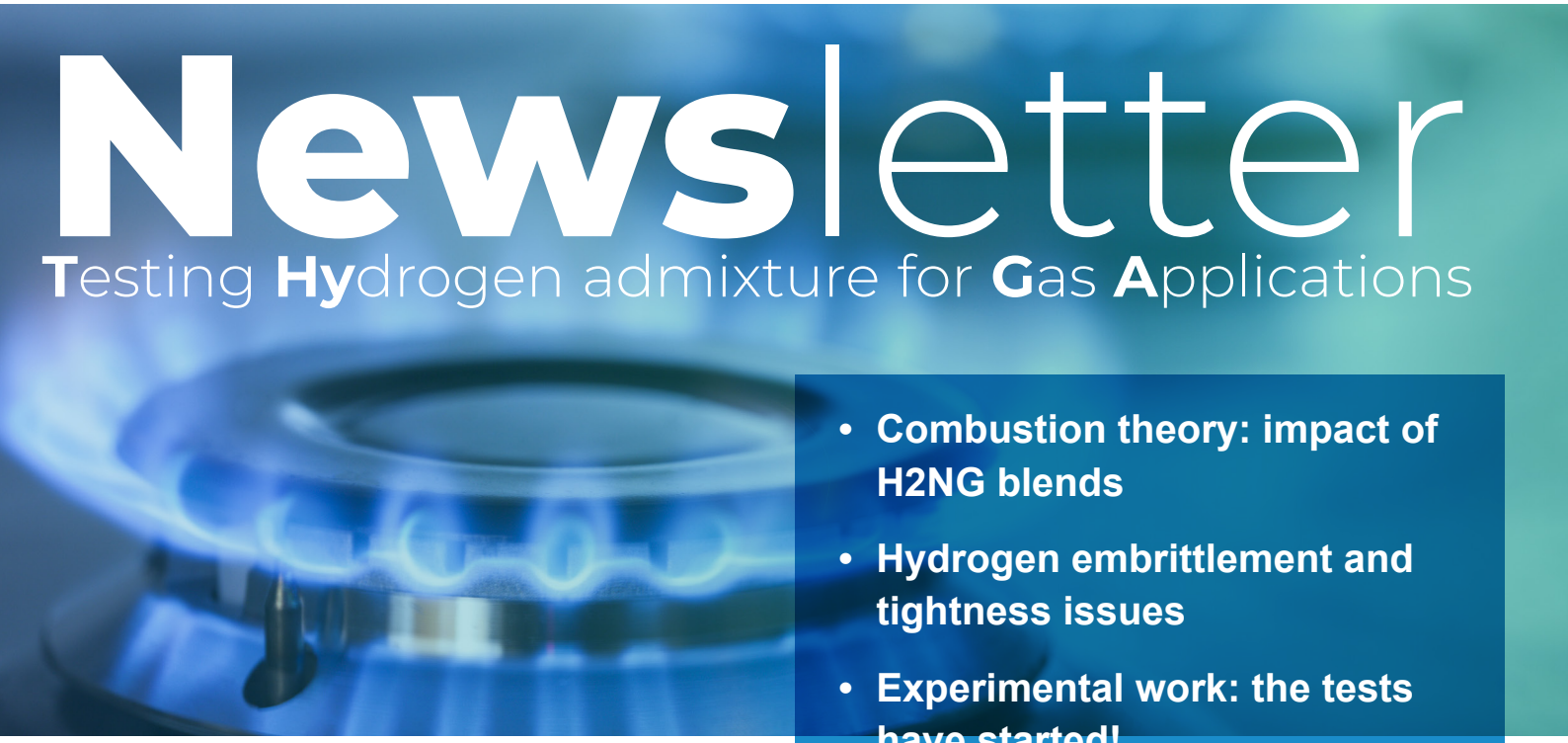
N°1
OCTOBER 2020

THyGA

Newsletter

Testing **Hy**drogen admixture for **G**as **A**pplications



- **Combustion theory: impact of H2NG blends**
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Introduction: Why blend hydrogen and natural gas?

'Hydrogen blending' refers to the injection of a certain percentage of hydrogen into the existing gas grid and is considered one of the solutions in the decarbonisation toolkit.

Blending hydrogen into the existing gas infrastructure is a quick win for abating emissions, without extensive new investment: a blend of 20% hydrogen by volume has the potential to provide of the order of 370TWh of carbon-free energy based on EU28 gas consumption of over 5500TWh (Eurostat 2019). Access to end-users of the natural gas grid would also boost near-term hydrogen demand, helping the development of the hydrogen market. Finally, as underlined in the Strategic Research and Innovation Agenda by Hydrogen Europe, 'the use of green hydrogen injection brings the important benefit of providing energy system flexibility and enabling sector coupling'.

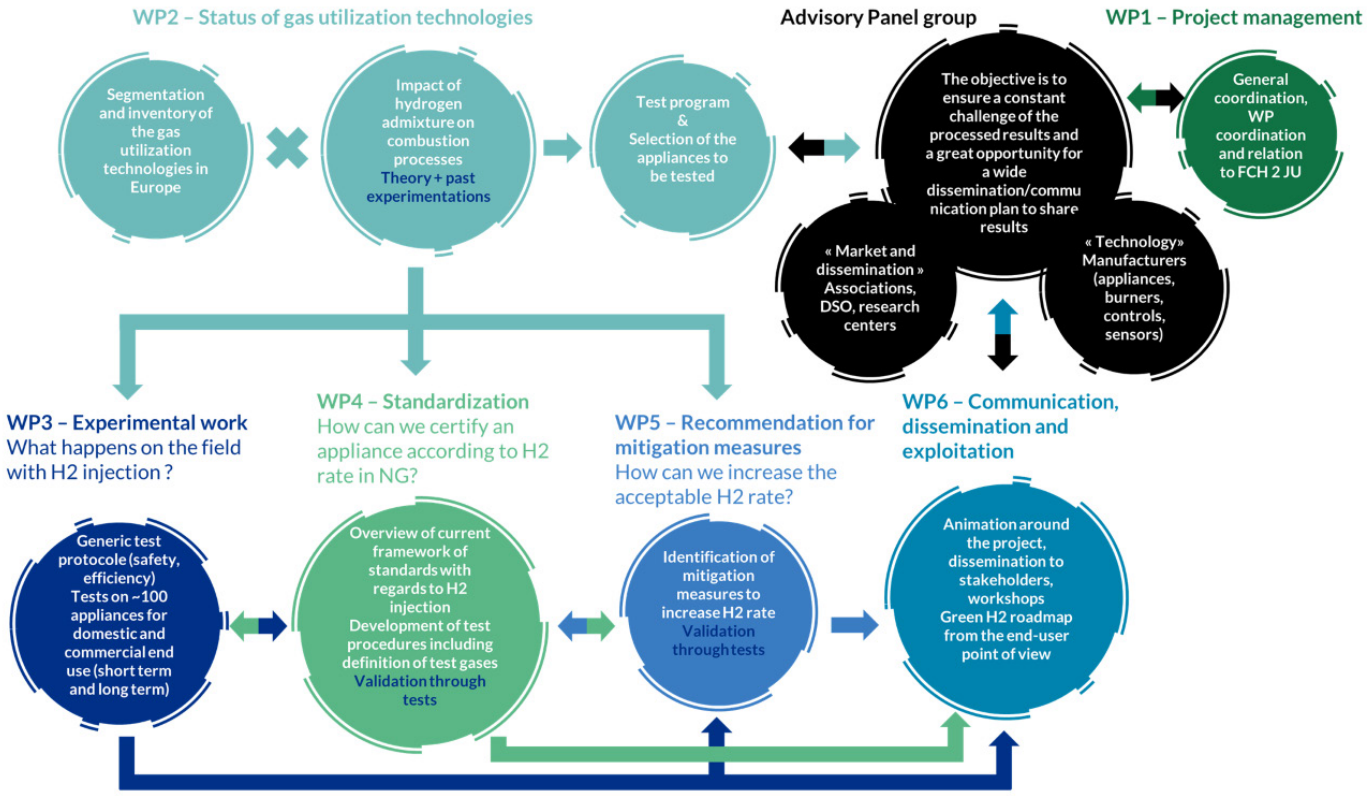
> *"The blending of hydrogen in the natural gas network at a limited percentage may enable decentralised renewable hydrogen production in local networks in a transitional phase. […] Blending also changes the quality of the gas consumed in Europe and may affect the design of gas infrastructure, end-user applications, and cross-border system interoperability."*
>
> - European Commission Hydrogen Strategy

However, the injection of hydrogen in a system designed to operate with natural gas requires a comprehensive assessment of the potential impacts. The THyGA project focuses on the end-user perspective: domestic and commercial gas appliances (space heating, hot water, cooking and catering), which account for more than 40% of the EU gas consumption.

The project covers technical and regulatory aspects. An experimental campaign on hydrogen tolerance tests will be performed, based on theoretical background from material science and combustion theory. Reports will be produced on rules and standards regulating H2NG blends for gas appliances (the status quo and potential future developments), and finally on mitigation strategies for coping with high levels of hydrogen admixture.

By this approach, the project will determine how different levels of hydrogen blending impact the various appliance technologies, and identify the regime in which a safe, efficient, and low-polluting operation is possible.

The Structure of the Project



The THyGA team at the Kick-Off meeting in GERG Brussels office

Combustion theory: impact of natural gas /hydrogen blends

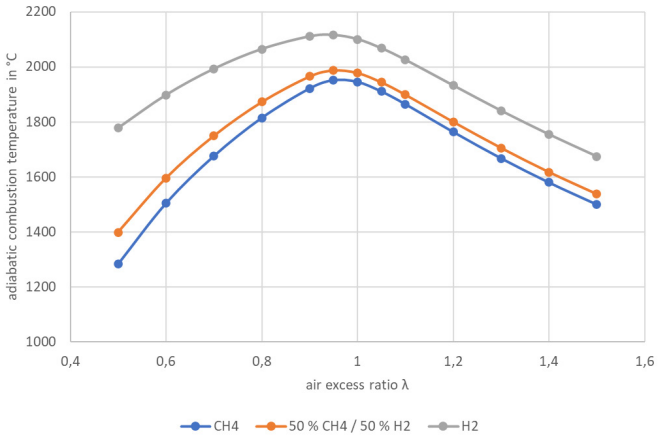
The impact of hydrogen blending on end-use appliances will mainly be a question of combustion.

To provide a high-level insight of the impact on combustion processes, the THyGA partners have produced an analysis based on combustion theory and literature reviews. This report addresses effects of hydrogen admixture on main gas quality properties, combustion temperatures, laminar combustion velocities, pollutant formation (CO, NOx), safety-related aspects, and the impact of combustion control.

The findings are available on the THyGA website.

One main finding for many common situations found in some of the residential appliances is that different effects of hydrogen may compensate each other to a certain degree. For example, in uncontrolled residential combustion systems (which comprise the large majority of the residential appliance population in the EU), hydrogen admixture will result in a shift of the air excess ratio towards higher values, which will largely counteract the increase of the laminar combustion velocity and combustion temperatures due to the presence of hydrogen.

This overview provides a basis for the next steps of the project: setting up of the testing program and recommendations for mitigation strategies to reduce potential negative consequences of hydrogen admixture on appliances.

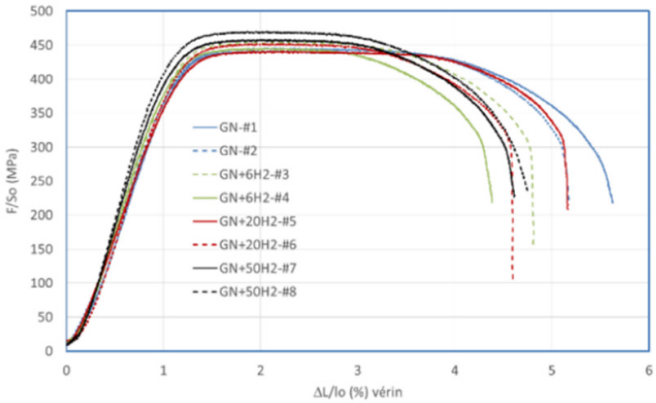


Adiabatic combustion temperatures of CH4, 50 % CH4 / 50 % H2 and H2 as functions of the air excess ratio, with air as oxidizer.

Hydrogen embrittlement and tightness issues

When adding a natural gas and hydrogen mixture into a gas distribution network, impacts non-related to combustion have also to be considered: hydrogen embrittlement of metallic components, chemical compatibility with other materials, and leakage concerns.

These issues are tackled in a bibliographic report by the THyGA project.



Tensile curves results for pure coper alloy on smooth specimens (Briottet and Portra, 2017).

Concerning hydrogen embrittlement, the main findings indicate that a gas mixture composed of natural gas and up to 50% hydrogen should not be problematic for any of the metallic materials employed in domestic and commercial installations, unless high mechanical stress or strain and high stress concentrations are applied. Furthermore, investigation on chemical compatibility have shown that polymer materials, and specifically polyethylene, are not subjected to deterioration after long term exposure in dihydrogen. Leakage figures for hydrogen are also presented in the report: due to different physical properties, hydrogen leaks 2.5 times quicker than methane.

The next step aims to evaluate experimentally the tightness of the components located on the gas line within the building. THyGA members gathered a large variety of components from several countries (France, Germany, Denmark, Belgium), both old and new; they will be assembled and go through a 2 years trial at CEA premises.

Experimental work Testing Protocol

Cooperation: sourcing of appliances

The test program of the THyGA project relies on an accurate estimation of the composition of market by type of appliances, that allows the selection of test appliances representative of those installed in European homes and businesses and taking into account new technologies on the way.

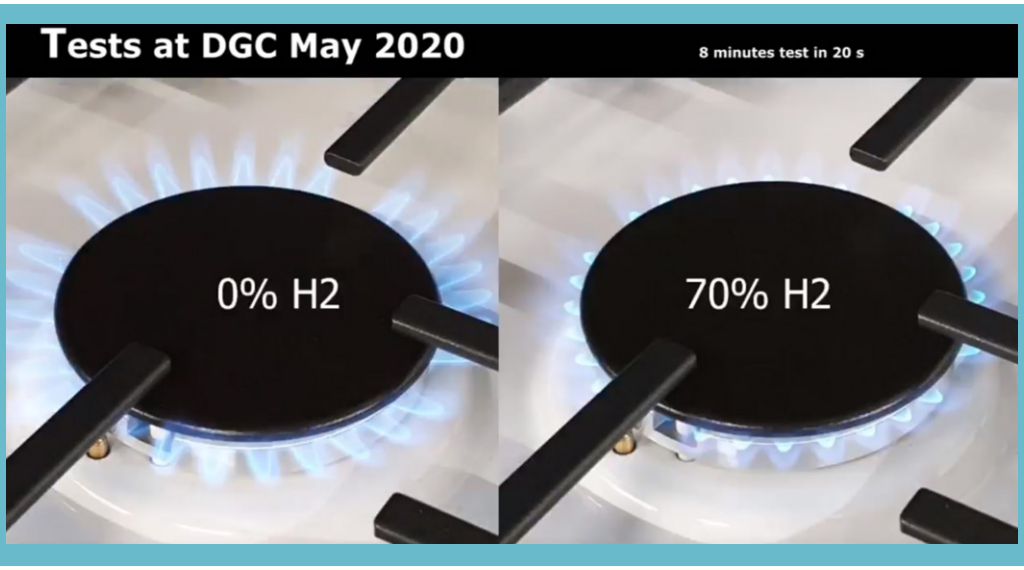
The choice of appliances to test is made in a collaborative manner, involving all labs participating in the project and the members of the THyGA Advisory panel. The Advisory panel includes European and International Associations, DSOs, and manufacturers, who also contribute their equipment for the experimental work.

The tests have started !

The testing has started, and the first results are showing the complexity of some of the phenomena linked to the presence of hydrogen in the gas mixture. One of the expected effects of the H_2 is the increase of sensitivity to flashback. However, flashback may not appear instantaneously and may be the combined effect of flame features changes due to H_2 and e.g. increasing temperatures at the burner surface under certain circumstances.

The chosen testing procedures need to consider those phenomena and we have so far used many resources to adapt and correct the original protocol, with the results of the first testing. There is no doubt that this iterative process will continue for a while in the light of test data and observations, in coordination with all stakeholders.

Given the complexity and differences of use cases (cooking, heating, catering…), the test protocol will be continuously improved throughout the project.



Demonstration video from THyGA tests:

Impact of the injection of hydrogen on the flame of a cooking hob

Watch the video

Impact on the current certification and standardisation framework

An analysis of the European current certification and standardisation frameworks and the way they are impacted by hydrogen admixtures is nearing completion. The objective is to define how the existing methodology can be adapted to account for the new or changed risks.

This THyGA analysis is being submitted for review to CEN TC238 and the gas appliances regulation exchange platform. The project will define any additional tests that may be required, appropriate (additional) limit gases, and eventually an additional or revised reference gas.

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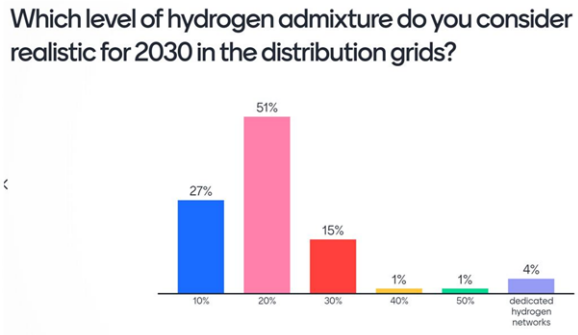
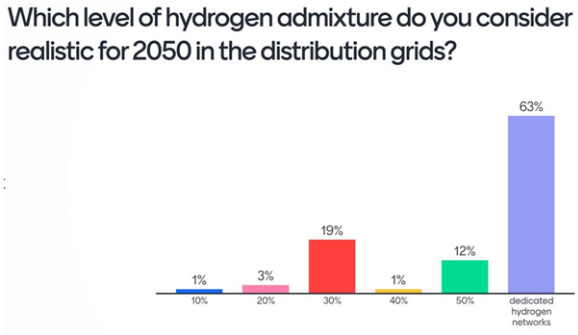
First THyGA workshop

THyGA held its first online workshop on the 6th of May, successfully gathering around 100 stakeholders for a very lively discussion.





The workshop was aimed at presenting first research results, methodology and discussing the specific consequences of hydrogen blending for the gas appliances sector, with the participation of researchers, manufacturers and associations.

Slides from the event are available here.

Upcoming THyGA Workshops

The THyGA team will organise two thematic workshops in October, to share the main findings of the project and provide a views exchange. The workshops are open to all - please register following the links below!

Materials Science

OCTOBER 26TH, 10-12 AM CET

Impacts of hydrogen blends non-related to combustion: Hydrogen embrittlement of metallic components, chemical compatibility with other materials, leakage concerns.

Register here!

Combustion theory

OCTOBER 30TH, 10-12 AM CET

Impact of hydrogen admixture on residential and commercial combustion processes: gas quality, combustion temperatures, laminar combustion velocities, safety, combustion control.

Register here!

If you want to stay informed about the activities of the THyGA project, please email contact_thyga@engie.com

THyGA Members

BDR THERMEA GROUP, cea, DGC Danish Gas Technology Centre, DVGW, Electrolux, ENGIE, gas.be, GERG The European Gas Research Group, gwi

"The THyGA project has received funding from the Fuel Cells and Hydrogen Joint Undertaking under grant agreement No. 874983. This Joint Undertaking receives support from the European Union's Horizon 2020 research and innovation programme, Hydrogen Europe and Hydrogen Europe research."