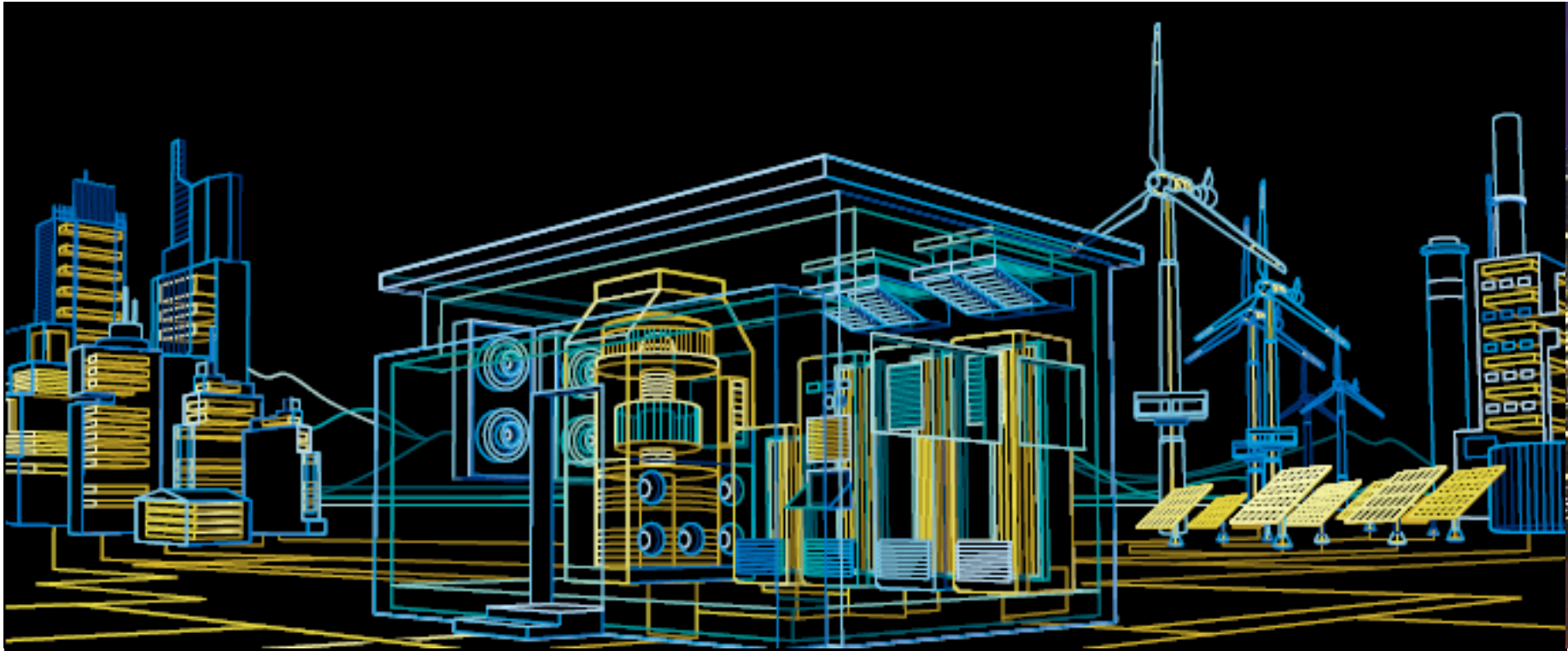




Cleiton Silva / Regional Sales Manager – EMEA & South America, Microgrid solutions / August, 2016

Renewable microgrids

Reduced LCOE and secured supply

Renewable microgrids

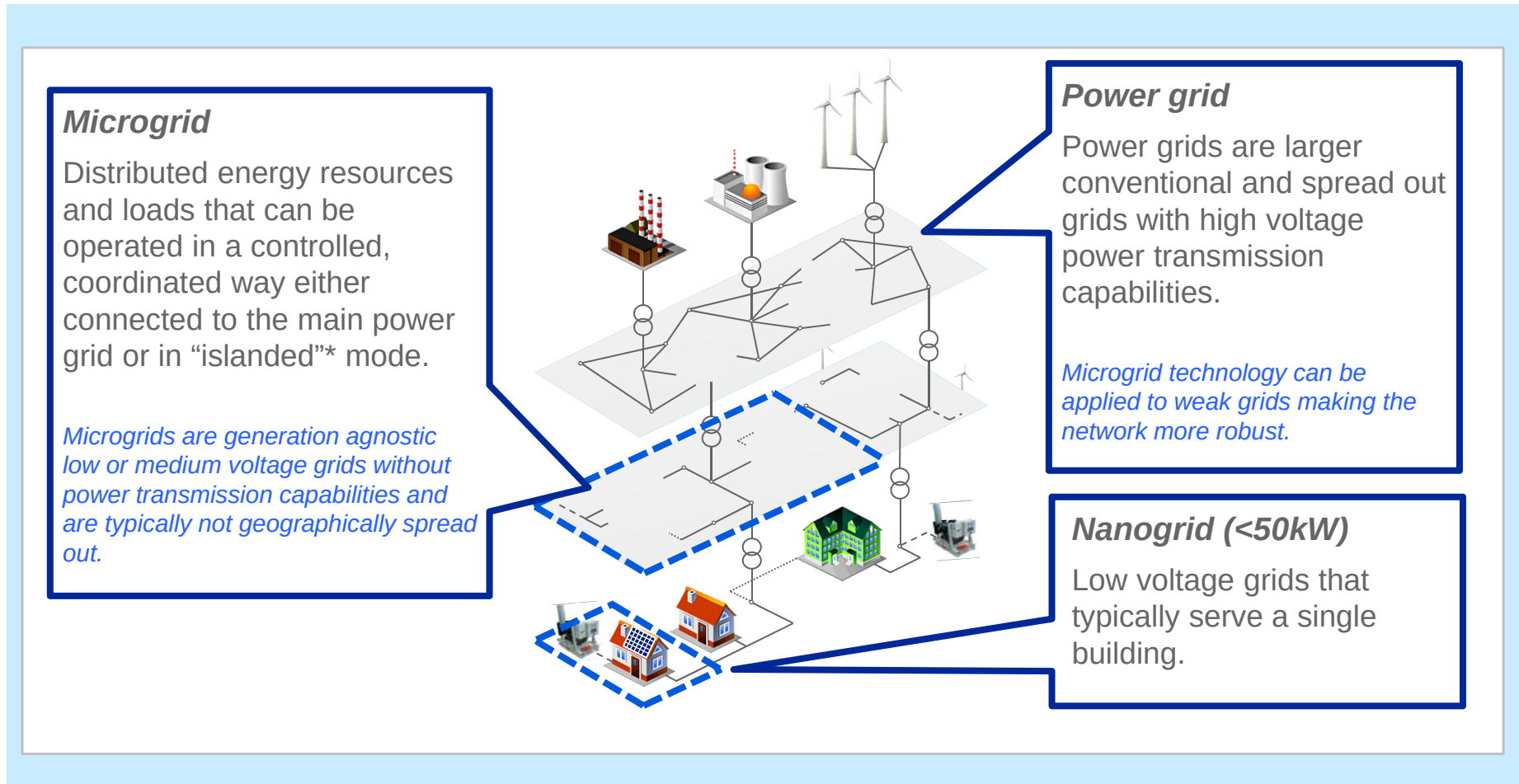
Agenda

- Microgrid overview
- Technological challenges: penetration & contribution
- ABB in microgrids
- References

Microgrid overview

Energy and grid transformation

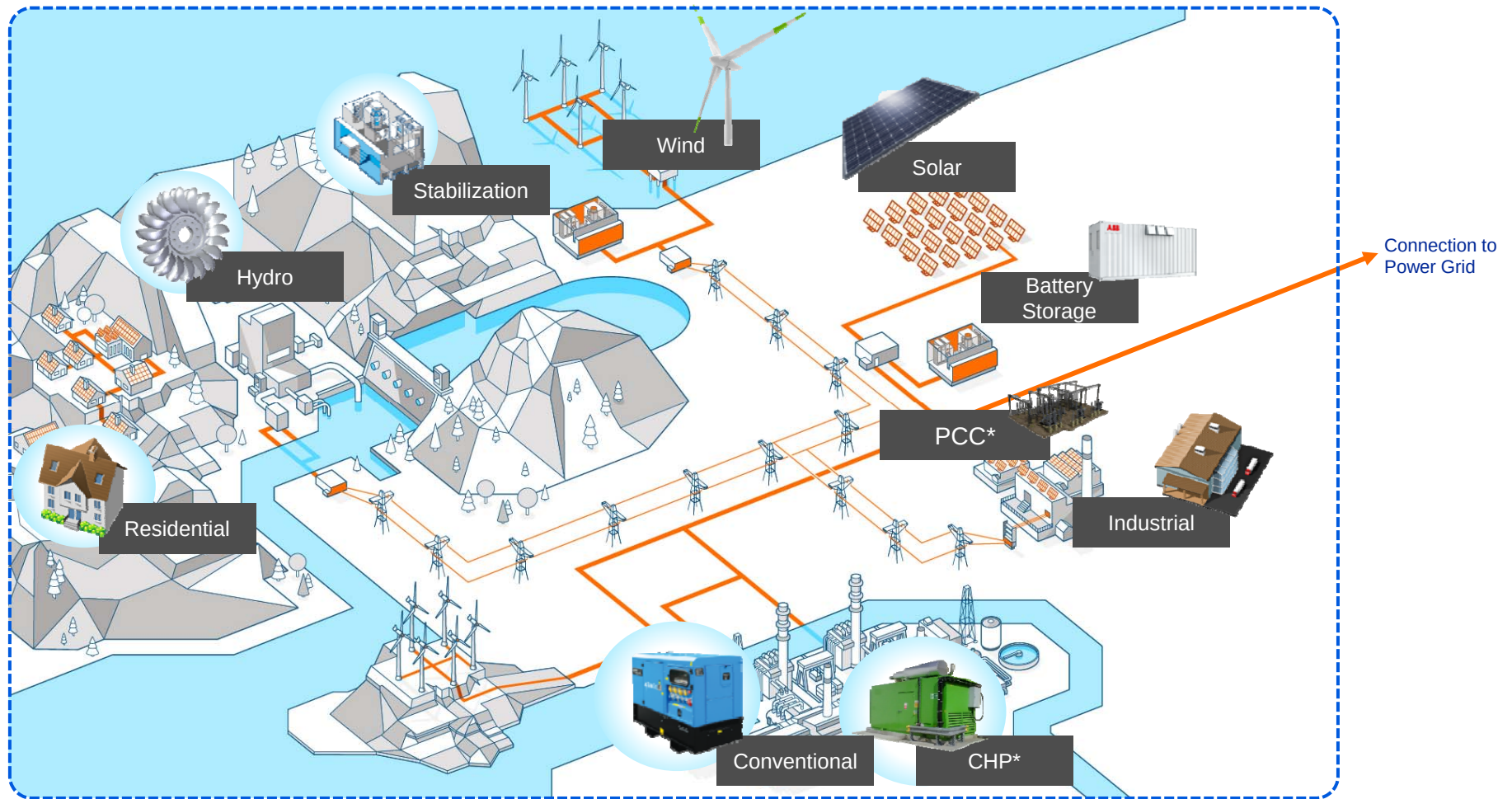
Microgrid participation



Islanded mode: ability to provide power independently from the main power grid

Grid connected microgrid

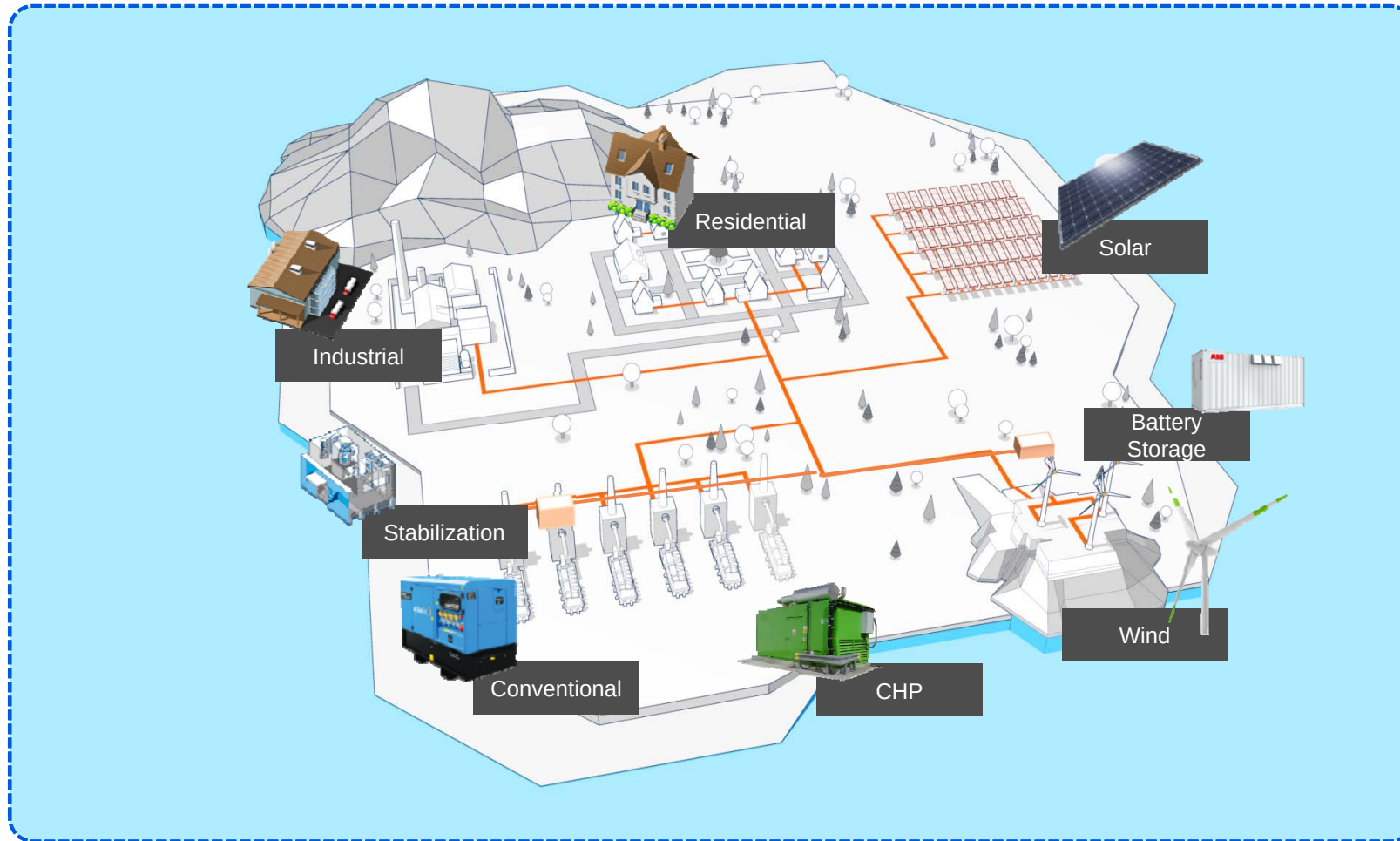
Improved grid resiliency, higher power quality and increased self consumption



PCC: Point of Common Coupling
CHP: Combined Heat and Power

Hybrid or Islanded microgrid

Access to power in remote locations, increased power quality, lower cost and reduced environmental impact



Microgrid segments and main drivers

Covering a diverse range of applications

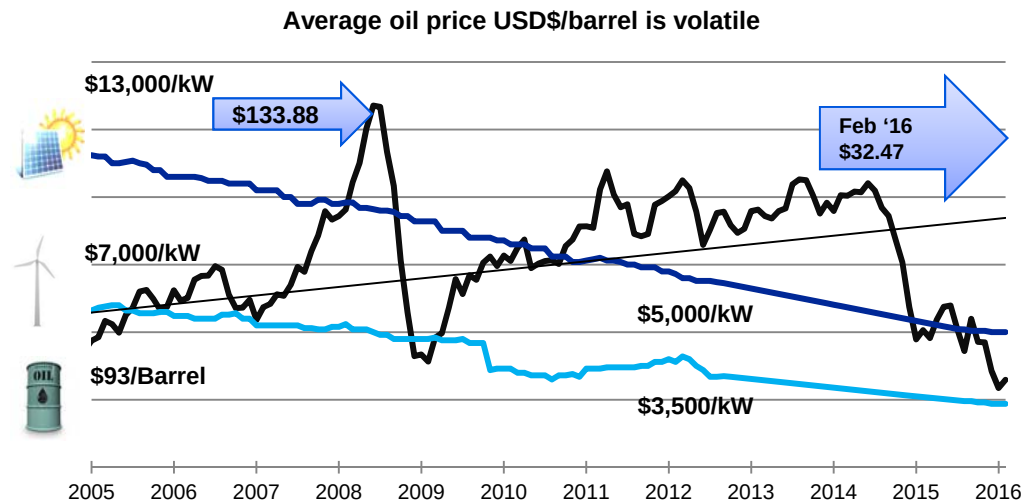
		Main drivers				
		Social	Economic	Environmental	Operational	
		Access to electricity	Fuel & cost savings	Reduce CO2 footprint and pollution	Fuel independence	Uninterrupted supply
Off-grid Weak grid Grid-connected	Segments	Typical customers				
	Island utilities	(Local) utility, IPP*	✓	✓	✓	(✓)
	Remote communities	(Local) utility, IPP, Governmental development institution, development bank	✓	✓	✓	
	Industrial and commercial	Mining company, IPP, Oil & Gas company, Datacenter, Hotels & resorts, Food & Beverage	✓	(✓)	✓	✓
	Defense	Governmental defense institution	(✓)	(✓)	✓	✓
	Urban communities	(Local) utility, IPP		(✓)		✓
	Institutions and campuses	Private education institution, IPP, Government education institution	(✓)	✓		(✓)

IPP: Independent Power Producer

✓: Main driver
(✓): Secondary driver

Driver: fuel independence and lower LCOE

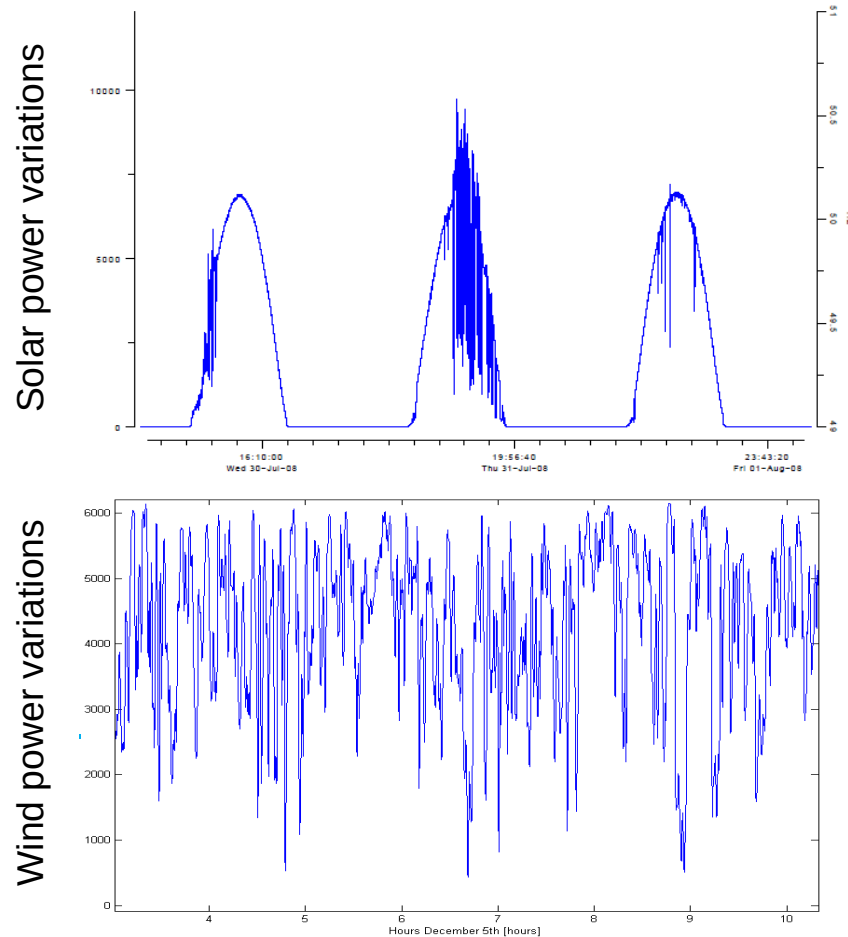
Secure power generation and fuel cost savings



- Fuel cost is volatile.
- Renewable energy cost is less volatile and decreases over time.
- Renewable energy is economically competitive today.
- An optimized energy mix leads to a lower cost of electricity.

Renewable energy integration challenges

Managing power output fluctuations



- Inherent volatility of renewable energy can compromise grid stability
- The renewable energy integration solution must address requirements traditionally fulfilled by diesel generation (base load)
 - Frequency and voltage control
 - Sufficient spinning reserve
 - Sufficient active and reactive power supply
 - Peak shaving and load levelling
 - Load sharing between generators
 - Fault current provision
- Renewable energy generation capacity should be sized to maximize ROI and fuel savings

ROI: Return on investment

Technological challenges: penetration & contribution

Microgrid Technologies

Energy Contribution vs. Power Penetration

Renewable Energy (RE) penetration:

Ratio of the power of renewable sources in the microgrid over the total microgrid power demand.

$$\text{Penetration} = \frac{\text{Renewable Power (kW)}}{\text{Primary load (kW)}}$$

Renewable Energy (RE) contribution:

Amount of energy consumed from renewable sources over the total energy consumed by the load

$$\text{Contribution} = \frac{\text{Renewable Energy (kWh)}}{\text{Total energy demand (kWh)}}$$

Microgrid Technologies

Energy Contribution vs. Power Penetration (cont'd)

Example:

Total load	Diesel gen. installed capacity	PV installed capacity
1.000 kW	1.000 kW	700 kW

@ 8 h
Load = 500 kW
PV = 200 kW

@ 12 h
Load = 600 kW
PV = 600 kW

@ 18 h
Load = 1000 kW
PV = 500 kW

$$\text{Penetration} = \frac{\text{Renewable Power (kW)}}{\text{Primary load (kW)}}$$

Penetration = 40%

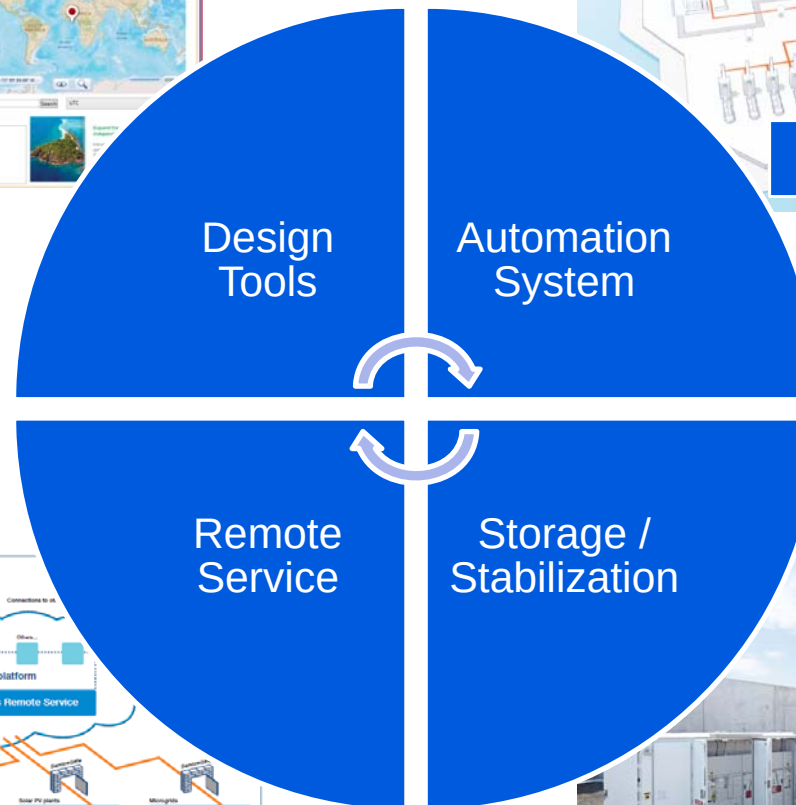
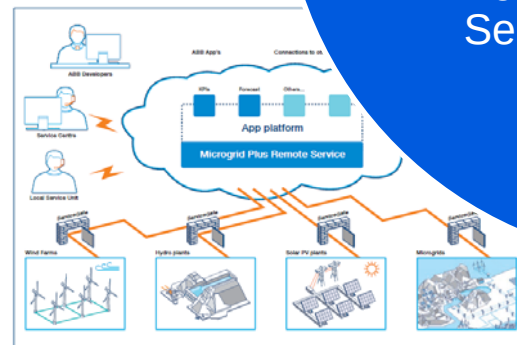
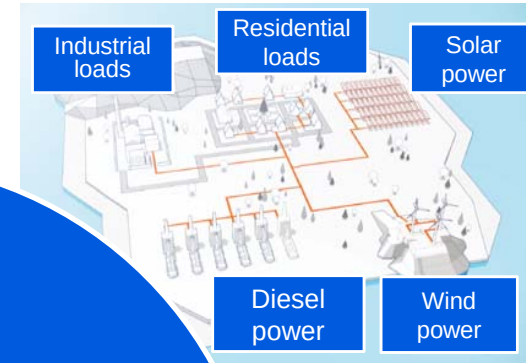
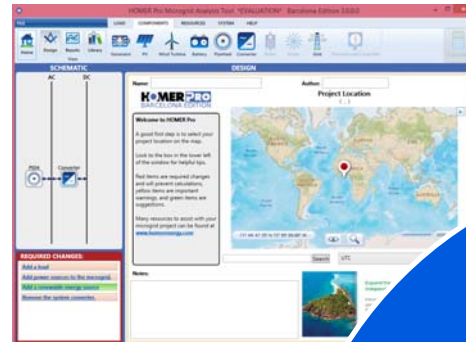
Penetration = 100%

Penetration = 50%

Grid penetration: 100%

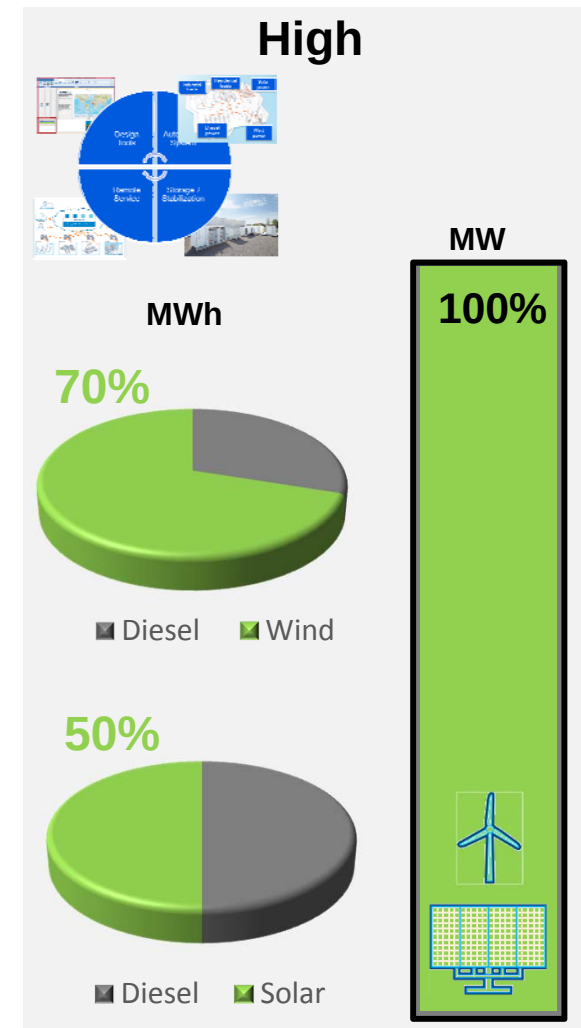
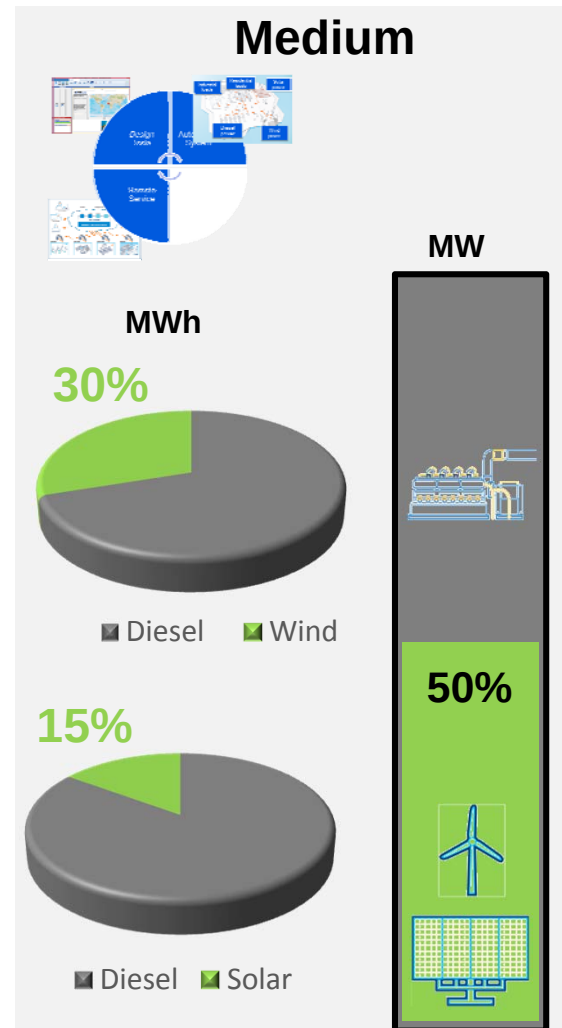
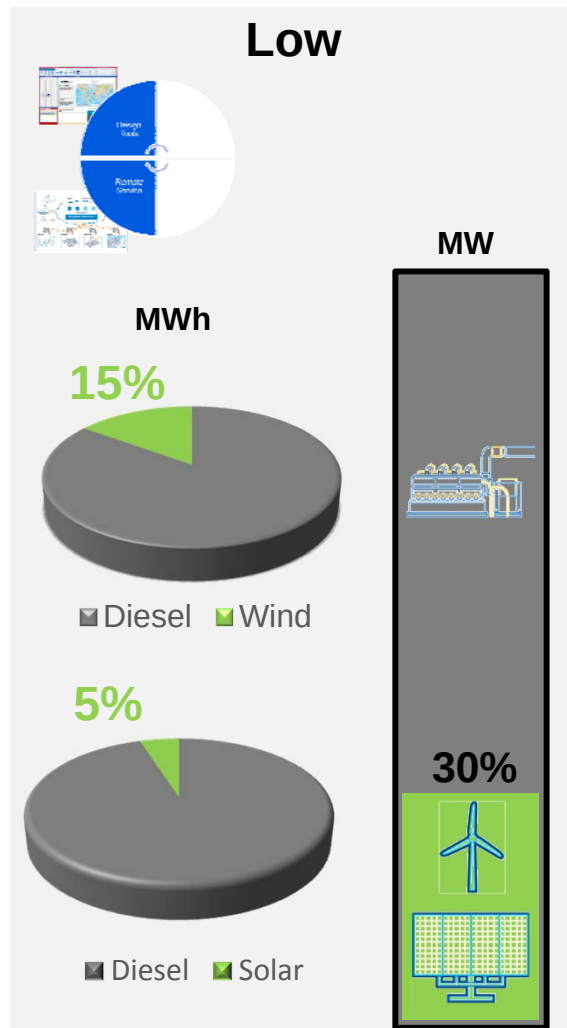
Hybrid power systems

Integration technologies



Microgrid technologies

Low, medium and high penetrations



Integration technology

Defined by renewable penetration levels

Reducing LCOE though the use of renewables

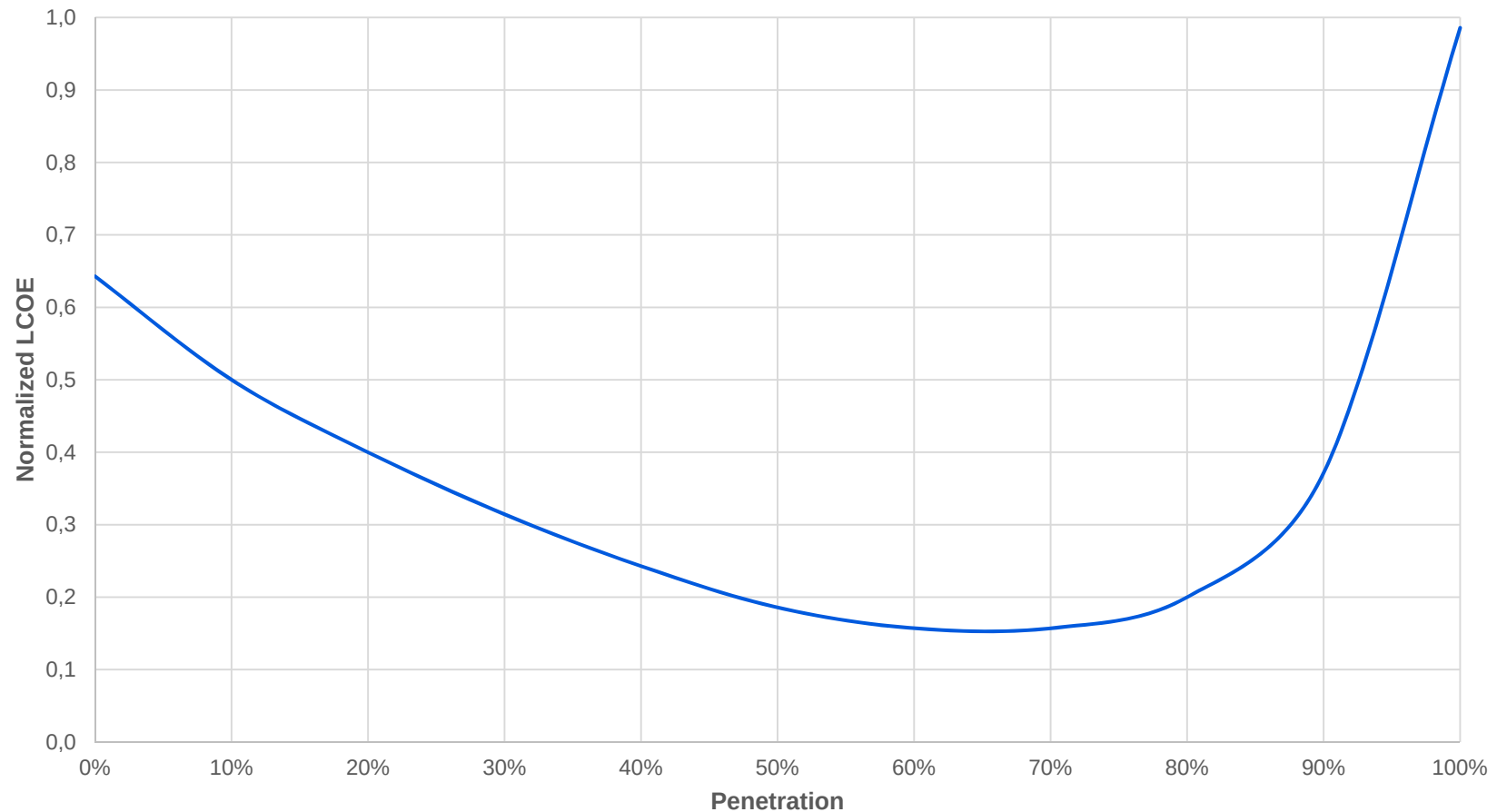


ABB in microgrid

ABB in microgrid

A leading supplier

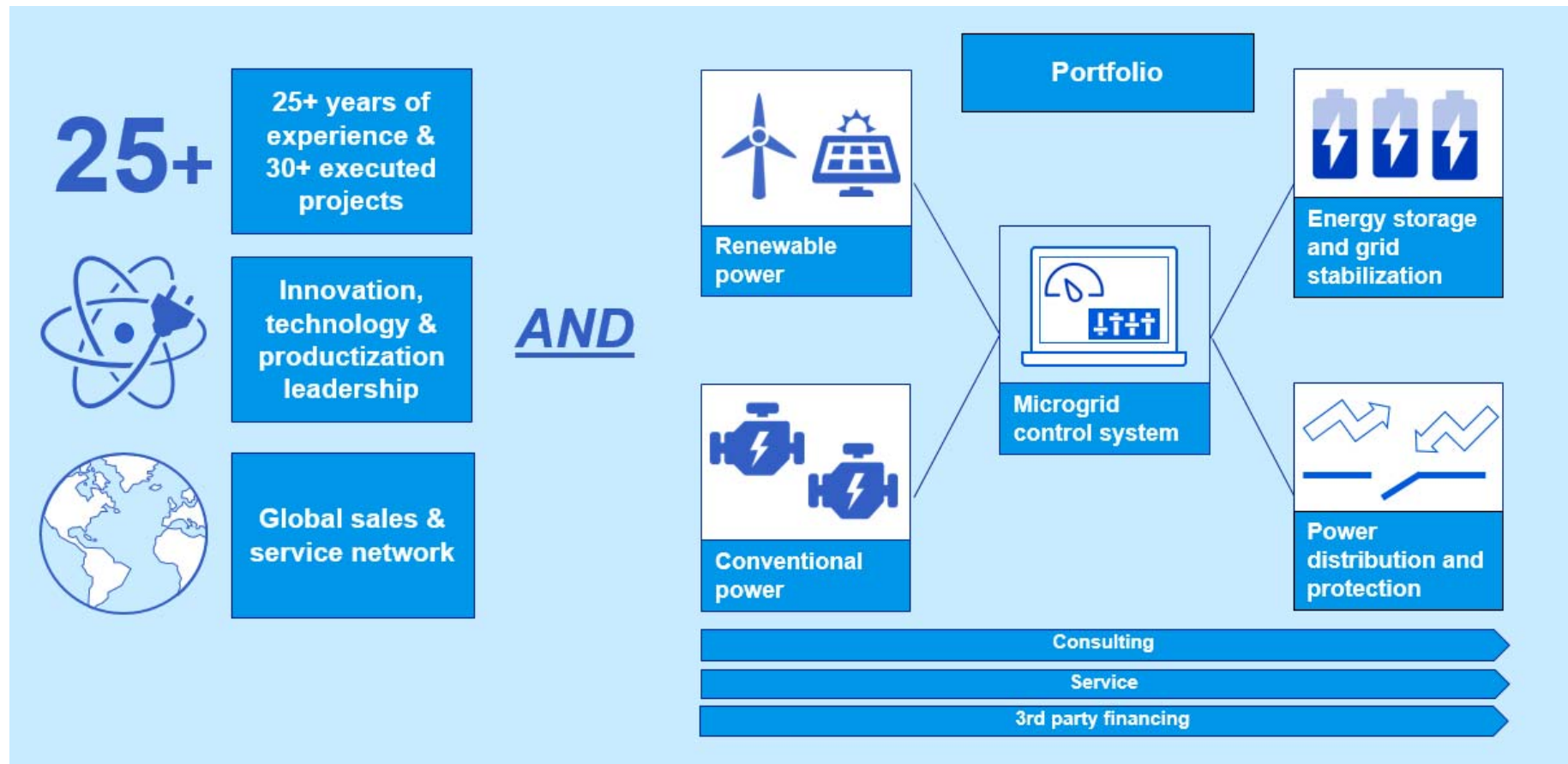


ABB in microgrid

Power generation

Conventional and renewable power generation

Comprehensive scope of plant electrification and automation systems including life cycle management services backed by 125 years of experience in the power generation industry.



- Coal and gas fired
- Solar, wind and hydro
- Distributed power generation
- Systems: Automation, optimization and control and remote monitoring
- Products: Control systems, drives, instrumentation, motors and generators, power converters and inverters

ABB in microgrid

Power distribution and protection

Power distribution and protection

An industry leader in power products, grid connection and integration solutions providing a full range of protection, control and measurement solutions available for both new and existing installations meeting the demands from all types of power distribution grids.



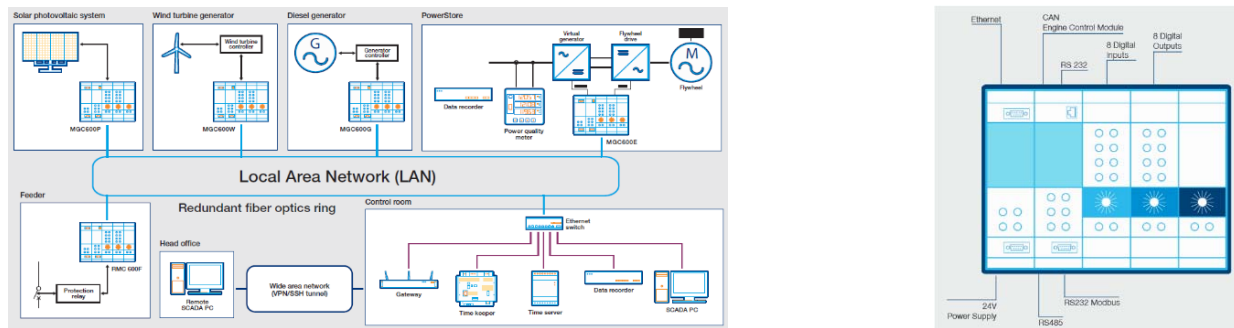
- Switchgears
- Transformers
- Circuit Breakers
- Substations
- Protection and control
- Measurement and monitoring

ABB in microgrid

Control system

Microgrid Plus system

Specially designed networked control system responsible for efficient and reliable power flow management.



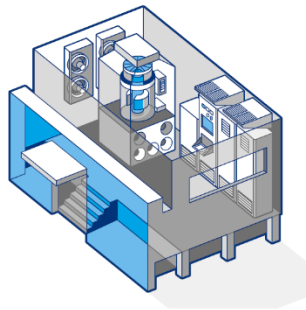
- Maximizes fossil fuel savings
- Optimizes use of renewable energy
- Guarantees optimum loading and spinning reserve in fossil fuel generators
- Distributed logic enhances reliability and scalability for future system expansions
- Modular and scalable

ABB in microgrid

Grid stabilization and energy storage system

PowerStore™

Compact and versatile grid stabilizing system capable of stabilizing power systems against fluctuations in frequency and voltage.



- Can stabilize 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 voltage and frequency
- Battery or flywheel based and includes state-of-the-art inverters and virtual generator control software
- Applicable to isolated grids or in grid support mode

ABB in microgrid

Consulting and Remote service

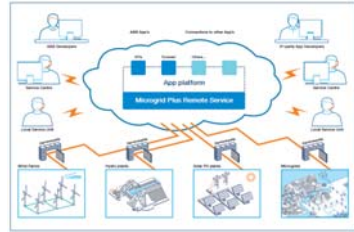
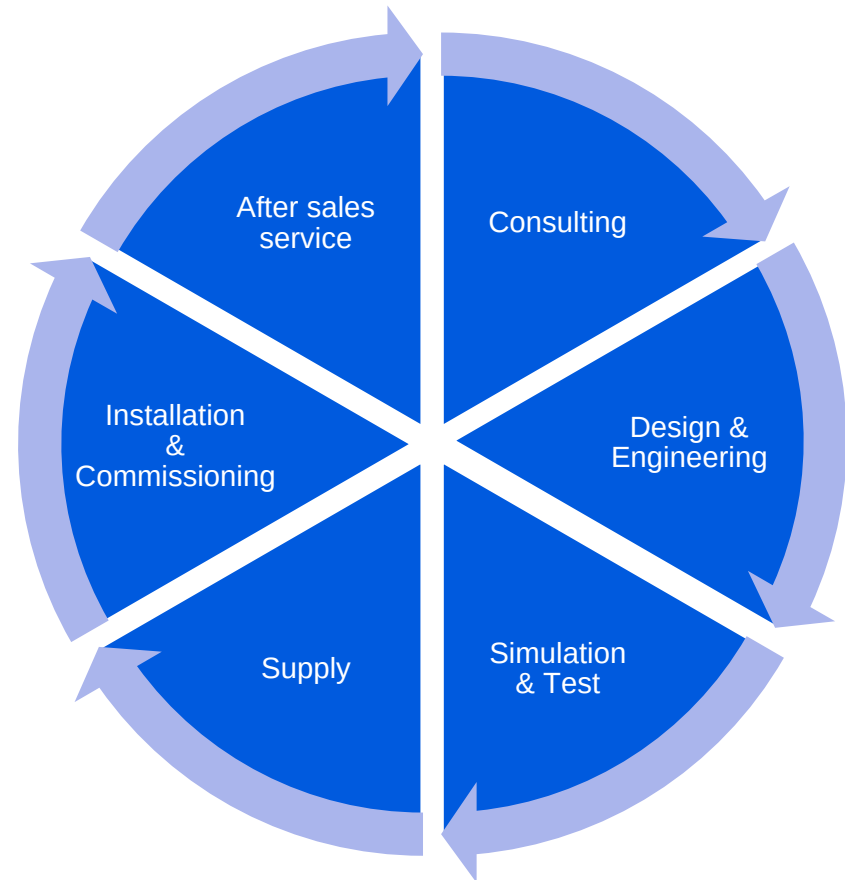
Consulting and Desing tools	Remote services for Operation and Maintenance
Our experience, capabilities and tools enable your resources to plan and operate the microgrid reliably and at maximum economic benefit.	A comprehensive solutions for unattended sites to increase productivity, improve energy efficiency and reduce operation costs.
	
Consulting is offered through out the complete lifecycle of a project with the goal to find the optimal solution that maximizes the value of the assets and financial investment. • Feasibility studies and simulations • Grid studies • Renewables engineering	Management of customers and plants from the same web portal, providing • Energy production reports • Interventions • Energy production forecasts • Real time data production • List of customers and plants

ABB in microgrid

Support during the complete lifecycle

- ABB offers a comprehensive portfolio of life cycle management and services throughout the whole project life cycle
- The consulting and service offering is based on extensive process and application know-how as well as one of the largest installed bases in the world
- ABB provides remote monitoring and control of all microgrid assets; a crucial element especially for remote microgrids



References

ABB Microgrids and renewable energy

Our offering

	Hybrid power station	Integrated wind or PV plant	Integration solution		
			Optimized microgrid integration	Renewable to grid connector	Ancillary power system services
					
What is it?	Turnkey solution for a greenfield microgrid project	Integration of renewable energy into fuel-based microgrids (HFO, Diesel, gas etc.)	Stabilization and flow optimization of renewable energy integration	Stabilization of on-grid renewable energy plants connected to a weak grid	Providing virtual inertia, grid stabilization, as well as other ancillary power system services
Reference	▪ Marble Bar (solar/diesel) ▪ Hopetoun (wind/diesel) ▪ Coral Bay (wind/diesel)	▪ Ross Island (wind/diesel) ▪ Rottneest (wind/diesel) ▪ Esperence (wind/diesel) ▪ Denham (wind/diesel)	▪ Faial (wind/diesel) ▪ Flores (wind/hydro/diesel)	▪ Carnegie (wave) ▪ Kalbarri (wind)	▪ SP Ausnet (GESS) ▪ Leinster Mine (peak lopping) ▪ Endesa (grid connection) ▪ REE (grid connection)

References – Hybrid power plant Marble Bar, PV/Diesel



Australian Government
Department of Climate Change
and Energy Efficiency

HORIZON
POWER



Project name

Marble Bar

Country

Western Australia, Australia

Customer

Horizon Power

Government of WA

Completion date

2010

ABB solution

- PV/diesel Microgrid with PowerStore grid-stabilizing technology and Microgrid Plus System
- The resulting system consists of:
 - Diesel (4 x 320kW)
 - PV (1 x 300kW)
 - PowerStore-flywheel (1 x 500kW)
 - Microgrid Plus System

Customer benefits*

- Minimize diesel consumption, 405,000 liters of fuel saved annually
- Minimum environmental impact, 1,100 tonnes CO2 avoided annually
- Reliable and stable power supply
- 60% of the day time electricity demand is generated by the PV plant

About the project

Marble bar and Nullagine are the world`s first high penetration, solar photovoltaic diesel power stations

References – Integrated wind or PV plant

Ross Island, Wind/Diesel



Project name

Ross Island

Location

Ross Island, Antarctica

Customer

New Zealand's Antarctic Division
USA McMurdo Station

Completion date

2009

ABB solution

- Integration of wind turbines into the microgrid with PowerStore grid-stabilization and Microgrid Plus System
- Implement a frequency converter to connect a 50Hz network to a 60Hz one
- The resulting system consists of: Diesel (9 x 125kW), WTG (3 x 330kW), PowerStore-flywheel (1 x 500kW), Microgrid Plus System, frequency converter

Customer benefits

- Minimize diesel consumption
- Reduced environmental risk of transporting diesel
- 463,000 liters of diesel fuel saved annually
- 2,800 tons CO2 avoided annually
- Up to 70% wind power peak penetration

About the project

- Integration of the southernmost wind farm in the world into a dual 50 and 60Hz microgrid

References – Integrated wind or PV plant

DeGrussa Mine - Solar/Diesel



Project name

DeGrussa Copper-Gold Mine

Country

Australia

Customer

juwi Renewable Energy

Completion date

To be completed in 2016

ABB solution

- Integration of a new 10.6 megawatt (MW) solar PV field and a battery storage system with existing diesel generation to provide reliable base-load power.
- The resulting system consists of: PowerStore™ grid stabilization solutions (2 x 2 MW), solar inverter stations (5 x 2 MW), solar MV stations, a transformer (5 MVA) and the Microgrid Plus System

Customer benefits

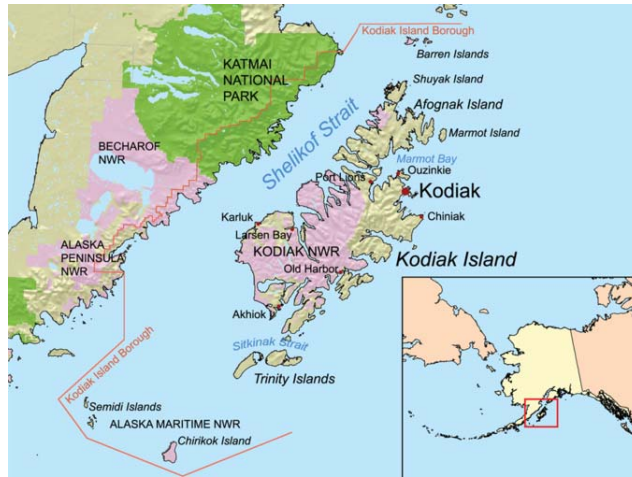
- Expected diesel fuel saving is 5 million liters per year, cutting diesel consumption by 20%

About the project

- The new hybrid solar facility will be the largest integrated off-grid solar and battery storage plant in Australia.
- Once fully integrated, the plant will reduce CO2 emissions by 12,000 tons.

References – Ancillary power system services

Kodiak Island, grid stabilizing system



Project name

Kodiak Island

Country

Alaska, United States of America

Customer

Kodiak Electric Association (KEA)

Completion date

Due to be completed in 2015

Image by, Karl Musser, created based on [USGS](#) data. [Category:Maps of Alaska](#)

ABB solution

- Deliver two PowerStore-flywheel units to stabilize the power grid and increase renewable energy

Customer benefits

- Provide voltage and frequency support for a new crane
- Extend the life of the battery systems by up to 6 years
- Help to manage the intermittencies from a 9 MW wind farm
- Reduced reliance on diesel generators

About the project

- Two PowerStores act in parallel in order to deliver optimal grid stabilization on Kodiak island
- “Not only will the ABB PowerStores allow us to shave the peaks off our cranes’ load, it will also reduce the stresses placed on our battery systems and extend their lifespans, which was a key deciding factor to move forward with this project.” *Darron Scott, president and CEO of Kodiak Electric Association*

Ancillary power system services

Longmeadow, PV/Diesel/Battery



Project name

Longmeadow

Location

South Africa

Customer

Longmeadow Business Estate

Completion date

2016

ABB solution

- PV/diesel microgrid with battery-based system to maximize solar contribution and ensure security of power supply at ABB's premises in Johannesburg
- The resulting system consists of:
 - 750 kWdc rooftop PV plant, including ABB PV inverter
 - 1 MVA/380 kWh battery-based PowerStore
 - Microgrid Plus System

Customer benefits*

- Reliable and stable power supply
- Optimized renewable energy contribution to the facility
- Ability to island from the grid in case of an outage
- CO2 reduction: over 1,000 tons/year
- Up to 100% renewable energy penetration

About the project

The microgrid solution is for the 96,000 sqm facility houses hosting ABB South Africa's headquarters as well as manufacturing facilities with around 1,000 employees. The innovative solution will help to maximize the use of solar energy and ensure uninterrupted power supply.

Additional information

Technical data and videos

Microgrid Solutions Website: <http://new.abb.com/power-generation/microgrids-solutions>

Introduction to ABB Microgrid Solutions technology: <https://www.youtube.com/watch?v=Yi2V-xeqHGM>

Marble Bar: Solar/PowerStore-Flywheel/Diesel <https://www.youtube.com/watch?v=Cx8fMdUisxg>

Faial Island: Wind/HFO <https://www.youtube.com/watch?v=iL0OIxwCuek>

SP AusNet: Grid/PowerStore-Battery/Diesel <https://www.youtube.com/watch?v=lqzgNF6DyWo>

Kodiak Island: PowerStore-Flywheel <https://www.youtube.com/watch?v=CFaZDdAWul8>



Contact information

For any questions, please contact me

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Power and productivity
for a better world™

