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RESEARCH

PowerHouse Energy Group plc

27th July 2017

Waste-to-hydrogen disruptor with gold standard in green technology moving towards commercialisation

AIM listed PowerHouse Energy (PHE) is a waste-to-hydrogen business focusing on the development and commercialisation of its proprietary Ultra High Temperature Gasification technology.

G3-UHt system – PowerHouse's flagship, DMG, is a disruptive technology

PowerHouse's Distributed Modular Gasification (DMG) G3-UHt system can convert high calorific value waste material such as tyres, plastic & hazardous waste, into a clean synthesis gas. **This "syngas" contains a high percentage of hydrogen that can be cleaned up to 99.9995% purity using off-the-shelf technology to produce a road quality hydrogen fuel.** This will be branded as "DMG-H2". DMG allows for distributed electrical generation, distributed waste elimination and distributed hydrogen production.

A third, previously under-developed, method of hydrogen production

PowerHouse's ultra high temperature gasification technology has numerous ecological and economic advantages over other hydrogen production methods such as steam methane reformation (SMR) and electrolysis. It can produce a high quality, low cost, low carbon product – a feat previously unachievable by any other waste conversion processes.

Targetting the UK & overseas hydrogen markets

Having refined its technology significantly PowerHouse is developing a G3-UHt prototype into a fully operational commercial unit capable of processing 25 tonnes per day of waste. Near term, the company will deliver electrical generation, however, **the intention is to take advantage of opportunities in the hydrogen fuel industry, both in the UK and overseas.**

A unique and first to market process that potentially unlocks the Fuel Cell Vehicle (FCV) market

The G3-UHt system has the potential to reduce the cost per mile of a hydrogen car significantly lower than a petrol or electric car with a zero, arguably negative, carbon footprint. **This puts the company in an excellent position to take advantage of growth in the FCV market.**

DCF valuation suggests 324% upside potential

Our DCF analysis suggests a net NPV of £52.75 million, or 4.24p per share, 324% above the current share price of 1p. But, using what we consider to be conservative assumptions, we see significant further potential upside. **We initiate coverage of PowerHouse Energy with a Conviction Buy stance.**

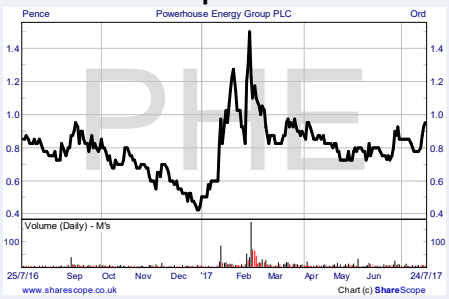
This investment may not be suitable for your personal circumstances. If you are in any doubt as to its suitability you should seek professional advice. This note does not constitute advice and your capital is at risk. This is a marketing communication and cannot be considered independent research.

CONVICTION BUY – Price Target 4.24p

Key data

EPIC	PHE
Share price	1p
52 week high/low	1.5p/0.43p
Listing	AIM
Shares in issue	963,608,856
Market Cap	£9.64m
Sector	Alternative Energy

12 month share price chart



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Executive Summary

- Gold Standard in green technologies

PowerHouse Energy has evolved and expanded its Distributed Modular Gasification (DMG) Waste-to-Energy system into a novel Waste-to-Hydrogen technology. PowerHouse believes the G3-UHt system, "*has the potential to be one of the most robust, cost-effective, operationally efficient, and flexible gasification systems on the market"* - capable of delivering distributed electrical generation as well as producing distributed hydrogen at, or near, the point of end-use.

- **The G3-UHt system has multiple advantages**

Put simply, the G3-UHt system is able to turn waste materials into a high quality synthesis gas which can be subsequently purified into hydrogen gas, which can then be used as a fuel. This reduces the amount of waste sent to landfill or incineration and reduces carbon dioxide and methane emissions. The system can use a range of different waste material as feedstock and is able to capture the vast majority (90%+) of the waste's contained energy, or calorific value.

- A high quality hydrogen for use in fuel cell vehicles.

PowerHouse has demonstrated that the G3-UHt system can generate a synthesis gas ("syngas") that is up to 75% hydrogen by volume. **Crucially, the hydrogen component can be separated, sequestered and delivered at 99.9995% purity.** 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 syngas can also be used for on-site power generation, providing further potential for revenue generation.

- PowerHouse has the ability to produce a low cost hydrogen product.

Unlike other methods of hydrogen production, such as steam methane reforming (SMR) or electrolysis, PowerHouse earns an income in the form of gate fees for its feedstock, thus significantly improving the economics of its projects. Operating a distributed production model also reduces costs and other problems associated with hydrogen infrastructure and transportation.

- Demonstration unit now on-site in Chester and multiple third-party agreements signed to advance commercialisation

Since early May a G3-UHt unit has been in situ at the Thornton Science Park in Chester, UK, where PowerHouse has leased a former Shell Oil emission laboratory and new offices at the Energy Centre. This provides an ideal base to showcase the technology to potential customers, investors and the public at large. A range of MOUs have also been signed over the past few months with industry specialists in order to advance commercialisation.

- Fundraisings provide working capital and simplify the balance sheet

During 2016 and 2017 to date PowerHouse has raised a total of £3.3 million. Proceeds from a recent £2.5 million placing have provided some working capital, however, £2 million of the proceeds paid off a convertible loan from major investor Hillgrove. **The balance of the note (£1.4 million) is to be converted into equity shortly, leaving the business debt-free and removing 15% p.a. of interest charges**. Hillgrove will be a circa 25% shareholder in the company and has agreed to a 12 month lock-out in trading its shares.

- Base case DCF valuation suggests value of 4.24p per share with further upside potential

Given its pre-revenue stage of operation we consider a discounted cash flow (DCF) analysis the most relevant way to value PowerHouse Energy. Our NPV calculation suggests value of 4.24p per share, 324% above the current share price of 1p. **However, we see significant further potential upside given that we consider many of our assumptions to be conservative.**

Corporate Background

PowerHouse Energy (PHE) is a waste-to-hydrogen technology business which came to market in June 2011 via the reverse takeover of AIM listed Bidtimes. 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.

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

PowerHouse made the acquisition as it identified the Pyromex concept as a 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 technology was inherently flawed, its execution was fundamentally poor and thus unable to be commercialised in its existing state.

So in early 2015 PowerHouse made the decision to abandon further development of the Pyromex technology, close its operations in Germany and Switzerland, and focus on its own in-house proprietary technology for ultra-high temperature gasification with a new team based on a new approach.

Engineering operations moved to Brisbane, Australia, where a newly designed system, the G3-UHt, was created.

A project commenced to re-engineer the system from the ground up, incorporating PowerHouse's own PHE (G3-UHt) technology while also taking into account the valuable experience gained with Pyromex. The project encompassed the concept of the original system but dramatically re-engineered it to develop a more robust and reliable technology based on the latest science of ultra-high temperature gasification, incorporating significant improvements in material sciences and increased electrical efficiencies. PowerHouse believes that the new technology represents a truly commercial Waste Gasification Technology which also has a much lower cost base than other waste-to-energy technologies.

During 2016 PowerHouse completed the development of the G3-UHt unit and undertook initial testing in Brisbane alongside development consultants OrePro, a company focused on ultra-high temperature microwave kiln development which was associated with major investor Hillgrove Investments. In the past 6 months the operational and engineering focus has shifted back to the UK, where the company sees good future demand for its technology, and has set up a base from which to continue the commercialisation of the G3 technology and develop sales both nationally and overseas. **PowerHouse is now at the point where its G3-UHt Ultra High Temperature Gasification Waste-to-Hydrogen system is on the cusp of commercialisation, with the key opportunity and focus being on producing hydrogen for use in road fuel and stationary hydrogen fuel cells.**

PowerHouse ENERGY

Operations

PowerHouse's flagship development and principal asset is the G3-UHt Ultra High Temperature Gasification unit, and the proprietary Distributed Modular Gasification (DMG) system which it believes, "*has the potential to be one of the most robust, cost-effective, operationally efficient, and flexible gasification systems on the market.*" **Put simply, it is able to turn waste into high quality hydrogen gas as well as providing distributed electrical generation.** PowerHouse has built and is currently operating a demonstration unit which is a nominal 1-3 tonne per day (tpd) system at the Thornton Science Park in Chester, UK.

Distributed Modular Gasification© (DMG)

The G3-UHt unit incorporates PowerHouse's proprietary Distributed Modular Gasification© (DMG-H2) technology. 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".

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, as well as 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 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. **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-H2 technology can use a range of waste types by siting a G3-UHt unit where the waste is actually located, 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. "Distributed production" refers to hydrogen being produced in generally small units at the location where it is needed, 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 grid losses should the fuel be used for on-site power generation as it is made and delivered exactly where it is needed. Current "grid-loss" is estimated to be as high as 18% on a national basis.

The G3-UHt unit has been designed with expansion in mind, effectively interlocking and using both front-end and back-end plant components. **The company has previous experience of a 25 tonne per day (tpd) unit, which gives it experience and confidence in being able to scale up to this level of capacity and, because of its modular design, well beyond by simply incorporating additional modules when required.**

Focus on high quality hydrogen

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 syngas produced by the G3-UHt system is primarily hydrogen and carbon monoxide, with relatively small quantities of methane, carbon dioxide and other trace contaminants that are removed through a simple cleaning process. However, as discussed further below and key for the investment case, **PowerHouse has demonstrated the ability to produce a *hydrogen rich* syngas by fine-tuning the gas composition during production.**

Overall, PowerHouse believes that it is producing the cleanest syngas 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.

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. If it chooses to only generate electricity, it has modeled the ability to generate up to 1MW per hour of net exportable electricity.

G3-UHt 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)

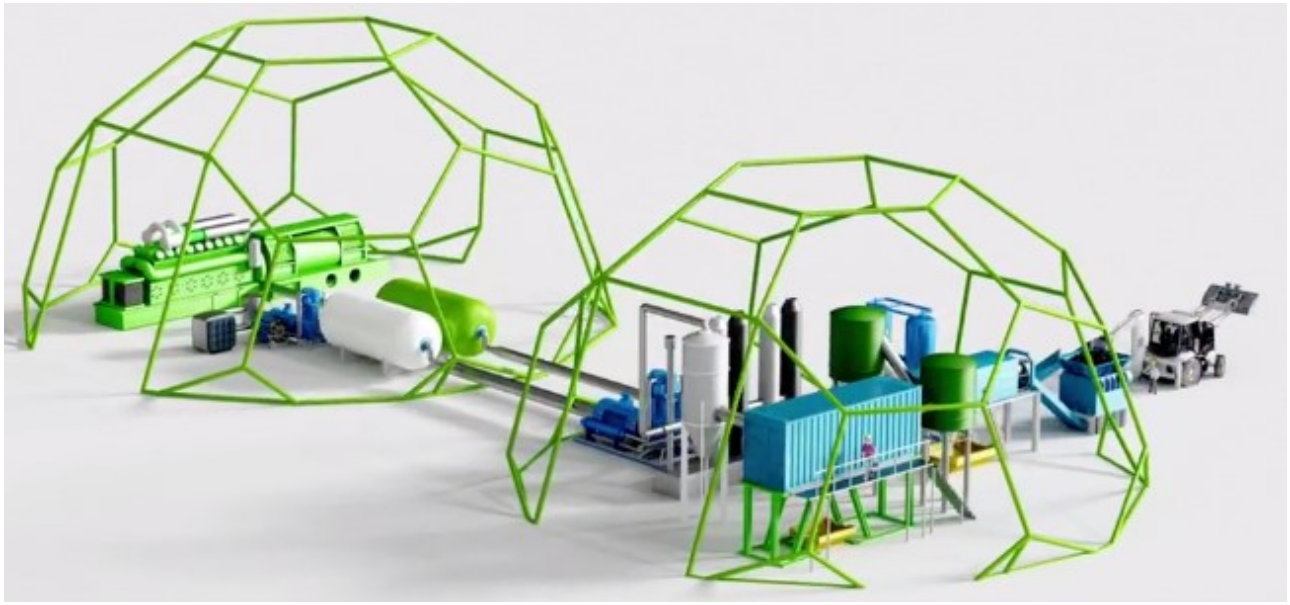
Step 2 - feedstock is passed through vacuum controlled feed bin system to remove any air.

Step 3 - air-free feedstock moves through the rotating ultra-high temperature gasification 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 synthesis gas.

Step 4 - The syngas 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 - The syngas 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.



G3-UHt Ultra High Temperature Gasification Waste-to-Energy system. 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 such as 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 - 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. 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. Today, 95% of the hydrogen produced in the United States 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 a between 39 to 79 kWh of electricity to produce 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-H2 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

PowerHouse has demonstrated that the DMG technology can generate a syngas that is up to 75% hydrogen by volume. Crucially, the hydrogen component can be separated, sequestered and delivered at 99.9995% 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 technology.**

Political and corporate actions assist the hydrogen economy

Governments and corporations around the world continue to push the hydrogen fuel agenda given the energy, environmental and business challenges faced by them, thus providing good opportunities for PowerHouse to pursue with its ground breaking technology.

In the UK alone the government has an "ambition" for almost all new cars and vans to be zero emission by 2040. The Department for Transport has previously announced that it will provide £600 million to support the uptake of ultra-low emission vehicles between 2015 and 2020, with £100 million of this being allocated to hydrogen infrastructure, with an additional £390 million announced at last year's Autumn Statement for ultra-low emission vehicles and driverless cars.

While the hydrogen infrastructure in the UK is sparse at the present time a number of recent developments point to a rapid expansion over the coming years.

For example, the Office of Low Emission Vehicles (OLEV) recently announced that a new £23 million fund is being created to accelerate the take up of hydrogen vehicles and infrastructure. On the corporate side, energy giant Shell opened its first hydrogen refuelling station in the UK in February - the first fully branded and public hydrogen refuelling site in the country and one of three hydrogen stations Shell plans to open in the UK in 2017.

Unlocking the potential of the fuel cell vehicle market

As mentioned above, fuel cell vehicles require ultra-high hydrogen purity. So PowerHouse's DMG-H2 technology looks ideally positioned to meet the growing supply needs of fuel cell vehicles. Demonstrating the expected increase in demand, a recent report from research and advisory firm Technavio forecast **the global hydrogen fuel cell vehicle (HCFV) market will grow at a CAGR of more than 82% during the period 2017 to 2021 in terms of units, with additional production of 90 million tonnes of hydrogen required annually to sustain growth.**

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 just three minutes. Recognising this, the UK Government has committed to the findings of report by UKH2 Mobility (UKH2M), a joint-industry government project which examined the potential for hydrogen as a transport fuel. The body is 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. In London, in order to meet EU emissions standards, from next year all new double-decker buses will be hybrid, electric or hydrogen. 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.

Recent developments

2016 operational highlights

During 2016 PowerHouse completed the development of the G3-UHt unit and undertook initial testing in Brisbane alongside consultants OrePro, a company associated with major investor Hillgrove Investments.

In September a system-wide testing program was completed for the now commissioned G3-UHt unit. During testing the unit used feedstock which included both shredded plastic and tyre crumble, and successfully cycled the system repeatedly. The nominal 1-3 tpd unit operated as designed, gasifying the feedstock at temperatures above 1,100°C, generating synthesis gas and cleaning and cooling the syngas for use in electrical generation or other fuel creation.

The company estimates that a 25 tpd operation has the potential to provide 1 MW of net exportable electricity per hour, a level sufficient to provide power for up to 1,000 homes or a local industrial project.

Move to the UK for pilot testing

A decision was then made, primarily due to attractive market dynamics and supportive political policies, to target the UK and certain European markets. As such, the majority of R&D, engineering, development, design and corporate operations have now been moved to the UK. At the end of March 2017 the G3-UHt unit cleared UK customs after a seven week journey from Brisbane and was delivered to its initial recommissioning site near Manchester. Engineering firm, Engsolve Ltd, was appointed to assist in both the recommissioning and the complete and thorough engineering validation of the unit's capabilities.

At the end of April PowerHouse confirmed that the first phase of the re-commissioning of the G3-UHt unit had been completed, with the successful production of syngas from the system. The unit operated at a temperature of over 1,000^{o}C, demonstrating its capacity to gasify any historically difficult waste material and generate synthesis gas.

Since early May the G3-UHt unit has been in situ at the Thornton Science Park, a high-tech research and innovation centre operated by the University of Chester. PowerHouse has secured a two year lease of a purpose built emission laboratory and offices at the site which will provide testing capabilities and a base to showcase the technology to potential partners, investors and the public. **Open days at the site are expected to commence in the coming weeks.**

Commercial development enhancements are now underway, along with automation of the control systems, a Hazard and Operability Study (HAZOP) and a Hazard Identification Study (HAZID). Upon successful completion, PowerHouse expects to gain the British Health Safety & Environmental certifications, as well as local Council approval, necessary to operate the unit at full capacity. With the company previously achieving both CE Certification and Environmental permissions to operate in Munich and California for prior generations of its systems we believe that this should be a relatively simple milestone to achieve. Initial design and engineering work is now being undertaken to construct the first commercially operating 25 tpd system.

Third party deals signed to advance commercialisation

In January this year PowerHouse entered into a Cooperation Agreement with **Waste2tricity**, Ltd, appointing the firm as its Project Development Consultant on an initial 24 month contract. Under the deal the two firms will work together on the development of multiple waste-to-energy (WTE) plants in the UK using the G3-UHT gasification technology, subject to both parties meeting specific performance criteria. The initial deal may be extended if development milestones are met and is subject to cancellation with a 90 day notice period. Waste2tricity has the exclusive rights to exploit the AFC Fuel Cell (see below) for waste-to-energy applications in the UK.

Under the deal, subject to successful commercialisation, both parties will have a right of first refusal for projects using each other's technology for projects up to 1,000 tonnes of waste per day. Subsequent to successful project development, and after each party recovers its project-related costs the profits of the project will be shared 50/50.

MOU with Peel Environmental

In February 2017 PowerHouse signed a Memorandum of Understanding (MOU) with Peel Environmental and its subsidiary This is Protos to collaborate on the development, construction and operation of an energy from waste plant at Peel's Protos facility near Chester, not far from the Thornton Science Park.

The agreement, which was brokered by Waste2Tricity, covers a collaboration period until 1st May 2018 and sets out the basis on which PowerHouse and Peel Environmental will work together. The joint project envisages the construction of PowerHouse's first commercial enterprise using the G3-UHt system at the Protos site, together with a proposed plan for the delivery of five energy from waste plants. Results for 2016, released in mid-June, commented that the company remains in active discussions with Peel over the siting.

Deal with AFC Energy

In March 2017 PowerHouse confirmed an order of a small-scale fuel cell system originally ordered in 2014 from fellow AIM listed company AFC Energy - the order was delayed awaiting the completion of the construction and testing of the G3-UHt Unit**. Delivery is now expected in Q4 this year when PowerHouse expects to have a high quality hydrogen stream produced from the G3-UHt to integrate with the fuel cell and provide production of electrical power.**

Receipt of the fuel cell is contingent upon the G3-UHt unit being capable of producing a hydrogen stream compatible with the fuel cell. **The successful integration of the two technologies are anticipated to create significant new markets in clean distributed power generation and grow the increasing prominence of the hydrogen economy in the UK and overseas.**

Collaboration Agreement of up to £500,000

In June 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 five G3-UHt 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 G3-UHt unit in active operation.

Waste Market Background & Opportunities

PowerHouse is targeting a rapidly growing global market with its waste-to-hydrogen technology, with the industry being driven by factors such as rising levels of municipal waste and increased demand for energy to come from renewable, or green, sources.

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 also have to pay Landfill Tax at a standard rate of £86.10 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.

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 report released this year 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

PowerHouse Energy's accounts over the past few years reflect that of a pre-revenue business focusing on the development of its technology.

Year to Dec	2013	2014	2015	2016
Revenues (£m)	N/A	N/A	N/A	N/A
Pre-tax (£m)	-678,462	-2,549,999	-781,647	-1,334,009
EPS (p)	-0.22	-0.65	-0.2	-0.24

Source: Company accounts

For the record, although not critical for the investment case at this stage, results for the year to 31st December 2016 reported a pre-tax loss of £1,334,009. Of this, £0.85 million of administration expenses were incurred (including a one-off, non-cash settlement charge of £299,152 and share based payments of £68,000), with a notable £482,106 of interest accrued on the Hillgrove convertible loan note (see next section). **This sizeable amount of interest will be significantly reduced in 2017 following a recent refinancing and will be completely eliminated for 2018.**

The balance sheet showed net liabilities of £3.22 million at the period end, with £56.4 million of accumulated losses being the major balance sheet item. Current assets of cash and trade receivables covered trade payables a comfortable 3 times.

Following the financings completed this year, cash on hand as at the date of the results release (16th June) was said to be £235,000, with an additional c.£60,000 in VAT and Customs Duties recoverable. This was said to represent sufficient resources to enable the company to *"meet its obligations as they fall due."*

Financing

Since 2010 PowerHouse has been working with Hillgrove Investments on an operational and financial basis. Hillgrove was responsible for funding the vast majority of the company'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.

Refinancing simplifies balance sheet and remove substantial interest costs

The most recent financing agreement was announced on 15th February this year, with PowerHouse raising £2.5 million via a placing of 312.5 million new shares at a price of 0.8p. Of the proceeds raised, £2 million were used to part pay off the Hillgrove convertible note. The remaining £1,402,155 note related debt was agreed to be converted into new PowerHouse shares at the previously agreed 0.5p conversion price, amounting to 280,430,920 shares, and ceased accruing interest upon the transfer of the £2 million. This will eliminate the convertible note from the balance sheet. Hillgrove has committed to a 12 month lock-in period on its newly issued shares, which are expected to be issued "in due course". Any remaining funds raised from the placing are being used for working capital.

Also taking part in the placing was Yady Wordwide S.A. an investor with interests in several hydrogen and waste-to-energy sector investments. Yady contributed £0.5 million to the placing and has also agreed to a 12 month lock in period for the new shares. This followed a previous investment by Yady Worldwide in PowerHouse, with £250,000 being placed at a price of 0.7p in January this year.

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 stage of its product. However, the firm is still in the pre-commercialisation stage and 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 host 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. However the company is not inherently a "technology" company – it is a project company - and due to the breadth of application of its technology, multiple projects can be envisioned which could conceivably be successful in the absence of the G3 technology.

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 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 G3-UHt unit. 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.

Management

Keith Allaun - Executive Chairman

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, Programme Development

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 both in the UK and internationally. Prior to joining PowerHouse he worked as an independent consultant, providing his expertise to a number of 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.

In line with corporate governance best practice the Board has decided to separate the role of Chairman and CEO at an appropriate time and expects to announce the appointment of a leading figure in the Waste-to-Energy sector in the coming months.

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.

Major Shareholders

Holder	No. Of shares	%
Hargreaves Lansdown (Nominees)	260,173,290	27.00%
Paul Warwick	130,124,799	13.50%
Yady Worldwide S.A.	98,214,285	10.19%
RenewMe Limited	90,932,961	9.44%
Jarvis Investment Management	45,813,593	4.75%
Investor Nominees	41,673,952	4.32%

Following the Hillgrove loan note conversion the major shareholders will be as follows.

Holder	No. Of shares	%
Hillgrove Investments Pty	300,430,920	24.15%
Hargreaves Lansdown (Nominees)	260,173,290	20.91%
Paul Warwick	130,124,799	10.46%
Yady Worldwide S.A.	98,214,285	7.89%
RenewMe Limited	90,932,961	7.31%
Jarvis Investment Management	45,813,593	3.68%
Investor Nominees	41,673,952	3.35%

DCF model valuation

In order to monetise its technology PowerHouse intends to own and operate facilities, working in partnership with third-parties, and earn an annuity like income mainly from hydrogen fuel sales, power generation and gate fees. However, it may consider a unit-sales model should relevant opportunities present themselves.

Given its pre-revenue stage of operation we consider a discounted cash flow (DCF) model the most relevant way to value PowerHouse Energy. Working with management we have put together a base case financial model for both genset (power generation) and hydrogen plants using the following key assumptions:

Genset

- 25 tpd unit operating at 8,000 hours per annum producing a net 1.155 MWe per day.

- 12 month construction period and 20 year unit life.

- 10% discount rate and 2.5% annual inflation rate.

- income derived from gate fees (starting at £80 a tonne and rising in line with inflation for 10 years and then remain flat) and sale of energy (£70 per MWh rising with inflation over the term).

- capex per 25 tpd unit of £5.49 million.

- operating expenses of £0.57 million in year 1 of operation, rising by inflation thereafter.

- 100% ownership by PowerHouse and capex debt financed.

Hydrogen

- 25 tpd unit operating at 8,000 hours per annum producing a net 0.666 MWe per day.

- 12 month construction period and 20 year unit life.

- 14% discount rate to reflect the earlier stage of the hydrogen industry and 2.5% annual inflation rate.

- income derived from gate fees and sale of energy as above, along with hydrogen sales starting at £9 per kg and rising with inflation thereafter. We believe the hydrogen price assumption is reasonable given a widely available price of £10 per kg in the UK market.

- capex per 25 tpd unit of £10.12 million.

- operating expenses of £0.78 million in year 1 of operation, rising by inflation thereafter.

- 100% ownership by PowerHouse and capex debt financed.

Applying this information to our financial model derives an NPV for each genset project of £1.29 million and a project internal rate of return of 13.27%. We point out that the project IRR return is well within the range of a typical return for UK waste projects**. For hydrogen, each project has an NPV of £2.45 million, with a project IRR of 16.8%, the higher value coming due to the contribution from hydrogen sales.**

Project roll out

The next key challenge is to derive assumptions as to the number of units in operation and when the units will begin operation. Again working with management, we do this in the table below for years up to 2024. We then multiply the NPV of each project (calculated above) by the number of plants in operation and apply an additional time discount to take the valuation point to the end of 2017. For modelling purposes we assume all plants begin operation at the start of the year. While the company believes it can implement a substantial roll out programme over the next 5 years in the UK and overseas we have assumed, what we believe to be, conservative numbers in our base case.

	2018	2019	2020	2021	2022	2023	2024
New plants in operation - genset	0	2	2	3	3	4	4
New plants in operation - hydrogen	0	0	2	4	8	10	14
Total plants for specific year	0	2	4	7	11	14	18
TOTAL PLANTS IN OPERATION	**0**	**2**	**6**	**13**	**24**	**38**	**56**
Genset annual NPV (£m)	0.00	2.58	2.58	3.88	3.88	5.17	5.17
Hydrogen annual NPV (£m)	0.00	0.00	4.89	9.78	19.57	24.46	34.24
Genset discount back to 2017 (£m)	0.00	2.14	1.94	2.65	2.41	2.92	2.65
Hydrogen discount back to 2017 (£m)	0.00	0.00	3.30	5.79	10.16	11.14	13.69
TOTAL (£m)	**0.00**	**2.14**	**5.24**	**8.44**	**12.57**	**14.06**	**16.34**
TOTAL NPV (£m)	**58.79**						

Source: Align Research

Taking our modeled total project NPV of £58.79 million, less our estimated NPV of corporate costs of £6.04 million, and dividing by 1,244,039,776 shares in issue (the number we expect to be in issue following the conversion of the remaining Hillgrove loan note), equates to a value of 4.24p per share, 324% above the current share price of 1p.

Valuation	
Total project NPV (£)	58,786,896
less NPV of corporate costs	6,041,005
NET NPV (£)	**52,745,891**
Shares in issue	1,244,039,776
p per share	**4.24**

Despite the significant upside implied here we believe that our model is conservative for a number of reasons.

Firstly, as mentioned above, management believe that it can achieve a *substantial* roll out programme over the next 5 years. To illustrate the potential upside here, if we assume only 1 additional plant of each type is added every year (2019-2024 for genset, 2020-2014 for hydrogen) compared to our base assumptions then our valuation would rise to 5.17p per share. An additional 2 genset and hydrogen plants every year over the time frame of our model takes the valuation to 6.1p and so on, with 0.93p per share of value being added for adding 1 additional type of plant per annum to the base case assumptions.

Secondly, as the hydrogen economy continues to progress we see the potential to reduce the 14% discount rate used in our hydrogen model to reflect lower risks. A 12% discount rate being used in our base case model for the hydrogen plants (all other things being equal) would result in a valuation of 8.26p per share, with a valuation of 14.2p per share at a 10% discount rate.

Thirdly, although we model for individual 25 tpd units we note that there is further upside to our numbers should these be scaled up via the modular format, with output able to be increased without increasing capex or operating expenses at the same rate. As such we believe our figures are conservative based on management feedback.

What's more our model assumes no value for projects commissioned after 2024, ignores the potential for other sources of income such as unit sales or prepayment of development costs from customers, and does not take into account the potential for declining capex over time as the technology progresses from being first of a kind to being fully established.

Accordingly, with our base case valuation of 4.24p per share representing 324% upside from the current share price, combined with the potential for further upside discussed above, we initiate coverage of PowerHouse Energy with a Conviction Buy stance.

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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/

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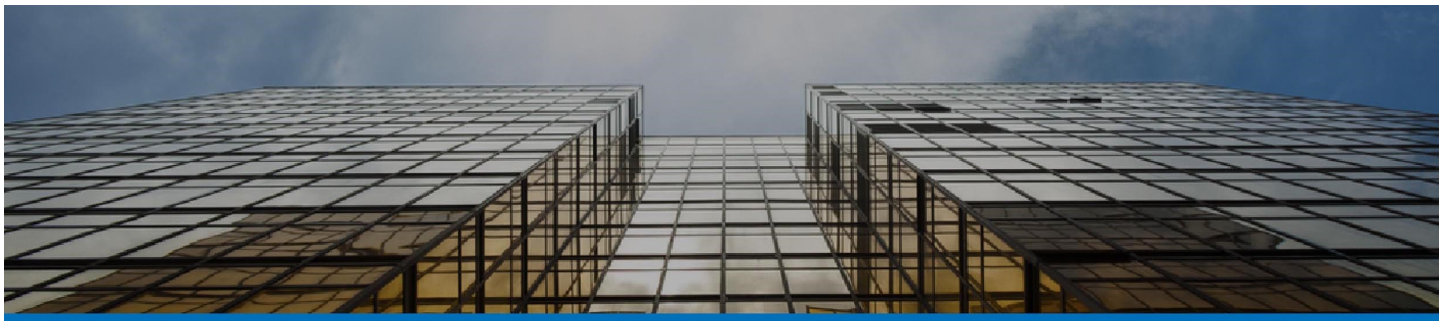

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