Assessing renewable fuels/energy carriers options

Innovation areas over time

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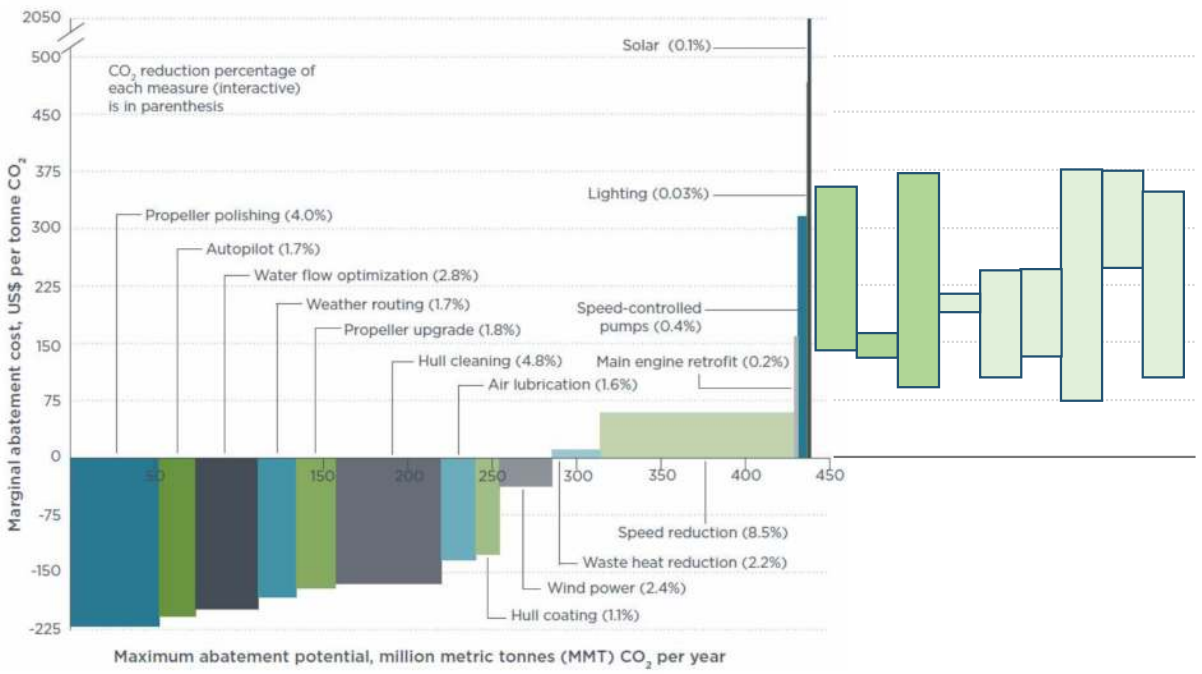
Carbon abatement options in shipping

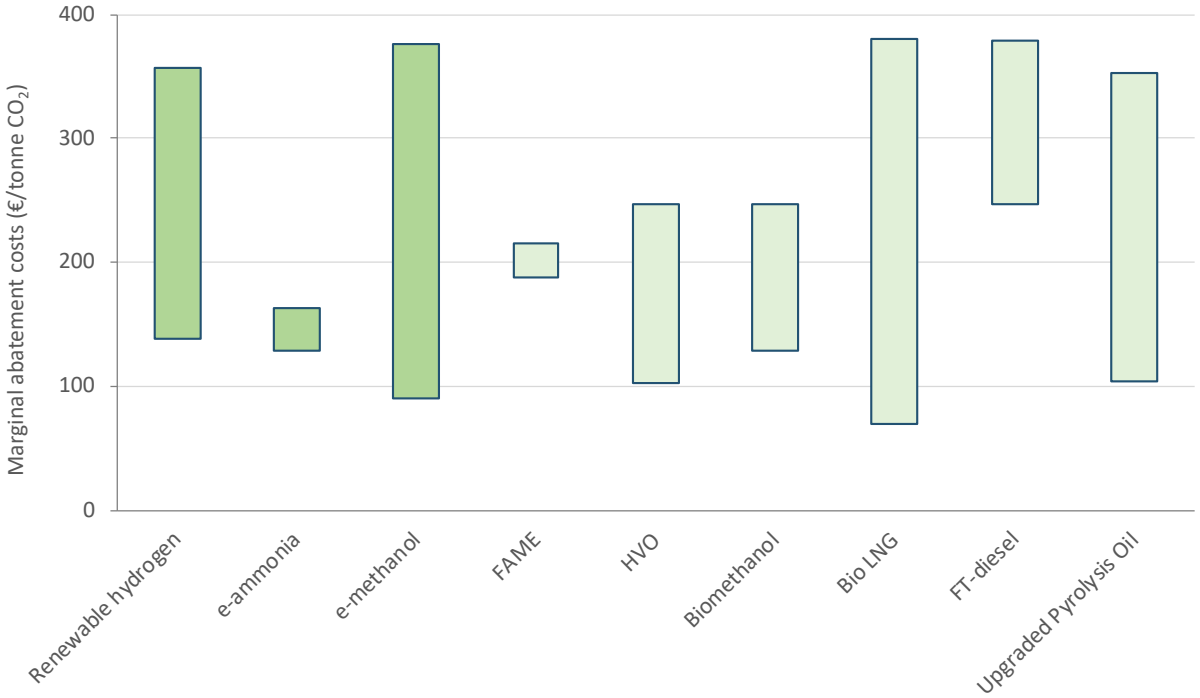
- IMO target: 50% less greenhouse gas emissions in 2050 compared to 2005
- Demand for shipping increases
- If demand would stay same, efficiency measures can achieve 33%
- Renewable fuels should deliver remaining 17%
- Abatement costs range from 150 to 500 euro/ton CO_2
- Range is uncertain, assumptions differ per fuel
- Costs can be lowered through innovation, learning, scale-up and competition



Efficiency measures can achieve 33%

Renewable fuels should deliver remaining 17% or at least 230 Mtonne CO_2 (equals at least 70-120 Mtonne renewable fuels)

Renewable shipping fuels CO_2 abatement costs

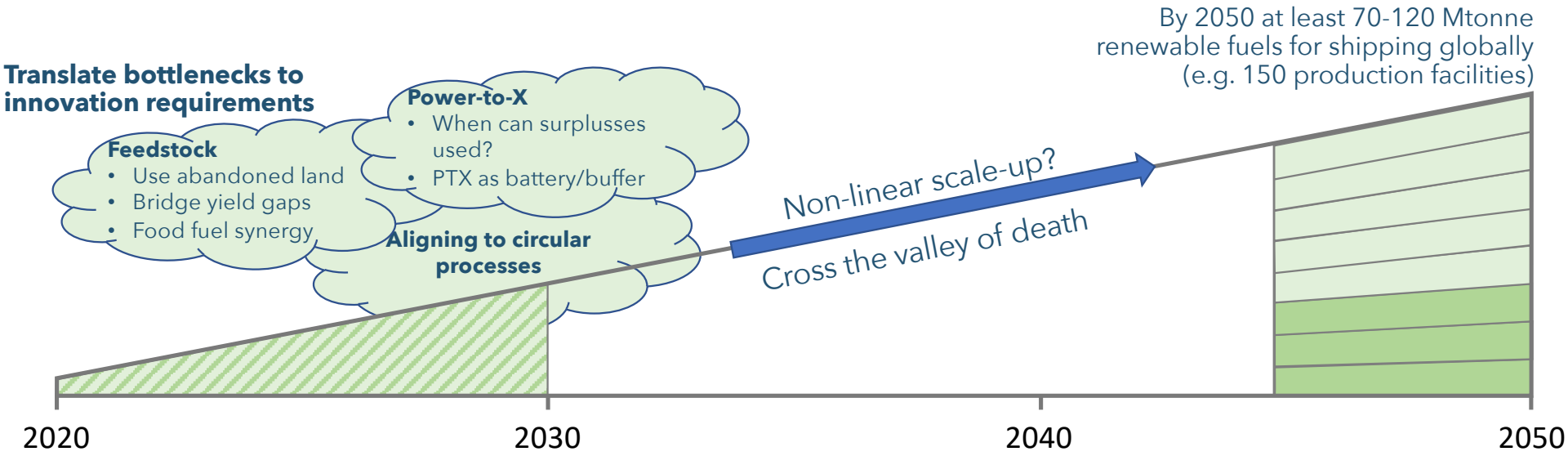


Data sources and analysis

- Mix of cost and price information
- Hydrogen [Hydrogen council 2020 Path to hydrogen competitiveness A cost perspective, EC 2020 State of the Art on Alternative Fuels Transport Systems in the European Union]
- Ammonia [ISPT 2017 Power to Ammonia]
- e-methanol [Bos Kersten Brilman 2019 Wind power to methanol: Renewable methanol production using electricity, electrolysis of water and CO2 air capture]
- All biofuels [E4tech 2018 Master plan for CO2 reduction in the Dutch Shipping sector]
- Costs of renewable fuels compared to fossil HVO
- Assumed average CO2 emission reduction of 80%

- Underlying data is mix of current and projected, small and large scale, production cost and sales price → limited comparability !
- Lower ranges can be achieved by (1) scale, (2) learning, (3) competition

Roadmap renewable fuels for shipping



Innovate and Demonstrate

- Feedstock production
- Conversion pathways
- Distribution
- Fleets and engines
- Transparency and trust
- Policy instruments

Invest in scale-up production and supply

- Mobilize renewable power surplus
- Develop renewable biomass plantations
- Global alignment and roll-out
- How to fund?

Scale-up demand

- Align IMO and national targets

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