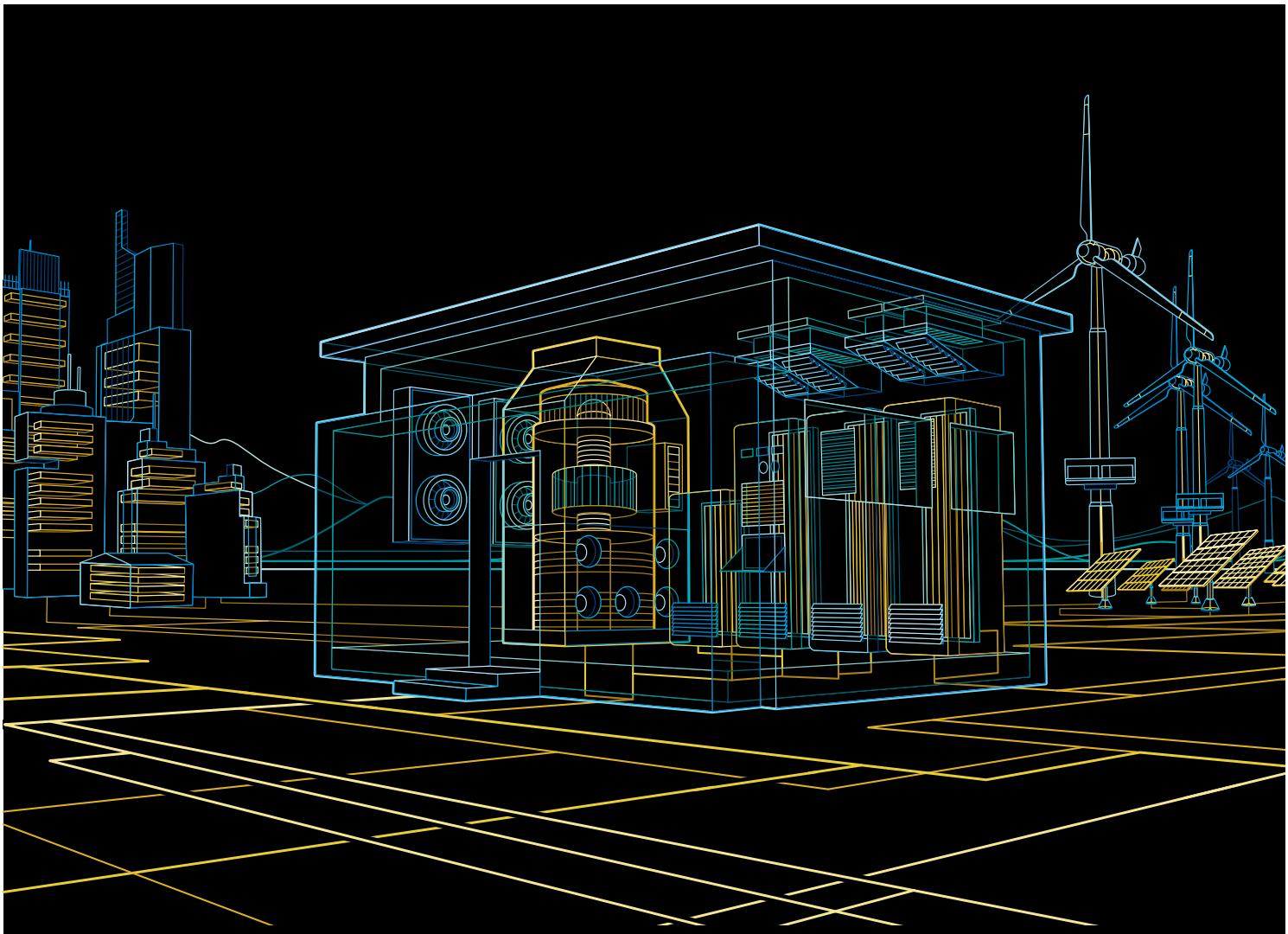


Integrating renewables into remote or isolated power networks and microgrids

Innovative solutions to ensure power quality and grid stability

Power and productivity
for a better world™

ABB

ABB is a leading provider of integrated power and automation solutions for conventional and renewable-based power generation plants and water applications, such as pumping stations and distribution plants. The company's extensive offering includes turnkey electrical, automation, instrumentation and control systems supported by a comprehensive service portfolio to optimize performance, reliability, and efficiency while minimizing environmental impact.

ABB`s microgrids and renewable integration platform provides a modular and scalable solution that integrates renewable power generation into microgrids that previously operated solely on fossil fuel.
The key is to design a renewable power plant that can maximize return on investment, while delivering a stable, safe and reliable power supply.
ABB`s solution includes grid stabilization technology that enables high penetration of renewable power generation, and distributed control systems that provide intelligent power management and efficient hybrid power plant operation.
Our solution achieves 100% peak penetration of renewables in wind/diesel and solar/diesel power systems, maximizing fuel savings and supplying reliable, grid-quality power in remote off-grid locations.

ABB technologies enable the flow and control be more flexible, reliable, efficient, intelligent

A renewable future

Most people never think about the vast, complex electrical networks behind every wall socket and how indispensable these networks are to our world.

Electricity plays a key role in economic and social development, yet more than 1.3 billion people in remote areas still don't have access to it.

Fortunately, technology exists that can ensure access to reliable sources of quality electricity, even in isolated areas far away from regular power networks.

The power sector plays a major role in efforts to reduce greenhouse gas emissions by integrating renewables

# of electricity for power networks to and environmentally friendly

The power of innovation

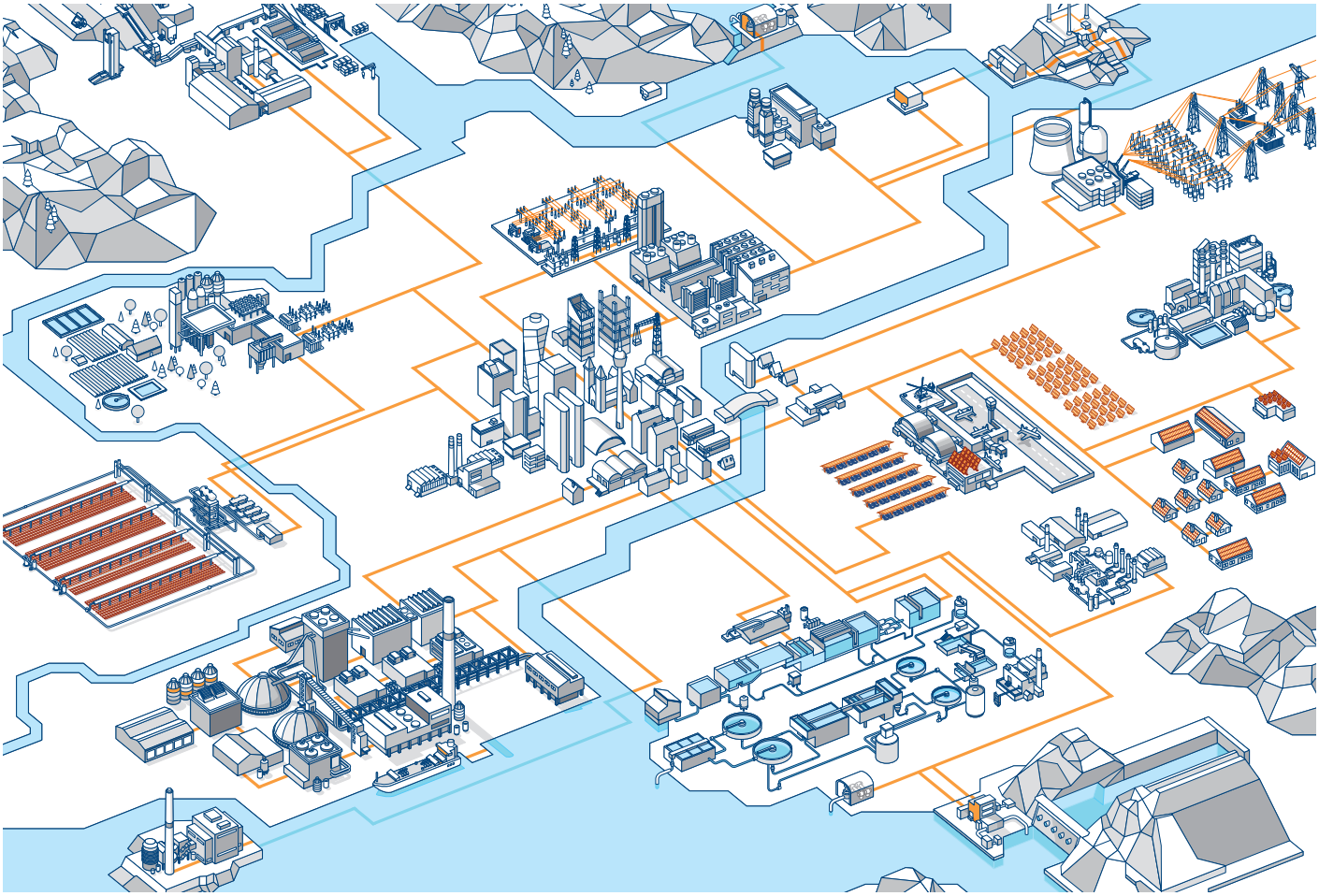
The easiest way to generate electricity in areas not serviced by electrical networks is with a generator that burns fossil fuels, like diesel, gas or heavy fuel oil. Yet remote places may also be rich in renewable energy sources, like sun, wind and water, which could be harvested.

Reducing the reliance of remote communities on fossil fuels is driving the development of technologies designed to integrate, manage and control renewable generation in isolated networks. This technology has successfully increased the production and integration of renewable energy into isolated power generation systems that once relied on fossil fuels alone. These hybrid generation solutions provide high-quality electricity in isolated places, making them much less vulnerable to escalating fossil fuel prices or erratic power supplies.

The intermittent nature of renewables makes this a challenge. Electricity generated by a wind turbine, for example, can create surges of electricity caused by gusting winds. An isolated grid must be equipped to overcome these surges, or it can collapse. The challenge has been to devise a method which can harvest clean energy when nature cooperates and compensate or smooth things out when it does not.

Now, ABB can offer a solution that successfully and safely integrates renewable power into small, isolated or remote grids.

Managing renewable energy



Electricity networks are complex systems that cannot be efficiently and securely operated without an appropriate energy management and control system.

ABB is a global leader in energy and generation management systems, with more than 5,000 installations worldwide. The Group recently acquired Powercorp, a company with a unique portfolio that connects remote communities and isolated enterprises with quality power which can be generated almost entirely from renewable sources, or easily combined with existing fossil fuel generation systems to reduce costs and risks.

Powercorp developed the technology to help automate diesel-generator power stations across Australia's remote Northern Territory. The challenge was to integrate renewables into remote power grids, initially focusing on wind-diesel hybrid systems before expanding into solar energy, enhanced by a control system capable of instantly balancing renewable and fossil fuel generation in one power network.

One of the biggest challenges of integrating renewable generation in any power grid is intermittent generation, which can be caused, for example, by gusting wind or clouds on a sunny day. This simple occurrence can destabilize the grid and cause an unwelcome generator response known as hunting, even when wind flow is low, which leads to unnecessarily high consumption of backup fossil fuels, higher engine maintenance, and expensive blackouts.

Power fluctuation is common in isolated networks, but the problem also exists in large networks at the end of transmission lines, or at the interconnection point of wind or solar farms and other critical nodes.

We have the solution

Our innovative technology solution can stabilize an electricity network by rapidly absorbing power surges from the renewable energy source, or by injecting power to make up for short term lulls, in order to maintain high-quality voltage and frequency. Combined with automation and control systems that ensure the most efficient and reliable power flow possible throughout the network, it is a solution that makes it possible to have utility-grade power virtually anywhere.

PowerStore

PowerStore™ is a flywheel-based, grid stabilizing system, which includes state-of-the-art inverters and virtual generator control software. It enables the integration of intermittent and often erratic renewable generation. It can help achieve up to 100 percent penetration of renewable energy source into remote grids, and enables the higher utilization of renewable energy generators, protecting remote communities from exposure to volatile oil prices.

Poor integration design can inflict damage on a power generating station. PowerStore safeguards conventional microgrids, and ensures the safe integration of large amounts of wind and solar energy, reducing emissions and dependency on fossil fuels. High-speed software controls the power flow into and out of the flywheel, essentially making it a high inertia "electrical shock absorber" that can instantly smooth out power fluctuations generated by wind turbines or solar arrays.

PowerStore acts like a STATCOM (advanced grid technology that quickly stabilizes voltage and improves power quality) and in addition is capable of rapidly absorbing or injecting real power within an isolated power network. It can stabilize both voltage and frequency, hold 18 MWs (megawatt seconds) of energy and shift from full absorption to full injection in 1 millisecond to stabilize the grid. Without a grid stabilizing technology like PowerStore, the instantaneous penetration of renewable energy is limited to about 30 percent of the total system load before the renewable component starts to destabilize it. In small isolated networks, this is a frequent problem.

Automation and control

PowerStore technology is augmented by a robust, specially designed distributed control system (Microgrid Controller 600, in brief MGC600) that can manage the energy flow within a power network to ensure balance between supply and demand and optimize the use of the renewable energy.

The MGC600 controls and monitors all renewable generating units, all diesel and/or gas generator sets, consumer feeders and energy storage in a power system. It provides event reporting, trending, remote access and external alarm notification. Depending on system load conditions, the controllers start and stop generators to optimize station fuel efficiency. The system maintains optimum loading and spinning reserve on all in-service generator sets. It continuously monitors the feeder load and matches the most economical configuration of the generator sets with the renewable energy sources or demand.

Technology that can smooth out power surges and optimize flow control within isolated networks ensures maximum penetration of renewable energy into these networks, maximizing savings. PowerStore, combined with MGC600 technology, is the only technology of its kind to provide electricity in areas that cannot be supplied by a conventional electricity network.

Together, grid-stabilizing PowerStore technology and MGC600 power management system enable up to 100 percent instantaneous penetration of renewable generation in a power network, while running thermal generation units at their optimal loading points, or as back-up. It is a proven renewable integration solution, installed in many projects worldwide, including Australia, Europe, North America and even Antarctica.

We have the solution

ABB has been in the energy business for 125 years, and over the years has pioneered many additional product and system innovations to help improve efficient energy use and lower environmental impact in the industrial and utility sectors. These include:

Balance of system

ABB's comprehensive renewable energy portfolio ranges from Electrical Balance of Plant (EBoP), automation, instrumentation and control system products and solutions supported by a service portfolio that optimizes performance, reliability, and efficiency, all the way to complete Balance of System (BoS) packages and turnkey project capability.

Our scope of supply can include an entire project, from site assessment to plant design, engineering, manufacture and procurement, installation, commissioning and grid connection.

Consulting

ABB has many years of experience integrating renewable energy sources in technically challenging microgrids, and this combined with strict adherence to industry-accepted tools and 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 conditions and technical requirements.

> The power system of the future will be more flexible and interconnected, leading to the evolution of a stronger and smarter grid, balancing our growing need for power with environmental concerns

To start, ABB consultants evaluate design options for both off-grid and grid-connected distributed generation applications. Optimization 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 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.

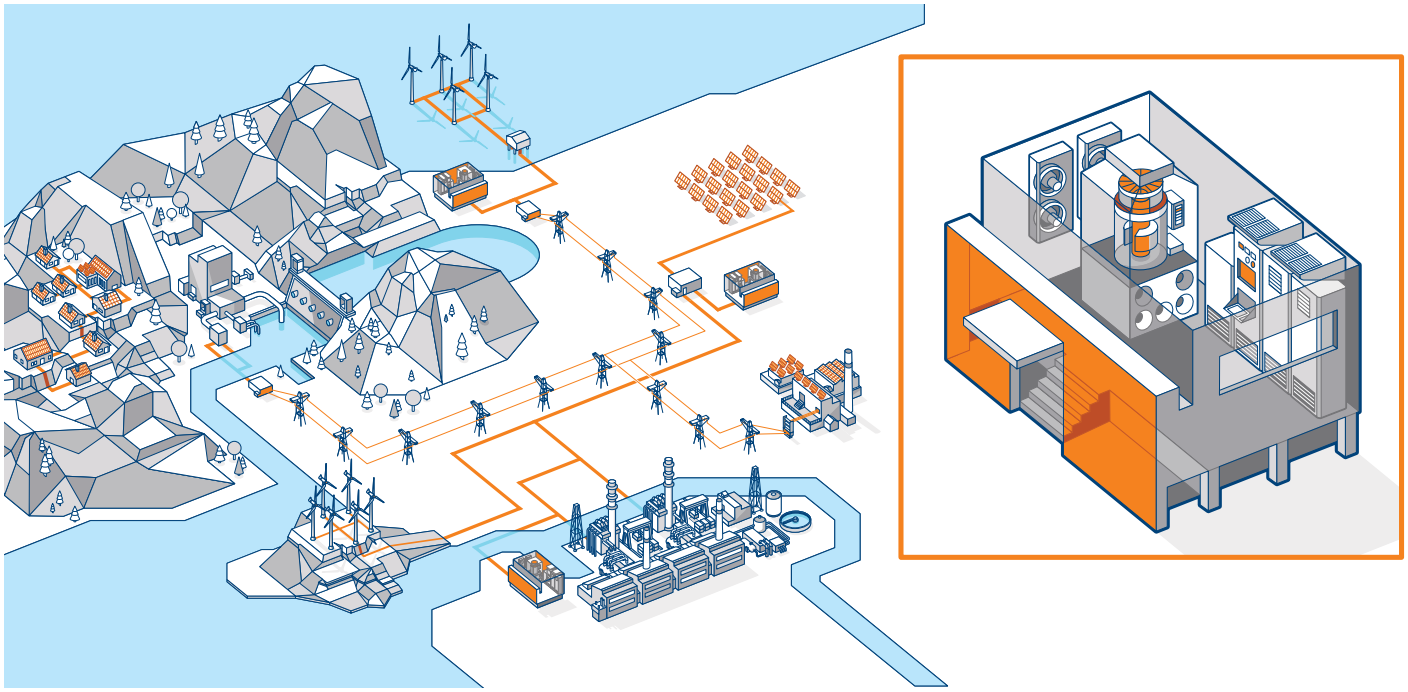
ABB verifies its models with data taken from similar completed, commissioned projects. This helps to identify problems in the simulation process, and increases the accuracy of future models. This way, ABB consultants can rely on real-world experience and working systems to ensure the most valid simulation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

Service

Service is a key ABB competency. Over the past 10 years, ABB has built up a remote service capability for power generation facilities, and now provides several hundred plants with remote monitoring from dedicated control centers. The same concept is also available for renewable generation plants.

For microgrids, especially in remote areas, it is critical to maintain constant power supply and be connected to technical support at all times. 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.



Applications

PowerStore grid-stabilizing technology is extremely beneficial in remote and microgrids where it offers real and reactive power support in isolated communities and industrial settings, such as mines, fish canneries and construction sites, where fuel costs and production schedules are critically important. In addition it can provide virtually instantaneous support for and protection from electrical surges created by large scale electrical equipment on site.

This breakthrough solution combined with the solid MGC600 power management solution enables the injection of up to 100 percent renewable energy into remote networks. The benefits are clear for island communities cut off from mainland grids, isolated tourist centers, remote villages and industrial sites far removed from conventional power networks.

ABB solutions facilitate the generation, transmission and distribution and utilization of electricity in remote or isolated areas - enabling efficiency, reliability and power quality

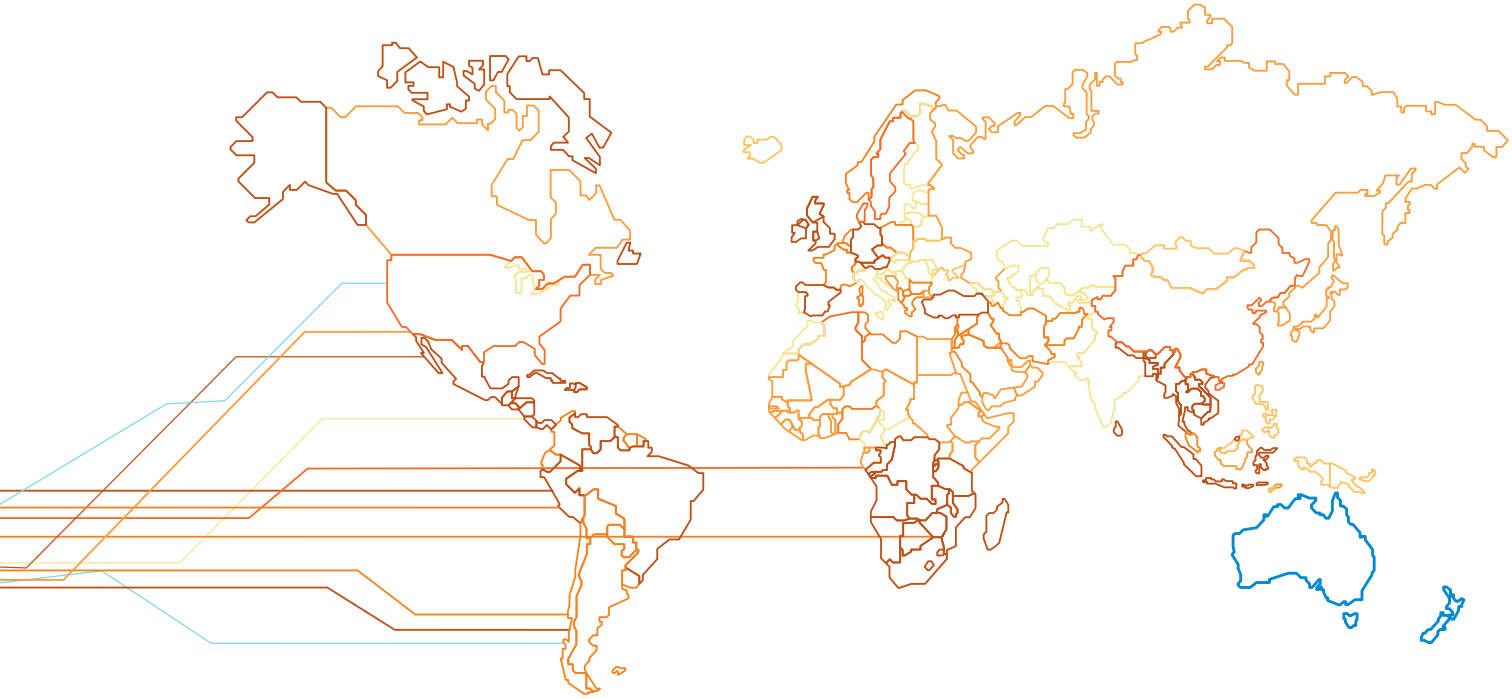
Helping our customers achieve their targets

Marble Bar

The world's first high penetration, solar photovoltaic diesel power stations were commissioned in 2010 in the towns of Nullagine and Marble Bar, 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-stabilizing technology and DCS power management solution ensures maximum solar energy (100% peak penetration) goes into the network by lowering diesel generation, up to the minimum loading of the generation units. When the sun is obscured, the PowerStore covers the loss of solar power generation as the DCS ramps up the diesel generation, so 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 liters of fuel and 1,100 metric tons of greenhouse gas emissions each year.

Ross Island

New Zealand's Scott Base and America's McMurdo Station in Antarctica are important research bases and home to about 1,200 people in the Antarctic summer. They have always relied completely on fossil fuels for power and heating, until a new system based on wind turbines, a new distributed control system and PowerStore grid-stabilizing technology 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 liters, and cut CO_2 emissions by 1,242 metric tons 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 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-stabilizing system and DCS power management solution 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 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. Power station data indicates more than 80 percent of Coral Bay's power is wind generated for one-third of the year. The data also shows that for nearly 900 hours per year, wind provides more than 90 percent of Coral Bay's power supply. PowerStore maximizes an environmentally friendly solution.

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