Hydrogen Research & Innovation Days

24-25 November 2025

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Hydrogen Research & Innovation Days
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THOTH2 PROJECT

Novel meTHOds of Testing for measurement of natural gas and H2 mixtures

Ludovico Mazzocco - GERG

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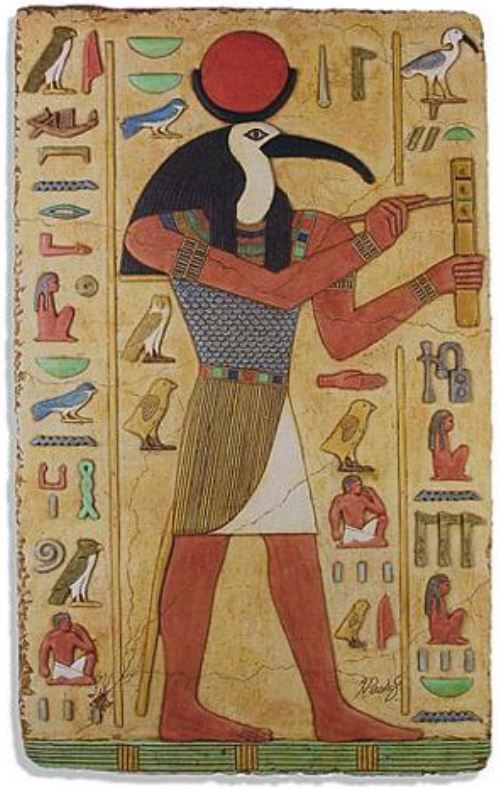
From THOTH…to THOTH2



A long time ago, in the in ancient Egypt…

THOTH was a Moon god. The Moon not only provides light at night, allowing time to still be measured without the sun, but its phases and prominence gave it a significant importance in early astrology/astronomy. The perceived cycles of the Moon also organized much of Egyptian society's rituals and events, both civil and religious. Consequently, Thoth gradually became seen as a god of wisdom, magic, and the measurement and regulation of events and of time."

…nowadays, in Europe

THOTH2 consortium focuses on energy measurement value chain and instruments' ability to accurately measure physical parameters of H2NG mixtures with increasing H2 percentages, up to 100%, in order to make NG infrastructure resilient to the challenges of tomorrow.

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THOTH2 Partners

THOTH2

snam

CESAME-exadébit SA

enagas

ENEA

FONDAZIONE BRUNO KESSLER

GAZ system

GERG

natran

ING

INRETE DISTRIBUZIONE ENERGIA

INRiM ISTITUTO NAZIONALE DI RICERCA METROLOGICA

METAS

ALMA MATER STUDIORUM A.D. 1088

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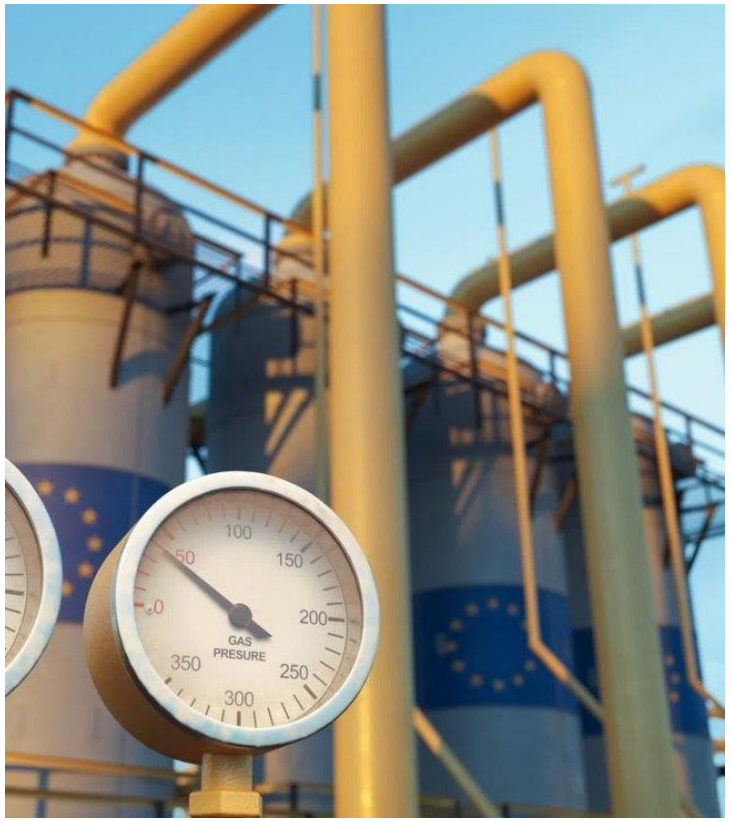
Project context



- **H_2 blending** in existing gas infrastructure can play a central role in unlocking the green transition.
- To date, H_2 blending is limited also due to **uncertainties on the impact of new mixtures on the already installed devices** in the gas value chain, such as measuring instruments.
- The **normative framework**, including testing methodologies for Hydrogen and Natural Gas (H_2NG) mixtures, is still under-construction.
- **Validated protocols** are required to define the H_2 limits and tolerances of the measuring devices installed in the NG grids.

Project objectives

THOTH2 will focus on the energy measurement value chain and the instruments' ability to accurately measure physical parameters of H2NG mixtures with increasing H2 percentages, up to 30% in volume, and also pure hydrogen.

Cover the **normative and standards gaps** relating to methodologies and protocols for measuring devices with H2NG mixtures or pure H2.

Design dedicated methodologies to test different types of measuring devices installed, at different operative conditions

Provide recommendations to International Standard Bodies, gas TSOs and DSOs, measuring devices' manufacturers, and the R&D community.

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Target devices categories

The THOTH2 project aims to **experimentally investigate the limits and tolerance of H2 content in NG for SoA measuring devices** installed in gas transmission and distribution grids.

Specifically, the following targets will be pointed out:

- the **protocols developed for testing devices**
- the **criteria for selecting the devices to be tested**
- the **main characteristics** of the devices to be tested
- the characteristics of the **testing benches** in the Consortium

Gas meters

Gas chromatographs

Pressure and temperature transmitters

Trace water sensors

Leak detectors

Volume converters

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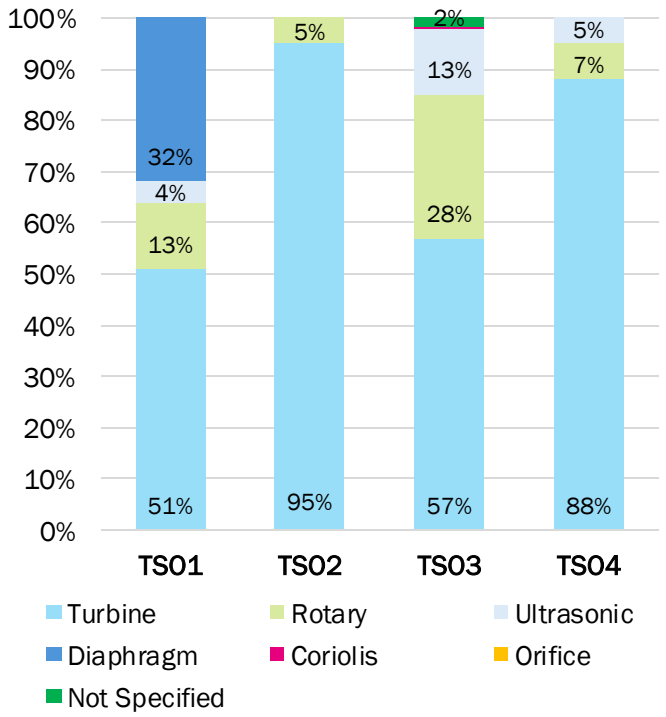
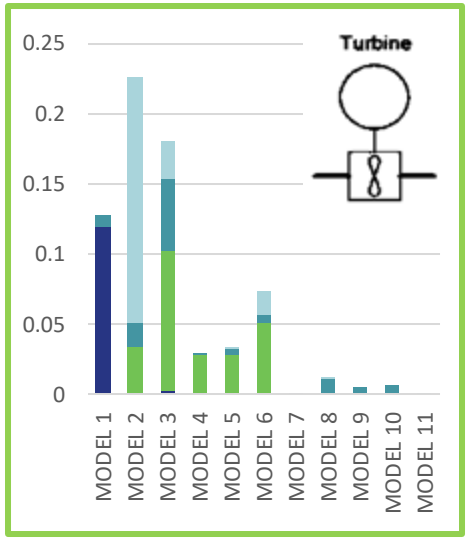
Gas meters in transmission networks

Technology share



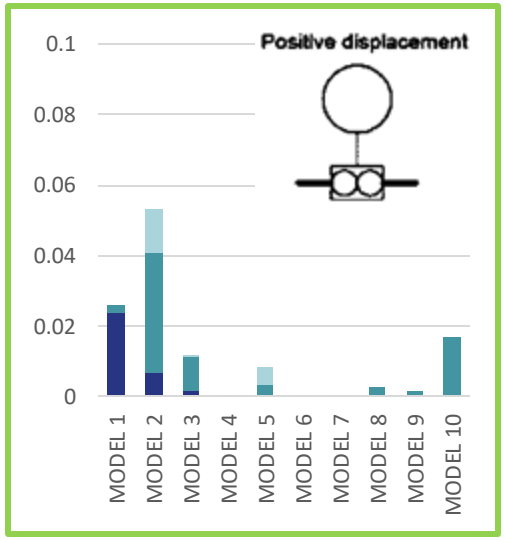
Market penetration *(Different colours refer to different TSOs)*

Turbine gas meters



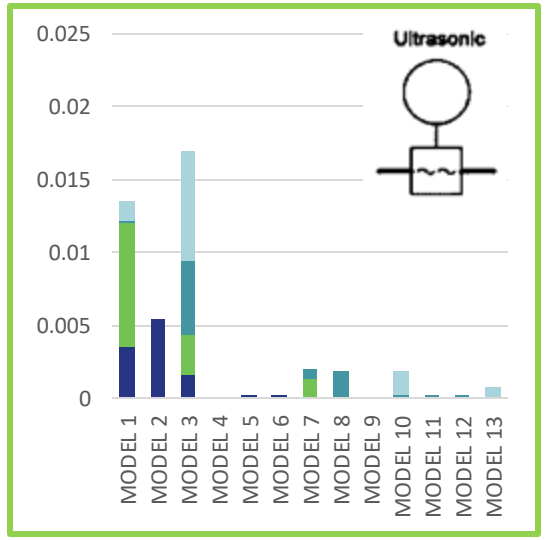
11 different models from
9 manufactures
0,10 - 0,2 devices/km

Rotary gas meters



10 different models from
7 manufactures
0,01 - 0,10 devices/km

Ultrasonic gas meters



13 different models from
11 manufactures
0,01 - 0,05 devices/km

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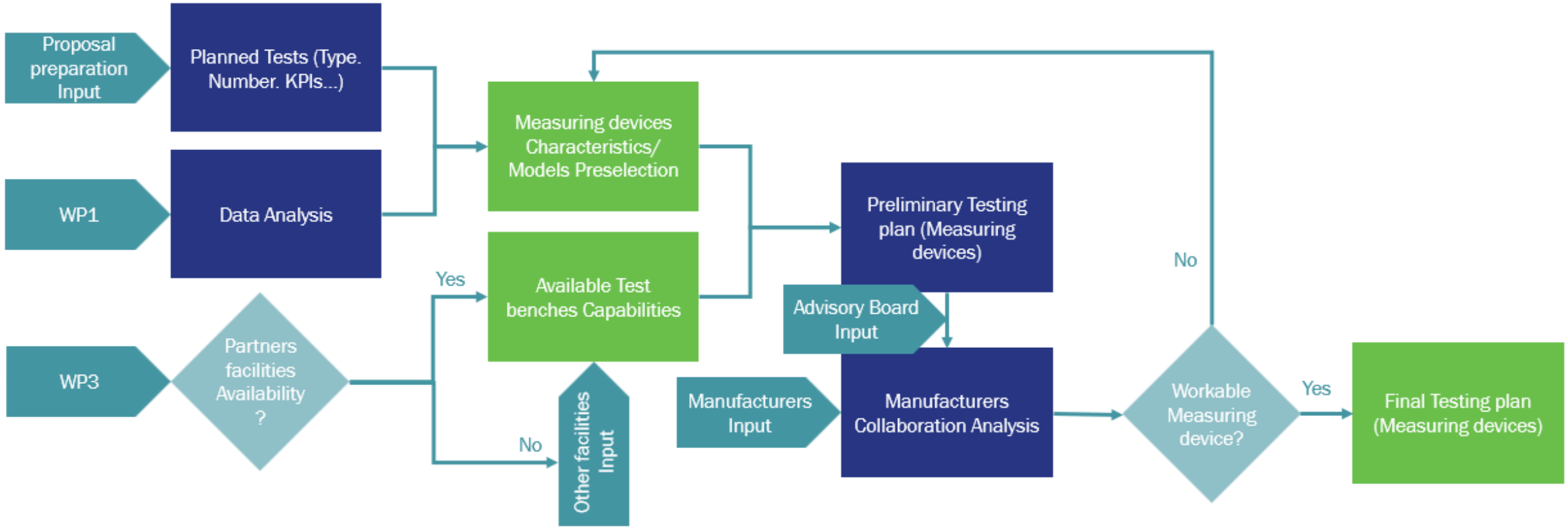
Ref.: D1.1, SoA of measuring devices installed in NG transmission and distribution networks

Devices selection methodology



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Ref.: D2.1, Roadmap of the potential measuring devices, sensors to be tested by the consortium

Devices selected for the testing campaign

TSO Gas meters

13 meters selected:

- Rotary meters:
  - *4 models G100 & G250*
- Turbine meters:
  - *4 models G160 & G650*
- Ultrasonic meters:
  - *5 models DN100 & DN300*

DSO Gas meters

12 meters selected:

- Diaphragm meters:
  - *6 model G4 & G6, G10 & G16, G40 & G65*
- Thermal mass meters:
  - *2 model G6 & G25*
- Ultrasonic meters:
  - *4 models G4 & G6*

Trace water sensors

7 sensors selected:

- TDLAS:
  - *1 model*
- Ceramic metal oxide:
  - *4 models*
- Capacitive:
  - *2 models*

Leaks detectors

5 sensors selected:

- TDLAS:*1 model*
- MOS: *1 models*
- Catalytic: *1 models*
- IR: *1 models*
- TC: *1 models*

Flow computer

1 model selected

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Ref.: D2.2, Testing protocols will be provided to WP3 as an input for testing

TSO gas meters testing benches

Meters calibration before and after aging with H2NG and/or pure H2 (at CESAME and NaTran facilities).

Parameter	CESAME	Enagás	Gaz-System	NaTran
Fluid	Air	NG	NG	NG
Operational mode	Open loop	Closed loop	Closed loop	Open loop
Pressure	1 - 50 barg	3 - 50 barg	8 - 54 barg	< 30 barg
Flow rate	5 - 50000 Nm^3/h	10 - 10000 m^3/h	8 - 6000 m^3/h	0.1 - 2000 Sm^3/h
Uncertainty	0.21%	0.23 - 0.26 %	0.22 - 0.29 %	-
Max diameter of the DUT (device under test)	400 mm	DN600	DN300 (+ DN350 & 400)	DN80

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Ref.: D3.1, Test rigs preparation and reporting procedure for experimental activities

DSO gas meters testing benches

Meters calibration before and after aging with H2NG and/or pure H2 (at INIG and Natran facilities).

Ageing	Laboratory	Fluid	Pressure (kPa)	Temperature (C)	Period of time
1	INIG	25% H_2/CH_4 (vol/vol)	2 ÷ 8	ambient	4+4
2	INIG	100% H2	2 ÷ 8	ambient	4+4

Ref.: D3.1, Test rigs preparation and reporting procedure for experimental activities

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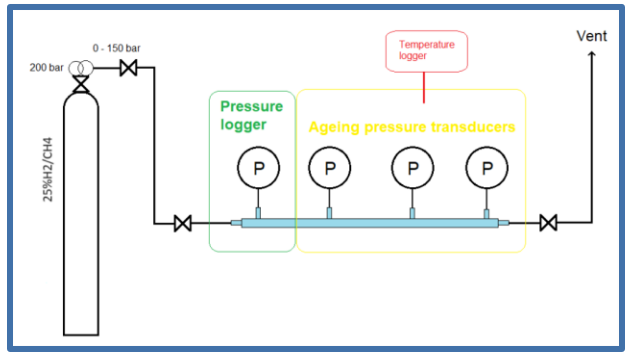
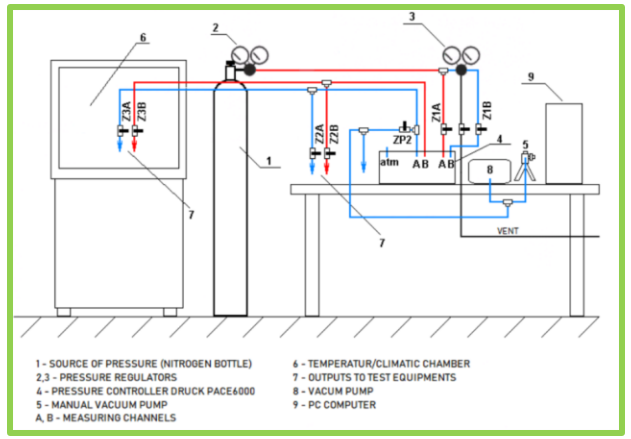
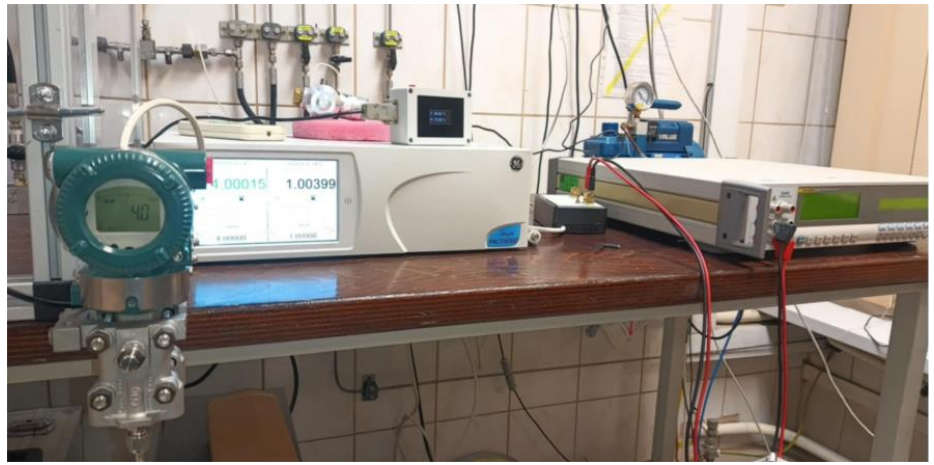
Pressure transmitters test skids







Ageing	Lab	Fluid	Period of time (months)
1	INIG	25% H2/CH4(vol/vol)	4 + 11
2	CESAME	Pure H2	4 + 11

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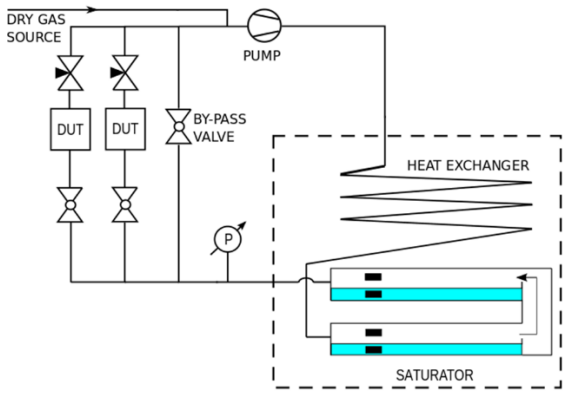
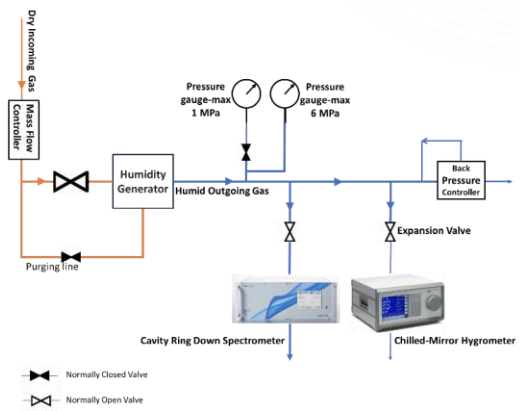
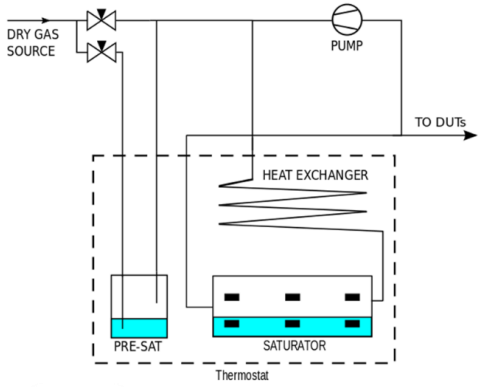
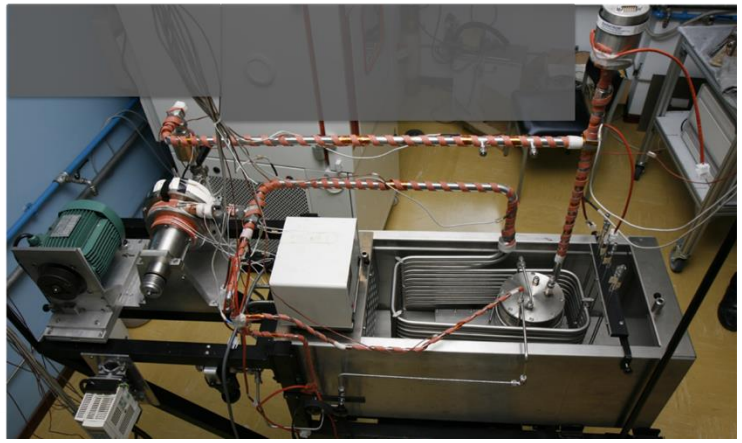
Ref.: D3.1, Test rigs preparation and reporting procedure for experimental activities

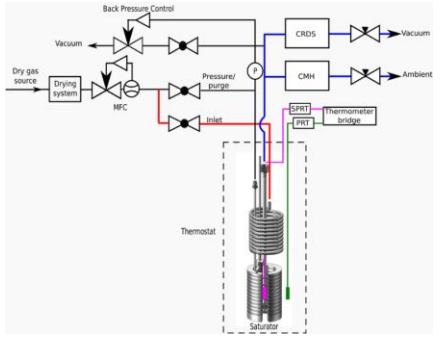
Trace water sensors test benches











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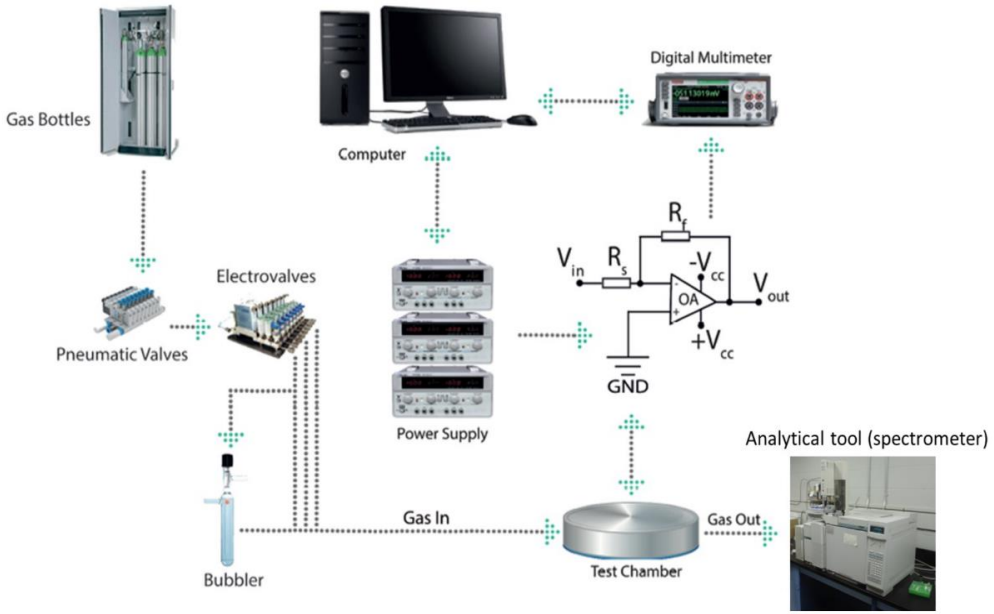
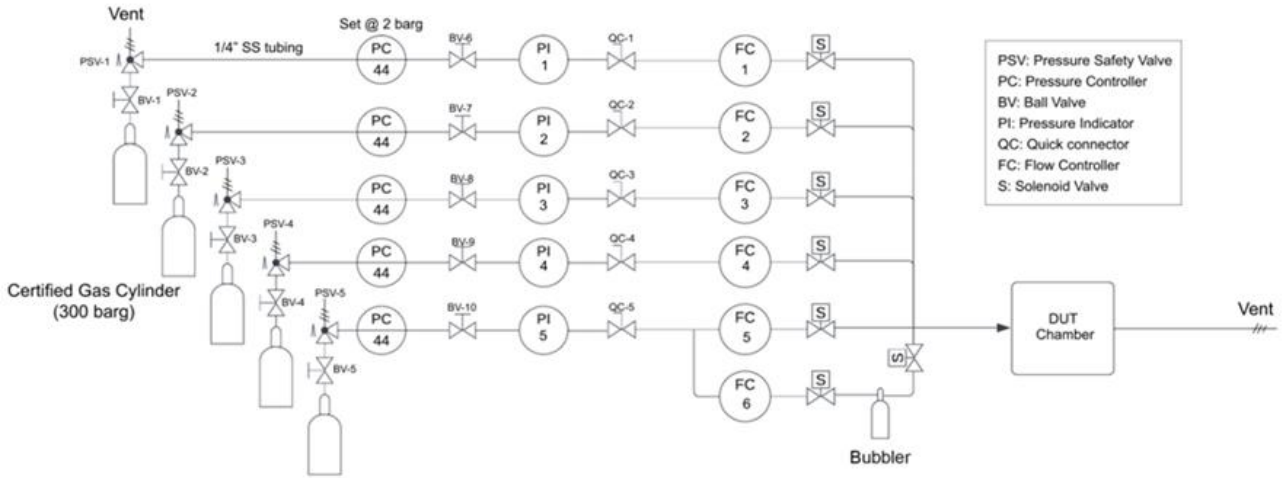
Ref.: D3.1, Test rigs preparation and reporting procedure for experimental activities

Leaks detection test benches





Directly controlled setup parameters					Indirectly controlled setup parameters	
Gas cylinder concentration [ppm mol]	Gas flow [sccm]	Temperature [°C]	Injection time [s]	Gas mixture composition	Gas concentrations [ppm mol]	RH% [%]

Ref.: D3.1, Test rigs preparation and reporting procedure for experimental activities

Volume conversion testing room

The testing procedure has the purpose of checking the register of the selected flow computer (**compressibility factor**, **conversion factor**, errors, etc.) for **different hydrogen concentrations** (inside and outside of limits defined in standards for compressibility factor calculation).

It is not considered detailed testing according to standard EN 12405 ‘Gas meters, Conversion devices, Part 1. Volume conversion’.

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Ref.: D3.1, Test rigs preparation and reporting procedure for experimental activities

Support to standardization activities

Standard number	Title	Affected by H2NG /H2
EN 12480	Gas meters - Rotary displacement gas meters	★
EN 12261	Gas meters - turbine gas meters	★
EN 12405-1	Gas meter - Conversion devises - Part 1: Volume conversion	★
EN 12405-2	Gas meters - Conversion devices - Part 2: Energy conversion	★
EN 12405-3	Gas meters - Conversion devices - Part 3: Flow computer	
TR 16061	Gas meters - Smart gas meters	
EN 16314	Gas meters Additional functionalities	
EN 1359	Gas meters - Diaphragm meters	★
EN 14236	Gas meters – Ultrasonic domestic gas meters	★
EN 17526	Gas meters – Thermal mass flow meter-based gas meters	★
EN 437	Test gases - Test pressures - Appliance categories	★
EN ISO 6974-1	Natural gas – Determination of composition and associated uncertainty by gas chromatography_ General guidelines and calculation of composition	
EN ISO 6974-2	Natural gas - Determination of composition and associated uncertainty by gas chromatography_ uncertainty calculations	★
EN ISO 6974-6	Natural gas -Determination of hydrogen, helium, oxygen, nitrogen, carbon dioxide and C1 to C8 hydrocarbons using three capillary columns.	★
EN ISO 6975	Natural gas - Extended analysis - Gas-chromatographic method	★

Standard number	Title	Affected by H2NG /H2
EN ISO 6976	Natural gas - Calculation of calorific values, density, relative density and Wobbe indices from composition	★
EN ISO 14912	Gas analysis - Conversion of gas mixture composition data	
EN ISO 15970	Natural gas - Measurement of properties - Volumetric properties: density, pressure, temperature and compression factor	★
EN ISO 20765-1	Natural gas - Calculation of thermodynamic properties - Part 1: Gas phase properties for transmission and distribution applications)	★
EN ISO 20765-2	Natural gas - Calculation of thermodynamic properties - Part 2: Single-phase properties (gas, liquid, and dense fluid) for extended ranges of application	★
EN ISO 20765-5	Natural gas - Calculation of thermodynamic properties - Part 5: Calculation of viscosity, Joule-Thomson coefficient, and isentropic exponent	★
EN 1776	Gas infrastructure- Gas measuring systems- Functional requirements	★
ISO 10790	Measurement of fluid flow in closed conduits- Guidance to the selection, installation and use of Coriolis meters (mass flow, density and volume flow measurements)	★
ISO 17089	Measurement of fluid flow in closed conduits_ Ultrasonic meters for gas	★

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Ref.: D4.1, Preliminary guidelines and recommendations for new standards (under development)

Conclusions and further steps

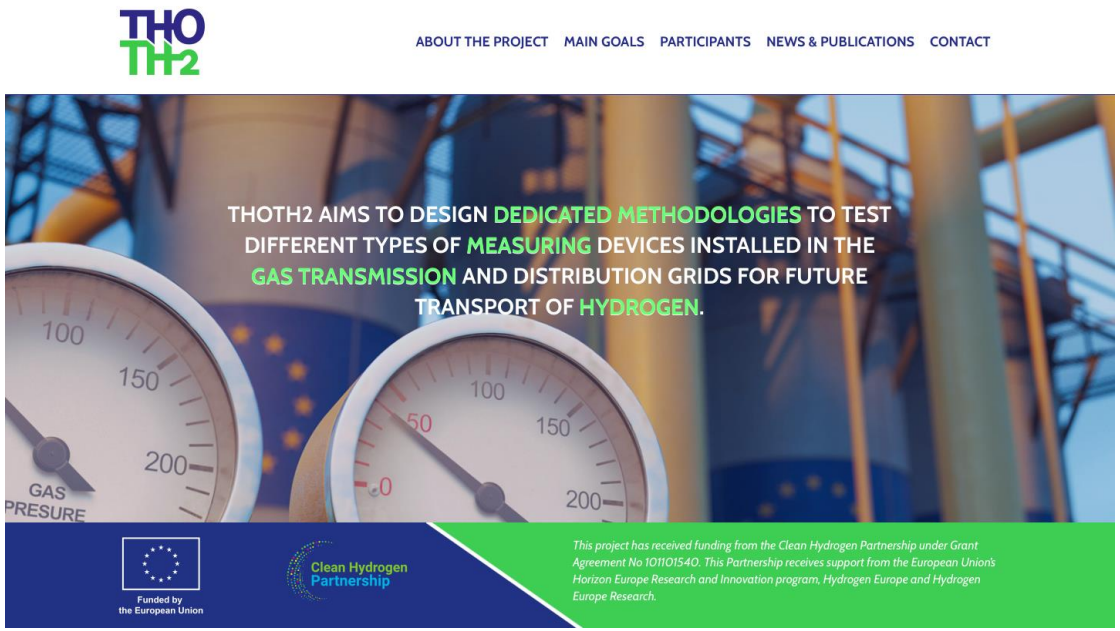
- Launch of the **R&D+i Hub** (coming soon!)
- Collection and processing of **experimental results**
- Analysis of the testing campaign results **with the manufacturers** involved in the project and with **the stakeholders advisory board members**
- Ongoing coordination and engagement with **standardization bodies** and **technical associations** involved in the standardization process

Project website

The THOTH2 project website is part of the **communication and dissemination strategy** foreseen in WP5.

The site will enable the project to gain greater visibility among insiders as well as among a wider audience. In fact, it is meant to serve as the **primary conduit for communicating with the public** about the project.

The website will have **regular updates** on the many THOTH2 phases, the publication of specific deliverables, and a possibility to explore other project-related contents.



https://thoth2.eu/

Thank you!

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