METHANE IN ABANDONED COAL MINES IN CHINA – AN UNEXPLOITED RESOURCE

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Presented by:
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PRESENTATION OUTLINE

• Goals and Objectives of the Study
• Shanxi Mine Closure Objectives
• Selection of the Study Area
• Estimating Reserves
• Results
• Project website: www.chinamethane.org
• Summary and Conclusions
GOALS AND OBJECTIVES OF STUDY

• Determine data availability for abandoned mines
• Develop an approach to estimate the methane emissions through time for a sample set of abandoned mines based on the data available
• Estimate the methane resource available for development by mine
• Utilize Geographical Information System (GIS) technology to facilitate project identification
SHANXI MINE CLOSURE

OBJECTIVES: 11th 5 YEAR PLAN

• Closed 6,799 mines by 2005
• Closed 1,156 mines from July 2005 through June 2006
• Planned on closure of 600 mines between July 2006 and June 2007
• Planned on closure of 500 mines between July 2007 and June 2008
The greater Qinshui coal basin of Shanxi province was chosen because:

- Most of the coal mined is high gas content anthracite and coking coal;
- There has been a long history of coal mining and hence a large number of abandoned mines; and
- Numerous active mine methane capture and utilization projects are underway which could provide operational expertise for AMM projects.
Qinnan Gas Region

Shouping Gas Region

Xingjiash Gas Region

The Greater Qinshui Coal Basin

Daning-Jixian Gas Region

Qinnan Gas Region
ESTIMATING RESERVES*

• An initial estimate of the recoverable resource is necessary for project planning
  – Estimate the original volume of methane in place in the mine area
  – Estimate the amount of methane liberated during mining activities
  – Estimate the amount of methane emitted to the atmosphere from time of closure to the present

ORIGIONAL METHANE IN-PLACE

- Total coal thickness
- Mining area
- Original gas content of the coal
- Percent methane in the adsorbed gas
MEASURED GAS CONTENTS FOR MINES IN GAS REGIONS

Gas Content by Mine for the Shanxi Gas Regions

- Shouping
- Xingjashe
- Qinnan
- Daning-Jixian

Gas Content m³/tonne
METHANE LIBERATED DURING MINING

• Mass of coal mined prior to closure
• Specific methane emissions
  – volume of methane per mass of coal mined (m³/t mined)
  – May be a function of initial gas content (m³/t) and ratio of total coal thickness to mined coal thickness
The decline function is an expression of the pressure loss in the system through time as more methane is emitted to the atmosphere.

As the adsorption pressure decreases in relationship to the atmospheric pressure, the rate of methane loss decreases.

The decline function can be thought of as the baseline methane emission rate.
GAS REGION ISOTHERMS

Gas Region Isotherms

- Qinnan
- Shouping
- Daning-Jixian

Gas Content, m³/tonne
Pressure, MPa
THE DECAY (DECLINE) STUDIES

阳泉一矿 永红矿 Yonghong Mineshaft of Yangquan #1 Mine
Baseline Methane Emissions

- Mine Closure 1976
- Project start - 2012
- Project end - 2022
- Nominal Generating Capacity = 5.5 MWe

Emission Rate, m³/d
Year From Closure
Of the 44 abandoned mines studied 36 are expected to be able to produce over 60 million m$^3$ over a twenty year project life. The largest of these mines may produce as much as 630 million m$^3$

While estimated recoverable volumes are uncertain, the process developed provides a valuable screening tool upon which to base further evaluation.
Estimated Nominal Power Generation Capacity from Abandoned Mines in Each Shanxi Gas Region
The Shouping gas region shows the highest potential for AMM development based on mine size, coal thickness and gas content followed by the Qinnan gas region.

Pro forma economic analysis showed that projects should produce an IRR of between 10% and 30% for projects between 3MWe and 10MWe based on current incentivized power prices.
DATA ENABLING ANALYSIS

3 PROJECT PARTNERS

JOOMLA DRIVEN SITE

SQL DATABASE

SQL, PHP, GOOGLE API MASHUP

BACKEND INTERFACE TO SQL

BACKEND INTERFACE TO MASHUP

DINAMICALLY INTERLINKED

FRONT END INTERFACES

ADDITIONAL FILTERS

MORE DATA LAYERS, AND . . .
ABANDONED MINE METHANE DATABASE

The AMM Database provides a detailed inventory of abandoned coal mines in Shanxi Provinces, People’s Republic of China. To search for abandoned coal mine data, first select a city. Relevant basins will then appear in the basin field. To refine the search, select a basin or simply click search to view records for all relevant basins. If a basin is selected, the Mine Name field will auto-populate with relevant Mine Names. Search results can be downloaded as a CSV file.

Abandoned coal mine data can also be searched using the Map Interface.

<table>
<thead>
<tr>
<th>City</th>
<th>Jincheng</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basin</td>
<td>Qinshui</td>
</tr>
<tr>
<td>Mine Name</td>
<td>Select a basin to refine the search, or for multiple or intra-basin searches, just click search</td>
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<td>Basin</td>
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</tr>
<tr>
<td>Mine Name</td>
<td>Fuyanshan Coal Mine</td>
</tr>
<tr>
<td></td>
<td>Fuyanshan Coal Mine</td>
</tr>
<tr>
<td></td>
<td>Gaoliang Coal Mine</td>
</tr>
<tr>
<td></td>
<td>Niushan Coal Mine</td>
</tr>
<tr>
<td></td>
<td>Qiling Coal Mine</td>
</tr>
<tr>
<td></td>
<td>Shangkong Coal Mine</td>
</tr>
<tr>
<td></td>
<td>Shangkong Yicheng Coal Mine</td>
</tr>
<tr>
<td></td>
<td>Shenjiazhuang Duanjiagou Coal Mine</td>
</tr>
<tr>
<td></td>
<td><strong>Tianhu Coal Mine</strong></td>
</tr>
<tr>
<td></td>
<td>Tuncheng Coal Mine</td>
</tr>
<tr>
<td></td>
<td>Wanshan Coal Mine</td>
</tr>
<tr>
<td></td>
<td>Wozhuang Coal Mine</td>
</tr>
<tr>
<td></td>
<td>Xianghe Coal Mine #1 Mineshaft</td>
</tr>
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<table>
<thead>
<tr>
<th>Mine Name</th>
<th>City</th>
<th>Basin</th>
<th>Gas Region</th>
<th>Year of initial Production</th>
<th>Year of closure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuyanshan Coal Mine</td>
<td>Jincheng</td>
<td>Qinshui</td>
<td>Qinnan</td>
<td>1952</td>
<td>1986</td>
</tr>
</tbody>
</table>

Records 1-1 of 1

Sort results by:
- City (A to Z)
- Basin (A to Z)
- Gas Region (A to Z)
- Mine Name (A to Z)
- Year of initial Production (Low to High)
- Year of closure (Low to high)
- CH4 Vented m3 (Low to High)
- CH4 in Coal after 20 yrs m3 (Low to High)
- Rate after 20 years m3 (Low to High)
ABANDONED MINE METHANE DATABASE

The AMM Database provides a detailed inventory of abandoned coal mines in Shanxi Provinces. People first select a city. Relevant basins will then appear in the basin field. To refine the search, select a basin or a basin is selected, the Mine Name field will auto-populate with relevant Mine Names. Search results can also be reviewed in the Map Interface.

Abandoned coal mine data can also be searched using the Map Interface.

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<tr>
<td>Basin</td>
<td>Qinshui</td>
</tr>
<tr>
<td>Gas Region</td>
<td>Qinnan</td>
</tr>
<tr>
<td>Main Shaft Latitude</td>
<td>35.64</td>
</tr>
<tr>
<td>Main Shaft Longitude</td>
<td>112.29</td>
</tr>
<tr>
<td>Total Coal Thickness in Region m</td>
<td>21.72</td>
</tr>
<tr>
<td>Year of initial Production</td>
<td>1952</td>
</tr>
<tr>
<td>Year of closure</td>
<td>1996</td>
</tr>
<tr>
<td>Mining Area km2</td>
<td>3.2</td>
</tr>
<tr>
<td>Mined Coal Thickness m</td>
<td>5.04</td>
</tr>
<tr>
<td>Coal Produced Mt</td>
<td>10.8</td>
</tr>
<tr>
<td>Gas Content m3mt</td>
<td>11.84</td>
</tr>
<tr>
<td>Average Daily Rate mtd</td>
<td>1232.88</td>
</tr>
<tr>
<td>Average Emission Rate m3d</td>
<td>43219.97</td>
</tr>
</tbody>
</table>
China Methane
Methane Emissions from Abandoned Coal Mines

The Map Interface shows the location of abandoned coal mines in Shanxi Province, People's Republic of China. Click on a marker to view an information window containing details on a specific abandoned coal mine. For more detailed information, click on the Database Record link in the information window, or use the dropdown search option located below the map.

Use the links to the right to filter abandoned coal mines by City, Basin, or Gas Region. Abandoned coal mine data can also be searched using the Abandoned Mine Methane Database.

MAP INTERFACE
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MARKER PATH TO DB
Use the links to the right to filter abandoned coal mines by City, Basin, or Gas Region. Abandoned coal mine data can also be searched using the Abandoned Mine Methane Database.
SUMMARY AND CONCLUSIONS

- The very large number of abandoned mines ensures numerous successful projects.
- Sufficient data exists at the prefecture city level in Shanxi province to estimate AMM reserves at a high level of uncertainty.
- Drilling boreholes into the abandoned workings to test gas pressure and production rate is necessary to reduce uncertainty to acceptable levels.
SUMMARY AND CONCLUSIONS

• Geographical Information System (GIS) technology was used to build an interactive online database to aid project developers in identifying potential AMM project sites by
  – Probable methane reserves
  – Favorable access to necessary infrastructure such as the existing power grid, pipelines, roads and towns.

• The database is readily expandable
Thank You!

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