Hydrogen monitoring & measurement: Evidence report to support LDAR and MCERTS development

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Content

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Background: Hydrogen Landscape

Hydrogen indirect greenhouse gas (impact on atmospheric chemistry):

- It reacts with the hydroxyl radical (·OH) extending methane's (CH_4) atmospheric lifetime, increasing tropospheric ozone, and increasing stratospheric water vapour (all contributing to warming).
- It has an estimated Global Warming Potential (GWP_{100}) of ~12 relative to CO_2.

Minimising emissions: essential to ensure **safety,** maintain **efficiency** and security, and **protect the climate benefits** of hydrogen deployment.

Robust **evidence and measurement capability** are needed to understand emission rates and to detect and locate leaks effectively.

There are currently **no agreed standard methods for monitoring and measuring hydrogen emissions** across the value chain, limiting regulatory and industry confidence.

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Background: LDAR and MCERTS

Leak Detection and Repair (LDAR):

- LDAR scheme aims to **identify, quantify and minimise fugitive emissions** from equipment and components, while improving **environmental performance and process safety**.
- Must align with **Best Available Techniques (BAT)** as described in relevant BAT Reference Documents (BREFs) and acknowledge existing key standards.
- Be **integrated into broader UK strategies** including the *methane action plan, Fugitive Emissions Strategy 2022*, and delivery mechanisms such as the *Green Gas Support Scheme*.

Environment Agency's Monitoring Certification Scheme (MCERTS):

An MCERTS scheme provides a framework for **personnel, equipment and organisations** to demonstrate compliance with **defined quality and performance requirements** for the monitoring and periodic surveillance of emissions to the environment.

Any industrial setting using hydrogen is expected then to have MCERTS and LDAR schemes in place prior to operations (next 3 to 5 years).
As of today, **none of these schemes are setup or defined for hydrogen**.

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Project Objective & Deliverables

Commissioned to National Physical Laboratory (NPL)

To produce an evidence report to support the development of standards (MCERTS/LDAR [1]) for the monitoring and measurement of hydrogen emissions

Key deliverables:

- **Collate existing evidence** on current and emerging hydrogen monitoring and measurement techniques and assess their **performance and suitability** for regulatory use.
- **Identify technical gaps and challenges**, including sensitivity, selectivity, calibration, and deployment constraints, and **define high-level requirements** for future standards.
- **Structure the evidence base** so that it can be readily used to develop **draft standards for submission** to the British Standards Institution (BSI) in the future.

(1) MCERTS (Monitoring Certification Scheme): GOV.UK MCERTS page; LDAR (Leak Detection and Repair): EPA's LDAR Best Practices Guide

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Previous work

Pre Normative Hydrogen Release Assessment (NHyRA) (2024 – 2026)

- Funded by the Clean Hydrogen Partnership.
- Development and validation of methods to detect and quantify fugitive hydrogen emissions at component spatial scale.
- Leak detection using sniffer instruments and acoustic cameras.
- Leak quantification using the high flow sampling method.
- Connor et al (2025). Review of monitoring methods; https://doi.org/10.1016/j.meaene.2025.100069
- Validation of calculation-based methods: fugitive, vented and incomplete combustion.
- Design of an emissions database.

Measurement campaign (2025)

- Undertaken by NPL and funded by DESNZ. Field campaigns to detect and quantify of fugitive emissions.

Report by EA's Chief Scientist's Group (2025)

- Net zero: Hydrogen monitoring review: summary - GOV.UK

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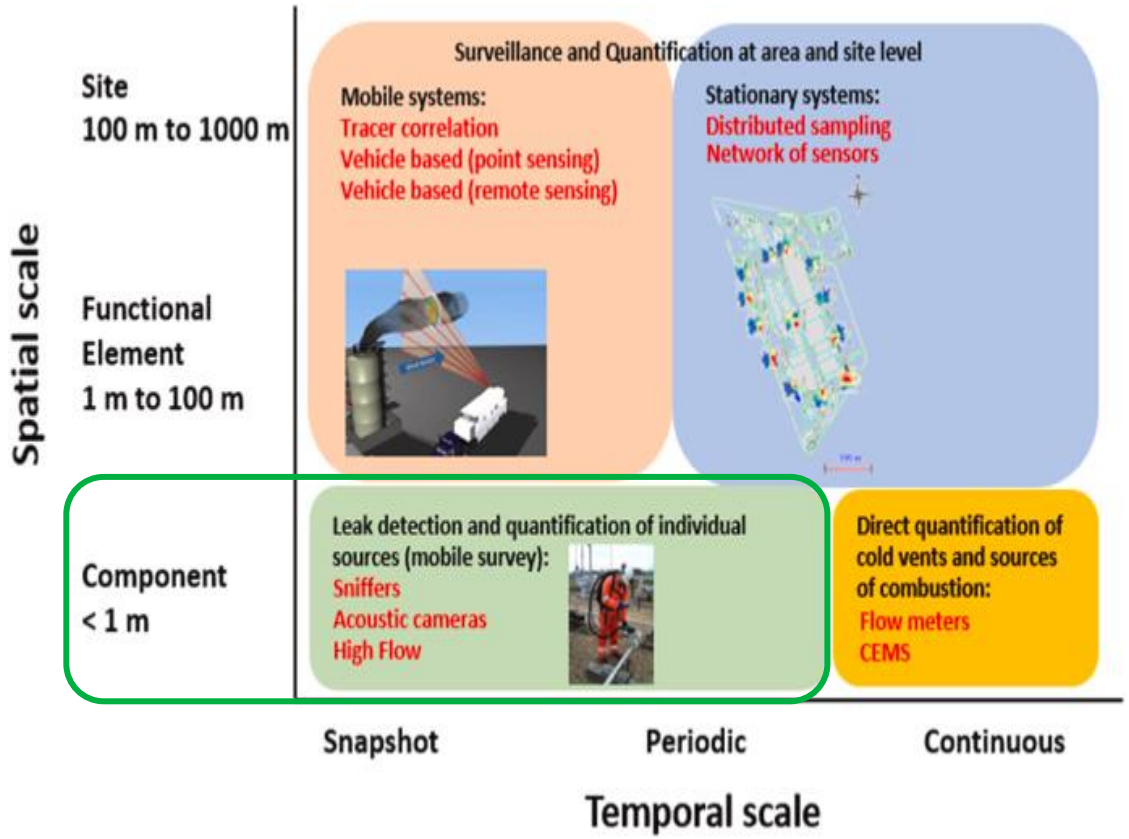
Scope

- Hydrogen value chain with focus on production

- Focus on **measurements of emissions at component level** (< 1m; as per spatial scale): direct measuring leaks from small components (i.e., flanges).
- Leak detection and quantification of individual sources.
- Quantify because relying on concentration itself to represent emissions is quite challenging.



Temporal and spatial measurement scales involved in monitoring a site. **X-axis:** temporal scale from 'snapshot' to continuous measurement. **Y-axis:** spatial scale; component (e.g., a flange), functional element (e.g., a storage tank), site and multiple sites clustered together.

Connor, A., et al (2025). Measurement: Energy. 8:100069. https://doi.org/10.1016/j.meaene.2025.100069

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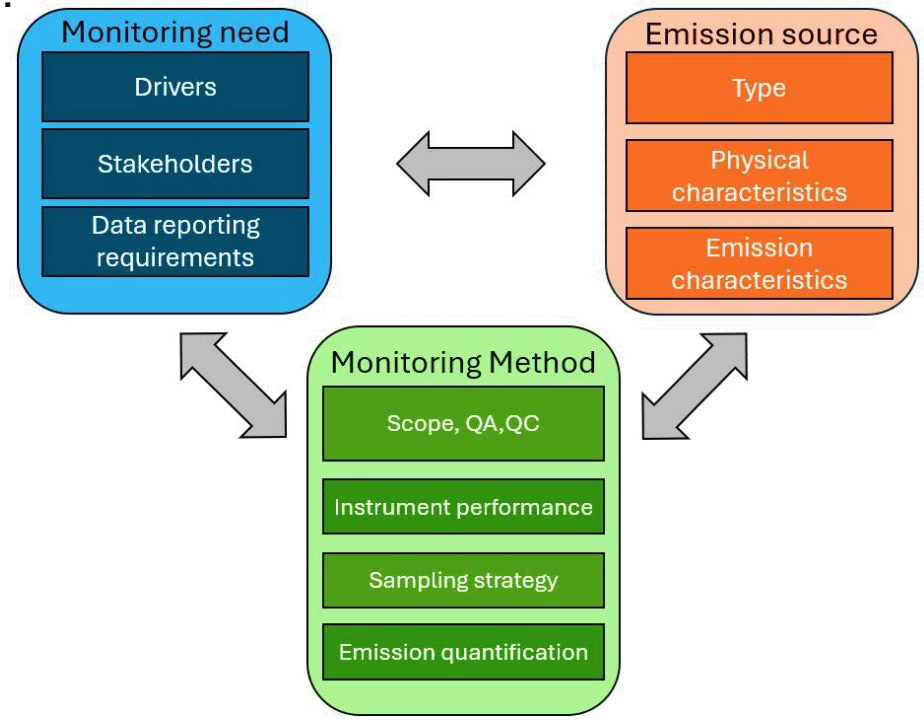
Methodology

- Collate knowledge on existing and emerging techniques.
  - Update on current techniques: their scope, limitations and availability (builds on previous work).
- LDAR and MCERTS standards (gaps, challenges and requirements):
  - An overview of hydrogen production sites: current and future.
  - How emissions should be described and reported.
  - Lessons learnt from recent hydrogen measurement campaigns.
  - How to define data reporting requirements.
  - To define what a measurement-based method is and its lifecycle.
  - LDAR and MCERTS - how schemes could look like for hydrogen.
- Stakeholder workshop between NPL, Government and industry.



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LDAR: examples and challenges for hydrogen

EU Best Available Technique (BAT) (e.g. refining of mineral oil and gas):

- Leak Detection And Repair (LDAR) based on portable sniffing (EN15446).
- Fugitive emission of Volatile Organic Compounds (VOCs) from leaking infrastructure.
- Measure concentration of leak, set of correlations to estimate mass emissions.
- Optical Gas Imaging, Differential Absorption Lidar, Solar Occultation Flux – not suited for hydrogen and Reverse Dispersion Modelling.
- EN17628 – standard set of methods for fugitive and diffuse emissions (VOCs)

LDAR for hydrogen:

- Techniques based on absorption spectroscopy – poor sensitivity.
- Adopt methods developed and validated i.e., NHyRA project: optical methods, Raman spectroscopy, etc.
- Challenges: physical access of components, non continuous nature of some leaks.
- Sensor based challenges: environment, cross interference, specificity to hydrogen.

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MCERTS requirements

- Product certification – performance standards (potentially adaptable to hydrogen emissions).
  - HEMS[1] (stack and borehole, currently no MCERTs scheme for fugitive hydrogen).
  - Consider adapting **EN15267**:
    - 1 and 2. General principles and assessment of manufacturers quality system.
    - 4. Performance criteria for automated measurement systems P-AMS. Use this as a basis for passive sensors, sniffers and high flow sampler for hydrogen at component level.
  - Performance: laboratory and field based (ensure reliability under real conditions).
- Personnel certification (depends on technique and use of data)
  - Depends on technique. e.g. what competency is required for emerging techniques such as acoustic cameras?
- Organisational accreditation.

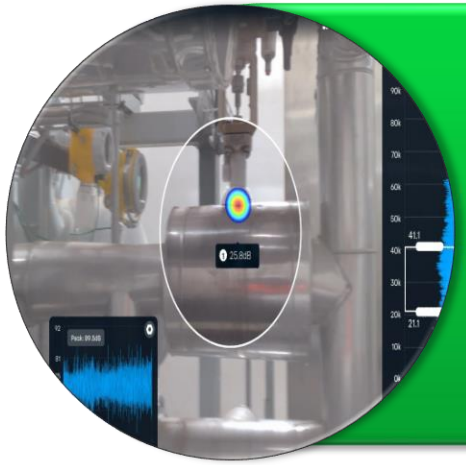
[1] HEMS: Handheld Emissions Monitoring Systems; MCERTS: Performance standard for handheld emissions monitoring systems - GOV.UK

On-field campaigns

Undertaken by NPL, funded by DESNZ

High-flow

- Hydrogen leak detection campaigns on ***refurbished infrastructure, new hydrogen-ready industrial site, and a hydrogen-specific site***
- **Large number of components surveyed** (~1100) identifying relatively **small number of leaks** (48) (most **at low emission rates**)
- Most detectable leaks (0.005–8.5 L/min) were quantified
- Very small/transient leaks sometimes missed (*i.e., dilution, detector limits, accessibility constraints and complex geometries*).



Acoustic camera

- Acoustic camera was trialled as an **indirect, indicative detection technique**, useful for **rapid screening** and complementing sniffers.
- Performance **strongly influenced by site-specific factors** (e.g. *materials, leak geometry, line-of-sight*) and **not yet suitable for robust quantification**.

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Workshop

Purpose: To understand the key challenges and barriers for implementing LDAR and MCERTS for hydrogen detection and quantification at component level.

Key findings:

- **No single monitoring technique fits all needs**: methods are often complementary, with clearly different roles for detection and quantification; scope, limitations and uncertainties must be explicitly understood.
- **Evidence gaps** remain significant, particularly for quantification uncertainty, emission behaviour, and non-fugitive sources (e.g. venting and combustion slip); **current hydrogen data are insufficient** to derive emission factors or correlations.
- **Practical experience is critical**, especially for emerging techniques, requiring real-world testing, validation and collaboration with industry to build confidence and support defensible regulatory decisions.
- **Strong demand for guidance (pre-standards):** participants highlighted the need for best-practice guides (e.g. for acoustic cameras and site surveys), clearer expectations for instrument suppliers, and early thinking on scalable MCERTS-style certification and validation frameworks.
- Ongoing **collaboration and data sharing between regulators, industry and researchers is essential** to accelerate development and underpin future hydrogen-specific LDAR and MCERTS standards.

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Conclusions

- The project **assessed the monitoring and measurement needs for future LDAR and MCERTS standards** for hydrogen within the EA permitting framework.

- Effective mitigation depends on **reliable, comparable emissions data, underpinned by robust metrology**, validated methods and assured performance in field conditions.

- A significant **evidence gap remains in measured hydrogen emissions across site types and components**, limiting the ability to establish permitting conditions and compliance expectations.

- Key **capability gaps include continuous monitoring and wide-area/remote techniques**, including inaccessible or complex locations.

- **No current MCERTS standard covers fugitive hydrogen emissions**; development of a hydrogen-specific standard could build on the structure and principles of **EN 15267-4**, adapted to hydrogen's properties and use cases.

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Next steps

Report to be published by NPL in the next few months.

Explore developing interim guidance for permits: *Hydrogen monitoring & measurements*.

Creating a **working group** on standards and guidance for hydrogen monitoring and reporting.

Gathering feedback and suggestions from specialised groups like this one on what is going on.

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Any Questions?

Thanks!

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