The Mine Methane Capture Protocol and Mining Economics

Summary

In October 2013, the Mine Methane Capture protocol (protocol) was presented before the Air Resources Board (Board). While voicing support for the protocol, the Board acknowledged that stakeholders were concerned that the protocol could, through the value of the offsets it would produce, encourage more coal mining than would otherwise occur. In Resolution 13-44, the Board directed that "the Executive Officer will make available for public review an analysis of the potential impact of cap-and-trade offsets on coal mine economics."

In response to Resolution 13-44, ARB staff focused on whether the protocol could encourage more coal mining than would otherwise occur by examining the following questions:

- How would the value of the offset created by the protocol compare to the value of coal?
- Would the protocol encourage new coal mines to begin production?
- Would the protocol encourage existing mines to produce more coal?
- Would the protocol shift production between existing coal mines?
- Would the protocol impact the price of coal?

In answering these questions, staff found that the protocol would not encourage additional coal mining. The results of the analysis show that while the protocol provides an incentive to capture and destroy coal mine methane that would otherwise be vented into the atmosphere, the value of the offset does not change coal production decisions or shift the demand for coal.

How would the value of the offset created by the protocol compare to the value of coal?

From 2014 through 2020, the value of offsets generated through the protocol would represent less than one half of one percent of the value of domestic coal production. Similarly, the rate of return to coal mine owners from mine methane capture (MMC) offset projects is estimated to be less than one percent of coal mine profits. The rate of return on MMC offset projects is expected to be sufficient to encourage MMC capture and destruction under the protocol, but the return is estimated to be very small as compared to the profits associated with coal mining.

Would the protocol encourage new coal mines to begin production?

No, the protocol would not encourage new coal mines to begin production. Coal mines are capital-intensive long-term investments. The potential returns from a MMC offset project are dwarfed by the upfront investment required to begin coal production. Looking at the simple payback period for upfront mine investment, potential returns from

an offset project would not reduce the payback period of mine investment costs. The protocol does not produce enough return to alter long-term planning and investment decisions.

Would the protocol encourage existing mines to produce more coal?

No, the protocol will not encourage existing mines to produce more coal. Mines are operated to satisfy contractual obligations and to maximize profits given current and anticipated coal market conditions. Safety requirements, labor agreements, and land lease terms are also important determinants of coal production decisions. Because MMC offset project returns are insensitive to marginal changes in coal mine operating decisions, and because MMC offset project returns are so small compared to coal mining costs and profits, the MMC offset project returns do not influence production decisions. Long-term production decisions of a coal mine are driven by market fundamentals and costs of production, which are not influenced by MMC offset projects.

Would the protocol shift production among existing coal mines?

No, the protocol would not shift production among existing coal mines. The majority of U.S. coal is purchased through structured contracts that can restrict the ability of buyers and sellers to alter production decisions. Because MMC offset project returns do not affect the marginal cost of coal production, MMC offset projects are unlikely to shift production among existing coal mines.

Would the protocol impact the price of coal?

No, the protocol would not impact the price of coal. The MMC offset project returns do not change coal production decisions. Consequently, no new mines would begin production, no existing mines would increase production, and production would not shift among existing mines. MMC offset projects also do not impact the global demand for coal. With both supply and demand unchanged as a result of MMC offset projects, the protocol will not have any impact on the price of coal.

Technical Appendix

The MMC Protocol

Development of the protocol began in early 2013 and involved a series of technical working groups, public workshops, and extensive interactions with project developers and academic experts.[1] The protocol also benefited from existing voluntary offset projects developed under the Climate Action Reserve (CAR) and Verified Carbon Standard (VCS).[2] These voluntary MMC projects were developed over years of consultation with industry, environmental, regulatory, and financial stakeholders and have demonstrated the viability of MMC offset projects while laying the groundwork for the ARB protocol.

Voluntary MMC projects developed under CAR and VCS, as well as projects operated under U.S. Environmental Protection Agency's Coalbed Methane Outreach Program (CMOP) serve as case studies that can be used to assess the potential impact of the protocol on mine economics.[3] The analysis that follows relies on data gathered from existing voluntary MMC projects as well as data on coal production and coal markets from the International Energy Agency (IEA) and the U.S. Energy Information Administration (EIA).

The Market for Coal

Analyzing the impact of the protocol on coal mining requires assembling answers to general questions about the market for coal including: what is the price of coal and what impacts the supply and demand for coal?

Coal is not a uniform commodity. There are many different types of coal found all over the world, with varying carbon content and different end uses. The most commonly discussed category of coal, when thinking of price and trade, is hard coal, a high quality grade of coal with high carbon content. There are two main classifications of hard coal— coking coal and non-coking coal. Coking coal is used for making iron and steel and is of a higher quality than non-coking coal used primarily for heat and power generation. Coking coal and non-coking coal (also referred to as steam coal) are not homogenous products, but vary by the amount of energy and carbon they contain, as well as other attributes, such as sulfur content.

Not only does coal vary by quality and energy content, it varies by geographic location. In 2012, nearly 6,818 million tons of coal was produced globally. The largest coal producing countries were China, the U.S., India, Indonesia, and Australia (IEA 2013). Despite the global production, coal is mainly a domestic fuel-- 85 percent of coal is

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[1] Additional information regarding the development of the ARB protocol, how it meets the AB 32 offset criteria, and its potential environmental impacts is available in the staff report (ARB 2013).

[2] Information on specific voluntary offset projects is available at: http://www.climateactionreserve.org/ and http://www.v-c-s.org/.

[3] Information on EPA's CMOP is available at: http://www.epa.gov/cmop/.

consumed in the same country in which it is mined. The high proportion of domestic consumption is due largely to the cost of transporting coal.

Over time, domestic coal markets have become linked through international trade, specifically for coking and steam coal. In the last 30 years, coal exports have risen from 4 percent to 17 percent of total coal production (Conrnot-Gandolphe 2013). Increases in global fuel prices have made coal competitive on the global market, despite high transportation costs. Today, the quantity of coal exports is large enough to link coking and steam coal prices around the globe. While there are many types of coal and many domestic markets around the world, there are emerging global markets for both coking and steam coal.

In the past 30 years, the U.S. has also become a major coal exporter. In 2012, the U.S. produced just over one billion tons of coal, 126 million tons of which were exported, the highest export total ever for the U.S. (EIA 2014a). In 2012, the U.S. was the world's fourth largest exporter of coal behind Indonesia, Australia, and Russia (IEA 2012a). Table 1 presents a summary of U.S. coal production and consumption in 2012.

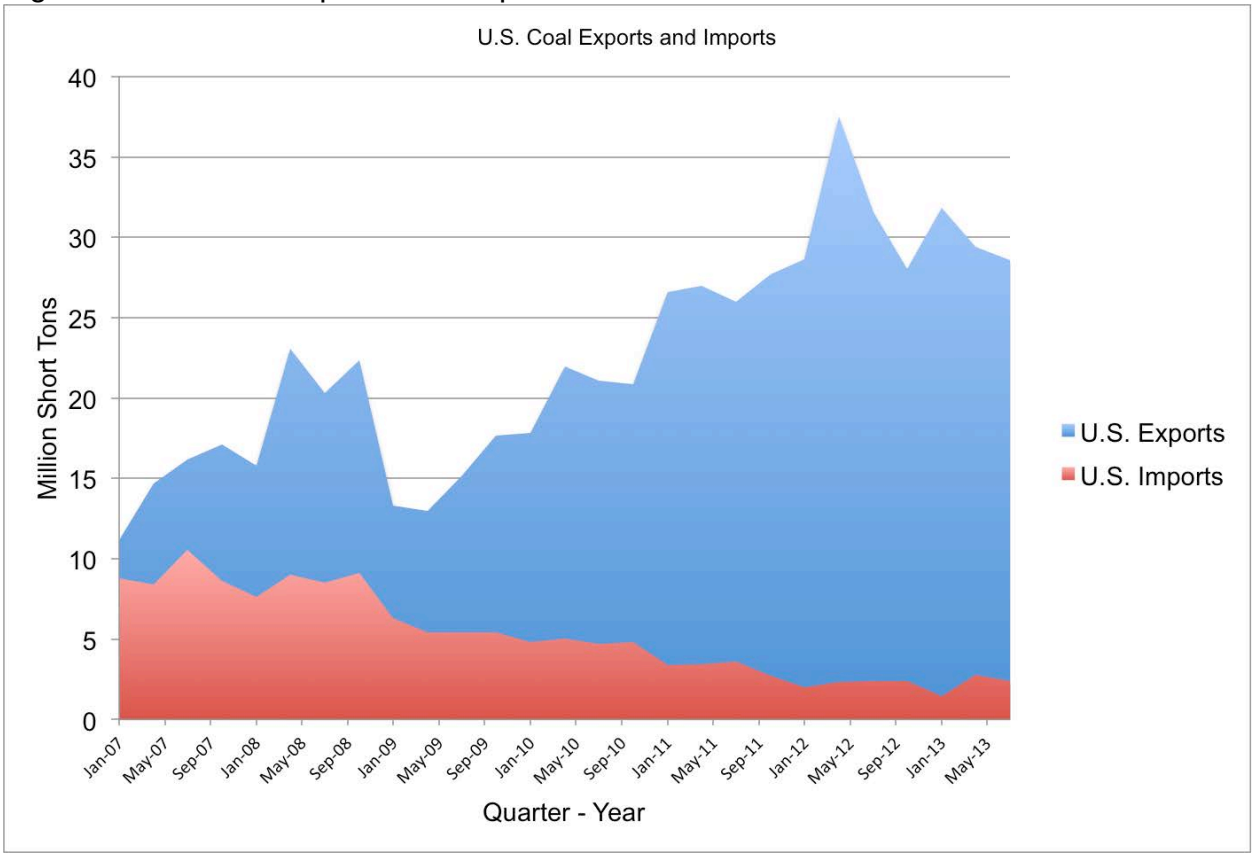
Table 1. 2012 U.S. Coal Summary

Coal Production	1,016.4 million tons
Coal Imports	9.2 million tons
Coal Exports	125.7 million tons
Coal Consumption	889.2 million tons
Electric Power Sector	*823.6 million tons*
Other Sectors	*65.6 million tons*

Adapted from EIA (2014a).

In 2012, U.S. coal production accounted for 13 percent of global hard coal production an amount nearly equivalent to the total amount of coal traded on the international market. Increasing demand for coal in developing nations and the extensive capacity of rail and port transport systems in the U.S. have contributed to the increasing quantity of coal exports, as presented in Figure 1.

Figure 1. U.S. Coal Imports and Exports



Adapted from EIA (2014).

The Price of Coal

The increasing global coal trade has unified the world's segmented coal markets into a world market, linking domestic coal prices (Ellerman 1995). The international coal price is based largely on the logistic costs of transportation and the difference between domestic and global prices can largely be explained by transportation costs. The overall price of coal, however, is largely determined by the costs of mining including the cost of labor, machinery, and accessing the coal. For the global hard coal market, mining costs compromise more than half the export price for most coal (Light 1999).

Table 2 presents the average price of U.S. exported and domestic coal by type during 2012. The U.S. price for steam coal varies by the end user and highlights the role of contracts in understanding the global and domestic market for coal. The domestic U.S. price is also higher than the export price, as the export price does not include transportation costs.[4]

[4] The export price is based on the free alongside ship (fas) value of the coal. This means that the price includes the seller placing the coal on a ship in the port of departure and the buyer is responsible for all subsequent transportation charges.

The price of coal in the U.S. can also vary by end-use, based in large part on the prevalence of contracts between coal mines and coal buyers. Coal contracts generally specify the delivery price, quantity and frequency of delivery, as well as the quality of the coal, the source of the coal, and the length of the contract (Joskow 1987). Structured contracts account for an estimated 70 percent of electric utility coal consumption in the U.S., more than any other sector (Joskow 1985). In 2012, the electric power sector accounted for 93 percent of U.S. coal consumption (EIA 2013a). This sector also secured the lowest average price for steam coal, outlining the impact of contract structure on the price of coal.

Table 2. 2012 Coal Prices in the U.S.

	Steam Coal	**Coking Coal**
Domestic (price per ton)	$45.77 / $70.33 / $90.76[+]	$190.55
Export (price per ton)	$77.02	$158.10

+ Average price paid by electric power end users, other industrial end users, and by commercial and institutional end users, respectively. Table adapted from EIA (2013a).

How does the value of the offset created by the protocol compare to the value of coal?

The value of the offset relative to the value of coal can be estimated cumulatively through 2020 as well as for individual mines. First, we estimate the value of offsets generated by the protocol. In consultation with project developers, mine operators, and researchers, staff estimates the protocol would result in emission reductions of 50 to 100 million metric tons through 2020.[5] Currently, offsets are being sold on the secondary market for approximately 85 percent of the price of current vintage allowances. Assuming the relationship between offset and allowance prices continues, the value of 100 million metric tons of offsets through 2020 is $1.2 billion at the Cap-and-Trade auction reserve price (currently $11.34 per metric ton).

The protocol only applies to coal mines in the continental U.S. Using EIA (2013) projections of U.S. coal production through 2020 and the lowest average domestic coal price in Table 2, the estimated value of U.S. coal production through 2020 is $267 billion.[6]

Conclusion: From 2014-2020, the estimated value of offsets generated through the protocol represents less than one half of one percent of the value of U.S. coal production.

This finding is sensitive to assumptions regarding the price and quantity of coal production as well as offset emission reductions. Increases in the price or quantity of

[5] This range is based in large part on inventory data collected by EPA on potential MMC projects (EPA 2008, 2008a, and 2009).
[6] The EIA forecast does not include any prospective or pending GHG reduction policies, only those currently in place.

offsets will increase the value of offsets relative to coal, while increases in the price or quantity of coal will reduce the value. Table 3 presents a sensitivity analysis in which the value of the offset relative to the value of coal is estimated under a range of values for the price of offsets and coal.

Table 3. MMC Offset Project Value Relative to the Value of Coal

MMC Offset Price (Dollars per Metric Ton)	**Coal Price (Dollars per Short Ton of Coal**		
	$45.77	**$75**	**$120**
85 percent of auction reserve price	0.45%	0.27%	0.17%
$10	0.37%	0.23%	0.14%
$30	1.1%	0.68%	0.43%
$50	1.9%	1.1%	0.71%

The value of MMC project offsets would represent 1.9 percent of the total value of U.S. coal production at an offset price of $50 through 2020. Raising the price of all domestic coal to $120 per ton would reduce the value of offsets relative to the value of coal to 0.17.

Next, we evaluate the impact of the MMC offset value on specific coal mines in the U.S. The value of the offsets generated at individual coal mines is estimated using data collected on voluntary offset projects developed by CAR and VCS. Table 4 presents the value of MCC project offsets relative to the value of coal produced at three active MMC projects. These estimates are based on mine specific production data and state-level coal pricing data from EIA (2013) and assume a $10 offset price, the approximate current price of offsets on the secondary market.

Table 4. Relative Value of MMC Offset Projects and Coal

Mine and State	2012 Coal Production (tons)	2012 State Average Coal Price	Estimated Annual Offset Potential	Offset Value Relative to Coal Value
North Antelope, WY	107,639,188	$14.24	100,000[7]	0.07%
McElroy, WV	9,400,485	$81.80	100,000[8]	0.13%
Blue Creek, AL	10,324,000	$106.57	25,000[9]	0.02%

Based on these estimates, the value of the offsets generated by the protocol represents less than one half of one percent of the value of U.S. coal mining.[10] This estimate is based on revenue and does not account for any costs associated with coal mining or the MMC offset project. In reality, costs represent a significant portion of the revenue generated both by the offset project and coal production.

In order to estimate the impact of the protocol on the profits of coal mining, we next compare the rate of return to the coal mine owner from MMC offset projects to the profits associated with coal mining. We assume coal mine profits average 10 percent[11] of domestic coal revenue and that the rate of return to coal mine owners from MMC offset projects is, on average, 15 percent of offset revenue.[12] Under these assumptions, from 2014-2020, the estimated return to coal mine owners from MMC offsets would be about 0.67 percent of the profit associated with coal mining.[13] Table 5 outlines the rate of return from MMC offset projects and the coal mine profits for the three voluntary MMC projects presented in Table 4.

[7] This is estimated from Ruby Canyon Engineering's Verification Report for the Verdugo McElroy VAM Abatement Project (2014), available at: http://www.climateactionreserve.org.

[8] This is estimated from First Environmental, Inc.'s Validation Report for the North Antelope Rochelle Coal Mine Methane Capture and Use Project Campbell County, Wyoming (2009). Available at: http://www.v-c-s.org.

[9] This is estimated from Ruby Canyon Engineering's Verification Report for the VAMOX Demonstration Project at JWR Shaft No. 4-9 (2010), available at: http://www.climateactionreserve.org.

[10] An offset price of $50 through 2020 would increase the value of MMC offset projects relative to the value of mined coal to 0.29 percent, 0.59 percent, and 0.10 percent, respectively for the three voluntary MMC projects.

[11] The 10 percent coal mine profit margin is provided by researchers at Stanford, who found an average profit margin of 9.4 percent across 6 U.S. coal mining companies from 2008 – 2012. Additional information is available at: http://www.arb.ca.gov/lists/com-attach/49-discussion-draft-ws-VCdUJl09VGlWNgRr.pdf.

[12] The 15 percent rate of return to coal mine owners from MMC projects is based on confidential MMC project data collected from three MMC voluntary offset project developers and relayed to staff at ARB.

[13] These estimates assume the offset price is 85 percent of the auction reserve price through 2020 and use the EIA (2013) forecast of U.S. coal production through 2020.

Table 5. Returns from MMC Offset Projects and Coal Profits

Mine and State	Estimated 2012 Coal Profit	Estimated Annual Return to Coal Mine from MMC Offset	Rate of Return of Offset Relative to Coal Profit
North Antelope, WY	$153,278,204	$450,000	0.29%
McElroy, WV	$76,895,967	$450,000	0.59%
Blue Creek, AL	$110,022,868	$112,500	0.10%

Conclusion: The returns to coal mines from MMC offset projects will be less than one percent of the profits earned on coal production.

This result holds when assumptions regarding the rate of return to the coal mine owner from MMC offsets and coal mine profits vary. Table 6 presents a sensitivity analysis of potential returns from MMC offsets and coal mine profit margins for the McElroy, WV mine that has a voluntary MMC project forecasted to produce 100,000 offsets annually.

Table 6: Returns from MMC Offset Projects and Coal Profits for the McElroy, WV Mine

Rate of Return From MMC Offset Project	Coal Mining Profit Margin		
	5 percent	10 percent	25 percent
10 percent	0.78%	0.39%	0.16%
15 percent	1.17%	0.59%	0.23%
25 percent	1.95%	0.98%	0.39%

Table 6 highlights the impact of assumptions on the potential rate of return from MMC offsets relative to coal profit – the return from MMC offset projects could vary from 0.16 percent to 1.95 percent of estimated coal mine profits.

Does the protocol encourage new coal mines to begin production?

Coal mines are long-term capital-intensive investments sensitive not only to current coal prices and profit margins, but also to forecasts of market conditions well into the future. The return to coal mine owners generated by the protocol, estimated as less than one percent of coal mine profits, would not be sufficient to encourage investment in new domestic coal mines as the capital costs of initiating mining would dwarf the potential return on investment from the MMC offset project.

One method to estimate the impact of the protocol on the decision to open a coal mine is to look at the payback period for the capital investments required to open a coal mine. These initial costs include land leases, acquisition of mineral rights, and mining

equipment. Estimating the initial capital costs at $250 million[14], we can compare the payback period of the investment with and without the increased rate of return from the MMC offset project.[15] Using the 2012 average underground coal price of $66.56 and an annual production of 4 million tons, equivalent to the annual production of the 50th largest U.S. coal mine, the payback period for the capital investment is 9 years and 5 months, or 113 months (EIA 2013). This assumes there is no carrying cost and that all profit from the coal mine, including returns to the coal mine owner from the offset, is used to pay down the capital investment.

Adding a MMC project generating 100,000 metric tons of emission reductions each year to this representative coal mine would increase mine profits by 0.56 percent each year. This would not result in the upfront capital cost of $250 million being repaid earlier.[16]

This result is not sensitive to changes in offset price or returns to the coal mine owner from the MMC offset project. Looking at a range of offset prices from $10 to $50 and offset returns from 10 to 25 percent, the capital investment does not has a shorter payback period MMC offset project. The rate of return to the coal mine owner from the MMC offset project would not be sufficient to alter long-term investment decisions.

Conclusion: The protocol would not encourage any domestic coal mine to begin production.

Does the protocol encourage existing mines to produce more coal?

EIA collects data on the capacity utilization of U.S. coal mines. This value represents annual coal mine production as a percent of total possible coal production. In 2012, the average capacity utilization of coal mines was 79 percent (EIA 2013). This means that, on average, coal mines could increase production by 21 percent. Using state-level data on capacity utilization, Table 7 estimates the remaining mine production capacity and the additional profit that could be realized from coal mine expansion for the three mines with MMC projects detailed in Table 4, Table 5, and Table 6.

[14] The estimated capital cost roughly corresponds to information published in 1976 by the Department of the Interior in which the upfront investment required for an underground coal mine with annual production of 2.6 million tons is equivalent to $259 million in 2012 dollars (Duda 1976).

[16] This example assumes an offset price of $10 and a 15 percent rate of return to coal mine owners from MMC offset projects.

Table 7. Capacity Utilization for U.S. Coal Mines

Mine and State	Remaining Mine Capacity	Estimated Additional Annual Profit	Estimated Annual Return to Coal Mine from MMC Offset Project	Return from Offset Relative to Additional Profit
North Antelope, WY	22,990,895	$32,739,034	$150,000	0.46%
McElroy, WV	2,335,451	$19,103,992	$150,000	0.79%
Blue Creek, AL	1,779,165	$18,960,565	$37,500	0.20%

The additional profits that could be gained by expanding mine capacity represent roughly 20 percent of the estimated 2012 profit of these mines. Irrespective of the protocol, coal mine owners have a large financial incentive to maximize the capacity of the coal mine. The fact that annual coal mine production is less than possible mine production suggests that there are additional factors affecting the production decisions at the mines, which may include geologic conditions, mine safety regulations, labor regulations, lease terms for land and mineral rights, and market conditions (i.e., demand).

The rate of return to the coal mine owner from MCC offset projects would not be large enough to encourage existing coal mines to expand production. The development of a coal mine occurs over many years and production decisions are based on market fundamentals and the cost of production which are not influenced by MMC offset projects.

Conclusion: The protocol would not offer enough additional profit to coal mine owners to change the long-term production decisions of a coal mine.

Would the protocol shift production among existing coal mines?

The vast majority, 93 percent, of coal produced in the U.S. is consumed by the electric power sector and an estimated 70 percent is purchased through a structured contract.[17] The prevalence of structured contracts, some lasting up to 50 years, makes switching coal suppliers difficult. In addition, coal-fired power plants are designed to burn specific types of coal. Deviating from expected coal quality can lead to costly repairs and loss of performance (Joskow 1986). When switching coal suppliers, an electric power

[17] An estimated 15 percent is purchased on the spot market and the remaining 15 percent is purchased through a vertically integrated mine (Joskow 1985).

generator must ensure the new supplier is producing the same type of coal with similar properties.

Conclusion: It is unlikely that the protocol would shift production among existing coal mines based on the prevalence of structured contracts and the variation in coal quality by mine.

Does the protocol impact the price of coal?

The protocol would not impact the supply of coal; no new mines would begin production and no existing mines would increase production. The returns from the MMC offset project to the mine owner would not impact the marginal cost of producing coal or transporting the coal and would not be represented in the price of coal.

The vast majority of coal produced in the U.S. is consumed in the U.S. The protocol would not change the domestic demand for coal, and therefore would it change the global demand for coal.

Conclusion: Without shifts in either the supply of coal or the demand for coal, the price of coal would not change and the protocol would have no impact on the price of coal.

Summary and Conclusion

In response to Resolution 13-44, staff finds that the protocol would have a nearly imperceptible impact on mine economics. While the protocol presents an opportunity to achieve emission reductions in a carbon-intensive industry, it would not encourage additional coal mining. The protocol would not expand nor extend the production of coal at any individual mine, nor change the global supply or demand for coal. On average, the rate of return from the MMC offset project would increase coal mine profits by less than one percent, which would not shift long-term production decisions.

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