



DMITRE

Roundtable for Unconventional Gas Projects, South Australia

Monday 2 December 2013
Working Group Meetings, Industry Practice and Research Needs

Meeting commenced: 08.35am

Attendees: See attached attendee register

Apologies: See attached apologies listing

Minutes: Yolanda López (DMITRE); Sophie Giorgines (DMITRE)

Introduction: BG welcomed everyone and outlined what is in store for the day

- Email will be sent post meeting with minutes and links attached.
- Outlined agenda details.
- Social and natural economic environment conversations need to be done before the academic discussion.
- Leading practice regulation doesn't permit feet on land until rules of engagement are established for communities and investors so that certainty is provided and trust is built.
- Reviewed the Roundtable's development:
 - Key driver to form the roundtable was regulation (won't go into too much detail today).
 - Looked at 2011 and 2012 progress of the roadmap.
 - Process of reaching 125 recommendations – consultation through meetings and the ratings for 'doability' and 'materiality'.
 - Since the release of the Roadmap publication we have been looking at the implementation of the recommendations through working groups etc.
- Showed global map of shale gas deposits – you need a number of things to get in: a market, support of investment, get into a pipeline and trusted regulatory frameworks.
- If we don't move down our cost curve we will be put in a world of stranded gas.
- Overview of technically recoverable potential of shale gas.
- Comparative advantage: you can drill a lot of verticals at a fraction of the cost compared with horizontal drilling.
- As part of the recommendations from the roundtable we have been developing maps. What was asked of the government was to give information out to move things along as far as showing where the plays are. We have maps determining relativities of value in the subsurface.
- We have in excess of 200 tcf in the Cooper Basin in the current market.
- The JVs currently underway will require much better infrastructure.

- Have now worked out legal frameworks from information resulting in the previous roundtable meetings.
 - Trying to pass on information to companies on how they can become more cost effective when putting in flowlines etc.
 - Introduced PG (DMITRE, Industry Participation).
 - We want people to think that investing in SA is sustainable and profitable.
 - WG 1 recap, BG asked PG to give details about WG 1.
- PG: Bringing together all key operators and tier one suppliers that exist in Australia already, and try to understand what their aspirations are for training and development.
- Both Beach, Senex and Santos have agreed to producing an onshore training facility (Tonsley, to be underway by quarter 3, 2014).
 - We want to get people inducted and get them into the Cooper Basin quickly and cost effectively. Want to establish a one 'common induction card' that works for all areas.
 - Key operators who are leading WG 1's 'common induction card' project will be meeting again on 12 December.
- BG: Want to develop JVs for JVs as cooperating in order to compete is a good idea.
- Invited SG to the stage to outline tomorrow's proceedings.
- SG: Tomorrow will be the roundtable's research day, focusing on capabilities, improve productivity and lowering costs curves. Wednesday includes the tours of the University of Adelaide and Wark campus where everyone is welcome to participate.
- Trying to build capability especially through the University. Trying to obtain a world class leader with the contribution from many companies (Beach, Santos etc).
 - The agenda tomorrow has people from CSIRO, ANU, speaking on a range of matters. Geoscience and Flinders University will look at environmental impacts.
- BG: WG 2: we have thought provoking information to distribute in the next coming months. We will be looking at different supply chain routes.
- Have put together a materials list so we can come up with a 15 year forecast.
 - This will inform when we should look at rail vs road.
 - Work with DPTI to optimise supply chain routes.
 - Special facilities' licences have been granted for new depots in the Cooper Basin, now working on airstrip licences and petroleum handling facilities.
 - Now have the integrated transport and land use plan that has been brought out by DPTI where they plan to seal the Strzelecki track.
 - WG 2 will inform how quickly this needs to be done.
 - Currently have 3 or 4 rigs in SA and QLD for unconventional exploration drilling. If this is successful we can see the future 15 year model.
 - If everything goes smoothly it's possible, in 2016, that people will be at investment decision point.

WG 3: Leading operators have met and are planning to come together to share information to reduce cost and reduce water use and / or reuse water – this will foster environmental outcomes etc.

- Look at opportunities for a third party to pipe water (cooperating to compete).

WG 4: During APPEA 2013 DMITRE tried to speak with SA and QLD Ministers, however the timing was not right therefore WG 4 has not progressed all that much.

- Introduced MM who has been speaking with QLD government.
- Introduced DH and outlined the national regulator in Brisbane. We need to be educated on what meets objectives.

WG 5: Met on Friday 22 November 2013

- URS did a study with the University of Texas and the EPA has adopted a lot of their findings, University of Adelaide has been working with Queensland as well as the CSIRO working with industry.
- The National Greenhouse Gas (NGHG) database is for all types of GHG, CO₂, methane etc.
- We should have a discussion with the community about the importance of developing ever better technologies which are more cost effective to monitor and measure all forms of GHG.
- WG 5 will come out with valuable FAQs.

BG: Opened for comments

- As we see unconventional being sourced the State will need to have conversations with everyone as to what are the different risks.
- Is compatibility realistic or not? Before stepping on land we will go through discussion with investors to identify different risks.
- Notice of Entries (NOEs) must be given to ensure people make informed decisions.
- The dispute resolution process doesn't start until we resolve concerns.
- Roadmap was to show what has been safe as well as what will and won't be allowed. It is a regulatory scheme.

AD: Spoke with land owners who live close to a well that we not plugged.

BG: This could be a legacy issue – under other / previous Acts this may have happened. It is illegal now to go on to land without an NOE, if you do, you are at risk of losing your licence.

Action: BG will get details from AD and will look into this further.

Break for morning tea.

Project Updates

BG: Introduced CG (Santos Ltd)

CG: Commenced 9.47am

- There is currently a lot of focus on Australia especially due to the stable government aspects.

- View on prospective plays specifically looking at the Nappamerri Trough, shale play and hybrid shale (upper Patchawarra etc) and the deep coal play.
- Santos has had a team focused on unconventional since approximately 1996.
- The Cooper Basin provides a lot of information. Santos has a large data set, a lot of 3D and core data.
- JV in the Cooper Basin – first project involved drilling in the Nappamerri Trough.
- When discovered gas, Santos was pleased. It had good sand development, it was cooler, more head room to operate in the area.
- Interested in 3D.
- Tested a number of wells and well boards and the deep coal play extends into the Nappamerri Trough.
- Shale play – where Santos has been drilling horizontal and vertical.
- Much of this process is learning – trial and error.
- This may cost in excess of \$1 billion. Interested in working tighter as an industry.
- The play is very large in the Cooper Basin and there are secondary plays as well.
- Shale play – worked with extensive vertical and horizontal wells and now testing vertical wells .
- 2014 focus – too early to see where the highlights are. Have done many stages. Santos need enough wells and enough stages to increase the rate per stage. Santos has the benefit of a larger data set from the wells drilled by Beach Energy.
- Increase surface area to bring up to an increased economic state – move costs down by 50%.
- Plan on drilling wells down in the Daralingie. Want to learn how to frac, do it quickly and cheaply.
- 3D seismic surveys: interesting to see the differences across the States and what the different companies are contributing.
- Santos shot a specialised 3D survey. Very long offset that tied into other 3D seismic and will tie into next year's program. If successful Santos will do another, larger, survey in 2014.
- We need supplier competition. Our vision is to have 25 rigs run on unconventional, this would mean that costs would drop significantly.
- Things in Australia in certain areas can be very expensive, therefore we need to be cost effective and aware of environmental impacts.
- Thanked JV partners.

BG: Thanked CG. If the JVs that are competing with each other find a way to cooperate on data so that we can all learn what we can as soon as possible it would be a great outcome for all.

- Invited MP (Beach Energy) to speak

MP: Commenced 10.10am

- Tight gas aspect of the Cooper Basin are very exciting.
- Nappamerri Trough project – PL218 in SA and ATP855 in QLD.
- Have demonstrated that there are many untapped resources across the basin. It's trapped there because of shale.
- Wells Holdfast and Encounter proved the play existed.
- Start with high cost and not so much on learning curves.

- There have been previous attempts to reach these areas but failed or had limited results.
- Now in vertical / horizontal exploration stage.
- Building models and experimenting with different techniques.
- Costs aren't coming down at this stage but knowledge is increasing.
- Next stage is continued appraisal. Build confidence in the resources. Possible small scale pilots.
- Followed by real pilots. Building deliverability and targeted development. Go into development phase and drive cost down through repetition.
- Have already been exploring, looking at technology, rocks and flow tests. What are the targets and productivity?
- During the exploration of rocks, we have found that the depth goes down to 5000ft. There is a need to redesign rigs to be able to withstand the pressures and depth of this area. Gas was found so Beach know that it is worth pursuing.
- Has helped monitor stress magnitudes.
- Looking also down to the micro scale. Injection tests etc help look at the fine detail of the rock.
- Want to see the increase in rate – make it more cost effective.
- Attempting to use sand plugs for isolation fracture stimulation intervals.
- Have tried fracture stimulation flow through plugs.
- Using oil tubing jetting.
- To improve fracture stimulation, Beach went down to a 5 - 5½ inch casing.
- Flow rates across the area: Holdfast 1 was the first well that was flow tested, it produced 2 million per day. Encounter after six stages produced 4 million per day.
See 'exploring flow rates' slide for more details on different wells
- Appraisal cross section: most wells have drilled through the Patchawarra formation.
- Holdfast 2 update: currently trialing micro seismic. A big challenge encountered is due to temperature, it can get up to 200 degrees celsius or more. Micro seismic allows you to see where your fracture stimulation is growing. Want to understand this so that we can see how much rock we are connecting up.
- Have tried different technologies which have some risks.
- Downhole microseismic and surface microseismic was undertaken to see the extent of fracs.
- Currently in the process of pulling the data to see how big the fracs are and where they went.
- Horizontal wells allow you to play with different stages and techniques. Now have a good opportunity to trial.
- Boston well: drilled close together to gather base geological information needed.
- If successful can go to a pilot around the area.
- Summary of timeline: Beach will be drilling through to December 2013 / January 2014 and frac stimulation through beginning of 2014.

BG: Question, where do you see Beach in 2017?

MP: Boston will be the initial pilot and will continue provided we see some positive outcomes. We hope to see some production by 2015 then build rig capacity afterwards.

BG: Introduced JMc (Senex Energy)

JMc: Outlined what Senex is doing in the Cooper Basin with regards to unconventional and conventional activity. Commenced 10.38am

- Senex has approximately 65 different permits.
- Want to maintain recent outcomes.
- Have booked a commercial gas discovery called Hornet Gas Field.
- Focused on building a company that understands the risks in this industry.
- Strong focus on collaboration.
- Have announced a 15 year tenure agreement which allows for operational flexibility.
- Projected demand is three times (720PJ/a) (current) in 5 years.
- Would like to develop field appraisal.
- Senex's unconventional activity has been more so around the Innamincka area. 5 wells that have been fracture stimulated in various stages, these wells undertook significant coring and appraisal assessment resulting from this drilling.
- Hornet Gas Field details – see slide.
- Next: commercialise gas reserves and resources. Move to reserve based assessment.
- Oil production is on the upward in production areas to the North West of Moomba, expect production to increase this year for up to 1.6million barrels of production.
- Discoveries in the North West and North East have undertaken 1800 square kilometres of seismic.
- Activity in last three months has been in the South and South East of Moomba – more discoveries yet to be properly assessed.
- Success in the Southern Cooper now producing some 1000 barrels per day.
- Focus to move to execution excellence.
- Now around 40-45 days for discovery to production.
- Our future is both in oil and gas – reserve growth from 4 – 6 million barrels in 2014.

BG: Thanked JMc and introduced CT (Strike Energy)

CT: Commenced 10.53am

- Strike Energy is a smaller company but still with assets in Australia as well as in the US.
- Participate in six permits in SA, operate PL96.
- A hard play to work with is Eagleford. Upper and lower broken into three units.
- There is a need for trial and error.
- Targeting coal in the Cooper Basin. When we chase unconventional, we want access to infrastructure.
- Decided to look to the domestic market, looked at industry to partner with us.
- Decided to focus within 10km of the Moomba to Adelaide pipeline.
- Drilled well, Marleston, then Davenport and had well over 100m of coal and 2 great seams in the Patchawarra.
- Where else could they find similar development? Looked for common geological aspects.
- Take the next steps from basic core data – stimulation, testing and optimisation cycle.
- Partnered with Aurica.
- Technical feasibility: need to understand the organic content, it's maturity, porosity.

- Trying to find the zone / the right depth to have maturity and permeability to make it work.
- Need an understanding of what's driving it, what we don't yet understand is the permeability, what will work with regards to stimulation and well design.
- Currently in the appraisal stage, what's the resource concentration?
- Plan to frac and move into a pilot program to get an understanding of what the next well needs to look like (technical feasibility).
- Need to make and break this play as efficiently as possible.
- Future program: currently drilling Le Chiffre 1 well and have gathered a lot of core to get a good understanding of the rocks around. Now understand the geomechanics and the need to get to the next stage. Currently trying to understand what's going on with the stress regime to get a better idea of stimulation and well design.
- Pre-production wells are pilot wells and we want to get back to drilling by middle of next year.
- Objective: want to be meeting the gas market by 2016 in order to see the benchmarks as we go along.
- Plan on doing extended production testing. Focus on initial wells already drilled. Keep costs down and within the focus area.
- Conclusion: confirming key aspects of the Senex model – continue to gather critical data to make quick decisions.
- Have an ongoing drilling and evaluation program.
- Gas market continues to tighten.
- Potential to accelerate pilot testing.

BG: Introduced TF (Beach Energy) and outlined stakeholder engagement.

TF: Commenced 11.13am

- Overview of engagement strategy for EIR and SEO for Otway Basin.
- Alignment and strategy with the MCMPPR principle, engaging with communities and stakeholders.
- History of drilling in SA: Beach drill on both sides of the boarder.
- Current interest in unconventional in PL494 and PL495 and another in 4 years in PL486.
- Historically there has been an active SEO in the South East for many years.
- SEOs need to be reviewed every 5 years under the Act. Beach has been going through this process in the past few months.
- Local communities in the South East are different than in the Cooper Basin.
- Beach recently met with local councils to ensure we had mapped all the correct stack holders and to hold public meetings.
- As part of the presentation to community they outlined fracking stimulation as well as the regulation side. Included the fact that Beach are heavily regulated.
- Meetings were well attended, many questions asked, Beach had some of their technical team to help answer questions.
- The type of questions asked can be found in Beach's environmental impact report. DMITRE assessed this report to be of low environmental impact.
- Once all comments from DMITRE were reassessed it was gazetted on 14 November.

- Beach know that time needs to be invested to ensure public approval before going ahead with fracture stimulation.
 - MCMPR – the document ‘communities and stakeholders’ acts as a guide.
 - Community engagement is a critical stage of any project.
 - Principles: Communication, transparency, collaboration, inclusiveness, integrity.
 - Beach has a successful history of working with landholders.
 - Outstanding environmental track record.
 - Engaging stakeholders.
- BG: The public should not be expected to know what oil and gas people do. Oil and gas people need to know what people who work the land do.
- As part of the PACE program, we will have educational tools for both parties.
- JEF: Keep in mind that many geologists etc come from the land / grew up in rural areas.
- TK: Question to TF, reporting back to the community, how do you intend on keeping the community informed of the progress / process?.
- TF: We will spend much time going down and speak with communities. We want to ensure people that it is best practice.
- BG: Under the multiple land use working group there is the coal seam gas steering group – not yet in a position to have a frac. focus on a national basis. We don’t have all information readily available to the public and are not yet at the point of having leading practice on a national basis. We need better IT resources.
- GB: Question for TF, compare contrast between states. Thoughts on what’s happening in Victoria?
- TF: Government to understand what’s happening with fracture stimulation as well the community understanding that Beach can’t be compared with Victoria as we are trying to engage thoroughly with the community.
- BG: Generally the bad information is what gets inflated; previously industry and the government haven’t been very good at holding people accountable for the truth.
- Need cultural awareness across industry / government (all parties).
- SM: Perception is sometimes stronger than fact.
- Need to fight the perception that government profits from company gain.
- JB: Community engagement is very important. Be aware that there is community engagement fatigue, ensure meetings continue and people don’t feel as though it’s repeated information.
- RW: Challenge of calibration: best practice differs from person to person. We need to be on the same page.

LS: Had worked with the energy NSW project. Went to the farmers' forum where they asked great questions without animosity, mainly about multi-use of land. Stakeholder engagement starts at the land.

PB: In NSW there have been threats of picketing lines where fracking is intended. Bad quality information needs to become good quality information.

BG: We require companies to discuss issues with people before there is a back lash.

- In an economy that needs resources it is tough to improve when held back.

BG: Introduced LS (Santos Ltd)

LS: Commenced 11.53am

- Overview of current project at Santos where asked to develop a Cooper Basin water strategy.
- There was the view that water was either sourced for supply or a by-product that had to be dealt with.
- Project scope – there wasn't much data to create a project strategy.
- Much more about the geography of where the water was located as well as the source and supply of volumes.
- Took 2012 as current model to work off, then built 2013-17 model.
- Important that the strategy was created by the stakeholders.
- Was able to use the GoldSim model and able to retain the learning in-house therefore didn't outsource / use contractors.
- Created an online survey to gain an understanding of direct engagement.
- Model is structured by Operating Area. Was able to take much of the information from existing sources.
- Rather than trying to capture each well's data Santos grouped it by water by area eg. Total amount in one region.
- Most water is going to evaporation ponds.
- Drilling and completions example – looked at different water types and how they are treated.
- Example results – relativity: extracting water in total over 25 years is the same amount produced as LNG in Qld.
- Looked at the amount of water sitting in ponds.
- Surprised to see how much water we use in roads etc. only looking at direct use, it is up almost double over 5 years.
- GoldSim can include the dimensions of the different ponds.
- The model is only as good as the data provided.
- Opportunity to optimise reuse where geography is favourable.
- Deliverables and follow on projects: understanding of water volumes, improved data, guide water management to stakeholders and corporate alignment to water management.
- Cost of water, balance results provide input data, develop model both direct and indirect costs.
- Water forecasting.

- Industry collaboration – proposal is to do a water balance to a high level which breaks the Cooper Basin up, then we can overlay results.
- Improve and expand. One thing we didn't have was third party forecasts, need to get a handle on third parties trucking water from the sites.
- Look into camp use and reinstated water metres.

Open to comments and questions:

BG: Push for JVs to pull their water demand and supply to ensure resources aren't wasted.

- This is industry coming up with a basin-wide model.

JK: Who owns the water and how will it change in the future?

LS: Cross use amongst operators / different parties. There is a licence that DMITRE holds across the basin. Santos holds a licence in Moomba for up to 2 gigalitres. Many of the bores Santos use are owned by them.

MM: There is an allocation for 60 megalitres per day in SA for the coproduced water. In terms of water bores there isn't an allocation as they are given as stock usage. Essentially our Minister's owns the coproduced water.

BG: Water outside of the Cooper Basin, there are significant differences in the salinities etc.

- It isn't simply a matter of drawing from deep resources that no one has a use for but demonstrating the integrity of cement pipe to prevent cross flow.

LS: Comes down to the casing of the water. Need education.

AB: Well integrity becomes increasingly important. What we see is an increased focus on measuring the integrity of the well, monitoring it and ensuring systems are there for the long term.

AD: You can have well integrity problems no matter how many casing, cement eg. In the South East there is also the potential for earthquakes. Look at what's happened in the past and how it's being fixed now, the effect it can have on the agricultural land.

BG: Prevention is better than cure. People need to understand the benefits and the risks. Can we better communicate that risk balance is ok?

QG: There was a workshop in 2012 about water resources etc – there are copies of the publication available at the ANU.

JEF: Well integrity – there is a lot of data from wells, documented examples from other parts of the world that can be looked at and applied to in Australia.

LS: Main point from discussion is to look at reuse.

JK: **Put on agenda:** there are magnetite mines. Look outside of the P&G sector and share across the board.

LS: Valid point, has already been speaking with mining people.

TK: Expansion of water ponds etc. There is a concern with regards to fauna entrapment, there needs to be further / better state reporting. It affects all different environmental areas.

LS: There are different regulations across SA and Qld (which are much stricter); this is an area that needs to be worked out more in depth.

BG: Thanked LS.

Break for Lunch - 12.33pm

BG: Introduced MH (Genessee & Wyoming)

MH: Commenced 1.36pm

- Brief overview of G&W: large company in USA, operate in USA, Canada, Europe and Australia (since 1997 in Australia) and are able to operate in all states. Provide the Ghan service.
- North American shale – operate on crew side and destination.
- Shale operations: crude-by-rail, natural gas liquids and drilling inputs
- 30+ railcars per well.
- Terminals provide all services, unloading sand, drill cutting disposal and water.
- Handle waste water.
- Compared to Australia, which is point to point, the US works across the board.
- Case study: need to collect crude to a pipeline. Invested in developing a loading facility.
- Business has grown to 6% of the energy section.

BG: Question, are we looking at having a link to the Cooper Basin?

MH: A connection to Leigh Creek. Looking at \$800 million for this.

BG: Cost of sealing the Strzelecki Track?

JP: It would cost \$2.5million to seal. Currently trying to improve access to this road, currently in a flood area.

BG: Key issue with regards to cost curve. How much forewarning is needed?

MH: Takes about one year to get railcars here.

BG: Getting JVs in would drive this decision.

MH: Need to understand how many wells are expected to be generated. Rail works really well when the volume is there because of the infrastructure and the size of the railcars, you get the efficiencies of hauling by rail.

BG: When you're building a rail line are there things like ICT that you look at?

MH: When you have a rail line other things develop. For example, the line to Darwin unintentionally opened up agricultural movement and mining needs.

JEF: *Unable to capture this question*

MH: Have to look at the price / cost of gas due to BTU drop.

BG: Thanked MH.

BG: Introduced HN (DeGolyer & MacNaughton)

HN: Commenced 1.53pm

- D&M are a global consulting company in oil and gas. Deliver information to stakeholders.
- Have opened regional offices around the world.
- Reservoir and engineering studies.
- Involved in economics. Work with government agencies with regards to economic modeling.
- Strategic service: help enhance oil recovery and production forecasting.
- Supporting reserves.
- 2013 experience in the Cooper Basin: remind people that shale may be different, things are not like the Haynesville.
- Currently in an evolving stage. Starting to see the development of local analogy, particular to certain plays that aren't listed anywhere else.
- Seen big league farm-outs, more discoveries with better testing.
- Companies are now seeing their oil opportunities to pay the bills. Starting to see the 3D seismic being used more and more.
- There is growing recognition in the eastern states of their frailties.
- Tudor, Pickering, Holt Co. (US integrated energy investment and merchant bank) published a report on the Cooper Basin, *The Australian Business Review* published an article relating to this report which can be found [here](#)
- More integrated deals and commitments by companies in 2013.
- Trying to understand the data that comes from the different plays. The better the data, the more you can understand about the play.
- There is great value in sharing information.
- The most relevant part of the North America shale experience: large single type plays shrink to care areas (fairways) (*see slide 7*).
- Do things that put you in a position that keeps you going, for example partnerships, share data, seek out additional help etc.
- The Petroleum Resource Management System: way to understand how companies are expressing themselves.
- Tries to capture the added value of what companies are doing with their work.
- Has had an impact on the SEC rules and will impact the ASX rules.
- PRMS classification framework: moving from undiscovered (prospective resources) to productivity.

- Looking very much at hydrocarbons: where is it coming from?
- Discovery test worksheet: different waiting of different things, do we have discovery yet? Good measurements for coal but seeing flows to surface and other types of plays is what we are after.
- Contingent resources: covers a broad topic. In the absence of performance from an adjacent well, can we have a pilot project?
- What would an analogous reservoir look like? It would share in similar proximity.
- Start putting analogy together. Local and proximal aspects will start to look very good.
- If you don't have a pilot project, get one, test one.
- D&M have been able to monitor current pilot programs and can see the benefits.
- Project contingencies: transportation, lack of approvals, lack of finance and commitment etc.
- Technical contingencies: resource.
- CR classification flowchart (*see slide 30*).
- Progressing contingent resources to reserves. Take away the contingencies and D&M believe you will see the reserves.

BG: Based on HN's experience from North America, how far off do you think Australia is?

HN: It is possible that we are very close to this point. We can see the pieces of work that the US didn't use. If they had done their initial technical work they might not have destroyed so much capital and time and might have been much more successful. There are different plays within a play.

BG: How many years do you need to flow a few wells before you know?

HN: We like to see it in about 1 year / 18 months, having an analogue allows you to see commercial attractive performance.

BG: Thanked HN

BG: Panel to now begin. Asked the panel to come on stage.

Panelists include: JM (Halliburton), AB (Schlumberger), ST (Baker Hughes) and CL (Condor Energy)

Moderator: KW (Beach Energy)

KW: Introduced himself. To develop such a large resource will take a large effort from the industry. The play itself is very challenging and is a capital intensive place to work in. Today is a great opportunity to capture the learning from across the Cooper Basin and North America.

Panel introduced themselves and encouraged people to ask questions.

JM: Background in hydraulic fracturing.

CL: Condor Energy is a pressure pumping company. CL has a background in pressure pumping services. Worked with Schlumberger and in various areas in the oil and gas industry.

AB: Worked in Abu Dhabi where they were in earlier stages. Prior to this was in western Canada where they were in later stage. Schlumberger can be involved in all different stages of the project, it depends on the client and what point in the project we engage.

- ST: Background in drilling evaluation then integrated services. At what point are we going to see unconventional technologies take over?
- BG: We see that pad drilling and unconventional drilling are the sorts of things that have brought costs down in North America. What do you think we need to do to get costs down in Australia?
- JM: Get many rigs up and running. Santos are already doing pad drilling projects. Some technologies are coming into fruition. The real solution is activity for cost reduction. In Australia we have fly-in, fly-out people on top of labour being more expensive. It's a long way from high activity at this stage.
- CL: We need to recognise that this activity growth won't happen overnight. Personnel costs are anything from 15 – 30% of costs compared with the US that is 6 - 10%. We won't be able to get around this anytime soon. Our geography plays a large part. We work out of the desert and we need to manage the scheduling and human resource element. Transport and logistics: 20 – 25% of frac. costs is in this. Moving towards a model where more activity is there will assist us but we need to form appropriate hubs, this gets easier with increased activity. It's all a function of supply and demand. Lastly, competition, the cost of entry into Australia to provide a service is huge.
- AB: Factory drilling means something different to everyone; prefer to use the term 'lean manufacturing process.' Understanding the shale and marrying up completion and reservoir qualities is the way to move forward. The economics of our unconventional development turn our professional thinking on its head; normally the drilling costs outweigh everything else. In unconventional it's the completion costs that become the more expensive portion. If we want to reduce cost then we need to spend more time on completion costs more than what has been done before. How can we move away from traditional ways of fracking and improve the technology required? Take advantage of technologies that have been applied elsewhere in the world and apply them rapidly here.
- ST: Drilling the limit – get back to this thinking. Look at combing things on single runs / lines. Look at what technologies are being used, perhaps slow things down a bit.
- CT: Talking about development phase, we won't reach needed activity until we see commercial rates. How do we save costs when we think about targets? Build a program to meet these objectives.
- JM: This is a difficult problem. There are areas that are shared by operators etc; it's a struggle when you're in the appraisal, operation phase. You can drag cost down with good technologies, for example with micro seismic. You need to be sure that you have organised it properly. We need to do the diagnostics early on.
- CL: We need to deal with what we have here today. We need to think differently when you are competing with larger companies. We have logistic benefits but the standard equipment doesn't fit and we have different requirements across states in Australia. We need to look at standardisation. There are areas within the different regulatory operators across Australia that we need to agree upon.

- AB: Operators talk amongst themselves, for example we hear of frac. clubs and rig clubs. We need coordination between all parties to ensure you're not being pulled in all different directions at the same time. There is also data acquisition, we need to think about how we take this data and use it, then we don't need so much data down the road.
- ST: It's about collaboration, when we can't justify bringing in large equipment. Look at people who are bringing in new datasets all the time.
- MP: Best practice technologies for unconventional development, what are the big ticket variables? How do we blend knowledge from all service companies?
- ST: It's difficult to say what is the best practice when you don't have a correct analogue. It's more about the workflow rather than the technology.
- AB: There are different areas of expertise, those related to geosciences for example. Some are more transferable than others. Project management needs to be taken from different areas in the world and tailor it to your project and production. Geoscience is a centralised set of skills that provides the backdrop for all engagement.
- CL: The US has developed best practice from trial and error over thousands of wells. The upfront diagnostics is critical in determining success. Every well can be vastly different. We need to develop our own models in Australia.
- JM: Best practice is different when in exploration appraisal phase compared to development phase. Horizontal drilling knowledge in Australia is very limited. Making an assumption here, this is part of the solution – this is a trial and error business. Diagnostics are critical.
- HN: Question for AB, when in Canada, can you speak of being involved in the Horn River and how some of these aspects are very relevant with regards to remoteness?
- AB: The Horn River was very remote. The collaboration we got involved in was where to put the rail in and unload supplies (propane) fast enough to get it out to crews. Instead of each operator bringing in supplies individually they combined everything. They pulled resources from everywhere – 'collaborate and compete.' Sometimes we need to break some of those established taboos to collaborate to compete.
- TD: Reducing costs – comparison on establishing and producing local supply compared to established supply chains. We are capable and there is enthusiasm to do this. Looking at potential drill pipes. Is this a benefit to the industry?
- JM: Halliburton has a large source of local materials but there are large areas in the Cooper Basin where it is imported eg. proppants. If we bring things in from the US it is an approximate 4 month lead time, you need large warehouses etc. We also try to build our own machinery here. Cost is a factor, sometimes importing is cheaper.
- BG: It's not government policy to ask for services that are not competent or competitive be the services that you take.

CL: The infrastructure and domestic know how needs to be developed to make things more efficient. Big thing at the moment is volume cost. Cost of human resources in Australia are much higher. Many specialist products need to come from outside Australia.

AB: Competitive advantage comes from a specialty chemicals.

ST: Different product by product. We have great talent, education etc therefore we do see the quality in SA. There are always going to be problems with sourcing locally.

DW: Do you think that the commerciality of the Cooper Basin rely on horizontal drilling and fracking more stages or are we going to have some sort of technological step change?

ST: Is the Cooper Basin going to be viable? This depends on the market and how it develops. We always need to be looking at drawing more value from the resource for the market (if it's there).

AB: Anything we can do to make fluids more effective. RND, there is more than just engineering aspects. Look at ways at determining where things are, not necessarily running logging sheets. There will be research in engineering to develop where the sweet spots are.

CL: We have taken the approach of working with local universities that have some of the infrastructure. Looked at how we can improve fracture stimulations etc. Go back to harmonising regulations and promote competition and the continued innovation in our industry. We are always looking at Australian content.

JM: With regards to technology, there are still things on the RND side that still needs to go further. Temperature is one of the biggest issues, seismic relating to horizontal wells. Big problem of tools and extending the technology, some options are not quite there.

CW: Can really see the expansion of capability.

AD: Wells are meant to last a lifetime, how long is a lifetime?

JM: To the point where it is no longer economical. There isn't a final number of how long it will last, there are wells in the USA that are over 100 years old that are still producing.

KW: You want wells to last a life time. Monitor wells and take every teaching you can get. Things change and you get new technologies, logging wells, material selection. You want the well to last forever.

BG: If there are areas where wells need to be remediated, you need regulatory standards that enable perpetual protection.

JEF: With regards to the breakthrough: have any of the contractors looked at the statistics in outing this together? Integrating these thoughts? Have you been thinking about linking these to stress regimes and is there any focus?

AB: On more mature basins there is a move to a more shared model to ensure a more meaningful understanding.

JM: There is work done on the stratigraphic side of things. There are only a handful of productive wells to compare to.

ST: We are starting to go back and look at log data.

AB: Gave an example of using multiple data from different sources and how it's beneficial. We use such a small portion of this data.

HN: The data is out there, there is a significant opportunity to do more with this data as the opportunity is definitely there.

MP: Which are the intervals to target? It's a combination of operators looking at targets from geological information and then trying to come up with good solutions. Need the operator to set the tone of where to go.

KW: Afternoon break but time for more questions in the second part of the panel section.

20 min break – commenced 3.45pm

BG: Asked panelists to return to front of stage – commenced 4.07pm

- There have been a couple of themes from today:
 - In North America – the way cost curves were descended took 10s of operators to learn while doing and to understand that unconventional was being done by mid size companies, it was important that everyone worked together. We just don't have those economies of scale. Our JVs aren't at the point of drilling 100s of wells per year. We need to share learnings and be competitive.
 - Is there any legacy data or information that is free to you? If so, have somebody else work their way through it and add to new data. Are there any ideas about that?
 - Also, your view on leading practice transparency for chemicals.
 - Third, what are research problems worth solving i.e. temperature, stress strain, CO2?

AB: Legacy data: there's data at first glance we're unsure whether it has value, for example drilling reports. It may only act as a guide to an area to go into deeper. The use of core data needs to be utilised more and the data that can be pulled from this.

JM: Biggest thing for the Cooper Basin is the stress regimes. Any free information that can explain stress sweet spots, fracturing spots we need to ask ourselves, how is this going to relate?

AB: Transparency: why is this question significant? It's about reducing / eliminating environmental damage. Find a way to disclose information without giving away too much. It may mean looking at our chemicals from a solution perspective.

CL: From a practical perspective we are looking at the toxicity and environmental impact so as long as those issues are disclosed through post toxicity tests, that is what we are after. When companies are looking at replacing current chemicals with other chemicals it's either because of efficiency, performance or an environmental perspective (generally all three).

ST: It's not what we want / don't want to disclose, we have a duty of care to the public and the environment and this is what allows us to have a business model.

JM: With regards to pure disclosure and the toxicity side, in the US there is always some IP protection system in place, we need this in Australia when disclosing to the regulator but be protected from public disclosure.

CL: It's all about temperature. There is a lot of equipment that will not function at such high temperature.

AB: Need to keep striving for innovation, look at new ways of stimulating wells, we've made steps but there are still ways to go when stimulating wells. Challenge the way to produce if it's an economic issue.

DT: How can anyone ground their research if they can't get access to production data?

BG: In SA all production data is available after 6 months.

HAK: Have we started to test and tweak?

JM: With unconventional there are only a hand full, therefore only small amounts of trying different methods and fluids. A few wells make it hard to know statistics.

HN: Permeability and characterization.

CM: Learning from other sectors with regards to stress, temperature etc. Any comments from geothermal in the USA?

BG: Geothermal is riding on oil and gas as there aren't too many rocks and secondly the manner of completions is very different. Are we seeing anything like the fractures in the Habanero? It's also sheer versus other fractures.

BG: Thanks to everyone for coming. Hope everyone gained what they were after. Tomorrow's meeting will be lead by the University of Adelaide. We will briefly look at the Roundtable working groups tomorrow also. Thanked the panelists, speakers and all for coming.

Closed: 4.30pm