


TF HYDROGEN
Brief overview

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TECHNICAL ASSOCIATION
OF THE EUROPEAN NATURAL GAS INDUSTRY

Gert Müller-Syring (DBI), Aurélie Carayol (GRTgaz), Hiltrud Schülken

Leaders *Secretary*

Agenda

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- **Background and Motivation**
- **Scope of work**
- **Mode of work**
- **Conclusion**

- **The existing Marcogaz-Infographic (9/2019, Doc TF_H2-427)**

This infographic aims to:

- Provide an overview of the technical readiness of the gas infrastructure and end uses equipment to handle hydrogen-natural gas mixtures at each stage of the gas chain. The infographic currently focuses on material aspects and functional principles It does not consider the effect of increasing levels of hydrogen on performance, efficiency and output.

…

- Collect and appraise the current state of knowledge of transmission, storage, distribution and use of H_2NG and hydrogen, drawing on the wide expertise and experience of network operators, storage operators and end use experts.

…

- Assist with the investigation into the opportunities with the existing gas infrastructure to achieve the best benefits and contribute to reaching climate goals.

Background and Motivation
Recap of the first step

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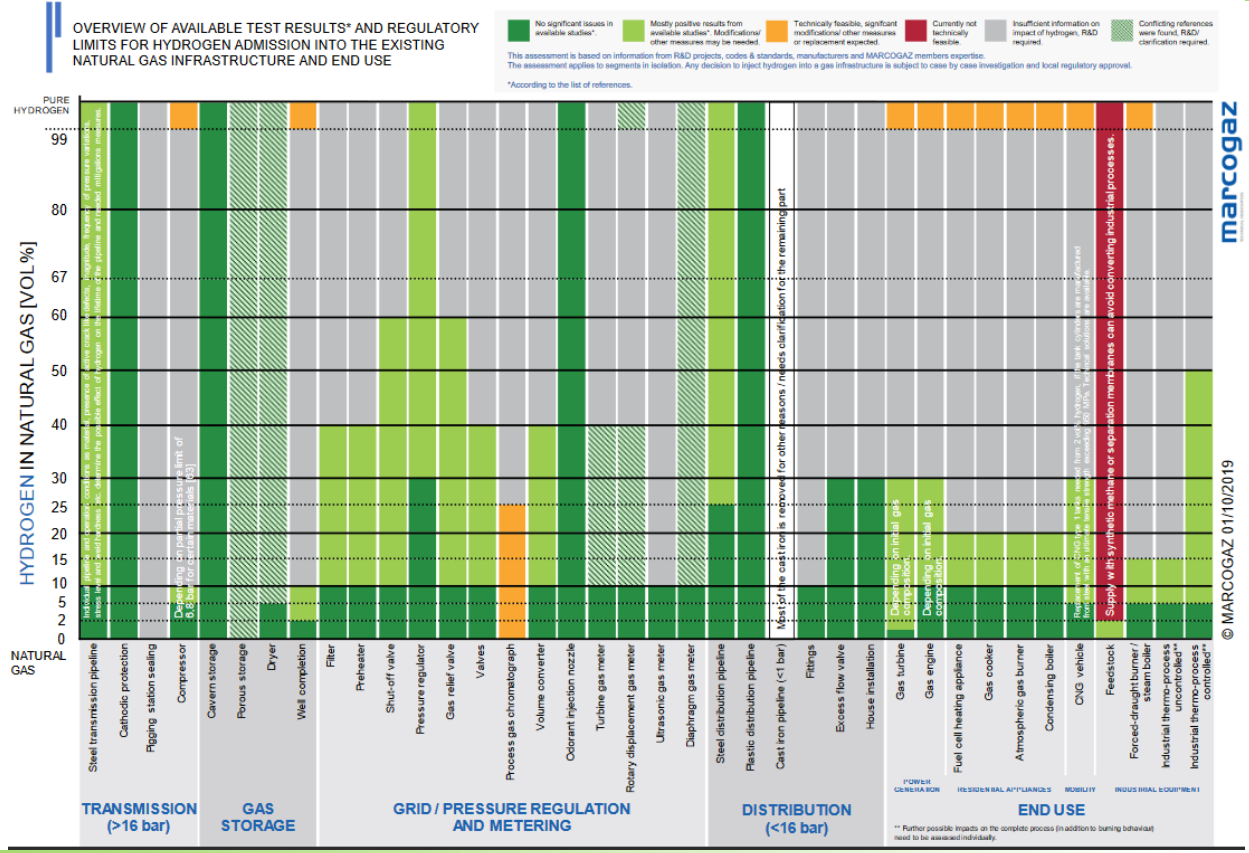

Background and Motivation
New action needed

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- Hydrogen is increasingly considered as key energy carrier in the future energy system
- The EU-Hydrogen Strategy as well as national hydrogen strategies appreciate hydrogen
- Hydrogen is still questioned in the heating market (blending)
- Political and public awareness that molecules and gas infrastructure/end use are crucial for successful energy transition needs to be improved urgently
- We see still doubts of the capabilities to be H2-ready in time and safety concerns
- **→ Proof of safe and cost efficient transformation of gas infrastructure and end use needed**

Scope of work
Overview

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1. WP 1 "Mitigation and cost analysis"
   a. next to the H2-tolerance, quantification of the volume of assets for the components in the European gas infrastructure
   b. estimation of mitigation costs for key concentrations (e.g. 2, 5, 10, 20 and 100 vol.-% H2).
   - Mode of work: Look up information on volumes and mitigation costs based on studies and discussion with other players looking for the same data.

2. WP 2 "H_2 safety and risk"
   a. Agreement on common European consensus on safety aspects for the whole gas infrastructure (from transmission to cut off valve to the client)
   b. Elaboration a common analysis shared by the Marcogaz safety related WG and the TF H2.
   - Gather the Marcogaz internal work results (e.g. WG Health and labour safety) and external work results incl. from national and european WG and projects (e.g: Hydrogen Transmission Safety Group, H2 Gas Assets Readiness (H2GAR), Hydeploy…).

The results of the different safety projects are not expected before the end of the year.

Mode of work
Collection of data and knowledge WP1

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- Broaden the set of information on volumes and mitigation costs based on:
  - TF-members support, own data
  - Other projects as Thyga etc.

  = basis for specific values that are verified by the group and further organisations e.g. ENTSOG, EHI, IFIEC…

  Covering the gaps:

  - ➢Additional input from TF-members
  - ➢Opportunities to share work/get support from other initiatives/projects e.g. PMG

Mode of work
Current projects in Europe (WP2)

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- **Current projects : time schedule and need for contact details**
  - EC-CEN/GERG H2NG: results expected end 2021
  - H2 in built constructions:
    - Hy4Heat WP 7 safety : need contact for input
    - CEN-CLC/JTC 6 Technical Report 'Safe use of H2 in built constructions : expected ?
  - DSO
    - Hydeploy : need contact for input "The HSE are satisfied that the blend of gas will be as safe as the gas we all currently use. The hydrogen content will be up to 20% and has so far reached 15%."
  - TSO :
    - H2GAR WG safety: interim report by end 2021; final 2022?
    - Pipeline Safety Group : results expected end of 2021
  - WG Marcogaz
    - Odorization report: conclusions on blends to be validated by SCGI
    - Storage ?
    - Health and labor safety ?

Conclusion

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- **Consensus on the potential of the gas infrastructure and end use was established**
- **Proof of safe and cost efficient transformation of gas infrastructure and end use needed for political and public awareness needed**
- **TF will provide first cost estimations and information for a safe infrastucture/end use transformation**

Thank you !

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Organisation

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OF THE EUROPEAN NATURAL GAS INDUSTRY

- **Chair:** Gert Müller-Syring, DBI
- **Co-chair:** Aurelie Carayol, GRTgaz
- **Secretary:** Hiltrud Schülken, DVGW
- **Support** Marcogaz Secretariat: Benjamin de Ville de Goyet
- **Membership:** Nominations by Marcogaz members and partner organisations

➢ Co-operation and involvement of furhter stakeholders foreseen and appreciated (contacting is in process)

GERG

THE EUROPEAN GAS RESEARCH GROUP

Overview of Hydrogen Activities

GERG: The European Gas Research Group

Joining Forces for a Sustainable Energy Future

HIPS-NET June 16th 2021

The European Gas Research Group

GERG
THE EUROPEAN GAS RESEARCH GROUP

Our members

DGC · DNV · enagas · ENGIE · GASSCO · gasunie · GRTgaz · GRDF · GRTgaz · Italgas · kiwa · nationalgrid · nedgia Grupo Naturgy · nortegas · OGE · PGNiG · Shell · snam · storengy · Synergrid · TERÉGA · TSO OPERATOR

Friends of GERG

DBI GTI · EBA · ENSGTI · Hanzehogeschool Groningen · IFE · Imperial College London · RISE · ROSEN · TNO innovation for life · uni Research · Hydrogen Europe

- Collaborative R&D group for gas with strong industry focus
- Over 30 members - gas companies, research centres and universities
- Young Researchers Event – presenting the best students
- Links to Brussels Institutions and External Organisations

knowledge 4 innovation
K4I Forum of the European Parliament

FCH · cen · entsog · Gas Infrastructure Europe

PRCI Pipeline Research Council International · gti · EPRI · METHANE GUIDING PRINCIPLES · LCRI Low Carbon Resources Initiative · Decarbonised Gas Alliance · FUTURE FUELS CRC · eurogas · gas naturally · IGEM · IGU International Gas Union · marcogaz

EC-funded Projects

DEO • CONRAD • DIGBUILD • VOGUE • MICROMAP • PRESENSE • LABNET • GIGA • COMBO • NATURALHY • ORFEUS • INTEG-RISK • GASQUAL• LNG DENSITOMETER • ELEGANCY • THYGA • Biomethane Barriers, • H2PNR

GERG Working Groups: Research Roadmaps

Methane Emissions

Biomethane

Hydrogen

BRAINSTORMING PHASE

Gathering of insights from GERG industry professionals and experts

DEFINITION OF RESEARCH TOPICS

Scoping of research knowledge gaps and evaluation of criticality

PRODUCTION OF THE ROADMAP

Summary of results and recommendations for the most prominent research topics

PROJECT CREATION IN THE GERG PROGRAMME COMMITTEES

Distribution and Utilisation
Transmission and Storage
LNG

Hydrogen Research Roadmap: 6 themes

Gas Quality

- Meters, Analysers, and sensors
- Quality and Purity of the blend
- Gas properties and billing

New Technologies

- H2 injection and blending
- Ammonia and other H2 carriers
- Separation of hydrogen and natural gas from the blend

Asset Materials

- Pipeline Integrity
- Impact of H2 on Other Components and New Materials
- Impact of H2 on Transmission Compressor

Maintenance & Safety

- Odorisation
- Safety: leak, flammability and explosivity
- Maintenance and monitoring

End-Uses

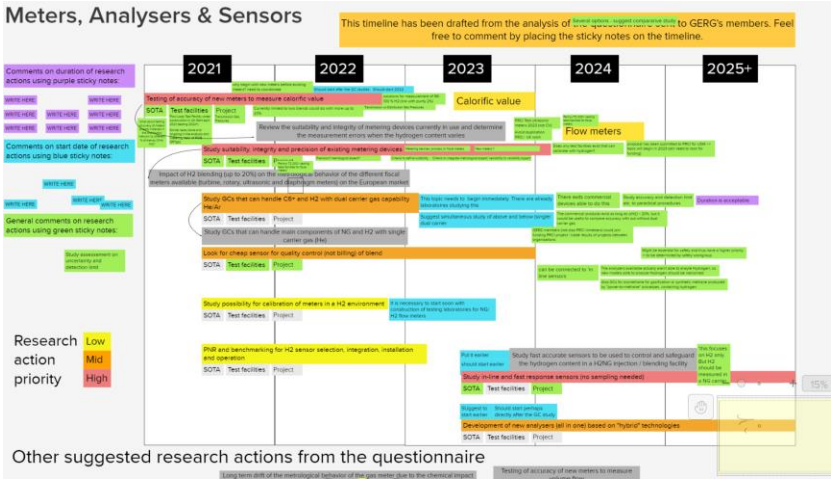
- Industrial end-use
- Domestic appliances
- Combustion of H2NG blends

Underground Storage

- Storage: Salt Caverns & Aquifer

Hydrogen Research Roadmap: Gas Quality

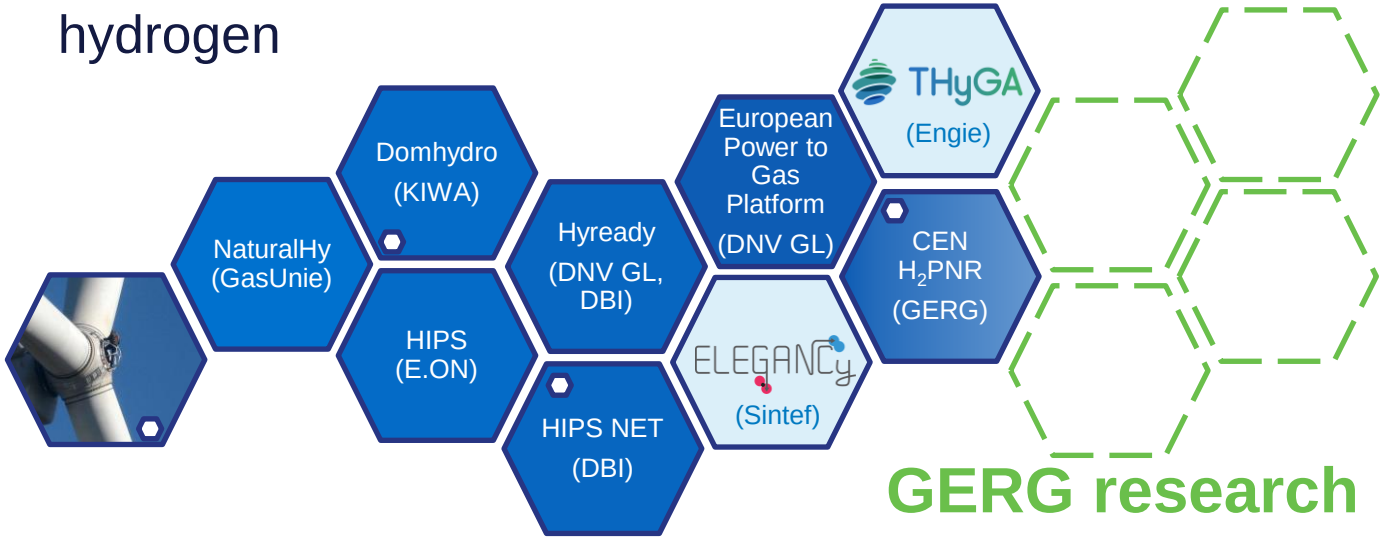
- Gas quality is one of the 6 themes identified by the Working Group. The latest workshop, organized end of January, aimed to clarify, refine, and add further information to important research topics.
- Gas Quality
  - Meters, analysers, and sensors
  - Quality and purity of the blend
  - Gas properties and billing
- Mapping to other initiatives (e.g. PRCI, CEN, Hydrogen Europe, Prime Movers etc)
- The results are being analysed, with the objective to have a list of well-defined topics without ambiguity, duplication and overlap of ideas, placed on a timeline based on the members' survey. This result will form the first draft of the roadmap.



GERG Hydrogen Projects

Overview of GERG Hydrogen activities

Network adaptation and hydrogen



GERG research roadmap

Fundamental Research → Gap analysis + PNR → **Standards**

SFEM Working Group Hydrogen

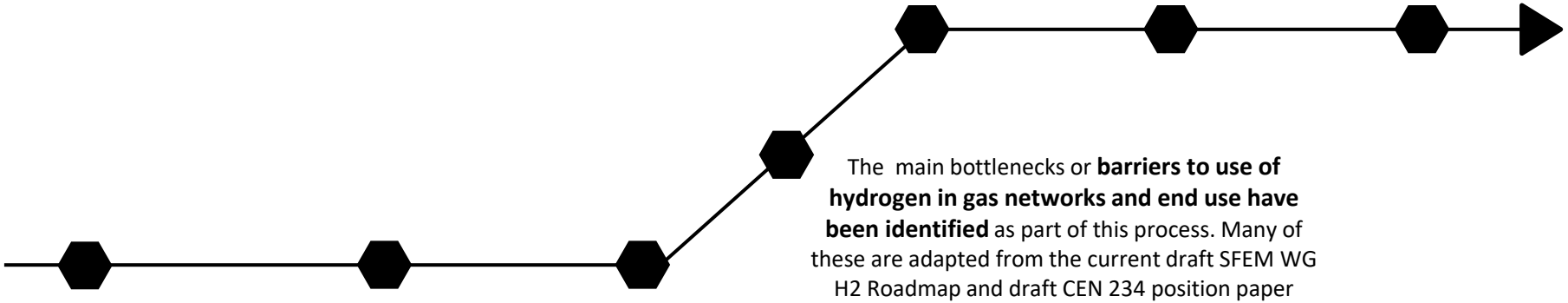
CEN H2PNR

CEN H2NG PNR Gap analysis 2020

- A European-scale GAP analysis to collate the **current status of knowledge on H2 in gas networks** delivered by GERG
- Priorities set by the **industry** through consultation with **CEN working groups**
- **Aligned with roadmap to standardization** being developed by CEN and the European Commission
- Strong **industry buy-in**

	Priority / topic area	Expected Lead Organisation
1	Safety	DNVGL
2	Gas Quality	GRT Gaz
3	Underground storage	DBI
4	Power Generation and Engines	DNVGL
5	Industry	Engie
6	Steel Pipes	GRT Gaz
7	Network Equipment	DBI
8	End use commercial and domestic	DGC
	Project administration on behalf of CEN	DIN
	Integration coordination, interfaces and transverse subject management	GERG

Background and Objectives



GERG along with CEN TCs (initially specifically CEN TC234 and TC 408 WGs) were tasked by DG Energy to **establish a shortlist of potential priority subject areas for PNR actions** to reduce barriers to injection of hydrogen in the natural gas grid

Subject areas have been prioritised by CEN TCs and Sector Fora (SFEM, SFG-I, SFG-U) to establish first of all the scope of literature surveys which could initiate a Work Programme

This **parallels the approach already underway on biomethane barriers** (CEN TC 408 and GERG)

The main bottlenecks or **barriers to use of hydrogen in gas networks and end use have been identified** as part of this process. Many of these are adapted from the current draft SFEM WG H2 Roadmap and draft CEN 234 position paper

In general, **the priority list is closely aligned with the "height" of the barrier** to introduction of hydrogen into gas networks

This work was done in August 2019 and there have been **numerous developments since then**

Specific Agreement signed by Commission in October and **countersigned by CEN in December** – Officially validated by EU/CEN on 17th December

Priority 1

Safety

Literature survey and action plan for H2 and H2NG blends relating to current safety approaches, implemented for natural gas considering issues relating to hydrogen blends

Partners

DNV GL (lead), Kiwa, DBI, DGC, National Grid, Gasunie, Enágas, Storengy, Engie & GRTgaz, Terega

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OBJECTIVES

- Develop a status review on the impact of H2 and H2NG blends on current safety approaches
- Propose required actions to mitigate and manage the use of H2NG gases whilst maintaining current standards of safety as a PNR work programme

ISSUES TO BE ADDRESSED

- Behaviour H2NG in existing natural gas pipework at high percentage up to 100% in homes and households
- Classification of leaks
- Safety-related sensors for detection of hydrogen and hydrogen mixtures
- Gas tightness of installations and piping (e.g. testing with air or other test media)
- Integrity management and inspection in a H2 pipeline (pigging etc.)
- To also address combustion and explosion related safety issues

EXPECTED OUTCOMES AND BENEFITS

- Updated information to fill knowledge gaps and address bottlenecks
- Action Plan with road map to address any “show-stopper” safety not already being addressed
- Work Programme proposal for PNR actions including numerical simulations, research work, experimental testing or demonstrations, with their costs, for assessing and mitigating the impact on safety of H2 injection
- Removal of safety barriers to the widespread introduction of H2 as an energy carrier

Priority 2

Gas Quality

Influence of H2NG and 100% H2 on gas quality parameters and their ripple effect on the gas chain as a whole

Partners

GRTgaz, ENGIE, DNVGL, DBI, Kiwa, RISE, DGC, TNO, Terega, Snam, PGNIG, Gaz System, National Grid

OBJECTIVES

- Identify the impact of H2 on **gas quality properties**
- Evaluate the impact of H2 injection on **billing**
- Evaluate solutions to **eliminate or mitigate the adverse effects of hydrogen**

ISSUES TO BE ADDRESSED

- **Hydrogen quality** needed for injection in natural gas (grids)
- **Odorization** – effects of H_2 on NG odorization (containing sulfur or sulfur-free)
- **Sensors and measurement** of varying H_2 concentrations
- **Impacts of billing, energy measurement and methods to overcome commercial constraints** (new methods of sensing gas at different points related to injecting H2NG and change of gas quality – technical and commercial)
- Impact of hydrogen addition in gas mixtures up to 100% hydrogen on **physical properties of the gas mixtures, incl. energy density, relative density**
- **Discontinuous injection** impacts

EXPECTED OUTCOMES AND BENEFITS

- Gaps to be filled for **safe operation conditions of infrastructures and usages**
- Gaps to be filled for **accurate billing**
- Input to **revision of gas quality specifications standards**
- Definition of a **PNR programme with detailed gas quality element**

Data Collection Methodology

Klaas van Alphen (Future Fuels CRC)	Plastic pipes for hydrogen and blends	Project Report	**3.1-03 Future proofing plastic pipes**	2022	Australia	Deakin University, University of Wollongong, APA, Jemena, Worley Parsons, OSD, AusNet	Develop a standardised suite of tests to identify polymer/elastomeric compatibility with hydrogen and its blends and generate an understanding of the capacity for current pipeline materials (plastics and elastomeric) to transport future fuels
Robert Judd (GERG)	Storage	External publication	**Current status of chemical energy storage technologies**	2020	Europe	Joint Research Center (JRC)	The aim of this report is to give an overview of the contribution of EU funding, specifically through Horizon 2020 (H2020), to the research, development and deployment of chemical energy storage technologies (CEST). In the context of this report, CEST is defined as energy storage through the conversion of electricity to hydrogen or other chemicals and synthetic fuels. On the basis of an analysis of the H2020 project portfolio and funding distribution, the report maps research activities on CEST at the European level. In addition, projects funded at national and international level, occurring within the same timeframe, have been considered.
Maxime Bertin (GRTGaz)	General	External publication	**Options of natural gas pipeline reassignement for hydrogen : Cost assessment for a Germany case study**	2020		S. Cerniauskas et al.	
Maxime Bertin (GRTGaz)	Integrity	Internal Report	**Impact sur la ténacité d'un mélange 99,5%N2 + 0,5%H2 et calculs API**	2020	France, Europe	GRTgaz	Experimental study of the effect of hydrogen on toughness of an API X70 steel and defact assessment ussing API579 "fitness for Service
Maxime Bertin (GRTGaz)	Integrity	Internal report	**Impact de l'ajout d'hydrogène sur les cirètre du Guide d'Analyse des Défauts**	2020	France, Europe	GRTgaz	Study of the effect of hydrogen of GRTgaz defect assessment criteria
Amelie Louvat (GRTGaz) Graham Hill (GHD)	General	External publication	**H2@Scale: Opportunities for Hydrogen as an Energy Intermediate**	2020	USA	NREL	Document summarizes objectives of H2@Scale project and desired outcomes for future of hydrogen in energy systems.
Robert Judd (GERG)	Summary of projects	Internal Report	**National Grid Hydrogen Innovation Programmes**	2020	UK, Europe	Antony Green	A complete list of Completed, ongoing and Future Natioanl Grid Hydrogen Projects
Robert Judd (GERG)	Summary of projects	Internal Report	**Strategic Hydrogen projects of GERG Members Overview**	2020	Europe	GERG	To understand the current panorama of member activities in order to construct a Roadmap for hydrogen introduction
Gary Choquette (PRCI)	Boiler End-Use	External publication	**The Development of Natural Gas/Hydrogen Boiler System**	2020	Netherlands, Europe	DNV	A sustainable route to reduce the CO2 emission of industrial heating processes is the addition of hydrogen to natural gas and on the long term to replace natural gas completely by hydrogen. In this study a burner system that allows the safe and reliable combustion of natural gas, natural gas/hydrogen mixtures and hydrogen is developed and tested.
Klaas van Alphen (Future			**FFCRC 3.1-01 | Review of future fuels**			University of Wollongong,	Literature review - Review fracture control methodologies and testing methods for future fuels pipelines, review past and present projects along with existing

Identification Initial review by: | **Subtopic** | **Nature of knowledge** | **Document Publication title**

Publication year | **Geographic area (Country)** | **Authors** | **Objectives**

Results | **%H2 studied** | **%H2 acceptable** | **Availability of data**

Sharing modalities | **Source** | **Relevance of study**

- Adapting **approach used in recent PRCI SoTA** study
- Developing **Datasheet with all relevant parameters** and **indexed according to sector:**
  - Build in **recent knowledge gained from other studies**
  - **Strong industry input** to add knowledge from across European operations
  - **Liaise with existing projects** and initiatives e.g. THyGA, NewGasMet, SFEM, national activities, CEN Tcetc

- Currently over 800 references.

Data Assessment and Mitigation

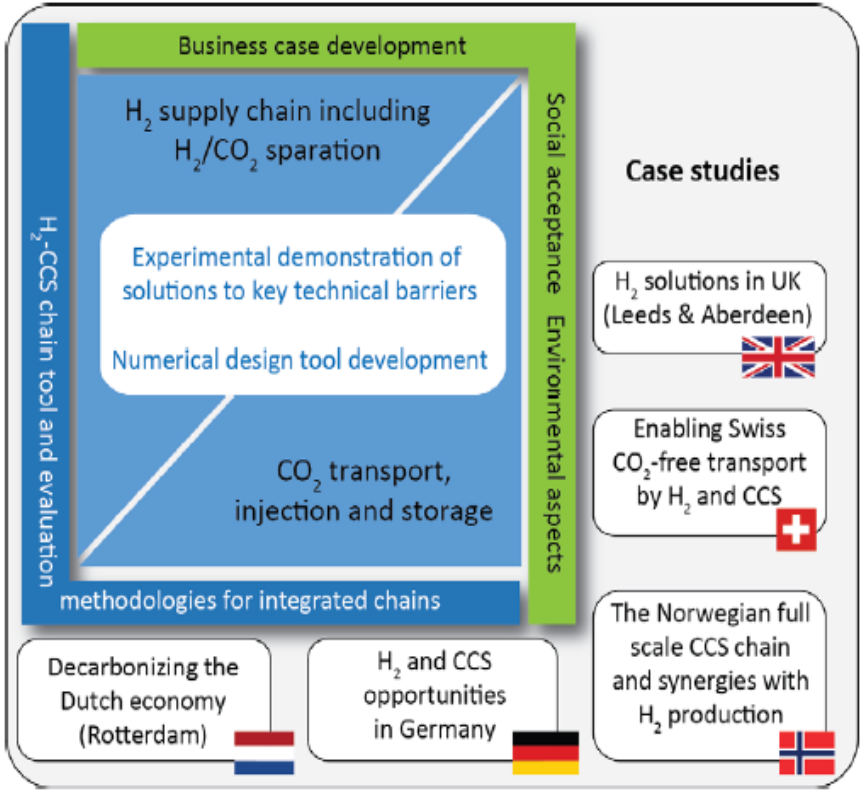
- Use data set to **identify current knowledge status and gaps**
- Use **traffic light system to identify areas** where **knowledge is sufficient** and where there are **gaps** for specific H2 to 100%
- Identify **mitigation actions to fill gaps and costs where possible**
- Develop **Plans for PNR activities** focusing on **lowering barriers to standardization**

- **Final Integrated report due on 30th November 2021**

ELEGANCY

Enabling a low-carbon economy via hydrogen and CCS

ELEGANCY, 2017-2020 , Accelerating CCS



- ELEGANCY – led by Sintef – GERG partners include Shell, OGE, Gassco, Imperial College, GERG
- **5 Case Studies**:
- The **Netherlands**: decarbonizing industry by a comprehensive H2-CCUS value chain.
- **Switzerland**: decarbonizing road transport, accelerating its CCS/geothermal roadmap
- The **UK**: switching large cities to a 100% H2 network,
- **Germany**: accelerating the decarbonization of gas infrastructure via a H2-CCS chain
- **Norway**: developing an optimal infrastructure investment scenario for H2 export and utilization.

THyGA:

Testing Hydrogen admixture for Gas Appliances

THyGA

GERG THE EUROPEAN GAS RESEARCH GROUP

Project Consortium

This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking under grant agreement No (No. 874983). This Joint Undertaking receives support from the European Union's Horizon 2020 research and innovation programme, Hydrogen Europe and Hydrogen Europe research.

THyGA: enabling the wide adoption of hydrogen in natural gas blends

THyGA

Project Objectives

SCREEN THE PORTFOLIO OF APPLIANCES

Screen and segment the portfolio of appliance technologies in the **domestic and commercial sectors** and assess the impact of hydrogen admixtures.

TEST APPLIANCES

Test **up to 100 various residential and commercial gas appliances** (boilers, water heaters, cooking appliances, catering equipment, local space heaters, radiant heaters…).
Up to 60 vol.% of hydrogen admixed.

MAKE RECOMMENDATIONS

Make recommendations for **manufacturers, decision makers and end-users** along the gas value chain for appliance design, manufacture and certification.

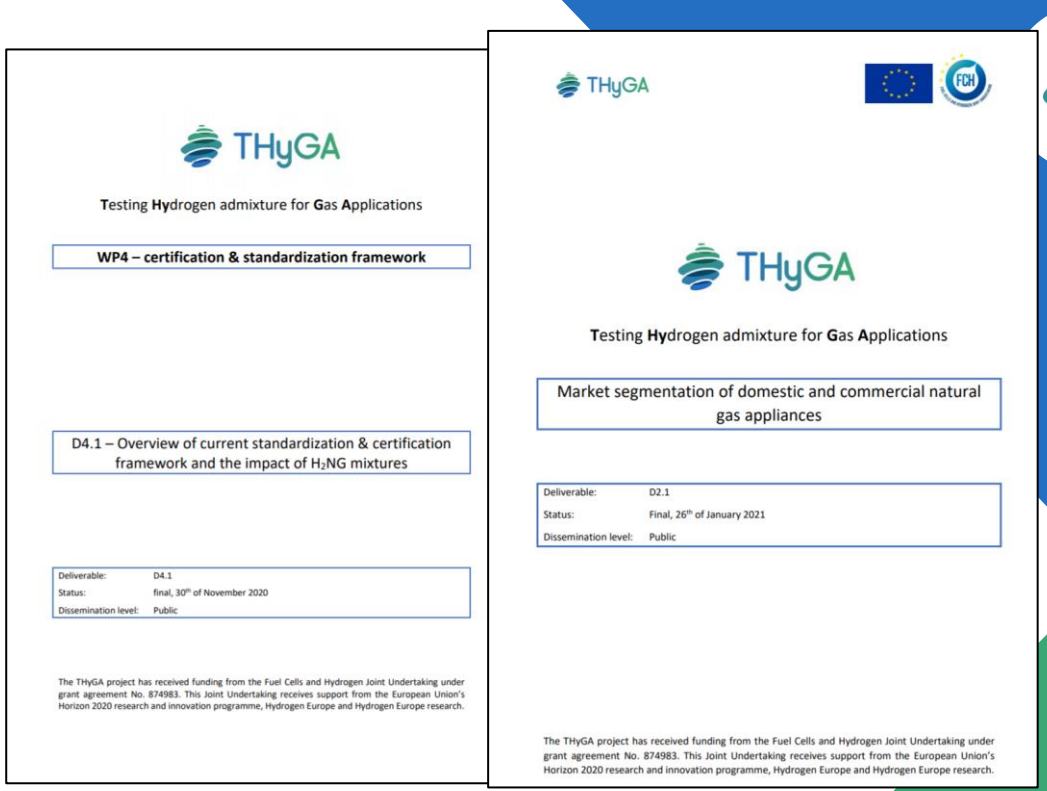
DEVELOP A CERTIFICATION PROTOCOL

Work on **certification protocol for different levels of H2 in natural gas**, exchanges and recommandations to Technical Committees

Latest deliverables

Available on the THyGA and GERG websites:

https://thyga-project.eu/



THyGA

Testing Hydrogen admixture for Gas Applications

WP4 – certification & standardization framework

D4.1 – Overview of current standardization & certification framework and the impact of H_2NG mixtures

Deliverable:	D4.1
Status:	final, 30th of November 2020
Dissemination level:	Public

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.

THyGA

THyGA

Testing Hydrogen admixture for Gas Applications

Market segmentation of domestic and commercial natural gas appliances

Deliverable:	D2.1
Status:	Final, 26th of January 2021
Dissemination level:	Public

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.

Thank you for your attention