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Hydrogen

Implications for the food and drink industry

October 2024

SLR

Housekeeping

- Q&A session at the end (use chat function)
- Recording & slides will be available after

Meet your speakers

Ben Turner

Principal
Air Quality

- Assesses industrial emissions on human health and biodiversity.
- Provides regulatory advice to government authorities.
- Offers pragmatic solutions to minimise risks while safeguarding environmental integrity.

Greg Altria

Technical Director
Environmental Permitting

- European Sub-Sector Lead for Hydrogen.
- Over 10 years' experience guiding organisations through environmental compliance and sustainability strategies.
- Expert in preparing environmental permit applications, including for hydrogen production facilities.

Graeme Precious

Technical Director
Carbon Management

- Over 15 years' experience supporting high-profile organisations, including The Carbon Trust.
- Specialises in carbon reporting and emission optimisation.
- Develops strategies to help businesses optimise energy usage and achieve Net Zero.

SLR Services

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- Carbon & Energy Management
- ESG Strategic Advisory
- Mining Advisory
- Energy Advisory
- Safety Advisory
- Transactional Due Diligence
- Sustainable Waste Management

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- CAD
- Civil & Structural Engineering
- Construction Services
- Geotechnical Engineering
- Land Surveying
- Mine Waste Engineering
- Process Engineering
- Transport Engineering
- Water Resource Engineering
- Water & Wastewater Engineering

Planning & Assessment

- Environmental & Social Impact Assessment
- Environmental Management Permitting & Compliance
- GIS & Information Services
- Transport Planning
- Landscape Architecture
- Planning
- Resiliency Planning

Environmental Sciences

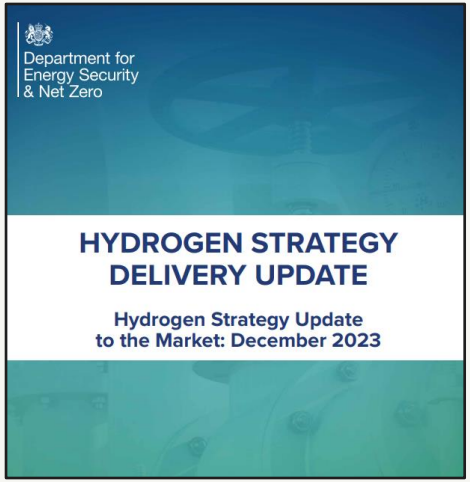
- Acoustics & Vibration
- Air Quality
- Archaeology
- CFD, Wind & Energy
- Ecology & Biodiversity
- Hazardous Material Management
- Marine Science
- Occupational Hygiene

Earth Sciences

- Geology
- Hydrogeology
- Hydrology
- Land Quality & Remediation
- Risk Assessment & Toxicology
- Soil Science

Background

- Clean and infinite fuel
- Primary fuel to replace natural gas
  - Net Zero 2050 target (CCA)
  - Energy security
- Industry largest demand / decarbonisation opportunity
  - 2/3 fuel in F&D sector natural gas (energy)
- Infrastructure (industrial clusters form national network):
  - Project Union (national network)
  - Hynet North-West (DCO 2025)
  - East Coast Hydrogen
- Operators conducting trials (DESNZ)



What's the issue?

- Transition is underway but lack of information:
  - 1D focus on Net Zero – balance other impacts
  - No reference to Hydrogen in current legislation (IED, MCPD, BAT)
  - EA Technical Working Group delay issuing guidance (March 2024)
- **Aim:** Discuss potential environmental and regulatory challenges and opportunities
  - High-level overview based on our experience and knowledge (all TBC)

The road to Net Zero is complex

Today's Agenda

1. Air Quality

- Formation of NOx from combusted hydrogen and the risks.

2. Environmental Permitting

- How Permitting Authorities (EA, NRW and SEPA) may manage this transition.

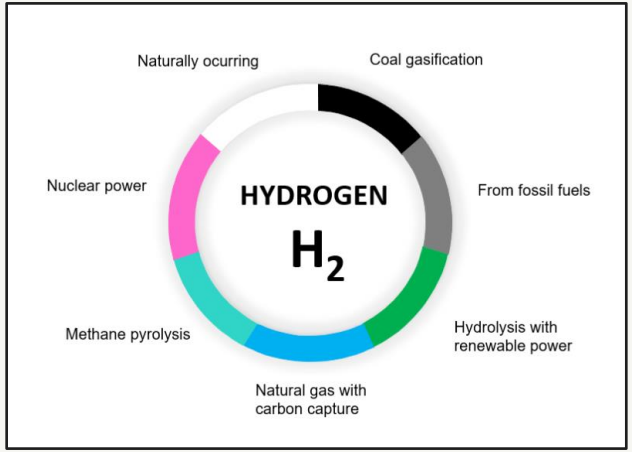
3. Carbon Reporting

- Implications on carbon emission reporting schemes (ETS, CCA and SECR).

Overview of Hydrogen

- Colours to reflect different production methods
  - Grey: Natural gas (cheapest)
  - Blue: Recovery from natural gas (CCS)
  - Green: Renewables

- Transition to renewable options (simplify colours)



Potential Barriers

Purity of hydrogen (blending)

Timescales (HyNet – 2027)

Retrofitting of existing systems

Lower energy output (will more appliances be needed?)

Different colours (further consideration of upstream carbon)

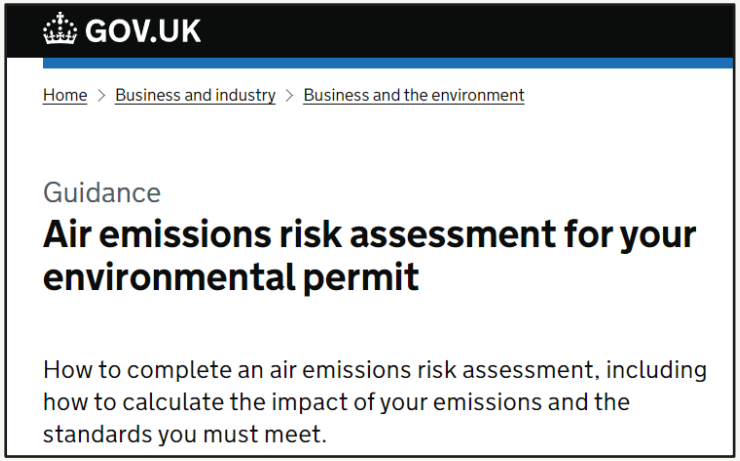
Air Quality

Ben Turner

NOx Background

Key Pollutant: NOx

- NOx = Nitric Oxides (NO) and Nitrogen Dioxide (NO_2)
- Principal pollutant of concern in UK
  - Biodiversity: nitrogen deposition
  - Human health: Mortality and pregnancy issues
- Main source = combustion
- Environmental Permitting:
  - Application: Air Emissions Risk Assessment
  - Operational: Regulated NOx ELVs / BAT-AELS



NO_2 in Focus

- Health & social £9.2bn by 2035 (PH England)
- 6,000 deaths a year in UK
- 553 AQMAs UK (87%)
- CJEU legal challenge

Formation of NOx

Fuel NOx

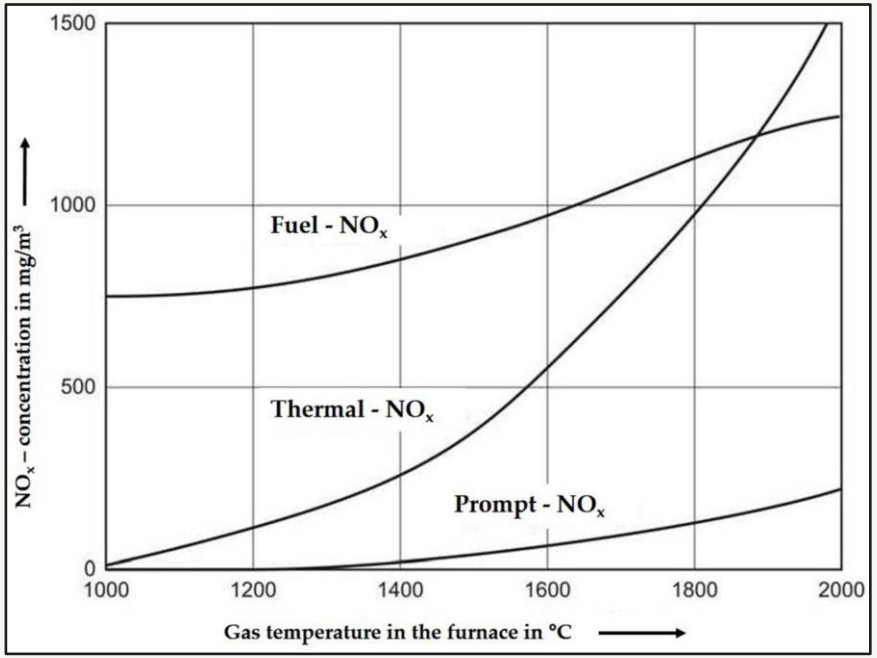
- Combustion of nitrogen in fuel (coal, oil)

Thermal NOx

- Oxidation of nitrogen in air under high temperatures

Hydrogen & NOx

Hydrogen & NOx

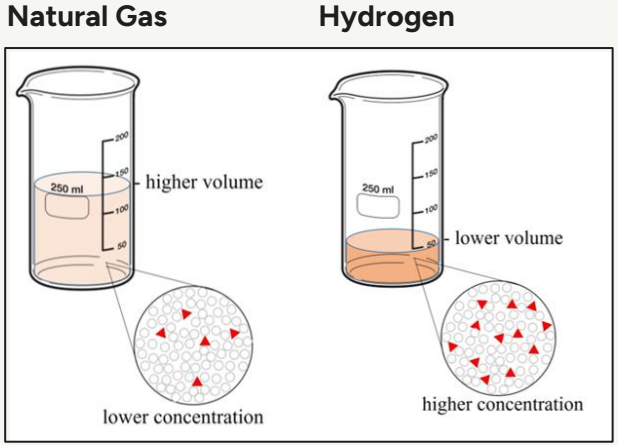


- **Misconception that hydrogen is clean**
- Hydrogen burns at a higher temperature to natural gas = higher thermal NOx
  - Natural Gas 1,960 °C
  - Hydrogen 2,660 °C
- >600% increase NOx vs. Natural Gas

NOx will still be a concern

EA Emerging Research

- **Aim**: No greater NOx emissions vs Natural Gas (WIP)
- Align with current IED / MCPD limits (standardised dry volume)
- Combusted hydrogen = lower dry volume (no CO_2)
  - If lower dry volume, higher NOx concentration
- Adjust ELVs by 1.37 (100% hydrogen)
  - Linear interpolation for varying blends (25%, 50%, 70%)



Proposed ELVs

Proposed Emission Limit Values for Hydrogen and Non-Conventional Fuels

Table 2: Proposed NOx ELVs for blended natural gas and hydrogen fuel in existing plant

	100% Natural Gas (mg/Nm^3)	75 % Natural Gas with 25% Hydrogen (mg/Nm^3)	50 % Natural Gas with 50% Hydrogen (mg/Nm^3)	25 % Natural Gas with 75% Hydrogen (mg/Nm^3)	100% Hydrogen (mg/Nm^3)
LCPs					
Gas Turbine >50MWth	50.0	54.6	59.3	63.9	68.5
Boiler >50MWth	100.0	109.3	118.5	127.8	137.0
Gas Engines >50MWth	100.0	109.3	118.5	127.8	137.0
MCPs					
Gas Turbines >5MWth	150	163.9	177.8	191.6	205.5
Boilers >5MWth	200	218.5	237.0	255.5	274.0
Gas Engines >5MWth	190	207.6	225.2	242.7	260.3
Gas Turbines >1 <=5MWth	150	163.9	177.8	191.6	205.5
Boilers >1 <=5MWth	250	273.1	296.3	319.4	342.5
Gas Engines > 1<=5MWth	190	207.6	225.2	242.7	260.3

Note Reference conditions are 273.15K, 101.3kPa, dry, 3% oxygen for boilers and 15% oxygen for gas turbines and engines.

Challenges

Dynamic ELVs

- ELVs set according to hydrogen blend
  - 25%, 50%, 75% and 100%
- Cause monitoring and compliance complications
  - Stack monitoring will need fuel mix analysis

In Practice

New Appliances

- Air Emissions Risk Assessment (accompany Permit application / variation)

Existing Natural Gas Appliances

- Permit Variation
- Can the ELVs be achieved?
- No greater NOx emissions but changes to dispersion conditions (assessment?)
  - Temperature
  - Volumetric Flow
  - Exit velocity

Sites that:

- Low stack height (landscape constraints)
- Near to sensitive receptors (European Designations)
- Operating near maximum environmental capacity

Environmental Permitting

Greg Altria

What is Environmental Permitting?

- Requires operators of specified activities to obtain and comply with the conditions of a permit / licence
- Aims to protect environment and human health
- Offence to operate a regulated facility without a permit or comply with conditions
- Transposes numerous pieces of legislation & retained EU Directives

Country	Applicable Legislation	Regulatory Authority
England	Environmental Permitting (England and Wales) Regulations 2016 (as amended)	Environment Agency
Wales		Natural Resources Wales
Scotland	Pollution Prevention and Control (Scotland) Regulations 2012 (as amended) Currently consulting on updates to Environmental Authorisations (Scotland) Regulation to replace PPC Regs	Scottish Environment Protection Agency
Northern Ireland	Pollution Prevention and Control (Industrial Emissions) Regulations (Northern Ireland) 2013 (as amended)	Northern Ireland Environment Agency

How does Hydrogen Consumption sit within the Regulations?

- ‘Installation’ activity described in Schedule 1 Section 1.1 if being used as fuel in a combustion appliance >20MWth or where numerous combustion appliances aggregate to >50MWth .
- Medium Combustion Plant or Specified Generator in Schedule 25A & 25B if being used as a fuel in combustion plant >1MWth in capacity.
- Or as a ‘Directly Associated Activity’ to food and drink sites regulated under Schedule 1 Section 6.8.

Emission Limit Values (ELVs)

- Hydrogen as a fuel is not currently considered in current environmental permitting guidance or regulations.
- Medium Combustion Plant Directive refers to 'gaseous fuels other than natural gas' for example, but the ELVs are not appropriate for hydrogen combustion (intended for chemical industry process gases).
- Environment Agency proposing specific ELVs for hydrogen combustion.

Table 1

Emission limit values (mg/Nm^3) for new medium combustion plants other than engines and gas turbines

Pollutant	Solid biomass	Other solid fuels	Gas oil	Liquid fuels other than gas oil	Natural gas	Gaseous fuels other than natural gas
SO_2	200 (1)	400	—	350 (2)	—	35 (3) (4)
NO_x	300 (5)	300 (5)	200	300 (6)	100	200
Dust	20 (7)	20 (7)	—	20 (8)	—	—

When will guidance become available?

- EA is currently in the process of preparing guidance. Draft guidance on ELVs for hydrogen combustion have been circulated to trade bodies.
- ELVs to be aligned within IED and MCPD minimum standards for nat gas.
- In time, BAT guidance would be developed and ELVs applied in addition to min standards i.e. typically lower.
- Nat gas ELVs proposed to be factored by 1.37 to account for high concentration but lower volume of flue gas to maintain mass emission rate the same.
- ELVs for blends would be calculated using a fuel-weighted average based on the relative thermal input of the hydrogen and natural gas.
- Lower ELVs could be applied if there was a site-specific need such as to prevent exceedance of air quality standards or a designated habitat site.

Review your Permit!

- Environmental permit may or may not state fuel types permitted for use
- And / or permits may have ELVs set which the plant will not be able to comply with following a switch to H2 due to being based on nat gas
- If so, permit variation will be required

Table S3.1 Point source emissions to air – emission limits and monitoring requirements

Emission point ref. & location	Source	Parameter	Limit (including unit)	Reference period	Monitoring frequency	Monitoring standard or method
A1 on site plan in Schedule 7	Boiler 1 10.6 MWth fuelled on natural gas	Oxides of Nitrogen (expressed as NO_2)	100 mg/m^3	Periodic	Annually	MCERTS BS EN 14792
		Carbon monoxide	No limit set	Periodic	Annually	MCERTS BS EN 15058

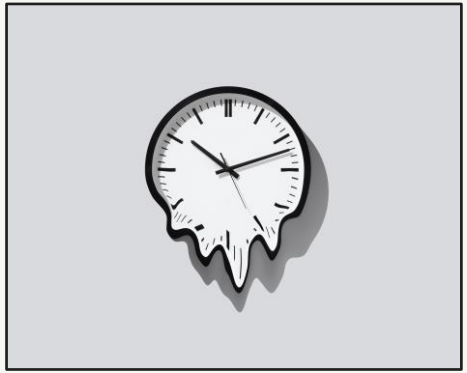
Variation Applications for Environmental Permits / PPC Licences

- Application must be made to the applicable regulatory authority
- Content of application will be dependent on the proposed scheme, for example amount of H2 storage proposed, site setting and manner in which the appliance is to be regulated.
- Variation to a Section 1.1 activity will require demonstration of Best Available Techniques application and air quality dispersion modelling.
- MCP / SG variation application could involve as little as completion of application forms and screening of distance from designated habitats sites and human receptor locations up to detailed dispersion modelling.

Timescales

- Timescales for obtaining an environmental permit variation / PPC licence can be significant.
- Applicants should be prepared to expect:
  - c. 1-2 years for a bespoke variation application to be determined.
- Does differ between regions (Scotland can be quicker).
- Potential delays if applications are submitted prior to guidance being published or if many applications are received at same time.

- Don’t hold me to any of this!

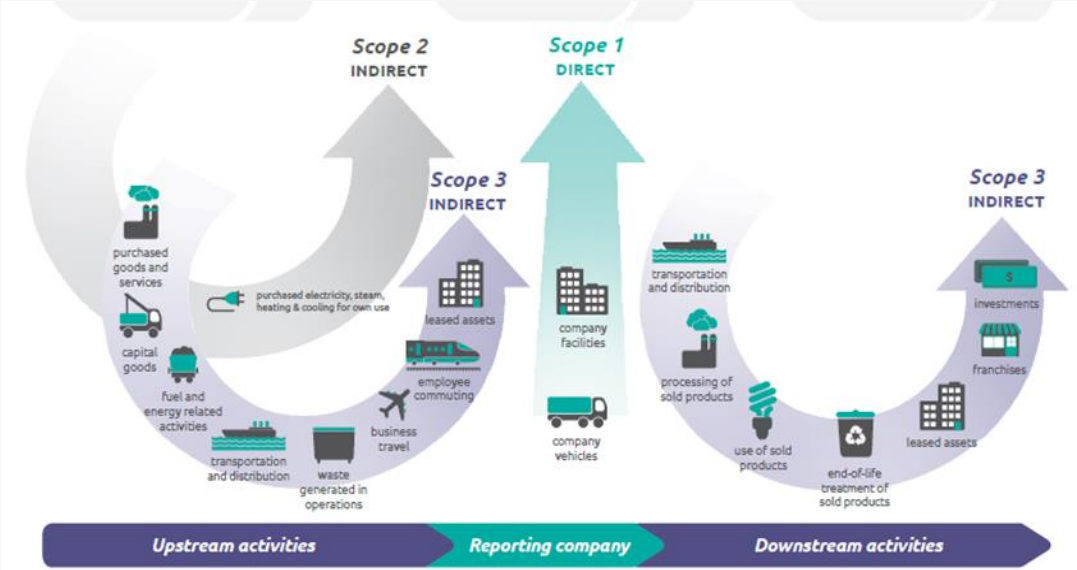


Carbon Emissions

Graeme Precious

Carbon Emissions - Scopes

- Under the GHG Protocol **'Corporate Standard'** methodology greenhouse gas emissions are categorised by the following three scopes:
- **Scope 1 (Direct Emissions)**
- **Scope 2 (Indirect Emissions from Purchased Energy)**
- **Scope 3 (All Other Indirect Emissions)**



Direct Emissions (Scope 1)

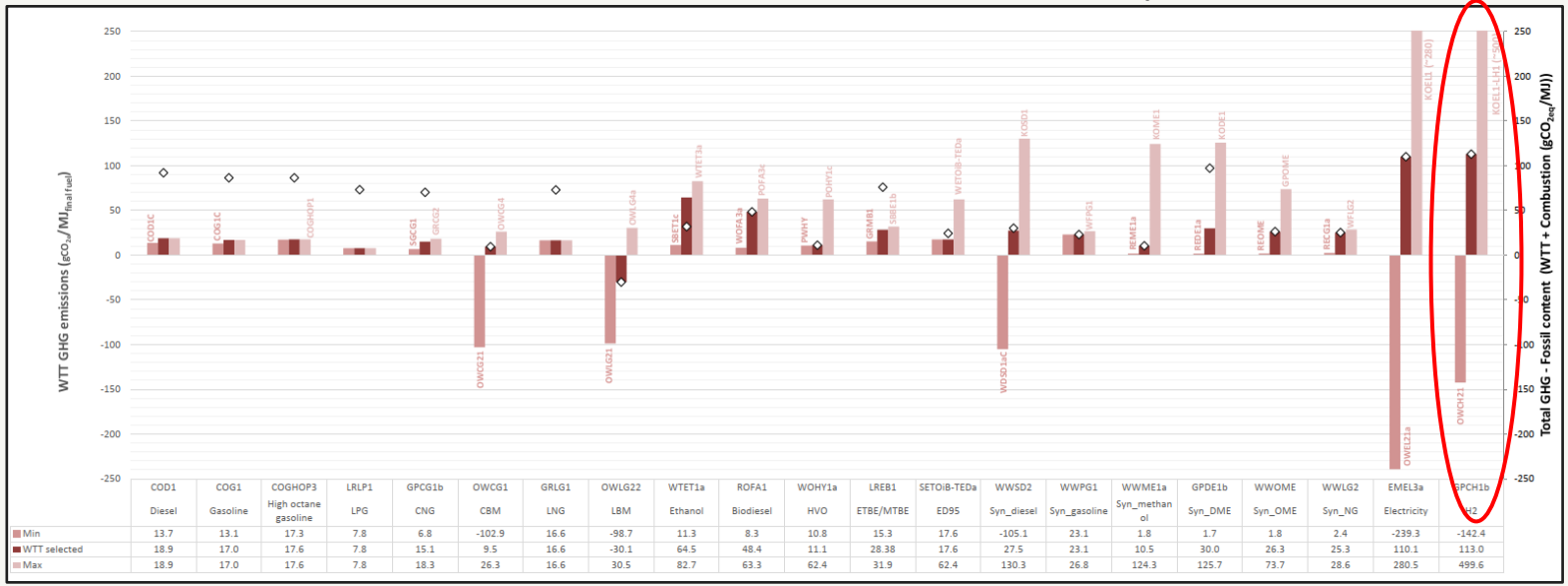
- Hydrogen **doesn't emit CO_2** on combustion and therefore **Scope 1** emissions from on-site combustion can be considered **Zero**
- This would not be the case however for any blended mixes e.g. H_2/Natural Gas
- There are also potentially significant **Scope 3** emissions associated with H_2 production (see next slide)

- This has potential implications for your GHG reporting and associated schemes
  - CCA – Buy-out based on direct emissions
  - UK/EU ETS - Direct Emissions Reporting
  - SECR – Direct Emissions Reporting
- …and any additional reporting e.g. CDP, SBTi targets etc.

Well-to Tank Emissions (Scope 3)

- These can vary greatly dependent on the production route and process used to generate the fuel: **Brown/Grey/Black** (from fossil fuels without CCS), **Blue** (from natural gas with CCS), **Green** (electrolysis with renewable electricity)
- The EU Study 'JEC Well-to-tank v5 (2020) models a range of **-0.14 to +0.5 kgCO2e/MJ** JRC Publications Repository - JEC Well-to-Tank report v5 (europa.eu) - *negative WTT emissions associated with net emissions from biofuel farming processes and CCS*
- Potentially **significantly higher** than for traditional fuels

WTT GHG Emissions Summary EU Commission JEC Well-to-tank v5 (2020)

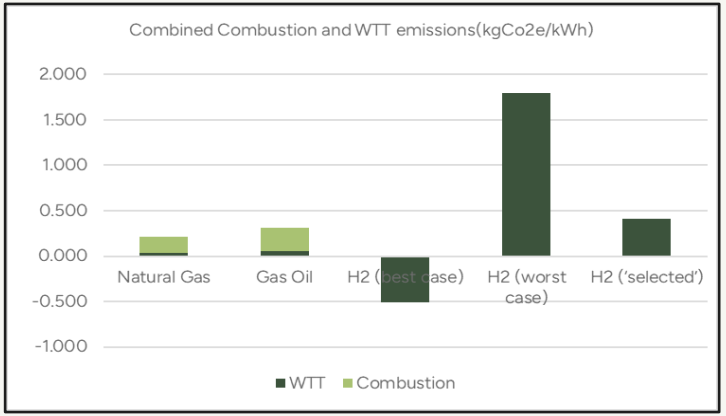


	COD1 Diesel	COG1 Gasoline	COGHOP3 High octane gasoline	LRLP1 LPG	GPCG1b CNG	OWCG1 CBM	GRLG1 LNG	OWLG22 LBM	WTET1a Ethanol	ROFA1 Biodiesel	WOHY1a HVO	LREB1 ETBE/MTBE	SETOiB-TEDa ED95	WWSD2 Syn_diesel	WWPG1 Syn_gasoline	WWME1a Syn_methanol	GPDE1b Syn_DME	WWOME Syn_OME	WWLG2 Syn_NG	EMEL3a Electricity	GPCH1b H2
Min	13.7	13.1	17.3	7.8	6.8	-102.9	16.6	-98.7	11.3	8.3	10.8	15.3	17.6	-105.1	23.1	1.8	1.7	1.8	2.4	-239.3	-142.4
WTT selected	18.9	17.0	17.6	7.8	15.1	9.5	16.6	-30.1	64.5	48.4	11.1	28.38	17.6	27.5	23.1	10.5	30.0	26.3	25.3	110.1	113.0
Max	18.9	17.0	17.6	7.8	18.3	26.3	16.6	30.5	82.7	63.3	62.4	31.9	62.4	130.3	26.8	124.3	125.7	73.7	28.6	280.5	499.6

Scope 1 + Scope 3 emissions

Source	kgCO2e/kWh (WTT)	kgCO2e/kWh (combustion)	Total
Natural Gas*	0.030	0.183	0.213
Gas Oil*	0.059	0.256	0.316
H2 (Min)	-0.513	0.0	-0.513
H2 (Max)	1.799	0.0	1.799
H2 ('selected')	0.407	0.0	0.407

* Source UK Gov factors 2024



- Although H_2 is a 'zero carbon' fuel on combustion (Scope 1) the overall emissions impact is very dependent on the method of manufacturing
- Dependent on source the overall emissions (Scope 1 + Scope 3) could actually be **higher** than traditional fossil fuels
- Under the new Carbon Border Adjustment Mechanism **(CBAM)** to be implemented in 2027 imports of Hydrogen gas from less clean sources would be subject to **import tariffs**

Potential Impacts – 'Mandatory' schemes

SCHEME	IMPLICATIONS
UK/EU ETS Emission Trading Schemes	• Replacing fossil fuels with H_2 will **reduce direct on-site** emissions, therefore should reduce the cost of the scheme to an installation • Potentially result in a **Permit surrender** (combustion threshold is based on **CO_2** emissions from combustion – which does not apply to H_2 combustion) – but clarification would be needed from the EU/UK Gov - *H_2 may have to meet **sustainability criteria**/apply to 'Green H_2' only?* • The 2022 UK Gov Consultation 'Developing the UK ETS' refers to needing time to have a *'clearer picture of the changing landscape'* ref Hydrogen
CCA Climate Change Agreements	• fdf target is based on **energy** consumption (absolute or relative) • Switching from fossil fuel to H_2 may potentially **increase** energy? – making the target harder to achieve *(although calorific value of H_2 is **higher** than Natural Gas (**120 vs 45 MJ/kg**) it is much less dense – requiring 3-4 times the volume to deliver equivalent energy)* • However, if H_2 is zero carbon rated then **buy-out costs will be reduced** • H_2 may have to meet **sustainability criteria** as per Biofuels - apply to 'Green H_2' only? – no information available on this yet
SECR Streamlined Energy and Carbon Reporting	• No financial implications – use of H_2 will **reduce** direct on-site and/or vehicle emissions **(Scope 1)** • **Scope 3** emissions from fuel supply chain not currently required to be disclosed under mandatory reporting but this is currently under consultation

Potential Impact – Carbon Targets

Switching to hydrogen will impact on your Net Zero/Carbon Reduction Targets both directly and indirectly:

- **Scope 1 targets** – the impact on direct emissions will be positive as no CO_2 is emitted, supporting any Scope 1 & 2 specific targets
- The impact on broader targets incorporating **Scope 3** will vary dependent on the manufacturing route of the H_2
- **SBTi** targets for fdf companies are **very likely** to include Scope 3 emissions
- Your Scope 3 emissions will form part of your **customers** supply chain (Scope 3) emissions, and therefore their targets - again need to consider the source of H_2 and the impact on your emissions

CDP
DISCLOSURE INSIGHT ACTION

SCIENCE BASED TARGETS
DRIVING AMBITIOUS CORPORATE CLIMATE ACTION

Summary

Summary

- Air Quality:
  - Combusted hydrogen emits NOx
  - Align with natural gas IED / MCPD (can existing plant be retrofitted?
  - Unsure on assessments (existing appliances)
  - Monitoring challenges with dynamic ELVs (blended fuels)
- Environmental Permitting:
  - Change to ELVs trigger variation
  - Lengthy timescales (EA etc may take risk-based approach)
- Carbon Reporting
  - Clarification required regarding treatment of Hydrogen under CCA/ ETS
  - Overall emissions impact is very dependent on the manufacturing route

Do you have any questions?

Making Sustainability Happen

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Ben Turner

Principal

Air Quality

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