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28th June 2012

DEPARTMENT OF ENERGY AND CLIMATE CHANGE

By email

Dear Sirs,

RESPONSE TO PUBLIC CONSULTATION: THE ROLE OF GAS IN THE ELECTRICITY MARKET

SUMMARY

Gas can be decarbonised as readily as electricity.

This response to the above consultation is based on decarbonising the UK gas grid at source. This will decarbonise gas fired electricity generation without needing to add CCS to new or existing CCGT's.

The UK gas grid can be decarbonised at source by injecting high pressure pipeline quality decarbonised Synthetic Natural Gas (SNG) into the gas transmission grid. Decarbonised SNG is made by converting an approximately 50% biogenic Carbon content mixture of hazardous and non-hazardous wastes, biomass and coal into SNG, and capturing and sequestering approximately 50% of the total Carbon throughput. The sequestered biogenic Carbon at the SNG plant offsets fossil Carbon emissions at the downstream CCGT.

This response is based on a presentation on 23rd May attended by a team of engineers from DECC and ETI; representatives of GL Noble Denton Ltd, Jacobs Engineering Group Inc, Johnson Matthey plc, Timmins CCS Ltd, and Dr. John Lacey, the former director of the British Gas Corporation Synthetic Natural Gas (SNG) programme. A subsequent presentation was given to National Grid plc on 18th June 2012. The 'key' issues which emerged from these presentations were:

- Grandfathering the 450 gCO_2/kWh Emissions Performance Standard for gas fired electricity generation until 2045 can be made consistent with achieving economic electricity system emissions intensity of 50 gCO_2/kWh by 2030 by supplying gas which has been decarbonised at source to conventional gas fired power stations.

- DECC and ETI have stated that CCS and bioenergy are the 'keys' which 'unlock' a number of least cost technology pathways to decarbonisation. By combining bioenergy, and low cost CCS using high pressure industrial gas processing technologies, the production of decarbonised SNG significantly reduces the cost of CCS and low Carbon energy, compared with fossil fuel combustion to produce electricity.

- The need to economically deliver decarbonisation, and to provide: economic daily electricity grid balancing; back up for intermittent renewable energy resources, and the annual industrial and domestic heat demand cycle, will be met by: decarbonising the UK gas grid; providing enhanced gas storage, and retaining the gas grid at a significant proportion of its current size

- Decarbonised SNG can be injected into existing gas transmission nodes, unlike wind power which is frequently located remote from existing centres of energy demand, thus reducing the need to extend the electricity grid. Energy transmission via gas is more economical per unit MWkm than via electricity.

- The gas grid provides a far greater quantity of energy storage at far lower cost than bulk electricity storage.

- Decarbonised SNG with CCS is a clean, storable, dispatchable, renewable primary energy resource made from low cost indigenous sustainable fuels. Combined with other conventional and unconventional gas resources, this will deliver diverse, flexible and secure energy supplies.

- Dispatchable, load balancing decarbonised SNG fired electricity generation will support low carbon electricity generation by intermittent renewables and inflexible base load nuclear.

REPORT

This response is based on the proposal for a substantial proportion of UK gas to be supplied by low Carbon content renewable gas known as "decarbonised SNG". 80% mixed hazardous and non-hazardous wastes; Refuse Derived Fuel; woody and contaminated biomass, and 20% coal and Tyre Derived Fuel will be converted at high pressure into pipeline quality low Carbon content SNG at net energy efficiency in excess of 76%, including CCS. The decarbonised SNG will be injected into the high pressure gas transmission grid.

The input fuel mixture will have an average biogenic Carbon content in excess of 50%, and near zero average net cost. Avoided Landfill Tax at an average of £-8/GJ will offset the cost of coal and biomass at an average of £2.0 to £3.25/GJ. More than 50% of the total Carbon throughput of the SNG plant will be captured and sequestrated producing gas, which when consumed will produce near zero net Carbon emissions. Downstream gas users: electricity generation, heat, industry and transport will be decarbonised at effectively ZERO COST.

The technology to deliver this vision was developed between 1955 and 1992 by British Gas Corporation against North Sea gas supplies running out. In 1985, Dr. Lacey wrote that the need for SNG would most likely arise during the period 2010 to 2020. British Gas developed and proved the WORLD'S HIGHEST EFFICIENCY SNG technology in order to supply the WHOLE OF UK GAS DEMAND by high pressure SNG produced at around 76% net energy efficiency. The research, design, engineering, test and operational records of this 30 year £1bn+ R and D SNG programme are held by GL Noble Denton Ltd, the successor organisation to British Gas Corporation. Parts of the process are licensed to Johnson Matthey plc and its subsidiary Davy Process Technology Ltd.

In the British Gas SNG scheme, nearly pure CO_2 is separated as a net zero marginal cost by-product, and discharged to atmosphere at 1.2 bar pressure. SNG production is thus inherently Carbon Capture Ready. By means of a simple, but ingenious, high pressure gas recycle loop, using all proven commercial gas process industry technology, invented by the late Cyril Timmins, a retired senior ex-British Gas engineer, it is possible to recover the separated CO_2 as a liquid at 60 bar pressure and 15^0C. This reduces the parasitic energy loss for compressing CO_2 to 150 bar supercritical phase for transmission in a CCS pipeline. The Timmins CCS scheme also reduces the parasitic energy used in separating the CO_2 to less than the base British Gas SNG scheme. The Timmins CCS scheme thus both captures CO_2, and increases base plant energy efficiency. The improvement in base plant efficiency largely offsets the additional Capital and Operational costs of the Timmins CCS scheme thus reducing the marginal cost of adding Timmins CCS to an already inherently Carbon Capture Ready SNG plant.

Converting a Carbon Capture Ready (CCR) SNG plant incorporating Timmins CCS to full CCS requires the simple addition of a fluid pressurisation pump to increase the pressure of liquid CO_2 from 60 to 150 bar. The low additional Capital and Operational costs of this pump produces low Marginal Abatement Cost of Carbon. The operational flexibility of a simple low cost conversion from CCR to CCS when a combination of policy and economic conditions, and the availability of a CO_2 pipeline grid, makes the conversion from CCR to CCS practicable, reduces the regulatory and financial risks associated with investment in decarbonised SNG.

COST BENEFIT ANALYSIS

Combining the proven high efficiency British Gas SNG scheme with the patented Timmins CCS Ltd gas recycle loop, and a low cost partly biogenic 80% waste and biomass:20% coal fuel mixture, produces exceptionally good economic and emissions results.

- Marginal abatement cost of Carbon: £17.50/tonne (150 bar supercritical phase at plant gate).
- Levelised cost of dispatchable low Carbon electricity: £45/MWh.
- Levelised cost of decarbonised SNG: 45 p/therm (60 bar at plant gate).
- 415 gCO_2/kWh emissions intensity to electricity generation unabated Carbon Capture Ready.
- 65 gCO_2/kWh emissions intensity to electricity generation abated with Carbon Capture and Sequestration.
- Convert 75 mtpa of mixed wastes, biomass and coal to supply 50GW of connected CCGT's at average 50% plant load factor to deliver an average of 25 GWe pa (at 3mtpa per GWe for 8000 hours pa).
- Receive revenue enhancement of £60/MWh ROC and 100 p/therm RHI.

THE POTENTIAL FOR DEVELOPING SYNTHETIC NATURAL GAS (SNG)

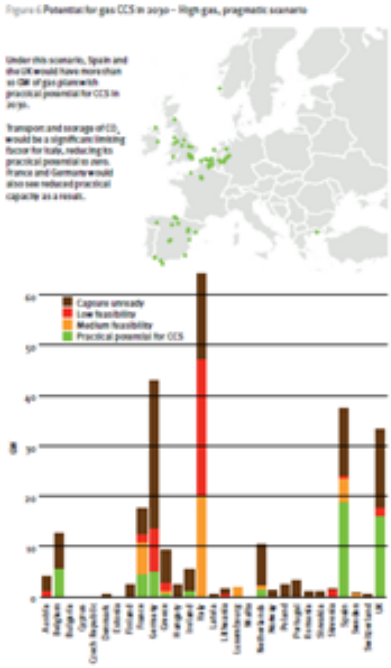
British Gas' plans to supply the whole of UK gas demand by SNG might seem fanciful, but only 50 years ago, the whole UK gas supply was produced in gas making plants. In the 1970's sufficient British Gas designed and licensed plants to convert oil distillates to SNG were built in USA in a 5 year period to supply the whole of UK gas demand.

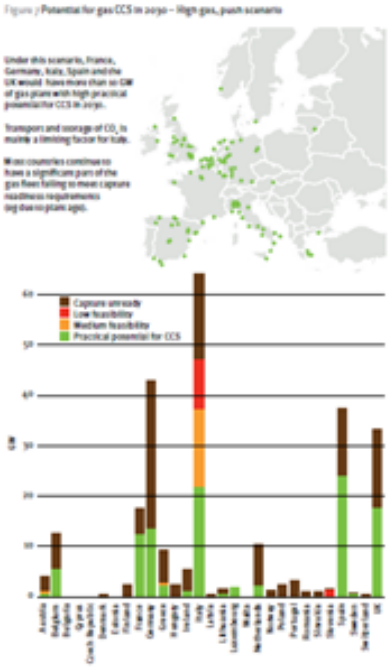
Even larger scale developments are occuring in China under the current 5 year plan. Johnson Matthey plc is currently engaged in building five SNG plants in China. Jacobs is engaged in building SNG plants in Korea and China. SNG plants are also being built in USA and Indonesia. There are currently 32 SNG plants being developed in China with a total capacity of 110 bn cub.m. pa, of which Johnson Matthey advises the likely completion of 80 to 90 bn cub.m.pa, out of a planned increase in total domestic gas production capacity of around 275 to 300 bn cub.m. pa. China plans to build sufficient SNG capacity to replace the whole of UK demand in 5 years.

CHINESE COAL TO SNG 2012: 32 PLANTS PLANNED OR IN DEVELOPMENT. TOTAL CAPACITY 111 bn m^3 pa

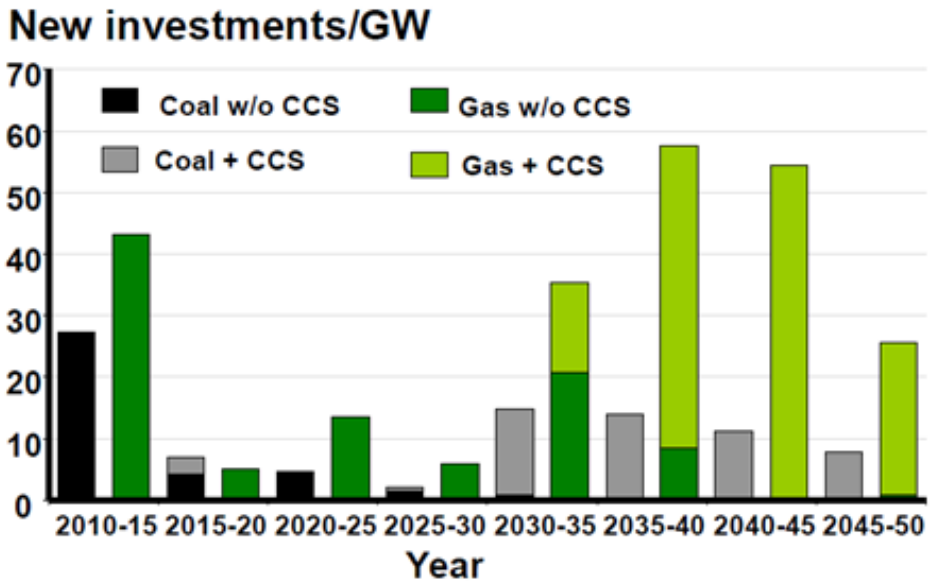
Projections by IEA and EU suggest that the total market for decarbonised SNG in Europe could be sufficient to supply up to 150GW of 'clean gas' fired electricity generation by 2030, and up to 240GW of clean gas fired electricity generation by 2050.

EU PREDICTS 50 TO 150 GW OF GAS FIRED GENERATION WITH CCS BY 2030. MARKET LEADERS: UK,SPAIN & ITALY





IEA PREDICTS 240GW OF NEW 'CLEAN GAS' GENERATION BETWEEN 2010 AND 2050 AND 50GW OF NEW 'CLEAN COAL'



Taking China and EU together, there is a potential market to develop around 250 to 300 bn cub.m. pa of decarbonised SNG plants. SNG developments with CCS, electricity and fertiliser are underway in USA. The Great Plains SNG plant in Dakota, has been operational since 1984. British Gas designed high temperature HICOM combined shift and methanation catalysts are being used at Great Plains, supplied by Johnson Matthey plc.

1989 CPS HIGH TEMPERATURE HICOM CATALYST USED AT GREAT PLAINS LIGNITE TO ELECTRICITY, SNG, CCS/EOR AND FERTILISER

ALL SNG plants are inherently economically Carbon Capture Ready (CCR) because they produce a large stream of nearly pure CO_2 as a by-product of the SNG process.

SNG PLANTS: LARGE HIGH CONCENTRATION POINT SOURCES OF CO_2

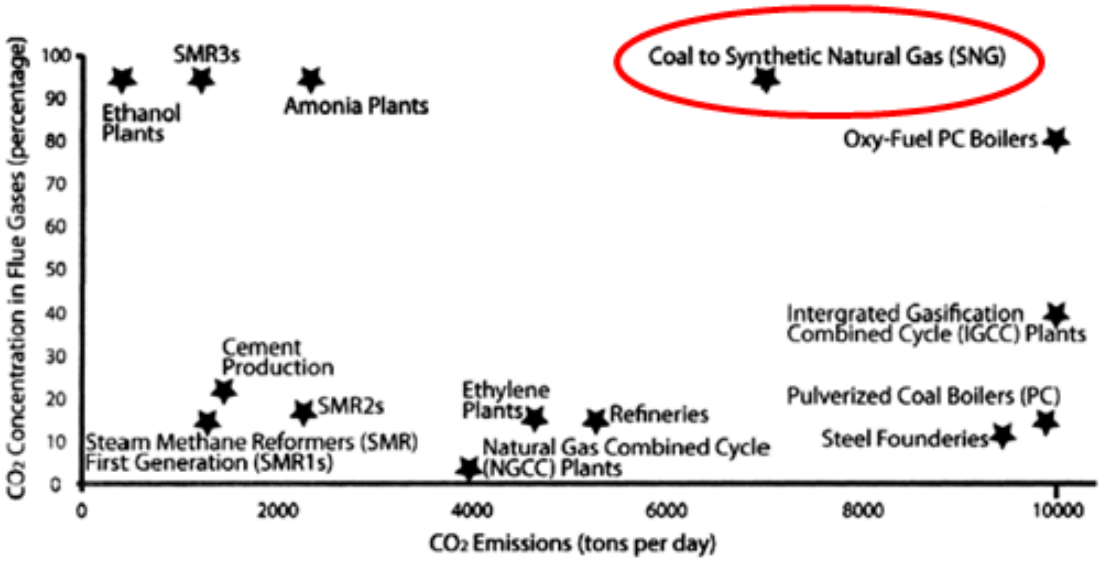
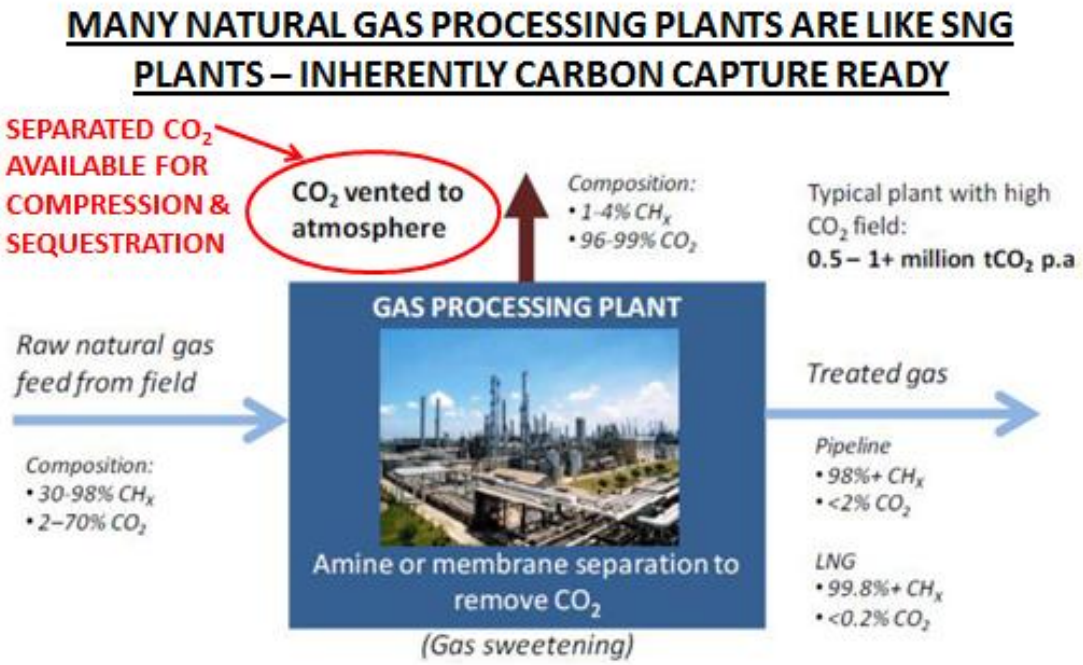


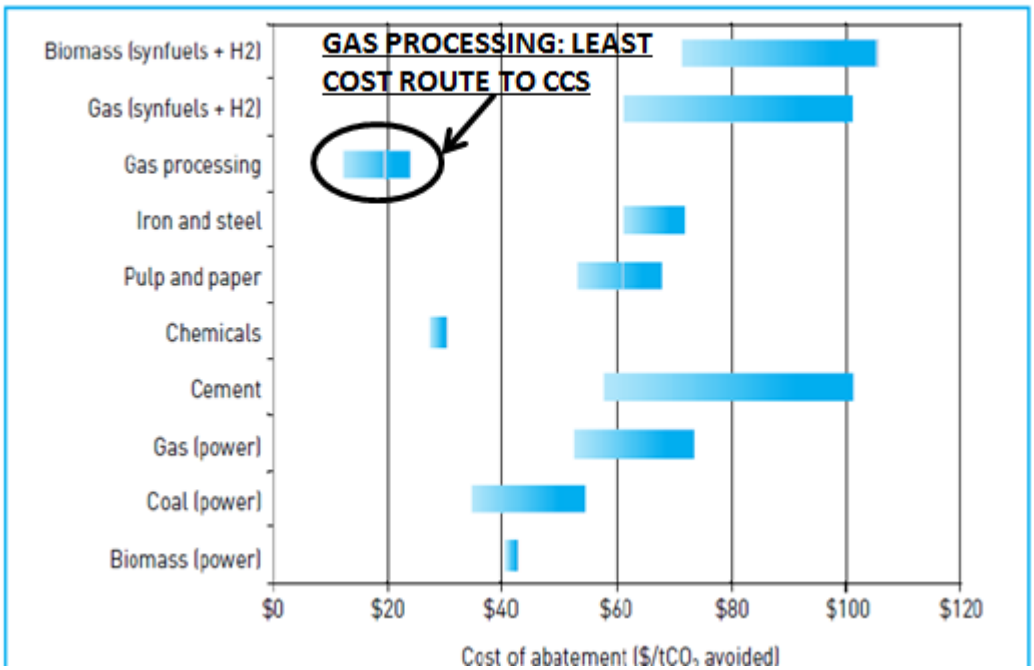
Figure 4 - CO_2 Point Sources: Amount vs. Concentration

CCS on gas processing is already a mature and economic industrial technology as many fossil Natural Gas supplies contain large quantities of fossil CO_2, which is separated and used commercially for CCS or Enhanced End of Well Oil Recovery (EOR).



The combination of large point source of nearly pure high pressure high concentration CO_2, and high efficiency conversion of low cost fuels to fungible, storable, dispatchable, high added value, low Carbon content form of renewable gas produces a winning combination of low cost energy and low Marginal Abatement Cost of Carbon.

Figure 1: CCS abatement cost range – 2010-50 by sector (USD/tCO_2 avoided)[14]



THE USE OF DECARBONISED SNG FOR ELECTRICITY GENERATION

Whole electricity system scenarios below indicate:

1 Dispatchable low Carbon gas fired electricity generation can economically support intermittent renewables and base load nuclear.

2 If by 2030 the proportion of total energy supplied by dispatchable partly biogenic Carbon content decarbonised SNG is increased, and the proportion of total energy supplied by non-dispatchable intermittent renewables is reduced, it would be possible to increase the proportion of electricity supplied by renewable energy to 50%, without needing to convert the electricity grid from demand led to supply led operation, or develop large scale electricity storage or international electricity grid interconnectors.

3 The deployment of a dispatchable, storable primary renewable energy resource will enable whole electricity system plant load factor to be increased to 50% by 2030.

4 Whole electricity generating system emissions intensity of less than 50 gCO_2/kWh in 2030 is technically and economically feasible without having to fit post combustion CCS to UK's fleet of gas fired power stations.

The two scenarios below demonstrate a potential low cost scheme for UK electricity generation before and after 2030, meeting the criteria set out above:

REDUCING THE 'OVERNIGHT' CAPITAL COST OF DECARBONISING THE UK ELECTRICITY GRID 2010 TO 2025									
UK GRID SCENARIO 2015 TO 2030 BASED ON NATIONAL GRID PLC 'GREEN GAS' AND 'STORAGE SOLUTION' SCENARIOS. EXISTING TECHNOLOGIES. MODERATE DEMAND MANAGEMENT. ENHANCED GRID INTER-CONNECTORS AND ENERGY STORAGE REDUCE SUPPLY/DEMAND FLUCTUATIONS, DEMAND RESPONSE REDUCED. TOTAL RENEWABLE AND BIOMASS ENERGY CONTENT APPROXIMATELY 37.5% OF TOTAL ELECTRICITY SUPPLY. CCS AT DEMO STAGE									
	Connecte	Base	Peak min	Peak max	Average	Load	% total	Carbon	Renewable
	load	load	wind/sun	wind/sun	supply	factor	supply	intensity	proportion
Nuclear	10 GW	8 GW	9.0 GW	8 GW	8.5 GW	85%	14.2%	0	0%
Intermittent renewables	40	10	6.5	28	12.5	31%	20.8%	0	100%
Multi-fuel IGCC. Carbon Capture Ready	15	10	14	10	12.5	83%	20.8%	415	52.50%
Fossil NG fuelled existing CCGT	32	16	30	10	20.5	64%	34.2%	410	0%
Bio-Methane fuelled existing CCGT's	1.5	1	1.5	1	1	66%	1.7%	0	100%
Coal with post combustion CCS (plant demo stage)	1.5	1	1.5	1	1	66%	1.7%	90	0%
Embedded micro-generation/demand management	8	4	2.5	7	4	50%	6.7%	0	100%
TOTALS	**108 GW**	**50 GW**	**65 GW**	**65 GW**	**60 GW**	**55%**	100%	**227 gCO2**	**40.1%**
Add Reserve generation to back up macro demand management, inter-connectors and energy storage.								**/kWh**	
Low merit gas/hot spinning coal (capacity payment)	12 GW	0 GW	5 GW	5 GW	61.5 GW	13%	1.33%	410	0%
TOTALS	**120 GW**	**50 GW**	**70 GW**	**70 GW**	**61.5 GW**	**51%**		**232 gCO_2/**	**39.10%**
								kWh	
REDUCING THE 'OVERNIGHT' CAPITAL COST OF DECARBONISING THE UK ELECTRICITY GRID 2025 TO 2050									
GRID SCENARIO 2025 TO 2050 BASED ON NATIONAL GRID PLC/ENA 'GREEN GAS' AND 'STORAGE SOLUTION' SCENARIOS. EXISTING TECHNOLOGIES. MODERAT DEMAND MANAGEMENT, ENHANCED GRID INTER-CONNECTORS AND ENERGY STORAGE REDUCE SUPPLY/DEMAND FLUCTUATIONS, DEMAND RESPONSE REDUCED. TOTAL RENEWABLE AND BIOMASS ENERGY CONTENT APPROXIMATELY 50% OF TOTAL ELECTRICITY SUPPLY. FULL CCS ROLL-OUT.									
	Connecte	Base	Peak min	Peak max	Average	Load	% total	Carbon	Renewable
	load	load	wind/sun	wind/sun	supply	factor	supply	intensity	Proportion
Nuclear	15	12.5 GW	12.5 GW	12.5 GW	12.5 GW	83%	16.66%	0	0%
Intermittent renewables	55	15	7	37	18.5	34%	24.66%	0	100%
Multi-fuel IGCC (CCS on SNG product only)	15	12.5	14	11.5	13	86%	17.33%	65	52.5%
SNG fuelled existing CCGT's	30	6.5	28	1.5	10.5	35%	14%	65	52.5%
Bio-Methane fuelled existing CCGT's	2.5	1	2.5	1	1.5	60%	2%	0	100%
Coal with 90% post combustion CCS	15	10	14	11.5	11.5	77%	15.33%	90	0%
Embedded micro-generation/demand management	17.5	7.5	7	10	7.5	43%	10%	0	100%
TOTALS	**150 GW**	**65 GW**	**85 GW**	**85 GW**	**75 GW**	**50%**	100%	**34 gCO_2**	**51.10%**
Add Reserve generation to back up macro demand management, inter-connectors and energy storage.								**/kWh**	
Low merit gas (Capacity payment)	10 GW	0	5 GW	5 GW	1 GW	7%	1.33%	410	
TOTALS	**160 GW**	**65GW**	**90 GW**	**90 GW**	**76 GW**	**48%**		**39.5 gCO_2**	**50%**
								/kWh	

The co-production of SNG and dispatchable electricity, combined with: flexible throughput gasification; on site Syngas storage; constant output SNG plant, and using the gas grid as an energy store, will support a combination of flexible electricity generation, and high load factor SNG plant operation. This will maximise CAPEX recovery at lowest levelised cost of energy.

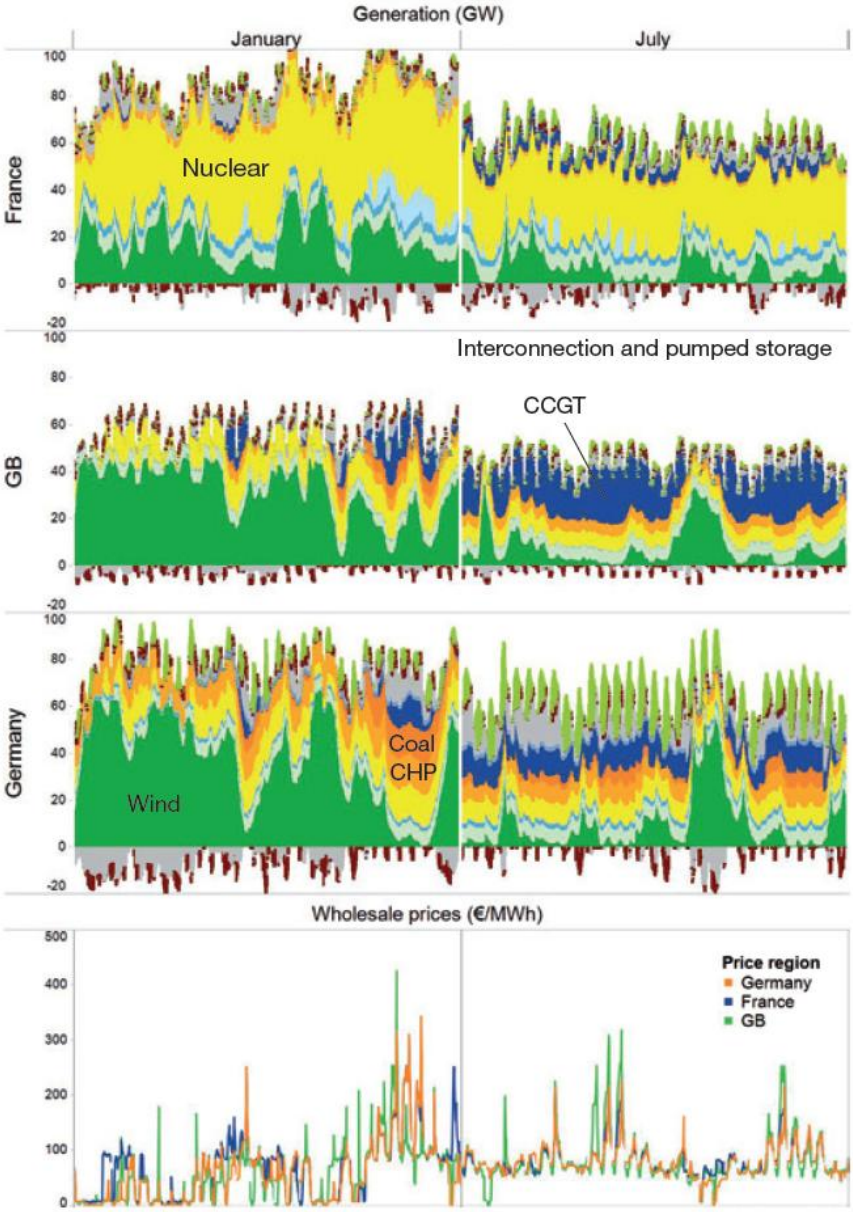
THE IMPACT OF INTERMITTENT RENEWABLES ON DISPATCHABLE ELECTRICITY GENERATION

Poyry has modelled the impact of intermittent renewables on different electricity supply technologies, and electricity prices in UK, France and Germany for one month in January and July 2030. The modelling combines January and July 2010 weather records with projected 2030 wind generation capacity.

By 2030, the electricity system will be transformed. In all countries, wind generation becomes a dominant factor, and the rest of the thermal system has to flex in response. The French system still has a lot of nuclear generation, and the balancing of the wind is achieved via a combination of flexing the nuclear plant along with imports and exports. In GB during the winter months, the thermal plant have much lower load factors than in 2010, and operate in response to wind generation. With the drop in wind speeds in the summer, the CCGTs run at much higher load factors.

There are also very significant swings in output – for example in Germany at the end of January where a period of 4 days of very low wind is followed by a ramp to 50GW of wind generation which drives most of the conventional plant off the system. During the summer months, the German system has large amounts of solar generation.

Prices in 2030 are much more extreme and unpredictable than at present. There are a large number of low or zero priced periods when there is significant wind generation, and when the wind dies, prices jump to high levels.



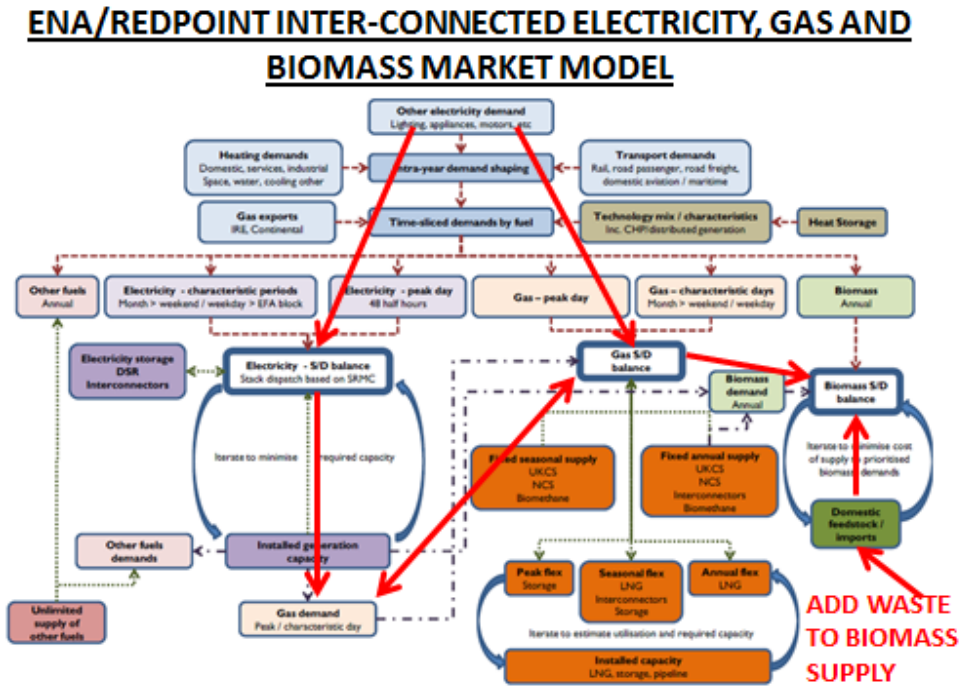
Generation type
- Solar
- Pumped storage
- Peaker
- Interconnection
- CCS CCGT
- CCS Coal/Lig
- CCGT
- Coal/Lig
- CHP
- Nuclear
- Reservoir hydro
- ROR hydro
- Other Renewables
- Offshore wind
- Onshore wind

The diagrams above demonstrate:

- Increasing variation at fast ramp rates, and reduction in predictability, of plant load factors for all technologies including gas fired generation.
- Increased electricity price and volatility, including periods of zero wholesale electricity prices in the Winter.
- Vital role of CCGT plant to balance UK electricity supply and demand at fast ramp rates.
- High correspondence of wind output across wide area of Northern Europe.
- A combination of large reversible wind output driven inter-connector flows between France and Germany, and small UK to Europe inter-connector capacity, renders the inter-connectors ineffective for balancing UK wind variation.
- The assumption that large scale flexing of French nuclear plant is possible, ignores the constraints of nuclear plant operating ramp rates, and the cost impact of running high fixed Capital cost nuclear plant at part load for long periods of time. The implicit assumption is that by 2030 the Capital cost of the French nuclear fleet will have largely been written down.

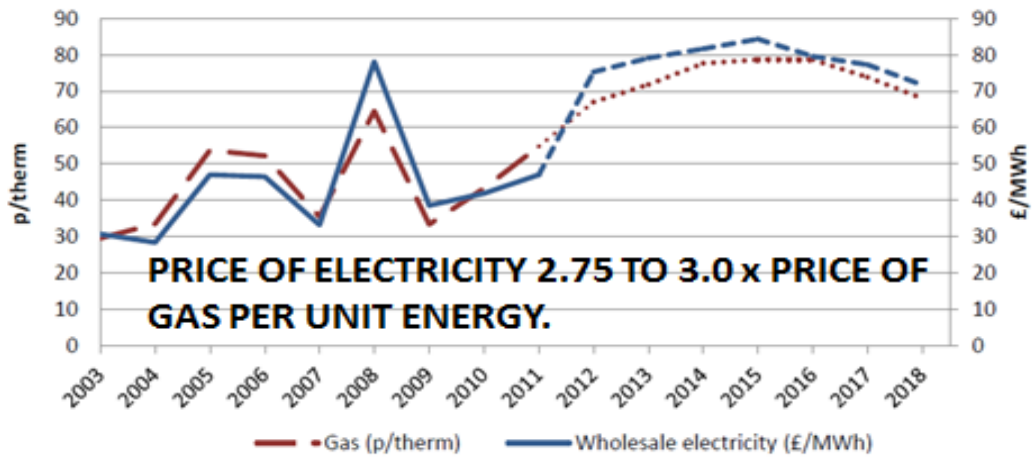
GAS MARKET REFORM

Gas is a primary storable, fungible energy resource. Electricity is an instantaneous secondary energy vector. Gas fired electricity generation provides around 50% of total UK electricity supply. Energy flows from the gas grid to the electricity grid. The gas grid provides the primary energy store for load balancing electricity generation. It is axiomatic, therefore, that decarbonising the gas grid at source must also decarbonise the electricity grid.



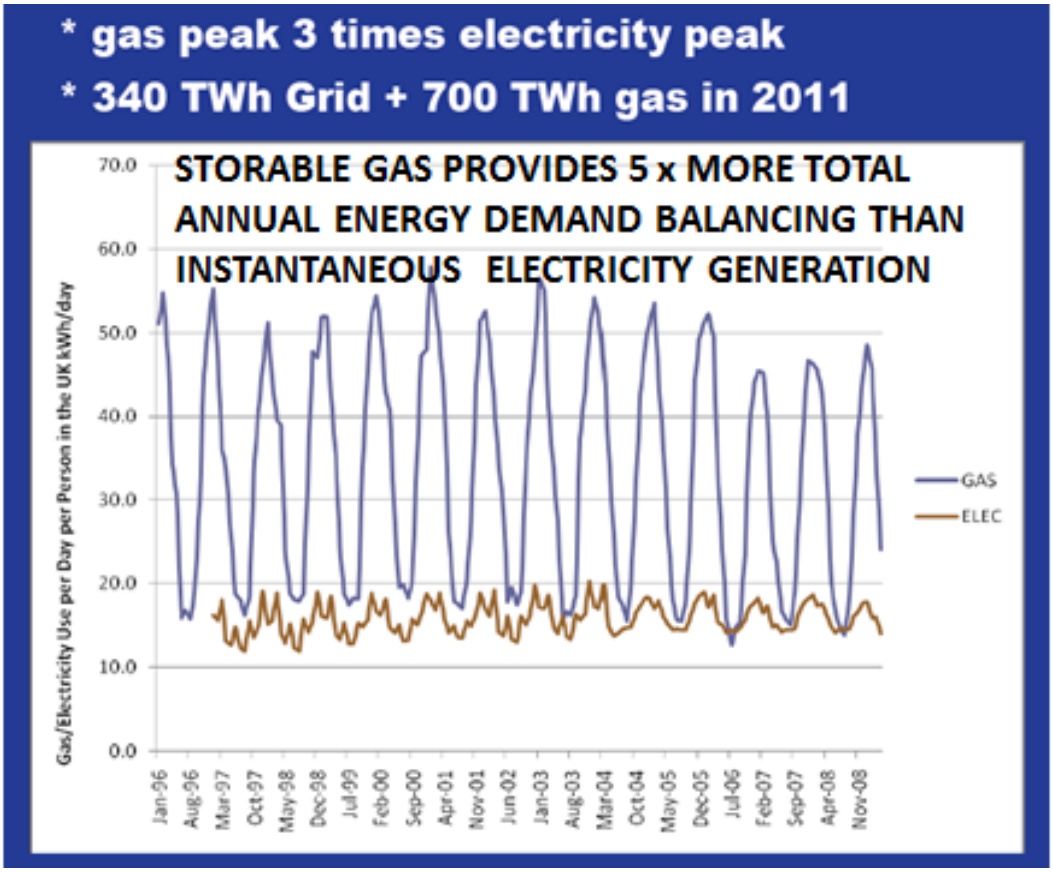
The electricity and gas markets are inherently inter-dependent both technically as described above, and economically, as shown below. This response argues that to produce a 'level playing field' between decarbonising the UK gas and electricity grids, Gas Market Reform is required in parallel with Electricity Market Reform.

Chart 1: Historic and projected electricity and gas prices



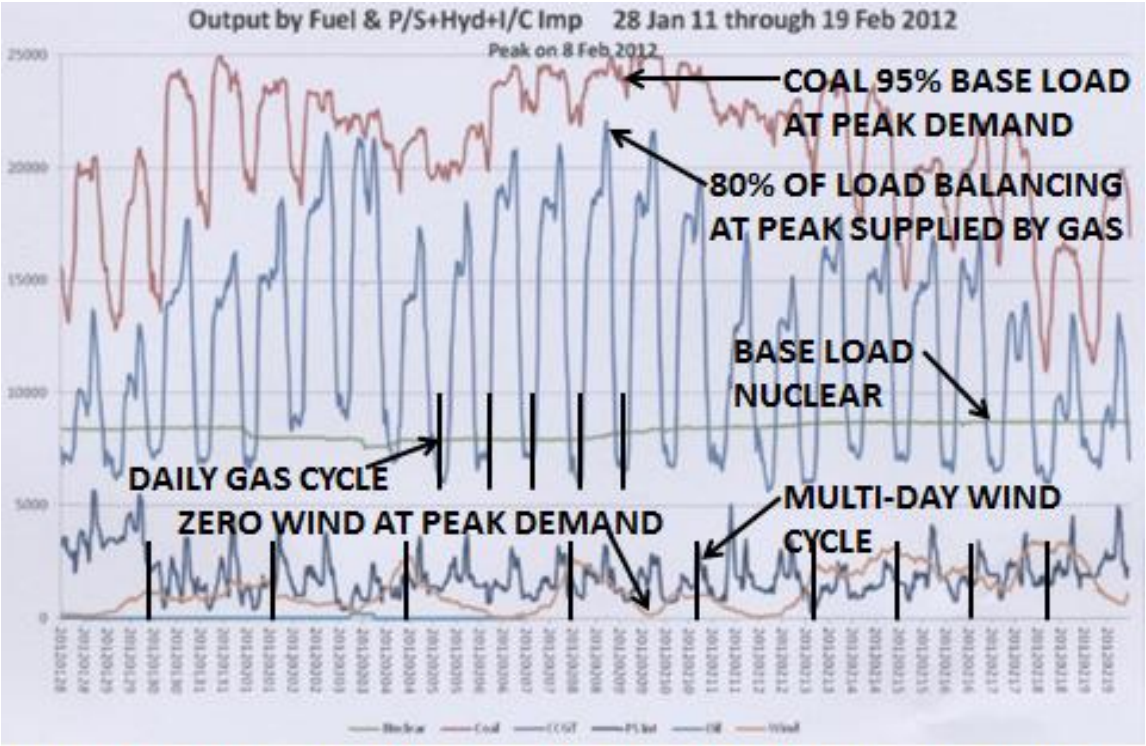
Source: Annual averages. 2010 prices. Historical gas prices: Bloomberg. Historical electricity prices: London Energy Broker's Association. Gas and electricity projections (central): DECC 2011

The annual and daily supply and demand profiles for gas and electricity are, however, very different due to gas being a storable energy resource, and electricity being an instantaneous energy vector:



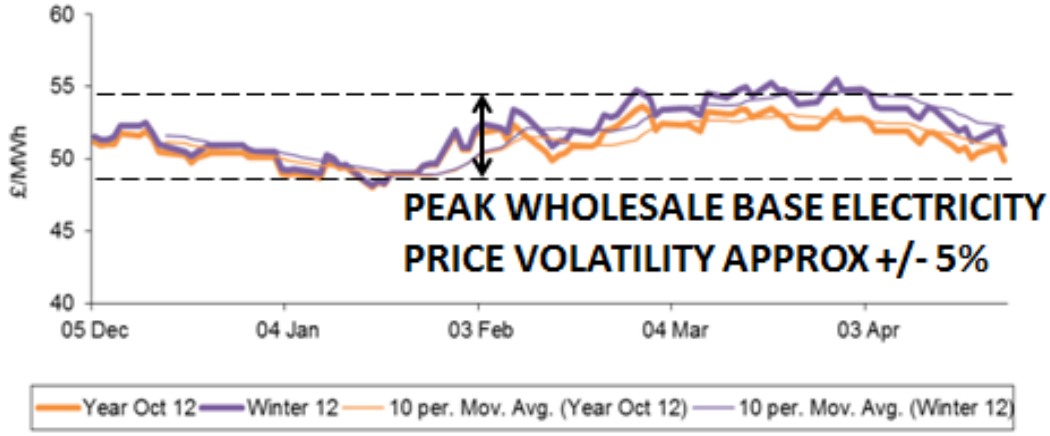
National Grid plc has argued that the transfer of the annual heat demand cycle from the gas to the electricity grid will involve an enormous reconstruction of the electricity transmission and distribution grids, and that all, or part, of the annual heat demand cycle should continue to be served by the gas grid.

The following 3 diagrams relate to the peak electricity demand period during the Winter of 2012:



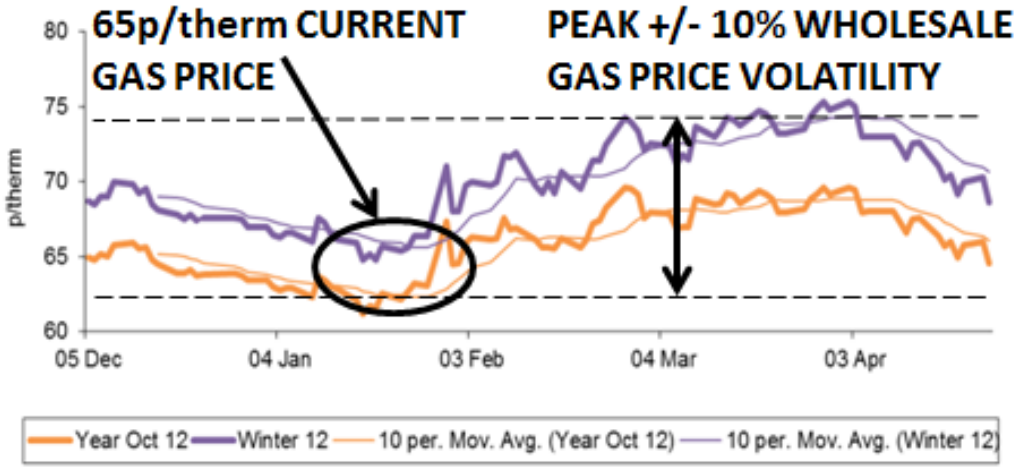
WINTER 2012 DAILY ELECTRICITY DEMAND BALANCING

WELL FUNCTIONING MARKET: ELECTRICITY AND GAS FUTURES ABSORB PEAK DEMAND VOLATILITY



The diagrams above and below indicate that the gas and electricity markets functioned well during the recent peak Winter demand period. The ability to store gas enables large annual heat, and daily electricity, demand fluctuations to be absorbed at low price volatility. The combination of gas storage, and flexible gas supply, effectively 'smooths' electricity and heat price fluctuations.

WINTER 2012 PEAK GAS DEMAND FUTURES



Electricity and gas prices remain inter-dependent because gas fired electricity generation has a high degree of operational flexibility and dispatchability, useful for electricity grid load balancing purposes. Dispatchable gas fired electricity generation for load balancing purposes cannot be displaced by non-dispatchable energy

resources: intermittent renewables and base load nuclear, except if very large scale energy storage other than the gas grid becomes a technical and economic reality. The argument that intermittent renewable energy supplies will reduce the exposure of the UK electricity market to international gas price fluctuations is untrue.

This paper proposes that UK should develop large scale indigenous renewable gas supplies. The technology and fuel supply to do this both exist. The ex-British Gas Corporation SNG programme records are currently in a privately held archive at Loughborough, and the technology is being actively developed in China. UK is a small densely populated island, and produces large quantities of residual wastes (i.e. the residue after waste reduction reuse and recycling) of all kinds. The conversion of this partly biogenic sustainable low cost fuel into storable low Carbon SNG at net energy efficiency in excess of 75% will provide more economically and technically useful energy than waste incineration at 25% net efficiency to generate base load electricity. (Waste incinerators are constant thermal energy throughput rate machines and cannot change throughput to suit fluctuations in either waste supplies or energy demand.)

The effect of the Renewable Heat Incentive (RHI) and Renewables Obligation (ROC) has been to level the financial playing field between renewable electricity and renewable gas. For a 52.5% biogenic Carbon content fuel, the gross revenue per unit energy input is currently nearly identical for a waste, biomass and coal fuelled plant producing either low Carbon electricity, or low Carbon SNG.

GAS OR ELECTRICITY?

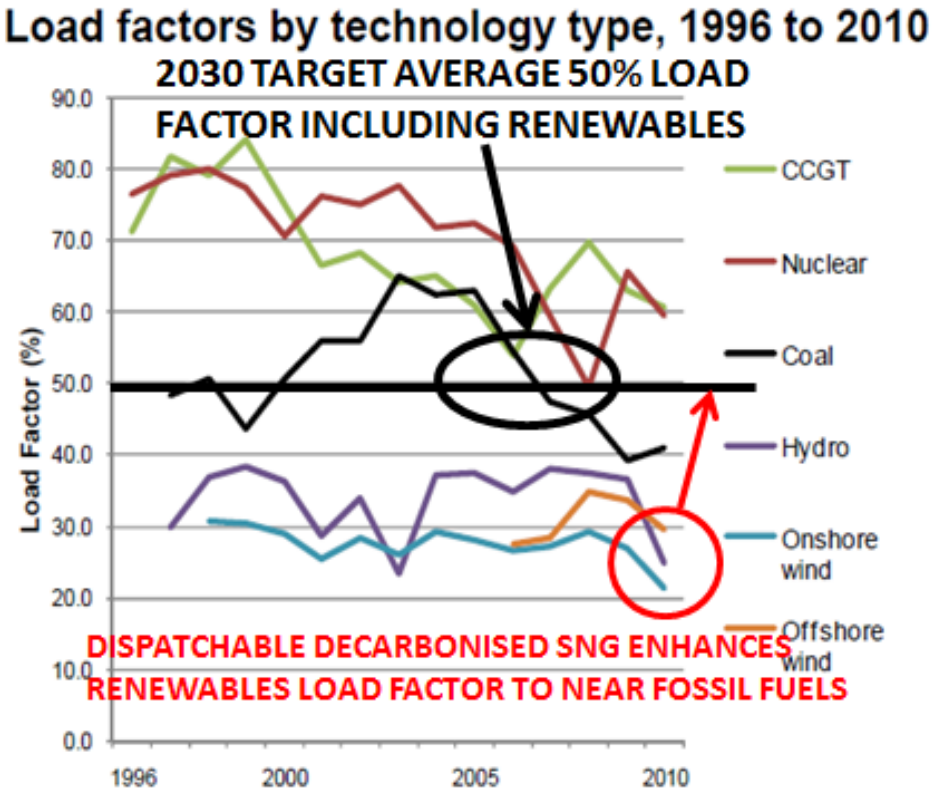
- Gasification produces 100% SNG; 100% electricity, or mix of SNG and electricity.
- Typical 75% efficiency to SNG, 45% efficiency to electricity. 1.66 x more energy output per unit energy input for SNG than electricity.
- BUT price per unit energy 2.75 to 3.0 x higher for electricity than SNG.
- All things being equal, electricity is always 66% more profitable than SNG.
- 1GJ of 52.5% biogenic fuel converted at 45% efficiency produces £7.50 of peak electricity + £6.85 ROC = £14.35 revenue (2012 buy out value + 50% recycled 'fines' at 2018 1.8 ROC banding for advanced gasification)
- 1GJ of 52.5% biogenic fuel converted at 75% efficiency produces £4.69 of SNG + £10.06 RHI = £14.75 revenue (2011-2031 fixed RHI for biomethane)
- ROC and RHI banding and values effectively produce 'level playing field'.
- What happens when RHI ends in 2031? Propose long-term flexible CfD for decarbonised gas, otherwise SNG plants may all convert to electricity.

The RHI is a tax payer funded subsidy ending in 2031. HMG plan to replace ROC's by Contracts for Differences (CfD's). This paper argues that because of the technical and economic inter-connectivity between the gas and electricity markets, it is irrational for the gas and electricity markets to operate to two different sets of rules.

Current UK energy policy will lead to the electricity market being driven primarily by decarbonisation; and the market for fossil gas being driven by price. This is likely to lead to complexity, market gaming, rent-seeking and perverse incentives. This paper argues for a transparent, liberalised, integrated market for both decarbonised electricity and decarbonised gas.

If the primary economic instrument to deliver decarbonised electricity is to be flexible cost neutral CfD's, this paper argues that the same mechanism should be applied to the supply of decarbonised gas. This will provide the same degree of certainty to investors in decarbonised gas as investment in decarbonised electricity. Investors in decarbonised gas will, however, have greater certainty as to future plant load factors due to the existing ability of the gas grid to store large quantities of energy.

The diagram below from DUKES shows that electricity generating plant load factors have been declining for the last several years. This was acceptable at a time when many paid down legacy power plants were connected to the grid. The upcoming need to replace obsolete coal fired and nuclear power generation will inevitably lead to electricity price increases as new replacement generating capacity will have fewer running hours per year in which to recover CAPEX, and higher OPEX due to more plant starts per annum, etc.



RESPONSE TO CONSULTATION

Taking the above together, we respond to the specific questions set out in the Public consultation as follows:

a) What are the strengths and weaknesses of gas generation in helping to deliver a secure, affordable route to decarbonisation through 2020 and then by 2050?

The strengths of gas fired electricity generation are:

- Gas is a storable, fungible primary energy resource with an existing well-developed national and international market and supply infrastructure.
- Gas fired electricity generation is clean, flexible, efficient with low Capital cost and risk.
- Because the marginal cost of gas fired electricity generation frequently sets the marginal price of electricity, gas fired electricity generation is effectively a 'self-hedging' investment risk.

The weaknesses of gas fired electricity generation are:

- Exposure to gas supply and price volatility.

- No market exists in UK for decarbonised gas.
- Decarbonised SNG are high Capital cost projects, more alike to petrochemical industry investments than electricity industry investments. The electricity and gas industries have historically been competitors, operating to different economic paradigms. Synthetic Natural Gas technology, albeit with a long historical track-record, is often perceived by electricity industry investors as high technical risk.

b) What role can gas fired generation play in the future, and what level of gas generation capacity is desirable?

Several projections forecast a total of around 50GW of connected CCGT and OCGT capacity by the late 2020's. This response proposes that an annual average of 25GW of low Carbon gas fired electricity generation be supplied at an average plant load factor of 50%, spread across higher load factors for newer high merit order plants dispatching to market, and low load factors for older low merit plants supported by Capacity Payments.

The pre- and post-2030 scenarios shown above, with and without widespread CCS on thermal power generation, indicate a technically and economically feasible fleet mix, which can meet renewables and decarbonisation targets, by reducing the proportion of non-dispatchable intermittent renewable electricity generation, and increasing the proportion of dispatchable storable renewable gas fired electricity generation.

These scenarios indicate the feasibility of supplying 33% of UK electricity demand using low Carbon gas fired electricity generation.

c) What are the key factors driving the economics of investing in new gas-fired power generation and how are these factors likely to change?

The 'key factors' affecting the economics of a gas fired electricity generating plant are:

- Capital cost per unit energy thoughput.
- Net energy efficiency.
- 'Clean spark spread'.
- Plant load factor.
- Cost of Carbon.

Of the above factors, the intended primary future use of gas fired generation is to back-up an increasing proportion of intermittent and unpredictable wind power, thus reducing gas generation plant load factor. This conflicts with the investment case for gas generation thus increasing the cost of backing up intermittent wind.

The argument that the marginal cost of wind is zero is untrue. The total on-site and off-site fixed Capital and operational costs for wind power, including: connection, transmission, balancing, constraint, back-up and loss of plant load factor elsewhere need to be accounted to obtain the true marginal cost of wind power. Until the 'whole system' marginal cost of 'non dispatchable' wind power is fully accounted for, in relation to competing 'dispatchable' technologies, the electricity market will continue to be operationally and economically distorted.

Distorting the operational economics of 'dispatch' in a competitive market adversely affects the investment case for 'dispatchable' electricity generation. This already difficult situation is made worse by regulatory and financial uncertainties arising from market distorting renewables subsidies and general policy uncertainty.

d) What barriers do investors face in building new gas generation plants in the UK? What are the key regulatory uncertainties that may prevent debt and equity investors making a final investment decision in gas generation and supply infrastructure?

HMGovernment has no policy to encourage investment in on-shore conventional and unconventional gas supplies; gas storage; infrastructure associated with gas fired electricity generation, or gas distribution. Published 2050 scenarios show a significant transfer of energy flows from the gas grid to the electricity grid, and from fossil fuels and intermittent renewables, thus undermining investor confidence in the long-term future of the UK gas grid and associated infrastructure.

e) Are there any policy issues that need to be addressed beyond the Government's proposals for the capacity mechanism and the EPS?

DECC Scientific Advisory Group (SAG) has advised H.M.Government that "gas is not a sustainable long-term low Carbon energy resource." Based on the same argument, Climate Change Committee (CCC) has advised H.M.Government that grandfathering the current Emissions Performance Standard until 2045 is incompatible with the large scale development of gas fired electricity generation and the policy target of largely decarbonising UK electricity supplies by 2030 unless as yet technically and economically unproven post capture CCS on gas fired power stations can be implemented at large scale.

This response states that SAG and CCC's advice to Government is incorrect. Gas can be decarbonised at source as readily as electricity. Between 1955 and 1992, British Gas Corporation developed inherently Carbon Capture Ready Synthetic Natural Gas technology capable of supplying the whole of UK gas demand. The Marginal Abatement Cost of compressing the already available CO_2 into a pipeline is significantly lower than any CCS process fitted to combustion based electricity generation.

As a consequence of gas being a decarbonisable storable energy vector, there is no need to transfer large Winter heating season energy flows, or intermittent gas flows to gas generation to support intermittent wind generation, from the gas grid to the electricity grid. 2050 energy supply scenarios based on the large scale transfer of energy flows from the gas grid to the electricity grid should be reconsidered.

The 2003 Energy White Paper focussed on delivering decarbonisation solely via electrification by developing intermittent renewables, base load nuclear and coal with CCS. Gas can be decarbonised as readily as electricity. This response proposes: the decarbonising of the gas grid at source; the parallel decarbonising of the gas and electricity grids, and Gas Market Reform in parallel with Electricity Market Reform.

This proposal is a radical departure from UK energy policy for the last decade, which has focussed on supplying high cost sustainable energy via the electricity grid; and affordable, secure energy via the gas grid.

EMR will introduce a mechanism for flexible Contracts for Differences for low Carbon electricity generation. This response proposes a similar mechanism for CfD's for low Carbon gas supplies. The 'strike price' for low Carbon gas can be related to the 'strike price' for low Carbon electricity via the historic 'clean spark spread' of around £5 to £6/MWh, adjusted for inflation, or similar.

It would be desirable to introduce a seasonal 'swing' element into the CfD 'strike price' for low Carbon gas in order to promote seasonal production 'swing' to meet the annual heating demand cycle. The premium price for Winter low Carbon gas supplies will off-set the loss of plant load factor during the Summer season.

This response does NOT propose the use of market distorting fixed Feed in Tariffs for low Carbon gas.

f) Given a continuous role for gas and the potential for increased volatility in gas demand, to what extent is gas supply and related infrastructure a barrier to investment in gas fired generation? What impact will unconventional gas have on the case for investing in gas generation and the supporting infrastructure?

This response proposes: a greater proportion of UK heat continuing to be supplied by gas; a greater proportion of electricity supply continuing to being generated from renewable gas, and less electricity being generated by

intermittent renewables, than 2050 energy system scenarios based on large scale transfer of energy flows from the gas grid to the electricity grid. Taken together, this will reduce gas demand volatility.

In addition, the ability to make gas on demand from indigenous fuel resources, and then store the gas, will improve gas supply response to varying gas demand. Reduced gas demand volatility, and enhanced gas demand response, taken together will reduce gas demand, supply and price volatility.

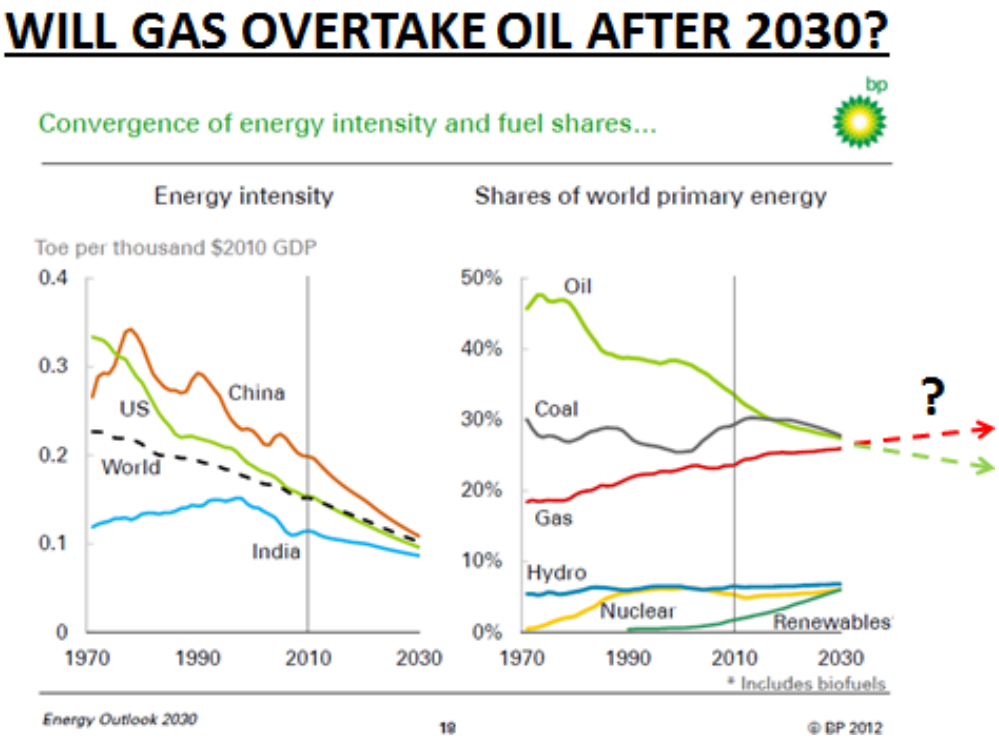
A commitment by H.M.Government to support the continuing development of: UKCS conventional fossil gas; unconventional fossil gas, and unconventional renewable gas supplies will underpin investor confidence in the continuing future of the UK gas industry. On the other hand, the widespread publication by HMG of reports showing the planned rapid replacement of gas by electricity; policy support for EMR with no similar policy support for GMR; lack of support for unconventional fossil gas supplies and gas storage, and near total failure to comprehend that large quantities of low cost renewable gas can be produced using technologies fully developed by British Gas more than 20 years ago in order to supplement reducing UKCS gas production, may have undermined investor confidence in the long-term future of the UK gas market.

The future UK market for unconventional gas is generally very uncertain due to a combination of policy and regulatory uncertainty, and economic uncertainties relating to supply, demand, costs and prices. Nonetheless, taken together, the development of various conventional and unconventional gas resources: UKCS Natural Gas; shale gas, tight gas; Coal Bed Methane, Underground Coal Gasification; Biomethane from Anaerobic Digestion, and decarbonised SNG with CCS, potentially provide a continuing long-term UK indigenous gas supply.

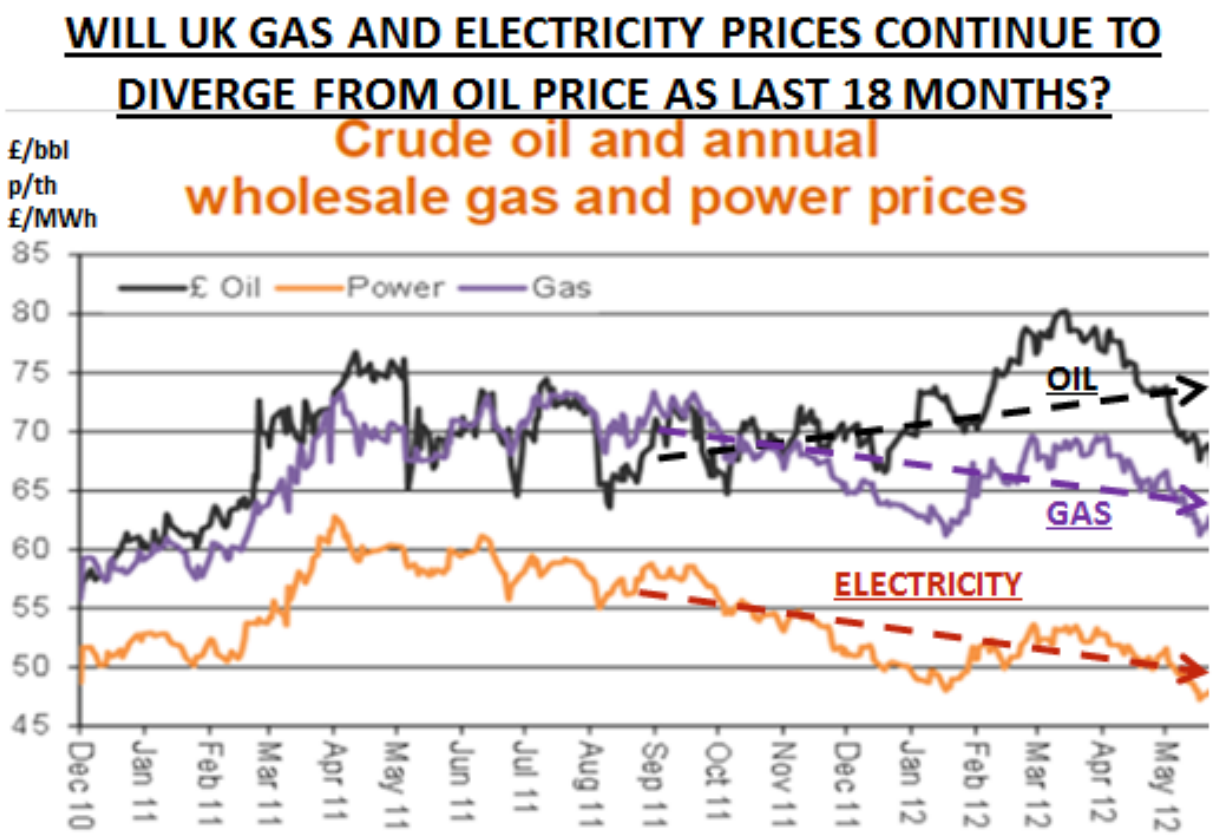
The financial case for decarbonised SNG is different from fossil gas sources. Investment in gas fired electricity generation is largely 'self-hedging'. Because decarbonised SNG can be economically and progressively decarbonised to meet planned decarbonisation trajectories, it is largely future proofed against changes in decarbonisation policies, but is not future proof against the Carbon floor price, and low Carbon energy prices.

Because the gas grid provides both diurnal and seasonal demand swing, matching SNG supply and gas demand will be technically and economically easier than for intermittent renewable electricity generation. Making gas at preferred locations will ease energy infrastructure issues compared with geographically diverse renewables.

There is a considerable uncertainty over the long-term price trajectories for competing fossil fuel supplies.



There are indications that the gas price in the UK market may be uncoupling from oil prices, thus reducing the price certainty offered by long-term oil indexed 'take or pay' gas contracts.



There is also uncertainty over the future trajectory for subsidies for renewable gas supplies. The RHI has been set at a fixed price until 2031, excluding any allowance for inflation, but including a built in total value cap to prevent excessive cost to H.M.Treasury. Recent experience of the reduction in the Feed in Tariff for solar power may have damaged investor sentiment. Long-term price uncertainty for decarbonised SNG is potentially the largest single negative impact on an investment, which may have a pay-back period of 20 years, and 50 year plant life.

The future availability of a UK CO_2 grid is also a significant negative uncertainty. This uncertainty is associated with the Carbon price floor escalator. The design of the decarbonised SNG scheme enables the cost effective future conversion from Carbon Capture Ready (CCR) to Carbon Capture and Sequestration (CCS). On the other hand, there is no certainty that a CO_2 grid will be developed to correspond to the certainty that the Carbon price floor escalator will 'bite' on net revenue.

Please let me know if you require any additional information.

Yours faithfully,

REDACTED

Enc. Powerpoint presentation on decarbonised SNG with CCS.