Integration of Engines and Propulsion Systems in the Marine World

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INTRODUCTION

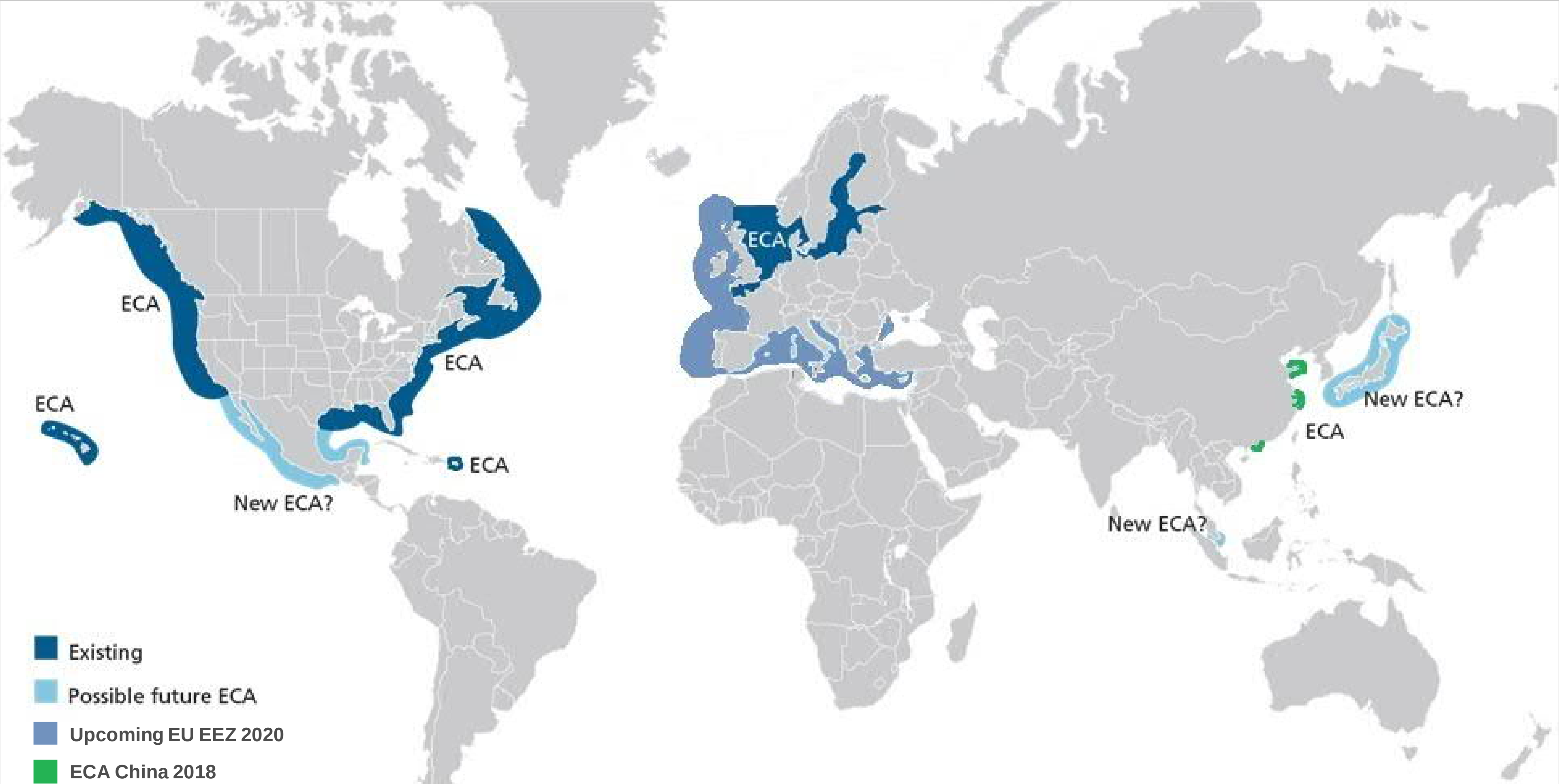
The Trends and Challenges in the Marine Industry

The Engine and Propulsion Products

The Propeller Systems Integrated Solutions

Concluding Remarks

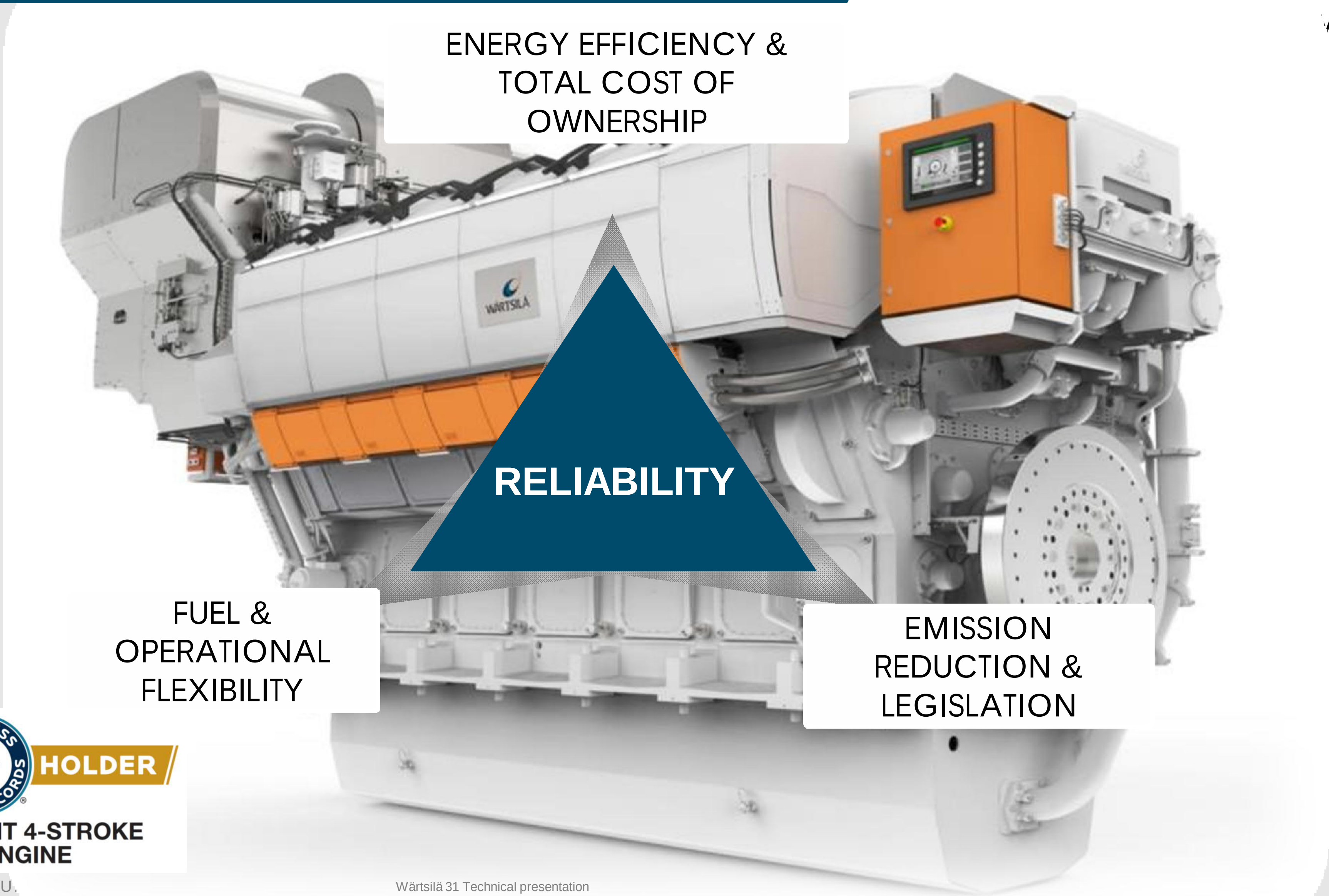
CURRENT AND POTENTIAL EMISSION CONTROL AREAS



As of January 1st 2016 China has enforced 3 new ECA's: Perl River Delta, Yangtze River Delta & Bohai Rim.

2016 – Individual ports can implement 0,5%S fuel requirement.
2017 – 0,5%S fuel requirements in all ports for ships staying longer than 2 h.
2018 – Vessels entering ECA ports need to use 0,5%S fuel at all times.
2019 – Vessels operating within an ECA need to use 0,5%S fuel at all times.

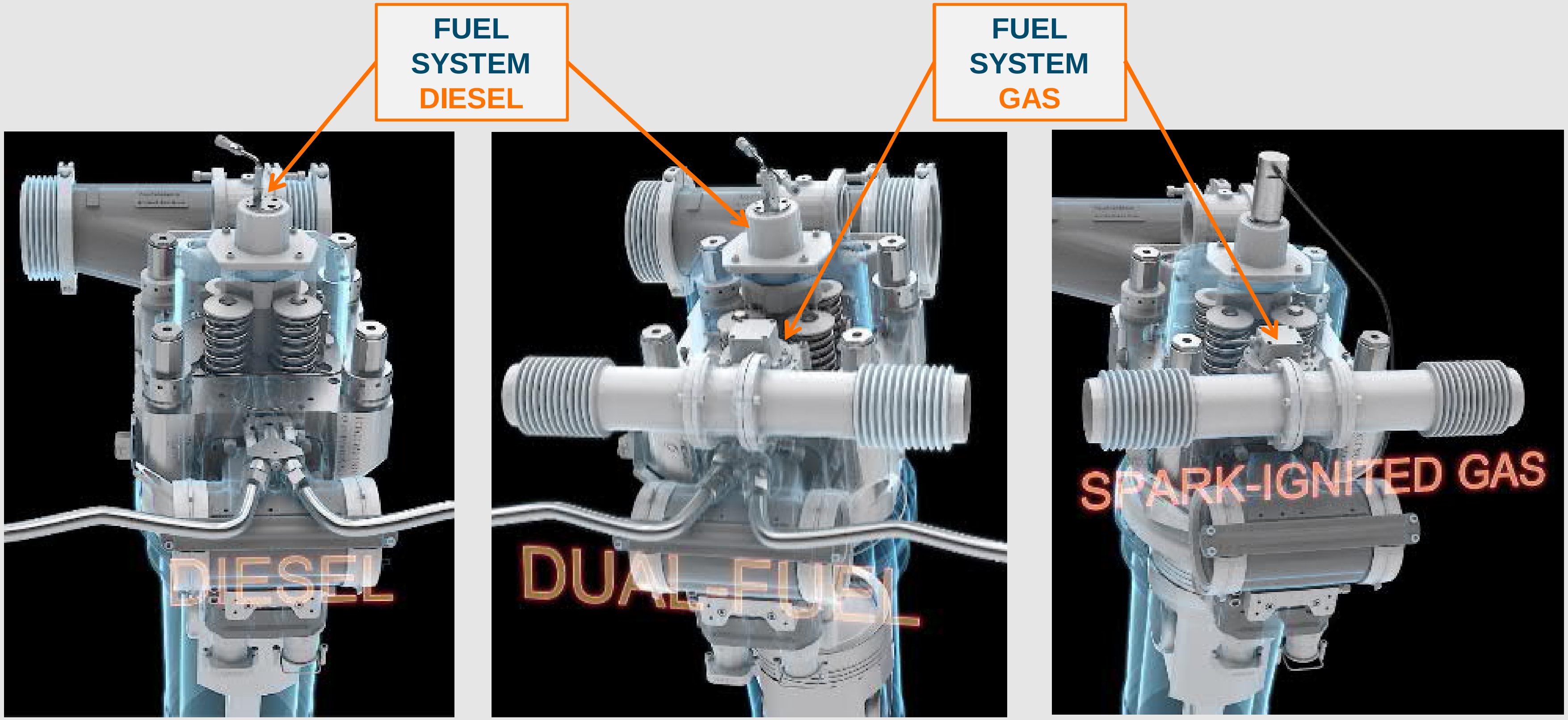
W31: WHAT HAS BEEN THE DRIVERS FOR THIS ENGINE DEVELOPMENT



RECORD HOLDER GUINNESS WORLD RECORDS

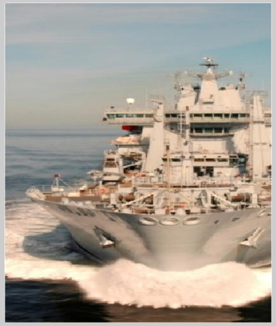
MOST EFFICIENT 4-STROKE DIESEL ENGINE

W31: FUEL FLEXIBILITY BUILT-IN



> Fuel flexibility, three-in-one

MARINE MARKET SEGMENTS AND PROPULSION SYSTEMS

		Merchant	Offshore	Cruise and Ferry	Navy	Special Vessels
						
MAIN PROPULSION UNITS	Propellers (FP/ CP)	●	●	●	●	●
	Steerable thrusters		●	●		●
	Waterjets		●	●	●	
MANOEUVRING UNITS	Tunnel Thrusters	●	●	●	●	●
	Rudders	●		●		●
ENABLING SYSTEMS	Gear Boxes	●	●	●	●	●
	Propulsion Controls	●	●	●	●	●

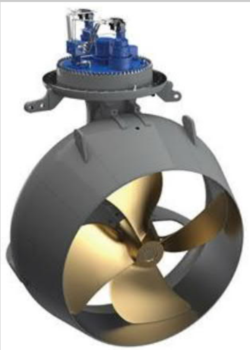
PROPULSION SYSTEMS

Inland water ways
Propeller diameters < ~3 m

Fixed Pitch Propellers
Propeller diameters up to 12 m

Controllable Pitch Propellers
Propeller power up to 60.000 kW

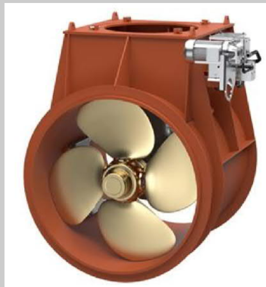
Waterjets
Power up to 33.000 kW



Offshore thrusters
Power up to 6.500 kW

Steerable thrusters
Power up to 3.200 kW

Special applications
i.e. ICE POD



Tunnel thrusters
Power up to 4.500 kW

Efficiency rudders

Marine gears

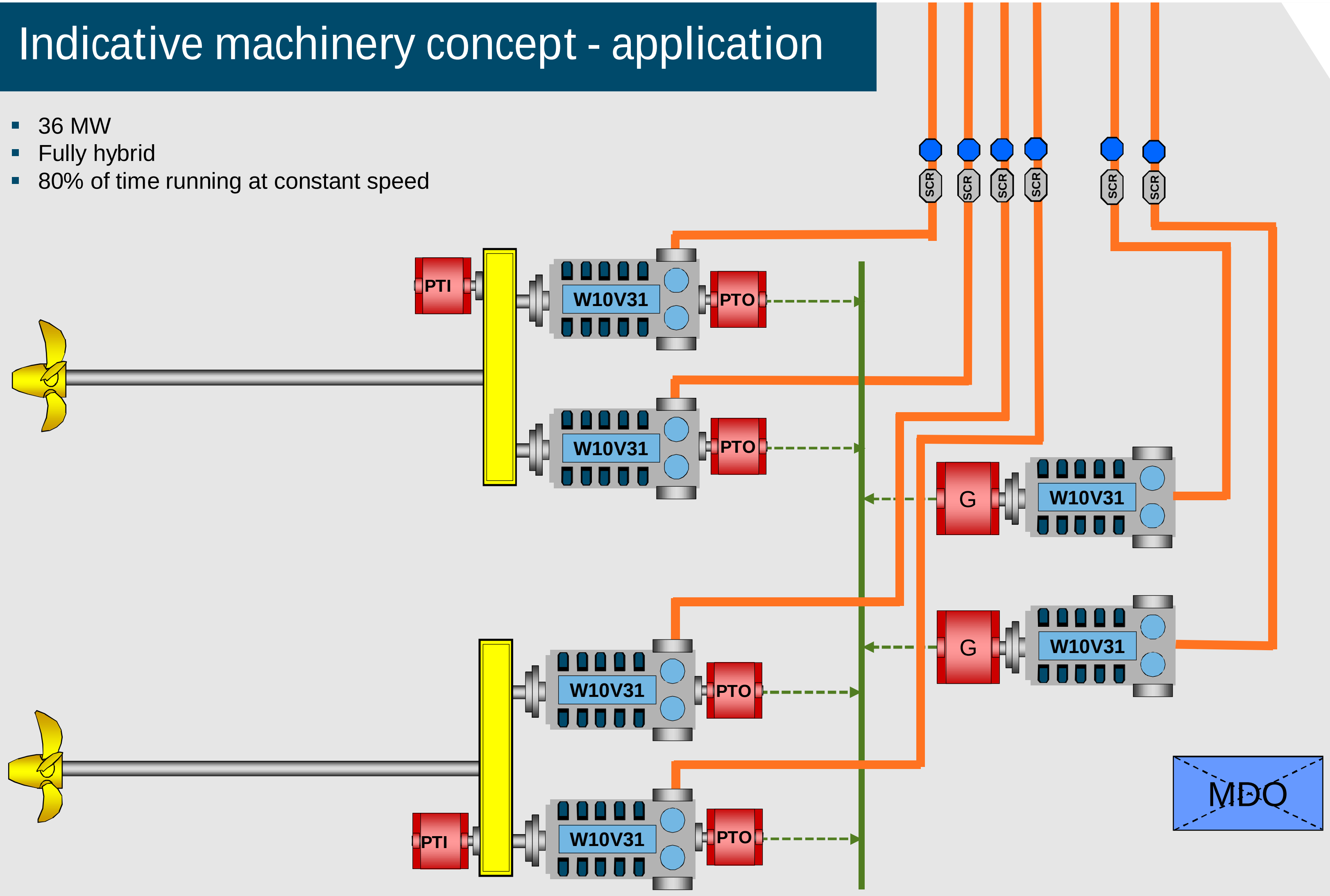
Propulsion control systems

CIMAC CONGRESS

Indicative machinery concept - application

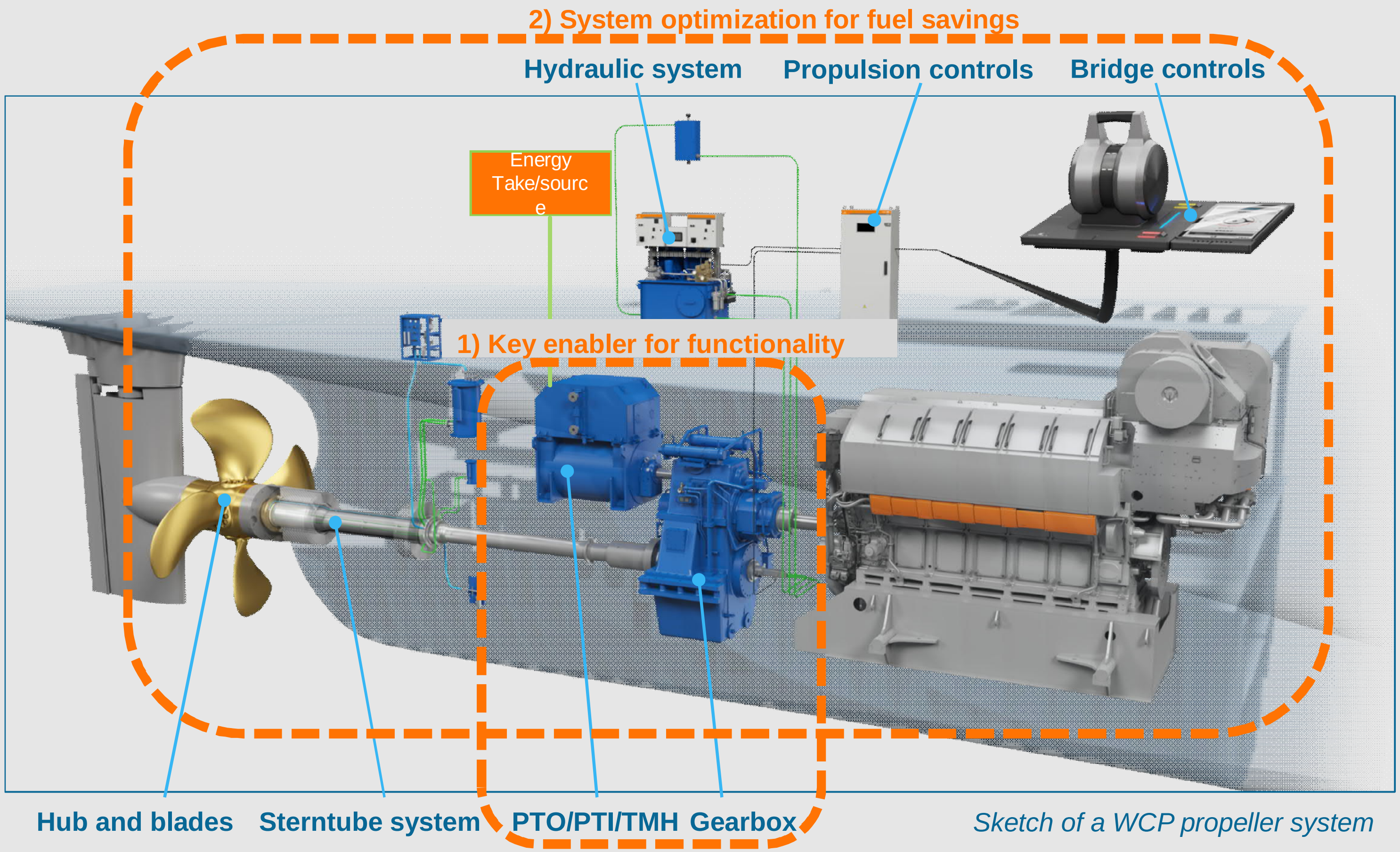
WÄRTSILÄ

- 36 MW
- Fully hybrid
- 80% of time running at constant speed



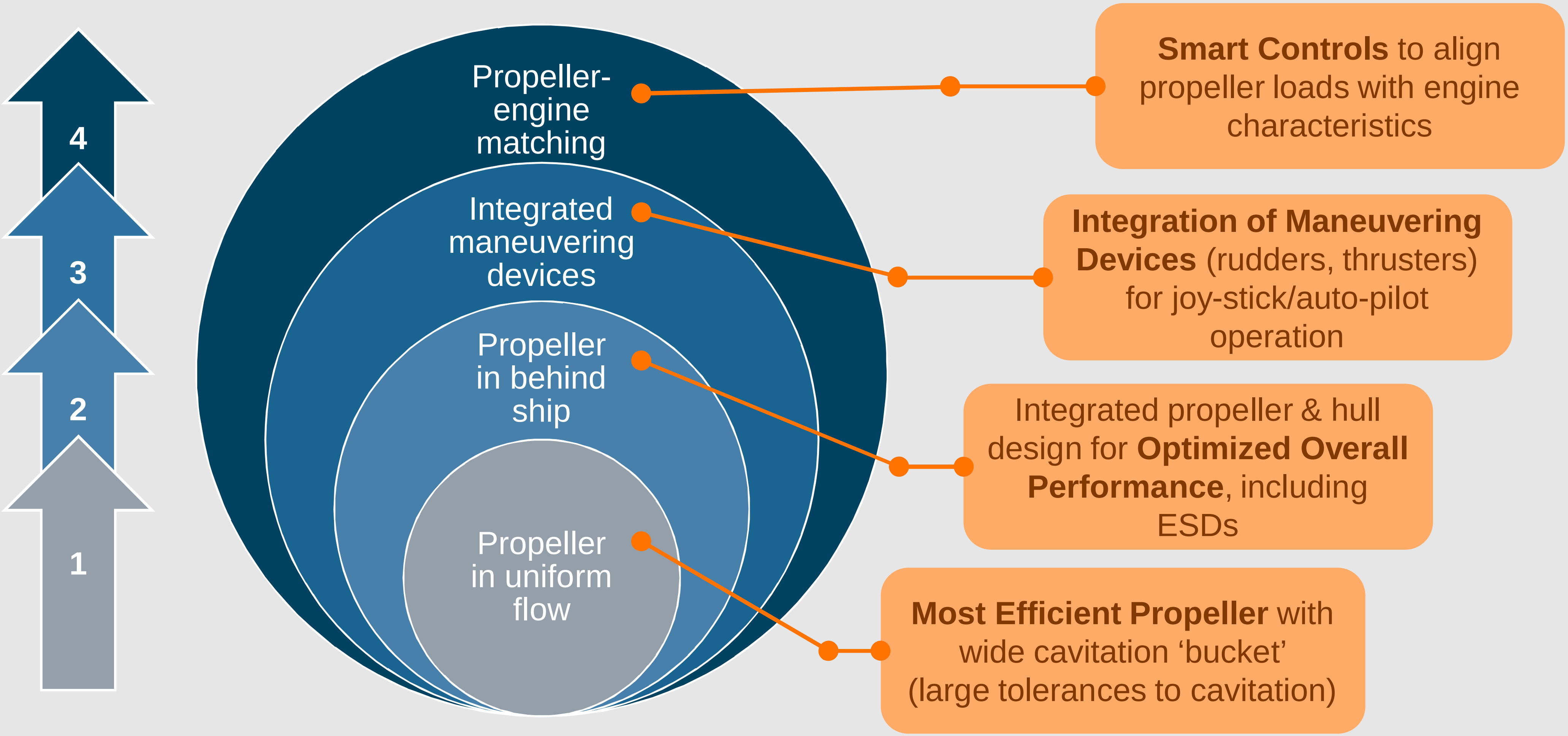
Total installed power: 36 MW

PROPELLERS AND GEAR BOXES ARE FULLY INTEGRATED IN THE WARTSILA BUNDLE OFFERINGS



Sketch of a WCP propeller system

Four-levels of attention in fuel-efficient & silent propeller operation

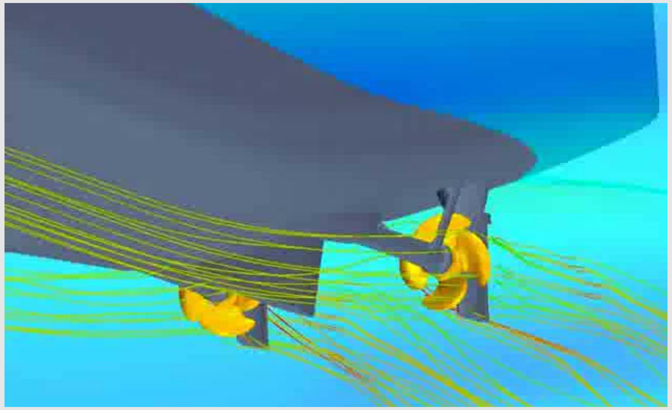


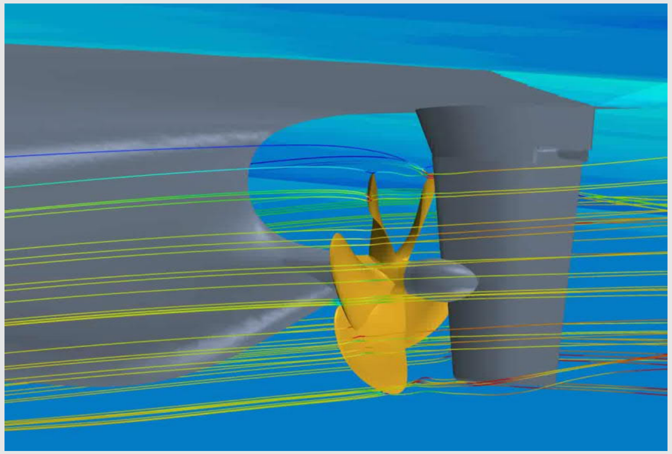
Vessel Efficiency with OPTI-Design

OPTI-Design saves 7 – 10% fuel oil through:

- Overall propulsive efficiency optimized by propeller/ rudder performance and propeller-hull interaction analysis
- Modern design tools and numerical 3D CFD simulations
- Full-scale performance evaluation
- >100 years of Lips propeller design experience

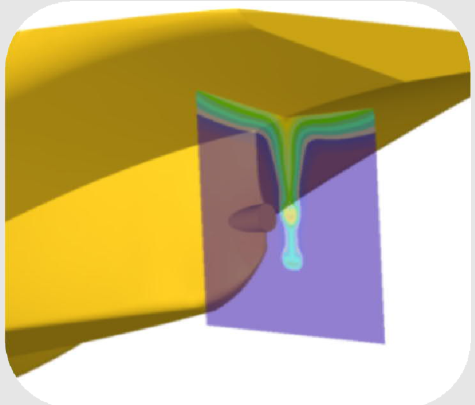
In addition it gives proper alignment of brackets upstream of the propeller to improve inflow to the propeller.

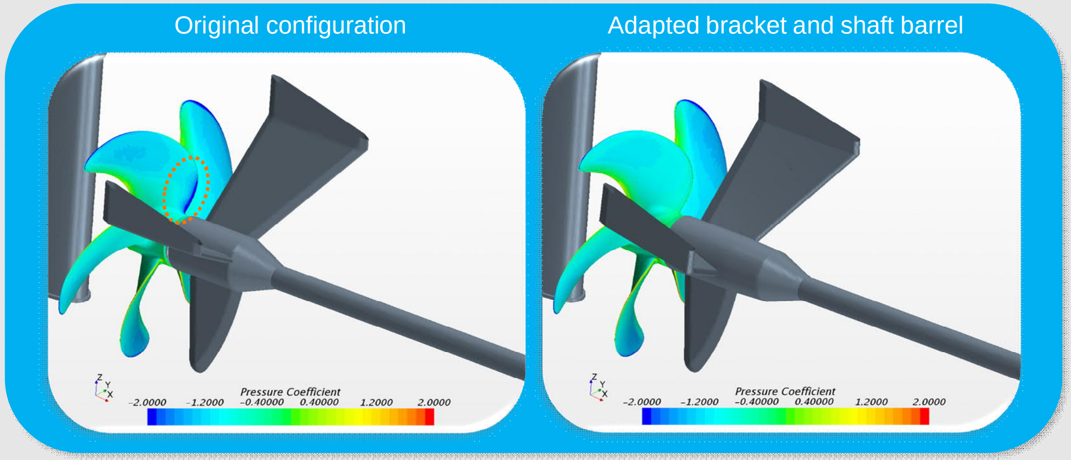


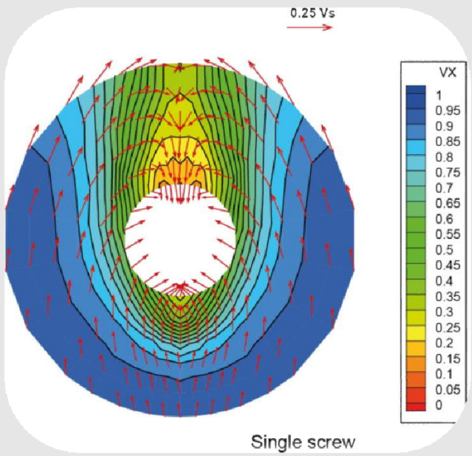


Quality of inflow to propeller

- Since the propellers operate behind the ship, the inflow to the propeller is **non-uniform** (wake-field).
- The inflow variation leads to **load fluctuations**, which need to be taken into account in the design process.
- **Optimization of hull geometry with active propeller** can improve the inflow, based on CFD simulations.

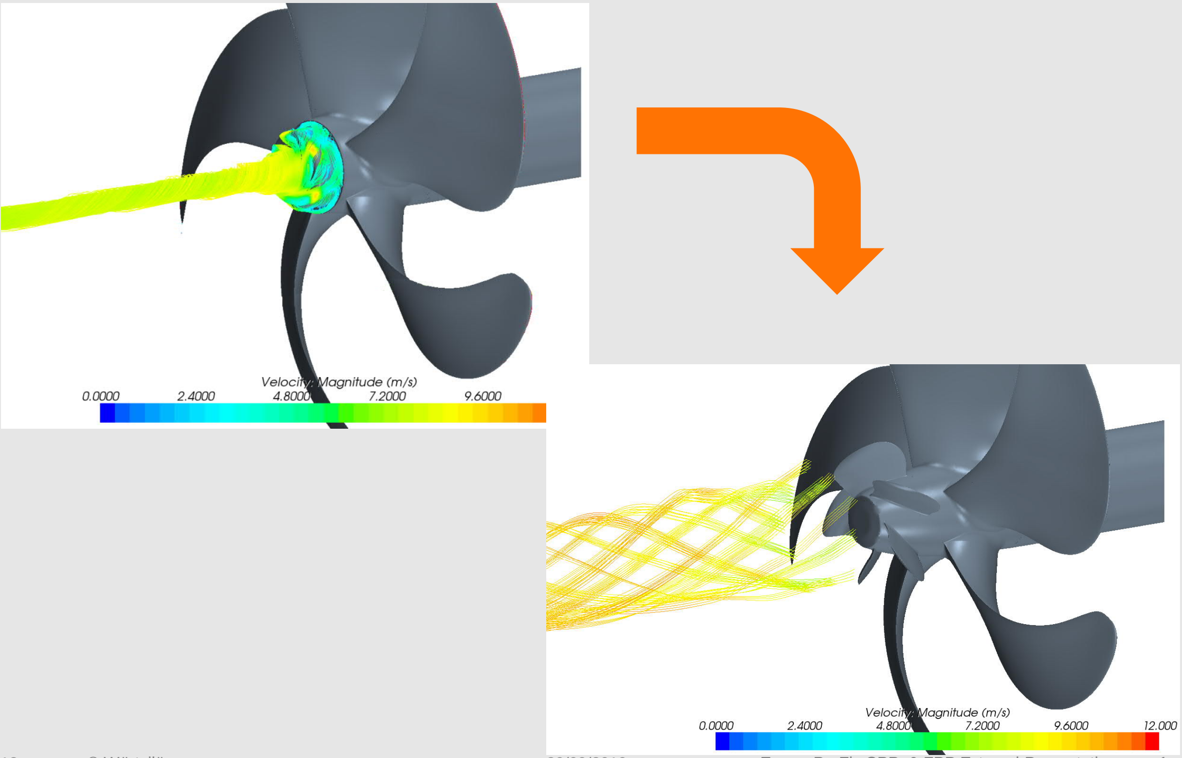






Improved propulsive efficiency by weakening the propeller hub vortex

- Partly the energy losses of a propeller are related to losses around and after the propeller boss (hub vortex and rotating flow).
- The EPF weakens or eliminates the propeller hub vortex behind the propeller hence manifesting itself as increased thrust. The deflection of the flow aft of the propeller by the optimized profiled fins reduces the propeller torque.
- In addition to the improved propulsive efficiency, the EnergoProFin can also be applied to reduce propeller-induced noise and vibrations.

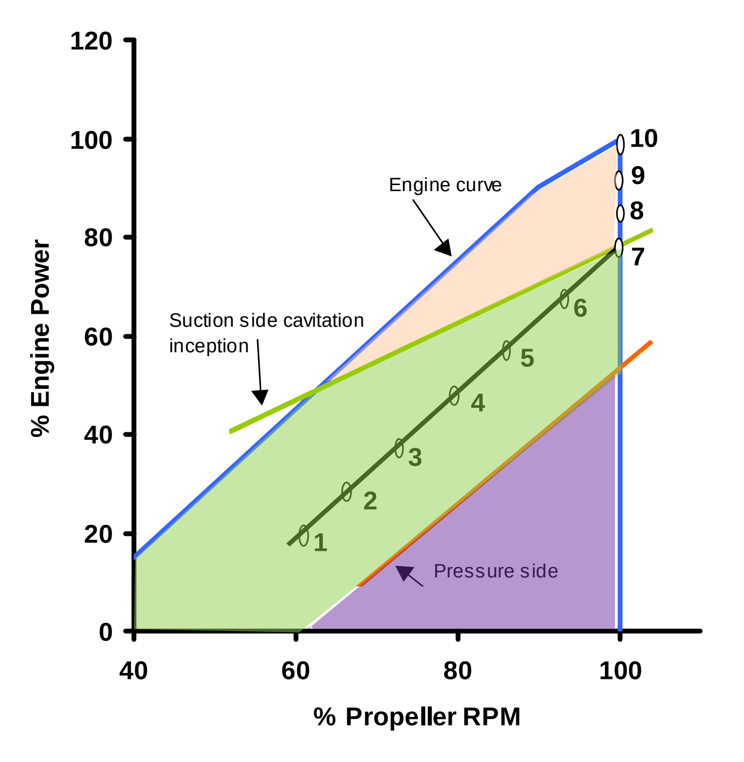


Key-benefits

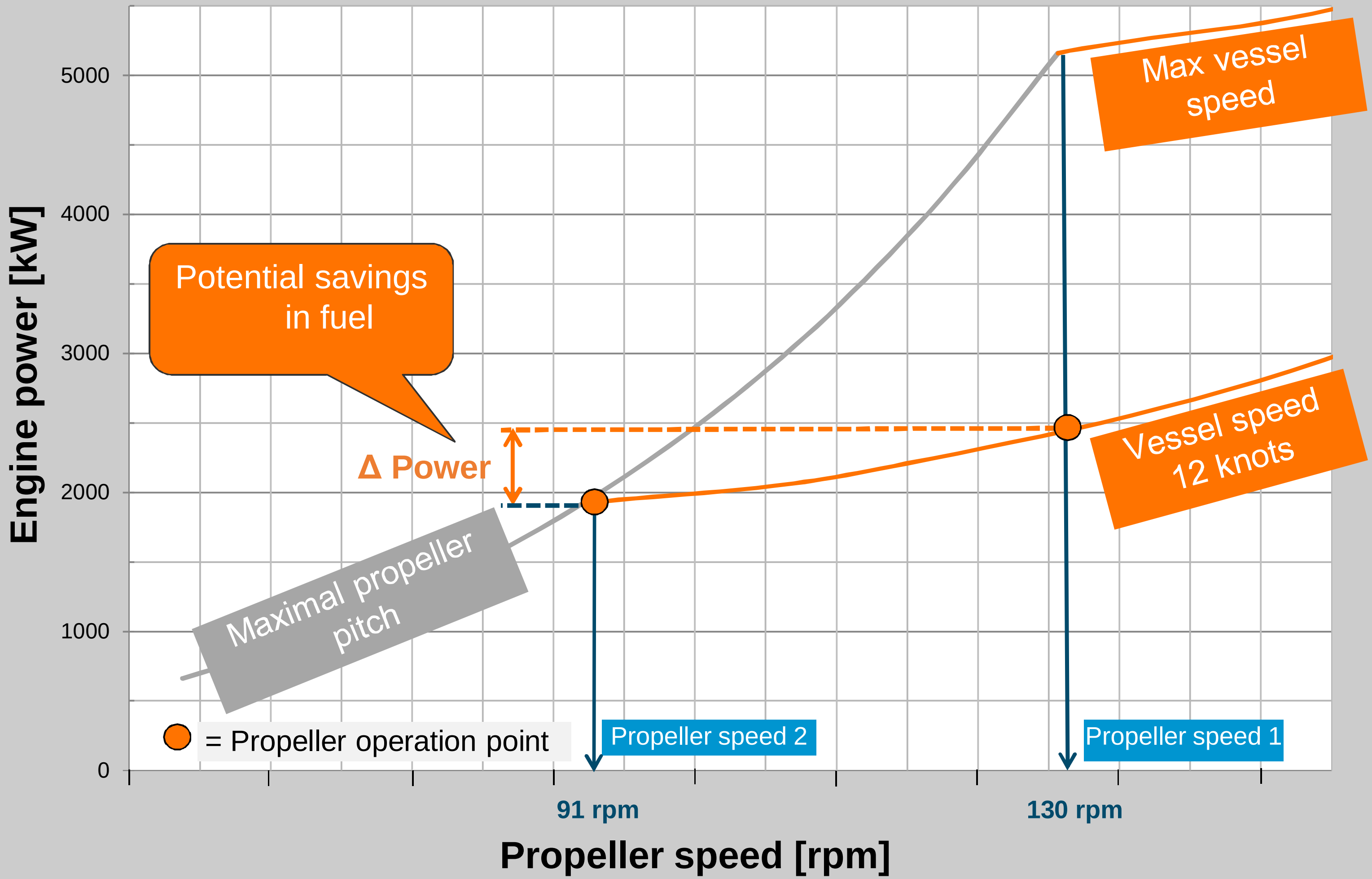
- Average fuel savings of 2% (up to 5%)
- Payback times less than 1 year.
- Reduction of vibrations
- Reduction of underwater noises.
- Reduced emissions.
- Easy & fast installation, underwater installation is possible
- Elimination of rudder horn cavitation damage

The Issue of Under Water Radiated Noise: Controllable Pitch Propeller operation – constant or variable RPM

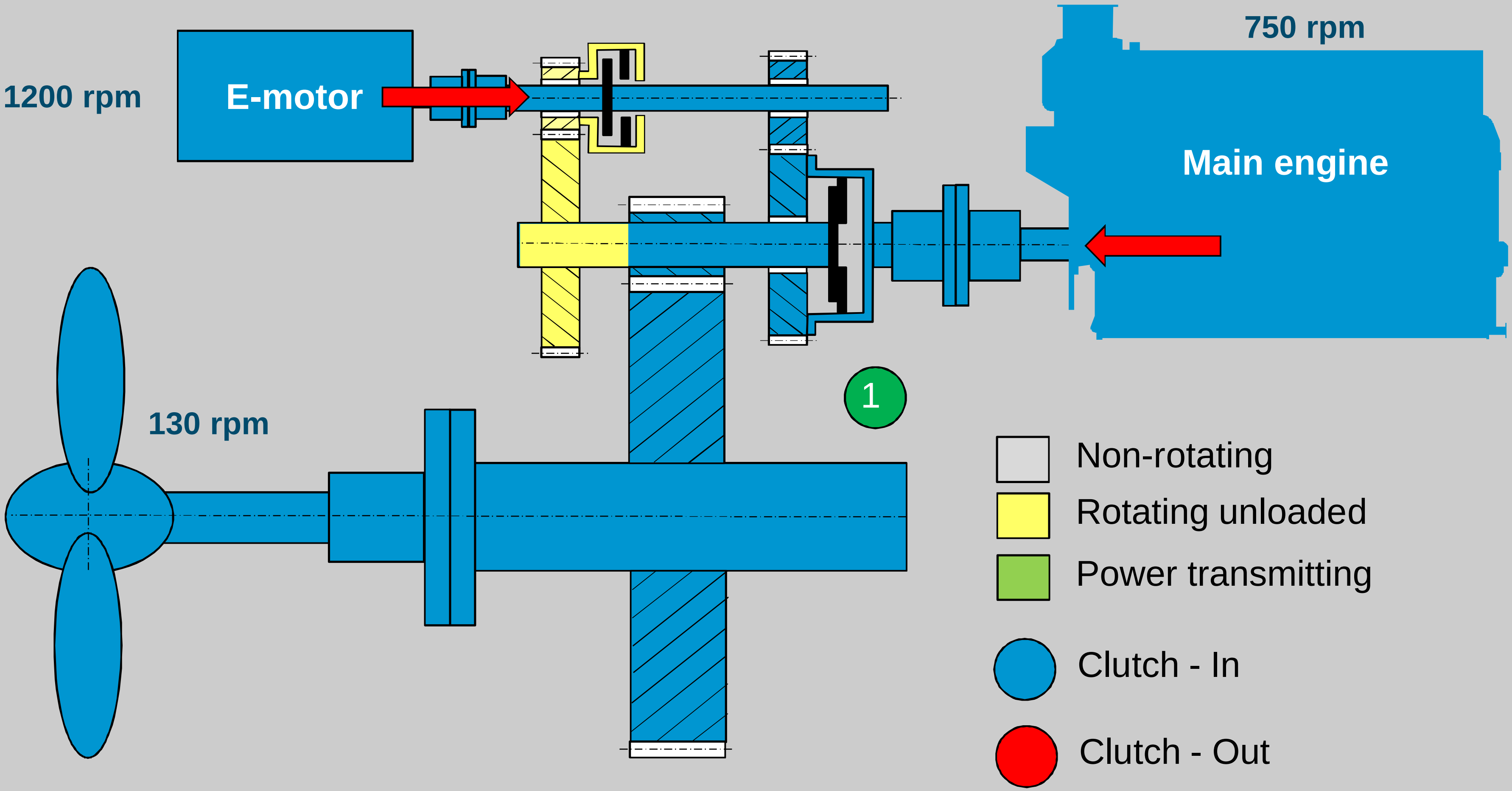
- Cavitation free operation of a controllable pitch propeller is indicated with the green area.
- Up to handle position 7, the CPP is operated at variable RPM.
- The maximum ship speed which can be reached without occurrence of cavitation is called CIS (Cavitation Inception Speed).
- Note: in case the driveline can only be operated at 100% (constant) RPM, pressure side cavitation and thus noise will be present below 50% engine power.



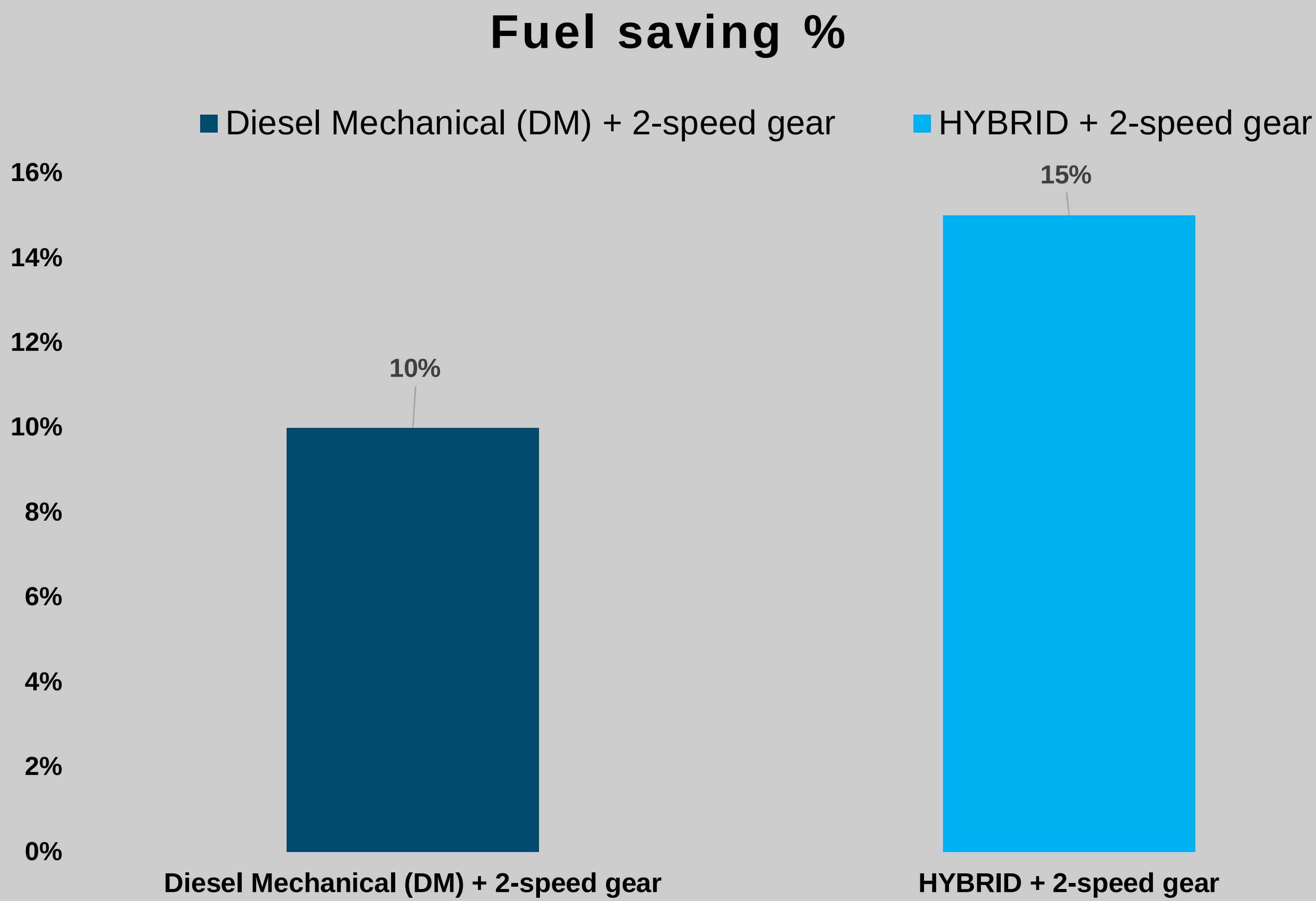
TWO SPEED TRANSMISSION UNITS



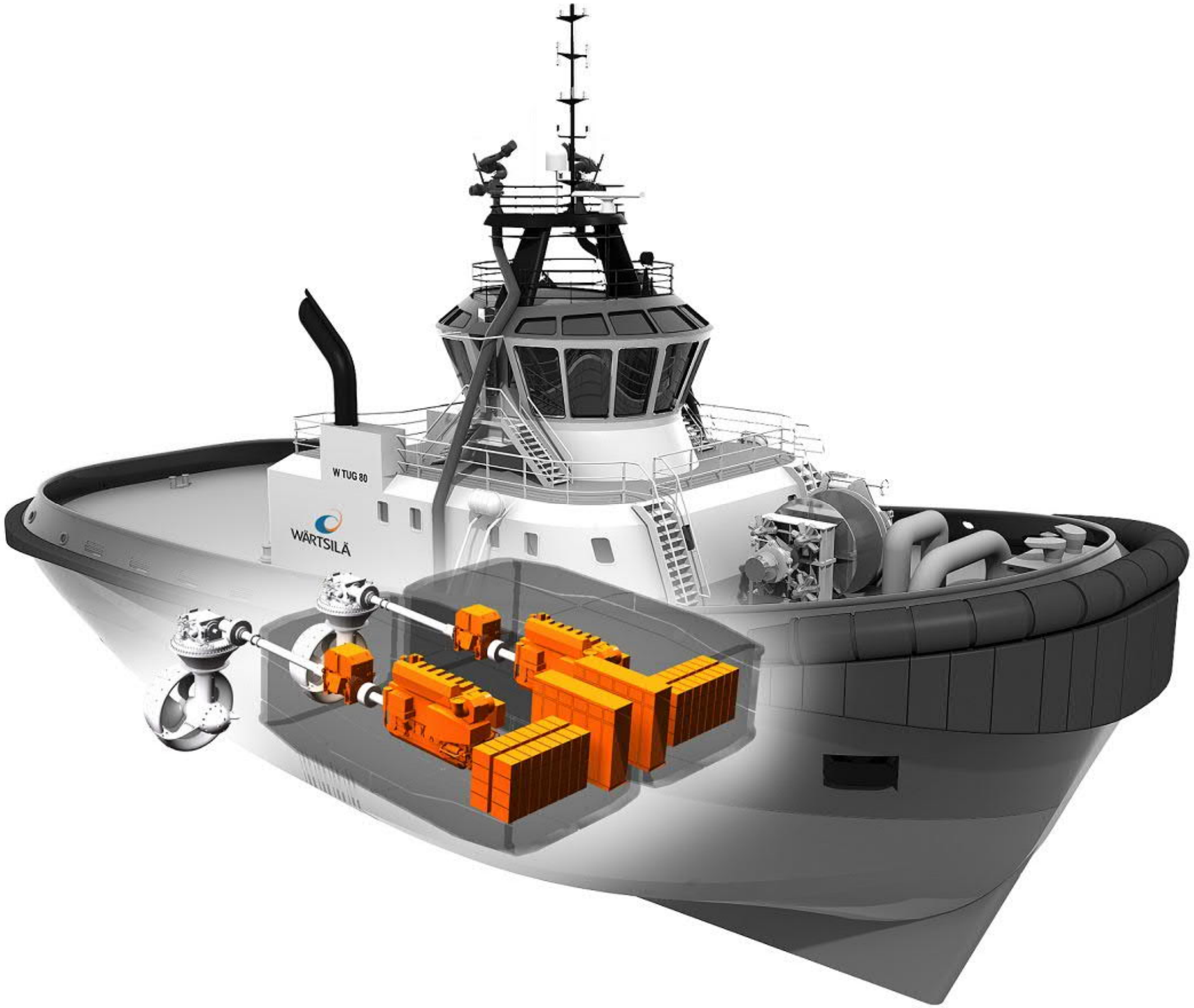
TRANSMISSION UNIT WITH TWO INPUT SPEEDS (MAIN ENGINE AND EL. MOTOR)



FUEL SAVINGS WITH FULL CP HYBRID SYSTEM

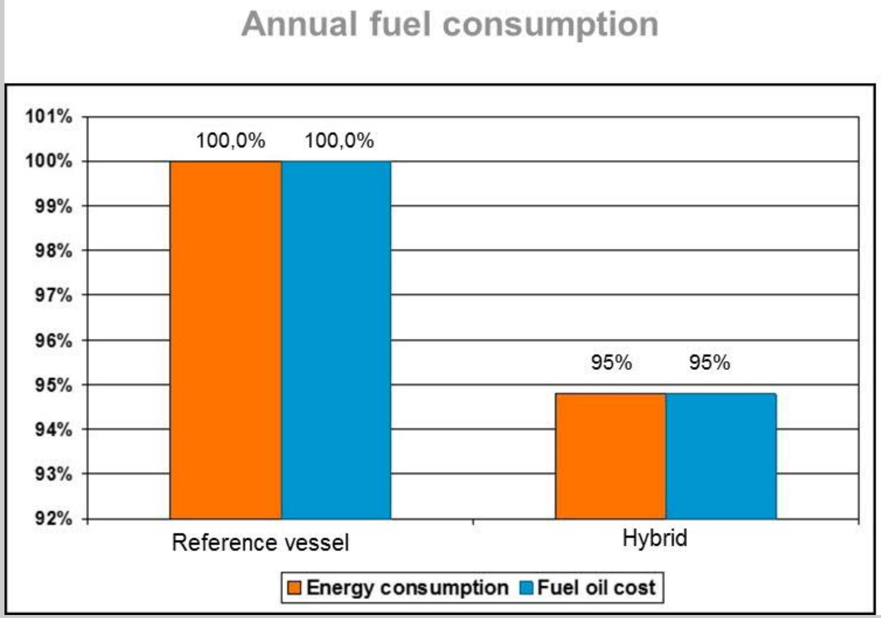


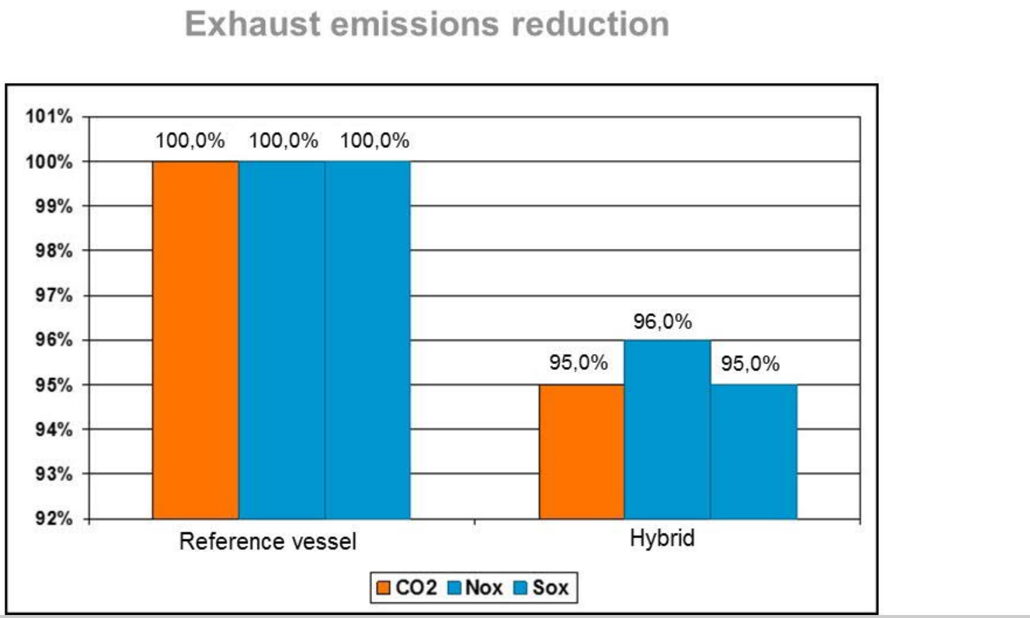
TYPICAL MACHINERY FOR HYBRID THRUSTER SYSTEMS



Advantages:
- Increased Vessel Operational flexibility
- Redundancy
- Fuel economy (5% +)
- Reduction of overall installed power
- Possible retrofits at existing fleet

FUEL AND EMISSION BENEFITS OF HYBRID THRUSTER SYSTEMS





+ Operational flexibility

CONCLUDING REMARKS

1) Technological leadership extends from → to:

Component design → System → Propulsion Unit → Vessel Integration

2) Integration covers mechanical, electrical and hydrodynamic disciplines

3) The hydrodynamic interaction is critical
Optimization through CFD improves the vessel efficiency in early design stages

4) The power transmission concept is crucial for the integration.
Create options according to vessel needs (two speed gears, hybrid, …)

5) The fuel efficiency improvement potential through integration is significant and
It can be combined with additional operational benefits (external noise, …)

6) Partnerships of industrial and academic partners are important in order
to achieve the best results