ARROW ENERGY
MINE PRE-DRAINAGE

Derek Hannigan & Bill Koppe
TODAY’S PRESENTATION

• CSG and coal mining co-development in the Bowen Basin
• How Arrow can add value to mining
• Opportunities for regional-scale coal and CSG co-development
• Costs and economic drivers
• Aligned objectives
• Success factors
ARROW ENERGY

JOINTLY OWNED BY SHELL AND PETROCHINA

• Bowen & Surat Basin CSG resources
• CSG tenements overlap coal tenements
• Commenced gas production in 2004
• 1100 wells – 600 producing
• Providing domestic gas and electricity
• Developing CSG-LNG export capacity

**Arrow adding value to mining:**

• CSG drainage of future mine projects
• Access to higher value gas markets
• Access to CSG technical capabilities
• CSG ability to offer regional gas integration
LOCATION

- Bowen Basin in Central Queensland
- World-class coal and CSG resource
- 2011 coal exports worth $29 Billion
- Methane drainage in underground mines
- Mine site gas power generation 120 MW
- Expanding coal mining development
- Arrow domestic CSG business
- Arrow CSG-LNG development
MORANBAH GAS PROJECT – MINE PRE-DRAINAGE PLATFORM
MORANBAH GAS PROJECT AND MINING CO-DEVELOPMENT

- Moranbah Gas Project 2004 start-up
- SIS drainage from mineable seams
- CSG drainage of planned mining project
- Gas off-take from adjacent operating mine
- Several additional adjacent planned mines
- Scope for regional gathering of mine gas
- Future connection to CSG-LNG market

**MGP adding value to mining with:**

- pre-drainage of planned mining projects
- access to gas pipelines
- access to higher value markets
**BENEFITS TO MINING OF ARROW PRE-DRAINING & TECHNOLOGY**

**Arrow pre-drainage of mineable coal:**
- Gas drainage of planned mines
- Major reduction of mine costs
- No impact on safe and efficient mining

**Access to Arrow data and technology:**
- Exploration, Production & Environmental data
- State of art reservoir modelling
- Regional gas resource variation
MINE METHANE ABATEMENT ILLUSTRATIVE COST OPTIONS

SIS = Surface to In-Seam
UIS = Underground In-Seam
VAM = Ventilation Air Methane

Mitigation choice - deep pre-drainage or VAM?
ILLUSTRATIVE COST OPTIONS – NET OF METHANE MARKET VALUE

Unit Mitigation Cost
Mitigation choice - deep pre-drainage or VAM?

- full pipeline & LNG value
  - no air contamination

- modest site utilisation value
  - major air contamination

- little energy value
  - methane contaminated air

Unit Mitigation Cost
Mitigation choice - deep pre-drainage or VAM?
**METHANE ABATEMENT TECHNOLOGY ECONOMIC DRIVERS**

**Current Australian pipeline gas and carbon prices drive:**
- deeper SIS pre-drainage maximising methane value
- lower residual methane in coal when mined
- lower mining emissions in the absence of viable VAM oxidation

![Diagram showing economic drivers for methane abatement technology.](image)
MANAGING VALUE AND COST IN COAL METHANE

**Mining company objective**

- Optimise mine design, using vent air methane as a design limit
- Mine degassing plan matched to mine plan and lower the target seams gas density for safe access and design limit of ventilation system
- Lower the gas density as safely, quickly and for lowest cost.
- Minimise carbon liability

**CSG-LNG company objective**

- Optimise drainage design for best economic recovery, and maximum marketable gas yield
- Sequence gas production to LNG facility from lowest to higher production cost
- Lower the gas density safely, at lowest cost and with maximum yield
SUCCESS FACTORS FOR CO-DEVELOPMENT PROJECTS:

1. Committed and aligned parties
   • Aligned values - especially safety,
   • Both parties seeking win/win outcomes
   • Assisted by economic drivers and supportive legislation

2. A robust co-development plan
   • defining practical co-development and timing
   • effective communication and exchange of data
   • maximising mutual opportunities and benefits
   • minimising potential constraints and conflicts
   • flexibility within agreed framework for planning

3. A robust co-development agreement
   • designed for the implementation of the co-development plan
   • providing the certainty required for investment

Arrow and Anglo American have worked this way for 10 years
SUMMARY

• Arrow’s Bowen Basin CSG tenements overlap world class coal deposits

• Domestic CSG production already degassing coal resources ahead of mining
• Domestic CSG pipeline provides a high-value market for uncontaminated mine gas
• Export CSG-LNG development will expand mine gas off-take opportunities

• CSG production can provide major reductions in mine development costs
• CSG infrastructure provides regional mining access to high value markets

• Access to CSG data and technology assists mine planning
SUMMARY

• Australian gas and carbon prices are driving deeper SIS pre-drainage
• High value markets support deeper pre-drainage and reduce mine emissions

• The gas drainage objectives of mining and CSG companies are aligned
• Success requires aligned values, commitment, and collaborative planning

Arrow is committed to co-development of CSG with coal mining
Questions

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