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NOT RATED

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#### Key Data

Share price	116.4p
Dil. NAV	97.03p
Dil. premium	19.96%
Market cap	£126.0m
Sector	Investment Funds
Stock codes	HGEN.L / HGEN.LN

Priced at close 08/12/2021

#### Published Research

For more detail on the hydrogen economy and the specific opportunity from a managed funds perspective please see our previous note [Hydrogen – an emerging renewables sub-sector](#) published in May.

Please also see our detailed analysis on the size of the global Green Hydrogen opportunity [Green Hydrogen - Rapid scale-up to 6.5TW](#) published in April.

## Initiation of coverage HydrogenOne Capital Growth Fuelling Up

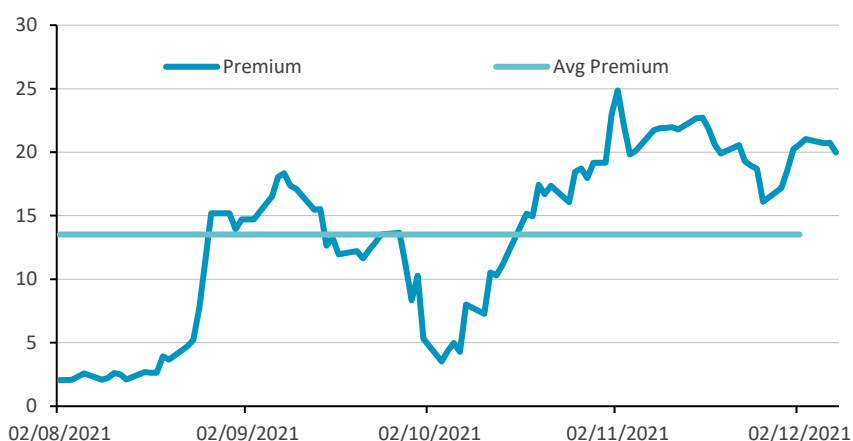
Earlier this week, HydrogenOne Capital Growth plc (HydrogenOne), the first London listed hydrogen fund, announced its third Private Equity (PE) investment into NanoSUN, a developer of hydrogen distribution and mobile refuelling equipment, for £9m. This follows PE investments into HiiROC, an innovative supplier of clean (turquoise) hydrogen production technology, for £10m and leading electrolyser and fuel cell manufacturer Sunfire GmbH for €24m (£20m).

Since the IPO in July, HydrogenOne has made significant progress with its planned investment in the Clean Hydrogen sector with nearly £50m now fully invested. The managers are on track to meet all commitments made at IPO with early deployment into listed and private companies and project selection progressing well, with capital deployment expected next year.

- ▶ **The first London listed hydrogen fund:** HydrogenOne was admitted to trading on the London Stock Exchange's Main Market for listed securities on 30th July 2021. The IPO raised gross proceeds of £107m, including a strategic cornerstone investment of £25m by INEOS Energy, the world's 3rd largest chemicals company. The Company is the first London listed hydrogen fund, offering growth potential in clean hydrogen and related technologies. By excluding sectors such as fossil fuels producers and focusing strongly on energy transition themes, HydrogenOne aims to deliver attractive returns and a positive environmental impact.
- ▶ **INEOS – a key strategic investor:** We think the importance of INEOS as a key strategic investor cannot be overstated. INEOS is the world's third largest chemical company with turnover of US\$61bn employing 26,000 people across 36 businesses in 29 countries throughout the world. Crucially, it has identified the development of green hydrogen as a fuel and has made considerable commitments to the sector with substantial activities already underway.
- ▶ **Sunfire – solutions across the value chain:** HydrogenOne's first PE Investment in Sunfire GmbH for €24m (£20m) was committed for a minority equity stake, as part of a €109m fundraising round. Sunfire is a leading manufacturer of alkaline and solid oxide electrolysers, which can be deployed to manufacture green hydrogen. Sunfire operates across the hydrogen value chain, also producing fuel cell solutions for off-grid power and heating markets. We view its portfolio of technologies addressing multiple applications, including the production of e-Fuels, as a strong offering, which also presents various ways for HydrogenOne to create value upon exit.
- ▶ **HiiROC – innovative turquoise hydrogen technology:** HydrogenOne's second PE investment was made in HiiROC, a plasma torch technology company producing turquoise hydrogen, where £10m was committed as part of a £26m fundraising round. HiiROC's technology can be located at the point of demand thereby avoiding transport costs and enabling the use of existing infrastructure. The importance of deploying appropriate, cost-effective clean hydrogen technology to maximise decarbonisation as quickly and efficiently as possible has accelerated and so we view HydrogenOne's exposure to another production technology as positive.

- ▶ **NanoSUN – pioneering hydrogen refuelling:** HydrogenOne’s third PE investment has most recently been made into NanoSUN based in Lancaster, UK, where £9m was committed as part of a £12m funding round. NanoSUN is aiming to accelerate hydrogen use with its innovative technologies by bridging the gap between the hydrogen supply industry and the needs of hydrogen users for convenient, low cost, simple-to-use and safe hydrogen refuelling stations (HRS). NanoSUN’s Pioneer HRS offers a low-cost solution to costly fixed HRS helping fleet operators to introduce and grow their hydrogen vehicle fleets in a cost-efficient manner.
- ▶ **The public piece:** HydrogenOne has invested 9% of its IPO proceeds into a portfolio of around 20 globally listed Hydrogen equities. Portfolio composition is heavily weighted to European listed stocks and those with a market capitalisation over \$1bn. Importantly, the average 2-year revenue CAGR for the portfolio is 119%. Trading into the public piece was timed well with positions being taken during the market sell off in early September and prior to the subsequent rally that begun mid-October. This part of the fund provides sector focus and global exposure but also ensures management has a close eye on public valuations to maximise PE investment returns upon exit.
- ▶ **Corporate activity supporting performance:** A major catalyst for the Hydrogen and Fuel Cell sector, particularly the European names, was the European gas crisis at the end of October and newsflow ahead of COP26. More importantly, corporate activity and investment has continued apace. In October, Plug Power in the US announced an aggressive sales target of \$30bn by 2030 and ITM Power in the UK successfully completed a £250m fundraise to accelerate the scale-up of its electrolyser capacity to 5GW by 2024, highlighting the longer-term growth potential and the capital required to scale. This translated into continuing demand and support from institutional investors for access to the sector, which in turn largely supported share prices.
- ▶ **A healthy premium:** Given the fund has until recently only been invested in public equities (since the first PE investment into Sunfire in October) this has been the main driver of performance. Since listing HydrogenOne has traded at a healthy average premium of 13.5%, reflecting an average performance of the public portfolio of 9%.

#### Premium since admission (%)



Source Morningstar, Panmure Gordon

- ▶ **Project selection on track:** HydrogenOne is targeting an expected position of up to four project holdings, subject to availability of funds. Project selection is on track leveraging the expertise of technical adviser ARUP with the first investment expected to take place in FY22, with all project investments onstream by FY24. We expect the investment potential in this portion of the portfolio to be significant as the requirement for increased scale and capacity grows in line with targets. With financing key at this early stage of market development, we see substantial opportunity for HydrogenOne to play an increasingly important lead role here being one of Europe’s prominent funds.

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## THE FIRST LONDON LISTED HYDROGEN FUND

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**HydrogenOne was admitted to the premium listing segment of the Official List of the FCA and to trading on the London Stock Exchange's Main Market for listed securities on 30th July 2021. The IPO raised gross proceeds of £107m, including a strategic cornerstone investment of £25m by INEOS Energy, the world's 3rd largest chemicals company. The Company is the first London listed hydrogen fund, offering growth potential in clean hydrogen and related technologies.**

The Company offers investors diversified exposure to private equity and listed hydrogen companies on an international basis and qualifies for the London Stock Exchange's Green Economy Mark. By excluding sectors such as fossil fuels producers, focusing strongly on energy transition themes, and proactively engaging with investments and other stakeholders more broadly, HydrogenOne aims to deliver attractive returns and a positive environmental impact.

### INEOS – A KEY STRATEGIC INVESTOR

We think the importance of INEOS as a key strategic investor cannot be overstated. INEOS is the world's third largest chemical company with turnover of US\$61bn employing 26,000 people across 36 businesses in 29 countries throughout the world. Crucially, it has identified the development of green hydrogen as a fuel and has made considerable commitments to the sector with substantial activities already underway.

Indeed, INEOS recently announced that it is to invest more than €2bn into electrolysis projects to make green hydrogen across Europe. Its first plants will be built in Norway, Germany, Belgium with investment also planned in the UK and France. The first unit to be built will be a 20MW electrolyser, which will lead to a minimum reduction of around 22,000 tonnes of carbon dioxide per year by reducing the carbon footprint of INEOS' operations at Rafnes and serving as a hub to provide hydrogen to the Norwegian transport sector.

In Germany INEOS plans to build a larger scale 100MW electrolyser to produce green hydrogen at its Koln site. The development will further support decarbonisation of INEOS operations at the site. Hydrogen from the unit will be used in the production of green ammonia. The Koln project will result in a reduction of carbon emissions of over 120,000 tonnes per year. It will also open opportunities to develop E-Fuels through Power-to-Methanol applications on an industrial scale.

INEOS, through its subsidiary INOVYN, is already Europe's largest existing operator of electrolysis. It is also developing other projects in Belgium, France and the UK and the business expects to announce further partnerships with leading organisations involved in the development of new hydrogen applications. It also has extensive experience in the storage and handling of hydrogen which puts it in a unique position to drive progress towards a carbon-free future based on hydrogen.

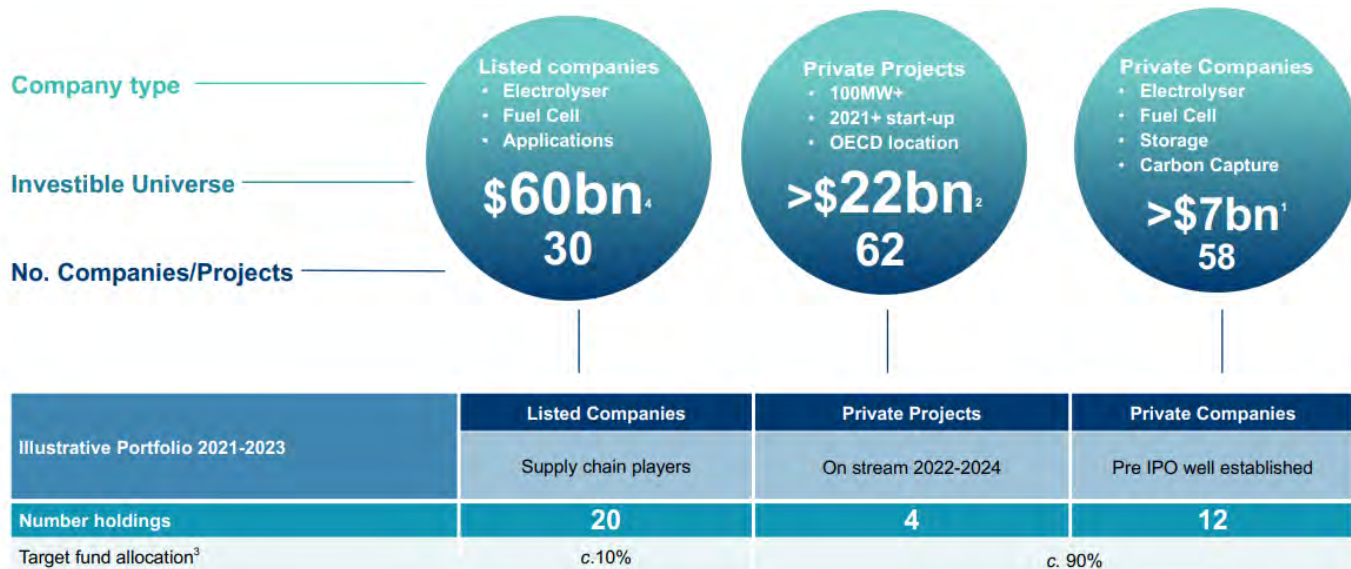
INEOS has also launched a new business as part of INOVYN to develop and build green hydrogen capacity across Europe, which will be headquartered in the UK and aims to build capacity to produce hydrogen across the INEOS network of sites in Europe, in addition to partner sites where hydrogen can accelerate decarbonisation. Importantly, it also intends to work closely with European governments to ensure the necessary infrastructure is put in place to facilitate hydrogen's major role in the new Green Economy.

HydrogenOne will provide INEOS Energy access to green hydrogen through investment in a diversified portfolio of hydrogen and complementary hydrogen-focused assets to deliver capital growth with a strong sustainability focus. INEOS Energy has also been granted co-investment rights over any additional capacity in private projects identified for investment by the Company and has appointed Roger Bell as non-executive director to the Board of the Company.

**EXECUTING ON THE INVESTMENT STRATEGY**

HydrogenOne’s investment strategy is centred around providing global access to listed companies, private projects and private companies. An investible universe of over c\$89bn across the three company types was identified pre-IPO.

**Investible universe and target portfolio in place**



**Note** As set out in the investment proposal. 1. estimates based on company data 2. estimates based on average project size of 100MW equivalent to NPV7 3. Maximum Listed Companies weighting 30%; minimum Private companies and projects weighting 70% 4. Bloomberg data April 2021

Source Company, Panmure Gordon

Since the IPO on 30th July, the company has made significant progress with its planned investment in the Hydrogen sector with early deployment into listed and private companies and working towards deployment next year into selected hydrogen projects. We summarise progress made to date below and look more closely at the first three PE investments and public piece in the following sections.

**Listed companies – 9% allocation**

- ▶ Deployment of c9% of fund into listed companies – target allocation at 10%
- ▶ Investments timed in Q3 2021 market sell down
- ▶ Global exposure to hydrogen equities via LSE listing
- ▶ Example holdings include Plug Power, Doosan Fuel Cells and Aker Horizons

**Private projects & companies – 90% target allocation**

- ▶ Long-list of private company investments increased from 30 to more than 120 during 2021
- ▶ Sunfire entry October 2021
- ▶ HiiROC entry November 2021
- ▶ NanoSUN entry December 2021
- ▶ Assessing multiple corporate opportunities for 2022 purchase
- ▶ 11 opportunities currently under non-disclosure agreements (NDA)
- ▶ Targeting companies of \$50-500m with \$10-20m investments for 3-30% target ownership
- ▶ Intending to invest into at least two private hydrogen projects with targeted investment sizes of \$10-\$20m
- ▶ INEOS follow-on to leverage larger deals

## SUNFIRE – SOLUTIONS ACROSS THE VALUE CHAIN

HydrogenOne’s first Private Equity Investment was made in Sunfire GmbH, where €24m (£20m) was committed for a minority equity stake, as part of a €109m fundraising round led by Lightrock and Planet First Partners and including Carbon Direct Capital Management and existing shareholders. Sunfire is a leading manufacturer of alkaline and solid oxide electrolyzers, which can be deployed to manufacture green hydrogen addressing what we see as a [6.5TW opportunity globally by 2050](#). Sunfire operates across the hydrogen value chain, also producing fuel cell solutions for off-grid power and heating markets. We view Sunfire’s portfolio of solutions across fuel cell and electrolyser technology addressing multiple applications, including the production of e-Fuels, as a strong offering. Importantly, this also presents various ways for HydrogenOne to create value upon exit.

Founded in 2010, Sunfire is a manufacturer of industrial electrolyzers and solid oxide fuel cell solutions. Sunfire employs more than 270 people and in Germany, Norway and Switzerland. Sunfire manufactures its SOEC electrolyzers in Germany, including the cells, stacks and systems, where it has a 7MW per year capacity. Its alkaline electrolyser stacks are manufactured in Switzerland, where it has a further 40MW per year capacity. Its fuel cell systems are manufactured in its Neubrandenburg facility where it can produce 1200 systems per year. Each facility also has a dedicated R&D centre.

Dresden, Germany (HQ)



Monthey, Switzerland



Neubrandenburg, Germany



Source Company

Sunfire’s electrolyser portfolio covers Solid Oxide (SOEC) and Alkaline technologies, which can produce renewable hydrogen or syngas, enabling the transformation of carbon-intensive industries that are currently dependent on oil, gas or coal.

### Alkaline & SOEC electrolyzers



Source Company

Sunfire has an established Alkaline electrolyser technology that has a demonstrated system runtime of over 30 years and benefits from competitive pricing and pressurised hydrogen production without extra investment into compressors. Its innovative SOEC electrolyzers offer high-efficiency (84%) steam electrolysis with a low-capacity need of renewable electricity but can also enable co-electrolysis of steam and carbon dioxide to syngas to produce e-Fuels and chemical products, offering an efficient solution for every industrial hydrogen application.

Established – Sunfire-HyLink (Alkaline)



Source Company

Importantly, Sunfire’s SOEC electrolyzers have been validated by the likes of Boeing (Gen 0), Total (Gen 1) and Neste (Gen 2). Sunfire has now been involved with over 70 projects across 24 countries installing over 250MW of capacity. Crucially, several current projects, such as GrInHy2.0, MultitPLHY and Demo4Grid, have already received EU funding.

Sunfire operates across the hydrogen value chain and, in addition to electrolyzers offering solutions to produce green hydrogen and e-Fuels, offers two solid oxide fuel cell solutions, targeting remote and domestic CHP applications, ranging from 350W to 1250W.

Sunfire-Remote (350W-850W)



Sunfire-Home (750W-1250W)



Source Company

Sunfire was a one of the pipeline investments HydrogenOne identified pre-IPO and aligns with the strategy to invest material positions in companies that are pivotal to the increased production of clean hydrogen. Sunfire is one of a handful of leading electrolyser suppliers focusing on providing solutions to enable the production of clean hydrogen, in a market that is poised for significant growth in the coming years.

The €109m raised will enable Sunfire to industrialise its two principal electrolysis technologies and building the first in a series of production gigafactories, aimed at creating meaningful electrolysis capacity. The final investment decision should be made upon completion of site selection and is subject to obtaining the necessary financing, including those requested within the IPCEI framework.

This is a similar approach to the four listed pureplay electrolyser companies of ITM Power, NEL, McPhy and Green Hydrogen Systems, that have each raised significant capital over the last 12 months to build out capacity. On average over the last two years, the listed European electrolyser pureplays have increased 5x and now represent a total market capitalisation of \$7.7bn.

We view Sunfire’s portfolio of solutions across fuel cell and electrolyser technology addressing multiple applications, including the production of e-Fuels, as a strong offering. Importantly, this also presents various ways for HydrogenOne to create value upon exit.

## HiiROC – INNOVATIVE TURQUOISE HYDROGEN TECHNOLOGY

HydrogenOne's second PE investment was made into HiiROC, a technology company established in 2019 to develop and commercialise its plasma torch technology in the production of turquoise hydrogen, where £10m was committed as part of a £26m fundraising round. HiiROC's technology enables the low-cost, zero emission production of hydrogen from biomethane, methane and other hydrocarbons through thermal plasma electrolysis and can be located at the point of demand thereby avoiding transport costs and enabling the use of existing infrastructure. The importance of deploying appropriate, cost-effective hydrogen technology to maximise decarbonisation as quickly and efficiently as possible has accelerated and so we view HydrogenOne's exposure to another clean hydrogen production technology as positive.

On Monday 29th November, HydrogenOne announced that it had signed definitive agreements for a PE investment of £10m in HiiROC Limited (HiiROC), an innovative supplier of clean (turquoise) hydrogen production technology. HiiROC employs around 40 people with its development centre located in Hull, UK. HydrogenOne's investment formed part of a c£26m fundraising round, introducing other new investors including Melrose Industries, Centrica, Hyundai and Kia, alongside existing strategic investors Wintershall Dea and VNG. HydrogenOne also has the right to a board seat at HiiROC.

HiiROC's proven technology converts biomethane, natural gas or methane and into clean hydrogen and carbon black, through a proprietary electrolysis process using thermal plasma. This results in zero CO<sub>2</sub> hydrogen production, known as "turquoise hydrogen" (see more on page X), at a cost comparable to the predominant, but high-emission steam methane reforming (SMR) process, and only using only one fifth of the energy required by water electrolysis.

### Solution benefits

Category	Description
Environmental	No emissions / CO <sub>2</sub> – only hydrogen and carbon black
Economical	Same cost as SMR, lower cost than electrolysis and low capex
Efficiency	No transport, storage & compression costs via onsite production at 50 bar
Scalability	A single 400 kg/day modular unit to industrial scale production
Technology	Higher temperature, pressure & efficiency resolves carbon 'condensation' and provides operating longevity

*Source Company, Panmure Gordon*

The solid carbon byproduct, carbon black, also has its own applications, with these ranging from tyres, building materials and as a soil enhancer. Carbon black is largely manufactured in an oil furnace process with high associated emissions. However, as the below table shows, its production using HiiROC's technology avoids the emissions and pollution inherent in the predominant manufacturing process.

### Emission comparison by production process

Substance	Oil Furnace Process	HiiROC Process	Emissions avoided per 1kt pa
CO <sub>2</sub>	2000kg/tonne	0	2000 tonnes
Carbon disulphide	30/kg/tonne	0	30 tonnes
Carbonyl sulphide	10kg/tonne	0	10 tonnes
Methane	25kg/tonne	0	25 tonnes
Acetylene	45kg/tonne	0	45 tonnes
Ethane/Other	2kg/tonne	0	2 tonnes

*Source Company, Panmure Gordon*



The HiiROC technology can be placed where hydrogen is needed, thereby using existing infrastructure and avoiding storage and transport costs. Plants can be small to industrial scale based on the modular core production unit which is compact, fitting within a ten-foot container and capable of producing up to 400kg of hydrogen per day alongside carbon black.

**HiiROC's Plasma Torch**



*Source Company*

HiiROC has strong growth potential in several hydrogen sectors including grid injection, electricity generation, decarbonising industry replacing natural gas, flare mitigation and synthetic aviation fuel production. HiiROC investors Wintershall Dea and VNG have recently announced a 400kg/day hydrogen facility in Germany using HiiROC technology, due to be operational in 2023. Other projects include EPI's biomethane pilot plant in Chelmsford and with Northern Gas Networks as part of its hydrogen programme.

HiiROC is currently completing development work with first production units to be launched in 2022. The funding will be used to expand the deployment of pilot units to more customer segments, positioning the technology for future roll-out and accelerate HiiROC's technical development.

**Turquoise hydrogen – a brief teach-in...**

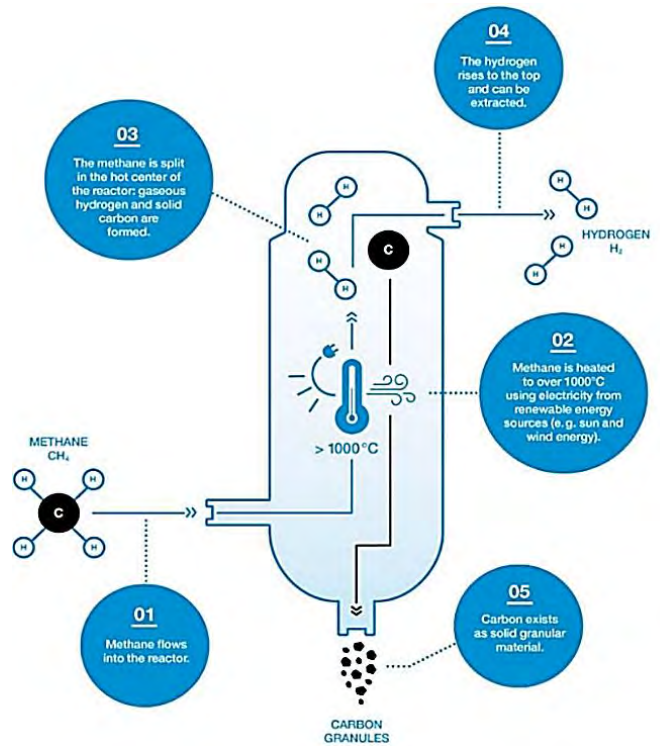
**Turquoise** hydrogen is a type of clean hydrogen alternative that in many ways sits between **blue** (SMR combined with Carbon Capture and Storage (CCS)) and **green** (electrolysis using 100% renewable electricity) hydrogen, hence the **turquoise** colour association.

It is produced via the method of ‘methane pyrolysis’ (aka methane cracking) and like **grey** and **blue** hydrogen uses methane as a feedstock, but the process is driven by heat produced with electricity rather than through the combustion of fossil fuels. Methane is heated to high temperature in a reactor or chamber using electricity, as shown opposite in the BASF example. Methane pyrolysis is a potential tool to help improve the cost-efficiency of decarbonised hydrogen with molecules being deployed strategically where efficient.

It is a fundamentally new process technology that like **blue hydrogen** splits natural gas or biomethane directly into the components of hydrogen and solid carbon, requiring relatively little energy. However, unlike blue hydrogen production, the carbon is in solid form rather than a gas. As a result, there is no requirement for CCS and the carbon can be used in other applications, such as a soil improver or the manufacture of tyres.

Where the electricity driving the pyrolysis is renewable, like **green hydrogen**, the process is zero-carbon, or even carbon negative if the feedstock is biomethane rather than fossil methane (natural gas).

**Illustrative BASF Methane pyrolysis Process**



**Basic definitions:** **Green hydrogen** uses electricity to split water (H<sub>2</sub>O) through electrolysis. **Turquoise hydrogen** uses electricity to split methane (CH<sub>4</sub>) via methane pyrolysis. **Blue hydrogen** uses SMR to split natural gas (CH<sub>4</sub>) and CCS to store the carbon dioxide. **Grey hydrogen** uses SMR to split natural gas (CH<sub>4</sub>).

**Q: Why is methane pyrolysis less energy intensive to split methane than electrolysis is to split water?**

**A:** One of the most referenced advantages of turquoise hydrogen is the reduced electricity requirement, where 10-20kWh is needed versus 60kWh for electrolysis per kg of hydrogen.

The main reason is that the molecular bonds holding together the carbon atoms and the hydrogen atoms in methane are more easily broken than the bonds between hydrogen and oxygen in water.

**Q: What is the technological readiness of methane pyrolysis versus electrolyzers?**

**A:** Electrolysis is more developed than pyrolysis (IEA technology readiness level 6 vs 8/9). Nevertheless, pyrolysis is reaching commercial scale this year with projects under commission that will come online in 2022 (Monolith Materials in the US).

The most advanced method of methane pyrolysis and the route with most advantages is thermal plasma, which is currently at a technology readiness level (TRL) of 8 i.e. a system is complete and qualified but not yet proven in an operational environment. BASF has also been developing methane pyrolysis technology since 2019, which is currently under development in pilot scale (TRL 5).

**Q: What is the OPEX cost of methane pyrolysis vs electrolysis?**

**A:** At a commercial scale pyrolysis can be more cost-effective than electrolysis. However, in terms of the relative allocation of costs, pyrolysis has relatively higher OPEX compared to electrolysis, but considerably lower CAPEX. The costs for all technologies will come down with scale.

Moreover, pyrolysis has the byproduct of solid carbon (carbon black), which itself has a market. The excess heat produced could also have other applications and further improve the cost effectiveness of the process.

**Q: What are the relative emissions of methane pyrolysis compared to electrolysis?**

**A:** Pyrolysis may have higher emissions in the full lifecycle due to possible methane leaks, but these can be avoided with the appropriate infrastructure and effective leak detection and repair.

Moreover, it is often argued that the manufacturing of infrastructure for electrolysis has significant associated emissions and requires the use of scarce resources. As such, full lifecycle assessment, as opposed to just the production process itself, is becoming of increasing focus when making a technology comparison.

## NANOSUN – PIONEERING HYDROGEN REFUELLING

HydrogenOne's third PE investment has most recently been made into NanoSUN, a developer of hydrogen distribution and mobile refuelling equipment based in Lancaster, UK, where £9m was committed as part of a £12m funding round. NanoSUN is aiming to accelerate hydrogen use with its innovative technologies by bridging the gap between the hydrogen supply industry and the needs of hydrogen users for convenient, low cost, simple-to-use and safe hydrogen refuelling stations (HRS). NanoSUN's Pioneer HRS offers a low-cost solution to costly fixed HRS, helping fleet operators to introduce and grow their hydrogen vehicle fleets in a cost-efficient manner. Centralised hydrogen production at scale is increasingly recognised as a key to reducing costs and importantly NanoSUN's Pioneer HRS unlocks the full value of this cost benefit by eliminating duplication of costly machinery at the refuelling point.

On Monday 6<sup>th</sup> December, HydrogenOne signed definitive agreements for a PE investment of £9.05m in NanoSUN Limited (NanoSUN), a supplier of mobile hydrogen storage and HRS to hydrogen consumers. HydrogenOne's investment formed part of a £12m fundraising round, introducing other new investors including strategic investor Westfalen Group, of Germany. With this minority equity stake, HydrogenOne also has the right to a board seat at NanoSUN.

Hydrogen as a vehicle fuel has a chicken and egg adoption problem. Vehicle manufacturers cannot sell hydrogen vehicles without an adequate refuelling infrastructure, but similarly infrastructure and fixed fuel network providers cannot recover their investment if utilisation rates are low i.e. not enough vehicles are using hydrogen. Furthermore, a fixed HRS is expensive costing around £2-3m, requires planning and permitting and can be unreliable to operate.

NanoSUN's innovative mobile Pioneer HRS provides a flexible and low-cost connection between hydrogen customers such as truck stops and concentrated hydrogen supply sources. The Pioneer units are filled with hydrogen at source and transported to customer sites, where they provide storage and refuelling facilities, in a single, refillable system. The offering to customers is more flexible and lowers structural costs by around 60% versus traditional systems, by combining distribution and dispensing equipment into a single unit.

NanoSUN's competitive edge centres around the Flexible Cascade technology. A unique and low-cost cascade dispenser is integrated within each unit, which allows the refuelling unit to work with few moving parts; no compressor, no rotating machines and no pumps. Fixed HRS tend to have many moving parts, which often break down with no back-up. Importantly, NanoSUN has several patent claims centred around the Flexible Cascade technology, with four patents filed and two more due. The future product pipeline includes higher pressure and capacity units allowing for fast-fill, catering for larger fleets and multiple users, which are due for deployment in 2023/24.

### Decant vs Pioneer Cascade Technology

There are typically two ways to transfer hydrogen gas from one receptacle to another without using a compressor: decant or cascade technology. Both methods use the pressure gradient between a higher-pressure source and the low-pressure target tank to move hydrogen fuel without any external energy requirements.

**Decant Technology:** A decant system takes a high-pressure system of a certain volume and is connected to the target system also at a certain volume and at a lower pressure. The systems are opened to one another and the hydrogen flows from high pressure to low pressure. This movement of gas stops when both systems have reached the same pressure. This is known as equalisation.

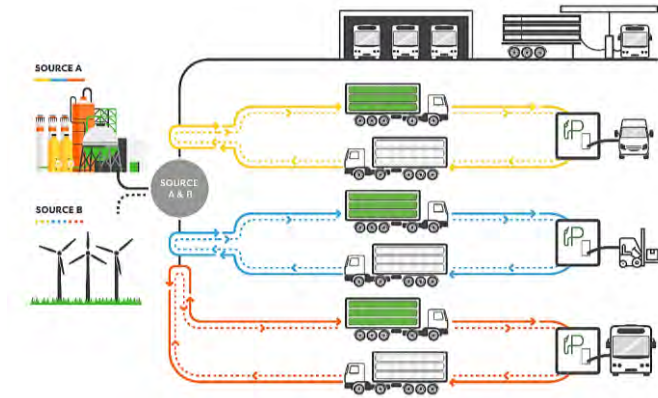
**Pioneer Cascade Technology:** The Pioneer HRS uses cascading refuelling, which is essentially an automated sequence of individual decants. This technique enables the filling of significantly more vehicle tanks to higher fill pressures & greater hydrogen utilisation from the refueller than through simple decant filling. A cascade filling system is a multi-bank high-pressure gas cylinder storage system which is used for the refilling of smaller compressed gas cylinders.

For logistic vehicle fleet owners looking to introduce a hydrogen vehicle fleet to the transport market, the high capital expenditure (capex) of a fixed HRS is an expensive factor when looking to get a fleet network up and running, particularly in low-margin logistical operations. NanoSUN’s Pioneer HRS enables capex on a fixed HRS to be postponed until such a time that it may become economically viable. This presents an appropriate economic hydrogen refuelling solution until a vehicle fleet reaches such scale that a fixed HRS is needed and without changing the fleet owner’s existing operating model. Furthermore, as a customer’s hydrogen vehicle fleet grows and further points of use are required, additional Pioneer stations can then be added due to its scalability.

As the below left-hand-side graphic shows, a larger fleet of Pioneers improves resilience in the network as stations can back each other up and the fixed hydrogen infrastructure itself during any periods of downtime. This growth continues until the point, where for some larger fleets or multi-user stations, investment in a fixed HRS becomes justified. The Pioneer HRS can then continue to serve the fixed station as a distribution asset with a high-pressure cascade built in, or it can simply be redeployed to serve other points of use and replaced by a conventional hydrogen tube trailer supply or on-site electrolyser.

NanoSUN’s Pioneer deployed at scale

NanoSUN’s Pioneer HRS on the road



Source Company

This year, in collaboration with INEOS, Wrightbus and RYZE Hydrogen, Pioneer delivered hydrogen refuelling to the world’s first hydrogen double-deck bus developed by Wrightbus, alongside further refuelling roadshows in other parts of Scotland and Germany. These demonstrations illustrated the flexible multi-role nature of the Pioneer and its significant role in providing volume hydrogen storage, hydrogen transportation and hydrogen dispensing in a single easy-to-use package.

NanoSUN has identified substantial demand for the Pioneer product and intends to use the proceeds of the fundraise to increase its manufacturing capacity whilst continuing to develop larger units. Indeed, the fundraise is about scaling NanoSUN so it can help its customers accelerate the roll out of fleets of hydrogen buses, trucks, vans and forklifts in the thousands over the coming years.

Importantly, HydrogenOne’s investment supports its strategy set out at IPO of investing in companies central to the growth of clean hydrogen production with NanoSUN’s refuelling equipment likely to be integral in the downstream hydrogen sector.

## THE PUBLIC PIECE

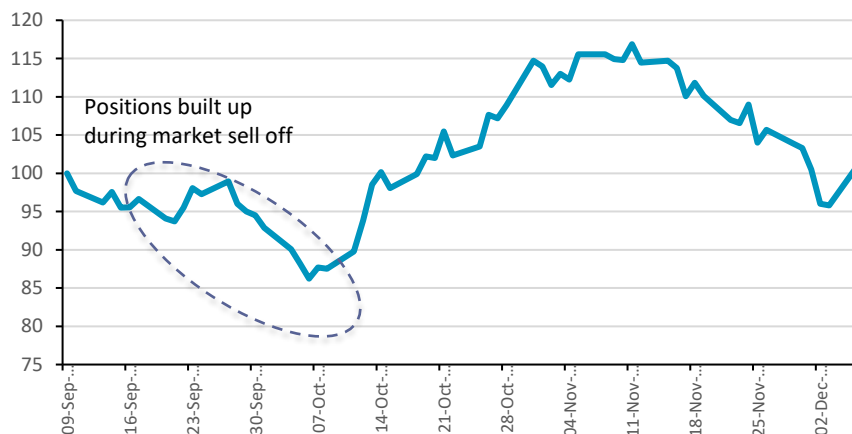
HydrogenOne has invested 9% of its IPO proceeds into listed Hydrogen equities meeting its target allocation as set out in the investment prospectus. Portfolio composition is heavily weighted to European listed stocks and those with a market capitalisation over \$1bn. Importantly, the average 2-year revenue CAGR for the portfolio is 119%.

Listed stock selection has been based on the following criteria:

- ▶ Minimum market capitalisation of US\$200m but with a preference for at least a US\$1bn
- ▶ Preference for companies with current revenues and rapid revenue growth plans
- ▶ Preference for manufacturers with systems integration capability
- ▶ Strong intellectual property and licensing/contracted manufacturing strategies

During September and into October, the global Hydrogen and Fuel Cell sector was under increasing pressure with average share price performance of -6% reflecting the reality that despite the positive rhetoric of global policymakers there was a lack of tangible support, which continued to weigh on sentiment. As the below chart shows, trading into the public piece was timed well with positions being taken during the market sell off in early September and prior to the subsequent rally that began mid-October.

### Listed Portfolio Performance (rebased)



Source Refinitiv, Panmure Gordon

Portfolio composition is heavily weighted to European listed stocks, perhaps unsurprisingly given the number of pureplay manufacturers, particularly in the electrolyser segment. In terms of market capitalisation, all companies exceed the minimum threshold of \$200m, with a majority (53%) over the preferred \$1bn hurdle. Only a minority are currently pre-revenue, with expected revenues forecast in the next financial year. Importantly, the average 2-year revenue compound annual growth rate (CAGR) for the portfolio is 119%.

### Portfolio composition by market capitalisation and region (%)



Source Refinitiv, Panmure Gordon

## PERFORMANCE AND DISCOUNT

Given the fund has to date only been invested in public equities (until the PE investment into Sunfire in October) this has been the main driver of performance. Since listing HydrogenOne has traded at a healthy average premium of 13.5%, reflecting an average performance of the public portfolio of 9%. Performance of the sector has been supported by the European gas crisis at the end of October and more newsflow ahead of COP26. More importantly, corporate activity and investment continued apace. In October, Plug Power in the US announced a string of new partnerships, acquisition and an aggressive sales target of \$30bn by 2030 and ITM Power in the UK successfully completed a £250m fundraise to accelerate the scale-up of its electrolyser capacity to 5GW by 2024, which highlights the longer-term growth potential of the sector and the capital required to scale. This translated into continuing demand and support from institutional investors for access to the sector, which has in turn supported share prices.

An important event for the Hydrogen and Fuel Cell sector was the European energy crisis that started in October, which served as another wakeup call for policymakers to not only intervene more aggressively in energy markets to meet climate change agendas but also to ensure security of supply and reduce the over-reliance on imports. Indeed, what the crisis showed specifically is that fossil fuels remain inherently subject to extreme price fluctuations, which has proven less of an issue for countries with a lower share of gas in the power mix. Conversely, those with low renewable output particularly exposed to international gas prices suffered a shortage in supply and abnormally high prices.

The crisis highlighted the need for more decisive action in shifting energy systems towards more competitive renewable power coupled with flexible storage technologies to deal with intermittency problems, where green hydrogen and Power-to-Gas (PtG) can play a significant role in ensuring demand is met at the lowest cost. PtG can meet the demand for long-term, large-scale energy storage, converting surplus renewable energy into hydrogen gas by rapid response electrolysis and subsequently injecting it into the gas distribution network.

Unsurprisingly, following the crisis there has been more pressure from industry for accelerated investment in renewables and electrification but also green hydrogen production. Ultimately, having a more flexible energy system depends on the level of storage, interconnection and demand management to make best use of renewable resources and break the link between gas and power prices.

### Natural gas prices in European markets since April (Dutch TTF)



Source Intercontinental Exchange, Inc. (ICE)

There has also been plenty of company-specific positive news across the sector. US listed Plug Power (PLUG) continues to invest heavily in building a green hydrogen ecosystem through a national network of plants in the US that will supply 500 tons per day of liquid green hydrogen by 2025 and 1,000 tons per day globally by 2028.

In September, PLUG announced it is expanding its ecosystem with the construction of a new production facility in California. It will be the largest green hydrogen production facility on the west coast, producing more than 30 metric tons of liquid green hydrogen daily. The facility will use a new 300MW zero-carbon solar farm to power 120MW of PLUG’s PEM electrolyzers. Pending environmental and construction permitting approvals, the plant will complete commissioning in early 2024.

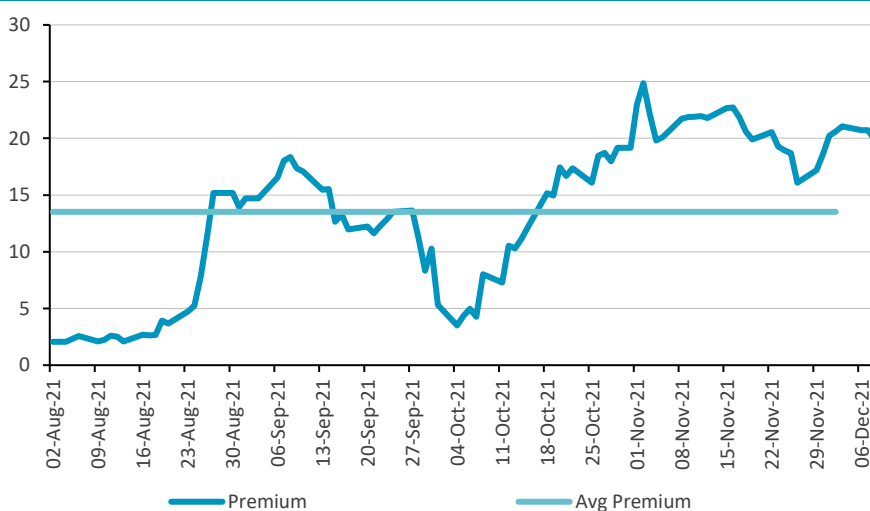
At its annual conference in October, PLUG also announced a string of new partnerships and a major acquisition driven by the company’s ambition to produce 500 tons of liquid green hydrogen in the US per day by 2025 and establish 13 green hydrogen plants by the end of 2025. Perhaps more telling for the longer-term growth potential of the sector, PLUG also established long-term guidance of \$3bn in annual sales by 2025, with 65% growth expected in the next year alone. This came ahead of extra help from Congress, where the proposed bipartisan infrastructure bill calls for an \$8bn investment to establish at least four regional clean hydrogen hubs and \$1bn in grants to improve electrolyzers for efficiency and cost.

Towards the end of October and into November PLUG also announced further partnerships with the likes of Acciona Energía and Lhyfe to address and develop green hydrogen markets across Europe, with the latter aiming to generate 300MW of total hydrogen capacity by 2025 and develop a 1GW production site.

Hot on Plug Power’s heels for the limelight in October was UK listed ITM Power that announced a £250m fundraise to fast-track its expansion plans despite having £170m of cash already on its balance sheet, following a significant equity raise in October of last year. The company cited the acceleration in demand for large scale green hydrogen projects, where 140GW is needed by 2030. The company pointed to around £210m being used to support the semi-automation of the newly opened Gigafactory Bessemer Park, the development and full automation of a 2nd Gigafactory in the UK and a new international factory with an aim to reach 5GW of annual manufacturing capacity by 2024. The fundraise was supported by strategic shareholder and EPC (engineering, procurement and construction) partner Linde for a subscription of £20m.

These announcements highlight the longer-term growth potential of the sector and the capital required to scale, which has translated into continuing demand and support from institutional investors for access to the sector, which has in turn largely supported share prices. Given the fund has to date only been invested in public equities this has been the main driver of fund performance. Since listing HydrogenOne has traded at a healthy average premium of 13.5%, reflecting an average performance of the public portfolio of 9%.

Premium since admission (%)



Source Morningstar, Panmure Gordon

## PROJECT SELECTION ON TRACK

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**HydrogenOne is targeting 90% of fund allocation across private companies and projects with an expected position of up to four project holdings subject to availability of funds. Project selection is on track with HydrogenOne's technical adviser ARUP providing due diligence, project monitoring and support, leveraging its 70 years of expertise in challenging design and engineering projects. A total of 730 projects initially identified have now been shortlisted to around 40 based on HydrogenOne's primary investment objectives with the first investment expected to take place in FY22, with all project investments onstream by FY24.**

HydrogenOne's primary investment objectives were projects:

- ▶ Commencing development between 2021 and 2025, with a clear date for FID (final investment decision) and commencement of production
- ▶ Post pilot stage with commercial development supplying hydrogen of 20MW to 1GW
- ▶ Where the proposed technology already in wide commercial operation (TRL 8-9)
- ▶ With zero scope 1 emissions
- ▶ Located within Europe, North America, the GCC or Asia Pacific

The shortlisted projects will now go through a rigorous process of grading according to HydrogenOne's preferred criteria to:

- ▶ Minimise operating and construction risk and maximise project and technology credibility
- ▶ Identify projects with strong exit potential through their ability to scale

These projects are greenfield clean hydrogen supply opportunities in green hydrogen. It is expected that the customers for the hydrogen from these projects are existing large industrial off-takers of hydrogen used in manufacturing processes and new off-takers for clean hydrogen in heavy transport sectors. It is expected that each of the target projects will have strong growth potential, beyond the initial capacity, with off-takers expected from blending the hydrogen produced with existing natural gas grids and expansion of other clean hydrogen applications.

With Europe alone aiming to have 40GW of largely green hydrogen capacity by 2030 and an estimated €470bn (£400bn) of public and private investment in the sector expected by 2050, there is plenty to go for. Indeed, most of the hydrogen projects within the Illustrative Portfolio as per the investment prospectus were in Europe, reflecting the fact that Europe is one of the most advanced regions in the world for commercialisation and development of green and blue hydrogen supply projects. The managers still believe that Europe will continue to be a productive region for green hydrogen production projects with North America and Australia key regions for future developments.

We expect the investment potential in this portion of the portfolio to be significant as the requirement for increased scale and capacity grows in line with targets. For example, there is currently a large shortfall between the EU's 2030 target of 40GW of installed capacity and the 22GW of announced proposals. The time horizon gives plenty of scope for an acceleration in project developments in the meantime and with financing key at this early stage of market development and many projects focused on clearing state aid hurdles to access funding, we see substantial opportunity for HydrogenOne to play an increasingly important lead role being one of Europe's prominent funds in the space. The launch of new hydrogen infrastructure funds like that managed by Hy24, a new 50/50 joint venture between private investment house Ardian and Five T Hydrogen and led by a consortium of hydrogen heavyweights including Air Liquide, TotalEnergies and VINCI, which is aiming to raise €1.5bn to support project development, shows the demand here.



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