Microgrid Solutions
Enabling resilient and cost effective access to power
ABB in Microgrid
A leader in technology, solutions and execution

25+

- 25+ years of experience & 30+ executed projects
- Innovation, technology & productization leadership
- Global sales & service network

Portfolio
- Renewable power
- Microgrid control system
- Energy storage and grid stabilization
- Power distribution and protection

Consulting
Service
Agenda

1. Microgrids in the context of Power Systems
4. ABB Offering
5. Experience and Key Project Learnings
Microgrids in the context of Power Systems
Microgrid Technology
Microgrids High Five

EMS: Energy Management System
What is a Microgrid?

**CIGRE definition:** Microgrids are electricity **distribution systems** containing **loads** and **distributed energy resources**, (such as distributed generators, storage devices, or controllable loads) that can be operated in a controlled, coordinated way either while **connected to the main power network** or while **islanded**.

PCC: Point of Common Coupling
CHP: Combined Heat and Power
Microgrids
Transition to Islanded Microgrid

Transition to islanded operation without interruption of service to loads within the microgrid
Microgrids
Transition to Grid Connected Microgrid

Transition to grid-connected operation once the power grid returns to normal state
# Microgrid segments and main drivers

Covering a diverse range of applications

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</tr>
</thead>
<tbody>
<tr>
<td>Island utilities</td>
<td>(Local) utility, IPP*</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>(√)</td>
</tr>
<tr>
<td>Remote communities</td>
<td>(Local) utility, IPP, Governmental development institution, development bank</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
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<tr>
<td>Industrial and commercial</td>
<td>Mining company, IPP, Oil &amp; Gas company, Datacenter, Hotels &amp; resorts, Food &amp; Beverage</td>
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<td>(√)</td>
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<tr>
<td>Defense</td>
<td>Governmental defense institution</td>
<td>(✓)</td>
<td>(✓)</td>
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<tr>
<td>Urban communities</td>
<td>(Local) utility, IPP</td>
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<tr>
<td>Institutions and campuses</td>
<td>Private education institution, IPP, Government education institution</td>
<td>(✓)</td>
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<td>(✓)</td>
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IPP: Independent Power Producer

✓: Main driver
✓: Secondary driver
Microgrid Technology Solutions

Value stacking of aggregated generators, loads and storage

Microgrid Applications (8S)

1) Standalone autonomous operation; black start
2) Seamless transitions grid → island → grid
3) Stabilisation voltage/frequency
4) STATCOM; maintaining voltage and balance
5) Spinning Reserve; getting paid for capacity
6) Smoothing of loads or renewables
7) Shaping or peak lopping
8) Shifting of energy based on time or cost

Microgrid managed as single generator/motor load
Microgrid Energy Management System: ABB Microgrid Plus
Microgrid Plus System Architecture

Networked control system responsible for efficient and reliable power flow management

- **Distributed control system** without central decision making, reflects the architecture of the electrical assets
- Maximizes **fossil fuel savings** and optimizes **use of renewable energy**
- Manages **grid connection**
- Guarantees **optimum loading** and spinning reserve in fossil fuel generators
- Distributed logic enhances **reliability, modularity** and **scalability** for future system expansions
- Enables **multi vendor** integration of electrical assets into one power system
## Microgrid Control System
### Definition of Terminology

<table>
<thead>
<tr>
<th>Name</th>
<th>What is controlled?</th>
<th>Who controls?</th>
<th>How controlled?</th>
<th>Response time</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>L1: Primary Control</strong></td>
<td>Frequency</td>
<td>Generator Automatic</td>
<td>Speed Governor</td>
<td>1-3 sec</td>
<td>Maintain grid frequency</td>
</tr>
<tr>
<td></td>
<td>Voltage</td>
<td>Generator Automatic</td>
<td>Generator AVR</td>
<td>1s</td>
<td>Maintain local voltage</td>
</tr>
<tr>
<td><strong>L2: Secondary Control</strong></td>
<td>Active Power</td>
<td>Operator, M+</td>
<td>Offset to speed controller</td>
<td>10-30sec</td>
<td>MW loadsharing, Avoid overloads</td>
</tr>
<tr>
<td></td>
<td>Reactive Power</td>
<td>Operator, M+</td>
<td>Offset to AVR</td>
<td>5–10sec</td>
<td>MVAr loadsharing, Avoid overload</td>
</tr>
<tr>
<td><strong>L3: Tertiary Control</strong></td>
<td>Frequency, Time</td>
<td>Operator, M+</td>
<td>Offset to speed controller</td>
<td>5-10min</td>
<td>Maintain 50/60Hz, Maintain time reference (no time drift)</td>
</tr>
<tr>
<td><strong>L4: Dispatch</strong></td>
<td>Gens online, P/Q setpoints</td>
<td>Operator, M+</td>
<td>On/Off, P/Q Setpoints</td>
<td>e.g. 30sec 20min</td>
<td>Maintain spinning reserve, step load, generators online, max renewables</td>
</tr>
<tr>
<td><strong>Scheduling (unit commitment)</strong></td>
<td></td>
<td>Operator</td>
<td>Schedule Table</td>
<td>Hours, days ahead</td>
<td>Maintain for instance balanced generator run hours by manually scheduling priority of plant</td>
</tr>
</tbody>
</table>

**ABB Microgrid Plus System**
Microgrid Energy Storage System: ABB PowerStore™
Battery Energy Storage System (BESS)  
ABB PowerStore

Battery Supplier

Battery management system

Microgrid Plus control system

Supplied by ABB
ABB PowerStore
Virtual Synchronous Generator

Features

- Grid Stabilizing
- Scalable & Modular
- Frequency Control
- Synthetic Inertia
- Voltage Control
- Fault Ride Through
- Fault Current provision
- Grid Forming
PCS100 Platform
From Modules to Systems

- The PCS100 converter platform is a modular structure
- Flexible sizing of converters by adding power modules
- Service is simple
- Highly reliable with redundancy

~ 100 kVA
Microgrid technology solutions
PowerStore – Power Conversion with Virtual Generator

Scalable from 100 kVA cabinet to 6 MVA* containerised solution

Overload capability of up to 200% of rated power.
Operate as voltage source with virtual generator functionality

*Continuous rating
Our Offering

Our Delivery during the Complete Lifecycle

- ABB offers a comprehensive portfolio of lifecycle 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 unmanned microgrids.
Creating a Business Case?
How to make a technical and financial assessment

- Sizing PV/Diesel and Storage
- Capex and Opex
- Grid tied Storage
- Load modelling
- Battery behaviour
- System Integration

Business Case and ROI
How to create a Business Case?

Energy Flow & Net Present Cost

1. Modelling
2. Simulating
3. Optimal solution

http://www.homerenergy.com/
Microgrids and PowerStore Experience and Key Learnings
Integration of renewables and storage with diesel
Western Australia, PV/diesel and storage

**Project name**
DeGrussa Copper-Gold Mine
**Location**
Western Australia
**Customer**
juwi Renewable Energy
**Completion date**
2016

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**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 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.

Hybrid power plant
Marble Bar, PV/Diesel

Project name
Marble Bar
Country
Western Australia, Australia
Customer
- Horizon Power
- Government of WA
Completion date
2010

ABB solution
- Turnkey solution for a greenfield microgrid project
- 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 litres 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
Marble Bar, PV/Diesel Project Video

https://www.youtube.com/watch?v=mWqB4CuxI5E
Ancillary power system services
SP AusNet, grid energy storage system

Project name
SP AusNet GESS
Location
Victoria, Australia
Customer
SP AusNet
Completion date
2014

About the project
First Embedded Generation system with Battery Grid Energy Storage for distribution network support in Australia

ABB solution
- Design, engineering, installation and testing of PowerStore-Battery, transformer and diesel generator
- Microgrid Plus System for overall system management
- Based on transportable containerized solution

Customer benefits
- Manage peak demand - Active and reactive power support during high demand periods
- Transition into isolated/Off-grid operation on command or in emergency cases without supply interruption
- Delay of power line investments
Power and productivity for a better world™