THyGA

Testing Hydrogen admixture for Gas Applications

Work Package 2

Status of gas utilisation technologies – impact of hydrogen admixture and design of testing programme for devices

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.

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Task 2.3: Impact of hydrogen admixture on combustion processes – Practice

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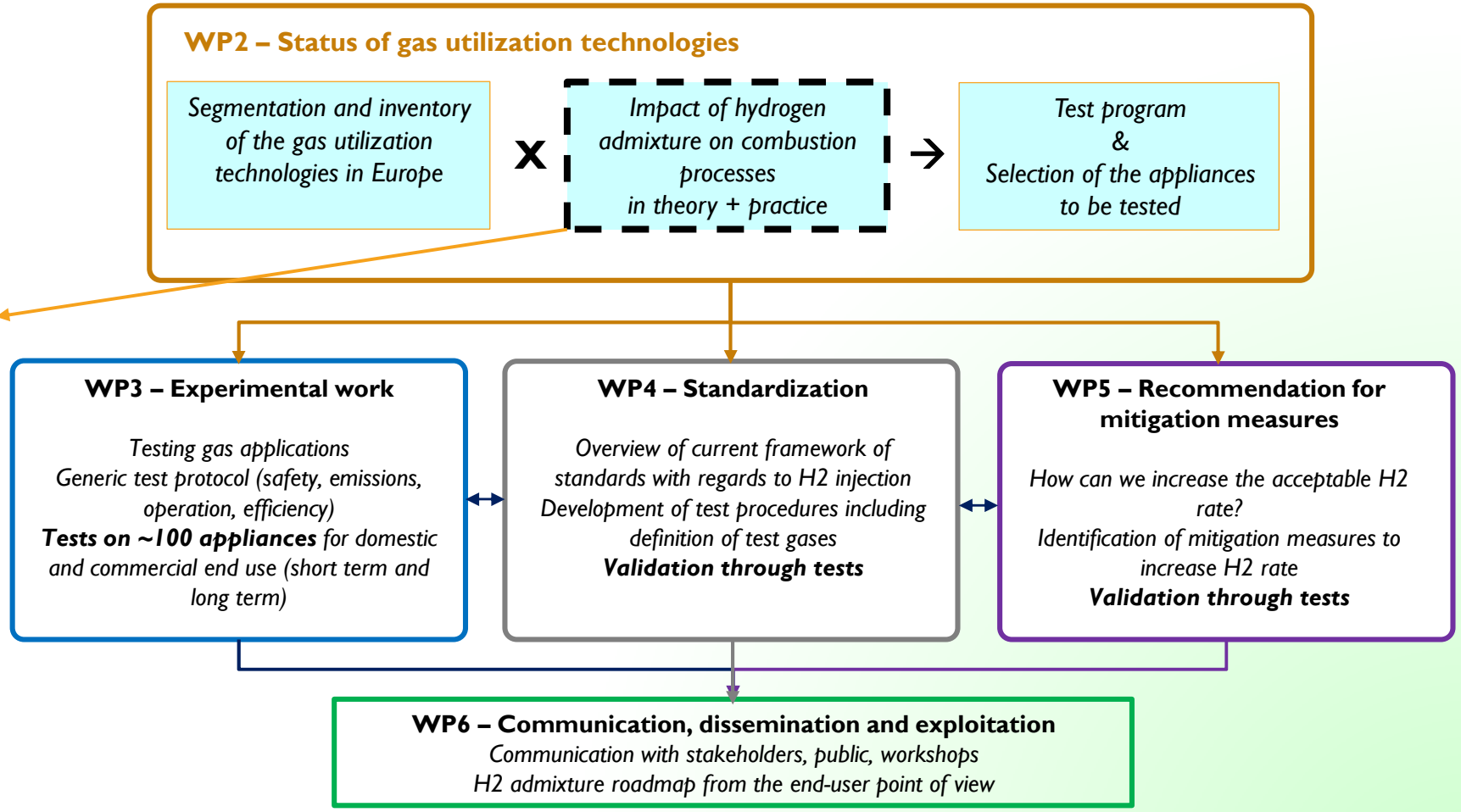
OBJECTIVES

An extensive literature analysis to study the impact of hydrogen admixture in natural gas on combustion, operation, safety, efficiency and emissions

- The key results and conclusions relevant for THyGA will be:
- reviewed by partners and shareholders from the advisory panel
- summarized by developing a matrix to provide the readership a comprehensive and compact overview of the status of hydrogen tolerance in practice
- published online within a publicly available deliverable summer 2020



PARTNERS

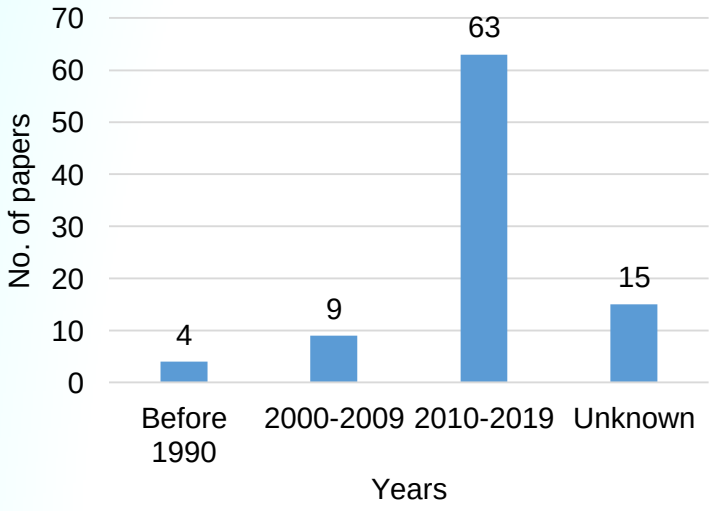
Work Package Lead	GWI
Task 2.1 – Market Segmentation	GWI, ENGIE, DGC, GAS.BE, DVGW-EBI
Task 2.2 – Impact of H2 in Theory	GWI, ENGIE
Task 2.3 – Impact of H2 in Practice (& Projects) fff	**GWI, ENGIE, DGC, GAS.BE, DVGW-EBI**
Task 2.4 – Embrittlement and Tightness	CEA
Task 2.5 – Development of Testing Programme	GWI, ENGIE, DGC, GAS.BE, DVGW-EBI, CEA, BDR, ELECTROLUX
Task 2.6 – Selection of Appliances to Test	GWI, ENGIE, DGC, DVGW-EBI, GAS.BE, CEA

STATUS AND METHOD

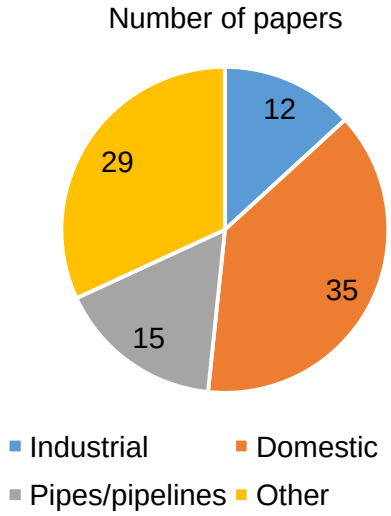
- Up to now > 100 references have been collected by the THyGA partners. Documents were reviewed and summarized, covering a variety of topics and outcomes.
- Major projects: DOMHYDRO, NATURALHY, GRHYD, Ameland, HyGrid, HyDeploy, Hy4Heat, GasQUAL, MATHRYCE,HIPS, etc. … in total 91 papers and counting were included.
- 5 Categories were defined for summarising the knowledge on the impact of H_2 admixture on:
  1. Safety [CO; flash back; H_2 leakages; overheating; other]
  2. Appliance types
  3. Appliance reliability [Lifetime and impact on materials]
  4. Efficiency
  5. Emissions [CO_2; NO_X]
- Focus on reports on H_2 admixture tests/measurements
- The key results are being sorted according to the appliance types and the admixture level of H_2.
- A matrix presenting the most central information is being developed.
- The work is in progress and will be finalised by summer 2020 (available on THyGA website)

EVALUATION OF THE LITERATURE REFERENCES – FIRST INSIGHTS

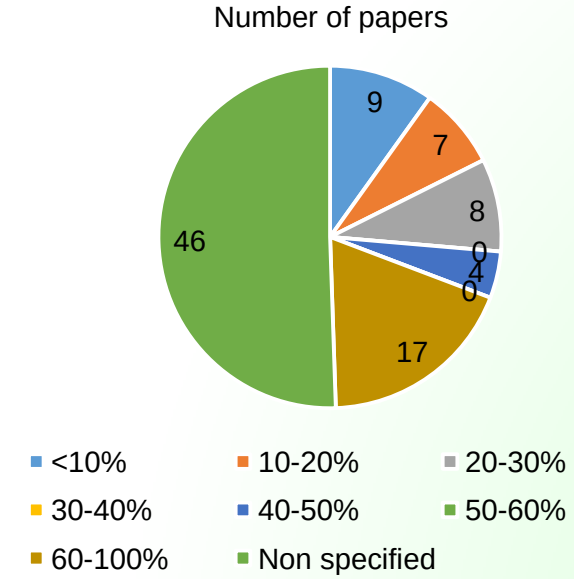
Year



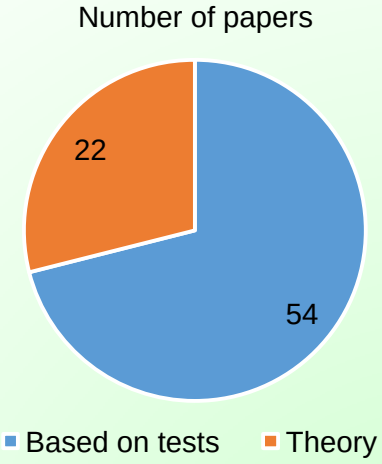
Context



H_2 Admixture level

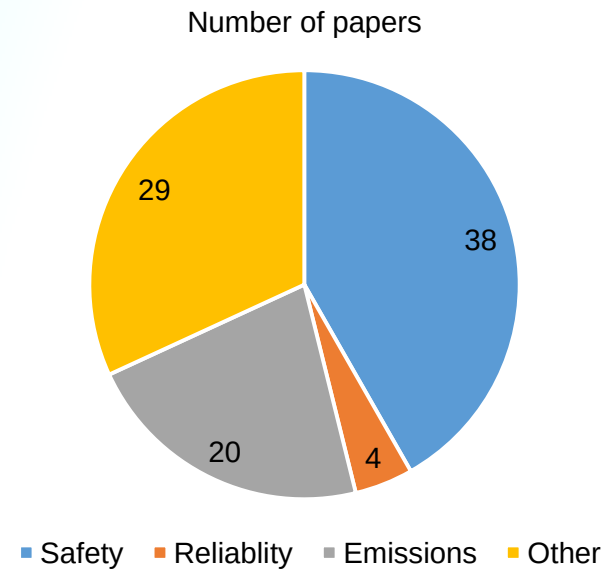


Method

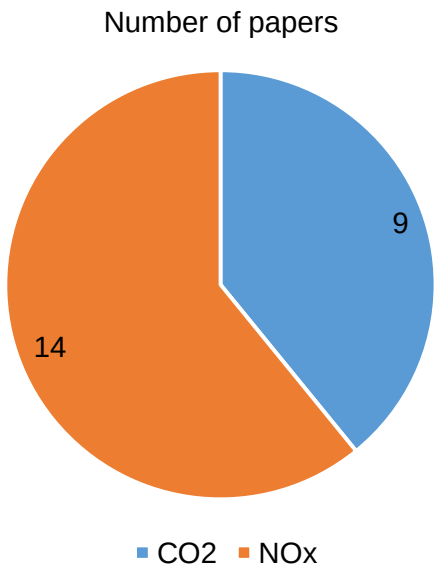


EVALUATION OF THE LITERATURE REFERENCES – FIRST INSIGHTS

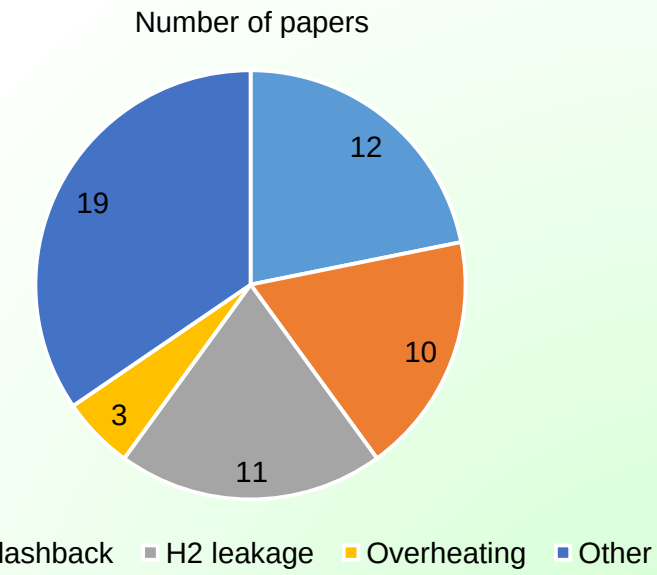
Aspect



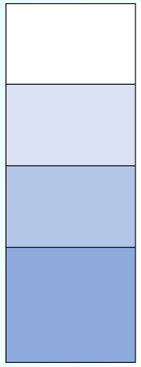
Emissions



Safety



FIRST RESULTS FROM LITERATURE



no references available

good

ok: only after technical adjustment or adaptation

acceptable: only after technical adjustment or adaptation

The **white** cells means that there were no information found in the reviewed literatures.

The **blue colour gradient** shows the compatibility of the appliances with increasing the percentage of admixture H_2 in NG:

The light blue means it is **compatible**.

The dark blue means it is **not compatible**.

In between means **software** and/or **hardware adjustments** may be needed.

Technology	H_2 %	Criteria							
		Safety				Reliability	Efficiency	Emissions	
		CO	Flashback	H_2 leakage	Overheating			CO_2	NOx
Boilers	<10								
	10-30%								
	30-60%								
	>60%								
Water heaters	<10%								
	10-30%								
	30-60%								
	>60%								
Fires and other	<10%								
	10-30%								
	30-60%								
	>60%								
Cookers/Catering	<10%								
	10-30%								
	30-60%								
	>60%								
GHP&CHP (ICE)	<10%								
	10-30%								
	30-60%								
	>60%								

FIRST RESULTS FROM LITERATURE

Boilers:

CO decreases; *Flashback* no problems reported, with the fuel rich app. problems can occur; *Leakage* no problem (<2bar); *Overheat* depends on the burner but no major problems; *Reliability* no problems; *Efficiency* very little effect, reduced heat output the higher the H2 % is; CO_2 *emissions* decrease and *NOx* emissions (increase) but decrease with increased air ratio.

Water heaters:

CO no problems; *Flashback* no flashback, with the fuel rich app. problems can occur; *Leakage* no info; *Overheat* no info; *Reliability* no info; *Efficiency* no efficiency losses till 10% H_2; CO_2 *emissions* no info, *NOx* emissions decrease in modern appliances.

Fires and others:

CO slightly lower; *Flashback* no flashback up to 25% H_2; *Leakage* no info; *Overheat* the higher the H_2%, the burner surface temp. Increases; *Reliability* no info; *Efficiency* small decrease in Wobbe index; CO_2 *emissions* decrease, *NOx emissions* (increase) but decrease with increased air ratio.

Cookers:

CO decrease; *Flashback*: no flashback up to 25% H_2, fuel rich app. problems can occur; *Leakage*: no problems; *Overheat* the higher the H_2%, the burner surface temp. Increases; *Reliability* no info; *Efficiency* small decrease in Wobbe index;CO_2 *emissions* decrease, *NOx emissions* (increase) but decrease with increased air ratio.

GHP, CHP:

CO decreases; *knocking (flashback)* no problems; *Leakage* no problems; *Overheat* no info; *Reliability* no info; *Efficiency* no info; CO_2 *emissions* decrease, *NOx emissions* (increase) but decrease with increased air ratio.

CONCLUSIONS FROM THE FIRST RESULTS

- No general conclusion according to reviewed literature references can be made.
  - Different boundary conditions that are not applicable to all appliances in the same way
  - Different technologies considered in the surveys but the results not always differentiate in a precise way the impact on each technology – general statements
- Most of tested appliances showed no technical problems with hydrogen mixtures up to 20%
- For atmospheric and premix burners different behaviour is reported. Deeper analysis of included literature will focus on these details in the next weeks
- Combustion technology in an appliance has a huge impact on H_2 in terms of efficiency, safety, performance and emissions but less references to these topics were available for the investigated appliances to different hydrogen admixtures, especially in case of flashback and overheating
- The literature was focused on short term test, hardly any results found for the long-term effects of high hydrogen blends
- Further experimental work needed for all the appliances within the same boundary conditions; a high potential for the ongoing project THyGA

DISCUSSION

- Unsatisfactory number of literature references were available for the topics reliability, overheating and H_2 leakage.
- Cooking devices as well as ICE-based appliances and FCs broadly under-represented
- Impact of combustion control insufficiently clarified (fixed volume ratio vs. fixed air ratio)
- Identified literature in many cases not from peer-reviewed journals

THyGA

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Thank you!

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