Sustainable Marine System Design: Propulsion, power and energy system design of a harbor tug

Synergetics | Synergies for Green Transformation of Inland and Coastal Shipping

Funded by the Horizon Europe Programme of the European Union under Grant Agreement No 101096809

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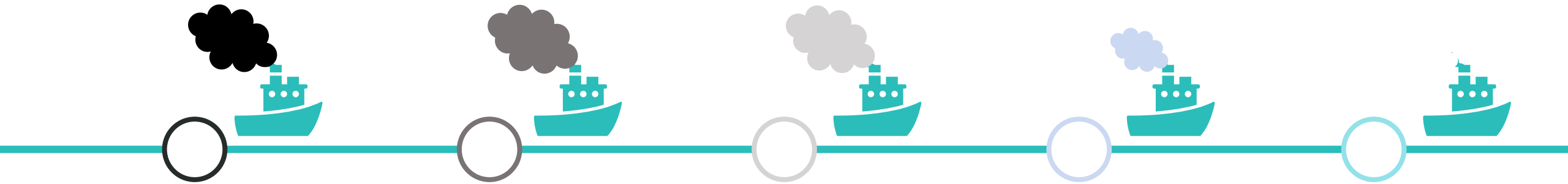
- Context and design approach

European path to climate neutrality



2023

IMO Short Term

EEXI and CII are IMO directives requiring significant energy improvements in the existing fleet taking effect January 2023.

2024

EU ETS

Shipping to be included in the EU ETS carbon trading system

2025

FuelEU Maritime

EU regulation to limit the yearly average GHG intensity of energy used on-board a ship sailing from and/or to EU ports

2030

Firm Reduction Targets

EU: 55% reduction in carbon emissions relative to 1990.

The IMO:40% reduction in carbon intensity compared to 2008 levels

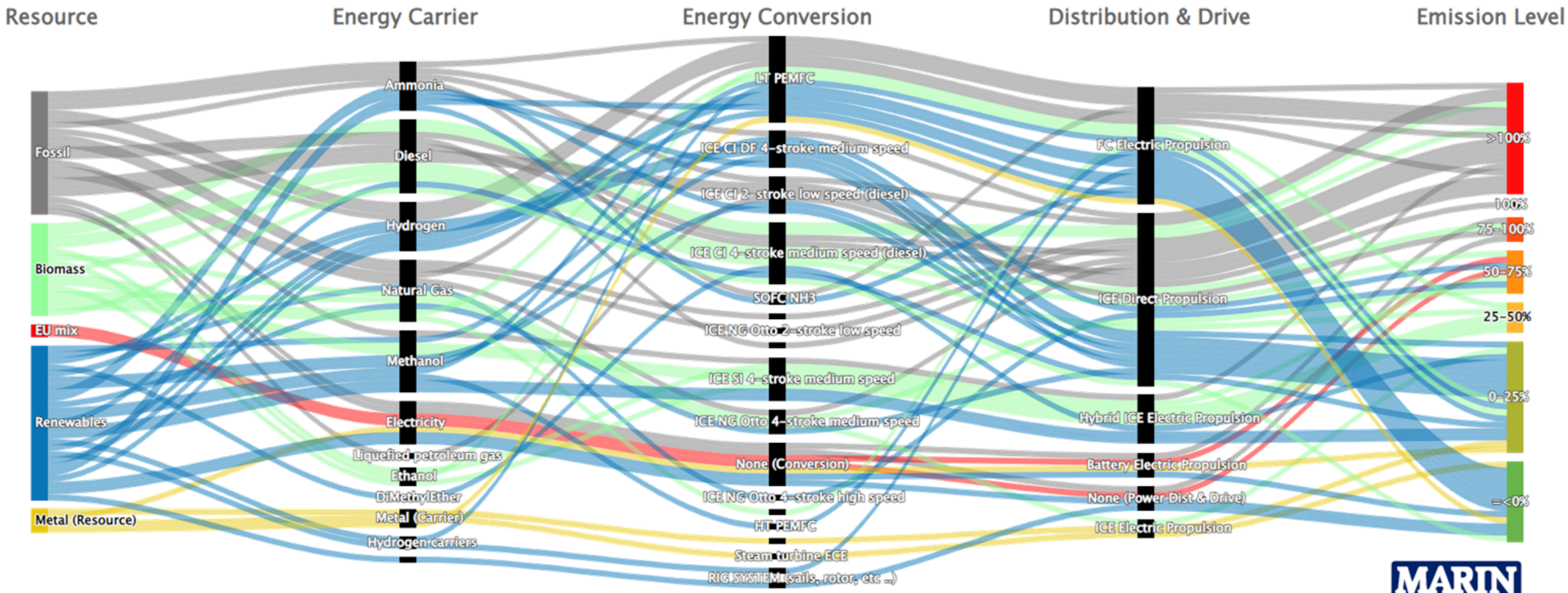
2050

Climate Neutrality

EU targets climate neutrality by 2050, while the IMO aims for 50% reduction relative to 2008

New Challenges in Ship Design

The decarbonization challenge requires new solutions on board of ships!



Source: https://sustainablepower.application.marin.nl/

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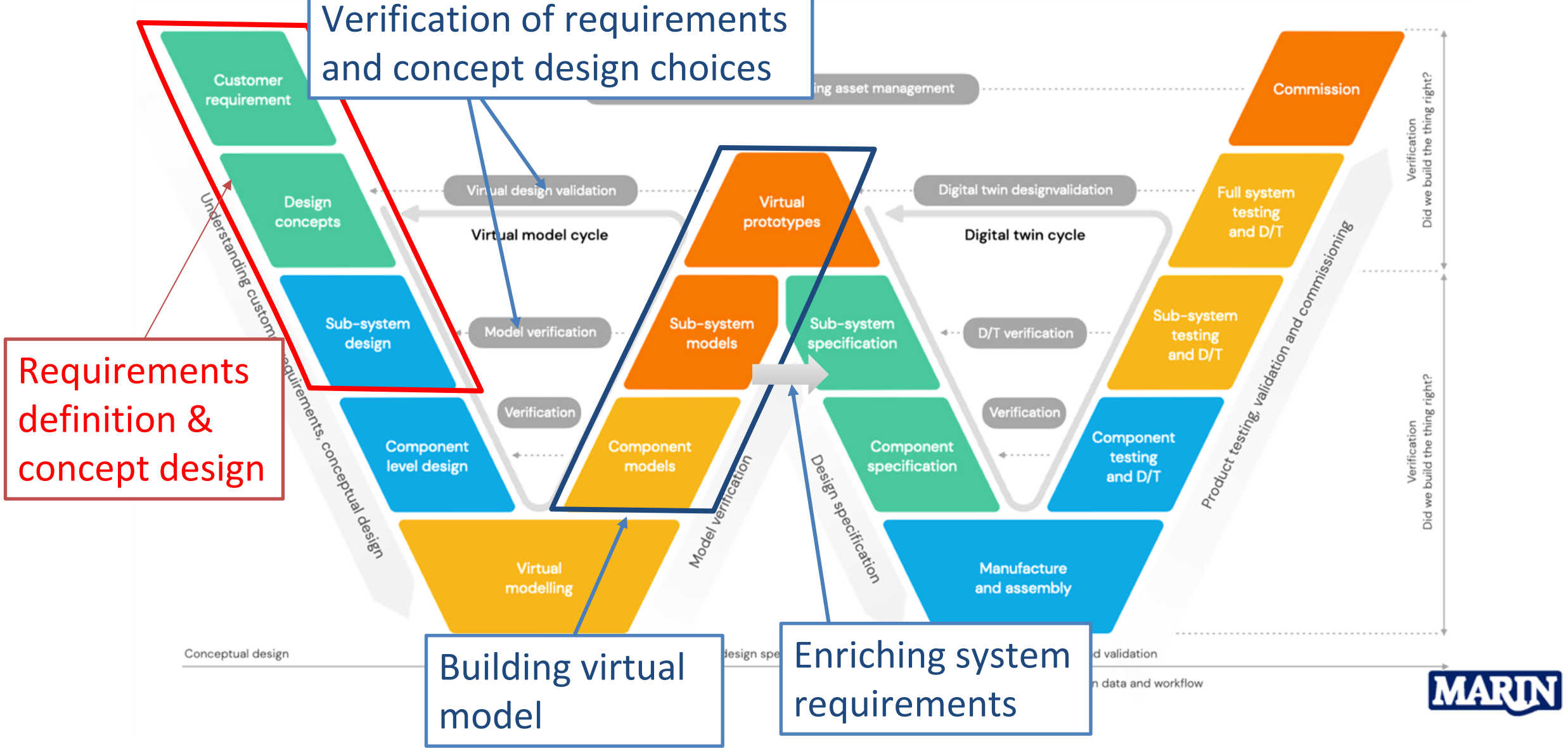
How to verify at an early stage that the design meets the requirements?

New Challenges in Ship Design

W-model approach



- Synergetics Use Case 6: viadonau push boat

Synergetics Use Case 6: viadonau push boat

Operational Capabilities:

- Waterway marking (with barge)
- Bathymetric survey
- Maintenance of the Danube river after extreme event (with barge)

Design Goal:

The vessel is currently running on HVO. The goal is to explore alternative solutions and designing a propulsion, power and energy system as close to climate neutrality as possible

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Operational analysis: *How is the vessel used? What is needed from the vessel?*

Key Aspects

- Area of operations and its environmental conditions → From GPS data and DoRIS - viadonau (bmk.gv.at), as well as from data provided by viadonau
- Power demand →
  - Hotel load: Electric load balance
  - Propulsion load: power prediction
- Energy demand → Development of different operational profiles based on the operational capabilities of the vessel.

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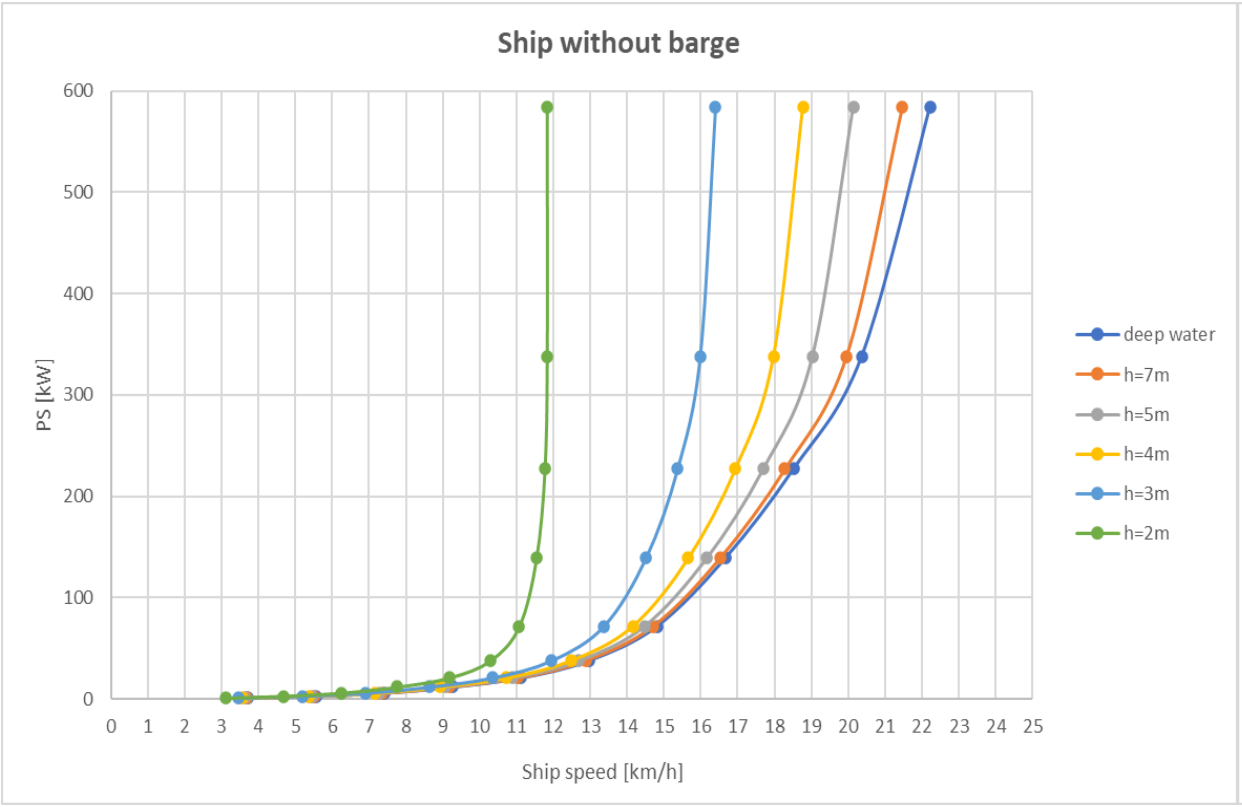
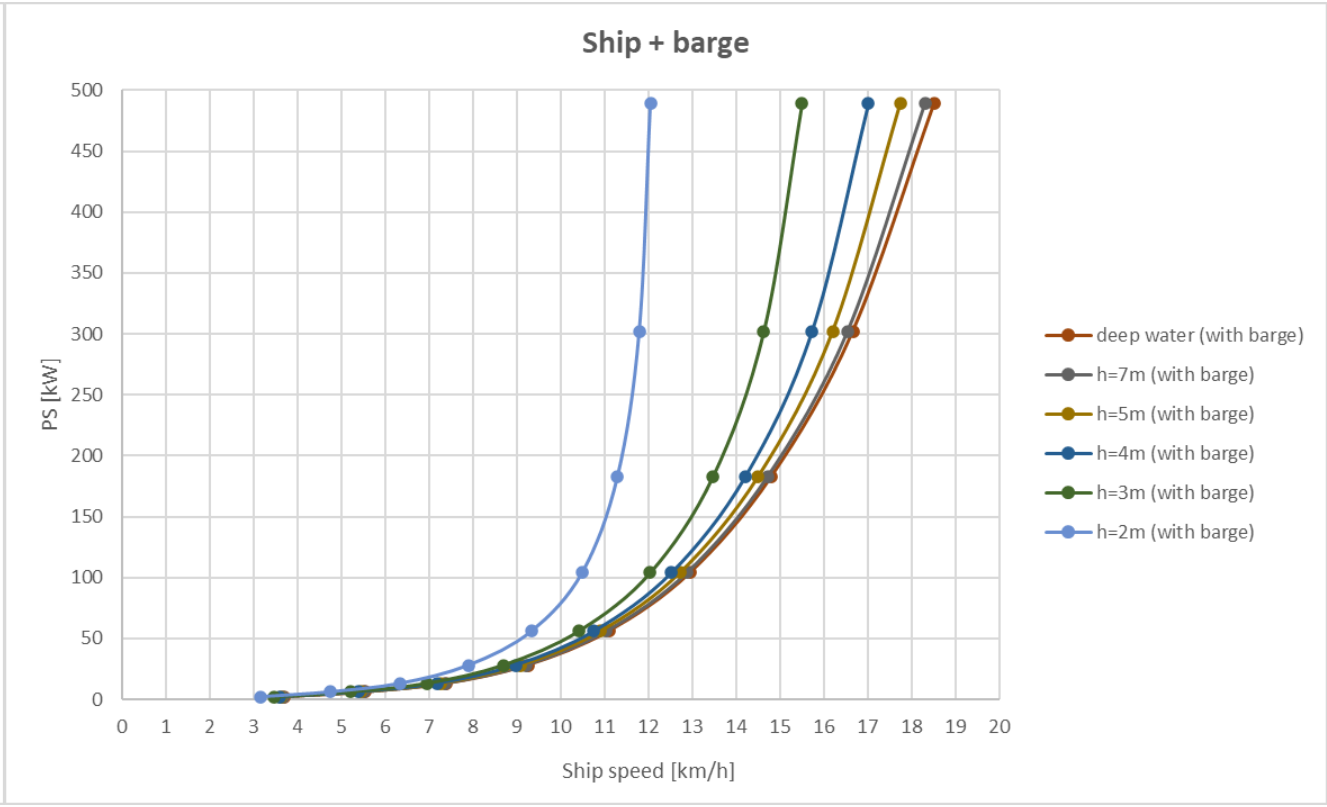
Propulsion power prediction - Overview





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Operational analysis - overview

Maintenance of the Danube river after an extreme event has resulted to be the most critical operation in term of energy consumption, however this is not the most frequent operation that the vessel does.

- 700 km
- 100 hours of continuous operation
- Energy needed: about 15 MWh

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Comparison of different technologies at concept level through a multi criteria analysis.

Information on technologies stored in a database (https://sustainablepower.application.marin.nl/)

Considered criteria

- Volume
- Weight
- Efficiency
- Emissions: greenhouse gasses and air pollutants
- Technical readiness level
- Societal readiness level
- Operational and investment costs

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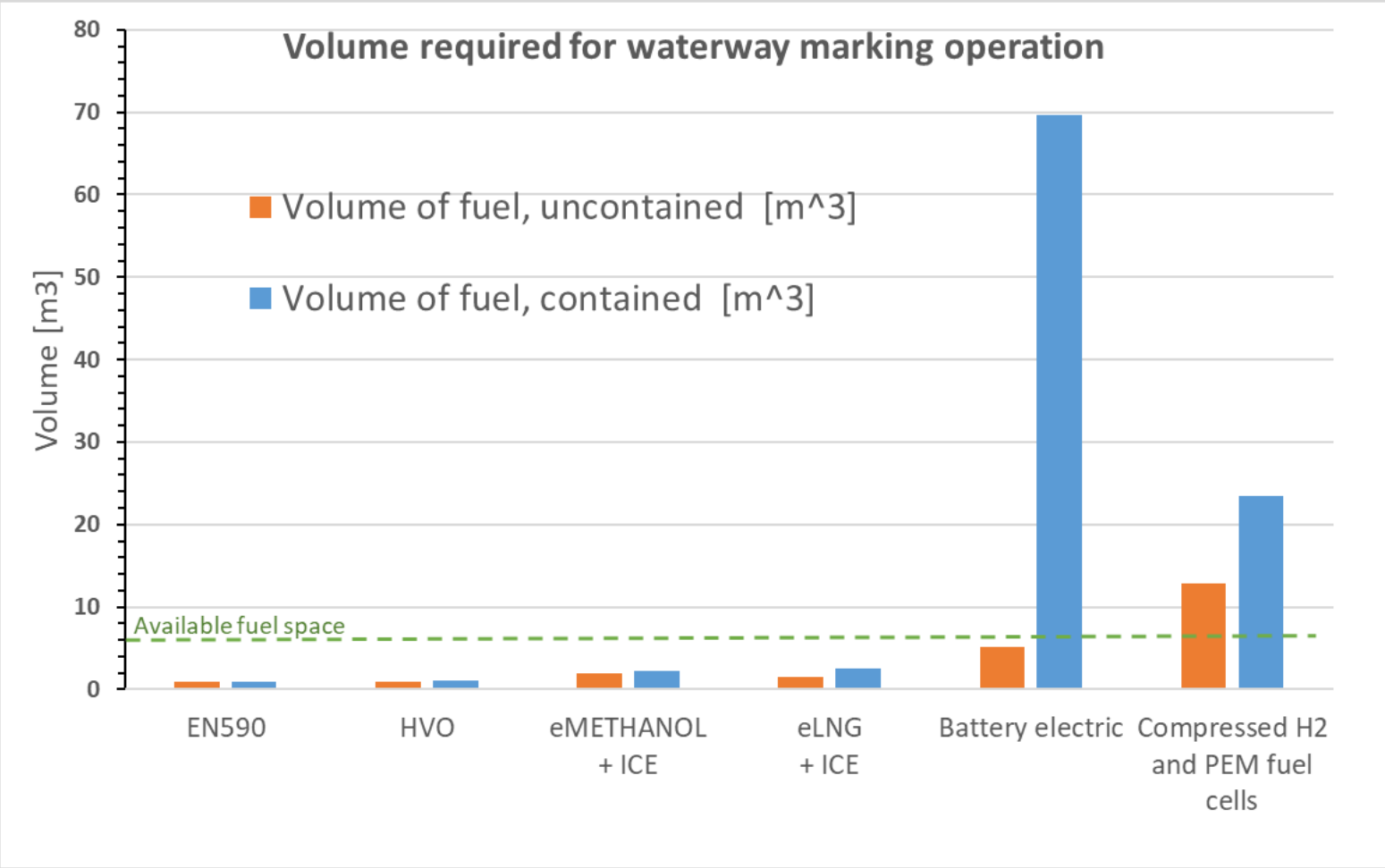
Comparison of alternative fuels

First assessment:



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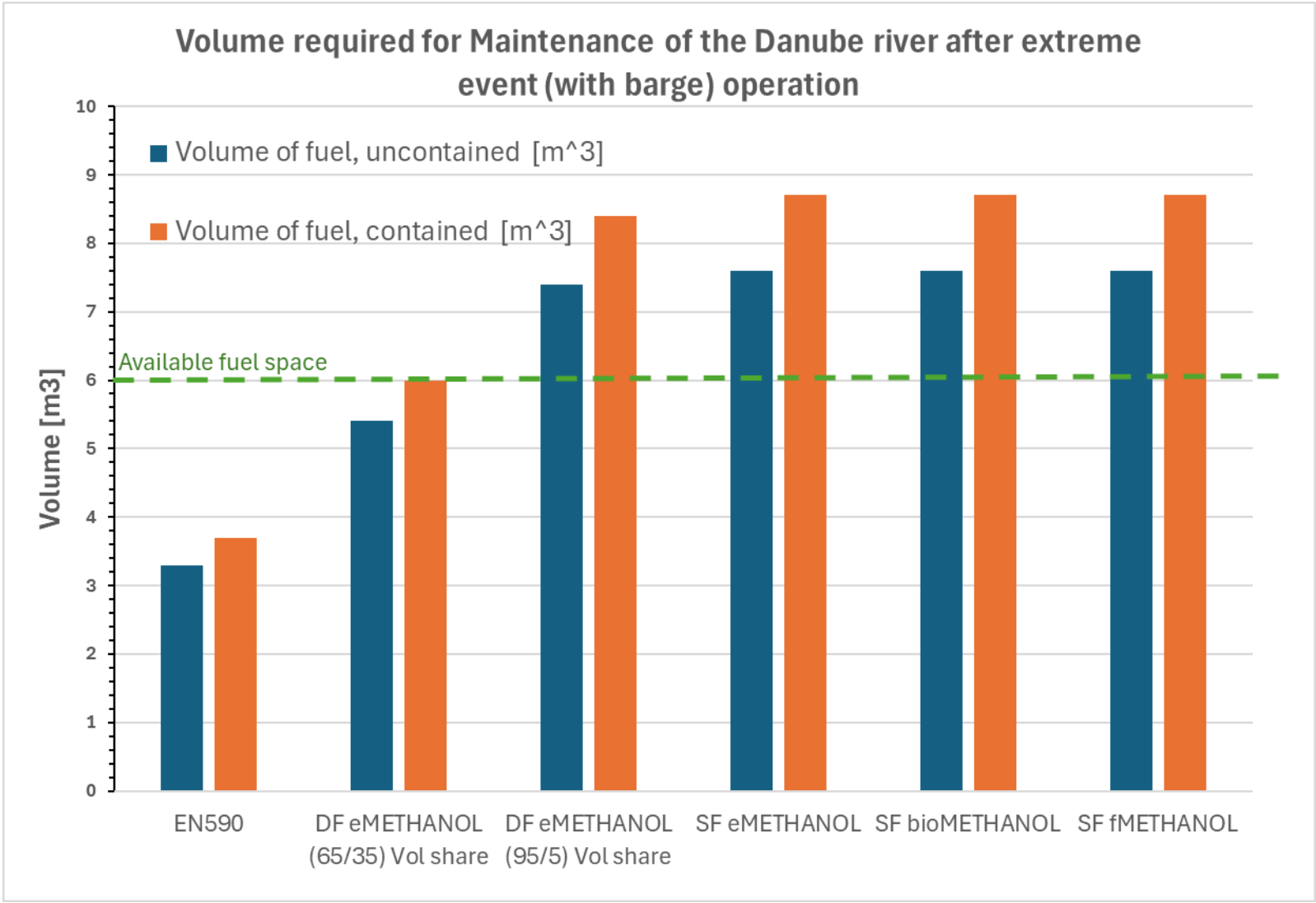
Methanol as a way forward solution

Second assessment:



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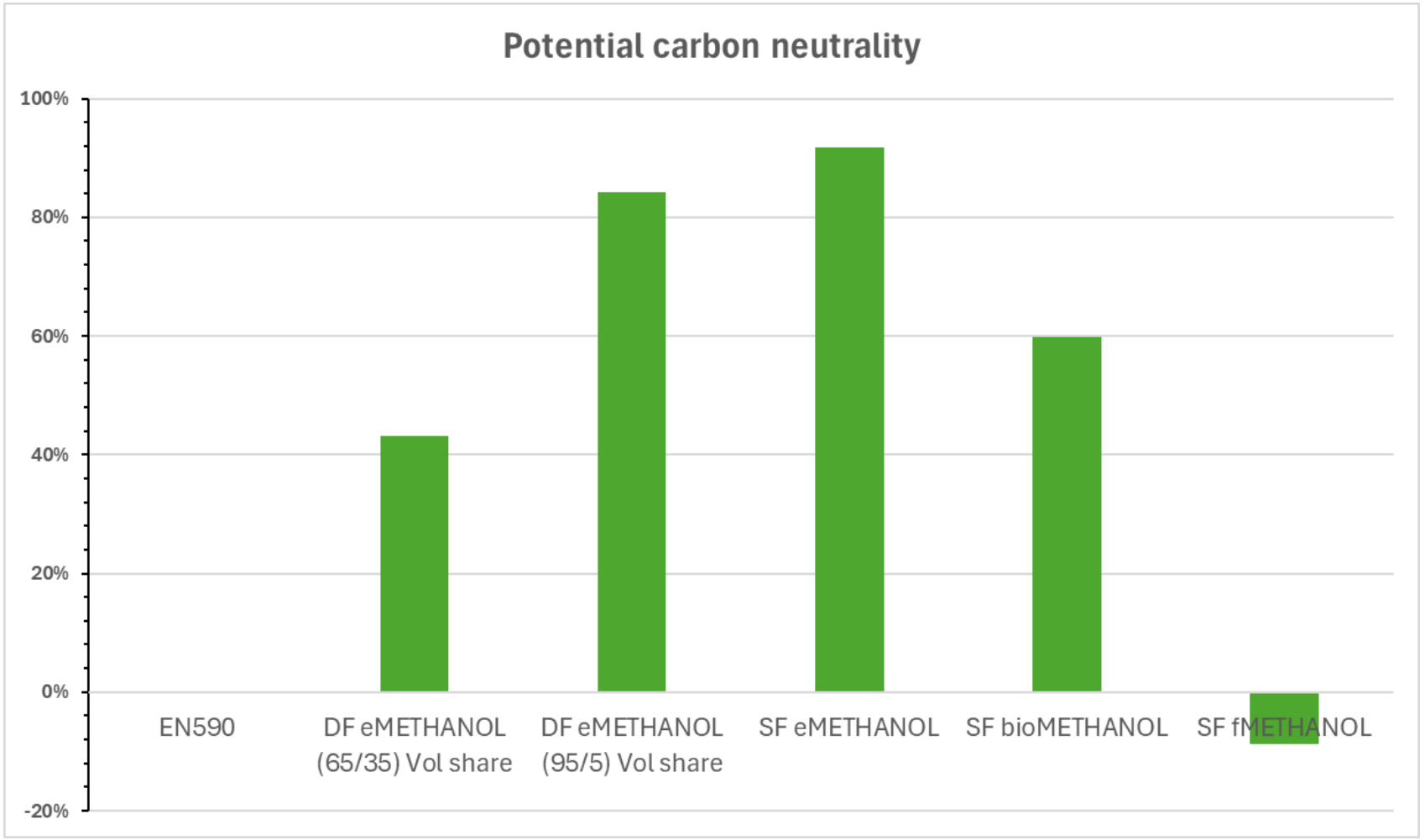
Methanol as a wayforward solution

Potential carbon neutrality comparison considering gCO2eq (WtW)



- Next steps

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Next steps

- Investigation and evaluation of different propulsion architectures (direct, methanol – electric)
- Qualitative and quantitative comparison of SF vs DF solutions. What are the benefits and the challenges of each of them?
- Finalize the marine power system design: selection and sizing of power and energy components, arrangement on board

Thank you!

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