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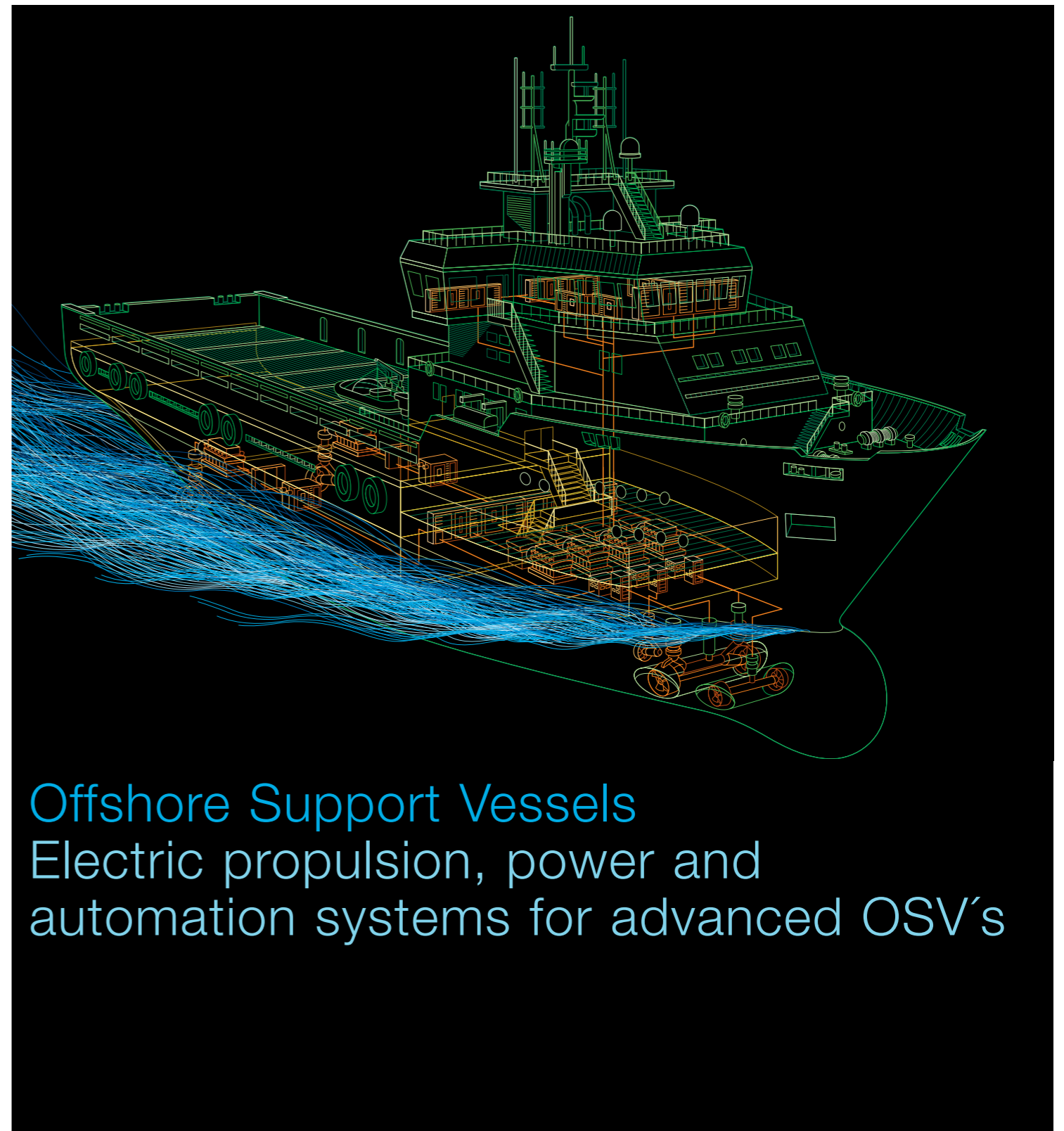
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## Electric propulsion

- good for the environment, good for the bottom line

### The future is electric

The OSV market has experienced tremendous growth in recent years and has witnessed a technology shift from diesel-mechanical to diesel-electric propulsion. Low fuel consumption, low emissions and the opportunity to use almost any current or future energy source - diesel-electric, gas-electric or e.g. fuel cell technology - has made electric propulsion the technology of choice for modern, eco-friendly OSV's. ABB is the electric propulsion frontrunner and has supplied electric propulsion to hundreds of energy-efficient OSV's of all types.

### High quality lifecycle solutions

For Offshore Support Vessels, ABB provides electric power, propulsion and automation solutions tailored for optimal efficiency, reliability and performance in demanding offshore conditions. Qualified ABB project engineers provide low-risk project execution and our global OSV service team ensures fast response whenever and wherever needed.

### Efficient OSV project execution - worldwide

ABB Marine is a global organization with operations in all key marine and offshore hubs worldwide. Our dedicated OSV organization is headquartered in Ulsteinvik, Norway. To effectively contribute to OSV construction projects globally we have local engineering resources and project management capabilities in countries such as China, Singapore and Brazil. By establishing close local relations between companies and people, ABB contributes to more efficient projects and better overall vessel solutions.

Since the mid-1990's, ABB has been a pioneer in electric propulsion technology for Offshore Support Vessels. Today a major part of all OSV newbuilds are equipped with electric propulsion, and nearly half of the OSV fleet have electric propulsion from ABB.

Platform Supply Vessels

Anchor Handling Tug Supply Vessels

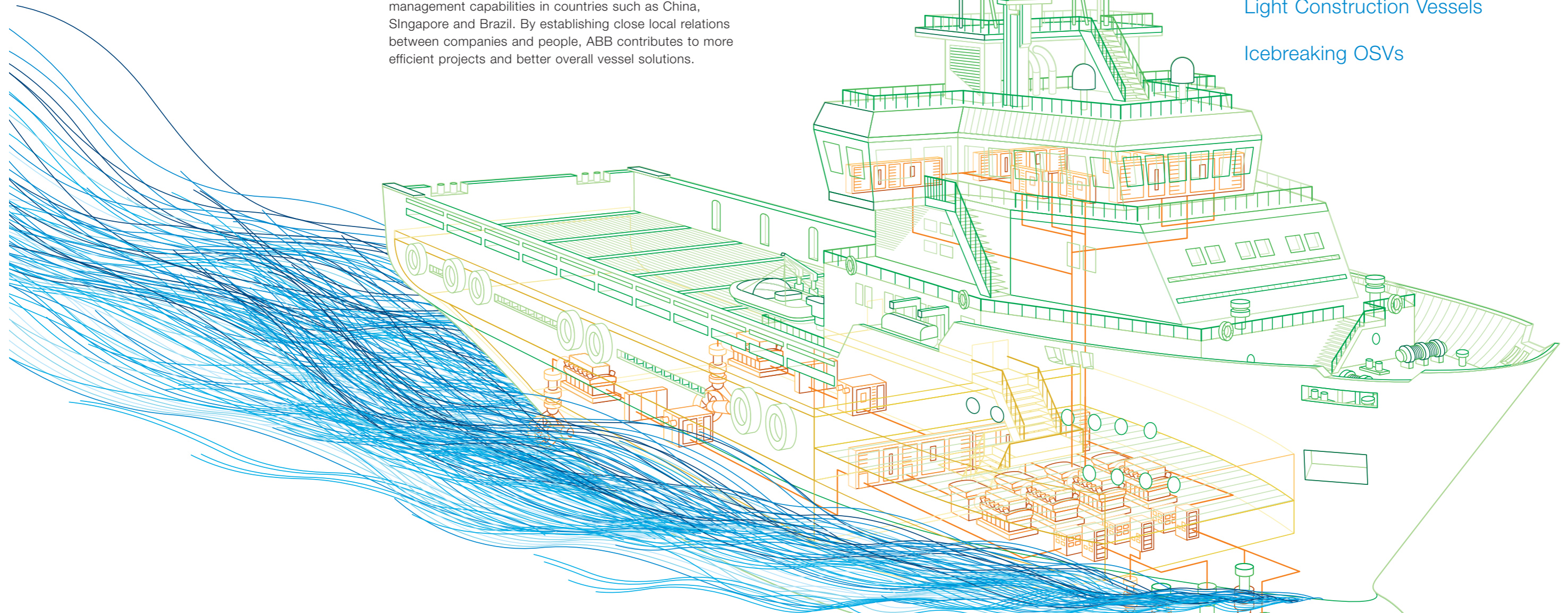
ROV Vessels

Multipurpose Platform Supply Vessels

Standby / Rescue Vessels

Light Construction Vessels

Icebreaking OSVs





Examples of environmentally-friendly Offshore Support Vessels equipped with ABB electric propulsion solutions

ABB works closely with OSV designers, owners and yards worldwide and has supplied electric propulsion to more than 250 OSV's.



1. *Skandi Salvador* - Multipurpose Offshore Vessel. Owned by DOF ASA, built by STX Brazil Offshore.
2. *Bourbon Mistral* - Platform Supply Vessel. Owned by Bourbon Offshore Norway, built by Ulstein Verft.
3. *Volstad Viking* - Platform Supply Vessel. Owned by Volstad Shipping, built by STX Norway AS, Brattvåg.
4. *Rem Forza* - Multipurpose Subsea Vessel. Owned by Rem Offshore, built by Kleven Verft.

5. *FESCO Sakhalin* - Icebreaking Supply and Standby Vessel. Owned by Far-Eastern Shipping Company, built by STX Finland OY, Helsinki.
6. *Far Samson* - Anchor Handling Tug Supply Vessel. Owned by Farstad Shipping, built by STX Norway AS, Langsten.
7. *Viking Avant* - Platform Supply Vessel. Owned by Eidesvik Offshore, built by STX Norway AS, Langsten.
8. *Bourbon Herald* - Platform Supply Vessel/Well Stimulation Vessel. Owned by Bourbon Offshore, built by Zhejiang Shipbuilding.



## A total ABB package solution improves overall vessel performance and profitability

### Total solutions...

ABB's scope of supply to the Offshore Support Vessel segment includes the following systems:

- Electric power generation system
- Electric power distribution system
- Main propulsion drives including electric motors, transformers and converters
- Thruster drives including electric motors, transformers and converters
- Azipod® C azimuthing electric podded propulsion units
- Automation systems - IAS/PMS

ABB solutions for OSV's are built to perform in rough offshore operating conditions. Rather than engineering complex specialized solutions, we base our marine systems on industry standard ABB products that are certified for marine operations. Our electrical products represent the pinnacle of modern, energy-efficient power technology, and as building blocks for a total solution they are unmatched.

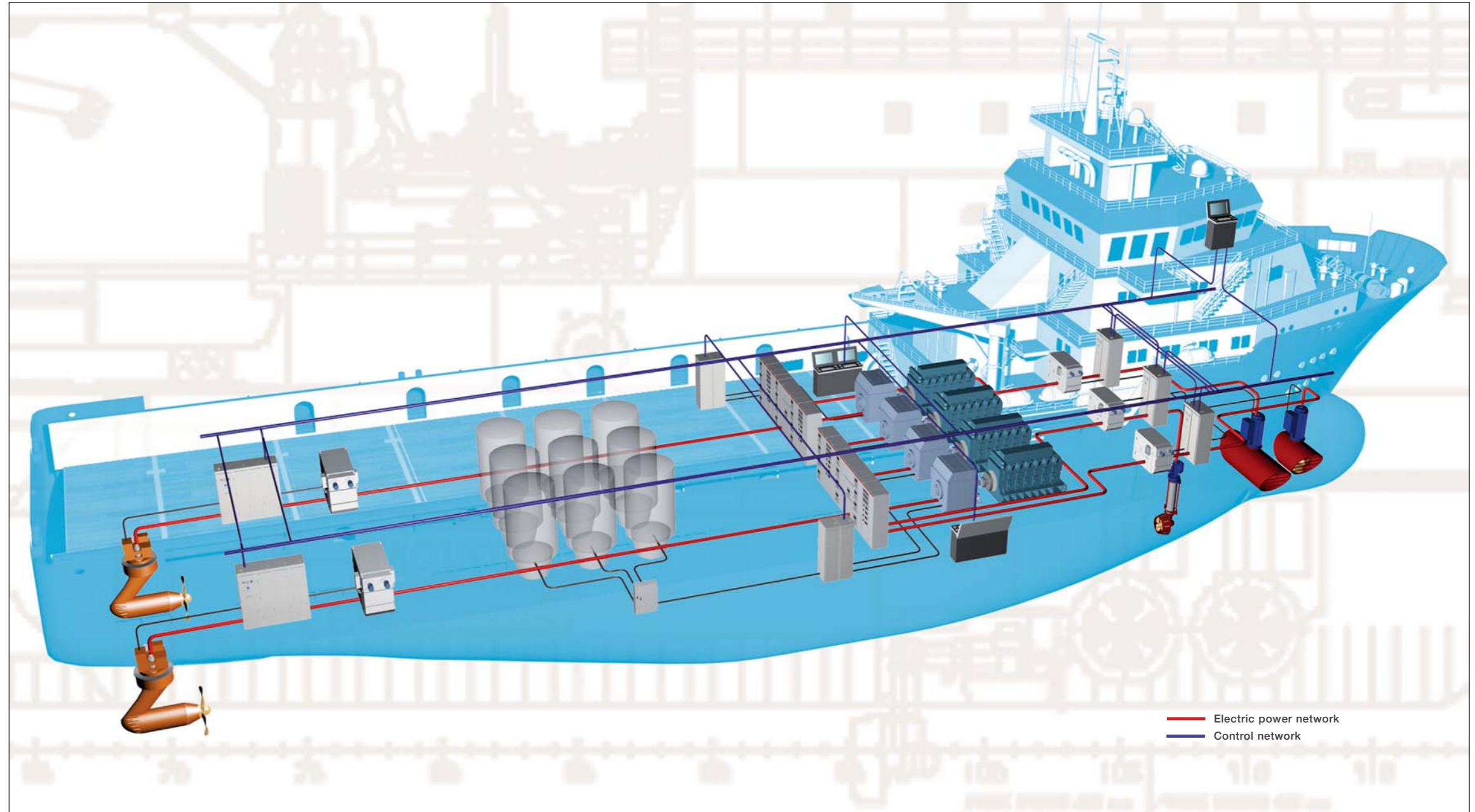
### ...total responsibility

ABB is a total system integrator, and an important element of our scope of supply is the portfolio of services we provide throughout the vessel life cycle. These services include:

- Project management including overall responsibility for the delivery
- Project engineering, documentation and studies needed for vessel construction, installation, commissioning, and for the classification society for certification of the electrical plant and equipment
- Site support, depending on customer preference - typically commissioning and sea trials but also site management, installation supervision and engineering support
- Warranty and after-sales services

ABB provides solutions engineered to meet specific vessel requirements and the unique demands of each customer. Fast-track projects are made possible by reusing "best practice" solutions, interfaces, documentation and, not least, experienced personnel.

ABB solutions for OSV's are based on our leadership in electric power, propulsion and automation technology supported by a dedicated OSV organization offering world class system engineering, project execution and after-sales support.



The figure above represents a typical ABB total solution for an OSV, including electric power, propulsion and automation systems.

### The advantages of a total ABB solution

The electric propulsion solution forms the core of ABB offerings to the OSV market. Delivering AC propulsion to all types of vessels, ABB has developed technology unique in performance, lifecycle economy and environmental impact.

By choosing a total package - electric power, propulsion and automation - from ABB, customers gain a thoroughly proven functional solution based on unified technology. This eliminates problematic interfaces, and single-point supply clearly defines responsibility during the project and operation phases.



## The main systems and advantages of a fully electric Offshore Support Vessel



Generator installation on an advanced OSV with electric propulsion

### Major energy savings

The large variations in the propulsion and thruster load profile of an OSV fully exploit the attributes of electric propulsion. The reported fuel savings of ships with electric propulsion are very dependent on the ship's operating profile and are typically 15 - 25% on average over full operational cycles, and up to 50% in DP modes.

There are two main reasons for the significant savings in fuel and emissions compared with mechanical propulsion:

- Variable speed control of the propellers reduces no-load losses of the propellers to a minimum compared with traditional fixed speed, controllable pitch propellers
- The use of several smaller constant speed engines, and automatic start/stop of the engines depending on load demand ensure that the engines operate continuously at optimum load and that only the necessary numbers of motors are in operation. This gives much cleaner combustion and significantly better fuel economy than running one or two large engines mostly far below their optimum operating point.

Other benefits of electric propulsion include flexible location of thrusters and machinery components, allowing for more payload, and enhanced crew comfort due to less onboard noise and vibration.

### Electric Power Generation and Distribution System

The power generation and distribution plant of a modern electric OSV consists of several medium- or high-speed diesel/gas engines that drive the electric generators connected to the main electric switchboards. All loads including propulsion, thrusters, auxiliaries and ship systems are normally fed from this grid and the total load is shared between the running generators which are automatically selected to match the total required power.

Total installed propulsion power for an OSV is typically in the range of 4000 - 8000 kW and a low voltage main power system at 690 V is normally the most cost-effective solution. For vessels with higher power requirements, such as Icebreaking OSV's, a 3.3 or 6.6 kV medium voltage power system will normally be the optimal solution.

Safety through redundancy is an important asset of an electric powered OSV. To protect against a total loss of propulsion power and station-keeping capability in case of any single failure, most OSV's are designed with full redundancy in the electric power and propulsion system.

An electric OSV is equipped with an electric propulsion system, an electric power generation and distribution system and an automation system for optimal control and running of the complete power and propulsion installation.



Azipod® CO propulsor ready for shipment from ABB factory

### Electric Propulsion System

Demanding offshore operations place high requirements on vessel maneuverability. A typical electric OSV utilizes two azimuthing thrusters as main propulsion, 2 bow thrusters and often a retractable thruster - all driven by speed-controlled AC motors.

With a complete range of marine certified Variable Speed Drives and AC propulsion motors, the ABB product platform sets no limitations for our engineers when designing solutions for our customers. The main challenge is to meet the class and ship-specific requirements with a minimum total cost and the right balance between capex and opex. ABB provides different drive system configurations - with and without transformers - to meet the class requirements for harmonic distortion levels (typically < 5%).

ABB offers two solutions for main OSV propulsion:

- AC propulsion motors for onboard installation and connection to traditional mechanical thrusters
- Azipod® CO and CZ - unique electric podded propulsion systems for powers up to 4.5 MW (more information on Azipod® CO and CZ on page 13)



Screenshot of the Power Management System (PMS)

### Automation Systems - IAS and PMS

The ABB Integrated Automation System (IAS) takes an all-in-one approach to vessel automation, encompassing all control and monitoring functions onboard a ship - including those normally handled by separate dedicated systems. Based on ABB's Compact Products 800 control, software and communication platform, the system is modular, scalable and is easily configured to meet the unique requirements of each ship. Comprehensive system monitoring, alarming and operator interface are available through an advanced, fully integrated multi-screen operator station.

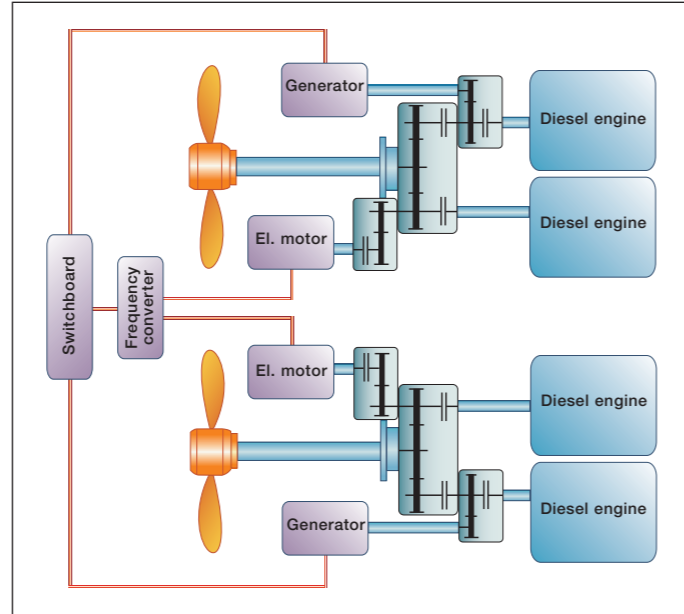
The Power Management Systems (PMS) can be delivered as an integrated part of the IAS or as a stand-alone system. PMS is an important system in an electric OSV, ensuring that it always has sufficient power for the actual operating conditions by monitoring and controlling the load and status of the generator sets and the power system. The Power Management System also provides extended functionality for energy optimization.



## Hybrid propulsion technology for Anchor Handling Tug Supply (AHTS) vessels



*Far Sapphire* is a UT732 AHTS owned by Farstad Shipping, equipped with an energy-efficient hybrid propulsion system.



*Far Sapphire's* hybrid propulsion solution includes generators, switchboards, converters and electric motors from ABB.

The substantial fuel savings and environmental benefits of electric propulsion are stimulating the industry to search for innovative new vessel-specific propulsion solutions. For AHTS with high bollard pull, a hybrid mechanical and electric propulsion solution is increasing in popularity.

AHTS vessels have traditionally been designed and optimized for high bollard pull performance and low construction costs, with little regard to operating costs and environmental operations. However, today's unpredictable fuel prices and the threat of more stringent environmental regulations are causing a change of thinking. In recent years, a new generation of fuel-efficient and environmentally-friendly AHTS vessels has been realized with hybrid propulsion.

### Combining the best of two technologies

AHTS vessels mostly operate with low engine power, and maximum engine power is required for short periods only. This operating profile is a good fit for a diesel-electric solution, but zero-speed bollard pull and maximum efficiency at full power are still important AHTS operating parameters. To realize the benefits of mechanical and electric propulsion, both technologies have been combined in a hybrid propulsion system.

A hybrid propulsion system typically provides the following operational modes:

- Full electric propulsion for maneuvering, transit and DP
- Full mechanical propulsion for tug operations and high speed transit
- Hybrid system for boosting maximum bollard pull when required

For large AHTS vessels requiring very powerful machinery installations, a hybrid propulsion solution is usually less expensive than a pure electric solution. Fuel consumption is about the same for a hybrid solution as for a fully electric solution. However, hybrid systems are more complex mechanically and require manual determination and selection of the optimal operational mode according to current conditions.

## Azipod® VI - podded propulsion for icegoing and icebreaking OSV's



Equipped with Azipod®, *Arcticaborg*, owned by Wagenborg Kazakhstan, has operated in the Caspian Sea since 2002.

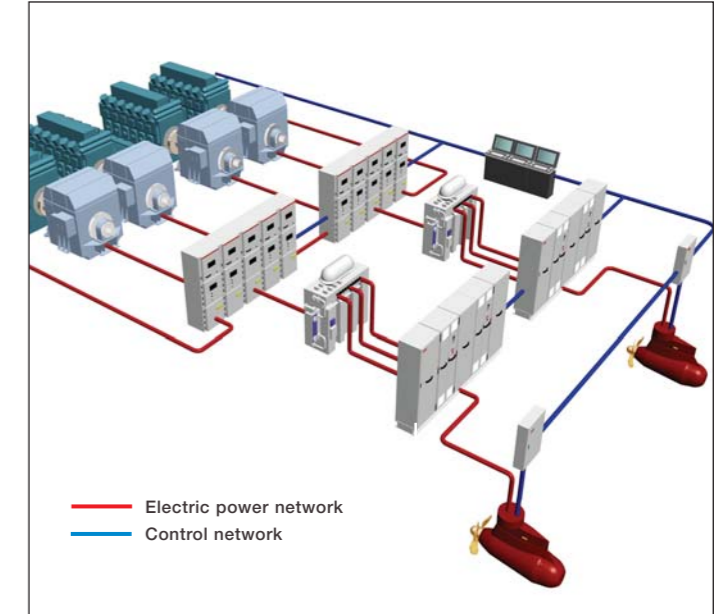


ABB is the only manufacturer of complete electric power and propulsion solutions for icegoing and icebreaking vessels.

The ice version of Azipod® is the leading propulsion system for icegoing and icebreaking vessels. For more than 20 years, Azipod® has proven its unique benefits and reliability in ice conditions, including propelling a number of ice-breaking OSV's operating in some of the harshest climates in the world.

### Ice competence and experience

Throughout the years, ABB has gained broad experience and a deep understanding of the arctic environment, ice conditions and, not least, the forces and ice-loads on ships and Azipod® in frozen water. Customers utilize our unique competence in designing and dimensioning the propulsion system for new icebreaking vessels. Our know-how in vessel power control and power plant design provides protection and minimizes the risk of black-outs in demanding arctic operating conditions.

### Unique icegoing features

Azipod® was originally developed for icegoing vessels, and its highly reliable mechanical design combined with unique maneuvering capability in ice has made Azipod® the system of choice in this market segment.

Azipod® propulsion attributes include:

- Robust mechanical design, no gears and no need for nozzle
- Capability to withstand high impact loads during ice-milling
- Strength to enable fast thrust changes
- Extreme ice-penetrating capabilities
- Enhanced maneuverability in heavy ice conditions
- Full torque and thrust in all directions - even at zero speed
- High hydrodynamic and mechanical efficiency

A typical ABB scope of supply to an icebreaking vessel includes one or more Azipod® units, frequency converters, propulsion transformers, main switchboards and propulsion control and monitoring system.

# Solutions based on standard, well-proven products all developed and manufactured by ABB

All main products in our offshore vessel solutions are produced in-house, which enables us to control and secure complete deliveries and simplifies lifetime maintenance and service.

ABB's products for marine and offshore applications are characterized by light weight and small footprint, low noise and vibration, and high efficiency. Straightforward construction gives high reliability with less maintenance. Certification by leading classification societies ensures compliance with all major international standards.

## Generators and electric motors

Our factories have produced generators and motors for more than 80 years. High efficiency and robust construction make our machines ideal for marine applications, providing considerable savings over the vessel lifetime. Our AMA and AMI motors are utilized for main propulsion and thruster applications and are produced for the power range up to 5.5 MW. They are delivered in both low and high voltage versions.

## Switchgears

MNS is ABB's intelligent, modular low voltage switchgear that is well proven in thousands of marine and offshore installations. MNS is delivered with ratings up to 5200A - 690V and is used for main switchgears, distribution switchgears and motor control centers (MCC). The design is compact and flexible with front and rear access, back-to-back or double side configurations, allowing MNS to be tailored to the specific needs of each installation.

## Transformers

For distribution, propulsion and thruster systems we use our RESIBLOC® transformer, an epoxy resin insulated, dry type transformer that is designed to fulfill the most exacting requirements. These non-flammable, environmentally safe transformers are relied upon to withstand stress from high voltage peaks that can occur in marine networks. ABB has produced RESIBLOC® transformers for over 30 years.



Synchronous AMG generator



Low Voltage MNS switchgear



RESIBLOC® dry type transformer

## Marine Variable Speed Drives

Based on our unique Direct Torque Control (DTC) motor control technology, ABB marine drives for propulsion and thruster applications offer the most accurate and smooth speed and torque control available.

Our marine drives feature a unique water-cooled design with small footprint, light weight and simple construction for high reliability. Depending on the requirements of each project, ABB can deliver drive solutions with 6-, 12-, 24- and quasi 24-pulse/AFE configurations.

## Azipod® CO and CZ electric podded propulsion

Azipod® CO and CZ are unique all-in-one propulsion and steering solutions that stand out from other thrusters due to their built-in electric motors. A fixed propeller is mounted directly to the motor shaft, eliminating mechanics such as gears, shaft lines and bearings, which makes the thruster unit extremely resilient to mechanical stress and wear.

With a pulling propeller design, Azipod® CO provides high hydrodynamic efficiency. The pulling propeller works in an optimum environment where the water inflow is homogenous and undisturbed. Driven by an advanced permanent magnet motor with no mechanical transmission losses between motor and propeller, overall propulsion efficiency is very high. Azipod® CZ has a pushing propeller and is a highly efficient podded thruster unit with excellent thrust performance.

## Compact Products 800 automation platform

ABB's marine automation systems are based on the ABB Compact Products 800 system concept, which is scalable in both size and performance and is distinguished by its overall user friendliness. The system hardware including controller, I/O panels and operator interface is easy to configure, set-up and program. Usual vessel functions are implemented by standard software modules and customer-specific requirements are handled by advanced programming and engineering tools.



Compact, water-cooled ABB marine LV drive



Azipod® CO propulsion unit



Azipod® CZ thruster unit



Working with our customers all the way -  
from the early concept phase throughout the life of the vessel



ABB's commitment starts early in the project by contributing services to ensure optimal ship design and efficient, on-time project execution. Ongoing services are provided through our global Marine Services Center network.



**Project services**

In the design phase, ABB helps our customers develop and optimize the total vessel concept through evaluation of electrical power and propulsion solutions and life cycle cost analysis. Throughout the building phase, we offer a full scope of services to customer requirements. ABB assigns a dedicated project manager for each OSV project to serve as a single point of contact for all aspects of project management and execution.

**Commissioning and training**

ABB Marine has a proven track record of providing high quality commissioning services. ABB service engineers together with the project team are actively involved in commissioning and apply clearly defined commissioning processes, and proven procedures for start-up and sea trials.

To provide our customers with the necessary understanding and working skills for our equipment, ABB Marine Academy offers a broad spectrum of specialized training courses at one of our training centers, onboard or remotely.

**Preventive and on-call services**

The ABB service concept is a framework of specialized services designed to provide the highest equipment availability and optimum vessel performance. For ongoing technical support, ABB offers Preventive Maintenance programs and On-call Services. Preventive Maintenance includes tailored Maintenance Contracts, Spare Parts programs, the e-MST day-to-day Maintenance Support Tool and Remote Diagnostic Services (RDS). Our 24/7 Service Hotline and qualified service personnel are available whenever you need us.

**System upgrades and modernizations**

ABB's R&D investments in electric power and automation technologies exceed a billion dollars a year and more than half of this is devoted to improving energy efficiency. To make these technology developments available to our marine customers we offer product enhancements and upgrade packages for existing onboard systems. For vessel lifetime extension and compliance with new safety and environmental regulations, we perform equipment overhauls, upgrades and replacements. We deliver complete modernization projects for propulsion and thruster systems, electric power systems, drives and automation systems.



**Project Services**  
 Conceptual Design | Project Management | Project Engineering | Commissioning | Training - Marine Academy



**Ongoing Services**  
 Preventive Maintenance | Spare Parts | On-call Services | Modernization