NHyRA

N°1 – December 2024

Newsletter

pre-Normative Research on Hydrogen Releases Assessment

This issue

It's been almost a year that the NHyRA project has been launched and project participants have worked hand in hand to help the project reach its objectives.

You will find below an overview of some of the activities implemented by the project partners in the past months, as well as events they have attended on behalf of NHyRA!

Co-funded by the European Union

Clean Hydrogen Partnership

This project has received co-funding from the European Commission and the Clean Hydrogen Partnership under Grant Agreement No. 101137770. This Partnership receives support from the European Union's Horizon Europe Research and Innovation program, Hydrogen Europe and Hydrogen Europe Research.

H_2 emissions inventory

No inventory currently collects data about Hydrogen (H_2) emissions from the components, systems, or plants in the H_2 value chain. Otherwise, available data are usually limited and disseminated through the literature. This is a high limitation for a validated estimation of H_2 emissions into the atmosphere.

To solve this gap and provide a valuable tool to interested stakeholders, WP1 aims to design a new inventory where H_2 emissions data will be gathered from the literature review, experiments with validated methodology, and any other communications within the Consortium. quality check.

To date, WP1 activities have already completed Task 1.1, which aims to identify the potential archetypes in the H_2 supply chains to be included in future scenario analysis in WP4 and the sources of emissions. Task 1.3 is prioritizing the archetypes to be tested based on a multicriteria analysis that is performed thanks to the inputs and contributions of the partners.

Simultaneously, Task 1.4 is updating the inventory approach proposed in Task 1.2, by collecting new data, preparing questionnaires to be shared with market experts in accordance with the new correlations developed for calculating H2 emissions.

The EU-funded NHyRA project addresses the knowledge gap regarding the potential amount of the H_2 emissions expected along the entire H_2 value chain and aims to provide recommendations in terms of mitigation strategies which would help to improve the efficiency of the hydrogen economy and mitigate its environmental impact due to the indirect greenhouse effect of the H_2 gas. Since the aim of the hydrogen economy is reducing emissions of greenhouse gases, NHyRA project is strongly connected to other EU-projects founded under HORIZON-CL5-AWP23-D1-01-03: *Climate impacts of a hydrogen economy*, addressing the indirect forcing effect of H_2 emissions on greenhouse effect.

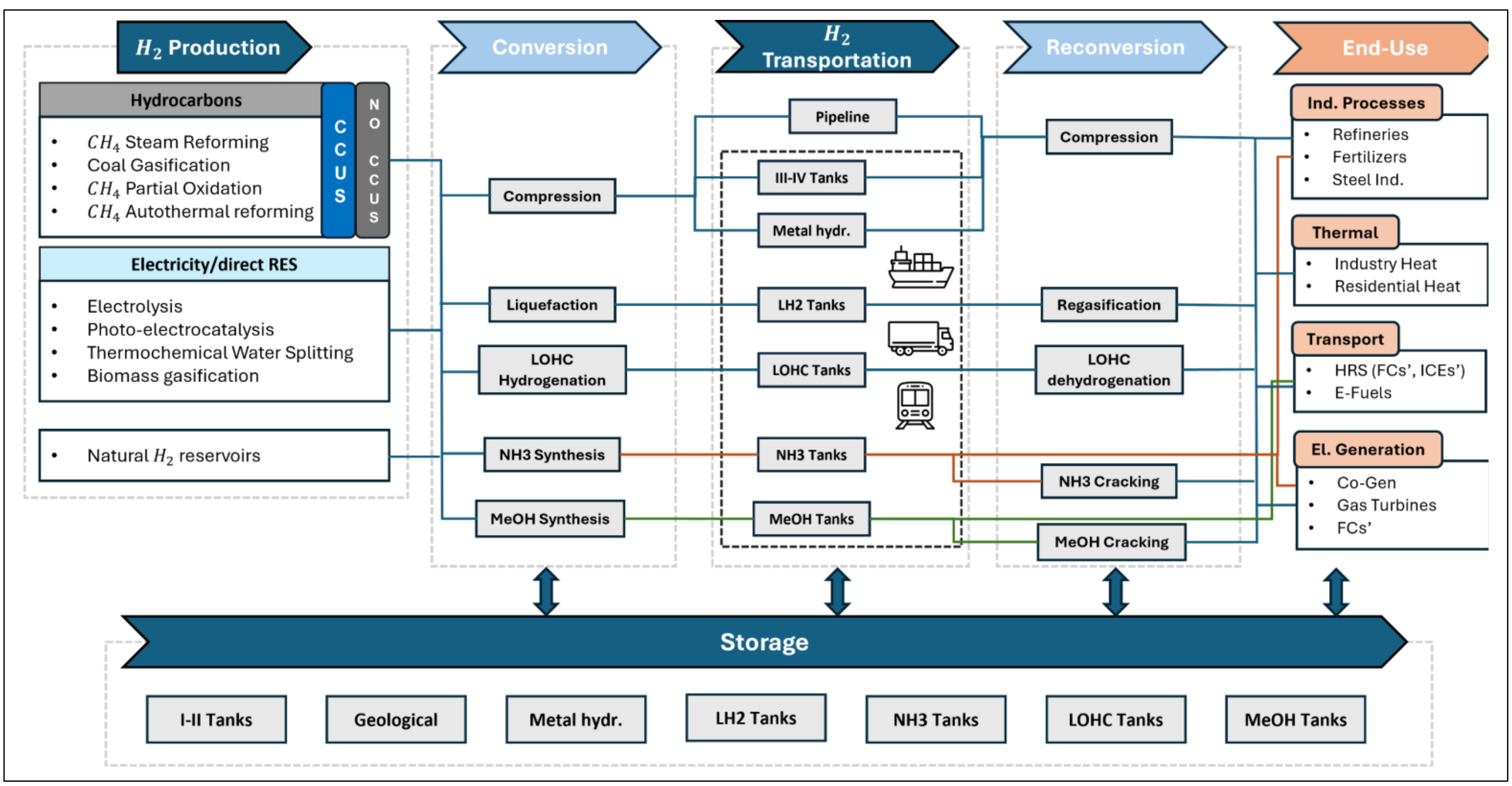

Figure 1.

Liaison with EU-Projects on climate impacts of hydrogen economy

The identification and exchange of information with such projects is the object of task 5.3 led by ENEA, which is chronologically the first activity of WP5 (led by FBK). Two projects are funded under the above-mentioned call:

- HYway, whose main object is to evaluate the climate and environmental risks and co-benefits of a hydrogen economy in order to advise policymakers and industry on options for addressing those risks;
- HYDRA, which aims to analyse possible climate impacts associated to a large-scale penetration of hydrogen-based technologies on the market and provide insights into policies and guidelines for a sustainable development of the hydrogen economy.

Explorative meetings were organized in order to establish a two-way communication channel between the projects:

- On April 5th, a meeting with WarrantHub was organized by Snam where the possibility of a collaboration NHyRA-HYDRA was discussed together with bureaucratic details;
- On June 7th and July 18th, a couple of meetings were organized by Engie to discuss the collaboration NHyRA-HYway.

Then, on September 4th, during the HYway kick-off meeting, information on methodology and targets between projects has been exchanged: HYway project was presented by Maria Sand (Cicero), Hydra project was presented by Rossella Urgnani (WarrantHub), while Matteo Robino (Snam) presented the project NHyRA. Among other things the quantification of H2 emissions, the role of the atmosphere and the soil sink, and the expected climate impact were discussed. Moreover, H_2 GWP100 values from several models were shown and the value of the hydrogen GWP100 was shared, i.e. 11.6±2.8 (one standard deviation) [1], the largest contribution coming from changes in methane (44%), followed by ozone (38%) and stratospheric water vapor (18%).

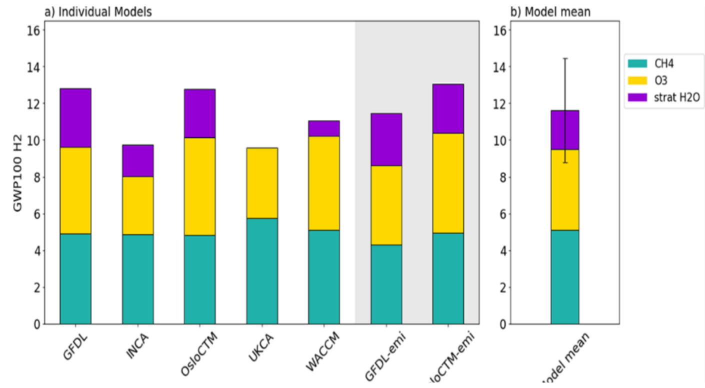

Figure 2. The GWP100 of hydrogen

Monitoring H2 emissions

The team has been reviewing the requirements for monitoring H2 emissions from hydrogen value chain. It is proposed that techniques for the monitoring of fugitives and diffuse (from vented emissions or sources of combustion H_2 emissions are categorised as follows:

- Detection of leaks at component level. Sniffers, passive sensors and acoustic cameras are candidate techniques for method development.
- Detection and quantification of leaks at component level. High-flow sampling is a candidate technique to consider for method development.
- Surveillance and/or quantification of emissions at area/site level. Distributed networks and tracers are candidate techniques to consider for method development.

Figure 3 illustrates the different temporal and spatial measurement scales involved in covering a site.

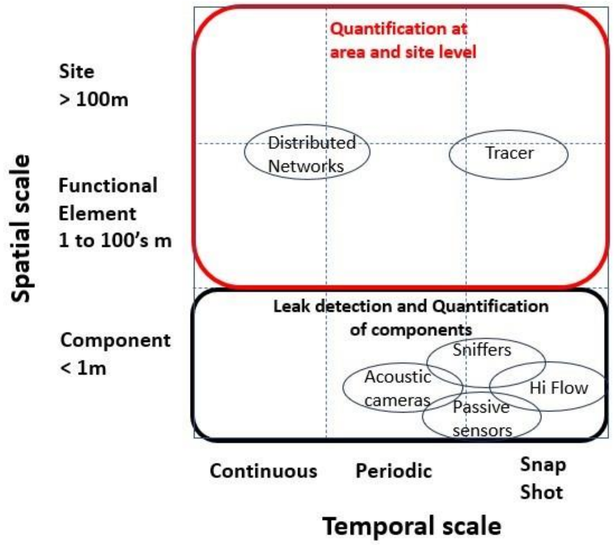

Figure 3. Temporal and spatial measurement scales for site covering

An important issue regarding hydrogen emissions regards the processes that cannot be directly measured, such as some vents and accidents. Measurement of hydrogen emissions during scheduled vents can be challenging to perform for technological reasons such as volume flow rate or geometry of the measurement site or the general conditions at the site (e.g. physical access to hazardous zones, weather, etc.) or composition of emissions (e.g. presence of water vapour). For this reason, in the case of vented emissions, it may be necessary to apply engineering calculations or CDF method. Therefore, the team also plans to use this type of solutions to develop emission estimation methods.

In addition, work on experimental measurements has begun. The team is developing a procedure for detecting and quantifying hydrogen emissions from leaks based on laboratory tests using previously chosen apparatus and techniques.

Quantifying H2 Emissions from Pipe Connection Loss

The team at University of Surrey has been investigating the method for estimating hydrogen release caused by connection or tightness loss in pipes. This includes both flanged and welded pipe joints. To quantify hydrogen emissions from these sources, both the emission factor and the activity factor need to be considered.

The emission factor (*EF*) represents the quantity of H_2 mass released into the atmosphere, measured in kilograms. In contrast, the activity factor (*AF*) describes how frequently hydrogen is released over the course of a year. The equation below addresses the relationship between these factors to obtain total hydrogen mass [2]:

$$E = EF \times AF = Q_{H_2} \times t \times N_{leaks} \tag{1}$$

where *EF* and *AF* can be derived as Q_{H2} which denotes the mass flow rate of hydrogen in kg/s, t is the leak duration in seconds which, for example, activation time of the emergency shutdown system could be considered, and N_{leaks} is the number of the detected leakages per year.

The Surrey team has successfully developed a predictive tool with a user-friendly frontend for estimating the total mass of hydrogen emission. This tool is designed to accelerate the calculation process and is easy to use. Figure 4 shows the user interface for calculating hydrogen release, which includes both the mass flow rate and the total mass.

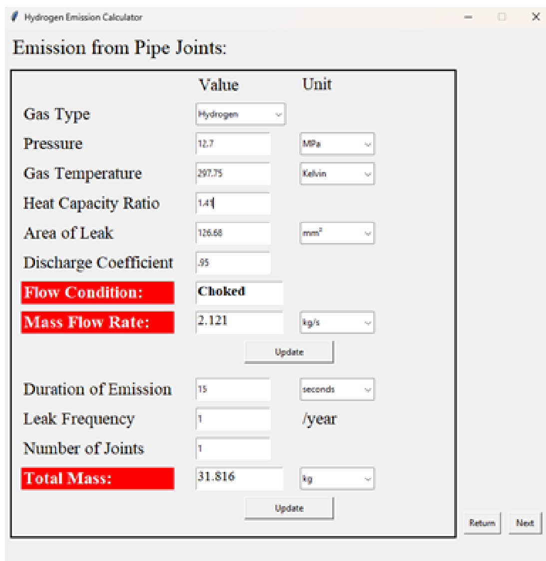

Figure 4. Graphical user's interface of hydrogen emission calculator

Validation of the predictive tool has been conducted using the experimental data from Hammer et al., (2022) for the predicted mass flow rate. Carbon dioxide (CO_2) was used in the experiment, with an average gas temperature of 23.88°C and a reservoir pressure of 121.08 bar as the gas flowed through an orifice [3].

Figure 5 shows the comparison between the mass flow rates from both the experiment and the calculations. The discrepancy is about 10.97%. The data pattern, as measured by the R^2 score, is almost identical, with a value of 0.95 out of 1.00. Overall, the validation is in reasonably good agreement with the measurements.

The predicted hydrogen mass flow rates for different hole sizes are also shown in the plot. These generally differ by about 48% from the values for CO_2. This is partly because hydrogen has a much lower molecular weight.

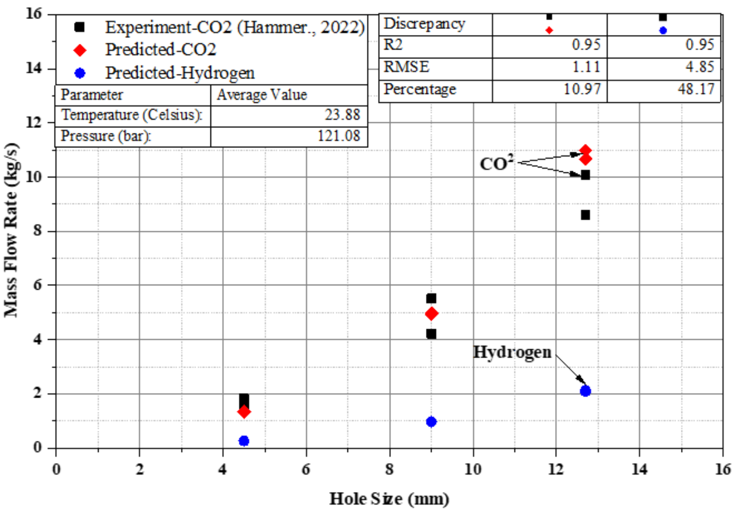

Figure 5. Comparison of the predicted and measured mass flow rates vs orifice hole size.

NHyRA at the International Forefront

Snam has cooperated in the dissemination and communication activities led by GERG by presenting the project at several external events and conferences. The "Excellence in Production Systems and Operations for Green and Blue Hydrogen Facilities" event, held in Barcelona on April 12th was attended. During the event, Snam presented the NHyRA project's vision, objectives, and progress, highlighting its potential impact on the development of green and blue hydrogen production facilities. It was the opportunity to emphasize how this project represents a key step in advancing hydrogen technologies, contributing to the decarbonization of energy systems, and fostering sustainable industrial solutions.

NHyRA was also showcased at the Scientific Poster Exhibition during the 6th European Gas Technology Conference (EGATEC 2024), held in Hamburg on June 18th–19th. Among several submissions, NHyRA was honored to be one of the eight projects selected for an on-stage presentation, underscoring its significance within the field. During the event, Snam presented the project's scope and objectives, engaging in meaningful discussions with stakeholders in the exhibition auditorium. This opportunity highlighted NHyRA's contribution to advancing gas technologies and promoting sustainable innovation.

On September 16th, the NHyRA project was featured at the "Hydrogen Emissions and Environmental Impacts Workshop", organized by U.S. Department of Energy at the University of California, Irvine. This prestigious event brings together international governments, industry leaders, and environmental stakeholders to address the atmospheric impacts of hydrogen emissions. The aim of the Workshop is to share advancements in climate science, detection and mitigation technologies, and to identify key R&D priorities. Once again, Snam had the opportunity to present the NHyRA project as part of the workshop Session "Sources and Sinks of Atmospheric Hydrogen". This opportunity underscores NHyRA's role in shaping the future of hydrogen technology and its environmental sustainability.

References

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[2] MarcoGaz. *Assessment of Methane Emissions for Gas Transmission and Distribution System Operators*; Brussel, (2019).

[3] Hammer, M., Deng, H.; Austegard, A., Log, A.M., Munkejord, S.T. Experiments and Modelling of Choked Flow of CO2 in Orifices and Nozzles. *Int. J. Multiph. Flow*, (2022), 156, 104201, doi:10.1016/j.ijmultiphaseflow.2022.104201.

Project Partners

Thank you for your interest in the NHyRA activities!

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