PROTECTING PEOPLE AND PLACES FOR 50 YEARS HSE

Health and Safety Executive (Great Britain)

Pipeline Regulators Summit, International Pipeline Conference, Calgary, 23 Sept 2024

Simon Gant, Strategic Science Adviser for Net Zero

Outline

- Introduction to HSE
- Energy transition
  - Context of industrial developments in Great Britain
  - Status of HSE regulation of hydrogen and CO_2 pipelines
  - HSE scientific research
  - Technical issues
  - Joint industry projects
  - Standards and guidelines
- Ongoing challenges in pipeline safety
- Public engagement
- Future meetings

Meeting agenda

- Introductions and overview of each regulator
  - 5-7 mins each depending on number of attendees
- Description: Overview from each regulator:
  - Mandate
  - Issues and challenges

Introduction to HSE

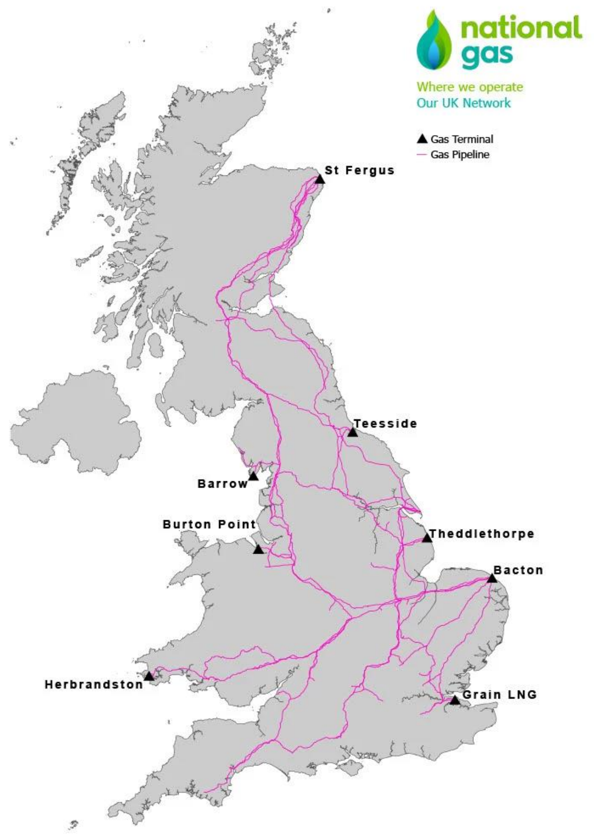
- The Health and Safety Executive (HSE) is Britain’s national regulator for workplace health and safety
- We are dedicated to protecting people and places, and helping everyone lead safer and healthier lives
- HSE objectives include: enabling industry to innovate safely to prevent major incidents and supporting the move towards net zero
- Activities: evidence gathering, policy development, consultation, regulation, incident investigation, enforcement
- In 2022-23, HSE investigated over 230 fatal and 5,500 non-fatal incidents
- 2,695 total staff (full-time equivalent)
- £262M (US$344M) budget: 66% from Government, 34% from external income and cost recovery

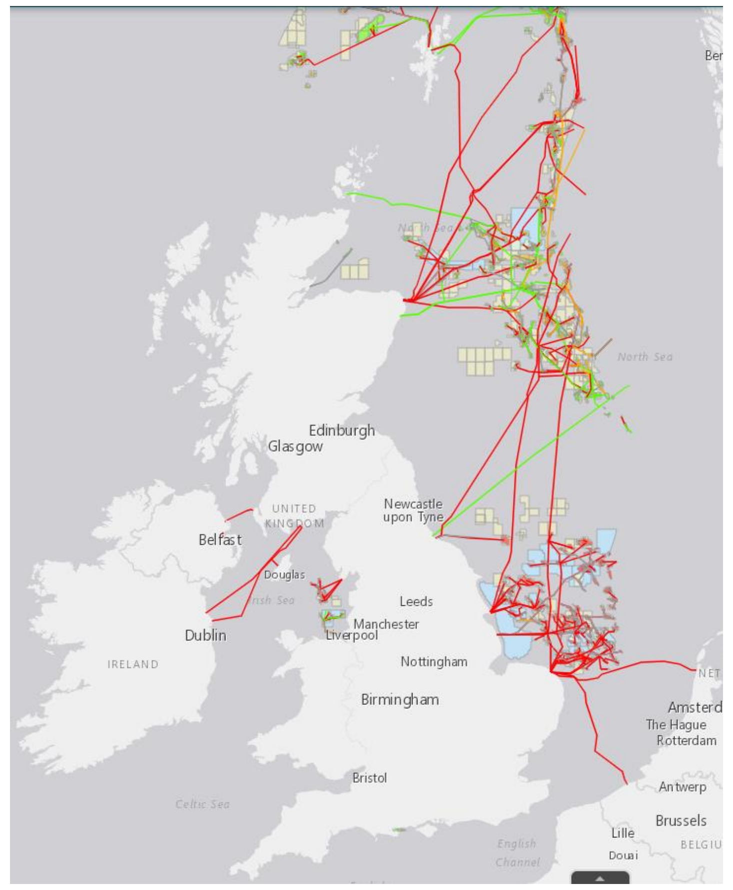
https://www.hse.gov.uk

HSE - Gas and pipelines

- Regulates onshore and offshore pipeline transport in GB
  - Natural gas transmission and distribution networks
  - Hydrocarbon and chemical pipelines
  - Material not deemed to have major accident hazard potential
- Key Legislation
  - Pipelines Safety Regulations 1996 (PSR) https://www.hse.gov.uk/pubns/books/l82.htm
  - Gas Safety (Management) Regulations 1996 (GSMR) https://www.hse.gov.uk/pubns/books/l80.htm

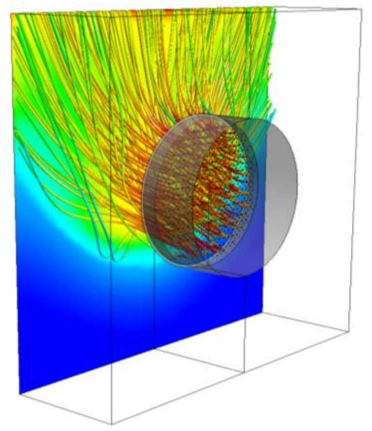
https://www.nationalgas.com/our-businesses/network-route-maps





https://oeuk.org.uk/uk-oil-and-gas-licensing/

HSE Science & Research Centre

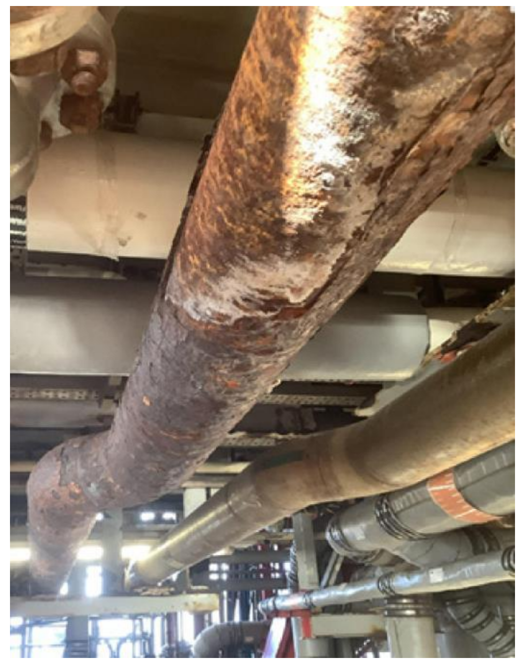
- Scientific support to HSE and other Government departments
- “Shared research” or joint-industry projects co-funded by HSE
- Bespoke consultancy on a commercial basis
- 400 staff, 550 acre test site



- Examples of ongoing shared research projects:

1. Engineered composite repairs (2024-2025)
   - Lifecycle management and quality assurance
   - Inspection and non-destructive testing
   - Durability and residual property assessment
   - Key learnings and dissemination

   https://www.hsl.gov.uk/media/34690/2402020K%20Roberts%20-%20ECR%201%20v4.pdf



2. Corrosion under insulation (2024-2027)
   - Insights and intelligence from data
   - Lifecycle management
   - Inspection and NDT technique validation
   - System performance
   - Ensuring a quality installation
   - Key learnings and dissemination

   https://www.hsl.gov.uk/media/34357/CUI%20SHARED%20RESEARCH_FINAL%20-%202024.pdf

Overview of current challenges

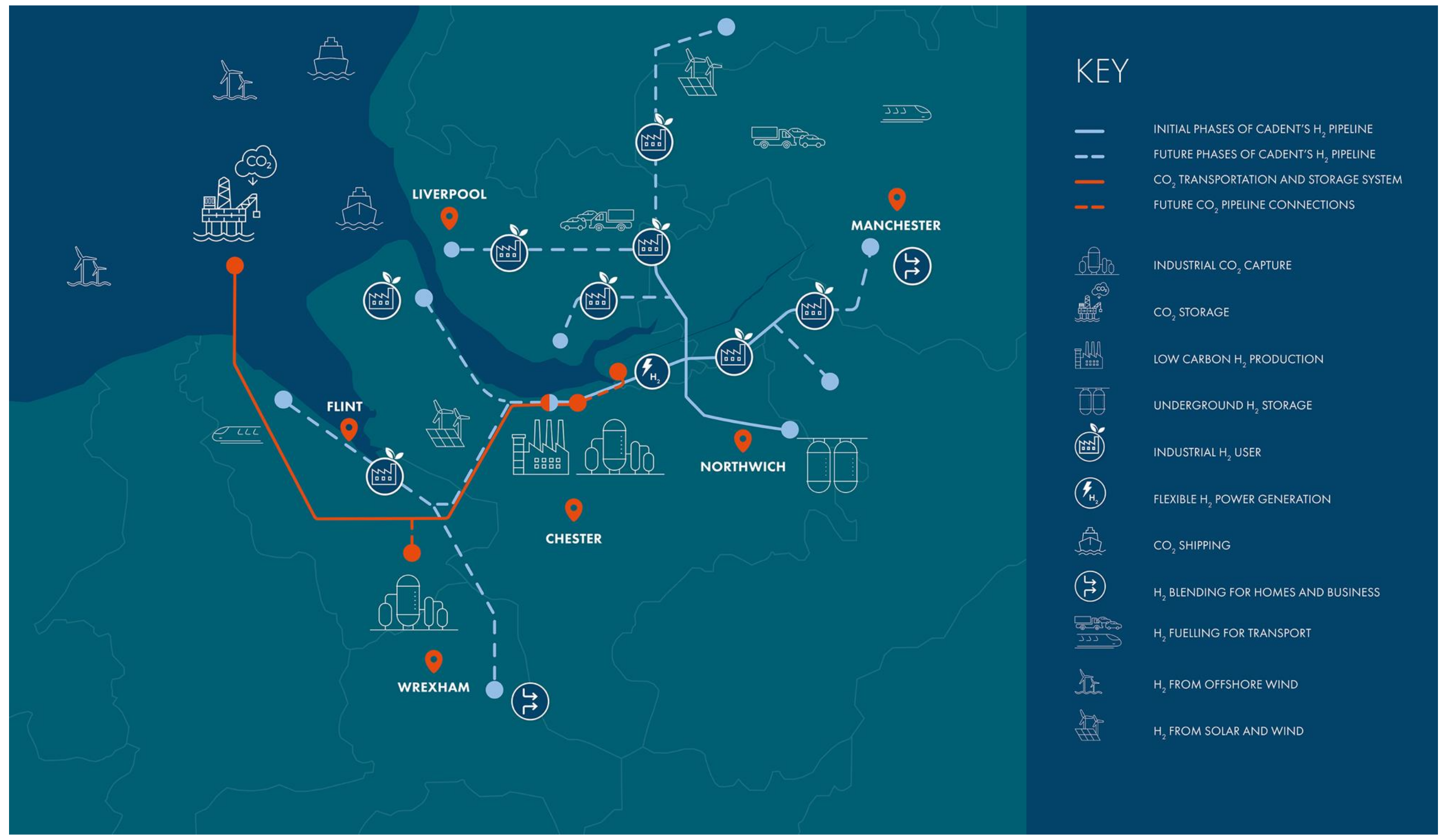
- Energy transition
  - Significant industrial developments planned
    - Hydrogen: production, transmission, distribution, end use
    - Carbon dioxide: capture, utilisation, transport, sequestration
  - Some experience from industrial gases and use in refineries, but Net Zero infrastructure will be much larger in scale, new operators, new applications
  - No previous history of large-scale hydrogen or CO_2 pipeline transport in the UK
  - Good practice guides and standards still under development in some areas
  - Many active research topics
  - Example:
    - Repurposing of natural gas transmission pipelines for hydrogen: requalification process, monitoring techniques, risk assessment

Discussion 1

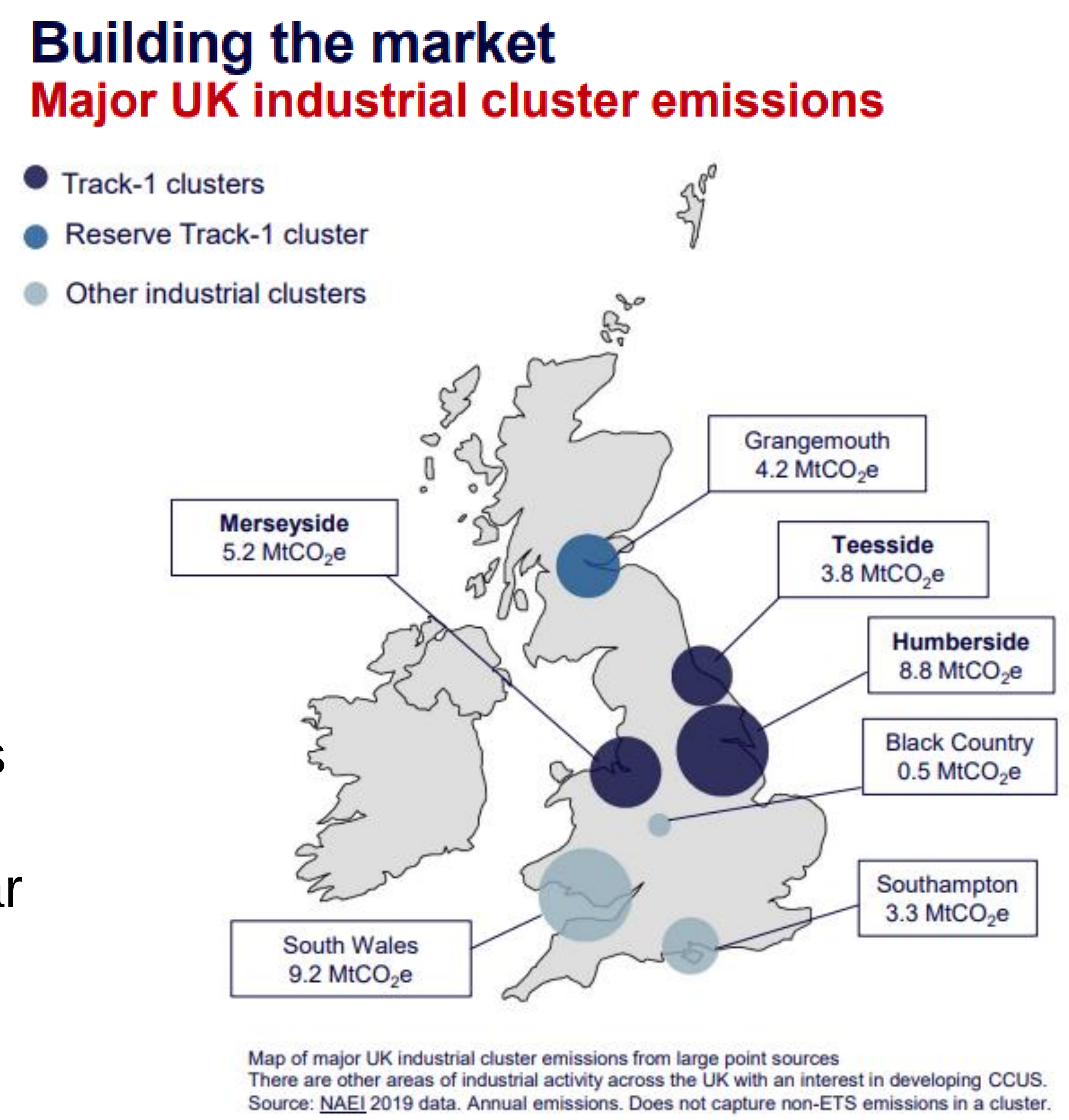
- Description: How are regulators preparing for the Energy Transition?
- Transportations of emerging fuels, such as hydrogen and ammonia
  - CO_2 and storage
  - Funding and influencing research
  - Participation on joint industry projects
  - Changes and updates to regulations and standards
  - Impact on safety, environment, and socioeconomics
- Discussion Question: How can regulators work together to share information and remove any competitive barriers as we move towards the energy transition?

Energy Transition:
Industrial context in Great Britain

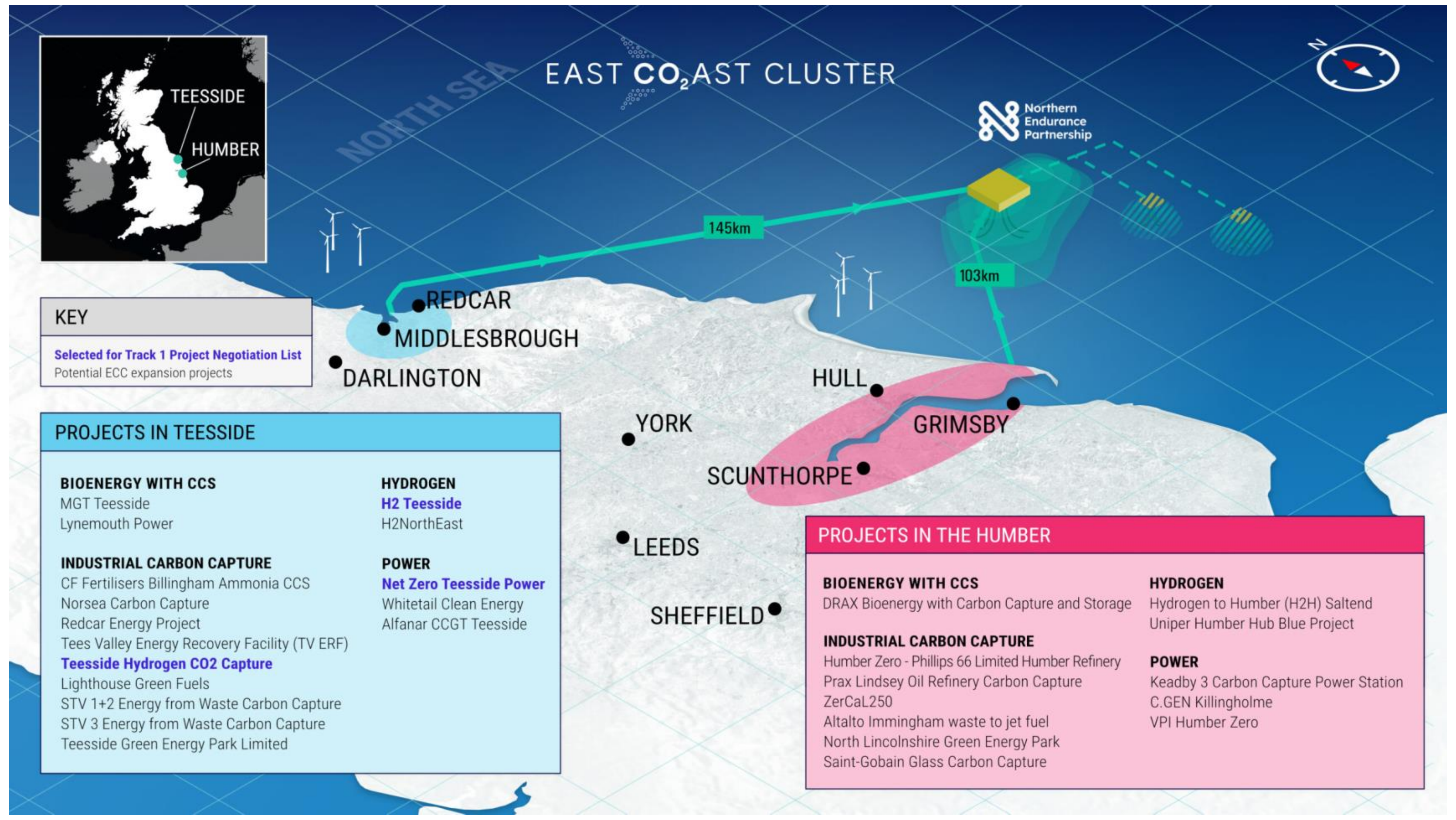
Energy Transition context in Great Britain



HyNet project
- Initially, gas-phase onshore/offshore CO_2 pipelines with sequestration in depleted natural gas field
- 40 miles of onshore pipeline, MAOP approx. 42 bar
- Later, transition to dense-phase CO_2 pipelines offshore – compression at the coast
- Pipelines: 20”, 24” and 36” diameter, mixture of repurposed and new
- New ENI offshore platform connected to several repurposed normally unmanned installations
- Capture plants: cement, refinery, blue hydrogen
- Planned to store 10 $MtCO_2$/yr by 2030
- https://hynet.co.uk



https://www.gov.uk/government/publications/carbon-capture-usage-and-storage-net-zero-investment-roadmap/ccus-net-zero-investment-roadmap-capturing-carbon-and-a-global-opportunity



East Coast Cluster project
- NEP Partners: BP, Equinor and TotalEnergies
- Onshore gas and dense-phase CO_2 pipelines
- Two new offshore dense-phase CO_2 pipelines: 16-24 inch diameter
- March 2023: Track 1 funding awarded
- Sept 2023: NSTA awarded further licenses to BP and Equinor for 1 GTe CO_2 storage
- Due to be operational by 2027
- https://eastcoastcluster.co.uk

Energy Transition context in Great Britain

- Other developing CCS and CO_2 pipeline projects
  - Acorn https://www.theacornproject.uk/
  - Viking CCS https://www.vikingccs.co.uk/
  - Morecambe Net Zero cluster https://www.mnzcluster.com/
  - Bacton Thames Net Zero https://www.eni.com/static/bactonthamesnetzero/
  - Poseidon https://perenco-ccs.com/the-poseidon-project/
  - Orion https://perenco-ccs.com/the-orion-project/
  - South Wales industrial cluster https://www.rwe.com/en/research-and-development/hydrogen-projects/south-wales-industrial-cluster/
  - Solent CO_2 Pipeline Project https://www.solentco2pipeline.co.uk/

Energy Transition context in Great Britain

- Hydrogen pipeline projects
  - Transmission
    - FutureGrid research https://www.nationalgas.com/future-energy/futuregrid
    - Project Union https://www.nationalgas.com/future-energy/hydrogen/project-union
    - European Hydrogen Backbone initiative https://www.ehb.eu/
    - SGN LTS Futures https://www.sgn.co.uk/about-us/future-of-gas/lts-futures-0
  - Distribution
    - H100 neighbourhood trial https://www.h100fife.co.uk/
    - H21 https://www.northerngasnetworks.co.uk/wp-content/uploads/2024/03/H21-Phase-2-Technical-Summary_V4-compressed-compressed-2.pdf

Energy Transition:
Status of HSE regulation

Energy Transition: Pipeline Regulation in Great Britain

- Pipeline Safety Regulations, 1996 (PSR) provides a risk-based goal-setting approach to regulating pipelines in Great Britain
- The regulations cover:
  - Definition of a pipeline
  - General requirements for all pipelines (design, construction, operation etc.)
  - Requirement for co-operation amongst pipeline operators
  - Measures to prevent damage to pipelines

Energy Transition: Pipeline Regulation in Great Britain

- Major Accident Hazard (MAH) pipeline is one which conveys a dangerous fluid
- Classification of dangerous fluid given in Schedule 2 of PSR (see next slide)
- PSR sets out requirements for MAH pipelines:
  - Emergency shut-down valves
  - Notifications
  - Major accident prevention document
  - Emergency procedures
  - Emergency plan
- HSE has a duty to provide land-use planning advice around MAH pipelines
  - HSE uses the pipeline risk assessment model (MISHAP) and creates risk-based LUP zones around the pipeline
  - HSE advice is provided to planning authorities when they are considering new developments near pipelines (e.g., new housing, hospitals, schools etc.)

Definition of Dangerous Fluid (PSR Schedule 2)

1. Flammable, boiling point < 5°C at 1 bar(a) and conveyed in the pipeline as a liquid.
2. Flammable, conveyed in the pipeline as a gas at above 8 bar(a) ← Hydrogen at > 7 barg, 100 psig
3. Liquid with vapour pressure > 1.5 bar(a) at temperature of pipeline or 20°C
4. Toxic/very toxic fluid which is gas at 20°C and 1 bar(a) and is conveyed as a liquid or a gas
5. Toxic with vapour pressure > 0.4 bar at 20°C h and is conveyed in the pipeline as a liquid
6. Acrylonitrile
7. Very toxic with saturated vapour pressure > 0.001 bar(a) at 20°C or is conveyed in the pipeline as a liquid at a pressure > 4.5 bar(a)
8. Oxidising fluid conveyed as a liquid
9. Fluid which reacts violently with water
10. Oxidising liquid and toxic or very toxic fluid, or reacts violently with water if it has been, or is liable to be classified, pursuant to regulation 5 of the Chemicals (Hazard Information and Packaging for Supply) Regulations 1994, as the case may be, oxidising, toxic, very toxic or reacts violently with water.

CO_2 is not currently classified as a dangerous fluid

Natural gas pipelines and hydrogen blends

- Onshore natural gas pipeline network operators are also regulated under the Gas Safety (Management) Regulations, 1996 (also offshore gas export by pipeline)
- High-hazard permissioning regime
- Applies to networks transporting “gas”: any substance in a gaseous state which consists wholly or mainly of methane
- However, specification of GB natural gas currently has a hydrogen limit of ≤0.1% (molar)
- Transportation of blends in the gas network outside of this limit requires an HSE exemption
- Work has been ongoing in the GB gas industry since 2017 to assess the implications of blends up to 20% hydrogen https://hydeploy.co.uk/
- March 2023: Government took strategic policy decision to support blending of up to 20% hydrogen by volume into GB gas distribution networks
- Plans in Europe to increase hydrogen content in natural gas has implications for GB, due to pipeline interconnectors between EU and GB

CO_2 pipeline regulation

- CO_2 pipelines are not currently classified as Major Accident Hazard (MAH) pipelines
  - Classification is irrespective of the operating pressure (gaseous or dense-phase)
  - Therefore, no legal requirement to notify HSE of plans for new CO_2 pipelines
  - Not subject to controls under land-use planning regulations
- However, HSE inspects and regulates non-MAH pipelines, prioritisation based upon risk
- Potential hazards of CO_2 pipelines reviewed by HSE in the period 2007-2017
  - https://www.hse.gov.uk/research/rrhtm/rr1121.htm
- Guidance published on HSE website: https://www.hse.gov.uk/pipelines/co2conveying-full.htm
- Existing major hazards regulatory framework not drafted with CCUS in mind
- There are provisions in existing regulations relevant to CO_2 pipelines (see next slide)
- Consideration of whether any regulatory amendments required

CO_2 pipeline regulation

- Health & Safety at Work etc. Act 1974 - Sections 2 and 3

- General health and safety legislation, e.g.
  - Management of Health and Safety at Work Regulations – Risk assessment requirement

- Specific health and safety legislation, e.g.
  - PSR Part 2 applies to all pipelines (design/ materials/ examination/ maintenance/ construction/ installation/ emergency arrangements/ decommissioning)

- Standards and relevant good practice

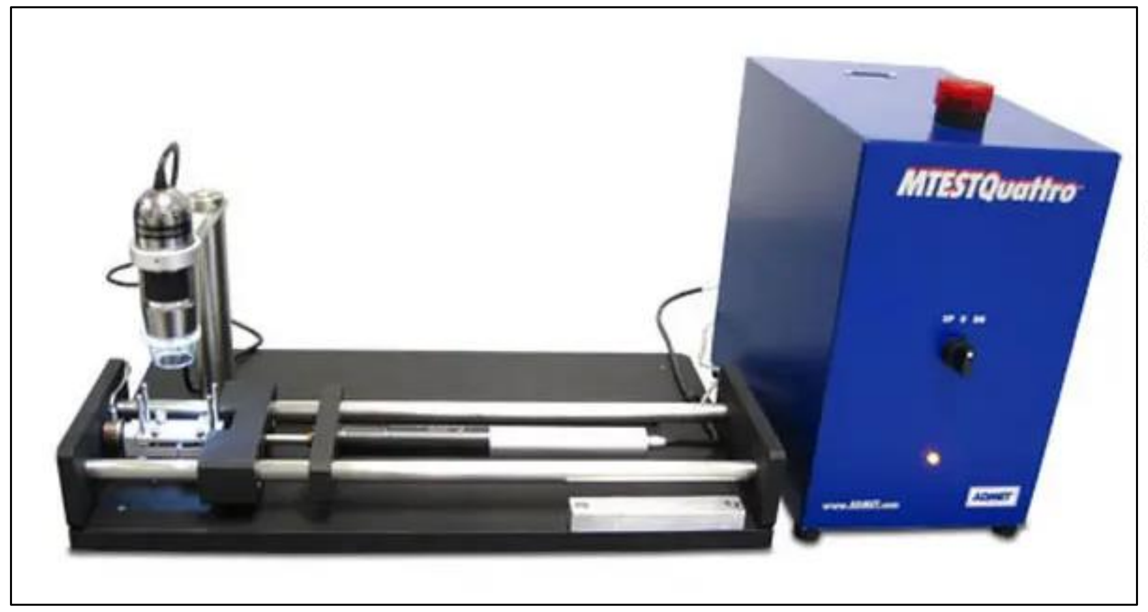
Energy Transition:
HSE scientific research

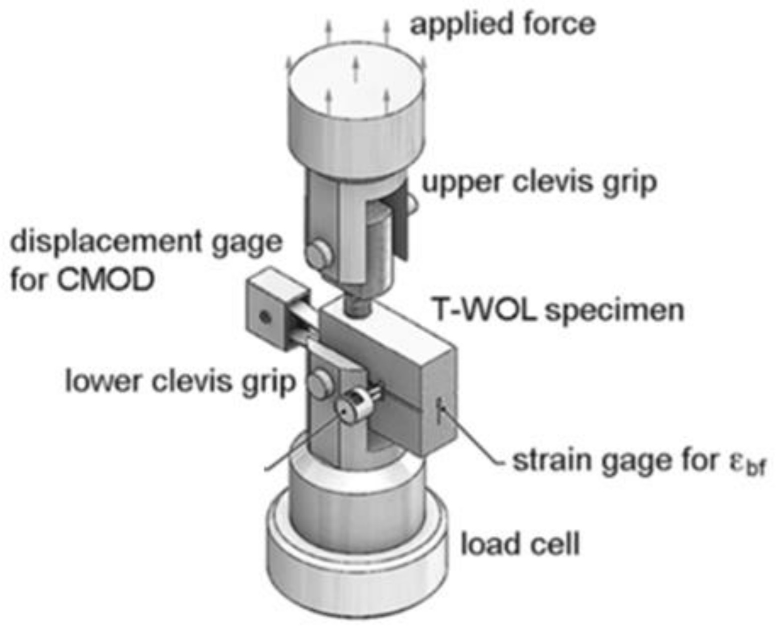
HSE pipeline risk modelling

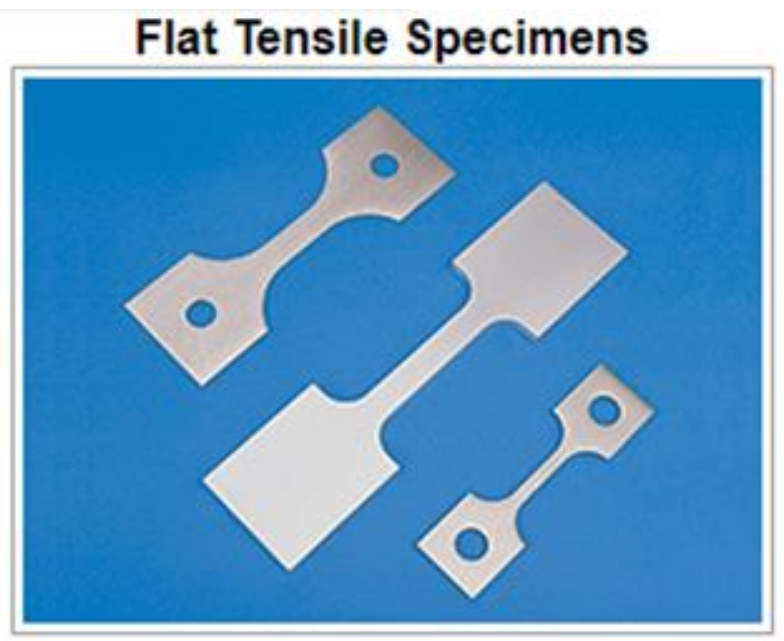
- Objectives: Review HSE's pipeline risk assessment methodology to determine its suitability for hydrogen and CO_2, and update it if needed, considering:
  - Failure rate model, pipeline release rate model, event trees, ignition model, fire and explosion model, dispersion model for CO_2, including consideration of crater source model
- Motivation: Need to update HSE pipeline risk assessment methodology for hydrogen and CO_2 pipelines, for application to provision of HSE's statutory land-use planning advice to local planning authorities (CEMHD)
- Key milestones
  - 60 km onshore gas phase HyNet CO_2 pipeline was granted DCO in March 2024 https://infrastructure.planninginspectorate.gov.uk/projects/Wales/HyNet-Carbon-Dioxide-Pipeline/
  - 125 km high pressure HyNet North West hydrogen pipeline currently in pre-application stage, application is expected in 2025 https://national-infrastructure-consenting.planninginspectorate.gov.uk/projects/EN060006
- Size of SD activity: large (2-3 years)
- SD activity lead: Zoe Chaplin
- Related projects and 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

HSE hydrogen materials testing facility

- HSE is investing in a new hydrogen materials testing facility at its Science and Research Centre in Buxton
- Aim to conduct long-term exposure tests of materials (~years) in gaseous hydrogen up to 10 bar
- Testing methods:
  - In-situ micro tensile testing
  - Ex-situ tensile testing
  - Ex-situ impact testing
- Testing of metals, polymers and elastomers
- Four vessels acquired, setup ongoing
- Due to be operational in 2025

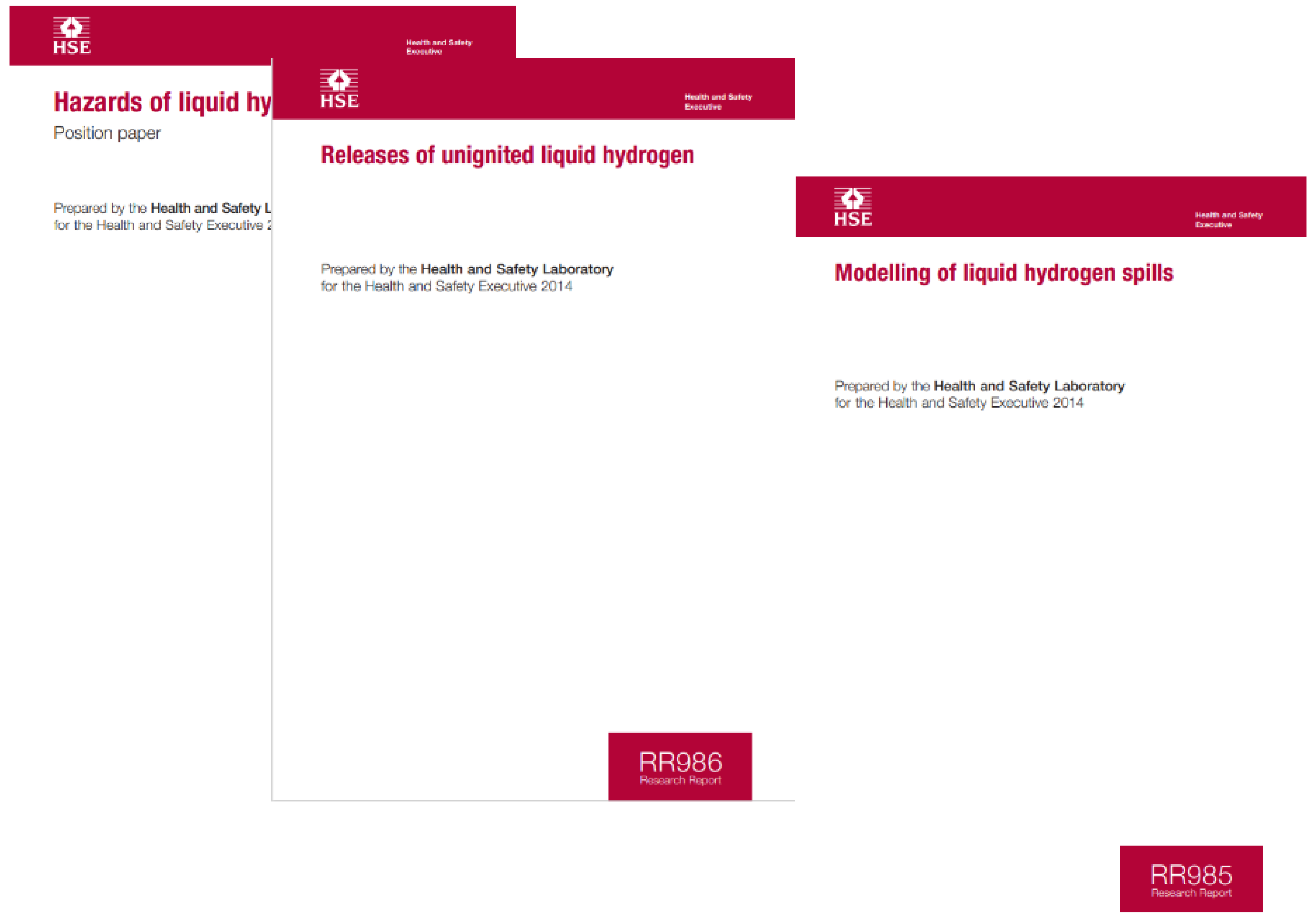






HSE publications on hydrogen

- RR1133 - Maintaining the integrity of process plant susceptible to high temperature hydrogen attack. Part 1: analysis of non-destructive testing techniques
- RR1134 - Maintaining the integrity of process plant susceptible to high temperature hydrogen attack. Part 2: factors affecting carbon steels
- RR1169 - Hydrogen in the natural gas distribution network: Preliminary analysis of gas release and dispersion behaviour
- RR715 - Installation permitting guidance for hydrogen and fuel cell stationary applications: UK version
- RR1047 - Injecting hydrogen into the gas network – a literature search
- RR769 - Hazards of liquid hydrogen: position paper
- RR985 - Modelling of liquid hydrogen spills
- RR986 - Releases of unignited liquid hydrogen
- RR987 - Ignited releases of liquid hydrogen
- RR1159 – Hydrogen research priorities workshop
- RR615 – Spontaneous ignition of hydrogen: Literature review



https://www.hse.gov.uk/research/rrhtm/index.htm

Energy Transition:
Technical issues

Technical issues: hydrogen

- Uncertainties in risk assessment
  - Failure rates
  - Potential for delayed ignition
  - Consequences of delayed ignition
- Some uncertainty in material response to long-term hydrogen exposure
  - Findings so far suggest:
    - Steel strength not significantly affected but effect on elongation to failure is significant
    - Fracture toughness reduced for most steel grades
    - Some studies indicate that theoretical net fatigue life in the presence of hydrogen is 10-100 times less than in natural gas. Greatest effect is on crack growth rate
- Pipeline inspection: techniques for monitoring defect size?

Technical issues: hydrogen

- Increased size of hazardous areas: encroachment into public spaces
- Relative impacts of different %blends of hydrogen
- Repurposing of low-pressure iron mains
- Evaluation of measures to mitigate risk to domestic consumers: excess flow valves, hydrogen detection and automatic isolation valves
- Leakage
  - Pipelines and all associated assets, e.g., valves, joints etc.,
  - Potential ingress of air over prolonged period of time into isolated sections of pipework
  - Inspection and testing of domestic pipework

Technical issues: CO_2

- Pipeline risk assessment and emergency planning and response
  - Terrain effects: heavier-than-air CO_2 cloud flowing downhill, collecting in low areas
  - Issues with dispersion models
    - Crater source: uncertainty (correlations based on just two experiments)
    - Need to develop fast-running dispersion models that can simulate terrain effects
  - Need experimental data to develop, test and validate these models
- Venting
  - Some dispersion models used for venting studies lack validation: need experimental data to assess accuracy of models

Skylark project aims to tackle these issues

http://dx.doi.org/10.1016/j.ijggc.2015.04.001

Technical Issues: CO_2

- Offshore sequestration of CO_2
  - Planned and accidental releases of CO_2 offshore
    - Venting strategies: from the underside of platforms?
    - Detection and emergency control systems on platforms handling both hydrocarbons and CO_2
    - Potential impact of dense CO_2 clouds on floating support vessels, ingress of CO_2 into lifeboats
  - Consequences of subsea CO_2 pipeline release or well blowout
    - How much CO_2 is absorbed into the water column?
    - Characteristics of rising plume and zone affected on sea surface

https://www.equinor.com/energy/sleipner

Technical issues: CO_2

- Fracture propagation
  - Brittle fracture due to cooling of CO_2 release: growth of small punctures to ruptures?
    - Approach taken by Sleipner, Snøhvit and USA CO_2 pipelines for EOR?
  - Running ductile fractures in dense-phase CO_2 pipelines due to net decompression speed of the fluid < fracture propagation speed along the pipe
    - Effect of CO_2 impurities on decompression behaviour
  - Recent publications on running ductile fractures:
    - Skarsvåg *et al*. (2023) "Towards an engineering tool for the prediction of running ductile fractures in CO_2 pipelines" Process Safety and Environmental Protection 171 (2023) 667–679. https://doi.org/10.1016/j.psep.2023.01.054
    - Cosham *et al*. (2022) "The decompressed stress level in dense phase carbon dioxide full-scale fracture propagation tests". Proceedings of the 14th International Pipeline Conference IPC2022, 26-30 Sept 2022, Calgary, Canada
  - Revision of guidance in DNV-RP-F104 and ISO 27913 (TC/265)?
  - Further CO_2 pipeline rupture experiments to inform guidance?
  - More work done on dense-phase than gaseous; therefore, less certainty in fracture arrest requirements for gaseous CO_2

Technical Issues: CO_2

- Fracture tests
  - Suitability of Charpy impact test and Drop-Weight Tear Test (DWTT) to predict fracture resistance in CO_2
- Corrosion
  - If water present, other impurities (NOx, SOx) can increase likelihood of corrosion
  - CO_2 specification is project-specific?
    - Refrigerated storage for rail/ship transport requires very low water content (< 30ppm)?
  - What to do in case of process upset (e.g., CO_2 composition outside specification)?
  - Inspection and maintenance regimes?
- Measurement of CO_2 composition
  - Wood JIP findings? Energy Institute work proposed by Andy Brown (Progressive Energy)
- Risk assessment
  - What failure rates probabilities should be used for CO_2 pipelines and vessels?
  - Need to modify fracture-mechanics model used in pipeline risk assessment code?

Technical Issues: learning lessons from CO_2 incidents

- Worms, Germany (1988) 30 tonne CO_2 vessel over-pressurized and BLEVE
  - Earlier failure of heater, which led to temperatures of -60°C, possible weld embrittlement
  - Force of explosion threw vessel 300 m: 3 fatalities, 8 serious injuries, $20m damages
- Repcelak, Hungary (1969) ice or hydrate blocked level gauge and led to overfilling and BLEVE of CO_2 vessel
- Mönchen-Gladbach, Germany (2008) CO_2 released from automated fire-extinguishing equipment in in wood-processing warehouse. Fire brigade arrived and opened doors, their car engine stalled, calm winds, CO_2 cloud followed down a gentle slope to homes, cyclists and pedestrians on the road fainted. CO_2 filled the basements of the houses. Field hospital was set up. Around 12 helicopters used to vent the area
- Other incidents due to sudden CO_2 releases from fire-extinguishing systems: no warnings before release, no emergency breathing apparatus, no emergency pathway lighting, no emergency ventilation system, no emergency exit training, lack of SCBA for rescue

Sources: Energy Institute "Hazard analysis for onshore and offshore carbon capture installations and pipelines", 2024
Hans Pasman "Brandeinsatz mit CO_2-Freisetzung in einem Lagerbetrieb", Private Communication, Sept 2023

Technical Issues: learning lessons from CO_2 incidents

- Nagylengyel, Hungary (1998) loss of containment from CO_2 well used for EOR during work to replace a blowout preventer with a christmas tree well-head
- 207 bar reservoir, natural CO_2 source contained H_2S
- Dry ice built up to depth of 1.5 to 2 m thick around release point
- Hot air blower brought in to melt ice and gain access, but was ultimately unsuccessful
- Release started on Friday, hot air blow arrived Sunday, hot water repair rig installed Tuesday, finally isolated…

Figure C.1 Outbreak of CO_2 escape

Figure C2 Melting the ice with the large capacity hot air blower

5,000 people evacuated, no injuries/fatalities

© Energy Institute "Technical guidance on hazard analysis for onshore carbon capture installations and onshore pipelines", 2010

Technical Issues: learning lessons from CO_2 incidents

- Valves
  - Reports from Satartia incident: previously experienced problems with dry-ice blocking pipeline valves in their open position
    - What valves and/or operating procedures should be used?

- Existing CCUS plant operations (onshore and offshore)
  - E.g. Sleipner, Snøhvit, Shell Quest, In Salah, Gorgon
  - Has there been a review of safety-related operational practice?
    - Gas detection, corrosion, dry-ice plugging, maintenance issues, near-misses, emergencies

Energy Transition:
Joint Industry Projects

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Skylark CO_2 pipeline dispersion project

- Aims
  - To undertake dispersion experiments on CO_2 pipeline releases and venting, including releases from craters and dispersion in sloping/complex terrain
  - To run joint collaborative model validation exercises
  - To improve emergency preparedness and support first responders
- Work Packages
  - CO_2 pipeline craters and source terms – **DNV**
  - Wind-tunnel experiments – **University of Arkansas**
  - Simple terrain dispersion experiments – **DNV**
  - Complex terrain dispersion experiments – **DNV**
  - Model inter-comparison and validation – **HSE**
  - Emergency response – **NCEC**
  - Venting – **DNV**

Timeline: starting late-2024 for 3 years

Contacts: daniel.allason@dnv.com
simon.gant@hse.gov.uk

https://www.dnv.com/article/skylark-pioneering-excellence-in-co2-pipeline-safety-250648

Joint Industry Projects

CO2SafePipe	To close knowledge gaps identified in the transportation of CO_2 in pipelines covering CO_2 in both gas phase and dense phase, including: 1. CO_2 stream composition and its effect on corrosion and materials 2. the risk of running ductile fracture The project will update Recommended Practice DNV-RP-104	https://www.dnv.com/article/design-and-operation-of-co2-pipelines-co2safepipe-240345/	2023-2024
Materials in CCS Wells	1. Identifying the role of key environmental factors on damage modes in Corrosion Resistant Alloys (CRAs) based on preliminary thermodynamic calculations. 2. Characterizing the performance of CRAs and establishing environmental limits for localized corrosion and SCC in CCS storage wells. 3. Creating a framework to translate qualification test observations into long-term performance predictions in service.	https://www.dnv.com/article/materials-performance-in-ccs-wells/	2023-2025
Skylark	Study CO_2 dispersion in complex terrain and CO2 venting	https://www.dnv.com/article/skylark-pioneering-excellence-in-co2-pipeline-safety-250648/	2024-2026
CO-CO_2 cracking in pipelines	1. Define limits on CO and oxidizers (O_2, NO_2) to prevent CO/CO_2 cracking 2. Identify metallurgical limits (yield strength/hardness) to mitigate CO/CO_2 cracking 3. Develop a qualification test methodology to screen line pipe steels and welds for susceptibility to CO/CO_2 cracking.	https://www.dnv.com/article/establishing-guidelines-to-avoid-co-co2-cracking-in-co2-pipelines-251263/	?
CO_2 CFD simulation software	Model development and validation of KFX including complex thermodynamics and heat transfer processes for release of liquid CO_2, including: dry ice formation, deposition of dry ice on the ground and in complex geometries, sublimation of dry ice, condensation of moisture in the surrounding air	https://www.dnv.com/article/co2-cfd-simulation-software-232808/	-2024
Offshore CO_2 good practice	Good Practice Guide for working on offshore oil and gas structures repurposed for CO_2 streams, including consideration of what action to be taken in the event that an evacuation proves necessary	Andy Brown proposed to EI in 2024	2024-

Joint Industry Projects

SAFEN	Develop risk models for hydrogen, ammonia and CCS Share knowledge for development of best practices for safe design of technologies	https://www.safetec.no/en/news/safen-jip-ready-to-meet-new-challenges	Phase 2 2024-
Offshore Monitoring of Large-Scale Subsea Releases of CO_2	The project will collect observations from four releases from 300 meters depth, each lasting approximately 30 minutes Aim is to create an open curated dataset for public utilization	contact: Paal.Skjetne@sintef.no	2024-2025
CO_2 EPOC	Characterization and prediction of the CO_2 effect on polymeric materials within the CO2 transport chain (pipelines and ships) in order to avoid leakage and failure	https://www.sintef.no/en/projects/2020/co2-epoc/	2020-2025
MASCO2T II	Materials Assessment for Supercritical CO_2 Transport 1.Generate corrosion data for candidate metallic materials in high pressure/supercritical CO_2, with varying types and concentrations of impurities 2.Establish a thorough knowledge of the impact of a range of environmental factors (such as pressure, temperature, fluid composition etc.) on (i) the corrosion behaviour of candidate metallic materials including welds, and (ii) the effect of stress on the environmental performance of candidate metallic materials and welds.	https://www.twi-global.com/media-and-events/press-releases/2023/join-our-new-supercritical-co2-transport-project	2023-2026
Permeation of CO_2 through thermosets	Combined Permeation of Pressurised CO_2 and Impurities through Thermosets 1. To establish the barrier performance of thermoset materials to CO_2 with associated impurities. 2. To establish if any transport of these impurity species causes ageing in the thermoset matrix.	https://www.twi-global.com/what-we-do/research-and-technology/research-programmes/joint-industry-projects#/	?
Industry Guidelines for Setting the CO_2 Specification for CCS Chains	to define an industry accepted set of guidelines to set the CO_2 specification for effective and economic CCS chains • The guidelines shall cover the full CCUS chain, considering different CO_2 sources and transport options. • The JIP will collaborate with research and industry experts to provide a holistic understanding of the impact of impurities.	https://www.woodplc.com/insights/blogs/leading-the-way-with-carbon-capture-and-storage-ccs	2022-2024

Joint Industry Projects

- Possible future PRCI projects (shared in PRCI CO_2 sub-committee, Feb 2024):

Validation for water and acid solubility in CO2 with impurities
Cracking and corrosion fatigue in CO2-H20-CO. H2 gas embrittlement
Guidance for CO2 Specifications for Pipeline Transport & Storage
Review and Refine EOS for CO2 Transport
Guidelines for Crack Arrest Design for CO2 Pipelines
Non-Metallic Material Components for CO2 Pipelines
Full Scale Fracture Propagation Test with Gas Phase CO2
Corrosive Impact of Trace Components in Transport of CO2
Effects of CO2 on the ductile to brittle fracture initiation transition temperature
Evaluation of Odorants for CO2 Service
Decompression Radius Modelling of CO2 Pipeline Rupture
Literature Review of Technical Standards applicable to CO2
Comprehensive Metal-Loss Assessment Criterion for CO2 Pipelines
Building CO2 Transmission Pipelines: A Primer
Inline Inspection Tools for Dense Phase

https://www.prci.org/

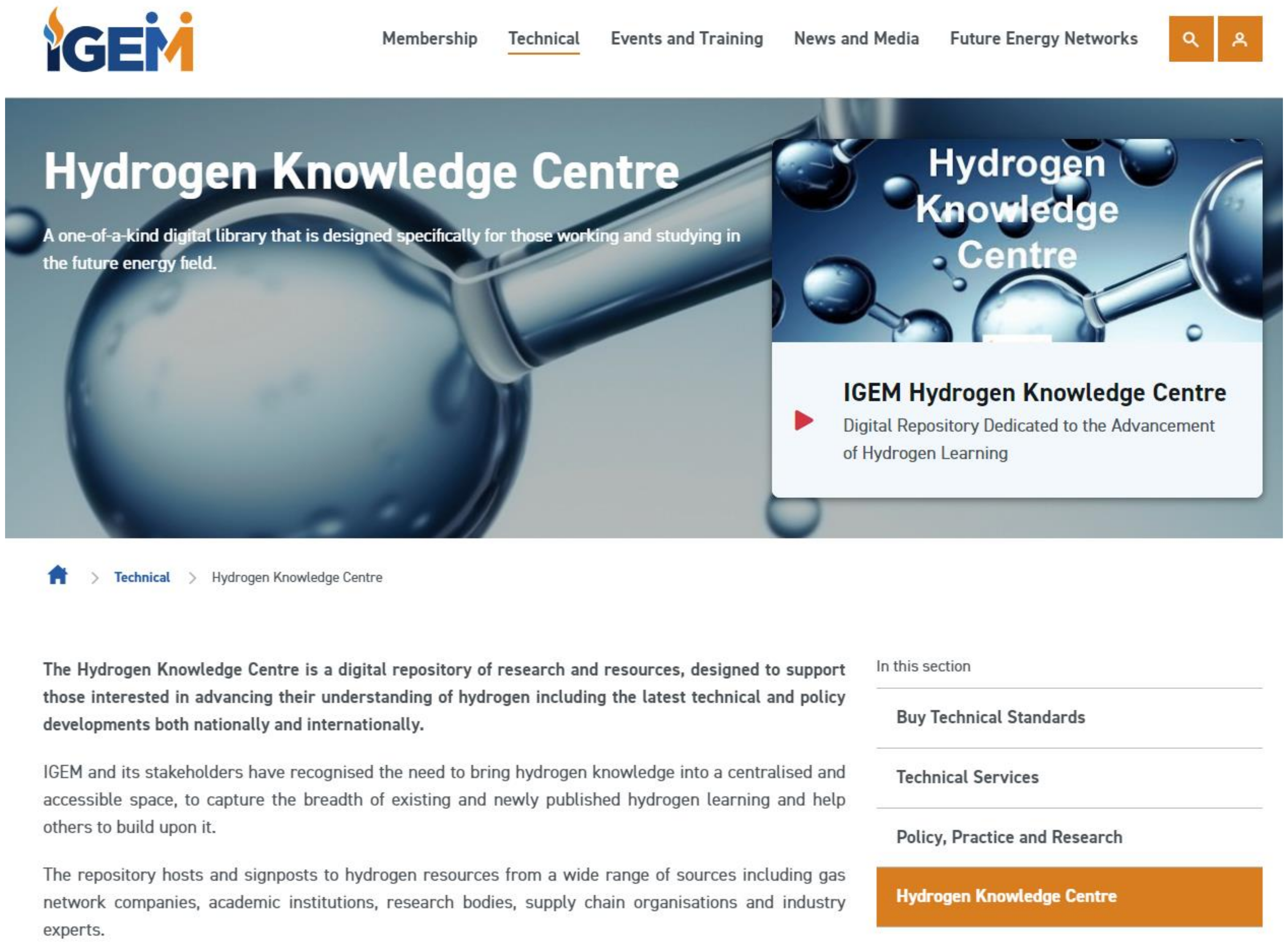
Energy Transition:
Standards and guidance

Existing hydrogen pipeline guidance and standards

- ASME B31:12 *Hydrogen piping and pipelines*
- European Industrial Gas Association
- Compressed Gas Association
- ISO and British Standards
- Institute of Gas Engineers and Managers (IGEM)
- Energy Institute
- DNV

Transport	Safety	Environmental	Containers	Materials
BS EN IEC 62282-4-102:2023	BS EN 17649:2022	BS EN 16429:2021	BS ISO 19880-8:2019+A1:2021	BS EN 15001-1:2023
BS EN IEC 62282-4-600:2022	BS EN 12120:2022	PD CEN/TR 17674:2021	BS EN 17339:2020	BS EN 15001-2:2023
BS EN IEC 62282-4-101:2022	BS ISO 23555-1:2022	BS 10176:2020	BS EN 17127:2020	PD CEN/TR 17797:2022
BS ISO 3828:2022	BS ISO 23555-2:2022		BS EN 17533:2020	BS ISO 16573-2:2022
BS EN 17124:2022	BS ISO 22441:2022		BS EN ISO 17268:2020	BS EN IEC 60034-33:2022
BS ISO 23274-2:2021	BS EN 17348:2022		BS ISO 19880-1:2020	BS EN 15502-2-1:2022
	BS EN ISO 11138-8:2021			BS EN 12583:2022
	BS ISO 29903-1:2020			BS ISO 23216:2021
				BS IEC 60747-5-13:2021
				BS EN 12732:2021
				BS EN ISO 13919-2:2021
				PAS 4444:2020+A1:2021
				BS ISO 16573-1:2020
				BS EN ISO 21663:2020

IGEM hydrogen knowledge centre



https://www.igem.org.uk/technical/hydrogen-knowledge-centre.html

IGEM TD1 hydrogen supplement for transmission pipelines

Resource library search > IGEM/TD/1 Edition 6 Supplement 2 - High pressure hydrogen pipelines

Transmission and Distribution (TD Series) Dec 2021 by Institution of Gas Engineers and Managers

IGEM/TD/1 Edition 6 Supplement 2 - High pressure hydrogen pipelines

This supplement gives additional requirements and qualifications for the transmission of Hydrogen, including Natural Gas/Hydrogen blended mixtures (subsequently referred to as NG/H blends), and for the repurposing of Natural Gas (NG) pipelines to Hydrogen service. For the purposes of this document any NG/H blend above 10% MOL is considered to be an equivalence to 100% hydrogen. For blends below 10% MOL there is no evidence to confirm that blends containing up to 10 mol.% hydrogen do not cause material degradation, but it is considered that the risk is low.

This Supplement covers the design, construction, inspection, testing, operation and maintenance of steel pipelines and certain associated installations in Hydrogen service, and the repurposing of NG pipelines to Hydrogen service, at maximum operating pressure (MOP) exceeding 7 bar and not exceeding 137.9 bar.

Scope

S2.1 This Supplement covers the design, construction, inspection, testing, operation and maintenance of steel pipelines and certain associated installations in Hydrogen service, and the repurposing of NG pipelines to Hydrogen service, at maximum operating pressure (MOP) exceeding 7 bar and not exceeding 137.9 bar.

S2.3 Where required reference is to be made to IGEM/TD/13 Edition 2 and the Hydrogen supplement to it.

S2.8 NG/H blends are considered to be equivalent to 100 mol % Hydrogen with respect to limits on design stresses, the potential effect on the material properties, and damage and defect categories and acceptance levels, unless an additional technical evaluation is carried out to qualify the materials (see clause S5.8). NG/H blends containing in excess of 10 mol % Hydrogen are considered to be equivalent to 100 mol % Hydrogen with respect to all other requirements.

S2.9 The design factor of pipelines in Hydrogen service is limited to 0.5 (as compared to 0.72/0.8 in NG service). A material performance reduction factor, as defined in ASME B31.12, is applied to reduce the allowable design factor for grades higher than L360 (X52) (see Table 1). Materials may be qualified to operate in Hydrogen service at higher design factors through testing (see clause S5.8).
Note: The material performance factors defined in ASME B31.12 are based on limiting the hoop stress, not derating the tensile properties. The design factors in Table S1 are based on the material performance factors for pressures not exceeding 137.9 barg (2,000 psig).

https://www.igem.org.uk/resource/igem-td-1-edition-6-supplement-2-high-pressure-hydrogen-pipelines.html

Energy Institute hydrogen guidance

energy institute

https://publishing.energyinst.org/topics/hydrogen

- Energy Essentials: A guide to hydrogen
- Model code of safe practice Part 1: The selection, installation, inspection and maintenance of electrical and non-electrical apparatus in hazardous areas
- High level framework for process safety management
- Guidance on assigning ignition probabilities in onshore and offshore quantitative risk assessments
- Technical workshop proceedings: Hydrogen safety cases – Challenges in hydrogen safety case development in UK/European industrial clusters
- Guidance on hydrogen delivery systems for refuelling of motor vehicles, co-located with petrol fuelling stations (Supplement to the Blue Book)
- EI Model code of safe practice Part 15: Area classification for installations handling flammable fluids
- Research report: Literature review of asset integrity in repurposing existing natural gas infrastructure for hydrogen
- Research report: Application of life cycle assessment methodology to the understanding of the energy balance and efficiency of hydrogen value chain building blocks
- EI Research report: Review of directives/regulations relevant to the safe and environmentally compliant production, transportation and storage of hydrogen
- Guidance for UK hydrogen safety case development onshore and offshore
- Research report: Landscape review of skills needed for an emerging hydrogen based economy
- Research Report: Hydrogen value-chain infrastructure integration: Interface analysis landscape review
- Research report: Environmental impacts of the large-scale deployment of hydrogen
- Research report: Literature review of asset integrity in repurposing natural gas infrastructure for hydrogen – Phase 1A
- Guidance on green and low carbon hydrogen production: plant design, construction, operation and maintenance, co-location and other considerations
- Research report: Understanding stakeholder needs and integration challenges across the hydrogen value-chain
- Research report: Global activities in hydrogen development

Contact: Mark Scanlon mscanlon@energyinst.org

DNV pipeline recommended practice documents

- NV-RP-C205 Environmental conditions and environmental loads
- DNV-RP-F101 Corroded pipelines
- DNV-RP-F102 Pipeline field joint coating and field repair of linepipe coating
- DNV-RP-F103 Cathodic protection of submarine pipelines
- DNV-RP-F105 Free spanning pipelines
- DNV-RP-F106 Factory applied external pipeline coatings for corrosion control
- DNV-RP-F107 Risk assessment of pipeline protection
- DNV-RP-F108 Assessment of flaws in pipeline and riser girth welds
- DNV-RP-F109 On-bottom stability design of submarine pipelines
- DNV-RP-F110 Global buckling of submarine pipelines
- DNV-RP-F111 Interference between trawl gear and pipelines
- DNV-RP-F113 Pipeline subsea repair
- DNV-RP-F114 Pipe-soil interaction for submarine pipelines
- DNV-RP-F115 Pre-commissioning of submarine pipelines
- DNVGL-RP-F116 Integrity management of submarine pipeline systems
- DNV-RP-O501 Managing sand production and erosion

https://www.dnv.com/oilgas/pipelines/pipeline-codes/

DNV service specification documents

DNV

SERVICE SPECIFICATION

DNV-SE-0499 Edition March 2017
Amended September 2021

Certification of pipeline components

CONTENTS

DNV

SERVICE SPECIFICATION

DNV-SE-0657 Edition December 2023

Re-qualification of pipeline systems for transport of hydrogen and carbon dioxide

CONTENTS

DNV CO_2 guidance

- DNV https://www.dnv.com/focus-areas/ccs/standards-and-guidelines/

Qualification procedures for carbon dioxide capture technology - DNV-RP-J201

Design and operation of carbon dioxide pipelines - DNV-RP-F104

Geological storage of carbon dioxide - DNV-RP-J203

Certification of sites and projects for geological storage of carbon dioxide - DNV-SE-0473

Industry guidance to manage challenges and potential hazards associated with handling CCS CO2 streams - CO2RISKMAN

Energy Institute CO_2 guidance

energy institute

https://publishing.energyinst.org/topics/ccus

- High level framework for process safety management
- Review of equations of state and available experimental data for carbon capture and storage fluids
- Repurposing and design guidelines for carbon dioxide pipelines
- Hazard analysis for onshore and offshore carbon capture installations and pipelines
- Good plant design and operation for onshore and offshore carbon capture installations and pipelines

Contact: Mark Scanlon mscanlon@energyinst.org

ISO international standards for CO_2 pipelines

- ISO TC/265 https://www.iso.org/committee/648607.html

Standard and/or project under the direct responsibility of ISO/TC 265 Secretariat (8)

ISO 27913
Carbon dioxide capture, transportation and geological storage — Pipeline transportation systems

ISO/CD 27914
Carbon dioxide capture, transportation and geological storage — Geological storage

ISO/AWI 27916
Carbon dioxide capture, transportation and geological storage — Carbon dioxide storage using enhanced oil recovery (CO2-EOR)

ISO/AWI 27917
Carbon dioxide capture, transportation and geological storage — Vocabulary — Cross cutting terms

ISO/DTR 27926
Carbon dioxide capture, transportation and geological storage — Carbon dioxide enhanced oil recovery (CO2-EOR) — Transitioning from EOR to storage

ISO/DIS 27927
Carbon dioxide capture — Key performance parameters and characterization methods of absorption liquids for post-combustion CO2 capture

ISO/CD 27928
Carbon dioxide capture, transportation and geological storage — Performance evaluation methods for CO2 capture plants connected with CO2 intensive plants

ISO/DTR 27929
Transportation of CO2 by ship

- Also CEN TC/474 https://www.cencenelec.eu/news-and-events/news/2023/brief-news/2023-11-30-ccus/

IOGP CO_2 guidance

International Association of Oil & Gas Producers

https://www.iogp.org/bookstore/

Creating a sustainable business case for CCS value chains

This paper focuses on the discussion of needed funding and de-risking mechanisms, it describes the complex CCS value chains and...

Design guidance for subsea carbon capture and storage systems

SKU: 665

This Report provides guidance to designers and developers of carbon capture and storage (CCS) systems with all, or portions, of...

Gap analysis of standards and guides for carbon capture, transport, and storage

SKU: STA028_221107

Carbon capture and storage (CCS) has been widely acknowledged as an effective component in the toolkit to achieve the targets...

Techno-economic methodology to assess carbon capture technologies

SKU: 671

Carbon capture and storage (CCS) plays a crucial role in decarbonizing the energy sector. Current projections show a significant increase...

Overview of lifecycle assessment for carbon capture and storage projects

SKU: 672

Building on a growing library of resources related to lifecycle assessment and emissions quantification for carbon capture and storage, this...

API CO_2 emergency response guidance

Carbon Dioxide (CO_2) Emergency Response Tactical Guidance Document

Best Practice Guidelines for Preparedness and Initial Response to a Pipeline Release of Carbon Dioxide (CO_2)

AUGUST 2023
(UPDATED NOVEMBER 2023)

American Petroleum Institute · Liquid Energy Pipeline Association · NASFM National Association of State Fire Marshals

This guide was developed by the American Petroleum Institute and the Liquid Energy Pipeline Association with input from the National Association of State Fire Marshals.

Contents

https://www.api.org/-/media/files/policy/carbon-capture/co2-tactical-guidance

Discussion 2

- Description: Challenges related to pipeline safety
- Management systems and programs are mature; however, these are still occurring:
  - Pipeline failures.
  - Material quality issues.
  - Construction quality issues.
- Discussion Question: What else can regulators do to resolve these issues?

Ongoing challenges in pipeline safety

- Recent incident:
  - Ongoing HSE investigation of natural gas transmission pipeline release (July 2024)

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NEWS

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Gas leak near industrial park closes roads

The gas leak is visible in footage from the scene

Emily Ford
BBC South

Daisy Stephens
BBC South

16 July 2024

People are being urged to avoid an area of Romsey after a suspected gas leak at an industrial park.

Hampshire fire service **confirmed it had responded** to the incident near Timsbury earlier.

Police said **officers were assisting gas workers** with road closures at Wynford Industrial Park in Belbins.

Gas company SGN said engineers will remain on site into the evening and added there had been no loss of gas supplies to homes or businesses.

There are several road closures in place near Rudd Lane, including Bunny Lane, Yokesford Hill and Sandy Lane.

Witnesses have reported that the leak is emitting a strong smell as well as a loud hissing noise, with local resident Pete Fielder describing the sound as "a mixture between a steam train and a fighter jet".

"We did some investigating and we found a big plume of what looked like steam," he said.

"We've got several big gas mains going through the farm but never had anything like this before."

Discussion 3

- Description: Challenges related to “Public Engagement.”
- Evolution of public attitudes towards oil and gas facilities over the past decade
- From public acceptance as being necessary utilities, towards a desire to eliminate fossil fuel infrastructure
- Discussion Question: How have public engagement dynamics evolved in your jurisdictions, and how are you addressing these challenges?

Public Engagement – Guidance

Pipeline Public Engagement

API RECOMMENDED PRACTICE 1185
FIRST EDITION, MARCH 2024

American Petroleum Institute

Contents

https://www.apiwebstore.org/standards/1185

Public Engagement – Guidance

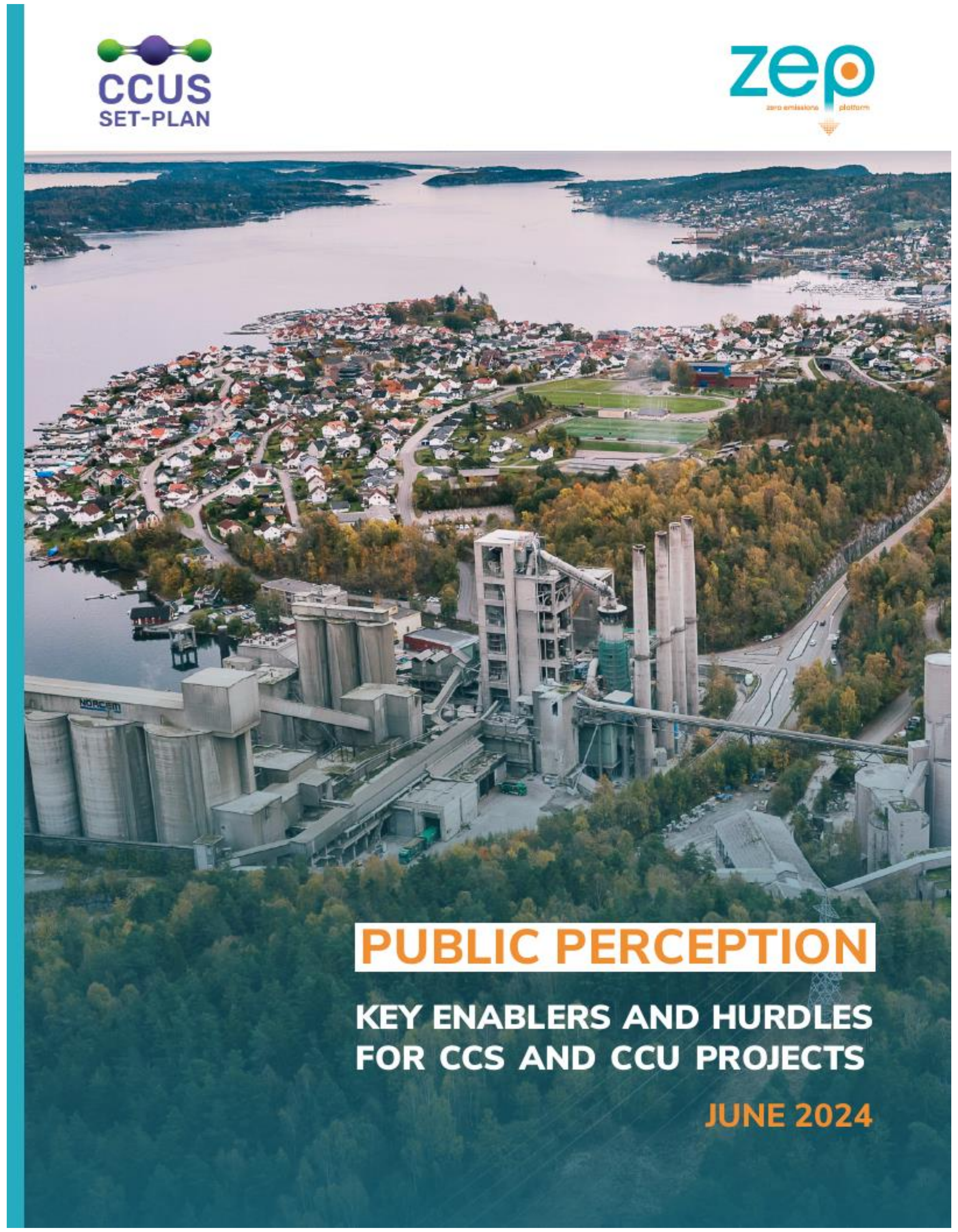

TABLE OF CONTENTS

ENABLERS FOR CCS/CCU PROJECTS

TRUST AND CREDIBILITY Establishing trust in CCS projects and their developers is fundamental for gaining public and stakeholder support. This trust is cultivated through transparent communication about the project's objectives, processes, and outcomes. Involving credible, unbiased experts such as scientists and industry specialists to share facts and debunk misconceptions about CCS technology contribute to the project's legitimacy. Demonstrating accountability and openness in addressing potential risks and sharing the measures taken to mitigate them also reinforces this trust.

PUBLIC AWARENESS Public understanding of CCS technologies, their environmental, social, and economic benefits, and their critical role in climate mitigation is paramount. Educational campaigns that explain the science behind CCS, its importance in reducing greenhouse gas emissions, and its contribution to achieving national and global climate targets can significantly enhance public knowledge. These efforts can be supported through various mediums, including social media, workshops, informational brochures, and interactive platforms.

COMMUNITY ENGAGEMENT Engaging local communities from the inception of CCS projects ensures that their concerns are heard and addressed, and the benefits of the projects are clearly communicated. This engagement includes regular meetings, feedback sessions, and participatory decision-making processes. Ensuring communities understand how the project impacts them positively, through local job creation, environmental protection, and sustainable development, fosters support and cooperation.

DEMONSTRATION OF BENEFITS Clearly showcasing the environmental benefits, such as reduced carbon emissions, and economic advantages, including job creation and energy security, is crucial. Success stories and case studies from existing CCS projects can be powerful tools in illustrating these benefits. Highlighting the role of CCS in supporting local economies and contributing to global climate goals makes the technology more relatable and acceptable to the public.

RESEARCH AND KNOWLEDGE SHARING Ongoing research into public perceptions of CCS and the development of effective engagement strategies are vital. Initiatives such as the Zero Emissions Platform's Projects Network play a crucial role in facilitating the exchange of knowledge and best practices among CCS stakeholders. Publishing findings from these research efforts and sharing lessons learned from past projects can guide future initiatives and improve their chances of success.

https://zeroemissionsplatform.eu/public-perception-key-enablers-and-hurdles-for-ccs-and-ccu-projects/

Public trials of hydrogen distribution and use in domestic premises

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Ellesmere Port hydrogen heating trial scrapped after protests

11 July 2023

The hydrogen heating trials have been called off in Ellesmere Port

Plans for a Cheshire village to be used to trial the UK's first hydrogen-powered community have been scrapped after residents objected.

Gas firm Cadent had applied for Whitby in Ellesmere Port to be included as the site for the Hydrogen Village pilot.

The aim was to test the suitability of the gas for domestic homes - but the plans were met with opposition, with some saying they felt like "lab rats".

Energy Minister Lord Martin Callanan confirmed Whitby would not be used.

MP Justin Madders said there had been safety concerns and the decision was inevitable.

Lord Callanan said: "After listening to the views of residents it's clear that there is no strong local support.

"Therefore Whitby will no longer be considered as the location for the UK's first hydrogen village trial."

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Redcar hydrogen trial scrapped by government

People living in the trial areas called for a public vote

Francesca Williams
BBC North East & Cumbria

14 December 2023

A proposed pilot project to replace home gas supplies with hydrogen will not go ahead, the government has said.

Redcar, on Teesside, was the remaining area bidding to host the trial after proposals for Ellesmere Port were scrapped in July due to residents' objections.

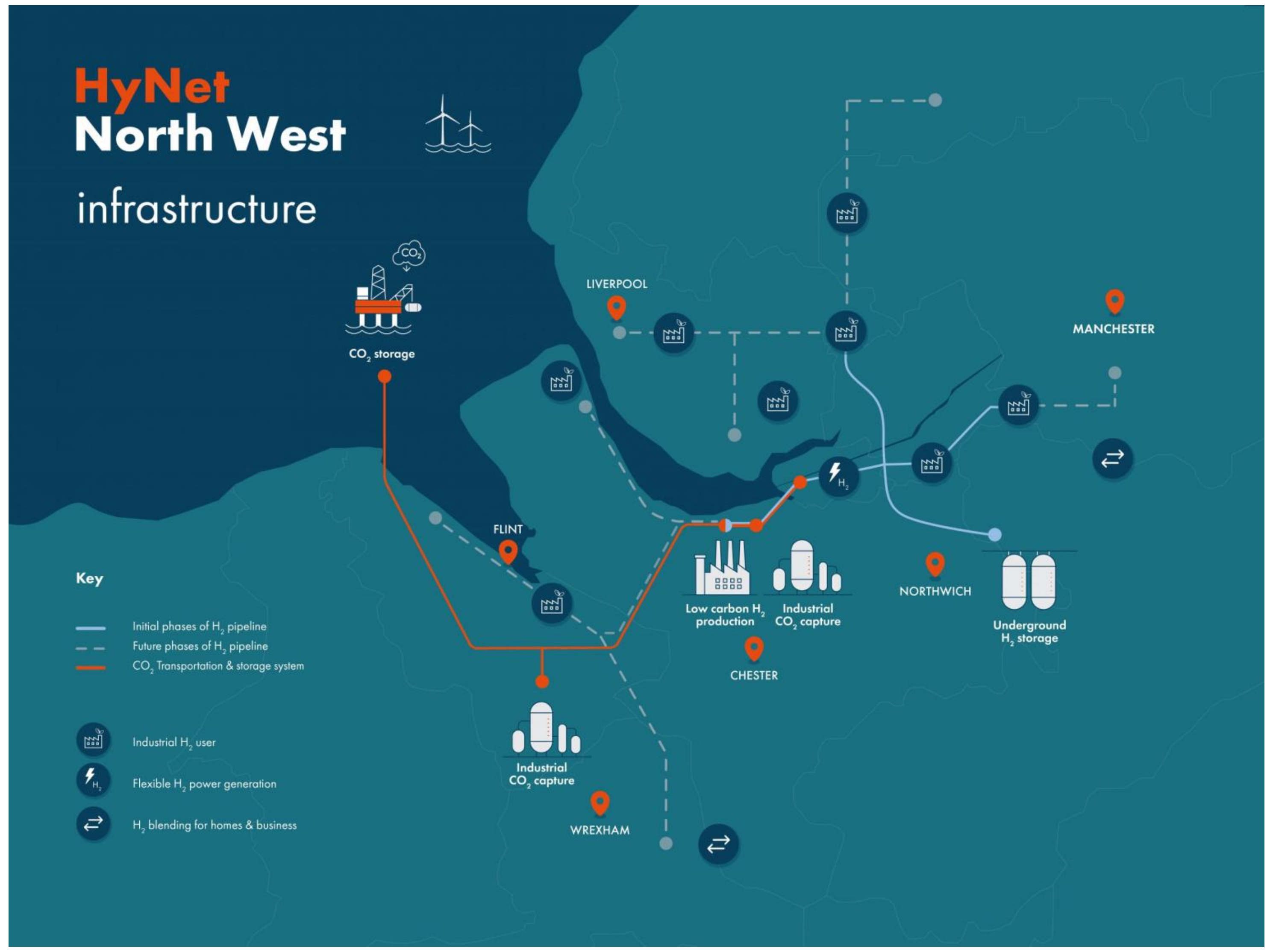
Both areas have seen protests by people concerned about safety, cost, and the ability to opt out of any trial.

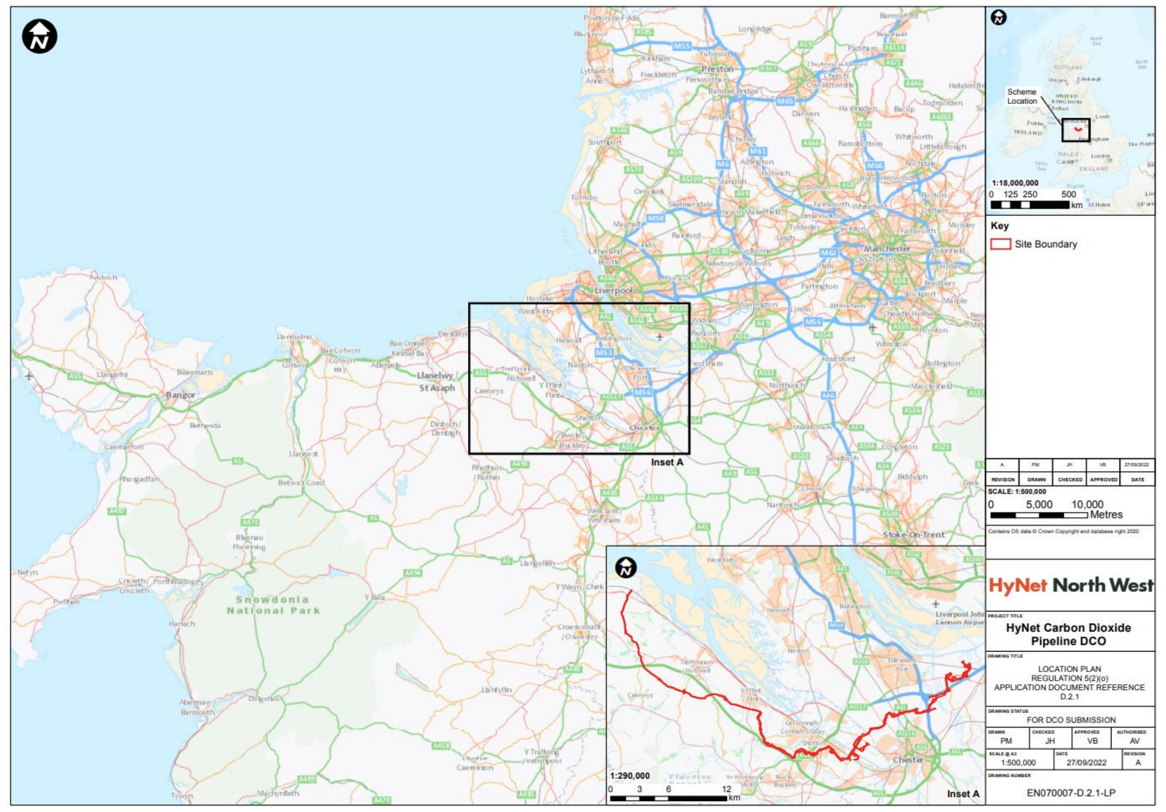
Northern Gas Networks (NGN), which would have run the Redcar trial, said it was "disappointed".

The company said the trial was not going ahead because the expected green hydrogen facilities would not now be available.

"We're disappointed that we won't be able to take forward our plan to heat homes and businesses in Redcar with low carbon hydrogen," a spokesperson said.

Public consultation on HyNet CO_2 pipeline





The Planning Inspectorate
Yr Arolygiaeth Gynllunio

National Infrastructure Planning
Temple Quay House
2 The Square
Bristol, BS1 6PN

Customer Services: 0303 444 5000
e-mail: hynetco2pipeline@planninginspectorate.gov.uk

Your Ref:
Our Ref: EN070007
Date: 20 March 2024

Dear Sir/Madam,

Planning Act 2008 – Sections 116 and 117; and The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 – Regulation 31

Application by Liverpool Bay CCS Limited for an Order Granting Development Consent for the HyNet Carbon Dioxide Pipeline

Notice of the decision by the Secretary of State

I write to notify you of the publication of the Secretary of State's decision and statement of reasons and the Order granting development consent in relation to the above application.

The Secretary of State as the decision maker under s103 and s104 of the Planning Act 2008 (PA2008) has decided that development consent should be granted and therefore has made an Order under s114(1)(a) of PA2008.

Electronic copies of the decision documentation, including the Secretary of State's decision letter, Habitats Regulations Assessment and the text of the made Order can be viewed at:

https://infrastructure.planninginspectorate.gov.uk/projects/wales/hynet-carbon-dioxide-pipeline/

National Infrastructure Planning

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Other Pipe-lines:
HyNet Carbon Dioxide Pipeline
by Liverpool Bay CCS Limited
Gweld y prosiect yn Gymraeg / View this project in Welsh

Decision | Decided | Withdrawn

Find out more about the process >

The Secretary of State has today granted development consent for this application.

For further information, please refer to the following decision documentation:

- Planning Inspectorate's notification of decision letter – English (PDF, 160 KB)
- Planning Inspectorate's notification of decision letter – Welsh (PDF, 112 KB)
- Secretary of State for Energy Security and Net Zero Decision Letter – English (PDF, 504 KB)
- Secretary of State for Energy Security and Net Zero Decision Letter – Welsh (PDF, 557 KB)
- Development Consent Order as made by the Secretary of State (PDF, 2 MB)
- Examining Authority's Recommendation Report (PDF, 8 MB)
- Regulation 31 Notice (PDF, 65 KB)
- Habitats Regulations Assessment (PDF, 2 MB)
- Post Examination submissions

20 March 2024

Overview | s51 advice | Exam Timetable | Documents | Relevant Representations

What happens next

A decision on the application for a Development Consent Order for HyNet Carbon Dioxide Pipeline was taken on 20 March 2024 and has now been issued.

The period for legal challenge is defined in s118 of the Planning Act 2008. Further information about legal challenge can be found in the letter sent to all Interested Parties accompanying the

Show more

Timeline (67 items)

- Habitats Regulations Assessment (PDF, 2 MB)
- Post Examination submissions

20 March 2024

Decision made by the Secretary of State *20 March 2024*

The responses received to the Secretary of State consultation letter dated 31 January 2024 have now been published *16 February 2024*

The Secretary of State has today issued a letter (PDF, 124 KB) to the Applicant, Cadent Gas Limited, The Canal and River Trust, Dŵr Cymru Welsh Water,

About this project

A new build carbon dioxide (CO2) pipeline that will transport CO2 produced and captured by future hydro-gen producing facilities and

Show more
Visit developer's website

Project location

From the Ince AGI in Cheshire, via Stanlow Refinery, to Talacre Beach in North Wales

https://hynet.co.uk

https://infrastructure.planninginspectorate.gov.uk/projects/wales/hynet-carbon-dioxide-pipeline

Public consultation on HyNet CO_2 pipeline

Excerpts from transcript of public hearing, 10 Aug 2023

00:54:17:21 - 00:54:51:24
And thirdly, I wanted to talk about the integrity and, um, regulation around the land based pipeline. Carbon dioxide is odorless, colorless, heavier than air, so will not disperse quickly and is an intoxicant. So transporting carbon dioxide by pipeline poses serious public safety risks. Firstly, there's a risk of corrosion. Historically, pipelines have transported relatively dry and pure carbon dioxide.

00:54:51:26 - 00:55:37:06
But in this pipeline, different sources of carbon dioxide will likely introduce higher water content and more impurities. And these are corrosive and exacerbate the risk of brittle fracture. There are additional risks associated with repurposing pipelines previously used to transport hydrocarbons, as in the case of this one. The Health and Safety Executive states with regard to the re-use of existing pipelines, any proposal to change the fluid conveyed will require a reassessment of the original pipeline design to ensure that the pipeline is capable of conveying the fluids safely.

00:55:38:00 - 00:56:02:06
There appears to be little information in this application concerning the repurposing of the 24 kilometre pipeline between the Flint Connection and Point of Air that has previously carried in methane from Liverpool Bay. Can the applicant explain how risk of corrosion and fracture is managed both in the new and in the repurposed pipeline?

00:56:04:11 - 00:56:57:27
Soil stability. The risk of rupture in addition to corrosion will be exacerbated by climate change related increased rainfall and temperatures, which may impact on soil stability in areas previously considered stable. In 2020, a pipeline in Cetacean, Mississippi ruptured, leading to the evacuation of around 200 residents and 46 people being treated in local hospitals. The investigation into the incident undertaken by US Regulatory Authority, the Pipeline and Hazardous Material Safety Administration, which I'll refer to as Mssa in future, implicated a landslide triggered by heavy rains which created axial strain on the pipeline and resulted in a full circle differential circumferential.

00:56:58:04 - 00:57:16:11
You can't do that. Girth Weld failure. The subsequent issued an advisory note listing 17 significant pipeline incidents in the US related to Earth movement in the period 2016 to 2022.

And there's limited understanding and regulation internationally. Regulation and guidance has not kept up with recent interest in systems and new large scale pipelines associated with them. The incidents in Satoshi prompted the NSA to initiate new research and development projects related to the safe transportation of carbon dioxide through pipelines. They attempt to address knowledge gaps, for example, in relation to fracture, toughness and steel pipe quality needed to prevent leak and eruptions ruptures the effects of corrosion, dents, cracks or gouges on a wide range of steel grades.

00:58:08:06 - 00:58:38:23
Odor ization strategies, which is one of the simplest ways to ensure leak detection as well as public safety and emergency response. Defining a safe distance or plume Dispersion This dispersion model for developing a potential impact area. And again, without a potential impact area, it's impossible to establish accurate emergency response, safe distances, potentially with deadly consequences.

00:58:39:02 - 00:58:46:09
These reports that have been commissioned by the US Regulatory Authority will not report for two years.

00:58:50:07 - 00:59:32:10
In the UK the situation is similar. The states that currently the I'm quoting currently the behaviour of carbon dioxide, when released in its dense and supercritical phases, is not yet fully understood, and that details standards and codes of practice written specifically for the design and operation of dense phase or supercritical carbon dioxide plant and pipelines are still being developed. A 2009 report concluded that carbon dioxide for has sufficient toxicity to be regarded as a dangerous fluid under the pipeline safety regulations.

00:59:32:12 - 01:00:02:26
But these regulations have not been updated since 1996. A 2011 report. These are reports, by the way, concluded that carbon dioxide has major accident hazard potential if released at or above its critical pressure. Yet it is not currently defined as a dangerous substance under the control of major accident hazard regulations of 1999

01:00:04:15 - 01:00:28:10
as part of a written response in July this year to my request for information about regulation of carbon dioxide transport. HSC responded. HSC has initiated a four year programme of work to developing modelling capacity capability for carbon dioxide pipelines to support Hse's role as a statutory consultee in the planning system.

01:00:30:22 - 01:01:02:07
The applicant states in Chapter 13 of the environmental statement on accidents and Disasters that it has followed the principle of the regulations to ensure the risks are identified and managed out. But I ask how can risk be eliminated when international understanding is and understanding is limited in so many ways. Programs of research will not report for several years and regulation is so out of date.

https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN070007/EN070007-002553-HyNet_10%20Aug_OFH_PT1.pdf

Roundtable Session

- Discuss the draft terms of reference and agreement in establishing the summit as a recurring event and formalizing participation

Discussions between pipeline regulators

- European Pipeline Authority Meetings (EPAM)
  - Annual meetings with representatives from pipeline regulators across Europe (including UK, Norway and Switzerland)
  - Mission: to provide a forum for those European Authorities responsible for the regulation of national pipelines, and their Pipeline Inspectorates, to exchange information and experience related to the design, construction, commissioning and operation of pipelines, and the regulation of such activities, with the aim of protecting life, preventing injury, protecting the environment and minimising economic loss
  - Origin of EPAM dates back to 1985, led by UK and Norway
  - Recent meeting in March 2024 in Brussels, Belgium
- HSE also has six-monthly calls with NOPSEMA, the Australian offshore regulator
- HSE would welcome regular calls with PHMSA and CER

Thank you

simon.gant@hse.gov.uk

- Disclaimer: the contents of this presentation, including any opinions and/or conclusions expressed, are those of the authors alone and do not necessarily reflect HSE policy
- To review HSE areas of research interest, search here: https://ari.org.uk/