

# **Hydrogen infrastructure in the UK: Regulatory challenges and scientific knowledge gaps**

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# Outline

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- Background to UK major hazards regulation
  - COMAH
  - Land-use planning
  - Pipelines
  - Other relevant regulations
- Regulatory and policy development challenges
- Scientific planning for Net Zero
  - Risk models for hydrogen pipelines
  - Hydrogen storage
  - Material compatibility
  - Risk assessment and hazardous area classification
- Concluding remarks

# COMAH

- **Control of Major Accident Hazards (COMAH) Regulations 2015**
- Implements the majority of the Seveso III Directive (2012/18/EU) in Great Britain
- Competent authority: HSE, Environment Agency (EA, SEPA, NRW), ONR
- All sites: reduce risks to As Low As Reasonably Practicable (ALARP)
- Adopt relevant good practice as a minimum (ACOPs, ISO, CEN, API etc.)
- QRA not always necessary to demonstrate ALARP
- Additional duties for upper tier sites: Safety Report, Major Accident Prevention Policy, test external emergency plan, provide public information
- Dangerous substances defined according to Classification, Labelling and Packaging Regulation 2008 (CLP) and its amendments

	Lower Tier	Upper Tier
Hydrogen	5 t	50 t
Ammonia	50 t	200 t

Aggregation rules for multiple hazardous substances stored on the same site

CO<sub>2</sub> not a named toxic substance in CLP

<https://www.hse.gov.uk/pubns/priced/l111.pdf>

# Land-Use Planning

- Seveso land-use planning requirements are implemented in GB by the Planning (Hazardous Substances) Regulations 2015
- New sites handling substances above controlled quantity are required to seek land-use planning consent
- Process led by planning authority, HSE is statutory consultee
- HSE assesses residual risks to people using combination of risk and consequence-based calculations, e.g., models such as DRIFT for dispersion
- HSE advises local planning authority, who makes decision to grant permission or not
- If consent is granted against HSE’s advice: potential for HSE to call for review
- For existing consented sites: HSE provides public safety advice to developers and planning authorities via web app <https://www.hse.gov.uk/landuseplanning/planning-advice-web-app.htm>



	Consent threshold
Hydrogen	2 t
Ammonia	50 t

Lower than COMAH lower tier threshold  
<https://www.hse.gov.uk/landuseplanning/about.htm>  
<https://www.legislation.gov.uk/ukxi/2015/627/schedule/1/made>

# Pipelines

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- Pipelines Safety Regulations 1996: risk-based, goal-setting
- General duties:
  - Pipelines designed to be safe, within the range of operating conditions
  - Requirements for appropriate installation, maintenance, inspection, monitoring, leak detection etc.
  - Application of relevant good practice (e.g., BS, ISO, IGEM, CEN standards)
  - Risk calculations are required for pipeline routing purposes
- Additional duties for Major Accident Hazard (MAH) pipelines
  - COMAH competent authority must be notified of new MAH pipelines
  - Major accident prevention document and emergency plans are required
  - Emergency shut-down valves (ESDVs) are required for offshore installations
- Definition of MAH pipelines
  - Flammable gases (including hydrogen) transported above 7 bar(g)
  - Other definitions given in PSR 1996 Schedule 2 (CO<sub>2</sub> is not currently included, but it is under review)
- HSE uses a pipeline risk assessment model to determine land-use planning (LUP) zones around MAH pipelines, to provide guidance to developers and local planning authorities in GB

<https://www.hse.gov.uk/pubns/books/l82.htm>

<https://www.legislation.gov.uk/uksi/1996/825/contents/made>

# Other relevant regulations

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- Health and Safety at Work Act (1974)
  - Primary legislation covering occupational health and safety in GB
  - Duty of every employer to ensure the health, safety and welfare at work of all their employees, so far as is reasonably practicable
  - Also, the duty of every employer not to expose the public to risks to their health or safety, so far as is reasonably practicable.  
<https://www.hse.gov.uk/legislation/hswa.htm>  
<https://www.legislation.gov.uk/ukpga/1974/37/contents>
- Offshore Installations (Offshore Safety Directive)(Safety Case etc) Regulations 2015
- Offshore Installations (Prevention of Fire and Explosion, and Emergency Response) Regulations 1995 and amendments

# Regulatory Challenges with Net Zero

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- New infrastructure developments planned for Net Zero that were not foreseen when Seveso thresholds were defined, e.g., liquid hydrogen vehicle refuelling sites in cities
- Scientific understanding of risks of new infrastructure is still developing
- Lack of historical data on operation of new facilities: uncertainties in major accident hazard scenarios and failure rates
- Important for HSE's land-use planning advice to keep pace with developing knowledge
- Challenge to amend legislation to account for new major accident hazards
  - E.g., Classification of CO<sub>2</sub> as having major accident hazard potential above consent threshold?
  - Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (CDG 2009) uses the UN Model Regulations, which assigns CO<sub>2</sub> as Class 2.2 substance (non-flammable and non-toxic gases, which could cause asphyxiation), but CO<sub>2</sub> is not just an asphyxiant gas <https://www.eiga.eu/uploads/documents/SI024.pdf>

# Science Planning for Net Zero

## HSE - HYDROGEN PROGRAMME - next 2 YEARS - 2024 - 2026

Vision: 'Apply hydrogen knowledge to growing applications & develop regulatory tools & capability'

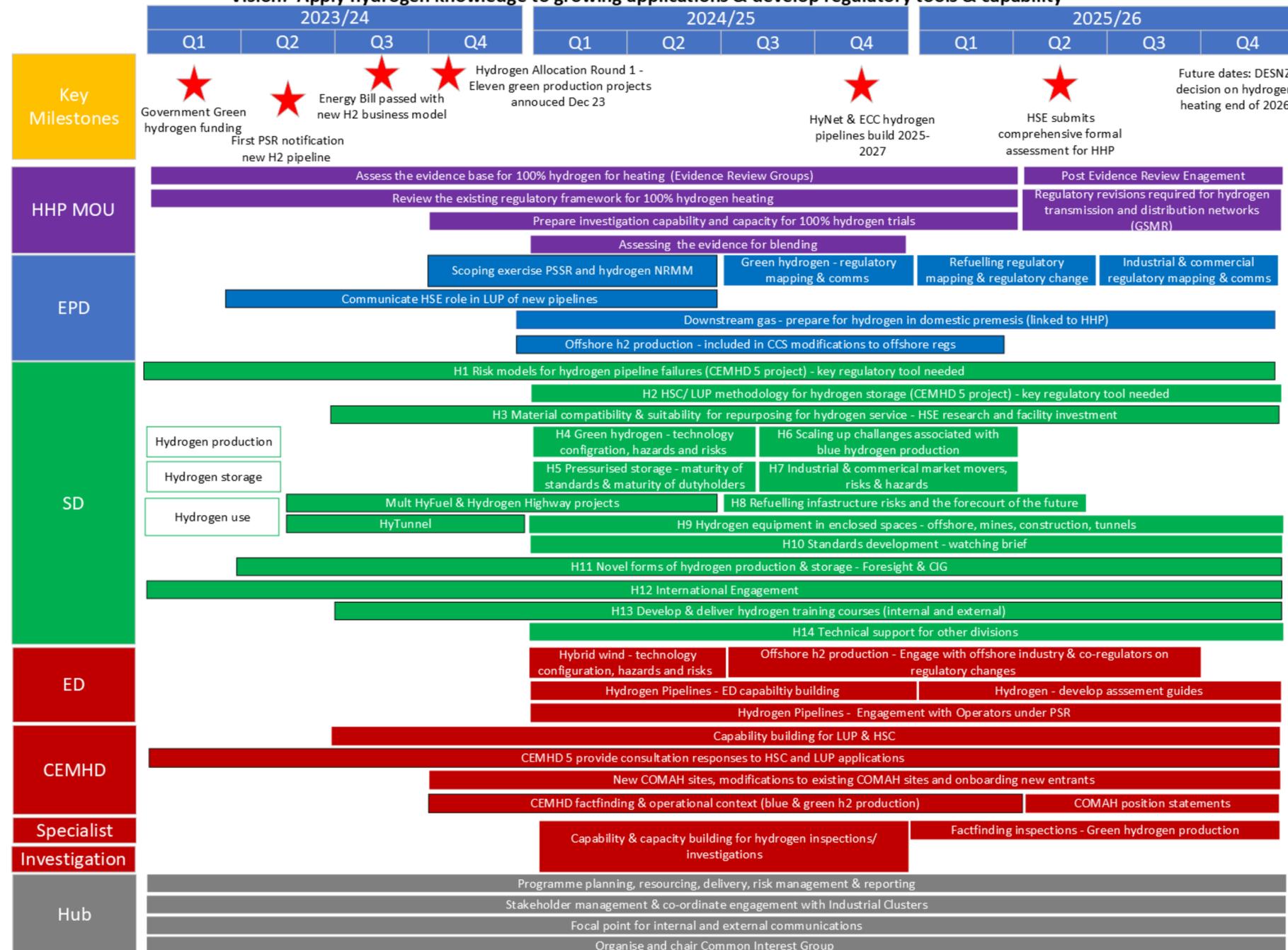
Hydrogen heating programme

Engagement and Policy Division

Science Division

Energy Division

Chemicals, Explosives and Microbiological Hazards Division



Continues to future years

# Risk models for hydrogen pipelines

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- Objectives
  - Review HSE’s pipeline risk assessment methodology to determine its suitability for hydrogen, and update it if needed, considering:
    - Failure rate model, including changes in material behaviour in the presence of hydrogen
    - Gas pipeline release rate model
    - Ignition model and event trees – are delayed ignitions credible for hydrogen pipelines?
    - Fire model for immediate ignition
    - Explosion model for delayed ignition (if needed)
- Motivation
  - Need to update pipeline risk assessment methodology for hydrogen pipelines, for application to provision of HSE’s statutory land-use planning advice to local planning authorities
- Key milestones
  - Planning application for 125 km high pressure HyNet North West hydrogen pipeline expected in Spring 2024  
<https://national-infrastructure-consenting.planninginspectorate.gov.uk/projects/EN060006>
- Relevant information
  - SAFEN Joint Industry Project <https://www.safetec.no/en/news/safen-jip-ready-to-meet-new-challenges>
  - FutureGrid <https://www.nationalgas.com/insight-and-innovation/transmission-innovation/futuregrid>
  - Energy Institute guidance <https://publishing.energyinst.org/topics/hydrogen>
  - IGEM standards development <https://www.igem.org.uk/technical/buy-technical-standards/transmission-and-distribution.html>

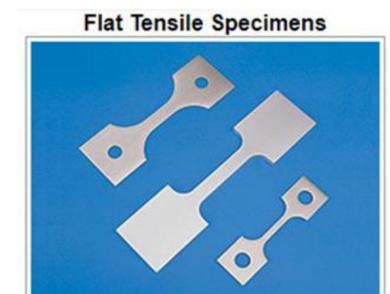
# Hydrogen Storage

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- Objectives
  - Review HSE’s risk assessment methodology for bulk storage of gaseous and liquid hydrogen
  - Widen validation of models, considering results from recent hydrogen experiments
  - Improve understanding of hydrogen incidents and review release scenarios and failure rates
- Motivation
  - Need to ensure HSE’s risk assessment methodology keeps pace with developing knowledge, for application to provision of HSE’s statutory land-use planning advice to local planning authorities
- Key milestones
  - Ongoing discussions with developers of GB hydrogen infrastructure
- Relevant information
  - SAFEN Joint Industry Project <https://www.safetec.no/en/news/safen-jip-ready-to-meet-new-challenges>
  - Energy Institute guidance <https://publishing.energyinst.org/topics/hydrogen>
  - SH2IFT experiments on liquid hydrogen BLEVEs <https://sh2ift-2.com/>
  - ELVHYS project <https://elvhys.eu/>

# Material compatibility

- Objectives
  - Review new test data and recent literature on material compatibility and suitability for hydrogen service
  - Develop HSE testing facility for long-term exposure of materials in gaseous hydrogen up to 8 bar, including in-situ micro tensile testing and ex-situ impact and tensile testing (metals, polymers and elastomers)
  - Review and (if necessary) update fracture mechanics model for HSE’s hydrogen pipeline risk assessment model
- Motivation
  - Advice to HSE inspectors and information to support guidance and incident investigation
  - Need to update pipeline risk assessment methodology for hydrogen, for statutory LUP advice
- Key milestones
  - HSE to provide policy options for future safety regulation of hydrogen for heating in September 2024, and final written advice to the Department for Energy Security and Net Zero in March 2025
- Relevant information
  - HSE Safe Net Zero 2024 event, 13 February <https://www.hsl.gov.uk/health-and-safety-training-courses>
  - SAFEN Joint Industry Project <https://www.safetec.no/en/news/safen-jip-ready-to-meet-new-challenges>
  - FutureGrid <https://www.nationalgas.com/insight-and-innovation/transmission-innovation/futuregrid>
  - Energy Institute guidance <https://publishing.energyinst.org/topics/hydrogen>
  - IGEM standards development <https://www.igem.org.uk/technical/buy-technical-standards/transmission-and-distribution.html>



# Risk assessment and area classification

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- Objectives
  - Review hydrogen flammability and explosion limits (4% or 8% v/v? Downward flame propagation?)
  - Review appropriate hole sizes for hazardous area classification with hydrogen
  - Review “negligible extent” criteria for hydrogen, based on potential fire and explosion hazards
  - Review transition point at which hydrogen leaks affect the ventilation rate in enclosures
- Motivation
  - Advice to HSE inspectors on review of hazardous area classification at sites handling hydrogen
  - Information to support guidance (e.g., for vehicle refuelling stations) and incident investigation
- Key milestones
  - Ongoing discussions with developers of GB hydrogen infrastructure
- Relevant information
  - SAFEN Joint Industry Project <https://www.safetec.no/en/news/safen-jip-ready-to-meet-new-challenges>
  - Energy Institute guidance <https://publishing.energyinst.org/topics/hydrogen>
  - IGEN standards development <https://www.igem.org.uk/technical/buy-technical-standards/transmission-and-distribution.html>
  - ISO/TC197 Hydrogen technologies <https://www.iso.org/committee/54560.html> and IEC 60079
  - IEA Task 43 <https://www.ieahydrogen.org/task/task-43-safety-and-rcs-of-large-scale-hydrogen-energy-applications/>

# Concluding Remarks

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- Developments in Net Zero infrastructure are moving at pace
- Challenging to review risk assessment methodologies and consider revisions to legislation with limited resources
- Need to act as enabling regulator, whilst ensuring safety of workers and public
- Benefits to working collaboratively with other OECD/EU regulatory authorities, both on regulatory issues and scientific research topics
- Programme of lectures to help inform regulators of new developments?
  - NFPA 2 standard on separation distances for hydrogen installations
  - Electrolyser safety, incidents, technological developments
  - Etc.

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# Thank you

## Any questions?

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