

# Fusion-H<sub>2</sub> - Breakthrough Hydrogen Flow Sensor

Revolutionising hydrogen measurement with advanced ultrasonic technology built with future proof lead-free materials

## Key Deliverables

### Development of the Fusion-H<sub>2</sub> flow sensor

- A groundbreaking ultrasonic sensor design, specifically for hydrogen flow metering, utilising the latest high-performance lead-free XLF piezoelectric ceramics developed by Ionix.

### Addressing the challenges of lead-free ceramics with the revolutionary XLF material series

- Overcoming poor sensitivity compared to current lead-free materials suitable for elevated temperature operation.
- Avoiding high manufacturing costs with water-based processing and mitigating reliance on rare earth materials.

### Meeting hydrogen metering requirements

- Tackling the challenges posed by hydrogen's relatively high speed of sound, which leads to wide beam spread, increased noise, and low signal strength – by providing sensors with high sensitivity, focused beam architecture, and wide operating temperature range (-200 to 350°C) whilst being intrinsically safe.

### Testing and Validation

- Sensors successfully constructed and tested in hydrogen and hydrogen mixtures with validation by Hydrogen UK Infrastructure.

## Overview

Ionix are proud to have been chosen as a partner for the UK government's 'Future Grid' project, to develop the FUSION-H<sub>2</sub> sensor – a novel ultrasonic meter specifically designed for hydrogen flow measurement. This innovative technology, being developed with lead-free piezoelectric materials, addresses the most pressing challenges in the field, establishing new benchmarks for innovation and precision.

Hydrogen is set to be a key player in the UK's journey towards net zero, offering low-carbon solutions essential for a deeply decarbonised and renewable energy system. As a versatile alternative to high-carbon fuels, low-carbon hydrogen can significantly reduce emissions across critical UK industrial sectors while providing flexible energy for power, heat, and transport.

The UK is uniquely positioned to foster a robust hydrogen economy, leveraging its vision, resources, and expertise. With world-class innovation, UK companies have the opportunity to thrive in both domestic and global markets. In support of the UK Hydrogen Economy, Ionix aligns its work with the UK Hydrogen Strategy to facilitate the transition to a low-carbon energy system, ultimately supporting the country's net-zero commitments. The UK Hydrogen Strategy outlines a roadmap for the 2020s, aiming to achieve a 5GW production target by 2030 and support the nation's Sixth Carbon Budget and net-zero commitments.

## The Challenge

Hydrogen is set to become a vital element of sustainable energy in the future, but accurately measuring its flow presents several significant challenges.



- Re-purposing gas networks demands high-fidelity metering for custody exchange and effective leak detection.
- Conventional ultrasonic flow meters struggle with hydrogen due to the high speed of sound (over 1,300 m/s), leading to wide beam spread, increased noise, and low signal-to-noise.
- Future proofing sensors requires lead-free materials as incoming legislation will act to gradually restrict the use of lead in electronic ceramics, including PZT.
- High bandwidth and wide operating temperature range are essential as hydrogen mixtures will likely contain methane and carbon dioxide, with requirements spanning -200 to 350°C.
- Meeting the milestone set for 2025 to conduct technology testing on the UK Future Grid, contributing to the development of safe and reliable hydrogen transmission.

## The Solution

New applications require new materials and solutions, the Ionix HotSense™ platform with XLF lead-free materials is specifically designed to overcome the demanding challenges of hydrogen metering. The FUSION-H<sub>2</sub> sensor represents a breakthrough in hydrogen flow measurement, addressing key challenges with:

- Increased sensitivity lead-free ceramics, to overcome traditional lead-free materials, exhibiting an order of magnitude increase in signal strength.
- A 250 kHz, high directivity probe designed to overcome wide beam spread, and reduce signal-to-noise found with conventional probes in hydrogen gas.
- Material selection, adapting to hydrogen's unique properties, by removal of organic and hydrogen sensitive materials to prevent embrittlement and increase the temperature operation range.
- Built on the HotSense™ platform, to enable continuous operation across a wide temperature range up to 350°C.



*Intrinsically safe, hydrogen flow metering transducer operating at 250 kHz, from -200 to +350°C continuously.*

## Execution

Ionix, with gas metering partners, have successfully built and tested hydrogen flow metering in mixtures from 0 to 100% hydrogen, demonstrating:

- High sensitivity through gas mixtures, including hydrogen, carbon dioxide, and methane.
- High directivity to overcome the issues of high speed of sound hydrogen mixtures.
- Wide continuous operating temperatures from -200 to +350°C in an intrinsically safe package.