Microgrid
Enabling resilient and cost effective access to power

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Plenary 4: Flexibility in Future Energy Systems
Energy and grid transformation

Transition from a centralized to a distributed grid

New developments are accelerating the transition
Energy and grid transformation
Trending towards increased complexity and lower cost

DER: Distributed Energy Resources

Small installations: optimization with few DERs

Commercial installations, some

Larger installations: many different DERs, power & heat, grid services

DER: Distributed Energy Resources
Energy and grid transformation

Microgrid participation

**Microgrid**
Distributed energy resources and loads that can be operated in a controlled, coordinated way either connected to the main power grid or in “islanded” mode.

*Microgrids are low or medium voltage grids without power transmission capabilities and are typically not geographically spread out.*

**Power grid**
Power grids are larger conventional and spread out grids with high voltage power transmission capabilities.

*Microgrid technology can be applied to weak grids making the network more robust.*

**Nanogrid**
Low voltage grids that typically serve a single building.

*Microgrid technology can be applied.*

Islanded mode: ability to provide power independently from the main power grid
## Microgrid segments and main drivers
### Covering a diverse range of applications

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

- ✓: Main driver
- ✓: Secondary driver

**Grid-connected**

**Weak grid**

**Off-grid**
Grid connected microgrid

Grid resiliency, power quality, self consumption and lower environmental impact

PCC: Point of Common Coupling
CHP: Combined Heat and Power
Hybrid or Islanded microgrid
Access to power in remote locations, power quality plus lower cost and environmental impact

CHP: Combined Heat and Power
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
- Steady decline of renewable energy installation costs is opening new market opportunities
- An optimized energy mix leads to a lower cost of electricity

Sources:
1) US Energy Information Administration – Independent Statistics and Analysis
2) Alliance for Rural electrification (ARE). Projections made from a case study based in Ecuador with real natural conditions.
Driver: uninterrupted power supply
Managing power 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)
- Renewable energy generation capacity should be sized to maximize ROI* and fuel savings

*ROI: Return of Investment
Every element in the microgrid plays a role to fulfill customer goals.
Microgrid operational goals and power system functions drive choice of technology

Operational goals

• Maximize reliability
• Resilience in the face of severe weather or natural disasters
• Resilience in the face of a weak, unreliable grid
• Meeting environmental targets
• Maximizing penetration of renewable energy sources
• Minimizing operating expenditures
• Energy independence
• Participation in regulation or ancillary services markets

Power system functions – “8S”

1. Stabilizing
2. Spinning reserve
3. STATCOM (static synchronous compensator)
4. Seamless transition between islanded and grid-connected states
5. Standalone operation
6. Smoothing
7. Shaving
8. Shifting
ABB in microgrid
ABB in microgrid
A leader in technology, solutions and execution

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

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

Consulting
Service
3rd party financing
PowerStore™ Battery
Transformation through smart energy

- What is PowerStore™
  - A reliable containerized plug-and-play microgrid solution, available in various ratings with a standardized specification.
  - The heartbeat of any microgrid and its “Virtual Generator” can form the grid, integrating up to 100% of renewable energy.

- Instant power wherever and whenever it is required
Distributed generation enabled by PowerStore™
Instant power wherever and whenever it is required

- Configurable to your unique requirements

  - For 25 years ABB has been the world's authority on Microgrid solutions.
  - Delivering over 30 Microgrid installations across the planet; from the coldest and most remote reaches of Antarctica, to the searing heat of the Australian Outback.
  - The most technologically innovative and robust Microgrid products and solutions available today – wherever you are.
  - Allow customers to access to utility grade power, virtually anywhere.

- Island Utilities

- Remote Communities

- Industrial & Commercial

- Urban communities

Additional applications also possible for Defense, Institutions and Campuses
### ABB in microgrid

**Control system**

<table>
<thead>
<tr>
<th>Microgrid Plus</th>
</tr>
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<tbody>
<tr>
<td>Specially designed networked control system responsible for efficient and reliable power flow management.</td>
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</table>

- 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
Microgrid Plus Solar diesel

Brings the knowledge and benefits of Microgrid Plus in a cost-effective system optimized for hybrid solar-diesel applications.

- For medium (30-50%) peak solar penetration in isolated systems
- Simple and cost competitive solution
  - «out-of-the-box» solution, no application engineering needed
- Flexible and scalable
  - Can be integrated with ABB SCADA system
  - Fully compatible with ABB solar inverters (TRIO, PVS800) and diesel genset controllers from leading vendors
### Consulting and Design tools

Our experience, capabilities and tools enable our customers to plan and operate the microgrid reliably and at maximum economic benefit.

- Feasibility studies and simulations
- Grid studies
- Renewables engineering

### Remote services for Operation and Maintenance

A comprehensive solution for unattended sites to increase productivity, improve energy efficiency and reduce operational costs.

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
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 microgrids.
ABB in microgrid
Global references

- Mawson Station, Antarctica
- Faial Islands
- Canary Islands
- Cocos Islands, AU
- Marble Bar
- Ross Island, Antarctica
- Mawson Station, Antartica
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
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

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.
Integration of renewables
Kenya, Wind

**Project name**
Marsabit wind farm

**Location**
Kenya

**Customer**
Socabelec East Africa Ltd (SEAL)

**Completion date**
2016

**ABB solution**
- Supply, installation and commissioning supervision of a PowerStore-flywheel
- Stabilizes the connection of 2 x 275kW wind turbines to the grid

**Customer benefits**
- System optimization to avoid curtailment of excess wind power
- Reliable and stable power supply

**About the project**
ABB solution allows the customer to maximize renewable energy penetration by stabilizing the system and avoiding curtailment of excess wind power
Reliable power in presence of a weak grid
Johannesburg, PV/diesel and grid

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.
“THANK YOU”