

The UK, shale gas and unburnable carbon: Questions for the UK Government

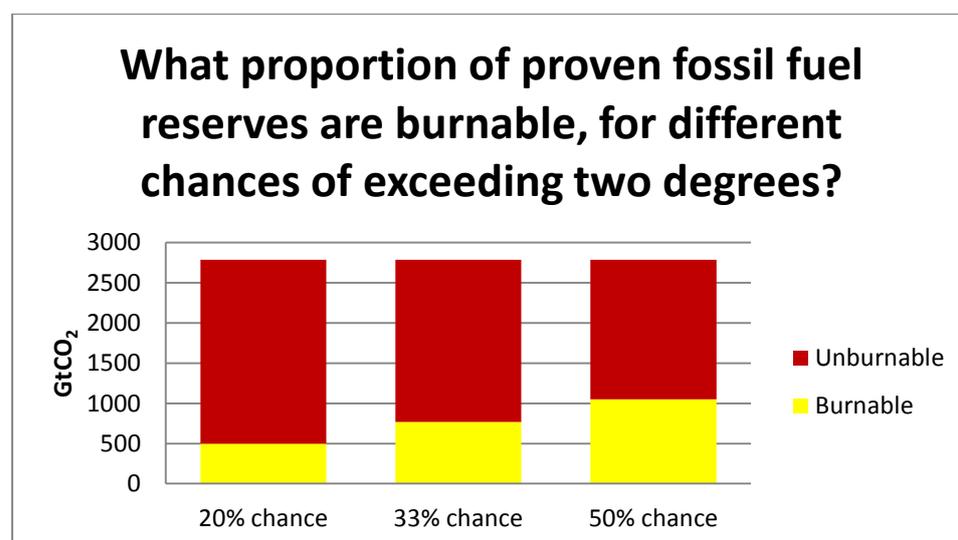
October 2013

Summary

The world has vast amounts of proven reserves of fossil fuels – oil, coal and gas. But, most of these proven reserves are unburnable:

- The UK and other Governments have agreed to limit temperature rises to less than two degrees, to prevent dangerous climate change.
- To keep the risk of exceeding two degrees to below 50%, we can only emit 1050 billion tonnes of carbon dioxide (GtCO₂) globally between now and 2049¹. To keep the chances of preventing two degrees below 33% - the IPCC definition of “likely” - only 800 billion tonnes can be emitted. The September 2013 IPCC 5th Assessment report² gives very similar carbon budgets (see p22).
- But, the world’s proven reserves alone, if extracted and burned, would emit 2800GtCO₂³. There are far greater “potential” and “possible” reserves extractable as well.

As economist Dieter Helm puts it: *“The problem is that we have too much fossil-fuel resource, not too little – enough to fry the planet several times over.”*⁴



So, if the world cannot burn most of its proven reserves, then:

- What does this mean for individual countries? What proportions of their reserves can be extracted and burned? And what does it mean for the relative use of coal, oil and gas?
- If we already have more proven fossil fuels than we can afford to burn, isn't it at best risky to drill for new extra resources – it would just be adding to what are largely already unburnable reserves? Won't these just become stranded, unusable liabilities?

This briefing looks at the implications of unburnable carbon for the UK's fossil fuel extraction, in particular the potential for shale gas development.

The UK's share of the world's burnable carbon, and implications for shale gas

This briefing calculates a fair share for the UK of the world's remaining burnable carbon – this comes to 0.1 GtCO₂.

The UK, by contrast, is planning on extracting fossil fuels equivalent to 40 to 200 times that amount: 4-20 GtCO₂. It plans to extract not just its proven reserves of oil and gas, but double that amount of reserves currently classified as "probable" and "possible". Central projections are for 4 GtCO₂; on top of that comes additional new North Sea oil and gas, and plans for 'unconventional' fuels such as shale gas.

The UK plans on producing far more than a reasonable share of the world's burnable carbon. Shale gas is just adding to a huge unburnable carbon problem.

Unburnable carbon: coal vs oil vs gas

Globally, gas is often touted as a bridging fuel, a cleaner alternative to coal. But to prevent dangerous climate change requires limits on gas as well as coal and oil:

The world's proven fossil fuel reserves would emit 1670GtCO₂ (coal), 720 GtCO₂ (oil) and 400GtCO₂ gas. Could we keep within a 1050GtCO₂ global carbon budget and use more than proven reserves of gas?

In 2012, global emissions were 15 GtCO₂ (coal), 13 GtCO₂ (oil) and 7 GtCO₂ (gas).

Just using proven gas reserves would require a 3% annual global cut in oil and coal emissions, a very tall ask. This would lead to burning all the world's proven gas reserves, under half the world's proven oil reserves, and a fifth of the world's proven coal reserves. Any delay in cutting oil and coal use would lower what is left for gas.

So, burning current, proven global reserves of gas therefore seems to be an absolute top end of what is possible for gas, and even that relies on immediate progress in cutting global oil and coal use. This is before shale gas and other unconventional are considered. There does not seem to be any space for further new gas exploration.

Contents:

1	Introduction	p4
	- Unburnable carbon: seven questions for the UK Government	p4
2	How much fossil fuel should the UK extract?	p5
3	Implications of unburnable carbon for the UK	p6
	- Moratorium on new exploration	
	- Remove tax breaks	
	- Focus on cutting fossil-fuel demand	
	o Energy efficiency and demand reduction	
	o Decarbonise power	
	- Use role as global financial centre to direct investment away from fossil fuels	
4	Questions:	p8
	- Why shouldn't the UK extract what it likes?	
	- Don't we need to extract more oil and gas for security of supply?	
	- Don't we need to extract more oil and gas for the tax revenues?	
	- Won't Carbon Capture and Storage save the day?	
	- Isn't it consumption that matters, not production?	
	- Won't shale gas cut carbon emissions, like in the USA?	
	- Won't shale gas cut energy bills, like in the USA	
	Technical annex	p13
	- What is still extractable globally?	
	- How does that compare with proven reserves?	
	- What is the UK's share of what's still extractable globally?	
	- How much does the UK plan to extract in future?	
	- To what extent are these plans compatible with the UK's share?	
	Other issues	p21
	- Carbon accounting	
	- Coal reserves data	
	- Units	
	- IPCC carbon budgets	
	References/notes	p23

1) Introduction

The work of Carbon Tracker⁵ highlights that the world has a huge unburnable carbon problem. To have a good chance of preventing dangerous climate change, the world's fossil fuel emissions should be at the very most around 800 billion tonnes between now and 2050. But burning proven reserves alone would emit 2800 billion tonnes. The IPCC recently confirmed this analysis (see p22). And there are far more fossil fuel resources out there than just proven reserves.

This is not some niche NGO analysis. Shell has responded to the Carbon Tracker work, saying that: *"There is really nothing to argue about in terms of the CO₂ math itself. It is certainly the case that current proven reserves will take us well past 2 °C if completely consumed and the CO₂ emitted"*⁶.

So if there is a clear unburnable carbon problem, what does this mean for individual countries? In particular, what does it mean for the UK? This is directly relevant issue because the UK is not only committed to extracting all of its proven reserves of oil and gas, it plans on extracting most of its probable and possible reserves as well, is intent on also extracting new "unconventional" resources such as shale, and has an overall strategy *"to continue maximising the recovery of indigenous hydrocarbon resources – on land and at sea"*⁷.

This strategy appears to be at odds with global and UK climate goals. Seven questions for the Government are:

- Does the Government accept that there is a big global unburnable-carbon problem. If so, isn't the UK's *"maximising recovery"* strategy just going to make it worse?
- Increasing UK production makes it more likely that UK and global consumption will rise. How is that compatible with global and UK climate goals?
- Aren't the Government's tax breaks⁸ for new fossil fuel production just encouraging investment in infrastructure that will become unusable liabilities - "stranded assets"?
- Does the UK think it is OK for other countries to also *"maximise recovery"*, given that we are doing it as well – and what would be the global climate consequences if they did?
- Would the UK have any legitimacy in international negotiations to call for, for example, China to stop burning its coal resources, if we are *"maximising recovery"* of our own oil and gas?
- What is a reasonable share for the UK of the world's remaining extractable carbon?

- Shouldn't the UK's strategy for shale gas start from an assessment of its compatibility with global climate change goals?

2) UK fossil fuels and climate change – how much can the UK extract?

This briefing argues that the **UK claim to the world's remaining burnable carbon is just 0.1 GtCO₂** – see the technical annex on pages 15-18 for detail.

This analysis is based on:

- Calculations of what is a safe level of future global emissions of climate change – a “global carbon budget”
- Calculations of what is a reasonable share of this global budget for the UK, based on the UNFCCC's principles of “differentiated responsibility”.

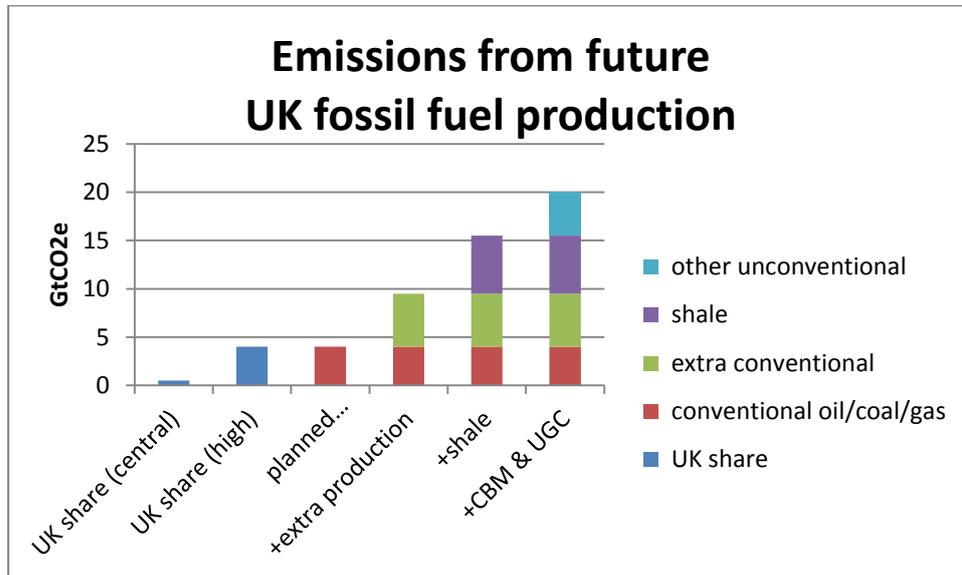
We assume first that the world's climate goals are a “likely” probability of keeping temperature rises below 2 degrees, and second that the UK's share of what is still burnable ignores historic responsibility for climate change before 1990.

One could argue that either of these assumptions could be stricter or more lenient. We believe that both are already lenient. For example, 2 degrees is a high level of global warming and a 100 countries have called for a 1.5 degree target. And our assumption on historic responsibility is in our view generous to the UK - it ignores our very large oil production in the 1970s and 1980s, and huge coal production in preceding decades.

However, if we relaxed either of these assumptions even further – say, to make it a 50/50 chance of exceeding two degrees (pretty dangerous, for something Governments want to avoid), or ignoring historic responsibility before 2000, then the UK's share of remaining burnable carbon increases – to around 2.5 or 4 GtCO₂ respectively.

By contrast, **the UK's emissions look set to be somewhere between 4 and 20 GtCO₂e**, largely depending on the level of exploitation of unconventional fuel sources such as shale gas:

- The UK Government's central projections for the future UK production of conventional oil, coal and gas will lead to emissions of around 4 GtCO₂.
- There is the potential for around 5 GtCO₂ more from conventional sources.
- Unconventional sources in the UK may produce an additional 11 GtCO₂: 7 GtCO₂e from shale gas, 4 from Underground Coal Gasification (UCG), and 0.5 GtCO₂ from Coal Bed Methane (CBM).



So even with very lenient allocation of the world's remaining carbon budget for UK fossil fuels, we are planning to extract far more than that.

3) Implications of unburnable carbon for the UK

Most of the world's proven reserves of oil, gas and coal will need to stay in the ground. Exploring for new sources will simply be adding to the stock of already unburnable carbon. **But at present the UK plans to burn far more than just its proven reserves. It is on course to burn between 40 and 200 times its share of the world's remaining burnable carbon, depending on the extent to which it exploits unconventional sources like shale gas and exploits new North Sea gas fields.**

Climate change is a global problem, and the UK puts itself at the forefront of international climate change diplomacy. But why should the Chinese or anyone else listen to UK or developed country calls not to exploit their fossil fuel resources, if we are merrily exploiting as much as we possibly can ourselves?

We cannot expect other countries to tackle their emissions if we continue to over-exploit our own fossil fuel resources. It's only by not exploiting our own fossil fuel resources that we will persuade others to do the same. As Bill Clinton had it: *"People are more impressed by the power of our example rather than the example of our power"*⁹.

Friends of the Earth does not advocate turning off the oil and gas pipes tomorrow. But continuing to pump out fossil fuels means the UK will exploit and get the economic benefit from far more than a reasonable share of what is still burnable globally. The UK's current fossil fuel strategy is completely out-of-step with its commitments to preventing dangerous climate change.

For the UK to do its part in preventing dangerous climate change, it needs to:

- **Set a moratorium on exploring for new resources and developing new fields** – whether that is North Sea Oil and Gas, or unconventional sources such as shale gas, coal bed methane or underground coal gasification. We cannot keep adding to the already huge levels of unburnable fossil fuels.
- **Remove all tax breaks for fossil fuel extraction**¹⁰. Recent tax breaks have spurred major new investment in the North Sea¹¹. We should not be making it easier to extract resources the world cannot burn.
- **Massively ramp up its strategies to reduce our demand for oil, gas and coal, through energy efficiency and demand reduction.** This is in any case the cheapest economic course and the most important way to ensure the UK's energy security. This would involve:
 - Massive investment in reducing demand for oil:
 - Cleaner and electric vehicles
 - Investment in buses, trains, cycling and walking
 - Strategies for reducing the need to travel
 - Massive investment in reducing demand for gas and coal
 - Energy efficiency improvements for heating homes and businesses
 - Invest in low carbon power, so the role for gas becomes primarily around system balancing, and coal is phased out
- **Set a target in the Energy Bill to decarbonise the power sector to 50g/kWh by 2030, and ramp up the deployment of renewable technologies.** North Sea and other seas' wind, wave and tidal renewable resources will be the economic powerhouse to replace our economic reliance on coal, oil and gas.
- **Use its role as a global financial centre to direct investment away from companies and sectors with high-exposure to unburnable carbon.** When Governments get serious about tackling climate change, carbon resources are increasingly going to become a liability, not an asset. For example:
 - **Companies listed on the UK stock exchange should be required to report on their full exposure to fossil fuels;**
 - **The Bank of England's Financial Stability Authority should proactively consider the risks to the economy caused by overexposure to fossil fuel assets.**

4) Some questions...

a) Why shouldn't the UK just extract what it likes?

Tackling climate change is a global problem which will require the co-operation of all countries. Any solution will need to be perceived as being fair to all nations; this is also written into the international negotiations, for example the UN Framework Convention on Climate Change, ratified by 195 countries, which says: *“The Parties should protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities. Accordingly, the developed country Parties should take the lead in combating climate change and the adverse effects thereof”*¹².

The EU and G8 have said that the climate goal should be that global temperature rises do not exceed 2 degrees Celsius over pre-industrial levels. International Climate negotiations take 1990 as a starting date for setting targets – this is also the basis for the targets in the UK's Climate Change Act. So taking a 2 degree target and a 1990 date as starting points:

- The global carbon budget – an amount of allowable global carbon dioxide emissions – for a 33% chance of exceeding 2 degrees (the IPCC definition of “unlikely”) is 1400 GtCO₂ for 1990-2049¹³.
- The UK's share of that – on an equal per capita basis - is 12.2 GtCO₂.
- By contrast, the UK's extraction of oil, gas and coal just between 1990 and 2011 has already resulted in emissions of 12.1 GtCO₂.

So, working from the UNFCCC's equity and climate goals, the UK only has a reasonable claim to a very small amount of remaining burnable carbon (around 0.1GtCO₂). This is far less than the carbon from proven reserves, let alone new ones or unconventional sources such as shale gas.

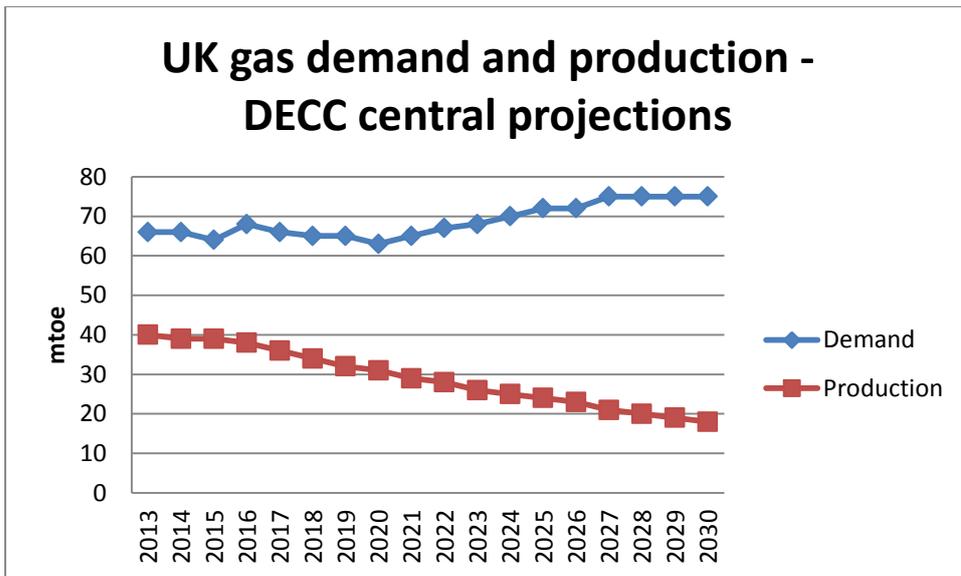
It could be argued that these calculations already give the UK an unreasonably large carbon budget, for example:

- 2 degrees would be a dangerous amount of warming. Over 100 countries have called for a 1.5 degree target, which would mean a smaller global carbon budget¹⁴.
- 33% is a high level of risk to accept for something Governments say we must avoid (you insure your house against <1% risks). Bringing the risk of exceeding two degrees down below 33% would mean a smaller global carbon budget.
- A 1990 start date is not exactly fair to developing countries – it conveniently ignores the large production, use and economic benefit derived from fossil

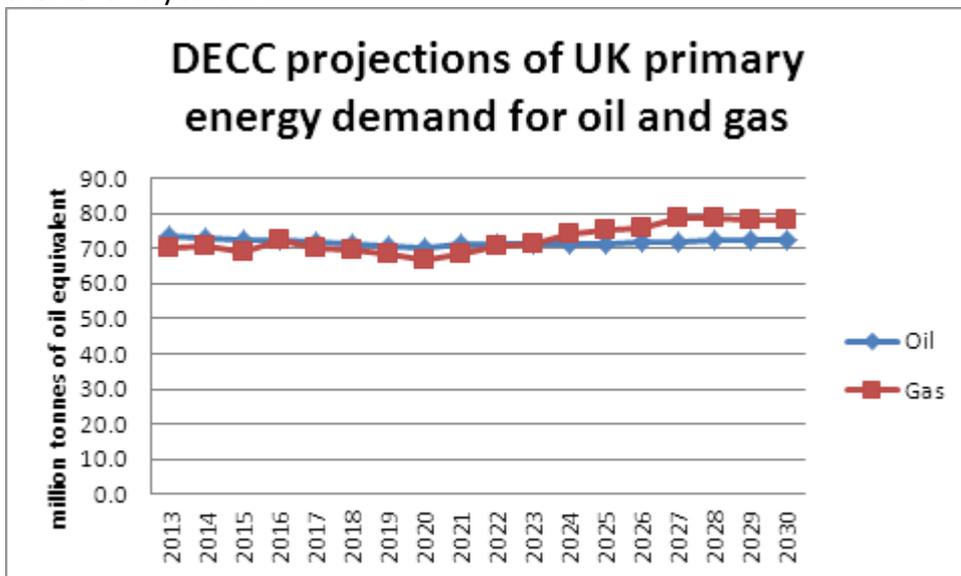
fuels in earlier decades by developed countries. An earlier date would lower the UK's carbon budget.

b) But don't we need to extract more oil and gas for security of supply?

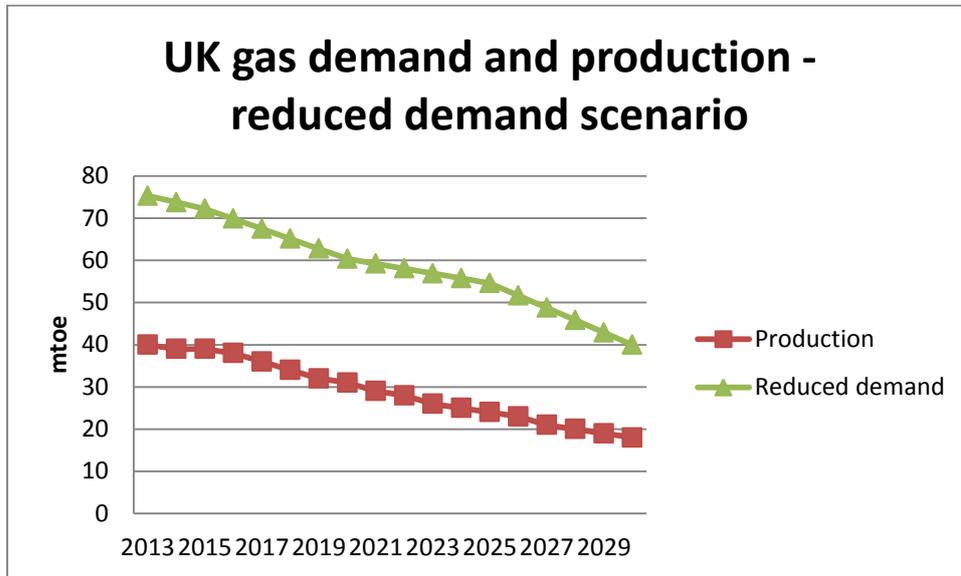
Because North Sea Oil and Gas production is falling fast, the UK is already a net importer of oil and gas. The Government predicts that this import gap will get much wider in the coming years¹⁵:



The Government response to this is to “maximise recovery” to stop the oil and gas production falling as fast as it is. The big untapped response however is to tackle oil and gas demand. Despite the Government’s commitment to tackling climate change its official projections show no projected progress in reducing oil and gas demand in the next 20 years¹⁶:



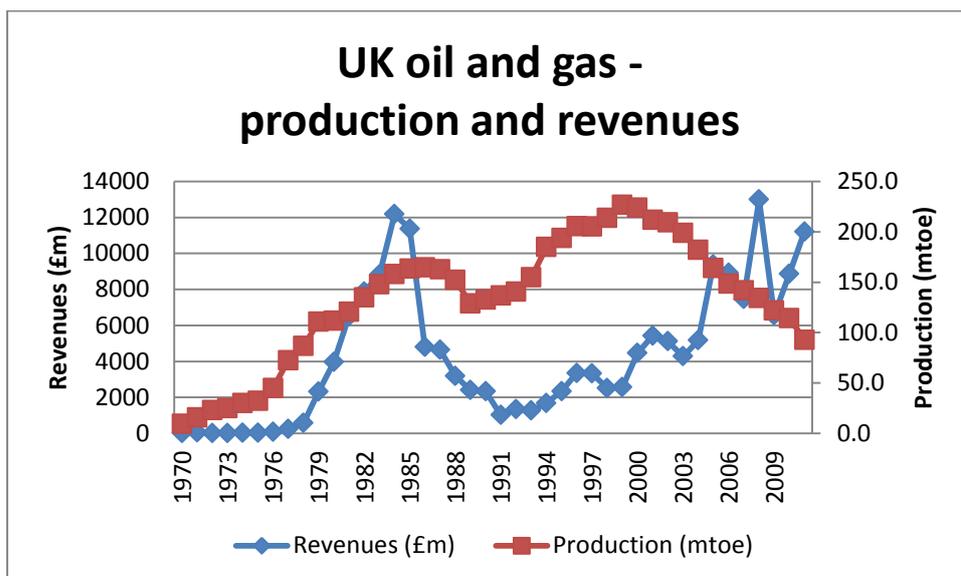
Instead of maximising recovery, a strategy to cut demand through energy and electricity efficiency, demand reduction and alternative fuel sources, would simultaneously cut our energy imports and tackle climate change¹⁷:



With this scenario, the UK would be importing less gas in 2030 than it is now.

c) But don't we need to extract more oil and gas for the tax revenue?

There is little correlation between UK oil and gas production and UK oil and gas tax revenue¹⁸:



If the Treasury wants to keep revenue up while production falls, they can do this by increasing taxation levels.

This happens in other areas of taxation policy. For example, tax revenues from tobacco have almost doubled since 1990, while consumption of tobacco has halved¹⁹.

d) Yes, but won't Carbon Capture and Storage save the day?

Carbon Capture and Storage (CCS) will hopefully have a transitional role to play globally – retrofitting many of the world's current coal and gas-fired power stations. But Carbon Tracker have estimated that even an “optimistic” and “idealised” scenario of huge investment in CCS infrastructure would only extend global carbon budgets by 125GtCO₂²⁰. It is no panacea:

- It can only deal with some fossil fuel emissions. It's possible to fit CCS onto large power stations or large industrial processes. But around 40% of gas is used for domestic and commercial heating, which is not suitable for CCS. And most oil is used in transport – again, not suitable for CCS.
- It still emits carbon. A CCS coal fired power plant might capture 90% of emissions, but that still leaves average emissions at 90g/kWh (grammes of CO₂ per kilowatt hour of electricity) - this is way lower than the current 900g/kWh²¹, but still nearly double the average emissions needed by 2030: the Committee on Climate Change have repeatedly argued that average emissions need to be 50g/kWh by 2030.
- It is still commercially unproven at Gigawatt scales. Deployment at scale and across continents will take many decades.
- At present, CCS seems to be more a justification for allowing coal and gas investment to go ahead, on the vague understanding that CCS might happen in the future, rather than something that must be in place before new investment can occur. Politicians need to make it clear that coal and gas in power only have any sort of future if CCS is definitely applied. The global coal and gas industry need to put in their own resources, on a large scale, to make it a reality.

e) But surely UK production does not matter – if we didn't produce it, someone else would? It's consumption that counts.

Consumption clearly matters. But consumption and production are linked, and what happens in one country can affect what happens in another. For example, in the USA, massive recent shale gas exploitation has meant that USA demand for coal has fallen. This has led to increased USA exports of coal to Europe, which has led to coal falling in price, leading to increased coal consumption in Europe²², at the expense of...gas.

Investing in fossil fuel supply infrastructure also creates additional political pressure to maintain consumption patterns around fossil fuels. Global carbon emissions need to peak and decline almost immediately – this requires a twin approach of reducing demand and reducing supply of fossil fuels.

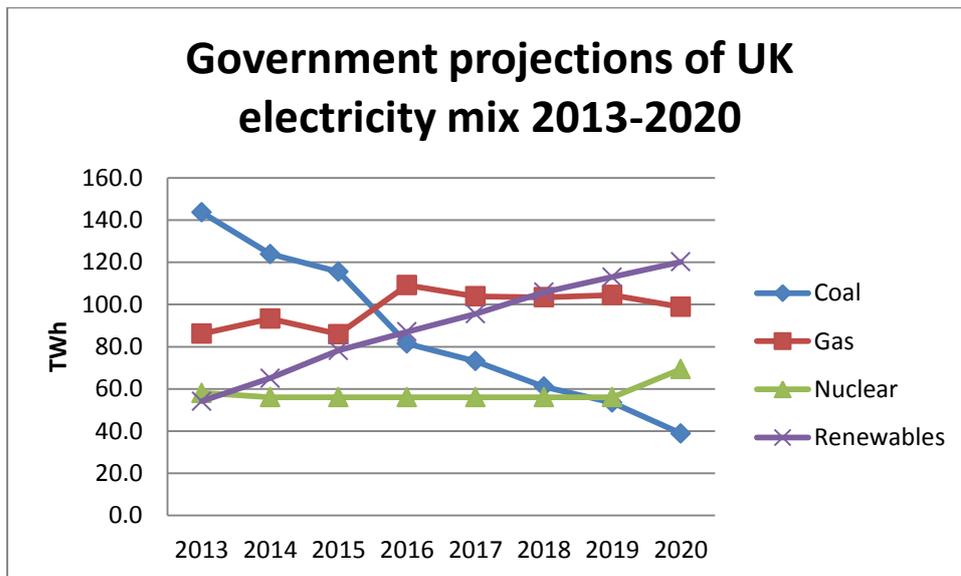
Here in the UK, the prospect of a looming multi-hundred-billion pound import bill for oil and gas should be a major spur for a programme to make the UK use less fossil fuel. Our net import bill for oil is £5 billion a year now; DECC estimate it will be £33 billion a year by 2030²³. The current approach of largely ignoring demand and focussing mainly on boosting supply is exceptionally short-sighted – for both the climate and the economy.

The linkage between UK production and global emissions is very complex and dependent on many factors. The UK Government's recent report on shale gas and climate stated that: *“without global climate policies (of the sort already advocated by the UK) new fossil fuel exploitation is likely to lead to an increase in cumulative GHG emissions and the risk of climate change.”*²⁴ In our view the prospects of a strong global deal on climate change are made much less likely if developed countries like the UK continue to accelerate their own fossil fuel production programmes.

f) But doesn't shale gas cut carbon emissions - like it did in the USA?

Switching from coal to gas is part of the reason the USA's carbon emissions have fallen in recent years. However, one consequence of this is that the USA exported more coal, which lowered coal prices in the EU, and is part of the reason coal consumption and carbon emissions have gone up in the UK and Germany recently. So looking wider than the USA, the USA shale revolution may have led to extra gas consumption as well as coal consumption, not gas instead of coal²⁵.

In the UK, shale gas is not going to switch for coal. The UK government is predicting coal use to be largely phased out by 2020. By the time shale gas is in major production (which if it happens will not be til the 2020s at the earliest) coal will have been largely phased out in the UK – so shale will not be competing with coal, but with lower-carbon electricity sources – see graph below²⁶.



g) Won't shale gas cut our bills – like it did in the USA?

Shale gas production costs in Europe are likely to be higher than in the USA. Reasons for this include less promising geology, higher population density and associated problems of land availability, and tougher environmental regulation²⁷.

Factors such as these led the International Energy Agency (IEA) to conclude that operating costs in Europe will be 30-50% higher than in the USA²⁸. Similarly, Bloomberg²⁹ in 2013 said that UK shale was “*unlikely to lead to a significant reduction in UK natural gas prices*”. But perhaps the most compelling argument not to believe the hype that shale gas will bring down bills is from the shale industry itself, who have said that the impact of UK shale gas on bills will be “*basically insignificant*”³⁰. The Secretary of State has also recently said that: “*North Sea Gas didn't significantly move UK prices – so we can't expect UK shale production alone to have any effect.*”³¹

Technical Annex

The vast majority of the world's proven fossil fuel reserves are unburnable, if we want any decent chance at preventing dangerous climate change.

If most global fossil fuel reserves have to stay in the ground, what does that mean for the UK's fossil fuel reserves?

This technical annex sets out:

- 1) What is still extractable globally?
- 2) How does that compare with proven reserves?
- 3) What is the UK's share of what's still extractable globally?

- 4) How much does the UK plan to extract in future?
- 5) To what extent are these plans compatible with the UK's share?

1) What is still extractable globally?

The work of Meinshausen et al on “global carbon budgets” sets out what is the percentage chance of exceeding a given temperature target for a given amount of global carbon dioxide emissions. For example, a global carbon budget of around 900 billion tonnes of carbon dioxide (GtCO₂) between 2000 and 2049 has a 20 per cent chance of exceeding two degrees global warming³²:

Table 1 – Carbon budgets for different likelihoods of exceeding two degrees		
Likelihood of exceeding two degrees	Global carbon budget 2000-2049 (GtCO ₂)	Global carbon budget 2013-2049 (GtCO ₂) ³³
20%	886	498
25%	1000	612
33%	1158	770
50%	1437	1049

The critical questions are therefore:

- What temperature rise are we seeking to avoid?
- What percentage chance of that are we willing to accept?

The EU and G8 climate change goal is that global average temperature rise must not exceed two degrees Celsius above pre-industrial levels. Over 100 countries argue for a 1.5 degree temperature target³⁴.

The IPCC³⁵ has definitions of likelihoods which range from:

Table 2: Likelihood scale	
Term	Likelihood of the outcome
Virtually certain	99-100%
Very likely	90-100%
Likely	66-100%
About as likely as not	33-66%
Unlikely	0-33%
Very unlikely	0-10%
Exceptionally unlikely	0-1%

The EU's target is explicit that: “The EU must adopt the necessary domestic measures and take the lead internationally to ensure that global average temperature increases do not exceed pre-industrial levels by more than 2°C” (our underlining)³⁶.

Given this framing, it seems that the highest level of risk compatible with this “do not exceed” wording would be to keep the likelihood to “unlikely” or lower, in other words – less than 33% chance of exceeding two degrees.

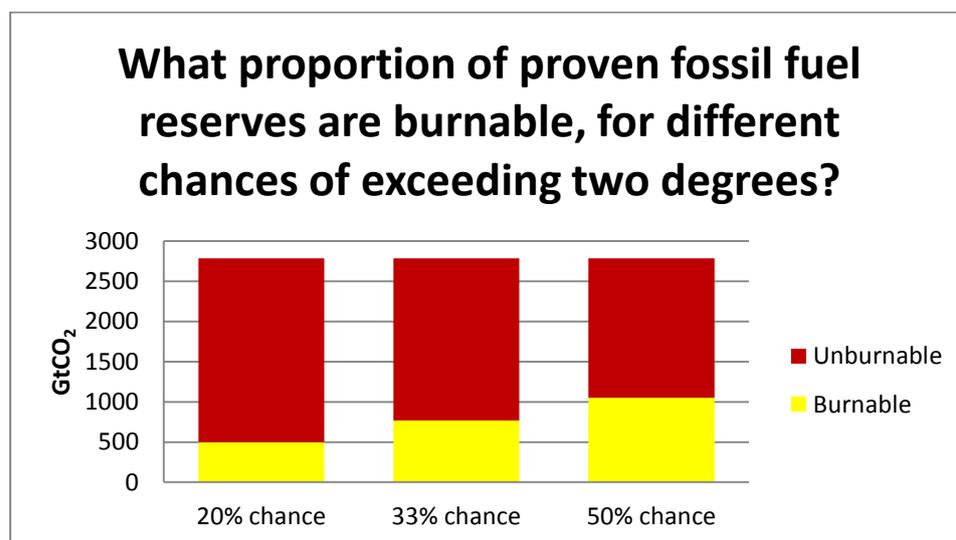
This implies that a maximum remaining carbon budget would be around 800 GtCO₂ – even this accepts a high level of risk, and a temperature target above that advocated by over 100 countries.

2) How does that compare with proven reserves?

Proven fossil fuel reserves if burned would emit 2,800 GtCO₂³⁷:

Table 3: Global fossil fuel reserves		
	Proven reserves	Emissions from proven reserves (GtCO ₂)
Oil	236 billion tonnes	724
Gas	187 trillion cubic metres	396
Coal	861 billion tonnes	1667
Total		2787

Burning the world’s proven reserves would emit more than three times a maximum safe global carbon budget. As energy analyst Dieter Helm puts it: *“The problem is that we have too much fossil-fuel resource, not too little - enough to fry the planet several times over.”*³⁸



3) What is the UK’s share of extractable carbon?

If we can only burn a fraction of the world’s proven reserves, there is a new set of questions:

- Which fraction can be burned?
- Which countries should not burn their existing reserves?
- Should any countries seek to add to proven reserves, if we can't burn what there is already?

Climate change is a global problem, requiring the co-operation of all countries. Any workable agreement will need to be demonstrably fair. This point is emphasised in the Framework Convention on Climate Change, signed by 195 nations, which states: *“The Parties should protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities. Accordingly, the developed country Parties should take the lead in combating climate change and the adverse effects thereof”*³⁹.

The issues of responsibility, fairness and justice run through international climate negotiations. Global temperature rise is due to a combination of both future and historic emissions: the cumulative build of greenhouse gases in the atmosphere. Simply, developed countries are overwhelmingly responsible for historic emissions, and so developing countries have a greater claim to remaining future emissions.

As a result, splitting any remaining global carbon budget by a country's share of the world population would be equal, but not compatible with the Convention's or subsequent Copenhagen Accord's “differentiated responsibilities” – for it would be ignoring all historic responsibility.

To attempt to address historical responsibility, we look at three different “start-dates” – 1970, 1990 and 2000. For each we first calculate the total carbon budget for the period. This is equal to historic global emissions from the given start date to 2012, plus remaining global carbon budget from 2013-2049. And then for each time period, we calculate an indicative UK share, based on the UK's percentage of global population over that period⁴⁰. This is set out in Table 4:

Table 4: UK's share of Global carbon budget for an different likelihoods of exceeding two degrees (in GtCO₂)					
		% likelihood			
		20%	25%	33%	50%
Period of global carbon budget:	1970-2049	14.6	15.6	16.9	19.3
	1990-2049	9.9	10.9	12.2	14.6
	2000-2049	7.5	8.5	9.8	12.2
	2013-2049	4.1	5.1	6.4	8.7

We can calculate what therefore remains for the UK by subtracting from this the UK's actual emissions from its fossil fuel production so far, which are set out in table 5:

Table 5 Actual UK emissions from fossil fuel production⁴¹				
GtCO ₂	Oil	Gas	Coal	Total
1970-2012	9.8	5.1	7.7	22.6
1990-2012	6.2	3.7	2.2	12.1
2000-2012	3.0	2.2	0.7	5.9

So, subtracting the data in table 5 from the data in table 4, the UK's remaining extractable carbon is:

Table 6: UK's remaining extractable carbon (2012-2049) for different probabilities of exceeding two degrees (GtCO₂)					
		20%	25%	33%	50%
Start date for calculating carbon budget	1970	-8.0	-7.0	-5.7	-3.3
	1990	-2.2	-1.2	0.1	2.5
	2000	1.6	2.6	3.9	6.3
	2013	4.1	5.1	6.4	8.7

Minus (red) numbers indicate scenarios where we have already extracted more than a reasonable UK share of global fossil fuel. Only the non-shaded cells are scenarios with any remaining extractable carbon for the UK.

Which is the most appropriate scenario to choose?

On **risk**, if the target is to not exceed 2 degrees, the absolute minimum level of risk seems to be around 33% - this is the IPCC's definition of "unlikely". 20% is the level chosen by the CarbonTracker initiative⁴². Friends of the Earth used 33% in its Reckless Gamblers report⁴³, with the heavy caveat that this was a very risky level, and indeed that 2 degrees itself is too risky – with over 100 countries supporting a 1.5 degree target.

On start date, tackling climate change is a global problem which will require a fair contribution from all countries. It is hard to see why any developing country would accept any limits on its own production if countries which have used vast amounts of fossil fuels in the past are able to ignore this historical responsibility. A start date of

1990 – widely used in climate negotiations – seems an absolute minimum. Taking into account historical emissions more comprehensively would mean a much earlier start date. As the Bolivian Government put it: *“Developed countries with less than twenty percent of the world’s population are responsible for around three quarters of historical emissions. Their current per person emissions continue to exceed those of developing countries by a factor of four. Their accumulated historic emissions on a per person basis exceed those of developing countries by a factor of eleven”*⁴⁴.

Overall, in Friends of the Earth’s view a UK share based on a 33% chance of exceeding two degrees and a 1990 start date seems as dangerous as anyone would want and as generous as you could be to the UK. On that reckoning, the UK has a claim to just 0.1GtCO₂ of the world’s remaining extractable fossil fuels.

4) What the UK plans to extract in future

Future production is a combination of four sources:

- Oil
- Gas
- Coal
- New “unconventional” sources – shale gas, coal bed methane, and underground coal gasification

DECC projections of future production of convention oil, gas and coal are set out in table 7:

	Production	Emissions (GtCO ₂)
Oil	687 million tonnes of oil equivalent (mtoe)	1.9 ⁴⁶
Gas	522mtoe	1.2
Coal	234 million tonnes	0.6
Total		3.7

For oil and gas these projections reflect far more production than current proven reserves. DECC classify oil and gas reserves into five categories:

Name	Detail
Proven	Discovered, remaining reserves that are recoverable and commercial. Can be proven, probable or possible depending on confidence level
Probable	
Possible	
Potential Additional Resources	Discovered resources that are not

	currently technically or commercially producible
Undiscovered resources	Undiscovered potentially recoverable resources in mapped leads

DECC estimates of the different types of oil and gas reserves are set out in Table 9:

Table 9: UK reserves of oil and gas, 2013⁴⁸		
	Oil (mtoe) ⁴⁹	Gas (mtoe) ⁵⁰
Proven	410	200
Probable	370	200
Possible	320	170
Potential Additional Resources	290	160
Undiscovered resources	730	450

As DECC is projecting UK oil production of 687 mtoe to 2030, they are assuming the development of oil equivalent to almost all the proven and probable reserves. Similarly, as DECC is projecting UK gas production of 522 mtoe to 2030, they are assuming the development of gas equivalent to almost all the proven, probable and possible reserves.

Unconventional sources

Estimates of what is possible or likely from unconventional sources are still very uncertain.

The British Geographical Survey have recently revised their projections for shale gas sharply upwards – to 1300 trillion cubic feet (tcf) for the Bowland shale in the North of England alone⁵¹. This is an estimate of the total resource. It is uncertain how much of that might be extracted – 10% appears to be a reasonable estimate⁵². 130tcf would see emissions of around 7GtCO₂⁵³.

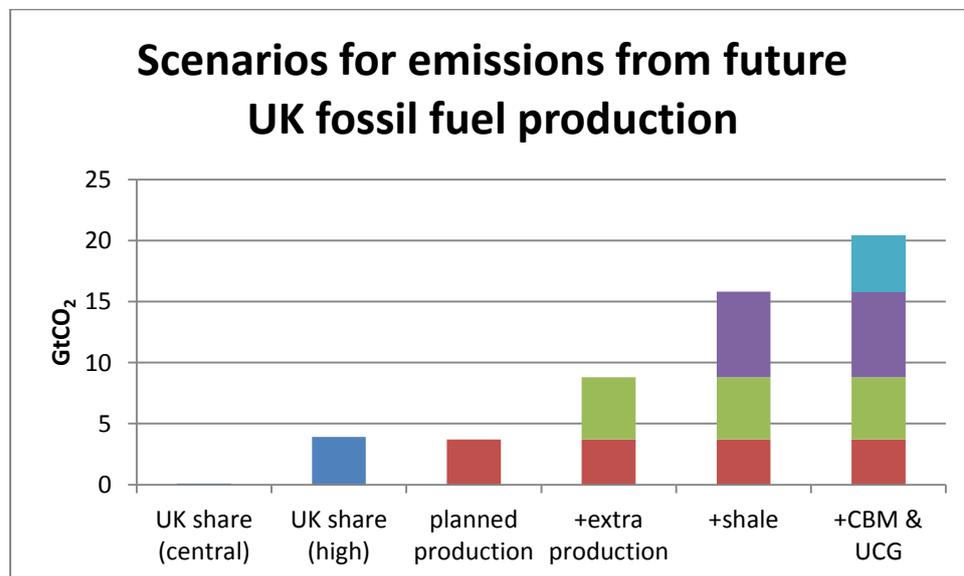
There are also other unconventional sources, other than shale gas. DECC has estimated coal bed methane at 235 mtoe⁵⁴, which would be an additional 0.5 GtCO₂. And the British Geological Survey estimates there is 17 billion tonnes of coal resource potentially suitable for Underground Coal Gasification⁵⁵. Assuming 2.4 tCO₂ a tonne, and 10% of the resource suitable, that would be around 4GtCO₂⁵⁶

Summarising the above data for conventional and unconventional sources, UK future extraction is likely to have the following carbon emissions (Table 10):

Table 10: Carbon dioxide emissions from future UK fossil fuel production (GtCO₂)⁵⁷			
	DECC projections	Potential extra ⁵⁸	Total
Oil	1.9	3.7	5.6
Gas	1.2	1.4	2.6
Coal	0.6	- ⁵⁹	0.6
Shale Gas	-	7.0	7.0
Coal Bed Methane (CBM)	-	0.6	0.6
Underground Coal Gasification (UCG)	-	4.0	4.0
Total	3.9	16.7	20.4

5) To what extent are these projections compatible with a reasonable UK share?

Assuming that the UK production of conventional oil, gas and coal is in line with DECC projections, how does that compare with a reasonable UK share of remaining extractable carbon?



Even planned production of conventional oil and gas is as much as even a very generous allocation of the world's remaining burnable carbon to the UK. Additional production or exploiting unconventional sources such as shale would be way over any reasonable share.

Other issues 1) – Carbon budgets: production or consumption?

Accounting for carbon is a complex business. The conventional approach, used in the UNFCCC and in the UK's Climate Change Act, is to look at "end-user" emissions. So a gallon of oil produced in Kuwait, used in a car made in France running on a British road would count under Britain's carbon dioxide emissions.

This method of accounting hides two issues. First, a country with massive net oil exports – such as Venezuela – might appear to be making little contribution to climate change. Second, a country with massive net exports of products – such as China – will have very large emissions, but much of this for products which will be consumed in other countries.

The reality is that countries are interconnected, and whichever accounting method is chosen will inevitably obscure some of the complexity surrounding the responsibility of individual nations for tackling climate change.

In the UK, although we have carbon budgets which set a clear strategy for our end-use fossil fuel emissions, little is said about the UK's production of fossil fuels, and their contribution to climate change. Indeed, the presence of end-use UK carbon budgets has been used as a justification that North Sea Oil production is irrelevant to climate change, and can be ignored⁶⁰. But, more fossil fuels extracted creates pressure to continuing investing in fossil fuel infrastructure, rather than lower carbon alternatives, such as renewable power rather than gas, or energy efficiency rather than continued consumption. And at a global level it is no coincidence that some of the most hostile nations to progress on international climate negotiations are those with the large fossil fuel reserves⁶¹.

Fossil fuel emissions depend on supply and demand factors – both are critical. If the world has far more supply than we can safely burn, then it's essential to look at which fraction of that supply we can burn, and whether there is any point in adding to that supply. Indeed, adding to supply will lower its cost, making it more likely that more will be burned.

The UK has in recent years moved from being a net exporter to a net importer of fossil fuels, and this trend is set to continue. In this context the UK Government wants to extract as much fossil fuels out of the North Sea for two reasons – to keep tax revenues coming into the exchequer for as long as possible, and to reduce our dependence on imported fuels as much as possible. But this has two negative effects. First it means there is a policy push away from low-carbon – as seen in the recent "gas generation strategy" where the Treasury wants to see expanded gas generation at the expense of low-carbon power. Second, at an international level it weakens any diplomatic efforts to persuade other countries to keep their fossil fuels in the ground.

An alternative approach would be to say that the UK should use its existing fields, but no more. Instead of increasing supply, the UK should focus on lowering demand. There is ample potential for this – DECC projects that UK oil demand will fall by less than 3% by 2030, and that gas demand will rise by 10%, when large cuts are possible: the MARKAL projection for DECC suggests 35% cuts are possible⁶².

A leadership role for the UK on climate would see a shift in strategy away from maximising fossil fuel supply to one that minimises fossil fuel demand.

Other issues 2) – Coal reserves data

Coal reserves are defined differently to oil and gas. DECC says: *“The Coal Authority estimates economically recoverable and minable coal resource in current operations and those in the planning or pre-planning process at 320 million tonnes in underground mines and 120 million tonnes in surface mines. In addition there are some 250 million tonnes at closed underground mines still in licence. The tonnage in identified prospects is 2,030 million tonnes suitable for underground mining and 780 million tonnes suitable for surface mining.”*⁶³

Other sources have similar figures. BP states that the UK has 228 million tonnes of coal reserves⁶⁴. DECC pathways’ “low production” scenario⁶⁵ implies UK production of around 250 million tonnes 2012-2030 and 340 million tonnes 2012-2049. Overall, 250 million tonnes, equivalent to 0.6 GtCO₂, looks a conservative assessment of likely carbon dioxide from UK coal production

Other issues 3) Units:

Throughout this report uses the unit GtCO₂ – billion tonnes of carbon dioxide. Carbon dioxide is not the only greenhouse gas - Meinshausen gives budgets in GtCO₂e (which includes other non CO₂ greenhouse gases (GHGs), as well as GtCO₂. Here the report assumes that percent cuts in other GHGs would happen at the same level as for CO₂. This is optimistic – it will be harder to cut other major GHGs, such as nitrous oxide from food production, so deeply. This assumption likely overestimates the likely available global CO₂ budget⁶⁶.

Other issues 4) IPCC carbon budgets

In late September 2013 the IPCC’s 5th Assessment report set out, for the first time, carbon budgets for different likelihoods of keeping below 2 degrees. It sets out a budget for 2012 onwards of 1133GtCO₂ for a 50% chance of exceeding two degrees. This report is using a budget of 1050 GtCO₂ between 2013 and 2049, based on the work of Meinshausen. Meinshausen sets out that budgets for 2049 onwards are of the order of 150 GtCO₂, which suggests that total budget is from 2013 onwards is around 1100GtCO₂ – ie extremely similar to the new IPCC budgets.

References/end notes:

- ¹ Meinshausen, M et al, 2009. [Greenhouse-gas emission targets for limiting global warming to 2 °C](#). Meinshausen gives budgets for 2000-2049; emissions 2000-2012 subtracted from that, using data from Oliver J et al, 2012. [Trends in global CO2 emissions; 2012 Report](#), The Hague: PBL Netherlands Environmental Assessment Agency; Ispra: Joint Research Centre, and BP, 2013. [Statistical review of World Energy 2013](#).
- ² IPCC, 2013. [Fifth Assessment report, Working Group 1, summary for policy makers](#). E.8
- ³ Reserves data and conversion factors from BP, 2013. [Statistical review of World Energy 2013](#). This value is similar to that used by CarbonTracker, 2013. [Unburnable carbon](#). (2860 GtCO₂)
- ⁴ Dieter Helm, 2012. [New paths to power](#). The Spectator, 10th November.
- ⁵ CarbonTracker, 2013. [Unburnable carbon](#).
- ⁶ David Hone, 2013. [The carbon bubble reality check](#). May 3rd. David Hone is Shell's climate change adviser.
- ⁷ Ed Davey, 2013a. [Green Growth, Green Jobs: The success of renewables in Scotland](#). 18th March.
- ⁸ Friends of the Earth, 2013. [UK fossil fuel tax breaks](#). May.
- ⁹ Bill Clinton, 2008. Democratic Party Convention.
- ¹⁰ Friends of the Earth, 2013. [Fossil Fuel Tax Breaks in the UK](#). February
- ¹¹ DECC, 2012c. [Brown Field Allowance Sparks New Wave of Oil Investment](#). 24th October. For more detail on tax breaks, see Friends of the Earth, 2013. [UK fossil fuel tax breaks](#). May.
- ¹² UNFCCC, 1992. [Convention text](#).
- ¹³ Meinshausen et al, 2009 op.cit. give a 1158GtCO₂ budget for a 33% chance, for 2000-2049. Global emissions 1990-1999 were 234 GtCO₂
- ¹⁴ See also Christina Figueres, UNFCCC executive secretary comments in 2011. [UN chief challenges world to agree tougher target for climate change](#). Guardian, 1st June
- ¹⁵ DECC, 2013a. [UKCS Oil and Gas Production Projections](#). Costs from DECC, 2012a. [Updated Energy Projections – Annex F Price Growth Assumptions](#). October. Import costs undiscounted.
- ¹⁶ DECC, 2012b. [Updated Energy Projections – Annex H Primary Energy Demand](#). October.
- ¹⁷ A high energy efficiency scenario taken from FOE inputs to DECC's pathway calculator. Has gas demand at 40mtoe in 2030. Government modelling using MARKAL 3.26 model for high energy-efficiency pathway also has much lower demand in 2030: 45mtoe
- ¹⁸ Revenue data from DECC, 2012. [Government revenues from UK oil and gas production](#). Production data from BP, 2013. [Statistical review of World Energy 2013](#).
- ¹⁹ Tobacco Manufacturers Association, 2012. [Facts and Figures](#). Accessed March 2013.
- ²⁰ CarbonTracker, 2013. [Unburnable carbon](#). Page 12.
- ²¹ 912g/kWh in 2011 says [Digest of UK Energy Statistics](#) 2012. Table 5A.
- ²² Bloomberg, 2012. [Gas Golden Age Darkens in Europe on US coal: Energy Markets](#). 31st Oct
- ²³ DECC, 2012a and DECC, 2013, op.cit.
- ²⁴ DECC, 2013b. [Potential Greenhouse Gas Emissions Associated with Shale Gas Extraction and Use](#). 9th September.
- ²⁵ This issue is discussed by Broderick and Anderson, 2012. [Has US Shale Gas Reduced CO₂ Emissions?](#) Tyndall Centre
- ²⁶ Data from DECC, 2012. [Updated Energy Projections. Annex E Total electricity generation by source](#).
- ²⁷ For further information on fracking see Friends of the Earth's general briefing - Friends of the Earth, 2013. [Unconventional, unnecessary and unwanted](#). May
- ²⁸ International Energy Agency, 2012. [Golden Rules for a Golden Age of Gas](#).
- ²⁹ Bloomberg, 2013. [UK shale gas no "get out of jail free card"](#). 21st February.
- ³⁰ The Independent, 2013. [Cuadrilla PR man admits George Osborne's shale gas revolution won't cut energy bills](#). 12th June.
- ³¹ Ed Davey, 2013b. [The Myths and Realities of Shale Gas Exploration](#). 9th September
- ³² Meinshausen et al, 2009. Op cit. [Greenhouse-gas emission targets for limiting global warming to 2 °C](#).
- ³³ This column subtracts 2000-2011 emissions from the 2000-2049 budget, using data from Oliver J et al, 2012. [Trends in global CO2 emissions; 2012 Report](#), The Hague: PBL Netherlands Environmental Assessment Agency; Ispra: Joint Research Centre. The values in this table are very similar to those in Meinshausen, et al, 2009. [Supplementary information - Greenhouse gas emission targets for limiting global warming to 2°C](#). Table S3.
- ³⁴ 350.org. [Countries for 350ppm/1.5 C](#).
- ³⁵ IPCC, 2010. [Guidance Note for Lead Authors of the IPCC Fifth Assessment Report on Consistent Treatment of Uncertainties](#).
- ³⁶ COMMISSION OF THE EUROPEAN COMMUNITIES, 2007. [Limiting Global Climate Change to 2 degrees Celsius The way ahead for 2020 and beyond](#). 10th January.

37 Reserves and conversion data from BP, 2013. [Statistical review of World Energy 2013](#).

38 Dieter Helm, 2012. [New paths to power](#). The Spectator, 10th November.

39 UNFCCC, 1992. [Convention text](#).

40 Population data from United Nations Department of Economic and Social Affairs, 2012. [World population prospects, the 2012 revision](#).

41 Production data taken from BP, 2013. [Statistical review of World Energy 2013](#). Assumes 100% coal and gas burned, 90% of oil burned.

42 Carbon Tracker, 2012. [Unburnable Carbon](#).

43 Friends of the Earth, 2010. [Reckless Gamblers](#).

44 See Bolivia's submission to the UNFCCC. [Commitments for Annex I Parties under paragraph 1\(b\)\(i\) of the Bali Action Plan: Evaluating developed countries' historical climate debt to developing countries Submission by the Republic of Bolivia to the AWG-LCA](#). 2009

45 DECC, 2013a. [UKCS Oil and Gas Production Projections](#).

46 Table 7 assumes that all coal and gas produced is burned. It assumes that 90% of oil is burned – some oil will be used for other purposes. For example, the British Plastics Federation [states](#) that 4% of oil worldwide goes into plastics; also a very small percentage goes into other products, rather than being burned, such as lubricants and asphalt. For more detail see US EIA, 2013. [Petroleum and other liquids – refinery yield](#).

47 DECC, 2013. [Oil and Gas field data](#).

48 Reserves data from DECC, 2013. [Oil and Gas field data](#). Accessed February 2013.

49 Figures rounded to the nearest 10. The PAR value is a central estimate, with the low and high estimates 110 and 680. The undiscovered resources value is a central estimate, with the low and high estimates 420 and 1320.

50 Figures rounded to the nearest 10. The PAR value is a central estimate, with the low and high estimates 80 and 290. The undiscovered resources value is a central estimate, with the low and high estimates 290 and 790.

51 British Geological Survey, 2013. [New shale gas resource figure for Central Britain](#). www.bgs.ac.uk accessed June 2013.

52 British Geological Survey, 2012. [Evidence to Energy and Climate Change Select Committee. The impact of shale gas on energy markets](#). October

53 130tcf = 3btoe (times by 1000/5800 to get billion barrels oil equivalent, divide by 7.5 to convert to btoe), then using BP, 2013. Op cit. conversion factor 2.35 tCO₂/toe

54 DECC, 2012. [THE UNCONVENTIONAL HYDROCARBON RESOURCES OF BRITAIN'S ONSHORE BASINS - COALBED METHANE \(CBM\)](#).

55 British Geological Survey. [Clean coal exploitation and unconventional gas](#). accessed March 2013.

56 The climate impacts of underground coal gasification are uncertain and complex, and depend on many factors, such as the level of use of CCS. These issues are covered in depth in McLaren Environmental, 2013. [Climate impacts of underground coal gasification](#). May, Sweden.

57 This analysis assumes that extracted fossil fuels will be burned with usual carbon dioxide emissions. This might not be the case if Carbon Capture and Storage (CCS) occurs to a large degree. This issue is covered on page 11

58 For oil, figure calculated from central estimates of possible, potential additional reserves and undiscovered resources. Data from DECC, 2013. [Oil and Gas field data](#). Accessed February 2013. For gas, figure calculated from central estimates of potential additional reserves and undiscovered resources.

59 The UK has very large coal resources in "identified prospects", but at present it does not look as though there are large plans to exploit them.

60 Chloe Smith and Jonathan Mills, April 2012. [Oral evidence to Environmental Audit Committee](#). 25th April. ; "I challenge the idea that investment in fossil fuels and the move to a low carbon economy are fundamentally incompatible", John Hayes, 2012. [High Carbon Investment Debate, House of Commons](#). Column 827. 18th December

61 Clark, D, 2012. [Revealed: How fossil fuel reserves match UN climate negotiating positions](#). 16th February, Guardian.

62 DECC, 2012. [2050 pathways](#). Markal scenario 3.26, intermediate output table.

63 DECC, 2012. [UK energy sector indicators 2012](#). p16

64 BP, 2012. [BP Statistical Review of World Energy. Chapter 30, coal](#). June.

65 DECC, 2012. [2050 pathways](#).

66 A further issue is land-use change emissions, some of which are CO₂. Anderson and Bows, 2011 argue in [Beyond dangerous climate change: emission pathways for a new world](#) that the effects of land-use change emissions should be used to alter available global CO₂ budgets – the effect of this will also reduce the available global budget.