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De-risking the development and integration of renewable energy

High penetration, max fuel savings

Mainstream's vision



The world is now experiencing a once-off transition to sustainability....to survive and to gain critical competitive advantage each country and company must go through this transition

Mainstream is a dynamic and flexible platform to deliver wind and solar plant in response to the global transition to renewable energy

Mainstream's profile

- Global wind and solar developer operating in key global mining markets
- 8 GW off-shore wind, 11GW onshore wind (230 MW in construction) 500 MW solar Pipeline (100 MW in construction)
- Not tied to any technology provider = best overall solution (price, performance, warranty) for each project
- Highly experienced board of management with track record in the delivery and financing of renewable energy plants
- Key investors who operate in the mining space

Mainstream's solution

- De-risk the development process from project inception to operation
- Provide optimum technical solution based on best price, performance, warranty and bankability
- Provide project finance and long-term ownership capability leaving Mining Co. capital free for allocation to core activities

De-risking the development and integration of renewable energy

Customer perception and fears

- “Renewable energy production output won’t meet our demand profile”
- “Renewable energy is too expensive...so how much will this cost me? “
- “Costs aside, how can renewable energy meet our unique power quality requirements?”
- “How will renewable energy be integrated with our incumbent system?”
- “Where has this been done before?”

De-risking the development and integration of renewable energy

The solution must...

- Reduce LCOE
- Maintain or improve power quality
- Enable the customer to retain control of their power supply
- Ensure everyone needs to get paid (or save money!)

ABB's profile

- A major global energy technology company
- Proven track record in supplying turnkey PV and hydro plants
- Experienced in the integration of large renewable energy plants

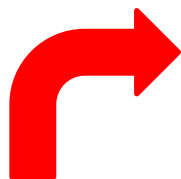
ABB's solution

- A leading technical solution provider to integrate renewables at high penetration levels
- High penetration - maximum fuel saving
- Power quality is maintained through new unique technology
- Global presence and strong local expertise

Remote Mining Sector



Total De-risked
Offering Through
Collaboration



- Proven technology platform
- Global mining player

ABB

- Development Platform
- Finance Platform
- Ownership Platform



The benefits of collaboration



**Unique
Complete
Solution**



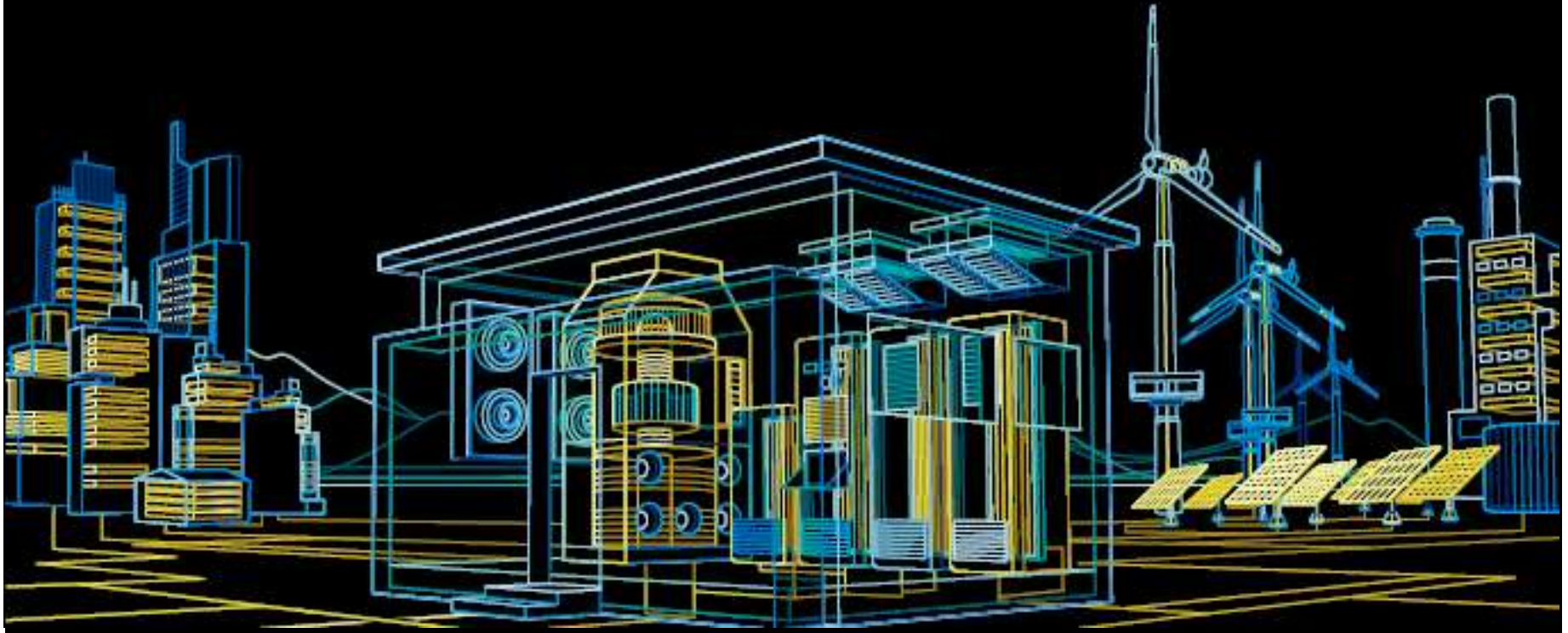
**Maximum
High
Penetration**



- **Maximum Savings possible**
- **Bankable Technology Performance**
- **Energy Hedge**
- **Fixed Price for a quantity of mine electricity**
- **Operations Sustainability**

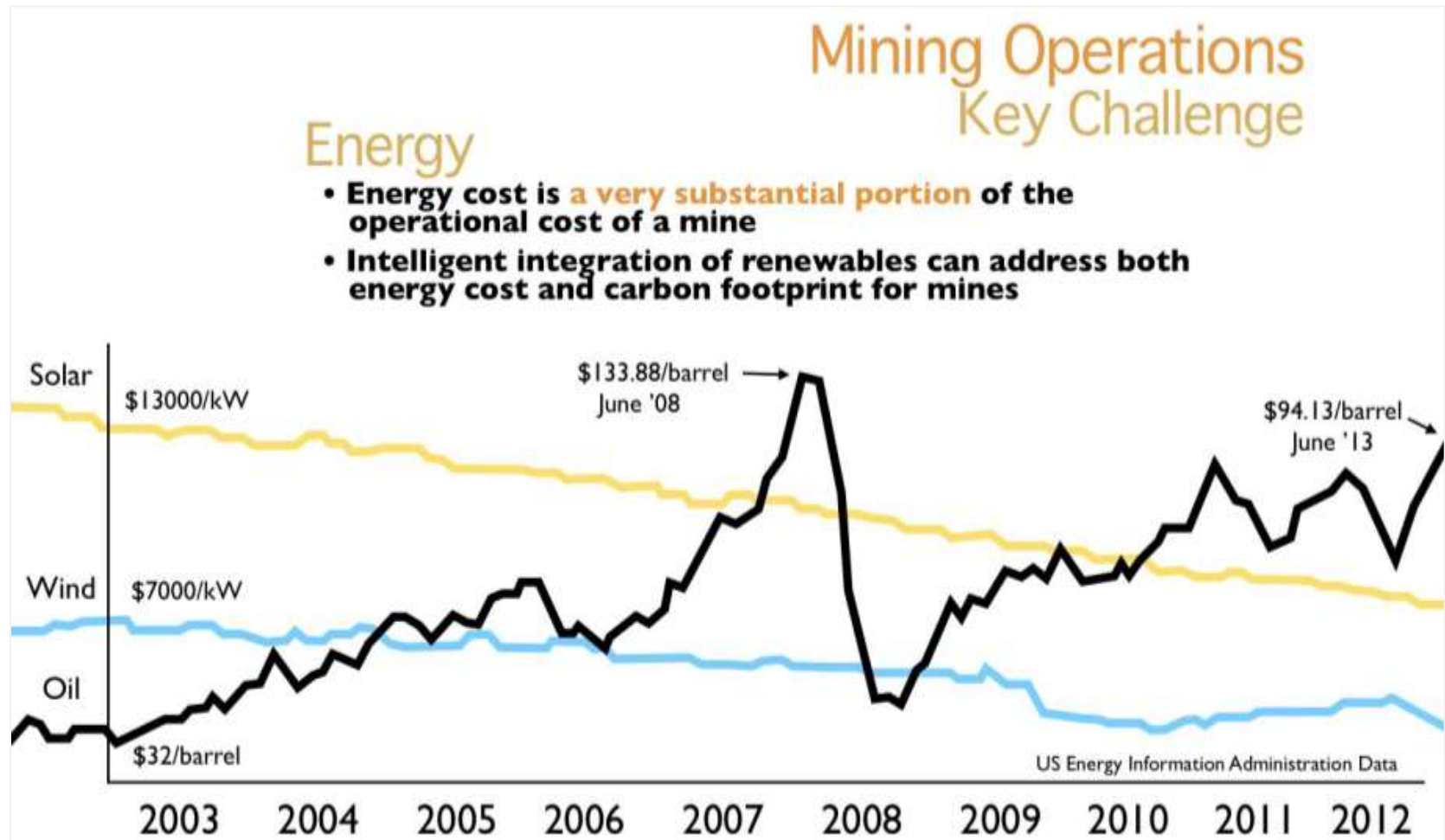


Problems and solutions



The problem

Future risk of fuel cost spikes



Renewable energy integration

Solar farm



Wind farm



Offering: renewable energy integration

Diesel power station



Load



Renewable energy integration challenges

Diesel power station



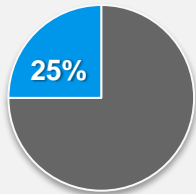
- Frequency and voltage control
- Fault current
- System inertia
- Spinning reserve
- Step load (load increase and reject)
- Unbalanced load supply
- Firm capacity
- Active & reactive power supply
- Loadsharing between generators
- Automatic dispatch control

Renewable energy integration

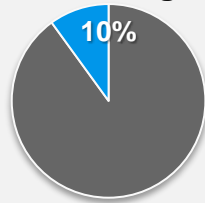
High penetration leads to short payback and higher ROI

Low renewable energy contribution

Peak Power



Annual Avg Energy/
fuel savings



- **Control system:** none/simple
- **Grid frequency:** within operational limits



Solarfarm



Windfarm

Renewable integration



Fossil fuel power station



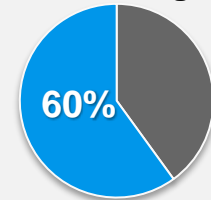
Load

High renewable energy contribution

Peak Power



Annual Avg Energy/
fuel savings



- **Control system:** sophisticated
- **Grid frequency:** stable

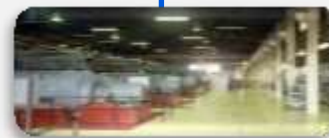


Solarfarm



Windfarm

Renewable integration



Fossil fuel power station



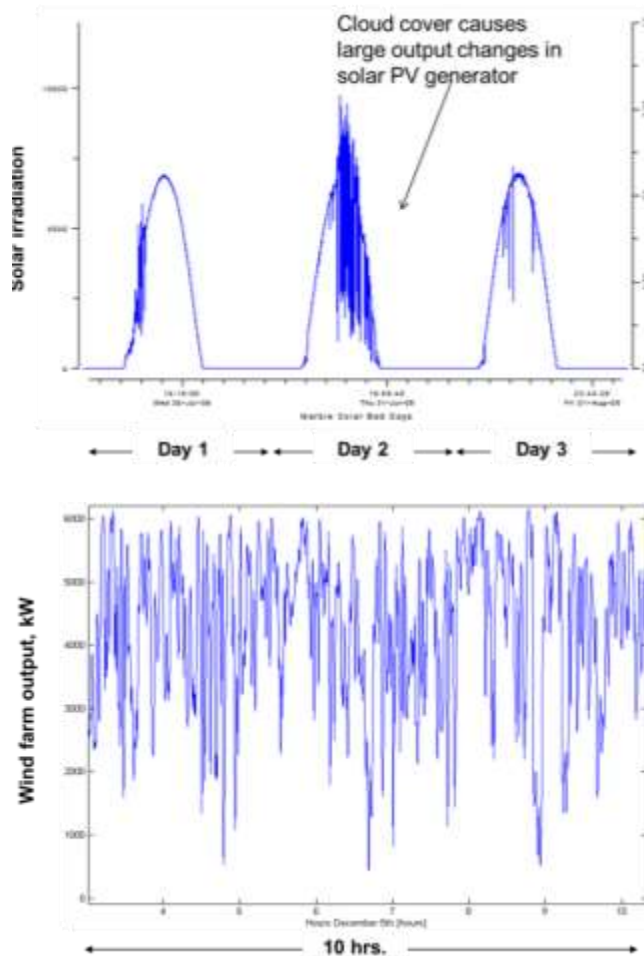
Load



Grid stabilization

Renewable energy integration challenges

Managing power output fluctuations

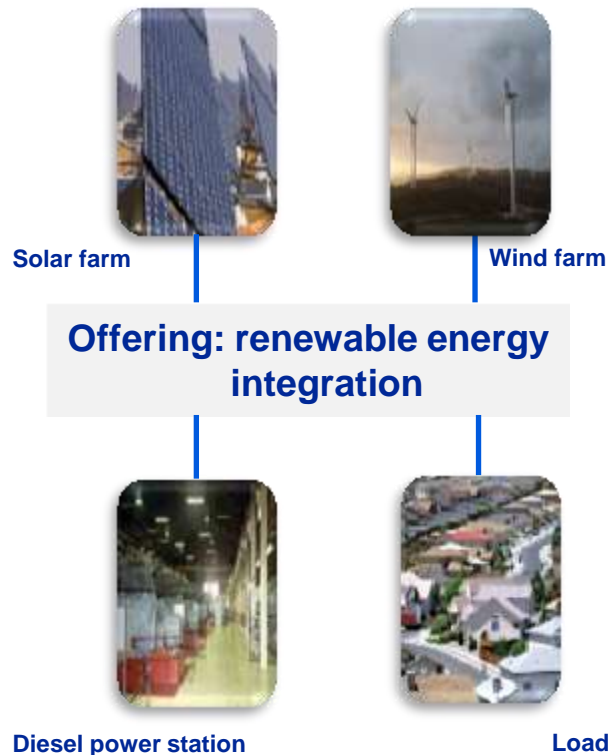


- Inherent volatility of renewable energy can compromise grid stability
- The renewable energy integration solution must address requirements traditionally fulfilled by diesel generation (base load)
 - Frequency and voltage control
 - Sufficient spinning reserve
 - Sufficient active and reactive power 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

Renewable energy integration challenges

.....keeping the system together



Wind /solar PV / diesel system

- Spinning reserve
- Unbalanced load supply
- Active and reactive power supply
- Load sharing between generators
- Automatic dispatch control

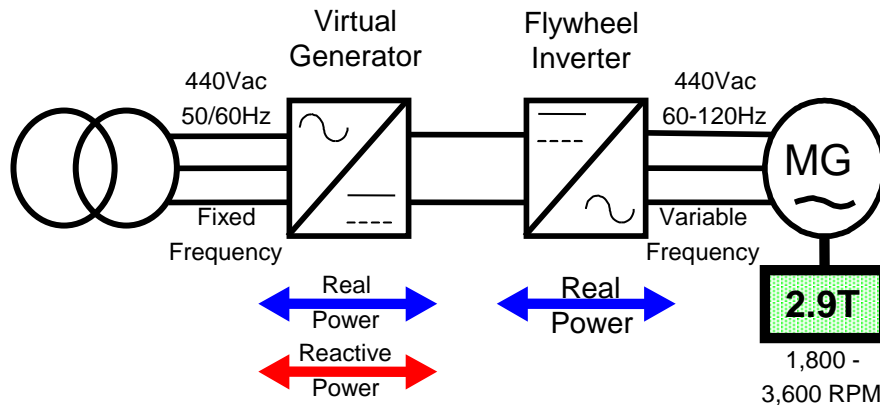
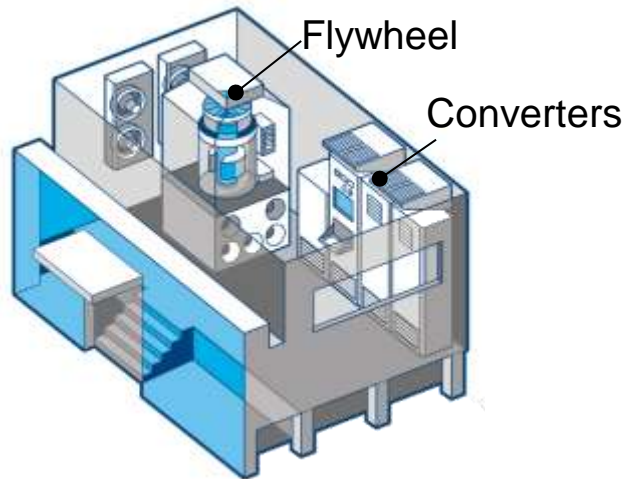
Renewable energy integration challenges

Microgrid technology solutions - typical penetration levels

Wind/solar/diesel systems	Annual Average Contribution	Peak Penetration
No integration	7-10%	20%
Automated dispatch	10-15%	22%
Grid stabilizing	40-60%	100%
Automated demand response	60-80%	100%
Energy storage	100%	100%

ABB's PowerStore™ flywheel system

Grid stabilization

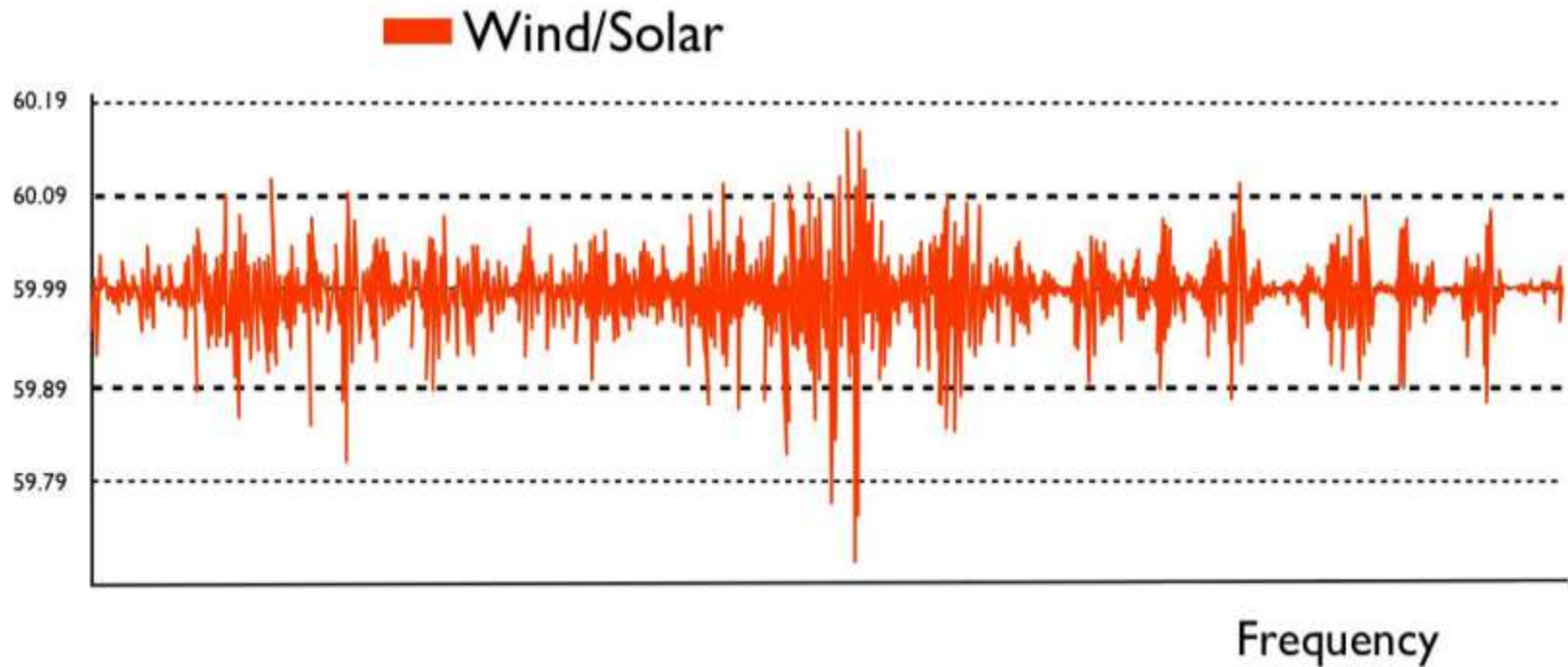


- Stabilizes frequency and voltage fluctuations
 - Heavy-duty application: dynamic power injection and absorption in milliseconds
- Maximizes fuel savings through highest possible renewable penetration
- Proven track record
 - 3,000 kW installed and 2,100 kW under commissioning

What the Powerstore does

Grid fluctuations due to renewable energy input

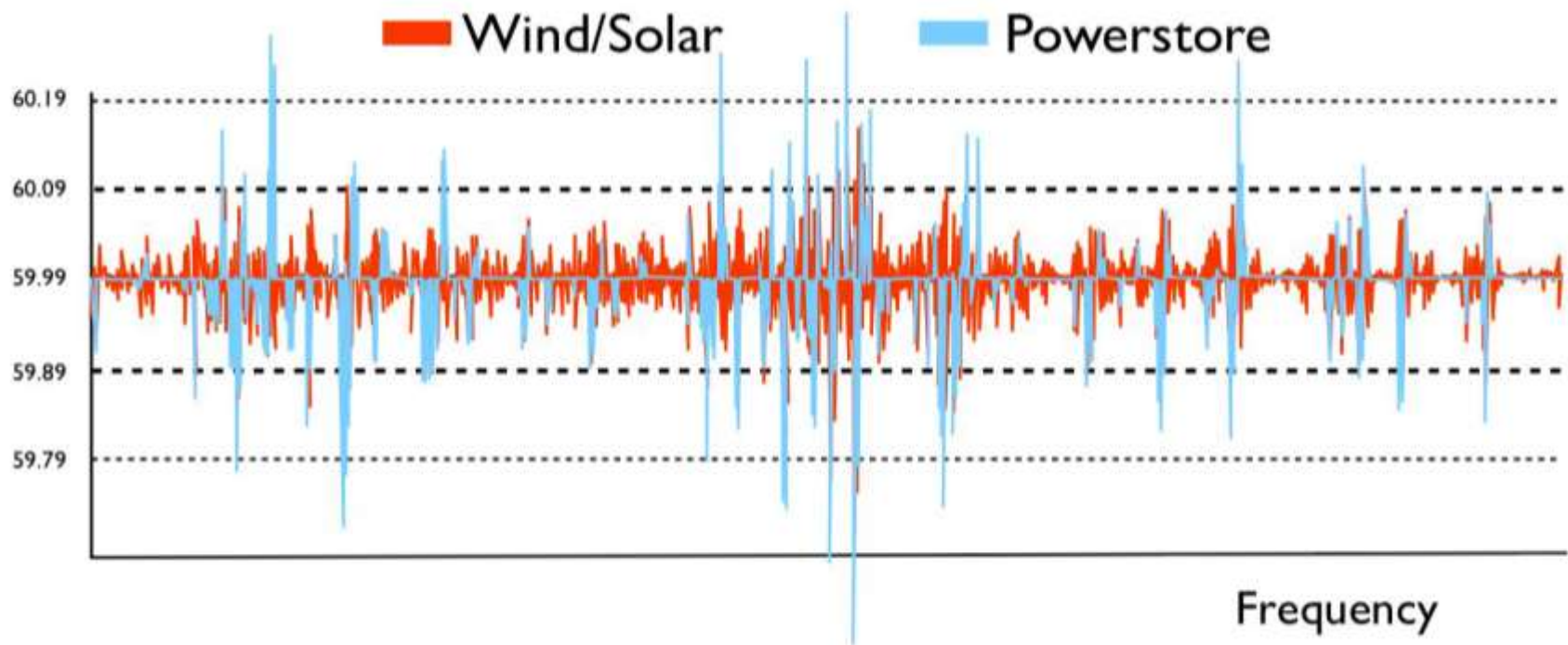
ABB Microgrid Solution Grid Stabilizing Powerstore Flywheel System



What the Powerstore does

Powerstore injection/rejection of real power

ABB Microgrid Solution Grid Stabilizing Powerstore Flywheel System

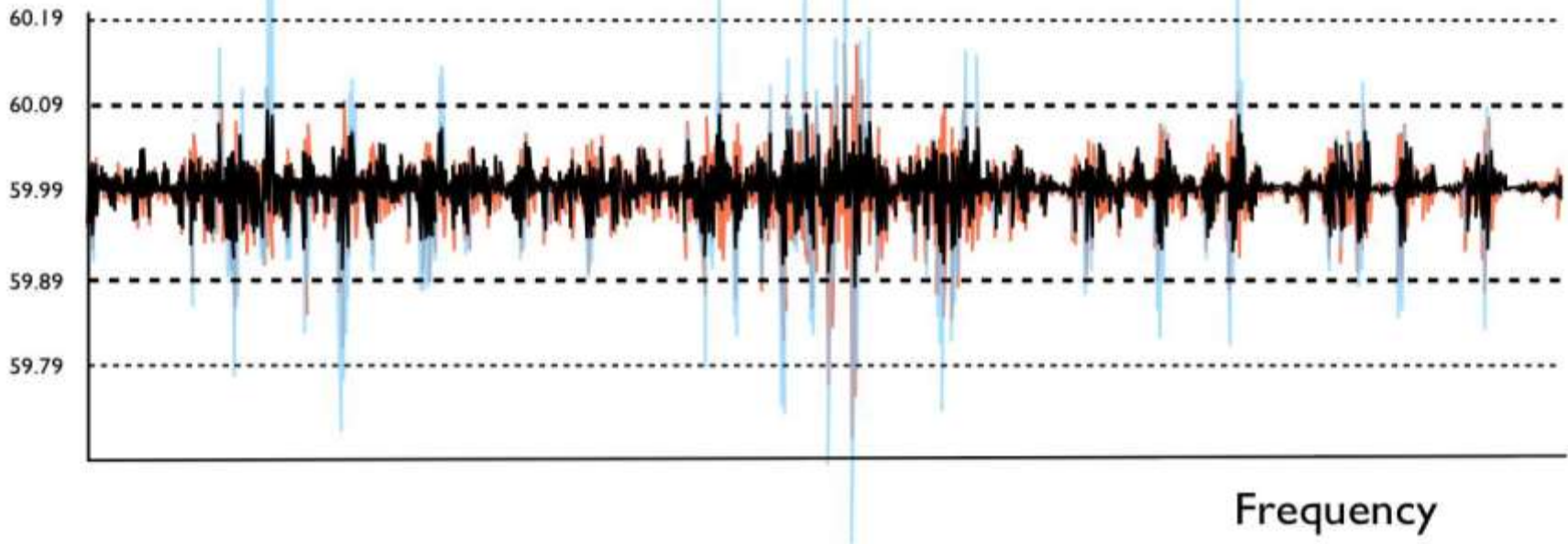


What the Powerstore does

Damping of frequency fluctuations

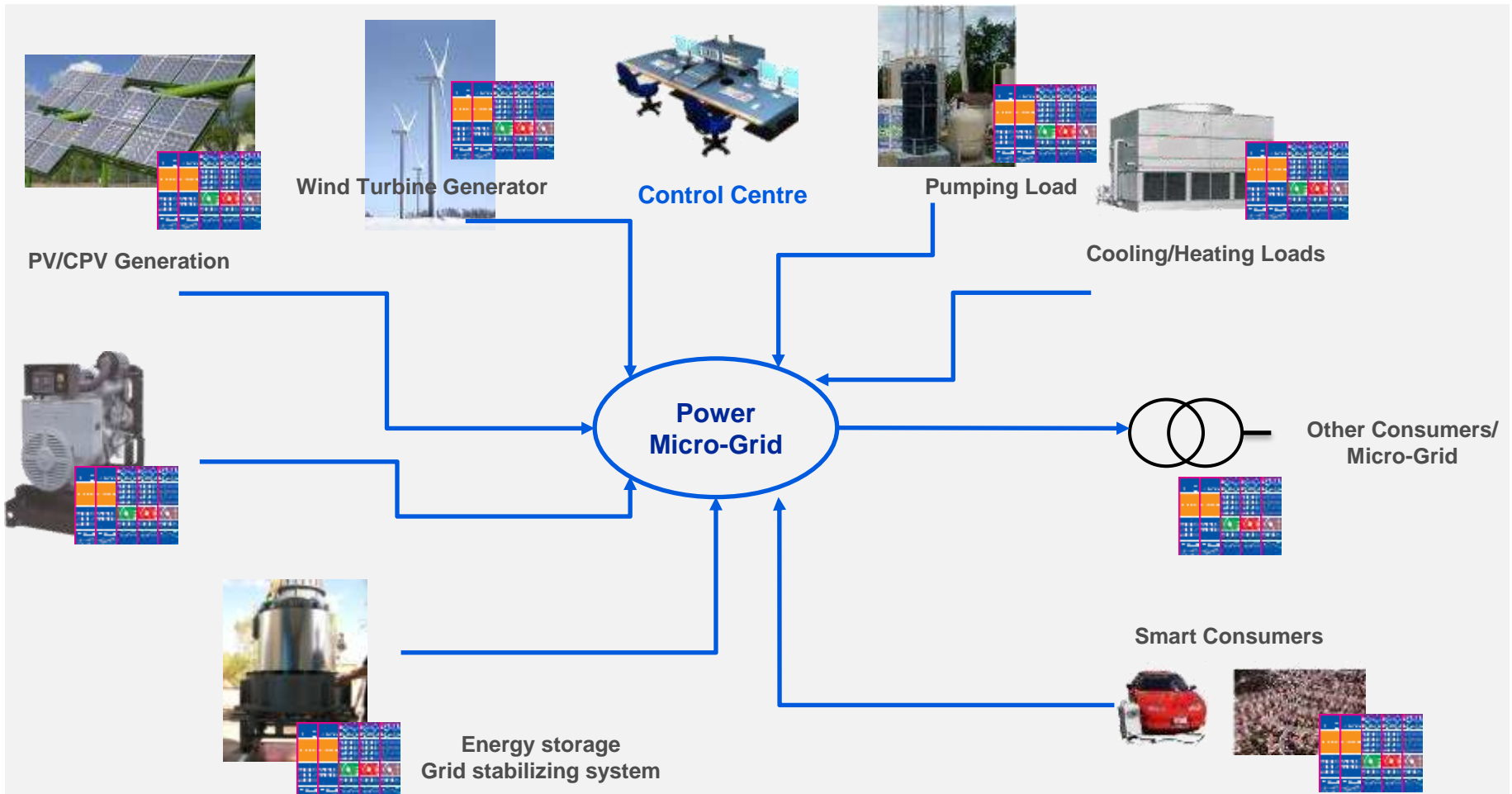
ABB Microgrid Solution Grid Stabilizing Powerstore Flywheel System

Wind/Solar & Powerstore



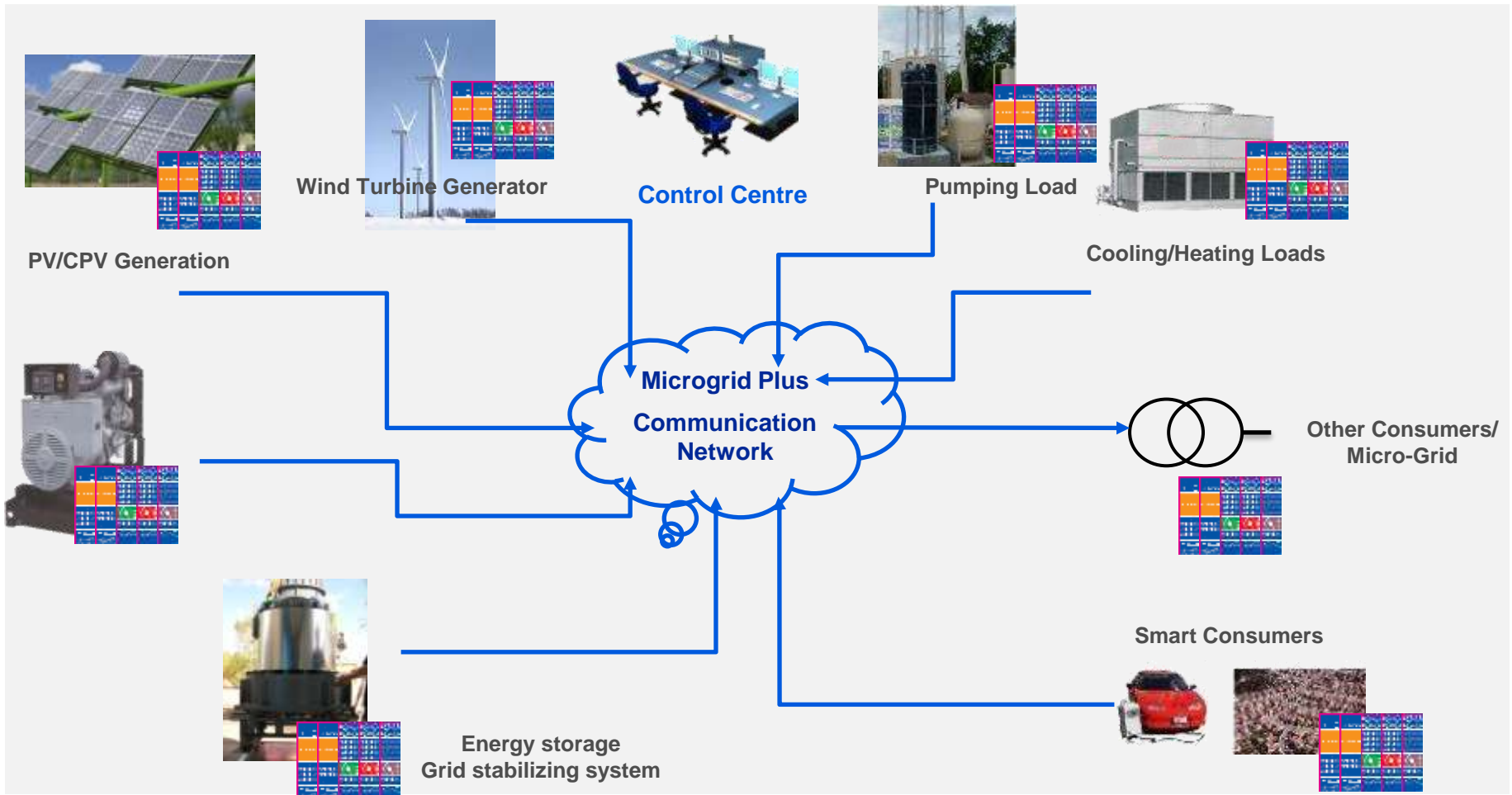
System control – real time active control

Distributed power control and dispatch system



System control – real time active control

Distributed power control and dispatch system








Multiple working examples



Experience and references

History

1990	1998	2001	2007	2010
Napperby Northern Territory	Denham Western Australia	Mawson Antarctica	Coral Bay Western Australia	Marble Bar and Nullagine Western Australia
Automation of diesel power station (Battery system)	Wind/diesel	Wind/grid stabilizing	Wind/diesel/ flywheel	Solar/diesel/ flywheel
0% Penetration	15% Penetration	85% Penetration	95% Penetration	100% Penetration
				

Penetration is annual average renewable energy as percentage of total energy generated

Project experience

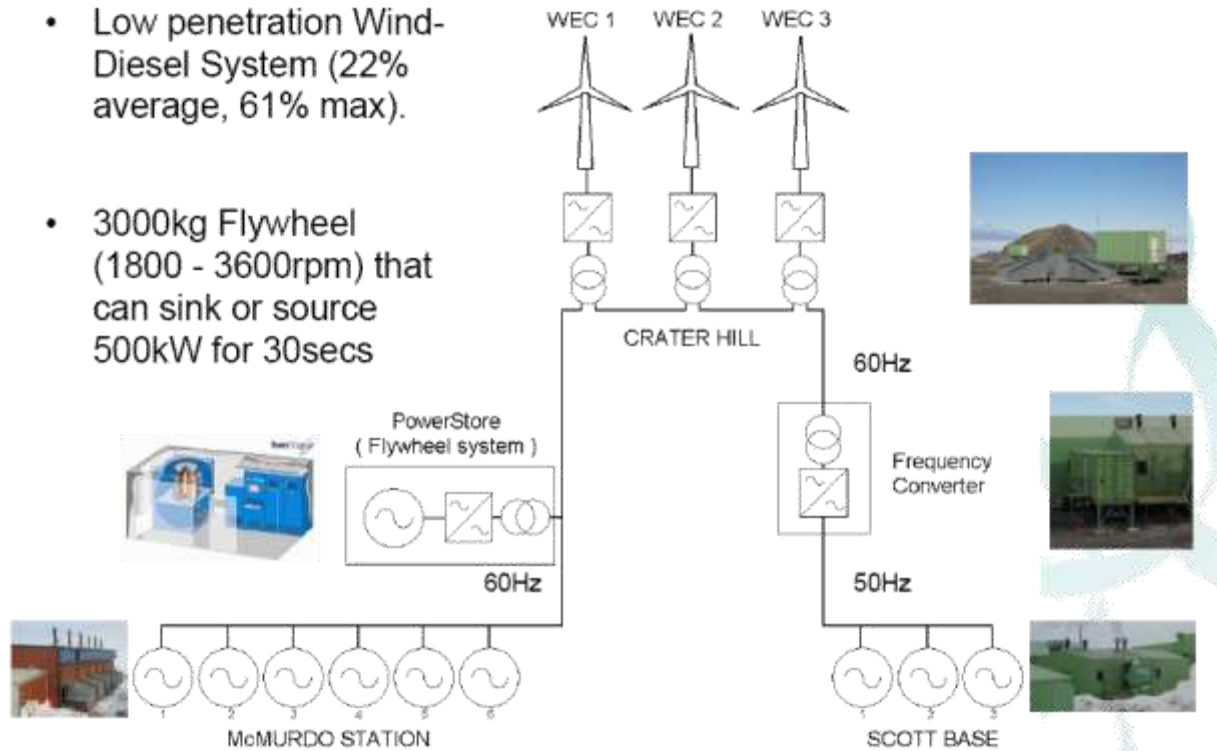
Ross Island, wind/diesel system, Antarctica

Stage 2 plans are to increase the number of wind turbines, creating a high penetration system

RIWE Stage 1 – Crater Hill Wind Farm



- Low penetration Wind-Diesel System (22% average, 61% max).
- 3000kg Flywheel (1800 - 3600rpm) that can sink or source 500kW for 30secs



Project experience

Ross Island, wind/diesel system, Antarctica



- Two power systems coupled by frequency converter:
 - 6 x 1500 kW / 60 Hz diesel
 - 3 x 225 kW / 50 Hz diesel
 - 3 x 330 kW wind turbines
 - 1 x 500 kW flywheel
- Option to include electric heating load
- Integration of US/NZ power system network

Business case



Business case

Total net savings need to be a minimum 10% of current mine energy costs

- **Current Costs:**
 - 20 MW (175GWh) Power Plant using 15m gallons p.a. @ \$5/gal = \$75m
- **Target Savings:**
 - 10% net savings = \$7.5m
- **Cost of Wind Farm**
 - 10 MW Wind farm cost = \$5m p.a.(\$150 / MWh)
- **Total Savings Required From High Penetration System**
 - \$12.5m
- Target level of penetration achieved by PowerStore installation needs to deliver minimum savings of
 - 17% of current diesel consumption (175GWh) or
 - \$12.5m (as per above example)

Business case

- Customer-driven collaborative approach required
- PPA model, B&T, BOOT
- Business model dependent on customer profile



Renewable Energy Integration



Project Development & Delivery

- Power system **integrators** who design, supply and construct Renewable Energy Power Stations
- **Enable** organisations to make the **transition** from fossil fuel based generation to **Renewable energy** based generation
- Specialists in **high penetration of wind and/or solar** in diesel/gas plants

Thank
You.

Mainstream and ABB

The right combination for your success

