Environment and Public Affairs Committee

From: Dr Lauren Palmer
Sent: Friday, 20 September 2013 1:02 PM
To: Environment and Public Affairs Committee
Subject: ATSE Submission: Inquiry into the Implications for Western Australia of Hydraulic Fracturing for Unconventional Gas.
Attachments: WA Inquiry Hydraulic Fracturing_ATSE Response_020913.pdf

Dear Ms Liveris,

Please find attached a submission from the Australian Academy of Technological Sciences and Engineering (ATSE) to the *Inquiry into the Implications for Western Australia of Hydraulic Fracturing for Unconventional Gas.*

We would like to include the report *Engineering Energy: Unconventional Gas Production* which is referred to in the attached submission. Unfortunately the file is too large to send via email, however can be accessed using the following link:
http://www.acola.org.au/PDF/SAF06FINAL/Final%20Report%20Engineering%20Energy%20June%202013.pdf

Yours sincerely,
Lauren

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Australian Academy of Technological Sciences and Engineering (ATSE)

Response to

Inquiry into the Implications for Western Australia of Hydraulic Fracturing for Unconventional Gas

by

The Australian Academy of Technological Sciences and Engineering (ATSE)

to

Standing Committee on Environment and Public Affairs

Legislative Council

Parliament of Western Australia

September 2013

Inquiry into the Implications for Western Australia of Hydraulic Fracturing for Unconventional Gas

The Australian Academy of Technological Sciences and Engineering[1] (ATSE) welcomes the opportunity to respond to the Inquiry.

Introduction

The Australian Council of Learned Academies (ACOLA) which combines the four Learned Academies (Australian Academy of Science, Academy of Social Sciences in Australia, Australian Academy of the Humanities and the Australian Academy of Technological Sciences and Engineering) published a Report in June 2013 on shale gas in Australia, titled: *Engineering Energy: Unconventional Gas Production – a study of shale gas in Australia*[2]. The Report reviewed the range of issues facing shale gas development in Australia and made 51 key findings (under its terms of reference, the Report did not make 'recommendations')[3] considering the potential environmental, social and economic impacts of an Australian shale gas industry. The Report also addressed the potential impact of hydraulic fracturing, the regulation of fracking chemicals, and the use of groundwater, brackish water and produced water for fracking operations. An electronic copy of the report is attached to this submission. ATSE provided project services on behalf of ACOLA Secretariat and it is in that context that ATSE provides these comments.[1]

While the Inquiry addresses some of the key issues related to hydraulic fracturing for unconventional gas, ATSE considers that the potential impacts on human health, greenhouse gas emissions and the issue of gaining and retaining the social licence to operate are also important and brief observations on some of these matters are included in this ATSE submission. This submission utilises the ACOLA Report as a basis for the submission.

How hydraulic fracturing may impact on current and future uses of land

There is potential for shale gas exploration and extraction to have an impact on the landscape and biodiversity in Australia. The ACOLA Report states: '*shale gas production is no different from any other development of our landscapes and* as such poses *risks to the condition of the water, soil, vegetation and biodiversity, and has the potential to reduce the capacity of our natural resources to supply human, as well as ecological needs.*'[4]

During a shale gas fracking operation there are many processes that can impact the environment including the direct clearing of land to establish the fracking site, construction of access roads, levelling of the site, fragmentation of patches of native vegetation,

[1] ATSE was established in 1975 with the mission to promote the application of scientific and engineering knowledge to the future benefit of Australia. ATSE is one of four learned national Academies, which have complementary roles and work together both nationally and internationally. ATSE has some 800 elected Fellows who are the leaders of applied science and engineering across the country.

[2] http://acola.org.au/ACOLA/index.php/projects/securing-australia-s-future/project-6

[3] Recommendations were developed by the Office of the Chief Scientist in consultation with relevant government departments and can be found here: http://www.chiefscientist.gov.au/wp-content/uploads/shalegas-recommendationsFINAL.pdf

[4] Cook, P, Beck, V, Brereton, D, Clark, R, Fisher, B, Kentish, S, Toomey, J and Williams, J (2013). Engineering energy: unconventional gas production. Report for the Australian Council of Learned Academies

fragmentation of habitats and landscape function, fauna and flora mortality, the spread of invasive species, increased fire risk, and impacts on soils.[4] In addition, particularly in arid regions, the impact to ground water and surface water may be an issue. The ACOLA Report highlighted that the extraction of water used in hydraulic fracturing operations or the perturbation of ground water pressure gradients, has the potential to change the hydrology of wetlands and other ground water dependent ecosystems.[4] However none of these potential impacts are inevitable if best practice is followed.

Well failure (including blowouts), have the potential to impact surface environments. However, as noted in the ACOLA Report, thus far in Australia there have been very few such events and the risk of a shale gas blowout is low provided best practice is followed.

The ACOLA Report notes that through using knowledge of Australian landscape processes together with specific landscape, geological and hydrological data, it is possible to work out how resources such as shale gas can be extracted in a manner and in locations that do not compromise agriculture, water resources, and landscape function.[4] Surface infrastructure will be dependent on whether vertical or horizontal wells are used and as a result the footprint of a shale gas operation can vary significantly depending on whether horizontal or vertical wells are used. The ACOLA Report provides the following model of the surface infrastructure that might be associated with the development of a 1000ha shale play[4]:

- Vertical Wells: 64 vertical wells on individual pads of 0.8 hectare each, using 50 hectares of land in total, about 40 kilometres of roads, 40 kilometres of pipelines, plus 4 to 8 facility pads to effectively capture the gas reserves
- Horizontal Wells: 16 horizontal wells from 1 pad of 2.5 hectares, with 3 kilometres of roads, 3 kilometres of pipeline and one facility on the same pad as the wells.

The foot print of shale gas operations can be minimised through measures such as the use of multiwell drilling from a single pad. In addition, the ACOLA Report highlights that well pads will also need facilities for storing water and proppants; gas treatment and compression facilities; and power.[4] Further infrastructure will include access roads and tracks to the site; pipeline infrastructure; gas processing plants; storage facilities; workers accommodation and offices; and telecommunication infrastructure.[4] Shale gas processing plants will be larger than coal seam gas (CSG) processing plants due to the broader range of gas compositions likely to be encountered.

If Australia is to develop a commercially viable shale gas industry with minimal impact, it will be important to acknowledge co-use of landscapes: a whole-of-system framework will be essential in managing the impacts of multiple land uses.[4] The ACOLA Report states that '*shale gas developments will need to work within a robust legislative and regulatory framework to ensure sensible and equitable multiple land use, based around well-resourced regional strategic biophysical and geological resource planning and cumulative risk assessment*'.[4]

Cumulative impacts on groundwater aquifers can have significant effect on the current and future use of the land. Large scale extraction of groundwater for shale gas activities can also place cumulative pressure on ecohydrological groundwater systems. These impacts can be compounded by competing use of the land (such as irrigation for crops) or prolonged or extreme drought conditions.[4] In addition, in developed areas of Australia many streams are in poor ecosystem health.[4] The use of cumulative risk assessment tools and a Strategic Environmental Assessment prior to shale gas developments is essential.

<u>The regulation of chemicals used in the hydraulic fracturing process</u>

Depending on the characteristics of water used for fracking and the shale being fractured, a typical hydraulic fracturing fluid can contain many additive chemicals. Whilst the concentration (by volume) of chemicals used in hydraulic fracturing is very low (typically 0.1 to 0.5%), it is important that best practice and regulations are in place to minimise any adverse impact.[4] The ACOLA Report noted that approximately 30-70% of injected hydraulic fracturing fluid is recovered, with the remainder trapped in macro-pores, micro-pores and fractures within the shale.[4] Therefore effective management and recycling of fracking fluids is an important aspect of shale gas operations.

Overseas evidence suggests that inappropriate disposal of fracking fluids can have negative consequences for the environment. Looking to the US, key concerns in responsible management of the recovered fluid (outlined in the ACOLA Report) include[4]:

- *Unregulated release to surface and groundwater resources;*
- *Leakage from on-site storage ponds;*
- *Improper pit construction, maintenance and decommissioning;*
- *Disposal of large volumes of brine;*
- *Incomplete treatment;*
- *Spills on-site; and*
- *Wastewater treatment accidents.*

Regulation in Australia should ensure that these types of impacts are avoided. It will also be important to take care when storing hydraulic fracturing chemicals onsite and offsite and the impoundment and subsequent treatment of flowback wastewater. The ACOLA Report noted that spills associated with shale gas production can impact surrounding ecosystems resulting in contamination of riparian areas, or death or dieback of vegetation.[4] It will be important to have appropriate regulations for flowback disposal.

The ACOLA Report states: *'contamination of freshwater aquifers can occur due to accidental leakage of brines or chemically-modified fluids during shale gas drilling or production; through well failure; via leakage along faults; or by diffusion through over-pressured seals. Contamination of terrestrial and riverine ecosystems may occur from spills associated with chemicals used during the early stages of production; from impoundment ponds and holding tanks; and because of the volume of traffic needed to service operations. The petroleum industry has experience in managing these issues and remediating them, but in a relatively new shale gas industry, unanticipated problems may arise and it is important to have best practice in place, to minimise the possibility of this risk.'*[4]

ATSE believes that best practice must be followed, and full and transparent disclosure of chemicals used and regulations are in place, to control the chemicals used and to minimise spills and contamination. The ACOLA Report suggests companies should fully and publicly disclose the chemicals used in fracture stimulation treatments. This is already a feature of many shale gas operations in the USA.

The use of ground water in the hydraulic fracturing process and the potential for recycling of produced water

Ground water

Each hydraulic fracture stage uses approximately 500,000 litres of fresh to brackish water; there are multiple fractures stages per well and with horizontal drilling up to 15 ML (million litres) of water may be used.[4] The majority of this water will need to be extracted from surface and/or groundwater resources or sourced from recycled water, non-water based fluids or water imported from elsewhere.[4] It is possible to use gases such as nitrogen or carbon dioxide for fracking but does not appear to be as effective as the use of more conventional fracking fluids. The extraction of water from ground water and its impact and availability on local resources will require examination within the National Water Initiative principles and particularly in terms of cumulative impacts on the regional groundwater systems.[4] The Council of Australian Governments (COAG) Water Reform Network and the National Water Initiative cover the allocation, entitlement and use of ground and surface water resources due to the resources being matters of national interest.[4] The ACOLA Report states '*if water entitlement allocation and management for shale gas operations is to be done according to the NWI then water resources in all aquifers (fresh, brackish or saline) within the shale gas basin, will need to be addressed in a systematic manner. It cannot be assumed an aquifer is an unallocated resource in States where the NWI has been implemented*'.[4]

The ACOLA Report also highlights that while extraction of water for shale gas operations will be significant, only a proportion of this water (from flowback) will need to be stored on the surface for re-use, or once treated, reinjected into suitable geological strata or appropriately discharged to surface waters. It should be noted that the flowback from each well can be up to 7.5 ML and therefore it will be essential for industry to follow best practice and carefully manage the storage, re-use and treatment of flowback.

Produced water

Before gas production begins, water that has been injected during the shale fracture stimulation back-flows from the fractures into the well. During production water, known as produced water, is returned to the surface; this is often saline and may contain dissolved methane and other hydrocarbons, chemicals dissolved from the geological strata, and fracking fluids. In order to avoid damage to the environment and water supplies, produced water must be stored, treated and disposed of appropriately. It is important to follow best practice and regulations to treat and dispose the produced water; inappropriate disposal, even of high quality treated water, can have ecological impacts if the produced water makes its way into ephemeral streams in arid regions.[4]

Produced water can potentially harm aquatic life and crops, as well as streambed erosion from discharges if discharged inappropriately.[4] The ACOLA Report considered that discharge of produced water into streams is unlikely to occur from shale gas operations in Australia provided best practice is followed. However, in the event that it was to occur, discharges would need to be conditioned to ensure the environmental values and water quality objectives were met.[4]

The amount of produced water from shale gas operations over the life of the project is orders of magnitude less than for CSG. Produced water is approximately 0.3 ML per well for shale and can be 7-300 ML/well/year for CSG wells. Therefore, compared to CSG operations, shale gas operations will not face the same disposal and replacement or large volumes of produced water over the life of the project.[4] However, it should be noted that large quantities of water will need to be extracted from surface and/or groundwater resources during the initial stage of shale gas operations, though this does not need to be fresh water. Whilst shale gas operations produce less water overall, the water is generally of poorer quality. Therefore some of the re-use and recycle options used for CSG operations (such as industrial uses, aquaculture and irrigation) may not be suitable for shale operations. The ACOLA Report suggests that as a consequence there '*will be a dependence on suitable hydrogeological conditions which would facilitate re-injection or its safe storage and reuse for further hydraulic fracturing.*'[4]

The process of extraction and disposal of produced water must be managed within regulatory processes. As noted in the ACOLA Report, '*these processes include water entitlements compliant with the National Water Initiative, and aquifer management plans, and are necessary in order to minimise changes to flow regimes in streams and water levels in groundwater aquifers, and the potential for contamination of both types of water resource.*'[4]

<u>The reclamation (rehabilitation) of land that has been hydraulically fractured</u>

'*Shale gas developments can extend over large land areas and have aggregated and cumulative environmental impacts through surface disturbance and clearing of native vegetation for drilling pads, roads, pipelines and related infrastructure.*'[4]

The ACOLA Report noted that it is important to begin to undertake research and collect baseline information on ecological systems, groundwater chemistry, methane emissions, landscape changes and seismic activity.[4] The ACOLA Report highlighted that this research and baseline information will need be at a level of accuracy and resolution to enable any future impacts arising from shale gas activities to be clearly identified at an early stage.[4] This baseline information could assist with future rehabilitation of the land.

Like many other resource-related activities, shale gas activities need to be appropriately managed to avoid impacts to the landscape '*such as destruction and fragmentation of habitats and the overall landscape function, loss of threatened species habitats and ecological communities or an increase of invasive species. The use of cumulative risk assessment and best practice in minimal impact infrastructure will be crucial to the future of the shale gas industry*'.[4] However there will be events that occur and have negative impacts on the environment. Companies will need to adhere to well-defined procedures to limit the impact on the environment and ensure there are steps in place to remediate the land.

Well abandonment is an area that needs to be considered: the ACOLA Report highlights that in Australia there are effective regulations in place covering abandonment for conventional gas wells. However shale gas regulations will need to consider that there could eventually be hundreds of wells, many of them passing through major aquifers. Therefore it is important that best practice is followed in well abandonment and in some instances, long term monitoring of the wells will be required.

Other matters

Induced Seismicity

Overseas evidence suggests there is minor potential for induced seismicity events associated with shale gas operations. The evidence documents only a few cases that involved low magnitude events that were a result of the hydraulic fracturing process. There is more evidence of induced seismicity resulting from re-injection of water after fracturing. Currently in Australia, no seismic risk data for shale gas operations exists, however to minimise the potential of induced seismicity, it will be important to follow best practice mitigation through monitoring the volume and pressure of reinjected produced water and gaining better knowledge of fault structures near shale gas operation sites. The ACOLA Report highlights the need for best practice approaches such as sensing technologies; real-time monitoring systems; and the establishment of 'cease operation' triggers that can minimise the potential for induced seismicity.[4]

Social licence

Gaining and retaining a 'social licence to operate' will be essential to the success of an Australian shale gas industry. Shale gas production will be a National issue and stakeholders at all levels will need to be considered. The ACOLA Report states: '*the magnitude of social and economic impacts associated with resource projects will vary significantly depending on where the development in question is located, the speed and scale at which it occurs, its duration and how it is configured. For instance, the size of the economic multiplier in a local or regional area will be determined by factors such as the size and degree of diversification of the local economy, whether a FIFO* [fly-in fly-out] *or residential model is used, and the extent to which project operators purchase inputs from the local or regional economy.*'[4] Respect, transparency and building trust will be critical elements to securing a social licence to operate.[4] It will be crucial for government and industry to address societal and community concerns on potentially adverse environmental and health impacts of a shale gas industry and to build community confidence in the science and technology associated with shale gas technology.[4] In addition, government and industry will need to demonstrate the ability and preparedness to implement and enforce strong regulatory controls.[4] These will help build the social licence to operate and build community confidence in the regulators, government and industry.

Knowledge needs

The Expert Working Group did not see any technology show stoppers that would stall a shale gas industry in Australia. However as noted in the ACOLA Report there is limited or insufficient understanding of many environmental impacts and surface and subsurface physical, chemical and biological processes.[4] It is therefore critical to undertake baseline surveys and monitoring to ensure the potential environmental impacts of shale gas operations is readily recognisable.[4] Regulators will need to work with industry and the community to determine what constitutes acceptable levels of contamination and in the event of an incident, how it can be adequately remediated or in the case of a significant event, stopped. This process could also involve determination of levels that are acceptable to regulators and the community if a significant issue were to arise. Adequate response systems need to be put in place to assist with risk mitigation.

Summary

In summary, as pointed out in the ACOLA Report, '*the Review did not gain the impression that shale gas in Australia will be a great bonanza that will be easily won. Rather it became evident that whilst shale gas has enormous potential, it will require great skill, persistence, capital and careful management of any impacts on ecosystems and related natural resources, to realise that potential. It will also need an informed and supportive community, and transparent and effective regulations and companion codes of practice. Provided we have all these in place (and the right rocks), shale gas could be an important new energy option for Australia.*'[4]