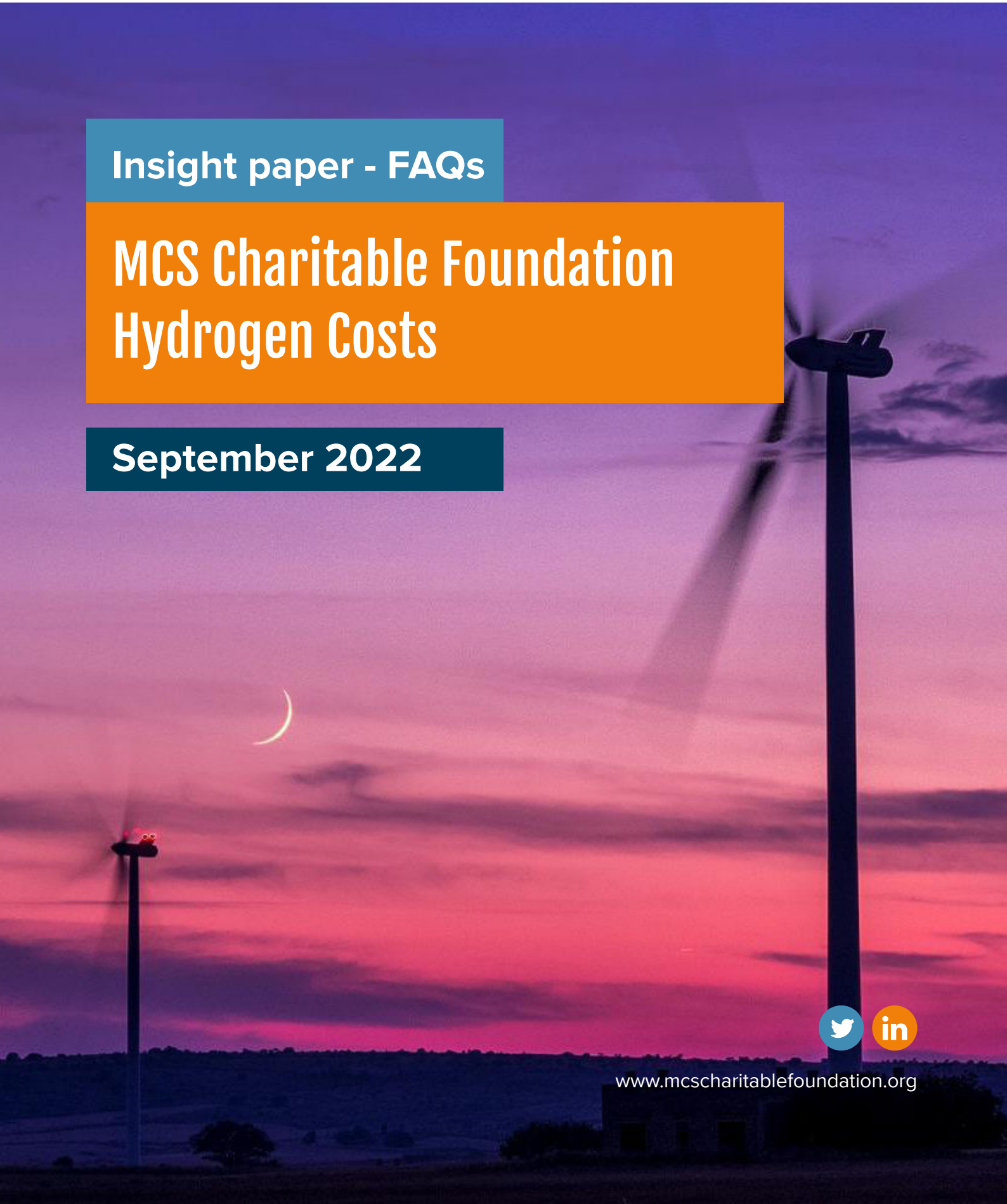
MCS CHARITABLE FOUNDATION



Insight paper - FAQs

MCS Charitable Foundation Hydrogen Costs

September 2022

www.mcscharitablefoundation.org

1.1 What is it?

1.1.1 What is hydrogen for heat?

Decarbonising the UK will require a reduction in fossil fuel use in the home. Hydrogen may be able to replace some uses of natural gas. If compared to alternative technologies such as heat pumps, heat networks and thermal storage, 100% hydrogen for heat is not yet a commercially or technically viable option. Research is being carried out to fully assess the feasibility, costs, and benefits of transforming the energy system to accommodate hydrogen.

1.1.2 What are the different 'colours' of hydrogen?

Talking about hydrogen can introduce a confusing rainbow of colours. Hydrogen gas in its natural form is always colourless. The 'colour' is a shorthand to indicate how the hydrogen was produced.

- Grey hydrogen is the most common process currently. Powered by natural gas, or methane, it uses steam reformation
- Green hydrogen uses surplus energy from renewable generation and an electrochemical reaction to split water into its components of hydrogen and oxygen
- Blue hydrogen uses steam reformation and incorporates Carbon Capture and Storage (CCS) to reduce the carbon impact
- Black and brown hydrogen uses coal
- Pink hydrogen uses power from nuclear energy
- Yellow hydrogen is from solar PV
- Turquoise hydrogen uses methane pyrolysis to produce hydrogen and solid carbon
- White hydrogen is naturally occurring hydrogen found in underground deposits, which could be extracted by fracking

1.1.3 Will using hydrogen for heat reduce consumer bills?

This modelling suggests that heating the average GB home using 100% hydrogen will increase the cost on average by 70% when compared to using natural gas and circa 5% using an 80:20 hydrogen to natural gas blend.

1.2 Preparing for hydrogen

1.2.1 Is hydrogen a like-for-like replacement for natural gas?

There are similarities and differences between using hydrogen and natural gas for heating in the home.

Both are delivered to the home in a gaseous form through pipes. Hydrogen and natural gas can both be produced from renewable sources – green hydrogen converted from excess renewable source electricity, and biogas from waste and biological matter – although both are overwhelmingly produced in carbon intensive ways today.

The Health and Safety Executive has approved trials blending hydrogen into the gas network at up to 20% by volume with minimal changes to the existing gas network and appliances. Any blending above 20% is likely to need new appliances and legislation, so an intermediate blending step between 20% and 100% hydrogen looks unlikely.

Hydrogen has a lower energy density per volume than natural gas. The lower density means a larger quantity of gas would need to be transported through pipes to provide the equivalent amount of energy. The carbon benefits of hydrogen are proportionate to the lower energy density – blending 20% hydrogen by volume saves 7% of carbon dioxide emissions.

Trials are underway to test the suitability of hydrogen in a range of environments, including industries with hard to abate carbon emissions. These include plans for hydrogen heat trials for a neighbourhood sized scheme by 2023, a village by 2025 and a potential pilot hydrogen town by 2030.
However, using 100% hydrogen for heating is not a straightforward ‘like for like’ replacement from their existing gas heating. This is because households will need

to have their existing pipework surveyed and possibly changed to make it safe for hydrogen, their meter changed, and switch all gas appliances to ones suitable for use with hydrogen. It is estimated this will cost households upwards of £4000.

1.2.2 Would customers see a difference with hydrogen for heating, compared to natural gas?

Safe trials are underway to see if customer behaviour changes in homes that use hydrogen for heating instead of natural gas. It is not yet clear how consumer attitudes are affected by the characteristics of hydrogen when used in the home: it produces different emissions including some that could be harmful, has a relatively colourless flame, and is less energy dense than natural gas. The outcome of the in-home trials are awaited.

1.2.2 Can I use my existing gas boiler with hydrogen?

Trials underway replacing 20% of natural gas with hydrogen generally do not require customers to get new appliances or have new pipes fitted. If 100% hydrogen was used instead of natural gas it is likely that new meters, boilers, appliances and pipework could be needed in many homes. Some boiler manufacturers are introducing “hydrogen ready” boiler, which are easily convertible from natural gas to hydrogen.

While policy support for replacement of domestic appliances and pipework may be introduced in future, government has not yet indicated that this will be the case.

1.2.4 Why make decisions now, when the Government will not finalise the domestic heat policy until 2026?

Long-term investment decisions are made by governments and homeowners alike. A customer refurbishing their kitchen would like to understand if they need new pipework installing, or if they need a futureproof cooker when the work is being undertaken.

A policy decision on blending is planned for 2023, subject to the outcomes of ongoing economic and safety assessments and wider strategic considerations.

1.3 What don't we know?

1.3.1 How can you be sure of your cost predictions?

Cornwall Insight produces a quarterly Benchmark Power Curve (BPC) calculation and report using industry knowledge, insight, and least cost optimisation modelling expertise. Through this process we are able to test how and when net zero is achieved and provide insight into the projected electricity generational mix and pathway seen in this achievement. This report is available through a subscription service and is regularly reviewed by over 40 customers including large industrial users, energy suppliers and marketeers, and various private and public sector organisations involved in the net zero transition. Our BPC product is widely recognised as industry leading.

In the BPC calculation input assumptions are used for the price of gas, production of electricity costs for various technologies including technological efficiency gains, and a projection of carbon prices. Outputs from the BPC calculation include 30 year half hourly electricity price projections (i.e. currently out to 2052), and a stack of electricity generating capacity by technology and their associated generation volumes. We have used both our BPC input assumptions and outputs, alongside publicly available datasets to calculate the cost of blue and green production costs. The specific input assumptions used are listed in the report.

1.3.2 What are the alternatives to using hydrogen for heat?

There are a range of other low carbon technologies which could be used to replace gas for domestic heating. This include direct electrical heating, heat pumps, heat networks, and solar thermal. All have benefits and drawbacks around cost, consumer behaviour change and ease of retrofit into existing and new homes.

These technologies are at different levels of technological development.

1.3.3 With energy prices so high, shouldn't we try everything?

The UK is not expected to have significant supplies of hydrogen available due to the timescale required to implement large-scale production before the end of the next decade and as such is unlikely to be able to help mitigate the current energy crisis. In the long term, producing our own hydrogen in the country may help to mitigate the UK's dependence on foreign energy sources and help the country avoid a repetition of the current energy crisis although a100% hydrogen fuel source for domestic heat is not seen as a cost effective solution.

Government is working with industry, regulators, and others to deliver a range of research, development, and testing projects to obtain the required evidence to understand the future case for hydrogen. Concentrating resources on established and more promising options could help ensure long-term cost certainty.

1.3.4 Pilot schemes include homes. Hasn't that proved hydrogen for heat works?

The pilot schemes include homes, with testing carried out to extremely high standards of safety and demonstrating that hydrogen for domestic heating is technically feasible. However, this modelling suggests that even if proven safe, 100% hydrogen to heat homes is not currently economical and will not become economical.

1.3.5 There's big business backing for hydrogen – won't innovation drive costs down?

As technologies scale up, innovation can produce unanticipated efficiencies. This modelling includes "learning rates", which are forecast cost reductions due to improvements in technology and economies of scale.

With a newer application of a technology – such as hydrogen for heating – it is hard to forecast future trends compared to more established technologies such as natural gas, thermal storage or heat networks. There is always the possibility of a technological breakthrough which will deliver significant cost reductions, and there i s a lot of research going on which may deliver these cost reductions.

Currently, creating hydrogen from renewable sources is prohibitively expensive, but anticipated technological gains in offshore wind technology could see green hydrogen production costs fall to compete with blue hydrogen.

1.3.6 The grid won't be able to cope with electrification of heat, so won't hydrogen help alleviate that pressure?

Electricity networks can only transport limited amounts of power between generators and users. Upgrading the electricity network may be needed to alleviate bottlenecks, or 'constraints'.

Infrastructure investment decisions may differ depending on locational usage and energy system features. Our modelling suggests that using hydrogen for heating is unlikely to represent the lowest cost to consumers in average scenarios.

1.3.7 Is a heat pump or hydrogen for heating best for customers?

It's important to acknowledge that one-size-doesn't-fit-all. Community needs may differ, with customer comfort with hydrogen being tested in trials. Heat pumps are an established application of technology, widely used in some European countries.

Our modelling suggests that the wholesale costs of creating hydrogen to use to heat homes is unlikely to represent the cheapest option.

1.3.8 If hydrogen isn't going to be suitable to heat homes, where will it be most useful?

Trials are underway testing the use of hydrogen in many areas. Globally there is interest in using renewable source hydrogen in carbon-intensive industries such as steel, cement, trucking, shipping and aviation, where other technologies may not be able to meet decarbonisation requirements.

These sectors cannot currently be electrified because they require high-density, local energy sources, which are best fulfilled by fossil fuels or hydrogen.

1.3.9 If energy prices change, will that make hydrogen for heat viable?

Producing hydrogen from electricity or natural gas loses energy due to conversion inefficiencies. Therefore, using this energy directly may be more economically viable than creating hydrogen. However, as low carbon hydrogen production methods capture carbon during the process, increasing carbon prices or taxes may make green hydrogen more economically viable.

If there are electricity network constraints which would result in lots of curtailed renewable generation, then using this power – which would otherwise be wasted – to produce hydrogen would see lower costs of green hydrogen.

If technologies which improved the efficiency of hydrogen production were to emerge, then this would also improve the economics of hydrogen. Our analysis includes a level of efficiency improvements, but not the potential impact of a fundamental shift in efficiency levels.

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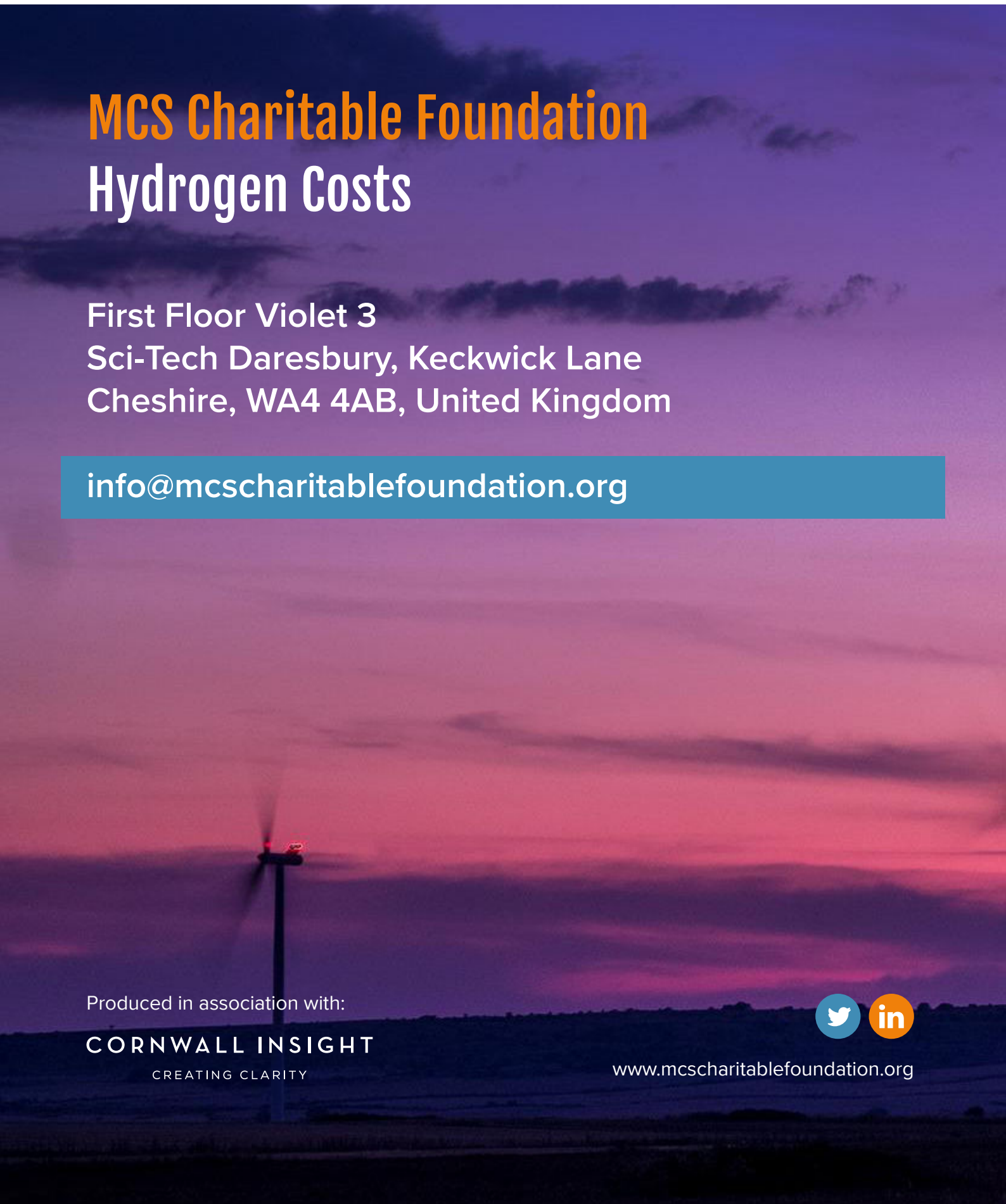

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