Coal Bed Methane

Considerations for Developing a Montana Resource

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Montana is at a critical juncture in its economic and energy history. The state's economy has languished for several years, particularly when compared with the recent economic growth experienced in other areas of the nation. Our slowed economy has been further compromised by an increasingly volatile energy sector. The ramifications of deregulation, tightening supplies, and increasing demand are being felt throughout the Northwest, and the future is even more uncertain as Montana moves toward full deregulation.

Amid the uncertainty, several things are clear. First, power that is generated in Montana is now "on the market," and Montana industries and consumers will no longer enjoy relatively cheap energy. Second, Montana has a significant reserve of a potentially important energy source: coal bed methane. Third, given the soaring costs of methane, or natural gas, this resource is attractive for development. Fourth, the state has choices about how to develop this resource, and the decisions have important implications for the Montana economy and environment in the short and long term.

Figure 1
Montana Coal Occurrences

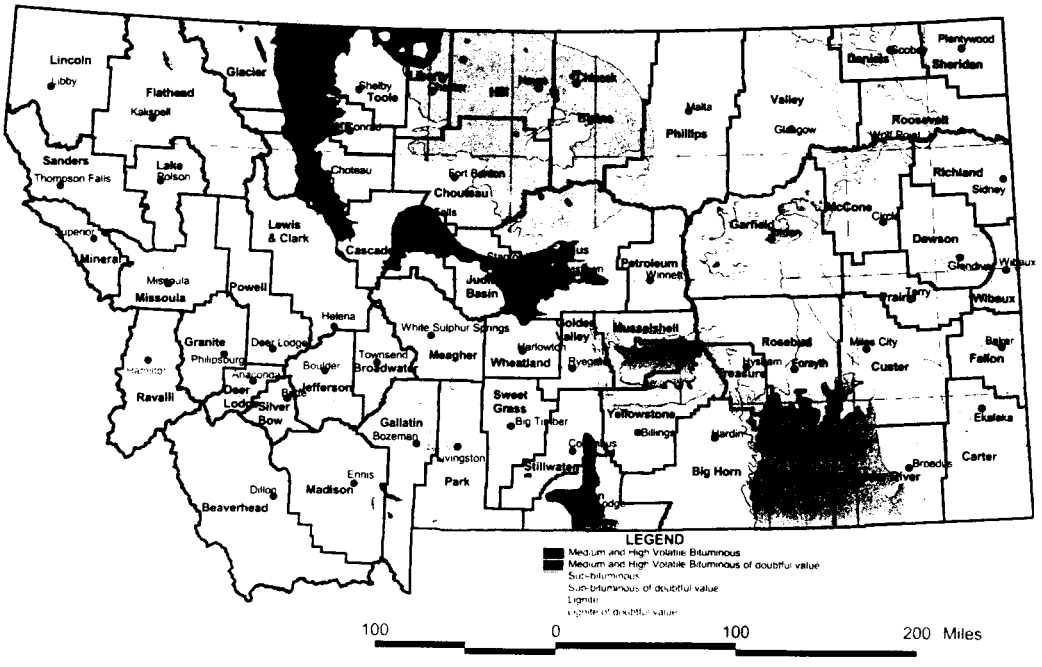
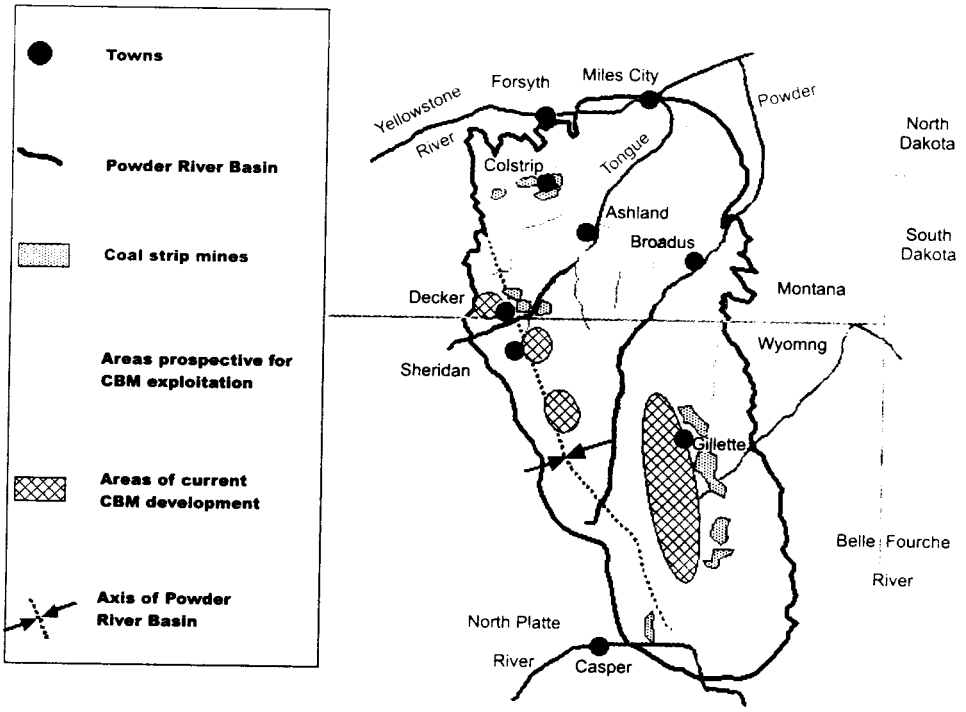


Figure 2
Coal Reserves in the Powder River Basin



In this article, we will discuss the opportunity coal bed methane offers as a source of both energy and economic growth if Montana elects an appropriate and long-term approach to its development.

Coal Bed Methane

Natural gas consumption, which accounted for 23 percent of domestic energy use in 1999, is expected to grow more rapidly than any other major fuel source from 1999 to 2020.[1] In the past 20 years, gas consumption has varied, from a low of 16.2 trillion cubic feet (tcf) in 1986 to a high of 22.1 TCF in 1972. However, due to industry restructuring and increasing demand for gas-fired electricity generation, natural gas is increasingly in demand.

For example, the National Petroleum Council's 1999 study, "Meeting the Challenges of the Nation's Growing Natural Gas Demand," estimated that demand for gas could increase 32 percent between 1998 and 2010.[2] And as demand increases, so will pressure on the supply of natural gas. In fact, the ramifications of this are already evident, and resulting price increases have caught even industry analysts by surprise.[3] The 1999 benchmark study expected the weighted U.S. wellhead price of natural gas to remain below $3 per thousand cubic feet (mcf) through 2010. Instead, the average wellhead price exceeded the $3 in April 2000, and has stayed up ever since, with spot market prices in excess of $7.[4] The price volatility will likely continue. At these prices, natural gas is an increasingly attractive energy resource, and U.S. production is increasing.

Methane is a form of natural gas that is found in coal seams. Coal bed methane (CBM) production involves extracting gas from coal seams by drilling wells and pumping out ground water, thereby decreasing the pressure and allowing the methane gas to escape. The quantity and quality of CBM varies greatly between coal deposits, but estimates suggest that technically recoverable resources of coal bed gas in the lower 48 states range from 13 to 130 tcf.[5] It is also likely that these estimates will increase as technology evolves to make more coal bed gas recoverable.

Coal bed methane extraction is a relatively new process, and was not a significant proportion of the natural gas industry as recently as ten years ago. But as natural gas

demand and prices have surged, so has interest in CBM. Gas production from coal bed methane totaled 1.2 tcf in 1999, comprising 5.9 percent of U.S. natural gas consumption; by 2003, it is projected that CBM production will approach 1.8 tcf, an increase of 9 percent.[7] Analysts estimate that coal bed methane wells could eventually comprise 12 percent of the nation's natural gas supply.[8] By any estimating parameters, coal bed methane could clearly play an important role in meeting energy needs in the near future.

Montana has the largest coal reserves in the nation. At present, most attention has been focused on the Powder River Basin, an area of 5,000 square miles that is estimated to contain 1.3 trillion short tons of coal, the largest coal deposit in the country. Most of the Powder River Basin coal is located in Wyoming — Montana's share of the reserves is about 5 to 10 percent.[9] Estimates of methane reserves in the Powder River Basin vary widely, from 20 trillion cubic feet (tcf) to 60 tcf.[9] However, only a portion of methane reserves are actually recoverable — that is, technically and economically feasible for development. A conservative estimate of recoverable methane in the Powder River Basin is 1 trillion cubic feet.[10] It is likely that more reserves may become recoverable as the technology advances and the economics of the gas industry make development even more attractive. While much of the current attention is focused on the Powder River Basin, Montana has other coal reserves that are also starting to be examined. The Montana Board of Oil and Gas Conservation plans to authorize up to 200 exploratory wells in Carbon, Stillwater, Park, and Gallatin counties as well as in the Powder River Basin.[11]

It is hard to know precisely what the economic potential of developing coal bed methane in the Powder River Basin will be for the state of Montana, but there are obvious short-term benefits in terms of royalty payments and severance taxes. One rough estimate, developed by CMS Energy and presented to the Coal Bed Coordination Group, predicted a total production tax value of $441.8 million over 20 years.[12] Compare this with another industry estimate of production taxes to Montana totaling $982 million over a projected 22-year life of CBM development in the Powder River Basin.[13] Clearly there are huge discrepancies in estimates of potential benefits, as these estimates are necessarily based on assumptions about well productivity, product demand, selling price, and other variables. Unfortunately, these estimates, no matter how tenuous, often are offered as facts in the larger public debate over resource development.

While the economic potential of coal bed methane in Montana is significant, there are a number of concerns that accompany development of this resource. These include impacts on water quality and availability, disposal of discharged groundwater, infrastructure development, noise pollution, and long-term impacts on agricultural and ranching economies.

While the economic potential of coal bed methane in Montana is significant, there are a number of concerns that accompany development of this resource. These include impacts on water quality and availability, disposal of discharged groundwater, infrastructure development, noise pollution, and long-term impacts on agricultural and ranching economies. There is little data available about many of these impacts, and no reasonable attempt has been made yet to estimate potential costs. For example, a recent industry-sponsored study of coal bed methane development in the Powder River Basin identified no costs over the life of the project, but estimated a $4 billion benefit.[14] It is hoped that these costs will be addressed in a more reasonable fashion in the forthcoming Environmental Impact Statement (EIS) (see page 15).

The benefits and some of the costs of CBM production are becoming evident in Wyoming, which has moved ahead of Montana in developing coal bed methane in the Powder River Basin. The experience in Wyoming offers some insights into CBM production.

The Wyoming Experience

Wyoming has been actively developing the Powder River Basin in recent years. According to the Wyoming Oil and Gas Conservation Commission, CBM production in the Powder River Basin totaled 58 million cubic feet of gas in 1999, a twelvefold increase over production just four years earlier.[15] And forecasts are that production will increase to 145 mcf in calendar year 2000.[16]

Coal bed methane development is having immediate economic benefits for Wyoming, but it is difficult to precisely quantify the magnitude of the impact. Table 1 shows the mineral severance taxes Wyoming receives from natural gas and all sources, including projections through 2002. Clearly, natural gas is becoming a more important component of Wyoming's revenue stream.

Wyoming does not separate coal bed methane from other sources of natural gas when estimating severance taxes. However, coal bed methane represents only a portion of total natural gas production. Table 2 uses forecast projections for estimated price and production levels of CBM in Wyoming to develop a very rough estimate of potential severance taxes from CBM. Using this method of

Table 1
Wyoming Mineral Severance Taxes

FY	Natural Gas	Total Severance	Natural Gas as a % of Total
1990	$50,223,894	$251,377,942	20
1995	$43,372,402	$184,256,060	24
2000	$120,540,4121	$275,143,604	44
2001*	$218,000,000	$388,800,000	56
2002*	$177,600,000	$329,300,000	54

* Projected.
Source: January 2001 Wyoming Consensus Revenue Estimating Group, Table 6 Mineral Severance Taxes.

Table 2
Estimate of Severance Tax from Coal Bed Methane

Calendar Year	CBM Price (1/2/01)	Production/ sold (mcf)	CBM Production as a % of Total	Estimated Severance (assume 6%)
2000	$3.00	145,000,000	10.0%	$26,100,000
2001	$4.00	175,000,000	11.3%	$42,000,000
2002	$2.50	225,000,000	14.1%	$33,750,000

Source: January 2001 Wyoming Consensus Revenue Estimating Group, Major Mineral Commodities — CREG Forecast Comparisons.

Table 3
Wyoming Coal Bed Methane Production
Powder River Basin

	1995	1999
Gas (mcf)	4,753,448	58,106,679
Water (bbls)	17,102,477	154,249,005

Source: January 2000 Wyoming Consensus Revenue Estimating Group, www.eadiv.state.wy.us/creg.

estimation, CBM accounted for 10 percent of the total natural gas production in 2000 and, assuming a 6 percent severance tax, it contributed $26 million to state funds.[17] In other words, CBM represented only about 9 percent of Wyoming's total severance taxes that year. While significant, this amount is considerably less than some of the numbers that have emerged as part of the public debate.[18]

Along with severance and royalty revenues, CBM also directly impacts local mineral rights holders. According to Wyoming Oil and Gas data, nearly 7,000 coal bed permits were issued between February 2000 and 2001 for state, federal, and fee lands, with the vast majority (72 percent) issued for fee land.[19] Landowners who also own the mineral rights to their property will receive royalty payments, estimated to approach $120,000 during the average life of a well.[20] Property owners who don't hold the mineral rights are generally limited to negotiating one-time payments for surface damages. In addition to the direct economic benefits

One can argue that there is not much emphasis on developing this resource with an eye toward maximizing long-term economic development opportunities. Instead, CBM is being developed and exported, and when the reserves are exhausted the boom will, once again, be over. This is a scenario that has repeatedly been played out in many western states when it comes to natural resource development.

to mineral rights holders, local communities and businesses experience increased demand for goods and services, as well as increased costs associated with the influx of labor.

Along with the direct and indirect economic benefits of CBM development, there are also some costs. In order to release the methane contained in coal seams, large quantities of ground water have to be pumped out and discharged, as illustrated in Table 3.

A single methane well may produce an average of 12 gallons of water per minute (discharge is higher initially and lower later). Over the course of an estimated lifetime of 10 years, this amounts to a significant quantity of ground water. The way this discharged water is managed has become a real concern.[21] While some states require specific mitigation practices of one sort or another (e.g. reinjection wells to return the water underground), there are no uniform requirements for handling the water in Wyoming, and it is generally allowed to run off.[22] The combination of dewatering and surface runoff can cause problems with flooding, erosion, and dry water wells. It also raises concerns about long-term sustainability for rural communities heavily dependent on ground water.

This is particularly true when the benefits and costs (direct or indirect) of development are not easily known — when, for example, the land owners are not the same people as the mineral rights owners. Wyoming, like Montana, has a mix of land and mineral ownership. It is often the case that surface rights are owned by one entity and mineral rights by another. Overall, approximately 50 percent of the land in Wyoming is federally owned, and the mineral rights are 70 percent federally held. The Bureau of Land Management, which issues the permits for CBM production of federal reserves, requires that the lessee operator provide a comprehensive water management plan as part of the application to drill, but standards are largely of a reporting nature. There is also a water well agreement that BLM requires of CBM operators on federal leases. The agreement addresses monitoring of any properly-permitted water well that fall within the Circle of Influence (defined as a 1/2 mile radius around a well). If wells in this radius become impaired, they can be mitigated (e.g. reconfigured, redrilled, or mitigated by other means). Recently the state has also insisted that similar agreements be offered to landowners affected by drilling on state lands, and is pressuring operators to do the same for drilling on fee lands. It is less clear what the implications will be if groundwater sources outside the Circle of Influence are affected, or if the landowner and operator fail to agree on causes and remedies for damages.

Water quality is also an issue. While the ground water in the Powder River Basin is considered potable, high salinity often makes it unsuitable for irrigation, and the discharged water may harm range grass.[23] Initially, the discharged water did not meet Wyoming's water quality standards, but the standards were lowered in 2000.[24] In sum, the long-term effects of CBM development on surface and ground water is uncertain.

Wyoming presently has about 7,000 methane wells, with some scenarios projecting that number may go as high as 40,000. Development is obviously generating increased revenues for the state and for others in the short term. At the same time, there are some concerns about the long-term impacts of the way CBM is being produced. Perhaps just as importantly, one can argue that there is not much emphasis on developing this resource with an eye toward maximizing long-term economic development opportunities. Instead, CBM is being developed and exported, and when the reserves are exhausted the boom will, once again, be over. This is a scenario that has repeatedly been played out in many western states when it comes to natural resource development. We believe there are alternative development options that Montana must consider if coal bed methane is to provide a long-term economic benefit.

Development Options for Montana

Large quantities of methane reside in the coal seams of eastern Montana. We can assume that profit drives industry and without favorable economic conditions, exploration and production of the resource will not occur. If the same favorable economic conditions that have given rise to massive development in Wyoming during the past three years continue for the next five to ten years, Montana is likely to experience a substantial influx of industry into the state.

We need to examine coal bed methane as an asset and leverage it to economically benefit Montana residents. We should pursue approaches that add value to the resource, develop local expertise and businesses, and take a long-term approach to the development of this valuable resource.

In the short term, Montana faces an energy dilemma. Many

of the state's largest employers are energy-intensive industries. Businesses that were able to secure long-term contracts for electricity some 18 months ago find themselves in good position for the time being. Energy-intensive businesses with contracts that have expired, or will expire shortly, are at the mercy of the market.

This is truly ironic, as Montana is an energy-rich state. Yet, we are at the mercy of supply-side energy markets, now competing with states with large population centers and stronger economic bases. Deregulation will create price parity in the long run. But this is not necessarily good news for Montana. In 1998, Montana ranked fourth out of 50 states for lowest average revenue per kilowatt hour.[25] The theory of price parity is that a business in Helena, for example, will pay relatively the same price for electricity as a similarly situated business in Reno, Nevada, or elsewhere. When one couples this situation with a small and widely-dispersed market, Montanans may well find themselves paying a price "above parity" in the long run.

As a state, how can we address our energy needs? Montana has proven reserves of coal bed methane of 1 tcf (trillion cubic feet), and much of Montana's coal reserves have yet to be examined for methane content. The coal reserves of Montana are of great interest to industry as long as prices stay high. With elevated prices, industry will seek to rapidly produce and export this valuable Montana resource in an attempt to meet demand for consumers elsewhere in the nation. The federal and state governments, along with mineral holders, will enjoy a substantial windfall in the short term.

But the expected life of a coal bed methane well is 10 to15 years. According to one industry-generated estimate, if development started now and the projected 9,550 wells were developed, the production rate forecast for all lands in the Powder River Basin of Montana would peak by 2008 and decline thereafter.[26] This type of development does little for residents of Montana in the long run. And it will not directly ease the energy price crunch we are facing.

Instead of a traditional boom and bust approach, Montana has an opportunity to plan how to best develop coal and methane resources. The rush to immediate development in Montana has been slowed by a lawsuit the Northern Plains Resource Council filed against the Montana Board of Oil and Gas Conservation. A subsequent agreement between MBOGC and Northern Plains resulted in a moratorium on new CBM permits until an Environmental Impact Statement is completed in spring 2002. In the meantime, the existing 264 permitted coal bed methane wells continue to operate, and there are many more drilling applications expected. It should be noted that the EIS is not expected to consider various development options as discussed below; instead, it will focus on more conventional approaches of extracting this resource, and emphasize short-term costs and benefits. If Montana wants to develop strategies for the long-term development of CBM and our economy, we need to take the initiative ourselves.

Methane Combined Cycle

One piece of the Montana energy puzzle could involve building natural gas (methane) combined-cycle power plants to address short-term energy needs. This type of generation has many benefits:

1) Combined-cycle units operate at about 52 percent efficiency while new coal-steam units operate at 35 percent efficiency.

2) The cost of construction for combined-cycle units is about 41 percent of coal-steam units at roughly $300,000 per megawatt.[27]

3) Combined-cycle plants do not require the economies of scale of other designs and can be appropriately "sized" to meet the needs of a specific region or area.

4) A combined-cycle unit can be brought online in less than 18 months.[28]

5) Combined-cycle units are environmentally friendly, producing lower levels of carbon dioxide emissions as compared to coal-steam units.

If these units were built through a public/private partnership, the benefits could be directly captured by Montana residents in the form of reduced energy costs. Montana has long been a net exporter of energy. Instead of exporting all our energy out-of-state, only to be faced with buying it back at market prices, it should be a priority to develop Montana natural resources in ways that benefit residents first, and regional markets second.

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Microturbines

Value is added to methane through its conversion into electrical energy via steam, turbine, or fuel cells. The most promising of the traditional electricity generating devices is the microturbine. Microturbines are relatively inexpensive to operate, costing as little as one-third of the running costs of a comparable diesel generator. Microturbines operate by burning fuel such as methane or propane and are utilized as grid-connected or stand-alone units. The operating efficiency of microturbines is about 32 percent and each unit is capable of producing from 25kw to 500kw of electricity.[29] In addition, microturbines emit very low levels of

pollutants and have been documented as operating for up to 15,000 hours without maintenance.[30]

The earliest role for microturbines was as backup to primary systems where a constant and reliable source of electricity was necessary to support critical or continuous operations. Due to current national energy shortfalls and the consequent rise of "distributed generation," microturbines are now being viewed as primary energy systems. Energy analysts predict that distributed generation technologies will be a $30 billion market by 2010. The average cost of microturbines is approximately $1,000 per kilowatt.

Many of Montana's power consumers are relatively small. That creates an ideal setting for microturbines. Microturbines can be structured as an array and create enough electricity to power a fast-food restaurant, a hotel, a small office building or medical building. And the inexhaustible source of fuel to power this array of microturbines is a mere 300 feet below the surface of vast regions of Montana.

Fuel Cells

Perhaps the most exciting piece of the long-term energy and economic development puzzle in Montana could involve fuel cells. The most promising emerging technology that utilizes methane as a fuel source is the Solid Oxide Fuel Cell (SOFC). SOFCs do not "burn" fuel to generate electricity, but rather do so by electrochemical reaction. Though SOFC technology is fairly recent, many industry professionals believe that SOFCs will play a major role in our energy future, and regional energy companies (e.g. Montana Dakota Utilities) are extremely interested in its development.

There are three technical reasons why this technology is so promising:

1) The reforming of the fuel stock to create a hydrogen rich stream does not require elaborate preprocessing or large pieces of equipment as does other fuel cell technologies.

2) The SOFC design is much more tolerant of other chemical compounds in the fuel stream. For example, a SOFC would have no difficulty performing with a stream that is 95 percent methane, whereas this fuel stream would cause other fuel cell technologies to fail.[31]

3) Great strides have been made in material science. Proof of concept was accomplished with exotic alloys and complex ceramic compounds. Research has progressed to the point where very little efficiency or electrical capacity has been sacrificed, while more common (i.e. less expensive) materials are being utilized.

Along with the technological advances, there are important geographic and economic reasons why fuel cells are so attractive for Montana's energy future. Montana has coal and gas reserves over much of the state east of the Continental Divide. Fuel cells can potentially run directly off these methane sources, and provide energy in a variety of ways. At a minimum, cells could supply the power to operate all of the wells in a coal bed methane pod. The resource can also be extracted and used to benefit local residents and industries via fuel cells. For example, cells could be used to supply electricity to a broad base of our rural population with minimal environmental impact. Distributed fuel cells would not require the huge infrastructure (pipelines and roads) that conventional coal bed methane development does. Ultimately, fuel cells could be used to produce electricity to feed into a grid system. This would extend the life of the coal bed methane resource beyond the typical 15-year time horizon by an additional 15-20 years and moderate the impacts of water discharge. Potentially, fuel cells offer Montanans an opportunity to become more energy independent. In addition, the state has the chance to be at the cutting edge of using and refining a critical new technology. Fuel cells have attracted attention (and investment) from a number of entities. There are other regions in the world (notably China) where coal, methane, and fuel cells are also attracting notice. We can develop expertise and businesses to support this form of energy generation that will really contribute to long-term economic development.

Conclusion

We believe Montana has choices about how to develop coal bed methane. It is a valuable resource and one that is clearly in demand. We encourage Montanans to develop this resource in an environmentally responsible manner, with the highest regard to community drinking water supplies and the well being of the state's farming and ranching industry. Montanans should take a strategic view of the resource and leverage it to provide a clean and inexpensive source of electrical energy for all of its residents and businesses. Coal bed methane has the potential to benefit Montana beyond the calculated 15-year lifespan of a well. Rather than view coal bed methane as an extractive resource, employing a handful of people for a short time, our resource base can provide long-term economic development by attracting clean industry, providing inexpensive energy to our rural population, and stabilizing energy prices in our cities. The application of clean, efficient, and reliable electricity generation technologies will add value to the resource and offer Montanans the energy independence needed to compete in tomorrow's marketplace.❑

References

[1] Annual Energy Outlook 2001, "Issues in Focus," p. 8. DOE EIA-0383.

[2] National Petroleum Council, "Natural Gas: Meeting the Challenges of the Nation's Growing Natural Gas Demand," Vol. 1 Summary Report, (Dec. 1999), p. 33.

[3] U.S. Dept. of Energy, Office of Natural Gas and Petroleum Technology, "Outlook for Natural Gas: Is a Train Wreck Pending?" Dec. 2000. Strategic Initiatives Workshop.

[4] ibid. p. 4.

[5] Colorado School of Mines, "Potential Supply of Natural Gas in the United States," Report of the Potential Gas Committee, Dec. 31, 1998.

[6] Morgan Stanley Dean Witter, April 10, 2000, p. 5.

[7] Montana DEQ Issue Paper, "Coal Bed Methane Production in Montana," January 2001, www.deq.state/mt.us.coalbedmethane.

[8] ibid.

[9] *Billings Gazette*, "Chasing Wealth," 2/20/01.

[10] John Wheaton, Montana Bureau of Mines and Geology. Published estimates of recoverable methane in the PRB range from a mean of 1.11 trillion cubic feet (USGS Executive Summary of the 1995 National Assessment of the U.S. Oil and Gas) to 10 tcf (*Wall Street Journal*, "It Was Dry; Now It's Wet," 12/27/99).

[11] DEQ Issue Paper, op. cit.

[12] David Heinz, CMS Energy, presentation to Coal Bed Methane Coordination group, Oct. 18, 2000.

[13] *Coalbed Methane Development: Economic and Social Impacts of Proposed Development*, June 1, 2001. This is an industry sponsored report prepared by Anderson ZurMuehlen & Co.

[14] ibid, p. 20.

[15] Wyoming Oil and Gas Conservation Commission, Production data 1995 and 1999, www.wogcc.state.wy.us.

[16] Wyoming Consensus Revenue Estimating Group, Jan. 2000, www.eadiv.state.wy.us/creg.

[17] The 6 percent assumption is a simplfying one as Wyoming has an incentive severance tax of 2 percent that will increase to 6 percent.

[18] See, for example, *Billings Gazette* article, 2/20/01, "Chasing Wealth", where Wyoming's deficit of $180 million has now become a projected surplus of more than $700 million. Clearly, CBM cannot have been the major contributor to a shift of this magnitude.

[19] Wyoming Oil and Gas, coal bed data, 2/13/01.

[20] *Wall Street Journal*, op cit. 12/27/99.

[21] *High Country News*, "Backyard Boom," 9/25/2000; and Powder River Basin Resource Council, www.powderriverbasin.org.

[22] Water disposal methods vary according to geology and economics. For example, in some areas shallow reinjection would contaminate groundwater, while in others it may be a viable solution.

[23] *Billings Gazette*, "Threat or Blessing?" 2/19/01.

[24] According to one source, the water is highly unsuitable for lawn watering and irrigation. Powder River Basin Resource Council, Feb. 2001.

[25] Energy Information Administration The Changing Structure of the Electric Power Industry 2000: An Update, www.eia.doe.gov.

[26] CMS Energy, op. cit.

[27] Energy Information Administration, "Annual Energy Outlook 2001", www.eia.doe.gov.

[28] "Panda to Construct $350 Million Power Plant in Tallmadge Michigan", 6/2000, www.pandaenergy.com.

[29] "Ingersoll-Rand to Deliver Commercial PowerWorks Microturbine Systems by mid 2001", www.ingersoll-rand.com/newsroom/releases/100400.html.

[30] "PanCanadian's Capstone MicroTurbine MultiPac Surpasses 6,000 Hours of Non-Stop Operation; Using Flare Gas as Fuel, Six Microturbines Providing Prime Power at Remote Oilfield", *Canadian Corporate Newswire*, 12/5/00.

[31] Global Thermal Electric Gas Analysis/Montana Bureau of Mines and Geology, 2000.

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