Overview of research initiatives at European Commission targeting environmental impacts of hydrogen emissions

Hydrogen Emissions and Environmental Impacts Workshop
University of California, Irvine
September 16-17, 2024

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Joint Research Centre

Outline

- Background
- Ongoing European funded initiatives
- Research at the JRC

European Commission

Expert Workshop on the Environmental Impacts of Hydrogen

organizers

Clean Hydrogen Partnership

U.S. DEPARTMENT OF ENERGY

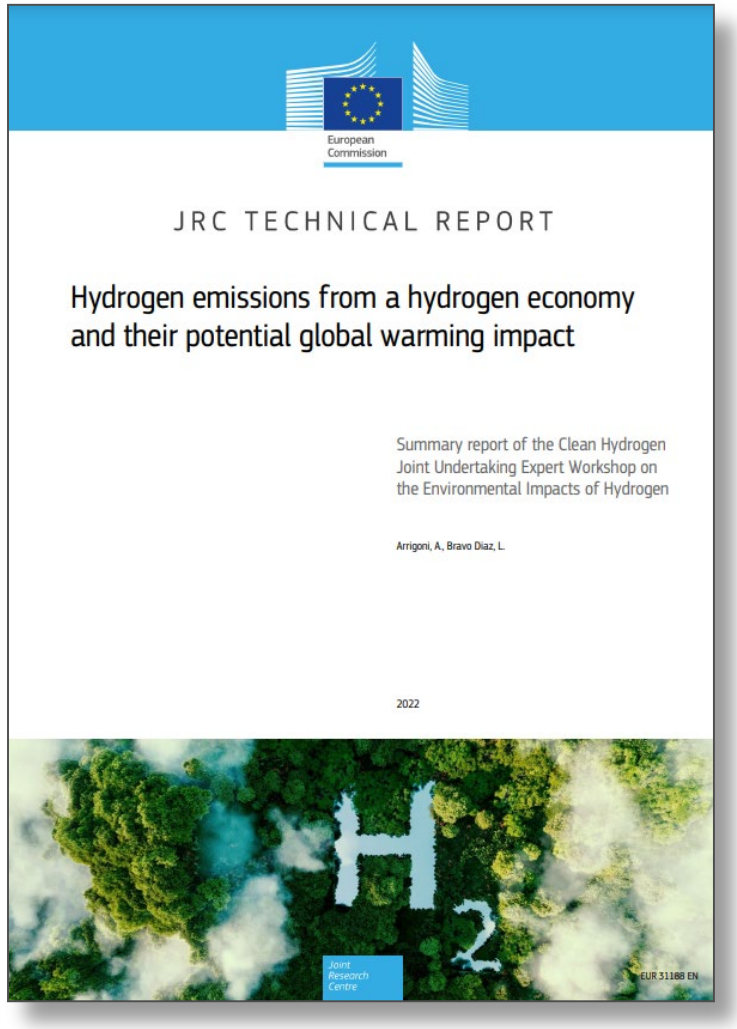
with the support of

Joint Research Centre JRC

Hydrogen Europe

Hydrogen Council

IPHE



JRC Publications Repository - Hydrogen emissions from a hydrogen economy and their potential global warming impact (europa.eu)

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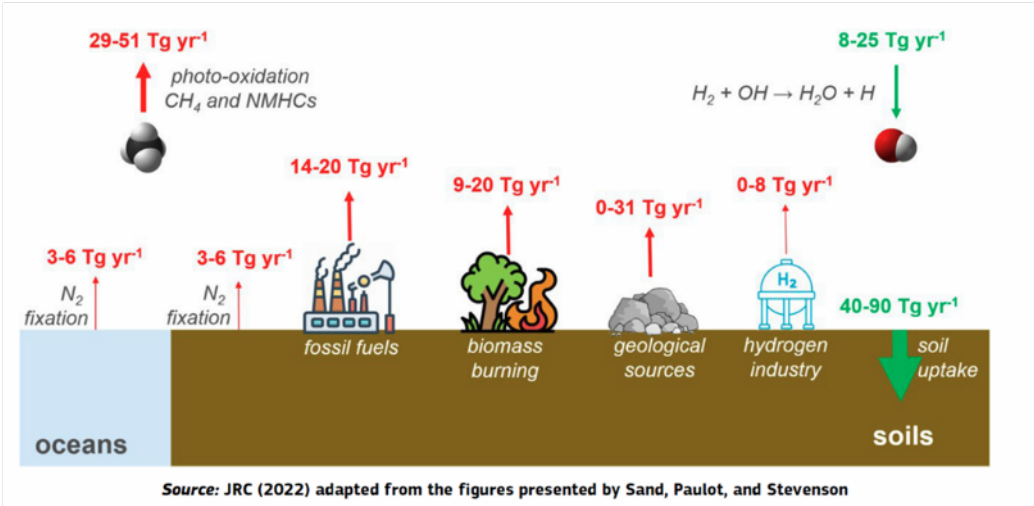
Horizon Europe Research Topic
Climate Impacts of a hydrogen economy

- To achieve deeper and more precise understanding of the overall mechanisms driving the hydrogen cycle and its future development under concentrations higher than historically observed (with a specific focus on hydrogen sink processes).

- Analysis of the radiative forcing impacts of hydrogen, specifically by investigating the mechanistic interactions of hydrogen with tropospheric gases, in particular methane, carbon monoxide, nitrous oxide and the potential to increase atmospheric water vapor.

H_2 concentration in the atmosphere: 0.5 ppm

H_2 lifetime in the atmosphere: 1.4 – 2.5 years



Source: JRC (2022) adapted from the figures presented by Sand, Paulot, and Stevenson

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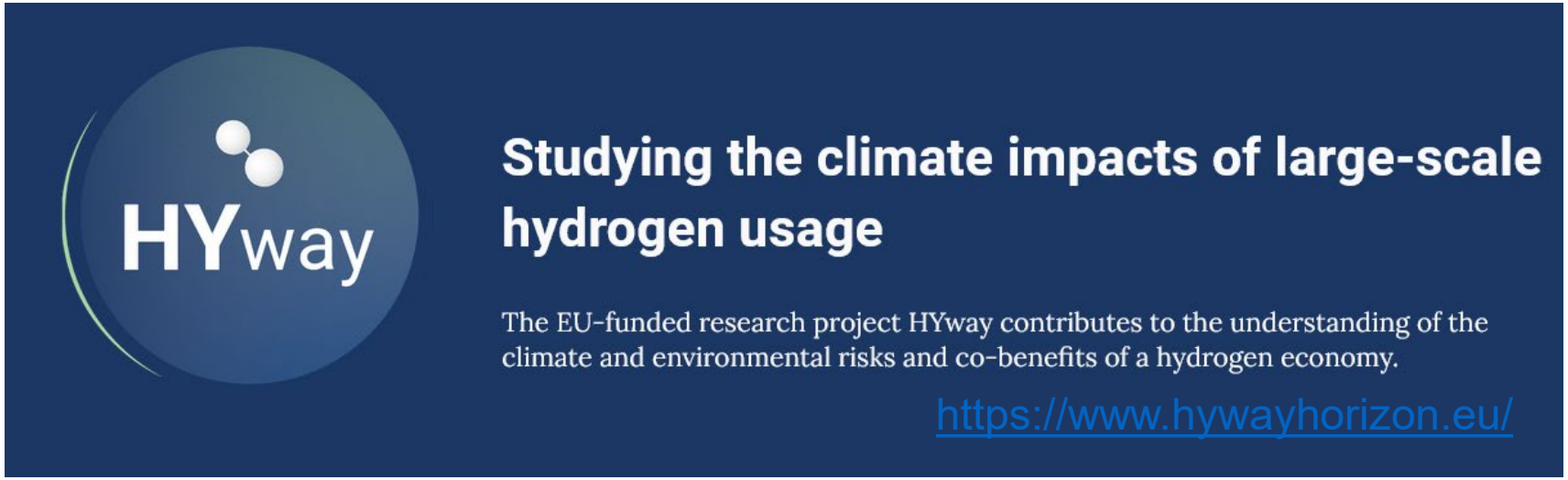
Horizon Europe funded projects



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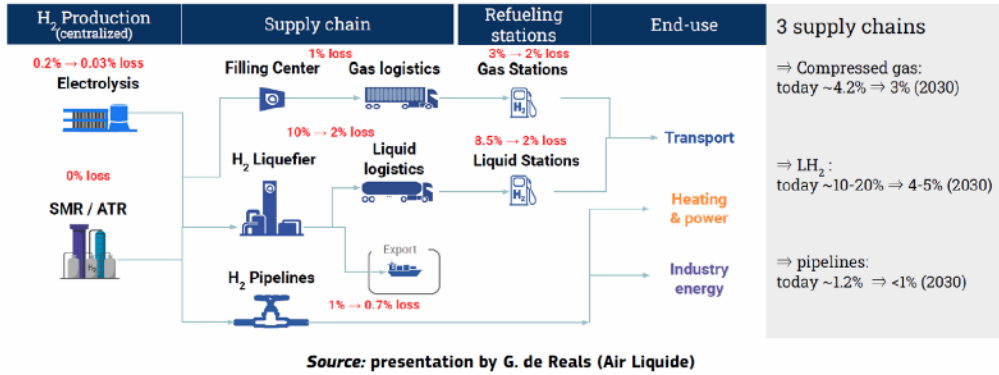
Clean Hydrogen Partnership Topic Assessment of potential hydrogen releases along the entire hydrogen value chain

- Identification, quantification, and preparation of an inventory of the types of anthropogenic hydrogen releases expected throughout the hydrogen value chains, in the short (2030) and long term (2050);

- Identification and ranking of the main elements of the hydrogen value chain in terms of the estimated hydrogen release and definition of potential mitigation strategies;

- Simulation and forecasting models of hydrogen releases along the hydrogen value chains for the quantification of the hydrogen releases;

- Identification and investigation of potential measuring technologies to detect and quantify hydrogen releases.



Source: **presentation by G. de Reals (Air Liquide)**

Pre-normative Research on Hydrogen Releases Assessment

https://nhyra.eu/

LCA comparison of hydrogen delivery options

What is the most environmentally sustainable option of ***delivering of 1 Mt/y of renewable H_2 to a single industrial customer*** *via a direct transport pathway (via ships or pipelines)*

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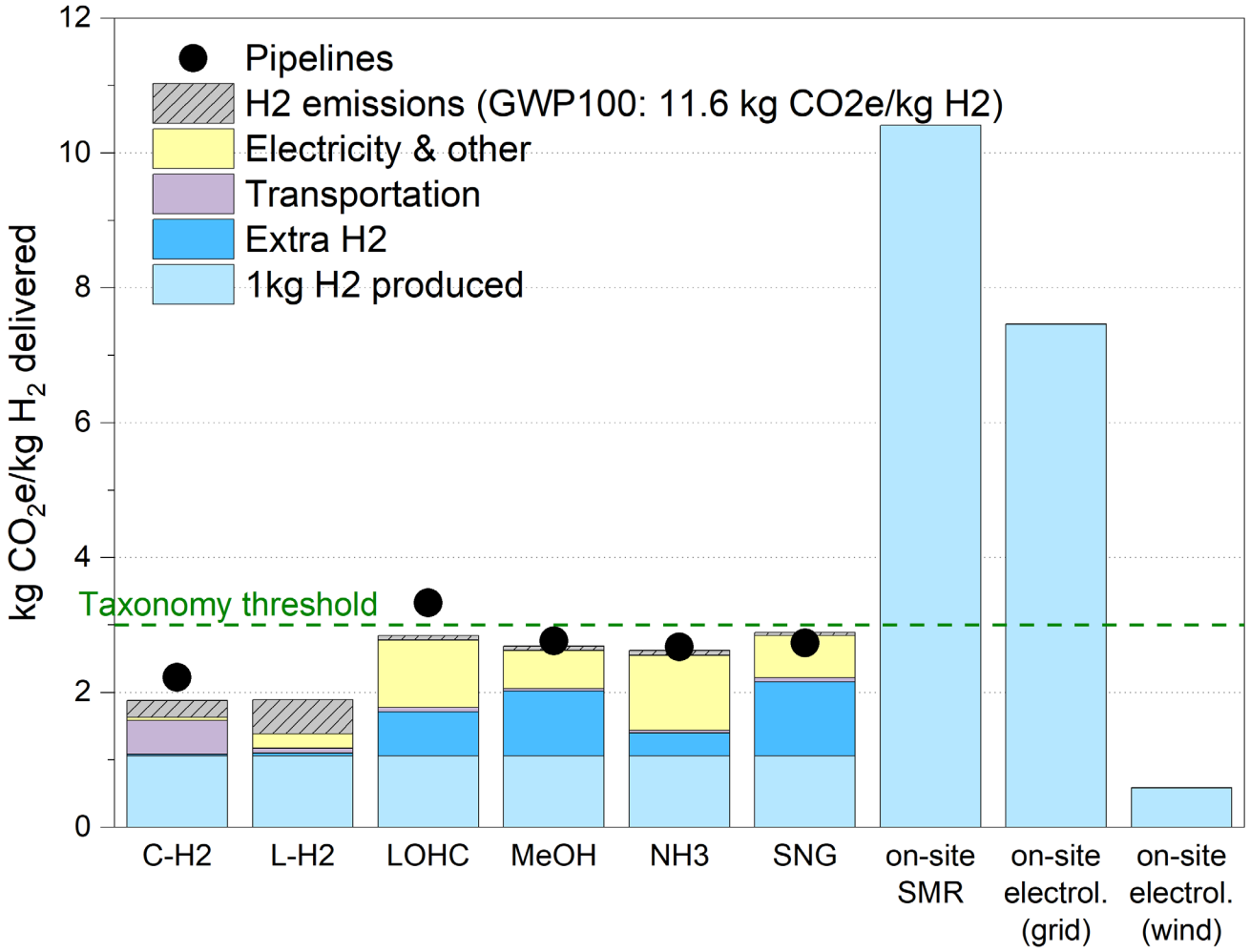
Results: Climate change potential impact



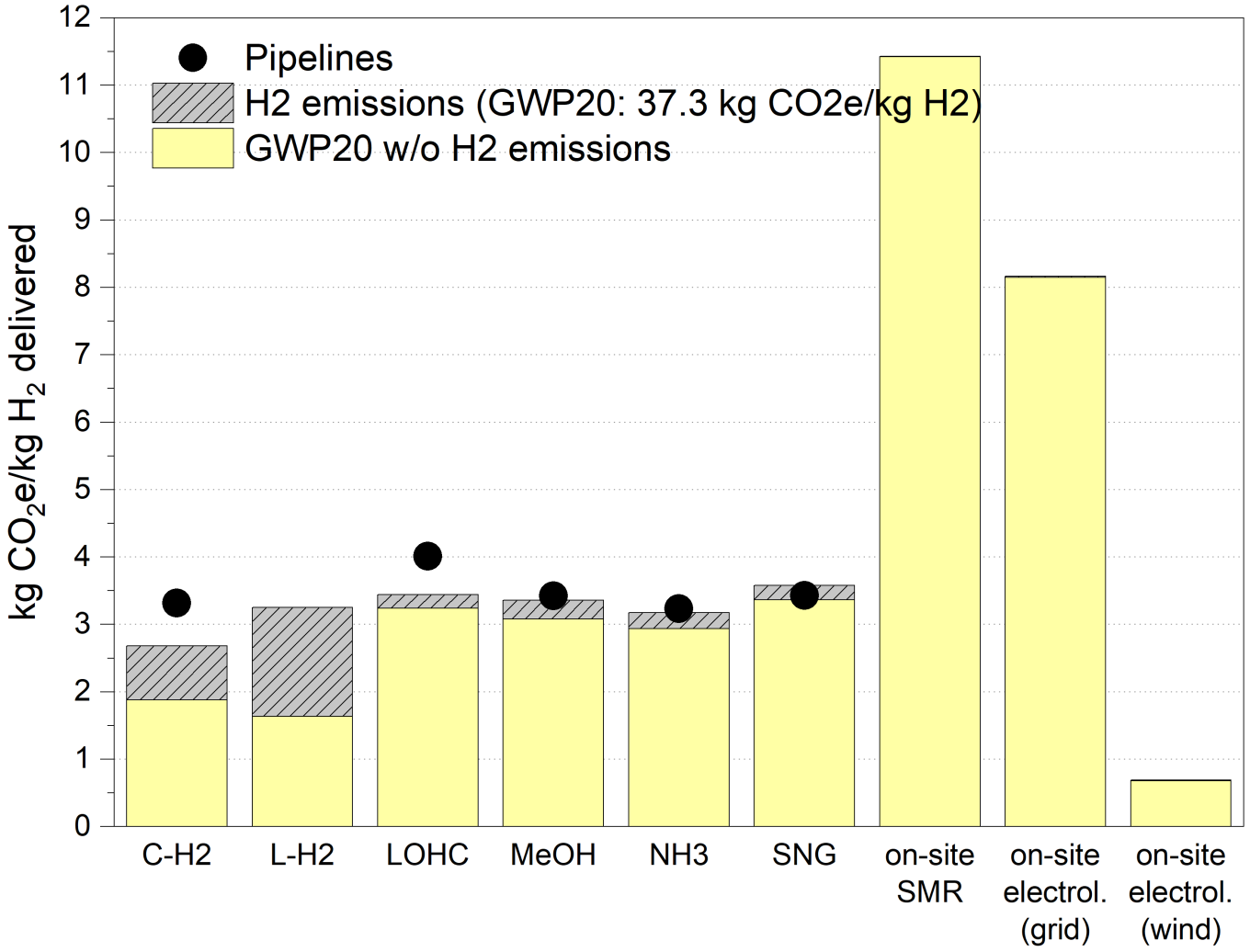
Extra H2: H_2 to make up for losses, and H_2 used for heat

GWP_{100} value from Sand et al. (2023)

Hydrogen emissions along the delivery chain could noticeably increase the global warming impact of the hydrogen delivered.

Nevertheless, the options more prone to losses (liquid and compressed hydrogen) are the ones exhibiting the lowest global warming impact.

GWP20 results



GWP_{20} value from Sand et al. (2023)

When shorter time horizons are considered (e.g., 20 years), the global warming impact advantage of transporting hydrogen in a compressed or liquefied form compared to hydrogen carriers diminishes.

This is due to the short lifetime of hydrogen in the atmosphere (approximately 2 years), which leads to a higher indirect global warming potential value over 20 years compared to 100 years.

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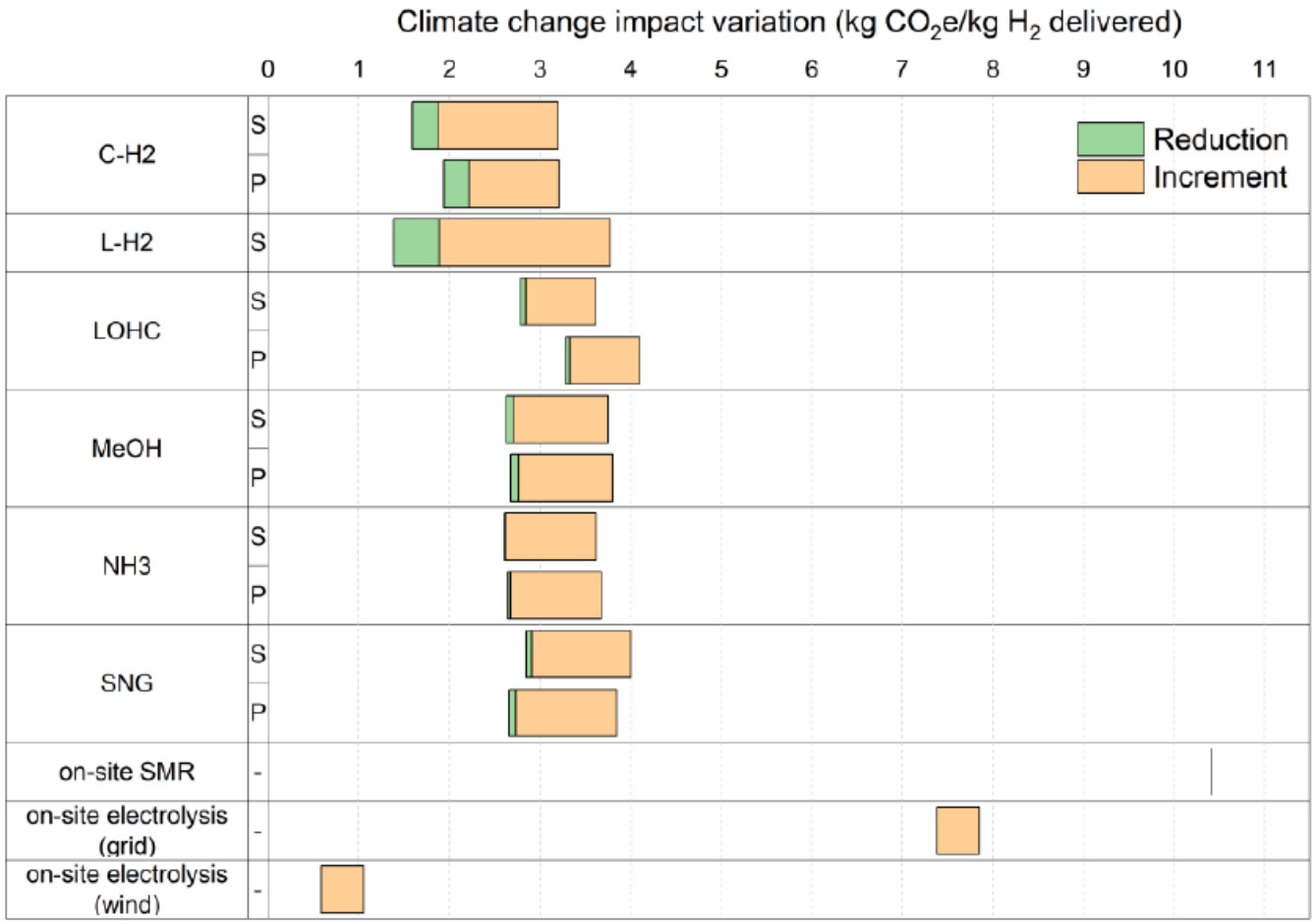
Sensitivity analysis on hydrogen losses



Current loss estimates are extremely high for liquid hydrogen, but are expected to be significantly reduced in the coming years.

If emissions were not reduced in the coming years and if the worst values for hydrogen losses found in the literature were considered, the impact of the hydrogen delivered via the liquid hydrogen pathway could be well above the EU Taxonomy threshold of 3 kg CO2e/kg H2.

More research is needed to reduce the uncertainty around hydrogen losses along the hydrogen delivery chain.

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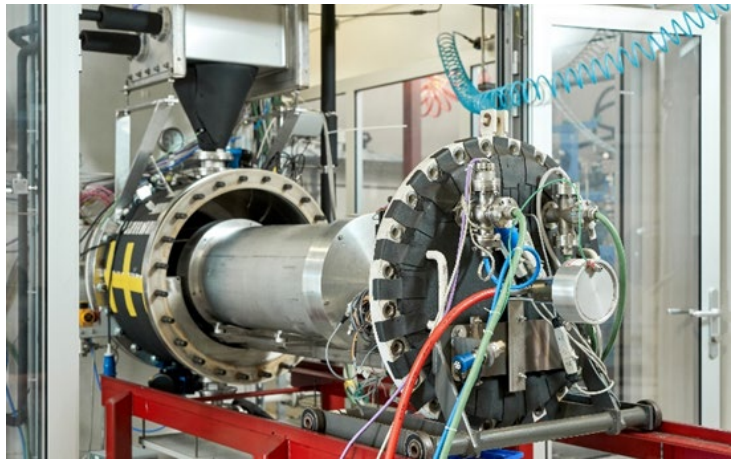
Experimental measurement of hydrogen leakage in pipelines

JRC.C1 **High Pressure Gas Testing Facility** (GASTEF) is **unique in Europe**.

Its capabilities for **hydrogen cycling & permeation tests** are exploited to address knowledge gaps about the influence of hydrogen in existing infrastructure.

- Dynamic tests for accelerated ageing under extreme hydrogen pressures and high cycle frequencies
- Monitoring and measurement of leaks



https://visitors-centre.jrc.ec.europa.eu/en/media/virtualtours/take-virtual-tour-gas-testing-laboratory

Thank you

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