APPEA Submission to the 'Inquiry into Hydraulic Fracturing in the Northern Territory'

June 2014

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ABOUT APPEA

The Australian Petroleum Production and Exploration Association is the peak national body representing Australia's oil and gas exploration and production industry. APPEA has more than 85 full member companies exploring for and producing Australia's oil and gas resources. These companies currently account for around 98 per cent of Australia's total oil and gas production and the vast majority of exploration. APPEA also represents over 290 associate member companies providing a wide range of goods and services to the industry.

Almost one quarter of APPEA's full member companies have petroleum interests in the offshore and onshore areas of the Northern Territory. Thirteen of these have offshore interests, 11 are investing onshore while three have offshore and onshore interests. APPEA members account for most of the exploration activity currently occurring within granted onshore exploration permits.

THE INQUIRY

APPEA welcomes the opportunity to provide input to the Northern Territory Hydraulic Fracturing Inquiry. The Terms of Reference for the inquiry are restated in Attachment 1.

APPEA hopes that the Inquiry will help to properly inform the public on both the benefits and management of risks associated with hydraulic fracturing and onshore petroleum exploration and development in the Northern Territory. This will enable the community to have an informed and constructive conversation about the development of the onshore oil and gas industry. The Inquiry also provides the opportunity for the Government to consider how to improve and build community understanding and confidence in its regulatory processes. APPEA looks forward to working with Government to address the outcomes of the Inquiry.

Impacts in relation to health, cumulative impacts, seismicity, fugitive emissions, social impacts, groundwater contamination and best practice regulation for onshore natural gas have been considered extensively in the existing literature and other government-initiated inquiries within Australia and overseas.[1] APPEA strongly recommends that this Inquiry closely consider the wealth of science-based material that is already available and utilise the expertise and experience that is available in institutions like the CSIRO, the GasFields Commission Queensland and regulators in states like South Australia and Western Australia.

This submission should be read in conjunction with submissions from APPEA's members which will provide further details about their activities, their use of hydraulic fracturing and approaches to risk management.

[1] See for example publications by the Australian Council of Learned Academies (ACOLA), the International Gas Union and International Energy Agency and recent inquiries conducted by governments in Western Australia, Victoria, the USA and the UK. For more information see http://www.appea.com.au/industry-in-depth/external-reports/

EXECUTIVE SUMMARY

The science indicates that with robust and transparent regulation in place, shale and tight petroleum resources can be developed safely and effectively as an environmentally friendly and economically important energy source. A landmark multi-disciplinary study by the Australian Council of Learned Academies (ACOLA)[2] for example concluded that:

> *"The evidence suggests that provided appropriate monitoring programs are undertaken and a robust and transparent regulatory regime put in place (and enforced), there will be a low risk that shale gas production will result in contamination of aquifers, surface waters or the air, or that damaging induced seismicity will occur."*[3]

The Opportunity

Further development of the Northern Territory's onshore oil and gas resources, including those contained in shale and tight formations, would improve the Territory's long-term energy security and provide a reliable source of energy and gas feedstock for new industrial development. The potential supply of gas to other markets in the eastern states or overseas would help to reduce the growth in Australian and global greenhouse gas emissions and help to improve air quality and living standards in developing countries such as China. Experiences elsewhere have shown that increased oil and gas development would create new employment and business opportunities for regional areas and indigenous communities and greater royalty receipts for the NT Government.

Addressing technical concerns

The key technical issues at the centre of the Inquiry are being managed effectively by the petroleum industry in the way the exploration programs are planned and developed. The process of hydraulic fracturing has been used in the Northern Territory's oil and gas industry since the 1980s and in other Australian jurisdictions since the 1960s. Since that time around 1500 wells in South Australia, Western Australia and the Northern Territory have been hydraulically fractured with no adverse effects on water aquifers[4]. This includes the fracture of 30 wells in the Amadeus Basin in the NT.

The technology that is used to fracture wells accessing conventional oil and gas resources is the same as that used to fracture wells drilled into deeper shale oil and gas resources (regardless of whether the wells are vertical only or also extend horizontally). The types of risks encountered in fracturing conventional oil and gas wells and the management practices used to minimise those risks are the same as those encountered and managed while drilling shale and tight oil and gas deposits. The sizes or level of risk are similar and in some cases lower due to the greater depths associated with shale deposits and hence greater vertical separation between fracture zones and water aquifers. The critical issues around the hydraulic fracturing and development of shale and tight resources have been considered in detail by ACOLA.[5]

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[2] ACOLA comprises the Australian Academy of the Humanities, the Australian Academy of Science, Academy of the Social Sciences in Australia and the Australian Academy of Technological Sciences and Engineering. Together these Academies represent around 2300 of Australia's leading scientists and scholars.

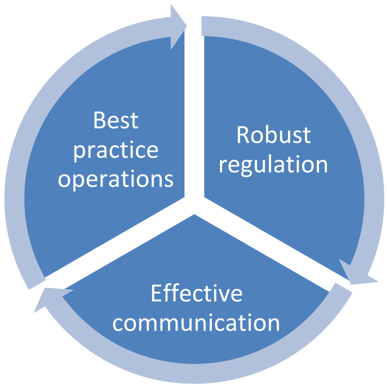
[3] Cook, P, Beck, V, Brereton, D, Clark, R, Fisher, B, Kentish, S, Toomey, J and Williams, J (2013). *'Engineering Energy: Unconventional Gas Production.'* Australian Council of Learned Academies (ACOLA), www.acola.org.au. P. 17

[4] See for example, "*DMP sets the record straight for shale and tight gas*", http://www.dmp.wa.gov.au/7105_17715.aspx

[5] ACOLA

Community Confidence and Industry Development

The industry has the technical capability to safely develop all forms of oil and gas resources. However, expansion of the industry into onshore areas with little previous exposure to oil and gas exploration will require the development of understanding and confidence among local communities and landholders.[6] This confidence will require robust regulation, responsible operator practices and early and effective communication with stakeholders. While addressing the Inquiry terms of reference, this submission will also comment on how the industry is working across these three areas to build confidence and provide several recommendations about regulatory reform.



Regulation

Effective regulation is critical to building community confidence as it ensures that activities are assessed and approved to standards that mitigate risk and minimise environmental impacts. If investment is to be encouraged and maximised, regulation must also be efficient, in terms of avoiding duplication while delivering certainty and transparency. The oil and gas industry is committed to working with the regulator in updating and adapting the onshore regulatory regime to changes in the industry including the development of a shale oil and gas sector. The Northern Territory Government also needs to ensure that its reform process and the outcomes it is delivering are well understood by the community, particularly those with an interest in the land accessed by petroleum explorers and producers.

Industry supports strong risk-based environmental standards, based on scientific assessment and high levels of regulatory certainty. Unnecessary and duplicative regulation imposes unnecessary costs on industry, the community and individuals. Regulatory duplication between jurisdictions should be eliminated and the roles of government agencies including the Department of Mines and Energy (DME) and Environment Protection Authority (EPA) need to be clearly defined. The NT should also learn from and seek to apply the best aspects of regulatory approaches adopted in other jurisdictions such as Western Australia and South Australia.

[6] *'Golden Rules for a Golden Age of Gas'*, International Energy Agency (2012), www.iea.org

RECOMMENDATIONS

1. Recognising that for the majority of issues, good regulatory and operating practices for shale oil and gas will be identical to those for 'conventional' operations, the Inquiry note that the industry is developing principles and guidelines that will promote best practice among operators and provide stakeholders and communities in the NT and elsewhere with accurate information about how the oil and gas industry manages the risks associated with its onshore activities.

2. The NT DME and EPA consider and where possible adopt best practice approaches to shale oil and gas regulation that exist in other jurisdictions. Regulation should be objectives-based (rather than prescriptive) with clear timelines and efficient processes. It should recognise the difference between low impact exploration and potential major project development.

3. The NT DME should retain regulatory responsibility for the environmental management of all low impact exploration and development proposals, including well stimulation activities (such as hydraulic fracturing) forming part of a low impact proposal. The circumstances under which a proposal may potentially have a significant environmental impact or pose significant environmental risk and hence require assessment by the EPA, should be clearly defined.

4. The NT Government ensure the level of resources available to the Energy Directorate of the Department of Mines and Energy keeps pace with the needs of a growing oil and gas industry and enables it to complete its wide-ranging regulatory reform process in a timely and predictable manner.

5. The NT Government improve information sharing and community consultation about its regulatory reform process and the changes being introduced and how these are delivering a regulatory regime that is efficient and effective.

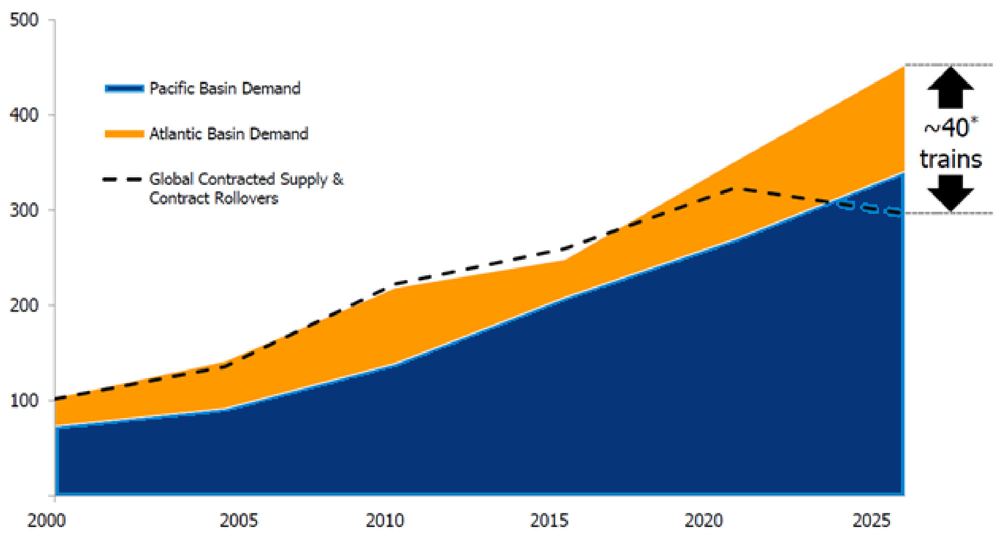
THE ROLE OF OIL AND GAS IN FUTURE ENERGY MARKETS

Globally

Energy is a fundamental enabler of modern societies and lifestyles. Globally, seven billion people use energy each day, making their lives richer, more productive, safer and healthier. The US Energy Information Administration recently projected global demand for energy will increase by 52 per cent between 2010 and 2040.[7] While nuclear and renewable sources will provide increased contributions (2.5 per cent per annum), fossil fuels are expected to supply nearly 80 per cent of world energy needs through to 2040.[8]

Much of this demand will come from non-Organisation for Economic Cooperation and Development (OECD) countries which are expected to increase their energy demand by 90 per cent during this period (compared to 17 per cent in OECD countries).[9] Natural gas will continue to play a critical role in meeting the world's demand for energy, particularly for countries in the Asia Pacific region. The International Energy Agency recently estimated that Southeast Asia's energy demand will grow by over 80 per cent between now and 2035 (a rise equivalent to current demand in Japan).[10]

Figure 1 - Global Liquefied Natural Gas (LNG) Demand and Supply



Source: Santos 2013

Sustained growth in China and continued strong demand in Japan and Korea have driven gas demand and prices in world energy markets. Recognition of the environmental benefits of gas, in particular the contribution it can make to reducing greenhouse gas emissions, is also supporting the growth in gas demand. Gas will continue to be an important part of a diverse, environmentally friendly and affordable energy mix for decades to come.

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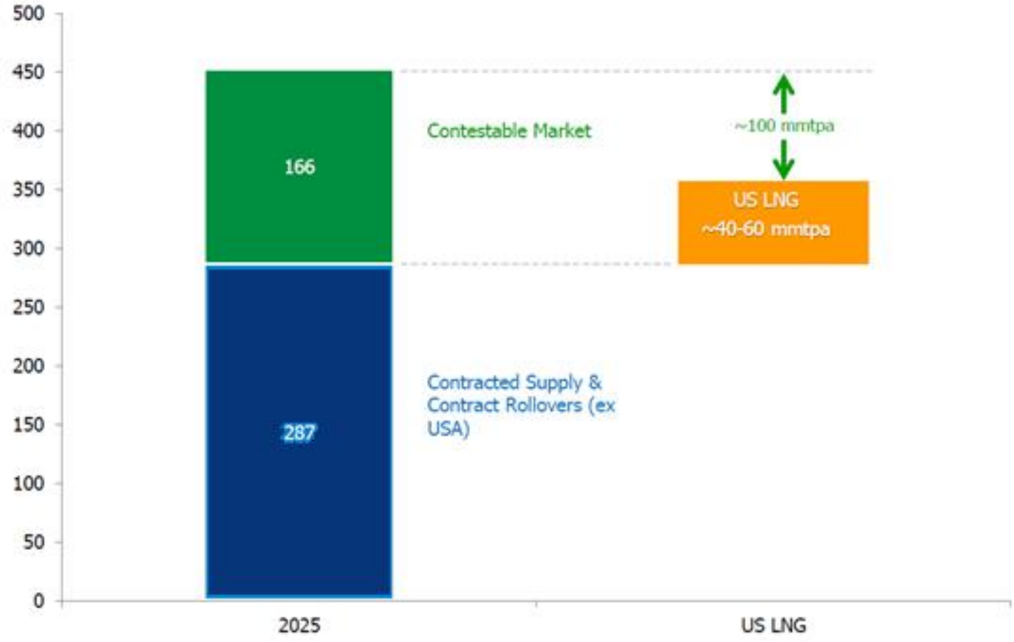
[7] 'EIA projects world energy consumption will increase 56per cent by 2040', US Energy Information Administration, (2013) http://www.eia.gov/todayinenergy/detail.cfm?id=12251 [Accessed 17/09/13].
[8] Ibid.
[9] Ibid.
[10] 'Southeast Asia Energy Outlook', International Energy Agency, http://www.iea.org/publications/freepublications/publication/SoutheastAsiaEnergyOutlook_WEO2013SpecialReport.pdf

These factors have changed the dynamics of key international resource, product and capital markets and have encouraged the growth of the Australian gas industry at higher levels than was expected five years ago.

Figure 2 - Global LNG demand vs US LNG Supply in 2025



Source: Santos 2013

The opportunity for Australian LNG

To help meet this growing demand, Australia's LNG production capacity will increase at unprecedented levels to over 80 million tonnes per annum by 2017 at current construction and expansion rates. Almost $200 billion is currently being invested in oil and gas projects across Australia including seven major LNG projects, which will deliver large economic benefits to the nation. The increased production capacity will propel Australia towards being the world's second largest LNG exporter behind Qatar with the potential to become the largest.

This expansion is underpinned by Australia's position at the cusp of a major shift in the world's economic weight from west to east. The economic advance of our region is overwhelmingly positive for Australia. It plays to our comparative advantages as a secure and reliable energy exporter and our close proximity to key export markets.

However, the world will not wait for Australia to develop its resources to their full potential. The competition for LNG investment and markets is increasing with a large number of new LNG projects being planned in the USA, Canada and east Africa. These are also targeting the Asian gas market in direct competition with Australia.

Domestic gas market growth

Domestically, Australia's energy demand is expected to increase by 29 per cent between 2008 and 2035. Petroleum products, which represented 39 per cent of energy consumption in 2011-12, will meet most of this demand. Into the future natural gas will continue to supply energy to various industries (e.g. mining), households (e.g. hot water, stove tops) and sectors such as transport (e.g. compressed natural gas bus fleets).

The Northern Territory is particularly dependent on the continuing availability of competitively priced gas supplies for electricity generation and industrial development. Most of the electricity used by households and industry in the Top End is generated from gas piped from the Blacktip Gas Plant located 240 kilometres south-west of Darwin (near Wadeye). The plant is supplied by an unmanned platform located approximately 110 km offshore in the Joseph Bonaparte Gulf. The Blacktip Project, which is 100 per cent owned and operated by Eni, has been delivering gas to the NT for power generation since September 2009.

Prior to the development of Blacktip, Darwin's gas supplies came from the Mereenie field near Alice Springs which commenced production in 1984 (oil) and 1987 (gas). Oil is currently trucked south to Port Bonython, whereas gas is reinjected into the main oil production reservoir while new gas sales contracts are actively being sought. In April 2013 Santos committed to a $100 million drilling and appraisal program over Mereenie targeting oil and evaluating natural gas in the sparsely drilled western and central areas of the field.

Also in the Amadeus Basin, the Palm Valley and Dingo gas fields are wholly owned and operated by Central Petroleum. The Palm Valley field has been in production since 1983 using the Amadeus-Darwin gas pipeline to transport gas to its customers in the NT. The Dingo gas field was discovered in 1981 and development has commenced following the recent signing of a long-term gas sales agreement with Power and Water Corporation for the sale of up to 31 PJ of gas (30 Bcf) over a 20-year period from 2015.

In the longer term new supplies of gas will need to be secured to meet Darwin's growing electricity generation market and to provide energy for new industries such as chemicals processing. These needs cannot be met by renewable energy sources alone so it is important that the NT maintain an active gas exploration industry.

Opportunities for the NT

The economic benefits generated from the development and use of gas could be multiplied many times over through the expansion of the Territory's LNG production capacity or the development of pipelines to the eastern states. The NT is well placed to help meet the growing gas needs of Australia's eastern states gas market by developing new pipeline connections to hubs such as Moomba. These would provide the market opportunity to support the earlier development of the NT's gas resources and on a much larger scale than would be possible by reliance on the NT market alone. With the increasing challenges and cost of offshore gas developments, it is likely that onshore gas fields will become more prominent sources of natural gas supply for the Northern Territory. In addition to reinforcing the Territory's energy security, onshore natural gas (and oil) production have the potential to provide significant benefits to regional areas and to the Northern Territory Government through increased royalty receipts.

THE IMPORTANCE OF INNOVATION

Over many decades of petroleum developments, the industry has employed innovative solutions to respond to cost pressures and technically challenging environments. Cost effective technologies have been developed by the industry to both extract and transport gas. The development of LNG technologies made natural gas available to more distant markets that could not be reached by pipeline at the time. This helped globalise trade in natural gas, opening up new markets around the world. Innovative technologies to commercialise gas have continued to develop, as has been demonstrated by the development of Floating Production, Storage and Offtake (FPSO) vessels and trans-continental pipelines.

More recently in the United States, the application of horizontal drilling and hydraulic fracturing techniques has enabled the extraction of natural gas from shale rock formations at a competitive cost. In 2000, shale gas provided only one per cent of U.S. natural gas production; by 2010 it was over 20 per cent and the US government's Energy Information Administration (EIA) predicts that by 2035, 46 per cent of the United States' natural gas supply will come from shale gas.

The driving force behind this shift is that it has become economically feasible to extract unconventional sources of gas that were previously considered inaccessible. The use of horizontal drilling has become a standard industry practice since the first true horizontal oil well was drilled in the 1920s. Whereas a vertical well allows access to tens or perhaps hundreds of metres of a formation, a horizontal well can be drilled to conform to the formation and can therefore extract gas from thousands of metres of shale.

However, horizontal drilling alone would not have enabled exploitation of the unconventional gas resources because the reservoir permeability is not sufficient to achieve economical gas production by natural flow. Hydraulic fracturing was developed in the 1940s to fracture and increase permeability of target formations and has since been improved to match the characteristics of specific types of reservoirs, including shales.

It was the combination of hydraulic fracturing and horizontal drilling that led ultimately to the shale gas "revolution" in the United States. While other factors were present (pipeline infrastructure, proximate large domestic market, large local services sector), a recent review of the emergence of shale gas development in the US found that of all the factors that converged in the early 2000s to make it profitable for firms to produce large quantities of shale gas, the most important was technology innovation.[11]

Contrasted with energy shortages in Europe, the success of the US experience has led some to conclude that "governments must support the realities of economics and technology." Chatham House recently summed up the current climate for energy projects when it stated that "the oil and gas industry is more competitive than ever"[12]. Within this environment of high competition, oil and gas companies have also been forced into more challenging environments to develop energy resources to meet the world's demand. Research by Wood Mackenzie indicates that more than half of the international global oil and gas companies are focusing on long-term capital investments in deepwater, shale/tight oil, shale gas and oil sands.[13]

It has therefore become critical for companies to innovate and push the technological evolution of the industry. Another example of this is the development of Floating LNG (FLNG) in response to cost and technological barriers.

Developments in technology, including advances in drilling and hydraulic fracturing and the advent of FLNG, are critical to the future of the industry and to host regions such as the NT. Advances in

[11] Z. Wang, A. Krupnich, 'A Retrospective Review of Shale Gas Development in the United States: What Led to the Boom?', Resources for the Future, 2013, http://www.rff.org/RFF/documents/RFF-DP-13-12.pdf, P.3.
[12] Chatham House, John Mitchell, *What Next for the Oil and Gas Industry?*, October 2012, P. 64
[13] The Wall Street Journal, Guy Chazan, *Big Oil Heads Back Home*, 5 December 2011, available at: http://online.wsj.com/article/SB10001424052970204479504576638731600191382.html

drilling technology are enabling the Territory's deep shale resources to be accessed and Darwin is set to become a major supply base to FLNG projects under construction or being planned in Australia's northern waters.

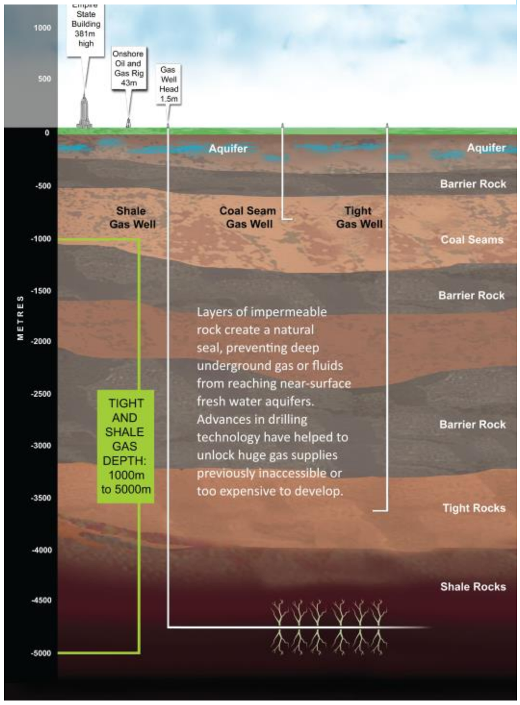
ONSHORE NATURAL GAS IN THE NT

This section relates to Terms of Reference 1.

There is no material difference between the composition of natural gas retrieved from conventional sources (e.g. the gas exported through the Darwin LNG project) and natural gas from shale or tight rock sources. The key difference between "conventional" and "unconventional" natural gas is the manner, ease and cost associated with extracting the resource. Shales are fine-grained sedimentary rocks formed from the compaction of silt and mud. 'Tight' rocks are typically limestone and sandstone. Both shale and 'tight' rocks have very low levels of permeability and are found deep underground, typically at depths of between one and five kilometres.

In addition to the significant conventional oil and gas resources located in onshore basins such as the Cooper and Amadeus (that have been and will continue to be developed through the selective use of hydraulic fracturing), the US EIA has estimated that Australia's onshore basins could possess even larger recoverable resources of 17.5 billion barrels of shale oil and condensate and 437 Tcf of shale gas[14]. These figures suggest Australia could have the sixth and seventh largest global reserves of shale oil and gas respectively. The NT's shares of Australia's shale gas reserves are estimated to be 56 Tcf of risked recoverable and 262 Tcf of potential resources. As noted by the EIA, these estimates are uncertain given the relatively sparse data that currently exist and more exploration will need to be undertaken to determine whether these figures are indicative. They also do not account for some of the other basins considered to be prospective for shale oil and/or gas.

Figure 1: Underground Gas Resources



As indicated in Figure 2 exploration for conventional and unconventional oil and gas is currently being focussed on the Macarthur, Bonaparte, Beetaloo, Georgina and Amadeus basins. Activity is divided between "brownfields" exploration around known fields (in particular the Mereenie field in the Amadeus Basin west of Alice Springs) and "greenfields" exploration in areas which have seen very little if any exploration activity. In those situations, little is known about the nature and size of any underground resources so companies often target conventional and unconventional forms of petroleum when conducting exploration activities such as geomagnetic surveys, seismic and drilling.

[14] Based on the risked recoverable levels of the Georgina, Beetaloo, Maryborough, Canning and Cooper Basins. See 'Technically recoverable shale oil and shale gas resources', US Energy Information Administration (2013), http://www.eia.gov/analysis/studies/worldshalegas/ [Accessed 17/09/13].

Outside of the Amadeus Basin, exploration activity is still at relatively low levels with less than a dozen deep shale wells drilled to date in the NT. Most of the exploration activity during 2013 was in the form of geotechnical studies and seismic programs with just two wells completed and nine wells commenced during the year. Eight of the 11 wells drilled or commenced in 2013 were operated by Santos and located in the Mereenie production leases. Santos also commenced a well (Mt Kitty) in a permit to the south west of Alice Springs and Armour Energy drilled one well and commenced another in the Beetaloo Sub Basin (south of the Gulf of Carpentaria and near the Queensland border).[15]

Drilling activity is expected to increase in 2014 with plans for around 25-30 wells to be drilled across the Territory targeting a mixture of conventional and unconventional resources. Not all of these wells will be extended horizontally or hydraulically fractured and some will be shallow stratigraphic wells to obtain core samples for further analysis. Up to one half (12-15) of these wells may be hydraulically fractured during the course of the current dry season drilling campaign.

These levels of activity indicate that claims being made by some groups that thousands of wells are being drilled and hydraulically fractured across the Territory are grossly exaggerated. Permit work commitments published by the DME are for an average of around 20 wells drilled per year to 2017. While these represent a minimum level of activity, the high cost and limited availability of rigs and experienced crews capable of drilling deep wells will clearly be a constraint on growth.

The Georgina Basin is a region of proven oil potential with target horizons ranging from 300 metres (m) to 1000 m. It is a sparsely explored green field area which has all the attributes of a productive hydrocarbon province.

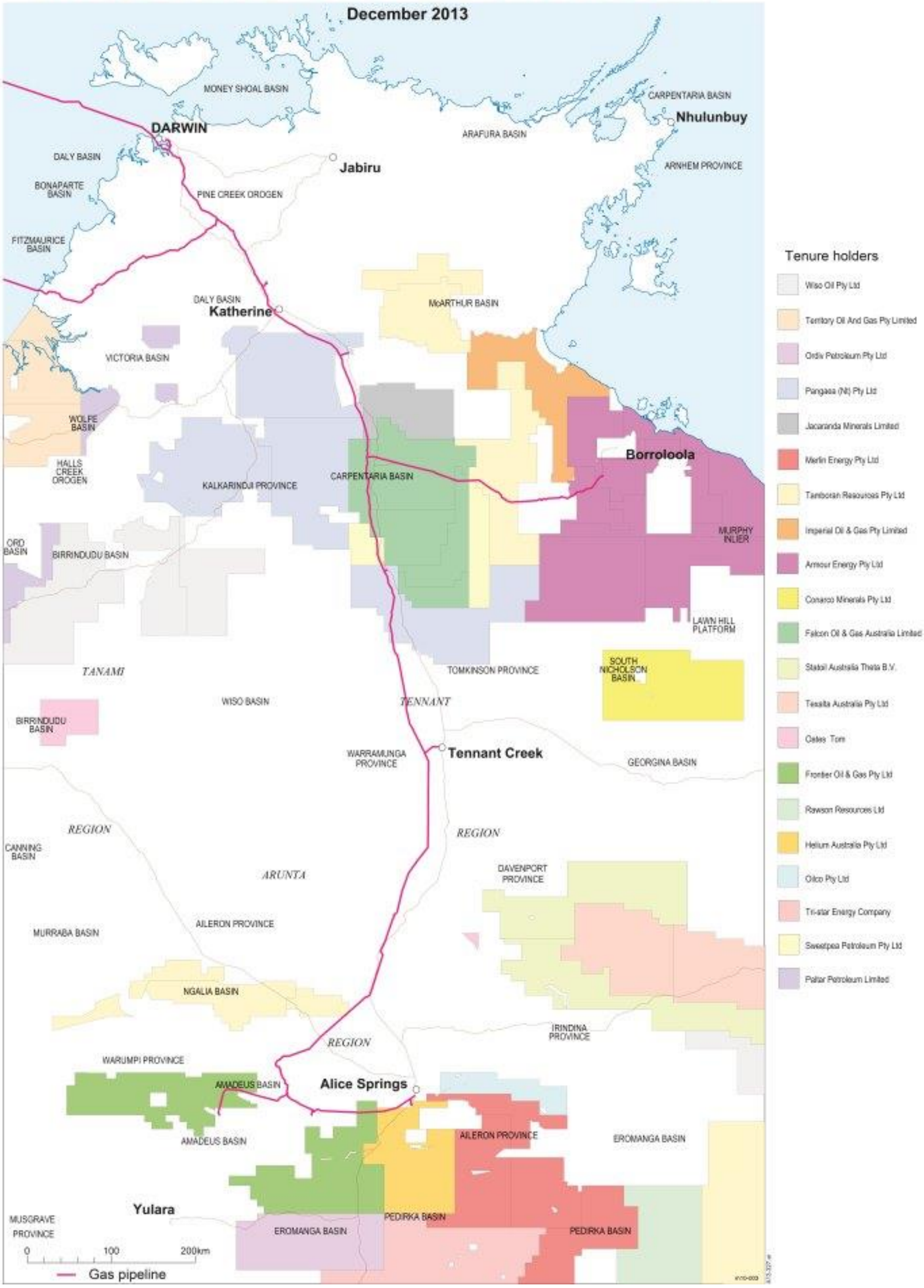
The Beetaloo Basin, located around 500 km southeast of Darwin, has been identified as one of the few remaining virtually unexplored, onshore sedimentary basins in the world. The basin is more than 3000 m thick and there is evidence that both unconventional and conventional hydrocarbons are present. The current pipeline is too small to be of any significant use for the transport of gas and would need to be looped or duplicated. Petroleum liquids could be transported by road or rail.

The McArthur Basin is a petroleum frontier basin with indications of oil and gas although no prior shale gas exploration or production activity. The target for shale gas is predominantly the Barney Creek and equivalent formations which have both conventional and unconventional prospects. Additionally, the Velkerri Formation within the Roper Group has also shown potential for significant gas volumes. There is an existing 700 km pipeline from the McArthur River to Darwin and access to the Carpentaria Highway.

Recent exploration by Armour Energy in the southern McArthur basin has reported significant finds of gas in the Glyde Sub-basin and Barney Creek formations. Modelling and field work conducted by Imperial Oil & Gas in conjunction with the Adelaide Research Institute has found that large portions of the middle and northern McArthur basin are highly prospective for both oil and gas. This research has been supported by recent exploration by Armour Energy. Further modelling and mapping work has identified high potential for oil and gas between the Arafura Sea in the North to the Carpentaria Highway in the south.

[15] See http://www.nt.gov.au/d/Minerals_Energy/Content/File/pdf/PetroleumSummaries/2013_EnergyNT.pdf

Figure 2 - Petroleum Explorers in the NT



Source: NT Department of Mines and Energy

BENEFITS OF OIL AND GAS

Economic Benefits

The petroleum exploration and production industry is an integral part of the Australian economy. The industry's direct contribution includes:

- the supply of reliable, clean, efficient energy supplies for households and industry;
- employment of tens of thousands of Australians;
- regional investment;
- export income (and the replacement of imports); and
- the payment of significant amounts of government tax revenues (on average, more than $7 billion per annum over the last five years).

In addition, substantial indirect benefits flow from the industry, including to the national, state and NT economies via a growing services and contractor sector. Reliable, secure and competitively priced energy is crucial to industry, our communities and households. It underpins Australia's economy and industrial structure. Within this framework, oil and gas plays a key role. In 2012-13, petroleum (oil and gas) accounted for 55 per cent of Australia's primary energy consumption and this is projected to increase to 80 per cent in 2049-50.[16]

The construction of seven LNG projects in Australia is expected to increase GDP by up to 2.2 per cent a year and require a construction workforce peaking at over 100,000 full-time equivalent jobs. By 2025, the construction and operation of these projects will add more than $260 billion to Australian GDP and contribute between $7.9 billion and $12.1 billion a year in taxation revenue. This is just the contribution of the first wave, only considering currently committed and under construction projects.

Once operational, the Ichthys and other LNG projects will also help reduce the growth in global greenhouse gas emissions, improve Australia's energy security and increase the competitiveness of our energy markets. They will also provide a long-term boost to jobs and income for service industries and tax revenues for governments.

There is also $180 billion of investment in the planning stage, and bringing this investment to operational fruition would benefit the entire nation: GDP would increase by 1.5 per cent and approximately 150,000 jobs would be created[17].

The development and availability of natural gas will have broad benefits, as demonstrated by the recent and rapid transformation of the North American energy sector which has significantly bolstered the US economy. The global forecaster IHS recently found that the resurgence in onshore gas and oil in the US had created at least 1.7 million jobs across the US in 2012 with estimated growth to 2.5 million jobs by 2015.[18] The US shale gas industry has generated US$63 billion in government revenues and this is expected to increase to US$113 billion by 2020.

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[16] 'Energy Projections to 2050', Bureau of Resources and Energy Economics (2012). See http://bree.gov.au/documents/publications/aep/Australian-Energy-Projections-to-2050.pdf

[17] McKinsey & Co (2013), *Extending the LNG boom: Improving Australian LNG productivity and competitiveness*, May (available at www.mckinsey.com/locations/australia/knowledge/pdf/extending_lng_boom.pdf).

[18] 'America's New Energy Future – The Unconventional Oil and Gas Revolution and the US Economy', IHS Global Insight (2013), http://www.ihs.com/info/ecc/a/americas-new-energy-future-report-vol-2.aspx, [Accessed 17/09/13]

While these figures are derived from a very mature and likely significantly larger industry than the NT will see, the US experience has demonstrated that benefits can flow to adjacent states that have little or no production in addition to those that host the industries. Large economic contributions have been seen through the delivery of critical goods and services that are vital to the oil and gas supply chain.[19]

A similar success story has been seen in Australia with Queensland's coal seam gas industry identified as a significant contributor to the State's economy through job creation. In Queensland more than 40,000 people, direct employees and contractors, were working in the industry as at the end of 2013. Direct employment totalled 6821.

Between January 2011 and Q4 2012, economic flows from the CSG industry to Queensland communities was valued at over $97 million. While offshore LNG projects are generally an order of magnitude beyond a shale or tight gas project in terms of scale, they do provide an indication of the type of community benefits that can flow from energy developments.

In Western Australia, the offshore oil and gas sector has been operating and supporting local communities in the State's north-west for over 25 years, including significant investment in community infrastructure and social initiatives across the region.[20] For example, the North West Shelf project currently spends approximately $600 million per annum with Australian-based businesses for operational activities.

The NT is sharing in the benefits from the current wave of LNG investment. The Ichthys LNG Project for example, has a construction workforce of up to 4,000 people and is generating employment and business opportunities among NT-based suppliers. To date more than 130 NT-based businesses have secured 170 contracts or supplier purchase orders with the project and ultimately, around $5 billion is expected to be directed towards local suppliers including Aboriginal and Torres Strait islander businesses. A partnership between INPEX, the Chamber of Commerce and Industry NT and the NT Indigenous Business Network (NTIBN) has formed an Indigenous Business Capability initiative which will give Indigenous businesses access to a range of services and events provided by the Chamber, including workplace health and safety programs, training and networking opportunities. To date, more than 400 Aboriginal and Torres Strait Islander peoples have been employed by the Ichthys Project, including 90 trainees, and 37 businesses have been engaged on 76 scopes of work.[21]

The Project has invested in new training facilities with an A$3 million investment in the construction of the Larrakia Trade Training Centre and A$3 million to help establish the North Australian Centre for Oil and Gas at Charles Darwin University. Infrastructure associated with the project will provide long-term benefits for the NT well beyond the completion of the current construction phase, such as the $22.5 million spent to date to improve community road infrastructure and safety.

Darwin-based suppliers are not only gaining business from this and other oil and gas projects but in some cases have also captured significant volumes of work from projects in Queensland and Western Australia. These types of improvements to the capacity and competitiveness of the NT's oil

[19] Ibid.
[20] 'The wider contribution to Australia of the Oil and Gas Industry', Australian Venture Consultants (2012), P. 15.
[21] Ichthys Project Bulletin May, http://www.ichthysproject.com/media/bulletins/archive/201405

and gas services sector, without government subsidies or assistance, will deliver large, long-term benefits to the NT and Australian economies.

In addition to the economic activity generated from these projects, the energy sector also has a history of supporting projects within the communities in which they operate, including investment in infrastructure, education and research (e.g. health and environmental).

The development of a shale and tight gas industry in the NT would have significant social and economic benefits depending on the location, speed, scale, duration and configuration of new project developments.[22] ACOLA notes that economic diversification that leverages energy projects is the best way of contributing to the long-term wellbeing of a region. The NT onshore gas industry has the potential to expand and diversify economies in regional areas now faced with limited growth opportunities and to provide an alternative source of income for pastoralists and indigenous communities (through community development programs, local contract work and employment opportunities).

Case Study: Intract Indigenous Contractors at Mereenie

In 2013, Intract Indigenous Contractors won an earthworks contract with Santos' Mereenie drilling and appraisal program. The contract included the construction of lease pads for the drill rigs, new buildings and accommodation camp and about 40 kilometres of roads. The work provided training and employment for members of the local community that will assist them in gaining further work in the industry.

"It's great to work out here on my land see, and a lot of my nephews and that, they can see what I'm doing and it might encourage them to do the same. I've learnt a lot of stuff here and I'd like to see more young men like me doing the same."[23]

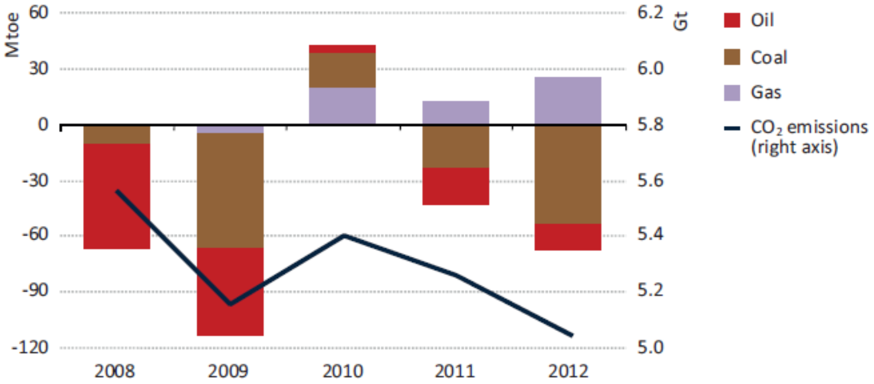
Greenhouse Gas Emissions Reduction Benefits

The development of a shale and tight gas sector has the potential to provide a number of other positive benefits including the reduction of greenhouse gas emissions. In June 2013, the International Energy Agency (IEA) released a report noting that emissions from the United States had fallen by 3.8 per cent (200 million tonnes) over the previous year. In total, US emissions have fallen between 400 and 500 million tonnes – twice the reduction achieved in the rest of the world as a result of the Kyoto Protocol.

The IEA attributed this fall to the increased uptake of natural gas, in particular from shale sources, which replaced coal in power generation, as indicated in Figure 3 below.

[22] ACOLA. P. 153
[23] Anslem Impu Jnr, ABC 7.30 NT Report, http://www.abc.net.au/news/2013-06-21/gas-and-oil-expansion-generates-work-for/4773150

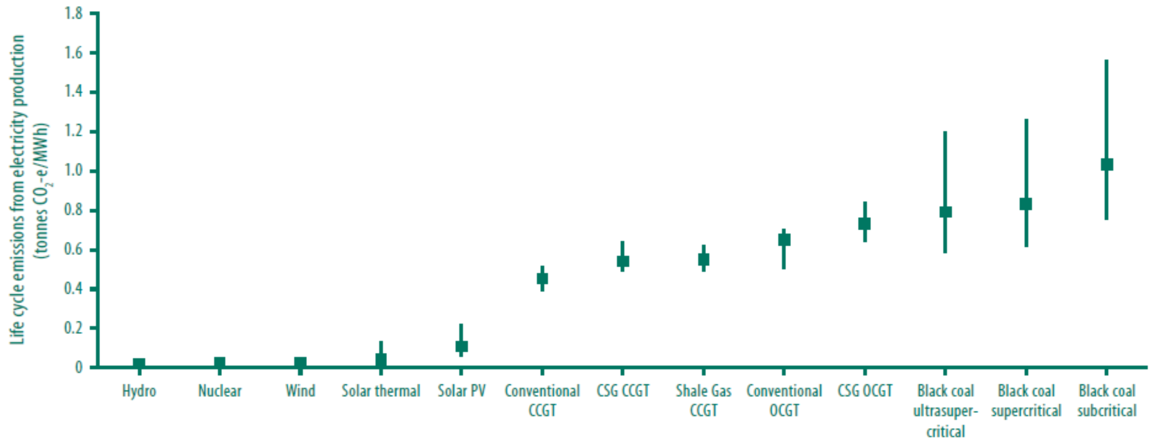
Figure 3 - Change in fuel consumption and total energy-related CO_2 emissions in the US



Source: IEA[24]

Natural gas currently offers the cleanest viable source of baseload and peaking power in Australia. This is supported by evidence out of the US which highlights falling carbon emissions as a result of the uptake of shale gas. Within Australia it is expected that increased access to shale and tight gas would likely decrease the contribution of coal-fired generation (as happened in the US) to the electricity mix.[25] This conclusion has also been supported by a recent study from the UK Department of Energy and Climate Change and the ACOLA report in Australia, as illustrated in Figure 4 below.[26]

Figure 4 – The range of life cycle emissions for electricity generation (tonne CO_2e/MWh)



Source: ACOLA

Some critics of natural gas, in particular the increased use of shale and tight gas, have made clear their opposition to the industry because it delays the transition to renewable energy.[27] This

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[24] 'Redrawing the energy-climate map', International Energy Agency (2013), http://www.worldenergyoutlook.org/media/weowebsite/2013/energyclimatemap/RedrawingEnergyClimateMap.pdf, [Accessed 17/09/13].
[25] ACOLA. P. 17
[26] MacKay, D, Stone, T, 'Potential Greenhouse Gas Emissions Associated with Shale Gas Extraction and Use', Department of Energy and Climate Change (2013), https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/237330/MacKay_Stone_shale_study_report_09092013.pdf, [Accessed 17/09/13].
[27] "We want to see more renewable energy and energy efficiency and will continue to campaign against the development of unconventional gas and oil, coal and nuclear as future energy options." Environment Centre NT Public Hearing Transcript, Committee on the Northern Territory's Energy Future, 24 February 2014. http://www.nt.gov.au/lant/parliamentary-business/committees/future%20energy/Inquiries.shtml

argument ignores the evidence and experience in the US for example, which show that natural gas provides the quickest, most economically efficient and reliable opportunity to reduce Australia's carbon emissions.

The scale and benefits of shale and tight gas developments will vary from region to region but will need to be supported by effective strategic planning to ensure impacts are minimised, benefits are maximised and coexistence is maintained.

The Roundtable for Unconventional Gas in South Australia hosted by the Department of Manufacturing, Industry, Trade, Resources and Energy is a good example of such a planning process. Such planning, when supported by communication, information sharing and transparency, ensures that the benefits to the community from a potential industry are maximised (including components of projects such as surface infrastructure).[28]

SAFE AND RESPONSIBLE OPERATOR PRACTICES

The industry is focussed on carrying out all aspects of its activities safely and in a sustainable manner and this section outlines current practices to achieve this. In particular, the industry understands and agrees that conservation and protection of ground water is a top priority. Key factors which protect the environment during natural gas production include:

- Rigorous well construction standards to protect aquifers;
- Isolation of all fluids that might have a detrimental impact;
- Well designs that ensure numerous failsafe levels of protection; and
- Full disclosure and consultation with communities and Government agencies before, during and after all activities.

Many of these practices are detailed in the industry's voluntary Code of Practice for Hydraulic Fracturing (see Attachment 2).[29]

The industry supports the findings of ACOLA that resources can be extracted in a manner and in locations that do not compromise agriculture, water resources, alternative land uses and landscape function. [30]

THE USE OF HYDRAULIC FRACTURING IN A SAFE AND SUSTAINABLE WAY

This section relates to Terms of Reference 2, 3, 5 and 7(b).

The use of multi-stage hydraulic fracturing represents best practice within the industry for accessing low permeability, conventional and unconventional oil and gas resources on a commercial basis. Provided in Attachment 3 is an outline of how the process works and detailed below are the ways in which the industry uses it safely and sustainably.

When combined with horizontal drilling, multistage hydraulic fracturing techniques are prime examples of the importance of innovation in the oil and gas industry to overcome technical

[28] ACOLA. P. 154
[29] 'Code of Practice for Hydraulic Fracturing', Australian Petroleum Production and Exploration Association (2011), http://wa-onshoregas.info/sites/wa-onshoregas.info/files/APPEA_Code_of_Practice.pdf, [Accessed 17/09/13].
[30] ACOLA P. 98

challenges. These techniques and technologies have been developed over decades of research, trial and testing and are safe and sustainable ways of developing resources when best practice is followed by operators.

Hydraulic fracturing has also been used extensively within Australia. Since the early 1980s, Santos has hydraulically fractured 30 wells in the Amadeus Basin. In South Australia, the technique has been used for conventional petroleum extraction more than 685 times over the last 40 years and in Western Australia it has been used more than 780 times (including 734 times on Barrow Island). Located off the coast of Western Australia, Barrow Island has been identified as an 'A' Class nature reserve – the highest level of environmental protection afforded in the State. Hydraulic fracturing is also commonly used by oil and gas operators in Australia's offshore waters.

Since the 1960s, around 1500 wells in South Australia, Western Australia and the Northern Territory have been hydraulically fractured without adverse impacts on groundwater.

Hydraulic fracturing can also be used in geothermal energy production and to stimulate water flows. Its use in oil and gas wells has generated concerns that:

- a fracture may extend up through the formations and enter a water aquifer thereby contaminating the water; and
- the risks of environmental damage are much higher for horizontal well fracturing compared to vertical well fracturing.

It is not possible for a fracture to rise vertically a thousand metres or more to reach shallow water aquifers. Each well and fracture operation is specifically engineered based on the geology, geomechanics and well parameters.[31] Fracture behaviour typically depends on a variety of site-specific factors, including:

- the physical properties, types and thicknesses of the objective formation and the surrounding formations;
- the presence of existing natural fracture systems and their orientation;
- the amount and distribution of stress through the target and surrounding formations
- the design of a particular stimulation, including the volume of fracturing fluid injected into the subsurface, the fluid injection rate and the fluid viscosity; and
- placement of casing perforations.

In light of these factors, the propagation of fractures is controlled through various techniques including careful selection of fluids, their volumes and pumping rates. Taking these factors into account, fracturing stages are designed and controlled in ways that limit fractures to only the formation of interest, thereby maximising the commercial extraction of hydrocarbons and minimising fracturing costs.

Operators in the NT have indicated that depending on the stratigraphy and well design parameters, fractures extend to a maximum of 150 metres around the well bore (regardless of whether the fracture zone is located in a vertical or horizontal well). Fracture growth can be monitored through a variety of means, including microseismic techniques that provide an image of the fractures by

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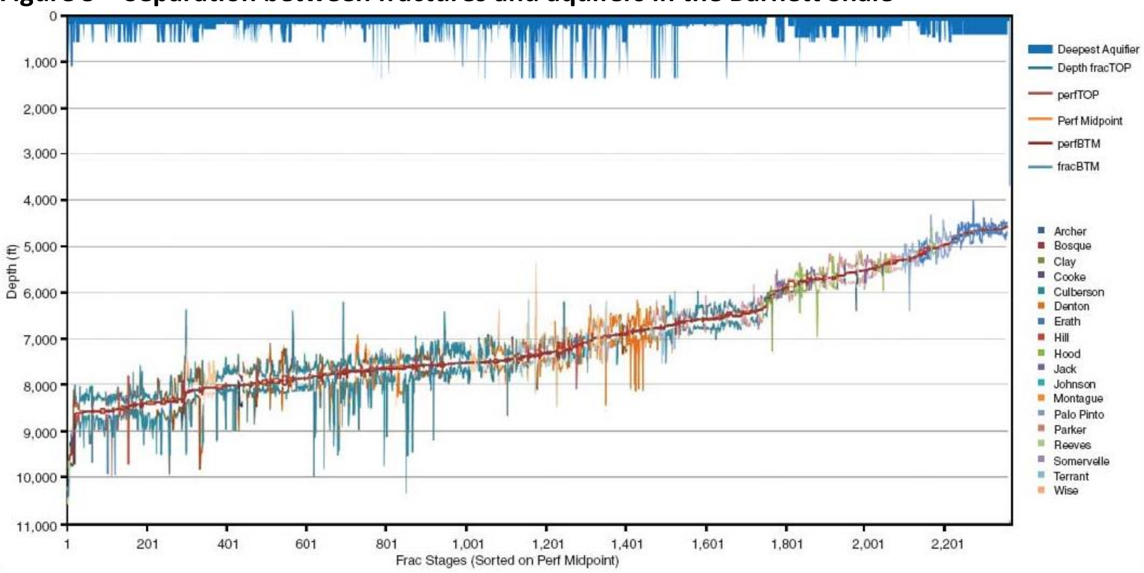
[31] For further information see "*National Human Health Risk Evaluation for Hydraulic Fracturing Fluid Additives*" prepared by Gradient Corporation for Halliburton Energy Services, May 2013. http://www.energy.senate.gov/public/index.cfm/files/serve?File_id=53a41a78-c06c-4695-a7be-84225aa7230f

detecting microseisms that are triggered by shear slippage on bedding planes or natural fractures adjacent to the induced fracture.

Every vertical and horizontal well utilises high strength materials, including concentric layers of cement around multiple layers of steel casing that are selected to meet that well's engineering specifications and design parameters. Compared to conventional oil and gas fields, deeper shale wells have greater separation from water aquifers and generally have multiple natural barriers and formations with very low permeability above the fracturing zone. The fracturing of horizontal wells is therefore no riskier than fracturing vertical wells.

Microseismic studies undertaken in the Cooper Basin and extensive research on hundreds of wells in the US have conclusively demonstrated that the fractures induced by the process are normally confined to the rocks close to the zone of interest. The following chart shows the relative separation of aquifers from fractures, with the maximum extent of the induced fractures and their relation to the aquifers.

Figure 5 – Separation between fractures and aquifers in the Barnett Shale



Source: FracFocus[32]

The industry believes there is clear evidence that the technology has been and will continue to be applied safely and sustainably in the Northern Territory.

CONSTRUCTION OF WELLS TO EXACTING STANDARDS

This section relates to Terms of Reference 5 and 7(b)

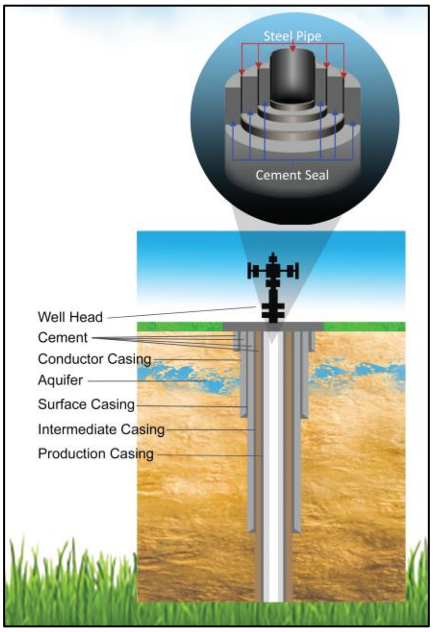
Petroleum producers construct wells to the highest standards to ensure that gas is kept within the well and water is kept out. Responsible companies will rely on established standards relating to well design, well construction, well integrity management and well abandonment that adhere to practices published by organisations such as the American Petroleum Institute. These meet or commonly exceed expectations of the regulator and are subject to review and audit. In addition to

[32] 'Hydraulic Fracturing: The Process', FracFocus, http://fracfocus.org/hydraulic-fracturing-how-it-works/hydraulic-fracturing-process [Accessed 17/09/13].

meeting regulatory requirements, companies have a significant financial incentive to ensure that there is no connectivity between a well and surrounding aquifers. Any loss of hydrocarbons from a well reduces the amount that is produced and sold.

In addition to complying with regulatory requirements and industry standards, the design of a particular well will take into account a variety of site-specific factors, including the depth of the target formation, the presence of intervening formations containing gas that must be isolated, the presence and depths of aquifers to be isolated and the anticipated pressures to which the well will be subject, among others. However, certain fundamentals are characteristic of all modern shale gas wells and other wells used for producing oil and gas from unconventional formations.

Figure 6 – Separation from aquifers



As demonstrated in Figure 6, multiple layers of steel and cement, along with extensive surface safety equipment, are used to keep the gas and fluids inside the well and under control as they pass through shallow formations with drinking water aquifers. The design, construction and completion of a well to the highest standards is recognised as one of the most important ways of ensuring that the environment is protected throughout operations. When a well is properly constructed it provides a strong, long lasting seal that isolates the well and deep gas formations from aquifers.

A 2011 report from the US Ground Water Protection Council examined more than 34,000 wells drilled and completed in the state of Ohio between 1983 and 2007, of which a total of 12 had issues related to well construction.[33] Of 187,000 wells drilled in Texas the study found that there were two incidents relating to well construction. Most of those incidents (more than 80 percent) occurred in the 1980s and 1990s before improved cement formulas and regulations were in place. Similar to performing a service on a car, these wells required routine maintenance on the casing or cement.

Importantly, there have been no cases where hydraulic fracturing has been identified as the cause of groundwater contamination.[34]

Ensuring that well integrity is maintained throughout the life of operations is critical to safety and the protection of the environment. The risk of a well casing failure in Australia is low because the industry is committed to ensuring that wells are constructed and maintained to the highest standards.[35] APPEA is not aware of any problematic, abandoned oil and gas wells in the Northern Territory.

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[33] Kell, S, 'State Oil and Gas Agency Groundwater Investigations And their Role in Advancing Regulatory Reforms', Ground Water Protection Council (2011), http://www.gwpc.org/sites/default/files/event-sessions/05Kell_Scott_0.pdf [Accessed 27/09/13].
[34] Peterson, J, Hamilton, H, 'No contamination from Fayetteville Shale Exploration Found in Sampled Wells', United States Geological Society (2013), http://www.usgs.gov/newsroom/article.asp?ID=3489#.UjfgtEqQ-70 [Accessed 17/09/13] ; 'EPA's Lisa Jackson on Hydraulic Fracturing', EnergyInDepth YouTube, http://www.youtube.com/watch?v=_tBUTHB_7Cs [Accessed 17/09/13].
[35] ACOLA P. 120

The industry will continue to construct wells to the highest standards to ensure that gas and fluids are kept in and water is kept out of wells. This includes taking advantage of innovation in cements to continue to improve the construction of new wells and the durability of casings. The industry is also committed to monitoring and performing maintenance on any wells that are not functioning as expected.

MONITORING EVERY RELEVANT ASPECT OF THE ENVIRONMENT FOR CHANGE

This section relates to Terms of Reference 7(h).

Companies use extensive monitoring to detect any possible changes in the environment as a result of operations. Before, during and after activities commence, monitoring is put in place to measure the potential impact on the environment. Before drilling a well, it is standard practice that companies undertake extensive surveys to fully understand the environment.

Technicians and engineers use a range of monitoring techniques to show that the production process is working safely and effectively. Monitoring processes are designed for the specific environmental and geological conditions and risks associated with each project. Standard forms of monitoring include:

- Water sampling (e.g. surface water, groundwater)
- Air quality (e.g. gas, dust and noise)
- Vegetation and flora (e.g. weed infestations)
- Fauna (e.g. for conservation species)
- Fracture monitoring (e.g. geophone arrays to assess stimulation extent)
- Well head (e.g. pressure changes within the well)
- Soils/topography (e.g. for erosion)
- Social (e.g. impact on communities)
- Cultural (e.g. disturbance of cultural sites)

This information could have wider applications and be accessible to landholders and others through the development of a government-sponsored environmental database. This would assist industry generally (not just oil and gas) and lead to a more informed discussion about the potential environmental impacts of industry activity.

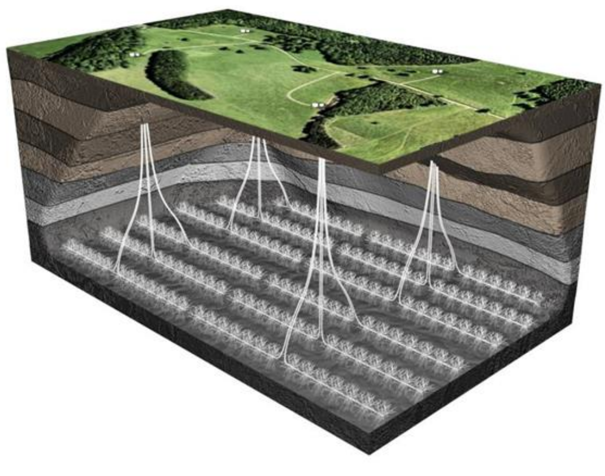
MINIMISING IMPACTS ON THE LANDSCAPE

This section relates to Terms of Reference 4, 7(a) and 7(i).

Companies are committed to working with landowners to minimise the disturbance and inconvenience of petroleum activities, by locating operations in areas of least impact.

The cost of drilling a petroleum well in the Northern Territory is very expensive, often around $10 million and much more if the well is targeting deep shales and is hydraulically fractured. Therefore a great deal of preparatory work, planning and engineering is undertaken before committing to a drilling program. In the current early stage of

Figure 7 – Multiple wells drilled from central pads



Source: Statoil

exploration companies will primarily rely on vertical wells. If the industry moves towards commercial production, producers will likely use some horizontal drilling. This will improve the efficiency of the operations and allow for the use of widely spaced drill pads limiting the potential for surface land disturbance.

Horizontal drilling describes the process of drilling vertically to a target depth and then turning and drilling horizontally, usually to a distance of 1-3 kilometres. This increases the amount of rock in contact with the well and increases the gas production rate, thereby decreasing the number of wells required. Typically 6-12 horizontal wells can be drilled from a single surface location or 'pad', which concentrates all activities into an area of approximately a hectare, thereby minimising surface disturbance (see Figure 7).

As noted by the International Gas Union (IGU), shale gas production requires a much smaller land use footprint than conventional natural gas drilling and other forms of energy production.[36] While pads containing multiple wells are likely to require more land than a pad for a single well, it has been found that this extra land use would more than offset the fewer well pads required overall. A pad containing between four and eight wells is expected to cover less than the size of a standard house block after land rehabilitation. In a development where multiple pads were required to commercialise a field, these pads would be placed between one and four kilometres apart.

As noted by ACOLA, "overall, there clearly is a smaller total area of land disturbance associated with horizontal wells for shale gas development than that for vertical wells."[37] These levels of land disturbance are also expected to be lower than those associated with agriculture or urban development.[38] Strategic planning for coexistence of industries should seek to take into account the impact of all activities and how they can minimise their total land disturbance.

After a well is established and a project moves from exploration to production, most of the land is rehabilitated around each well pad and the associated infrastructure. Each well head will have a two metre tall 'Christmas Tree' – or valve assembly – to control the gas production. These well pads would typically be spaced between one and three kilometres apart across a production area. The number of wells and well pads will depend on the nature of the reservoir rocks identified by exploration programs and production history of the wells.

Planning for multiple land uses to ensure coexistence of potential shale gas activities with existing activities will be very important to industry and landowners. It will also be an important way of ensuring that the maximum benefit is obtained from potential developments, with surface infrastructure in remote locations such as the Georgina Basin potentially also serving to assist with unlocking these regions.

In this regard, implementation of the Standing Council on Energy and Resources Multiple Land Use Framework, discussed further at Attachment 4, should be pursued across government to deliver shared benefits to all stakeholders. This Framework should be integrated into planning documents and any strategic frameworks relating to the further development of the onshore gas industry in the Northern Territory.

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[36] 'Shale Gas: The Facts About Environmental Concerns', International Gas Union (IGU) (2012), http://www.igu.org/gas-knowhow/publications/igu-publications/UG20120064_IGU_ShaleBooklet_Final_forWeb1.pdf, [Accessed 17/09/13].
[37] ACOLA P. 103
[38] ACOLA P. 104

Provided at Figure 1 (Annexure 1) is an aerial photograph illustrating the outcome of companies working closely with landholders in eastern Australia to optimise the layout of infrastructure and minimise disruption on intense farming land.

All energy sources have a land use footprint. Figure 2 in Annexure 1 shows 11 gas wells dispersed amongst a number of wind turbines while Figures 3 and 4 show the footprint of wind and solar parks in Western Australia.

DISCLOSURE AND USE OF LOW IMPACT CHEMICALS

This section relates to Terms of Reference 7(d).

During hydraulic fracturing a fluid is used to carry 'proppants' which hold the rock fissures open and allow the gas to flow more easily into the well. The fluid is mostly made up of water and sand (approximately 99.5 per cent). The remainder is a mixture of chemical additives, added at very low concentrations and which enhance the outcomes from the fracturing treatment. A typical fracture treatment will use three to 12 additive chemicals, depending on the characteristics of the water and the formation being fractured.

Figure 8 – Typical proppant used in hydraulic fracturing

Source: Todd Energy

Each chemical serves a specific engineering purpose[39] and ensures the operation is carried out safely and the long term integrity of the well is assured.[40] These chemicals are found in familiar household products including ice cream, vinegar, table salt, cosmetics and antiseptics.

The industry strongly supports transparent practices and companies operating in the NT publish details of their activities and environmental protection methods. The Department of Mines and Energy (DME) publishes summaries of environment management plans and details of the chemicals used in hydraulic fracturing on its website. It is also developing chemicals disclosure guidelines. These should encourage the use of leading practice and innovative, environmentally benign chemicals in hydraulic fracturing.

To lift the visibility of the chemical disclosure regime, APPEA would encourage consideration of a FracFocus.org style website for the Northern Territory, which could provide a one-stop-shop for information on areas being explored for shale and tight gas and the chemicals used in each well. The Queensland Department of Natural Resources and Mines (DNRM) has developed a similar model for providing information to the public on exploration activities, called the Coal Seam Gas Globe (further information is available at www.dnrm.qld.gov.au). It is noted that the benefit of the DNRM model is that the data is government-sourced which enables a high level of consistency in the information.

APPEA notes that several companies are investing in 'green' or non-toxic additives to hydraulic fracturing fluids. APPEA would support further consideration of whether supplementary approaches beyond current regulatory requirements are required to continue to encourage innovation.

[39] Including to reduce friction, remove bacteria and algae and prevent the formation and build-up of scale
[40] IGU P. 30

MINIMISING WATER USE AND RECYCLING WHERE POSSIBLE

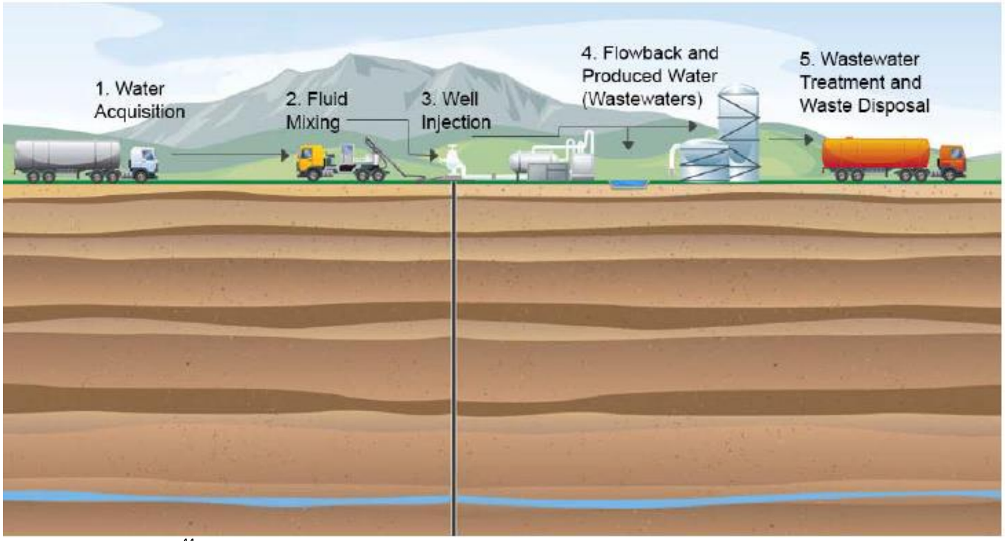
This section relates to Terms of Reference 7(c) and 7(e).

Most of the water used in tight and shale gas production is used in the hydraulic fracturing process and quantities vary depending on local geological conditions, such as depths, porosity and the length and number of horizontal wells.[41] Water is generally obtained within the vicinity of operations and is typically brackish (i.e. not potable).

Companies are committed to minimising their footprint and all water used in hydraulic fracturing operations will be captured and reused where possible. As part of the approvals process, a company must also demonstrate that the taking of water will not have unacceptable impacts on aquifers.

The IGU estimates that between 11 and 19 million litres (ML) of water – equivalent to four Olympic swimming pools – is required to fracture a well.[42] The ACOLA Report notes that while water requirements might be large when considered independently, they are "modest when set against consumption in irrigated agriculture."[43] In 2011-12, the agriculture, mining and manufacturing sectors in the NT consumed 102,000 ML of water.

Figure 9 – Hydraulic fracturing water cycle



Source: Todd Energy[44]

After hydraulic fracturing has been completed and the pressure from pumping is reduced, water begins to flow back to the wellhead. This 'flow back' is a mixture of the original hydraulic fracturing fluid – containing less than one per cent of chemical additives – and any natural formation water – containing dissolved constituents from the shale or tight formation itself.[45]

Between 20 and 70 per cent of this water will flow back to the surface with the initial gas production, with the rest remaining in the formation. This can be recycled and used to hydraulically

[41] ACOLA P. 113
[42] IGU P. 28
[43] ACOLA P. 113
[44] Todd Energy P. 89
[45] IGU P. 28

fracture other wells. The quantity of water being recycled is increasing as companies become more familiar at handling waste onsite, water treatment technologies become more readily available and as chemical additives are improved.

Proponents manage the supply of water, storage, containment and disposal of recovered stimulation fluid appropriate to their environmental setting. In many locations, water that cannot be recycled is placed in specially designed ponds for evaporation. The residue from this process is tested and, if required, safely removed to a licensed disposal facility. At no point does this water contact groundwater sources.

With appropriate well design and protection in place, risks and mitigation in relation to impacts on water from shale gas should primarily focus on reinjection and impacts at the surface.[46] These activities are strictly regulated by DME and companies are required to address the management of water at the surface and disposal in an Environment Management Plan.

The industry is keen to work with the government in improving understanding of the NT's water resources. Oil and gas exploration often identifies new water resources or provides more information about known aquifers that could be of value to local landholders and others.

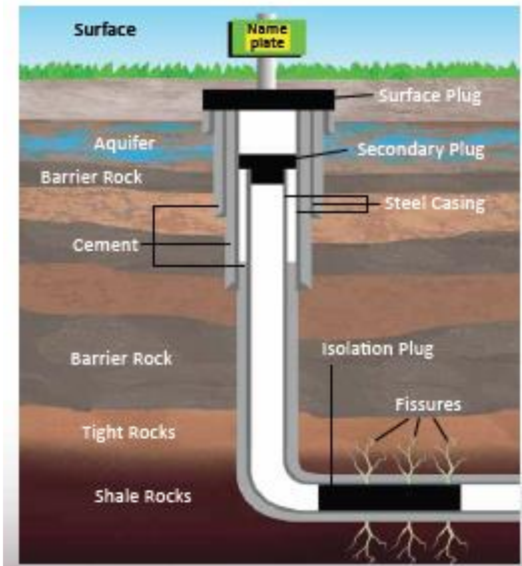
REHABILITATION OF LAND IMPACTED BY PETROLEUM ACTIVITIES

This section relates to Terms of Reference 7(j) and 7(k).

All sites impacted by operations are rehabilitated to pre-disturbance standards, unless otherwise agreed with the landholder. As per the NT Petroleum Act regulations, companies are required to identify in their approved Environment Plan how land will be rehabilitated after the conclusion of all relevant activities. Companies are also required to report the progress of rehabilitation efforts to DME on a regular basis.

Once production is exhausted the operator will permanently seal the well with cement plugs – a process called abandonment. All cements used in operations are specially formulated to withstand high pressures and last for decades.[47] The abandonment process is subject to strict conditions and a company's process is reviewed and approved by DME.

Figure 10 – Well decommissioning



Figures 5, 6, 7 and 8 in Annexure 1 illustrate the effectiveness of rehabilitation of petroleum exploration sites. Figure 9 in Annexure 1 illustrates the effectiveness of rehabilitation techniques on a pipeline corridor in Queensland.

46 ACOLA, P. 129.
47 ACOLA, P. 128.

NOISE AND LOCALISED IMPACTS

This section relates to Terms of Reference 7(g).

Oil and gas operators consult with landholders about the location of wells and management of drilling and associated activities so as to minimise noise and other localised impacts. The Model Access and Compensation Agreement being developed by APPEA and the Northern Territory Cattlemen's Association (NTCA) for example, includes processes for consultation between pastoralists and petroleum operators about the activities of each party and ways in which any adverse impacts or disruptions may be minimised. The Code of Conduct attached to the Model Agreement obliges operators to comply with a range of measures designed to minimise the impact of petroleum operations on a pastoral property. These include requirements around rehabilitation, biosecurity, use of roads, speed limits, impacts on stock, fencing, fire management, rubbish disposal, abandonment of water bores, gates, protection of trees and location of accommodation camps.

Many of the impacts such as noise are of short term duration while specific types of activities are being undertaken (such as drilling or hydraulic fracturing). Once a well enters production and is connected to an underground pipeline gas gathering network, many of the localised impacts such as noise and vehicular traffic are greatly reduced or eliminated entirely.

FUGITIVE EMISSIONS

This section relates to Terms of Reference 7(f).

Greenhouse gas emissions from all stages of the production, supply and use of natural gas, including natural gas produced onshore, are reported by the Department of the Environment (DOE) in Australia's *National Greenhouse Accounts*[48].

The measurement, estimation and reporting of emissions, including fugitive emissions, is required by the Australian Government under the *National Greenhouse and Energy Reporting Act 2007*. Information collected under the NGERs Act is made available to all States and Territories including the NT.

The industry meets all its estimation, measurement and reporting obligations under the NGERs Act and all its carbon liabilities under the *Clean Energy Act 2011.*

According to the Department of the Environment (DOE) fugitive emissions from the extraction of oil and natural gas have decreased 1.3 per cent since 1990 to 12.9 million tonnes of carbon dioxide equivalent (Mt CO_2-e) in 2011-12[49]. This includes methane emitted during production, in particular during drilling, testing, well completion, processing, venting and flaring.

To put this in context, since 1990 fugitive emissions from all sources[50] have increased by 25.2 per cent, reaching 39.9 Mt CO_2-e in 2011-12. This means fugitive emissions from the extraction of oil and natural gas across Australia was around 32 per cent of the total.

[48] This data is available www.climatechange.gov.au/emissions.
[49] Across Australia during that period, production of crude oil has fallen by 42 per cent, while production of condensate has increased by 130 per cent, production of LPG by 1 per cent And production of natural gas by 185 per cent.
[50] Fugitive emissions occur during the production, processing, transport, storage, transmission and distribution of fossil fuels such as black coal, crude oil and natural gas. Emissions from decommissioned underground coal mines are also included in this sector. In the 2011-12 financial year, fugitive emissions accounted for 7.2 per cent of Australia's national inventory (2.3 per cent from oil and gas and 4.9 per cent

Across Australia, coal mining represents the largest source of fugitive emissions, at around 27 Mt CO_2-e or 68 per cent of the total.

The emissions estimation methods used in the *National Greenhouse Accounts* are subject to external independent review each year by an Expert Review Team selected by the United Nations Framework Convention on Climate Change (UNFCCC).

NGERS provides a single national framework for emissions reporting by corporations. Corporations that meet the reporting thresholds must report their greenhouse gas emissions, energy production, energy consumption, and any other information specified under NGER legislation. The reporting thresholds are 25 kt of CO_2-e emitted (or 100 TJs of energy consumed or produced) per year for facilities, or 50 kt of CO_2-e emitted (or 200 TJs of energy consumed or produced) per year for corporations.

The NGER Determination provides methods and criteria for calculating emissions and energy data under the NGER Act. In addition, the *National Greenhouse and Energy Reporting (Measurement) Technical Guidelines* provide further information and calculation methods to assist with the application of the NGER Determination and the estimation of greenhouse gas emissions.

Operators of facilities that meet reporting thresholds are required to report fugitive emissions from all stages of exploration, processing and production under the NGER Act and Regulations. Estimation methods must be consistent with the NGER Determination.

Emissions that occur during other stages of the supply and use of natural gas must also be reported under the NGER Determination if the relevant entities meet reporting thresholds. For example, suppliers may be required to report fugitive emissions due to leakage from pipelines, and large end-use customers are likely to meet thresholds for combustion of gas for heating or electricity generation purposes.

CONTINUOUS IMPROVEMENT

The industry is constantly seeking ways to improve its performance, including through innovation in technology and adapting techniques that further improve the sustainability of activities. Codes of practice are used to unite and demonstrate the industry's commitment to environmental and social sustainability. Australian and international studies inform and improve the way the industry does business and protects the environment.

The industry recognises that setting, communicating and adhering to high operating standards in relation to onshore natural gas operations is essential for maintaining and building a reputation which ensures that the industry is a welcome part of the Australian economy and communities.

This is particularly challenging with the wide variety of regulatory regimes and industry participants across Australia. Community and media attention has also made the challenges quite public and widely debated across a broad range of stakeholders.

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from coal). See www.environment.gov.au/system/files/resources/d616342d-775f-4115-bcfa-2816a1da77bf/files/nggi-quarterly-update-dec13.pdf for more.

APPEA is therefore in the process of developing a set of leading Operating Principles and Practices which will be promoted to all member companies. These will be used to:

- Set an appropriate expectation of leading practices;
- Encourage consistency in approach across the industry;
- Provide a basis for harmonised, or at least consistent, laws and regulations across the jurisdictions; and
- Promote the responsible and sustainable practices of the industry with stakeholders.

Recommendation

- Recognising that for the majority of issues, good regulatory and operating practices for shale oil and gas will be identical to those for 'conventional' operations, the Inquiry note that the industry is developing principles and guidelines that will promote best practice among operators and provide stakeholders and communities in the NT and elsewhere with accurate information about how the oil and gas industry manages the risks associated with its onshore activities.

The Australian Council of Learned Academies Report, '*Engineering Energy: Unconventional Gas Production*', is referred to throughout this submission and should play a larger role in the discussion in Australia. Released in May 2013, APPEA views this document as the most comprehensive study of the industry and its potential impacts in Australia and would commend the document to the Commissioner of the Hydraulic Fracturing Inquiry.

EFFICIENT AND ROBUST REGULATION

Onshore regulation

Effective regulation is critical to building community confidence as it ensures that activities are assessed and approved to standards that reflect community expectations and are able to mitigate risk and minimise environmental impacts. Regulation must also be efficient, in terms of avoiding duplication and being predictable and transparent, if investment is to be encouraged and maximised.

Continuous improvement and the maintenance of an objective-based regulatory framework will be important to address potential environmental impacts – a key requirement that government and industry must continue to meet in order for the benefits of shale and tight gas to be accessed.

The oil and gas industry is committed to working with the regulator in updating and adapting the onshore regulatory regime to changes in the industry including the development of a shale oil and gas sector. At the request of the NT Government, an independent and comprehensive review of approvals processes and regulation applying to onshore oil and gas was undertaken by Dr Tina Hunter (formerly Assistant Professor at Bond University) in 2011. Dr Hunter's recommendations and the government's response are on the DME website.

Many of the report's recommendations have been implemented or in the process of being implemented. On 1 January 2014 the Petroleum Amendment Act 2013 came into force, allowing a competitive assessment process for multiple exploration permit applications over the same vacant land. New processes for permit renewals and surrendered acreage have also been introduced aimed at encouraging the early development of potential onshore oil and gas reserves. Further reforms are being progressed:

- full review of the NT Petroleum Act and merger with the Petroleum (Submerged Lands) Act to incorporate the Hunter review recommendations and any changes resulting from the Inquiry into Hydraulic Fracturing;
- development of environment regulations, including the Hunter review recommendations and new requirements around chemical disclosure;
- development of resource management regulations; and
- review of the NT Energy Pipelines Act.

There is an opportunity to better promote this significant reform agenda to the public, which will ultimately strengthen the Territory's capability in relation to oil and gas regulation. Widespread knowledge of the substantial work that has been undertaken by government will be a critical component of building public confidence. The industry is providing input to the reform process to help ensure that the objectives of efficiency and effectiveness are met. The industry also welcomes the way in which the DME is learning from and, where appropriate, adopting the reforms introduced in other jurisdictions, particularly those with emerging shale gas sectors like South Australia and Western Australia. This enables the Department to leverage the work of others (thereby reducing its own costs) while helping to improve regulatory consistency across the nation.

The industry strongly support this process and recommends that the Government increase the level of resources available to the Department to ensure that it can complete the reform process in a timely manner, as well as meet the increasing demands being made on its services by the rapidly expanding onshore industry. Investment into an efficient and robust regulatory framework should assist with delivering improved regulatory outcomes, facilitating community confidence and ultimately improving the attractiveness of the NT as an investment destination.

A second priority of the Northern Territory Government should be to ensure that its reform process and the outcomes it is delivering are well understood by the community, particularly those with an interest in the land accessed by petroleum explorers and producers.

Recommendations

- The NT Government ensure the level of resources available to the Energy Directorate of the Department of Mines and Energy keeps pace with the needs of a growing oil and gas industry and enables it to complete its wide-ranging regulatory reform process in a timely and predictable manner.
- The NT Government improve information sharing and community consultation about its regulatory reform process and the changes being introduced and how these are delivering a regulatory regime that is efficient and effective.

Streamlining project approvals

Industry supports strong environmental standards, based on scientific assessment and high levels of regulatory certainty. Unnecessary and duplicative regulation, particularly environmental regulation, continues to be a cause of frustration for the development of oil and gas projects and a burden that imposes unnecessary costs on industry, the community and individuals.

APPEA's 'cutting green tape' report[51] released in 2012 identified a number of case studies where duplication was evident, including the Inpex Ichthys development which has processing facilities onshore near Darwin.

Industry supports strong environmental standards, based on scientific assessment and high levels of regulatory certainty. Unnecessary and duplicative regulation imposes unnecessary costs on industry, the community and individuals. Regulatory duplication between jurisdictions should be eliminated and the roles of government agencies including the Department of Mines and Energy (DME) and Environment Protection Authority (EPA) need to be clearly defined. The DME for example, should continue to have regulatory responsibility for the environmental management of low impact exploration and development proposals, including well stimulation activities (such as hydraulic fracturing) forming part of a low impact proposal. The circumstances under which a proposal may potentially have a significant environmental impact or pose significant environmental risk and hence require assessment by the EPA, should be clearly defined. Transparent roles and processes with the level of assessment linked to a science-based assessment of environmental risk would minimise the regulatory burden on industry and if adequately explained and promoted, increase community confidence in the government's regulatory role. This would ensure that high standards of environmental protection are maintained while improving the NT's competitiveness for new oil and gas investment.

In seeking to reform and improve its legislation and regulatory processes, APPEA recommends the NT Government carefully consider, and where appropriate implement, reforms adopted in other jurisdictions. Particularly, by those states that are also seeking to develop shale and tight gas industries such as South Australia and Western Australia. Oil and gas fields do not necessarily respect state and territory borders and many companies operate in multiple jurisdictions. Adopting best practice and harmonising regulatory approaches across onshore jurisdictions would also help to reduce regulatory uncertainty and costs for industry.

Recommendations

- The NT DME and EPA consider and where possible adopt best practice approaches to shale oil and gas regulation that exist in other jurisdictions. Regulation should be objectives-based (rather than prescriptive) with clear timelines and efficient processes. It should recognise the difference between low impact exploration and potential major project development.
- The NT DME should retain regulatory responsibility for the environmental management of all low impact exploration and development proposals, including well stimulation activities (such as hydraulic fracturing) forming part of a low impact proposal. The circumstances under which a proposal may potentially have a significant environmental impact or pose significant environmental risk and hence require assessment by the EPA, should be clearly defined.

[51] 'Cutting green tape: Streamlining major oil and gas project environmental approvals processes in Australia', APPEA, http://www.appea.com.au/wp-content/uploads/2013/04/APPEA_Cutting-Green-Tape.pdf.

Case Study: Shale Gas Regulatory Regimes in Australia

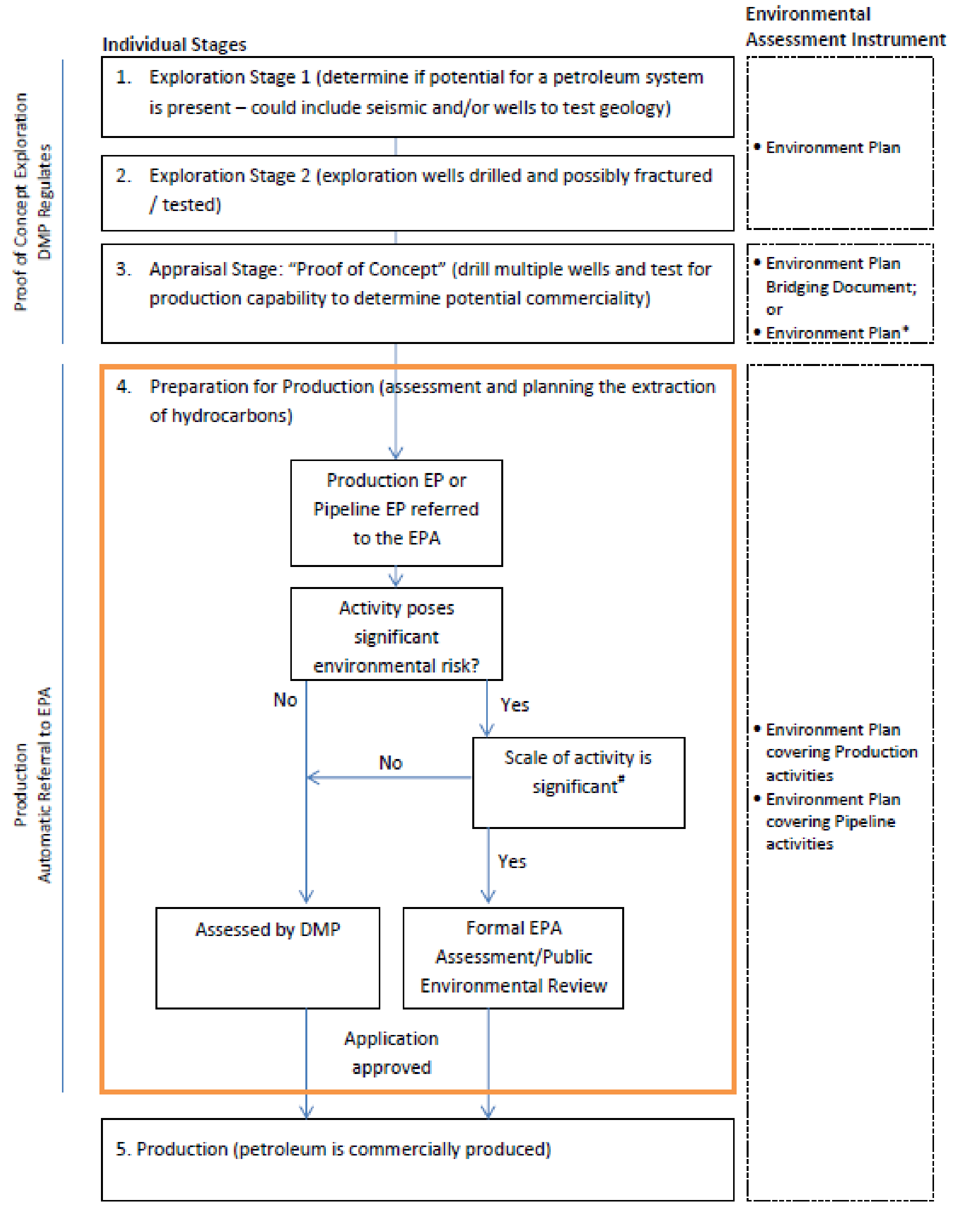
APPEA supports effective and efficient regulation that sets an objective and science based framework for reducing risk while providing certainty to industry. Both Western Australia and South Australia rely on, or are seeking to adopt, objective-based regulatory regimes.

Western Australia

The Western Australian Department of Mines and Petroleum (DMP) has been designated a lead agency for the State Government's assessment of shale and tight gas projects. The Department is the primary regulator for projects in the State and works closely with other regulatory agencies (including through an inter-agency working group) to ensure that the assessment of projects draws on a wide body of knowledge and expertise, across a range of environmental, health and safety impacts.

The *Petroleum and Geothermal Energy Resources Act 1967* provides the legislative framework for petroleum activities that take place onshore Western Australia. The Act is supported by separate safety and environment regulations, with public comment currently being sought on regulations relating to resource management (including well operations and integrity). The finalisation of the resource management regulations will result in a fully objective-based regime that requires the identification and mitigation of risks through a safety management plan, environment plan and well management plan.

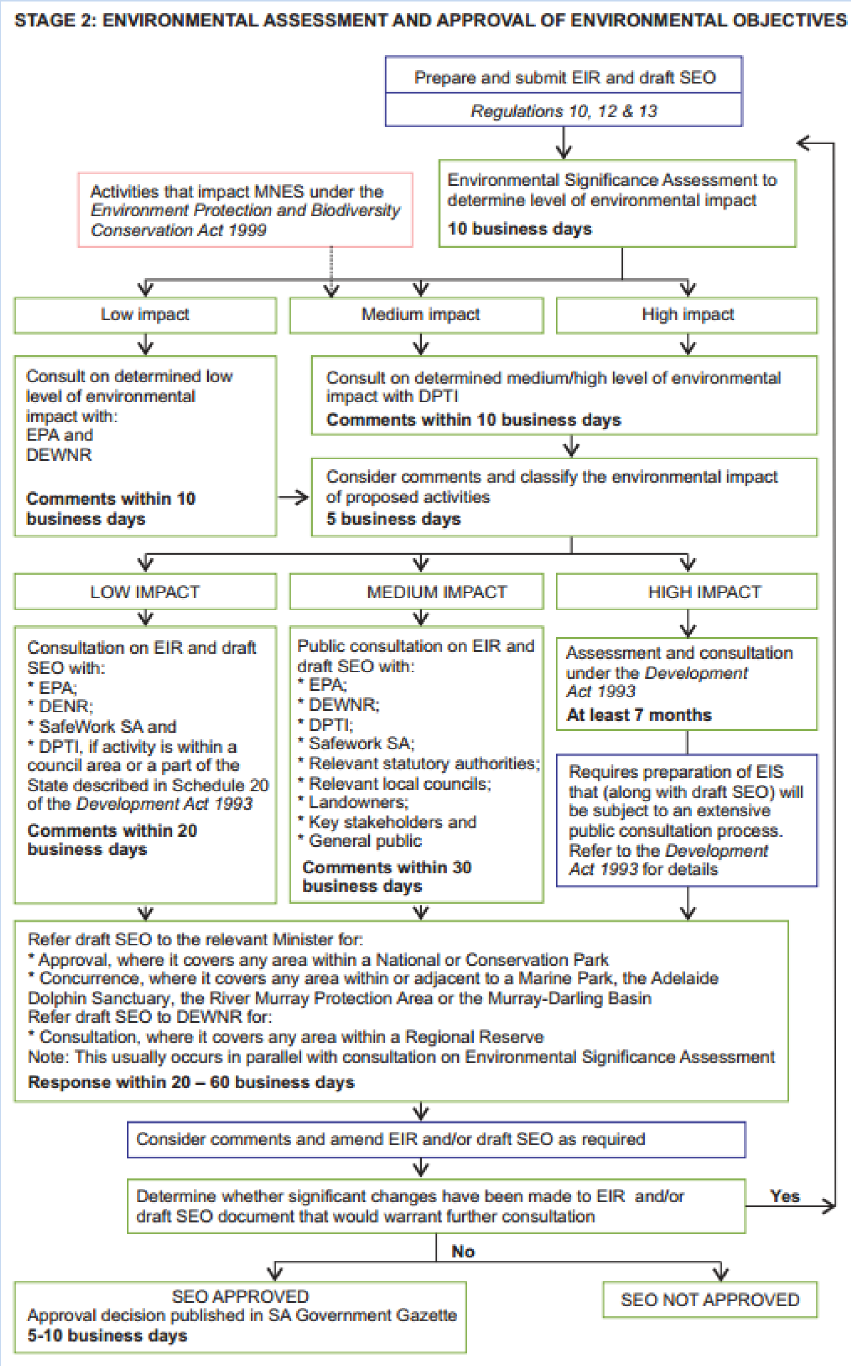
The State's Environmental Protection Authority (EPA) has considered a number of shale and tight gas proposals and found they pose minimal risk. This was due to the small scale and 'proof of concept' nature of the activities, which are able to be managed by the DMP's current regulatory processes without having a significant impact on the environment. Outlined below is an input that APPEA has provided into considerations of when the EPA could be involved in the assessment of onshore shale and tight projects.



Notes:
Advice from DMP is that the scale of projects, including whether they are significant, can only be determined by the EPA after it has become familiar with assessing onshore projects.
* A new Environment Plan may be required if activities, such as extended well testing, have not been described sufficiently in the original EP

South Australia
The South Australian Department of Manufacturing, Innovation, Trade, Resources and Energy (DMITRE) administers the *Petroleum and Geothermal Energy Act 2000*, which establishes the legislative framework for all onshore areas in the State. The *Petroleum (Submerged Lands) Act 1982* provides the framework for offshore areas within the State's jurisdiction (i.e. within three nautical miles of the coastline).

Activities require an approved Statement of Environment Objectives (SEO), which outlines potential impacts and measures to mitigate the risks identified in an Environmental Impact Report (EIR). The SEO identifies the environmental objectives to be achieved and the criteria to be used to assess achievement of the objectives. In relation to hydraulic fracturing, the EIR and SEO must identify how aquifers will be protected. The chart below outlines the process that DMITRE follows for assessing environmental impact, including how other key regulatory agencies (such as the State's Environmental Protection Authority) are engaged in the process.



BUILDING TRUST WITH COMMUNITIES

Shale and tight gas resources can be developed safely and effectively as an economically important additional energy source which could also reduce Australian and global greenhouse gas emissions.[52] Issues that have been the subject of public debate - health, cumulative impacts, seismicity, fugitive emissions, social impacts, groundwater contamination and best practice regulation for onshore natural gas - have been considered extensively in the existing literature.[53]

The industry has the technical capability to develop shale and tight gas resources. A key determinant of the rate of development will be community confidence.[54] Robust regulation, responsible operator practices and early and effective communication with stakeholders contribute to the development of public confidence.

The industry invests significant time and effort in working with independent experts and in engaging with communities and key stakeholders.[55] For example, APPEA, its NT members and the CSIRO have participated in a series of community information meetings in Darwin and regional centres organised by the DME.

The industry and governments have responsibility for informing and educating the community about their respective roles and activities. The industry is working to explain what it does, the risks this creates and how those risks are managed and minimised. Likewise, governments have an equally important role in informing the community about regulatory processes (such as permit application and activity monitoring processes), how these are changed and updated, and about decisions resulting from these processes (such as the reservation of areas around Darwin in late 2013).

APPEA and its members work closely with key stakeholders (affected landholders, Traditional Owners, shires, government representatives and other interest groups) to provide them with all relevant information in relation to activities. As noted above, APPEA is also working with its member companies on an industry-wide code of practice for the onshore gas industry.

Working with regional communities and the agriculture and pastoral sectors

APPEA is working nationally with peak farming and pastoral industry bodies and directly with regional communities to address some of the concerns about development of natural gas production on private land, including in relation to water management and farmers' and pastoralists' rights.

The petroleum sector recognises that good communication and trust-building underpins successful coexistence. On this basis, APPEA is working with companies and the NT Cattleman's Association

[52] Cook, P, Beck, V, Brereton, D, Clark, R, Fisher, B, Kentish, S, Toomey, J and Williams, J (2013). *'Engineering Energy: Unconventional Gas Production.'* Australian Council of Learned Academies (ACOLA), www.acola.org.au.
[53] These issues have been covered in detail in publications by ACOLA, the International Gas Union and International Energy Agency.
[54] *'Golden Rules for a Golden Age of Gas'*, International Energy Agency (2012), www.iea.org
[55] ACOLA, P. 26.

(NTCA) to establish a shared understanding of how science and cooperation can help in resolving technical issues and concerns about petroleum exploration activities.

The key concerns raised by NT pastoralists include:

- Long-term well integrity and risk to water aquifers;
- Biosecurity and chemicals management;
- Land access, compensation arrangements and pastoralists rights; and
- Uncertainty about the scale, nature and timing of future industry activity.

APPEA and the NTCA are in the final stages of developing a model access and compensation agreement which could be used in whole or in part by pastoralists and oil and gas operators and which would:

- Foster good communications and build trust between pastoralists and oil and gas operators;
- Protect the viability and amenity of pastoral land;
- Protect the environment – particularly water supplies; and
- Provide benefits to pastoralists in the form of compensation for damage or disturbance, improvements to infrastructure such as station roads and water production facilities, and opportunities to earn additional income from contract work.

Other ways of providing information to, and engaging with, NT pastoralists are also being pursued such as APPEA sponsorship and provision of an information booth at the NTCA Annual Conference in March 2014.

Working with Traditional Owners

Shale and tight gas exploration companies working with Traditional Owners in the NT have made it a priority to engage with Aboriginal communities. As the projects move from exploration to commercial development, Traditional Owners will emerge as key beneficiaries of the onshore petroleum industry.

APPEA aims to assist oil and gas operators and Aboriginal communities by working with the land councils in the development and provision of information about the industry's activities and environmental impacts. Information workshops about onshore oil and gas are being planned and APPEA is also seeking to ensure that approvals processes for gaining access to land operate in a transparent and efficient manner to the benefit of all parties, including indigenous communities.

THE IMPORTANCE OF A FACT-BASED DISCUSSION

The strength of the industry's ongoing commitment to continuous improvement and the extensive regulatory oversight of the industry are often lost within the onshore gas debate. This debate has often seen fact and science-based evidence diluted by extremist claims from "ideological crusaders"[56] seeking to spread misinformation rather than engage in a constructive dialogue. In this regard, Attachment 5 provides details of 'Frequently Asked Questions' and responses that APPEA has used to clarify a number of inaccurate statements.

[56] Potter, B, "Demand to sort out `ideological crusaders'", *Australian Financial Review*, 9 September 2013.

However, it is noted that APPEA has also had positive engagement with conservation groups where there is an appetite to constructively discuss the issues and how activities can be better managed.

APPEA strongly believes that trust is critical to building community confidence and where there are legitimate landowner concerns they must be addressed by the industry.

Case Study: Informing the Discussion with Independent Third Parties

In June 2013 CSIRO participated in an initial workshop on onshore oil and gas with members of the NT Cattlemen's Association (NTCA). CSIRO's Chief Research Scientist for water use in the resources sector (Professor Damian Barrett), plus 10 representatives from 7 onshore operators led a briefing and discussion session that addressed issues such as long-term well integrity, chemicals management and benefits for pastoralists.

In September 2013 APPEA, CSIRO and representatives of four companies operating in the southern half of the NT participated in community information meetings organised by the DME and held in Alice Springs and Tennant Creek. CSIRO also participated in community information meetings held in Darwin and Katherine on 21st and 22nd November which again, were strongly supported by the industry (8 companies represented at Darwin and 7 at Katherine).

The community information meetings aimed to provide information about shale oil and gas exploration in the NT and respond to community concerns around issues such as well integrity and impacts on water aquifers.

ATTACHMENT 1 – TERMS OF REFERENCE

Hydraulic fracturing for hydrocarbon deposits in the Territory, including the assessment of the environmental risks and actual environmental impacts of hydraulic fracturing and the effectiveness of mitigation measures, and more particularly the matters mentioned in the following clauses:

1. Historical and proposed use of hydraulic fracturing (exploration, appraisal and production) of hydrocarbon deposits in the Northern Territory (number of wells; locations; timeline).
2. Environmental outcomes of each hydraulic fracturing activity for hydrocarbon resources in the Northern Territory (number of wells; frequency of types of known environmental impacts).
3. Frequency of types and causes of environmental impacts from hydraulic fracturing for hydrocarbon deposits in the Northern Territory and for similar deposits in other parts of the world.
4. The potential for multiple well pads to reduce or enhance the risks of environmental impacts.
5. The relationship between environmental outcomes of hydraulic fracturing of shale petroleum deposits with geology, hydrogeology and hydrology.
6. The potential for regional and area variations of the risk of environmental impacts from hydraulic fracturing in the Northern Territory.
7. Effective methods for mitigating potential environment impacts before, during and after hydraulic fracturing with reference to:
   a) the selection of sites for wells
   b) well design, construction, standards, control and operational safety and well integrity ratings
   c) water use
   d) chemical use
   e) disposal and treatment of waste water and drilling muds
   f) fugitive emissions
   g) noise
   h) monitoring requirements
   i) the use of single or multiple well pads
   j) rehabilitation and closure of wells (exploratory and production) including issues associated with corrosion and long term post closure
   k) site rehabilitation for areas where hydraulic fracturing activities have occurred.

ATTACHMENT 2 – CODE OF PRACTICE FOR HYDRAULIC FRACTURING

At the end of 2011, APPEA and its onshore gas members released a Code of Practice for Hydraulic Fracturing to demonstrate what the gas industry is doing to successfully and responsibly develop significant onshore gas reservoirs in Western Australia.

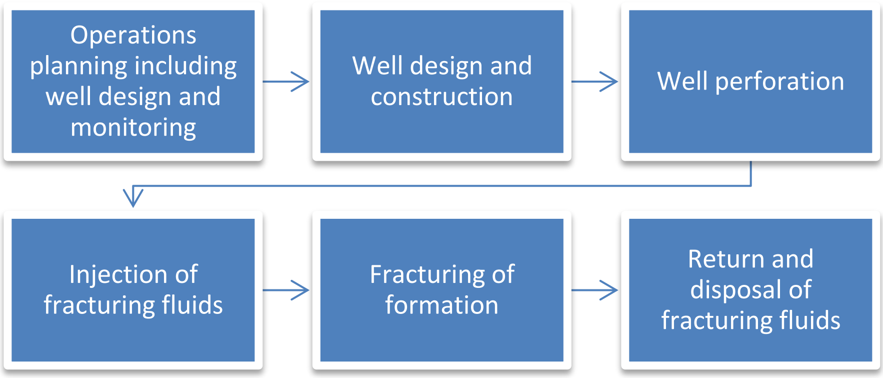
The Code was developed by a working group of industry operators based on established operating principles and leading practices in other jurisdictions that are relevant to local conditions. The document can be viewed in full at www.wa-onshoregas.info and includes a number of points relevant to the Inquiry, in particular:

- Guideline 1 – Community, landholder and stakeholder interaction. The aim of this guideline is to ensure operators communicate openly and as early as practicable with landholders, local communities and other stakeholders. This communication includes explaining how risks are being managed to minimise any potential unwanted or adverse impacts.
- Guideline 3 – Sourcing and use of water. The aim of this guideline is to protect and, where required, effectively and responsibly use groundwater resources. For example, all water used in hydraulic fracturing operations will be captured and reused where possible and a company needs to demonstrate that the taking of water will not have unacceptable impacts on aquifers.
- Guideline 4 – Use of chemicals in hydraulic fracturing. The aim of this guideline is to minimise the use of chemicals in hydraulic fracturing operations, provide clear and accurate information on any chemicals that may be used, and promote the safe and responsible use of chemicals. This includes by supporting the public release of information and using chemicals with the lowest toxicity to facilitate operations.
- Guideline 5 – Fluid flowback and produced fluids containment. The aim of this guideline is to ensure that post-fracture stimulation clean-up flowback or produced fluids cannot come into contact with Production Aquifers or pollute soil or soil substrate. This includes sealed storage and recycling where possible of all recovered hydraulic fracturing fluids.
- Guideline 7 – Continuous improvement. The aim of this guideline is to ensure continuous performance improvement and the sharing of information with regulators and other stakeholders to reduce potential risks of hydraulic fracturing.

ATTACHMENT 3 – HYDRAULIC FRACTURING

Like the natural movement of the Earth's crust, hydraulic fracturing of rocks releases trapped fluids or gasses. In the context of petroleum operations, hydraulic fracturing is used to increase the flow of oil and gas to a well, therefore increasing production and reducing the total number of wells needed to develop a resource. It allows commercialisation of low permeability (shale or tight gas) reservoirs in which oil and gas do not easily flow. It can also be used with other natural resources such as to access geothermal energy and to increase water production.

Key steps in well design and construction and hydraulic fracturing are outlined below:

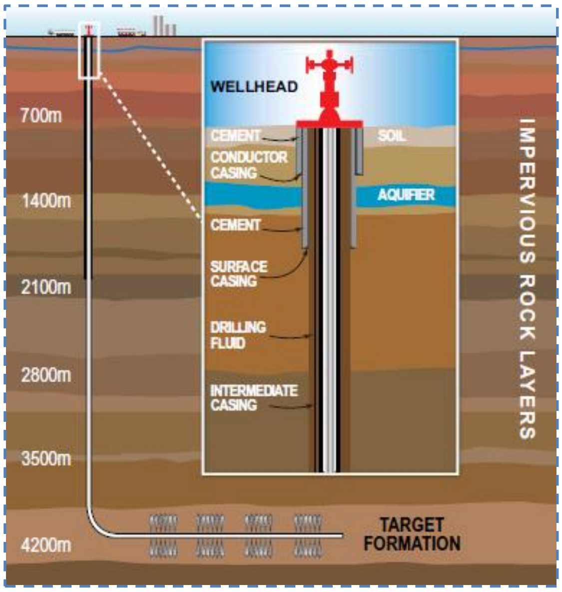


1. After a well has been drilled, including any horizontal pathways, it is cased in multiple layers of steel (casing) and concrete.

2. A perforating tool is then used to create small holes in the lowermost well casing within the target zone (i.e. the depth at which gas is expected to be located) so that fluid can only enter within a certain section of the well.

3. Hydraulic fracturing is then used, which involves pumping a fluid down the well at high pressure to open tiny cracks in the target rock reservoir. This fluid contains 'proppants', such as sand or tiny ceramic beads, which are used to hold the fissures open and improve the flow of gas or oil. Most fluid contains a small percentage – less than one per cent – of chemical additives to make the technique more efficient.

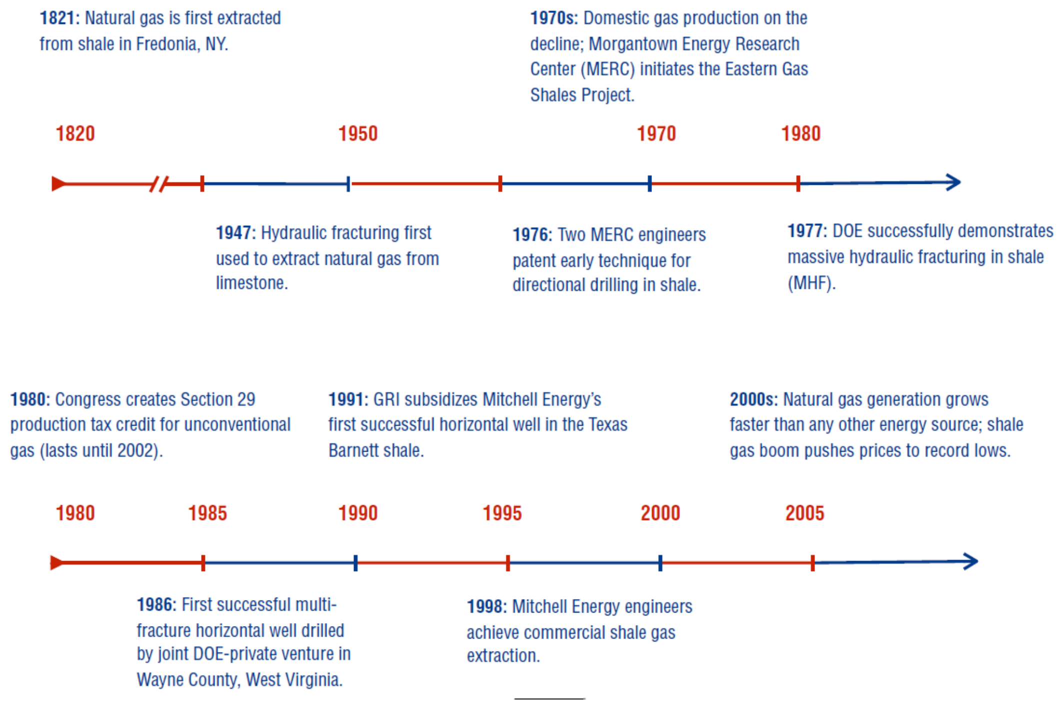
Figure 1.– The Hydraulic Fracturing Process



All recovered fluids are isolated in sealed storage areas designed to prevent leakage, including specially designed and constructed dams or above-ground holding tanks. Depending on regulatory conditions, these fluids are then reused in subsequent well stimulation activities, treated for other uses or disposed of through an approved facility.

Reviews of the emergence of shale gas development in the US have found that a number of factors converged in the early 2000's to make it profitable for firms to produce large quantities of gas. As outlined below in Figure 2, this includes public-private partnerships into research and commercialisation and federal government support for commercialisation. Hydraulic fracturing technology took time to develop but ultimately resulted in cost-effective production of natural gas from shale rocks. [57] Ultimately, government support and the development and implementation of multistage hydraulic fracturing and horizontal drilling techniques enabled shale resources to be accessed on a commercial basis.

Figure 2. Shale Gas Development in the US: A Timeline



DOE = US Department of Energy; GRI = Gas Research Institute

Source: Breakthrough Institute[58]

The Development of Hydraulic Fracturing

Hydraulic fracturing was first used commercially in 1949 in Stephens County, Oklahoma, and Archer County, Texas, to increase flow rates from tight hydrocarbon reservoirs and has since been used more than 2.5 million times worldwide. Within the first year of its implementation, 332 wells were treated with an average production increase of 75 per cent. It is now reportedly used in approximately 60 per cent of all petroleum wells drilled and, as at 2010, was credited with adding more than nine billion barrels of oil and 700 trillion cubic feet of gas to US reserves alone.[59] In general, fracturing is considered to have increased US oil and gas reserves by at least

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[57] Wang, Z, Krupnick, A, 'A Retrospective Review of Shale Gas Development in the United States: What Led to the Boom?', Resources for the Future (2013), http://www.rff.org/RFF/documents/RFF-DP-13-12.pdf, [Accessed 17/09/13].

[58] Trembath, A, Jenkins, J, Nordhaus, T, Shellenberger, M, 'Where the Shale Gas Revolution Came From', Breakthrough Institute (2012), http://thebreakthrough.org/blog/Where_the_Shale_Gas_Revolution_Came_From.pdf, [Accessed 17/09/13].

[59] Montgomery, C, Smith, M, 'Hydraulic Fracturing: History of An Enduring Technology', Society of Petroleum Engineers (2010), http://www.spe.org/jpt/print/archives/2010/12/10Hydraulic.pdf, [Accessed 17/09/13].

30 per cent and 90 per cent respectively and is expected to move the country towards levels of energy security it hasn't experienced in decades.

Figure 3. The first commercial fracture treatments by Halliburton

Source: Society of Petroleum Engineers[60]

[60] *Ibid.*

ATTACHMENT 4 – MULTIPLE LAND USE FRAMEWORK

APPEA supports and has engaged with the process by the Standing Council on Energy and Resources (SCER) to develop the Multiple Land Use Framework (MLUF). Achievement of the below outcomes would provide clear shared benefit for all stakeholders in the development of onshore gas industry:

- Shared commitment by government, industry and the community to multiple and sequential land use - Minimise incidences of land use conflict by improved ability to recognise differing needs and benefits to all stakeholders early, and acting upon this through a risk - based approach to mitigate adverse impacts and realise mutual benefits.

- Better informed public discourse - Increased transparency and consistency in land use decisions, provision of easy access for the public to relevant and factual information, improved understanding of land access regulations relevant to each activity, as well as recognising benefits of coexistence and collaboration through multiple land use approaches.

- Merit based land use decisions - Ensure land is not arbitrarily excluded from other uses without fully understanding the consequences. Providing certainty for industry and improved community confidence in land use decisions.

- Deliver acceptable outcomes for affected communities and landholders - Demonstrate and facilitate that multiple and sequential land use approaches can be accommodated in a manner that is beneficial to all stakeholders and engender greater confidence in, and positive engagement by, communities and land holders impacted by industry developments

ATTACHMENT 5 – FREQUENTLY ASKED QUESTIONS

An Approach Based on Facts & Science, Not Fiction or Fear
Shale and tight gas is natural gas – the fuel the NT Power and Water Corporation uses to generate electricity for NT homes and businesses. It's clean and efficient, producing about half the greenhouse gas of coal in generating electricity.[61] The development of gas resources located near Alice Springs and off the Territory's west coast has been overwhelmingly positive for the economy. The further development of natural gas from shale and tight rocks in several onshore basins could be equally important in generating jobs, building infrastructure, providing income and increasing energy security. The industry supports high operational and regulatory standards based on science, transparency, stakeholder involvement, predictability and consistency.

What is Happening Around the World?
Worldwide shale gas production is expected to be the biggest single source of new global energy over the next two decades. The US EIA has estimated that shale gas production will increase from 34 per cent in 2011 to 50 per cent in 2040.[62] The International Energy Agency estimates that natural gas will account for 20 per cent of world total primary energy supply by 2035.[63]

The USA is leading the world in development of the shale gas industry with significant economic and environmental benefits. The recent and rapid transformation of the North American energy sector based on natural gas from its shale resources highlights the potential for these benefits. One recent study illustrates the extent of the transformation. It found that the resurgence in onshore gas and oil in the US had created 1.7 million jobs in 2012.

The UK Government is encouraging petroleum companies to step up drilling programs for shale gas in Britain. Britain has significant potential for shale gas, with a number of groups looking at how these resources can replace ageing, coal-fired power stations.

China and Canada are expected to become major shale gas producers as global energy consumption increases by more than 50 per cent in the next two decades.[64]

What is Happening in the NT?
There is no shale or tight gas production in the NT at present though initial exploration by a number of companies is gaining momentum. Most of the Territory's existing supplies of natural gas come from the Blacktip project located near Wadeye. However, the Territory has extensive exploration areas showing potential for shale and tight gas production.

The most prospective areas for shale oil and gas are the Bonaparte, Beetaloo, McArthur, Georgina and Amadeus Basins. Most of the exploration projects are in the early or proof-of-concept stages. Exploration is governed by a tested framework of regulation and operating practices which focus on reducing risks to the environment, ensuring safe operations and supporting open and transparent engagement with local residents.

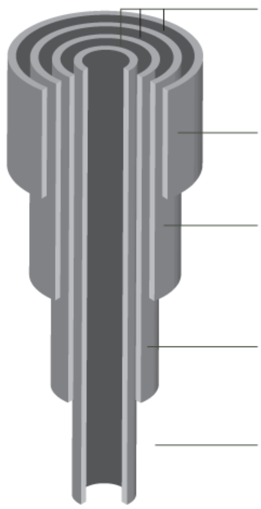
[61] US Environmental Protection Agency, 'Natural Gas', http://www.epa.gov/cleanenergy/energy-and-you/affect/natural-gas.html.
[62] US Energy Information Administration. 'Annual Energy Outlook 2013', http://www.eia.gov/forecasts/aeo/MT_naturalgas.cfm
[63] IEA, http://www.iea.org/publications/freepublications/publication/kwes.pdf
[64] US Energy Information Administration, 'International Energy Outlook 2011', http://www.eia.gov/forecasts/ieo/

If commercial development goes ahead, the gas would be used initially for domestic markets, delivering secure long-term supplies of gas at competitive prices for homes and industry. The industry has the potential to underpin a new phase of the NT's strong economic performance and promote economic and social development in regional areas.

What are the Facts About the Environmental Concerns?

The process of hydraulic fracturing

The process of hydraulic fracturing – pumping fluid into deep geological zones to stimulate the flow of gas into production wells – is one feature of tight and shale gas production. It has been used in the oil and gas industry in the NT for at least 30 years and in other states well before then. Since the 1950s, some 780 petroleum wells have been drilled and fractured in Western Australia with no adverse effects on the environment, water sources or public health according to the WA Department of Mines & Petroleum. In the Northern Territory around 30 wells have been hydraulically fractured since the early 1980s with no adverse impacts on water aquifers. It is a tightly controlled and highly regulated process.



The regulations covering the industry are stringent and comprehensive. An explanation of the process can be found on the websites of the DME and APPEA.[65]

Protection of groundwater

The industry recognises the conservation and protection of ground water is a top priority. Key factors which protect groundwater during natural gas production are:

- The strength of the wells

Reinforced steel and concrete casings are designed to keep the gas inside the well. The diagram to the right is a cross section of a typical shale or tight gas well, reinforced to keep gas in and water out.

A 2011 report from the US Ground Water Protection Council examined more than 34,000 wells drilled and completed in the state of Ohio between 1983 and 2007, of which a total of 12 had issues related to well construction.[66] Of 187,000 wells drilled in Texas the study found that there were two incidents relating to well construction. Most of those incidents (more than 80 percent) occurred in the 1980s and 1990s before improved cement formulas and regulations were in place. Similar to performing a service on a car, these wells required routine maintenance on the casing or cement.

- The depth of the gas-bearing rock

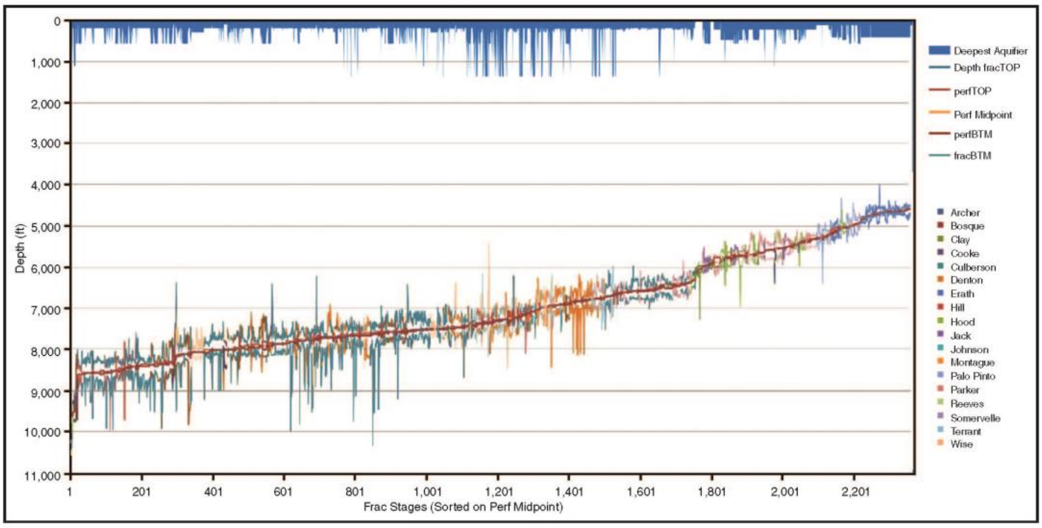
Shale and tight gas resources are typically between one and five kilometres below the ground, separated from near-surface freshwater aquifers by hundreds of metres of very low permeability

[65] DME: http://www.minerals.nt.gov.au ; APPEA: http://wa-onshoregas.info
More detail is available at http://www.youtube.com/watch?feature=player_embedded&v=BEH4M7EuIsU

[66] Kell, S, 'State Oil and Gas Agency Groundwater Investigations And their Role in Advancing Regulatory Reforms', Ground Water Protection Council (2011), http://www.gwpc.org/sites/default/files/event-sessions/05Kell_Scott_0.pdf [Accessed 27/09/13].

rock. The process of hydraulic fracturing is monitored to confirm that the extent of the rock fractures remain separated from ground water, typically by one to two kilometres of rock in the NT. Extensive research on hundreds of wells in the US has conclusively demonstrated that the fractures induced by the process are confined to the rocks close to the zone of interest. The following chart shows the depth of the process, the maximum extent of the induced fractures and the separation from aquifers.

Barnett Shale Mapped Fracture Treatments (TVD)



- Effective monitoring programs

Highly trained technicians use a range of monitoring techniques based on seismic, pressure-testing and water sampling technology to show that the production process is working safely and effectively. Information from the monitoring is available to the public. These monitoring programs are closely regulated by various Government agencies.

- Limited water usage

Based on the NT experience to date, each stage of hydraulic fracturing uses about 2.5 million litres of water – equivalent to the contents of an Olympic swimming pool. A well may undergo several stages of fracturing but water use is reduced by the re-use of water that flows back to the surface following previous fracturing stages.

- Surface water management

Again based on the NT experience to date, up to 80 per cent of the fluids used during the fracturing process flow back to the surface. These fluids are stored in lined pits or in steel tanks until they can be reused in future fracturing jobs. When they are no longer needed, the fluids are placed in specially designed ponds for evaporation, leaving a small residue. This residue is tested and can then be safely removed and taken to a licensed disposal facility.

- Use of chemicals

The hydraulic fracturing fluid used to improve gas and oil production is typically comprised of more than 99.5 per cent water and sand and 0.5 per cent chemical additives. Many of the chemicals used are also found in common household and commercial applications. They include guar gum used in jelly sweets, salt, detergents and antiseptics - all of which are used in extremely low concentrations.

The chemical additives are assessed, fully disclosed and managed according to strict regulations. Monitoring ensures they remain in a closed process system – and don't contact fresh water.

Landscape Impacts
Opponents of natural gas production from shale and tight rocks have made wildly exaggerated claims about the number of wells which could be drilled in the NT. They have also used photographs of gas fields in the US which are very different in design and scale to the projects which might be developed in the NT.

A NT shale and tight gas development is expected to be based on multiple horizontal wells from one well pad. This allows for higher natural gas production from one location and a smaller land use footprint.

After a well is established and a project moves from exploration to production, most of the land is rehabilitated, leaving a small area around the well head and the associated infrastructure. Each well head will have a two metre tall "Christmas Tree" – or valve assembly – to control the gas production. These well pads would be spaced between one and four kilometres apart across a production area.

The number of wells and well pads will depend on the success of current exploration programs – and the development of gas markets, but will be far less than the unfounded claims being made.

The Gasland Myth
Gasland, a movie which has been used by groups opposing onshore natural gas development, was produced in the style of a documentary by filmmaker Josh Fox, who now makes a successful living from anti-gas campaigning.

A number of US authorities have followed up the allegations in his film and have found the majority to be untrue. For example, the signature scene is a "flammable faucet" segment in which a Colorado householder claims that gas producers have polluted his water supply with methane. He demonstrates this by lighting a match next to a kitchen tap which bursts into flames.

Tests by the State of Colorado Oil and Gas Conservation Commission on this location showed the gas was naturally occurring and not the result of commercial gas production activity.[67] The household bore had intersected a natural biogenic methane accumulation – a common local phenomenon reported long before the gas producers arrived on the scene. Mr Fox was provided with this information but chose not to use it in the film.

A more complete analysis of the film can be found at Energy in Depth.[68]

Calls for a Moratorium
Some opponents of the industry have called for a moratorium on shale and tight gas exploration.

A halt to exploration would be counter-productive and unnecessary given the regulatory assessment and requirements imposed on operators by the Department of Mines and Energy and

[67] State of Colorado Oil & Gas Conservation Commission, http://cogcc.state.co.us/library/GASLAND%20DOC.pdf
[68] Energy in Depth, 'GasLand Debunked', http://www.energyindepth.org/wp-content/uploads/2011/11/Debunking-Gasland.pdf

the Environmental Protection Agency. The information from exploration programs is being used to provide important data for the effective management and regulation of a future industry.

The moratorium would stop this flow of information and delay the introduction of shale and tight gas - without improving the level of local knowledge. This knowledge will be important in developing operational and regulatory approaches which can ensure that the Territory's shale and tight gas resources are developed in an environmentally responsible manner.

Exploration for shale oil and gas is also providing valuable new data about the size and location of the NT's underground water resources. New aquifers have been discovered including deeper saline aquifers unsuitable as drinking water but able to be used for drilling and hydraulic fracturing.

A Partnership Approach
APPEA has worked with the Territory Government and CSIRO to conduct public meetings and workshops in regional communities that provide access to information people can trust and to create a dialogue with regulators and exploration companies. The NT industry believes that this partnership represents a proactive, innovative and responsible approach for delivering local background information to support national and international scientific studies.

ANNEXURE 1 – LAND USE IMAGES

Figure 1.– Well sites coexisting with intense farming land (Surat Basin – NSW/Qld). This property contains 34 petroleum wells, identified by the small white boxes along property boundaries.

Figure 2.- Land impacts of wind turbines and 11 gas wells (Saxony, Germany)[69]

[69] 'Energy Impact', Bishop Hill, http://bishophill.squarespace.com/blog/2013/7/21/energy-impact.html.

Figure 3. - Collgar Wind Farm (Merredin WA) – 18,000 hectares/206 MW [70]

[70] 'Welcome to Collgar Wind Farm', http://www.collgarwindfarm.com.au/.

Figure 4. - Greenough River Solar Farm (Mid West WA) – 50 hectares/10 MW[71]

Figure 5. - Mountain Bridge-1 well site post rehabilitation work, wellhead location highlighted by the yellow box (Mid West, WA)

[71] 'Photos – Greenough River Solar Farm', http://www.greenoughsolarfarm.com.au/photos

Figure 6. - Rehabilitation of Exploration Well Site (Mid West, WA)

Prior to site rehabilitation at the Kingia-1 well site in 2006

Post site rehabilitation at the Kingia-1 well site in 2006

Figure 7.– IGas drilling site, Willoughbridge UK

Before drilling

Drilling

Rehabilitated site

Figure 8.– Well site at Brawboy, Gunnedah Basin, NSW

Well pad

Well pad after removal of infrastructure

Rehabilitated site

Figure 9.– Rehabilitated 48-inch gas pipeline corridor in Queensland leading to LNG plant (carries equivalent to 40,000,000 tonnes per annum of coal which would need to be transported via railway line).