

# Methane Abatement in Maritime Innovation Initiative (MAMII)

Practical learnings and technology updates  
on methane emissions in maritime

*IMO Technical Seminar  
on methane-based fuels*



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# MAMII at a glance

Methane is **28 times more potent** than CO2 on a 100-year scale and the second most significant Greenhouse Gas (GHG).

- ! Adopting a GWP20 approach means that methane's climate impact is 82.5 times more potent than CO2

## MAMII Mission:

“ An innovation initiative led by Safetytech Accelerator in collaboration with key maritime and LNG stakeholders, accelerating the adoption of technologies to monitor, measure and abate methane emissions. ”

## Our Goal

To mitigate the environmental impact of LNG-fuelled ships

### WtT

- ✓ LNG value chain ~4% of global CH<sub>4</sub>; WtT much lower
- ✓ Monitoring tech enables global methane detection
- ✓ MAMII WtT transparency & certification (e.g. collaboration with MiQ)

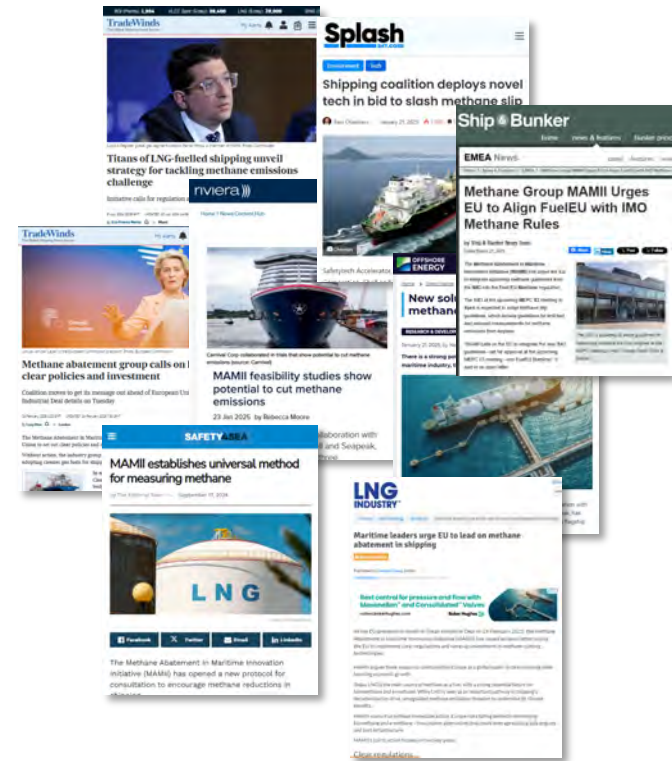
### TtW

- ✓ Methane slip is the main onboard methane emissions source, regardless of fuel origin.
- ✓ Methane abatement is a fast, high-impact shipping climate solution.
- ✓ Technology allowing for negligible methane emissions is already proven and available.

# MAMII in a nutshell

# 40%

LNG powered vessels are part of MAMII



Industry-led initiative to measure and reduce methane emissions from LNG-fueled ships, launched by Safetytech Accelerator in 2022.

20 major shipping lines, energy firms, and technology providers to accelerate methane abatement technology adoption.

Focus on technology trials, feasibilities, and advocacy, for methane measurement and abatement.



# MAMII Current Activities



## Pillar 1: Technology Landscape

- **Ongoing tech scouting** & landscape analysis
- Structured evaluation of maturity, feasibility & performance
- Curated tech reports & targeted showcases
- **Deep-dive sessions** with selected providers
- **MAMII events with demos** & industry engagement



## Pillar 2: Pilot & Feasibility Support

- Prioritize technologies for **studies & pilots**
- Bi-weekly feasibility calls with providers & partners
- Share feasibility results with partners
- Advance selected technologies to pilots
- **Share pilot design & execution best practices**



## Pillar 3: Advocacy & Outreach

- Working group on **EC guidelines** for reporting and verification of actual TtW methane slip (Cslip) emission factors
- Coordinated responses to methane regulations & policy monitoring
- Ongoing Brussels engagement with **MEPs & European Commission officials**



## Pillar 4: Protocol, Operations and Collaboration

- Exploring collaboration with **SEA-LNG** as technical partner at IMO.
- Participation in **FUMES 2** Scientific Advisory Board
- Exploring collaboration with **SIGTTO**
- Engage on well-to-tank methane transparency & certification (e.g. **MiQ**)

# MAMI Technology Highlights

240+

Companies identified  
(measurement, abatement and fugitive emissions detection)

## Measurement

Companies analysed:

72

Tech Categories:

Laser Spectroscopy, Standoff Cameras, IoT/ Solid state sensors, Drones, Gas Chromatography, Satellites, Flow Meters

Deep Dive Sessions:



Feasibility Studies:



10+

Feasibility studies

## Abatement

98

Catalyst, Scrubber (Wet/Dry), Plasma, Drones



18+

Deep dive sessions

## Fugitive Emissions

76

Optical gas imaging, Sensor Networks & AI, Laser based system, Acoustic/Ultrasonic Imaging, Methane capture materials, Hyperspectral Imaging, others

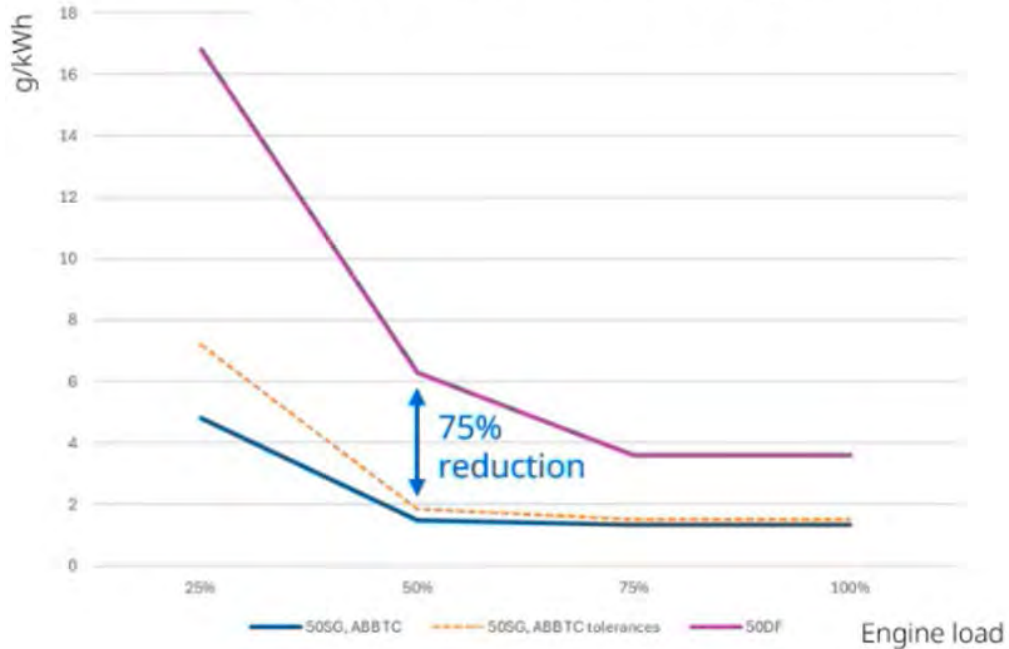


# Engine Developments – Cslip Improvements

# 4-Stroke Engines

## 50DF Conversion to Spark Gas (SG)

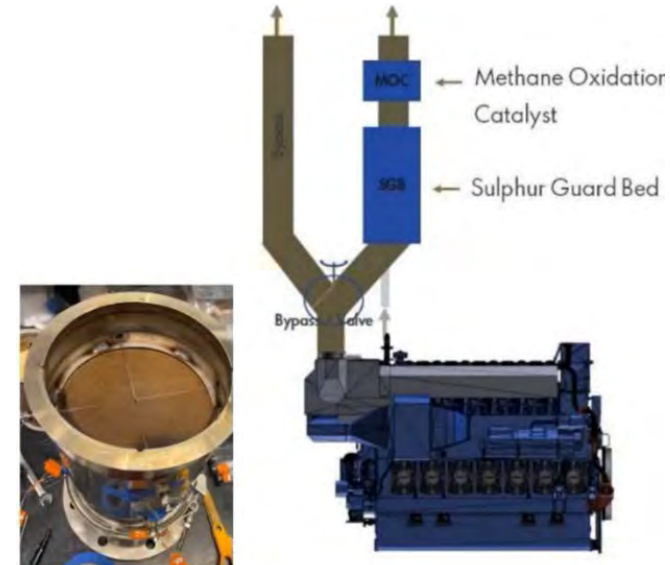
### Methane Emissions comparison



- **Retrofit option** for 50DF engine
- The SG solution introduces an electrically controlled pre-combustion chamber valve for a more optimized combustion process
- Potential improvement in efficiency and **methane slip reduction up to 80%**

Source: Wartsila, 2025

## Methane Oxidation Catalyst



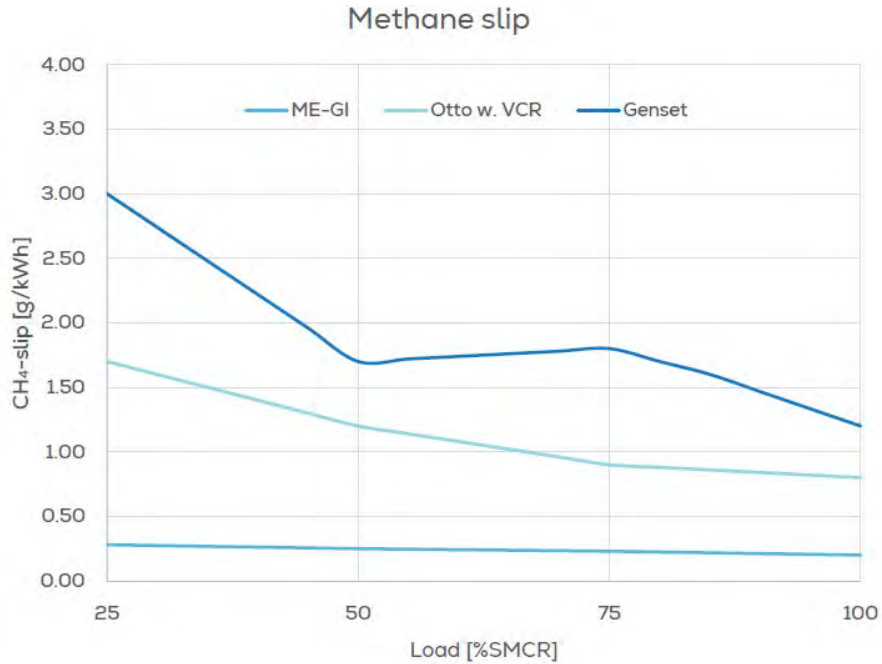
Key challenges – Under testing:

- Sulphur tolerance – sulphur guard bed, non-noble catalysts
- High temperature requirement – more active catalysts, pre-turbine installations
- Effect on engine operation – especially in the case of pre-turbine solutions
- Economic feasibility – size, cost, lifetime

Pilot project with SHELL currently in progress

# High-Pressure 2-Stroke Engines

## B&WG70ME-10.58 and 10.7-GI



- **Gas Injection Pressure**
- ME-10.58-GI: 325 bar
- ME10.7-GI: 380 bar
- Lower **fuel consumption** compared to the existing G70ME-C10.5
- **Tier III Abatement** with HPSCR, EGBP or EcoEGR

Source: Everllence, 2026

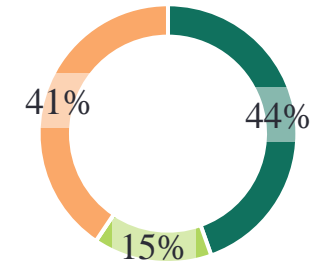
## X82/92-DF-HP



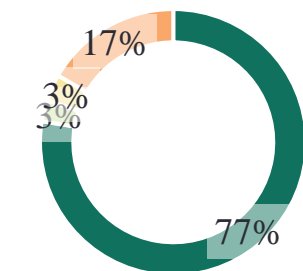
- **High-Pressure DF LNG** combustion system
- **First deliveries** expected in 2028
- Available in X82 and X92 bore sizes
- **Tier III emissions compliance with SCR**
- Compatible with LNG, bio-LNG, and e-LNG.

Source: WinGD

## LNG DF Fleet (excl. LNGCs) | Existing



## LNG DF Fleet (excl. LNGCs) | Orderbook



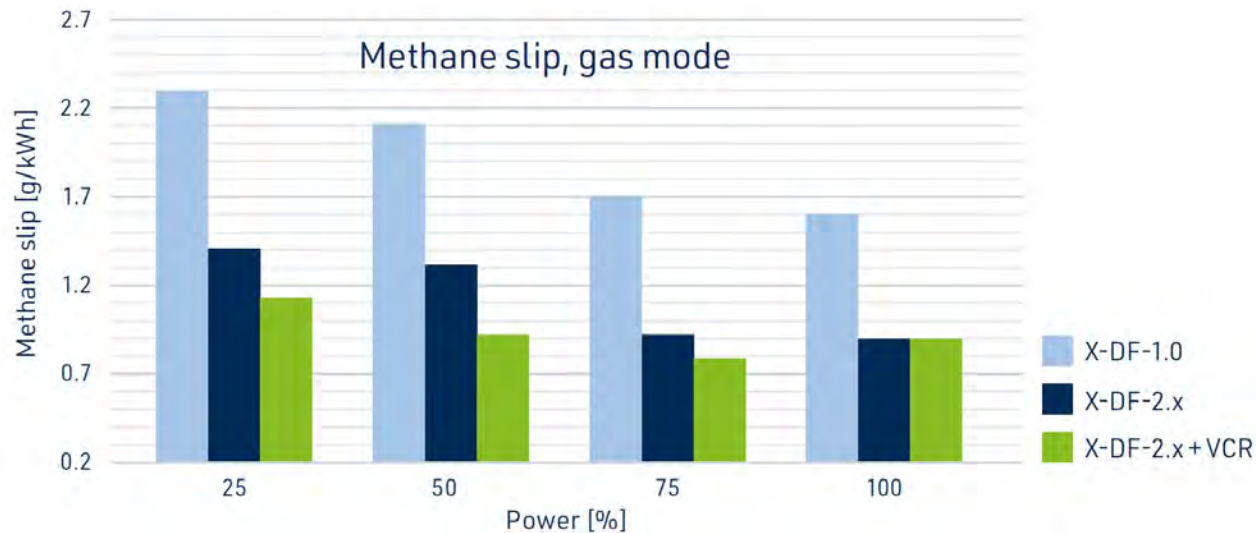
- HP2S
- LP2S
- LP2S + EGR
- LP4S

Source: IHS Database (Dec. 2025)

# Low-Pressure 2-Stroke Engines

X-DF2.2/2.x

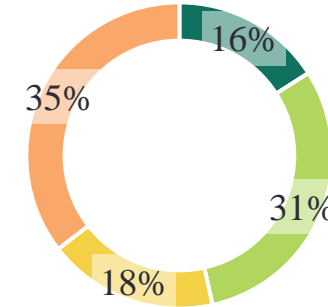
Methane slip emissions for X72DF type engines



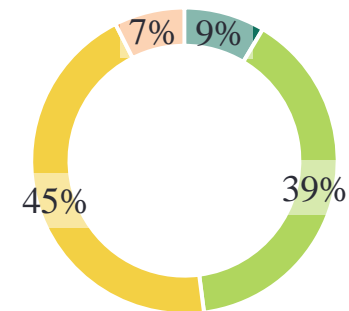
- With iCER or VCR technology, methane emissions expected to be lower than these of first-generation X-DF engines
- iCER technology is available for X72DF-2.1/2.2
- Variable Compression Ratio (VCR) technology available for X62DF-2.1, X62DF-S2.0 and X72DF-2.1/2.2
- VCR offers fuel consumption reduction by up to 3.1% in gas mode.

Source: WinGD

No. of LNGCs | Existing



No. of LNGCs | Orderbook



■ HP2S ■ LP2S ■ LP2S + EGR ■ LP4S

Source: IHS Database (Dec. 2025)

# Methane Oxidation Catalysis (MOC)

## ➤ What is a MOC?

Passive solution for methane slip reduction.



## ➤ Critical Parameters:

- **Exhaust Gas Impurities**
- **Temperature Range** – methane conversion increases when temperature rises
- **Exhaust flow** – lower exhaust flow, increased conversion rate

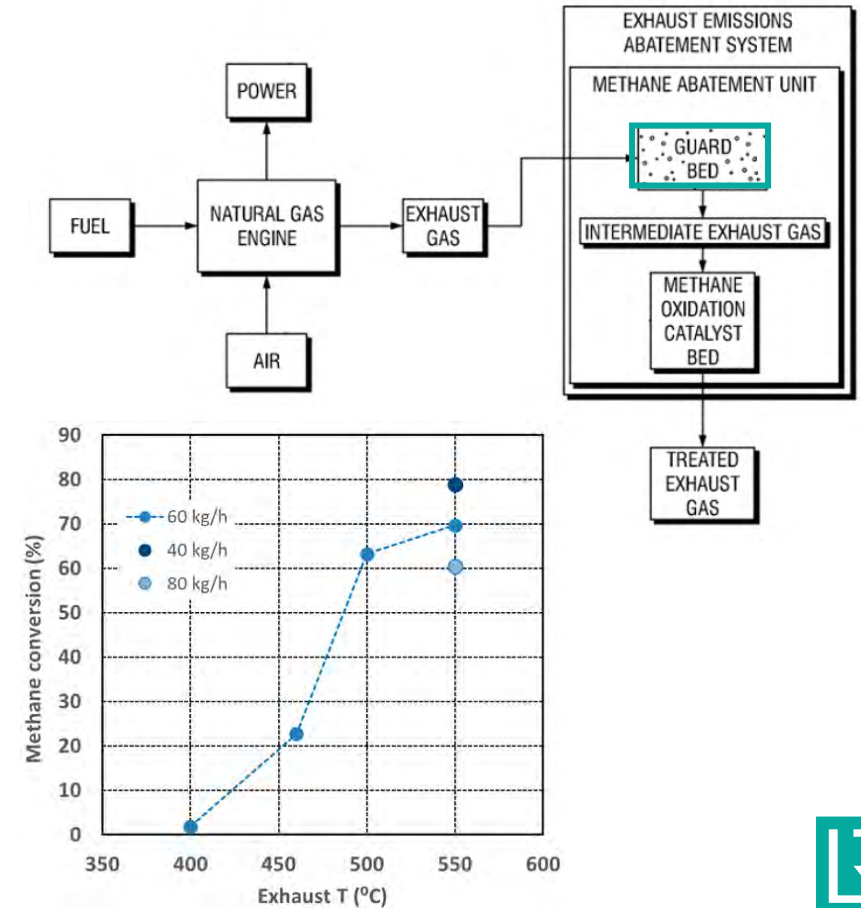
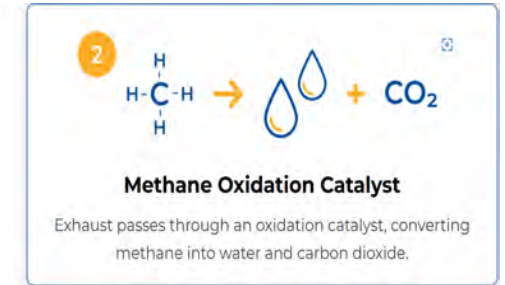
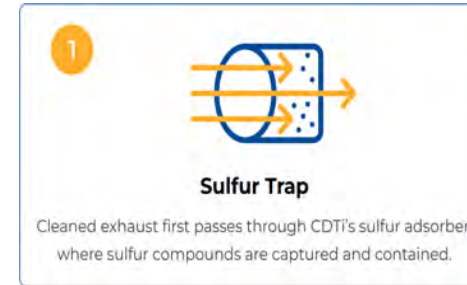
## ➤ Main Challenge:

Catalyst stability – Brief exposure to trace of sulfur (ppm level) may result in irreversible catalyst loss (**sulfur poisoning**).

## ➤ Solution:

**Sulfur (SO<sub>x</sub>) guard** that traps sulfur before reaching the catalyst.

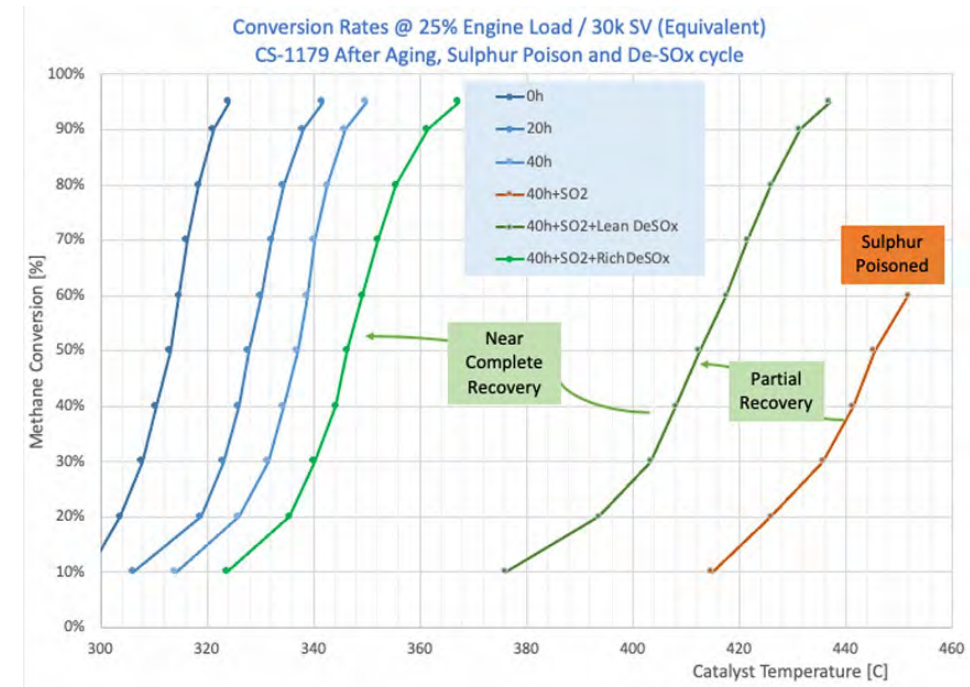
*Without sulfur guard, MOC lifetime is very limited.*



Source: VTT - Dinex, Green Ray Project, CDTi

# CDTi: Methane Oxidation Catalyst

- Oxidises CH<sub>4</sub> into CO<sub>2</sub> and H<sub>2</sub>O
- Two-stage system:
  - Sulfur adsorber to protect the catalyst from poisoning
  - Methane oxidation catalyst
- Operates effectively across variable engine loads and temperatures
- Reduction: Up to 80% methane conversion
- Maintenance: every 3,000 hours
- MOC expected lifetime: 20,000 hours
- Lab-based validation: Testing conducted in simulated exhaust conditions using synthetic gas, including catalyst performance mapping, aging simulations and sulfur poisoning/recovery studies.
- No public pilot demonstrated




# Other MOC examples

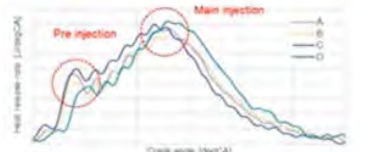
In-cylinder technology and software updates could reduce methane slip up to 50%; MOCS under development

### In-Cylinder Technology

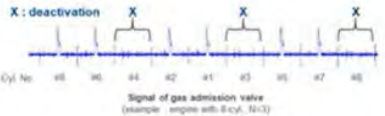
**HIMSEN MSS** (Methane Slip Solution)



: Crevice volume



Multiple pilot fuel injection




Cylinder cut off

**More than 50% CH<sub>4</sub> reduction**  
(for 4s HiMSEN DF)

+

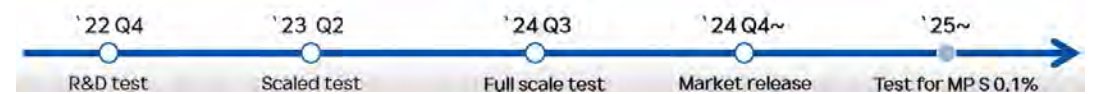
### MOC<sup>TM</sup>

(Methane Oxidation Catalyst System)



**over 80% CH<sub>4</sub> reduction**  
(for 4s HiMSEN DF)

MOC tested for 800 hours, with full-scale engine tests in 2025; sulphur resistance up to 0.1% under development

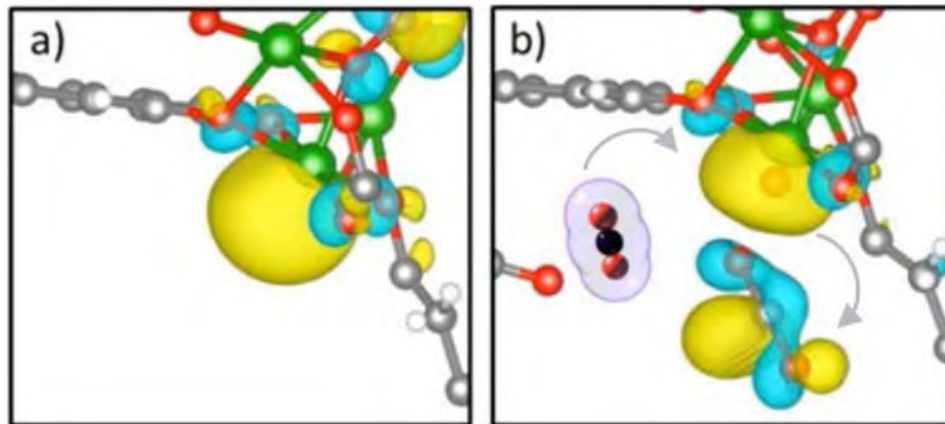


# Emerging technology: Metal Organic frameworks (MOFs)

Already applied to land facilities| Ongoing research for ship installation feasibility

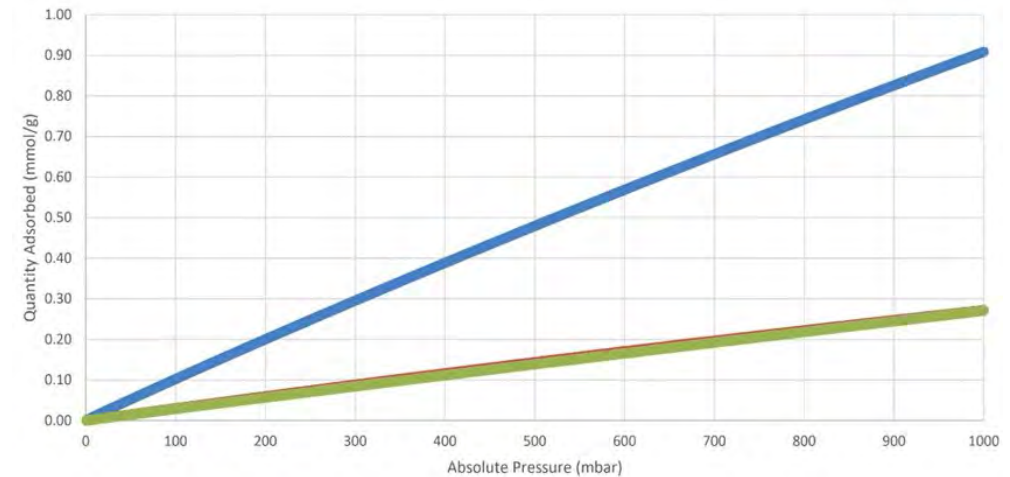
Applications include:

- Gas treatment
  - Air treatment – capture of GWP pollutants (CO<sub>2</sub>, Methane, Nox, HFC etc.), atmospheric water harvesting
- Gas storage
- Gas separations including cyclic H<sub>2</sub>S capture
- Catalytic treatment applications
- Temperature

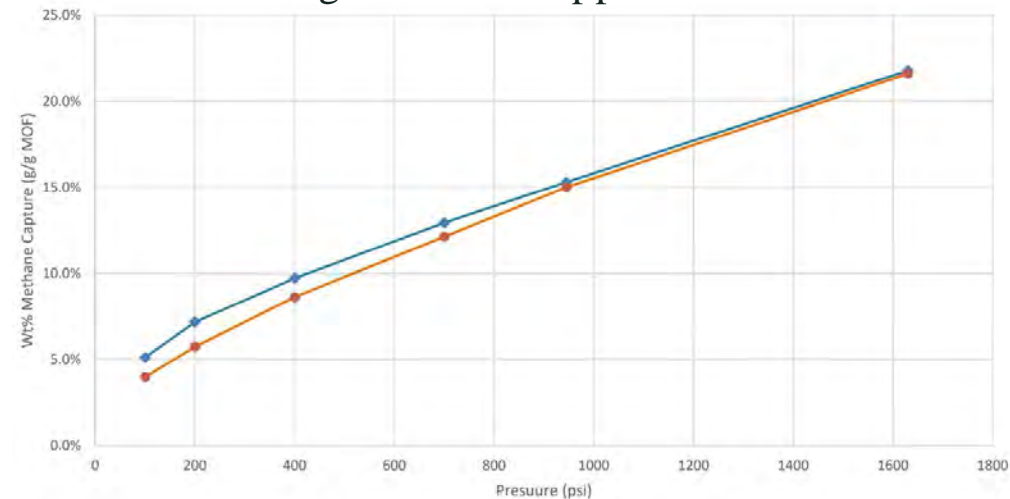


Source: Framergy, 2025

### Low- Pressure Application



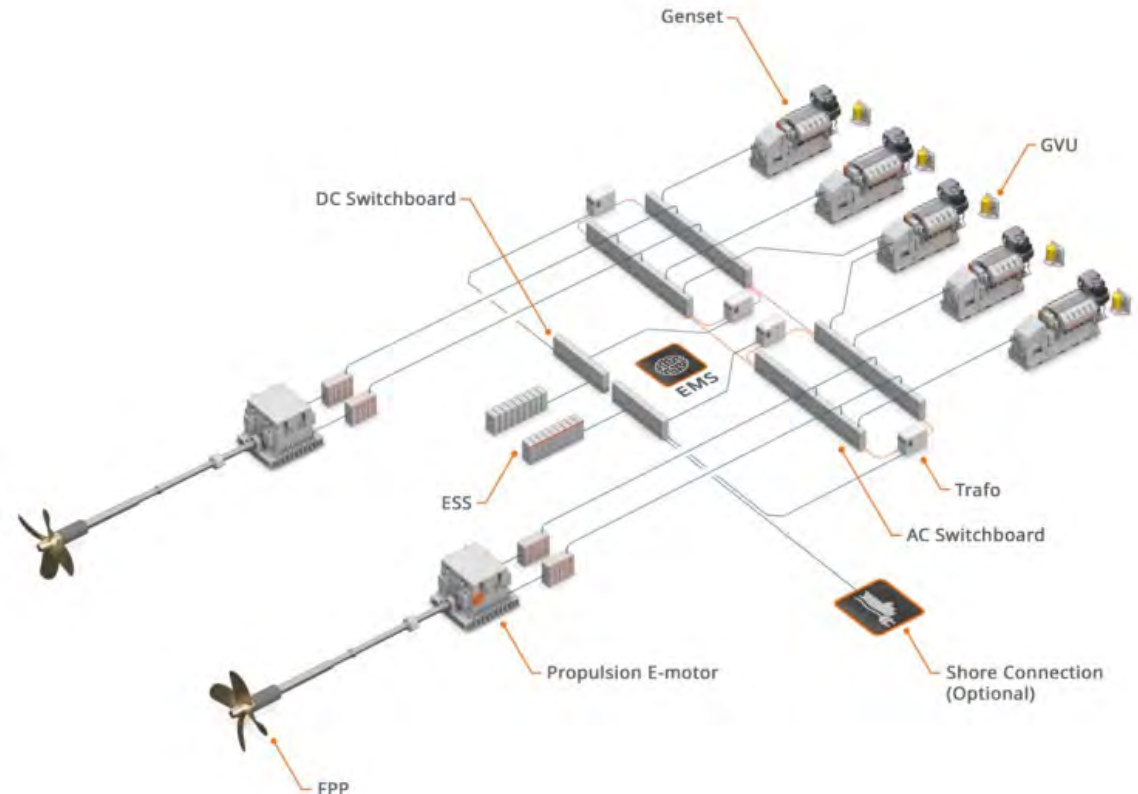
### High- Pressure Application



# SHELL – Wartsila – Hanwha Ocean Hybrid Concept

## Hybrid electric system overview

- Fully electrified & modular power system
- Mix of Wärtsilä 31 Spark Gas and Dual Fuel GENSETS
- Wärtsilä 690VAC, Low-Loss Concept electrical distribution - minimum electrical losses and maximum redundancy & highly proven in service
- 2MWh, 3C Battery Energy Storage combined with DC Hub & Smart Energy Management Software:
  - Spinning Reserve -> enables optimal load factors to greatly improve performance and reduce running hours
  - Peak shaving -> enables steady state load on generating sets & eliminates dynamic load losses
  - Capability to operate in zero emissions mode with either battery or shore connection
- Efficient and compact permanent magnet e-motors driving large and efficient low speed FPPs
- 30% lower installed power and 40% lower weight vs current 2-stroke designs



# Concluding Remarks

- **Technology** which can ensure WtW methane emissions mitigation is **available** as we speak
- **Methane slip has been reduced by 60-70%** across all engine technologies in the last 3 years. **MOCs** and other abatement solutions can deliver up to total extinction of methane slip.
- We are not yet there, the integration of methane in **more regulatory schemes** in the future could have a **detrimental impact** to many engines in service. We need to look back and develop retrofit solutions.
- With the introduction of **methane measurement guidelines**, we have taken a huge step in addressing the problem. There are still though a number of questions stemming from their application and more work to be done in rationalizing them.
- As more energy is now invested on methane slip, we should take a closer look to operational or fugitive leaks , develop operational guidelines and uptake feasible technology towards the **methane proof ship**

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