



ABB synchronous condenser packages

Boosting power grid stability and resilience

For more information, please contact
your local ABB representative or visit

new.abb.com/motors-generators/synchronous-condensers

The effective way to maintain good power quality

Strong, stable networks have helped the electric power industry to build its reputation for reliability. Ensuring grid strength and stability has started to become more challenging, however, due to shifts in the generation mix and changes in network structures.

Large, fossil fuel rotating generators are being decommissioned to help combat global warming, resulting in reduced inertia and fault ride-through capability. At the same time the penetration of renewables – mainly wind and solar – is increasing. Renewable power plants are often remotely located in weak network areas, and they are controlled by frequency converters or use inverters to synthesize DC into AC for the network. The combination of decentralized weak networks and synthesized power can result in stability issues due to limitations in renewable plants' rotating energy or inertia reserve. This leads to challenges when disturbances occur and the network requires support.

These developments have turned the spotlight on synchronous condensers (SCs) which

boost grid stability by providing additional inertia. SCs are rotating machines that can both supply and absorb reactive power, delivering voltage support and dynamic regulation. By generating short-circuit current (SCC) they bring local fault support capacity to weak network areas. They also strengthen synchronizing torque and help to damp low frequency oscillations.

ABB synchronous condensers are tailored on the basis of network studies for the specific location where grid support is needed. Pre-designed synchronous condenser packages are easy to transport, install, commission and integrate. They are small or medium sized units that can be strategically sited for optimal results – an ideal decentralized solution to increase grid strength and stability.



Short-circuit power for increased transmission capacity and excellent fault ride-through capability.

Significant overload capacity to support the network during prolonged voltage sags. High inertia – available instantaneously – helps ensure stable network frequency.

Ability to supply and absorb reactive power, providing voltage support and dynamic regulation.

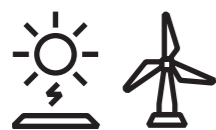
Tailored on the basis of network studies, engineered from quality components and backed by ABB's worldwide support organization.



Darlington Point Solar Farm, New South Wales, Australia. This 275 MW solar farm is supported by two air cooled ABB synchronous condensers at its 132 kV connection point (images supplied by Edify Energy and Octopus Investments).

Synchronous condensers provide grid support exactly where it's needed

ABB synchronous condensers are applied across the industry, from renewable and fossil fuel power plants, through transmission and distribution systems to industrial electricity consumers.

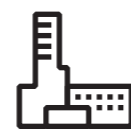


Renewable energy developers



“We develop remote wind parks and solar farms. We need solutions that are easy to transport and install, and will effectively support weak networks.”

- SCs support grid code compliance. ABB supplies simulation models (PSCAD, PSS/E®, Powerfactory), as well as grid code compliance simulation and validation services.
- Are supplied in pre-designed packages with drawings for shorter engineering lead times and overall project times. Clear mechanical and electrical interfaces for easy substation integration.
- Support voltage stability and mitigate transient faults when integrating large wind farms.
- Combat phase-locked loop (PLL) synchronization instability in converters, as well as limitations in the power infeed caused by low short-circuit level (SCL).
- Are easy to transport and install.
- Ensure optimal local network support when installed at remote wind or solar farms.
- Reduce project risks – a proven solution supplied in pre-engineered packages with clear interfaces.
- Enable solar farms to increase revenue by boosting active power output. Without SCs part of the total inverter power has to be assigned for reactive power compensation.

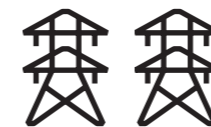


Power producers



“We use synchronous condensers to absorb reactive power during ramp-up, and to supply additional inertia to the grid.”

- SCs mitigate frequency instability (increased RoCoF) that occurs through the balancing of peak demand and renewable power (“duck curve”).
- Support the grid with inertia and offload reactive power from generators during peak or ramp times.
- Enable sales of additional ancillary services such as higher inertia, additional fault current and reactive power.



Transmission System Operators (TSOs)



“We needed to increase short-circuit capacity in

order to prevent voltage collapses during high load periods. Synchronous condensers are the perfect solution.”

- SCs effectively mitigate protection problems due to decreased SCL, PLL instability, rapid changes in power flow, system stability problems, power system splits due to different inertia levels, and other issues.
- Facilitate inertia planning.
- Provide additional short-circuit capacity to strengthen the network and remedy voltage collapse during heavy load peaks.
- Mitigate transient faults when integrating large wind farms.
- Realize higher system availability through redundancy when multiple units installed.
- Can be remotely deployed in decentralized grids to reduce the risk of power oscillation.
- Limit risks when the grid is split/grid configuration is changed.
- Provide decentralized support for fault currents (support of PLL control for power electronics), and a decentralized sink for harmonics and unbalance.
- Support grid code compliance. ABB supplies models for simulation studies (PSCAD, PSS/E® and Powerfactory).



Distribution System Operators (DSOs)



“We installed SCs to resolve

power quality issues in the system. SCs supply both fault current support and dynamic voltage support.”

- SCs mitigate large variations in SCL between day and night periods, deeper voltage dips that are caused by reduced SCL, and general power quality problems.
- Can be configured to supply “switchable” fault current support during high/low load times.
- Provide dynamic voltage support and help to counteract voltage dip issues.
- Supply fault current and inertia during island operation.
- Are available in a range of pre-designed package sizes for easy integration into distribution grids, substations and microgrids.
- Prevent overloading at substations in areas where rooftop PV (with inadequate inverter filtering) is common.



Industrial companies



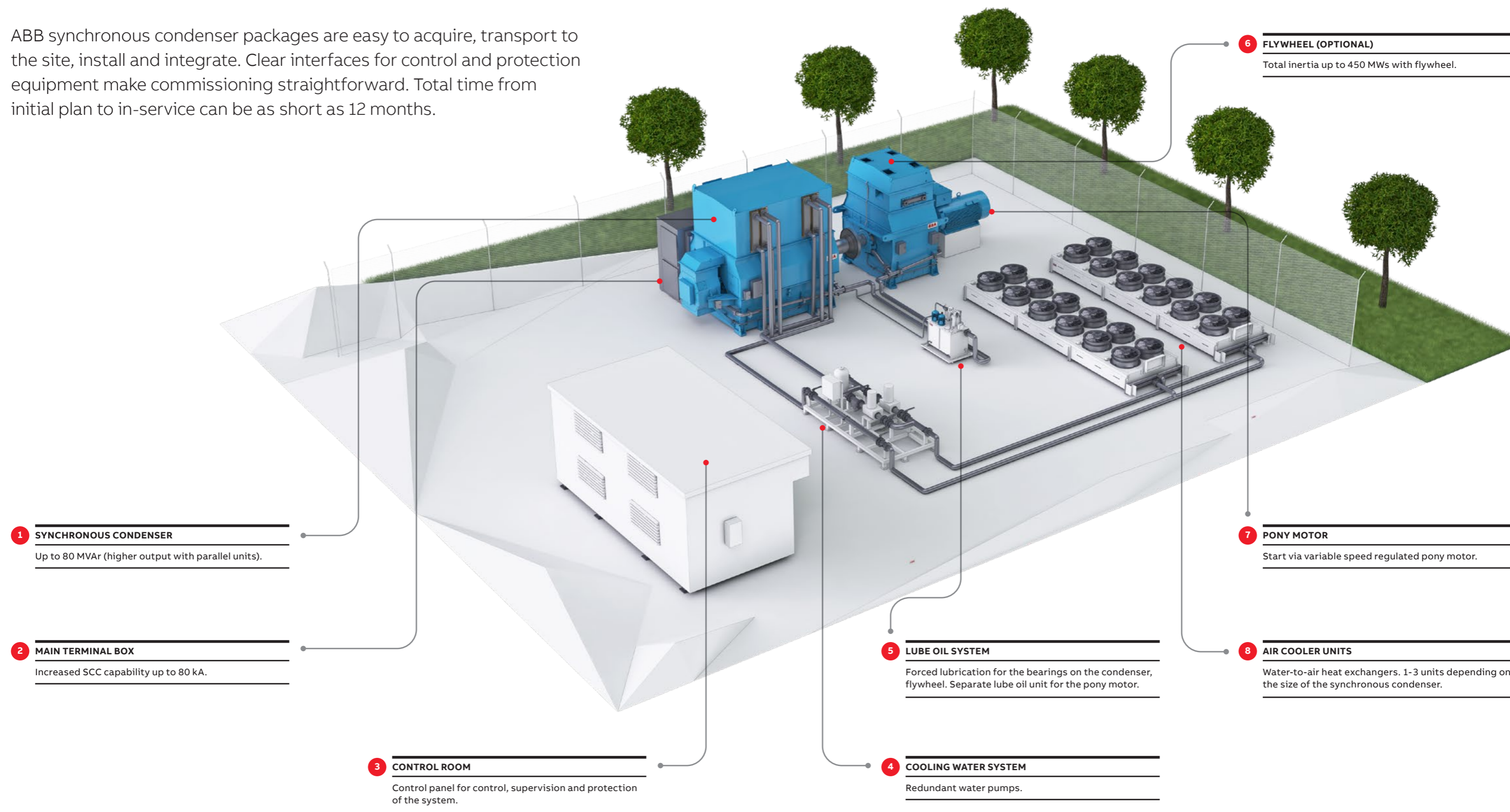
“Our grid is weak and power quality

problems used to cause disruptions to some processes. We eliminated these issues by installing SCs to boost short-circuit capacity.”

- SCs resolve power quality issues in weak grids, counteracting voltage dips which cause variable speed drives to trip and interrupt production processes.
- Increase fault current and reduce the transfer of power quality issues (flicker, harmonics, unbalance) to the grid.
- Add reactive power and SCL support to damp harmonics generated by variable speed drive controlled electric motors.
- Mitigate voltage stability issues associated with heavy industries like mining, especially when fossil fuel generators are phased out.
- Supply short-circuit capacity to strengthen the network and prevent voltage collapse during heavy load peaks.
- Increase fault current and reduce problems with motor starting and demanding loads like gearless mill drives and furnaces at mines.

Compact pre-designed synchronous condenser packages are easy to deploy

ABB synchronous condenser packages are easy to acquire, transport to the site, install and integrate. Clear interfaces for control and protection equipment make commissioning straightforward. Total time from initial plan to in-service can be as short as 12 months.



1 SYNCHRONOUS CONDENSER
Up to 80 MVar (higher output with parallel units).

2 MAIN TERMINAL BOX
Increased SCC capability up to 80 kA.

3 CONTROL ROOM
Control panel for control, supervision and protection of the system.

5 LUBE OIL SYSTEM
Forced lubrication for the bearings on the condenser, flywheel. Separate lube oil unit for the pony motor.

4 COOLING WATER SYSTEM
Redundant water pumps.

6 FLYWHEEL (OPTIONAL)
Total inertia up to 450 MWs with flywheel.

7 PONY MOTOR
Start via variable speed regulated pony motor.

8 AIR COOLER UNITS
Water-to-air heat exchangers. 1-3 units depending on the size of the synchronous condenser.

Flexible solutions to the challenges facing power grids today

Synchronous condensers deliver instantaneous support to strengthen and stabilize the network, and improve power quality. Functions include providing inertia, increasing short-circuit current (SCC), supplying or absorbing reactive power, supporting voltage and boosting fault ride-through capability.



Technical data	
Reactive power	Up to 80 MVAR (higher output with parallel units)
Voltage	Up to 15 kV
Frequency	50/60 Hz
Speed	1000/1200/1500/1800 rpm, 4 or 6 poles
Short-circuit power	Custom (higher short-circuit power with parallel units)
Overload capabilities	Custom
Inertia	Up to 450 MWs with flywheel (higher inertia with parallel units)
Maximum voltage withstandability	15 kV (+10% continuous)
Excitation	Brushless, PMG excitation supply
Insulation class/temperature rise	• Condenser: F/B (stator), H/B (rotor) • Pony motor: F/B
Mounting	Horizontal
Cooling	• Condenser: IC81W or IC616 • Flywheel: IC86W or IC36 • Pony motor: IC 411
IP class	Up to IP56
Standards	IEC or NEMA

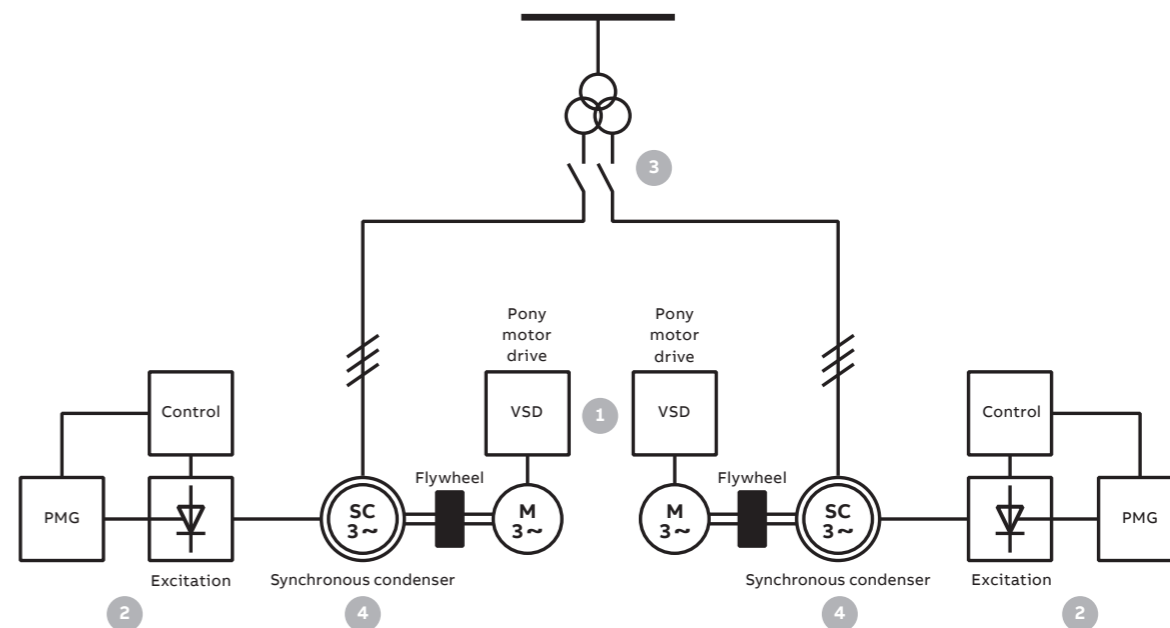


Challenge	ABB synchronous condenser package solutions	Key features
Frequency instability in power grid.	Provide high and instantaneous inertia, reducing Rate of Change of Frequency (RoCoF) and ensuring network frequency stability.	Additional inertia up to 450 MWs with flywheel (higher inertia with parallel units).
Voltage stability issues, need for reactive power compensation.	Supply and absorb reactive power, providing dynamic reactive power compensation to support network voltage.	Reactive power up to 80 MVAR (higher output with parallel units).
Transient stability issues in the network requiring FRT (fault ride-through).	Support network transient stability through increased inertia, increased overall short-circuit capacity, and dynamic overloadability during network transients.	Excellent dynamic properties and short-term overload capability in transient situations stabilize the network in the event of contingencies. Over-excitation (field forcing) capacity increases the margins for transient stability.
Low fault current level in the grid.	Increase transmission line capacity and contribute to overall short-circuit capacity in the network node where installed.	Short-circuit power level can be customized (higher short-circuit power with parallel units).
Power quality issues.	Increase the network's short-circuit fault levels, which reduces voltage harmonics. Fast, dynamic reactive power compensation stabilizes network voltage fluctuations.	Over-excitation (field forcing) capacity increases the margins for transient stability.
Grid code compliance issues.	Support grid code compliance.	ABB supplies simulation models (PSCAD, PSS/E®, Powerfactory), as well as grid code compliance simulation and validation services.
Requirement for fast delivery and installation to support weak grid.	Supplied in pre-designed packages complete with drawings for shorter engineering and overall project times. Clear mechanical and electrical interfaces ensure easy substation integration.	Pre-designed ABB synchronous condenser package solutions can be in service in as little as 12 months from the initial plan.

Modular package overview

This example shows two parallel water or air-cooled SCs and flywheels with condenser circuit breakers (CCBs) on the secondary side of a three-winding step-up transformer. Deploying parallel units with flywheels provides higher reactive power, short-circuit power and inertia.

- 1 A small pony motor brings the synchronous condenser up to the network synchronous speed with the help of a variable speed drive.
- 2 Excitation is fully connected, and the voltage and power factor regulators start to operate, based on the voltage and power factor reference.
- 3 When synchronization is reached between the network and the synchronous condenser, the breaker to the network is closed. The SC is now running on-line.
- 4 After successful synchronization the pony motor is de-energized and runs idle with the SC.



Global support

ABB offers a complete portfolio of services to ensure trouble-free operation and long product lifetime. Our services cover the entire life cycle of your ABB synchronous condensers.

Throughout the life cycle

From installation and commissioning – through spares, repairs and upgrades – to remote monitoring solutions, ABB offers the most extensive service offering to fit your needs. Based on 130 years' experience of building and servicing rotating electrical machines, ABB service units and authorized value providers offer services that maximize performance, uptime and efficiency throughout the life cycle of your ABB synchronous condensers.

Service near you

Our network of service centers and certified partners spans the world. This enables us to deliver local support no matter where you are located, and ensures that we always provide the optimum, most cost-effective solution.

Benefits of ABB support

- High uptime
- Maximum performance
- Extended useful equipment life



Keep your facility running



Pre-purchase

ABB's front-end sales organization can help customers to quickly and efficiently select, configure and optimize the right product for their application.

Installation and commissioning

Professional installation and commissioning by ABB's certified engineers represent an investment in availability and reliability over the entire life cycle.

Engineering and consulting

ABB's experts provide energy efficiency and reliability appraisals, advanced condition and performance assessments and technical studies.

Condition monitoring and diagnosis

Unique services provide early warnings before failures occur. Data can be collected by an engineer on-site or by remote monitoring. With the ABB Ability™ platform data can be transmitted to the cloud and accessed and analyzed remotely, allowing even greater insight into the health of the equipment. The services focus on the bearings, rotor winding, stator winding insulation and overall mechanical condition.



Maintenance and field services

ABB offers life cycle management plans and preventive maintenance products. The recommended four-level maintenance program covers the entire product lifetime.

Spare parts

Spare parts and support are offered throughout the life cycle of ABB products. In addition to individual spares, tailored spare part packages are also available.

Repair and refurbishment

Support for rotating electrical machines from ABB and other vendors is provided by ABB's global service organization. Specialist teams can also deliver emergency support.

Migration and upgrades

Life cycle audits determine the optimum upgrades and migration paths. Upgrades range from individual components to direct replacement machines.

Training

Product and service training courses take a practical approach. The training ranges from standard courses to specially tailored programs to suit customer requirements.

Specialized support

Specialized support is offered through ABB's global service organization. Local units provide major and minor repairs as well as overhauls and reconditioning.

Service contracts

Service contracts are tailored to the customer's needs. The contracts combine ABB's entire service portfolio and 130 years of experience to deploy the optimal service practices.