

THE ROYAL SOCIETY OF EDINBURGH

Options for Scotland's Energy Future

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ADVICE PAPER (BP15-01)

JUNE 2015

OPTIONS FOR SCOTLAND'S GAS FUTURE

Executive Summary

Scotland is heavily reliant on gas in both the residential and commercial sectors for heating. Natural gas also plays a significant role in electricity generation. Even in the event of an significant increase in the gas the consumption, a significant quantity would still be required for many uses that are as a chemical feedstock for the petrochemical industry.

The UK is currently reliant on imports for over 50% of its gas consumption. To meet its future gas needs and increase energy security, total production could be increased in other countries or offshore. Action to reduce demand is also an option, but would need to be taken in addition to one or several other options.

Scotland is committed to meeting industry climate change targets and any course of action to meet its future gas needs must be consistent with these goals as well as addressing energy security, cost to the consumer and public acceptability. Scotland has a number of options to increase its gas production, but these are limited by the environmental and public acceptability of such measures, such as onshore oil and gas production, although such actions could raise gas prices.

A significant decrease in gas demand would need to be met in the event of demand reduction across the whole energy sector. A course of action that greatly reduces consumption of gas by meeting heat demand from gas to electricity would also help to reduce gas demand, which Scotland would find very difficult to meet.

Reducing demand for gas could prove beneficial in many ways, including decreasing the cost of fuel, reducing the risk of fuel poverty, and having a less environmentally impact. Such a course of action would be difficult to achieve, however, due to the dependence of gas in a heating fuel, the current and rising prices of gas, and the cost involved in installing fuel-efficient homes and business.

Importing gas into the UK offers several advantages, including being able to adjust the amount of gas to the needs of the Scottish market. It results in a more stable and secure gas supply, and would also allow local environmental problems and would be a more secure option than producing gas domestically. Multiple import options are for Scotland to meet its energy demand and the UK's membership of the European Union provides a level of energy security.

However, importing gas from abroad leaves Scotland vulnerable to political instability and oil price fluctuations in the countries from which it imports. Furthermore, rising gas production abroad means the Scottish and UK Governments have to continue to fund and comply with environmental controls which raise the cost of gas. Transportation of fuel also results in significant emissions.

Onshore production of unconventional gas would allow Scotland to meet its gas requirements for electricity and production. The impact of unconventional gas production on the environment is considered to be comparable to conventional gas. The availability, abundance and safety surrounding on-shore industry will be a major factor in the decision, although it is not clear to what extent it is viable. Domestic production options could improve energy security for its energy consumption.

Public opinion regarding to onshore unconventional gas development, particularly in connection with Scotland's other regions and this could make developing an industry in Scotland difficult. The characteristics of unconventional gas are notably different from the oil and gas production with which the country is familiar. Offshore oil and gas production could be a more secure option, and one and light pollution could be a major factor in the decision. Consideration should be given to the impact of such production on the environment, including the significant government expenditure that would be required to back such a strategy which could be for a long time.

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Options for Scotland's Gas Future

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Electricity Generation Mix in Scotland, 2013

Source	Percentage
Gas	10%
Nuclear	35%
Coal	20%
Oil	1%
Renewables	33%

Scotland's Energy Mix

Coal-powered Longannet Station scheduled to close early 2016

Scotland's only 2 nuclear power stations scheduled to be decommissioned by 2023

- Scotland set to import electricity from RUK

Need to import baseload energy as renewable generation is unsteady

Imported baseload will be gas-fired, coal-fired or nuclear

But energy does not just = electricity!

Total final energy consumption in Scotland, 2012

Category	Percentage
Heat	55%
Electricity	21%
Transport	24%

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Category	Percentage
Heat	55%
Electricity	21%
Transport	24%

Electricity Generation Mix in Scotland, 2013

Source	Percentage
Gas	10%
Nuclear	0%
Coal	0%
Oil	0%
Renewables	33%
Other	57%

Scotland's Energy Mix

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- Scotland set to import electricity from RUK

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But

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- Assume Scotland is largely successful in decarbonising generation by 2050
- Current gas consumption is 48,618GWh
- Still significant demand in 2030
 - National Grid predict max UK demand reduction of 19% by 2035
 - 19% reduction in Scotland ~ 39,400GWh
 - >10% of current natural gas consumption (5,594 GWh) = chemical feedstock

National Grid Annual Gas Demand Scenarios, UK (TWh)

Year	No progression	Slow progression	Gone green	Low carbon life
2013	~850	~850	~850	~850
2020	~820	~820	~820	~820
2035	~850	~700	~700	~850

	Demand Reduction	Import	Onshore	Offshore
KEY:				
Very positive impacts				
Some positive impacts				
No impacts, or some impacts that may be positive or negative				
Some negative impacts				
Very negative impacts				
Numerals relates to level of uncertainty:				
No number Relatively certain				
1 Some uncertainty				
2 Large uncertainty				
Safety (of site operators)				
Health and Wellbeing (of local communities)				
Environmental				
Climate Change				
Economic: government investment				
Economic Growth				
Economic: cost to consumer				
Viability: can it be done?				
Energy Security				
Environmental and Social Justice				
* n.b. although addressed under cost to consumer, there are significant health and wellbeing implications of fuel poverty.				
** CCS refers to carbon capture and storage. The Scottish Government can mandate CCS on Scottish-based projects, but there will be a cost passed on to the consumer.				

	Demand Reduction
Safety (of site operators)	
Health and Wellbeing (of local communities)	*
Environmental	
Climate Change	
Economic: government investment	
Economic Growth	
Economic: cost to consumer	2
Viability: can it be done?	1
Energy Security	
Environmental and Social Justice	


Demand Reduction

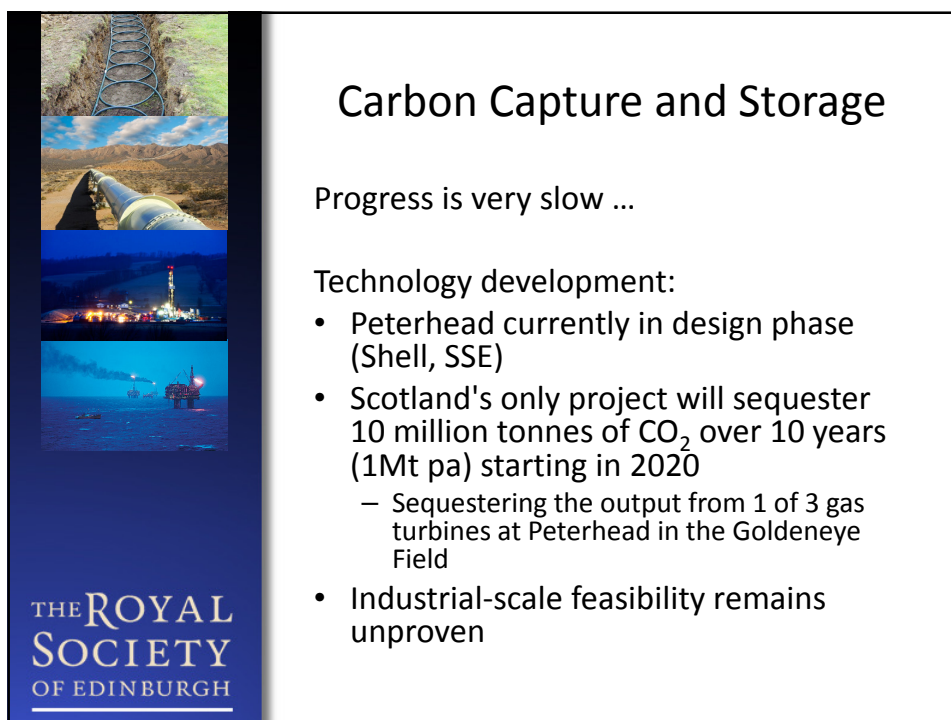
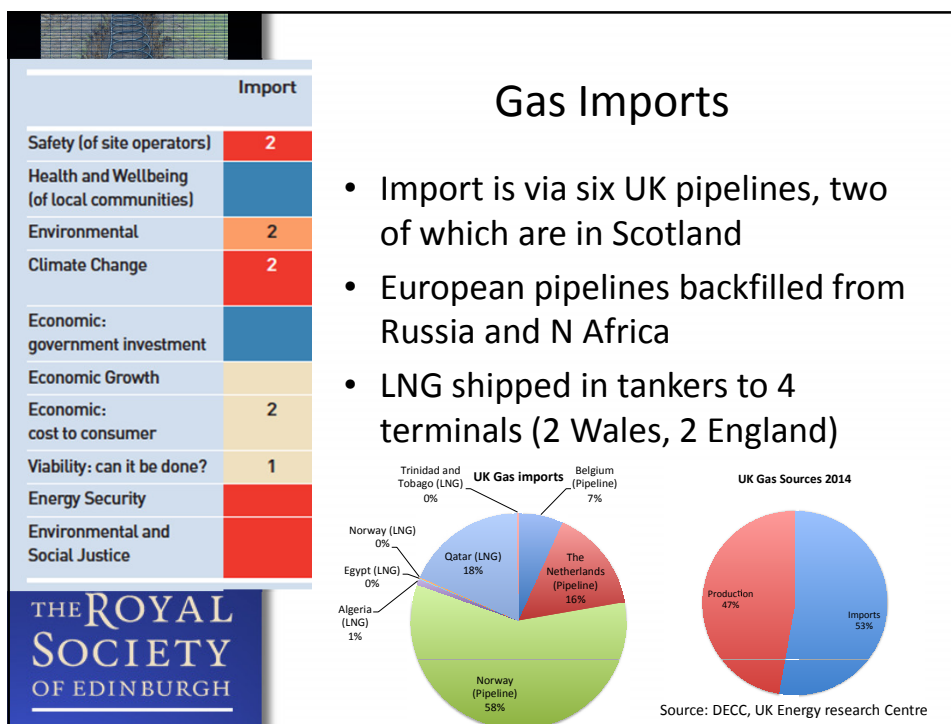
78% households reliant on gas
 Total Scottish gas consumption fell from 60,000GWh to 48,618GWh between 2005 and 2013


- Insulation improvement
- Heat pumps
- District heating systems

Significant further reductions will require conversion from gas to electricity (transport and heat)

- How will we generate more electricity?
- UK generation 81% reliant on fuel
- Gas-fired or nuclear power







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On-shore Gas Production


Onshore unconventional gas in Scotland could be in the form of:

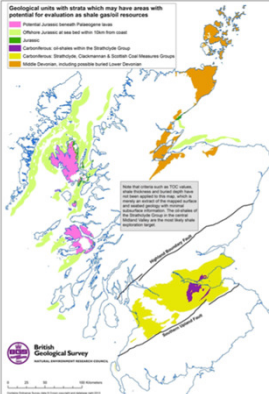
- Shale-gas
- Coal-bed methane (CBM)
- Underground coal gasification

Source: BGS - Scottish prospects for shale-gas

Scottish Government Independent Expert Scientific Panel report in July, 2014

Source: BGS - Scottish prospects for CBM







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THE TIMES Section: News
Edition: 01
Date: 20 October 2015
Page: 7

Fracking opponents ridiculed for claiming sand is cancer risk

Ben Webster Environment Editor

Friends of the Earth, the green campaign group, has been accused of scare-mongering to raise money by suggesting that sand used in fracking could cause cancer.

The group distributed thousands of leaflets asking for donations to help stop fracking. The leaflets said fracking would expose communities to chemicals that could cause cancer because it involved "pumping millions of litres of

It's exactly the same stuff that's on every sandy beach in the country. What are they proposing? That we treat all beaches as contaminated land and pave them over? The debate about fracking should be on the basis of reason, not wild, unsubstantiated allegations that reveal that they don't have the first clue about mainstream chemistry, let alone environmental toxicology", he said.

Cuadrilla said that it was planning to

Dodgy challenges

- The Rev Michael Roberts, a retired vicar, forced an anti-fracking group in Lancashire to stop issuing a leaflet making claims that the industry used chemicals which caused diseases

ALL independent expert panels, including the Scottish Government's, have concluded that **if well regulated**, the industry is safe

Onshore	
Safety (of site operators)	
Health and Wellbeing (of local communities)	1
Environmental	
Climate Change	no CCS 2, CCS ** 2
Economic: government investment	2
Economic Growth	2
Economic: cost to consumer	no CCS 2, CCS 2
Viability: can it be done?	2
Energy Security	
Environmental and Social Justice	

UK/Scottish Shale-Gas

Key differences to US Industry

- No open surface ponds
- Limited flaring, venting only permitted as emergency safety measure
- Fracking fluids must be declared
- Mandatory microseismic monitoring
- Operations stop if microseismic events are increasing in magnitude
- Smaller number of well heads and more long horizontal wells
- Limits on the volume of water allowed per fracturing stage (less seismicity and smaller fractures)
- Landowners do not own resource so industry can not escalate rapidly

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Offshore	
Safety (of site operators)	
Health and Wellbeing (of local communities)	
Environmental	
Climate Change	no CCS 2, CCS 2
Economic: government investment	2
Economic Growth	2
Economic: cost to consumer	no CCS 2, CCS 2
Viability: can it be done?	2
Energy Security	
Environmental and Social Justice	

Off-shore Oil and Gas Production

Further development in off-shore production could include:

- High pressure high temp HPHT
- Deep water development
- Extraction of tight gas

Exploration & appraisal activity declined steadily since 1990

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	Demand Reduction	Import	Onshore		Offshore	
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Numerals relates to level of uncertainty:						
No number Relatively certain						
1 Some uncertainty						
2 Large uncertainty						
Safety (of site operators)		2				
Health and Wellbeing (of local communities)	*		1			
Environmental		2				
Climate Change		2	no CCS	CCS **	no CCS	CCS
Economic: government investment			2	2	2	2
Economic Growth			2		2	
Economic: cost to consumer	2	2	no CCS	CCS	no CCS	CCS
Viability: can it be done?	1	1	2		2	
Energy Security						
Environmental and Social Justice						

* n.b. although addressed under cost to consumer, there are significant health and wellbeing implications of fuel poverty.

** CCS refers to carbon capture and storage. The Scottish Government can mandate CCS on Scottish-based projects, but there will be a cost passed on to the consumer.

Scottish policy is in a UK context

Electricity generation mix in Scotland, 2023?

UK Gas imports

Current policy relies on the UK meeting its future electricity requirements

- i.e. **nuclear new build**

The UK already imports over 50% of the gas it consumes

- Major energy security risk
- Higher carbon footprint due to gas transportation
- No controls over the environmental, health and safety regulation nor social justice for local communities

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- Appetite for public involvement in decision-making (referendum)
 - strength of public feeling around ALL energy developments

RSE Recommendation: Public participatory decision-making should be used in reaching a verdict on which option, or options, Scotland takes forward. The decision-making process should be framed by our wider energy needs

If we say NO to domestic production of gas and nuclear, we are saying YES to something else...

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