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VN-H POWER GENERATION LTD

Elettra Produzione S.r.l 50MW Power Plant in Piombino now **CLOSED**

3rd Round Enterprise Investment Scheme

This memorandum is issued to individuals for their exclusive use who, in the belief of the directors of VN-H Power Generation Limited, are Certified High Net Worth Individuals for the purposes of the Financial Services and Markets Act 2000 (Financial Promotion) Order 2005, defined as a person with annual income of not less than £100,000 or who has capital assets, excluding their house and pension, of at least £250,000 and who has a signed certificate in the format set out in page 33 of this Information Memorandum.

Europe Gas Carnage Shown by E.On Closing 3-Year-Old Plant

By Tino Andresen and Tara Patel Mar 12, 2013 6:04 PM GMT+0100

E.On SE's Irsching-5 in Bavaria, Germany.

Three years ago, Germany's largest utility spent 400 million euros ($523 million) building a natural gas-fired power station. Later this month, the company may close the plant because it's losing so much money.

E.On SE's Irsching-5 in Bavaria last year operated less than 25 percent of the time as slumping power prices made burning natural gas unprofitable by record margins. As Europe's weak economy holds back electricity demand, cheaper coal, requirements to buy renewable energy and the collapsing cost of carbon permits are undercutting gas-fired plants.

The pattern is repeated throughout Europe as utilities including France's GDF Suez SA and Centrica Plc mothball gas plants. The impact is both environmental and commercial. Switching to coal increases emissions, while it lowers profit for gas plants, which generate almost a quarter of European power, and shrinks the market for suppliers led by OAO Gazprom. (GAZP)
"Gas-fired plants are stopped three days out of four," Gerard Mestrallet, chief executive officer of GDF Suez, France's former gas monopoly, said at a briefing on Feb. 28. "The thermal industry is in crisis. There is overcapacity."

The difference between the cost of fuel and the price paid for the power generated reached a record low today. The so-called spark spread for the month ahead fell to as low as minus 18.35 euros a megawatt-hour ($23.87). Gas plants are also unprofitable in France, the Netherlands, Spain and the Czech Republic, according to data compiled by Bloomberg. ***In the U.K., they're barely breaking even.***
At the same time, spark spreads for coal plants are profitable in every European market tracked by Bloomberg as prices for the fuel drop.

Idling Stations
The idling of power stations built to last a generation is holding back Europe's consumption of the fuel. The region's demand will drop 3.5 percent to 550 billion cubic meters in 2015 from 2010 levels, according to International Energy Agency forecasts. Russia's Gazprom lost its position as Europe's largest gas supplier to Norway last year as shipments slid, Societe Generale SA said.

"The switch from gas to coal in Europe is a very serious retrograde step from a climate change perspective," Dieter Helm, an energy policy professor at the University of Oxford, said by e-mail. "In Germany it is worse -- building new coal power stations which will be locked in for decades."

RWE AG (RWE), Germany's second-largest utility and Europe's largest carbon dioxide emitter, churned out 11 percent more greenhouse gases last year as coal-fired plants increased production, according to the company's annual report. Their profitability has been increased by the collapse in carbon permits to record lows, cutting the cost of burning coal.

Shut Plants
Utilities in Europe need to shut more than 30 percent of fossil-fuel fired stations to counter increasing production from wind turbines and solar, UBS analysts led by Per Lekander said in a note last week. Gas-fired plants will lead shutdowns, they said.

Electricity output from French gas-fired plants dropped 24 percent in 2012, according to grid manager Reseau de Transport d'Electricite, or RTE, the French power grid operator owned by Electricite de France SA. GDF plans to close or mothball 10,000 megawatts of capacity across Europe, mostly gas plants, Mestrallet said.

Centrica Energy Plc is considering permanently closing at least one gas-fired facility in the U.K. this year. EON has already withdrawn two gas plants from the grid, reserving them only for periods of peak demand. RWE, where plants are operating near half their capacity, has said it will idle two units for six months of this year.

In Spain, the under-use of gas-powered plants is "outlandish," said Antonio Llarden, chairman of Enagas, the operator of the country's natural-gas transportation network. Gas-fed plants were only used 19 percent of the time in 2012, compared with 51 percent in 2008, he said.

Cloudy Days
The troubled gas-generation market is an issue for policy makers, who need the flexibility gas offers when windless or cloudy days cut renewable production.

In the U.K., the regulator Ofgem said last month the country may face a power capacity shortfall as the lack of gas-fired capacity combines with the withdrawal of coal units because of environmental regulations.
Germany "needs" flexible gas plants to underpin a greater share of renewable sources if the country's exit from nuclear power is to succeed, Environment Minister Peter Altmaier said in January.

The remedy may be so-called capacity mechanisms, where generators are paid to keep plants on line even when they aren't used. The U.K. plans a new system to encourage investment and may start payments in 2018, under changes to the energy industry making their way through parliament.

EON's Teyssen has called for incentives to keep capacity available in Germany, but in the meantime, plants are likely to keep closing until the mismatch between power and gas prices ends, analysts said.

"The market is signaling that some power plants should be turned off and there should be no investment," said Josef Pospisil, head of utilities at Fitch.

BBC NEWS BUSINESS

14 November 2013 Last updated at 08:15 GMT

RWE to close or idle power plants

German power giant RWE says it will mothball or shutdown some of its gas and coal-fired power stations because of an increase in renewable energy.

The company said a boom in solar energy, and a combination of high natural gas prices and emission fines meant many of its power stations were no longer profitable. A total of 3,100 megawatts of generating capacity will be taken off line, representing about 6% of RWE's total capacity.

Separately its Npower business in the UK posted a fall in half-year profits.

Tighter margins

RWE is one of the biggest energy generators in the world. Its power stations affected are in Germany and the Netherlands.

"Due to the high price of natural gas and the continuing boom in solar energy, many power stations throughout the sector and across Europe are no longer profitable to operate," RWE said in a statement.

"During the first half of 2013, the conventional power generation division's operating result fell by almost two-thirds. The massive reduction in power station margins is a major factor in this development."

Meanwhile, RWE said its UK operations, Npower, had seen a 3% fall in operating profits to £176m (206m euros) in the first half of 2013.

The company said new government regulations that require energy firms to simplify their tariffs and pay for energy saving measures in consumers' homes had weighed on profits. However, the prolonged cold weather in the second quarter enabled the company to increase its gas revenues in the UK by 11%. Npower put up its gas prices by 8.6% last November.

Paul Massara, chief executive of Npower, also hinted at possible job losses in the near future, as part of its programme of reducing costs.

"To do this we need to make some major changes and, although some of these will be difficult, I believe it's the right thing for both our customers and our business," he said.

"As part of our ongoing commitment to maintain open dialogue with our people, and where people are affected, we will continue to consult with them and their representatives first and avoid compulsory redundancies, wherever possible," he added.

Natural Gas Fuels Increase in Power Prices

By Matthew Rocco Published January 08, 2014 FOXBusiness

REUTERS

Higher spot natural gas prices helped fuel an increase in electricity prices last year, with supply and demand issues particularly affecting New England and the Pacific Northwest.

According to the Energy Information Administration, average wholesale, on-peak power prices were higher across the country in 2013 and jumped the most in the Pacific Northwest, which is typically among the least expensive areas.

The Pacific Northwest typically benefits from a regional concentration of hydroelectric generation and its low operating cost. But last spring was drier than the previous two years, elevating power prices there.

Like the rest of the nation, the Pacific Northwest was also impacted by colder-than-normal temperatures in December that led to short-term spikes in natural gas and power markets. The EIA said 5% of the year-over-year increase in power prices is attributable to the price spike last month.

Those cold temperatures continued into 2014, with record lows pushing natural gas demand to all-time highs. On Tuesday, the EIA released a report detailing pipeline constraints into New York and from the west and south into New England.

Spot prices for natural gas scheduled for delivery the next day have soared. In New York City, day-ahead spot prices checked in at $12.83 per million British thermal units for the weekend before jumping to $47.80 per mmBtu on Monday.

In New England, cold weather also strained natural gas pipeline infrastructure early last year. Prices spiked in both the natural gas and power markets in January and February 2013, before climbing again in late November and early December.

Other markets like Texas benefited from a cooler-than-normal August. Texas had the lowest increase in 2013 power prices.

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A "Sophisticated investor" is one who has a current certificate signed by an authorised person to the effect that he or she is sufficiently knowledgeable to understand the risks associated with the type of investment described by the Information Memorandum and who has signed, within the period of twelve months ending on the date of this document, a statement that he or she is qualified as a Sophisticated Investor in relation to such investments and accepts that he or she may receive financial promotions which have not been approved for the purposes of section 21 of the FSMA.

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PAST AND FUTURE PERFORMANCE

Past performance is not a reliable indicator of future results. Future performance figures are based on the internal calculations of VN-HPG and are subject to change at any time. Such forecasts are not a reliable indicator of future results. Furthermore, the financial projections in this document are based on, and begin from, the date on which the company receives 100% of its desired funding.

The attention of prospective investors is drawn to the contents of page 31 of this document entitled "Risk Factors".

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Investors are encouraged to seek independent legal and tax advice prior to submitting an application to invest in the company and to conduct their own due diligence into the terms of this offer and the investment opportunity.

Information Memorandum Index

Principal Definitions

In this Information Memorandum, where the context so admits:

Board	The board of Directors of the Company
Business Plan	The document describing the total project delivery and anticipated returns
CCGT	Combined Cycle Gas Turbine
Closing Date	The date that the subscription will close & no further subscriptions will be accepted
Consultancy Revenues	Income received from manufacturers for design and outsourced manufacturing
COP	Conference of Parties
DGTW	Diesel Gas Turbine Worldwide
Directors	The Directors of the Company from time to time
EHG	Electro Hydrogen Generator
EIS	Enterprise Investment Scheme
Fourth Round Funding	640 shares issued pursuant to successful completion of the fourth subscription
Full Subscription	The total subscription required from all Subscribers
FI	Forecast International
Generator	Gas turbine powered electrical generator
GHG	Green House Gas
Initial Subscription Price	The amount payable by the Initial Subscribers
IEA	International Energy Agency
IP	Intellectual Property
Licence Revenues	Receipts from Generator manufacturers and operators utilising specific EHGs
Minimum Subscription	The minimum individual investment as decided by the Company
NFS	New Founder Shareholders
O&M	Operating and Maintenance
PTA	Power Take Off Agreement
Second Round Funding	58 shares issued pursuant to successful completion of the second subscription
SEIS	Seed Enterprise Investment Scheme
Siemens	Siemens AG Energy Sector - Fossil Power Generation Division & Energy Solutions
SG	The accounting firm of Simmons Gainsford LLP
Shares	Ordinary shares of 1p each in the Company
Subscribers	Those persons who subscribe for the Shares in the company
Third Round Funding	315 shares issued pursuant to successful completion of the third subscription
TSB	Technology Strategy Board
TMH	Turbo Machinery Handbook
UKTI	United Kingdom Trade and Investment
VNCP	Originator of the UK EHG development project

Introduction

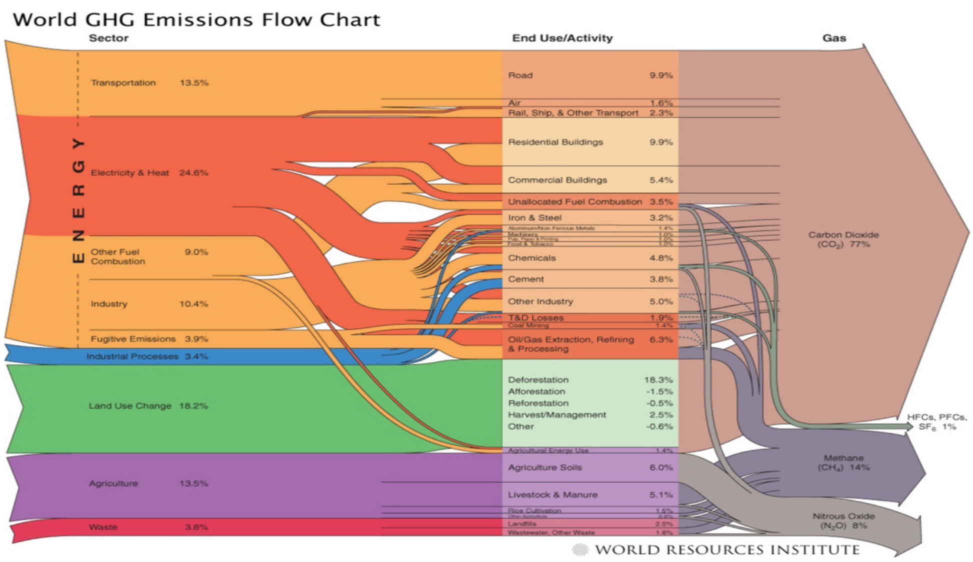
Having successfully met the Stage 1 Project development milestones, in 2005 VN-H Power Generation Ltd raised a further £290,000 of EIS funding to prove the scalability of the engineering design concept behind the Electro Hydrogen Generator technology ("EHG"). This part of the project has now been completed successfully, delivering an innovative, scalable mechanical design that is proven after comprehensive testing thus adding value to the company by further de-risking the project.

The company is now holding a 3rd Round of Funding to prove further designs by building and testing larger and more productive EHGs enabling the delivery of fully comprehensive technical drawings and schematics of a scaled EHG to match a GE PGT10b gas turbine. Delivery of this documentation will be the precursor of monetising the technology through licencing agreements with major Natural Gas Turbine Generator manufacturers and Power Station operators.

Manufacturers are under significant pressure from operators to produce a "clean" and more "fuel efficient" generating plant following the decision of governments around the world to reduce allowed CO_2 emissions and encourage increased fuel efficiency. Failure on these levels for the manufacturers would result at best in loss of market share, or worse, no sale of equipment. For the existing operators the choice is even simpler; reduce and clean up, or shut generation down, because after allowance fees and fines it will simply not be commercially viable. *This is clearly evidenced by E.On's move to 'standby generation' only of their €400m, 3-year old Gas-fired plant in Bavaria see http://www.eon.com/en/about-us/structure/asset-finder/irsching.html) and many others throughout Europe.*

However, with the UK power generation industry currently in disarray over its long term strategy, (No clear replacement for coal fired power stations that are closing quicker than replacement power can come online, and the nuclear option now also in limbo.) compliant gas fired power stations will soon be the only short-to-medium term alternative to providing reliable, consistent and relatively cheap power generation in the UK.

24.6% of the worlds CO_2 pollution stems from Power & Heat Generation (see graph below) EHG technology has the potential to allow both manufacturers and operators to meet the 2012-2025 emission reduction and fuel efficiency increase targets as laid down by EU and Global legislation. *(See page 15)*



Greenhouse Gas Emissions (see http://www.wri.org/resources/charts-graphs/world-greenhouse-gas-emissions-2000

Penalties in Europe for CO_2 emissions from Natural Gas Fired power stations are in the billions of pounds. The successful development of the VN-H Power Generation technology has the potential to reduce the CO_2 emissions from these power stations, and therefore reduce the fines for operators that adopt the developed VN HPG solution. The adoption of this technology by operators and manufacturers through licencing agreements has the potential to generate profits at VN-H Power Generation worth hundreds of millions each year, which in turn has the potential to produce gains for subscribers in VN-H Power Generation worth a significant multiple of their original investment.

EHG technology in this application will deliver a device designed to produce Hydrogen from the power generator waste energy streams. The Hydrogen produced is then compressed and stored onsite, (for future use) or fed directly to the gas turbine component of the generation plant and co-fired with Natural Gas. The Hydrogen introduced increases the burn efficiency of the gas turbine and then replaces conventional fuel with a corresponding percentage (of Hydrogen). *Thus by co-firing with a low-cost, onsite produced, 'clean fuel', purchasing less CO_2 allowances and less natural gas, plants that are not economical today, can continue to operate, and newer more efficient plants can operate profitably.*

VN-H Power Generation Ltd negotiated a globally exclusive development Licence in December 2012 allowing it to utilise existing *intellectual property and patents registered in 27 countries*, to develop and monetise the technology within the Gas Turbine Power Generation market. (See Schedule 4 for Patent Coverage)

The EHG uses a unique combination of centrifugal force, magnetic force and conventional electrolysis, which when combined produces a more efficient level of Hydrogen generation. The technology's capability was demonstrated under laboratory conditions whilst being developed in Russia by respected scientists. Dr Fulcieri Maltini on behalf of the UK Trade & Industry (UKTI) witnessed the experiments and hydrogen output.

The data was further validated by an International peer science review team in the UK prior to its recognition in April 2011 by the UKTI as a *Technology of Exceptional Global Potential, being led by a Professional Management Team* and thus its subsequent development in the UK. (Copy UKTI certification available upon request)

Following testing, the unit has a proven and witnessed efficiency in excess of 95%. (See Schedule 6)

VN-H Power Generation Ltd believes it is positioned to leverage industry expertise at world-renowned companies together with specialist scientific teams. In November 2012 during discussions with Siemens AG Energy Sector - Fossil Power Generation Division and Energy Solutions, interest was expressed in them participating in the project as joint developer and test-bed provider if the Stage 1 tests delivered an energy equation indicating production efficiency ratios in excess of 70%. This interest is in line with the recently announced successful conclusion of tests carried out by the Svenskit Gastenknist Centre AB on "Co-firing with hydrogen in industrial gas turbines". This study has led to Siemens and Infraserv Höchst rating the Siemens SGT- 700 & SGT 800 gas turbines suitable for 15% co-firing with hydrogen.
(See SGT http://www.sgc.se/ckfinder/userfiles/files/SGC256(1).pdf)

Key Information Summary

Stage 1: '***FULLY SUBSCRIBED'*** (New Founder Shareholder ("NFSH") offer £150,000 via the issue of 150 shares)

The Company raised £150,000 via an SEIS New Founder Share Holder offer that closed 'over-subscribed' on the 8th of February 2013. The project commenced on the 25th March 2013 with proceeds of the raise used by the Company to secure the exclusive development Licence for EHG use within the Combined Gas Turbine Power Generation market and to commission a report from Newcastle University referencing upward scalability constraints together with predicted scalable output quantity metrics.

Based upon the EHG3 and new prototype EHG4-M, this report provides the "Energy Equation" i.e. a predicted cost of scaled production "energy in vs energy out" or efficiency as described in kWh terms.

As a benchmark, in April 2005 under laboratory conditions in Moscow, Dr Maltini recorded that the EHG 3 model produced 21.2 – 24.6 standard litres of hydrogen per hour when driven by an electric motor at speeds between 4,500 & 8,000rpm using a 30% concentration of sulphuric acid electrolyte. (Report available upon request)

The latest conventional alkali Proton Exchange Membrane (PEM) electrolyser in the industrial sector is approximately 69% efficient at scale, i.e. 500kw – 1MW. Dr.Maltini's report, (based on the Russian science and data provided) *suggests that the Russian EHG3 had an efficiency of approximately 91%*. The main focus for Stage 1 was to provide supporting evidence and data for this efficiency claim.

The Stage 1 confirmation report author is Keith Scott - Professor of Electrochemical Engineering at the School of Chemical Engineering and Advanced Materials within Newcastle University. Quoting from the report, (see Schedule 6) he states:

"The best performance was achieved with the sulphuric acid electrolyte based EHG tests. A peak hydrogen production rate at an equivalent current of 71 Amps and an energy consumption of 36 kWh/kg was obtained which is superior to that for water electrolysis. The average energy consumption for the short term tests is comparable with those for standard water electrolysis". This means that the EHG is more efficient, and therefore potentially a more competitive technology than the existing alkali based electrolysers, i.e. it costs less to produce the same amount of hydrogen as existing technologies. (See page 4 of Schedule 6)

"Qualitatively increased rotation rate appears to improve hydrogen production rate as does an increase in temperature. At a rotation rate of 1000rpm the current enhancement above background current was some 8A, compared with an enhancement of some 37A at a rotation rate increase from 1000 to 2250 rpm. This indicates an exponential type of increase in production rate with increase in rpm, rather than a non-linear increase". This indicates that the technology's output and efficiency can be significantly improved when scaling it. (See page 12 of Schedule 6)

"Based on the thermoneutral potential of 1.41 V the minimum energy consumption is 37.5 kWh/kg. Thus an efficiency approaching 100% is indicated." (See page 12 of Schedule 6)

The above is caveated with *"This data should be used with caution due to the short term duration of the tests and the inherent assumptions in the calculations. There is clearly a need to perform more detailed tests under stable operating conditions to verify the performance observed so far."*
*This will be an ongoing process during Stage 3 development.

In early 2013, VN-HPG Directors held discussions with Siemens AG Energy Sector (Fossil Power Generation & Energy Solutions Division) and were verbally set the target of achieving a 70% + efficiency as a level at which Siemens would potentially enter the project. However, in July 2013, Siemens changed their Managing Board, certain business units were then dismantled or amalgamated with other divisions, including the unit VN-HPG were working with. The data obtained from the EHG4-M trials at Intertek Tickford and the conclusions contained within Professor Scott's report were shared with VN-HPG's previous contacts in Siemens and the report communicated to Siemens' new Head of Power & Gas Division. This led to the signing of an NDA between VN-HPG and Siemens AG and following recent upper management and divisional changes communication has been reinstated.
(See http://www.siemens.com/press/en/pressrelease/?press=/en/pressrelease/2013/corporate/axx20130746.htm
& http://www.siemens.com/press/en/pressrelease/index.php?sheet=2

Pre-approval from HMRC for inclusion in the Seed Enterprise Investment Scheme was granted on the 20th of February 2013, an SEIS 1 Compliance declaration was filed on the 25th of July 2013. 2nd Round EIS approval was granted on the 30th January 2014 and an EIS 1 Compliance declaration was filed on the 20th of October 2014. HMRC have been informed in writing that a 3rd Round of funding is now being held. Approval therefore will (subject to the information provided to HMRC at time of original application not changing) be automatically accorded to the project.

An IP Development Licence in relation to the 'Decomposition of Water', patent family deriving from International patent application number PCT/RU03/000413 and registered in 27 countries, was negotiated *(at an initial stage 1 cost of £50,000)* with the beneficial owner *Viridis Navitas IP Ltd* to complete the development programme.

The 'Stage 2' development was planned in conjunction with the Siemen's objectives, utilising: Pragma Energy, (PE) Professor Scott of Newcastle University (NU) and Fordfleet Limited ("Fordfleet"). All additional IP created during development will be jointly owned by VN-H Power Generation Ltd and VN-IP Ltd for their mutual benefit on a royalty-free basis. The programme was developed via a series of design, build and test iterations targeted at producing a characterised EHG8-M version that could be scaled up to operate with the target gas turbine mentioned in Stage 3/4. Each iteration to had a clear 'Go – No Go' break point linked to output performance.

NOTE

In July 2014 post publication of the Stage 1 success, VN-HPG Directors started discussions with various large manufacturers of heavy duty centrifuges interested in acquiring a manufacturing and licencing deal for the EHG technology. A comprehensive commercial and technical dialogue was entered into with Thomas Broadbent & Sons, one of the UK's largest centrifuge manufacturers. Promotion of the funding round was temporarily suspended pending negotiations and possible beneficial commercial results, as the amount to fundraise would change significantly, and the Directors wanted to protect the investor's, and their own, share dilution position. During this process, all major challenges involved with centrifuge design were examined and all possible alternatives for a design solution that would facilitate the EHG's specific technical requirements explored. The process, of putting together the VN scientific, engineering, design, IP and commercial resources to create a solution from a 'blank sheet of paper' and understanding in detail what didn't work from our Russian colleague's results, resulted in the new EHG design, and completely negated the need for a manufacturing partner at this stage. It also helped to substantiate a project development plan that would not affect the shareholder value, nor impose any constraints on the commercial proposition or its flexibility of delivery to make money for shareholders.

In August 2015, as a result of the delays incurred, and to ensure that no opportunity to improve the projects prospects for success had been overlooked, the Directors reviewed every aspect of the project, re-investigating, re-evaluating and where required, adjusting the plan to benefit the following: Timeline, Cost Reduction, Manageability and Control, Security and Potential Supplier Risk.

Where appropriate previous supplier or partnership arrangements were amended or changed completely when beneficial in one or more of the aforementioned areas. This, and information gleaned from the scaling design work mentioned in the previous and following paragraphs, led to a significant reduction in the development capital estimated to be required for Stage 2, lowering the fundraise requirement from £1,150,000 to £600,000, therefore avoiding greater investor dilution.

As mentioned in the above paragraph, in parallel with the negotiations and to keep momentum in the project, the Directors decided to commission the design for a scalable larger version of the EHG. This was actioned in June 2015 and carried out in parallel utilising funds raised at that time.

This has delivered the following:

1. A completely new series of EHG designs
2. A prototype manufactured and assembled
3. A series of technical workshops held to provide engineering adaptations and design updates
4. Preliminary mechanical longevity testing
5. Preliminary alkali electrolyte testing with initial on-target results achieved.

A significant proportion of the initial raise remains, sufficient to build further scaled iterations of the EHG, for more testing and development.

As a result of these deliverables, additional reduction in project and technology risk and to ensure existing Investors derive maximum value from these activities so far, the Directors decided to close Stage 2 funding at £290,000 on the 19th May 2016.

The subsequent 3rd funding round will target £315,000 at £7,500 per share, reflecting the additional value derived from the previous activities.

Round 3 funding will underpin proof of scalability, and enable the next phase of scale-up to be done using 3D modelling. With the results confirmed, our design team will move onto producing full engineering and manufacturing drawings, so that the larger EHG can be built immediately and tested on the Dynamometer to deliver an independent test report showing optimal and increasing hydrogen output throughout the scaling stages.

In conjunction with the technical development, negotiations are also underway to purchase a mothballed 50MW Gas Fired Power Station in Italy. Piombino Power Plant was commissioned in April 2003 and was specifically built to utilise producer gases from the adjacent steel plant in conjunction with natural gas supplied from the national network. The 11.25MW gas turbines are therefore exactly suited to co-fire Hydrogen, Oxygen and Natural Gas. The plant comprises two GE PGT10b gas turbines and one Ansaldo steam turbine producing a maximum of 58MW in combined cycle.

Plant Background:

The plant received a Feed-in Tariff under the CIP6/92 law for a term of 15 years.

The plant was purchased from the Lucchini subsidiary, GLL, by Hutton Collins Mezzanine Partners in December 2004 and refinanced in 2006. Piombino is now owned by Elettra Produzione S.r.l., a special purpose vehicle established by Hutton Collins for the refinancing of the plant.

In 2011 the Italian State passed legislation to curtail the CIP/6 incentive scheme and gave producers an option to be bought out.

Piombino applied for, and accepted the State buy-out of the contract in 2013 and the plant was closed down in January 2014 as it was not able to compete in the free-market using natural gas only as a fuel. Producer gas is no longer available in significant volumes due to the partial closure of the adjacent steel plant.

The plant has been on sale since early 2014, with a price of €8M.

VN-HPG is under NDA and has a signed MOU with Elletra. We are offering a figure closer to €4M and if price negotiations are successful, the plant will act as a test, technology proofing and demonstration site for the company.

The Round 4 raise will be to buy the plant, and fund its operation whilst development and integration of an industrial-scale EHG into the existing infrastructure as a demonstration unit is completed. Revenues thereafter will be driven by sales of electricity via a commercial power take off agreement and gases produced sold to a suitable partner, thus providing investors with a early realisable balance sheet asset within their investment and an income stream.

Stage 2: *(Closed)* was financed by a 2nd round funding of £290,000 via the issue of a further 58 shares and delivered:

- The design of a series of stage revised EHG-M units; each being larger than the previous unit with continuous characterisation improvement using data obtained from the previous sequential output test results
- 1st scaled version of the finalised EHG design manufactured
- Various technical challenges overcome with engineering adaptations and changes to original design to complete mechanical proof of concept
- Preliminary mechanical and longevity testing completed
- Preliminary alkali electrolyte testing completed with initial on target results achieved.

Stage 3: Now Open and will be financed by a 3rd round funding of £315,000 via the issue of a further 42 shares and will by building and testing further scaled EHG's deliver:

- 1 x Industry accepted independent test report showing optimal and increasing hydrogen output throughout the stages (Provided by Intertek Tickford & Professor Keith Scott of Newcastle University)

- 1 x Set of draft design drawings for a fully characterised EHG used either singly or in a series, matched as a minimum to the 10% co-firing fuel requirements of an GE PGT10b gas turbine operating in a Combined Cycle Gas Turbine Generation plant being driven by an industry standard steam turbine, power take off drive, or electric motor

- 1 x signed 'Option to Purchase' contract for the Elettra Produzione S.r.l owned 50MW CGT Power Plant in Piombino, Italy.

It is envisaged that the generator-manufacturing partner will make commercial research and development funding available; this however is not being taken into account within the Stage 3 budget. In the event that commercial R&D funding is made available before the raise closes, the Directors reserve the right to reduce the amount raised, thus reducing the dilution of all shareholders and increasing their share value proportionately.

Stage 4: Financed by a 4th round raise of £6,400,000 via the issue of a further 640 shares at £10,000 or research and development funding if appropriate or available. (Budgetary figures only)

Delivering:

- The purchase of the Piombino Power Plant together with operating finance for 24 months
- 1 x Set of integration drawings for the EHG waste energy drive system
- 1 x Pre-commercial EHG unit for trial and testing.
- 1 x Set of negotiated supply contracts for 3 x subsequent EHG builds and installation of same, complete with timeframes and delivery service level agreements
- 2 x EHG unit integrated drive systems installed for commercial operation at the Piombino Plant.

The design will be focused on the GE PGT10b gas turbine. Consisting of a waste heat / steam driven fully characterised Electro Hydrogen Generator, producing hydrogen and co-firing it with conventional fuel. We will initially fit the EHG to one of the GE PGT10b 11.25MW multi-fuel industrial gas turbine which are capable of burning a mixture of natural gas and other gases at a 60/40 ratio, providing the plant with a targeted 10% fuel replacement capability and 10% plant reduction in CO_2 emissions, as proof of concept. Once the first EHG unit is deemed to be operating successfully a further unit will be commissioned and installed.

Commercialisation, Timings and Costs

Stage 1 of the programme was completed within 6 months of the raise closing and within budget. Costs were estimated at £126,000 including a minimum stage 1 payment *(£50,000, being 20% of the full cost of £250,000)* of the negotiated development Licence fee. *Note: All Legal, Accountancy and 3rd Party costs as indicated on Page 23 of this IM (estimated at £24,000) were made before project commencement. Project expenditure at £126,000 included a 10% overrun / contingency fee.*

Stage 2 was completed within 12 months of commencement and within budget. Costs were estimated at £261,000. *Note: All Legal, Accountancy and 3rd Party costs as indicated on Page 23 of this IM (estimated at £57,000) will be made before project commencement. Project expenditure at £261,000 included a 10% overrun / contingency fee.*

Stage 3 will take place over a 12-month period with costs estimated at £283,000 including a stage 2 payment *(£50,000 being 20% of the full cost of £250,000)* of the negotiated development Licence fee. *Note: All Legal, Accountancy and 3rd Party costs as indicated on Page 23 of this IM (estimated at £29,500) will be made before project commencement. Project expenditure at £283,000 includes a 10% overrun / contingency fee.*

Stage 4 will take place over a 24-month period with costs estimated at £5,792,000 including a final payment (£150,000 being 60% of the full cost of £250,000) to complete the purchase of the development Licence fee. *Note: All Legal, Accountancy and 3rd Party costs as indicated on Page 23 of this IM (estimated at £608,000) will be made before project commencement. Project expenditure at £5,792,000 includes a 10% overrun / contingency fee.*

A Business Delivery Plan describing the science and technology background, the market drivers, size and target sectors, competition, key objectives and high-level deliverables, organisation and structure, commercialisation, timings and costs, business model, market development, risks and risk mitigation and partner relationships has been developed and can be found in Schedule 1. All other relevant supporting documents are included in Schedules 2, 3, 4, 5 & 6.

The Directors believe that the successful development of EHG technology in this multi-billion £ pa market has the potential to produce revenues worth hundreds of millions each year. In turn, this has the potential to produce significant returns for subscribers in VN-HPG.

Directors, Professional Advisers and Company Information

Directors:

Michael Avison (Technical)
Mark Gilmore (Sales)
David Newman (Commercial)

Secretary and Treasurer:

Steven Strauss FCA

EHG Engineering Consultants:

Allenfield Engineering

EHG Design Consultants

Fordfleet Ltd

Science Advisor:

Professor Keith Scott

Solicitors:

Howard Kennedy,
19 Cavendish Square,
London W1A 2AW

Auditors:

Sopher & Co
38 Berkeley Square
London
W1J 5AE

Registrars:

Simmons Gainsford LLP
4th Floor 7-10 Chandos Street,
London W1G 9DQ

Registered Office:

4th Floor
7-10 Chandos Street,
London W1G 9DQ

Directors:

Mick Avison is a highly experienced Senior Executive Manager, with a referenceable track record in the development, construction, operation and management of power generation projects and businesses (renewable and conventional energy) in Europe. Mick has significant knowledge and experience of Private Equity and Commercial Banking Finance and Risk Management.

He has particular skills in the development of renewable projects, particularly the negotiation and management of EPC contracts for the construction of Power Plants, fuel supply and Power Take Off agreements (PTAs) together with operation and maintenance contracts. Mick also advises private institutions on energy-related issues and asset management.

This expertise has been gained in a number of professional and commercial roles over the last 28 years. Aged 54, his skills mix reflects core training as an engineer, leadership roles in Joint Venture companies and blue chip power generation companies.

Since 2004, Mick has provided independent practitioner and advisory services to private investors, government agencies and independent power companies. In particular, Mick has managed a power business in Italy comprising 230MW CCGT power plant utilising industrial producer gases to co-fire the gas turbines.

In addition, he has developed wind, biomass and solar projects in the EU working with a strong network of contacts. Mick was instrumental in the contract restructuring of the Elettra business in Italy resulting in a successful €170m refinancing in 2007.

Mark Gilmore is a founding Director of Viridis Navitas Capital Partners Ltd *(the sponsor of EHG technology)* and a highly motivated, tenacious and achievement orientated individual who has constantly delivered on business, margin and project targets throughout his career.

Be it participating in successful IT start-ups, or working within a 'FTSE 500' company, Mark brings more than 20 years successful operating experience at senior and executive sales management level to VN-HPG.

Mark's most recent corporate role was managing COLT Managed Services strategic markets region (6 countries and 27 employees). In his last year he delivered over £30m in revenues (118% against target) and nearly £13m of new business bookings (122% against target). This achievement was coupled with the process of transitioning the pre-sales technical architects, with corporate incentive structures to technical consultants holding personal incentive schemes.

Prior to this Mark held a number of senior Business Development roles including; Dimension Data for over 4 years, significantly exceeding revenue, bookings and margin targets in each of the 4 years he was there; GTS Carrier Services; and TGNS S.A. In between these roles, Mark started Big Picture Interactive, a brand new digital multimedia and interactive web company and took the company from start-up to over £1m turnover in the first year, and prior to that converted an antique shop into a pub and restaurant and ran it for 2 years before exiting.

David Newman is also a founding Director of Viridis Navitas Capital Partners Ltd *(the sponsor of EHG technology)* and another highly commercial, innovative and success driven individual. He is also an entrepreneur with a strong electronic, electro-mechanical, automotive and heavy engineering background.

Following 10 years of military service operating throughout the world, David spent the next 10 learning the commercial realities of international business by apprenticing himself to the most successful business owners and companies he could find. During this period, he was tasked across a broad range of industries including, leisure, entertainment, automotive, telecoms, advertising and IT.

His corporate roles have included: Project Management, New Business Procurement, Financial Restructuring, Technical Creation and Support, IT Solution Creation & Delivery, Training Program Creation & Delivery and Change Management.

In 1999 he formed his own Telecoms consultancy and later that year created Trans Global Network Services, the world's first global fibre optic leasing operator.

After successfully exiting TGNS in 2002 with annual revenues of $27m, David accepted the role of Commercial advisor to the then Maltese Minster of Finance, The Right Hon Mr John Dalli.
There he formed part of a 3-man team charged with redesigning the Countries FDI programme, agencies and Industrial Estate Management.

Successful completion of this project delivered a 'step change' in Government attitude toward FDI procurement, Business Promotion and even its own work force, pre the Country's accession to Europe.

In 2004 David continued his career by taking on international consultancy roles within the restructuring IT and telecoms sector and later within the emerging renewable energy industry.

He returned to the commercial 'start-up' market place in 2008, designing and building an "outsourced" Debt Management and Cash Collection business for top 50 London accountancy practice, Simmons Gainsford LLP. SG Debt Management was initially created to assist SG client's post-recession but today has exceeded that brief. David successfully exited the business in 2014 with annual cash collections in excess of £13m.

In mid-2009, David was invited to lead the design team in building an 'algae-to-fuel' Photo Bio Reactor for a US project. In mid-2010 working with the same US affiliates, he went on to manage the design and build of an innovative 'oleophilic membrane' crude oil recovery rig. With support from the US Department of Energy, the machine was deployed in the Gulf of Mexico and trialled as part of the Deep Water Horizon clean-up operation.

In September 2010 David joined forces with Mark and formed Viridis Navitas Capital Partners Ltd (VN-CP) specifically to target the renewable energy start-up funding gap experienced by inventors, engineers and scientists alike. Since inception VN-CP has delivered 7 successful funding rounds for platform technology application spinouts raising in excess of £2M via HMRC Pre approved Seed Enterprise Investment Schemes & Enterprise Investment Schemes. The above-mentioned experiences have allowed David to build up a broad network of contacts throughout Governments and industries alike that he leverages to the benefit any company he works with. Understanding the financial risk versus reward balance for investors, as a 'real' investor himself, he brings an unusual but extremely useful skill set to the company.

Secretary and Treasurer

Steven Strauss is a Chartered Accountant and Fellow of the Institute of Chartered Accountants in England and Wales. Steven read Economics at the London School of Economics, gaining a BSc Honours Degree in 1981, studied for his articles and qualified in 1985 receiving an associate membership of the Institute of Chartered Accountants in England and Wales later in that year.

In addition to work in the tax field, Steven has also had a significant amount of commercial experience, advising and consulting corporate entities on a wide range of matters.
Steven has been a Director of an Australian Stock Exchange Quoted company and is currently Chairman of an International payments solution company, Senior Partner at Simmons Gainsford LLP and Financial Director of VN-Capital Partners.

EHG Engineering Consultant

Allenfield Engineering is a specialist provider of highly technical precision manufactured engineering solutions. They have been involved with the creation and manufacturing of all UK EHG variants and their evolution since the technologies migration from Russia to the UK.

EHG Design Consultants

Fordfleet Ltd has worked within the nuclear, aviation and power generation engineering design sector for the past 20 years. Recognised for their innovation capabilities and unique solution designs, Fordfleet have operated in conjunction with Allenfield to deliver specialist-engineering solutions to global industry for the past 13 years.

Science Advisor

Prof. Keith Scott is Professor of Electrochemical Engineering at the School of Chemical Engineering and Advanced Materials, Newcastle University.

Research activities include:
Electrochemical power sources: fuel cells, batteries, microbial and biological fuel cells
Electrochemical environmental engineering, photochemical processes, Membrane materials and membrane separations.

Research Interests are:
Fuel cells, power sources and energy systems,
Electrocatalysis
Electrochemical systems and engineering,
Reaction engineering, catalytic reactors
Membrane separation processes and membrane reactors

Research themes & Projects:
Alkaline Polymer Electrolyte Fuel Cells
Project Leader(s): Prof Keith Scott

An Oxygen Electrode for a Rechargeable Lithium Battery.
Project Leader(s): Prof Keith Scott

Enhanced Fuel Cell Flexibility
Project Leader(s): Prof Keith Scott

SUPERGEN III - Fuel Cells: Powering a Greener Future.
Project Leader(s): Prof Keith Scott

To develop a potential energy self sufficient process to treat waste and waste water using Microbial Fuel Cell
Project Leader(s): Prof Keith Scott

Executive Summary

Company History & Objectives

This Information Memorandum has been published to enable the Company to raise a further £315,000 in third round of funding. This is offered on terms, which will enable qualifying subscribers to benefit from the EIS regime.

Having successfully met the Stage 1 project development milestones the Company is now raising (Round 3) an additional £315,000 via the issue of a further 42 ordinary shares of 1p each at £7,500.00 per share as new subscription capital, which (upon full Round 3 subscription) will represent 2.8% of the total share capital in the Company.

3rd Round investors will also be offered the option to acquire 21 shares in total (at £5,000 per share) from the Founder Shareholders after the Company has successfully met the Stage 3 project development milestones. This transaction will take place at the same time as the 4th Round funding. This would (if full exercise takes place) increase their shareholding to 2.94% in the Company.

Note In addition to the 42 shares being made available under EIS to 3rd round investors, a further incentive is provided in the form of share options. In the event that the company meets all of its specified commercial targets and milestones, 3rd round investors will be able to acquire one existing founder share (at £5,000) for every two EIS shares held. It is envisaged that the exercise of these options will be concurrent with the 4th funding round when EIS shares will be available at £10,000 per share.*

For the 4th Round funding the Company will raise an additional £6,400,000 via the issue of a further 640 shares at £10,000 per share, representing (upon full subscription) 29.91% of the share capital in the Company.

Upon the successful closing of 4th funding round, and full exercise of the options held by the 2nd & 3rd Round subscribers, the shareholdings will be:

Founding shareholders:	56.07%
New Founder Shareholders	7.01%
2nd Round subscribers:	4.07%
3rd Round subscribers:	2.94%
4th Round subscribers:	29.91%

The objectives of the company are to exploit the globally exclusive Licence rights to successfully develop an Electro Hydrogen Generator ("EHG") by:

1. Licence and Design sales of retrofit EHG solutions to manufacturers / operators currently using natural and industrial gas fuelled turbines to provide lower operating costs and secondary gas products for resale

2. Sales of EHG licencing rights to Gas Turbine manufacturers for all new Gas Turbine plant.

The sales value of Natural Gas used globally by the power generation industry that is capable of using EHG technology is estimated at **£234 billion pa**. (Estimates use the natural average gas price paid by Elettra Produzione Sprl, Italy an EHG site partner in 2011)

VN-HPG's business model is based upon replacing a minimum of 10% of natural gas per installation with on-site produced co-fired hydrogen, thus producing a potential market size of **£23.4 billion pa**. With hydrogen offered at net 50% of the market price for Natural Gas, the Company revenues could build to exceed **£11.7 billion pa**, but even with limited market penetration we envisage multi-million £ revenues providing subscribers with the very real potential for significant returns.

Legislative Business Drivers

The business opportunity that VN-H Power Generation seeks to exploit is being driven by government legislation across the world focusing on the reduction of CO_2, and the need to counter the rising price of natural gas and liquid fuels used to fuel gas turbines. To underpin this global emission reduction strategy, incentives, taxation and fines have been put in place to drive business behaviour and have therefore created the need for new and innovative technologies to actually deliver the required reductions.

These reductions are managed through Multilateral Environmental Agreements (MEA) under the auspices of the United Nations Environment Programme (UNEP) and supported by international legal instruments such as Emission Trading schemes (ETS) such as the European Emission Trading Scheme that has been in operation since 2005.

Evidence in the 1960s and 70s that concentrations of carbon dioxide (CO_2) in the atmosphere were increasing first led climatologists and others to press for action and in 1988, an Intergovernmental Panel on Climate Change (IPCC) was created by the World Meteorological Organization and UNEP, which issued a first assessment report in 1990 which reflected the views of 400 scientists. The report stated that global warming was real and urged that something be done about it. The Panel's findings spurred governments to create the United Nations Framework Convention on Climate Change (UNFCCC), which was ready for signature at the 1969 United Nations Conference on Environment and Development - more popularly known as the "Earth Summit" - in Rio de Janeiro.

The Kyoto Protocol adopted in Kyoto, Japan, in 1997 is an international agreement linked to the UNFCCC, it's major feature is binding targets for 37 industrialized countries and the European community for reducing greenhouse gas (GHG) emissions. The detailed rules for the implementation of the Protocol were adopted at the 7th conference of parties (COP 7) in Marrakesh in 2001, and are called the "Marrakesh Accords". The Kyoto Protocol entered into force on 16 February 2005.

The Kyoto Protocol contains provisions for reducing GHG emissions from industrial activities, power generation, international aviation and shipping which are treated in a different way to the former sources due to their global activities that is, pursuing though the International Civil Aviation Organization (ICAO) and the International Maritime Organization (IMO) respectively. Emissions from domestic aviation and shipping are included in national targets for Annex I countries. ICAO and IMO regularly report progress on their work to UNFCCC.

The 17th Conference of the Parties to the UNFCCC (COP17) and the 7th Session of the Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol (CMP7) were held in Durban, South Africa, on 28 November–9 December 2011. After prolonged debate, the Kyoto Protocol was extended into a second commitment period. The meeting of COP18/CMP8 took place from 26 November-7 December 2012 in Doha, Qatar and agreed to extend the Kyoto Protocol until 2020.

The ETS operates in 30 countries: the 27 EU Member States plus Iceland, Liechtenstein and Norway. It covers CO_2 emissions from installations such as power stations, combustion plants, oil refineries and iron and steel works, as well as factories making cement, glass, lime, bricks, ceramics, pulp, paper and board. Launched in 2005, the EU ETS works on the "cap and trade" principle. This means there is a "cap", or limit, on the total amount of certain greenhouse gases that can be emitted by the factories, power plants and other installations in the system.

Within this cap, companies receive emission allowances, which they can sell to or buy from one another as needed. At present, the vast majority of allowances are given out for free but will be charged for in the near future. The limit on the total number of allowances available ensures that they have a value. At the end of every year, each company must surrender enough allowances to cover all its emissions (*otherwise heavy fines are imposed; (currently €100 per tonne).* If a company reduces its emissions, it can keep the spare allowances to cover its future needs or else sell them to another company that is short of allowances.

The number of allowances is reduced over time so that total emissions fall. In 2020 emissions will be 21% lower than in 2005. The current level of emissions allowances in the EU27 (2.01 billion tonnes) will be cut by 1.75% per year until 2020. 1.3 billion tonnes per year are emitted globally from combustion plant comprising of 8,482 installations. Commencing January 2013 all European combustion Power Generators have had their 'free allowances' removed, and all CO_2 allowances must now be purchased in the market.
(See http://ec.europa.eu/clima/policies/ets/index_en.htm)

Impact of COP21, Paris, 12 December 2015

195 countries agreed for the first time that a reduction in carbon emissions was necessary with the aim of maintaining a rate of rise of global temperature below 1.5°C and reducing the rate to Zero by 2050.

Industrial nations will provide funding and/or technology transfer to developing countries, it is estimated that $1 Trillion will need to be spent in the decade 2020-30 on clean technologies.
Countries not making the agreed efforts will be named and shamed in addition to penalties that already apply in various countries.
Thus pressure will be put on fossil fired power plants to reduce emissions either by re-powering or plant modification and emission abatement.

*NOTE**

The United Kingdom's exit from the European Union does not affect the its commitment to the COP21 agreement.

The Market

There are 2 main sales opportunities for the deployment of EHG technology within this market:

1. New Gas Turbine Plants
2. Refurbishing existing GT Power Plants as part of their operating and maintenance (O&M) programme.

New Gas Turbine Market Place

Forecast International predicts sales of 1,072 gas turbines for electrical power production in 2014, increasing steadily to 1,300 units by 2023. The value of production will be $18.4 billion in 2014, rising to $22.3 billion by 2023.

Annual growth in global gas turbine unit sales will drop from 2.3% in 2014 to 1.3% in 2017. A rebound of 2% is likely in 2018, maintaining 3% over the next three years. Value of production is expected to average 1.7% over the next ten years, with the least growth again in the span from 2016 to 2018.

Nearly 60% of the turbines produced in the coming decade will be of an output below 50MW, corresponding to the needs of developing countries, distributed generation and peaking power requirements.

These units in simple cycle are also likely to find use in conjunction with renewable energy power plants, helping them keep their generating profile level. Larger output gas turbine machines will typically be installed in combined cycle service for power generation, industrial cogeneration or combined heat and power applications.

In the coming decade, it is projected that 11,769 gas turbines will be built for electrical power generation, having a value of production in excess of $205 billion (in current U.S. calendar-year dollars). *(Source: **Turbo Machinery Handbook 2014**)*

For new Gas Turbine equipment development production, VN-HPG will provide a consultancy service for EHG design but will primarily receive its revenues via "rights of use" Licence fees paid by the major GT plant manufacturers and based upon a percentage of the "replacement fuel supplied" value. The table below shows the market opportunity using 2011 actual figures and the following assumptions are based on the VN-HPG technical team's past operational experience within the industry.

- Peak plant operates for 500 hours per year
- Standby plant is not considered in the calculations
- Continuous plant operates for 5500 hours per year
- Gas priced at 30p per m^3 in 2011
- Energy in gas is 10.5kW/m^3.

*NOTE**
Current European gas price is $6.25/mmbtu divide by 28.26m^3/mmbtu = £0.15/m^3 based on exchange rate of $1.48 = £1. All assumptions in the financials refer to 30p per m^3, as forward market pricing indicates that this is a more realistic figure for 2018.*

The total market in NG sales to fuel the Generation plant sold in 2011 was £12.4bn
(See table below – Source: DGTW - Diesel, Gas Turbine Worldwide)

Global Gas Turbine Sales 2011

Size Range	No. Sold	MW Sold	S/By	Peaking	Continuous	Efficiency	Gas Consumption	ating Hours per Year		Consumption	Price	Market Size
MW	No	MW	No	No	No	%	m3/h	Peak	Continuous	Total m3/year	£/m3	£
1.00 - 2.00	118	161	94	0	24	23%	913.04	500	5500	120,521,739	0.3	36,156,522
2.01 - 3.50	54	152	42	0	12	23%	1,597.83	500	5500	105,456,522	0.3	31,636,957
3.51 - 5.00	67	274	38	0	29	25%	2,100.00	500	5500	334,950,000	0.3	100,485,000
5.01 - 7.50	47	278	3	0	44	25%	3,150.00	500	5500	762,300,000	0.3	228,690,000
7.51 - 10.00	45	353	1	0	44	30%	3,500.00	500	5500	847,000,000	0.3	254,100,000
10.01 - 15.00	83	1,176	0	0	83	32%	4,921.88	500	5500	2,246,835,938	0.3	674,050,781
15.01 - 20.00	5	81	0	0	5	32%	6,562.50	500	5500	180,468,750	0.3	54,140,625
20.01 - 30.00	9	232	0	0	9	33%	7,954.55	500	5500	393,750,000	0.3	118,125,000
30.01 - 60.00	98	3,549	0	21	77	34%	13,897.06	500	5500	6,031,323,529	0.3	1,809,397,059
60.01 - 120.00	67	5,484	0	16	51	35%	27,000.00	500	5500	7,789,500,000	0.3	2,336,850,000
120.01 - 180.00	37	5,617	6	5	26	36%	43,750.00	500	5500	6,365,625,000	0.3	1,909,687,500
> 180	47	11,474	0	0	47	38%	63,552.63	500	5500	16,428,355,263	0.3	4,928,506,579
	677	**28,831**	**184**	**42**	**451**					**41,606,086,741**		**12,481,826,022**

VN-HPG will target the replacement of 10% by volume of NG, thus providing the company with a potential £1.24bn pa market opportunity before discounting, based on a projected cost of gas in 2018 of 30p per m^3.

Retrofit Market Place

Over 177,000 Power Generating units are installed in 80,000 power plants worldwide, 37,000 using Alternative or Gas Turbine technology. (*Platts Energy Today 2011) 21% of the total power generated globally is achieved by firing natural or industrial gas. (*World Bank Energy Report 2011)

The number of existing generator units that can be retrofitted with EHG technology is estimated at 27,750, ranging in size from 1MW CHP (Combined Heat and Power) to 400MW combine cycle units. The Natural Gas burned to fuel these plants amounts to some £234 billion pa.
VN-HPG on-site EHG plant will potentially provide a minimum of 10% in replacement hydrogen for co-firing, thus providing a ***£23.4 billion pa*** *market opportunity before discounting, based on a projected cost of gas in 2018 of 30p per m^3.*
(Source: Number of units that can be retrofitted is based on units sold as published in DGTW within the past 15 years and those that are registered as still available for service)

In conjunction with its integration partners VN-HPG will carry out the design for all retrofit applications. It will subcontract manufacturing, assembly, installation and O&M, deriving income streams from both the design and the supply. As with the new turbine equipment opportunity "rights of use Licence fees or royalties" will be based upon the amount of replacement fuel supplied at a discounted price, pegged to the market price of Natural Gas.

The VN-H Power Generation Solution

In the industrial power generation sectors, EHG technology will both reduce legislated emission levels and reduce fuel consumption by providing hydrogen as a 'clean fuel' for co-firing. When co-fired with conventional fuel, hydrogen initially increases the engine combustion efficiency (up to a maximum of 3%) after this point the hydrogen simply replaces conventional fuel on a proportional basis.
As the conventional fuel is replaced by hydrogen generated by the EHG, greater fuel efficiency is achieved and correspondingly CO_2 emissions are reduced.

The technology VN-HPG is developing will produce Hydrogen "onsite". EHG technology splits water derived either from natural sources, mains supply or by desalination and stored in a reservoir on site (most existing power generators have facilities for cooling and steam raising processes).

It is fed to the EHG after being heated by the waste streams available from the existing generator and mixed with an electrolyte. Hydrogen is then generated and co-fired via the secondary industrial gas feed and management system.

By producing and having the compression / storage option for Hydrogen on site, VN-HPG can mitigate the peak / off peak electricity demand curves without losing production capacity.

While VN-HPG will offer a solution to generator manufacturers seeking to meet the ever-growing legislative targets for fuel efficiency and CO_2 emissions, it will also produce an additional benefit for those manufacturers by providing a retrofit solution for existing equipment.

*NOTE**

There is also the possibility of a second revenue stream. In the event that the EHG produces in excess of the 10% forecast for co-firing, or the market price of hydrogen & Oxygen is greater than that of natural gas, all or any hydrogen & Oxygen produced can be sold into the commercial gas market place providing operators with supplementary revenue streams. This opportunity IS NOT reflected in the financials section of this Information Memorandum but when applied to the Piombino Plant financials sees a potential EBITDA of €80M instead of the recorded 2011 loss of €8M.

EHG Technology

The Electro Hydrogen Generator (EHG) is a device proven in laboratory conditions to produce accelerated hydrogen from water *using electrical energy as a rotational force.*

In this application, VN-HPG will use the combination of waste steam and heat energy derived from existing turbine generating systems to provide centrifugal / rotational force. This when combined with magnetic force and conventional electrolysis provides a far greater level of hydrogen production than conventional electrolysis with a zero energy cost, as the EHG makes use of waste energy streams which would otherwise be lost.

Before its development in the UK, the basic principles of the technology were developed in Russia by respected scientists (see EHG History on page 46) and validated by an International peer science review team prior to its endorsement by the UKTI. The review team established by UKTI comprised:

Prof. Derek Frey: Dept. of Materials Chemistry, Cambridge University
Dr. Fulcieri Maltini: EBRD scientist and fuel expert
Dr. Juan Matthews: BERR International Technology Promoter (UKAEA)

An adapted technology application specifically for the automotive industry went on to win a Shell Springboard award in 2008. (See http://www.shellspringboard.org/alumni/2008/electro-hydrogen-generator)

Published Quotations from the Peer Review Team & Shell Springboard Judge

"The process theory has been confirmed by a series of differential equations and the EHG has provided a proof of the Hydrogen and Hydrogen Peroxide production."
Dr. Fulcieri Maltini

"Project EHG is one of the few projects of all those I have seen in recent years that is genuinely proposing a workable solution to our transport needs from an energy usage point of view."
Dr. Ricardo Martinez-Botas – Professor of Turbo-machinery at Imperial College and Shell Springboard Judge

Newcastle University Interim Report: *Keith Scott - Professor of Electrochemical Engineering at the School of Chemical Engineering and Advanced Materials within Newcastle University.* (See Schedule 6)

"The best performance was achieved with the sulphuric acid electrolyte based EHG tests. A peak hydrogen production rate at an equivalent current of 71 Amps and an energy consumption of 36 kWh/kg was obtained *which is superior to that for water electrolysis.* The average energy consumption for the short term tests is comparable with those for standard water electrolysis"

"Qualitatively increased rotation rate appears to improve hydrogen production rate as does an increase in temperature. At a rotation rate of 1000rpm the current enhancement above background current was some 8A, compared with an enhancement of some 29A at a rotation rate increase from 1000 to 2250 rpm.

This indicates an exponential type of increase in production rate with increase in rpm, rather than a non-linear increase" and *"based on the thermoneutral potential of 1.41 V the minimum energy consumption is 37.5 kWh/kg. Thus an efficiency approaching 100% is indicated"*

The Business Model

Revenue Streams

There are two immediate revenue streams generated in this business model:

1. Design, consultancy and rights of use Licence fees from the major gas fired generator manufacturers which would allow them to integrate EHG technology with their new Gas Turbine generator design
2. Design, consultancy and rights of use Licence fees for integration of EHG technology into existing Natural and Industrial gas fuelled power stations by the generator manufacturers as part of their O&M / upgrade process to lower operating costs and provide second and third gas revenue streams.

Value of EHG "Rights of Use" Contracts

Whilst the commercial supply of EHG technology has not yet been achieved, using the Platts Natural Gas index identifies the cost benefit and relating NG market pricing to on-site produced Oxygen and Hydrogen. Using this data a pricing model has been built and revenue projections made.

In both revenue streams VN-HPG will receive a Licence fee linked to the replacement fuel value produced on-site. This is pegged to the market price of Natural gas and then discounted to make the model commercially viable.

If we take the example of a plant in northern Italy, which consumes both natural gas and steel process gas using a Siemens' design gas turbine. The plant consumed 2.361 billion m^3 of gas over the past 5 years at an average cost of £0.30/m^3 or approximately £708,333,333 in total expenditure. If an EHG had been fitted at the plant replacing just 10% of the gas required, at 50% of the market gas price, savings of £35,416,666 over 5 years or £7,083,000 per annum would have been achieved.

VN-HPG Ltd Balance Sheet as at 31st March 2015

(Prior to Round 2 Subscribers' Funds)

	2015		2014	
	£	£	£	£
Fixed Assets	30,000		40,000	
Tangible Assets	336		672	
	___________		___________	
	30,336		40,672	
Current Assets				
Debtors	70,876		51,538	
Cash at Bank	89,270		118	
	___________		___________	
	160,150		51,476	
Creditors: Amounts falling due within one year	-20,000		-10,000	
	___________		___________	
Net Current Assets		140,150		41,476
		___________		___________
Net Assets Less Current Liabilities		170,486		82,148
		==========		==========
Capital & Reserves				
Called up Share Capital		15		14
Share Premium Account		419,998		149,999
Profit & Loss Account		-249,527		-67,865
		___________		___________
Shareholders Funds		170,486		82,148
		___________		___________

General Disclosures

The Directors hereby undertake not incur liabilities outside of the funding amounts raised.

The Company will not issue dividends within the first three years following the offer. Dividends may be paid in subsequent years when the project will be deemed successful i.e. when the characterised and scaled EHG is installed, operating, and providing at least 10% hydrogen on site as replacement fuel.

The shareholders will share in any initial and all ongoing profits resulting from Design, Consultancy, technology sales or "Rights of Use" revenue generated by the Company within the Gas Turbine generation industry on an annual basis. It is the company's intention to distribute dividends from free cash-flows, though the goal for management is to secure a trade-sale or "listing" of the company to secure an investor exit.

Structure for Investment in the Company

The Company will raise £315,000 in this round of funding to enable it to deliver the project and to provide for the Company's overhead and working capital:

(i) Round 1: £ 150,000 (Fully Subscribed)
(ii) Round 2: £ 290,000 (Fully Subscribed)
(iii) Round 3: £ 315,000 OPEN
(iv) Round 4: £ 6,400,000 TBA

Prior to the subscription of equity capital by the 'New Founder Shareholders', the Founding Shareholders, with their associates, have negotiated terms for the IP development Licence, access to the original scientific research file, access to the results from, and test rights to, the UK built EHG 4M at Tickford Powertrain Testing Ltd. They have also negotiated consultancy / services supply contracts with the necessary industry and scientific partners to deliver the project, created the business plan and in April 2011 had the technology approved and given 'Green Light' status by the UKTI.

In consideration of this, the Founding Shareholders currently hold, and will retain, 1,250 shares (initially 100% equity interest in the Company). The Company issued a further 150 shares priced at £1000 per share to the New Founder Share Holders (NFSH) upon successful closing of Round 1 funding. In Round 2 the Company issued a further 58 shares (priced at £5000 per share) and an additional option to purchase another 29 shares from the Founding Shareholders at £5000 per share after the company has successfully met the Stage 2 delivery milestones.

In Round 3 an issue of a further 42 shares (priced at £7,500 each) is offered. Upon the successful closing of the Round 3 funding and full uptake of the Round 2 options, the Founder Shareholders (FS) will have been diluted to 81.4%, New Founder Shareholders to 10%, Round 2 subscribers (R2S) to 5.8% and Round 3 (R3S) subscribers 2.8%.

3rd Round investors will also be offered the option to acquire 21 shares in total (at £5,000 per share) from the Founder Shareholders after the Company has successfully met the Stage 3 project development milestones. This transaction will take place at the same time as the 4th Round funding. This would (if full exercise takes place) increase their shareholding to 2.94% in the Company.

All new subscribed funds will be used to pay for the project proof and development, acquisition of any identified (now or in the future) external expertise or know how, IP registration, legal fees, and to meet the assembly and working capital and costs of the Company, as follows:

Projected Development cost (including VAT)	£6,439,500
Capital Raising and Project Assembly Costs	£ 429,300
Legal and Accounting Costs	£ 286,200
TOTAL	£7,155,000

The Company has budgeted for a distribution fee equal to 6% of the capital raised by the Company through the issue of the Shares, less any amount payable by the Company in respect of any introductory fees payable to authorised third parties.

Note: The full terms of subscription are shown on page 29..

Successful Project

The project will be deemed fully successful when the characterised and scaled EHG is installed, operating and providing at least 10% hydrogen on-site as replacement fuel. The shareholders will share in any initial and all ongoing profits resulting from Design, Consultancy, technology sales or 'Rights of Use' revenue generated by the Company within the Gas Turbine power generation Industry on an annual dividend basis.
Note: Dividends paid may be subject to tax in the investor's hands at the relevant rate at the time payment is made.

Unsuccessful Project

In the event that the project is not successful or it is determined that it is not commercially viable to continue with the sales and development effort at any of the milestone points described within the development programme, the Directors undertake that the Company will not incur creditor liability beyond the amount raised in the funding rounds pre revenue, therefore:

a) The Company may be sold to a third party for the value of any residual assets and the proceeds distributed amongst the investors
b) The Company may be put into liquidation, the liquidated assets sold and the proceeds distributed amongst the investors.

In any of the above, the disposals will require shareholder approval to a special resolution on the action to be taken.

Exit Strategy and Potential Returns for Round 3 Subscribers

Upon successful deployment of the EHG technology the Directors plan an Initial Public Offering of the shares in the company between 2019 and 2022 or at such time as the Directors believe a significant multiple on initial investment may be achieved for subscribers.

No guaranteed forecast can be given of the likely or potential returns to Subscribers upon the successful delivery of the project. Therefore, given current market uncertainties, allowances have been made for a broad spectrum of returns.

On the basis of Market Research carried out by VN-HPG, the cost of electricity generation using NG in the target sector is estimated currently to be £234 billion in 2018.

Of this, we are proposing that 10% be replaced by EHG generated hydrogen, providing a market opportunity of ***£23 billion pa.***

The 670 or so New Generator sales made each year incur another £12.48 billion in fuel costs, thus providing a further ***£1.248bn pa market opportunity****.*

The business model uses Platts pricing of NG discounted by 50% and assumes 10% of the turbines fuel requirement being replaced with hydrogen produced by the installed EHG. The 'equipment installed' revenue assumptions through the period 2018 to 2022 are based upon a minimum 20% retention of gross replacement gas revenue by way of licencing fees, plus Design & Consultancy income of £1m per unit targeted at 8 unit designs pa. (4 x new turbine models & 4 x Refurbished existing models).

The balance of revenue (80%) provides for hardware, installation and equipment O&M costs. VN-HPG is budgeting for fixed annual operating costs of £1m in 2018 rising to £2m in 2019, £3m from 2020 and £4m from 2021 onwards. Costs of £2m pa upwards are primarily for Design and Consultancy services that will be outsourced. There is potential to substantially reduce the outsource costs if insourcing is considered a more strategic option.

Of the 27,750 CCGT and GT units that are in use today, around 25% are Siemens technology, (see page 45 for Installed Market Breakdown) which amounts to 6938 units. Of these VN HPG proposes to penetrate 0.5% pa, (35 units), in line with Siemens O&M service programmes. *(See Schedule 5 Financials).*

Penetration into the New Generator sales market place is restricted by the number of prototype designs VN-HPG can produce annually, and by the 12 notional MW output bands manufacturers use when manufacturing generators.

VN-HPG is focussing initially on the 5.01MW – 7.5MW models to match the initial prototype design brief. This sector provides an average of 47 units or 7% of the total market manufactured and sold annually. There are 2 major manufacturers in this particular size sector and we are targeting participation with one of them to provide 5 units in year 1.

We are predicting annual growth by way of selective prototype design to match generator sizes, thus in year 2 we are targeting the most valuable sector the 60.01MW – 120MW, in year 3, 30.01MW – 60MW units, in year 4, 10.01MW-15MW units and year 5, 7.51MW – 10MW.

VN-HPG's approach to the market provides for exceptional returns but we are showing a nominal market penetration post Year 1 in our projections. The business model is not to sell manufactured EHG units, rather to Licence the technology to manufacturers based on having proven, size matched prototypes for the market's most popular models. The same principle applies to the retrofit market place with design focussing on the most common generators in use today.

Post round 2, VN-HPG will actively engage with all other manufacturers and management are confident that the Company will penetrate one other manufacturer successfully as competition and cost pressures leverage manufacturers to seek new technology and market differentiation. VN-HPG has not however, included the additional revenues/margins in this document, as they would be indicative only.

The information included within the IM is the most accurate market data available to-date and therefore reliable in the context of VN-HPG's assumptions and resultant revenue/margin projections.

The following tables demonstrate possible Investor returns for all subscribers given a varying range of circumstances and market uptake i.e.

1. 5 units pa of Siemens 'new build ' 5.01MW - 7.5MW market share & 0.5% (35 units) of their refurbishment market place in 2018 returns total revenues for VN-HPG of £9.1m p.a. (Scenario 1)
2. 6 units of Siemens 'new build' 60.01MW - 120MW market share and 0.5% (35 units) of the their refurbishment market place in 2019 returns total revenues for VN-HPG of £14.42m p.a. (Scenario 2)
3. 10 units of Siemens 'new build' 30.01MW – 60MW market share and 0.5% (35 units) of their refurbishment market place in 2020 returns total revenues for VN-HPG of £21.5m p.a. (Scenario 3)
4. 8 units of Siemens 'new build' 10.01MW – 15MW market share and 0.5% (35 units) of their refurbishment market place in 2021 returns total revenues for VN-HPG of £29.5m p.a. (Scenario 4)
5. 5 units of Siemens 'new build' 7.51MW – 10MW market share and 0.5% (35 units) of their refurbishment market place in 2022 returns total revenues for VN-HPG of £35.5m p.a. (Scenario 5).

Note: The gas sales revenue numbers used with this model are averaged usage NG costs across the 670 units produced in 2011 (see Gas Turbine Sales Chart on Page 17) and are therefore extremely conservative.

New Founder Shareholder SEIS Round (Closed)

Round 1 (NFS) Example Investment of £50,000 = 50 Shares						
				Potential Return on Investment		
Year	Gross Income	EBITDA	Sales Projections	P/E	P/E	P/E
				7	10	12
2020	£9,168,287	£4,968,287	Scenario 1	£812,570	£1,160,815	£1,509,059
2021	£14,429,275	£9,229,275	Scenario 2	£1,509,461	£2,156,373	£2,803,284
2022	£21,536,586	£15,336,586	Scenario 3	£2,508,320	£3,583,314	£4,658,309
2023	£29,503,822	£22,303,822	Scenario 4	£3,647,821	£5,211,173	£6,774,525
2024	£35,503,391	£29,503,391	Scenario 5	£4,825,321	£6,893,316	£8,961,310

EIS Round 2 Shareholder Raise (Closed)

Round 2 Example Investment of £50,000 = 10 Shares						
				Potential Return on Investment		
Year	Gross Income	EBITDA	Sales Projections	P/E	P/E	P/E
				7	10	12
2020	£9,168,287	£4,968,287	Scenario 1	£162,514	£232,163	£301,812
2021	£14,429,275	£9,229,275	Scenario 2	£301,892	£431,275	£560,657
2022	£21,536,586	£15,336,586	Scenario 3	£501,664	£716,663	£931,662
2023	£29,503,822	£22,303,822	Scenario 4	£729,564	£1,042,235	£1,354,905
2024	£35,503,391	£29,503,391	Scenario 5	£965,064	£1,378,663	£1,792,262

EIS Round 3 Shareholder Raise Open

Round 3 Example Investment of £50,000 = 6.6 Shares						
				Potential Return on Investment		
Year	Gross Income	EBITDA	Sales Projections	P/E	P/E	P/E
				7	10	12
2020	£9,168,287	£4,968,287	Scenario 1	£107,259	£153,228	£199,196
2021	£14,429,275	£9,229,275	Scenario 2	£199,249	£284,641	£370,034
2022	£21,536,586	£15,336,586	Scenario 3	£331,098	£472,998	£614,897
2023	£29,503,822	£22,303,822	Scenario 4	£481,512	£687,875	£894,237
2024	£35,503,391	£29,503,391	Scenario 5	£636,942	£909,918	£1,182,893

EIS Round 4 Shareholder Raise (TBA)

The potential investor returns assume the following:

1. An example Third Round Shareholder investment of £50,000
2. Shares in the company are offered for sale to the public
3. Market penetration assumption numbers 1-5 on page 27 are met
4. EHG units achieve at least 10% hydrogen production
5. Shares in the company trade at a significant multiple of the underlying earnings per share
6. All options offered to Round 2 Investors are fully subscribed in Round 3
7. All options offered to Round 3 Investors are fully subscribed in Round 4.

Note 1: These figures were prepared using Industry P/E ratios prevailing in July 2013.

Note 2: With the advent of Gas "Fracking", its growth in the US, its potential growth in the UK, and other markets, the NG electricity generator manufacturer market is highly likely to benefit from this by means of significant growth. The figures herein will therefore also benefit significantly from this development.

Note 3: None of the figures contained in this section are guaranteed as they rely on a range of assumptions that may ultimately prove to be inaccurate. Accordingly, subscribers should not rely on these figures, which are not guaranteed by the company, when making a decision to subscribe for shares.

Note 4: VN-HPG reserves the right to amend the minimum second round investment figure at its discretion.

Terms, Conditions and Procedures for Subscription in Round 2– EIS Shareholder Raise

1. Subscriptions for the Shares are subject to the terms and conditions set out below.

2. Subscribers will subscribe for Ordinary 1p shares in the Company at a premium of £7499.99 per share, giving a subscription price per share of £7,500.00.

3. The Minimum Individual Amount of £15,000 will be a subscription for 2 shares. The Directors retain the power to vary the amount of the Minimum Individual Amount.

4. The full subscription of £315,000 under this offer, as satisfied wholly through the proceeds derived from the allotment of the Round 3 shares, will be a subscription for 42 shares representing 2.8% of the Company's issued shares upon closing. At the time that these shares are issued, the total issued shares of the Company will be 1500 shares, of which the Founding Shareholders will hold 83.3% via their 1,250 shares, the New Founder Shareholders 10%, 2^{nd} Round Shareholders 3.9%.

5. The subscription offer will be closed immediately on the receipt of applications for the full amount required by the Company or such earlier date as the Directors may decide by any changes in circumstances that may affect the start date of the project, including but not limited to; any Government, Technology Strategy Board or commercial offering of co-funding, a negotiated reduction of the Stage 2 development budget, operational availability of the technical partners, legislative or regulatory requirements.

6. The Directors at their absolute discretion will determine the basis of allotment. The Letter of Subscription should be completed in full and sent or delivered to the Company, as set out in the Letter of Subscription together with the due payment to be made by bank transfer to the designated ‟ client bank account" set up for VN-HPG and operated by Simmons Gainsford LLP. The Directors may have to scale down applications or they may accept them on a first come, first served basis or otherwise.

7. Upon completing and delivering the Letter of Subscription at the end of this Information Memorandum, a fourteen-day period shall commence (cooling-off period) during which the Subscriber may withdraw the Letter of Subscription.

8. If the Letter of Subscription is not so withdrawn, the Subscriber undertakes and confirms as follows:

    a) To subscribe for the amount of Shares specified in the Letter of Subscription on the terms of, and subject to, the conditions set out in this Information Memorandum and the Company's Articles of Association, including these terms and conditions

    b) That a subscription for the Shares shall be deemed to be an offer to subscribe up to the value of the Subscriber's subscription and that such offer shall be deemed to take effect on dispatch by post of the Letter of Subscription

c) To accept such Shares as may be allotted to the Subscriber in accordance with the Letter of Subscription or such smaller amount as the Directors may determine prior to the allotment of the Shares

d) That all subscriptions, acceptances, allotments and contracts arising from the Letter of Subscription will be governed by and construed in accordance with English law and the English courts will have exclusive jurisdiction to determine any disputes

e) That the Subscriber is not under the age of 18 and that if the Subscriber signs the Letter of Subscription on behalf of somebody else, or a corporation, that the Subscriber has the authority to do so and such person will also be bound accordingly and will be deemed also to have given the confirmations, warranties and undertakings contained in these terms and conditions of subscription

f) The Subscriber authorises the Company or any of its respective agents to send by post certificates for the amount of Shares for which his subscription is accepted, to his or her address (or that of the first named Subscriber) as set out in the Letter of Subscription and to procure that his name(s) (together with the name(s) of any other joint Subscriber(s) is/are placed on the Share register of the Company in respect of such Shares

g) That the Subscriber is not relying on any information or representation other than those contained in this Information Memorandum and accordingly he or she agrees that neither the Company nor any person responsible solely or jointly for this Information Memorandum or any part thereof shall have any liability for any such other information or representation in the absence of fraud

h) That the Subscriber is a person in one or more of the categories listed in the Important Regulatory Notice on the first page inside the front cover of this Information Memorandum, namely a Certified High Net Worth Investor, a Sophisticated Investor or a Self-Certified Sophisticated Investor

i) That the advisers to the Company named in this Information Memorandum are acting for the Company and not acting for the Subscriber and that accordingly, they will not be responsible to the Subscriber for providing protections afforded to their clients for advising the Subscriber on the information in this Information Memorandum or ensuring that the Shares are suitable for the Subscriber

j) That the Subscriber has read and complied with the Terms, Conditions and Procedures for Subscription.

9. No person receiving a copy of this Information Memorandum and Letter of Subscription in any other territory (other than the United Kingdom) may treat the same as constituting an invitation to him or her to subscribe, nor should he or her in any event use such Letter of Subscription, unless in the relevant territory such an invitation could lawfully be made to him or her and such Letter of Subscription could lawfully be used without contravention of any regulation or other legal requirements.

10. It is a condition of any subscription by any such person outside the United Kingdom that he or she has satisfied themselves as to the full observance of the laws of any relevant territory, including the obtaining of any governmental or other consents which may be required and has observed any other formalities in such territory and paid any issue, transfer or other taxes due in such territory.

11. The Company reserves the right to request Subscribers to produce evidence satisfactory to them of their right to subscribe for the Shares and that such subscription would not result in the Company, its advisers or the Directors being in breach of any laws or regulations of the relevant jurisdiction.

12. The Company reserves the right to treat any subscription, which does not comply strictly with the terms and conditions of the subscription as nevertheless valid.

13. Subscriptions will be irrevocable.

14. By completing and delivering a Letter of Subscription, the Subscriber declares that he has read, understood and agreed to the terms and conditions contained in this Information Memorandum (including the Risk Factors), the Letter of Subscription, and where applicable, these Terms and Conditions for subscription and that he or she has taken all appropriate professional advice which he considers necessary before submitting the Letter of Subscription and that he is aware of the special risks involved and he understands that his subscription is made upon the terms of the aforementioned documents.

Risk Factors

Share Liquidity and Currency

There is no established market in the shares. Accordingly, any subscriber may be unable to dispose of their shares.

Subscribers will subscribe in pounds sterling; revenue proceeds may be in currencies other than sterling. The exchange rate between currencies is subject to continuous fluctuation and can distort the net returns arising.

Potential Subscribers are reminded that this investment may not be suitable for all recipients of this Information Memorandum and are accordingly advised to consult an investment adviser who is authorised under the Financial Services and Markets Act 2000 before making the decision to subscribe.

The ability of the project to pay costs which are in a currency other that of sterling may be impaired by an adverse exchange rate.

The Company's Stage 3 business involves a degree of risk, inasmuch as:

1. An investment in the Company is speculative because, although it has access to a substantial amount of research and data compiled regarding the EHG project, and has a full IP exploitation Licence granted by the IP owner, the EHG has been proven to produce hydrogen in laboratory and test facilities only. Whilst the engineering being utilised to enable the EHG to be driven by waste energy within the Gas Turbine environment is 'industry standard Turbine Drive technology' it has not been used to drive an EHG to date. Therefore, there is a possibility that the process may not deliver the desired results and the project could fail

2. Although best endeavour has been used to verify all the scientific research and data the Company is relying on for this project, it may transpire not to be reliable

3. The market uptake for an EHG type product is unproven. The project's success is driven by legislation that forces the Generation Industry to continuously reduce emissions in the face of perpetually rising fuel costs and low spark prices. This is forcing manufacturers to build 'low emission' and 'fuel-efficient' machines, however there is no guarantee that the EHG will become the industry's 'preferred' solution

4. Estimates of potential value and costs may not be reliable inasmuch as:

- The potential Licence income values are illustrations based on available comparable industry information
- The estimates are subject to market input variables that cannot be determined until the unit is developed and ready for market
- The illustrations of potential income value in this Information Memorandum may accordingly not be reliable despite the Directors best efforts to judge them accurately.

Enterprise Investment Scheme

A condition of HMRC's approval of EIS is that the conditions relating to the Company and its trade have to be complied with throughout the three-year period following the issue of the Shares. Although it is the intention that the Company's activities should qualify under the EIS, if the conditions are not complied with, the Company would have breached the EIS legislation and EIS income tax relief would be withdrawn.

Statement of Certified High Net Worth for Individuals

I declare that I am a certified high net worth individual for the purposes of the Financial Services and Markets Act 2000 (Financial Promotion) Order 2005.

I understand that this means: -
a) I can receive financial promotions that may not have been approved by a person authorised by the Financial Conduct Authority
b) The content of such financial promotions may not conform to rules issued by the Financial Conduct Authority
c) By signing this statement I may lose significant rights
d) I may have no right to complain to either of the following:

(i) The Financial Conduct Authority or
(ii) The Financial Ombudsman Service

e) I may have no right to seek compensation from the Financial Services Compensation Scheme.

I am a certified high net worth individual because at least one of the following applies: -
a) I had, during the financial year immediately preceding the date below, an annual income to the value of £100,000 or more; or,
b) I held, throughout the financial year immediately preceding the date below, net assets to the value of £250,000 or more.

Net assets for these purposes do not include:
(i) The property which is my primary residence or any loan secured on that residence; or
(ii) Any rights of mine under a qualifying contract of insurance within the meaning of the Financial Services and Markets Act 2000 (Regulated Activities) Order 2001, or
(iii) Any benefits (in the form of pensions or otherwise) which are payable on the termination of my service or on my death or retirement and to which I am (or my dependants are), or may be, entitled.

I accept that I can lose my property and other assets from making investment decisions based on financial promotions.

I am aware that it is open to me to seek advice from someone who specialises in advising on investments.

Name: ………………………………………… Address: ………………………………………………………………………………
Please print in block capitals

…………………………………………………………………………………………….

Signature: ………………………………….... Date: …………………………………….
Please sign here **Please Date**

Letter of Subscription

To: The Directors of VN-H Power Generation Limited
C/o Simmons Gainsford LLP,
4th floor, 7/10 Chandos Street,
London, W1G 9DQ

Dear Sirs,

VN-H Power Generation Limited ("the Company")

OFFER FOR SUBSCRIPTION – 42 Ordinary Shares of 1p each in the Company @ £7,500 per share

I request and authorise you to register any allotted Shares for which this application is accepted in the name(s) set out below in the Company's Share Register and to forward the definitive certificate or any moneys returnable by post to the first named person below at his/her risk.

Any capitalised term, which is not defined in this letter, has the same meaning given to that term in the Information Memorandum.

I refer to the Information Memorandum issued by the company dated January 2017 (the "Information Memorandum") and confirm I am Certified High Net Worth individual within the meaning of The Financial Services and Markets Act 2000.

I agree to provide the Company (and its professional advisers) with such evidence, as, in its absolute discretion, it requires as to my identity or that of any persons on whose behalf I am acting for the purpose of all money laundering rules and regulations currently in force in the United Kingdom.

I have arranged for payment of the full amount of the subscription for the Shares to be made to the Company c/o the designated client account set up and operated by Simmons Gainsford LLP representing the Company.

I declare that I am resident in the United Kingdom.

VN-H Power Generation Limited

SUBSCRIPTION FOR ORDINARY SHARES OF 1P EACH IN THE COMPANY

Please complete using block capitals:

I ………………………………………………………………………… hereby offer to subscribe for ……….. Shares in the capital of the Company on the Terms, Conditions and Procedures for Subscription contained in the Information Memorandum and the Memorandum and Articles of Association of the Company, with a total subscription consideration of **£…………………………**

Any term, which is not defined in this letter, has the same meaning given to that term in the Information Memorandum.

Yours faithfully,

……………………………………………… (Signature of Subscriber/Applicant)

……………………………………………………………………………………………………… Address

Date…………………………………………………

……………………………………………………………………………………………………… Address

EIS Round 3 Advanced Assurance

HM Revenue & Customs

Small Company Enterprise Centre
Cardiff
Wealthy and Mid-sized Business Compliance
Mid-sized Business
S0970
Newcastle
NE98 1ZZ

Mr M Gilmore
VN-H Power Generation Ltd
4th Floor
7/10 Chandos Street
Cavendish Square
London
W1G 9DQ

Phone 0300 123 1083

Fax 03000 582 456

Email enterprise.centre@hmrc.gsi.gov.uk

Web www.gov.uk

Date 29 September 2016
Our ref WMBC/MSB/S0970/12732 29867/SCEC
Your ref

Dear Mr Gilmore

VN-H Power Generation Ltd
Enterprise Investment Scheme

Thank you for your letter and enclosures of 1 September 2016.

I am pleased to confirm that, on the basis of the information supplied, I would be able to authorise the company to issue certificates under Section 204(1) ITA 2007 in respect of Ordinary Shares issued to individuals, following receipt of a properly completed form EIS1 within the time limit prescribed by Section 205(4) ITA 2007. You are reminded that:

- Responsibility for the accuracy of the information supplied and considered by me rests wholly with the company.
- This provisional assurance is based solely on the information supplied in and with the clearance application and will not apply in circumstances that vary from those described therein. You are therefore advised to forward particulars of any proposed changes, and the draft of any shareholders subscription, investment or similar agreement, for clearance prior to the issue of shares.
- This clearance does not guarantee the availability of any form of relief under the Enterprise Investment Scheme to any particular subscriber.

Yours sincerely

Simon Lamb
HM Inspector of Taxes

Information is available in large print, audio and Braille formats.
Text Relay service prefix number – 18001

Assistant Director: Colin Wood

Authority to Issue Tranche 2 of the Round 2 EIS Shares

HM Revenue & Customs

Enterprise Investment Scheme

Local Compliance
Small Company Enterprise Centre (Cardiff)
Local Compliance
Mid-size Business
S0970
Newcastle
NE98 1ZZ

Mr Mark Gilmore
VN-H Power Generation Ltd
4th Floor
7-10 Chandos Street
London
W1G 9DQ

Date **23 September 2015**

Reference **LC/MSB/S0970/12723 29867/SCEC**

Please use this reference if you write or call. It will help to avoid delay.

Your Ref

Phone 03000 588907

Authority to issue certificates relating to subscriptions for eligible shares

Name of company

VN-H Power Ltd

I authorise the company to issue certificates, on the attached forms EIS3, for subscriptions for eligible shares issued on

04 April 2015

which are listed at Page 1 of the form EIS1 signed on

05 August 2015

Investment made under EIS constitutes State aid in accordance with the principles laid down in the Community Guidelines on Risk Capital Investments in Small and Medium-sized Enterprises.

This does not guarantee the availability of reliefs under the Enterprise Investment Scheme to any particular subscriber. Subscribers receiving a form EIS3 should read the information given on it before deciding whether they are able to claim relief.

Page 1 of each form EIS3 should be completed **fully** before it is issued.

The termination date for these shares is

04 April 2018

Until that date, the shares, and the company, must continue to meet all the requirements of the Scheme as summarised on the EIS1. If that is not the case, income tax relief will be withdrawn from investors, and any deferred chargeable gains will be brought back into charge.

In the event of a failure to continue meeting these requirements, the company must tell me within 60 days of the event which caused that failure.

Authorised by
Cardiff SCEC

HMRC office reference number
12723 29867

pp
Paul Morgan
SCEC Officer

EIS2 HMRC 10/12

Authority to Issue Tranche 1 of the Round 2 EIS Shares

HM Revenue & Customs

Enterprise Investment Scheme

Small Company Enterprise Centre (Cardiff)
Mid-size Business S0970
PO Box 3900
GLASGOW
G70 6AA

David Newman
Viridis Navitas Capital Partners
4th Floor
7/10 Chandos Street
London
W1G 9DQ

Our Ref LC/MSB/S0970/12732 29867/SCEC

Please use this reference if you write or call. It will help to avoid delay.

Your Ref

Name Mike Barnaby

Phone 03000 588 907

Authority to issue certificates relating to subscriptions for eligible shares

Name of company

VN-H Power Generation Ltd

I authorise the company to issue certificates, on the attached forms EIS3, for subscriptions for eligible shares issued on

04 April 2014

which are listed at Page 1 of the form EIS1 signed on

20 October 2014

Investments made under EIS constitutes State aid in accordance with the principles laid down in the Community Guidelines on Risk Capital Investments in Small and Medium-sized Enterprises.

This does not guarantee the availability of reliefs under the Enterprise Investment Scheme to any particular subscriber. Subscribers receiving a form EIS3 should read the information given on it before deciding whether they are able to claim relief.

Page 1 of each form EIS3 should be completed fully before it is issued.

The termination date for these shares is

04 April 2017

Until that date, the shares, and the company, must continue to meet all the requirements of the Scheme as summarised on the EIS1. If that is not the case, income tax relief will be withdrawn from investors, and any deferred chargeable gains will be brought back into charge.

In the event of a failure to continue meeting these requirements, the company must tell me within 60 days of the event which caused that failure.

Authorised by

HMRC
SMALL COMPANY
ENTERPRISE CENTRE
CARDIFF
13 NOV 2014
TY GLAS, LLANISHEN
CARDIFF
CF14 5FP

M A Barnaby
SCEC Officer

Please use the reference 12732 29867 when completing forms EIS3

EIS2 HMRC 10/12

SEIS Round 1 Advanced Assurance

HM Revenue & Customs

Small Company Enterprise Centre Cardiff
Large & Complex Businesses S0970
PO Box 3900
GLASGOW
G70 6AA

Tel 029 2032 6170

Fax 029 2032 6870

Email enterprise.centre@hmrc.gsi.gov.uk

www.hmrc.gov.uk

Mr Mark Gilmore
VN-H Power Generation Limited
5th Floor
7/10 Chandos Street
London
W1G 9DQ

Date 20 February 2013
Our ref LC/L&C/S0970/12732 29867/DMG
Your ref

Dear Sirs,

VN-H Power Generation Limited
Seed Enterprise Investment Scheme Advance Assurance

Thank you for your advance assurance application of 05 February 2013 and the enclosures therewith. I am pleased to confirm that, on the basis of the information supplied, I would be able to authorise the company to issue certificates under Section 257EC(1) ITA 2007 in respect of Ordinary Shares issued to individuals, following receipt of a properly completed form SEIS1 as prescribed by Section 257ED.

You are reminded that:

- Responsibility for the accuracy of the information supplied and considered by me rests wholly with the company.
- This provisional assurance is based solely on the information supplied in and with the clearance application and will not apply in circumstances that vary from those described therein. You are therefore advised to forward particulars of any proposed changes, and the draft of any shareholders subscription, investment or similar agreement, for clearance prior to the issue of shares.
- This clearance does not guarantee the availability of any form of relief under the Seed Enterprise Investment Scheme to any particular subscriber.

Yours faithfully

D M George
H M Inspector of Taxes

Information is available in large print, audio tape and Braille formats.
Text Relay service prefix number – 18001

Assistant Director: Marian Kitson

Authority to Issue SEIS Shares

HM Revenue & Customs

Seed Enterprise Investment Scheme

Small Company Enterprise Centre (Cardiff)
Large & Complex Businesses S0970
PO Box 3900
GLASGOW
G70 6AA

Mr Mark Gilmore
VN-H Power Generation Ltd
4th Floor
7/10 Chandos Street
London
W1G 9DQ

Our Ref LC/L&C/S0970/12732 29867/SCEC/DMG

Please use this reference if you write or call.
It will help to avoid delay.

Your Ref

Name **Darren George**

Phone 029 2032 **6170**

Authority to issue certificates relating to subscriptions for eligible shares

Name of company

VN-H Power Generation Ltd

I authorise the company to issue certificates, on the attached forms SEIS3, for subscriptions for eligible shares issued on

27 March 2013

which are listed at Page 1 of the form SEIS1 signed on

02 August 2013

Investments made under SEIS constitute de minimis aid within the meaning of Article 2 of Commission Regulations (EC) No 1998/2006.

This does not guarantee the availability of reliefs under the Seed Enterprise Investment Scheme to any particular subscriber. Subscribers receiving a form SEIS3 should read the information given on it before deciding whether they are able to claim relief.

Page 1 of each form SEIS3 should be completed **fully** before it is issued.

The termination date for these shares is

27 March 2016

Until that date, the shares, and the company, must continue to meet all the requirements of the Scheme as summarised on the SEIS1. If that is not the case, income tax relief will be withdrawn from investors, and any deferred chargeable gains will be brought back into charge.

In the event of a failure to continue meeting these requirements, the company must tell me within 60 days of the event which caused that failure.

D M George
Inspector of Taxes

Authorised by
Cardiff SCEC
Ty Glas
Llanishen
Cardiff
CF14 5FP
12 August 2013

Please use the reference 12732 29867 when completing forms SEIS3

SEIS2 HMRC 10/12

EIS Relief information

Highlights

- An individual can invest annually up to £1 million in EIS companies and obtain a tax credit equal to 30% of the cash investment.
- For EIS it is possible to invest up to £1 million in 2015/16 and carry back £1 million to 2014/15, provided certain conditions are met.
- Certain types of trade do not qualify for EIS relief. These include certain financial activities, property development, hotels and providing legal or accountancy services.
- A 'disqualifying arrangements' test has been introduced to exclude VCTs, EIS or SEIS that do not invest in qualifying companies and are set up solely for the purpose of giving investors tax relief.

The following sections analyse the main features:

- Income tax credit on the amount invested and when it may be withdrawn
- The capital gains tax exemption and/or utilisation of capital losses on the disposal of the shares
- Deferral relief, provided the relevant conditions (explained below) are met and
- Business Property Relief (BPR) from inheritance tax (IHT), where certain conditions are met.

Income tax

- Income tax credit at 30% of the amount invested in subscribing for new shares (maximum annual investment of £1 million).
- By election, where an EIS investment is made in one year it can be treated as though it was an investment made in the immediately preceding tax year, subject to the overall limit for that year.
- Dividends paid on EIS shares are taxable.
- Where the EIS shares are sold within 3 years, the EIS investor receives value or an option is placed over the shares, then the EIS tax credit is clawed back.
- The claw-back amount is the lower of:

  Original income tax credit; and

  30% x sale proceeds received (only applicable if sold for a loss)

  There can also be a claw-back if the company loses its EIS status within 3 years.

Capital Gains Tax (CGT) Relief

- An EIS investor is entitled to exemption from CGT on a disposal of those shares, provided he has held them for three years. Therefore, any growth in value is effectively tax-free.

Relief for Capital Losses on Disposals

- Relief is given for allowable losses arising on the disposal of the shares against either income of the tax year of disposal (or of the previous tax year) or chargeable gains, provided all the relevant conditions referred to below are met.
- Any income tax relief obtained under EIS, which was not withdrawn, reduces the capital loss.

CGT Deferral relief

- The tax due on a gain on any asset can be deferred by subscribing for shares in EIS qualifying companies, in a period beginning one year before and three years after the disposal of the original asset.

Business Property Relief

- Shares in EIS companies held for at least two years will normally qualify for 100% BPR for IHT purposes.

EIS Conditions

For EIS purposes, both the investee company invested and the investor need to meet certain conditions: Conditions to be met by the company:

- The company's gross assets must not exceed £15 million immediately before the shares are issued and £16 million immediately afterwards
- The Investee Company must be unquoted when the shares are issued and there must, broadly, be no arrangements for it to become quoted. A company admitted to AIM will not be regarded as quoted for these purposes
- The Company must exist to carry on a qualifying trade (i.e. conducted on a commercial basis with a view to making profits; and the trade does not include, to a substantial extent (20% or more), excluded activities such as property development, leasing, dealing in land, shares and/or commodities etc.)
- The company must not be a 51% subsidiary of another company
- The Company must not have any subsidiaries that are not 51% subsidiaries
- The issuing company must either be a UK resident company carrying on a trade in the UK or be an overseas company with a UK permanent establishment carrying on a trade
- The Company must not be in financial difficulty
- The Investee Company must have fewer than 250 full-time employees
- The Investee Company cannot raise more than £5 million in total over a 12-month period under the EIS and the VCT scheme.

Conditions to be met by the investor:

The key conditions are as follows:

- The subscription must be in newly issued, ordinary shares and paid for in cash, as well as being for genuine commercial reasons and not for tax avoidance purposes
- To retain the income tax relief and to be exempt from capital gains tax, the shares must be held for at least three years
- The investor must not be connected for EIS purposes with the company. Investors who are connected with the company cannot claim income tax relief but may still qualify for capital gains tax deferral relief
- An investor will be connected with the company if he, either on his own or with associates, possesses or is entitled to acquire more than 30% of the issued share capital, voting power or assets of the company or any subsidiary on a winding up
- An investor will also be connected if he or she is an employee of the company or its group. They can be directors provided they meet certain conditions. An investor must not receive any amount of remuneration as a director that is excessive in comparison to the services performed. Relief will be withdrawn if the investee company, or a person connected with the company makes a payment to the investor (which is not “insignificant”) up to one year before, and three years after, the share issue.

Schedule 1- The Business Plan

Science & Technology - Background

Today's global economy relies on energy largely derived from fossil fuels. Decreasing supply, increasing demand and political upheaval have led to large increases in fuel prices. This in turn has again stimulated interest in alternative energy sources. In addition, our reliance on fossil fuels has brought about what many consider a direct impact on climate change, and as a result punitive legislation to reduce carbon emissions and other pollutants.

Due to the amount of CO_2 emitted, the Power Generation industry in particular is faced with a set of Global emissions legislation that is continuously decreasing the amount of CO_2 and particulates that can be emitted. This legislation targets all Power Generators regardless of the technology used.

The world is focussing on the reduction of CO_2, and the need to counter the rising price of natural gas and liquid fuels used to fuel gas turbines and large internal combustion engines. To underpin this global emission reduction strategy, incentives, taxation and fines have been put in place to drive business behaviour and have therefore created the need for new and innovative technologies to actually deliver the required reductions. These reductions are managed through Multilateral Environmental Agreements (MEA) under the auspices of UNEP and supported by international legal instruments such as Emission Trading Schemes (ETS) such as the European Emission Trading Scheme that has been in operation since 2005.

The ETS operates in 30 countries: the 27 EU Member States plus Iceland, Liechtenstein and Norway. It covers CO_2 emissions from installations such as power stations, combustion plants, oil refineries and iron and steel works, as well as factories making cement, glass, lime, bricks, ceramics, pulp, paper and board. Launched in 2005, the EU ETS works on the "cap and trade" principle. This means there is a "cap", or limit, on the total amount of certain greenhouse gases that can be emitted by the factories, power plants and other installations in the system. Within this cap, companies receive emission allowances, which they can sell to or buy from one another as needed. At present, the vast majority of allowances are given out for free but this will change in the near future. The limit on the total number of allowances available ensures that they have a value.

At the end of each year, each company must surrender enough allowances to cover all its emissions *otherwise heavy fines are imposed (currently €100 per tonne).* If a company reduces its emissions, it can keep the spare allowances to cover its future needs or otherwise sell them to another company that is short of allowances. *(see http://ec.europa.eu/clima/policies/ets/index_en.htm)*

The number of allowances is reduced over time so that total emissions fall. *In 2020 emissions will be 21% lower than in 2005.* The current level of emissions allowances in the EU27, 2.01 billion tonnes will be *cut by 1.75% per year until 2020. 1.3 billion tonnes per year are emitted from combustion plant comprising of 8,482 installations. Commencing January 2013 all European Combustion Power Generators have had their 'free allowances' removed, and all CO_2 allowances must now be purchased in the market.*
The rate at which this change is being legislated against is such that the industry faces potentially huge costs to transition from a polluting technology, to a lesser and ultimately non-polluting one. To exacerbate the problem further, the ultimate goal of complete transfer to 'clean fuels' such as hydrogen is currently not feasible, due to the vast financial requirements for infrastructure investment and the current high cost of hydrogen production using conventional technology.
This, the low spark price for electricity and volatility in the Gas marketplace, is now leading to gas-fired power stations closing down or being mothballed, as they are simply not economical to operate.

The Solution

The least disruptive and lowest cost solution is to implement a technology that integrates with existing Power Generation technologies without any change to infrastructure i.e. refuelling. This technology delivers significant decreases in CO_2 emissions and particulates to reduce pollution and therefore fines to the Power Generation industry whilst still making use of existing power plants that otherwise would be forced to close as unprofitable operations.

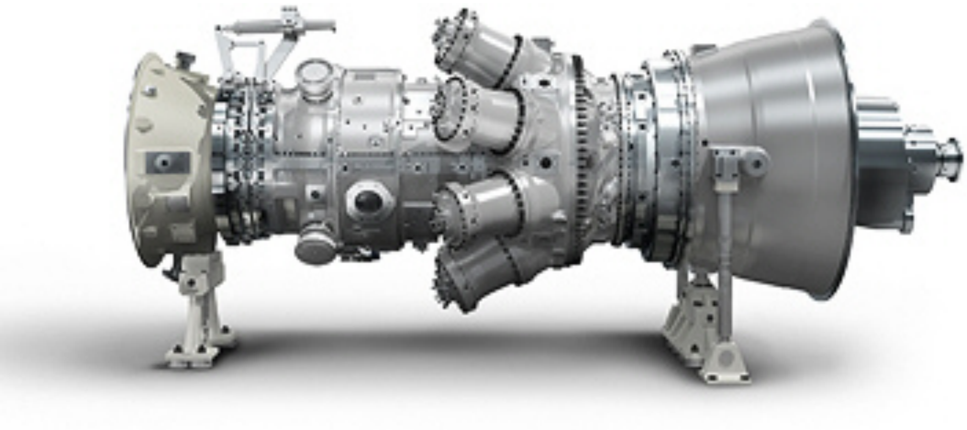
A "non-disruptive" technology such as described above will be more readily accepted, due to the fact that it does not compete with, detract from, or in any way undermine existing technologies or infrastructures. It merely assists those industries and infrastructures to make the transition to new technologies and solutions over a longer period, at very low cost and with many economic and environmental benefits to its adoption.

Swedish Gas Technology Centre Press Release July 2013.

"Following extensive testing, stable operation at near 40 % by volume H2 has been demonstrated in a Siemens gas turbine SGT-700"

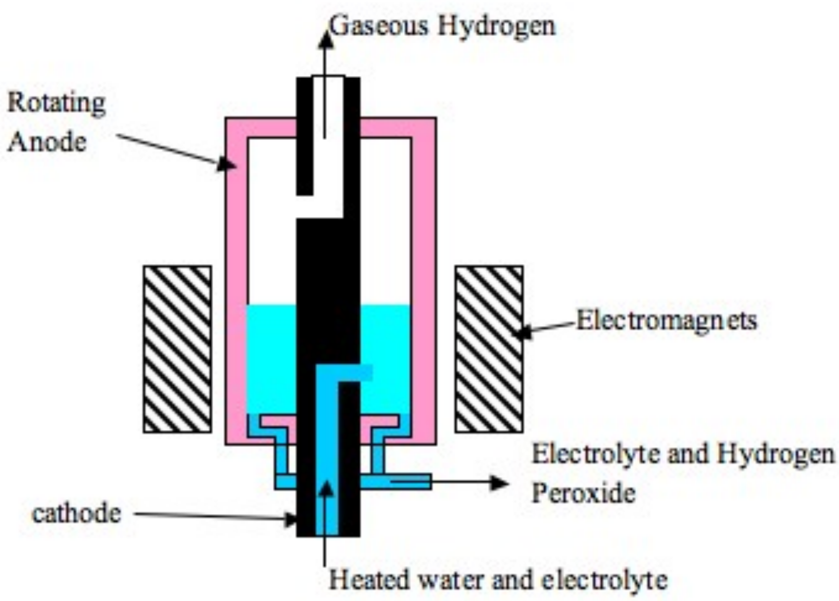
Based on this test the accepted level of hydrogen co-firing in the SGT-700 and SGT-800 has been increased to 15 % by volume, well above the proposed level of 10 % H2 by volume in the VN-HPG business case and the proposed volumes to be used in the European Natural Gas net. Siemens are a global market leader in this space and their move indicates a definite shift in turbine fuelling policy going forward. It is logical therefore to assume that their competitors are pursuing a similar path.

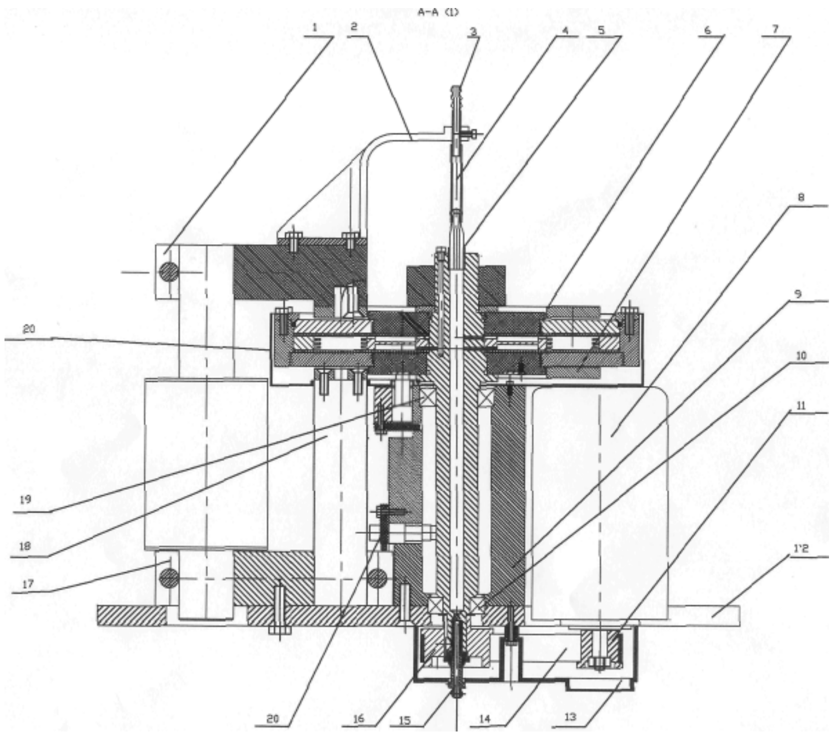
(Source: http://www.sgc.se/ckfinder/userfiles/files/SGC256(1).pdf - then click to open ' **SGC** report H2 as GT fuel final'*)*



SGT 750 Gas Turbine

The Technology





EHG 4M Schematic

The EHG technology relies on an innovative electrolysis system to separate hydrogen molecules from oxygen molecules in water.

Conventional electrolysis relies on electricity to separate the hydrogen and oxygen atoms. In the EHG process water is mixed with an electrolyte and spun in a cylinder, which has ceramic magnets on the outside. Separation of the hydrogen and oxygen is achieved by two forces, firstly, centrifugal force moves the heavier oxygen ions to the outside of the cylinder, leaving the lighter hydrogen near the axis.

Secondly, as the charged hydrogen and oxygen ions pass through the magnetic field they are moved either towards the outside (oxygen) or inside (hydrogen) by Lorentz forces. As a result of the separation of the charged particles, a potential difference is established between the outside and inside of the cylinder. If a connection is made between the two an electric current will flow, electron exchange takes place and gaseous hydrogen is released.

The hydrogen peroxide and electrolyte are then recycled by the system. This is an endothermic process and so the water has to be heated before it enters the unit. In the Natural Gas Powered generation application, energy to rotate the device is derived from one of three sources that can be deemed as 'waste or lost' energy circuits. A Power take-off from the existing turbines, Steam for an external EHG specific turbine or non-required electricity (off-peak generation) drives the EHG via an electric motor. The preferred route is for an external EHG specific steam turbine to be fitted to the existing Gas Turbine system to capture any waste energy from the plant. This system is already used in all gas-fired Power Stations and the base technology can easily be utilised for the EHG.

Heat and water will also be obtained from the existing plant system thus capturing even more of the waste energy. *These are the principal reasons why the system is ideal for existing and new CCGT plant, which have both waste heat and rotational energy available to drive the process.*

History

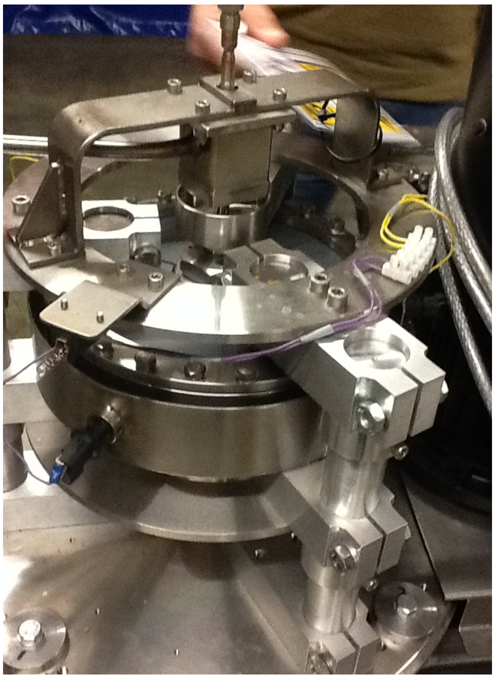
The concept was proved via a basic model (EHG 1) in a Moscow laboratory. The success of this experiment led to two further prototypes EHG 2 and 3 being produced and tested.

Table 1 EHG prototypes

	EHG 2	EHG 3
Radius	12 cm	7.3 cm
Height	8 cm	8 cm
Max RPM	5000	12000

In April 2005 under laboratory test conditions in Moscow, Dr Maltini recorded that the EHG 3 model produced 21.2 – 24.6Lt of Hydrogen per hour when driven by an electric motor at between 4,500 & 8,000rpm. A theoretical model for the process was developed indicating that increasing the magnetic field strength could decrease the required speed. This research concluded phase1 of the science project.

UK Laboratory Prototype



To cope with problems experienced when testing the previous EHG 1, 2 & 3 variants, it was decided by the IP owners and management team to design a simpler model of the Electro Hydrogen Generator to prove in a UK test environment that which was reported in Russia, plus remove any design problems identified there. This unit was called the EHG4-M.

The unit was built out of 316 Stainless steel to reduce the chemical (background) hydrogen production seen with the EHG 2 & 3 variants.

It was equipped with high strength ceramic permanent magnets to reduce the high rotor working speed requirement, and floating brush gear pickups to complete the electrical circuit between the anode and cathode. Built for easy disassembly, the simplified cathode / anode design allows for a cathode change or coatings to be applied going forward if this is deemed necessary.

Cell dimensions were changed to reflect the use of a permanent magnetic field with the cell size being reduced by approximately ⅔ the size of the previous models.

Base structural design allows for cell design changes that can incorporate new advances in the technology and materials, without having to redesign and build the complete rig again, potentially saving time and money.

A purpose built dynamometer test rig was designed and built by Intertek Tickford to contain the EHG4-M. This provides an electrical motor drive system, an electrolyte heating element & tank, water header tank, pressurisation device and pump circuit, together with full external monitoring capability via an umbilical cord connected to a digital data logger.

Dynamometer Test Rig in operation

The testing program took the following into account:

- the external magnetic field effect on negative and positive ion separation in electrolyte at different rotational speeds
- the ability to use electrolytes that reduce corrosive effect on materials
- the electrode geometry and the effect on electrolysis when using SS316 as cathode and anode
- the working capacity of seals under hydrogen emission and centrifugal pressure
- the working capacity of high-speed bearings in this environment,
- the operating capacity and maintenance requirements of the EHG4-M under resonant frequency conditions.
- the difference in hydrogen production when a current was passed through the electrolyte between the anode and cathode.

The following EHG4-M parameters were studied during electrolysis:

- the hydrogen measured using an in-line Hydrogen Analyser with varying cell rotation speeds
- the electrolyte composition and concentration i.e. acid or alkaline electrolyte %w/v or v/v
- the electrolyte temperature
- the solution characteristics dependence on these parameters
- the nature of electrochemical reactions on the anode, cathode, in all ducting, pumps, holding / heating and cooling tanks.

The results obtained allowed the team to determine optimum electrolytes composition, pumping frequency, coating materials, thermal conditions, and rotor speed.

All results from these trials were made available to VN-HPG as part of their development and licencing agreement plus further specific trials relating to alkali electrolytes and scalability were carried out at VN-HPG's request.

The projected hydrogen output from this unit is not expected to be at the levels required by the business plan. However, the results will verify the magnetic acceleration effects in the design, and enable the VN-HPG Science & Engineering design team to calculate the theoretical scalability of the device.

VN-HPG commissioned a report from Professor Keith Scott of Newcastle University, which includes the verification of size scalability constraints, in addition to the projected increased output quantity metrics.

Based upon previous test results from the EHG3 and the new prototype EHG4-M, the report is focused on providing the "Energy Equation" i.e. a predicted cost of scaled production "energy in vs energy out" or efficiency as described in kWh terms.

The latest designs of industrial PEM alkali electrolysers at the 500kW to 1MW size (optimum) are 69% efficient. Dr Maltini working with data supplied by the Russian Scientists rated the EHG with an acid electrolyte, at 91% efficient.

The tests carried out with the EHG4-M laboratory rig indicate that the technology is able to replicate or better this performance i.e. reduced rpm requirement and accelerated molecular separation by way of the permanent magnetic field. The technology therefore on a prima facie level is able to meet both the Science team and Siemens AG's technical requirements. Siemens AG set the target for their potential inclusion in the project at 70% efficiency on a "no cost / low cost" waste-energy driven scaled unit.

Tickford Technical team refilling the rig with electrolyte

2nd test session - data monitoring

Market Drivers, Size and Target Sector

The immediate markets for this technology are in new plant design and existing gas fired power generation plants. These sectors are coming under increasing legislation to reduce carbon emissions and this is where VN-HPG's technology offers the most attractive value proposition.

There are 2 main sales opportunities for the deployment of EHG technology within this market:

1. New Gas Turbine Plants

2. Refurbishing existing GT Power Plants as part of their O&M programme.

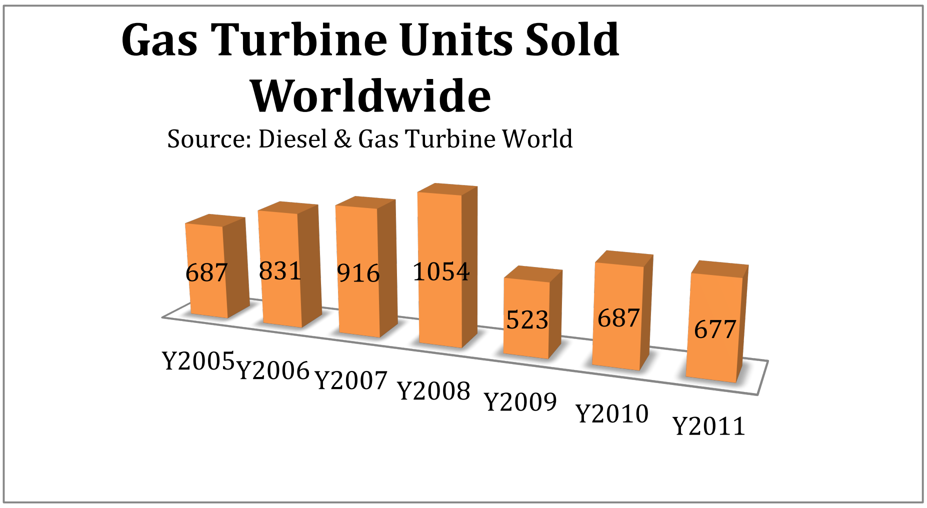
Forecast International predicts sales of 1,072 gas turbines for electrical power production in 2014, increasing steadily to 1,300 units by 2023. The value of production will be $18.4 billion in 2014, rising to $22.3 billion by 2023.

Annual growth in global gas turbine unit sales will drop from 2.3% in 2014 to 1.3% in 2017. A rebound of 2% is likely in 2018, maintaining 3% over the next three years. Value of production is expected to average 1.7% over the next ten years, with the least growth again in the span from 2016 to 2018.

Nearly 60% of the turbines produced in the coming decade will be of an output below 50 MW, corresponding to the needs of developing countries, distributed generation and peaking power requirements.

These units in simple cycle are also likely to find use in conjunction with renewable energy power plants, helping them keep their generating profile level. Larger output gas turbine machines will typically be installed in combined cycle service for power generation, industrial cogeneration or combined heat and power applications.

In the coming decade, we project that 11,769 gas turbines will be built for electrical power generation, having a value of production in excess of $205 billion (in current U.S. calendar-year dollars).
*(source: **Turbo Machinery Handbook 2014**)*



For new Gas Turbine equipment development production, VN-HPG will provide a consultancy service for EHG design but will primarily receive its revenues via "rights of use" Licence fees paid by the major GT plant manufacturers and based upon a percentage of the "replacement fuel supplied" value. The table below shows the market opportunity using 2011 actual figures and the following assumptions:

- Peak plant operates for 500 hours per year
- Standby plant is not considered in the calculations
- Continuous plant operates for 5500 hours per year
- International gas price is based on 30p per m^3 (This is the projected cost of gas in 2018)
- Energy in gas is 10.5kW/m^3.

The total market in NG sales to fuel the Generation plant sold in 2011 is £12.4bn, see table below. (Source: DGTW)

Global Gas Turbine Sales 2011

Size Range	No. Sold	MW Sold	S/By	Peaking	Continuous	Efficiency	Gas Consumption	ating Hours per Year		Consumption	Price	Market Size
MW	No	MW	No	No	No	%	m3/h	Peak	Continuous	Total m3/year	£/m3	£
1.00 - 2.00	118	161	94	0	24	23%	913.04	500	5500	120,521,739	0.3	36,156,522
2.01 - 3.50	54	152	42	0	12	23%	1,597.83	500	5500	105,456,522	0.3	31,636,957
3.51 - 5.00	67	274	38	0	29	25%	2,100.00	500	5500	334,950,000	0.3	100,485,000
5.01 - 7.50	47	278	3	0	44	25%	3,150.00	500	5500	762,300,000	0.3	228,690,000
7.51 - 10.00	45	353	1	0	44	30%	3,500.00	500	5500	847,000,000	0.3	254,100,000
10.01 - 15.00	83	1,176	0	0	83	32%	4,921.88	500	5500	2,246,835,938	0.3	674,050,781
15.01 - 20.00	5	81	0	0	5	32%	6,562.50	500	5500	180,468,750	0.3	54,140,625
20.01 - 30.00	9	232	0	0	9	33%	7,954.55	500	5500	393,750,000	0.3	118,125,000
30.01 - 60.00	98	3,549	0	21	77	34%	13,897.06	500	5500	6,031,323,529	0.3	1,809,397,059
60.01 - 120.00	67	5,484	0	16	51	35%	27,000.00	500	5500	7,789,500,000	0.3	2,336,850,000
120.01 - 180.00	37	5,617	6	5	26	36%	43,750.00	500	5500	6,365,625,000	0.3	1,909,687,500
> 180	47	11,474	0	0	47	38%	63,552.63	500	5500	16,428,355,263	0.3	4,928,506,579
	677	**28,831**	**184**	**42**	**451**					**41,606,086,741**		**12,481,826,022**

VN-HPG will target to replace 10% of that volume thus providing the company with a £1.24bn pa market opportunity before discounting.

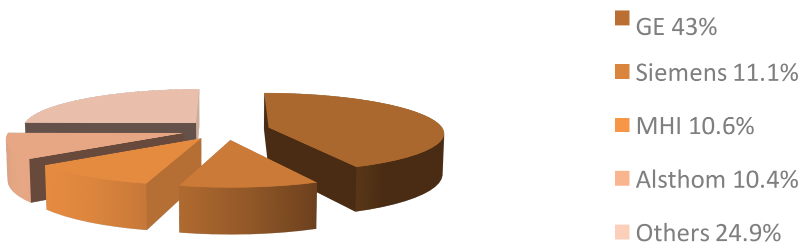
Penetration into the New Generator sales market place is restricted by the number of prototype designs VN-HPG can produce annually, and by the 12 notional MW output bands manufacturers use when manufacturing generators. (As shown above)

In Year 1 designs for the 5MW – 7.5MW range will be undertaken, in Year 2 designs for the 60MW – 120MW range, in Year 3 designs for the 30MW – 60MW, in Year 4 designs for the 10MW – 15MW range and in Year 5 designs for the 7.5MW – 10MW range. This approach delivers the revenue and EBITDA projections shown in Schedule 5.

Manufacturers market share is divided as per the following pie charts and our approach to the market is via preferred partner relationships with one or more of the 4 major players in this space. Whilst the business plan provides for exceptional returns, we are showing a nominal market penetration in the VN-HPG predictions. The model is not based on selling EHG units; rather having proven prototypes matched to the markets most popular gas turbine generator models. The same principal applies to the retrofit market place where design will be focussed on the most common generators in use today.

For New Gas Turbine plant production, VN-HPG will seek to JV with, or Licence manufacturing rights to, the Original Equipment Manufacturers. Licencing fees will be calculated on the hydrogen generation capability of the specific EHG and then valuing the replacement fuel by comparing with Platts market prices for Natural Gas.

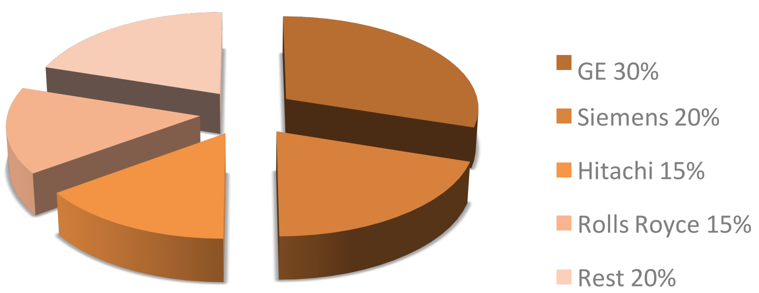
Gas Turbine Manufacturers New Sales pa.
(Source: Gas Turbine World Handbook and Performance Specs 2012)



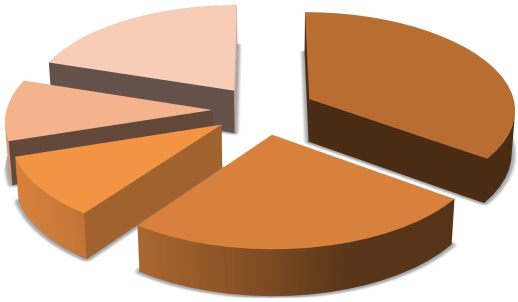
Over 177,000 Power Generating units are installed in 80,000 power plants worldwide Note: Platts Energy Today 2011 and 21% of power generated, is from natural gas Note: World Bank Energy Report 2011. The estimated number of generating units that can be retrofitted is estimated at 27,750, ranging in size from 1MW CHP to 400MW combined cycle units. The Natural Gas burned to fuel these plants amounts to some £234 billion pa (based on a projected gas price of 30p per m^3 in 2018). VN-HPG on-site EHG plant will provide a minimum of 10% in replacement hydrogen for co-firing, thus providing a **£23.4 billion pa market opportunity**.

Gas Turbine Manufacturers Existing Installations.
(Source: Gas Turbine World Handbook and Performance Specs 2012)

5MW to 30MW Range



30MW Upwards Range



In conjunction with its integration partners VN-HPG will carry out the design for all retrofit applications. It will subcontract manufacturing, assembly, installation and O&M, deriving income streams from both the design and the supply. As with the new turbine equipment opportunity "rights of use Licence fees or royalties" will be based upon the amount of replacement fuel supplied at a discounted price, pegged to the market price of Natural Gas.

With 27,750 prospects worldwide VN-HPG will not be able to service the whole of this market directly but will carry out (in conjunction with our integration partners) the design of the EHGs for each application. VN-HPG will also subcontract manufacturing, deriving income streams from both the design and the supply.

Competition

Conventional Electrolysis

Electrolysis is a well-known process, for which many suppliers of production equipment can be found, for example Hydrogenics *(See http://www.hydrogenics.com/hydro/companies), ITM Power (see http://www.itm-power.com) & Siemens (see http://http://www.siemens.com/innovation/apps/pof_microsite/_pof-spring-2011/_html_en/electrolysis.html)*

ITMs PEM Electrolyser

These companies rely on conventional or PEM electrolysis to liberate hydrogen from water so have a production running cost that makes their net production efficiency much lower than the EHG technology. However, most companies developing electrolysers are doing so to produce hydrogen for fuel cells or local area fuel station use. To date there is no hydrogen co-firing solution on offer to Gas Turbine Power Generators.

Government Ambitions

The UK, EU and US Governments are focusing on a 40-year Hydrogen roadmap. Priority is currently on fuel cell technology and replenishment aimed at reducing CO_2 emissions within the transport industry. All projects to date have hit the same stumbling block – high hydrogen production costs because of high electricity prices.

Germany however, is on an accelerated path to the Hydrogen economy with alternative energy solutions deeply rooted in its pronounced commitment to address climate change head on. The Federal government has passed legislation committed to reducing CO_2 emissions by 250 million tonnes through 2020.
To do this, substantial commitments have been made to support renewable energy use and improved energy efficiency. Specifically, the Renewable Energies Sources Act and the Combined Heat and Power Act guarantee special fuel cell bonus and feed-in tariff rates in support of new technologies and infrastructure.

In addition to substantial support from the Federal government, a very comprehensive public funding strategy is in place. Established in 2006, the National Hydrogen and Fuel Cell Technology Innovation Program (NIP) has a budget of €1.4 billion to bolster technology development. The purpose of NIP is to prepare hydrogen and fuel cell products for entry into the marketplace through late-stage R&D projects.

Furthermore, Germany has started to address the challenge of solving the Wind-Power challenges; i.e. it blows in the wrong place, at the wrong time and the electricity can't be distributed across the legacy infrastructure.

The German strategy is storage i.e. convert the electricity into Hydrogen, and store it for use either at peak periods or to distribute through the gas main infrastructure, which requires little or no upgrade or retrofitting. In this specific area Siemens have spent over €200m developing a more efficient PEM electrolyser at the 1MW scale, to convert wind produced energy into a usable/storable/transportable commodity, utilising existing infrastructure. This is where VN-HPG views the greatest potential as a complementary technology addressing a significant problem, whilst negating the requirement for massive investment in infrastructure

Technology Application Conclusions

The benefits of "co-firing" hydrogen in gas turbine plants are already well established. However, all of the current projects and market solutions generate hydrogen upstream of the gas turbine power plant and create large CO_2 emissions during the production process.

To distribute / deliver hydrogen, the gas needs to be compressed to form a liquid so sufficient quantity can be stored. This "liquefaction" of hydrogen requires even more energy – thus further reducing the economic viability of vehicle delivered / transported hydrogen use.

The unique proposition of the EHG technology is that it uses waste energy with a "zero or near zero operating cost" from the existing gas turbine plant to power the EHG unit and generate hydrogen "on-demand" thus overcoming the problems associated with upstream hydrogen production.
The hydrogen produced by the EHG can be co-fired directly at the time of production, or compressed and stored for later use via existing plant technology if required.

Today the science and functionality of the equipment has been proven in a number of prototypes, which have run and generated hydrogen. In order to realise a profitable business from this technology there are a number of stages requiring further work. While the final objective is to develop the equipment to a large scale so it can be used in a Gas Fired Power Station environment there are intermediate targets, which will add significant value to the company.

The objective of the commercialisation plan is to achieve these targets on a 'step-by-step' basis, matching spend to IP gained and therefore increased capital value as the targets are met. In summary these targets are:

- Prove the size scalability of the technology
- Optimise and characterise EHG hydrogen generation levels, and detail dependencies
- Choose a demonstration Power Station
- Work with the existing technology integrators to develop a system for capturing waste energy from the plant and demonstrate adequate energy availability
- Design a matched prototype, build and install it
- Integrate hydrogen flow with the gas turbine operation and storage facility to prove sustainability
- Calibration of the EHG under power generation conditions
- Creation of a design, delivery and support team.

Taking these targets in order:

STAGE 1

(a) Prove the size scalability of the technology ***'COMPLETED'***

In conjunction with Newcastle University using the existing test EHG4-M driven by an electric motor; carry out investigations into differing electrolytes, rotational speed, magnetic strength, potential differences, electrolyte volumes, internal dimensions and materials. In identifying the dependent parameters, it will establish that the theoretical effects are linear or not. This will identify the possibility of scaling to increase the overall volume production at any given efficiency. The durability of the material will also be considered when optimising rotational speeds and electrolyte formulation.

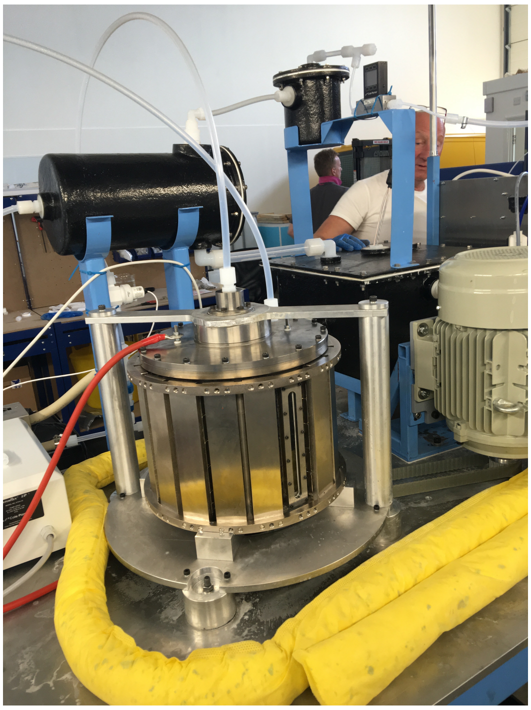
"Qualitatively increased rotation rate appears to improve hydrogen production rate as does an increase in temperature. At a rotation rate of 1000rpm the current enhancement above background current was some 8A, compared with an enhancement of some 29A at a rotation rate increase from 1000 to 2250 rpm. This indicates an exponential type of increase in production rate with increase in rpm, rather than a non-linear increase" ***Newcastle University Report August 2013.*** *(See Schedule 6)*

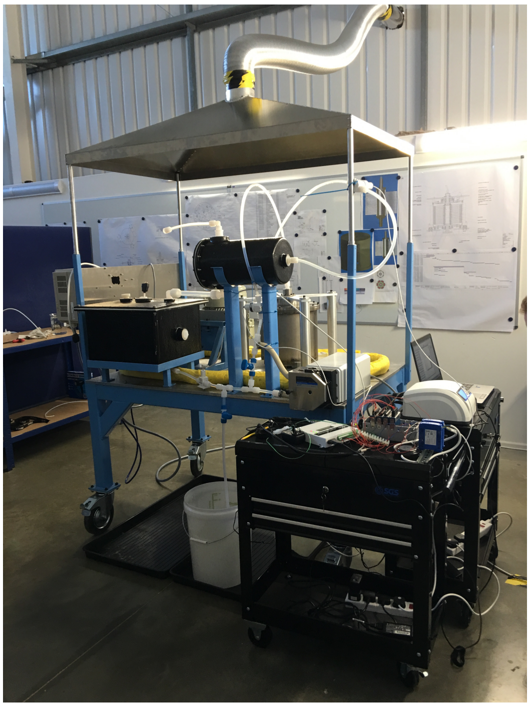
Stage Output:

IP knowledge and prototype equipment covering the effects of a range of variables when generating hydrogen from this technology. This could be used as intended by VN-HPG or the unit could be driven using other energy sources.

Stage 2

(a) Design a scalable EHG, manufacture 2 versions using Stainless Steel and Titanium, assemble components, mount on dynamometer for mechanical longevity and fluid integrity testing, run unit with an alkali electrolyte with and without external current generation, measure hydrogen production.
'COMPLETED'



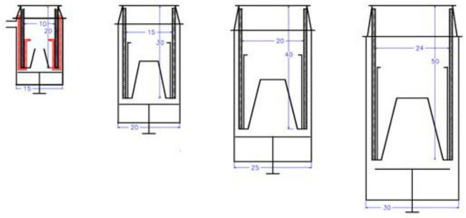
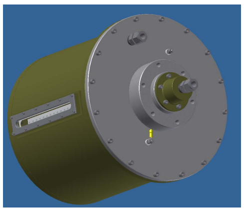
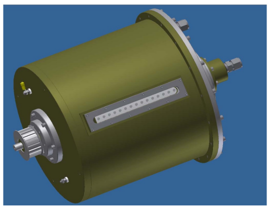
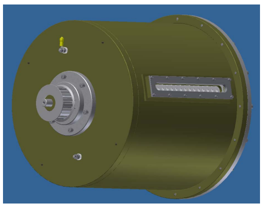


Stage Output:

IP knowledge and design prototypes that are unique that could be used as intended by VN-HPG or utilised in other areas of electric motor / pump research.

Stage 3 via a fundraise of £315,000 NOW OPEN

(a) Optimise and characterise EHG hydrogen generation levels and scalability, detailing all dependencies

Stage Output:

VN-HPG will deliver IP knowledge and scaled prototype equipment which will provide consistent quality and increasing quantity of hydrogen.

(b) Design a series of stage revised EHG-M units; each being larger than the previous unit with continuous characterisation improvement using data obtained from the previous sequential output test results.

Stage output:

Industry accepted independent test report showing optimal and increasing hydrogen output throughout the stages (Provided by Intertek Tickford & Professor Keith Scott of Newcastle University) 3D modelled scaling designs and a series of ever increasing in size EHG iterations built and tested.

(c) Draft design for a fully characterised EHG matched as a minimum to the 10% co-firing fuel requirements of an GE PGT10b gas turbine operating in a Combined Cycle Gas Turbine Generation plant being driven by an industry standard steam turbine, power take off drive, or electric motor.

Stage Output:

1 x Draft set of manufacturing drawings for both the EHG and drive system.

(d) Choose a demonstration Power Station

Stage output:

Signed agreement with Plant owner now in place and negotiations to purchase the Plant are ongoing. This will deliver an option-to-buy contract, with defined price, timings and completion requirements.

Stage 4 via a fundraise of £6.4M will deliver:

- Signed final purchase agreement with Elettra Produzione S.r.l for the Piombino plant at an agreed price of €4M or less
- Confirmed design and manufacturing drawings for integration of the EHG waste energy drive system
- Built pre-commercial EHG unit for trial and testing
- 1 x Set of negotiated supply contracts for 3 x subsequent EHG builds and installation of same, complete with timeframes and delivery service level agreements
- Installation 2 x EHG unit integrated drive systems for commercial operation at the Piombino Plant
- Integration of hydrogen flow with the gas turbine operation and storage facility to prove sustainability
- Calibration of the EHG under power generation conditions
- Design and installation of the management control system to regulate hydrogen production, usage, compression and Storage
- Protection of any and all IP, knowledge and knowhow
- Creation of design drawings, installation instructions and data to allow replication on other sites
- Purchase and adaptation of a filter and control system, which will enable the turbines to run effectively and be provided with a consistent purity of hydrogen throughout the speed / load envelope. The technology to accomplish this is available in a number of forms, off-the-shelf
- Development of an ongoing design, sales and delivery team together with a full integrator partner agreement to provide a fully functioning, professionally managed global EHG Design and Supply Company with unique IP and initial revenues derived from its prototype installation.

Organisation & Structure

Commercialisation is split into two fundamental areas, optimisation of the EHG, and its application to gas turbine power generator plant. The scientific work to characterise and optimise the EHG will be under the control of Professor Keith Scott, together with on an ‘as required’ basis, the leading Russian scientists who developed the original unit to its current stage. The Moscow team have been retained to support the ongoing UK operations. The resulting know-how and any IP created will be owned by VN IP Ltd and made available to VN-HPG royalty free for use within in its specific development licence field.

The application work to integrate the EHG to a gas turbine will be conducted in the United Kingdom under the management of Mick Avison Technical Director.

Whilst the EHG development is new and an improved electrolysis science**,** *it should be realised that the majority of the application work is known technology, where there are many existing experts available to us.*

Following discussions with gas turbine manufacturers and power plant operators it has been established that much of the technology required for commercialisation can be provided free of charge in return for an agreement to provide early prototype units for test. Not only has this demonstrated interest in the device by the industry, but also allowed the ongoing commercialisation cost to be reduced.

The co-firing technology to combine hydrogen and conventional fuel in gas turbines is in place today, specifically within the Siemens SGT range, which provide for up to 20% hydrogen co-firing today. Therefore, adaptation rather than invention is required.

Commercialisation, Timings and Costs

Stage 1 of the programme was completed within 6 months of the raise closing and within budget. Costs were estimated at £126,000 including a minimum stage 1 payment *(£50,000, being 20% of the full cost of £250,000)* of the negotiated development Licence fee. *Note: All Legal, Accountancy and 3rd Party costs as indicated on Page 23 of this IM (estimated at £24,000) were made before project commencement. Project expenditure at £126,000 included a 10% overrun / contingency fee.*

Stage 2 was completed within 12 months of commencement and within budget. Costs were estimated at £261,000. *Note: All Legal, Accountancy and 3rd Party costs as indicated on Page 23 of this IM (estimated at £57,000) will be made before project commencement. Project expenditure at £261,000 includes a 10% overrun / contingency fee.*

Stage 3 will take place over a 12-month period with costs estimated at £283,000 including a stage 2 payment *(£50,000 being 20% of the full cost of £250,000)* of the negotiated development Licence fee. *Note: All Legal, Accountancy and 3rd Party costs as indicated on Page 23 of this IM (estimated at £29,500) will be made before project commencement. Project expenditure at £283,000 includes a 10% overrun / contingency fee.*

Stage 4 will take place over a 24-month period with costs estimated at £5,792,000 including a final payment (£150,000 being 60% of the full cost of £250,000) to complete the purchase of the development Licence fee. *Note: All Legal, Accountancy and 3rd Party costs as indicated on Page 23 of this IM (estimated at £608,000) will be made before project commencement. Project expenditure at £5,792,000 includes a 10% overrun / contingency fee.*

Stage 3 Programme & Budget

1. Design and construction of a series of pre-industrial prototype EHG-M's, including power circuitry output, improved electrolyte closed recirculation system, waste output system, improved auxiliary systems, instrumentation and control systems to achieve a linear growth of Hydrogen output to 250 standard litres per hour (slph).

2. Study and assessment of low-pressure steam turbines to enable the design of a standard industrial EHG-M drive system.

3. Market confirmation study

4. Design of a standard industrial model EHGM.

Costs estimates for phase 2 = £315,000 - This includes provision for the following:

- 2nd Stage Payment for IP Licence £50,000
- Design & Drawings £70,000
- Procurement of material and equipment £60,000
- Manufacturing of EHG-M units £100,000

Note: all prices are for fixed price deliverables by third party specialist contractors & include a 10% over run contingency.

Business Model

There are two immediate revenue streams generated in this business model:

1. Design, consultancy and rights of use Licence fees from the major gas fired generator manufacturers which would allow them to integrate EHG technology with their new Gas Turbine generator design
2. Design, consultancy and rights of use Licence fees for integration of EHG technology into existing Natural and Industrial gas fuelled power stations by the generator manufacturers as part of their O&M / upgrade process.

Value of EHG "Rights of Use" Contracts

Whilst the commercial supply of EHG technology has not yet been achieved, the cost benefit can be simply identified by using Platts Natural Gas index and relating NG market pricing to onsite produced hydrogen. Using this data, a pricing model can be built and revenue projections made.

In both revenue streams VN-HPG will receive a Licence fee linked to the replacement fuel value produced onsite. This is pegged to the market price of Natural gas and then discounted to make the model commercially viable.

Market Development

The timing of VN-HPG's introduction of the EHG to the market will be critical in ensuring a smooth uptake of the technology, requiring adequate supporting data and 3rd party referenceability of the technology's output.

One of the major driving forces for the EHG (or anything else that will produce hydrogen for co-firing in the Power Generation Industry) is the perpetual tightening of the emissions regulations.

However, there are also two other equally and linked powerful drivers. Firstly, the cost of Natural Gas continues to be unstable and secondly, the alternative co-firing industrial gases that are in use today (blast furnace and coke gas) are in decline as their own industries come under mounting emission legislation pressure.

There are many examples in Europe where Generators are selling back their PTAs (Power Take Off Agreements) to Government and closing plant simply because the plants are not profitable when run purely on Natural Gas.

This is a Global trend that will drive EHG adoption when the technology is positioned to OEMs correctly. It is more cost effective to refurbish existing plant than build new. Even with new plants manufacturers still have to develop technologies to reduce emissions in line with the 2020 – 2030 accords.

Within the current gas injection / burning technologies, there is already control and management software / hardware to enable co-firing. The current generation plant targeted, (27,750 units) are fully capable of co-firing up 20% hydrogen within their current operating procedures.

The performance benefits demonstration can be most easily accomplished by the installation of a fully matched and characterised unit into an operating Power Plant that is already co-firing coke or blast furnace gas. The Piombino Plant in Italy has been identified as such a location and as mentioned on page 6 and discussions with the owners / operators and technical teams are very positive and ongoing.

VN-HPG are engaged with all major CCGT & GT generator manufacturers in the market place and are prioritising our participation/partner requirements by using those with a reputation for utilising 'green' technology wherever possible.

We have an informal arrangement for the exchange of information with the objective that these will be the first companies to which the EHG will be made available for demonstration. They already hold adequate technical information to begin the design of the waste drive or power take-off drive once we provide them with the energy requirements of the EHG and are interested in working with us to integrate the hydrogen output into their programs.

Once a working prototype has been integrated with a CCGT or GT and the hydrogen production and co-firing capability is confirmed, together with economy and emissions benefits demonstrated the data would be used to drive further discussions into the market place with Manufacturers and Operators alike.

Risks and Risk Mitigation

The business model will evolve as the product and markets mature, but there are a number of risks that have to be considered, for example:

RISK: The Company is a pre-revenue start-up, which has access to technology 'demonstrated in the laboratory and test cell facility' but has yet to complete full characterisation, which leaves some uncertainty as to the full market opportunity of the product.

MITIGATION: *By working on a stage-by-stage funding basis we provide continuous proof before progressing. Therefore the risk vs reward ratio is maintained via the share offer pricing as the project progresses*

By completing in Stage 3 a fully characterised EHG producing hydrogen onsite and co-firing it with a gas turbine generator we provide 3rd party witnessed proof of emission reduction and fuel economy thus opening up the market place

It is VN-H Power Generation's intention to sign MOUs with all major CCGT and GT manufacturers post Stage 2 completion to allow technical information exchange and provide supply agreements if not 'solid' order obligations.

RISK: Some governments may wish to protect their domestic markets by favouring particular solutions. Existing manufacturers may lobby governments to delay the introduction of emission targets until they can develop something in-house.

MITIGATION: *VN-HPG has the Governments support with this solution via the UKTI and it will leverage that position with UK based Operators and Manufacturers to get their buy-in. Emission legislation is in place across the world as previously mentioned in this document and Governments are unlikely to change their position on reductions. However, the sales team will initially focus on EU and 1st World countries where legislation and patent protection is in place, using JVs and licencing to achieve market penetration and resulting revenues.*

Partner Relationships

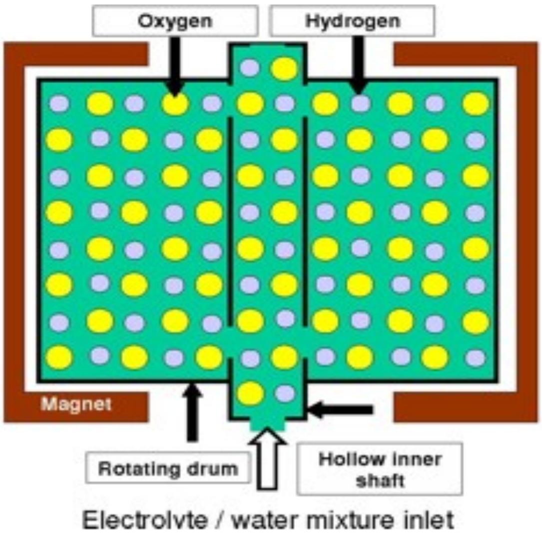
UKTI

UK Trade & Investment is supporting VN-H Power Generation through its Global Entrepreneur Programme. This is a programme run by UK government to seek out technology and innovations of exceptional potential, and attract the founders and entrepreneurs to set up in the UK to create a global company. *EHG technology was recognised in April 2011 by UKTI as a "Technology of Exceptional Global Potential, being led by a Professional Management Team".*

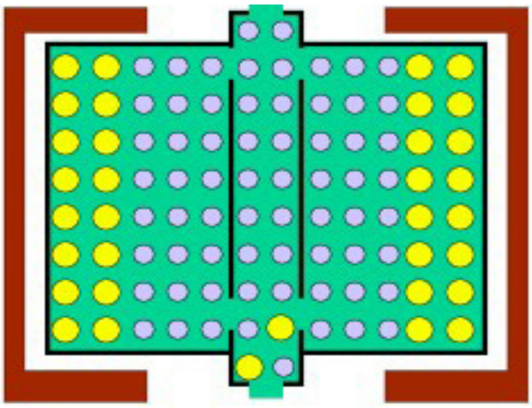
Industrial Partners

VN-HPG are in communication with major Gas Turbine and Power Generator manufacturers and plant operators who have verbally agreed *(subject to successful completion of Stage 2)* to VN-HPG supplying them technical data that will enable integration design and manufacture pricing to take place and provide facilities for testing final full size prototypes. As a consequence of non-disclosure agreements, which are in place, it is not possible to disclose third party details in this document.

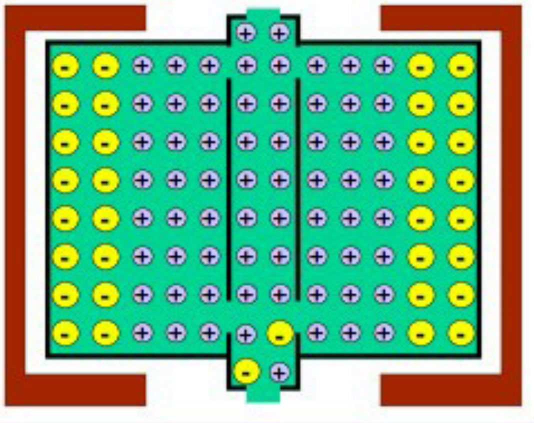
Schedule 2- The Electro Hydrogen Generator Technology



Water is allowed into the drum in the form of hydrogen and oxygen ions, generated when mixing with an electrolyte.



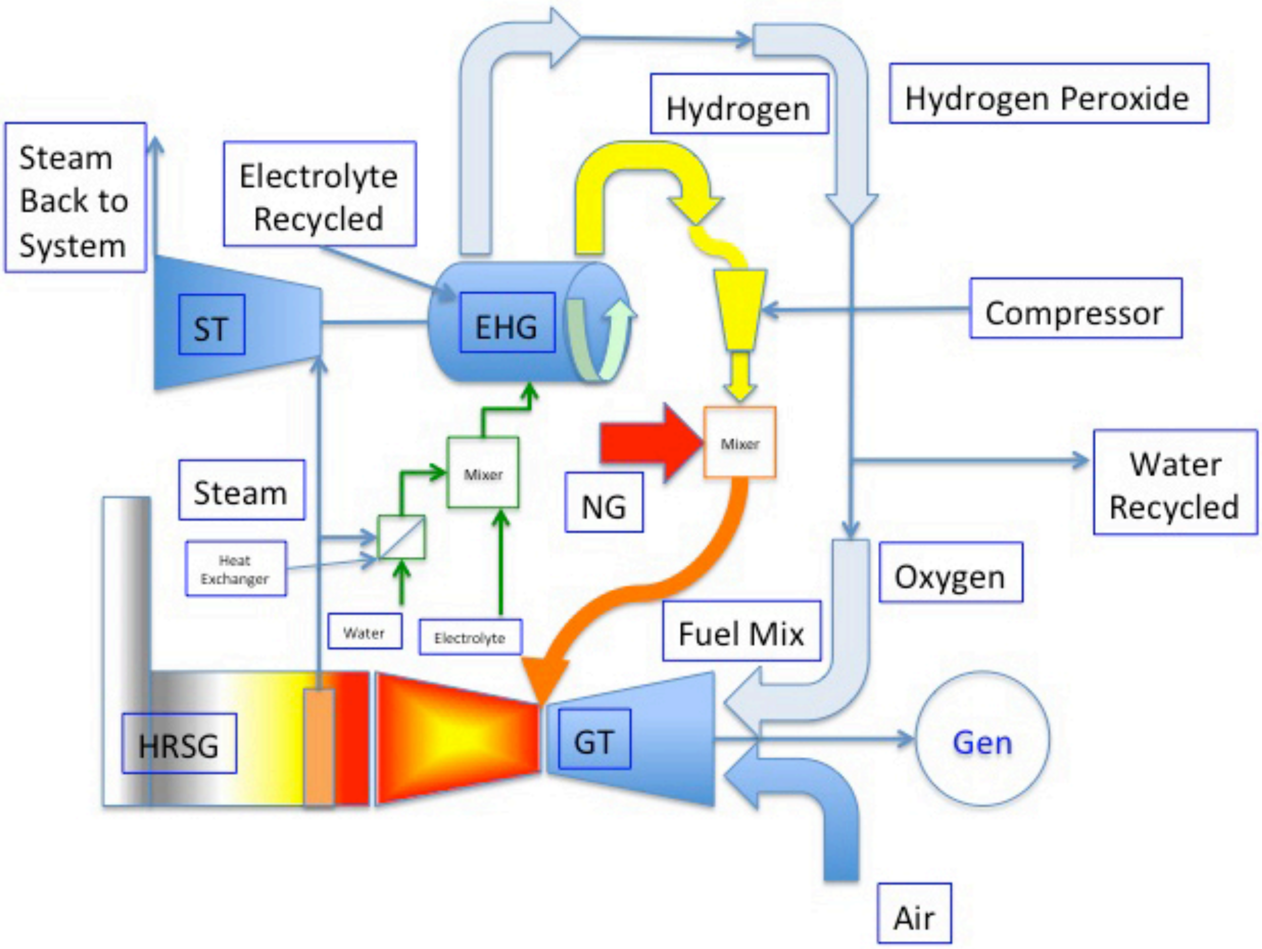
As the drum rotates centrifugal and magnetic forces push the heavier oxygen ions to the outside and leave the lighter hydrogen ions on the inside.



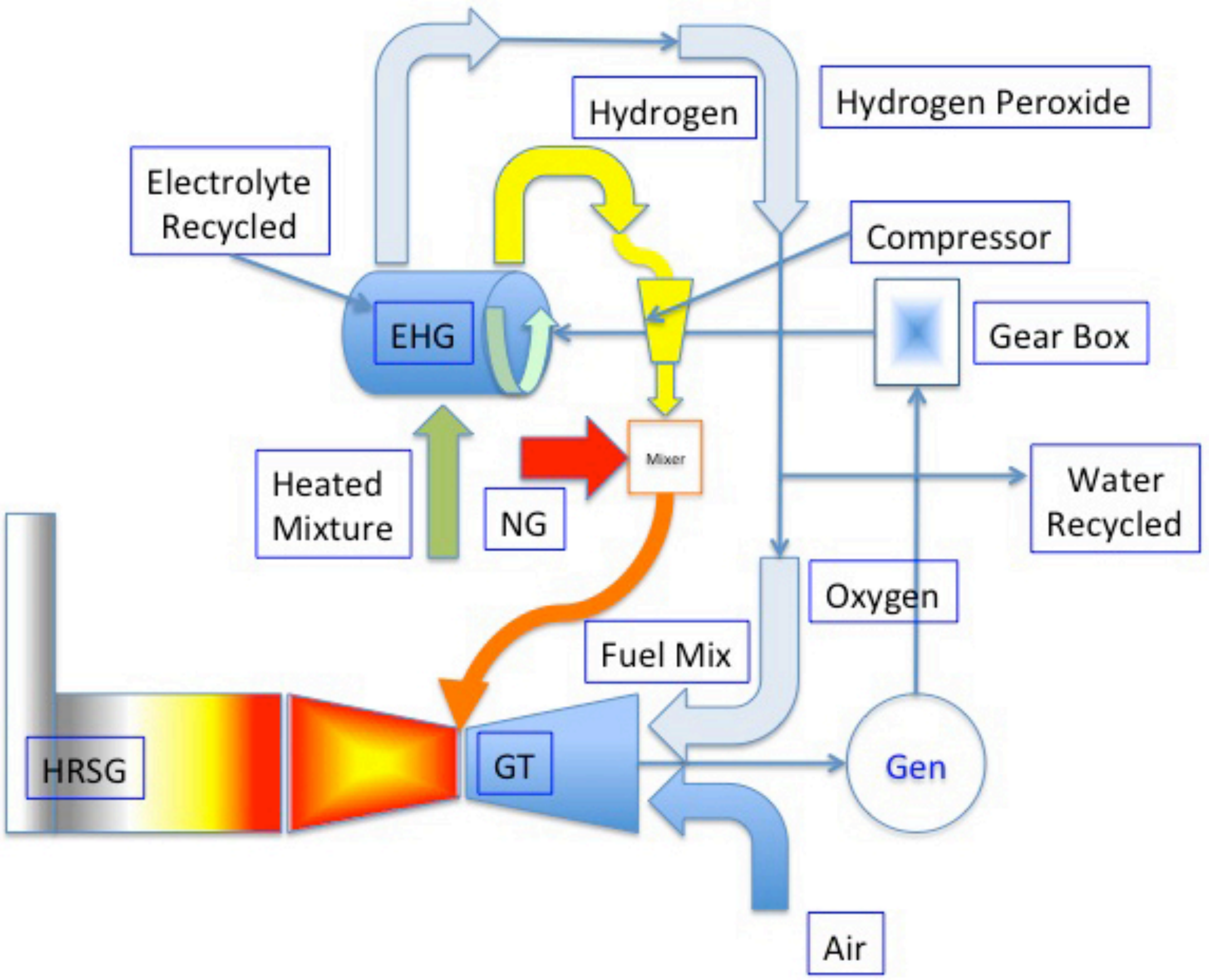
The hydrogen ions are positively charged and the oxygen negatively, so there is an electrical potential between the drum and the shaft. When this circuit is closed hydrogen begins to be generated and moves through the hollow tube out of the EHG.

Schedule 3- Electro Hydrogen Generator System Options

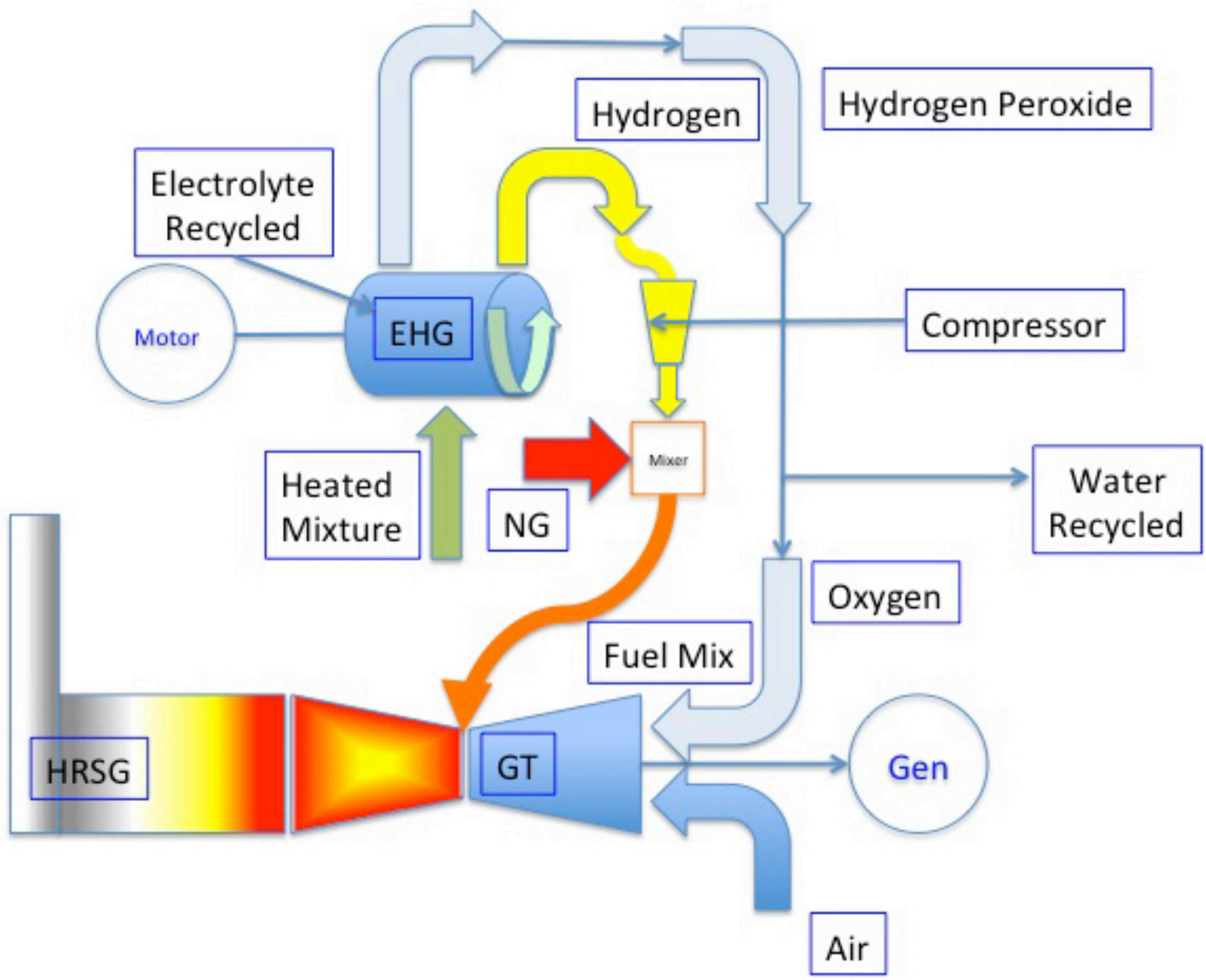
Steam Turbine Drive:



Power Take Off Drive:



Electric Motor Drive:



Schedule- 4 Patent Portfolio

Type	Title	Country	Application No.	Patent No.	PCT Filing Date	Status
Patent	Water Decomposition	Brazil	PI0318117-0	P/309277BR	18/09/2003	Granted
Patent	Water Decomposition	Japan	2004-568237	4729311	18/09/2003	Granted
Patent	Water Decomposition	South Korea	7015120/2005	10-1005342	18/09/2003	Granted
Patent	Water Decomposition	Mexico	PA/a/2005/008734	284044	18/09/2003	Granted
Patent	Water Decomposition	Poland	P-377577	205891-B	18/09/2003	Granted
Patent	Water Decomposition	USA	11/205771	US7553398	18/09/2003	Granted
Patent	Water Decomposition	India	2312/CHENP/2005	230023	18/09/2003	Granted
Patent	Water Decomposition	New Zealand	542433	542433	18/09/2003	Granted
Patent	Water Decomposition	South Africa	2005/07508	2005/07508	18/09/2003	Granted
Patent	Water Decomposition	China	3826292.4	CN100588744C	18/09/2003	Granted
Patent	Water Decomposition	Europe	3751665.5	309416EP	18/09/2003	Granted

The European Patent 309416EP has now been ratified in the following countries as individually protected territories

Type	Title	Country	Application No.	Patent No.	PCT Filing Date	Status
Patent	Water Decomposition	Austria	3751665.5	309416EP	26/12/2012	Granted
Patent	Water Decomposition	Belgium	3751665.5	309416EP	27/12/2012	Granted
Patent	Water Decomposition	Switzerland	3751665.5	309416EP	27/12/2012	Granted
Patent	Water Decomposition	Liechtenstein	3751665.5	309416EP	27/12/2012	Granted
Patent	Water Decomposition	Germany	3751665.5	309416EP	27/12/2012	Granted
Patent	Water Decomposition	Spain	3751665.5	309416EP	27/12/2012	Granted
Patent	Water Decomposition	Finland	3751665.5	309416EP	27/12/2012	Granted
Patent	Water Decomposition	France	3751665.5	309416EP	27/12/2012	Granted
Patent	Water Decomposition	Hungary	3751665.5	309416EP	27/12/2012	Granted
Patent	Water Decomposition	Italy	3751665.5	309416EP	27/12/2012	Granted
Patent	Water Decomposition	Netherlands	3751665.5	309416EP	27/12/2012	Granted
Patent	Water Decomposition	Romania	3751665.5	309416EP	27/12/2012	Granted
Patent	Water Decomposition	Sweden	3751665.5	309416EP	27/12/2012	Granted
Patent	Water Decomposition	Slovak Republic	3751665.5	309416EP	27/12/2012	Granted
Patent	Water Decomposition	Turkey	3751665.5	309416EP	27/12/2012	Granted
Patent	Water Decomposition	United Kingdom	3751665.5	309416EP	27/12/2012	Granted

Schedule 5- Financials

See page 23 for assumptions

Projected Unit and Licence Sales with Inward Cash Estimates.

OEM Design Consultancy for Manufacture		**2020**	**2021**
New & Refurbishment GT & CCGT EHG model design		8	8
Design cost		£3,200,000	£3,200,000
Design charge		£6,000,000	£6,000,000
Total Gross Profit		£2,800,000	£2,800,000
New Plant Installations			
Global Production at 2011 with zero growth predictions		677	677
Total Gas value consumed (assumes £/m^3=0.3)		£12,481,825,982	£12,481,825,982
10% Replacement Hydrogen value at 50% discount		£624,091,299	£624,091,299
Average gross revenue opportunity by way of licencing and 'rights of use' fees @ 20%		£124,818,260	£124,818,260
Targeted annual & recurring revenues from 1st Year initial penetration into 5.01MW to 7.5MW product range at 5 in number		£243,287	£486,574
Targeted annual & recurring revenues from 2nd Year initial penetration into 60.01MW to 120MW product range at 6 in number			£2,092,701
Targeted annual & recurring revenues from 3rd Year initial penetration into 30.01MW to 60MW product range at 10 in number			
Targeted annual & recurring revenues from 4th Year initial penetration into 10.01MW to 15MW product range at 8 in number			
Targeted annual & recurring revenues from 5th Year initial penetration into 7.51MW to 10MW product range at 5 in number			
Sub Total		£243,287	£2,579,275
Existing Plant Refurbishments			
27,750 units consuming Gas valued at £234bn in 2011	£234bn		
Siemens Market penetration at 25% (see page 42) = 6938 units representing a total gas volume of £58.5bn in 2011	£25.97bn		
Siemens Market share as a 10% replacement hydrogen value opportunity discounted by 50% is £2.925bn in 2011	£1.129bn		
20% retained by way of Licence fees	£585m		
Assume 0.5% penetration pa into Siemens market share starting 2018		35	35
20% Licence fee retained		£2,925,000	£5,850,000
Gross anticipated income		£9,168,287	£14,429,275
Opex		£4,200,000	£5,200,000
EBITDA		**£4,968,287**	**£9,229,275**

Note* Development takes place in years 2015 - 2019

Schedule 5- The Financials (continued)

See page 23 for assumptions

Projected Unit and Licence Sales with Inward Cash Estimates.

OEM Design Consultancy for Manufacture	2022	2023	2024
New & Refurbishment GT & CCGT EHG model design	8	8	5
Design cost	£3,200,000	£3,200,000	£2,000,000
Design charge	£6,000,000	£6,000,000	£3,750,000
Total Gross Profit	£2,800,000	£2,800,000	£1,750,000
New Plant Installations			
Global Production at 2011 with zero growth predictions	677	677	677
Total Gas value consumed (assumes £/m^3=0.3)	£12,481,825,982	£12,481,825,982	£12,481,825,982
10% Replacement Hydrogen value at 50% discount	£624,091,299	£624,091,299	£624,091,299
Average gross revenue opportunity by way of licencing and 'rights of use' fees @ 20%	£124,818,260	£124,818,260	£124,818,260
Targeted annual & recurring revenues from 1st Year initial penetration into 5.01MW to 7.5MW product range at 5 in number	£729,861	£1,187,241	£1,644,621
Targeted annual & recurring revenues from 2nd Year initial penetration into 60.01MW to 120MW product range at 6 in number	£4,185,402	£6,278,103	£8,370,804
Targeted annual & recurring revenues from 3rd Year initial penetration into 30.01MW to 60MW product range at 10 in number	£1,846,323	£3,692,646	£5,538,969
Targeted annual & recurring revenues from 4th Year initial penetration into 10.01MW to 15MW product range at 8 in number		£645,832	£1,291,664
Targeted annual & recurring revenues from 5th Year initial penetration into 7.51MW to 10MW product range at 5 in number			£282,333
Sub Total	£6,761,586	£11,803,822	£17,128,391
Existing Plant Refurbishments			
27,750 units consuming Gas valued at £234bn in 2011	£234bn		
Siemens Market penetration at 25% (see page 42) = 6938 units representing a total gas volume of £58.5bn in 2011	£25.97bn		
Siemens Market share as a 10% replacement hydrogen value opportunity discounted by 50% is £1.1299bn in 2011	£1.1299bn		
20% retained by way of Licence fees	£585m		
Assume 0.5% penetration pa into Siemens market share starting 2018	35	35	35
20% Licence fee retained	£8,775,000	£11,700,000	£14,625,000
Gross anticipated income	£21,536,586	£29,503,822	£35,503,391
Opex	£6,200,000	£7,200,000	£6,000,000
EBITDA	**£15,336,586**	**£22,303,822**	**£29,503,391**

Note* Development takes place in years 2015 - 2019

Strictly Confidential

SCHEDULE 6- VN-HPG Investment Memorandum

Report on EHG Tests carried out for

VN-H POWER GENERATION LIMITED
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Cavendish Square
London
W1G 9DG
United Kingdom.

Author: Professor Keith Scott, Professor of Electrochemical Engineering

School of Chemical Engineering & Advanced Materials

Contents

The report relates to work carried out on the:

EHG Feasibility

The overall objectives for the project are for the theoretical, and subsequent test data supporting theory for the scalability of the EHG technology.

Objective 1— Phase I- Feasibility Study

To carry out a study with the objectives:

To assess the EHG process and the H_2 production units functionality and capability. This will be achieved by inspecting the Intertek Tickford Automotive test facility unit and from discussions of the facility with relevant personnel at Intertek Tickford and from VN-HPG and by assessing relevant documentation.

Summary

This report examines data produced by the EHG test rig located at the Intertek Tickford site. Tests were performed with a KOH based electrolyte and a sulphuric acid electrolyte. In the case of the KOH electrolyte an imposed "electrolysis" current was applied. EHG tests with an alkaline electrolyte gave at best current equivalents of 5 Amps and energy consumptions, which are some ten times greater than that for water electrolysis. With an imposed " electrolysis" current the best (peak) currents with the imposed currents were around 18.5 Amps, at an imposed current of around 3.5 A. A similar performance was achieved with the alkaline electrolyte with and without an imposed current. The best performance was achieved with the sulphuric acid electrolyte based EHG tests. A peak hydrogen production rate at a equivalent current of 71 Amps and an energy consumption of 36 kWh/kg was obtained. The average energy consumption for the short term tests are comparable with those for standard water electrolysis.

1.0 Introduction

This report examines data produced by the EHG test rig located at the Intertek Tickford site. The test rig is based around the operation of a two electrode cylindical reactor which under rotation produces hydrogen from the decomposition of water. The application of a magnetic field may potentially improve the rate and efficiency of hydrogen generation.

The data was collected during two tests periods in March 2013 and July 2013 (between the period 02/07/2013 to 04/07/2013) using electrolyte solutions of aqueous KOH and H_2SO_4.

The Initial understanding of the EHG cell/reactor concept is that essentially the device relies on electricity generation through rotation in a magnetic field. The electric field produced is then effectively pushed through an electrolyte solution whereby in contact with electrodes, electrode reactions are induced; one of which is notably hydrogen evolution. An additional feature of the device is that the rotational fluid motion augments the electrochemical reactions at either or both electrodes.

2.0 Analysis Methods of Gas Production Rates

The gas output from the hydrogen generation EHG device is measured from a hydrogen analyser as the percentage of gas (%H) in the exhaust stream and the exit flow rate, *v*. The exit flow will consist of a mixture of the inert carrier gas (N_2) and H_2 and O_2 generated, including water vapour (with small amounts of mineral acid or alkali used as electrolyte). This assumes that the EHG cell reactions are merely water decomposition.

The H_2 gas flow is the $F_H = \%H \times v /100$ (1)

The moles of H_2 is determined from the gas law at the temperature (T) and pressure (P) of the exit gas stream:

$n_H = PV/RT$ (2)

the molar flow of hydrogen is thus:

$N_H = P\,F_H/RT$ (3)

To assess the EHG H_2 gas production, a comparison can be made with respect to the performance of an electrolyser. The equivalent current required to produce the gas flow can be determined from Faraday's law of electrolysis. This law, simply presented states that for zF coulombs of charge passed 1 mole of hydrogen is produced. In the case of hydrogen production z = 2.

The charge (Amp seconds) required to produce n_H moles of hydrogen is = zFn_h

The current required to produce hydrogen at the rate N_H ,

$I = z\,F\,N_H$ (4)

Combining equs. (1) to (4) gives

$I = z\,F\,(P/RT)\,(\%H\ v/100)$ (5)

The typical gas outlet temperature in the EHG rig is 18.5 °C (291.8 °K), F = 96485 C/mole, R = 8.314 J (mole K)$^{-1}$ = 8.314 10^{-5} m^3 (mole bar K)$^{-1}$

Therefore $I = 79.54\ 10^5\,(P.\ \%H\ .v/100)$ (6)

Where P is in bar and hydrogen flow is in m^3/s

With the EHG hydrogen flows in units of standard litres per minute (slpm)

$$I = 79.54\ 10^5\ (P.\ \%H\ .v/100)\ /[10^3\ .\ 60]$$

$$\mathbf{I = 1.326\ (P.\ \%H\ \mathit{v})\ \ (Amps)} \qquad \mathbf{(7)}$$

2.1 Comparison with Electrolysers for Hydrogen Generation

For the production of hydrogen other than from hydrocarbon and oxyhydrocarbon compounds, eg. methane steam reforming, the only commercial technology operated at a significant scale is water electrolysis. Water electrolysis uses direct current electrical energy to form hydrogen and oxygen. Decomposition of water requires a practical minimum of 1.41 volts (the thermoneutral potential) based on thermodyamics. This voltage falls with an increase in temperature. In practical operation, voltages required are higher to overcome electrode polarisation (activation overpotentials) and internal electrolyte resistance. Thus for example practical alkaline electrolysers operate at voltages of the order of 1.8-2.0 V, depending upon electroyser design, operating conditions and materials for electrodes and separators. Thus electrical efficiencies based on the ratio of the thermodynamic minimum and the practical voltages are of the order of 70-78 %. [Note that in some cases the standard water decomposition potential is used, i.e 1.21 V]. The voltage of operation determines the Energy Consumption of the electrolysis.

2.2 Energy Consumption

The energy efficiency of the test rig can also be determined and compared with that achieved by an electrolyser. Based on only the energy input in rotation, as the first approximation ,

i.e rotor power $= V_R\ I_R$

Where V_R and I_R are the rotor voltage and current respectively.

The energy consumption (EC) of the EHG rig is = Power/ N_H (Ws $mole^{-1}$)

For hydrogen; EC $=$ Power/ (2 N_H) (kWs kg^{-1})

$=$ Power/(7200 N_H) (kWh kg^{-1})

From equation (4) $N_H = I /(z\ F)$

Hence EC $=$ Power/(7200) (z F /I) = **26.8 Power/I** (8)

[note that a kg hydrogen has approximately the energy equivalence of 1.0 US gal of petrol]

In electrolysis, with a cell voltage E_{cell}

Energy consumption (EC) = $z\,F\,E_{cell}$ / (3600 M {CE}) [kWh/kg]
C.E. is the current efficiency as a fraction, which is assumed = 1.0

Typical values fo hydrogen: (molar mass, M = 2, F= 96485 [As/mole], CE = 1.0)

z = 2, E_{cell} = 1.8 to 2.0 V. EC = 2x96485x1.8/(3600x 2) = **48.24 to 53.6 kWh/kg**

2.3 Electrolyser production rate

In electrolysers the rate of hydrogen production is measured in terms of the current density, i.e current per unit cross sectional area of the electrode, as discussed above. Thus it is possible to make a comparison of the EHG test rig with that of an electrolyser based on the equivalent current density, i.e the equivalent current produced per unit cross sectional area of the electrodes, S:

$$j = I/S$$

Note that an alkaline electrolyser operates with a current density of a single cell of between 2000 to 5000 A m^{-2}.

In the present EHG cell the cross sectional area of the rotor is around 100 cm^2. Hence an equivalent current (hydrogen production rate) of 1 Amp represents an equivalent current density of 100 A m^{-2} and an equivalent current of 20 Amps a value of 2000 A m^{-2}. Hence at such hydrogen generation rates the EHG would require a similar electrode area as an electrolyser. This comparison does not consider aspects of cell stacking, where it may be suitable to consider the performance based on volume also.

3.0 Observation from March Test data

The tests with caustic electrolyte were performed initially with the cell not rotating and then followed by applying rotation. The background equivalent current was 3.0 Amps. On rotation, at 2000 rpm, the equivalent current increased to 3.4 Amp.

4.0 Data Analysis of Test Observations

Test data gas output pressures are only a few thousand kPa above atmospheric gauge pressure (1.01 bar) hence we assume that all pressures are atmospheric, which gives generally a slight underestimate of performance of a few percentage. The equivalent current from equ. (7) is thus

$$\mathbf{I} \quad = \quad \mathbf{1.34 \; (\%H \; \mathit{v}) \quad (Amps)}$$

In the following, the test observations and data, as presented in the Appendix are analysed. Calculations of equivalent current, I, are included in Table 1, as a spreadsheet.

4.1 KOH Electrolyte EHG Tests

At the test set up of time 9.15, the background equivalent current (referred to current for future reference) was of the order of 0.9 A. This is presumably due to corrosion effects although direct evidence for this is needed. The accumulation of solid deposits and decolourisation was an indicator of this although there was no apparent visual damage to the EHG cell.

At time 12.20 current increased on rotation to a maximum of 1.44 A, i.e an increase above background current of approximately 0.5 Amp. This may have been an outcome of some physical gas release due to rotation or/and due to the centrifugal field effect on the EHG. Increase in temperature to 90^{o}C caused a significant increase in %hydrogen. Currents at the %H measured are some 4 and 3 Amps above background. However the increase in gas output may have been a result of the much reduced gas solubility at 90 ^{o}C. It was observed that the gas production decreased after this; which concurs with the effect of a decrease in solubility of hydrogen as the amount of dissolved hydrogen would decrease with time causing a decrease in hydrogen desorption rate.

An increase in rotation from 2000 to 3000 rpm caused an increase of some 0.5 A compared with an increase of only 0.1 A when the rotation rate was increased from 1000 to 2000 rpm.

Considering briefly the energy consumption (EC) with alkaline electrolyte. Motor currents applied during rotation were of the order of 0.4 Amp. Assuming a 240 V DC supply the motor power used was 96 W. Using equation (8) for energy consumption:

$$EC = \mathbf{26.8\ Power/I}$$

Hence with a current equivalent of 4 Amps, the EC = 643 kWh/kg, which is a factor of 10 greater than water electrolysis.

4.2 EHG with electrolysis mode of operation

With the EHG operated in electrolyser mode, the background current was low at around 0.7 Amp. Introduction of an electrolyser current caused an initial large increase in the current (hydrogen production) of 20 Amp, which fell to 4.5 Amp, although the electrolyser current was recorded at 0.5 A (time 18.17).

There was a considerable variation in hydrogen production with currents varying between 3 to 10 Amp, with the EHG rig under rotation of 2000 to 3000 rpm. The applied electrolyser currents were typically around 2 to 3 A.

The EHG test system during the electrolyser mode tests was exhibiting significant dynamics with current pulsing and cell pressure variation. Such dynamics will affect the hydrogen production dynamics and may explain why the measured hydrogen production currents are often well above the actual electrolyser currents applied to the EHG cell. However it may be that imposing a centrifugal field (in conjunction with a magnetic field) has enhanced the hydrogen production above that predicted from the electrolyser current imposed. One way of checking this would be to integrate (over time) the hydrogen production rate and compare this with the integrated electrolyser current with time, i.e. accumulated charge passed.

The best (peak) currents with the imposed currents were around 18.5 Amps, at an imposed current of around 3.5 A.

Thus an enhancement of some 15 Amp maximum was achieved for the "electrolyser" system. The typical enhancement was of the order of 10 Amp which is roughly in agreement with that achieved without an imposed current. Thus a similar performance was achieved with the alkaline electrolyte.

4.3 EHG Tests with Sulphuric Acid

Tests of the EHG cell with sulphuric acid (30% aqueous solution) were performed after the electrolyser tests but with no imposed current. In addition to production of hydrogen and oxygen from water electrolysis, it is possible that sulphate can be oxidised to persulphate at high sulphate concentrations. This effect may influence performance but is not quantifiable in the present test system, without detailed analysis.
On start up of the EHG cell without rotation, large quantities of hydrogen were produced, with equivalent currents of the order of 17- 43 Amps at temperatures of around 60 ^{o}C. These are large amounts of background hydrogen which is potentially a result of corrosion. This has subsequently been potentially attributed to corrosion of internal stainless steel springs which can result in hydrogen production through the sacrificial oxidation of the steel.

Rotation of the cell caused a large increase in currents of up to 71 Amp at 2250 rpm. However at this point the cell tests had to be stopped after 5 minutes of operation and thus it is not certain whether the very large increase in hydrogen was due to the EHG cell dynamics. Notably this performance was achieved after the cell exhibited an apparent "exotherm" with the EHG cell electrolyte exit temperature some 2.6 ^{o}C above the inlet temperature. Such an effect would normally be associated with large Ohmic heating in an "electrolyser" mode, due to high current passing through the cell.

A 71 Amp current value is good when compared with the production capabilities of alkaline electrolysis, i.e. an equivalent current density of some 7000 A m^{-2}, cf. electrolysers at up to 5000 A m^{-2}. The measured values of approximately 40 Amps compares well with current electrolyser technology. However this data does not allow for background currents which is difficult to absolutely quantify.

There is no real quantifiable trends in the effect of rotation on performance. Qualitatively, an increased rotation rate appears to improve hydrogen production rate as does an increase in temperature. At a rotation rate of 1000 rpm the current enhancement above background current was some 8A, compared with an enhancement of some 37 A with a rotation rate increase from 1000 to 2250 rpm. This indicates an exponential type of increase in production rate with increase in rpm, rather than a non-linear increase; although caution is advised in this assessment.

4.4 Efficiencies and other observations from the test data.

The recorded rotor currents in EHG tests without applied electrolysis are of the order of milliAmps and as such suggest hydrogen production is not associated with current flowing in the external circuit between the EHG anode and cathode.

Motor currents applied during rotation are of the order of 0.4 Amp. Assuming a 240 V DC supply the motor power used is 96 W. Using equation (8) for energy consumption

EC = **26.8 Power/I**

At a current of 71 Amps this gives an EC = 36 kWh/kg and indicates that an energy consumption at least comparable with electrolysis is possible.
Based on the thermoneutral potential of 1.41 V the minimum energy consumption is 37.5 kWh/kg. Thus an efficiency approaching 100% is indicated. This data should be used with caution due to the short term duration of the tests and the inherent assumptions in the calculations. There is clearly a need to perform more detailed tests under stable operating conditions to verify the performance observed so far. The data does not allow for background currents. However taking values of current of 37 Amp (which allows for background current) gives EC =69 kWh/kg and efficiencies (compared to electrolysis) of around 50%; approaching those of electrolysis.

5.0 Conclusions and Recommendations

EHG tests with an alkaline electrolyte gave at best, current equivalents of 5 Amps and energy consumptions, which are some ten times greater than those for water electrolysis.

With an imposed " electrolysis" current the best (peak) currents with the imposed currents were around 18.5 Amps, at an imposed current of around 3.5 A. Thus an enhancement of some 15 Amp maximum was achieved for the "electrolyser" system and a typical enhancement of the order of 10 Amp. A similar performance was achieved with the alkaline electrolyte with and without an imposed current.

The best performance was achieved with the sulphuric acid electrolyte based EHG tests. A peak hydrogen production rate at a equivalent current of 71 Amps and an energy consumption of 36 kWh/kg was obtained, which is superior to that for water electrolysis. The average energy consumption for the short term tests are comparable with those for standard water electrolysis.

5.1 Recommendations

It is recommended that following the re-build of a new EHG test cell and rig that tests with sulphuric acid electrolyte be performed. These tests should be carried out with varied rotation rates up to the maximum possible, e.g. aound 5000 rpm. The tests should be conducted to a point where a reasonable steady state of hydrogen production is achieved, of the order of 1 hour for each condition investigated (temperature and rpm). In addition the accumulated hydrogen production rates should be recorded to enable energy consumption and performance in general to be better assessed over the campaign of the test. This is because of the gas solubilities and electrolyte conductivty and mass transfer of gases will vary with changes in temperature and rotation rate. Measurements of any current flowing between the two EHG electrodes should be made to check for the effects of induced current from the magnetic field. This should be done with an external electrical circuit which has a low resistance. The potential difference between the two electrode terminals should be measured.

In addition to examining the effect of operating variables with sulphuric acid electrolyte, examining the influence of sulphuric acid concentration (10% and 40%) should be considered. An alternative acid to sulphuric acid, which has a larger ion size, e.g. methane sulphonic acid, should be considered.

Such electrolytes have been effectively used in other electrochemical cells to improve electrode catalysis. In addition the larger ionic size of the methane sulphonate should make it more susceptible to a combined rotation and magnetic field; potentialy providing faster ion transport and interfacial electrode charge accumulation. If appropriate, tests which also include the use of an imposed "electrolysis" current should be considered.

The influence of the magnetic field should be examined by dis-engaging the magnets from the EHG cell.

Longer term considerations should be given to investigating the EHG cell design, its scalability and the materials used, for electrodes and any catalysts. Investigation of the gas and liquid flows through the cell should be considered from practical and fundamental aspects.

Notes:

Status Report on Electro Hydrogen Generation (EHG) carried out by VN- H POWER GENERATION LIMITED. 12th January 2017

Summary

This report describes the development work of an electro hydrogen generation (EHG) system for the production of hydrogen from the application of a rotating electrode system within a magnetic field. The system design was based on data generated from the previous development programme using a small scale single cell system. The report gives details of the flow circuit components, the drive train and sealing system for the new EHG cell.

1.Background.

The principle of operation of the EHG is that by rotating electrodes and an associated electrolyte in a magnetic field, at right angles to the direction of rotation, creates an electrical potential difference and thus the ability for current flow (orthogonal to both the magnetic field and direction of rotation) and thus for electrolysis to occur. The electrolysis can typically be the decomposition of water which produces hydrogen gas (and oxygen).

The efficiency of the device is believed to be improved through supply of external waste heat and operation at moderately high temperatures, e.g. ca. 60 °C.

2. Previous Feasibility Tests.

The previous test work on EHG1 has demonstrated the feasibility of using a combination of rotational force with a magnetic field to generate hydrogen from both concentrated aqueous acid and alkaline electrolytes on a small scale. The test rig was based around the operation of a two electrode cylindrical reactor (see Fig 1 schematic), of short length (H = 2cm) which under rotation produced hydrogen from the decomposition of water on the inner surface of the external electrode. However, although electrochemically, high rates of hydrogen were generated, over short time scales, of an order of magnitude similar to more conventional electrolysis using external voltage/current supply, the test data produced was limited due to engineering problems of the rig associated with the rotation mechanical mechanism, seals and materials scaling and corrosion. Ultimately this test system failed mechanically.

3. Phase 2 programme.

One of the limitations of the EHG1 was the electrode area available, in a unit volume of the system, and consequently the rate of hydrogen generated per unit volume (sometimes referred to as the space time yield (STY, kg m^{-3} h^{-1}). To increase the STY essentially requires introducing more electrode area in the available space, which can be achieved by using an array of so-called bipolar electrodes. (noting that increasing the electrode diameter reduces the area per unit volume}. Thus EHG2 was designed on the basis of a stack of relatively large bipolar, rotating, flat disc electrodes, with a central hole for positioning of the EHG rotor and magnets, as shown in Fig. 2. The electrodes in this system rotate in the plane of the discs as opposed to EHG1 in which the electrodes surface was at 90 degrees to the direction of rotation. However in both systems the lines of magnetic field strength, rotational force and any subsequent potential field are all orthogonal; complying thus with theoretical requirements of the EHG operating principle (Fig. 3).

To support the operation of EHG2 required detailed engineering design of rotational components, seals, electrical contacts and electrodes.

3.1 Status of EHG2 test programme.

The work carried out in the test period concentrated on the design and commissioning of the EHG2 and the flow, mechanical and electrical systems.

3.1.1. EHG2 design with a variable number of rotating bipolar disc electrodes.

The device consists of an array of a maximum of 17 rotating electrodes, positioned around a central shaft which has access for fluid flow at the bottom. The electrolyte flow passes into the rotating shaft and flows out between the spaces between each bipolar disc electrode. Permanent magnet rings are positioned (north and south poles facing one another) on the inside and outside of the disc (annular) electrodes. The bipolar disc electrodes function during electrolysis by virtue of an induced potential gradient, normal to the surface, causes one side to act as a cathode (e.g. for hydrogen generation) and the other side to act as a anode. Current flows through the complete stack via stationary electrodes positioned at the top and bottom inner surfaces of the EHG2.

3.1.2 Design specification and manufacture of electrodes.

For water electrolysis it is beneficial to reduce the required voltage for hydrogen and oxygen evolution by using electrocatalysts. Stainless steel is not an ideal material for electrolysis in acid, e.g concentrated sulphuric acid electrolytes as it has no electrocatalytic activity and may potentially corrode. Electrodes for the EHG need to be non-magnetic, have high electrical conduction, to be mechanically strong and be chemically resistant to a range of electrolytes. This EHG2 hydrogen generator is designed to be used with, concentrated sulphuric acid, concentration potassium hydroxide and methane-sulphonic acid and sodium chloride electrolyte. The latter gives the option to produce sodium hypochlorite as an alternative to oxygen, the former being an important disinfectants used in a number of environments for water treatment, for example in power stations. State of the art bipolar disc electrodes were designed based on a chemically stable titanium sheet coated with a thin electrocatalyst cathode layer on one side and a thin electrocatalyst anode layer on layer on the other side.
A stack of stainless steel electrodes has been designed and built for the EHG.

3.1.3 Design of main rotation drive for EHG2 stack testing.

The EHG1 failed mechanically due to the rotor only being fixed in place at the bottom location. EHG2 was designed to be fixed in place at both the top and bottom of the unit. Preliminary tests with an external motor and pulley drive proved to be inefficient, generating large amounts of heat and temperatures and had limited rotation rates. This drive system for the EHG2 rotor was replaced with a direct drive motor fixed to the base of the EHG rotor.
The direct drive resulted in a redesign of the motor-drive configuration to initially prove the concept, and then a subsequent set of design adjustments resulting in a robust, flexible and reliable drive mechanism capable of dealing with the very large torque requirements without failure. Subsequent testing proved the new drive setup, and the impact on the reliability was immediate. The rig was able to reach up to nearly 2300rpm, though this was not a constraint

on the drive mechanism, rather the electric motor power and internal EHG design. The direct drive has been specified to reach speeds of up to 5000 to 6000rpm.

3.1.4. Test rig design

Design of test rig with efficient gas engagement and fluid recirculation and accurate hydrogen and oxygen gas analysis is essential for EHG2 testing. A requirement for EHG2 operation is to avoid a build-up or gas (two phase gas liquid mixture) in the recirculation loop, which requires the introduction of efficient gas liquid separation. A flow circuit with electrolyte heating and temperature control, gas disengagement and on-line hydrogen and oxygen flow and compositions sensors has been designed and commissioned. The gas-liquid separator functioned in an effective manner; separating the gases from the liquid after the EHG2 and thus preventing gas re-entering the flow circuit. Gas analysers have been calibrated and provide high accuracy for both hydrogen and oxygen composition measurement in the generate product gas stream.

3.1.5. Design and specification of robust seals for fluid containment.

Retaining liquid integrity of the EHG2 during operation is critical for long term operation. Preventing electrolyte loss through the point of contact of the rotating central rotor and the EHG2 stationary body requires seals that can tolerate strong acid and alkali at moderate temperatures and the friction produced between the two surfaces. This required evaluation (both mechanically and chemically) of a number of sealing options.

The first set of seals designed and fabricated by Fluorocarbon Company Ltd. of Hertford, (see attached schematic –Figure 4) was a lipped seal made from a mixture of PTFE and a polyamide filler to reduce the heat effect on the PTFE. Some heat-effect testing was performed by Fluorocarbon, though it was limited and was only done in air, not with electrolyte, up to 60C. This version failed soon after filling the EHG with water and rotating the shaft at relatively low speeds. The following version included an energised spring design, incorporated into the original design, made from Hastelloy, but again this failed after the introduction of electrolyte to the EHG and on commencement of rotation. The final version was a PTFE graphite mix. Various degrees of longevity of the seals resulted, but none were successful in completely sealing the bottom of the EHG shaft. It also became clear that any filler that was too abrasive would start to wear the seal journal, and so after more investigation into potential alternative suppliers. Erks Seals were tried with an off-the-shelf solution, but this also failed. AllSeals Inc of California designed a simpler more robust solution, (see schematic of seal 2; Figure 5) which consisted of a PTFE and Ekanol, with a light loaded canted coil spring seal with a hastelloy spring. AllSeals also suggested a hardness and surface finish for the seal journal to ensure electrolyte-tight integrity. As a result of this recommendation a supplier was found that could deposit a ceramic coating to the surface and hardness requirements onto the Ti shaft without altering the overall dimensions, to ensure that the EHG could be rebuilt without any 'Fitting' issues or leaks. This seal and surface treatment on the TI was tested at various temperatures with water prior to full testing with electrolyte and was watertight. Subsequently, with both acid and alkali at temperatures up to 45C the seals also proved to be electrolyte-tight.

3.1. Conclusions

Design, commissioning and initial testing of EHG2 has been carried out and has resulted in the following achievements:

EHG2 bipolar stack tests showed electrical integrity during using both an array of stainless steel (non-magnetic) electrodes and coated titanium electrodes.

Electrode materials research identified a suitable Ti metal substrate that could be coated with electrocatalyst for hydrogen and oxygen evolution (and chloride electrolysis) by thermal decomposition, that was compatible with acidic, alkaline and chloride electrolytes. Disc electrodes were manufactured with mechanical tolerance, after thermal treatment, suitable for use. The EHG2 was successfully mechanically tested with the array of bipolar, coated Ti electrodes.

A direct drive system has been specified and successfully mechanically tested for operation and rotation of the EHG2 at rates of 2300 rpm with a design capability of 5000-6000 rpm.

A flow circuit with electrolyte heating and temperature control, gas disengagement and on-line hydrogen and oxygen flow and compositions sensors has been designed and commissioned.

A seal system based on has been identified and evaluated under the relatively short term tests carried out so far.

Figures.

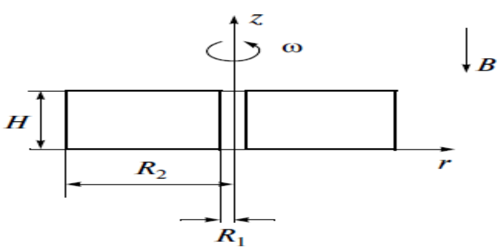
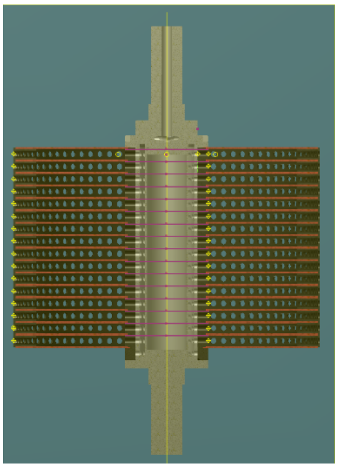


Figure 1. Schematic of EHG1. Electrodes of length H= positioned at radial positions R_1 (3 cm)and R_2.(15 cm). Magnetic field in direction B. Rotation around coordinate z.



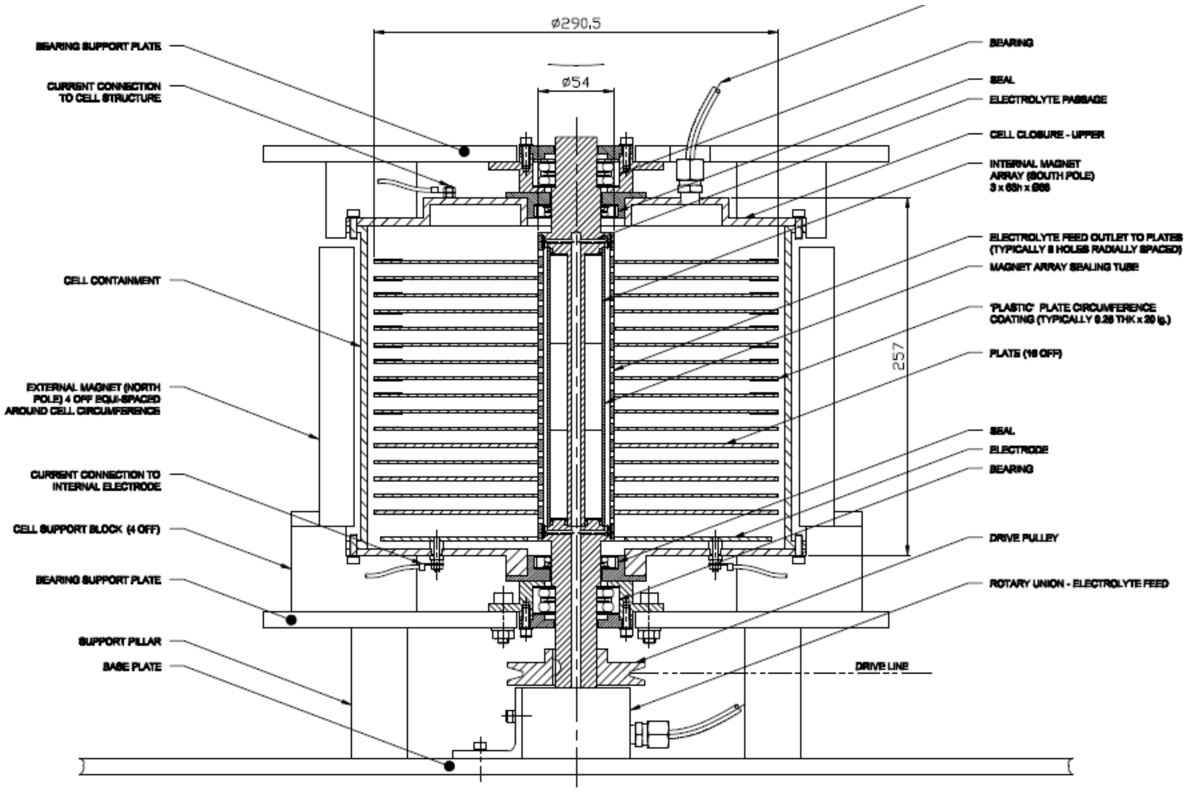


Figure 2. Schematic of electrode disc stack around central rotor. Scale diagram of EHG 2

Disc inner diameter = 5.4 cm; outer diameter =29 cm.

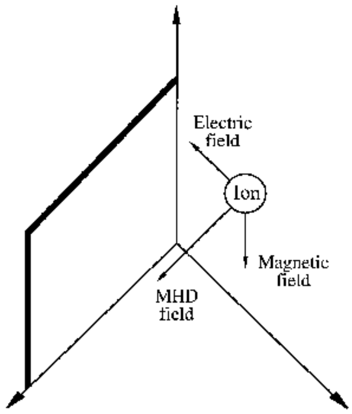


Fig 3. Schematic of lines of force fields for EHG operation. Ionic movement is generated in a medium by the coupling of an electric and a magnetic field. The direction of movement is perpendicular to the fields. The resulting force action along the solid surface generates flow at the interface

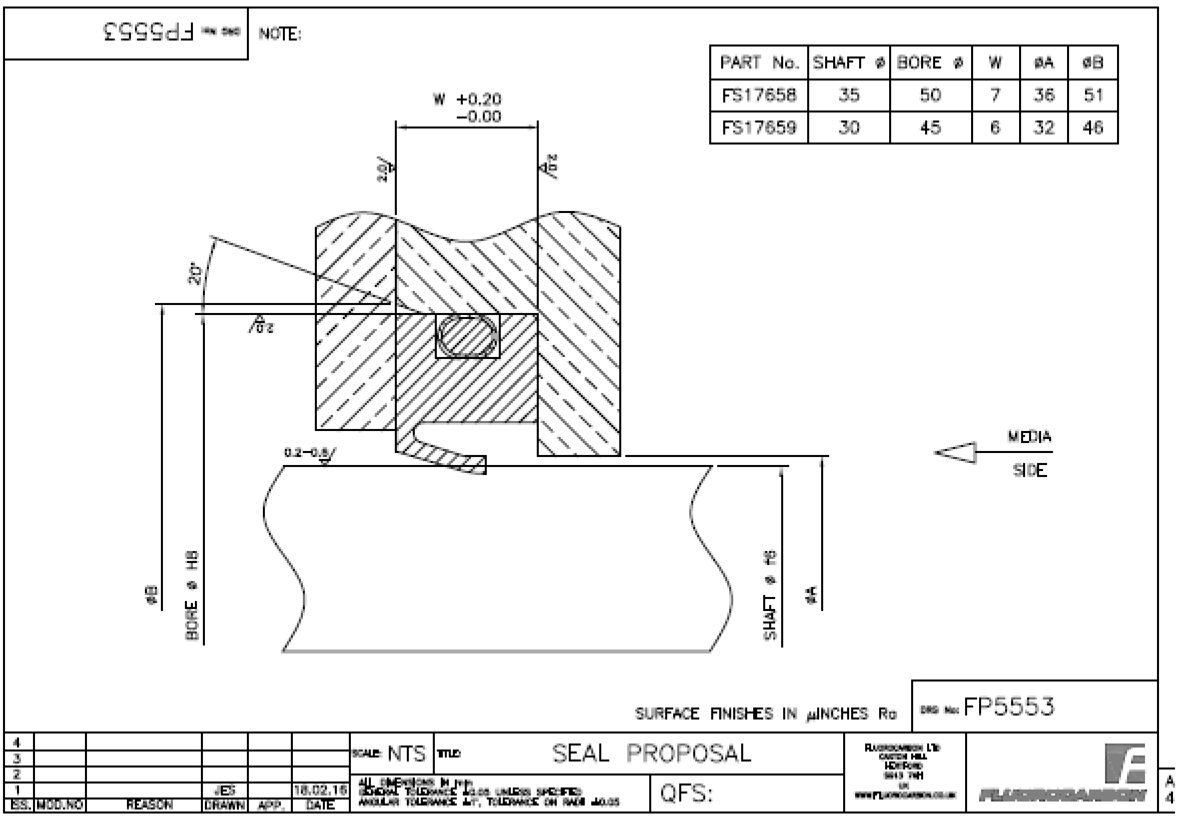


Figure 4. Schematic of Seal 1.

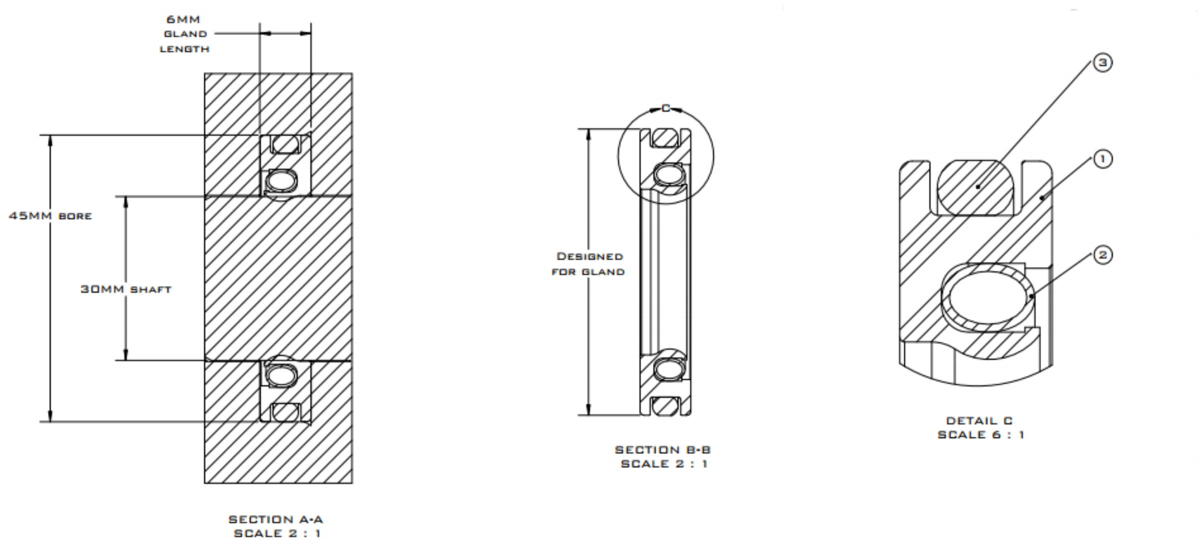


Figure 5. Schematic diagram of seal 2.

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