## **EMPIR Decarb:**

Metrology for decarbonising the gas grid

WP1: Flow Metering NEL, VSL, DNV, Enagas

Decarbonising the Gas Grid: Measurement Challenges and Standardisation

2<sup>nd</sup> November 2023



# WP1: Flow metering



Task 1.1: Understanding operating conditions for decarbonised gas grids

Task 1.2: Traceable flow facilities for the decarbonised gas grid

Task 1.3: Accuracy testing for hydrogen blending in natural gas

Task 1.4: Test Programme for carbon dioxide and CCS



**Gabriele Chinello** 

## **Measurement Needs**



To **develop metrology infrastructure**, including development of new traceable facilities to enable calibration of flow meters:

- for hydrogen and hydrogen-enriched natural gas in the gas grid in accordance with the Directive 2014/32/EU Measuring Instruments (MID) with maximum permissible errors as low as ±1 % depending on the type of flow meter; and
- 2. metering of carbon dioxide in Carbon Capture and Storage (CCS) processes in accordance with the Emissions Trading System (EU ETS) with an accuracy of ±2.5 %



## Task 1.1 – Progress and Outputs



To collect the required knowledge of the **operating ranges** of gas grids within Europe and plans for decarbonisation for each country. Enabling the WP1 partners to target appropriate operating ranges when developing new measurement capabilities and select **appropriate flow meters** for the subsequent test programmes



Hydrogen-and-

gas-Task-1.1.5-

hydrogen-

#### Towards Standardized Measurement of the CO<sub>2</sub> Transferred Across the Carbon Capture and Sequestration chain: A Comprehensive Review and Research Agenda Gabriele Chinello<sup>1</sup>, Yessica Arellano<sup>2</sup>, Roland Span<sup>3</sup>, Dennis van Putten<sup>4</sup>, Ara Abdulrahman<sup>5</sup> Karine Arrhenius<sup>6</sup>, Arul Murugan<sup>1</sup> 'TÜV SÜD National Engineering Laboratory <sup>2</sup>SINTEF Energy Research <sup>3</sup>Ruhr University Bochum <sup>4</sup>DNV Netherlands B.V. PVSL Dutch Metrology Institute "Research Institutes of Sweden AB (RISE National Physical Laborator ABSTRACT The global impact of anthropogenic greenhouse gas emissions on climate change is undeniable, with carbon dioxide (CO2) identified as the primary contributor to global warming. Urgent action is required to mitigate global warming by reducing anthropogenic CO2 emissions to achieve net-zero levels. Carbon Capture and Sequestration (CCS) stands as a proven technology to curtail CO2 emissions from various sources by capturing and sequestering carbon dioxide in geological formations. To address the challenge of deploying CCS on a global scale, it is crucial to accurately quantify the captured, transported, and stored CO2 since quantification underpins regulations and commercial contracts. However, the lack of standardization in CCS projects and measurement methodologies poses a significant challenge, necessitating a common measurement framework to ensure the transparency and reliability of these efforts. This article provides a comprehensive review, 230+ references, of the latest results and operating conditions for current measurement technologies overing the entire measuring system and not just a single instrument. As such it is a first of its kind effort at establishing a comprehensive framework for CCS measurement. This article serves as a single source of references and as a step toward developing an international documentary standard for the transferred CO2 measurement. By addressing measurement challenges and providing

In progress

comprehensive recommendations for future research, it contributes to the ongoing efforts to mitigate

alobal warming through the widespread deployment of CCS technology



## Task 1.2 – Progress



To develop **new primary standards and traceable flow calibration facilities** for metering of hydrogen and hydrogen-enriched natural gas.

H<sub>2</sub> & H<sub>2</sub>/CH<sub>4</sub> blends



#### H<sub>2</sub>/NG blends



## H<sub>2</sub> & H<sub>2</sub>/CH<sub>4</sub> blends



VSL Completed

Completed

**DNV** 

NEL In progress (Q1 2024) EMPIR EN ENTER The full relative is columbra to the European Union's Horizon 2020

## Task 1.2 – Progress



The VSL and NEL new primary standards will be used in an intercomparison to provide evidence for the claimed measurement uncertainties.

## H<sub>2</sub> & H<sub>2</sub>/CH<sub>4</sub> blends





## H<sub>2</sub> & H<sub>2</sub>/CH<sub>4</sub> blends



VSL

## Intercomparison

In progress (Q1 2024)





## Task 1.2 - Outputs



 3 traceable flow facilities operating with hydrogen and hydrogen-enriched natural gas. 2 completed, 1 in progress (Q1 2024)

 1 peer-reviewed article detailing the new traceable flow facilities design and performance, and results from the intercomparison. This will form Deliverable D1.



New traceable flow facilities to enable calibration of flow meters for hydrogen and hydrogen-enriched natural gas in the gas grid

#### In progress (May 2024)

www.decarbgrid.eu



## Task 1.3 - Progress



Test 8 different flow meters with hydrogen and hydrogen/natural gas blends.





# Task 1.3 – Tests at VSL





Meter 1: Thermal mass





# Task 1.3 – Tests at VSL

## Completed





Meter 2: Rotary





# Task 1.3 – Tests at NEL

#### Completed





#### Diaphragm meter



Reference flow rate, m3/h



# Task 1.3 – Tests at NEL









# Task 1.3 – Tests at DNV



- Turbine hydrogen-enriched natural gas
- USM hydrogen-enriched natural gas
- Turbine with pure H2



0	$Ggas_1 (p = 32bara)$
V	$Ggas_1 (p = 16bara)$
$\nabla$	$Ggas_2$ (p = 16bara)
0	$Ggas + 5\% H_2 (p = 32bara)$
V	$Ggas + 5\% H_2 (p = 16bara)$
0	$Ggas + 10\% H_2 (p = 32bara)$
$\nabla$	$Ggas + 10\% H_2 (p = 16bara)$
0	$Ggas + 15\% H_2 (p = 32bara)$
$\nabla$	$Ggas + 15\% H_2 (p = 16bara)$
0	$Ggas + 20\% H_2 (p = 32bara)$
$\nabla$	$Ggas + 20\% H_2 (p = 16bara)$
$\nabla$	$Ggas + 30\% H_2 (p = 16bara)$



## Task 1.3 - Outputs



#### Report on the outcomes of the testing in Task 1.3.

The report will include and assessment of which meter technologies are suitable for use with hydrogen/natural gas blends and for which types calibration with alternative fluids such as nitrogen or air may be applicable.

Recommendations for improvements to commercial meters and further work required to enable accurate flow meters for decarbonised gas grids.



#### In progress (Q1 2024)





# Task 1.4 - Progress

## Test flow meters with liquid and gaseous $CO_2$ for CCS.



Gas and Dense CO<sub>2</sub> small scale



#### Gas CO<sub>2</sub> large scale



VSL In progress HWU Completed NEL In progress



# Task 1.4 – VSL tests Gas CO<sub>2</sub>







Metrology for decarbonising

the gas grid

Meter 2: Rotary





# Metrology for decarbonising Task 1.4 – Tests NEL/HWU Gas CO2







## Metrology for decarbonising the gare of th







# Task 1.4 – Tests NEL CO<sub>2</sub>

## In progress – Completed USMs test with CO<sub>2</sub>



2 USMs (4" and 8"), 6" turbine, 3" Coriolis



## Task 1.3 - Outputs



## Report on the outcomes of the testing in Task 1.4.

The report will include a summary of current performance for commercial flow meter devices for carbon dioxide measurements in CCS as well as recommendations for further improvements. This will form Deliverable D2.



#### In progress (May 2024)





EMP

The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States

EURAMET

# **WP1 Summary**

#### Task 1.1: Understanding operating conditions for decarbonised gas grids





In progress



# **WP1 Summary**

#### Task 1.2: Traceable flow facilities for decarbonised gas grid



#### The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EURIPR Participating States





# **WP1 Summary**

Task 1.3: Accuracy testing for hydrogen blending in natural gas



Completed



Completed



Completed



#### In progress (Q1 2024)





# **WP1 Summary**

#### Task 1.4: Test Programme for carbon dioxide and CCS

#### Gas CO<sub>2</sub> small scale



#### In progress

Gas and Dense CO<sub>2</sub> small scale



Completed



**In progress** 





#### In progress (May 2024)



## EMPIR Decarb:

Metrology for decarbonising the gas grid

# Thanks!

https://www.decarbgrid.eu/

