

This note explains in further detail the conclusions drawn in the blog post '*A role for shale gas in a low-carbon economy?*' By Dr David Joffe, Head of Modelling at CCC.

<http://www.theccc.org.uk/blog/a-role-for-shale-gas-in-a-low-carbon-economy/>

How much worse are methane emissions than CO₂: 72x? 25x? 9x?

On the relative lifecycle emissions of shale gas vs. other fossil fuels it has been claimed, and regularly repeated, that leaks of methane in shale gas production and distribution mean that it has – or at least could easily have – higher lifecycle emissions than coal.

In order to assess the lifecycle of fossil fuels, it is first necessary to decide on a basis for comparing methane and CO₂ emissions; then we can look at the evidence on the emissions of CO₂ and methane from the shale gas fuel chain and those of other fossil fuels and make a comparison.

Firstly, we need to decide how to compare the relative importance of CO₂ vs. methane in driving climate change. Some of the 'worse than coal' analysis has used the 20-year global warming potential (GWP) metric, which places much more emphasis on near-term warming – during which period the relatively short-lived methane is a very potent greenhouse gas – at the expense of the longer term, when warming from CO₂ dominates. Methane has a 20-year GWP of 72, meaning that the warming from each tonne of methane emitted is equivalent to 72 tonnes of CO₂ over the following 20 years.

However, the Committee considers that the appropriate metric to use is the 100-year GWP, which is the internationally recognised basis for emissions accounting and is used by the CCC as standard across all its analysis. This will tend to capture better the long-term effects on global temperature and climate impacts of emissions of the different greenhouse gases. Even on this basis, methane has a 100-year GWP of 25 (i.e. each tonne of methane emitted is around 25 times as potent as a tonne of CO₂), so even small proportions of methane leakage are clearly important.

But it is also important to realise what this figure of 25 means. What many people assume is that releasing a tonne of methane is 25x worse than burning it and releasing the resultant CO₂. In fact the correct figure here is 9x – this is because burning a tonne of methane produces 2.75 tonnes of CO₂, so the comparison is between emissions of 25 vs. 2.75 tonnes of CO₂-equivalent (tCO₂e), a ratio of around 9.

Why? Because each methane (CH₄) molecule burnt leads to the release of one molecule of CO₂ (CH₄ + 2O₂ => CO₂ + 2H₂O), but each molecule of CO₂ is 2.75x heavier than a methane molecule (CH₄ has a molecular weight of 16, compared to 44 for CO₂).

Shale gas: worse than coal or better than LNG?

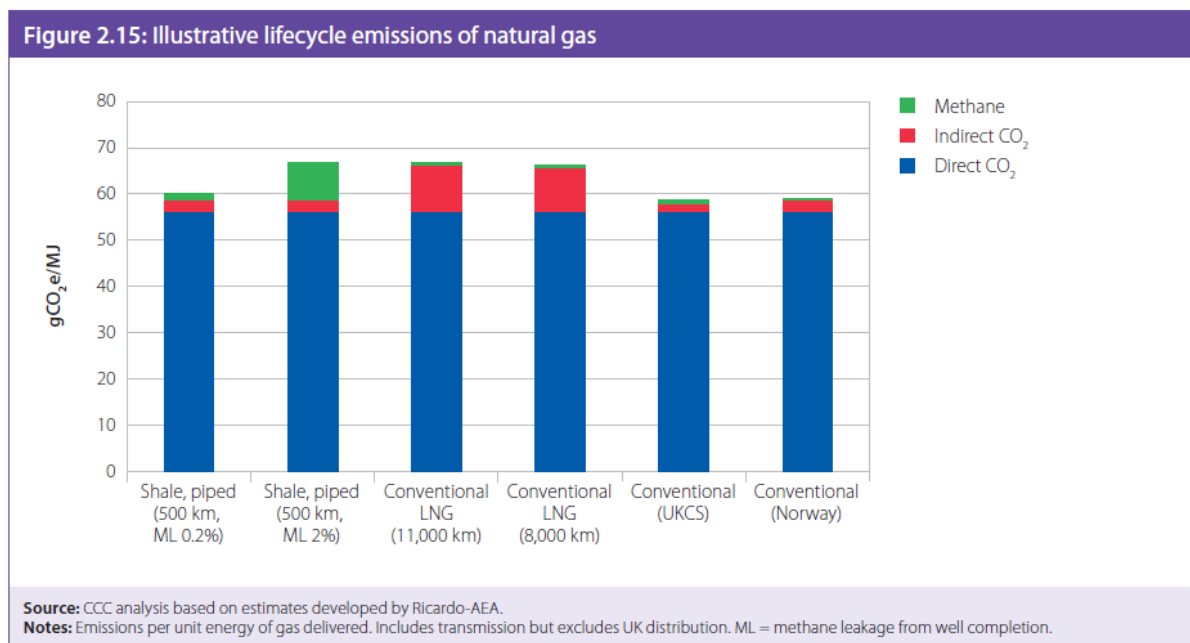
So if releasing a methane molecule is around 9x worse than burning it and releasing it as CO₂ then what does that mean for the overall footprint of shale gas? Well of course this depends on how much methane is escaping – this brings us to another thorny issue, which is that it's very difficult to ascertain such leakage rates.

Our report from earlier in 2013 on the UK's carbon footprint indicated that, leakage rates from shale gas production could be similar to those for conventional gas production, if appropriate regulations are in place to ensure measures to minimise methane release (e.g. 'green' completions). Of course if

these measures are not taken, as has been the case in some places where shale gas production has occurred, then leakage rates could be considerable.

But other fossil fuels have significant lifecycle emissions as well. The UK imports substantial quantities of liquefied natural gas (LNG), which has associated emissions caused by the energy needed to cool natural gas to -162°C so that it becomes a liquid, as well as some fuel required to ship the LNG from its source (e.g. Qatar) to the UK. Coal has much higher lifecycle emissions: not only does it release much more CO_2 per unit of energy than shale gas or LNG, but it also has large emissions in the rest of its fuel chain, both from methane leaks in coal mining and the amount of energy required to transport it.

The chart below – from our [report on the UK's carbon footprint](#) – compares UK shale gas production to other sources of natural gas, and indicates that even with a leakage rate below 2%, shale production in the UK would have lower emissions than those of imported LNG. So, at the margin, meeting a given amount of UK gas demand via domestic shale gas production could lead to slightly lower emissions than importing LNG.



For it to have higher lifecycle emissions than coal per unit of energy contained in the fuel, the methane leakage rate during shale gas production would need to exceed 11% – this is implausibly high even where regulation is lax, given the economic incentive to capture and sell the gas. This also doesn't account for the fact that gas-fired power generation is generally significantly more efficient than coal-fired, so for power generation the break-even methane leakage rate would be even higher.

Will gas prices fall or rise?

Although inherently uncertain, consensus projections suggest that even under optimistic assumptions about exploitation of shale gas reserves, UK and European gas prices are likely to go up rather than down:

- the [IEA Golden Rules for a Golden Age of Gas report](#) suggests that European gas prices will increase slightly by 2035 in a world with substantial unconventional gas or by around 30% without low unconventional gas production.
- [Navigant's report for DECC on the price impact of unconventional gas](#) has three scenarios: in the base case the 2030 gas price is at around the same level as that in 2012; in the high case prices increase by 20% over that period, while in the low case it falls by around 25%. In order to achieve the low case, it requires oil prices to fall significantly, the US and China also ramp up unconventional gas production and approve of export facilities, and that European shale gas production reaches 20% of EU demand by the early 2020s. Given the current lack of enthusiasm within Europe for shale gas production, this appears unlikely.
- [Pöyry](#) modelled the energy system of the UK and its interactions with North-West Europe. This modelling concluded that the impact of shale gas production in Lancashire would be to lower UK wholesale gas prices by 2-4% in the period to 2035.

UK gas prices would be relatively unaffected because we are part of a highly interconnected gas network with linked prices, spanning almost the whole of Europe, and connecting to neighbouring continents. For this reason it would take an extremely large amount of new low-cost gas production to enter the system in order to move European, and therefore UK, gas prices significantly.

This contrasts to the US experience, where the gas network is not well connected to other countries and where a surge of shale gas production therefore had a large downward impact on the price. There is also no guarantee that unconventional gas production in UK and across Europe will be anywhere near as low cost as in the US, given different geology as well as constraints relating to land use, public acceptability and environmental protection.

Given that prices are not likely to fall significantly, were costs of UK shale gas production to turn out relatively low it would make production profitable and would therefore lead to significant tax revenues. This contrasts to the US experience, where a glut of production depressed natural gas prices, driving out profits.

We will continue to need gas – the question is: UK shale gas or imports?

The need to meet our carbon targets necessarily means reducing the amount of fossil fuels we consume, both by reducing energy demand and switching to low-carbon energy sources. But this will happen at different speeds in different sectors. While we have consistently shown that virtual decarbonisation of the power sector by 2030 is a sensible strategy – based on renewables, nuclear and fossil CCS – the buildings and industry sectors will continue to use considerable, albeit declining, amounts of gas well into the 2030s.

Meanwhile, North Sea gas production is falling and our demand is increasingly being met by imports, both via pipelines (e.g. from Norway) and by shipping of liquefied natural gas (LNG, e.g. from Qatar). So while our gas consumption should fall over the coming decades, we will still have a considerable gap between production of North Sea gas and our total demand – this can either be met through imports or UK production of shale gas, or a combination of the two.

As outlined above, if anything using well-regulated UK shale gas to fill this gap could lead to lower overall lifecycle greenhouse gas emissions than continuing to import LNG. It would also increase the proportion of energy produced within the UK, improving our energy sovereignty.

Does shale gas mean a ‘dash for gas’?

In the debate around the potential for shale gas in the UK, people often equate UK shale gas production with expanded use of gas in the power sector. This is a flawed argument – natural gas is an energy source that is used in a range of sectors, so there need be no direct link between UK production and power sector consumption, especially while we remain a net importer of gas.

Expanded use of gas is not needed to drive coal from the power system, as most of the UK’s coal plants are already due to close under EU air quality regulations. The question is therefore how to replace the capacity (both coal and nuclear) that is due to close over the next decade or so.

As the Committee has set out in several reports, most recently in May’s [Next steps on Electricity Market Reform](#), in a decarbonising world with rising carbon prices the appropriate approach is to invest in low-carbon power generation. Assuming that it is proven to be technically and commercially viable, this will include the use of natural gas with CCS.

Our analysis shows that even if gas prices fall significantly, investing in low-carbon forms of electricity rather than unabated gas-fired generation will not cost us money. But if instead prices follow the central projections of the IEA and others, staying at today’s levels or rising modestly, investment in a portfolio of low-carbon generation would save around £25bn vs. pursuing a ‘dash for gas’ in the power sector, given a rising carbon price. And if gas prices are significantly higher than we expect, this saving rises to around £50bn.