

Digital Briefing: Green Distribution & Storage

TUESDAY, 15 JUNE 2021 09:00 (CEST)

**Maritime Industry and Infrastructure:
The Supply Chain of the Future**



HY-5 

The HY-5 logo graphic consists of three vertical bars in blue, green, and yellow.

Agenda

Opening Speech:

Thorsten Herdan (Federal Ministry of Economic Affairs and Energy | Director General)

Inspirational Speaker:

Prof. Dr. Johannes Gulden (HyStarter & University of Applied Science Stralsund)

Power Briefs:

Georg Böttner (HHLA | Head of Executive Board Projects)

Dr. Tim Husmann (H2-Region Emsland | Managing Director)

Jens Scharner (Rostock Port GmbH | Managing Director)

Prof. Dr. Matthias Rehahn (Helmholtz-Zentrum Hereon | Managing Director)

Dr. Lars Stemmler (bremen ports | Head of bremen ports international)

Q+A w/ GTAI & HY-5 Investment experts



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House keeping



Participants are muted



Webinar is recorded and is available for retrieval after the webinar



Questions via chat feature



Q&A session at each section of the presentation



What's next: **Opening Speech**

Thorsten Herdan

Director General
Federal Ministry of Economic Affairs and Energy



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What's next: **Inspirational Speaker**

Prof. Dr. Johannes Gulden

HyStarter & University of Applied Science Stralsund



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**Institut für Regenerative
EnergieSysteme
Prof. Johannes Gulden**



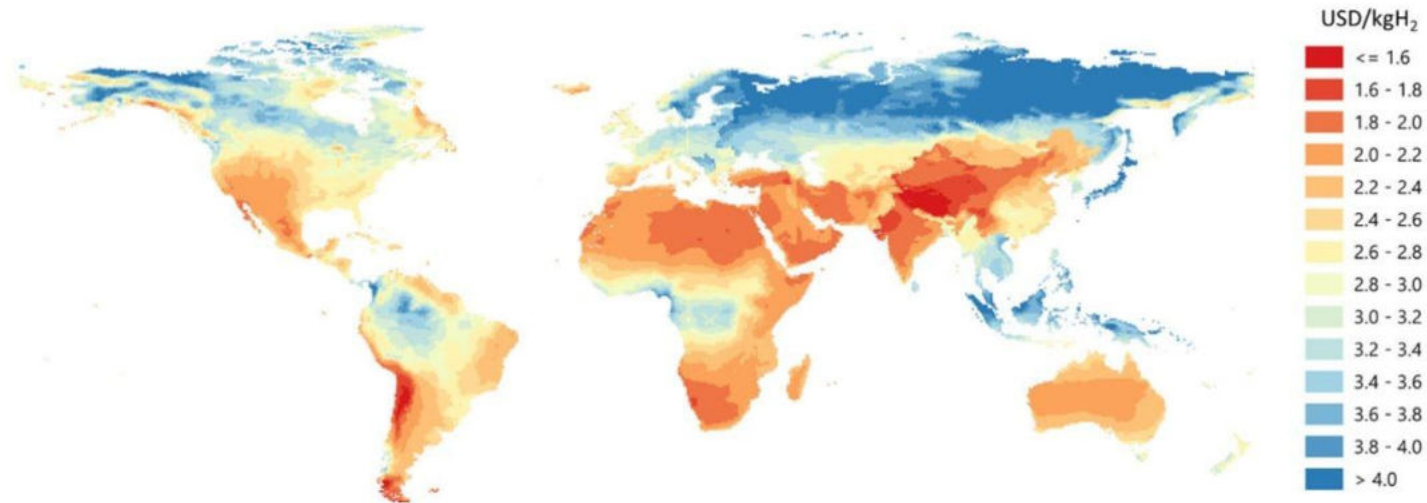


- Elektrical energy 510 TWh
- Green portion 188 TWh
- Chemical energy 1894 TWh
- Green portion 177 TWh
- total 2404 TWh

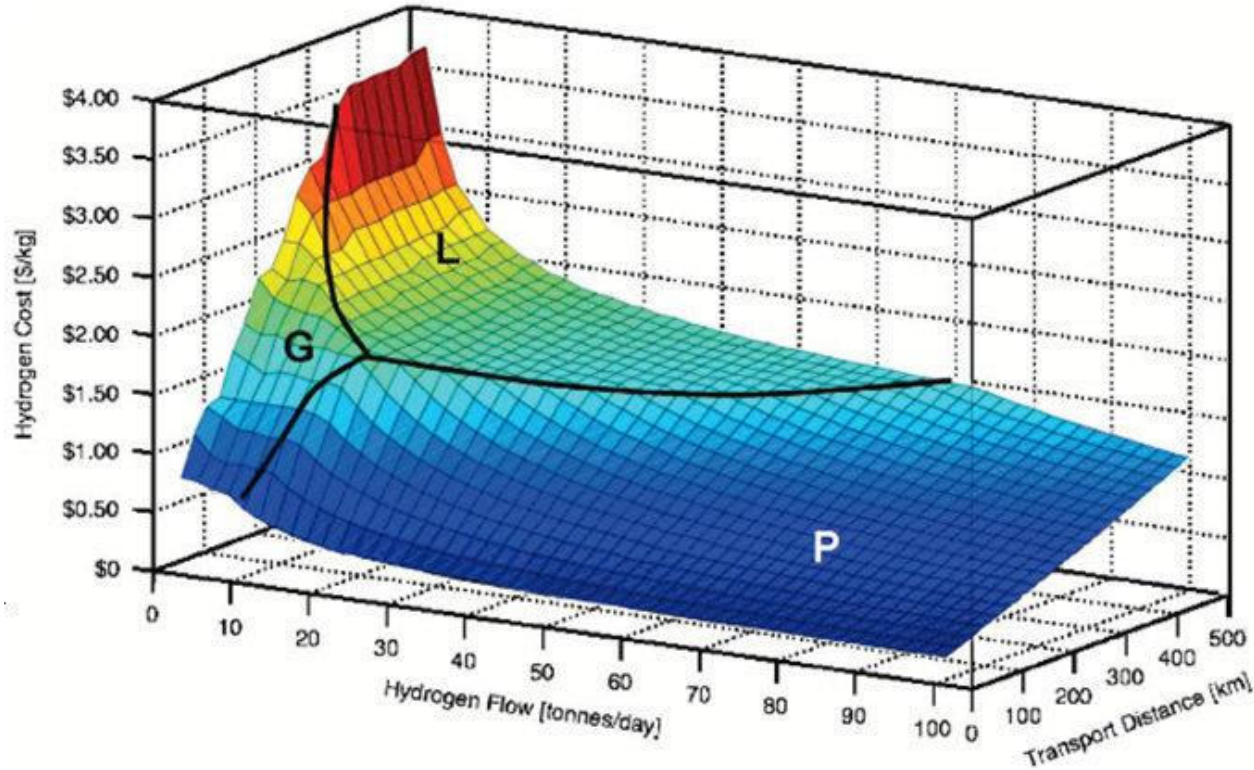
We need hydrogen

Hydrogen production costs

Hydrogen costs from hybrid solar PV and onshore wind systems in the long term

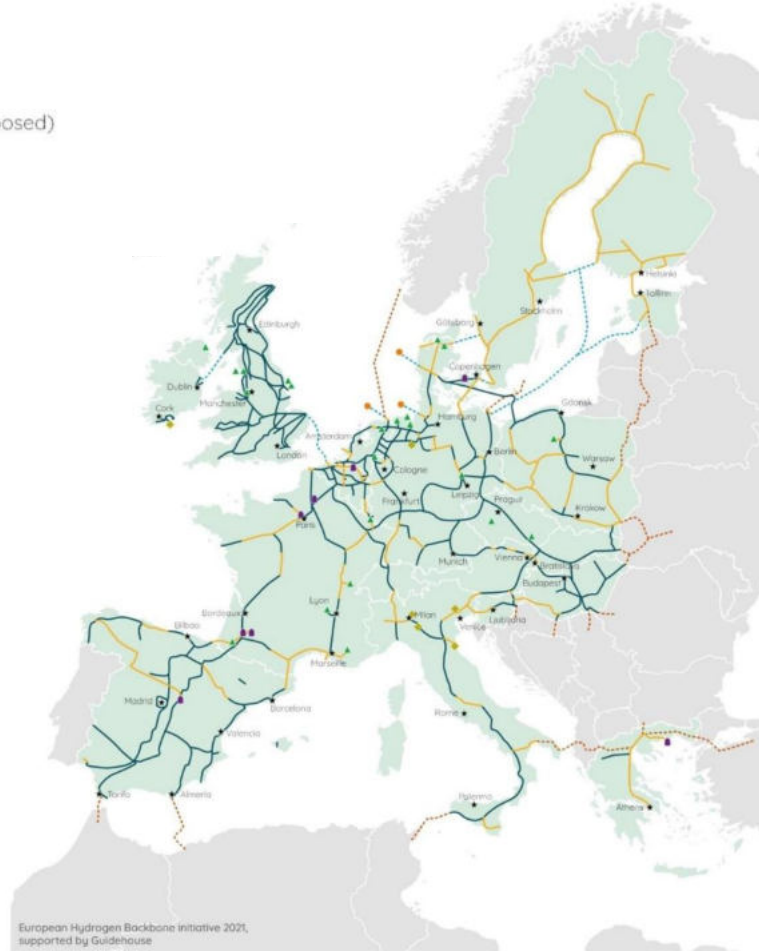


Hydrogen transportation costs



Energy demand in germany

- H₂ pipelines by conversion of existing natural gas pipelines (repurposed)
- Newly constructed H₂ pipelines
- Export/Import H₂ pipelines (repurposed)
- Subsea H₂ pipelines (repurposed or new)
- Countries within scope of study
- Countries beyond scope of study
- ▲ Potential H₂ storage: Salt cavern
- Potential H₂ storage: Aquifer
- ◆ Potential H₂ storage: Depleted field
- Energy island for offshore H₂ production
- ★ City, for orientation purposes

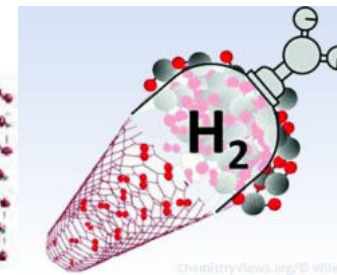
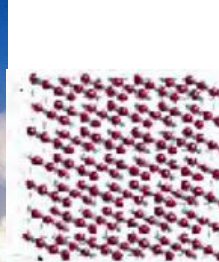
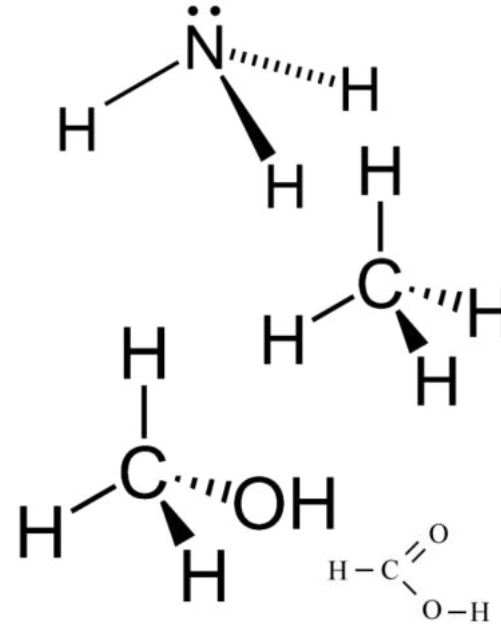


European Hydrogen Backbone Initiative 2021, supported by Guidehouse

Hydrogen storage technologies

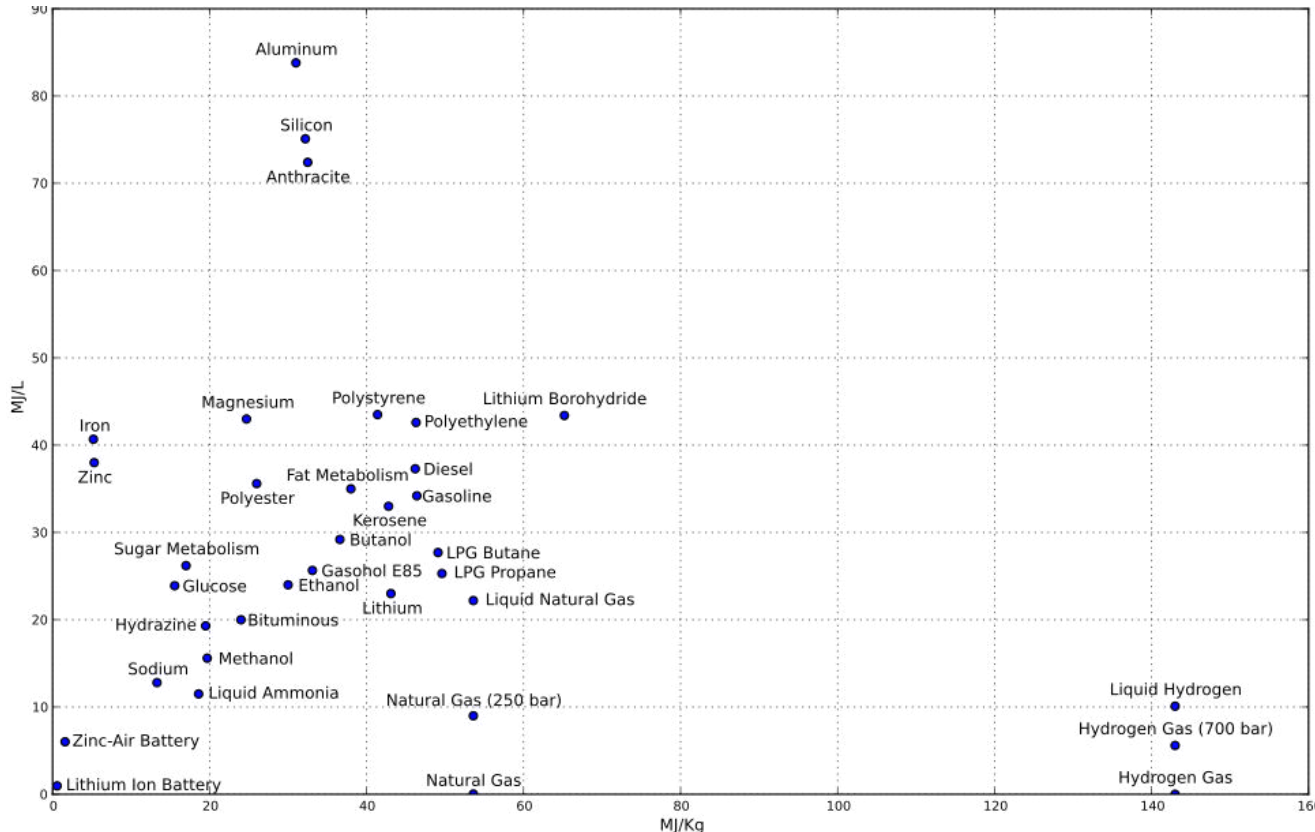


- compressed hydrogen (30 bar bis 700 bar)
- Liquid hydrogen (space applications)
- Metall Hydrids (Stationary applications)
- Chemically bound hydrogen
- Liquid Organic Hydrogen Carriers (LOHC)



Source: commons.wikimedia.org

Energy density comparison



Source: commons.wikimedia.org

Campusversorgung mit (ca. 40.000 kWh / Jahr) Wind-Wasserstoff-System der FH-Stralsund seit 1996



100 kW Wind
10 kW PV



El. E.

Wasser

20 kW
Elektrolyseur



H

Druck-Wasserstofftank



350 bar H2-Tankstelle (2013)

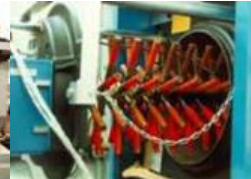


El. E.
Wärme
Wasser

BHKW



Heizkessel



Brennstoffzell



H

O₂



Welcome to the REGWA conference



hochschule-stralsund.de/regwa/

28th REGWA Konferenz
**Nutzung regenerativer Energien
und Wasserstofftechnologie**

November 2021
Hochschule Stralsund



Contact:

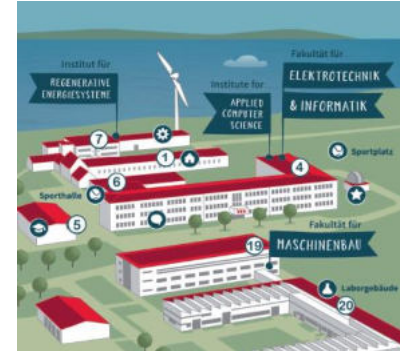
Hochschule Stralsund
Institut für Regenerative EnergieSysteme
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What's next: **Video Statement**

Christian Pegel

Minister for Energy, Infrastructure and Digitalization
in Mecklenburg-Vorpommern



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Hydrogen Distribution & Storage

The Supply Chain of the Future

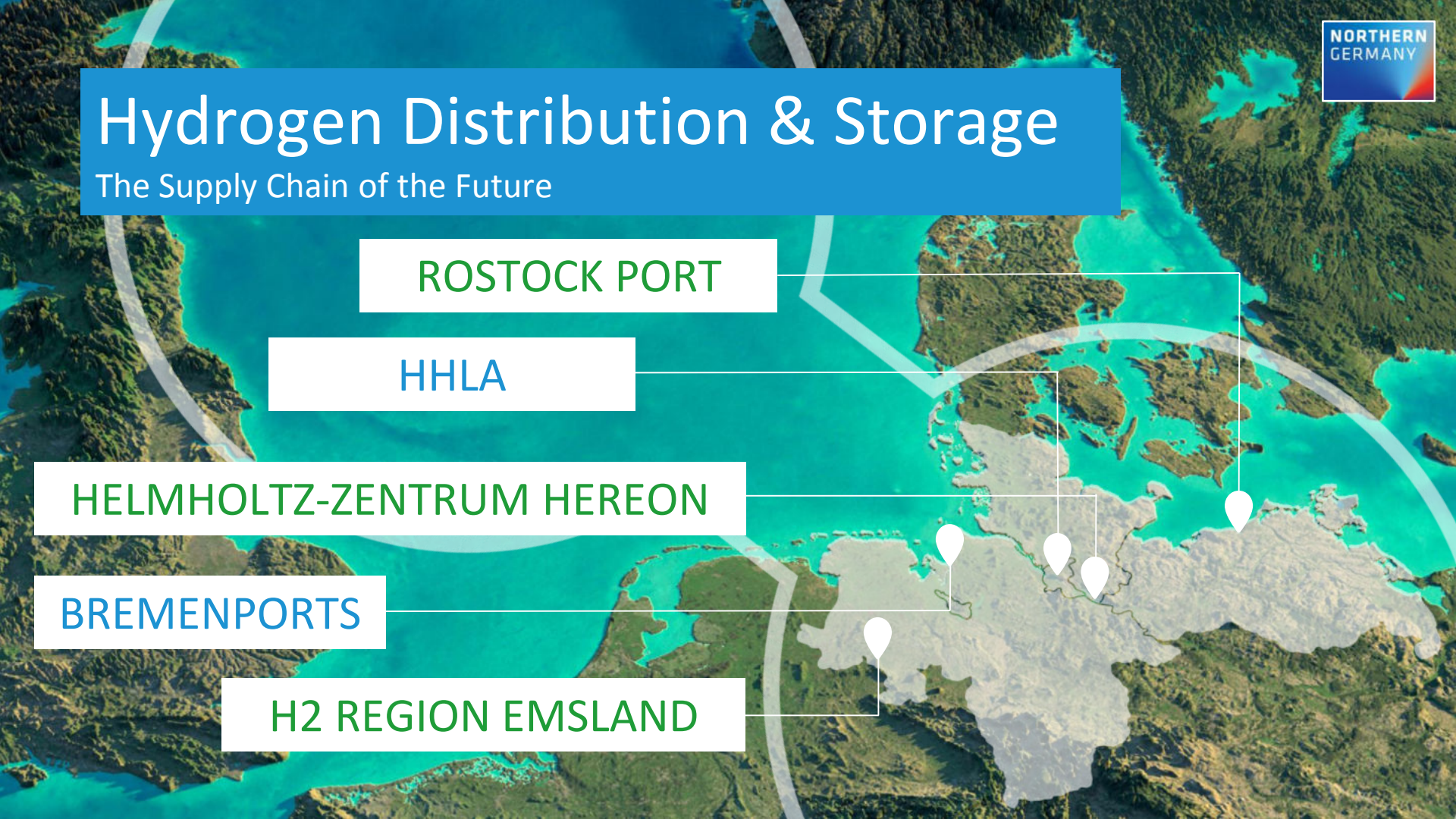
ROSTOCK PORT

HHLA

HELMHOLTZ-ZENTRUM HEREON

BREMENPORTS

H2 REGION EMSLAND



What's next: **Power Briefing**

Georg Böttner

HHLA | Head of Executive Board Projects



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HHLA

Starting Hydrogen: Application, Import and Distribution

June 15th 2021

HHLA is a vertical integrated port and transport logistics company serving customers along the entire transport chain



Port Operation

- Container throughput
- Container-related services (e.g. storage, repair)
- Multi purpose Terminals



Intermodal

- Container transport via rail and truck in the ports' hinterland
- Operation of inland terminals



Logistics

- Specialist handling of dry bulk, break bulk, vehicles, fruit, etc.
- Consulting and training

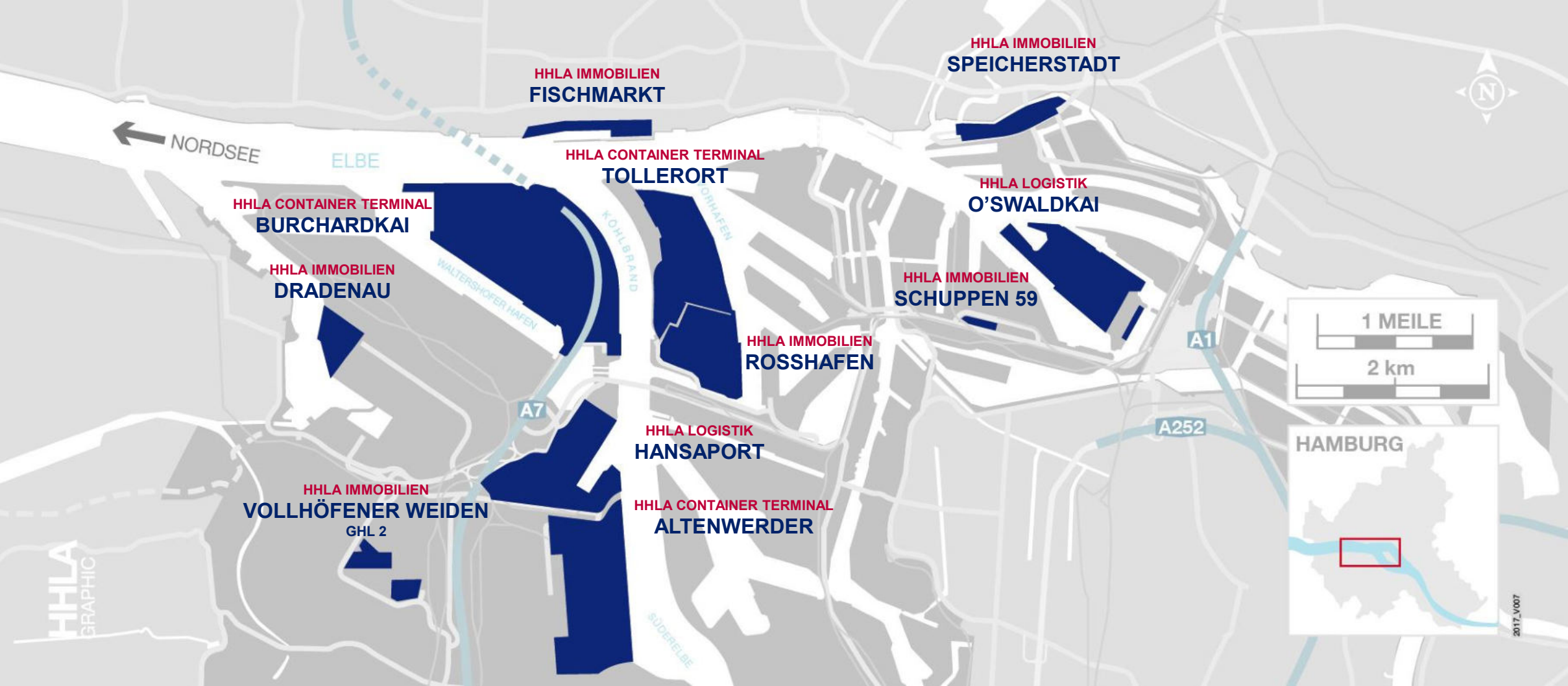


Real Estate

- DNA of HHLA and business card of the city
- Marketing of space in the Speicherstadt and Fischmarkt

* 2020 figures

HHLA operates various logistics and cargo handling facilities in the Port of Hamburg



HHLA's seaborne handling facilities in Hamburg, Tallinn, Trieste and Odessa are highly efficient logistics hubs for world trade



Container Terminal Altenwerder

- One of the most modern terminals in the world
- Very high degree of automation



Container Terminal Burchardkai

- Largest container terminal in Germany
- First facility in Europe to introduce tandem cranes



Container Terminal Tollerort

- Smallest but most flexible terminal in Hamburg
- Rail terminal built with five curved tracks



Container Terminal Odessa/Ukraine

- Largest container terminal in the Ukraine
- Success story for HHLA foreign investment since 2001



HHLA TK Estonia/Tallinn

- Largest container terminal in Estonia
- Terminal acquired in 2018



HHLA PLT Italy/Trieste

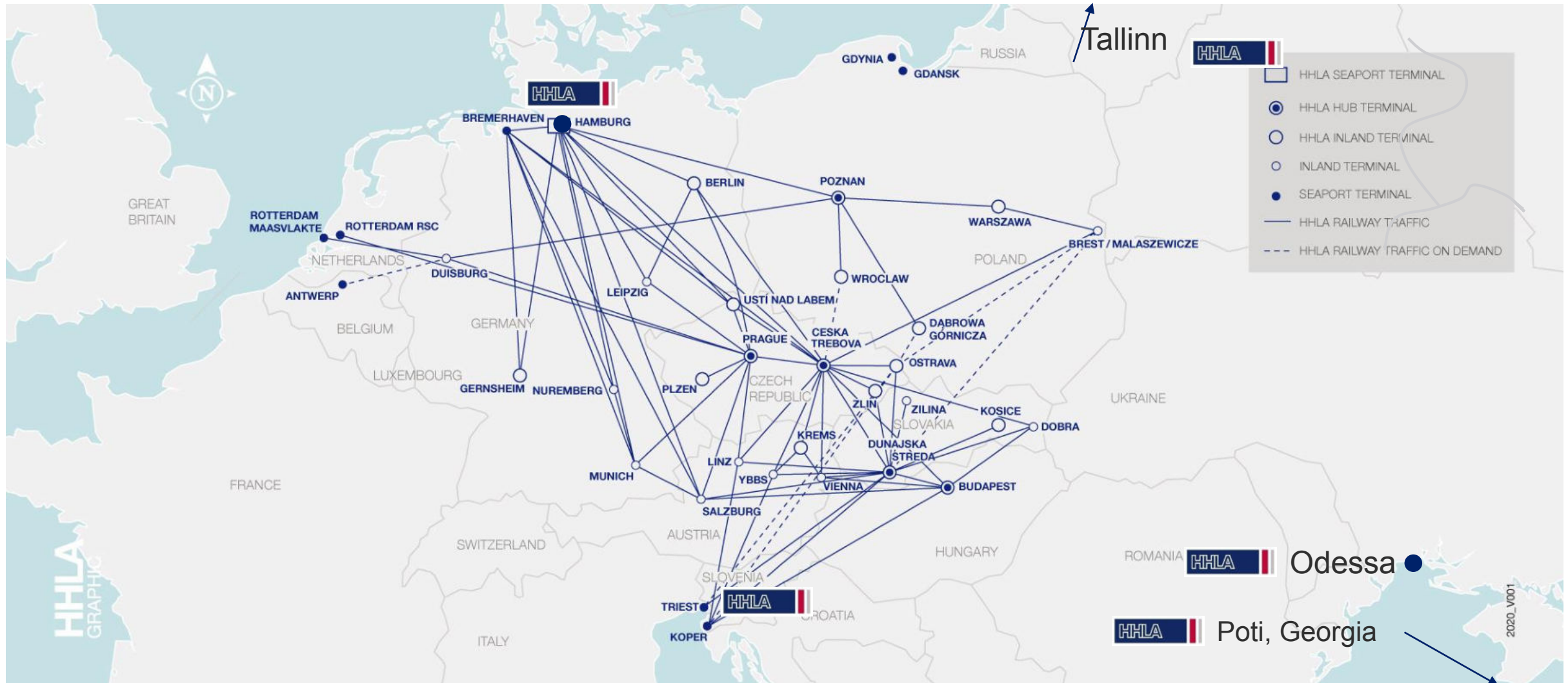
- New multipurpose terminal in Italy serving the Adria
- Acquisition of majority stake in 2021

CUSTOMER RELATIONSHIPS WITH ALL MAJOR CONTAINER SHIPPING LINES

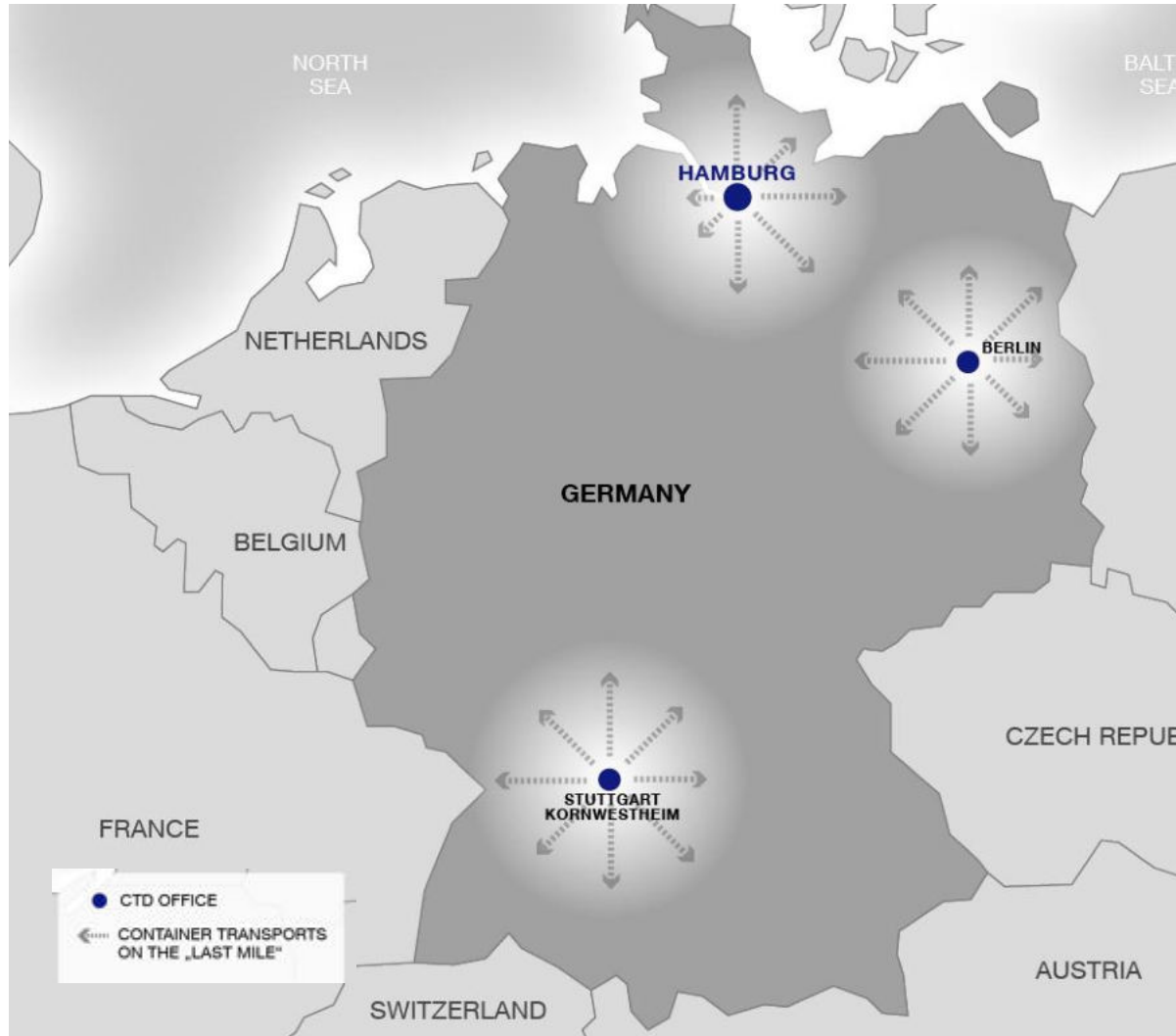
MARKET SHARE OF 17% IN THE EUROPEAN NORTH RANGE*

* incl. ports of Antwerp, Rotterdam, Wilhelmshaven, Bremen, Hamburg, 2019.

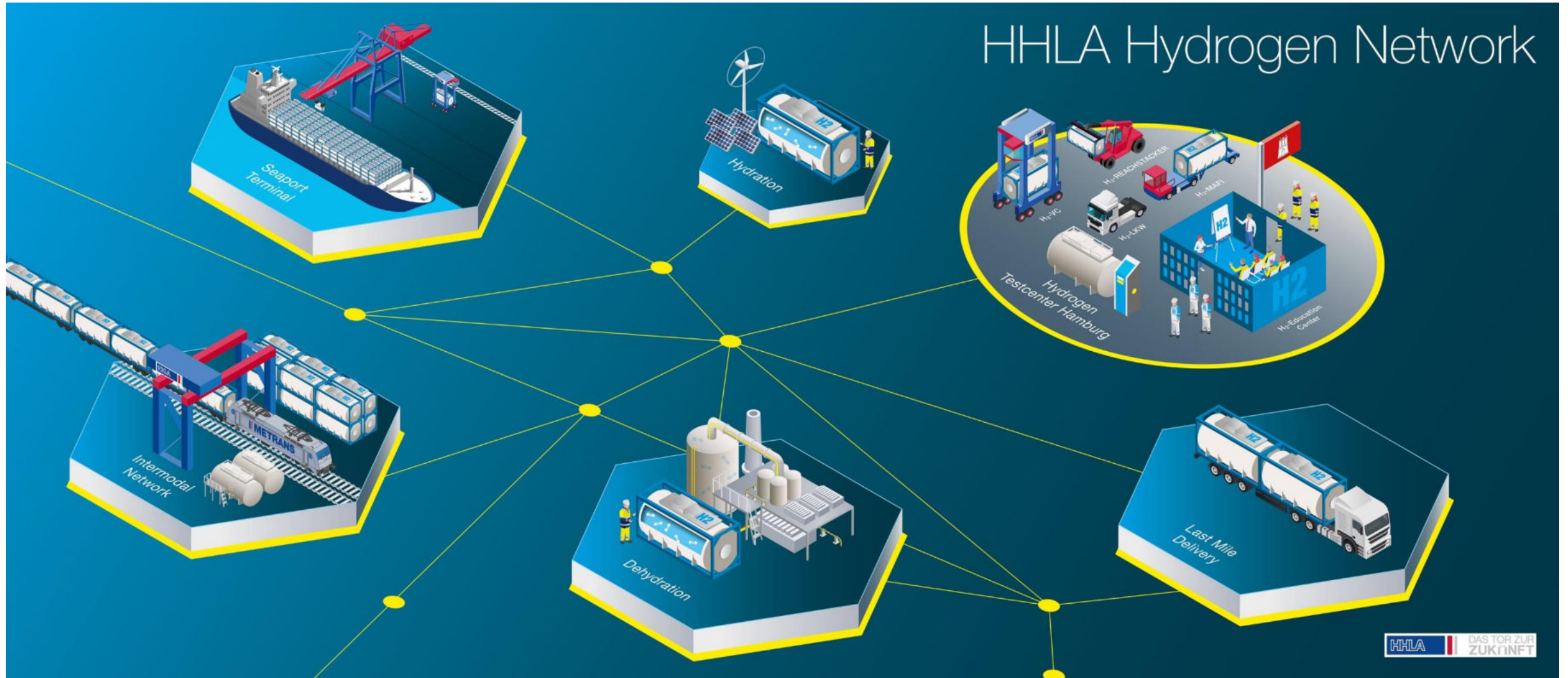
With over 600 weekly connections, HHLA-METRANS is the market leader in hinterland traffic in Central, Eastern and Southeast European industrial regions



HHLA subsidiary CTD organizes more than 500 local trucks and 5,000 local transports daily

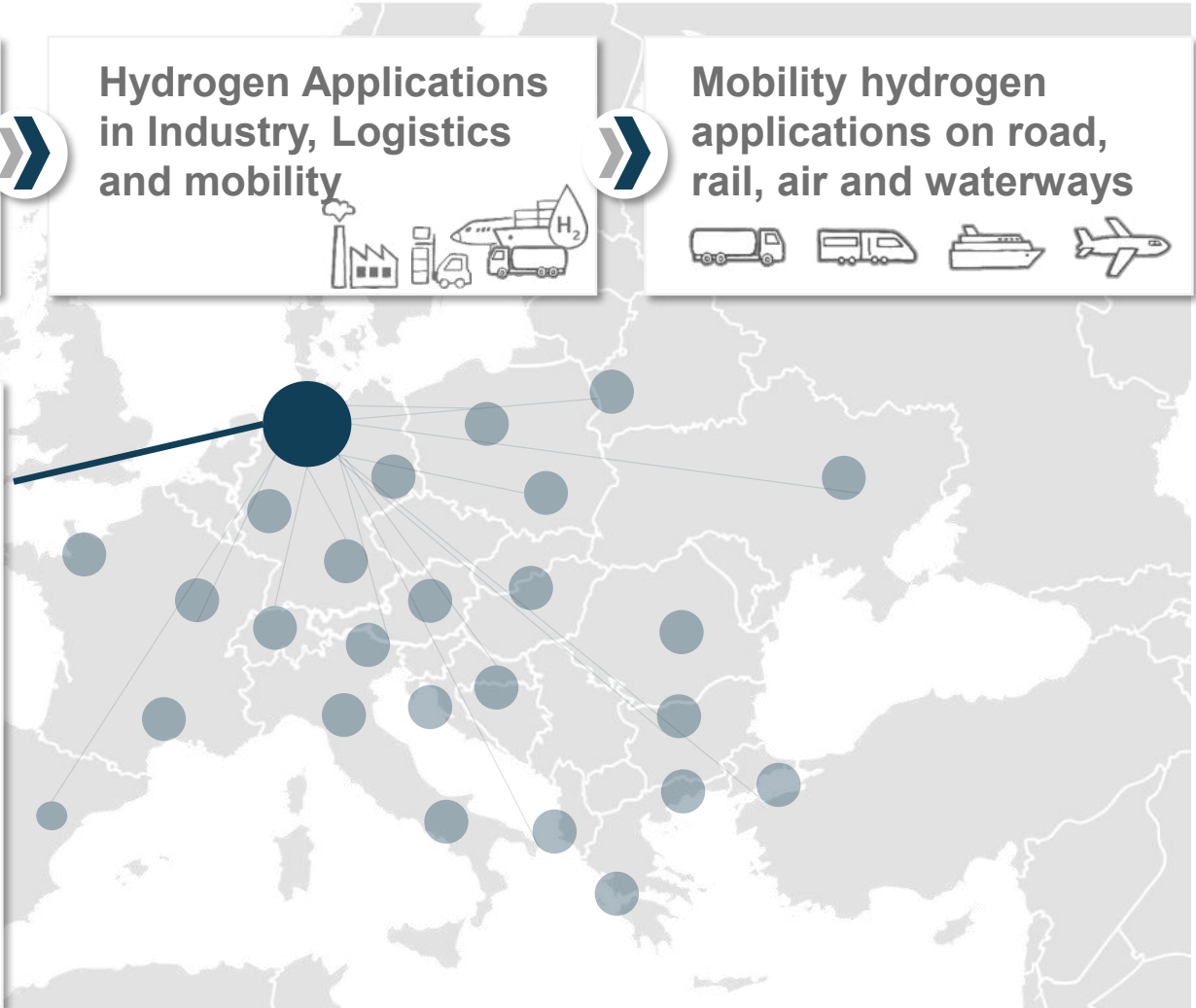


As part of our hydrogen strategy we link our heavy duty vehicle applications with national and international projects for hydrogen import and distribution



Hamburg Hydrogen Network

All of the Hydrogen Value Chain – concentrated in Hamburg









The Port of Hamburg: Hydrogen- and FC-applications for European Logistic Hubs

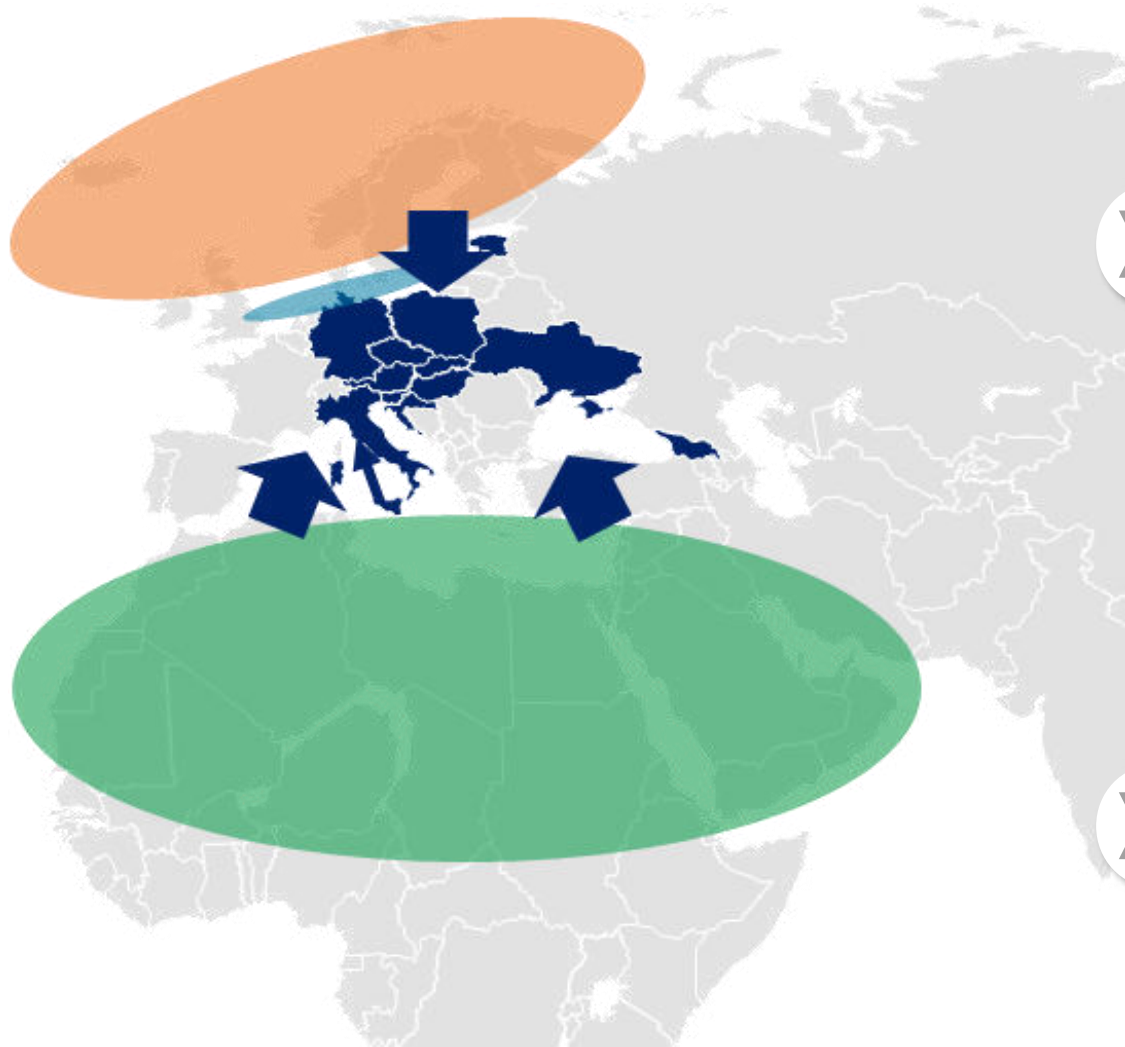
Infrastructure (production and filling stations)



Hydrogen application in HD-Mobility

<p>Trucks</p>  <p>HHLA</p> <p>DAIMLER</p> <p>MAN</p>	<p>Vessels</p>  <p>Lotsenschiff & Zukunftsbarkasse</p> <p>HPA Hamburg Port Authority</p>
<p>rail</p>  <p>HPA Hamburg Port Authority</p> <p>ALSTOM</p> <p>evb</p>	 <p>Schubboot</p> <p>GREENPLUG</p> <p>Personenfähre</p> <p>HADAG</p>
<p>Terminal-equipment</p>  <p>HHLA</p> <p>HYSTER-YALE</p> <p>KONECRANES</p> <p>KALMAR</p>	<p>Public Services</p>  <p>STADTREINIGUNG HAMBURG</p>

Together with partners we are implementing demonstration projects while also preparing for large scale implementation



Maritime Transport



- Implementation of demonstration projects for LH₂, CGH₂, Ammonia and LOHC (e.g. TransHyDe)
- Development of large scale national international transport chains
- Implementation of large scale import infrastructure (e.g. locations of import terminals)

European Hinterland Distribution



- Implementation of demonstration projects for LH₂, CGH₂, Ammonia and LOHC
- Development and implementation of intermodal distribution projects

Die weltweite Energiewende gestalten

H2:Global

Juni 2021

Gefördert durch

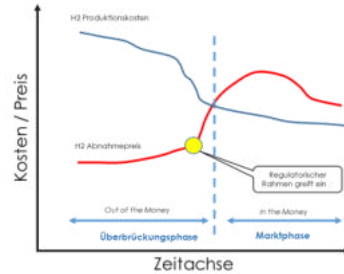


Bundesministerium
für Wirtschaft
und Energie



Überbrückung

- Unmittelbare Schaffung eines Instrumentariums zum Markthochlauf bis regulatorischer Rahmen greift



Definiertes System

- Schaffung eines auf mind. 1 GW begrenzten Systems
- Z.B. 10 Jahre – klare zeitliche Begrenzung



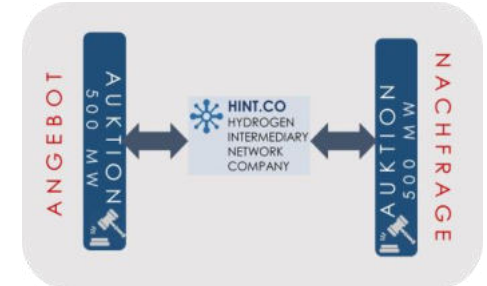
Contracts for Difference

- Ausgleichszahlungen in Form von CfDs
- Aufsetzen eines H₂ Intermediäres: die HYDROGEN INTERMEDIARY NETWORK COMPANY, HINT.CO



Wettbewerb

- Auktionen (oder vergleichbarer Mechanismus) auf H₂ Ankauf- und Verkaufsseite
- Stellung wettbewerbs-basierter Preise auf beiden Seiten





Thank you

Dr. Georg Boettner

Head of Executive Board Projects / Business
Development

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What's next: **Power Briefing**

Dr. Tim Husmann

Managing Director | H2-Region Emsland



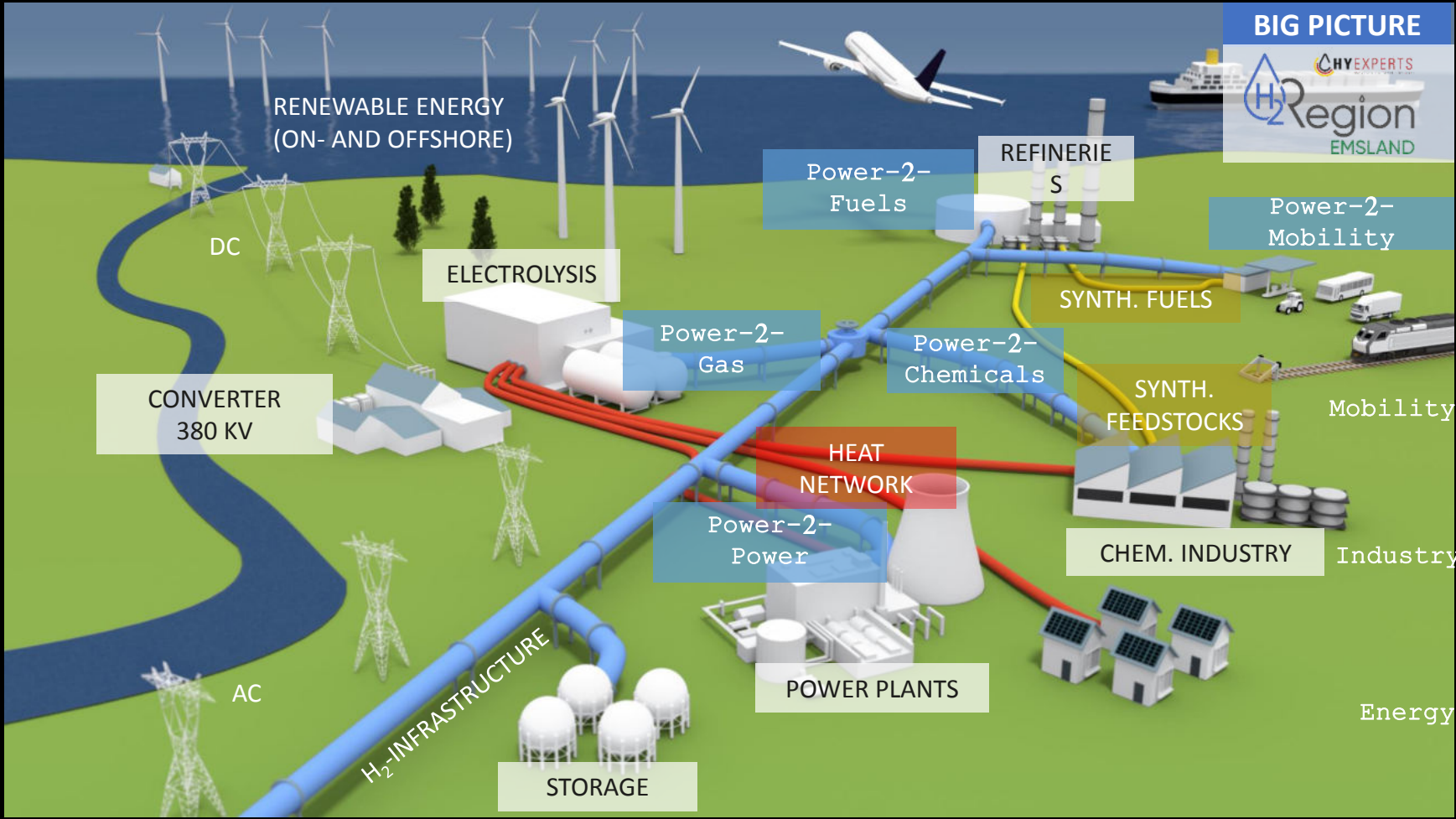
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H₂Region EMSLAND

The H₂-Hub in Northwest-Germany



BIG PICTURE



RENEWABLE ENERGY
(ON- AND OFFSHORE)

DC

ELECTROLYSIS

CONVERTER
380 KV

AC

H₂-INFRASTRUCTURE

STORAGE

Power-2-
Fuels

REFINERIE
S

Power-2-
Mobility

Power-2-
Gas

Power-2-
Chemicals

SYNTH. FUELS

SYNTH.
FEEDSTOCKS

Mobility

HEAT
NETWORK

Power-2-
Power

CHEM. INDUSTRY

Industry

POWER PLANTS

Energy

Distribution of Hydrogen

gaseous

chemically bound

liquid

Distribution of Hydrogen

gaseous

chemically bound

liquid

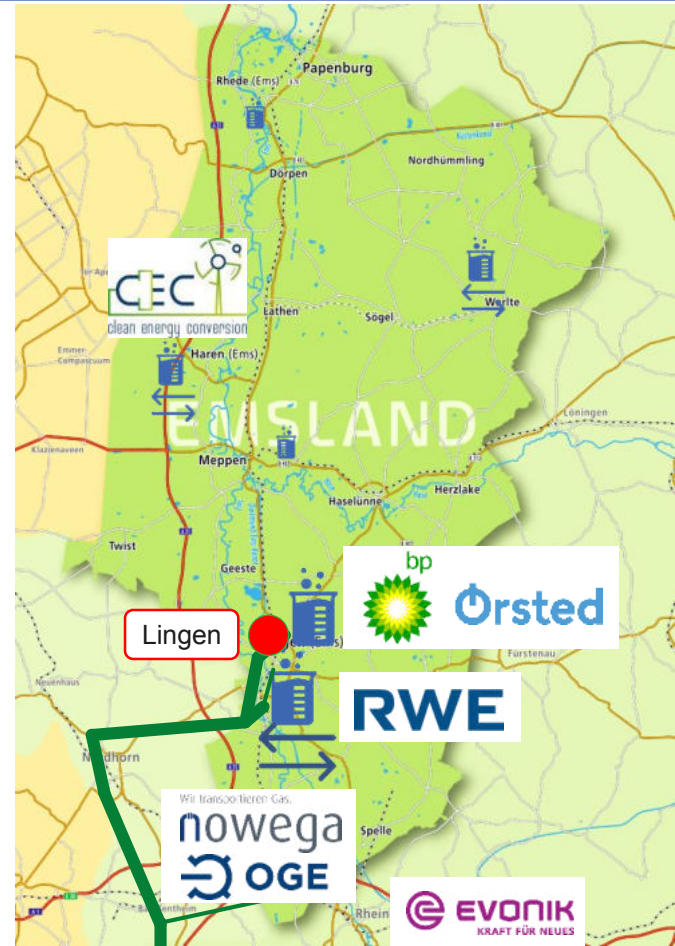
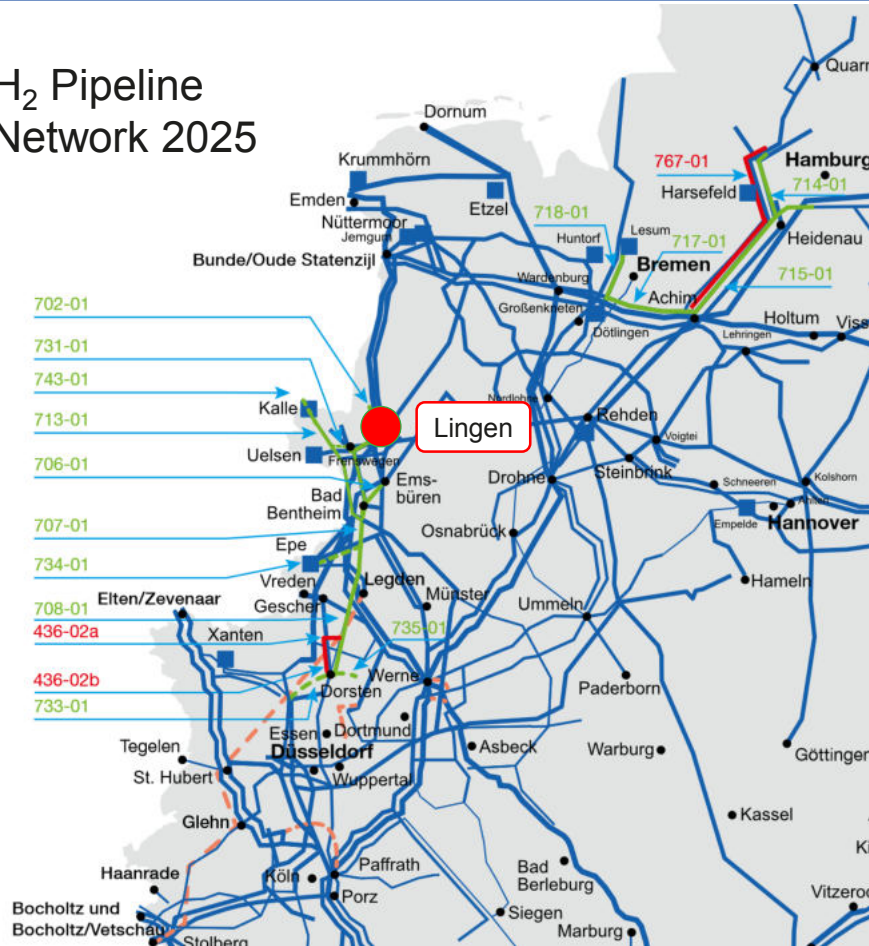


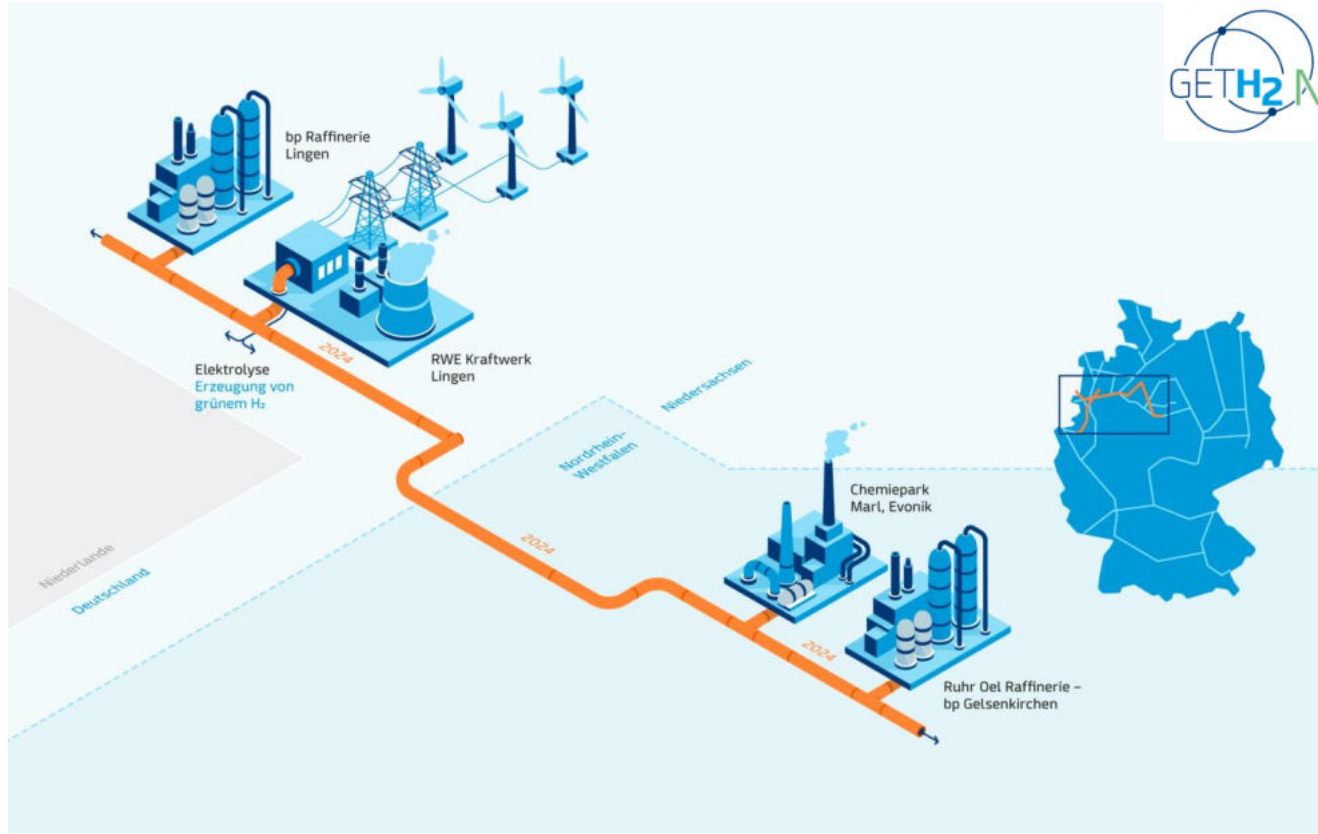
Hydrogen Pipeline Infrastructure

- repurposition of gas infrastructure
- building new infrastructure



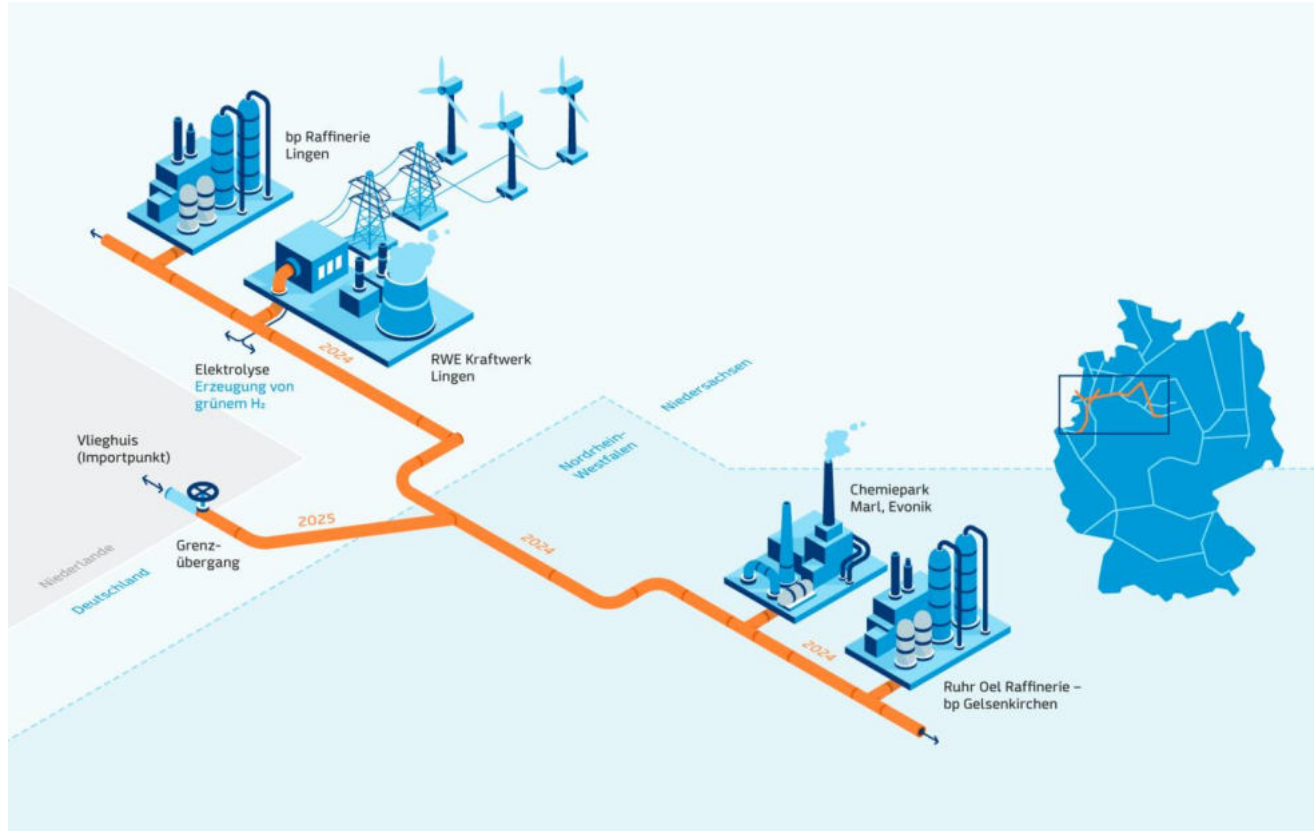
H₂ Pipeline Network 2025

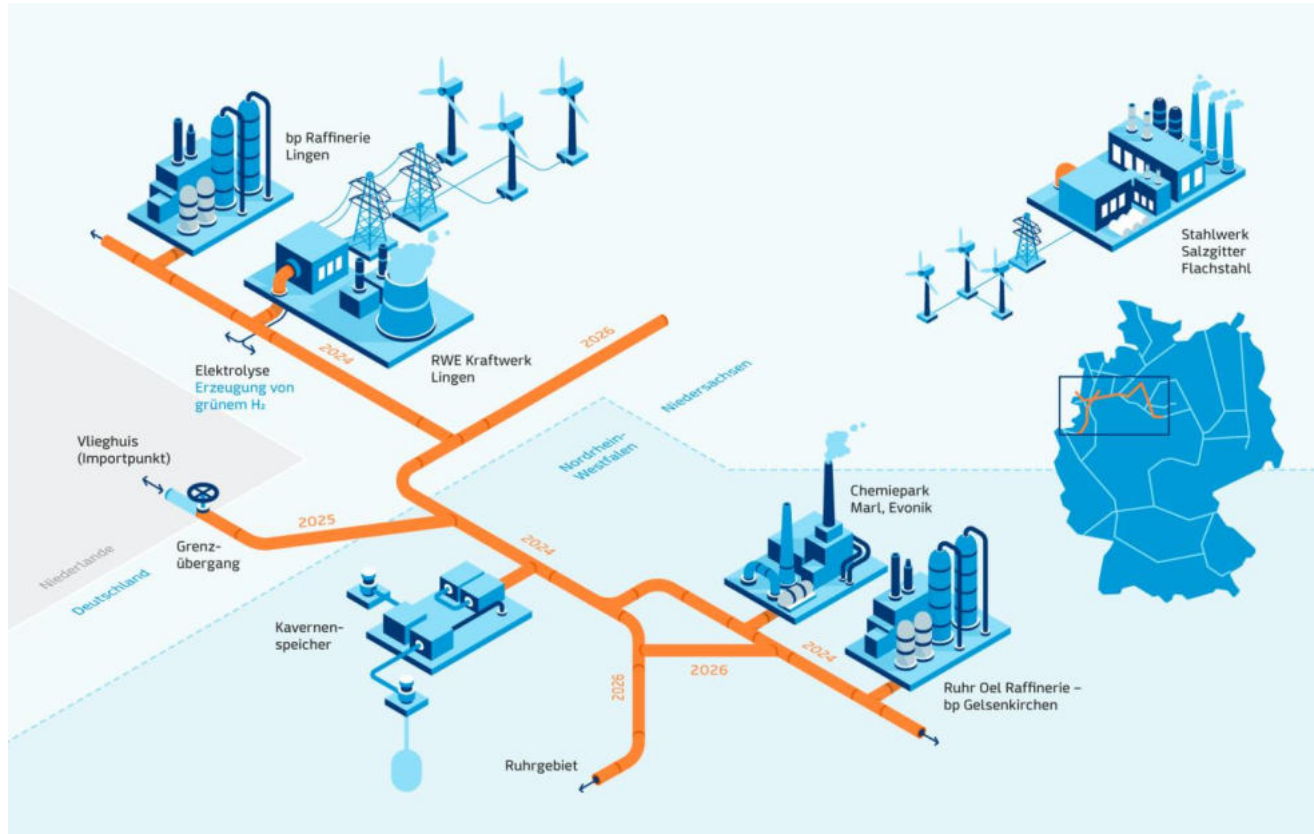


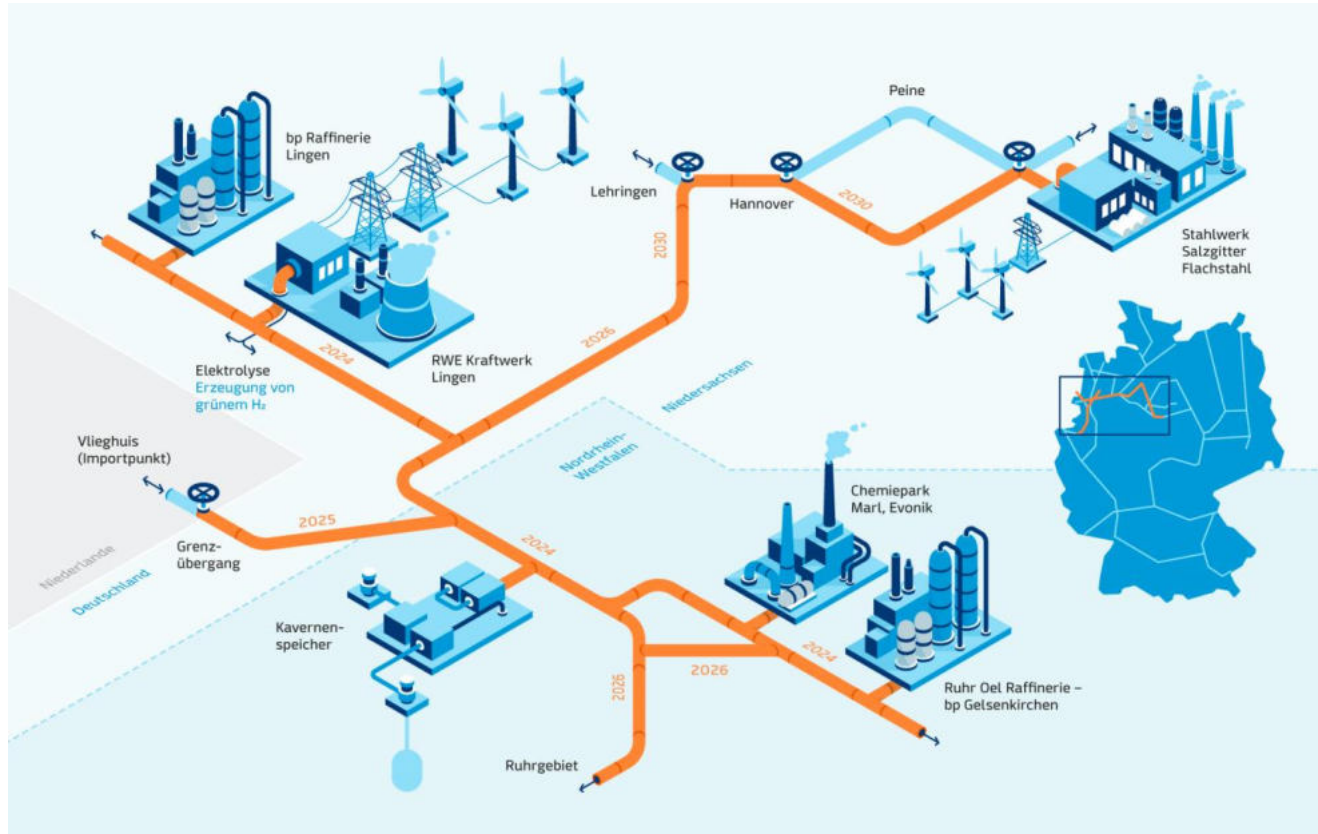


Wir transportieren Gas.
nowega









LOHC Technology

- chemically bound hydrogen
- organic, oil-like liquid



Project Green Crane: International Green Hydrogen Value Chain

Hydrogen-LOHC distribution via sea freight from Spain to Germany

hydrogenious
LOHC TECHNOLOGIES

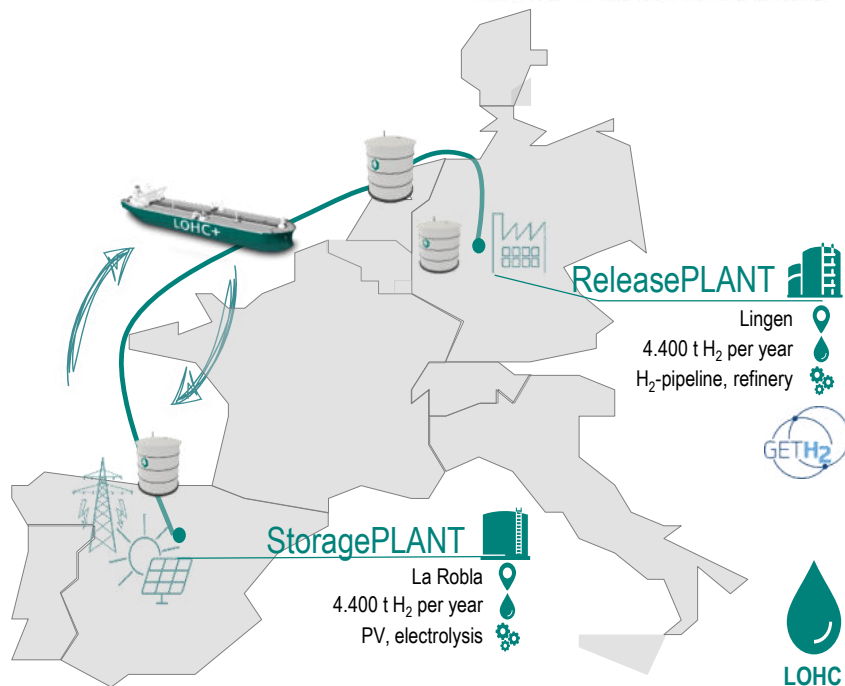
Project description

- Central green hydrogen production with PV electrolysis in the region of Castilla y León supported by grid access
- Central 12 t H₂ per day LOHC StoragePLANT at La Robla
- Shipment from port of El Musel to the port of Rotterdam, further transportation along the river Ems to the port of refinery in Lingen
- Release of gaseous Hydrogen from LOHC, distribution and injection into the local Get-H₂ Pipeline
- Unloaded LOHC returns to Spain and will be loaded again

IPCEI

Green Crane

Hydrogen
for Climate Action





large-scale hydrogen production

innovative distribution network

scalability and reliability

**our contribution for
Creating the Green Hydrogen Economy**

Dr. Tim Husmann
Manager

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What's next: **Power Briefing**

Jens Scharner

Rostock Port GmbH | Managing Director



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Energiehafen Rostock – the future hub for green hydrogen and powerfuels

June 2021

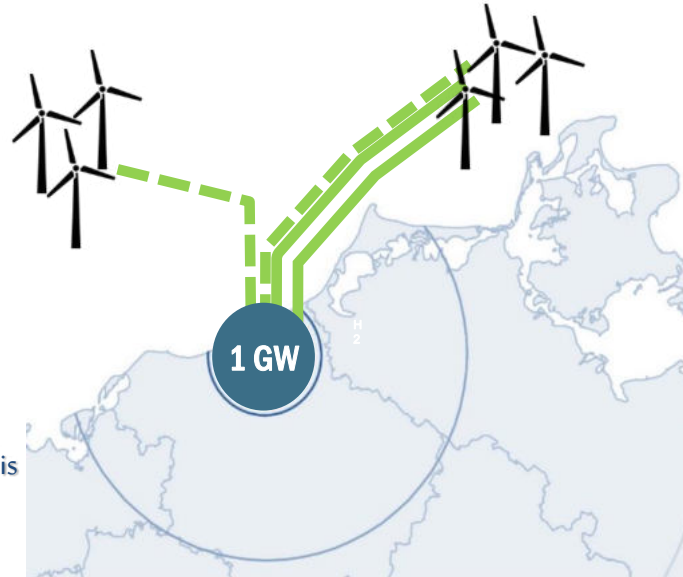


Key elements for the “Energiehafen Rostock”

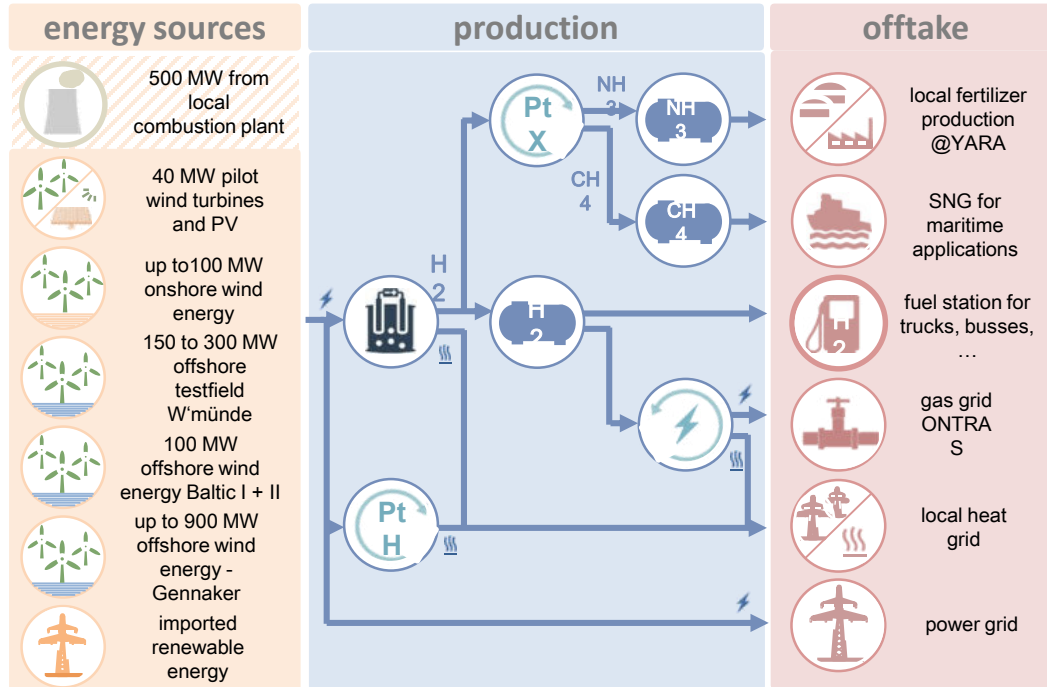
1. Production of green hydrogen at the port of Rostock with the aim of 1 GW electrolysis capacity in 2030
2. Import of hydrogen and synthetic fuels – port of Rostock as a future powerfuel hub

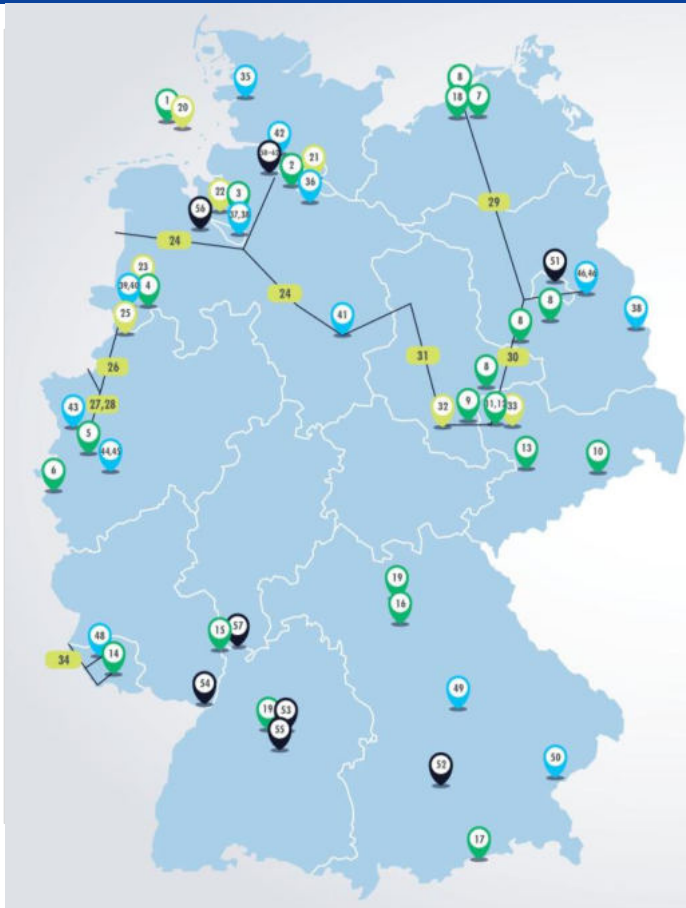
Direct access to renewable energy as a major advantage

- 67% of the electricity generated in Mecklenburg-Vorpommern comes from renewable energies
- today the offshore power in the german baltic sea region is about 1 GW and could increase up to 2,6 GW until 2030
- connection point to the 380 kV powergrid is located at the port of Rostock



Energy sources, production and offtake can be realized for 1 GW electrolysis.





H₂ Production

1. AquaVentus, Helgoland, RWE Renewables
2. HGHH, Hamburg – Vattenfall/Shell/Mitsubishi/Wärme Hamburg
3. Clean Hydrogen Coastline, NI - EWE/EWE Netz/swb
4. GET H2, Lingen – RWE Generation
5. GreenMotionSteel, Duisburg – Air Liquide DE
6. MAPEVA, NRW – Neumann&Esser
7. doing hydrogen, Rostock – APEX Energy
8. doing hydrogen, MV, BB, SA – ENERTRAG
9. Green Hydrogen Hub, Leuna – Linde/Total
10. H2-SARA, Dresden – Sunfire
11. LHyVE Erzeugung, Leipzig – EDL
12. LHyVE System, Leipzig – LVV
13. Project name not yet released for publication
14. Hydrohub Fenne, Völklingen – Siemens Energy/STEAG
15. Hy4Chem, Ludwigshafen – BASF
16. EYance, Erlangen – Siemens Energy
17. GH@BD, DE/AUT – Hydrogenious
18. HyTechHafen – Rostock – Rostock PORT GmbH
19. Bosh Power Units, BW, BY – Robert Bosch

Infrastructure

20. AquaVentus, Helgoland, GASCADE
21. HH-WIN – Gasnetz Hamburg
22. Clean Hydrogen Coastline, NI - EWE/EWE Netz/EWE Gasspeicher
23. Green Crane, Lingen – Hydrogenious
24. Hyperlink – Gasunie DE
25. GET H2, Gronau – RWE Gas Storage West
26. GET H2 – Nowega
27. GET H2 – Open Grid Europe
28. GET H2 – Thyssengas
29. doing hydrogen – GASCADE
30. doing hydrogen – ONTRAS
31. Green Octopus MD – ONTRAS
32. Green Octopus MD, Bad Lauchstädt – VNG Gasspeicher
33. LHyVE Transport, Leipzig – Ontras
34. mosaHyc – Creos DE

Industry Use

35. Hyscale 100, Kreis Dithmarschen – Holcim Deutschland/Hynamics Deutschland/Ørsted Wind Power Germany/Raffinerie Heide
36. H2H, Hamburg - Arcelor Mittal
37. Clean Hydrogen Coastline, Bremen – Arcelor Mittal
38. DRIBE2, Bremen, EH – Arcelor Mittal
39. LGH2, Lingen – BP
40. LGH2, Lingen – Oersted
41. GET H2, Salzgitter – Salzgitter Flachstahl
42. e-Methanol Projekt, Stade – DOW
43. tKH2steel, Duisburg - thyssenkrupp steel
44. Project name not yet released for publication
45. Project name not yet released for publication
46. doing hydrogen, BB – ENERTRAG
47. doing hydrogen, Rüdersdorf – CEMEX
48. H2SYNGAS, Dillingen – SHS/Saarstahl
49. BayH2, Neustadt – Vattenfall Innovation/Bayernoil
50. RHYME Bavaria, Burghausen – Wacker Chemie

Mobility Use

51. SENECA – H2 MOBILITY DE
52. BMW Produkt, München – Bayerische Motoren Werke
53. Brennstoffzellen Gigafactory, Region Kirchheim-Teck – cellcentric GmbH & Co KG
54. PEGASUS, Wörth/deutschlandweit - Daimler Truck
55. NextGen HD-Stack, Dettingen/Erms – ElringKlinger
56. Clean Hydrogen Coastline, Norddeutschland - FAUN Umwelttechnik
57. NextGadila, Weinheim – Freudenberg Performance Materials
58. WIPLiN, Hamburg – Airbus Operations
59. H2LoAD, Hamburg – HADAG Hafen und Logistik
60. HyPA, Hamburg – Hamburg Port Authority
61. H2 HADAG, Hamburg – HADAG Seetouristik und Fährdienst
62. H2SB, Hamburg – Green Plug





...thank you for your attention.



What's next: **Power Briefing**

Prof. Dr. Matthias Rehahn

Helmholtz-Zentrum Hereon | Managing Director



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Research on Renewables and Hydrogen @ HEREON

Prof. Dr. Matthias Rehahn
Managing Scientific Director
Helmholtz-Zentrum Hereon
Geesthacht

HY-5: „Green Distribution and Storage“

Online 15. Juni 2021



Helmholtz-Zentrum
hereon

Research on Renewables and Hydrogen @ HEREON

1. Metal Hydrides for Storage of Green Hydrogen
2. Membrane Technology for Gas Separation
3. Photoelectrochemistry for Green Hydrogen Production
4. Impact and Efficiency Maximation of Off-Shore Wind Parks

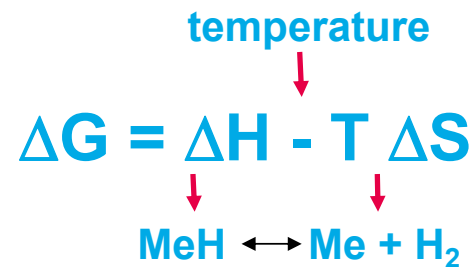
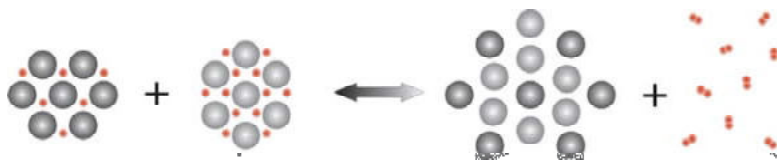
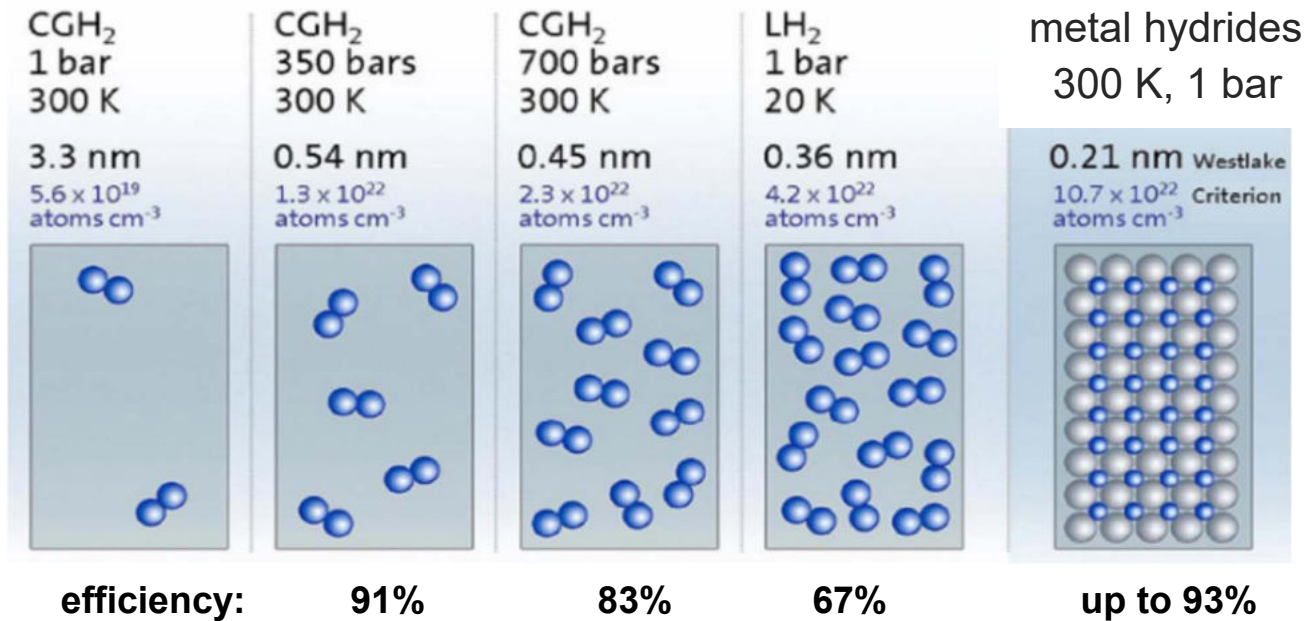


Metal Hydrides for Storage of Green Hydrogen

Principle and advantages



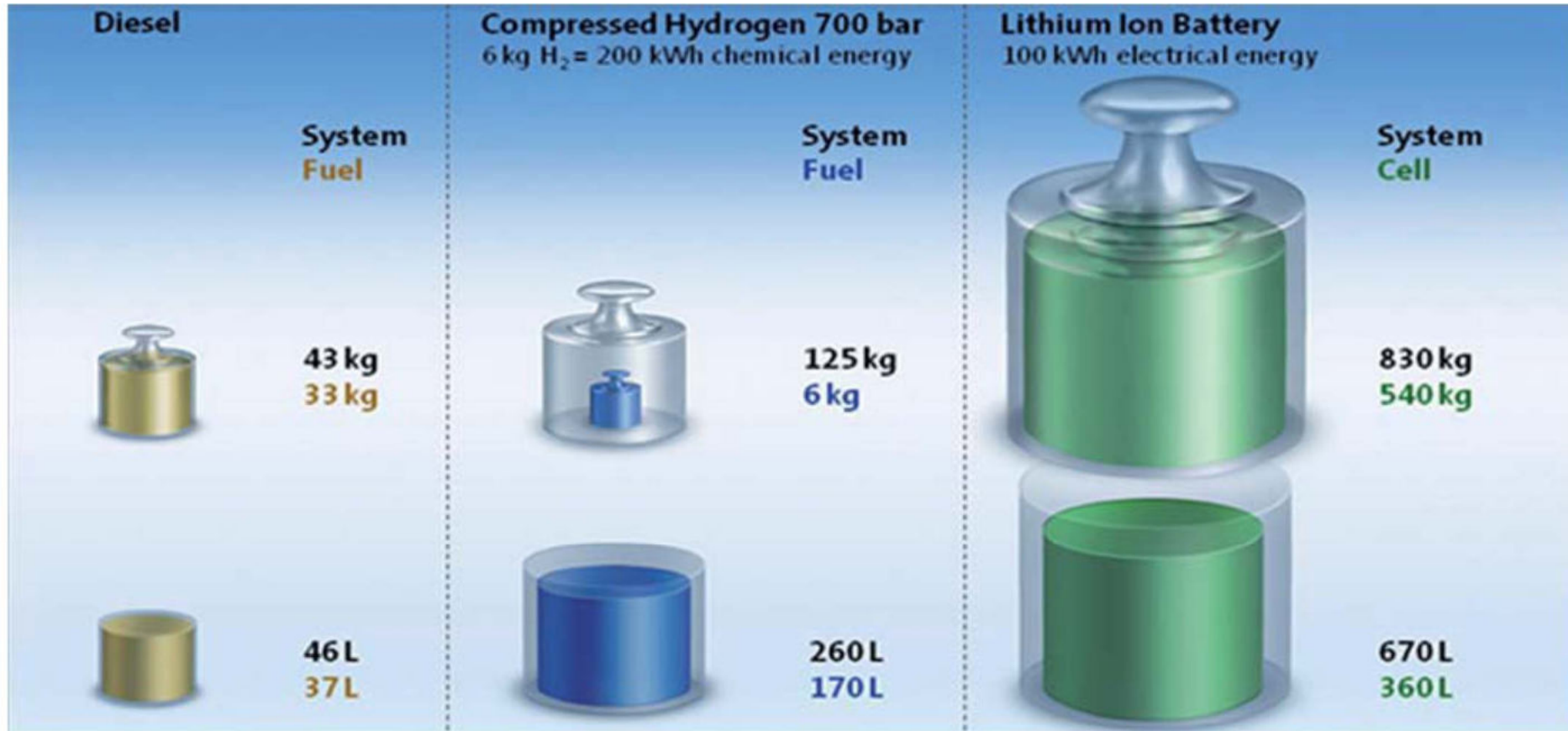
Average distance between H₂ molecules / between H atoms



HZG, 2020: Mechanisms of additives for RHC-composite, *Scientific Reports* 2020, 10, 8

Metal Hydrides for Storage of Green Hydrogen

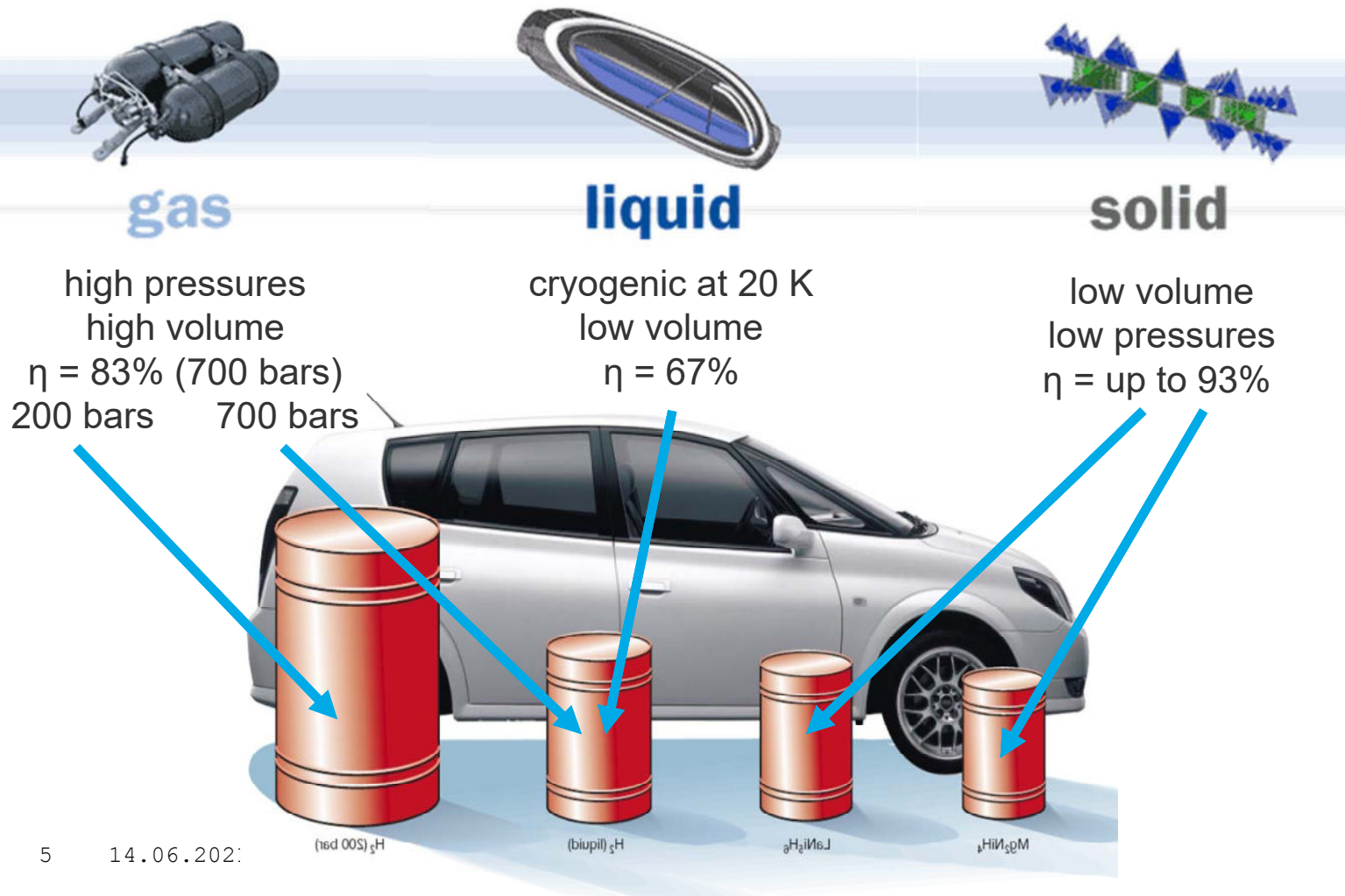
Principle and advantages



energy storage system weight and volume based on 500 km range

Metal Hydrides for Storage of Green Hydrogen

Principle and advantages



- ✓ High energy density
- ✓ High efficiency
- ✓ High safety
- ✓ High purity
- ✓ Abundant materials (Mg, Fe, Ti)
- ✓ Easy recycling/ cradle-to-cradle

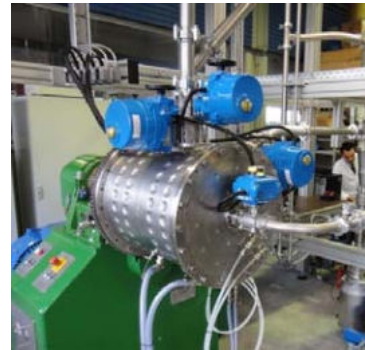
Metal Hydrides for Storage of Green Hydrogen

From fundamental materials research to efficient components by in operando experiments and simulations

Fundamental materials design



Scale-up of materials synthesis



Compact and safe storage design

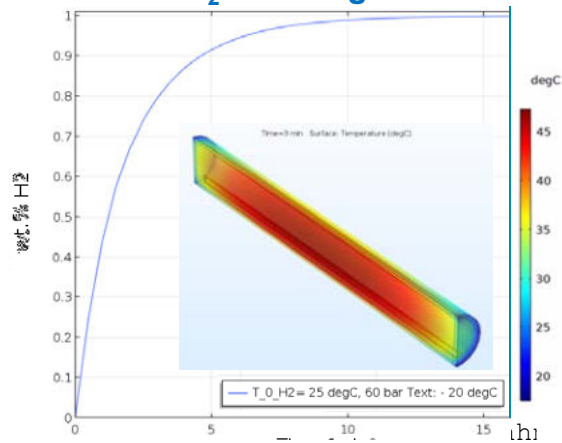


Urban Concept Car with metal hydride storage

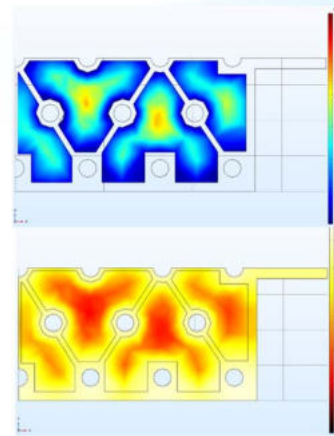


EcoBee

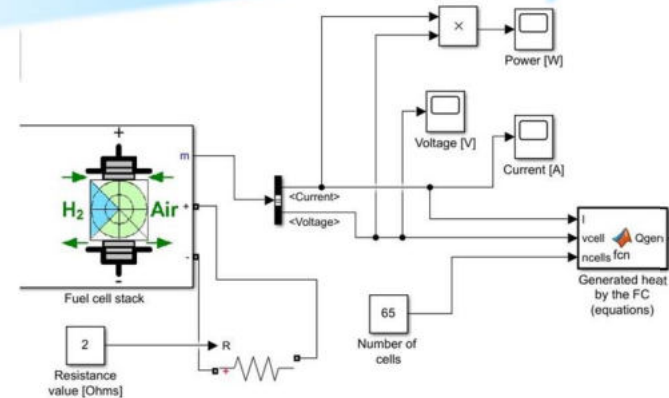
80% H₂ refueling in 3 min



Modeling H₂-refueling



Simulation of H₂ and heat transport



System simulation

Metal Hydrides for Storage of Green Hydrogen

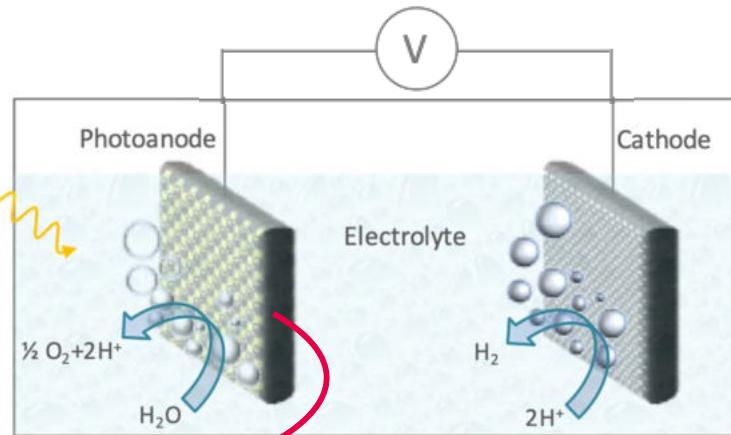
Current projects on technology transfer of metal hydrides



- **Road Traffic:** H₂ storage for a fuel cell car (Volkswagen, BMWI - H2Hybrid)
- **Air Traffic:** H₂ plane, production- and refuelling infrastructure (Airbus, HWI - Green Aviation)
- **Maritime Technology:** Research ship „Ludwig Prandtl 2“ (BMBF)
- **Wind Energy:** Sector coupling Power - Heat - Mobility (BMVI - HyReflexS; BMVg - DigiHyPro)
- **Climate:** Saisonal energy storage: „Helmholtz-Initiative Climate Adaptation and Mitigation (HGF - HI-CAM)“

„Artificial Leaf“ for Green Hydrogen Generation

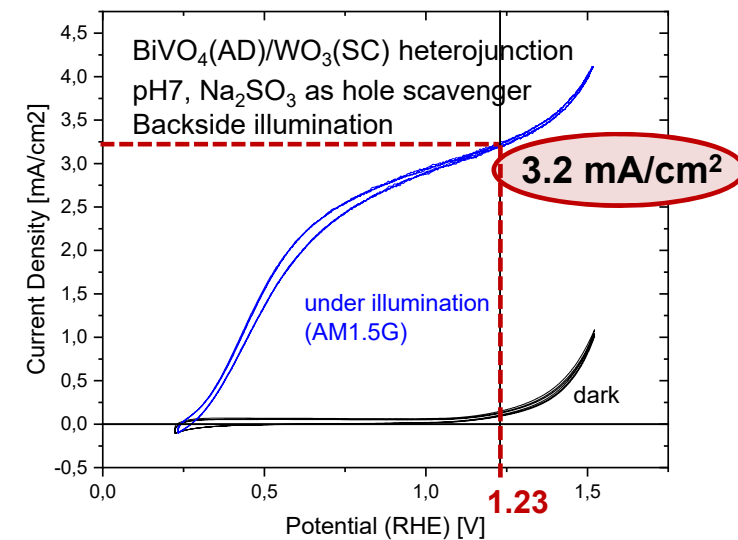
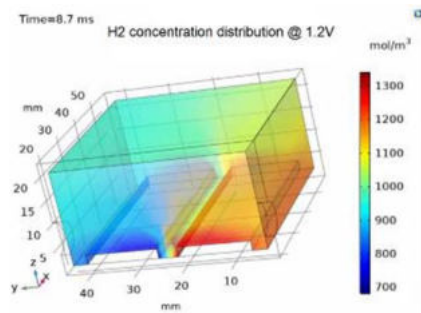
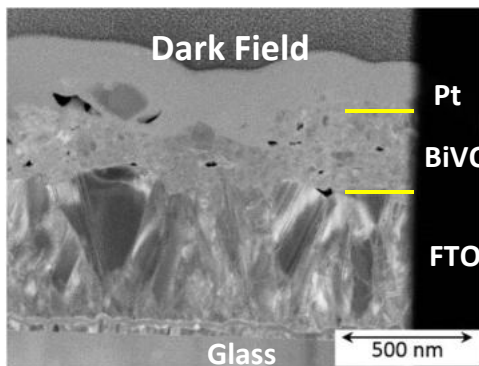
Photoactive Materials: From Coating Technology to Efficient Modules



- ✓ High efficiency
- ✓ Cost efficiency
- ✓ Scalable



Surface technology and cell design



HZG, 2021: Aerosol Deposited BiVO₄-Photoelectrodes for Hydrogen Generation, *Journal of Thermal Spray Technology*, 30, (2021), 603–616

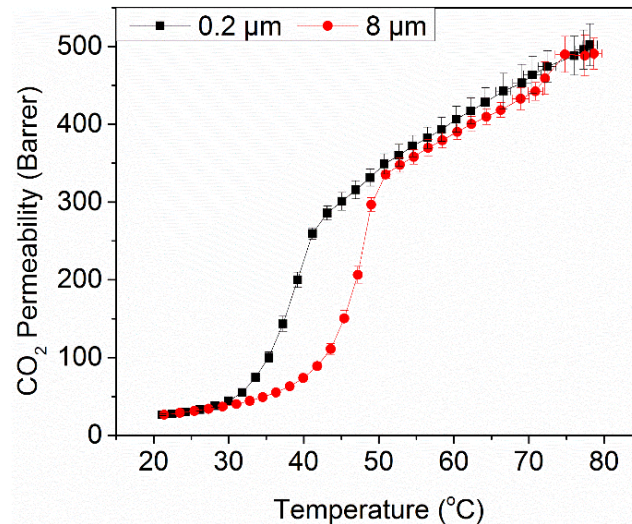
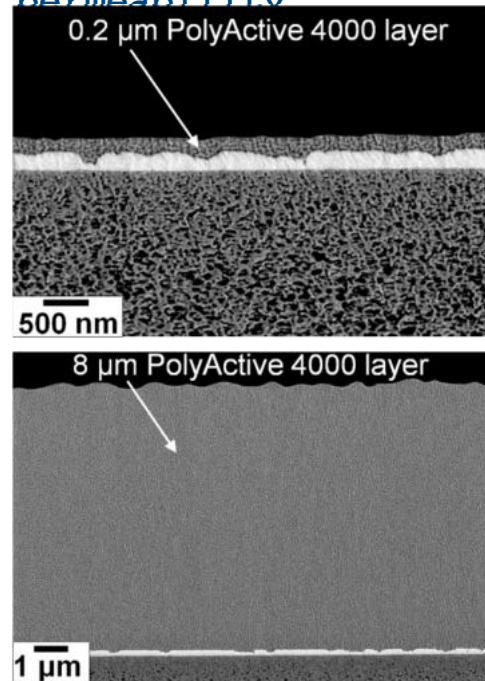
Gas Separation by Membrane Technology

From new polymers to process development and efficient system integration

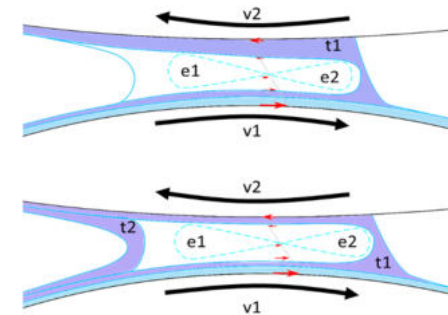
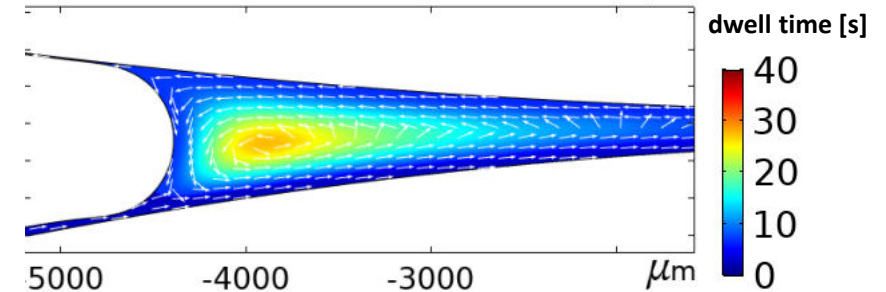
There is plenty of opportunities for useful application of gas separation membranes for e.g.

- Hydrogen separation from methane or domestic gas
- Carbon dioxide separation from exhaust gases (coal-fired power plants, vessels, ...)
- Carbon dioxide enrichment for reduction to synthetic fuels

Influence of thickness on permeability



Prediction of membrane thickness in a roll-to-roll casting process by CFD simulation

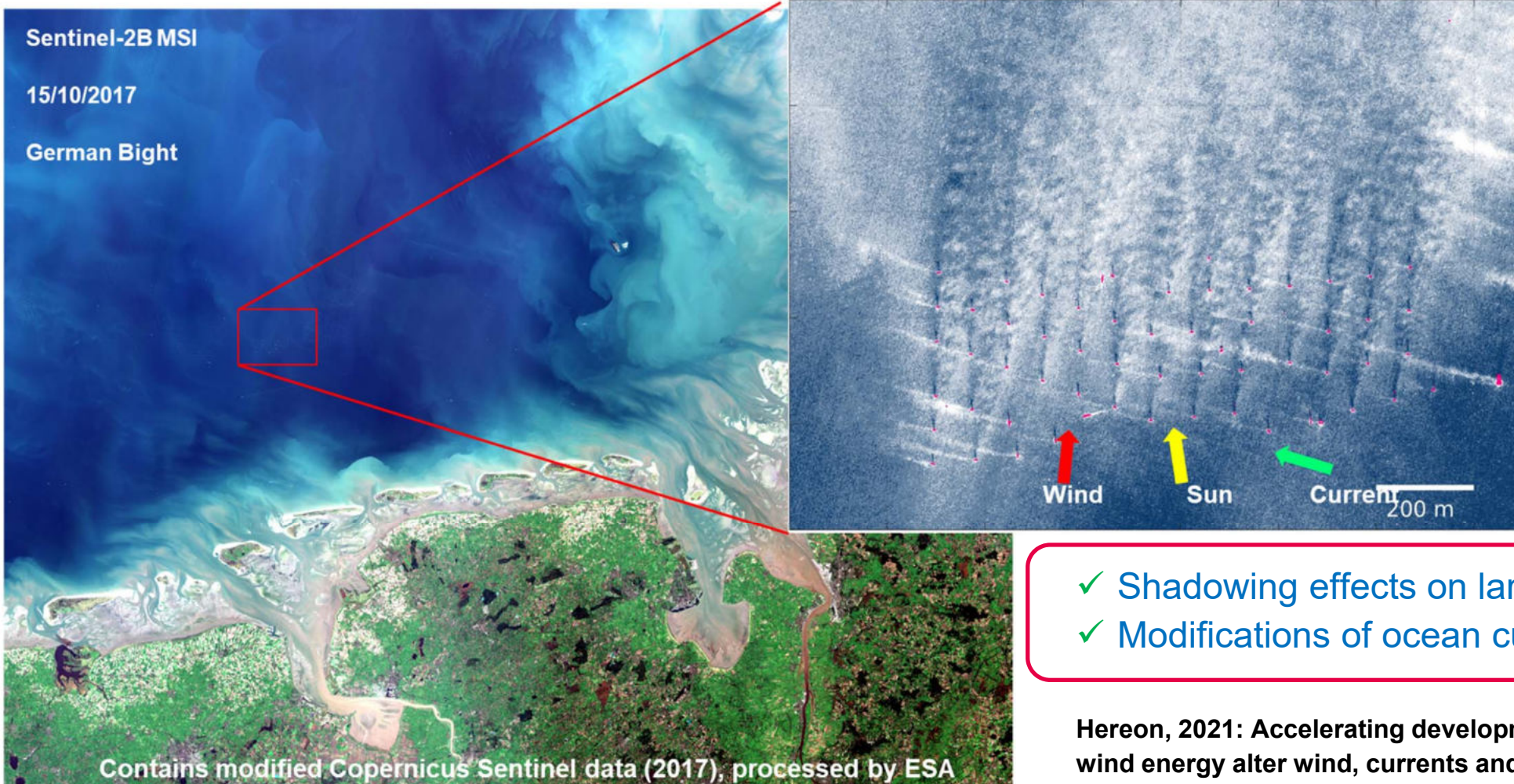


Offshore Wind: Dynamical Effects and Impacts

From fundamental analysis to action regarding ecology and optimum energy harvesting



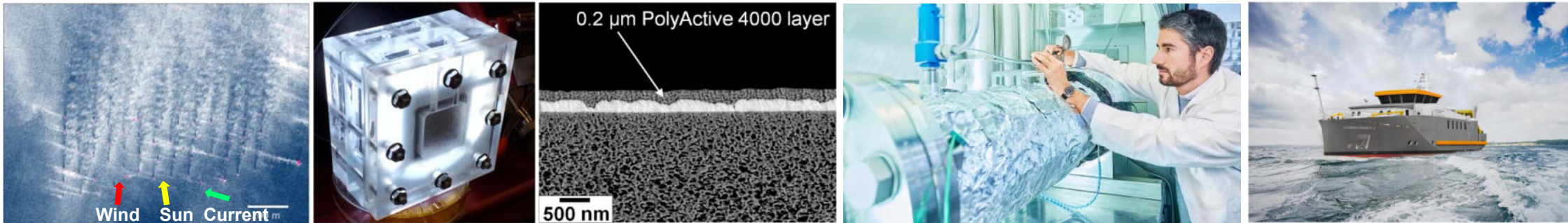
Heimholtz-Zentrum
hereon



- ✓ Shadowing effects on larger scale
- ✓ Modifications of ocean currents

Hereon, 2021: Accelerating development of offshore wind energy alter wind, currents and climate

Conclusions



- ✓ Hydrides for Storage of Green Hydrogen:
Compact, efficient and safe hydrogen storage
- ✓ Photoelectrochemistry for Green Hydrogen Production:
Efficient generation of green hydrogen
- ✓ Membrane Technology for Gas Separation:
Efficient capture of CO₂ or separation of H₂ from natural gas grid
- ✓ Coastal Research on Impact and Efficiency Maximation of Off-Shore Wind Parks: Perturbation of water body and wind shadowing

What's next: **Q&A**

GTAI
&
HY-5 Investment Experts



HY-5 

The HY-5 logo graphic consists of three vertical bars in blue, green, and yellow.

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Thank you!



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