# HYDROGEN UTOPIA INTERNATIONAL

INDUSTRIALS

**12 January 2022**

**HUI**

13.75p

Market Cap: £52.8m

Priced as at close on 7 January 2022

| KEY DATA | |
|---|---|
| Net (Debt)/Cash | £3.6m *(at 31/08/21)* |
| Enterprise value | £49.3m |
| Index/market | AXS |
| Shares in Issue (m) | 384.32 |
| Chairman | Guy Peters |
| Chief Executive | Aleksandra Binkowska |
| Technical Director | Keith Riley |
| Chief Financial Officer | Alexander Groves |

**COMPANY DESCRIPTION**

Hydrogen Utopia is a plastic waste-to-energy technology company.

**www.hydrogenutopia.eu**

**HYDROGEN UTOPIA INTERNATIONAL IS A RESEARCH CLIENT OF PROGRESSIVE**


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## Successful debut of energy and hydrogen from plastic waste company

**The successful IPO of Hydrogen Utopia International gives investors access to the European plastic waste to energy market, with the added bonus of exposure to the rapidly expanding hydrogen economy. The company will initially operate in Poland and mainland Europe, where it can benefit from EU carbon neutral grant funding as well as national government funds. Hydrogen Utopia has licensed proven technology from Powerhouse Energy, a quoted UK hydrogen from waste technology operator, and the companies intend to collaborate closely to become part of the solution to the problems of plastic waste and climate change.**

- **Established partner**. Hydrogen Utopia has a close relationship with Powerhouse Energy (AIM: PHE), which is about to deploy the first of its Distributed Modular Generation (DMG®) facilities at the Protos Energy Park in Cheshire in partnership with Peel NRE. This will produce cost competitive, nearly pure hydrogen from municipal plastic waste for use in fuel cell electric vehicles, as well as space heating and industrial processes.
- **Flexible technology**. Although Hydrogen Utopia has licensed the thermal reactor technology from PHE, it has further developed the design to ensure optimum flexibility. Hydrogen Utopia's sites can be configured to generate many output streams from the same feedstock, including electricity, syngas, hydrogen, methane, carbon dioxide and thermal energy.
- **First project identified**. Hydrogen Utopia has signed a Letter of Intent to build up to 10 waste-to-hydrogen facilities in the Polish city of Konin with potentially up to €120m funding from the EU 'Just Transition Fund' (JTF) and the Polish government. If the JTF application is successful, the remaining funds for this €250m project will be provided by HUI and its partners, the private sector, and ECB and government loans. It will provide a strong central European showcase for the company and its technology. Hydrogen Utopia has exclusive rights to the DMG® technology in Poland, Hungary and Greece, and will target these and other parts of Europe where transition funding is available, particularly where it can form strong local partnerships with municipalities and waste providers.
- **Initial public offering**. Hydrogen Utopia has been admitted to the AQSE Growth market after successfully raising £3m through a share placing and subscription. The funds will be used to progress towards developing a syngas reference site as well as to develop the pipeline of business opportunities, along with short-term working capital requirements and the costs of admission.

**The IPO of Hydrogen Utopia presents an opportunity to gain early-stage investment exposure to technological solutions addressing two pressing environmental problems: plastic waste and climate change. The company has a strong management team that blends financial markets, waste solutions and in-country experience. It has strong ties with its engineering partners, Linde, Electron and SWECO, which has led to improvements to the original design.**

# Executive Summary

## One technology for two problems

Hydrogen Utopia is developing technological solutions to address two pressing environmental problems: plastic waste and climate change. It has licenced and further developed a pyrolysis technology that can efficiently produce syngas from a non-homogenous, non-recyclable waste plastic stream. This gas can be used in conventional equipment to generate electricity or can be fed into industrial processes. This represents a major step towards the aim of recycling plastic waste and diverting it away from being exported, dumped or sent to increasingly scarce landfill sites. However, with the addition of more downstream processing, the syngas can be separated into its component gases or compounds to give a stream of nearly pure hydrogen and methane. Hydrogen has the potential to play a strong role in the decarbonisation of the global economy, particularly in the transport sector. A recent note by Bloomberg NEF stated that it could eventually replace almost a quarter of total fossil fuel consumption. Hydrogen Utopia therefore has the opportunity to play a part in the creation of a cyclical, climate-neutral global economy.

Hydrogen Utopia has deliberately sought to maintain a high level of flexibility in the design of its processing facilities to allow it to tailor different solutions to its target clients. In addition to its close collaboration with Powerhouse Energy, the licensor of the DMG® technology, it has strong relationships with its other engineering providers, including Linde, the largest global industrial gas engineer. Hydrogen Utopia will seek to form partnerships with local municipalities and waste processors to rapidly expand in Europe.

Hydrogen Utopia has exclusive rights to use the DMG® technology in Poland, Greece and Hungary, and non-exclusive rights in other parts of Continental Europe and the rest of the world excluding the UK. It will target potential applications where EU or national government grant funding for transition projects is available. An example of this approach is a proposed €250m waste-to-hydrogen project being planned as part the regeneration of the City of Konin in Poland. The city is in a region of Europe that is eligible for grant assistance to transition from its former high carbon-based industrial activity to a climate-neutral economy. An application for €60m of funding from the EU Just Transition Fund for this project would, if successful, be matched by the Polish government. The remaining funding will come from other national loans and grants as well as contributions from HUI, its partners and other private sector sources

The company has strong management and strategic advisors who bring a wide range of technical, financial and project development expertise, as well as strong links with potential customers in the target markets. Access to European Union transition funding and other potential sources of grant funding will be a major factor in the rapid roll-out the technology in Continental Europe.

The flexibility of the modular design of the units allows for a wide range of plant configurations depending on the customer requirement. It also allows for rapid scale-up of projects by adding more units. We have calculated that ROCE on the different project configurations is in the range of 8.8% to 12.3%. Being largely debt funded, the return on equity will be much higher.

The success of the recent IPO and admission to trading on the AQSE Growth exchange has given HUI a stable financial platform from which to develop the large portfolio of potential projects. It now has sufficient working capital headroom with which to accelerate projects from planning to financing and construction. The shares made substantial gains in early trading, reflecting the strong investor appetite for alternative energy and waste solutions.

## The Initial Public Offering and Admission to Trading

On 6 January 2022, Hydrogen Utopia International (HUI) shares commenced trading on the Access segment of the Aquis Stock Exchange (AQSE) following a successful subscription and placing of a total of 40,000,000 Ordinary Shares at 7.5p per ordinary share, raising gross proceeds of £3m (before expenses). On admission, the company had 384,324,000 ordinary shares in issue and an initial market capitalisation of £28.8m

The total gross IPO proceeds of £3m were achieved by the placing of 15,463,399 placing shares and the subscription of 24,536,601 subscription shares, representing approximately 10.41 % of the enlarged share capital of the company on admission. The net proceeds were £2.6m.

In addition, investors will receive one warrant for every placing share or subscription share subscribed for. Each warrant entitles the holder to subscribe for one ordinary share at a price of 15p during the period commencing on admission and ending on the second anniversary of admission.

As consideration for the broking services provided in connection with the placing, the company will issue Novum Securities with 1,200,000 warrants on admission. These warrants are exercisable for the period of two years following admission at 7.5p/ share.

The directors participated in the IPO with an aggregate contribution of £100,000. Other existing shareholders, including Conrad Griffiths, also subscribed. The fundraise was supported by Howard White, the founder of hydrogen fuel cell company, AFC Energy, and the major shareholder of Powerhouse Energy Group (PHE.L), from which HUI licenses the DMG® technology.

The major shareholder in the company continues to be the CEO, Aleksandra Binkowska, with 42.45% of the enlarged equity. In total, the directors account for 42.99% of the enlarged equity. The other shareholders with holdings over 5% are Steven Giles with 19.26% and Conrad Griffiths with 9.45%.

The net proceeds of the fundraising, together with HUI's existing cash resources, will be used to fund the pre-build costs of an HUI facility (planning applications etc.), marketing and business and working capital, including the remaining amount due to PHE.L for HUI exclusivity in Poland, Greece and Hungary.

# Hydrogen Utopia International

## Origins of the company

The company was founded in October 2020 by its current CEO, Aleksandra Binkowska, as HU2021, with the financial backing of four high-net-worth investors. Hydrogen Utopia International PLC (HUI) was subsequently incorporated as a public limited company under the laws of England and Wales in May 2021, and HU2021 became its wholly-owned subsidiary. The company currently also operates through two further 100%-controlled subsidiaries in Poland and Greece. It intends to incorporate more subsidiaries in other countries like Hungary, the Netherlands and Spain when opportunities arise in those regions. It is expected that individual special purpose vehicles (SPVs) will be incorporated for each project and that they will become subsidiaries or associates of the country subsidiary.

Hydrogen Utopia's objective from the outset was to be involved in the migration of Poland and other territories towards cyclical, net zero carbon economies by transforming mixed, non-recyclable plastic waste into syngas, a fuel gas mixture consisting primarily of hydrogen, carbon monoxide, and methane in varying proportions. In November 2020, the company signed an Heads of Terms agreement with Powerhouse Energy Group plc (AIM: PHE) to acquire a non-transferable licence for the application of technology developed by PHE to produce syngas from waste plastic. The agreement allowed HUI exclusive rights to exploit the PHE technology in Poland, Hungary and Greece, as well as other territories outside the UK on a non-exclusive basis. In October 2021, this became a binding collaboration agreement.

## Directors and Senior Management

**Executive Chairman – Guy Peters:** Guy has spent over 25 years acting as principal advisor to small to medium-sized businesses across a broad variety of sectors as an external corporate financier, stockbroking advisor, consultant or board member. His expertise encompasses IPOs, fundraisings, acquisitions, mergers and disposals as well as operational, business development, legal and accounting matters. Guy trained and practised as a solicitor with Herbert Smith Freehills in the City before moving into investment banking and stockbroking. He has worked at a senior level in some of the leading smaller company specialists in the market: Albert E Sharp LLP, Old Mutual Securities Limited, Arbuthnot Securities Limited, Shore Capital Ltd and Seymour Pierce Limited.

**Chief Executive Officer – Aleksandra Binkowska:** Aleksandra is a Founder and Director of Hydrogen Utopia International PLC and has been the CEO of what is now one of its subsidiaries, HU 2021 International UK Limited, since its incorporation in October 2020. Aleksandra is also the Chairperson of Hydropolis and a Director of Plastic Gold. Aleksandra founded the NGO, Plastic Neutrality Pledge, on 11 February 2021.

Since 2015, Aleksandra has been a senior director of Carulac sp Zoo, a Polish company with a fleet of buses providing bus services to one of the largest tourist companies in the world, Group Voyagers Inc. The buses serve travellers in Northern, Central and Eastern Europe.

**Executive Director – Keith Riley:** Keith is a Chartered Engineer and a Fellow of the Institute of Mechanical Engineers. He spent 24 years in the power industry working around the world for companies like Babcock and Rolls Royce. He is the former Managing Director of Veolia Environmental Services UK and has 45 years of experience in power, energy, waste and resources. He is a Non-executive Director of Powerhouse Energy and is the proposed Technical Director of Hydrogen Utopia.

**Non-executive Director – Paul Formanko:** Paul was a Managing Director and Head of CEEMEA Banks Equity Research at JP Morgan in London from 2013 to 2018, and Executive Director from 2003 to 2013. During this period, Paul worked as a sell-side analyst and investment advisor to regional and global institutional investors in respect of investments in Emerging Markets, with focus on CEEMEA financial equities.

**Non-executive Director – Steve Medlicott:** Steve is a Chartered Accountant by qualification and has worked as a stockbroking analyst then Finance Director of e-Therapeutics PLC prior to becoming CEO of Fuel3D Technologies Limited.

**Chief Financial Officer – Alexander Groves:** Alexander is the co-founder of Finiflo, a fundraising and growth agency focused on start-ups and SMEs. Alexander raised £5m seed capital across seven start-ups. He trained and qualified as a Chartered Accountant with Deloitte LLP within their corporate assurance and advisory department, focusing on technology businesses.

## Relationship with Powerhouse Energy

Powerhouse Energy is a UK technology company that focuses on producing hydrogen primarily from waste plastic but with the capacity to use other waste materials, like tyres. It employs a pyrolysis-based technology, which it describes as Distributed Modular Generation (DMG®). In collaboration with its development partner, Peel NRE, it is currently in the early stages of building its first commercial DMG® plant at the Protos Plastic Park in Ellesmere Port, Cheshire. A second project has also been announced to build a further waste-to-hydrogen plant at Rothsay Docks on the River Clyde.

The Protos Plastic Park is part of the Protos Energy Park, a 134-acre strategic energy and resource hub owned by waste infrastructure developer Peel NRE, part of Manchester-based property developer Peel L&P. The £165m Plastic Park is designed to develop solutions for processing some of the UK's 4.9m tonnes of annual plastic waste. It will cluster together innovative processing and treatment technologies to seek to derive the most value from plastic waste.

Powerhouse Energy became involved in the Protos project through its relationship with Waste2Tricity Ltd. (W2T), an independent energy from waste company that was established by Howard White, the founder of hydrogen power developer AFC Energy. Waste2Tricity was initially PHE's project development consultant and subsequently became its exclusive development partner in the UK, fostering a relationship with Peel in the process. Through this relationship, PHE partnered with Peel at Protos Energy Park, and in March 2020 PHE agreed, conditional upon completion of the acquisition of W2T, that Peel would have the sole rights to promote and develop DMG® technology in the UK. A first Peel facility utilising DMG® technology is expected to be operational in 2023. W2T was sold to Powerhouse Energy in 2020 via a share exchange, and Howard White became a significant shareholder in Powerhouse Energy. The transaction allowed a clearer commercial relationship between Powerhouse Energy and Peel NRE.

There are strong links between Powerhouse Energy and Hydrogen Utopia. Howard White is a strategic advisor to HUI, and Keith Riley, a non-executive Director of PHE and veteran of the European waste management industry, is the proposed Technical Director of HUI. HUI initially intends to work closely with PHE to create a project pipeline of HUI facilities.

## The Hydrogen Utopia strategy

Initially, HUI will concentrate its marketing and promotion of HUI facilities on the European continent. HUI also intends to explore opportunities across several industry verticals and, in due course, other non-European jurisdictions. HUI will target markets where there is significant private sector interest or where potential financial backing is accessible. This may include substantial EU and/or national and local government sources of funding like grants and loans. An example of such funding is the EU's 'Just Transition Fund', which was set up to help communities most affected by the transition towards carbon neutrality. The Just Transition Fund (JTF) was approved by the European Parliament in May 2021 to target those regions in Europe that will be most affected by decarbonisation of the economy. It is part of the wider €100bn EU Just Transition mechanism and has an overall budget of €17.5bn for 2021-2027. An application for €60m of funding has been made to this fund to support the Konin waste to hydrogen project. If successful, this would be matched by the same amount from the Polish government. HUI will focus on the target areas of the JTF fund for initial roll-out of its projects.

## The Konin project

One of the first potential JTF projects for HUI is expected to be in the City of Konin, the third largest city in Poland. HUI has a Letter of Intent (LOI) from the local municipality to develop up to 10 of its waste to hydrogen facilities on a single site in the city. Through its Polish subsidiary, Hydropolis, it has applied for a 15-year unsecured loan at 1% over LIBOR from the National Fund for Environmental Protection and Water Management in Poland. HUI was recently informed that its loan application had passed an initial stringent pre-qualification process and that it was one of only six companies to pass to the second stage of a two-stage application process. The loan is anticipated to be for approximately PLN88m (€19.4m) and would, if granted, be used towards the build costs of a HUI facility in Poland, which would probably be the first unit at Konin.

In parallel, HUI is exploring and pursuing other potential sources of financing and funding in Poland from potential commercial partners and other government initiatives and support such as funded grants and loans. It is expected that the City will apply for a grant of €60m from the Just Transition Fund for the full 10-unit project. The whole project is expected to cost €250m, comprising EU support of €60m, which will be matched by the Polish Government. Depending on the success of the EU funding application process, the remaining funding will be provided by ECB loans and funds raised in the financial markets. On completion, the project will create 200-300 jobs, which will assist with the economic regeneration of the city. HUI will operate the system and receive the revenues from sales of electricity, heat energy, residue, syngas and hydrogen.

At the end of 2021, HUI announced that SWECO**,** its engineering advisor and consultancy had, in collaboration with Hydropolis United, a wholly owned Polish subsidiary of HUI**,** submitted an application for an Environmental Impact Assessment for a waste plastics to hydrogen plant in Konin. The outcome is expected in the next 9-12 months.

## Other potential projects

### City of Simitli, Bulgaria

In addition to the LOI from the City of Konin, HUI has also recently signed an LOI with the City of Simitli, Bulgaria. The LOI could mark the start of a number of waste-to-energy projects to be rolled out across Bulgaria, together with others throughout Eastern Europe.

The letter sets out HUI's intention to build and manage a Powerhouse Energy Group DMG® plant sited in a commercial sector close to existing waste remediation facilities. Simitli is situated in the industrial South West of Bulgaria, and has a population of circa 8,000. The town, like many others in the region, has historically relied on the extraction of fossil fuels to support its economy. The area is set against a backdrop of semi-operational coal mines and is keen to promote sustainable, carbon-free regeneration projects.

The mayor of the City of Simitli has assured HUI that it will provide aid and support in relation to the application for EU funds for the construction of the proposed facility.

### City of Florina, Greece

HUI is currently in discussions with the mayor of Florina in Greece for the deployment of a local HUI facility. Greece is a signatory to the Paris Agreement on Climate Change and is also negotiating its access to the EU’s Just Transition Fund, which, if granted, could accelerate the deployment of HUI facilities in Greece

HUI’s subsidiary, Plastic Gold, signed an LOI with the Mayor of Florina on 16 July 2021, in which the Mayor of Florina expresses his support for the construction and operation of a HUI facility in the city of Florina. The Board of HUI believes that the main revenue stream for HUI facilities in Greece may be from electricity sales as the islands regularly experience blackouts and currently pay higher prices for their electricity than the mainland.

### Other regions

HUI is also exploring opportunities in Italy, the Netherlands, Spain, Ireland and France, often in conjunction with potential local joint venture partners. HUI has also been in conversation with investors based in Gibraltar for projects in Spain. Outside Europe, the company is in discussions with potential partners regarding a possible deployment of HUI facilities in Japan and will be pursuing a lead in India.

## The Hydrogen Utopia process

Each HUI facility will be modular, so depending on what products are being produced it will not always be necessary to install all of the components of the full process. Plastic waste will be transported to the plant, usually by the party wishing to dispose of the waste. On arrival, it will be inspected to ensure its compliance with the agreed specification, weighed and put into storage.

As required, the waste will be removed from storage and processed by sorting, to remove major contaminants, and shredding, to break the plastic into a uniform size. The shredded plastic can then be stored in silos ready for processing in the pyrolysis reactor.

### The production of syngas

Both plastics and petroleum-derived fuels contain carbon and hydrogen, with the essential difference that plastic molecules contain longer carbon chains than liquid fuels. Therefore, it is possible to convert waste plastic into fuels by breaking their carbon chains, which can be achieved by heating the waste material to around 450˚C in a pyrolizer in the absence of oxygen. This initiates the cracking process and reduces long chain plastic molecules to free radicals and smaller molecules. If allowed to cool immediately, the output of the pyrolysis reactor would be a tar-like liquid as the gases reform into smaller hydrocarbon molecules. This in itself can be used as a fuel.

However, further heating results in even smaller molecules until, at temperatures in excess of 1065˚C, methane itself is broken down into carbon and hydrogen. However, such extreme heat is not necessary to generate hydrogen. The application of steam to the pyrolysis reactor causes methane to react with water to form carbon monoxide and hydrogen, and this constitutes the main reaction in the production of syngas. In addition, carbon monoxide can react with steam to generate carbon dioxide and hydrogen.

Steam reforming of methane: $CH_4 + H_2O \rightarrow CO + 3\ H_2$

methane water carbon monoxide hydrogen

Water gas shift reaction: $CO + H_2O \rightarrow CO_2 + H_2$

carbon monoxide water carbon dioxide hydrogen

As a consequence of these two reactions, the output of a steam reforming pyrolytic reactor that is generating syngas will comprise of unreacted methane, carbon monoxide, hydrogen, carbon dioxide, nitrogen and small amounts of larger hydrocarbon molecules, which is described as the residue. The chemistry in the reactor can be optimised by applying different temperatures and amounts of steam treatment to give a wide range of mixtures from carbon monoxide rich to hydrogen rich. Its calorific value or heating value will depend on its composition, but it is generally in the range of 15-36MJ/$m^3$ or between 50% and 100% of natural gas. This gives an indication of the sales value of syngas as it will be benchmarked by heating value against the price of natural gas. The composition of syngas from waste pyrolysis streams is shown in the following table. Precise HUI output specifications will depend on the feedstock and process parameters.

**The composition by volume of syngas derived from waste feedstocks**

| Feedstock | Hydrogen | Methane | C2-C4 | Carbon monoxide | Carbon dioxide | Nitrogen | Net calorific value (MJ/m3) | NCF as a proportion of natural gas (%) |
|---|---|---|---|---|---|---|---|---|
| Refuse derived fuel | 16.0% | 25.0% | 24.0% | 18.0% | 15.0% | 2.0% | 27.3 | 74.6 |
| Biomass | 15.0% | 26.0% | 3.0% | 35.0% | 17.0% | 4.0% | 17.1 | 46.7 |
| Plastic waste | 25.0% | 38.0% | 18.0% | 9.0% | 5.0% | 5.0% | 28.0 | 76.5 |
| Tyres | 19.0% | 40.0% | 28.0% | 3.5% | 6.5% | 3.0% | 36.0 | 98.4 |

*Source: Biogreen, part of ETIA S.A.S*

The main application of pyrolysis-produced syngas is typically the generation of power and heat, which can be done in many types of equipment from steam cycles through to gas engines and turbines. These include stand-alone combined heat and power (CHP) plants and co-firing of the syngas in large-scale power plants. Although the gas does not usually need extensive pre-treatment when used in steam cycle boilers, gas engines require a higher degree of purification and preparation. The Hydrogen Utopia system uses flue gas scrubbers designed by Linde, the largest quoted global gases and engineering company, to clean its output gas.

## From syngas to hydrogen

The main objective of the Hydrogen Utopia plant is to generate clean syngas fuel from waste plastic. It has partnered with Powerhouse Energy to gain access to the DMG® technology in order to ensure it has access to a proven technology for converting plastic waste into syngas. In collaboration with its thermal process engineering partner, Electron Thermal Processing, it has developed an alternative reactor design in order to diversify its technical approach and increase its ability to respond to local conditions. The company will receive gate fees for processing the waste in line with the avoided cost of sending the waste to a landfill site. The Hydrogen Utopia units will be capable of operating in pure generation mode to convert 40 tonnes per day of mixed plastic waste into around 58MWh of electricity and 675 MW of heat, which will then be sold. This on its own is a profitable business model and the company is ready to roll it out across Europe. However, there is also the possibility of further processing the syngas to produce almost pure hydrogen and methane. This will depend on the future economics of hydrogen and the development of a distribution infrastructure, but it is the objective on which Hydrogen Utopia is most focussed in the longer term.

To separate hydrogen from the syngas it is necessary to process the gas mixture through a pressure swing adsorber. Pressure swing adsorption (PSA) is a process used to separate individual gas species from a mixture of gases under pressure according to the species' molecular characteristics and affinity for an adsorbent material. It operates at near-ambient temperature and significantly differs from cryogenic distillation, the other process commonly used to separate mixtures of gases. The pressure swing adsorption process is based on the phenomenon that under high pressure, gases tend to be trapped or adsorbed onto solid surfaces. The higher the pressure, the more gas is adsorbed. Selectively adsorbent materials like zeolites and activated carbon adsorb the target gas species at high pressure. The process then swings to low pressure to desorb the adsorbed gas. PSA can be used to separate gases in a mixture because different gases are adsorbed onto a given solid surface more or less strongly. If a gas mixture such as air is passed under pressure through a vessel containing an adsorbent bed of zeolite that attracts nitrogen more strongly than oxygen, a fraction of nitrogen will stay in the bed, and the gas exiting the vessel will be richer in oxygen than the mixture entering. When the bed reaches the limit of its capacity to adsorb nitrogen, it can be regenerated by decreasing the pressure, thus releasing the adsorbed nitrogen. It is then ready for another cycle of producing oxygen-enriched air.

The process adds significant extra capital costs to the basic pyrolizer configuration, but it does allow the syngas to be converted into a pure hydrogen offtake. It also potentially allows separation of methane from the syngas. This, of course, is at the expense of the electricity output because the removal of hydrogen and methane significantly reduces the heating value of the syngas. However, in situations where there is a demand for hydrogen and methane for applications such as transport, the flexibility to switch to individual gas output instead of electricity and heat is a valuable asset.

## Hydrogen Utopia financials

### The effect of the IPO

The company published an audited balance sheet for the 11 months to 31 August 2021 in its Admission Document. This showed that it had net cash in its balance sheet of £0.77m and resulted in net cash to equity of 33%. Taking account of the share issues that took place post the balance sheet date, including the recent IPO issue, we have estimated that net cash is currently £3.6m, resulting in a net cash to equity figure of over 70%

**Estimated pro-forma post-IPO balance sheet**

| **(£'000)** | | **31 Aug 2021 (audited)** | **Pro-forma post IPO (estimates)** |
|---|---|---|---|
| Fixed assets | | 1049 | 1100 |
| Current assets | Debtors | 1158 | 1100 |
| | Cash | 764 | 3581 |
| | Total | 1922 | 4681 |
| Creditors | Trade creditors | (650) | (692) |
| | Other | (5) | (0) |
| | Total | (655) | (692 |
| **Net assets** | | **2317** | **5088** |
| | | | |
| **Capital and reserves** | | | |
| Called-up share capital | | 300 | 384 |
| Share premium account | | 300 | 5304 |
| Shares to be issued | | 2132 | 0 |
| P&L reserves | | (417) | (600) |
| **Total equity** | | **2317** | **5088** |

*Source: Company data and Progressive Equity Research estimates*

The company is now financially well-placed for the next stage of its development. The proceeds from the IPO are expected to be used in the next 18 months as follows:

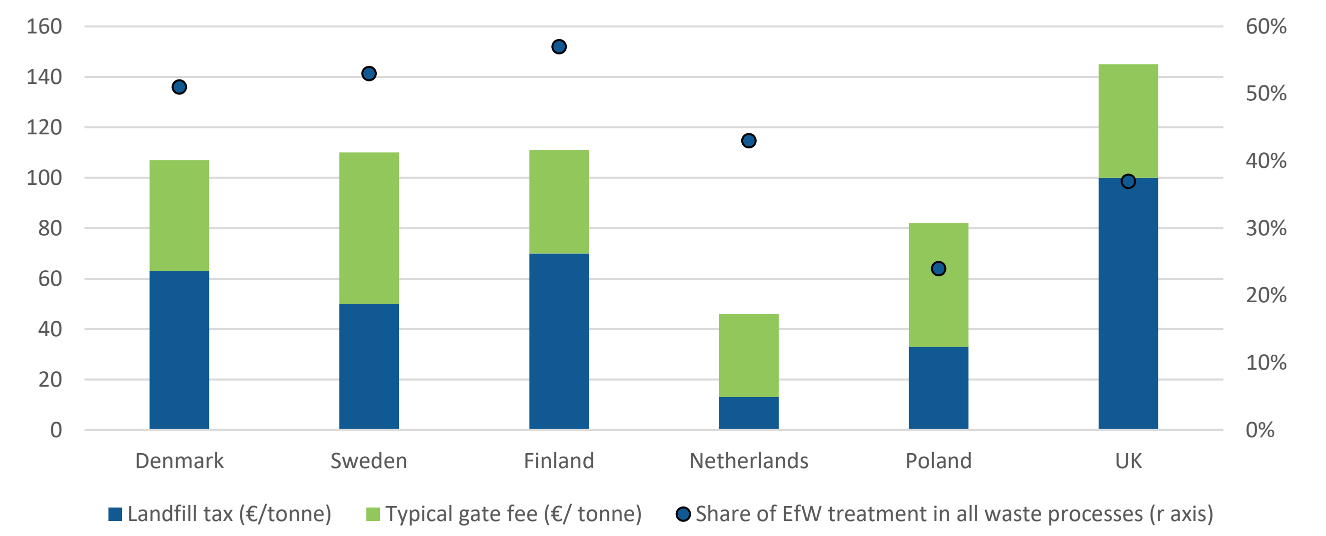
- pre-build costs of a HUI facility including planning application and permit costs, land acquisition. And any further fees and expenses relating to the finalisation of the design of the reactor. £1.3m
- marketing and business development. £0.6m
- working capital £0.7m

## Financial forecasts

Hydrogen Utopia has yet to generate any revenue and it reported a loss of £0.42m in its last audited accounts for the 11 months to the end of August 2021. Going forwards, the company expects that its revenues will be derived from a variety of sources, dependent upon location and configuration of its individual facilities, including the sale of syngas, hydrogen and other gases, electricity and heat sales, and the payment to it of fees for a given quantity of plastic waste received at a HUI facility, known as gate fees. Whichever configuration is used, the feedstock will always be non-recyclable plastic waste and therefore gate fees will be the common component of all HUI facilities. The company intends to update the market with financial forecasts as and when projects reach financial close.

To assess gate fee potential, the Hydrogen Utopia process can be compared to an energy from waste facility in that it provides an outlet for waste plastic that avoids landfill or export. Data collated by Letsrecycle.com show the present range of gate fees in the UK for energy-from-waste (EfW) processors is £88-105/tonne. The compares with refuse-derived fuel at £96-99/tonne and the cost of landfill, including landfill tax, of £112.7-123.7/tonne. The fees are slightly lower in Poland but so too is the proportion of EfW treatment in all waste processed, as the following chart shows. Currently, Poland only just meets its EU Renewable Energy Directive commitment, which stipulates that 15% of total energy is derived from renewable sources. Electricity generated from waste is regarded as renewable. A circular and zero carbon economy will require more energy from waste, not less. We have therefore assumed that gate fees of €100/tonne will be achievable.

**Waste disposal costs and share of EfW in selected countries**




*Source: IEA, Sep 2020*

The second major income stream will be from the sale of energy, either as syngas, electricity or waste heat. In common with many other economies, wholesale electricity prices in Poland have doubled in the year to September 2021 to 465.7 zloty per MWh (£83.8/MWh), driven by the worldwide squeeze on gas supplies and compounded in Europe by the rising prices of carbon permits under the EU emissions trading scheme. Poland still relies on coal for almost 70% of its energy production, which is by far the highest in the EU, but all fossil fuel prices are benchmarked to the gas price to a greater or lesser extent. By comparison, the wholesale electricity price in the UK is currently over £110/MWh.

The weekly average wholesale price of gas has risen from £16/MWh to £39/MWh since the beginning of 2021, which will, of course, increase the price that HUI could sell its syngas at. At present there is little sign of an end to the volatility of the natural gas price, and we note that the trend has been upwards for the past two years. Going forward, we have assumed a price for electricity of £70/MWh and for syngas, based on 75% the calorific value of natural gas, of £22.5/MWh. The other potential revenue stream for the plant is hydrogen, which is similarly affected by the natural gas price. However, we have assumed that hydrogen produced from waste will command a higher price than grey hydrogen from natural gas, but perhaps not as high as the current price for green hydrogen. We have assumed a price of US$3,000/tonne.

On this basis, we have modelled three output scenarios consisting of syngas only, electricity only and a mix of hydrogen, hydrogen depleted syngas and electricity. This is probably unrealistic since in any real scenario the revenues are likely to be more mixed and tailored to the specific requirements of the customer, but it does demonstrate the operating flexibility and scope of the technology.

**Annual revenue estimates for a 40 tonne per day unit**

| £m | Syngas only | Electricity only | Hydrogen, methane plus electricity |
|---|---|---|---|
| Gate fees | 1.27 | 1.27 | 1.27 |
| Sale of methane | 1.44 | 0 | 1.26 |
| Sale of hydrogen | 0 | 0 | 2.86 |
| Sale of electricity | 0 | 1.77 | 0 |
| Other | 0.3 | 0.30 | 0.3 |
| **Total revenue** | **3.01** | **3.35** | **5.69** |

*Source: Progressive Equity Research estimates*

Clearly, the capital and operating costs will be affected by the operating mode of the unit. All three modes considered above will require plastic handling, storage and shredding plant for preparation of the reactor feed stock. However, a pyrolysis reactor with flue gas treatment sufficient to produce a clean syngas for onward sale will not require a power island for electricity generation or a pressure swing adsorber to separate hydrogen and methane from the syngas.

In October 2020, PHE estimated the capital expenditure required for a full hydrogen and electricity capable 40 tonne/day plant was £25m. Hydrogen Utopia has the advantage that construction costs in Poland are lower and believes that it can achieve the full plant for €25m. We have taken a cautious view and stuck with the sterling figure.

If HUI went for the first option of syngas production only, the costs associated with power generation and pressure swing adsorption drop out and we estimate the capital expenditure would fall to around £10m/unit. We estimate that the cost of a power island to generate electricity would add a further £5m to this sum.

Operating costs are largely dominated in all scenarios by labour costs. Each unit will run around the clock, thus requiring 24-hour control room shifts of two or three operators. In addition, the plant will need maintenance crews for most of the operating day. Access control, site logistics, unloading, sorting and shredding are likely to require two shifts of 5-6 people. In view of these factors, we estimate that staff costs will be in the region of £0.75 -0.8m a year. The next largest cost is likely to be the licencing fee due to PHE, at £0.5m per unit. Depreciation and other operating costs will depend on the mode in which the plant is operated. We assumed a standard running year of 8,000 hours, resulting in a load factor of 91%.

**Annual operating costs estimates for a 40 tonne per day unit**

| £m | Syngas only | Electricity only | Hydrogen, methane plus electricity |
|---|---|---|---|
| Staff | (0.70) | (0.75) | (0.80) |
| Licence | (0.50) | (0.50) | (0.50) |
| Other | (0.80) | (1.00) | (1.40) |
| **Total** | **(2.00)** | **(2.25)** | **(2.70)** |

*Source: Progressive Equity Research estimates*

Based on these price and cost assumptions, we have calculated the return on capital employed (ROCE) for each operating scenario in a full year of operation.

**Profitability and return on capital employed for a 40 tonne per day unit**

| £m | Syngas only | Electricity only | Hydrogen, methane plus electricity |
|---|---|---|---|
| Operating Profit | 1.01 | 1.10 | 3.19 |
| Finance | (0.30) | (0.43) | (0.55) |
| PBT | 0.71 | 1.53 | 3.74 |
| Tax | -0.14 | -0.29 | -0.71 |
| PAT | 0.58 | 1.24 | 3.03 |
| NOPAT | 0.88 | 0.81 | 2.48 |
| | | | |
| ROCE (%) | 8.78 | 8.84 | 12.12 |

*Source: Progressive Equity Research estimates*

It can be seen that all operating scenarios produce an attractive return on capital employed, with the single output syngas-only and electricity-only scenarios both being about the same at around 8.8%. We have already mentioned that these are not particularly realistic operating assumptions since we would expect each unit to generate more than one revenue stream in real-life operation, and we have only added a very small amount in each instance for the considerable amount of thermal energy that a unit would produce. The most realistic operating scenario is the full hydrogen plus electricity plus methane operation, which gives a ROCE of over 12% despite having much higher capital costs. Given the funding models for the projects which involve a high proportion of debt and grant funding, we expect the return on equity in each instance to be substantially higher.

## Risks to estimates

As with all large capital projects, there are significant risks in the construction phase of cost overrun and delays. HUI has sought to mitigate these risks by partnering with PHE, which is further along in the development of its own first facility. In addition, HUI has liaised with strong engineering partners in Electron, Linde and SWECO.

The volatility of global fossil fuel markets has been an advantage to the HUI model so far but a substantial reduction in the price of natural gas would have a knock-on effect on the price that the company could charge for syngas, electricity and hydrogen. The flexible design of the HUI facilities allows the company to optimise revenue streams across a wide range of supply and demand scenarios, and it will always be able to rely on gate fees for plastic waste feedstock, which is never likely to be in short supply.

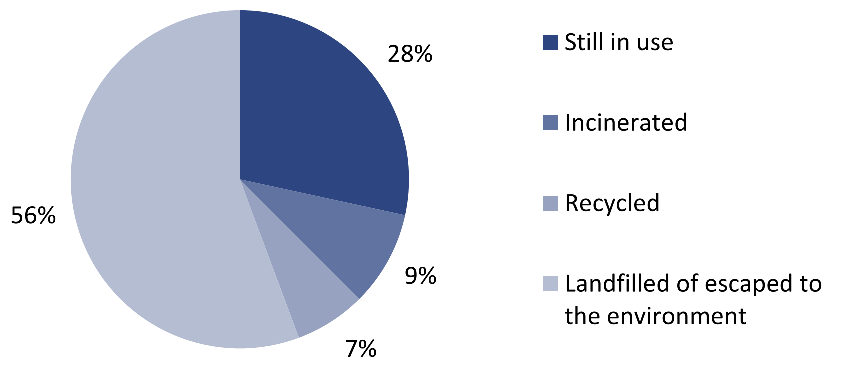
## The Markets

Hydrogen Utopia has a proven technological solution to two pressing global issues: waste plastic disposal and the excessive use of fossil fuels have caused increased environmental pressure on the planet that now requires urgent remedial action.

## The global plastic waste problem

According to a study by Geyer, Jambeck and Law (‘*Production, use and fate of all plastics ever made*’, Science Advances 19/7/17, Vol 3 No 7), of all the plastic produced in the world by that time, around 8.3bn tons, only 2.5bn tons or 30% was still in use. By the end of 2015, all plastic waste ever generated from primary and secondary or recycled plastics had reached 6.3bn tons, 700m tons of which were polyphthalamide fibres (nylon).

**The fate of all plastic produced in the world up to 2015**




*Source: Science Advance V3, N7, July 2017*

There are essentially three different fates for plastic waste. First, it can be recycled or reprocessed into a secondary material. Recycling delays, rather than avoids, final disposal, but in theory thermoset plastics can be melted and reconstituted to substitute for virgin polymer. In practice, the costs of logistics, cleaning and processing are prohibitive and this option displaces very little primary plastic production. Contamination and the mixing of polymer types generates secondary plastics of limited technical and economic value, which also have to be disposed of at the end of their life.

Second, plastics can be destroyed thermally. Although there are emerging technologies, such as pyrolysis, which extract fuel from plastic waste, to date virtually all thermal destruction has been by incineration, with or without energy recovery. The environmental and health impacts of waste incinerators strongly depend on emission control technology, as well as incinerator design and operation. In countries like Switzerland, where there is a ban on landfill, incineration rates are much higher while recycling rates remain much the same as countries where landfill is allowed. According to the industry trade body PlasticEurope, in the UK, for instance, 28.6% of plastic waste is recycled, with 30.6% incinerated and the rest goes to landfill. Switzerland, on the other hand, recycles 24.5% of plastic and incinerates 70.6% (2019 figures).

Finally, plastics can be discarded and either contained in a managed system, such as landfills, or left uncontained in open dumps or in the natural environment. As we show in the chart above, between 1950 and 2015, approximately 4.9bn tons, or 60% of all the plastic ever produced, went down this route. There are no reliable statistics on the split between plastic waste to landfill and plastic waste in the environment. This is important because it will vary significantly from country to country. In simple terms, plastic that goes to well-engineered landfill is not a problem. It is unlikely to decompose but it is not going to cause a climate change impact. However, it does represent a waste of resource because it has high energy value and can be either converted to electricity or hydrogen using the Hydrogen Utopia technology.

There is also a very real problem with waste plastic that escapes into the environment, and it is this that has caused such a media outcry in recent years. Such waste constitutes an environmental hazard of massive proportions. In the absence of hard data, if we were to assume that just 20% of discarded plastic escapes to the environment, that would equate to a billion tonnes of waste, much of it eventually destined for the oceans.

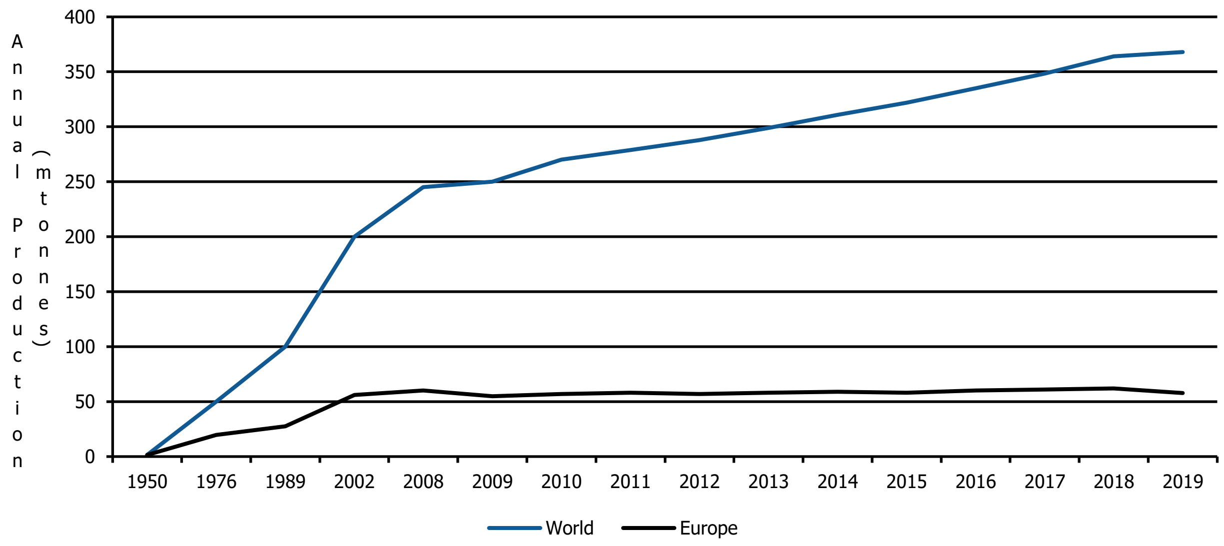
## Solutions to the plastic waste problem

Going forward, there are four potential solutions to the plastic waste problem. The options are:

- Reduce use of plastic.
- Recycle more.
- Make the disposal routes more effective.
- Ensure that plastic waste that escapes to the environment decomposes quickly and safely.

### Use less

**Global growth in the annual production of all plastics (m tonnes/yr)**



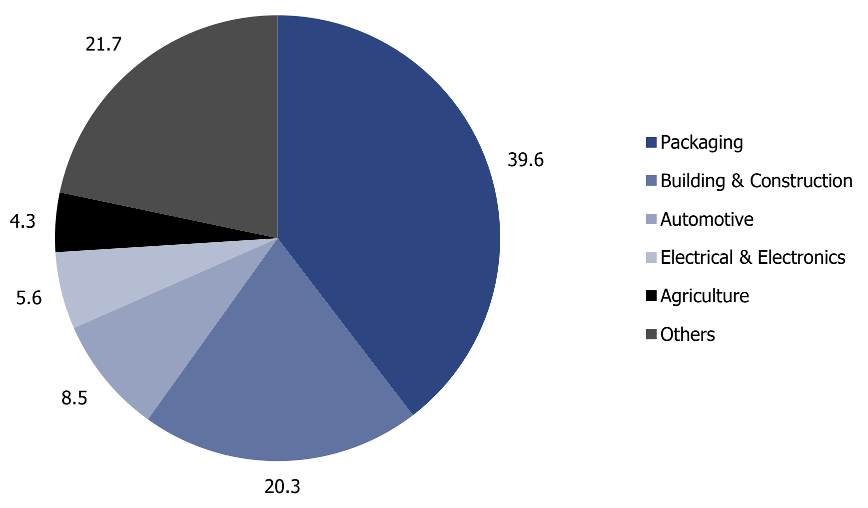

*Source: Statista from various collated sources*

Since 1950, the growth in plastic production has been exponential, at an average compound rate of 8.7%, with only a few short periods of decline. The current global production of plastic is around 335m tonnes a year, and it is forecast to grow at a compound rate of 5.4% to reach a total annual output of 1,900m tonnes by 2050 (*PAI Partners ESG Lab, The Plastics Issue*). Petrochemical companies have invested US$180bn in new production facilities since 2010 to turn fossil fuels into plastics. The global push to reduce carbon emissions may lead to less fossil fuels being burned, but that does not mean that they have to stay in the ground. The fact is that plastic is useful. in some applications, such as modern healthcare it is essential. It is the cheapest and most hygienic solution for many packaging applications, and in many cases the use of alternatives would consume more energy and other natural resources.

According to Plastics Europe' latest data, in 2018 Europe produced over 29m tonnes of waste plastic. In Europe, just under one-third of waste plastic is recycled. A further 43% is incinerated with or without energy recovery. With regard to the rest, it is mostly sent to landfill, but landfill capacity is becoming scarce and consequently alternative routes have been sought for its disposal, including export. Until recently, waste plastic was exported outside the EU but as a result of a ban by China on plastic waste imports in 2017, exports from the EU reduced by 39% between 2016 and 2018. Subsequently other countries have followed China's example and banned plastic waste imports. Further, since 1 January 2021 the EU legislated against the shipment of unsorted waste plastic to foreign non-OECD countries.

We do not believe that measures to reduce the amount of plastic packaging used, like the UK bag tax and banning single-use plastics, will have a significant impact on the rate of growth of total plastic production or plastic packaging demand. The annual market for flexible packaging is US$83bn or around 40% of the total global demand for all plastic, and it is growing at an estimated 4.2% annually, with the biggest regional consumption and growth being in Asia (*GrandViewResearch, Mar 2021*). In all regions globally, the growth in plastic packaging outpaces that of paper packaging. Measures to reduce plastic packaging consumption in developed countries are likely to be swamped by growth in developing countries that do not have the advanced infrastructure necessary to collect and recycle or eliminate plastic waste.

**Global demand for plastic by application (%)**



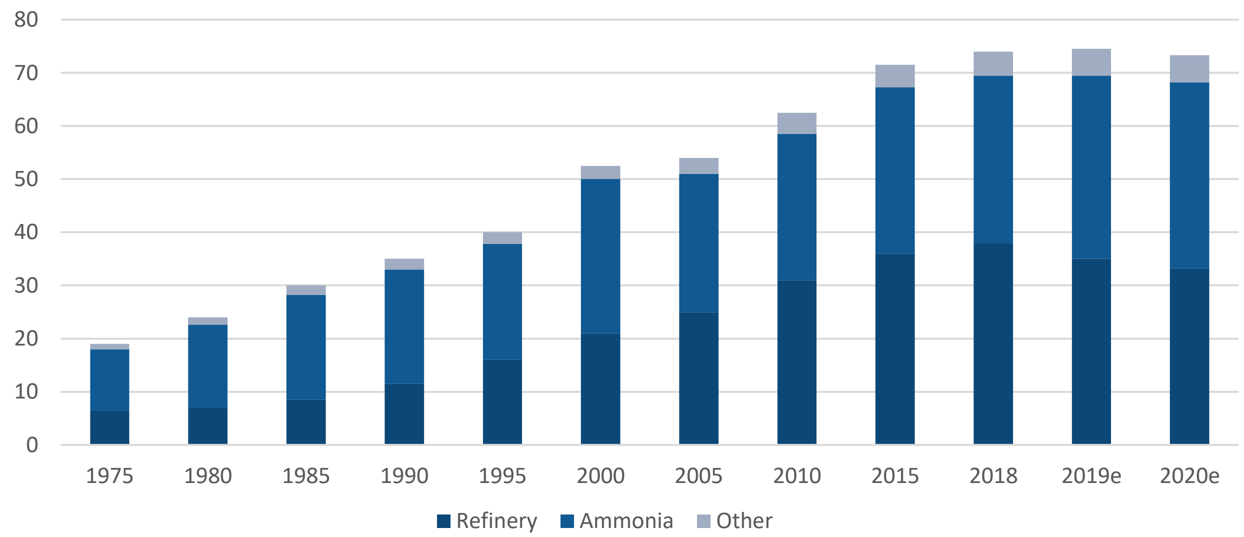

*Source: PlasticsEurope 2015 (PEMRG)/ Consultic/ ECEBD*

# The Global Hydrogen Market

## Demand for hydrogen

The global market for industrial hydrogen has grown steadily in recent years and is expected to accelerate in the next decade. A recent report by Grand View Research estimated that the global hydrogen generation market was worth US$120.8bn in 2020. A similar study by ResearchandMarkets in May 2012 forecast this to grow to US$184.1bn by 2025. The International Energy Agency (IEA) recently announced that although global demand for hydrogen had dropped by 1.6% in 2020 to 73.3m tonnes due to the global pandemic, this still represented a three-fold increase in the last 40 years at an average annual compound growth rate of 2.9%. The IEA expect this to increase to at a rate of between 5.7% and 6.1% from 2021 to 2028, driven by an exponential increase in the demand for clean and green fuel. Currently, over 90% of industrial hydrogen production is utilised in oil refining and the production of ammonia for the fertiliser industry. Other uses include the production of methanol, electricity generation and transport fuel.

**Global production of hydrogen by end use (m tonnes/yr)**




*Source: International Energy Association*

## Production of hydrogen

Over 95% of industrial hydrogen is currently produced from fossil fuels, principally coal and natural gas, and hydrogen production accounts for 6% of global natural gas usage (*Research and Markets, The Global Hydrogen Market, May 2021*). Hydrogen generation from fossil fuels is achieved by reacting hydrocarbon fuels with high temperature steam to produce hydrogen and carbon dioxide. Alternatively, hydrogen can be produced from water or alkaline solutions by electrolysis. This has the advantage that it does not produce waste carbon dioxide but it is significantly more expensive than steam reforming unless there is a readily available source of low-cost renewable energy.

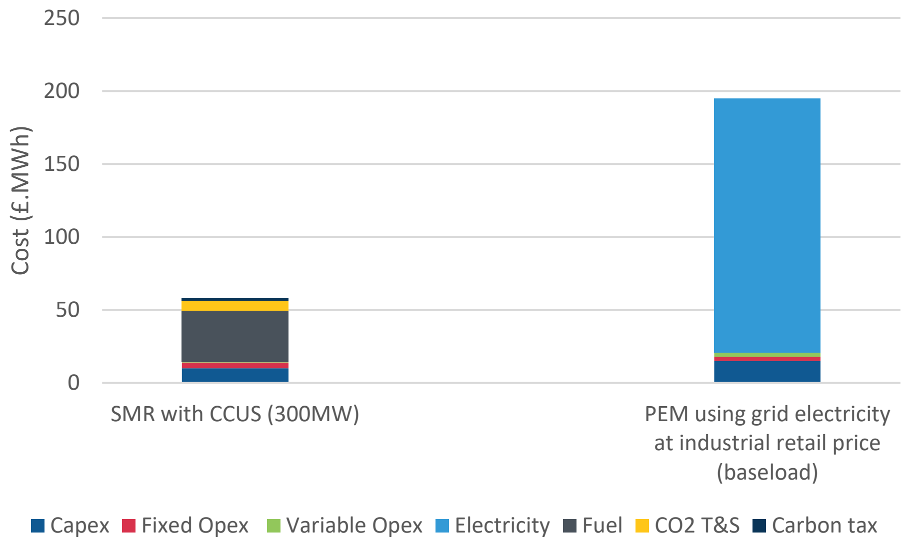
The cost of hydrogen varies significantly according to the production process. The cheapest hydrogen is made by steam reforming of fossil fuels but, as we have already said, this also generates carbon dioxide as a by-product. For every tonne of hydrogen produced from natural gas, over 5.5 tonnes of carbon dioxide is generated, which incurs gas separation and carbon costs. Clearly this is not a solution to reducing carbon emissions unless a means of carbon capture, usage and storage (CCUS) is added to the back end of the process. This results in higher costs and gives rise to two hydrogen prices. Hydrogen made from fossil fuels with carbon capture and storage is called blue hydrogen, while that produced from natural gas without CCS is termed grey hydrogen. The terms brown hydrogen and black hydrogen are sometimes used to define that produced from brown coal and bituminous coal. Hydrogen produced by electrolysis of alkali solutions using renewable energy sources is called green hydrogen.

Of course, the HUI pyrolytic process also generates carbon dioxide as a by-product of producing syngas and again as an emission from the electricity generation process. However, as the reactor can be heated electrically, the syngas contains very little nitrogen as no combustion air is required in the reactor. This means that the carbon dioxide in the syngas could be separated in the pressure swing adsorption equipment to give another pure and valuable gas output. At this stage there are no plans to incorporate this into the design but it would be relatively simple to do so due to the modular design of the process.

In a recent report by the IEA, the global current price of industrial hydrogen produced from steam reforming of fossil fuels without CCS was put in the range US$0.5-1.7/kg. The range is wide largely due to the variation in the costs of using coal compared with natural gas. However, the recent volatility of natural gas prices has also contributed to hydrogen price variability, along with the variation in the capacity of production plants. The price of green hydrogen produced by proton exchange membrane (PEM) electrolysis was put in the range US$3-8/kg, reflecting the very early stage of development of this technology. A recent Bloomberg NEF report (*Hydrogen Economy Outlook, March 2020*) stated that this cost could fall to US$1.2-2.75/kg by 2030.

The production cost of hydrogen from natural gas is influenced by a range of technical and economic factors, with gas prices and capital expenditures being the two most important. Fuel costs are the largest cost component, accounting for between 45% and 75% of production costs. Low gas prices in the Middle East, Russia and North America give rise to some of the lowest hydrogen production costs. Gas importers like Japan, Korea, China and India have to contend with higher gas import prices, and that makes for higher hydrogen production costs.

**Levelised cost of hydrogen production for steam methane reformation and proton exchange membrane electrolysis (£MWh)**




*Source: Hydrogen Production Costs 2021, Dept BEIS.*

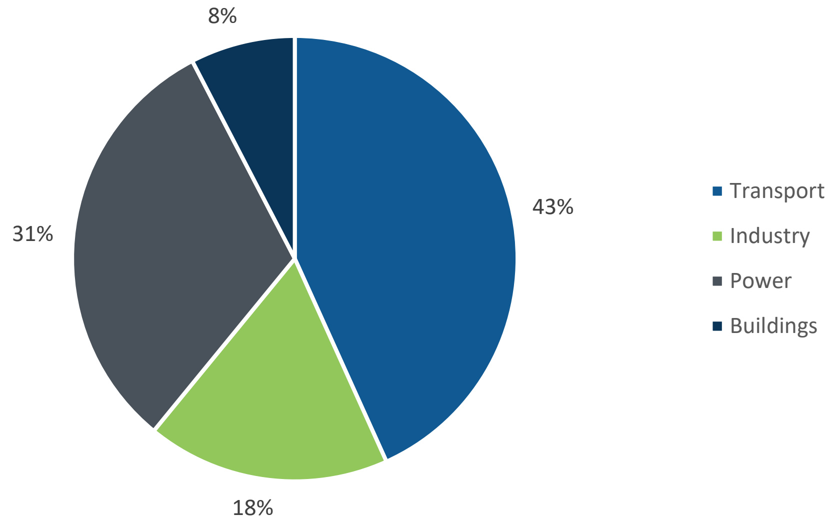
It can be seen in the chart above that the cost of natural gas in the case of SMR and electricity in the case of electrolysis account for around 60% and 90%, respectively, of the total costs of hydrogen production for each process. This makes a compelling argument for the use of waste plastic as the feedstock where the cost is effectively negative due to the gate fees received for processing waste.

## Potential uses of hydrogen

At present, most of the 73m tonnes/year of hydrogen produced globally goes into refining and the manufacture of fertiliser. However, the role of hydrogen in a decarbonised world could be substantially greater. Theoretically, hydrogen could replace all fossil fuel requirements, but that would require an 18-fold increase in hydrogen production to 1370m tonnes/year, which is unlikely to prove practical.

Hydrogen can be substituted for natural gas in many applications, although to transport it in existing gas grids would require a significant upgrade in technology. Bloomberg NEF estimates that by 2050 up to 24% of the world's energy needs could be met by hydrogen. This would equate to the production of 696m tonnes/year, representing an almost 10-fold increase in current production at an estimated investment cost of $11 trillion. The Bloomberg report notes that this would require strong and comprehensive global political support as opposed to a piecemeal policy. Within the strong support scenario, transport would account for almost half of the potential demand for hydrogen.

**Potential applications for hydrogen in 2050 assuming it meets 24% of global energy needs**




*Source: Bloomberg NEF, Hydrogen Economy Outlook Mar 2020*

Although it is theoretically possible to use hydrogen in internal combustion engines in much the same way as LPG is currently used, in practice this is unlikely to become the dominant solution for transport applications overall, but may be the prime solution for heavy goods and service vehicles where electric motors give rise to power-to-weight issues The higher combustion temperatures of hydrogen inside the engine result in production of more nitrous oxides than with the use of fossil fuels. The most likely means of using hydrogen for transport purposes is through fuel cell electric vehicles (FCEVs), in which compressed hydrogen is converted to electricity by the fuel cell, which then powers an electric motor.

More than 40,000 FCEVs were on the road globally by the end of June 2021. FCEVs grew an average 70% annually from 2017 to 2020, but in 2020 growth fell to only 40% and new fuel cell car registrations decreased 15%, mirroring the contraction of the car market overall due to the Covid-19 pandemic. In 2020, FCEVs made up a very small share of the global stock of total vehicles (<0.01%) and of electric vehicles (0.3%). However, 2021 is expected to be a new record year, with more than 8,000 FCEVs sold in the first half of 2021, and record-high monthly sales recorded in California (759 in March) and Korea (1,265 in April).

12 January 2022

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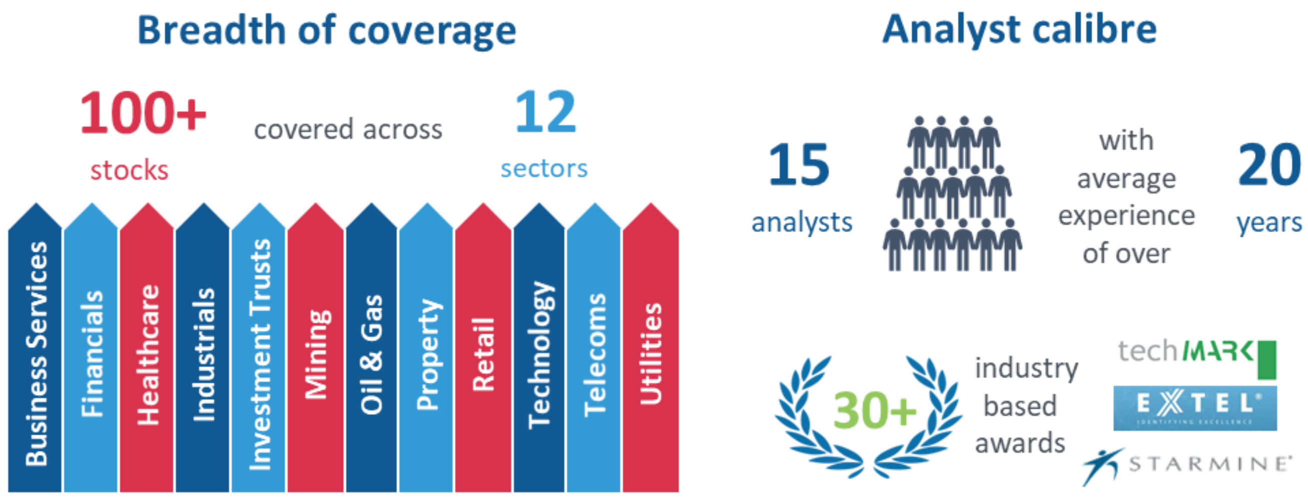


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