

Hydrogen Site Lampoldshausen – On-site Production of Green Hydrogen and Technology Transfer from Space Applications

Juni 2022

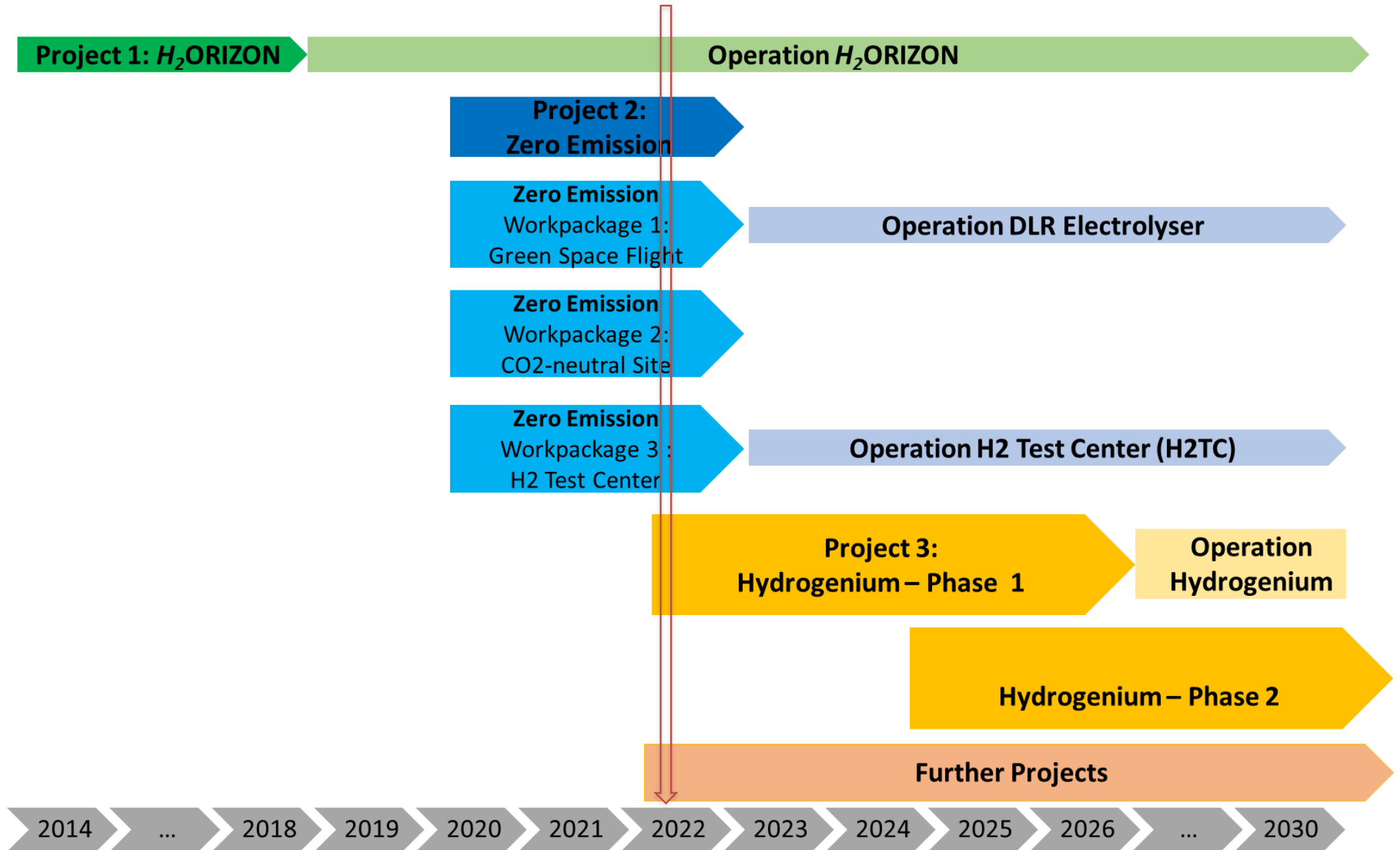
Dipl.-Phys. Dr.-Ing. Birgit Gobereit
DLR Institute of Space Propulsion
Department Applied Hydrogen Technologies (AWT)



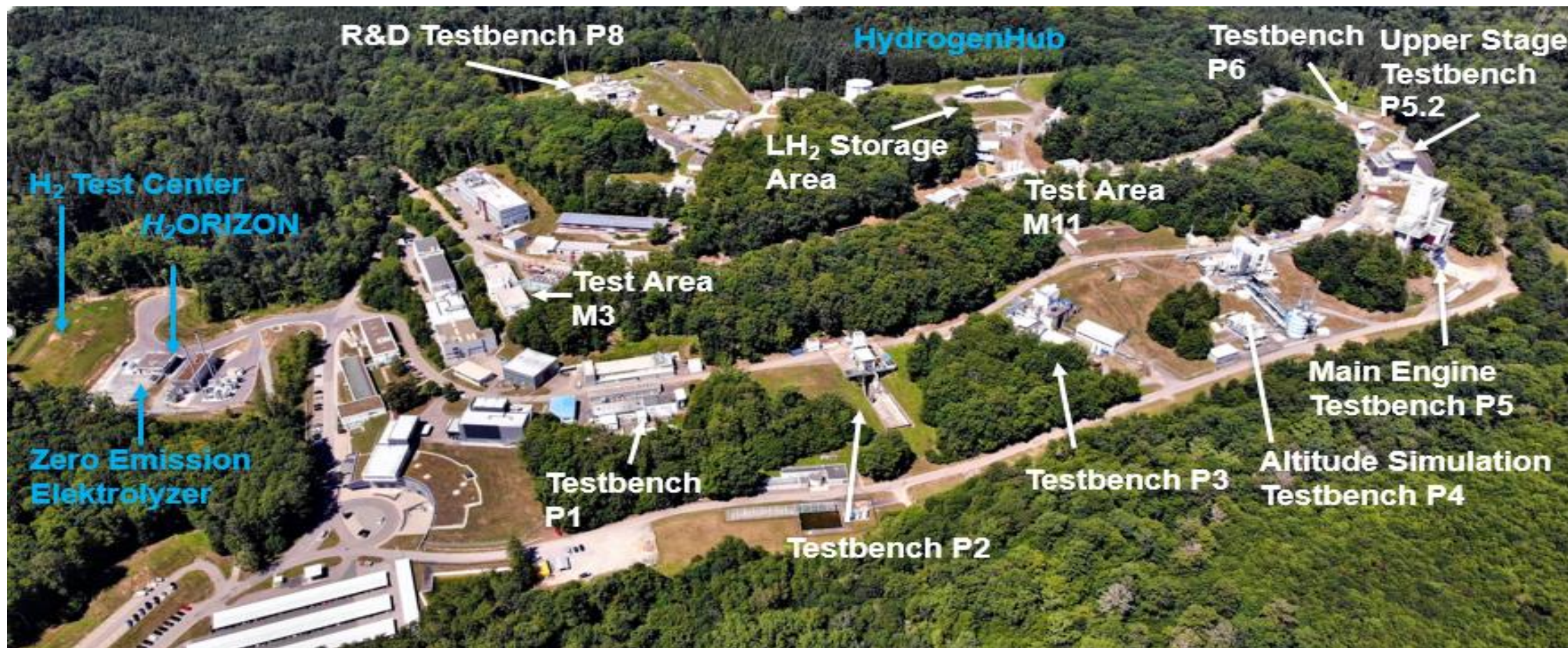
Knowledge for Tomorrow



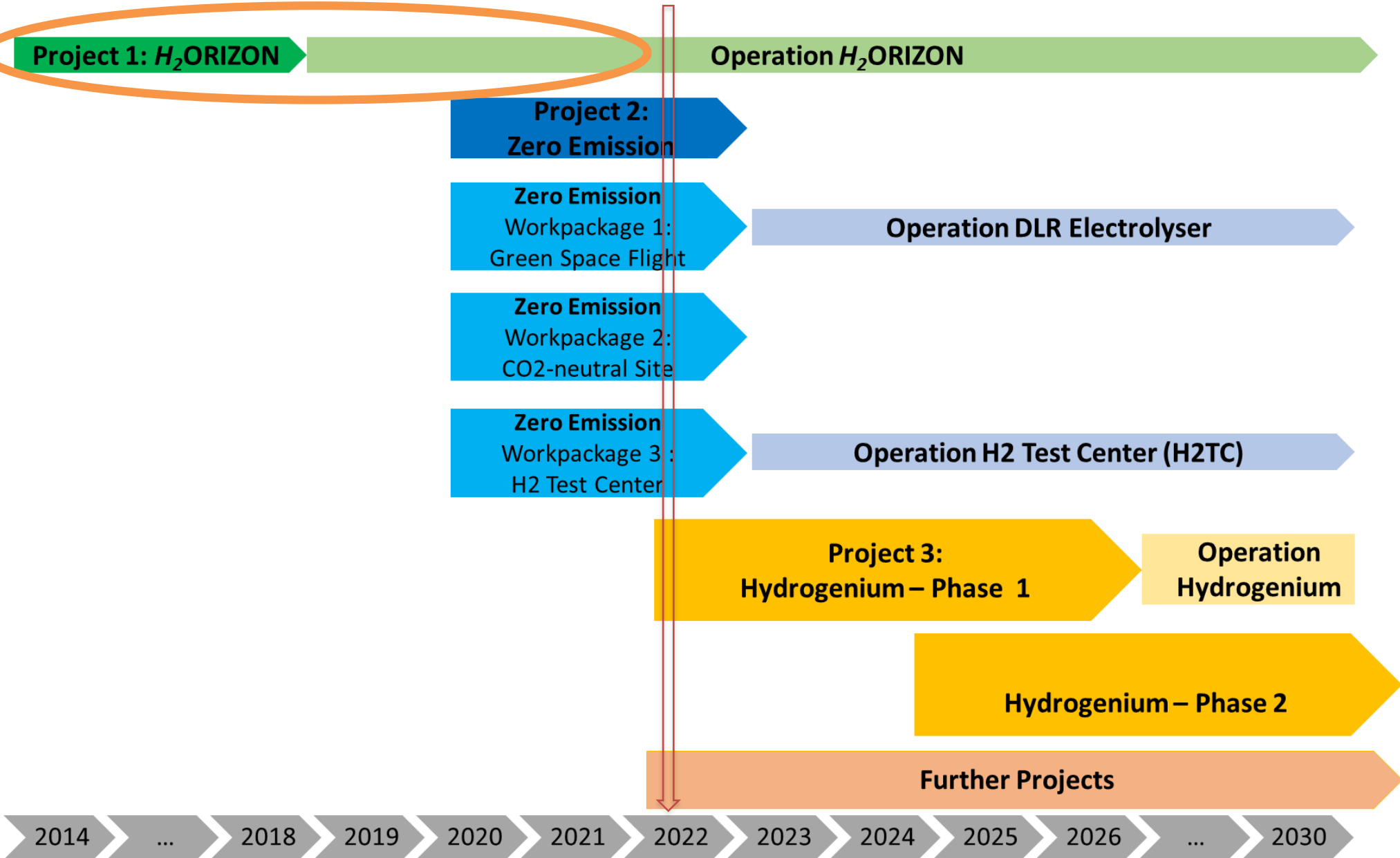
Outline



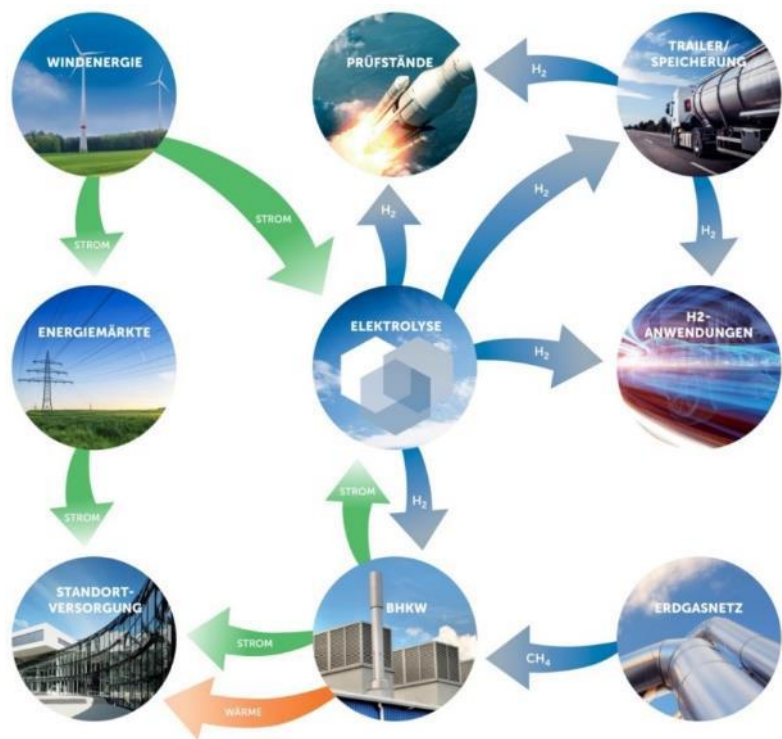
DLR Site Lampoldshausen



Outline



H₂ORIZON: Research- and Demonstration Platform



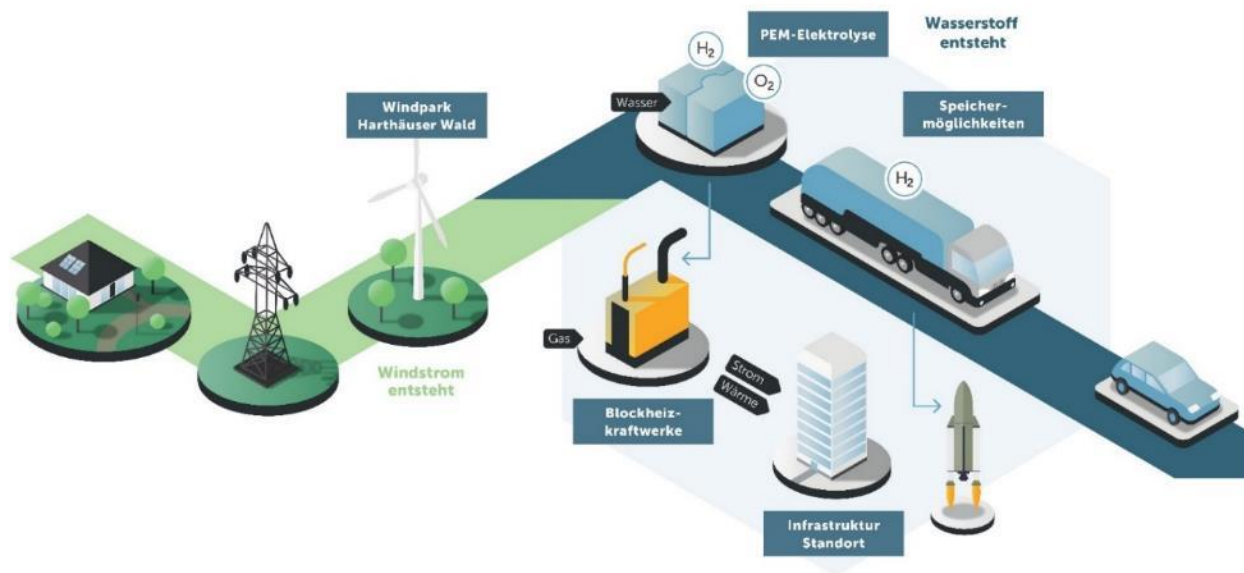
Fact sheet
Project start 2015
~ 900.000 Euro funding Ministry for the Environment, Climate and Energy Management
Project Partner ZEAG Energie AG
PEM Electrolyzer as **Research platform**
Hydrogen production via wind power
Usage of hydrogen for rocket engine tests and in H₂ test center
Power & heat generation via BTTP with methane hydrogen mixture
Start of normal operation 03/2022

- ✓ Usage of existing **Infrastructure** *(54MW wind park & DLR test facilities)*
- ✓ combining of **Competences** *(Research, hydrogen & energy economy)*
- ✓ **Sector coupling** for an optimized operation *(space flight, energy economy & Traffic)*



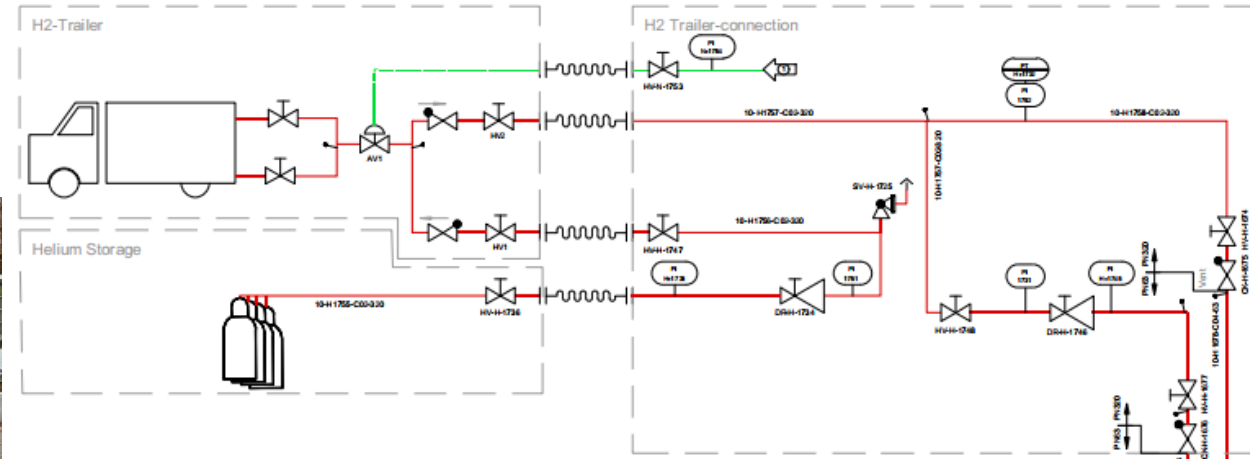
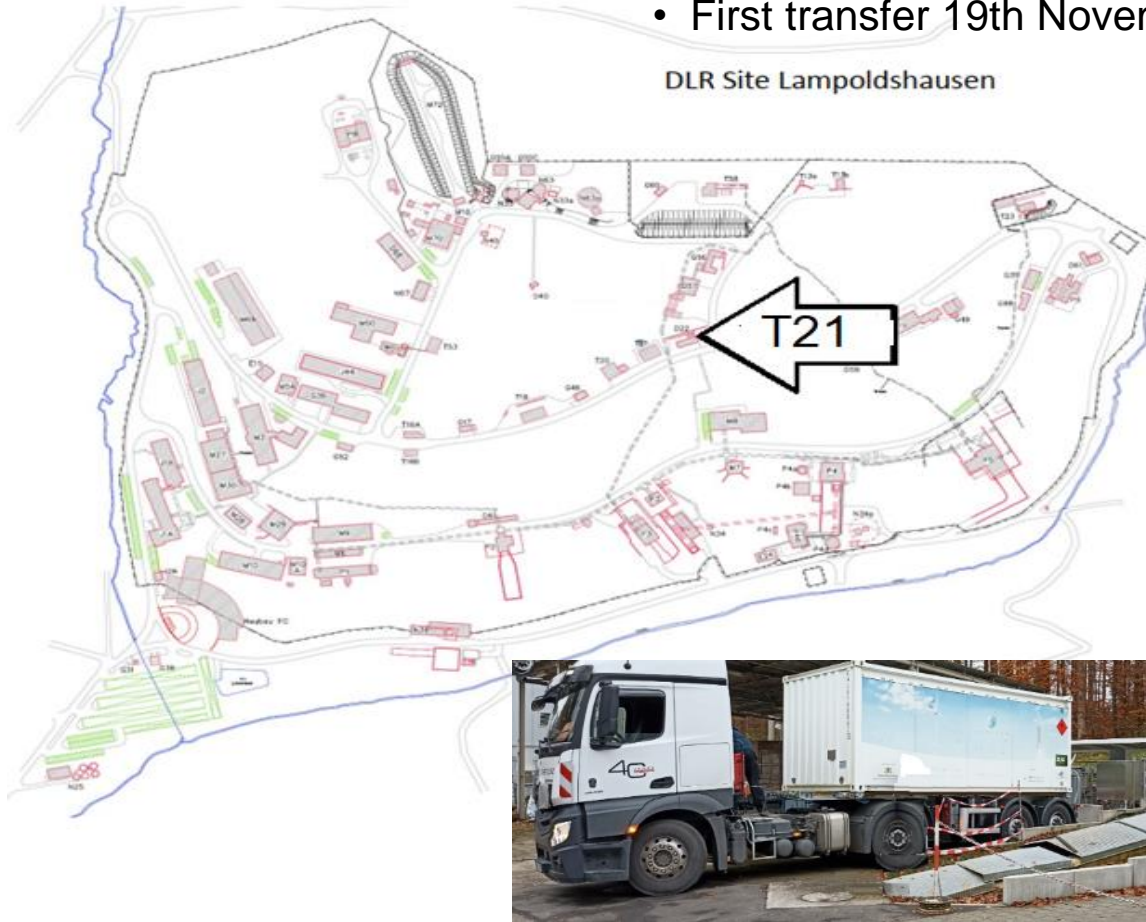
H₂ORIZON at a Glance

- PEM electrolyzer (880 kW electrical power, max. 14,1 kg/h GH₂)
- 100 % green hydrogen from wind energy
- Compression auf 300 bar
- Tube trailer as buffer storage (about 300 kg @ 300 bar)
- Combine heat and power plant with gas motor peak power 1,7 MW (thermal) und 1,4 MW (electric)

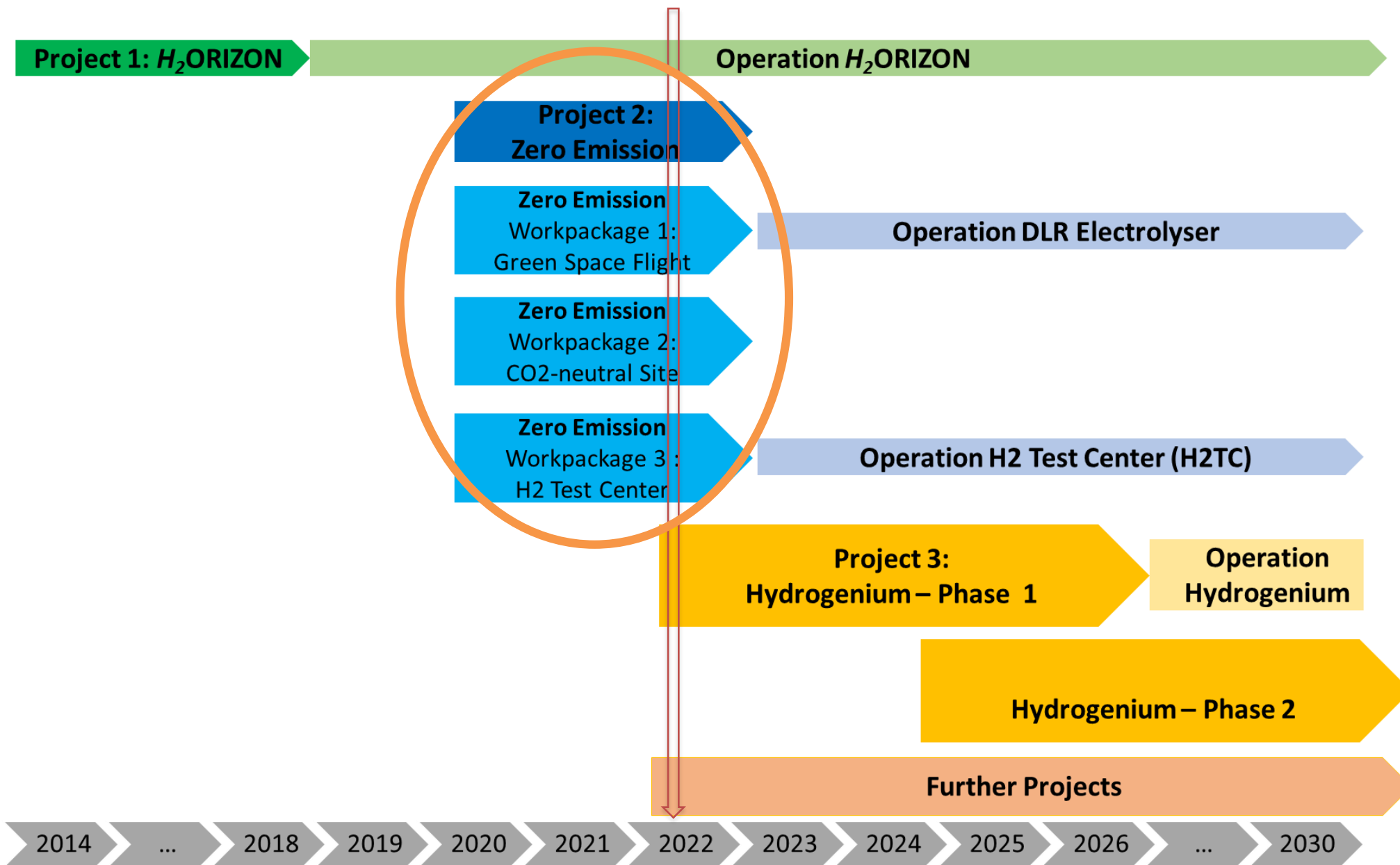


GH2 Transfer

- Hardware status unloading panel at T21
 - ZEAG trailer
 - First transfer 19th November 2021





Outline



Project: Zero Emission

 Green Space Flight

 CO₂ – neutral Site

 H₂ Test Center


 Enhance production of green hydrogen with 2nd PEM electrolyzer (about 3 MW – 300 t/year)

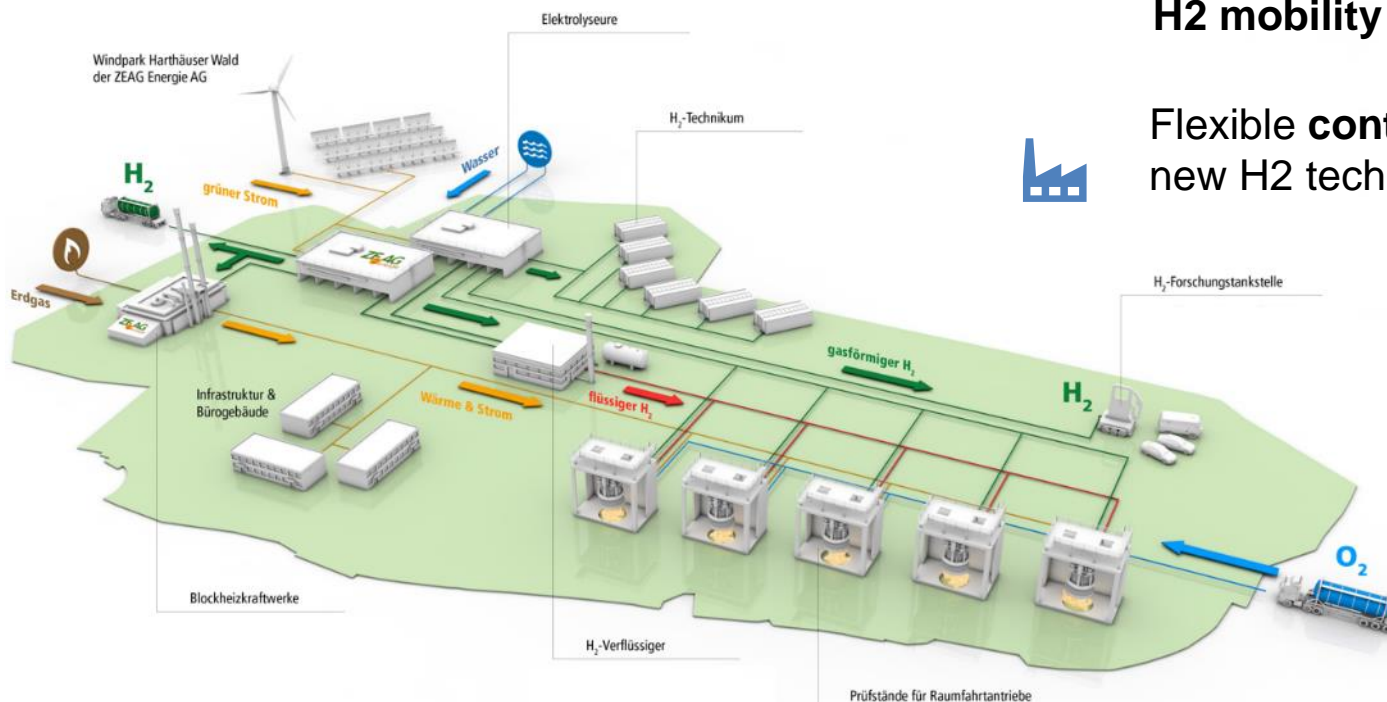
Extension of H₂ infrastructure (storage & distribution system)

On-site production of LH₂ with **liquefier**

 Assessment and optimization of **site energy system**

H₂ mobility (vehicles & fueling station)

 Flexible **container based test center** to support development of new H₂ technologies in cooperation with industry and science



Realization framework

Project duration: 05/2020 to 12/2023

~16 Million € Funding
Ministry of Economics, Labor and Housing
Baden-Württemberg

Zero Emission – Green space flight

Erection of an additional electrolyzer

- Increase of H₂ generation capacities
- Construction of a pipeline to connect the electrolyzers and the H₂ test center to each other and to the on-site media supply for the test bench facilities

Erection of a liquefier

- Additional supply of approximately 140 tons of liquid hydrogen per year

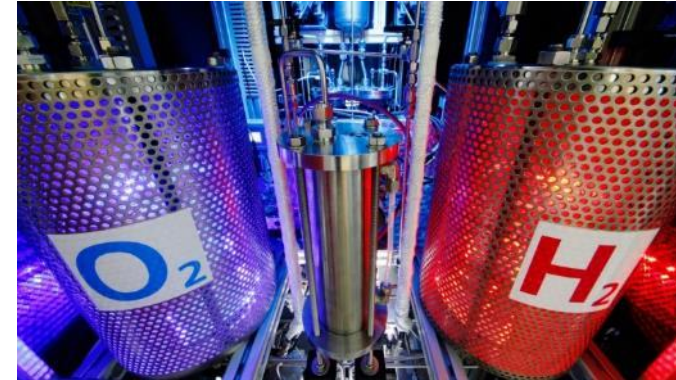


Foto: DLR / Thomas Ernsting

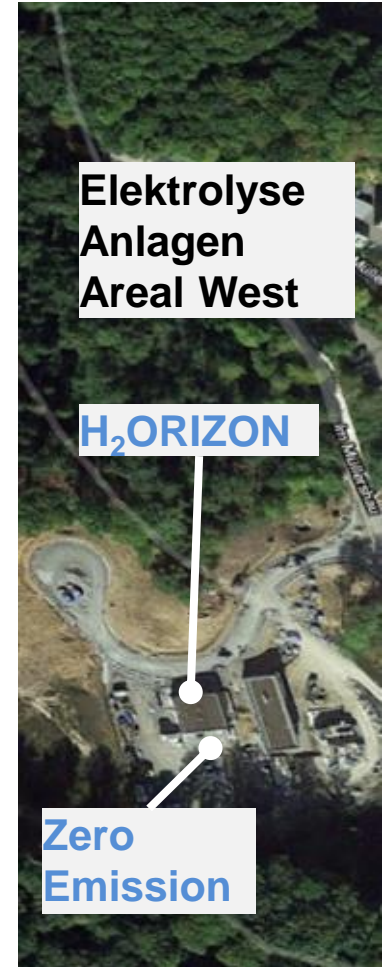
Electrolysis capacities

ZEAG Energie AG: 0,9 MW

100 tons of H₂ per year

DLR: 2 MW

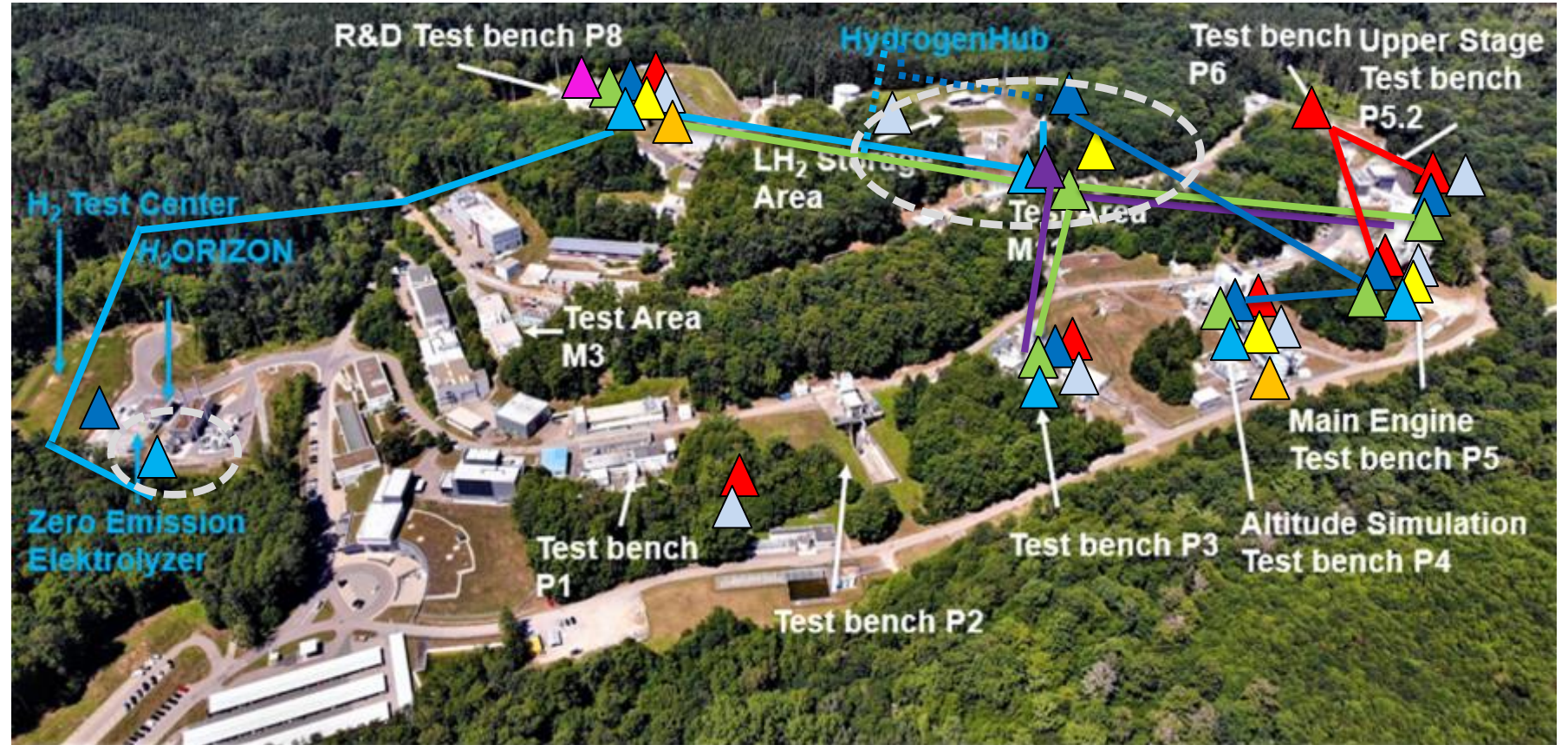
180 tons of H₂ per year



Main media supply systems

	Piping	Tank
GH ₂		
LH ₂		
GN ₂		
LN ₂		
GOx		
LOx		
CH ₄		
GHe		
Water		

Production and/or Refilling area



Zero Emission – CO₂-neutral site

Expansion of the site's energy supply system based on a sustainable design

- Design of an ideal energy system (generation, storage, sector coupling).
- Design of the new energy system, development and implementation of an optimal operation management with machine learning methods

Reduction of emissions in mobility

- (Procurement and operation of a mobile H₂ filling station)
- Expansion of the vehicle fleet with fuel cell vehicles
- Clarification of research questions on H₂ mobility

Fuel Cell car Toyota Mirai II



Project partner

DLR Institute of Networked Energy Systems

DLR Institute of Vehicle Concepts

DLR Institute of Space Propulsion

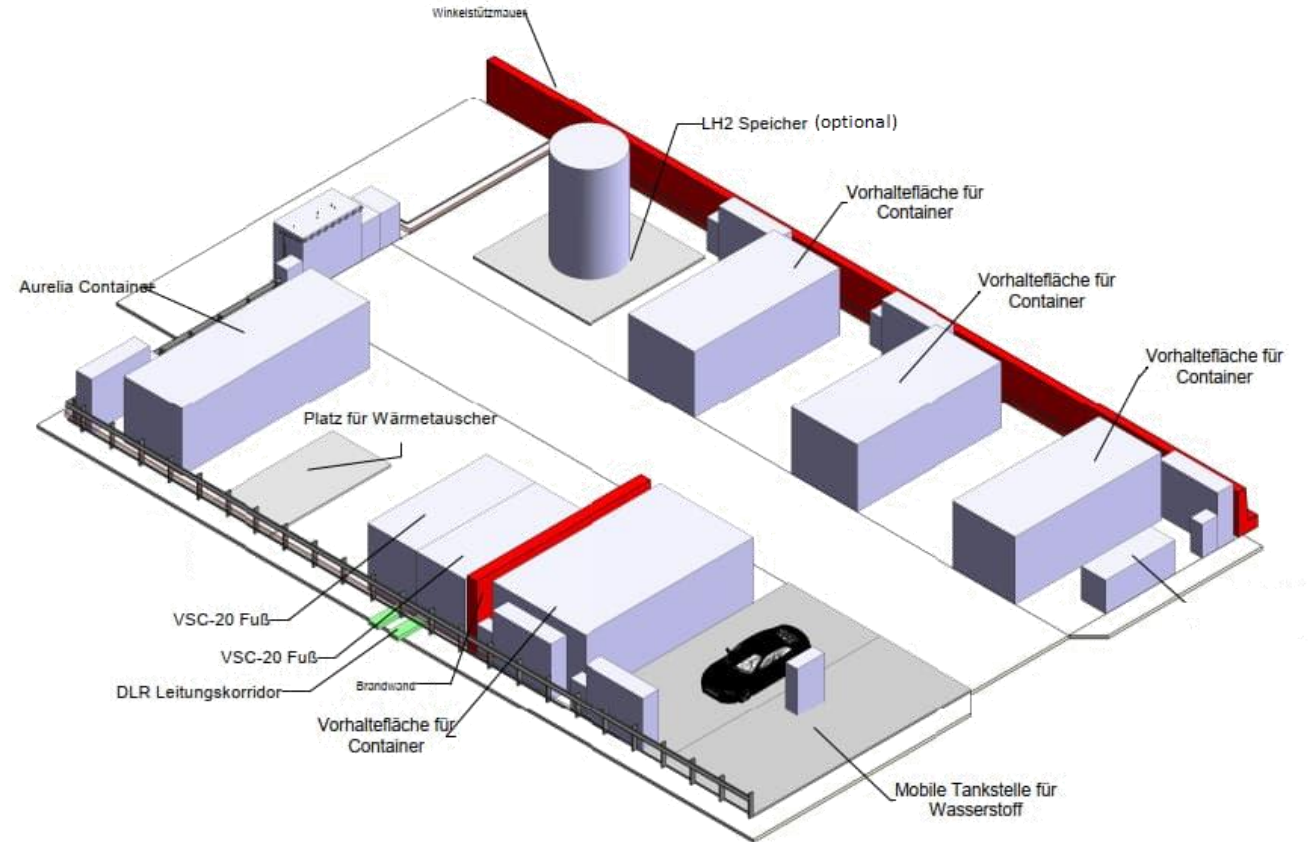


H2CT - Container-based Hydrogen Test Center

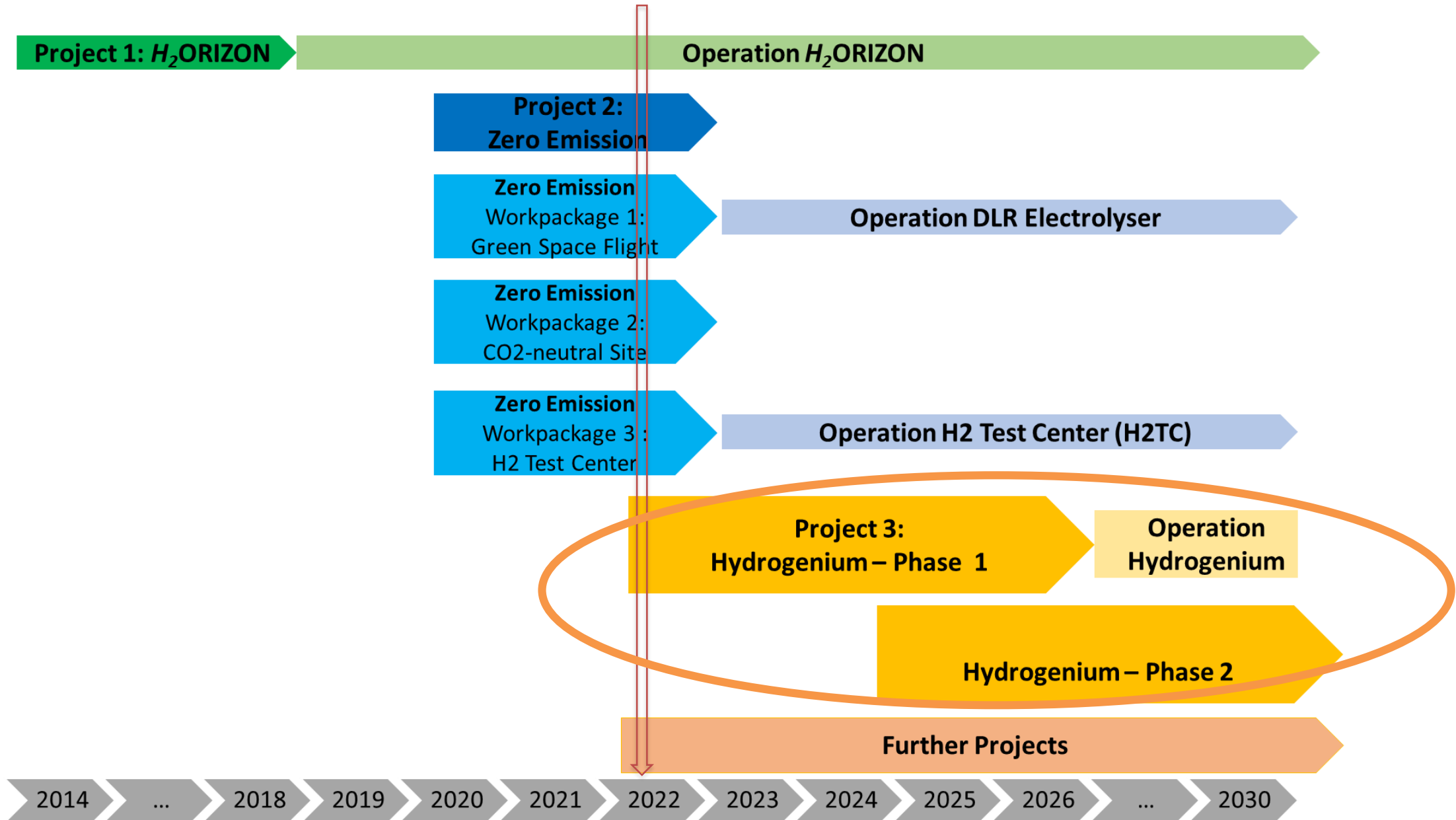
- Hydrogen test center with 7 test positions, centralized media and safety infrastructure, 24/7 operation
- Start of operation Q2 2023

Main supplies:

- Green GH2 from own electrolyzer
 - 30bar (for 24/7 operation)
 - 300bar (not for 24/7 operation)
 - Max. 60kg/h
- Liquid H2 supply as growth potential (one test position blocked)
- Nitrogen 300bar (purge & valve control)
- Power up to 500kW
- Use water
- Ultra-pure water



Outline



Hydrogenium

Expansion of a permanent test, application and transfer center on an industrial scale for medium-sized companies:

- Development and testing of hydrogen components and systems
- Innovative solutions from idea generation to market maturity of systems and components
- Various studies by partners, such as a diffusion study in the Heilbronn-Franken region
- Test infrastructure focusses:
high mass flows and liquid hydrogen



Realization framework

Project duration: 07/2022 to 12/2026

~12 Million € Funding

EFRE, EU & Ministry of Economics,
Labor and Housing Baden-
Württemberg

Project management: Heilbronn Region
Economic Development Agency



Hydrogenium

Media Supply with green liquid and gaseous hydrogen:

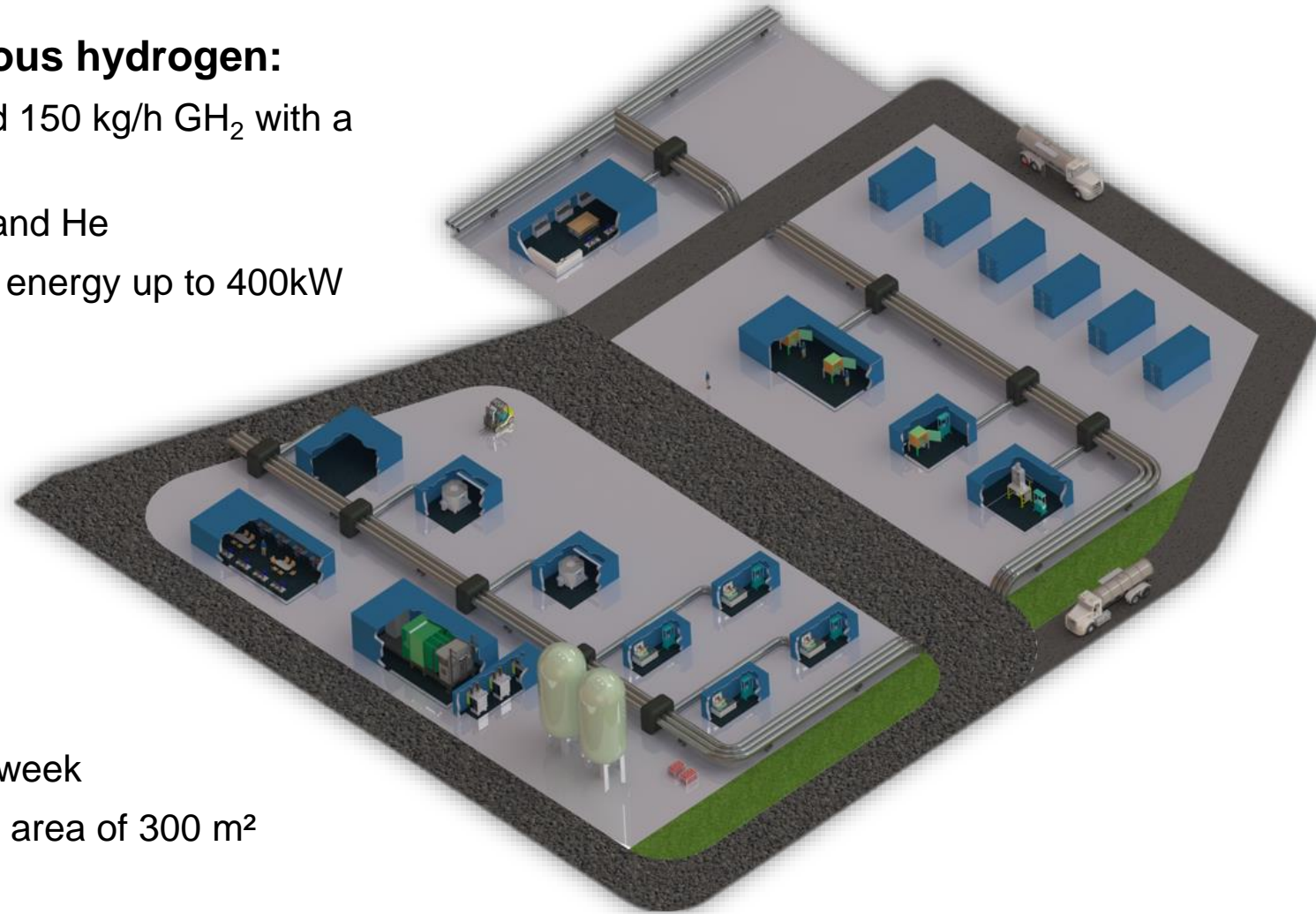
- Reliable supply up to peaks of 500 kg/h LH₂ and 150 kg/h GH₂ with a maximum pressure of 300 bar
- Additional supply of every test bench with GN₂ and He
- Demand-based supply and delivery of electrical energy up to 400kW

Services:

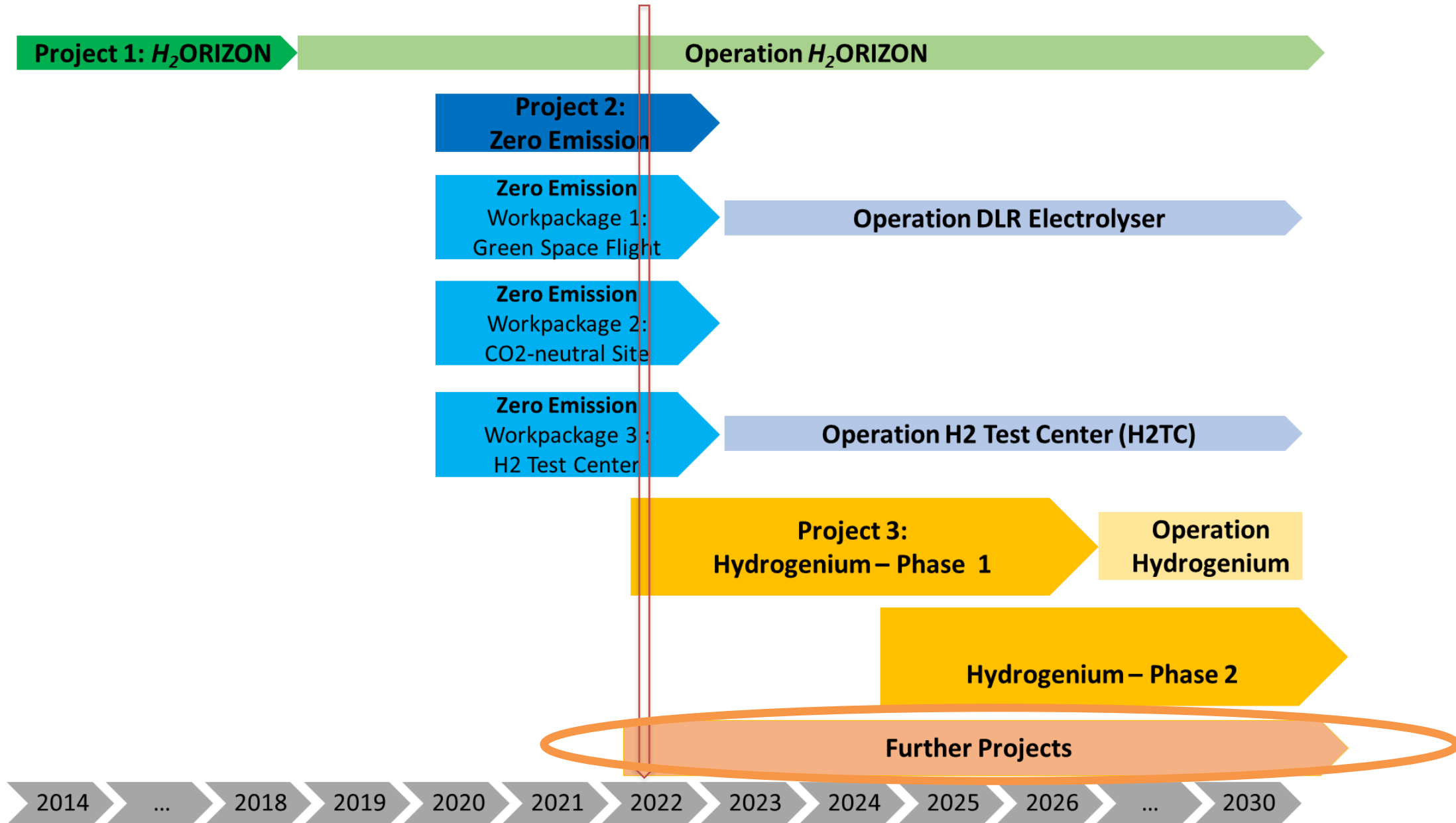
- Support in projects
- Support for erection and operation
- Preparation area

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



Outline



Further Projects

Do228FC LH2 flight demonstrator of MTU und DLR-FX

- Flight demonstrator of a FC driven DO228
- RA-AWT: Design und erection of a ground fueling station at DLR-FX airfield in Oberpfaffenhofen

A320 H2 Demonstrator of Lufthansa Technik

- Ground demonstration of operation of a FC system in an A320 plane with LH2 supply
- RA-PTE: Design of LH2/GH2 System incl. tank in plane
- RA-AWT: System simulation of the design (in parallel)

HYTAZER (HYdrogen Tank ZERtifizierung)

- DLR internal Impulse project

BALIS

- Test platform for LH₂ driven fuel cell systems >1MW
- RA supports planning and erection of LH2/GH2 systems

KENTECH (Korean University in planning phase)

- Feasibility study of Fraunhofer concerning Liquification as research and lab topic

Systogen 100

- LA as living laboratory

...



Summary & Outlook

- Expansion of test capacities and extension of the test portfolio for applications from the maritime, aviation, mobility and energy sectors.
- On site production of green hydrogen.
- Further hydrogen projects with research and industry.



Thank you for our attention



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Additional Slides



Aerospace technology transfer - Projekt H_2 ORIZON

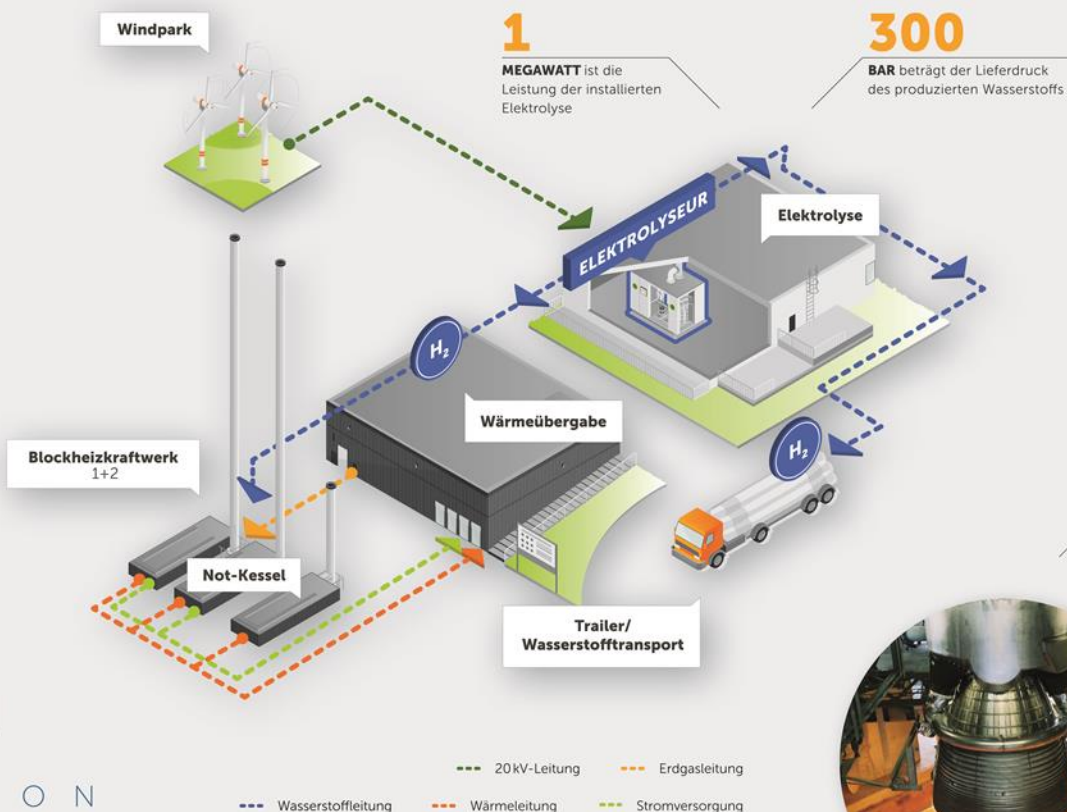
WASSERSTOFF aus WINDKRAFT: So fließt die Energie

5
MILLIONEN Euro investieren die ZEAG Energie AG und das DLR jeweils in das Projekt H_2 ORIZON

340
KILOGRAMM ist die Tagesproduktion an Wasserstoff

100
TONNEN Wasserstoff können pro Jahr produziert werden

5.0
ist die höchste Qualitätsstufe des Wasserstoffs



ZEAG
energie



40
TONNEN flüssigen Wasserstoff braucht das Triebwerk einer Rakete auf dem DLR-Teststand in zehn Minuten

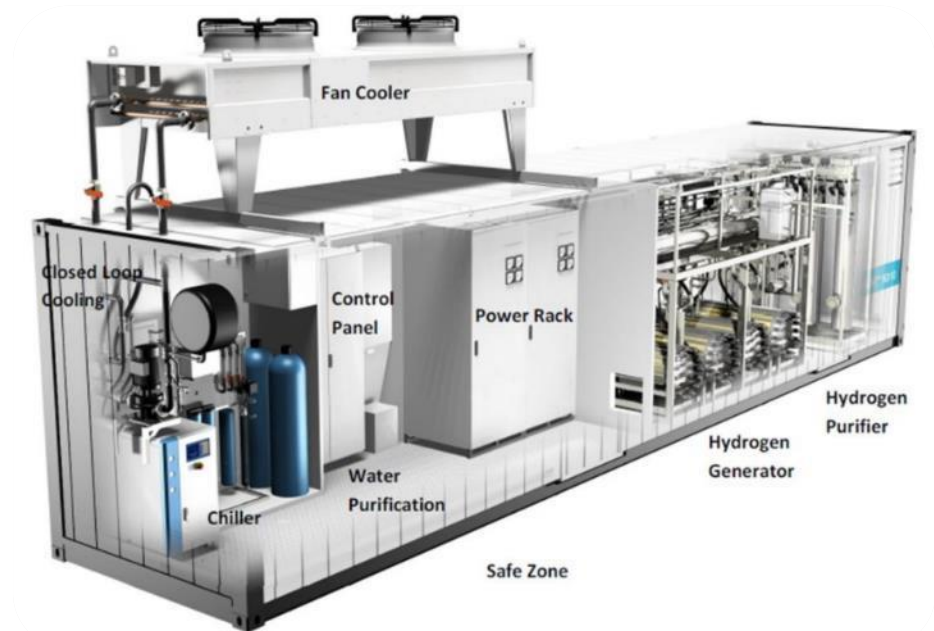
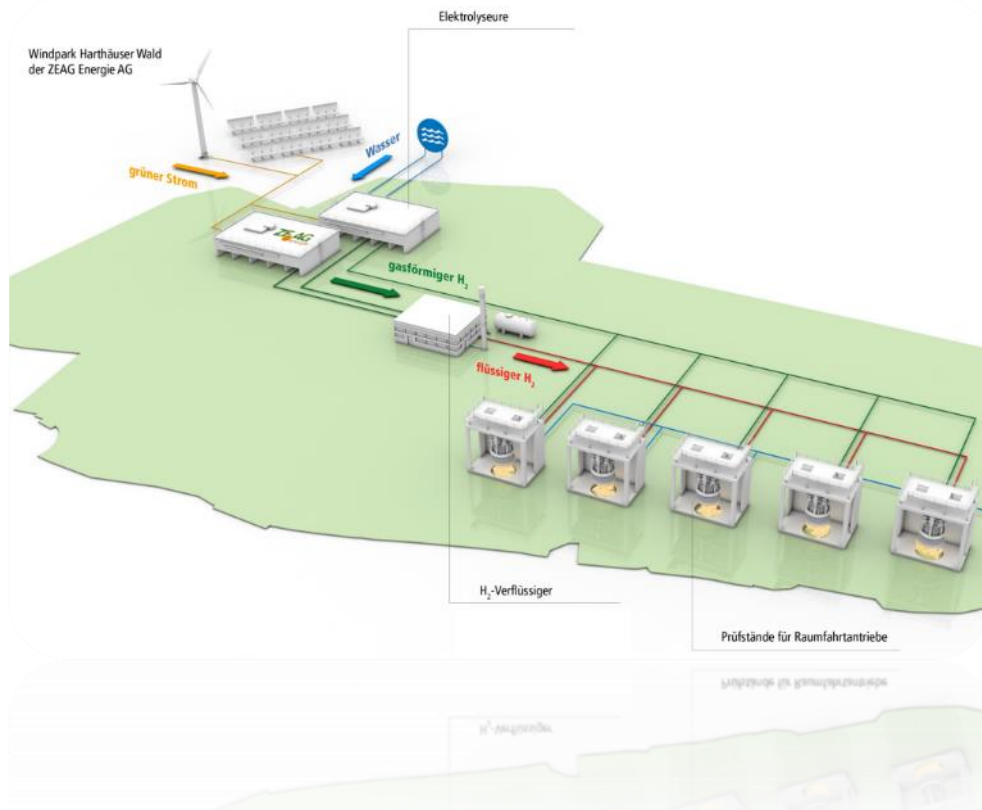


H₂ORIZON

- ✓ Sustainable energy supply with heat and electrical energy
- ✓ Real laboratory of the energy transition
- ✓ Fuel for emission-free mobility
- ✓ Research platform for hydrogen applications
- Nucleus for a hydrogen economy/region

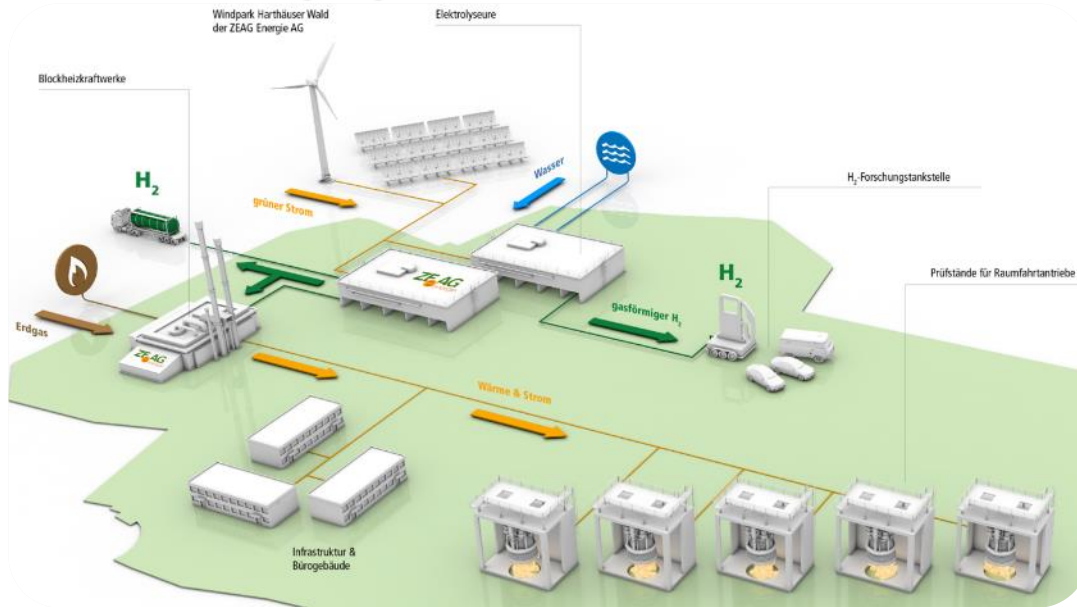
Zero Emission – Grüne Raumfahrt

- 2,3 Megawatt (elektrische Leistung) PEM-Elektrolyseur (max. 35,8 kg/h grüner, gasförmiger Wasserstoff)
- Betrieb mit regenerativem Strom aus lokalen Anlagen (Hardthäuser Windpark)
- Versorgung des H₂-Containertechnikums und des H₂-Verflüssigers Ausgangsdruck bei ca. 30 bar
- Zusätzliche Einbindung des erzeugten Wasserstoffs in die bestehende Medieninfrastruktur



Zero Emission – CO₂-neutraler Standort

- Beschaffung einer mobilen H₂-Forschungstankstelle zur Betankung von Brennstoffzellenfahrzeugen bei 700 bar sowie Mobilitätsanwendungen bei 350 bar
- Integration von Messtechnik zur Erfassung aller Stoff- und Energieströme
- Beschaffung von zwei Brennstoffzellenfahrzeugen (Hyunday Nexo und Toyota Mirai)
- Ausstattung der Fahrzeuge mit zusätzlicher Messtechnik (Druck, Temperatur, CAN-Signale) zur Analyse des Betankungsvorgangs
- Standortversorgung mit Strom und Wärme durch H₂-Beimischung in BHKWs



H2CT

Medienversorgung	
Wasserstoff	5 Testpositionen: 30bar bis $60 \frac{\text{kg}}{\text{h}}$
	1 Testposition: 300bar bis $30 \frac{\text{kg}}{\text{h}}$
	LH2-Speicher optional
Stickstoff	Purging 5bar bis $65 \frac{\text{kg}}{\text{h}}$
	Command pressure 7bar bis $30 \frac{\text{kg}}{\text{h}}$
Erdgas	(nur Aurelia)
DI-Wasser	$3 \frac{1}{\text{h}}$ (pro Testposition)
Spannung	400 V
Elektr. Leistung (Bezug/Abgabe)	500 kW



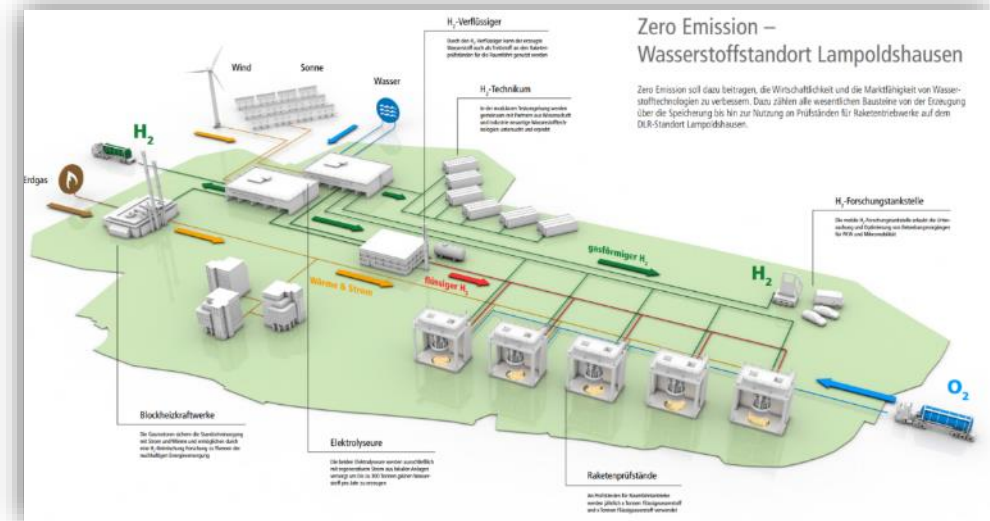
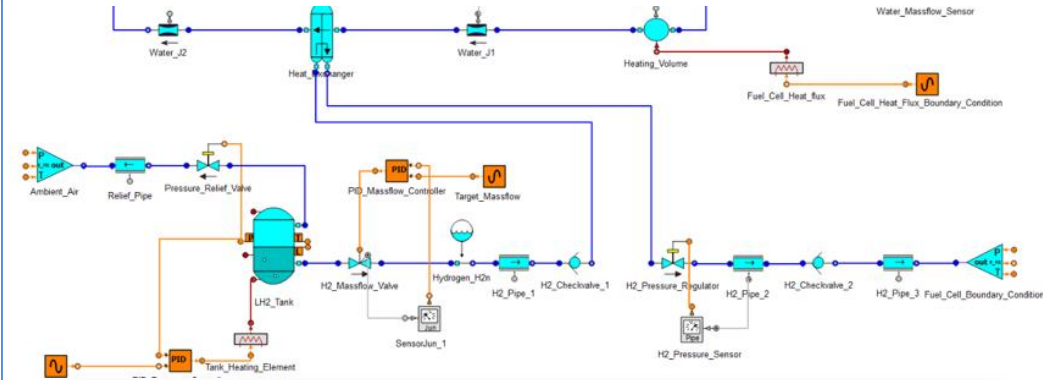
Tasks of Department Applied Hydrogen Technologies

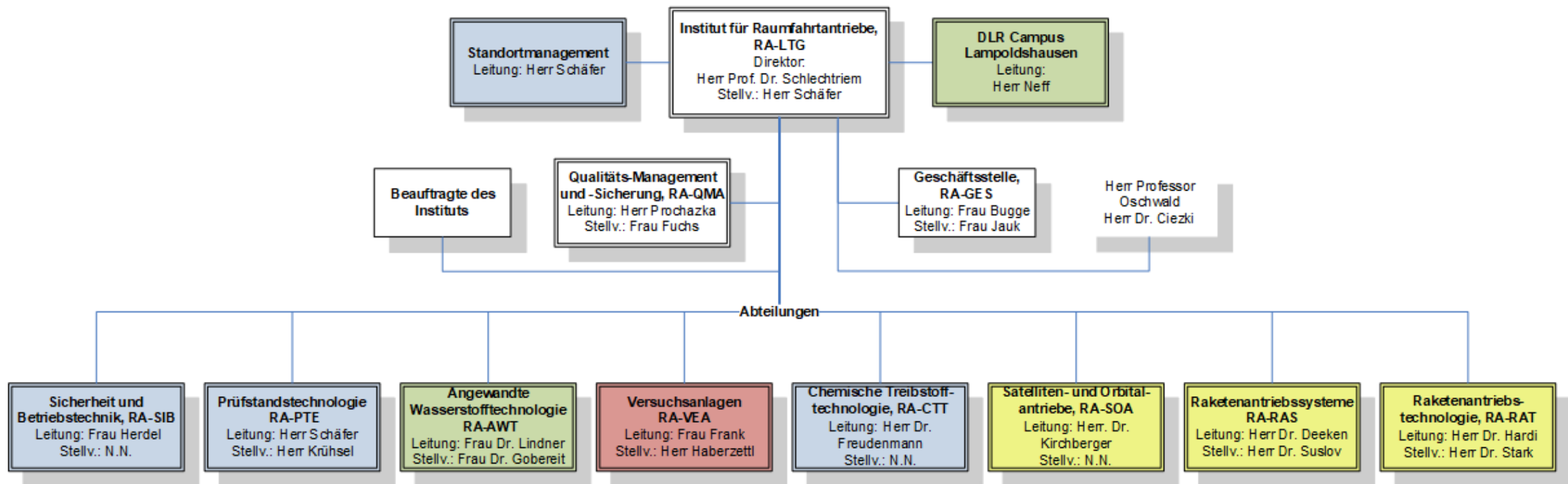


- Link to the other departments, enabler of technology transfer projects
- System simulation of LH₂/GH₂ power trains and H₂ Systems
- Operation of the H₂ Technical Center
- Safety Considerations
- Conceptional Design of H₂ systems and test stands
- Support with erection and operation of H₂ facilities

Goals:

1. Development of technology transfer projects with hydrogen systems
2. Development of test capacities for hydrogen technology demonstrators in industry & research





Stand: 01.01.2022



Zero Emission – Hydrogen Site Lampoldshausen

The project stands for the **production** and **use** of **green hydrogen** under the energy-intensive conditions of the DLR Test Center for Space Propulsion.



Green space flight: Production of liquid and gaseous hydrogen from wind energy

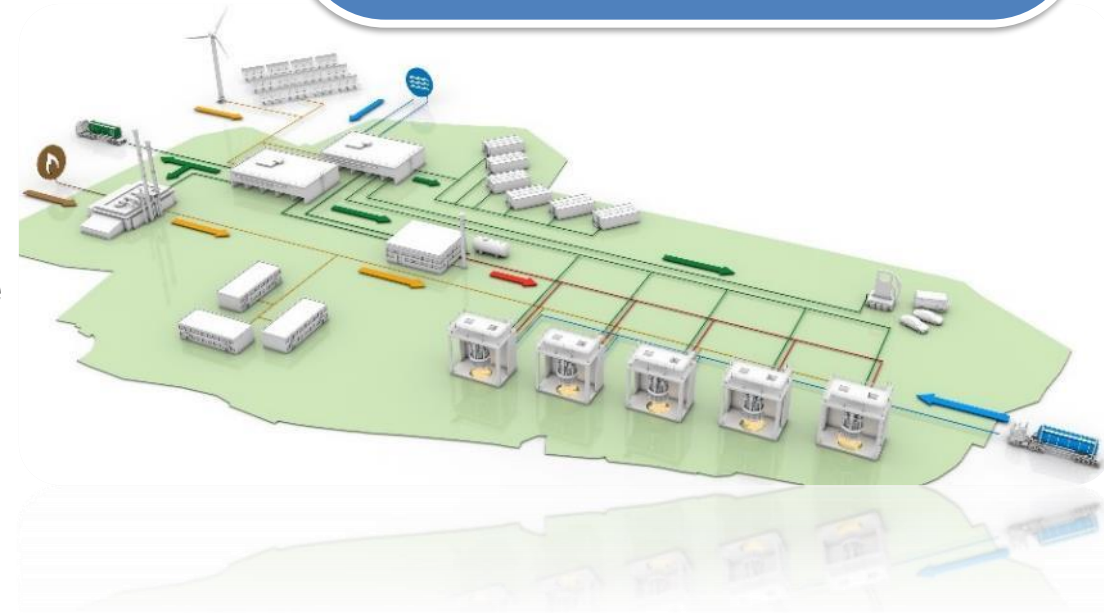


CO₂-neutral site: Measures to avoid CO₂ at DLR's Lampoldshausen site



H₂-container technical center: Modular and flexible test environment for H₂ technologies

Realization framework
Project duration: 05/2020 to 12/2022
~16 Million € Funding
Ministry of Economics, Labor and Housing Baden-Württemberg



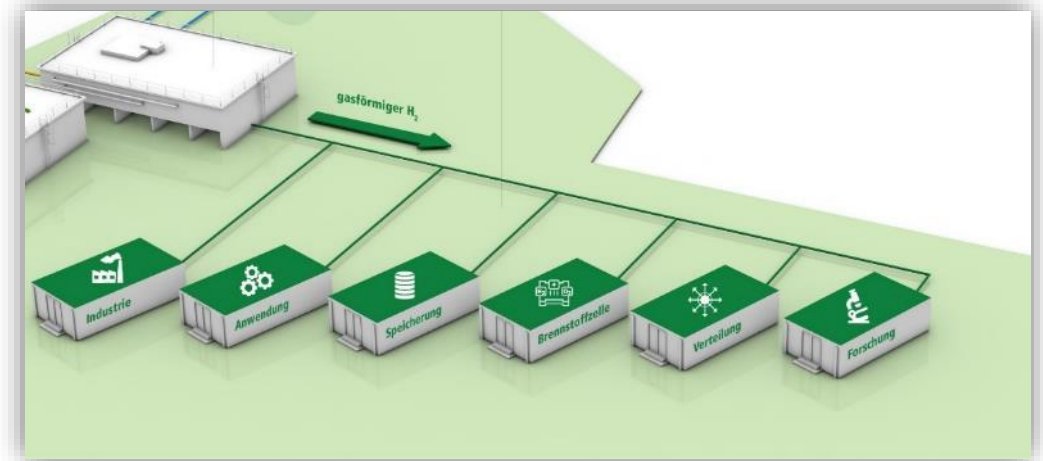
Zero Emission – H₂ Test Center

Construction of a modular, flexible test environment for hydrogen technologies

- Container-based test bench according to customer requirements
- Supply of green hydrogen
- Initial research projects:
 - Fuel cell in continuous operation
 - Micro gas turbines
- Study: Demand analysis of medium- and long-term requirements for test capacities for H₂ applications

Technology comparison "Electrolysis"

- Extension of the existing PEM electrolysis plant (*H₂ORIZON*) with measurement technology
- Comparison study with an AEL plant



Project partner & customers

Freudenberg Sealing Technologies

J.A. Becker

ZEAG Energie AG

*Zentrum für Sonnenenergie- und
Wasserstoffforschung BaWü*

