AACHEN/JÜLICH, 2022

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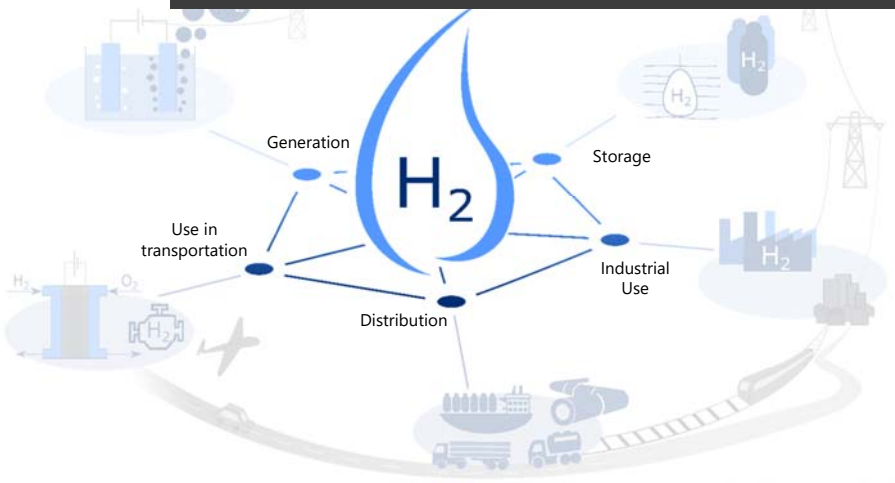
RWTH AACHEN - FORSCHUNGSZENTRUM JÜLICH

HYDROGEN CLUSTERS4FUTURE
ZUKUNFTSCLUSTER WASSERSTOFF

SYMPOSIUM: INTERNATIONAL COOPERATION FOR GREEN HYDROGEN



CLUSTERS 4 FUTURE
Innovationsnetzwerke für unsere Zukunft

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

JÜLICH Forschungszentrum
RWTH AACHEN UNIVERSITY

AGENDA

Zukunftscluster Wasserstoff

Vision | Basis | Strength | Approach

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JÜLICH Forschungszentrum
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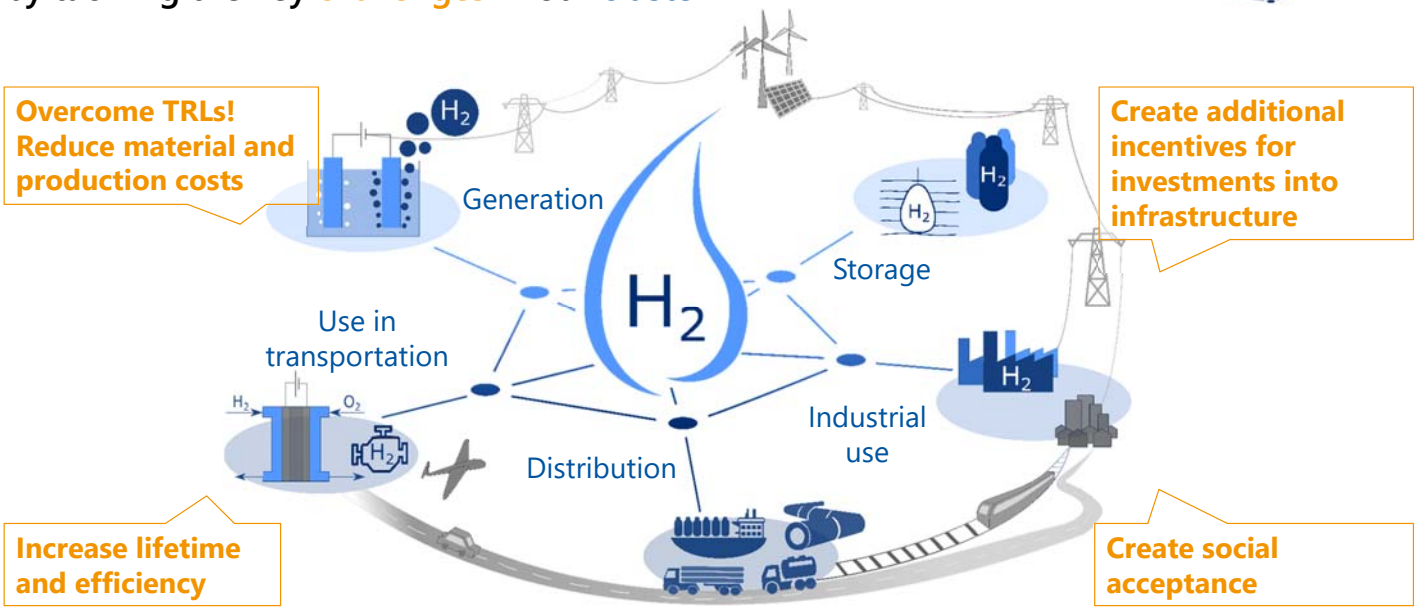
Our Vision: Achieve CO2-neutral and economical operation by tackling the key challenges in our cluster



Note: TRL = Technology Readiness Level

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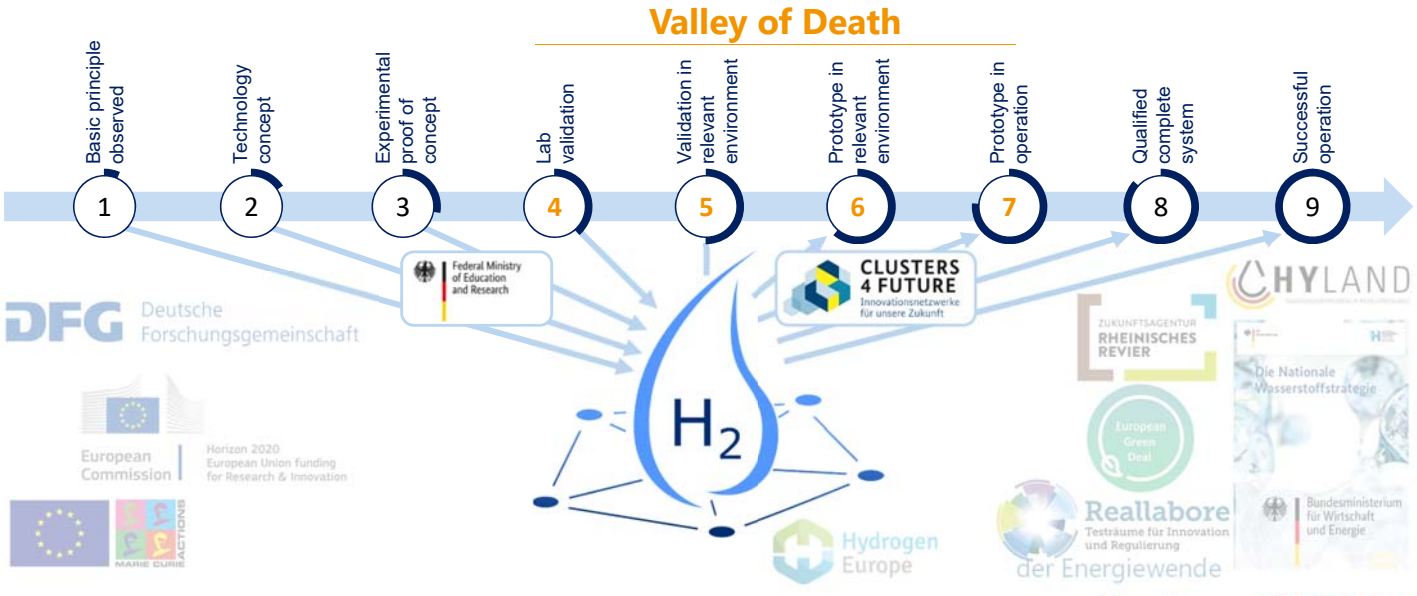
The cluster approach: Overcoming the challenges through thematic (horizontal) and technological (vertical) networking

TECHNOLOGY READINESS LEVEL (TRL)



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Vision | **Basis** | **Strength** | Approach

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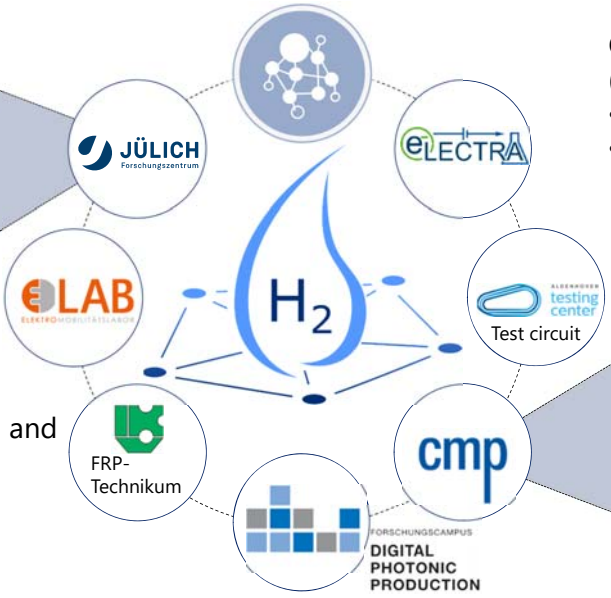
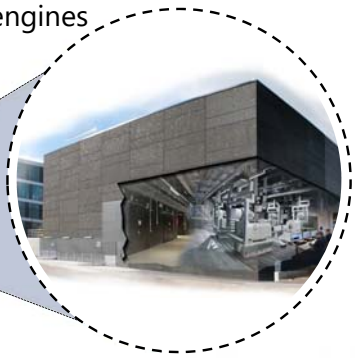
Our Basis: Unique high-tech innovation environment along the entire value chain in the Aachen/Jülich region

+Infrastructure of the industry partners

Technikum Jülich
- Production processes for cell and stack components
- Assembly robots
- Fuel cell testing center



Center for Mobile Propulsion (CMP)
- 16 chairs
- 20 test laboratories, e.g. for fuel cell systems and hydrogen combustion engines



Note: FRP = fiber-reinforced plastics (in our case for H_2-tanks); ELECTRA = NRW competence center for industrial electrochemistry

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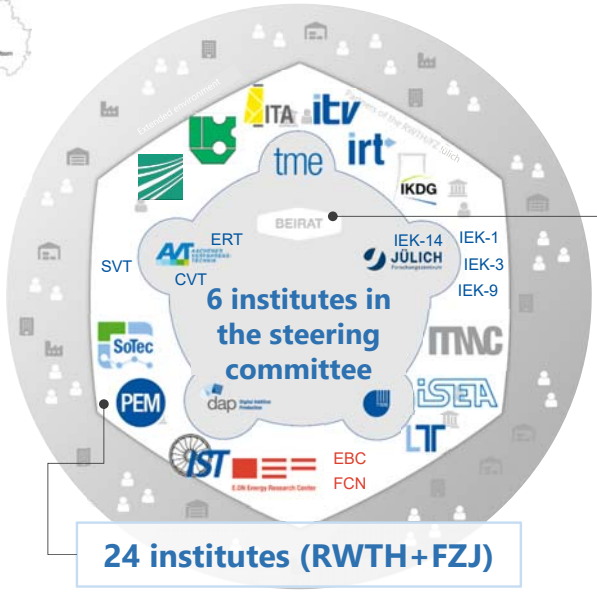
During the concept phase the RWTH Aachen university and the FZ Jülich created a regionally shaped and powerful network

NRW

34 actors from NRW



24 institutes (RWTH+FZJ)

Germany

13 additional actors from Germany

16 partners on the advisory board (from NRW, Germany und international)

International

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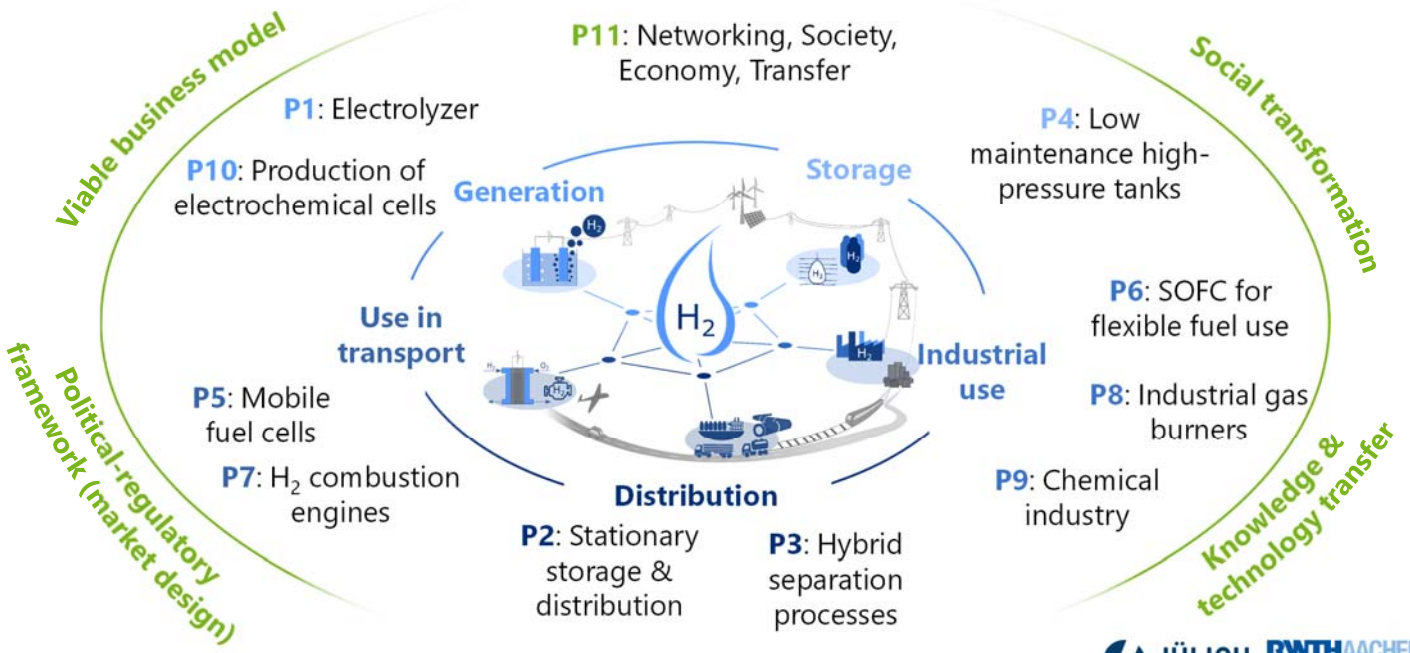
Our approach: Objectives and efficacy of the projects are based on technological, economical and social networking



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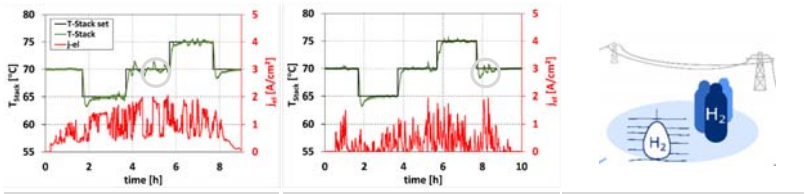
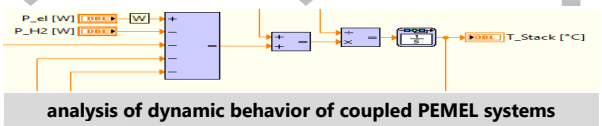
HyInnoLyze targets the requirements for the dynamics of electrolysis in renewable energy systems

HYINNOLYZE – DYNAMICS, COUPLED SYSTEMS AND H2 STORAGE

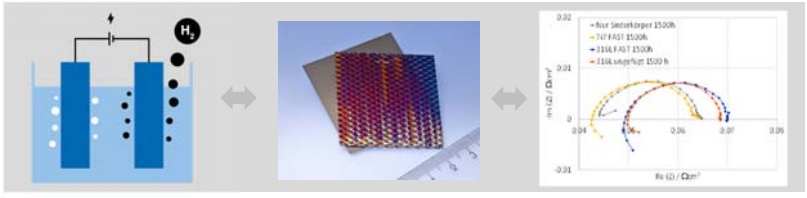
Influence of load on dynamic behavior of process variables (temperature, pressure, …)



Photovoltaic | **Wind** | **H_2**



analysis of dynamic behavior of coupled PEMEL systems



APPROACH

- Modelling PEMEL & intermediate H_2 storage systems
- Analysis of interconnection variations of PEMEL systems, intermediate storages, and power electronics
- Analysis of dynamic behavior in coupled systems and components
- Corrosion and stability tests

PROJECT PARTNERS

Associated:

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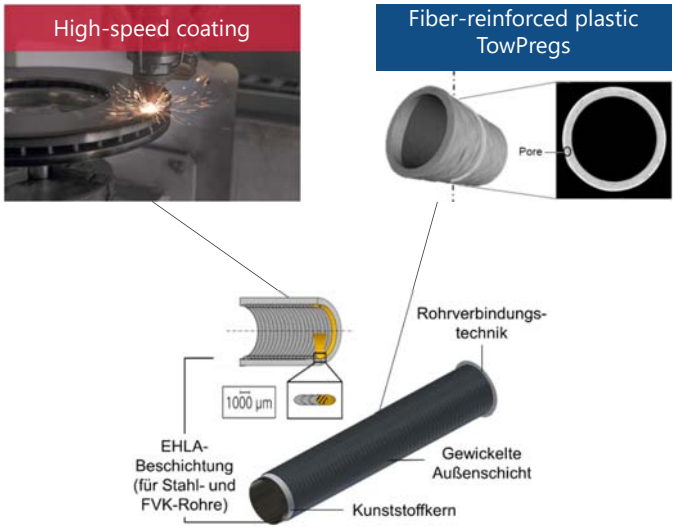
HyInnoNets creates coated and fiber-reinforced embrittlement-resistant pipelines for hydrogen transport

HYINNONETS – ENABLING TRANSMISSION NETWORKS FOR H2 OPERATION



APPROACH

- Fiber-reinforced plastics (FRP) pipelines:
  - Material development & process parameters
- Hydrogen permeation barrier coating by EHLA:
  - Development of necessary optics & process development
  - Coating of FRP pipelines

PROJECT PARTNERS

Associated:

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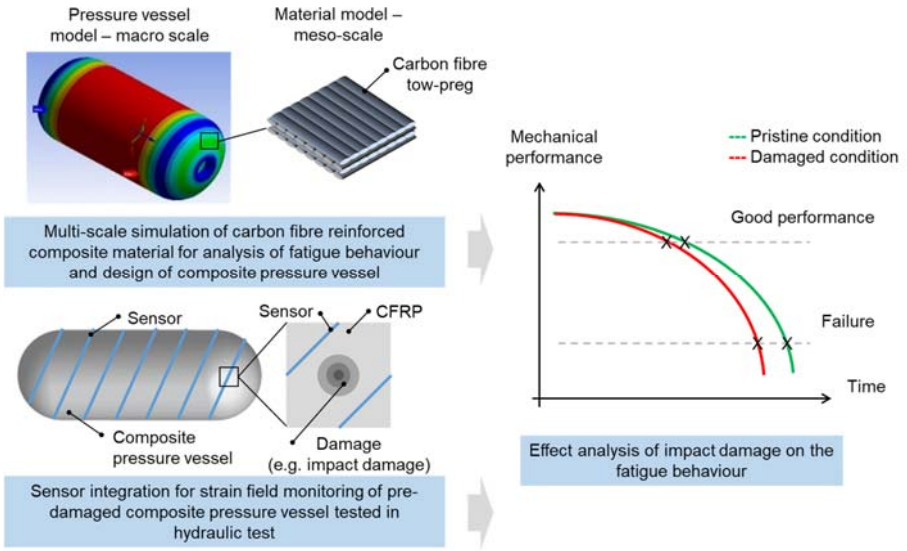
HyInnoTank targets strain field monitoring by fiber-based sensors for service life prediction

HYINNOTANK – LOW-MAINTENANCE, MOBILE HIGH PRESSURE TANKS



APPROACH

- Sensor choice and integration
- Sensor testing
- Analysis on pre-damaged tanks
- Investigation of burst pressures and failure characteristics
- Validation of the methods

PROJECT PARTNERS

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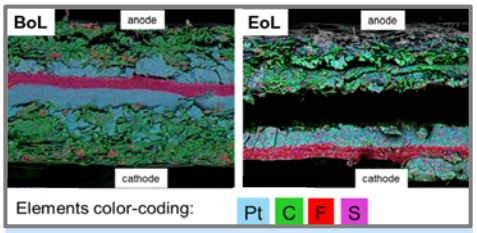
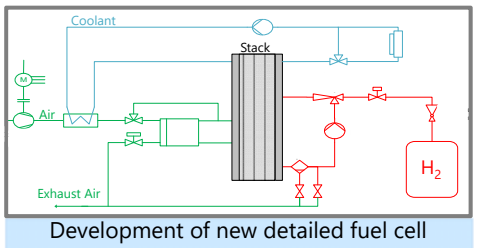
HYInnoPEM develops a model predictive control considering the state of health as a major influence

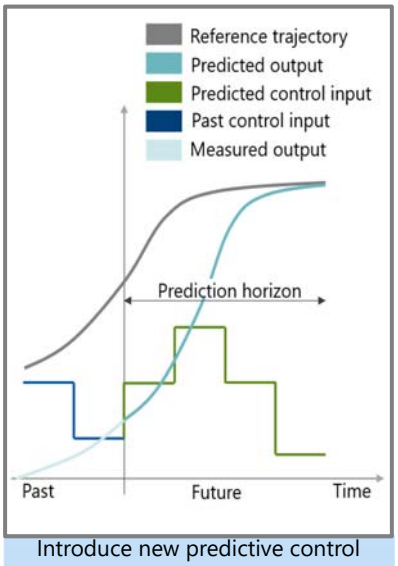
HYINNOPEM – INNOVATIVE CONTROL, EXTENDED LIFETIME



Analyse and quantify degradation



Development of new detailed fuel cell system models



Introduce new predictive control and maintenance strategies

APPROACH

- Test bench construction & identification measurements
- Fuel Cell system & degradation model development
- Development & validation of a model predictive control
- SoH prediction and TCO analysis

PROJECT PARTNERS

Sources: Behavioural study of PEMFC during start-up/shutdown cycling for aeronautic Applications, Dyantyi et. al., 2019, in Material for Renewable and Sustainable Energy

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Demonstration of an innovative hydrogen combustion engine for future CO_2-neutral mobility

HYINNOICE –DEMONSTRATOR VEHICLE WITH A HIGHLY INNOVATIVE H2 COMBUSTION ENGINE

Hydrogen direct injection (H_2-DI)

1.5 liter engine, originally developed for gasoline fuel

Fully variable valve train

Innovative ignition system

New boosting system

Demonstrator vehicle

Source pictures: Ford

APPROACH

- Fundamental research on the combustion processes
- Functional development and calibration
- Vehicle integration and testing
- Study of novel fuel systems

PROJECT PARTNERS

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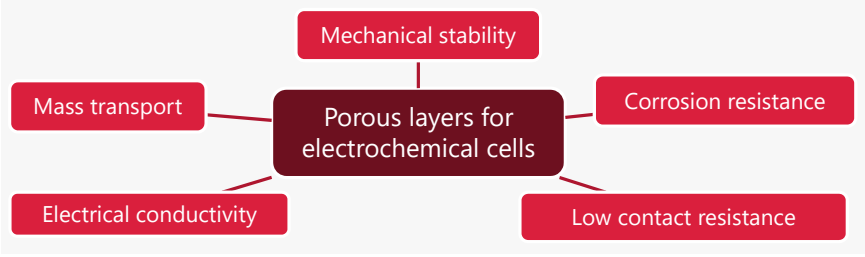
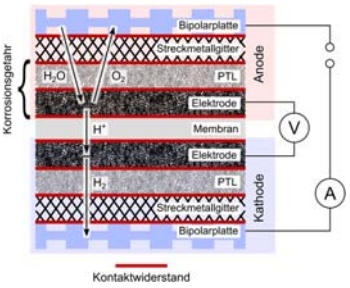
HyInnoCells creates porous transport layers for electrochemical cells with optimized properties

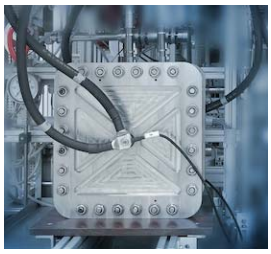
HYINNOCELLS – PRODUCTION OF ELECTROCHEMICAL CELLS





Additive Layer Manufacturing

Noble metal free



APPROACH

- Additive layer manufacturing using expanded metal grids
- Non-noble metal, inexpensive coatings
- Electrochemical testing
- Analysis of the potential for serial production and transfer to fuel cells

PROJECT PARTNERS

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HyInnoSys targets the technology-accompanying and strategic orientation for hydrogen market preparation and intersectoral connection

HYINNOSYS – MARKET PREPARATION, HYDROGEN ECOSYSTEM, TECHNOLOGY AND KNOWLEDGE TRANSFER

Perspectives of the hydrogen economy

Ecological level
- Drivers and barriers from an environmental perspective

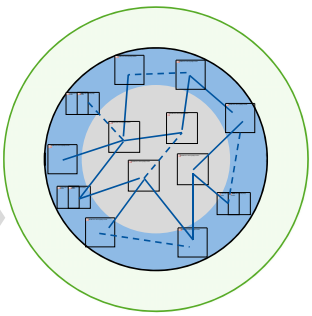
Society level
- Ecosystem actors
- User acceptance and perception

Corporate level
- Business models along the hydrogen chain
- Market introduction processes in ecosystems

Political regulatory level
- Influencing parameters and targets for selected economic sectors

Future level
- Scenario analysis
- Delphi Study

Regional innovation ecosystem hydrogen



Creation, cross-linking, testing and **analysis** of an **ecosystem**

Building an **ecosystem blueprint**

APPROACH

- Develop viable business models and identify market introduction processes
- Analysis of the actors in the ecosystem, user acceptance of hydrogen technology
- Regulatory design of hydrogen-centred energy markets
- Techno-economic system analysis
- Derivation of future scenarios and implications for the coordination and development of hydrogen ecosystems

PROJECT PARTNERS

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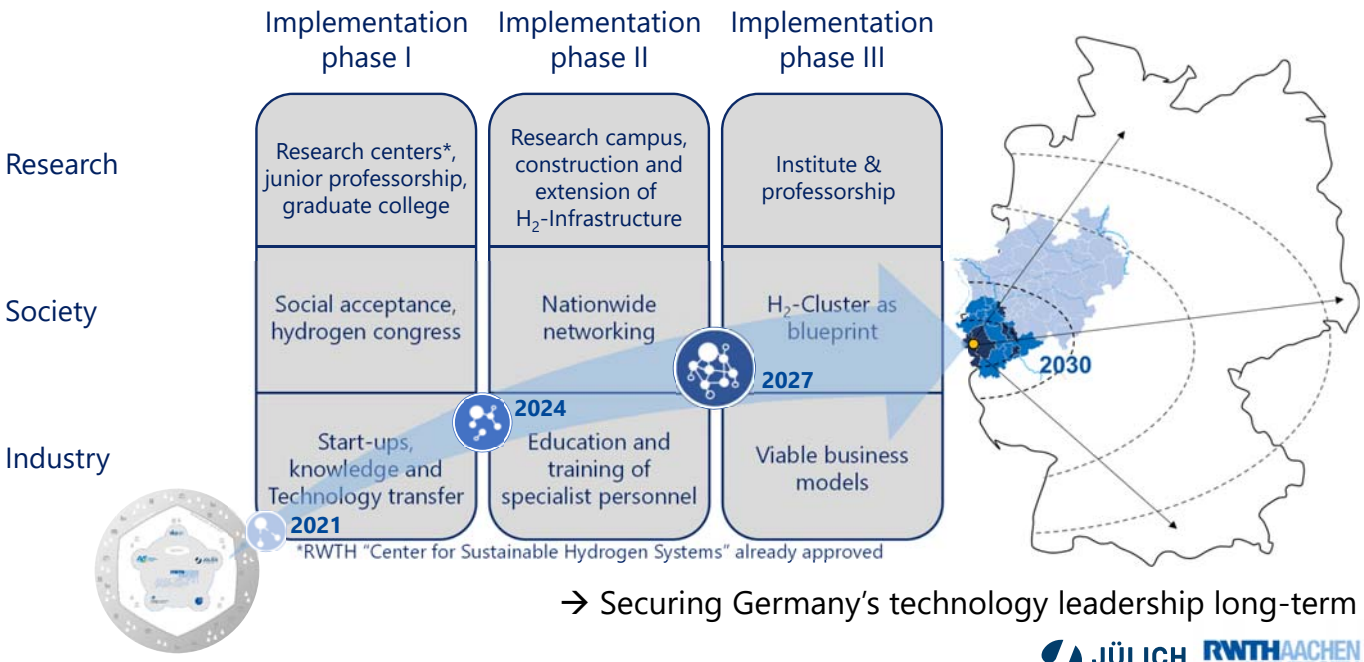
Our strategy: Nationwide establishment of hydrogen technologies with disruptive innovation potential



→ Securing Germany's technology leadership long-term

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The Hydrogen Clusters4Future at a glance

- Networking of the fields of generation, distribution, storage and consumption
- Model region for „hydrogen technologies made in Germany"
- Pioneer for a German hydrogen economy
- Value creation in a sustainably oriented society

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Hydrogen Clusters4Future – Zukunftscluster Wasserstoff
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