Biofuels in the Transition of Maersk

Can we use biomass and which biofuels should we produce?

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TC Biomass, Denver, 19-21 April 2022

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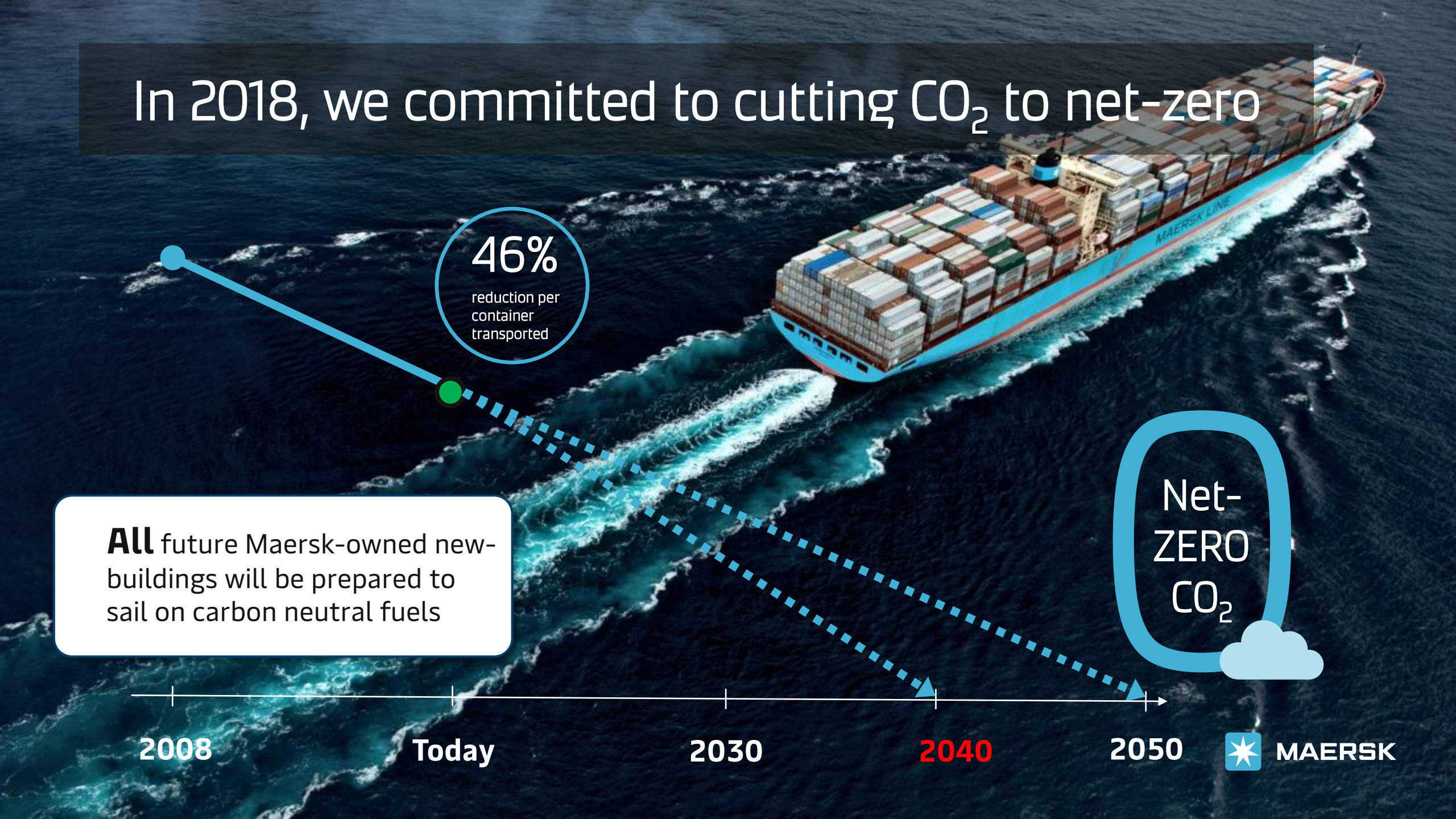
In 2018, we committed to cutting CO_2 to net-zero



The climate challenge in shipping is huge

- The maritime sector consumes **300 million tonnes of fuel oil per year**, and emits **3%** of global GHG emissions.
- Maersk's 700+ container ships consume **11 million tonnes of fuel oil per year** and emit **0.1%** of global GHG emissions
- But – the technologies and solutions are there, we just need to '**get going**'!

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Who can use the limited biomass???

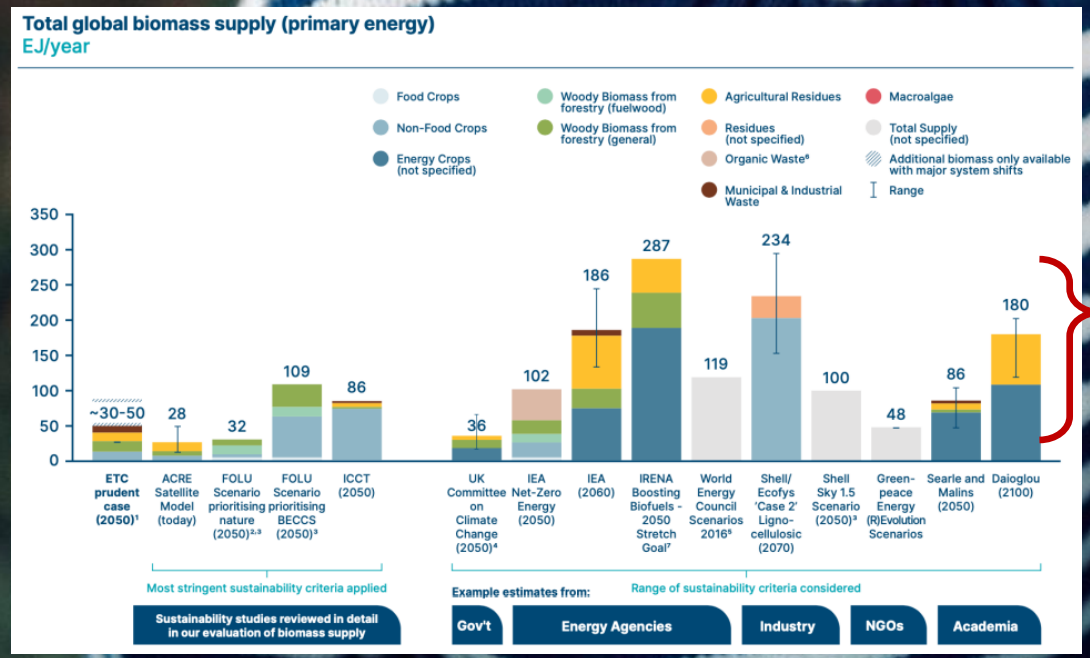
250 × Maersk energy consumption

≈

Total global biomass supply in 2050!

From Biofuture campaign: 28-287 EJ

Biofuture Platform All Member Group Web Meeting (ieabioenergyconference2021.org)



Average:
112 ±78 EJ

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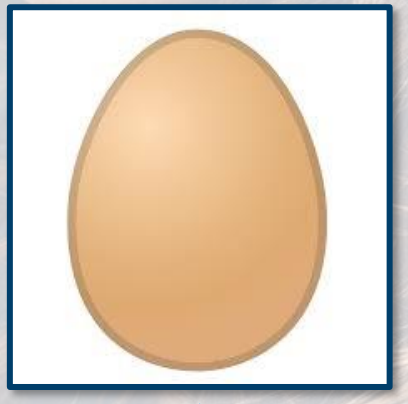
Chicken and egg dilemma:
- How to start a green transition?

Who will build a ship for fuels that are not available?

?



Who wants to produce green fuels with no offtakers?

!

!

[Maersk Orders 12 Methanol-Powered Container Ships With Fuel-Saving Design] (needs 500,000 tpa methanol)

[Maersk secures green e-methanol for the world's first container vessel operating on carbon neutral fuel]

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Maersk engages in strategic partnerships to scale green methanol production by 2025

E-methanol

Bio-methanol

Strategic Partners	Type of fuel	Geography
CIMC ENRIC	bio-methanol	China
European Energy	e-methanol	North & South America
GTB	bio-methanol	China
Orsted	e-methanol	North America
Proman	bio & e-methanol	North America
WasteFuel	bio-methano	South America

A.P. Moller - Maersk engages in strategic partnerships across the globe to scale green methanol production by 2025 | Press Release | News

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Potential 1-molecule fuels

Technology/fuel	Learnings sofar…	Doable?
1. G ethanol	Food vs. Fuel issue.	No
2. G ethanol	Tech. has improved, but market price will remain high, depends of road-electr.	Perhaps
Higher alcohols	Potential solution from e-fuel-process by Prometheus Fuels	Perhaps
Bio-methanol	Relatively mature (biogas & gasification), best overall feasibility profile	Yes, med.-term
E-methanol	Depends on carbon capture (DAC, point-source) and renewable power	Yes, long-term
Bio-methane (gas)	Most likely not scalable, slip issues (production & use)	No
E-methane (gas)	Slip issues (use), high energy-loss in production vs. e-methanol	No
DME (gas)	Potential use as pilot-fuel for methanol or as single-fuel	Joker
Hydrogen (gas)	Potentially for short distance shipping	Joker
E-ammonia (gas)	Uncertainty on safety issues, cheapest e-fuel, regional regulatory differences	Perhaps

new fuel + new ship

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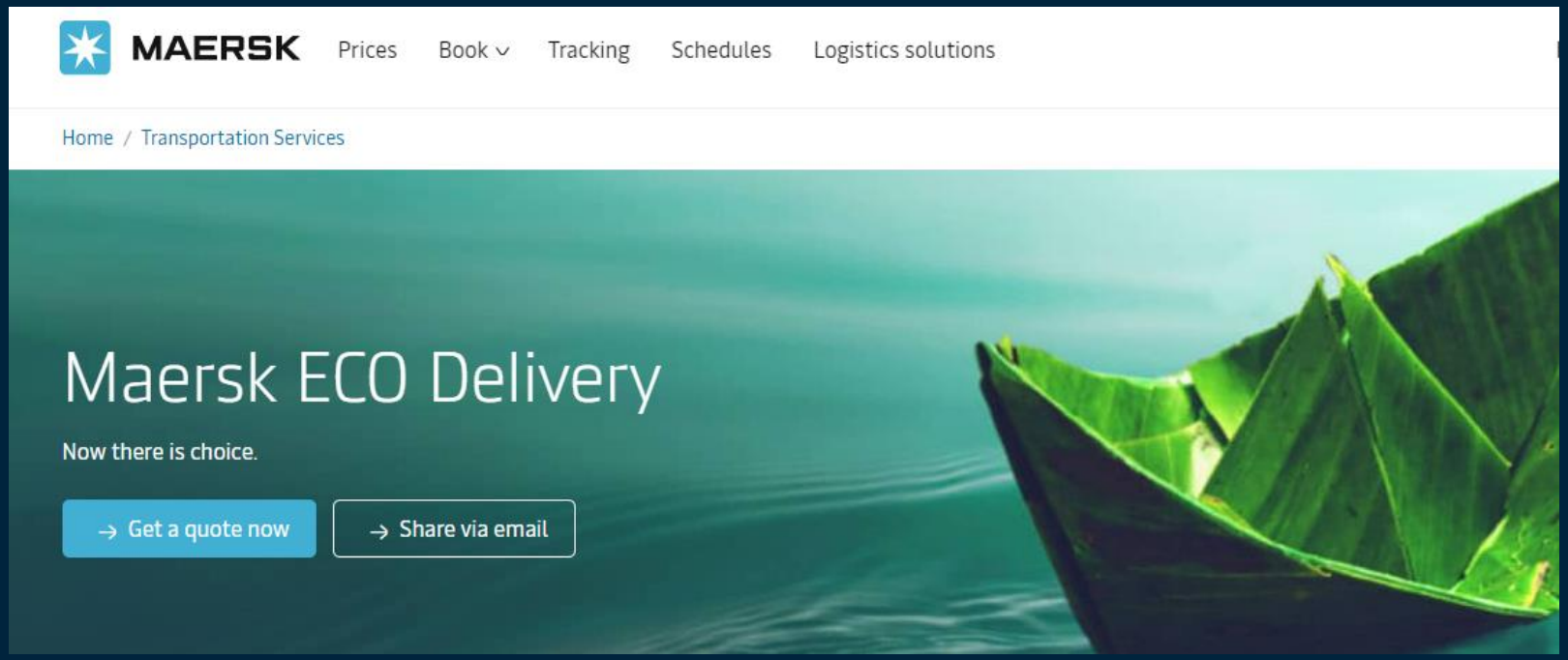
Potential drop-in bio-fuels

Fuel	Learnings sofar…	Doable?
Biodiesel (FAME)	Feedstock limitations, regulatory concerns	Short-term
Renewable diesel (HVO)	Feedstock limitations, regulatory concerns	Short-term



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Potential drop-in bio-fuels

Fuel	Learnings sofar…	Doable?
Biodiesel (FAME)	Feedstock limitations, regulatory concerns	Short-term
Renewable diesel (HVO)	Feedstock limitations, regulatory concerns	Short-term
Pyrolysis/HTL fuels	Promising: Cheap, 2. G feedstock, drop-in fuel but need for upgrading	Med.-term
Jet-bottoms	Promising: 'Leftover' from SAF, high quality, price uncertain	Med.-term
Fischer-Tropsch	Heavy end of Fischer-Tropsch might be blend-in quality	Perhaps
Alcohols-to-heavy oil	Promissing drop-in fuel if efficient conversion is developed ('alcohols-to-jet')	Perhaps
Lignin-alcohols	Promising if lignin value remains low: cheap, drop-in for MeOH in ICE	Joker

fuel blending + existing ships

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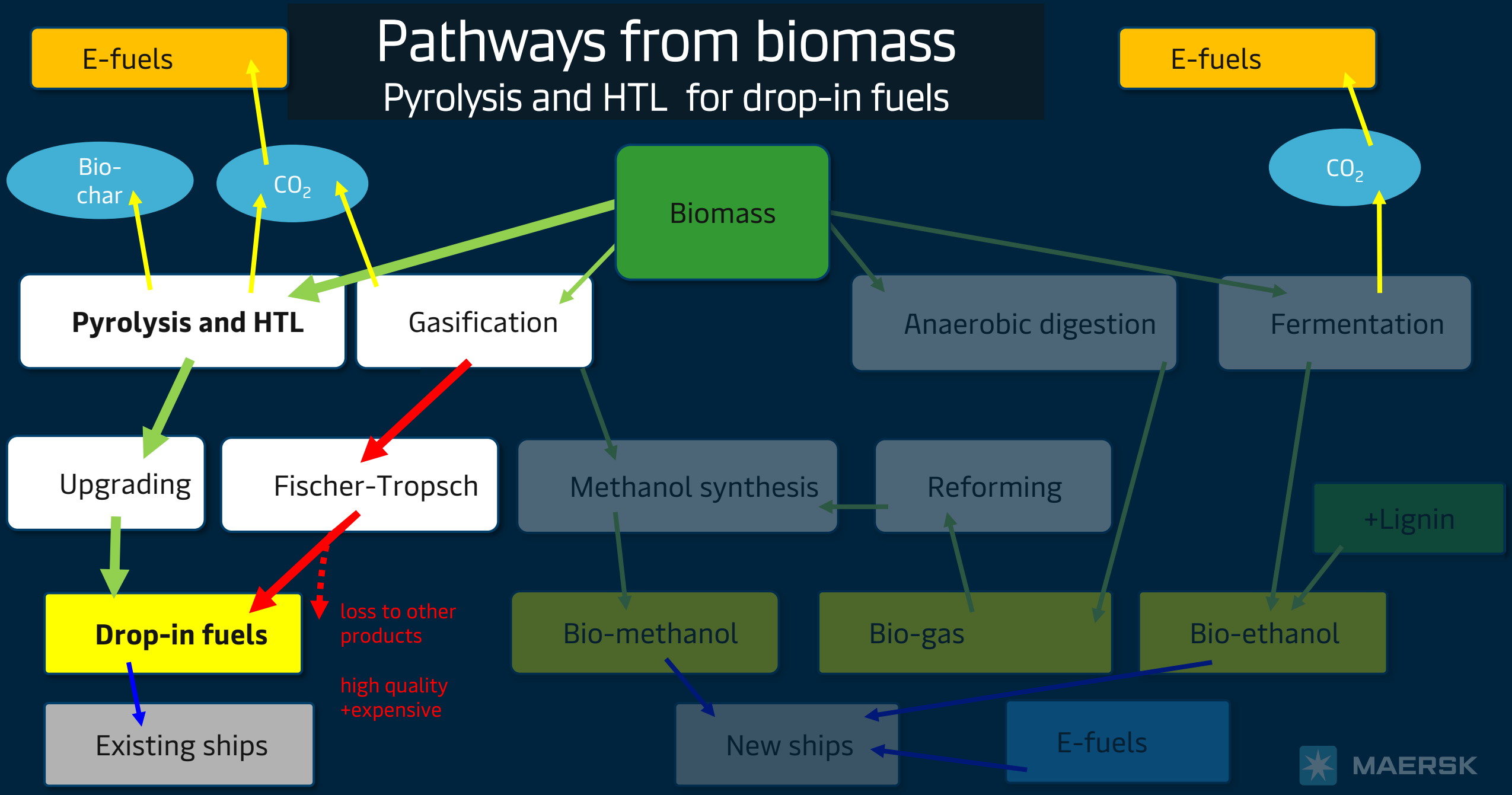
Pathways from biomass

Pyrolysis and HTL for drop-in fuels



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New drop-in fuel production

Pyrolysis is simple – but also very complex

pyrolysis

[pʌɪˈrɒlɪsɪs]

NOUN *chemistry*

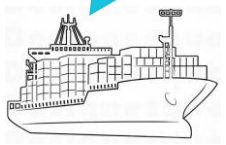
decomposition brought about by high temperatures.
"steam pyrolysis of hydrocarbons" · [more]

See more definition

Already being done

Use for heating oil

We believe this is possible



Use for marine fuels?

We believe this is difficult

Use for aviation fuels?

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Anything that burns...

- Possible to handle most fuels on a ship

HFO wikipedia

We are used to utilize poor quality oil!

- HFO: High viscosity, impurities, aromatics, acidity, ...

Few hard requirements for new drop-in fuels:

- Flash point: Above 60˚C
- Stability: At least 9 months storage
- Miscibility: Prefered fully miscible (or well-defined limitation).
- Pour point: Below 30°C

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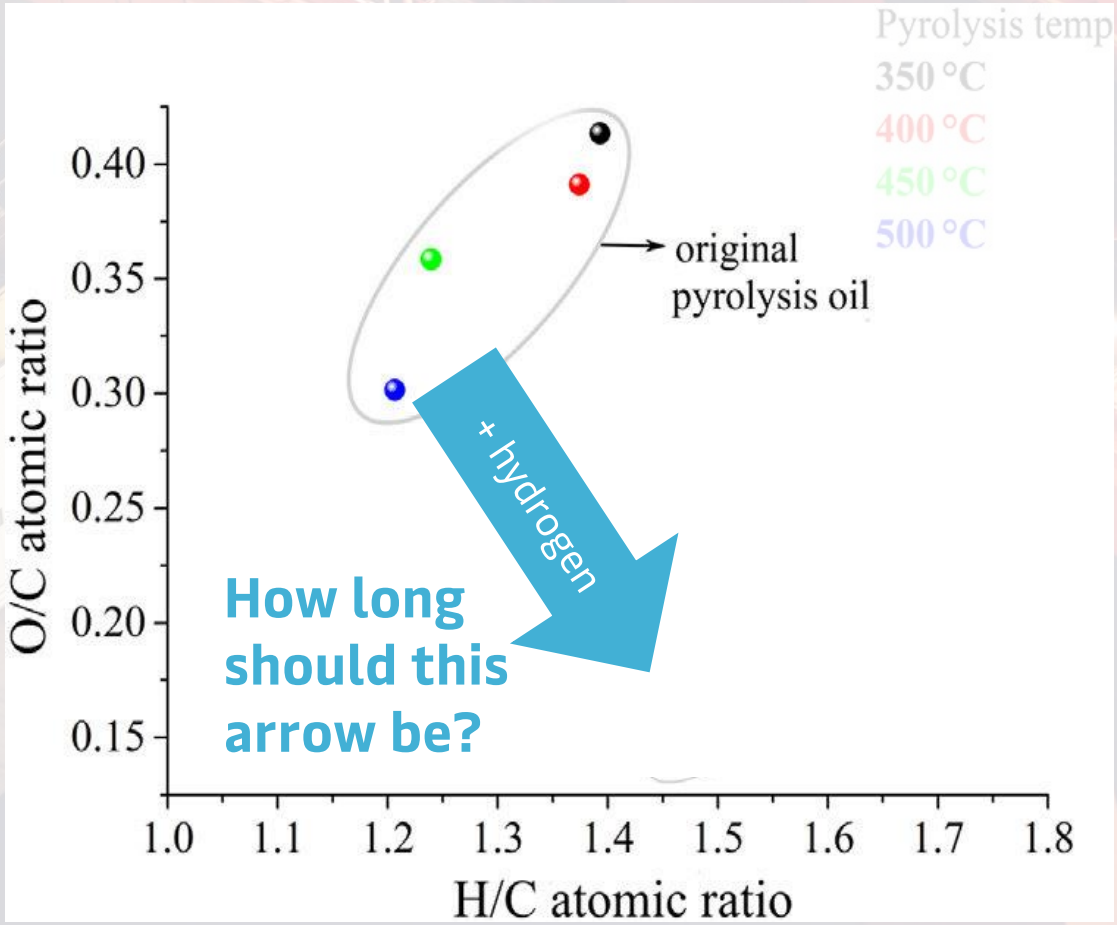
Why upgrading with hydrogen?

Pros and cons

- ÷ More hydrogen → more cost
- ÷ Hydrotreating of these oils is technically difficult!
- ÷ Low catalyst lifetime (?)
- ✓ More hydrogen → higher quality (or at all useable)
- ✓ More hydrogen → more energy per CO_2 emitted



Boscagli et al, 2019: 'Influence of feedstock, catalyst, pyrolysis and hydrotreatment temperatureon the composition of upgraded oils from intermediate pyrolysis'

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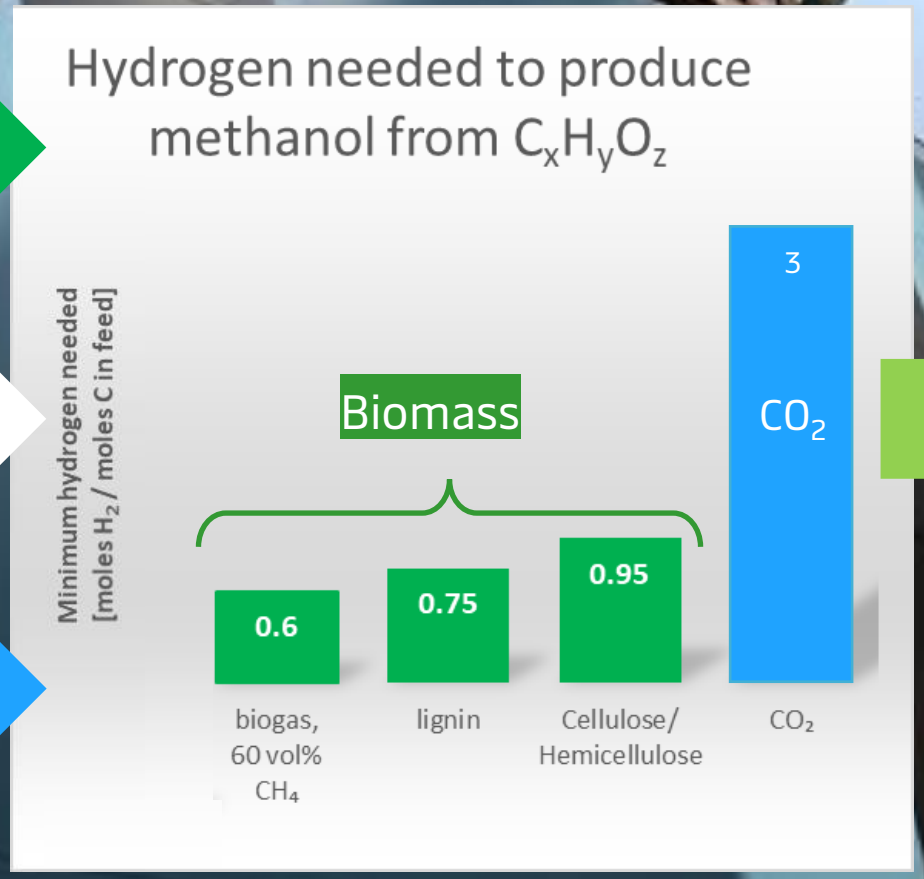
E-fuels or bio-fuels ?

Biomass

Hydrogen (/power)

Non-fossil CO_2



Green methanol

Bio-fuels
Pro : cheaper, low power consumption for hydrogen (> 4 times lower)
Con: needs biomass (!) + transporting this

Ammonia /hydrogen
Pro: no carbon in, no carbon out!
Con: Power consumption + safety + regulation + no solution ready (yet)

E-fuels
Pro: no biomass, can be simple process
Con: Biogenic CO_2 + power consumption

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Summary
- What are we looking for?

Maersk will need large amounts of green fuels

- If biomass is available and can be used – this is our preferred feedstock
- If this is not the case: e-fuels will be the long-term solution

We can use a number of biofuels

- For our new ships we can use methanol, ethanol, ligning/alcohols
- For the new ships we need green pilot fuels (~5 vol% of consumption)
- Fuels for blending into HFO are needed and might be produced from pyrolysis or hydrothermal liquifaction – most likely with an upgrade by mild hydrotreatment
- We are open to new possibilities

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Thank you!

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