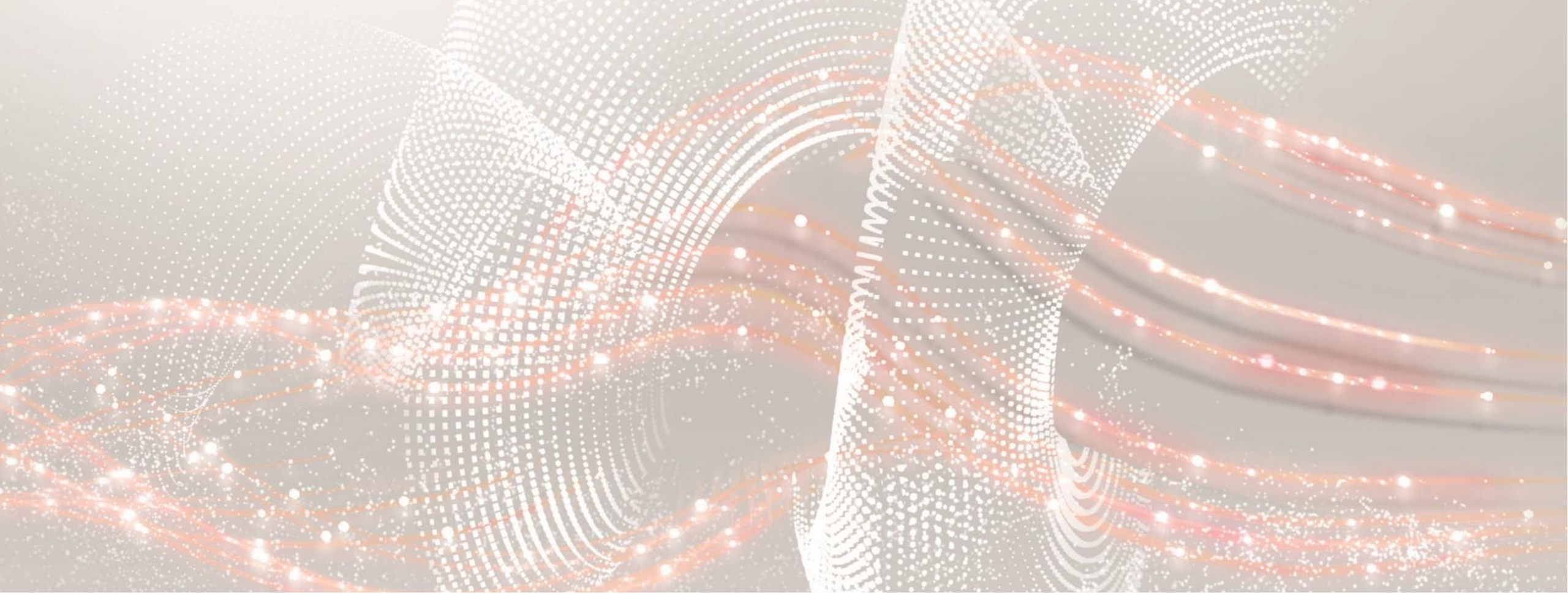


II JORNADAS TÉCNICAS - ABB EN PERÚ, 6 ABRIL, 2017

EssPro™ - Battery energy storage

The power to control energy

Dario Cicio; Global Product Manager Energy Storage Solutions

Challenges of the future power grid

Long-term drivers for energy storage

Electricity Consumption on the rise
- Electrification of everything – moving towards electricity as the primary source of power
- Economic and population growth will lead to increasing demand for power

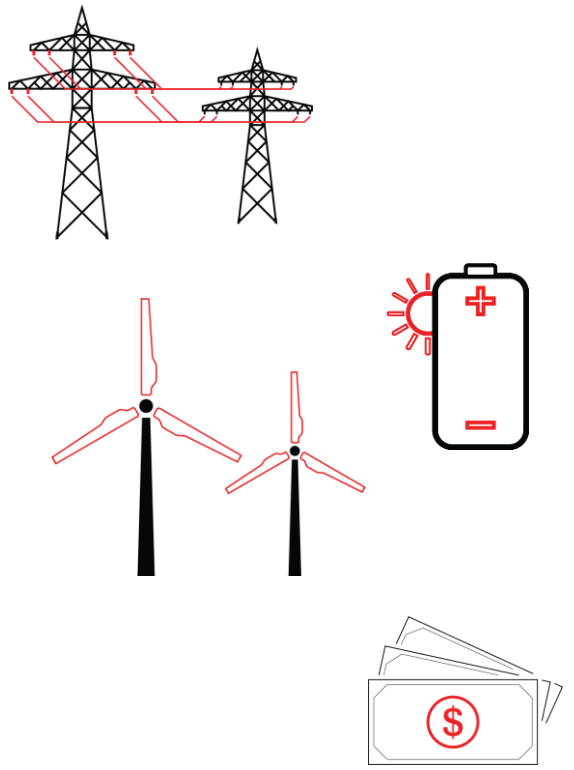
Coal plant retirements
- Reducing baseload power capacity
- Limited resources for ancillary services on the utility grid

Growth in renewables
- Governments and industry moving towards solar and wind
- Intermittent generation sources can reduce reliability on the electrical grid.

Electrification of transportation
- More users of EVs can increase peak loads placing more strain on the electrical grid.
- Increase in high speed rail

Proliferation of Smart Grid Technology
- Bi-directional flow of power requires additional coordination between power supply and demand

Tax and regulatory incentives
- Electrification of everything – moving towards electricity as the primary source of power
- Economic and population growth will lead to increasing demand for power



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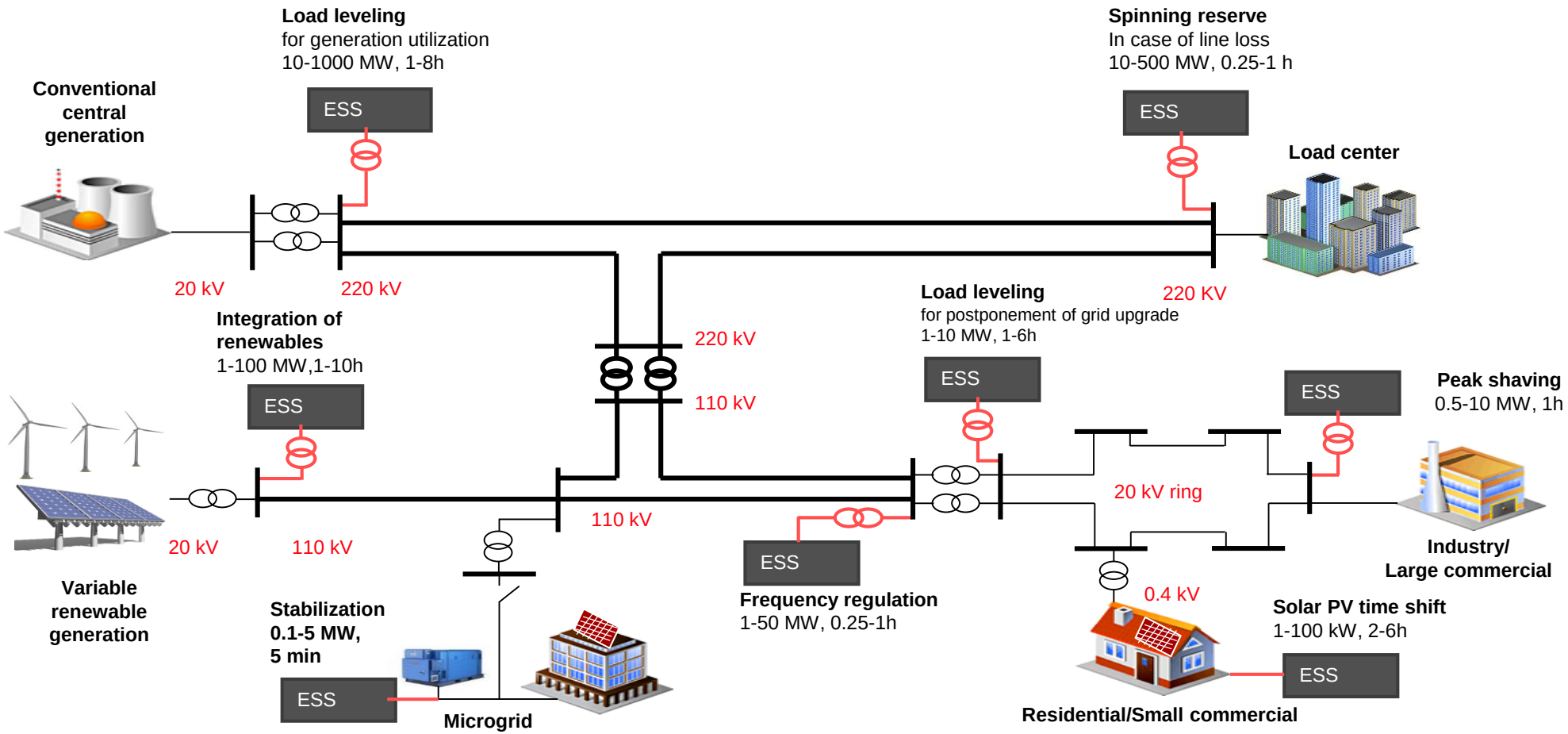
Grid connected energy storage applications



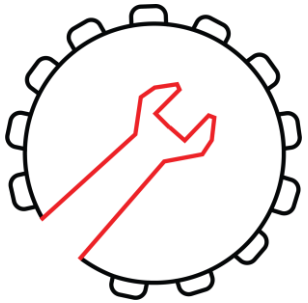
Energy storage media

Various types of methods of storing energy

Mechanical

Gravitation
- Pumped hydro

Kinetic
- Flywheel

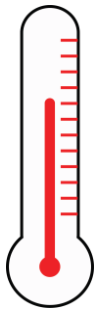


Thermo-dynamic

Heat
- Thermo-electric

Pressure
- Compressed air (CAES)

Pressure heat
- Adiabatic CAES

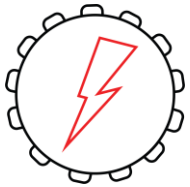


Electromechanical

Batteries
- Lead acid
- NiCd
- NaS
- NaNiCl
- Lithium
- Ni-MH
- Metal Air

Flow Cells
- Vanadium
- ZnBr
- PSBr

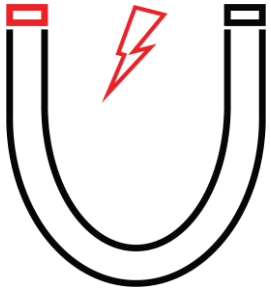
Hydrogen
- Electrolyzer and fuel cell



Electromagnetic

Electric
- Capacitors supercaps

Magnetic
- Super-conducting (SMES)



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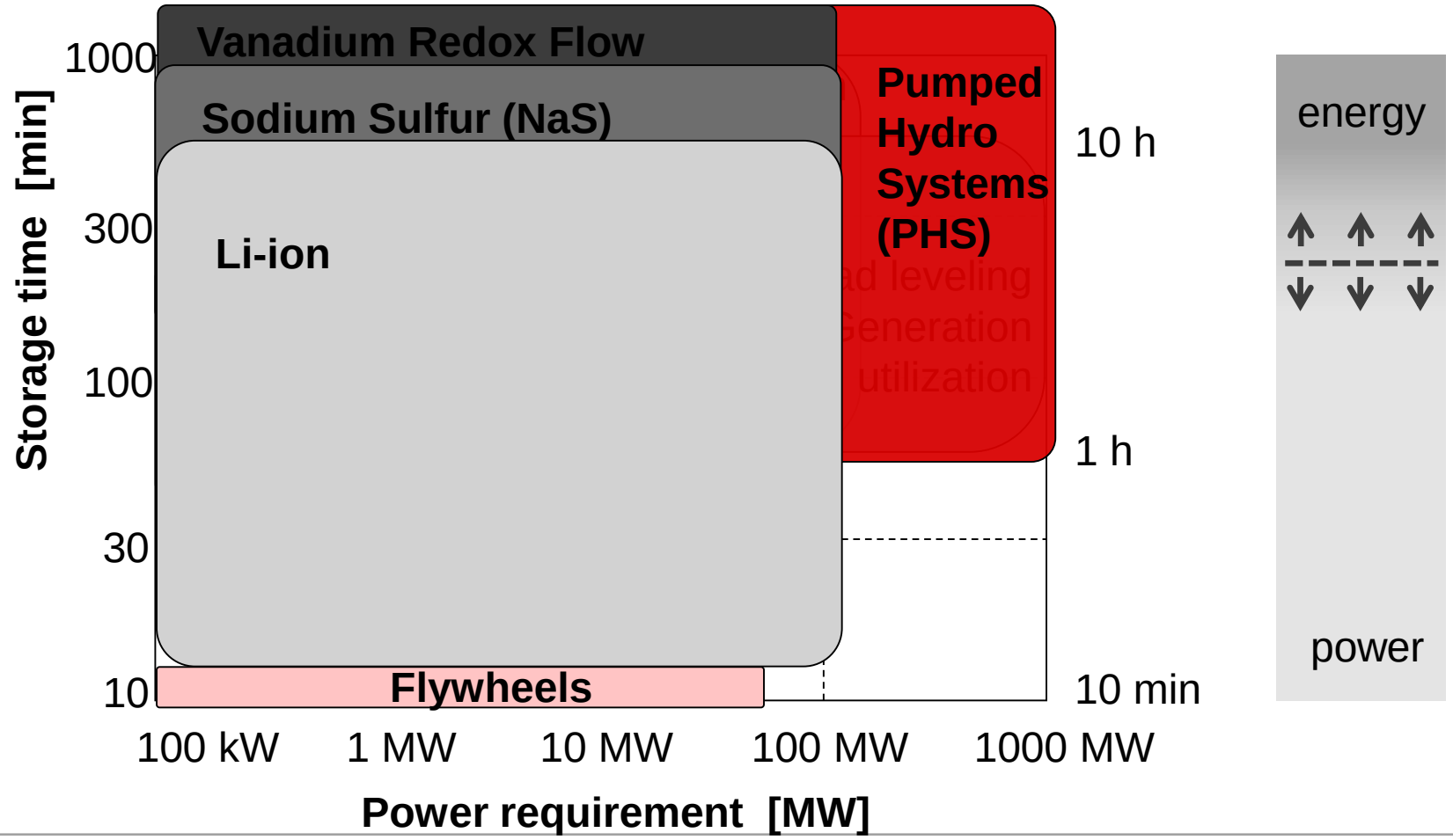
ESS applications

Applications and corresponding technologies



Battery energy storage solutions

ABB stationary energy storage offering

Residential – REACT

C & I – EssPro™

Utility-scale – EssPro™

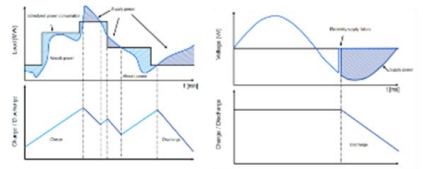
ABB offers battery energy storage solutions from kW to MW range

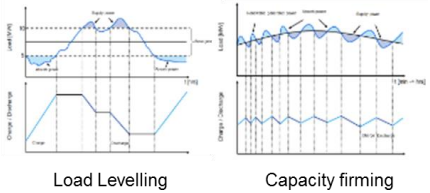
©ABB

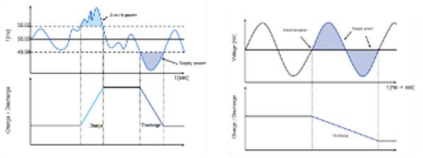
EssPro battery energy storage solutions

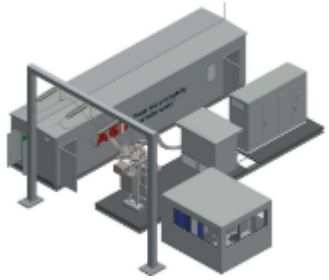
Utility-scale offering

EssPro™ PCS	Advanced Controls and Algorithms	EssPro™ Electrical Balance of Plant (EBOP)	EssPro™ Grid Turnkey Solution









- ABB is a pioneer and leader in energy storage
- Flexible and modular solutions to fit customer requirements

- Advanced controls and algorithms for full asset value and optimization
- Minimized risk due to proven technology

- Expertise in grid operations and systems
- Utility grade, robust designs

©ABB

EssPro power conversion system (PCS)

System sizes from 100 kW to 50 MW

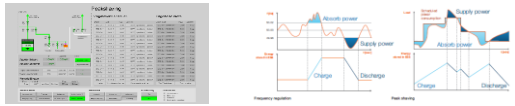
Indoor units

Outdoor enclosures

Outdoor system solutions

EssPro Grid

Overview of system components

System components		
Power Converters		Range of leading-edge power converters to suit a wide range of applications and system sizes
Batteries		Optimal battery technology for every application
Control systems and algorithms		Integrated EssPro EPIC control system enables manual and automatic operation of all system components in various control modes
Protection equipment		State-of-the-art protection systems for AC and DC equipment
Transformers and switchgear		Full range of transformers for local standards LV, MV and HV switchgear ensures safe and reliable grid connection
Modular and scalable		Scalable and flexible systems facilitate easy and safe operation

EssPro Grid

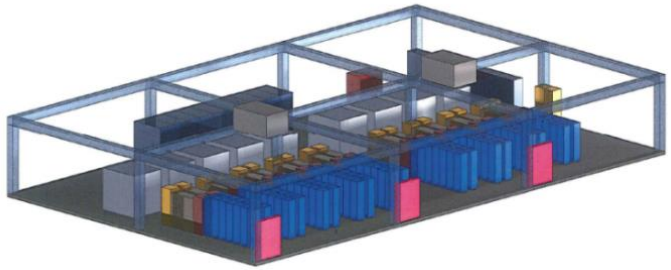
Flexible layouts

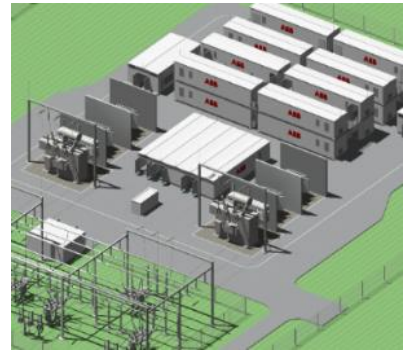
Scalable solutions

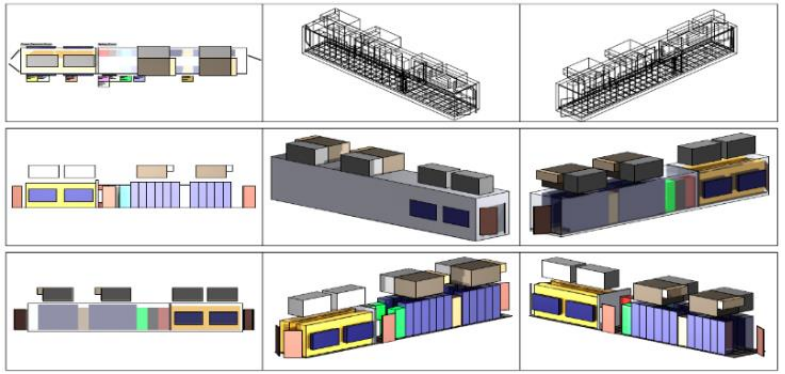
Containerized solutions and buildings

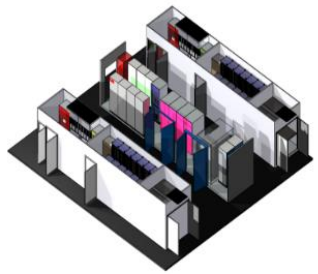
Coupled and decoupled solutions

Including ancillary equipment
- Fire fighting
- HVAC (heating, ventilation and air-conditioning)
- Intrusion control
- Auxiliary supplies
- AC and DC protection
- Power and control cables
- Distribution boards
- Current and voltage transformers (CT's and VT's)









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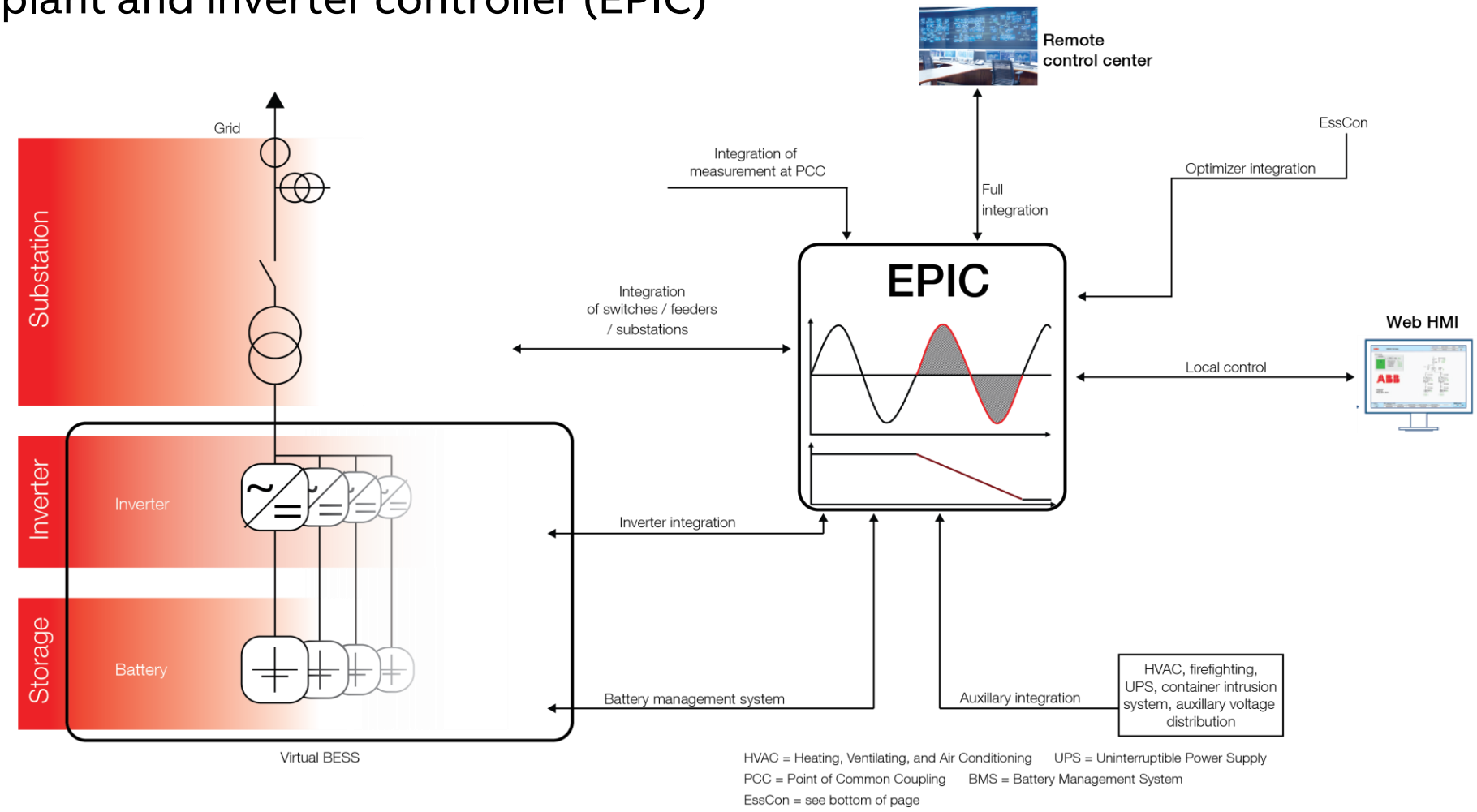
EssPro EPIC

Electrical plant and inverter controller (EPIC)



Battery energy storage systems

Electrical plant and inverter controller (EPIC)

Secure and high level of redundancy – Multi-processor architecture

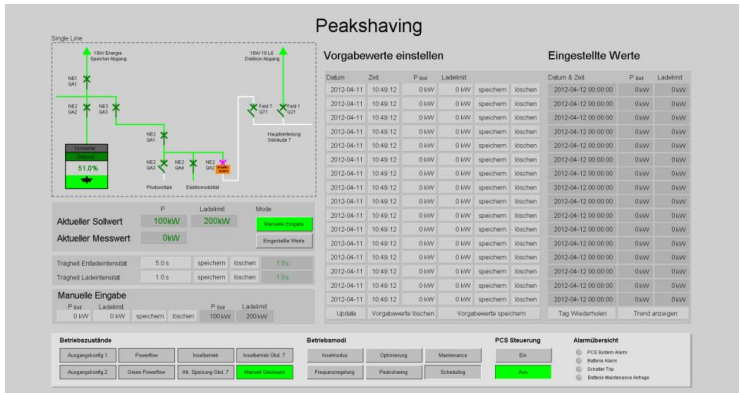
Proven substation technology

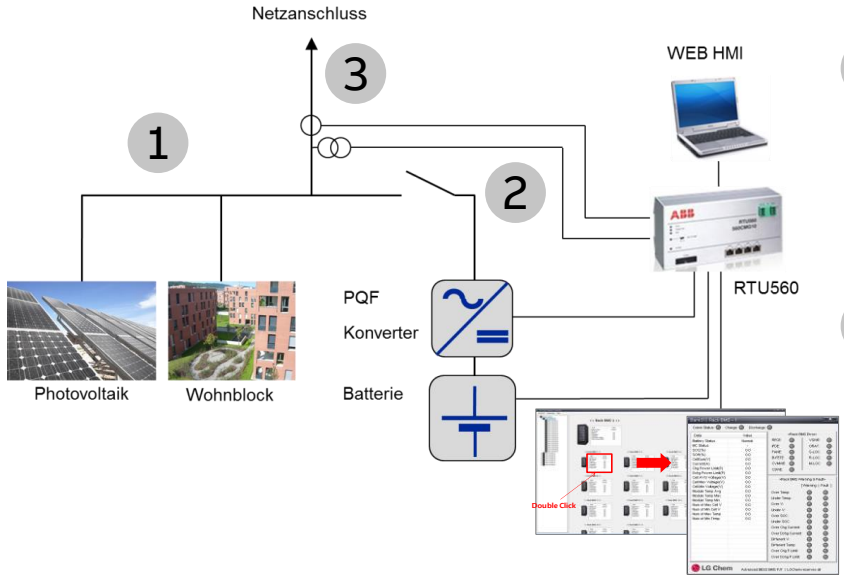
Wide range of communication protocols available (61850, 101, 104, Modbus, DNP3)

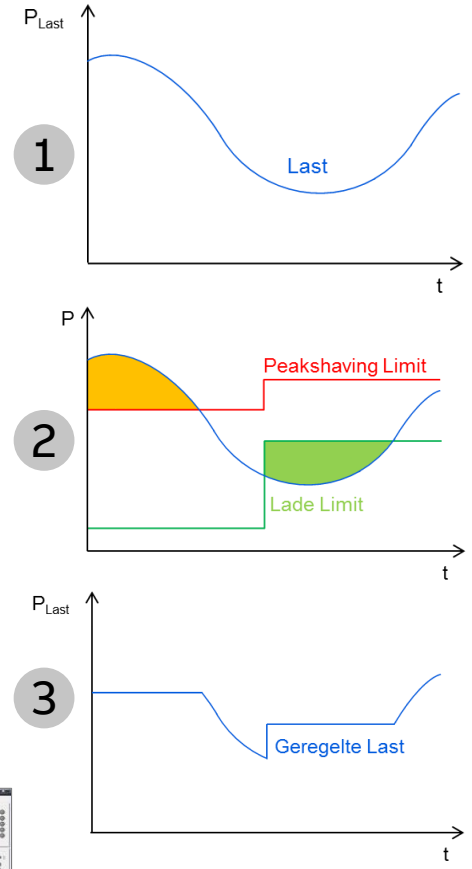
Application algorithms

Data logging

Independent of battery technology





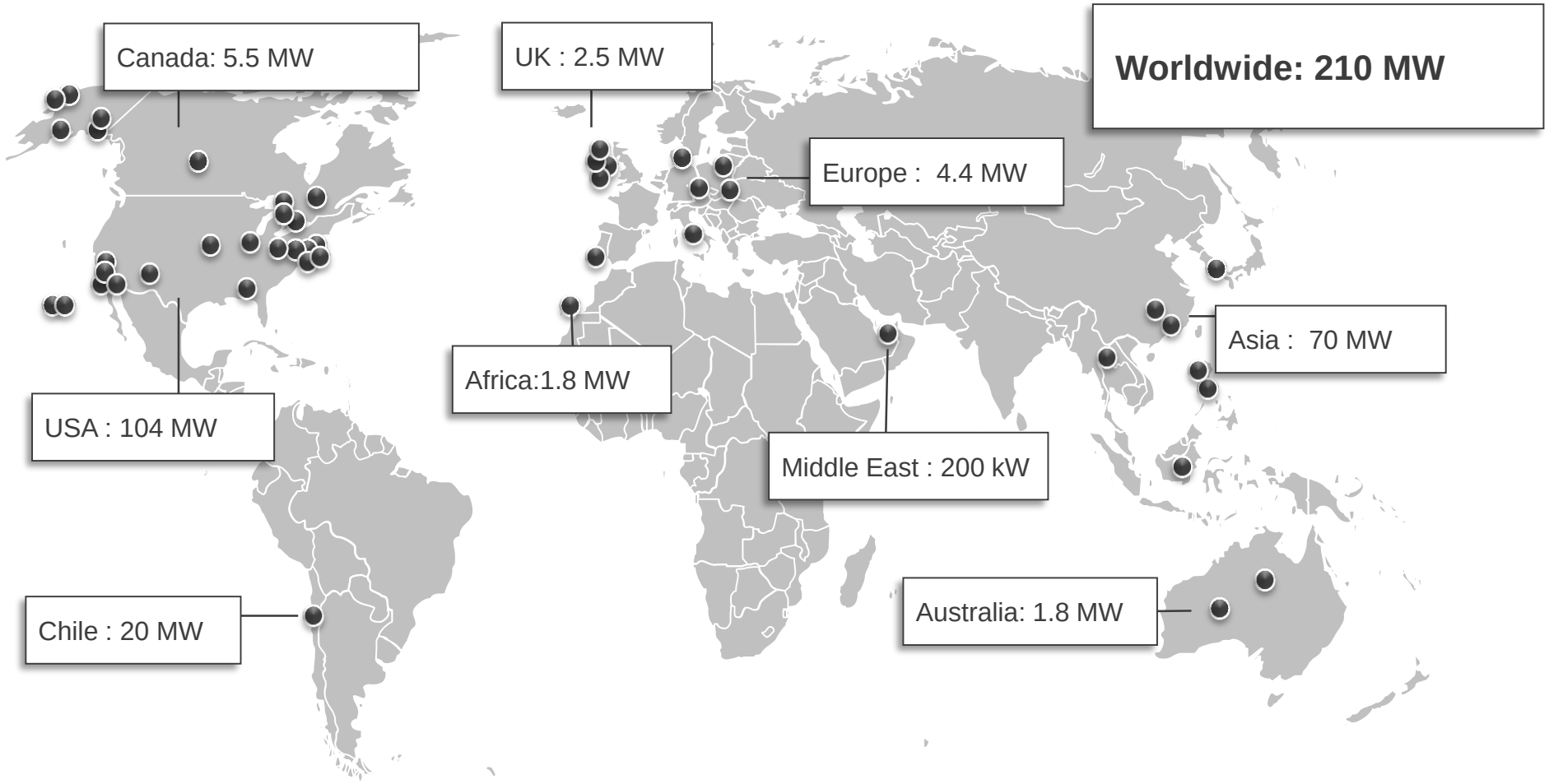


EssPro™ Energy Storage Solutions

Selected References

EssPro™ Installed Base (Full Turnkey/PCS)

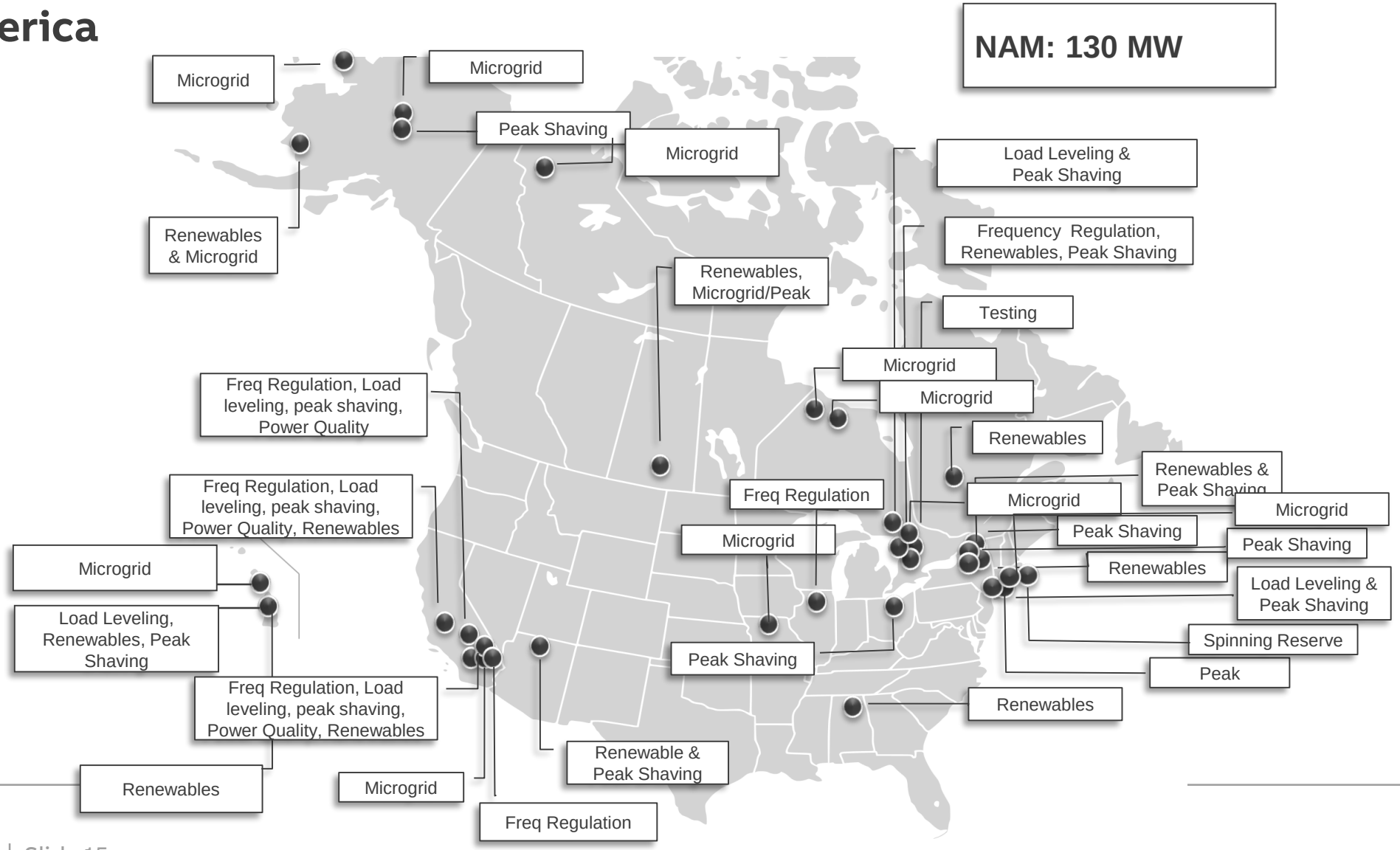
Worldwide experience



Last Updated: March 2017

EssPro™ Installed Base (Full Turnkey/PCS)

North America



Last Updated: March 2017

** note: installed base for North America includes projects in South America*

ABB Energy Storage Experience

BESS Project Chitose Hokkaido - Japan 17 MW

Need:

- 28 MW PV grid integration
- Ramp Rate control 1%/min - Voltage support - Capacity firming

Project details :

- Li-ion batteries
- Installed in 2016

ABB Scope:

- (4) x 4 MW + (1) x 1 MW Outdoor PCS
- PCS inverters, DC contactors, AC circuit breakers
- MV-LV Coupling transformer
- MV Switchgear
- Local controller integrating PCS, Switchgear and MBMS
- Local HMI

©ABB

ABB Energy Storage Experience

BESS Project Yangguang Power Plant - China 9 MW

Need:
- Integration with coal fired power plant 300 MW
- Frequency regulation

Project details :
- Li-ion batteries (15 minutes)
- Installed in 2016

ABB Scope:
- (3) x 3 MW Outdoor PCS
- PCS inverters, DC contactors, AC circuit breakers
- MV-LV Coupling transformer
- MV Switchgear
- Local controller integrating PCS, Switchgear and MBMS
- Local HMI

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ABB Energy Storage Experience

KIUC Anahola Project – Hawaii 6 MW

End user & Installation year:

- KIUC installed in 2015

System size & Technology:

- 6 MW - 4 MWh lithium-ion batteries

Customer needs:

- Help integrate solar power on the network
- Frequency & Voltage regulation; spinning reserve

ABB Scope:

- PCS rated at 6 MW integrated in (2) 20'ISO containers
  - 2 x 3 MW Converters
  - HVAC
- EssPro Controller
  - Frequency regulation
  - Voltage regulation
  - Firming

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ABB Energy Storage Experience

BESS Integrator / PJM - USA 20 MW

Need:
- PJM Regulation Market
- Frequency regulation

Project details :
- Li-ion batteries
- Installed in 2014

ABB Scope:
- (4) x 5 MW Outdoor PCS / 35kV
- Includes inverters, dc circuit breakers, ac circuit breakers, control, protection and external isolation / step-up transformer to 35kV grid
- Metering / Data Management
- Noise suppression

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ABB Energy Storage Experience

Tehachapi – USA 8 MW

8 MW / 32 MWh Tehachapi Storage Project

Customer needs

- Smart grid program
- Assess the capability and effectiveness of storage to support 13 operational applications

Project details

- Li-ion batteries
- Installed in 2013

ABB response

- (2) x 4 MW / 4.5 MVA PCS100 for BESS
- EssPro Vantage Controller
- DC bus and protection circuit breakers
- System models, RTDS and simulations
- Commissioning, training and installation supervision

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ABB Energy Storage Experience

Tehachapi – USA 8 MW

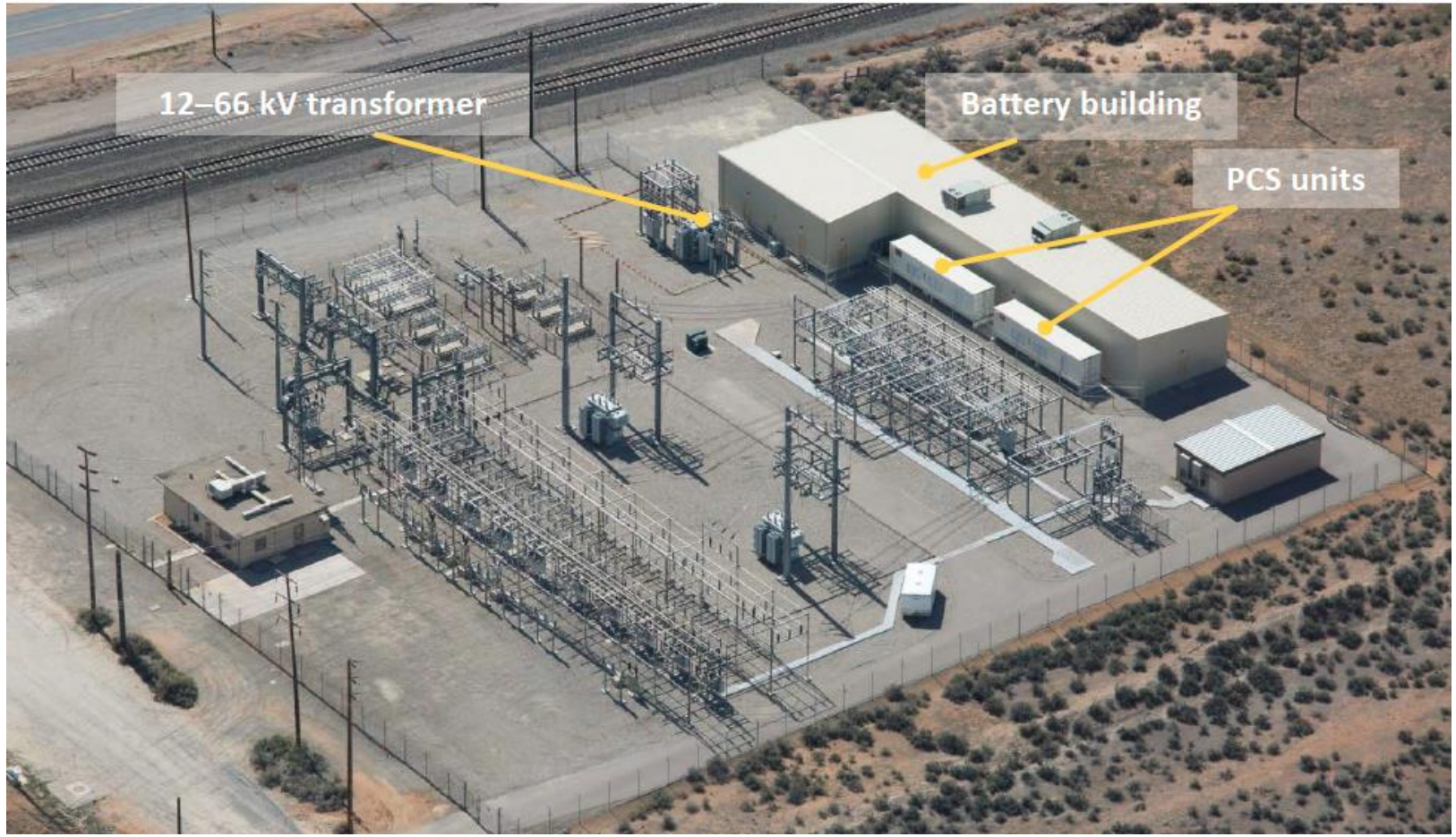

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ABB Energy Storage Experience

Angamos, Chile - 20 MW

Need:
- Spinning reserve
- Frequency regulation

Project details :
- Li-ion batteries
- Installed in 2011

ABB Scope:
- 5 x 4 MW PCS Containers
- Each containing inverters, circuit breakers, step up transformers, control, MV Disconnect Switch

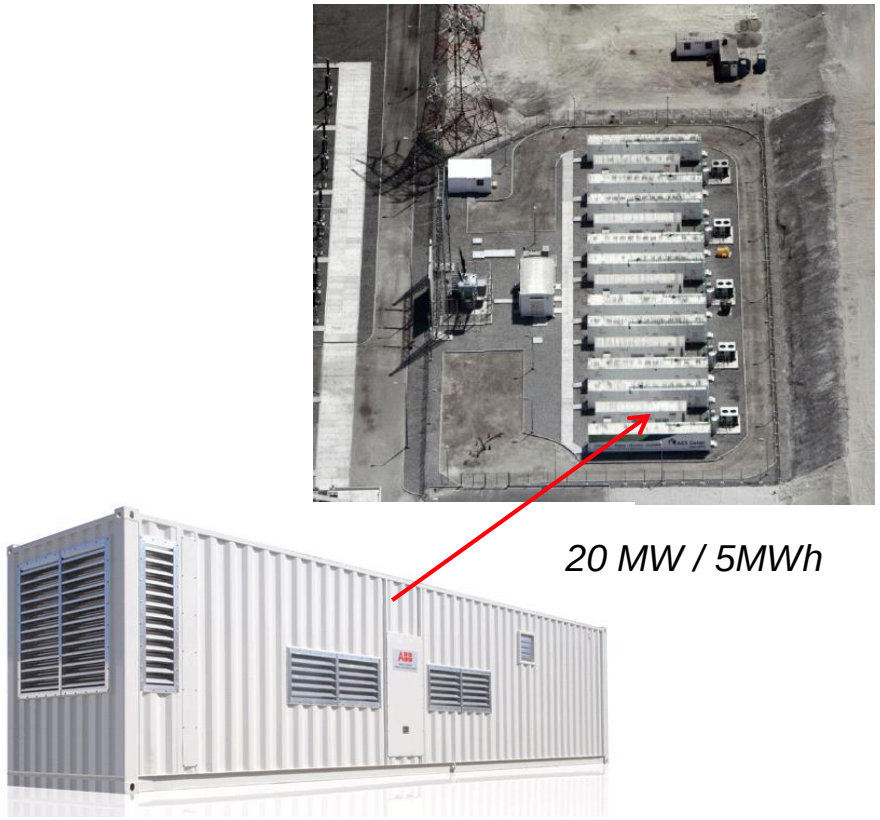

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ABB Energy Storage Experience

NYPA, Garden City – USA 1 MW

Need:
- Load leveling
- Peak shaving

Project details :
- NaS battery technology
- Installation in 2006

ABB Scope:
- Powered gas compressors during the day and recharge at night
- Shift compressor demand to night, lowers daytime peak demand rates
- BESS provides backup power supply

1MW / 6.5MWh

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ABB Energy Storage Experience

World's largest battery – Fairbanks – Alaska 46 MW

Need:

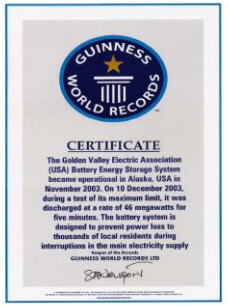
- Improve reliability of electricity services
- Emergency power source to feed energy to the grid until backup generation can come online

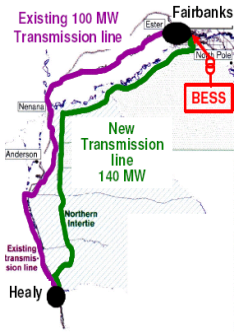
Project details :

- 15 minutes power boost to get generators online, leading to 90 percent reduction of power blackouts due to grid faults
- Cost-effective and reduced carbon emission solution.
- Installed in 2003

ABB Scope:

- Turnkey BESS including converter, transformer, Ni-Cd batteries (battery supplier SAFT), metering, protection and control devices and service equipment
- 27 MW - 15 minutes / 46 MW - 5 minutes
- BESS operation at temperatures as low as -52°C





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