CIMAC CIRCLE

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INTEGRATED PROPULSION SYSTEMS

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CIMAC Circle 2012

YOU

And
The Panel:

1. Elias Boletis, Wärtsilä Propulsion Netherlands B.V., Netherlands (chair)

2. Christof Fenske, MTU Friedrichshafen GmbH, Germany

3. Christian Poensgen, MAN Diesel & Turbo SE, Germany

4. Christian Roduner, ABB Turbo Systems Ltd., Switzerland

5. Feng Wang, Shanghai Marine Diesel Engines Research Institute, China

Purpose of the CIMAC Circle 2012

‘Integrated Propulsion Systems’

Present position papers from the Panel members

Trigger the discussion with **YOU, THE AUDIENCE**

Purpose of the CIMAC Circle 2012

Statement:

The energy efficiency is of paramount interest for the ship Operator and Owner.

Which are the main trends?

-**The reciprocating engine concept** seems to remain the basis for fuel energy conversion to mechanical energy, with emphasis on fuel versatility and the broad introduction of gas.

- **Alternative energy systems** integrating wind, photovoltaic, fuel cell power, sometimes in a hybrid system layout start to be considered as efficiency enhancements.
- The **ship propulsion systems** (propellers, steerable thrusters and advanced designs of high- efficiency potential) undergo new development with emphasis on high vessel propulsive efficiency and engine compatibility.
- **Advanced exhaust gas processing systems** (SCRs, EGRs etc) are developed which need to be fully integrated with the engines.
- The **vessel design** itself is to be adapted to the new propelling and machine room equipment. Obviously this integration can better be done in early ship and system design phases.

How the shipping requirements are going to be better fulfilled?

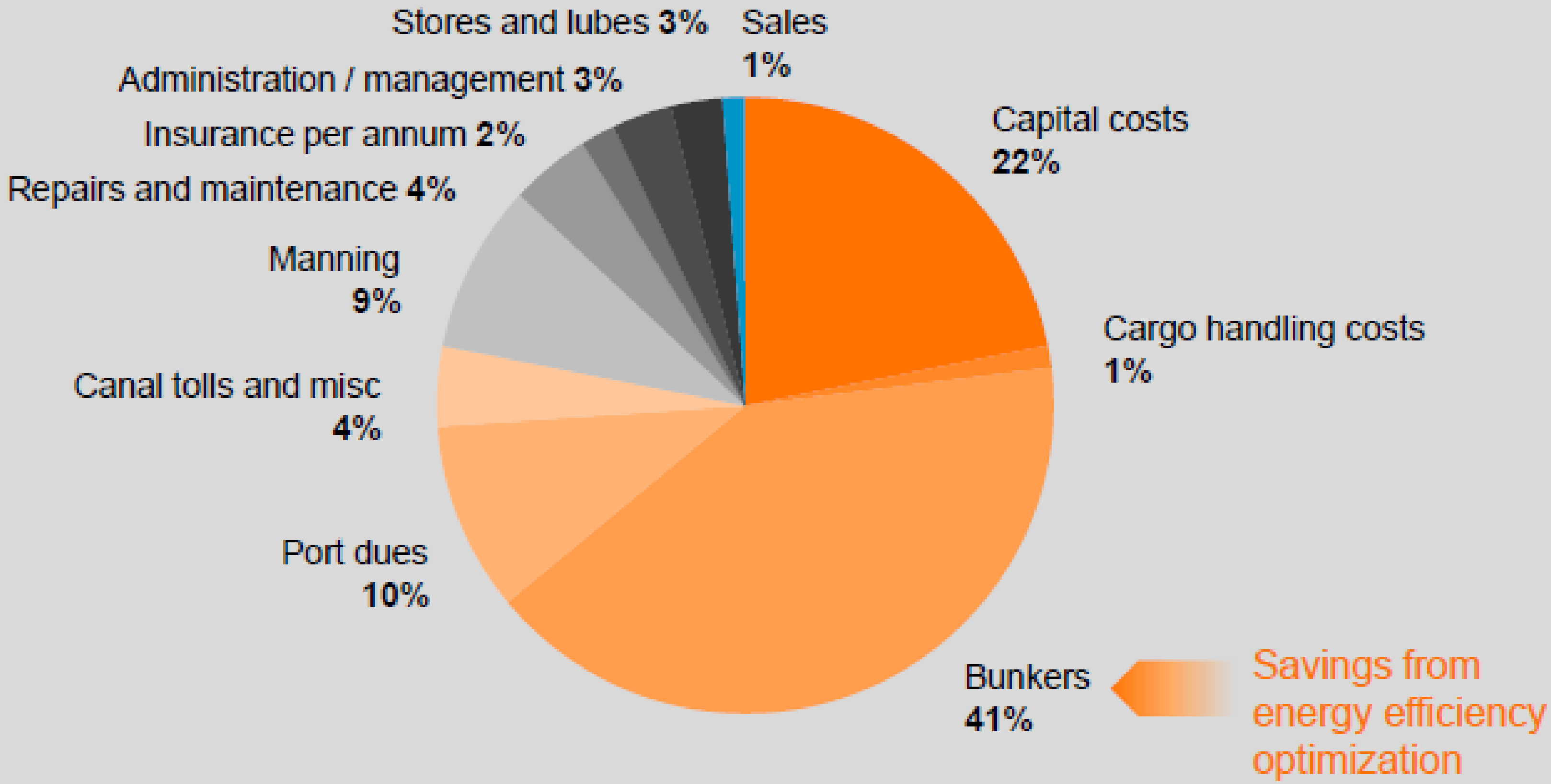
How the Equipment Manufacturers are responding to these trends? Which are the expected efficiency improvements and at which timeframe?

Which level of cooperation is required with the ship Owners and Operators and the whole Shipping Community?

Shipping cost structure

THE ROAD AHEAD

Typical cost structure of a merchant ship



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Towards more competitive and sustainable shipping

The shipping industry is consuming roughly 335 million tons/year of fuel*. This means roughly 230 billion USD per year **

Large un-efficiencies are currently present. Examples:

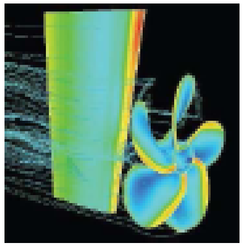
- Crew and officers with little experience and training + more complicated installations
- Non optimal maintenance practices (e.g. propeller and hull fouling; engine key components)
- Non optimal practices during navigation (e.g. trim; speed – power – route – weather optimization)
- Very little on-shore vessel performance monitoring, diagnosis, improvement actions and follow-up

A holistic approach to the optimization of ship performance requires:

Measurement

Real time data to be fed to models

Accurate models



Real time modeling of energy use

Advanced controls

Automatic controls + recommendation to operators onboard

Communication system

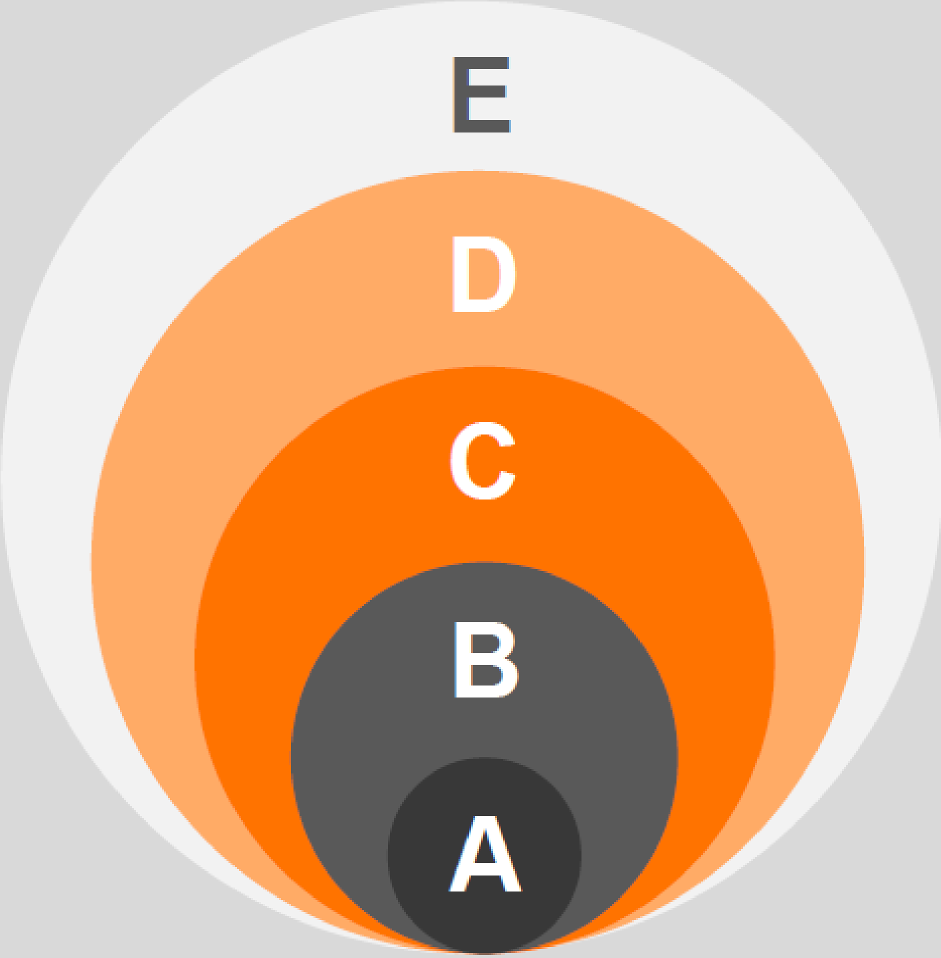
Information exchange onshore - onboard

KPI and reporting

Savings reported to fleet management

Notes: * DNV; ** calculations based on current fuel prices

Energy & efficiency saving potential



Fleet energy efficiency optimization
- Best vessel for the job
- Optimal fleet capacity usage

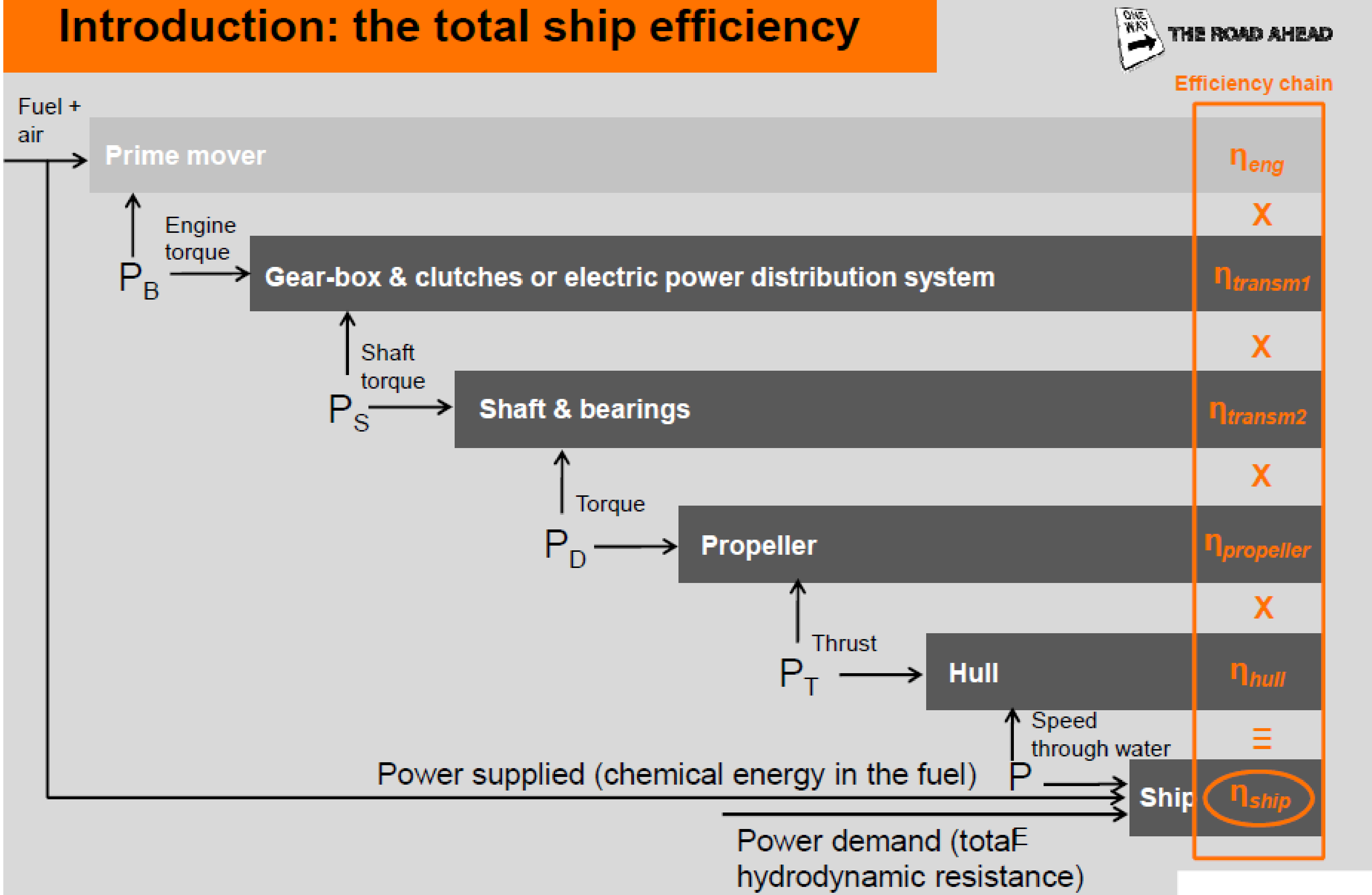
Voyage energy efficiency optimization
- Navigation → "Clever routing"
- Just in time arrival

Ship's energy efficiency optimization
- Trim optimization
- Hull cleaning

Power plant efficiency optimization:
- Advise optimum machinery usage to match required output needs

Machinery efficiency optimization:
- (re) tuning or configuration of the product for operational conditions
- Upgrade machinery to higher performance level
- Maintain the original performance

Introduction: the total ship efficiency



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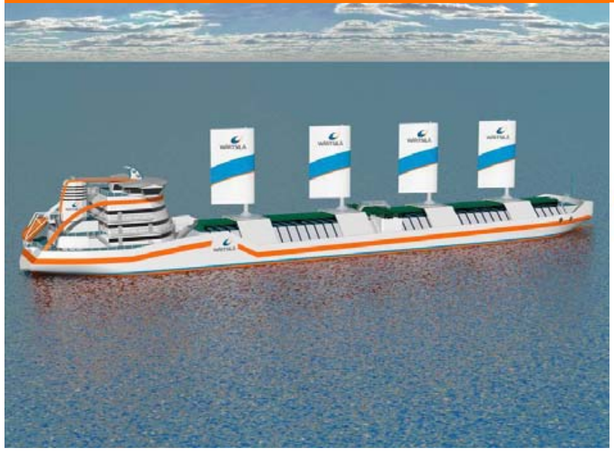
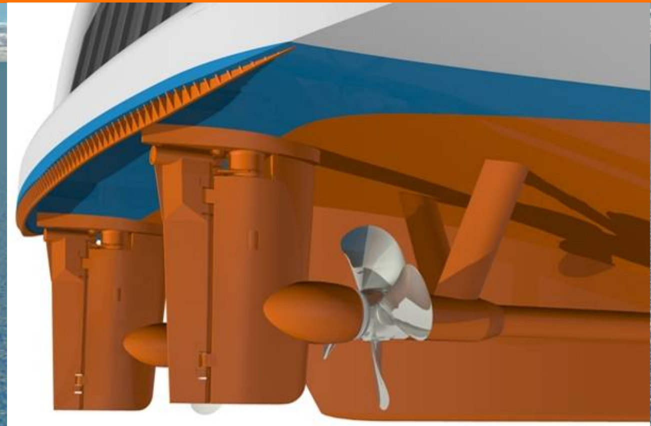
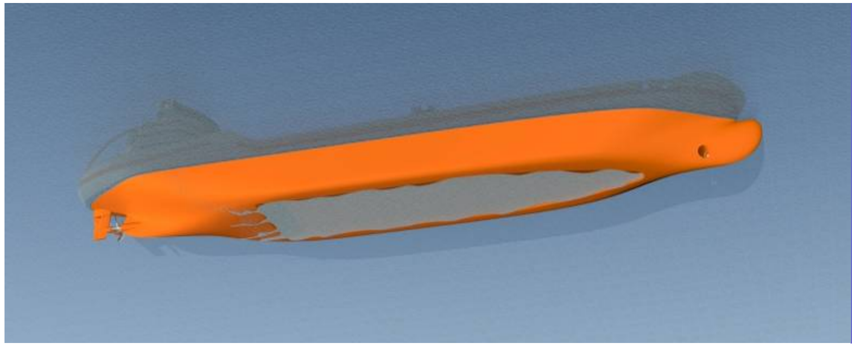
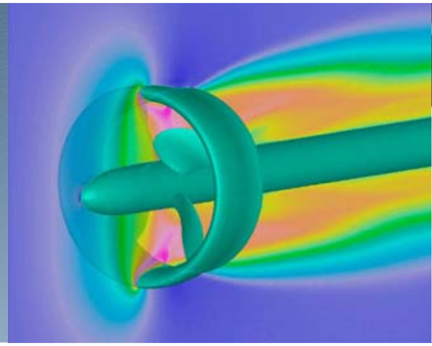
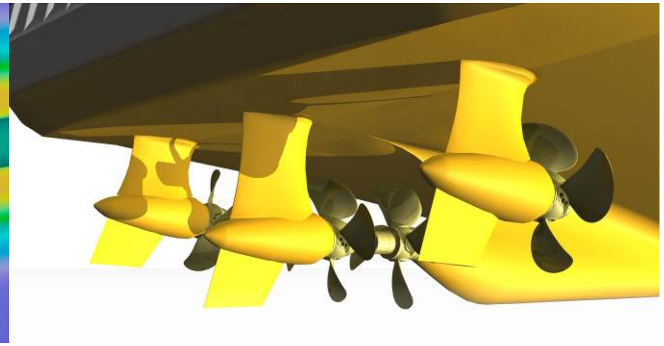
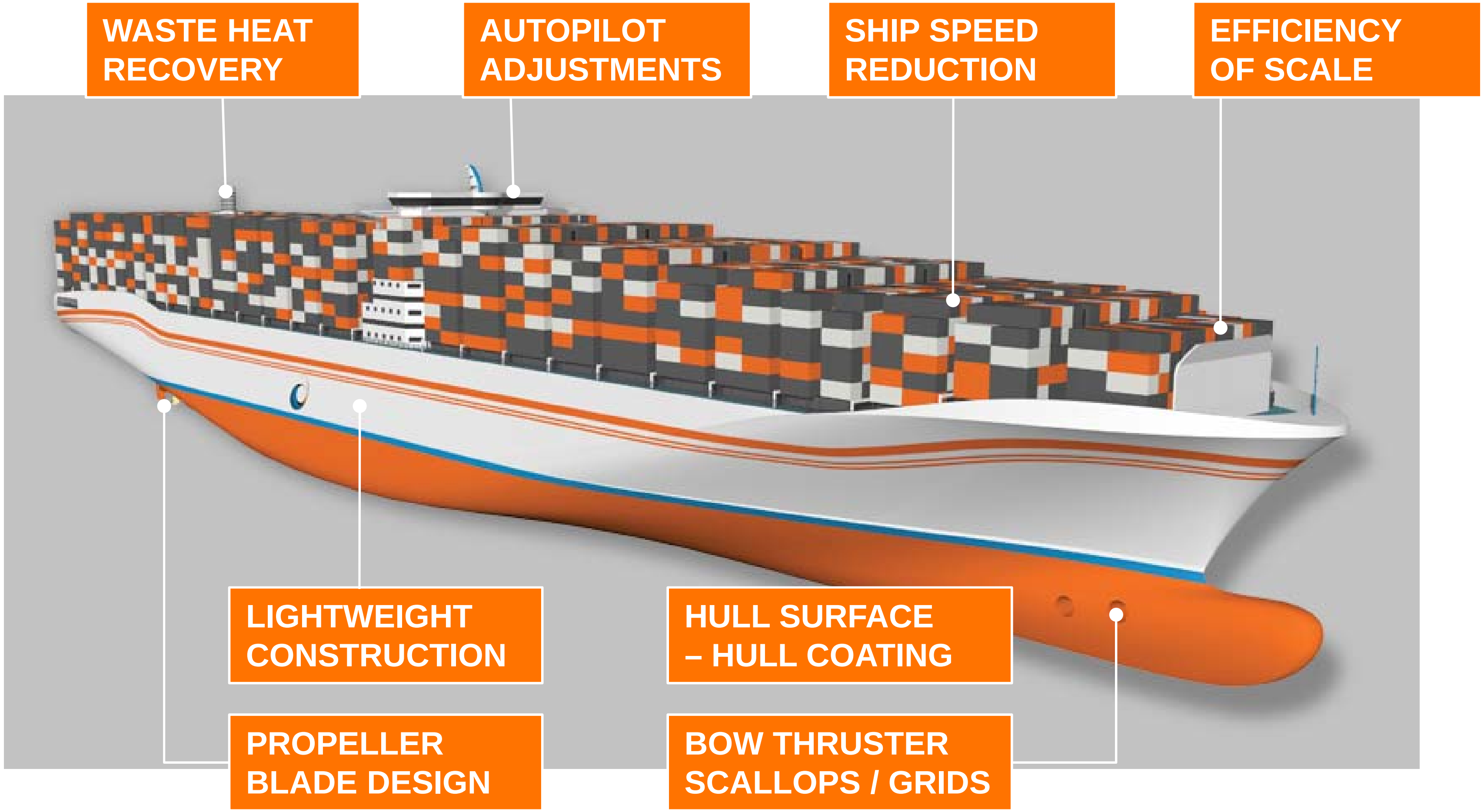
Integrated systems for customized solutions


Our aim is to show from a neutral viewpoint a vast range of potential areas for efficiency improvement. They are based on today’s technology and are presented irrespective of the present availability of such solutions either from Wärtsilä or any other supplier.

CONTAINER VESSELS



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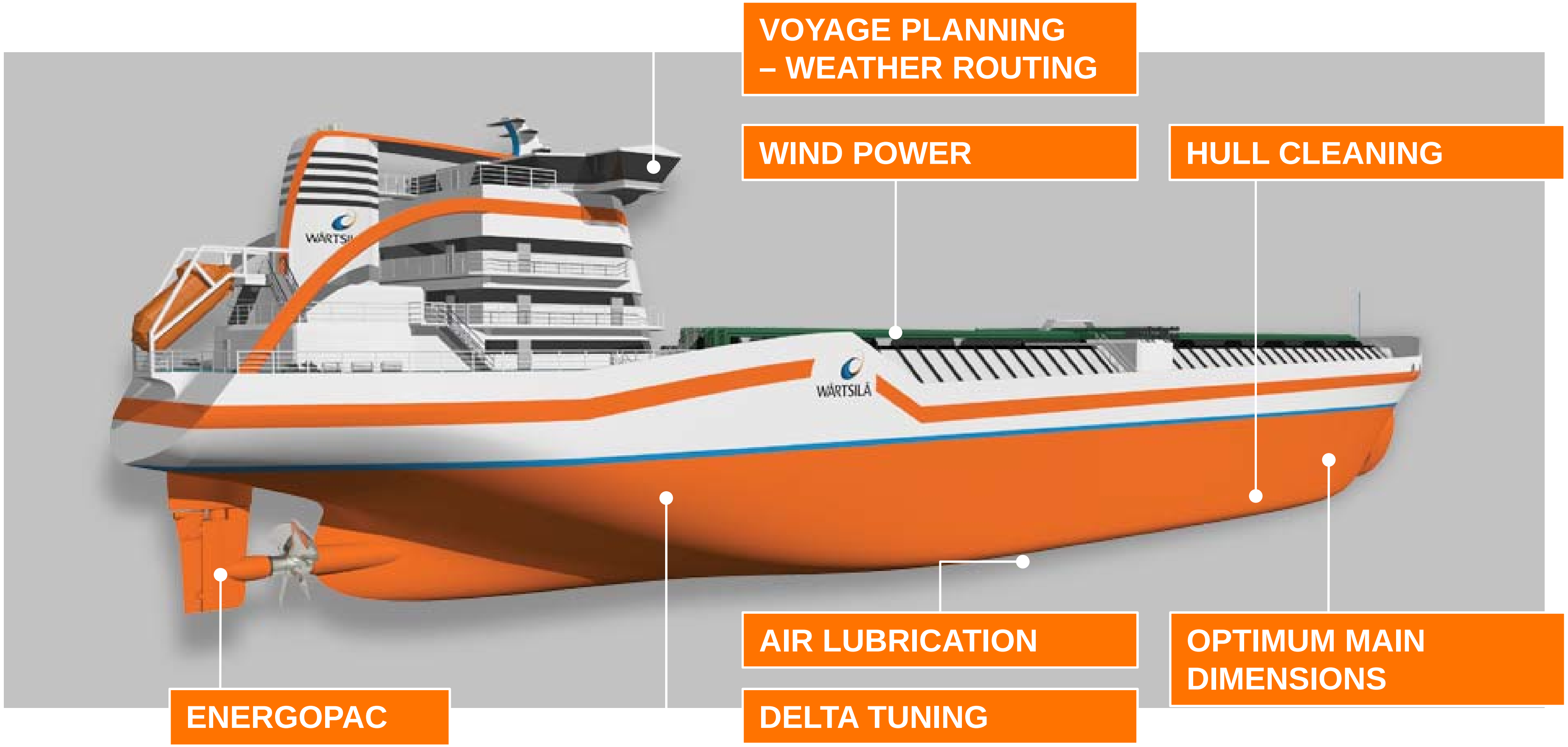
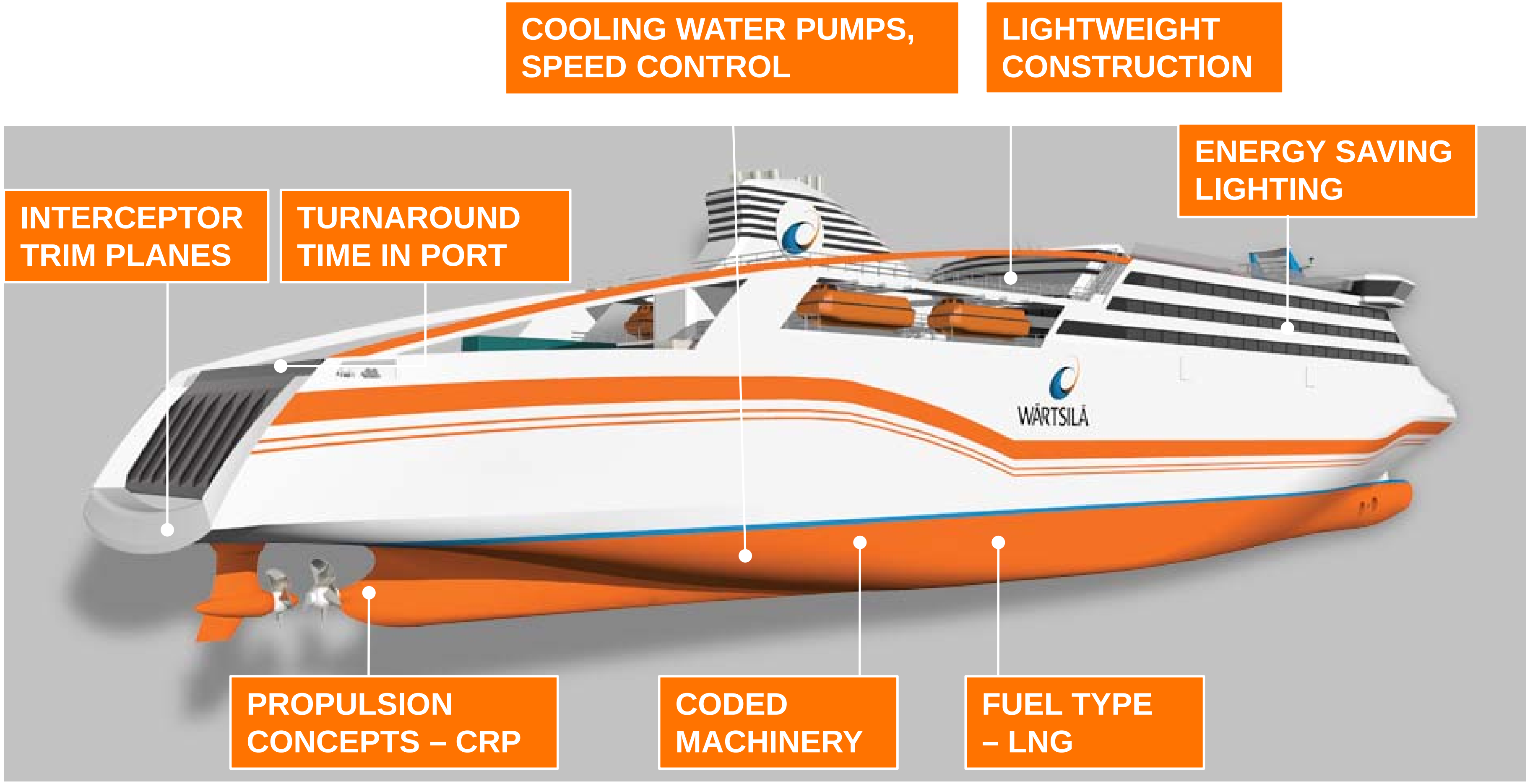
TANKERS AND BULKERS



FERRIES



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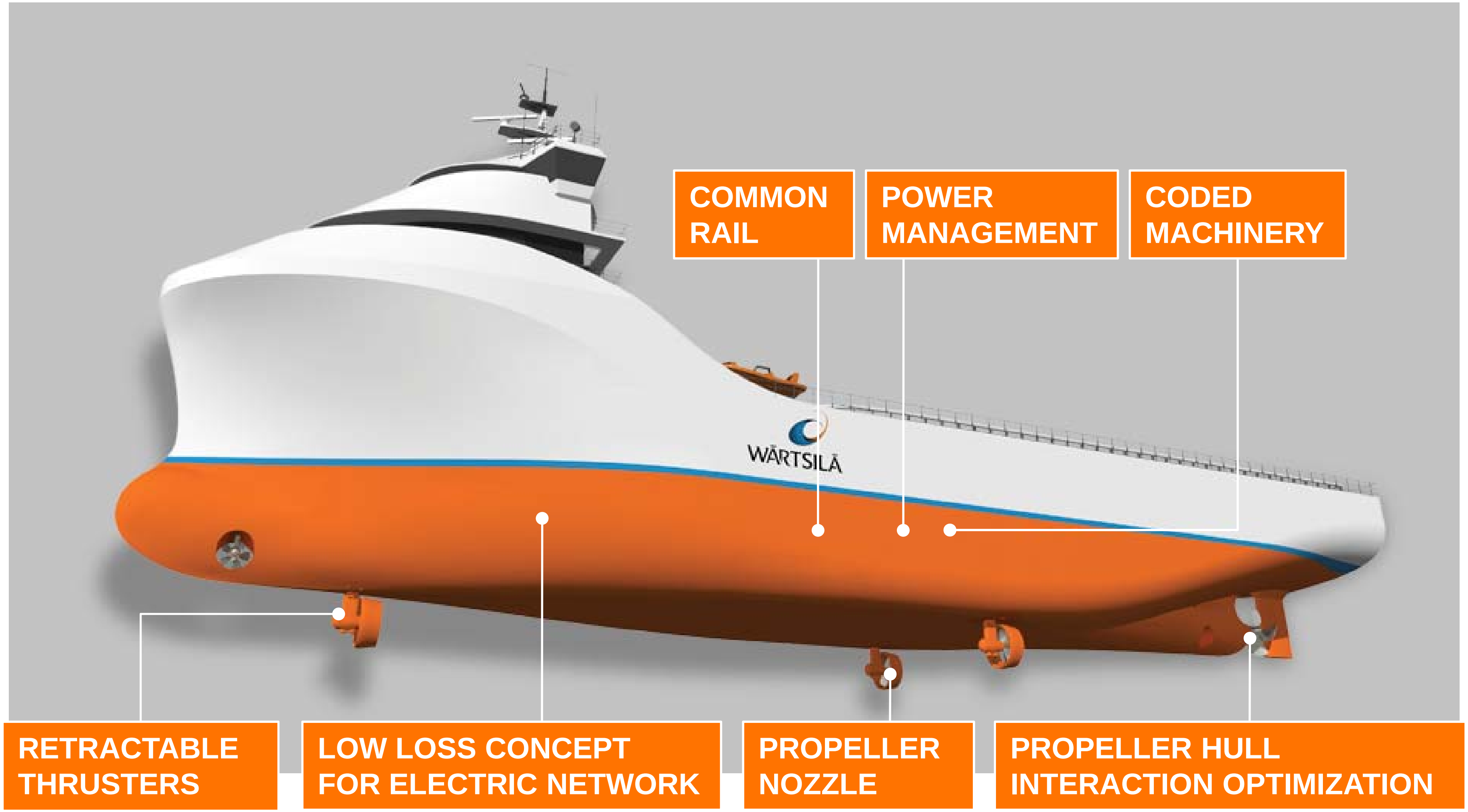
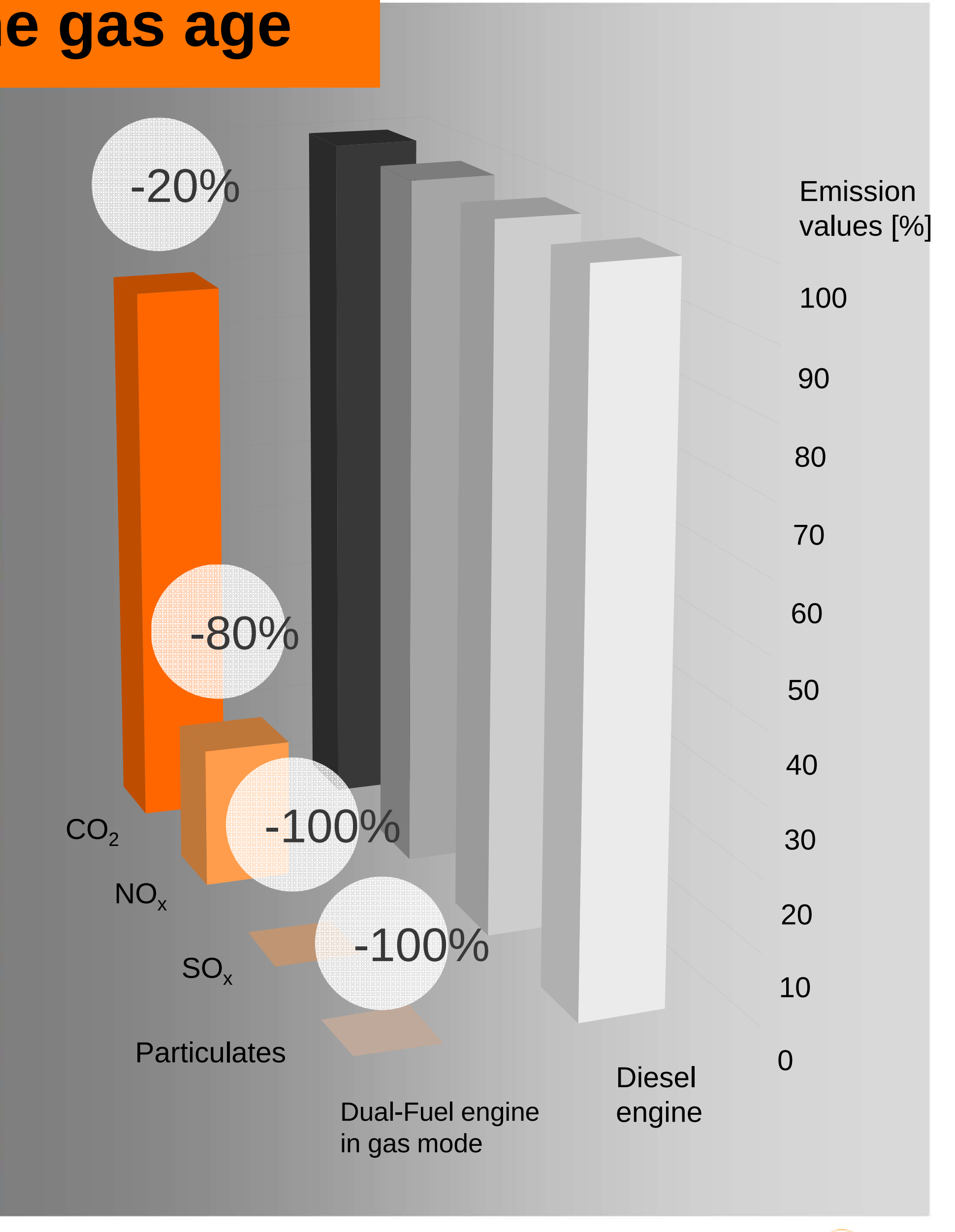
OFFSHORE SUPPORT VESSELS

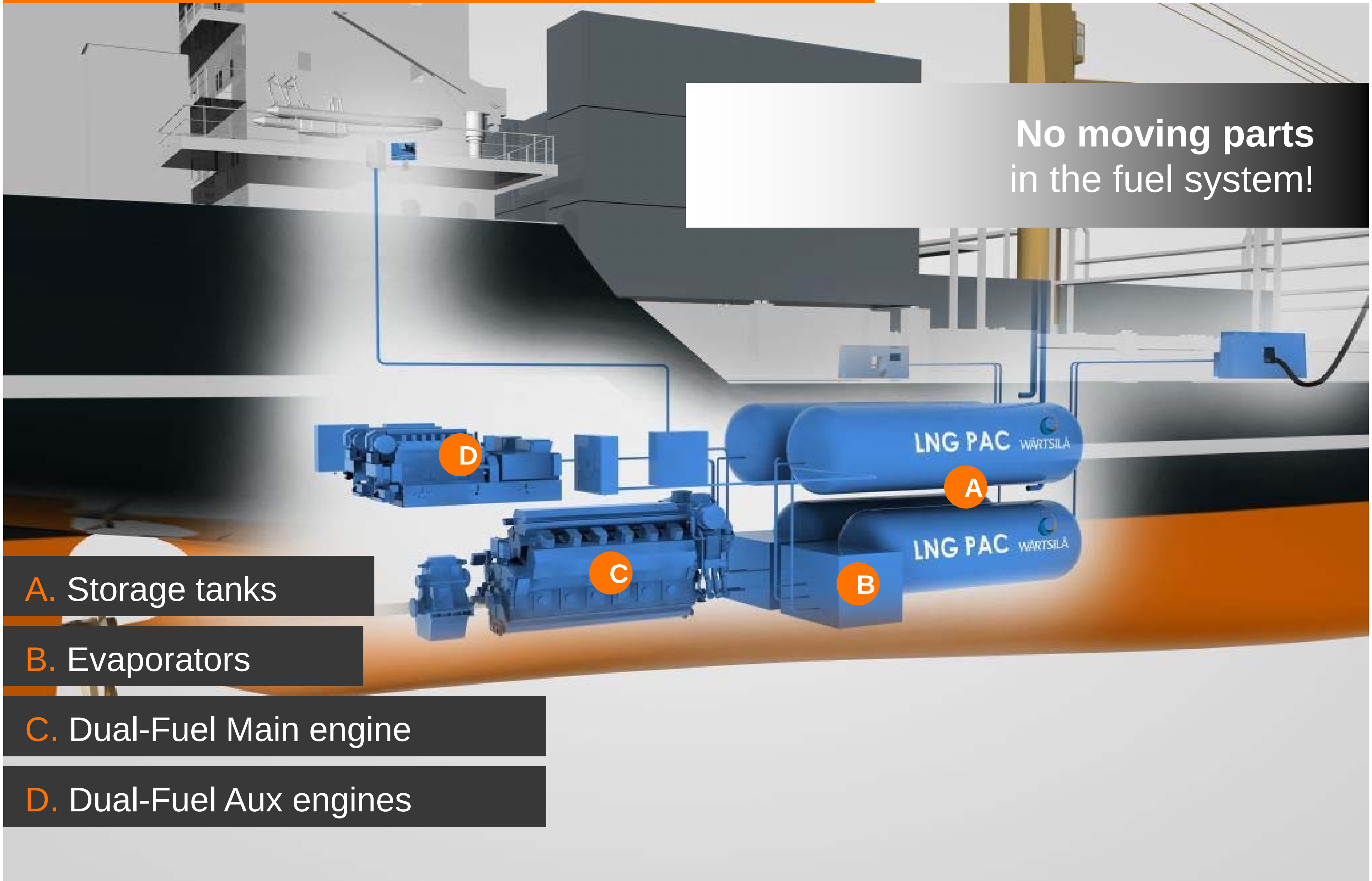


This is what we bring overall to the market

We have already entered in the gas age



Gas fuel system - basic description



No moving parts
in the fuel system!

A. Storage tanks

B. Evaporators

C. Dual-Fuel Main engine

D. Dual-Fuel Aux engines

Natural Gas As Marine fuel

Wärtsilä Dual Fuel Engines

Fuel flexibility optimizes Operational Expenses:

- In ECA zones, no exhaust after treatment technology is required
- Outside ECA zones, the most advantageous fuel can be selected

Total Concept Optimization

We engineer integrated fuel solutions for LNG delivery, storage, transportation and utilization onboard.

This is what we bring overall to the market

Example of Detailed Products & Proposals

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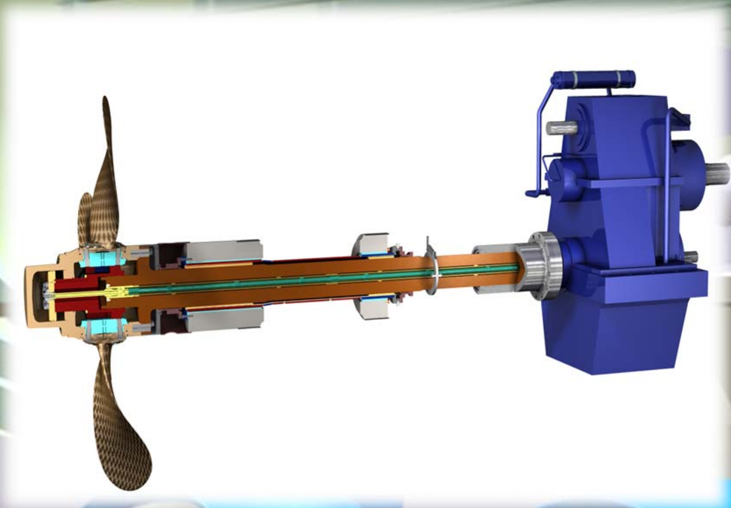
New Base Propulsion Products for Integrated Designs

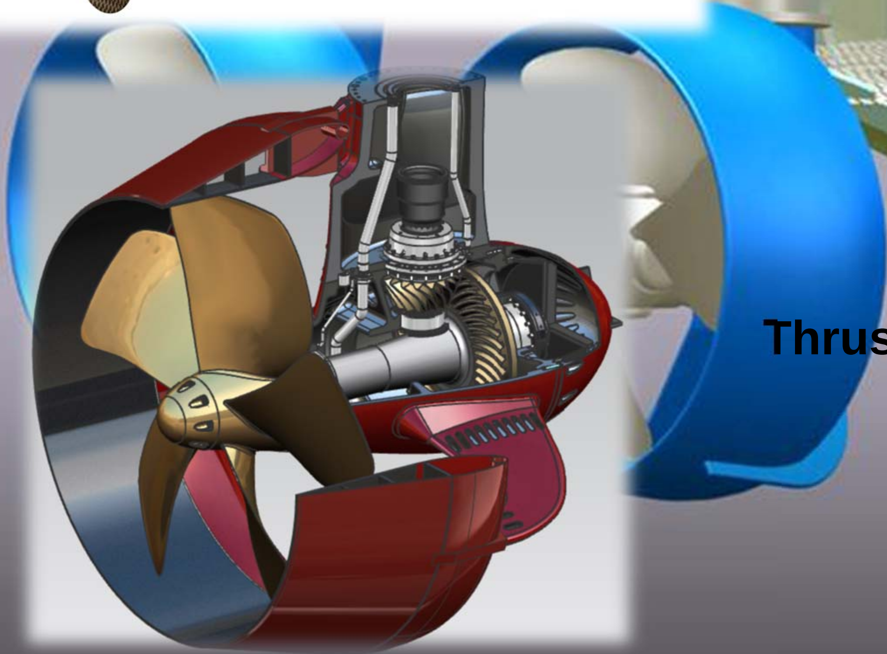


Marine Gear Boxes

- Single stage reduction
- Hybrid - two stage reduction
- Two in - single out

Propellers

- All applications
- Heavy Duty
- Ice applications
- Customized as required



Thrusters

- Low Initial Cost
- Optimized for ship designs
- Ice class as required
- Retractable or Under Water Demountable
- Both Steerable and Tunnel

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New Base Propulsion Products for Integrated Designs

Marine Gear Boxes

- Single speed reduction
- Hybrid - Two speed reduction
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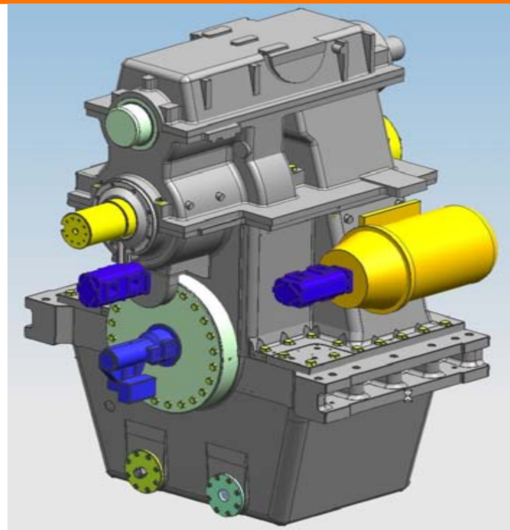

Propellers

- All applications
- Heavy Duty
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Thrusters

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- Optimized per application
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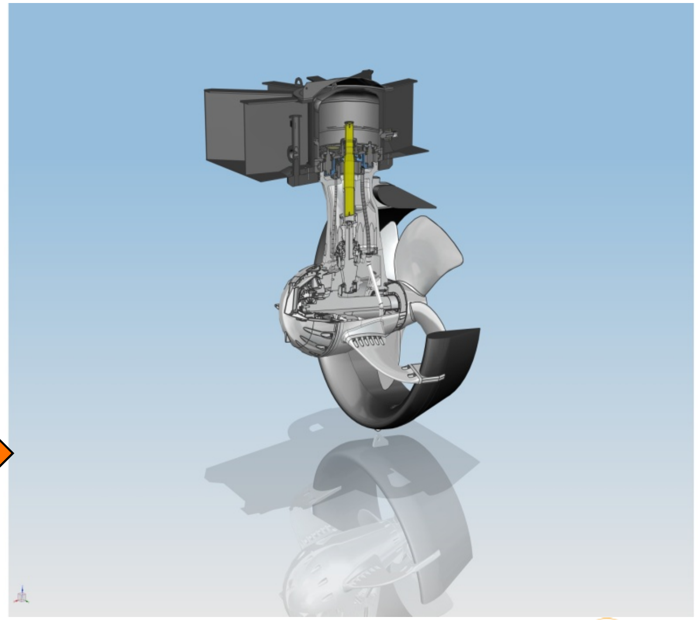

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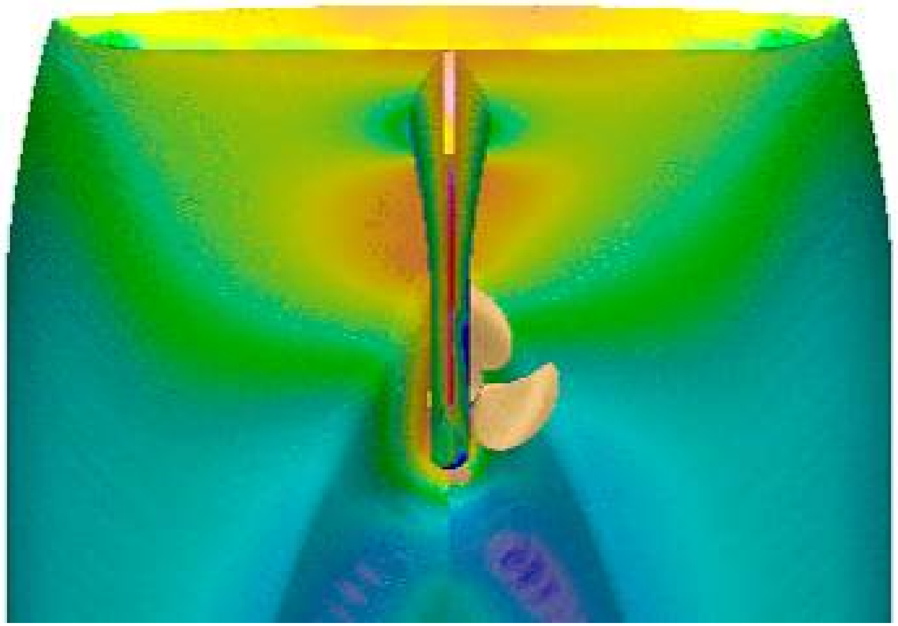
Example 1: Optimization of Propeller and hull interaction

< 4%

The propeller and the ship interact. The acceleration of water due to propeller action can have a negative effect on the resistance of the ship or appendages. This effect can today be predicted and analysed more accurately using computational techniques.

Redesigning the hull, appendages and propeller together will at low cost improve performance by **up to 4%.**

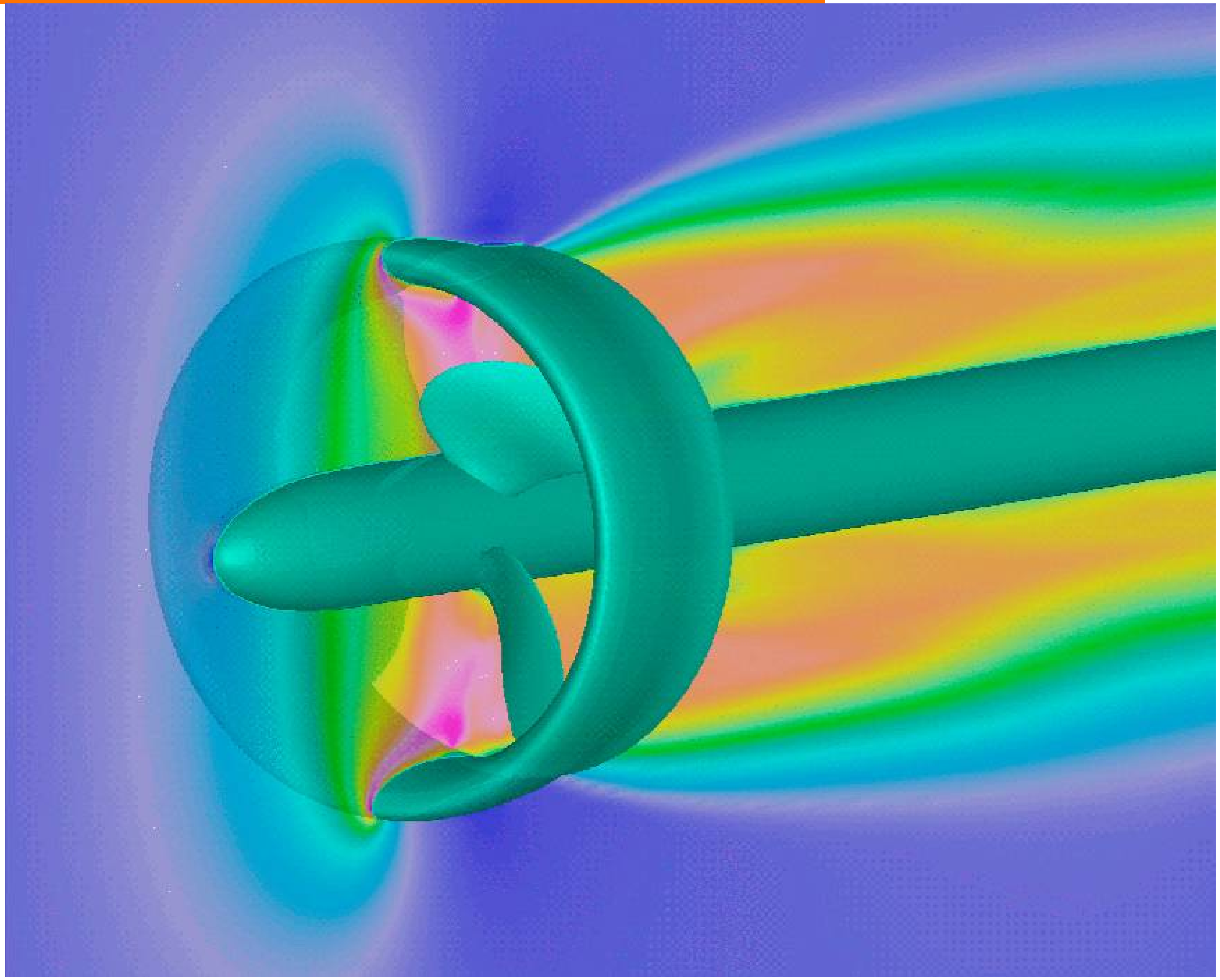


Example 2: Application of a Propeller nozzle

< 5%

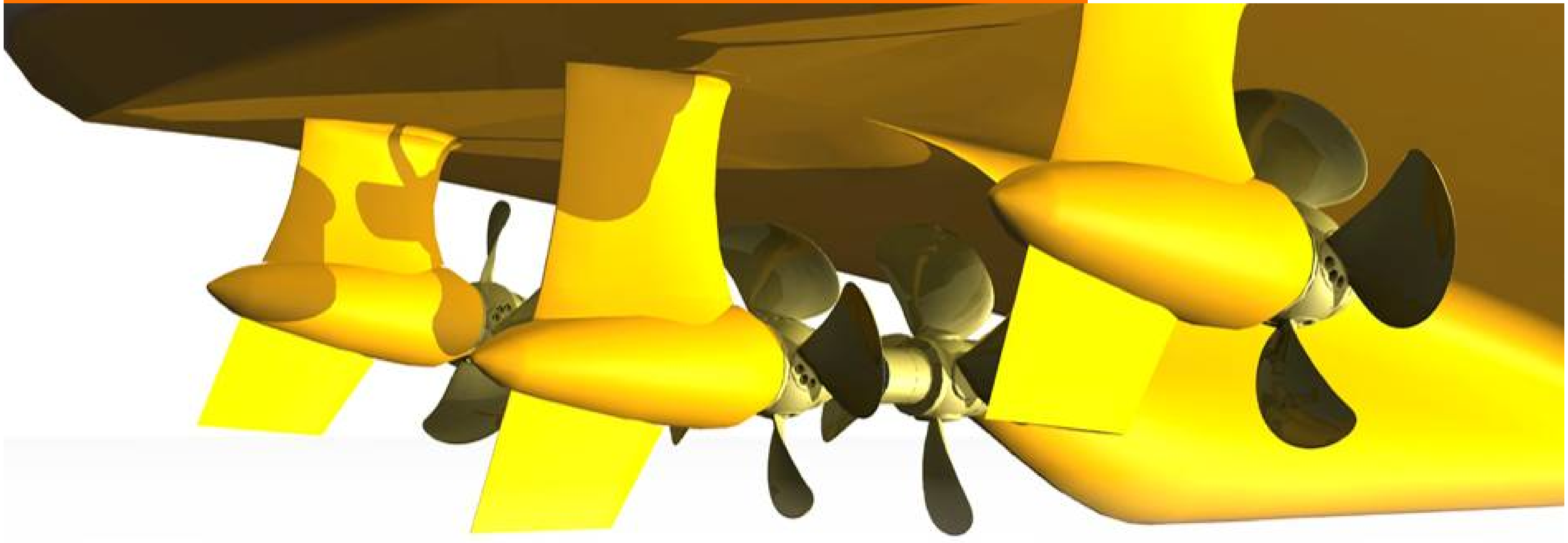
Installing nozzles shaped like a wing section around a propeller will save fuel for ship speeds of up to 20 knots.

Up to 5% power savings compared to a vessel with an open propeller.



Example 3: Advanced Pulling thruster

< 10%



Steerable thrusters with a pulling propeller can give clear power savings.
The pulling thrusters can be combined in different setups.

They can be favorably combined with a centre shaft on the centre line skeg in either a CRP or a Wing Thruster configuration.

Even a combination of both options can give great benefits.

The lower power demand arises from less appendage resistance than a twin shaft solution and the high propulsion efficiencies of the propulsors with a clean inflow.

The propulsion power demand at the propellers can be reduced by **up to 15%** with pulling thrusters in advanced setups.

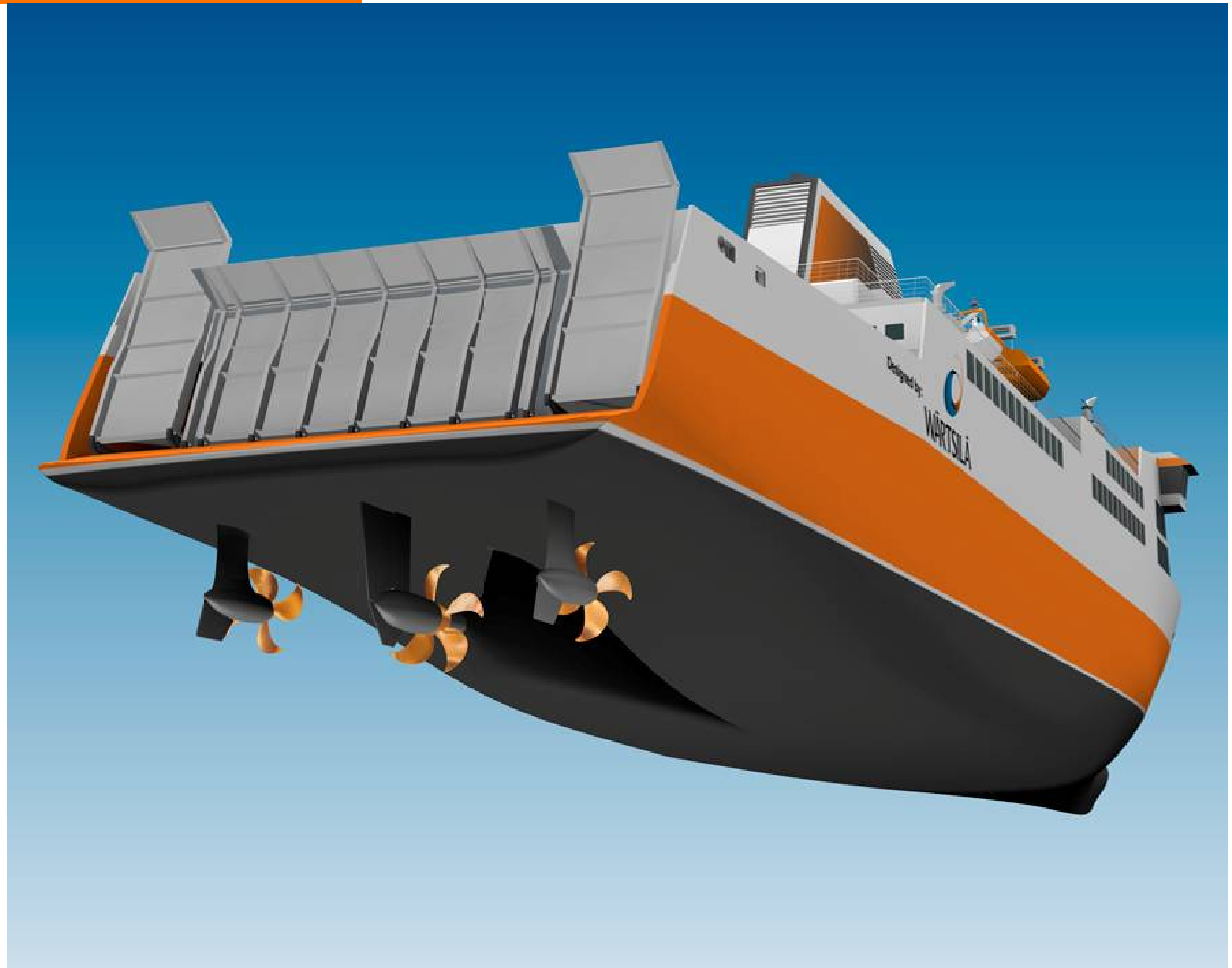
Example 4: Wing Thrusters

< 10%

Installing wing thrusters on twin screw vessels can achieve significant power savings, obtained mainly due to lower resistance from the hull appendages.

The propulsion concept compares a centre line propeller and two wing thrusters with a twin shaft line arrangement.

Better ship performance in the range of **8% to 10%.** More flexibility in the engine arrangement and more competitive ship performance.



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Example 5: Minimising resistance of hull openings

The water flow disturbance from openings to bow thruster tunnels and sea chests can be high. It is therefore beneficial to install a scallop behind each opening. Alternatively a grid that is perpendicular to the local flow direction can be installed. The location of the opening is also important.

Designing all openings properly and locating them correctly can give up to 5% lower power demand than with poor designs. For a container vessel, the corresponding improvement in total energy consumption approaches 5%.

< 5%

Example 6: Take care of Propeller surface finish/polishing

< 10%

Regular in-service polishing is required to reduce surface roughness on caused by propellers of every material organic growth and fouling. This can be done without disrupting service operation by using divers.

Up to 10% improvement in service propeller efficiency compared to a fouled propeller.

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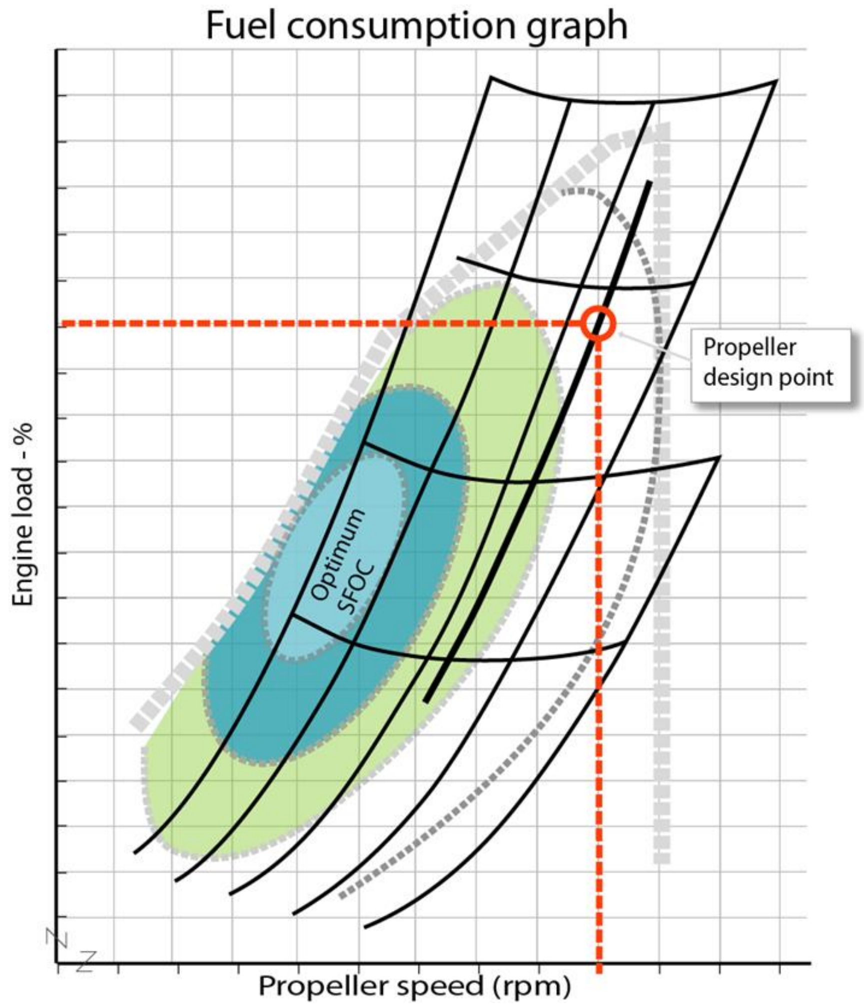
Example 7: Constant versus variable speed operation

For controllable pitch propellers, operation at a constant number of revolutions over a wide ship speed reduces efficiency. Reduction of the number of revolutions at reduced ship speed will give fuel savings.

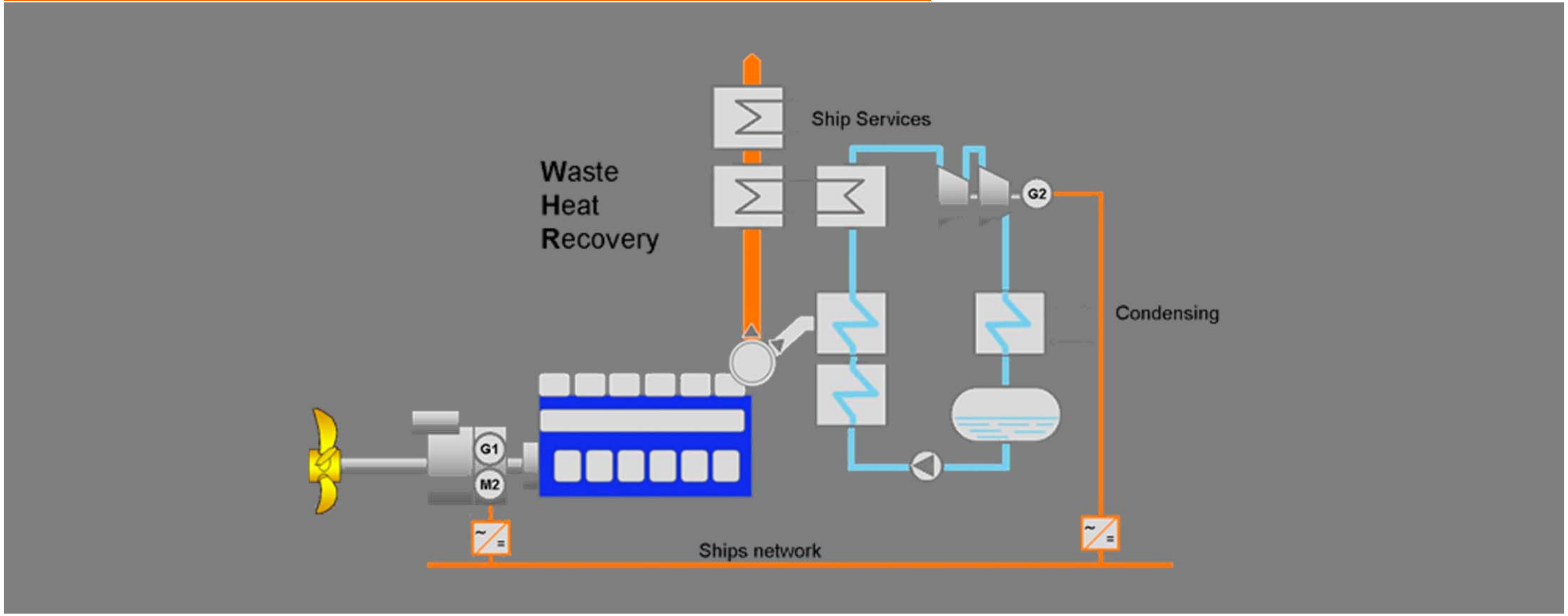
Saves 5% fuel, depending on actual operating conditions.

< 5%



Example 8: Waste heat recovery

< 10%

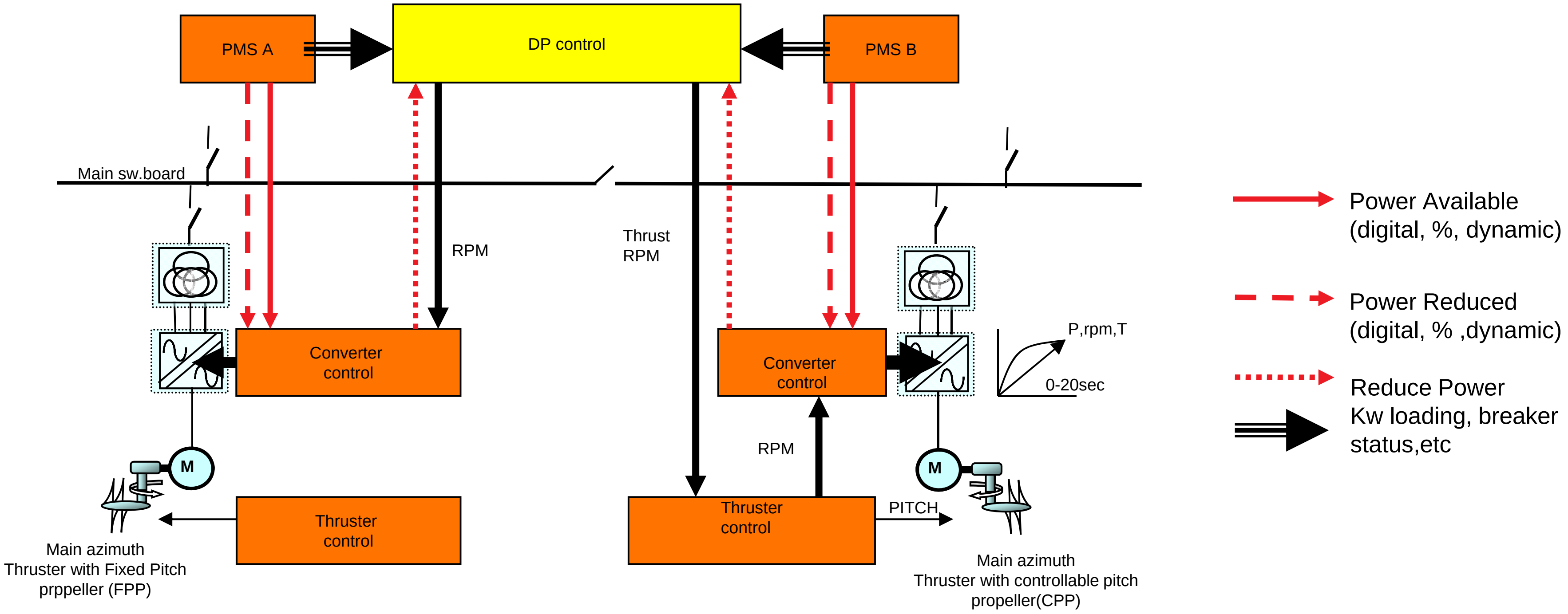


Waste heat recovery (WHR) recovers the thermal energy from the exhaust gas and converts it into electrical energy. Residual heat can further be used for ship onboard services. The system can consist of a boiler, a power turbine and a steam turbine with alternator. Redesigning the ship layout can efficiently accommodate the boilers on the ship.

Exhaust waste heat recovery can provide up to 15% of the engine power. The potential with new designs is up to 20%.

Example 9: Power management

< 5%



Correct timing for changing the number of generating sets is critical factor in fuel consumption in diesel electric and auxiliary power installations. An efficient power management system is the best way to improve the system performance.

Running extensively at low load can easily increase the SFOC by 5-10%.

Low load increases the risk of turbine fouling with a further impact on fuel consumption.

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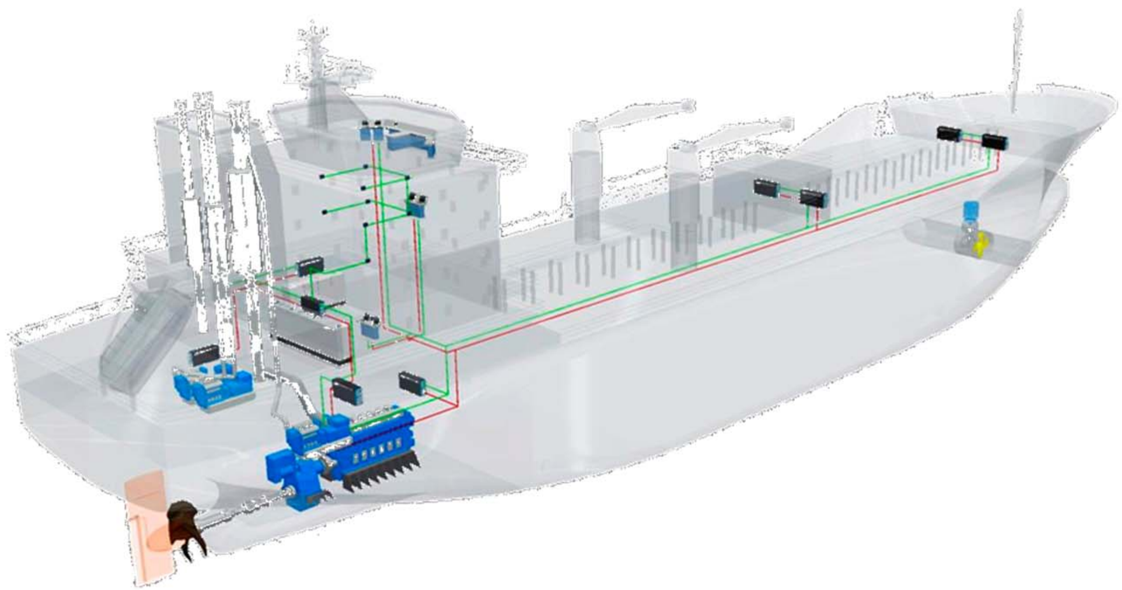
Example 10: Ship Automation

< 10%



An Integrated Automation System (IAS) or Alarm and Monitoring System (AMS) includes functionality for advanced automatic monitoring and control of both efficiency and operational performance.

The system integrates all vessel monitoring parameters and controls all processes onboard, so as to operate the vessel at the lowest cost and with the best fuel performance.

Power drives distribute and regulate the optimum power needed for propeller thrust in any operational condition.

Engine optimisation control, power generation & distribution optimisation, thrust control and ballast optimisation give 5-10% savings in fuel consumption.

Example 11: Ship speed reduction/ optimization

Reducing the ship speed an effective way to cut energy consumption. Propulsion power vs. ship speed is a third power curve (according to the theory) so significant reductions can be achieved. It should be noted that for lower speeds the amount of transported cargo / time period is also lower. The energy saving calculated here is for an equal distance travelled.

Reduction in ship speed vs. saving in total energy consumption:

- 0.5 kn --> - 7% energy
- 1.0 kn --> - 11% energy
- 2.0 kn --> - 17% energy
- 3.0 kn --> - 23% energy

BACK

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Array of Measures for New Build and Existing Vessels

	TANKERS / BULKERS	CONTAINER VESSELS	ROROs	FERRIES	OFFSHORE SUPPORT VESSELS
PROPULSION					
Wing thrusters					
CRP propulsion					
Pulling thruster					
Propeller hull interaction optimization					
Propeller – rudder combinations					
Advanced propeller blade sections					
Propeller tip winglets					
Propeller nozzle					
Constant versus variable rpm operation					
Propeller efficiency measurement					
Wind power – sails and kites					
Wind power – Flettner rotor					

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Concluding Remarks

- Fuel cost and environment are the drivers
- Large percent of shipping cost is fuel (40% in many cases).

- A significant Fuel Saving Potential exists. It can reach up to 50% in some cases.

- We would need the combined Industry effort to take full advantage of such a Potential.