Decarbonising Maersk - The role of bio-fuels

Jacob Hjerrild Zeuthen
Senior Future Fuels Manager, A.P. Moller – Maersk

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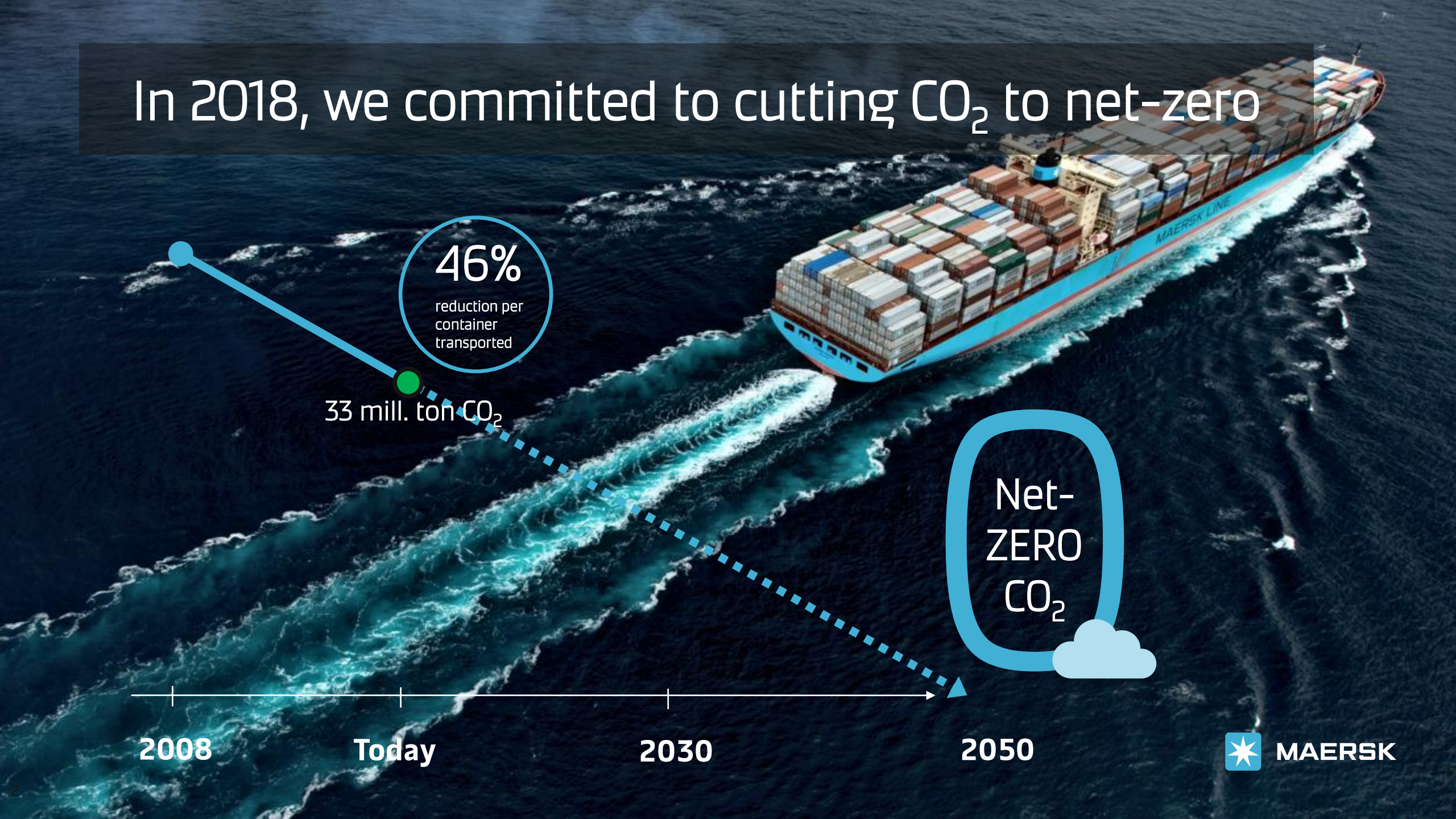
In 2018, we committed to cutting CO_2 to net-zero



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The climate challenge in shipping is huge

- The maritime sector consumes **300 mio. ton fuel oil/year**, and emits **3%** of global CO_2 emissions.
- Maersk's 700+ container ships consume **10 mio. ton fuel oil/year** and emit **0.1%** of global CO_2 emissions

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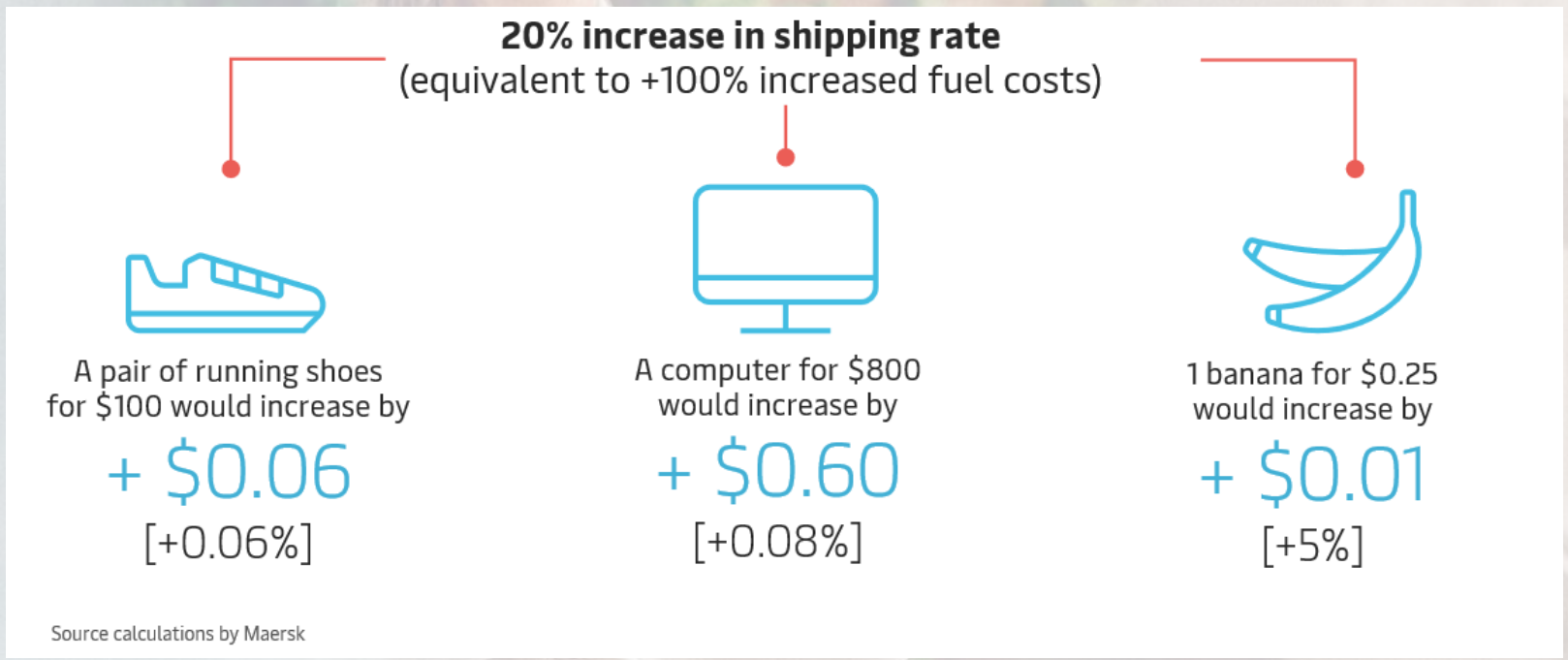
‘Facts’ to remember regarding the shipping sector and decarbonisation

- Shipping is (normally) a **low-margin business** → challenge to suddenly pay 2-3 times the fuel cost
- Fossil fuel purchase is based on **SPOT markets** → now we need to engage in long term offtake agreements
- **Used to run on the ‘residual oils’** of poor quality → This is an opportunity for us when we need to find green fuels

We depend on customers to value and pay for carbon-neutral transport and we believe they (continue to) do so



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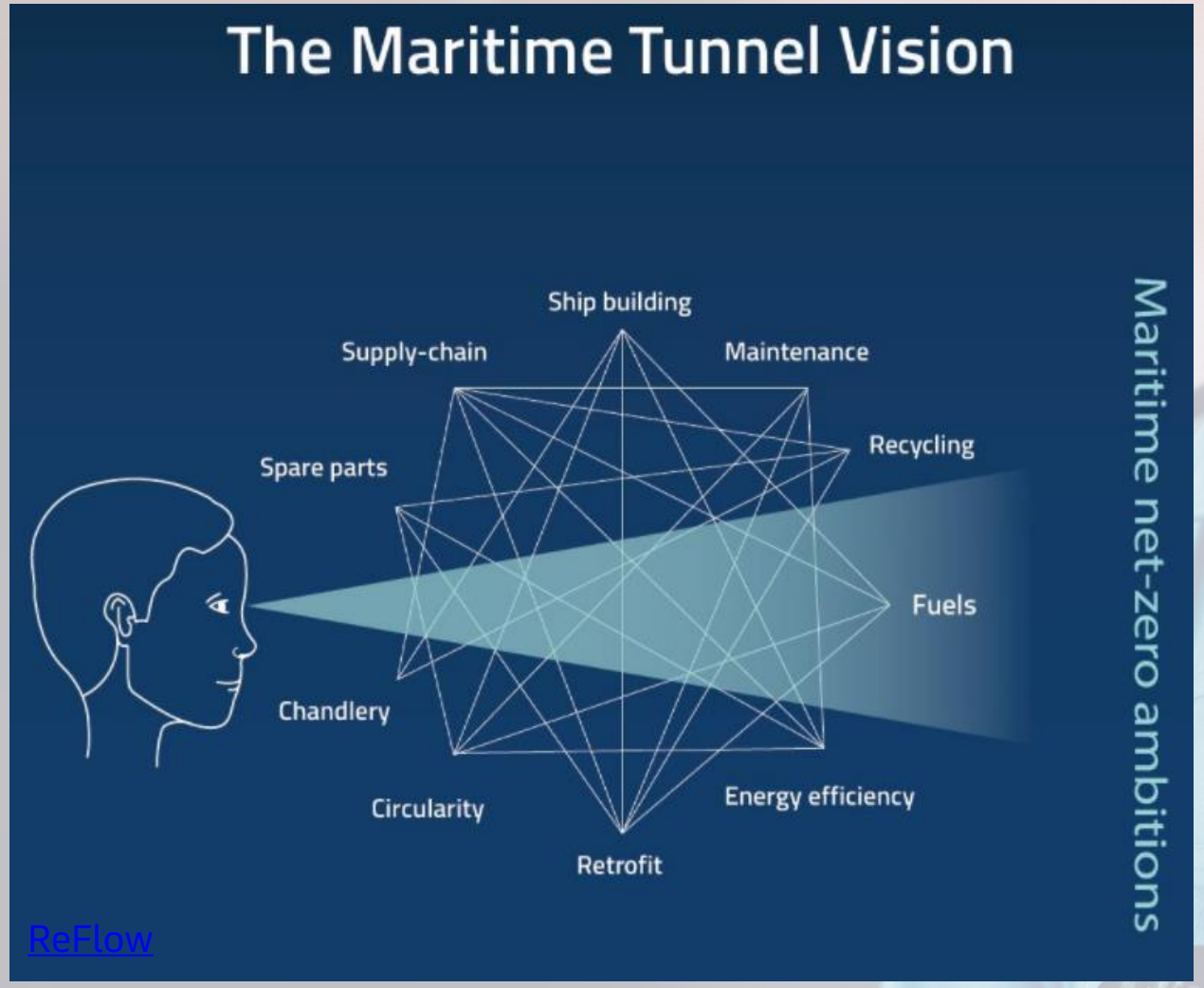
We need more than new fuels



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Potentiel technologies & drop-in fuel options

Technology	Learnings sofar…	Doable?
Battery	Viable for short-sea shipping, but not deep sea shipping	No
Hydrogen	Perhaps viable (ICE/FC) for short sea, not deep sea shipping due to storage iss.	No
Nuclear	No public acceptance + regulatory challenges	Monitoring
CC - onboard	Storage of CO_2 onboard an issue	Monitoring
Fuel Cells	Especially SOFC promising due to multi fuel & high efficiency	Yes, long-term

not only change of fuel

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

fuel blending + old ship

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Anything that burns...
- Possible to handle most fuels on a ship

1. Quality biofuels will be used for aviation etc
   - HVO from triglycerides is limited and cannot be scaled for shipping
2. We are used to utilize poor quality oil!
   - HFO: High viscosity, impurities, aromatics, acidity, ...
3. Few hard requirements for new drop-in fuels:
   - Flash point (above 60˚C)
   - Stability
   - Miscibility
   - ...

...?

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Potentiel 1-molecule fuel options for decarbonising shipping

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
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
DME (gas)	Potential use as pilot-fuel for methanol or as single-fuel	Joker
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
E-ammonia (gas)	Uncertainty on safety issues, cheapest e-fuel, regional regulatory differences	Perhaps

new fuel + new ship

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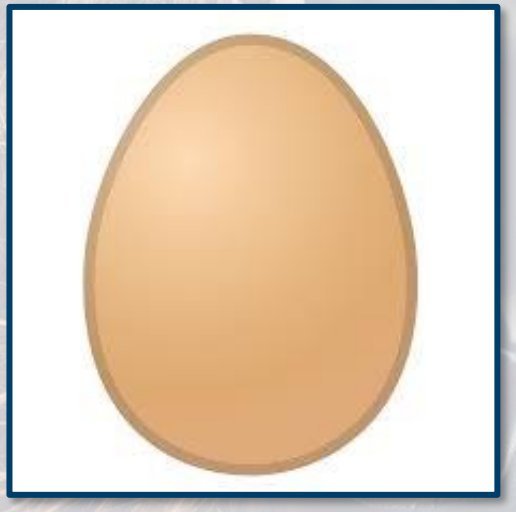
Chicken & egg dilemma
- an obstacle to urgent action

?



Who will BUILD A NEW TYPE OF SHIP if there is no fuel or fuel infrastructure?

Maersk accelerates fleet decarbonisation with 8 large ocean-going vessels to operate on carbon neutral methanol

Who will produce a GREEN FUEL if there are no customers for it?

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

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CO_2 is 'biomass with no energy'! → E-fuels need much more hydrogen than bio-fuels

To produce methanol an inputs of carbon and hydrogen are needed

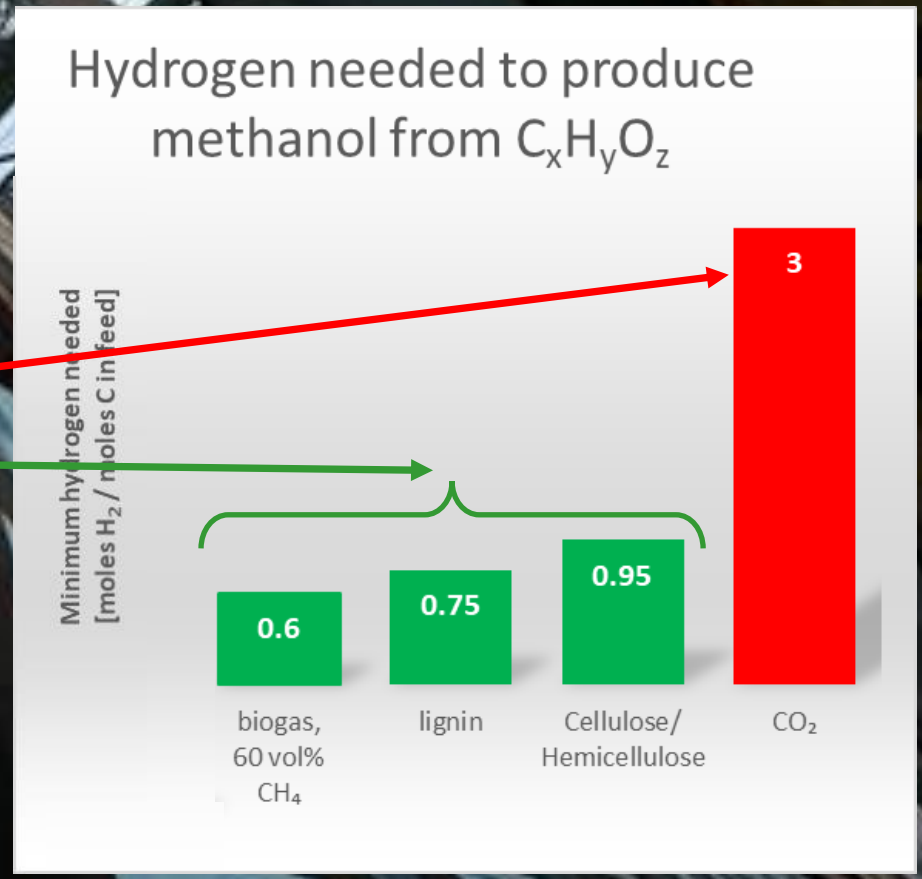
General formular for biomass can be written $C_xH_yO_z$

and can also be used to describe CO_2

The carbon source add much of the energy for the fuel in case of fossil sources, less for biomass and none for CO_2

For this reason much more green hydrogen is needed to produce e-methanol than bio-methanol

Example: 4 times more hydrogen to convert CO_2 than lignin!



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Who needs the limited biomass?

Current Opinion in Environmental Sustainability
Volume 2, Issues 5–6, December 2010, Pages 394-403

The global technical potential of bio-energy in 2050 considering sustainability constraints

Helmut Haberl [1] ✉, Tim Beringer [2], Sribas C Bhattacharya [3], Karl-Heinz Erb [1], Monique Hoogwijk [4]

Discussion and conclusions

Figure 2 summarizes the three components of the technical bio-energy potential in 2050 based on the values reported in Table 2, Table 3, Table 4. We find a technical global bio-energy potential in 2050 of approximately 210 (160–270) EJ/yr. Dedicated bio-energy crops contribute 81 (44–133) EJ/yr, which is at the lower end of the potentials found in previous assessments (Table 1), but higher than the potentials

200 × energy consumption by Maersk = all the 'bio-energy crops' in the world in 2050!

Maersk entirely on e-fuels (50% conv. Loss) → high need for renewable power: ~ 228 TWh → More than 6 × Denmarks power consumption today or ~ 50 GW offshore wind

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Thank you!

Jacob Hjerrild Zeuthen
Senior Future Fuels Manager,
A.P. Moller – Maersk
Jacob.Zeuthen@maersk.com

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