Coal Bed Methane: the Past, Present and Future of Alberta’s Most Abundant Non-traditional Source of Natural Gas
**Introduction**

Coal bed methane (CBM) is a type of natural gas that is trapped in coal seams. Its extraction and development has a twenty-five year history of increasing prominence and use in the United States and other countries such as India. Although it has not been widely commercially produced in Canada as of yet, coal bed methane is an abundant resource in several regions of the country including Alberta. As technology progresses and the commodity prices for natural gas make more CBM projects economically viable, Canada is beginning to develop this resource, using government incentive programs, groundbreaking institutional research and private investment by corporations.

In this paper I will examine the nature and distribution of CBM reserves in Canada and the United States. Following a brief analysis of the history of commercial production of CBM in the United States I will compare the US industry to the current Canadian CBM industry, focusing mainly of the Alberta portion of the industry. I will include the number of projects undertaken, along with their locations and number of companies involved. Drawing on government policy and current industry innovations I will attempt to provide an overarching summary of the industry.

Next I will provide an overview of important issues surrounding the CBM industry and its development. This will include environmental issues such as water disposal and clean energy, legal issues such as ownership rights to CBM and also regulatory issues such as government royalty regimes.

Finally I shall examine the future of the coal bed methane industry in Canada. I will draw conclusions as to the effectiveness of government regulations and incentive programs in achieving the results that our federal and provincial governments desire in each of these areas, and I will suggest improvements and possible policy changes where the current reality and desired results are not congruent.
Part 1: The Resource

Coal bed methane is a gas, methane, that naturally occurs in coal seams. It is formed during the conversion of organic material to coal and becomes trapped in cleats in the coal seam. The coal bed methane is trapped in the coal seam in part by water pressure and in part by weak covalent bonding forces known as Van de Waals forces.

CBM is extracted by drilling. A CBM well begins as a water-producing well; the removal of the water pressure from the seam changes the hydrostatic pressure exerted on the methane molecules and allows them to rise naturally to the surface where they are collected. In some cases, hydraulic fracturing of the coal seam is carried out in order to expedite the process of CBM liberation.

For a CBM project to be economically viable there must be large amounts of recoverable gas trapped in the coal seam. This typically requires coal seams that are a minimum of 20 feet thick. Other contributing factors to the viability of the project are the rank and maturation of the coal.
Coal Mine Methane

There is a distinction between Coal Mine Methane (CMM) and Coal Bed Methane (CBM); this distinction becomes important in the classification of projects according to government definitions of resources. Coal mine methane is gas trapped in mines that are expected to be mined, while coal bed methane occurs in coal seams that are not economical to mine. CMM can be thought of as a sub-category of CMB that is generally shallow. Some government jurisdictions recognize coal mine methane projects as being more environmentally friendly than coal bed methane projects, because coal mine methane gases will inevitably be leaked into the atmosphere when the coal seam in which they are trapped is mined, if they are not first recovered.

The Global Warming Potential of methane, also a greenhouse gas, is 21 times that of carbon dioxide, the most common greenhouse gas. By capturing and burning CMM instead of letting it escape into the atmosphere corporations can obtain emissions credits. The same emissions credits are not given to companies who extract deep CBM, because its extraction is not seen as a ‘reduction’ in greenhouse gases. Without human intervention to remove the CBM, it would not ever reach the atmosphere and thus would not contribute to global climate change⁴.
**Renewable Resource?**

Scientists have long known that coal bed methane can be produced biogenically, meaning by bacteria that exist in the coal seams. However, recent findings prove that significant populations of anaerobic microorganisms exist in certain coal formations, such as the Powder River basin in Wyoming, and that the rate at which they produce methane can be manipulated by temperature, pressure, presence of oxygen and other environmental factors. This could have a significant impact on the sustainability and lifespan of the CBM industry, extending it up to three times what geologists had originally predicted.
Part 2: Coal Bed Methane in the United States

The United States currently produces approximately 1.6 trillion cubic feet (tcf) of coal bed methane per year, a figure that represents 6 percent of annual nationwide production. The United States Department of Mines estimates that 300 tcf of CBM exists as reserves in the United States, of which 150 tcf is commercially viable under present economic conditions. There are several areas of intensive CBM production in the United States, the most prominent of which are the Powder River, San Juan and Black Warrior basins.

Powder River, Wyoming
The Powder River coal bed methane projects are estimated to contain 61% of Wyoming’s coal bed methane resources. Coal bed methane reserves in the state of Wyoming are estimated at 16.74 tcf, which alone is over 3 tcf more than traditional dry natural gas estimates for the state of 13.65 tcf. Production of coal bed methane in Wyoming was about 6.75 billion cubic feet (bcf) per month in 2000, coming from 1412 producing wells and 907 that were shut in because of lack of access to pipeline facilities. In 1999, 64 bcf of coal bed methane was produced from Powder River, making it the largest coal play in the United States for that year.

San Juan Basin, New Mexico
The San Juan basin is located in Northwestern New Mexico and Southwestern Colorado. With a span of over 100 miles from north to south and over 90 miles east to west, the basin’s size makes it one of the most impressive locations of CBM in the United States. Although over ninety percent of the basin’s coal is comprised of inferior quality lignite or sub-bituminous coal, characteristics which tend to be associated with inferior coal bed methane product, the thickness of the coal deposits is what makes this basin so attractive economically. The 7,500 square mile area has been the location of some of the most intense coal bed methane development in the past two decades.
Black Warrior Basin, Alabama

The Black Warrior Basin is referred to as the ‘San Juan Basin of the East’. Considered by most geological experts to be the home of the modern era of CBM production, the Black Warrior Basin was the site of the United States’ first recognized coal degasification site, the Oak Grove degasification field, in 1980. The Warrior basin reserves of CBM are estimated to be between 10 and 20 tcf of economically recoverable gas. By the year 2000 Alabama was the 9th largest producer of natural gas in America, 25 percent of which was due to coal bed methane production. The cumulative production of CBM from this field is less than one tcf, fewer than five percent of the Alabama’s total CBM, which is an indication of the future potential of this basin.

The US Federal Tax Credit

The federal tax credit for unconventional gas development was enacted by Congress in 1980. Scheduled to provide a short term incentive for experimental development, the program lasted only until shortly after the beginning of the 1990s. This initiative was instrumental in the United States’ early development of coal bed methane, as it rendered many commercially unfeasible projects profitable. Without this important stimulus, it would have been highly unlikely for the United States’ CBM industry to be as developed or as successful as it is today.

The Coal Bed Methane Outreach Project

The Coal Bed Methane Outreach Project (CMOP) is an initiative of the US Environmental Protection Agency that helps to encourage the recovery of CMM on coal sites. CMOP has been in operation since 1994 and has prevented the release of 308 bcf of coal mine methane. CMOP provides education for potential industry users, partnership opportunities for countries around the world and symposiums for all levels of government regulators, researchers and engineers.
Part 3: Canadian Coal Bed Methane

Reserves
The Canadian Gas Potential Committee places estimates of CBM in Canada between 187 and 568 tcf. This could potentially be more than conventional gas reserves, which are estimated to be 233 tcf. The Alberta Energy and Utilities Board (EUB) places British Columbia’s probable economically recoverable reserves of CBM at 90 tcf, with Alberta being home to the largest share of the resource in Canada with an estimated 130 tcf.

Canadian Production
As of late December 2003 there were a total of 90 CBM projects being carried out in Canada by 34 different corporations. Alberta was host to the highest number of these projects at 56, and was followed by British Columbia at 29.

Alberta
The EUB reports established reserves of traditional natural gas in the province to be 43 tcf. At current development and consumption rates, the province will require non-traditional gas sources by as early as 2008. The same agency reports the in situ amount of coal bed methane resources in the province to be 410 tcf - 60 tcf in the Foothills and 350 tcf in the Plains region. The economically recoverable numbers of this resource are estimated to be much lower, between 0 and 150 tcf. In all sectors of the Alberta economy the demand for energy is rising, particularly in the electricity generation segment; this has the potential to lead to a situation in which provincial demand outstrips supply. This
situation, combined with an increased demand for more environmentally friendly coal development, an increased awareness of CBM potential and rising natural gas pricing, has created a compelling case for CBM production in the eyes of many oil and gas corporations and the government. These are among the primary reasons why there has recently been such a large increase in interest in CBM and CBM technology in Alberta.

There are three key areas of CBM production in Alberta: Horseshoe Canyon-Belly River, Mannville and Ardley. The most developed area is Horseshoe Canyon, the most central CBM formation. The reserve field extends from North of Red Deer to approximately one hundred kilometers south of Calgary. Horseshoe Canyon is the location of 300 of the 1000 currently drilled CBM wells in Alberta. The more Northerly Mannville field runs diagonally from Northwest of Edmonton through to Southeast of Red Deer, and is estimated to contain 60% more in situ CBM than the Horseshoe Canyon field. One obstacle to its development however is the enormous water-gas ratio of the coal seams; this is one reason for the fact that it contains less than 50 wells, a mere 5 percent of CBM drilling in Alberta.

At the end of 2003 the nearly 1000 CBM wells in Alberta represented a three fold increase over total wells drilled in 2002. It is still uncertain whether so-called ‘wet coal’ wells will ever be viable in the province, however for the moment attention seems focused on the exploitation of ‘dry coal’ wells. Horseshoe Canyon-Belly River, with an exponentially lower water-gas ratio than Mannville and Ardley, will clearly continue to be the most attractive coal play until a more effective and inexpensive method of developing wet coal deposits is discovered. Until this time, the Mannville formation’s water-gas ratio of nearly 7%, as well as the salinity of the water, will likely continue to be prohibitive to its development. The Alberta Research Council is currently undertaking an innovative project to test the injection of carbon dioxide into coal seams in order to release coal bed methane and act as a sink for this undesirable and harmful green house gas. The location of this project is Mannville. The process is called Enhanced Gas Recovery, and has been championed
by Burlington Resources in the San Juan Basin. This development could contribute to Alberta’s drive to reduce carbon dioxide emissions as well as develop more economically its sources of CBM.

Nova Scotia and Others
Nova Scotia, Saskatchewan and the Yukon each have one CBM project underway. The reserve base in these locations is comparatively small, and governments of the respective jurisdictions do not appear as motivated to encourage CBM development as are the governments of Alberta and British Columbia.

British Columbia
There are less than half as many CBM projects currently under way in British Columbia as in Alberta. The province’s reserves are clearly less voluminous than those of Alberta, however in some areas the government has been more progressive in addressing obstacles to CBM development. One particularly promising location for future development is the sparsely populated Northeast area of the province. There is little community opposition here, one reason why it has become home to the majority of BC’s CBM pilots. Elk Valley in the Southeast corner of the province has also seen test wells drilled, as has the Comox area on Vancouver Island14.

There are many challenges to the development of the CBM industry in Canada, and particularly in Alberta.

Regulatory Environment
One prominent issue is the regulatory environment surrounding the resource. While in the United States it was a federal government tax credit program that created the impetus for widespread investment in CBM technologies in the 1980s, Canada currently has no such program in place. The government is not restricted to the use of a tax credit as a tool to stimulate investment in CBM. The government of British Columbia, for example, has been instrumental in jump-starting the CBM commercial development program with their royalty incentive programs.

Recent amendments to the BC Petroleum and Natural Gas Royalty Freehold Production Tax Regulation include the following features:

1. Including the costs of water management in producers’ cost of service allowances for CBM wells. This is crucial because of the high volume of waste water produced from CBM wells and the relatively high cost associated with its proper disposal.
2. Raising the threshold volume of gas produced from a well from 5,000 mcf/day to 17,000 mcf/day before the well becomes subject to royalties. This feature is important because it provides incentive for corporations to invest in CBM technology even where there is a risk that it will not be immediately profitable.
3. Raising the royalty credit to $50,000 on CBM wells.

The government of British Columbia is also acting in other strategic ways in order to stimulate investment in and production of CBM. Another initiative is through the expansion of the term ‘special scheme’ in the Petroleum and Natural Gas Act to include
Coal Bed Methane projects. Natural Gas projects approved by the BC Oil and Gas Commission as ‘special schemes’ are not subject to regular well placement regulations and are thus free to space their wells without restriction in a pattern that will result in optimal production. ‘Special schemes’ also allow for the extension of the time period in which well production data can remain confidential. With the inclusion of CBM projects in this definition, they become much more attractive\textsuperscript{15}.

The regulatory environment in Alberta has not been as progressive in legislating special exemptions for the CBM industry. In 2003 the Alberta Government formed the coal bed methane Multi-Stakeholder Advisory Committee (MAC), which will provide feedback to the government on a variety of community and industry concerns in early 2005\textsuperscript{16}. Only after this date will the government begin the process of moving forward with legislation or new policies involving CBM.

Ownership of Resources
Another way in which the regulatory environment issue has manifested itself is the ownership of resources issue. There was initially a large controversy over the legal ownership of CBM rights. Ownership of coal is treated very differently than ownership of natural gas, and CBM would seem to be caught between the two jurisdictions. Although CBM is trapped in coal, it is in fact a gas. Following this reasoning, the legal rights to CBM have already been deemed by British Columbia and Alberta governments to be of the same nature as natural gas rights. The province owns and can sell the rights to develop these resources, unlike those of coal beds.

The Coalbed Gas Act, assented to by the government of British Columbia on April 10, 2003, clarifies the ownership rights of CBM resources. Section 4(1) of the act states that ‘a natural gas tenure, whether made before or after the coming into force of this Act, includes any coalbed gas rights.’ The act further clarifies that, ‘a coal tenure, whether made before or after the coming into force of this Act, does not include any coalbed gas rights\textsuperscript{17}.’ This clearly shows that it is the owners of the natural gas mineral rights and not the owners of the coal rights who have ownership of CBM.
This has upset some land owners; at least one citizens’ action group is contesting the right of the government to sell licenses to extract CBM on their private property.

Figure 1.4 Newspaper advertisement to rally land owners with CBM resources underground

Of all the issues that surround and inhibit the development of CBM in Canada however, the ownership issue, although contentious, is not likely to be the biggest hurdle. The government has already clarified the issue and made an official ruling, so any further dissent is not likely to result in regulatory change.

Environmental Concerns

A large problem for CBM developers is the environmental consequence of its extraction. Water treatment is an important issue for many stakeholder groups in the CBM industry. The unique nature of CBM wells requires large volumes of water to be pumped down the well in order to liberate the CBM from the coal deposits and allow it to rise to the surface for collection. However, many private citizens are concerned about the use of potable water to pump into wells; the more potable water is pumped into the ground, the less is available for other uses such as agriculture and human consumption.

A subsequent water issue is the production and disposal of the water from the CBM well in later stages. If the water is characterized as brine, meaning that it has a high salinity or a measurement of more than 4000 mg per liter of particles, it cannot be returned in a
normal way, without treatment, to the environment. One alternative way of putting the water backing into the environment has been vaporization, but it is still unclear as to how effective this would be on a large scale and whether it would be acceptable to stakeholder groups.

Economic Sustainability
The economic issue is, unsurprisingly, one of the larger hurdles that the industry must overcome in order to begin to flourish on a large scale. Without corporations being able to demonstrate to their investors and directors that the revenue stream from these capital intensive CBM projects will be long term and sustainable, there is little chance of their approval. It must be conclusively demonstrated that commodity prices for natural gas are likely to remain high (over $5.00/mcf), that the regulatory environment will remain unchanged or will change in a way that is favorable to profits and that there will be sufficient demand increases in Canada to absorb the supply bubble created. Alternatively, the demonstration that there are markets within reach by easily accessible pipelines with excess capacity would strengthen the argument for the development of these projects in a similar way.

Kyoto Accord
One issue that has been simmering on the back burner for years, but will now likely be brought into the limelight very quickly, is the implementation of the Kyoto accord and its implications. The regime of environmental regulations and cutbacks on carbon dioxide and other assorted greenhouse gases was signed by Canada in 1997 under Prime Minister Jean Chrétien and ratified in 2002. However, the accord did not come into force until 55 percent of the world’s countries representing 55 percent of the world’s emissions had signed and ratified it. With Russia’s ratification only last month, Canadians will be subject to the provisions of the accord beginning in February 2005. This means that the oil and gas industry will be looking desperately for profitable projects that also reduce their emissions and therefore cause them to need to purchase less emissions credits. With the government committing to charge a maximum of $15 per ton of carbon dioxide emissions that companies must pay (and thus paying the balance out of federal revenues),
corporations will find any ‘clean energy’ project desirable that reduces the number of emissions credits they must buy and costs less than $15 more than the best ‘dirty energy’ alternative.

The key issue is the global warming potential of methane, the gas extracted in CBM development. If industry can successfully lobby the government and convince policy makers that a ton of methane extracted from CBM is worth 21 tons of carbon dioxide emissions saved, then they will be able to emit 21 tons more carbon dioxide from operations than they previously could, without being forced to buy emissions credits. It is now up to the government of Canada to decide the rate at which they will encourage CBM production.
Part 5: Conclusions and Suggestions: Possible Policy Directions for the Coal Bed Methane Industry in Canada

It cannot be emphasized vehemently enough that an accelerated timeline is crucial for the development of coal bed methane in Alberta. There are several reasons for this.

Firstly, Canada, and specifically the province of Alberta, already lags behind other jurisdictions with which we compete as energy producers in the domain of CBM. On a state level, the United States has developed this non-traditional source of natural gas much earlier and more successfully than Alberta. Even on an inter-provincial level, other provinces are more progressive than Alberta. British Columbia, although it is the location of fewer CBM development pilots, has been much more progressive in a regulatory sense, overcoming key issues that have yet to be decided by the Alberta Government.

The second reason why timing is crucial in the implementation of CBM technology is the fact that the Kyoto Accord has recently been ratified by the federal government and its provisions will come into effect in 2005. Alberta’s energy intensive economy is very susceptible to the effects of this new regulatory environment and the economic consequences that it brings. To maintain economic competitiveness in Canada, and specifically in Alberta, the government must find creative ways to adhere to the law and encourage environmentally responsible development, at the same time as it encourages a higher level of development.

The Alberta CBM industry is in its infant stages, but it is already threatened by many forces beyond the control of provincial and even national producers. The threats of declining and unsustainable commodity prices, an immature regulatory environment and deteriorating national competitiveness are all indications that the future of CBM could be less than encouraging for investors. It is therefore the urgent business of the Canadian and specifically, the Albertan, governments to take immediate steps to protect the competitiveness of the entire oil and gas industry. Government regulation should be
immediately enacted in order to liberate potential CBM producers from the barriers to production facing them. Important policy considerations, necessary for the immediate improvement of CBM production in Alberta, are summarized below.

1. *Review and Increase of the Well Spacing Requirements.* The current regulatory maximum in Alberta (one well per section) is widely recognized as being insufficient to depressurize the coal seams and to allow for stimulation of coal bed methane production. This is a regulatory hurdle that must be quickly overcome in order to allow CBM producers to effectively begin development.

2. *Provincial regulations allowing corporations engaging in CBM projects to claim emissions reduction credits that offset other GHG emissions.* Under this regime, CBM will provide a source of emissions credits to Alberta Producers. This will lessen the negative effects on the oil and gas industry and provide an incentive for responsible and forward looking progressive development.

3. *A Canada made CMOP.* Such a program would be inexpensive because the American format could simply be adapted to Canadian specific data and information. The benefits would be increasingly large to society and to producers able to take advantage of the program’s services.

4. *Tax credit or incentive program with defined dates and certainty for producers.* Because the American equivalent of this program had a defined expiry date, producers rushed to take advantage of the ‘limited time offer’. There are many research and development projects that compete for scarce capital with CBM technology in Alberta, but by introducing a credit for CBM projects the government could increase the number of wells drilled and ultimately expedite the development process.

Coal Bed Methane is an integral component of the United States’ plan to increase domestic energy production and to become a greener producer on its own terms. Because
of the specific circumstances of coal bed methane, and the positive effects on the
environment that arise from substituting it for dirtier energy sources, this energy source is
very important to Canada’s future as an energy producer. In the face of threats to
Canadian national productivity from the Kyoto accord it should be abundantly clear to
both the provincial and national governments that action is necessary to encourage the
future development of CBM. It is based on these premises that the above issues should
be viewed and debated, and their policy solutions brought to fruition.


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2 http://www.blackdiamondenergy.com/coalbed2.html#

3 http://www.blackdiamondenergy.com/coalbed2.html#
