



Det Norske Vitenskapsakademi

Rolls-Royce LNG Systems

2018-11-14

Oscar Kallerdahl

Vice President – LNG Systems

© 2018 Rolls-Royce plc

The information in this document is the property of Rolls-Royce plc and may not be copied or communicated to a third party, or used for any purpose other than that for which it is supplied without the express written consent of Rolls-Royce plc.

This information is given in good faith based upon the latest information available to Rolls-Royce plc, no warranty or representation is given concerning such information, which must not be taken as establishing any contractual or other commitment binding upon Rolls-Royce plc or any of its subsidiary or associated companies.

Trusted to deliver excellence



Rolls-Royce

Rolls-Royce Gas Systems in Operation

- 39 vessels are in operation running on gas
- 77 Engines
- 29 System Deliveries



Our vision

Complete LNG systems and propulsion packages with a strong focus on the full system throughout the design, build and service stages



Rolls-Royce

The fuel of the future

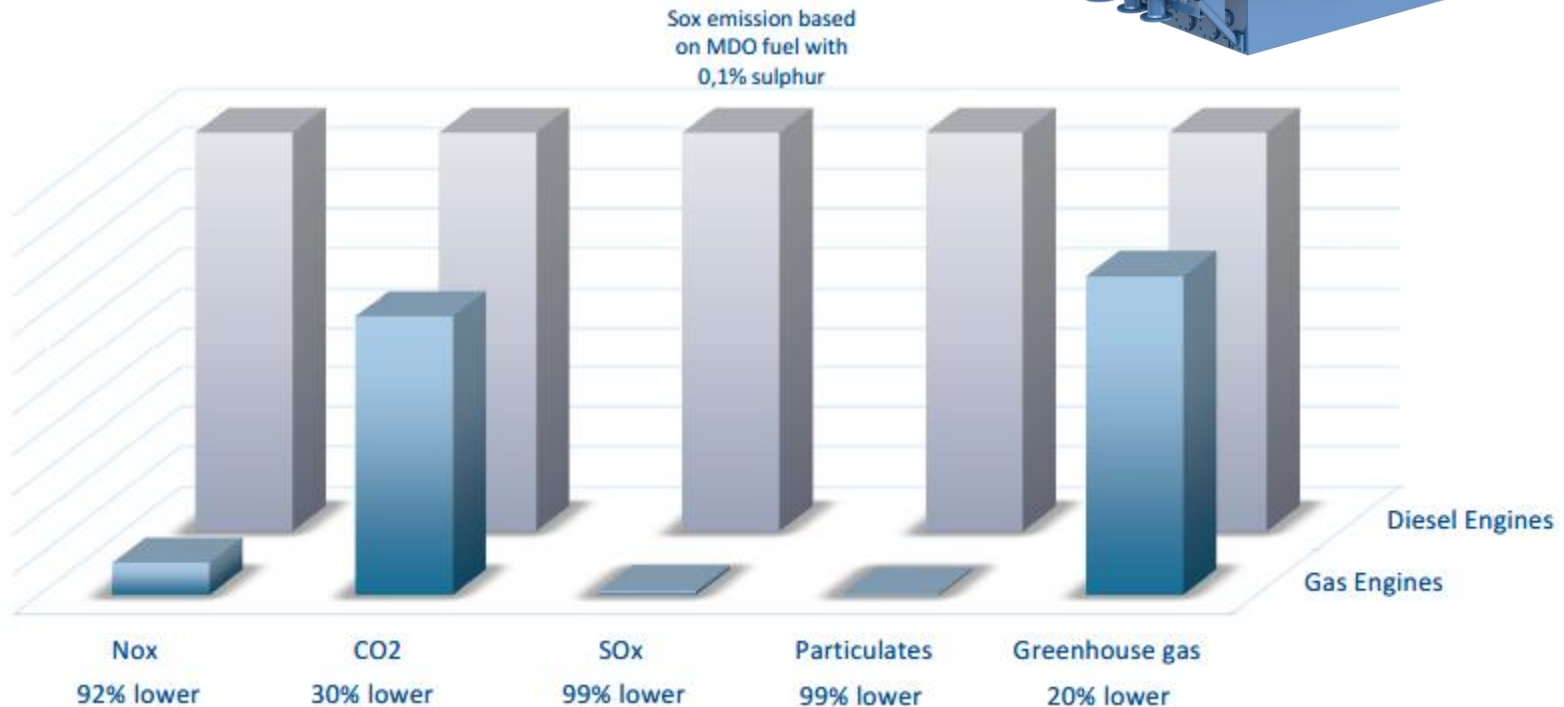
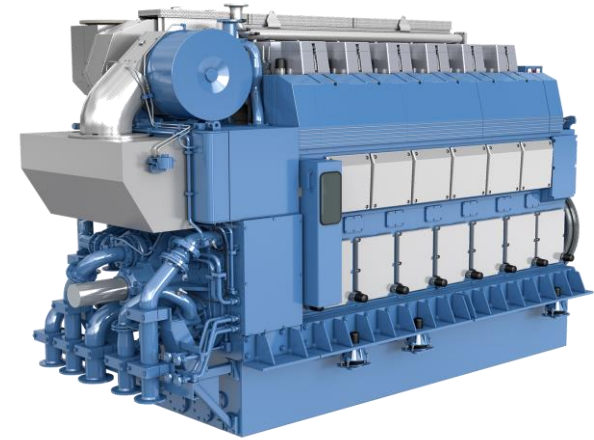
Pure natural gas



Rolls-Royce

Emissions running on Gas

- **Rolls-Royce Bergen Engine**
- Including Methane Slip



Rolls-Royce

Gas Engine/Systems Reference List

6



Owner	Vessel name	Yard	Prod. Year	Engine type	Ship type
Anthony Veder Rederijzaken B.V.	Coral Methane	Remontowa	2007	2 KVGB-12G4	Tanker
Balearia / Gas Natural Fenosa	Abel Matutes	- Existing ship -	2015	1 C26:33L6AG	ROPAX/Passengerferry
Boreal Transport Nord AS	Hasvik	Fiskerstrand	2015	1 C26:33L6AG	Ferry
Boreal Transport Nord AS	Bergsfjord	Fiskerstrand	2015	1 C26:33L6AG	Ferry
Bukser & Berging AS	Borgøy	Sanmar Shipyard	2012	2 C26:33L6PG	Tug
Bukser & Berging AS	Bdln	Sanmar Shipyard	2013	2 C26:33L6PG	Tug
CNOOC (China National Offshore Oil Corporation)	Hai Yang Shu You 525	Zhenjiang Shipyard (Group) Co., Ltd	2 0 1 4	2 C26:33L9PG	Gas Fuel Tug
CNOOC (China National Offshore Oil Corporation)	T B V	Zhenjiang Shipyard (Group) Co., Ltd	2 0 1 4	2 C26:33L9PG	Gas Fuel Tug
Egil Ulvan Rederi AS	With Harvest	Fiskerstrand Verft BRLT AS	2013	1 C26:33L9PG	Fish feed vessel
Egil Ulvan Rederi AS	With Marine	Fiskerstrand Verft BRLT AS	2014	1 C26:33L9PG	Fish feed vessel
Eidsvaag Rederi AS	M/S Eidsvaag Pioneer	Vard Aukra	2012	1 C26:33L9PG	Fish feed carrier
Fjord Line AS	MS Stavangerfjord	Bergen Group Fosen	2012	4 B35:40V12PG	Ro-Pax (Ferry)
Fjord Line AS	MS Bergensfjord	Bergen Group Fosen	2012	4 B35:40V12PG	Ro-Pax (Ferry)
Fjord1	Bergensfjord	Aker Sjøviknes	2006	2 KVGS-12G4	Ferry
Fjord1	Bergensfjord	Aker Sjøviknes	2006	2 KVGS-16G4	Ferry
Fjord1	Fana fjord	Aker Brattvåg AS	2006	2 KVGS-12G4	Ferry
Fjord1	Fana fjord	Aker Brattvåg AS	2006	2 KVGS-16G4	Ferry
Fjord1	Raunefjord	Aker Brattvåg AS	2006	2 KVGS-12G4	Ferry
Fjord1	Raunefjord	Aker Brattvåg AS	2006	2 KVGS-16G4	Ferry
Fjord1	Mastra fjord	Aker Sjøviknes	2006	2 KVGS-12G4	Ferry
Fjord1	Stavangerfjord	Aker Sjøviknes	2006	2 KVGS-12G4	Ferry
Fjord1	Tresfjord	TBA	2010	1 C26:33L9AG	Ferry
Fjord1	Boknafjord	Fiskerstrand BLRT	2011	3 C26:33L9AG	Gas Ferry
Golar LNG	Golar Hilli	Keppel Shipyard Ltd.	2016	2 B35:40V20AG	LNG Tanker FLNG
Haugland Tankers AS	Bergen Viking	Retrofit	2 0 1 4	2 C26:33L6AG	Tanke {Product/Chemical
Island Offshore	Island Crusader	STX Brevik	2011	2 C26:33L9AG	PSV>4000
Island Offshore	Island Contender	STX Brevik	2011	2 C26:33L9AG	PSV>4000
Nor Lines AS	Kvitbjørn	Tsuji Heavy Industries	2012	1 B35:40L9PG	RoRo
Nor Lines AS	Kvitnos	Tsuji Heavy Industries	2013	1 B35:40L9PG	RoRo
NSK Shipping	MS Høydal	Tersan Shipyard	2011	1 C26:33L6PG	Gas Food supply vessel
NSK Shipping	TBA	Tersan Shipyard	2016	1 C26:33L8P	Fish feed carrier
Sea Cargo	SEACARGO RENERGY	Bharati Shipyard Pvt. Ltd.	2009	1 B35:40V12PG	RoRo
Sea Cargo	SEACARGO INNOVATION	Bharati Shipyard Pvt. Ltd.	2009	1 B35:40V12PG	RoRo
Torghatten Nord	Barøy	Remontowa S.A.	2011	1 C26:33L9PG	Ferry
Torghatten Nord	Lørdingen	Remontowa S.A.	2012	1 C26:33L9PG	Ferry
Torghatten Nord	Landegeode	Remontowa S.A.	2011	1 B35:40V12PG	Ferry
Torghatten Nord	Værøy	Remontowa S.A.	2011	1 B35:40V12PG	Ferry



- 55 Vessels
- 77 Engines
- 29 LNG Systems

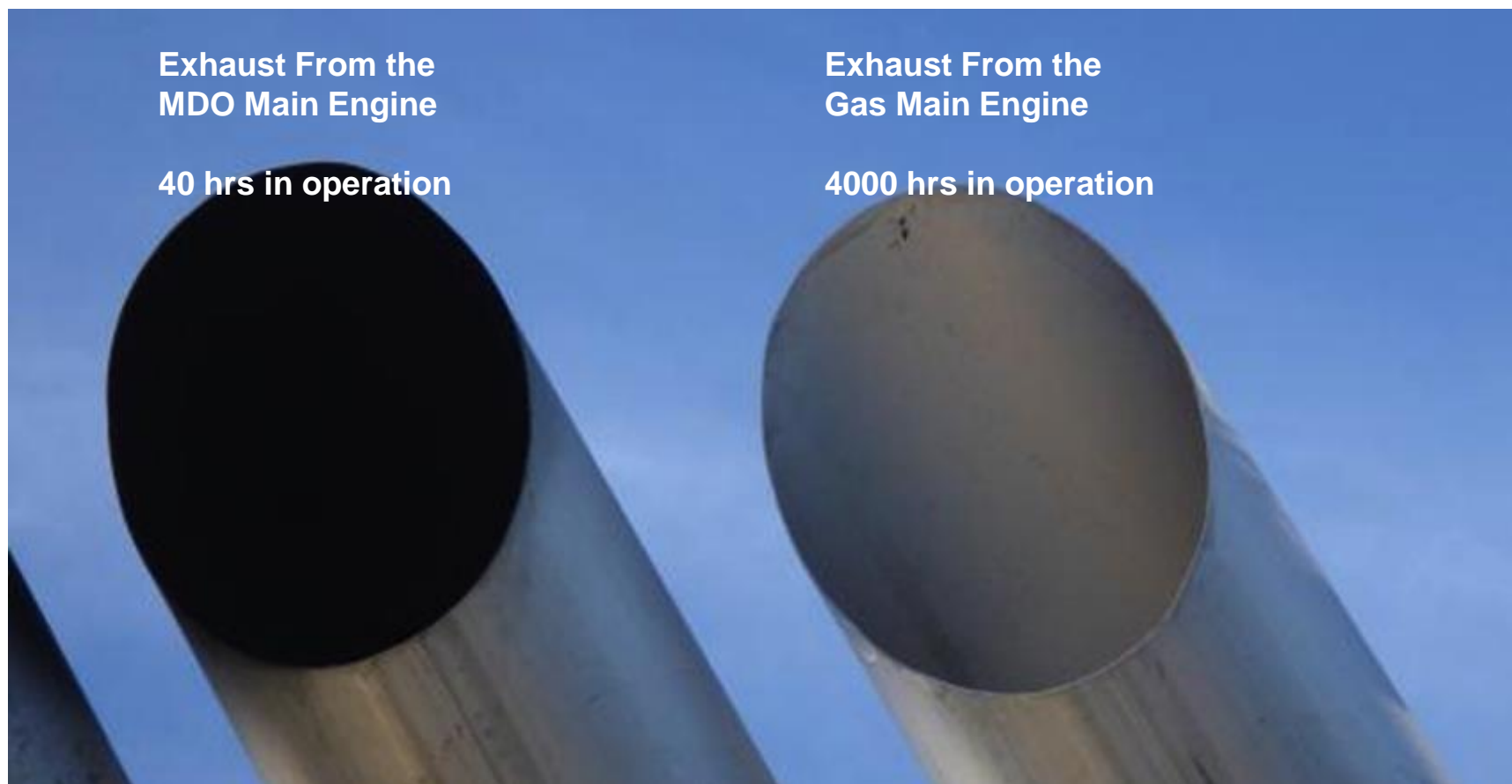
Rolls-Royce data-strictly private



Rolls-Royce

The lean burn gas engine

Clean exhaust

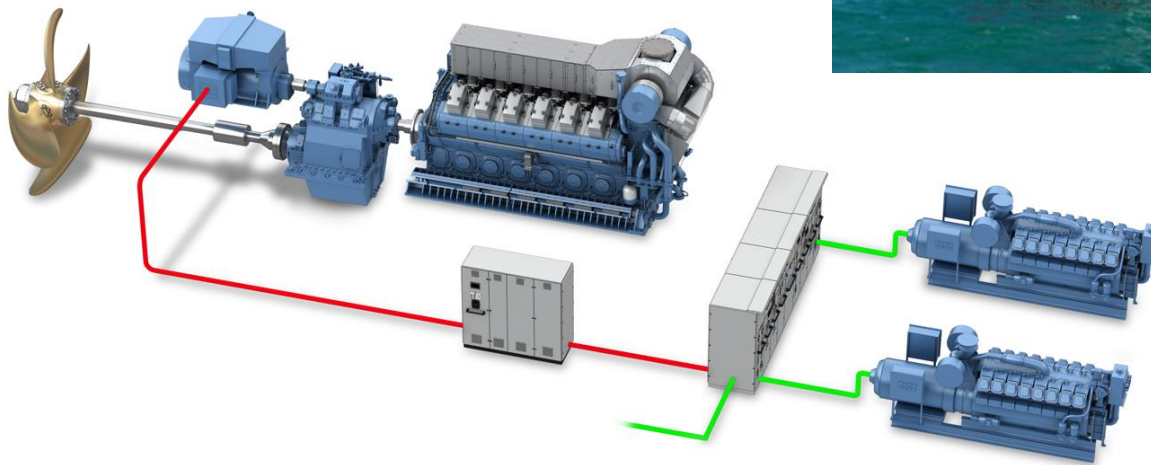


Rolls-Royce

Gas Propulsion Systems

1 Tank - 1 Tank Connection Space

- Redundancy by:
 - A PTI/PTO through a gear box



Norlines

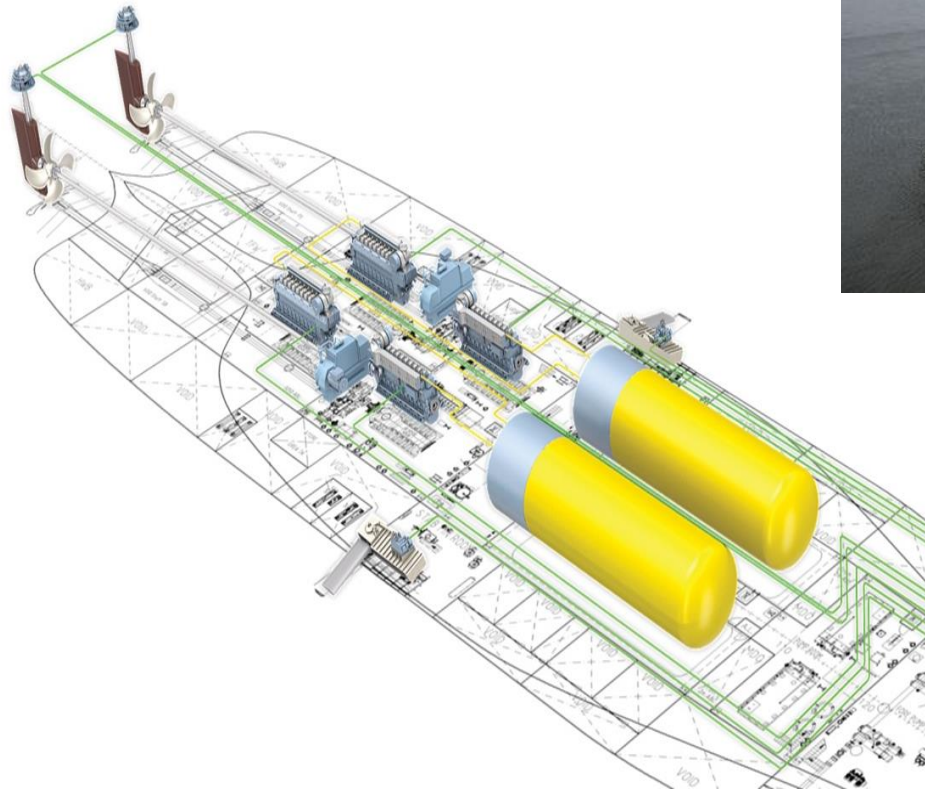


Rolls-Royce

Gas Propulsion Systems

1 Tank - 1 Tank Connection Space

- Redundancy by:
 - 2 parallel systems with Gas Cross Over
 - Back Up give 85% power



Fjord Line

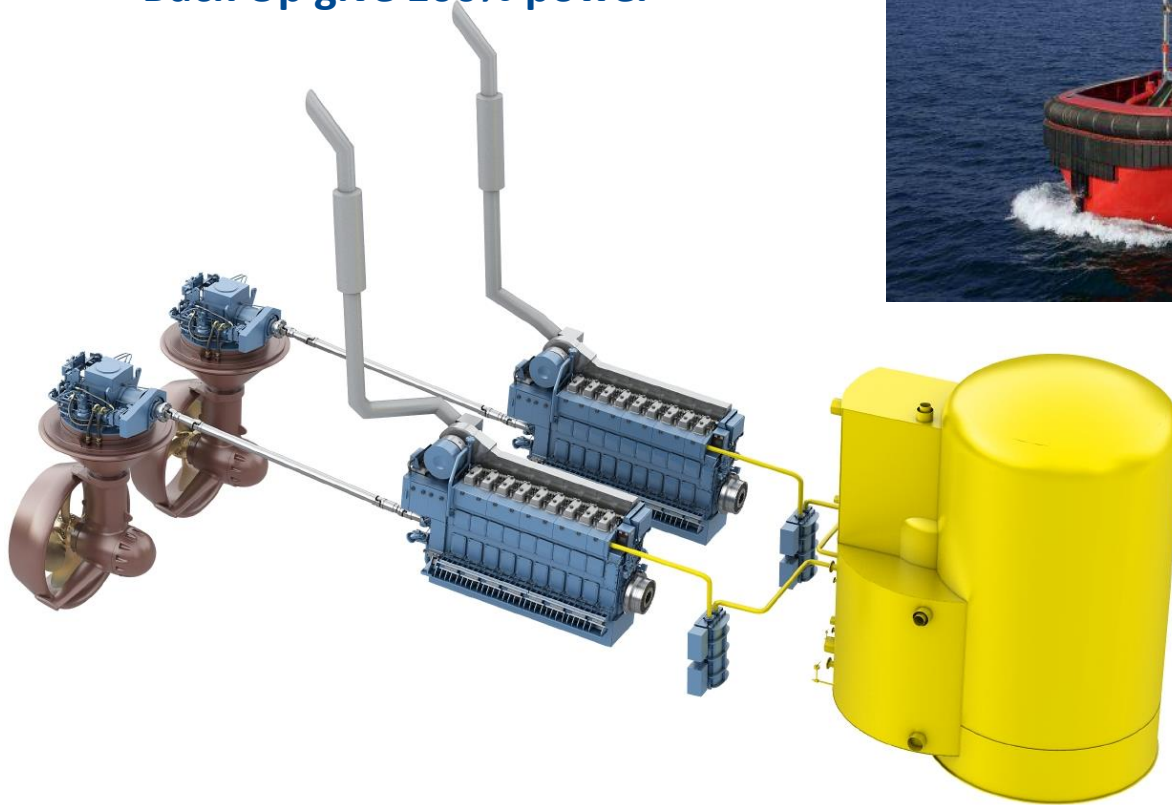


Rolls-Royce

Gas Propulsion Systems

1 Tank - 2 Tank Connection Spaces

- Redundancy by:
 - 2 parallel power trains connected with a Gas Cross Over
 - Back Up give 100% power



Buksér og Berging

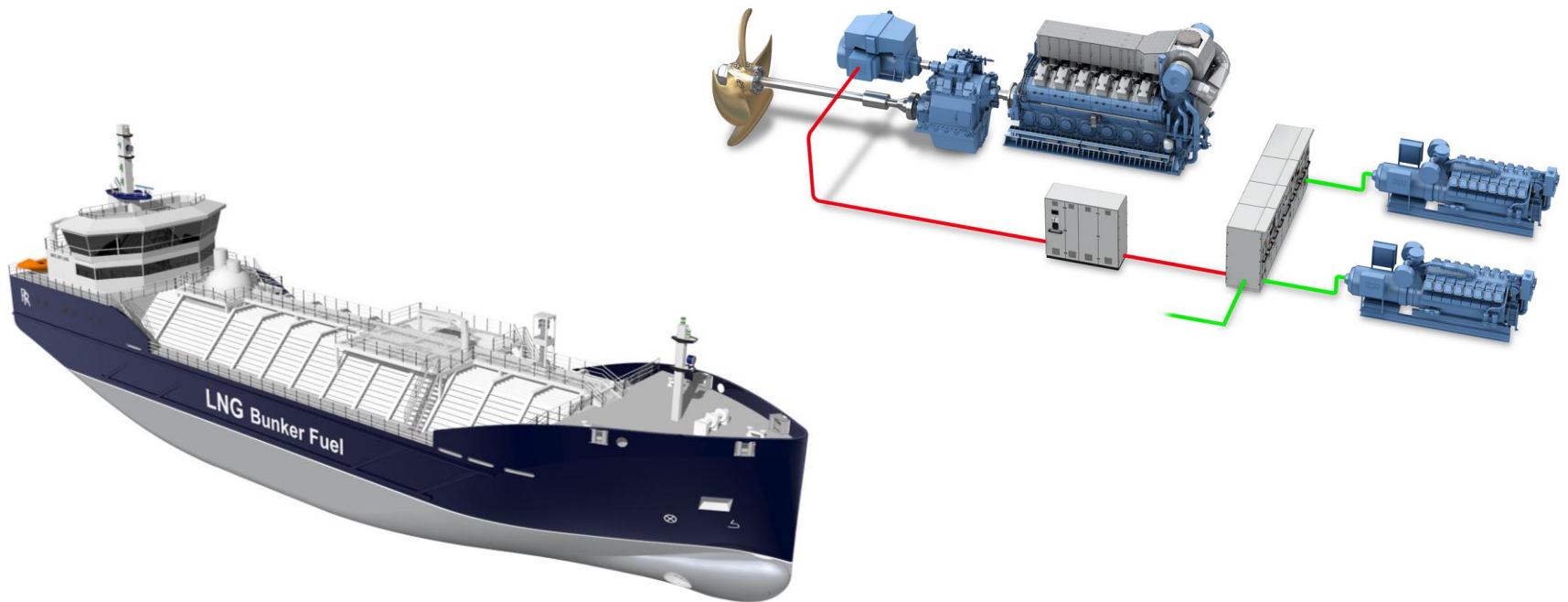


Rolls-Royce

Gas Propulsion Systems

LNG/NG Feed System from Cargo Tanks

- Redundancy by:
 - 2 parallel gas feed systems



Rolls-Royce

The Environship Concept

NVC 405 – LNG , General Cargo Vessel

Norlines, Kvitnos



Rolls-Royce

The Environship Concept

NVC 405 – LNG , General Cargo Vessel

- 5000 dwt
- 400 m³ LNG



- Low emission
 - 40% less CO₂ emissions than previous Rolls-Royce design



Rolls-Royce

The Environship Concept

NVC 405 – LNG , General Cargo Vessel



Reduction
5-8%

Rolls-Royce
PROMAS

Design & Engineering –
Integrated Ship System
Reduction 4-6%



Rolls-Royce
Wave Piercing
Technology

Reduction
5-8%

Reduction
4-6%

Rolls-Royce
HSG – Hybrid
Shaft
Generator



Rolls-Royce
Gas Engines &
Systems

Reduction
18-22%



40% less CO₂ emissions than previous Rolls-Royce design



Rolls-Royce

WAVE PIERCING TECHNOLOGY

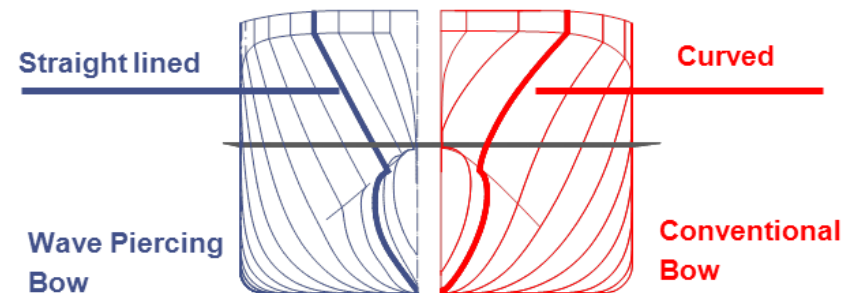
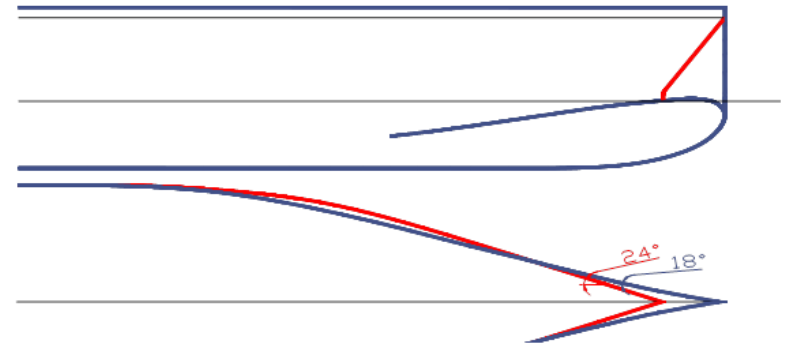
How does it work.....

1 Maximum Waterline Length / Less Resistance

- ✓Length/Breadth ratio optimised
- ✓Water entrance angle optimised
- ✓Reduced “shoulder”

2 No “Flare” at bow

- ✓Less speed loss “ In A Sea Way”
- ✓Less “Green Sea”
- ✓Less “Bow Impact” / “Slamming”

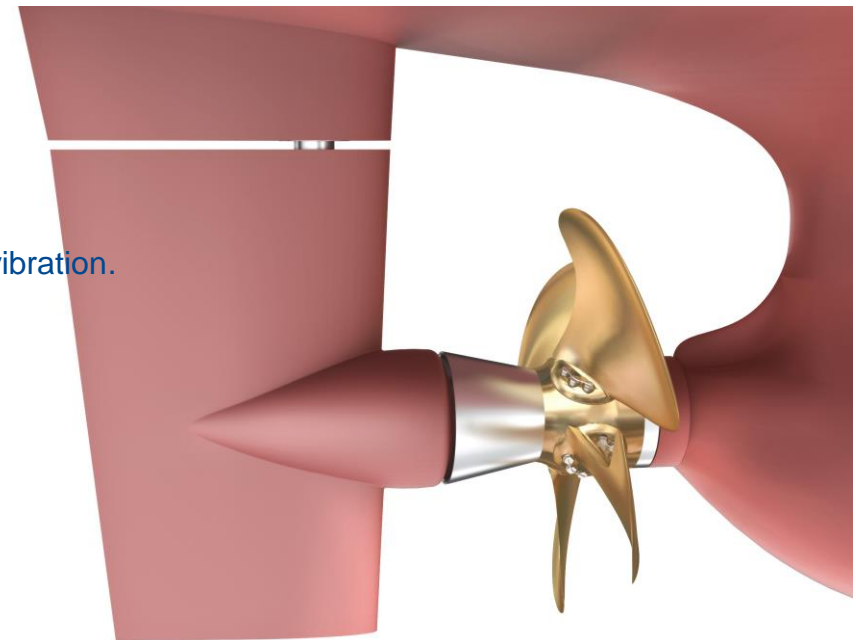
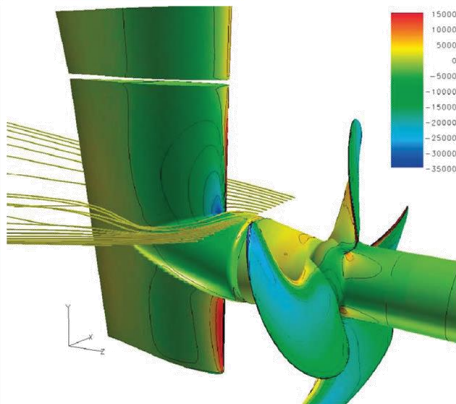


Rolls-Royce

INTEGRATED RUDDER & PROPULSION SYSTEM

Promas integrates the propeller, a hub cap, a rudder bulb and the rudder itself into one hydrodynamically efficient entity.

- ✓ Twisted Rudder with Leading edge towards the propeller flow
- ✓ Propeller and rudder are designed together as a single unit.
- ✓ No hub vortex losses
- ✓ Better load distribution on propeller.
- ✓ Propulsive efficiency is increased by typically 4-8%.
 - ⇒ Less fuel consumption
 - ⇒ Less environmental impact
- ✓ Less pressure pulse towards hull / low noise propeller and vibration.
- ✓ Improved low speed maneuverability.
- ✓ Simple and robust design.
- ✓ PROMAS LITE – Retrofit Existing Vessels

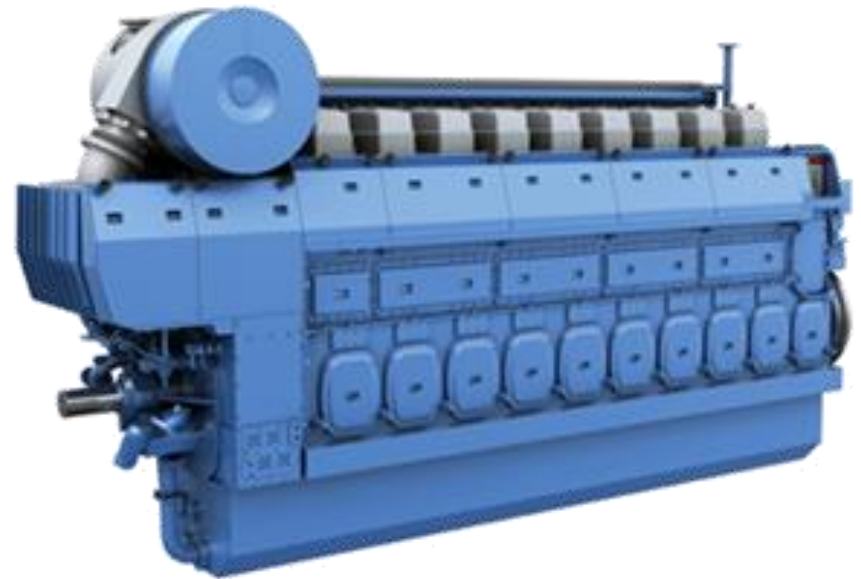


Rolls-Royce

GAS ENGINES AND SYSTEMS

Bergen Lean Burn gas engines

- Lean-Burn combustion
- Good Fuel Economy
- Compact and powerful, high power to weight ratio.
- Low emissions of NO_x, CO₂, SO_x and particles
- Available for both Gas-mechanical and Gas-electric application
- High efficiency, 48%
- Approved by DNV for marine applications
- Service friendly
- Optimum response at all engine load points (Variable Turbo Geometry)
- Stable frequency
- No oil contamination, clean ER.
- No visible smoke



Rolls-Royce

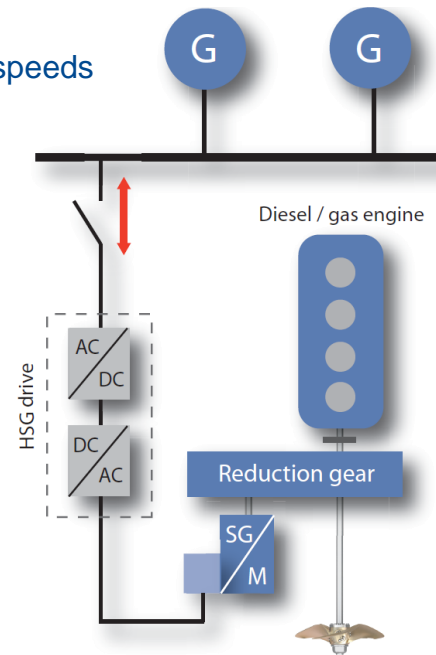
HYBRID SHAFT GENERATOR

Shaft generator to switchboard power flow control.

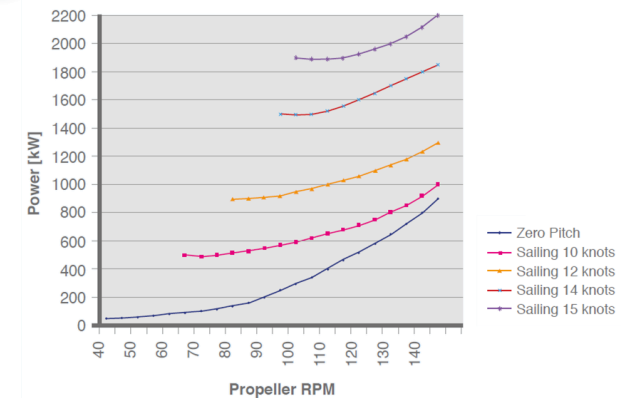
- ✓ Engine and propeller can operate at variable speeds
- ✓ Stable network frequency
- ✓ Fixed voltage

Benefits.

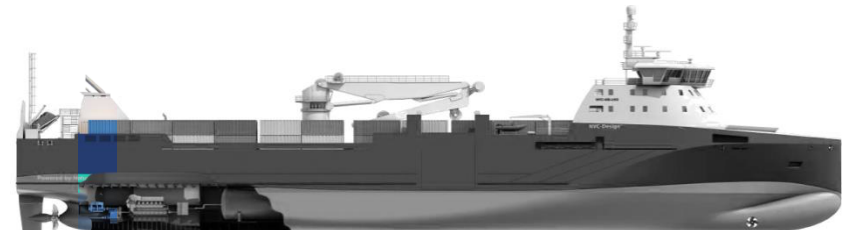
- ✓ Reduced fuel consumption
- ✓ Flexible operations
- ✓ Optimized propulsion mode selection
- ✓ Longer engine life and reduced maintenance
- ✓ Increased comfort on board
- ✓ Improved redundancy



Propeller shaft Input power as a function of RPM



ROLLS-ROYCE HSG – HYBRID SHAFT GENERATOR

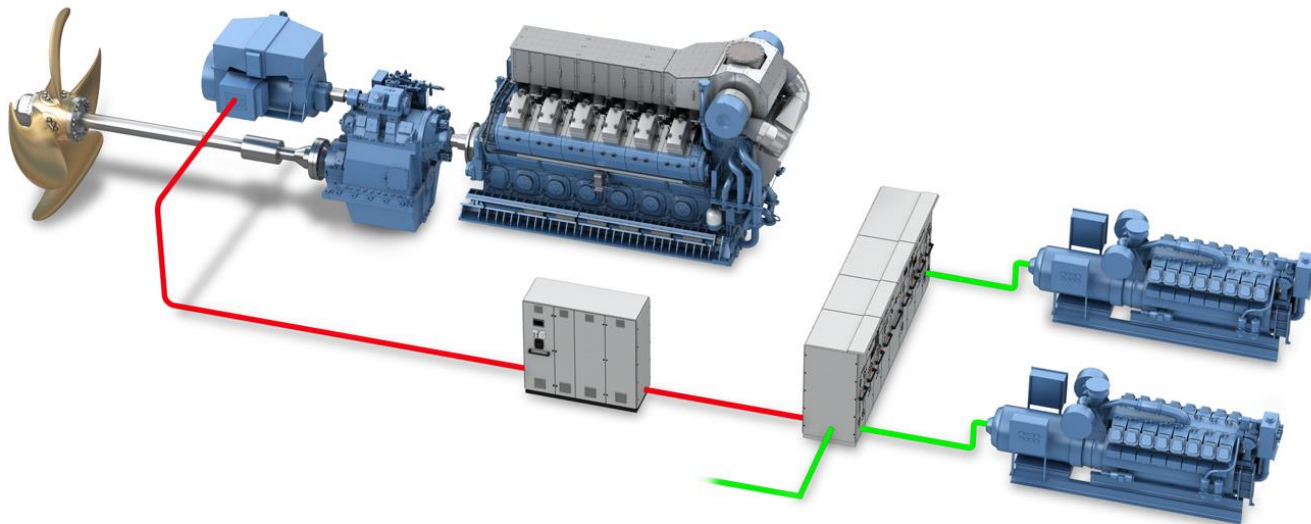


Rolls-Royce

The Environship Concept

Engine and Propulsion Arrangement

- **Hybrid Shaft Generator**
 - Power Take In – Power Take Out
 - Power to the Electric System at any rpm
 - Boost of Propulsion when needed



Rolls-Royce

The Environship - Norlines – Kvitbjørn - Kvitnos



Rolls-Royce

The Voyage – operating purely on LNG

 LNG Bunker stations



Rolls-Royce

Bergen, Norway
Fredrikstad, Norway
Cartagena, Spain
Cochin, India
Singapore
Shanghai, China



THE WORLD'S LONGEST JOURNEY BY LNG AT SEA
POWERED BY ROLLS-ROYCE



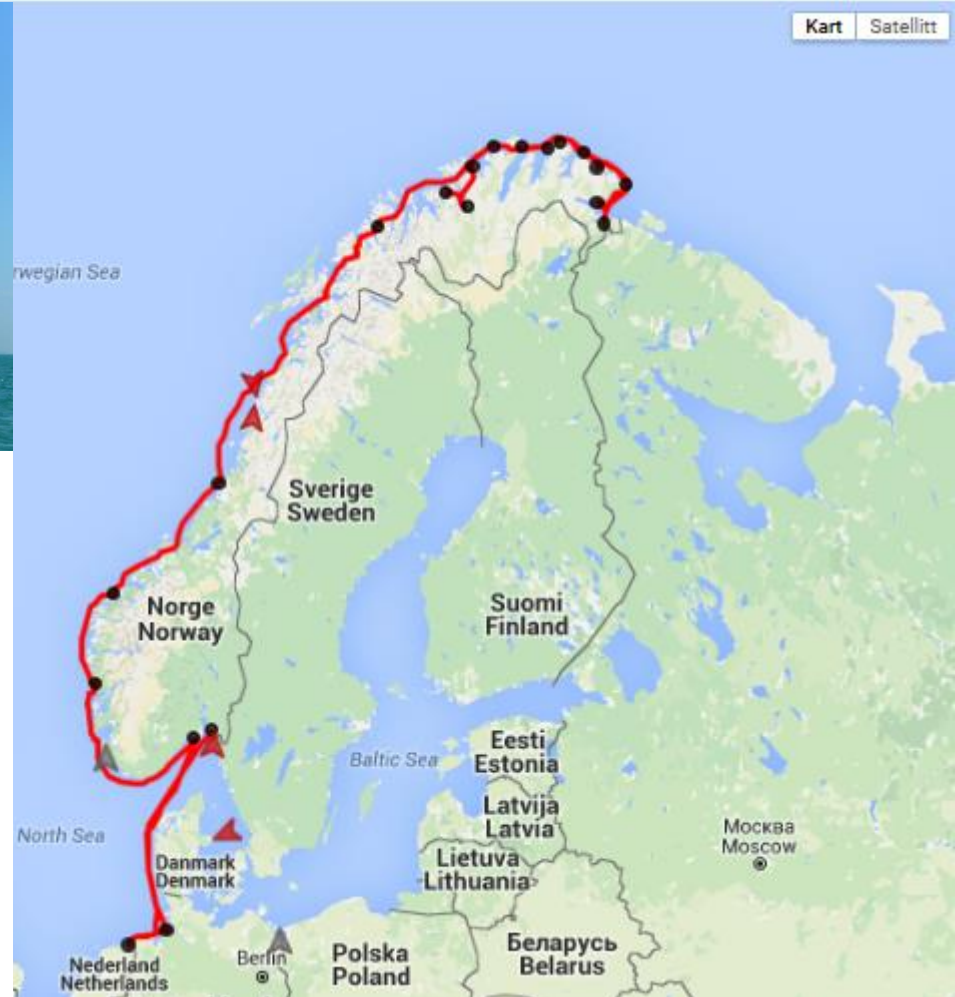
Rolls-Royce

Vessels Operating purely on LNG

Norlines – Kvibjørn and Kvitnos en Route



- 14 days roundtrip - 2900 nm
- Bunkering 290 m³ LNG
- MGO usage approx 2 m³
- 90 % load on main engine - Power Take Out mode
- Speed of 15 knots



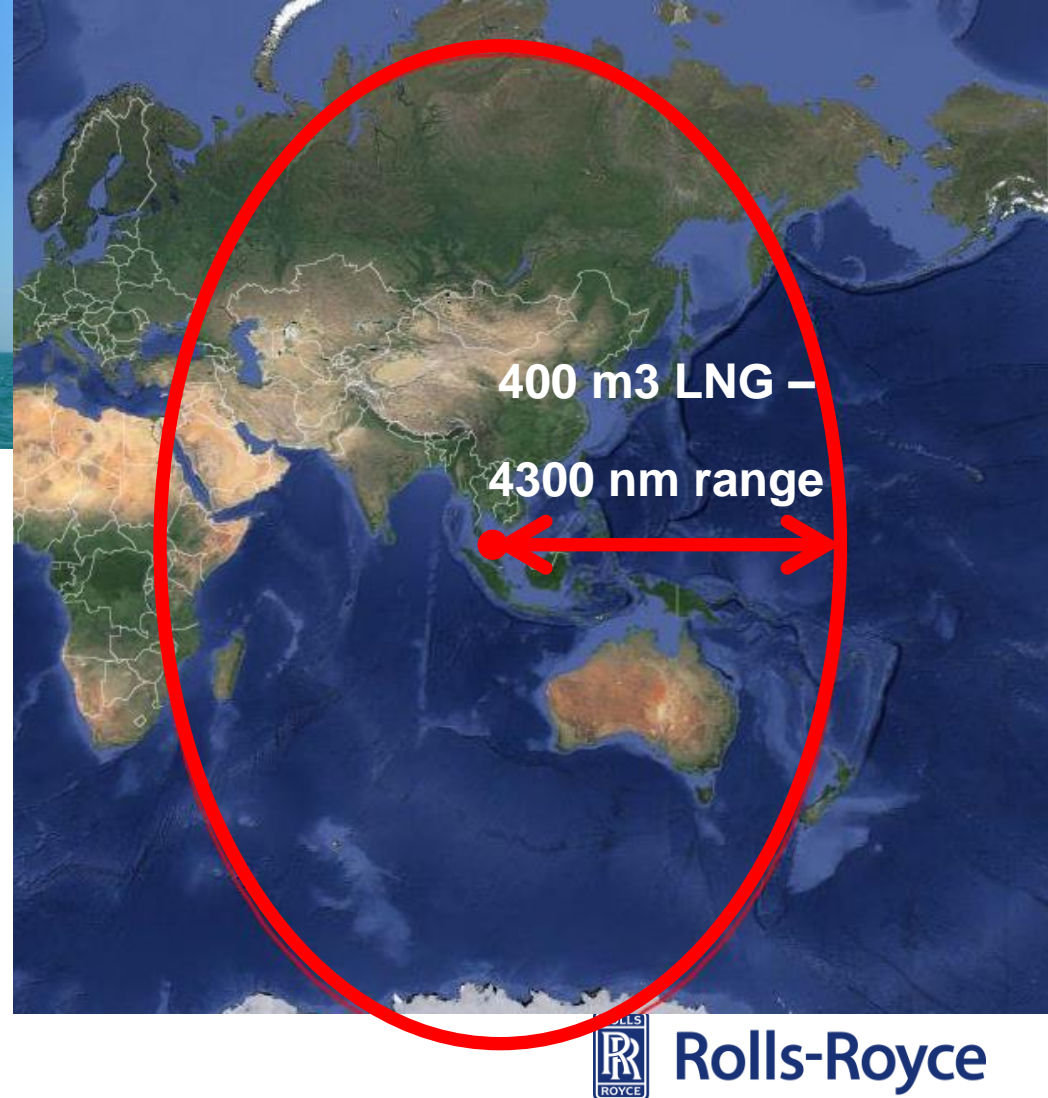
Rolls-Royce

Vessels Operating purely on LNG

Norlines – Kvibjørn and Kvitnos en Route



- 400 m³ – 4300 nm range
- MGO add another 2200 nm
- Total Range 6480 nm
- 22 days of sailing



Web and Social Media

- www.Rolls-Royce.com/LNG



- Linked In – join our group!
“Rolls Royce LNG “



End

Thank you for your attention