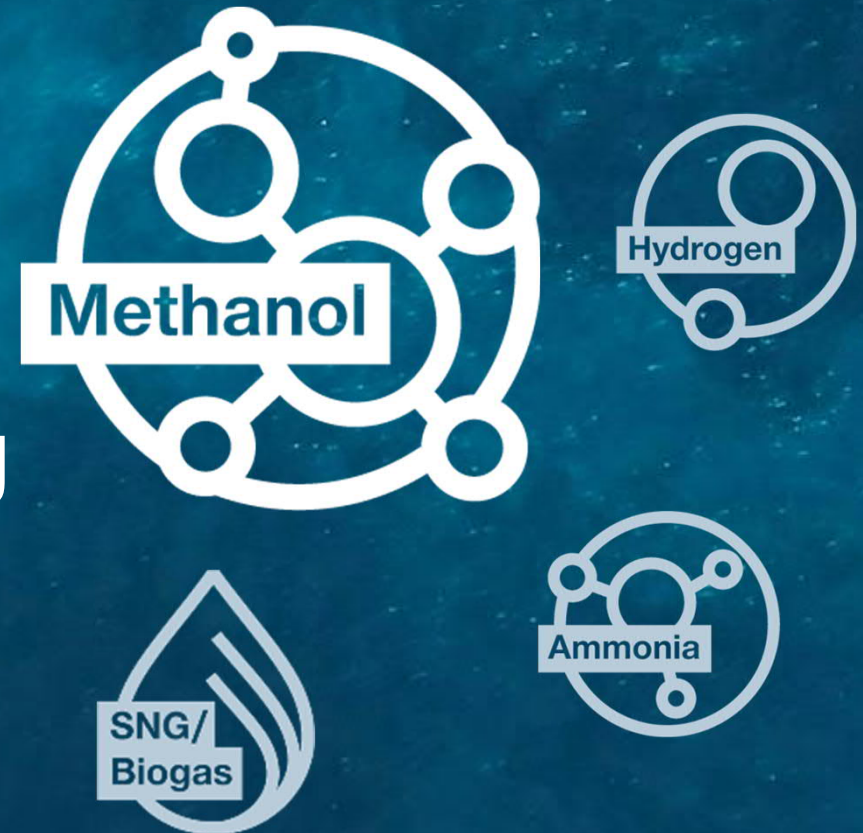


Methanol as a Shipping Fuel

How to de-fossilize shipping

Alexander Feindt
Global Business Development Manager, Marine Four-Stroke

28.06.2022, Workshop „Alternative Kraftstoffe VI“, Hamburg



We are committed to decarbonization

~ **80-90%** of global freight is transported by sea.

Shipping is responsible for ~ **3 %** of the global CO2 emissions.

~ **50 %** of global freight is transported by a MAN ES engine.

Our engines are responsible for ~ 1.5 % of the global CO2 emissions, so we have a significant impact on the global maritime sustainability agenda.

Methanol as a marine fuel is gaining momentum



CNN BUSINESS Markets Tech Media Success Perspectives Videos

CBAI | ELECTRIC POWER | OIL | PETROCHEMICALS | SHIPPING — 10 Sep 2021 06:15 UTC — Register

Maersk just ordered 8 carbon neutral ships. Now it needs green fuel

DFDS advances methanol use plans for shipping fleet as part of climate goals

16-04-2021 | SHIPPINGWATCH.COM

Shipping majors bet on different paths in decarbonizing shipping

"The only tangible solution you have today, apart from **methanol**, is LPG or LNG. ... "For **methanol**, the technical feasibility is already there, since (there are, ed.) vessels operating on **methanol** as a fuel out there. 🔑

SHIPPINGWATCH

Carriers Suppliers Offshore Ports Logistics Regulation Danish

X-Press Feeders orders eight methanol-powered container vessels

Methanol advances as alternative bunker fuel with barge-to-ship operation

14 May 2021 - Methanex Corporation subsidiary Waterfront Shipping carried out barge-to-ship bunkering of methanol in collaboration with

European Energy will establish a new e-methanol facility in Denmark and provide renewable energy to fuel it.

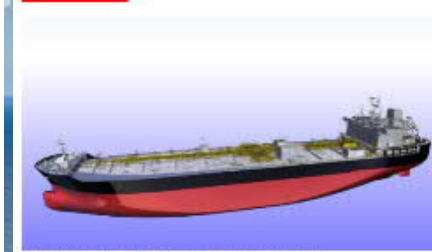
icct THE INTERNATIONAL COUNCIL ON Clean Transportation

A step forward for “green” methanol and its potential to deliver deep GHG reductions in maritime shipping

Waterfront Shipping orders 8 methanol dual-fuel ships from Hyundai Mipo Dockyard



Design for Methanol-Fueled Tanker Receives Class AIP



Bloomberg Green

Green

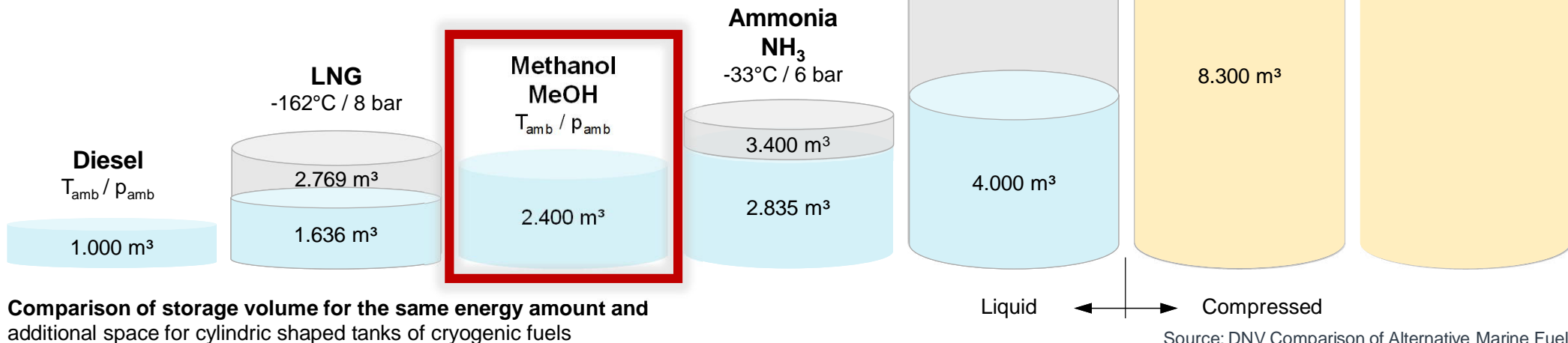
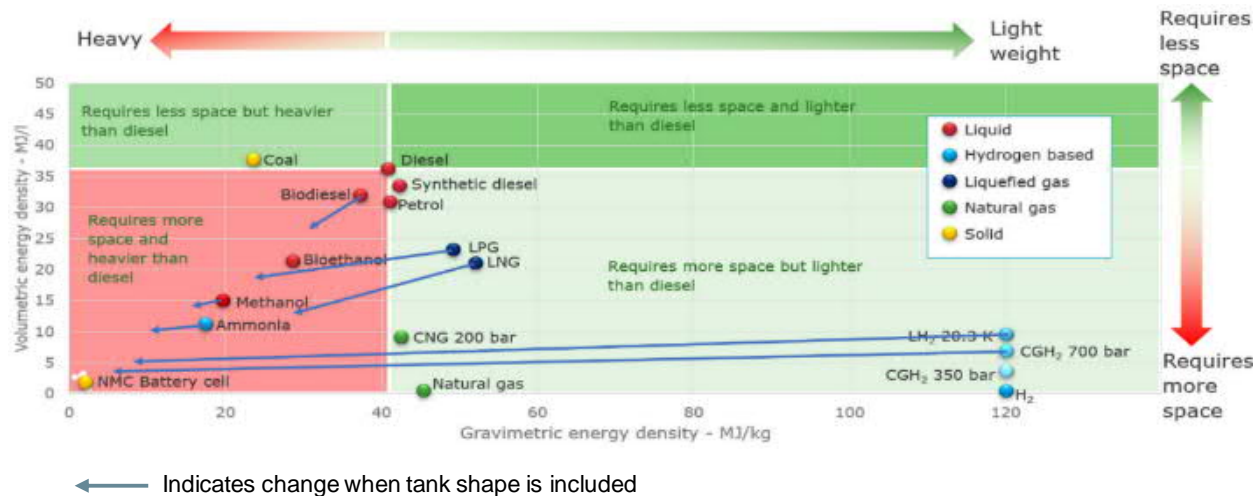
Maersk Makes \$1.4 Billion Green Bet on Methanol-Fueled Ships

Swedish Climate Leap, “Klimatklivet”, invests SEK 151 million (€15 million) in Liquid Wind’s facility, FlagshipONE, producing carbon neutral fuel

Will deliver 50,000 tons renewable and fossil free fuel for the shipping industry

FlagshipONE will be connected to Övik Energi's combined heat and power (CHP) plant Hörneborgsverket in Örnsköldsvik, in the north of Sweden. The construction process is scheduled to start in the spring of 2022. Once operational, the facility is expected to produce 50,000 tons of eMethanol starting in 2024. The new facility will upcycle carbon dioxide emissions and combine this with green hydrogen, made from renewable electricity and water to produce eMethanol.

The mosaic of Shipping (Syn-)Fuels, e.g. density

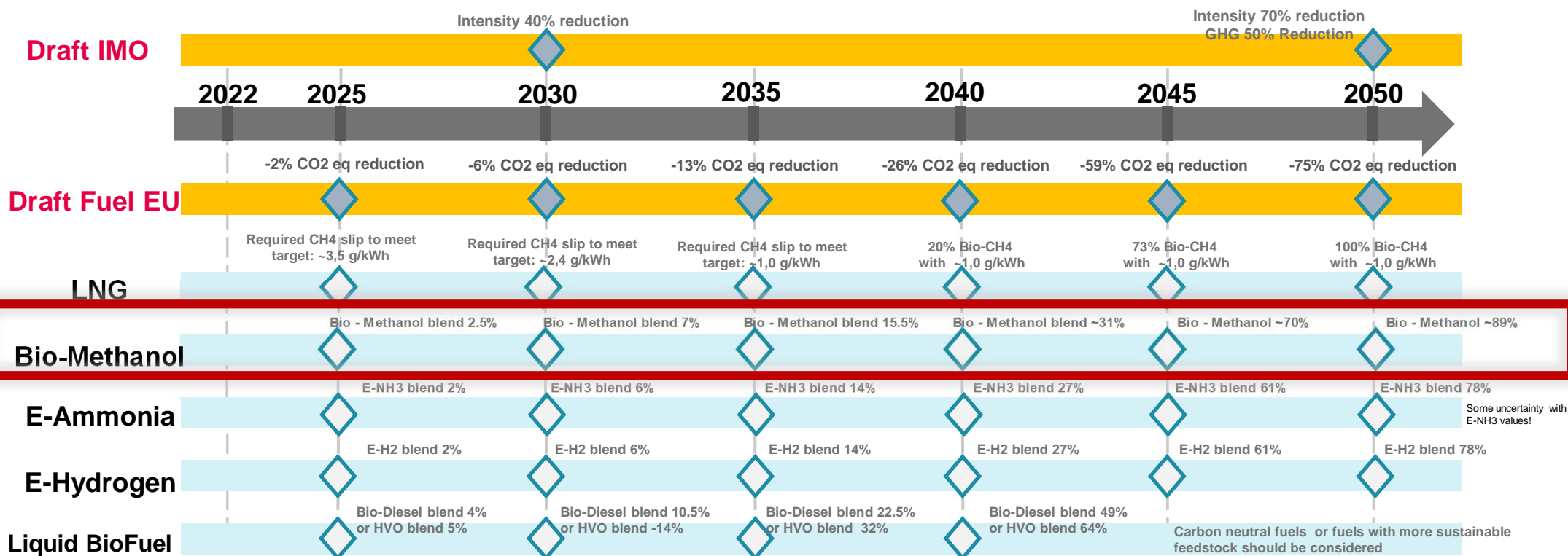


Generic De-fossilization/carbonisation pathways

Overview Future Fuels & Emissions



* all % are in energy share with MGO

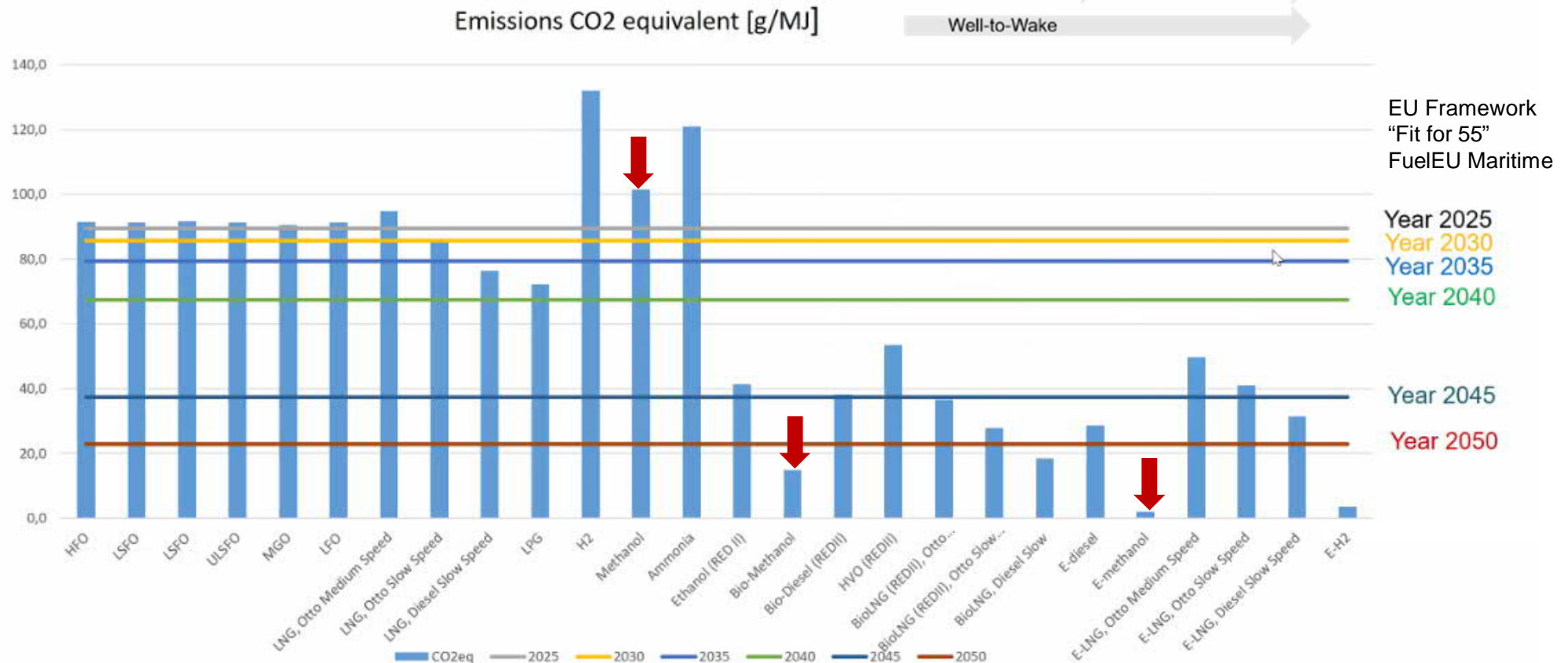
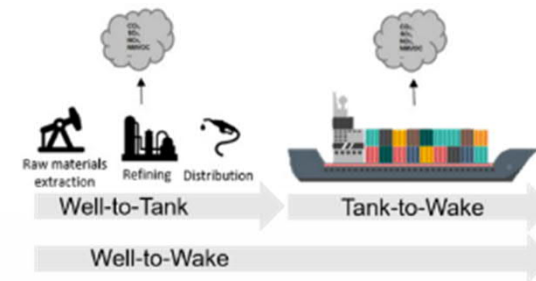


Many decarbonisation paths are possible to meet future legislation

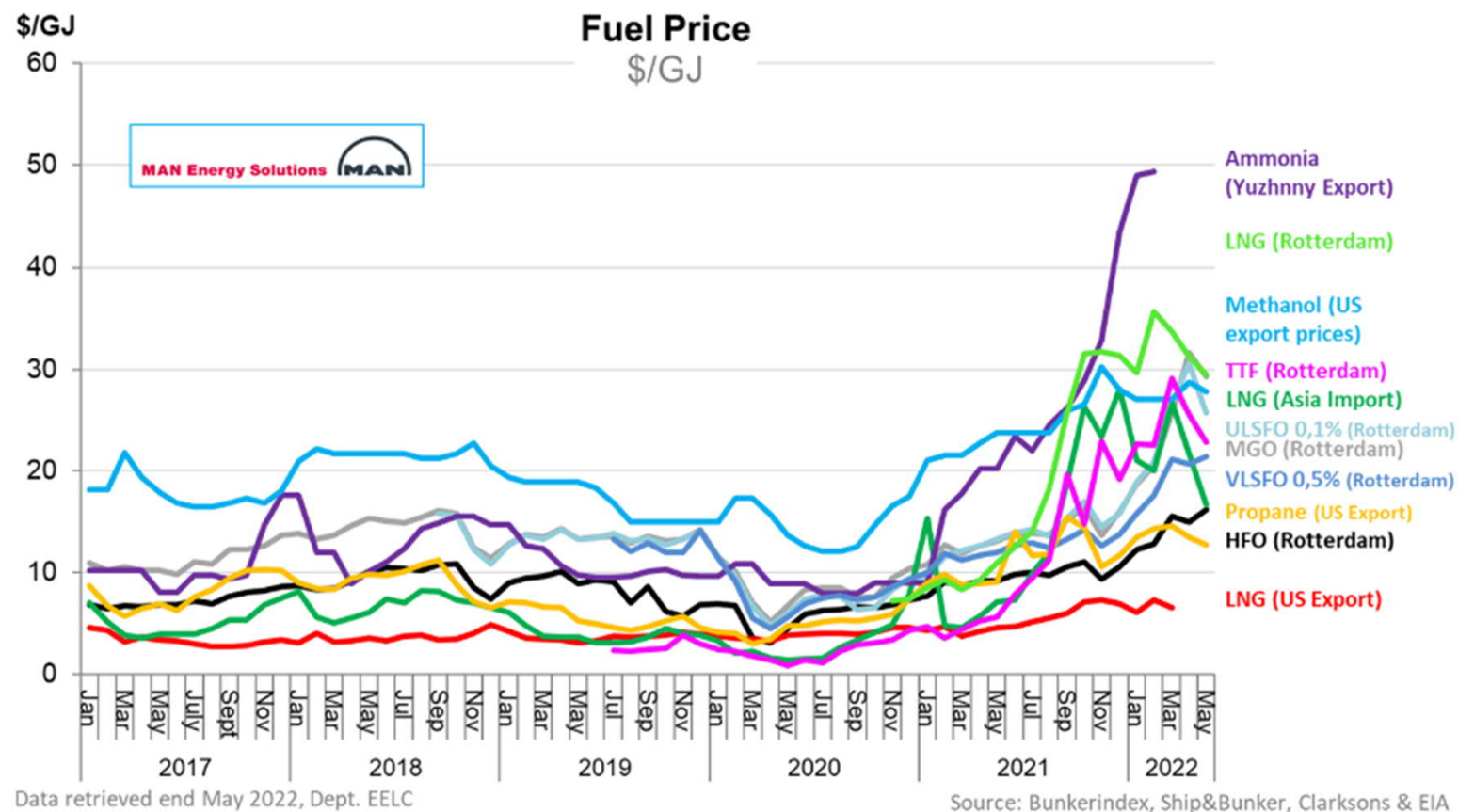
- 0 [@Vladimir Ivanov] : Few comment to add please.
Complete LNG decarbonisation paths with blends in 2040 and onwards?
Add the Ammonia path?
For Biofuel is it either or blend or botha are needee?
Add footnote for onshore power supply
; 2021-11-08T16:32:57.152

Methanol and the EU

Well-to Wake Carbon Footprint as per EU Fit for 55 Framework (preliminary)



Fuel Prices (as of June 2022)



Prices excl. bunkering costs, GHG penalties

Methanol Supply

Overview Future Fuels & Emissions



Theoretical availability



Storage & handling:

- Storage similar to gasoline
- Double walled piping & Leakage detection necessary
- Personal protection equipment necessary

[Methanol Safe Handling Manual](#)

Conclusion

- Easy handling and storage
- Diesel-like tank size
- Only green and blue methanol with relevant CO₂e reduction well-to-tank, but not onboard
- Conventional methanol widely available

Production of green methanol is picking up slowly

Uptake in green-methanol production plants on-going. Demand from shipping will be very high.



Yearly total production capacity from **E-methanol** and **bio-methanol** plants (known Q4 2021) from 2024-2025 onwards, where production capacity is already published:
≈2.6 million tons of green methanol

Enough to fuel **≈ 150 Aframax Tankers** for one year

Or **≈ 250 small feeder vessels**

Or **≈ 60 very large container vessels**

Product
■ Biomethanol
■ E-methanol

Source: <https://www.methanol.org/renewable>



MeOH bunkering by Methanex in ROT in 2021

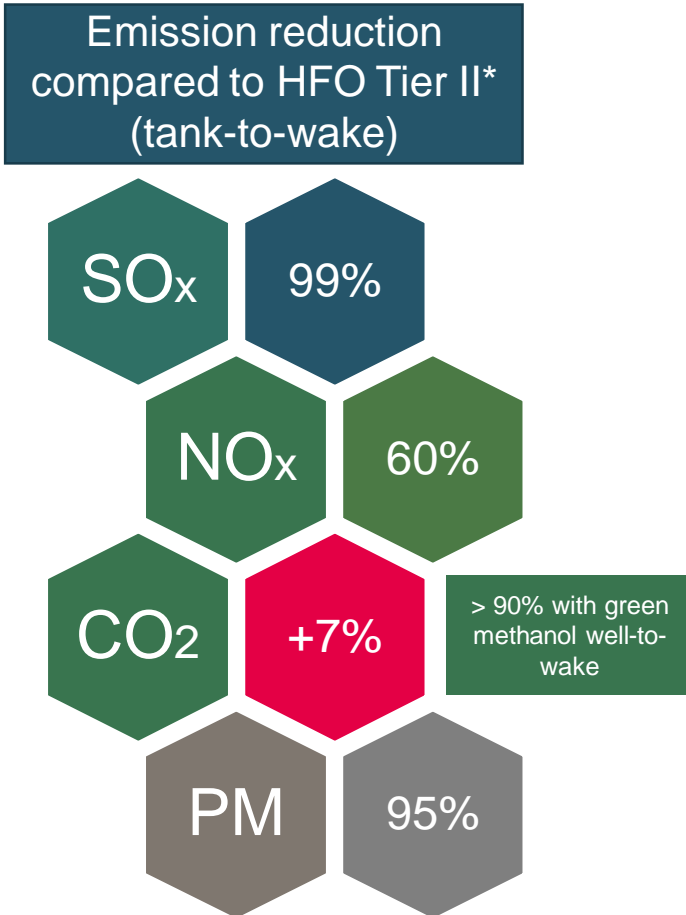


Q1 2022: Maersk have themselves secured 6-700.000 tons of green methanol, starting from 2025

Methanol – CH₃OH – MeOH



Overview Future Fuels & Emissions



CO ₂ e [g/MJ] acc. to Fuel EU Fit for 55	102 (conventional) 4 (green)
Efficiency	Similar to current DF engines
Equivalent tank volume (includes tank shape)	2,4 x Diesel 0,9 x LNG
Storage	Room temperature / ambient pressure
Ignitability	With diesel
Power output in methanol mode	60-100%
Challenges	Corrosive behavior Solvent

- Green Methanol is CO₂ neutral well-to-wake
- Methanol combustion is nearly soot free

* Indication. Assumes PFI technology based on DF engine technology at 75% engine load – see chapter 3

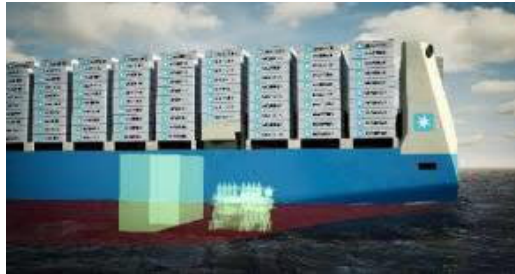
The world's first 2S methanol engine for large and ultra large container vessels

MAN B&W 8G95ME-C10.5-LGIM EGRTC

8 X 16200 TEU Container vessels



MAN has 110,000 running hours on MeOH in shipping



**MAN B&W LGIM engine
(2-Stroke)**



Engine / Retrofits (4-Stroke)

2024-2025

Port-Fuel Injection



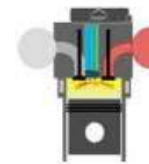
- Diesel / DF base engine:
- MeOH port fuel injection (PFI)
 - Diesel main- or pilot-injector for ignition
 - Pre-mixed (Otto) combustion

Adaptions:

- Automation system
- MeOH-System
- Safety-System

2026-2028

High Pressure Injection

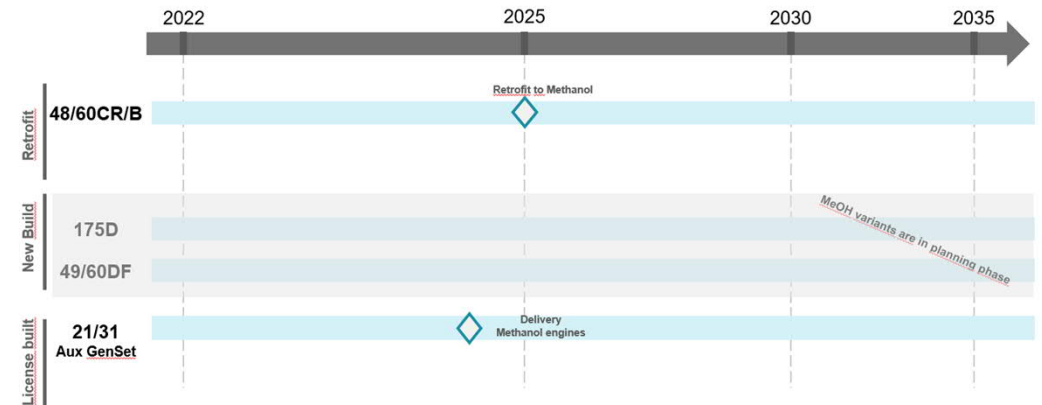
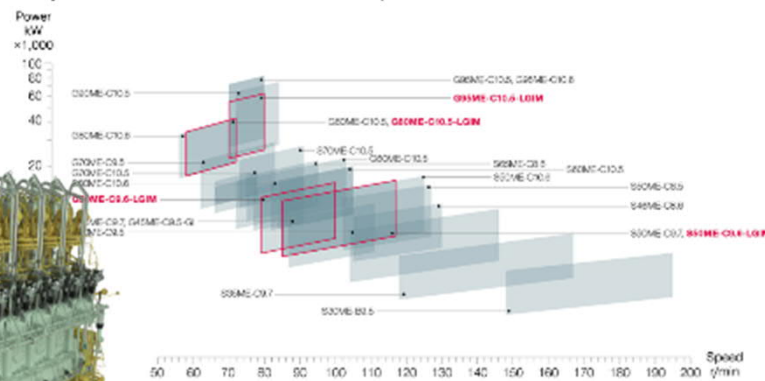


- Diesel base engine:
- 2nd / integrated high pressure multi fuel injector (MeOH, NH3)
 - Diesel ignition
 - Diffusive (diesel) combustion

Adaptions:

- Cylinder Unit
- Pilot fuel system
- Safety-System
- Automation system
- MeOH-System

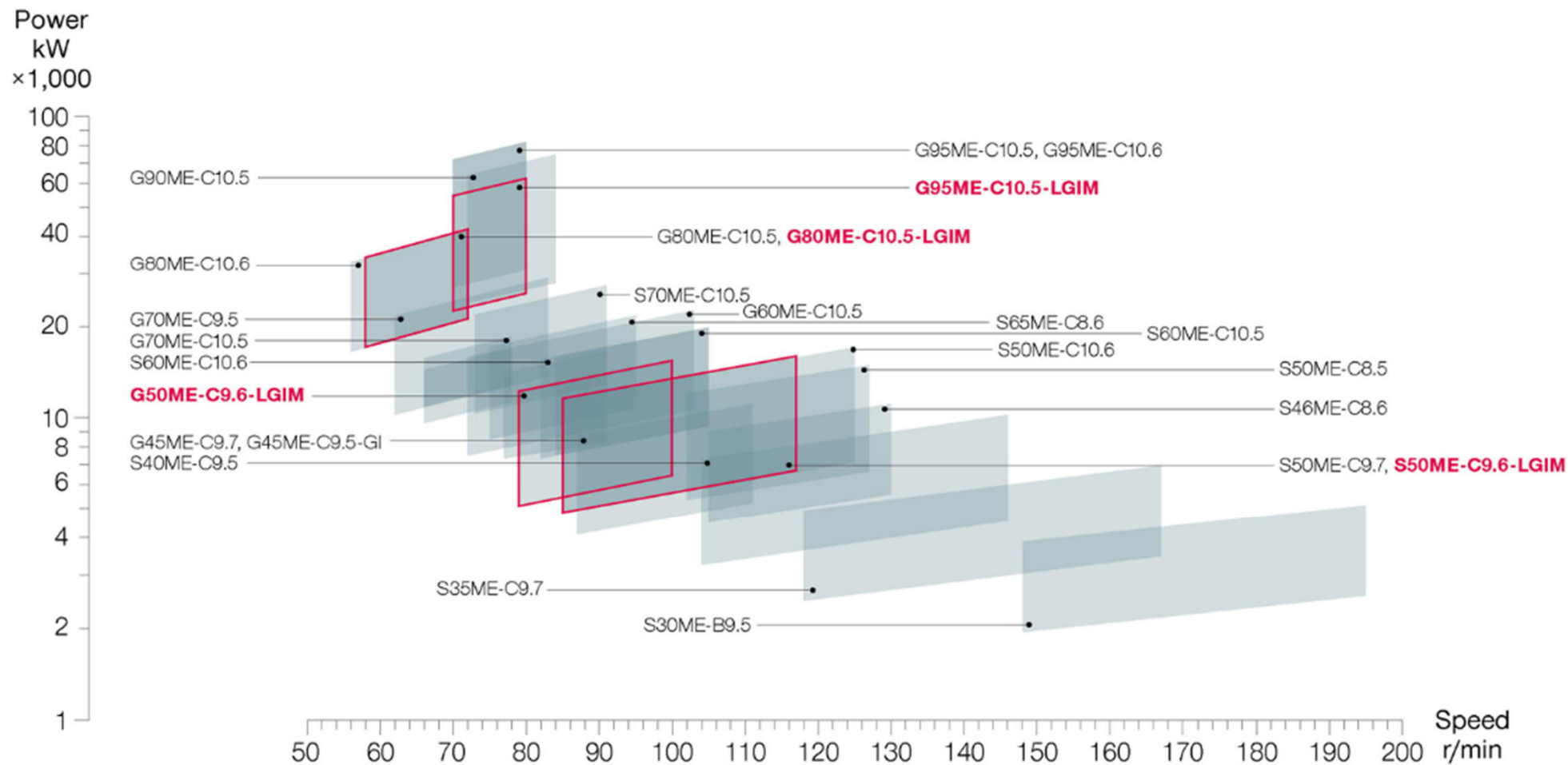
Newly introduced G80 as well as G95-LGIM with up to 61830 kW.



MAN B&W (2S) Methanol engine portfolio



Newly introduced G80 as well as G95-LGIM with up to 61830 kW.



4S Retrofits to Methanol (Dual Fuel)

Some key considerations



Assumptions

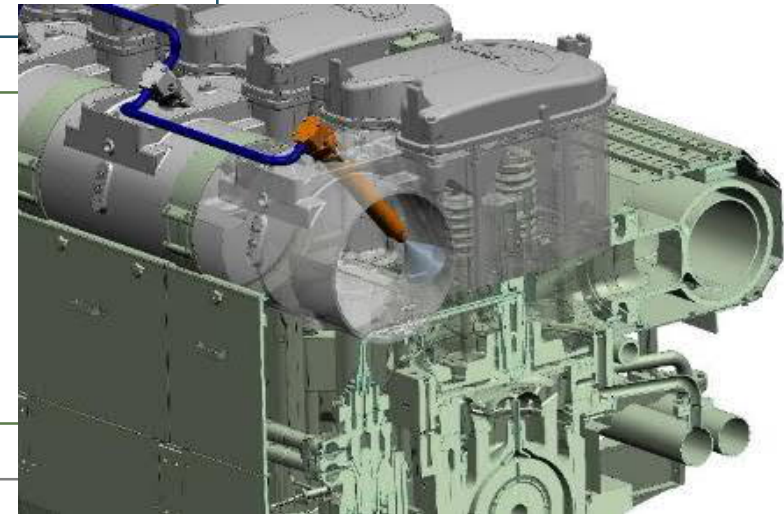
- Conventional or common-rail base engine with retrofit
- 100% MCR to be maintained in diesel mode

Retrofit package to the engine

- Methanol **Port-Fuel-Injection** system integrated into the intake manifold
- Methanol fuel train to the engine
- Design changes on engine to accommodate FIE equipment
- Engine automation, combustion control and safety system
- Methanol engine safety system (draining, purging, double walled pipes)
- Type Approval Test in cooperation with classification society

Plant requirements

- Methanol supply @ 10bar and appropriate flow rate (m³/h)
- Exhaust aftertreatment depending on classification requirements
- Plant safety concept ← close cooperation with classification society

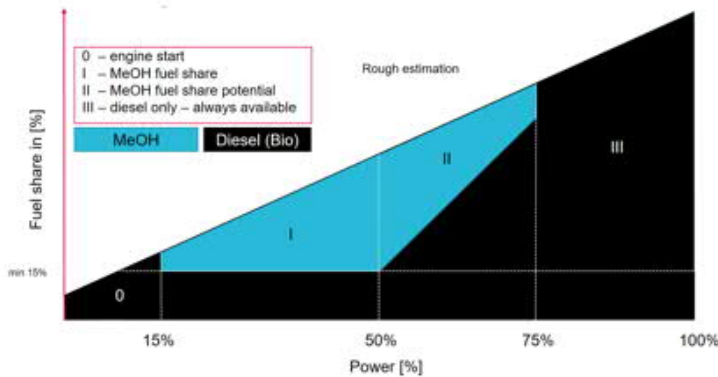


Methanol PFI – power and fuel sharing

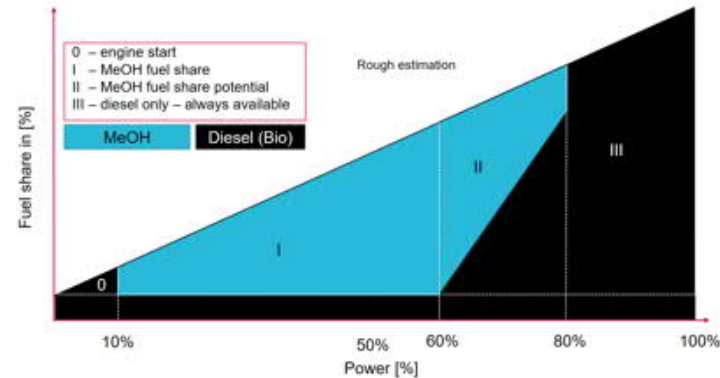
Technology & performance



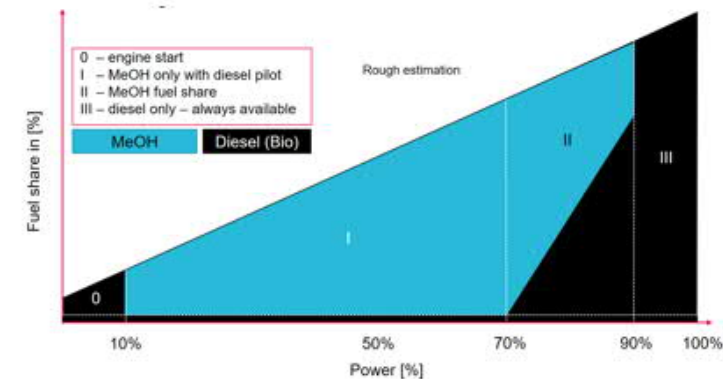
Conventional Diesel injection for ignition



CR1.6 Diesel injection for ignition



Dual Fuel pilot injection for ignition



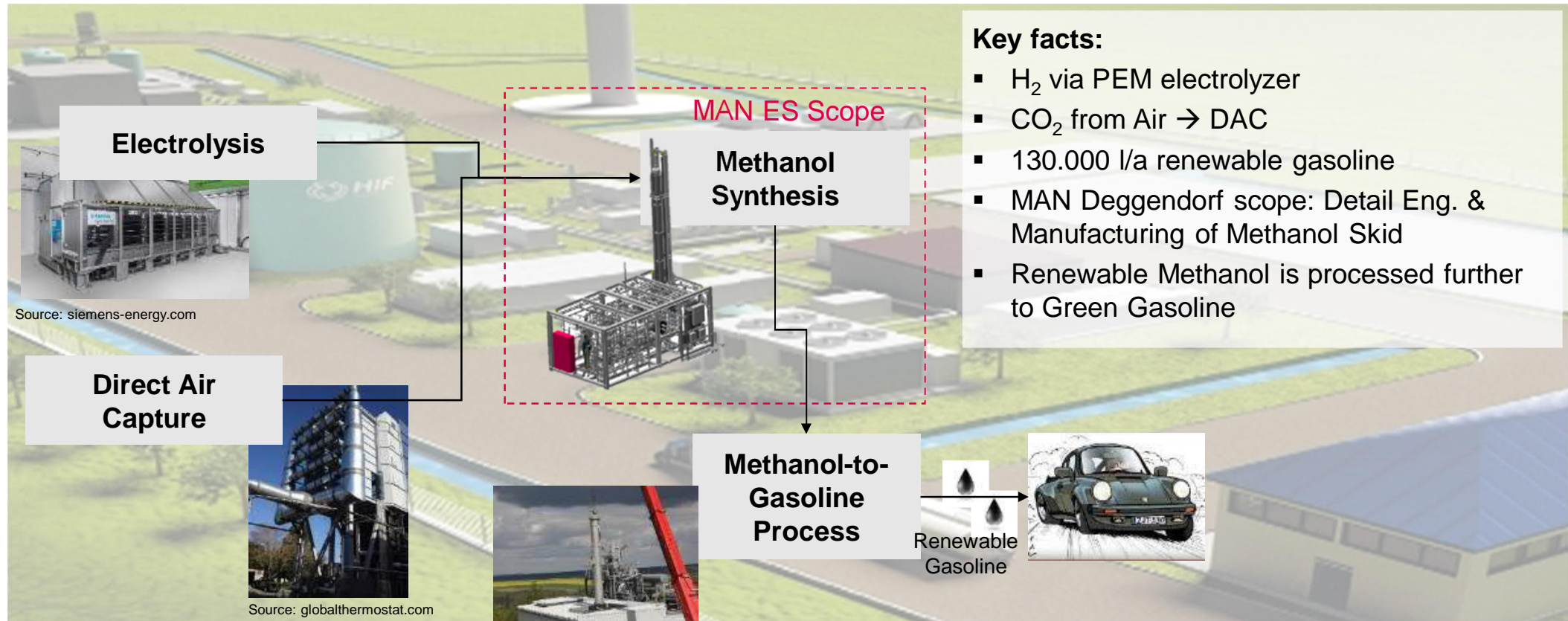
Dual Fuel Pilot injector enables larger MeOH operating map. 100% Diesel capability in all cases.

Indication, non binding

Green Methanol Production – MAN Reference Project



Haru Oni (Chile), Phase 0 – Demonstration plant renewable Methanol & Gasoline (Porsche / HIF)



Construction, Commissioning & Operation planned starting in Q1/2022

Summary



Some truths and what to expect...

- All fuels have respective dis-/advantages → there will be a fuel mix in shipping based on segment and region
- Fuels/Opex will become more expensive - through emission regulation/penalties or „green“ production. Think about how to pass on costs contractually (e.h. hedging, carbon contracts for difference)!
- **Technology will not be the bottleneck**, bunker supply and availability will be (competing sectors!)
- Consistent regulation (regional vs. global, intra-EU, polluter pays principle) will change dynamics/incentives and needs to be watched
- Bunker frequency will likely increase (due to energy density and storage loss avoidance) and operations will change (toxicity). Crews need to be upskilled (and paid accordingly).
- New rules for access to capital and financing as well as insurance.
- Fossil fuels will be phased out only slowly via blending in of bio and syn fuels
- *Open items: green fuel production ramp up, IGF code guidelines, port bunkering approvals and infrastructure, certification of green fuels („guarantees of origin“), safety standards, crew training, acceptance by society*

MAN Energy Solutions
Future in the making



Thank you.

alexander.feindt@man-es.com

