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Hydrogen opportunities for industrial products companies:
Heat and power generation

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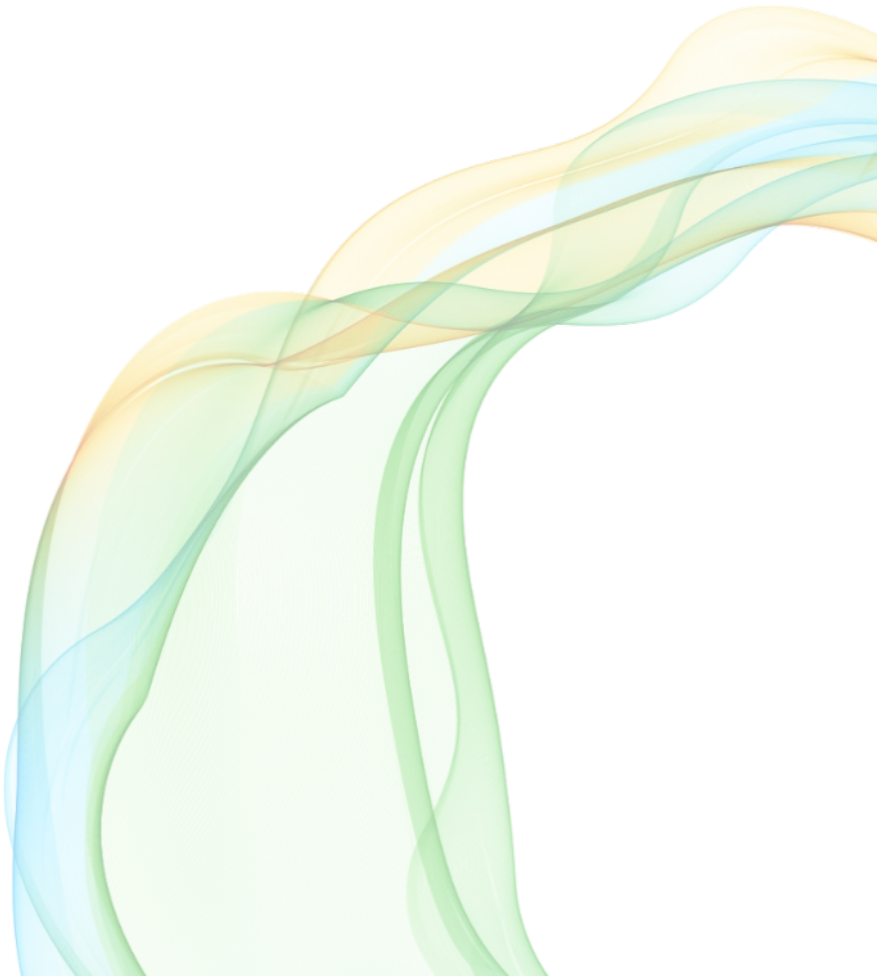


Introduction

The UK hydrogen market is developing at pace. Engineering studies and planning are progressing to build hydrogen supply infrastructure, while many companies are waiting to see what financial support might be available to influence their decisions. The availability of hydrogen as a low-carbon energy source could increase significantly from the second half of this decade.

At the same time, industrial companies and power generators face growing pressure to reduce their energy-related emissions.

It is time for industrial products companies to explore market opportunities and ask:

- What hydrogen-ready equipment and services will customers need and when?
- Will we be ready to supply them when they are needed?
- What if the market develops faster than expected?

This report gives industrial products companies an overview of the opportunities to provide hydrogen compatible or ready equipment, accessories and services in the industrial heat and power, and power generation sectors in the UK.

We identify a minimum of 389 sites across the UK that show high potential to adopt hydrogen heat and power equipment. These include:

- combined heat and power (CHP) units (where data is publicly available)
- hard-to-abate industrial sites
- existing and planned power plants.

The real market could be much larger as publicly available information on CHPs is limited.

Businesses will consider a range of factors before investing in hydrogen-ready equipment. As none of the decarbonisation options seem cheap or simple, hydrogen could play a substantial role in fuel switching.

Net zero and hydrogen

The UK Government's net zero pledge will transform how the UK generates, transports and consumes energy. Energy efficiency and low-carbon fuels will drive this transformation.

This, and the need to upgrade or replace today's fossil-fuel based equipment with greener and more efficient technologies, will create sizeable opportunities for industrial products companies. The opportunity for equipment and service suppliers could be worth hundreds of billion pounds over several decades.

The Net Zero Strategy's three scenarios all include hydrogen as a key part of the UK's energy mix by the middle of the century.[i]

This is because the net zero commitment mandates emission reduction in sectors where decarbonisation is particularly difficult, such as refining and chemicals; iron and steel production; cement and glass manufacturing; and heavy-duty transport. Hydrogen is one of the few viable options in these sectors as electrification or use of alternative fuels is challenging.

In power generation, hydrogen can be used to store renewable electricity in the long term and provide extra stability and security to the grid.

And although electrification is preferred in domestic heat and several transport segments, hydrogen may gain traction over time in these sectors as well.

Replacing fossil fuels with hydrogen in most cases will need modification to equipment.

Many power stations, CHP units, kilns and furnaces can use a certain percentage of hydrogen in their gas blend, but they will need additional accessories to regulate its flow due to differences in its chemical properties compared to natural gas.

Others will need new hydrogen-ready equipment.

These potentially growing needs will offer new opportunities for equipment providers.

> ***The opportunity for equipment and service suppliers could be worth hundreds of billion pounds over several decades.***

Industrial fuel switching

Industrial companies are under pressure to reduce their emissions. The net zero strategy targets industrial emissions to fall by 63 to 76 per cent by 2035 compared to 2019 levels.

Switching approximately 50 TWh of fossil fuels in industry to low-carbon sources by 2035 will help achieve this target, alongside efficiency savings and carbon capture and storage.

In 2019, direct fossil fuel use made up over half of industrial energy use, equivalent to about 150 TWh.[ii] Natural gas, petroleum, coal, coke and coke oven gas are commonly used to generate high and low temperature process heat, space heat, energy for drying and separation, and drive motors for various industrial processes.

Switching the targeted 50 TWh, nearly a third of total fossil fuel demand in 2019, to low-carbon sources by 2035 will be a challenge.

Companies can choose from a range of options to decarbonise their operations.

Electrification is likely to be the top choice for many low temperature processes in the food, drink and tobacco, printing and textile manufacturing sectors.

But CHP unit owners in these industries and in others, including refining and chemicals, car manufacturing and electrical engineering, may find electrifying heat a complex challenge. For them, switching fully to hydrogen or as part of a fuel blend for cleaner energy may appear a simpler option.

Below we explain the potential for hydrogen use by prime mover technology type.

Prime mover technology	Fit for hydrogen	Potential for hydrogen fuel use	Market for industrial products companies
Reciprocating engine	✗	Not recommended because of the combined inefficiencies of engine and hydrogen fuel. Additional investment needed to reduce NOx emissions.	Heat pumps or stationary fuel cells are likely to replace these over time.
Combined cycle and open cycle gas turbines	✓	Most models can run on up to 20 per cent hydrogen/natural gas blend.	Potential to replace these with hydrogen turbines above 20 per cent hydrogen content in the gas supply.
Back pressure and pass out condensing steam turbines	✓	Steam turbines can operate on any blend of fossil fuel and hydrogen but are relatively inefficient.	There is no technical need to replace these, but fuel cells provide significantly higher overall efficiency.

Source: Deloitte analysis

What is the UK potential?

We identified 174 combined heat and power (CHP) units and 197 hard-to-abate industrial sites across the UK that show high potential to switch to hydrogen as a fuel source. Lack of information on CHP units in the public domain means that the real figure could be significantly higher.

How did we do it?

We mapped the location of:

- planned hydrogen generation sites across Scotland, England and Wales
- CHP units (where available in the CHP Quality Assurance Scheme database) and hard-to-abate industry sites

We assessed how many of these facilities fall within a 50-mile radius of a planned hydrogen generation site.

Why does the distance from a hydrogen generation site matter?

Today, most natural gas CHP units (where data is available) and hard-to-abate industrial facilities use pipelines to receive fuel. They would need constant access to hydrogen if they chose to blend it in their gas intake. For gas turbines and combined cycle gas turbines (CCGT)/open cycle gas turbines (OCGTs), this would work up to the turbine's technical limit (approximately 20 per cent). According to the HyDeploy project, existing gas pipelines can already accommodate a blend up to that level.[iii]

However, between 20 and 100 per cent hydrogen use would need dedicated pipelines. Unless the gas grid is fully converted to hydrogen, being close to a hydrogen generation site could be an important factor in choosing hydrogen as a fuel source as it helps reduce the investment needed in dedicated hydrogen pipelines.

We, therefore, assume that CHP units and hard-to-abate industrial sites within a 50-mile radius of a planned hydrogen generation site show higher potential to adopt hydrogen fuel either fully or as part of a gas blend.

A few small CCGTs/OCGTs are off the gas grid and some hard-to-abate industrial sites use coal or fuel oil. For these, switching to hydrogen may be simpler than other decarbonisation options as they are already used for regular fuel deliveries.

CHP units

We found that 174 out 191, over 90 per cent of CHP units, are within 50 miles of planned hydrogen generation sites (Source: CHP Quality Assurance Scheme (QAS) data). The real number could be significantly higher because the QAS data only accounts for a small fraction of industrial energy use.

Most CHP units are in industrial clusters and could share dedicated hydrogen pipelines.

Thirty-two units are off-grid, 30 of which are within 50 miles from hydrogen production facilities – all of which may consider adopting hydrogen fuel.

Opportunities for industrial products companies include providing hydrogen-ready boilers, steam boilers, CHP systems, stationary fuel cells, industrial equipment and hybrid boilers (for example air source heat pumps with hydrogen). Installing these hydrogen systems will also need other products, such as pipes and valves.

Hard-to-abate industrial sites

In hard-to abate industries, using hydrogen as part of a gas blend or on its own will be one of the few decarbonisation options. Fossil fuels are currently used to produce high-temperature heat in blast furnaces, kilns or in direct reduction of iron. Electrifying these facilities could be a very expensive and/or technically complex task.

We found 216 hard-to-abate industrial sites in the iron and steel, cement and glass manufacturing, chemicals and refining sectors.[iv] 197 of these 216 sites are located within a 50-mile radius of a planned hydrogen generation facility.[v]

Full or partial conversion to hydrogen at these sites would require upgrades, hydrogen-ready furnaces and kilns along with a range of accessories including sensors, controls and burners as well as on-site hydrogen storage.

Power generation

The Net Zero Strategy requires all power generation to come from low-carbon sources by 2035, subject to security of supply. Hydrogen is expected to be such a source, but power stations will need to invest in technology to use hydrogen as a fuel.

Demand for power will grow as electrification of transport and heat progresses in the UK.

At the same time, more renewable electricity is projected to come online and make up a larger proportion of the future energy mix.

However, the variability and unpredictability of renewable energy could lead to grid stability issues in the future. This means that on cloudy, windless days electricity demand could exceed power supply.

Today, when renewable generation dips, higher fossil fuel use and/or electricity imported from Europe via interconnectors make up the shortfall. However, on sunny, windy days power exceeding network capacity could go into the system. When this happens, we switch renewable sites off to protect the grid.

In the future, excess electricity could instead be stored as hydrogen for use in gas-fired power stations later. It could also be burnt on its own by hydrogen-ready gas turbines to provide system flexibility.

Between 4 GW and 8 GW of hydrogen-based power generation capacity will be needed by 2035.[vi]

There are plans for at least one, 100 per cent hydrogen-fuelled power station in the UK, but some of the required capacity could come from upgrading existing fossil fuel power plants.[vii]

Younger power plants and those located close to planned hydrogen generation sites are more likely to attract the investment needed for upgrades. These are power plants that:

- will be 25 years old or less in 2030, retaining much of their economic value at the time of the upgrade
- are located within a 50-mile radius of planned hydrogen production facilities. This would reduce the investment need in pipelines dedicated to transporting hydrogen to the power plant (as with CHP units and hard-to-abate industry site).

What's the UK potential?

We identified 11 existing and 17 planned power plants that show a higher potential to be upgraded with hydrogen technology.

How did we do it?

We mapped the location of:

- planned hydrogen generation sites across Scotland, England and Wales
- existing and planned power plants

We assessed how many of the power stations:

- are in a 50-mile radius of a planned hydrogen generation site
- will be less than 25 years old in 2030

Currently, the UK has 67 fossil fuel power plants producing 35.9 GW of combined capacity. Many of these plants can already handle a blend of hydrogen and natural gas up to the turbine's technical limit. For most turbines these limits are between 3 to 5 per cent, while for others up to 30 per cent or higher. [ix] Burning a blend of hydrogen up to the turbine's technical limit would help reduce the carbon intensity of electricity when natural gas is used for flexible power generation. Blended hydrogen could be delivered through the existing natural gas pipeline, which, can accommodate a blend up to 20 per cent.[x]

An existing power plant will need an upgrade to burn concentrations of hydrogen above the gas turbine's technical limit. And to run on 100 per cent hydrogen, the plant will need a new hydrogen-ready turbine and dedicated hydrogen pipeline(s).

Of the 67 existing plants:

- 11 with 10.5 GW combined capacity will be less than 25 years old in 2030 and within a 50-mile radius of a planned hydrogen plant. Providing upgrades and turbines for these power plants could be potential opportunities for industrial companies.
- 47 will be more than 25 years old in 2030 (with a combined capacity of 23 GW) and are also within a 50-mile range that could be considered for investment in hydrogen technology.

In addition, 17 of the 18 natural gas plants that are planned or have received development consent as part of the Nationally Significant Infrastructure Projects in England and Wales, will also be within 50 miles of planned hydrogen projects.[xii] At least five of these 17 plants are planned in close vicinity of existing plants.

Other opportunities include the provision of stationary fuel cells for the grid or critical facilities (such as hospitals or telecom masts) that currently use diesel generators. However, these are outside of the scope of this report.

A sizeable market

We identified a minimum of 389 sites – CHP units (both on and off-grid), hard-to-abate industry facilities and power plants (both existing and planned) – within a 50-mile range of proposed hydrogen generation plants.

Figure 1 shows the location of these sites. Many of these facilities could consider choosing hydrogen to replace fossil fuels in their operation, and potentially create a substantial market for hydrogen-ready equipment.

389 sites identified within a 50-mile radius of planned hydrogen facilities:

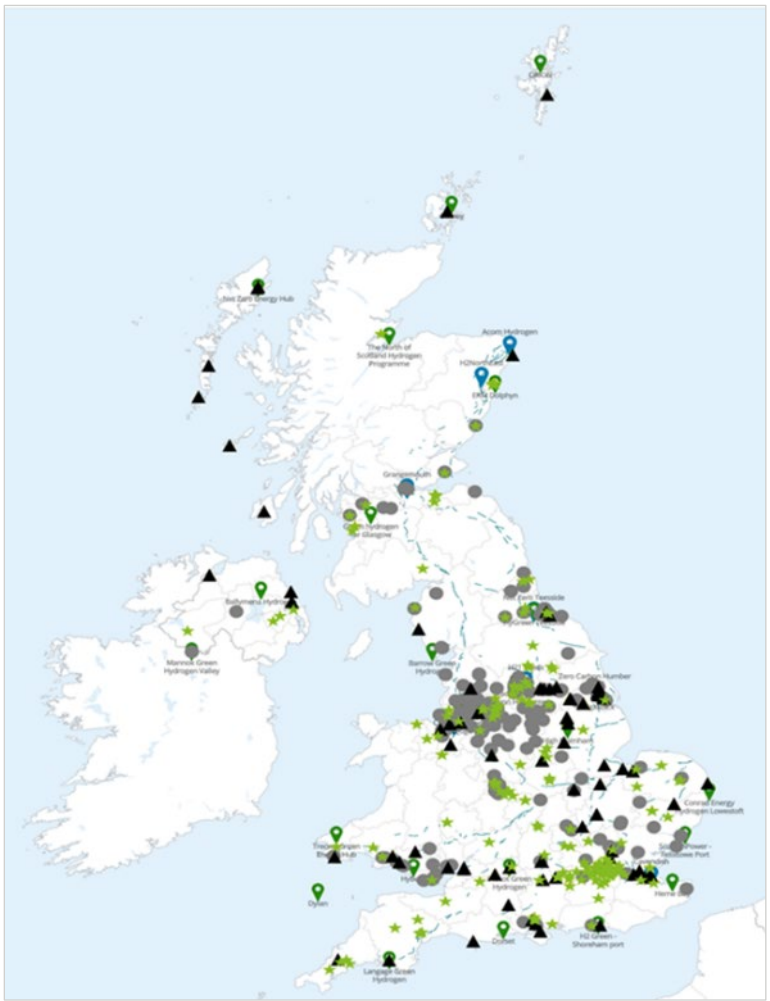
Industrial fuel switching:

- 174 CHP units
- 197 hard-to-abate industry sites (10 overlap with CHP units)

Power generation:

- 11 existing power plants
- 17 planned power plants

Figure 1. Industrial sites with high potential for hydrogen



Source: Deloitte analysis based on publicly available sources.

Choosing hydrogen as a fuel

Industrial companies will consider a range of factors when choosing new technology and fuel to decarbonise their operations.

Many will look to electrify thermal processes once energy efficiency measures have been exhausted. Others will consider biofuels and hydrogen as well as hybrid options (electrification with some low-carbon fuel source such as biofuels and hydrogen).

Large, carbon intensive operations with access to carbon dioxide storage may also investigate carbon capture and storage.

Most companies will consider the factors in Figure 2 before choosing hydrogen as a fuel source.

Anticipating and managing some of these factors could make hydrogen-ready technology more attractive for customers.

Figure 2. Factors to consider when choosing hydrogen as fuel

Factors	Considerations
Cost	• What are the projected costs of hydrogen fuel and technology? • Are there additional switching costs?
Risk	• What is the appetite for regulatory, technology and other risks? • Are there safety concerns?
Switching	• How easy is it to switch technology? • How compatible is the customer's existing equipment with hydrogen?
Timing	• Where is the customer's asset in its replacement cycle? • Will hydrogen-ready models/fuel be ready by the time the customer needs to switch?
Location	• Is there ready access to fuel supply infrastructure? • What would be the cost implications of building own-supply infrastructure?
Security of supply	• Will there be access to sufficient and uninterrupted fuel supply in the future? • What happens when supply is disrupted?

Source: Deloitte analysis

What if the hydrogen market moves faster than expected?

The success of infrastructure projects, support mechanisms and regulatory developments will determine the speed of developments in hydrogen supply and demand in the UK.

Today, a handful of global power equipment manufacturers and a small number of niche companies make hydrogen-ready turbines, CHP units and back-up generators. Research on solving technical issues and increasing unit size is also progressing.[xii]

The market for hydrogen equipment is expected to grow slowly throughout the 2020s as hydrogen supply infrastructure is gradually built. Most early projects will provide low-carbon hydrogen to chemical plants and refineries to replace currently used carbon intensive hydrogen. Demand for hydrogen-ready equipment, associated products and services may grow faster as generation projects get underway and their outputs increase from 2028 (according to our estimates). When the market picks up, it will need a wider range of models that are also cost-effective and efficient.

If demand for equipment grows faster than expected – perhaps due to a surge in international hydrogen fuel supplies – manufacturers will need to respond rapidly while tackling technical, cost, supply chain and regulatory issues at the same time.

Companies planning to enter or expand in this market must act now.

Lead times to develop new products and offerings, improve efficiency or reduce the cost of existing products can be lengthy, so too can putting the financial, infrastructure and supply chain structures in place.

Product development also needs considerable commitment of engineering capacity.

Companies that act now may secure early on opportunities and larger market share in the future.

Get started

Companies considering investment in hydrogen should ask the following questions:

Strategy		
	Strategy	• Have we got a clear focus and understanding of our target market? • Will we grow organically or buy/partner/invest? • Can we anticipate and manage some of the factors included in Figure 2? • Have we explored potential uses of our products in a wider range of segments and applications?
Delivery		
	Financial	• How will we build a strong business model? • Will we consider innovative business models – such as 'hydrogen product as a service'? • If we develop new products, have we explored net zero-related grants, tax incentives, capital allowances and Patent Box for R&D?
	Skills and capabilities	• How will we ensure we have the right capabilities and skills to develop and deliver our products?
	Technology	• What can we do to future-proof our products?
	Collaboration and partnerships	• Will we explore opportunities to co-operate, collaborate or partner with other companies, research institutes and trade associations?

Contacts

Get in touch if you'd like to discuss the opportunities raised in this report or delve deeper into our data of possible hydrogen sites.

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Endnotes

i. Net Zero Strategy: Build Back Greener, UK Government, 2021. See also Net Zero Strategy: Build Back Greener - GOV.UK (www.gov.uk)

ii. Digest of UK Energy Statistics, Final energy consumption by sector, 2021.

iii. HyDeploy project successfully proves case for 20% hydrogen blending, H2 View, 2021. See also HyDeploy project successfully proves case for 20% hydrogen blending (h2-view.com)

iv. Many of these facilities have CHP units, but there is no overlap with CHPs in the CHP QAS database.

v. 10 sites out of the 191 CHP unit sites and 216 hard-to-abate industrial sites overlap. Therefore, these are taken out of the overall number of sites that we believe have higher potential to adopt hydrogen as a fuel.

vi. Future of Energy Scenarios 2021, National Grid, 2021. See also https://www.nationalgrideso.com/future-energy/future-energy-scenarios

vii. Plans for first-of-a-kind hydrogen and CCS projects, SSE, 2021. See also Plans for first-of-a-kind hydrogen and CCS projects | SSE

viii. Digest of UK Energy Statistics, 5.11.

ix. The Future of Hydrogen, International Energy Agency, 2019. See also The Future of Hydrogen – Analysis - IEA

x. HyDeploy project successfully proves case for 20% hydrogen blending, H2 View, 2021. See also HyDeploy project successfully proves case for 20% hydrogen blending (h2-view.com)

xi. National Infrastructure Planning. See also Projects | National Infrastructure Planning (planninginspectorate.gov.uk)

xii. High-Volume Hydrogen Gas Turbines Take Shape, Power, 2019. See also https://www.powermag.com/high-volume-hydrogen-gas-turbines-take-shape/

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