

# Hydrogen Industry Leaders 100 Breakfast Hub

## Durham Energy Institute – Hydrogen Research & Innovation

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**Chair of Energy Systems  
Durham University**

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**Academic Lead, Teesside Industrial Cluster**

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Energy Systems Integration and Energy Efficiency in Industrial Processes**



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# Growing Teesside's Hydrogen Economy and Catalysing a Just Transition to Net Zero

## Vision

To accelerate a just transition to hydrogen energy adoption through catalysing and embedding R&D.

- > Drive productivity
- > Change behaviours
- > Empower a green industrial transformation in the Tees Valley and beyond

## Why?

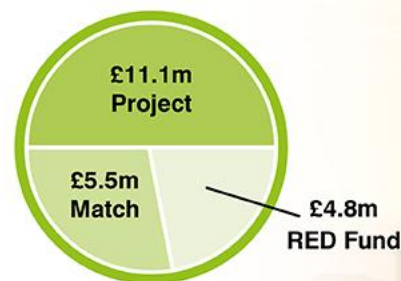
**Right Time:** Urgency created by statutory commitments and increasing energy security concerns

**Right Place:** Existing industry, infrastructure, natural assets, green growth plan

**Right level of ambition:** Stimulate productivity, and address barriers to growth

**Right partners:** Combine academic and applied research capability of universities and the SME supply chain

**Right approach:** Involvement of stakeholders from industry and civil society in the design, delivery and dissemination



Teesside aim to be world's first 'net-zero' carbon cluster by 2040

Hydrogen Transport hub located in Tees Valley

2GW of Hydrogen by 2027 planned for Teesside, delivering 30% of UK production target

Eight large scale industrial projects in TVR on green/blue hydrogen production, transport and domestic use



## How do we achieve this vision?

### Central approach:

Co-production of R&D programme with stakeholders and embedded R&D capacity in industry



### 4 domains:

- > High-grade heat
- > Flexible & resilient electrical power
- > Heavy duty transport
- > Just transition, planning, regulatory and legislative processes



### Stakeholder and sandpit events:

Identify industrial challenges  
Co-produce academic/industrial collaborative projects  
Increase

- > supply chain innovation
- > productivity and competitiveness
- > resilience to policy and regulatory changes
- > export opportunities



### Capacity building:

- 12 industrial and 2 policy fellows
- > be mentored and supported
  - > become independent researchers
  - > continue professional development



## Impacts

**Long term: deliver significant economic, societal, and environmental impacts**

- > Public engagement and perception
- > New skills
- > Increased turnover
- > Increased productivity
- > Decoupling of economic growth & energy consumption
- > New policies and regulations

## Why Research England funding?

**Develop the hydrogen economy**

**Enable capacity building**

**Improve skills levels and innovation**

**Stimulate collaboration**

**Deliver innovative solutions**

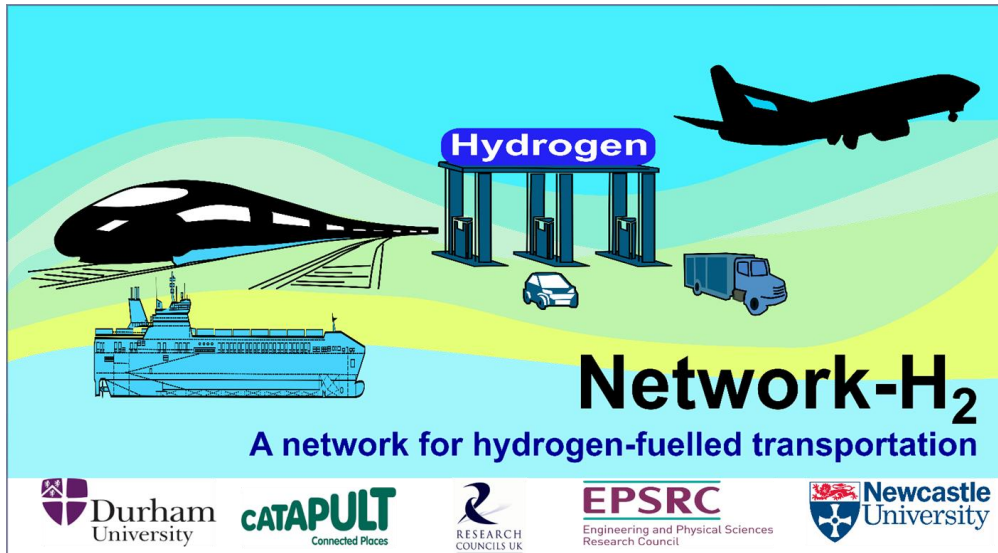
**Ensure dissemination of experiences and lessons learned**

# Net-Zero Research Network - hydrogen fuelled transportation and decarbonisation of heating and cooling

## A Network+ for the Decarbonisation of Heating and Cooling

### Key objectives:

- Act as a forum to maximise impact of research and communicate, share best-practice, and dissemination outcomes and stimulate knowledge transfer
- Capture the state-of-the-art and identify the research challenges
- Target funding to unlock collaborative research across the wider research community to address important gaps in knowledge.

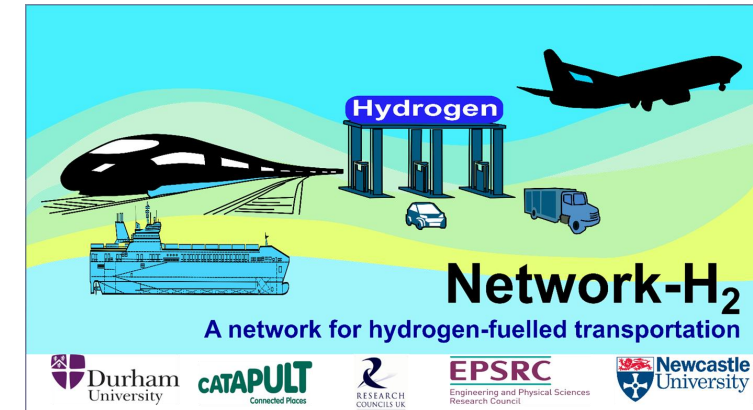


<https://www.net-zero-research.co.uk/>

# Network H2 - Stakeholder engagement activity examples

Monthly Thematic Webinars and Conferences:

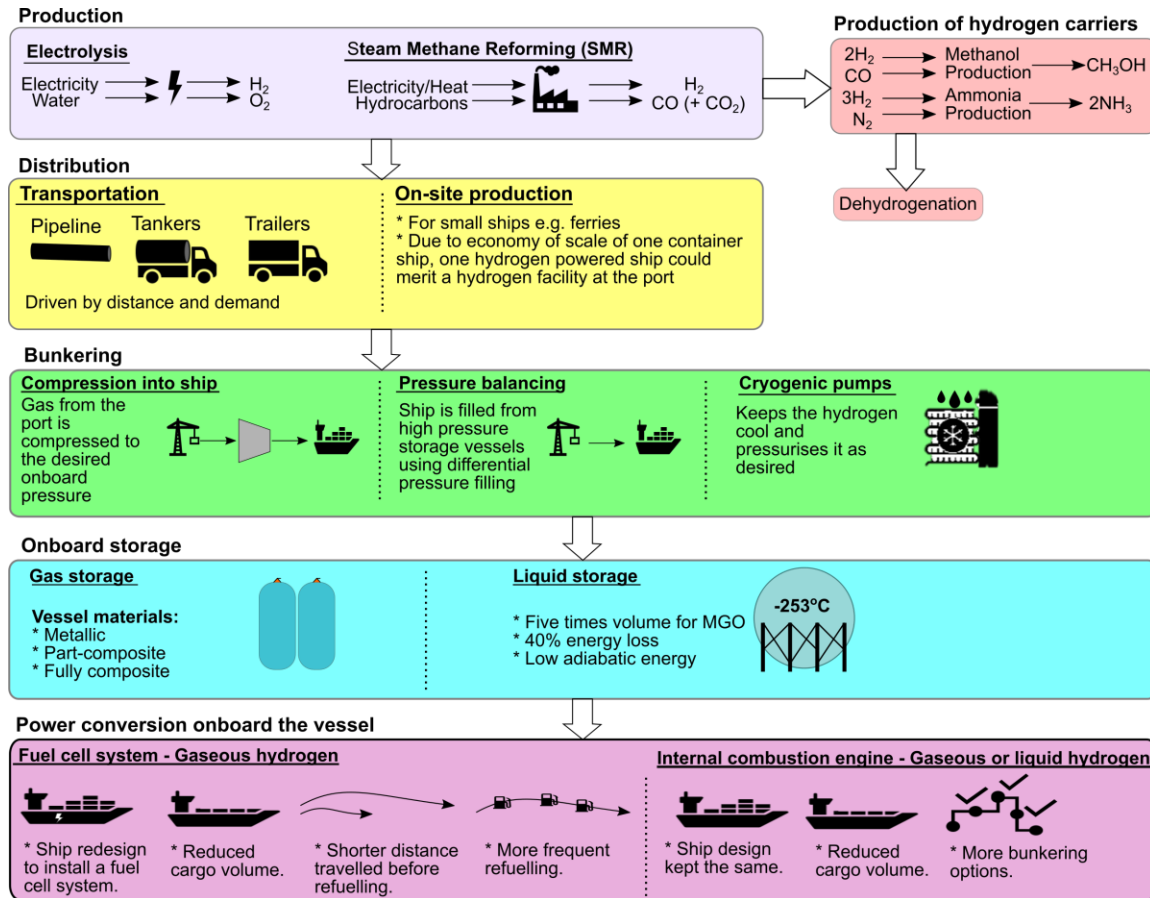
- **The Whole Transport System:** (i) "The whole transport/hydrogen system" by Joe Stevenson, Arcola Energy, UK; and (ii) "Hydrogen supply chains from an environmental point of view" by Dr Christina Wulf of Forschungszentrum Jülich, Germany
- **Pathways to Sustainable Production and Distribution:** (i) "Sustainable pathways to hydrogen production and distribution" by Professor Robert Steinberger-Wilckens of University of Birmingham, UK; and (ii) "Sustainable pathways to hydrogen production and distribution" by Beth Dawson of Fuel Cell Systems, UK
- **Compact and Lightweight on-board Storage:** (i) "Compact onboard storage" by Julian Jepsen, Helmut Schmidt University; (ii) "Compact onboard storage - safety considerations" by Stuart Hawksworth of Health and Safety Laboratory's Centre for Energy and Major Hazards
- **Compact and Lightweight Hydrogen Energy Conversion Devices:** (i) "EVERY WH2ERE - project to prove fuel cell equipped gensets' reliability through demonstration" by Dr Stefano Barberis of RINA; (ii) "Hydrogen based energy pack for the marine sector" by Professor Alberto Traverso and Dr Lorenzo Di Fresco of BluEnergy Revolution



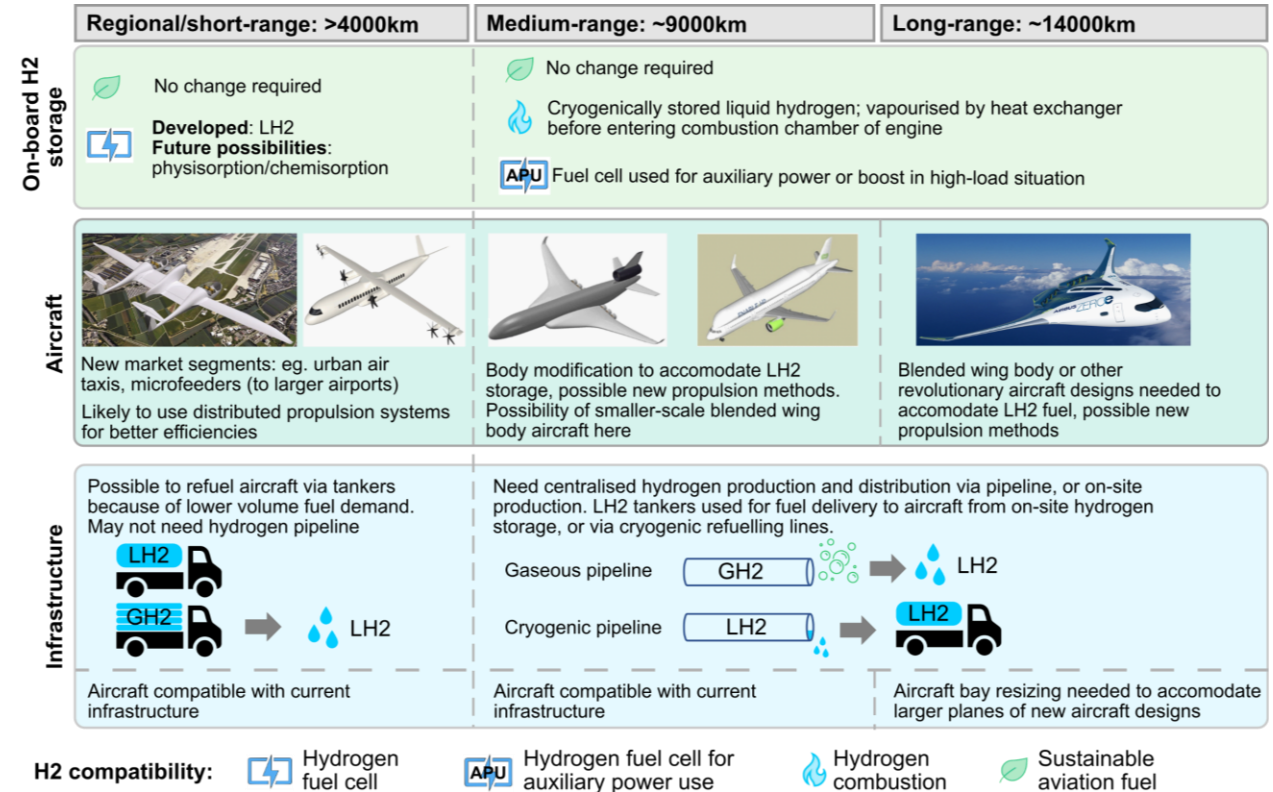


# Network H2 – horizon scanning

## Hydrogen fuelled marine transport



## Hydrogen fuelled aviation



## Network H2 - Thematic Areas Research Funding

### **Techno-economic feasibility study of hydrogen-fuelled freight transportation**

University of Kent, Cranfield University, University of Exeter, Heriot-Watt University

### **Development of a compact and highly efficient on-board ammonia cracking system to produce hydrogen in a hydrogen-fuelled long haul civil airliner**

University of Hull, Robert Gordon University, Cranfield University

### **Assessing electrochemical hydrogen pumps for deblending and purification of hydrogen from repurposed natural gas grids for use in vehicles**

Imperial College London, National Physics Laboratory



## Network H2 - Thematic Areas Research Funding

### **Ammonia powered ship with proton conducting solid oxide fuel cells**

Imperial College London

### **Computational analysis of a zero-carbon hydrogen fuelled thermal engine for heavy duty transport applications**

Edinburgh Napier University, University of Glasgow, University of Cambridge, Brunel University

### **Analysis of a strategic hydrogen refuelling infrastructure**

Heriot-Watt University





# Zero-Carbon Emission Integrated Cooling, Heating, Power & Transport Hub

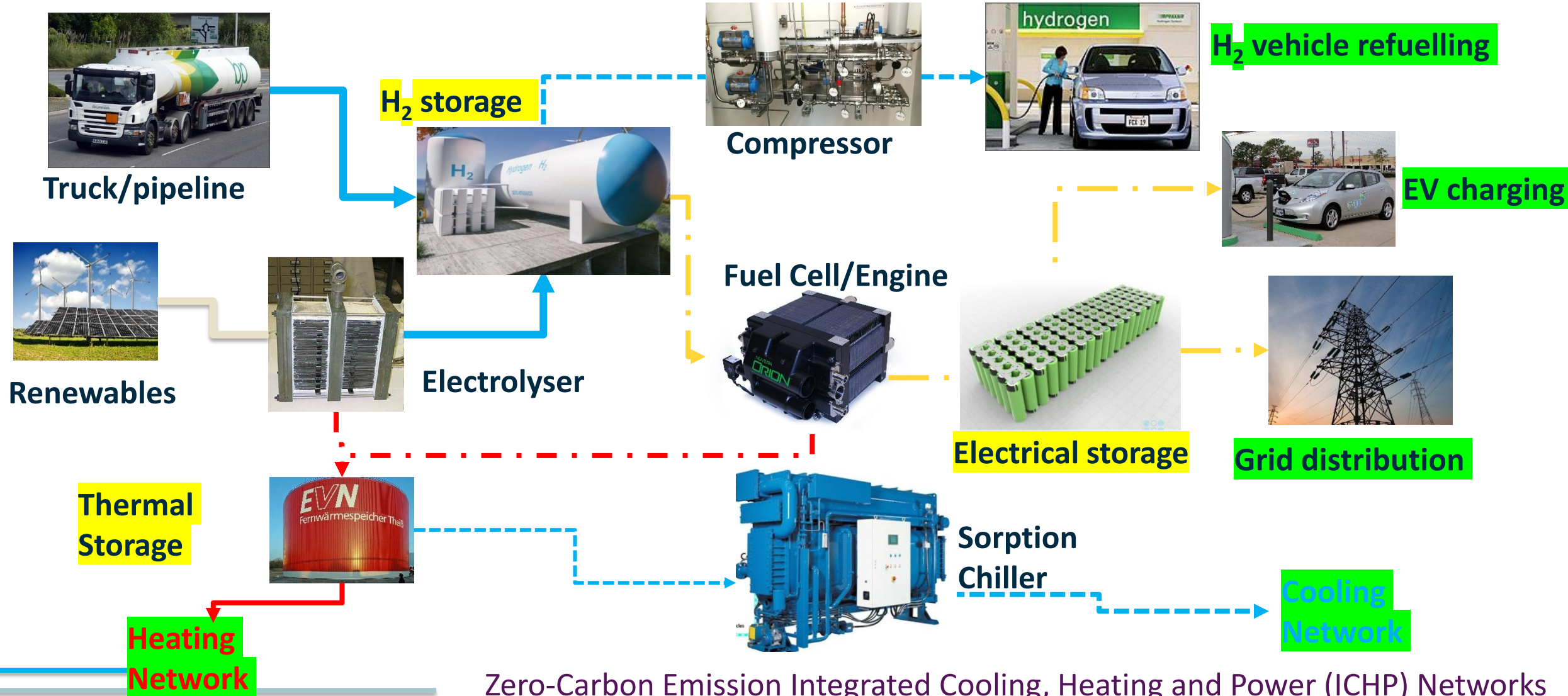


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Physical Sciences  
Research Council



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Durham Energy Institute

Imperial College  
London



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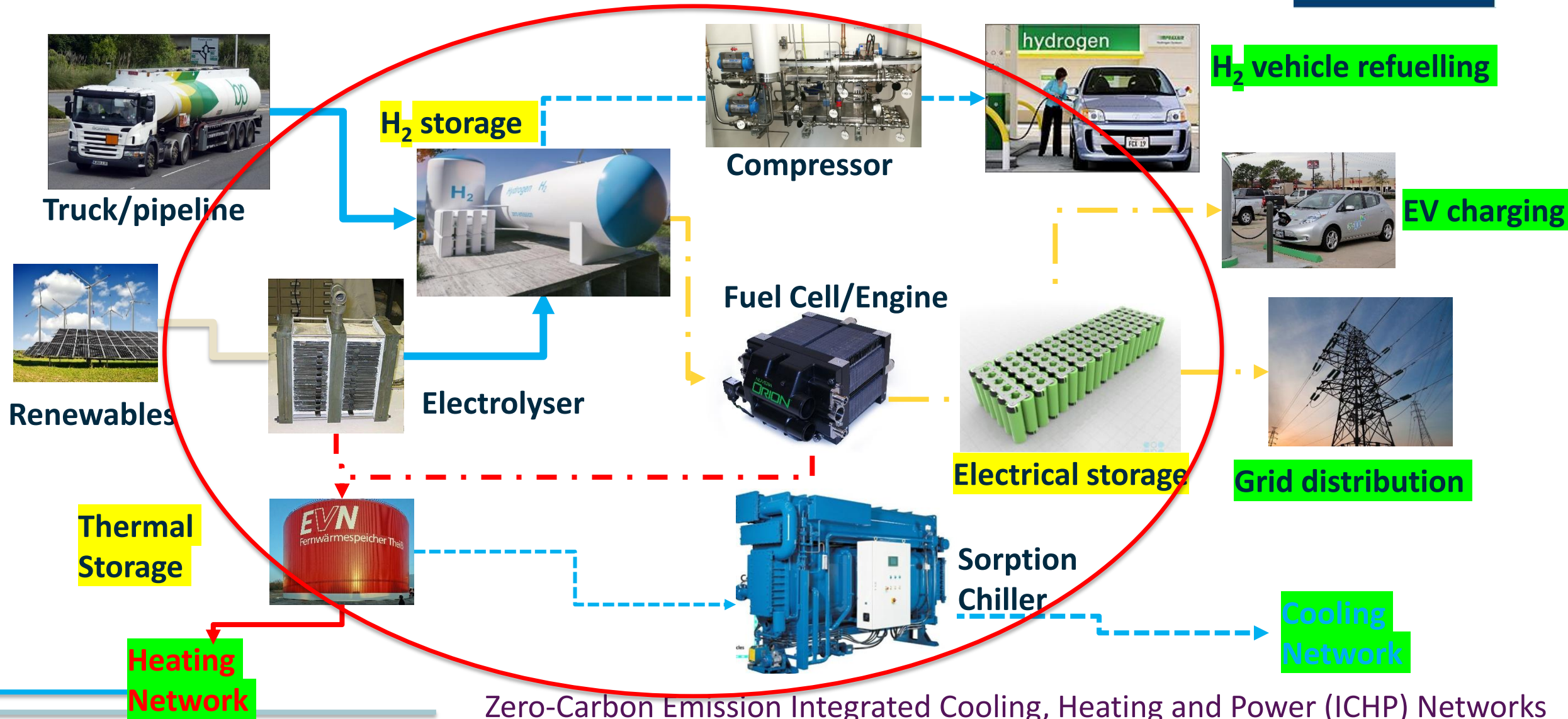


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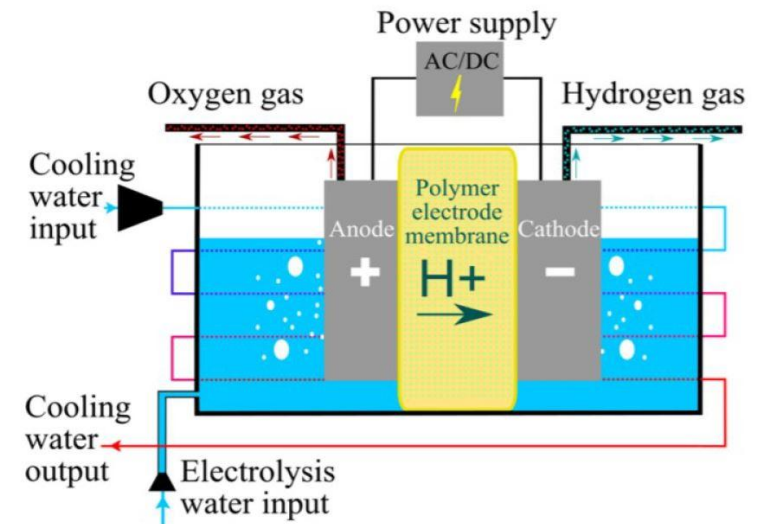
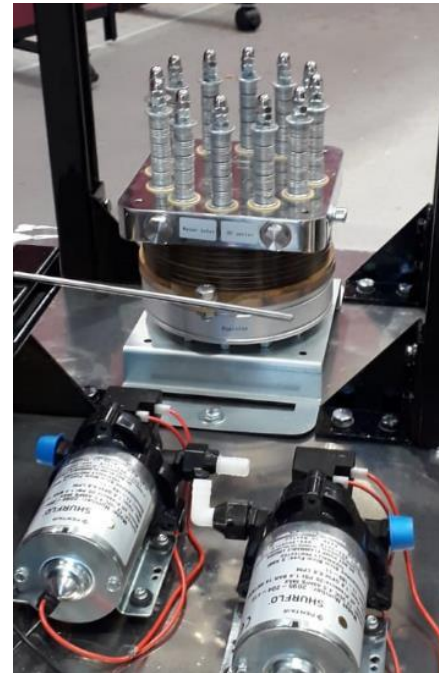
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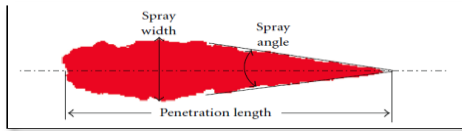
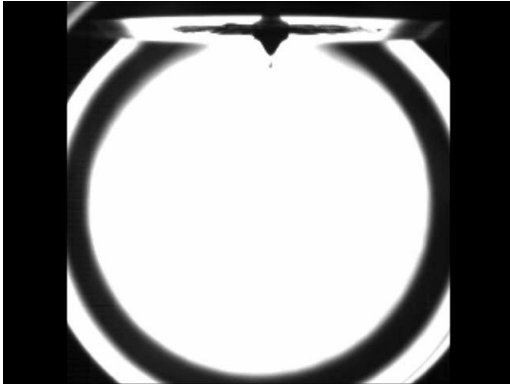
# Durham Hydrogen Laboratory and Experimental Facilities

- Hydrogen production and gas compression system efficiency
- Integration of solid-state metal hydride hydrogen compression technology with PEM electrolysis.
- Modelling and demonstration of improved in energy system efficiency for electrolysis and gas compression of hydrogen.
- Gas compression project (Industrial Decarbonisation Research & Innovation Centre)



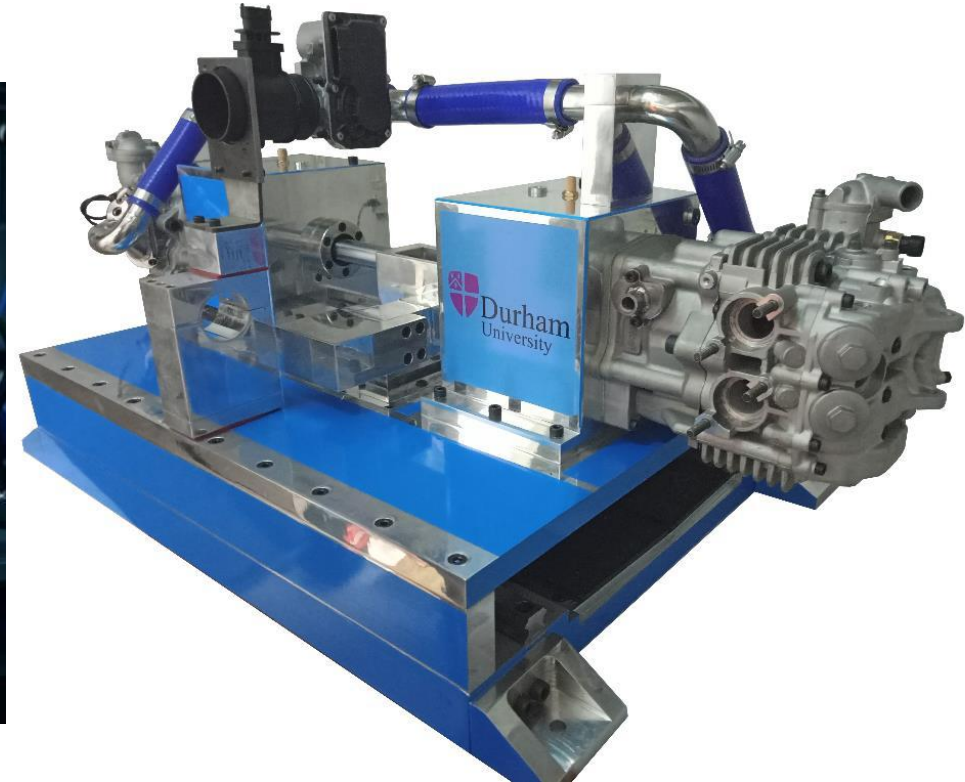
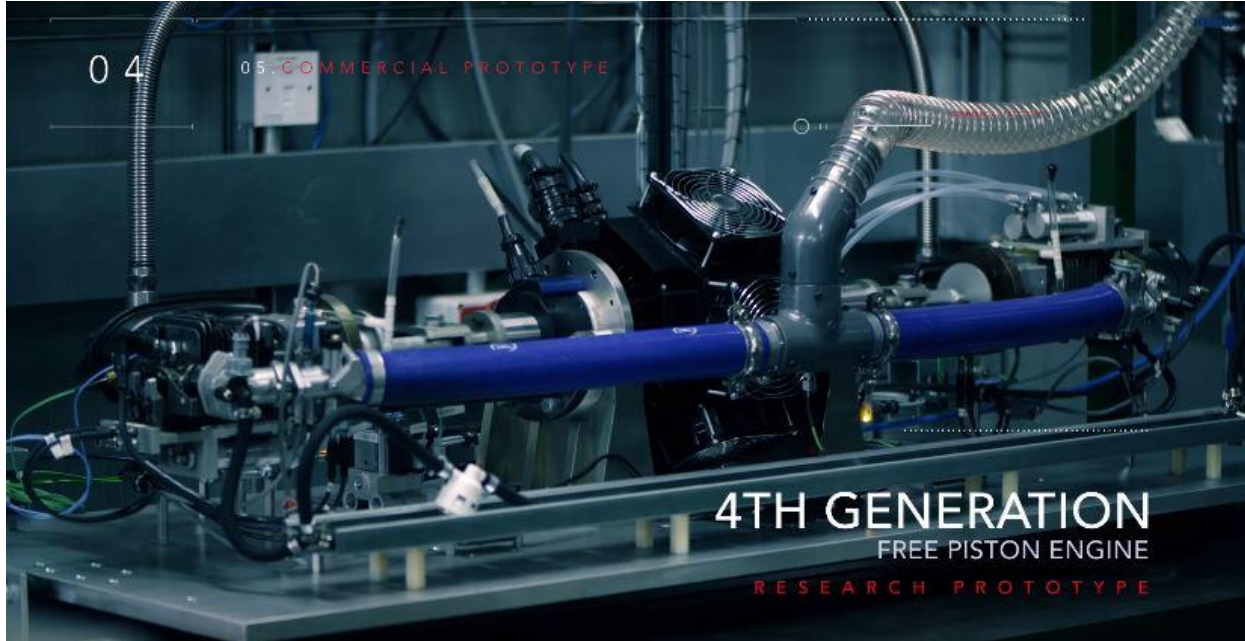


# Durham Hydrogen Laboratory and Experimental Facilities



Dual fuelled hydrogen and biofuel CHP and Trigenation

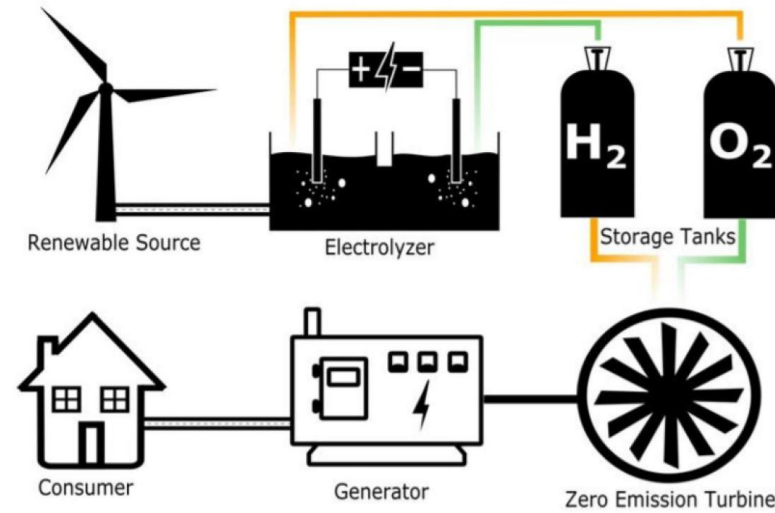
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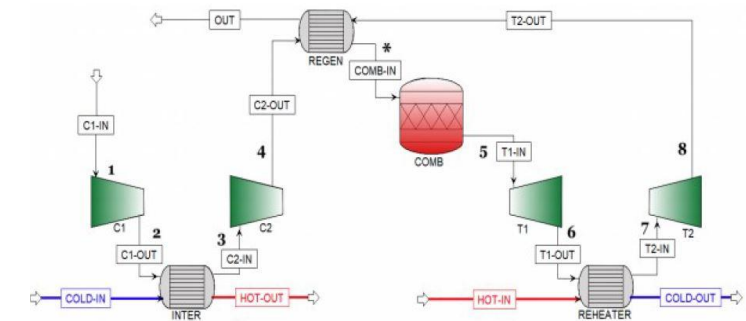
- Patented technology with similar electrical efficiency as PEM fuel cells
- Potential use for large road, train and marine powertrains and also power generation & CHP with higher conversion of fuel energy to power.
- Cheap to manufacture, operate and maintain – high reliability and availability
- Operate with variations in hydrogen fuel quality and contamination.
- Northern Accelerator funding to spin-out and create new company.



# Durham Hydrogen Laboratory and Experimental Facilities



- Store and use green hydrogen and green oxygen from electrolysis
- Patented Oxygen-combustion of hydrogen in a closed-cycle to produce zero emissions
- Exploration of argon and helium as working fluids to achieve high electrical efficiency



Zero-emission closed-cycle power generation and CHP



# Durham Hydrogen Laboratory and Experimental Facilities



- Photo catalytic waste water treatment for hydrogen and clean water production
- Pyrolysis of waste biomass for hydrogen rich gas and high-value carbon products
- Hydrogen and chemical feedstock production through controlled anaerobic fermentation of biomass waste streams.

Biomass Conversion and Carbon Capture

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