# ABB Microgrid Solutions: Advancing sustainable and reliable energy solutions.

Globally, electricity consumption per capita has increased by 40 percent since 1990. Along with growing demand for renewable energy, there are still over 1.3 billion people in remote areas who either don't have access to reliable sources of electricity or who aren't connected to a power grid at all.

A new approach is needed for the grid of the future; a grid that can support remote mining and industrial sites and communities, and that can manage the peaks and troughs of energy demand. And a grid that can support the need for a greener planet.

The next evolution of the conventional grid is ABB's Microgrid solution which can safely integrate the maximum possible renewable energy into small scale power networks, or Microgrids.

For the customer, this means the lowest long-term energy costs, grid stability and the best outcome for the environment. Importantly, these solutions merge the best of power and automation technologies to create a more flexible and adaptable grid.

**Pioneers in Microgrid technology**

ABB is a leading provider of integrated power and automation solutions for conventional and renewable-based power generation plants

By successfully powering research stations from Antarctica, Alaska and Flores Island to remote mines and communities in the desserts of Australia using integrated energy sources, ABB has become a pioneer in Microgrid technology.

ABB's Microgrid Solutions group specialises in implementing modular and scalable technology packages that supply power, improve power quality, and integrate renewable energy into fossil-fuel Microgrids.

For the customer, this means reducing the cost and risk of their power generation and transmission. They can not only improve the capacity, reliability and efficiency of their power, but incorporate the maximum possible energy from their wind, solar, hydro and wave installations.

ABB's global centre of excellence for Microgrids is based in Darwin, Australia. Our research and development programs focus on achieving both incremental and breakthrough developments for our customers to address challenges relating to remote Microgrid power supplies; integrating renewable power sources into the Microgrid; and enhancing power system stability, reliability and flexibility.

## Microgrid Communities

ABB defines the 'Microgrid' as an integrated energy system consisting of distributed energy resources and multiple electrical loads operating as a single, autonomous grid – either in 'grid-connected' or 'islanded' mode, depending on the existing utility power grid. A Microgrid is similar to a traditional power grid, but on a smaller scale and with a smaller total power rating.

ABB has identified three types of Microgrid Communities, each experiencing its own set of challenges to sourcing quality power, which can all be rectified by implementing the right tailored, technology-based solution. These are:

1. *Isolated autonomous* – which can be found on islands with no connection to the main grid;
2. *Semi-autonomous* – which occur in remote locations on the mainland such as remote communities, research stations, defence bases and industrial sites;
3. *Weakly-connected* – which appear at the ends of the lines of larger traditional grids, and may also appear in facilities that can go 'off-grid' when desired.

**Technology now for a better future**

Most people never think about the complex electrical networks behind every light switch and wall socket and how indispensable these structures are to our daily lives. In today's highly-connected society, electricity plays a key role in our economic and social development and, in many cases, our survival. Yet, many of us take for granted our reliance on electricity, assuming it will always be there.

Over 1.3 billion people in remote areas around the world either don't have access to reliable sources of electricity, or aren't connected to power grids at all. As we become more reliant on electricity, governments around the world are investing in infrastructure to help provide electricity to poorly-connected areas.

ABB plays a key role in devising solutions that provide reliable power to people in remote areas, yet curb the amount of

greenhouse gas emissions being produced. Integrating renewable forms of electricity in to the grid solves both these problems.

**Integrating renewable energy**

The easiest way to generate electricity in areas not serviced by electrical networks is with a generator that burns fossil fuels, such as diesel, gas and heavy fuel oil. However, many remote places are also rich in renewable energy sources like the sun, wind, water and bio-waste, which could all be harvested as a cost-effective and environmentally-friendly means to provide power in these areas.

ABB's quest to assist Microgrid communities reduce their reliance on fossil fuels has driven the development of a number of technologies designed to integrate, manage and control renewable generation in isolated or weakly-connected grids.

Already, these technologies have increased the production and integration of renewable energy into a number of power generation systems across the world that previously relied solely on fossil fuels.

**Managing power fluctuations**

One of the biggest challenges of integrating renewable generation into an existing power grid is intermittent supply. As those who use renewable power will attest, we are at the mercy of the environment.

The most common occurrence of gusting winds, or clouds on a sunny day, can interfere with generation, destabilising the grid. In the case of wind, gusts can cause an unwelcome generator response known as 'hunting', whereby unnecessarily-high levels of backup fossil fuels are consumed, engine maintenance is higher, and expensive blackouts can occur.

Power fluctuation is another common anomaly when using isolated networks, however the problem also exists in large networks at the end of distribution lines, or at the interconnecting point of wind or solar farms and other critical nodes.

There is a range of reasons customers in the Microgrid market require the solutions ABB offers, however our customers typically fit into one of the following categories:

- Those who do not have access to power.
- Those who are relying on fossil fuel-based generation and have a valid business case to integrate renewable generation.

- Those who have an existing hybrid power plant and are experiencing either integration and stabilsation issues, or simply want to increase their penetration of renewable energy generation.
- Those who are weakly-connected to the grid and are experiencing strain caused by intermittent renewable generation.
- Those who require virtual intertia as an ancillary power system service at any point along the network.
- Those who simply want to increase their renewable generation output.

# Integrated solutions

ABB has been in the energy business for 125 years, and during this time has pioneered a number of product and system innovations to help improve efficient energy use and lower environmental impact in the industrial and utility sectors.

ABB offers five comprehensive, integrated Microgrid solutions to suit a range of customer requirements.

### Hybrid Power Plant

ABB's Hybrid Power Plant is made up of a minimum of one fuel-based generator and one renewable energy generator. ABB can provide a full turnkey solution including consultation (technological and economical feasibility, etc), plant design, installation, commissioning and service support. This solution has been designed for those who do not have access to quality power and there is a valid business case for renewable and fuel-based generation.

### Integrated Wind or PV Power Plant

ABB's engineered solution for integrating PV or wind into an existing fuel-based generation Microgrid has been designed for those who want to upgrade an existing power system with renewable energy generation, thereby reducing their reliance on fossil fuel and improving the security of supply.

### Optimized Microgrid Integration

ABB's engineered Microgrid stabilisation and energy flow optimisation solution is designed for customers who have an existing hybrid power plant but are experiencing stability issues and want to improve security of supply. ABB's Optimized Microgrid Integration solution has the ability to optimise the operations of existing power stations with existing renewable energy generators.

### Renewable-to-Grid Connector

This solution provides a compliant grid connection for any existing form of renewable generation into a weak grid. ABB's Renewable-to-Grid Connector solution reduces the strain on weak grids from intermittent renewable generation, helping customers improve their renewable energy output.

### Grid Stabiliser

ABB's Grid Stabiliser was designed for customers who require virtual inertia as an ancillary power system service, and has the ability to connect to any point on the network. The main benefits include an increase in the time it takes the system to

respond to frequency disturbances, along with load shedding minimisation. The system can either run in parallel with the grid, or go ‘off-grid’ with authorisation from the network authority.

# Support

At ABB our customers make our business. This is why we have some of the most extensive and comprehensive support services in addition to our integrated solutions. Our customer focus does not stop at the completion of a project. We also offer product and solution consulting, which includes design evaluations, economic analyses and technical consulting and after-sales service, including technical support, service checks and maintenance.

### Consulting

ABB has many years of experience integrating renewable energy sources in technically-challenging Microgrids, and this experience combined with strict adherence to industry-accepted modelling and design tools, and power systems standards, is the foundation of ABB's consulting offering.

Making the right economic and technical decisions can be difficult, but using sophisticated simulation tools, ABB can tailor a solution to fit specific wind and solar conditions, commercial considerations and technical requirements.

To start, ABB consultants evaluate design options for both off-grid and grid-connected distributed generation applications. Optimisation and sensitivity analysis algorithms evaluate the economic feasibility of many technology options, and account for cost variations and energy resource availability.

In addition to thorough economic analysis, ABB provides a strong technical consulting capability, including flexible, dynamic simulation tools that produce extremely accurate grid models. ABB's Microgrid Solutions' experience with remote power generation is constantly helping to improve the tools and design process in these studies, while an experienced engineering team guarantees the end result is a high-quality, technically-detailed project simulation.

ABB verifies its models with data taken from similar completed, commissioned projects; this helps to identify problems in the simulation process, and increases the accuracy of future models. In this way, ABB consultants can rely on real-world experience and working systems to ensure the most valid simulation models are delivered.

### Service

Service has been a key ABB competency for over 100 years. The company has been building-up a service capability for power generation facilities since the invention of the steam turbine back in the 1900s, and now provides several hundred plants with remote monitoring from dedicated control centres.

For the past 15 years, ABB has been providing this same level of service for Microgrid-generation plants. For Microgrids – especially in remote areas – it is critical to maintain constant power supply and have access to technical support 24 hours a day, seven days a week. ABB technology enables remote access, monitoring and control of such installations.

Servicing the components that hold remote systems together ensures essential power generation at remote sites is not interrupted. ABB can perform routine service checks, regular maintenance and unscheduled service remotely, with minimal impact on the Microgrid.

# Technology

Innovation is key to ABB's competitive advantage, and our market leadership position is built on consistent investment in R&D. Every year, ABB invests over a billion dollars globally into R&D across its system groups, and our scientists and engineers are continually searching for new ways to tackle challenges together with our customers and partners.

Over a number of years ABB has proven the technology that is vital to realising these stabilizations solutions for Microgrid communities. That technology that centres around the Microgrid Plus System and PowerStore.

Our Microgrid Plus System and PowerStore work by dispatching or controlling the power of fossil-fuel and renewable energy-based generators and eligible loads in a coordinated manner, allowing customers access to utility-grade power, virtually anywhere. Both these offerings were designed specifically to complement our five integrated solutions, which are individually-tailored to suit our customers' specific requirements.

**Microgrid Plus System**
A specially-designed, networked control system, Microgrid Plus is a key technology to coordinate the operation of hybrid power stations, and to integrate renewables into and stabilise Microgrids.

The unit manages the energy flow within a power network to ensure there is enough spinning reserve, step load capability and balance between supply and demand in the power grid. It also optimises the average use of renewable energy, even when sources are intermittent.

**PowerStore™**
A flywheel or battery-based grid stabilising system, PowerStore enables intermittent renewable energy to be integrated in to the grid. State-of-the-art ABB inverters allow the power conversion device to be used either to support the grid, or as a Virtual Generator.

PowerStore is extremely beneficial in Microgrids where it offers real and reactive power support to remote and island communities, remote research centres, industrial and commercial areas, defence bases, and institutions and campuses where fuel costs and production schedules are critically important.

# References

### Marble Bar

The world's first high penetration, solar photovoltaic diesel power stations were commissioned in 2010 in the towns of Marble Bar and Nullagine, in Western Australia. The projects include more than 2,000 solar modules and a solar tracking system that follows the path of the sun throughout the day. When the sun is shining, PowerStore grid-stabilising technology and the Microgrid Plus power management system both ensure maximum solar energy (100% peak penetration) goes into the network and significantly reduces diesel generation. When the sun is obscured, PowerStore covers the loss of solar power generation by ramping-up the diesel generation, meaning the network has an uninterrupted energy supply. The solar energy systems generate over 1 gigawatt hour (GWh) of renewable energy per year, supplying 60 percent of the average daytime energy for both towns, saving 405,000 litres of fuel and 1,100 metric tonnes of greenhouse gas emissions each year.

### Ross Island

New Zealand's Scott Base and America's McMurdo Station in Antarctica are both important research bases, and home to about 1,200 people in the Antarctic summer. They had always relied completely on fossil fuels for power and heating, until a new installation based on wind turbines – consisting of the Microgrid Plus control system and the PowerStore grid-stabilising solution – was commissioned in 2009. The bases still need back-up diesel generators, but three 333 kilowatt (kW) wind turbines reduce the amount of diesel required for power generation by around 463,000 litres, and cut CO2 emissions by 1,242 metric tonnes per year, while lowering the risks of transporting and storing liquid fuel in this precious environment. A frequency converter interconnects the Scott and McMurdo bases, which operate at different frequencies – 50 Hz (NZ) and 60 Hz (US), allowing power flow in both directions.

### BHP Billiton Leinster nickel mine

BHP Billiton's Leinster nickel mine in Western Australia is the third-largest producer of nickel concentrate in the world. Ore is extracted from 1,000 meters underground with a large, electrically-driven winder which, at 8.5 megawatts (MW) of demand shift over 120 seconds, is a large cyclic load, given the unit's average power consumption is just 2 MW. To upgrade the winder's power supply, BHP temporarily installed a 1 MW PowerStore system, which reduced the total demand shift to 6.5 MW while adding 1 MW of spinning reserve to the system. Its flywheel-based energy storage system provides peak lopping and overcomes transient and cyclic loads on grid-connected or isolated systems. The mine was able to increase winder production without affecting power system reliability. Fully automated, PowerStore gets power to the winder when

it’s needed most, and provides high-resolution data of winder performance and local electrical grid disturbances.

### Coral Bay

Coral Bay is the gateway to the Ningaloo Reef World Heritage Area in Northwestern Australia, where power demand increases significantly during the tourist season. A PowerStore grid-stabilising system was introduced and a Microgrid Plus power management system oversees the town’s power supply, which consists of seven 320 kilowatt (kW) low-load diesel generation units combined with three 200 kW wind turbines. PowerStore’s 500 kW flywheel-based technology enables the wind turbines to supply up to 95 percent of Coral Bay’s energy supply at times, with a total annual wind penetration of 45 percent, while maintaining city grid standards of power stability and quality. Current statistics show that for up to four months of the year, more than 80 percent of Coral Bay’s power is wind-generated. The data also shows that for nearly 900 hours per year, wind provides more than 90 percent of Coral Bay’s power supply.

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