Methane matters
Is the future electric?

Richard Keech critically examines the sustainability of gas.

I'VE heard it said that 50% of what we've learnt is probably wrong; the trick is knowing which 50%. I submit that the received wisdom that gas is a clean fuel is probably wrong.

Consider more generally the burning of materials for their direct energy content. The use of wood, then coal, then oil and gas has underpinned the entire arc of human progress and achievement. But the advent of electricity meant much of that combustion no longer took place with the end user. At a time when renewable energy sources such as solar thermal, solar PV and wind can displace increasingly large amounts of that burning, why are we still persisting with policies that favour the burning of gas?

Perverse policies

At present in Australia fossil methane gas provides about 25% of all the energy to homes and business. It is generally viewed favourably as a safe, cheap and clean fuel.

That prevailing view of gas is influencing environmental policy. For example, various state rebates favour gas hot water units. This is based on the idea that gas produces fewer carbon emissions than the coal-fired electricity required for an equivalent electric hot water system.

But the electricity for a hot water system does not have to come from coal. Although it is still true that most of our mains electricity does come from coal, retail electricity customers have the option to source their power from renewable sources.

A policy that penalises hot water services because of the upstream deficiencies at the generator is perverse; in fact, the lowest emissions way of heating water is to use electric hot water with zero-emission electricity.

Gas vs coal emissions

The direct emissions from burning gas are about half those of burning brown coal. The problem here is that 50% fewer direct emissions does not equal low emissions—and arguably hinders the push to the level of long-term emission reductions that we need. The direct emissions from burning gas are about 51 kg CO_2/GJ—still a high value in absolute terms.

Per unit of energy delivered, the emissions associated with gas are increasing as conventional gas reserves are depleted and unconventional forms of gas such as coal-seam gas and shale gas are brought into production. Emissions from ageing conventional reserves are also going up. In these reserves, it is necessary to actively compress where previously the gas came out under its own pressure. In addition, extra processing of the gas stream is required as progressively lower quality reserves are tapped, with entrapped CO_2 separated and vented to the atmosphere.

Fugitive emissions

Combustion emissions are not the only emissions associated with gas. The net emissions are also influenced by leakage, or 'fugitive' emissions. Two main factors influence the calculation of emissions from the leakage of gas: a) the global warming potential (GWP) of methane, and b) the rate of leakage of methane in gas production, processing, distribution and consumption.

Warming contribution of methane

The warming contribution (or GWP) of atmospheric agents other than CO_2 are significant, and dealing with them has been called the 'second front in the climate war'. It is estimated that methane has contributed about 30% of total human-caused warming since 1750.

As shown in Table 1, official estimates of the GWP of methane, stated relative to the effect of CO_2, have increased over time. Because different warming gases last different times in the atmosphere, it is customary for both 20-year and 100-year GWPs to be cited.

So which GWP figure to use? The current Australian government guidelines still use the older value of 21. Given the increasingly compressed timeframe for effective action in reducing emissions, the use of the 100-year GWP no longer seems appropriate. It is more reasonable to use a GWP timeframe consistent with the time remaining for mitigation efforts to be effective. The IPCC is soon to release an updated assessment. In the meantime, widely cited research by Shindell of NASA estimates the 20-year GWP as 105.

The other factor in Table 1 is the residence time: how long the gas lasts in the atmosphere. Methane has a stronger warming effect than CO_2, but a shorter residence time—about 12 years rather than centuries. Interestingly, because of this, the benefits of reduction in methane will be felt more quickly than reductions in CO_2.

Production leakage rates

The current Australian standard method for calculation of methane production leakage rates uses an assumed leakage rate of 0.12%.

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Assessment	20-year GWP	100-year GWP	Residence time (years)
IPCC, 1992	63	21	10
IPCC, 2001	62	23	12
IPCC, 2007	72	25	12
Shindell et al, 2009	105	33	12

Table 1. Emerging understanding of the global warming potential (GWP) of methane.

Numerous recent studies suggest that fugitive emissions are much greater than 0.12%. The US EPA puts leakage in 2009 at 2.4%; other studies show higher leakage, around 4% to 9%.

In Australia, a study of the literature on fugitive emissions was conducted by Pitt & Sherry in 2012. This compares numerous studies which are consistent with a leakage rate of much higher than 0.12%.

A study by Hardisty et al suggests that "if methane leakage approaches the elevated levels recently reported in some US gas fields (circa 4% of gas production) and assuming a 20-year methane GWP, the GHG intensity of CSG-LNG (coal-seam gas liquid natural gas) generation is on a par with sub-critical coal-fired generation." In other words, it may be that the emissions situation for gas is actually no better than for coal-fired power.

Distribution leakage

Leakage also occurs in the domestic gas distribution network of pipes, meters and other reticulation equipment. Harrison et al, in the USA, measured about 75% of total fugitive gas emissions to be downstream of the initial production. A 2013 study from New York City concludes leakage exceeds 5%. Data from Adelaide suggests rates of lost gas as high as 7.8%. Current official estimates from the Australian government put gas distribution leakage factors, depending on state, at around 1.5%. A study from Sydney in the 1990s inferred leakage rates greater than 10%. A realistic estimate is likely to be somewhere in between these estimates.

My own calculations suggest that the effect of gas leakage exceeds emissions from combustion when the system-wide leakage rate is above 3.3%, assuming a GWP of 87. The literature suggests that the actual leakage rate is probably in the range of 5% to 7.5%. So, gas leakage could more than double the emissions effect of simply burning the gas.

Other issues with gas

The Australian domestic gas market has historically been isolated from world-parity pricing. This ceases in anticipation of the Gladstone LNG export terminal opening in 2014, exposing Australian consumers to significantly tighter and less stable market conditions. For the consumer this means higher prices and price volatility.

A 2012 study by Bloomberg reports that life-cycle costs of new wind and PV generation is already cheaper than new gas for large-scale generation. Under business as usual, there is every possibility that gas supply will be highly contested in 20 years time.

Gas in and around our buildings is a hazard because of toxicity and flammability issues. According to the Gas Regulators Technical Committee, "Carbon monoxide is a silent killer and is the major cause of gas-related deaths and chronic illnesses throughout the world." The combustion by-products of gas include nitrous oxides, carbon monoxide, carbon dioxide (CO_2) and sulphur oxides, which can have direct effects on respiratory and cardiovascular health. Poorly maintained gas heaters can be fatal.

Methane can be synthesised from a wide variety of bio-waste streams such as sewage, landfill waste and agricultural residues; this is sometimes called biogas. In special cases it makes sense to generate and use biogas onsite, for example, for power generation in piggeries and feedlots. It also makes sense to tap landfill gas.

However, there is insufficient capacity in Australia to substantially displace current usage of fossil gas with biogas. These carbon-rich waste streams will have several higher-value uses such as in industrial feedstock, for liquid transportation fuels and carbon sequestration initiatives.

The future is electric

In a gas-free future, energy services could instead be provided by efficient electric appliances. In the case of hot water, aside from solar systems, there are now heat pump units that work in all climate zones and use less than half the energy of an equivalent resistive electric unit. For cooking, the new generation of induction electric cooktops provide efficient and responsive cooking. For space heating, efficient heat-pump split systems can provide both heating and cooling by exploiting abundant ambient heat energy.

Is there enough clean electricity to make up the energy shortfall were we to phase out gas? Based on what I know about the potential of energy efficiency and the readiness of renewables to supply baseload, I'm confident that with sufficient consumer demand and government support, we'll see abundant clean power come on stream as users disconnect from gas.

Time to 'reinvent fire'

The present-day widespread use of gas as a fuel in buildings is a legacy of questionable value. The trend of green buildings using gas to attempt to reduce their emissions is worrying and is distracting the green building movement from real sustainable solutions.

A century ago it was commonplace to get light from burning gas or kerosene. Today we accept that we no longer have to burn stuff directly to get light. Perhaps it is time for our remaining use of gas in buildings to go the same way.

The burning of materials for the chemical energy they contain will one day, I hope, seem odd. In the words of American energy guru Amory Lovins, we are "reinventing fire". ✱

This article is based on work that forms part of the *Zero Carbon Australia Buildings Plan* from Beyond Zero Emissions. bze.org.au/buildings.