# Hydrogen Storage and Distribution System at DLR Site Lampoldshausen

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3rd Germany-Korea Hydrogen Conference

28.09.2022

# Outline

- DLR at a glance

- Hydrogen Storage and Distribution for Space Test Benches at DLR Site Lampoldhausen
- Extension of Hydrogen Storage and Distribution Facilities for Technology Transfer
    - Platform for Container Based Test Benches
    - Test Platform Hydrogenium

- Summary

# DLR at a Glance

- Research institution
- Space Administration
- Project Management Agency

Areas of research:

- Aeronautics
- Space research and technology
- Transport
- Energy
- Security (cross-sectoral area)
- Digitalisation (cross-sectoral area)

# Locations and employees

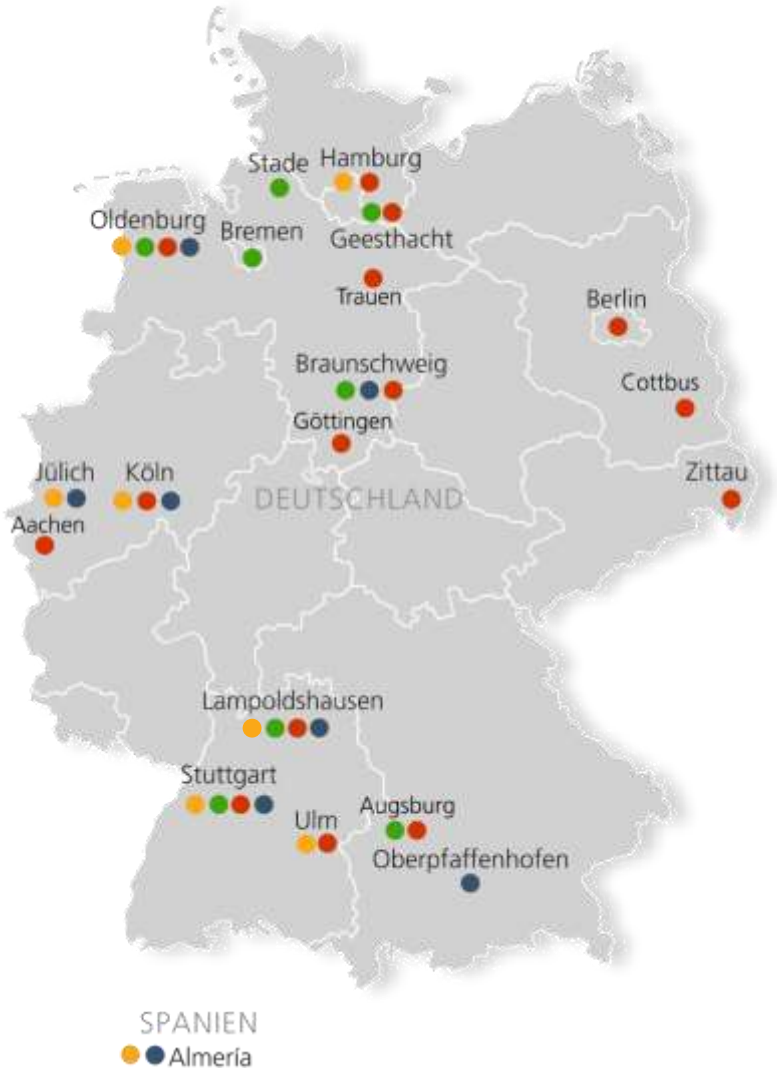
More than 9000 employees work in 54 institutes and facilities at 30 sites across Germany.

International offices in Brussels, Paris, Tokyo and Washington D.C.

Institute of Space Propulsion founded 1959 by Prof. Sänger

(DLR - Institut für Raumfahrtantriebe - Die Geschichte des Standorts)


# DLR Sites with Hydrogen Activities




Production electrolysis & solar thermal processes

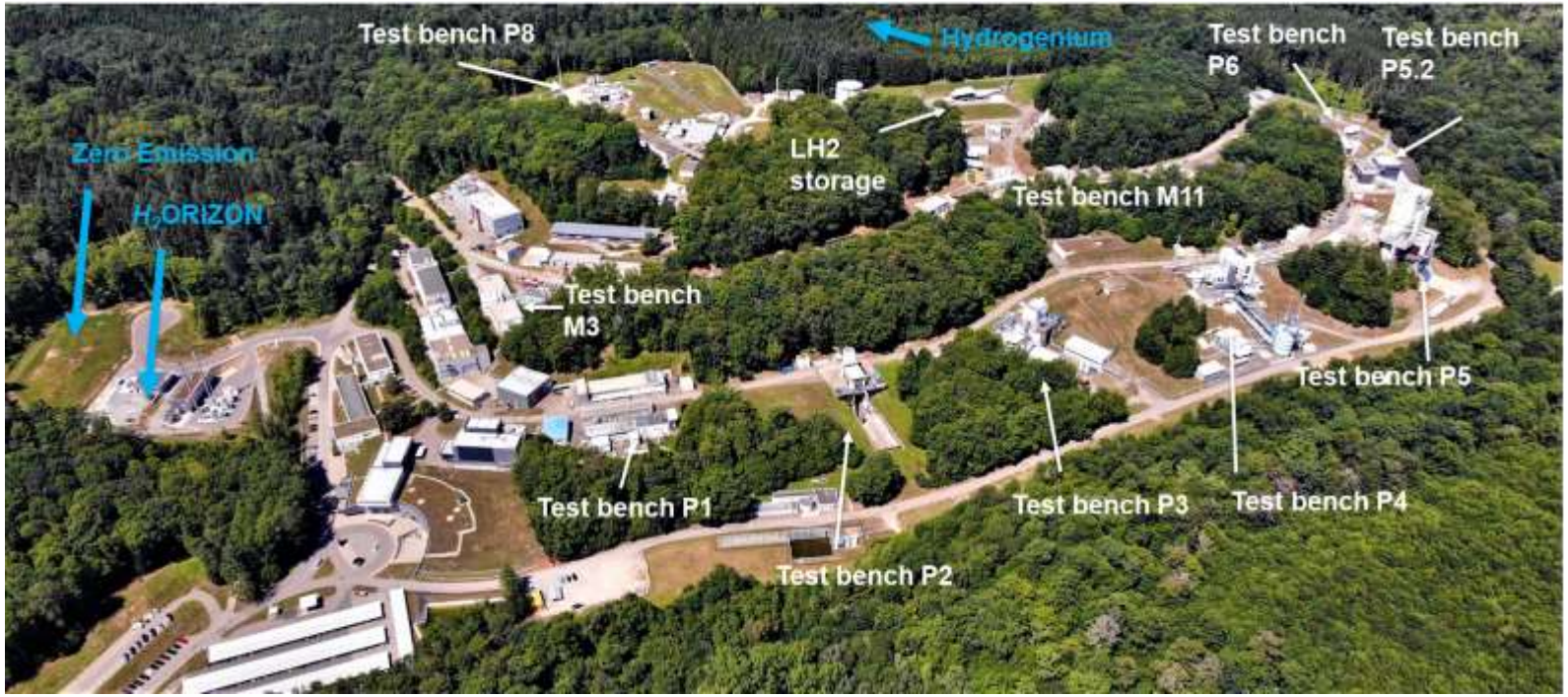
Storage & Distribution

Application

System/market analysis, technology assessment, sustainability

# DLR Site Lampoldshausen

- Operation of DLR and ESA test facilities
- H2 consumption about 380 t/a (mainly liquid)
- Operational experiences of hydrogen systems since decades
  - Knowledge about
    - $H_2$-resistant materials, Components and $H_2$ systems
    - Safety infrastructure and permissions for $H_2$ plants (12.BImSchV/StöV)
- Knowledge- and technology transfer
  - Annual hydrogen day since 2013
  - Dept. for Applied Hydrogen Technologies




Site Video: www.dlr.de/ra

# Test facilities & Infrastructure – Part 1

## Low pressure test facilities

- High altitude simulation
- $N_2O_4$, MMH, $H_2O_2$
- Thrust range 200 - 600N



- ESA test facility
- High altitude simulation
- P4.1: $LH_2$, LOx, up to 250 kN
- P4.2: $N_2O_4$, MMH, up to 30 kN

- ESA test facility
- Ground tests
- $LH_2$ and LOx
- Up to 4.000 kN



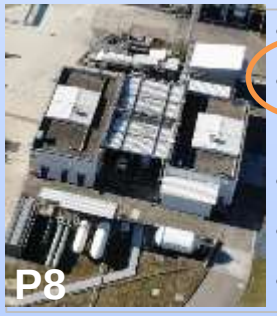
- Turbo pump and system tests
- ground and high altitude simulation tests
- $LH_2$, LOx, $LCH_4$, LNG, GNG, up to 75 kN

## Low pressure test facility for upper stage and tanks


- ESA test facility
- Testing the complete cryogenic upper stage ULPM of Ariane 6 (engine with tank system)
- autarchic control
- Up to 32 tons fuel (LOx and $LH_2$)
- 900 seconds hot run

## High pressure test facilities


- ESA test facility
- ground and high altitude simulation tests
- $LH_2$, LOx, $LCH_4$, LNG
- Mass flow up to 330 kg/s
- I/F-pressure up to 280 bar




- DLR-CNES-ArianeGroup
- $LH_2$, LOx, $GCH_4$, $LCH_4$, LNG Ethanol
- ground and high altitude simulation
- Mass flow up to 12 kg/s
- I/F-pressure max. 360 bar


- $LH_2$, LOx, LNG, $LCH_4$, LNG
- Mass flow up to 1,25 kg/s
- I/ F-Pressure max. 95 bar

# Test facilities & Infrastructure – Part 2

## Miscellaneous test centres


- Green propellants
- Gel propellants
- Vacuum plant
- Scramjet research


- Physical chemical laboratory
- Cryogenic laboratory
- Basic research
- Micro combustion chamber
- $LH_2$, LOx, $LCH_4$

## Special hydrogen infrastructure


- $LH_2$ storage tank, 270m³
- $LH_2$ pilot tank, 55m³
- Transfer delivery rate of up to 200m³ $LH_2$ per day


- PEM-Electrolyser research platform
- 880kW $P_{el}$ from wind park
- 14,1 kg/h green hydrogen


- PEM-Electrolyser
- 2300kW $P_{el}$ from wind park
- 35,8kg/h green $H_2$

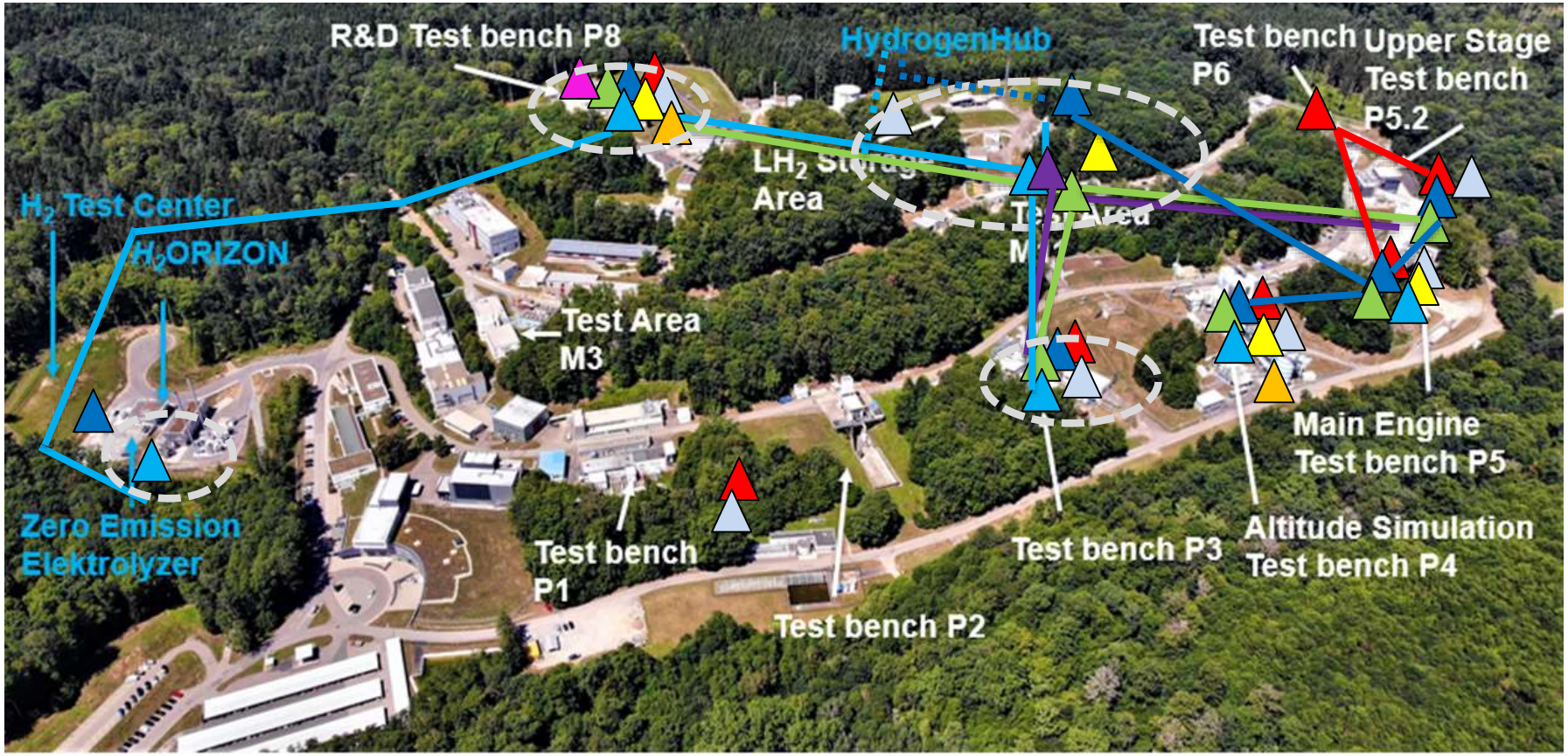
## Test centres for hydrogen applications


- container-based test facility
- 5 test positions for components and demonstrators
- $GH_2$ (green, LP+HP), ~50kg/h
- $LH_2$ as growth potential


- Large test facility with $LH_2$ supply (up to 500kg/h peak) and $GH_2$ (300kg/h Peak, HP/LP)
- laboratory
- 10 test positions (small/big)

# Main Media Supply Systems

| | Leitung | Tank |
|---|---|---|
| $GH_2$ | | |
| $LH_2$ | | |
| $GN_2$ | | |
| $LN_2$ | | |
| GOx | | |
| LOx | | |
| $CH_4$ | | |
| GHe | | |
| Water | | |




Production and/or
Refilling area

# Storage and Distribution to Test Benches

- Delivery by LH2 trailers
- Main Storage tanks 270 m³ @ 1,1 bar and 50 m³ @ 6,5 bar
- Complete LH2 storage capacity with run tanks at test benches nearly 1000m³

LH2

- Transfer of LH2 via pipeline (up to 200 m³ per day):
  - Pressurization of tank + hydrostatic pressure due to higher altitude of centralized storage than decentralized run tanks at test benches.

LH2

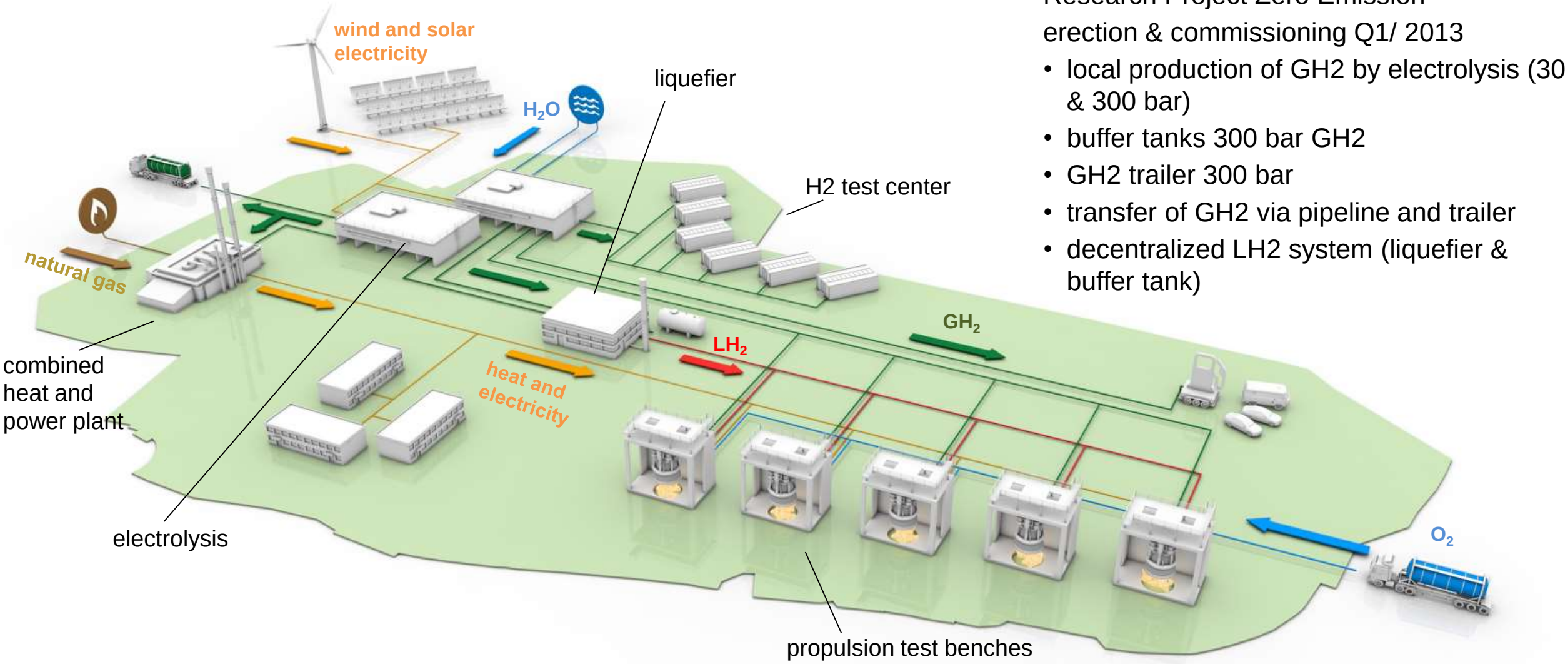
LH2

- Transfer of GH2 via pipeline
  - Evaporation of LH2
  - Pressurization up to 300/800 bar

GH2

GH2

# Storage and Distribution Extension for H2 Test Center




Research Project Zero Emission

erection & commissioning Q1/ 2013

- local production of GH2 by electrolysis (30 & 300 bar)
- buffer tanks 300 bar GH2
- GH2 trailer 300 bar
- transfer of GH2 via pipeline and trailer
- decentralized LH2 system (liquefier & buffer tank)

# Hydrogenium

**Media Supply with green liquid and gaseous hydrogen:**

Reliable supply up to peaks of 500 kg/h LH2 and 150 kg/h GH2 with a maximum pressure of 300 bar

Additional supply of every test bench with GN2 and He

Demand-based supply and delivery of electrical energy up to 400kW

**Services:**

Support in projects

Support for erection and operation

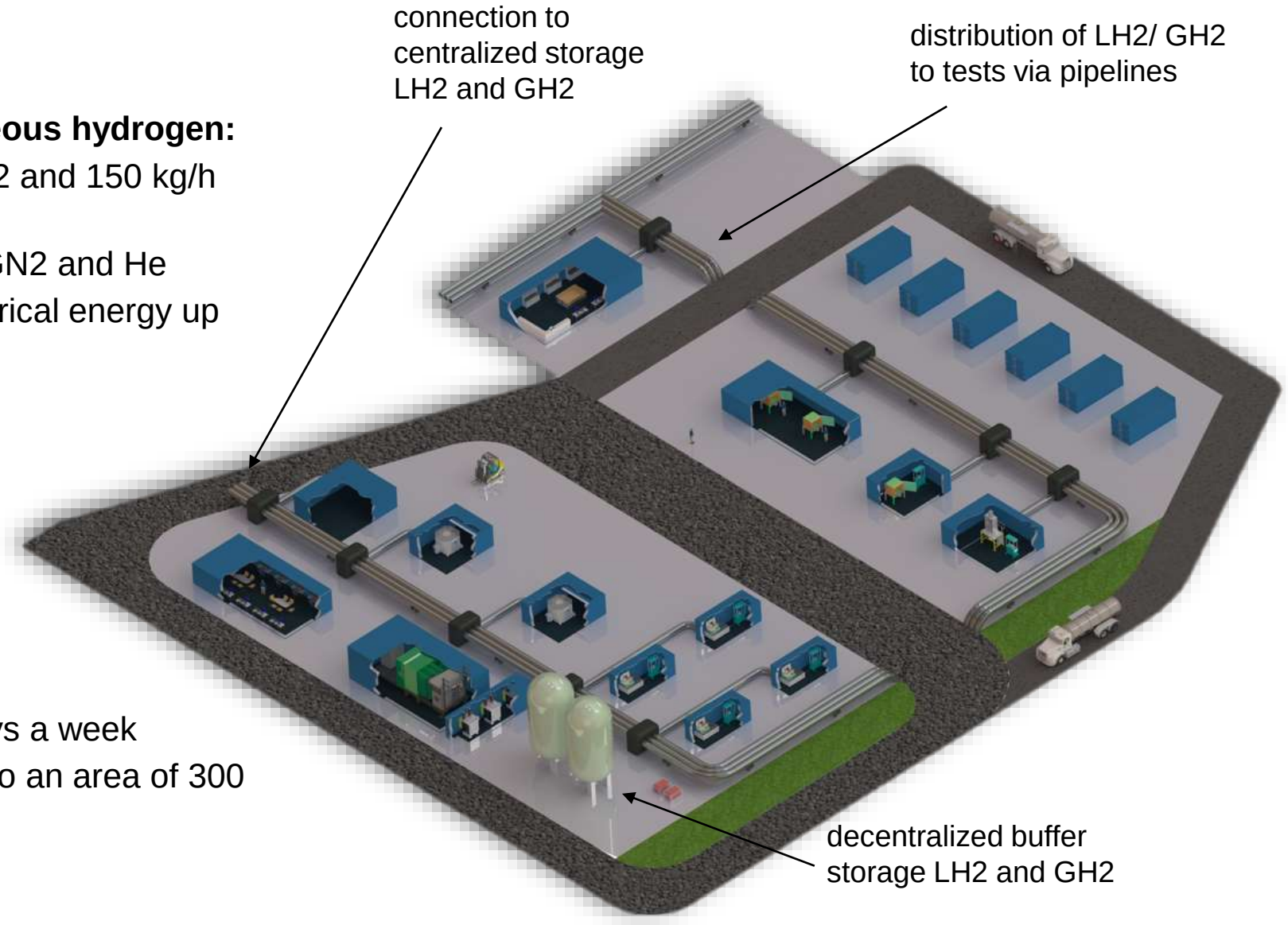
Preparation area

**Hydrogen Cluster of Excellence:**

Opportunity of testing 24 hours a day, 7 days a week

Flexible, container based test positions up to an area of 300 m²

Open to all sectors/technologies



# Summary and Outlook

- Test benches at DLR Site Lampoldshausen consume huge amounts of GH2 and LH2.

- Storage tanks with different volumes and pressure levels are on site to provide the required amounts of hydrogen.

- Filling of centralized storage tanks is done by
    - delivery of LH2 by trailer;
    - delivery of GH2 by trailer (on site produced by wind energy);
    - recovery of GH2 on site produced GH2.

- Distribution to decentralized run tanks via pipeline
    - LH2: cryo-piping, overpressure in storage tank due to evaporation unit and hydro-pressure;
    - GH2: evaporation of LH2 or use of low pressure GH2 and compression to 300/800 bar.

- Flexible test fields are planned on site for technology transfer (H2CT – start of operation Q2/2023; Hydrogenium – funding approval expected soon)



# Thank you for your attention !

Contact

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