Launch of EU-funded project CryoMet that will develop methods of reliable measurement for bio-liquefied natural gas (bio-)LNG and liquefied hydrogen (LH_2)

- *An increased usage of liquefied energy gases will help the EU to reach the 55 % net greenhouse gas emissions reduction by 2030 goal*
- *The project consortium is made up of 20 partners from 11 EU countries*

The EU-funded project *CryoMet* (Metrology for Reliable Liquefied Energy Gases Measurement) aims to expand the European liquified gas metrological framework, focusing on (bio-) liquefied natural gas (LNG) and liquified hydrogen (LH_2). The project's outcomes will support the uptake of these gases, a required measure within the framework of the ”Fit for 55” package of legislation, aiming to achieve a 55 % net reduction in greenhouse gas emissions by 2030.

Despite the legislative requirements for increased use of liquefied energy, the current measurement uncertainty for flow, composition, and temperature measurements in liquefied gas in-field conditions is relatively large compared to gaseous energy gases. A liquefied gas metrology project is therefore urgently needed to facilitate a safe, secure, affordable, and sustainable energy system.

(Bio-)LNG is an immediate (drop-in) and affordable decarbonised fuel option, and renewable LH_2 is a key element in decarbonised aviation. Currently, the accepted measurement methods for (bio-)LNG and LH_2 are lacking verified accuracy under in-field process conditions with sufficiently low uncertainties.

The overall goal of CryoMet is to determine the accuracy of (bio-)LNG measurement systems under in-field custody transfer process conditions and to reliably establish achievable accuracy for LH_2 measurement systems. To accomplish this task, the project will tackle this main goal from four different complementary perspectives.

First, the project will determine the measurement reliability and uncertainty of (bio-)LNG flow meters in-field, developing also traceable (bio-)LNG and LH_2 meter diagnostics. Second, CryoMet will determine the reliability of (bio-)LNG composition and density measurements. Third, the accuracy of liquefied gas in-field temperature measurements is determined down to –253 °C (as applicable to LH_2), including the impact of static and dynamic effects on the temperature measurement system. Fourth, and related to the last-mentioned one, the CryoMet consortium will also perform SI-traceable flow and temperature measurements in LH_2 conditions, to develop SI-traceable calibration procedures for LH_2 flow, hydrogen isomeric composition (para/ortho), and temperature measurement systems. All these procedures will facilitate the take-up of the technology and measurement infrastructure developed in the project by the measurement supply chain and documentary standardisation bodies involved with liquefied gases.

Outcomes for industrial and other user communities

The improvement in in-field (bio-)LNG density measurement uncertainty from 0.45 % (k = 2) to 0.3 % (k = 2) and the project's reference data sets will be crucial for improving LNG transport and distribution value chains. Also, the project's good-practice guide for LNG and bio-LNG sampling will support TSOs/DSOs, (bio-)LNG plant operators, and (liquefied) natural gas traders in the reduction of systematic vaporisation and sampling errors, and hence a reduction in concomitant uncertainty. On the other hand, improved LH_2 temperature measurement accuracy will support the upscaling of LH_2 production plants and long-haul LH_2 transport systems.

Outcomes for the metrology and scientific communities and standardisation bodies

The project's development of SI-traceable isomer composition (para- and ortho-hydrogen) determination of LH_2 at low uncertainty (1.0 %, k = 2) will enable scientists to perform consistent LH_2 composition measurements. In turn, it will stimulate the development of accurate thermodynamic (EoS) property measurements and modelling. The aerospace

research community will also benefit from improved accuracy of LH_2 (and LNG) standards for flow, composition, and temperature, as this will support their development of prototype components for sustainable aviation and aerospace applications. Regarding the metrology community, the project's inter-comparisons for (bio-)LNG and LH_2 flow, composition, and temperature measurement standards can be used to create a foundation for a European liquefied gas measurement metrological framework. The consortium already has well-established links to relevant standardisation committees to transfer any contribution to the standards' development.

Long-term economic, social and environmental impacts

The project will support the achievability of reliable liquefied gas measurements across the entire supply chain. Cost-effective composition measurements will help to support the proliferation of replacing fossil LNG with drop-in bio-LNG fuel, leading to immediate decarbonisation in the heavy-duty transportation sector. The accuracy of LH_2 isomer composition and temperature measurements will also lead to robust risk assessments of LH_2 use. For aviation, the projects' LH_2 SI-traceability will help the development of operational aircraft using hydrogen as a fuel.

In economic terms, LNG imports currently account for approximately 37 % of the EU's natural gas imports. The development of this reliable measurement framework will mitigate the risk of energy price increases, reducing the volatility seen in energy prices in recent years. In addition, by facilitating a secure and affordable energy system, the project will help to improve the EU's economic competitiveness.

The project (24GRD07 CryoMet) has received funding from the European Partnership on Metrology, co-financed by the European Union Horizon Europe Research and Innovation Programme and from the Participating States. In total, the project receives from the European Partnership on Metrology €2.6 million funding.

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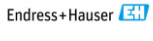
Consortium

The consortium is made up of 20 partners from 11 countries:

Logo	Partner and description
	VSL (NL): VSL coordinated the three LNG metrology projects under EMRP/EMPIR and is coordinating this project. VSL established the unique SI-traceable LNG calibration and test facility ("VSL's LNG facility") for flow and quality measurements, which is used in the project for the generation of reference data sets and development of calibration procedures. VSL further developed traceability for LH_2 flow in 20IND11 MetHyInfra. VSL is a worldwide leading NMI in flow, composition, and temperature measurement and LNG metrological research.
	Cesame Exadébit (Cesame, FR): Cesame is the French DI for medium and high gas flows. Cesame was involved in LNG metrology projects under EMRP/EMPIR where it developed the cryogenic LDV LNG flow standard. Cesame further developed traceability for LH2 flow in 20IND11 MetHyInfra.
	Czech Metrology Institute (CMI, CZ): CMI is the NMI of the Czech Republic. CMI has experience with CFD modelling of cryogenic flows, aiding standards development as part of projects under EMRP/EMPIR, using CMI's computational cluster with OpenFoam software. CMI has experience with cryogenic calibration of measurement instruments of road tankers using a CFM master meter.
	University of Zagreb, Faculty of Mechanical Engineering and Naval Architecture (FSB, HR): FSB is the Croatian DI responsible for temperature, pressure and humidity. The lab's current focus is on expanding contact thermometry calibration capabilities in the low-temperature range. This includes evaluating calibration and measurement uncertainties, sensor characterisation, numerical simulations (heat gain) and developing measurement devices and software.
	TUV SUD Limited (NEL, UK): NEL is the DI responsible for supporting the UK national standards for flow. NEL is experienced in LNG composition and sampling system research and will contribute to thermodynamic (indirect) LNG density determination in this project.
	National Physical Laboratory (NPL, UK): NPL is the UK's NMI and has world-leading capability and expertise for low uncertainty thermometry from 4 K to > 3000 K. NPL has coordinated several temperature metrology projects (HiTeMS, SIB01 InK1, 15SIB02 InK2, and 18SIB02 Real-K). NPL will provide its expertise in low temperature measurements and uncertainty evaluation and take part in the international comparison of low temperature sensors.

PTB Physikalisch-Technische Bundesanstalt National Metrology Institute	German National Metrological Institute (PTB, DE): PTB is the German NMI and has extensive experience, apparatus and facilities to realise primary and practical thermometry. It is the only NMI that realises and disseminates both the ITS-90 and the PLTS 2000 in the range from 0.9 mK to 3300 K. PTB has participated in many European thermometry and hydrogen-related projects. PTB will ensure the SI-traceability of temperature measurements in the project down to LH2 temperatures.
RI. SE	RISE Research Institutes of Sweden (RISE, SE): RISE is the Swedish NMI and national laboratory for the gas analysis of energy gases, and it has a strong profile directed to the gas industry. RISE has abundant experience with the development and validation of sampling and analytical methods for energy gases (liquefied or gaseous) and dedicated testing rigs. RISE has participated in many projects related to hydrogen and biomethane gas metrology. RISE is currently coordinating 21NRM04 BiometCAP (2022-2025) and 22NRM03 MetHyTrucks (2023-2026).
TÜBİTAK	The Scientific and Technological Research Council of Türkiye (TÜBITAK, TR): TÜBITAK has experience in energy gases and will bring its gas mixture preparation and analysis experience to support the work on static reference standards by using its existing gas mixture preparation facilities and gas measurement systems. TÜBITAK will contribute to this project with reference standards and reference data set creation.
EffecTech	EffecTech (UK): EffecTech is a leading company in gas measurement, providing accredited inspection, calibration and testing services to the energy and power industries for gas quality, flow and total energy metering. EffecTech will bring its expertise to the project and will calibrate Raman spectrometers with its unique accredited liquefier that can generate “reference LNG”.
GERG THE EUROPEAN GAS RESEARCH GROUP	European Gas Research Group (GERG, BE): GERG – the European Gas Research Group, is a non-profit international research association with a membership of European gas companies across the value chain, universities, and research centres. The association’s priorities include hydrogen and biomethane. Taking advantage of its network of stakeholders from industry, academia, and standardisation, GERG has expertise in coordination, knowledge management, and dissemination for R&D projects.
IMPERIAL	Imperial College of Science, Technology and Medicine (IMPERIAL, IC): IC is a world-leading university, and its Thermophysics Laboratory specialises in precision experimental measurements of fluid properties over wide ranges of temperature, pressure, and chemical composition. The group has world-leading expertise in measurements of the speed of sound and is equipped with the facilities necessary to work safely with compressed and liquefied hydrogen. IC will develop one of the two methods for hydrogen ortho- and para-spin isomer composition and will contribute to direct LNG density determination.

	Institute for Energy Technology (IFE, NO): IFE is the Institute for Energy Technology in Norway and a leader in energy research, especially concerning energy gases, biogas and the petroleum sector. IFE's efforts focus on developing strategies to minimise greenhouse gas emissions and optimise energy systems, enhancing efficiency and sustainability in energy production. IFE will participate in field studies on comparisons of bio-LNG composition measuring systems, demonstrating new sensor (Raman) technology.
	Leibniz Universität Hannover (LUH, DE): LUH has one of the strongest German transfer programs and is home to a world-leading research group for accurate thermophysical property research of fluids (mixtures) over a wide temperature and pressure range. Its experience comprises natural gas and hydrogen, e.g., involving (cryogenic) densimetry and (LH2) Raman spectroscopy. LUH will use its laboratory infrastructure and expertise to develop one of the two methods for hydrogen ortho- and para-spin isomer composition and direct LNG density determination.
	Royal Netherlands Aerospace Centre (NLR, NL): NLR is the Netherlands' main research establishment for aviation and aerospace. NLR is involved in the development of hydrogen technology for aviation and aerospace applications, including researching hydrogen fuel cells for aircraft, developing new materials and technologies for hydrogen storage and transportation, designing and optimising aircraft for hydrogen fuel cell propulsion, and addressing safety and regulatory aspects of hydrogen use in aviation. NLR has unique test capabilities for LH_2 flow and will use them to develop a LH_2 flow standards test programme.
	Ilmenau University of Technology (TU-IL, DE): TU-IL is a German University of Technology represented by the department of process measurement and sensor technology. Its research includes nano-scale dimensional and temperature measurements. It has broad expertise in the investigation of temperature sensors and thermometers, thermal modelling, calibration and development of calibration and testing equipment for sensors and thermometers. TU-IL will contribute by (I) developing a unique calibration facility for industrial thermometer calibration, modelling and testing of (II) thermometers, and (III) measuring points for the estimation of thermal errors.
	University of Ljubljana (UL, SL): UL includes a metrology research group at the Faculty of Mechanical Engineering at the University of Ljubljana, whose central fields of research are fluid flow metrology and measurement dynamics. UL will contribute its research experience in cryogenic CFM modelling for the investigation of fluid, pressure and temperature-related effects under liquefied gas conditions. UL will also participate in the review of available technologies, modelling and evaluation of uncertainty contributions in liquefied gas temperature measurements.
	Endress+Hauser Wetzer GmbH Co KG (E+H, DE): E+H The entity E+H Wetzer GmbH & Co KG in Germany provides solutions for temperature measurement and recording. It supports the project by providing experimental, industrial probes for measurements.

Endress+Hauser	Endress+Hauser Flow Deutschland GmbH (EHFL, DE): EHFL is the branch of Endress+Hauser which provides solutions for fluid flow measurements and will support the project by providing flow measurement devices and expertise.
EMERSON	Emerson M (NL): Emerson M is a global leader in automation technology and software. Emerson M helps customers in varied industries by providing CFMs, which are installed in field conditions. Emerson M is specialised in CFM manufacturing and will provide equipment samples and expertise in this area.