POTENTIAL SYNERGIES BETWEEN THE HELMHOLTZ CLUSTER FOR A SUSTAINABLE AND INFRASTRUCTURE-COMPATIBLE HYDROGEN ECONOMY AND ERUM RESEARCH

07/29/2025, ERHOLUNGS-GESELLSCHAFT AACHEN 1837

Shaping the Digital Future of ErUM Research: Sustainability & Ethics

Hans-Georg Steinrück

Institute for a Sustainable Hydrogen Economy, Forschungszentrum Jülich

RWTH Aachen University, Institute of Physical Chemistry

Research Mission






- We discover new particles yielding deep insights into the fundamental laws of physics
- Observe and explore distant galaxies, stars and new planets
- Investigate the structure and function of proteins drugs and viruses
- Discover new materials
- Observe chemical reactions in real-time

6

Martin Erdmann, Shaping the Digital Future of ErUM Research: Sustainability & Ethics, Aachen, 07/28/2025

KFS – COMMITTEE RESEARCH WITH SYNCHROTRON RADIATION

Research with synchrotron radiation

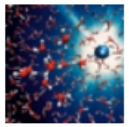
Properties - research fields - grand challenges - applications

Research with synchrotron radiation and its applications

Synchrotron radiation light gives us a better understanding of the material world. It provides insight into the microscopic structure of materials and the relationship between structure and function. This knowledge is essential for tackling the key challenges of our time. We search for solutions for clean and affordable energy, environment protection, health and well-being, as well as information and data science where tailored materials are at the heart of a sustainable future.

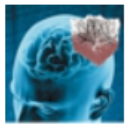
Energy and environment

Energy transformation, reduction of emissions, conservation of resources - the development of new catalytic processes, batteries and new energy storage processes can only succeed with an insight into structure and dynamics with photons. [more]



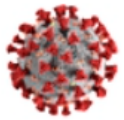
Materials

Synchrotron radiation allows exploring the structure and function of new materials at various levels of complexity, thus contributing to a targeted design or knowledge-based improvement of material properties. [more]



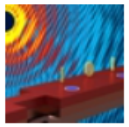
Health

With X-ray photons, we can understand biomolecules and active substances at the atomic level, use tomographic methods to decipher the complexity of biological structures, and use X-ray flashes at the European XFEL to follow the mechanisms in a time-resolved manner. Latest example: SARS-CoV-2 research. [more]



COVID-19

To fight COVID-19, we need vaccines and drugs. For their development, we need to know the virus SARS-CoV-2 precisely. Since the virus itself is smaller than the wavelength of visible light, short-wave synchrotron radiation helps here. Corona research at synchrotrons goes far beyond the study of virus structure and function. [more]

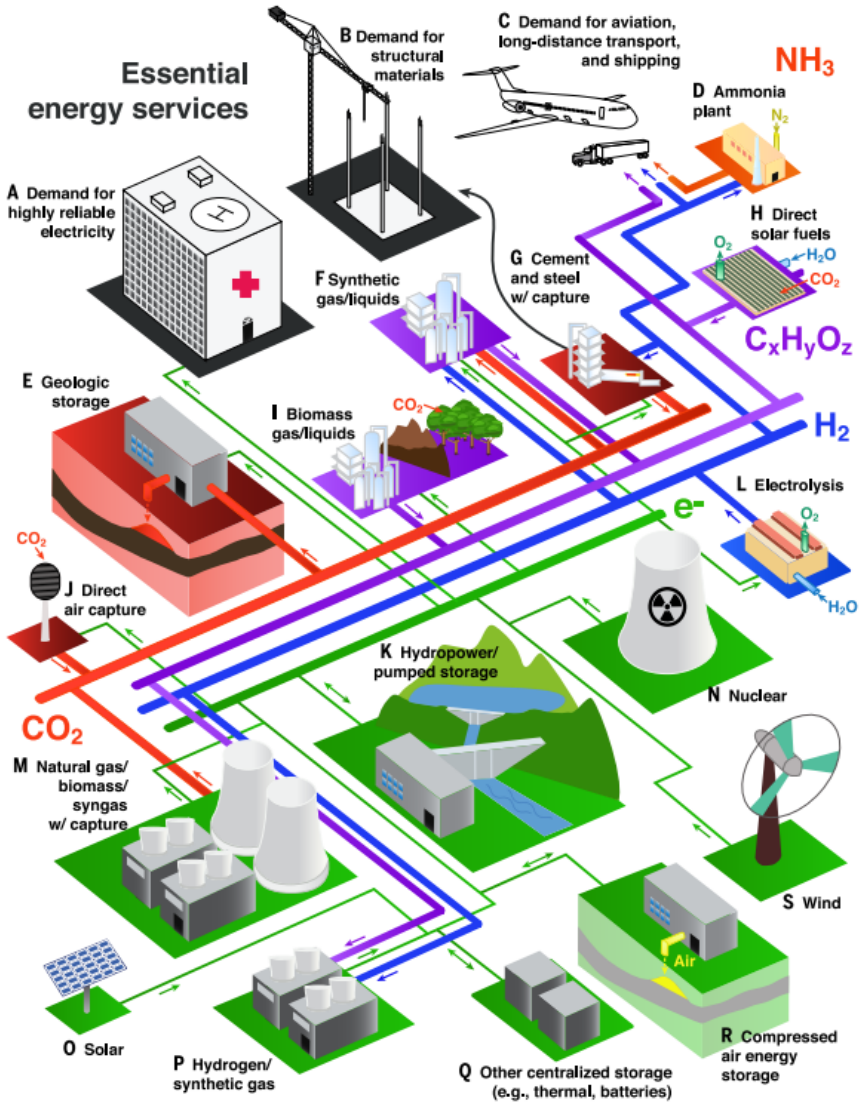


Information

Nanoelectronics, quantum computers, photonics, new types of data storage - only with the insight provided by synchrotron radiation will it be possible to store faster, better and larger quantities. [more]

NET-ZERO EMISSIONS ENERGY SYSTEMS

System level



Materials level

Davis et al., Science 360, eaas9793 (2018)

HC·H2

Helmholtz-Cluster
Wasserstoff

HC·H2
Helmholtz-Cluster
Wasserstoff

THE PROJECT

Helmholtz-Cluster Hydrogen

For a sustainable and infrastructure-compatible hydrogen economy

HC-H2 – Development history

14-08-2020
Special measure of the Federal Government and
the State of North Rhine-Westphalia (NRW)
Structural Reinforcement Act for Mining Regions: **Measure 30 in §17**

27-08-2020
Established on August 27th 2020 in a Conference on Structural Change
Combination of institutional funding and project funds in a
planned demonstration region

02-09-2021
Handover of the approval notice

Funding until 2038: ~1 billion €

„Structural change and energy transition from a single source“

PROFILE

Structure of the HC-H2

Largest *Strukturwandelprojekt* in NRW with ~1 billion € funding until 2038

Institute for a Sustainable Hydrogen Economy (Innovation Centre)
of Forschungszentrum Jülich

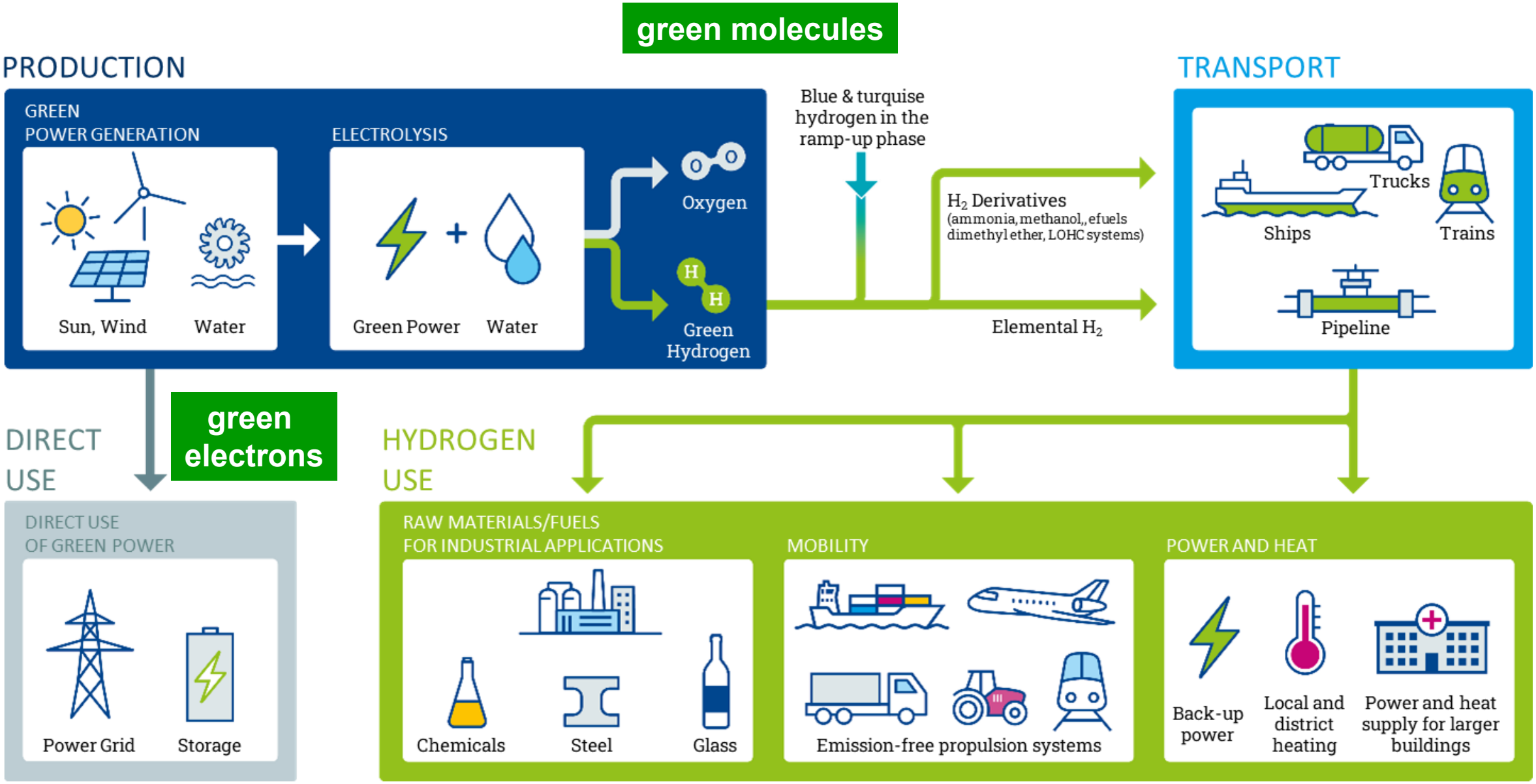
Cooperations with Core Partners (e.g. RWTH Aachen)

H_2 Demonstration Region
With partners from industry, academia & municipalities

Mission Statement:

- Infrastructure-compatible technologies for the hydrogen economy
- Production and use of chemical H_2 carriers
- Technology-Agnostic
- Basic research up to commercialization with partners
- H_2 model region with Europe-wide appeal

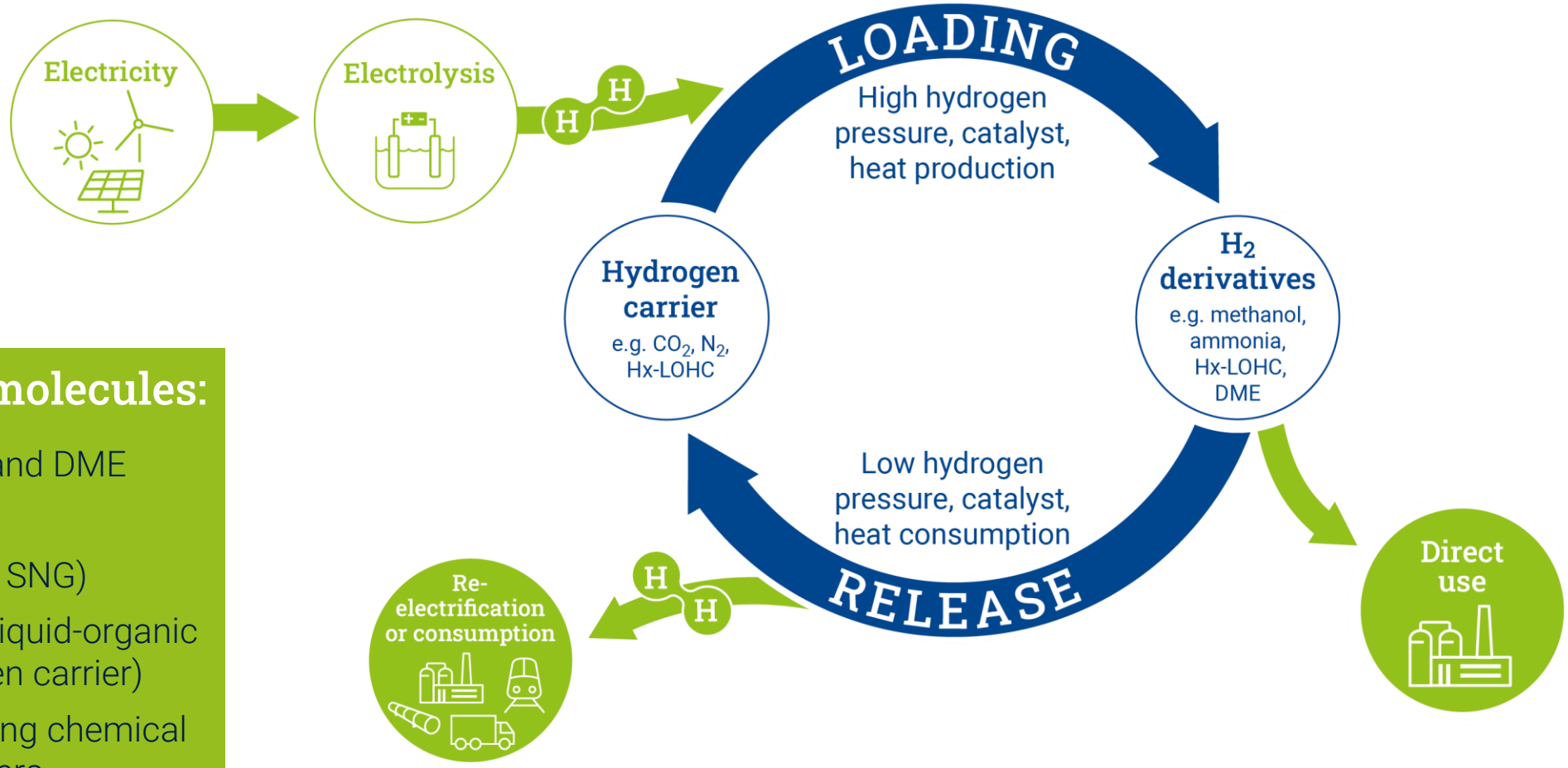
THE ROLE OF HYDROGEN IN THE FULLY DEFOSSILIZED ENERGY SYSTEM OF THE FUTURE



MISSION

Chemical Hydrogen Carriers

Enabling long-term storage and long-distance transportation



Focus molecules:

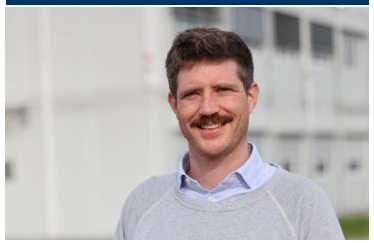
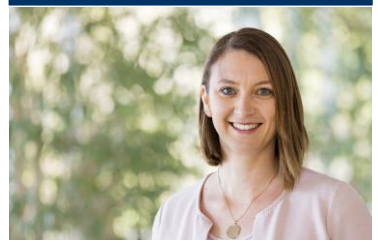
- MeOH and DME
- NH_3
- CH_4 (as SNG)
- LOHC (liquid-organic hydrogen carrier)
- Upcoming chemical H_2 carriers

Organigramm INW

Institute for a Sustainable Hydrogen Economy (INW)
Prof. Peter Wasserscheid

INW-1	INW-2	INW-3	INW-4	INW-D	INW-I
Prof. Hans-Georg Steinrück	Prof. Regina Palkovits	Prof. Peter Wasserscheid	Prof. Andreas Peschel	N.N.	Dr. Susanne Spörler

Chemical Hydrogen Storage

Catalytic Interfaces	Catalytic Materials	Reaction Engineering	Process and Plant Engineering	H_2-Demonstration Projects	Infra. & Scientific Coordination
				**tbd** 	

> 130 Employees

As of: July 2025

PROFILE

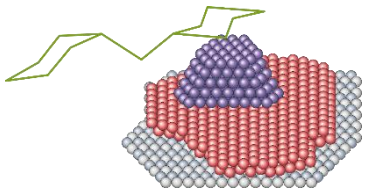
Structure of the HC-H2

The H2 innovation center

INW-1 (Prof. Steinrück)

Catalytic Interfaces
For Chemical Hydrogen Storage

- Optimization of active sites for different storage molecules
- Reduction or substitution of the noble metal



INW-2 (Prof. Palkovits)

Catalytic Materials
For Chemical Hydrogen Storage

- Optimization of mass and heat transfer at the catalyst pellet

INW-3 (Prof. Wasserscheid)

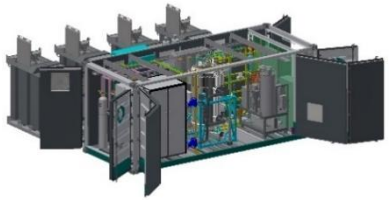
Reaction Engineering
For Chemical Hydrogen Storage

- Hydrogen supply and removal
- Heat management

INW-4 (Prof. Peschel)

Process- and Plant Engineering
For Chemical Hydrogen Storage

- Process synthesis and analysis
- Experimental testing from laboratory to pilot plant
- Key technology & technology platforms



Spectroscopy, Microscopy, “on-line monitoring“, Sensor technology
Theory & Simulation: DFT, MD, Lattice-Boltzmann, CFD, Mass and Heat Balancing, Process modeling

Research aspects and scientific topics for the development and technical realization of optimum hydrogen storage processes

INW-D

Hydrogen Demonstration Region

Aim: 15 - 20 innovative H2 demonstrators distributed across the Rhenish Mining Area

Status:

Three demonstration projects launched so far (total funding volume approx. 37.5 million €)

Since 15.11.2022:

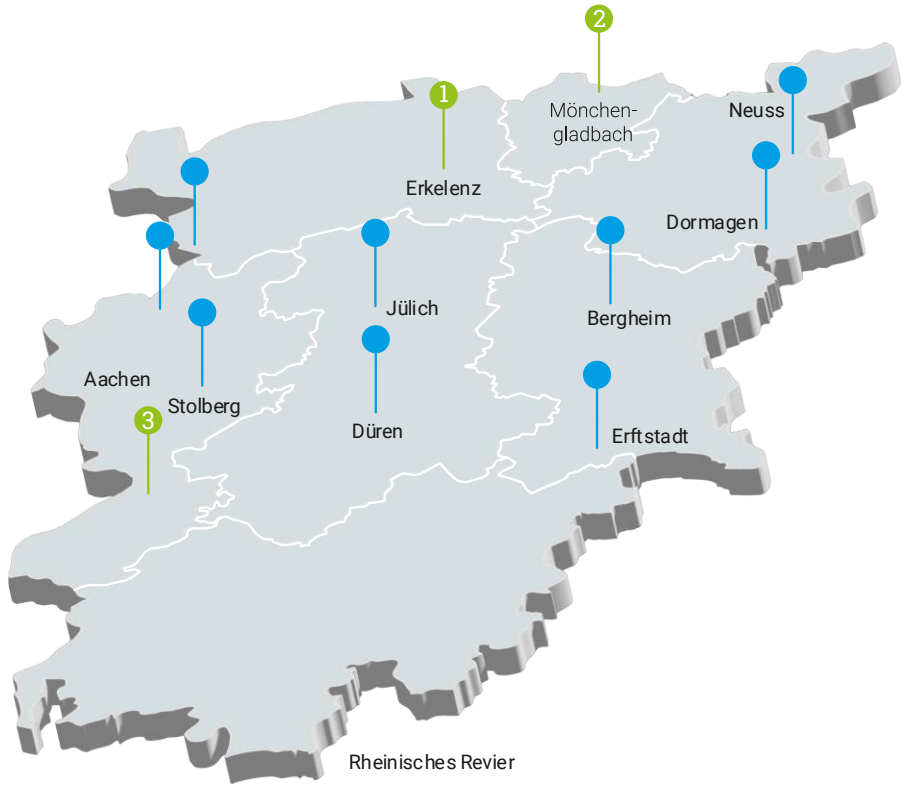
1 **Multi-SOFC**
Electricity and heat generation from hydrogen derivatives (Erkelenz)

Since 01.04.2024:

2 **HyFRed**
H2-based reduction of iron ores (Mönchengladbach)

Since 01.01.2025:

3 **HyHeat**
Hydrogen as a fuel in industrial furnaces for press hardening processes (Simmerath)



Mission of the demo region:

Demonstration of new hydrogen technologies in collaboration with partners from industry

HyHeat

Pressure hardening using green hydrogen for heat generation

Partner

schwartz GmbH (including econova GmbH), Forschungszentrum Jülich GmbH

Project start and duration

01.01.2025, 24 months

Funding

€1,711,413

Topic

- Use of hydrogen and hydrogen-containing mixtures for firing a heat treatment plant
- Hydrogen release from chemical hydrogen carriers for the reliable operation of a heat treatment plant

HyFRed

Hydrogen-based fine ore reduction route for steel production

Projectpartner: SMS group GmbH

Forschungszentrum Jülich GmbH
Institut für nachhaltige Wasserstoffwirtschaft

Duration: 01.04.2024 to 31.03.2029

Multi-SOFC Erkelenz

Reduced CO_2-emmisions

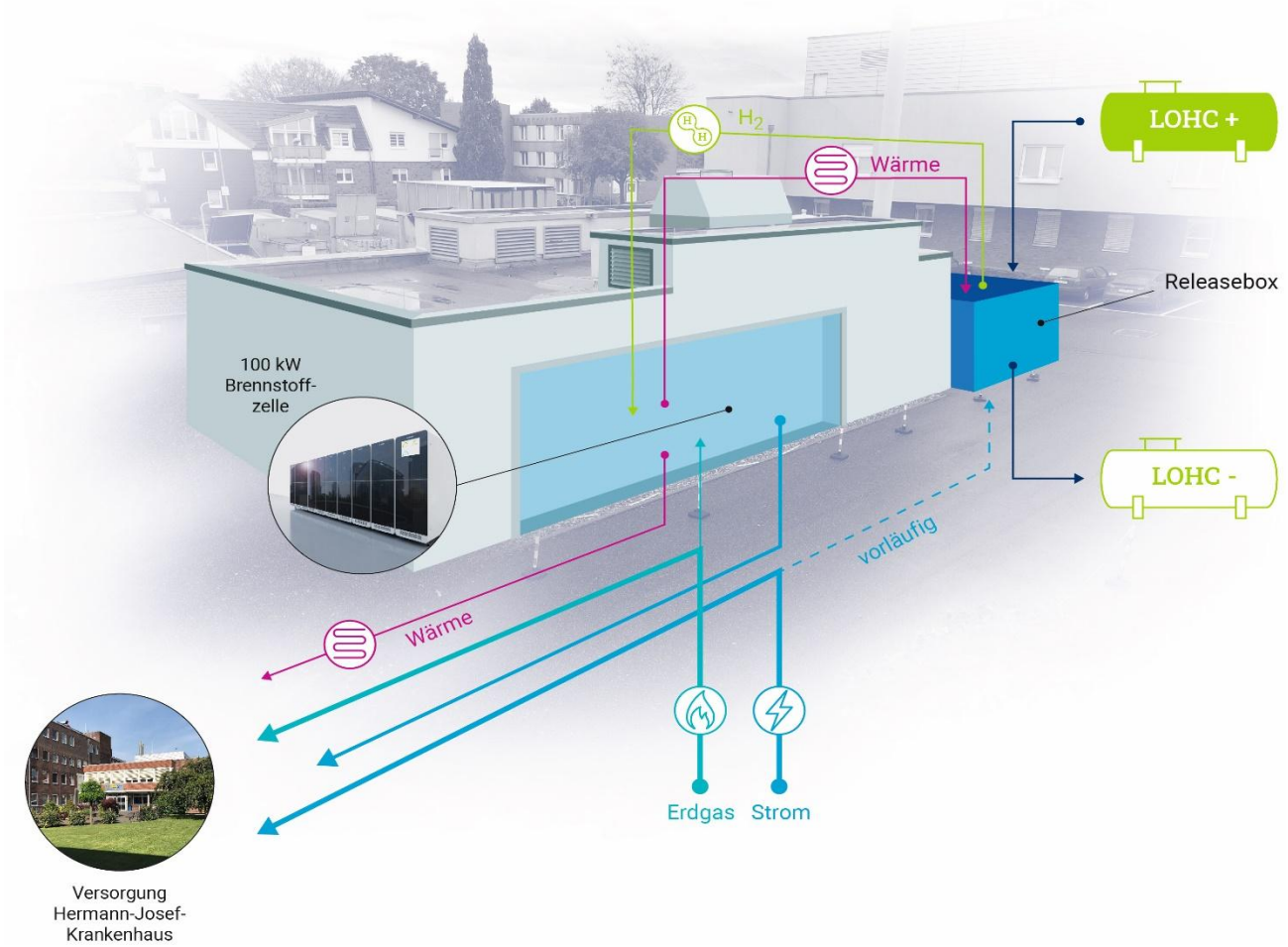
- Supplying heat and electrical power by solid oxide fuel cells

Safe Hydrogen Storage

- Supply hydrogen by LOHC dehydrogenation

Improved Storage efficiency

- Utilize high-temperature heat for LOHC dehydrogenation



OUR SITE OUTSIDE THE FZ JÜLICH CAMPUS

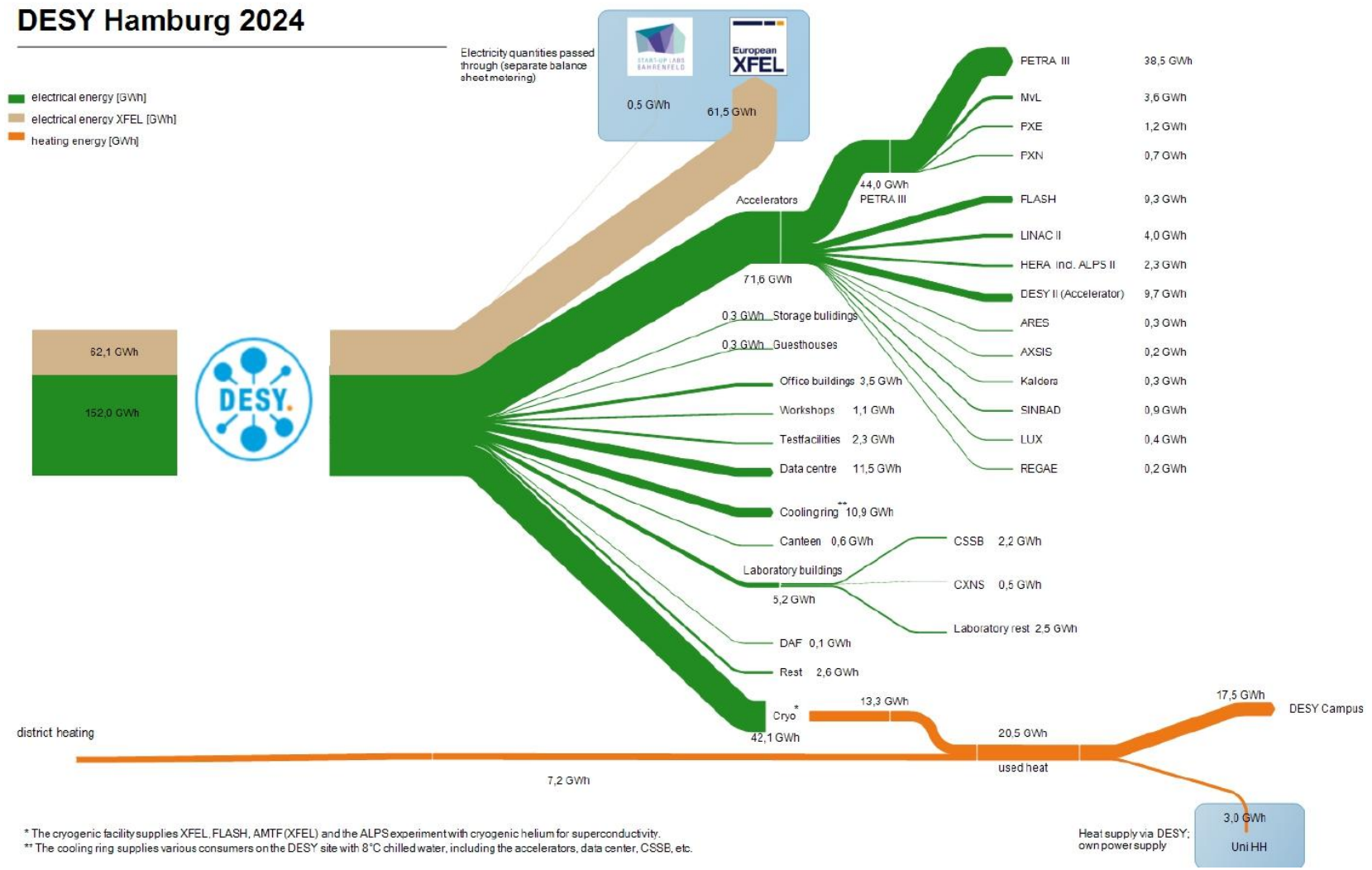
Here – at Brainergy Park!

Possibilities for the settlement of industry, trade and research facilities

Coordination by Brainergy Park GmbH

Over 52 hectares of commercial space

Planned high tech industrial park



POTENTIAL SYNERGIES BETWEEN THE HELMHOLTZ CLUSTER FOR A SUSTAINABLE AND INFRASTRUCTURE-COMPATIBLE HYDROGEN ECONOMY AND ERUM RESEARCH

- ErUM facilities
  - Large and expensive infrastructure
  - Long term operation (e.g., DORIS: 1974 – 2013)
  - Solutions for decades ahead (including regulation and societal awareness)
- Sustainable energy supply
  - CO2 neutral and redundant
  - Hybrid solutions, defossilization in phases
  - Transition from natural gas and biogas to hydrogen
- Living Lab Energy Campus at Forschungszentrum Jülich
  - Various energy demonstrators - such as liquid and gaseous hydrogen technologies, lithium-ion batteries and photovoltaic system - are being installed on campus and networked with each other via intelligent control programs

HC-H2 Network

Connect players, communicate ideas & concerns, create cooperations

Network mission:

- **Communicative link** between HC-H2 and its surroundings (companies, research institutions, municipalities)
- **Synchronizing H2-activities** of the HC-H2/INW with existing initiatives in NRW
- **Developing strategies** for the promotion of H2-technologies and for the **rapid establishment of an H2-economy** in the Rhenish Mining Area, Europe and worldwide

Newsletter	https://www.hch2.de/newsletter/
Website	https://www.hch2.de/netzwerk/
LinkedIn	https://www.linkedin.com/company/hc-h2/
Database	https://www.hch2.de/netzwerk/datenbank/

- **Networking**
- **Information**
- **(Political) influence**
- **connect@hch2.de**

POTENTIAL SYNERGIES BETWEEN THE HELMHOLTZ CLUSTER FOR A SUSTAINABLE AND INFRASTRUCTURE-COMPATIBLE HYDROGEN ECONOMY AND ERUM RESEARCH

- ErUM facilities
  - Large and expensive infrastructure
  - Long term operation (e.g., DORIS: 1974 – 2013)
  - Solutions for decades ahead (including regulation and societal awareness)
- Sustainable energy supply
  - CO2 neutral and redundant
  - Hybrid solutions, defossilization in phases
  - Transition from natural gas and biogas to hydrogen
- Living Lab Energy Campus at Forschungszentrum Jülich
  - Various energy demonstrators - such as liquid and gaseous hydrogen technologies, lithium-ion batteries and photovoltaic system - are being installed on campus and networked with each other via intelligent control programs

HC·H2
Helmholtz-Cluster
Wasserstoff

Helmholtz Cluster for a Sustainable and Infrastructure-Compatible Hydrogen Economy (HC-H2)

Marie-Curie-Straße 5
52428 Jülich

www.hch2.de

Contact:

Prof. Hans-Georg Steinrück
Director INW-1

h.steinrueck@fz-juelich.de

With funding from the:

JÜLICH Forschungszentrum

Federal Ministry of Research, Technology and Space

Ministerium für Kultur und Wissenschaft des Landes Nordrhein-Westfalen

Ministerium für Wirtschaft, Industrie, Klimaschutz und Energie des Landes Nordrhein-Westfalen