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Re-Analyzing the Economic Feasibility of Coal Mine Methane Capture and Use at the West Elk Mine, Somerset, CO

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Introduction

This report is the second in an ongoing review of the Mountain Coal Company's (MCC's) analysis of the economic feasibility of capturing and using coal mine methane (CMM) and coal mine ventilation air methane (VAM) at the West Elk Mine near Somerset, Colorado. That MCC analysis was submitted to the Bureau of Land Management (BLM) in September 2009.

In a previous report, we pointed out the additional information and analysis that BLM would need from MCC and its consultants in order to critically evaluate their conclusion that there were no economically feasible CMM capture and use options at the West Elk Mine.

This report continues our critical analysis to explain the changes that we think should be made in the MCC economic analysis to make it more accurate and/or to test the sensitivity of its conclusions. Some of these changes simply involve different quantitative values for key assumptions. Others focus on the basic methodology used for the economic analysis. For instance, the primary reason for focusing on the capture and destruction or use of the methane now being released into the atmosphere is the damage the methane threatens to do to the atmosphere and climate stability. Any true economic analysis of the capture and destruction or use of the CMM would have to treat those impacts of released methane as either an economic cost or the avoidance of those costs as a benefit. MCC's analysis did not do that. We discuss the bases for those recommendations. From this analysis, we then indicate three alternative CMM capture and use (or destruction) technologies that should be remodeled using these modified assumptions to test the economic feasibility of those three alternatives.

The further analysis we recommend does not call for re-engineering the technology alternatives. In general, we build on the information that MCC's consultants have provided and test their conclusions about economic feasibility within that context. We propose this approach for two reasons. First, it reduces the number of assumptions and data sets that are in contention. Second, the resources supporting this project do not allow such a re-engineering. If, largely using MCC consultants' own data, assumptions, and methods, it can be shown that there are CMM use technologies that appear to be economically feasible, this should provide the BLM with information that would allow it to reject MCC's conclusion that no CMM capture and uses are feasible. The results of that modified economic analysis could lay the basis for more careful and serious analysis of the alternatives to simply releasing this powerful greenhouse gas into the atmosphere.

I. Issues Common to the Economic Analysis of All Alternative Uses of CMM

A. Incorporating the Value of Carbon Offset Credits

With the passage of the American Climate and Energy Security Act (ACESA) by the House of Representatives in June 2009, a future cap and trade US carbon compliance market became likely. With the establishment of a compliance market, carbon offset credits will become much more valuable than they currently are. Because of the future value of carbon credits in a compliance market, it is very important to make sure that the estimates for the volume of carbon credits and the value of the carbon credits potentially available from the West Elk mine are estimated correctly. MCC did not do that. The MCC economic feasibility report:

i. appears to have understated the amount of equivalent CO2 available for carbon credits;
ii. failed to include the value of carbon credits directly into its analysis; and
iii. discussed only the lowest forecasted value for carbon credits instead of using the median value for carbon credits that its own consulting firm supports.

i. The Volume of CMM that Could Be Destroyed or Used

MCC's and its consultant Burns & McDonnell's (B&M's) value for the potential annual CO2 equivalent destroyed by the various technologies reviewed does not appear to be correct. Using 2.2 MMCFD of methane destroyed yields a yearly CO2 equivalent of 323,980 tonnes, or a difference of approximately 40% from B&M's estimate of 229,990 tonnes. See http://www.epa.gov/cmop/resources/converter.html (describing conversion of methane volume to CO2e); MCC Report, Exh. G (B&M report) at 3-1 (estimating methane rate availability of 2.2 mmcfd); id. at 5-3 (estimating CO2e destroyed). There is the potential that the gas that the exhausters are consuming would not count toward carbon credits because of additionality concerns. MCC consultant B&M estimates that the exhausters and potential compressors associated with a CMM collection system would consume 0.35 MMCFD (MCC Report, Exh. G, Table 3-1, p. 3-1). That is the maximum that could be subtracted from the 2.2 MMCFD because this number represents exhausters *and* compressors. Compressors would not be subject to additionality concerns because they would not be in place except to help collect the methane for destruction. In addition, to the extent that the exhausters may be operated at a higher level in order to facilitate capture and use, that additional consumption of methane in the exhausters should be included in the CO2 equivalent destroyed. Even using 1.85MMCFD instead of 2.2MMCFD, the stated value for CO2 equivalent destroyed is approximately 18.5% too low. It is important that the correct value for CO2 equivalent destroyed is used so that the carbon credit offset valuation can be correctly calculated. The sale of carbon credit offsets is an integral revenue stream for any of the methane capture options.

ii. Including the Value of Carbon Offset Credits in the Economic Analysis

MCC and its consultants did not include the value of carbon offset credits in their analysis of the feasibility of CMM capture and use. The B&M economic analysis was carried out ignoring any potential revenues from carbon offsets credits. At the end of the B&M report, however, a "sensitivity analysis" was carried out to see how much various important economic parameters would have to change in order for various CMM capture and use projects to meet the 10.99 percent rate of return hurdle MCC says it must earn on investments (MCC Report, Exh. G at 5-4 – 5-9). In the last part of this sensitivity analysis, B&M model how the value of carbon offset credits might change the economic feasibility of a CMM capture and use project (MCC Report, Exh. G at 5-6). B&M find that with the value of carbon offset credits in the $14 per ton of CO2 equivalent range, one CMM flaring option would be economically feasible and for values in the $15.50 range electric generation (with supplemental flaring) could be economically feasible, too. Given the projected value for carbon credits in the future estimated by multiple different government agencies, a feasibility study that includes the value of carbon credits is absolutely necessary.

iii. The Projected Future Value of Carbon Offset Credits

The value of carbon credits in the future *is* uncertain. The Environmental Protection Agency (EPA) and the Energy Information Administration (EIA), among other government agencies, have attempted to model the value of an offset credit under ACESA (EPA Analysis of the American Clean Energy and Security Act of 2009 H.R. 2454 in the 111th Congress 6/23/09 and Energy Market and Economic Impacts of H.R. 2454, the American Clean Energy and Security Act of 2009 August 2009). Because the bill considers a wide range of possibilities, there is a range of different projections for the value of an offset credit in the future. The lowest offset values result from the assumption that an offset market would quickly be established into which the United States would seamlessly move and that there would be more than enough offset credits for carbon emitters who are over their allowance to buy. This scenario is unlikely since it is likely to take some years for the market to develop in the United States. On the high end of the scenario range there is the assumption that there will be no international credits or very limited international credits allowed. This also is unlikely since it would place a high burden on current carbon emitters looking to buy offsets to come into compliance before there is a robust US market for them. It *is* likely that the offset value will fall somewhere in between the high and low scenarios.

MCC consultant Verdeo presented its analysis of the carbon market in Appendix F. In that analysis it chose to use the lowest EIA and EPA forecasted offset values for its Base Case (middle) scenario. Since there is a range of possibilities, a mean or median value approach would be a more appropriate way to represent this range. A more recent alternate analysis by Verdeo takes exactly that approach. Verdeo presented that analysis at the 2009 U.S. EPA Coal Mine Methane Conference in Boulder, Colorado (September 30-October 1 http://www.verdeogroup.com/documents/pdf-verdeo-epa-cmop-ghg-policy-0909.pdf "Verdeo CMOP 2009 Presentation"). In that conference presentation, Verdeo Group supplemented the EPA estimates of the value of carbon offset credits it used in its report to MCC with the estimates that EIA developed for the value of carbon offsets if the ACESA passed in June by the U.S. House of Representatives became law (Verdeo CMOP 2009 Presentation at 16). Those carbon values were *70 to 100 percent higher* than the EPA estimates for the years between 2012 and 2020. While the EPA value was $10/ton CO2e in 2012, the EIA value was $18/ton CO2e. In 2015 the EIA value was $22 and the EPA value was $13. Verdeo carried out its analysis for this late September 2009 EPA conference using a $12 to $20 per ton range of values.

The EIA values, even discounted to account for a possible difference in the value of "allowances" as opposed to the value of "offsets,"[1] would, according to the Burns & McDonnell sensitivity analysis, make both electric generation (reciprocating engine) and flaring (over the E Seam) cost effective (MCC Report, Exh. G at 5-7 – 5-8). Verdeo, in its presentation to the EPA conference, estimated the internal rates of return on the capture and use of CMM to be in the 25 to 40 percent range and for VAM in the 12 to 35 percent range (Verdeo CMOP 2009 Presentation at 19). All of these IRRs estimated by MCC's consultant would meet MCC's target for economic feasibility.

Since a compliance market is likely in the near future, it is extremely important to be incorporate the quantity and value of carbon credits that could come from the E-seam into the economic analysis. Analysis of economic feasibility should accurately calculate the CO2 equivalent that can be produced. That economic analysis should also choose a more realistic value for those offset credits similar to those that MCC's own consulting company and multiple different government agencies have estimated. Finally, the European carbon exchange (ECX), where 80% of the world's carbon credits are currently traded also provides a reference for the future US value of carbon credits. The value of the European version of a carbon allowance and offset credit (EUA and CER) as of October 29, 2009, had spot prices of 14.75 and 13.92 Euros per tonne of CO2e respectively (http://www.ecx.eu). This would represent US dollar values of $21.82 and

[1]Both the EPA modeling and the EIA modeling explicitly assumed that carbon allowances and carbon offsets would trade at the same value. An "allowance" is a official federal permit to emit greenhouse gases. An "offset" is likely to have to be evaluated by the federal government or a designated agency or organization for approval as meeting federal standards for the reduction of greenhouse gases. Because there is a difference in the certainty of federal approval and valuation, a small difference in value (10 to 20 percent) may emerge between the two. See R. Curran, Carbon Offsets, a Q & A, Wall Street Jl. (Sept. 21, 2009) available at http://online.wsj.com/article/SB10001424052970204683204574356303122443192.html.

$20.59.[2] The establishment of a cap and trade carbon market can produce a strong economic incentive to carefully consider the cost of carbon equivalent emissions and the value of reducing them. This value must be built into any analysis of the economic feasibility of the capture and use of CMM at the West Elk Mine.

B. The Weighted Cost of Capital

In its analysis of the economic feasibility of capturing and using CMM, MCC has stated that Arch Coal's weighted average cost of capital (WACOC) is 10.99 percent. That, combined with the actual role that long term debt has been playing in Arch Coal's capital structure and the actual cost of long term debt taken on by Arch would imply a cost of equity of 13.98 percent.

Value Line[3] reports that for Arch Coal long term debt has represented about 40 percent of total capitalization and that this is projected to continue through 2010. As of June 30th, 2009, the interest rate on Arch's long term debt averaged 6.51 percent. Short term debt costs in 2008 were approximately 2.7 percent.[4]

The estimated return on stockholders equity for 2009 for Arch Coal is 3 percent. The projected return for 2010 is 10 percent.[5] If one averages all of the actual and estimated returns on stockholder equity across all of the years that Value Line reports (2004 through 2010), the return was 10.7 percent, 3.3 percentage points below that implied by MCC's asserted weighted average cost of capital, actual debt costs, and actual debt share of capitalization. If the 10.7 percent return on equity is combined with the 40 percent debt share of total capitalization, the weighted average cost of capital would be 9.02 percent, 1.97 percentage points below the 10.99 percent used in the MCC economic analysis.[6]

Value Line, however, is forecasting that Arch Coal will be earning a 17.5 percent return on stockholders equity in the 2012-2014 period. Arch *did* earn a 20.5 percent return on equity in 2008 when coal (and other energy) prices rose steeply to peak highs. Value Line, apparently, believes that coal prices and Arch's earnings will return to those peak 2008 levels. In the face of impending carbon regulation, the large number of proposed coal-fired plants being canceled even during the peak in energy prices, the abundant supply of coal, and the relatively low natural gas prices, this may be more wishful thinking than reality.

Recent financial analyses of the cost of raising equity capital support a lower cost for that component of Arch's total capitalization. For instance, FINCAP, Inc. recently estimated the cost of equity to be in the 10.9 to 12.4 percent range. The low end of that

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[2] Currency conversion in later October 2009.
[3] Report dated September 11, 2009.
[4] Arch Coal 10-K SEC Annual Report, p. 59.
[5] Value Line, 9/11/2009.
[6] Venture capital often does require returns on equity investments in the 15 to 20 percent range or higher depending on the risks involved. An established company with profitable operations and markets well established does not require such returns on investments within its continuing operations.

range is close to the actual and estimated return on common equity for Arch Coal over a seven year period cited above.[7] The implicit 14 percent that MCC appears to be using is 2.4 percentage points over the middle of FINCAP's estimated range.

For all of these reasons we believe that the economic analysis should also be done with a weighted cost of capital that is two percentage points lower than the nearly 11 percent that MCC told their analysts to use.

C. The Net Present Value Analysis

The B&M economic analysis of CMM capture and use does not appear to have used either a long term debt ratio of 40 percent or a cost of debt of 6.5 percent. The B&M results cannot be reproduced using this capital structure and this cost of debt. Instead, B&M appeared to have done a simple cash flow analysis in which no distinction was made between debt costs and equity costs. In such an analysis the cost of debt and equity are assumed to be identical and equal to the weighted average cost of capital. This approach contradicts B&M's statements in their economic analysis that they included in their analysis the "principal and interest expenses for the debt required to finance the project" as well as income taxes (MCC Report, Exh. G, p. ES-3 and 5-2). Instead, B&M appear to have assumed that the project was entirely debt financed not at a market interest rate but at Arch's average weighted cost of capital. Only that assumption allows the reproduction of the results reported by B&M. Verdeo also explicitly did its economic analysis of VAM destruction using this type of simple cash flow analysis.

The way in which the Net Present Value and Internal Rate of Return analysis is carried out can make a difference in the apparent economic feasibility of a project. The reason businesses partially finance investments with debt is that debt capital is less costly than equity (e.g. Arch's 6.5 percent debt cost and asserted 14 percent equity cost). Financing a significant portion of an investment with borrowed money allows the difference between the cost of debt and the weighted cost of capital to accrue to stockholders (the difference between 6.5 percent and 11 percent in B&M's analysis).[8] The net present value can be significantly higher (10 to 20 percent) if the modeling takes into account the advantages of partial debt financing.

The economic modeling should be carried out making use of a reasonable debt component (40 to 50 percent) and the actual market interest rates actually faced by Arch Coal.

[7] Testimony of William E. Avera, principal, FINCAP, Inc., Austin, Texas, in prefiled testimony before the Montana Public Service Commission, Docket No. D2009.9.129, on behalf of NorthWestern Energy, October 16, 2009.
[8] Lenders ultimately limit how much debt a firm will be allowed to take on because the risk of default on the loans rises the more burdened a business is by fixed payment obligations.

D. The Economic Life of the Alternative CMM Projects

MCC is not likely to cease mining coal in the Somerset area in the next ten years at the projected end of its mining of the E-seam coal lease. In DEIS Rulemaking for Colorado Roadless Areas (USDA, Forest Service, July 2008, p. 118), the BLM estimated that the coal mines in the North Fork Valley have “access to an estimated total of 1 billion tons of in-place coal resources. This could represent 29 additional years of coal production. All existing leased reserves could be mined. Coal resources are expected to have similar quality to those currently being mined in the Somerset field…” Because of these extensive available coal resources MCC is actively pursuing a lease amendment to the E-seam and a new coal upgrading facility at the West Elk Mine.

MCC is actively pursuing a lease amendment that would allow it to mine coal for 2-3 more years on the E-seam past their current 10 year plan. In a January 15, 2009 application to modify their federal leases (C-1362 and COC-67232) Ark Land Company, the holding company for Arch Coal Inc, which owns MCC, requested the addition of 1,562 new acres to their lease. MCC believes that this would give them access to approximately 10 million more tons of coal. In personal communications with Desty Dyer (BLM mining engineer working with MCC on the West Elk Mine) and Charlie Beacham (BLM employee in charge of the lease modification) in late October 2009, they indicated that at normal West Elk mining rates this would represent two to three extra years of mining in the area. However, this is clearly not the only coal to which MCC could turn when the E-seam is mined out.

MCC is investing 25-30 million dollars in a coal upgrading facility at the West Elk Mine. With the addition of the coal upgrading plant, MCC will be able to go back into areas where it ran into low coal quality in the past such as the B-Seam. The upgrading facility will give MCC the ability to go after what would otherwise be considered uneconomical coal. In a 2004 Forest Service document (“2004 Coal Resource and Development Potential”) the Forest Service estimates that directly adjacent to MCC’s facilities there is far more than the 75 million tons of developable coal from the E-seam. The amount of coal that is still in the ground coupled with MCC sizeable investment in a coal upgrading facility all point towards a time commitment past the current ten year mine plan.

Whether MCC continues to expand its current mine plan or turns to mining other nearby coal reserves, it is clear that MCC will likely be mining in and around their current facilities for many years past the ten-year E-seam plan. Because MCC plans to continue to mine coal in this area past the 10-year period used to analyze the economic feasibility of CMM capture and use, the 10-year economic life assumption used in the economic analysis biases the analysis against the feasibility of the capital intensive CMM capture and use technologies such as electric generation and an alternative that MCC did not analyze, LNG production, that will be discussed later in this report. The economic lives, for instance, of both the reciprocating engine and combustion turbine technologies for generating electricity from the CMM are 30 years, three times the assumption made in B&M economic analysis. The gas processing equipment that would be used in the LNG alternative also has an economic life beyond 10 years.

These longer economic lives are not relevant only if MCC continues mining from the West Elk Mine's current location for more than ten years. The electric generating and gas processing equipment is modular in nature and built on skids that allow it to be moved to different locations. That economic value beyond 10 years needs to be included in the economic analysis.

In evaluating the economic feasibility of the capture and use of CMM, either a longer economic life should be used or the value of the primary capital equipment for use at other sites must be included in the analysis.

E. The Cost of the Collection System

MCC's consultants assume that the collection system would have to reach all MDWs and that the pipelines would have to follow the planned road system. This likely has significantly increased the cost of CMM collection. Many of the pipes in the collection system would be temporary in nature. If they were laid on the surface following the most feasibly direct line to the trunk pipeline, the mileage of pipe required could be significantly reduced. In addition, a cost effective analysis might indicate that the CMM expected to be collected from some of the MDWs could not justify extending the collection system to those locations. The economic analysis should consider a least cost collection system that optimizes the economic collection of the CMM. If that would require additional regulatory permission, it should not be dismissed as infeasible. An optimal system should be designed and analyzed so that regulators know what the benefits and costs would be associated with modifying existing permits.

F. The Cost of the Federal Royalty

The BLM's March 25, 2009 letter to MCC outlining the economic analysis BLM expected MCC to do explicitly states that "CMM…that is used on site for beneficial use will not be subject to a royalty. Beneficial use includes all uses of CMM…onsite including…generation of electricity that is used onsite at the West Elk Mine." For that reason the analysis of self-generation should not include the federal royalty as a cost.

In addition, the royalty would be applied to the value of the CMM as it leaves the mine. Processing and transportation costs that MCC incurs in order to sell the CMM would be deductible from the sale value under a net-back method. Using the value of the gas delivered to a pipeline as the basis for the royalty exaggerates the economic value of the CMM at the mine and the royalty that would be collected on it.

II. Issues with the Economic Analysis of the Flaring Option

MCC's consultants interpret "economic" and "economically feasible" to mean "an attractive investment for Arch Coal's stockholders." Although that may be appropriate when it comes to investments in the use of methane at the West Elk Mine or the sale of the methane to other commercial businesses away from the mine, it is not clear that that is the appropriate view that should be taken of the destruction of methane to protect the atmosphere and climate stability.

The flaring of methane is not a commercial use or sale. It would be undertaken for environmental reasons, to reduce the emission of a powerful greenhouse gas into the atmosphere. That is, it would be undertaken in the pursuit of non-market, non-commercial economic benefits. In that setting the appropriate economic analysis would be to compare the environmental benefits of reduced methane release into the atmosphere to the costs of collecting and flaring the methane. This is the type of economic analysis or cost-effectiveness analysis that is typically applied when it comes to environmental or safety regulations. Efforts to control air pollution are not usually analyzed as a profitable investment for the stockholders of the polluting company.

For that reason it is not clear that the approach to the economic analysis of the flaring of CMM (or the destruction of VAM through oxidation) taken by MCC and its consultants is appropriate. Instead, a two-stage economic analysis may be more appropriate. First, the economic rationality of collecting and flaring the CMM would be analyzed in the context of the environmental objectives of that flaring. Then, as an alternative to flaring, the incremental costs and revenues of moving the CMM to a central location for mine use or sale would be analyzed. Such a two-stage economic analysis might show that while flaring is economically rational on environmental grounds, incremental investments in use or sale are also commercially feasible and more attractive on environmental grounds. In the latter commercial business analysis, the costs of the collection and flaring system would not be included.

This distinction between CMM destruction for non-commercial purposes and CMM commercial use/sale could be incorporated into the economic analysis in alternative ways too. For instance, collection and flaring could be treated as an environmental measure being undertaken by MCC as a good corporate citizen or in anticipation of a regulatory mandate. In that setting, no direct financial return to stockholders would be contemplated and the analysis could be carried out entirely in terms of out-of-pocket costs. In that setting the collection and flaring costs could be assumed to be financed entirely with debt with no return to stockholders. In an internal rate of return analysis of such a non-commercial venture, a hurdle rate that included the cost of common equity would be inappropriate.

In either of these or other approaches to taking into account the difference between CMM destruction and CMM commercial use/sale, the analysis would have to avoid double counting the environmental benefits. It would not be appropriate, for instance, to include as benefits both future carbon offset credits and an estimated value of the avoided release of the methane.

III. Issues with the Economic Analysis of Electric Generation

A. The Capital Cost of Electric Generating Equipment

The B&M economic analysis of the economic feasibility of electric generation from the CMM provided estimates of the costs associated with both the capital costs and the operation and maintenance costs associated with the electric generators and the engines that drive them. If the electric generating facilities are separated from the collection system and possible flaring devices associated with excess methane production, the electric costs are show in the table below.

Burns & McDonnell Cost Estimates		
	Reciprocating Engine	Combustion Turbine
Capital Costs		
Engine-Generator package	$ 6,520,000	$ 6,000,000
Mechanical, Electrical, Structural, Civil	$ 3,193,000	$ 2,643,000
Emissions Control	$ 3,044,000	$ 2,493,000
Overhead, Engineering & Mangement Cost, & Owner's Cost incld Contingency	$ 7,114,000	$ 6,210,000
Total Capital Cost	$ 19,871,000	$ 17,346,000
Total Cost Per KW Capacity	$1,882	$3,942

Source: B&M Tables 3.3, 3.6, 5.2

It is important to note two things about these B&M capital costs of electric generation. First, "overhead" costs including management, engineering, and owner's costs represent about 35 percent of the total cost (see MCC Report, Exh. G at Tables 3-3 & 3-6). B&M estimates these by applying a 48 percent markup to the other enumerated costs (Id.). Second, the emissions controls are quite expensive, about 15 percent of the total costs (Id.). For the reciprocating engine, the emission control costs add almost 50 percent to the costs of the Engine-Generator package (Id. at p. 3-13). These two costs represent 50 percent of the total capital costs of the generators.

i. Other Estimates of the Capital Costs of Electric Generation

These estimated costs of engine-generators are substantially greater than costs estimated elsewhere. For instance, a federal-state commission set up by federal law to guide electric planning in the Pacific Northwest, the Northwest Power and Conservation Council, recently completed its draft Sixth Northwest Power Plan.[9] As part of the

[9] http://www.nwcouncil.org/energy/powerplan/6/default.htm

development of that plan, a federally-chartered advisory committee made up of professionals from investor-owned and public utilities, federal power agencies, and state regulatory agencies from California, Washington, Oregon, Idaho, and Montana reviewed the characteristics of all potential generating resources that might be included in the regional plan.[10] That characterization included the capital costs of different types of generators, standardized on a common basis so that they could be compared. The capital costs were "Total Project Costs" on an "overnight" basis, meaning that while development (feasibility study, engineering, permitting, geophysical assessment, management, etc.) and owner costs were included, financing costs, escalation, and interest costs during construction were not included in the stated capital costs. The later were not included in B&M's costs either. B&M added to the NPV analysis later, just as the Northwest Power Council did.

The estimated economic costs of the various alternative generating technologies became the inputs to the scenario modeling out of which a least-cost, least-risk regional electric plan was developed.[11] The table below compares the estimated costs for the two generating technologies B&M considered for electric generation using CMM with those developed for the Northwest Power and Conservation Council.

Comparison of Costs of Capital Costs of Electric Generation ($ per KW, 2009$s)			
	B&M	NPCC	Ratio B&M/NPCC
Reciprocating Engine	$1,882	$1,169	1.6
Combustion Turbine	$3,942	$617	6.4

Source: B&M Tables 5-2; NPCC 2009 Appendix I, Fig. I-1, p. I-7; NPCC cost estimates were adjusted from 2006$s to 2009$s using the CPI from mid-2006 to mid-2009.

The B&M costs are clearly much higher. For the reciprocating engine alternative the B&M costs are 60 percent higher. For the combustion turbine, they are massively higher, 6.4 times higher.

The combustion turbine results may be tied largely to the poor performance of that technology at high altitudes. It may simply be the wrong technology for use at the West Elk Mine site.

The higher costs associated with the reciprocating engine alternative, however, are likely tied to the costs discussed above: the very heavy "overhead" loadings and the expensive emission controls that are assumed to have to be installed.

Many electric utilities are required to periodically develop resource plans that lay out how they expect to meet their customers' future needs in a low cost and low risk

[10] The Generating Resources Advisory Committee (GRAC) http://www.nwcouncil.org/energy/grac/Default.htm

[11] The characterizations of the different generating technologies is contained in Appendix I of the draft Sixth Northwest Power Plan. http://www.nwcouncil.org/energy/powerplan/6/I_090309.pdf

manner. A basic input to such plans is an analysis of the costs of serving customers using different generating technologies. The table below shows the estimated capital costs for reciprocating engine and frame combustion turbine technologies that have been incorporated in recent Pacific Northwest utility resource plans.[12]

Capital Costs of Electric Generating Technologies Incorporated in PNW Electric Utility Integrated Resource Plans $ per KW, 2009$s						**Burns & McDonnell Capital Costs** 2009$s
	Pacificorp	Portland General Electric	Avista	NorthWestern Energy	Northwest Power Conservation Council	
Year of Plan	2008	2009	2009	2007	2009	
Technology						
Reciprocating Engine	$1,318	$1,100		$1,049	$1,169	$1,882
Combustion Turbine-Frame			$480	$658	$617	$3,942

Source: Information Collected by NorthWestern Energy in preparation for its 2009 Electric Resource Procurement Plan

These capital cost estimates also indicate that the B&M costs are significantly higher.

The relatively high cost of B&M's costs for the reciprocating engine alternative are also indicated by a 50 mw natural gas-fired reciprocating engine generating project outside of Butte, Montana. It was constructed in 2005 at a cost of approximately $800 per installed kilowatt in 2004 dollars. In 2009 dollars this would be $910 per kw, much closer to the NPCC estimates shown above than to B&M's estimates which are twice as high. This facility was supported by a 20-year power purchase contract with NorthWestern Energy. The contract provided for two 5-year extensions, suggesting up to a 30-year economic life for the engine-generators.

Finally, the characterizations of these technologies also include the estimated economic life of the engine-generator packages: These are reported to be 30 years for both the combustion turbine and the reciprocating engine technologies.

The economic modeling should be carried out using these lower capital costs of the reciprocating engine technology.

ii. Pollution Control Costs for CMM Electric Generation

The B&M economic analysis estimates that pollution control equipment costs of $4 to $5 million would have to be installed on the electric generators.[13] However, it is unlikely that it will be necessary to install the costly pollution control devices that B&M assume,

[12] Utilities standardize the costs associated with different technologies in different ways. That may make comparisons of the costs developed by different utilities questionable. The Northwest Power and Conservation Council draws on the expertise of all of these utilities and then carefully lays out how it standardizes the costs. For that reason the NPCC costs are the most reliable in evaluating B&M's costs.
[13] The emission controls themselves would cost $2.5 to $3.0 million. B&M then add planning, development, owner, and overhead loaders of 55.8 percent. The economic analysis adds a 3.38 percent construction finance cost to the capital costs. This brings the total capital cost to $4 and $5 million for the reciprocating engine and combustion turbine, respectively. Appendix G, Tables 3-3 and 3-6, and page 5-1.

namely Selective Catalytic Reduction or SCR, on either electric generating alternative (reciprocating engines or combustion turbines).

B&M assume that it is the US Forest Service that has regulatory jurisdiction over emissions from potential electric generators on MCC property. However, the US Forest Service would have primary jurisdiction over potential electric generation emissions at the West Elk Mine only if the engine-generators or other gas processing facilities were located on Forest Service land. In that situation, the Forest Service would have jurisdiction and *could* force the use of Best Available Control Technology (BACT) although it is unclear that they would. However, because the electrical generating units are planned to be located on private MCC land, they will fall under the jurisdiction of the State of Colorado's Stationary Source Program that monitors and enforces emission controls across the state. The Forest Service would not have primary jurisdiction although it would likely be consulted by the State of Colorado on appropriate emission controls.

This actual situation contrasts with the B&M's characterization of the situation. B&M speculates about the consequences if the West Elk Mine needs to get a state operating permit for its CMM-fueled electric generation (Appendix G, Section 4.2.1). If the West Elk Mine has to obtain such an operating permit, B&M opines that this would lead the Forest Service to become concerned about the potential for visibility impacts on Forest Service lands from the NOx emissions from the generator engines. This concern, B&M speculates, would lead to the USFS imposing a requirement that BACT be used on those engines. That B&M speculation that the Forest Service would likely force the use of BACT, i.e. SCR equipment, led B&M to include the costs of SRC emission controls in the electrical generating capital costs.

In conversations with the Forest Service's Air Resource Program and the State of Colorado's Stationary Source Program in October of this year, however, it was made clear that this would not be a requirement by the Forest Service or the State of Colorado. This would especially be true if the higher pollution control costs associated with this expensive emissions control technologies would block progress at the West Elk Mine to reduce its largest air emission problem, the ongoing release of large amounts of methane into the atmosphere.

Because BACT is not likely to be imposed, the SCR emission control technology is not necessary for the CMM electric generation alternatives. This means that the B&M cost estimates for the GE Jenbacher JMS 620 reciprocating engine and the Kawasaki GPB15 combustion turbine generating technologies need to be revised to remove the cost of the SCR emissions controls. This would significantly reduce the costs of CMM electric generation and, of course, increase the likelihood it being judged economically feasible.

B. A Potential Concern with Use of CMM for Electric Generation at West Elk Mine: The Variability of West Elk Methane Production

One of the problems that MCC's consultants pointed out with CMM-powered electric generation is that the amount of methane produced by the mine varies from day to day. It is high as a new panel is first entered and then declines as the mining of that panel proceeds. As that panel is abandoned and sealed and a new panel entered, the methane production rises again. Methane production from the actively mined area has a "saw-toothed" character. That could mean that electric production might also fluctuate across the year even if coal production is steady.

The size of this problem for the feasibility of electric generation can only be determined by a careful analysis that considers optimizing the methane production subject to the existing constraints of ensuring the safety of the mine and efficient production of coal. As the MCC analysis pointed out, gas would not only be drawn from the MDWs over the actively mined areas. It would also be drawn from MDWs over sealed panels. It is possible that production from the sealed panels could be varied to stabilize the overall gas supply, reducing withdrawals from the sealed panels when gas production is high from the active panel and increasing production from the sealed panels as production from the active panel declines.

Analysis of the current ventilation plan for the mine may also be appropriate. The methane content of the gas from the MDWs (55 percent) is quite low compared to that from many other "gassy" mines. This may be because production from the active panels is being mixed with production from the sealed panels. If that is the case, it simply underlines the potential of managing the capture of the gas in a way that increases its value for electric generation. In addition, the very low methane content of the ventilation mine methane (VAM), concentrations that apparently regularly fall below 0.2 percent, suggest over-ventilation. This may be tied to the opening of the new ventilation shaft and the fact that the new ventilation system has not been fine-tuned yet. This, too, may indicate that there adjustments that could be made that are consistent with safety and efficient mine operation that could boost the value of the methane for electric generation.

The economic modeling should proceed continuing to make use of the assumptions that B&M have made for electric generation: That the CMM supply will support the operation of approximately 10.6 mw of generating capacity operating at an 85 percent capacity factor. That may be optimistic but BLM should first test whether, using MCC-B&M numbers, electric generation appears to be economically feasible.

IV. The Liquid Natural Gas (LNG) Alternative to Using CMM

The most direct use of captured CMM is to process it into a pipeline quality fuel gas that is then injected into the national natural gas pipeline system for delivery to natural gas customers. B&M *does* analyze the economics of doing that. That alternative, however, is the highest cost alternative with the lowest net present value. Almost half (46 percent) of the capital cost (beyond the cost of the collection system that is common to all alternatives) is the cost of a trunk pipeline to carry the captured and processed methane to the Bull Mountain natural gas pipeline. That trunk pipeline was estimated to cost $10.5 million by itself (MCC Report, Exh. G, Table 2-3). If that pipeline cost could be avoided, the economics of the pipeline-quality natural gas alternative might look much more attractive. An alternative use of the captured CMM that does exactly that is to convert the methane to the equivalent of liquid natural gas (LNG) and deliver it to customers using truck or rail transportation. LNG is currently used on a small scale as a fuel for heavy trucks and, converted back to a gas, could also used as compressed natural gas (CNG) as a fuel for automobiles and small trucks.

Liquefaction and trucking[14] the liquefied fuel off the mine site to regional markets has some attractive attributes that help solve many of the drawbacks that the natural gas pipeline alternative has. Trucking the liquefied natural gas from the mine would avoid the very high costs associated with building a trunk pipeline from the West Elk Mine to the Bull Mountain natural gas pipeline. Liquefied natural gas sold as a transportation fuel is also worth considerably more than normal natural gas on an equivalent BTU basis because it is competing with conventional liquid transportation fuels such as gasoline and diesel. Finally, a somewhat irregular supply of methane would not create the same potential problem of the uncertain capacity value of the energy that arises for both the pipeline natural gas and electric production options since LNG can be stored both as it is produced and after it has been transported to markets for sale.[15]

The captured CMM has to be processed to “pipeline” quality under either the pipeline or the LNG alternative. One method of removing the nitrogen from the CMM to produce nearly pure methane for delivery to a natural gas pipeline involves taking advantage of the fact that nitrogen and methane have different temperatures at which they liquefy. A similar process would be used to liquefy the methane in the LNG alternative. *If* the cost of processing the methane to pipeline quality and then compressing it for delivery to a high pressure natural gas pipeline is similar to the cost of processing it into LNG, avoiding the $10.5 million pipeline cost would reduce the capital cost of the LNG alternative to $12.4 million. That would be 30 to 50 percent below the capital cost of the electric generation and gas pipeline alternatives. Of course the cost of trucking the LNG to market would have to be included as would any additional processing costs to produce the LNG. In addition, the value of the different products produced by the various uses of the CMM would have to be taken into account. As mentioned above, however, the value of the LNG would be higher than the value of the methane delivered to a natural gas pipeline.

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[14] Depending on the assumptions made about the West Elk Mine CMM supply and the size of the LNG tanker truck, one or two trucks per day would be required to transport the LNG.
[15] Contracts to purchase the LNG are likely to require a particular volume of delivery within specified time periods. The ability to store LNG allows the delivery pattern to be stabilized in a way that is not possible with electricity or natural gas (without a large natural gas storage reservoir).

Appalachian-Pacific Coal Mine Methane Power Company, LLC (A-P), has a grant from the U.S. Department of Energy's National Energy Technology Laboratory to study the conversion of CMM to LNG. A-P as also been associated with the West Elk Mine in reviewing the potential for CMM capture and use and in the preparation of a bid to lease the mine's CMM when BLM was considering putting that gas up for lease. Building on that past work at West Elk, A-P has recently done an economic analysis of the LNG alternative. In an October 2009 presentation to the North American Coalbed Methane Forum, A-P reported the conclusions that economic study of converting West Elk Mine CMM to LNG. A-P found that the modeled project had a very positive net present value and a very high return on investment (34 percent). A-P commented, however, that those results assumed "a partial government subsidy of project capital cost," the size and character of which was not specified. A-P also reported that even without those government subsidies, the LNG alternative had a positive net present value.[16]

Although A-P has informed us that its financial model is proprietary in character, the basic inputs to that analysis should be available to be entered into a conventional financial analysis similar to that which B&M has used. That would allow the LNG alternative to be compared to electric generation and flaring on a common basis. We plan to work with A-P to facilitate that independent economic analysis of the LNG alternative.

V. Conclusions

We recommend further economic modeling for three alternative uses of the CMM at the West Elk Mine:

i. Flaring of the CMM over the E Seam
ii. Electric Generation using reciprocating engines with complementary flaring of surplus methane.
iii. The processing of the CMM to pipeline quality gas and conversion to LNG for distribution and sale in regional markets.

In carrying out this additional modeling, the alternative assumptions developed in this report should be utilized. Namely:

a. The quantity of CO2 equivalent destroyed should be increased to 323,980 tonnes less the consumption associated with the current operation of the exhausters.

b. The value of carbon offset credits should be directly incorporated into the revenue streams in the economic analysis of each alternative.

[16] "CMM Utilization Options for the West Elk Mine, CO, North American Coalbed Methane Forum, Morgantown, WV, October 22, 2009. PowerPoint Presentation.

c. A median value of projected future carbon offset credits should be used rather than the lowest available projection.

d. The economic analysis of the collection and flaring option should recognize that flaring seeks to destroy the CMM for non-commercial reasons. The appropriate economic analysis of such a non-commercial undertaking should be different from that applied to the commercial on site use or off-site sale of the CMM.

e. For commercially oriented CMM uses or sales, a lower weighted average cost of capital (9 percent) should be used. A 40 to 50 percent debt ratio should be used with a cost of debt of 6.5 percent. For non-commercial destruction of CMM, complete debt financing is appropriate.

f. The economic life of the capital equipment that would be used in the capture and use of CMM far exceeds the 10-year period used in the economic analysis. MCC is also likely to continue to mine at the West Elk Mine or adjacent to it beyond the 10-year period. This should be taken into account by either extending the analysis period (e.g. to 20 years) or by assigning a reuse value to the engines, electric generators, gas processing, LNG equipment, and other moveable equipment with economic lives exceeding the 10-year analysis period.

g. The capital cost of the reciprocating engine electric generator should be reduced from approximately $1,900 per kw to $1,200 per kw.

h. The SCR pollution control costs should be removed from the economic analysis of the electric generation alternative.

i. The quantity and value of electric generation used by B&M in its analysis of the electric generation alternative should continue to be used in the modeling.

At the very least, these revised economic analyses would demonstrate the sensitivity of MCC's conclusions that CMM capture and use is not economically feasible to more realistic assumptions. The results of that new economic analysis, however, may demonstrate that CMM capture and use is, in fact, economically feasible at the West Elk Mine.