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Future of Natural Gas in the UK

UK shale gas exploration and efforts to mitigate climate change have stimulated debate about the future of the natural gas sector. This briefing looks at potential future pathways for the sourcing and use of natural gas in the UK. It also considers the implications for the economy, energy prices, the reliability of energy supplies and efforts to cut emissions.

Overview

- In 2014, the UK imported 45% of its gas.
- The Government plans to boost UK natural gas production to prevent or minimise falls in gas-related jobs, tax and investment.
- To stay within globally agreed climate change limits some existing gas reserves will likely need to go unused. This raises questions about new UK gas exploration.
- Burning natural gas produces lower greenhouse gas emissions than burning coal or oil. Switching to gas can help to meet short-term emission targets for power generation, heating and transport.
- However, installing too many new gas-using units may create barriers to reducing greenhouse gas emissions in the long term.
- Most long-term gas use depends on the use of carbon capture and storage or biogas.

Background

Natural gas is a methane-rich gas sourced from deep underground, where it has formed over millions of years. In 2014, the UK burnt natural gas to generate 70% of its heat and 30% of electricity.[1] The UK is the third largest gas producer in Europe, meeting 55% of domestic demand in 2014.[1,2] Future gas supply and use will be driven partly by UK and international policy aims including:

- **Greenhouse gas (GHG) emission reduction.** Climate change has costs for both the environment and the economy. The Climate Change Act 2008 commits the UK to GHG emission reductions of 50% on 1990 levels by 2025 and 80% by 2050.[3,4] This will require substantial reductions in the burning of fossil fuels, including gas. However, substituting oil and coal with gas could provide some GHG emission reductions.[5]
- **Minimising energy costs.** Energy prices affect the cost of living and industrial competitiveness, so successive governments have aimed to minimise energy prices, while achieving GHG emission goals. Gas provides price-competitive energy for a number of purposes so it is often seen as preferable to renewable or nuclear energy.
- **Maintaining reliable energy supplies.** Reliable gas supplies and steady gas prices are a key policy concern.
- **Economic aims.** The Government aims to cut the UK's budget deficit and increase investment and employment. This can drive policy relating to taxation of gas production and investment in gas infrastructure.

Other important factors influencing the future of gas include:

- **International gas supply and demand.** Gas is traded internationally; world events and changes in weather, can affect UK prices.
- **Alternative technology development.** If other energy supplies get cheaper then gas use may fall.

The following sections look at how pressure from these drivers may change natural gas production and use and the implications. In addition to covering natural gas, this briefing also addresses production and use of bio-sourced methane-rich gases. Liquefied petroleum gases (LPG), which do not contain methane and tend to have different uses to natural gas, are outside the scope of this briefing.

Future Gas Sources

UK Gas Production

UK gas production has declined since 2000 (see Figure 1) as the UK has extracted much of its economically-viable gas reserves.[6] In 2014, the UK produced 37 billion cubic metres (bcm) of natural gas and biogas combined. The UK used 70 bcm.[1,7] Future production levels will depend on production from conventional and unconventional natural gas sources and bio-sourced gases.

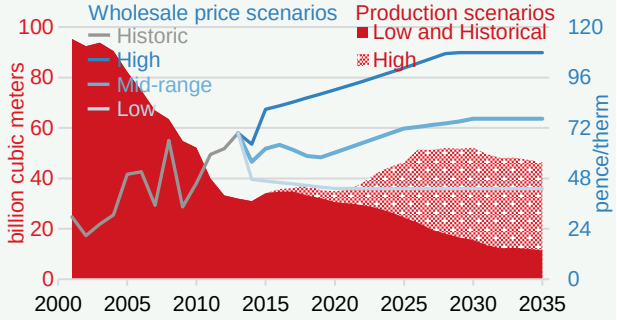

Figure 1. UK Gas Production and Prices 2001-2035[8]

Conventional Gas

UK conventional gas is mostly extracted from sandstone rock below the North Sea. The UK produced 35 bcm of conventional gas in 2014.[9] Industry expects this level to remain steady for the next few years. The Department of Energy and Climate Change (DECC) forecasts that the decline in production will restart in 2016 and fall to about 16 bcm/year by 2030.[10] The Government aims to maximise production by implementing the recommendations of the Wood Review.[11] These include plans to give extra powers to the new regulator, the Oil and Gas Authority, in the 2015 Energy Bill.[12,13] The Government also aims to maintain production by lowering tax rates on oil and gas profits.[14]

Unconventional Gas

Unconventional gas (POSTnote 374) includes shale gas, gas extracted from intact coal beds (coal bed methane) and gas produced when coal is gasified underground.[15,16] Onshore exploration for unconventional gas is at an early stage and the potential levels of economically-viable production are unknown.[17] Production levels will depend upon regulation and related environmental issues (see Box 1), extraction costs, gas market prices and public attitudes. It is unlikely that significant quantities of gas will be produced before the early 2020s given lead times for industry to evaluate economic viability, attract investment and establish infrastructure.[18]

Bio-sourced Gases

Biogas can be produced from a variety of organic materials: biodegradable domestic and commercial wastes, agricultural waste, sewage sludge and some crops.[19] In 2014, the UK produced 2.6 bcm of biogas.[20] With growth from anaerobic digestion (POSTnote 387) and new technologies that convert organic materials to 'bio-synthetic natural gas', bio-sourced gas production could reach up to 7 bcm per year by 2025.[21,22] This depends on Government incentives,[23,24] policy support for feedstock collection and is limited by the availability of organic material.[25]

Imports

In 2014, 45% of the UK's natural gas supply was imported.[1] Sources include pipelines from Belgium, the Netherlands and Norway, and Liquefied Natural Gas (LNG) imported by tanker from countries including Qatar (the largest source) and Algeria.[1] National Grid forecasts that by 2035 imports will supply 40-90% of GB gas demand, depending on future levels of demand and gas production.[10,26]

Box 1. Shale Gas and Local Environmental Issues

Concerns have been raised about the environmental effects of extracting shale gas using hydraulic fracturing.[27,28,29] Potential effects include seismic activity, groundwater contamination, methane leakage from new wells and old wells, air and noise pollution and visual changes to the landscape. In 2012, the Royal Society and Royal Academy of Engineering concluded that, provided the appropriate regulations and monitoring procedures were in place, risks could be managed.[30] However, in 2015 the Environmental Audit Committee reported concerns about whether there are sufficient resources and skills to regulate and monitor unconventional gas production.[27]

Implications of Changes in Gas Supply

Security of Gas Supply

Changes to the UK's sources of gas and levels of gas storage (see Box 2) can affect the reliability of its supply. However, a 2014 Government Risk Assessment concluded that for 2014-16 the UK gas market is set to remain resilient to all but the most extreme combination of severe infrastructure failure or supply shocks.[31] This is because of the UK's significant and diverse sources of gas supply.[32] Most commentators expect this to continue beyond 2016, despite a potential increase in reliance on imports.[33] Price stability could however be affected by extreme events such as a prolonged cold winter across northern Europe or Russia reducing gas flow to parts of Europe.[33]

Gas Prices

DECC forecasts UK gas prices remaining roughly level to 2020 in real terms and increasing by 25% by 2035, under a mid-range scenario (see Figure 1).[34] However, future UK wholesale gas prices (that make up around 50% of domestic bills[35]) are uncertain and depend upon when UK suppliers buy gas, (with much bought in advance of delivery) global supply and demand.[33] Strong influences on UK prices have included the cost of Russian gas and LNG, and Asian demand.[36] With new LNG supplies coming from Australia, Russia, the US and possibly East Africa it is expected that UK wholesale prices will remain depressed until at least the early 2020s.[37] Shale gas could affect UK prices from the mid-2020s, but it will only have a significant effect if EU-wide production is at the high end of speculative forecasts.[38,39,40] Other factors that affect wholesale prices include:

- UK and European gas demand. Milder or colder winters can lead to a fall or rise in demand and gas prices.
- Production costs. The long-term cost of production from mature regions is rising as gas is depleted. This may be offset by low-cost gas fields that are still to be developed.[7]

Box 2. Gas Storage

Dedicated short-, medium- and long-term gas storage provides a back-up supply of gas. There has been an increase in the amount of short-term storage in recent years, to manage fluctuations in gas demand from gas-fired power stations.[41] Some academics suggest that the UK's need for long-term storage has also increased because of the fall in domestic production and the declining condition of the UK's only long-term storage unit.[33,42,43,44] However, there may be insufficient need for extra long-term storage to warrant Government support, with extra security provided by the improved diversity of pipeline imports and stored gas in LNG tankers. [45] No new long-term gas storage is expected to be built in the near future.

Economic Implications

A decline in UK gas production will reduce tax revenue, investment and employment and worsen the balance of payments (value of exports less value of imports).

- **Tax.** The UK's oil and gas industry paid £2.1bn of tax in 2014-15.[46] The Office for Budget Responsibility expects this to fall to £0.7bn in 2019-20 and to zero by 2025, as decommissioning costs reduce taxable profits.[46] However, revenues are uncertain because of variability in fuel prices, industry expenditure, exchange rates and tax rates, and uncertainty about the scale of new sources.
- **Employment.** The number of domestic jobs supported by oil and gas production is expected to fall from 375,000 in 2014 to 340,000 by 2019.[47,48] Shale gas extraction could provide new jobs. Estimates of numbers range from very few up to between 16,000 and 74,000, depending on the success of the industry.[49,50,51]
- **Investment.** Investment in UK oil and gas production assets was £14.8bn in 2014 and this is expected to fall by over 80% to £2.5bn by 2018.[52] However, the shale gas advocates suggest there could be £2bn per year of investment in shale gas assets between 2016 and 2032.[50]
- **Balance of payments.** Increased gas imports would worsen the UK's balance of trade, which has been in deficit since 1998, with a £35bn deficit in 2014.[53,54]

UK GHG Emissions

The effect that changes to UK gas supply have on UK GHG emissions depends on the gas supply type. LNG has 12-36% higher associated GHG emissions than conventional gas due to extra processing and transportation.[55] Shale gas and coalbed methane have 0-25% more associated GHG emissions than conventional gas, depending on gas leakage rates and changes to land use.[55] Gas produced when coal is gasified underground produces twice the emissions of conventional natural gas.[16] Biogas-associated GHG emissions are about 90% less than for fossil sources.[56,57]

Global GHG Emissions Concerns and the 'Carbon Bubble'

Global proven fossil fuel reserves contain three times more GHG emissions than can be emitted while meeting the UN's target of limiting global temperature increase to 2°C. Emissions from these reserves would still be too high in scenarios with a successful roll-out of carbon capture and storage (POSTnote 335).[58] Consequently, if the world is to limit climate change some fossil fuels reserves will need to go unburnt. Whose fossil fuels go unburnt is a matter of contention.

These issues have also raised financial concerns. The Environmental Audit Committee suggests that fossil fuel companies are overvalued (the 'carbon bubble') because of the assumption that all proven fossil fuel reserves will be consumed.[59] A quick shift away from this assumption could lead to a sharp fall in share prices and financial market instability.[60] Others highlight that the impact may be greatest for state-owned companies that hold larger reserves than private companies, potentially leading to geopolitical instability in countries such as Russia and Iran.

Future Gas Use

Climate change targets are likely to be a key driver of changes in gas use. Using gas can help to meet short- and medium-term targets, where it replaces oil or coal.[61] However, building or installing too many new gas-using units could create political, economic and behavioural barriers to reducing emissions in future decades, when cuts in gas use will also be needed to meet carbon targets.[62,63] This section looks at future gas use and investment in new gas-using infrastructure in the following sectors: electricity generation, heating, non-energy industries and transport. It also covers the implications for the gas pipe networks.

Electricity Generation

In 2014, gas burning power plants generated 30% of UK electricity and 10% of UK GHG emissions by producing 400 grams of carbon dioxide per kilowatt hour (gCO_2/kWh).[1] To help meet the UK's binding GHG emission reduction targets the Committee on Climate Change (CCC) says that power sector emissions should be cut to 50-100 gCO_2/kWh by 2030.[64] Whether these targets are achieved or not, gas use is expected to change in one of two broad ways depending on the development of carbon capture and storage (CCS).

- CCS may increasingly be used with gas power plants, with potential Government support (see Box 3). CCS would reduce GHG emissions from gas power plants by 65-85%.[65] The CCC estimates that, in meeting targets, gas plants with CCS could generate up to 30% of power in 2030, depending on their price competitiveness versus other low-carbon options.[66] Using CCS for power and other sectors could halve the cost of climate change targets, but there are concerns about CCS progress.[67,68]
- Without CCS, gas plants will initially help GHG emission reduction if they displace coal plants, which produce higher GHG emissions (900 gCO_2/kWh[1]). However gas use would need to decline a lot to meet the CCC's 2030 target, with new-build gas plants increasingly limited to providing power for occasional peaks in demand. However, there are concerns that new plants could be used more frequently and that carbon budgets may only be met by purchasing EU carbon credits.[69,70]

Price Concerns

DECC forecasts future wholesale power prices rising over the period to 2035, in a mid-range scenario.[34] Part of the potential price increase may be caused by policies that

Box 3. Policies Relating to Gas-Fired Electricity Generation

There are a number of policies that apply to gas power plants, the costs of which are passed onto consumers.

- Contracts for Difference guarantee low-carbon electricity generators a fixed price for their electricity for a number of years. Gas with CCS is eligible to apply for these contracts initially through the CCS Commercialisation Programme.[71]
- The EU emissions trading system charges fossil-fuelled power generators for each tonne of CO_2 they emit. The UK's Carbon Price Floor sets a minimum price that UK companies must pay.[72,73]
- The Capacity Market pays generators in return for a commitment to deliver electricity when needed to help ensure security of supply.
- The Emissions Performance Standard limit emissions from new power plants to 450 gCO_2/kWh, which most gas plants meet.[74]

account for the costs of climate change. These include increases in the price of GHG emissions and increasing support for low-carbon alternatives, such as gas with CCS (see Box 3). Some organisations have voiced concerns about price increases.[75,76] Conversely, some academics argue that the carbon price may not provide sufficient encouragement for gas to displace coal power generation.[77]

Heating

In 2014, 70% of UK heat was generated by burning gas, predominantly in gas boilers.[78] To meet emissions targets for 2050 GHG emissions from heating will need to fall, but the CCC has highlighted a lack of progress.[79] Low emission options include biomass boilers, geothermal, solar heating systems, electric heat pumps (POSTnote 426) and using hydrogen, extracted from water, as a fuel. However, there are a number of challenges with these technologies, including cost and the potential need for far greater electricity generation capacity.[80] This could leave a role for alternative gas-using technologies to provide short- or medium-term GHG emission reductions.

- **Gas heat pumps** capture heat from the air or the ground and transfer it inside a building. They could reduce gas use by 20-40% compared with gas boilers, but have far higher up-front costs.[81,82] They could pay back their up-front costs faster than electric heat pumps.[81,83]
- **Hybrid heating systems** (a gas boiler with an electric heat pump) could help a transition from gas boilers to electric heat pumps, while barriers are overcome.[80,84]
- **Gas heat networks** circulate the heat from a large central gas boiler to a whole building or area. CCS could be combined with the large central boiler to reduce emissions significantly. Barriers to uptake include high up-front costs.[85,86] The Government supports heat networks through the Heat Network Delivery Unit.
- **Gas combined heat and power** (CHP) plants generate electricity then capture the waste heat and distribute it through a heat network. CHP plants can produce lower emissions than separate generation of heat from a gas boiler and power from a separate gas-fired power plant.[85]
- **Micro CHP** units generate both electricity and heat at the point of use but produce less emissions compared with the use of a gas boiler and grid electricity.[87] They are eligible for the Government's Feed-in Tariff.
- **Hydrogen** produced from natural gas could be used for heating if appliances and the gas pipe networks were adapted. CCS would need to be combined with this process to make it low-carbon.
- **Biomethane**, which is produced by removing the non-methane gases from biogas, can be injected into the gas grid**,** decreasing the carbon intensity of gas heating.

Most of these technologies have low take-up or are still to be demonstrated. Forecasts of total future gas use for heating vary. However, all forecasts suggest a decline in gas use, with significantly lower gas use by 2050.[84,88]

Industrial Non-Energy Use

Gas is used as a raw material in the manufacture of products such as ammonia (used for fertilisers) and other chemicals.[89] Some of these processes do not produce direct greenhouse gas emissions, although in these cases there are often emissions associated with product use and end of life disposal.[90] Future scenarios suggest that gas will continue to have an important role for non-energy uses.[88]

Transport

Electrification is seen as a key way to reduce GHG emissions from passenger vehicles, light goods vehicles and rail.[88] However, for heavy goods vehicles, merchant shipping and aviation electrification is unlikely in the near term.[91] Gas fuels only 0.3% of UK transport.[92]

- **Compressed natural gas and liquefied natural gas** may reduce GHG emissions savings over petrol or diesel equivalents by up to around 20%. However, for some transport and fuel type there are no savings.[93,94] Trials are being undertaken with trucks and tractors.[95]
- **Biomethane** produces 40-90% lower GHG emissions than petrol and diesel, depending on the bio-feedstock.[93] It supplies a tiny proportion of transport fuels, but it could make up 17% of road transport fuel by 2025.[93,96] The Government supports biomethane use with the Renewable Transport Fuel Obligation and the £25m Advanced Biofuels Demonstration Competition.
- **Hydrogen** extracted from natural gas with CCS and used in fuel cell vehicles would produce lower GHG emissions than conventional vehicles. Hydrogen vehicles could reach up to 50% of light duty vehicle stock by 2050.[97] However, there is a lack of investment and innovation in the sector because of market and policy uncertainty.[97,98]

Implications for the Gas Pipe Network

Forecasts of reductions in natural gas use have created uncertainty about the long term future of the gas pipe network. Some academics' projections suggest that it would need to be closed by 2050.[99] Consequently, upcoming multi-billion pound pipeline upgrades are at risk of being underutilised.[99] Long-term options for the gas network in a low carbon economy include:

- maintaining the network and using higher amounts of biomethane, small amounts of hydrogen, more carbon capture and storage or a mixture of these options
- decommissioning parts or the whole of the gas network
- using the network to carry pure hydrogen.

A long-term strategy could improve investment certainty for gas network operators. Alternatively, it could open up options to curtail network upgrades or prepare the network for hydrogen conversion, both of which could reduce the long-term cost of supplying heat to UK buildings.[99]

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