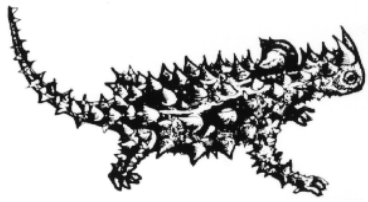


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Submission to the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

The Arid Lands Environment Centre (ALEC) is the peak regional environmental organisation servicing central Australia. ALEC is a community-based organisation, developing and delivering environmental and sustainability programs in Central Australia. For more than 36 years, ALEC has advocated for the conservation and responsible management of land, water and natural resources in the arid lands.

ALEC welcomes the scientific inquiry into the issue of hydraulic fracturing and the opportunity to properly communicate the full breadth of evidence of the environmental risk of the industry. We commend the breadth of the terms of reference acknowledging the need to properly investigate the full scale of risk and potential impacts for the Territory. Development of fossil fuel resources is a significant risk to the people and environments of the arid lands. ALEC works to ensure the healthy futures of people and country for many generations to come and has a history of comprehensive community and government engagement on the issue of gas. We will remain deeply involved in the progression of the issue continuing to communicate environmental issues and community concerns.

In this submission, ALEC will be presenting the case for a permanent ban on the use of hydraulic fracturing to uncover methane sources in the NT as it poses an irreversible and serious risk to people and country. There are a wide variety of risk factors that operate cumulatively on multiple levels. ALEC does not consider it possible for environmental regulation to be able to prevent the threat of serious irreversible harm to our water, air and land resources. The submission will be informed by the theory of ecologically sustainable development through the principles of precaution, public participation, inter- and intra- generational equity and a polluter pays system.

Ecologically sustainable development

Ecologically sustainable development is the foundational guiding principle of environmental policy. Intra- and inter-generational equity, public participation, precautionary principle and the polluter pays approach should be embedded in the process of identifying and assessing the scientific material on the risk of hydraulic fracturing. The decisions taken now in this panel will impact communities for many generations to come and their rights to a healthy environment and sustainable development are just as important as the needs of current generations.

The precautionary principle is a fundamental pillar of best practice environmental management. If there is a risk of serious irreversible environmental harm, the absence of complete scientific certainty cannot be used as a reason against taking preventative action. Prevention is the most effective and affordable approach to risk and is enshrined in international and domestic law. The US EPA has confirmed that Shale Gas Fracking does cause environmental contamination and is a threat to drinking water sources (US EPA, 2016).

The scientific literature on shale gas contamination risks definitively establishes positive associations with environmental contamination and actual incidents of contamination. While there does exist a degree of variation in the frequency of certain risks, the available data has firmly established that wells do fail and that methane is migrating into aquifers in close proximity to wells. It is difficult to establish with absolute certainty the origin of methane when it is discovered but isotopic tracking and chemical analysis of other n-alkanes has established that there is indeed a very real risk. As there is a risk of serious environmental harm, the absence of complete certainty about the frequency of contamination should not be used as a reason to not take preventative action.

Uncertainty and risk

The existence of significant risk shifts the burden of proof onto the party who is alleging there is no risk. The onus is on the industry to prove it is safe rather than groups having to prove it is harmful. Simply put false negatives in this context are far more dangerous than false positives (Evenson, 2016). While science has traditionally placed greater emphasis on false positives than false negatives, the fracking debate warrants a reversal of this emphasis because the implications of a false negative are far more harmful than a false positive (Evenson, 2016). As the Northern Territory is groundwater dependent and high quality aquifers are highly valued, one contamination event would be a significant loss. The Territory simply cannot afford to degrade the quality of any of its high-quality aquifers. The consequence of risk is so great that it becomes a high risk in the risk matrix. ALEC does not consider any level of risk to groundwater as acceptable.

The Northern Territory is scarcely populated with a significant lack of baseline groundwater data that undermines the ability of gas companies to refute the environmental risk. There is not yet enough information available for industry to be able to prove hydraulic fracturing is safe in the Territory. Another compounding factor in assessing risk is the sheer number of variables involved. Shale gas extraction comes with a whole host of ancillary activities which each present their own environmental impact. The impacts of these activities must not be assessed in isolation but rather as the sum of their parts, or the cumulative risk. This is how death by a thousand cuts or the tragedy of the commons occurs.

The panel has been tasked with identifying areas of risk but it is not clear how risk will be evaluated or assessed. Having established that risks exist the panel will need to assess the level of risk and consider methods of prevention or mitigation through regulation. ALEC urges the panel to prioritise prevention as the only viable way to ensure that serious and irrevocable harm does not come to people or country of the Northern Territory.

The remainder of the submission will outline the key areas of risk posed by hydraulic fracturing through presenting scientific, academic and media evidence establishing harm under each, and concluding that hydraulic fracturing and shale gas production is simply not worth the risk.

Recommendations

- That the burden of proof for the safety of fracking is shifted onto industry.
- That avoidance and prevention are prioritised above mitigation.
- That the panel encourage public participation and full transparency over fracking operations.
- That the panel recognise false negatives are far more harmful than false positives.
- That the panel acknowledge that contamination has occurred, wells do fail and that it is no longer a question of whether a risk exists but what level of risk is acceptable.
- That the panel acknowledge preventative action is the only reliable way to ensure aquifers are not contaminated.
- That the panel recommends further government research into groundwater quality for baseline data.

Contamination pathways

There are a variety of ways fracking can cause environmental contamination. Contamination can occur through well failings, barrier failing, waste water pond leakages, increased connectivity between aquifers, injection of water into aquifers and secondary chemical spills. There are documented instances of each scenario mentioned above which is contributing to the overall picture of the industry as a risk to groundwater systems. Wells have a limited lifespan and they are vulnerable to corrosion from underground salts and fracking additives. Sustained well pressure, construction issues and the presence of natural faults are multiplying factors in the risk of well failures (US EPA 2015). Leaking gas wells have been recognised as a mechanism of subsurface methane and heavier n-alkanes migration through aquifers or into the surface for many years (Ingraffea *et al* 2014). Well failure occurs due to hydrostatic imbalance, inappropriate cement density, inadequately cleaned bore holes, premature gelation of cement, excessive fluid loss, high permeability in the cement slurry, cement shrinkage, radial cracking and poor interfacial bonding (Ingraffea *et al* 2014).

Zonal isolation is compromised through barrier failure or failure of well integrity. This is one of the primary pathways for leakages and water contamination that is occurring in unconventional wells. As the distance between fractures in the shale formation decreases there is a greater possibility of linkages within and between aquifer systems. This risk is heightened in the Territory context as gas companies are proposing to drill multiple horizontal wells from each single vertical well, thus there are increased threats of frack hits and well communication events (Food and Water Watch, 2015).

A comprehensive review of all water quality investigations into shale gas fracking in the United States showed that 69% of research papers demonstrated a positive association or actual incidence of groundwater contamination in areas in close

proximity to gas wells (Hays & Shonkoff 2016). While there is no industry wide measurement on failure rates, industry and academic research has documented rates varying between 1% and 16%. This means despite the industry suggesting they can completely mitigate that risk there will always be variables that contribute towards well deterioration and corrosion. Well casing failure rates have been documented to be significantly higher in unconventional wells than conventional wells (Ingraffea *et al* 2014). An average failure rate of unconventional shale wells in Pennsylvania was documented at around 9.5% (Ingraffea *et al* 2014). This does not account for the risk of abandoned wells. Despite engineering advances, well failure is an everyday reality for the gas industry.

While it is possible to infer the behavior of fractures at the depth of the shale formation it is not possible to know exactly how the host rock is responding to the hydraulic fracture. For example the length and breadth of each fracture is not exactly known. Fracking activities are essentially an experiment in each location as each “target formation” has a unique geochemical and hydrological signature. There is thus an absolute limit on the capacity to monitor the movement of materials in the deep shale formations of the Territory.

A significant uncertainty of the industry is the fate of produced water that is not recovered after each frack. Between 40% and 60% of slick water that is used to fracture the target formation is not recovered (Kondash *et al* 2017). The industry is unable to explain where this water is moving or how it is able to monitor its migration through formations. Evaporation ponds are being abandoned in Queensland as the preferred method of produced water disposal because of contamination incidents and flood risks (Qld Department of Environment and Heritage Protection, 2016).

Methane contamination

One of the key challenges in establishing the incidence of contamination in shale gas extraction has been monitoring the migration of methane and contaminants in aquifers. Isotopic tracking of biogenic vs thermogenic sources of methane has proven successful in identifying the source of methane within contaminated aquifers. Elevated levels of thermogenic methane (arising from shale depth formations) have been discovered in aquifers in close proximity to active gas wells, thus establishing a definite causal connection between fracking activities and methane contamination of groundwater (Osborn *et al* 2011). It has been firmly established that proximity to unconventional gas developments in Pennsylvania is associated with elevated concentrations of methane in groundwater (Ingraffea *et al* 2014).

Thermogenic methane found in aquifers is a result of hydraulic fracturing as it is formed at shale depth whereas biogenic methane is formed at shallower depths from recent microbial action. Another way of demonstrating aquifer contamination from shale activity is the ratio of ethane to methane discovered (Darrah *et al* 2014). Ethane is found in higher concentrations in shale gas deposits so its presence in aquifers is indicative of contamination or increased connectivity between aquifers.

Shale formations are generally of very low permeability, hence the need for hydraulic stimulation. This means that natural migration of gas would only occur over periods of geological time. Elevated levels of methane in aquifers, in contrast to historical

levels suggests that new pathways between geological layers and aquifers are being created by hydraulic stimulation (Jackson *et al* 2013). The discovery of elevated levels of methane, higher chain hydrocarbons as well as elevated concentrations of heavy metals demonstrates there are contamination pathways between aquifers and shale gas formations experiencing hydraulic stimulation (Jackson *et al* 2013). Hazardous levels of methane gas were discovered within 1km of an active well above the Marcellus shale in the US (Jackson *et al* 2013).

It is now definitively proven that methane released from hydraulic fracturing is entering groundwater systems and drinking water aquifers, despite assurances to the contrary from gas companies (see APPEA link). The US EPA has confirmed this connection between fracking and methane contamination (US EPA 2016). The speed of natural gas migration is quite slow through these formations so it may take a long time before the full impact of increased permeability is known. This is one reason why baseline studies and long term monitoring data is absolutely vital. In some wells in the US methane migration was not discovered until many years after the first well was sunk. This means that fracking activities may be contributing towards methane migration well before it is detected, but at that point it becomes too late to prevent further migration. This also strengthens the case for precaution.

Recommendations

- That more research is commissioned into understanding the mechanisms of gas migration.
- That the Territory Government acknowledge and accept the evidence coming out of the US that establishes a causal connection between fracking and methane contamination.

Other contaminants

More research from the United States shale gas context has discovered contamination of groundwater systems with heavy metals such as selenium, strontium and barium. While heavy metals and other elements are naturally occurring, several investigations have shown a positive causal connection between elevated concentrations in an aquifer and proximity to an active well site (Fontenot *et al* 2013). This study showed that the highest levels of selenium occurred in sites closest to an active well. Historical levels of selenium, arsenic and strontium were below levels measured in the active wells by a significant margin. This means that in addition to methane contamination, hydraulic fracturing is causing the migration and subsequent concentration of heavy metals in groundwater systems. Radon gas has also been positively associated with shale gas production in hazardous concentrations (Casey *et al* 2015). This is what leads to the risks associated with disposal of produced or flow back water. CSG activity in NSW has caused environmental contamination of waters with high levels of uranium. SANTOS was fined by the NSW Environmental Protection Authority for contaminating an aquifer with uranium up to 20 times the normal environmental concentrations (Nicholls, 2014).

Chemical spills and produced water leakages are a reality of operating in the unconventional gas industry. Estimates range from 4-11 spills per 100 wells in the US. According to the US EPA the most common cause of spills are blowout prevention

failure, well corrosion and failed valves (US EPA 2016). Of the documented spills 64% reached soil and 10% reached surface water sources (US EPA 2016).

Depressurisation and drawdown

Aside from the risk of contamination, development of the shale gas industry is an additional stress on the groundwater resources of arid Australia. The Territory is a groundwater dependent region that is already challenged with managing competing water demands. Several aquifer systems in the Territory are already overallocated and many do not have potable water quality (ABC News, 2015). Shale gas extraction requires immense amounts of water through the use of slick water in horizontal fracks. It is not clear where the industry intends to source this water from but drawdown will inevitably result.

According to some estimates the water yield required for hydraulic fracturing may exceed the sustainable annual yield of some aquifers (Australian Council of Learned Academics, 2013). In other basins the annual yield required for fracking is a significant fraction of the annual extraction from that basin. It is thus environmentally irresponsible to allow fracking in these areas as they may displace existing economies and communities. For some basins with low annual extractions, withdrawal will prove fatal. The slow rate of recharge, over geological time, means there is the very real risk of basins disappearing over a long period of time.

Climate change is projected to decrease the rate of groundwater recharge and increase the rate of evapotranspiration in Central Australia (Federal Department of Environment and Energy). Groundwater systems are thus likely to become increasingly stressed over the coming years. These resources are needed to support human and non-human life for many generations to come and it is vital that over allocation is avoided. The Northern Territory does not have a sufficient understanding of the volume and quality of all groundwater systems. There is not enough baseline data to be able to ensure the industry will not compromise the water security of the Northern Territory.

Recommendations:

- That baseline studies are conducted for all prospective basins with a focus on pressure, water quality and presence of stygofauna

The Northern Territory experience

While gas has been produced in the Northern Territory for some decades, slick water horizontal hydraulic fracturing has not been used on the production scale. The industry does not have experience in fracking procedure for this region and it would thus be an experiment. Despite the lack of Territory experience to draw from there have been several incidents of environmental harm that highlight the risks associated with the industry. Below are a few examples of pollution incidents related to gas exploration and production.

Origin energy has been drilling shale gas reserves through their exploration permit in the Beetaloo sub-basin. Such exploration activities have come across several problems such as hazardous gas and methane leaks. While exploring for gas Origin's

own environmental assessment report assessed there being a medium to high risk to groundwater with “serious consequences” (Bardon, 2017). That same environmental assessment identified a risk to groundwater through abandoned wells as they degrade.

A groundwater extraction well in the Beetaloo sub-basin was abandoned after hazardous levels of methane was detected leaking from it. Although the source of this gas was not confirmed, it is illustrative of the lack of understanding of aquifer connectivity and gas operations.

An exploration well drilled in the Georgina basin was discovered to be emitting high levels of Hydrogen Sulfide. Hydrogen sulfide is often found alongside natural gas deposits, referred to as ‘sour gas’. One of the fracks at Baldwin -2Hst1 in this basin experienced a shallow well casing failure (Baraka Energy). The well was abandoned due to hazardous levels of hydrogen sulfide emissions. Natural gas extraction and processing accounts for one of the greatest contributions of global atmospheric hydrogen sulfide emissions (US EPA, 1993). The gas is routinely detected around natural gas extraction and processing facilities (US EPA, 1993). The concentration of hydrogen sulfide in the atmosphere is a risk to public health.

The Mereenie conventional gas field has been producing gas for many decades. The site has not been without issue. Spills have been reported in the media from those fields but they were not officially recorded as an environmental incident because the field is regulated through the Department of Resources.

[\(http://aliceonline.com.au/2012/03/15/fracking-the-centre/\)](http://aliceonline.com.au/2012/03/15/fracking-the-centre/). This highlights a risk of regulating the industry through the Department of Resources which is not adequately equipped or prepared to investigate the environmental issues of these projects while it encourages and promotes gas exploration.

Water has been injected to stimulate gas flow in the wells at Maereenie but this is separate to the slick water horizontal fracking that is the subject of this inquiry. The industry is trying to play down the risks of fracking by suggesting the Mereenie field is an example of the industry already in practice when they are very distinct processes. Slick water horizontal fracturing is at greater depths and lengths and results in far more fractures than what is already occurring at Mereenie.

In the late sixties the Territory Government was talking up a proposed experiment with the use of nuclear weapons for the production of shale gas (Centralian Advocate 2/3/67). This plan was only abandoned when experience from the US showed that it unsurprisingly produced highly contaminated gas and water. This goes to show how experimental the industry’s approach to gas production has been and the fact that companies will be forever attempting to improve the technologies they use. It is also reflective of the somewhat reckless culture of exploration that continues to have impacts in the Territory today.

The previous NT Government was highly supportive of fracking going ahead and was actively helping to promote the industry. It was the most supportive of any of the governments in Australia, advertising to convince the public of its safety, proposing liquid-to-gas plants, pipelines and approving Origin Energy to frack in Amungme in the Beetaloo Basin to occur one day after the election that saw the end of the Giles Government. This is part of the explanation for the lack of social licence and poor

public confidence in the ability of Government to adequately regulate the industry. The past government has been criticised for its lack of transparency in approving fossil fuel development and was perceived as having inappropriately close ties with industry (Aikman, 2016). It is difficult for the Government to be seen as an objective regulator when it was actively promoting and financing the growth of the industry.

In 2014 there was a chemical spill of fluids associated with gas production after a truck overturned on the Plenty Highway (ABC NEWS, 5/6/14). The chemical spilled was Nalco EC9356A which is a highly toxic agent used in the oil and gas industry. The regulation of chemical transport and risks in remote regions along rough roads is a significant challenge for the industry and government. Accidents will continue to occur and there will only be a higher risk with more trucks on the road if shale gas production is permitted.

The above examples demonstrate that it is impossible for companies to completely guard against unforeseen circumstances and accidents; which is compounded by a culture of not providing full disclosure of these incidents. Enough accidents associated with gas production in the Territory have already occurred to reasonably suggest there is indeed an ongoing risk to the environment.

Recommendations

- That the panel acknowledge the history of the gas industry in the Territory has not operated with full transparency and regulatory compliance that has set a dangerous precedent for future regulation.
- That the panel acknowledge there are non-preventable risks associated with the remoteness of some parts of the NT including transport accidents and chemical spills.

Regulation and governance

It is widely recognised that the industry will need to acquire a social licence in order to operate legitimately in the Territory. This social licence can only be gained if the public is confident in the ability of government to prevent harm through proper environmental regulation. However regulation of petroleum resources is not done through an environmental or social perspective. The industry tasked with compliance and enforcement is the same department tasked with promoting the industry and facilitating expansion. This obvious conflict of interest prevents proper transparency and accountability of the industry.

A serious challenge for environmental regulation in the Territory is the remoteness of well sites. This poses a challenge for the resourcing of monitoring and compliance activities because it becomes a choice for companies to disclose any incidents themselves. Self-reporting and compliance is not as strong as government oversight. Not all environmental incidents occurring on mining sites are reported so considering the remoteness it is possible that incidents will occur without public awareness.

An inadequate regulatory framework

ALEC also has serious concerns about the resourcing and compliance capacity of government considering the history of environmental regulation in the Territory. As

it currently stands petroleum activities are exempt from environmental licences under the Waste Management Pollution Control Act and the Water Act. While the Government is intending to reform these laws, it still remains largely uncertain what form a robust regulatory system could take. Regulation should not be used to provide financial and investment security but rather as a way of ensuring the sustainable use of resources, which at times demands prevention rather than mitigation.

Access to information about petroleum activities is severely limited in the Northern Territory. Applications for exploration and production licences are not open to public scrutiny and the price of such access is cost prohibitive. If a pollution event occurs, like that which has been alleged in the Mereenie aquifer (See AliceOnline article), the incident is confined to the Department of Resources and is not open for public scrutiny. It is difficult, if not impossible to get public access to information on these events due to the exemption under the WMPC Act.

One of the bodies tasked with investigating the unconventional gas industry is the Government and Industry Social & Environmental Research Alliance (GISERA). This organisation is a partnership between CSIRO and five major gas companies. It conducts research into the environmental issues associated with unconventional extraction, such as fugitive emissions. Such a partnership has been designed to garner support for the industry by investigating the impediments for a social licence. Industry has a financial interest in the outcome of this research that has been noted by the Australia Institute (Grudnoff, 2016). The Australia Institute has found that because of the organisations governance structure and strategic research priorities there is a real possibility of perceived or actual bias in their findings (Grudnoff, 2016). Environmental or farming groups do not have representation in the alliance. This makes it possible for industry to guide the direction of research and influence the findings to construct a particular view about unconventional gas production.

Assurance given by government and corporations, with the best professional expertise available, provides no guarantee that there will be adequate protection from mishaps or unforeseen consequences. Full regulatory compliance and corporate accountability is not guaranteed in the Territory. The review into water extraction licences since 2012 is evidence of this (Crothers *et al* 2015). Despite the existence of safeguards and government assurances, the track record of this industry does not inspire much confidence in the commitment to such assurances. There will need to be a considerable shift in regulatory and enforcement culture if companies are to be held properly accountable to environmental obligations and commitments made to the people of the Northern Territory.

Unlike other extractive industries, shale gas poses the greatest risks during exploration. Exploration means that fracturing is occurring before production has even begun. As it currently stands there are inadequate provisions for environmental bonds for petroleum activity. This means that any harm that may result from exploration is not insured and companies are not financially liable for environmental damage during the exploration phase.

ALEC was initially open to the potential of shale gas production within a strict and robust regulatory approach. This position has since become untenable because of more evidence emerging on the inability of regulation to prevent environmental harm in the US and Queensland. ALEC is also concerned about the ability of the government

and industry to regulate itself considering the influence of industry research and lobby groups that are undermining the integrity of the science about the environmental risk.

While ALEC remains committed to the moratorium on hydraulic fracturing, if fracking were to go ahead ALEC urges the panel to consider imposing best practice and strict governance structures and regulatory frameworks. This means enforcing both minimum baseline standards for well construction and also prescriptive standards. There needs to be robust and adaptive monitoring regimes in place that assess the total emission profiles of wells as well as aquifer connectivity and quality. In the event of contamination there should be a reversible burden of proof that presumes the company is responsible unless they can prove otherwise. If companies maintain fracking is safe then they should accept this rebuttable presumption of liability for water pollution. The 'reverse onus' provision is a key provision of the *Illinois Hydraulic Fracturing Regulatory Act* considered one of the most comprehensive regulatory regimes in the US. There should also be mandated no-go zones around human settlements, sacred sites and areas of high conservation value.

Recommendation:

- That a reversible presumption of liability applies to the industry in the event of water contamination.
- That the Panel acknowledge the integrity of research into unconventional gas by government bodies are exposed to risks of actual or perceived bias because of industry funding.
- That the findings of industry sponsored research is carefully critiqued.
- That the panel urges the NT Government to move enforcement and compliance of petroleum activity into the Environment Protection Authority.
- That the NT Government establish an Independent Commission Against Corruption to investigate the granting of petroleum licenses and government support to enable financing of coal and gas projects.

Fugitive emissions and climate

Australia has ratified the Paris Agreement which is a legally binding obligation to keep warming below 2°C. In addition to this, the Northern Territory has committed to 50% renewable energy by 2030. These commitments are based on the understanding that there is only a limited carbon budget remaining for the entire globe. The vast majority of the remaining fossil fuel reserves must stay in the ground to avoid accelerated catastrophic global climate change. Of the unconventional gas reserves, a minimum of 80% must stay in the ground, if not all new sources, to provide a good chance at avoiding more than 2°C of warming (Steffen *et al* 2017). If gas infrastructure and facilities continue to be developed we will be further cementing our dependence on fossil fuels at a time when we need to be transitioning away from them. While gas does undeniably have a role to play in domestic energy needs, conventional sources will be sufficient provided there continues to be increased investment in renewables (Steffen *et al* 2017).

The entire carbon profile of the gas industry and associated processes is unknown in Australia. There are significant gaps in the data on upstream and downstream impacts which means that the total emissions accounted for in Australian's database

are potentially vastly underestimated (Maher *et al* 2014). Methane is a highly potent greenhouse gas, up to 70 times more potent than CO₂ over a 20 year period, so it is absolutely vital that its contribution to global warming is fully understood. Fugitive emissions result from flaring and leaking along the process of extraction, processing and transport. While there is no consistent data available for the fugitive emissions from fracking it has been demonstrated that as little as 4% of produced gas escaping as fugitive emissions will undermine the potential carbon savings made transitioning from coal (Few *et al* 2017). Estimates of the total emissions lost through upstream, midstream and downstream range from 2.3-11.7% which means there is a high chance many wells are as polluting as the combustion of coal (Caulton *et al* 2014). Australian investigations into air quality have shown higher concentrations of atmospheric methane and CO₂ in CSG fields than areas without wells (Maher *et al* 2014).

Fugitive emissions, increased barriers to investment in low carbon technologies and the high operating cost of fracking operations undermines the role of gas in meeting global temperature goals. Full-scale development of shale gas is likely to increase the mitigation cost and effort required to meet global climate targets (Few *et al* 2017). There is no evidence to justify the claim that gas is a viable transition fuel away from coal. Some gas power stations in Australia emit more carbon dioxide than coal fired power stations (Steffen *et al* 2017).

Ethane is also emitted during the extraction, processing and transportation of natural gas. This is also a much more powerful greenhouse gas than CO₂ and global emissions are rising sharply in part due to the growth in unconventional gas production. This gas is not monitored so it represents another great unknown in the equation that further increases the greenhouse contribution of fracking. While global ethane levels were decreasing there has been a sharp rise since 2010, which is likely due to the rise of unconventional gas production (Kort *et al* 2016).

Recommendations:

- That an independent investigation into fugitive emissions from conventional and unconventional sources is urgently undertaken by the NT Government to establish an understanding of the impacts on National Greenhouse Gas reporting.
- That the industry conduct lifecycle assessments of shale gas wells and measure fugitive emissions of the up, mid and down-stream processes.
- That gas companies commit to providing transparent information about air quality and fugitive emission monitoring results.

Health

Shale gas production and its associated activities have had profound impacts on the health and wellbeing of communities in the United States (Concerned Health Professionals, 2016). Air quality data around processing, compaction and drill sites have demonstrated elevated levels of hydrogen sulphide, methane, ethane, benzene, ozone and other chemicals. All of these pose significant risks to human health. Several health conditions have been correlated with proximity to gas infrastructure. The range of conditions and diseases include:

- Increased incidence of asthma (Concerned Health Professionals, 2016)
- Increased hospitalisations for a range of problems, including occupational accidents.
- Skin and respiratory problems.
- Elevated risk of problematic pregnancies, premature birth and low birth weights.
- Exposure to endocrine disruptors and carcinogenic compounds could lead to the increased incidence of chronic disorders.

A comprehensive literature review on the impacts of shale gas extraction on air quality showed that 87% of papers reported a reduction in air quality (Hays & Shonkoff, 2016). This paper shows a positive association with fracking activities and the emission of hazardous compounds.

In addition to the physical health effects of gas production there are also profound social changes that can occur because of the influx of FIFO workers and changing demographics. The increase in male workers, typically associated with gas production and exploration causes a masculinisation of communities. This can drive demand for services such as brothels and strip clubs as well as increased prevalence of gendered violence and sexual assault. FIFO workforces are also subject to higher incidences of mental health issues including depression and suicide (Education and Health Standing Committee, 2015). This Inquiry found that mental health was occurring in greater rates in FIFO workforces than the general public but more research was needed to discover the full extent of the problem in order to prevent increased levels of suicide in the future (Education and Health Standing Committee, 2015).

Recommendations

- That there are more baseline health investigations undertaken to ensure that fracking does not have a deleterious impact upon health, especially in remote and vulnerable indigenous communities.
- That the Territory establish large, legislatively mandated minimum no go zones around human settlements and water catchment areas.

Aboriginal people

Almost half of the Northern Territory is held in title under the Aboriginal Lands Rights Act or under Native Title and because of this, they are going to be the most exposed to the industry. Health standards for Aboriginal people in the Territory are consistently below that of non-indigenous people, for example Indigenous people live on average 17 years less than non-indigenous Australians (Altman, 2009). The health impacts mentioned in the *Health* section above will be felt more acutely by Aboriginal people in the Northern Territory. Access to adequate health services is limited by the remoteness of these communities. It is very unlikely that fracking will improve the health of indigenous communities as they often experience a disproportionate share of the burdens without gaining equivalent benefit (Birch, 2016).

The creation of wealth from minerals and petroleum in Australia is often predicated on the expropriation of indigenous land (Altman, 2009). While free prior informed consent, or a right of veto for exploration does exist, it does not guarantee that negotiating parties to a petroleum project have equal bargaining power. Petroleum

licences threaten indigenous people's connection to land by making it harder to make a successful claim of Native Title (Altman, 2009). This is because mining leases frequently extinguish consistent connection to culture. Nonetheless, Native Title will not guarantee economic benefits from fracking because mineral rights are not included in the bundle of rights that is Native Title, nor are rights to veto. Mining competes with indigenous interests in the cultural and physical landscape by having a profound impact on the land.

ALEC is critical of the ability of unconventional gas to provide economic value to Aboriginal people as it will likely exacerbate existing issues of inequality and disadvantage. Fracking is likely to increase inequality in health and wellbeing outcomes for Territorians living in remote areas.

Recommendations

- That the Territory commit to improving health service access and delivery to remote indigenous communities near fracking activities.
- That veto rights for petroleum activities are granted at the production phase.
- That the NT Government investigate the full impact of petroleum production on Indigenous wellbeing and communities.

Economy and industry

Shale gas extraction will compete for access to resources with the dominant agricultural, pastoral and tourist industries of the NT. These industries require open access to land and water for their continued livelihood. Gas exploration is the biggest competitor for agricultural activity in terms of water allocation, clearing and land disruption. The alienation of productive agricultural land for unconventional gas production has caused significant financial losses for farmers in QLD because of CSG production. The surface impact of CSG is comparable to Shale Gas production and because of this it offers an insight into the potential interplay between agriculture and gas production. In 2016 CSIRO released a report demonstrating that CSG infrastructure on average caused losses of 10.9% to agricultural revenue and resulted in an average reduction of \$2.17m in property value through access tracks and lease areas (Marinoni & Garcia, 2016).

Coal seam gas infrastructure has been listed by the Commonwealth Bank as making a property unacceptable security for finance (Market Forces, 2016). There were four gas wells on this property that meant it could not meet the lending criteria of CommBank as it made the property "unacceptable for residential lending purposes". CSG infrastructure is undermining the commercial value of properties and the capacity of owners to receive finance. Fracking in the Territory would have a similar surface footprint so there would also be a risk to landholders on their ability to get finance or insurance from their properties if they hosted wells.

The water demand and environmental footprint of the industry will also have a profound impact on the pastoralist industry in the NT. Grazing cattle is a leading industry for the Territory and requires large quantities of water that cannot coexist with the demand of unconventional gas. Fracking for shale gas in Pennsylvania is causing cattle deaths and diseases through contamination of aquifers and produced water spills (The Nation, 2015). Fracking chemicals are being detected in cattle in the

US resulting in reproductive complications, neurological disease and gastrointestinal problems (Bamberger & Oswald, 2012). This paper investigated several cattle stations across the US and found many instances of cattle death and disease positively correlated with fracking chemicals. The uptake of chemicals through gas and water by livestock is a pathway to human contamination and disease. Detection of fracking chemicals in cattle could potentially cripple the pastoral industry in the NT, especially considering the value of organic certification, unique to the Territory. Fracking activities are likely to negatively impact on the livelihood of pastoralists and threaten the greatest source of income for the Territory.

Another industry that is highly vulnerable to shale gas production is the tourist industry. This industry is one of the biggest earners for Central Australia. Gas fields have not traditionally been popular tourist destinations. Central Australia is visited because of its perception of pristine, wild and natural landscapes. Petrochemical production, processing and transportation would radically alter that perception of the land if it is allowed to go ahead. Gas flaring, venting, the sound of compression facilities all detract from the amenity of the country and lead to an industrialisation of the landscape that draws people to the region.

Recommendation:

- That landholders are given veto rights to object to fracking operations on their land due to the economic consequences of doing so.
- That a comprehensive independent economic assessment of the impact of fracking on existing businesses be conducted as part of this inquiry.
- That livestock in the vicinity of hydraulic fracturing are tested for chemicals associated with shale gas production.

Gas supply, renewables and markets

There is a complex interplay between gas and renewable energy. Australia is at a pivotal point in its energy future with energy policy being at the forefront of national discussions. ALEC is concerned that fracking will inhibit investment and growth in the renewables sector. If the infrastructure is built it will commit the Territory to many decades of gas production and compete with the political and economic imperatives to invest and grow renewable energy (Steffen *et al* 2017). Shale gas will compete with renewables for available capital. ALEC implores the panel to recognise this as a risk not just in terms of finance but how it will further undermine our responsibilities to reduce our carbon emissions and increase renewable energy uptake.

Australians pay the highest rate for gas in the world. This is not because of a supply issue but rather a demand and pricing issue as prices are connected to overseas markets and there is limited domestic competition. This is a result of there being five main gas producers that have effectively created a cartel. The Australian Energy Market Operator (AEMO) has noted falling gas demand since 2012 and that increases in prices and supply issues are largely the result of the connection with expensive Japanese and other Asian market (Jericho, 2017). AEMO (2016) has also identified that production from unconventional sources will not alleviate price issues because of the increased cost associated with the exploitation of these reserves. Demand is forecast to greatly fluctuate considering the speed at which Australia's energy system

is evolving. Gas companies are effectively proposing that costly fracking is expanded while cheaper conventional sources are reserved for export (Jericho, 2017).

The economic issue of shale gas production is less about the issue of energy security as about resource sovereignty. Australian companies are investing in the expansion of natural gas extraction through unconventional methods to feed demand in Asia and processed through internationally controlled infrastructure, such as the ports of Gladstone and pipeline owners. The greatest risk to Australia's domestic supply is thus the price and export of it to international customers. Australian homes have become vulnerable to international market volatilities paying more since Australian gas fields were connected with Asian industries. Companies have invested billions of dollars in export infrastructure in a bid to ensure the long-term sustainability of export industries to maintain a return for shareholders (Dennis, 2016).

Shale gas is touted as an affordable transition fuel but this claim is completely unfounded. Economic modeling indicates that the 'dash for gas' approach could significantly increase the carbon mitigation cost under a 2°C emissions scenario and generally the cost of energy in a climate constrained economy (Few *et al* 2017). This study concluded that rapid expansion of shale gas is not at all cost-optimal in terms of the global economy. It is a very poor investment as a carbon mitigation technology. The most recent report from the Climate Council supports this position, concluding that unconventional gas is not a scientific or cost effective method of carbon mitigation and will undermine energy security in the long term (Steffen *et al* 2017).

Recommendations

- That there is a Federal investigation into the cause of the high gas prices in Australia.
- That legislation is introduced to curtail the power of the gas cartel in the NT.
- That the NT Government introduce a domestic gas reserve to support development of local industry and ensure adequate gas supplies to support the energy transition to renewables.
- That the NT Government engage in COAG processes to discuss a national policy for securing domestic gas supply and affordability.

Society

The unconventional gas industry does not have a social licence to operate. One of the reasons there is no social licence, aside from environmental concerns, is because of the problem of unequal distribution of benefits and burdens. Benefits will flow overseas and interstate as there is a strong reliance on a FIFO workforce and gas companies have significant international investment. Lack of public confidence in the benefits of the industry was enough for shale gas to be prohibited in Denton Texas (Evenson, 2016). Shale gas was rejected in the community because the non-mineral owners were paying the environmental and health risks while the mineral owners were receiving the direct economic benefits without being exposed to the environmental and health consequences (Evenson, 2016). This is an insurmountable challenge for the industry that is already struggling to gain a social licence.

Concepts such as distributive justice go towards more normative assessments of the fracking issue. While it is important to understand the science of the issue, science

alone cannot answer the question about how to balance risk or what is considered a reasonable cost. Fracking is a social issue as much as an environmental issue and it is important to consider the full weight of community opposition to fracking in the Territory. The public has a right to determine how our sovereign resources are exploited, or not. Community input is vital for environmental and economic justice and these values need to be weighed against the benefits of the income from gas production. There is a need to enforce a domestic gas reservation policy to provide greater resource sovereignty.

The Northern Territory has historically been characterized by industries that operate in cycles of boom and bust. Such a cycle renders communities vulnerable to the impacts of unemployment, poverty and general social instability due to down periods. To improve resilience in the harsh environment of Central Australia it is important to develop industries that are less vulnerable to market volatilities. Shale gas cannot provide economic resilience and certainty in this region as it is both exposed to market volatilities and environmental variables. Fracking increases our vulnerability to climate change and cannot guarantee sustainable long-term employment for people living in the regions impacted by it.

Recommendations

- That a comprehensive social impact assessment of the proposed shale gas industry is undertaken as part of this inquiry.
- That climate vulnerability assessments are undertaken by the NT government to understand the impacts that the industry has on climate resilience.
- That a comprehensive economic assessment of the shale gas industry is undertaken to determine the potential costs and benefits of the industry for the NT.
- That the NT Government introduces a domestic gas reservation policy to support the development of local industry to ensure long-term and sustainable employment opportunities.

Biodiversity

Expansion of unconventional gas reserves in the Territory would result in significant disruption to sensitive and vulnerable ecological systems. The vast network of interconnected pipelines, roadways and processing facilities would fragment ecosystems through land clearing, soil compaction and vehicle strike. This industrialisation of the landscape is also a significant threat to biological integrity through exacerbating the spread of invasive species. Disturbed landscapes are highly vulnerable to the colonization of invasive species such as opuntia cacti, Buffel grass and other highly invasive species. These species out compete natives for resources and will have flow on effects for indigenous use of lands, pastoralists and the tourist industry.

The arid lands of Australia supports sensitive ecosystems that have proven capacity to adapt to nutrient poor, highly variable and extreme environments. The biological impacts on ecosystems in the Territory are not well understood because biodiversity surveys of stygofauna (groundwater fauna) and insects is not legally required in environmental impact assessment in the Northern Territory. Groundwater dependent ecosystems, especially stygofauna communities will be most exposed to fracking

activities and there is not enough information about these species to ensure their safety in the event of fracking. These animals play a fundamental role in normal ecological functioning and we are unable to be sure that fracking will not have a profoundly negative impact on their health.

Environmental stewardship is emerging as a progressive and necessary principle of best practice environmental management. The ongoing health and integrity of ecological systems can only be guaranteed if we recognise the connection between development and environmental harm and ensure that human needs and imperatives for growth have a minimal impact upon other forms of life. We have a moral and ethical responsibility to preserve natural systems for many generations to come, not simply to facilitate the development of the land as a source of commodities.

Recommendations:

- That the NT Government conduct comprehensive groundwater monitoring to establish baselines across all prospective basins in the Northern Territory.
- That environmental impact assessments are conducted for all shale gas exploration projects.
- That the NT Government and the Environment Protection Authority consider the inclusion of stygofauna and arthropods in the assessment of projects for environmental impact.
- That the need for environmental stewardship is inserted into the Inquiry Terms of Reference.

Conclusion

Hydraulic fracturing has the potential to significantly impact landscapes, ecosystems, surface and groundwater resources, communities and the atmosphere. Research from unconventional production of gas in the USA definitively demonstrates that groundwater, land and atmospheric pollution is occurring because of fracking activities. Wells are failing and aquifers are being contaminated with heavy metals and methane. The consequence of this environmental risk is so great considering the groundwater dependency of ecosystems and communities in the Northern Territory. The impossibility of remediating a groundwater system means that fracking will always be high risk. Precaution thus mandates preventative action as the only way to guarantee the health of the arid lands and its people for many generations to come.

Expansion of the shale gas industry will jeopardise Northern Territory and national efforts at reducing carbon emissions and transitioning to a renewable energy economy. Fugitive emissions from shale gas extraction is potentially so large as to undermine the supposed emissions savings made burning gas over coal. Growth of the industry will commit the economy to many more decades of fossil fuel dependence at a time when science has shown 80% of known fossil fuel reserves must stay in the ground. Shale gas production through fracking would release vast amounts of CO₂ and methane that will use a significant portion of the remaining carbon budget making our carbon reduction commitments unviable. It will also compete for capital investment in renewables and inhibit the transition towards low carbon technologies.

Fracking poses a multifaceted risk to environments and communities. Fracking will alter economies through increased FIFO workforces, fragmented ecosystems, industrialise the landscape and contribute to health problems. Together these factors have a compounding effect and they cannot be considered in isolation to one another. ALEC does not consider it possible for a regulatory system to adequately protect our communities and country from these risks. Without having a social licence to operate it is difficult to foresee the possibility of the industry operating in the Territory without considerable community opposition. Water, climate and health concerns cannot be addressed through law and regulation, prevention is being demanded by the community and ALEC supports this.

In the event that the panel does not consider a ban feasible, ALEC urges the panel to ensure that fracking will only go ahead once further baseline water and health data is established to ensure the process will not threaten environmental and human health. If fracking is permitted, the NT Government must develop a robust and adaptive environmental regulatory and governance structure. Regulation must be the responsibility of the NT Government and a strong, well-resourced Environment Protection Authority. There must be strict independent monitoring of gas wells and this data must be made publicly available.

ALEC welcomes the Scientific Inquiry into Hydraulic Fracturing and acknowledges the scale of the task being undertaken by the Committee. ALEC will continue to be engaged with this issue throughout the inquiry process and the development and implementation of what is hoped to be a rigorous environmental assessment and approvals framework. On behalf of ALEC and its members, I thank you for the opportunity to make a submission to this incredibly important and timely assessment of this environmentally, socially and economically damaging extractive process. ALEC is happy to provide further references for any of the issues raised in this submission.

Complete list of recommendations

1. That the burden of proof for the safety of fracking is shifted onto industry.
2. That avoidance and prevention are prioritised above mitigation.
3. That the panel encourage public participation and full transparency over fracking operations.
4. That the panel recognise false negatives are far more harmful than false positives.
5. That the panel acknowledge that contamination has occurred, wells do fail and that it is no longer a question of whether a risk exists but what level of risk is acceptable.
6. That the panel acknowledge preventative action is the only reliable way to ensure aquifers are not contaminated.
7. That the panel recommends further government research into groundwater quality for baseline data.
8. That more research is commissioned into understanding the mechanisms of methane migration.
9. That the Territory Government acknowledge and accept the evidence coming out of the US that establishes a causal connection between fracking and methane contamination.
10. That baseline studies are conducted for all prospective basins with a focus on pressure, water quality and presence of stygofauna.

11. That the need for environmental stewardship is inserted into the Inquiry Terms of Reference.
12. That the panel acknowledge the history of the gas industry in the Territory has not operated with full transparency and regulatory compliance that has set a dangerous precedent for future regulation.
13. That the Panel acknowledge there are non-preventable risks associated with the remoteness of some parts of the NT including transport accidents and chemical spills.
14. That a reversible presumption of liability applies to the industry in the event of water contamination.
15. That the panel acknowledge the integrity of research into unconventional gas by government bodies are exposed to risks of actual or perceived bias because of industry funding.
16. That the findings of industry sponsored research is carefully critiqued.
17. That the panel urges the NT Government to move enforcement and compliance of petroleum activity into the Environment Protection Authority.
18. That the NT Government establish an Independent Commission Against Corruption to investigate the granting of petroleum licenses and government support to enable financing of coal and gas projects.
19. That an independent investigation into fugitive emissions from conventional and unconventional sources is urgently undertaken by the NT Government to establish an understanding of the impacts on National Greenhouse Gas reporting.
20. That the industry conduct lifecycle assessments of shale gas wells and measure fugitive emissions of the up, mid and down-stream processes.
21. That gas companies commit to providing transparent information about air quality and fugitive emission monitoring results.
22. That more baseline health investigations are undertaken to ensure that fracking does not have a deleterious impact upon health, especially in remote and vulnerable indigenous communities.
23. That the Territory establish large, legislatively mandated minimum no go zones around human settlements and water catchment areas.
24. That the Territory commit to improving health service access and delivery to remote indigenous communities near fracking activities.
25. That veto rights for petroleum activities are granted at the production phase.
26. That the NT Government investigate the full impact of petroleum production on Indigenous wellbeing and communities.
27. That landholders are given veto rights to object to fracking operations on their land due to the economic consequences of doing so.
28. That a comprehensive independent economic assessment of the impact of fracking on existing businesses be conducted as part of this inquiry.
29. That livestock in the vicinity of hydraulic fracturing are tested for chemicals associated with sale gas production.
30. That there is a Federal investigation into the cause of the high gas prices in Australia.
31. That legislation is introduced to curtail the power of the gas cartel in the NT.
32. That the NT Government introduce a domestic gas reserve to support development of local industry, sustainable employment and ensure adequate gas supplies to support the energy transition to renewables.
33. That the NT Government engage in COAG processes to discuss a national policy for securing domestic gas supply and affordability.

34. That a comprehensive social impact assessment of the proposed shale gas industry is undertaken as part of this inquiry.
35. That climate vulnerability assessments are undertaken by the NT government to understand the impacts that the industry has on climate resilience.
36. That a comprehensive economic assessment of the shale gas industry be undertaken to determine the potential costs and benefits of the industry for the NT.
37. That the NT Government conduct comprehensive groundwater monitoring to establish baselines across all prospective basins in the Northern Territory.
38. That environmental impact assessments are conducted for all shale gas exploration projects.
39. That the NT Government and the Environmental Protection Authority consider the inclusion of stygofauna and arthropods in the assessment of projects for environmental impact.
40. That the Inquiry recommends the moratorium on fracking is not lifted and is instead transitioned to a complete ban on the process in the NT.
41. In the absence of a ban, ALEC recommends as a minimum that a robust and adaptive regulatory regime is enforced on the Industry.

The position that we have taken in this submission was largely informed by the findings of this paper:

The case for an Urgent Ban on Fracking 2015

<[https://www.foodandwaterwatch.org/sites/default/files/Urgent Ban on Fracking Report March 2015.pdf](https://www.foodandwaterwatch.org/sites/default/files/Urgent%20Ban%20on%20Fracking%20Report%20March%202015.pdf)>

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