

# Coal Mine Methane (CMM) Finance Guide

Updated July 2019



## Introduction

Global methane emissions from the coal mining sector can be reduced through recovery and utilization projects that collect methane gas from coal mines for productive use or through destruction when an economic use is not feasible.

The U.S. Environmental Protection Agency's (EPA's) Coalbed Methane Outreach Program (CMOP) is a voluntary program with the goal of reducing methane emissions from coal mining activities. Our mission is to promote the profitable recovery and utilization of coal mine methane (CMM), a potent greenhouse gas (GHG) that contributes to climate change if emitted to the atmosphere. When collected and used for energy, CMM is a valuable fuel source.

CMOP estimates that more than 200 CMM projects exist worldwide. Many more project opportunities exist in emerging market countries and also in developed economies.<sup>1</sup> Several factors have prompted the resurgent interest in CMM projects around the world. First, the steep growth in global energy demand has catalyzed the search for new, unconventional sources of natural gas and power. Second, emissions trading programs

1. GMI. 2019. Global Methane Challenge. It's Time to Take Action! Removing Fugitive Methane Gas from Underground Coal Mines and Using It in Profitable and Practical Ways Can Improve Worker Safety, Enhance Mine Productivity, Increase Revenues, and Reduce Greenhouse Gas Emissions. Global Methane Initiative. Available: <https://globalmethane.org/sectors/index.aspx?s=coal>. Accessed 6/3/2019.

such as the Kyoto Protocol's Clean Development Mechanism and Joint Implementation originally created financial markets and incentives to develop projects that reduce GHG emissions, and the California and Quebec Cap-and-Trade programs have expanded to include CMM offsets. More recently, Article 6 of the Paris Agreement provides a pathway for international cooperation through markets and carbon pricing associated with Nationally Determined Contributions. Third, multinational collaborative initiatives such as the Global Methane Initiative ([www.globalmethane.org](http://www.globalmethane.org)) have focused on overcoming policy, regulatory, legal, and technical barriers that inhibit project development.

Often, the critical barrier to developing CMM projects is securing financing. This is due, in part, to the lack of awareness of the sources of finance and limited understanding of the requirements to secure financing. In fact, many funding and investment sources emphasize sustainable development, environmental protection, and climate change mitigation as strategic objectives and important components of projects that they finance. CMOP has developed this guide to address this information gap for project hosts, project developers, and investors who are interested in pursuing CMM project opportunities. In addition, the *CMM Finance Guide* can also be used to inform government decision-making to support CMM project development.

This guide summarizes the market potential for CMM projects (e.g., sources/uses of CMM),



project economics, types of financing, and risk mitigation in the United States and internationally. Particular attention has been paid to the emerging markets of carbon credits as potential project funding.

### **Disclaimer**

This version of the *Coal Mine Methane Finance Guide* is an update of the 2016 edition prepared by EPA. This analysis uses publicly available information in combination with information obtained through direct contact with mine personnel, equipment vendors, and project developers. The EPA does not:

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## Overview of Methane Capture and Use Projects

### Why Target Methane?

Methane, one of the principal greenhouse gases (GHGs), is second only to carbon dioxide (CO<sub>2</sub>) in its contribution to climate change. Globally, it accounts for approximately 20 percent of total global GHGs.<sup>2</sup> Methane is a potent GHG that is more than 28 to 34 times more effective in trapping heat than CO<sub>2</sub> over a 100-year timeframe.<sup>3</sup> Global average atmospheric methane concentrations have more than doubled – from approximately 700 to 1,853 parts per billion by volume – over the time period from 1750 to 2016, an increase of 257 percent.<sup>4</sup>

### Sources of Coal Mine Methane

Coal mines are a primary source of methane, accounting for an estimated 9 percent of global anthropogenic methane emissions by 2020.<sup>5</sup> Methane and coal are formed together during the conversion of vegetation into coal. Coal mine methane (CMM) refers to methane released from the coal and surrounding rock strata due to mining activities. In underground mines, it can create an explosive hazard to coal miners, so it is removed through ventilation systems. In some instances, it is necessary to supplement the ventilation with a degasification system to remove methane from the mine. Figure 1 illustrates how methane may be removed

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<sup>2</sup> IPCC. 2014. *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change* [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. Geneva, Switzerland.

<sup>3</sup> Ibid.

<sup>4</sup> WMO. 2017. *WMO Greenhouse Gas Bulletin: The State of Greenhouse Gases in the Atmosphere Based on Global Observations through 2016*. World Meteorological Organization, Geneva, Switzerland. October 30.

<sup>5</sup> EPA. 2012. *Global Anthropogenic Non-CO<sub>2</sub> Greenhouse Gas Emissions: 1990–2030*. Revised December. U.S. Environmental Protection Agency, Washington, DC. Available: [https://www.epa.gov/sites/production/files/2016-05/documents/epa\\_global\\_nonco2\\_projections\\_dec2012.pdf](https://www.epa.gov/sites/production/files/2016-05/documents/epa_global_nonco2_projections_dec2012.pdf). Accessed 6/3/2019.

from longwall mines through the ventilation system and a combination of gob wells, pre-mine drainage wells, and in-mine boreholes.

### Recovery and Use of CMM

Specific CMM end uses essentially depend on gas availability (i.e., gas quality, quantity, and market access). Worldwide, CMM is most often used as a primary fuel for power generation, district heating, boiler fuel, flaring, and town gas.<sup>6</sup> It is also sold to natural gas pipeline systems. Other uses of CMM include:

- Coal drying
- Heat source for mine ventilation air
- Supplemental fuel for mine boilers
- Vehicle fuel as compressed or liquefied natural gas (CNG/LNG)
- Manufacturing feedstock
- Direct gas sales to industrial or other end users

In addition to drained CMM, mine ventilation air methane (VAM) can also be captured and used, or destroyed. VAM refers to the very dilute methane stream in mine ventilation air that is generally less than 2 percent methane and often less than 1 percent methane. Despite this low-methane concentration, VAM is the single largest source of CMM emissions. Absent a cost-effective use, destruction of methane still presents significant environmental benefit due to the reduction of GHGs.

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<sup>6</sup> Town gas refers to local use of non-upgraded CMM gas (typically 30–40 percent methane) for heating and cooking.

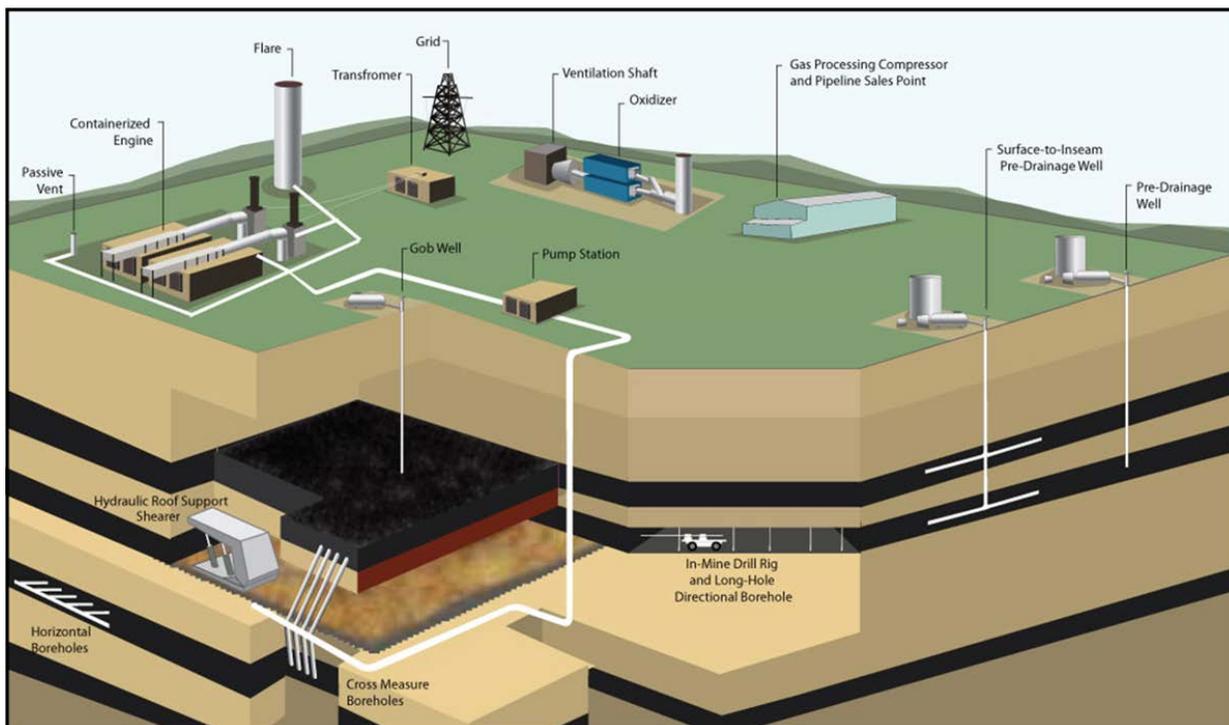


Figure 1. Removal of CMM from Longwall Mines

Methane may also be present in non-coal mines, usually in adjacent strata including sandstone, limestone, shale, and other coalbeds. Longwall mining introduces methane into the mine through collapse of the roof and floor or where conduits within the subsurface provide a transport pathway for methane into the mine. To differentiate from CMM, gas in non-coal mines is sometimes referred to as waste mine methane. Examples include deep gold mines, trona (soda ash) mines, and salt mines.

### CMM Project Market

It is estimated that over 200 CMM projects worldwide in 17 countries, in total, recover and use more than 5.5 billion cubic meters of gas annually from active and abandoned coal mines, thereby avoiding 77 million metric tons of carbon dioxide equivalent (MtCO<sub>2</sub>e) of GHG emissions each year.<sup>7</sup>

There are three main types of CMM recovery projects:

- **Drainage systems:** Globally, the greatest volume of CMM recovered and used is from drainage (degasification) systems at active underground coal mines. Degasification systems are employed at some of the most gassy coal mines in many countries.
- **Ventilation air methane (VAM):** VAM projects are currently operating in two countries: China and the United States (U.S.).
- **Abandoned underground mines:** Several countries with declining coal production are effectively capturing and using the methane from their closed abandoned (closed) underground coal mines, including France and Japan, where active underground mining has ceased.

### Project Opportunities

Drained gas is the methane captured or recovered from degasification systems at underground coal mines. Pre-mine drainage produces very high-quality gas with methane

<sup>7</sup> GMI. 2015. Internal Program Information. Global Methane Initiative. December.

concentrations that can exceed 90 percent. Gob wells generally produce lower-quality gas due to entrained air and other impurities. Methane concentration in gob gas varies widely, from less than 25 percent in some Chinese mines to 80 percent in some U.S. mines, depending on the age of the well and how carefully the air intrusion is controlled. Currently in the U.S., 25 underground coal mines employ degasification systems, liberating about 40 billion cubic feet (Bcf; 1.13 billion cubic meters) in 2017. Of this amount, about 32 Bcf were recovered and utilized for energy.<sup>8</sup> In addition, another 560 million cubic feet (mmcf) of VAM were destroyed using regenerative thermal oxidation.

Globally, most drained gas is used in internal combustion engines to generate power. Many countries including Australia, China, the Czech Republic, Germany, Russia, Ukraine, and the United Kingdom have projects of this type. Boiler fuel is another common use of CMM in many countries. In the U.S., natural gas pipeline sales are the most common CMM use, largely the result of a very mature and extensive natural gas transportation system and the common practice of pre-mine drainage that produces pipeline-quality gas. Other common uses for drained gas include locally distributed town gas, coal drying, mine shaft heating, vehicle fuel, flaring, and industrial uses. Flaring in particular has become a more accepted GHG mitigation practice in recent years as safe flaring has been demonstrated and the coal industry has grown more comfortable with the flaring practice.

Due to its low methane concentrations, VAM destruction is very dependent on non-traditional revenue streams at many sites.

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<sup>8</sup> Compiled from the EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2017 (available: <https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2017>, accessed 6/3/2019) and the Greenhouse Gas Reporting Program (available: <https://www.epa.gov/ghgreporting>, accessed 6/3/2019).

Although several technologies have been proposed, only regenerative thermal oxidizers (RTOs) have been proven at the industrial scale. RTOs have been used for many years in other industries to destroy volatile organic compounds and the technology has been successfully adapted to destroy VAM emissions. In addition to destruction purposes, the heat can be recovered for use in mine heating, district heating, power generation, and desiccant cooling. The economic feasibility of these projects on a commercial scale is currently being demonstrated in Australia, and projects are in operation or under development in China and the U.S.

Other VAM abatement technologies, including regenerative catalytic oxidizers, rotary kilns mixing VAM with a combustible fuel such as pulverized coal, and lean-burn microturbines have been laboratory tested on a small scale or demonstrated in the field, but have not yet operated at a commercial site.

Even where active mining no longer occurs, abandoned or closed underground coal mines can still produce significant methane emissions [known as abandoned mine methane (AMM)] from diffuse vents, fissures, or boreholes. This methane can be deliberately extracted and used to generate power or for other end uses. There are several thousand abandoned coal mines in the U.S. Of these, EPA has identified some 400 abandoned mines that are considered “gassy” and developed profiles for abandoned mines that might be good candidates for project development.<sup>9</sup>

### *CMM Project Development*

For CMM projects, project development generally entails some or all steps from

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<sup>9</sup> EPA. 2017. Abandoned Coal Mine Methane Opportunities Database. U.S. Environmental Protection Agency, Washington, DC. July. Available: [https://www.epa.gov/sites/production/files/2016-03/documents/amm\\_opportunities\\_database.pdf](https://www.epa.gov/sites/production/files/2016-03/documents/amm_opportunities_database.pdf). Accessed 6/3/2019.

conceptualization to operation. This includes defining and refining the project concept, negotiations with the project host, modeling gas availability, evaluating the technical and economic viability of the project, designing and financing the project, and acquiring equipment and services. It also entails project construction, installation, and commissioning. A developer will also identify end-use markets and secure off-take agreements.

Typical project participants include the mine owner/operator, the project developer (if different from the mine owner/operator), equipment suppliers, EPC (Engineering, Procurement, and Construction) contractors, regulatory agencies, and the end user or energy buyer. Project structuring is very important in project development. In some cases, project developers create a defined legal entity solely to build and operate the CMM facility. This practice of “ring-fencing” projects can provide certain legal protections to the project’s partners; establish clear roles and responsibilities for the project’s construction and operation; ensure that project partners have a say in decision-making commensurate with their investment; and add transparency for purposes of taxes, royalties, profit distribution, and share value. However, providing sufficient detail on project structuring is beyond the capacity of this document. For the purpose of this guide, the focus is on assessing the initial project economics (e.g., costs) and securing financing for CMM projects.

### *CMM Project Feasibility*

A project developer or investor must demonstrate a CMM project’s technical feasibility and financial viability in order to secure project financing. The project’s technical viability can be demonstrated through a combination of the following: preliminary feasibility or pre-feasibility studies (PFSs); full-scale, comprehensive feasibility studies (FSs); and technology demonstrations or pilot installations. These critical processes

and analyses are typically funded by the project developer; investors; and in some cases funding assistance may be available in the form of grants from government-supported agencies or multilateral development organizations, including the U.S. Trade and Development Agency (USTDA), the U.S. Agency for International Development, the U.S. Environmental Protection Agency (EPA), Australia’s Commonwealth Scientific and Industrial Research Organisation, Australia’s national government, the Asian Development Bank (ADB), the Global Environment Facility (GEF), the International Finance Corporation (IFC)/World Bank Group, the European Bank for Reconstruction and Development (EBRD), and the Japan Bank for International Cooperation (JBIC).

### *Project Idea Note or Project Concept Paper*

The first step in the project development pipeline is often an internal memorandum or a project idea note (PIN). The PIN is intended to be a brief and cursory project summary for initial decisions at an early stage before too much time and money is spent pursuing project development. A PIN will typically identify the project, the project host, the expected energy production and/or environmental attributes (e.g., carbon credits or renewable energy certificates) to be generated from the project, and the prospective off-takers of any energy or environmental commodities. Project opportunities and risks are reviewed at a very general level, and the PIN may include so-called “back of the envelope” calculations of project economics. A PIN is not required in every case, especially where reliable data exist and much is known about the host mine and the relevant markets. In these instances, a project sponsor may choose to begin with a PFS or move directly toward a full FS.

### *Pre-Feasibility Studies and Feasibility Studies*

The PFS is a first-order analysis of possible project configurations including location, size,

technology to be employed, market(s) to be served, costs, and revenues. The PFS identifies options that appear to be technically feasible and economically attractive. Typically, the PFS will be conducted at a level of detail adequate to broadly identify financing requirements and considers the potential capital structure, taking into account expected project cash flows under various scenarios. PFSs are usually based on conceptual engineering designs and typically have expected accuracy margins of plus or minus 20 percent. If the PFS indicates a potentially viable project, a more in-depth analysis, such as a comprehensive FS, would be conducted.

A comprehensive FS is a rigorous, detailed assessment of the technical and economic viability of a CMM project at a specific site or group of sites. The objective is to perform due diligence to determine if financial investment in the project is warranted, given the project risks. A comprehensive FS considers the financial as well as technical, legal, regulatory, and environmental elements of the potential project. Accuracy margins of plus or minus 10 percent are expected in the FS based on a higher level of engineering design than typically found in the PFS. Key elements of a comprehensive FS can be found in Appendix B.

Logistical, time, and financial costs are quite high for an FS at a coal mine, and several site visits and detailed information collection from mine site personnel are required. Such a study can typically take several months to a year or more to complete.

Historically, U.S. government agencies such as the USTDA<sup>10</sup> and EPA<sup>11</sup> have provided

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<sup>10</sup> The USTDA provides funding to facilitate the export of U.S. technologies, products, and services to developing and transitional countries. USTDA has provided grant funding for CMM studies in Poland, China, Ukraine, and Colombia (see <https://www.ustda.gov/>).

<sup>11</sup> EPA has funded a number of CMM pre-FSs and comprehensive FSs as part of its support for the Global Methane Initiative (GMI), including in China, India, Kazakhstan, Mongolia, Poland, Russia, Turkey, and

some technical expertise in identifying technically and economically feasible projects, particularly in international markets where there is a potential market for U.S. goods and services. EPA has supported several CMM pre-feasibility and comprehensive feasibility studies as part of its support for the GMI (see <https://www.epa.gov/cmop/international-activities>).

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Ukraine (see <https://www.epa.gov/cmop/international-activities>).

## CMM Project Economics

This section identifies the primary revenue streams and costs for typical CMM projects, as well as some of the risks associated with these projects.

### *CMM Project Revenue Streams*

- Revenues: CMM projects might generate revenues through the sale of gas or electricity, and/or realize cost savings from avoided energy costs.
- Carbon credits (e.g., GHG offsets, emissions reductions): CMM projects capture and utilize methane that would otherwise be vented into the atmosphere, thus reducing GHG emissions. These emission reductions, if properly verified, might be considered GHG offsets and sold as “carbon credits.” The financing opportunities associated with carbon credits are discussed further in the Carbon Financing section on 13.
- Renewable or Alternative Energy Credits (RECs/AECs): In certain U.S. states, the implementation of renewable or alternative portfolio standards has created RECs or AECs that may be sold to electricity producers to satisfy requirements for the generation of electricity from renewable or alternative sources. A handful of states now include CMM as a renewable or alternative fuel. Other incentives for “clean” energy development include feed-in tariffs or green energy tariffs that provide a higher rate for alternative energy. Such tariff structures may also mandate that the power grid accept all energy supplied by the alternative energy source. Countries including Germany and the United Kingdom have used green power tariff

structures to encourage use of CMM and AMM.<sup>12</sup>

- Tax credits: In certain jurisdictions, tax credits might be available for the development or recovery of CMM projects.<sup>13</sup>

### *CMM Project Costs*

Four general categories of costs are associated with CMM projects.

#### *Capital Costs*

Capital costs include costs associated with the development, construction, and financing of the project. Typical capital cost components are listed in Table 1.

Total capital costs of a CMM project to produce and sell pipeline-quality gas are likely to be several million dollars. Projects involving enrichment, power production (electricity generation), or equipment conversion may be more expensive, sometimes involving initial costs of more than \$10 million, even with an existing gas recovery system.

#### *Operating Expenses*

A project’s operating costs depend on the project’s complexity and the end product that is being sold. Operating costs for gas sales projects using high-quality gas from pre-mine drainage are generally lower than gas sales projects involving gas upgrade or enrichment, which, in turn, is lower than operating costs for electricity generation projects. Operating costs components include:

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<sup>12</sup> EPA. Undated. Coalbed Methane Outreach Program (CMOP). U.S. Environmental Protection Agency. Available: <https://www.epa.gov/sites/production/files/2016-03/documents/cmop-emerging-incentives-flyer.pdf>. Accessed 6/3/2019.

<sup>13</sup> Please contact legal and accounting advisors to determine if tax credits apply.

- Personnel, maintenance, and operation of gas recovery systems.
- Annual operating costs for compressors, a water/gas separator, and equipment maintenance and insurance.<sup>14</sup>

### Royalties, Fees, and Other Expenses

Royalties are assessed for the gas used by project developers who are not the owner of the gas rights. Generally, royalties are only assessed where the project generates revenues from energy and/or carbon credit sales. However, mineral rights owners may seek royalties on the lost mineral resource even when no revenue is generated because CMM is used onsite. On U.S. federal lands, the prevailing royalty rate is 12.5 percent, subject to individual contract negotiations. On private lands/leases, the royalty rate is negotiated but is typically at or near 12.5 percent.

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<sup>14</sup> For more project-specific information on capital and operating costs, please see EPA's Coal Mine Methane Project Cash Flow Model at <https://www.epa.gov/cmop/cmm-cash-flow-model>. For more detailed information on gas upgrade costs, see EPA's document, *Upgrading Drained Coal Mine Methane to Pipeline Quality (2008)*, at <https://nepis.epa.gov/Exe/ZyPDF.cgi/P1004NI6.PDF?Dockey=P1004NI6.PDF>.

**Table 1. Royalties, Fees, and Other Expenses**

Capital Cost Component	Description of Activities and Equipment
Degasification system	Drill, install, and complete wells and boreholes, including water disposal. Project developers may view this as a “sunk” cost and not consider capital expenditures for a CMM use/destruction project because the mine must install the degasification system for safety, irrespective of the CMM project.
Gas collection and gathering system	Blowers, compressors, lines.
Gas processing system	Separators, dehydrators.
Engineering, design	Project design and engineering.
Land fees	One-time charges for securing site access.
Civil and electrical engineering	Construction of the road, pad, fencing, and other necessary site preparation; and electrical connection.
Permits, registrations, authorizations, and other legal fees	One-time fees for construction and operation permits, environmental permits, legal filings, etc.
Procurement of equipment to use or destroy CMM	Equipment procurement, delivery, installation, and commissioning.
Procurement of measurement and monitoring equipment and systems	Purchase and installation of methane monitors, flow meters, temperature and pressure monitors, and automated systems for accurate recording of emissions reductions.
Off-take agreements	One-time costs associated with securing off-take agreements for environmental and energy commodities generated by the project, including project validation costs for environmental markets.

### Project Development Costs

In absolute terms, project development and up-front financing costs are roughly the same irrespective of the project’s size, in percentage terms; however, they are a much bigger burden on smaller projects. A number of organizational and transactional costs are associated with project development, which might represent upward of 25 to 30 percent of the total capital costs. These costs include:

- Conducting due diligence or examining and verifying the assertions and records of other project parties.
- Other significant recurring non-operational expenses include:
  - Taxes (federal, state)
  - Financing-related costs (including interest)
  - Royalties.

### Assessing Financial Feasibility

Discounted cash flow analysis is the standard method used to evaluate an investment. The net present value (NPV) and internal rate of

return (IRR) are the most widely used tools for evaluating cash flow streams. NPV and IRR are the principal financial metrics used to assess the financial feasibility of a CMM project, but other metrics exist:

- **NPV:** The sum of a project’s net cash flows over the project’s life is discounted to the present. The discount rate used to make this calculation represents the investors’ cost of capital. If a project’s NPV is positive, then the project is deemed capable of yielding the investor’s minimum required return, and the investor usually undertakes the project. If the NPV is negative, the investor is likely to reject the project. In the case of mutually exclusive projects, the investor will typically select the project with the highest positive NPV.
- **IRR:** The IRR on a project is the discount rate at which the NPV of the project’s net cash flow is zero. In other words, it is the rate that equates the present value of a project’s cash outflows with the present

value of a project's cash inflows. A project's expected IRR can be compared with return rates on alternative investment opportunities. Investors will typically undertake projects where the IRR is greater than the opportunity cost of capital (i.e., the IRR exceeds the hurdle rate). Hurdle rates vary and are specific to each investor. In addition to the cost of capital, factors considered in defining the hurdle rate include project risk, country risk, counterparty risk, and currency risk. The greater the risk, the higher the hurdle rate to compensate for the increased probability of an investment loss. Project developers and investors may specify hurdle rates as "pre-tax" and "post-tax" to clarify expectations.

- **Payback period:** The length of time (e.g., years or months) required to recover the initial investment in a project is its payback period. Since the payback period does not measure profitability, it is generally not used by itself to make an investment decision. Shorter payback periods are preferred to longer payback periods, and projects are often accepted if the payback period is less than a pre-specified number of years. The discounted payback period follows the same concept except it uses discounted cash flows to calculate the payback period.
- **Profitability index (PI):** PI is the present value of a project's future cash flows divided by the initial investment. PI, which is closely related to NPV, will be greater than one when NPV is positive. The financial attractiveness of a project increases as the value of the PI increases. A value lower than one indicates the project's present value is less than the initial investment, and a PI of one indicates a break-even point.

A sensitivity analysis should also be carried out to examine the impact of risks on project returns. Risks could include changes in key financial variables such as gas production or

electricity prices. A sound financial analysis should at a minimum include base, high, and low cases based on reasonable assumptions for all three cases.

The Coalbed Methane Outreach Program (CMOP) has developed the Coal Mine Methane Project Cash Flow Model,<sup>15</sup> a web-based cost-benefit analysis tool to assist project developers in evaluating the potential economic viability of recovering and beneficially using CMM. The model is intended to present an initial high-level assessment of project costs and returns, rather than a detailed analysis. If the model shows the potential for positive returns, project sponsors should then utilize a more rigorous project financial model tailored to support detailed project feasibility studies necessary for financing. Project financial models (also known as pro formas) should be sufficiently detailed to provide a reasonable and defensible projection of project revenues, costs, and returns. At the same time, a project financial model should be clearly organized and auditable with clear supporting documentation. Project sponsors can expect to share their model with any prudent and serious investors during due diligence ahead of financing.

### *CMM Project Development Risks*

Thoroughly identifying and understanding the risks associated with CMM projects are necessary for any successful project. Financing, in particular, is greatly impacted by project risks because the level and cost of financing are largely dependent on the actual and perceived risks associated with the project.

Identification and assessment of risks and adoption of a risk mitigation plan are not only critical steps in designing and operating the

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<sup>15</sup> EPA. 2019. Coalbed Methane Outreach Program CMM Cash Flow Model. Available: <https://www.epa.gov/cmop/cmm-cash-flow-model>. Last updated February 19. Accessed 6/3/2019.

project, but also in securing finance. Project developers may start with a very general risk analysis graduating to a thorough and detailed analysis. A systematic approach may also be employed to standardize completion of risk assessments within an organization.

For CMM projects, project development risks can include:

- Inability to obtain agreements with the mining company and adjacent land owners.
- Indications of marginal gas resource (such as gas quality, rate of flow, and longevity).
- Inability to negotiate energy sale agreements.
- Inability to obtain permits.
- Insufficient development capital.
- Inability to secure financing.

Project risks change depending on the stage of the project: development, construction, or operation. The equity investor generally bears the development risks of a project – those risks associated with the developer’s ability to complete the project and receive project cash flows. In this case, the developer/investor would be unable to recover “sunk” costs, such as legal or consulting fees incurred. Construction and operations risks might also be associated with substantial losses.

Project developers should identify and prioritize the risks that present the greatest threats to the project, and develop a risk management plan that identifies mitigation strategies for each of these risks.

### *Mine Operation Risks*

Mine operators might encounter a separate set of potential risks than project developers and/or investors. Mine managers are primarily concerned with the productivity and profitability of their mining operations. Mine operators are also concerned about potential risks that the CMM project could pose to their

coal operations in terms of safety and flexibility, as well as the risks of the project itself. Possible risks for mine operations include:

- Interference with mining operations: Coordinating gas production and use with coal operations require both detailed planning and great attention to implementation, which could potentially distract from or interfere with coal production, or both.
- Reduction in mine planning flexibility: Mine operators might be concerned that gas operations will limit their ability to change plans at a given mine or to close or sell a mine (e.g., contracts requiring delivery of specified amounts of gas over a given timeframe could infringe on the ability to alter coal mining operations).

### **CMM Project Financing**

Often, the critical barrier to developing CMM projects is securing financing. In part, this is due to the lack of awareness of the sources of finance and limited understanding of the requirements to secure financing. In fact, many funding and investment sources emphasize sustainable development, environmental protection, and climate change mitigation as strategic objectives and important components of projects that they finance. The arrival of carbon finance provided much-needed risk capital to underwrite wide-scale deployment of CMM projects [e.g., leading to the construction and operation of 64 projects between 2005 and 2012 in the Clean Development Mechanism (CDM) and Joint Implementation (JI)].<sup>16</sup> However, in recent years many investors have pulled back or exited the market altogether due to uncertainty over the future direction of international and

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<sup>16</sup> Ruiz, F., R. Pilcher, and C. Talkington. 2014. Addressing Barriers to Global Deployment of Best Practices to Reduce Methane Emissions from Coal Mines. 7th International Symposium on Non-CO<sub>2</sub> Greenhouse Gases. Amsterdam, the Netherlands. November.

U.S. environmental markets. While sources of funding remain, project sponsors interested in CMM, including coal mining companies and project developers, should be prepared for increased competition for development capital.

Project financing options include direct project investment in the form of capital and/or in-kind contributions (equity and equity financing), loans (debt financing), and structured trade financing (carbon finance, export trade finance, etc.). Actual project structuring will likely consist of a mixture of these financing options, which can be grouped into traditional and supplemental sources of financing as discussed below.

### *Traditional Sources of Financing*

- Financing off the balance sheet: Coal mining companies and developers with significant asset bases are able to finance CMM projects off their balance sheets. In effect, this means that a company can secure a loan with little or no collateral, which can occur when an established investor holds assets of such scale that an equity investment or debt instrument will not threaten the solvency of the company. Smaller developers may look to approach some of these companies with a proposal to partner on specific projects. In practice, many CMM projects developed in the U.S. have been financed through corporate resources rather than project-specific equity and debt. The potential advantages are lower financing costs and quicker turnaround.
- Equity: Securing equity is the most likely option for developers, and can come from several different sources:
  - Project developers and investors may have capital available for investment, although industry consolidation has made access to capital more competitive. This capital may come from corporate equity or through management of an investment fund established with the developer as a managing partner and other investors being limited partners. Typically, a fund will hold contributions from pension funds, foundations, high net-worth individuals, and other sources with sustainability goals and specific investment targets.
  - Compliance buyers in the European Union Emissions Trading Scheme (EU ETS), Japan, and other markets continue to initiate and invest in offset projects to meet their current or anticipated regulatory obligations.
  - Commodity trading houses that have not exited the market may seek assets that produce emissions reductions for their trading platforms, and with industry consolidation underway, many trading firms have looked to take equity stakes in projects or developers, or even acquire the developer outright.
  - Private equity, including venture capital, is also possible, but private equity firms generally show limited interest in carbon offset projects in today's market. Private equity typically has a very short investment horizon of three–seven years with high return expectations, and the relatively small scale of many projects does not meet investment criteria for these firms. One possibility is to aggregate a portfolio of projects presenting a larger investment opportunity. Most likely an equity investor will want to see that the project sponsor has a financial stake in the project. The advantage of equity financing for CMM projects is that it is more likely to be available than debt financing, and it strengthens the balance sheet by minimizing debt. Any project developer accepting equity, however, must recognize that equity shareholders may expect significant input into the project.

- Debt: For smaller companies or for companies with a limited operational history, securing debt financing is more difficult than for larger, more established companies. As with private equity, project size becomes a critical issue. The costs to conduct due diligence and extend financing are not that much greater for a larger project than a small project, but the returns to the investor or lender are significantly greater for a large project. Thus, there is more incentive to lend to a larger project. While acceptable debt-to-equity ratios vary, project financing using project debt can be highly leveraged, even up to 70 percent or 80 percent of total costs. Supporting agreements and creditworthiness of counterparties, especially for off-take agreements, are necessary; and scrutiny is very high for debt financing, especially for non-recourse finance. Lenders may require onerous terms for lending such as extensive collateral requirements or personal loan guarantees. The advantage of debt is that the project sponsor retains full “ownership” of the project compared with equity investment. Debt can improve the financial returns of a project when interest rates are very low. Challenges with debt financing include risk exposure if the project cannot service the loan at any point, fluctuating interest rates that are standard for a commercial loan, and in many cases the ability of the lender to demand the repayment of a commercial loan at any time.
- Vendor financing: Another possibility is vendor financing, whereby the equipment supplier takes an equity stake or extends a line of credit or loan facility to the project. This is a common model in the manufacturing sector and has been used in the CMM industry. In some cases, suppliers are backed by private equity groups or other investors who are looking to pair equipment sales or leases with project investment. Competition among

suppliers, combined with a slowdown in the market, may further incentivize suppliers to employ vendor financing. Individual product vendors and manufacturers, such as Caterpillar, General Electric, and Ingersoll Rand, offer a range of financing products for financing of equipment as part of a structured project finance arrangement, including capital leases, loans, fixed purchase options, and operating leases. The advantages of vendor financing are that it can be expedited and tailored by a vendor familiar with CMM projects. The loan agreement may also allow for the facilitated sale or loan of the project equipment should the project cease operation at any time in the future. A disadvantage may be a higher interest rate for these additional services as well as being tied to a specific equipment supplier.

- Multilateral, regional, and bilateral financial institutions: These institutions provide a range of debt, equity, and mezzanine instruments; and CMM projects meet many of their social and environmental goals. Although they prefer to finance projects greater than \$25 million, they may consider smaller projects. A portfolio or regional approach may be more attractive. Given the nature and purpose of international financial and bilateral financial institutions, project sponsors accessing multi-lateral or bilateral funds should be prepared to work through a detailed, prescriptive, and sometimes time-consuming process that may entail a public review of the project. These financing sources also often require that projects meet certain social and environmental objectives. For example, developmental impact and environmental impact assessments will be required as may a life-cycle cost analysis inclusive of social cost-benefit. Depending on the source of finance, lending is often government-to-government (i.e., project

finance must flow through the host government before moving to the project). A key advantage of multilateral and bilateral financing is the institution's ability to provide low-interest rate loans and take on country risk. They can sometimes provide technical assistance grant funds to support ancillary project objectives, and have ties to investment funds that can place equity into a project. The disadvantage to multilateral or bilateral funds can be the amount of time and the process required to secure the funds.

### *Supplemental Financing Sources and Other Incentives*

Many CMM utilization projects can offer financial returns that are sufficient on their own merits to attract traditional investors and lenders. For other projects, supplemental financing and other incentives may be required to make them an attractive investment. The sale of carbon credits from GHG emissions reductions is particularly useful for improving the cash flow of projects that are otherwise economically marginal and, therefore, unattractive to investors. Other incentives are realized through participation in renewable or alternative energy programs; federal- and state-sponsored capital investment incentives, grants, and tax benefits are also available to facilitate investment in CMM projects.

### *Carbon Financing*

Sufficient capital is necessary to originate, design, build, and operate a project. In some cases, CMM projects are unable to meet preferred rates of return on commodity sales alone. Carbon finance, which is tied to project-based GHG reductions, is an incremental source of finance that has the potential to generate additional revenues capable of making these projects "bankable."

Prior to 2005, voluntary carbon markets were the principal source of carbon finance in the

U.S. and internationally. Trading volumes were relatively small due to the voluntary nature of the markets and prices remained low. This changed when the EU ETS commenced in January 2005 followed by the Kyoto Protocol coming into force in February of that year. Together, these two events established a liquid international carbon market. Prices for international carbon credits (one tonne of CO<sub>2</sub> equivalent, CO<sub>2</sub>e) rose at a rapid pace in anticipation of these new markets, but declined dramatically following the end of the Kyoto Protocol's first commitment period (CP1) in December 2012.

As the markets took hold during CP1, capital began flowing at a rapid pace and in large quantities to project developers, allowing them to contract CMM projects in China, India, the Former Soviet Union, and Eastern Europe. In most cases, the availability of funding for methane-to-energy projects were directly or indirectly tied to the future value of the carbon credits generated by the project, and became known as carbon finance.

Among industry sectors, interest in CMM was especially high due in large part to the potential scale of emissions at the project level. Moreover, emissions at active mines are tied to a limited number of specific point sources, making them readily measurable and verifiable; CMM utilization and destruction technologies are proven in the field. Also attractive to investors were the contributions to sustainable development, namely mine safety and localized energy production.

The market in the U.S., by contrast, has evolved quite differently. Initially, without an active compliance market available for CMM offsets, the voluntary and pre-compliance markets were a potential source of carbon finance. However, voluntary prices remained too low to incentivize projects. Regional markets have led the way in the U.S., with the largest and most influential being California's regulated cap-and-trade program commencing in January 2013.

- Kyoto Protocol market mechanisms: The second commitment period of the Kyoto Protocol (CP2) runs from 2013 to 2020. As of May 3, 2018, only 112 of the necessary 166 countries have ratified the Doha Agreement needed to make the emissions reduction targets under CP2 legally binding.<sup>17</sup> Without any real demand, the value of Kyoto credits [certified emissions reductions (CERs) and emissions reduction units (ERUs)] has remained below €1 per tonne, and the credits are not typically used in various national or subnational emissions trading schemes and voluntary programs.
- California Cap-and-Trade Program: This program started in 2012 and entered into its first compliance period beginning on January 1, 2013. There are currently three approved offset project registries (OPRs) for the California Cap-and-Trade program for issuance of California Compliant Offsets, which are discussed more below: Verra, formerly the Verified Carbon Standard (VCS), the Climate Action Reserve (CAR), and the American Carbon Registry (ACR).

The California Air Resources Board (CARB) adopted the Mine Methane Capture (MMC) Protocol on April 25, 2014. The protocol, which became effective on July 1, 2014, includes MMC projects that capture and destroy methane from mining operations at active underground and surface coal and trona mines, and abandoned underground coal mines in the U.S.

The MMC Protocol applies to mines that install equipment to capture and destroy methane extracted through methane drainage systems or VAM collection systems. To be eligible as a compliance, a project must have started on or after July 1, 2014, with the exception of verified

emissions reductions from “early action” projects commencing between January 1, 2007 and December 31, 2014, and registered with an OPR. Early action projects in CAR and Verra must have been listed with the OPR by December 31, 2014 and verified by September 30, 2015. Emissions reductions achieved by early action projects totaled 2,879,684 tonnes CO<sub>2</sub>e. In addition, CMM compliance projects have been issued offset credits for 2,983,324 tonnes CO<sub>2</sub>e as of May 2019.<sup>18</sup>

All project types are eligible, with one notable exception. Natural gas pipeline sales projects at active underground mines are ineligible to participate in the California Cap-and-Trade Program because CARB considers such projects to be business-as-usual and not additional. Pipeline sales projects at abandoned mines are eligible, except in instances where a pipeline sales project existed prior to abandonment.

- Verra, formerly VCS: Launched in 2006, the VCS is a multiple registry system within the voluntary carbon market, which includes three international registries: APX Inc. in North America; Caisse des Depots in Europe; and Markit in the United States, United Kingdom, and Asia Pacific region. These registries work with the Verra project database to issue, hold, transfer, and retire Verified Carbon Units. Verra follows the CDM methodologies and also provides a framework to develop new Verra methodologies or revise existing CDM methodologies. Verra accepts CMM projects, including pipeline sales, boiler use, electricity generation, flaring, and VAM. Verra approved modifications to CDM methodologies to accept surface mine methane and AMM projects.

<sup>17</sup> UNFCCC. 2018. Doha Amendment. Available: <https://unfccc.int/process/the-kyoto-protocol/the-doha-amendment>. Accessed June 8, 2018.

<sup>18</sup> CARB. 2019. Offsets Credits Issued. Available: [https://www.arb.ca.gov/cc/capandtrade/offsets/issuance/arb\\_offset\\_credit\\_issuance\\_table.pdf](https://www.arb.ca.gov/cc/capandtrade/offsets/issuance/arb_offset_credit_issuance_table.pdf). Accessed 6/5/2019.

- **CAR:** Launched in 2008, the CAR is a carbon offset registry for the North American carbon market. Fourteen project-specific protocols currently exist, including CMM. Under the CMM Protocol, offset credits called Climate Reserve Tonnes are issued to projects that destroy methane that would have otherwise been vented to the atmosphere from active underground coal and Mine Safety & Health Administration-classified Category III gassy trona mines in the U.S. and its territories; surface and abandoned mines are excluded. Qualifying project activities include the use of CMM for electricity generation and flaring for projects destroying VAM. However, projects selling CMM to commercial pipelines are not eligible, and CMM to power projects only receive credit for the methane destroyed (i.e., no additional credits for displacing grid-based electricity).
- **ACR:** Launched in 1996, the ACR is a voluntary carbon offset program in the U.S. The ACR considers methodologies from other standards and systems that are consistent with the ACR Technical Standard, including CDM and VCS. The ACR announced the public comment period for its new *Methodology for Capturing and Destroying Methane from U.S. Coal and Trona Mines* in October 2018. The registry accepts CMM projects as a CARB OPR, and 11 projects have been listed on the registry as of June 2018, with offsets issued to 5 of these projects.<sup>19</sup>

On a volume basis, the CDM market peaked in 2012 with 3,403 GHG mitigation projects registered (all sources) and 339 MtCO<sub>2</sub>e in emissions reductions. Today, demand for Kyoto credits has tapered considerably and

<sup>19</sup> American Carbon Registry. 2018. Public Registry. Available: <https://acr2.apx.com/myModule/rpt/myrpt.asp?r=111>. Accessed 6/5/2018.

the World Bank estimates surplus supply in the CDM and JI pipeline on the order of three to five times expected demand through 2020.<sup>20</sup> Prices in the EU ETS for EU allowances (EUAs) have been on an upward trajectory since 2013, surpassing the €25.00 mark in 2018 for the first time since 2011.<sup>21</sup> However, offset (CERs and ERUs) prices have fared much worse, with CERs falling below €1.00 in late 2012 and below €0.25 since early 2017.<sup>22</sup>

In the U.S., allowances in the California cap-and-trade scheme are trading for around \$15/tCO<sub>2</sub>e and offsets are around \$14.<sup>23</sup> The adoption of the MMC Protocol by the CARB will likely spur increased development of mine methane projects throughout the U.S. In voluntary markets, the volume of offsets transacted market-wide from projects declined by 26 percent from 2015 to 2016, while average prices over the same period decreased by 9 percent from \$3.30 to \$3.00/tCO<sub>2</sub>e.<sup>24</sup> Reported prices in voluntary markets that accept CMM projects – Verra, CAR, and ACR – were \$3.29, \$2.60, and \$4.30/tCO<sub>2</sub>e, respectively, in 2015.<sup>25</sup>

<sup>20</sup> World Bank. 2014. State and Trends of Carbon Pricing 2014. World Bank, Washington, DC.

<sup>21</sup> QUANDL Intercontinental Exchange (ICE) EU ETS EUA Price History. Available: [https://www.quandl.com/data/CHRIS/ICE\\_C1-ECX-EUA-Futures-Continuous-Contract-1-C1-Front-Month?utm\\_medium=graph&utm\\_source=quandl](https://www.quandl.com/data/CHRIS/ICE_C1-ECX-EUA-Futures-Continuous-Contract-1-C1-Front-Month?utm_medium=graph&utm_source=quandl). Accessed 9/14/2018.

<sup>22</sup> QUANDL. Intercontinental Exchange (ICE) EU ETS CER Price History. Available: [https://www.quandl.com/data/CHRIS/ICE\\_CER1-ECX-CER-Emission-Futures-Continuous-Contract-1-CER1-Front-Month?utm\\_medium=graph&utm\\_source=quandl](https://www.quandl.com/data/CHRIS/ICE_CER1-ECX-CER-Emission-Futures-Continuous-Contract-1-CER1-Front-Month?utm_medium=graph&utm_source=quandl). Accessed 9/14/2018.

<sup>23</sup> California Carbon. 2018. Price for Golden California Carbon Offset (CCO) Available: <http://californiacarbon.info/>. Accessed 6/3/2019. Golden CCOs are guaranteed by the seller.

<sup>24</sup> Forest Trends Ecosystem Marketplace. 2017. Unlocking Potential: State of the Voluntary Carbon Markets 2017.

<sup>25</sup> Forest Trends Ecosystem Marketplace. 2016. Raising Ambition: State of the Voluntary Carbon Markets 2016.

## Other Incentives

In the U.S., 37 states have renewable or alternative energy portfolio standards in place, which require electricity providers to obtain a minimum percentage of their power from eligible energy resources by a certain date. Five states – Pennsylvania, Ohio, Utah, Indiana, and Colorado – currently include CMM as a renewable or alternative energy source.<sup>26</sup> By including CMM as a renewable energy resource, electricity generated from CMM could generate RECs, which are used to demonstrate compliance with the portfolio standard and can be sold or traded separately from electricity. Some states have also adopted programs to provide grants, tax credits, or loan guarantees that are applicable to CMM recovery projects (e.g., Pennsylvania and Ohio), while other state and federal agencies have approved or are considering royalty relief for CMM utilized or destroyed onsite (e.g., Colorado, Utah, Wyoming).<sup>27</sup> For additional information on emerging state and federal financial and regulatory incentives for CMM emissions reduction projects, visit <https://www.epa.gov/cmop/project-resources>.

The benefits of such incentives to CMM project developers will depend on the unique circumstances of each project. Prices for RECs are difficult to determine and depend on several factors, such as the volume purchased, the location of the generator, or whether the RECs are bought to meet compliance obligations or serve voluntary retail consumers, to name a few. In Pennsylvania, where REC prices are required to be disclosed, the weighted average price of a Tier I AEC – Pennsylvania's version of a REC

– used for compliance was \$12.16 per megawatt-hour (MWh) in 2017.<sup>28</sup> Prices for voluntary RECs are much lower, averaging around \$0.35 per MWh in 2016.<sup>29</sup>

Outside the U.S., other incentives have been used, including favorable tariffs such as feed-in power tariffs or green tariffs combined with mandatory offtake requirements to provide certainty of revenue for CMM and AMM projects. Germany and the United Kingdom, for example, have been successful in stimulating and maintaining CMM and AMM projects as a result of green tariff programs.

In many countries, regular power tariffs are increasing to levels that can support CMM projects. In these instances, mandatory offtake requirements alone can sustain CMM projects. One example is in Shanxi Province, China, where some projects are operating solely on power revenues and are not participating in carbon markets in any way.

## Challenges of Carbon Financing

Several challenges are associated with securing carbon credits for CMM projects:

- Lack of standardized methodologies: Because there is no one universal carbon trading program, GHG reduction projects are subject to different standards.
- Ownership of credits: In order to buy or sell credits, proof of ownership must be demonstrated and legally transferred to the other party following the transaction. Under most circumstances, credit ownership will be recorded under the appropriate trading mechanism (e.g., CARB, EU ETS), but in the absence of clear reporting [i.e., over-the-counter

<sup>26</sup> EPA. 2018. *Coal Mine Methane Developments in the United States*. EPA 430-R-18-002. U.S. Environmental Protection Agency. February. Available: [https://www.epa.gov/sites/production/files/2018-03/documents/cmm\\_developments\\_in\\_the\\_us.pdf](https://www.epa.gov/sites/production/files/2018-03/documents/cmm_developments_in_the_us.pdf). Accessed 6/3/2019.

<sup>27</sup> EPA. 2011. *Financial and Regulatory Incentives for U.S. Coal Mine Methane Recovery Projects*. EP-W-10-019. U.S. Environmental Protection Agency. August.

<sup>28</sup> Pennsylvania Alternative Energy Credit Program. 2018. Available: <https://www.pennaeps.com/reports/>. Accessed 6/5/2018.

<sup>29</sup> NREL. 2017. *Status and Trends in the U.S. Voluntary Green Power Market (2016 Data)*. Technical Report NREL/TP-6A20-70174. National Renewable Energy Laboratory, Golden, CO. October. Available: <https://www.nrel.gov/docs/fy18osti/70174.pdf>. Accessed 6/3/2019.

(OTC) markets], a contract specifying ownership of the resultant carbon credits should be obtained.

- Process for project validating: The Kyoto mechanisms and some other trading schemes and voluntary programs require that projects be reviewed and validated before generating credits. This process can be time-consuming and there is an associated cost. The development of “performance-based” CMM protocols in CARB and Canadian carbon markets have eliminated the need and cost of the validation process.
- Verification of credits: The verification of carbon credits is necessary to transact and monetize the credits. A verification program requires having an acceptable methodology and independent third-party verifiers. These mechanisms allow the market to impose some discipline by ensuring that credits are valid.
- Carbon off-set price fluctuation: The price of carbon is dependent on government policy, regulation, and intervention; and intergovernmental compacts and treaties. This causes significant variation in the price of carbon, adding uncertainty to the impact on a project’s revenues and

profitability. CARB and Canadian carbon markets have set floor (and ceiling) prices to help stabilize prices.

### *Investor Engagement*

Project sponsors should anticipate an extremely thorough due diligence process by investors. It is not unusual for investors or lenders to demand that a project be “shovel ready” to minimize risk and streamline due diligence. A shovel-ready project also demonstrates an early financial commitment by the developer.

In preparation for engagement of potential financial backers, project sponsors should expect that investors will want to see (1) a sound business plan supported by an auditable financial model and credible market analysis; (2) demonstration of sufficient and consistent gas availability for the term of the project; (3) engineering, equipment, procurement, construction, feed-stock, and off-take agreements with credit-worthy partners with sufficient remedies for non-delivery or non-performance; (4) possession of all required licenses, permits, authorizations, or approvals; and (5) proof of the developer’s ability to deliver the project with close scrutiny paid to the developer’s experience, qualifications, and balance sheet.

## VAM Mitigation: Cutting-Edge Technologies Convert Methane Emissions to Income

Driven by technological advancements and market developments, VAM projects are now being deployed in commercial applications. Below are highlights of several projects, and more are in the project development pipeline.

The world's first commercial-scale power plant using VAM as the primary fuel operated at the **West Cliff Colliery** of BHP Billiton in Australia from 2007 to 2017. The plant generated 6 megawatts (MW) of electricity, producing 300,000 MWh and reducing GHG emissions by 2 million tonnes tCO<sub>2e</sub> during its project life. See [https://www.unece.org/fileadmin/DAM/energy/se/pp/coal/cmm/12cmm\\_oct2017/25\\_October/10\\_Mr\\_Matt\\_us.pdf](https://www.unece.org/fileadmin/DAM/energy/se/pp/coal/cmm/12cmm_oct2017/25_October/10_Mr_Matt_us.pdf).

The **Blue Creek Mine No. 4**, owned by Walter Energy in Alabama, was the first active mine in the U.S. to host a VAM project. The nominal capacity of the RTO is 30,000 cubic feet per minute (cfm) or 14 normal cubic meters per second. The project qualified as an early action credit project under the California Cap-and-Trade program completing the sale of all 80,766 tCO<sub>2e</sub>. See <http://www.biothermica.com/content/1st-us-vam-project-0>.

A 160,000 cfm VAM project at Murray Energy's **Marshall County Mine** in West Virginia (U.S.), has been operating since May 2012. Through 2013, the project had resulted in net emissions reductions of 152,828 metric tCO<sub>2e</sub>, and the project is eligible as an early action project for the California Cap-and-Trade Program. See <http://www.sindicatum.com/portfolio/mcelroy-vam/>.

The **Gaohe Coal Mine VAM Project** in Shanxi Province, China, owned by the Lu'An Coal Mining Group, began operation in May 2015. All revenue is generated from power sales. The project utilizes 12 RTOs to oxidize up to 1,080,000 normal cubic meters for hour (Nm<sup>3</sup>/h) of VAM supplemented by CMM. The VAM plant produces up to 300,000 Nm<sup>3</sup>/h of hot exhaust gas to generate 30 MW of power. The project is expected to reduce GHG by 1.22 million tCO<sub>2e</sub> per year. See <http://www.durr-cleantechology.com/news-events/trade-presstechnical-articles/news-details/worlds-largest-ventilation-air-methanecoal-mine-methane-oxidation-project-goes-live/>.

See CMOP's VAM page on the EPA website for more resources: <https://www.epa.gov/cmop/us-underground-coal-mine-ventilation-air-methane-exhaust-characterization>.

## Risk Mitigation Support

Raising debt and equity to finance projects in developing countries can be challenging. A number of risk mitigation instruments facilitate raising private capital in these markets. These instruments are designed to transfer certain defined risks from lenders and equity investors to creditworthy third parties such as guarantors or insurers. Multilateral institutions (such as the World Bank, the ADB, and the Inter-American Development Bank), export credit agencies (e.g., U.S. Export-Import Bank, JBIC, Export Development Canada), and political risk insurers (e.g., Overseas Private Investment Corporation, Nippon Export and Investment Insurance, United Kingdom's Export Credit Guarantee Department) provide different types of risk mitigation support. The CMM

project sponsor that possesses a thorough knowledge of these instruments and practices will be better prepared to negotiate with potential financiers and, ultimately, will be more likely to succeed in attracting capital.

### *Loan Guarantees*

In order to reduce political risk exposure associated with cross-border lending, banks or other lending institutions might require a loan guarantee to ensure timely repayment. A loan guarantee is a promise of an acceptable, creditworthy party to repay all or part of the loan in the event (or under certain specified circumstances) that the borrower does not or is unable to repay the loan. In limited recourse project finance, project developers rarely provide guarantees of loan repayment,

although partial guarantees under specified circumstances (such as construction completion) do occur. Loan guarantees are typically provided by national governments interested in catalyzing economic activity in their areas (see text box). Depending on the credit quality of the guarantor, these guarantees reduce the loan default risk, which in turn reduces the interest rate on the loan.

Some financial institutions have standardized loan application forms that potential borrowers complete; and most, if not all institutions, will expect the borrower to present a business plan (i.e., project documents and technical studies). Appendix E provides a checklist of the typical lending terms and conditions that financial institutions might use in evaluating CMM projects. This checklist is intended to provide the CMM project developer with a good sense of the information required before approaching a financial institution.

### *Political Risk and Credit Insurance*

Risk mitigation, in the form of political risk insurance or credit insurance, is offered by public (multilateral and bilateral development institutions – see text box above) and private insurance companies. It is often used in international project finance transactions and is available to both lenders and equity transferability of foreign currency, expropriation and nationalization, political violence, and breach of contract. Credit insurance covers losses in the event of a debt

### **Conclusion**

A host of finance and revenue sources are available to CMM project developers worldwide. By tapping the appropriate sources, funding can be secured for all phases of the project development cycle, from prefeasibility studies, to technical specification development, to pilot/demonstration studies and full implementation. The finance organizations and opportunities outlined in this guide contribute to the project

### **Risk Reduction Assistance**

Certain institutions offer financial assistance to reduce the risks that domestic companies might face when exploring their products or service abroad.

- The **Export-Import Bank of the United States (Ex-Im Bank)** provides long-term loans and guarantees, working capital guarantees, political risk insurance tied to the sale of U.S. goods and service. It also offer certain special financial terms to companies that are unable to obtain traditional financial support. [www.exim.gov](http://www.exim.gov)
- The **Overseas Private Investment Corporation (OPIC)** helps U.S. businesses invest overseas by offering support to mitigate these risks. OPIC provides a range of traditional finance resources, such as loans and guarantees. In addition, it offers political risk insurance products for cross-border lending or investing in emerging markets. [www.opic.gov](http://www.opic.gov)
- As a member of the World Bank Group, the **Multilateral Investment Guarantee Agency (MIGA)** promotes foreign direct investment into developing countries to help support economic growth, reduce poverty, and improve people's lives. MIGA addresses investment concerns and political risk perceptions by providing political risk insurance, technical assistance, and dispute medication services to help remove obstacles. [www.miga.org](http://www.miga.org)

service default regardless of the cause investors. Political risk insurance typically covers the following risks: inconvertibility and (i.e., covering both political and commercial risks), and is often used when a government entity is the off-taker of the product.

development process in several ways. Some provide risk reduction products to mitigate a technology or service provider's concerns about entering foreign markets. Others provide lending and related financial assistance for projects that offer environmental benefits and contribute to sustainable development and poverty alleviation. Still others purchase carbon credits and thereby could supplement a

project's cash flow. The preceding examples demonstrate that by mixing equity investment with financing available from a variety of sources, project developers can support even the largest CMM development projects.

## Appendix A: CMM Project Participants

	Project Role
<b>Developer</b>	Responsible for conceptualizing, assessing, developing, and implementing a project. Identifies project opportunities and then completes or delegates project development tasks. Leads the project through all phases, which include project development, financing, construction, and operation. May be independent of, a partner with, or the same as, the mine operator. The project developer may have capital available to construct and commission the project or may secure financing from external sources. Many investors will want to see that the developer has some risk capital or equity stake in the project to demonstrate their commitment to the project and their financial viability to ultimately deliver the project.
<b>Mine Operator</b>	A critical participant and at a minimum, supplies fuel to the project and the project site for an onsite facility. Projects using CMM are located at the host coal company's mine, typically employing the mine's degasification or ventilation systems. Projects might take place prior, during or after mining, depending on the technology employed. Often plays an extensive role and may be the primary project developer and operator, or may partner with a developer.
<b>Regulatory Agencies</b>	Provide permits and approvals, including mine safety and health agency (generally the mine operator must file a degasification plan, state/provincial mining authorities, oil and gas agencies, power regulators including dispatch authorities, and environmental departments). In addition, other agencies such as provincial or federal treasuries and energy ministries may be involved. The developer might also need permits for rights of encroachment on the landowner's property and for potential environmental impacts related to pipeline rights-of-way, water treatment, and combustion related to gas processing. Local permits may be required for construction, occupation, and noise. Most permits require that the developer file detailed project plans, designs for underground and surface equipment, and land surveys.
<b>System Supplier</b>	Provides the systems that convert raw gas to pipeline quality gas, electric and thermal energy, LNG/CNG, or other product. The viability of a project depends on the system and its supplier's guarantees, and therefore is considered a major project participant. Vendors will often sell a system on a "turnkey basis," where the vendor is responsible for the installation and performance of the entire system. Often investors will insist that the system supplier retain system ownership until rigorous performance testing is completed (known as "acceptance"). Suppliers may extend their warranties through the project life by means of a maintenance contract. Other models include Build, Own, Operate, Transfer (BOOT) and Build, Operate, Transfer (BOT).
<b>Project Contractor</b>	Responsible for the design, procurement, construction, and/or installation of CMM project equipment. Commonly referred to as the EPC contractor (Engineering, Procurement, Construction) or EPCM contractor (Engineering, Procurement, Construction Management). Either possesses all necessary capabilities in-house, or will enter into subcontracting arrangement with other firms. Some contractors, in conjunction with a system supplier, will provide a project facility on a guaranteed turnkey basis, assuming responsibility for the project's completion and operational performance.
<b>Project Operator</b>	Responsible for cost-effective delivery of the energy product throughout the life of the project. Performs management functions, as well as the operation and maintenance (O&M) of the system, typically on a contractual basis with the project. Can be a separate third-party firm under contract to the project owners, or one of the other participants. Major maintenance is usually the function of the system supplier.
<b>Energy Commodity Off-taker</b>	Provides the CMM project's revenues from energy delivery. Off-takers include electric utilities, local gas distribution companies, gas wholesalers/blenders, major natural gas pipelines, and local fuel users (e.g., boilers, kilns). The mine itself could take delivery of CMM project electricity, thermal energy, or raw gas to power onsite equipment. In order to obtain debt financing for the project, the project will likely have to contract with the energy product buyer for a period not less than the term of the senior debt, plus a two-three year "tail." Lenders especially, but also equity investors, will look very closely at the creditworthiness of a project's off-takers.

Project Role	
<b>Financial Institutions/Carbon Financiers</b>	Fill multiple roles, from arranging to providing the financing for the project.
<b>Carbon Credit Validators and Verifiers</b>	Firms providing validation and verification services act as independent third-party auditors to ensure that carbon credits generated by a CMM project meet the standards of a specific registry or trading program.
<b>Carbon Market Off-Takers</b>	Buyers of carbon credits and others who facilitate the transactions such as brokers and traders.

## Appendix B: Key Elements of Feasibility Studies

A comprehensive feasibility study (FS) includes the following key elements:

- A summary of mine characteristics based on information from the pre-feasibility study (PFS) and site visit(s).
- A detailed assessment of available gas resources based on historical gas emissions from the mine, data on in-situ gas content, and plans for future mine activities. This element might include pilot well tests.
- A detailed assessment of degasification technologies and mine drainage techniques, both those currently in place and those that could be added to maximize the quality and quantity of the drained gas.
- A detailed assessment of technical possibilities to use the gas based on its quality, the overall project objectives, and the PFS results. End uses to be considered include power generation, gas sales to pipeline (with or without upgrade), coal drying, and mine heating.
- A detailed assessment of market opportunities for gas and/or power, including factors such as the distance to nearby pipelines, the current and projected market price of gas, the demand for and price of power generation in the area, and the possibility of carbon credits.
- A detailed assessment of proposed project costs for the project scenarios of interest, using estimates and financial projections. These are based on best available estimates from technology vendors and technical experts.
- A detailed assessment of site-specific legal, regulatory, and environmental issues, including the status of gas ownership rights, any issues associated with access to surface lands for degasification systems, and other restrictions on the potential project (e.g., wetlands infringement).
- A detailed financial analysis for each technically viable scenario based on the market assessment and the overall project objectives with base, high, and low cases. The financial analysis should be supported by an auditable financial model.
- For multilateral and bilateral financial institutions, a review of socioeconomic impacts and environmental impacts, and a qualitative or quantitative cost-benefit analysis.
- A summary of key staff positions and requisite education and experience for those positions.
- A target schedule for project implementation and operation.
- A conclusion section that includes an assessment of the project's overall viability, whether financial investment should be made, and any other appropriate recommendations.

## Appendix C: CMM Project Funding Sources

Type of Financiers	Risk/Return Portfolios	Specialized Investment Areas	Status
<b>Commercial Banks</b>			
<p>Commercial banks profit by lending money at higher interest rates than they pay on deposits. Banks might provide short-, medium-, and long-term corporate and project finance loans at a margin or spread over a benchmark rate such as the London Interbank Offered Rate.</p>	<p>Because banks are generally conservative, they apply risk minimization techniques. A project developer seeking bank financing therefore must be prepared to show the bank's loan officer all important project contracts, including a detailed business plan; a credible independent project technical assessment; and pro forma financial statements demonstrating the project's ability to service debt. The developer also should be prepared to discuss its own project development experience and creditworthiness, as well as project assets that could serve as collateral. Because banks are regulated at the federal and/or state levels and are legally restricted from making risky loans, they are conservative lenders, generally providing senior, secured loans to experienced entities. They typically do not fund projects in their development stages, preferring to wait until projects are well-characterized.</p>	<p>Bank financing has been used to fund large-scale CMM projects that require major capital investments in both gas recovery systems and collection/utilization components. Few, if any, smaller CMM projects have been bank-financed, however, because:</p> <ul style="list-style-type: none"> <li>• Most banks are unfamiliar with the CMM project market.</li> <li>• Smaller projects frequently are not profitable for banks, even when expected pricing is high, due to the bank's costs for examining and processing the transaction.</li> <li>• Collateral requirements are very challenging for smaller projects.</li> </ul>	<p>CMM projects are not inherently "unbankable," despite the lack of bank participation thus far. They are generally supported by strong contracts, earn sufficiently high rates of return, and employ a resource that is well-characterized. This last point is especially true in the case of projects at mines with degasification systems. If banks find a CMM project of an acceptable size and are willing to lend on a project-finance basis, they could play a more significant role once they have greater familiarity with the industry. Banks located near gas resources might be good candidates because they are more likely to have experience with the gas industry and, therefore, be more comfortable with CMM projects.</p>
<b>Gas Purchasers</b>			
<p>Gas pipeline companies and gas distribution companies are potential sources of capital for CMM projects because they are interested in securing low-cost supplies of gas.</p>	<p>These companies often face "make or buy" decisions: Will it be more profitable to buy or develop gas resources? By developing CMM and other gas projects, they might be able to ensure themselves long-term, low-cost supplies.</p>	<p>Gas/purchase sale contracts can be negotiated between the CMM project and the gas company such that the project is profitable and the gas company pays a relatively low price for gas.</p>	<p>Gas companies to date have played a significant role in financing CMM projects in the U.S.</p>

Type of Financiers	Risk/Return Portfolios	Specialized Investment Areas	Status
<b>Venture Capitalists</b>			
<p>Venture capitalists usually invest in convertible preferred stock because this instrument greatly increases the upside potential.</p>	<p>Because venture capitalists provide risk capital to fledgling ventures that often have nothing more than ideas, many of their investments are unsuccessful. In exchange for bearing this risk, venture capitalists expect to earn unusually high returns – in the range of 40 percent after taxes. Investment horizons for venture capitalists also tend to be short; three–five years is common.</p>	<p>Venture capitalists specialize in funding startup companies, including those that develop energy technologies. They might not be suitable investment partners for small CMM project developers, however, because they invest in companies rather than projects and given the active role they take in running companies. CMM project developers that partner with venture capital firms might have to be willing to cede some control of their companies.</p>	<p>In recent years, venture capital investments have been rushing toward clean or alternative energy technologies.</p>
<b>Pension Funds, Insurance Companies, and Other Institutional Investors</b>			
<p>Pension funds, mutual funds, and other institutional investors are large, regulated companies that pool money provided by smaller investors and then make investments. They control billions of dollars of U.S. investment funds.</p>	<p>Most institutional investors are strictly bound by U.S. Securities and Exchange Commission (SEC) laws and their own covenants and restrictions, which dictate the types of investments the investors might make.</p>	<p>Almost all money under institutional management must be invested in highly rated, publicly traded stocks, bonds, and other highly liquid securities.</p>	<p>Institutional investors have limited appetite for projects and, therefore, generally do not represent potential capital sources for CMM projects. However, these investors have taken equity stakes in CMM project developers and have invested in carbon funds.</p>
<b>Investment Bankers</b>			
<p>Investment bankers provide a wide variety of financial services (e.g., provide advice on corporate/project financing alternatives; arrange debt/equity public offerings and private placements; assist in transactions such as mergers, acquisitions, and divestitures).</p>	<p>Investment bankers have minimum-size requirements and are unlikely to be interested in project financing less than \$25–50 million. They might, however, be able to place equity with private investors. Where bankers line up private equity investors, investment horizons are very short (three–seven years). Expectations on returns can also be very high to offset risk (e.g., a 10-to-1 cash-on-cash return after 5 years).</p>	<p>Investment bankers could be useful to CMM projects because they can identify investors who are interested in investing in oil and gas projects, not bound by investment restrictions, and able to invest in smaller projects. Investment banks also might be able to help project developers identify suitable partners such as oil and gas exploration companies.</p>	<p>To date, a number of CMM projects have been financed through private investments. Numerous investment banks have arranged CMM project financing, while others, although they have not been involved in CMM projects, have worked with energy project developers and are interested in assisting CMM projects.</p>

Type of Financiers	Risk/Return Portfolios	Specialized Investment Areas	Status
<b>Multilateral Sources (Examples)</b>			
<ul style="list-style-type: none"> <li>• The Asian Development Bank (ADB), a multilateral development organization, strives to improve the social welfare of people in the Asia and Pacific regions.</li> <li>• The Global Environment Facility (GEF) works through implementing agencies including the World Bank, the United Nations Development Programme (UNDP), the UN Environment Programme (UNEP), and regional development banks to provide cost-sharing grants and concessional funding to help developing countries fund projects and programs that protect the environment, such as climate change mitigation projects.</li> <li>• The World Bank provides funding for projects that are consistent with its mission to fight poverty and improve the living standards of people in the developing world. The International Finance Corporation (IFC), the private sector arm of the World Bank Group, provides financing for a variety of sustainable energy and climate change mitigation ventures. IFC financing can include both debt and equity finance of private ventures.</li> <li>• The European Bank for Reconstruction and Development (EBRD) uses investment tools to help build market economies and democracies in countries from central Europe to central Asia.</li> </ul>	<ul style="list-style-type: none"> <li>• Compared with private lenders, multilateral development banks (also known as International Financial Institutions or IFIs) will often accept a higher degree of country risk at reasonable lending rates to encourage investment in emerging economies. However, IFIs tend to be risk averse. Like private lenders, they will want assurances of a project's legal and technical viability and the project team's competency in delivery such projects. IFI funding can also come with additional capacity-building support to enhance the chances of project success.</li> <li>• Environmental and social criteria are also very prominent in IFI lending, and applicants should be prepared to meet thorough, published criteria.</li> <li>• The operating practices and procedures at international financial institutions entail a detailed, public, and transparent review and approval process.</li> </ul>	<ul style="list-style-type: none"> <li>• ADB provides projects with technical assistance, grants, and loans. In recent years, ADB has focused on supporting clean energy projects (see <a href="https://www.adb.org/">https://www.adb.org/</a>)</li> <li>• The GEF Operational Strategy requires that any GEF-funded activity relating to climate change be fully compliant with the directives of the UN Framework on Climate Change Convention (see <a href="https://www.thegef.org/">https://www.thegef.org/</a>)</li> <li>• Projects that are smaller than the World Bank's preferred minimum lending threshold of ~ U.S. \$50 million may be bundled with other development activities to construct a finance package of adequate size (see <a href="http://www.worldbank.org/">http://www.worldbank.org/</a>).</li> </ul>	<ul style="list-style-type: none"> <li>• ADB has directly supported CMM through a project at the Jincheng Anthracite Mining Company using CMM for power generation, industrial use, and town gas. ADB also sponsored feasibility studies at several mines in China.</li> <li>• The World Bank has supported CMM (e.g., an \$80 million loan to the Shanxi Coal Bed Methane Development and Utilization Project that is set to conclude in 2016).</li> <li>• IFC purchased credits via ING Bank from a project that generates power using methane captured from coal mines in Ukraine.</li> <li>• The GEF has previously underwritten CMM drilling and utilization demonstration projects in China, India, and Russia.</li> </ul>

Type of Financiers	Risk/Return Portfolios	Specialized Investment Areas	Status
<b>Bilateral Sources (Examples)</b>			
<ul style="list-style-type: none"> <li>The Japan Bank for International Cooperation (JBIC), as the international wing of the Japan Finance Corporation (JFC), contributes to sustainable and sound development of international and Japanese economies.</li> <li>The U.S. Overseas Private Investment Corporation provides investors with financing, political risk insurance, and support for private equity investment funds, when commercial funding cannot be obtained elsewhere.</li> <li>KfW of Germany finances and supports programs and projects that mainly involve public sector players in developing countries and emerging economies. KfW maintains a strong emphasis on clean energy-related projects.</li> </ul>	<p>Bilateral financing agencies provide debt, equity, and mezzanine finance to projects. In addition to financing, they can provide political risk insurance and export credit insurance.</p> <p>Their goals are typically multifaceted: promoting exports of a country's goods and services while also promoting developmental, social, environmental, and, in some cases, political objectives.</p> <p>Similar to multilateral finance institutions, bilateral sources will accept country risk but project sponsors must still demonstrate that they have adequately addressed technical, managerial, and operational risks. In fact, projects are often structured to include financing from bilateral and multilateral institutions, and in many countries there is close cooperation among the donor agencies.</p>	<p>There are no specific funds directed at CMM projects. However, most bilateral agencies prioritize financing for developmentally and environmentally sustainable projects with considerable emphasis on climate change, energy development, and energy efficiency. The agencies tend to have broad definitions for these areas of emphasis, allowing a wide range of project types to fall within their financing mandate. Project sponsors should expect to spend considerable effort meeting with target financing agencies before formally seeking funding.</p>	<p>JBIC provided \$20 million in loan financing for the Jincheng project above. JBIC also recently signed a memorandum of understanding with The Energy and Resources Institute (TERI) of India for the development of GHG reduction projects in India (see <a href="https://www.jbic.go.jp/en/">https://www.jbic.go.jp/en/</a>).</p>
<b>Electric Utilities</b>			
<p>Historically, electric utilities in the U.S. have been required to purchase power from independent power producers (IPPs) with "qualifying facility" status (for which many CMM projects would be eligible). While competition in the electricity industry has reduced IPP business to some extent, it also might create increased electric utility interest in the CMM market.</p>	<p>This strategy serves two strategic policy objectives (in addition to the retention of a large customer). First, by taking a customer "off- line," the utility will reduce the burden on its own transmission and distribution system, thereby enabling the utility to defer significant investment. This type of savings could be important in a more competitive environment. Second, taking a large load off- line will also free-up the utility's own generating capacity so that it will be</p>	<p>Increased competition means that utilities will have to find creative new ways of serving the energy needs of customers. This is where CMM projects might be valuable: the utility might find that the best way to retain a client is to provide the client with the equipment and financing it needs to self-generate. The utility thus would earn profits by financing and selling equipment, providing O&amp;M services, and selling backup power, rather than through the traditional method of</p>	<p>Under a more competitive industry structure, all utilities will be looking to develop low-cost electricity sources wherever they might find them. CMM projects might represent relatively low-cost generating sources, and as such might provide a way for higher-cost utilities to compete in low-cost regions.</p>

Type of Financiers	Risk/Return Portfolios	Specialized Investment Areas	Status
	able to compete for more business in new markets.	selling kilowatt-hours.	
<b>Equipment Vendors/Turnkey Developers</b>			
Some equipment/technology vendors/providers are also planning to provide full turnkey service, including carbon financing for offsets/emissions avoided.		So far, VAM mitigation or energy-recovery technologies are the first in this market niche.	For example, Biothermica is developing a project using their VAM oxidation technology at a Walter Energy mine in Alabama, including a negotiated deal for carbon credits (see page 17).
<b>Carbon Financing</b>			
<p>Carbon financing has been an important source of project revenue in some countries, and is closely considered part of the overall project financing and economics. Internationally, China, Ukraine, and Poland have benefited from the Kyoto markets. The California Cap-and-Trade program will be driving new development of CMM projects in the U.S. In addition, there remains an active voluntary carbon market, and some participants choose to trade in these markets.</p> <p>For a detailed summary of carbon funds, visit <a href="https://climatefundsupdate.org/">https://climatefundsupdate.org/</a>.</p>		<p><b>Regulatory (compliance) markets:</b></p> <ul style="list-style-type: none"> <li>• Kyoto Protocol–Clean Development Mechanism (CDM) and Joint Implementation (JI)</li> <li>• European Union Emissions Trading Scheme (EU ETS)</li> <li>• California Cap-and-Trade MMC protocol</li> </ul> <p><b>Voluntary markets:</b></p> <ul style="list-style-type: none"> <li>• Verified Carbon Standard (VCS)</li> <li>• American Carbon Registry (ACR)</li> <li>• Climate Action Reserve (CAR)</li> <li>• Over-the-counter (OTC) offset/carbon credit scheme involving retailers, wholesalers, or aggregators; and brokers.</li> </ul>	<p>There are currently 84 CMM projects registered under the CDM/JI. Of those, 67 have produced CERs or ERUs, and total CER/ERU production from those facilities is 69.7 MtCO<sub>2e</sub> through May 2018 (see <a href="http://www.cdmpipeline.org/">http://www.cdmpipeline.org/</a>).</p>

## Appendix D: Resources

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### Selected Organizations

The **American Carbon Registry (ACR)** is a nonprofit offset program operated by Winrock International. Founded in 1996 as the first private voluntary offset program in the world, ACR is also an approved Offset Project Registry (OPR) for the California Cap-and-Trade program. ACR has 18 years of experience in the development of rigorous, science-based carbon offset standards and methodologies; as well as operational experience in carbon offset project registration, verification oversight, and offset issuance (see <http://americancarbonregistry.org/>).

The **California Air Resources Board (CARB)** cap-and-trade program is a key element in California's climate plan. It sets a statewide limit on sources responsible for 85 percent of California's GHG gas emissions, and establishes a price signal needed to drive long-term investment in cleaner fuels and more efficient use of energy. The program is designed to provide covered entities the flexibility to seek out and implement the lowest-cost options to reduce emissions. On July 1, 2014, CARB's Mine Methane Capture (MMC) Protocol took effect, allowing offsets generated from mine methane projects to be traded (see <http://www.arb.ca.gov/cc/capandtrade/capandtrade.htm> and <http://www.arb.ca.gov/regact/2013/capandtrade13/ctmmcprotocol.pdf>).

The **Climate Action Reserve (CAR)** is a national 501(c) (3) nonprofit organization representing international interests in addressing climate change and bringing together participants from the government, environment, and business sectors. It works to ensure integrity, transparency, and

financial value in GHG emissions accounting and reduction. It also offers an approved Offset Project Registry (OPR) for the California Cap-and-Trade program (see <http://www.climateactionreserve.org/>).

The **Center for Climate and Energy Solutions** (formerly the Pew Center on Global Climate Change) brings together business leaders, policymakers, scientists, and other experts to bring a new approach to a complex and often controversial issue. Pew's approach is based on sound science, straight talk, and a belief that multiple entities can work together to protect the climate while sustaining economic growth (see <http://www.c2es.org/>).

The **Climate Markets and Investment Association** is a trade association focusing on the climate, sustainable finance, and services community. Its primary area of interest is incentivizing low-carbon and resource-efficient investment through market mechanism, pre-compliance markets, or climate and sustainable finance mechanisms (see <http://www.cmia.net/>).

The **Coalbed Methane Outreach Program (CMOP)** of the EPA is a voluntary program whose goal is to reduce methane emissions from coal mining activities. Its mission is to promote the profitable recovery and use of CMM, a GHG more than 20 times as potent as CO<sub>2</sub>. By working cooperatively with coal companies and related industries, CMOP helps to address barriers to using CMM instead of emitting it to the atmosphere. In turn, these actions mitigate climate change, improve mine safety and productivity, and generate revenues and cost savings (see [www.epa.gov/cmop](http://www.epa.gov/cmop)).

The **Energy Information Administration (EIA)**, a statistical agency of the U.S. Department of Energy, provides policy-neutral data, forecasts, and analyses to promote sound policymaking, efficient markets, and public understanding regarding energy and its interaction with the

U.S. economy and the environment. EIA administers the Voluntary Reporting of Greenhouse Gases Program, established by Section 1605(b) of the Energy Policy Act of 1992, which provides a means for organizations and individuals that have reduced their GHG emissions to record their accomplishments and share their ideas for action (see <http://www.iea.org/>).

The **Environmental Markets Association (EMA)** is a trade association for environmental industry professionals who are active or interested in market-based solutions to combat pollution and create a sustainable environment. EMA members include large utilities, emissions brokers and traders, consultants, financiers, members of the press, government agencies, nonprofit organizations, and academics (see <http://www.emahq.org/>).

The **Global Methane Initiative (GMI)** is a voluntary, multilateral partnership that aims to reduce global methane emissions and to advance the abatement, recovery, and use of methane as a valuable clean energy source. GMI achieves this by creating an international network of partner governments, private sector members, development banks, universities, and nongovernmental organizations in order to build capacity, develop strategies and markets, and remove barriers to project development for methane reduction in Partner Countries (see <https://www.globalmethane.org/>).

The **Greenhouse Gas Reporting Program (GHGRP)**, administered by the U.S. EPA, collects annual GHG information from the top-emitting sectors of the U.S. economy, including underground coal mines liberating more than 36.5 million cubic feet per year of methane. The GHGRP is the only dataset containing facility-level GHG emissions data from large industrial sources across the U.S. EPA is using this facility-level data to improve estimates of national GHG emissions, including the U.S. Greenhouse Gas Inventory.

The data are public and can be found on multiple EPA websites listed at <http://www.epa.gov/ghgreporting/ghg-reporting-program-data-sets>. For more information, visit <http://www.epa.gov/ghgreporting>.

The **International Emissions Trading Association (IETA)** is a nonprofit business organization created to establish a functional international framework for trading in GHG emissions reductions. IETA's membership includes leading international companies from across the carbon trading cycle (see <http://ieta.org/>).

The **Project Developers Forum (PDF)** is a collective voice to represent the interests of companies developing GHG emissions reduction projects in international markets under the CDM, the JI, and other carbon emissions reduction schemes and programs. The PDF is incorporated and its primary aims are to improve the efficiency, legitimacy, and functioning of the regulatory systems governing the development and use of emissions reduction projects, and update and support independent standards and codes of conduct in order to further improve the integrity of the industry (see <http://www.pdf-forum.net/>).

The **United Nations Economic Commission for Europe (UNECE) Group of Experts on Coal Mine Methane** is a subsidiary body of the Committee on Sustainable Energy that promotes the reduction of GHG emissions from coal mines.

Its activities on recovery and use of methane reduce the risks of explosions in coal mines (see <http://www.unece.org/energy/se/cmm.html>).

Founded in 1992 in the context of the Earth Summit in Rio, and based in Geneva, Switzerland, the **United Nations Environment Programme Finance Initiative** was established as a platform associating the United Nations and the financial sector globally. The need for this unique United Nations partnership arose from the growing recognition of the links among finance and environmental, social, and governance challenges; and the role financial institutions could play for a more sustainable world (see <http://www.unepfi.org/>).

**Verra** supports climate action and sustainable development with standards, tools, and programs that assess environmental and social impacts, and enable funding for sustaining and scaling up these benefits. It is one of three approved registries for the California Cap-and-Trade program and also serves as a registry for voluntary credits (see <http://www.verra.org>).

Under partnership between the **World Resources Institute** and the **World Business Council for Sustainable Development**, the Greenhouse Gas Protocol is a widely used international accounting tool for government and business leaders to understand, quantify, and manage GHG emissions (see <http://www.ghgprotocol.org/>).

## Appendix E: CMM Project Lending Evaluation Checklist

### *Project Overview*

- Project description
- Business plan
- Project financial projections including all assumptions
- Description of principal project risks and risk mitigation analysis
- Financing plan with detailed sources and uses of funds (e.g., equipment, financing costs)
  - Project cost breakdown
  - Evaluation of equity or collateral contributed (e.g., cash, prepaid development expenses)
  - Leverage (i.e., financing provided by borrower and financing requested)
- Carbon finance plan (if applicable)

### *Borrower Information*

- Corporate documents (e.g., Articles of Incorporation, Partnership Agreement, LLC Articles, operating agreement)
- Relevant experience in CMM project(s) and related technology
- Resume(s) of project development staff
- Audited financial statements (e.g., balance sheet, income statement, cash flow) – year-to-date, plus two–three previous years, if available
- Three-year pro forma financial statements demonstrating anticipated results or expected impact of proposed transaction
- Corporate tax returns (most recent two–three years) may be required from project developer

### *Project Feasibility and Contractual Documentation*

- Project implementation schedule, showing target dates for achieving essential project milestones
- Feasibility studies, and technical and market reports (sufficient to demonstrate project's technical feasibility), with detailed information including:
  - Anticipated gas flow rate (e.g., Bcf/day)
  - Projected gas quality (i.e., percent methane and range)
  - For projects at active coal mines: projected mine life, description of mining plan (e.g., seams to be mined, planned production levels, seam depth) including mine maps
  - Planned investments for CMM and documentation about projected capital, operating, and maintenance costs; and expected performance
- Contractual flow chart (i.e., project participants and contracts)
- Environmental assessment
- Description of project contracts (i.e., project contracts to be included such as construction contract), especially agreement with mine owner/operator (for projects at active coal mines), and all agreements with surface owners and documentation of rights to the CMM
- Background information on each of the project participants, including financial information.

## Appendix F: Glossary

Note: terms with an asterisk (\*) are presented as defined by the World Bank Carbon Finance Glossary of Terms.<sup>30</sup>

**Additionality\*:** According to the Kyoto Protocol, greenhouse gas emissions reductions generated by Clean Development Mechanism (CDM) and Joint Implementation (JI) project activities must be additional to those that otherwise would occur. Additionality is established when there is a positive difference between the emissions that occur in the baseline scenario and the emissions that occur in the proposed project.

**Broker/Trader:** A party that mediates between a buyer and a seller (e.g., for the sale of carbon offsets).

**Carbon Finance\*:** Resources provided to projects generating (or expected to generate) greenhouse gas (or carbon) emissions reductions in the form of the purchase of such emissions reductions.

**Certified Emission Reductions (CERs)\*:** A unit of greenhouse gas (GHG) emissions reductions issued pursuant to the Clean Development Mechanism of the Kyoto Protocol, and measured in tonnes of carbon dioxide equivalent (tCO<sub>2</sub>e). One CER represents a reduction of GHG emissions of one tCO<sub>2</sub>e.

**Clean Development Mechanism\*:** The mechanism provided by Article 12 of the Kyoto Protocol, designed to assist developing countries in achieving sustainable development by permitting industrialized countries to finance projects for reducing greenhouse gas emissions in developing countries and receive credit for doing so.

**Discounted Cash Flow Method:** The sum of a project's net cash flows over the project's life is discounted to the present [i.e., the net

present value (NPV) of the project]. The discount rate used to make this calculation represents the investors' cost of capital. If a project's NPV is positive, then the project is deemed capable of yielding the minimum required return.

**Emission Reduction Units\*:** A unit of emissions reductions issued pursuant to Joint Implementation. This unit is equal to one tonne of carbon dioxide equivalent.

**European Union Allowances (EUAs)\*:** The allowances in use under the European Union Emissions Trading Scheme. An EUA unit is equal to one tonne of carbon dioxide equivalent.

**Internal Rate of Return (IRR):** Discount rate at which the net present value of the project's net cash flow is zero. In other words, it is the rate that equates the present value of future cash flows with the initial capital investment. The expected IRR on a project can be compared to return rates on alternative investment opportunities.

**Joint Implementation\*:** Mechanism provided by Article 6 of the Kyoto Protocol, whereby a country included in Annex I of the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol might acquire Emission Reduction Units when it helps to finance projects that reduce net emissions in another industrialized country (including countries with economies in transition).

**Retailer:** Refers to parties who sell relatively small amounts of carbon offset credits to individuals or organizations and have ownership of a portfolio of credits.

**Renewable Energy Certificates\*:** Tradable environmental commodities in the U.S. that represent proof that 1 megawatt-hour of electricity was generated from an eligible renewable energy resource.

<sup>30</sup>

[http://siteresources.worldbank.org/INTCARBONFINANCE/Resources/64897\\_World\\_Bank\\_web\\_lower\\_Res..pdf](http://siteresources.worldbank.org/INTCARBONFINANCE/Resources/64897_World_Bank_web_lower_Res..pdf)

**Turnkey:** A project or contract that provides for the complete design, procurement (of equipment), construction, and start-up of a facility – by a date certain – for a fixed sum and at guaranteed performance levels.

**Verified Emission Reductions\*:** A unit of greenhouse gas emissions reductions that has been verified by an independent auditor. This designates emissions reductions units that are traded on the voluntary market.