Arrow Energy

Surat operational update

July 2016
• Provide an update to the community on Arrow’s operational activities over the past 24 months
• Approval stages for the Surat Gas Project
• Upcoming survey activities
• Update on Arrow research activities including groundwater interconnectivity trials
• Arrow has delivered a $250M expansion of our Daandine facilities
• Evidences our commitment – focussed on growing domestic gas business in the Surat Basin
• Recent domestic gas expansion projects have demonstrated our coexistence commitment
• Continue to plan to find the best and most viable way to bring our Surat Basin gas reserves to market in a low oil price environment
• Challenging economic environment requires us to reassess all options to find the most economically-sound path forward
• Planning for Surat Gas Project continues, which includes collaboration opportunities
• Progressing innovation in technical and non-technical areas to minimise our impacts, improve coexistence with land users, optimise gas production and reduce cost
• Focus remains to develop our sizeable gas reserves in both the Surat and Bowen basins
About Arrow Energy

- Developing coal seam gas (CSG) since 2000
- Commercial supplier since 2004 (2006 in the Surat)
- Delivers almost 20 per cent of Queensland’s natural gas from
  - five CSG fields in the Bowen and Surat basins
  - about 1,450 gas wells
  - supplies five power stations throughout Queensland
  - supplies industrial users in Townsville and Moranbah
- Owned by a joint venture company between Shell and PetroChina (50/50)
- Approx. 21,000km² exploration tenement across Queensland
- Working to meet the growing demand for cleaner burning fuels
- CSG is natural gas trapped in underground coal beds by water and pressure
- To extract CSG a 300-750m deep well is drilled
- Water is pumped from the coal seams to release gas
- Gas and water flow up the well to the surface separately
- Wells are constructed to isolate coal seams from groundwater aquifers
• $250M expansion to a domestic gas business investment
• Daandine area in production since 2006
• Supplies Braemar 2 and Daandine power stations; as well as other 3rd parties
• Project stats:
  • increase capacity by up to 60%
  • increase Arrow supply by around 17%
  • employed approx. 200 contractors
  • utilised new gas production techniques
Braemar 2 Maintenance Project

- Major overhaul on gas turbine completed end of June 2016
- Turbine rotor (9m high, 53.5-tonne) lifted through the roof using 450-tonne crane
- ‘Hot Gas Path Overhaul’
- Purpose built 20m tall de-stacking shed, allowed contractors to remove blades safely
- Completed in 40 days
Kogan North

- Located 40km west of Dalby, owned by an Arrow and Stanwell Corporation JV
- Producing gas since January 2006, supplies CS Energy’s Swanbank E Power Station near Ipswich
- Drilling campaign included ‘twinning’ of nine production wells
- Utilised existing wellpads, access tracks and gas gathering network
- Twinned wells target a slightly deeper section of the Walloon Coal Measure, reduces Arrow’s footprint
- Additional planned construction work includes tie-in activities (hot-tapping) gathering network to connect the new wells
- Maintenance undertaken at Meenawarra Pilot, approximately 3km south west of Cecil Plains
- Three existing pilot wells (of the six-well pilot) have undergone workovers
- Additional surface facilities have included the installation, commissioning and operation of new well head skids
- The wells feed into the existing Meenawarra Pipeline and Tipton gathering system
- The original pilot was drilled, completed and surface infrastructure constructed in 2009
- The pilot has been restarted in order to gain more production data
Located 20km south of Dalby, producing CSG since 2007

Supplies Braemar 1 and Braemar 2 power stations

Four new ‘twinned’ wells to be drilled in 2016, utilising existing wellpads, tracks and gas gathering

Additional wells planned for early 2017 at three locations adjacent to existing field:
  - 2 vertical wells at site 1
  - 2 vertical wells at site 2
  - 1 vertical and 4 deviated wells at site 3
  - 5 km of water and gas gathering lines

Arrow is currently identifying preferred locations, with landholder negotiations ongoing
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Surat Gas Project

Key milestones

• process commenced in 2009 (impact assessment)
• lodged draft EIS in Dec 2011

Queensland Government approval

• EIS approved for public release in March 2012
• State approved in Oct 2013

Federal Government approval

• Federal approval in Dec 2013

Next steps

• Further studies for value improvement
• Collaboration discussion
• Environmental Authorities, Environment Protection and Biodiversity Conservation Act Plans
• Area Wide Planning
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Surat Gas Project

- Range of project design
- Concept studies
  - Environmental Impact Statement (EIS)
  - Supplementary Report EIS
- Engineering design
- Construction
- Production
- Area Wide Planning
- Pilots
- Demonstration projects
- Shareholders Final Investment Decision
- Community update
- Today
- Environmental Impact Statement (EIS)
- Supplementary Report EIS
• Development planning is ongoing
• All core tenure from an area north of Wandoan, to south of Cecil Plains is being assessed
• Focus on value improvement and opportunities for collaboration
• Not schedule-based
• Overarching project principles will remain unchanged, including a focus on coexistence
Wells and wellpads

- The number and type of wells is dependent on coal properties; depth, gas content and permeability.
- Average surface spacing of well sites will on average not be less than 800m on Intensively Farmed Land (IFL).
- Multi-well pads for deeper coals (approx 400m and below) with an average surface spacing of some 2 km.
- Vertical wells in shallower coals (<400m), with surface spacing’s ranging from 0.8 to 1.5 km (or greater).
- The expected life of a well pad from ‘on pump date’ to final abandonment is approximately 20 years.
Gathering

- Gathering lines will be underground, buried to a depth that will cater for future land use
- Low Point Drains and High Point Vents plus some water pumping equipment will have a small surface area along the gathering lines

Power

- Arrow’s preferred method for power supply for its proposed compression facilities is from the transmission grid by a Network Service Provider via overhead transmission lines
- On IFL, Arrow’s Surat Gas Project plans that power will be reticulated underground to well sites and water pumping stations, unless otherwise agreed with the landholder

Water

- Arrow continues to refine the scope of its water management plans; evaluating a range of management options
- Arrow remains committed to offsetting any impact it has on the Condamine Alluvium and to maximising beneficial use of its treated CSG water
Coexistence, compensation and local content

- Arrow has made 12 commitments to coexist on intensive farming land in the Surat Basin.
- Landholders and Arrow work together to identify locations for infrastructure; enables landholders to have greater involvement in the location of infrastructure on their land.
- The compensation framework for landholders recognises the potential impacts of gas CSG operations on their land.
- The framework accounts for high value land and intensively farmed land.
- Arrow is committed to providing opportunities for capable and competitive local suppliers.
Information will contribute to Qld and Federal Government approvals

Ecology surveys conducted by small teams of independent specialists: September and October 2016; February and March 2017

Target areas identified through the EIS as containing threatened ecological communities or species

Arrow will also prepare Water Monitoring and Management Plans (WMMP)

Groundwater dependent ecosystem surveys will assess ecosystems reliant on the sub-surface presence of water

Conducted in conjunction with the ecological surveys
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Water management

Arrow update
Operational update
Surat Gas Project update
Groundwater management
Interconnectivity trials
The removal of groundwater from a coal seam is required to release the gas stored in the seam.

A regulatory framework is in place via the *Water Act 2000* for managing groundwater related impacts, including:

- **Modelling**
  - Submission of and compliance with Underground Water Impact Reports (UWIR) including make good
  - Arrow’s obligations under the Surat UWIR, prepared by OGIA, are based on existing operations, as well as proposed future operations
  - Arrow has provided OGIA with a concept plan of the greatest potential development, from which Arrow’s current obligations are based

- **Groundwater monitoring**

- **Management of affects on groundwater**
• In the 2012 UWIR Arrow were required to install monitoring at 36 sites between 2012 and 2016

• These monitoring bores monitor formations above, into and below the Walloon Coal Measures

• Arrow has also installed a further 62 bores as part of technical studies

• Another 70 bores have been installed to monitor infrastructure

• Arrow has complied with the requirement to install the bores shown
• In 2016 UWIR Arrow is required to install 11 sites
• Six sites remaining for 2016
• Installation of groundwater monitoring bores to monitor groundwater levels in the Condamine Alluvium and Walloon Coal Measures
• At some sites; monitoring will include groundwater levels in three separate seams near the top, middle and bottom of the coal measures
• Data will be provided to OGIA to incorporate into updates to the UWIR
Baseline assessment of water bores

- Under the *Water Act 2000*, petroleum tenure holders are required to conduct baseline assessments of all water bores.
- Assessments obtain information about the bore, including water level and quality, bore construction, existing pumping infrastructure.
- Since 2011, Arrow has completed more than 750 baseline assessments of water bores in the Surat Basin.
- In 2016 and 2017, Arrow will conduct baseline assessments of water bores within Dalby Township.
- Arrow has contacted landholders with registered water bores in order to collect information for the assessment program.
- If you would like to participate in the program and are on Arrow tenure, please contact us on **1800 038 856 (free call)**.
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Interconnectivity trials

- Arrow update
- Operational update
- Surat Gas Project update
- Groundwater management
- Interconnectivity trials
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Objectives

- Queensland Office of Groundwater Impact Assessment (OGIA):
  - 2012 modelling indicated low potential for impacts
  - further research into degree of connectivity would enhance ability to predict impacts

- Arrow undertook pumping tests as part of the **Condamine Interconnectivity Research Project (CIRP)**, a wider program of investigations into connectivity, led by OGIA
Aquifer pumping tests undertaken at two sites:
- Daleglade (25 km northwest of Dalby)
- Lone Pine (15 km east of Cecil Plains)

Sites identified based on:
- geological criteria
- site access
- support from the landholder

Pumping tests involved:
- installation of dedicated monitoring bores
- collection of continuous core for display and additional laboratory testing
- extraction of groundwater from the landholder’s bores
- monitoring of groundwater pressure in multiple formations
Overview of Lone Pine Results

Pumping Test

Recovery

Scale (km)

Bore Emplacement

Alluvium
Tertiary Sand
Interburden
Coal
Interburden
Coal
Interburden

50 lbs over 40 days

Water level elevation (m AHD)

17-Oct
31-Oct
14-Nov
28-Nov
12-Dec

42233373
42233465
Cam Brea 17
LP15
LP16
LP14
RN119784
Conclusions

• Tests provided scientific evidence to address stakeholder concerns about impact on the Condamine Alluvium

• Completion of both tests increased Arrow’s ability to demonstrate coexistence with existing, laser-levelled, irrigated cropped land

• Data collected from the tests:
  • verified that there is only a low level of hydraulic connection between the Condamine Alluvium and the underlying Walloon Coal Measures
  • supported earlier OGIA modelling that predicted CSG operations would have a minimal effect on the Condamine Alluvium (OGIA, 2012)
Arrow has delivered a $250M expansion of our Daandine facilities

Evidences our commitment – focussed on growing domestic gas business in the Surat Basin

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