

# UNMATCHED TESTING CAPABILITIES



Our Large Drive Test Center (LDTC) provides full-load testing capabilities for electric machines and drives up to 18 MW. String testing with the customer’s frequency converters is also possible on request.



**Lappeenranta Large Drive Test Center – Finland**  
Full-load testing capability for electric machines and drives up to 18 MW

**Vaasa test center – Finland**  
Electric machine full-power testing over 10 MW. DC-Hub testing, including applications such as active front end (AFE), motor inverter and DC/DC. Full-power testing of drives over 3 MW

**Heiane test center – Norway**  
Member of the Energy House. System integration testing for DC-Hubs with batteries, fuel cells and more

All tests fulfill international standards and class requirements.



www.theswitch.com

The Switch is part of the BEMAC Group whose products are unified under the BEMAC brand.

# DRIVE-SPECIFIC TESTING AVAILABLE

The Switch offers full-power testing and drive-specific test setups at its various locations in Finland, Norway and China.

All tests fulfill international standards and class requirements.



**Heiane test center – Norway**  
Member of the Energy House. System integration testing for DC-Hubs with batteries, fuel cells and more



**Vaasa test center – Finland**  
DC-Hub testing, including all applications – AFE MI, DC/DC. Full-power testing over 3 MW



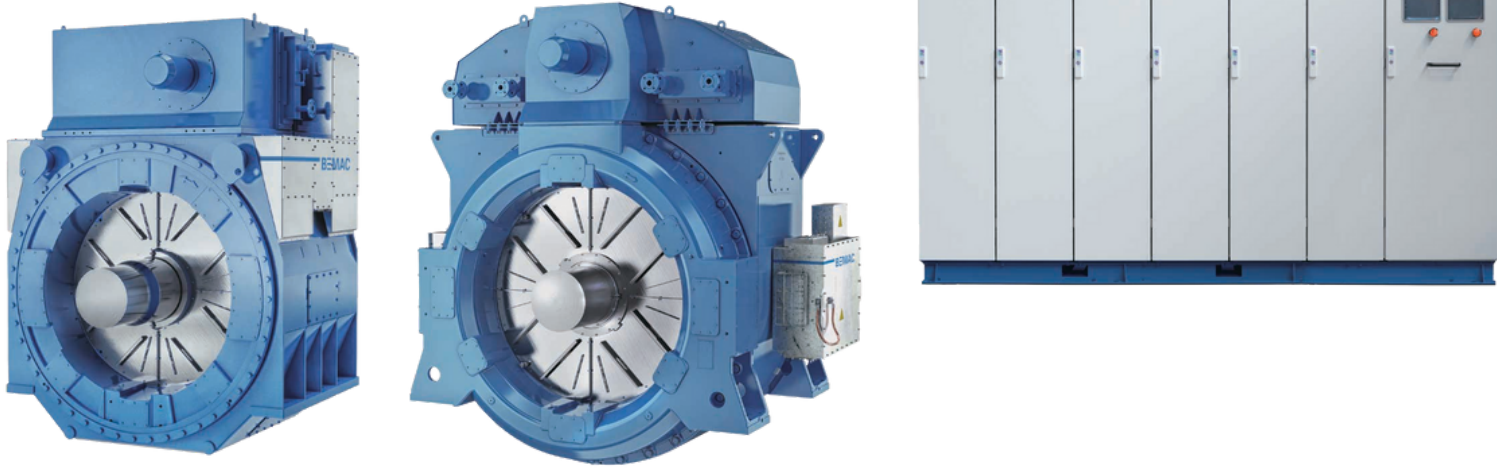
**Lappeenranta Large Drive Test Center – Finland**  
Full-load testing capability for electrical machines and drives up to 18 MW

# THE SWITCH LOCATIONS

<b>Finland</b> Helsinki, office Lappeenranta, factory Vaasa, factory	<b>China</b> Beijing, branch office Lu’an, workshop Nanjing, branch office and partner factory
<b>Norway</b> Stord, factory Trondheim, office	<b>Japan</b> Imabari, BEMAC head office

# THE SWITCH MARINE PRODUCTS

- Permanent magnet machines
- Single drives
- DC-Hubs for multi-megawatt DC switchboards



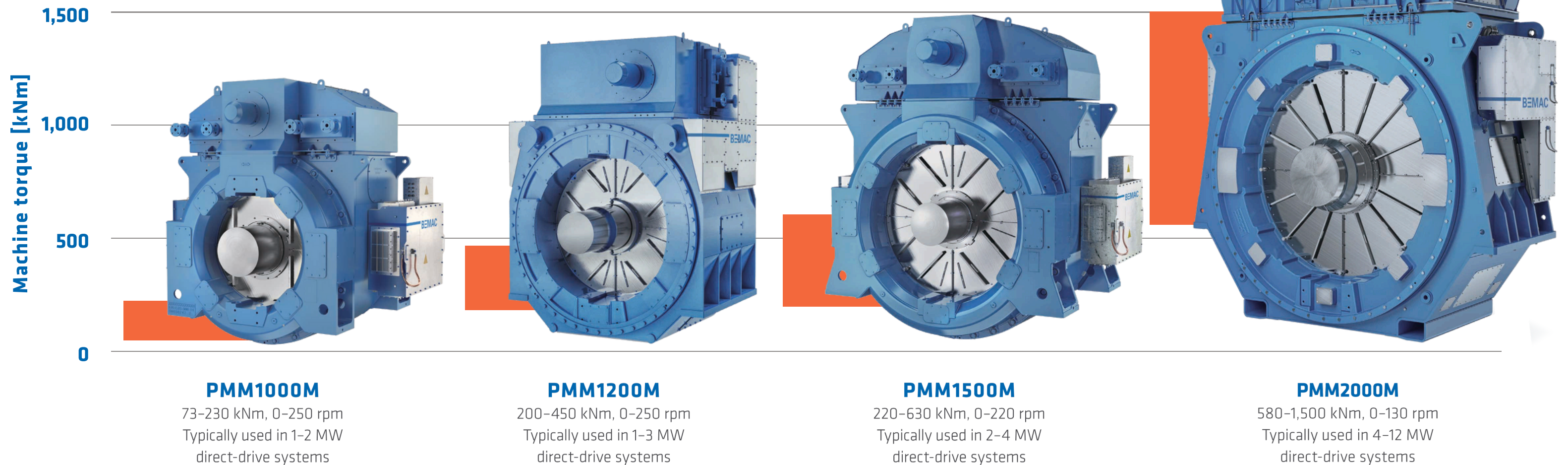
Version 3, 5/2025





# WIDEST RANGE OF PERMANENT MAGNET (PM) MARINE MACHINES AVAILABLE

Our wide range of PM machines improves overall efficiency for propulsion and on-board electricity generation, reducing CO<sub>2</sub> emissions and operating expenses.



## Permanent magnet technology

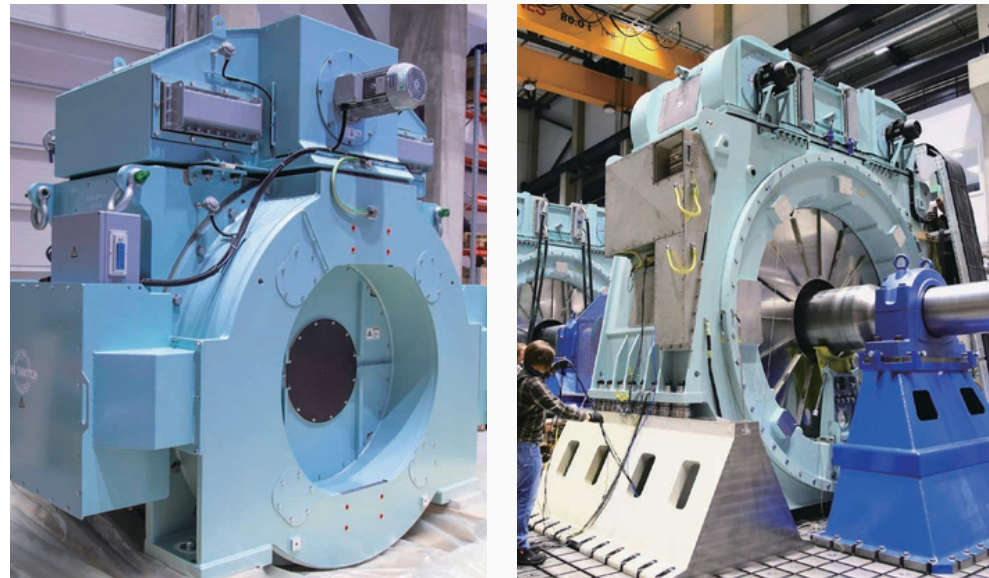
- Magnetic field created by strong Neodymium magnets
- Lossless excitation, ensuring maximum efficiency. This results in reduced fuel costs and lower emissions
- Extremely simple mechanical construction, resulting in high reliability and minimal maintenance need
- Form-wound stator with vacuum pressure impregnation (VPI)
- High power density, resulting in a compact design
- Based on over 2 decades of The Switch experience from MW-class PM machines for wind and marine applications
- Tailored to the customer's application
- Several million cumulative operating hours from marine
- Unlike electrically excited synchronous generators (EESGs), PM machines are type-tested at full power before delivery
- Testing with third-party drives is also possible
- No need to replace magnets during the entire lifetime





# INLINE SHAFT GENERATORS

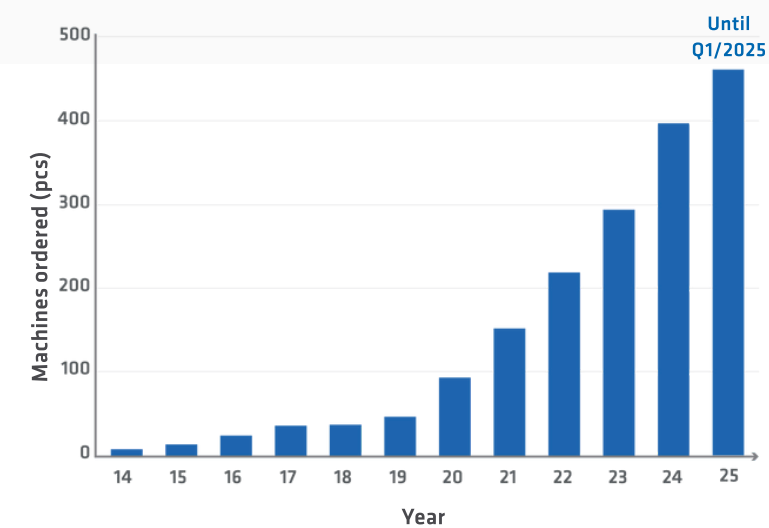
We were the first to deliver a megawatt-class PM shaft generator in 2015. Since then, over 450 of these machines have been sold, with cumulative operating hours exceeding several million. Today, PM shaft generators have become a standard solution in large ocean-going vessels, simplifying their compliance with IMO regulations.



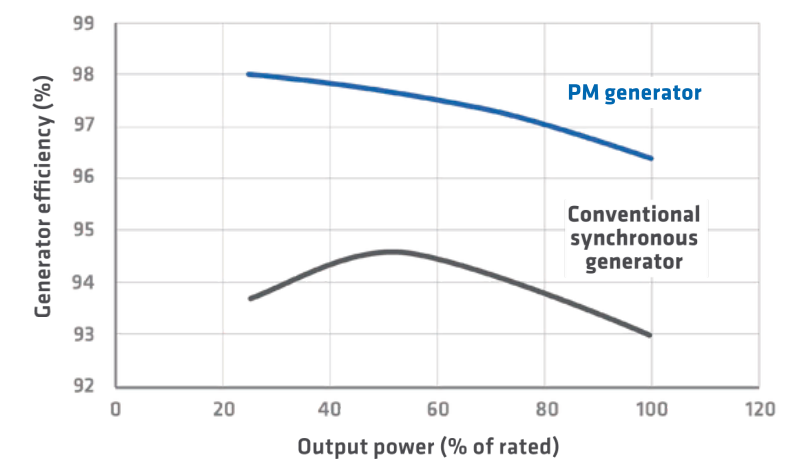
## Why choose The Switch PM shaft generator

- Significant fuel savings when electric power is produced by utilizing the vessel's 2-stroke main engine
- Permanent magnet technology further reduces emissions and fuel costs
- Minimal need for maintenance as gensets can stay shut down most of the time
- Possibility for PTI and PTH functions, allowing boost mode or emission-free maneuvering in port areas using batteries
- More space for cargo due to a more compact machine
- Reduced EU carbon tax due to lower emissions
- Minimized project risk with full-power testing of the machine at our factory
- Proven technology with several million cumulative operating hours
- Our machine is always tailored to the customer's system, with flexibility for design changes

Cumulative marine machine orders



Efficiency comparison



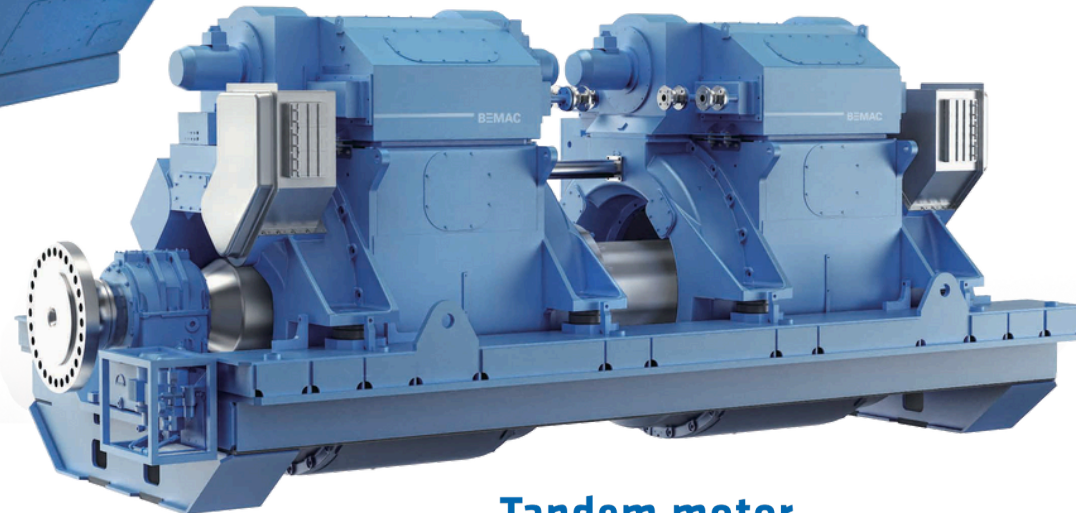


# DIRECT-DRIVE PROPULSION

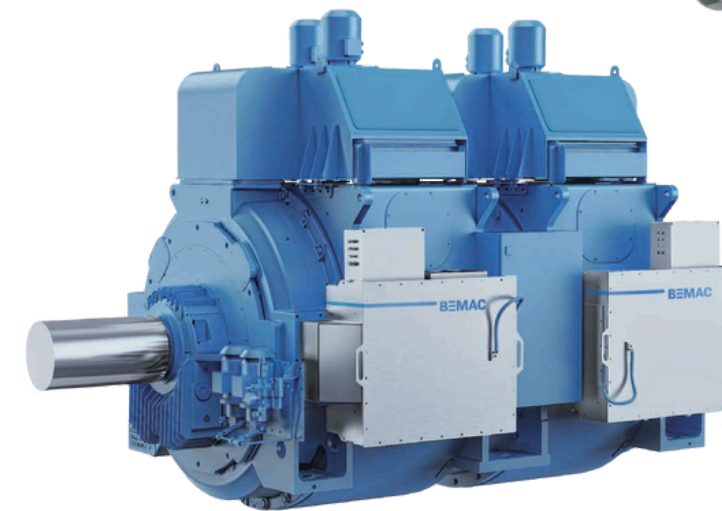
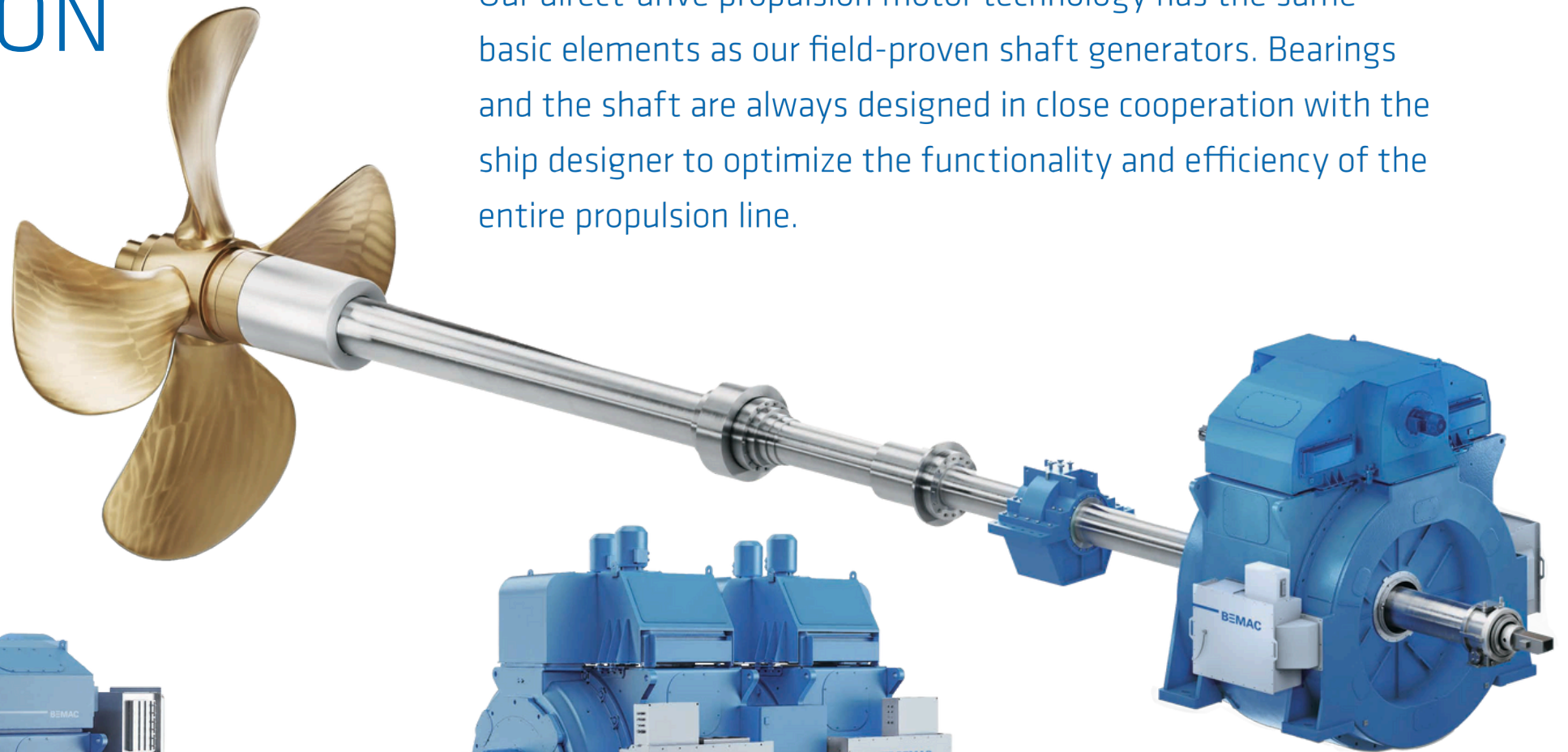
Our direct-drive propulsion motor technology has the same basic elements as our field-proven shaft generators. Bearings and the shaft are always designed in close cooperation with the ship designer to optimize the functionality and efficiency of the entire propulsion line.



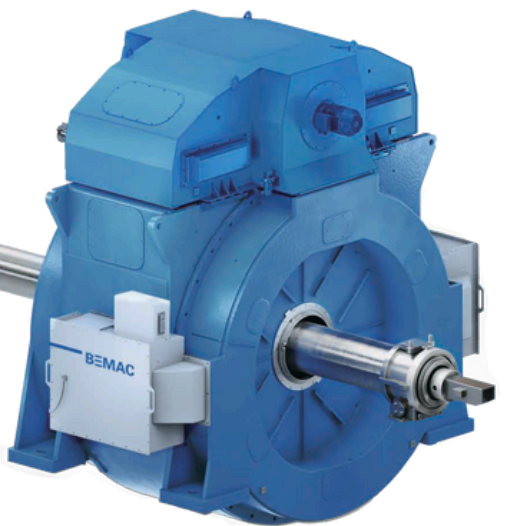
**Single motor with bearings**



**Tandem motor with bearings**



**Compact tandem motor**



**Single motor with the shaft and bearings provided by the yard or system integrator**

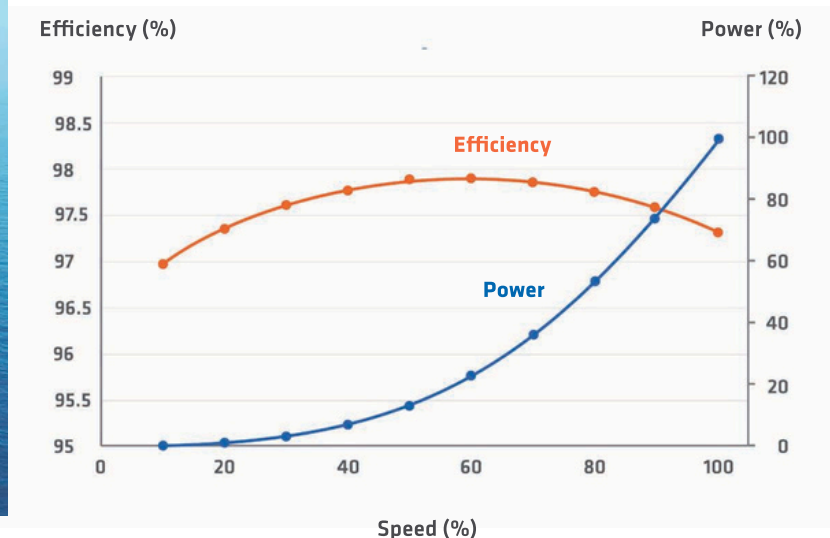
## Why choose The Switch PM propulsion motor

- Three different concepts depending on the customer's propulsion line design and redundancy requirements
- The tandem concept for single-screw vessels allows operation with over 50% power in case of motor failure, significantly increasing the system's redundancy
- The motors can also be used in silent applications, such as DNV Silent classes
- Bearings and the shaft are designed together with the ship designer to ensure compatibility, avoid resonances and more
- Extensive product portfolio ranging from below 1 MW to over 12 MW

M/S Nukumi with two The Switch PMM1500M propulsion motors



Typical efficiency of a 5 MW direct-drive PM propulsion motor





# STANDARD DRIVE FOR SPECIFIC MARINE APPLICATIONS UP TO 6 MW

*Over 1,500 rugged marine-specific drives now in operation.*



## MARINE-SPECIFIC DESIGN

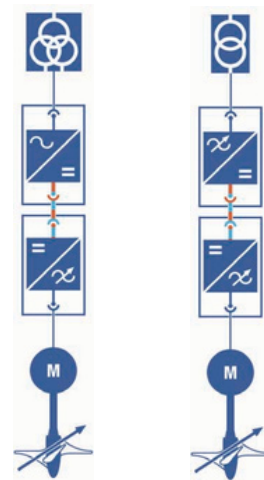
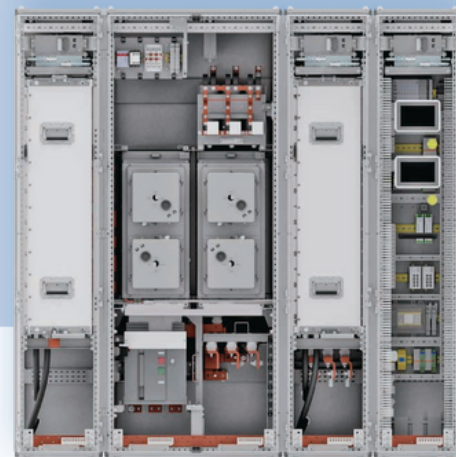
No compromises in features, materials or solutions

- **Very simple and robust cabinet structure**
- **Fast connectors in the power module** – enables fast and easy maintenance
- **Allows system-level optimization**
- **Vessel's freshwater cooling system connection**
- **Rigid foundation with vibration dampers** – for smooth operation
- **IP44 enclosure for both power module and cabinet** – robust for the environment and fast maintenance

### Propulsion

Drive to connect electric propulsion or other motors to AC system. Both passive and active rectifier available. Support for tandem configuration.

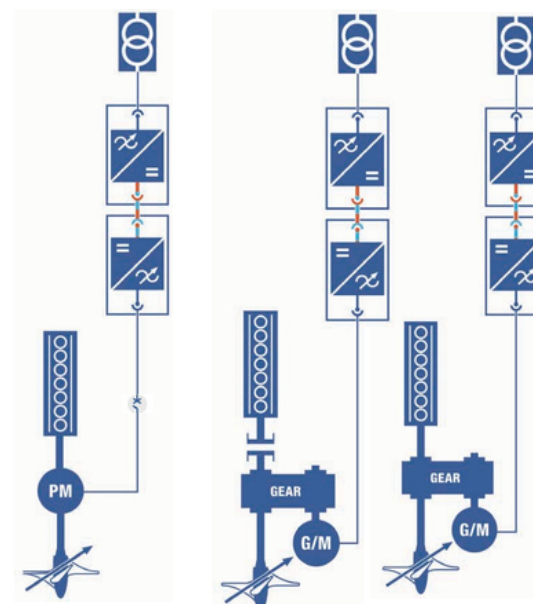
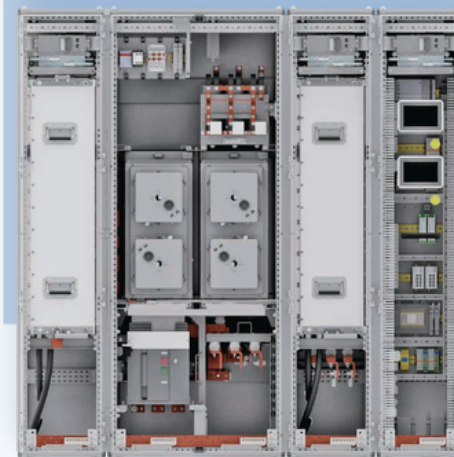
Power range from 800 A to 5,600 A.



### Shaft generator

Drive to connect shaft generator to AC system. Both inline and geared solutions available. PTI-PTO and PTH functionality.

Power range from 800 A to 5,600 A.



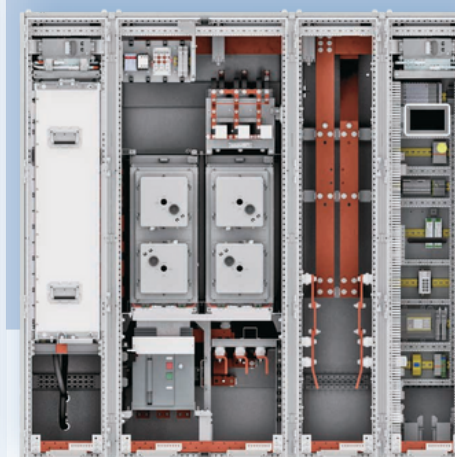
Inline  
PTI-PTO

Geared  
PTI-PTO-PTH

### Battery

Drive to connect battery to AC system, enabling effective battery use for multiple purposes. Load sharing with other energy sources.

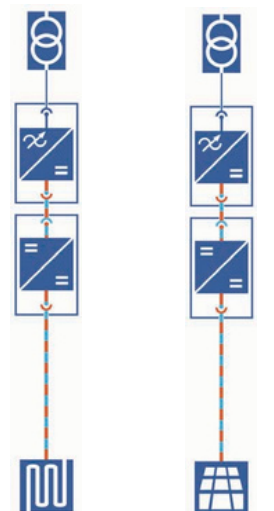
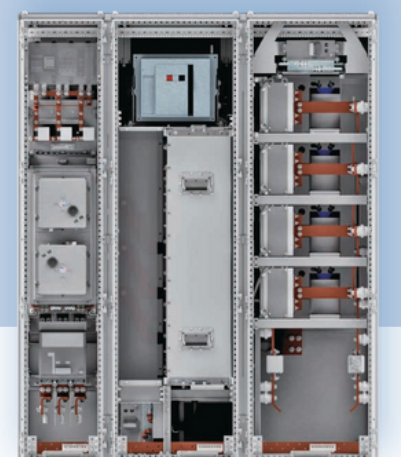
Power range from 800 A to 1,600 A.  
Several units can be connected to the same system.



### Fuel cells and solar

Drive to connect fuel cells, solar or other DC source to AC system. Configurable amount of DC outputs.

Power range from 800 A to 1,600 A.  
Several units can be connected to the same system.

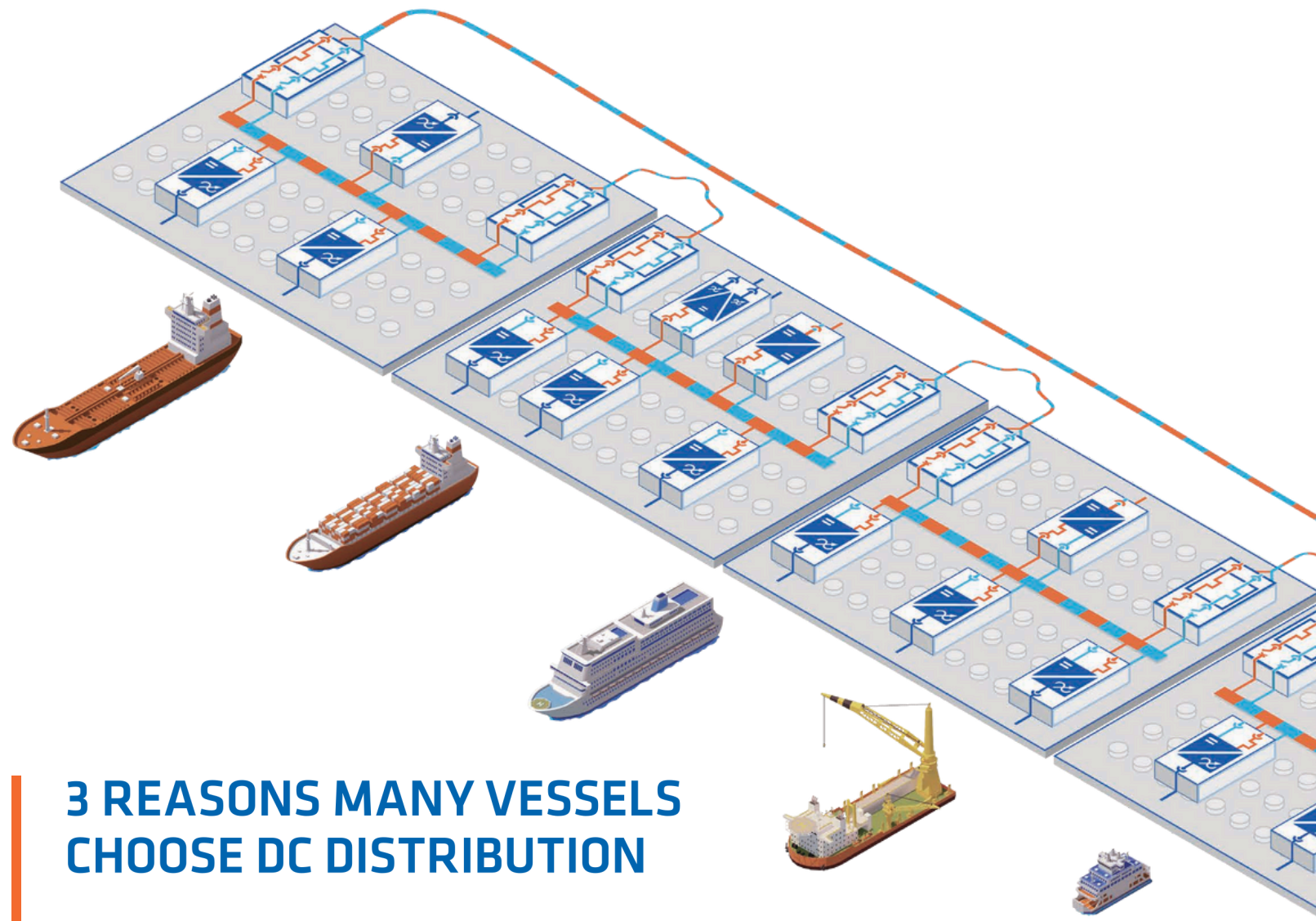




# THE SWITCH DC-HUB: ENGINEERED FOR COMPLEX MEGAWATT-CLASS POWER

## WHY DC DISTRIBUTION?

- Fewer components mean higher efficiency
- Efficient use of regenerated energy
- Smaller footprint
- Lower fuel use thanks to variable-speed generators
- Easy integration with batteries and other energy sources
- Future-flexible for changing regulations
- High fault tolerance and system redundancy with semiconductor-based protection



## 3 REASONS MANY VESSELS CHOOSE DC DISTRIBUTION

### #1 – Lowers fuel use, higher efficiency

Variable-speed gensets and batteries optimize energy use for longer operation.

### #2 – Increased system redundancy and fault tolerance

Ultrafast protection devices enable safe closed bus tie operations, even for DP3 operations.

### #3 – Easy to operate and maintain

Reliable, user-friendly products maximize uptime and simplify operations.

**DC distribution is the future.**

## SMOOTH RIDE THROUGH THE WAVES

The Switch Electronic DC Breaker (EDCB) – Handles short-circuit faults inside a DC-Hub

The Switch Electronic Bus Link (EBL) – Handles short-circuit faults between DC-Hubs

The Switch Electronic Current Limiter (ECL) – Handles short-circuit faults toward the battery on the DC-Hub end of the cable

The Switch Battery Short-Circuit Limiter (BSCL) – Handles short-circuit current from the battery, typically installed at the battery end of the cable

Full suite for safety covering the entire DC switchboard  
Our protection concept now includes 4 ultrafast devices, which protect inside DC-Hubs, between DC-Hubs and to and from batteries

## MARINE-SPECIFIC DESIGN

NO COMPROMISES IN FEATURES, MATERIALS OR SOLUTIONS

### Ready for harsh marine operation

- Allows system-level optimization and easy at-sea servicing
- Rigid foundation with vibration dampers
- Can be connected to the vessel's freshwater cooling system

### Unique ultrafast semiconductor-based protection concept

- Suite of 4 fit-for-purpose, game-changing products
- Electronic DC Breaker (EDCB) is unique in the market
- Ride-through capability

### Fast and reliable maintenance

- Crew can change the module
- Power module with precharge included
- Fast AC and DC connectors in power module
- Closed IP44 power module and cabinet structure
- No bolt connections in the main electrical path



# SWITCH TRACKS TO DC DISTRIBUTION

## 1 How can you connect a battery directly to the DC link?

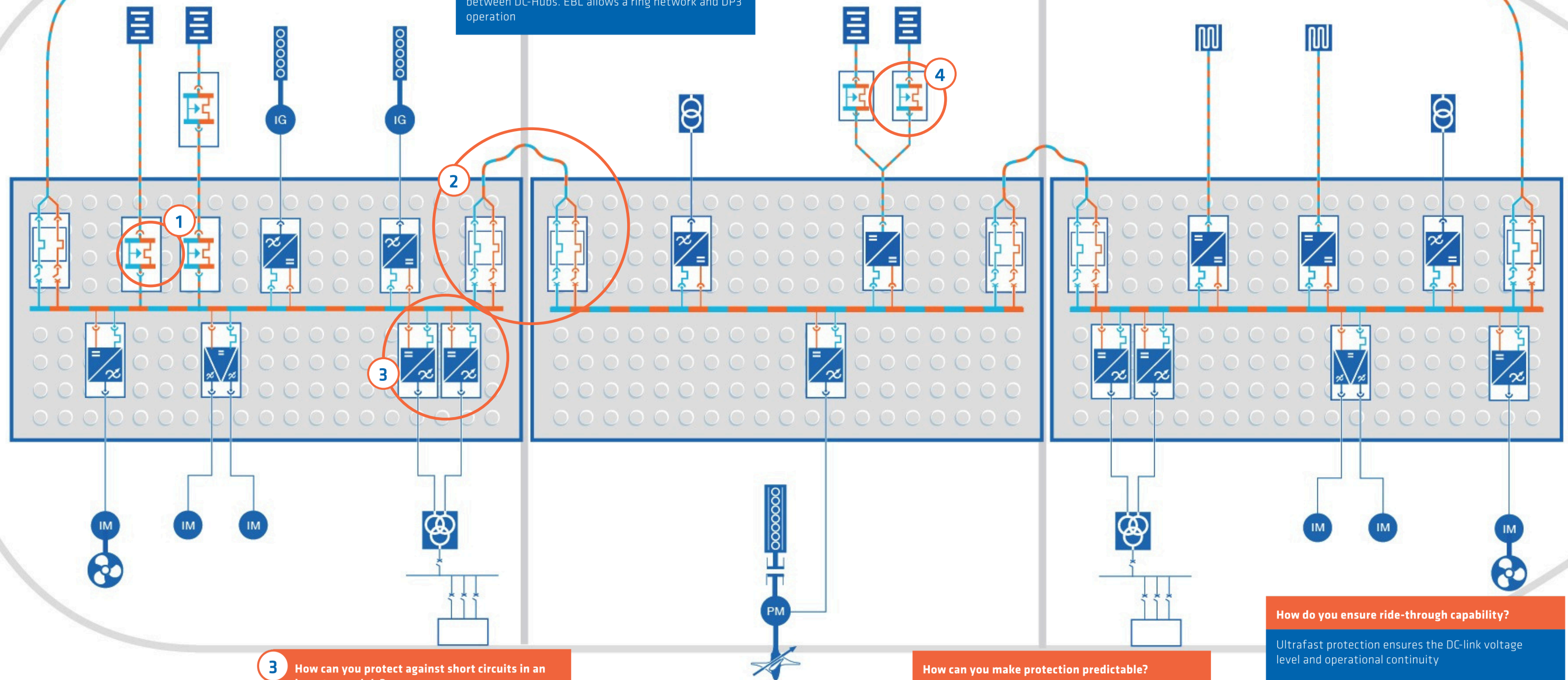
ECL (Electronic Current Limiter) protects the DC link and ensures operational continuity

## 2 How can you ensure system redundancy?

EBL (Electronic Bus Link) offers ultrafast protection between DC-Hubs. EBL allows a ring network and DP3 operation

## 4 How do you connect large batteries to a DC system?

BSCL (Battery Short-Circuit Limiter) blocks any high short-circuit current from the battery



## 3 How can you protect against short circuits in an inverter module?

EDCB (Electronic DC Breaker) offers ultrafast protection inside a DC-Hub toward the inverter module failure

## How can you make protection predictable?

After a critical fault, only a reset is required. Faulty components are removed from the circuit. Protection based on current measurement provides predictable selectivity

## How do you ensure ride-through capability?

Ultrafast protection ensures the DC-link voltage level and operational continuity

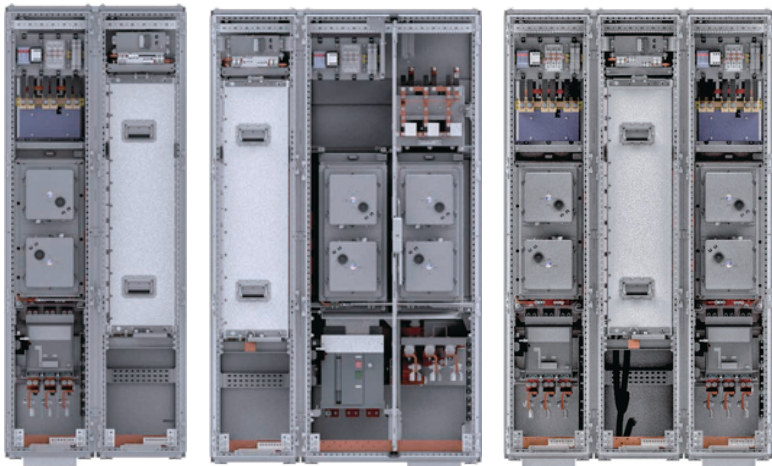


# BUILDING BLOCKS



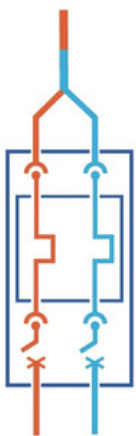
### Motor/generator inverter (MI/GI)

- Motor and variable-speed generator applications
- Shaft generator support (PTO, PTI, PTH)
- IM, PM, IPM and EESM supported
- Torque, speed, power, DC voltage and scalar control modes



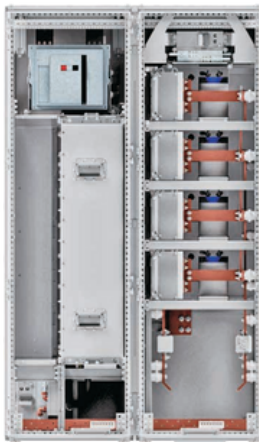
### Active front end (AFE)

- Grid compliance, THDu <5% (typically <3%)
- Grid or DC voltage control
- Island mode support with blackout start
- Active harmonics damping
- Possible to connect several AFEs to the system
- Possible to parallel units with LCL or dedicated winding



### Electronic Bus Link (EBL)

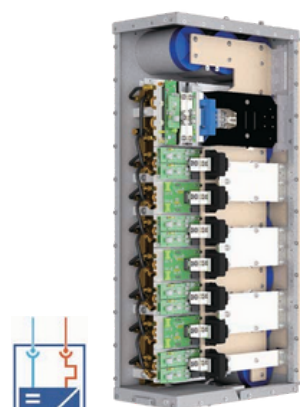
- Connects The Switch DC-Hubs together
- Critical faults are detected and disconnected in approximately 10 microseconds
- Allows a ring network
- Improves redundancy while enabling fuel savings
- DP3 tested and approved by DNV
- Several units can be connected to the system



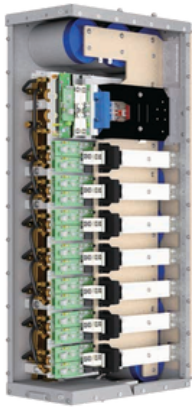
### DC/DC chopper for batteries

- Links battery, fuel cells and other DC-source connections to the DC-Hub with maximum efficiency
- Enables numerous applications: reserve power, peak shaving, backup power and more
- Ensures constant DC voltage
- Allows DC voltage, current or power control modes
- Configurable output
- Several units can be connected to the system

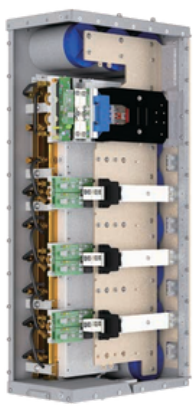
# POWER MODULES



High-power module with EDCB



Flexible module with EDCB

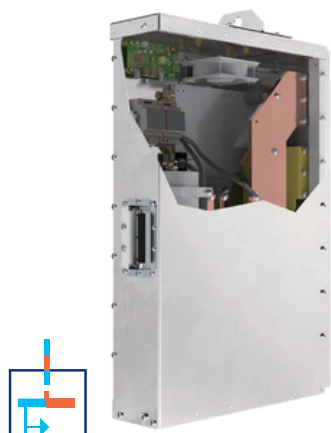


Half module with EDCB

	Normal duty current continuous (A)	Short-circuit capacity 500 ms (A) *	Dimensions		
			W	D	H
High-power module	1,600	2,500	305	580	1,140
Flex module	2 x 800	2 x 1,250			
Half module	800	1,250			

\*for AFE function. Longer duration with derating

# PROTECTION MODULES



BSCL



ECL/EBL



EBL

	Normal duty current continuous (A)	Number of protected poles	Dimensions		
			W	D	H
BSCL	1,800	1	147	563	805
ECL	1,800	1 or 2			
EBL	1,800	1			