GAS AS A TRANSITION FUEL?

A fact sheet compiled by David McKirdy and Tony Hill

Royal Society of NSW

Ray Strange/AAP

What is natural gas?
Natural gas is a mixture of methane and lesser amounts of other hydrocarbons (ethane, propane, butane & pentane), the so-called wet gas components or natural gas liquids (NGL). Also present in varying concentrations are heavier hydrocarbons, together with other gases such as carbon dioxide, nitrogen, hydrogen sulphide and helium. It is formed by the bacterial decay (biogenic) and thermal alteration (thermogenic) of dead organic matter. Liquefied natural gas (LNG) is natural gas that is cooled and compressed until it becomes a liquid suitable for transport in tankers to export markets [1].

Where is it found?
Conventional gas is found, commonly associated with oil, in underground permeable sandstone reservoirs from which it is extracted using traditional drilling techniques. ***Unconventional gas*** is more difficult to extract, occurring in coal seams up to 1 km below the surface; in more deeply buried shales; in low quality reservoirs (tight gas); and as methane hydrates in Arctic permafrost and sediments on the deep ocean floor [1, 2].

Natural gas is Australia's third largest energy resource after coal and uranium. Conventional gas resources are widespread onshore and offshore, occurring in fourteen different basins, but most of the resource is off the north-west margin in the Bonaparte, Browse and Carnarvon basins [1]. Australian natural gas fields on average contain 6.6% CO_2, but in provinces such as the Otway and Cooper/Eromanga basins the levels may be much higher (up to 98%) [3].

Greenhouse properties
Methane, the principal component of natural gas, is a potent short-lived greenhouse gas (GHG). It is 34 times stronger than CO_2 at trapping heat over a 100-year period and 86 times stronger over 20 years [4]. Upon combustion in a gas-fuelled power plant or vehicle, or when flared from a production well, it is converted back to CO_2 and water vapour, the primary greenhouse gases, that are then released to the atmosphere. This CO_2 can be distinguished from pre-industrial atmospheric CO_2 by its lighter carbon isotopic signature [5].

Environmental impacts
Natural gas emits 50–60% less CO_2 when combusted in a new, efficient natural gas power plant compared with emissions from a typical new coal plant. When burned in a typical vehicle it also emits 15–20% less heat-trapping gases than gasoline and diesel [4]. However, vehicle exhausts and emissions from smokestacks are only part of the story.

The drilling and extraction of natural gas from wells and its transportation in pipelines results in the leakage of methane. These so-called "fugitive" emissions amount to 1–9% of total life cycle emissions. Methane losses must be kept below 3.2% for natural gas power plants to have lower emissions than new coal plants. And if burning natural gas in vehicles is to deliver even marginal benefits, methane losses must be kept below 1.6% [4].

Natural gas becomes less attractive as an alternative to coal when it is realised that the benefits of lower emissions from its combustion are negated by methane leakage along the gas supply chain [6]. The assumption that natural gas is a climate friendly fuel is diminished every day as methane levels in the atmosphere increase substantially, with a large portion attributed to natural gas leakage [7]. Globally, this leakage during the extraction, storage, transportation, and distribution of oil and natural gas was estimated to account for 33% of the total anthropogenic methane emissions by 2020 [8, 9].

The requirement for emission reductions in Australia will be harder to accomplish as more coal seam and shale gas resources are developed, necessitating far greater numbers of wells per unit area than conventional gas fields. Examples include the Narrabri coal seam gas project in NSW, where 850 wells are planned [10], and the Beetaloo Sub-basin shale gas deposit in the Northern Territory [11, 12].

Other potentially significant environmental impacts of unconventional gas development include the health risks to nearby communities posed by contamination of ground and surface water with the chemicals used in drilling and hydraulic fracturing, and by the disposal of wastewater [13, 14]. The use of gas for heating and cooking in households and classrooms can trigger asthma in children and increase the risk of respiratory illness and carbon monoxide poisoning [15].

The vast volumes of water used in unconventional gas development also raise water-availability concerns, including the diminution of surface water for local agriculture because of the lowering of groundwater levels. Unlike other energy-related water withdrawals, which are commonly returned to rivers and lakes, most of the water used for unconventional gas development is not recoverable [2]. A single well with horizontal drilling can require 11 to 45 million litres of water when it is first fractured — dozens of times more than what is used in conventional vertical wells. Similar volumes of water are needed each time a well undergoes additional fracturing to maintain well pressure and gas production. A typical shale gas well will have about two work overs during its productive life span [2]. The disposal of fracking wastewater by pumping it at high pressure into deep injection wells can trigger significant earthquakes [16].

Do we need more supply?

Natural gas is being touted as the ideal transition fuel for the electricity sector, replacing coal's higher greenhouse gas emissions and acting as a bridge to an emissions-free, renewable energy future. However, according to the Australian Energy Market Operator (AEMO), demand for gas-powered generation has fallen by 41% since 2014 [17].

Another justification for the opening up of more gas fields in Australia is that it will result in cheaper prices. This ignores the fact that while gas supply on the east coast of Australia has increased threefold since 2014 (primarily for export), domestic gas prices have also tripled. Gas prices are fixed by the industry at levels far in excess of international parity prices. As a result, gas has already become an uncompetitive fuel source for power generation in Australia [17].

There are considerable as-yet-untapped conventional gas resources in Australia [1, 3], so it's more a case of the economics of getting this gas to market (and the associated environmental impacts), rather than of exploring for yet more gas.

Natural gas a feedstock for hydrogen production

In many decarbonisation scenarios, hydrogen is seen as a clean alternative fuel for use in heating, industry, and transport [18, 19]. Most hydrogen is currently manufactured from fossil fuels via the gasification of coal ("brown hydrogen") and the reforming of natural gas ("grey hydrogen"). Both processes generate CO_2 as a by-product. When combined with carbon capture and storage (CCS), the latter process produces "blue hydrogen". An alternative process, the electrolytic splitting of water, yields "green hydrogen", the ultimate clean energy resource. However, its production requires a lot of energy. The carbon footprint of hydrogen from electrolysis largely depends on the source of electricity used. Only low-carbon electricity such as hydro or wind power will result in a substantial reduction of GHG emissions compared to hydrogen from natural gas reforming [20]. Given the increased scale and lower costs of renewables, along with the higher costs of brown, grey and blue hydrogen production, green or low-carbon hydrogen is predicted to become economically competitive by 2040 [19].

Carbon capture and storage

In belated acknowledgement of the major role GHG emissions from the extraction and combustion of fossil fuels play in global warming, government and its industry backers are now actively promoting CCS as a technological fix [21]. However, the fact remains that CCS is yet to be proved physically and economically viable as a means of reducing emissions from fossil fuel power generation on a scale necessary to halt this warming [22]. First shown to be technically feasible in 1996, less than a fifth of CCS capacity under development in 2010 was operational by 2019. The technology remains expensive and niche, capturing only around 0.1% of global emissions [23]. Moreover, the addition of CCS to existing power plants is only an option when the adjacent subsurface geology is suitable to accommodate and retain the captured CO_2. This is rarely the case.

Australia's only CCS facility, and the world's largest, is sited on Barrow Island. Designed to remove and store the CO_2 in the natural gas being produced from Chevron's giant offshore Gorgon and Jansz-Io fields, it has been plagued by technical difficulties ever since it came on stream in 2016. In January 2021, it was still not fully operational; and even when it is, it will be sequestering only 40% of the gas plant's CO_2 emissions [21]. The remainder, around 5 million tonnes of CO_2 annually, are vented to the atmosphere.

After just three years in operation, the USA's flagship CCS project located at the Petra Nova power generation facility in Texas, was mothballed in 2020 because of its poor financial performance [23, 24]. It comprised a CCS facility retrofitted to a coal-fired power plant. The captured CO_2, amounting to only 33% of the total emissions from the plant's boiler, was compressed and piped 132 km to the West Ranch Oil Field where it was pumped back into the reservoir to enhance the recovery of oil. The nett result: more fossil fuel!

According to the Climate Council's energy expert, Greg Bourne, CCS "is not a climate solution, but an expensive attempt to prolong the role of fossil fuels in the energy system" [21].

Will we always have a partial need for gas?

In his Quarterly Essay, *Getting to Zero - Australia's Energy Transition*, our nation's former Chief Scientist Alan Finkel states: "Electricity from renewable energy (and in some countries from nuclear) will eventually completely replace all three fossil fuels as energy sources. Oil and natural gas will likely remain as chemical feedstocks in some manufacturing, but their use as a fuel will fade into obsolescence. ... [although] some residual peaking gas might still be used to make up for [power] shortages for a small number of hours per year" [18].

Conclusion

Natural gas is a large source of greenhouse gas when combusted, but also in the form of fugitive emissions during its extraction, processing, and transport. These emissions are not being correctly reported or accounted for, but nonetheless contribute to global warming.

The International Energy Agency (IEA), for almost 50 years the leading proponent of fossil fuels, has now changed its tune [25]. Its latest report states that for the world to reach net zero emissions by 2050, our reliance on fossil fuels must end, and much more quickly than previously thought [26]. In the words of Fatih Birol, the IEA's executive director: "If governments are serious about the climate crisis, there can be no new investments in oil, gas and coal, from now – from this year" [27].

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Authors

The authors of this fact sheet are retired fossil fuel geologists with decades of experience working in government, industry, and academia:

David McKirdy, Associate Professor (retired) and currently Honorary Visiting Research Fellow, Department of Earth Sciences, University of Adelaide.

Tony Hill, recently retired as Deputy Director of the Geoscience & Exploration Branch within the Energy Resources Division of the SA Department of Energy & Mining.