Wärtsilä R&D update: Good progress in future fuels development program

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4 September 2023

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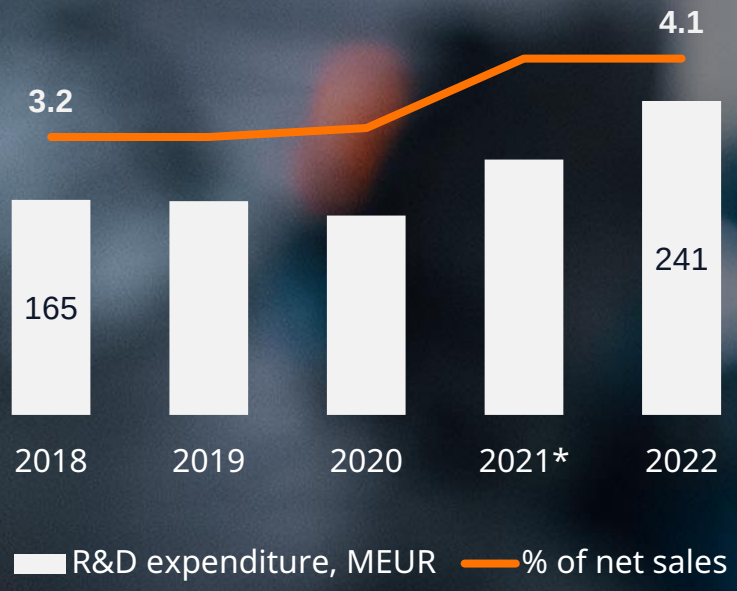
We continue to invest in innovation to ensure a broad, industry-leading solution offering



* Figure in the comparison period 2021 has been restated to reflect a change in the definition of research and development expenditure.

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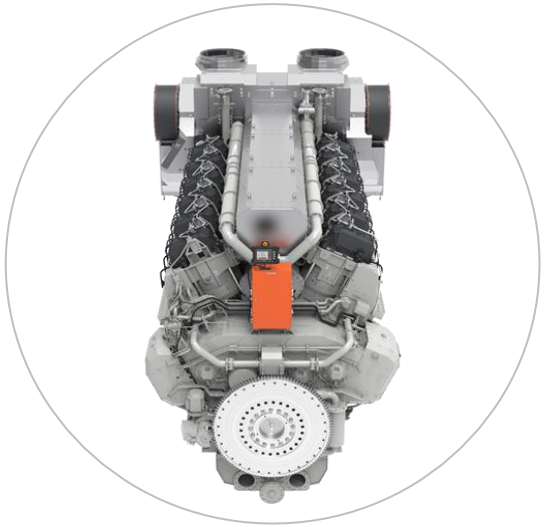
Stepwise approach in development ensures maximum quality, high return on investment and highest safety standards

Idea
Market opportunity

Technology development & proof of concept



Industrialised solution

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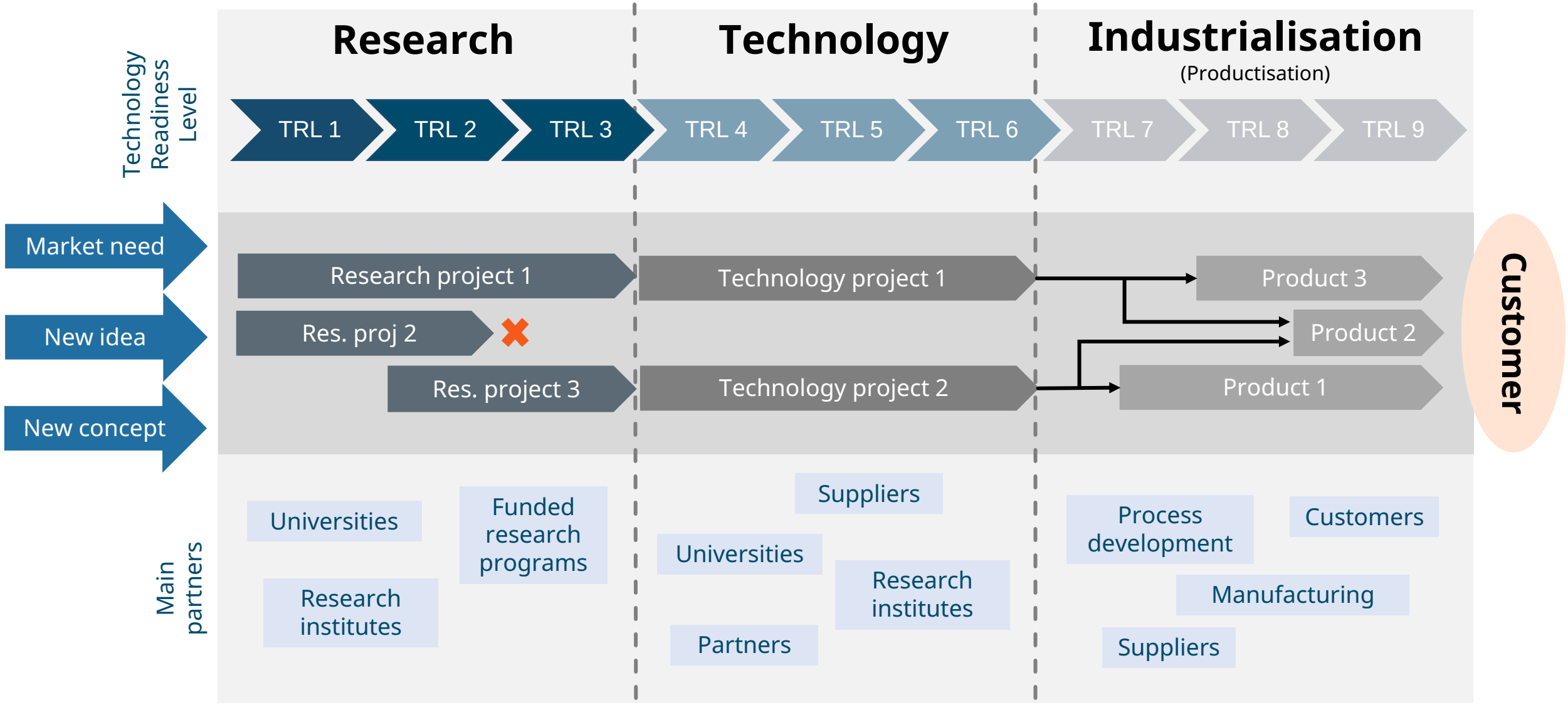
The Research & technology value stream: from research to markets



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New engine portfolio is based on common, modular architecture

Modularity built around customer requirements. Architecture is the foundation for product governance.

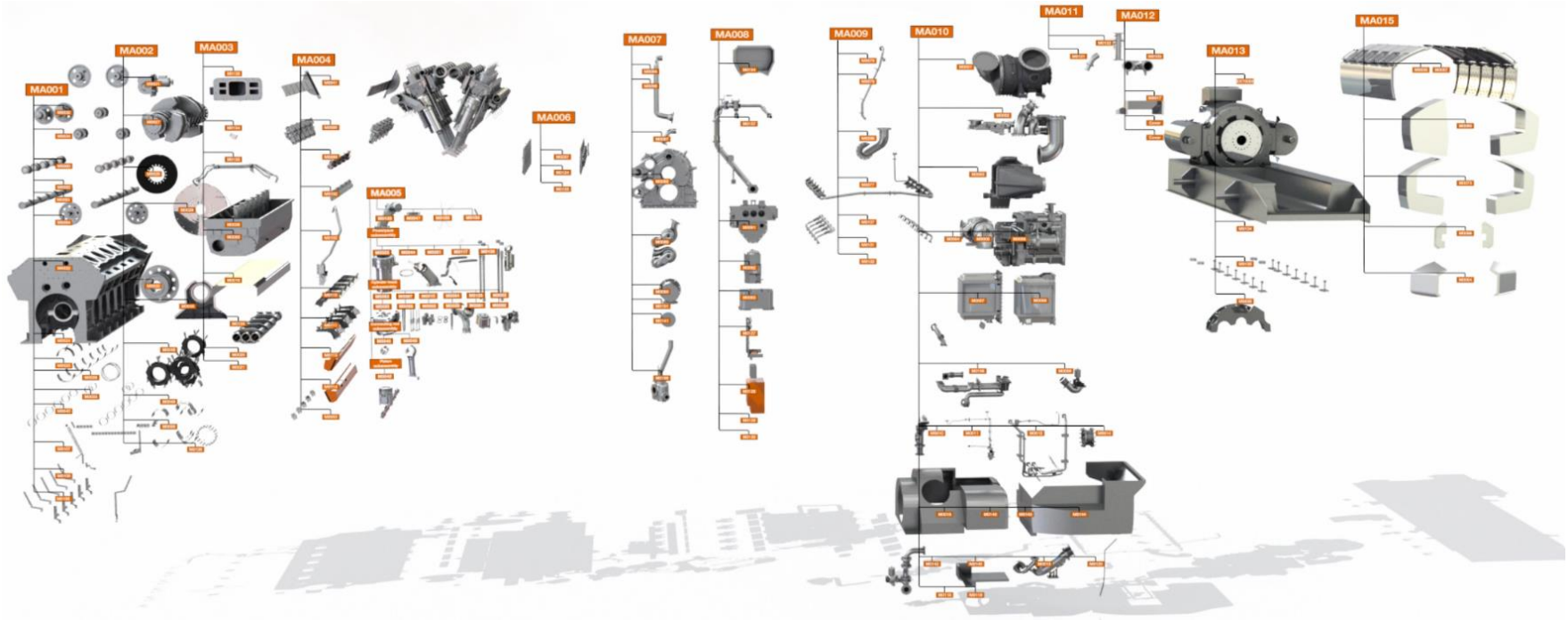
- Full portfolio introduced in 2022
- Built from customer requirements for customers
- Modularity enables conversions for future fuels in the future

Platforms in **predefined** common modular architecture

W25

W31

W46TS



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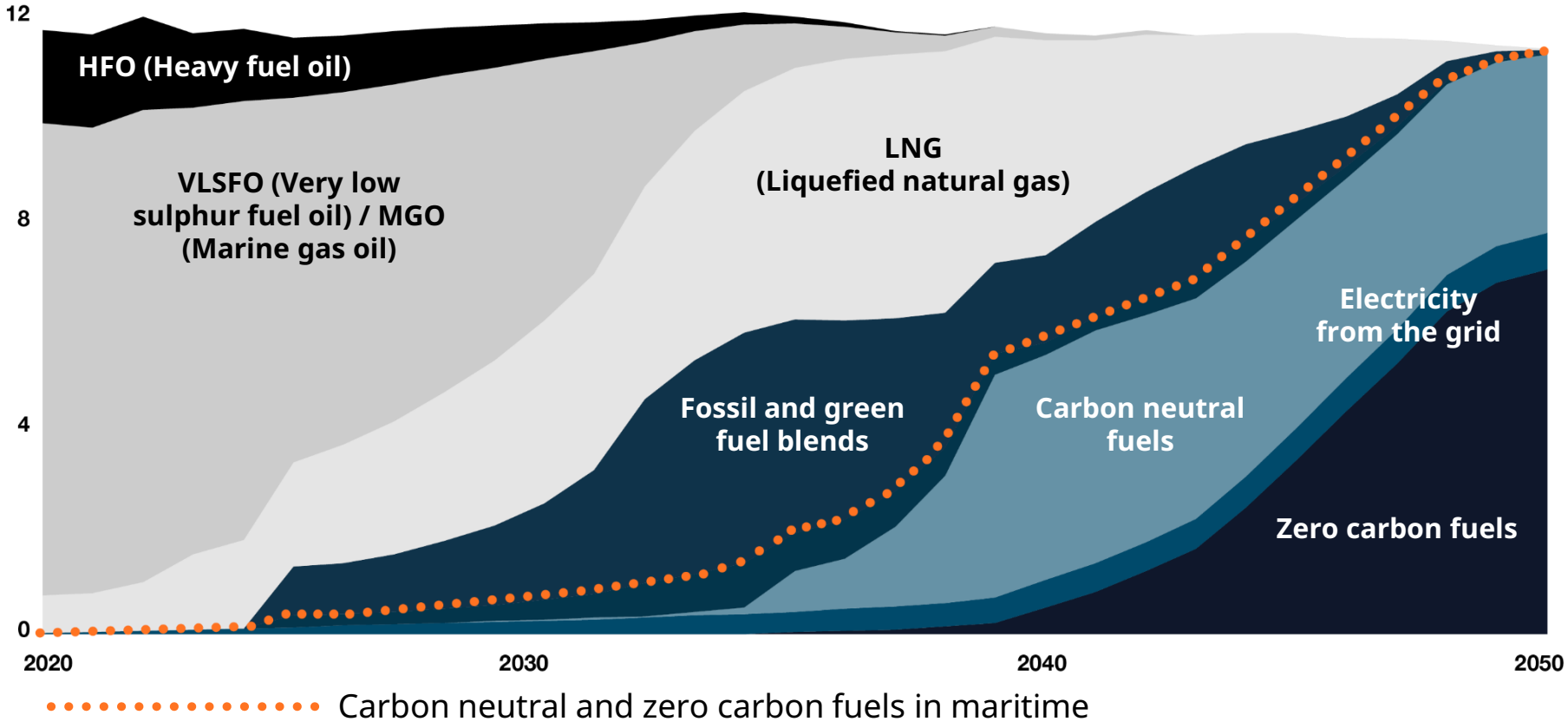
Moving from single-fuel industry to multi-fuel

Investment in fuel flexibility secures customers' asset lifetime

Owners will decide on technology partners now:

- Vessel life is 25-30 years
- Critical decision criteria:
  - Multifuel capabilities for blending with green fuels
  - Conversion capabilities for future fuels

Distribution of fuel types for Decarbonisation 2050 (1.5°C scenario), exajoule



Source: DNV Maritime Forecast 2050 model, Wärtsilä internal estimates

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Methanol: capability to power marine engines with carbon neutral solutions

2015

Conversion of Stena Germanica ZA40 engines

2020

Methanol technology refinement

2022

W32 Methanol engine launch & MethanolPac

2023

Launch additional methanol engine types & retrofit options

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Wärtsilä 32 Methanol – the power to reach carbon-neutral

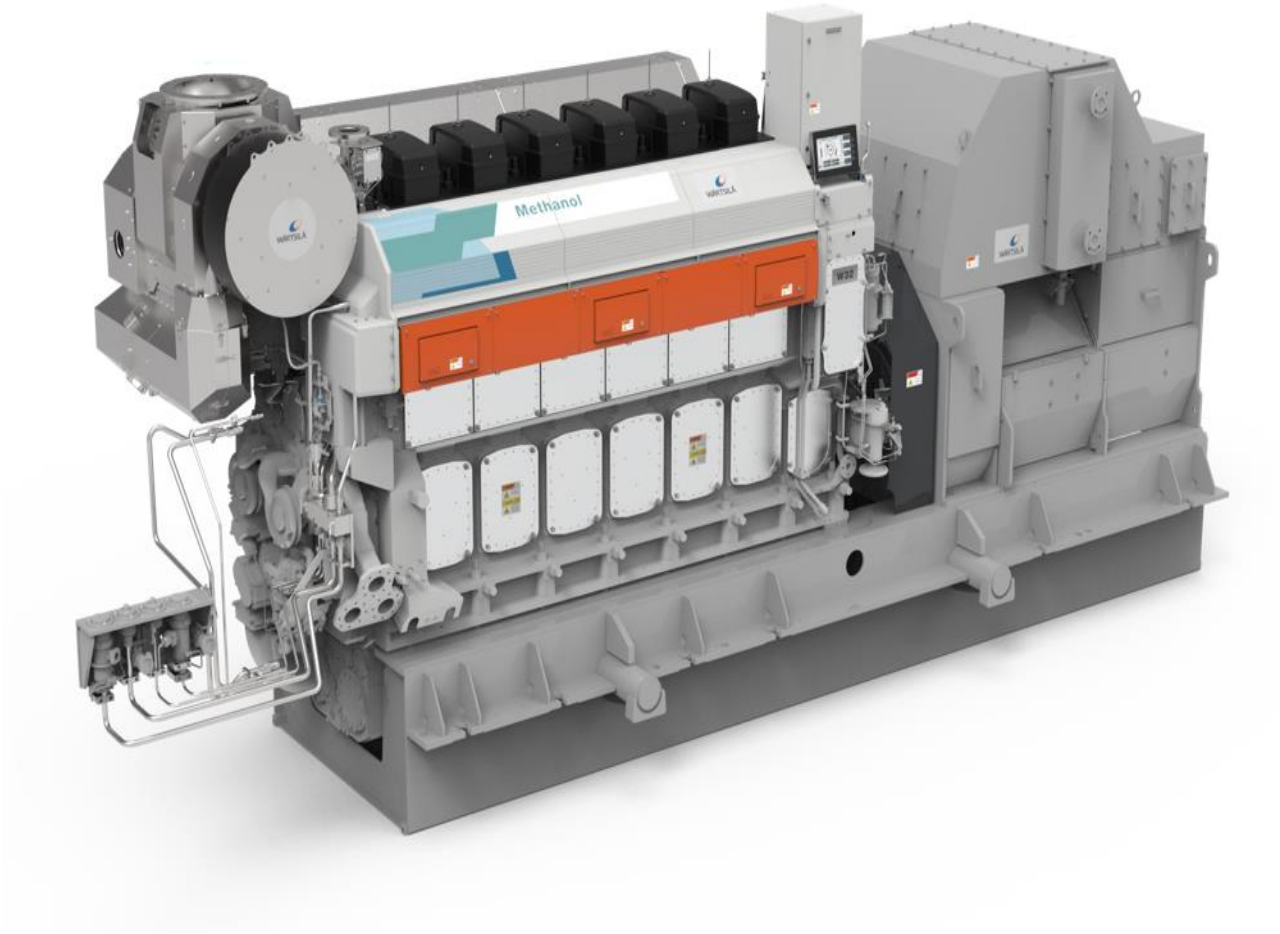
Methanol technology applied on proven and reliable W32 engine

Sustainability and flexibility

- Zero power loss during fuel switch
- Lowest emissions
- High performance in all applications

Applications

- Electricity production
- Auxiliary engine
- Variable Speed Main Engine



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

2021

First engine tests with ammonia blends

2022

Industry collaboration for solution validation

2023

Technical concept ready

2024

First ammonia engine deliveries

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Hydrogen: from blends to 100% hydrogen

2015

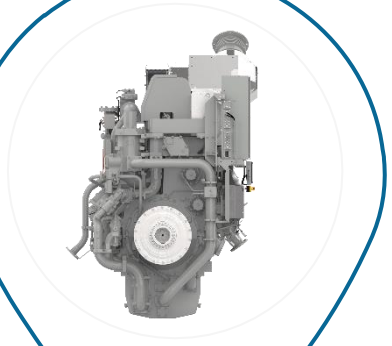
Hydrogen blending tests 25% H2 vol

2021

Pure H2 tests

2023

Technology validation



2025

Technical concept ready

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Hydrogen blending – from the lab to our customers

Conducted testing – October 2022

- WEC Energy group (US, 3 x Wärtsilä 50SG)

Agreed testing

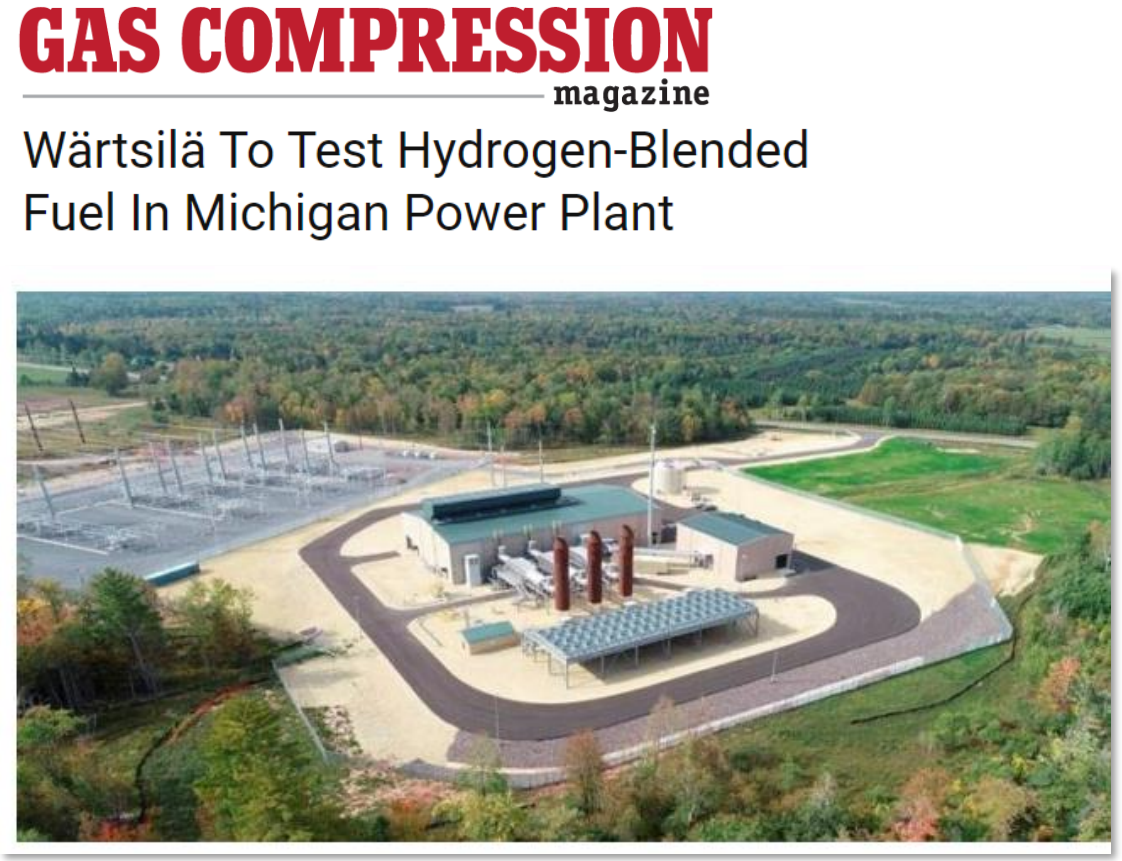
- Capwatt (Portugal, 1 x Wärtsilä 34sg)

Under discussion

- US, Wärtsilä 50DF
- UK, Wärtsilä 34SG
- India, Wärtsilä Vasa 34SG
- Japan, Wärtsilä Vasa 34SG

Key takeaways (WEC, US):

- Successful engine testing with up to 25% blends
- CO2 and GHG emission reductions
- No mechanical changes to engine, stable engine behaviour



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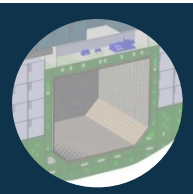
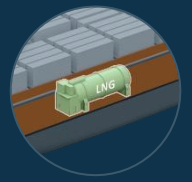
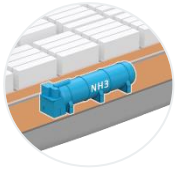
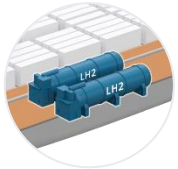
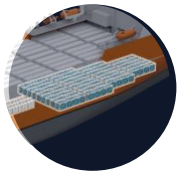
Fuel conversions will play a vital role in the fuel transition for both existing and new vessels built during this and next decade. Fuel selection impacts the vessel structure

Fuel type	 **Heavy Fuel Oil** @ 20°C	 **Liquified Natural Gas** @ -162°C	 **Methanol** @ 20°C	 **Ammonia** @ -33°C	 **Liquid Hydrogen** @ -253°C	 **Compressed Hydrogen** @350bar	 **Marine Battery Rack**
Key considerations	▪ Standard tank arrangement	▪ Cryogenic system	▪ Mildly toxic ▪ Flexible tank arrangement	▪ Toxic ▪ Corrosive	▪ Highly reactive ▪ Cryo system	▪ High pressure ▪ Multiple tanks arrangement	▪ Marine adaptation reduces density
Fuel price factor (per GJ)	1X	0.7X	2.2X-5.4X [2]	2.2X-4.5X [3]	2.7X-4.5X [3]	1.6X-2.6X [3]	1.3X-2.3X
	Production cost estimate 2025 [1]						
Gross tank size factor	1X [4]	2.4X	1.7X	3.9X	7.3X	19.5X	~40X (future potential ~20X)

1) Sources: Maersk Mc-Kinney Møller Center for Zero Carbon Shipping – Industry transition strategy 2021, Wärtsilä-DNV collaboration; 2) fuel price for e-methane is expected to be in a range similar to e-methanol; 3) fuel price range spans across blue, bio and green-electro equivalent; 4) gross tank estimations based on Wärtsilä experience

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Hybrid technologies developed to enable environmental efficiency

Wärtsilä has vast experience of hybrid installations

104 vessels ⟶ 211 MWh energy storage

Merchant

New Build	54	vessels
	83,675	kWh
Retrofit	2	vessels
	1,124	kWh

80.1 MWh

Cruise & ferry

New Build	16	vessels
	98,984	kWh
Retrofit	1	vessels
	1000	kWh

60.0 MWh

Offshore

New Build	0	vessels
	0	kWh
Retrofit	22	vessels
	19,454	kWh

18.7 MWh

Specials

New Build	7	vessels
	4,587	kWh
Retrofit	2	vessels
	2,234	kWh

6.8 MWh

First retrofit contract: 2012
First new build contract: 2016

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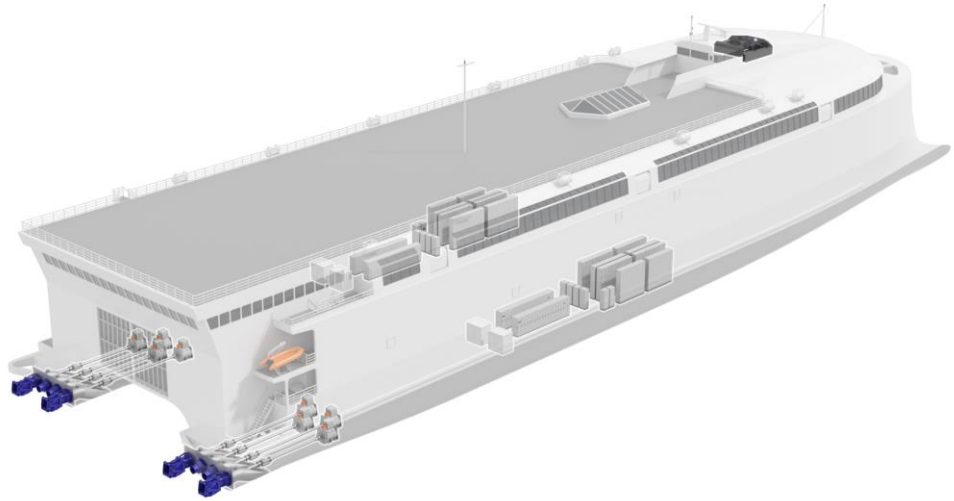
Full electric ships

Wärtsilä has developed full solutions for electric ships

- Wärtsilä is providing technology for the biggest battery electric ship – Incat Tasmania, 130 metres long ferry
- Electric propulsion is becoming possible in specific routes with charging arrangements in harbours
- Wärtsilä delivery: Waterjet propulsion, power conversion system, DC shore charging system, 40 MWh battery modules, DC hub, electric motors, propulsion control system
- Shipyard Incat Tasmania, customer Buquebus in South America. Vessel delivery in 2025



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Zotti/Sartori

New hybrid electric concept for Marine

Wärtsilä 4-stroke technology outperforms in sustainability

- Merchant vessels traditionally use mechanical propulsion drive with 2-stroke engines
- Decarbonisation calls for frequent efficiency improvements during vessel lifetime. Electrification gives a lot of opportunities
- Wärtsilä 4-stroke technology developed for electrical power plants gives efficiency and flexibility, enabling additions of batteries, fuel cell, wind assist etc with no compromise in efficiency

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