



## **District cooling**

Optimizing reliability, efficiency and costs of cooling generation, transmission and distribution

## Boosting district cooling system performance

District cooling systems play an important role in the efficient and sustainable cooling of buildings, since they use less energy than if each building had individual cooling generation on site. But it is not enough to simply generate cooling efficiently – it must be distributed and delivered with minimal cost and energy loss.



### System reliability and process continuity



“District cooling systems must be up and running whenever needed, to ensure people’s comfort and technical process reliability.”

#### Modern district cooling systems must be fully reliable...

- Air temperatures inside buildings during the hot season are a matter of comfort, health and productivity.
- Interruptions in technical processes that require constant cooling can put the operation of a mission critical facility at risk.
- Compressors and pumps are among the most crucial elements in district cooling, since they generate cooling and circulate chilled water between the cooling plant and consumers. Thus, compressor and pump operation must always be continuous, with no downtime.

#### ... ensured by the best-in-class technologies

- Uninterrupted generation, transmission and distribution of chilled water can be ensured by variable speed drives (VSDs) and softstarters, helping to avoid mechanical stress on the system components.
- Drives eliminate high starting currents which can have adverse effects on the power network.
- The drives' compliance with 'power-loss-ride-through' standards keeps cooling equipment operating during short power outages, significantly reducing downtime.
- VSDs withstand high vibrations, and even meet seismic standards, to ensure smooth operation in cooling plants and pumping stations.
- Motors feature protection against bearing currents, to increase motor reliability and life-time.
- ABB Ability™ remote condition monitoring services track the system health and warn about forthcoming failures.



### Energy efficiency and sustainability



“How can we get the highest efficiency from district cooling, to have the lowest carbon footprint?”

#### Taking care of the environment...

- Regardless of the energy source, district cooling has higher efficiency, with less carbon emissions than individual cooling.
- District cooling unlocks multiple opportunities for renewable thermal energy.
- Even residual heat from industrial processes, sewage or waste incineration can be used to generate cooling in absorption chillers.
- District cooling also enables Power-to-X technology for converting surplus electricity to cold, which can be stored and used later.
- High energy use for chilled water generation, transmission and distribution negatively affects tariffs and district energy attractiveness for end-users as a result.

#### ... while optimizing energy use in district cooling processes

- VSDs provide precise compressor, pump and fan control for optimal chilled water temperatures, flow rates and pressures, match the energy use to the specific load.
- On average, VSDs deliver energy savings of 20 to 60 percent.
- Upgrading to IE4 or IE5 efficiency class motors in cooling applications significantly reduces energy use in cooling generation, transmission and distribution.
- ABB Ability™ Smart Sensors for motors, as well as VSD energy counters, help analyze energy use and allow improvements in the entire system.



### Operation and maintenance



“I want smart operation and predictive services, to avoid costly inefficiencies and shutdowns.”

#### Optimize the cooling process and reduce overheads...

- Modern district cooling networks require transparency for best efficiency and operability. This can be ensured by a high level of digitalization and continuous data exchange and analysis.
- Operational costs can be optimized, without compromising cooling process continuity.

#### ... through smart functionality...

- Monitoring of temperature, overload, overcurrent, and other protection features in VSDs helps prevent failures in cooling applications, thus significantly reducing downtime costs.
- The real-time clock in the drives keeps a record of trips and faults, so facility management knows what happened and when.

#### ... IoT capability...

- ABB drives secure seamless connection to supervisory control and data acquisition (SCADA) systems, thanks to built-in industrial and building automation protocols.
- ABB Ability™ digital services for drives, motors and pumps provide remote monitoring and analysis of powertrain performance to reduce downtime, increase efficiency and allow smart maintenance. Regular inspections can be eliminated.
- VSD-enabled wireless connectivity provides remote access to hard-to-reach equipment, for easier troubleshooting.

#### ... and advanced maintenance practices

- ABB global service network and preventive maintenance agreements secure speedy response to critical issues in district cooling supply.
- 20 years or more of operational life can be attained by utilizing ABB's proactive maintenance services.
- ABB Life Cycle Assessment provides a clear understanding of the drive/motor installed base, detailing how asset performance will evolve over the next few years.
- Genuine spares are readily available locally.



### Project costs and return on investments



“Short payback periods and low operating expenses are the keys to attracting investors.”

#### District cooling is a way to invest in sustainable urban development...

- Demands for energy savings and decarbonization have accelerated globally, and district cooling has become one of the favored solutions to improve urban efficiency and combat climate change.
- Reliable, sustainable and cost-effective cooling supply attracts both investors and end-users.
- Alternatively, high infrastructure costs result in long payback times and may deter investors.
- High operating costs, due to inefficient energy use and unreliable processes, may compromise any sustainability benefits.
- Modern control solutions for district cooling can positively impact both capital and operating costs, decreasing the payback period.

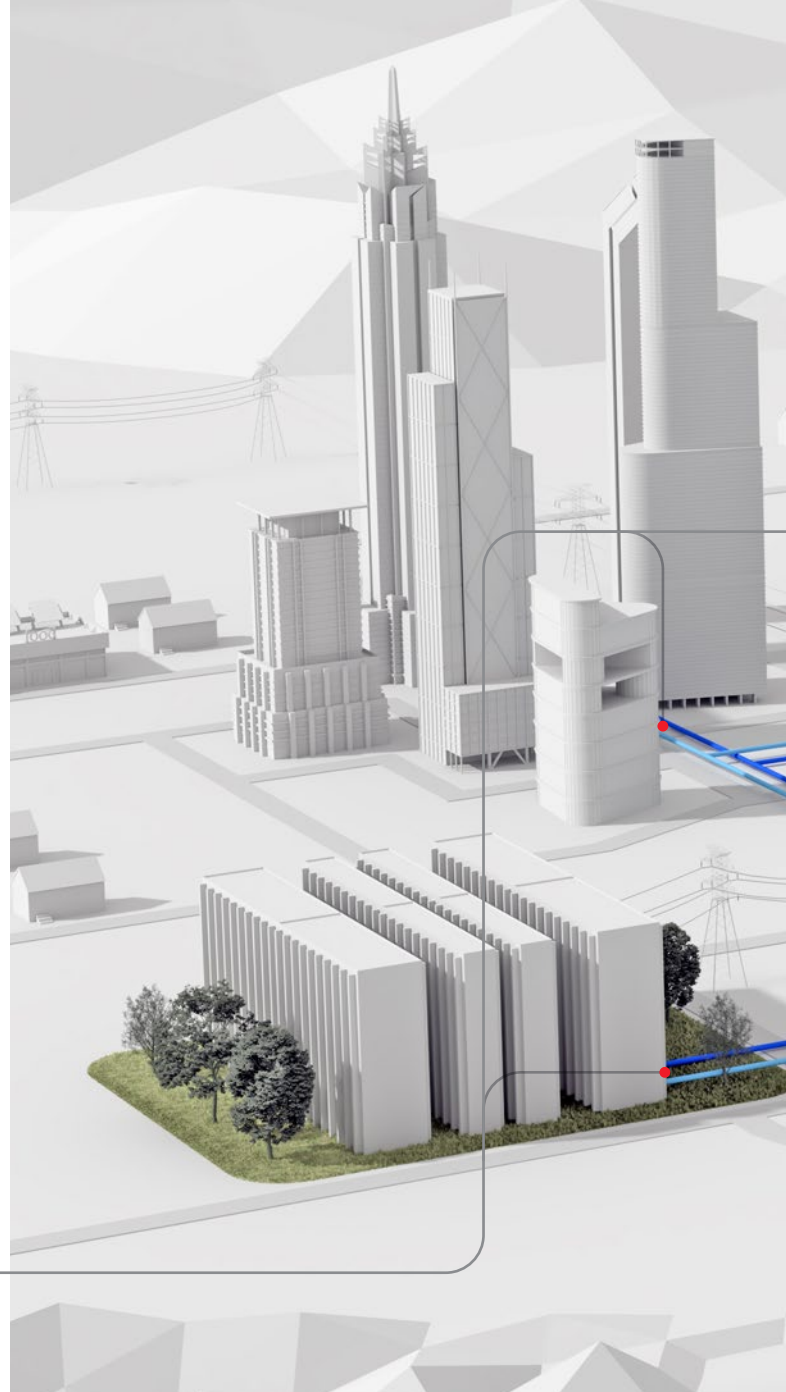
#### ... using the most cost-effective solutions

- District cooling ROI can be improved with ultra-low harmonic drives which ensure power quality and network operation stability. They also reduce the size of supply transformers, back-up generators and other power network components.
- ABB's strict quality control – all the way from component selection to factory acceptance testing – ensures the reliability and performance of the equipment, making investments reasonable.
- Ultra-low harmonic drives save on operating costs and tariffs for district energy consumers, since they help maintain a unity power factor and eliminate reactive power penalties from the utility.
- IoT enabled drives, motors and pumps give users valuable information about their performance, helping to schedule maintenance intelligently and lower operating costs.



## Economical, reliable and sustainable district cooling

District cooling offers many advantages in making chilled water generation, transmission and distribution more energy efficient, cost-effective and reliable. The potential use of waste or ambient cooling sources also makes it more sustainable.



### 1 COOLING SUBSTATIONS

Cooling substations can be standalone buildings or located in a building basement. They receive chilled water from a cooling plant and deliver it to a building's internal cooling system.

#### Applications:

- Circulation pumps

#### Requirements:

- Provide the consumers with the cooling needed, according to outdoor climate parameters or technical process needs.
- Cooling demand may change with daytime and season, so the chilled water flow in the building cooling system must be adjusted accordingly.
- Keeping up the required pressure and flow in the chilled water system.
- Multi-pump control for redundancy purposes, where a standby pump steps in if the main one fails.
- Pump performance monitoring, to support predictive maintenance planning.

### 2 BOOSTER SUBSTATIONS

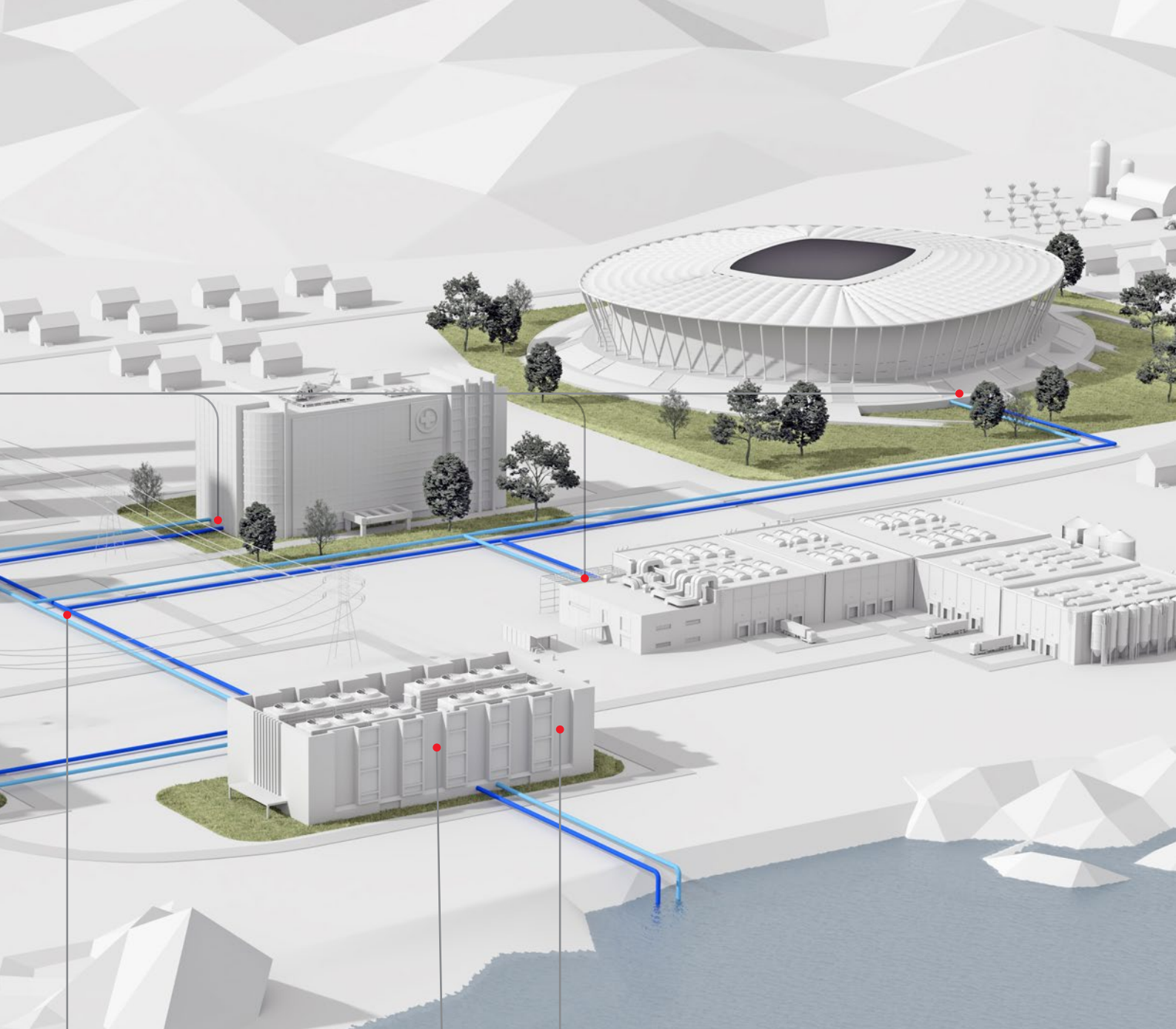
Pressure can drop significantly over the length of transmission pipelines, so booster pump stations help maintain the required pressure in each pressure zone and deliver the chilled water to the consumption point.

#### Applications:

- Booster pumps

#### Requirements:

- Ensure stable pressure at the consumer side.
- Leakage detection in the pipe/pump network.
- Multi-pump control for redundancy purposes.
- Pump performance monitoring, to support predictive maintenance planning.

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### COOLING PLANT

Cooling can be generated by dedicated cooling plants as well as a co-product of power generation at power and chiller plants or trigeneration plants. For carbon footprint reduction, it is becoming common to use sustainable sources for cooling generation.

#### Applications:

- Pumps, compressors, fans

#### Requirements:

- Adjust compressor speed in a chiller to exact cooling need, to save energy.
- Adjust circulation rate in the cooling network to the cooling need, to save energy.
- Higher fan speed in condensers /cooling towers may lead to lower condenser water temperature which positively affects chiller efficiency.
- Ensure the security of cooling generation for mission-critical facilities.

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### SYSTEM CONTROL

The SCADA system enables a high degree of automation, with fast, redundant and trouble-free communications, to provide access to all vital process information. It also supports the optimum integration of multiple decentralized cooling sources into one coherent, efficient cooling system.

#### Applications:


- District cooling system including cooling generation, transmission, distribution, and consumption

#### Requirements:

- Easy integration of system components (including drives) into a SCADA system.
- Scalable, flexible and open architecture.
- Fully integrated, cooling-specific digital applications for district cooling operation optimization.

# Unlock enormous hidden potential in district cooling systems

Motors equipped with variable speed drives and controllers that run cooling applications are excellent at providing comfort for the building's occupants or maintaining the required technical environment, while ensuring the cooling process continuity and efficiency. But there are many other important and profitable benefits to be gained as well.

Equipment	Challenge	Solution	Benefit
 <b>Cooling substations</b>	High energy consumption by pumps	<ul style="list-style-type: none"> <li>VSDs adjust pump speed to the building load</li> <li>Motors with IE5 efficiency</li> </ul>	<ul style="list-style-type: none"> <li>20 to 60 percent energy savings with VSDs compared to a modulating valve or bypass</li> <li>Up to 30 percent improved efficiency at partial loads with ABB synchronous reluctance ferrite-assisted motors</li> </ul>
	Substation uptime	<ul style="list-style-type: none"> <li>VSD pump protection includes overcurrent, overvoltage, motor overheating, under/overload control</li> <li>Less mechanical and electrical stress with VSD control, opposed to direct-on-line start</li> <li>Smart sensors collect information on pump performance, enabling predictive maintenance</li> </ul>	<ul style="list-style-type: none"> <li>Cooling continuity and building occupants' comfort</li> <li>Easier, hassle-free operations</li> </ul>
	Automation system overcomplexity	<ul style="list-style-type: none"> <li>VSD-based control capabilities for local control and extended external control tasks</li> <li>VSD-based fieldbuses without employing external gateways</li> </ul>	<ul style="list-style-type: none"> <li>Decreased infrastructure complexity and costs, with simpler operation and lower risk for errors</li> </ul>
	Pump acoustic noise or vibration	<ul style="list-style-type: none"> <li>VSD-based resonance control</li> <li>VSD switching frequency adjustment for lower motor noise</li> </ul>	<ul style="list-style-type: none"> <li>Quiet environment for enhanced comfort and productivity</li> </ul>
	Control reliability	<ul style="list-style-type: none"> <li>Control backup within VSDs – in case of external communication loss, VSDs can take over the control</li> </ul>	<ul style="list-style-type: none"> <li>Pump will continue running in a preset for local control mode until the external communication is recovered</li> </ul>
	Electrical harmonics in the power network	<ul style="list-style-type: none"> <li>ULH and multi-pulse drives reduce harmonics content in the network to a minimum</li> </ul>	<ul style="list-style-type: none"> <li>Network stability and elimination of large filters needed for harmonics mitigation</li> <li>Elimination of non-wattage penalties from the utility</li> </ul>

01






01 Chillers at a district cooling plant serving the entire city.

02 In Singapore, banks, residential towers, shopping malls, hotels and gardens are cooled down by the underground cooling plant with a thermal energy storage tank.





Equipment	Challenge	Solution	Benefit
 <b>Chillers</b>	High energy consumption	<ul style="list-style-type: none"> <li>VSDs adjust compressor speed to the supplied load need</li> <li>Motors with IE5 efficiency</li> <li>Optimized entering condenser water temperature</li> <li>Cascade control – next compressor kicks in when the load increases, so the system is always at its optimal efficiency point</li> </ul>	<ul style="list-style-type: none"> <li>20 to 60 percent energy savings with VSDs</li> <li>Up to 30 percent improved efficiency at partial loads with ABB synchronous reluctance ferrite-assisted motors</li> <li>Centrifugal chillers with VSDs get about 10 percent efficiency gain for every 5 degrees of condenser water temperature decrease</li> </ul>
	Compressor acoustic noise or vibration	<ul style="list-style-type: none"> <li>VSD-based resonance control</li> <li>VSD switching frequency adjustment for lower motor noise</li> </ul>	<ul style="list-style-type: none"> <li>Quieter environment for enhanced comfort and productivity</li> <li>Extended equipment lifetime</li> </ul>
	Chiller uptime	<ul style="list-style-type: none"> <li>Less mechanical and electrical stress with VSD control</li> <li>Remote condition monitoring of motors and drives running chiller compressors</li> </ul>	<ul style="list-style-type: none"> <li>Cooling plant operation continuity and city residents' comfort</li> </ul>
	Safety	<ul style="list-style-type: none"> <li>Max/min pressure monitoring in the drive</li> </ul>	<ul style="list-style-type: none"> <li>Reduced chances for refrigerant leakage and compressor parts damage</li> </ul>
	Hard start	<ul style="list-style-type: none"> <li>Drive can deliver 150% of the rated starting torque for 30 seconds</li> </ul>	<ul style="list-style-type: none"> <li>Smooth start with no need to open a pressure relief valve</li> </ul>
	Peak loads	<ul style="list-style-type: none"> <li>Drive can overspeed the compressor for a limited amount of time to handle the loads above nominal</li> <li>Drive can run compressors at higher speeds continuously, when bearings and mechanical parts are optimized</li> </ul>	<ul style="list-style-type: none"> <li>Smaller compressors can be used</li> <li>Increased control range</li> </ul>
 <b>Cooling towers</b>	Gearbox failures, oil leaks, misaligned drive shafts, high vibrations	<ul style="list-style-type: none"> <li>ABB provides a direct drive motor and VSD package for cooling towers, eliminating the need for a gearbox and associated components</li> </ul>	<ul style="list-style-type: none"> <li>Reduced maintenance time and cost</li> <li>Longer life as motors have up to five times the life expectancy of gearboxes</li> <li>Fast installation</li> <li>Reduced noise</li> <li>High efficiency thanks to VSDs</li> </ul>
	High energy consumption		
 <b>Booster pump stations</b>	Pump uptime	<ul style="list-style-type: none"> <li>VSD supervisory functions show possible upcoming mechanical failures like bearing wear or events like stalled impeller and dry running of pumps</li> <li>Smart sensors measure pump motor health parameters like vibration and temperature</li> <li>Auto-restart after power failure</li> </ul>	<ul style="list-style-type: none"> <li>District cold supply continuity and citizen's comfort / technical process reliability</li> </ul>
	Pipe leakage	<ul style="list-style-type: none"> <li>Leakage monitoring via VSD alarms when pressure in a pipe drops abnormally</li> </ul>	<ul style="list-style-type: none"> <li>No infrastructure damage and associated costs due to leaks</li> </ul>
	Booster set lifetime	<ul style="list-style-type: none"> <li>VSD-based intelligent pump control, distributing pump work hours evenly</li> </ul>	<ul style="list-style-type: none"> <li>Optimized operation for extended equipment lifespan</li> </ul>
	System cost	<ul style="list-style-type: none"> <li>VSD use eliminates the need for pressure-reducing valves</li> </ul>	<ul style="list-style-type: none"> <li>Optimized costs, without compromising functionality</li> </ul>

# Features and functions that benefit district cooling systems

ABB offers an extensive range of devices for district cooling applications. These range from motors, drives and softstarters to SCADA systems which bring all components together for effective automation and control. Choosing the right products and services is essential for giving your district cooling systems the highest possible energy efficiency and operational reliability.



## Variable speed drives

### Low harmonics

- Drives with built-in active front-end and line filter or multi-pulse drives reduce harmonic disturbances to a minimum, for best power network reliability and efficiency

### Real-time clock

- Trips and faults are date and time stamped, so facility management knows what has happened and when

### System efficiency

- VSDs increase system efficiency by adjusting motor speeds to the current needs
- Advanced Energy Optimizer feature improves energy use further by reducing the motor's magnetic losses
- Active front end drives reduce system losses due to almost non-existent harmonics and unity power factor

### Built-in PID control

- Application control without employing external controllers, thus decreasing automation system complexity and costs

### Control redundancy

- External communication loss is handled seamlessly by a VSD taking control until the external communication is recovered

### Embedded communication

- Control, monitoring and diagnostics for applications through embedded Modbus, BACnet, or other optional protocols eliminates the need for external gateways

### Intelligent pump/compressor control

- Control of multiple pumps/compressors in the set for higher efficiency – next pump/compressor automatically steps in when the load increases
- Distribution of work hours evenly between all pumps/compressors in the set, for extended equipment lifetime
- Redundancy – in case one of the pumps/compressors fails, the others take over the load



### Pump dry-run protection

- Prevent costly damage when a pump starts running outside its load curve, due to no liquid in the system

### Pipe leakage or blockage protection

- Get a warning and/or stop the pump when the pressure in the system is outside set limits

### Pump soft start and stop

- Allows smooth pump starts/stops, to avoid water hammer and damage to pipelines and connected equipment

### Safe torque off

- Built-in feature for safe maintenance of mechanical parts of cooling equipment

### Resonance control

- Allows pump/fan/compressor to avoid resonance by skipping resonant frequencies

### Sensorless flow calculation

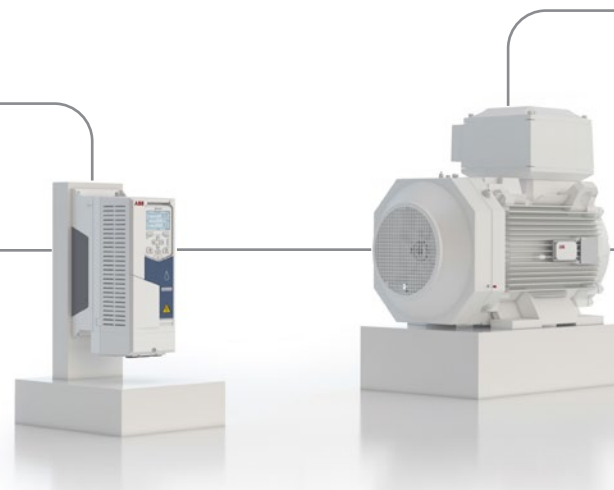
- Eliminates the need for an external flow meter, for lower system cost

### Increased starting torque

- Drive can deliver 150% of the rated starting torque for a limited time to ease the compressor start

### Overspeed

- Drive can overspeed the compressor to handle loads above nominal rating, using a smaller compressor







## Softstarters



### Soft start and stop

- Minimized mechanical and electrical stresses during starts and stops for applications with constant load

### Built-in bypass

- Reduced system size and complexity
- Reduced heat generation from internal losses by activating bypass at full speed

### Harsh environment tolerance

- Process continuity in dusty or wet environments with IP66 keypad and coated electronics

### Embedded communication

- Control, monitoring and diagnostics for applications through embedded Modbus RTU and other optional protocols



## Control solutions



### A world-class automation system from a leading supplier

- Scalable, flexible and open architecture
- Fully integrated digital applications built to optimize district cooling
- High level of automation for more effective operation, fuel savings and improved system maintenance

### Scalable and modular PLC solutions for district cooling

- Control with global leading-edge functionality
- Standard district cooling software at all levels, from basic functions to fully automated systems



## Motors



### High reliability

- Protection against external conditions with IP55 as standard
- Wide range of surface treatment and corrosion protection solutions available
- Protection against bearing currents with an extended portfolio of solutions including insulated bearings and shaft grounding
- Bearings locked at D-end to avoid axial play

### Efficiency

- Up to IE5 efficiency level without magnets to reduce energy consumption and improve total cost of ownership

### Easy installation

- Oversized terminal box as standard to ease installation
- Flexible cabling solutions
- Various mounting arrangements including direct drive, belt or transmission
- Horizontal and vertical mounting



## ABB Ability™ Smart Sensors for motors, pumps and bearings



### Minimized unplanned downtime

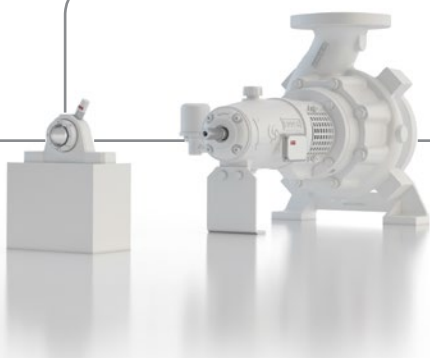
- Failures can be detected well before equipment needs to be shut down, avoiding unplanned downtime

### Reduced maintenance costs

- By changing from scheduled to condition-based maintenance, service costs can be considerably reduced

### Improved safety

- Eliminate the need for manual motor/pump/bearings check-ups in locations that are hard-to-reach or dangerous



## From the facility to the cloud and beyond


ABB Ability™ Condition Monitoring for powertrains optimizes the performance and efficiency of rotating equipment. It enables full transparency on all parameters for VSDs, motors, mounted bearings and applications like pumps.

### 1 Intelligent powertrain

The powertrain is equipped with sensors and cloud connectivity and can comprise motors, drives and mechanical components including bearings, couplings and applications like pumps.

### 2 Turning data into valuable information


Data gathered from VSDs' built-in sensors and loggers, together with that collected from ABB Ability™ Smart Sensors fitted to motors, bearings and pumps, can be collated, stored and further accessed via the cloud. The ability to gather and analyze this data can reveal information on the status and condition of your equipment, so that you can schedule proactive service.



Variable speed  
drive



Motor



Mechanical power  
transmission  
eg bearing



Application  
eg pump



## Accessing data for analytics

You have access to a monitoring portal to view key operational parameters of individual assets as one unified system. Detailed dashboards give full transparency so that you can take actions that lead to less downtime, extended equipment lifetime, lower costs, safer operations and increased profitability.



## Gain a digital advantage

Ensuring that the right person has the right information at the right time brings:

- Appropriate response to process challenges, minimizing operating costs
- Greater insight into various aspects of the process, thereby improving system performance
- Lower risk of process failure, while changing your maintenance from reactive to predictive

### System reliability and process continuity



### Energy efficiency and sustainability



### Operation and maintenance



### Project costs and return on investments





## Keep your facility running

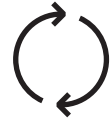
From spare parts and technical support to cloud-based remote monitoring solutions, ABB offers the most extensive service offering to fit your needs. The global ABB service units, complemented by external Value Providers, form a service network on your doorstep. Maximize performance, uptime and efficiency throughout the life cycle of your assets.

### With you every step of the way

Even before you buy a generator, drive, motor, bearing or softstarter, ABB's experts are on hand to offer technical advice from dimensioning through to potential energy saving.

When you've decided on the right product, ABB and its global network of Value Providers can help with installation and commissioning. They are also on hand to support you throughout the operation and maintenance phases of the product's life cycle, providing preventive maintenance programs tailored to your facility's needs.

ABB will ensure you are notified of any upgrades or retrofit opportunities. If you've registered your drives and motors with ABB, then our engineers will proactively contact you to advise on your most effective replacement option. All of which helps maximize performance, uptime and efficiency throughout the lifetime of your powertrain.



#### Replacements

Fast and efficient replacement services to minimize production downtime



#### End-of-life services

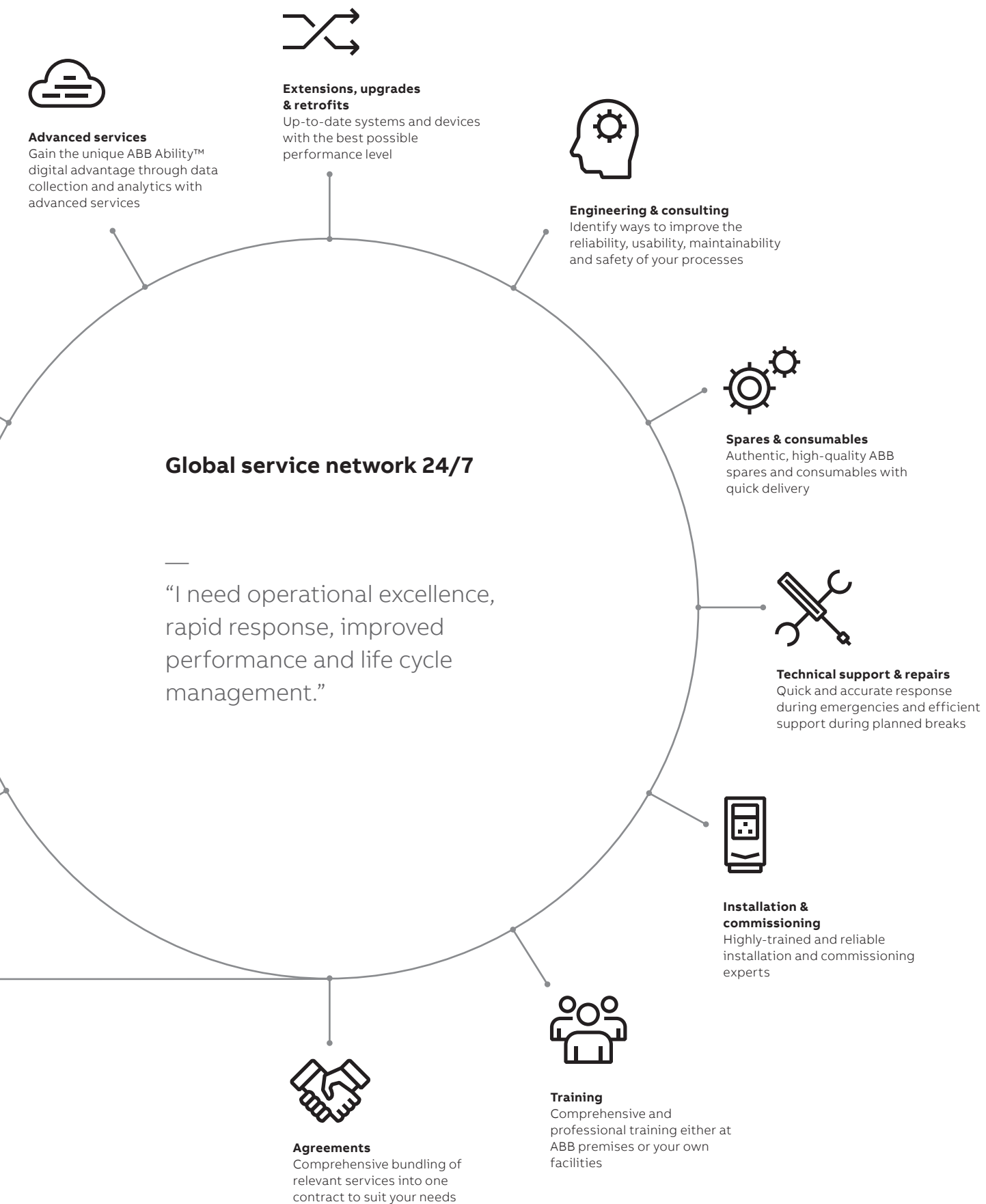
Responsible dismantling, recycling and reusing of products, according to local laws and industrial standards



#### Maintenance

Systematic and organized maintenance and support over the life cycle of your assets





## With you, wherever you are in the world

Partnering with ABB gives you access to some of the world's most innovative technology and thinking.

### Global reach

ABB operates in over 100 countries with its own manufacturing, logistics and sales operations together with a wide network of local channel partners that can quickly respond to your needs. Stock availability is good, with short delivery times for many products backed by 24-hour spare parts delivery.

In addition, ABB interacts closely with energy industry players including consultants, system integrators, energy generating companies and municipal authorities to help optimize costs, while simultaneously increasing reliability and

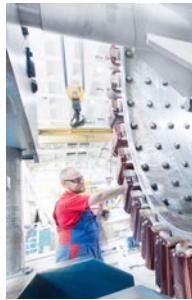
efficiency of cooling distribution networks to an absolute maximum, thus providing the best comfort to end users.

ABB has seven global R&D centers with more than 8,000 technologists and invests \$1.5 billion annually on innovation.

### End-to-end product portfolio

Alongside its diverse portfolio of VSDs, softstarters, motors and generators, ABB also offers district cooling:

- Medium voltage components and systems such as air- and gas-insulated switchgears,



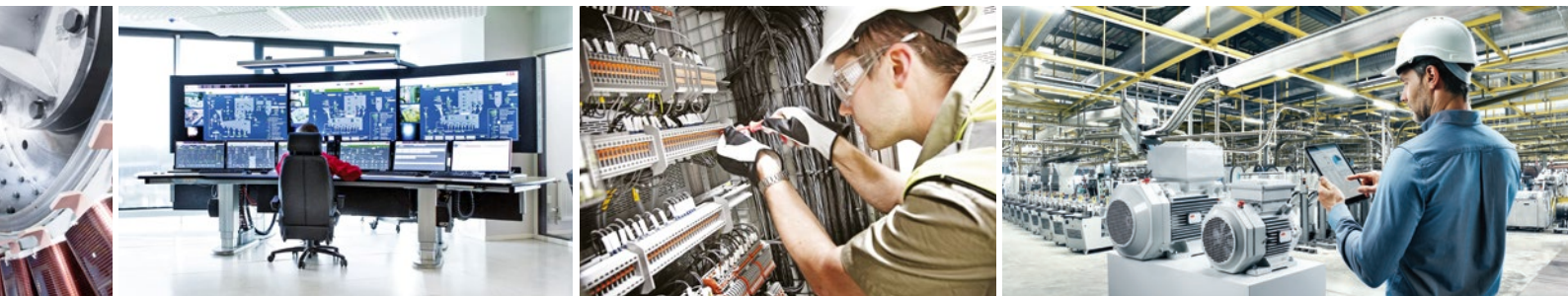


uninterruptible power supply units, relays, ultra-fast earthing switches, Is-limiters to reduce high short-circuit currents and more.

- Low voltage components and systems such as switchgears, uninterruptible power supply units, breakers, industrial plugs and sockets, RCD blocks, power distribution units, remote power panels, a wide range of scalable PLCs and HMIs and more.
- Digital solutions including ABB Ability™ cross-product and system offering providing intelligence all the way to the component level, improving overall visibility and making the system safe, reliable and efficient.

### Streamline sourcing

ABB's end-to-end product and services portfolio streamlines your sourcing and purchasing activities and standardizes processes across multiple sites, saving you money on spare part inventories while reducing maintenance costs.





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

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