



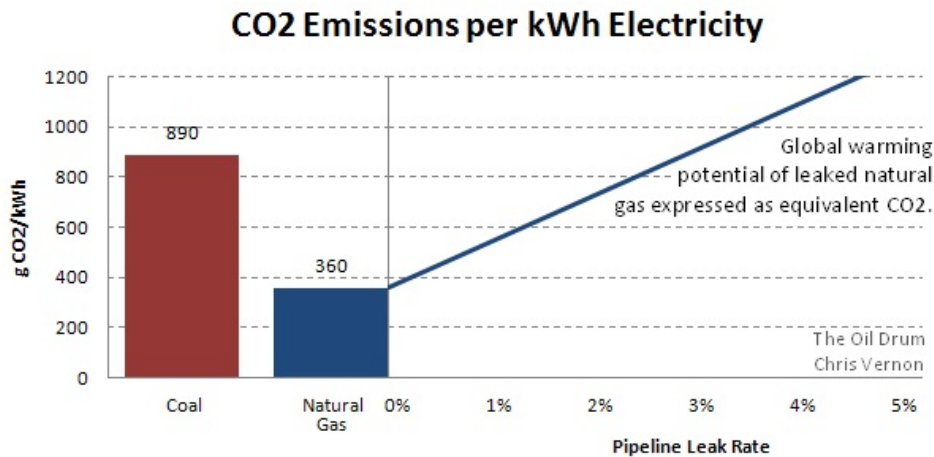
Natural gas, the green choice?

Posted by [Chris Vernon](#) on June 24, 2010 - 2:26pm in [The Oil Drum: Europe](#)

Topic: [Environment/Sustainability](#)

Tags: [carbon dioxide](#), [climate](#), [coal](#), [electricity generation](#), [gas](#), [gas pipelines](#) [[list all tags](#)]

Natural gas is regarded as a relatively environmentally friendly way of generating electricity. Gas burns cleanly without many of the problems associated with coal. Coal is a chemically complex substance. When it is burnt, it releases oxides of sulphur (SO_x) and nitrogen (NO_x), traces of mercury, selenium and arsenic, as well as particulates, and a non-combustible slag remains after burning. Coal mining is also a dirty and dangerous job. Coal emits considerably more CO₂ than natural gas per unit energy. However, natural gas (CH₄) itself is a potent greenhouse gas, and its release to the atmosphere without being burnt can quickly compensate for the CO₂ advantage against coal.



On the left, CO₂ emissions per kWh for coal and natural gas. On the right, the global warming potential of leaked CH₄ expressed as CO₂. With a leak rate of 3%, gas fired electricity has a similar global warming potential as coal.

Generating electricity from fossil fuels typically involves their combustion in large power stations. Due to the molecular differences of coal, oil and gas, different amounts of carbon dioxide are produced for each unit of thermal energy. For example, the [EIA tells us](#) coal (anthracite) releases 227 pounds of CO₂ per million BTU (or 351 g/kWh thermal), fuel oil or diesel 161 lb/MBTU (249 g/kWh) and natural gas releases 115 lb/MBTU (178 g/kWh). This, coupled with the variability in power station thermal efficiency leads to significant variations in the amount of CO₂/kWh of electricity emitted.

The figures below are for the UK electricity grid.

Carbon Dioxide Emissions

| Energy Source | g/k Wh |
|---------------|--------|
| Coal | 890 |
| Natural Gas | 360 |
| Nuclear | 0 |
| Renewables | 0 |
| Other | 530 |

Source: dti

This table was lifted from: <http://electricityinfo.org/co2emissions.php>

These CO₂ emissions are directly related to the fossil fuel combustion and power station efficiency. Lifecycle emissions are not included, leaving nuclear and renewables at zero, because emissions related to construction, decommissioning, uranium processing etc. are ignored. Natural gas is considered the 'greener' fuel as electricity from gas emits 2.5 times less CO₂ than coal, as well dramatically lower CO, NO_x and virtually no SO_x or particulates.

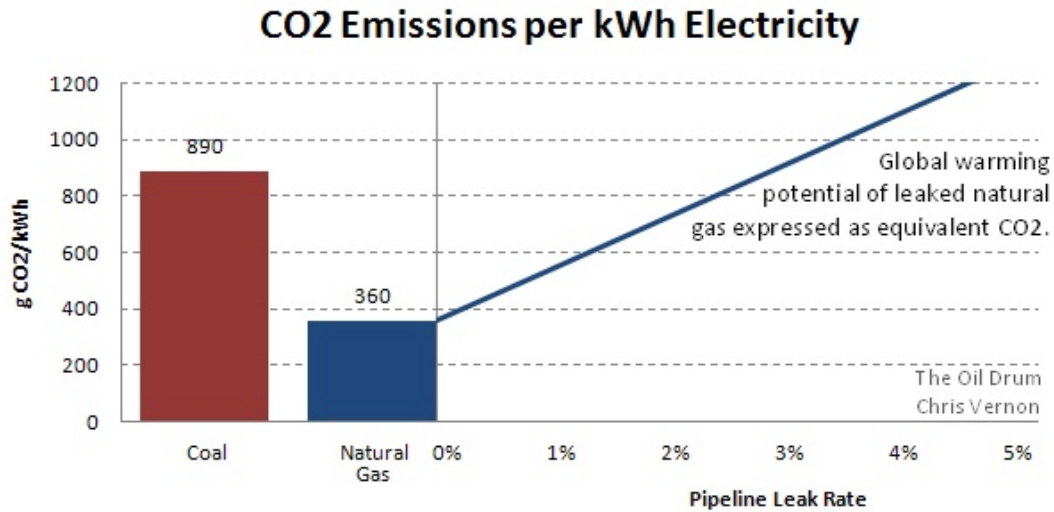
There is an issue of system boundaries here. The figures above only consider the power station and not any upstream supply system. While CH₄ may leak from the gas pipelines, there are also CH₄ releases from coal mines. For this post, let's consider emissions after the mine mouth or well head, and ignore emissions associated with transporting coal.

For oil and coal, the only significant route into the atmosphere is via combustion. However, besides being burnt, natural gas can be released without combustion as methane, CH₄. This becomes interesting when one considers both the impact of atmospheric emissions of CO₂ and CH₄. Both are greenhouse gases in that they that absorb and emit radiation within the thermal infrared range of the electromagnetic spectrum, however their respective radiative forcings are very different. The radiative forcing measures how much a greenhouse gas (or other factors) alters the balance of incoming and outgoing energy in the Earth-atmosphere system.

The Carbon Dioxide Information Analysis Center ([CDIAC](#)) part of the US Dept. of Energy uses Global Warming Potential (GWP), as it provides a simple measure of the radiative effects of emissions of various greenhouse gases, integrated over a specified time horizon and relative to an equal mass of CO₂ emissions. Over a common 100 year time horizon CDIAC state the global warming potential of CH₄ as 25 times greater than CO₂ [[link](#)]. The calculation is not trivial, and estimations do vary a little, but for this analysis the factor 25 is sufficient.

We saw above that natural gas emits 2.5 times less CO₂ than coal when used to generate electricity. However, when CH₄ is released to the atmosphere without first being combusted, the global warming potential is 25 times higher than CO₂. It is a more potent greenhouse gas. If only a little natural gas is released without being burnt, it will dominate the radiative forcing and more than compensate for the 2.5-fold advantage gas has over coal.

The chart illustrates this effect:



On the left, CO₂ emissions per kWh for coal and natural gas. On the right, the global warming potential of leaked CH₄ expressed as CO₂

If the natural gas leak rate is 3%, the global warming potential of a kilowatt-hour of electricity from gas is equivalent to coal.

Leak Rates

So what are pipeline leak rates? A [1997 US Environmental Protection Agency report](#) states US methane leak rates were 1.4 +/- 0.5 % in 1992. The largest source of leakage at that time was compressor components used in the processing, transmission, and storage, followed by the distribution network itself, with the small length of old cast iron pipes leaking disproportionately highly. The natural gas production process also contributes through millions of slowly leaking pneumatic control devices. A [larger study](#) carried out from 2005 by Brazil's largest gas distributor Comgas suggests cast iron pipe leak rates double the EPA study.

A [1990 study for Greenpeace](#) considered the UK distribution network then operated by British Gas. Greenpeace estimated low, medium and high scenario leakage rates of 1.9%, 5.3% and 10.8% respectively. This was in contrast to the 1% claimed by British Gas at the time. The authors were confident leakage rates were above 1.9%. These figures are likely obsolete today as there still existed a large amount of pre-1970 cast iron pipe work, much of it since replaced. In 1990 only 39% of the UK mains and 74% of the service pipes were plastic.

The 1.4% figure is also old, and only refers to the US, but it is a significant magnitude, it represents a 70% increase in global warming potential compared to the CO₂ alone and halves the CO₂ advantage gas has over coal based on the 360 and 890 g/kWh figures above.

Whilst these figures do not tip gas beyond coal, they halve its advantage. They are also only national. For the US this is quite understandable, but for the UK and Europe, the gas system is changing. Could leak rates become important as natural gas supply routes become longer? As Europe increases its reliance on Russia, as previously stranded gas is brought to market through longer pipelines than before, as a larger number of smaller deposits are exploited and as existing infrastructure ages, it seems likely that leak rates will increase. We often hear about struggles in the former Soviet states related to gas – is the leak rate there one percent or five? Is it economically feasible for the pipeline operator to make investments to stem the last percentage point of a system's leaks?

Is it possible that a 'green' gas power station in the UK is making a greater contribution to global

Does anyone have recent data on leakage rates, especially for Russia and Eastern Europe?



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