



Nordic Hydrogen Valleys as Energy Hubs

Rally to the Valley

Establishing Hydrogen Value Chains for the Nordics

Project Background



The decarbonization of the energy system will be highly dynamic in the years to come

- Fossil fuels are phased out, electrification manifests where possible, and energy efficiency increases.
- **Hard-to-abate sectors face problems in electrification.**
 - Impossible due to process or economic infeasibility.
 - Need for sustainable fuels but currently only small, sustainable quantities are available.
- **Renewable e-fuels** based on hydrogen are required.
 1. The **current use of hydrogen** (mainly as feedstock and for fertilizer production) must become renewable.
 - Requires a massive amount of additional renewable energy.
 - These sectors may become the main driver for the allocation of hydrogen infrastructure.
 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.
- The **Nordics are a frontrunner** in renewable energy technology roll-out:
 - **High potential** of renewable energy sources.
 - **Existing know-how** and expertise.
- Represent a promising location to explore the **future of a hydrogen value chain.**
 - The region may evolve as a hydrogen valley with **e-fuel exports,**
 - be largely **self-sufficient,**
 - or become a **net importer.**
- **What are the implications of these scenarios for the pathway of the energy transition in the Nordics?**

Project Objectives



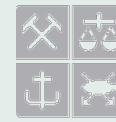
A joint pathway for a hydrogen value chain in the Nordics focusing on the maritime sector

- The project aims to **extend energy system models** for the analysis of **hydrogen value chains**:
 - Global supply and demand mapping,
 - Local operation of specific facilities.
- The project provides **insights into**:
 - **Hydrogen, ammonia, and e-fuel** use in the global and Nordic energy systems.
 - **Specific operation** of energy hubs and ammonia facilities.
 - **Policy and regulatory** instruments to ensure a smooth pathway.
 - **The role of ports** to identify specific needs for technology and current barriers.
- The structure of a Nordic hydrogen valley is shaped by:
 - The **carbon-neutrality ambitions** of the Nordic maritime industry,
 - The **demand for renewable fuels**,
 - The **regional infrastructure**,
 - The **renewable energy potential**.
- The **market design and regulation** will determine economic viability and the need for public funding.
- The project uses **detailed cases** to analyze the value chain:
 - **Rønne Havn** in Denmark,
 - A mobile Power-to-X facility developed by **H2Carrier** in Norway,
 - The fertilizer branch of **St1** in Finland.

Project Partners



Scientific Partners



Industrial Partners



Observers



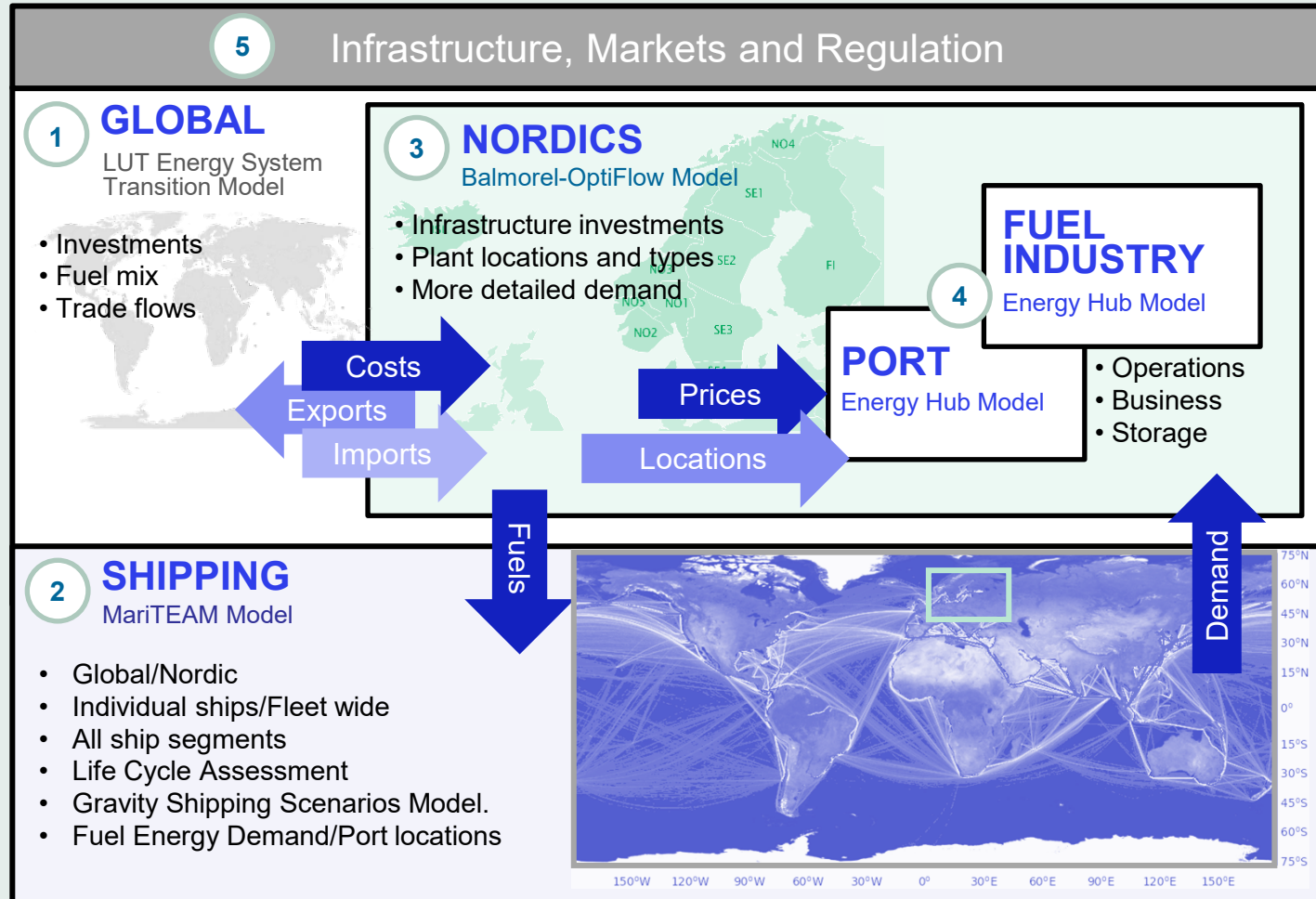
Mærsk Mc-Kinney Møller Center
for Zero Carbon Shipping



CERTH
CENTRE FOR RESEARCH & TECHNOLOGY HELLAS

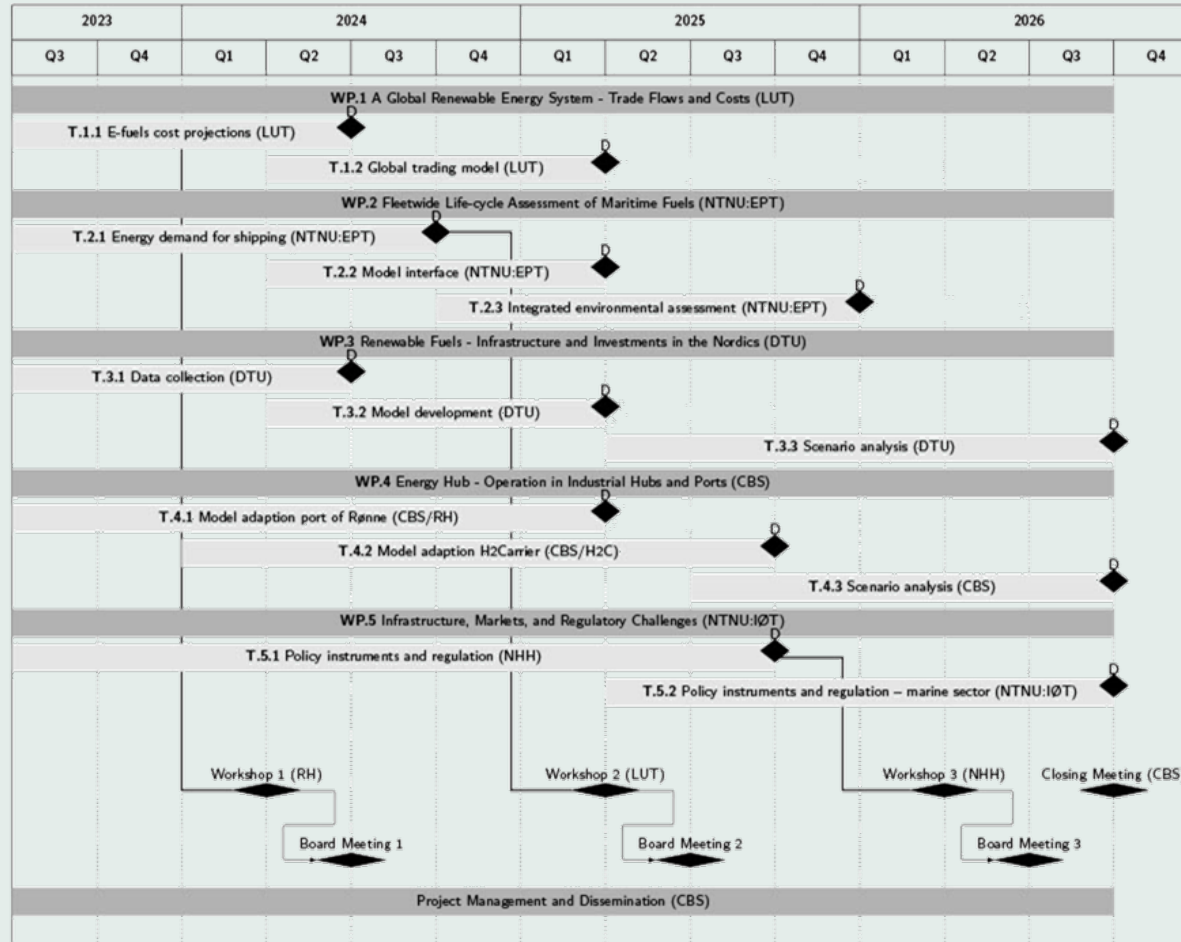


Project Structure



- WP 1: LUT, St1 FI
- WP 2: NTNU:EPT, St1 NO
- WP 3: DTU, LUT, NTNU:IØT, CBS, RH, H2C
- WP 4: CBS, DTU, RH, H2C
- WP 5: NTNU:IØT, NHH, CBS, St1 NO

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Work Package Structure



Global Perspectives

WP 1: A Global Renewable Energy System - Trade Flows and Costs

- The analysis addresses the background of electrofuels production options:
 - **Trade flows** for hydrogen-based e-fuels and e-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.
- The results will feed into the scenarios and costs used in the Nordics in WP 3.

WP 2: Fleetwide Life-Cycle Assessment of Maritime Fuels, Energy, and Ship Operation

- Modelling energy use and emissions in the maritime sector using the MariTEAM model:
 - Combination of data on **individual ship movements** on inter-Nordic, European, and global level,
 - Weather information, ship technical data,
 - **Geospatially explicit modelling** of ships and trade scenarios,
 - **Energy-emission models** across the whole fleet,
 - **Demand for different fuels** used in ports segmented by ship classes and destinations.
- The WP **links the global scenarios to a Nordic scale**
 - Perform fleetwide life-cycle assessments of hydrogen scenarios,
 - Comparison of conventional and alternative fuels.

Work Package Structure

Nordic and Local Perspectives



WP 3: Renewable Fuels - Infrastructure and Investment in the Nordics

- Focus on **locations for hydrogen-based fuels** covering:
 - Local resources,
 - Existing industrial, transport, and storage infrastructure,
 - Flexibility provided by renewable fuel solutions.
- **Considering scenarios** of
 - National self-sufficiency, imports and exports,
 - Decentralized vs. centralized fuel production,
 - Unique layouts of harbours.
- **Providing insights** into
 - Strengths and weaknesses of hydrogen value chains,
 - Prospective Nordic hydrogen valleys and their benefits, costs and environmental impact.

WP 4: Energy Hub - Operation in Industrial Hubs and Ports

- Analysis of **operation and business models of energy hubs** covers
 - The technical setup,
 - The interactions with the electricity market,
 - The regulatory framework,
 - Local resources.
- **Detailed modelling of the technical production process** enables
 - A realistic estimate of the needed flexibility,
 - Consideration of interdependencies between the production processes,
 - Representation of operational patterns of the hub.
- The **case studies of the industrial partners** will play a significant role in the analysis.

Work Package Structure

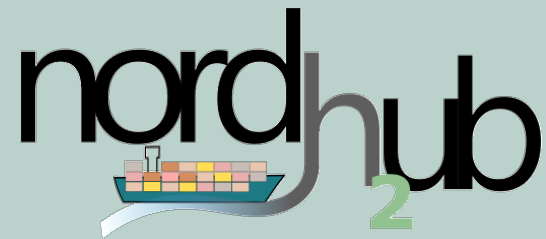
Infrastructure, Market, and Regulatory Perspectives



WP 5: Infrastructure, Markets, and Regulatory Challenges

- The analysis of the **development of hydrogen valleys** in the Nordic considers:
 - Input from WP 3 on timing and sizing of the construction of new power and gas infrastructure,
 - Ongoing plans and visions on the European level (e.g., the European Hydrogen Backbone by the gas TSOs),
 - Broader European initiatives towards large-scale hydrogen production, transport, and markets,
- The WP **investigates the hydrogen value** chain comparing
 - Options for hydrogen production include large-scale offshore wind,
 - Electrolysis offshore or onshore etc.,
 - Fossil alternatives.
- **Providing insights** into and **decision support** to:
 - Market designs for hydrogen trade,
 - Regulation of zero-emission fuels,
 - Regulatory and socio-economic challenges,
 - Aspects of public acceptance.

Thank you.



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This project is part of the
**Nordic Hydrogen Valleys
as Energy Hubs Programme**



**Nordic Energy
Research**



**Nordic
Hydrogen Valleys
as Energy Hubs**