Publishable Summary for 18NRM06 NEWGASMET
Flow metering of renewable gases
(biogas, biomethane, hydrogen, syngas and mixtures with natural gas)

Overview

Development of renewable energy sources is encouraged by the European Renewable Energy Directive 2009/28/EC and by the European Green Deal. Renewable gases like biogas, biomethane, hydrogen or syngas can be used for this purpose. As they have characteristics that are slightly different from well-known natural gas, the industry needs to study their impact on available flowmeters and to demonstrate their compliance with the Measuring Instruments Directive 2014/32/EU. The objective of the present project is to publish reliable data that is needed by the metrological and industrial community, and to provide recommendations on renewable gas measurement with adapted gas meter standards.

Need

In future, European policy to increase renewable energy sources will have significant impact on the characteristics of energy gases throughout Europe and therefore on the European gas infrastructure:

- Power generation from wind and solar sources will lead to the development of so-called “power to gas (P2G)” solutions; these plants will compensate for fluctuating electricity supplies by converting electricity into hydrogen to be injected in large quantities into the gas network.
- Biogas produced by the anaerobic digestion of organic waste will need to be directly measured in cogeneration facilities or before injection into the gas network after purification to biomethane.

The gas network is connected within Europe but the gas supply is dependent on the coordination of national operators for transport and distribution (TSO and DSO); this industry first needs to draw an overview of existing disseminated scientific results related to metrology and different national renewable energy policies (objective 1).

This evolution of the gas energy mix is expected to impact the accuracy of measuring instruments that are used to bill transactions according to commercial contracts. Today gas meters are indeed tested, calibrated and certified according to the Measuring Instruments Directive (2014/32/EU), using EN or OIML standards which have been written for natural gas applications.

Experts are also expecting a significant influence on the design of gas meters and on the way to perform tests; but this impact still needs to be fully evaluated (objective 2). This situation also results in the current absence of accredited laboratories to provide metrological calibrations of the meters that are used with renewable gases (objective 3).

This project aims to address the need for a common European approach to evaluate the conformity of commercially available meters to EN standards and to MID directive, and to provide recommendations to adapt their designs and the associated standards documents (objective 4).

Objectives

The overall objective of the project is to increase knowledge about the accuracy and durability of commercially available gas meters after exposure to renewable gases. This should lead to the improvement of existing meter designs and flow calibration standards.

The specific objectives of the project are:

1. To assess the typical uses of renewable gas for which the effects on accuracy, costs and life time are not sufficiently known. Furthermore, to define an acceptable range of gas compositions, which will be suitable to support the new “renewable” framework and to list the missing tests which need to be performed during calibration to cover the use of renewable gases with existing gas meters.

2. To develop traceable methods for the type testing and verification of flow meters that are used to measure renewable gas flows in compliance with the requirements of the 2014/32/EU Measuring Instruments Directive and to determine the uncertainty budget. Uncertainties of 1/5 Maximum Permissible Error (MPE) have to be achieved for type testing and 1/3 MPE for field verification. In addition, this project will study and evaluate the integrity of the meters' internal components, the durability of the materials, the insulation of electronic components and other possible technical issues (dependent on the composition of the evaluated gas).
3. To validate the calibration methods and uncertainty budgets developed for two flow calibration standards via an appropriate inter-laboratory comparison and to carry out type testing procedures for domestic and commercial gas meters with hydrogen.

To contribute to the standards revision work in technical committees CEN/TC 237 and OIML TC8/SC7 to ensure that outputs from the project are aligned with their needs, communicated quickly to those developing the standards and to those who will use them, and in a form that can be incorporated into standards at the earliest opportunity.

Progress beyond the state of the art

Harmonised CEN/TC 237 standards and the OIML R137:2012 recommendation are used for the certification of the legal metrology meters that are intended for use with conventional natural gas. The use of renewable gases is not taken into account and no international studies about their impact are known by the industrial and laboratory community.

The goal of this project is first to gather available knowledge on the performance of existing gas meters with renewable gases. Based on experts' expectations the study focuses on accuracy and durability aspects and providing an overview of the gas compositions that can be produced, transported and metered in Europe. This bibliographic conclusion will highlight the global knowledge gaps faced by the scientific community and industry and define the most important areas which have to be studied.

The normative standards used to demonstrate conformity to the MID need to be challenged against the wider scope of metering renewable gases. Moreover tests will be defined and even performed within the scope of this project to systematically assess the extent to which current gas meter standards need modification.

The last goal of the project is to gather available knowledge on the principles that can be used for accuracy testing gas meters with renewable gases (in the scope of MID) and to deliver solutions which provide sufficiently low uncertainties (1/5 MPE for type testing).

Based on the operating ranges of currently available test facilities for hydrogen and methane, an inter-comparison test campaign will be held on domestic gas meters to demonstrate the equivalence of the existing flow calibration standards, as well as checking the applicability of new test procedures.

Results

Literature overview on the effects of renewable gases on flow meters

In 2020, the NEWGASMET project published deliverables related to a literature review. This study was first to be finalised to gather available knowledge on the performance of existing gas meters and to demonstrate whether they could be used with renewable gases. This study collected data from laboratories and industry actors with a survey that has been sent to project partners and 57 other interested parties throughout Europe, including gas manufacturers, calibration laboratories (NMIs) and Transmission/Distribution System Operators (TSO and DSO).

The conclusions of this study are as follows:

1) very few scientific data are available on the flow metering of renewable gases, especially about hydrogen metering, and this confirms the real expectations of the NEWGASMET project,

2) biomethane is considered throughout Europe as equivalent to natural gas and no impact is expected on the flowmeters' performance with this type of gas,

3) the hydrogen tightness of gas meters is a very specific challenge for the whole gas infrastructure and especially for gas flowmeters,

4) the state of the art is that the impact of blending 10 % hydrogen with natural gas is not expected to affect metrology performance,

5) the use of biogas (or even syngas) addresses the issue of contamination and composition variability related to the durability and accuracy of the instruments.

The literature study also defined an overview of the European gas network in relation to gas composition ranges as well as metering technologies used in the field. It was based on both published economic forecasts and answers to the survey. Depending on the type of gas, compositions are related to the blending rate for biomethane or hydrogen, or for the rate of contamination for biogas and syngas.

Development of traceable methods for type testing and verification of flow meters to measure renewable gas

An expert group has been created to study the theoretical impact of renewable gases on the standards that are used to demonstrate the conformity of gas meters to the European Measuring Instruments Directive 2014/32/UE (MID). This group is in close contact with the CEN/TC237 committee and they studied the impact on the technical standard that is used for the usual certification and testing processes of rotary, turbine, diaphragm, thermal mass flow, and ultrasonic gas meters. Suggestions for possible modification of the gas meter standards, in order to make them suitable for demonstrating compliance with the MID when using renewable gases, were communicated to the CEN/TC237 WG convenors for 5 out of the 6 gas meter standards (EN12480, EN12261, EN1359, EN14236 and prEN17526 European standards).

Evaluation of meter integrity after durability tests with renewable gas

This project has also organised durability tests with three major steps defined in a specific test protocol; (1) customary calibration by a European National Metrology Institute with air, (2) exposure to renewable gas, and (3) air calibration and investigation of gas meters by Energy Dispersive X-ray Analysis Scanning Electron Microscopy (EDX-SEM) after exposure. The meter types studied were domestic diaphragm, ultrasonic, and a thermal mass flow gas meter. These meters were donated by market-leading suppliers.

The prior air calibrations were completed, after which the gas meters were installed in a biogas flow plant and on two test benches for static hydrogen exposure. The planned duration of the durability tests is twelve months. Some meters will be removed after a shorter duration. The effect on meter performance will be determined in the coming months by comparing air calibrations after exposure with the initial air calibrations. Partners have also started activities to investigate the effect of static hydrogen exposure on the durability and accuracy of electronic volume conversion devices (EVCD's).

A study has been undertaken on the hydrogen tightness of gas meters. This has been performed with a specific test bench designed for that purpose which showed that pressure loss could be observed, depending on the meter type. It is planned to publish the hydrogen gas tightness results shortly.

Validation of calibration methods for two flow calibration standards and type testing for meters with hydrogen

A result of the ongoing literature study, taking into account the most important Journals and conferences, more than 60 publications were identified which provide information about flow standards that are usable for testing and calibrating gas meters with renewable gases. Classification of their content will be summarised with respect to influences and restrictions; this study will be used to create a generic uncertainty budget and bench marking of available flow standard techniques.

After checking the CMCs of the involved partners, 4 different flow rates and 3 test gases were defined which will be investigated in the foreseen inter-comparison. A transfer package using critical flow Venturis and a mechanical meter, or a laminar flow element in series, was designed and partly realised. A test of the metrological behaviour is starting in a NEWGASMET partner's laboratory.

NEWGASMET has also designed and realised test benches for the calibration and testing of gas meters as part of the conformity assessment with renewable gases. Modifications of the high pressure natural gas test bench are in progress in order to investigate meters with a larger flow rate range (up to Qmax=160 m3/h) at up to 10 bar working pressure with natural gas mixed with 20 % hydrogen. These activities allow us to carry out the gas meter tests that are necessary during type testing in the final stage of the project and to compare the results as a means to reach comparable results with the test houses, in particular, for hydrogen.

Impact

The project has built a very wide stakeholder committee to spread this knowledge to research organisations and industrial users. During first half of the project, NEWGASMET's objectives and conclusions of the bibliography study were presented at different national and international meetings such as CEN, Working Group Measuring Instruments (WGMI European Commission), Energy Gases EMN and Welmec.

Impact on industrial and other user communities

The results from the bibliographic study are considered as useful for the industrial and standardisation communities. The consortium has created a relevant dissemination network comprising active actors in the gas sector and authorities. In addition several new members have recently joined the stakeholder committee.

To promote new knowledge about the flow metering of renewable gases, and to broadly share the data generated during the project with scientific and industrial end-users, different partners participated in conferences organised by standardisation bodies and industry associations.

Meetings with the stakeholders have been held in continuation of the project meetings to spread progress and to ensure that the project is in line with the expectations from the industry. Furthermore the stakeholders' meeting has been used as an opportunity to present the first conclusions of the French DSO's project about the injection of hydrogen into the gas network.

Impact on the metrology and scientific communities

In relation to the development of traceable methods for renewable gases, a setup was developed by a National Metrology Institute to assess leaky gas meters; this development could become an exploitable result for use in the technical standards that are used to prove the hydrogen tightness of gas meters. This particular issue is crucial as existing gas meters can be tight with natural gas, but not with hydrogen.

The partners have also developed durability test setups for hydrogen and biogas. Using their expertise, these setups could be used for further durability test services, which would be of interest to gas meter manufacturers, DSOs and TSOs.

Impact on relevant standards

Contacts have been made with regulation authorities at national and European levels. The CEN/TC237 secretary is chief stakeholder and the other committee members include gas manufacturers and TSO/DSO. The results from the literature study and the preliminary outcome from the study of the EN-standards and OIML recommendations were presented at the CEN/TC 237 plenary meetings in 2020.

Furthermore the chief stakeholder was regularly invited to the project meetings to give recommendations and to take part in the stakeholder committee meeting.

Several partners are also involved in regular standardisation working groups such as Welmec (Measuring Instrument Directive harmonisation) or WGMI (European Commission Working Group for MID).

Longer-term economic, social and environmental impacts

The EU strategy plan aims to reduce greenhouse gas emissions by 40 % by 2030 compared to the 1990 level, and to increase the renewable share of total energy consumption to at least 27 %. This major change aims to decarbonise energy production and to avoid energy imports from countries outside Europe. These renewable energies are produced using natural processes that are constantly replenished such as electricity produced by solar, wind or biomass resources. A new process called P2G or P2X aims to transport this potential power to end-users using the existing European gas network by converting electricity into hydrogen, or Synthetic Natural Gas (SNG) when hydrogen is combined with carbon dioxide. Another way to develop energy bio-sources is to install biogas/biomethane facilities that are supplied by agricultural by-products or by bio-waste which can be burned or injected into the gas network.

By investigating the effect on gas meters and delivering solutions to industry and to standards bodies, this project will improve the confidence of consumers and suppliers in the billing of renewable gases. This will help to develop renewable resources in Europe in order to reduce fossil fuel consumption according to the European Union Directive for Renewable Energy.

List of publications

There are no peer-reviewed publications at this early stage of the project.

This list is also available here: https://www.euramet.org/repository/research-publications-repository-link/

Project start date and duration:	June 2019, 36 months	
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Internal Funded Partners: 1. LNE, France 2. Cesame, France 3. CMI, Czech Republic 4. FORCE, Denmark 5. NEL, United Kingdom 6. PTB, Germany 7. VSL, Netherlands	External Funded Partners: 8. Enagas, Spain 9. FHA, Spain 10. GRTgaz, France 11. ISSI, Italy	Unfunded Partners: 12. HONEYWELL, Germany 13. ITRON, Germany 14. METERSIT, Italy 15. SICK, Germany
RMG: -		