MEDIUM VOLTAGE DRIVES, 2020

ACS2000 industrial drive

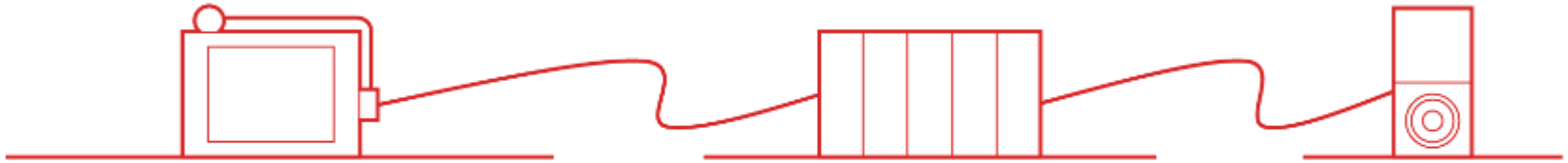
The flexibility you require. The reliability you expect.

9AKK107045A7281, REV. B

Get more using less

Our medium voltage drives run your motors based on the demands of your process rather than running them at full speed and ensure **optimized power consumption** and **process efficiency**.

This will add up to cost and time savings for you.

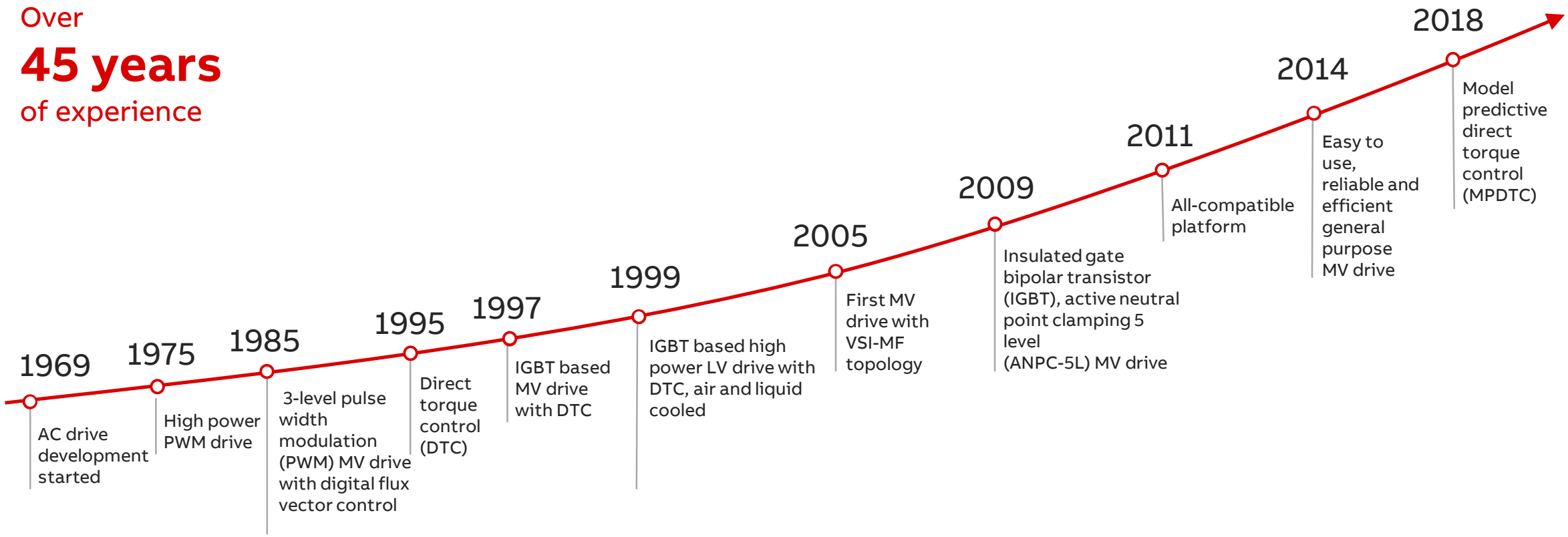


Transformer Converter Motor

The forerunner of technology

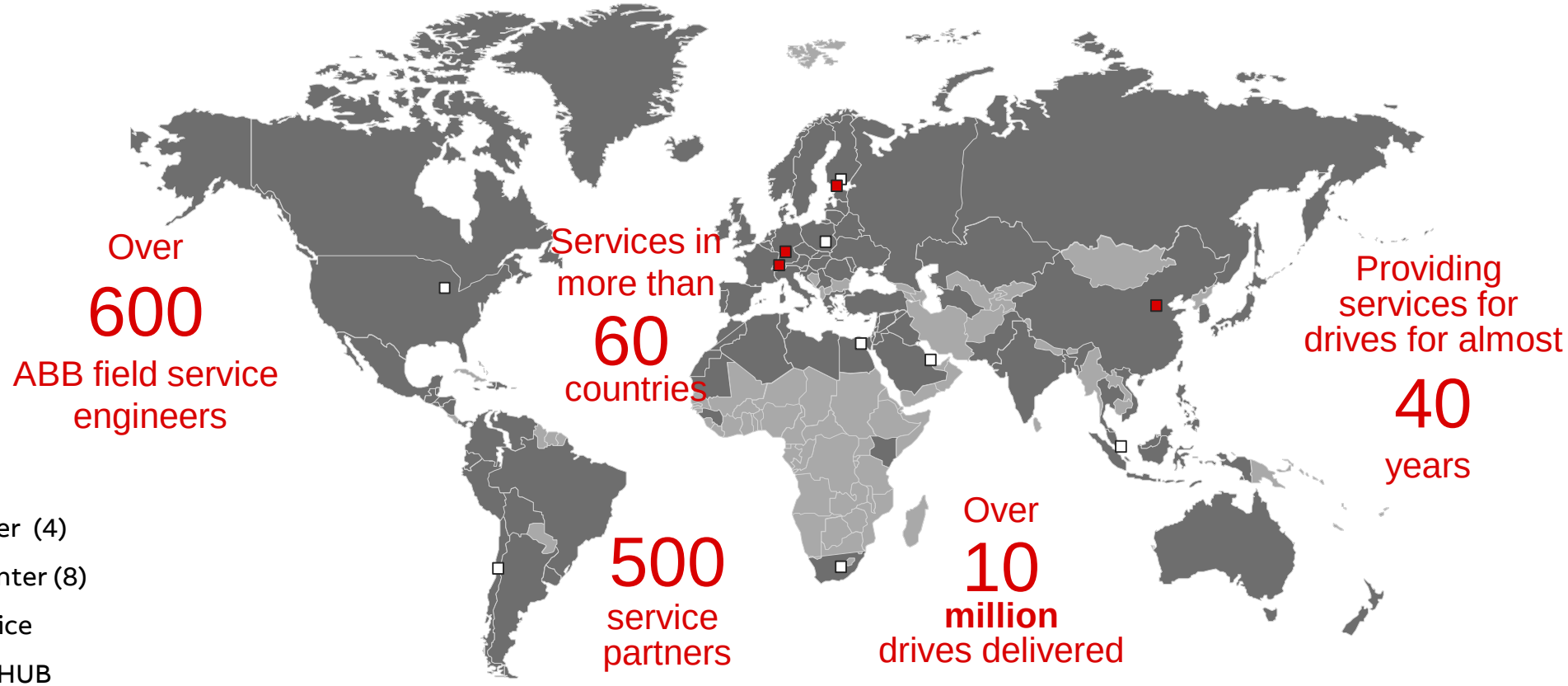
Cornerstones of innovation

Over
45 years
of experience



You choose, we respond. Globally.

The service network is well structured to ensure you have all the **experts close at hand**. We have local drives and control service units complemented by external ABB value providers in over 60 countries.



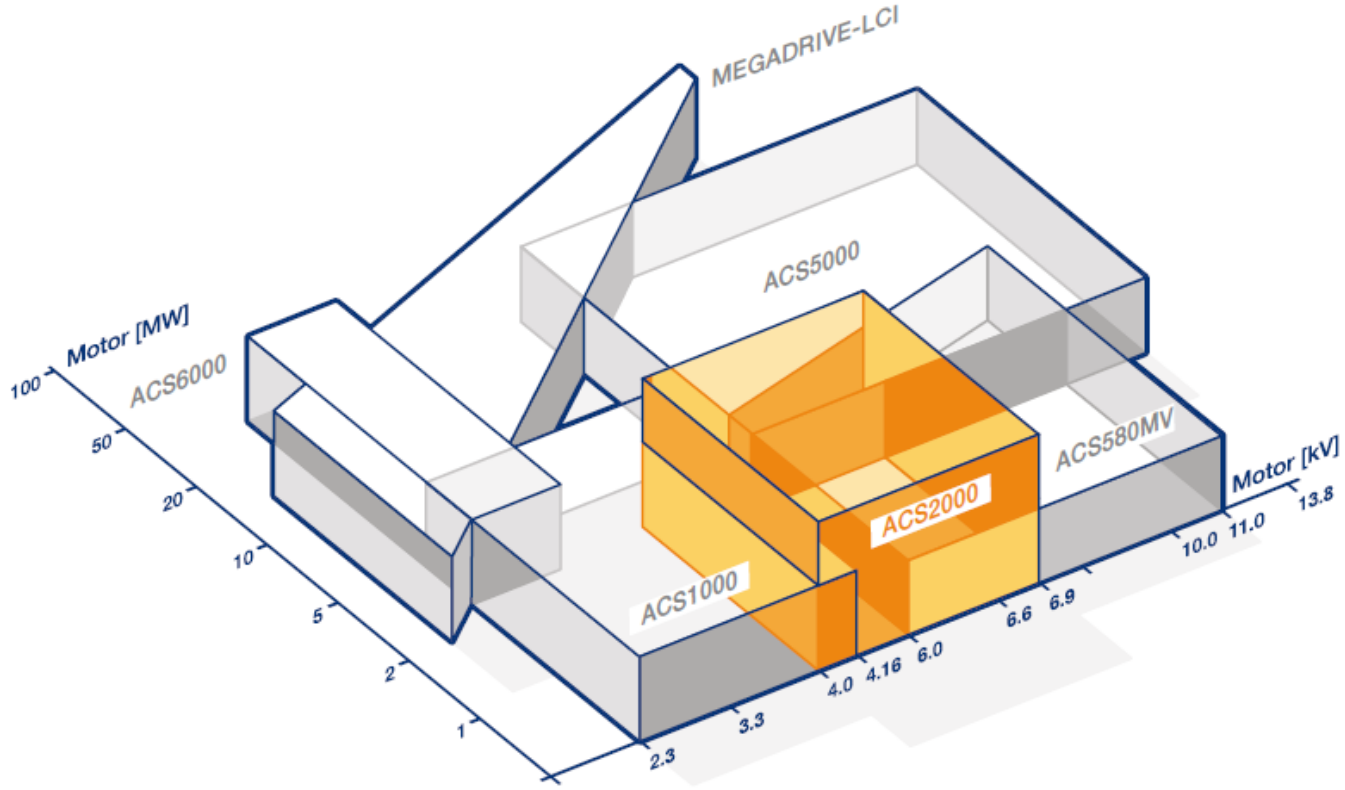
The ACS2000 Industrial drive

Power range: 250 kW – 3.68 MW (335 – 5000 HP)

Output voltage: 4.0 – 6.9 kV

Input voltage: 4.0 – 6.9 kV*

Air cooled



* Higher than 11 kV on request

Reliable across all applications

The ACS2000 masters simple and demanding applications and fulfills the needs for your specific performance.


Power generation


Food and beverage


Water and waste water


Wind


Cement


Mining and minerals


Metals


Marine


Chemicals


Oil upstream


Pulp & Paper

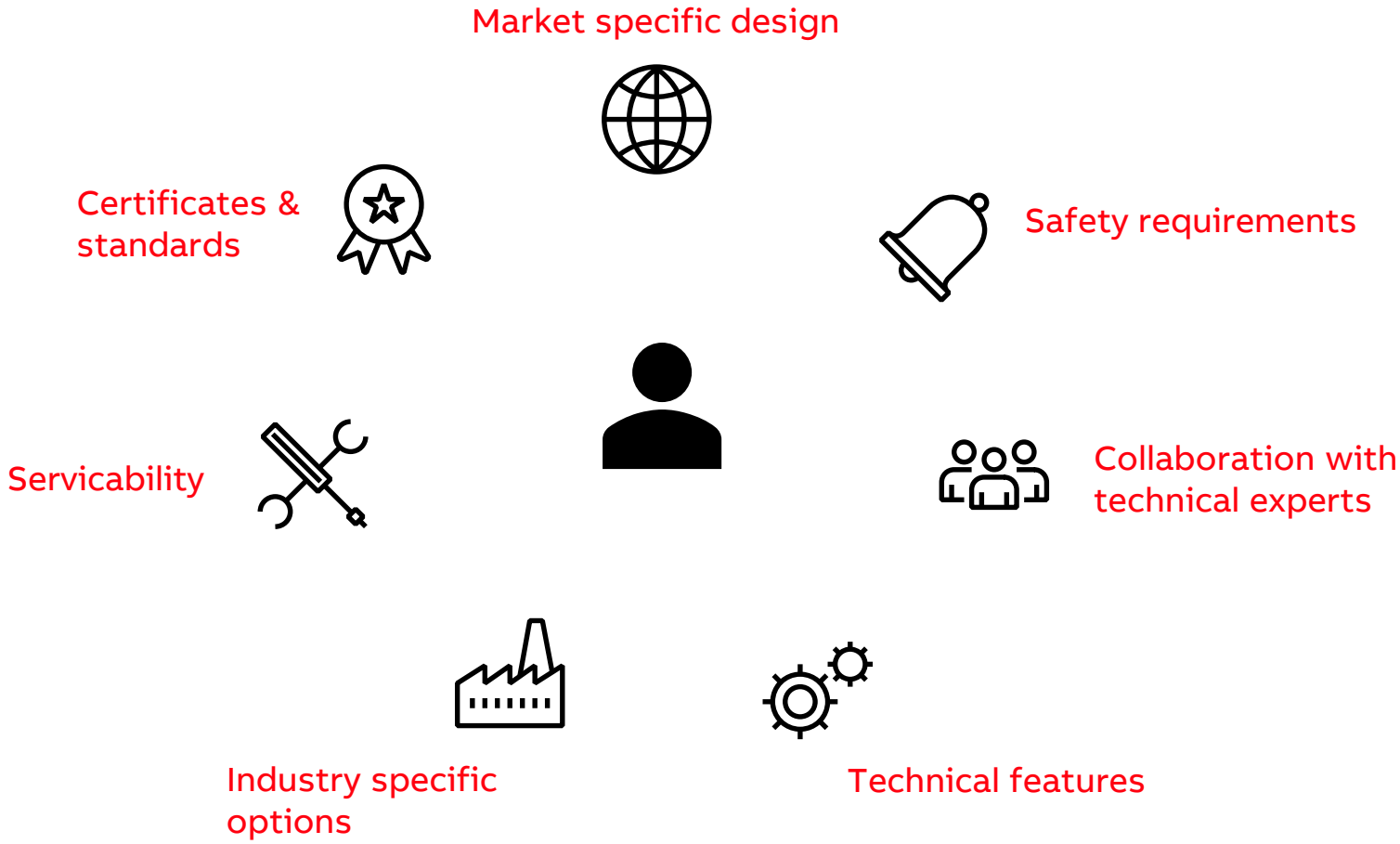

HVAC

The ACS2000 industrial drive

The flexibility you require.

Configurable drive to meet your specific needs

Different configurations of the ACS2000 adapt the drive to **meet the requirements of your application** and **fit into your industrial environment.**

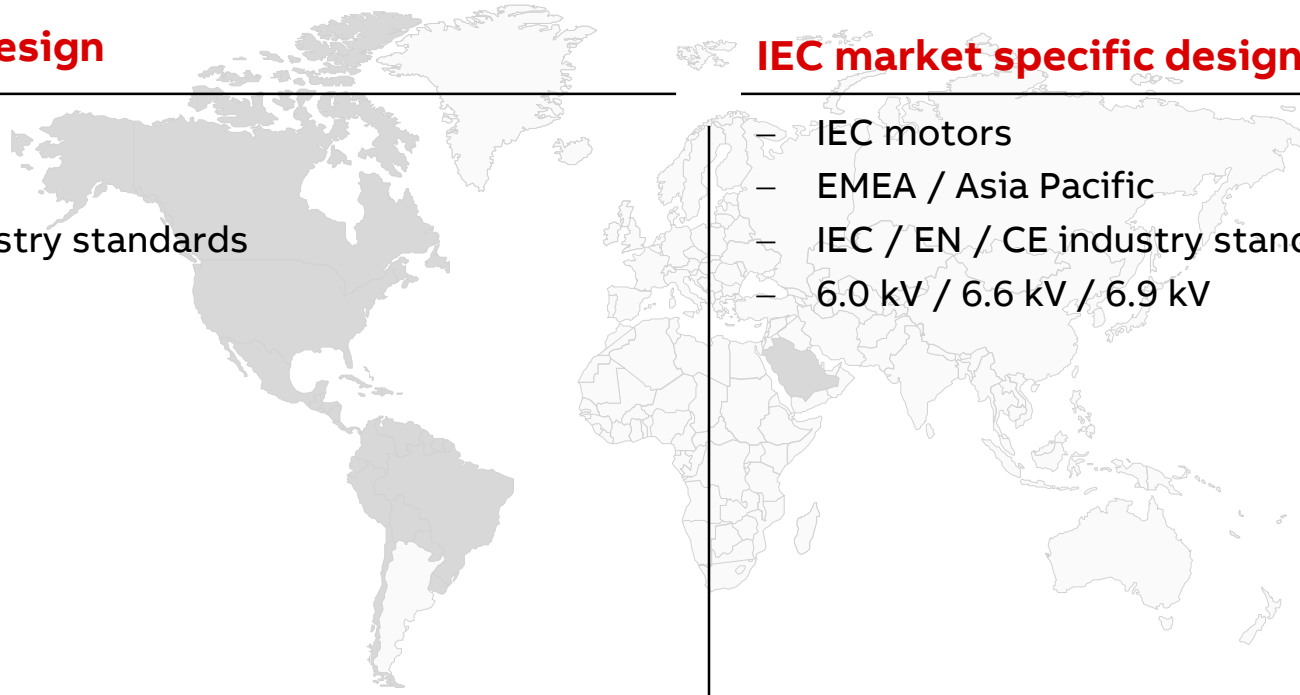


Use the ACS2000 in every global operation

Market specific product variants make the drive compatible with common **IEC and NEMA motor voltages**.

NEMA market specific design

- NEMA motors
- Americas
- ANSI / IEEE / NEMA industry standards
- 4.16 kV
- UL / CSA certification



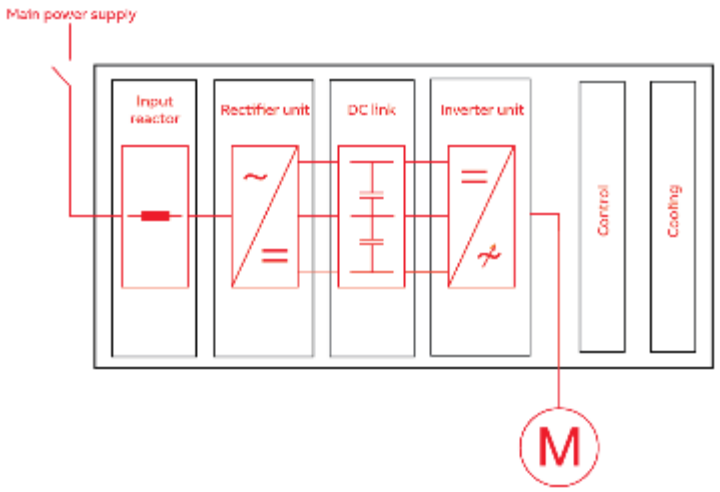
IEC market specific design

- IEC motors
- EMEA / Asia Pacific
- IEC / EN / CE industry standards
- 6.0 kV / 6.6 kV / 6.9 kV

Design flexibility for smooth integration into your supply network

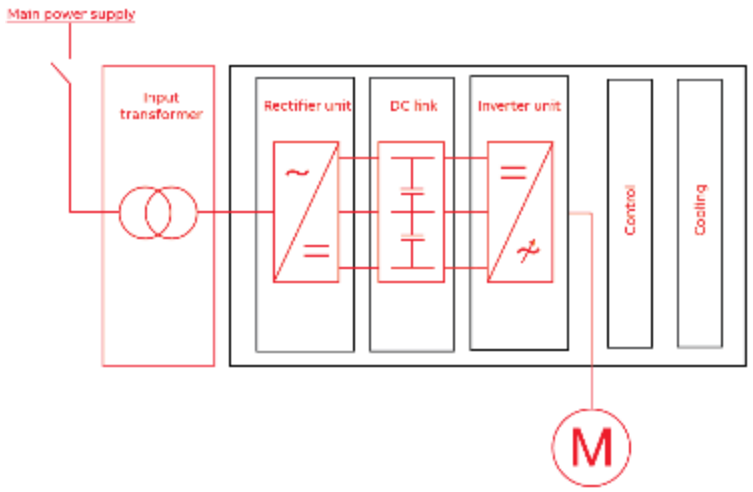
Easy grid connection using an integrated or external transformer, or a direct-to-line connection.

Direct-to-line



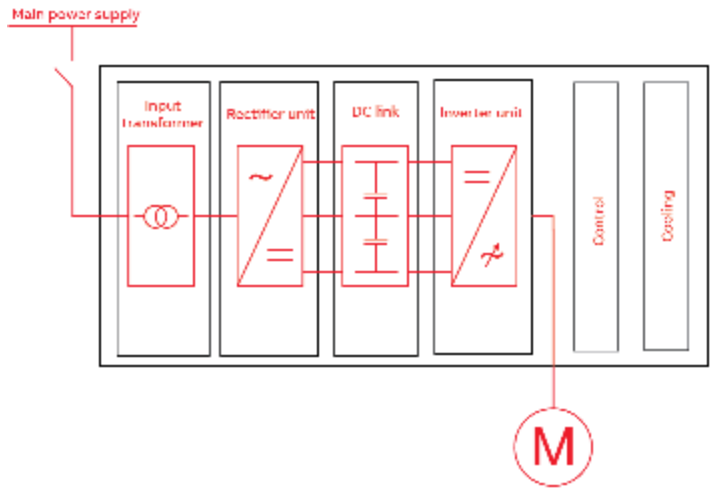
Small footprint, light weight
Easy to retrofit to DOL motors
Simple installation

External transformer



Lower heat loss in e-room
Galvanic isolation
Voltage matching

Integrated transformer



Simple installation
Galvanic isolation
Voltage matching

Design flexibility for smooth integration into your supply network

The drive is available with two line side connection configurations **DFE and AFE**.

Diode front end (DFE) – 24 pulse

Simple

Reliable diode 24- pulse rectifier solution enables compliance with all common harmonic standards

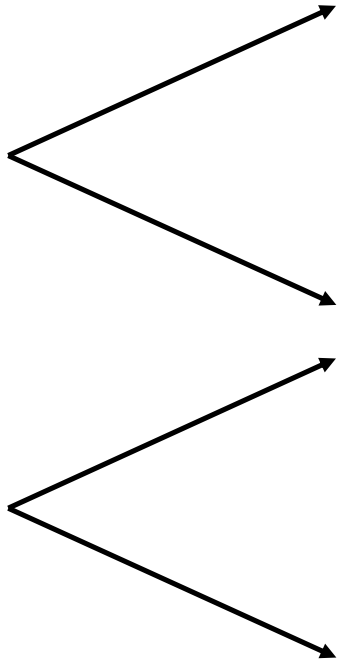
DFE enables drive configurations for industry specific solutions e.g. motors in hazardous areas or long motor cables

Active front end (AFE)

Regenerative

Innovative AFE solution, which is compliant with all common harmonic standards

The AFE feature enables **regeneration**, which allows energy efficient continous braking leading to siginificant **energy savings**.



Integrated transformer

Small footprint, light weight
Easy to retrofit to DOL motors
Simple installation

External transformer

Lower heat loss in e-room
Galvanic isolation
Voltage matching

Direct-to-line (DTL)

Simple installation
Galvanic isolation
Voltage matching

Benefit from the compact footprint

Due to ACS2000's **compact size and light weight**, you will save on transportation costs and need less space in the electrical room.

IEC 6 kV DTL

- Length: 2'205 mm (Frame 1)
  3'800 mm (Frame 2)
- Height: 2'490 mm (incl. cooling fan)
- Depth: 1'140 mm

IEC 6 kV AFE external transformer

- Length: 1'705 mm (Frame 1)
  3'000 mm (Frame 2)
- Height: 2'490 mm (incl. cooling fan)
- Depth: 1'140 mm

IEC 6 kV DFE external transformer

- Length: 1'730 mm (Frame 1)
  2'180 mm (Frame 2)
  2'530 mm (Frame 3)
  2'530 mm (Frame 4)
- Height: 2'490 mm (incl. cooling fan)
- Depth: 1'140 mm

IEC 6 kV DFE integrated transformer

- Length: 3'330 mm (Frame 1)
  4'380 mm (Frame 2)
  4'930 mm (Frame 3)
  5'130 mm (Frame 4)
- Height: 2'490 mm (incl. cooling fan)
- Depth: 1'140 mm

Operation in hazardous areas

For every motor type the ACS2000 enables drive operation.

Zone 1

Zone 2

Ex ec (former nA)
Non sparking motors

Asynchronous motors up to 23MW
HXR 355 – 560 (cast iron)
AMI 400 – 1000 (modular)
Synchronous motors up to 55MW
AMS 710 - 1250
AMZ 710 - 2500

Asynchronous motors:
- ACS1000
- ACS2000 DFE (EMC or sine filter) / AFE*
- ACS5000

Synchronous motors:
- ACS5000
- LCI Megadrive

Ex eb (former e)
Increased safety motors

Asynchronous motors up to 7MW
HXR 355 – 560 (cast iron)
AMI 400 – 630 (modular)

All Ex eb machines with frequency converter **must be certified by authorized certification body**. In case of Ex eb machine the process must be carried out separately **for each completely identical machine** series with identical frequency converter.

Possible to offer ACS1000 / ACS2000 DFE+sine filter

+$$$$

Ex db (former d)
Flameproof motors

Asynchronous motors up to 7MW
AMD…R 355 – 500
AMD…T 500 – 900

Gas group IIA, IIB:
- ACS1000
- ACS2000 DFE (EMC or sine filter) / AFE*

Gas group IIC:
- ACS1000
- ACS2000 DFE / sine filter

Ex p
Pressurized motors

Same products and frames available as for Ex ec

Asynchronous motors:
- ACS1000
- ACS2000 DFE (EMC or sine filter) / AFE*
- ACS5000
- ACS6000

Synchronous motors:
- ACS5000
- ACS6000
- LCI Megadrive

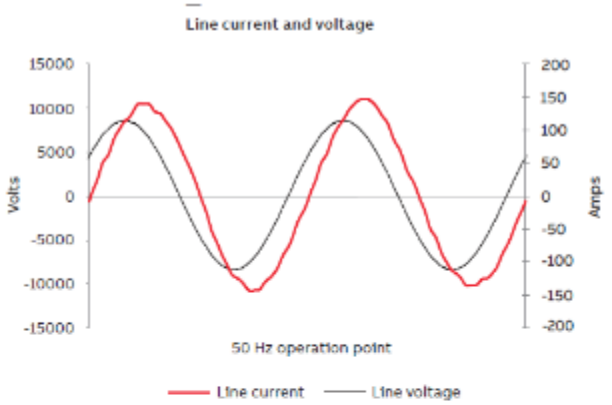
$

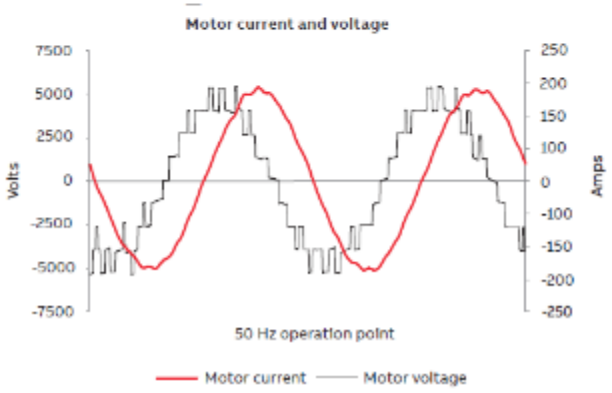
$$$

General: for all cases only grounded EMC or sine filter – floating filters are not permitted in hazardous area
* ACS2000 AFE: dedicated special input transformer required in accordance with ACS2000 transformer specification.
Consider this solution only for 4Q applications - $$$

Choose an output sine filter to gain perfect output power

Side effects of an inverter such as voltage reflections and common mode voltages will be totally eliminated, resulting in an **excellent waveform** voltage and current waveform supplied to the motor.





Use a sine filter for:

- **Retrofitting** of old motors with an aged insulation system
- Very **long** motor cables
- Special application such as electric submersible pumps (ESP) and conveyors in underground mines

Best fit for your application

For standard applications in all industries, the ACS2000 is a perfect fit. With a range of pre-engineered options we can easily customize the drive as desired.

Selection of pre-engineered options

- Operation at elevated ambient temperature
- Customized spare parts package
- Insulator and earthing switch up to 13.8 kV
- Customer IOs wired to terminal blocks
- Reduced noise level
- Permanent magnet motor control
- Operation at high altitude
- Marine – design and spot approval
- Operation for 3.3 – 5.5 kV motors
- Integrated transformer up to 22 kV input voltage
- EU preferential origin
- Supply voltage tolerance up to +20%
- Variety of fieldbus communication methods between customer and drive

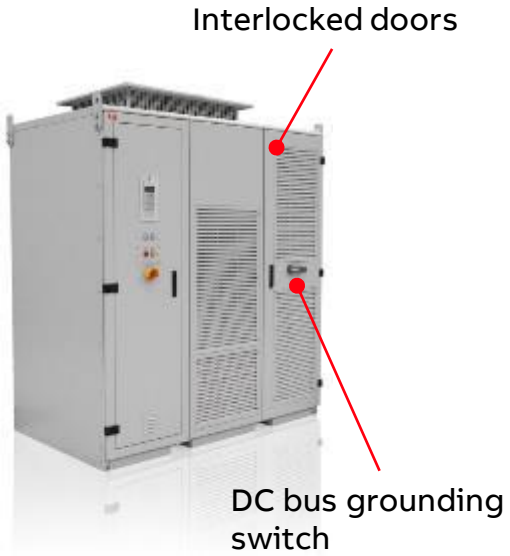
The ACS2000 industrial drive

The reliability you expect.

High personnel safety

Workforce and property are protected from dangerous electric arcs with the ACS2000's **arc resistant design**. **Certified functional safety** features and an integrated **DC grounding switch** make your system safe and reliable.

ABB standard



Arc fault resistant

Arc fault resistant design and certification in accordance with IEC62271-200

Functional safety

SIL3 / Ple certified stop functions in accordance with IEC60204-1

- Emergency off
- Emergency stop

SIL3 / Ple certified safety functions in accordance with IEC61800-5-2

- Safe torque off

High personnel safety

ABB offers IAC certified **arc resistant design with arc elimination** as an option.

Arc fault

- Arc faults are caused by a breakdown of the insulation
- Short circuit currents flow through ionized air, called an arc

➢ As a primary effect, high energy is released, causing a pressure, sound and heat wave

➢ Harmful gases and particles represent a secondary danger

Arc fault safety: ABB's approach – the 4 safety classes

Class I: Protection based on arc prevention
Equipment damage in case of an arc: severe

Class II: Protection based on arc resistant cabinet structure
Equipment damage in case of an arc: severe

Class III: Protection based on external arc fault limitation and elimination
Equipment damage in case of an arc: moderate

Class IV: Fast arc elimination
Equipment damage in case of an arc: neglegible

High personnel safety

ABB offers IAC certified **arc resistant design with arc elimination** as an option.

Class I

- Design of insulation systems in accordance with relevant IEC and NEMA standards to prevent arcs and provide personnel safety
- **Standard** for MV drives
- Class I is not a certified arc resistant design, it is mainly focusing of arc fault prevention

Based on design according to:

IEC 60146-1-1

IEC 61800-4

Class II

- The **cabinet is designed** to withstand the pressure of an arc flash
- Arc fault is contained in the cabinet or guided through pressure relief vents

Class III

- **HV Fuses** are applied externally to the drive in order to limit the arc fault current to less than half cycle of the fundamental AC frequency (< 10ms in case of 50Hz supply)
- This method is only used to reach arc resistant designs for MV drives connected without external drive transformer to the mains (integrated transformer solutions and DTL solutions)
- ABB applies this solution in combination with Class I and II

Class IV

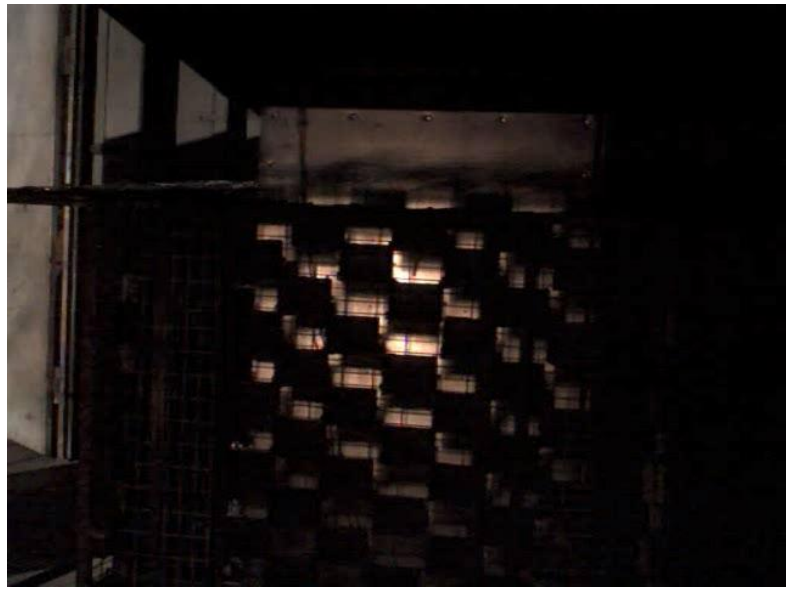
- This is a ABB patented method, ABB MV drives **"protection firing"** system. The arc fault is detected and converted into a non severe bolted short circuit
- For an even faster detection and elimination (4-8 ms), an optical ABB **arc fault detection system** is available
- Provides highest level of personnel safety and the equipment remains undamaged and can be immediately restarted after inspection and elimination of the arc ignition cause

Arc resistant design IAC Certified according to IEC62271-200

High personnel safety – Comparison between a Class II and a Class IV MV drive

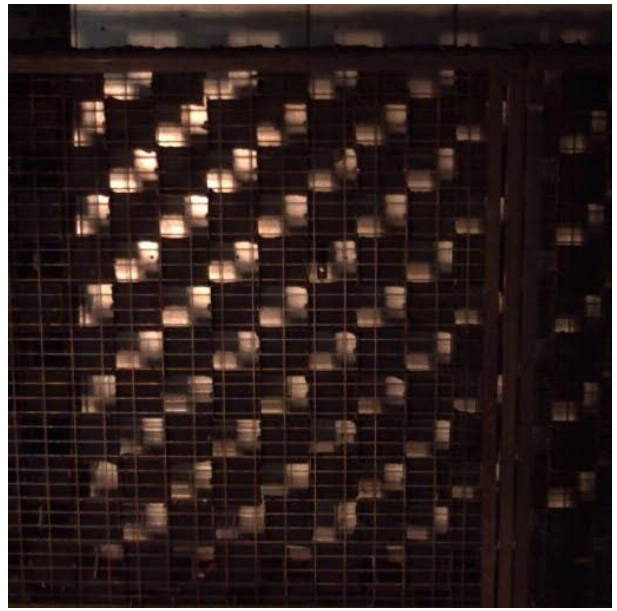
ABB offers IAC certified **arc resistant design with arc elimination** as an option.

Class II product



Classification 23kA, 0.5s IP54

Class IV product



Classification 28kA, 0.5 IP42

No damages after an arc with Class IV

High personnel safety

Functional safety options

	Modulation immediately stopped while MCB is being opened.
Emergency Off (EOFF)	The EOFF command is initiated by internal or external means (internal control, safety pushbutton, or user-controlled relays). When the EOFF command is detected by the safety logic, the MCB opens and the motor is coasted to a stop.
Emergency Stop (ESTOP)	A controlled stop with power available to the machine actuators to achieve the stop and then removal of power when the stop is achieved. The ESTOP is simply a redundant time delay to trigger the EOFF function. This time delay (30s maximum) allows the software to ramp the motor down with its software functionality which cannot be certified. At the end of this time duration, the timer will initiate the EOFF function independently of the software .
Safe torque off (STO)	The STO command energizes the same circuitry as the EOFF function. The MCB opens so that there is no energy flowing into the drive and the motor is left to coast down to a stop. Advantages: Reuse of existing system component Lowest system costs

Increase productivity due to precise process control

The ACS2000 drive control platform uses ABB's **direct torque control (DTC)** for **increased process efficiency.**

Benefits

- Uniform product quality of your process
- Precise control of motor condition
- Accurate torque and speed control, also at low speed, as well as full starting torque
- No pre-defined switching frequency, for each control cycle the optimum switching parameter is used
- Reduces energy consumption
- Limitation of produced harmonics

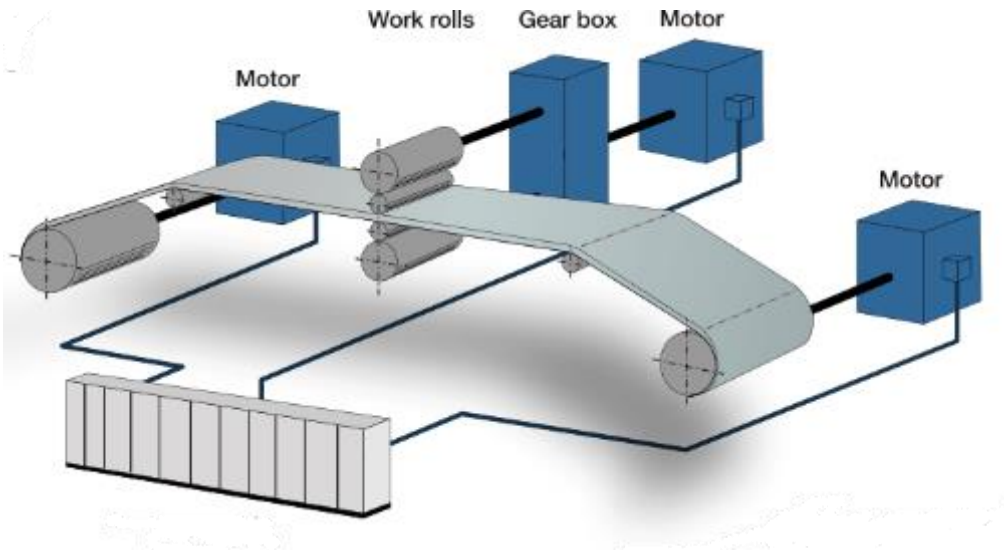
Reliable performance of constant torque loads

In addition to square torque loads, the ACS2000 permits operation of **constant torque loads** enabling accurate performance of **conveyors, compressors, mixers, mills, extruders, hoists, crushers and positive displacement pumps**.

Benefits

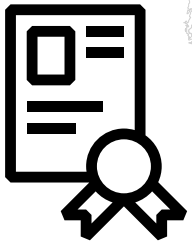
- Applications where the torque loading is not a function of speed
- Setting default points for minimum and maximum speed in between which constant torque is requested
- Due to high dynamic response to torque changes, uniform product qualiy
- Thickness, flatness and tension control

Example reversing cold mill



Made in EU

We are producing the ACS2000 IEC in our factory in Poland, giving **origin** guarantee.



The ACS2000 industrial drive

The configuration you need.

ACS2000 – Hardware overview

Frames, voltages and power

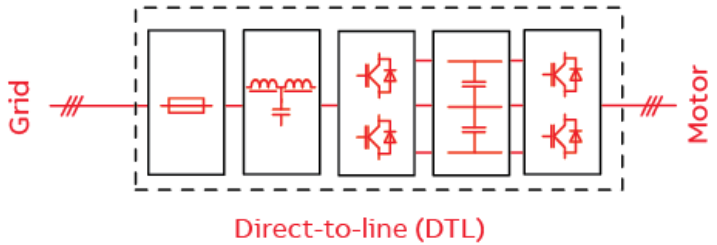
	IEC 6.0 kV		IEC 6.6 kV		IEC 6.9 kV		NEMA 4.16 kV
Configuration	**DTL / AFE**	**DFEe / DFEi**	**DTL / AFE**	**DFEe / DFEi**	**DTL / AFE**	**DFEe / DFEi**	**DTL**
Frame 1	250 – 800 kW	250 – 800 kW	275 – 880 kW	275 – 880 kW	290 – 920 kW	290 – 920 kW	300 – 1000 HP
Frame 2	900 – 1600 kW	900 – 1600 kW	990 – 1760 kW	990 – 1760 kW	1035 - 1840 kW	1035 – 1840 kW	1250 – 2000 HP
Frame 3		1800 – 2400 kW		1980 – 2640 kW		2070 – 2760 kW	2250 – 3000 HP
Frame 4		2500 – 3200 kW		2750 – 3520 kW		2875 – 3680 kW	

DTL: direct-to-line
AFE: active front end with external transformer
DFEe: diode front end with external transformer
DFEi: diode front end with integrated transformer

ACS2000 – NEMA 4 kV DTL

Small footprint, light weight

- 4.0 – 4.16 kV system voltage
- Integrated fans
- UL/cUL certified
- Cabinet dimensions
  - Length: 1’940 mm (Frame 1)
2’915 mm (Frame 2)
3’485 mm (Frame 3)
  - Height: 2’106 mm (converter only)
2’500 mm (incl. cooling fan)
  - Depth: 1’140 mm
  - Weight: 2’100 – 4’100 kg

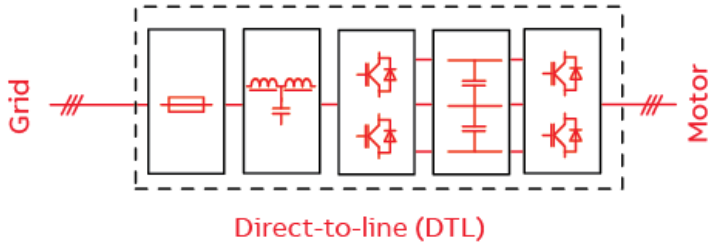


Direct-to-line (DTL)

ACS2000 – IEC 6 kV DTL

Small footprint, light weight

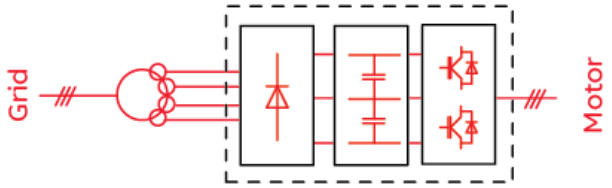
- 6.0 – 6.9 kV system voltage
- Integrated fans
- Cabinet dimensions
  - Length: 2’205 mm (Frame 1)
3’800 mm (Frame 2)
  - Height: 2’100 mm (converter only)
2’490 mm (incl. cooling fan)
  - Depth: 1’140 mm
  - Weight: 2’500 – 4’260 kg



ACS2000 – IEC 6 kV DFEe

Lowest cooling demand, perfect voltage matching

- 6.0 – 6.9 kV system voltage
- Integrated fans
- Cabinet dimensions
  - Length: 1’730 mm (Frame 1)
2’180 mm (Frame 2)
2’530 mm (Frame 3)
2’530 mm (Frame 4)
  - Height: 2’100 mm (converter only)
2’490 mm (incl. cooling fan)
  - Depth: 1’140 mm
  - Weight: 1’500 – 2’100 kg

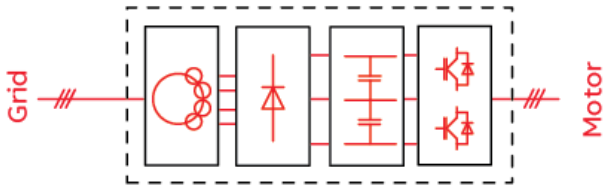


Diode front end, external transformer (DFE)

ACS2000 – IEC 6 kV DFEi

Simple installation, perfect voltage matching

- 6.0 – 6.9 kV system voltage
- Integrated fans
- Cabinet dimensions
  - Length: 3’330 mm (Frame 1)
4’380 mm (Frame 2)
4’930 mm (Frame 3)
5’130 mm (Frame 4)
  - Height: 2’100 mm (converter only)
2’490 mm (incl. cooling fan)
  - Depth: 1’140 mm
  - Weight: 3’120 – 8’200 kg

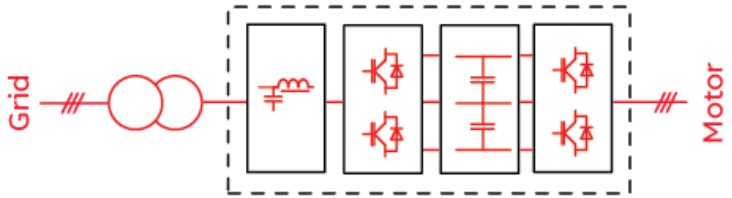


Diode front end, integrated transformer (DFEi)

ACS2000 – IEC 6 kV AFE

Regenerative, low harmonic

- 6.0 – 6.9 kV system voltage
- Integrated fans
- Cabinet dimensions
  - Length: 1’705 mm (Frame 1)
    3’000 mm (Frame 2)
  - Height: 2’100 mm (converter only)
    2’490 mm (incl. cooling fan)
  - Depth: 1’140 mm
  - Weight: 1’550 – 2’550 kg



Active front end, external transformer (AFE)

Service and support

Services to match your needs.

Every ACS2000 is equiped with ABB Ability™ to enable remote condition monitoring.

Your service needs depend on your operation, life cycle of your equipment and business priorities.

We have identified our customers’ four most common needs and defined service options to satisfy them.

Services to match your needs

Keep your drives running with precisely planned and executed maintenance.

Operational efficiency

If your drives require immediate action, our global network is at your service.

Rapid response

Maximize your drive's lifetime with our services.

Life cycle management

Get optimal performance out of your machinery and systems.

Performance improvement

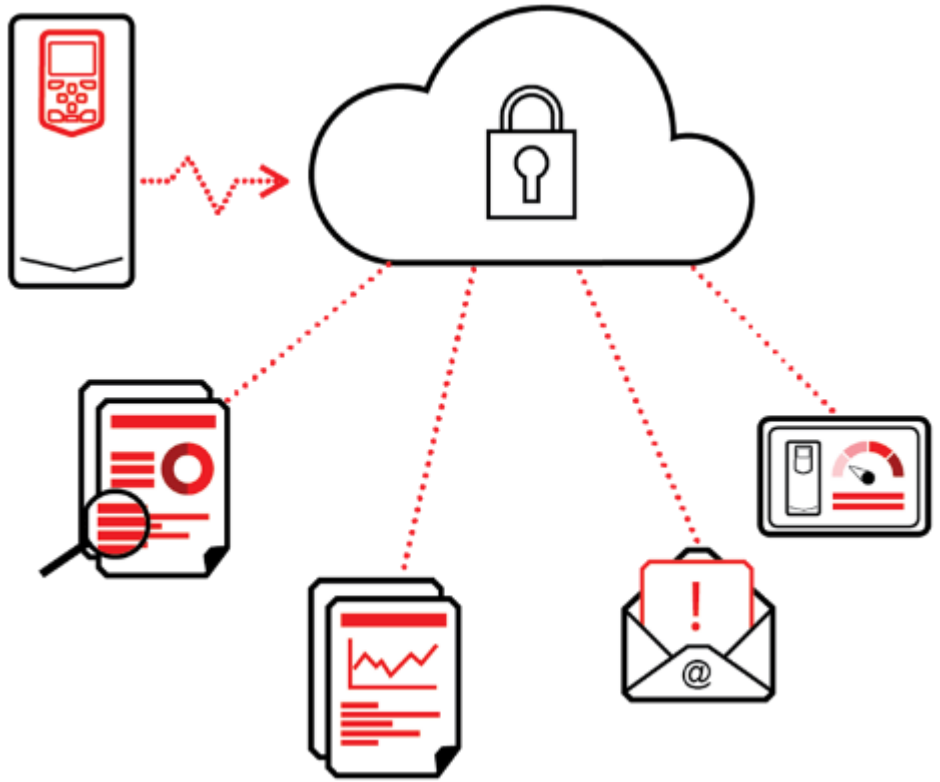
ABB Ability™ Condition Monitoring service

Always one step ahead

Reveal your drive's true potential

ABB Ability™ Condition Monitoring for drives is a service that delivers you accurate, real-time information about drive events to ensure your equipment is available, reliable and maintainable. The data can be stored in the cloud or in your local storage.

When you have all the facts, you can make the right decisions.



Providing the right blend of technology, expertise and information

According to your needs

Make the best decisions

You know your process, we know the drives.

Our monitoring system provides you with data and information from the drives for your best decisions.

Reduce the risks

You have the information when needed most.

Our monitoring system is continuously collecting data for you to set warning limits and to trouble-shoot potential problems

Available on your need

You can combine Remote Assistance Service Product with Condition Monitoring Service.

Our experts will always be on hand to consult with you.

Customize your own remote service plan for drives

1 Select your drives

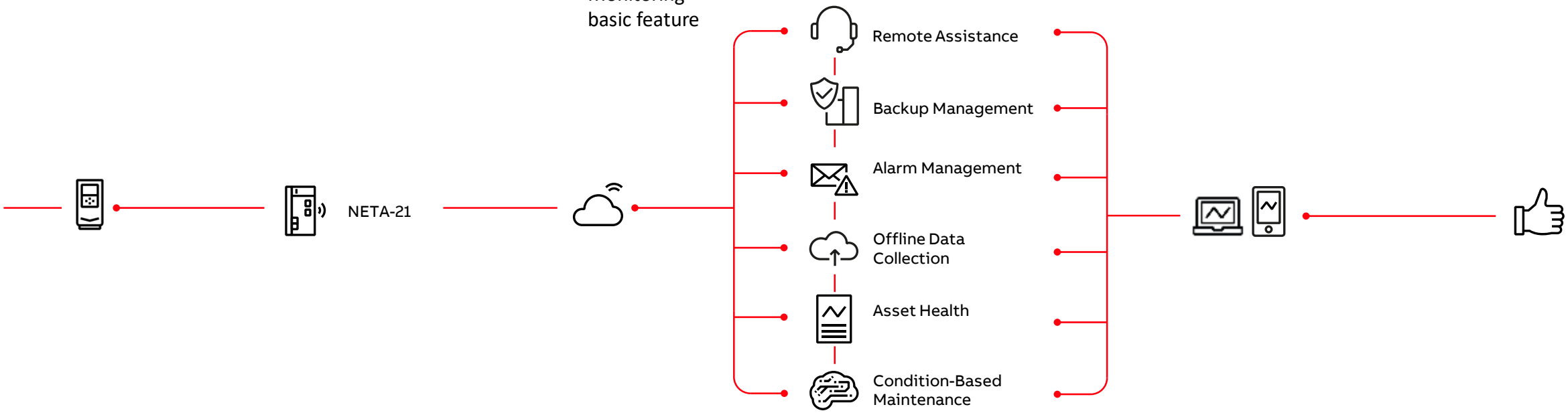
2 Install the connectivity device

3 Activate your access to the Condition Monitoring basic feature

4 Pick your optional features and customize

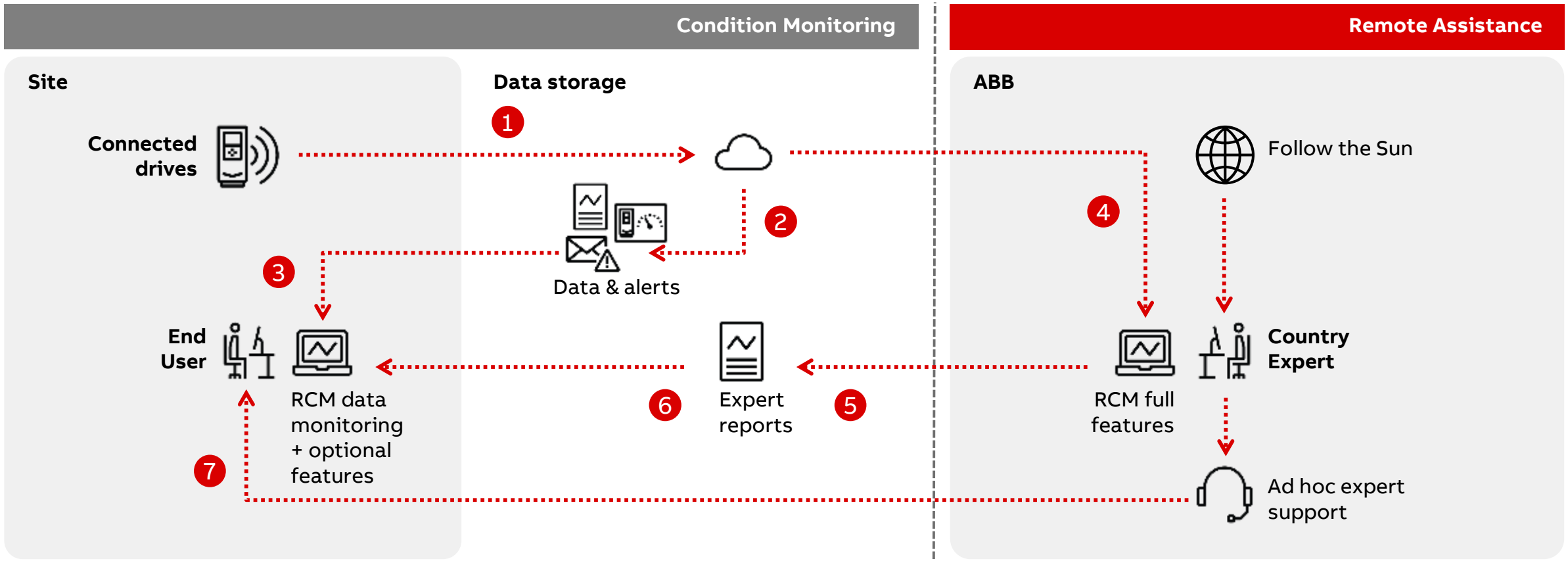
5 Start monitoring

6 Enjoy the customized service



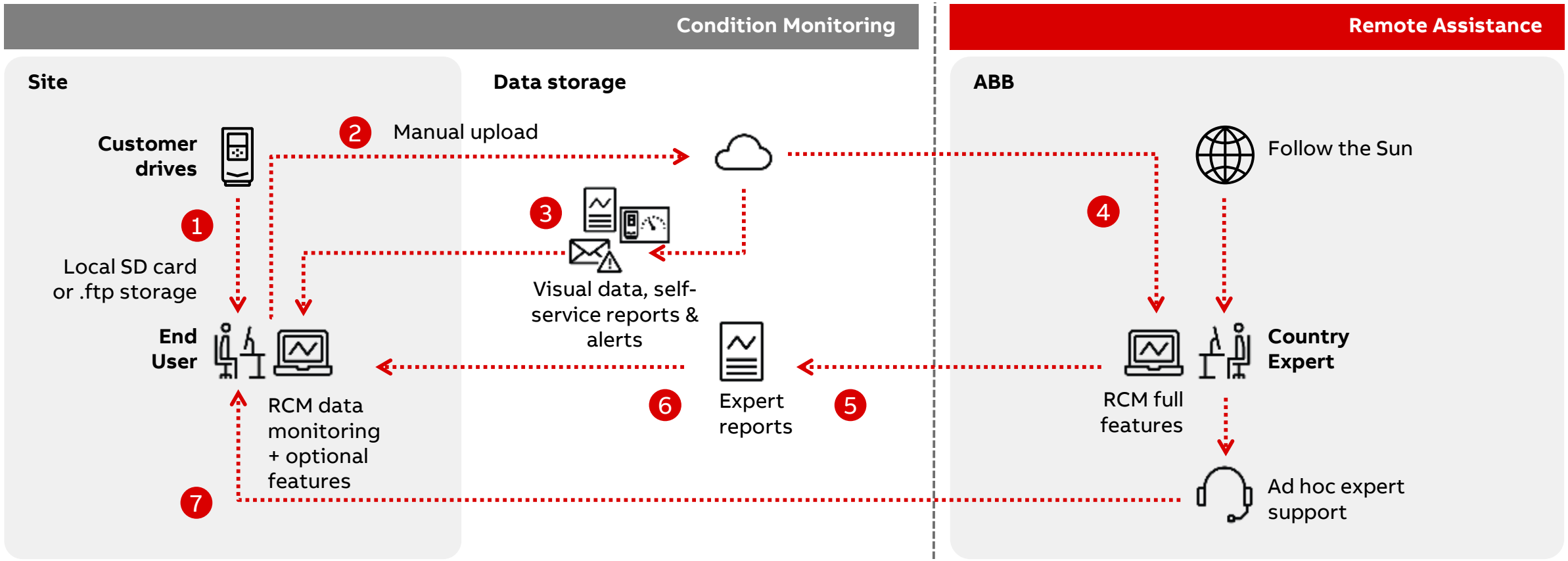
Delivery concept: Remote Services for drives

Remote Condition Monitoring: End User Solution, permanent connection



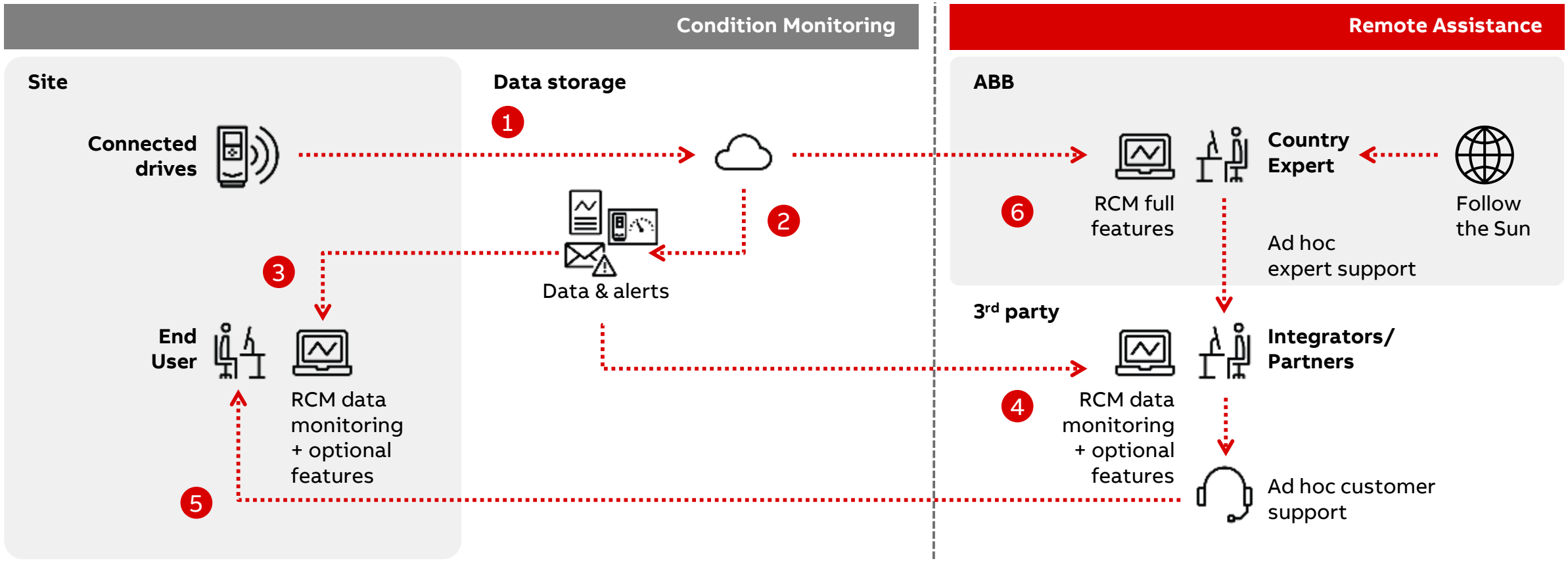
Delivery concept: Remote Services for drives

Remote Condition Monitoring: End User Solution, bulk upload / manual data injection



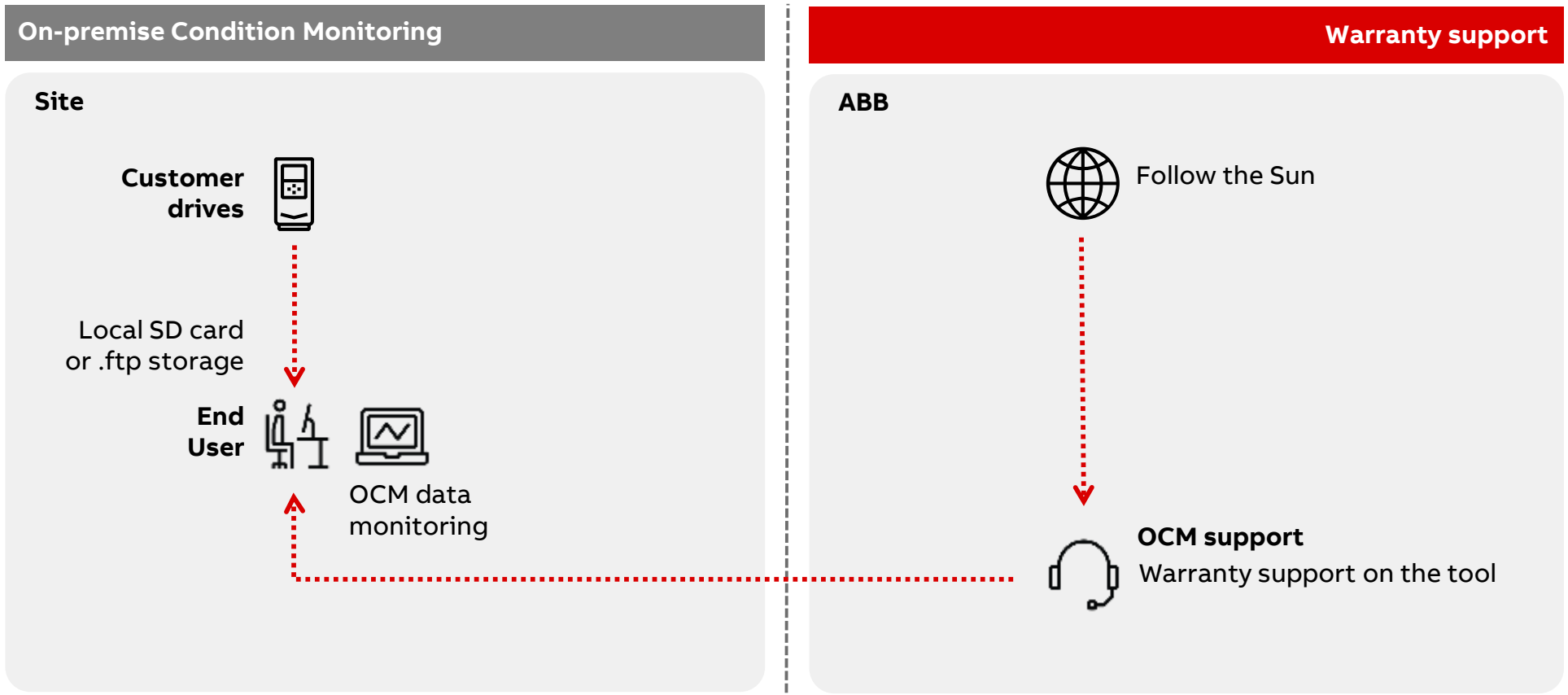
Delivery concept: Remote Services for drives

Remote Condition Monitoring: Partners/Integrators Solution



Delivery concept: Remote Services for drives

On-premise Condition Monitoring: End User Solution



Minimizing your downtime by easy maintainability

Service and maintenance for the ACS2000 is simple and smooth as you have easy front access to all components. In addition to various diagnostic tools, you will profit by convenient remote monitoring.

Fast commissioning by “DriveStartup™” software (step-by-step guidance)

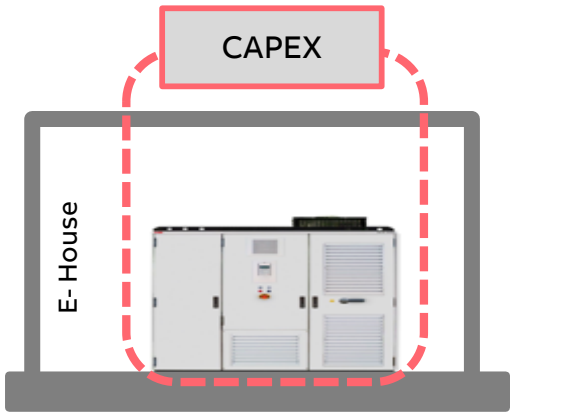
Fast maintenance due to easy front access to the drive

Withdrawable phase modules allow quick replacement of components

Total cost of ownership

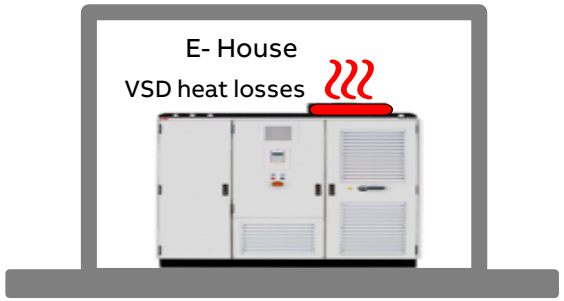
Choose the most economical solution.

Consider total cost of ownership (TCO) instead of VSD purchase price only



Purchase of VSDs is often based on initial / first hand cost only

Consider TCO (CAPEX & OPEX)



- CAPEX main items:
  - VSD
  - VSD heat loss cooling system
- OPEX main items:
  - MAINTENANCE cost of VSD and heat loss cooling system
  - ENERGY cost of VSD and heat loss cooling system

ABB's drive experts support you in selecting the most economical solution for your specific project.

- Consider TCO over the expected VSD lifetime > 20 years
- Specify / Select the most economical drive for your project requirements

VSD system design and selection criteria

VSD power supply connection point

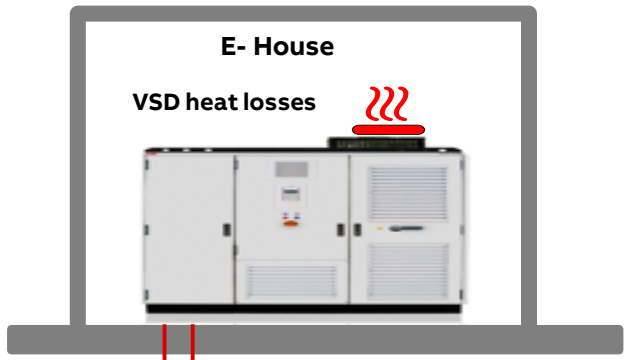
- 3.3 - 11 (33 kV) kV

Environmental conditions
Temperature, dust, corrosive air, etc.

VSD heat loss cooling method

Air cooling
- Ventilation
- HVAC

Water cooling
- Plant cooling water
- Fin-Fan cooler or Chiller



VSD transformer location
- Integrated solution
- External solution

Impact on:
- VSD system efficiency
- Power supply connection point
- VSD heat losses into E-house
- HVAC Capex and OPEX
- E-house size
- E-house HVAC

- With a VSD, motor voltage can be different from the line voltage
- Power & speed dictate the motor design

- Consider TCO over the expected VSD lifetime > 20 years
- Specify / Select the most economical drive for your project requirements

Case study: 2.5 MW air-cooled pump drive

Maintenance during 20 years lifetime

ACS2000	Replacement required from start up
Power modules	No replacement required
Foil DC link capacitor	No replacement required
EMC filter AC capacitor	11 years
Printed circuit boards, power suppllies	11 years

Multicell topology	Replacement required from start up
Power cells	5 – 9 years
DC link capacitors	5 – 9 years
Printed circuit boards, power suppllies	8 – 11 years

DC link capacitor module equipped with long lifetime self-healing foil capacitors and thyristor crowbar (fuse-less design)

Withdrawable phase modules for simple and fast removal

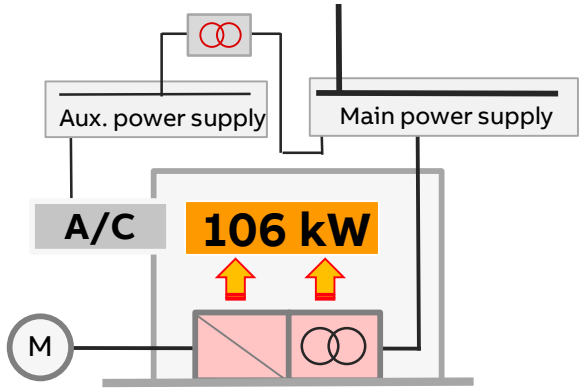
Low part count topology

ACS2000:
Optimized for minimum Total Cost of Ownership and equipped with long-life components requiring a low amount of maintenance during the expected life time > 20-year

Case study: 2.5 MW air-cooled pump drive

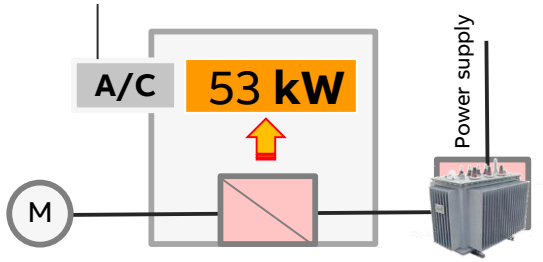
Heat losses external vs. internal transformer

Integrated transformer



- Typical VSD with intergrated transformer efficiency: **96%**
- Converter losses into E-house: 4%
- High E-house A/C equipment cost (CAPEX)
- High A/C aux. power demand (CAPEX & OPEX)
- High cooling air flow demand

External transformer

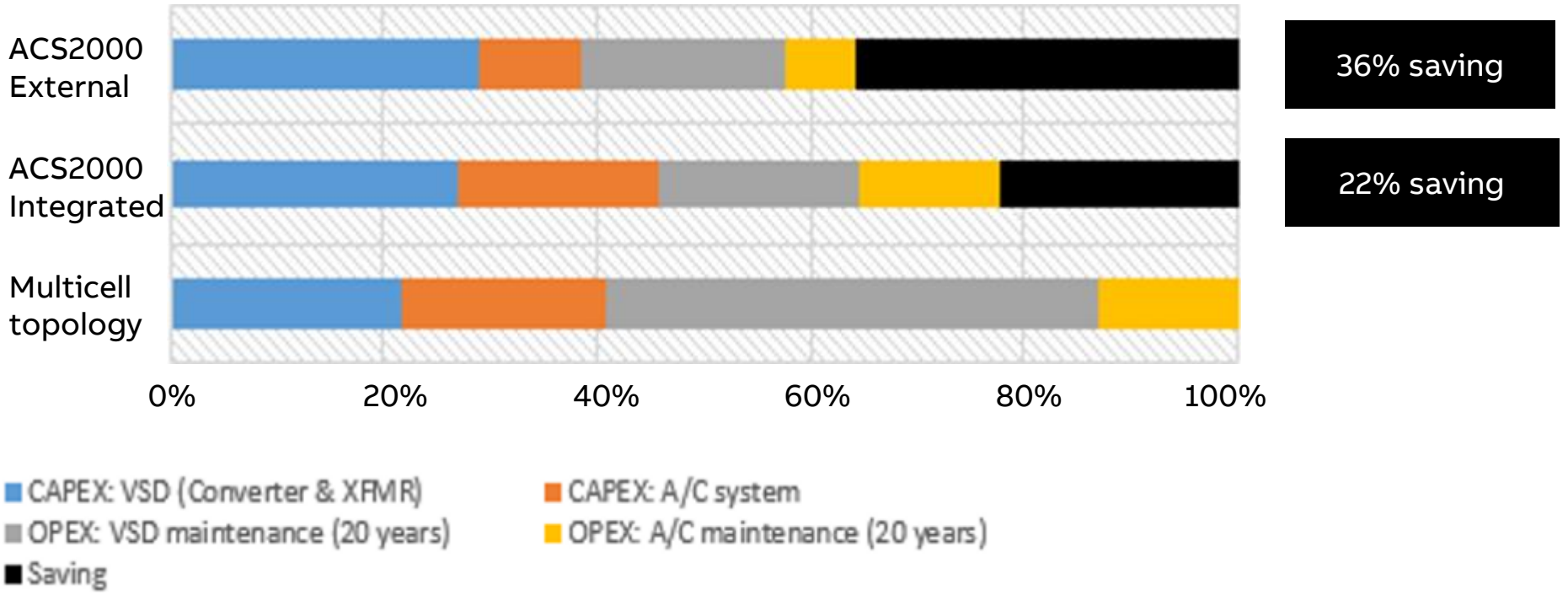


- Typical VSD with external transformer efficiency: **97%**
- Converter losses into E-house: 2%
- External transformer efficiency: 99%

50% less E-house cooling (A/C) with external transformer solution compared to integrated transformer solution.

Case study: 2.5 MW air-cooled pump drive

Integrated vs. external transformer of ACS2000 vs. multicell topology



ACS2000:
Optimized for minimum Total Cost of Ownership and equipped with long-life components requiring a low amount of maintenance during the expected life time > 20-year

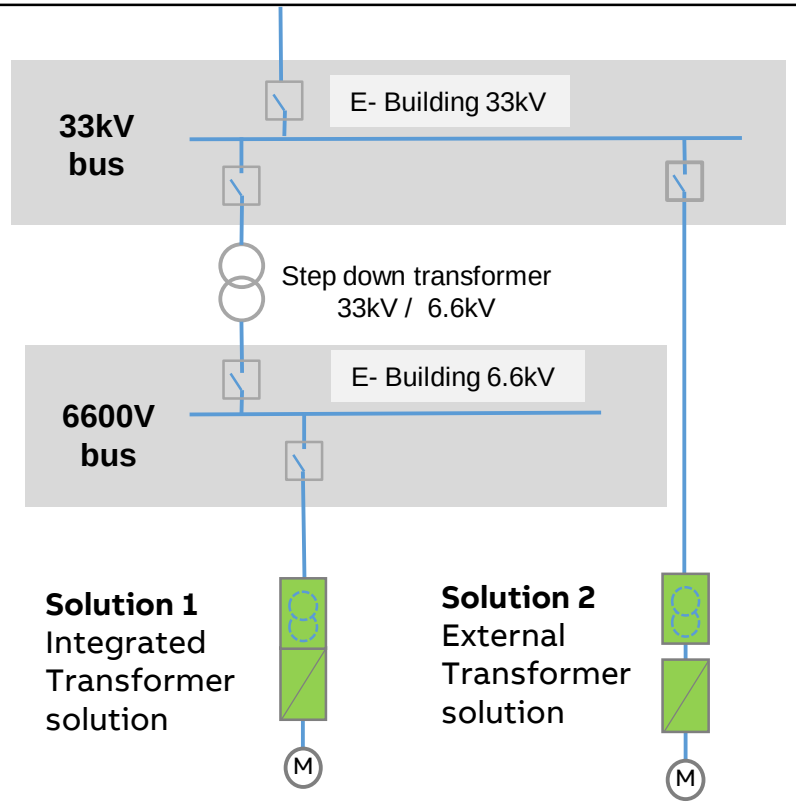
Multicell topology:
Optimized for minimum upfront investment cost of the VSD (converter & integrated transformer)

Remark:
Energy cost savings of external transformer solution not included

Case study: VSD power supply voltage level – 33kV / 6.6 kV

Example

Integrated and external transformer solution



Benefits of solution 2

CAPEX savings:

- Needs one less transformer, saving the cost of 33kV / 6.6kV step down transformer

OPEX savings (power consumption):

- Assumed transmission losses of step down transformers: 1% (assumed 600 kW/h)
- Saving potential: 4.26 million kWh per year

The ACS2000 industrial drive

Reference cases.

ABB enables optimized pumping process in a large scale desalination plant

First time use of reverse osmosis on a large scale instead of evaporation technology to deliver fresh water to 1 million people.

Application

Water & Wastewater

Pumps

Customer need

- Stringent harmonic requirements
- High process pressures
- Operation under harsh environmental conditions

Solution

ABB offered a drive and motor package:

- ACS2000, 24 pieces
- ACS800, 32 pieces
- ABB motors

Values

- Process optimization
- Smooth process integration
- Application specific product

Mining in a harsh environment with an ACS2000

The strong performance of the ACS2000 convinced the end-user to invest in further ACS2000 drives for an extension project.

Application

Mining

Conveyors

Customer need

- Operation in remote location
- Robust and compact design with regenerative capacity and full starting torque
- Operation under harsh environmental conditions

Solution

ACS2000, 42 pieces equipped with:

- AFE
- DTL

Values

- Cost savings – lower transportation costs due to compact footprint
- Reduced floor space
- Clear and transparent communication between ABB and the end user
- Application specific product

ABB offers reliable solutions with the ACS2000

The customer’s high satisfaction with the ACS2000’s performance and reliability lead to a further customer order of ACS2000 drives for an extension project.

Application

Oil & Gas

Combustion air blower

Customer need

- Trustworthy and reliable drive

The customer insisted that the ACS2000 is included in the OEM offering.

Solution

ACS2000, 2 pieces

Previous order:
ACS2000, 14 pieces for pump application

Values

- Positive past experience
- Reliable product
- Good relationship of ABB with end user and OEM

ACS2000 allows tailored solution

ACS2000 performing in a subsea multiphase pump application for an offshore oil and gas field, which accounts for a total production of 150’000 barrels of oil equivalent per day.

Application

Oil & Gas

Subsea MPP

Customer need

- Highest personnel safety
- Suitable and certified for installation on an offshore platform
- Permanent magnet motor
- 1.5 km cable length

Solution

ACS2000, 2 pieces equipped with:

- Arc resistant design with active arc elimination
- Output sine filter suitable for output voltage boosting up to 7 kV
- Permanent magnet motor control
- Marine design with ABS spot approval

Values

- Marine certification
- High personnel safety
- Application specific product

ACS2000 in action on a large oilfield

The end user is a major energy player, which produces and markets fuels, natural gas and low-carbon electricity.

Application

Oil & Gas

ESP

Customer need

- Long motor cables (>4 km)
- Highest personnel safety

Solution

ACS2000, 12 pieces equipped with:

- Arc resistant design with active arc elimination
- 6.6 kV output voltage to compensate the voltage drop along the long motor cables

ABB also provided the switchgear, which was tested together with the drive at ABB.

Values

- ABB's extensive expertise enabled valued support
- High personnel safety
- Application specific product

ACS2000

Key values

High personnel safety

Maximum motor compatibility

Design flexibility for smooth integration

Customer specific solution for demanding applications


ABB