Members of the Independent Scientific Panel Inquiry into Hydraulic Fracture Stimulation in WA

Herewith my submission into the inquiry

Peter Lane

[redacted]

"Where will we get our energy from?"

The terms of reference of the enquiry, in summary are to assess *"the environmental values potentially at risk from unconventional oil and gas developments involving hydraulic fracture stimulation"*. Each technical method of producing energy has very different characteristics, and each presents a greater or lesser risk of causing damage to our environment. To consider the potential impact of one technology in isolation would be a futile exercise. I consider it imperative that the environmental risks associated with hydraulic fracture stimulation (fracking) must be considered in the wider sense, that is the attributes, failings and risks of fracking being weighed against other methods of producing energy. It is also a premise, that an (un-stated) aim of the Committee is not to materially negatively affect the supply, reliability or cost of energy to the state.

While making no pretence of being definitive in assessing the potential environmental impacts and other aspects (e.g. reliability) various technologies present, this submission is an attempt to address the wider issue of how to meet our demand for energy.

The advantages of natural gas as a fuel for power generation

Of the fossil fuels, natural gas is the most efficient and the least polluting.

1) When burnt, natural gas (methane, CH_4) emits CO_2 and H_2O.[i]

   Coals vary. Western Australian Collie coal is 'black coal', but for this quality coal, it is low in carbon (generally about 76% C)[ii] and high in sulphur and ash. On burning, Collie coal emits CO_2, SO_2, NO_X, heavy metals, metallic compounds and considerable ash remains.

2) Gas fired power stations can be switched on/off. A 500MW Combined Cycle gas power plant can be at full power in under 25 minutes and can be switched off instantly. This makes gas a unique complementary fuel to carbon-free alternatives (solar, wind, wave). This ability to respond to demand materially improves both its efficiency and environmental impact compared to coal[iii].

3) For many industrial and domestic purposes natural gas can be used as a direct fuel (e.g. cooking, water heating and a range of industrial purposes), and depending on location and infrastructure, this can be significantly more efficient than using gas for power generation.

4) While carbon-free alternatives supported by batteries are making inroads, they do not yet present a viable option for base load power generation.

For the above reasons, natural gas is clearly the preferred fuel for base-load and peak-load power generation, and, excluding transport, for direct burning.

Detriments of mining Collie coal

Collie coal fired power stations total 2557 MW of the state's generating capacity, and carbon-free alternative generating capacity (solar, wind, hydro – eg Ord River) amounts to only 444 MW.[iv] As well, alternative power generation is site dependent, and on average generates considerably less than 12 hours/day. While every effort must be made to increase carbon-free generation, for the foreseeable future gas is the only viable alternative to coal. For these reasons the environmental impacts of mining coal need to be considered.

Below, in general terms, I refer to these impacts:

1) Collectively, Collie coal mines have licences to extract 49 gigalitres/year (GL/y) of groundwater[v]. Over a decade this would be the equivalent of one Sydney Harbour of water. Licences for a further 17.5 GL/y groundwater extraction have been issued for power generation. The radius of drawdown within the aquifer from this combined extraction probably exceeds 50 kilometres.

2) While some extracted groundwater is stored in mine voids and ponds and a small amount diverted to power generation, most is discharged into the East and South Branches of the Collie River. Many of these discharge sites are heavily polluted, the water being acidic and containing quantities of arsenic, lead and mercury which far exceed health standards. Many of these areas are now ecologically 'dead'.

3) Underground mining has caused cracking and ground surface movement, while the visual impact and loss of natural and man-made assets due to open-cut mining is all too apparent. To these environmental impacts, add noise and, at times, dust.

4) As referred to above, for the amount of energy produced, CO_2 emissions from coal fired power stations far exceed those of natural gas-powered stations, and as gas has the ability to meet both base load and intermittent demand, gas CO_2 emissions can be further and significantly reduced, at the same time achieving greater efficiency.

5) The health impacts of mining and burning coal have largely been ignored. A recent report concluded that in the EU dust from coal-fired power plants claims some 23,000 lives and causes more than half-a-million asthma attacks in children a year, as well absence from work amounted to 32.4 billion to 62.3 billion euros a year.[vi]

Fracking ban in the South-West

I refer to this ban, as I consider it was put in place for no other but political expediency. My reasons for coming to this conclusion are detailed in footnote[vii] and[viii] which explain why it is difficult to imagine there could be any potential for fracking in the south-west.

Impact of fracking and loss of casing and cement bond integrity

There are many studies showing fracking is a risk to ground and even surface water and just as many showing that it is not. The impact of fracking cannot be generalised; there are places where it presents minimal risk, and many where the risk is high, this being dependent on the geology of the area. Fracking for CSG (refer footnote [vii], there is no potential for CSG in WA), specifically towards the eastern edge of the Surat Basin where the coal seams are shallow, thin, discontinuous, faulted and often adjacent to aquifers,[ix]is an example of where fracking presents a high risk to aquifers.[x] Similarly, fracking for shale gas in shallow formations has been demonstrated to be of unwarranted risk, an instance being around Fort Worth, Texas, where gas in water wells was found to originate from the shallow Strawn Formation, rather than the deeper and historically productive Barnett Shale.[xi]

The geology, specifically depth of reservoir, reservoir and seal lithology, reservoir relationship to aquifers and structural regime, of each area is a fundamental in assessing the risk oil-field operations pose to the environment, yet a number of oft-referred to studies make no mention of the geology.[xii]

Of the numerous studies, arguably that of the Academy of Medicine, Engineering and Science of Texas is one of the most current, objective and reputable. It found fracking has not contaminated groundwater in Texas,[xiii] (albeit, this appears to be in contradiction to the results of contamination from the shallow Strawn Formation, near Fort Worth, above).

There is evidence that fracking has triggered earthquakes, Fox Creek oil and gas field[xiv] close to the Rocky Mountain foothills, Alberta being an example of earthquakes being attributed to fracking. However, it has been in Oklahoma where earthquake activity has rapidly increased. The US Geological Survey has concluded it has been the disposal of formation water, and not fracking, that has triggered earthquakes. They have been triggered by this water, produced primarily from oil wells and in volume more than ten times the amount of water used in used in fracking operations, being injected into deep reservoirs close to faults. [xv]

I am confident that those better qualified will make adequate comment on the risks associated with casing and cement integrity and the WA regulatory regime in respect of these aspects.

Other environmental and community concerns

Again, I will not dwell on these. Suffice to state that disposal of recovered fracking fluids is likely to be a contentious environmental and possibly community issue, but one that is very much dependent on local conditions and for operators to engineer and resolve under State regulations. I have no doubt that the nature and handling of chemicals used in fracking will be critically addressed, whereas the wider issue of land access and use is, I understand, beyond your terms of reference.

I must also add (as a generality, but nevertheless a truism), that provided good engineering practices are followed, in meeting the domestic demand, gas produced from either fracked or conventional fields onshore poses a far lesser environmental risk than gas produced from offshore fields.

Of interest, in 2016 almost two thirds of the oil and gas wells drilled in the US were horizontal and fracked.[xvi]

No conflict of interest

I hold no shares, nor do I have any financial or commercial relationship with any corporation which may have an interest in the outcome of this enquiry.

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[i] If present, ethane (C_2H_6) may be burnt with methane, while heavier hydrocarbons are generally stripped from the gas stream. Some natural gasses contain trace sulphur and/or nitrogen.

[iiii] Eastern states' coal ranges from about 81% to 91% C, Galilee Basin coals being the exception at < 80% C.

[iii] National Bureau of Economic Research, Euro-Mediterranean Centre on Climate Change and other institutions, July 2016, found: "A study of 26 countries showed that as renewables lacked economically viable storage options, renewable energy integration with fast-reacting fossil-based technologies* acting as back-up results in a greater increase in renewable in the long run than renewables alone." http://www.nber.org/papers/w22454

*natural gas, specifically combined-cycle power plants.

[iv] https://en.wikipedia.org/wiki/List_of_power_stations_in_Western_Australia

[v] Upper Collie Water Management Plan, Issue Scoping Report, Beckwith Environmental Planning Pty Ltd Prepared for Department of Water, Government of Western Australia, June 2007 (note, I have searched but have been unable to find a more recent water management plan).

[vi] http://env-health.org/policies/climate-and-energy/europe-s-dark-cloud/

[vii]

1) Shale gas. Up to 90% of the world's fracking occurs in marine shales ('shale gas'). Sediments in the SW with potential for hydrocarbons range from early Permian in age, however there is are no marine sequences and no possibility of the presence marine shales being present. There is no shale gas potential in the SW.
2) Coal seam gas (CSG). Most fracking in Australia is for extraction of CSG (I have not been able to find the number of wells fracked, but it appears to be well below 50%[vii]). Gas in coal seams is trapped in both the molecular structure and in pore space of coals, and is released by lowering the pressure within the seam, this being achieved by de-watering the seams. Being thin, horizontally unpredictably discontinuous, often faulted, closely related to aquifers and at shallow depth, these operations pose a distinct risk to both ground and surface water. In Queensland, 2015-16, for the production of 145 petajoules (PJ) of CSG, 60 GL of groundwater was extracted.[vii] As well, due to well drainage areas being relatively small and horizontal drilling at shallow depths being unviable, well spacing is dense. Surface impact of CSG infrastructure is severe, and although substantially different to both conventional and other unconventional gas production projects, much of the opposition to onshore gas development in WA, conventional or not, is based on CSG experiences, primarily in Queensland.
   Lower Permian Sue Group coal measures within the Bunbury Trough of WA have been found to be water wet, test wells on the Vasse Shelf maintaining constant water flow with no gas[vii] and there is ample evidence of hydraulic connectivity between the coal measures and the overlying Leederville aquifer (refer footnote vii) Within the trough proper, coal seams are at depths and of such low permeability[vii] that they would not be viable for CSG production. There is no potential for CSG in the SW, and the Department of Mines, Industry Regulation and Safety consider the state of WA has no potential for CSG (DMR presentation to Augusta Margaret River Shire Council).
3) Fracking was developed to improve gas and oil production rates and recoverability from low permeability (tight) sandstones. Within the SW, Lower Permian gas reservoirs discovered at Whicher Range have been extensively evaluated and best represent the nature of the (lack of) potential for fracking in the SW. The reservoirs are tight sandstones, yet they have been unresponsive to fracking. There are a number of reasons why this is so and why conventional flow rates have been less than commercial:

- The individual sandstone reservoirs are relatively thin, and having been deposited in a fluviatile environment are very likely discontinuous. This alone means the drainage area of each well is small, and gas flow rates rapidly decline.
- The sandstones contain a clay which swells in contact with water and is probably mobile when pressure is reduced. Both of these responses block pore spaces and greatly reduce gas flow.

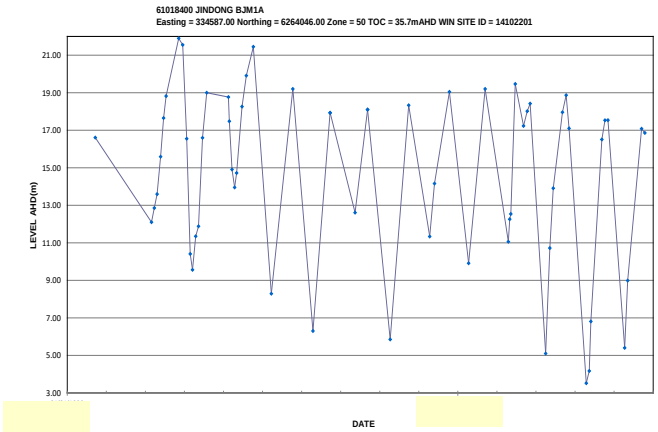
- The area is faulted and there is a strong likelihood of there being minor faulting undetectable by seismic. With these thin sandstones, gas reservoirs are more than likely to be juxtaposed across a fault against non-reservoir rocks, again reducing drainage area.
- Clays within the sandstones are very likely smeared on fault planes, resulting in permeability barriers and further reducing drainage areas.
- In parts of the field there are dolerite sills[vii] which have metamorphosed reservoir sands, making them impermeable, yet again reducing flow rates and reservoir extent. The presence of these sills is not predictable.

The lack of reservoir horizontal continuity has been verified in the 2106 WR-4 long-term test. The flow rate was low (apparently less than commercial) and declining, and I have been advised there was no pressure decline observed in a well only some 400m away, ie confirming that the horizontal extent of the reservoirs was very limited.

In view of the above points 1 to 3, it can only be concluded that there is no, or at very best absolute minimal, potential for fracking in the SW. Acknowledging the SW is an ill-defined area, the government ban on fracking will, and indeed can have no effect on activities.

[viii]

Hydrograph of Sue Group monitoring bore demonstrating hydraulic connectivity to Leederville aquifer



[ix] Also refer http://tamest.org/wp-content/uploads/2017/07/Final-Shale-Task-Force-Report.pdf. "This low likelihood (of aquifer contamination) can be contrasted with oil and gas production in some areas outside of Texas, such as from coalbed methane or in shallow formations, where fracturing may be sufficiently close to potential water sources to be of concern."

[xxxx] "Lock the Gate" have a formatted email submission form for objectors to fracking to sign. Although I respect their argument for greater rights in respect of property, the "scientific" argument Lock the Gate puts against fracking is based heavily on the Queensland CSG experience and is irrelevant. This is the formatted email (of which you will no doubt have received numerous copies), irrelevant portions highlighted:

- Unconventional gas mining and fracking is harmful to health. Communities living near gasfields in Queensland and the USA have reported serious health effects following the commencement of unconventional gas operations. These conditions include respiratory ailments, nose throat and eye irritations and neurological illnesses.

- Water and chemical use and wastewater production from fracking places WA's vital water resources at risk from contamination and depletion. Our state is one of the driest places on earth and climate change is already leading to decreased rainfall in southern WA. Our land and environment are under growing pressure from a lack of fresh water. We cannot afford to put our precious groundwater at risk for a short term and unnecessary fracking industry.

- Landholders and Traditional Owners don't have the right to refuse access to oil and gas companies in WA. This creates stress and leaves individuals and communities worried about their financial security and their ability to farm their land. The cards are stacked unfairly in favour of the gas industry and human rights are being ignored for a resource that is no longer strategically vital as it can be replaced by renewable forms of energy generation.

- Research into the economic and social impacts of the unconventional gas industry in Queensland has shown that the industry has led to a reduction in community well-being and social cohesion. It also caused a deterioration in local skills and infrastructure; few additional local job opportunities; and limited economic benefit to the wider economy.

- Unconventional gasfields in Queensland have seen reductions in farm productivity, efficiency, land values and credit availability to landholders.

- Fracking leads to large deliberate and fugitive emissions of methane, adding to climate change.

I urge the inquiry to make a recommendation to permanently ban fracking and all unconventional gas mining in Western Australia.

[xi] https://en.wikipedia.org/wiki/Barnett_Shale#frb-inline

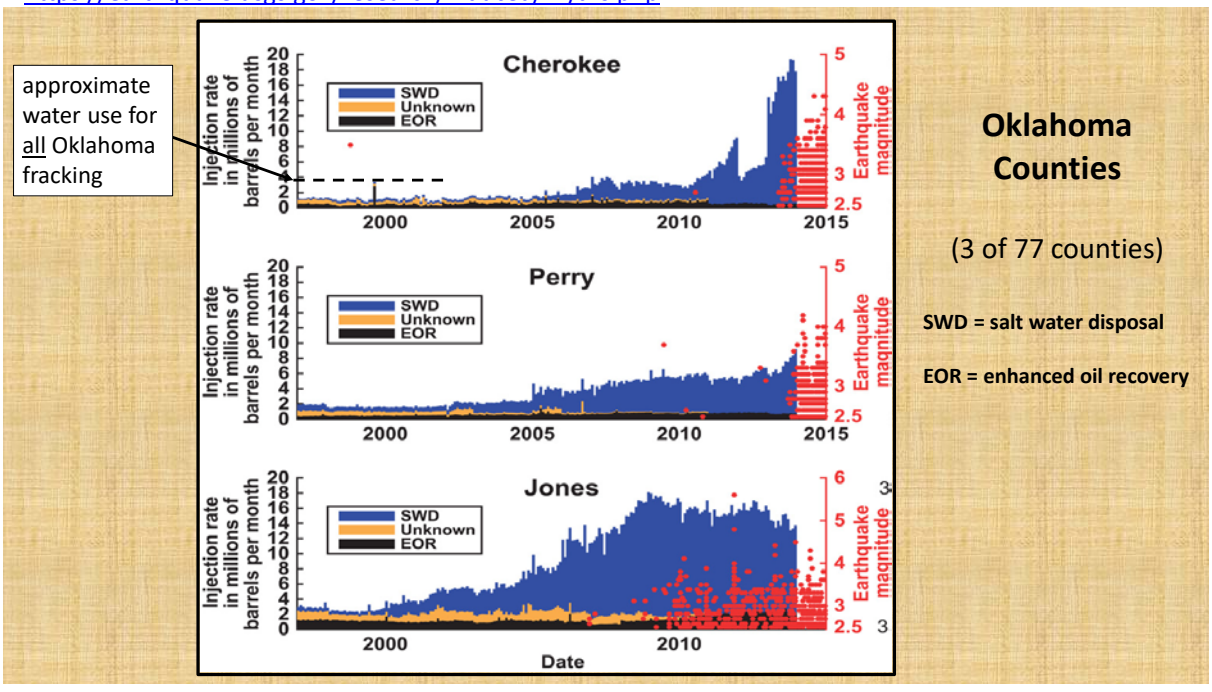
[xii] A study often referred to is that of Bachu and Watson in respect of the number of 'casing' failures in old well (gas leaks due to loss of cement bond integrity) in the Zama Oil Field of northern Alberta. As I had worked on this field, I found this study of particular interest, but was left no less than astounded that no mention was made of the lithology of the producing zone. This interval, the Zama Member of the Keg River Formation, is an exhumed carbonate reef, dolomitised and vuggy, a lithology difficult and at times impossible to achieve a cement bond.

https://www.researchgate.net/publication/254528166_Identification_of_Wells_With_High_CO2Leakage_Potential_in_Mature_Oil_Fields_Developed_for_CO2Enhanced_Oil_Recovery

[xiii] http://tamest.org/wp-content/uploads/2017/07/Final-Shale-Task-Force-Report.pdf. "The depth separation between oil-bearing zones and drinking water bearing zones in Texas makes direct fracturing into drinking water zones unlikely, and it has not been observed in Texas." In 2015 the DEP also found there was no groundwater contamination from fracking in Pennsylvania, a state which produces some 12 times as much gas as WA consumes.

[xiv] https://www.sciencenews.org/article/volume-fracking-fluid-pumped-underground-tied-canada-quakes

[xv] https://earthquake.usgs.gov/research/induced/myths.php



[xvi] https://www.eia.gov/todayinenergy/detail.php?id=34732