

The Hamburg Hydrogen Hub

Experience and Lessons Learned for Cluster
Development around Ports

Agenda

Speaker

Time

TOP 1: Introduction & Context of the Webinar

Moderator, All

10 min

TOP 2: In a Nutshell: the German National & the Hamburg Hydrogen Strategy incl. Take-aways for India

HPA

20 min

TOP 3: Cornerstones and Lessons learned | Renewable Energy Hamburg Cluster

HPA

20 min

TOP 4: Cornerstones and Lessons learned | Hydrogen Hamburg HUB

HPC

25 min

TOP 5: Conclusions & next steps

HPA, HPC

45 min

TOP 1: Introduction & Context

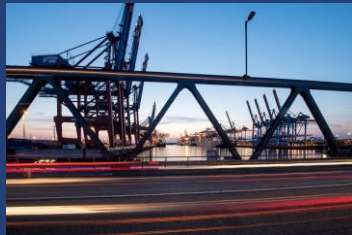
The roles in the Port of Hamburg

Port authority and private terminal operators



Regulatory body responsible for the management of the port area and several public authority functions

1. As **landlord**: planning and management of port area; provision of infrastructure; traffic management
2. As **regulator**: planning framework; enforcement of rules & regulations
3. As **operator**: nautical services (e. g. pilotage) & merchandise (e.g., loading)
4. As **cluster and stakeholder manager**



Private, commercial terminal operator that rents land from the HPA and uses port infrastructure

1. **Port operations**: especially container cargo handling
2. **Planning, provision & maintenance of superstructure**: cargo handling equipment or warehouses
3. Employment of **dock labor**



HPC Hamburg Port Consulting is a 100% subsidiary of HHLA and has been playing a leading role in the international port and transport consulting sector

Hydrogen – A promising future, but still work in progress

Definition of terms – What are we aiming for?

Cluster

- “Clusters are agglomerations of interconnected companies and associated institutions.”
 - “Firms in a cluster produce similar or related goods or services and are supported by a range of dedicated institutions located in spatial proximity, such as business associations or training and technical assistance providers.”
 - Advantages: assess economies of scale, facilitate access to skilled labour, proximity to suppliers/customers, access to information networks, cost sharing for shared infrastructure
- **Paving the way for hub development, bundling activities around physical hubs**

Hub

- “Hubs are central collection or distribution points”
- “By ‘hub’ is meant a very specific location, where physical activities are bundled”
- “A point where many routes meet and traffic is distributed, dispensed or diverted.”
- “Hubs are very common in the natural gas distribution industry, where pipeline networks interconnect in order to bring together gas from many different production fields, or to distribute gas to dispersed markets”

Anchor project

- “Large producer, usually in a single location, which provides a significant proportion of the H2 in a cluster of H2 projects”
- First mover who takes the first step and subsequently attracts surrounding projects
- Used to kick-off hub building

Sources: <https://creativeeconomy.britishcouncil.org/guide/hubs-clusters-and-regions/>; <https://wikidiff.com/cluster/hub>; <https://www.globalccsinstitute.com/wp-content/uploads/2019/08/Understanding-Industrial-CCS-hubs-and-clusters.pdf>

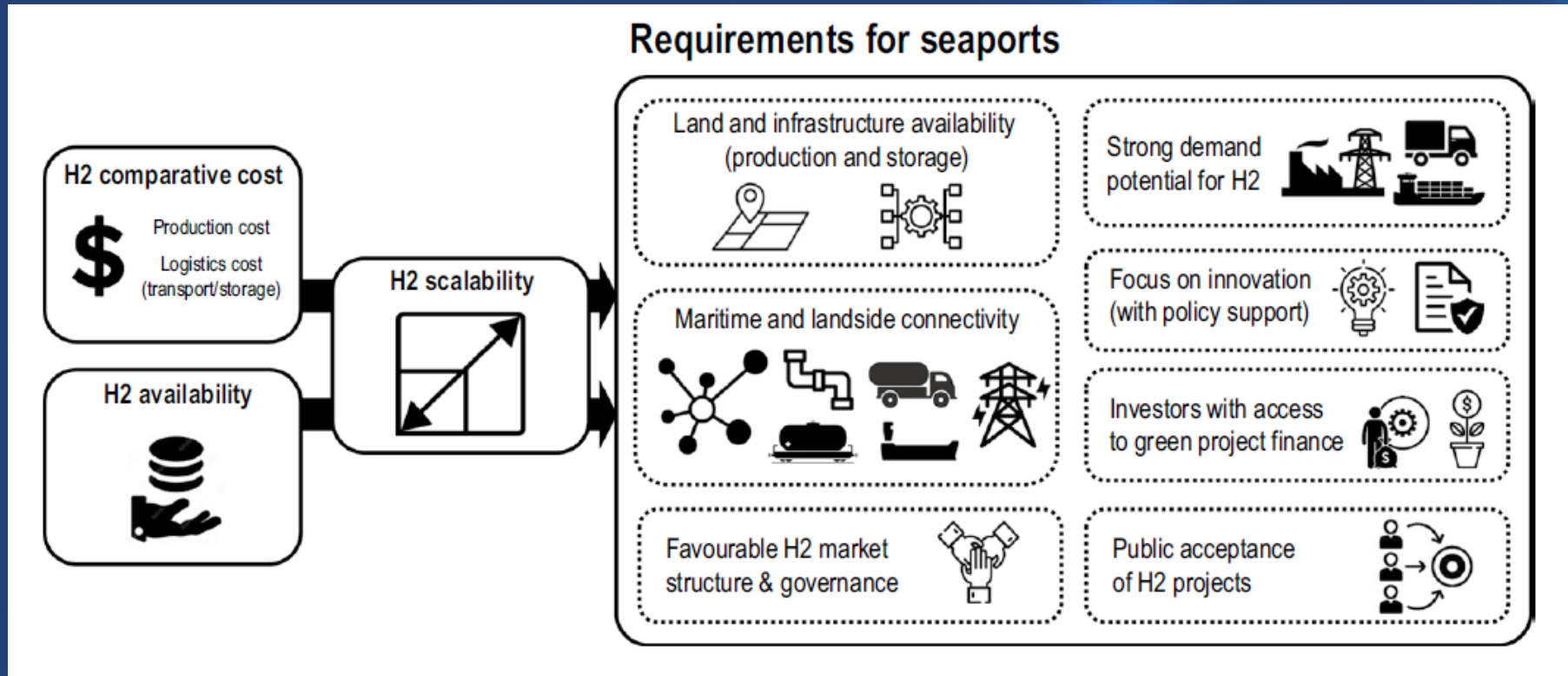
Hydrogen – A promising future, but still work in progress

Challenges in a developing market



Hydrogen – A promising future, but still work in progress

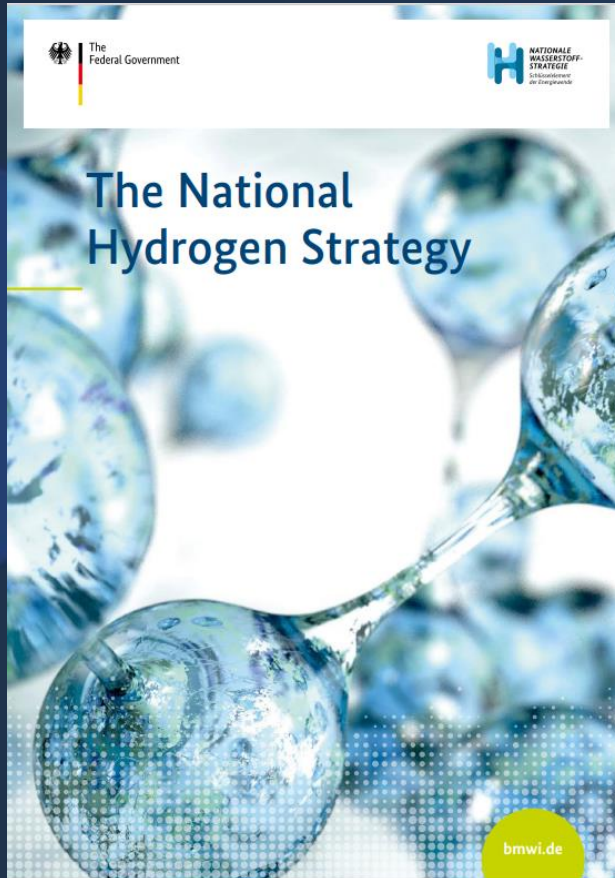
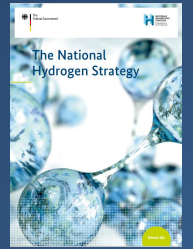
Beneficial framework conditions for hydrogen hubs



TOP 2: The German National & Hamburg's Hydrogen Strategy

Take-aways for India

National Hydrogen Strategy



Source: German Federal Ministry of Economic Affairs and Energy

Published by the German Federal Ministry for Economic Affairs and Energy in June 2020, but currently under further development

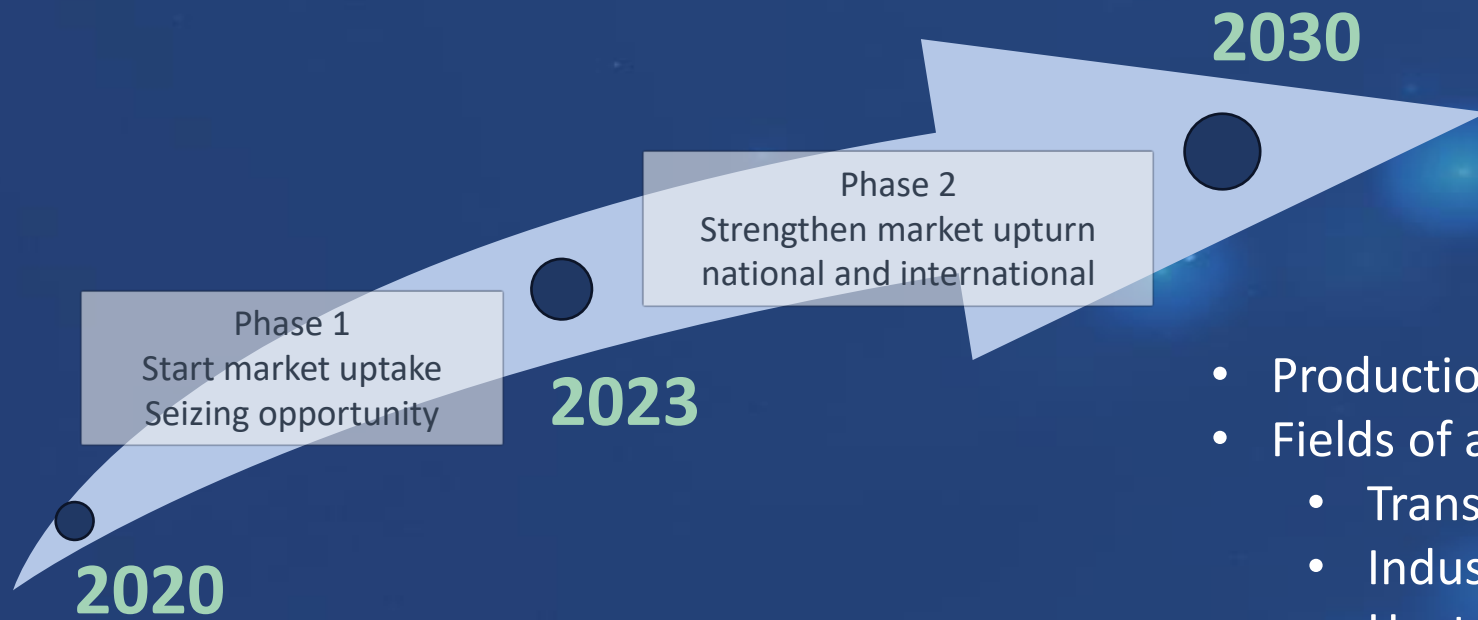
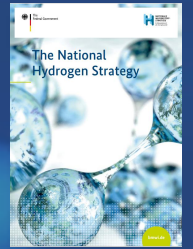
TARGETS:

- **2030:** 10 GW (instead of 5 GW) of electrolysis power for the production of green hydrogen
- According to coalition contract more focus on local production

OTHER TARGETS SET BY NEW GERMAN GOVERNMENT

- Climate protection as a new stipulation for all political decisions (referred to as „climatecheck“)
- expansion target for electricity from **renewable energies** of 80 percent by 2030
- **solar** duty on new commercial buildings; objective 200 GW by 2030
- allocation of new areas for **onshore wind** (2 percent land area) and procedural efficiency
- **offshore wind** expansion target of 30 GW by 2030, 40 GW by 2035

National Hydrogen Strategy

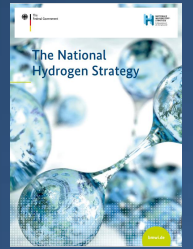


Phase 1
Start market uptake
Seizing opportunity

Phase 2
Strengthen market upturn
national and international

- Production of hydrogen
- Fields of application
 - Transport
 - Industry
 - Heat
 - Infrastructure/supply
 - Research, education and innovation
- The need for European action
- International Hydrogen Market and Foreign Economic Partnerships

Strategic International Hydrogen Partnerships



Areas of potential green hydrogen surplus for export

- Middle East/North Africa
- South Africa, Namibia
- Chile, Argentina, Uruguay
- Canada
- Australia
- Norway, Scotland, The Netherlands
- India?

Memorandums of Understanding HPA

- Canada/Halifax
- Chile

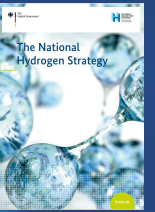
Main players

- Governments, Agencies, Ministries
- Big producers of hydrogen derivatives

Main issues

- Import of hydrogen derivatives
- Alternative shipping fuels

Hydrogen-IPCEI in Germany



- Over 62 large-scale projects all over Germany
- Funding with more than eight billion euros
- Overall 33 billion euros investments with 20 billion euros from private investors

PRODUCTION

- Overall more than 2 GW electrolysis capacity

INFRASTRUCTURE

- More than 1.700 km hydrogen pipelines

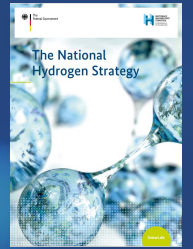
INDUSTIAL USE

- Focus on steel and chemicals production

MOBILITY USE

- Development and production of fuel cell vehicles
- Construction of hydrogen fuel station

Hamburg's Political Framework of Hydrogen Policy



Federal Level

2020

National Hydrogen Strategy

National Coalition Agreement
2021 - 2025

2021

State Level

Hamburg Climate Plan

2019

Joint Hydrogen Strategy of Coast
Federal States



2025: 500 MW electrolysis power
2030: 5 GW electrolysis power
2035: Green hydrogen economy

2019

Hamburg Coalition Agreement

2020 - 2025

2020

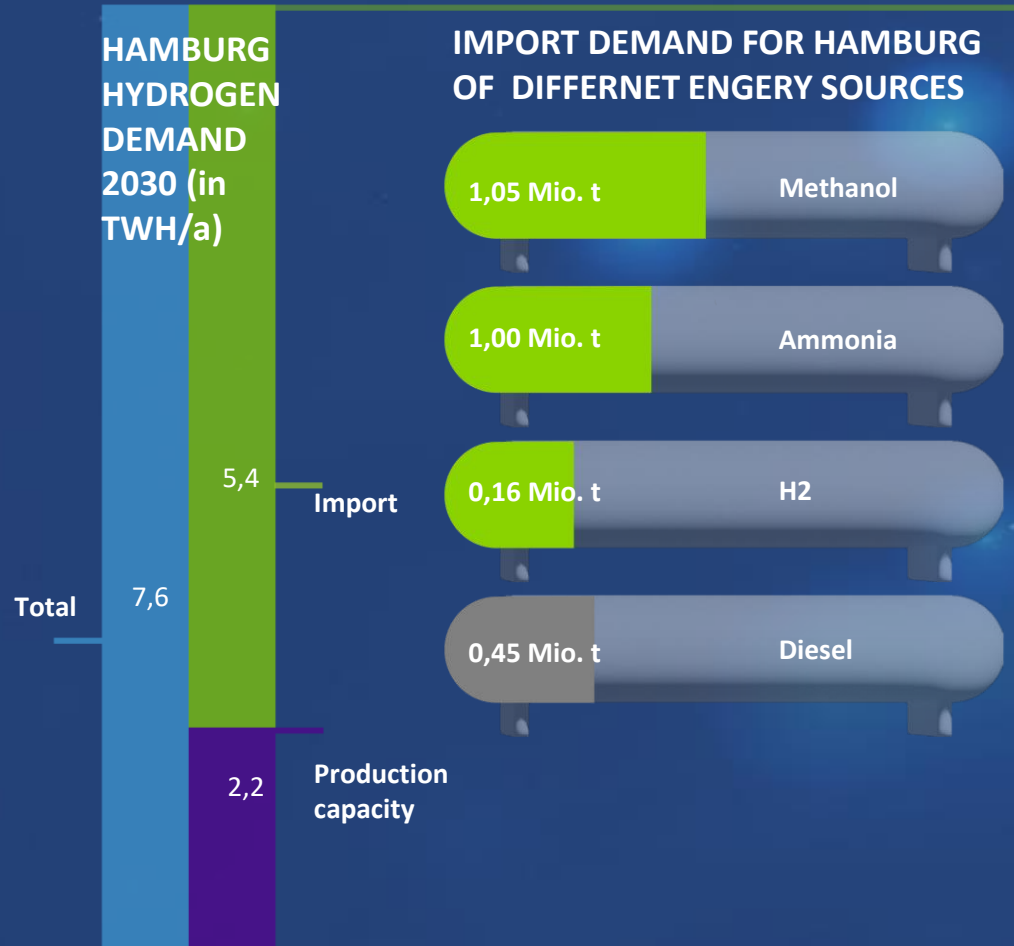
1. Decarbonization of port, industry, logistics & air transport

2. Building a competitive green hydrogen economy

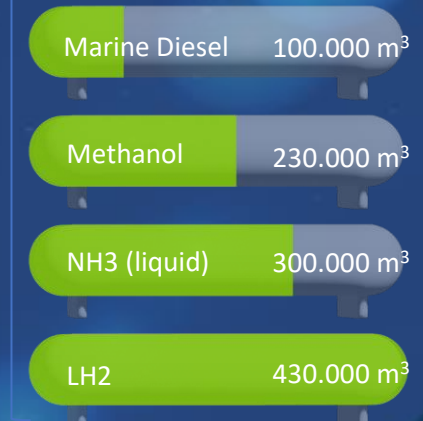
Hydrogen Demand and Derivates

Hamburg is already a critical import and storage location for fuel security in Germany.

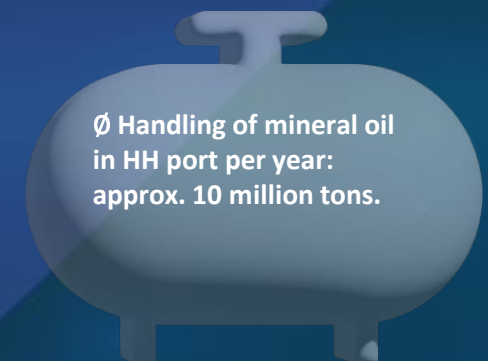
We as a port are dedicated to become a hub for sustainable energy and energy imports.



EQUAL AMOUNTS OF ENERGY COMPARED TO 100.000 m³ MARINE DIESEL



Sustainable fuels have higher gravimetric but lower volumetric energy density

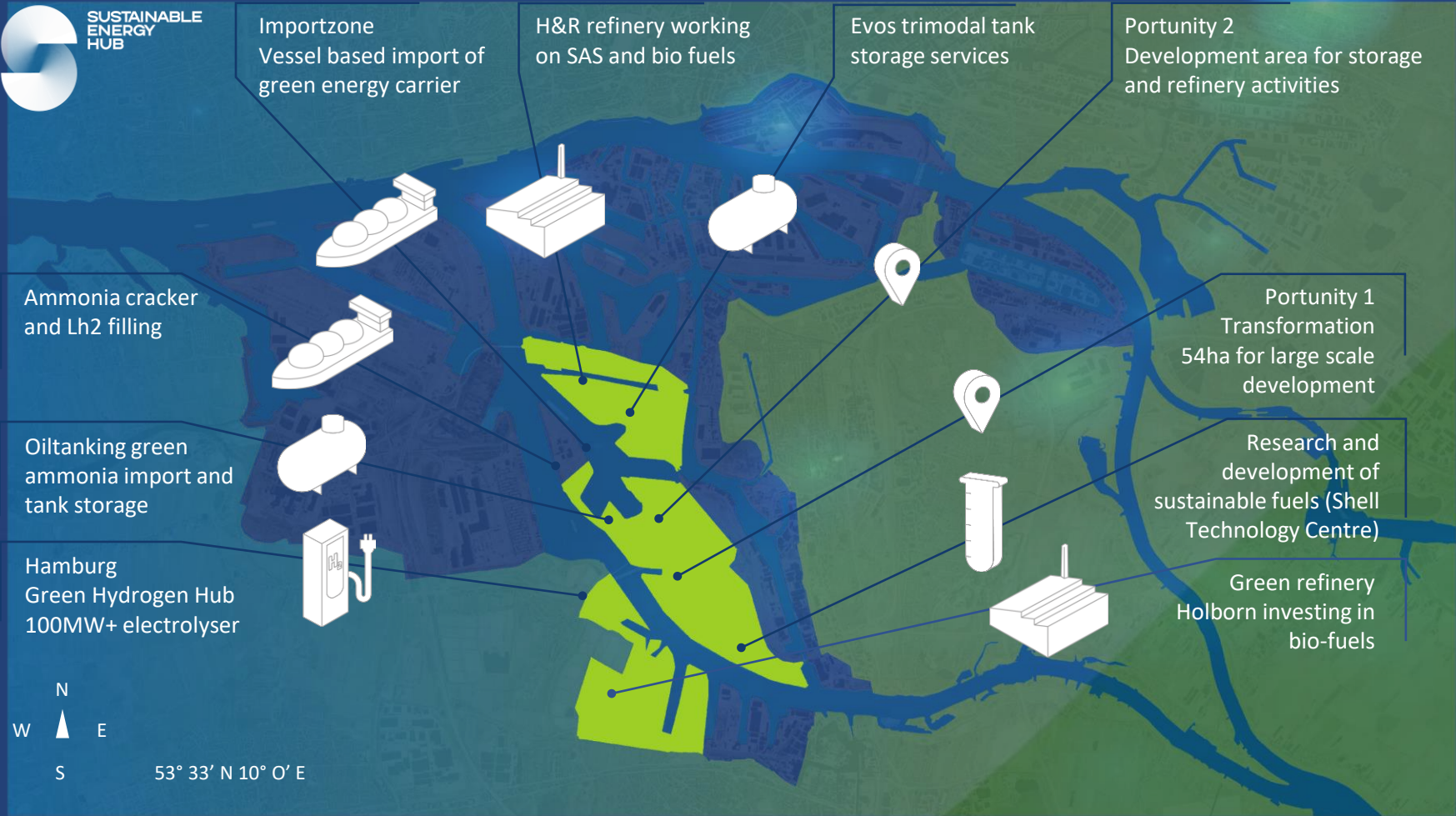


H2 Value Chain in the Port of Hamburg



Sustainable Energy Hub Hamburg

The sustainable energy hub builds on a strong cluster with decades of experience, cooperation as well as ambitious transformation projects of global scale.



Hamburg's Potential | Development into the Green Hydrogen Hub Europe

H2 Imports & Redistribution

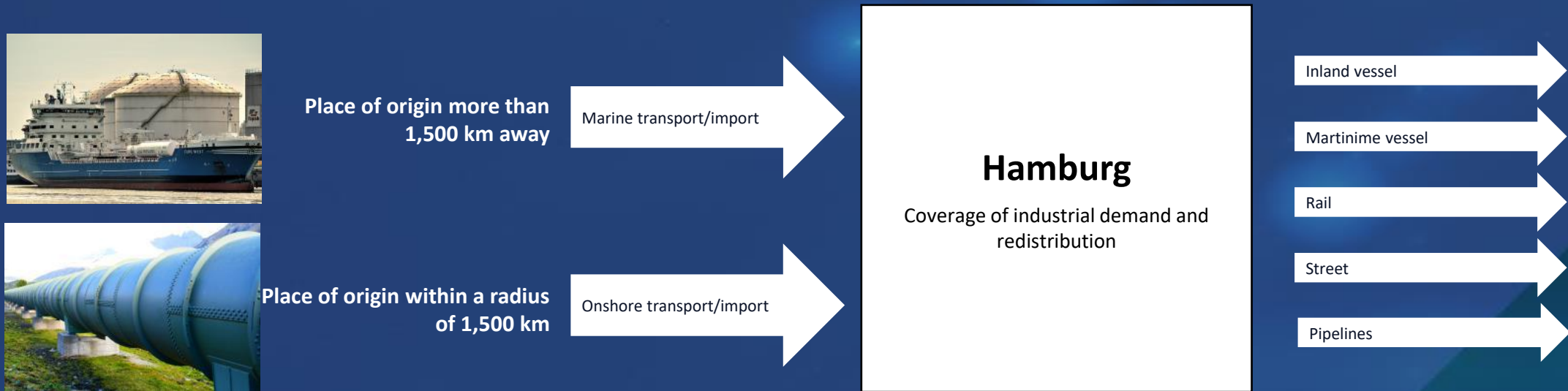


Image source: Pexels

Life-Cycle-Consideration of Green Hydrogen

Collaboration in the logistics chain

Hydrogen consumers need certified green hydrogen in order to be able to account for CO2 emissions trading

- Hydrogen production with renewable energy in exporting countries
- Hydrogen derivate tankers become first mover for alternative fuels
- Energy efficiency in distribution through the use of pipelines, railways and inland waterways
- Use of waste heat in transformation processes



Take-aways

- Key player: to get the market started
 - Private operators
 - State, municipality
 - Port authorities: Point of contact landlord, matchmaker, facilitator
- Understand the needs of off takers
- Think about the whole life-cycle of green hydrogen
- Public Funding and support is helpful to get the market started
- Simultaneous scale up/rump up market of supply, demand and infrastructure
- Renewable energy is critical

TOP 3: Renewable Energy Hamburg CLUSTER

Cornerstones and Lessons learned

Renewable Energy Hamburg Cluster Network at a Glance

WIND ENERGY
HYDROGEN
SECTORCOUPLING
SOLAR
RENEWABLE HEAT
BIOMASS

54

Founding Members in 2010

220+

Members,
Companies &
Institutions
in 2022

- Manufacturers
- Project Developers
- Utility Companies
- Grid Operators
- Logistics Specialists
- Lawyers
- Financial Service Providers
- Communication Experts
- Start-ups
- Universities
- Research Institutions
- ...

Renewable Energy Hamburg Cluster Activity



NETWORKING & CONTACT INITIATION

Individual members
Priority Groups
Whole cluster



MARKETING

Website
Newsletter
Blog
Videos
Social media
Brochures



EVENTS

Annual event:
German Renewables
Award
Contact points
Conferences
Seminars and webinars
Open House Event

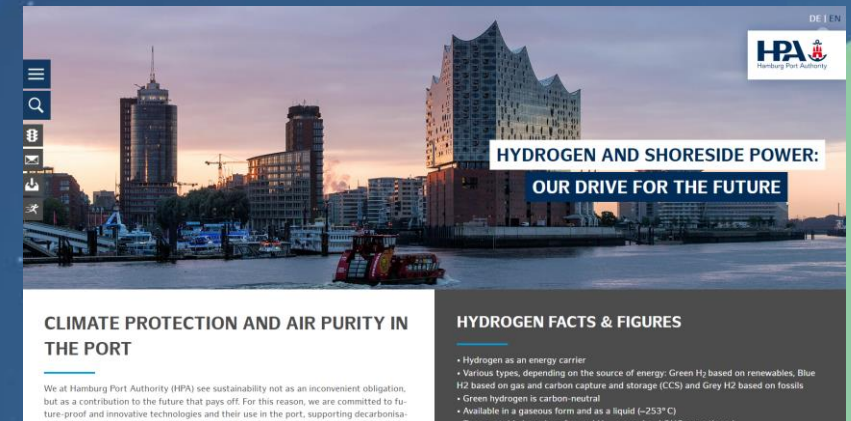
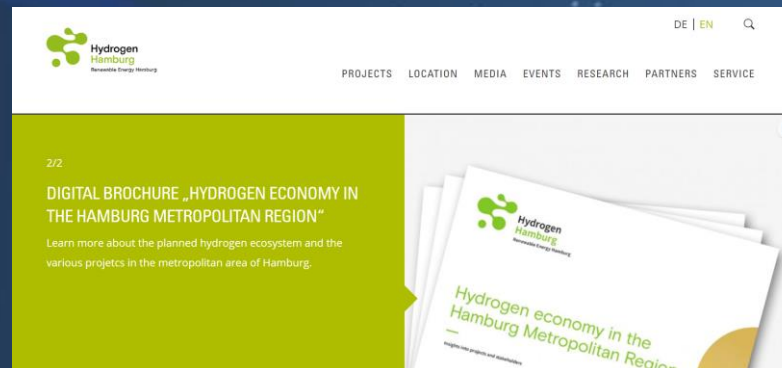
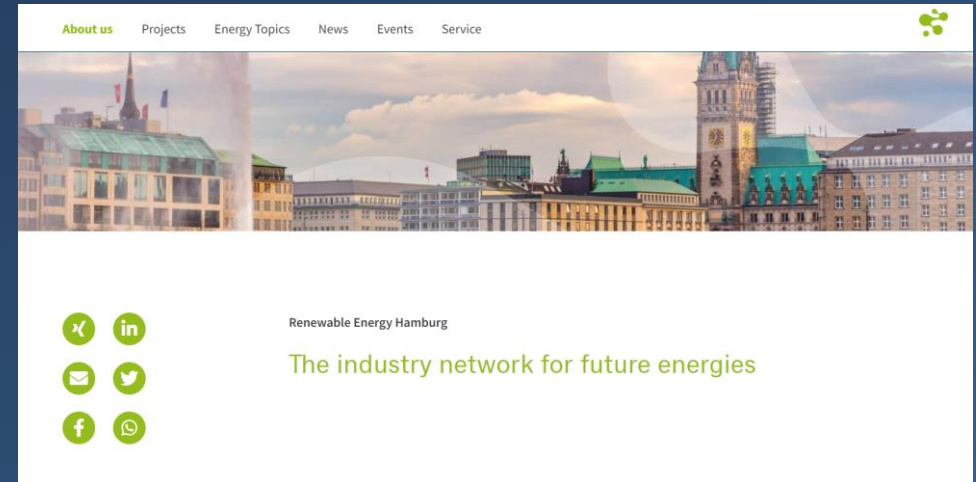


MEASUREMENT

WindEnergy Hamburg &
H2Expo
Hannover Messe
E-world
Husum wind and others

Cluster Areas of Work Public Relations

- German and English Website
 - Hydrogen facts & figures and project overview
- Newsletter in German and English
- (Explanatory) films on YouTube
- Print materials
- Blog
- Social media
 - LinkedIn
 - Instagram
 - Xing
- Face-to-face events
- Webinars
- Press visits



[Renewable Energy Hamburg](https://www.renewable-energies-hamburg.de) | [Renewable Energies Hamburg](https://www.renewable-energies-hamburg.de) | [EEHH \(erneuerbare-energien-hamburg.de\)](https://www.eehh.de)

Research & Innovation Forums

Target

- Regular direct exchange of stakeholders/networking
- Working on current issues and developing medium- and long-term strategies
- Strengthening of the HH location in the field of renewable energies/sector coupling
- Initiation of projects to promote the practical implementation of innovations

Format

- Regular appointments (approx. 1x per quarter)
- Changing Location
- Limited number of participants (approx. 50 persons)
- I. d. R. fixed circle of participants, but in principle open to “all”

Organization

- Three forum leaders from the industry per forum
- Forum Management & Project Management R&I (Cluster-EEHH) are responsible for the topics to be discussed, the selection of speakers and the other organization



NORDSEE

KMW BRU/SBÜTTEL
Wind to Gas

HEIDE / HUSUM



HyHamburg Green Hydrogen Hub Hamburg

A complete hydrogen ecosystem in close proximity

power supply system 380 kV

The port: central hub

One of the largest seaports in Europe
100 MW electrolyser
45 km of H2 pipeline
380 kV connection

Growing demand

Energy-intensive large-scale customers from the basic material and petroleum industry and the maritime sector

Visionaries and doers

Already 60 hydrogen projects in the fields of aviation, maritime, logistics, mobility, renewable energies

FINKENWERDER

HAMBURG

MOORBURG

Hydrogen system

HARBURG

GEEST HÄCHT

- Holborn Europa refinery
- Vattenfall
- Shell

- Trimet
- Linde
- Arcelor Mittal
- H&R Ölwerke Schindler
- Hansewerk electrolyser

- HADAG
- Flotte Hamburg

- Sasol Wax

- Aurubis

- Renewable Energy Hamburg
- Hydrogen Association Hamburg
- HHLA
- Hamburg Port Authority
- hySOLUTIONS
- Gas supply system Hamburg
- Siemens Gamesa
- Northern German regulatory sandboxes
- Hamburg University of Applied Science (HAW)
- Municipal cleaning Hamburg
- Hochbahn Hamburg (public transport)
- Biogas plant Bützberg
- Westküste 100
- RWE
- Helmholtz centre

H2 ecosystem

- GENERATION OF RENEWABLE ENERGY
- TRANSFORMATION & DISTRIBUTION
- INDUSTRIAL CUSTOMERS
- HYDROGEN APPLICATION
- IMPORT & PORT LOGISTICS
- RESEARCH & DEVELOPMENT

Lessons learned

Important tasks

- Socio-economic platform
- Facilitate interaction among market players
- Community building
- Create opportunities to meet
- Ensure coverage
- Be open for all players of the hydrogen value chain
- Be aware of limits: real business is confidential

TOP 4: Hydrogen Hamburg HUB

Cornerstones and Lessons learned

Metropolitan region and port of Hamburg

Beneficial preconditions for highly efficient nucleus of the hydrogen economy



**Cluster for production,
heavy and basic industry**



**Spatial proximity to
North German (offshore)
wind farms**



**Infrastructure for sea
and pipeline imports**
Port, European Hydrogen
Backbone



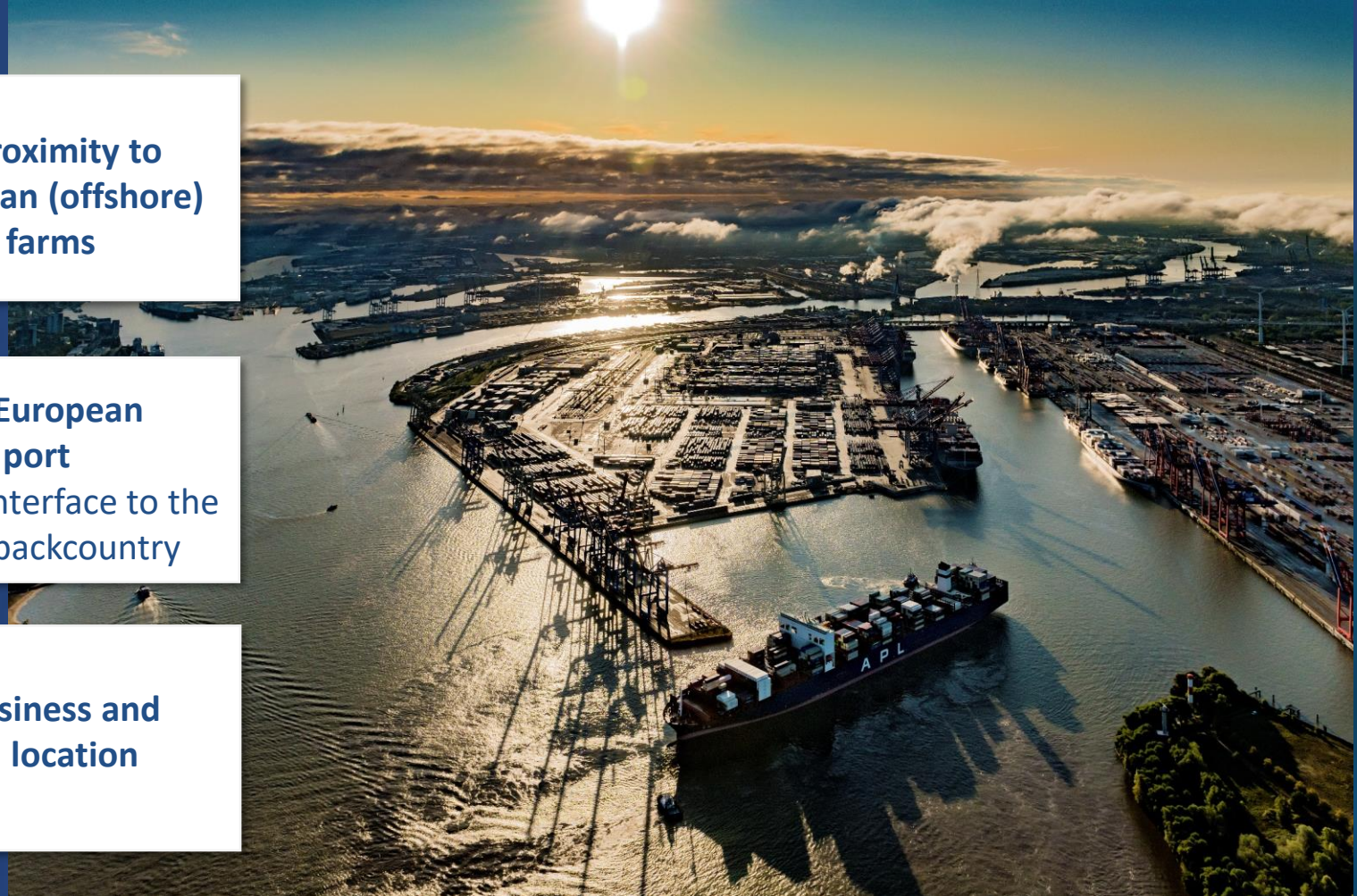
**Largest European
rail port**
Sustainable interface to the
European backcountry



**Largest field for hydrogen
applications in heavy
logistics**



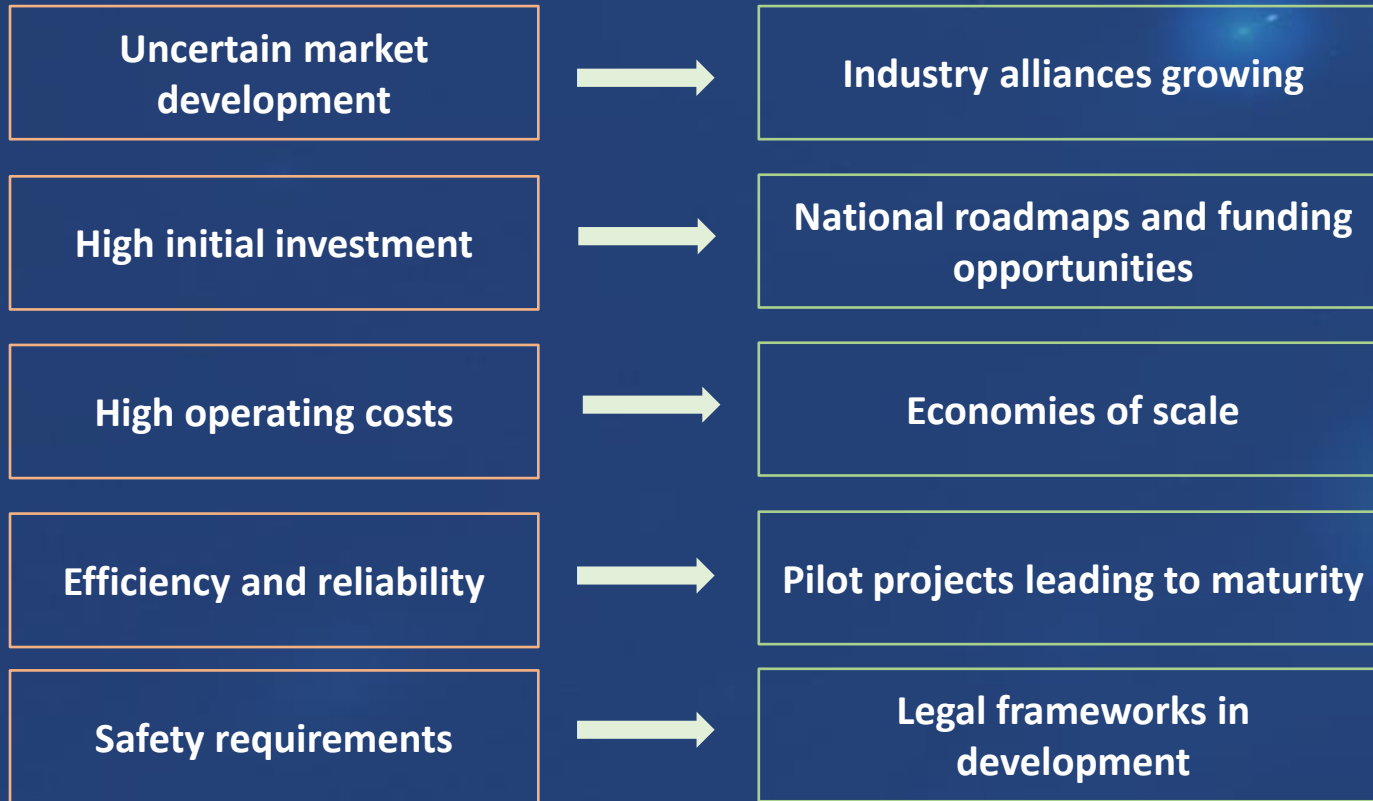
**Strong business and
research location**



Hydrogen Alliance Hamburg

Why to join forces?

Obstacles and Drivers for a Hydrogen Economy



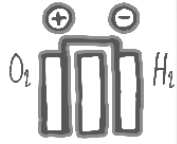
Aligned Project Development

- **Risk reduction to facilitate investments**
 - Secures market demand
 - Enables cost sharing
 - Backs-up business cases
 - Highlights lack in legislation and need for action
- **Coordination of timelines**
 - Drives ramp-up
 - Ensures parallel development
 - Simplifies match-making
 - Provides relevant framework conditions in time

Hydrogen Alliance Hamburg

Covering the entire hydrogen value chain

Production of green hydrogen



Infrastructure to connect supply and demand



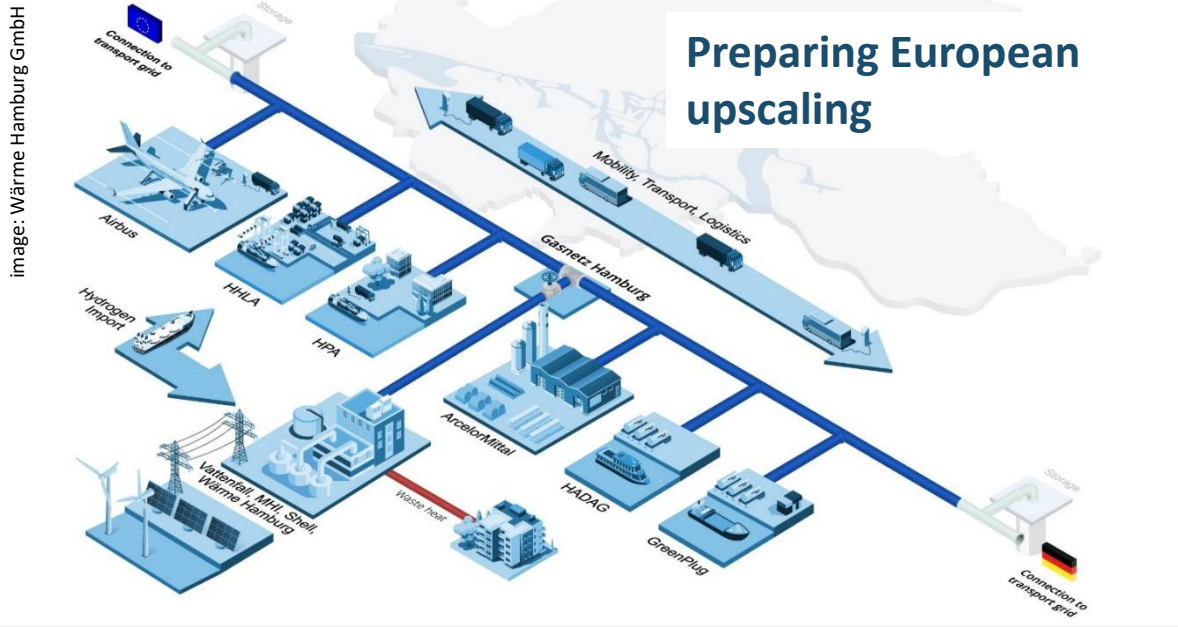
Application of green hydrogen in **Industry, Logistics and Mobility**



Every mobility sector represented: **road, rail, water, air**




Preparing European upscaling



Hamburg Green Hydrogen Hub

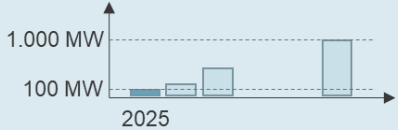
Local production

Large-scale decarbonization of industry and transport through the production and use of green hydrogen



100 MW Electrolyzer 11,500 t H₂ per year

- Commissioning 2025
- scaling potential:




Green energy site


- Conversion of the Moorburg power plant
- Site expertise / site owner
- Logistics & energy hub in the port area



GHG-Reduction 92,000 t CO₂/year

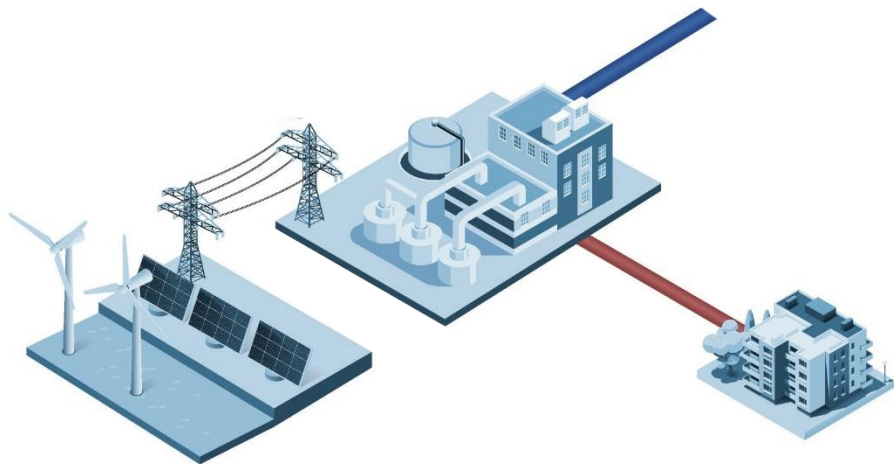
in the sectors

- Industry
- Mobility / Transport
- Households



Renewable Energy

- Direct coupling
 - On-/Offshore Wind
 - Solar
- Existing 380 kV-power connection





End to end integration

Wide-ranging networking, esp. industry and logistics

H₂ injection: HH-WIN

Waste heat: Integration into district heating system

Oxygen: potential industrial application



Booster for market ramp-up

- Filling station network and distribution to customers
- Expansion Option hydrogen storage
- Expansion option import/export terminal

Green Ammonia Import Terminal

Import

Large-scale ...

- Plans for Germany's first large-scale, green energy import terminal in the Port of Hamburg
- Joint development agreement between terminal operator and hydrogen producer signed in November 2022 (MoU already in February 2022)
- Targeted to provide hydrogen to Germany in 2026
- Planned import terminal will be located at existing tank terminal in the port: **partial conversion of infrastructure**
- Significant investments to deploy energy infrastructure capabilities and expertise to accelerate the energy transition in Hamburg as the key import gateway for Germany
- Import from large-scale production facilities around the world, conversion of ammonia to green hydrogen via Air Products' facilities in Hamburg, before distributing it to buyers locally and across northern Germany



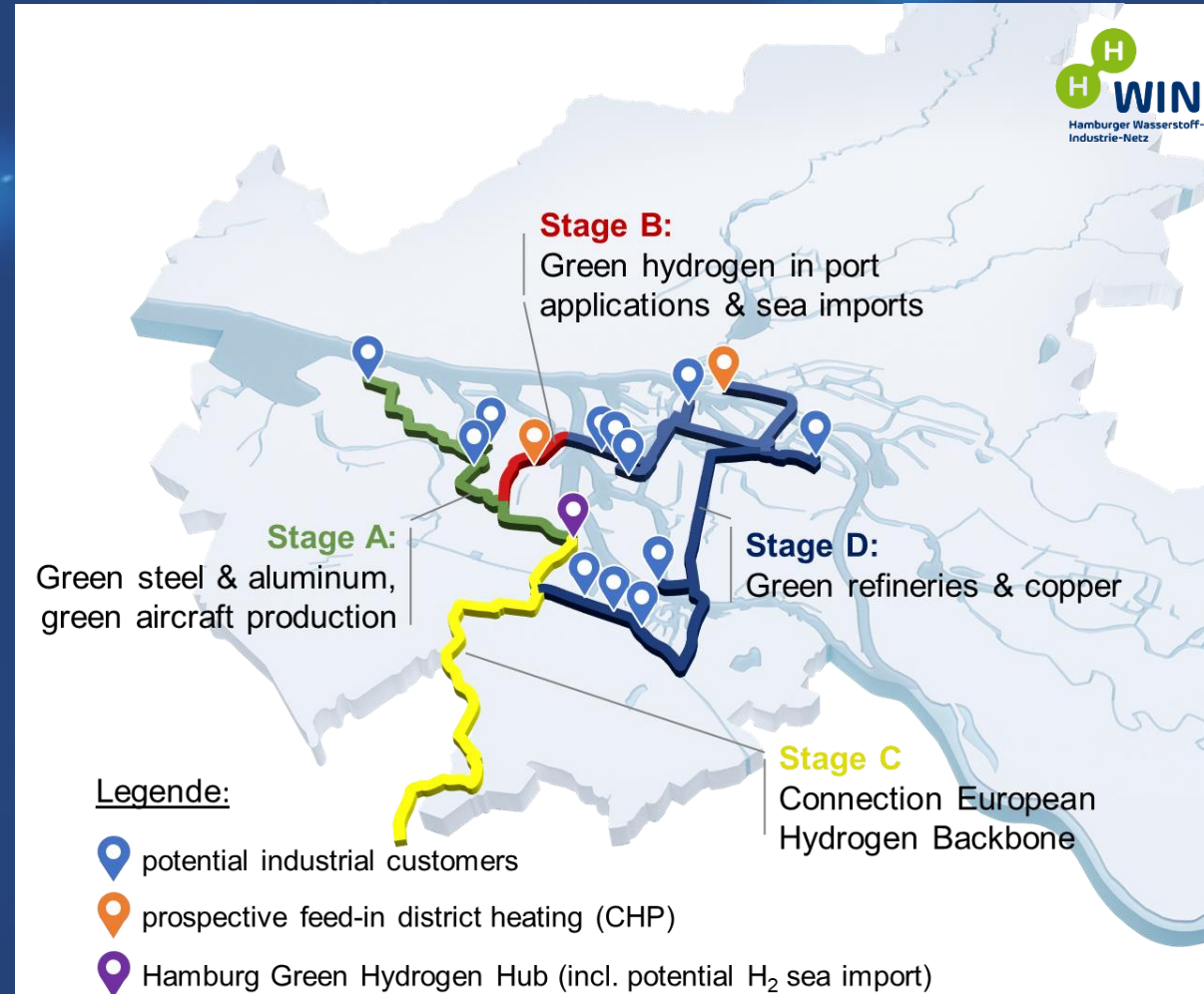
Hamburg Hydrogen Industry Grid

Distribution

Expansion Stages A to D

- A **hydrogen grid** for industry and commerce in the south of Hamburg (>200 RLM customers with 7.6 TWh)
- With **60 km hydrogen pipeline** around one third of Hamburg's natural gas consumption can be replaced, i.e. **570 million m³ natural gas p.a.** (6.4 TWh at 14 industrial sites)
- **Annual CO₂ savings potential**
 - ≈ **1.2 million metric tons of CO₂**
14 industrial sites
 - > **1.4 million metric tons of CO₂**
all >200 RLM customers

Non-discriminatory grid infrastructure enables the **ramp-up** of a real, flexible hydrogen market



H2Ready

Industrial Offtake

Conversion and operation of the existing DRI plant with addition of hydrogen



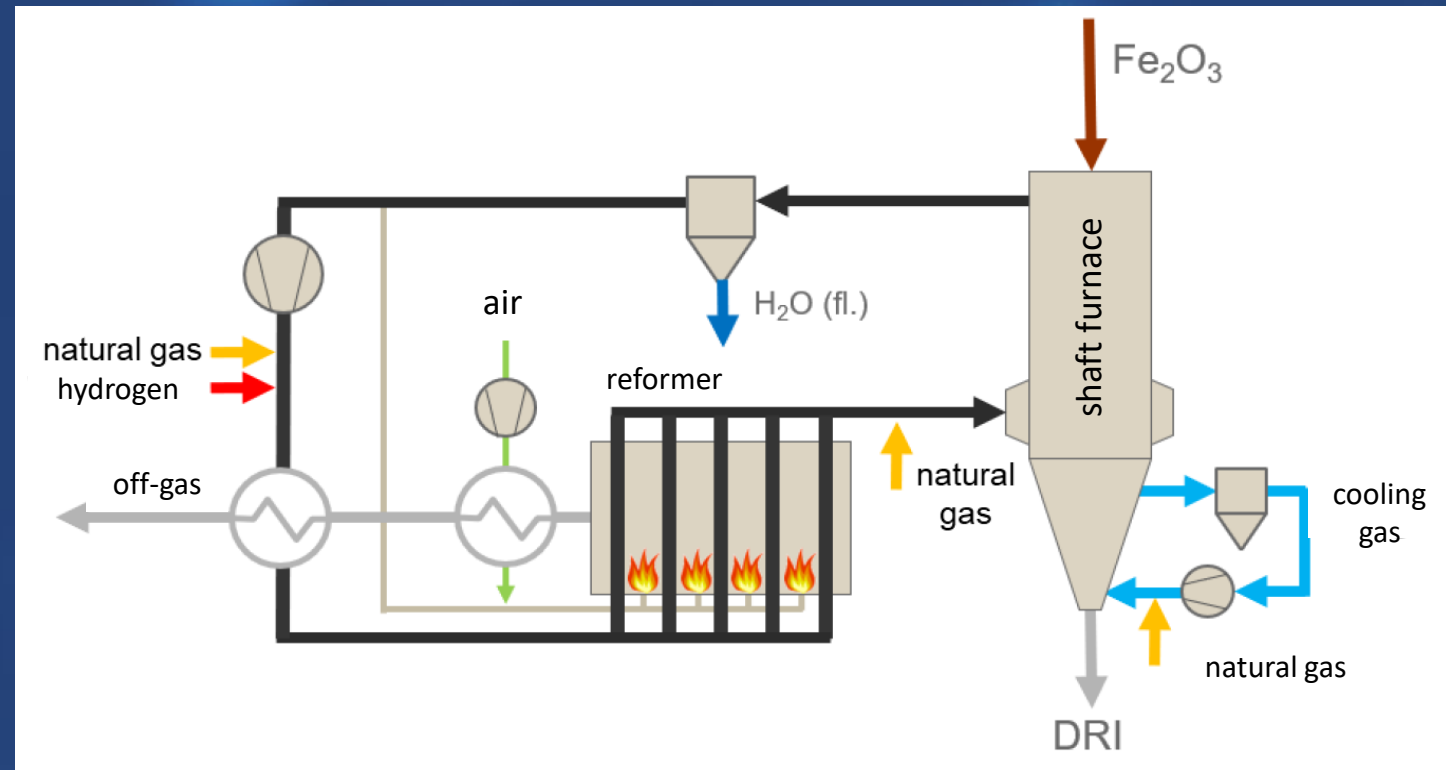
Production of CO₂-neutral steel in Hamburg



Hydrogen use in existing direct reduction plant for the production of sponge iron as an intermediate goal on the way to a pure H₂ reduction plant



- Replacement of 15% natural gas by hydrogen → **100,000 tons of green sponge iron per year** (out of a total of 700,000 metric tons per year)
- **CO₂ savings of 46.000 metric tons per year**
- Plant retrofit and six-month test operation included in 2025



Port of Hamburg as a blueprint for hydrogen and fuel cell applications in European logistics hubs

Mobility Offtake

Refuelling infrastructure



Hydrogen applications

Trucks



DAIMLER



Ships



Pilot ship & Future launch



Push boat
GREENPLUG



Passenger ferry



Shunters



Terminal equipment



HYSTER-YALE

KONECRANES



Lessons learned

- **Industry alliances reduce investment risks**
 - Secure market demand
 - Enable cost sharing
 - Back-up business cases
 - Highlight lack in legislation and need for action
 - Facilitates proposition for standardization of procedures
- **Coordination of timelines enables ramp-up**
 - Production depends on distribution depends on off-take
 - Simultaneous market ramp-up
 - Parallel development required for financially viable hydrogen economy
- **Dynamically adjust national/regional strategy based on project development**

TOP 5: Conclusion & Next Steps

Next steps to establish a successful hydrogen economy

Stakeholder-Management and Project Administration

- General project administration (including reporting, organizing of meetings, administrative duties)
- Identify relevant stakeholders
- Develop stakeholder strategy
- Organize and prepare stakeholder workshops
- Collect stakeholder's needs and requirements

Governance-Structure

- Benchmark governance options from similar hydrogen endeavors
- Build up optimal structures, processes and systems that define decision-making and interactions amongst various stakeholders
- Allocate roles and responsibilities between private operators, research institutions and public actors
- Define role and function of port authority: facilitating role; active involvement?

Next steps to establish a successful hydrogen economy

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Logistics Concept

Integration of a hydrogen hub into an international supply chain

- Definition of options for transporting green hydrogen overseas?
 - Assessment of most promising hydrogen state of aggregation for transport
 - Assessment of transport routes / Definition of a hydrogen transport circle
 - Assessment of type of carrier and implications on infrastructure
 - Elaboration of handling / operations / safety concepts
 - Assessment of permit requirements
- Depending on import relations / market studies, what would be the preferred transport scenarios? (e.g. centralized, decentralized)?
- How would transport facilities look like for the different options of transporting hydrogen? (e.g. site analyses, transport scenarios, development roadmaps)

Business Plan

Can a hydrogen hub be financially viable for a private investor?

Review of potential for generating sufficient revenues to justify the investments

- Which income streams can be determined and how do they develop?
- Which are required operations expenses (labour, maintenance & repair, energy, and administration cost) over time?
- What is the volume and schedule for capital expenditures for infrastructures and superstructures?
- Is the investment commercially viable from the investor's point of view (under consideration of financing options)?
- Can the investment demonstrate benefits for the society (based on an analysis of cost and benefits)?

Discussion

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Back up

Andreia Thiel, PhD

Head of Strategy | R&D | Environmental Affairs and Sustainability

Port expert in the field of strategy development and implementation

HPA - HAMBURG PORT AUTHORITY

Main areas of expertise

- Active shaping, coordination and revision of the strategic measures for the corporate development of HPA
- Engagement in consultancy projects and support of the management board regarding the operative and strategic business issues (incl. the organization and steering of international cooperation and sister-port agreements with Asian ports)
- Development and implementation of new business fields in the port | Coordination with port companies and other relevant port stakeholders
- Preparation of market-, trend and client analyses; development of competition analyses, market valuation models and KPIs for port authorities | Preparation of decision papers and presentations; representation of the HPA at national and international level



“A good strategy has to be built up at the interplay of excellence, pioneering spirit and the courage to get things done”

Past employment:



HPC Hamburg Port Consulting

Main areas of expertise:

- Consultancy projects in the port and logistics segment
- Market and competition analysis
- Traffic and throughput forecasts development
- Cost-benefit analysis; prize- und supply policy
- Project planning and steering for international clients (in particular Asia, Middle East, Africa and Southern Europe)

Johannes Schmidt, PhD

Senior Manager | Port trends | Sustainable port area development

Port expert in the fields of sustainability, innovation and strategy with extensive operational knowledge acquired through working in one of the leading port management consultancies.

HPA - HAMBURG PORT AUTHORITY

Main areas of expertise

- Responsible for climate mitigation & adaption projects for the port estate department
- Development of port area strategies and plans with a focus on sustainability and innovation
- Elaboration of Green Port Actions Plans and Roadmaps in collaboration with port stakeholders
- Conducting environmental benchmark and lifecycle studies
- Preparation of environmental lifecycle & profitability analysis
- Systematic innovation and sustainability scouting as well as market and trend monitoring worldwide



“Passionate about tackling climate change and fostering sustainability”

Past employment

HPC Hamburg Port Consulting

Main areas of expertise

- Responsible for worldwide sustainability projects for the port & logistics sector
- Acquisition of projects in the field of terminal optimization and sustainability
- Participation in several transport and port planning projects
- Preparation of port market-, trend and competitor analyses



Bionic Production GmbH

Main areas of expertise

- Strategic product management and business development
- Project management and sales development



Ingo Fehrs

Head of Environmental Strategy and Sustainability

Port expert in the fields of strategic port development, port governance, sustainability and port cooperation

HPA - HAMBURG PORT AUTHORITY

Main areas of expertise



- Senior adviser strategic port development
- Analysis of megatrends
- Expertise in port industries
- Role of Port Authorities and port governance
- Development of port area strategies and plans with a focus on sustainability, added value, jobs and growth
- Responsible for hydrogen strategy of HPA



“transition of economy in a post-fossil world is crucial”

Past employment

Hamburg Ministry of economic affairs and innovation



Main areas of expertise

- Asset management
- Free port and European policy
- Airport economics and regulation

Dorothe Görtz

Project Role: Terminal Planning and Sustainability Expert



Senior CONSULTANT

- 5 years of experience in ports, intermodal and logistics industry
- Main focus on optimisation of terminal processes, logistics hub development, network strategy and energy efficiency
- Expert in supply chain design for alternative energies

NUMBERS

- 7 Development plans and optimization projects for intermodal terminals and inland hubs worldwide
- 5 Traffic network analyses and optimization studies to derive and implement road maps and improvement strategies
- 5 Support in business development and successful application for external funding to implement innovative projects

KEY PROJECT ACHIEVEMENTS

Provided terminal planning expertise in the revision and optimization of terminal layout and planned operational processes for 2 greenfield projects in North America and in the analysis and optimization of processes in intermodal terminals in Germany, Austria, Hungary and United States.

Supported the development of an innovation cluster for fuel-cell powered equipment in ports, including analysis of requirements, funding management, specification of refuelling infrastructure and evaluation of hydrogen supply chains.

Successfully conducted a quay simulation analysis for different vessel size scenarios for a greenfield terminal to define a feasible service level.

SAMPLE OF CLIENTS



**SOUTH
CAROLINA
PORTS**



Federal Ministry
for Digital
and Transport

