POLICY facts

U.S. Department of Energy
Office of Fossil Energy
National Energy Technology Laboratory

Strategic Center for Natural Gas and Oil

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Coalbed Natural Gas

Once a nuisance and mine safety hazard, coalbed natural gas – commonly referred to as coalbed methane or "CBM" — has become a valuable part of our nation's energy portfolio. CBM production has increased during the last 15 years and now accounts for about 1/12th of the U.S. natural gas production. Natural gas demand is forecast to increase substantially over the next two decades[1] and CBM will become increasingly important for ensuring adequate and secure natural gas supplies for the U.S.

What is Coalbed Methane?

CBM is the gas found in coal deposits. It consists mostly of methane but may also contain trace amounts of carbon dioxide and/or nitrogen. Most coal beds are permeated with methane, and a cubic foot of coal can contain six or seven times the volume of natural gas that exists in a cubic foot of a conventional sandstone reservoir. Within coal seams, methane is present on the surface of the solid material. Hydrostatic pressure causes the methane to adhere to the coal surface via a phenomenon termed adsorption. Whenever reservoir pressure is reduced, the methane desorbs off of coal surfaces, diffuses through the matrix material, and then flows though the cleat system and into a well for delivery to the surface. CBM is the same as the natural gas in our transmission and distribution pipelines, and is used for space heating and power generation, as a feedstock for chemical production, and in manufacturing processes.

Coalbed methane is either biogenic or thermogenic in origin. Biogenic methane is generated from bacteria in organic matter and is typically a dry gas. It is generally found at depths of less than 1,000 ft from the earth's surface in low rank coals, that is, coals having a lower carbon content. Thermogenic methane forms when heat and pressure transform organic matter in coal into methane. This type of methane is typically a wet gas and frequently contains trace amounts of water vapor, carbon dioxide, nitrogen, and possibly hydrogen sulfide. It is generally found at greater depths, in higher rank coals.[2]

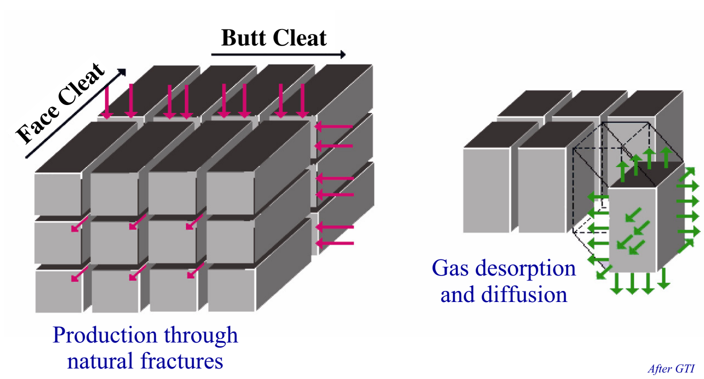

Figure 1. Natural Gas and Water Production from Coal

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Resources, Reserves, and Production

The contiguous United States is estimated to have coalbed methane resources [in-place] of 700 trillion cubic feet (Tcf), of which 100 Tcf may be economically recoverable.[3] The most prolific basins exist in the western United States, but eastern areas of the nation also have notable reserves of CBM. Other areas that have significant CBM potential include Alaska, the Illinois Basin, and Canada. Alaska contains nearly half of U.S. coal reserves and an associated CBM resource of nearly 1,000 Tcf.[4] Northern Alaska's Colville Basin and the Alaskan Peninsula's Chignik and Yukon Basins are areas of interest. The Illinois Basin has not historically produced coalbed methane, but its geological characteristics are favorable for production. In Canada, CBM development has recently begun in Southeast and Central Alberta, Northeast and Southeast British Columbia and on Vancouver Island. It is estimated that nationwide, Canada may hold up to 460 Tcf of coalbed methane.[5]

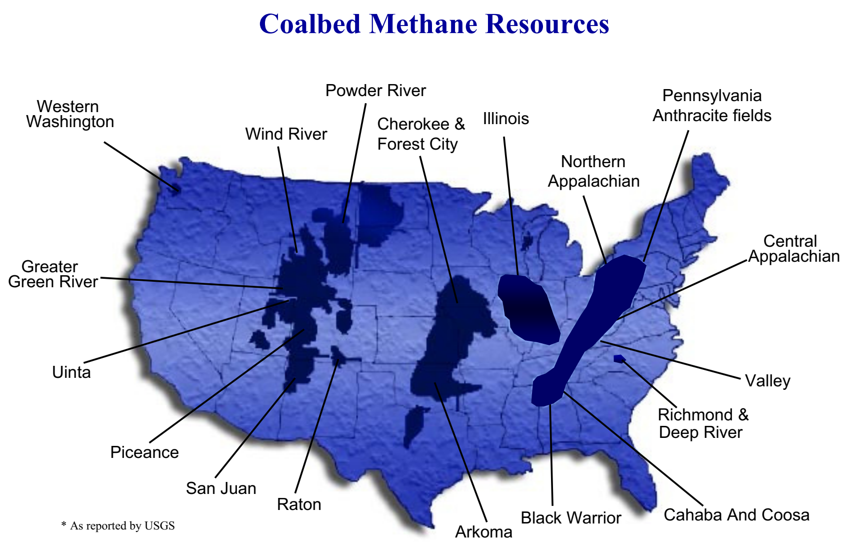

Figure 2. U.S. Coalbed Methane Resources

In the U.S., proved reserves and CBM production have grown nearly every year since 1989. See Figures 3 and 4. In 2003, CBM accounted for 18.7 Tcf or 10% of proved dry gas reserves with 1.6 Tcf being produced or >8% of dry gas production.[6] The most prolific producing areas are in Colorado, New Mexico, and Wyoming. Together, CBM produced in these 3 states totaled nearly 1.3 Tcf during 2003, which represents 80% of total CBM production. Other notable basins include the Central Appalachian and Warrior in the eastern U.S., and the Unita and Raton Basins in the Rocky Mountain region. The majority of future CBM production is expected from western basins.

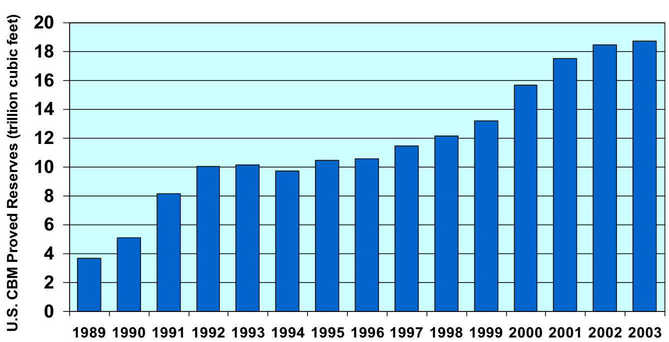

Figure 3. U.S. Coalbed Methane Proved Reserves, 1989 - 2003 (Source: EIA)

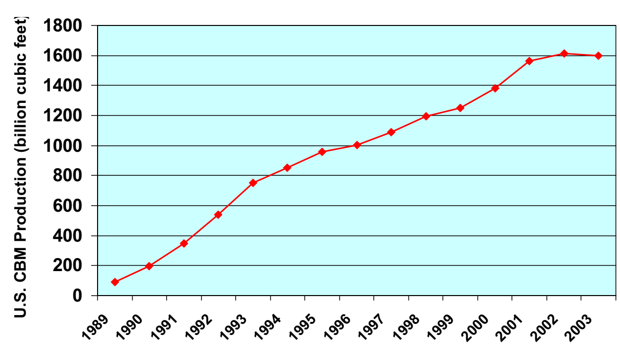

Figure 4. U.S. Coalbed Methane Production, 1989 – 2003 (Source: EIA)

Coalbed methane can be recovered from underground mines before, during, or after mining operations. Significant volumes of coalbed methane is also extracted from "unminable" coal seams, which are relatively deep or thin, of poor or inconsistent quality, or represent difficult mining conditions. Ninety percent of the country's coal resource is unminable but represents a vast potential source of natural gas.

Vertical and horizontal wells, including multi-laterals are used to develop CBM resources. For the most part, the *quality* of a seam's cleat system (high conductivity flow paths), will dictate the type of completion and stimulation employed. In high permeability settings no flow enhancement may be required. In other situations, hydraulic fracturing and cavitation stimulations are used. Hydraulic fracturing is a process in which fluids, primarily water, are pumped at high pressure creating a crack though with natural gas can easily flow into a well. The "cavitation method" involves enlarging the original well bore and linking the well bore with the natural fracture system or cleats within one or more coal seams. In all cases, water must be initially pumped out of the coals (dewatering) in order to reduce the reservoir pressure and allow the methane to desorb.

Using a different production process, coalbed methane can be recovered after removing coal from an underground mine. After mining, the resulting void needs supports to hold up the strata above it. When these supports are removed, the roof and walls collapse and the former mine fills with debris. (Also occurs when coal is longwall mined.) This debris is referred to as the "gob." Methane existing within the debris is referred to as "gob gas" and is released into the mine as it collapses. Gob gas is initially of high-quality; however, over time its quality declines as the methane mixes with air. It usually contains 30% to 80% methane.[7] Lower quality gas cannot be injected into pipelines so gob gas is well suited for applications that allow for variation in methane content, including power production and heating.

Resource Development Issues

Although development of CBM resources has been quite successful, the industry continues to face many issues. These issues are varied, some highly contentious, and include:

- Access to resources
- Permitting
- Extensive environmental planning
- Litigation
- Produced water management
- Natural gas markets and capital formation
- The need for advanced technologies

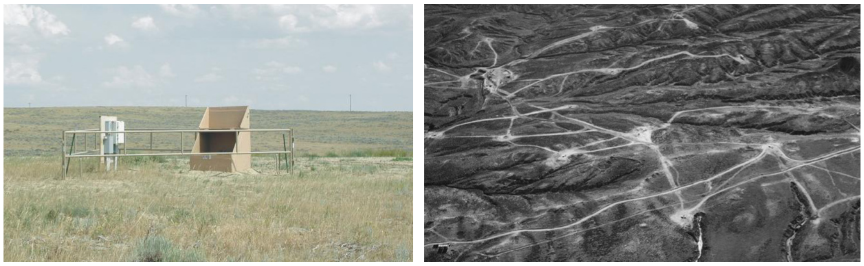

Figure 5. Incongruent "Perceptions" of CBM development.

Much of the CBM resource underlies federal or state lands (surface ownership and/or mineral estate), which are encumbered with multiple restrictions when it comes to energy development projects. These restrictions dictate the timing, locations, and levels of activity permitted, all of which may impact the profitability of operations. Further, comprehensive environmental analysis of impacts is required by the National Energy Policy Act for all activities involving federal property. Two or more years and more than a million dollars may be required to complete such an analysis. In split estate situations involving private lands, residents may be unaware that those with subsurface rights must be given access to the resources. Landowners have been forced to allow mineral owners to drill on land meant for farming, ranching, and hunting. Conflicts involving access and land use have heightened and have given rise to widespread adoption of surface use agreements.

Because of the large amount of water produced during dewatering operations, produced water management is one of the most significant issue facing CBM development. Some wells may initially produce several hundred barrels of water per day. Topics of concern include the volumes of water that must be manage, water quality, disposal and treatment costs, and possible depletion of aquifers. In one CBM play, about 1.5 million barrels of water per day must be managed from over 12,000 wells.[8] In addition to produced water, the stimulation of CBM wells – by hydraulic fracturing – has come under much scrutiny. EPA recently completed a study to assess impacts to public health, resulting from potential USDW contamination from hydraulic fracturing of CBM wells. Their study did not find evidence that any drinking water well had been contaminated as a result of the practice but hydraulic fracturing of coals remains a topic of much controversy.[9]

Release of methane into the atmosphere, either through natural seeps, ventilation during mining, or via other means has environmental consequences. Methane is a potent greenhouse gas, with 21 times the global warming potential of carbon dioxide.[10] In fact, coal mining accounts for approximately 10% of U.S. methane emissions.[11] Therefore, recovery of CBM mitigates a large source of methane emissions and allows for economic use of the energy source.

Related Links

Arthur Langhus Layne LLC
http://www.all-llc.com/CBM/index.htm

Bureau of Land Management, Reservoir Management Group
http://www.wy.blm.gov/minerals/og/res.mgt/resevmgt.html

Bureau of Land Management, San Juan Field Office
http://oil-gas.state.co.us/Library/sanjuanbasin/blm_sjb.htm

Illinois Basin Consortium
http://www.uky.edu/KGS/emsweb/cbm/cbm_illinoisbasin.htm

Montana Department of Environmental Quality
http://www.deq.state.mt.us/coalbedmethane/index.asp

National Energy Technology Laboratory/Carbon Sequestration
http://www.netl.doe.gov/coal/Carbon%20Sequestration/pubs/SequestrationRoadmap4-29-04.pdf

Northern Plains Resource Council
http://www.northernplains.org/

Powder River Basin Resource Council
http://www.powderriverbasin.org/cbm/index.htm

Tricora
http://www.gti-ticora.com/CBMAlerts.html

U.S. Environmental Protection Agency
http://www.epa.gov/region08/water/wastewater/npdeshome/cbm/cbm.html
(produced water management)
http://www.epa.gov/safewater/uic/cbmstudy.html
(hydraulic fracturing of coal seams)
http://www.epa.gov/coalbed/
(coalbed methane outreach program)

U.S. Geological Survey-CBM Home
http://energy.cr.usgs.gov/oilgas/cbmethane/products.htm

Wyoming CBM Clearinghouse
http://www.cbmclearinghouse.info/

Department of Energy Role

The Department of Energy is a longtime supporter of CBM research and development. The DOE has been instrumental in providing the fundamental knowledge base to industry. This foundation includes: assessing the resource, identifying geologic areas of favorable production, establishing efficient recovery schemes, demonstrating advanced drilling and completion technologies, and supporting capture and use of diluted natural gas streams.

Currently, the Department, though the National Energy Technology Laboratory is supporting a research effort in the Illinois Basin as well as a portfolio of R&D projects targeting the water management issues associated with CBM development. Fossil Energy is also active in CBM-related regulatory, policy, and marketing issues. The Department coordinates with multiple federal and state agencies, and undertakes efforts collaboratively with these entities.

CBM-related research at DOE also focuses on the potential for enhanced gas recovery and carbon sequestration as an integrated operation. The idea is to sequester CO_2 in unmineable coal beds, which have an enormous capacity for CO_2 storage. The CO_2 would be injected via wells drilled into the coal, and pressure from the CO_2 would displace the methane out of the coal. CO_2 storage is feasible because coal preferentially adsorbs CO_2 at twice the volume that it stores methane. The net result would be less CO_2 in the atmosphere and additional recovery of sorely needed natural gas. Although technical and economic hurdles still exist, continued, successful research can provide a new solution to our energy and environmental concerns.[12]

Additional information concerning CBM development is available on NETL's website and from the sources listed under related links.

Endnotes:

1. Energy Information Administration, Annual Energy Outlook 2005.
2. AG Edwards, *Coal Bed Methane Energy Conference Summary*, March 14, 2001.
3. United States Geological Survey-CBM Home
   http://energy.cr.usgs.gov/oilgas/cbmethane/products.htm
4. Flores, R.M., Stricker, G.D., and S.A. Kinney (2003). Alaska Coal Resources and Coalbed Methane Potential, United States Geological Survey Bulletin 2198, version 1.0 (February).
5. Alberta Chamber of Resources.
   http://www.acr-alberta.com/Featured/Black_Gold.htm
6. Energy Information Administration. U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves 2003 Annual Report, DOE/EIA-0216(2003), November 2004.
7. U.S. Environmental Protection Agency. *What is Coal Mine Methane?* March 1998.
8. Wyoming Oil and Gas Conservation Commission, January 2005.
   http://wogcc.state.wy.us/
9. U.S. Environmental Protection Agency. *Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Natural Gas Reservoirs* (draft), August 2002. EPA 816-D-02-006.
10. U.S. Environmental Protection Agency. Coalbed Methane Outreach Program – About CMOP.
    www.epa.gov/coalbed/index.html
11. U.S. Environmental Protection Agency. *Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2000*, April 2002.
12. U.S. Department of Energy, National Energy Technology Laboratory. "Coalbed Methane Gas From Miner's Curse to Valuable Resource." In *FETC Focus*. Sept. 1998.
    http://www.netl.doe.gov/publications/FETC_Focus/sept98/20-25.pdf