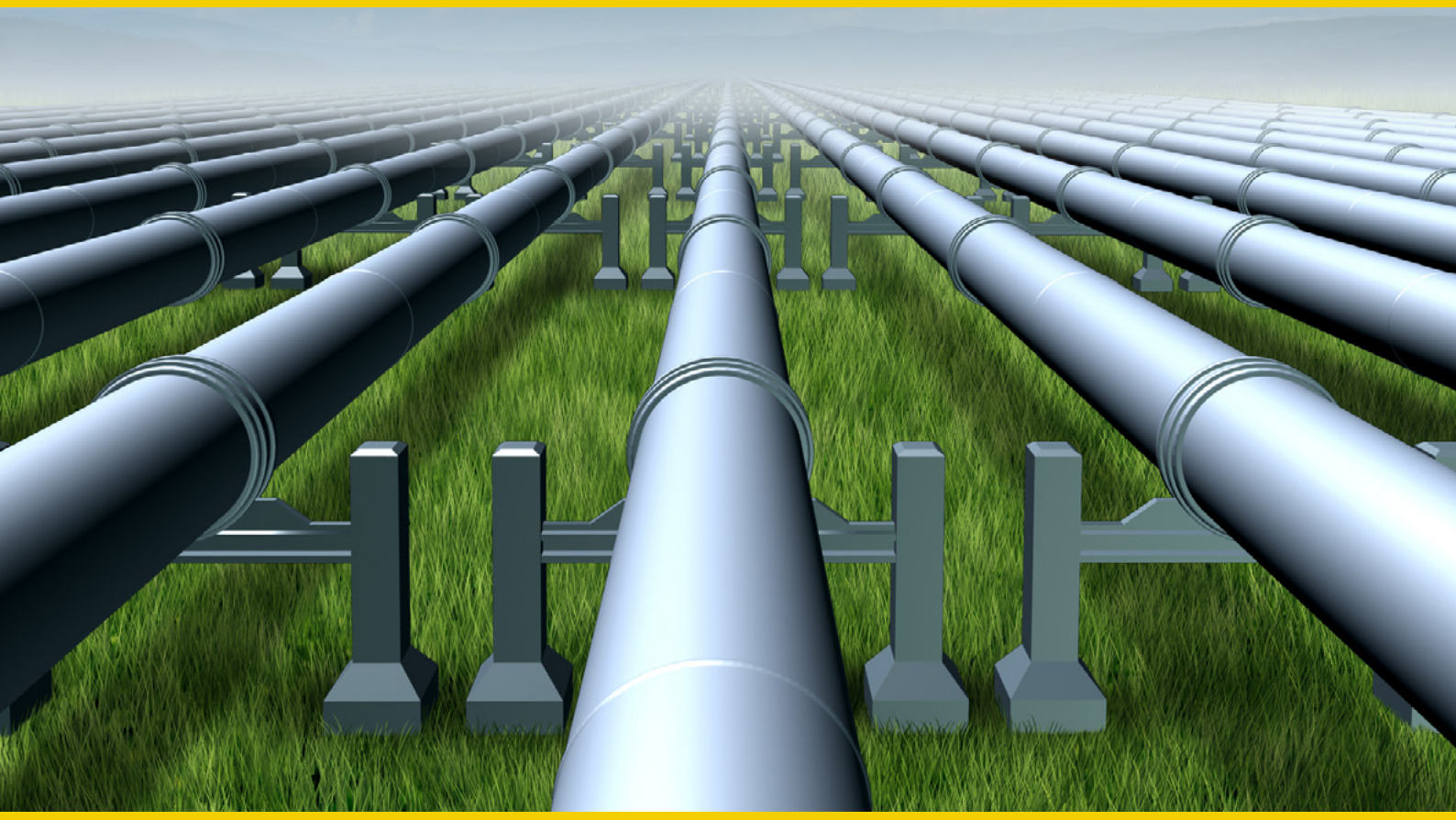
European Metrology Research Programme

Delivering Impact



A new sensor for the liquid natural gas grid

The use of liquid natural gas (LNG) as a fuel is as an essential step towards making Europe carbon neutral. However, accurate knowledge of its composition, which varies depending upon the location of its extraction, and can change upon transportation and storage, is vital to ensure confidence in the trade and uptake of LNG.

Europe's National Measurement Institutes working together

The European Metrology Programme for Innovation and Research (EMPIR) has been developed as part of Horizon 2020, the EU Framework Programme for Research and Innovation. EMPIR funding is drawn from 28 participating EURAMET member states to support collaborative research between Measurement Institutes, academia and industry both within and outside Europe to address key metrology challenges and ensure that measurement science meets the future.

Challenge

Europe aims to be carbon-neutral by 2050 and use of Liquid Natural Gas (LNG) has been identified as an essential step during this energy transition. The amount of energy in LNG is proportional to the methane content, given by the 'methane number' (MN), with 100 MN being equivalent to 100 % methane. By measuring the LNG composition, one is able to determine the MN of the gas. Furthermore, the energy content can be calculated, which is necessary for example in trade and billing.

However, LNG composition varies depending upon the extraction location and can change during processing, transport and storage. Thus, it's essential to accurately measure it at each stage, from extraction to injection into the supply and distribution networks, or in the fuel line of a gas engine.

Updating the networks to smart gas grids, 'intelligent' digitised networks that monitor quality and consumption in real-time, optimise energy use and better integrate renewables such as biomethane, has been identified as a priority by the Trans-European Networks for Energy.

Traditionally methods such as gas chromatography (GC) are used to analyse LNG composition. However, chromatograph instruments are too large to be used as in-line sensors for smart grids and too expensive to be used at all the points a distributed sensor network requires. New, accurate, smaller LNG composition sensors are required to help Europe decarbonise its energy use at the lowest societal cost.

Solution

During the EMPIR project LNG III, project partner TNO validated an innovative capacitive sensor array (CSA) to measure the composition of LNG in its gas phase.

The sensor has a series of capacitive chips, coated with responsive coatings. The coatings absorb the gasses in the LNG gas mixtures, which results in a change in the electrical properties of the coating. This change is measured by the chips connected to a printed circuit board and converted to the full composition of the gas, using a smart conversion algorithm.

The sensor array was tested against 16 standard gas mixtures prepared in the project, containing methane, ethane, propane, butane, pentane and their isomers, which formed a common, traceable reference set. Its ability for in-line monitoring was then assessed in a feedline of a truck engine.

The sensor was further improved with the addition of two chips for sensing temperature and pressure and a microprocessor to transmit the data remotely. The validation stage was then repeated with the reference gases and comparison to GC. This demonstrated the ability of the chip to rapidly respond to gas composition and permitted calculation of the MN with an accuracy of approximately 1 MN unit.

Impact

TNO, based in the Netherlands, is an independent, not-for-profit-research organisation working to connect people and knowledge to create innovations that boost the competitive strength of industry and the well-being of society in a sustainable way.

The innovative CSA developed by TNO is small (~30 cm^3) allowing in-situ measurements of LNG in gas engine fuel lines, pipes or other network components. It is also robust, requiring little maintenance or calibration, and can communicate over the ethernet to a central control point to collate information in real-time.

The new, cost-effective sensor, along with the modelling systems for its use from TNO, is ideal for use in the smart gas distribution networks. This enables fair billing of LNG during custody transfer and also speed up the integration of renewables such as biomethane or hydrogen into the grid. This is an essential step towards making Europe the first carbon neutral continent.

Improved measurements for making Europe carbon neutral

The LNG III project delivered new facilities and instruments improving measurements for liquefied natural gas (LNG) and liquefied biogas (LBG).

It completed the world's first facility for metrological determination of LNG flow and composition. The project supported development of the international standard ISO 21903:2020, specifying requirements for flow meters measuring refrigerated hydrocarbons. Three new sensors for LNG composition and methane number were developed – a Capacitive Sensor Array (CSA) , a Tuneable Filter Infrared (TFIR), and a Fourier Transform Infrared (FTIR), along with the world's first metrologically validated liquefier for calibration of optical probes measuring LNG composition directly. A primary standard for flow was also validated that can act as a transfer standard. A good practice guide was produced, highlighting the issues associated with LNG traceable measurements.

This work will improve trust in LNG and LBG as clean alternatives to oil and diesel and help make Europe carbon neutral by 2050.

EMPIR EURAMET

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