Tai Xi Coal Group
Coal Mine Methane Feasibility Study
Inner Mongolia, China

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Project Goals

- Identify host coal mine
- Prepare pre-feasibility study
- Analyze methane gas resource
- Conduct market assessment
- Conduct technical analysis of degasification system
- Evaluate CMM utilization options
- Estimate capital and operating costs
- Calculate potential emission reductions
- Conduct economic analysis
- Prepare final feasibility study report
Undergoing Major Re-organization in 2009

- In 2003, 81,000 mines reduced to 25,000 mines
- In 2009, further reduced to 15,000 mines
  - 12,000 existing mines produce < 300,000 tons/a
  - New mines must be > 300,000 tons/a
  - Top 268 mines produce over 800 million tons/a
    - Account for approx. 32% of China’s total production, but only 14% of fatalities
- Larger coal production groups being formed:
  - Thirteen 100+ million tons/a conglomerates
Initially, RCE and HEL considered coal mines from six different provinces
  - Information requests were sent to all candidate mines

Mines were dropped from consideration for several reasons including
  - Lack of real interest
  - Too small in size or not yet developed
  - Already have CDM projects listed with UNFCCC

RCE and HEL conducted site visits to two mine groups
  - Sichuan and Inner Mongolia Provinces
The Gulaben mining area is in the Helan Mountains, ranging from 1,800–2,400 meters above sea level. It is crescent shape, about 15 km long and 5.5 km wide, and covers an area of about 64 km².
Re-organization of Mines in Erdaoling Mining Area

• Over 200 small mines operated in the 1960s
• 14 closely spaced individual mines consolidated into one large mine group in 2006
  • Methane explosion at one of the mines just prior to consolidation
• In 2009, Tai Xi undergoing technical and safety improvements for planned 11 mines
  – Increased mechanization
  – Larger ventilation fans
  – Improved gas drainage systems
Tai Xi Group in Inner Mongolia was selected for a feasibility study because of:

- High level of interest in participating in the project shown by management
- Potentially high coal production rates
- Potentially high methane emission rates
- Providing significant safety and social benefits
- Need for specialized methane drainage
- Need for additional power generation in the area
- Currently no CMM projects in this area
Gulaben Mining Area

- Large resource of high quality and high value anthracite coal
  - 247 million tons proved reserve
- 11 coal seams (totalling 21.4 meters) located within small stratigraphic thickness (140 meters)
- Total caving mining method
  - releases large volume of gas from both roof and floor
- Coal gas content is very high
  - ranges from 13.9 to 22.7 m$^3$/t
  - 2.6 billion m$^3$ of methane in the area
Coal Section Highlights
• The 2-1 upper seam will be mined first in most of the mines followed by the 2-1 seam
• 118 million tons of coal are in these two seams (47% of total reserves)
• 1.5 billion m³ of methane are in these two seams
Structural Setting of Erdaoling Mining Area

Inner Mongolia Helan Mountain Coal Field Erdaoling Mining Area
Coal Seams in Erdaoling Mining Area
Mines Facing Many Challenges!

- Ventilation – regulation of ventilation air methane maximums will necessitate highly efficient methane drainage systems
- Drainage – Options limited by low-perm coals, steeply dipping seams, and mining methods
- Aggressive coal production schedule – will require significant increase in gas drainage activities each year to maintain safe operations
  - China has increased annual coal production from 2 billion tons to 3 billion tons from 2005-2010!
- Methane utilization options - limited by remote location and difficult terrain
Methane Utilization Possibilities

➢ Power Infrastructure & Needs – Currently use 5MW from existing 3x6 MW coal plant.
  ▪ Maximum grid-based electricity available is 7 MW
  ▪ Mine will need 23 MW
  ▪ Additional local industry will need >10 MW

➢ Nearest Gas Pipeline – 47 km away
  ▪ Alashan city itself has no gas distribution network

➢ Only local industry is cement plant due to close in 2012

➢ Local Thermal Needs - Small
  ▪ Mine building heating and mine air heating
  ▪ Local town of Bei Li Gou has 2,500 residents
Surface Facilities at Erdaoling Mining Area

18 MW Coal-Fired Power Plant

Mine Offices and Maintenance Buildings
Pre-Feasibility Findings

Current State of Mining and Methane

- **Mining Methods – Shortwall (70m x 300m) with low-level mechanism**
  - Drill & blast followed by simple gravity loading
  - < 1.0 million tons produced in 2010

- **Ventilation Air Methane – Conventional exhaust system**
  - Currently only at 1/3 the capacity needed for full production
  - VAM concentration 0.2%

- **Current Methane Drainage – Pilot program at 3 mines**
  - Cross-measure boreholes (34 deg)
  - In-seam shorthole drilling
  - 600m longholes (bisecting 5 coal seams)
  - Achieving less than 10% drainage efficiency
Mining and Ventilation Scheme

Coal face cut at an angle of 45 degrees to the return roadway to reduce the effective steepness of the face.
High rates of methane will be released during mining

The gas forecast rates are based on:

- Methane release rate of from 377 to 677 l/sec
- Very high calculated specific emissions of from 38.1 to 68.2 m³/t mined (1,345 to 2,407 ft³/t mined)
- Gas capture efficiency is expected to improve from 20% of total methane release to 50% over four years as drainage crews gain experience
- Uncertainty in volumes are related to uncertainty in methane content and permeability enhancement
Proposed CH₄ Capture Method

• Very low coal permeability precludes pre-draining the methane. The gas can only be captured once mining has enhanced coal permeability.
• Cross Measure Boreholes will be *pre*-drilled into the seams *below* the working longwall
• Where possible additional holes will be *post*-drilled into the seams *above* (i.e., only drilled once the longwall has passed)
• Or - an adjacent “3rd gate” roadway will be needed from which the holes can be drilled
Proposed CH₄ Capture Method

3rd Gate Borehole avoids fracture zone

Maximum Permeability

Return gate

3rd gate

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Appendix 1
Plan shows:
Option B – Roof boreholes drilled from adjacent Gate Roadway.
Seams shown at 45°
Diagrammatic – Not to Scale
Borehole

Maximum Permeability

3rd gate floor borehole completely in the coal but must have slotted liner
Pre-mining drill from gate road to roof may result in collapse of the roof borehole after the coal face passes the borehole

Drilling stations at 5 meter spacing

To obtain the desired 15kPa suction pressure at the drainage boreholes assuming a plant suction pressure of 50kPa requires:

- 1000 meters of 400mm diameter steel pipe to the shortwall
- 600 meters of two pairs of 250mm steel pipe down the shortwall to gather gas from boreholes
Plan shows: Typical Methane Pipe Layout

- Proposed vacuum at these points
  - 15 kPa
- One methane range pipe
  - 400mm diameter shown 1000m long

- Proposed vacuum at these points in the system
  - 95 kPa
- Upper roadways carry return air and methane drainage pipes.
- Seem to be worked shown at 45° (other seams not shown)

- 250mm pipes (2)

- 400mm pipe

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Diagrammatic – not to scale
Appendix 1
Projected Mid Case Methane Liberated, Drained and Utilized
Methane Capture Forecast

Forecast assumes gas utilization to be a fraction of the total gas drained

- 64% of gas may be suitable for utilization
  - > 25% CH₄
  - minimum pressure

- 90% run time for gas engines
Proposed CMM Utilization Technology

- Phased installation of packaged combined heat and power plants (CHP) gensets
  - 10MWe and 10MWth by 2011
  - Add 10MWe and 10MWth by 2013
  - Add 10MWe and 15MWth by 2017
  - Add 5MWe and 15MWth by 2020
- Operate only at methane concentrations greater than 25%
- Use heat for shaft heating and district heating
- Flare any unused methane
Installation of Gas Utilization Equipment

- Gas resource available
- Gas resource utilised
Revenue From Power and Heat Generation

![Revenue From Power and Heat Generation Graph](image-url)
Over 6 million CER’s could be generated under CDM
Unfortunately, Revenue From CMM Emission Reductions Not Guaranteed

As of August 2010 only 40% of China CMM projects registered

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- Post-2012 CER value very much in doubt (currently $8.00/tonne)
- Demand for CMM projects in voluntary carbon markets is low
Methane Use Facilities

Ventilation Fans

Mine Air Heaters

1.5 MW CMM Power Plant
Sustainable Project Benefits

- Enhanced mine safety
- Enhanced coal production security
- CMM utilization using an electric power plant delivering grid security and plentiful low-cost electricity
- Energy conservation through use of CHP will also provide enough heat locally that increases coal sales and decreases emissions from coal combustion.
Thank You!