Why we are here today

- 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 update

Operational update

Surat Gas Project update

Groundwater management

Interconnectivity trials

Tipton Seismic survey
• 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.
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Operational update

1. Arrow update
2. Surat Gas Project update
3. Groundwater management
4. Interconnectivity trials
5. Tipton Seismic survey
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Daandine Expansion Project

- $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
• 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

- Concept studies
- Supplementary Report EIS
- Environmental Impact Statement (EIS)
- Community update
- Shareholders Final Investment Decision
- Production
- Area Wide Planning
- Engineering design
- Construction
- Range of project design
- Pilots
- Demonstration projects
- Today

Range of project design
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
Arrow’s groundwater obligations

- 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
• 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).
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
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)
- Surat Basin coals comprise the Walloon Subgroup
- Walloon Coal Measures (WCM) include the Juandah Coal Measures and the Taroom Coal Measures
- The general location of the Horrane Fault has been known for some time; although the exact location had not been determined
- Deeper layers of rock are hot and soft, in comparison to surface layers which tend to be cooler and less malleable
- Faults form when stress from underlying rock movements causes the more brittle surface rock to crack or slip
Seismic survey from 5-25 February 2016 in the Tipton and Cecil Plains areas

The survey took place along 117km of public roads

Seismic surveys are used to gather detailed images of the rock formations below the earth’s surface

The seismic profile can be used to interpret the architecture and structural attributes of coal seams

The survey was designed to map the Horrane Fault, to provide Arrow with information about how the fault intersects with the Walloon Coal Measures

Crew of 40 people; 15,264 man hours

22,158km driven

~6.6km seismic completed per day

~13,300 vibration points, ~13,300 receivers
• Horrane Basin, a small sub-basin located within the Surat Basin

• Location of the Horrane Fault identified; occurs within the Walloon Coal Measures

• The major faulting has occurred at depths of 50-600m

• Beside the major fault, various minor faults extend to the east

• The major fault lies immediately east of Arrow’s existing Tipton field which has been operating since 2007

• Horrane Fault is not geologically unique; similar faults exist in Arrow’s Daandine and Tipton fields, as well as other areas across the Surat Basin
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Arrow update overview

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