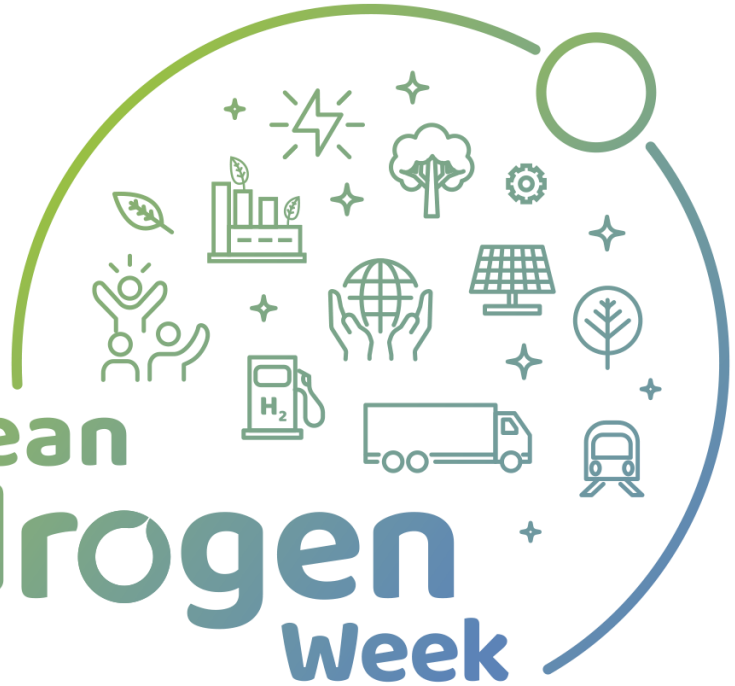
Testing Hydrogen admixture for Gas Applications

THyGA



Speaker Patrick Milin
ENGIE

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FCH

European Commission

Project Overview

- Call year: 2019
- Call topic: FCH-04-3-2019 - Hydrogen admixtures in natural gas domestic and commercial end uses
- Project dates: January 2020 – December 2022
- % stage of implementation 01/11/2021: 60%
- Total project budget: 2.5M€
- FCH JU max. contribution: 2.5M€
- Other financial contribution: 0
- Partners: BDR Thermea, CEA, DGC, DVGW-EBI, ELECTROLUX, ENGIE, Gas.be, GERG, GWI

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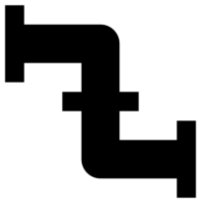
Project Summary

Context: Hydrogen, along with green electricity from wind and solar power, provides a pathway to decarbonise the European energy systems. Hydrogen blending in the gas grid would reduce the carbon footprint of gas utilisation, contributing to an overall reduction of greenhouse gas emissions.

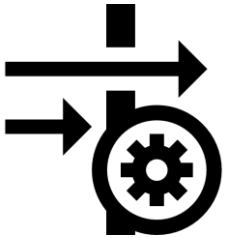


HYDROGEN INJECTION IN THE GAS GRID

One way to use hydrogen as an energy vector is to inject it directly into the existing natural gas grids.

INCREASED LEVELS OF HYDROGEN

End-use equipment across all sectors need to deal with higher levels of hydrogen in natural gas in a safe, efficient and environmentally friendly way.



NEW CHALLENGE FOR END-USE EQUIPMENT

Hydrogen is not part of natural gas compositions, i.e. existing equipment was not designed with hydrogen in mind.

200 MILLION GAS APPLIANCES

There are an estimated **200 million gas appliances installed in the European residential sector alone**

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Project Summary

Objectives and expected results

CLOSE KNOWLEDGE GAPS

Closing knowledge gaps regarding **technical impacts on residential and commercial gas appliances**.

IDENTIFY STANDARDS TO MODIFY

Identify standards that should be adapted to answer the needs for new appliances and proposals on test gases.

CLARIFY THE ACCEPTABLE HYDROGEN PERCENTAGE

Clarify the acceptable hydrogen percentage that wouldn't compromise **safety and performance**.

Project Progress/Actions

Understanding the available knowledge on the impact of H_2NG blends on end-use appliances

Achievement to-date

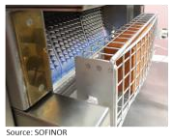
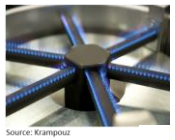
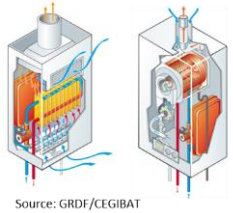
Many initiatives and projects without common methodology

25% 50% 75%

Identification of differences and incomplete knowledge

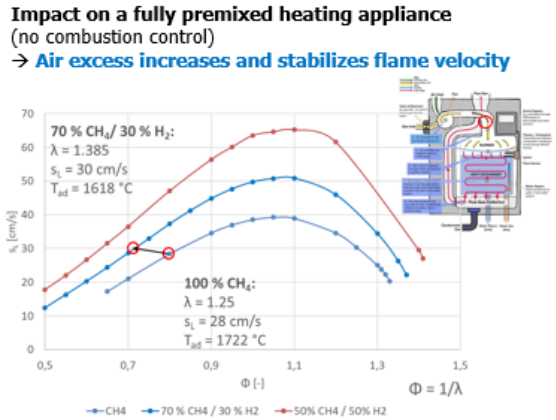
Segmentation of the portfolio of residential and commercial appliances in Europe



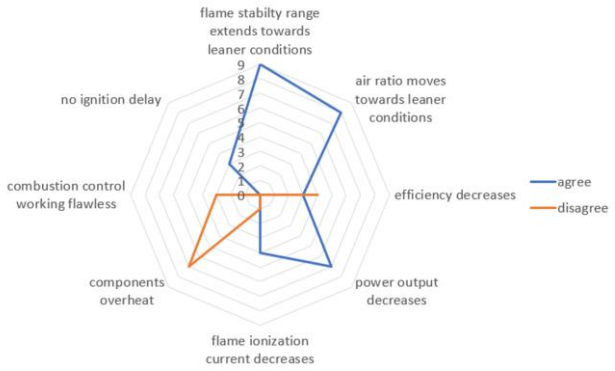




Source: GRDF/CEGIBAT

Background of **combustion theory for hydrogen admixtures**.



First assessment of potential hydrogen impacts based on experts view and literature study.



Prioritization of the appliance market segments for representative testing.

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Project Progress/Actions

Testing and results provided to the stakeholders

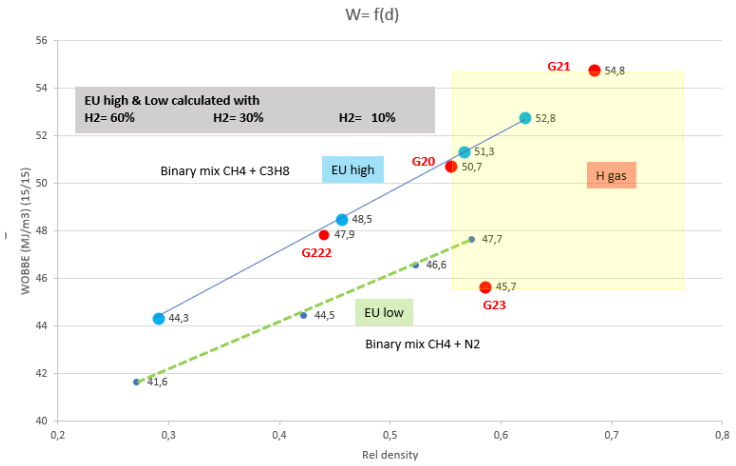
Achievement to-date

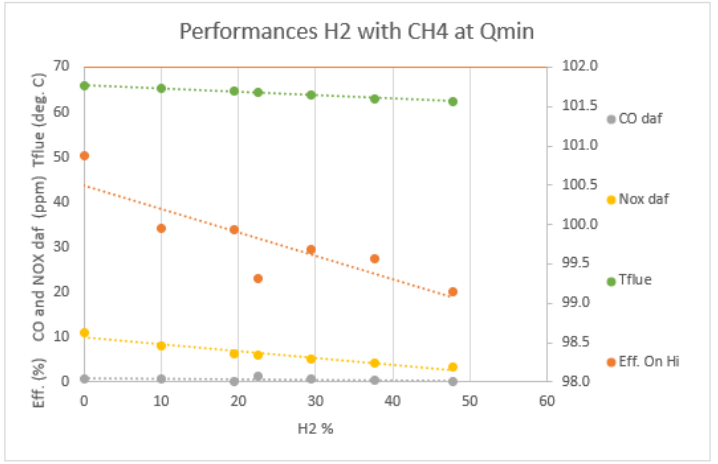
Around 90 appliances to test

25% 50% 75%

knowledge provided to stakeholders regularly

- So far, **35% of the appliances tested**: condensing and atmospheric boilers, cooking hobs, ovens, fires, catering
- Generally, when H_2 % is increasing: Efficiency is not significantly impacted, NOx tend to decrease, CO can or not be impacted





Overview of main results

- **The atmospheric technologies tested so far have been able to cope with 30**% of H_2. Above 30%, potential issues of flashback and high temperature due to a change of combustion properties (cooking hobs).
- The principal reason for issues for the **premix appliances** is the adjustment. If we consider that this can be solved, most appliances will have no problem anymore and **can burn gas with at least 40% H_2.**

Project Progress/Actions

Overview of the current standardization/certification framework

Achievement to-date → Current standardization framework → Description and identification of issues

25% 50% 75%

H_2 and **H_2NG** are **in the scope of Gas Appliances Regulation** (EU) 2016/426

Current certification approach

APPLIANCE USE	APPLIANCE CERTIFICATION	
WORKING CONDITIONS	TEST CONDITIONS	
DISTRIBUTED GAS	TEST GASES	+ TESTS + REQUIREMENTS

Test gases are defined by **EN 437** elaborated by CEN/TC238

Objective	Name	Composition	W_s
Reference	G20	100 % CH_4	50,72
Incomplete combustion + sooting	G21	87 % CH_4 + 13 % C_3H_8	54,69
Light back	G222	77 % CH_4 + 23 % H_2	47,87
Flame lift	G23	92,5 % CH_4 + 7,5 % N_2	45,66
Overheating	G24	68 % CH_4 + 12 % C_3H_8 + 20 % H_2	52,09

Example with H group

Main conclusions

- H_2NG supply may compromise an existing appliance's conformity to a significant number of essential requirements
- Existing appliances did not have to be designed for H_2NG supply ⇒ H_2NG supply cannot be considered as 'normal use' ⇒ no product liability by manufacturer

What is going-on regarding standardization?

- Already several Initiatives from notified bodies and CEN Technical Committees on H_2NG certification
- Results from THyGA testing programme will be provided to CEN TCs and manufacturers as Technical guidelines to support standardization activities

Risks, Challenges and Lessons Learned

Impact of covid-19 pandemic on planning

- Many meetings, internally or externally, that ensured a **strong visibility** for THyGA (but also **time-consuming**)
- Delays in some tasks, especially finalization of deliverables but without impact on other tasks and **quality has been enhanced**
- **Delays on the start of the tests** for some Labs → risk on the planning (but all mitigation measures are taken to cope with it)

Kick-Off meeting, only « physical » meeting for the project in 2 years

Risks, Challenges and Lessons Learned

A fast-moving environment requiring a lot of flexibility

- CEN TCs starting to work on "H_2 ready" certification
- "H_2 ready" concept discussed in regulation for Energy-related Products (ErP): Ecodesign & Labelling
- Manufacturers H_2 roadmaps pushed by the "Primemovers" initiative
- DSO / TSO clearer about possible H_2% in the gas grid (up to 20 - 30%)

Example of consequences for the project

➡ **READJUSTING THyGA testing to give the best value to the industry (focus on 0 to 30% H_2)**

➡ **ADAPTATION of the content and objective of the WP4 to best suit the needs of the stakeholders**

Exploitation Plan/Expected Impact

Exploitation

- 80% of the deliverables are public
- Around 40 advisory panel members + ~25 manufacturers providing appliances for tests + links/liaisons with 10 CEN Technical Committees + panel of "external Labs"

- The project already organized ~10 public or technical workshops to discuss our methodology and analysis of the first results. Presentation of the project's progresses during TC meeting (TC109, TC49, TC106, etc.) → The goal is to make sure that the created knowledge is used directly by relevant stakeholders

- Strong link with the GENR CEN PNR project (WP8)

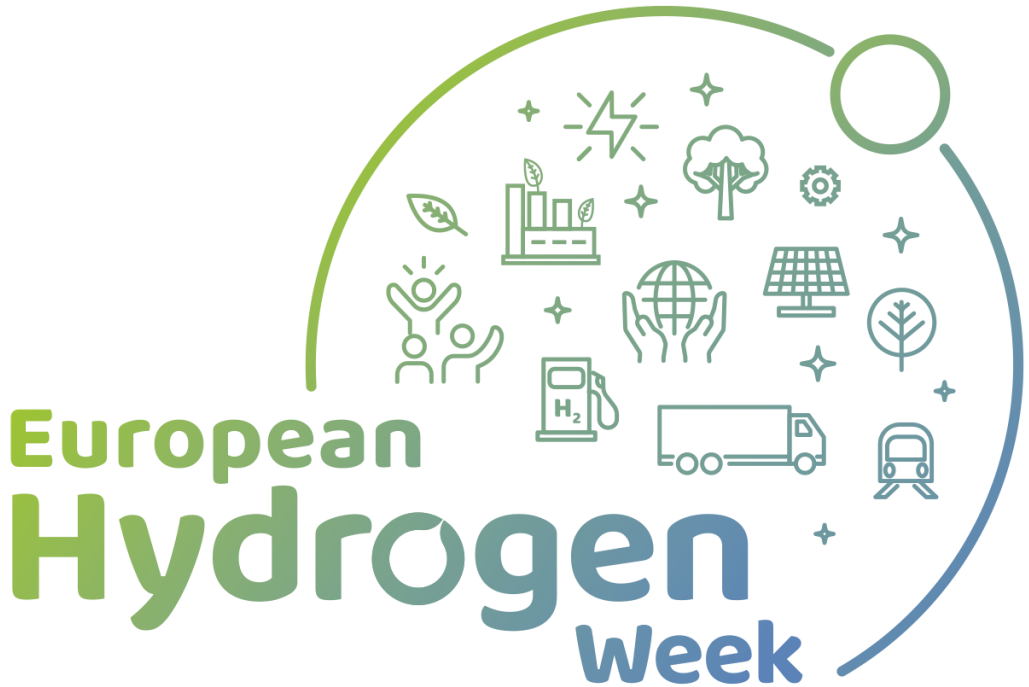
- "Green Hydrogen" for Europe roadmap in link with other EU projects (Higgs…)

Impacts

- Establishing how the existing certification shall be modified to allow higher concentrations, including the related additional costs and the required changes to common gas burners

- Recommendations for revision of EN or ISO standards or drafting of new standards based on PNR results and a review of the existing testing methods

- Improved knowledge on the effect of H_2NG on common burner types including necessary adjustments and design changes. This will help the industry to bring on the market appliances that will accept H_2NG.



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Optional Slides

WP3 Test program

TESTING PROGRAMME & Instructions

1.1 SAFETY- with CH4
1.2 SAFETY- with EULOW
1.3 SAFETY- with G23
1.4 Cold start.
1.5 Hot start.
1.6 Low air temperature (- 10 C)
1.7 Flue gas pipe length
1.8 ROC (PLUGG FLOW)
1.9 Impact of H2 on flame detection.
1.10 Flashback analysis.

2 Merged test
3.1 ADJUSTMENT A
3.2 ADJUSTMENT B
3.3 ADJUSTMENT H
3.4 ADJUSTMENT G
4.1 Delayed ignition test.
4.2 Soundness
4.3 Quick variation Qmin-Qmax Shut-off
4.4 Overheat. Meas. of temp.
4.5 Cooker hob test with 4 burners on
4.6 Influence of wind
4.7 Long term (limited time)
4.8 Fluctuation of the aux. energy
4.9 Fluctuation of pressure
4.x Other test

PRACTICAL information and instructions

1. Few abbreviations used
2. Overall chronology. Testing: before, during, after
3. Document DATA Sheet
   - 3.1 Introduction DOCUMENT "DATA SHEET"
   - 3.2 Document DATA SHEET Content
   - 3.3 Overall instructions to fill in sheets
   - 3.4 Nomenclature for saving datasheet files names
   - 3.5 Test programme. Standard Test & additional tests
   - 3.6 Sheet TEST PROGRAMME
   - 3.7 Sheets EU Low and EU high (Gases)
   - 3.8 Gases parameters calculation (for each test)
   - 3.9 Sheet DATA SHEET: Overall colour code
4. Testing
   - 4.1 Overall Test conditions Sheet "STANDARD TEST CONDITIONS"
   - 4.2 Flashback
   - 4.3 Instructions to perform the test following the sheet "DATA SHEET")
5. Open questions
6. Annexes

Optional Slides

WP3 Test program: focus on adjustement

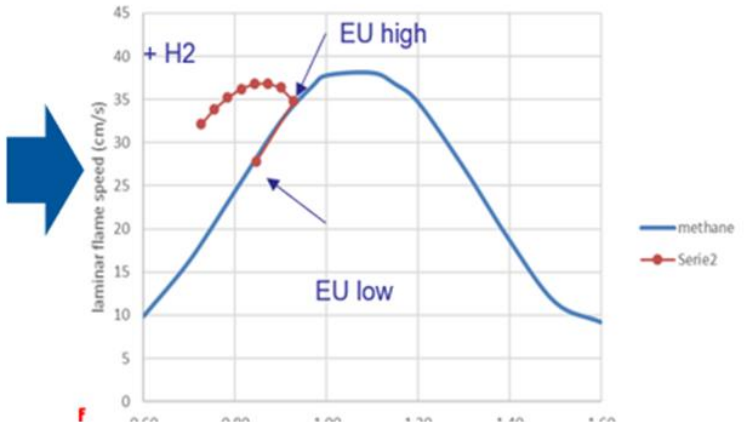
Adjustement is an issue for premix boilers (and other segments?)

a) ADJUSTMENT EU HIGH -> Gas used= EU LOW + H2

b) **ADJUSTMENT EU LOW -> Gas used= EU HIGH + H2 (this test is the most critical for appliances that can be adjusted)**

c) ADJUSTMENT EU LOW + 20% H2 -> Gas used= EU HIGH + H2

d) ADJUSTMENT EU High + 20% H2 -> Gas used= EU low + H2



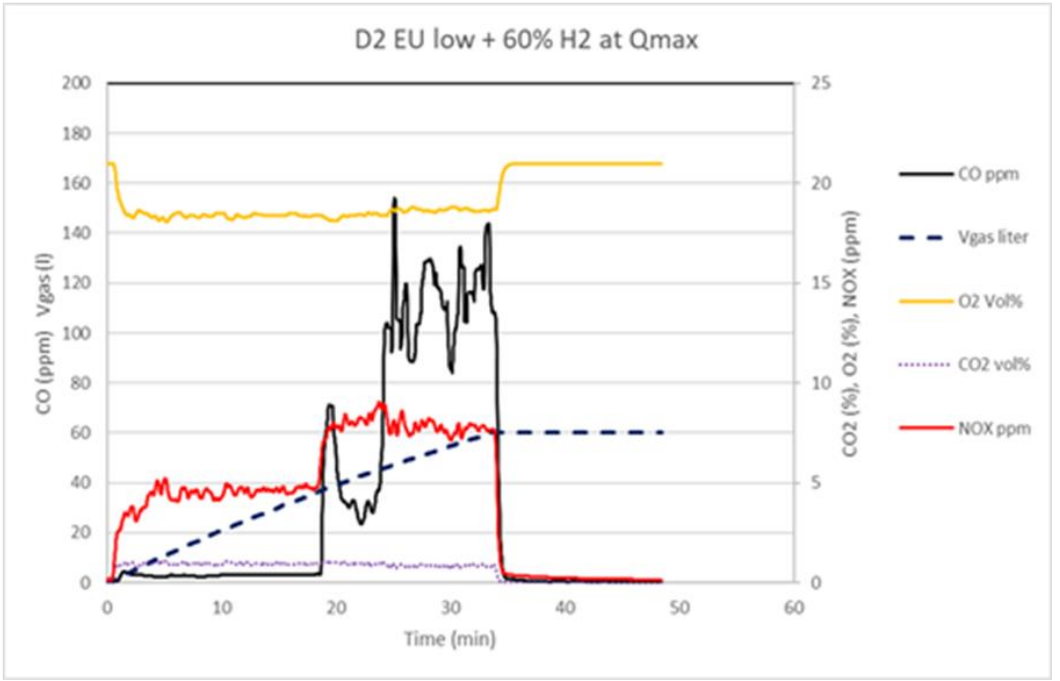
Identification of the most critical adjustement (peak of CO)

CASE	EULOW + 10, 20, 30% H2	EU low +0 to 60% H2	CH4	EU high + 20% H2	EU high + 0 to 60% H2
G	Adjusted →				Used

Consequence on the market: installers would need to be able to assess the % of H2 in the grid during installation and maintenance

Optional Slides

WP3 Test program: focus on flashback



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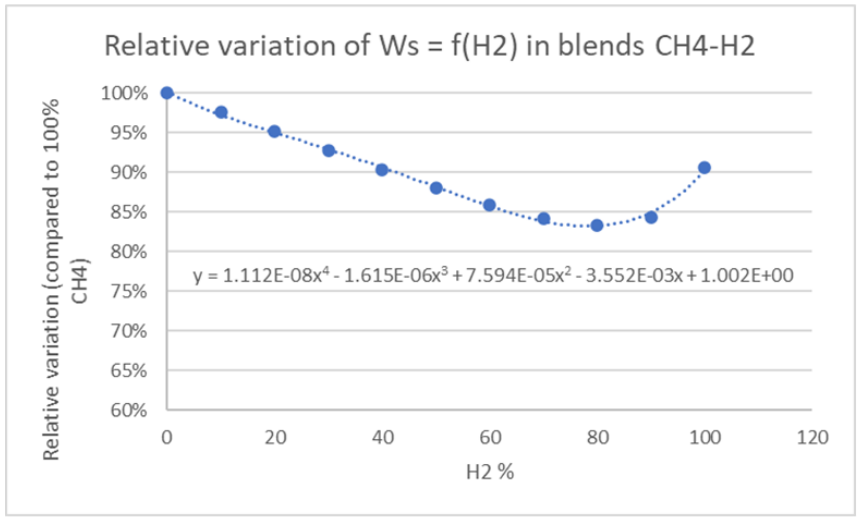
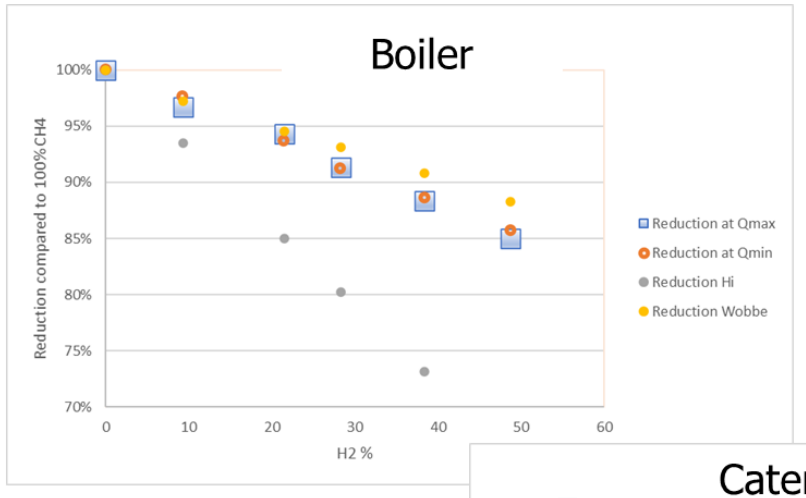
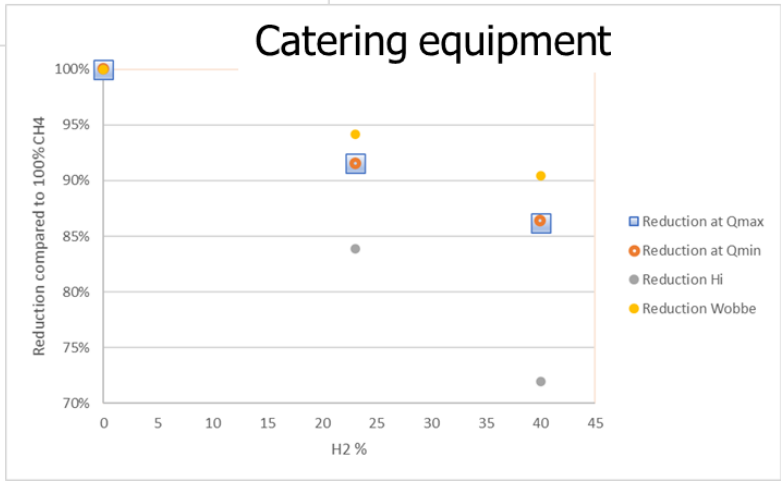
Optional Slides

WP3 Test program: focus on heat output

Impact on heat output

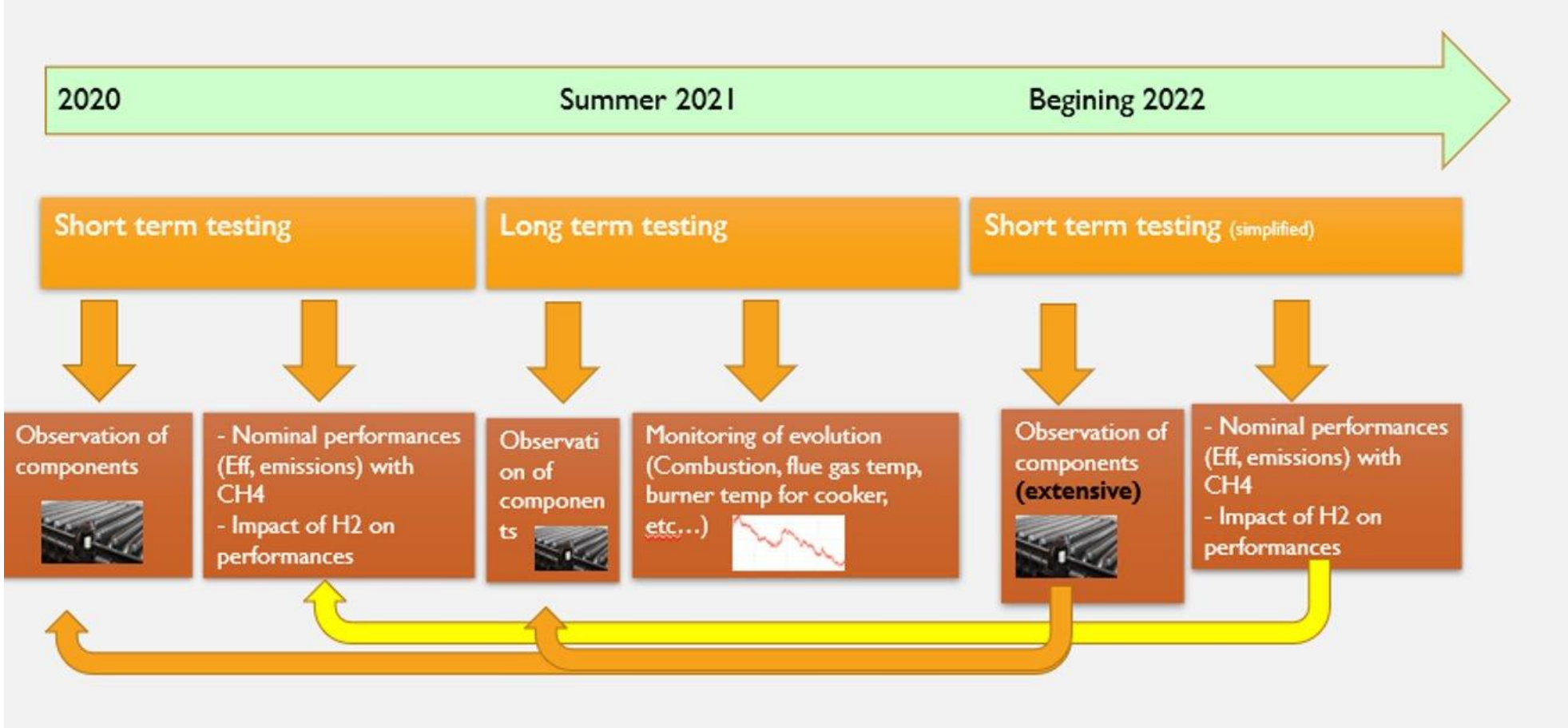






Optional Slides

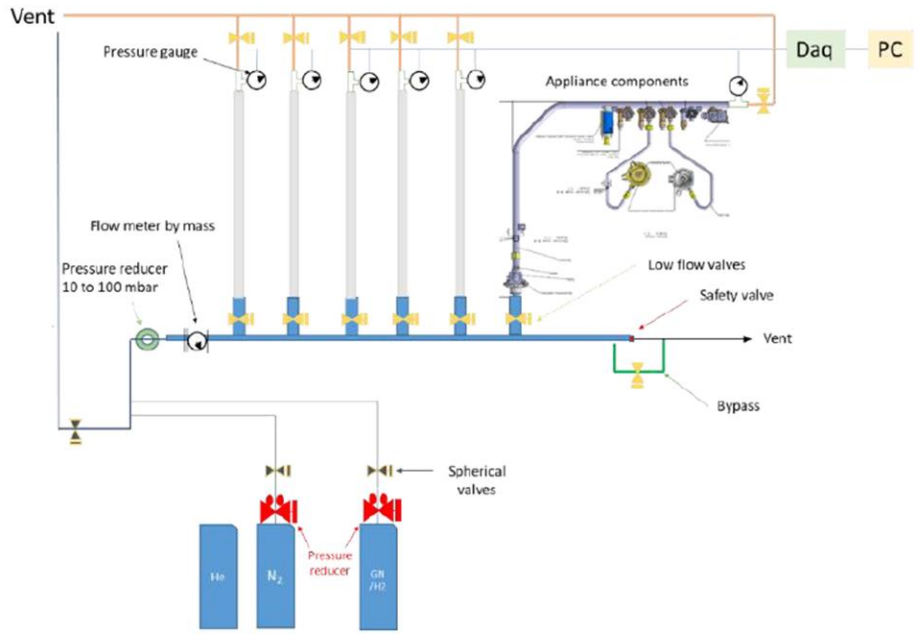
WP3 Long term tests



Optional Slides

WP3 Leakage tests

Test rig structure



Assembly lines

Old components gathered from THyGA partners: DGC (Denmark), ENGIE (France), GWI (Germany) and DVGW.EBI (Germany).

New components from appliance manufacturers

STATIC METHOD: the installation would be filled with the gas mixture (60%CH4+40%H2) to a given pressure and closed.

- The pressure and temperature would be monitored along the whole test duration.
- A pressure drop would indicate the presence of a leak.

DYNAMIC METHOD: a gas flow would be imposed in the line to reach a determined pressure level.

- The measured flow necessary to maintain the required pressure level, would indicate and quantify a leak.

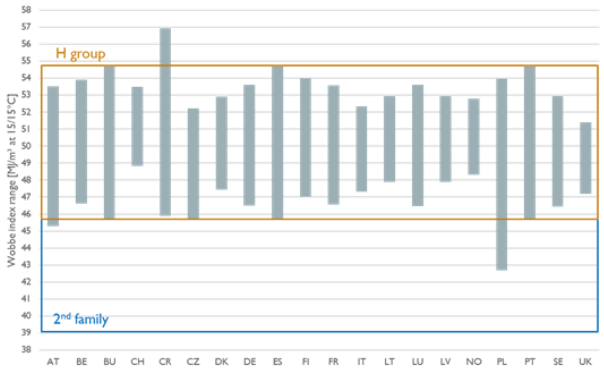
Optional Slides

WP4 Current standardization/certification framework

APPLIANCE USE

WORKING CONDITIONS

DISTRIBUTED GAS



TOWN GAS

NATURAL GAS

LPG

APPLIANCE CERTIFICATION

TEST CONDITIONS

TEST GASES + TESTS + REQUIREMENTS

TEST GAS STANDARD EN 437

1st gas family

2nd gas family

L group

H group

REFERENCE GAS G20

LIMIT GASES
G21 → incomplete combustion + sooting
G222 → light back
G23 → flame lift
G24 → overheating

E group

3rd gas family

APPLIANCE STANDARDS EN XXXX

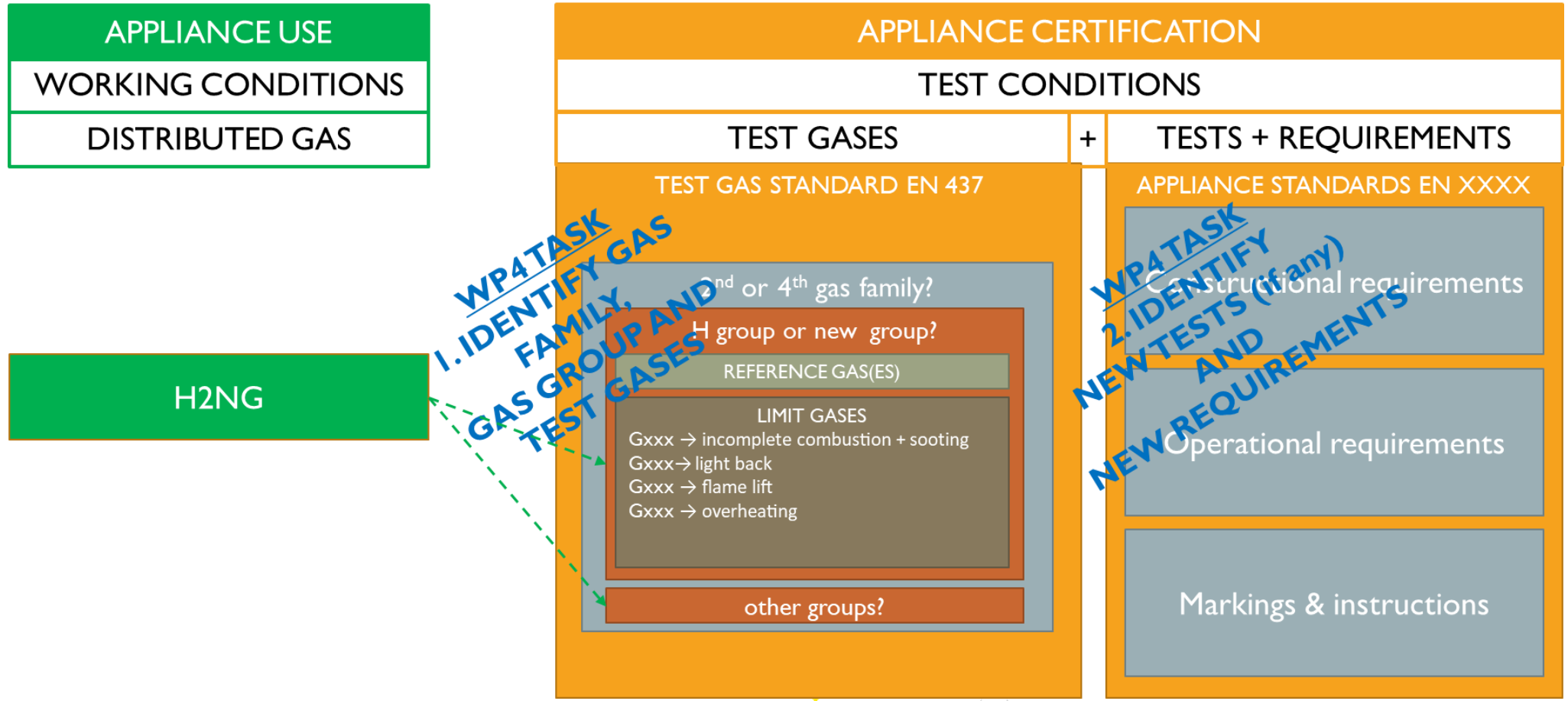
Constructional requirements

Operational requirements

Markings & instructions

Optional Slides

WP4 H_2NG INTEGRATION IN CURRENT APPROACH



Optional Slides

WP5 Methodology

- Preparation of a survey to the advisory panel members to gather information for D5.1 "Review on other projects related to mitigation and identification of usable sensors in existing appliances": the goal is to **understand the main orientations about mitigation and information about technologies planned to be used by stakeholders**
- The idea is to build the deliverable step by step, from different sources of information

Impact of H2NG blends on appliances	WP2 – Theoretical and « in practice » impacts of H2NG on appliances WP4 – Risk analysis
Criticity of appearance of phenomena	WP3 – Test results AP group feedback
Application to type of appliance	WP2 - Segmentation
Mitigation approach per step of %H2	According to European trends: Ecodesign review, Standardization activities

Communications Activities

VISIT THE THyGA WEBSITE

All public presentations and deliverables of the project will be available on the project website

thyga-project.eu

GERG LINKEDIN & WEBSITE

For regular updates, you can also follow the GERG LinkedIn page and website

GERG
THE EUROPEAN GAS RESEARCH GROUP

CONTACT EMAIL

Do not hesitate to contact us by email at contact_thyga@engie.com

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Dissemination Activities

- Organisation of thematic webinars (combustion theory, leakages and material science related to H_2NG blends, standardization…)
- THyGA Newsletter: distribution through GERG Mailing, Social media, THyGA and GERG websites; included in the FCHJU newsletter
- Publications, ex: 'THyGA Burning Bright', Global Voice of Gas by the International Gas Union, June 2021
- Around 10 participations to conferences/workshops (IGRC 2020, Wind meet Gas, ENTSOG PrimeMovers…)

Dissemination Activities

- **6 Public deliverables** (5 more to come by November 2021)
- Newsletters (subscribe!) and articles

- Replays of several workshops
  - ✓ **Kick off of the THyGA project**
  - ✓ **Impact of hydrogen admixture on combustion processes**
  - ✓ **Materials science – impacts of hydrogen blends**
  - ✓ **Standardization and certification of gas appliances in view of H2NG supply**

- 15th of December 2021: **General THyGA Workshop, showcasing the interim results**

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Synergies With Other Projects And Programmes

Interactions with projects funded under EU programmes

HIGGS
Hydrogen in Gas Grids

Interactions with national and international-level projects and initiatives

- CEN GERG Pre-Normative Research project

GERG
THE EUROPEAN GAS RESEARCH GROUP

Removing the technical barriers to use of hydrogen in natural gas networks and for (natural) gas end users.

Project Overview

Call year: 2019

Call topic:
FCH-04-3-2019 - Hydrogen admixtures in natural gas domestic and commercial end uses

Project dates:
[January 2020 – December 2021]

Total project budget:
4M€

Testing Hydrogen admixture for Gas Applications

% stage of implementation 01/11/2021: 60%

FCH JU max. contribution: 2.5M€
Other financial contribution: 1.5M€

European Hydrogen Week

Partners

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