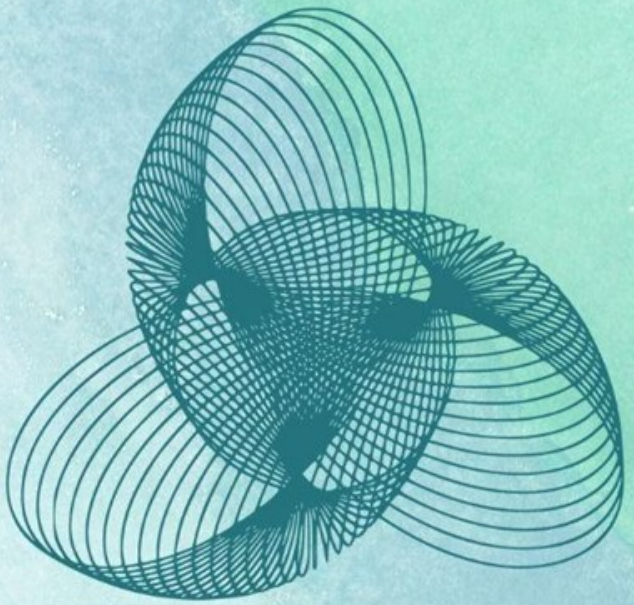

SEANERGY

the Sustainability EducationAl programme for greeNER fuels and enerGY on ports

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Module #3: Technologies and Techniques for Energy Transition – Part 2

Course coordinator(s):

Talha Isik

Name of the organization, country:

Argo-Anleg, Germany

Email: t.isik@argo-anleg.de

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Introduction

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Part1

- Global CO2 emissions of shipping
- IMO (International Maritime Organisation) Targets
- Actual ship and port technologies

Part2

- Comparison of Alternative Energy Carriers for Ships
- Forecast of Future Technologies
- The Role of Ports

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Alternative Energy Carrier

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- Electrification - Batteries
- LNG – Liquefied Natural Gas
- LPG – Liquefied Petroluem Gas
- Methanol
- DME – Dimethylether
- Ammonia
- Gaseous Hydrogen
- Liquid Hydrogen
- Biofuels
- Carbon Capture

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https://www.royalihc.com/dredging/dredging-innovations/fuels-and-transition-zero-emission-vessels

Alternative Energy Carrier

- Electrification - Batteries
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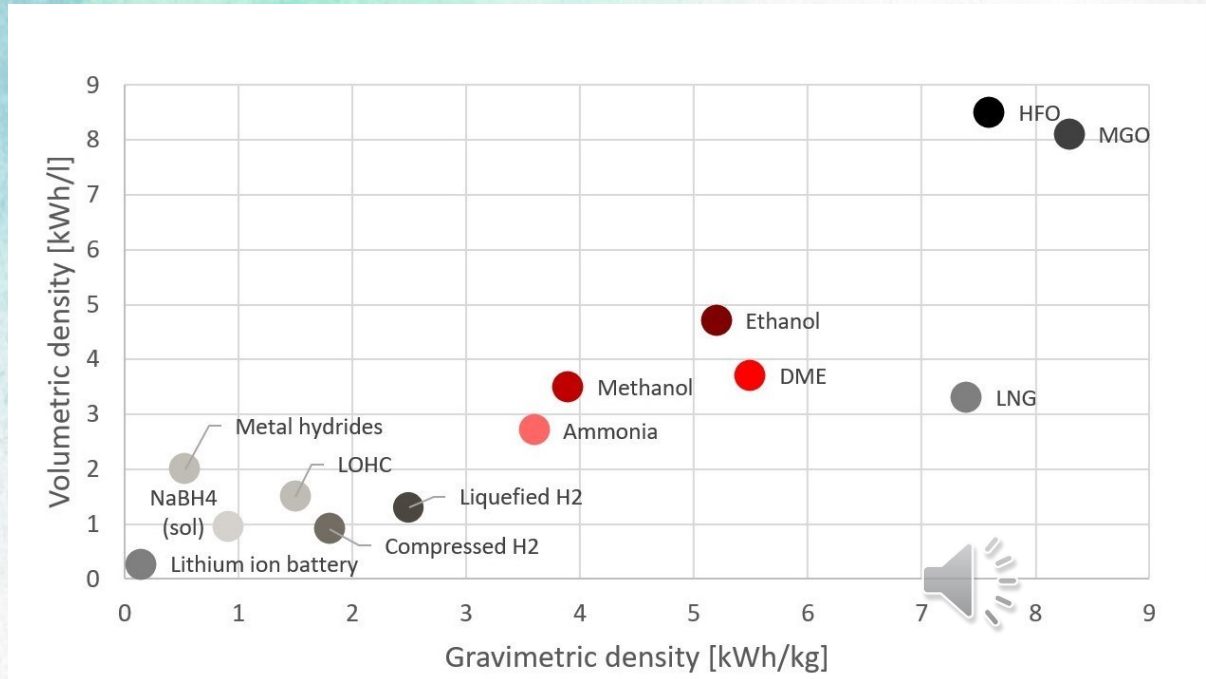

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https://www.royalihc.com/dredging/dredging-innovations/fuels-and-transition-zero-emission-vessels

Batteries

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Advantages

- Highest efficiency

- Ongoing development for better batteries
- Changing of battery possible

Disadvantages

- High weight
- Less energy density

- Strong limited usage possibility:
  Only applicable for short ranges with multiple loading opportunity

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LNG – Liquefied Natural Gas

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Advantages

- 20–30% less CO2
- 15-25% less total GHG
- 90% less NOx
- 99% less SOx

- Infrastructure available
- Ready technology

Disadvantages

- Cooling down to -161°C
- Cannot comply with 50% CO2 reduction
- Methan slipping (leakage) 25 x worse than CO2

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LPG – Liquefied Petroleum Gas

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Advantages

- 20% less CO2
- 20% less NOx
- 97% less SOx

- Cheaper than LNG
- Simple technology

Disadvantages

- Higher CO2 Emissions than LNG

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Methanol

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Advantages

- 99% CO2 reduction
- Simple to implement in existing engines
- Ready Overall technology
- Actual starting projects

Disadvantages

- High Energy Lost
- More Expensive to LNG

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DME - Dimethylether

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Advantages

- Up to 95% CO2 reduction
- Nearly no GHG emissions
- Simple to store
  - Low pressure
  - Atmospheric Temperature
- Not toxic
- Higher energy density than other renewable fuels

Disadvantages

- No Infrastructure
- Actually not used as alternative fuel

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Ammonia

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Advantages

- No CO2 emission
- Best green overall Energy efficiency
- Experience with storage and transport

Disadvantages

- Toxic and high environmental impact when leaked
- N2O generation (300 x worse than CO2)

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Gaseous Hydrogen

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Advantages

- No CO2 emission
- Experience with storage and transport
- Higher TTW Efficiency with Fuel Cell

Disadvantages

- Lower energy density
  - More Tank Volume needed
- Expensive
- No Infrastructure but technically possible

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Liquid Hydrogen

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Advantages

- No CO2 emission
- Experience with storage and transport
- Higher TTW Efficiency with Fuel Cell

Disadvantages

- Lower energy density
  - More Tank Volume needed
- Expensive
- No infrastructure
- Cooling to -252°C

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Comparison of Fuel Technologies

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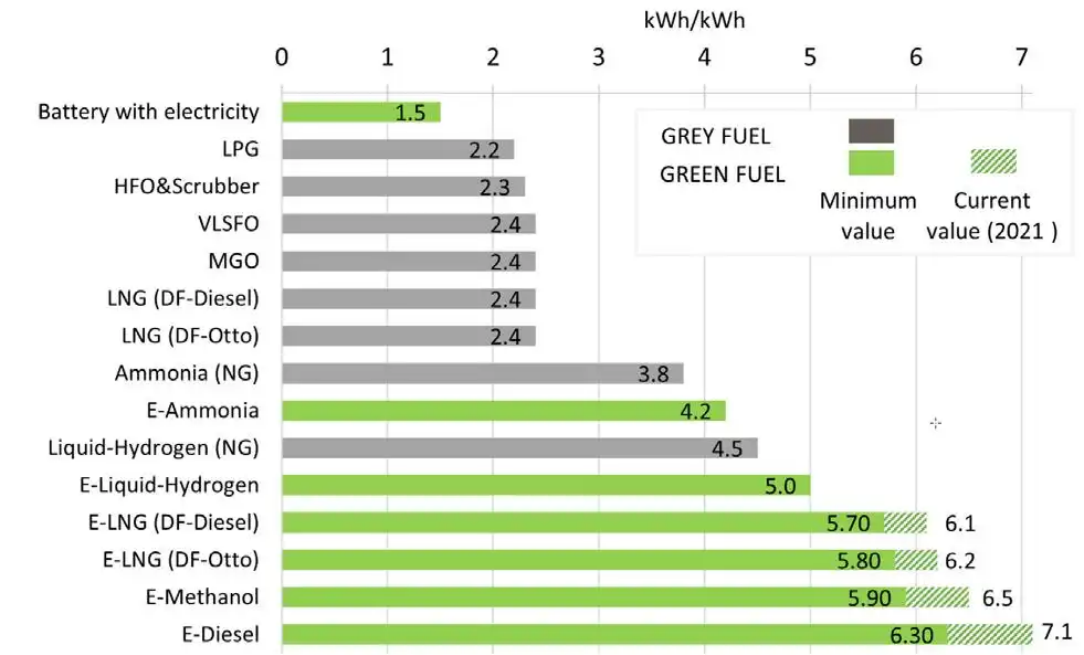
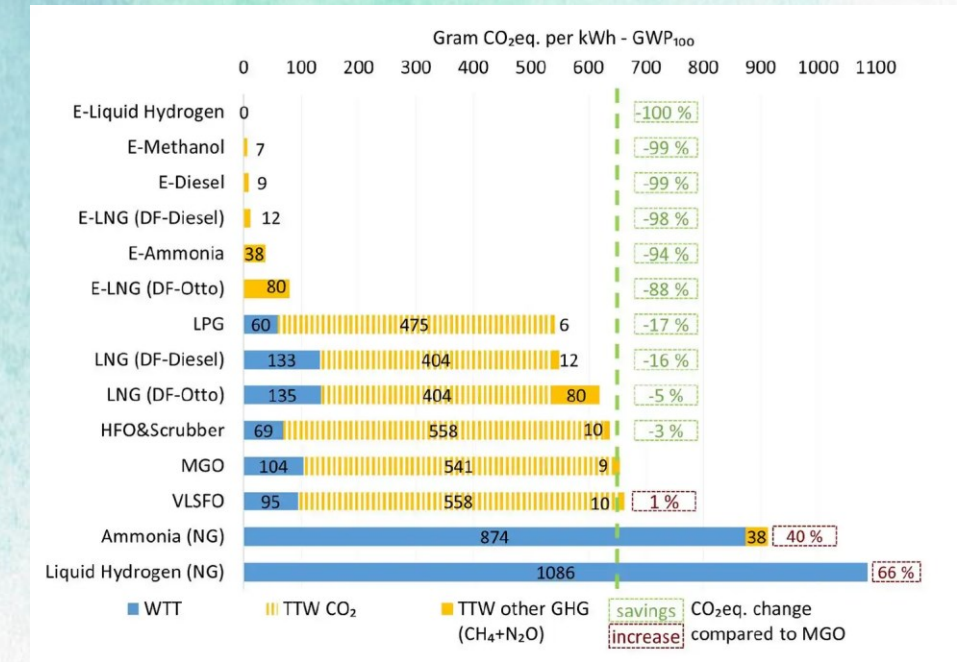
Well-to-Wake (WTW) Energy consumption



WTT (Well-to-Tank) – TTW (Tank-to-Wake) CO2 Emissions



https://issuu.com/tomkleppesto/docs/energy_transition_in_shipping_130622/s/16082052

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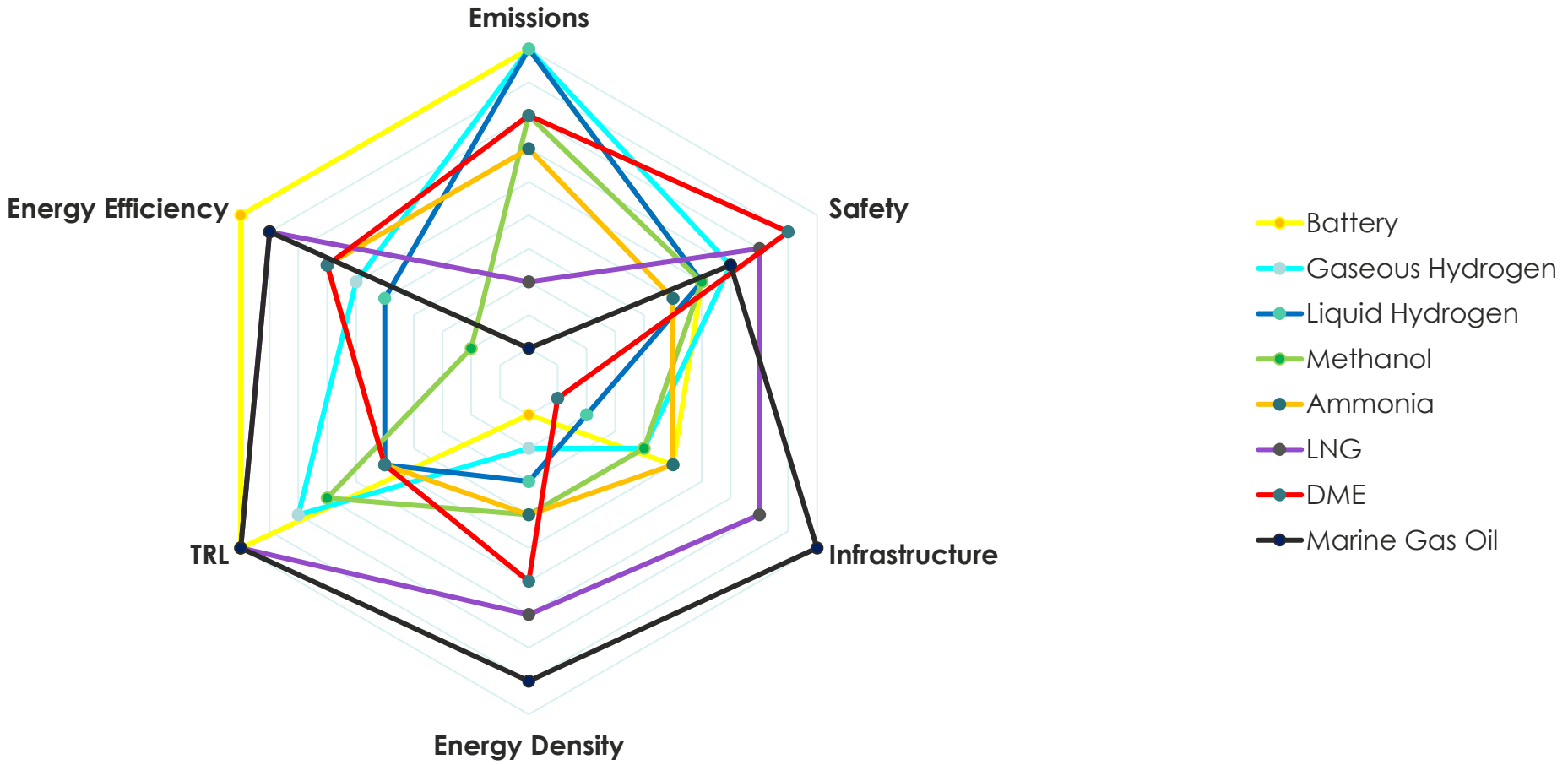
Comparison of Fuel Technologies



https://www.lr.org/en/expertise/maritime-energy-transition/maritime-decarbonisation-hub/zcfm/

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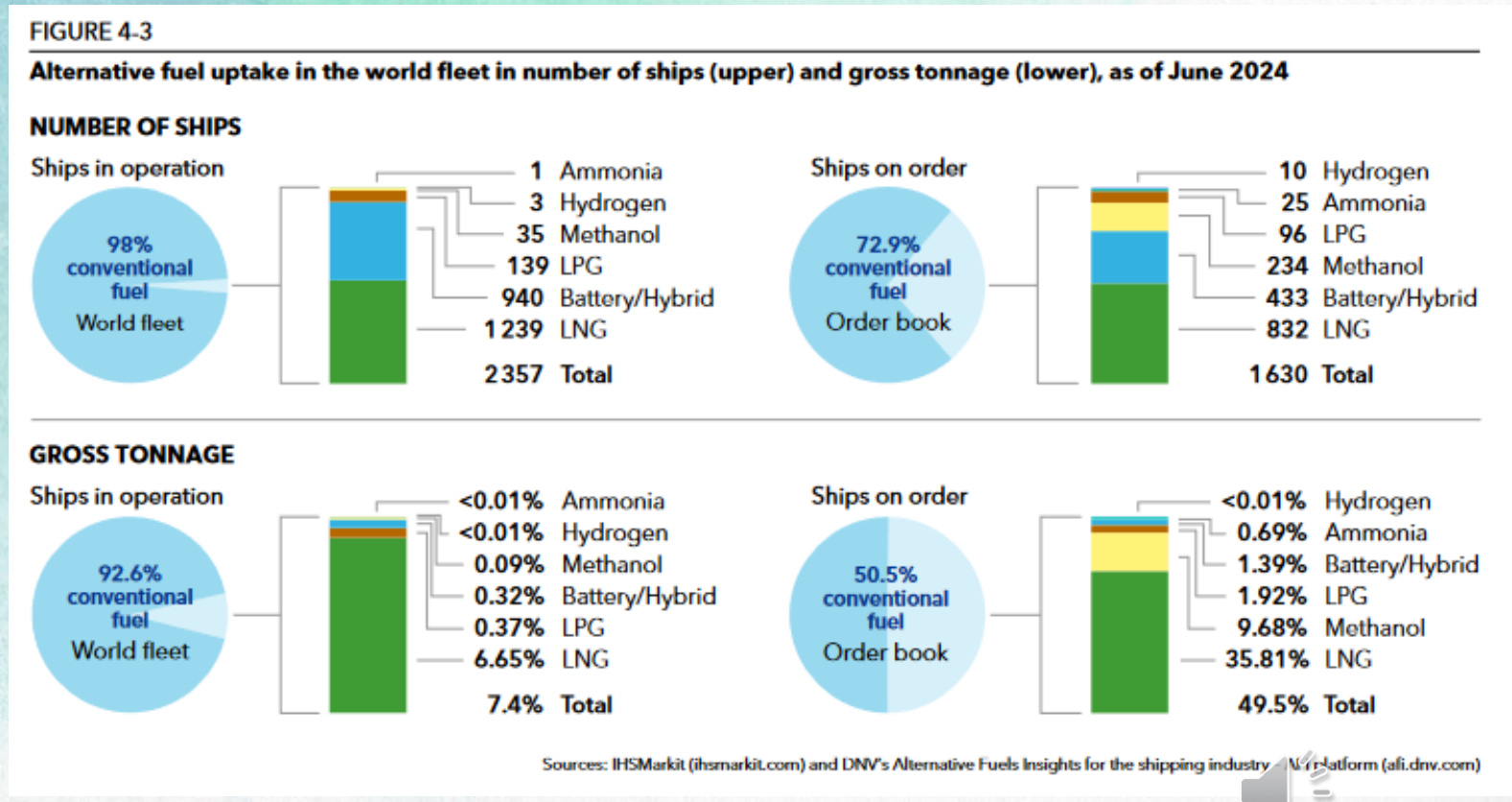
Actual Ordered Alternativ Fuel Ships

- ~27% of new ships have alternative Fuels
- New Ships can run on dual fuel (alternative and conventional)
- Focus on LNG and Methanol for heavy ships



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Scenarios for Alternative Shipping Fuels

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FIGURE 8-1
Bio and fossil fuels with CCS scenario - fuel use in shipping by energy
Units: Million tonnes of oil equivalent (Mtoe)

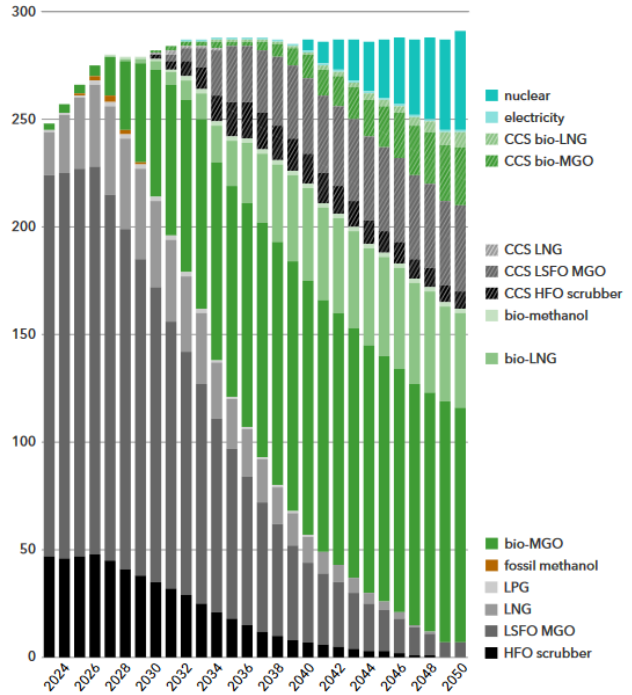


FIGURE 8-2
Methanol scenario - fuel use in shipping by energy
Units: Million tonnes of oil equivalent (Mtoe)

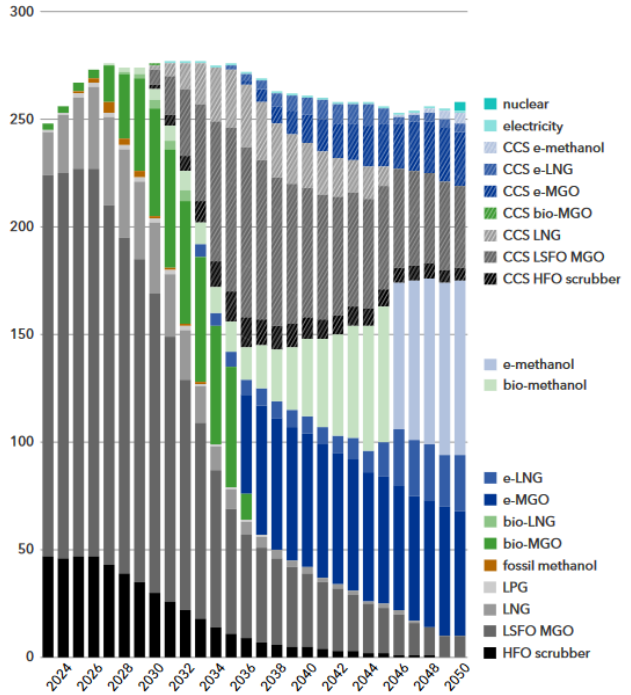


FIGURE 8-3
Ammonia scenario - fuel use in shipping by energy
Units: Million tonnes of oil equivalent (Mtoe)

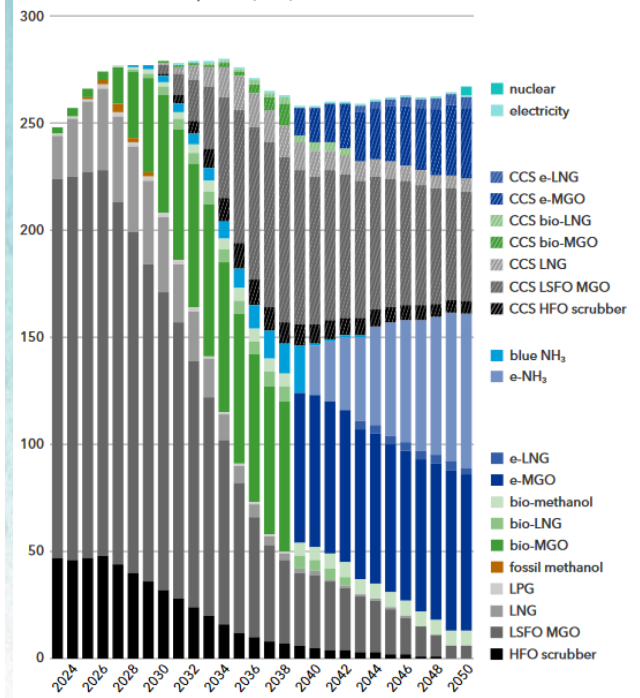
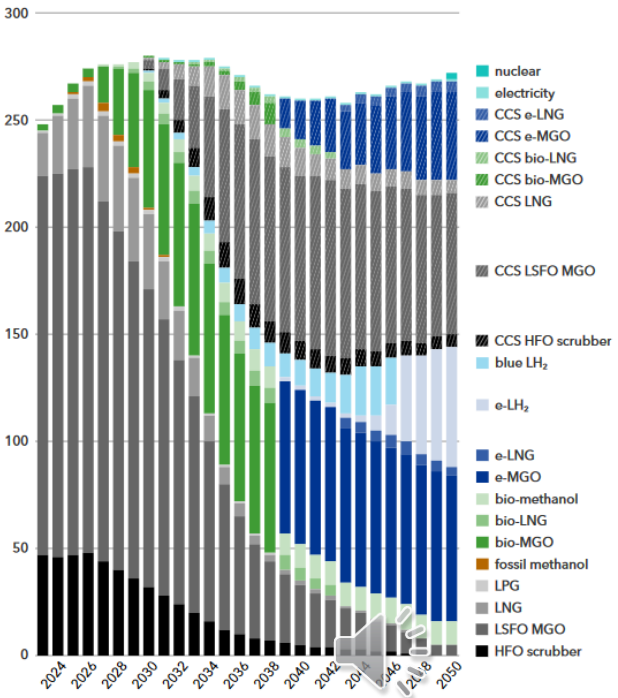


FIGURE 8-4
Hydrogen scenario - fuel use in shipping by energy
Units: Million tonnes of oil equivalent (Mtoe)



DNV, Energy Transition Outlook 2024, MARITIME FORECAST TO 2050

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Port as Fuel Infrastructure

Steam Cranes Queens Wharf 1866 - SLV

Coal loading in Newcastle 1800-1900

https://hunterlivinghistories.com/2022/04/07/coal-loading-newcastle/

https://www.rotterdammaritimecapital.com/ecosystem/energy-industry

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Port as Renewable Energy Hub

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- Electrification of Ports
  - Shore Power
  - Port Logistics (Crane, Forklifts, Trucks)
  - Integration and optimisation of onshore electrical grid

- Integration of Renewable Energy
  - Solar Power (Roofs, Floating)
  - Offshore Wind Power
  - Tidal and Wave Energy
  - Hydrogen Hubs (Import, Production and Distribution)

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Hydrogen Port of Rotterdam

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https://www.portofrotterdam.com/de/nachrichten-und-pressemitteilungen/2025-mehrere-terminals-in-rotterdam-bereit-fuer-den

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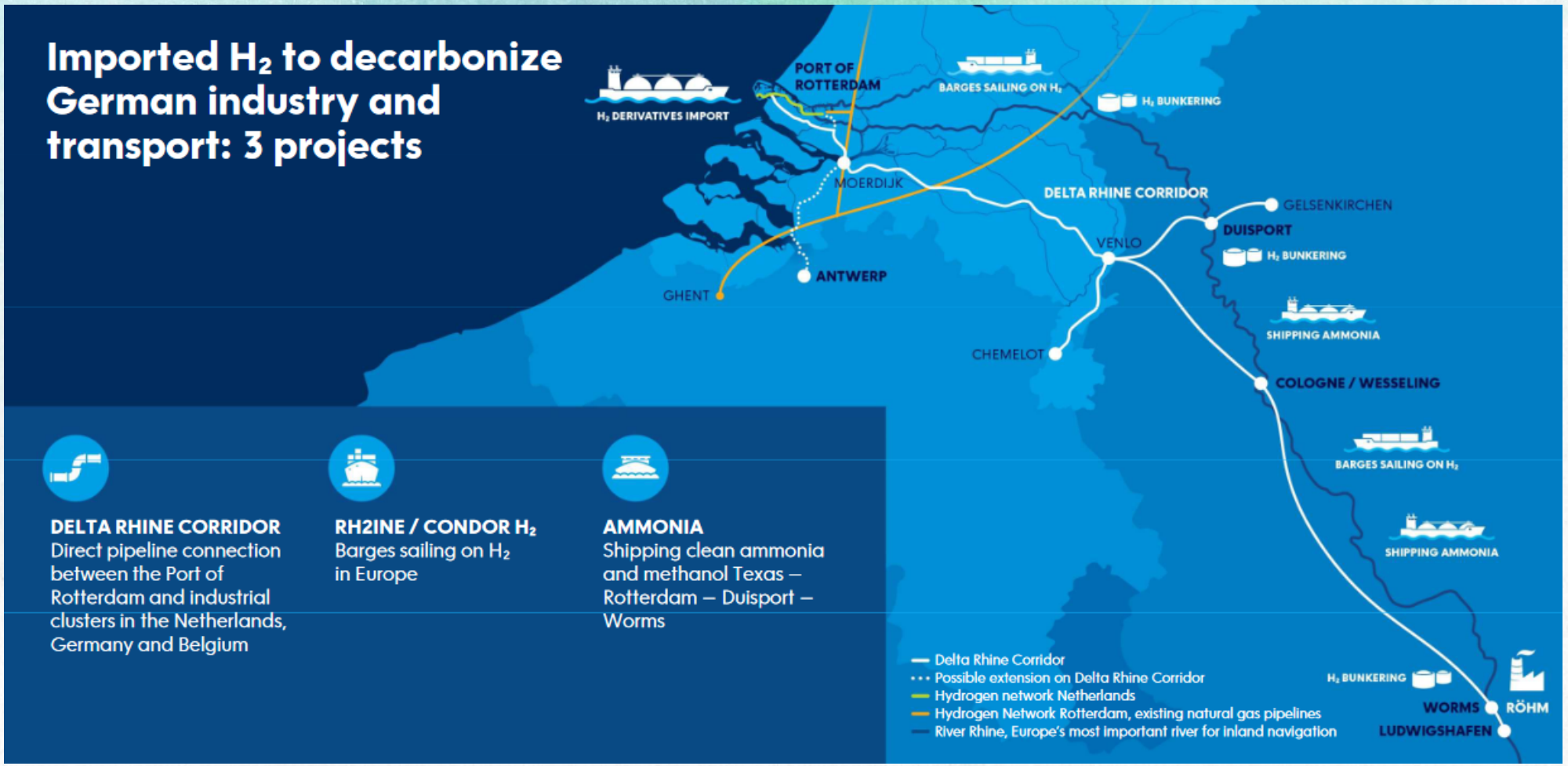
Delta Rhine Corridor



https://www.portofrotterdam.com/sites/default/files/2023-11/infographic-delta-rhine-corridor_0.pdf

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Conclusions and take home message

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Learning objective 1 – Comparison of alternative

- Summarizing different emission reducing energy carriers
- Analyzing of advantages and disadvantages
- Comparison of renewable fuel implementation possibility regarding the IMO targets

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Conclusions and take home message

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Learning objective 2 – Role of the Ports

- Ports have always been the refueling infrastructure of the ships
- For the future ports will become renewable energy hubs

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References

- https://www.emsa.europa.eu/sustainable-shipping/alternative-fuels.html
- DNV, Energy Transition Outlook 2024, MARITIME FORECAST TO 2050
- https://www.lr.org/en/expertise/maritime-energy-transition/maritime-decarbonisation-hub/zcfm/

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Additional reading materials

- DNV, Energy Transition Outlook 2024, MARITIME FORECAST TO 2050
- EMSA, Alternative Sources of Power https://www.emsa.europa.eu/sustainable-shipping/alternative-fuels.html

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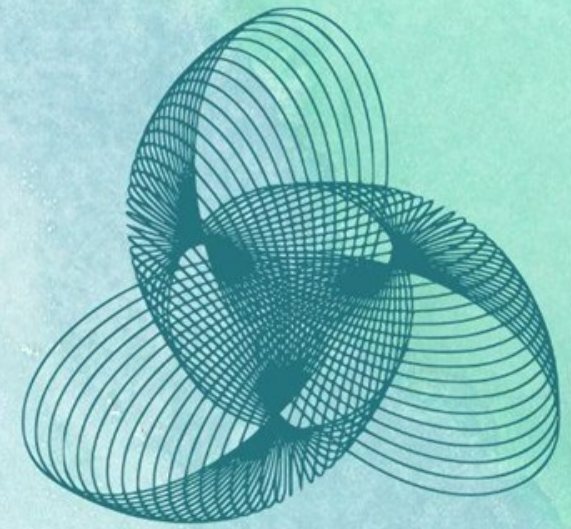

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FOR YOUR ATTENTION

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