

WÄRTSILÄ TWO-STROKE FUTURE FUELS CONVERSION

WÄRTSILÄ 2-STROKE SERVICES
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Owners face a critical decision

30,000 vessels will require recertification*

2023
EEXI / CII

2030
- 40% carbon intensity

2050
-70% carbon intensity &
-50% in total GHG emissions

*Source: DNV



WÄRTSILÄ POWER LIMITATION SOLUTIONS

The right upgrade solution for power limitation regardless of the propulsion train design

**2-STROKE ENGINE
POWER LIMITATION**

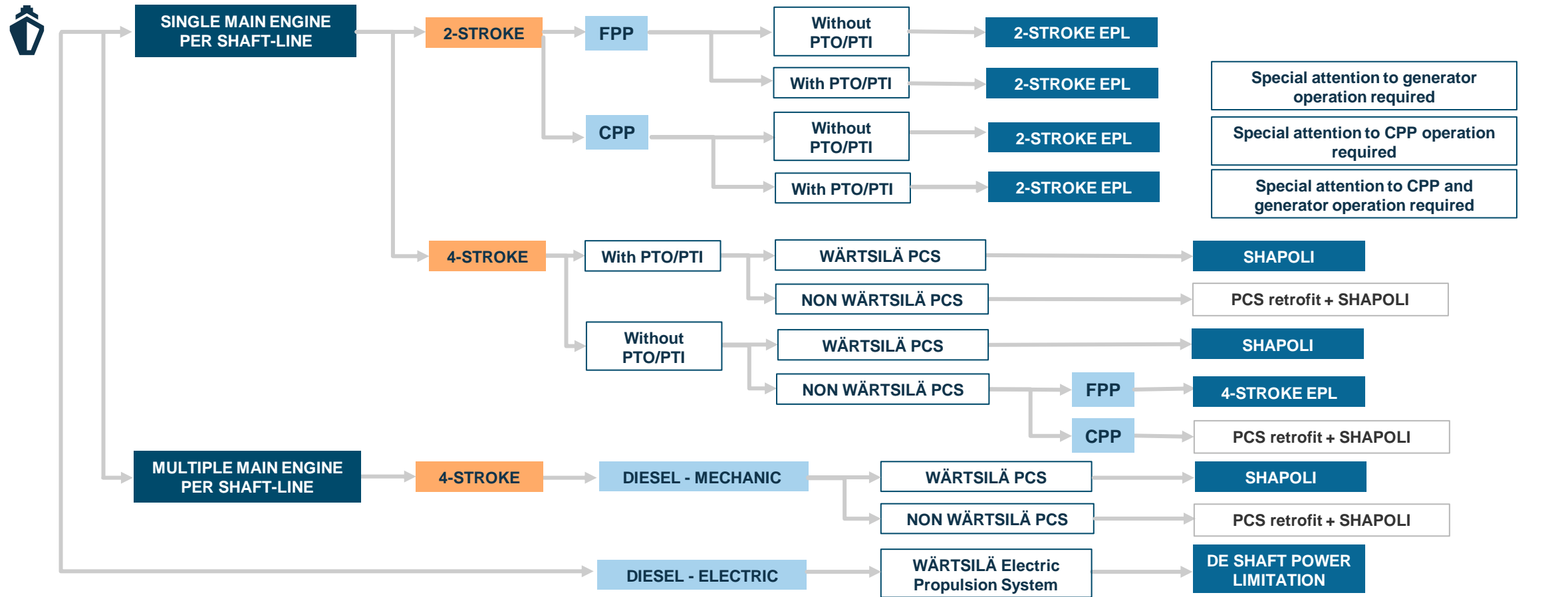
**4-STROKE ENGINE
POWER LIMITATION**

**SHAFT POWER
LIMITATION**

**DIESEL-ELECTRIC
POWER LIMITATION**

WÄRTSILÄ SOLUTIONS FOR LIMITED POWER

All Power Limitation solutions are available only for Wärtsilä installed base



PTO= Power Take Out
PTI= Power Take In

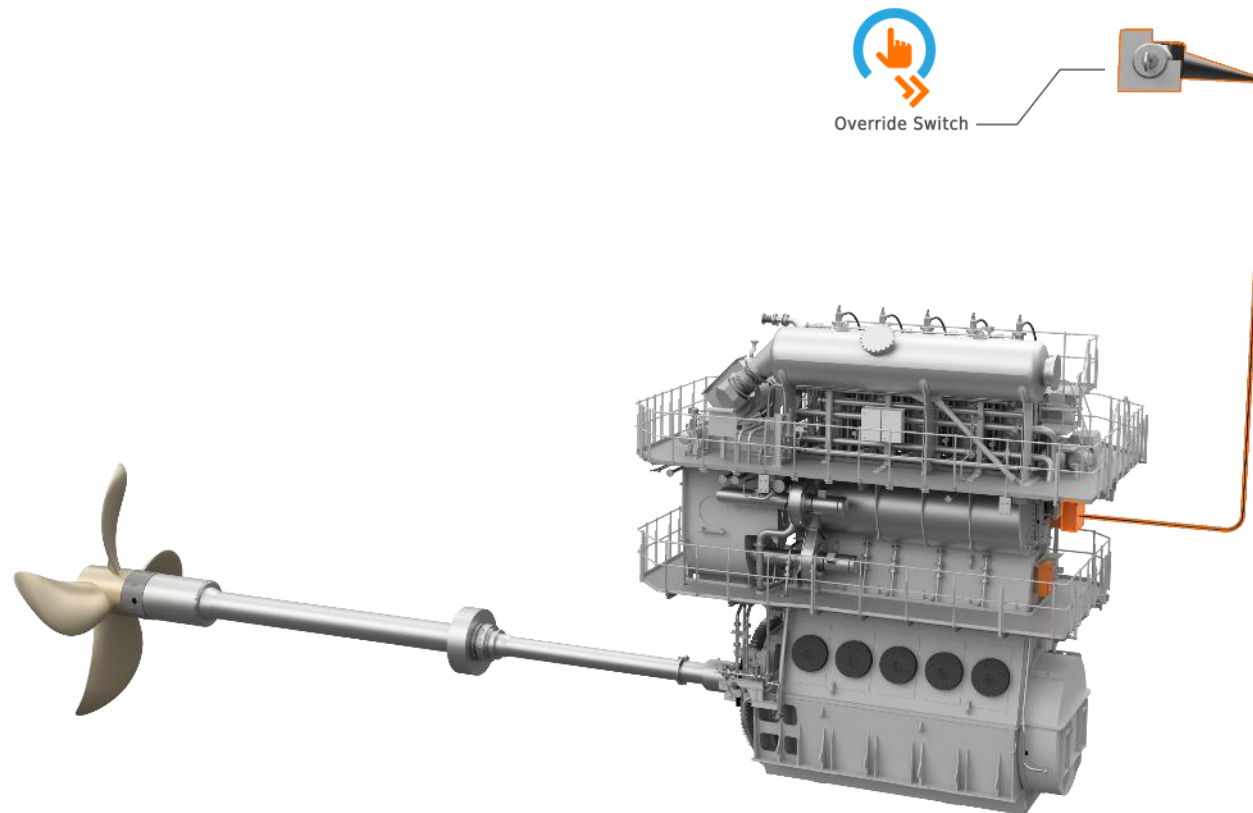
FPP= Fixed Pitch Propeller
CPP= Controllable Pitch Propeller

PCS= Propulsion Control System
DE= Diesel Electric

EPL= Engine Power Limitation
SHAPOLI

WÄRTSILÄ 2-STROKE ENGINE POWER LIMITATION

For vessels with Sulzer / Wärtsilä / WinGD 2-stroke engines



SCOPE OF SUPPLY:

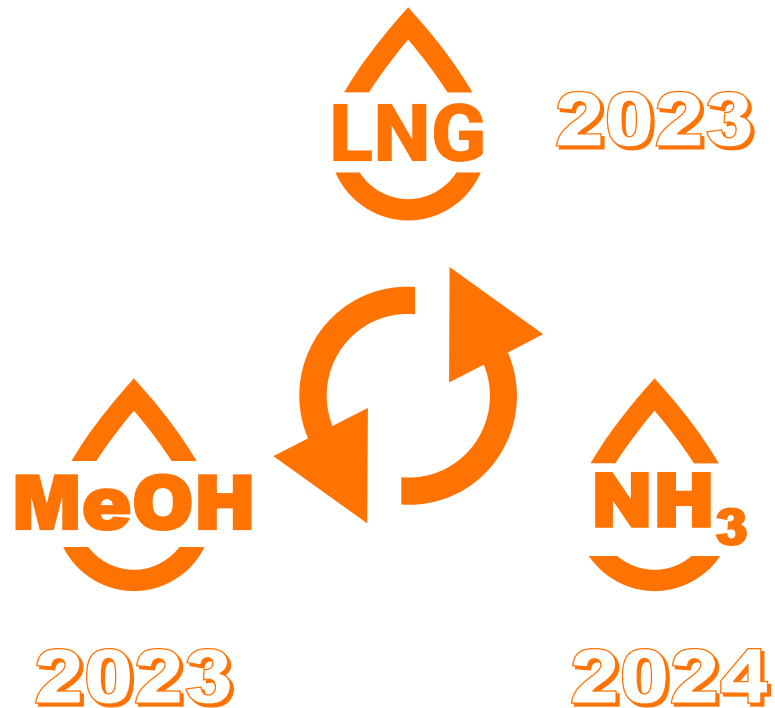
- Software update (for electronic engines with WECS & UNIC)
- EPL interface box (for mechanical engines)
- Data logging
- Override switch
- EPL documentation

INSTALLATION:

- During regular port stay
- 1 day installation per engine and commissioning
- **No dry dock needed**

INTRODUCING THE WÄRTSILÄ TWO-STROKE FUTURE FUELS CONVERSION PLATFORM

Commercially Available



- A retrofit-optimised solution to convert marine electronically controlled two-stroke engines to run on future fuels
- Features a flexible fuel injection and combustion concept that adapts to fuel type and quality eliminating fuel slip
- Fuel preparation takes place on the engine using existing energy sources
- Requires a low-complexity fuel supply system, with low energy demand, minimising CAPEX and OPEX
- The streamlined retrofit process makes the engine fuel conversion possible within three weeks
- Modular design offers true fuel flexibility by switching to different fuels with modest investment and retrofit efforts

HOW IT WORKS FOR LNG

An industry-first solution in which:

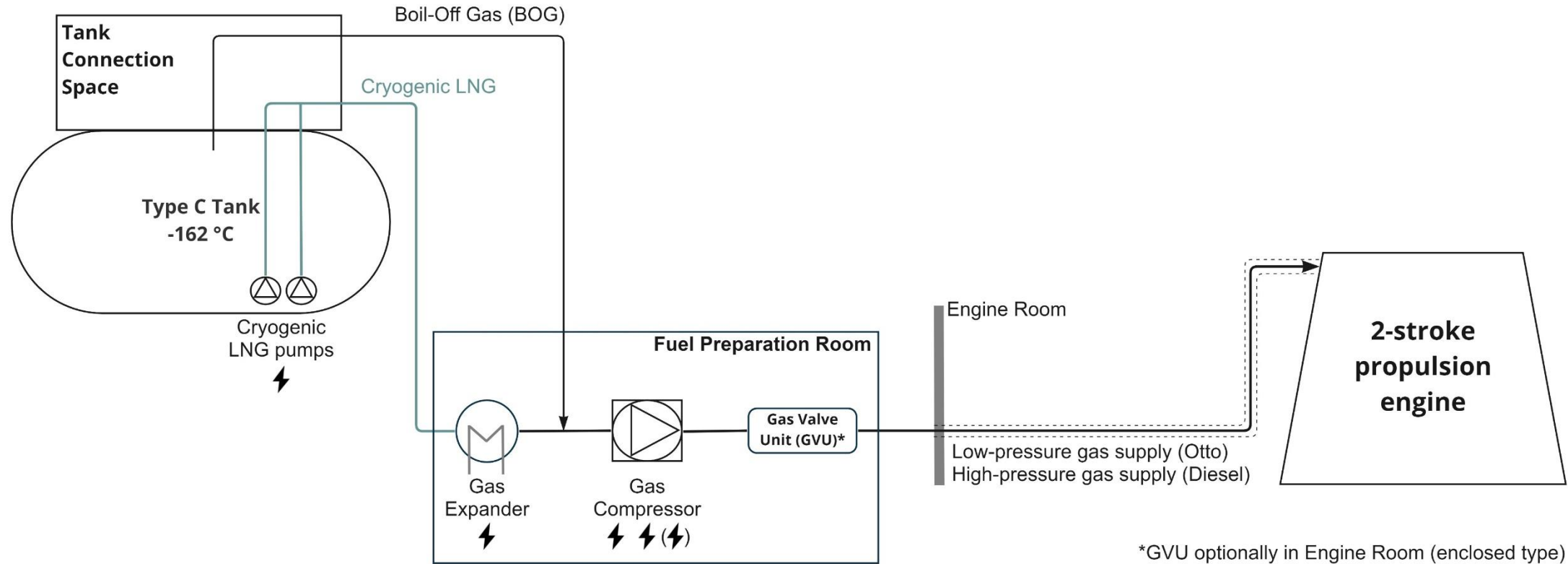
- Cryogenic LNG is supplied directly to the engine at low pressure
- Fuel pressure amplification and gas expansion take place on the engine using existing energy sources
- The expanded gas is injected into the cylinder at medium pressure

What does it mean for the vessel installation?

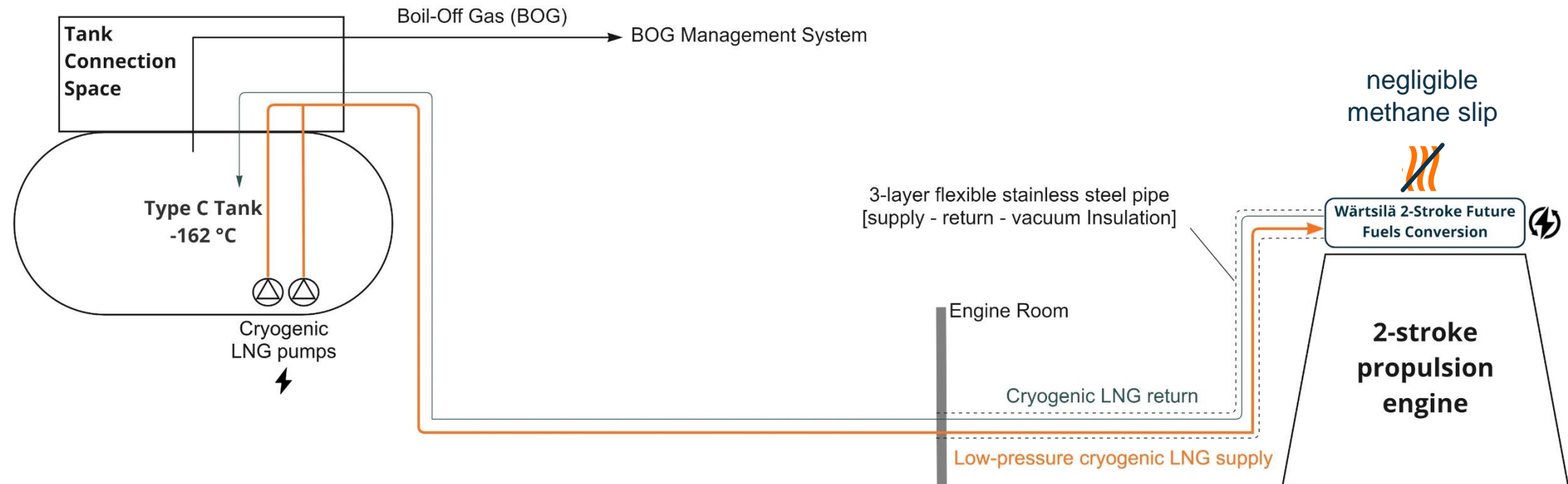
- Supplying cryogenic LNG directly to the engine at low pressure:
 - a. eliminates the need for expensive, energy-demanding and high-maintenance equipment in the fuel gas supply system and
 - b. means a minimal footprint for the fuel supply system, maximising retrofit installation flexibility
- On-engine pressure amplification and gas expansion using existing energy sources means lower energy costs and associated emissions



CONVENTIONAL TWO-STROKE LNG INSTALLATION

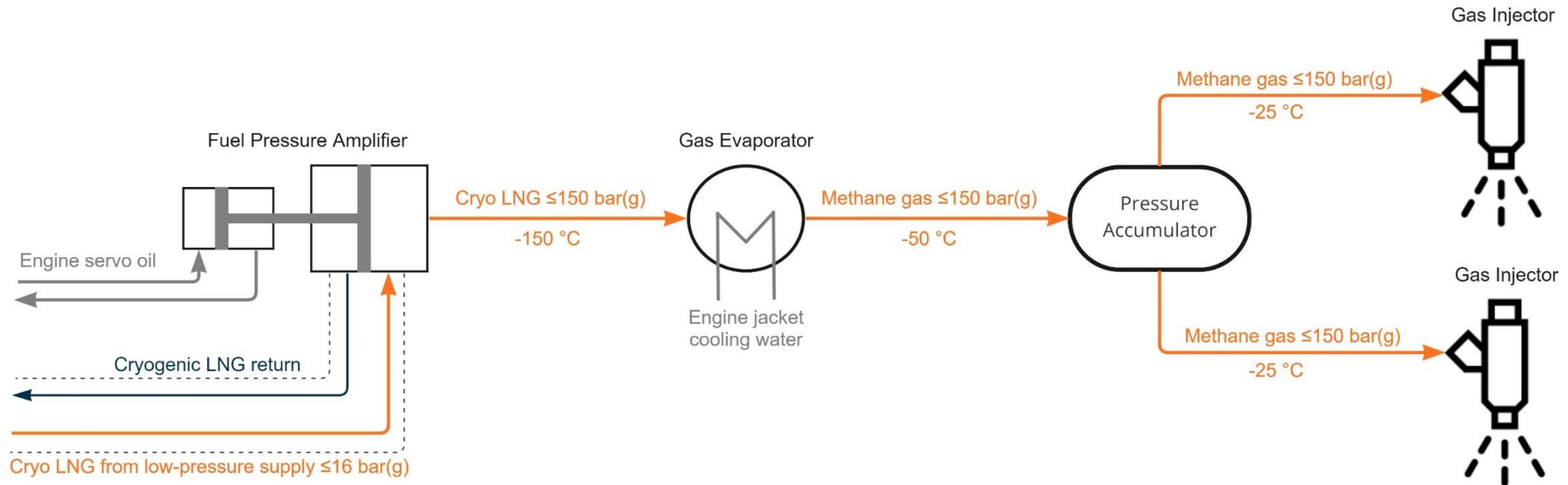


WÄRTSILÄ TWO-STROKE LNG CONVERSION



SIMPLIFIED DIAGRAM ON-ENGINE FUEL SYSTEM

Arrangement per cylinder for LNG



HOW IT WORKS FOR METHANOL

A retrofit-optimised solution in which:

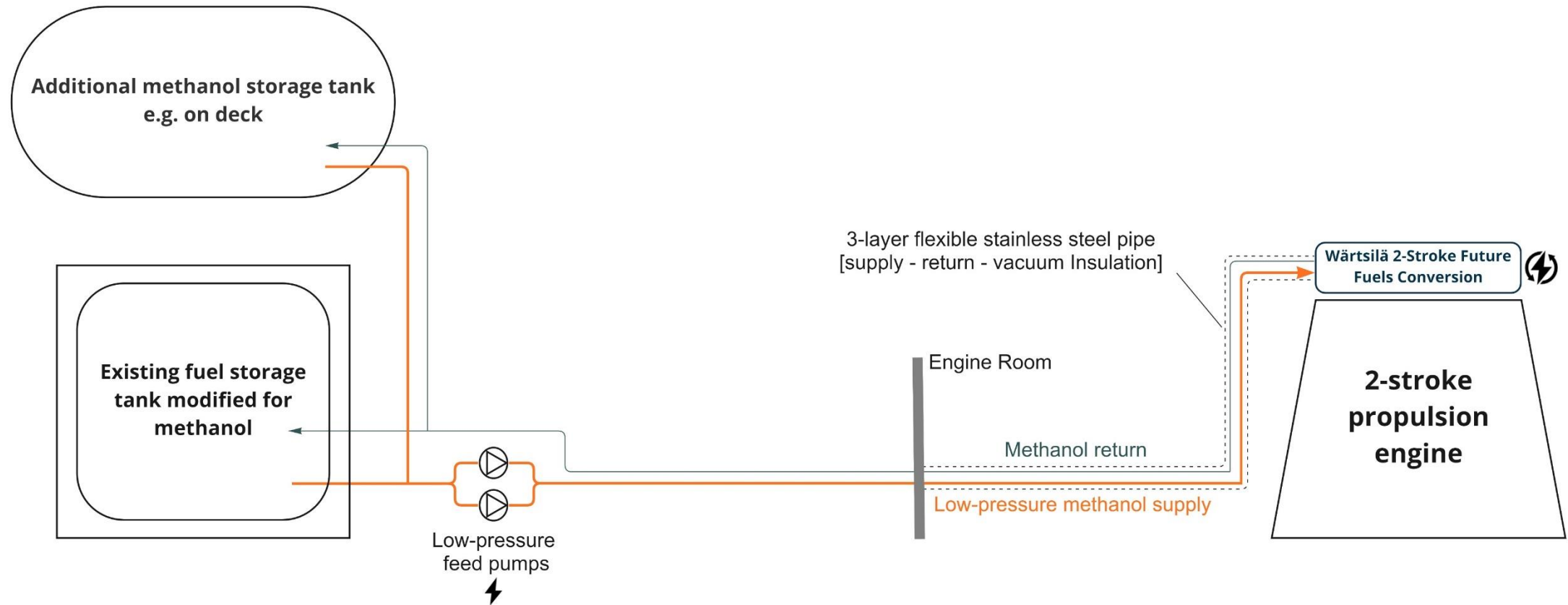
- Methanol is supplied directly to the engine at low pressure
- Fuel pressure amplification takes place on the engine using existing energy from the servo oil system
- Methanol is injected into the cylinder at medium pressure

What does it mean for the vessel installation?

- Supplying methanol directly to the engine at low pressure:
 - a. eliminates the need for costly and energy-demanding high-pressure equipment in the fuel supply system and
 - b. means a minimal footprint for the fuel supply system, maximising retrofit installation flexibility
- On-engine pressure amplification using an existing energy source means lower energy costs and associated emissions

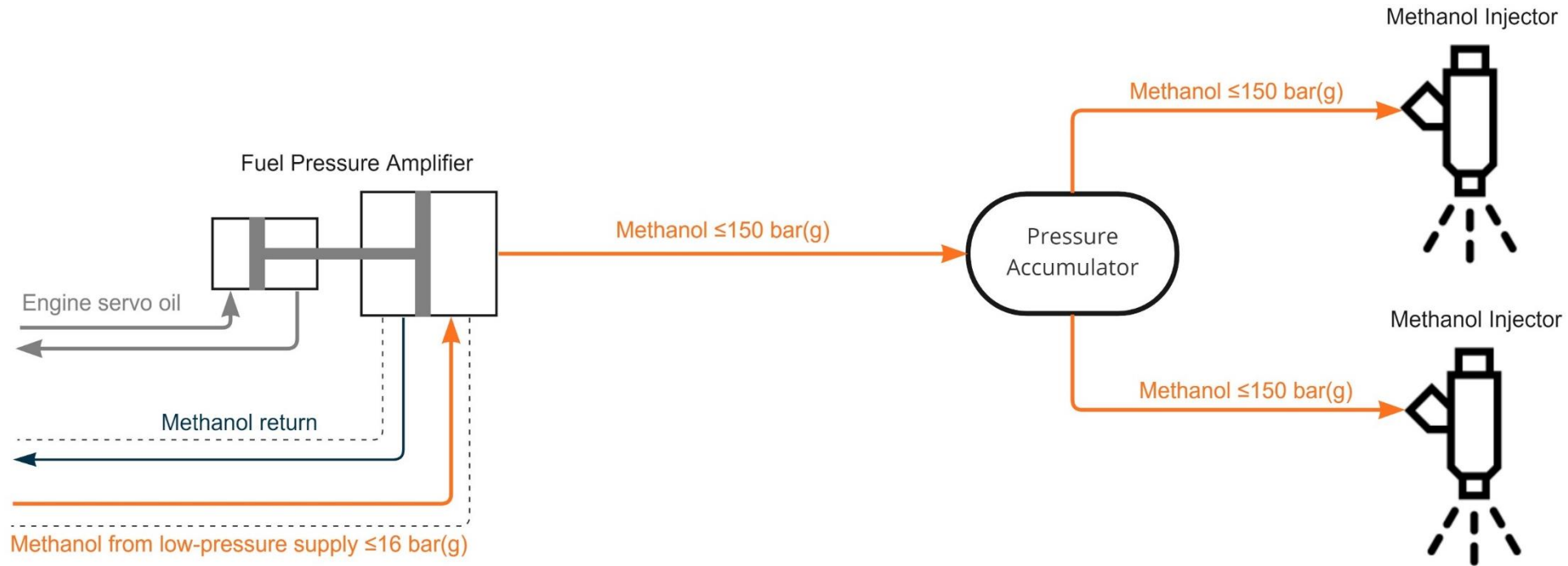


WÄRTSILÄ TWO-STROKE METHANOL CONVERSION



SIMPLIFIED DIAGRAM ON-ENGINE FUEL SYSTEM

Arrangement per cylinder for **methanol**



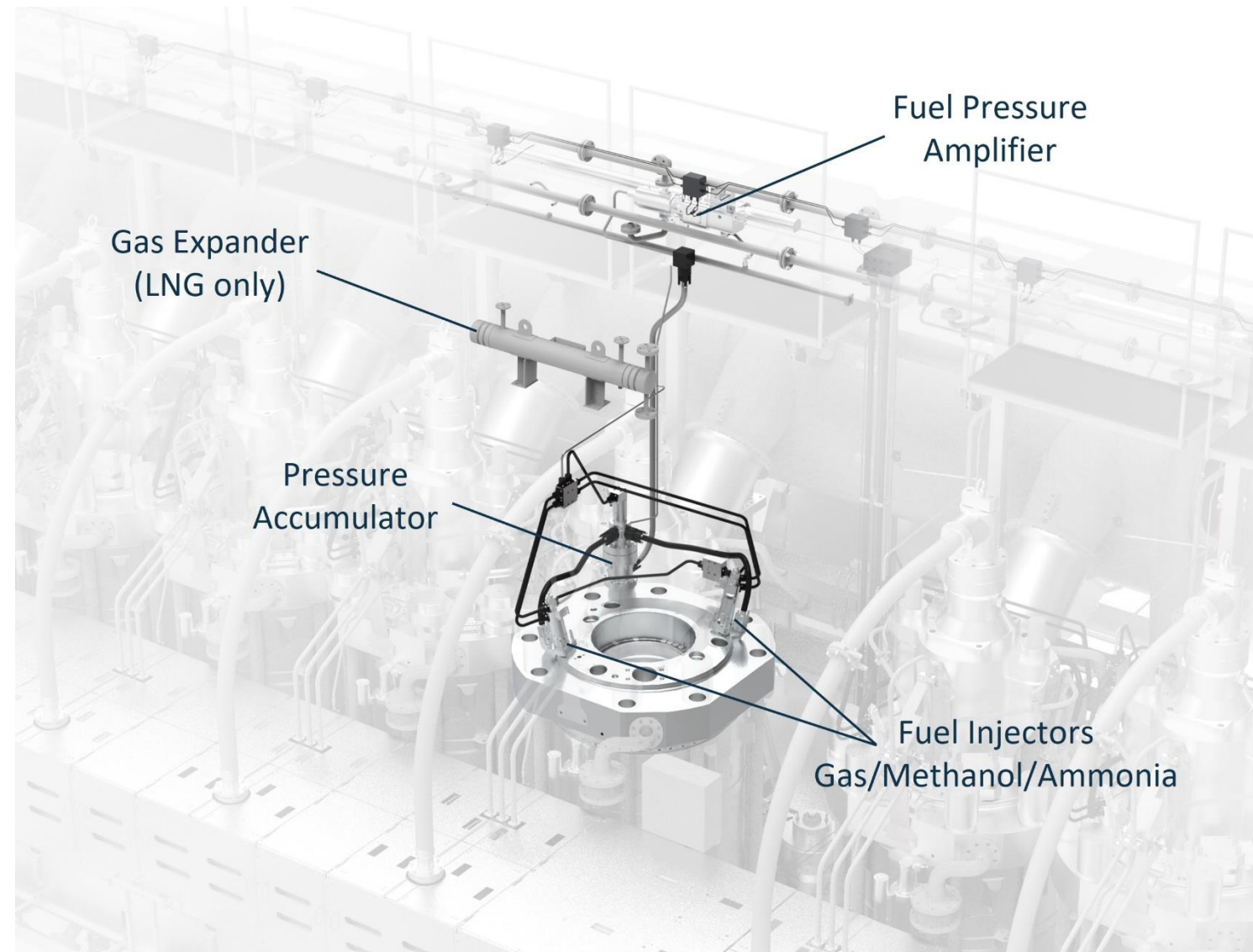
TWO-STROKE ENGINE FUEL CONVERSION SCOPE

Per cylinder

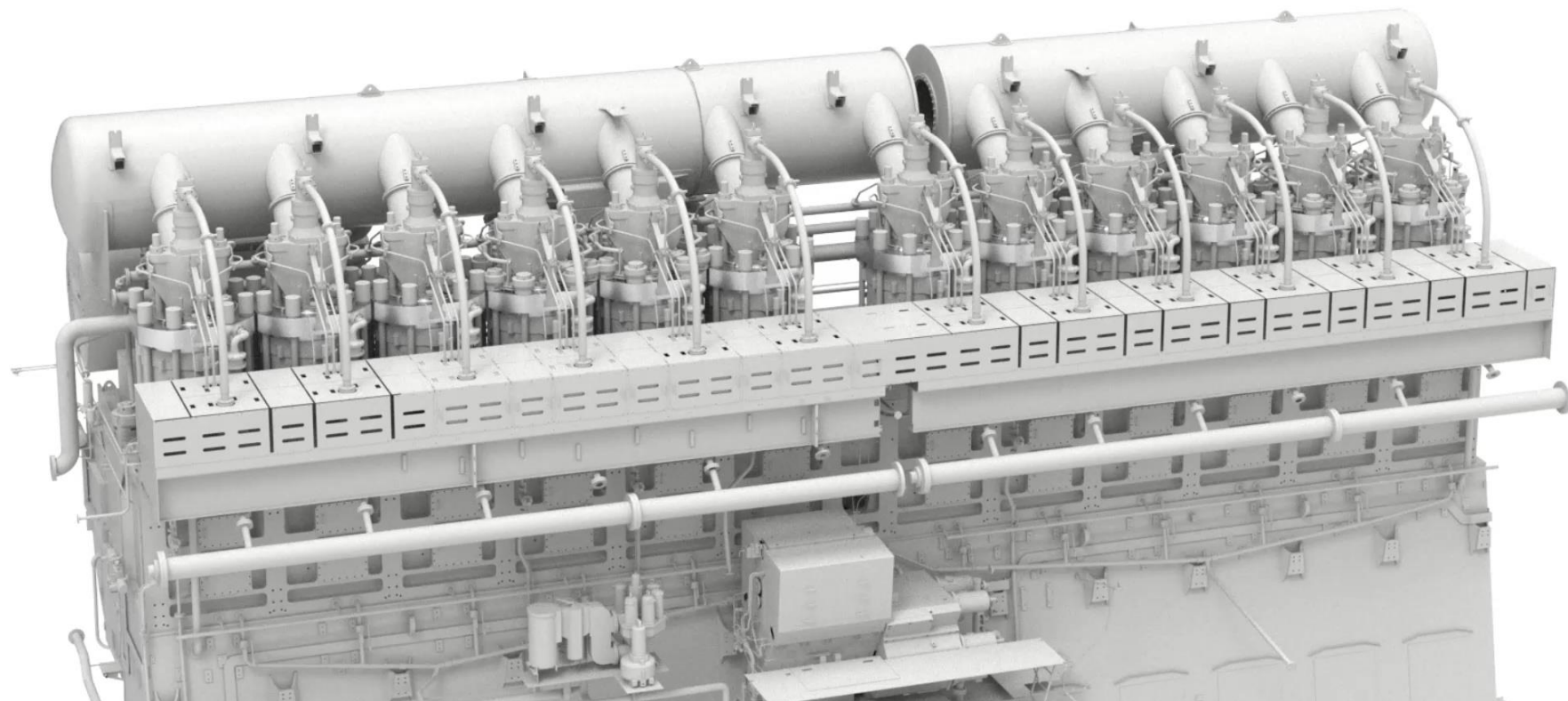
- Cylinder cover with fuel/gas injectors
- Pressure accumulator
- Gas expander (LNG only)
- Fuel pressure amplifier

Per engine

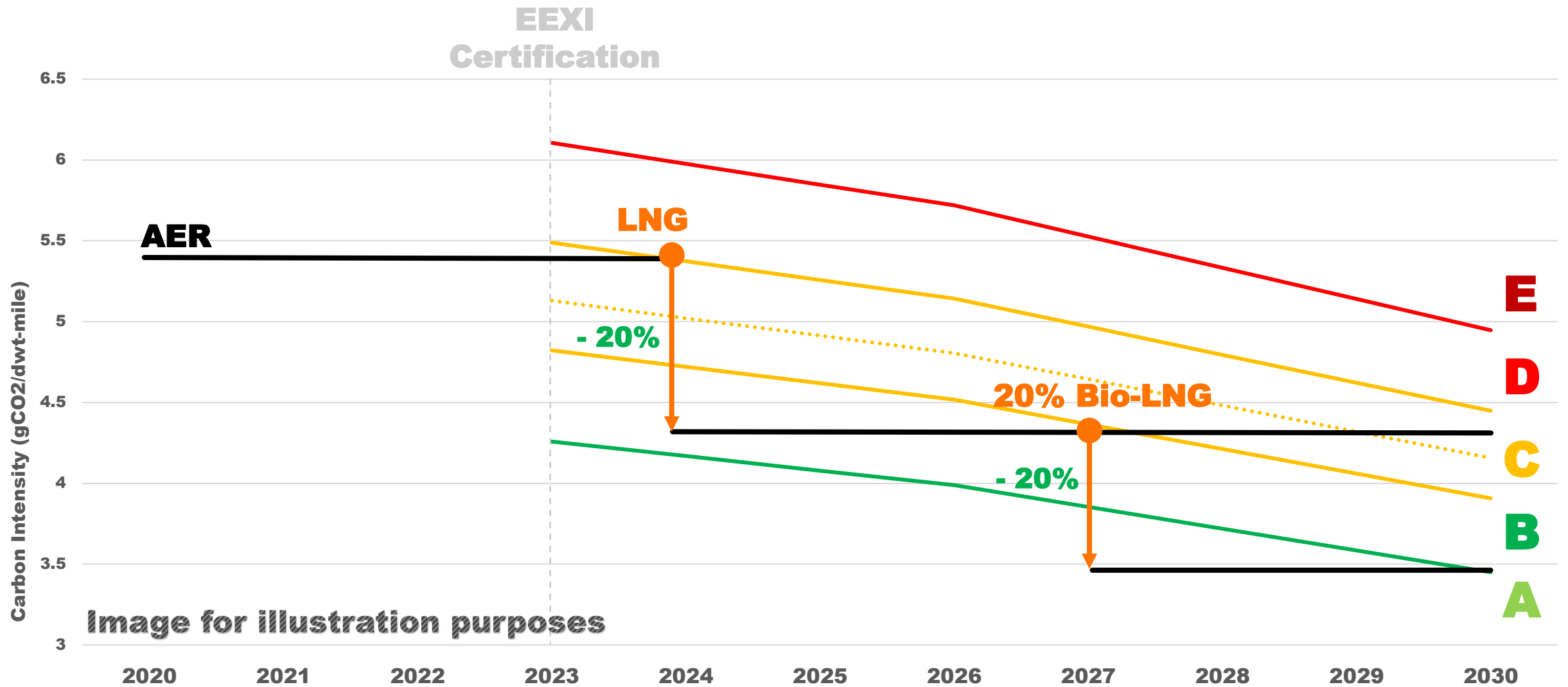
- Rail enclosure with ventilation system
- Fuel injection control system upgrade
- Instrumentation, sensors, cabinets & cables
- Safety & monitoring system extension
- On-engine piping
- On-engine platform modifications



TWO-STROKE **ENGINE** FUEL CONVERSION SCOPE



FUTUREPROOFING A 15K TEU CONTAINERSHIP



WÄRTSILÄ FUTURE FUELS CONVERSION OFFERING FOR MERCHANT VESSELS

Fuel Gas Supply System

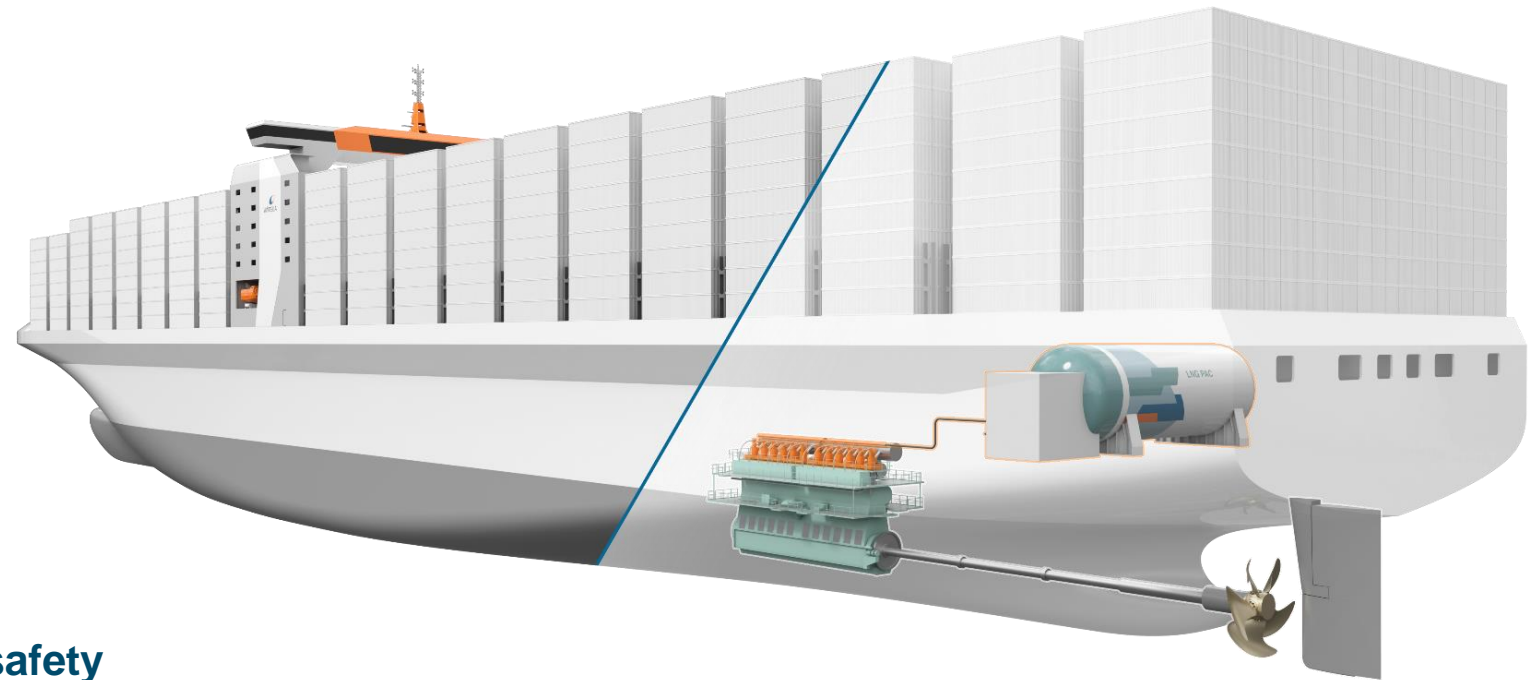
2-stroke main engine conversion

4-stroke DF/multi-fuel auxiliary engines

BOG management solutions

System integration incl. automation & safety

Digitally-enabled lifecycle solutions



KEY BENEFITS

- Reduced GHG emissions with negligible fuel slip and overall low energy consumption
- Long-term CII compliance and extended operational lifetime for the vessel
- Straightforward retrofitting concept minimising off-hire
- Fuel flexibility futureproofing your investment
- Access to sustainable financing and shorter pay-back time



WÄRTSILÄ