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COALBED METHANE EXTRA

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In this issue

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Opportunities in the US

Evaluating CMM Power Generation Projects in the U.S.

The keynote article in the August 2002 Coalbed Methane Extra focused on the issues and challenges facing coal mine methane (CMM)-fired power projects as well as the historical market conditions for CMM in the U.S. The article concluded that low electricity prices, institutional barriers, and site availability are some of the important challenges confronting future CMM project development. Nevertheless, favorable conditions and trends do exist. This follow-up article explores some of the key questions and issues that project developers need to consider when evaluating CMM power projects.

Introduction

Abandoned and operational coal mines in the U.S. offer good opportunities for developing CMM power generation projects. An estimated 48 billion cubic feet (Bcf) or 1.36 billion cubic meters (m^3) of CMM in the U.S. was drained via horizontal and vertical gob wells in 2001. Nearly 40 Bcf (1.13 Bm^3) of the 48 Bcf drained gas is captured and utilized as natural gas pipeline sales (source: *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2001*, USEPA 2003). Given the right conditions, most of the remaining 8 Bcf (227 million m^3) of drained gas could be used to fuel power projects instead of being vented to the atmosphere as is currently the case. Additionally, abandoned coal mines in the U.S. have also proven to be a reliable source of CMM for power projects; electricity is currently being generated with CMM at three abandoned coal mines in the U.S. The resource base from abandoned mines, while not as sizeable as active mines, is still significant. In 2000, the most recent year for which data is available, 11 Bcf (312 million m^3) was emitted from US abandoned mines (source: *Methane Emission Estimates & Methodology for Abandoned Coal Mines in the United States*, Draft Final Report, USEPA 2003).

A key element in evaluating CMM power project development opportunities is an analysis and selection of the appropriate power generation technologies. There are several basic technologies available for mine-site power generation, including gas turbines, reciprocating internal combustion (IC) engines, and fuel cells. Within each of these general categories, there are several subcategories of engine/generator combinations that are suited to certain conditions. In some cases, project developers may also have the option of considering used instead of new equipment. Each technology and the current condition of the equipment present certain benefits and costs to a project that should be considered when assessing the viability of a CMM-based power generation project.

To determine the best technical and economic option, a project developer should analyze six important technical factors before equipment is purchased and installed.

1) Perform a resource assessment. A reasonable estimate of the gas resource including volumetric flow and concentration are necessary to size the units.

2) Determine the size of generating units. This is a function of the fuel supply, but there are distinct advantages and disadvantages to using single versus multiple units.

(Continued on Page 2)

COALBED METHANE EXTRA

Evaluating CMM Power Generation Projects in the U.S. *(Continued From Page 1)*

3) Select the type of prime mover or combustion technology. The technology to be used to generate the electricity, such as IC engines, turbines, or other types should be carefully evaluated. Each type of engine has advantages and disadvantages, and selection should be based on site-specific factors.

4) Determine the relative cost of purchasing new or used equipment for the project. High-quality used equipment can often be purchased at much lower costs and can be purchased "as is" or refurbished. Purchasing used equipment is not with risk, however, and this should be considered.

5) Conduct a market analysis for electricity sales in a specific region and explore financing options. Project developers should establish relationships with the local electrical generating and distribution/transmission companies to assess electricity demand and options for transmission and distribution. In searching for financing, various debt and equity financing mechanisms should be considered.

6) Assess project risk and model project economics. Project economics can be evaluated once financing methods, capital costs, and expected revenues are determined. Additionally, a risk profile of the project should be developed to support financial decision-making.

This article examines each of these factors and discusses their possible impact on the project decision-making or evaluation process.

Resource Assessment

An estimate of the gas resources, historical coal production, ventilation emissions and gob well production rates (if wells are already in place) can be used to predict the long-term methane production rate at the mine. Based on the mine plan, a numerical model can be used to estimate the annual growth and decline rates of methane production over the life of the project. This information is essential for determining the size of the power plant and its relative economic potential.

Generators consume fuel according to their *heat rate* function (a measure of efficiency), which is usually expressed in Btus per kilowatt-hour. Hypothetically, a unit operating at 100% efficiency would use 3410 Btu/kW-hr, but efficiencies of today's power generators of 10MW or less range from 20-40%. (Combined heat and power units can achieve higher efficiencies). As a result, there is a range of fuel requirements for similar-sized generators. In general, each MW of electricity produced by a unit with a mid-range heat rate of 11,500 Btu/kW-hr (30% efficiency) uses approximately 300 thousand cubic feet per day (mcfd) (8.5 mcmd) of pure methane. Therefore, a 10 MW plant would require 3.0 million cubic feet per day (mmcfd) of methane. Currently, only 9 active mines in the U.S. produce this quantity of drained methane and no abandoned mines are known to produce at this level. However, there are 5 additional active mines and several abandoned mines that could support the fuel requirements for 5 MW power plants, while numerous coal mine sites could fuel power projects in the 1 to 5 MW range.

Size of Generating Units

Generating units are manufactured in many sizes. Depending on the application, single units (standby power) or multiple units (continuous power) may be

(*Continued on Page 3)*

TABLE 1A: MICRO AND SMALL GENERATING UNITS

Positive Factors	Negative Factors
Capital cost—Overall relatively low capital investment if purchasing small quantities	Final cost—A redundancy in equipment is introduced with increasing the number of units: switch gear, piping, control devices, and wiring.
Flexibility—Individual generating units can be installed (or retired) as the availability of fuel varies, or economic considerations change.	Installed cost per kW—The generator and prime mover cost/kW is higher than with medium units. Installation costs are also multiplied, with only a small economy of scale for multiple units.
Emissions—Small capacity can usually be regulated with emissions permit only.	Footprint—The smaller generators can require several times the area of a single medium unit.
Operation—Moderate technical skill is sufficient for maintenance of most generating units.	Maintenance—Generally, smaller units require more operator intervention relating to filters, belts, hoses, lubricants, etc.
Maintenance—Complete plant shutdown not required for repairs	

Evaluating CMM Power Generation Projects in the U.S. *(Continued From Page 2)*

TABLE 1B: MEDIUM AND LARGE GENERATING UNITS	
Positive Factors	**Negative Factors**
Total cost—Lower cost than multiple small units because of less redundancy, higher generator voltages can preclude the use of transformers	Lower flexibility. Requires more accurate projection of fuel availability and quality, as well as power usage
Instrumentation and control—1+ MW generators are generally equipped with protective devices, alarms, and other self-regulating equipment not included in smaller generator packages.	Constancy – If single units are deployed, electricity sales can be interrupted during shutdowns for maintenance and repairs.
Maintenance—1+ MW plants are available for unattended remote operation, requiring minimal intervention.	Supervision—Some training would be required to safely operate plant.
Footprint—Smaller space requirements than comparable multiple small-unit generating capacity.	

appropriate. It is convenient to divide the generator sizes into these categories for CMM applications.

Micro	< 200 kW
Small	+/- 500 kW
Medium	1 to 5 MW
Large	> 5 MW

Depending on the power needs, micro units can be feasible for CMM projects if multiple units are installed. Operating and maintenance costs, however, could be higher for several single units operating at remote locations, rather than multiple units set up at one location. Even the small size generating units will likely require multiple units per project. Alternatively, large units have the advantage of a single footprint, but a shut down will have a more significant impact. Tables 1A and 1B highlight the factors to consider when comparing micro/small and medium/large generating units for a coal mine power project.

Types of Generating Equipment

Several types of generating equipment can be considered for CMM projects:

1. Gas-fired boiler/steam turbine
2. Gas turbine generating sets
3. Reciprocating internal combustion (IC) gensets
4. Fuel cells

Gas-Fired Boiler/Steam Turbines

The steam turbine has several advantages including multiple fuel capability, low fuel pressure, and the ability to maintain efficiency at higher elevations.

However, at the anticipated power levels for CMM projects, the need for licensed boiler operators, water quality control technicians, and machinery maintenance personnel makes this option labor intensive and difficult to be economically viable. This option also requires a source of clean water for the steam turbine operations, which can be another limiting factor.

Gas Turbine Generating Sets

CMM typically contains 30% to 95+% methane in combination with inert gases such as CO_2, O_2, and N_2,. Because the quality of CMM from a single mine vent can vary considerably, additional critical operating conditions need to be considered for turbines. Since turbines are regulated by responses to variations in combustion temperature, changes in the heating value of the fuel at startup can affect performance. Most turbines, however, can accommodate this automatically, as long as there are no radical spikes in the fuel delivery.

Turbines can range in size from 500+ MW combined cycle turbines to small microturbines. Microturbines consist of a small, air-cooled gas turbine connected to a high speed generator and compressor on a single shaft. The simple design results in a system with a high power output, minimal noise generation, and efficient operation. Their compact size allows them to be located at remote locations, however higher costs remain an issue with microturbines. Ingersoll-Rand, Solar Turbines, Centrax Gas Turbines and Capstone Microturbines are a few of the turbine manufacturers who produce turbines less than 5 MW in size.

Turbines require fuel to be supplied at a much higher pressure (100 to 200 psig) than is required for IC engines. This becomes a significant issue at remote sites, such as coal mines, where CMM is only available at near-atmospheric pressures. As a result, a fuel compressor is needed to increase the pressure of the CMM before it is fed to the turbine. This can add a

(Continued on Page 4)

CMM Opportunities in the Rocky Mountain Region *(Continued From Page 3)*

significant parasitic load to the electrical generator, and if the compressor is driven by an electric motor, the net generation delivered may be up to 20% less than the nameplate rating of the turbine generator. In order to minimize this loss of efficiency, the fuel gas compressor could be driven by a reciprocating gas engine that will consume less methane (5-10%).

Reciprocating Internal Combustion (IC) Gensets

The choice between gas turbines and IC engines is primarily driven by the amount and the delivery pressure of fuel that may be available at a given location. Fuel must be provided at pressures over 100 psig for turbines, where IC engines can be operated with fuel pressures below 10 psig. Turbo-charged engines require approximately a 50–80 psig compressor per megawatt of capacity for fuel compression. Emission control systems may be required for used gensets and new micro units. New small and medium units are generally of a lean-burn design, which keeps emissions within regulatory limits.

The micro and small size (<500kW) IC gensets have electrical outputs available at 480 volts and would likely require transformers to provide the power for general distribution into the local utility grid. Medium-size units generally have outputs of 4,160 volts, while some may even be available with 12,000+ volt output. Depending on the application, IC gensets may require additional protective equipment, e.g., automatic shutoffs for out-of-norm engine operating conditions, reverse current relays, over- and under-voltage shutdowns, and frequency parameter controls.

Some of the companies that manufacture IC engines include: Caterpillar, Waukesha Engines, Cummins Engine, Deutz, and Jenbacher.

Fuel Cells

To date, fuel cells are only being used at CMM demonstration projects and have not yet reached widespread commercial availability. Northwest Fuel is providing a site for a research demonstration of a fuel cell at the Nelms Mines in Ohio, which is partially funded by the U.S. Department of Energy (U.S. DOE). The current capital costs for such an option approaches $4,000 per kW hour installed. U.S. DOE is developing more practical and affordable designs for stationary power applications and funding additional R&D projects to make this energy option commercially feasible. State-of-the-art fuel cells now being tested are likely to cost around $1,200 per kilowatt, with the goal of reducing their costs to $400 per kilowatt by the end of the decade. Currently, FuelCell Energy plans to locate a fuel cell at an Ohio coal mine as part of a DOE-funded demonstration project.

Capital Costs

In order to provide some guidance in evaluating varying capital costs of the various types of prime movers, one should calculate the amortized costs of various capital expenditures. Amortizing just the capital cost of $1,000 per kW at 10% interest for 10 years (with a 90% on-line factor) yields an additional cost of $0.020/kWh. That means that the generated electricity must have a value in excess of $0.025/kWh plus operating costs, before the $1,000/kW for a turn-key project can be justified. This does not even consider any operating costs or assignment of any value to the fuel. Depending on price guidelines, it may be necessary to keep the total plant capital cost less than $1,000/kW. With a rule-of-thumb that equipment alone constitutes about 50% of the total plant cost, the prime mover equipment costs should be held below $500/kW. **Table 2** summarizes the basic equipment costs for the various size units, excluding associated hardware and installation.

Evaluating New vs. Used Equipment

The project developer may wish to consider used equipment in addition to new equipment. In some cases, new equipment may be too expensive to allow for competitive power generation at current electricity prices in coal mining regions of United States. In instances where a project developer might consider used equipment, it is important to note that the typical size requirements for CMM generators make used equipment feasible. There are few CMM power projects that can support more than 10 MW of power generation, and there are a considerable number of small- to medium-size used generators available on the U.S. When considering used equipment, the following items should be evaluated.

(Continued on Page 9)

Table 2: Summary of Estimated Equipment Costs

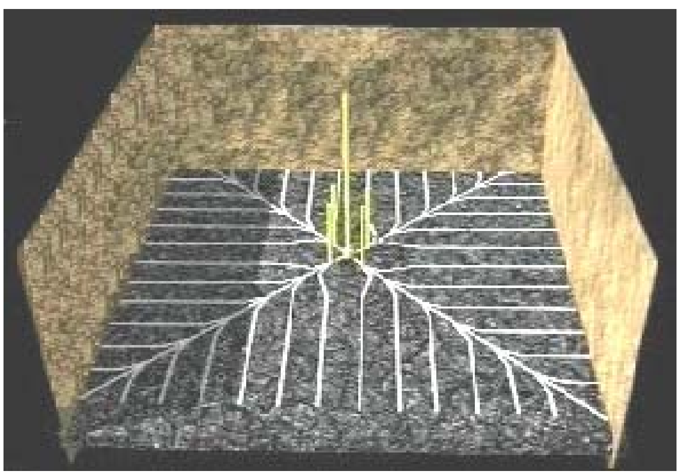
	Micro (<200kW)	Small (500kW)	Medium (1-5MW)	Large (>5MW)
New IC Engine	$400-$600/kW	$600-$800/kW	$600-$800/kW	$600/kW
Used IC Engine	$300-$400/kW	$300-$400/kW	$300-$400/kW	N/A
New Turbine	$1,000kW	N/A	$600/kW	$400/kW
Used Turbine	N/A	N/A	$300-$400/kW	$300/kW

New Breed of CBM/CMM Recovery Technology

Traditionally, companies have only been able to justify the cost of a pre-mining methane recovery project in the most gassy of coal mines. These projects typically involve an integrated drilling program of gob wells, in-mine horizontal wells, and vertical wells installed years in advance of mining. A coalbed methane drilling and production technology from CDX Gas has proven successful with pre-mine methane gas recovery. CDX has been using this technology, called the "Z-Pinnate™ Horizontal Drilling and Completion System", to capture CBM at active underground coal mines since 1998.

Two key technologies make up the system; the "Pinnate" multi-lateral drainage networks, and a dual-well drilling and production system. **Figure 1** shows the Pinnate system and how it incorporates a multilateral horizontal drainage network configured in the shape of a leaf (hence the name "Pinnate"). By contrast, traditional vertical drill and frac recovery methods require one well for every 80 acres of coal. This dual-well system provides an efficient down-hole water separation, allowing water to be easily pumped off and economical under-balanced drilling. CDX reports that the combination of the Pinnate network and dual-well system enables recoveries of 80 to 90 percent of the CBM in a two- to four-year period.

Figure 1:Four Pinnate patterns nested from one drill site



The first application of CDX technology was at the U.S. Steel Mining Pinnacle Mine in southern West Virginia. Currently, CDX Gas produces more than 14 mmcfd (400 thousand m^3) from 29 wells at the Pinnacle Mine in southern West Virginia. Other benefits include minimal surface disruption and associated costs, uniform drainage, and mining operations that have increased safety and produced very low overall methane emission rates. According to CDX, the Pinnate system has also been successfully implemented in other coal and shale basins in the US and Canada.

U.S. EPA would like to acknowledge and thank Joe Zupanick of CDX Gas for his contribution to this article.

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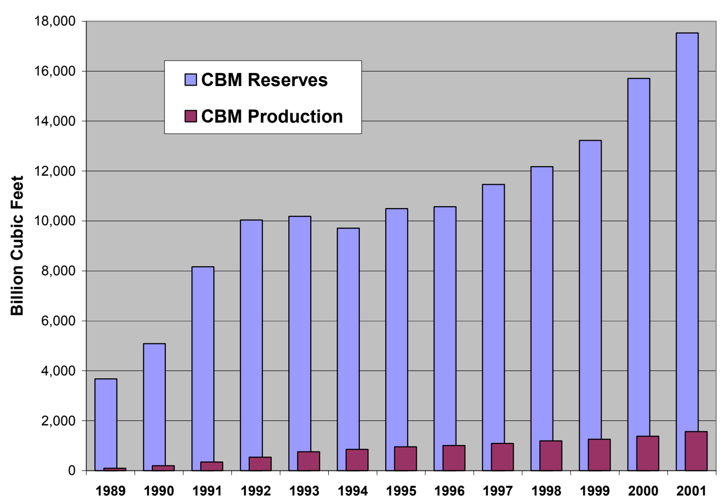
U.S. Department Of Energy Releases CBM Reserves & Production Report

In December 2002, the U.S. Department of Energy (US DOE) released the U. S. Crude Oil, Natural Gas and Natural Gas Liquids Reserves, 2001 Annual Report (Energy Information Administration (EIA), Office of Oil and Gas, U.S. DOE). The report presents estimates of proven reserves of crude oil, natural gas, and natural gas liquids as of December 31, 2001, as well as production volumes for the United States and selected States and State subdivisions for the year 2001. In 2001, proved reserves of CBM increased to 17,531 billion cubic feet, a 12 percent increase over 2000 (15,708 billion cubic feet). Further, U.S. CBM production grew by 13 percent in 2001 to 1,562 billion cubic feet, accounting for 8 percent of U.S. dry gas production. The figure below shows a summary of proven CBM reserves.



COALBED METHANE EXTRA

International Coal Mine Methane Updates

Australia

The Australian Government's Greenhouse Office continues to support greenhouse gas abatement projects through coal mine methane recovery and use. Through Rounds 1 and 2 of a greenhouse gas abatement program, the government has awarded AUS $30 million to four separate coal mine projects; Energy Developments Limited, BHP Billiton, Powercoal, and Environgen Pty. Solicitations for Round 3 are expected to be advertised by mid 2003.

Australia's Commonwealth Scientific and Industrial Research Organization (CSIRO) is developing a hybrid coal and VAM fueled gas turbine to oxidize ventilation air methane. In this unique system, waste coal and VAM are first co-fired in a rotary kiln. The heat of combustion is then captured in an air-to-air heat exchanger where clean air, compressed by a gas turbine's compressor, is heated to approximately 900^{o}C and then expanded in the turbine's power section. CSIRO is developing the pilot project using an Allison C-18 gas turbine that will generate 1.2 MW.

Russia

In October 2002, the United Nations Development Programme and the Global Environmental Facility (UNDP/GEF) approved a coal mine methane recovery and utilization project in Russia. The purpose of the project is to mitigate greenhouse gas emissions by removing barriers to the financing and implementation of coal mine methane (CMM) recovery and utilization projects in the Kuzbass Basin of Russia. The total project cost is US $8 million, with the UNDP/GEF contributing US $3.1 million. Additional information is available on the GEF website at: http://cfapp2.undp.org/gef/site/blank.cfm?module=projects&page=webProject&GEFProjectCode=500.

Kazakhstan

The 1st International Kazakhstan Coal Mine Methane Workshop was held on September 12, 2002 in Almaty, Kazakhstan. The conference focused on stimulating more productive collaboration between Kazakhstan and foreign experts to better identify ways of recovering and using Kazakhstan's significant coalbed methane (CBM) resources. The Methane Center and "Iteca" sponsored the Workshop. Both Kazakh and foreign organizations took part in the workshop, including the U.S. Environmental Protection Agency.

The workshop proceedings are available in English at http://www.epa.gov/coalbed/pdf/kazak-eng.pdf. For more information on CBM/CMM opportunities, contact Evgeny Alekseev of the Methane Center of Kazakhstan at ealekseev@azimut.kz.

United Kingdom

In 2002, coal mine methane power generators battled against record-low power electricity prices. The current market price has not improved and is approximately $0.025/kW-hr. As a result, Alkane Energy, which operates four CMM projects, announced a revised strategy for future CMM development in March 2003. The company plans to cease all further CMM development in the UK and focus their efforts on landfill methane and international CMM opportunities. StrataGas, which operates two CMM projects in the UK, is temporarily withholding investment in CBM/CMM projects following the rejection of a CBM pilot project in December 2002.

Germany

The German government has defined CMM power as a renewable energy source. The German Renewable Sources Act gives priority to such sources of energy, and as a result, CMM power projects have flourished since 2001. Currently, there are at least 30 projects operating at active and abandoned coal mines producing over 80 MW of electricity. Most project sizes range between 1 – 4 MW, with a few as large as 9 MW.

Government incentives include guaranteed price supports of $0.079/kW-hr for the first 0.5 MW and $0.68/kW-hr thereafter for 20 years. In addition, the German government requires no royalties or taxes by the CMM operators, and allows the operators to market any carbon credits resulting from the projects. Finally, the government reimburses the operator 80% of the cost of any dry holes.

India

The Government of India is aggressively seeking investment to produce methane from its coalbed methane fields. According to Dr. Avinish Chandra, Director General of Hydrocarbons, several basins in India have higher rank coals and may be good candidates for CBM/CMM development. The Government of India recently awarded exploration and development licenses for 8 blocks totaling 2,575 square kilometers and has plans to auction nine new blocks.

(Continued on Page 7)

COALBED METHANE EXTRA

COALBED METHANE OUTREACH PROGRAM

International Coal Mine Methane Updates (Continued from Page 6)

On June 12, 2003, a Government of India delegation presented details on the new auction at a road show in Houston, Texas. This meeting addressed the resource potential of the available acreage, as well as provided an informative discussion of the fiscal and regulatory issues, and a perspective on the improved investment climate in India.

In addition to the activity in CBM production, the UN Development Programme is funding a Global Environment Facility (GEF) project at the Moonidih and Sudamdih Mines to recover and use coal mine methane for power generation and as vehicle fuel.

For more information on India CBM/CMM, contact Mr. Mark Stern of MT Energy Associates at mhstern@erols.com or Peter Lagiovane of US DOE at Peter.Lagiovane@HQ.DOE.GOV.

For more information on the UNDP/GEF project, visit the project website at http://www.gefonline.org/projectDetails.cfm?projID=325.

To find out more about the CBM Road Show in Houston visit http://www.petrotel.com/cbm.htm.

China

The China-Japan Green Aid Project (GAP) "Tiefa Coal Mine Area Mine Methane Recovery and Utilization Demonstration Project" completion ceremony was held at the Tiefa Coal Group in Liaoning Province on October 19, 2002. Implemented by Tiefa Coal Group Co Ltd, the project lasted for five years from 1999 ~ 2002. Involving total investments from both Chinese and Japanese sides of more than US$11 million, the project achieved a complete coal mine methane drainage and extraction system and part of a surface methane distribution and transmission system.

In November 2002, the China National Coal Association, State Administration on Coal Mine Safety Supervision, the China Coal Information Institute and the US EPA held the 3rd International CMM/CBM Symposium in Beijing. More than 130 representatives participated including representatives from China, US, UK, Australia, and Japan, and the Netherlands and major multi-lateral institutions such as the World Bank, UN Development Programme, and Asian Development Bank. Participants at the Symposium discussed prospective development of coalbed methane capture and utilization and the regulations and policies to support further development. For more information, please visit http://www.epa.gov/coalbed/intl/china/2002-12.pdf.

CMM WORKSHOP ON SECURING FINANCING FOR COAL MINE METHANE EMISSION REDUCTIONS HELD AT ALABAMA CBM SYMPOSIUM IN MAY 2003

U.S. EPA, Natsource, EcoSecurities, Trexler and Associates, and Raven Ridge Resources hosted a workshop on financing CMM projects at the recent 2003 International Coalbed Methane Symposium in Tuscaloosa, Alabama. The workshop brought participants together to discuss the issues and steps required to develop CMM emissions reduction projects and realize additional project revenues. Neil Cohn of Natsource opened the technical portion of the workshop with an overview of the emerging global carbon market. Mr. Cohn pointed out there are actually two markets developing including one for voluntary emissions reductions. Mr. Cohn also discussed the various national and local markets including those developing in Japan, Canada, United States and several European countries.

During the next session, Justin Guest of EcoSecurities and Michael Coté of Raven Ridge Resources narrowed the focus of the workshop to CMM project design. Their presentation addressed the issue of additionality, baseline setting, monitoring, and verification as they pertain to implementation of CMM projects. Mr. Coté focused on the technical aspects of project design and implementation, while Mr. Guest spoke to documentation of the emission reductions.

The technical sessions closed with a presentation from Dr. Mark Trexler from Trexler & Associates in Portland, Oregon. Dr. Trexler presented a session on the changing dynamics of the carbon market and the perspective of investors and buyers of emission reductions in today's markets. He also discussed appropriate strategies to successfully package and market emission reduction projects in the U.S. Using several CMM case studies, he compared the economics of CMM emissions reductions projects to other emissions reduction-type projects, keying in on what it takes to satisfy both the buyer and seller. CMM projects at both active and abandoned mines are attractive to many investors/buyers due to their measurability and verifiability.

For more information or a CD ROM of the workshop presentations, please contact Clark Talkington talkington.clark@epa.gov. The presentations will soon be posted on the Coalbed Methane Outreach Program website at www.epa.gov/coalbed.

International Coal Mine Methane Updates

China Coalbed Methane Clearinghouse Supports China CMM Industry

Over the last several years, the China Coalbed Methane Clearinghouse (CBMC), with the support of USEPA, has been working in concert with Chinese coal mining companies to introduce interested investors and developers to CMM project opportunities. These opportunities are located at a number of gassy coal mines found in several provinces of China. Through a cooperative effort with coal mine operators, CBMC has published and released seven brochures that serve as introductions to the coal mining properties and outlines for potential projects. These project opportunities are ones that the coal mining companies feel could be fully realized with outside technical assistance and investment. Potential investments range from $5 to $30 million USD.

Since early 2002, CBMC has turned its attention toward a broader goal of promoting and supporting commercialization of CMM projects in China. The strategy undertaken by CBMC includes a variety of activities designed to disseminate information to investors and organizations worldwide, and to strengthen the capabilities of CMM and CBM professionals within China.

- In June 2002, CBMC sponsored a workshop in Zhuhai, China, where representatives of several mines met to discuss topics covering issues related to financing CMM projects.

- On November 13-14 of this year, CBMC hosted the Third International CBM/CMM Symposium in China in Beijing. This meeting focused on topics relevant to financing and development of CMM and CBM projects in China.

- CBMC is preparing a document, entitled "Guideline for Commercial Development of Coal Mine Methane in China," for publication that will be of interest to anyone desiring to know more about the opportunities for CMM development in China. The document will contain: (1) a brief description of CMM and CBM resources; (2) offer comprehensive information on the policy, regulations, and laws; and (3) lead the reader through the steps that must be taken to develop CMM projects in China.

Please contact Mr. Huang Shengchu or Ms. Hu Yuhong of CBMC at huangsc@coalinfo.net.cn or ceec@public3.bta.net.cn, respectively, for more information.

3rd International Methane & Nitrous Oxide Mitigation Conference to be Held in Beijing, China

The organizers of the 3rd International Methane & Nitrous Oxide Mitigation Conference have announced that the conference originally scheduled to be held from 14-19 September, 2003 in Beijing, China, is now scheduled for the 17-21 of November in Beijing. The conference will focus in detail on important sources of methane and nitrous oxide, including landfills and sewage management, natural gas and oil systems, coal mining, and agriculture. Attendees will participate in source-specific discussions on characterizing emission sources, using proven and innovative technologies to reduce emissions, and overcoming the barriers to project development. Cross-cutting themes, such as monitoring and verification procedures, the economics of mitigation, and multi-gas/multi-source analyses will be featured throughout the conference. With widespread participation from experts throughout the world, a global picture of the potential for expanded methane and nitrous oxide mitigation will be developed. For more information, visit www.ergweb.com/methane_china.com (English) or www.coalinfo.net.cn/coalbed/meeting/2203/2003z.htm (Chinese). Questions may be directed to Mr. Clark Talkington at talkington.clark@epa.gov or +1.202.564.8969, or Ms. Liu Xin at cbmc@public.bta.net.cn or +86.10.8461.2010. Proceedings from the 2nd International Methane Mitigation Conference, held in Novosibirsk, Russia, are available on the internet at http://www.ergweb.com/methane/

Opportunities in the US

Evaluating CMM Power Generation Projects in the U.S. *(Continued From Page 4)*

Equipment Availability

Many generator sets were originally purchased for backup or standby power and have rarely ever been used. Equipment of 1980s and 1990s vintage can by found in near-new condition, or used with just a few hundred hours of service. Surprisingly, a large number of used equipment dealers are located throughout the U.S. Also, many manufacturers like CAT, Cummings, Waukesha, and Deutz sell used power generating equipment as well as new. Other dealers sell a variety of industrial equipment and engines that use diesel, natural gas, or propane. In addition, many of the manufacturers stock replacement parts, offer installation services, and provide maintenance contracts.

Equipment Warranty

As with a purchase of any used equipment, or even new equipment, it is strongly recommended that a qualified third party be retained to inspect used equipment before purchase. With gas turbines, this would include careful inspection of the unit, paying particular attention to the turbine blades. The existence of a warranty from the supplier can provide some additional assurance regarding the reliability of the used equipment. Alternately, purchasing equipment "as is" reduces costs but may increase project risk. This risk is even greater when purchasing a higher-priced medium to large unit without a warranty.

Costs

A survey of vendors conducted for this article reveals that rebuilt equipment generally costs about 50-60% less than comparable new equipment. Used equipment also often includes ancillary equipment for which one would have to pay separately when ordering new generating units. While warranties reduce risk, they're not without an incremental cost. Depending on its age, the cost of rebuilt equipment *with a warranty* is generally 40-50% less than new. If one is willing to take the additional risk, the cost of "as-is" used equipment (not rebuilt) can be as low as 70% less than comparable new equipment. Taking this risk, however, is usually only recommended for an experienced buyer of used power generating equipment.

Installation costs are similar for both new and used equipment, typically \$200- \$300/kW. Since most equipment will not last ten years of operating without a major overhaul, operation & maintenance costs also need to be considered. These can range from \$0.003-\$0.008/kWh for gas turbines to \$0.005-\$0.015/kWh for

Markets, Financing and Calculating

Competitive Marketplace

The highest price one can sell electricity for in the United States is at the retail level. Retail electricity prices range widely across the U.S., with industrial rates ranging from \$0.03 to \$0.10/kW-hr (US DOE Energy Information Administration *2001 Electric Power Annual*, March 2003). As of March 2003, electricity restructuring or deregulation has occurred in eighteen states, including four of the major coal mining states: Pennsylvania, Ohio, Illinois, and Virginia. However, the costs of transmission tariffs and fees can make retail sales much less lucrative than it first appears. Existing generating capacity, line load, and consumer demand are all variables in determining the value of electricity in a given region.

The sale of electricity at the wholesale level to the local utility is another option. Generally, the wholesale price of electricity is driven by the need of the local utility to add generation capacity. Most often, they are only willing to pay their "avoided costs" of purchasing the power elsewhere (usually from a large power plant). Unfortunately, these prices are not very encouraging, typically ranging from \$0.015 to \$0.025/kW-hr.

Another option for selling electricity is for "on-site" use at the coal mine from which the CMM is produced. In 2002, most U.S. coal mines (located in 12 states) paid between \$0.036 - \$0.058/kW-hr for their electricity. In view of these prices, direct sales to the coal mine (without all of the transmission tariffs and fees) could make the most economic sense. These prices reflect the avoided electricity cost the mine would be paying to the local utility.

Financing

With installed cost of turn-key power plants ranging from \$400 - \$1200/kW and project sizes ranging from 200kW to 10 MW, capital costs can range anywhere from \$150,000 to \$12,000,000. The method of project financing may depend on the scale of the costs and the rate of return on investment. For the medium- to larger-scale units, it may make sense to lease the equipment rather than purchase it. Most retailers of new genset equipment typically provide financing, from conventional loans to flexible leases with no up-front costs and fixed monthly payments.

(Continued on Page 10)

COALBED METHANE EXTRA

COALBED METHANE OUTREACH PROGRAM

Opportunities in the US

Evaluating CMM Power Generation Projects in the U.S. *(Continued From Page 9)*

Site-Specific Considerations

Some consideration must be given to site conditions. It is well known that coal mine operators are wary of CMM developers interfering with mining operations. Important questions may arise upstream of the power plant. For instance, will a developer take possession of the methane at each wellhead or from a gathering system? Will blowers be able to be used to assure a minimum fuel supply? In the coal mine regions of Virginia, southern West Virginia, Colorado, and Utah, rough terrain limits the ability of a coal mine to install gas gathering systems economically. In these cases, the economic analysis for a CMM power project may show that it's less expensive to use higher-priced micro units at each wellhead and run wire rather than install pipelines to a single location. A mine may also need remote power at a few locations on the mine property that could lend itself to micro units as well. Also, cost-sharing gathering lines with the coal mine could greatly affect the economics of a project. Consequently, the installed costs of the different types and sizes of units do not provide the whole economic picture.

Project Risk Assessment and Project Economics

As with the development of any project, it is critical to perform a risk assessment. A project developer should define a critical path for project success and define the risks facing the project throughout the expected life of the project. There are many risks facing a CMM power project including the costs of equipment and maintenance, volatile swings in the price of natural gas and electricity, changes in demand for electricity, challenges over ownership of the gas rights, equipment failure, changes in regulatory regimes, and failure of the coal resource to produce gas in the quantities expected. All risks should be evaluated and quantified to the extent possible using decision-tree analysis, critical path method, Monte Carlo simulation or some other quantitative tool to account for anticipated and unanticipated costs.

Once the risks have been assessed, gas reserves have been determined and equipment features and costs researched, the next step in evaluating a project is to determine the power sales price and financing options available. With all of this information, an economic model of the project can be constructed. Conventional economic models can be used to evaluate CMM power projects, comparing capital costs, internal rates of return, net present values, and levels of uncertainty. Innovative ideas such as developing a partnership with the coal mine can help a CMM project's economic performance.

U.S. Projects

While CMM power projects are not widespread in the U.S., profitable ventures do exist. Northwest Fuel Development has fabricated new micro size units (75kW) that can be economically viable for CMM projects. The prime movers are 100 horsepower light truck engines. Multiple units can be installed for projects demanding up to 2 MW of installed capacity. The total cost of a plant with such units is less than $800/kW installed, including site development. Currently, a 675 kW system is operating at the Cadiz Portal in Ohio and a 1.8 MW plant is being developed at the Federal #2 Mine in West Virginia.

Projects that deploy used small-sized equipment have also proven economically viable. For example, Grayson Hill Farms is operating two 1.7 MW power plants at two different abandoned coal mine sites in southern Illinois. Each plant uses two rebuilt 850 kW CAT 3512 model gensets as the prime movers that are fueled by 850-900 Btu CMM. Fifty percent of the electricity is sold to a local utility for base load and the remaining amount is sold at a higher price for peak power. In addition, heat recovered from the units is used to heat greenhouses. With Grayson Hill Farms installing the units themselves, the cost for these power plants was less than $600/kW.

Conclusions

When designing a CMM power project, the first step is to conduct an accurate resource evaluation of the potential methane drainage. Second, since total installed costs can range from $400-$1,200/kW, it is important to select the best combination of available equipment (new or used) in order to keep this expense in the lower range. Once this is done, a careful evaluation of the local electricity market must be performed because prices vary widely from state-to-state. The economics of any project will be ultimately determined by minimizing the installed cost of the plant and maximizing the revenues through the sales of electricity. CMM can prove to be an important source of low-cost fuel for small-scale power projects throughout the U.S.

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COALBED METHANE EXTRA

NATIONAL MINING ASSOCIATION TO PARTICIPATE IN US CLIMATE VISION PROGRAM

On February 12, 2003, the National Mining Association (NMA) announced NMA's participation in the U.S. Government's Climate VISION (Voluntary Industry Sector Initiatives: Opportunities Now) program. The NMA represents the majority of the coal mining interests in the US, and it members include such leading U.S. CMM producers as CONSOL Energy, Jim Walter Resources, and Peabody Energy.

As part of this program, the NMA developed the "Mining Industry Climate Action Plan," a six-part mobilization strategy to increase efficiency and decrease carbon intensity. One of the six modules specifically targets coal mine methane where NMA members have committed to continue recovering methane at existing levels and increase recovery where technically and economically feasible. According to US EPA's *Draft Inventory of U.S. Greenhouse Gas Emissions & Sinks: 1990-2001*, US mines recovered and utilized almost 40 billion cubic feet (1.13 Bm3) in 2001, or about 80% of methane drained from active underground mines. For more information, visit NMA's website at http://www.nma.org/newsroom/press_releases.asp or the White House website at http://www.whitehouse.gov/news/releases/2003/02/20030212.html.

Upcoming Events

20th Pittsburgh Coal Conference
Pittsburgh, Pennsylvania
September 15-19, 2003
Will include an entire track on carbon sequestration, and a program on coalbed methane production. For more information, visit www.engr.pitt.edu/pcc.

CBM Water Management Strategies
Jackson Hole, Wyoming
September 28-30, 2003
Visit http://www.srinstitute.com/part_iter_site_page.cfm?iteration_id=557 for more information.

12th International Conference on Coal Science
Cairns, Queensland Australia
November 2-6, 2003
This year's emphasis will be on the environmental performance of coal and its contribution to sustainability. For more information and pre-registration, visit www.aie.org.au/iccs

3rd International Methane & Nitrous Oxide Mitigation Conference
Beijing, China
November 17-21, 2003
For more information, visit www.ergweb.com/methane_china.com (English) or www.coalinfo.net.cn/coalbed/meeting/2203/2003z.htm (Chinese) for the most current information.

Coal Seam Methane Market Update Conference
Brisbane, Australia
December 9-10, 2003
Following significant developments within the CSM industry, and the forthcoming market update conference will bring together the key players to discuss the outlook for Australia's CSM industry in 2004. For more information, visit www.ibcoz.com.au

2004 International Coalbed Methane Symposium
Tuscaloosa, Alabama
May 3-7, 2004
The conference series, traditionally a biennial event, will be held annual beginning in 2004. For more information contact Ed Martin at emartin@ccs.ua.edu or visit www.bama.ua.edu/~coalbed.

New Publications

Russia Coal Mine Methane Foreign Investment Issues
Available from Uglemetan – the International Coal & Methane Research Center at http://www.uglemetan.ru/HTML/WhitePapers5.htm

Natural Gas from Coal Seams in the Northern Appalachian Basin - Conference Wrap Up.
Presentations from the conference are posted at: http://www.iogcc.state.ok.us/ISSUES/CSNG/csng.htm

Multi-Gas Contributors to Global Climate Change: Climate Impacts and Mitigation Costs of Non-CO2 Gases
Available from the Pew Center on Global Climate Change at http://www.pewclimate.org/projects/multi_gas.cfm

The Proceedings of the Fourth Annual Unconventional Gas and Coalbed Methane Conference held in Calgary October 23-25, 2002 are available on CD-Rom for $200.00 Canadian funds. To purchase the proceedings please contact Brenda Belland via phone: (403) 218-7712, fax: (403) 920-0054, or email: bbelland@ptac.org

Field Studies of Enhanced Methane Recovery and CO_2 Sequestration in Coal Seams by Scott Reeves of Advanced Resources International, Houston, Texas. The interim report is available at: http://www.worldoil.com/magazine/MAGAZINE_DETAIL.asp?ART_ID=1906&MONTH_YEAR=Dec-2002

Impacts of Alternative Water Management Practices on Coalbed Methane Development in the Powder River Basin, *Policy Facts,* DOE. The full report and further information can be obtained from the SCNG website at http://www.netl.doe.gov/scng. The report summary is at http://www.netl.doe.gov/publications/factsheets/policy/Policy017.pdf

Proceedings of the 2nd Annual Australian Coal Seam & Mine Methane Conference
The proceedings are available for purchase at http://www.ibcoz.com.au/csm03.

Address inquiries about the Coalbed Methane *Extra* or about the US EPA Coalbed Methane Outreach Program to:

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Notice:

Karl Schultz is Leaving the CMOP
Effective August 1, Karl Schultz, Team Leader of USEPA's Coalbed Methane Outreach Program, will be departing the Program after nine very active and productive years. He will be moving to London with his family. Unfortunately, CMOP just does not have the resources to maintain a London office. Many of you know Karl well, and it has been Karl's initiative and positive outlook that have driven the Program. He began work with CMOP at its inception in 1994, and the key elements including our international technical assistance programs and ventilation air methane work are the result of Karl's creative and forward-thinking mind. We will miss Karl, but wish him the best of luck in the UK.