Port of Gothenburg as a hydrogen hub – from a stakeholder and barrier perspective

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Nordic Energy Research

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Nordic Hydrogen Valleys as Energy Hubs

Assessments of Hydrogen, Ammonia and Methanol pathways centered around ports in the Nordic region

- **Techno-economic conditions and drivers/barriers for implementation**
- **Opportunities for sector couplings and energy systems integration**
- **Possibilities of using existing underground rock caverns for storage**
- **Pathways for hydrogen-based value chains in Nordic ports by 2030/2040**
- **Four case studies in two countries (Sweden & Iceland)**

Luleå University of Technology

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NTNU Norwegian University of Science and Technology

University of Iceland

Landsvirkjun National Power Company of Iceland

Piteå Hamn AB

Port of Gothenburg

Luleå Energi

SSAB

Statkraft

Blámi

Port of Gothenburg as a hydrogen hub

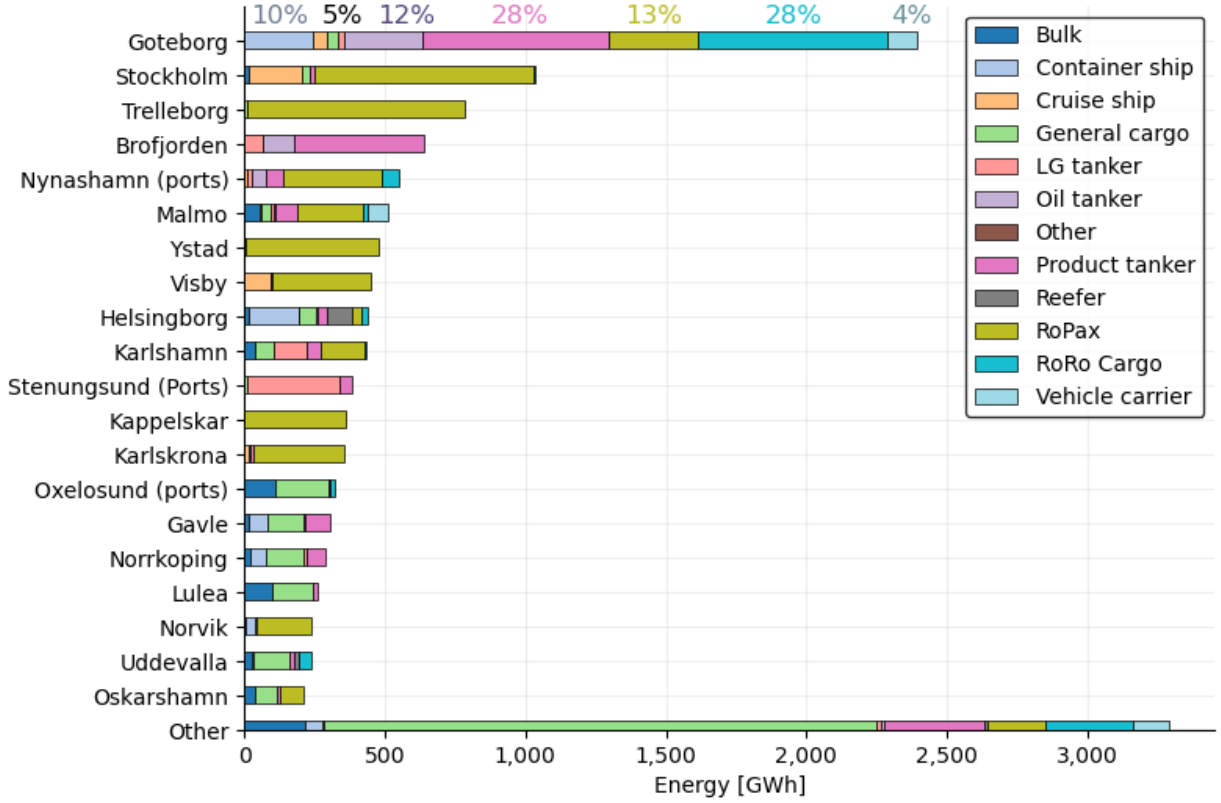
- Assesses the prerequisites for Port of Gothenburg to become large-scale hub for hydrogen-based fuels
- Develop a roadmap for the upscaling of hydrogen-based fuels in the port
- Focus on marine application

Why is Port of Gothenburg an interesting hydrogen hub case?

- Largest port in Scandinavia
- Key bunkering area
- Relevant industry transition
- Location
- Existing infrastructure

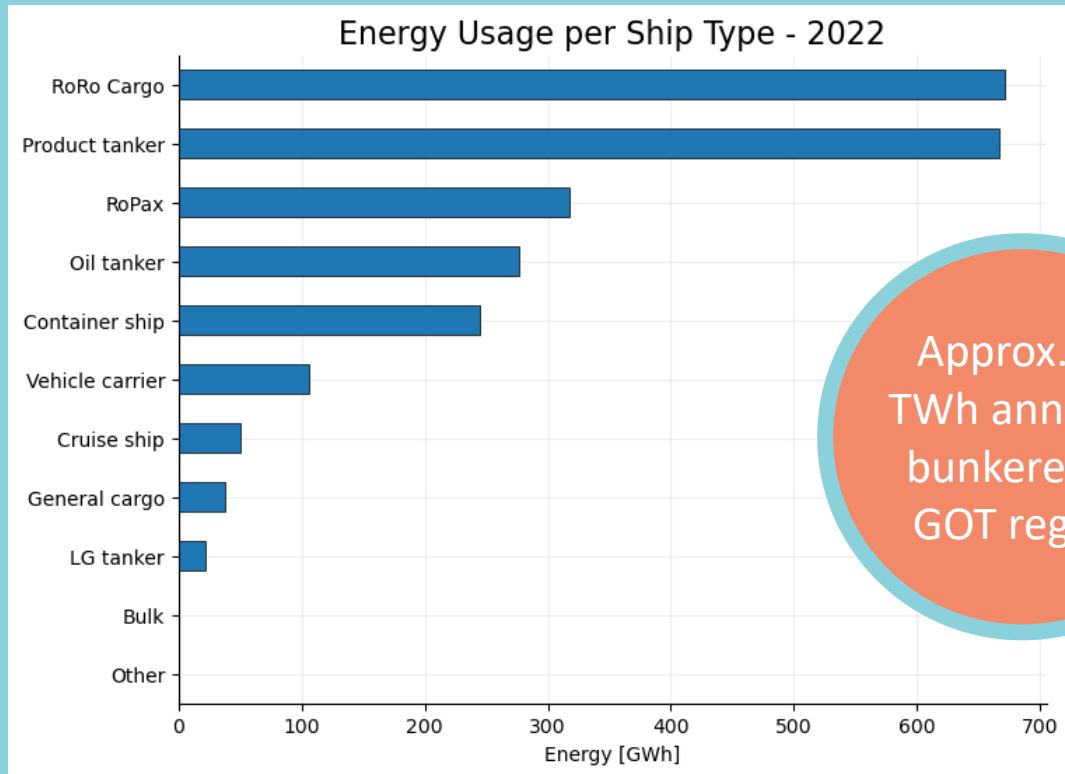
Shipping bunker consumption in Sweden and Gothenburg

Energy usage per port (2022)



*In total **14 TWh** of fuel used in 2022 including port stay, and at sea (domestic and half the way to and from foreign ports)*

Gothenburg



Approx. 20 TWh annually bunkered in GOT region

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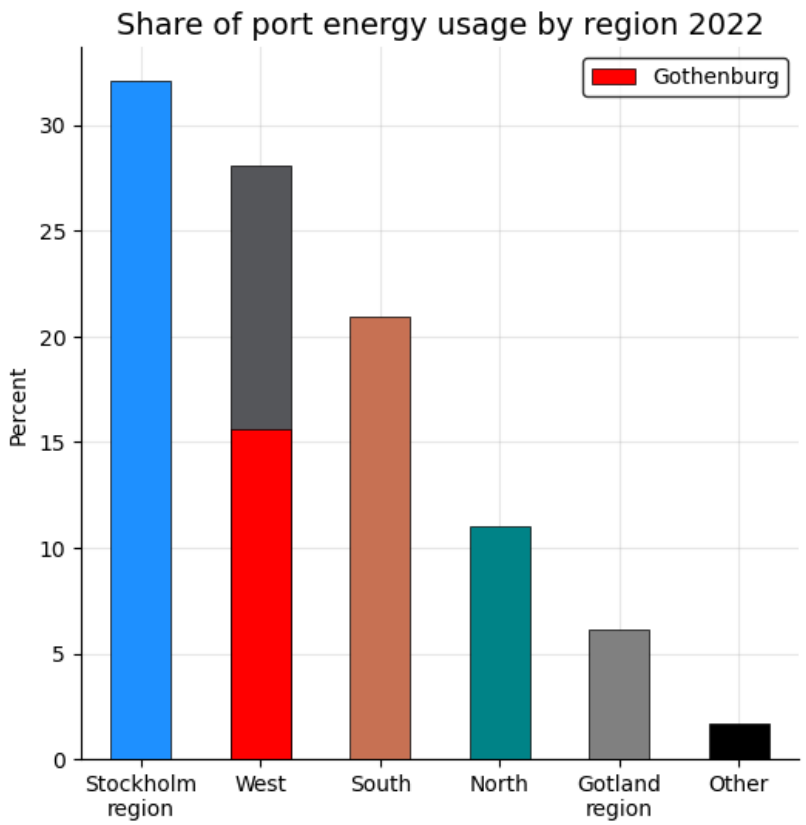
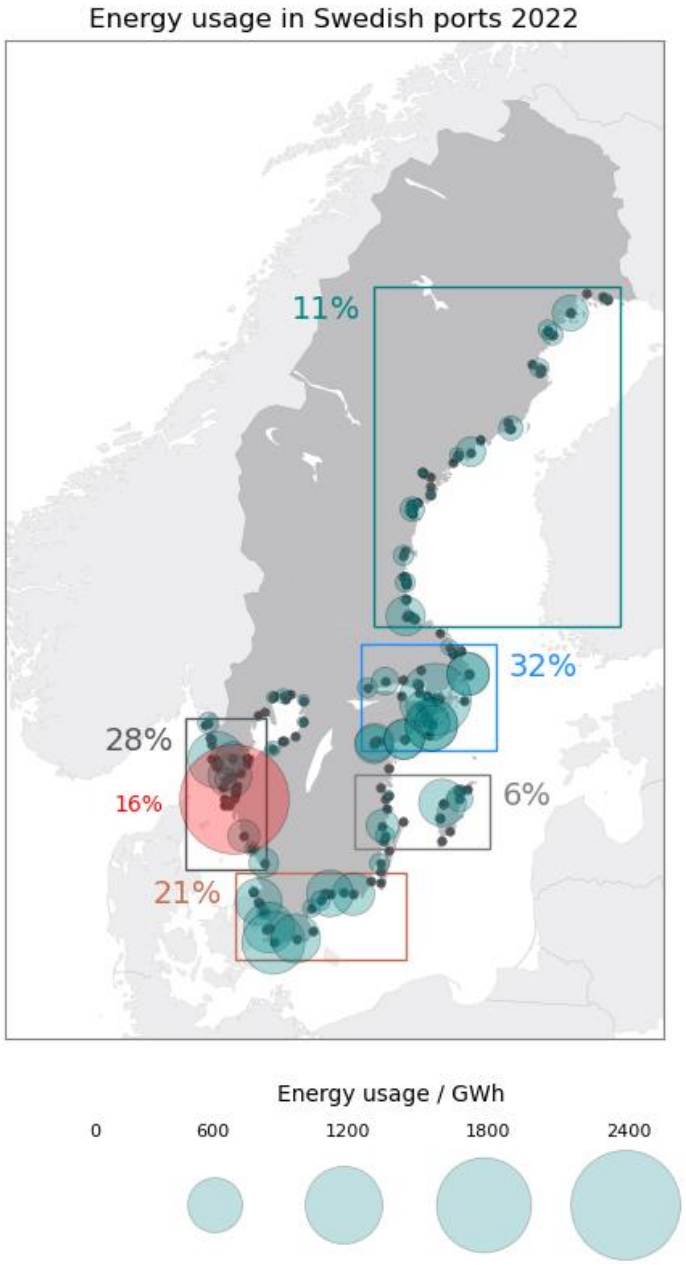
Swedish situation

Energy usage in ports (2022)





Energy in Port of Gothenburg:

- Onshore power supply (OPS) and charging for ferries, RoRo and product tankers
- Extensive bunkering operations
- All major marine fuels available (incl. MGO, HFO, LNG/LBG, methanol)

Ship to ship methanol bunkering (Port of Gothenburg)

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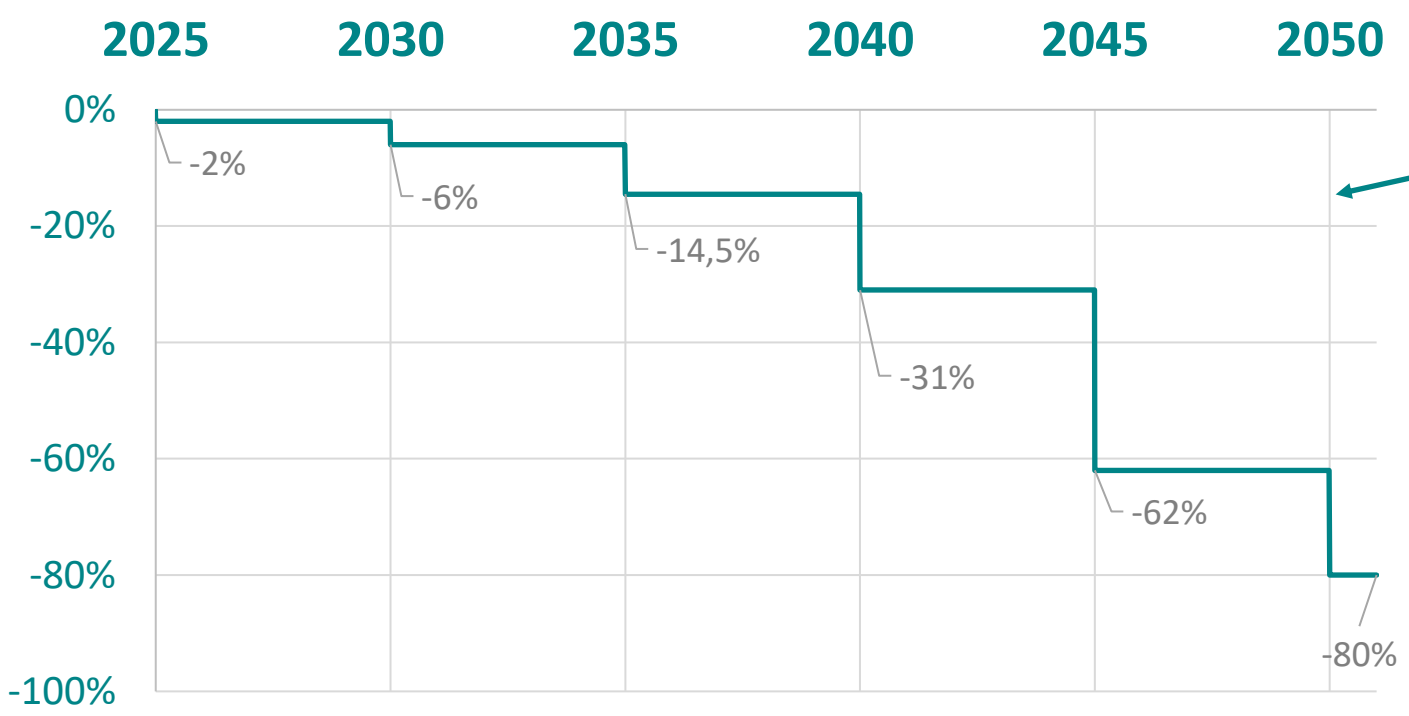
Drivers for the marine fuel transition

National, EU and IMO Polices and EU funding programs



- EU ETS
- FuelEU Maritime
- Renewable Energy Directive
- Directive for Alternative Fuel Infrastructure (AFIR)
- Taxonomy

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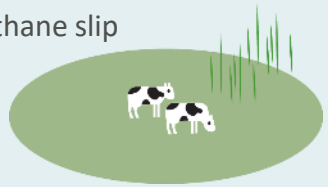
Renewable fuels and propulsion for ships

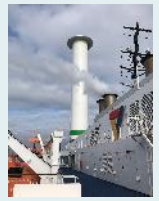
Biogas/LBM

- Good climate performance
- Ongoing production in Sweden
- Does not require specific adaptation in LNG vessels
- Methane slip



Wind

- So far mainly as assisting power supply in marine applications
- Ongoing development for wind as the main propulsion



Hydrogen

- Does not contain carbon
- Tested in marine applications
- Low energy volumetric density, storage issues
- Renewable production need to increase

HVO

- Requires no specific adaptation onboard
- Does not improve emissions of NOX and PM
- Dependence on imports (but Swedish production exists)

Electricity/Batteries

- Tested and proved
- Smaller ships typically suitable for full electrification and larger ships for hybrid solutions

Methanol

- Tested and proved in marine applications
- Good climate performance if from biomass or electrofuel
- Plans for production in Sweden

Ammonia

- Does not contain carbon
- Strongly toxic
- Not tested yet in marine applications
- Renewable production need to increase
- Safety issues

According to the Swedish Energy Agency's statistics, in 2022, just under 5% of renewable fuels were used for domestic shipping in Sweden (HVO included but electricity excluded). Natural gas accounted for 14%.

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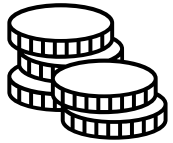
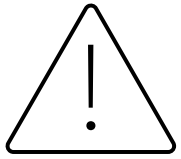
3 key barriers hindering the uptake of low carbon marine fuels



Demand and Cost remains a significant challenge

Lack of **fuel availability** and **bunkering infrastructure**



Technology and lack of **safety requirements and experience** for ammonia and hydrogen, limiting early uptake

Source: Nordic Roadmap project, https://futurefuelsnordic.com/
H2AMN project, https://www.ivl.se/vart-erbjudande/forskning/transporter/h2amn-vatgasbaserade-losningar-for-hamnar.html

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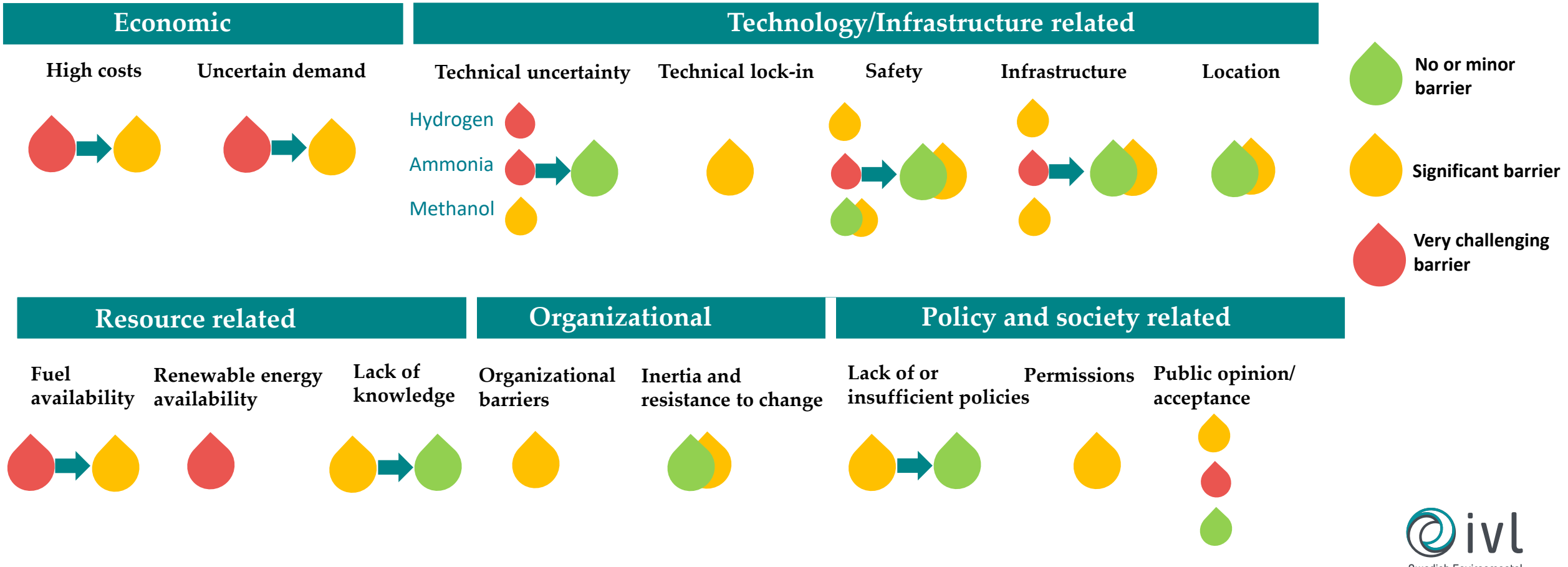
One practical barrier for ships and ports: Storage volume requirements

WORK MATERIAL

Key barriers for Port of Gothenburg to become a hub for hydrogen-based fuels



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Green shipping corridors

- A starting mechanism for the marine fuel transition and **enabler for ports** to become hydrogen hubs
- “Zero-emission maritime routes between two (or more) ports” (Clydebank Declaration)

Source: Nordic Roadmap project led by DNV, https://futurefuelsnordic.com/

Source: DNV

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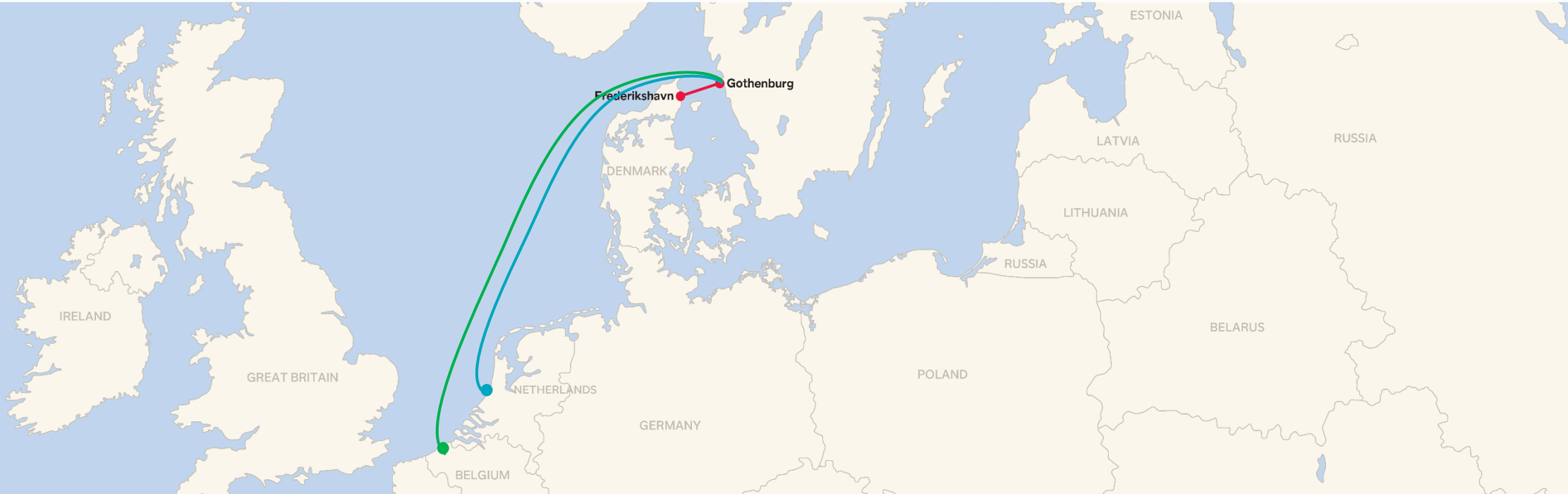
Green shipping corridor initiatives linked to Port of Gothenburg

Route	Segment	Fuels considered
Gothenburg - Rotterdam	Product tanker	LBG
Gothenburg - Belgium	RoRo (roll-on/roll-off) cargo vessel	Ammonia
Gothenburg - Frederikshavn	RoPax (roll-on/roll-off passenger) vessel	Electricity, biofuel or methanol



The Nordic roadmap project (2022-2025)

Nordic Council of Ministers

Nordic collaboration with 70 partners coordinated by DNV and funded by the Nordic Council of Ministers

Objectives:

- Gain **technical knowledge** and regulatory development
- Establish a **Nordic collaboration platform** and **green shipping corridor pilot studies**
- Develop a **Nordic fuel transition roadmap**

➢ Fuels in focus: **ammonia, hydrogen and methanol**

➢ 10 technical deliverables to date

➢ **3** ongoing **green shipping corridor pilot studies**

For more information, visit the project website:

https://futurefuelsnordic.com/

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WORK MATERIAL

Key barriers for turning the Gothenburg-Frederikshavn ferry route into a green shipping corridor:

	GHG abatement potential	Frequency of traffic on the specific route	Fuel availability	Fuel vessel flexibility	Port readiness	Safety and regulations	Stakeholders involved	Financial barriers	Technical maturity
Electricity				Invest-ment risk	Infra-structure			High battery cost	
Methanol			E-fuel				Fuel Supply	High fuel cost	
Biofuel			Cost develop-ment					High fuel cost	

Main barriers / challenges

Electricity
- High investment
- Economical risk - Uncertain second market value
- Power capacity

Methanol
- Green methanol availability
- Fuel cost

Biofuel
- Biofuel availability
- Fuel cost

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A range of engaged stakeholders needed for implementing a successful hydrogen hub

Besides **ports** e.g.,

Transporters and carriers

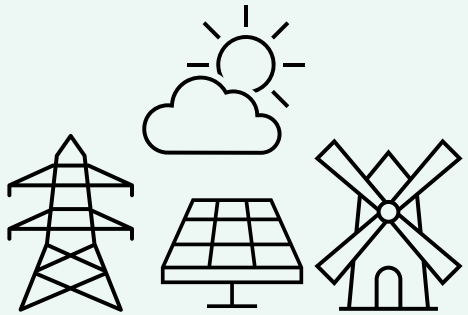
Policy and legislative bodies

Key energy suppliers and producers

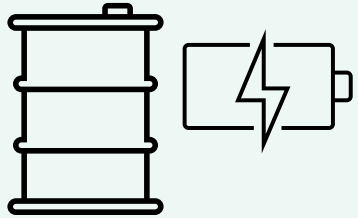
Other industries

Other interested parties incl. citizens

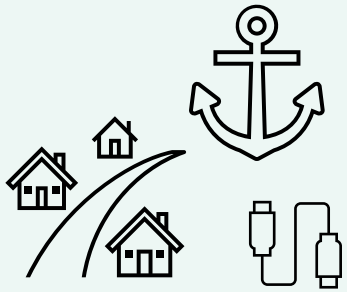
Renewable production



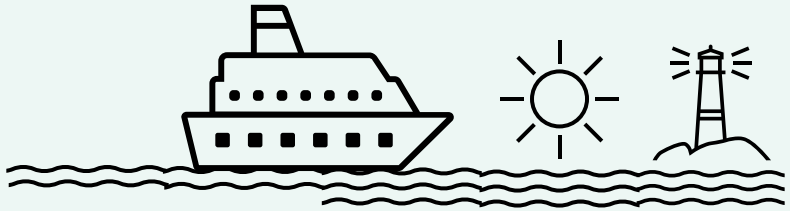
Renewable fuel



A sustainable port



Low-emission transport



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Challenges identified

- **Cost gap** need to be **reduced**…
- Current implemented policies not enough to support large-scale marine fuel shift in the short-to-mid term
- Complex puzzle of funding sources
- **Several actors**/operations need to commit and **collaborate** (several countries) -> **social engagement**
- **Ports** represent a vital actor
- **Social acceptance for** hydrogen fuels is necessary – increased knowledge in society is crucial

Thank you!

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