts in grid operations, where output intermittency can cause grid disruption and Battery Energy Storage System (BESS) can play a crucial role.



MEGATREND 3
Digitalization
In renewables, digitalization or automation, such as Energy Management System (EMS) in BESS, is a catalyst for harnessing the seamless integration of renewables and conventional generations.

Source:
1 McKinsey. (2022). The net-zero transition: What it would cost, what it could bring.t <https://www.mckinsey.com/business-functions/sustainability/our-insights/the-net-zero-transition-what-it-would-cost-what-it-could-bring>
2 United Nations Framework Convention on Climate Change. (2022) Race to Zero Campaign. <https://unfccc.int/climate-action/race-to-zero-campaign

Grid Edge Solutions

Our Local GES Microgrid Installation – We provide security and reliability

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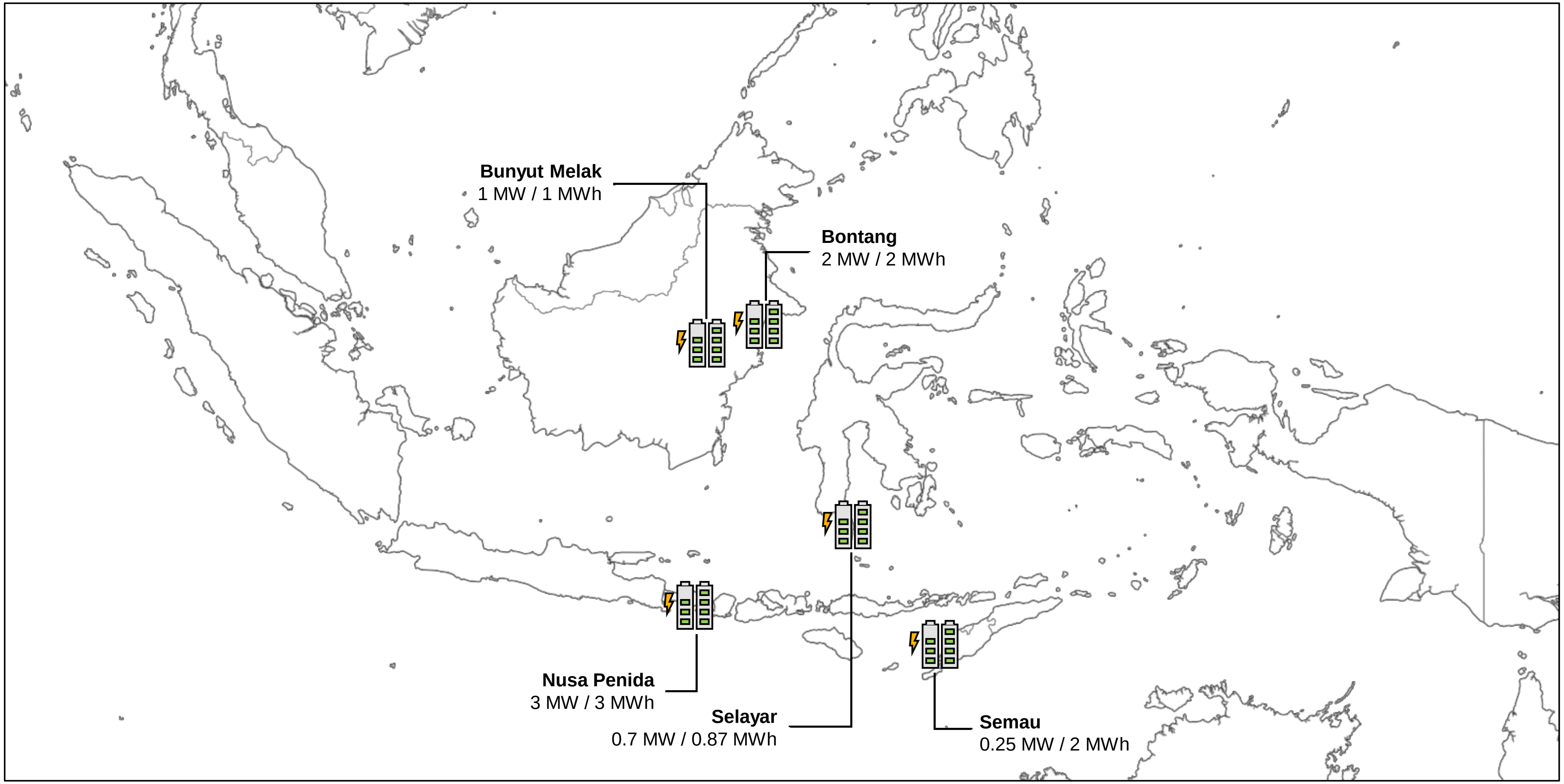

Microgrid fits as a solution for grid security in an archipelago country like Indonesia, where the remote islands/areas mostly are dependable to conventional generation, such as diesel fuel generator.

Non-utility Energy Grid Challenges

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CHALLENGE 1

Integration of Renewable Energy Sources (RES)

The variability of RES can cause voltage fluctuations and frequency inconsistencies, leading to potential blackouts and reduced power quality.

CHALLENGE 2

Network Instability

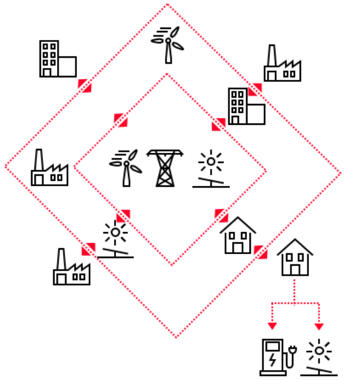
When a load is suddenly disconnected from the grid system, the energy that was being supplied to that load has nowhere to go, which can cause a spike in voltage. This overvoltage can damage sensitive equipment and reduce the lifespan of system components. Likewise, it can also happen during undervoltage event.

CHALLENGE 3

Technological and Economic Challenges

Achieving a reliable and stable grid with a high penetration of inverter-based resources (like wind and solar) involves overcoming both technical and economic hurdles. Combination of RES and BESS must replace conventional generation technically and economically.

…etc



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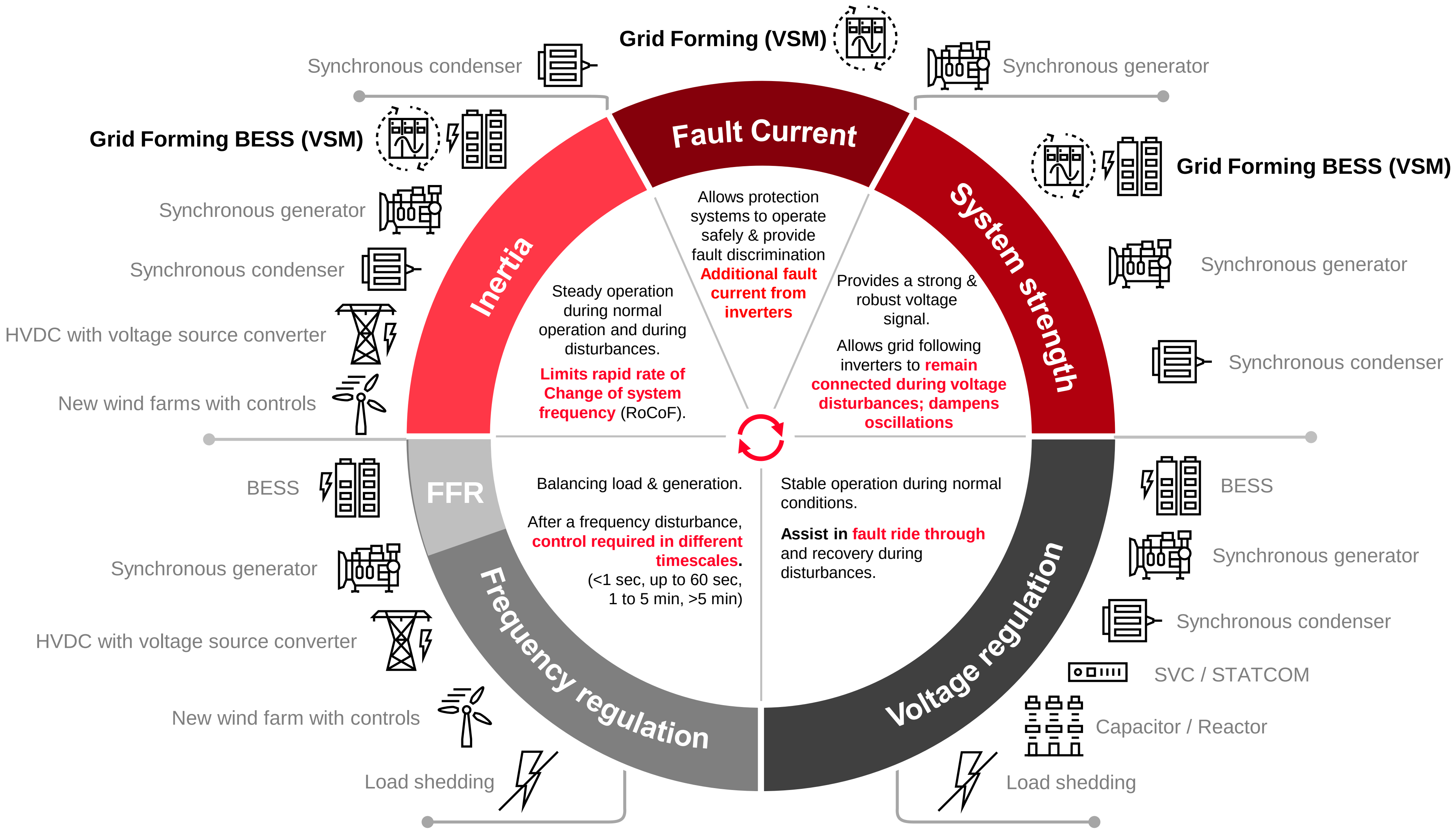
Ensures network stability through grid services



e-mesh capability

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Seamless Transition

Seamless transition from grid connection to islanded mode

Meet the challenges for robust power supply in isolation from national grid infrastructure and gain control of your power needs on ‘local’ level

Grid Stabilization

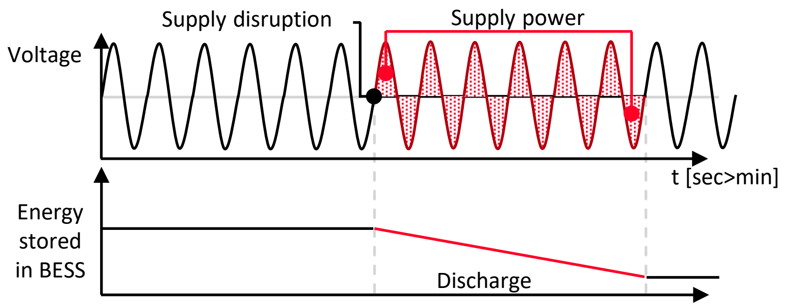
Reliable and affordable flow of power whenever it is required

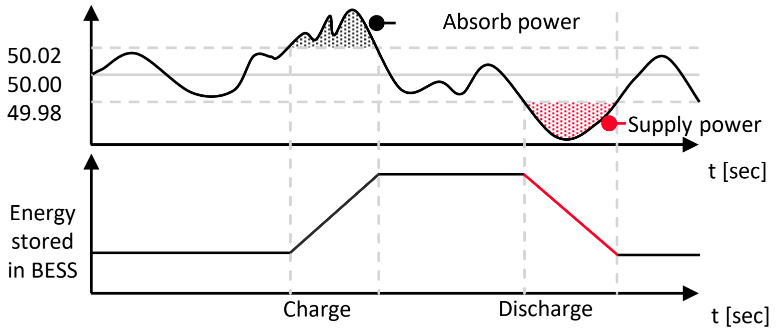
Stabilizes an electricity network by rapidly absorbing power surges or by injecting power to make up for short-term decline, in order to maintain high quality

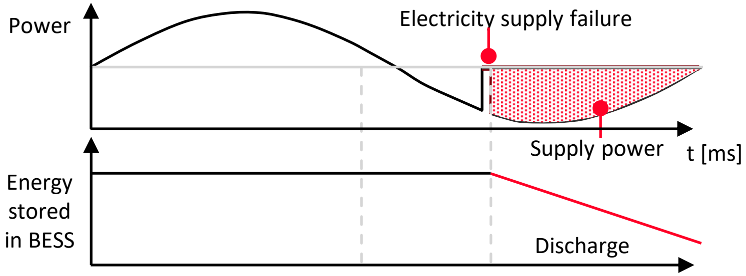
Standalone

Driving the transition to a carbon neutral tomorrow, today

Acts as “Virtual Generator” and can form the grid, handling up to 100% renewable energy.

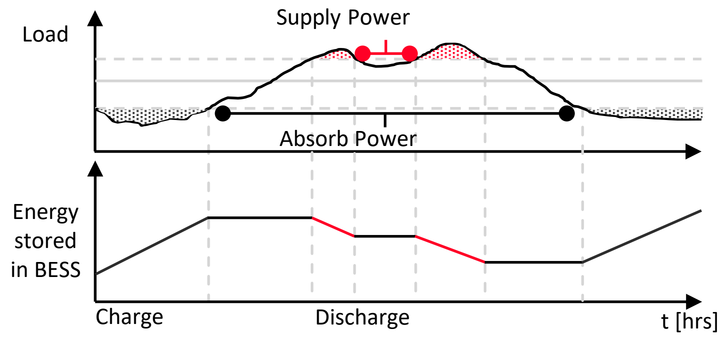




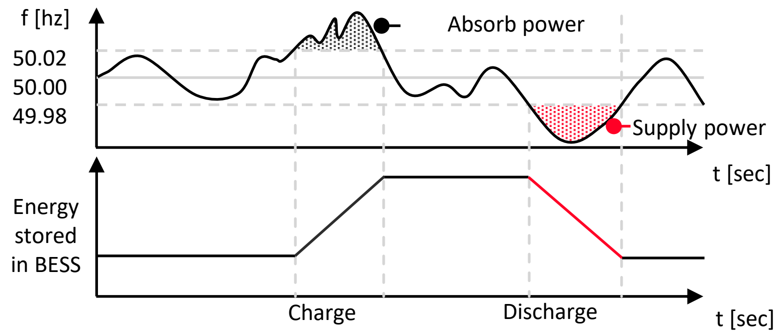


Advanced control algorithms enabling revenue stacking to maximizing return on investment

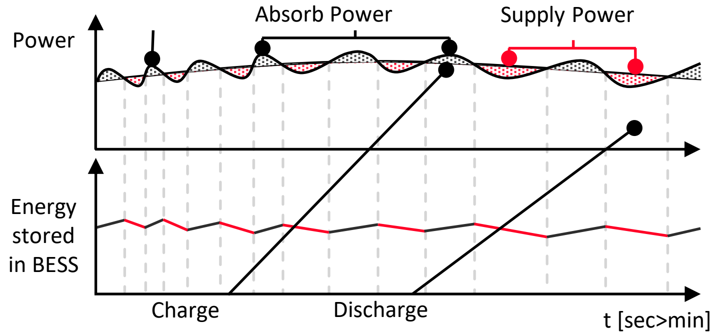
e-mesh application



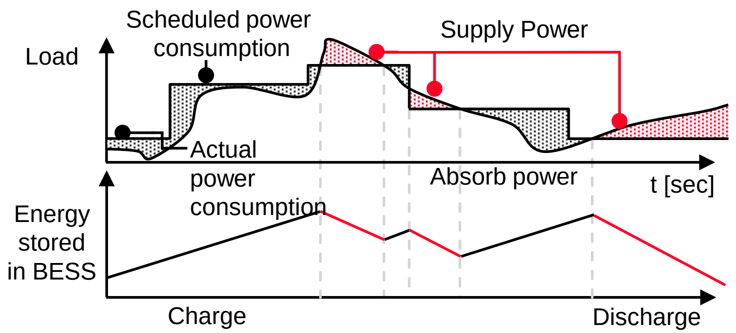
Load leveling



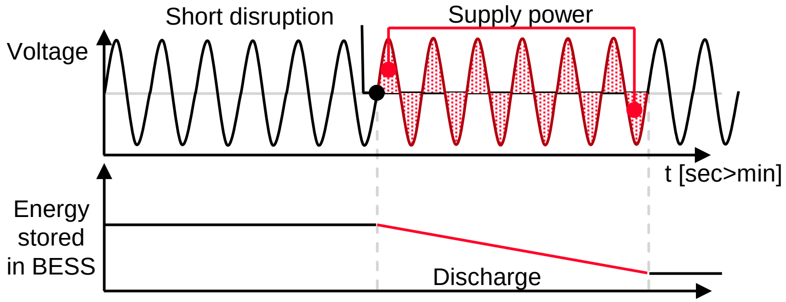
Ancillary services



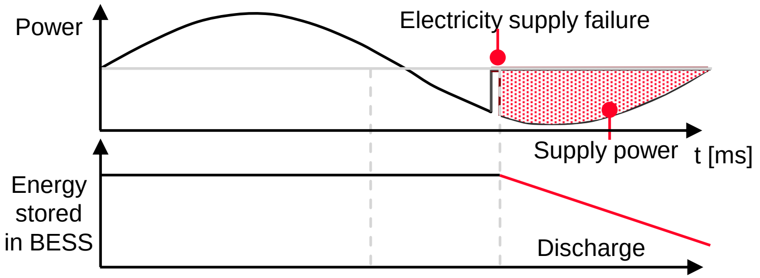
Integration of renewable resources



Peak shaving



Power quality



Spinning reserve

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Types Of Ancillary Services and Associated Products

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Ancillary service	Product	Description	Typical response time
Frequency regulation	Primary regulation	• The automatic local regulation provided by generating unit speed regulators. • Fast frequency response is a new product designed to remunerate the provision of fast response. • Wind turbines can provide inertial response through power electronic converters. • Photovoltaic (PV) installations, direct current systems and batteries can also provide synthetic inertial response if the inverter is programmed to do so. • If regulation allows, DERs can provide this service.	Sub-seconds to seconds
	Secondary regulation	The automatic regional regulation provided by automatic generation control (AGC), which sends signals from the control center to certain generators to reestablish the nominal frequency value and restore the primary reserve capacity. If regulation allows, DERs can provide this service.	5-15 minutes
	Tertiary regulation	The manual regional regulation provided by generating units and controlled by the system operator.	>15 minutes
Non-frequency regulation	Voltage support	• The injection of reactive power to maintain system voltage within a prescribed range. • Voltage control through reactive power provided by resources connected to the power system through inverters, such as solar photovoltaic and battery storage. • If regulation allows, DERs can provide this service.	Seconds
	Black-start	The ability to restart a grid after a blackout.	Minutes
	Ramping products	Fast ramping resources that can respond to large net load variations in a short time.	Minutes

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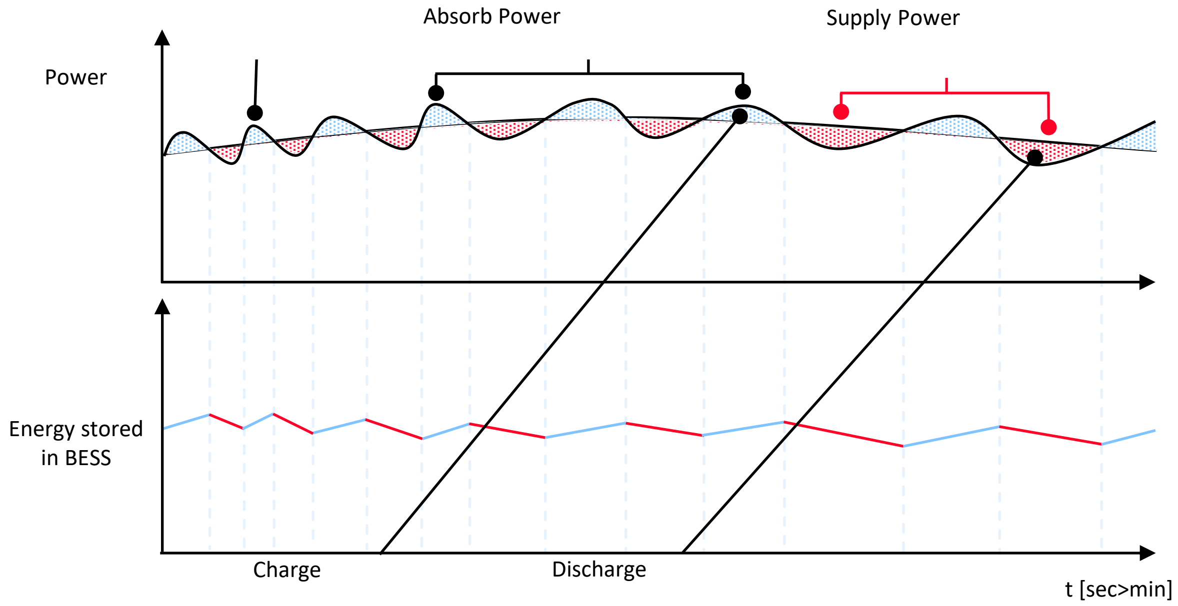
Non-utility Application: Renewable Output Smoothing

The output from a renewable energy source (PV or wind) is variable and unpredictable. The energy stored in an energy storage system (BESS) can be used to counteract the variations in renewable energy sources.

The variation in output can be defined as having a maximum ramp-up rate and a maximum ramp down rate; these rates are defined in kW/s.

The aim of this function is to smooth renewable energy sources output power by injecting power from BESS in order to maintain the combined (Renewable + BESS) output lower than the ramp-up and ramp-down limits at grid connection point. This function can be used for grid connected or islanded systems alike. (Ramp rate diesel @ 40 kW/s, ramp rate PV intermittency @ 100 kW/s, target ramp rate PV+BESS must far less than ramp rate diesel e.g. 1 kW/s)



Information required for simulating ESS capacity in power smoothing:

1. Weather data, especially the worst period in a year
2. Grid strength (ramp up & ramp down capacity)
3. PV smoothing algorithm

Non-utility Application: Grid Frequency Support

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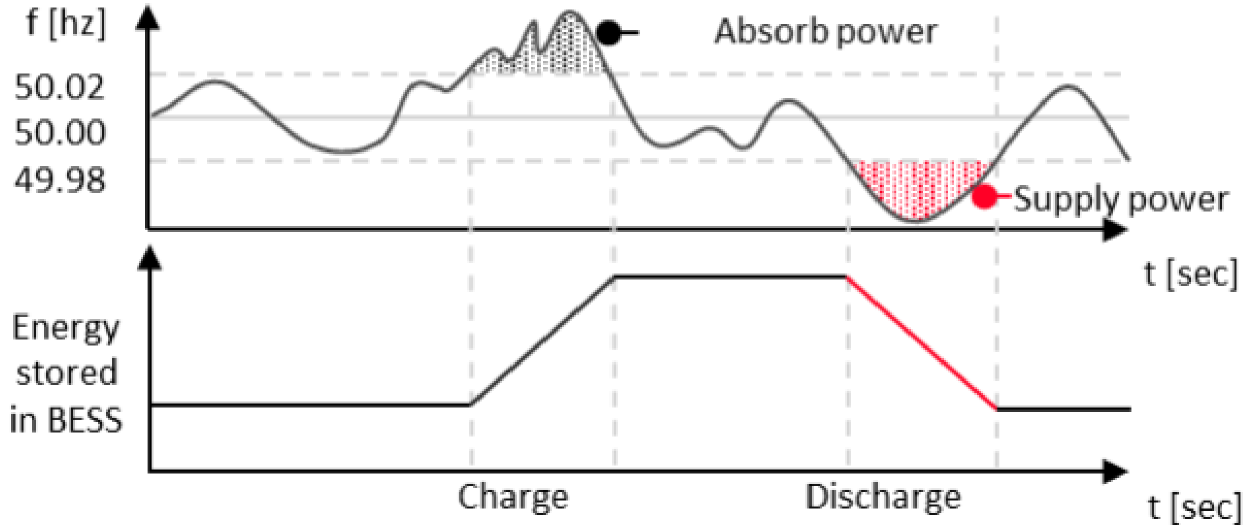
Grid frequency support function is a e-mesh™ controller primary function and the primary objective of the function is to maintain the frequency in the point of connection within the limits.

The BESS is it's allowed to charge, and discharge based on the change in frequency in the network within the agreed cycle for a day.

If the frequency is decreased in the grid, the controller will allow the converter to inject the respective real power to bring the frequency within the limits, likewise when the frequency is increased above the permissible limits the controller will ask the converter to absorb the real power or in charge mode to bring down the frequency within the limits.

Applications:

- Frequency Containment Ancillary services (FCAS)
- Frequency Containment Reserve (FCR)
- Frequency Sensitivity Mode (FSM)

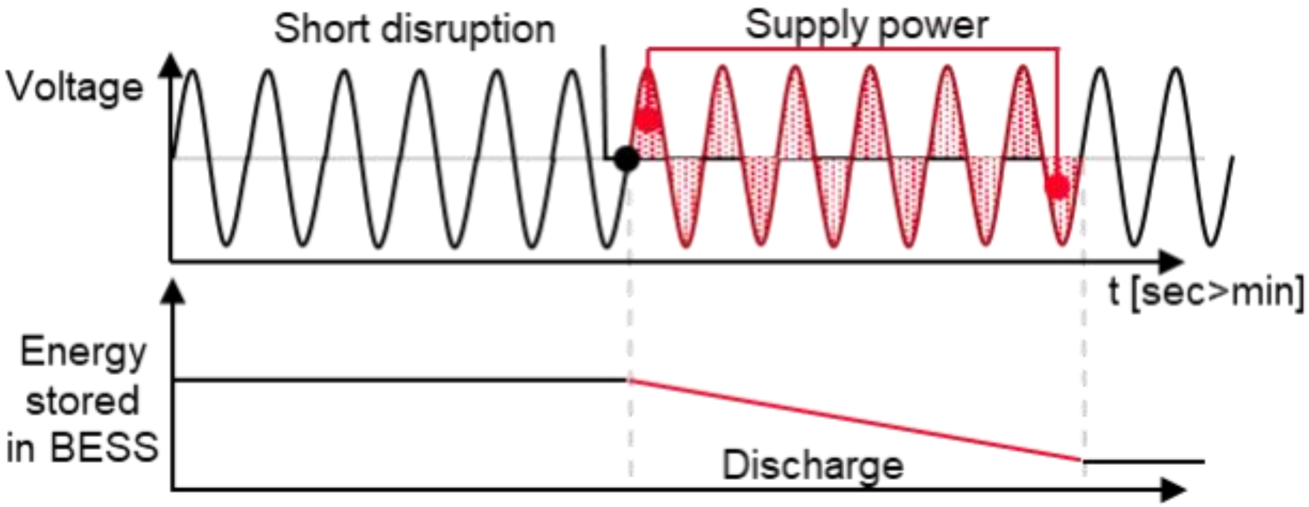


Grid Voltage Support

Grid voltage support function is a e-mesh™ controller primary function and the primary objective of the function is to maintain the voltage in the point of connection within the limits.

The customer needs to provide the allowable grid voltage variation limits which has direct impact on the coupling voltage of the converter.

If the voltage is decreased at the PoC, the controller will allow the converter to inject the respective reactive power to bring the voltage within the limits, likewise when the voltage is increased above the permissible limits the controller will ask the converter to absorb the reactive power or in charge mode to bring down the frequency within the limits.



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Non-utility Application: Peak Shaving

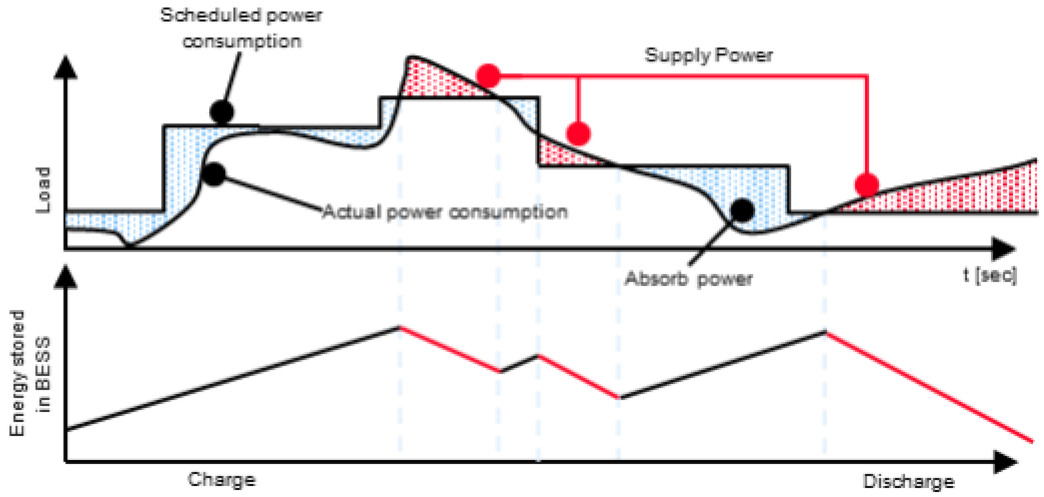
Peak Lopping is operated in grid-following mode.

This functionality operates BESS to supply active/reactive power or absorb active/reactive powers based on the scheduled power consumption or peak demand restriction at grid connection point.

BESS will discharge during peak demand hours and uses excess power available during off peak hours to charge batteries in order to reduce overall gird demand and its associated demand charges.

It also allows the selection of priority. Under this mode, when the Q priority is selected, the reactive power is favored on the active power whereas, with the P priority selected, the active power is favored on the reactive power.

Additionally, in this peak-lopping operating mode, the active and reactive power limits could be adjusted by changing the percentage of the nominal reactive and active power of the power plant that is allowed at the PoC, resulting in a reshaping of the capability curve at the same grid connection point.

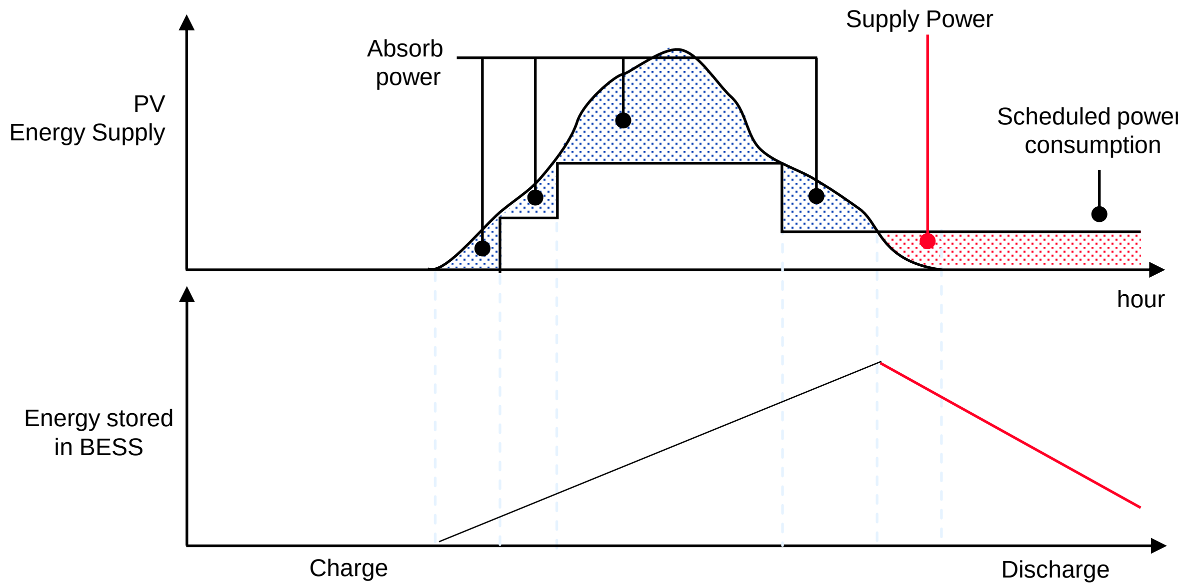


Non-utility Application: Fixed Output Power

BESS can store energy from renewable sources like solar and wind, or from the grid, and discharge it when needed to maintain a fixed output power. This helps in balancing supply and demand, especially during peak usage times.

The EMS coordinates the operation of the BESS, including charging and discharging cycles, to optimize performance and ensure a steady power supply. It also helps in integrating the BESS with other energy sources and managing the overall energy flow.

Using BESS for fixed output power can enhance energy reliability, reduce operational costs, and support the integration of renewable energy sources. It also helps in reducing carbon emissions by optimizing the use of renewable energy.



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Non-utility Application: EV Charging Station / Battery Swap Station

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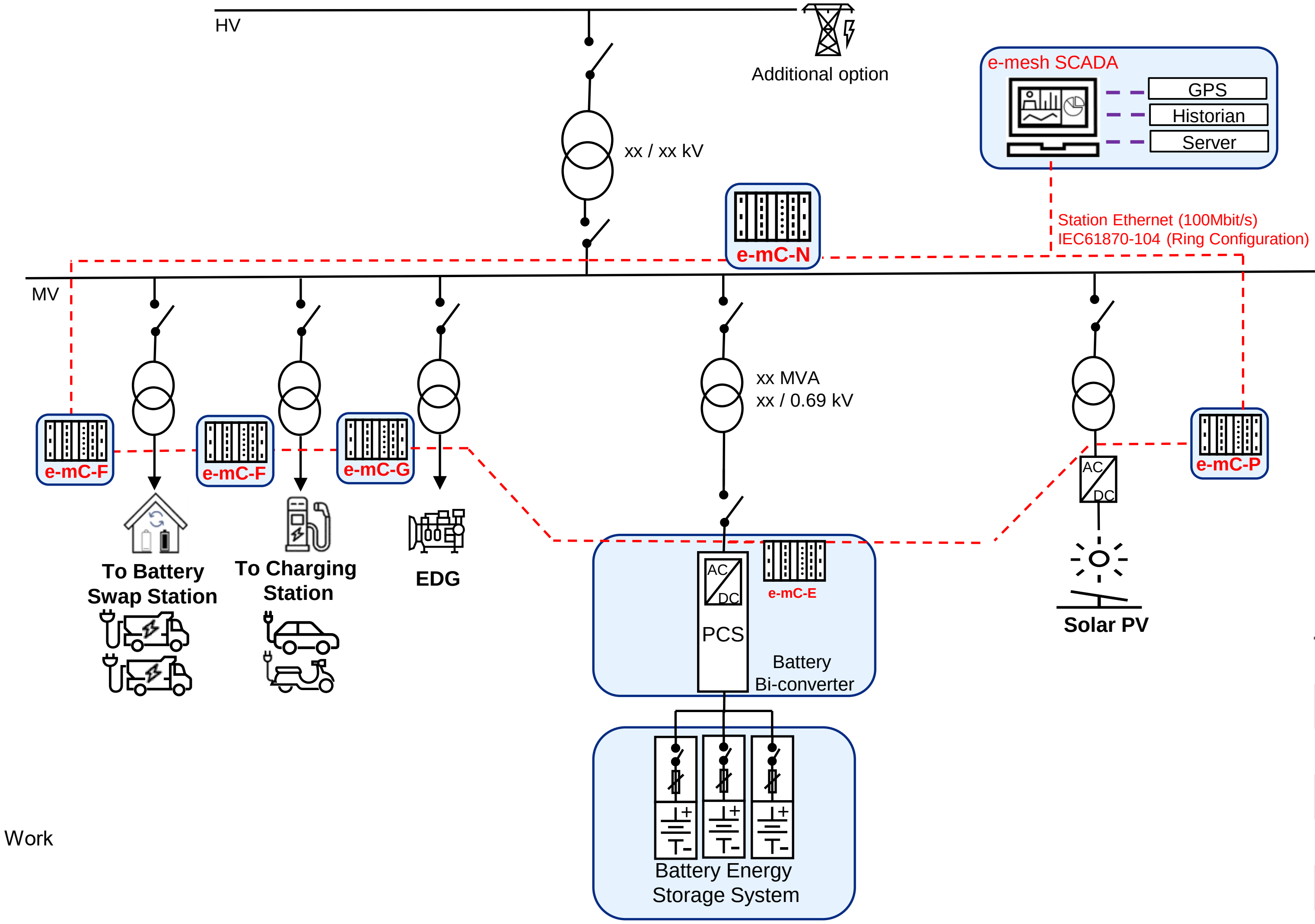
Disclaimer: The shown diagram is mainly for illustration of the proposed functionalities. The supplied goods might look different from the illustration shown.



Energy Assets	Controller	Application
	e-mC-P	PV inverters
	e-mC-E	BESS*
	e-mC-G	Fossil fuel generators
	e-mC-W	Wind turbines
	e-mC-F	Load feeders
	e-mC-N	Grid / network interface
	e-mC-RA	Renewable Power plant control

= Hitachi Energy's Scope of Work (supervision)

= Cable by Hitachi Energy

= Cable by Customer

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About Grid Edge Solutions

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As a pioneer in energy management and optimization, Hitachi Energy is your trusted partner in the evolving global energy ecosystem.

Our Energy storage and renewable integration solutions are **leading energy innovation and transition** with 30+ years of experience and 300+ projects**.**

Helping customers increase profitability and unlock new revenue streams by reducing energy cost, maximizing renewables and lowering CO_2.

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Grid Edge Solutions Evolution

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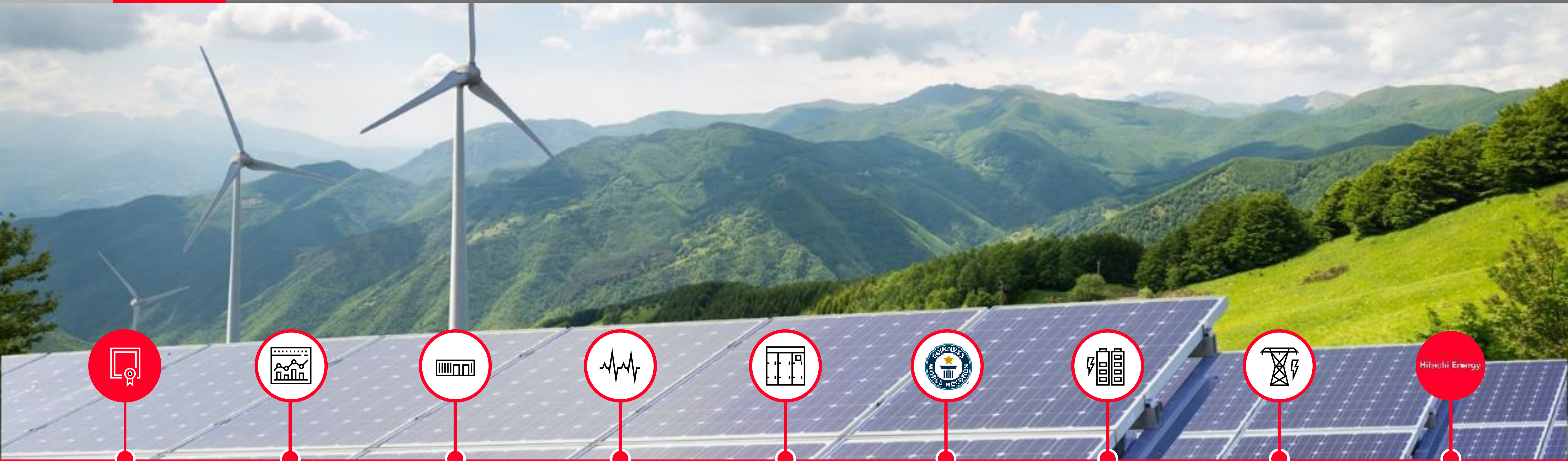

1906
IEC founded, we are a leading member

1960
Introduced first SCADA system

1988
Powercorp founded in Australia

powercorp

1990
Implemented first inverter-based system to stabilize energy output

2002
eks Energy founded in Seville, Spain

eks

2003
Guinness World Record for the world's most powerful battery to the date

2021
Hitachi Energy acquires Powercorp

2021
Hitachi Energy to deliver one of Europe's largest BESS in Finland

2023
Hitachi Energy acquires eks Energy, a leading power conversion manufacturer

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e-mesh™ portfolio produces value stacking benefits

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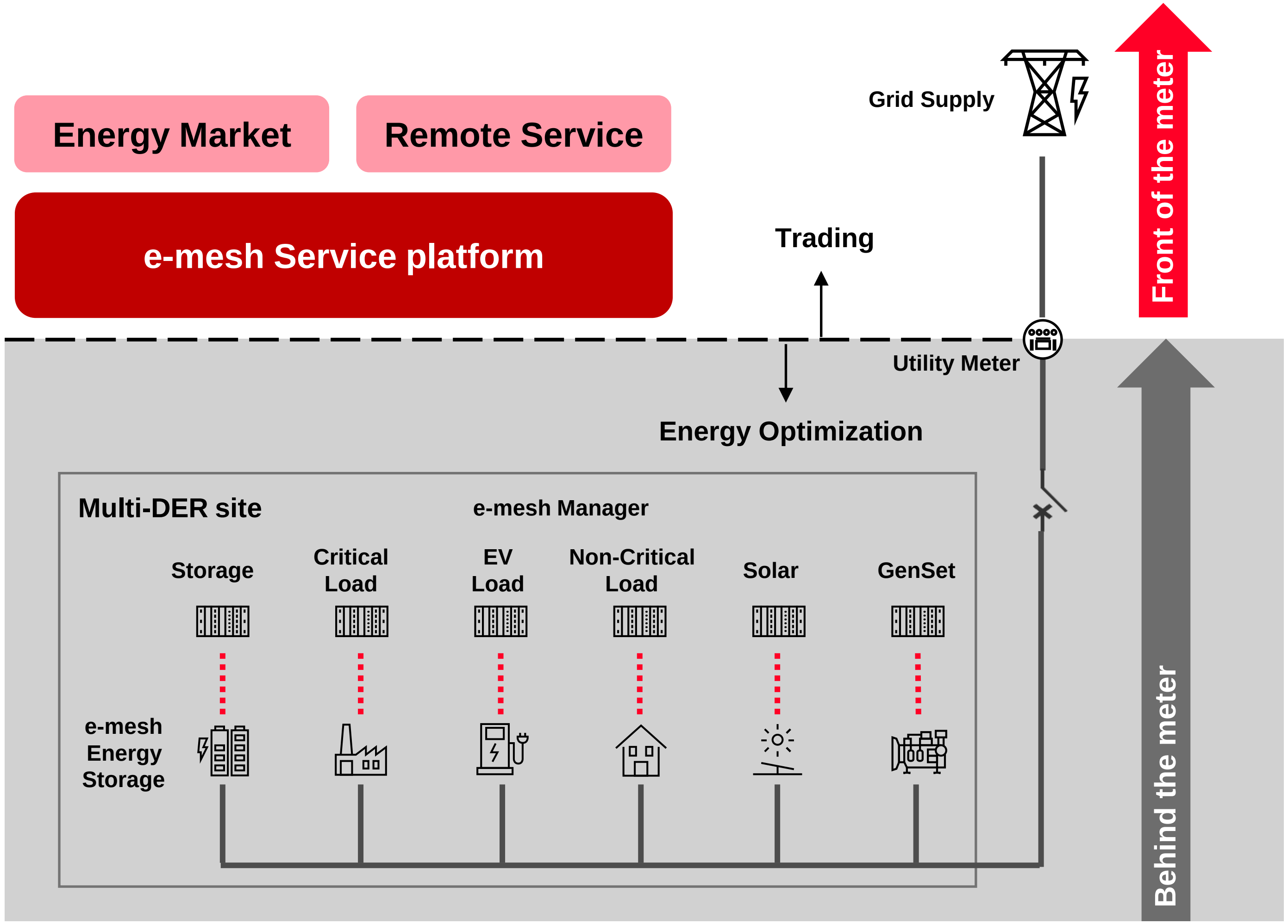
e-mesh value stack

e-mesh Service
additional value streams for optimized business cases

e-mesh Manager
integration of renewable sources, system optimization for max renewable penetration: Energy management is the optimization of a full depot or site energy profile incl smart charging

e-mesh Energy Storage
Site flexibility element for peak lopping, grid stabilization, islanding, and resiliency



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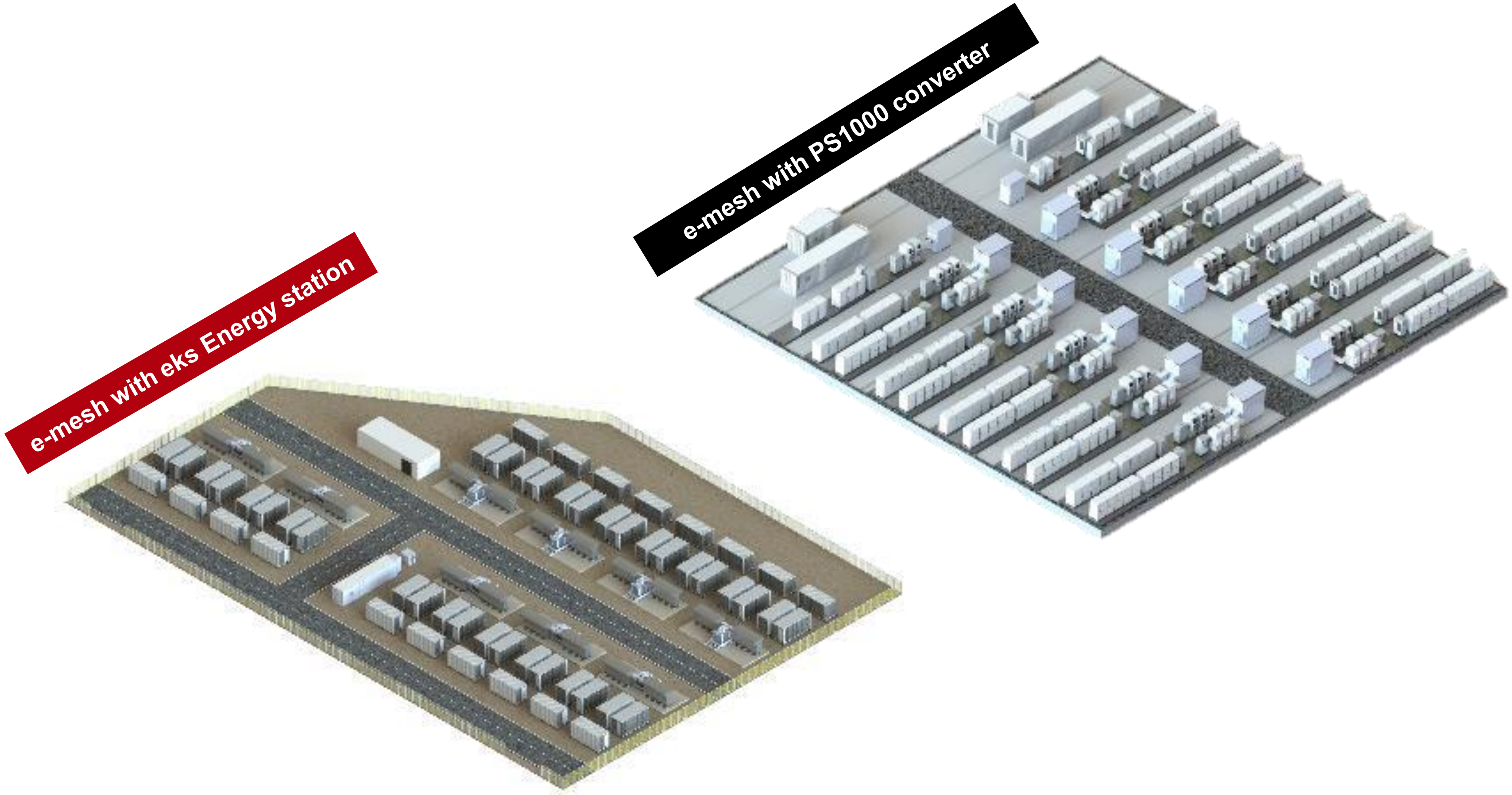
e-mesh Battery Energy Storage Solutions (BESS)

Scalable systems available in 1-3MW blocks enable faster site installation.

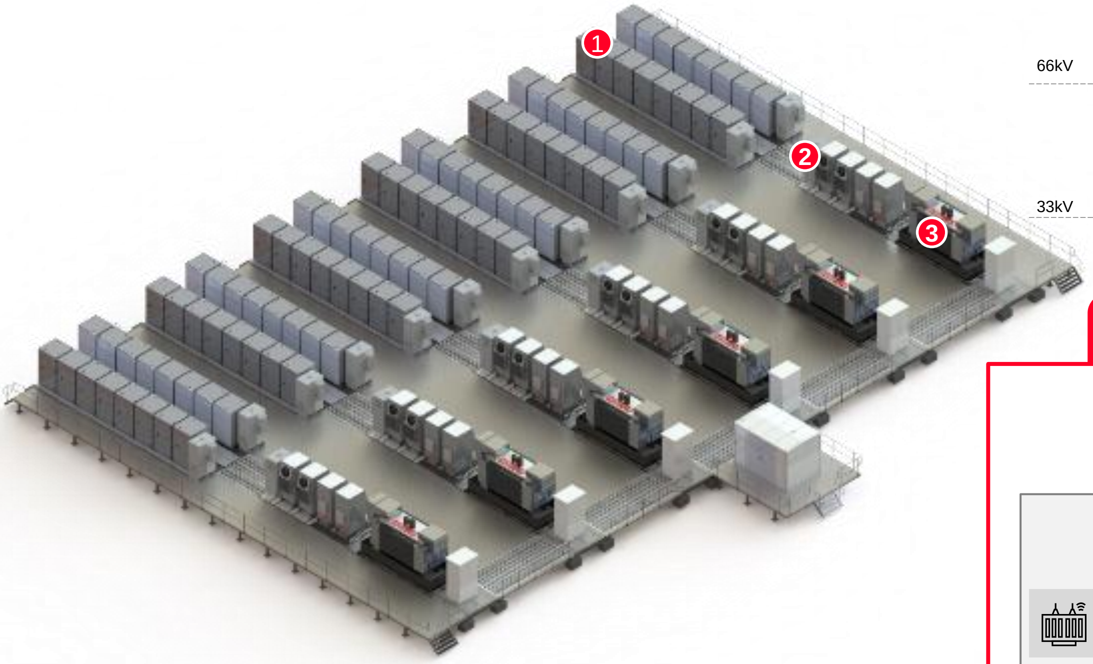
Reduced civil works and installation effort with the skidded or enclosed solutions.

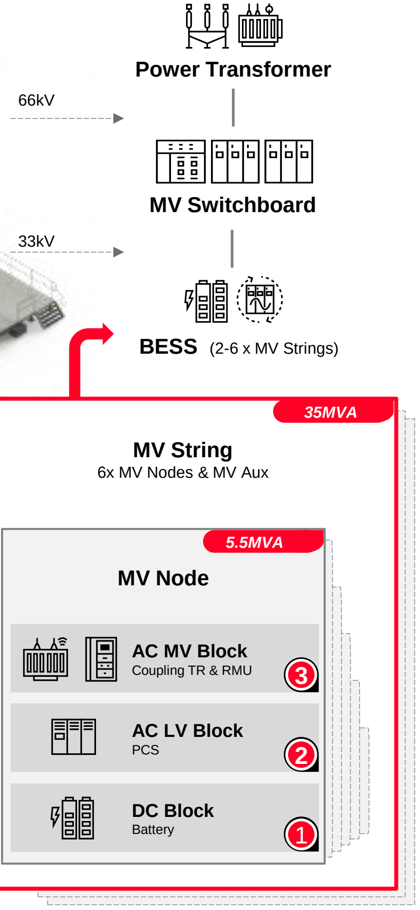
High quality guaranteed through pre-tested and pre-wired solutions.



We select the best technology to match customer needs

Differentiating “smart” BESS with e-mesh Manager solutions





External
Network operator, markets

Tertiary control or energy management
5-15 min cycle time

Secondary or plant control
10-100ms cycle time

Primary control
~1ms cycle time

Unit control
~100µs cycle time

System level – energy management
Techno-economic optimization
Unit commitment
Optimal dispatch

System level – power management
SoC mgmt., Frequency and Voltage support, Base load levelling, Peak shaving, Renewable smoothing, Blackstart, Islanding

Power Conversion level
Virtual Synchronous Generator (VGM) emulation

Grid code compliance (LVRT, protection)
Voltage source / Current source operation

Hardware	Automation	Functionalities

VGM: Virtual Generator Mode / LVRT: Low-Voltage Ride-Through

eks Energy

eks Energy at a glance

eks Energy is a leading power conversion station manufacturer focused on grid-friendly energy storage and renewable integration.

Leading power electronics and control capabilities, combined with intense customer focus, make eks Energy a preferred partner for demanding storage applications.

6+
GW installed

180+
Projects deployed

30+
Countries with eks Energy deployments

20+
Years of experience

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eks Energy key milestones

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2002
Founded in Seville, Spain
Power conversion and advanced control for wind

2009
Growth and global expansion
With 1 GW installed, expands internationally with grid-level PV solutions

2010
Enters US Market
WD family UL certification

2014
Transition to BESS
New strategic focus offering solutions to integrate energy storage systems

2018
Innovation: Solar + BESS
DC coupling proven in Hawaii

2019
eks Energy is born
Inheriting all the know-how from GPTech

2021
Largest project in LATAM
130 MW / 520 MWh Solar + Storage

2022
World's strongest BESS
With Powin, awarded contract to supply 850 MW / 1.7 GWh BESS in Australia

2023
eks Energy joins Hitachi Energy

Hitachi Energy

Three product lines from one modular converter station

PCS
Power Converter Station for BESS integration

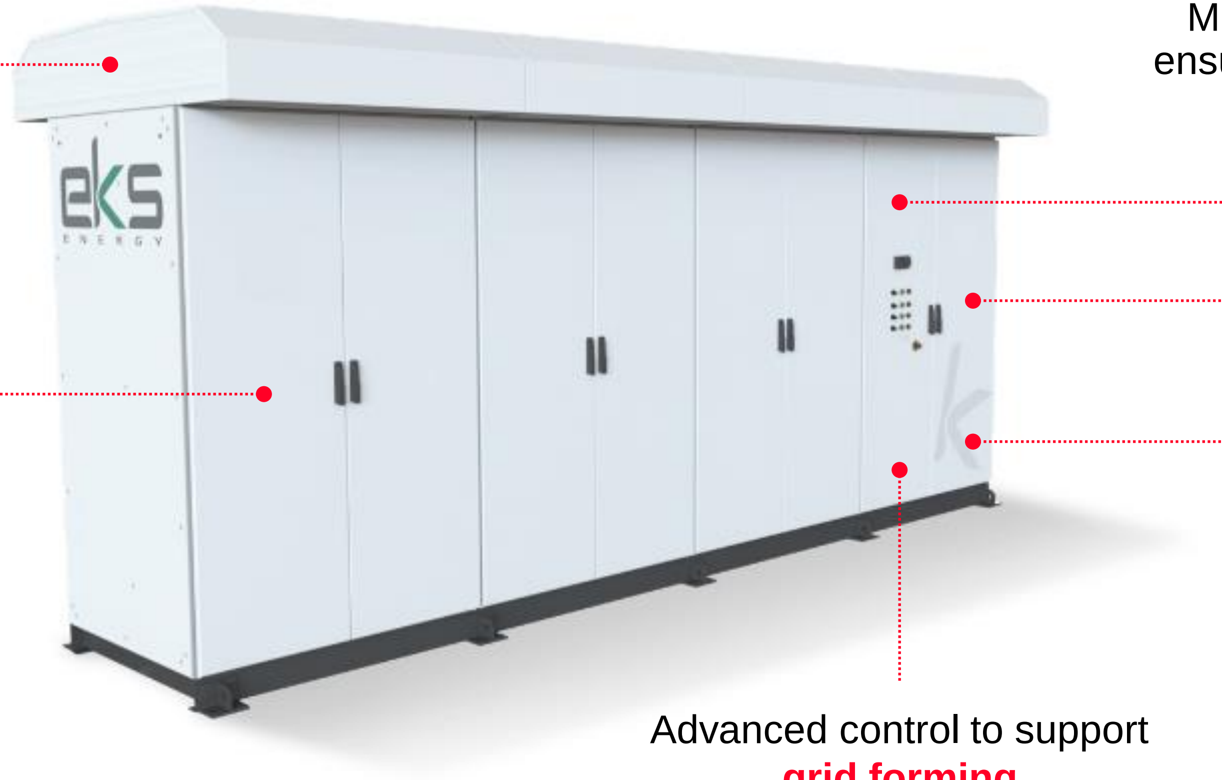
AMPS
Advanced Multiport Power Station for combining BESS and solar

PVI
Photovoltaic Inverter AC coupled for solar integration

Ready for the next generation of energy storage and renewable energy systems

These products are a part of the eks Energy portfolio, now part of Hitachi Energy

Platform competitive advantages



Robust design for maximum power in extreme ambient conditions

Full power rating up to **1500 VDC** ensures efficient project sizing

Multilevel coordinated control ensures **fast dynamic response**

Modular design for **increased availability**

Form factor **reduces installation costs**

Advanced control to support **grid forming**

These products are a part of the eks Energy portfolio, now part of Hitachi Energy

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Chitose Hokkaido: Utilities

Shin Chitose Solar needed to comply with local grid codes to reduce power fluctuation and improve renewable integration. With e-mesh, Shin Chitose is now able to meet a significant Japanese renewable initiative to generate 35 gigawatt-hours for 11,000 households.

Press release

About the project

- **Project name:** Chitose Hokkaido
- **Location:** Japan
- **Customer:** Japan's Energy Products Corporation and Korea Electric Power Corporation
- **Completion date:** 2017

Solution

- Solar PV (28 MWp)
- PowerStore Battery (17 MW / 8MWh)
- e-mesh Control system

Customer benefits

- Enabling Shin Chitose Solar plant to adhere to the stringent grid code requirements of a ramp rate of ±1%/minute of local utility
- Ensuring reliable integration of renewables into the main power grid
- Helping Shin Chitose plant to generate power to 11,000 local households

Matsuyama BESS

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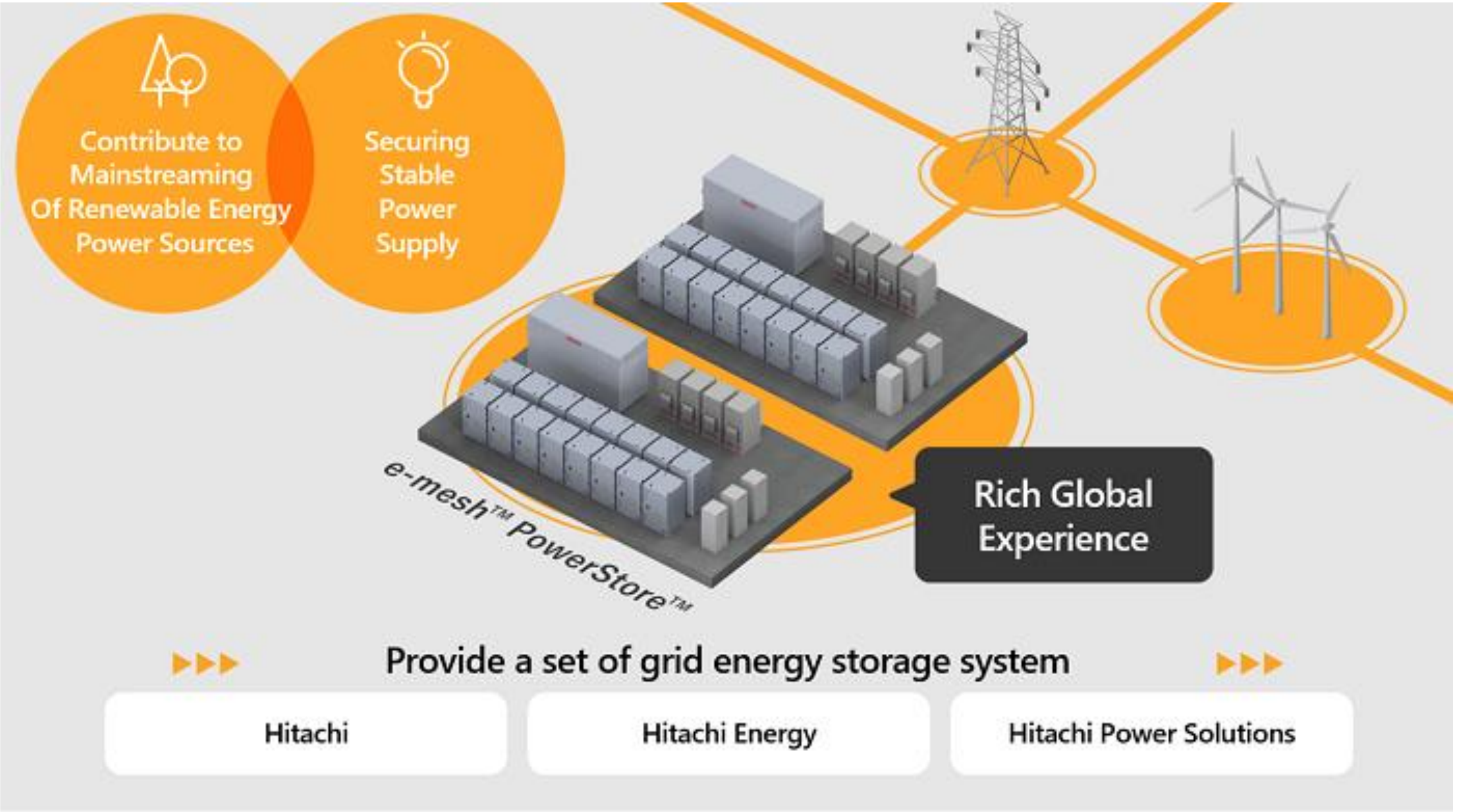

e-mesh global reference cases

Advancing renewable energy in the Andes region

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> Represents a great contribution and solution to alleviate congestion problems in transmission lines and resulting discharge of renewable energy. We will continue to grow with new projects.
>
> **Javier Dib**
> CEO of AES Andes

Challenge

The Andes region, characterized by rugged landscapes, is primarily reliant on fossil fuels, posing environmental challenges and contributing to climate change.

Solution

eks Energy's 130MW/650 MWh Solar + Storage DC-coupled system reduces congestion in transmission lines.

(Storage as a transmission asset)

Impact

By reducing reliance on fossil fuels, the project contributes to preserving the Andes' pristine natural environment and safeguards biodiversity.

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Supporting Hawaii's transition to a carbon-free future

> This project has multiple benefits for our Island. Adding more renewable resources helps make the island communities more self-sustainable by reducing their reliance on imported fossil fuels.
>
> **Shelee Kimura**
>
> CEO of Hawaiian Electric

Challenge

Hawaii is highly dependent on imported fossil fuels. Meeting clean energy targets is critical for supporting the economy, preserving the environment, and becoming energy secure.

Solution

The 30MW/120 MWh Solar + Storage minimizes dependency on fossil fuels during evening peak demand hours, while reducing CO_2 emissions.

Impact

AES Hawaii and eks Energy collaborated to transform the Waikoloa Power Plant from a fossil fuel-dependent facility to a sustainable and resilient energy source.

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World’s largest Battery Energy Storage System

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> This project aims to ensure a secure, reliable, and affordable energy supply to homes and businesses across Sydney, Newcastle, and Wollongong while new renewable energy zones are completed.
>
> **Marie Jordan**
> Transgrid Executive General Manager of Network

Challenge

New South Wales aging, coal-fired power plants are expensive, inefficient, hazardous to the environment, and require costly ongoing maintenance.

Solution

The 850MW/1680MWh Waratah Super Battery (WSB), with 288 eks Energy PCS, acts as “shock absorber” for the electrical grid and improves system reliability.

Impact

Enable the 2880 MW coal-fired Eraring Power Station closure in August 2025, seven years earlier than previously scheduled, while maintaining network security.

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Supporting the stability of Finland's energy network

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"With this investment in battery energy storage, we are helping to ensure uninterrupted electricity supply in Finland."

Sami Jakonen
Technical Director
TVO

Challenge

Must be able to support the entire energy network, in a potential production disturbance in the Olkiluoto 3 plant, and minimize the effect of power fluctuations on the grid.

Solution

Deployed an e-mesh 90 MW / 85 MWh energy storage solution as well as an intelligent digital e-mesh Manager, for substation expansion and maintenance support.

Impact

More than 30 percent of Finland´s electricity is expected to come from the island and support the transition of Finland's electricity production towards carbon neutrality in 2035.

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Dalrymple ESCRI: The world's largest autonomous microgrid

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"If the wind is blowing and the sun is shining the battery can support supply to the local community indefinitely, which is a great outcome for customers.

Rainer Korte
Group Executive,
Asset Management, ElectraNet

Challenge

Improving the reliability of supply in the lower Yorke Peninsula, South Australia, which is prone to lightning strikes, while supporting the integration of renewables.

Solution

Virtual Synchronous Machine with 30 MW/8 MWh e-mesh™ Energy Storage stabilizes the electricity grid and seamlessly islands the region to enhance reliability and utilize local wind power.

Impact

Reduced outages from 8 hours to 30 mins in the first six months of operation. All external funding repaid within 3 years.

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Sembcorp MRF: Utilities

A flagship research project between Sembcorp and Nanyang Technological University (NTU) to develop a Virtual Power Plant (VPP) by deploying a battery energy storage system connected and powered by the grid and/or PV to provide ancillary services to Singapore Power Grid.

Press release

About the project

- **Project name:** Sembcorp Materials Recovery Facility BESS
- **Location:** Tuas, Singapore
- **Customer:** Sembcorp and NTU
- **Completion date:** 2021

Solution

- PowerStore Battery (2 MW / 4 MWh)
- e-mesh Control System
- e-mesh SCADA
- e-mesh Monitor
- 10 years Service Level Agreement

Customer benefits

- To provide ancillary services such as Frequency Regulation using Automatic Generation Control (AGC) and Primary and Contingency Reserves
- To schedule and dispatch BESS by a cloud based Virtual Power Plant digital platform.
- To store excess power generated from rooftop PV system and discharge to Sembcorp MRF load

SN Aboitiz 24MW/32MWh BESS

SN Aboitiz Power (SNAP): Joint venture between Aboitiz Power Corp. and Norway-based company SN Power Invest AS set up in 2005.

SNAP is is the largest private hydropower company in the country with 642 MW in operation and a median production of 810 GWh.

SNAP is well-positioned to support the steady rise in demand for Res in Philippines. One of SN Aboitiz's company mission is to deliver reliable ancillary services toward a stable and secure grid.

SN | ABOITIZ
POWER GROUP

About the project

- **Project name:** Magat BESS Project
- **Location:** Ramon, Isabela / Philippines.
- **Customer:** SN Aboitiz
- **Completion date:** April 2023

Customer benefits

- Full product turnkey solution with long term service agreement
- Flexibility to expand power to 24MW
- Stable revenue stream from grid ancillary service
- First BESS portfolio within SN Aboitiz and a strategic complementary to SN Aboitiz's hydropower and solar

Solution

- 24MW/32.5MWh (BOL) installed capacity
- Scope: PS1000, Outdoor CATL battery cabinets, e-Mesh SCADA and control and e-Mesh Monitor; Installation Supervision + Testing & Commissioning
- Long Term Service Agreement

SN Aboitiz 24MW/32MWh BESS

Project delivery

SN Aboitiz 24MW/32MWh BESS

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SN Aboitiz 24MW/32MWh BESS

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e-mesh local reference cases

Successful Indonesia's Installed Base

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Bontang PV Hybrid

Indonesia's largest microgrid system in private sector

PowerStore Battery System and control & SCADA system integration:

- Existing 2x7 MW Coal Power Plant
- Existing 8 x 0.8 MW Diesel Generators
- 3 MWp PV Plant
- 2 MW / 2 MWh BESS
- Li-ion Battery NMC Samsung SDI – Containerized solution

Semau PV Hybrid

PLN's first smart microgrid

PowerStore Battery System and control system integration:

- Existing ~1.5 MW Diesel Generators
- Existing 450 kWp PV Plant
- 250 kW / 2 MWh BESS
- Existing Lead-acid VRLA – inside power house

Selayar PV Hybrid

Hybrid BESS project

PowerStore Battery System and control system integration:

- Existing >12 MW Diesel Generators
- 1.3 MWp PV Plant
- 700 kW / 870 kWh BESS
- Li-ion Battery LFP Local Adyawinsa – inside power house

Selayar photo source: PLN

Melak PV Hybrid

Hybrid BESS project

PowerStore Battery System and control system integration:

- Existing >7 MW Diesel Generators
- 2.2 MWp PV Plant
- 1 MW/ 1 MWh BESS
- Li-ion Battery LFP Durapower – Containerized solution

Nusa Penida Hybrid

Hybrid BESS project, Indonesia's largest microgrid system

PowerStore Battery System and control system integration:

- Existing >10 MW Diesel Generators
- 4.2 MWp PV Plant
- 3 MW / 3 MWh BESS
- Li-ion Battery LFP CATL – Modular solution

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Reference Case: Semau Island BESS

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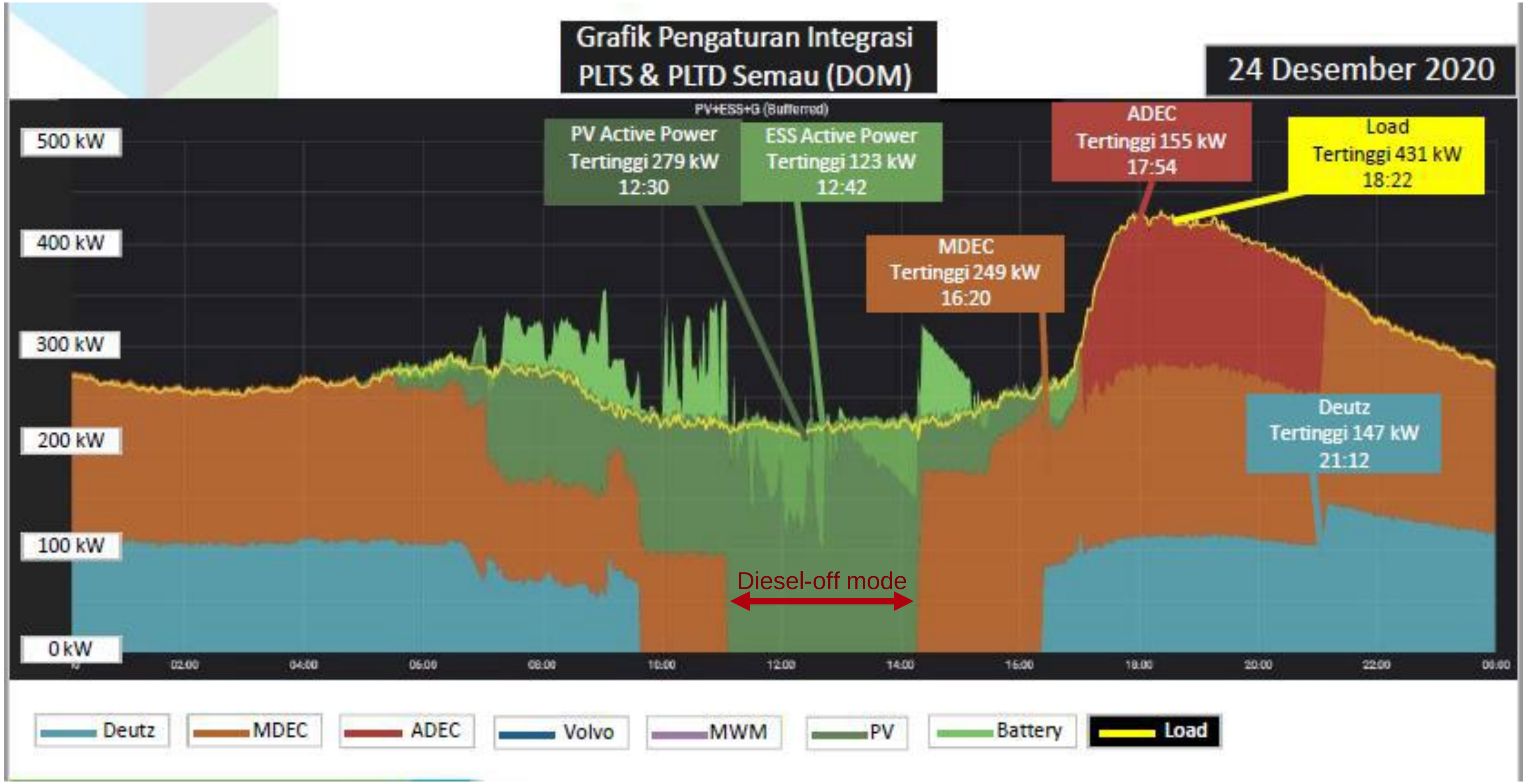
Island Utility (Hybrid Microgrid): PT. PLN (Persero) Nusa Tenggara Timur

Customer Benefits

- Diesel-off mode (100% Renewable Supply) during day-load
- Proper control and integration system (e-mesh Control) to combine PV/Battery and Existing Diesel Generators and make it as a single system which operates seamlessly
- Provide 24-hour reliable energy supply to the island which residentials become the majority of the demand and at the same time reducing diesel fuel consumption



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BESS Success Stories - Nusa Penida

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Deployed on an area of 4.5 hectares, the project development was carried out by PT Indonesia Power, subsidiary for Power Generation of PLN, to increase the reliability and sustainability of electricity supply in Nusa Penida. Working together with PT Surya Energi Indotama, Grid Automation’s solutions portfolio includes 3 MW/1,84 MWh Battery Energy Storage System (BESS) and advanced e-mesh control, expected to produce 6779 MWh annually, and reduce carbon emissions by 3,200 tons of CO_2 per year

In the media

PLN

G20 INDONESIA 2022

About the project

- **Project name:** Nusa Penida BESS
- **Location:** Indonesia
- **Consortium Partner:** PT Surya Energi Indotama
- **Customer:** PLN Indonesia Power
- **End-customer:** PLN
- **Completion date:** 2022

Customer benefits

- Delivers stable, coordinated operation of the BESS and solar PV with an existing diesel power plant.
- e-mesh control layer constantly monitors power operations for anomalies, and quickly dispatches the energy from the BESS to protect the island network
- Reduce carbon emissions by 3,200 tons of CO_2 per year

Solution

- Solar Ground Mounted (4.2MWp)
- Diesel Generators (10 MW)

- PowerStore Battery (3 MW / 3MWh)
- e-mesh Control System
- e-mesh EMS energy management system

Photo: Dok PT PLN (*Persero*)

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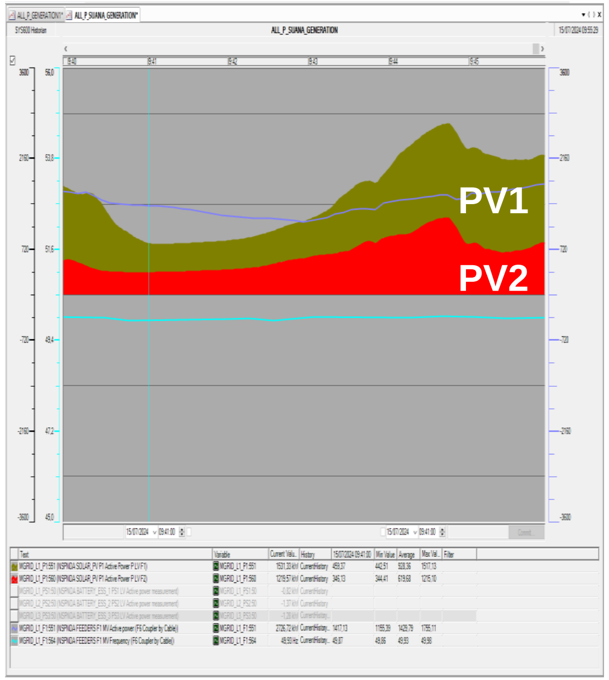
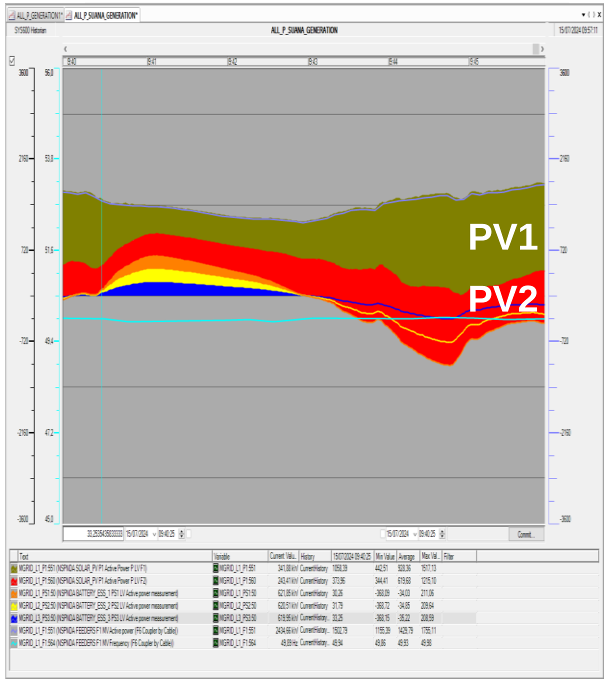
Reference Case: Nusa Penida PV Smoothing

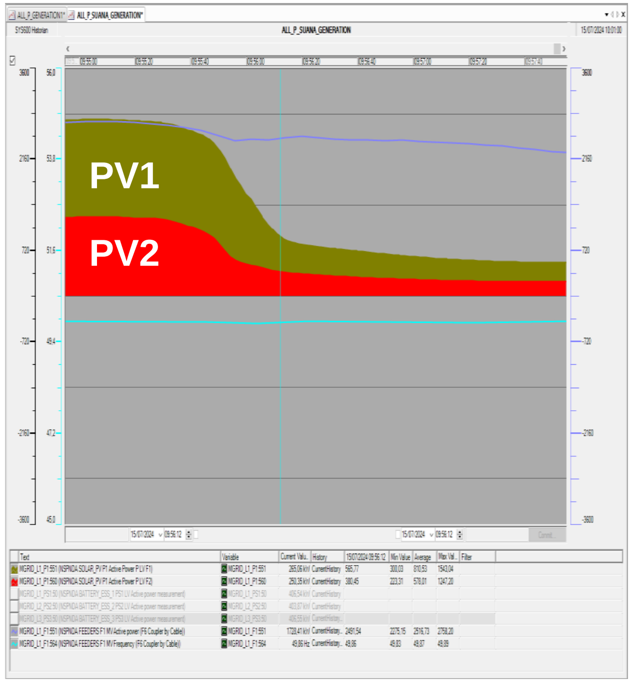
Without BESS



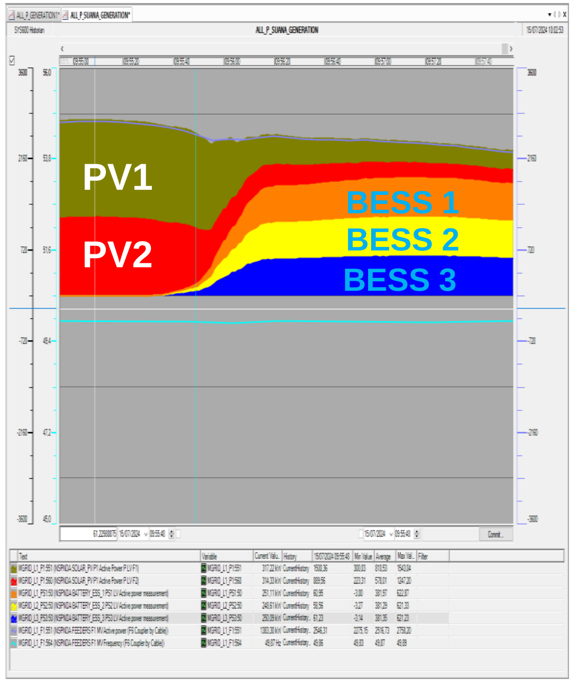
With BESS



Without BESS



With BESS



Reference Case: Bontang & Bunyut Melak

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Power System

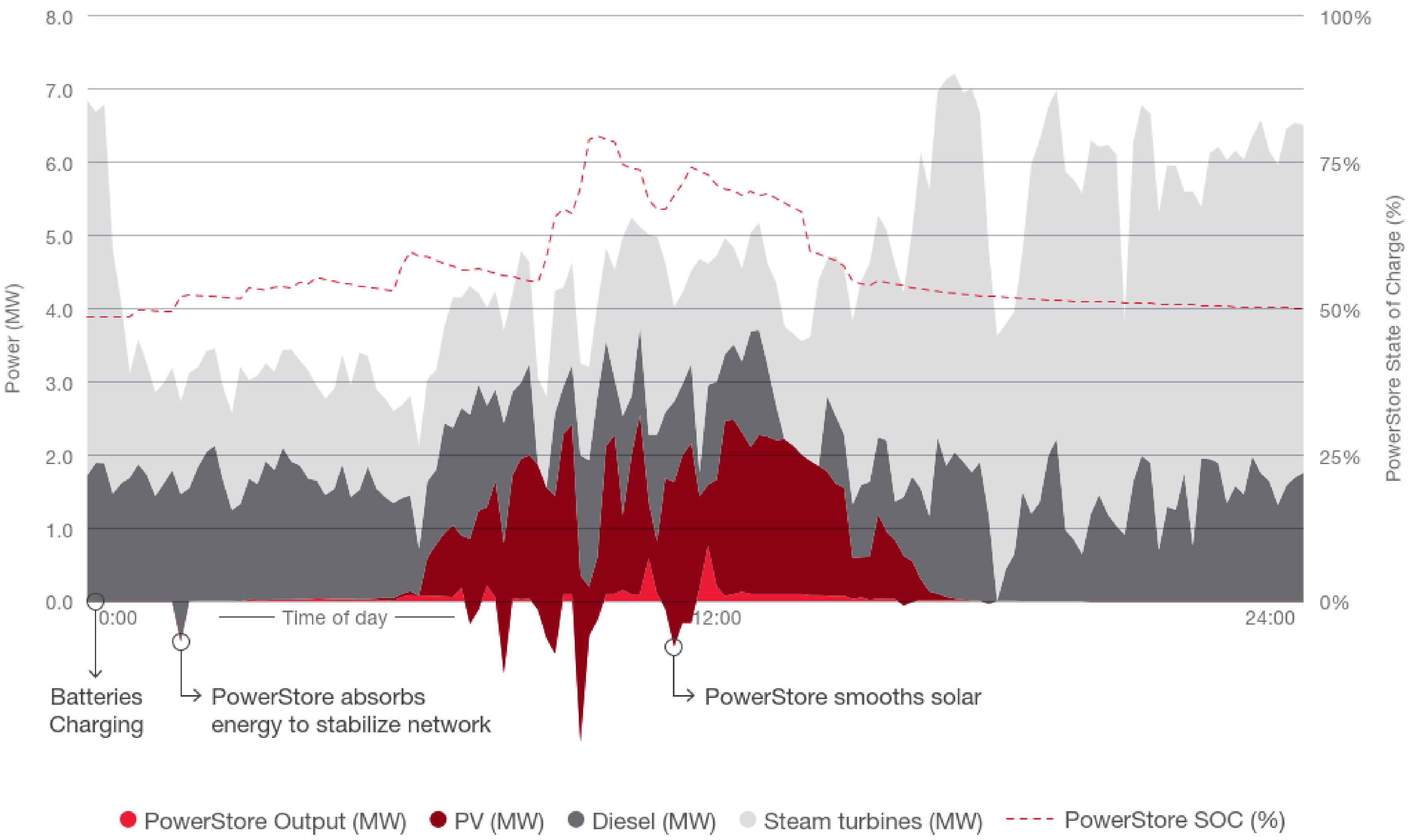
- Solar PV (3 MWp)
- STGs (2 x 7 MW)
- Diesel (8 x 0.8 MW)

Solution

- PowerStore Battery (2MW / 2MWh)
- e-mesh Control System
- e-mesh EMS energy management system

Customer benefits

- Renewable Smoothing (ramp rate control)
- Dynamic Stability:
  - Frequency Support
  - Generator overload/underload control
- Spinning Reserve
- Renewable Limits
- Feeder monitoring



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Microgrid and BESS solutions

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Hybrid AC-Coupled vs Hybrid DC-Coupled

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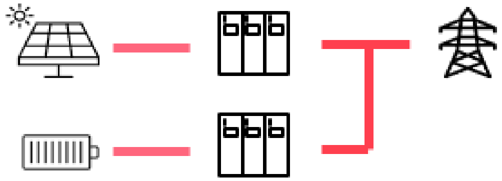
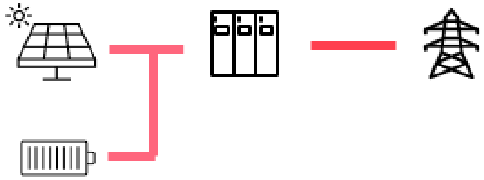
AC-Coupled BESS + PV System	DC-Coupled BESS + PV System
	
Pros: • **Easier installation and expanding capacity** • **Flexibility**: AC-coupled allows different allocations of BESS • **Versatility**: AC-coupled enable BESS to charge both from grid and PV System	**Pros:** • **Higher efficiency**: reduced energy losses due to DC-connection (η ~ 98%) • **Full power utilization** and oversizing: DC-coupled allows to generate more electricity than the inverter rating. Excess is used for the battery. • **Versatility**: AC-coupled enable BESS to charge both from grid and PV System
Cons: • **Lower efficiency**: round trip is lower from the conversions AC-DC DC-AC (η ~ 90 – 94%)	**Cons:** • **Limited flexibility**: the inverter must be located close to the battery
Battery Applications: • Capacity firming • Energy Time Shifting • Ramp rate control • Curtailment recapture from grid	**Battery Applications:** • Capacity firming • Energy Time Shifting • Ramp rate control • Clipping recapture • Curtailment recapture from PV System • Low voltage harvesting
Renown solution: • **Hitachi Energy:** e-mesh PowerStore (PS1000), EKS BPCS	**Renown solution:** • **Hitachi Energy:** EKS AMPS – Hybrid converter

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Secondary Controllers Diesel Generators Compatibility

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	Deep Sea Electronics (DSE)	PowerCommand (PCC)	ComAp	Woodward
Features	Real-time data monitor-ing, advanced diagnos-tics, remote monitoring, and user-friendly inter-faces	Integrated control and monitoring, load shar-ing, and synchronization capabilities	Intelligent control solu-tions, synchronization, load sharing, and re-mote monitoring	Advanced algorithms for start/stop control, pro-tection, and power man-agement
Strengths	Known for reliability and ease of use, DSE con-trollers offer compre-hensive monitoring and control, including auto-mated start/stop func-tions and load manage-ment	PCC controllers are highly integrated with **Cummins** generators, providing seamless op-eration and advanced power management features	ComAp controllers are known for their flexibility and scalability, making them suitable for both simple and complex power generation sys-tems	Woodward controllers are designed for distrib-uted power generation applications, offering ro-bust performance and reliability
Applica-tions	Suitable for a wide range of generator ap-plications, including in-dustrial and commercial settings	Ideal for complex power systems requiring pre-cise load management and synchronization	Used in various applica-tions, from small backup generators to large power plants	Suitable for a wide range of power genera-tion applications, includ-ing renewable energy integration

All secondary controllers above have been proven to be able working with Hitachi Energy's energy management system solution (e-mesh Control). Communication protocol e-mesh Con-trol-G or RTU G to secondary controller of diesel generator is through Modbus RTU, modbus TCP-IP or IEC61850.

Hitachi Energy have also been successfully operating without secondary controller in some sites in Indonesia due to old generators, etc. This operation is far more complex than those that have secondary controllers. Diesel generation with secondary controller is preferable due to easier operation.

Some battery integrators must use third-party EMS due to not their core product. This will increase after sales complexity for troubleshooting during daily operation issues. Meanwhile, **Hitachi Energy have a dedicated local team for e-mesh Control (EMS) in Jakarta, Indonesia.**

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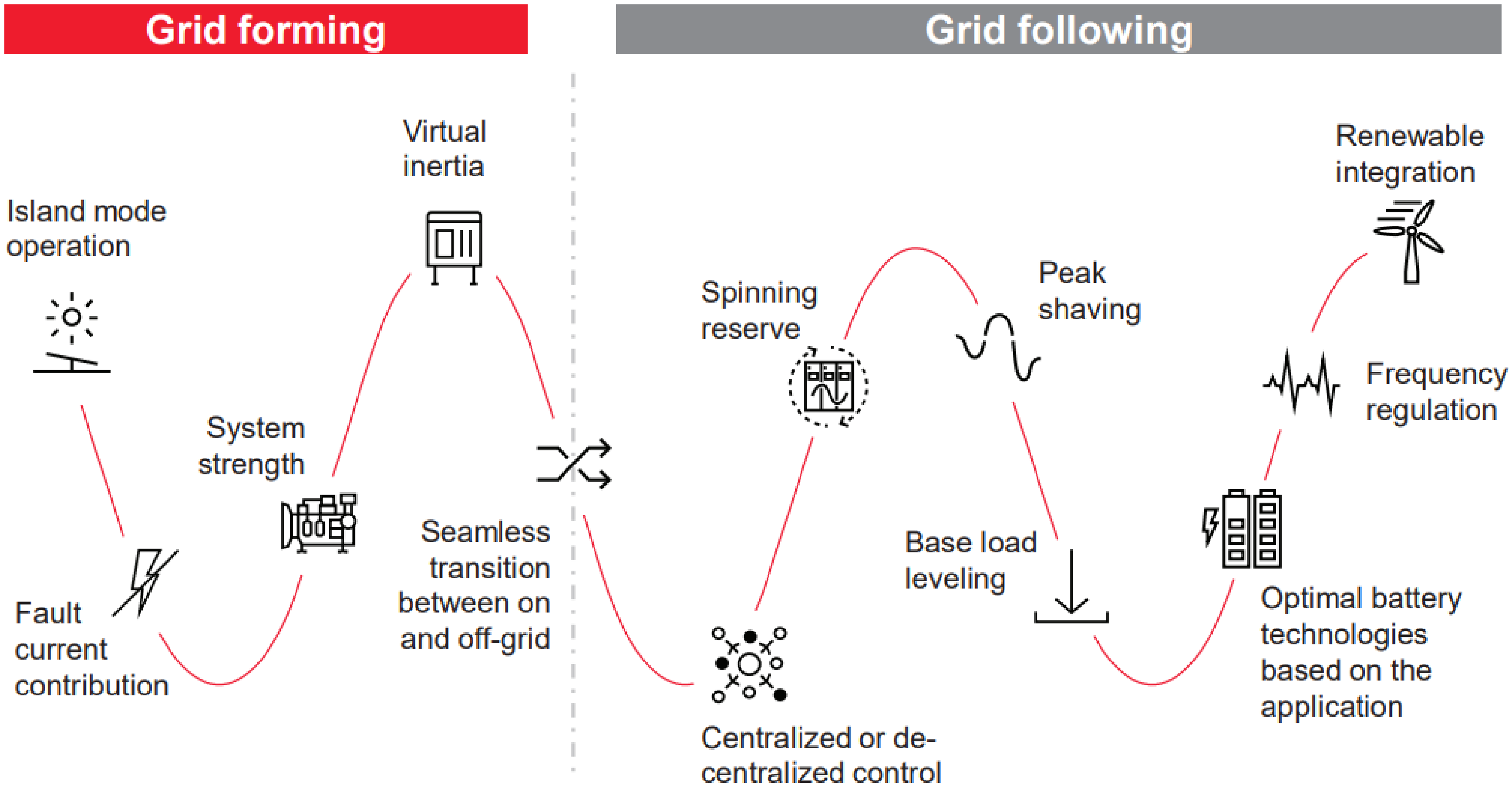
Grid Forming vs Grid Following



Our customers

Pioneer in technology, solutions and projects execution

Q&A

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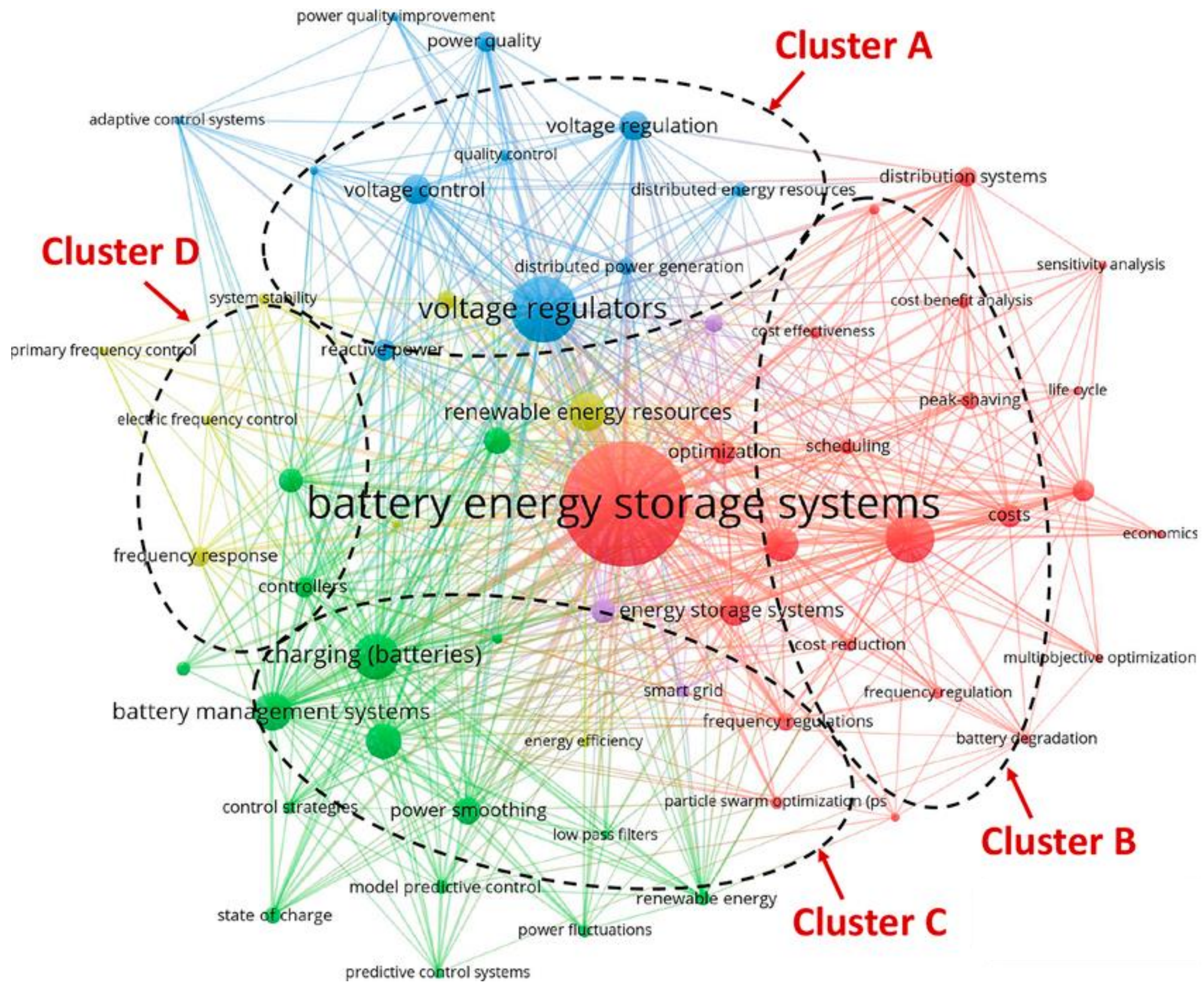

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