



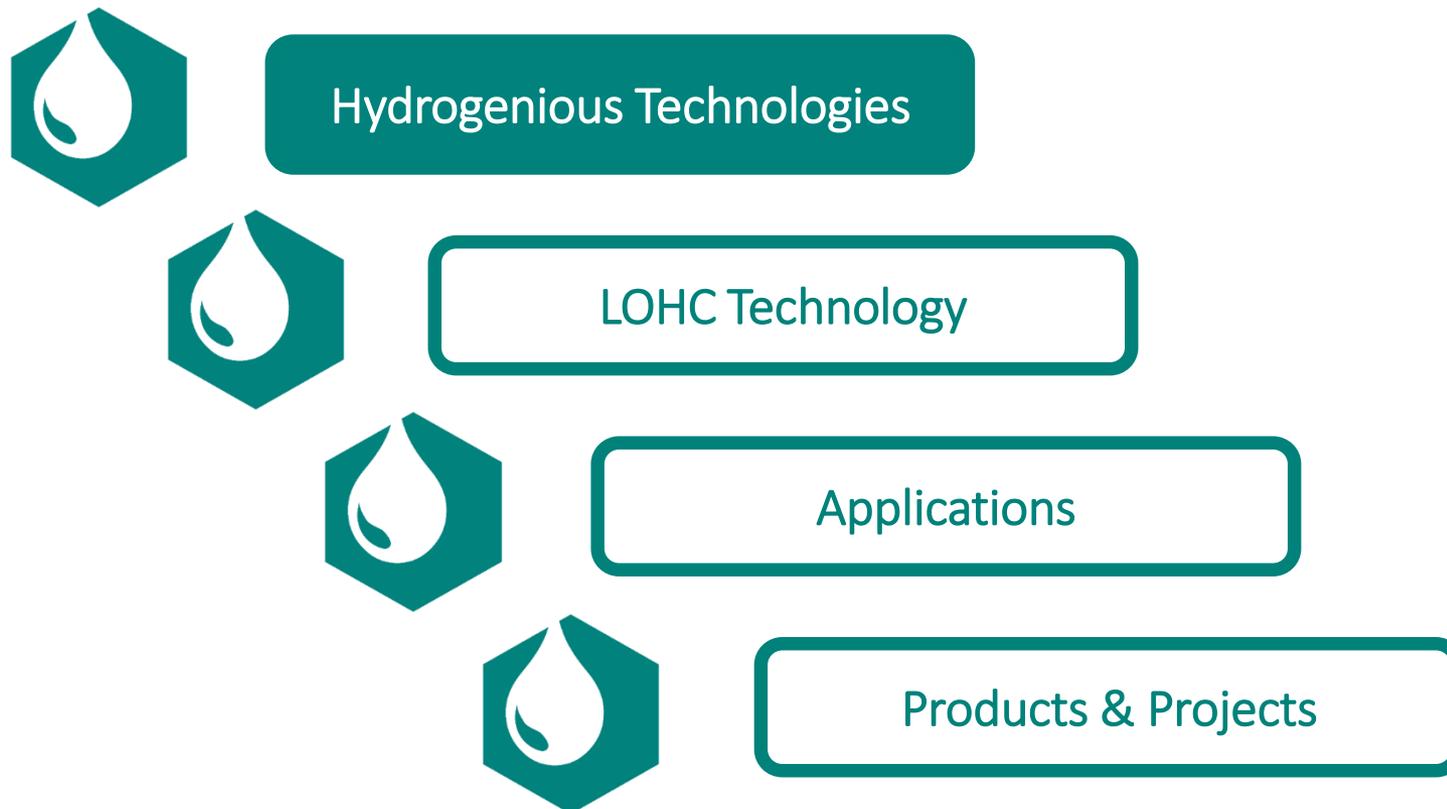
Hydrogen – stored as an oil

Erlangen, January 2018

HYDROGENIOUS TECHNOLOGIES GmbH

Weidenweg 13

91058 Erlangen



Hydrogenious Technologies GmbH – a pioneer in chemical hydrogen storage

- Founded in 2013 by Dr. Daniel Teichmann and Profs. Arlt, Schlücker and Wasserscheid; staff of 45; 25 patent families filed
- Global technology leader for Liquid Organic Hydrogen Carriers (LOHC) – the revolution in hydrogen storage and transport
- Focus on commercialization of hydrogen storage and release systems for industrial and mobile applications

Key Partners:



Hydrogenious has secured successful partnerships in commercialization and development of LOHC systems

Hydrogenious has closed the first **commercial projects**, ...

- Partnership with United Hydrogen Group
- Realization of first commercial applications in USA
- System delivery in Q3 2017



... commenced development of **industrial-scale storage** systems, ...

- Partnership with MAN Diesel&Turbo SE
- Development of industrial-scale LOHC hydrogenation reactors for central storage
- First system engineering to be finalized in 2017



... and continues in-house **development of release** systems.

- Supported by EUR 2.3 Mio. SME Instrument funding under Horizon 2020
- In-house build-up and operations of test systems
- Focus on modularization, standardization and system performance



Hydrogenious has the first LOHC-based hydrogen transport project in operation since June 2016

Hydrogenious HQ (Erlangen)



98kWp PV
@ Hydrogenious HQ



50kW Siemens
PEM Electrolyzer



StorageBOX 10

Excess heat
10kW



Transport of loaded
LOHC

Fraunhofer IAO (Stuttgart)



ReleaseBOX 33

PEM Fuel Cell



electric car filling station

Hydrogenious Technologies' management team combines scientific and business experience



Total team: 45 FTE



Dr. Daniel Teichmann
CEO & Founder

LEONI McKinsey&Company

Strategy, Technology,
Entrepreneurship



Dr. Cornelius von der Heydt
Head of Business
Development

Strategy, Finance,
Entrepreneurship

BCG
THE BOSTON CONSULTING GROUP



Deutsche Bank



Dr. Martin Schneider
Head of Product
Management

Project management,
Industry



Dr. Berthold Melcher
Head of Engineering & Ops

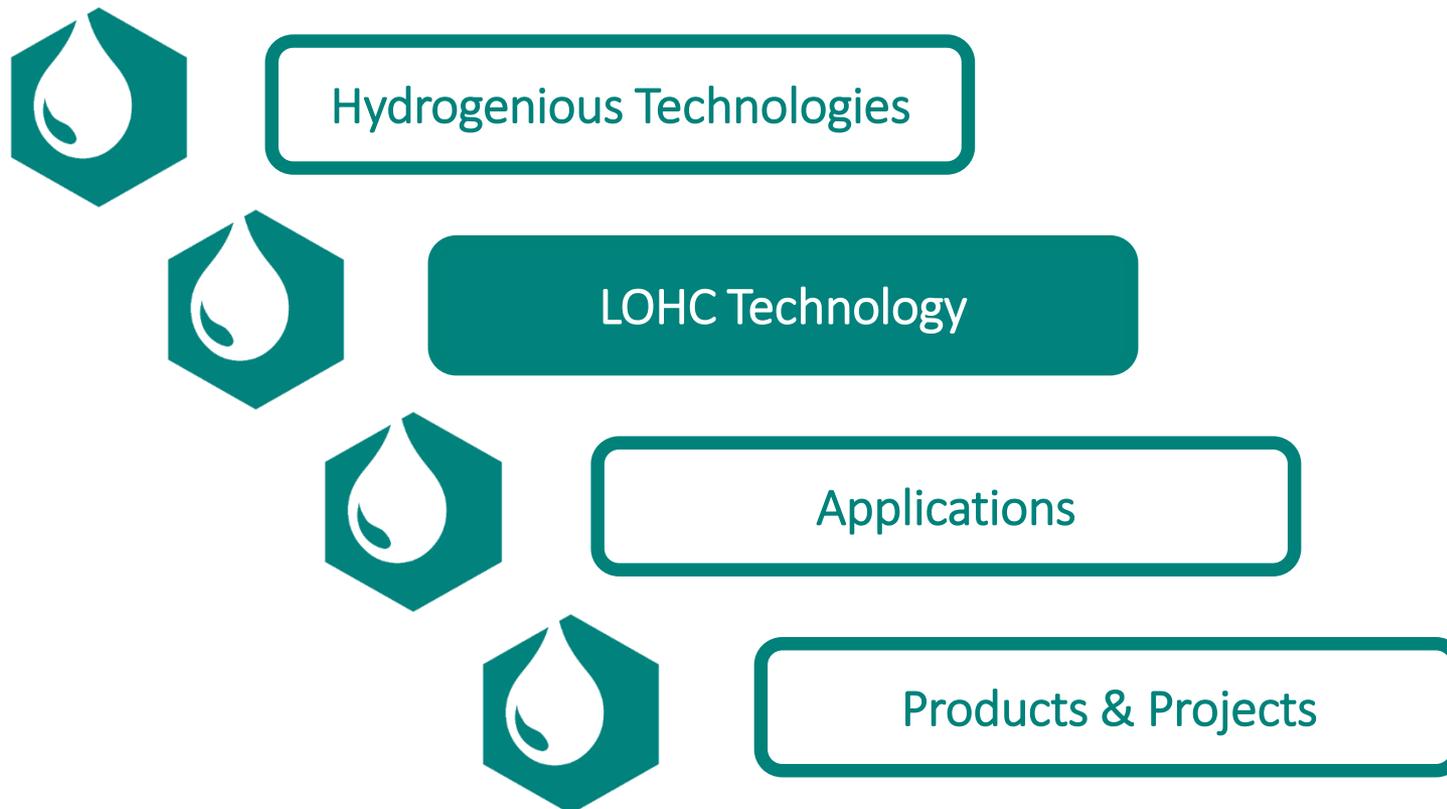
Industrial projects,
Product engineering,
Project roll-out



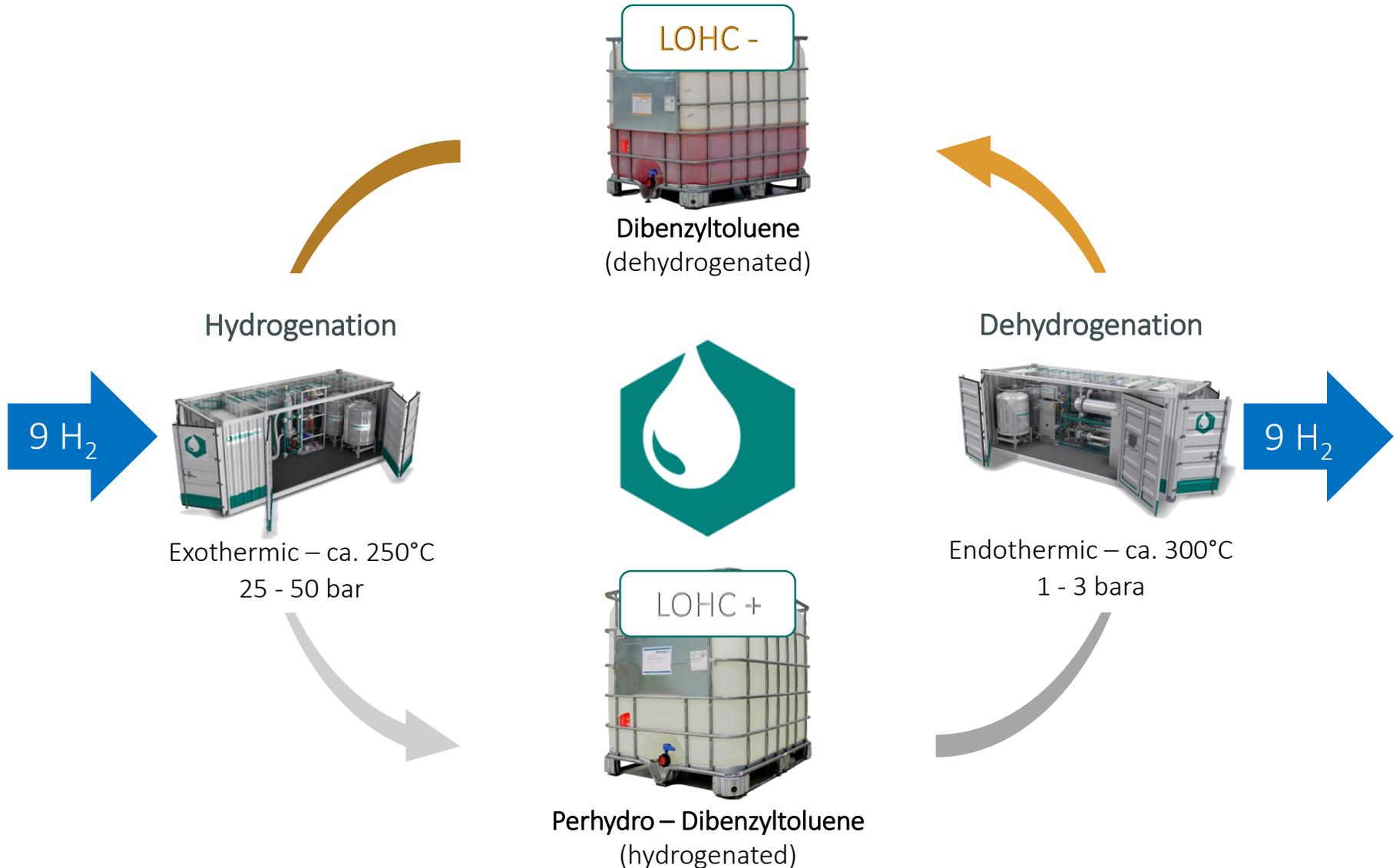
Dr. Caspar Paetz
Head of Product
Development

Process design &
optimization,
Plant development





Liquid Organic Hydrogen Carrier (LOHC) enable a safe and efficient transport of hydrogen at ambient conditions



Our LOHC technology has significant advantages in performance and handling compared to competing technologies

CGH₂

vs

LOHC



57 kg



Our LOHC is...

Efficient

- 630 Nm³ H₂ / m³ LOHC → 6.23 wt%

- 57 kg H₂ / m³ LOHC

Safe

- Non-explosive

- Not classified as dangerous good (ADR, etc.)

Easy to handle

- Diesel-like liquid

- Ambient conditions

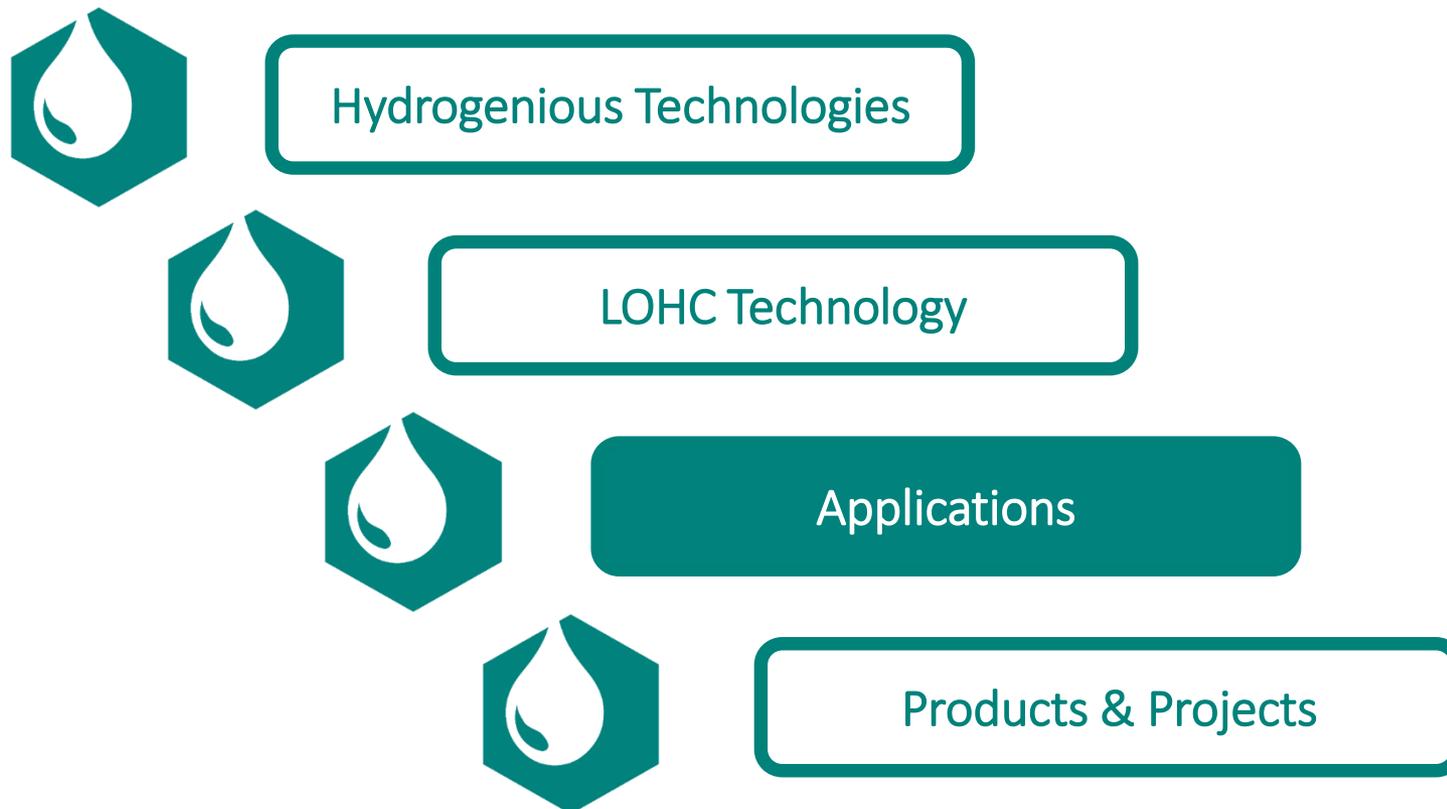
Low priced

- <5 €/kg

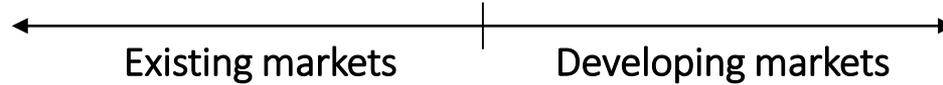
- Reusable

Our systems: containerized and easy to install on-site





The flexibility of hydrogen makes it a key resource in numerous applications and industries...



Industry



Fuels

Chemicals

Fertilizer

Metal refining

Food

Mobility



buses

Trucks

Trains

Ships

Cars

Special applications



Spacecraft

Submarines

Military

Energy



On-grid

Off-grid

Sectoral integration

... which can easily, safely and efficiently be connected by our LOHC technology to enable a sustainable hydrogen world

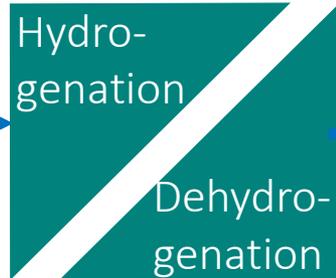
Industrial Hydrogen



Renewable Energies



Electrolysis



Industry supply



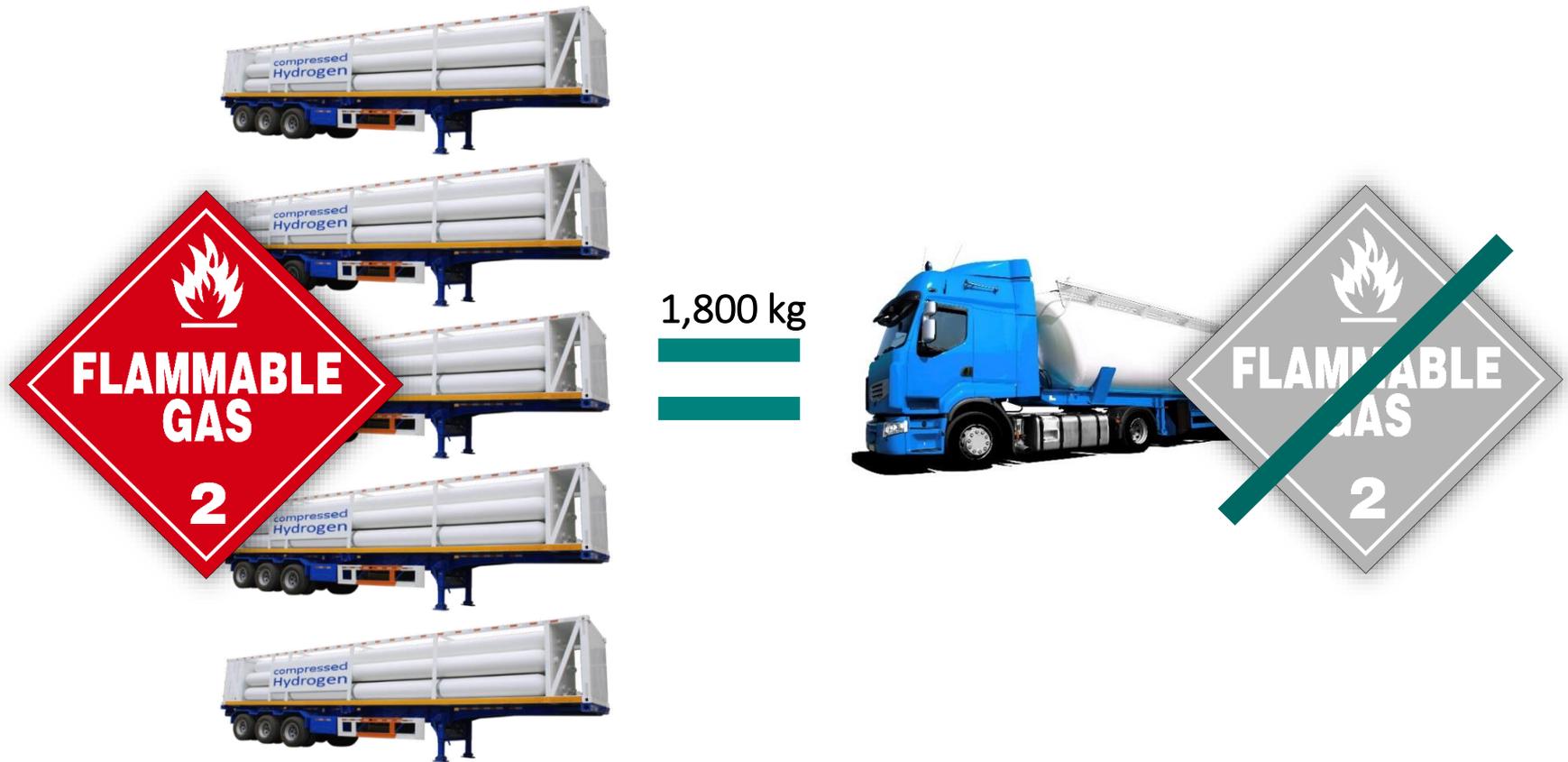
Hydrogen demand of 2 – 50 kg/h
Medium to long distance supply

Mobility



Large capacity refueling stations
buses, trains, captive fleets

The LOHC technology offers clear advantages in safety and transport compared to conventional technologies...



Capex for trucks & trailers

~ EUR 2,000,000

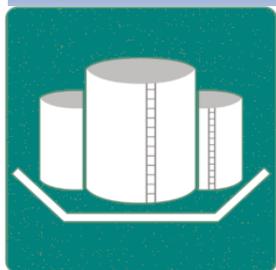
~ EUR 250,000

The LOHC technology offers significant advantages for large scale HRS – e.g. for bus, train or captive fleet supply...



Advantages of LOHC

- ✓ Low delivery frequency to HRS
- ✓ Lowest cost for H₂ bulk storage
- ✓ No boil-off losses / discharge
- ✓ Safe handling
- ✓ Small footprint through underground storage
- ✓ Highest social acceptance through oil handling



LOHC bulk storage
(2,000+ kg H₂)



LOHC+

ReleaseBOX

H₂

Dehydrogenation



Compression

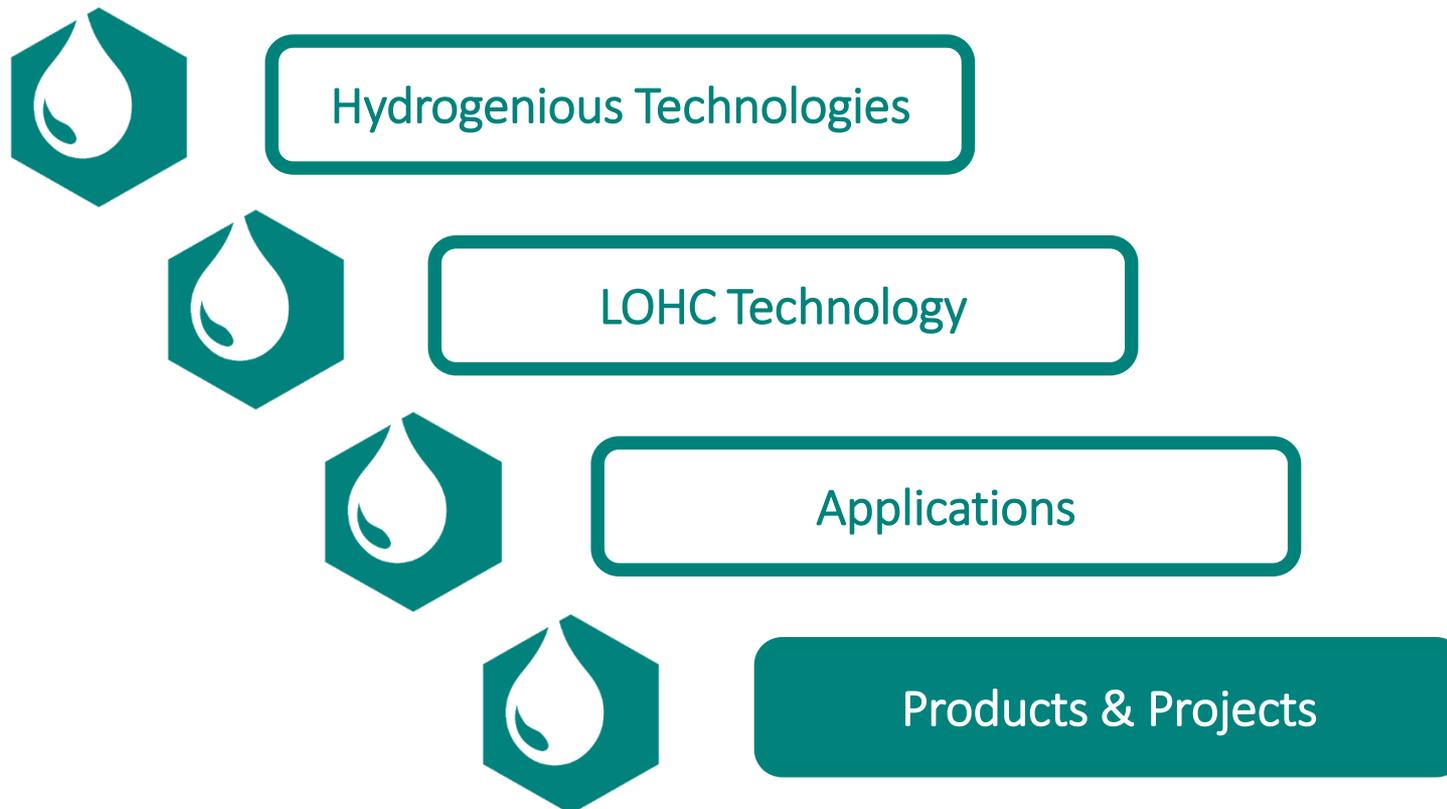


Pressure cascade

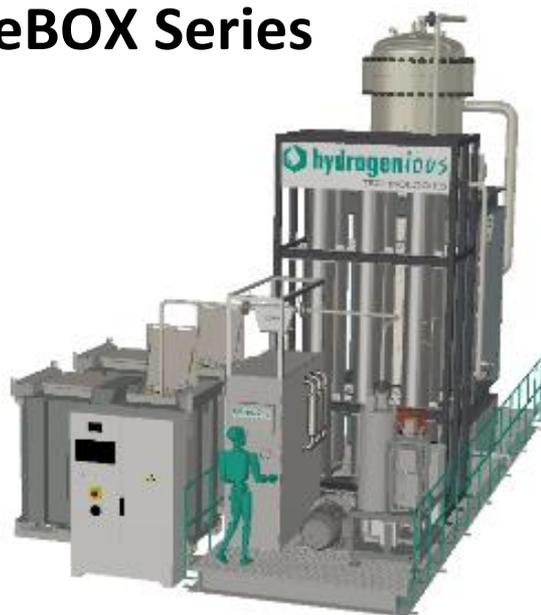


Dispenser





Hydrogenious' product portfolio: The StorageBOX Series



Interfaces

H ₂ inlet pressure	30 bar
Electr. Connection	400V
Cooling	10 kWh / kg H ₂

Series 100

H ₂ storage	100 Nm ³ / h
LOHC production	160 l / h
Housing	skid-mounted

Series 200

H ₂ storage	200 Nm ³ / h
LOHC production	320 l / h
Housing	skid-mounted

Series 400

H ₂ storage	400 Nm ³ / h
LOHC production	640 l / h
Housing	skid-mounted

Development of industrial scale hydrogenation plants started together with MAN Diesel & Turbo

Hydrogenious' product portfolio: The ReleaseBOX Series



Interfaces

H ₂ purity	up to 99.999%
H ₂ outlet pressure	up to 10 bar
Electr. connection	400V
Heating	~10kWh / kg H ₂ (Natural gas or electricity)

Series 10

H ₂ outlet	10 Nm ³ / h
LOHC throughput	16 l / h
Housing	20' container

Series 33

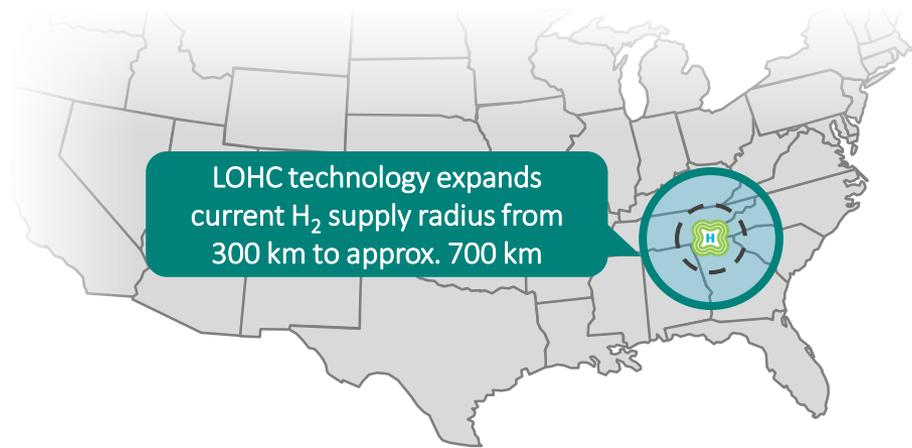
H ₂ outlet	33 Nm ³ / h
LOHC throughput	53 l / h
Housing	20' container

Series 110

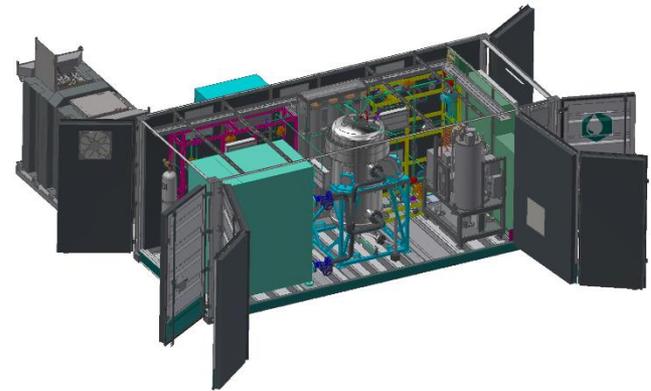
H ₂ outlet	110 Nm ³ / h
LOHC throughput	176 l / h
Housing	20'-30' container

Targeted system scale-up: hydrogen release capacities
of up to 1.000 Nm³/h

Commercial project: US market entry started with industrial demo project together with United Hydrogen Group



- Regional U.S. hydrogen distributor with >50 customers (Industry and mobility)
- **Current situation:** Limited distribution radius due to low transport capacities of pressure tube trailer technology
- **Targeted setting:** Expansion of supply radius through use of high-capacity LOHC technology
→ Win-Win setting for UHG and its customers
- Initial pilot systems contracted by UHG
 - StorageBOX 100 (9.1 kg/h H₂) - Centralized H₂ production
 - ReleaseBOX 33 (3 kg/h H₂) - Industry customers
 - ReleaseBOX 2.5 (0.23 kg/h H₂) - Power Plants



UHG demo-customers



System delivery:
Oct. 2017

Strategic cooperation with MAN Diesel&Turbo focusses on product development for merchant hydrogen infrastructure...

StorageBOX 10



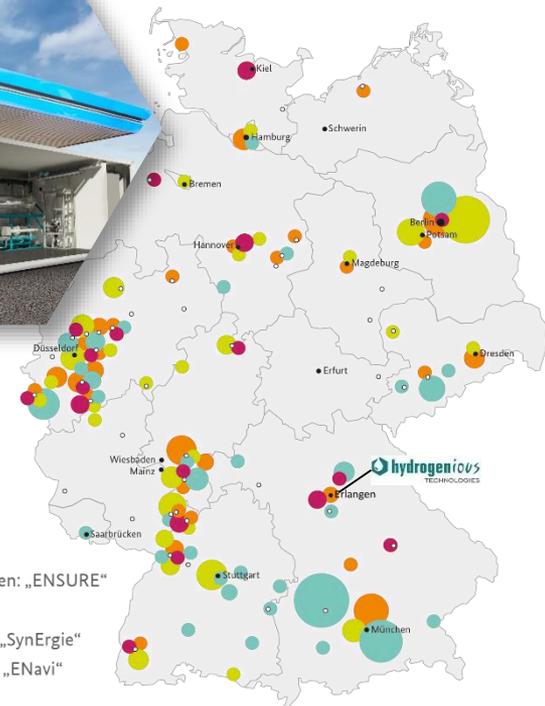
StoragePLANT



- ❖ MAN Diesel&Turbo is a global technology leader for large scale reactor systems for the chemical and petro-chemical industry
- ❖ Cooperation for development of **industrial-scale LOHC hydrogenation reactors** based on MAN's proprietary salt bed reactor technology
- ❖ Engineering and design of first pilot test reactor targeted for 2017

...whilst Hydrogenious and 11 partners focus on LOHC based hydrogen refueling stations in Kopernikus research program

- The “Kopernikus Projects” form Germany’s largest coordinated research program
 - Funded by the German Ministry of Research
 - > 90 companies and (research) institutes involved
 - Four specific excellence clusters
- “Decentral H₂-logistics” project with focus on LOHC based H₂ refueling stations
 - Budget of ~4 Mio. EUR over next three years
 - 12 partners involved including Linde, ThyssenKrupp, Clariant and AREVA



Thank you for your interest!

Head of Business Development & Sales

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