Nordic
Hydrogen Valleys
as Energy Hubs

Rally to the Valley

Establishing Hydrogen Value Chains for the Nordics

Nordic Energy Research

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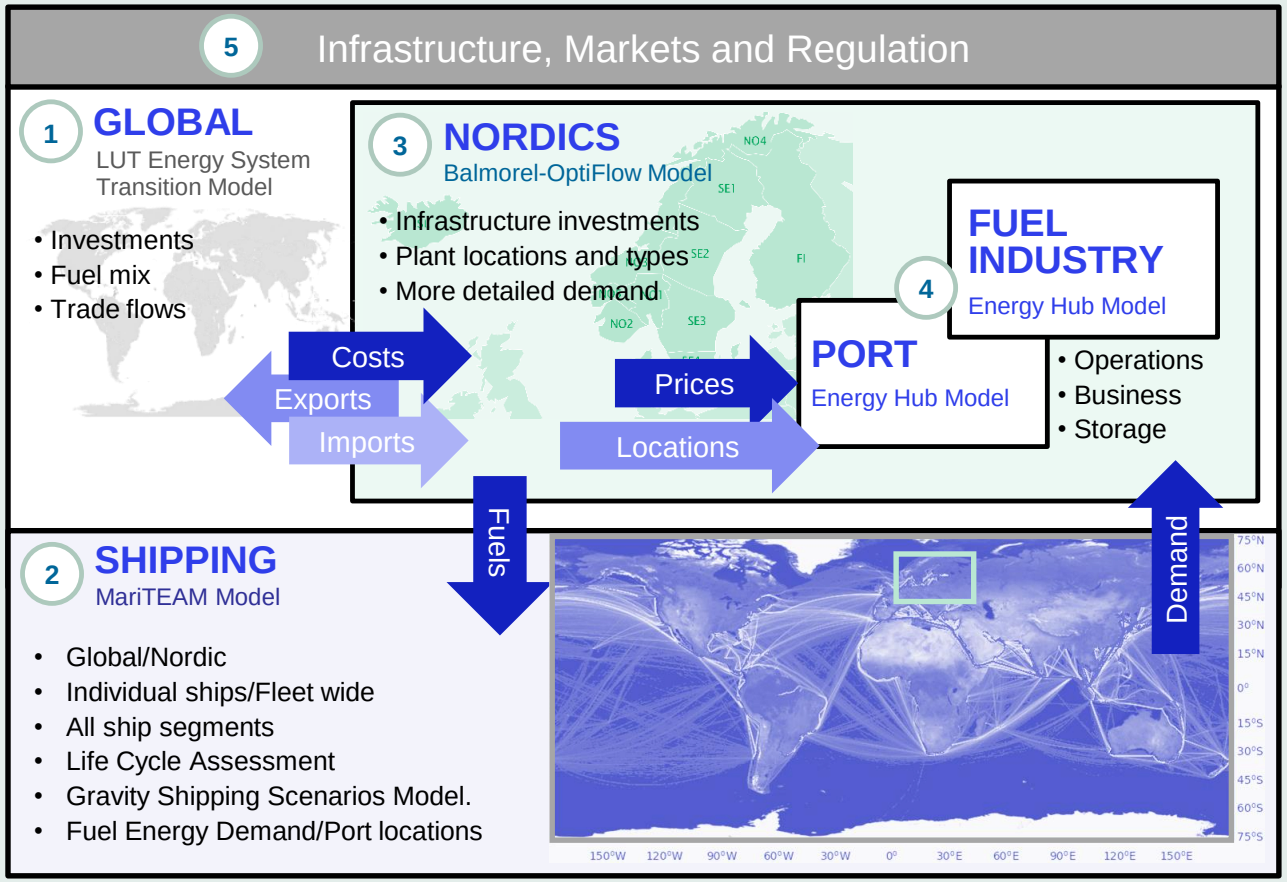
Hydrogen value chains focusing on the maritime sector



1. The **current use of hydrogen** must become renewable.
2. The (long-haul) **maritime sector** is a potential application area due to the lack of better alternatives. Currently, it remains unclear which fuels will prevail for this.

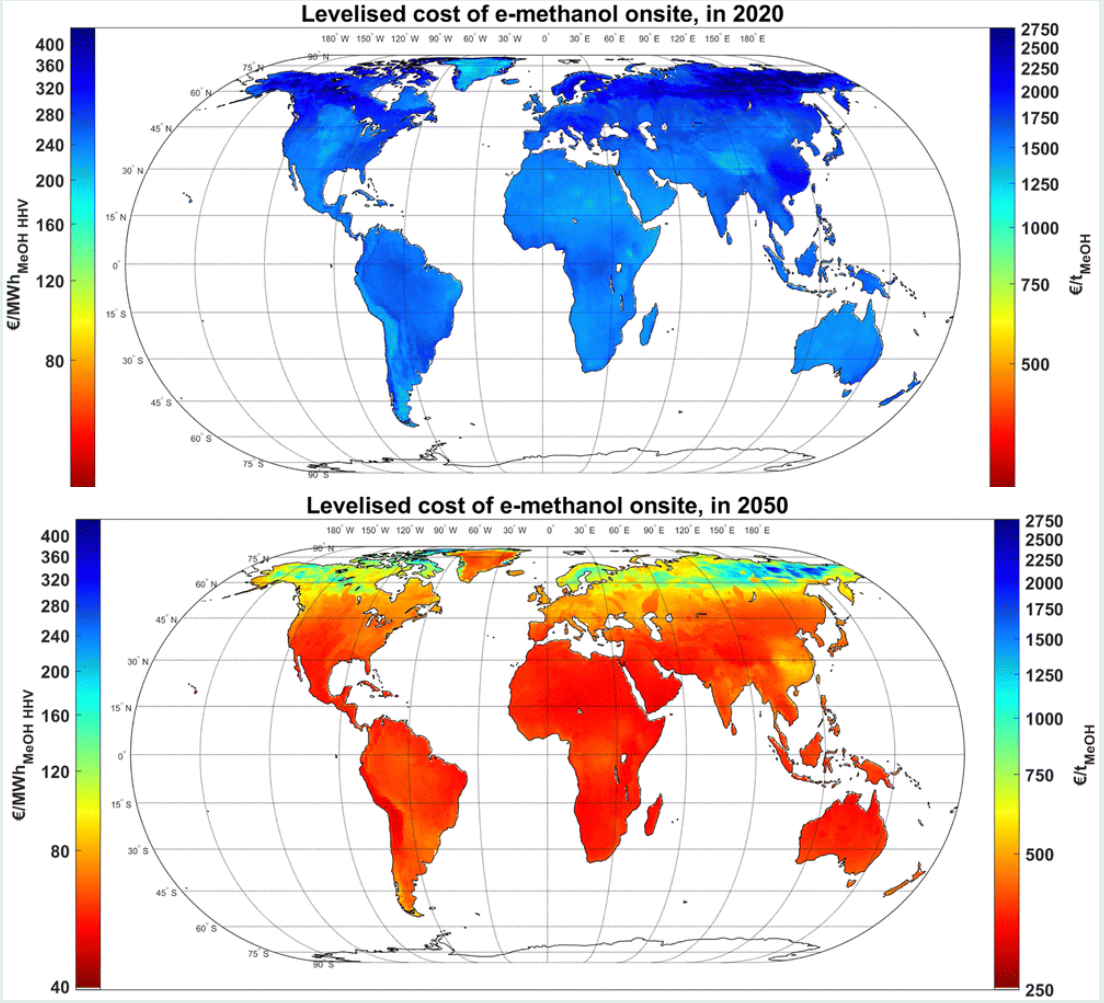
WP 1: LUT University, st1
WP 2: NTNU, st1
WP 3: DTU, LUT University, NTNU, CBS, Port of Roenne
WP 4: CBS, DTU, Port of Roenne
WP 5: NTNU, NHH, CBS, st1

A global perspective

Trends of Trade Flows and Costs

- The analysis addresses the background of green fuel production options:
  - **Trade flows** for hydrogen-based green fuels and green chemicals using the LUT-ESTM model,
  - **Supply costs** in the Nordics, Europe, and the global level,
  - **Competition for resources** such as biomass between regions and sectors,
  - **Relative competitiveness** of Nordic e-fuels,
  - **Policy options** and their impact on infrastructure.

- Long-term competitiveness of green fuels
  - **PV-dominated** power supply drives cost reduction.
  - Green fuel production scales with **low-cost CO_2**
  - **CO_2 pricing** determines when they become competitive



Fashini and Breyer (2024): Global production potential of green methanol based on variable renewable electricity

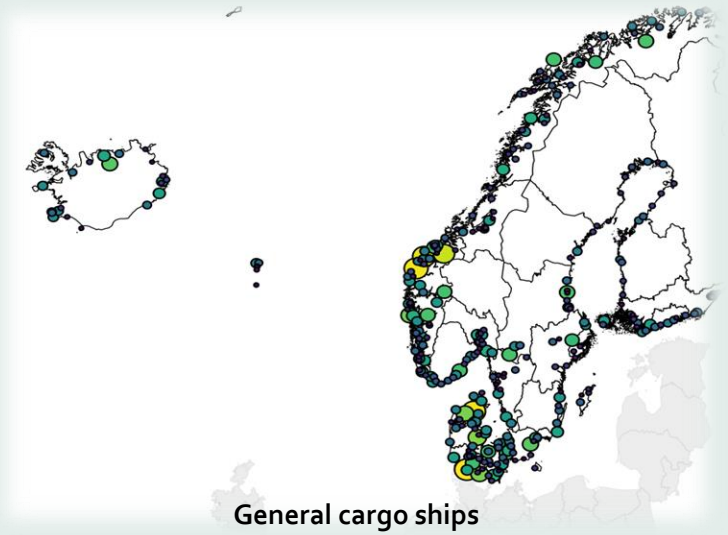
The Nordic Hydrogen Valleys Conference 2025

The maritime sector

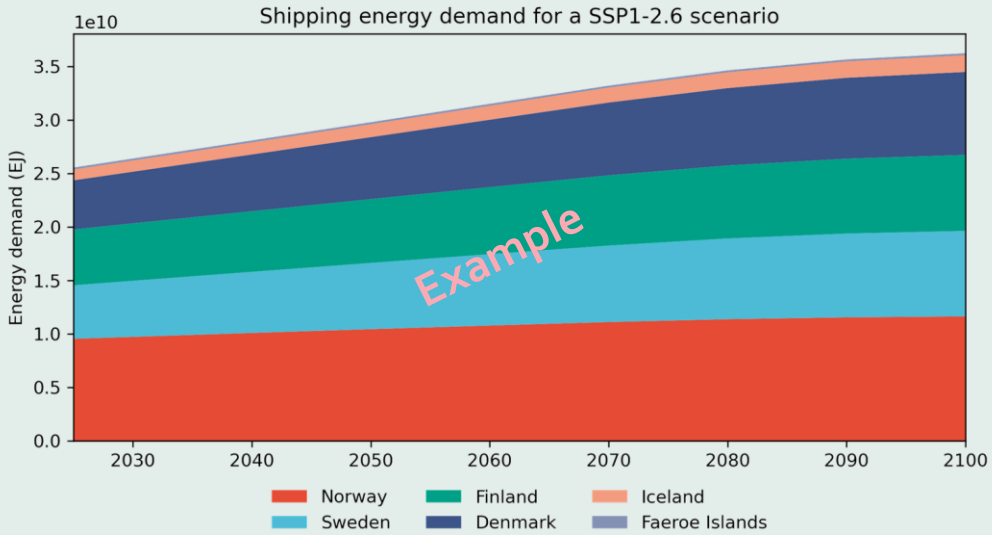
Explore future Nordic maritime energy pathways

- High maritime activity by
  - Patterns based on ship types (cargo, bulk, container, passenger)
  - ~3,000 ships operated in Nordic waters in 2019
- Shipping data covers port and regional levels.
- Fuel demand calculation for ships reaching their next ports.

- Project shipping activities
  - Using Shared Socioeconomic Pathways (SSP).
  - Investigate different energy demand pathways
- Creating a set of up to 28 energy demand scenarios

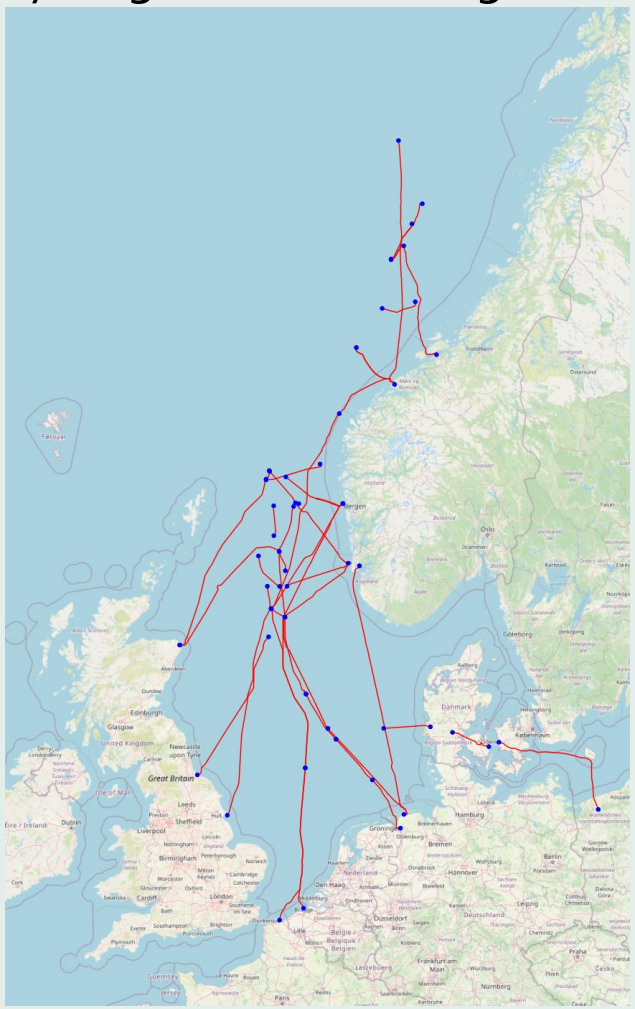


General cargo ships

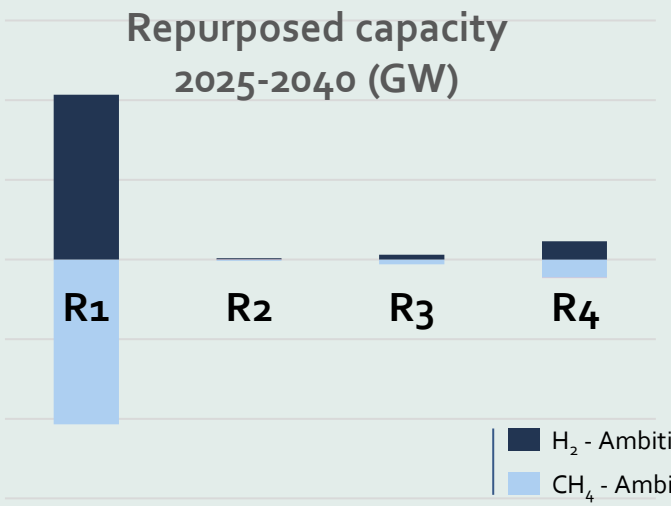


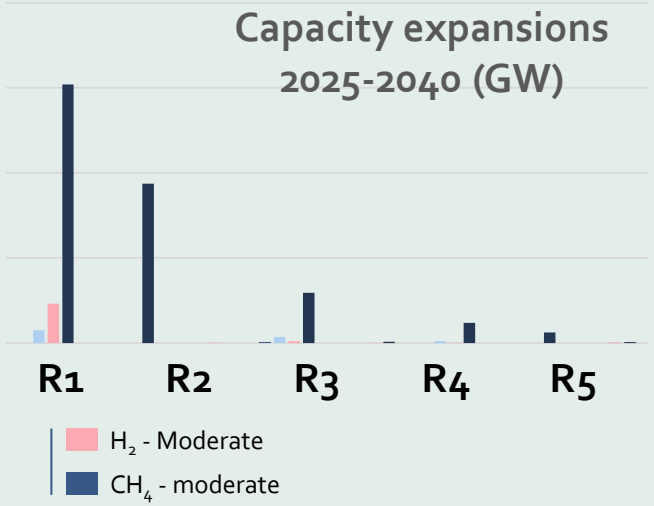
Hydrogen infrastructure

Phasing in hydrogen in a natural gas network.



- The starting point is the existing gas transmission networks and storages and an energy transition scenario
- High spatial resolution and disaggregated infrastructure up to NUTS3 level
  - Supply & Demand
  - Pipelines
  - Storages
- Model combines blending, repurposing and making pipelines bidirectional to expand the network.



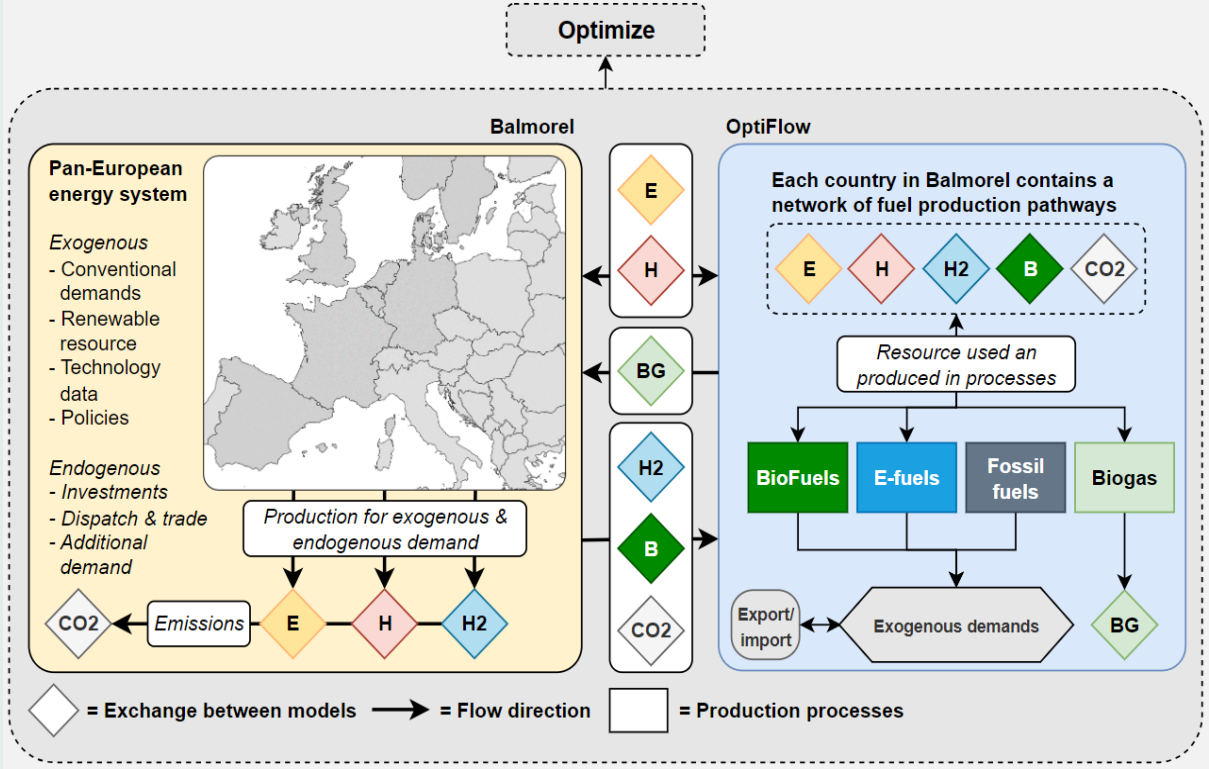


Locations and investments

Where to produce which kinds of hydrogen-based fuels in the Nordics?

- Take advantage of:
  - **Local resources,** such as carbon sources and VRE potentials
  - **Existing and new infrastructures,** such as fuel demand centers, industry point sources, and transmission and storage infrastructures
- Examine scenarios for self-sufficiency and imports/exports
  - National and Nordic s**elf-sufficiency** in electricity, hydrogen, and carbon sources
  - Competition from **global fuel exports**
  - Trade-offs between decentralized fuel production with high local storage requirements and centralized solutions with transmission expansion
- Understand the **impact of carbon management and infrastructure** on the utilization of specific carbon sources by location and fuel type

Modelling Setup:

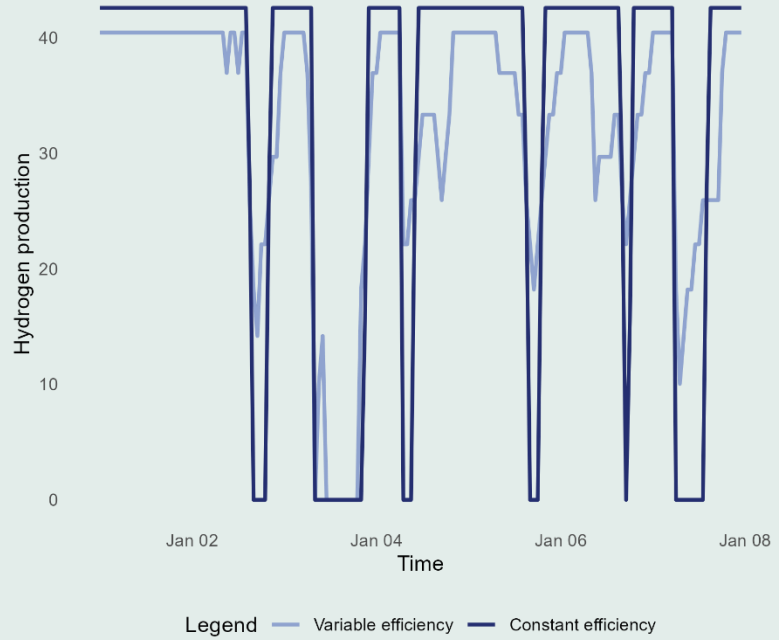


Conceptual overview of Balmorel/OptiFlow model

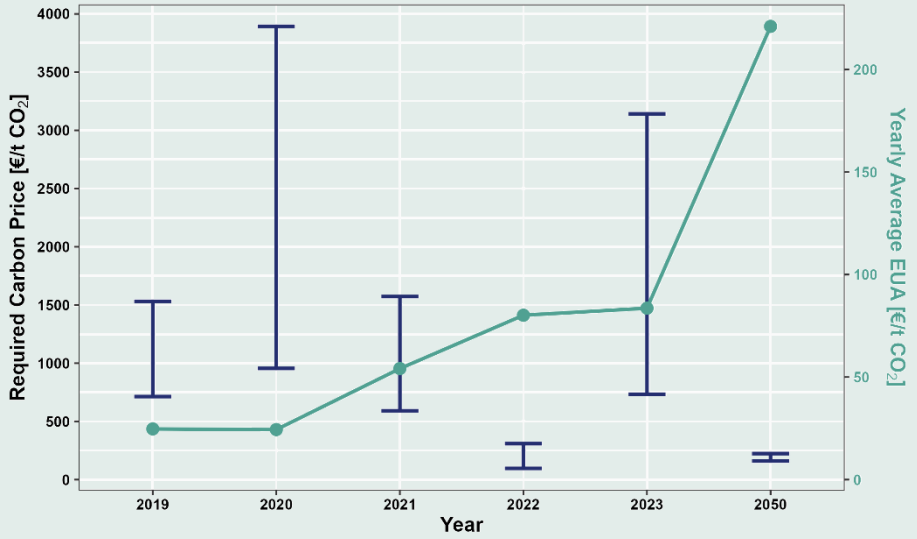
Renewable fuel production

Addressing Economic and Emission Challenges

- **Energy system and grid perspective**
- Modelling flexibility of hydrogen production requires
  - Variable efficiency representation
  - Constant factor shows higher and less detailed changes
- Energy hub concepts help to reduce peak feed-in from local PV generation.



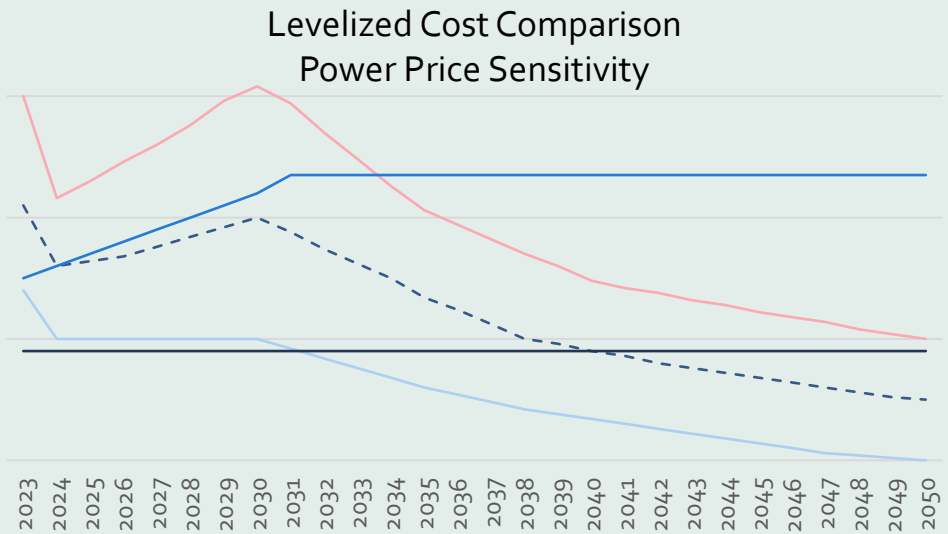
- **Economic perspective**
- **Green fuel production is currently not viable**
  - Renewable fuel production needs **financial support** and technological advancements to become economically viable.
  - **Renewable fuel quotas** can contribute to making green fuels competitive.
- Carbon pricing and power mix impact the sustainability

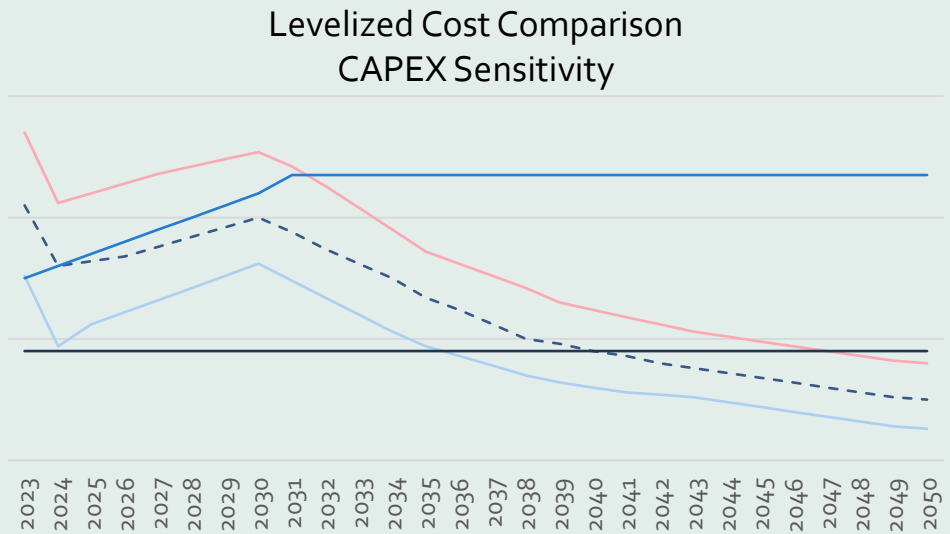


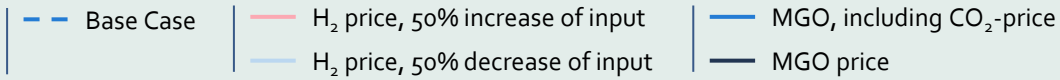
Aspects of carbon pricing

The price for the source must be low but for emissions high

- **When might hydrogen produced in Norway be expected to be cost-competitive with marine gasoil (MGO)?**
  - Levelized Cost of Hydrogen (LCOH) model
  - Relevant impact by CAPEX, power price and WACC
  - Comparison of scenarios with and without carbon taxes on maritime emissions
- Hydrogen can become cost-competitive in the 2030th
  - Access to low power prices
  - Strict implementation of carbon pricing
  - Securing access to renewable electricity
  - Realization of learning curves







Thank you.

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Scientific Partners

Industrial Partners

Observers

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This project is part of the

Nordic Hydrogen Valleys as Energy Hubs Programme

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