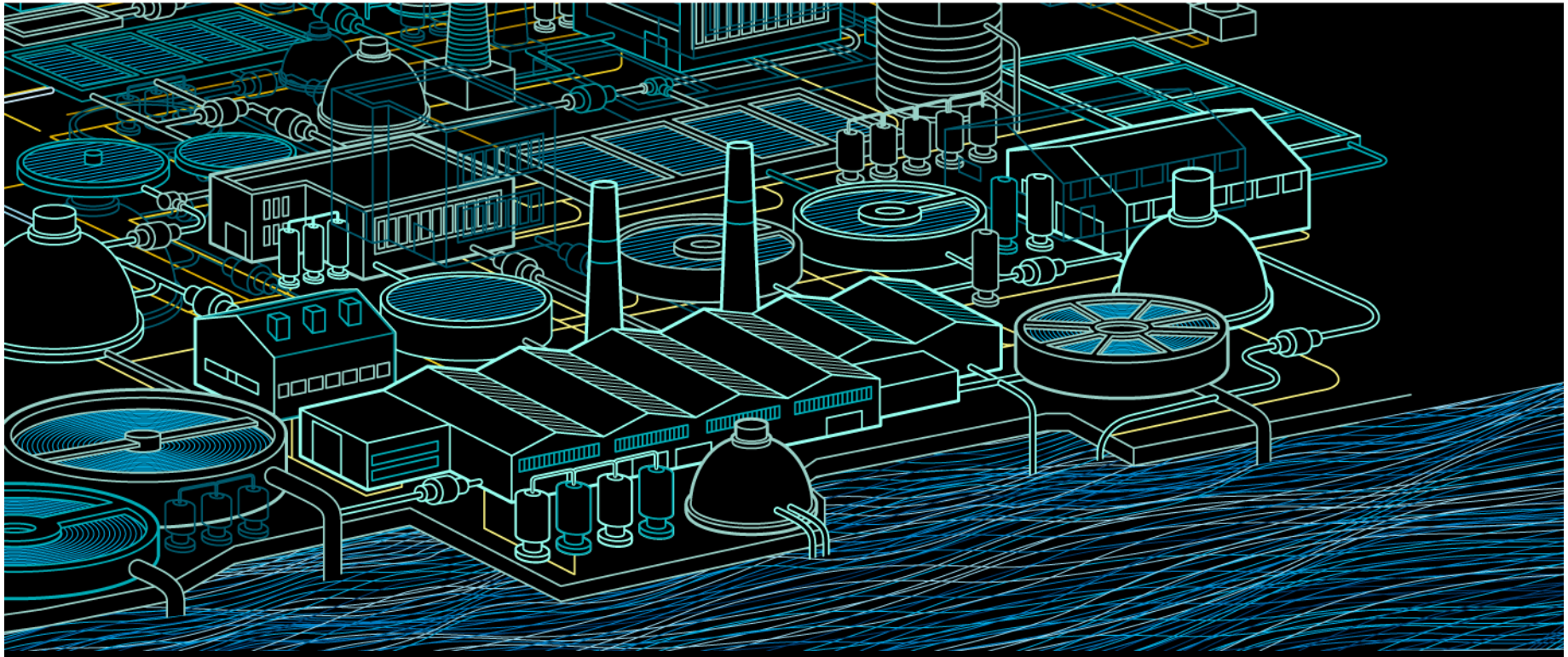


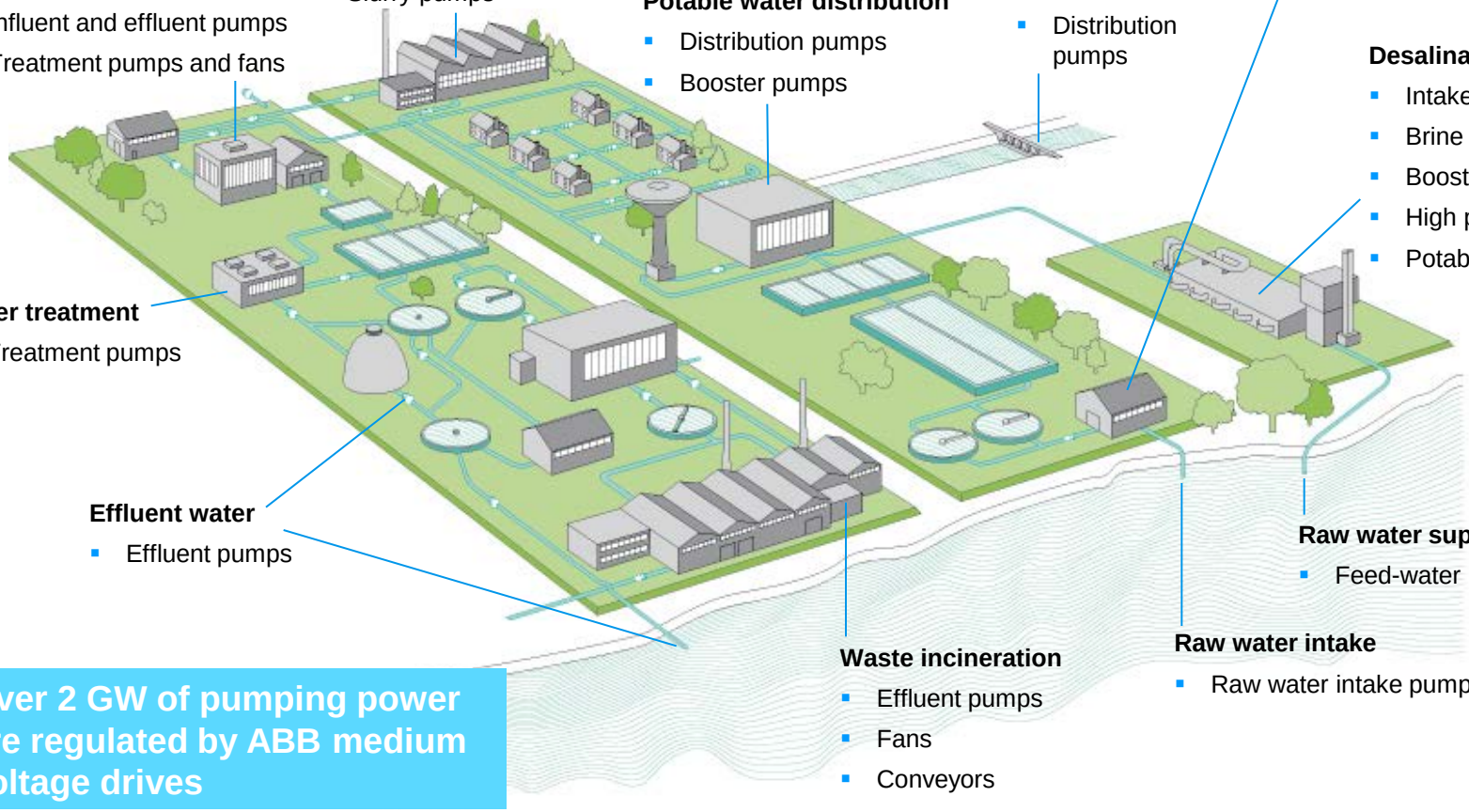
MV Drives, July 2012

ABB drives for water
Medium voltage drives for energy savings and life-cycle improvements

Challenges

- Rising demand for water coupled with limited availability imposes severe challenges on water utilities and consumers, such as
  - Rising cost of energy
  - Stricter anti-pollution laws and water quality standards
- ABB offers state-of-the-art products to support sustainable water management, including
  - SCADA for plant automation and leakage management
  - High efficiency motors
  - Variable speed drives and soft starters for improved controllability and energy savings

Variable speed drives in the water cycle



Industrial use
- Process feed-water pumps
- District heating pumps
- Cooling water pumps
- Slurry pumps

Water transmission
- Transfer pumps
- Distribution pumps
- Booster pumps

Sewage
- Influent and effluent pumps
- Treatment pumps and fans

Potable water distribution
- Distribution pumps
- Booster pumps

Irrigation
- Intake pumps
- Distribution pumps

Desalination
- Intake pumps
- Brine pumps
- Booster pumps
- High pressure pumps
- Potable water pumps

Water treatment
- Treatment pumps

Effluent water
- Effluent pumps

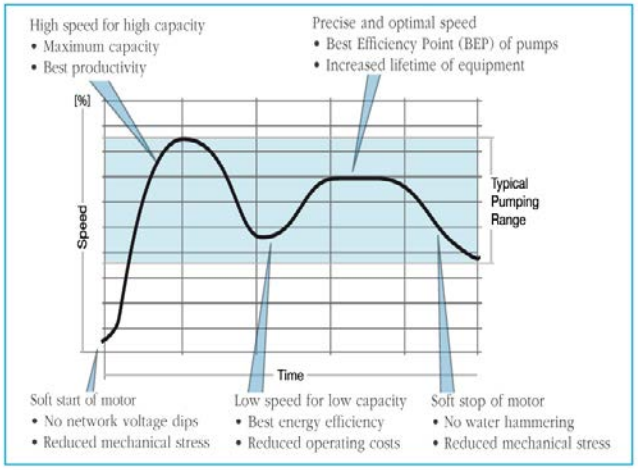
Raw water supply
- Feed-water pumps

Waste incineration
- Effluent pumps
- Fans
- Conveyors

Raw water intake
- Raw water intake pumps

Over 2 GW of pumping power are regulated by ABB medium voltage drives

Benefits of variable speed drives



- Energy savings
- Improvement of system efficiency
- Longer lifetime of equipment
- Reduced operating costs
- Fast and precise process control

Flow and pressure control

	Electrical	**Mechanical**
Variable speed	Variable speed drive	Hydraulic coupling
Fixed speed	On-off	Throttling valve or inlet guide vane

- Water consumption varies greatly during a day
  => flow and pressure of pumps need to be controlled
- 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

Fixed vs. variable speed control

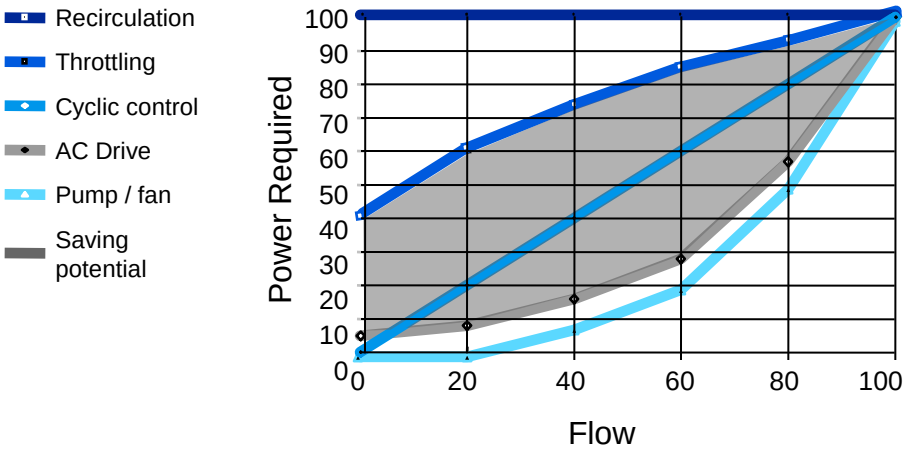
Fixed-speed control

- Fixed speed motor is controlled with a mechanical device, e.g. a valve
- This can be compared to adjusting the speed of a car by braking while keeping the foot on the gas
- Result: waste of energy and worn out equipment

Variable speed control

- Change in production volume is achieved by changing the motor speed with variable speed drives
- This can be compared to reducing the speed by taking the foot off the gas and switching to a lower gear
- Result: pumps will be operated at Best Efficiency Point (BEP), resulting in:
  - Energy savings
  - Decrease of CO_2 emissions
  - Minimized operating costs

Power requirement for various control methods



- Process equipment often runs at partial load, resulting in unnecessary high energy bills
- Many businesses find that a 20% cut in energy costs gives the same benefit to the bottom line as a 5% increase in sales

Control methods

Throttling

Bypassing

On/off control

Variable speed

Energy savings and reduced emissions

Pump affinity laws

1. Flow is proportional to speed
2. Pressure is proportional to the square of speed
3. Power is proportional to the cube of speed

- Pumps and fans typically run at partial loads
- Huge energy savings can be achieved by controlling their speed with variable speed drives
- A pump running at half speed consumes as little as one eighth of the energy compared to one running at full speed
- Energy consumption can be reduced by as much as 60% with variable speed drives
- Variable speed drives help to reduce CO_2 and NO_x emissions

Reduced maintenance cost

- Variable speed drives act as soft starters, reducing stress on network, motors and pumps
  - During starting process, variable speed drives progressively increase the motor speed and smoothly accelerate 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
  - Maintenance costs will be reduced and the lifetime of the equipment extended
- If water demand is reduced, variable speed drives slowly reduce the speed of the pumps, avoiding water hammering

Components of variable speed drives

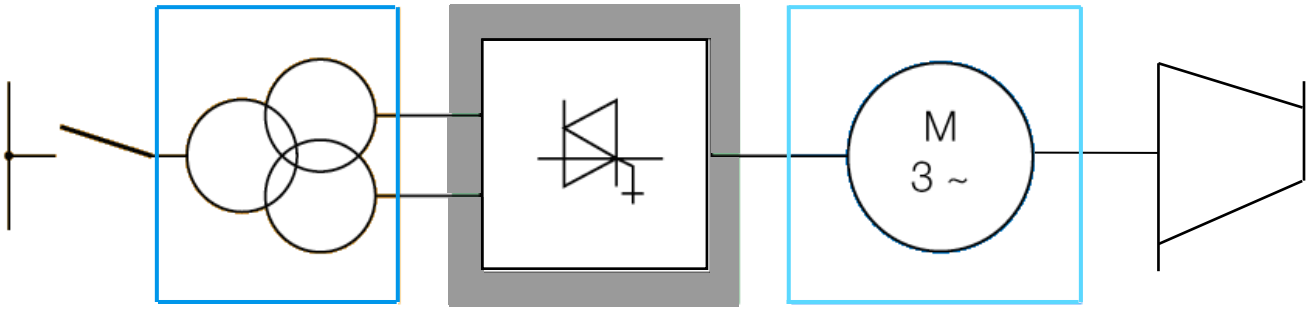


ABB can offer the complete variable speed drive system or assist in selecting components that match the process requirements.

A variable speed drive system consists of:

- Input transformer
- Frequency converter
- Electric motor

MV drives
General Purpose Drives

ACS 1000, ACS 1000i

- Cooling: air / water
- Power range: 315 kW – 5 MW
- Output voltage: 2.3 – 4.16 kV
- Air-cooled ACS 1000 available with integrated input transformer and input contactor (ACS 1000i)

ACS 2000

- Cooling: air
- Power range: 250 – 2,600 kW
- Output voltage: 4.0 – 6.9 kV
- Available for direct-to-line connection, for connection to a separate two-winding transformer or with an integrated transformer

MV drives
General Purpose Drives

ACS 5000 air cooled

- Cooling: air
- Power range: 2 – 7 MW
- Output voltage: 6.0 – 6.9 kV

  (optional 4.16 kV)
- Available with integrated input transformer

MV drives
Special Purpose Drives

ACS 5000 water cooled

- Cooling: water
- Power range: 5 – 32 MW
- Output voltage: 6.0 – 6.9 kV (optional 4.16 kV)

ACS 6000

- Cooling: water
- Power range: 3 – 27 MW
- Output voltage: 3.0 – 3.3 kV
- Available as single or multidrives

MV drives
Special Purpose Drives

MEGADRIVE-LCI

- Cooling: air / water
- Power range: 2 – 72 MW (higher on request)
- Output voltage: 2.1 – 10 kV

Technology highlights

- Direct Torque Control (DTC)
  - For highest torque and speed performance
- Power loss ride through
  - The drive system is able to withstand power supply disturbances
- Fuseless design
  - ABB medium voltage drives operate without fuses, resulting in less spare parts and fast re-starts
- Encoderless
  - ABB medium voltage drives can operate without encoders which are known to cause failures
- DriveMonitor™ (option)
  - Remote and real-time monitoring and diagnostics of ABB drives from any location in the world

DriveMonitor™
Intelligent monitoring and control

DriveMonitor™ is an intelligent diagnostic system consisting of

- Hardware module (installed in- or outside of drive)
- Software layer (collecting and analyzing selected drive signals and parameters)

Functions

- Monitoring of drive's performance, and, if required, other shaft line components (main circuit breaker, transformer, motor)
- Fast fault finding process

How much energy do you save?

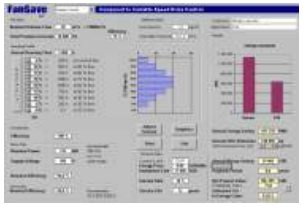
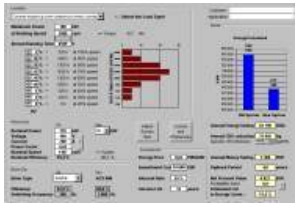
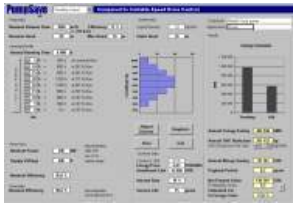
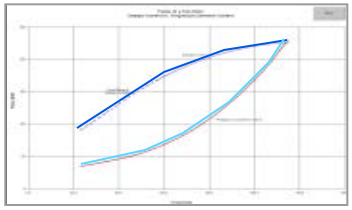





ABB has developed the following tools to assist in the calculation of energy savings:

- FanSave – for comparison of energy consumption between different fan control methods
- PumpSave – for comparison of energy consumption between different pump control methods

High voltage motors

- Induction motors
  - Available up to 18 MW
  - Induction motors are usually the first choice for applications up to 10 MW
- Synchronous motors
  - Typically considered for higher power ratings (e.g. above 8 MW to more than 100 MW)

Input transformers

- Input transformers have two functions:
  - To adjust the network supply voltage to match the converter
  - To protect the motor from common-mode voltages
- ABB transformers are available for all ratings and primary voltages, oil or dry type

Testing

ABB is committed to ensuring the reliability of every drive we deliver.

- Every component of a drive is subjected to thorough testing in ABB's modern test facilities
- Routine tests, functional tests
  - Integral part of the scope of supply
  - Performed in accordance with international standards and ABB quality assurance procedures
- Combined tests
  - Tests with the complete drive system including transformer, converter and motor – can be performed

Worldwide service and support

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

Water distribution
MWA, Thailand

- The Metropolitan Waterworks Authority (MWA) owns and operates one of the world's biggest water treatment plants and more than 30 pumping stations.
- Electricity costs amounted to almost 50% of MWA's production costs.
- ABB's medium voltage drives help MWA to achieve energy savings of more than USD 10,000/month for one pumping station.

Sewage
Changi, Singapore

- Singapore‘s water reclamation project is designed to meet Singapore‘s waste water treatment needs throughout the 21st century.
- 18 ABB medium voltage drives, with a total pumping power of 50 MW pump 3,200,000 m^3 of waste water / day through a 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 cubic meters of cooling water an hour to the power plant, LNG trains and petrochemical facilities.

Water lifting
Rijkswaterstaat, The Netherlands

- ABB supplied medium voltage drives for the IJmuiden pumping station, pumping water from the Netherlands inner channel to the sea.
- As the Netherlands is at some places as much as six meters below sea level, the pumping station helps to keep the Netherlands dry.

Water plant
Binhai water plant in Tianjin, China

A 30 percent reduction in energy consumption is achieved with the installation of a 315 kW medium voltage drive to replace mechanical throttle control on a pump at Binhai water plant in Tianjin, China.

In addition water losses are reduced by some 10 percent.

Water pollution control facility
City of Beloit in Wisconsin, USA

The City of Beloit in Wisconsin sought improved efficiency and process control for an aeration blower application that would save energy and improve total lifecycle costs.

Benefits:

The total plant power decreased by over a million kilowatthours once the ACS 2000 was installed. At an average composite electric rate of $0.062/kWh the annual savings of $75,000 per year were significantly better than the original projection of $48,000 per year.

ABB drives for water

Clean water applications	Pumps for 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

Power and productivity
for a better world™