

Feasible Options for Using CMM Recovered from Songzao Coal and Electricity Company Mines

Presented by,

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Acknowledgements and Appreciation

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- Management and technical staff of the Chongqing Energy Investment Group (CQEIG) and its subsidiary, Songzao Coal and Electricity Company (SCEC).
- Team members from RRR staff and outside experts



Outline

- I. Background
- II. Geologic and Physiographic Setting
- III. Market Conditions
- IV. Trends in Gas and Coal Production
- V. Production Forecasts End Use Options ,
and Economic Modeling
- VI. Conclusions



I. BACKGROUND





Background

- Basic project information initially gathered in summer of 2007 for two opportunities exhibited at the December 2007 Methane to Markets Partnership Expo
 - Liquefied Natural Gas (drained methane) project
 - VAM project
- Subsequently proposed as a candidate for one of three feasibility studies conducted at three coal mines in China
- Project was identified as a Methane to Markets sponsored activity and is being tracked and supported as a Methane to Markets Project.



Feasibility Study Approach

- Submitted detailed questionnaire requesting monthly coal production, drained gas production and VAM data for prior 3 years.
- Met with mine management and technical staff and corporate managers of CQEIG and SCEC. Visited each mine and potential construction sites.
- Conducted detailed review of prior end use options analysis provided to SCEC by the Chongqing Coal Mine Design Institute.



- Conducted market analysis, gathered costs for equipment and construction.
- Drafted prefeasibility study
- Reported results to CQEIG and SCEC upper management
- Management chose best end use option(s) and RRR finalized conceptual design and costing
- Working with recently revised economic analysis and drafting final report



Challenges and Considerations

- Songzao coal basin is remote and located in mountainous terrain. Slopes are steep
- SCEC mining complex extends ~25 km along the length of the basin. Six separate mines are producing and new mine construction is underway
- Population is concentrated near mining development and roads connect mines along drainages
- Prime agricultural development neighbors mining in south and is important to local economy. Conflicts may arise over land use

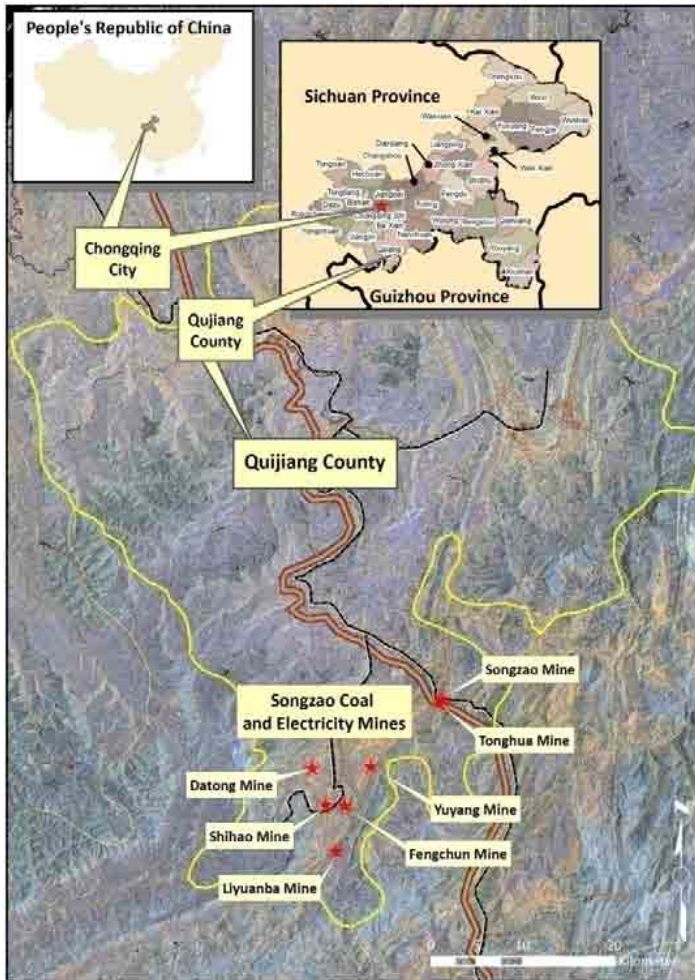


II. PHYSIOGRAPHIC AND GEOLOGIC SETTING



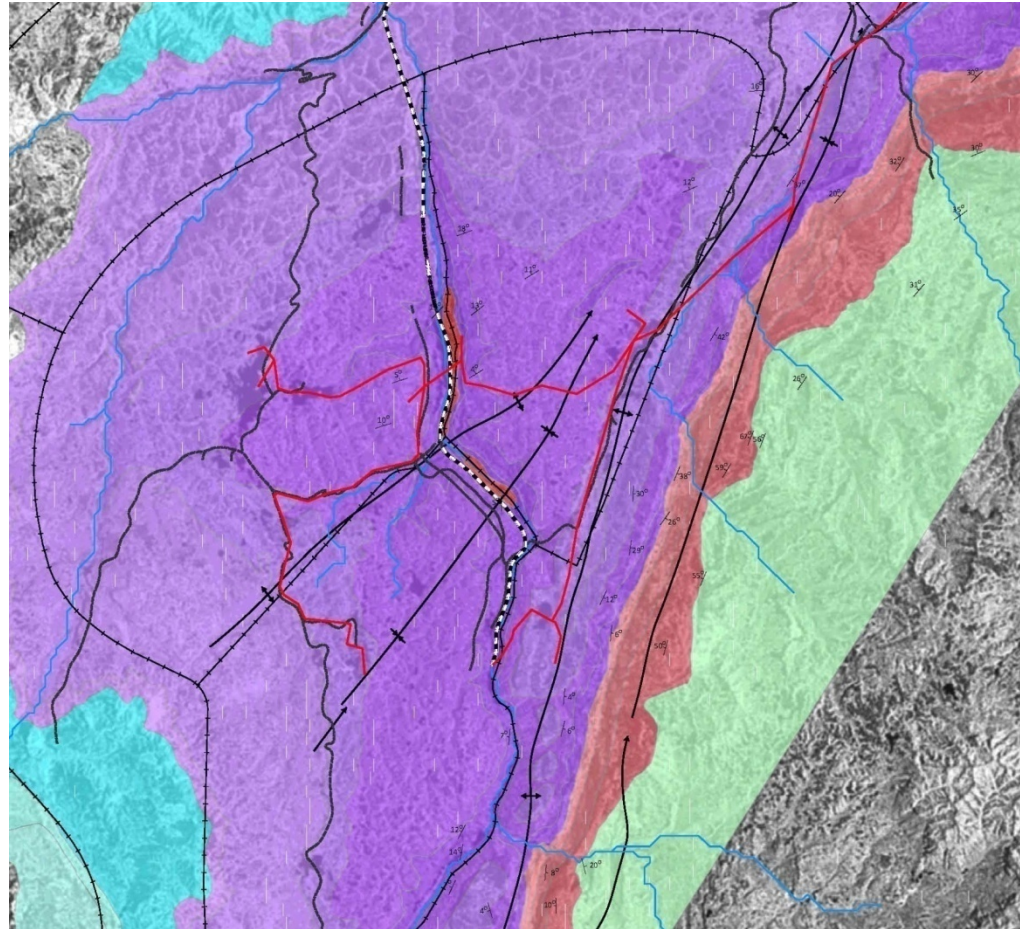


Location of Songzao Coal and Electricity Company Coal Mines





Geologic Overlay on LANDSAT 7 Image





III. MARKET CONDITIONS





- Existing gas gathering and transportation infrastructure is limited; but LNG sales price are relatively high
- Local residential and commercial market for gas is limited, best markets are distant; Chongqing is closest, but markets in southeast China are strong.
- Local electricity market, primarily mine use and residential are limited; electricity sales prices are low
- Regional market for electricity is complicated by dispatch order and driven by low avoided cost of hydropower and large coal fired plants

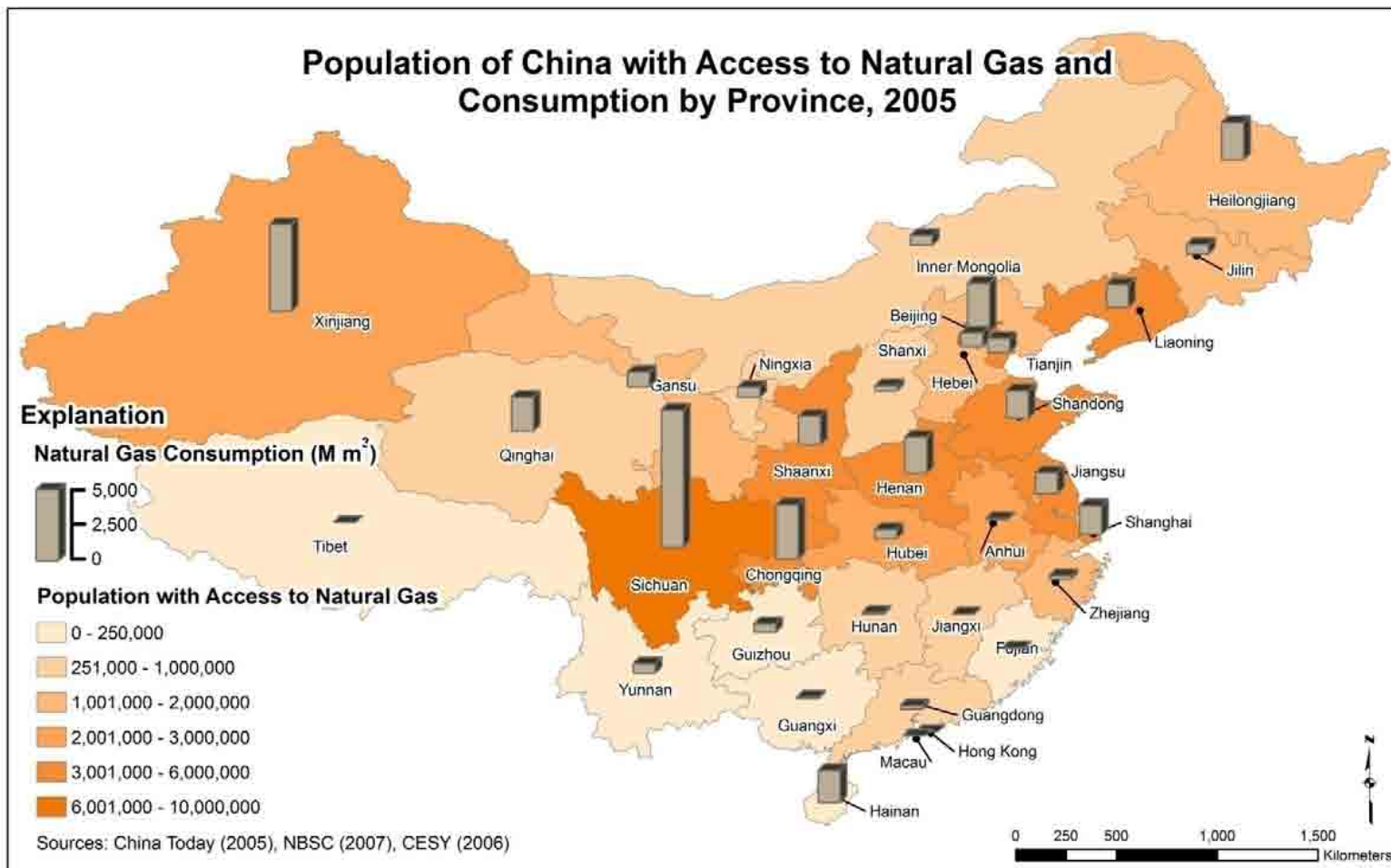


Urban Population of China, 2005



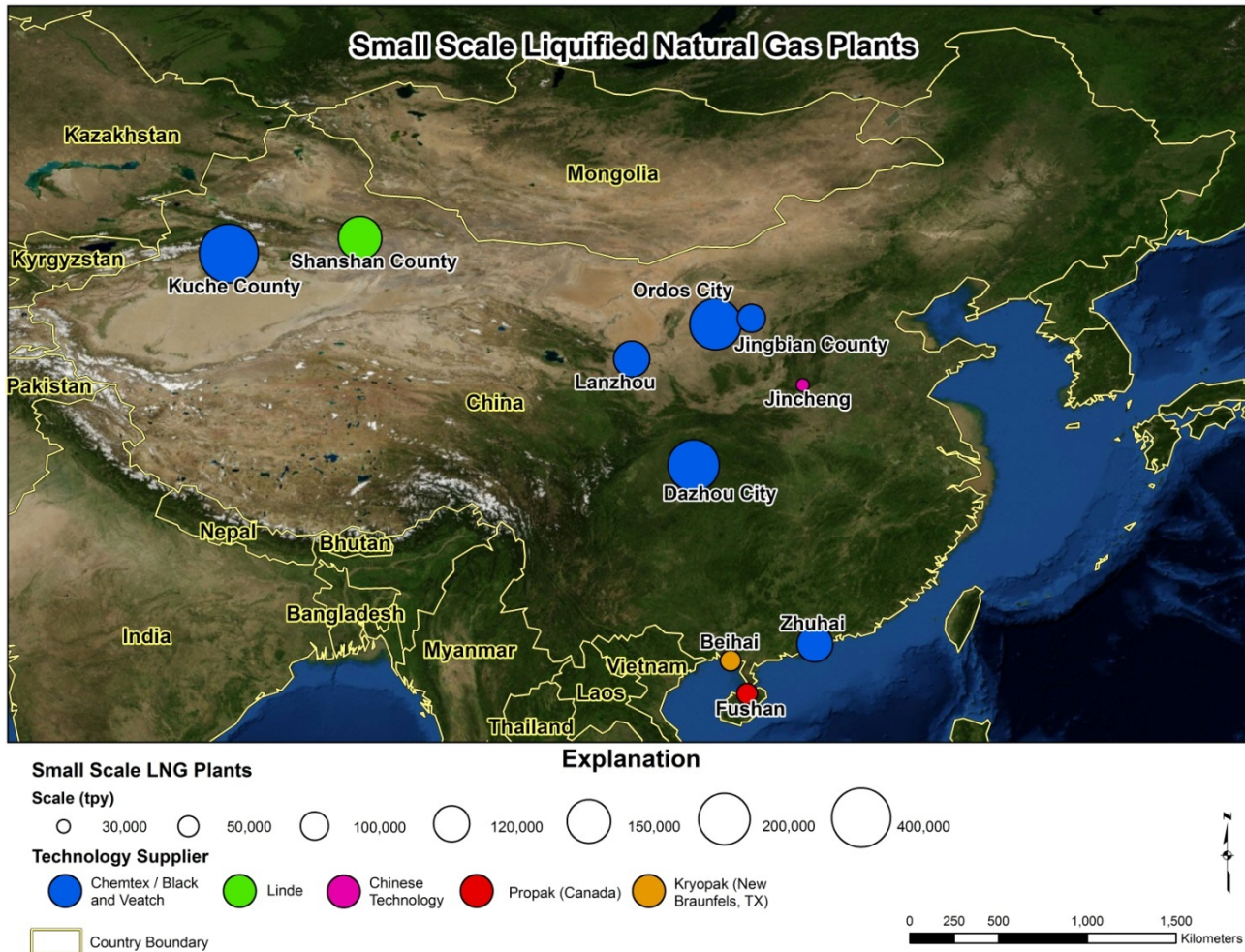


Population of China with Access to Natural Gas and Consumption by Province, 2005





Liquefied Natural Gas Plants in China





IV. TRENDS IN GAS AND COAL PRODUCTION

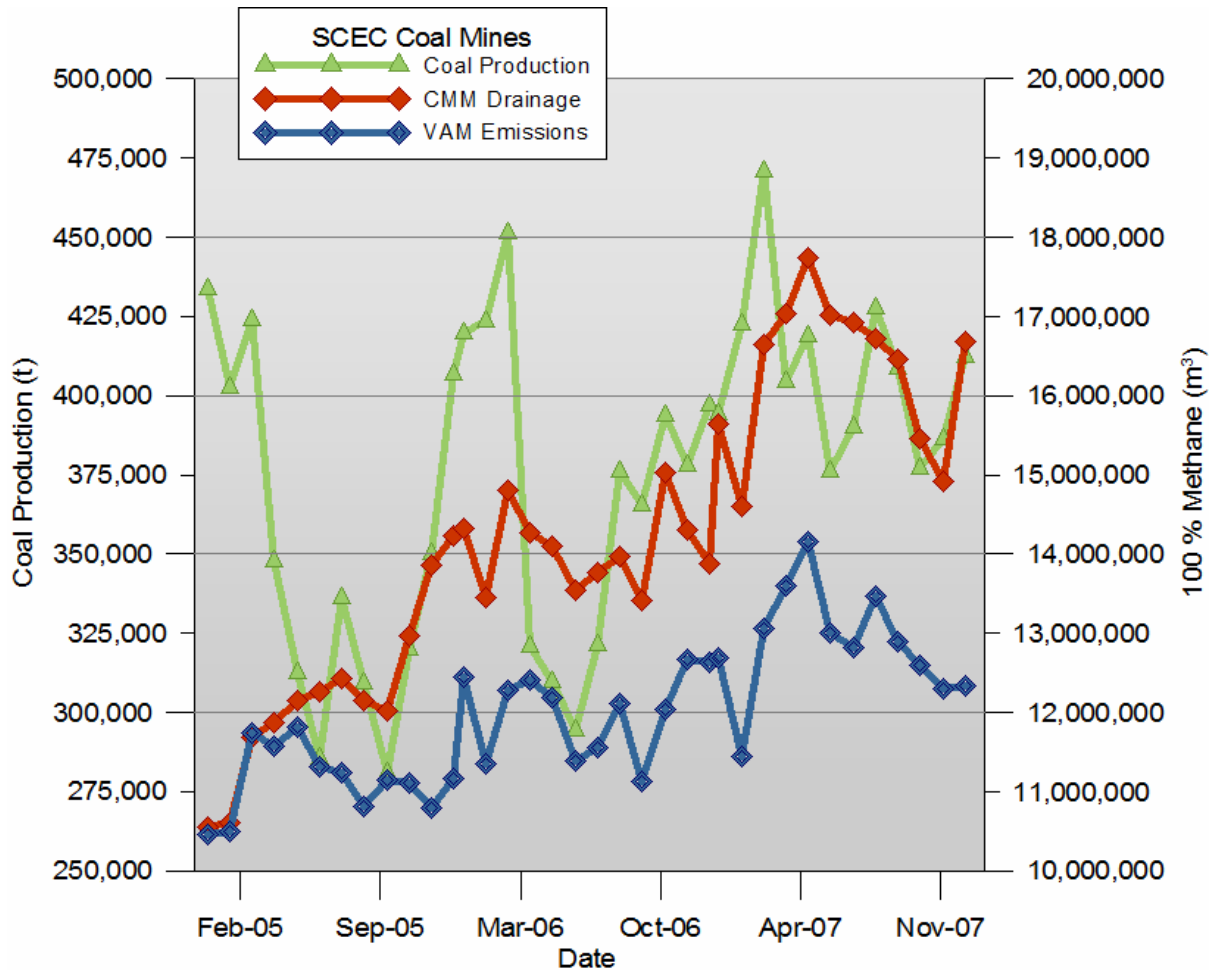




- SCEC is expanding coal operation in the Songzao basin at six active mines and one under construction
- Plans are underway to increase drained gas concentration and volume
- Coal production may increase to nearly 9 million tons per annum over the next 10 years
- Gas production may increase to over 300 million cubic meters per annum

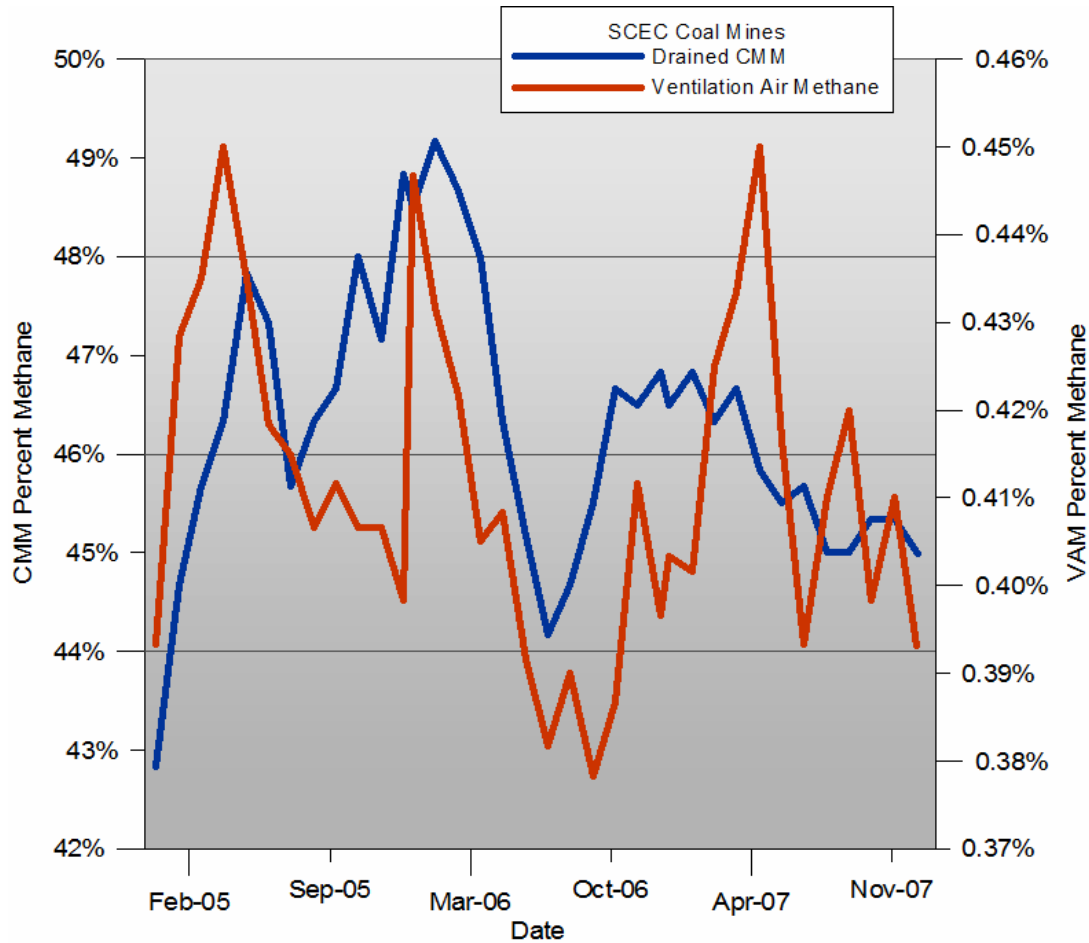


Coal, Drained Gas, and VAM Production SCEC Mines Years 2005-2007



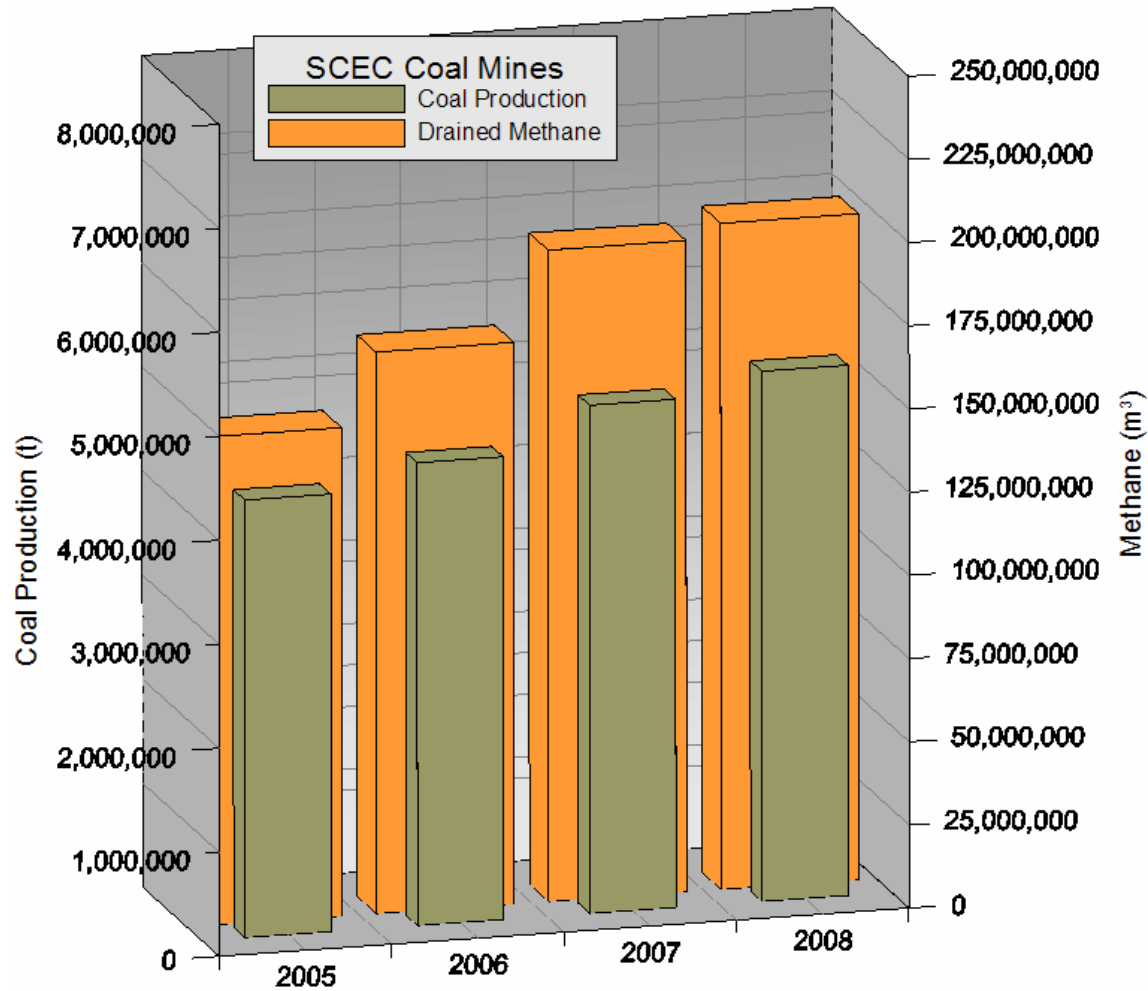


Variability of Concentration of Methane in Drained Gas and VAM





Coal Production and Drained Gas





V. PRODUCTION FORECASTS, END USE OPTIONS, AND ECONOMIC MODELING





Input Probability Distributions for Forecasting Gas Available for New Project End Use

- Coal production (based on plans for expansion)
- Gas drained per tonne of coal mined
- Gas concentration
- VAM emitted
- VAM concentration
- Ratio of gas drained to VAM emitted (drainage efficiency)
- Gas Used at CMM power facilities
- Residential and Commercial Use (metered and unmetered)



Metered Residential

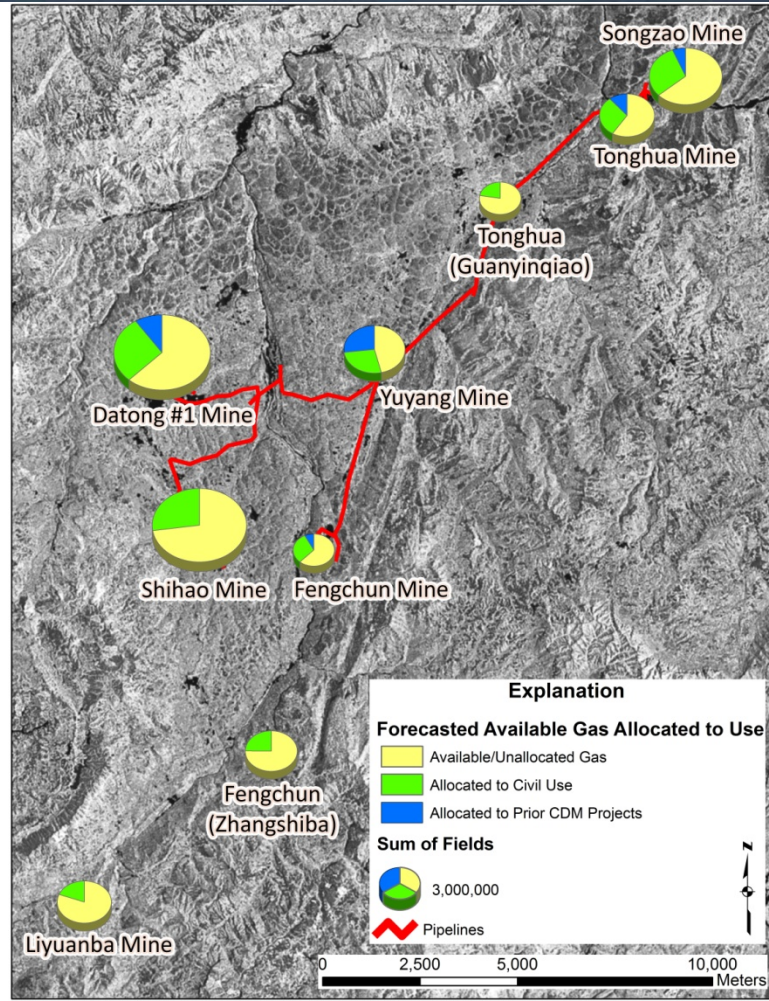
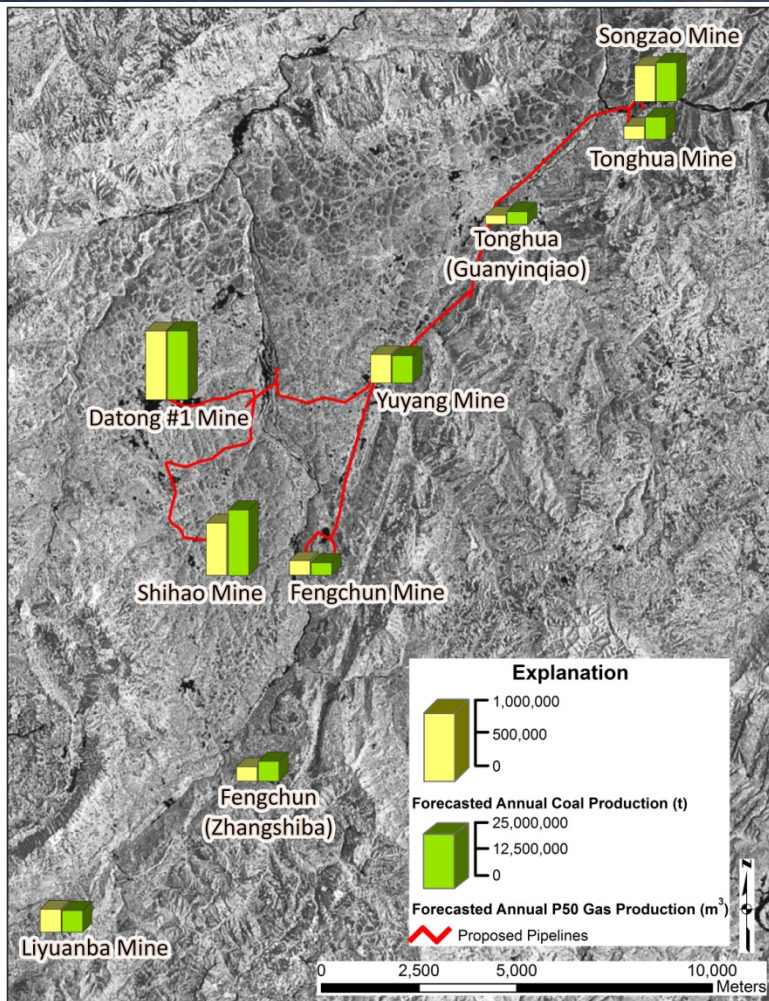




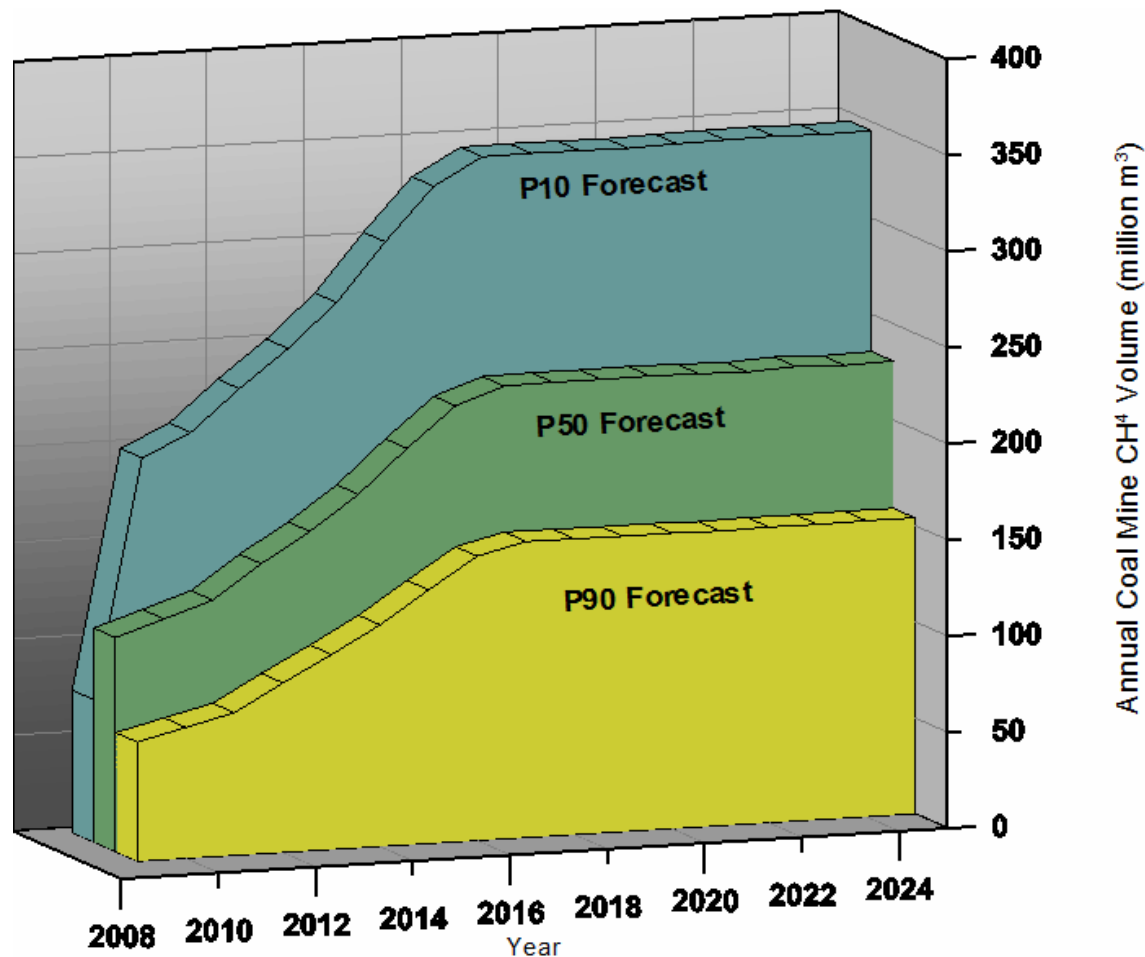
Unmetered Residential Use



Forecast of Coal, Gas Production, and Use



Forecast of CMM Available for Project Use



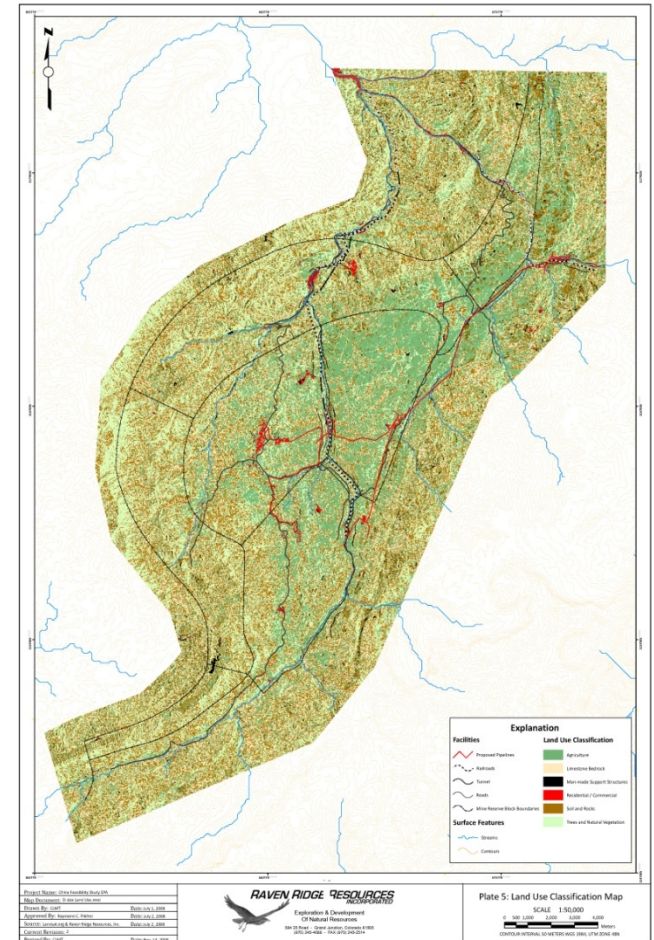
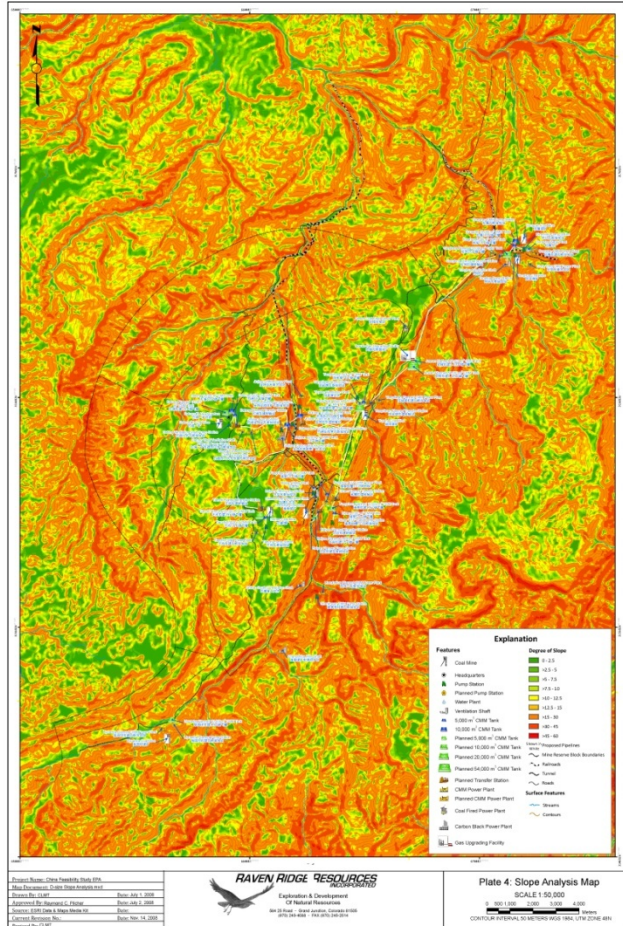


End Use Options Examined

- Power Generation Only
- LNG Only
- Optimized mix of LNG and power production

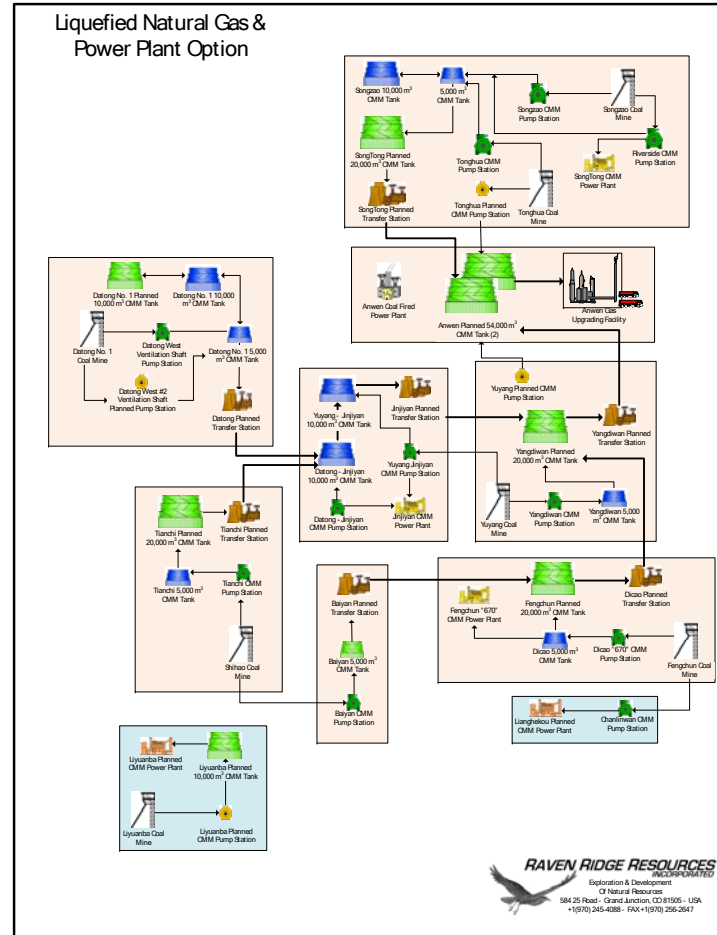


Overview of Terrain and Land Use



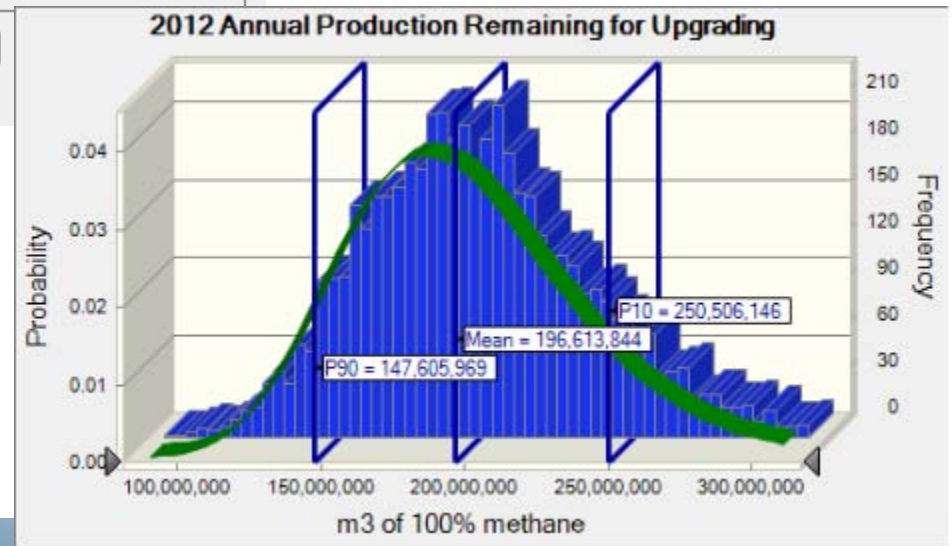
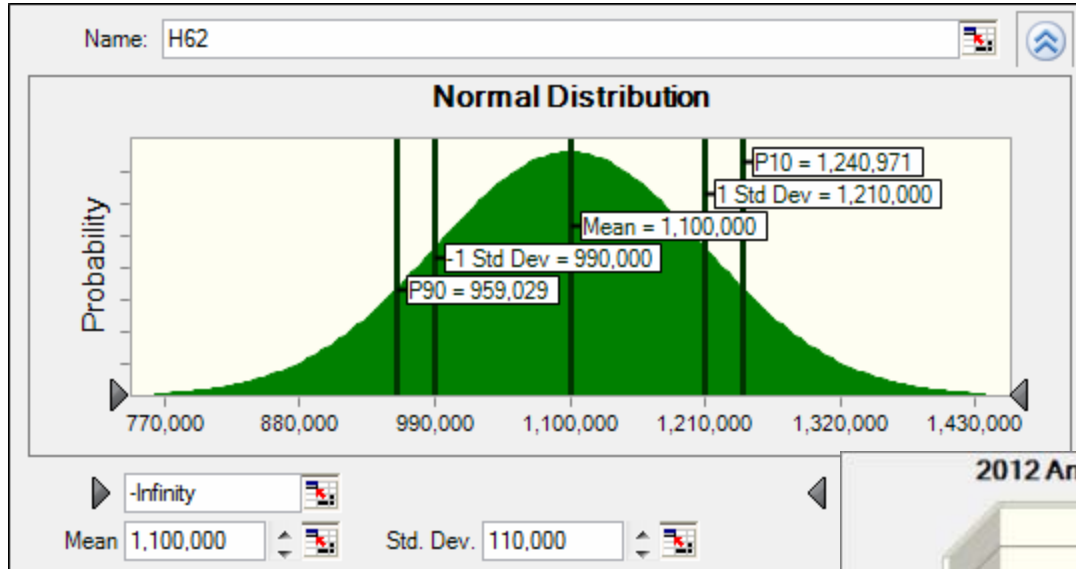


Optimized Scheme





Models are Used to Simulate Coal Production Increases and Forecast Gas Availability





Economic Modeling

- Probabilistic forecasts of unused gas production for each mine is aggregated to determine probabilistic forecasts of gas available for each end use option
- Ranges of numbers are used to estimate equipment and construction capital, and operating costs
- Taxes and incentives are incorporated
- Revenues for CERs are estimated
- Economic performance is calculated with and without CER revenue

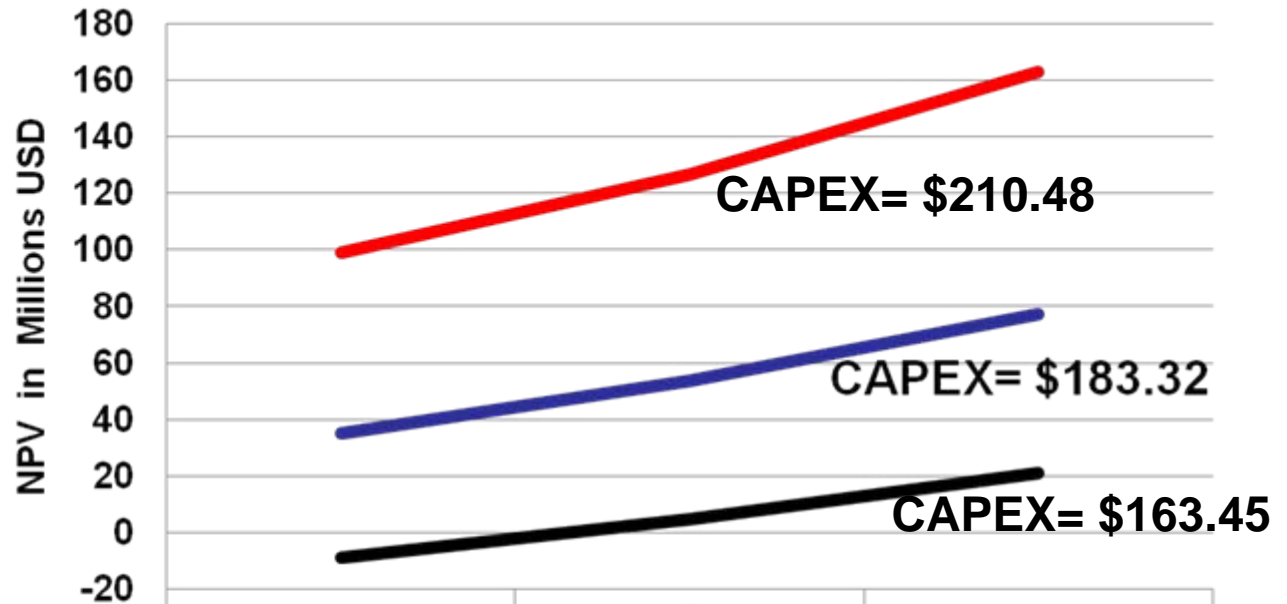


Optimized Project Scenarios at Forecasted Gas 34 Production Probability Thresholds

Probability Threshold	Installation Completed	2011	2015
p90	LNG Plant Installed Mm ³	80	40
	PowerGen Installed MW	21.4	
	Emissions Reduced tCO ₂ e	26,816,230	
	Total CAPEX	\$ 163,450,931	
p50	LNG Plant Installed Mm ³	120	40
	PowerGen Installed MW	19.9	
	Emissions Reduced tCO ₂ e	40,775,118	
	Total CAPEX	\$ 183,317,063	
p10	LNG Plant Installed Mm ³	200	50
	PowerGen Installed MW	21.4	
	Emissions Reduced tCO ₂ e	61,705,954	
	Total CAPEX	\$ 210,481,063	



Probabilistic NPV Forecast Matrix

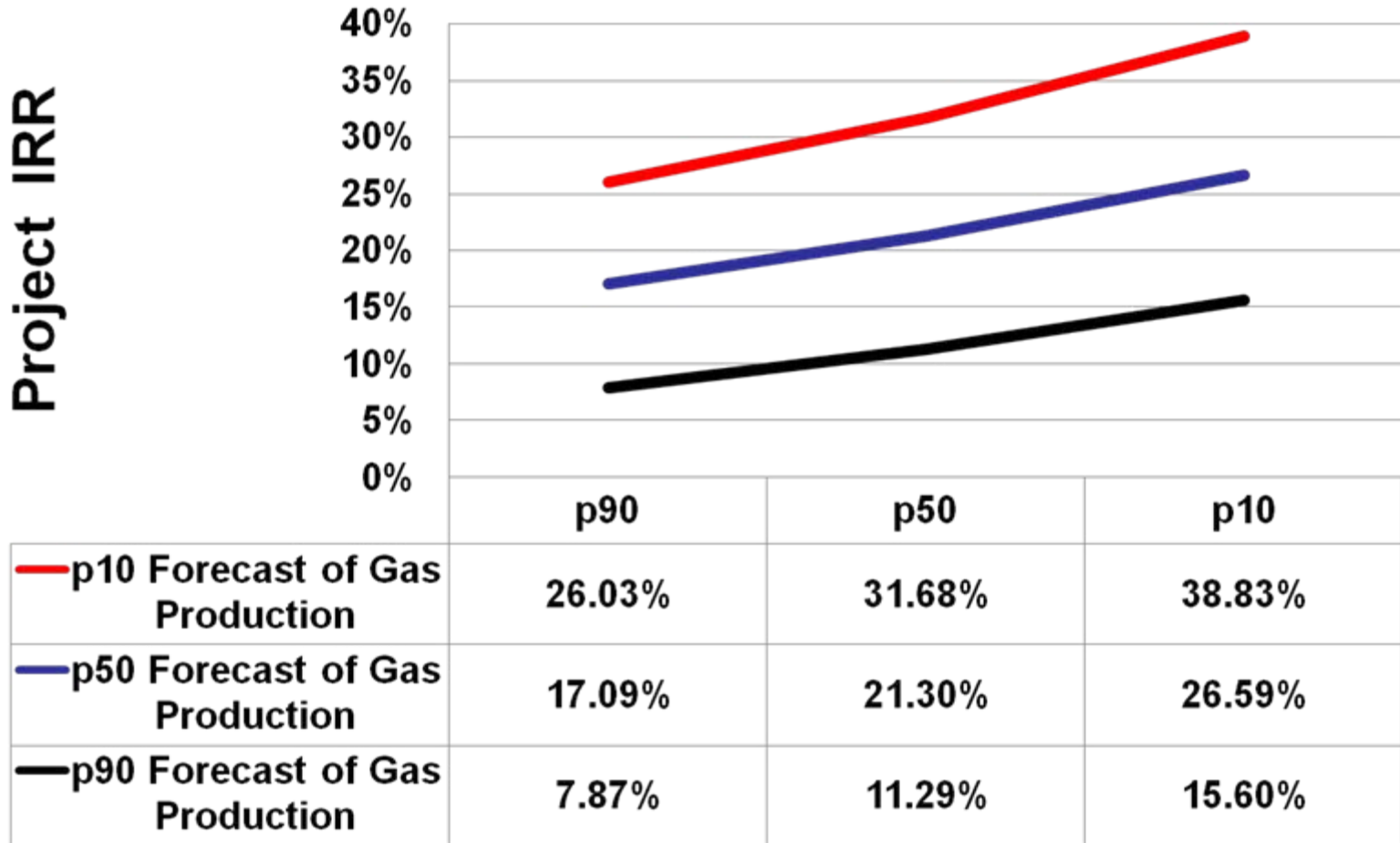


p10 Forecast of Gas Production
p50 Forecast of Gas Production
p90 Forecast of Gas Production

	p90	p50	p10
CAPEX = \$210.48	\$99.14	\$126.93	\$163.11
CAPEX = \$183.32	\$35.02	\$53.65	\$77.17
CAPEX = \$163.45	(\$8.65)	\$5.03	\$21.21



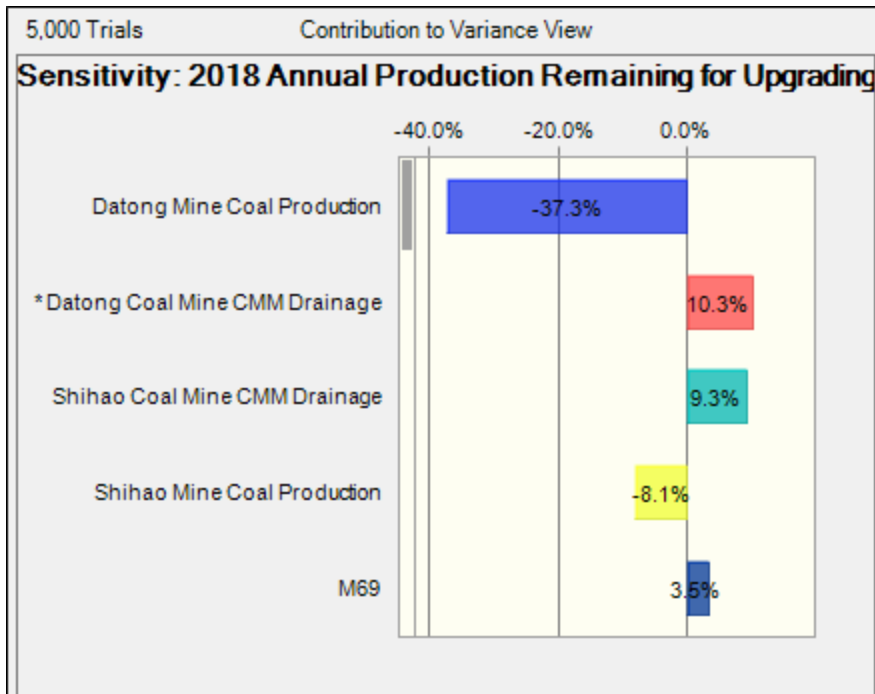
Probabilistic IRR Forecast Matrix





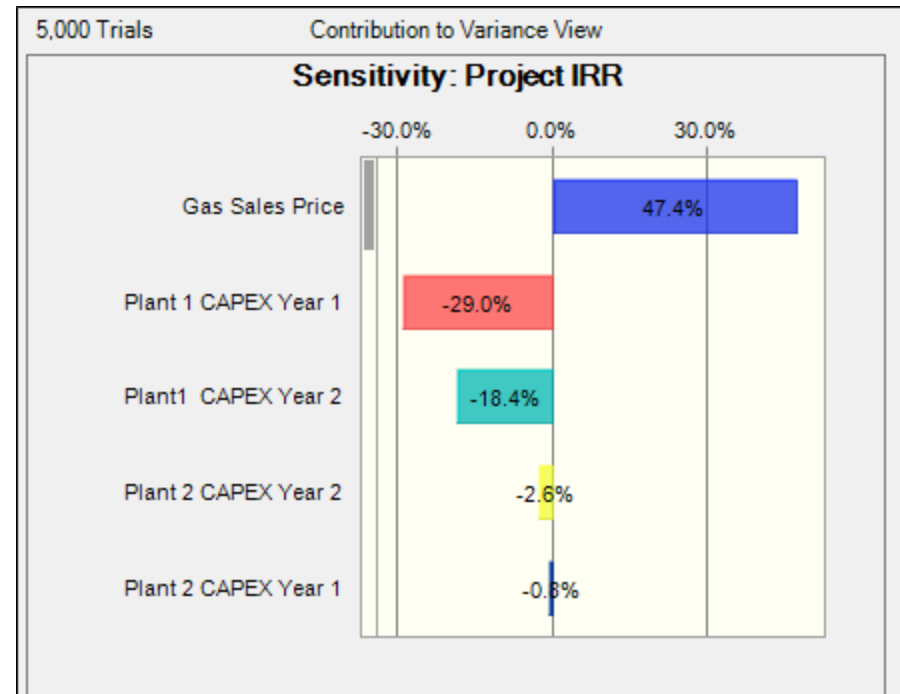
Indicative Sensitivity Analysis

Contributions to Uncertainty of Future Gas Production



* - Correlated assumption (sensitivity data may be misleading)

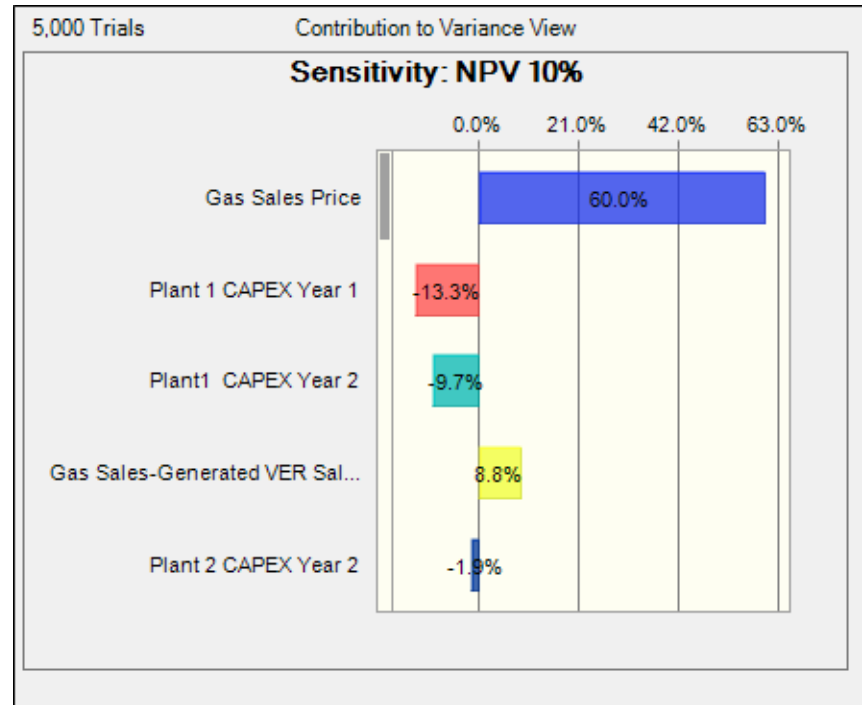
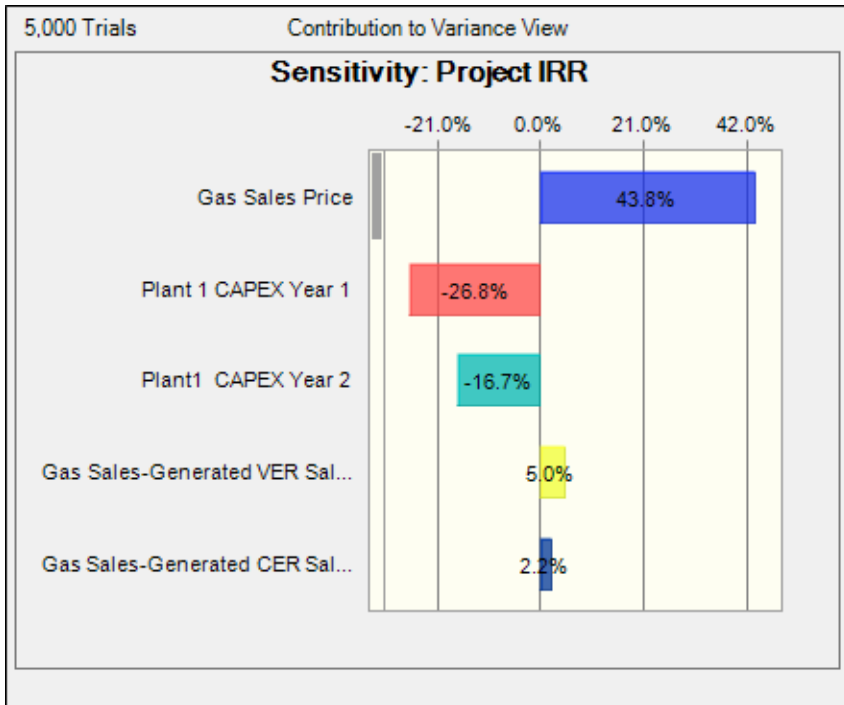
Contributions to Uncertainty of Economic Performance





Contribution of Carbon Credits to Uncertainty of IRR

Contribution of Carbon Credits to Uncertainty of Project NPV





Components of Uncertainty on Economic Performance of Project at p50 Gas Production

- Total CAPEX for p50 project is \$183 million USD
- Project IRR including revenue from CERs (\$13.00) and VERs (\$6.50) is 21.3%
- Without VERs the IRR is 13.6%
- Without CERs the IRR is 5.35%
- The post 2012 impact of the carbon market is significant
- Gas price rationalization is more significant



VI. CONCLUSIONS





Summary of Results

- For 15 year life of project and p50 gas production forecast :
- 40.1 million tonnes of CO₂e emission reduction average 3 million tonnes per annum after 2015 (emissions reduction are less than 2 million tonnes CO₂e until full production is achieved and equipment is installed)
- Range in investment from \$163.4 to 210.4 million USD



- Project economic performance is most sensitive to gas sales price.
- IRR without CER revenues (2011 and 2012) is negative for power generation and LNG options, but reduced and positive for optimized mix.
- The project NPV is sensitive to post 2012 emissions reductions market. VERs or CERs are important to overall economic performance.
- Project easily demonstrates financial additionality under present economic conditions in China.



¡Gracias!

