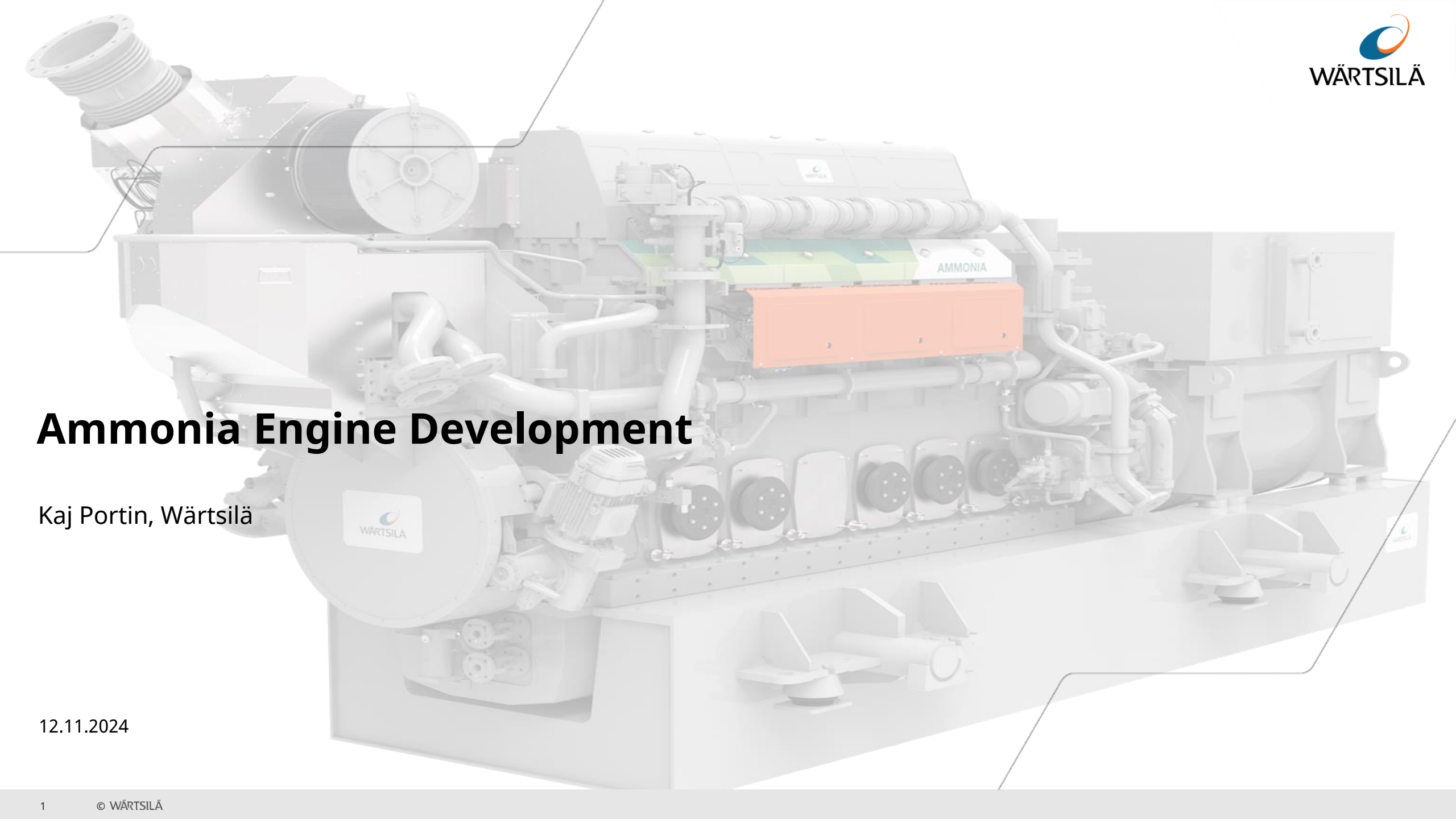


Ammonia Engine Development

Kaj Portin, Wärtsilä

12.11.2024



Marine Power product portfolio provides upgradable solutions for a net-zero future



Propulsion equipment



4-stroke medium speed engines



NOx reducers (SCR)



Energy & power management systems



Hybrid systems (including batteries)



Fuel gas supply systems (storage)



Transactional services



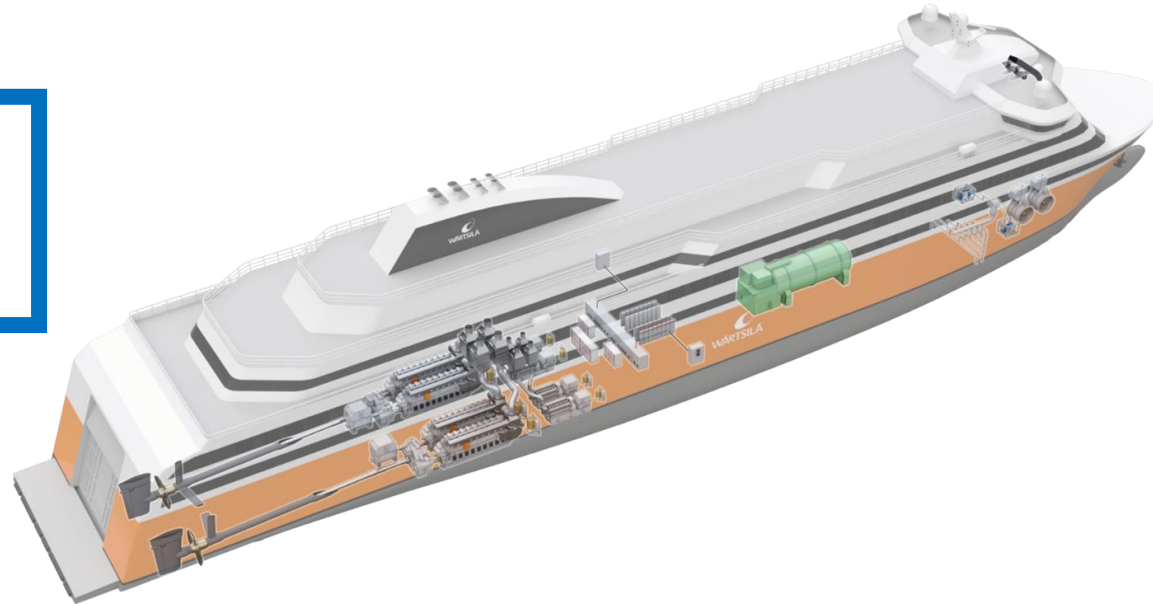
Agreements



Performance-based agreements

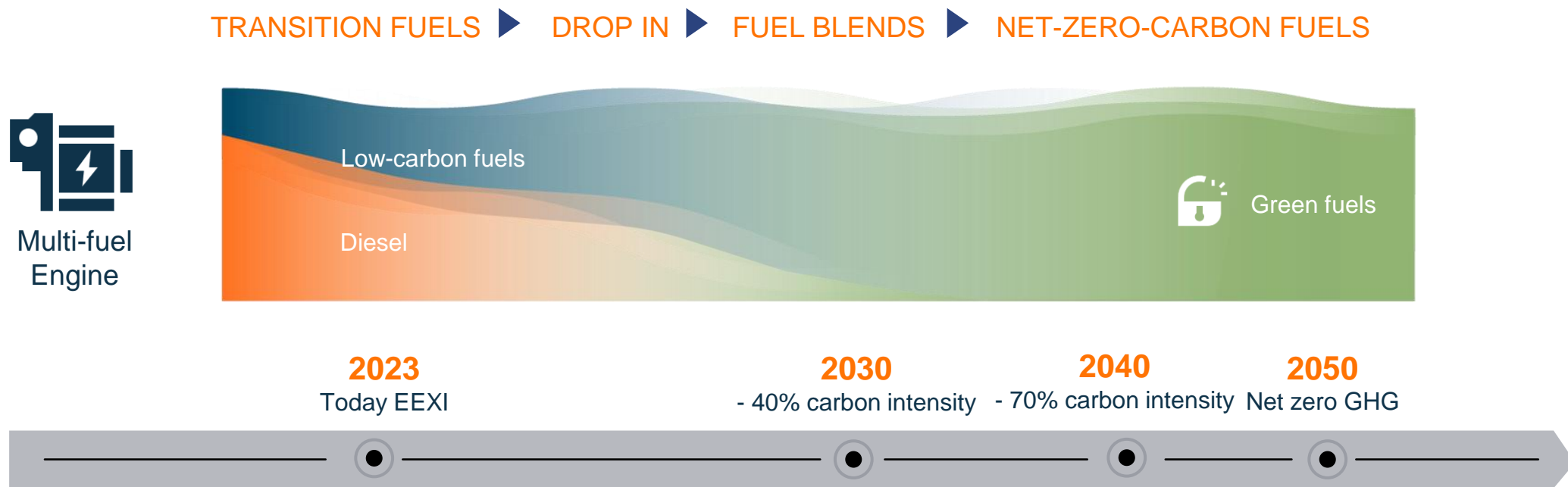


Project services



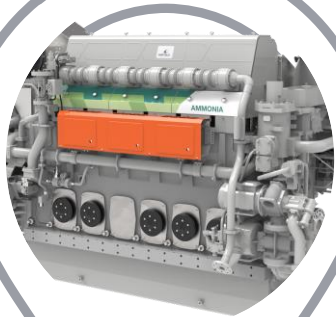
Certainty in transition

Infrastructure and availability of green fuels need time to mature - current Wärtsilä multi-fuel Wärtsilä multi-fuel technology offer a viable upgrade path





Ammonia: advancing from industrial chemical to zero-carbon ship fuel through R&D and collaboration



2019

Innovation initiative and ZEESS launch



2021

Technology development started



2022

Industry collaboration for solution validation



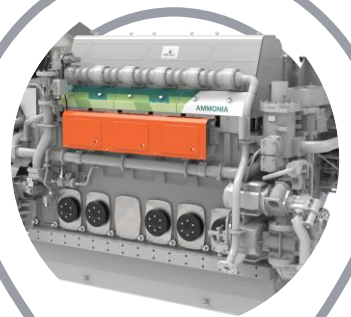
2023

Technical concept ready



2024

First ammonia engine orders



2025

First ammonia engine deliveries



Ammonia safety: advancing from industrial chemical to zero-carbon ship fuel through R&D and collaboration



2019-

**Training:
Internal &
External**



2020-

**Material and
combustion
testing**



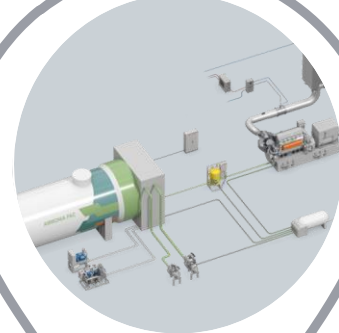
2020-

**Hazids and
Hazops**



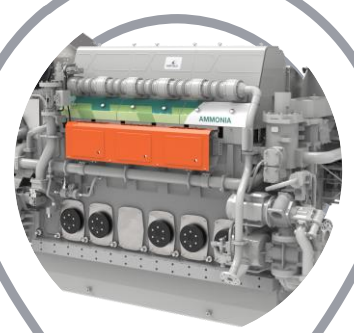
2020-

Safety systems



2020-

System design



2021-

**Engine
operation**

Single Cylinder Engine Testing

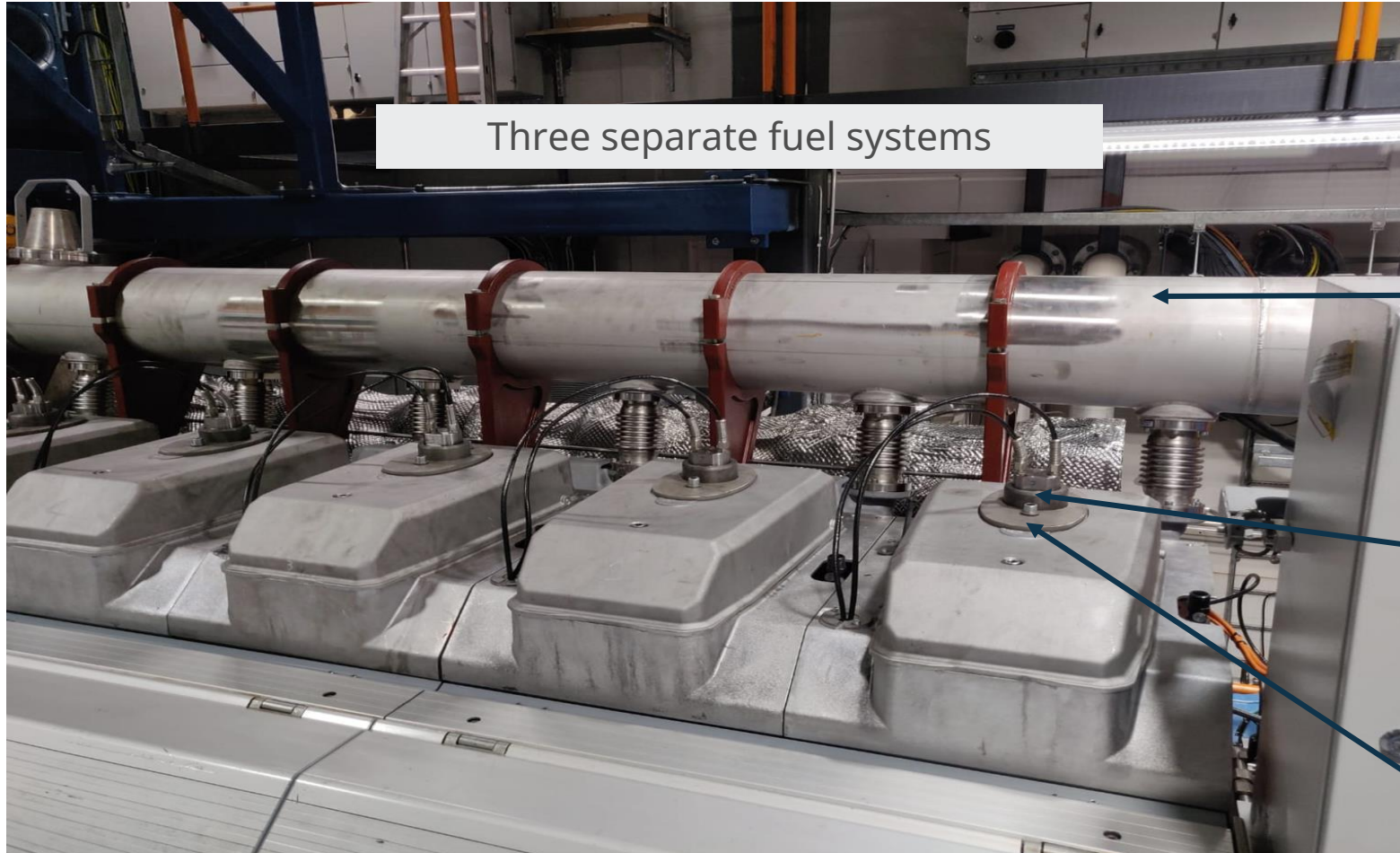
Features	Values
Bore [mm]	170...280
Stroke [mm]	220...350
Stroke/Bore	-
Speed [rpm]	350....1100
Cylinder Pressure Peak [bara]	300
Fuel types	LNG, HFO, LFO, NH ₃
Combustion types	Diesel, Otto, Other

Further engine characteristics:

- Stepless inlet and exhaust valve closing
- Common Rail liquid Fuel system
- Rapid controls prototyping software
- Real time turbo charger model running in GT-Power
- External charge air system, boost pressure up to 13barg and temperature up to 120°C.



The multifuel engine



Three separate fuel systems

- Gaseous fuels*
- LNG
 - LPG
 - **Ammonia**
 - Hydrogen

- Liquid fuels*
- HFO
 - MDO
 - LPG
 - **Ammonia**
 - Methanol
 - Ethanol

- Pilot fuel*
- MDO

* Including corresponding bio and synthetic fuel

Demo 2000 – NH3 Demonstration project at Stord

Partners



SUSTAINABLE ENERGY | NORWEGIAN CATAPULT CENTRE

 Forskningsrådet

 **REPSOL**

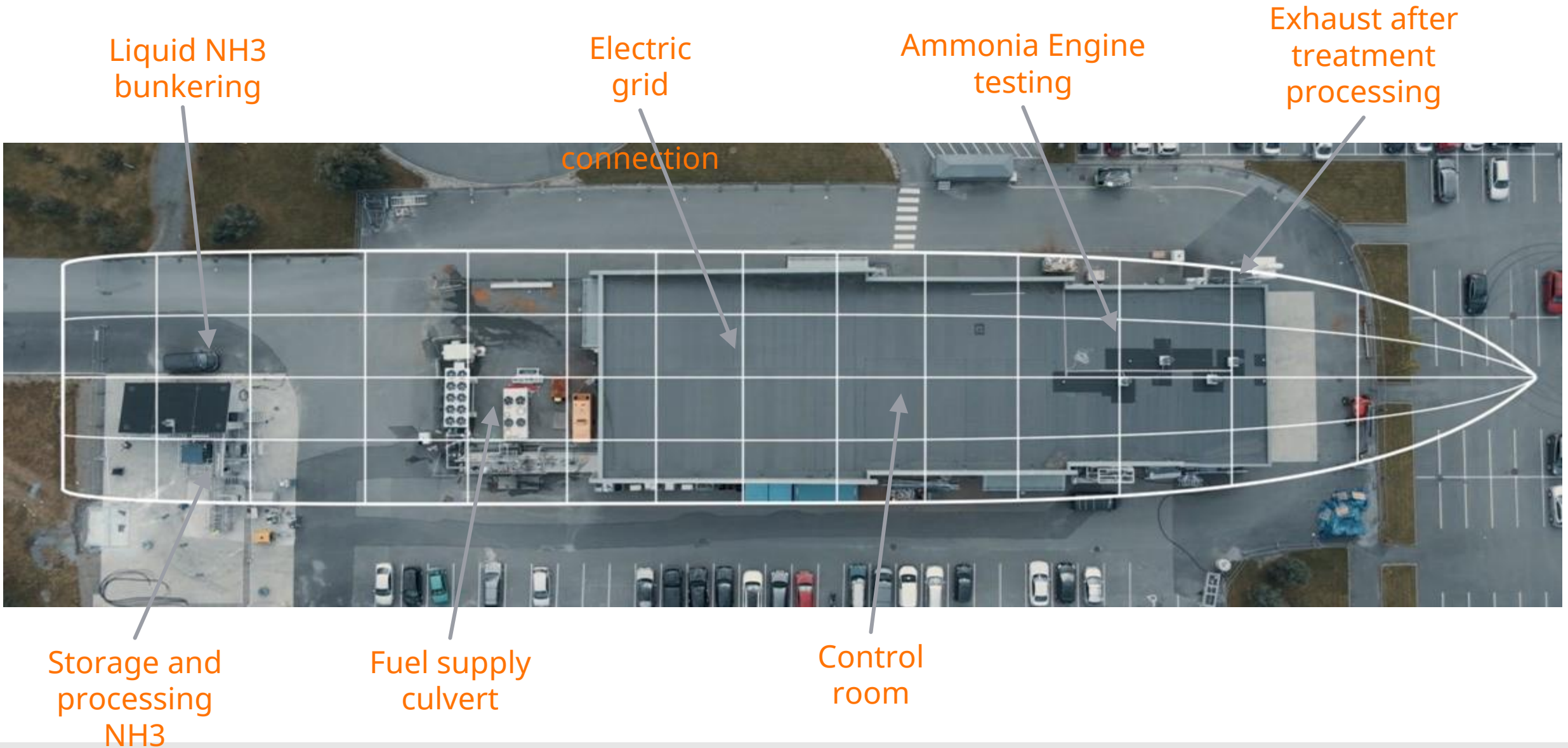
 Knutsen OAS Shipping

 equinor


WÄRTSILÄ

2020 - 2023

The ship view of the Demo 2000 ammonia engine testing



Ammonia engine testing in Katapult Center



Status:

150 tons of Ammonia consumed in Stord tests

> 500 operating hours

90% + Ammonia share

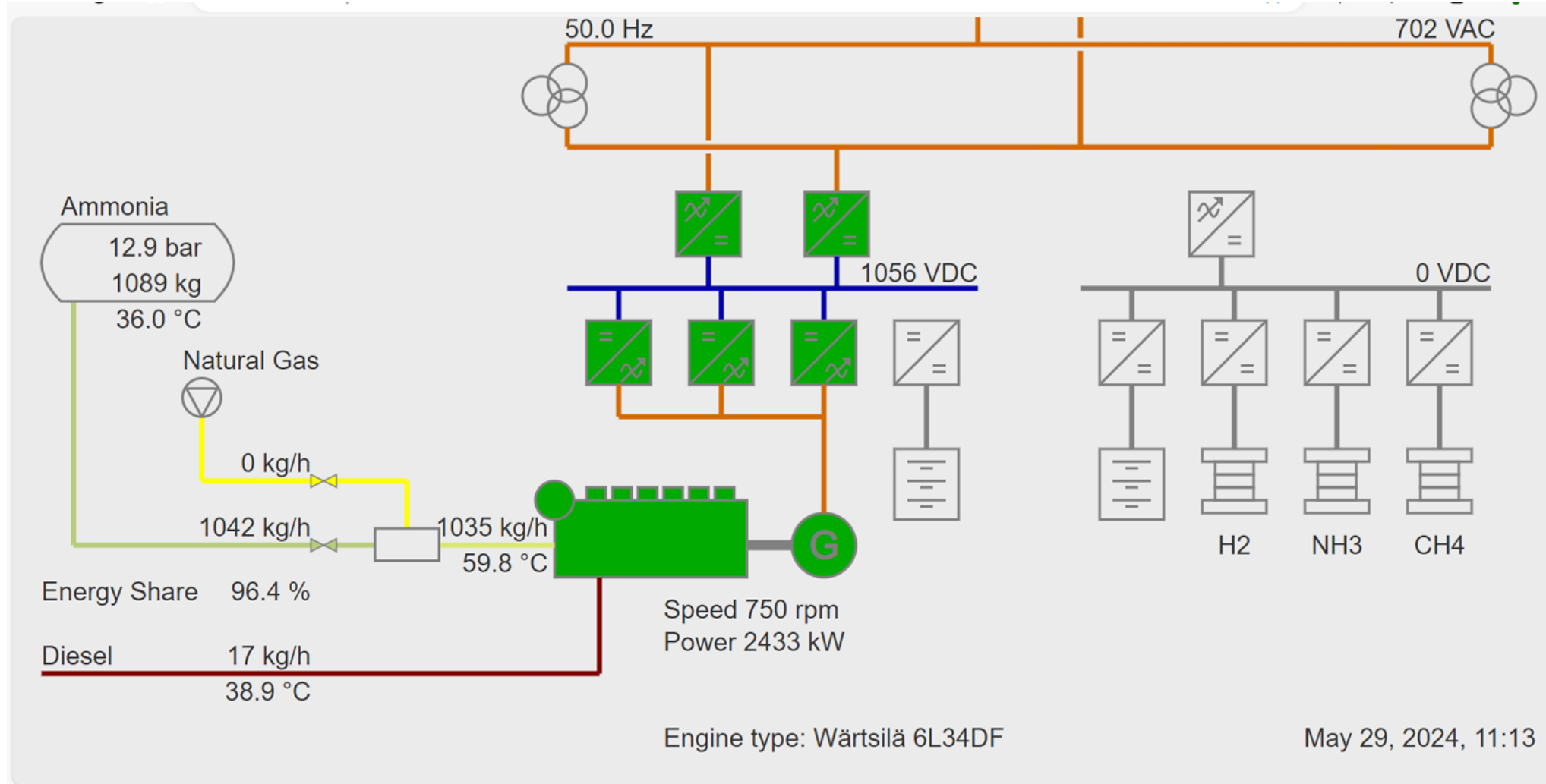
Natural Gas mixing

89% GHG reduction potential

$\text{N}_2\text{O} < 5\text{ppm}$ after Catalyst

NO_x = Most promising (<< Tier III)

Ammonia operation at Stord



Safety test with ammonia engine for classification purpose



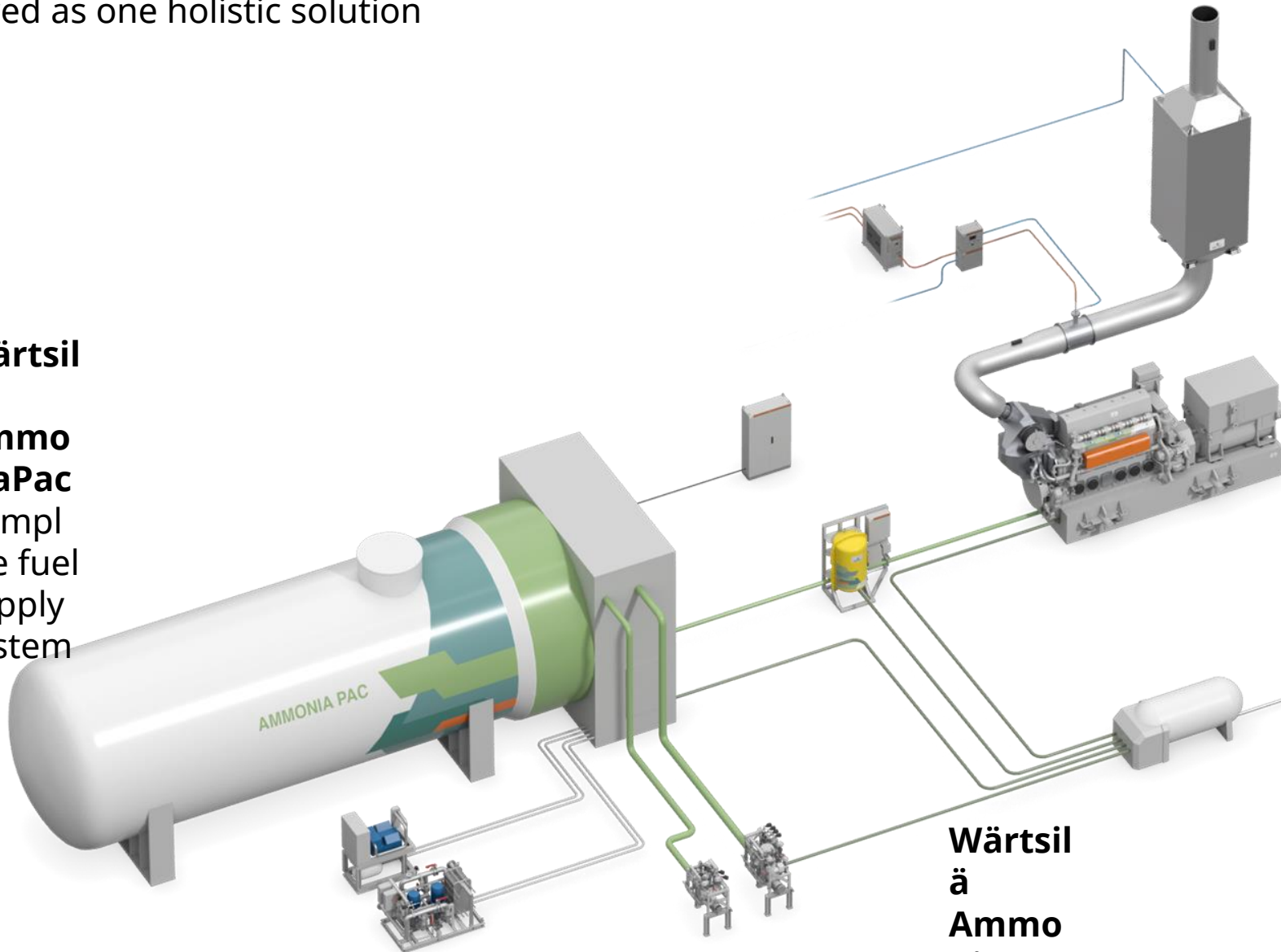
Teknisk Ukeblad February 2024



System overview

Engineered as one holistic solution

**Wärtsilä
AmmoniaPac**
Complete fuel
supply
system



**Wärtsilä
NOx
Reducer**
IMO
Tier II /
Tier III
**Wärtsilä
25
Ammonia**
1.7-
2.7MW

**Wärtsilä
Ammonia**

Approval in principle by Classification Societies



APPROVAL IN PRINCIPLE

Particulars of Product

Designer:	Wärtsilä Finland Oy
Product:	Wärtsilä 25DF Ammonia

This is to verify:

That the plan for development and principle of engine design has been assessed by DNV and found to comply with current Rules of the Society, as specified below.

- DNV Rules for classification, Ship, DNV-RU-SHIP-Pt.6 Ch.2 Sec.8 – FUEL READY Ammonia (MEc/AEc), July 2023



中国船级社
CHINA CLASSIFICATION SOCIETY
 船用产品原理认可证书
APPROVAL IN PRINCIPLE FOR MARINE PRODUCT
 概念认可证书
CERTIFICATE OF CONCEPT APPROVAL

证书编号/Certificate No.
JS23PPR00003_05

兹证明本证书所述设计方设计的下列产品的技术原理具有可行性，能够原则上满足列明标准的要求。

This is to certify that the innovative design principles in the following products designed by the designer stated in the certificate are feasible, and can meet the requirements of the standards listed below in principle.

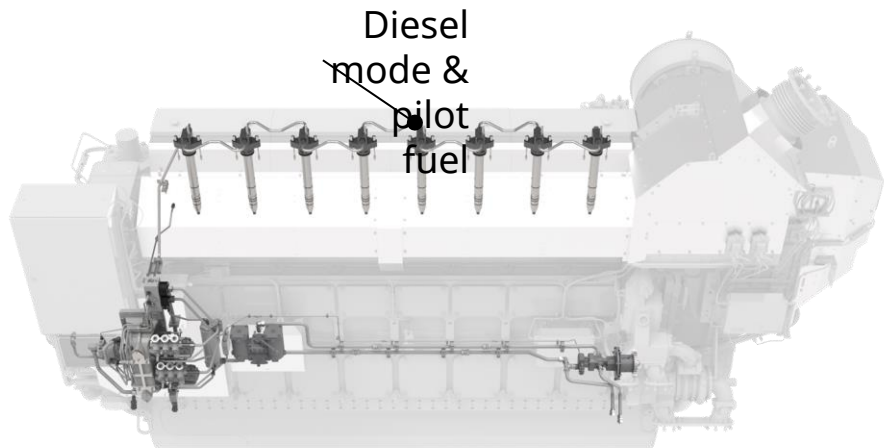
设计方/ **Designed by**

Wärtsilä Finland Oy

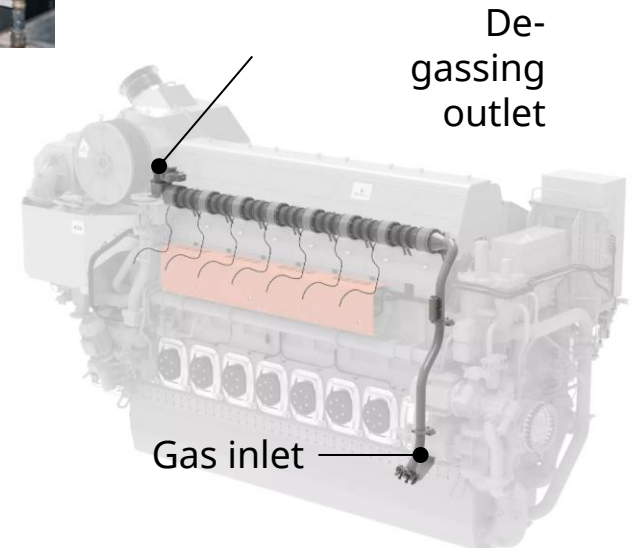
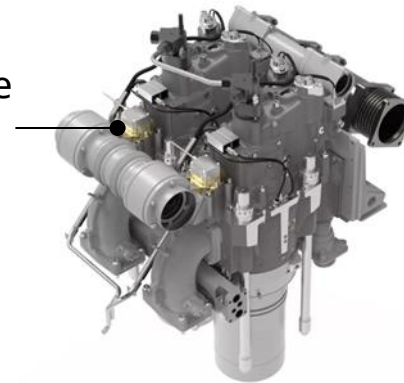
认可产品/ **Product Approved**

氨/燃油双燃料发动机
Ammonia/Fuel Oil Dual Fuel Engine

Wärtsilä 25 ammonia engine



Gas admission valve on cylinder head unit



Wärtsilä 25 engine data

	Wärtsilä 25		Wärtsilä 25DF		Wärtsilä 25 Ammonia	
Cylinder bore (mm)	250		250		250	
Piston stroke (mm)	340		340		340	
Nom speed (rpm)	900	1 000	900	1 000	900	1 000
Power / cyl. (kW)	345	375	315	345	280	305
BMEP (MPa)	2.72	2.70	2.52	2.48	2.24	2.19
6L power (kWm)	2 070	2 250	1 890	2 070	1 680	1 830
7L power (kWm)	2 415	2 625	2 205	2 415	1 960	2 135
8L power (kWm)	2 760	3 000	2 520	2 760	2 240	2 440
9L power (kWm)	3 105	3 375	2 835	3 105	2 520	2 745
Application	DM, DE, AUX		DE, AUX	DM, DE, AUX	DE, AUX	



First Ammonia engine deal signed in August 2024

Landmark deal between Wärtsilä and Eidesvik Offshore pioneers growing demand for ammonia in shipping

Wärtsilä Corporation, Press release 26 August 2024 at 13:00 UTC+2



Wärtsilä partners with Norwegian ship owner, Eidesvik, on world's first ammonia-fuelled platform supply vessel conversion

Technology group Wärtsilä has signed a contract with Norwegian shipowner Eidesvik to supply the equipment for the conversion of an offshore platform supply vessel (PSV) to operate with ammonia fuel. The vessel, 'Viking Energy', which is on contract to energy major Equinor, is scheduled for conversion in early 2026 and is expected to start operating on ammonia in the first half of 2026, becoming the world's first ammonia-fuelled in-service ship. In addition to chartering the vessel Equinor contributes with financing for the conversion. Wärtsilä will then supply the engine and complete fuel gas supply system and exhaust after-treatment needed for the conversion, making it also the first vessel to use [Wärtsilä's recently released ammonia solution](#).

Summary

- Decarbonising of the marine sector is urgent and requires a wide range of measures
- A successful development requires expertise and actions from many contributors
- Wärtsilä's portfolio provides several solutions towards a net-zero future
- Fuel flexibility secures a future proofed solution
- Concepts for ICE operation on the future fuels like Biofuels, **Ammonia**, Hydrogen, and Methanol are already being developed and demonstrated.

