Towards 100% renewable energy for mines

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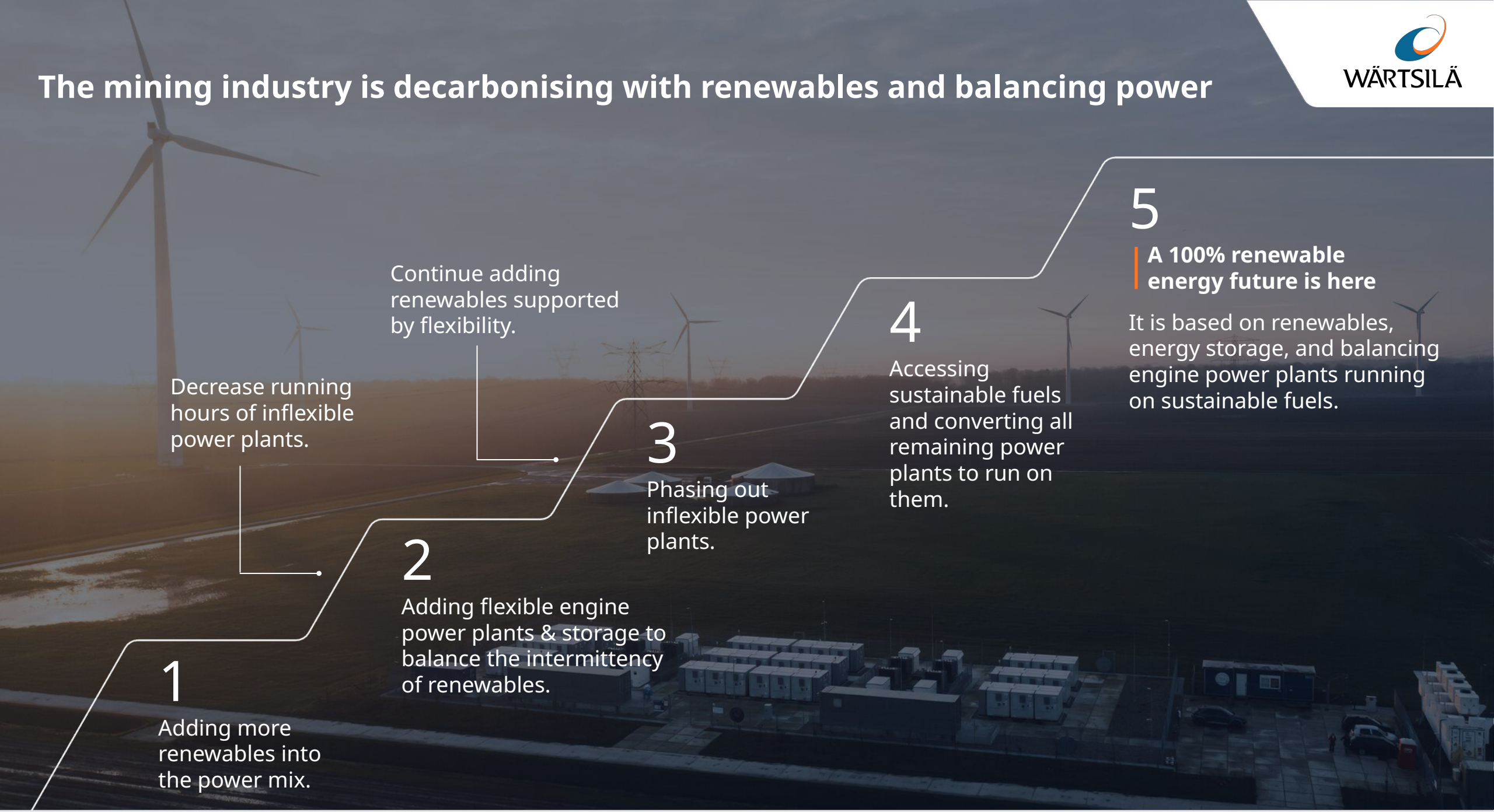
The mining industry is decarbonising with renewables and balancing power



1

Adding more renewables into the power mix.

Decrease running hours of inflexible power plants.

2

Adding flexible engine power plants & storage to balance the intermittency of renewables.

Continue adding renewables supported by flexibility.

3

Phasing out inflexible power plants.

4

Accessing sustainable fuels and converting all remaining power plants to run on them.

5

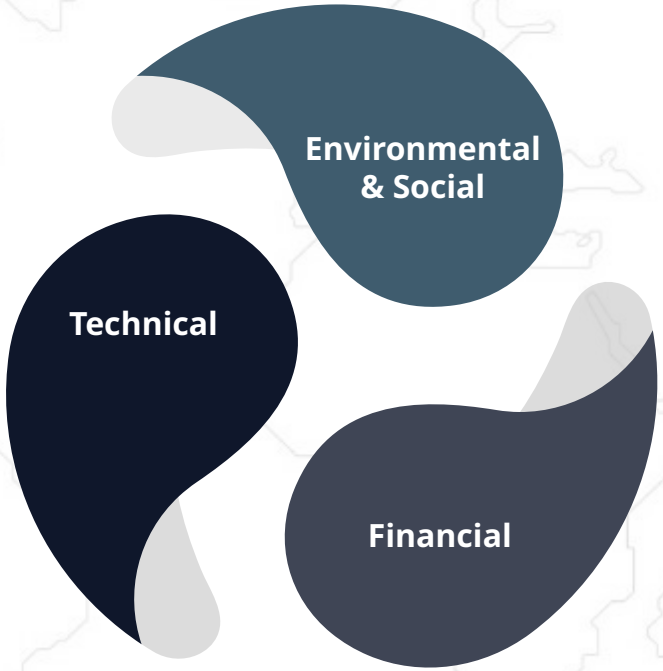
A 100% renewable energy future is here

It is based on renewables, energy storage, and balancing engine power plants running on sustainable fuels.

Even the first steps of decarbonising power generation can be complex

Delivering a genuine net effect requires a holistic approach

- High intermittency due to variable renewables sources
- Increased need for balancing solutions
- Microgrids becoming increasingly more complex
- Growing electricity demand due to mine electrification



- Geopolitical uncertainties
- Need for energy security
- Regulatory and policy compliance

- Maintain lowest LCOE
- Challenges to secure return on investments
- Avoid loss of production efficiently

We have identified common key challenges for customers implementing hybridisation in captive microgrids

As the variability of generation increases, optimisation becomes more complex - leading to:

CO_2 Suboptimal loading of thermal assets	High fuel consumption and emissions
Large amounts of renewable energy being curtailed to secure system stability	Wasted renewable resources and poor ROI
Reserve provision and unit commitments not being methodically managed, leading to issues with reliability, and even blackouts	Loss of production and decreased revenue

Optimising a hybridised microgrid requires advanced energy management

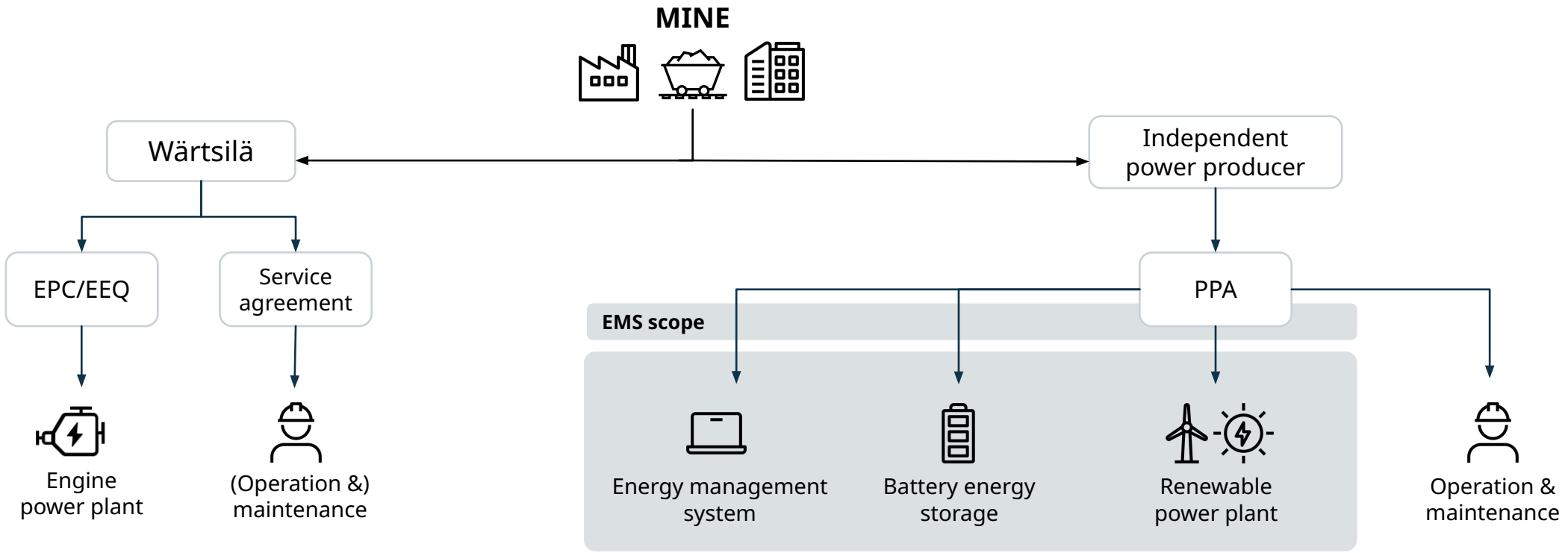
GEMS

Digital Energy Platform

GEMS solutions suite

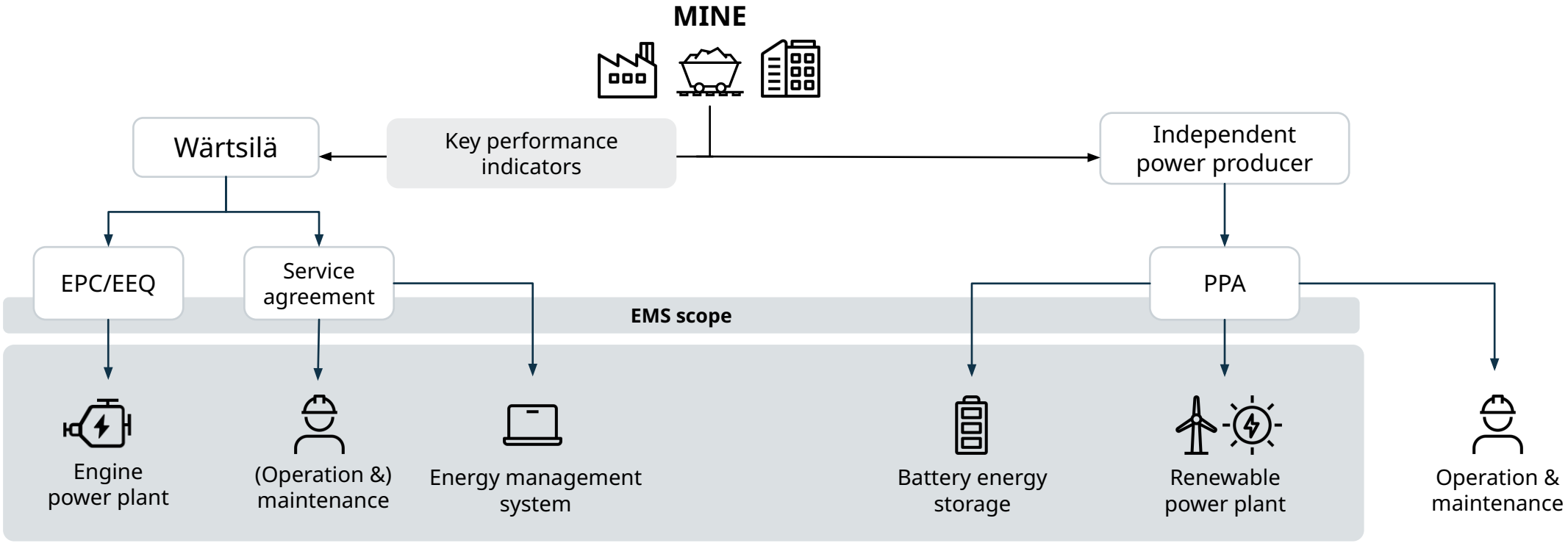
- Optimises all generation assets
- Secure, flexible, scalable
- Deployed in 125+ projects globally

However, the typical commercial approach does not enable system-level optimisation



Miners do not have a single partner, who is accountable for the technical integration and overall economic optimisation of their hybridised microgrids

Rethinking the structures enables maximising value



It is now a common interest to ensure the entire microgrid is running efficiently and reliably

The next steps in decarbonisation are already underway

Our fuel research and fuel-flexible technology are enabling the transition to sustainable fuels

The preferred fuel will vary between industries and companies, depending on:

- National or company decarbonisation targets
- Costs, availability, storage needs and safety risks
- Investment subsidies and ease of permitting

Our engine power plants can run on a diverse range of fuels:

Today	HFO LFO/Diesel Biodiesel (FAME) /HVO/ Bio-oils Natural gas/LNG Biogas/ Biomethane e-methane LPG, Ethane Hydrogen/natural gas blends (< 25%)
2026 – 2028	Hydrogen Methanol/Ethanol Ammonia

First sustainable fuel engines leaving the factory already in 2023

Milestones on low/zero carbon technologies in the pipeline

H_2

2021-2024
Combustion testing on hydrogen blends and 100% hydrogen

2023
Hydrogen blend capability offered for all gas engines

2026
Expecting to have and power plant concept ready for operating on 100% hydrogen

NH_3

2022
Combustion and performance testing, optimisation with different engine concepts and different engines platforms

2023
Sales release of the first ammonia-capable W25 marine engine, delivery 2024

CH_3OH

2015
First engine conversion ZA40S

2023
Delivery of first W32 methanol engines. Sales release of additional marine engines and engine conversion packages

A giant leap towards decarbonisation

Environment + Energy LEADER TOP PROJECT 2024
Energy Innovation

Together with WEC Energy Group we have successfully completed **hydrogen blend tests on an unmodified Wärtsilä engine.** The results were outstanding: engine efficiency improved when running on the 25 vol% hydrogen blend, while also reducing greenhouse gas emissions. This was a world's first, testifying that **Wärtsilä's technology can support the decarbonisation of the energy industry.**

25 vol%
H2 hydrogen blend with 95% engine load

9.1%
CO_2 CO_2 reductions at 95% load

WÄRTSILÄ

GEMS Digital Energy Platform

Future-proof flexible engine power plants

Energy storage systems

Outcome-based commercial models

Wärtsilä has all the capabilities needed to integrate and optimise hybrid microgrids

We empower microgrid operators to reduce CO_2 emissions, ensure availability and uptime, and secure long-term cost savings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