LOHC as the H2 export enabler.

Handling hydrogen as an oil.

NUMOV/BETD Event

Berlin, 22 March 2024

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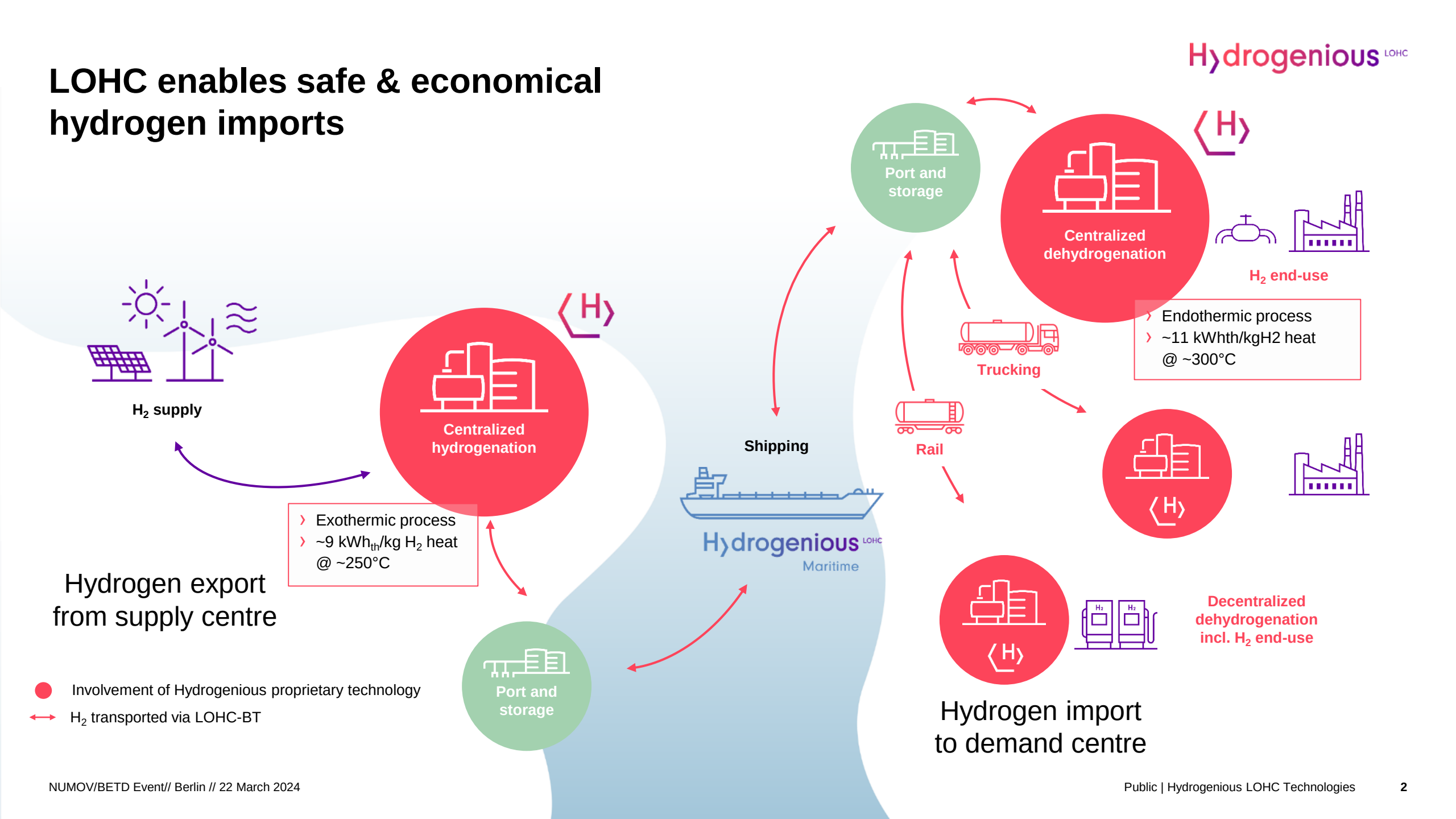
Hydrogenious LOHC

LOHC enables safe & economical hydrogen imports



Our LOHC-BT technology is disrupting hydrogen infrastructure

Superior safety

- No handling of molecular hydrogen
- Hardly flammable with flash point 112,5 °C, nonexplosive, even when loaded with hydrogen
- Hazard potential comparable to Diesel and thus clearly superior to ammonia

Enhanced flexibility

- Conventional liquid fuel infrastructure usable
- Handling at ambient temperatures and pressure during storage and transport
- No self-discharge over time – multi-month storage without losses

High efficiency

- Competitive volumetric storage density of 54 kg hydrogen per m^3 LOHC
- Carrier material commercially available and reusable hundreds of times
- More than 99,9 % hydrogen purity from the process without any purification

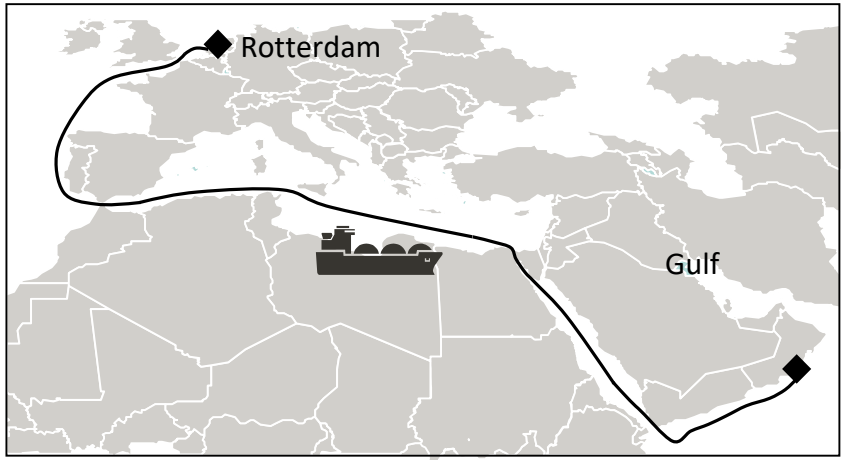
LOHC-BT can be transported at ambient conditions, using the existing global fleet of vessels

	Storage density & method	Vessel transport & hydrogen transport volume		Existing global fleet
LOHC-BT	54 $kg_{H2}/m^3_{LOHC-BT}$ 62 $kg_{H2}/t_{LOHC-BT}$ Storage at **ambient conditions**		<u>Transport in very large crude carriers (VLCC)</u> › VLCC (280,000 DWT) can carry **17,000 tonnes of hydrogen** › Upgrade to 450,000 DWT* possible (= 28,000 tonnes of hydrogen)	 ~ 800 vessels
Ammonia (incl. Cracking)	115 kg_{H2}/m^3_{NH3} 170 kg_{H2}/t_{NH3} Storage at -33 °C at **cryogenic conditions**		<u>Transport in LPG vessels</u> › 80k m^3 LPG vessel can carry **9,800 tonnes of hydrogen**	 ~ 50 vessels
Liquified H_2	71 kg_{H2}/m^3_{LH2} Storage at -253 °C at **cryogenic conditions**		<u>Transport in LH_2 vessels</u> › The only existing LH_2 vessel 'Suiso Frontier' from Kawasaki can carry **9,000 tonnes of hydrogen** (in 1,500 m^3 storage tank)	 1 vessel

*DWT = Deadweight tonnage

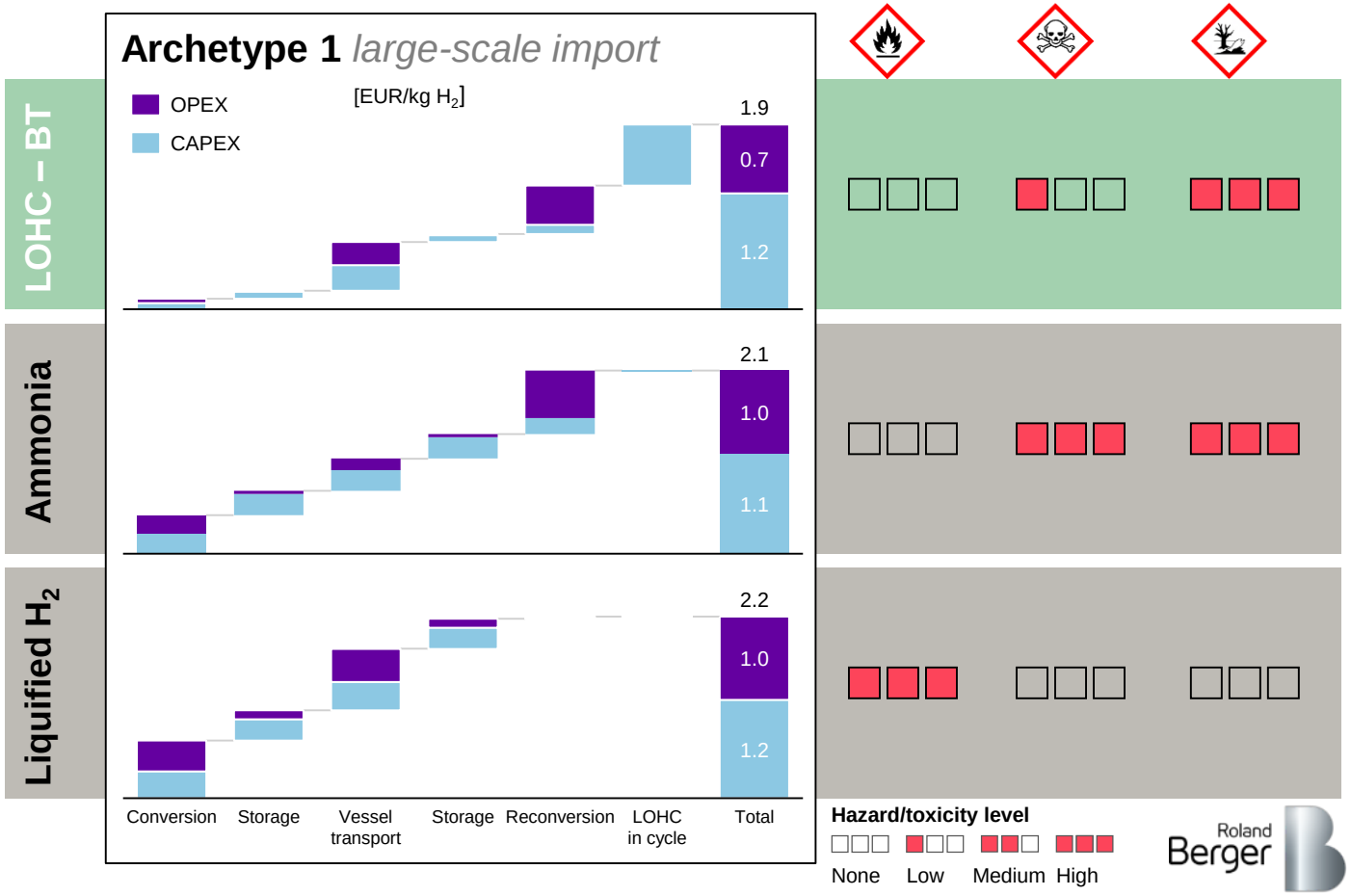
LOHC-BT with strong TCO competitiveness in long-distance and upside from advantageous hazard and toxicity profile versus NH_3

Archetype 1: Large-scale import – year 2030



- 200 tpd
- 2 x 100 tpd
- ~12,000 km via vessel (one-way)
- ~46 days per roundtrip (incl. port days)
- ~50,000 DWT* (vessel)
- 4 vessels
- 180,000 m^3 of storage capacity at each location
- ~236,260 t LOHC in the system

*Deadweight tonnage Depending on technology



Source: Roland Berger 2021; 2030 TCO values from linear interpolation between 2025 and 2035

Proven LOHC value chain and developing projects for international large-scale hydrogen trade routes

Containerized systems

- Proven technology with systems in Germany, Finland and the US
- Successful implementation of a comprehensive LOHC value chain

12 systems delivered

Capacity scale up 5 H_2 tpd

- Capacity
  - Storage: 5 H_2 tpd
  - Release: 1,5 & 5 H_2 tpd
- Reference Projects
  - Projects Hector & Puffin 2025
  - Green Hydrogen @ Blue Danube 2026

In Implemen-tation

Capacity scale up to 20 H_2 tpd

- Capacity
  - Storage: up to 20 H_2 tpd
  - Release: 12 H_2 tpd
- Reference Projects
  - Port of Rotterdam together with Royal Vopak

Feed

Large-scale plants for int. H_2 import / export up to 500 H_2 tpd

- Capacity
  - 100 to 500 H_2 tpd Storage & Release
- Reference Projects
  - H2A-RP 2028
  - 500 H_2 tpd project Saudi Arabia (partner undisclosed)
  - Further upcoming feasibility studies in Oman and Morocco

Feasibility studíes

Established in 2013, we are the global leading technology pioneer for LOHC

Investors

APVentures ADVANCE & PIONEER
ANGLO PLATINUM
Vopak
covestro
HYUNDAI
Chevron
jera Energy for a New Era
Pavilion Capital
TEMASEK
Mitsubishi Corporation
Winkelmann Group

Key partners

Østensjø Rederi
MAN Energy Solutions
BILFINGER
CLARIANT
EASTMAN

Technology cooperation partners

FAU Friedrich-Alexander-Universität Erlangen-Nürnberg
HI ERN Helmholtz Institute Erlangen-Nürnberg part of Forschungszentrum Jülich
HC·H2 Helmholtz-Cluster Wasserstoff

>230
employees

>55
patent families

>80mn
investor funding

Unleash the potential of clean hydrogen.

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Hydrogenious LOHC

Hydrogenious LOHC

World's 1st LOHC supplied hydrogen refueling station in Erlangen, Germany

- Green H_2 supply chain scheme:
  Solar Power – AEM Electrolyser – LOHC Storage – Transport – LOHC Release – HRS
- HRS opened in 2022
- Minimal footprint
- Worldwide first underground storage of 1.5 tons of hydrogen via LOHC-BT (ambient conditions)
- Hydrogen quality (fuel cell purity) according to ISO 14 687-2

H2Sektor-HRS Erlangen

GER/Erlangen

World‘s 1st LOHC HRS

Commissioning (official):	July 2022
Project partner:	H2MOBILITY
Hydrogen supply:	Own production and storage @Hydrogenious headquarters, Photovoltaic
Hydrogen release (max.):	9,000 H_2 kgpa [25 H_2 kgpd] ReleaseBOX 10

Gefördert durch

Bayerisches Staatsministerium für Wirtschaft, Landesentwicklung und Energie

H2Sektor-HRS Erlangen

Hydrogen Refuelling Station

H_2 Storage
45bar(g)

400kg H_2

H_2 Compressor

H_2 Storage
700bar(g)

LOHC Storage
underground tanks
ambient conditions
2x 30m³

1,500 kg H_2

ReleaseBOX 10
incl. purification + compression

H2MOBILITY
Scope H2 Mobility

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Scope Hydrogenious