

# ABB drives for water

Medium voltage drives for energy savings  
and life-cycle improvements



# Water – Increasing demand for a limited resource

Freshwater is one of the world's most important resources. But it is limited. Only three percent of the water on Earth is fresh water, and over two thirds of it is frozen in glaciers and polar ice caps. Water demand already exceeds supply in many parts of the world. The sustainable management of freshwater is one of the most important global issues.

Water is not only crucial to health but also to economic development. It is estimated that 15 percent of worldwide water use is industrial. All major industries rely on the unlimited availability of water as it is required by many processes and even forms a significant proportion of the final product.

As water demand continually rises, water is becoming increasingly vulnerable as a resource.

It is estimated that by 2025

- the population will increase by 1.5 – 2 billion,
- 2 billion people will move to cities,
- 1 billion people will not have access to clean drinking water,
- 2.4 billion people will not have adequate sanitation.

The rising demand for water coupled with its limited availability imposes severe challenges on water utilities and consumers.

## Challenges

Water utilities and consumers are faced with the following challenges:

- Limited availability of freshwater coupled with a rising demand
- Rising cost of energy
- Stricter anti-pollution laws and water quality standards

With hundreds of installations in the water industry worldwide, ABB has the experience and expertise that bring considerable benefits to companies in today's competitive water industry. ABB helps them to meet the challenges they face today by providing environmentally friendly solutions for efficient water conservation, such as:

- state-of-the-art electrical systems
- SCADA for plant automation and water leakage management
- high efficiency motors
- Variable Speed Drives (VSDs) and soft starters for improved controllability and energy savings

## Variable speed drives

ABB supplies variable speed drives and systems for various kinds of processes and applications in the water cycle:	
Clean water applications	Pumps for water extraction, transmission, treatment and distribution (incl. Electrical Submersible Pumps (ESP))
Sewage applications	Influent pumps, effluent pumps, treatment pumps and fans
Desalination plants	Raw water, process and high pressure pumps
Industrial applications	Pumps for cooling water supply and condensation
Other applications	Irrigation, water lifting, storage and district heating pumps

# Benefits of variable speed drives

The use of variable speed drives for flow and pressure control of electric motors results in significant energy savings and a reduction of life-cycle costs. In addition, variable speed drives provide soft starting/stopping features, which improve system reliability and extend the lifetime of motors.

## Flow and pressure control

Water consumption varies greatly during a day. Consequently, the flow and pressure of pumps need to be controlled. The flow and pressure can be adjusted either electrically with variable speed drives, or mechanically with fixed-speed solutions, such as inlet guide vanes, throttling valves or hydraulic couplings.

## Pump affinity laws

- Flow is proportional to speed
- Pressure is proportional to the square of speed
- Power is proportional to the cube of speed

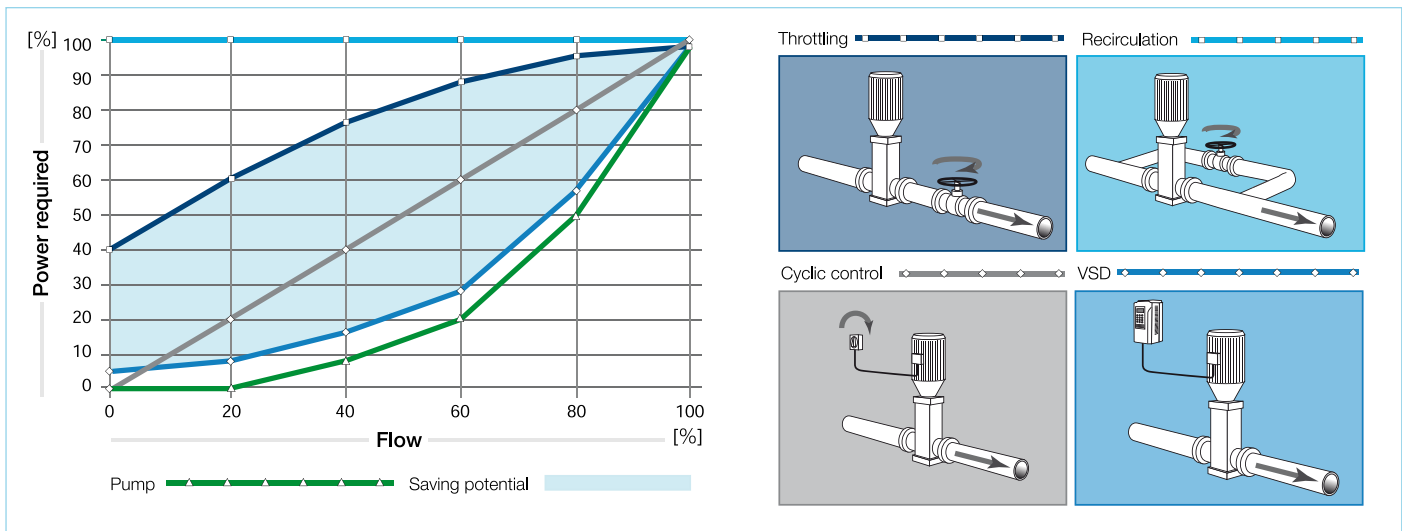
## Fixed vs. variable speed control

The most common flow control method is by means of a fixed speed motor regulated with a valve. This method can be compared to adjusting the speed of a car by braking while keeping the foot on the gas. This technique does not only waste a tremendous amount of energy, it also wears out the equipment.

## Benefits of variable speed drives

- Energy savings
- Typical payback on investment time: less than two years
- Improvement of system efficiency
- Longer lifetime of equipment
- Reduced operating costs
- Fast and precise process control

With electric variable speed drives, changing the flow is simply achieved by changing the motor speed, which can be compared to reducing the speed by taking the foot off the gas and switching to a lower gear. The pumps will be operated at the BEP (Best Efficiency Point) under all operating conditions. Electric variable speed drives are the most efficient control method - they save energy, decrease CO<sub>2</sub> emissions and minimize total operating costs.



Power consumption for various pump control methods

### Energy savings and reduced emissions

Energy saving has never been higher on the agenda than today. People have become increasingly aware of the correlation between wasting energy and environmental damage, and acknowledge the benefits of conserving energy by technical means.

Since pumps typically run at partial load, huge energy savings can be achieved by controlling their speed with variable speed drives. The power required to run a pump is roughly proportional to the cube of the speed, i.e. a small reduction in speed can make a big reduction in the energy consumption. A pump running at half speed consumes as little as one eighth of the energy compared to one running at full speed.

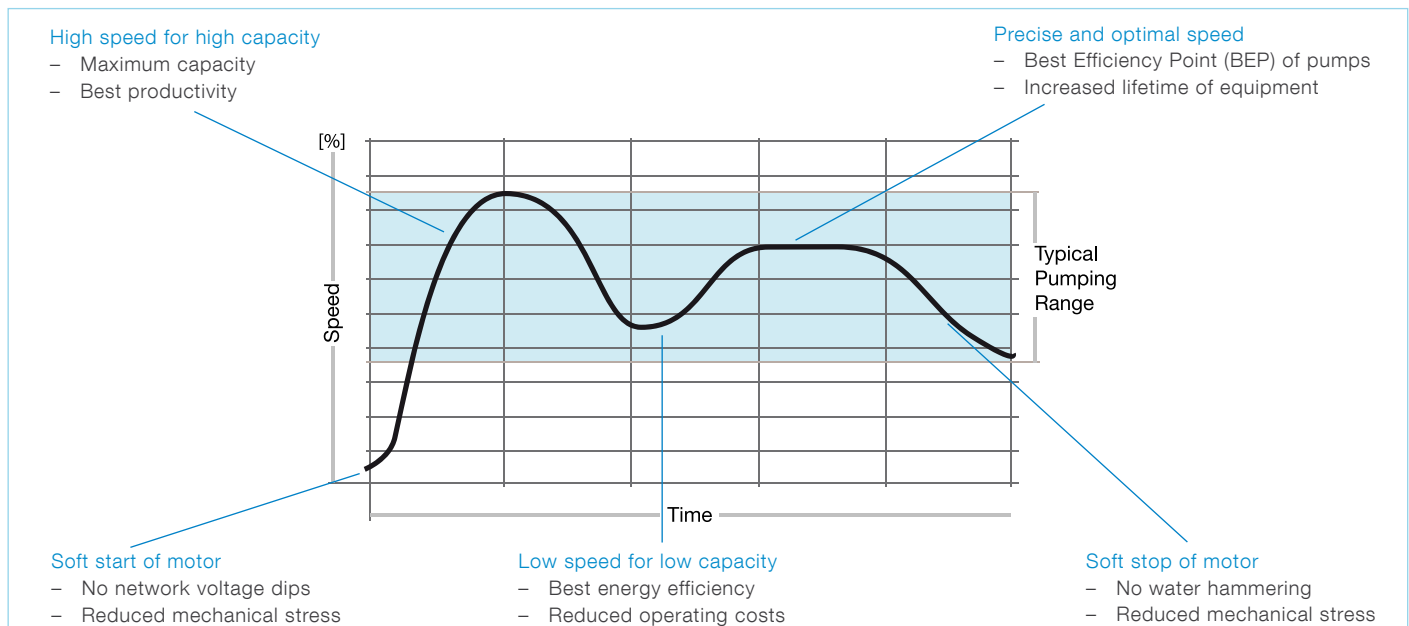
By employing variable speed drives on pumps instead of throttling, the energy bill can be reduced by as much as 60 percent (please refer to the picture “Power consumption for various control methods” on page 4). Consequently, electric variable speed drives also help to reduce CO<sub>2</sub> emissions.

### Reduced maintenance costs and longer lifetime of equipment

Variable speed drives also act as soft starters reducing the stress on network, motors and pumps. During the starting process, the variable speed drive progressively increases the motor speed and smoothly accelerates the load to its rated speed. One variable speed drive can start several pumps in sequence.

Soft starting eliminates high starting currents and voltage dips which can cause process trips. By soft starting, maintenance costs will be reduced and the lifetime of the equipment extended.

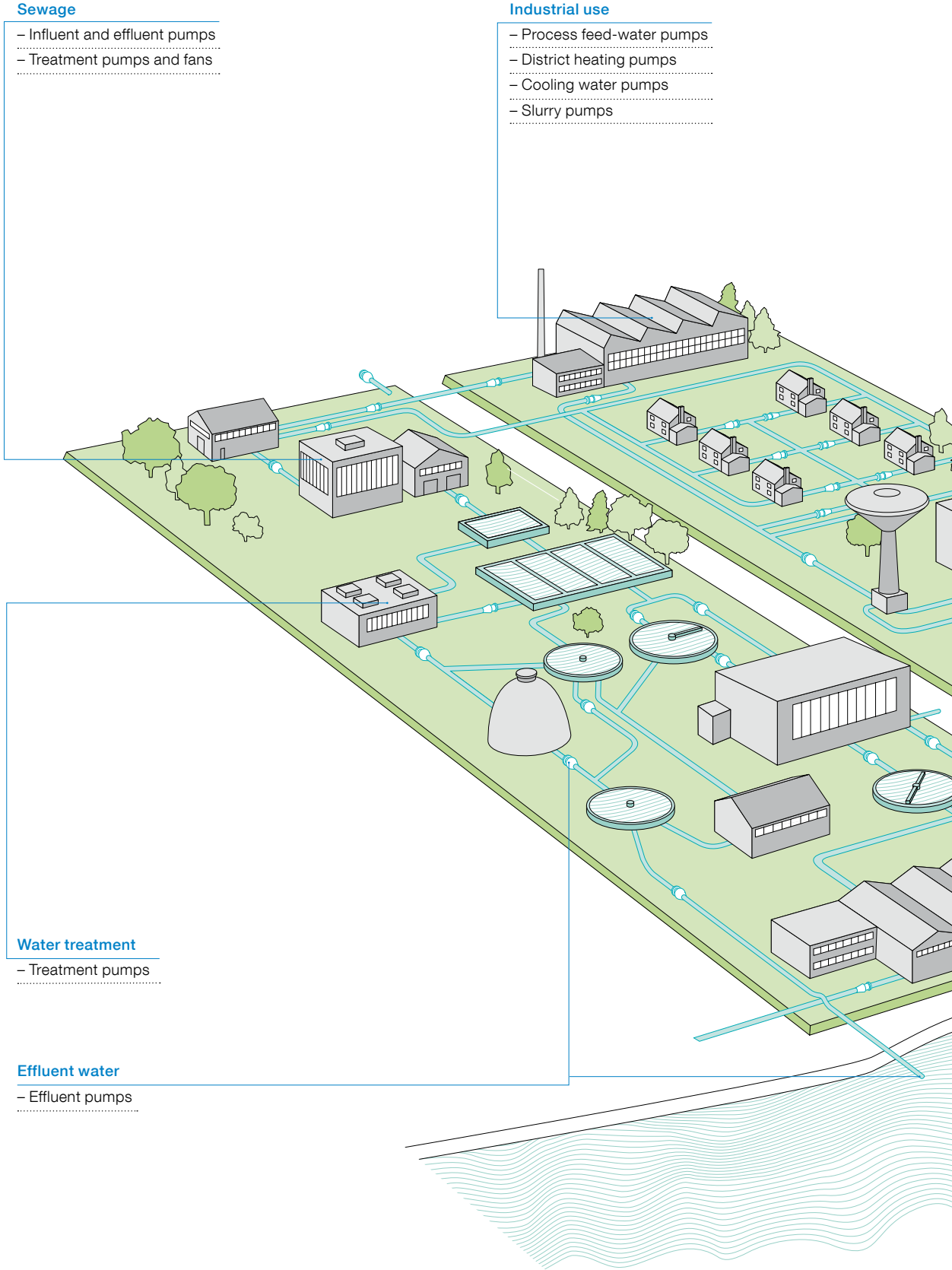
If pumps are turned off or water demand is reduced, variable speed drives slowly reduce the speed of the pumps, avoiding water hammering. The stress on the pumps is reduced resulting in a longer lifetime of the pumps.



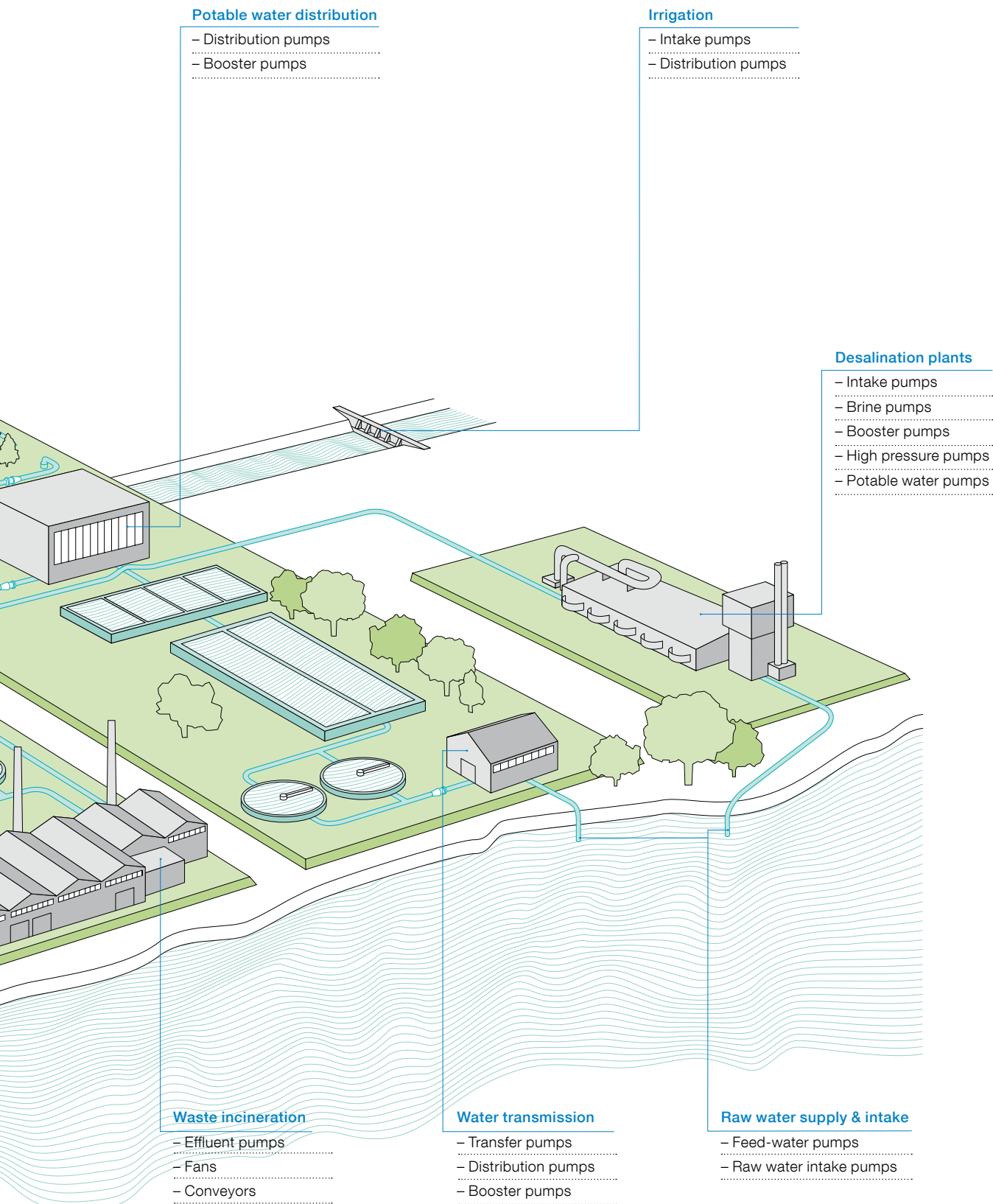
Summary of variable speed drive benefits for pumping applications

# Variable speed drives in the water cycle

Various processes and applications in the water cycle benefit from th



# The implementation of variable speed drives.



# Medium voltage drives

For more than 100 years ABB has provided drive products and systems to customers across many industries. ABB's extensive experience in variable speed drive technology, combined with its long experience with water applications, results in innovative drive solutions with unsurpassed performance and reliability.

ABB offers the entire range of medium voltage drives and soft starters for applications in the power range from 315 kW to more than 100 MW.

## ACS 2000

ACS 2000, the newest member of the ABB medium voltage drive family, is ideally suited for retrofit applications and with new standard induction motors, for voltages from 4kV up to 6.9 kV. It can be used without an input isolation transformer, thereby allowing a direct connection to the line supply (direct-to-line), or it can be connected to an input isolation transformer. This general purpose drive provides simple and reliable motor control for applications such as fans and pumps.

## ACS 1000

The ACS 1000 medium voltage drive is an unbeatable solution for pumping stations in the water industry. Due to its unique output sine filter, that eliminates common mode voltages and voltage reflections, the ACS 1000 is suitable for any new or existing standard motor. The ACS 1000i is a fully integrated standard drive which includes an input transformer and input contactor.

## ACS 5000

The ACS 5000 can be applied to standard induction and synchronous motors up to 6.9 kV. The ACS 5000 is ideal for high-powered pumping applications where the voltage is typically in the range of 6.0 to 6.9 kV. Retrofitting these pumps with the ACS 5000 will result in significant improvements in efficiency and reliability. The air-cooled ACS 5000 is also available with an integrated transformer.

## ACS 6000

ABB's ACS 6000 is a modular drive designed for the most dynamic and powerful single or multi-motor applications for both synchronous and induction motors. The ACS 6000 can be supplied with a 12/24-pulse diode rectifier or an IGBT active rectifier unit which minimize or even eliminate network harmonics. The ACS 6000 is the ideal solution for large pumping stations and demanding network conditions.

## MEGADRIVE-LCI

ABB's MEGADRIVE-LCI is an optimal solution for high voltage and high power pumping applications, as used for irrigation and water transfer schemes. Standard designs are available for ratings up to 72 MW, engineered designs for more than 100 MW. The MEGADRIVE-LCI is available as a variable speed drive or soft starter for multiple pumps.



**ACS 2000**  
300 - 3000 HP  
250 - 2300 kW,  
4 kV to 6.9 kV



**ACS 1000**  
400 - 6700 HP  
315 kW - 5 MW  
2.3 kV to 4.16 kV



**ACS 5000**  
1500 - 48,250 HP  
2 - 36 MW  
6 kV to 6.9 kV  
(higher power on request)



**ACS 6000**  
4000 - 48,250 HP  
3 - 36 MW  
3 kV to 3.3 kV



**MEGADRIVE-LCI**  
1500 - 100,000 HP  
2 - 72 MW  
2.1 kV to 10 kV  
(higher power on request)



# Technology highlights

Reliability is the main guiding principle of the research and development activities for medium voltage drives.

## Direct Torque Control (DTC)



The ACS drive control platform is based on ABB's award winning Direct Torque Control (DTC), resulting in the highest torque and speed performance ever achieved in medium voltage drives. Control of the drive is immediate and smooth under all conditions.

## Power Loss RideThrough

Due to its RideThrough function, the drive system is able to withstand disturbances of the power supply. The drive will continue to operate in an active but non-torque producing mode if the incoming supply voltage is cut off. The drive will be active as long as the motor rotates and generates energy to the drive. It will resume normal operation immediately upon return of power supply.

## Low parts count

The fewer the parts the higher the reliability. ABB uses high power semiconductor switching devices and a topology that brings down the part count to a minimum.

## Encoderless

Encoders are known to cause failures. They have an exposed position on the motor. ABB's medium voltage drives can operate without encoder.

## Remote monitoring and diagnostics

DriveMonitor™ allows secure real-time access to the drive. It supports monitoring and diagnostics of ABB drives independent of the implemented control method, thus also enabling the connection of existent installations.

The optional tool consists of a hardware module inside the drive, as well as a software layer that automatically collects and analyzes selected drive signals and parameters.

Long-term monitoring functions deliver important information on equipment status, tasks needed and possible performance improvements. Diagnostic procedures and trending can cover not only the converter itself but other parts of the shaft train as well.



# Components of variable speed drive systems

An electric variable speed drive system consists of input transformer, variable speed drive and electric motor. Transformerless variable speed drives are also available.

ABB can offer the complete variable speed drive system or assist in selecting components that match the process requirements. ABB's equipment is known for its state-of-the-art technology, high efficiency and reliability and worldwide support.

## Input transformers

An input transformer has two functions: it adjusts the network supply voltage to match the variable speed drive and it protects the motor from common-mode voltages. ABB input transformers are specifically designed for operation with variable speed drives.

ABB's input transformers are available for all ratings and primary voltages. Oil or dry type transformers are available for outdoor or indoor mounting.

## Transformerless configuration

A direct-to-line transformerless connection includes an Active Front End (AFE) for minimal line side harmonics providing near unity power factor and regeneration capability. This configuration also features three in-three out cabling for quick and easy installation, compact size, high reliability and low maintenance.

## Medium voltage motors

ABB's high voltage motors have earned an excellent reputation for performance and reliability. The product range consists of both induction and synchronous motors.

**Induction motors** are the workhorses of the industry due to their versatility, reliability and simplicity. In the power range up to 10 MW, a squirrel cage induction motor is usually the first choice. They are available up to 18 MW.

**Synchronous motors** are typically considered for higher power ratings. In addition to their high power capabilities, synchronous motors offer the benefits of high efficiency, high performance and a unity power factor. Permanent magnet motors are synchronous motors that do not need separate excitation. These motors are required for slow speed applications.



## Applications and references

To date, ABB has installed medium voltage drives with a total rated power in excess of 2,200 MW for applications in the water industry. Below are some examples.



Water distribution

### Metropolitan Waterworks Authority, Thailand

ABB supplied medium voltage drives to MWA (Metropolitan Waterworks Authority) in Bangkok, which provides tap water to 11 million people. MWA owns and operates one of the world's biggest water treatment plants and more than 30 pumping stations. Electricity cost amounted to almost 50 percent of MWA's production cost. The equipment supplied by ABB helps MWA to achieve energy savings of more than \$ 10,000/month for one pumping station.



Sewage

### Changi, Singapore

ABB supplied medium voltage drives for Singapore's water reclamation project, which is designed to meet Singapore's waste water treatment needs through the 21st century. 18 medium voltage drives with a total pumping power of 50 MW pump 3,200,000 m<sup>3</sup> of waste water/day through an 80 km long tunnel system. The new water reclamation plant will treat 528 million gallons of used water/day.



Cooling water supply

### Ras Laffan, Qatar

ABB supplied medium voltage drives for the Ras Laffan Common Cooling Water Project, which supplies vital cooling water to Ras Laffan Industrial City, one of the world's fastest growing industrial export locations. The cooling water system pumps 833,000 m<sup>3</sup> of cooling water an hour to the power plant, LNG trains and petrochemical facilities.

## Service - global network, local presence

Wherever you are, ABB is there for you.

After sales service is an integral part of providing the customer with a reliable and efficient drive system.

The ABB Group of companies operates in more than 100 countries and has a worldwide network of service operations.

### Services for ABB's medium voltage drives

- Supervision of installation and commissioning
- Training
- Remote diagnostics
- Customized maintenance contracts
- Local support and worldwide service network
- 24 x 365 support line
- Spare parts and logistics network

# Contact us

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