POWERHOUSE ENERGY
(PHE LN)

12 March 2025

Price (p)	**0.95**
Shares in issue (m)	4,197
Mkt Cap (£m)	40
Net debt (£m)	-17
EV (£m)	23
BVPS (p)	1.5

Share price performance

1m	-5.0%
3m	-7.3%
12m	0.0%
12 m high/low	2.2/0.7
Ave daily vol (30D)	5,357,973

Shareholders

Hargreaves Lansd'n	17.0%
Interactive Investor	8.9%
White-Reyes Serena	5.1%
Halifax Share Dealing	5.0%
White Ben	4.6%
Trading 212 UK Ltd	4.5%
White Josh	3.9%
Ing Groep NV	3.1%
Barclays PLC	2.8%
AJ Bell Securities Ltd	2.8%
Total for top 10	57.6%
Free float	77.3%
Source: Bloomberg	*03 Mar 25*
Next news	Finals Q2

Business description

Waste to hydrogen technology

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FTU UP AND RUNNING

The Powerhouse feedstock testing unit (FTU) at Bridgend is now up and running. This allows the company to demonstrate its working to potential customers at a commercial scale and we see this as taking Powerhouse to a new stage where it can sell on benefits rather than promises. With progress being made on projects in Ireland and Australia we see the company as having built a strong foundation with the FTU.

FTU Now Operating in Wales

Powerhouse's feedstock testing unit (FTU) at Bridgend in Wales provides a proper demonstrator of the company's Distributed Modular Generation (DMG) technology for potential clients and is designed with this in mind. The unit can process a variety of feedstocks and will enable the application of DMG technology to a wide range of use cases. The site can host visiting parties, showing them in real time how waste can be converted into syngas and then to other valuable products, with space on site to add further downstream processing in future developments. Carbon nano-tube developer TrimTabs is already using incubator space at the facility.

Technology Running Well

As such the site works well and naturally augments Powerhouse's low capital model of providing engineering, licencing and royalties with manufacturing licenced out. The site has already proved the technology with several days of continuous running with good results, although as a demonstrator the project is not necessarily expected to run flat out all the time. The unit also allows the company to develop the technology and to increase the efficiency of future commercial units.

Progress on Projects

The company is developing on several fronts, with projects at Ballymena in Northern Ireland and with National Hydrogen in Australia: the front runners for getting a project to financial close and delivering revenue to Powerhouse. In fact, there could be early revenue from either project during the front end engineering and design (FEED) stage and this could see Powerhouse booking first project revenues this calendar year in addition to the £500k already secured by its engineering services business EngSolve.

INVESTOR DAY HIGHLIGHTS FTU BENEFITS

Last week Powerhouse hosted a capital markets day at its feedstock testing unit (FTU) in Bridgend, Wales. The event was well attended by investors and gave the company the opportunity to demonstrate the unit and show its potential as a tool for developing new customers.

The FTU is sized at 2.5tpd which, although smaller than the planned commercial units at 40tpd, it is still of a size to properly demonstrate the process and allow potential customers to trial various feedstocks and potential output mixes.

A mixed plastic waste stream (non-recyclable waste from a UK recycling facility) produces a syngas as per the table below: with the balance being C5+ and Nitrogen.

Gas Outputs

Hydrogen	34.6
Methane	37.2
CO	26.7
CO2	0.01

Source: Powerhouse Energy

Investors Being Shown the Feedstock Input Unit

Source: Longspur Research

It can be seen that there is a good amount of space at the site which can allow for either future expansion or the installation of customers' downstream equipment to facilitate testing of advance products such as e-fuels.

A variety of feedstock samples have been successfully put through the process. The process ideally handles plastics especially those that cannot easily be treated or recycled by other technologies.

Feedstock Samples

Source: Longspur Research

The Feedstock Input Unit was designed in-house, combining both commercial and custom components. It offers the capability to control the feed rate and the environment of the feedstock as it is delivered to the rotary kiln. This, along with proprietary control of the kin and downstream processes, makes the DMG process more robust than other technologies.

Feedstock Input

Source: Longspur Research

The core of the technology is the rotating kiln. This is essentially a pyrolysis process rather than gasification as there is no oxygen in the system, at least on normal running. However the process can be altered with the injection of either steam or oxygen which makes it a gasification process. The flexibility in operation is key to the units applicability for many applications.

The main rotating kiln is shown below with feedstock input to the left and gas clean up to the right. Note that there is plenty of space in front of the installation for an additional plant.

Rotary Kiln and Main Unit

Source: Longspur Research

The process primarily produces syngas, a mixture of hydrogen, methane and carbon monoxide. Under normal conditions, the process is designed to maximise hydrogen in the syngas. Syngas output is put through a clean up stage which both cools and clean the syngas of any unwanted acid species. Once the syngas is cooled and cleaned it is ready to be used in energy production or converted into products such as Hydrogen, SAF or chemical precursors.

Gas Clean Up Stage

Source: Longspur Research

As a demonstrator site with limited permitting, syngas from the unit is simply flared. The picture below shows the red glow of syngas being burnt at the bottom of the flare stack, giving a vivid demonstration that the system is working.

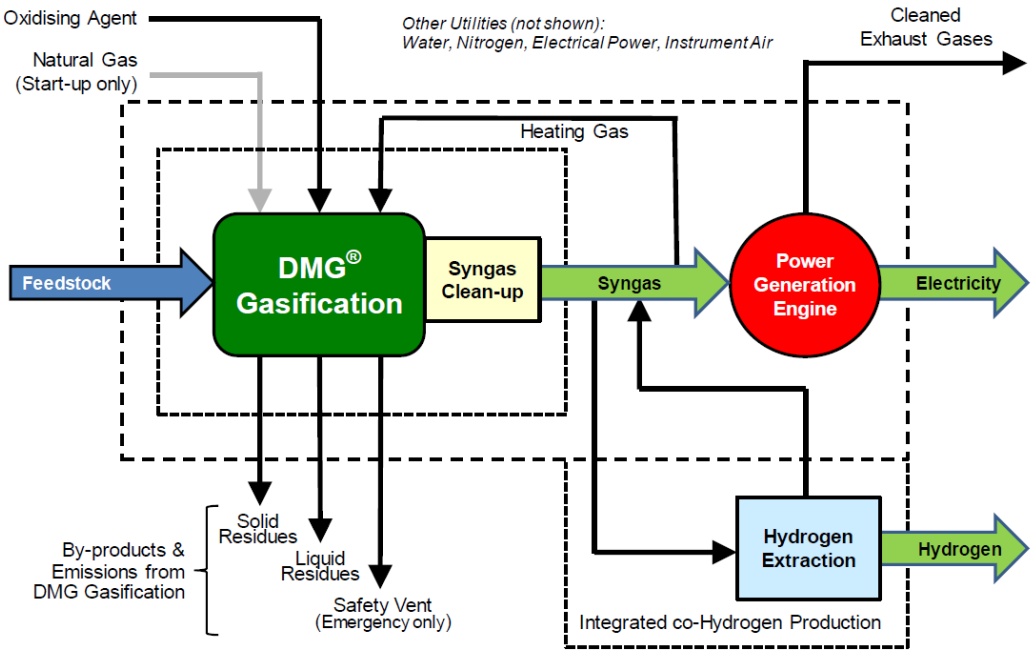
Gas Flare

Source: Longspur Research

THE POWERHOUSE PROCESS IN DETAIL

Powerhouse uses high temperature advanced thermal treatment of plastic waste to produce syngas, a mixture primarily of carbon monoxide (CO) and hydrogen (H2). After a gas clean up stage a proportion of the syngas is fed to an extraction unit using proven pressure swing adsorption technology to separate out the hydrogen. The remaining syngas is used to power the system and can also be used for power generation in reciprocating gas engines.

DMG Process Outline



Source: Company Data

Inputs and outputs

Most waste streams will be pre-sorted into plastic waste with other waste removed for recycling or other disposal. The plastic waste will be sourced from municipal solid waste as well as waste collected from commercial and industrial properties.

Natural gas is used to start the process and an oxidising agent is added. There are some solid and liquid residues which go for disposal. The process produces syngas and hydrogen. The hydrogen is 99.999% pure and does not contain any trace materials that might poison a fuel cell.

The generic system is size designed to process 40 tonnes of waste per day and if optimised for hydrogen it will produce 2-3 tonnes of the gas per day and around 3MW of power dependent upon feedstock. The system is deliberately modular, with larger capacity provided simply by providing more units. Some balance of plant saving is possible with larger units.

The feedstock testing unit is smaller at 2.5 tpd but this is still sufficient to show the process at a commerical level scale and to fully test the gasificaiton characteristics of varying feedstock. In particular, the unit is large enough to use gas burners to fully control temperature across the unit which was not possible on earlier demonstration units.

Off the shelf components

Most of the process uses standard, proven technology. The critical element is the rotary kiln. This makes use of a specialist steel alloy that allows for the high temperature production. Additionally, Powerhouse has developed control technology that is critical to making the process work.

The equipment has been manufactured and fabricated by standard equipment manufacturers and the company has relationships with fabricator including Chinese providers for the rotary kiln and German suppliers of the gas clean up stage.

POWERHOUSE CAN AVOID ISSUES FACED BY OTHER TECHNOLOGIES

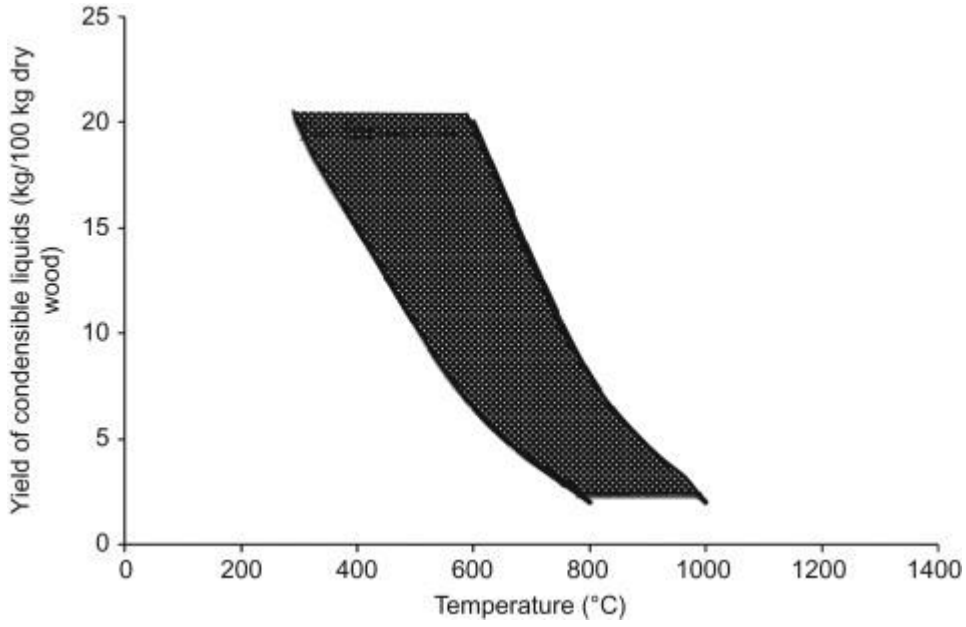
Pyrolysis and gasification of carbon feedstock to produce syngas is not a new technology but has had a difficult history with many projects having failed or been cancelled. Quite a few of these failures were due to factors not connected with the technology itself, with failure to secure reliable volumes of feedstock being a common issue. However, two key issues have been identified as creating problems for gasification, tar and scale up.

Tar

Tar is a complex mixture of hydrocarbons containing a wide range of aromatic substances including benzene, toluene and xylene (BTX) as well as polyaromatic substances. Many of these substances are carcinogenic. Tars generated by gasifiers of waste feedstock with plastic content may be notably high. BTX and tars can be present in between 1% and 10% of gas exiting the gasifier. Tars cool to form a liquid or semisolid substance that fouls the system.

Tar has been one of the major issues leading to gasifier project failures although it can be managed and minimised by process design and generally the higher the temperature of gasification the less tar is an issue although this has to be balanced against slag formation at higher temperatures.

Tar Yield by Temperature



Source: Baker, Brown, Elliott, Mudge, AIChE 1988 Summer National Meeting, Denver, CO.

Scale up

Perhaps one of the most high profile gasification failures in the UK was the Air Products project in Tees Valley. While little is officially known about the reasons for the decision by Air Products to write off this £1bn project, there appears to have been a number of factors including erosion of the gasifier walls and failure of the mechanical handling systems. But more importantly the scale up of the system from a 10ktpa demonstrator to a 350kt project was well ahead of a normal experience recommendation of a 10x scale up factor. Other projects with less dramatic scale changes have still found this to be an issue.

WHY PHE HAS FIXED THE KEY ISSUES

The Powerhouse process operates at high temperatures and utilises a rotary kiln, rather than a static vessel, to continuously move the feedstock through the system. This, along with the rapid cooling of the syngas, prevents the formation of tars typically found in other gasification technologies. These features ensure minimal tar production, which is collected at a specific stage of the process, reducing fouling in other parts of the system and addressing one of the main challenges in gasification. Because the system has been designed in a modular fashion there is little scale up to produce larger capacity systems. It is simply a case of adding more modules. This eliminates the other main issue in gasification.

INTELLECTUAL PROPERTY

The company's intellectual property is now well protected with patents granted in regions where Powerhouse expects to see growth as key markets. There are four patents granted to date with two in Japan, one in the UK and one in the EU. Further patents are pending in the UK, EU and for the Rest of the World. The GB patents have been filed in the UK, Greece, Hungary, Ireland, Macedonia and Poland with a unitary patent covering most of the remaining EU countries.

LICENSING MODEL REDUCES CAPITAL NEEDS

Powerhouse has developed a business model that can be replicated internationally. The model is quite similar to the licencing model used successful by a number of other clean tech players. The core business is licencing the DMG technology to developers. This will see a licence fee for use of the technology. Powerhouse will then receive royalty payments over the life of any projecct.

The company will also deliver engineering services during the development and construction stages of projects and will charge a fee and make a margin on doing so. This will bring useful up front revenues ahead of project commissioning. Powerhouse will also offer ongoing operations and maintenance services again for a fee and margin.

As it grows, Powerhouse will see early revenues as projects are developed but will also benefit from annuity like income streams over the life of each project.

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