# Integrating Low Carbon Hydrogen into the UK's Energy Mix:

## An Industry Perspective

Presented by Becca Neill

28th January 2025

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# Agenda

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## Aims of the Talk

1. Setting the scene: Net zero and the UK energy mix
2. Deeper dive into electrolytic hydrogen
3. Reflections from an industry perspective: Developing hydrogen projects

# Background: Becca Neill

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- Masters Electrical and Electronic Engineering
- Asset Management
- Electrical Design Engineer
- Grid Connections Engineer
- Senior Electrical Engineer
- Head of Project Development
- Senior Project Manger

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# Net Zero and the UK Energy Mix

# UK Net Zero Targets

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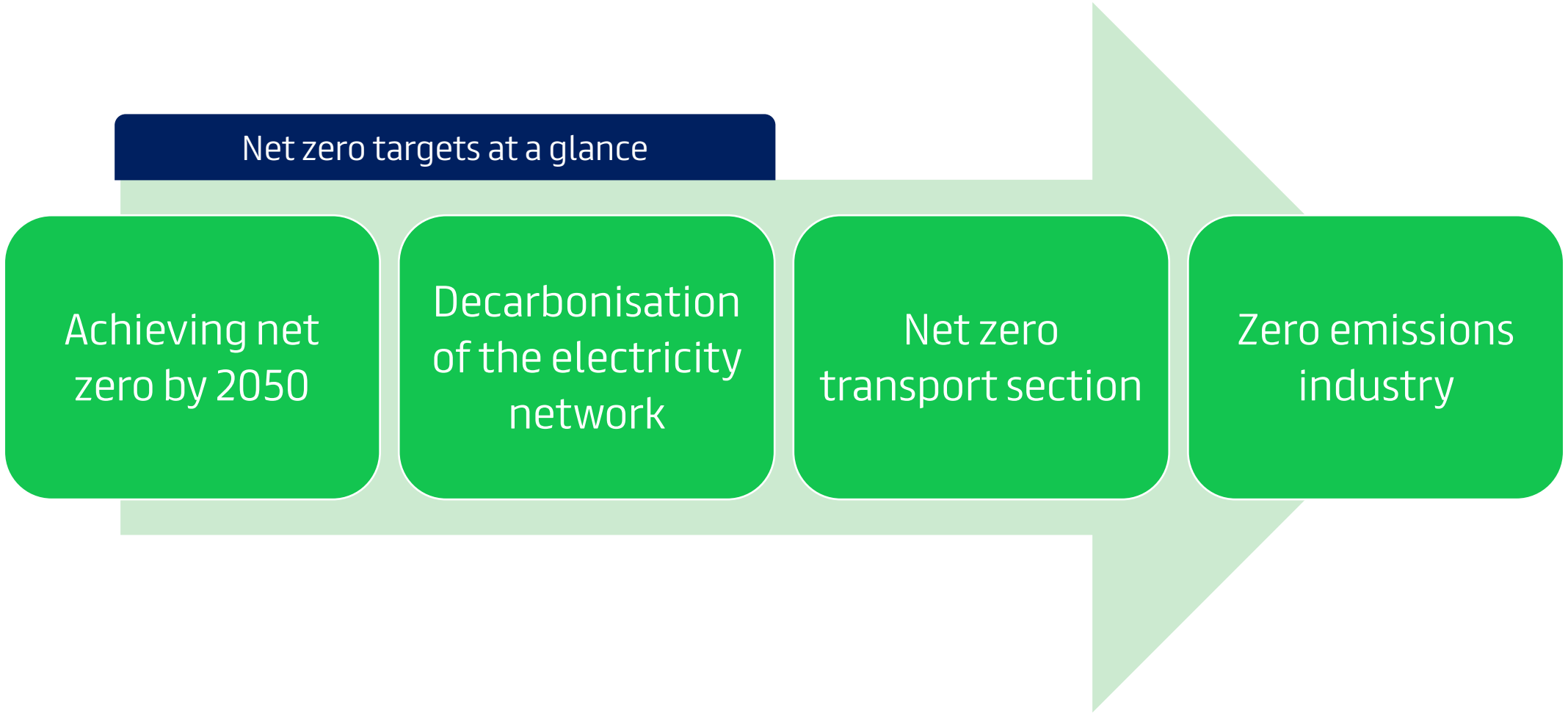

# Background: UK Energy Mix

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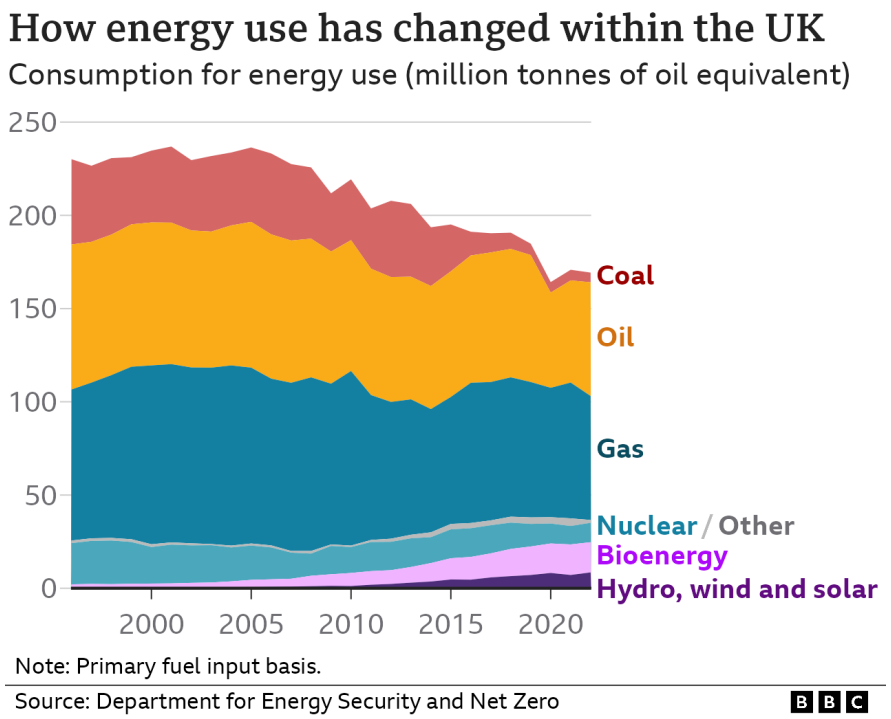
**Primary Energy: energy that comes from a natural source**

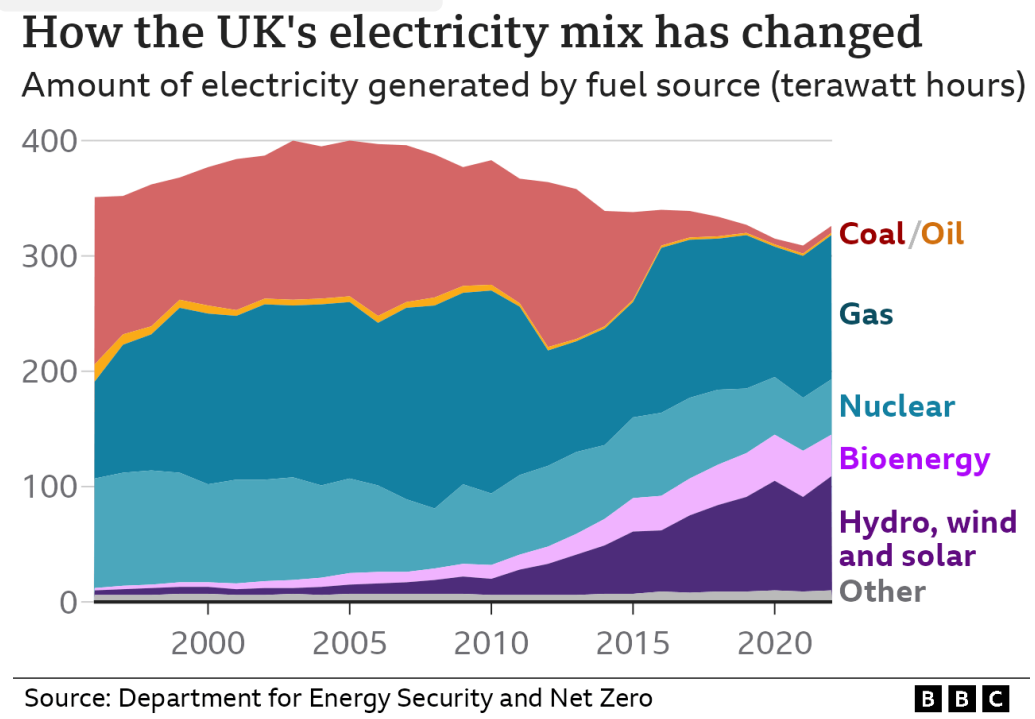
Examples: renewables (e.g. solar and wind), coal, natural gas, nuclear

**Secondary Energy: energy that comes from the transformation of a primary energy source into a form that is easier to use and transport**

Examples: electricity, refined petroleum products (e.g. diesel), and hydrogen




For example: UK electricity mix




Source: DESNZ

# Types of Hydrogen and How They are Made

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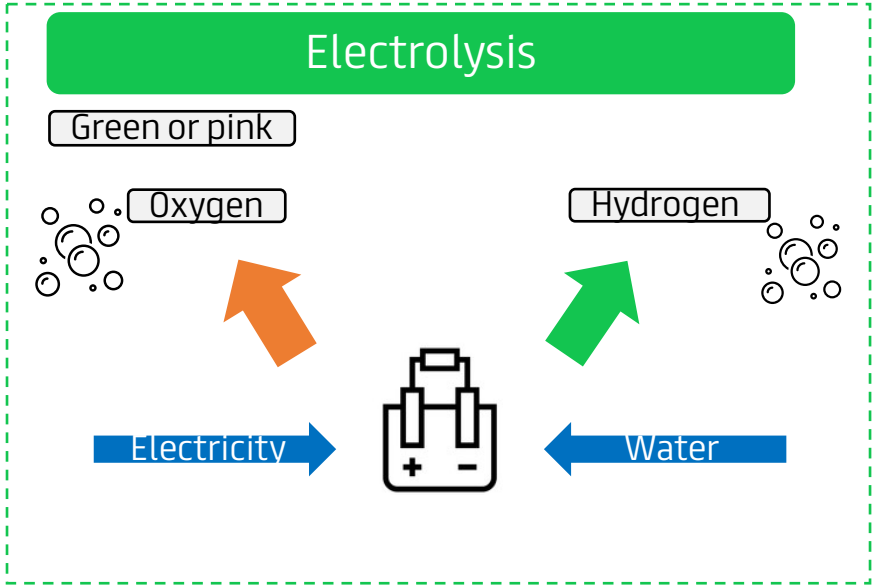
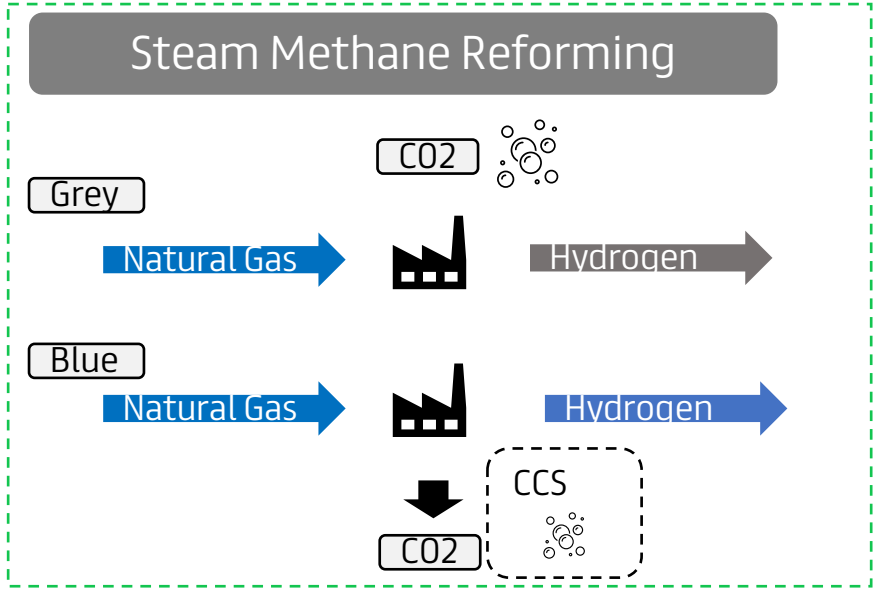
Background on types of hydrogen

Most industry relevant types

| Color | Brown Hydrogen | Grey Hydrogen | Blue Hydrogen | Turquoise Hydrogen | Green Hydrogen | Pink Hydrogen |
|---|---|---|---|---|---|---|
| Process | Gasification | SMR* | SMR or Gasification with carbon capture | Pyrolysis | Electrolysis | Electrolysis |
| Source | Coal | Natural Gas | Natural Gas | Natural Gas | Renewable electricity | Nuclear electricity |

*SMR: Steam Methane Reforming



# UK Fuel Usage and Relationship to Hydrogen

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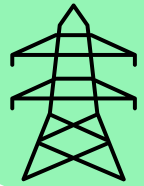
## UK Key Fuel Sources

The UK has three key dependent fuel sources (primary and secondary energy sources) used domestically, commercially and industrially .



Electricity

Natural Gas

Oil

## Fuel Transportation

Existing fuel transportation infrastructure locks the UK into path dependency around fuel usage.

Electricity transmission and distribution network

BEIS predicts it will cost £270-350 billion to get the electricity network to support Net Zero ambitions

Gas Distribution Network

Pipelines, tankers, and road/ rail

## Relevance to Hydrogen

Hydrogen is a secondary energy form and is an important component of the UK's Net Zero strategy.

Electricity is a necessary feedstock for creating low carbon hydrogen. Hydrogen can also be a form of storage.

Low carbon alternative for natural gas (e.g. industrial processes, heating)

Low carbon alternative for oil (e.g. HGV transportation, construction)

# How Does Hydrogen Fit into Net Zero

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## Net Zero and Hydrogen

It is identified that to achieve net zero we will need multiple routes of decarbonization. Low carbon hydrogen is one component of this.

Currently as the UK we have three key power distribution networks

- Electricity grid
- Gas network
- Transport fuel distribution

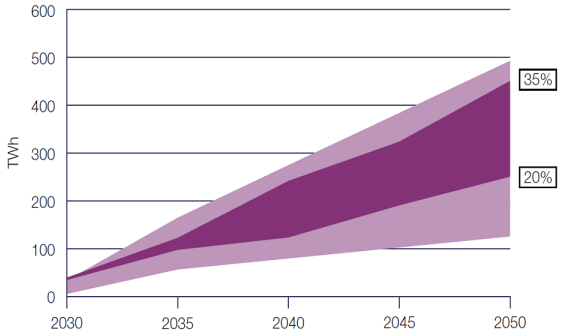
Moving all of this onto the electricity network has significant challenges and required major upgrades

There are use cases of fuel currently that are not well suited to conversion to electricity or to battery electric power

UK Government has set a target of 5GW of low carbon hydrogen production by 2030. This is equivalent to enough hydrogen to heat 3 million homes .

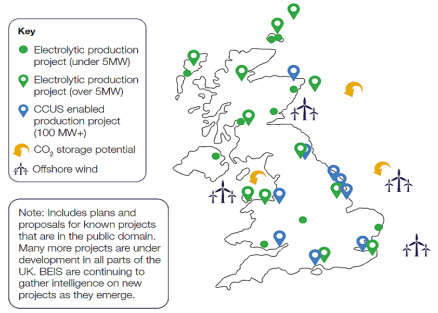
## 2021 UK Hydrogen Vision

**Figure 1.2: Hydrogen demand and proportion of final energy consumption in 2050**




% = hydrogen as proportion of total energy consumption in 2050

**Figure 1.3: Proposed UK electrolytic and CCUS-enabled hydrogen production projects**




## Examples of Policies

- 2021 UK Hydrogen Strategy
- Hydrogen Allocation Round (grants for H2 project)
    - Gas Shipper Obligation (proposed funding mechanism)
- Hydrogen Production Business Model
- Net Zero Fund

Source: UK Hydrogen Strategy

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# Deeper Dive into Electrolytic Hydrogen

# Key Hydrogen Use Case

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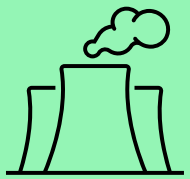
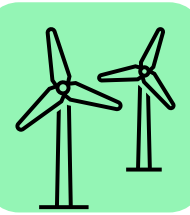


## Heavy Industry

Industries require high heat in processes which require a clean burning option



## Scaling Renewables

Allows incorporation of more renewables on the UK grid while avoiding curtailment and limitations of the electricity network

## Heating

Blending into the gas grid for direct use in boilers

## Heavy Transport

For heavy transport where battery electric solutions can be restrictive by weight and range constraints

## Energy Storage

Way to store surplus renewable energy for use  at a later point in time to generation

# How Hydrogen Can be Used

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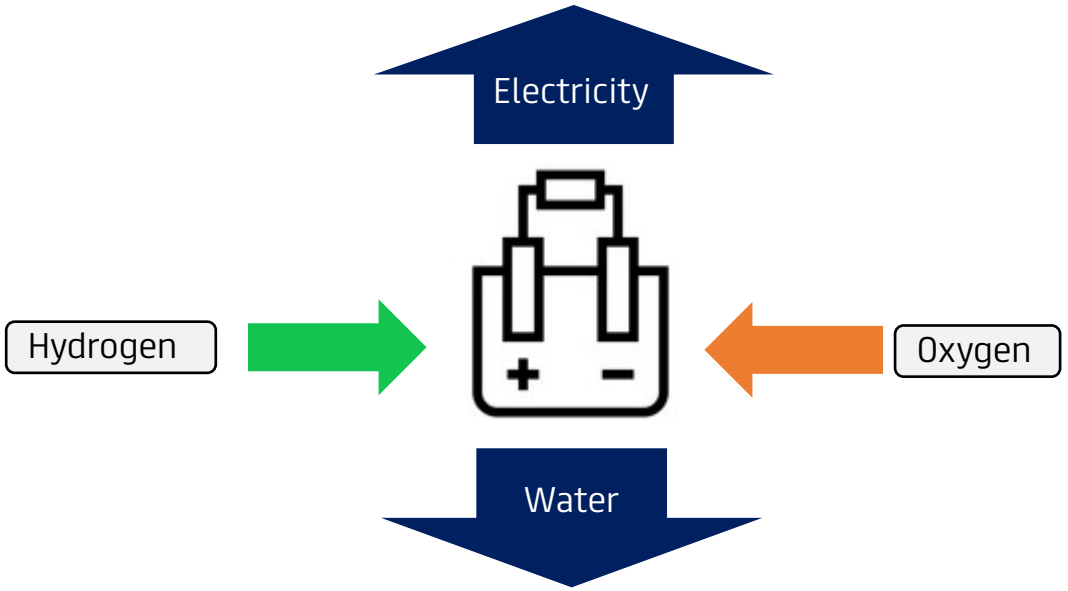
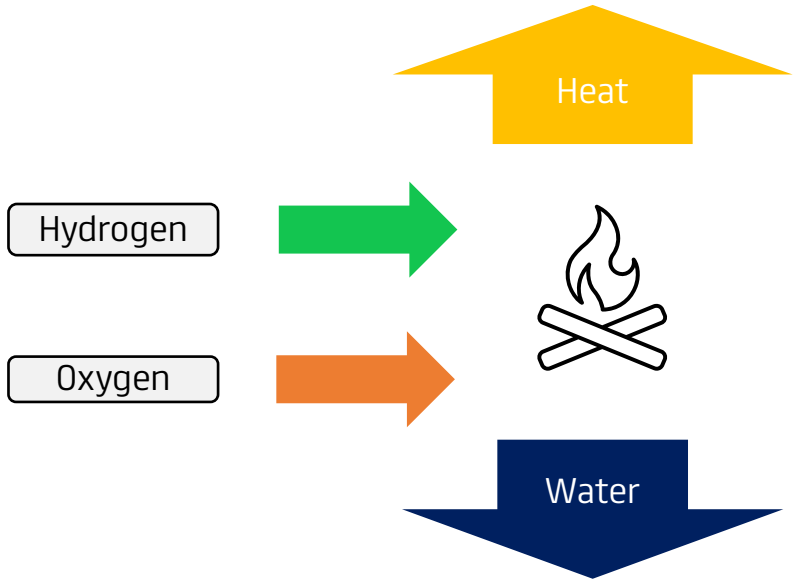
## Fuel Cells

Use of a fuel cell for production of electricity from hydrogen, electricity produced used to power the system. Reverse of the electrolysis process




## Combustion

Combustion used in situations where heat is required as part of the process. Can be used in industrial furnaces, combustion engines, turbines



# Aims of the Hydrogen Business Model

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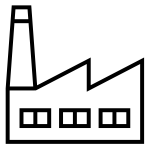
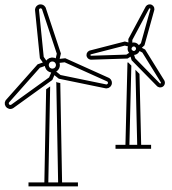
The leading UK policy for stimulating hydrogen usage is the Hydrogen Business Model applied through Hydrogen Allocation Rounds



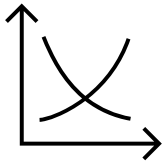
Decarbonize hard-to-abate sectors



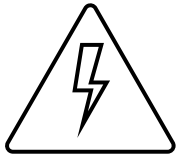
Transition to Renewable Energy

Attract Investment

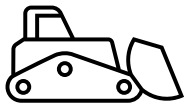
Economic Growth and Job Creation



Stimulate Supply and Demand



Energy Security



Infrastructure Development

# How the Subsidy Works

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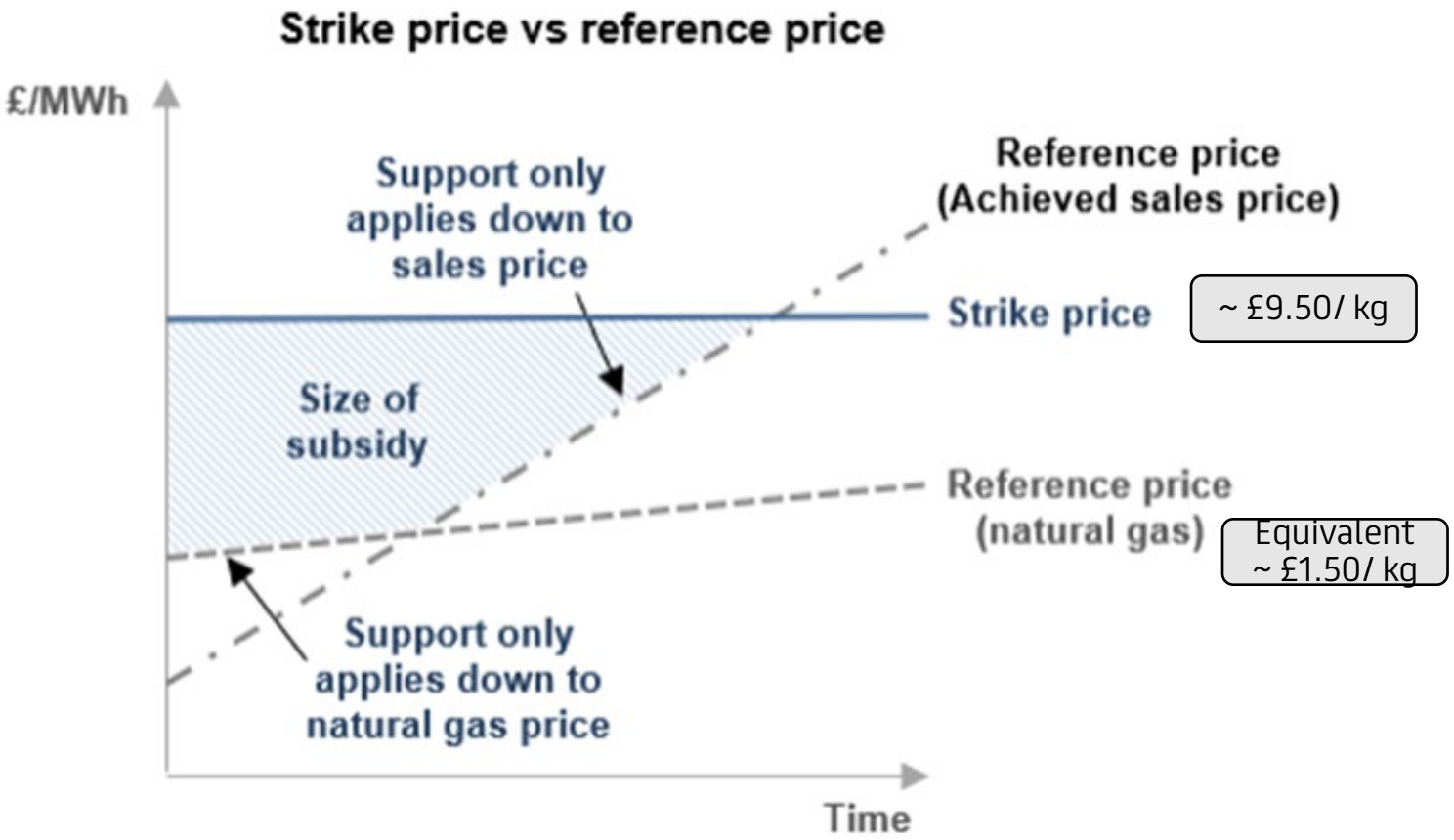
## Financial Mechanism

- Contract for difference based on the natural gas price
- Subsidizes the hydrogen price to the natural gas price for the customer
- Currently a negotiated strike price on a per project basis, future aims to move towards a similar auction to CfD where a strike price level will be set based on bids



# How to Make Sure It Is Green

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## Low Carbon Reporting

- Hydrogen produced under the subsidy scheme must be low carbon
- To be considered low carbon the hydrogen produced must meet the Low Carbon Hydrogen Standard
- GHG Emissions less than 20g CO2/MJ averaged over a month
- The power must be temporally matched. This means that the hydrogen must be produced in the same half hour that the power is generated
- Compared to the REGO system which is annual reconciliation

| Source | g CO2/MJ |
|---|---|
| Coal | 227 |
| Natural Gas | 136 |
| Biomass | 64 |
| Current Grid Intensity | 33 |
| Solar PV | 13 |
| Hydropower | 6.7 |
| Nuclear | 3.3 |
| Wind | 3.3 |

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# Industry Perspective:
# Developing Hydrogen Projects

# Bradford Low Carbon Hydrogen

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12.5 tonnes per day

800 buses

35MW Electrolysis

Largest HAR1 Scheme

2024
Enabling Works

2025
Construction Begins

2026
Site Commissioning

2027
Hydrogen produced at the site

# What Goes into a Hydrogen Site

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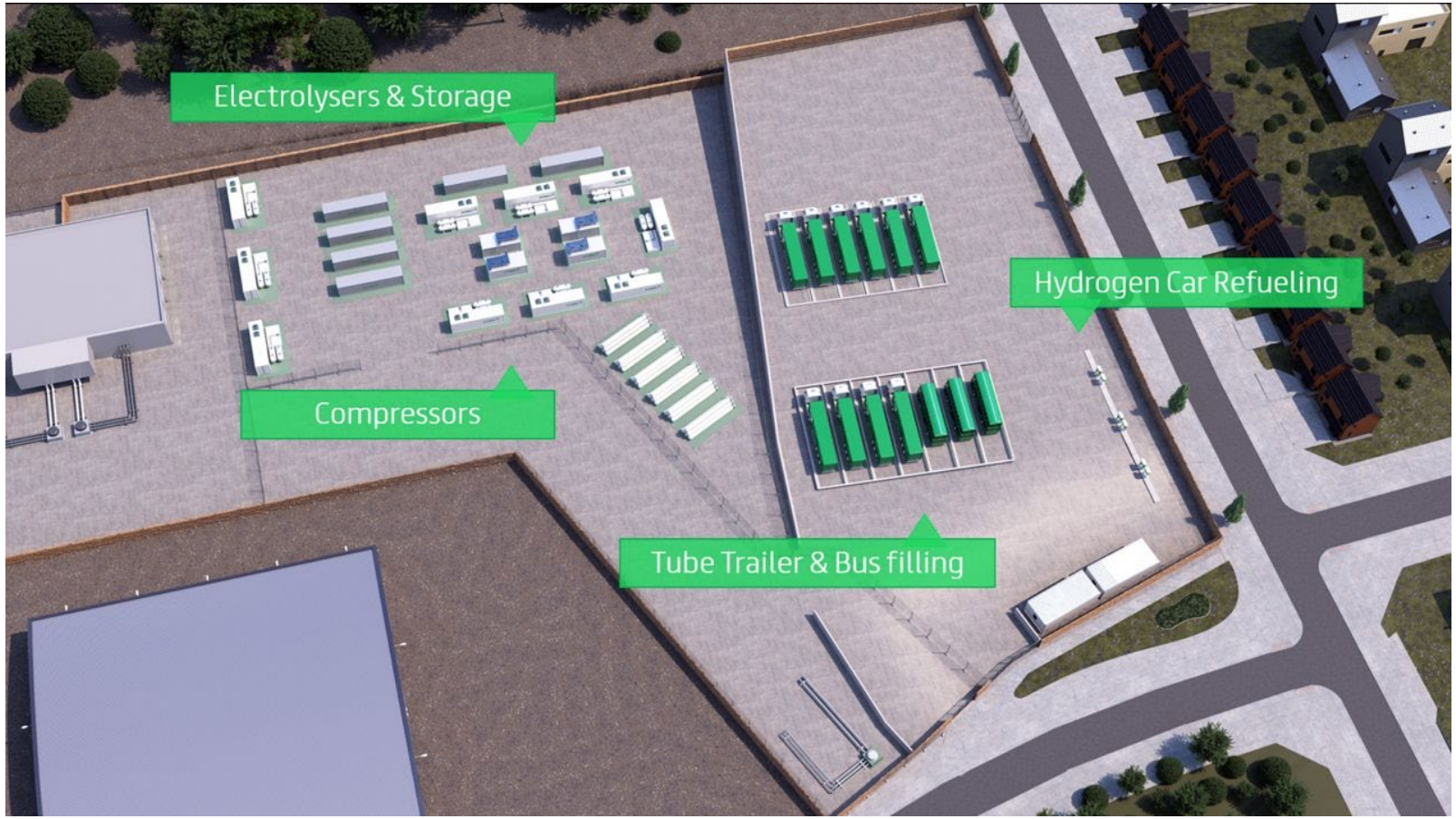


- 5MW Electrolyser blocks
- Compression to 500 bar
- Compression to 700 bar
- Hydrogen Storage
- Tube trailer bays for hydrogen distribution
- Utilities – nitrogen supply, cooling, water and waste water connection
- Electrical infrastructure
- Light vehicle refuelling

# The Cost of Producing Hydrogen

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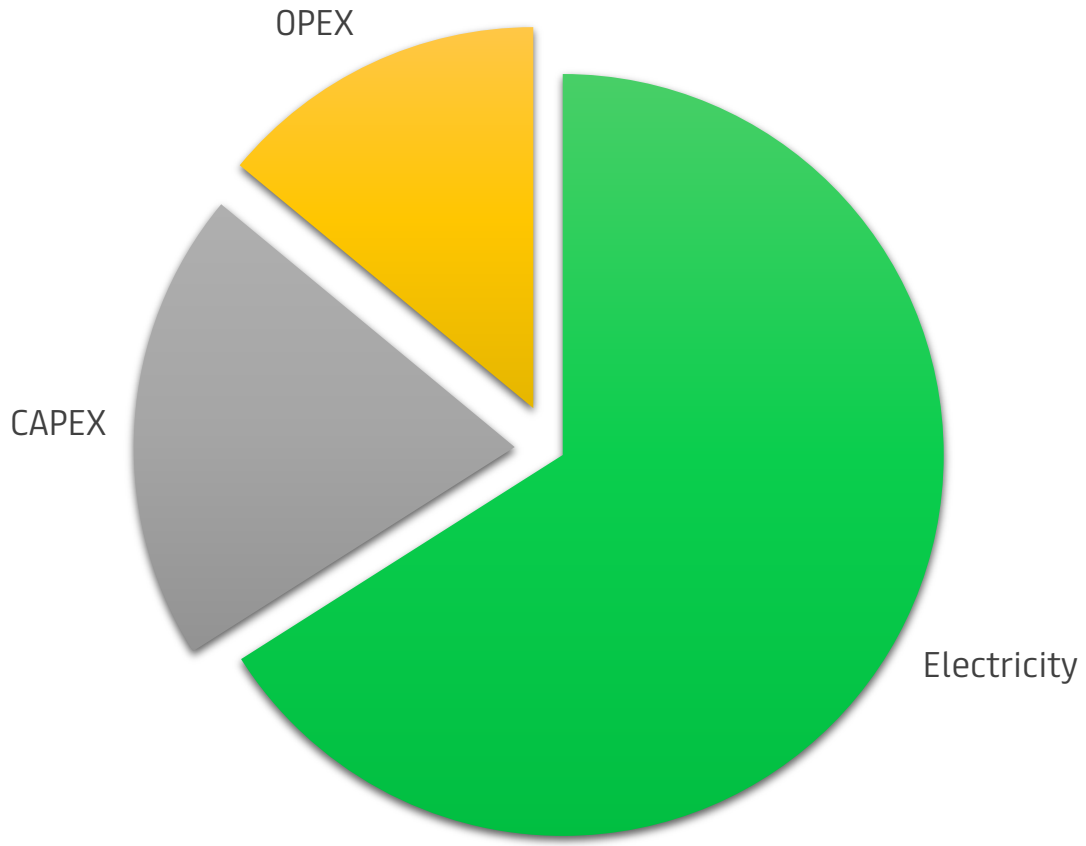
## Breaking down the cost of hydrogen




- Projects have a high up front CAPEX
- Electricity is the highest portion of the operating cost
- Cost of producing hydrogen is very locational based due to the strong relationship between power cost and hydrogen production cost

CAPEX = capital expenditures
OPEX= operating expenditures

# Challenges Developing Hydrogen Sites

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## Health and Safety

Managing public perception of hydrogen.
Ensuring that plants are designed with safety at the forefront and measures are in place to protect the site and the public.

## Availability of Electricity

UK grid has constraints of availability of capacity, with wider system reforms going on to try and mitigate issues.
Renewables have limited locations in the UK where they can be produced.

## Availability of Water

Some areas of the UK have water scarcity and are enacting water policies to limit water usage.
Water quality is key in the production of hydrogen and poor-quality water damages the system.

## Offtake Locations

Hydrogen is best used close to the source due to difficulties and cost of transportation.

## Government delays

Government delays around enacting hydrogen (and net zero) policies and funding can affect investor and company confidence.