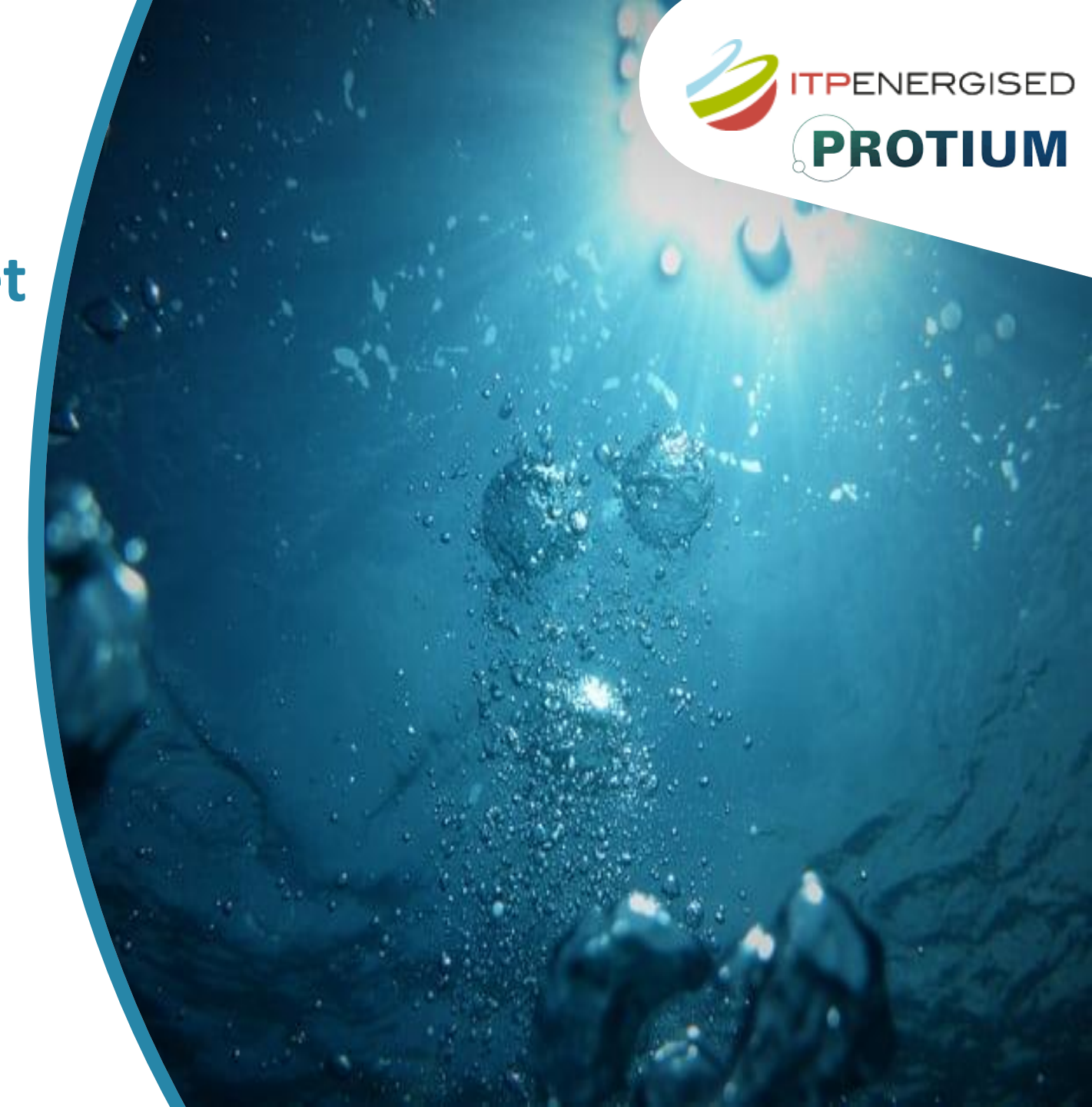
# Using Green Hydrogen to Drive the Transition to a Net Zero Economy

## Project Experiences of ITPEnergised and Protium

"We believe passionately in the world's transition to net zero. We are a team of trusted technical advisors who meet and exceed our clients' aspirations."



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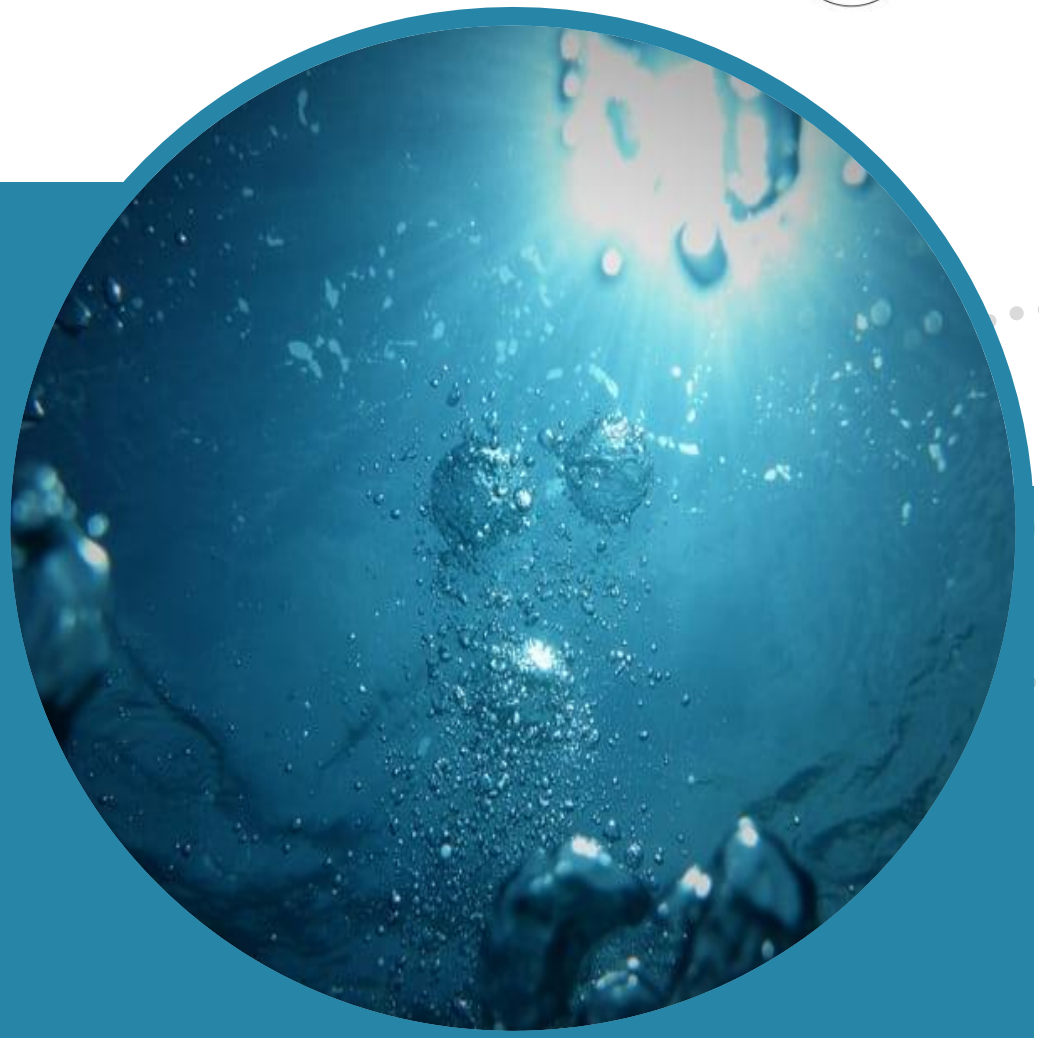

Trusted Technical Advisor

# Who we are: ITPEnergised

## ITPE in numbers

- > 150 clients
- 5 sectors
- > 150 countries
- > 10 locations globally
- > 100 GW of projects
- > 90 employees and growing
- > 2,500 projects
- > 40 years from genesis

Trusted Technical Advisor

# Passionate about net zero

## Our Approach: Life-Cycle Thinking


**We deliver from a position of passion in all we do:**

"We're passionate about Net Zero. We are a team of industry leading trusted technical advisors who aim to meet and exceed our clients' aspirations, targeting growth markets and clients."

Our chosen clients comprise like minded people who represent funds, lending banks, private equity, utilities, blue chip corporates, developers, oil & gas companies, regulators, government and network companies across the world who work tirelessly to transition our world to net zero.

We work across the lifecycle of projects for our clients leading to the delivery of portfolios across sectors levering out key areas of expertise:

**Sectors:**

- Onshore renewables
- Offshore renewables
- Oil and gas transition
- Industry and manufacturing
- Food and beverage

**Expertise:**

- Corporate advisory
- Environment and planning
- Technology

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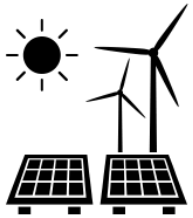
# Protium's mission is to end fossil fuel use in the UK, and promote a transition towards a low carbon future

We enable UK industries and local government to **reach zero greenhouse gas emissions**.

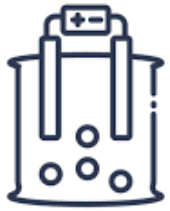
To achieve this, Protium develops, builds and finances renewable energy projects that produce **green hydrogen** from water and renewables.

We focus on projects and sectors where **early commercial traction** is viable without relying on government grants or subsidies.

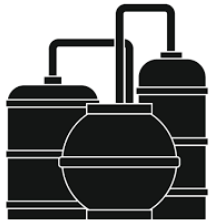
We believe hydrogen is the **key energy carrier** to replace fossil fuels in industrial heat and heavy transport, the hardest areas to decarbonise to date.



***Renewable Energy***



***Green H2 Production***



***H2 Storage & Distribution***

***Zero Emission Transport***

# The UK is serious about achieving net zero emissions

**UK enshrines new target in law to slash emissions by 78% by 2035**

Following the UK Government's announcement to be Net Zero by 2050 many businesses have set their own ambitious targets to tackle climate change.

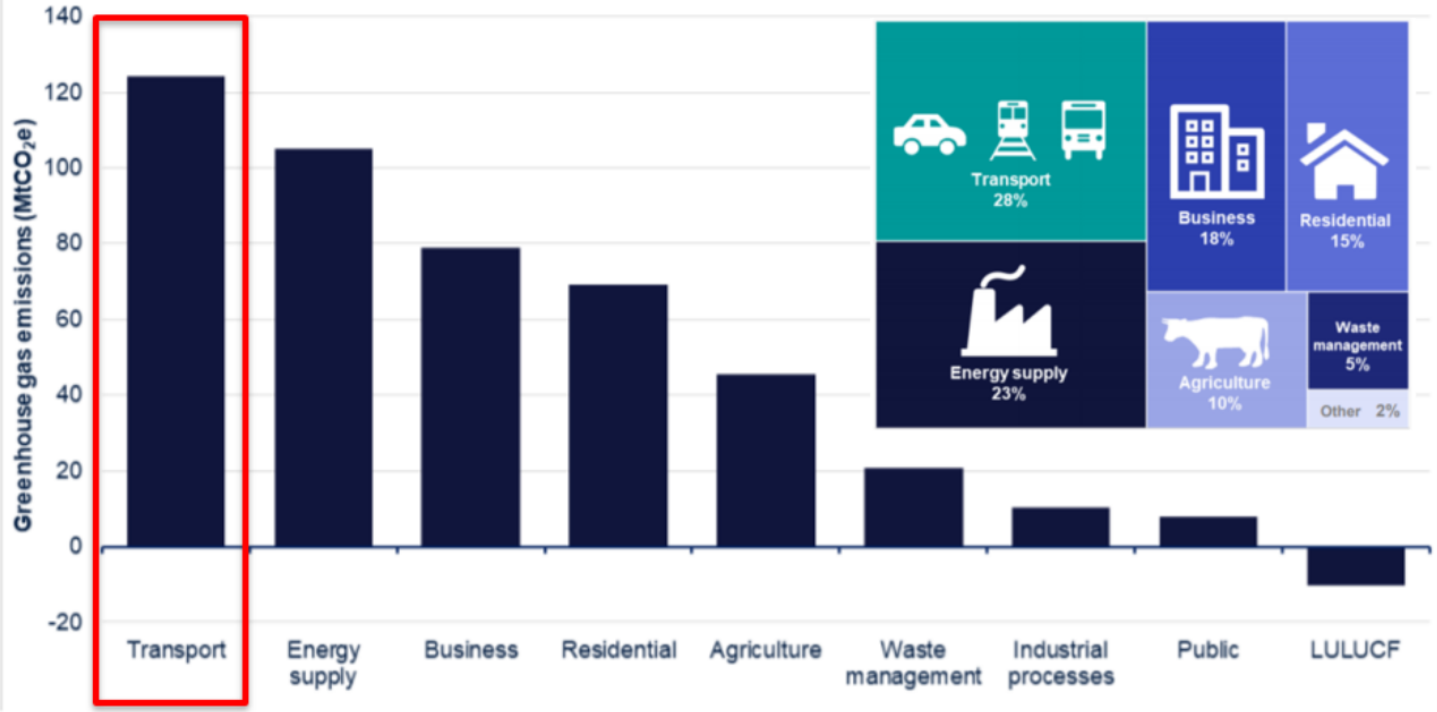
**GAS BOILERS TO BE BANNED FROM NEW HOMES BY 2025**

UK set to ban sale of new petrol and diesel cars from 2030

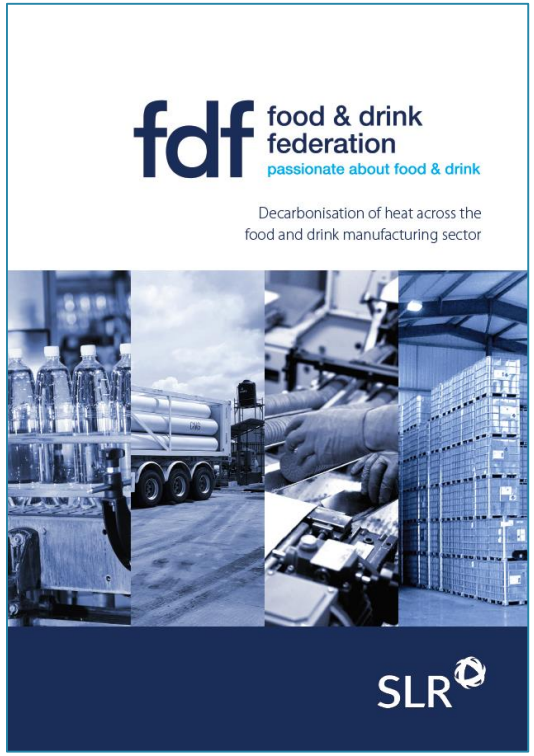
UK carbon price trades at £50 as market opens for first time

Early pricing levels suggest big UK polluters may face higher costs than groups in the EU

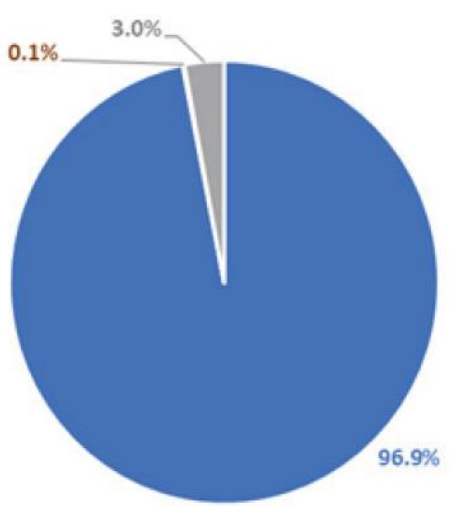
**Greenhouse gas emissions by source sector, UK, 2018 (MtCO2e)**

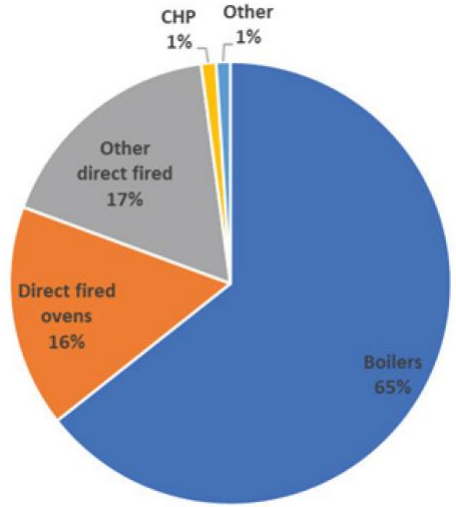


# UK food and drinks industry progress




- The FDF published a report to understand how the sector can decarbonise heat generation towards net zero
- The report found that low-grade heat can be electrified
- **A decarbonised gas system and green hydrogen** will be needed to replace natural gas over the long-term for high grade heat

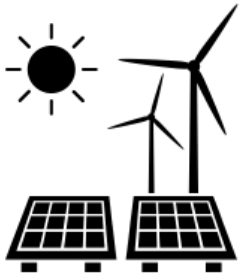



| | 2020 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|
| Boilers | Low carbon fuels, Renewables, Electrification (boilers or indirect heat users) | | | Low carbon fuels, Fully decarbonised gas, Hydrogen, Renewables, Electrification (boilers or indirect heat users) | | | |
| Direct Fired Overs | Electrification | | Renewables, Electrification | Low carbon fuels, Fully decarbonised gas, Hydrogen, Renewables, Electrification | | | |
| Other Direct Fired | Electrification | | Renewables, Electrification | Low carbon fuels, Fully decarbonised gas, Hydrogen, Renewables, Electrification | | | |
| CHP[5] | Renewables, Electrification (indirect heat users) | | | Low carbon fuels, Fully decarbonised gas, Hydrogen, Renewables | | | |
| Other | Electrification | | Renewables, Electrification | Low carbon fuels, Fully decarbonised gas, Hydrogen, Renewables, Electrification | | | |

# Many approaches to decarbonisation – each with trade-offs

## The best technical option (or options) for low carbon energy supply will be dictated by process and physical location



### Electrification

Transitioning all energy demand to electricity and pairing with renewable energy

***Includes:***

- Renewable Energy (Solar, Wind, Hydro)
- Nuclear Energy
- Electric Heating
- Electric Vehicles

***Potential Trade-offs:***

Grid constraints and supply limitations

### Energy Efficiency

Process and design improvements to reduce the total amount of energy required

***Includes:***

- Preventative Maintenance
- Equipment Upgrades
- Energy Management Systems
- Best-In-Class Technology Adoption

***Potential Trade-offs:***

Technical limits and residual emissions always remain

### Bioenergy

Conversion of organic material into energy through combustion or chemical processing

***Includes:***

- Biomethane (anaerobic digestion)
- Renewable Diesel and Biofuels
- Energy from Waste
- Biomass Heat & Power

***Potential Trade-offs:***

Limited availability of feedstock and biogenic emissions remain

### Low Energy Heating

Utilising natural environment heat differentials to generate additional heat or transferring heat

***Includes:***

- Heat Pumps
- Geothermal
- Fuel Switching

***Potential Trade-offs:***

Limited applications (not suitable at very low temperatures) and only available in specific locations


### Low Carbon Hydrogen

Production of green or blue hydrogen for heating and transport applications

***Includes:***

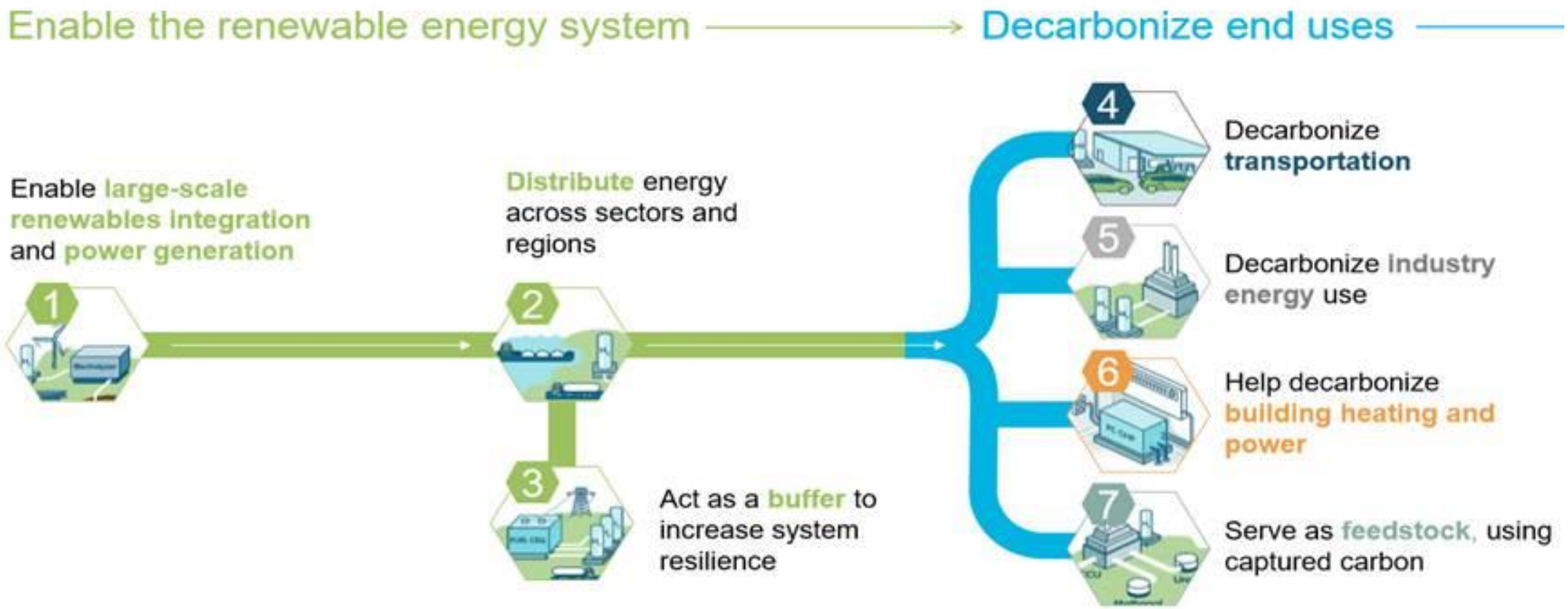
- Hydrogen Boilers
- Fuel Cell Electric vehicles
- Fuel Cell CHP
- Green Methanol / Ammonia

***Potential Trade-offs:***

Certain applications not yet price competitive (low-grade heat, short duration storage, aviation, etc)

# Green hydrogen has a critical role to play in decarbonisation

**Hydrogen is important particularly in hard-to-abate sectors, and is quickly transitioning from a chemical feedstock into an energy vector for storing and transporting renewable energy for a range of applications**



# The UK has identified hydrogen as a key pillar for decarbonisation

## National Initiatives:

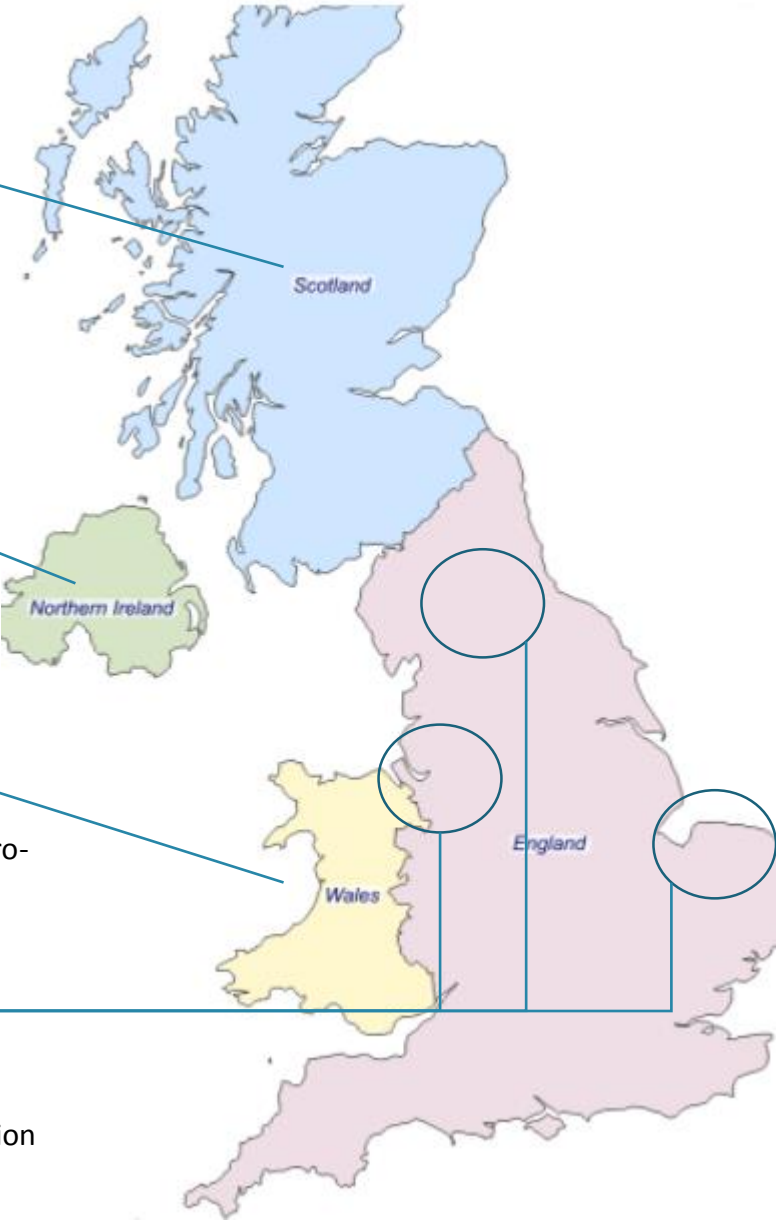
- 10-Point Plan for Green Industrial Revolution that includes a goal to develop 5GW of low carbon hydrogen by 2030
- £240M Net Zero Hydrogen Fund
- A standalone UK Hydrogen Strategy to be published in 2021


- Published Hydrogen Policy Statement
- Driving hydrogen investment and support for regional initiatives (BIG HIT in Orkenys, H100 in Fife)

- First fuel cell double decker busses being manufactured for sale to major UK cities

- Launched consultation to develop hydrogen energy sector; early development of fuel cell vehicles and zero-emission automotive industry

- Regional and LEP-level assessments and initiatives to accelerate green hydrogen as part of emission reduction plans



# Several funding programs and policy mechanisms are designed to promote greater production and use of low carbon hydrogen

## Main UK Ambitions:

- 5GW of low carbon hydrogen production by 2030
- £240M Net Zero Hydrogen Fund


### Hy4Heat

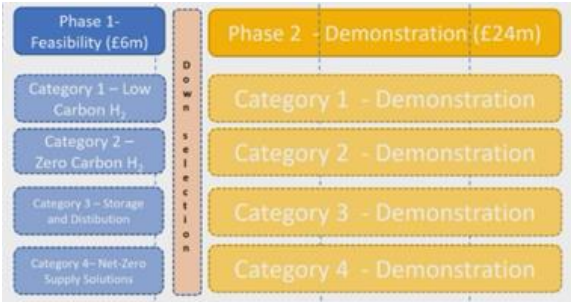
- £25M to establish the technical and safety considerations for replacing natural gas with hydrogen in residential and commercial buildings and gas appliances


### Low Carbon Hydrogen Supply 1

- £5M feasibility and £27M Demonstration for large scale low carbon hydrogen projects including HyNet, Gigastack, Dolphyn, HyPER, Acorn


### Industrial Fuel Switching

- £20M to test the potential of industry to switch to low carbon fuels
- Supported 7 feasibility studies and 4 demonstrations




### Low Carbon Hydrogen Supply 2

- £60M for projects that can develop a wide range of innovative low-carbon hydrogen supply solutions
- Delivered in 2 streams under 4 categories


### Net Zero Hydrogen Fund

- £240M to support commercially tested technology that are at TRL level 7 or above
- Scheme to be launched in early 2022

# There are already several examples of hydrogen solutions deployed in the field across Europe

| | *Snam, Southern Italy* | *Slovenia and the EU* | *U.S.A, New York* | *Switzerland* |
|---|---|---|---|---|
| |  |  |  |  |
| | **Water and Pasta factory** | **Glass manufacturing** | **Coca cola bottling process** | **Nespresso** |
| **Project Details** | • Blend of up to 5% green hydrogen and natural gas into the Italian gas transmission network;<br>• Offtakes include water and pasta factory;<br>• 3.5 billion $m^3$ injected into network and reduction of 2.5 million tons of carbon dioxide per year. | • Rooftop PV for green hydrogen use in glass manufacturing;<br>• Green hydrogen blended with natural gas and co-fired through burners to reduce manufacturing emissions. | • Continuous power for electrical needs and heat recovery for bottling process & space heating (0.8MW) manufacturing using UTC power fuel cells;<br>• Investment group includes Doosan Babcock. | • Nespresso logistic partner, von Bergen SA, is supporting hydrogen fuelled mobility for distribution in the country;<br>• It will support Nespresso's target of 50% carbon reduction for logistic operations. |

# Other field deployments


*Image: PDC Machines/Toyota, 2018, USA*


*Image: Siemens, PEM electrolysers, Germany, 2015*

*Image: Nel Asa, Alkaline electrolysers, Malaysia, 2019*

*Image: Hydrogen Storage at Vale Clydach Wales*

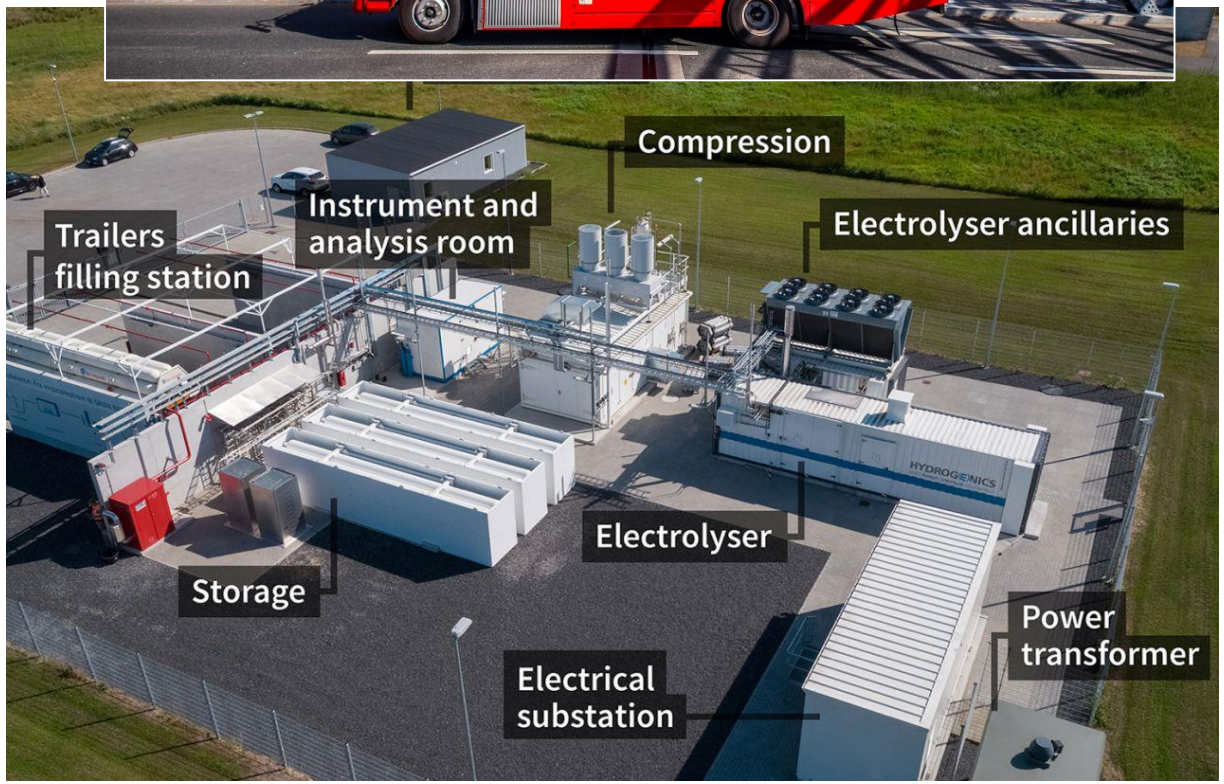

*Image: Plug Power, hydrogen storage and transport, USA, 2019*


*Image: Heatlie hydrogen BBQ, 2020, Australia*

# Other field deployments and concepts (continued)

*Solar to Hydrogen Electrolyser in Fukhisima*

*AB INBEV hydrogen delivery vehicle in China*

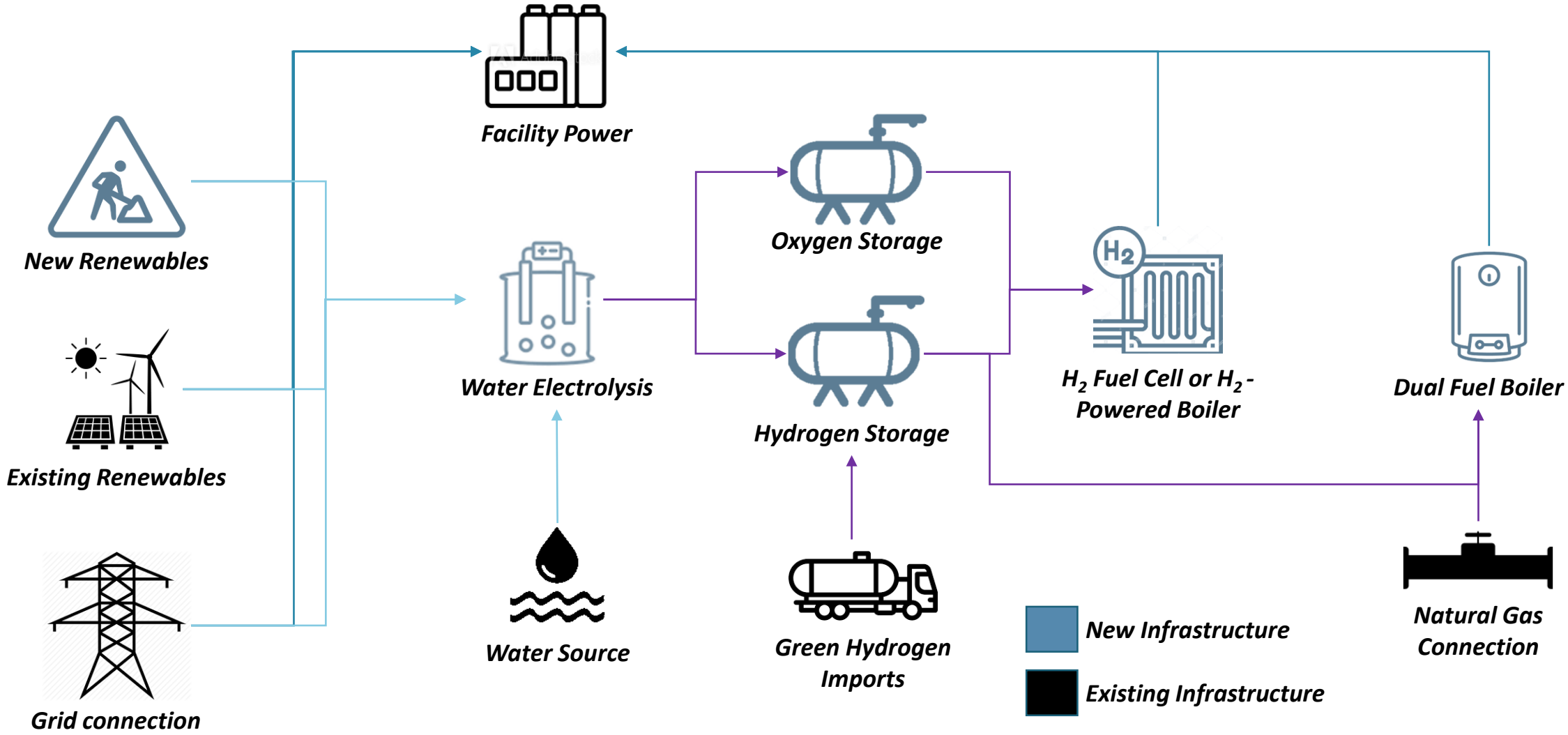





*Protium Hydrogen Refuelling Station Mock-up*

*Power to Hydrogen Station*

# Example project configuration of a green hydrogen heating solution



# Case Study: Hydrogen boiler at distillery in Scotland

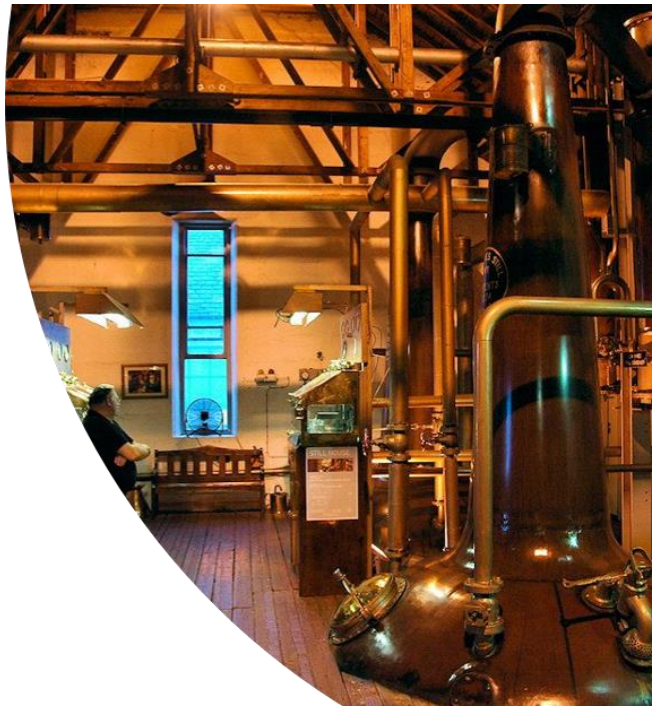
**HyLaddie is a project led by Protium's subsidiary Deuterium, in collaboration with Bruichladdich and Hydrogen Technologies Inc, under the UK Green Distilleries Competition.**

- First UK deployment of HTI's $H_2$-powered DCC™ steam boiler
- Will enable the Bruichladdich distillery on Islay to become net-zero
- Success would pave the way for decarbonisation of a highly fossil-fuel-dependent industry

**The feasibility project has two phases:**

- Phase One: Evaluate the deployment of a DCC™ boiler on site that meets the Bruichladdich distillery's heating requirements
- Phase Two: Installation of the DCC™ and evaluation of potential for broader roll-out

Completion of the two phases will **demonstrate feasibility for brownfield installations** and provide confidence for **wider market adoption**



# The pathway for developing a green hydrogen project

## Baseline Assessment

- Evaluation of current energy infrastructure
- Modelling future energy demand profile for facility
- Mobility analysis (fleet size, age, main routes, payloads, etc.)
- Modelling emissions profile of the company
- Carbon & energy scenario analysis

## Project Concept Development

- Needs/yield assessment
- Designing potential project configuration
- Identification of major equipment and compatibility with current site and processes
- Screening for red flags and any fatal technical flaws
- Hazard identification

## Commercial Development

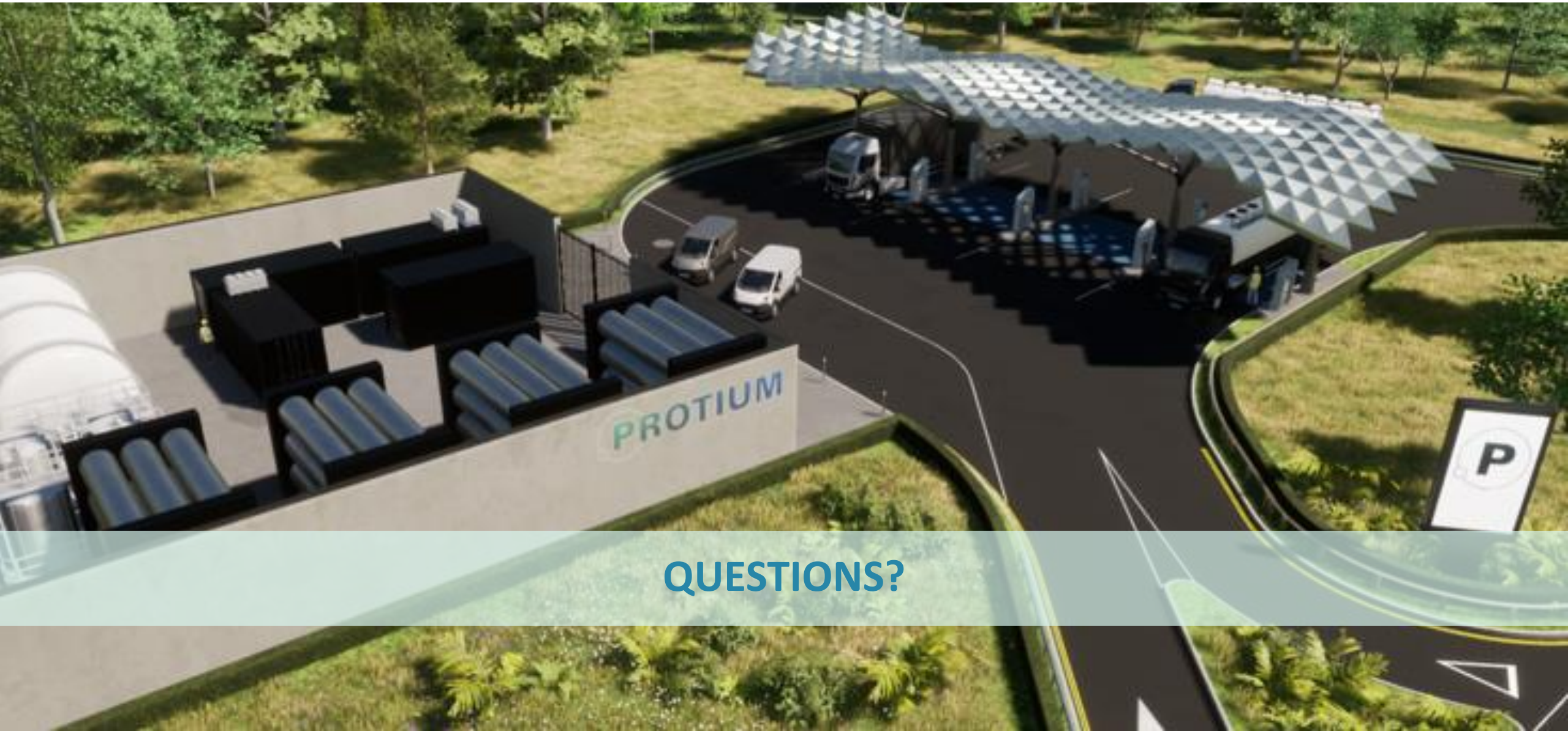
- Modelling main costs and benefits associated with preferred project configuration
- Review of quotes from potential suppliers
- Assembly of cost memo
- Total cost ownership modelling
- Carbon benefits modelling

## Project Execution

- Grid condition, potential upgrade requirements and connection design
- Identification and execution of planning and environmental permitting requirements
- Design and construction of equipment

## Operation & Management

- Management of continuous operations
- Performance analysis
- Determination of preventative maintenance programs and development after-support




# QUESTIONS?

# 15. Contact us


## Thank You!

**We would love to continue our net zero conversation with you.**

Please contact us at:

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