ALIGN
RESEARCH

PowerHouse Energy

20th November 2018

Pioneering waste-to-hydrogen tech provider now on the cusp of commercialisation & creating significant shareholder value

PowerHouse Energy (PHE) is an AIM listed company which is pioneering waste-to-hydrogen technology via its proprietary Distributed Modular Gasification (DMG®) process.

Revolutionary waste-to-hydrogen technology

PowerHouse's proprietary Distributed Modular Gasification (DMG®) process can convert high calorific value waste material such as tyres and plastic into a clean Ecosynthesis© gas. This "syngas" contains a high percentage of hydrogen that can be cleaned up to 99.999% purity using off-the-shelf technology to produce a road quality hydrogen fuel. DMG allows for distributed electrical generation, distributed waste elimination, and distributed hydrogen production allowing each to be used at the point of engagement.

Significant technical and commercial progress made

PowerHouse has been operating a process demonstration unit at the Thornton Science Park, Chester, since May 2017. A string of positive announcements have been made since then, culminating last month in the successful independent assessment of the feasibility of its Commercial Design by industry-leading technology assurance group, DNV-GL. . Powerhouse has also made significant commercial progress over the course of 2017 and 2018, including a Heads of Terms agreement with Peel Environmental to locate an initial commercial DMG® System. The Company is in late stage discussions with 6 additional potential customers at which an early DMG® System may be deployed, as well as commercial discussions with multi-national transportation providers in Japan.

Market drivers put the company in a sweet spot

PowerHouse's technology has the potential to solve increasing issues associated with global waste management, to take advantage of higher demand for clean "green" power generation and to supply a growing worldwide demand for road quality hydrogen fuel.

DCF valuation suggests significant upside potential

Our DCF analysis suggests an NPV(20) of £47.4 million, or 2.45p per share, some 6 times the current share price. However, we use very conservative assumptions in our model and see significant further potential upside. **We re-initiate coverage of PowerHouse Energy with a Conviction Buy stance.**

This investment may not be suitable for your personal circumstances. If you are in any doubt as to its suitability you should seek professional advice. This note does not constitute advice and your capital is at risk. This is a marketing communication and cannot be considered independent research.

CONVICTION BUY
Target price – 2.45p

POWERHOUSE ENERGY GROUP

Key data

EPIC	PHE
Share price	0.38p
52 week high/low	0.825p/0.285p
Listing	AIM
Shares in issue	1,716,431,621
Market Cap	£6.5m
Sector	Energy

12 month share price chart

Analyst details
Richard Gill, CFA
richard.gill@alignresearch.co.uk

IMPORTANT: PowerHouse Energy is a research client of Align Research. Align Research owns shares in PowerHouse Energy. For full disclaimer & risk warning information please refer to the last page of this document.

Corporate Background

PowerHouse Energy (PHE) is an AIM listed company which is pioneering waste-to-hydrogen technology via its proprietary Distributed Modular Gasification (DMG®) process. The company was founded in 2002 in California, initially focusing on the design, procurement, installation and commissioning of conventional onsite power generating systems that yielded environmentally responsible savings. However, in August 2010 the 30% acquisition of Pyromex, which was subsequently fully acquired three years later, brought with it the foundations of an ultra-high temperature gasification reactor technology. PowerHouse listed on AIM in June 2011 via the reverse takeover of Bidtimes.

Learning from experience to develop an industry gold standard waste-to-hydrogen system

PowerHouse acquired Pyromex as it saw it's concept as a potentially ground-breaking technology. However, the company discovered after significant time, monetary and operational efforts that, while the concept was revolutionary for distributed power and waste destruction, the then existing technology was inherently flawed, its execution was fundamentally poor and it was unable to be commercialised in its existing state.

In early 2015 PowerHouse made the decision to abandon further investment into, and development of Pyromex, close its operations in Germany and Switzerland, and focus on the development, from first principles, of its own in-house proprietary System for ultra-high temperature (UHt) gasification with a new team, based on a new approach.

A project commenced to develop the system from the ground up, incorporating PowerHouse's own technology and know-how, while taking into account the valuable experience it had previously gained with other mid-to high temperature and direct and indirect heating technologies. . The project encompassed the modular concept of the original system but completely re-engineered it to develop a more robust and reliable technology based on the latest developments in ultra-high temperature gasification and expanding knowledge of pyrolysis which allowed the incorporation of significant improvements in material sciences and increased electrical efficiencies.

During 2016 PowerHouse completed the development of its G3-UHt unit, the core of its DMG® System, and undertook initial testing in Brisbane, Australia, alongside development consultants OrePro, a company focused on ultra-high temperature microwave kiln development which was associated with the Company's previous financier, Hillgrove Investments.

The DMG® System provides a truly modular, scaleable, and robust commercial platform for the safe destruction of waste, and the extremely efficient extraction of energy from that waste. It is PowerHouse's belief that DMG® represents a sea-change in the approach to waste management as well as the delivery of distributed energy in the form of both electricity and hydrogen gas – in a manner that it substantively more cost effective when the costs of distribution and the greenhouse gas footprints of other systems are fully calculated.

Over the past c.18 months the operational and engineering focus has shifted back to the UK, a country where PowerHouse sees substantial demand for its technology. Here, the firm has set up a base from which to continue technological development and the commercialisation of the DMG® process, developing sales both nationally and overseas. **PowerHouse is now at the point where its DMG® technology is nearing the end of the commercial engineering design stage and on the cusp of maiden revenue generation. While a number of potential revenue streams have been identified, the key long-term focus is on the licensing of the Company's proprietary technology for the production of distributed "private wire" electrical generation, as well as the production of hydrogen for use as a road fuel and in stationary hydrogen fuel cells applications.**

Operations

PowerHouse Energy has developed a proprietary technology known as DMG® (Distributed Modular Gasification) which it believes, *"has the potential to be one of the most robust, cost-effective, operationally efficient, and flexible gasification systems on the market."* It is a highly effective mechanism for the eradication of waste and the creation of energy and hydrogen, being able to turn plastic, end-of-life-tyres and other waste streams, into ultra-high quality hydrogen gas and provide distributed electrical generation. **A single DMG® plant with the capacity to process 25 tonnes of waste per day (the nominal through-put of the first commercial design) is able to generate in excess of 1 tonne of road-fuel quality hydrogen, and more than 28MW/h of exportable electricity per day. It can achieve this out-put on less than 1 acre of land. In fact, when co-located with an operational waste facility, the DMG® System is likely to take up less than one-half, or one third, of an acre of land.**

POWERHOUSE ENERGYGROUP

PowerHouse has built and has been operating a nominal 1-3 tonne per day demonstration unit (the G3-UHt Process Demonstrator), at the University of Chester, Thornton Science Park, Energy Centre, since May 2017. The company has secured a two year lease of a purpose built emission laboratory and offices at the site which provide testing capabilities and a base to showcase the technology to potential commercial partners, investors and the public. Engineering firm, Engsolve Ltd, was appointed to assist in both the recommissioning and the complete and thorough engineering validation of the unit's capabilities.

Distributed Modular Gasification (DMG®)

The G3-UHt unit incorporates PowerHouse's proprietary DMG®® technology. Put simply, the unit works by using a gasification reactor to convert waste materials such as tyres, non-recyclable plastic, biomass, and other waste streams, into a high-quality, clean, synthesis gas, or "syngas". PowerHouse has branded the syngas produced from its own unit as EcoSynthesis® gas. Syngas is a mixture of carbon monoxide, carbon dioxide, hydrogen and small amounts of methane (dependent on the feedstock used) that can be produced via the gasification of a range of different carbon containing waste materials such as tyres, plastics, biomass and municipal waste. It can then be used for electrical power generation and to create high-quality hydrogen for use in fuel cells.

The ultra-high temperature gasification method used by PowerHouse sees carbon containing materials converted (effectively 'de-molecularised' and subsequently reconstituted) into the previously mentioned gasses by being reacted at temperatures of c.1,200 °C in an oxygen free environment. The G3-UHt reactor is made of an advanced material rated to +1,700°C and is impervious to the corrosive effects of some of the interim components of gasification. When an appropriate feedstock is introduced to the system it almost instantly reduces (or gasifies) to a combustible gas and a minor amount of hazard-free, non-leachable inorganic residue. With no combustion taking place, no smoke stack is required. **As the process occurs in a highly controlled environment, with high temperature steam acting as the oxidant, it produces negligible carbon dioxide emissions.**

The DMG® technology can use a range of waste types by siting a unit where the waste is actually located (co-location), thus removing the need to transport it over long distances to either a processing plant or to landfill. It is designed to completely decompose the complex molecules in the waste-stream and is able to capture the vast majority (90%+) of the waste's contained energy, or calorific value, in the derived synthesis gas**.**

Modular system, distributed production

While the current G3-UHt demonstration unit is small in scale, its design allows simple expansion via a modular approach for the distributed production of electricity and hydrogen, effectively interlocking and using both front-end and back-end plant components. "Distributed production" refers to hydrogen being produced in generally small units at the location where it is needed, (for example at a transport fleet depot) thus eliminating the need for, and the costs associated with, transportation. This is in contrast to centralised production where typically large units require a delivery infrastructure to get the hydrogen to its users – thus incurring further costs.

Being produced on site also eliminates losses during transmission should the fuel be used for on-site power generation as it is made and delivered exactly where it is needed. **This is a significant factor, with current "grid-losses" in the UK estimated by the National Grid to be 7.4% per annum, equating to around 26TW/h of power lost during transmission and distribution.**

Focus on high quality hydrogen and other revenue streams

Typically, syngas is 30 to 60% carbon monoxide, 25 to 30% hydrogen, 0 to 5% methane and 5 to 15% carbon dioxide *(Source: U.S. Department of Energy).* The EcoSynthesis® gas produced by the G3-UHt system is primarily hydrogen, methane, carbon monoxide and a small amount of carbon dioxide, with trace contaminants that are removed through a simple cleaning process. **However, PowerHouse has demonstrated the ability to produce a *hydrogen rich* syngas by fine-tuning the gas composition during production.**

Four potential revenue streams have been identified for the operator of a commercial DMG® Unit – gate fees for taking waste, the sale of electricity, hot water/steam and hydrogen fuel. PHE's business model is built around the licensing of the company's proprietary DMG® technology process.

Overall, PowerHouse believes that its technology process is producing the cleanest syngas (EcoSynthesis© Gas) in a small, distributable 25 tpd model, with the ability to produce large quantities (1 tonne a day) of high grade, low carbon, low cost, distributed hydrogen for use in road fuel and hydrogen fuel cells and in excess of 28 MW/h of exportable electricity per day. Concurrently, the company will be able to produce adequate electricity to run the DMG® facility with the excess syngas from a 25 tpd processing unit, making the entire process self-sufficient. **The technology uses off-the-shelf components in its construction, with PowerHouse's intellectual property being within the specific processes that take place within, and the management of, the equipment to produce EcoSynthesis® gas - the company works closely with its Patent Attorneys to maximise the protection of its proprietary technology process.**

Simplified DMG® process

Step 1 - Material with high calorific values such as tyres, plastics, bio-mass, municipal solid waste, and hospital and hazardous waste, is shredded and then separated into recyclable materials and feedstock (i.e. the remainder of the carbonaceous waste stream not able to be recycled or composted)

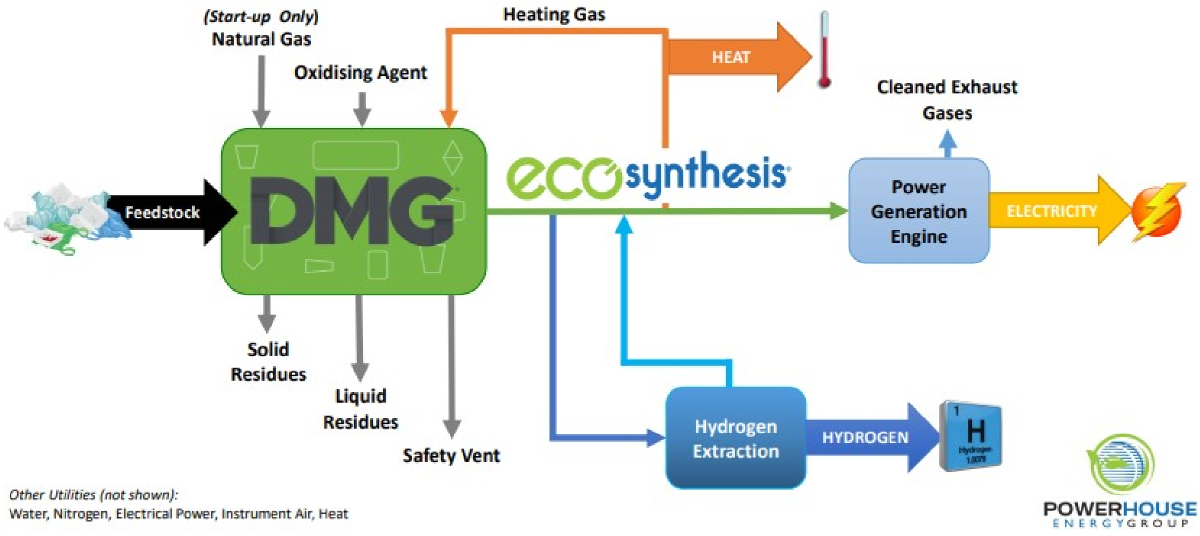
Step 2 - feedstock is passed through vacuum controlled feed bin system to remove any air.

Step 3 - air-free feedstock moves through the rotating ultra-high temperature thermal conversion chamber at atmospheric pressure in a non-combustive environment. The reactor, operating at above 1,200°C, breaks down the feedstock within seconds, converting it into Ecosynthesis gas.

Step 4 - The Ecosynthesis gas passes out of the reactor and any remaining solids, which are benign, are removed and disposed of according to local environmental compliance requirements.

Step 5 - This EcoSysthesis gas is then "scrubbed" twice by a shower of caustic liquid. This effectively washes the gas of any impurities.

Step 6 - The syngas can then be used to immediately generate electricity in a gas-powered turbine or the syngas may be separated into hydrogen, with the remaining carbon monoxide (a fuel) used to power the gas generator.



DMG® process – simplified flow diagram. Source: Company

Substantial Progress at Thornton Science Park & in Commercial Engineering

The process demonstration unit has seen significant progress since it was sited at the Thornton Science Park in May 2017, with PowerHouse having kept the markets up to date with a steady stream of positive announcements.

In July 2017, having successfully completed the rebuilding and initial enhancement of the G3-UHt unit, the company began extensive test engineering of native and mixed plastic feedstock in support of its commercial design effort. Within the first few weeks of testing the company recorded a maximum peak flow rate of over 50m³ per hour of syngas following commission testing using tyre crumb as the input feedstock. **The first extended technical trial was completed in August, and, again operating on a feedstock of tyre crumb, the syngas produced was greater than 50% hydrogen by volume, demonstrating the efficacy of the DMG® process. No carbon dioxide was measured and there were only small amounts of carbon monoxide and methane.**

October 2017 saw the company announce that, based upon independent third-party laboratory analysis by Linde BOC, several multi-national suppliers of hydrogen clean-up and purification equipment confirmed that their equipment would allow the DMG® system to achieve the delivery of 99.999% pure hydrogen. This level of purity is key in meeting the needs of fuel cell electric vehicles (FCEVs) – discussed in more detail on page 13.

Further, PowerHouse reached an initial agreement in principal, subject to minor engineering detail and finalisation of commercial arrangements, with one of the suppliers to provide its proprietary small-scale Pressure Swing Adsorption (PSA) equipment to separate and clean up the hydrogen within the syngas to road-fuel quality hydrogen. **This key milestone was a pre-requisite for PowerHouse to accelerate commercial discussions with industrial transportation and other hydrogen road-fuel users.**

In November 2017 the first major engineering design milestone was achieved with the completion of the pre-Front-end Engineering and Design (pre-FEED) stage. This validated the DMG® technology's ability to deliver commercial quantities of high-grade syngas for use as a fuel, for electrical production, and for the extraction of 99.999% road-fuel-quality hydrogen.

Another major announcement came in June 2018, with the demonstration plant connected to the Thornton Science Park microgrid for the first time, supplying it with electricity. This was a relatively simple operational process but being the first practical application of the technology goes to prove that PowerHouse is able to deliver clean energy to a customer, as it has been promising for several years. This step will further lead towards the production of mainstream commercial waste to hydrogen generation units

A month later the company confirmed that the latest performance and modelling data showed strong results in terms of outputs from a variety of feedstocks. The generic Front End Engineering Design (FEED) had been completed, allowing initial safety design reviews and independent third-party design reviews to be initiated on schedule.

Successful independent assessment

In October this year another major milestone was hit, with the DMG® process receiving an independent "Statement of Feasibility" from DNV GL, a global leader in technical assurance certification. This independent verification further reduces the technology risk associated with the company and goes to support its current commercialisation efforts. GNV is a well-respected services provider in the energy industry, providing testing and advisory services, including independent accredited certification services, to a range of renewables customers.

Following a review of the engineering design, test data, process modelling and the equipment engineering design required for the commercial application of the DMG® technology, which took several months to complete, the statement confirmed that DNV found no prohibitive obstacles under its Technology Qualification process RP-A203. According to DNV, the RP-A203 process aims to provide a systematic approach to technology qualification and ensure that failure modes and the qualification activities are relevant and complete. This should improve confidence in novel technology, improve the likelihood of its commercialisation and underpin its business case.

Highlights of the Statement of Feasibility include:

"The PowerHouse Energy Group's DMG® Waste-to-Energy technology can convert 25 tonnes per day of feedstock comprising high calorific value waste materials."

"The produced energy-rich syngas can be combusted to produce power for distributed electrical generation. The DMG® technology allows for integrating a process for the co-production of high purity hydrogen (1 tonne per day) from a proportion of the syngas in addition to generating power."

The benefits of the DMG® process listed include: waste elimination with high levels of energy recovery, production of electrical power for distribution and the ability to co-produce high purity hydrogen with electrical power. The statement also confirms that the modular design of the DMG® process complies with all current regulations and statutory requirements and also with availability and operational demands.

This was Phase One of the RP-A203 Technology Qualification process and PHE will continue to work with DNV GL to finalise the full Technology Qualification with its first commercial site.

G3-UHt Ultra High Temperature Gasification Waste-to-Energy system. Source: Company

Key Commercial Partnerships & Agreements

Concurrent with the progression of the process demonstration facility, Powerhouse has made significant progress in the commercialisation of its technology over the course of 2017 and 2018. To further drive its efforts, Bruce Nicholson, who has 30 years of project management, asset management and business development experience, was appointed as Commercial Operations Manager in April 2018.

Key agreements signed or in negotiation to date include:

In January 2017 PowerHouse entered into a co-operation agreement with **Waste2tricity Ltd**, appointing the firm as its Project Development Consultant on an initial 24 month contract. Under the deal the two firms are working together on the development of multiple waste-to-hydrogen plants in the UK, subject to both parties meeting specific performance criteria. Currently the Companies are in late negotiations with 6 potential early adopters, each of which represents multiple DMG® Systems. While the first targeted H2 facility is going through the permitting and planning process, multiple other sites are being prioritized for subsequent roll-out, or for co-location facilities which represent substantially more attractive cap-ex and op-ex investments.

MOU with Peel Environmental leads to agreement for initial commercial DMG® System

In February 2017 PowerHouse signed a Memorandum of Understanding (MOU), brokered by Waste2tricity, with **Peel Environmental** and its subsidiary This is Protos. This is to collaborate on the development, construction and operation of an energy from waste plant at Peel's Protos facility near Chester, a few miles away from the Thornton Science Park at Ellesmere Port. **In December 2017 the partnership was expanded, with the two parties reaching Heads of Terms for a 25 year lease to locate the initial commercial DMG® System at the one acre site.**

This was deemed an ideal site for an early DMG® unit, allowing it to benefit from access to the national gas grid, commercial electrical grid, roads and waterways. Also, the opportunity to expand on the site means that PowerHouse will ultimately target the production of over well over 2MW of electricity and over 3 tonnes of high-quality hydrogen per day. **In recent interim results PowerHouse commented that the fabrication, build, and commissioning of the first DMG® system is expected to be completed, depending on specific customer requirements, and adequate funding being in place, by the end of Q3 2019, with full commercial operation commencing soon thereafter.**

Toyota

In early July 2018 PowerHouse reacted to an article in the Sunday Telegraph which suggested that Toyota, working with PowerHouse, may invest £15 million into a trial production plant. The company responded to the markets with a statement saying that it is in discussions with a number of potential industrial customers regarding the use of its technology, including Toyota. However, no agreements have yet been entered into.

At the same time, Waste2tricity confirmed that it has had a commercial executive deployed in Tokyo for 12 months under its representation agreement with PowerHouse. Toyota Tsusho, the trading arm of Toyota Corporation, is one party with whom the representative has been in direct discussions with over that time with a view to developing an MOU and ultimately, firm contract. The intention is for Toyota Tsusho to carry out a full technological review of PowerHouse's technology and its potential for deployment in Japan, with the intention of funding a complete system. The latest "Statement of Feasibility" provided to PHE by DNV-GL has been viewed quite favourably by Toyota Tsusho according to Waste2Tricity representatives and a formal invitation to commercial negotiations has been received by Waste2tricity to meet with senior executives of Toyota Tsusho in late November 2018.

Toyota Tsusho is one of the 17 members of the Toyota Group. On its website, Toyota Tsusho states: "As the Toyota Group's sole general trading company, we gather information and promote the development of new business from a global perspective. As automotive professionals with unique capabilities and know-how, we strive to lead the Toyota Group in the challenge to develop the evolution of next-generation mobility to contribute to the development of both society and the Toyota Group."

Japan is an extremely attractive market for Waste2tricity and PowerHouse, with indicative gate fees for unrecyclable plastics being around £200 a tonne and private wire prices c.£100 per MW/h. Given a 20% royalty fee on a PHE system using 25 tonnes of plastic a day it is estimated that PowerHouse could generate a minimum of £0.68 million of revenues per DMG® Unit as the technology provider. Waste2tricity intends to establish a Japanese subsidiary to take advantage of these opportunities.

Collaboration Agreement of up to £500,000

In June 2017 PowerHouse announced a collaboration agreement with an un-named UK partner that is involved in the development of energy and waste projects. Subject to achieving certain performance milestones of the G3-UHt demonstration unit at Thornton Science Park and to entering into an option to lease land to site the units, the partner has committed two tranches of funding of up to £500,000. These are intended to meet the cost of preparing and funding applications for planning permission and environmental permits of the initial demonstration unit and first systems. The agreement will require PowerHouse to supply five systems at locations of the partners' choosing on a prioritised basis, based upon the completion of UK certifications and demonstration of the unit in active operation. The successful re-commissioning and operation of the G3-UHt at Thornton Science Park released the first £100,000 tranche in July 2017.

Wrightbus

In February 2018 Powerhouse announced a non-binding partnership MOU, again in collaboration with Waste2tricity, with Wrightbus, a leading bus manufacturer based in Northern Ireland whose products include hydrogen powered buses. PowerHouse expects this to lead to a definitive agreement under which Wrightbus will supply hydrogen fuel powered buses and PowerHouse will provide access to its DMG® system for the low cost and environmentally responsible production of hydrogen.

Bus Projects in Bulgaria and Romania

In April 2018 Powerhouse announced its first international distribution agreement, targeting the supply of the DMG® process into hydrogen bus projects in Bulgaria and Romania. The agreement is with Tresoil Biofuels, a leading Energy Project Developer in Romania and Bulgaria, to seek deployments of hydrogen buses fuelled by PowerHouse's DMG® technology in partnership with Wrightbus. Tresoil will be responsible for applying for grants, integrating with end users and enabling the establishment of Special Purchase Vehicle's which will initially be 51% owned by the PHE/W2T relationship and 49% by Tresoil. Bus operators in Romania and Bulgaria are actively seeking to replace aging fleets of highly polluting public transport buses, with the region encouraged by the EU to deploy low carbon alternatives. Early negotiations regarding collaboration in the region have begun with Engie Romania, RomWaste, and others for whom these eastern EU projects have a specific interest.

.

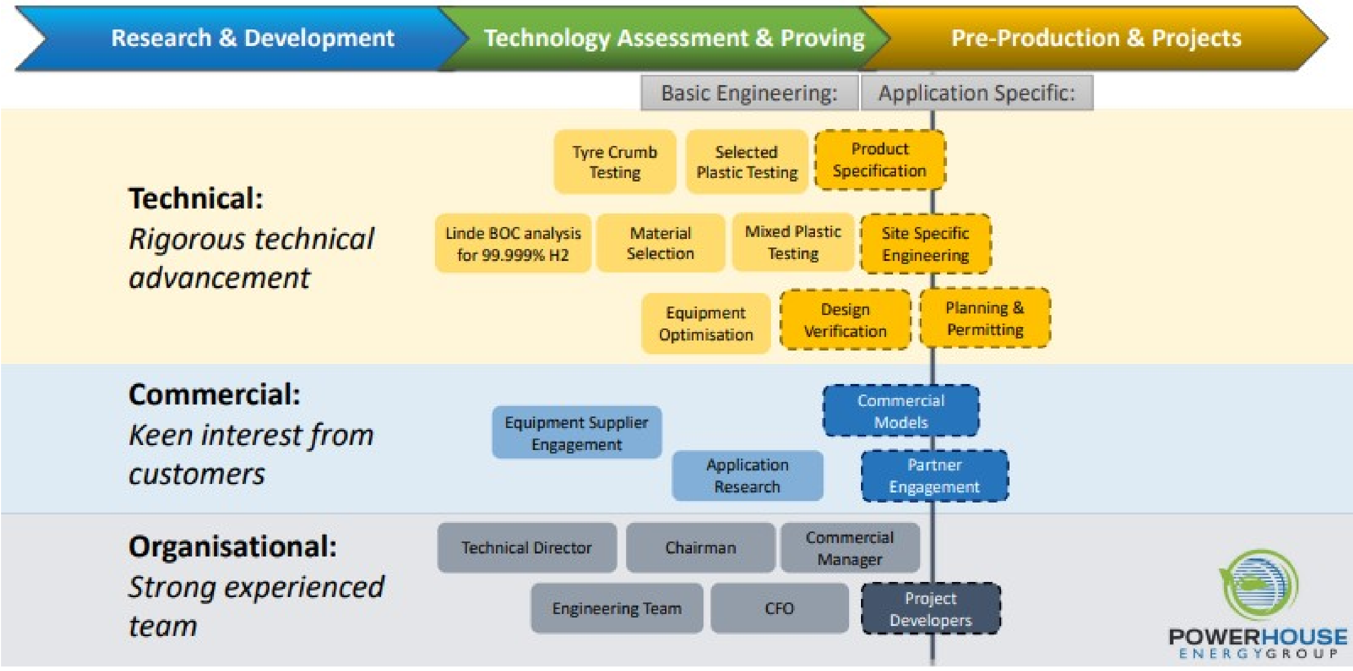
MOU for waste-to-hydrogen facilities in Qatar

In September 2017 PowerHouse entered into an MOU, co-ordinated by Waste2tricity, with Energy & Environment Holding (EEH), an independent consulting firm specialising in energy, environment, privatisation, and sustainable development based in Doha, Qatar. The two parties agreed to investigate the opportunity of enabling Qatar to establish a network of DMG® systems for the conversion of waste to hydrogen and distribute this through a network of fuel cell vehicle filling stations in advance of, and in preparation for, the 2022 FIFA World Cup. This would support potential fleets of hydrogen powered buses, taxis, and other vehicles. However, we understand that following the current diplomatic crisis in Qatar and associated sanctions, progress is currently on hold.

Latest progress

A brief operational update released in mid-October revealed further progress has been made. PowerHouse and Waste2tricity are said to have met with two "substantial" but un-named waste suppliers to advance negotiations which have the potential to lead to "multiple" DMG® System deployments.

PowerHouse has also engaged with, and has provided significant technical detail to an un-named major UK-based, multi-national EPC (engineering, procurement, and construction) company to support Waste2tricity's negotiations on behalf of both itself and PowerHouse, to obtain a system "wrap" and guarantee on the first deployment of the DMG® System which will allow for a faster roll-out of the technology on a world-wide basis. Negotiations are ongoing.



PowerHouse progress timeline. Source: Company

Targeting the Hydrogen economy

In a global sector which is seeing increasing levels of demand year on year, the race is on to find alternative sources of energy to fossil fuels. While having many advantages, especially in terms of abundance, calorific value and reliability, fossil fuels such as petroleum, coal and natural gas, cause many well-known problems. For example, their supply is being depleted by the increasing global demand for power and, perhaps most important from an environmental and political standpoint, their combustion releases a range of harmful gasses, including carbon dioxide, into the atmosphere.

One alternative source of energy which has great potential to become a leading "green" fuel, especially in the area of transportation, is hydrogen.

Hydrogen is the fuel that powers the sun. It is the lightest and most abundant element in the universe and even in low concentrations (as low as 4% in air) is a highly flammable gas. When burned with oxygen, hydrogen is considered to be a ***zero emission fuel*** as the only by-products are water vapour and heat. Hydrogen also has a very high energy density, having a much higher calorific value than common fossil fuels - 1 kg of hydrogen contains the same amount of energy as 2.6 kg of natural gas or 3.1 kg of gasoline.

Hydrogen production

Because it is so light, and rises into the atmosphere, hydrogen is not found in its pure elemental form on Earth in any significant quantity. There are no hydrogen mines. This creates the first challenge for establishing hydrogen as a leading green fuel – creating a supply by separating the element from other molecules.

There are two common methods of producing hydrogen. The first and most common is **steam methane reforming (SMR)**, a process which reacts steam at a high temperature with a fossil fuel, typically natural gas, and delivers high hydrogen yields. According to the Office of Energy Efficiency & Renewable Energy, 95% of the hydrogen produced in the United States today is made by natural gas reforming in large central plants. But disadvantages of this method include a high amount of carbon dioxide emissions being created (9-12 tonnes of carbon dioxide per tonne of hydrogen produced), higher methane concentrations, significant scale being required to be economical and the hydrogen then having to be distributed to end users.

The second method, **electrolysis**, takes advantage of the most abundant source of hydrogen on the planet – water. Here, electricity is run through water to separate hydrogen and oxygen atoms. While this can use green sources of power such as wind and solar, it is highly energy intensive and expensive – to produce 1kg of hydrogen takes between 39 to 79 kWh of electricity dependent on efficiency. Capital costs of the electrolysers themselves are also significant. Additionally, if traditional coal-fired electrical generation is used for electrolysis, the carbon dioxide released in the generation operation is comparable to that of SMR. In this case, the carbon dioxide footprint is not reduced - it is simply moved to the point of combustion of the coal.

Competing with the existing methods of hydrogen production, **gasification** is now coming to the forefront as a third method of hydrogen production, with PowerHouse believing that its own DMG® technology provides a unique method of producing high quality hydrogen, at low cost, with lower carbon emissions, previously unachievable by any other waste conversion process.

PowerHouse's hydrogen advantage

At the Thornton Science Park PowerHouse has demonstrated that the DMG® process can generate a syngas that is up to 50% hydrogen by volume. Crucially, the hydrogen component can be separated, sequestered and delivered at 99.999% purity. The company believes that the hydrogen produced is compliant with the minimum requirements of the low carbon emission regulations contained in the UK government's CFD scheme for renewable energy. **This is significant given the increasing role of hydrogen in the new energy economy and especially for fuel cell vehicles, which require ultra-high hydrogen purity.**

The nearly pure hydrogen can be diverted from the syngas with existing, off-the-shelf technology, compressed, stored at site and delivered to appropriate infrastructure and used in applications such as refuelling fuel cell vehicles. **Being located on site overcomes issues and costs associated with transporting hydrogen and, unlike steam reforming or electrolysis, comes with the huge advantage of the feedstock having a revenue attached to it (in the form of gate fees) rather than being an expense. This significantly improves the economics of the DMG® technology.**

Political and corporate actions assist the hydrogen economy

While the infrastructure required to support the hydrogen economy remains limited, governments and corporations around the world continue to push the agenda given the energy, environmental and business challenges faced by them. Here in the UK, in July this year the government launched its "Road to Zero" strategy, which sets out its ambition for at least 50% and as many as 70% of new car sales to be ultra-low emission by 2030, alongside up to 40% of new vans.

However, at present, the UK infrastructure for electric vehicles is much more advanced than that for hydrogen vehicles. There are only 15 hydrogen refuelling stations currently in operation in the UK (*Source: H2Stations.org*) and, according to the Road to Zero report, there will be only an estimated 250 FCEVs on UK roads by the end of 2018. This is somewhat of a chicken and egg situation, with the low number of fueling stations resulting in a low number of FCEVs and vice versa.

Modest funding is being provided by the government to improve the hydrogen infrastructure, with £23 million earmarked under the Hydrogen for Transport Programme via the Office of Low Emissions Vehicles (OLEV). A funding competition for the first phase of the programme, which ended in March, offered £9 million to provide match funding for eligible projects. Stage two, which closes in November and is offering £14 million, aims to fund ten Hydrogen Refuelling Stations and associated fleets of cars and vans.

On a global corporate scale the size of the investment is much larger. For example, the Hydrogen Council was formed in January 2017, with the current members including top level directors from 50+ multi-national energy and transport companies including the likes of Airbus, Audi, BMW, Honda, Shell, Total and Toyota. **On formation the initial 13 members announced plans to invest a combined $10.7 billion in hydrogen related infrastructure within five years.**

Elsewhere, news on global hydrogen infrastructure investment is coming through on a daily basis. Of many recent announcements news includes Hyundai Motor signing an MOU with Beijing-Tsinghua Industrial R&D Institute (BTIRDI) to jointly establish a 'Hydrogen Energy Fund' aiming to raise $100 million. In Germany, Chinese car manufacturer Great Wall Motor has recently announced an investment in H2 MOBILITY Deutschland, which is looking to operate 100 hydrogen stations in Germany in 2019 and has ambitions for up to 400 by 2023.

Unlocking the potential of the fuel cell vehicle market

As mentioned above, fuel cell vehicles require ultra-high hydrogen purity. So PowerHouse's DMG® process, which can achieve the delivery of 99.999% pure hydrogen, looks ideally positioned to meet the growing supply needs of fuel cell vehicles. Demonstrating the expected increase in demand, a recent report from ResearchandMarkets notes that the global hydrogen fuel cell vehicle market was worth $479 million in 2017 and estimates it to grow to $6.983 billion by 2023 at a CAGR of 56.3%.

Hydrogen fuel powered vehicles have a number of advantages over traditional petrol fueled and electric vehicles

They produce no carbon emissions or air pollution, have a range of several hundred miles (higher than electric vehicles) and refuel in around the same time as it takes to fill a tank with petrol, compared to hours for charging an electric vehicle. Recognising this, the UK government has committed to the findings of a 2013 report by UKH2 Mobility (UKH2M), a joint-industry government project which examined the potential for hydrogen as a transport fuel. The body was looking for a network of 65 hydrogen refuelling stations to be operational in the UK by 2020, followed by a larger phase to align with greater adoption rates.

On the vehicles side of the market several major manufacturers such as Hyundai, Renault and Toyota are currently rolling out their range of fuel cell electric vehicles. Notably, Toyota sees significant growth in this area, having in 2014 ended a venture with Tesla for electric vehicles in order to focus on its own Mirai hydrogen fuel cell vehicle. It has recently invested in new facilities to meet expected growth in demand for FCEVs from c.3,000 units in 2017 to 30,000 units globally from the 2020s.

In London, in order to meet EU emissions standards, all new double-decker buses will be hybrid, electric or hydrogen. Also looking to reduce their emissions, the Metropolitan Police recently ordered a fleet of 11 Toyota Mirai's as part of plans to have 550 zero or ultra-low emission vehicles by 2020.

Additionally, the industrial transportation sector, with high capacity trucks and road-trains, is a rapidly growing segment of the FCV market as is evidenced by the Nikola Motor Truck and the Toyota Portal Project in the Port of Los Angeles California. Also in the US, May saw beer maker Anheuser-Busch order up to 800 trucks from hydrogen-powered semi-truck maker Nikola Motor Company.

Waste Market Background & Opportunities

On the waste side of the equation, PowerHouse is targeting a rapidly growing global market with its waste-to-hydrogen technology. The industry is being driven by factors such as rising levels of municipal waste and increased demand for energy to come from renewable, or green, sources. The world's waste issues have been extensively highlighted in the media over the past year, with programmes such as the BBC's Blue Planet 2 and multiple outlets reporting on the damage that plastic waste in particular is having on the environment.

According to a 2012 report from the World Bank, global solid waste generation will rise from more than 3.5 million tonnes per day in 2010 to more than 6 million tonnes per day by 2025. Another report published in the journal Nature by Hoornweg, Bhada-Tata and Kennedy forecasts that solid waste generation rates will more than triple to exceed 11 million tonnes per day by 2100.

These forecasts suggest a very conducive landscape ahead for PowerHouse

Due to the rising levels of waste, those bodies whose job it is to deal with it, such as local governments, face many challenges. Traditional waste disposal methods have focused on landfills and incineration. But both are undesirable for many reasons. Landfill for example produces the highly polluting gas methane, which is estimated to warm the earth by 86 times as much as carbon dioxide and poses other environmental threats to water and land.

UK councils have to pay Landfill Tax at the current standard rate of £88.95 per tonne so have a clear incentive to reduce the amount of waste being sent to landfill. Incineration meanwhile can use a limited range of feedstock, has high capital costs and can produce a number of different pollutants. China's decision in January 2018 to stop the importation of 24 kinds of solid waste has increased the headache in the UK and worldwide.

The political and regulatory framework covering waste disposal also poses challenges. In the European Union for example operators of waste disposal sites have to meet with the requirements of the EU Landfill Directive. Implemented in 2001, the Directive seeks to prevent or reduce as far as possible negative effects on the environment from the landfilling of waste. It also sets out targets for waste reduction, including for all EU Member States to send no more than 35% of the volume of bio-municipal waste to landfill than they did during 1995 by 2020. Failure to comply with the Directive could result in fines for non-compliance.

With the challenges come opportunities for companies like PowerHouse

According to a 2017 report by Global Market Insights, the waste-to-energy market is forecast to grow from a value of $20.6 billion in 2015 to over $35.5 billion in 2024, driven by rising demand for alternatives to landfill and incineration. **Alternatively, a report from Allied Market Research sees the global market growing at a CAGR of 7.6% from 2017 to 2023 to $54.18 billion.**

Other regulations also provide opportunities. For example, the EU Renewable Energy Directive requires EU members as a whole to fulfil at least 20% of their energy requirements from renewable sources by 2020, to be achieved through the attainment of individual national targets based on a country's starting point and overall potential for renewables. All EU countries must also ensure that at least 10% of their transport fuels come from renewable sources by 2020.

Financials

2017 results

Numbers for the year to 31st December 2017 reflected spending on the re-commissioning and testing of the demonstration plant at Thornton Science Park, along with the expansion of commercial development and of the company's management team and advisory panel. A total of £1.8 million was spent on administrative expenses during the period, up from £0.85 million in 2016, with the net loss being £1.87 million, up from £1.33 million.

A total of £4.6 million was raised during the year to repay a convertible loan note from investor Hillgrove, in a combination of cash and shares, and to fund engineering design and company operations. Hillgrove was responsible for funding the vast majority of PowerHouse's operations from mid-2012 to 2016 via a convertible loan note secured by a debenture over the assets of the company. By February 2017 Hillgrove had extended a total of £3,402,155 to PowerHouse, including accrued interest, which was being paid at a rate of 15% per annum. The agreement to retire the loan note was significant as it was accruing c.£500,000 of annual interest charges. Cash at the period end was £0.75 million, up from £0.15 million 12 months previously.

Interims – results for the six months to 30th June 2018 showed a total operating loss of £1.16 million as £0.725 million was spent on administration expenses during the period and £0.41 million on research and development. With minor finance costs and no tax the net loss was also £1.16 million. Equity fundraisings during the period totalled £2,088,434, including shares issued to settle the Hillgrove loan note and for the settlement of services. Hillgrove is now no longer a substantial shareholder in the company. Cash at the period end was £0.25 million, with all debt eliminated following the final conversion of the Hillgrove note during the period. Along with the post period-end funding described below, a number of grant applications are currently being applied for, which if successful could result in additional funding during 2019.

Recent fund raisings

Since we initiated coverage of PowerHouse in July 2017 the company has since completed a series of further fundraisings.

August 2017 – placing of 160 million new shares at a price of 1p each to raise £1.6 million. The proceeds were used to accelerate the engineering of the commercial platform for DMG®, to fund expansion of the team for continued research and testing of the processes.

April 2018 - PowerHouse issued 115,255,355 new ordinary shares at 0.5p per share in an over-subscribed placing and direct subscription to raise gross proceeds of £576,276.76, to advance the commercial development of DMG®. In addition, the shares remaining in the control of PowerHouse as a result of the convertible note with Hillgrove Investments were placed, with the final 64,744,645 shares placed at 0.5p per share with private shareholders.

July 2018 - placing of 98,807,004 new ordinary shares at 0.5p and a subscription for 20,000,000 new shares at the same price from a private investor to raise a total of £594,030. One warrant, exercisable for 2 years at a subscription price of 0.5p per share, was issued for every two shares acquired. The proceeds were allocated for further commercial activities, including achieving the independent engineering validation, as well as progressing the relationship with Toyota Tsusho and other multi-national opportunities in the UK, the EU, and Australasia.

Director investment

Following the receipt of the Statement of Feasibility from DNV GL in October it was announced that CEO Keith Allaun invested £100,000 into the company by exercising 16,666,667 share options at a price of 0.6p per share, taking his total stake to 1.09%. The options were exercised at a c.28% premium to the share price at the time. Keith Allaun has also made a written commitment to hold the newly issued shares for a minimum of 18 months.

Management

Dr. Cameron Davies - Non-Executive Chairman

Dr. Davies was the founder, CEO, and Executive Director of AIM-quoted Alkane Energy, building it from its initial concept to the point of providing over 160MW of connected power generation, and delivering a successful exit for his shareholders - a c.£60 million sale to Balfour Beatty Infrastructure Partners in October 2015. Prior to Alkane, Dr. Davies led a number of other start-up companies and is currently a Non-executive Director of AIM-quoted Ascent Resources plc. Dr. Davies was awarded a PhD in Applied Geochemistry from Imperial College London. Over the course of the past 20 years Dr. Davies has evaluated numerous gasification technologies and projects. He is also a Fellow of the Geological Society of London a member of the European Petroleum Negotiators Group, and the Petroleum Exploration Society of Great Britain.

Keith Allaun - CEO

Mr. Allaun has a background in alternative energy, venture capital and management consulting. Mr. Allaun has worked with leading companies in emerging technologies for over 30 years. Educated at Stanford University in Palo Alto, CA, Mr. Allaun possesses an extensive background in management and brings a wealth of results-driven experience to PowerHouse Energy Group. Mr. Allaun has helped build or revitalize dozens of companies & organizations throughout his career including Linc Energy, Apple, Yahoo, Amazon and Hewlett-Packard.

David Ryan - Executive Director

David was the former CEO and Managing Director of Thyssenkrupp Industrial Solutions' Oil & Gas Business Unit for the UK. Prior to his employment with Thyssenkrupp, he founded and built a successful engineering consulting organisation, Energy & Power Limited, which was acquired by Thyssenkrupp in 2012. He has over 30 years of increasingly complex engineering, business development, and project management experience. An expert in sophisticated design engineering, David will bring a breadth of project delivery, international business management, and general engineering acumen to the Board.

Christopher Vanezis - Chief Financial Officer (non-Board position)

Christopher trained with Deloitte and Coopers & Lybrand, qualifying as a chartered accountant in 1990. He has over 15 years' experience in the energy sector, with a strong track record in major infrastructure projects in the UK and internationally. Prior to PowerHouse he worked as an independent consultant, providing expertise to several companies in the renewable energy sector.

Brent Fitzpatrick - Non-Executive Director

Mr. Fitzpatrick has over 20 years' experience as a corporate finance consultant. In the last 15 years he has been instrumental in advising a number of companies on their acquisitions and subsequent flotations. Mr. Fitzpatrick was Non-Executive Chairman of Global Marine Energy plc- an AIM listed oil services company and Non-Executive Chairman of Risk Alliance plc, an insurance broker consolidator. Mr. Fitzpatrick is also an adviser to ECO Capital, a global clean tech fund and is a member of the Audit Committee Institute.

James Greenstreet - Non-Executive Director

Mr. Greenstreet has over 20 years of corporate and structured finance experience. Having started his career at Arthur Andersen, Mr. Greenstreet joined BAE Systems in 1994 to work in the corporate finance team. After leaving BAE, Mr. Greenstreet held corporate finance positions at IBM and XL Capital, once more focussing on asset and lease finance. In 2001 he co-founded Orbis Capital a successful corporate and structured finance business. Over the past 10 years Mr. Greenstreet has been instrumental in sourcing, structuring, packaging and managing transactions for a number of high profile clients across a wide range of sectors.

Advisory Panel

Supporting the board, PowerHouse has put together an experienced advisory panel. The members provide a mix of commercial, scientific and engineering counsel to the management team. None are receiving any cash compensation for their roles.

Peter Jones OBE - has over 25 years' experience in the waste industry, with 20 years spent at board level at Biffa. During his time at Biffa the company expanded significantly through a combination of both organic and acquisition led growth.

Myles Kitcher - has a wealth of experience in the energy and waste industries with a career which has spanned local government, public sector and private enterprise. As Managing Director of Peel Environmental, he is leading their efforts at Protos - the flagship destination for energy, innovation and industry near Ellesmere Port.

Keith Riley - is a fellow of the Institute of Mechanical Engineers as well as a Member of the Institute of Waste Management. Previously the MD of the Technology Innovation Services at Veolia, he is currently leading environmental & waste management consultancy Vismundi.

Howard White - is an experienced entrepreneur, strategic advisor, and investor. As the founder of AFC Energy, and the Deputy Chairman of Waste2tricity, he has exceptional knowledge of the burgeoning hydrogen economy, coupled with expertise across both public and private companies.

Roudi Baroudi - a global energy expert with over 37 years' experience of international public and private companies across oil & gas, petrochemicals, power, energy-sector reform, energy security, carbon trading mechanisms and infrastructure. He is currently a member of the U.N. Economic Commission for Europe's Group of Experts of Gas – a body which promotes safe, clean & sustainable solutions for natural gas production.

Key Risks

The company is currently at the pre-commercialisation stage

PowerHouse Energy has de-risked its investment case to a certain extent by moving from the development stage to the validation and pre-commercialisation stage of its product. However, the firm must achieve a number of further milestones before being able to sell in commercial volumes, including achieving both regulatory and environmental certification for the operation of its gasification systems.

There is also uncertainty as to when the first units will be sold and if there will be sufficient demand for the company to break-even over time. PowerHouse's technology may not be the go-to choice within the marketplace for a number of reasons, including that larger companies are chosen for non-strictly commercial considerations or for other reasons unforeseeable at this time.

Technology risk

PowerHouse operates within a dynamic and evolving market place of disruptive technologies. We believe the company currently has a keen technological edge however, this may not always be the case and technological challenges may arise on the path to commercialisation.

Competition risk

A number of competing companies with significant resources are competing within the same space and PowerHouse's technologies may be eclipsed by a competitive technological development or an unforeseen new entrant to the space. However, PowerHouse believes that a more economical and efficient process than that of the company will not be developed in the near-term given its development over the past decade.

Financing risk

With PowerHouse currently being pre-revenue it remains loss making. The company will need to build up sufficient scale before reaching cash flow break-even and until that point having sufficient funds for research & development, capital expenditure and working capital remains a risk. PowerHouse sees it likely that as commercial engineering and business development continues it will choose to pursue additional funding options including equity, debt, or possible project financing models.

Regulatory risk

There is no certainty that the required regulatory approvals, in the UK or other markets, will be granted for the DMG® technology. However, as previously highlighted, prior versions of the PowerHouse technology have been approved for operation in both Munich and California - two of the most rigorous regulatory environments in the world.

Valuation

Given its pre-revenue stage of operation we consider a discounted cash flow (DCF) model the most relevant way to value PowerHouse Energy at this point in time. Working with management we have put together a base case financial model which examines the potential for the company to act as a licensor of the DMG® technology, taking a licence fee as a percentage of operating profits on projects which are owned and operated by third-parties. This is a highly profitable strategy, with high margins and low capital expenditure requirements. Although there remains uncertainty over the precise economic details of each plant commissioned at this point in time, we use what we believe are reasonable assumptions to highlight the value creation opportunities.

Key assumptions

In line with recent comments from the company, we assume that the first plant is commissioned in 2019. Following the successful commissioning of the first plant we expect a rapid roll out of further orders as the technology is proven to potential customers and the company has a commercial reference point.

We assume that 20 new plants are commissioned each year for the following 5 years, for a cumulative total of 101 plants by 2024, and that no more commissioned after that. We model for a 12 month build period for each plant i.e. the first revenues start to come in one year following the plant being commissioned. Each plant is assumed to have a 20 year operating life, so this takes our model out to the year 2044 when the plants commissioned in 2024 stop generating revenues.

Revenues

To forecast the license revenues that PowerHouse will earn we first forecast the profits that come from the third-party owned plants. We model for two revenue streams, gate fees and power generation only. We do not consider hydrogen sales at this stage, with the syngas created assumed to solely be used for power generation and there being no separation of hydrogen – this point is discussed in further detail below. There is also the potential for PowerHouse to earn fees in the form of services including design, plant management and maintenance, although we also do not model for these.

Gate fees – 25 tonnes per day of waste, adjusted for operating 8,000 hours per annum for a total of 8,333.33 tonnes of waste per annum. Gate fees are assumed at £80 a tonne in 2019, rising in line with inflation (assumed at 2.5%) each year thereafter.

Power generation – each 2.7 MWe (net) plant is assumed to dispatch 21,600 MW/h of power per annum (c.59 MW/h a day). We assume a price per MW/h of £60 in 2019, rising in line with inflation to the end of the forecast period.

Operating expenses – we assume operating costs of c.£0.875 million per plant in 2019, rising in line with inflation.

Licence fee – PowerHouse is assumed to earn a 20% licence fee on the profits of each plant. To derive total licence fees (thus PowerHouse's revenue) we multiply the licence fee by number of plants in operation for each year.

DCF Analysis

For our DCF analysis we begin with the total licence fees per annum. From this we subtract corporate overheads which begin at £1.5 million in 2019 (around double the £0.73 million spent in H1 2018) and rise in line with expected inflation. Corporation tax is assumed at 17% for the duration of the model.

For modelling purposes, depreciation is assumed to be zero due to the low capex requirements associated with the licensing model. However, we assume that an additional capex/R&D spend of £1 million is required in 2019 to get to the first commissioned plant.

PowerHouse had cash of £0.25 million as at 30th June this year which, added to the £0.69 million raised from the post period end placing and director investment gives £0.94 million. With total admin and R&D expenditure of £1.14 million in the first half we assume that these funds will last the company until around the end of the current year. Therefore, to meet the additional capex/R&D spend we factor in a £1 million fundraising in early 2019 which, for modelling purposes, we assume is via an equity placing at the current price of 0.455p. **We make the point however that the funding could prove to be less dilutive with Powerhouse currently applying for various grants and seeking other sources of funds.**

From 2020 we assume zero capex, reflecting the licensing model. Net working capital movements are minor, assumed to be only 2.5% of corporate costs but are included in the model for completeness.

DCF Findings

Discounting the forecast cashflows back to 2019 using a very conservative discount rate more typical of private equity of 20% results in a net present value of £47.38 million. **Assuming the £1 million equity raise mentioned above we divide by an expected 1,936,211,841 shares in issue which results in a value per share of 2.45p. We set this as our as our initial target price.**

For illustration purposes, the NAV per share is 3.51p at a 16% discount rate, 2.92p at 18% and 2.07p at a 22% discount rate.

Discussion

While our target price is some 5 times higher than the current share price we believe that our model is conservative for a number of reasons quite aside from the high discount rate used.

Firstly, management believe that they can achieve a substantial roll out programme once the initial reference plant is up and running. As discussed, our model assumes a total of 101 plants commissioned by 2024 and then none thereafter. We believe this is conservative as management sees potential in the UK for up to 700 sites. **To illustrate the upside potential, if we assume an additional 20 plants are commissioned in 2025 then the NPV rises by c.14% to £54 million and the NPV per share to 2.79p.**

Secondly, as mentioned, our model also ignores the potential for other sources of income. For example, fees for the supply of hot water/steam could run to c.£25 MW/h and those for services could be several hundred thousand pounds per plant.

More significantly, we do not consider hydrogen sales at this stage. Instead of using the syngas solely for power generation, a portion can be used for the separation of hydrogen which can be sold as road fuel. There is a trade-off here between power supply and hydrogen but one which becomes more lucrative as hydrogen is produced.

To illustrate this, if we assume only c.28MW/h of power per day (10,400 MW/h per annum) is produced, down from c.59 MW/h a day in our model, then, as per recent company announcements, at least 1 tonne of road-fuel quality hydrogen could be produced from the remaining syngas. Using our above assumptions for 2019, that would take power sales per plant to the owner/operator down from £1.296 million down to £0.624 million.

However, under the power and hydrogen scenario, additional sales of the 1 tonne of hydrogen fuel could amount to £2.92 million per annum if we assume a price of £8/kg. This scenario therefore delivers total income to the owner/operator of £3.544 million (without the gate fees), some £2.248 million higher than under the power generation only scenario. **The potential for PowerHouse to earn additional licence fee income is thus hugely increased under the hydrogen production scenario, although we flag that the construction and operating costs for a hydrogen plant will be higher for the owner/operator.**

As a final point we note that, while we model for individual 25 tpd units, there is further upside to our numbers should these be scaled up via the modular format.

Conclusion

After many years of development that has been decimatory for existing shareholders, we are now of the firm belief that PowerHouse is very close to finally commercialising its pioneering waste-to-hydrogen technology. Great progress has been made with the demonstration plant at the Thornton Science Park over the past c.18 months, with further clarity being achieved on how to build the final commercial unit. Alongside this, deals have been signed and discussions are ongoing with a range of potential commercial and development partners. This, in our opinion, all puts the company in a sweet spot to take advantage of the range of positive drivers across the waste management, clean power and hydrogen fuel industries.

While risks remain, we believe that our model demonstrates that significant returns could be delivered to shareholders over the coming years. **We re-initiate coverage of PowerHouse Energy with an initial first target price of 2.45p post financing and a stance of Conviction Buy.**

DISCLAIMER & RISK WARNING

It is the policy of ALIGN Research to only cover companies in which we have conviction in the investment case. Our "Conviction Buy" recommendation is derived from our conviction in either taking equity as payment for our research services, or applying our fee to the purchase of equity in a covered company whilst absorbing the cash cost of our freelance analyst payments.

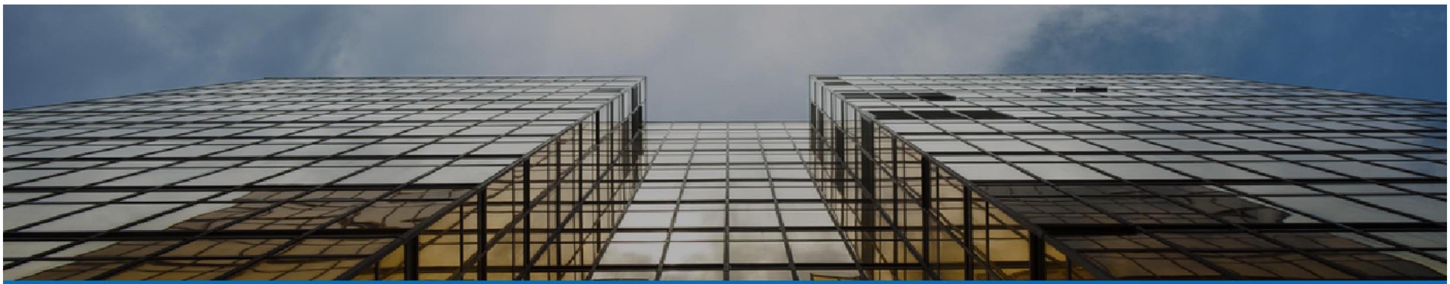
PowerHouse Energy is a research client of Align Research. Align Research owns shares in PowerHouse Energy. Full details of our Company & Personal Account Dealing Policy can be found on our website http://www.alignresearch.co.uk/legal/

ALIGN Research has made every reasonable effort to ensure the accuracy of the information in our research reports and on our website, although this can not be guaranteed. Our research reflects the objective views of our team of analysts. As we actively seek to take the majority of our fees by the way of equity payment in the companies we cover, we believe that we are aligned with both investors and the subject company. Additionally, we only write about those companies that we have conviction in. However, as a consequence of this alignment, our vested interest is in an increase in value of the subject company's equity. As such, we can not be seen to be impartial in relation to the outcome of our reports.

ALIGN Research has both a personal & company dealing policy (covering staff & consultants) in relation to the dealing in the shares, bonds or other related instruments of companies that we follow & which adhere to industry standard personal account dealing (PAD) rules. ALIGN Research may publish follow up notes on these securities/companies but has no scheduled commitment and may cease to follow these securities/companies without notice. Our reports are not subject to any prohibition on dealing ahead of their dissemination by staff members.

Your capital is at risk by investing in securities and the income from them may fluctuate. Past performance is not necessarily a guide to future performance and forecasts are not a reliable indicator of future results. Nothing in this report should be construed as an offer, or the solicitation of an offer, to buy or sell securities by us. As we have no knowledge of your individual situation and circumstances the investment(s) covered may not be suitable for you. You should not make any investment decision without consulting a fully qualified financial advisor. The marketability of some of the companies we cover is limited and you may have difficulty buying or selling in volume. Additionally, given the smaller capitalisation bias of our coverage, the companies we cover should be considered as high risk.

ALIGN reports may not be reproduced in whole or in part without prior permission from ALIGN Research. This financial promotion has been approved by Align Research Limited, which is authorised & regulated by the Financial Conduct Authority. FRN No. 768993. ® 2018 Align Research Limited.



Align Research Limited
7 Moorhead Lane
Shipley
UK
BD18 4JH

Tel: 0203 609 0910
E: info@alignresearch.co.uk