KONGSBERG

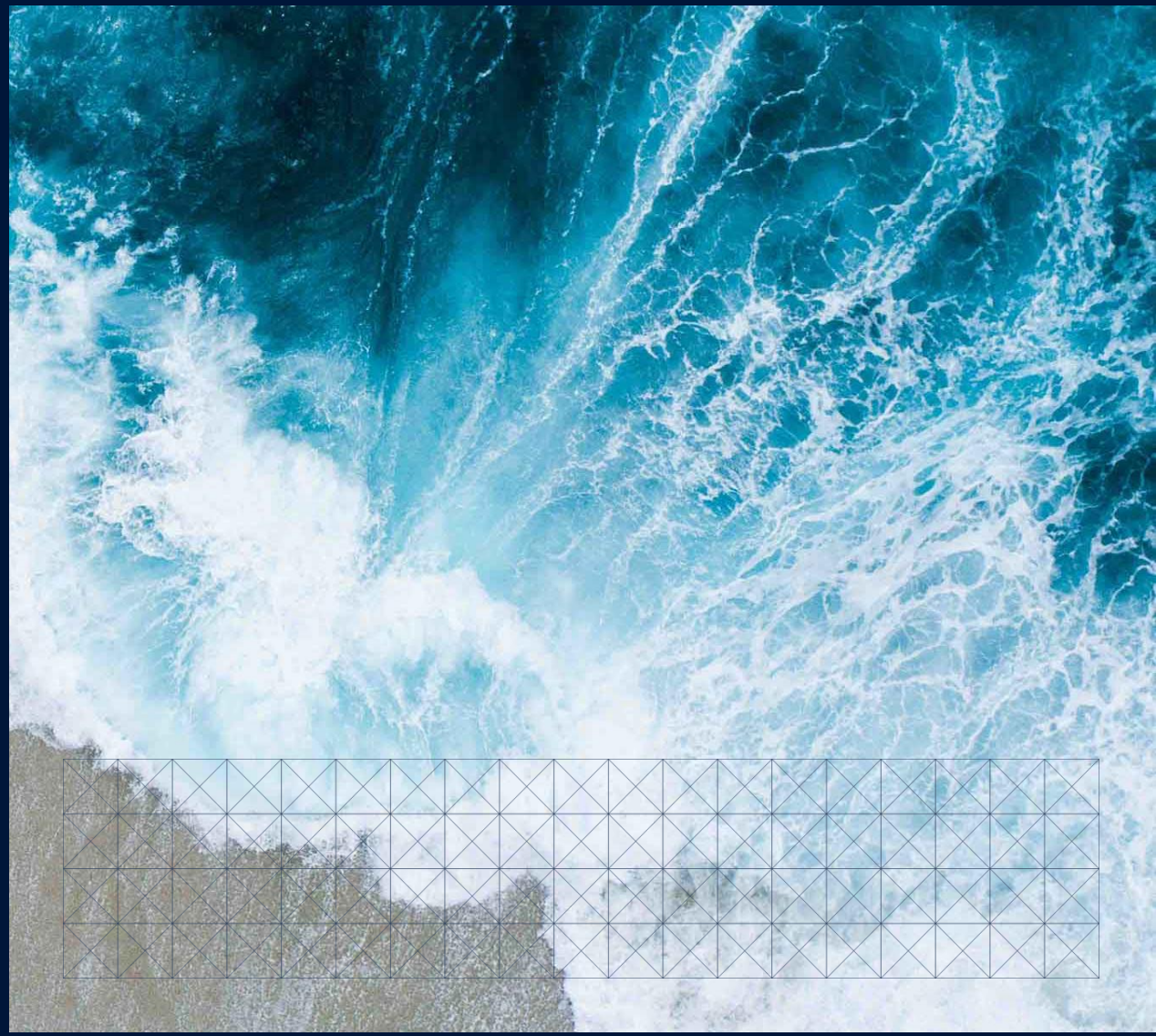
SUSTAINABLE MARINE TRANSPORT

Hybrid propulsion solutions – building blocks and applications

25/04/2019

Dr. Erling Johannessen

General Manager Product - Electrical



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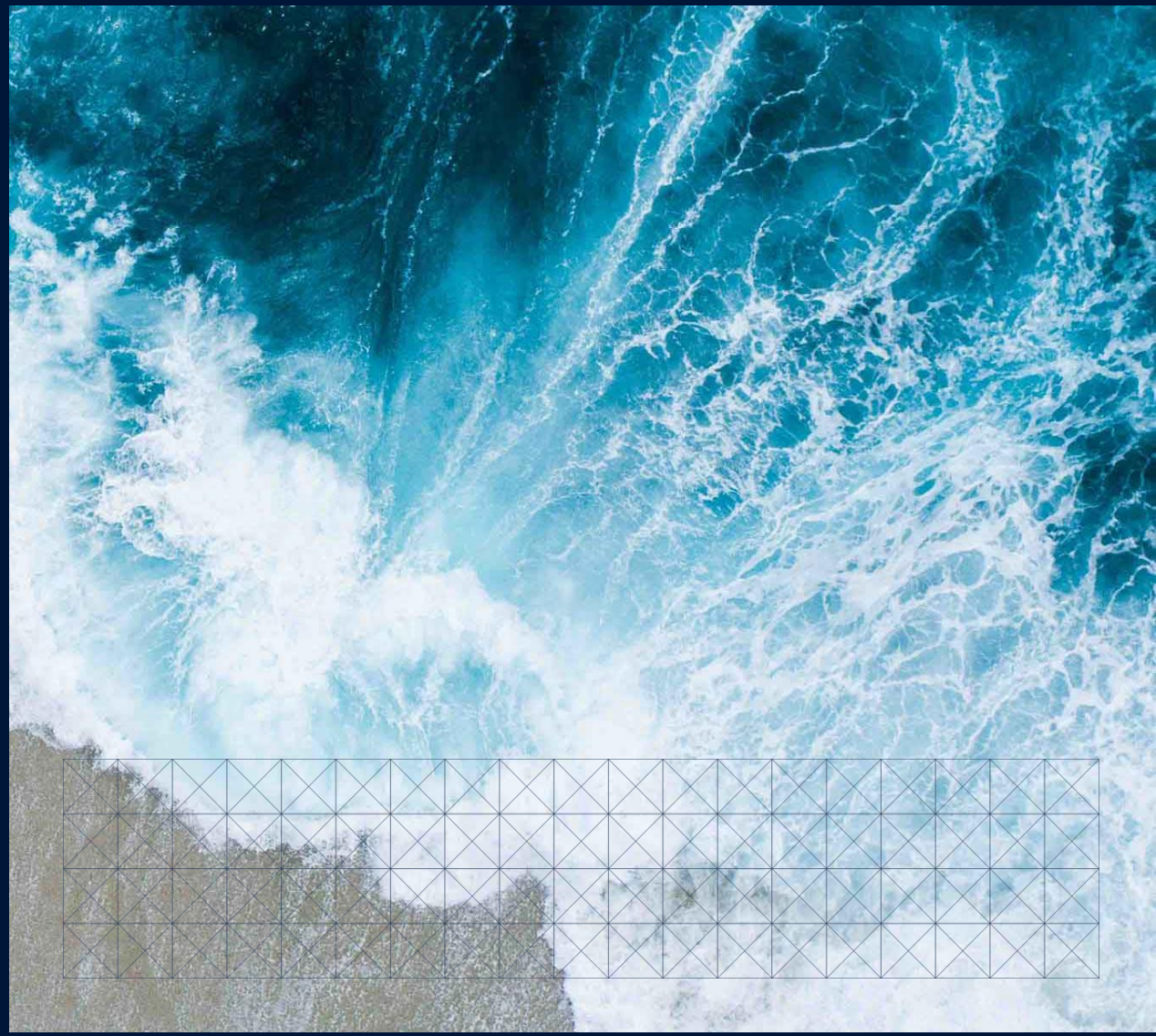
Two Great Companies

PERFORMING TOGETHER

1 April 2019



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A perfect fit

Performing together to shape the future of the maritime industry

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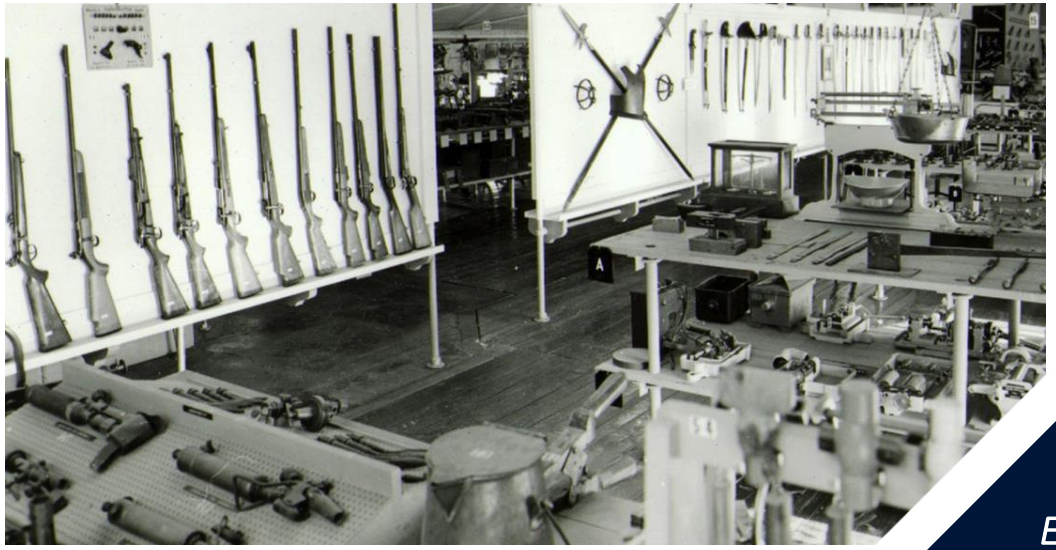
KONGSBERG has a long and unique history

Our history spans over two centuries



Est.
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Our Vision

Our Values


DETERMINED
COLLABORATIVE
INNOVATIVE
RELIABLE://
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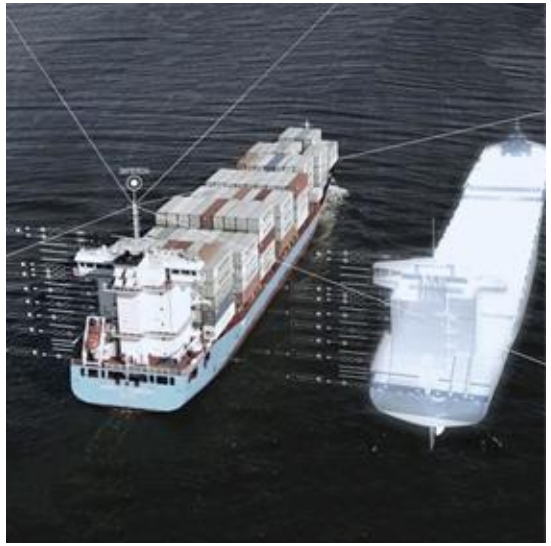
Our Solutions

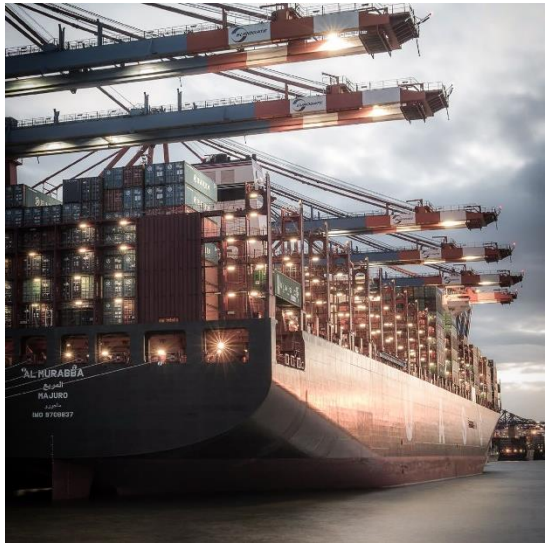
Business Areas

Technology is our common core



KONGSBERG DIGITAL

Maritime simulation
Industrial digitalization



KONGSBERG MARITIME

Seaborne transportation
Robotics and Sensors
Offshore, Oil & Gas

KONGSBERG DEFENCE & AEROSPACE

Defence
Space and Surveillance

The Maritime Industry is Changing

COST OPTIMIZATION **DIGITALIZATION** **SUSTAINABILITY** **SIZE MATTERS**

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Our Global Reach

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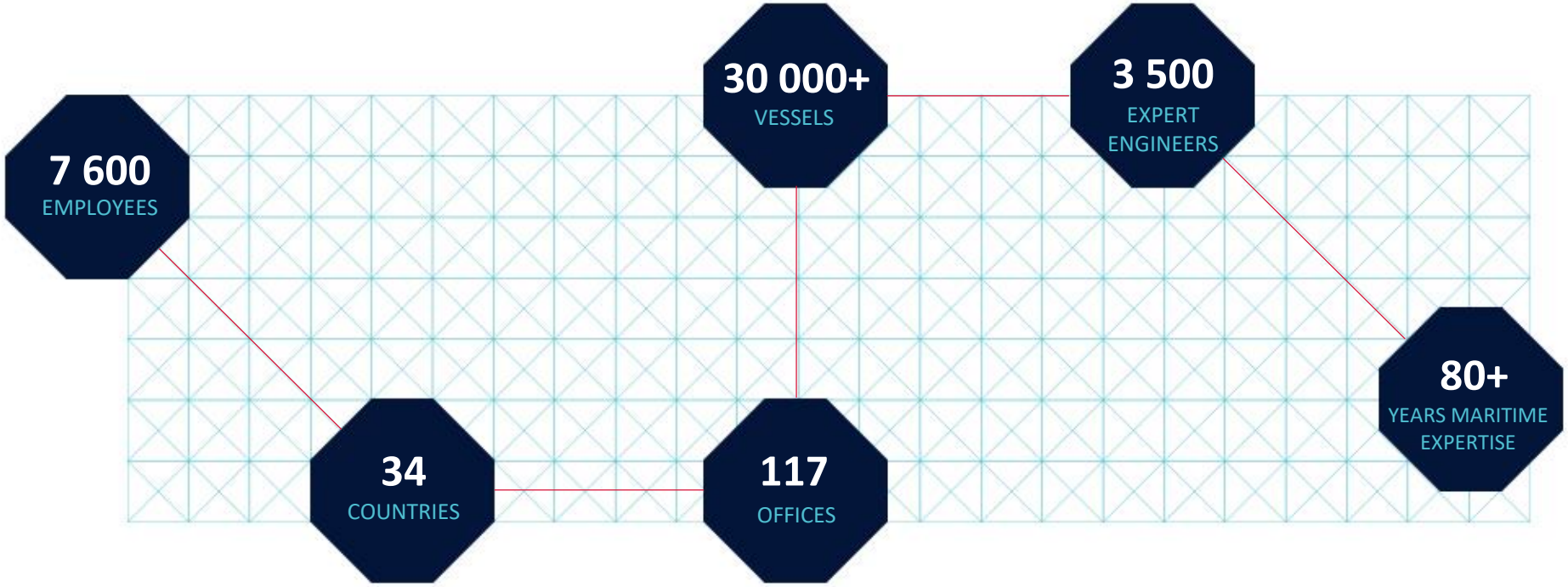
Kongsberg Maritime

Company Highlights



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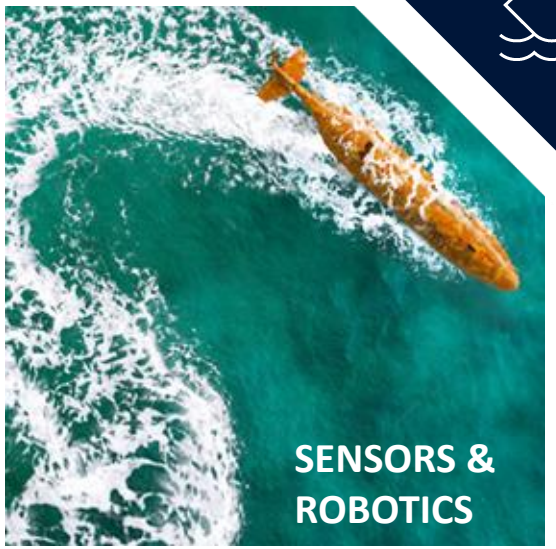
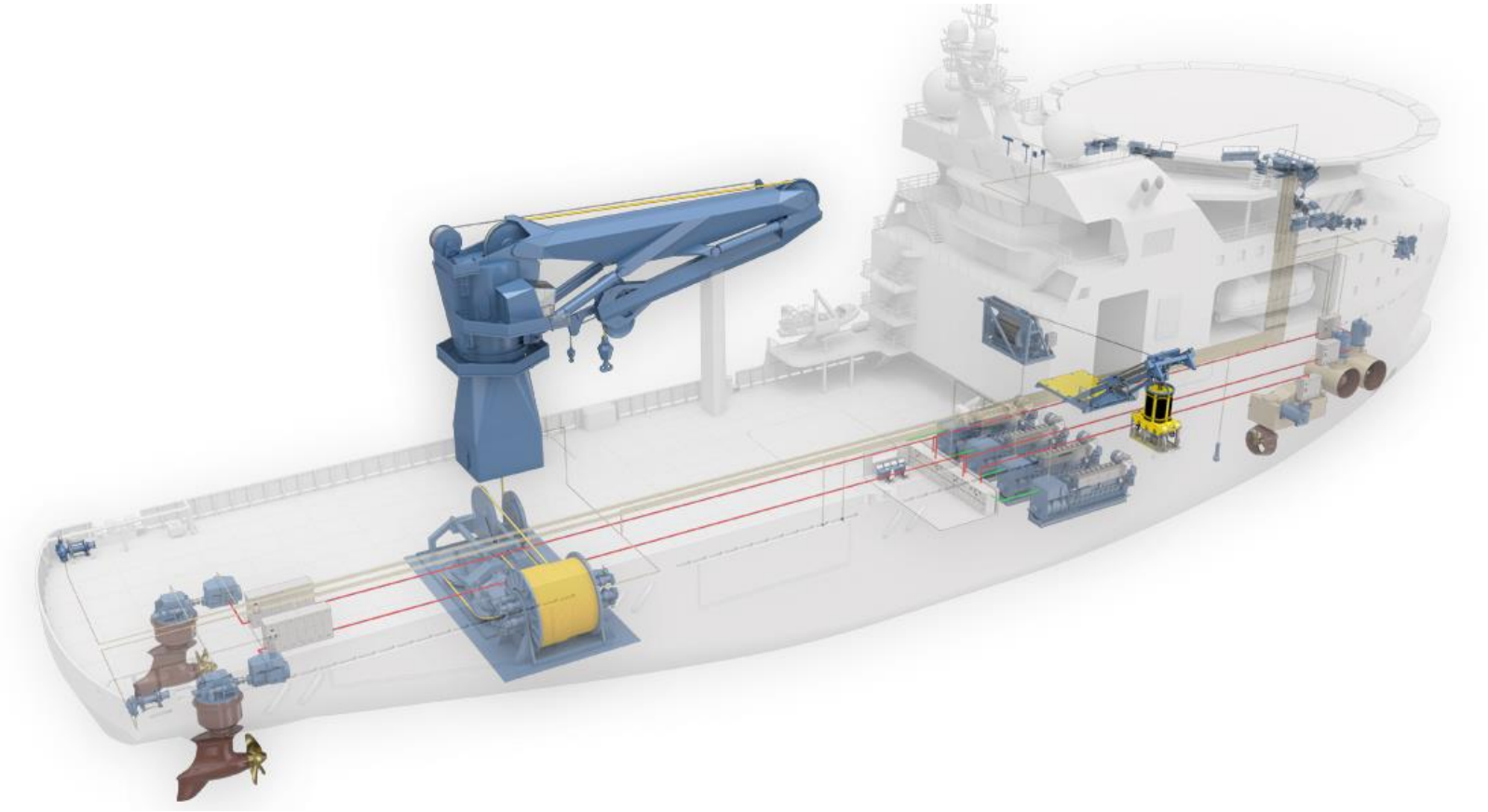
The Broadest Portfolio of Products

Throughout the entire maritime industry



Enabling stronger system integration capabilities

From the bridge down to the propeller



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In Summary

Two highly complementary organizations

- A broad range of complementary World Class maritime products
- Allowing for seamless integrated solutions from throughout the vessel
- A strategic partner for improving efficiency and operational capabilities of the vessels

World leading Sales & Service network

- A strong global sales- and service network across 34 countries
- Global reach, local presence – wherever the customers are
- Servicing a combined installed base of approximately 30,000 vessels

Shaping the maritime technologies

- Combining the best of the maritime industry's leading engineering capabilities
- Industry leadership in today's as well as future technologies such as digitalization, remote operations and autonomy

Economies of scale

- Complementarity enables scale
- Scale allows for more efficient operations
- An even more robust and competitive organization


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Maximizing performance by providing
THE FULL PICTURE

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Outline

- Hybrid propulsion systems – definition?
- Building blocks
  - Power electronics
  - Energy storage
- Selected application
  - Multipurpose vessel for the Norwegian Coastal Administration

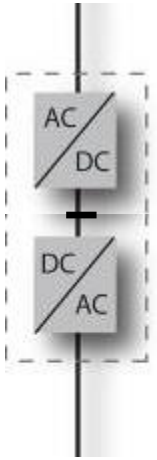
Hybrid propulsion - definition

- Traditional propulsion solutions
  - Main engine coupled to propeller
  - Variations: Controllable pitch and gearbox
- «First generation hybrid» - hybrid transmission
  - Power Take-In/Power Take-Out on gearbox
  - Linking main propulsion and switchboard/vessel power station
- Our definition: Hybrid propulsion
  - Propulsion solutions with energy storage elements in the power system
  - Energy storage enables «de-coupling» of electrical producers (typically generating sets) and consumers (propulsion, «hotel» load)
  - Typical usage: **Zero emission**, **peak shaving**, **spinning reserve**

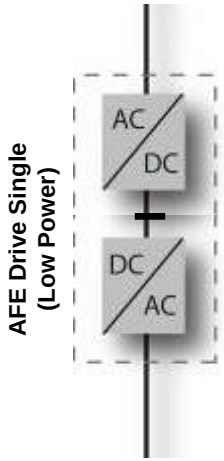
Building block: Power electronics

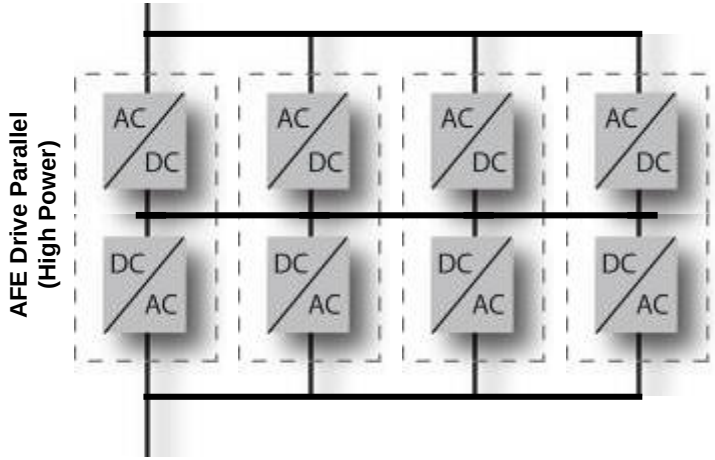
Power conversion and control

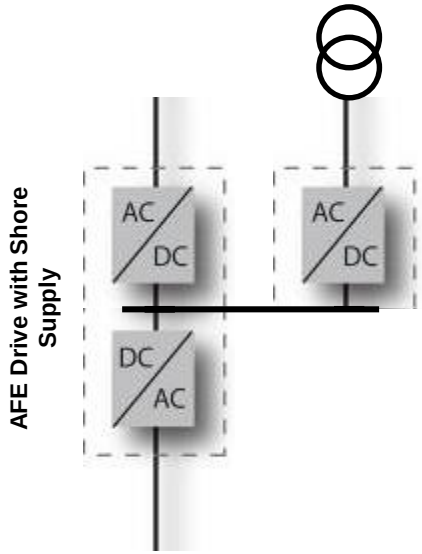
- Frequency conversion
  - Traditional – full bridge: Fixed AC to variable AC
  - AC to DC
  - DC to AC
- Voltage level matching
  - E.g. DC to DC
- State of the art technology
  - IGBT – Insulated-Gate Bipolar Transistor
  - High frequency real time control of transistor switching – microsecond resolution
- Enables delicate power flow control

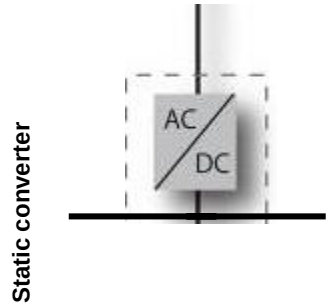


Power electronics «LEGO»



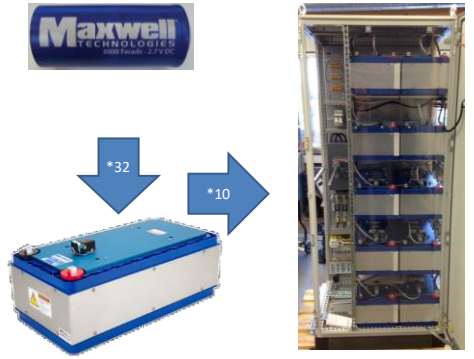




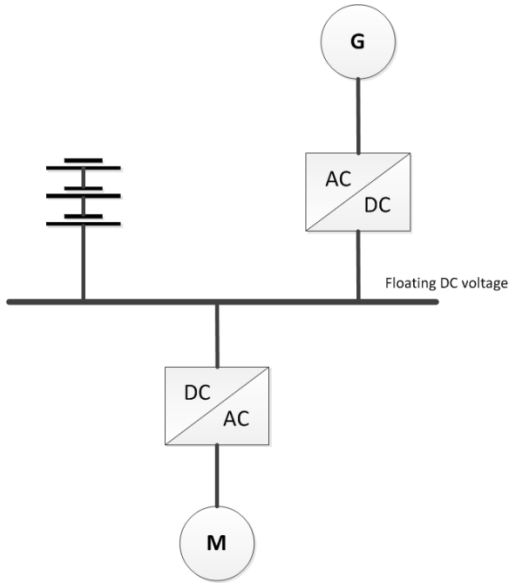


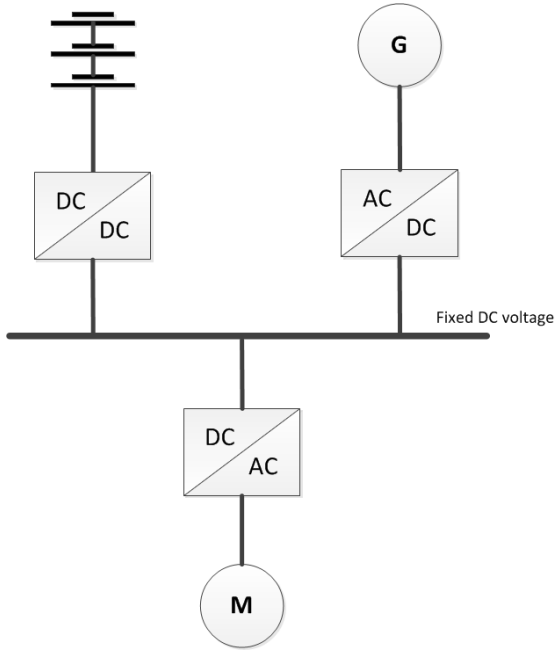
Building block: Energy storage

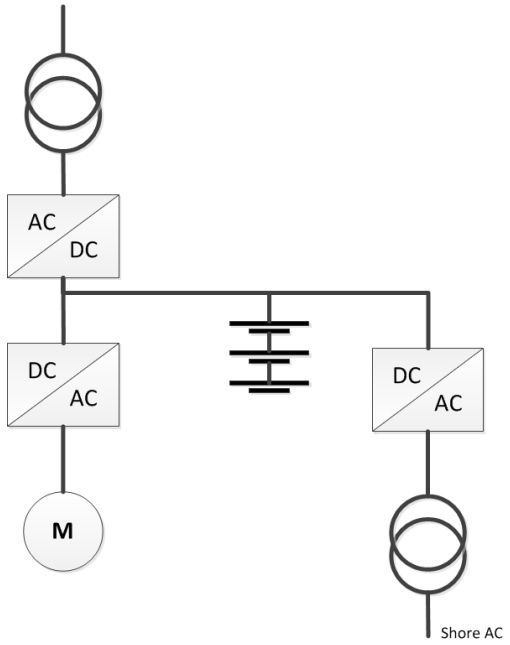
- **Characteristics**
  - Dynamic performance – charge and discharge
  - Capacity
  - «Size»
  - Cost
  - Safety
- **Super capacitors**
  - Limited capacity, high dynamic performance
- **Batteries**
  - Li-Ion – various «chemistries»
  - High power
  - High energy



Arranging energy storage in power systems







Energy storage experience

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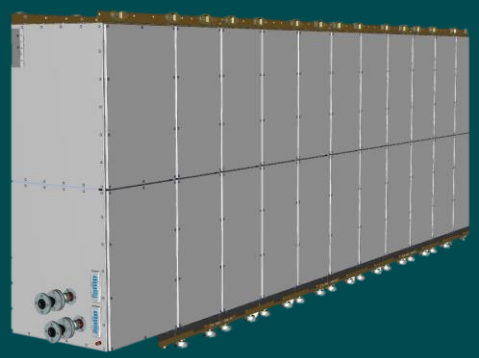
SAVe Energy

- Energy Storage Systems in operation since 2010
- 35 MWh+ delivered or in ongoing projects



9 x Platform supply vessels

1 x Fishing vessel

2 x Multipurpose vessels

9 x Cruise vessels

1 x Sailing vessel

1 x Research vessels

OV Ryvingen

Innovation in multipurpose vessels

Products + Engineering = Systems

Kristian E Holmefjord

Product Systems – Electrical, Automation & Control

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The NCA Replacement Plan

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Norwegian Coastal Administration

To make our coast and waters the safest and purest in the world.




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Norwegian Coastal Administration

NCA Fleet
Replacement Plan

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Norwegian Coastal Administration

This is where we work

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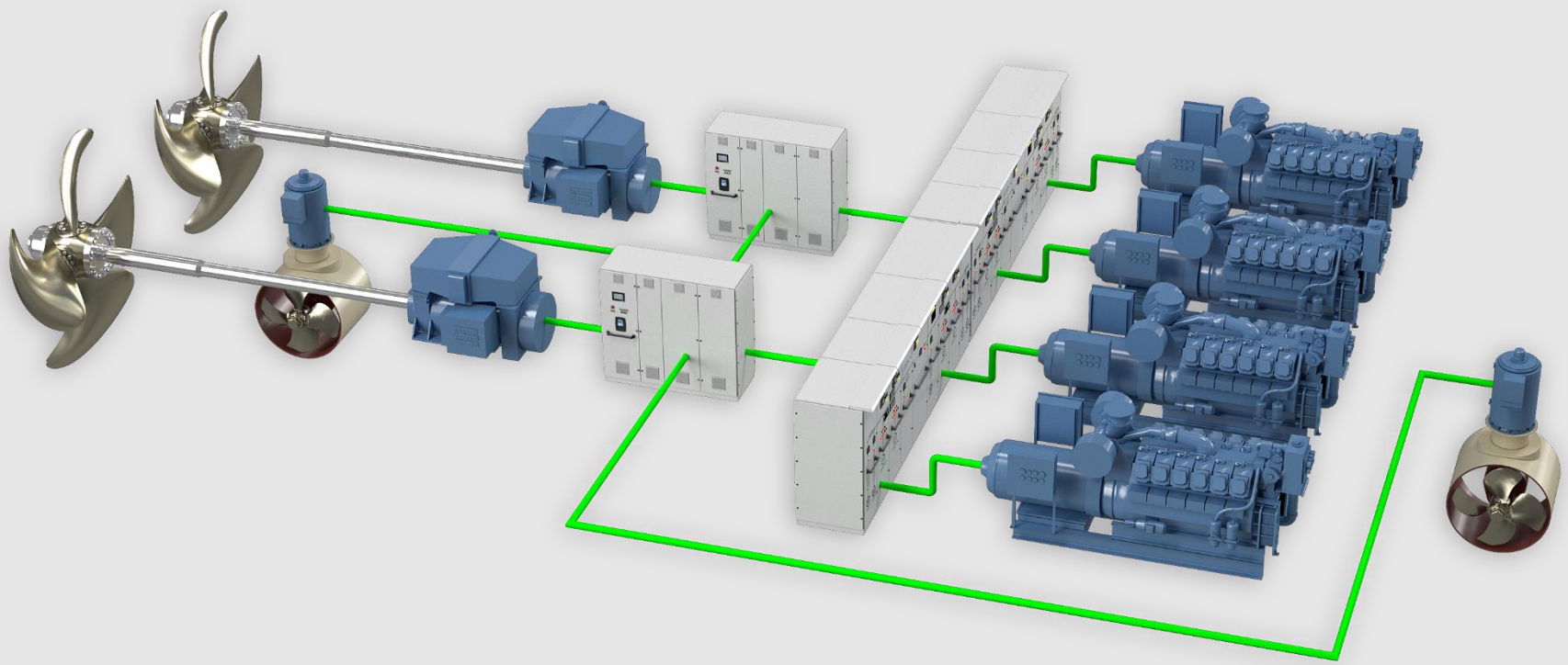
Norwegian Coastal Administration

The Replacement Plan

Vessel No. 1

Diesel Electric
4 high-speed engines
Multi Drives
Shaft line propellers
2 Tunnel thrusters

Vessel No. 2



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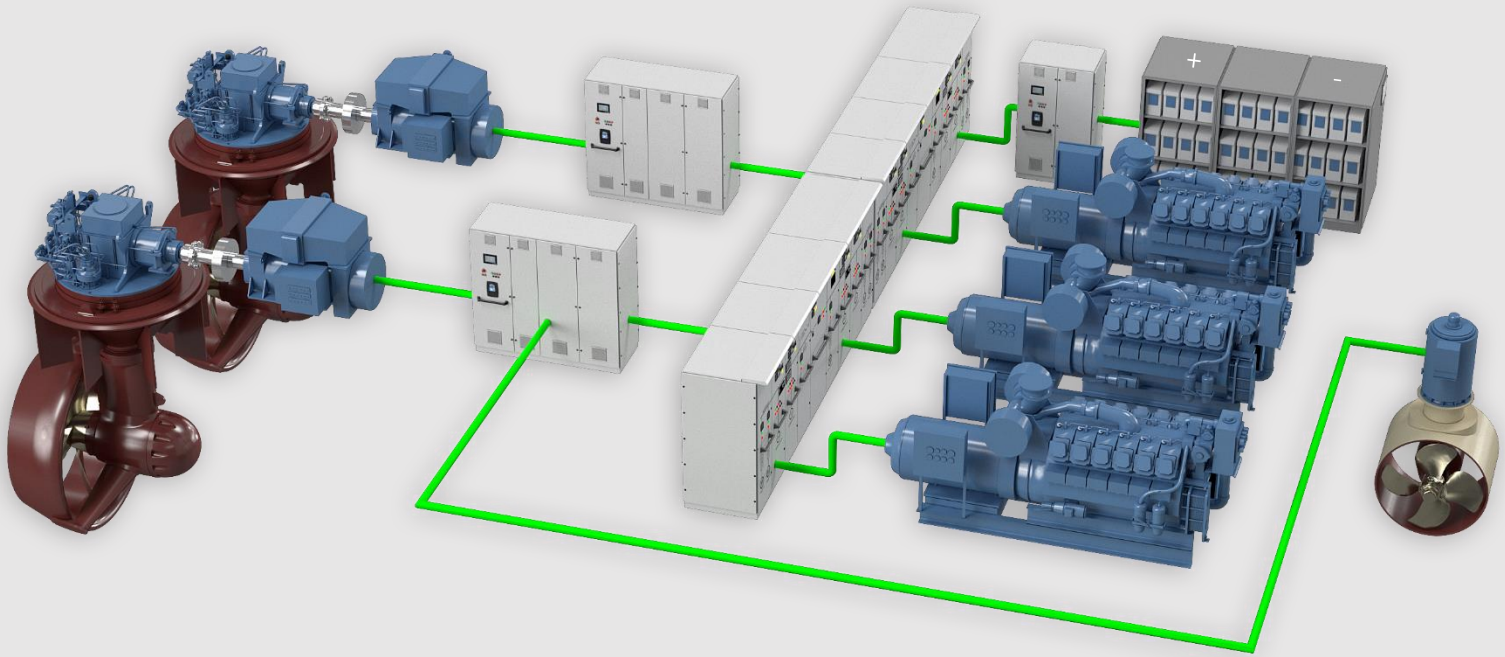
Norwegian Coastal Administration

The Replacement Plan



Vessel No. 3

From four to three engines by converting from shaft propellers to azimuth thrusters, freeing up space for a battery solution. Due to azimuth thruster the aft tunnel thruster could also be removed.

New Technology

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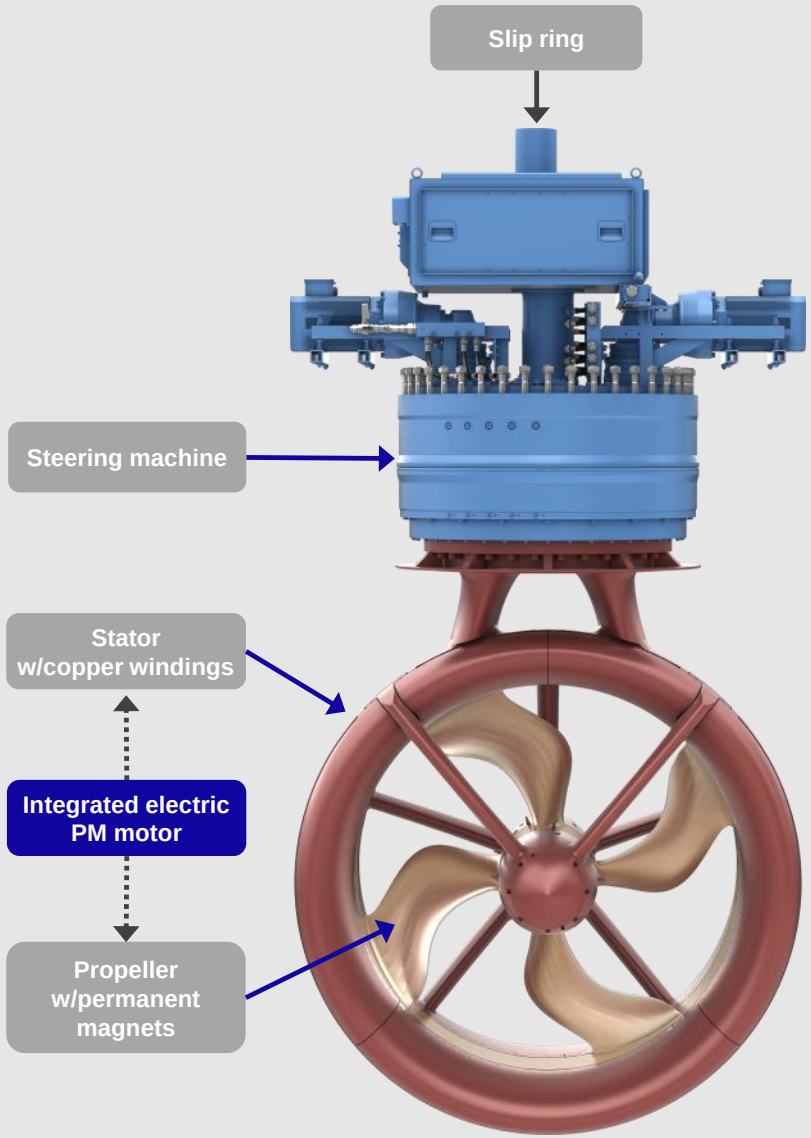
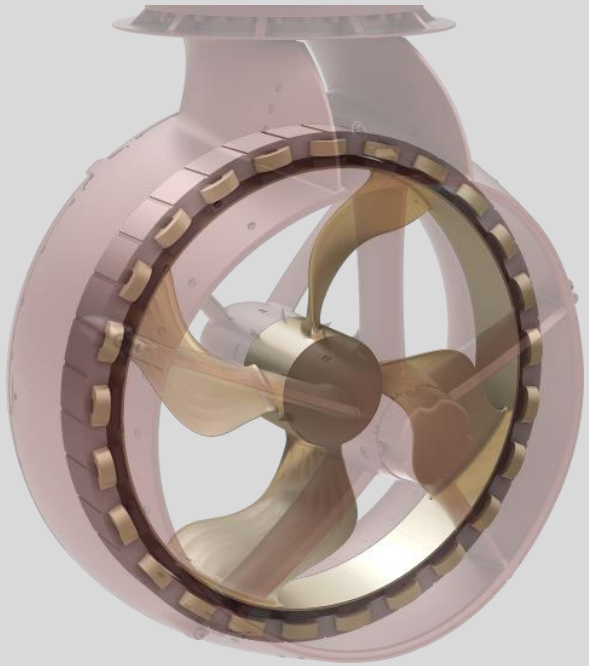
New Technology

The worlds first commercial Permanent Magnet Azimuth Thruster



What and Why

1. Efficiency
2. Simplicity
3. Compactness
4. Comfort



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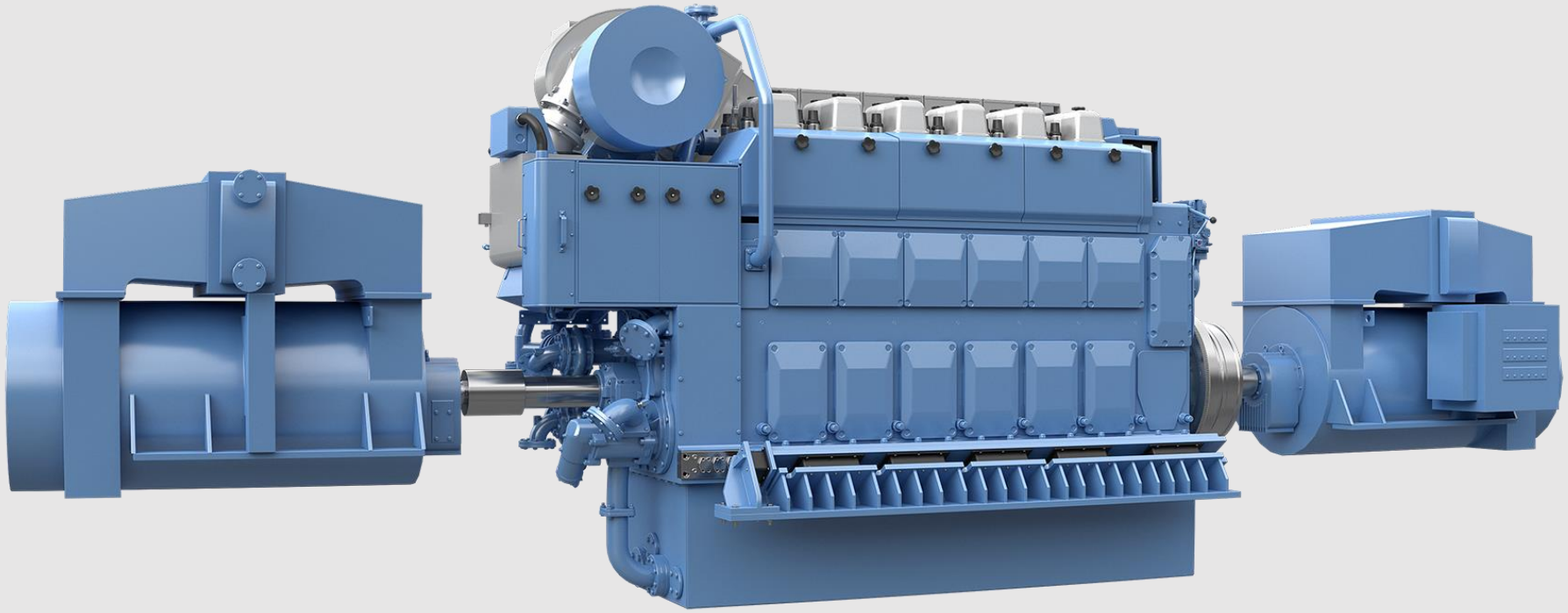
New Technology

Dual Generator System

Approval in Principle by DNV GL



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New Technology

SAVe CUBE
All frequency drives housed in a single DC Distribution Switchboard

The OV Ryvingen

Case study

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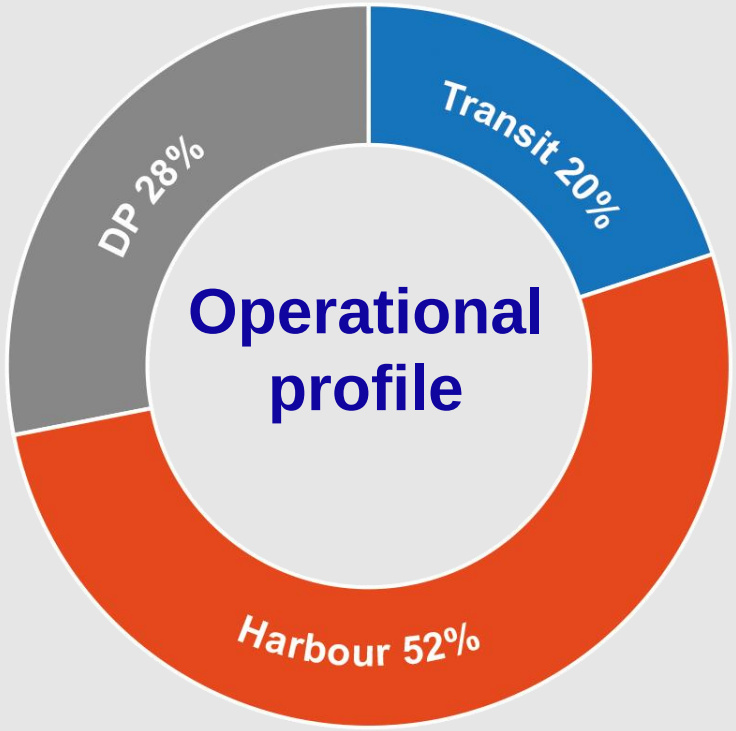
The OV Ryvingen case study

Vessel No. 4:
OV Ryvingen

Fitjar Mekaniske Verksted
Heimli Design



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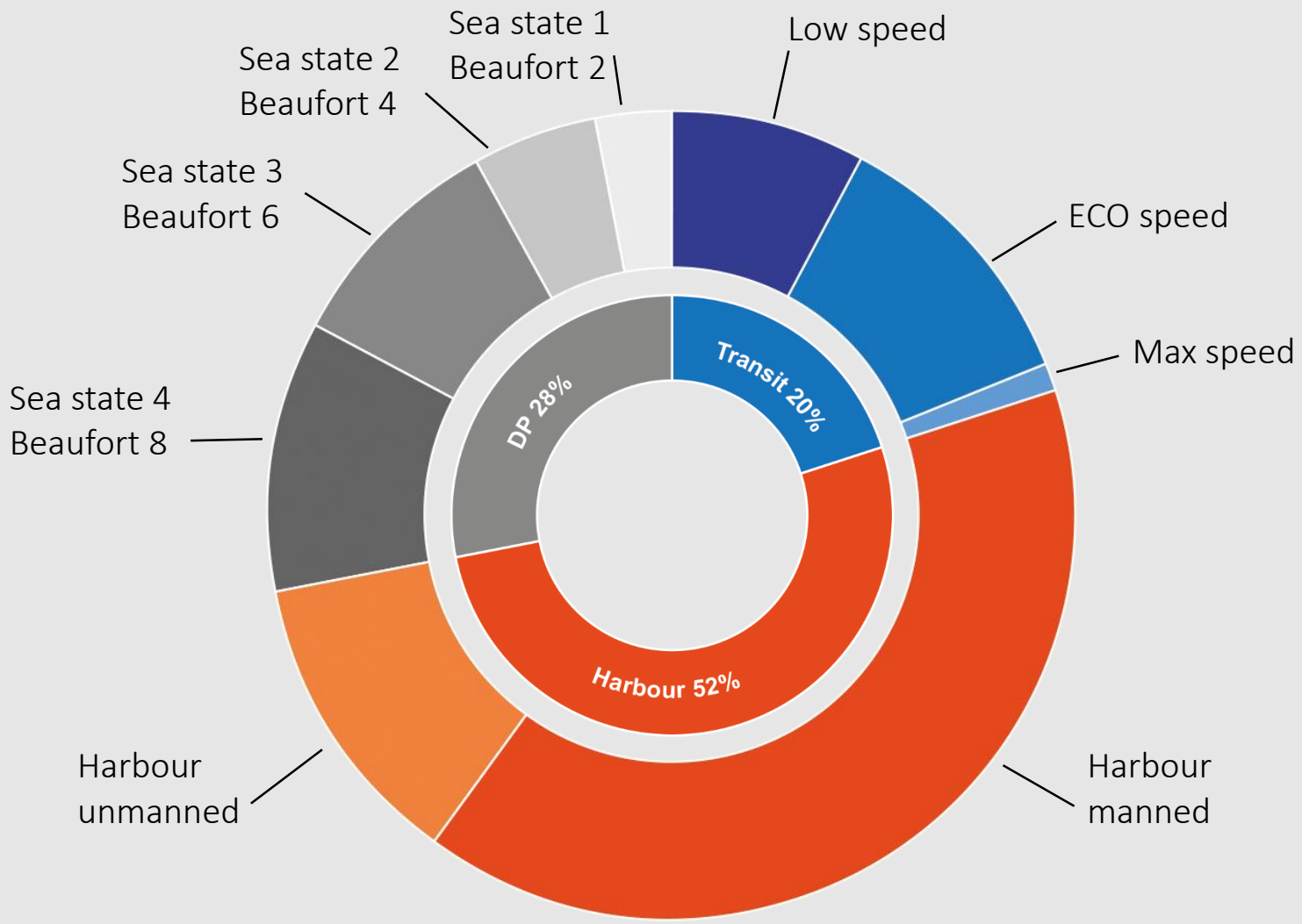
The OV Ryvingen case study

Breaking down the operational profile gave necessary background information for a tailor-made system

Detailed Operational Profile



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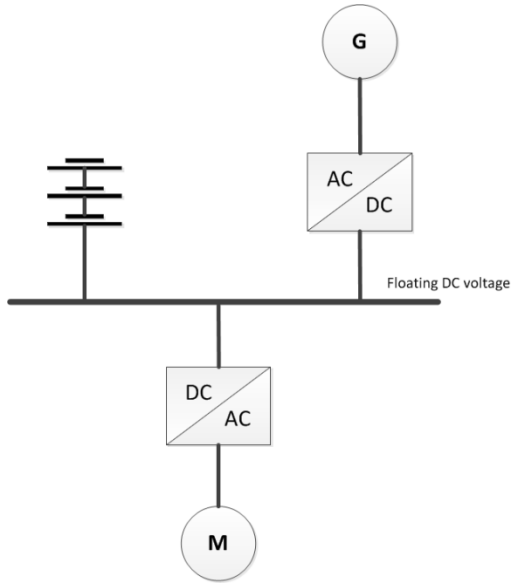
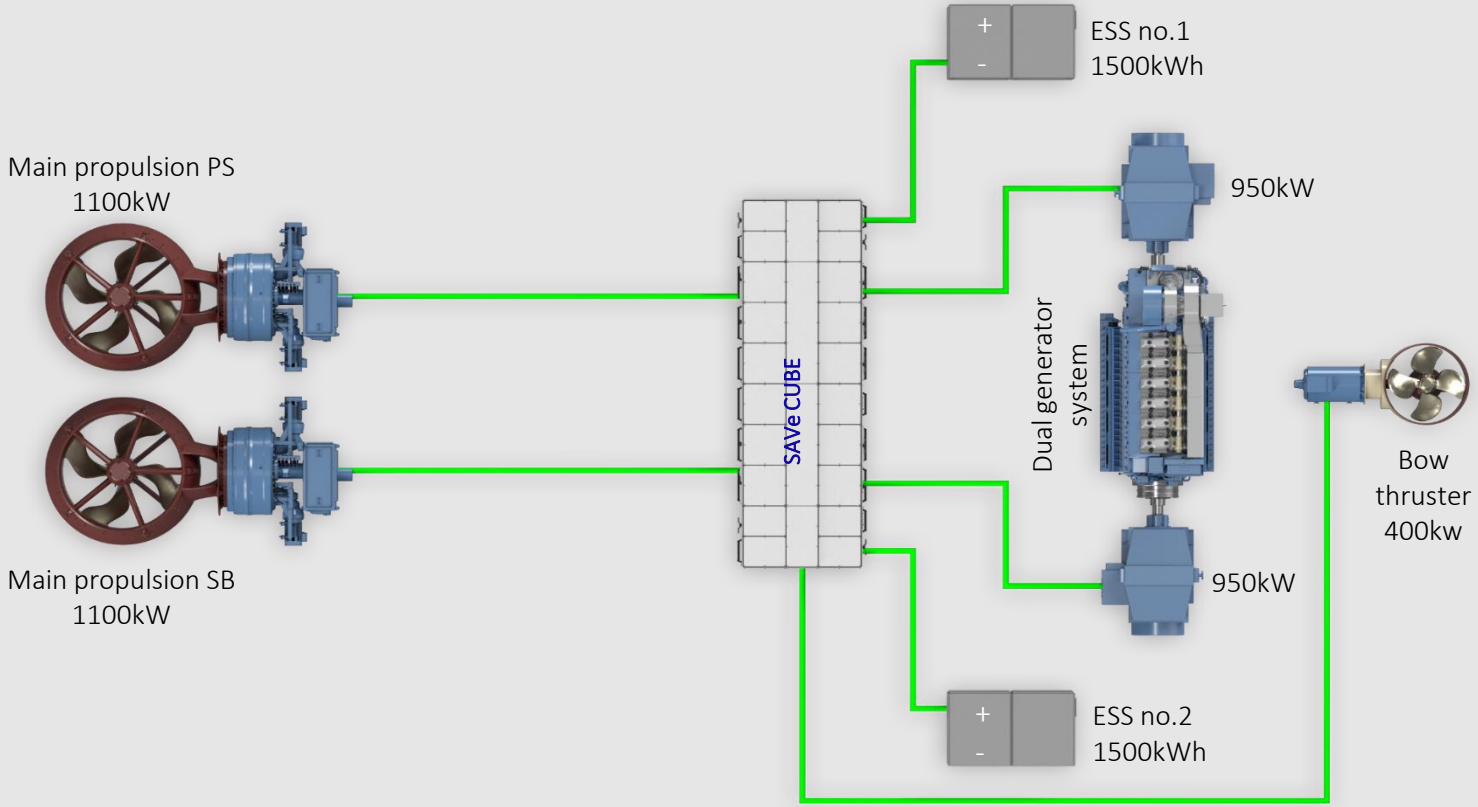
The OV Ryvingen case study

Power System Overview

Solution principle:



A unique innovation for a multipurpose work vessel. A six-cylinder medium-speed engine running a dual generator system replaced the three high-speed engines – a massive improvement in both fuel efficiency and maintenance.



From 42 to 6 Cylinders

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The OV Ryvingen case study

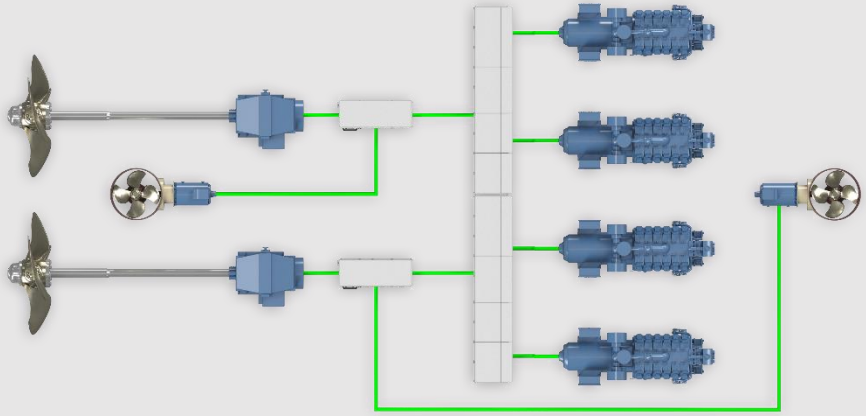
From 42 to
6 cylinders

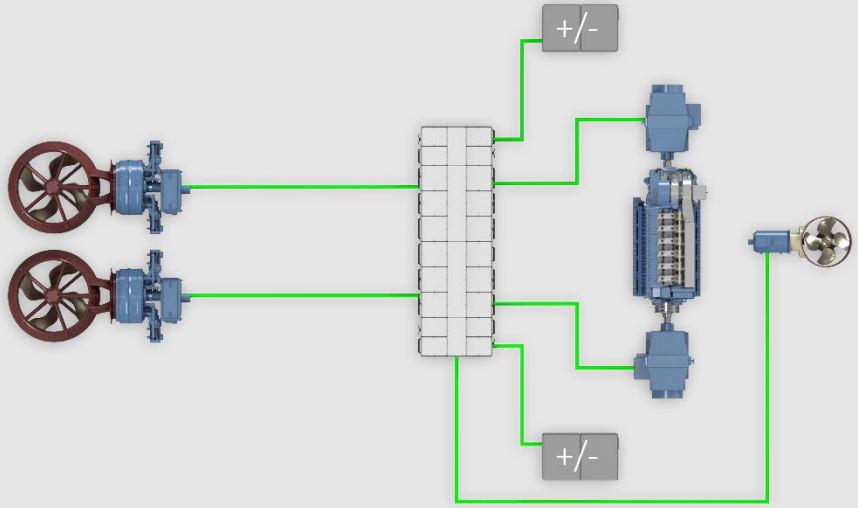
From multi-drives
to fully integrated
DC switchboard

From shafted
propellers to worlds
first permanent
magnet azimuth
thruster

Vessel No. 1

Vessel No. 4





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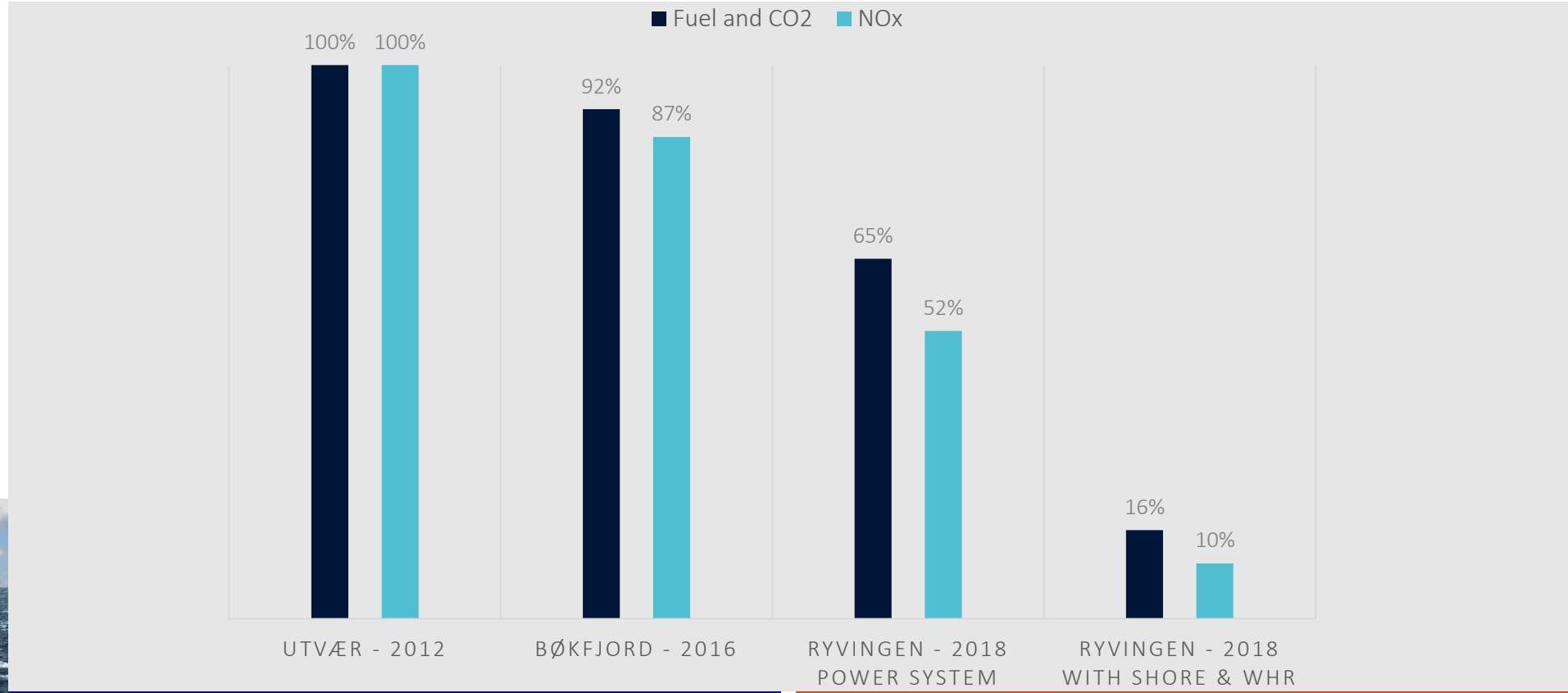
The OV Ryvingen case study

Complete Delivery



Products:

- 1 x Diesel Engine C25:33L6AV, 2000 kW
- 1 x SAVe Cube Hybrid
- 2 x Electrical Generators, 950 kW
- 2 x Azimuth Thrusters PMAZM 1900, 1100 kW
- 1 x Tunnel Thruster TT1300 CP, 400 kW
- 1 x Motor, 400 kW for TT
- 2 x Switchboards (440V + 230V)
- 2 x Energy Storage Systems, 1500 kWh each
- 2 x Versatile Shore Connection, 99 kVA

Systems:

- Energy Management 2 System (EM2)
- Power Management System (PMS)
- Integrated Blackout Prevention System (BPS)
- ACON Integrated Automation System (IAS)
- Icon Dynamic Positioning System 1 (DP1)
- Poscon Joystic System
- Helicon X3 Control System

OV Ryvingen

User Experience

OV Ryvingen

First full-electric operation Feb 13th, 2019

- Two separate battery packs enables efficient engine use.
- High responsiveness.
- Improved maneuverability at low speeds.
- Noise reduction improves safety, efficiency and work environment.

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Thank you!

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