Conducting Pre-Feasibility Studies for Coal Mine Methane Projects

Module 2 – Mine Background Information and Evaluation

Welcome

The United States Environmental Protection Agency (EPA) developed this course in support of the GMI and in conjunction with the United Nations Economic Commission for Europe (UNECE).
This course introduces principles for assessing the potential of developing projects to capture and/or use Coal Mine Methane (CMM). The introduced general approach should be underpinned by mine-specific data and analyses, allowing the principles to be tailored to the unique conditions at each mine. Ideally, such an assessment will lead to project development and implementation.

What is the GMI?

The Global Methane Initiative (GMI) is a voluntary, multilateral partnership that aims to reduce methane emissions and to advance the abatement, recovery, and use of methane as a clean energy source.

GMI Partner Countries account for nearly 70% of total global manmade methane emissions, which is equivalent to approximately 5,000 MMTCO2e.

Conducting Pre-Feasibility Studies for CMM Projects: Course Modules

Module 1:	Introduction and Objectives
Module 2:	Mine Background Information and Evaluation
Module 3:	Resource Assessment
Module 4:	Forecasting Methane Production from Gas Drainage Systems
Module 5:	Improvements to Gas Drainage
Module 6:	Quantifying the Benefits of Improvements to Methane Drainage Systems
Module 7:	Market, Risk, and Financial Analyses
Module 8:	Case Study – Liulong Mine, China

Module 2: Introduction and Objectives Title Slide

What You Will Learn

In this module, you will learn about:

- A two-stage approach to data gathering and analysis for CMM project prospects.
    - Stage 1: Initial Data Request

    - Stage 2: Detailed Mine Evaluation

- How to identify the data requirements for each stage.
- How and why the data are collected and their relevance to a pre-feasibility study.

Time needed to complete this module – Approximately 45 minutes.

Two Stages of Mine Evaluation

Mine evaluations for CMM projects are conducted through a two-stage approach:

- Stage 1: Initial data are requested from a mine owner/operator to obtain general mine background information.
- Stage 2: Initial analysis is conducted, which might include: clarifying data, visiting a mine site and initiating a more detailed analysis.

Stage 1: Initial Data Request

The initial data request is a simplified request to obtain general but informative data at the beginning of a pre-feasibility study. Such a request is typically brief and in an easily understood format to ensure a quick response from the mine owner/operator.

It can also rely on publicly available information, such as corporate annual reports, regulatory filings and other similar sources.

Additional follow-up with the owner/operator may be required.

Initial Data Request Questions

The initial data request should answer the following questions:

- Who is the mine owner/operator and what is their interest, technical capacity and financial capability to support the project?
- Where would the project be located?
- Is there reasonable access to the site?
- Does the owner/operator have experience hosting and/or developing other CMM or VAM projects?
- Is the gas resource potential sufficient to supply a CMM or VAM project over time?
- Is the type of mining (longwall vs room-and-pillar) and the rate of coal production likely to release reliable, consistent, and predictable quantities of gas?
- Is the mine gas of a quantity and quality that is capable of supplying an end use?

Other Initial Data Request Questions

Additional questions that are important to consider initially include:

- Is the remaining life of the mine sufficient to plan, develop, construct and operate the project to secure a net positive financial return?
- Are there any plans for a reserve addition that could impact project life and gas quality and quantity?
- Are there possible changes to the gas drainage system that could improve gas availability?
- What are the potential markets for use or destruction of the gas?
- Are there policy, legal or market drivers or barriers that could impact the project?
- Could the project face climatic, topographic or other technical challenges that would impact development and operation of the project?

Benefits of the Initial Data Request

Benefits of conducting the initial data request include:

- Requires responses from mine owner/operator without significant level of effort.
- Offers an opportunity for cost-effective data collection, since data can be transferred quickly and site visits are not required.
- Provides a basis for substantive engagement with the mine owner/operator.
- Allows for early-stage evaluation of CMM or VAM project potential before commitment of significant financial and labor resources for the pre-feasibility study.
- Highlights some notable issues that could impact a project and project structure.
- Flags items for more in-depth review and analysis

The table below provides an example of a simplified data request that is used by GMI and EPA.

Note that the data request can be tailored to the specific circumstances at a mine based on prior knowledge.

GMI/EPA Example Initial Data Request	
1	Name of coal mine
2	Physical Address (with map and/or satellite photo if possible)
3	Parent company overview
4	Name of mine contact/Position/Telephone and email details
5	Date coal mine opened

GMI/EPA Example Initial Data Request	
6	Coal and gas resources and reserves if known
7	Remaining life of mine (years)
8	Coal production capacity (tonnes per year)
9	Historical coal production – last 5 years (tonnes per year)
10	Depth of mining below surface
11	General description of topography (flat/rolling, hills, mountains)
12	Subject to extreme weather conditions? What conditions and which season(s)?
13	**Mine gas emissions**
14	Total CH_4 emissions
15	VAM share of emissions
16	Gas drainage system share of emissions
17	**Ventilation Data**
18	Number of ventilation shafts in the mine
19	Airflow (m^3/minute)
23	Maximum, minimum and average methane (CH_4) concentration
24	**Gas Drainage System**
25	Description of gas drainage system used at the mine
26	Average total gas production flow rate (m^3/minute)
27	Average CH_4 concentration and normal range of CH_4 concentrations
28	% of gas drainage that is vented to the atmosphere
29	**CMM/VAM utilization**
30	Provide a brief description of current, past or planned future CMM or VAM projects
31	Is there an objective for the CMM/VAM project?
32	Is there demand for heat, power or natural gas at the mine or locally?
33	Is access to the electricity grid or gas pipeline network possible?
34	Average cost of electricity, natural gas, and/or heat paid by the mine
35	Carbon market or other incentives available to a CMM/VAM project
36	Are there any mine safety, environmental, or other regulations affecting CMM/VAM projects?
37	Regional and National coal production, CMM emissions and CMM/VAM utilization data

Other Sources of Data

Relevant data may also be available from other public sources, including:

- Corporate information
- Mine plans, including ventilation and degasification

- Geologic data
- National, regional, and mine-specific coal and gas production and sales
- National, regional, and mine-specific coal and gas reserves
- CMM project type (power generation, flaring, etc.) and emission reductions
- Natural gas infrastructure
- Potential markets for CMM, energy pricing and pricing for environmental attributes (e.g., carbon pricing, feed-in-tariffs, etc.)
- Mine safety records
- Topographic, geographic and meteorological information

Where to Find Other Data

Data can be found on the Internet, often with very limited effort, or through direct approaches to regulatory agencies.

Sources may include:

- Corporate annual reports, especially for publicly held companies
- Websites for mine owner/operators
- Other stakeholders such as GMI, USEPA, UNECE, CSIRO, CCII, and the International Centres of Excellence on CMM and other organizations
- Regulatory filings with regulatory agencies and design institutes
- Tax records showing gas and electricity production

Other Options to Locate Data

Data may also be found by reviewing conference and workshop presentations, papers and feasibility/pre-feasibility studies that are available to the public, as well as by checking:

- Documentation and websites for mine safety, energy, environmental and bilateral trade ministries.
- Carbon registries and carbon trading programs such as the UNEP CDM pipeline and the California Cap-and-Trade Program.

Examples of Publicly Available Data

Examples of public websites that provide mine information are presented below

- Mine Safety and Health Administration
- Coalbed Methane Outreach Program
- Centre on Energy, Climate and Sustainable Development

Stage 2: Preparing for the Detailed Mine Evaluation

Data obtained in response to the initial data request can be used to determine whether to continue with a pre-feasibility study.

If this initial analysis shows promising results, continuing the study will require:

- Additional clarification of responses to the initial data request.
- A detailed mine evaluation based on a more detailed data request.
- Site visit to review additional data at the mine, engage with the mine staff, and tour the surface and underground workings.

Objectives of the Detailed Mine Evaluation

- Provide additional insight into the mine company management and operations.
- Confirm location of mine facilities and planned CMM project site and site access.
- Obtain detailed geologic data to confirm gas and coal resources necessary for accurate gas production forecasts.
- Obtain more detailed time-series data on coal production, drained gas production, and VAM emissions including variations in CH_4 concentrations and flow rates.
- Gather mine maps showing longwall panels, mains, gate roads, ventilation circuits, boreholes and shafts.
- Obtain surface maps, cross sections, stratigraphic columns and geologic history.
- Confirm borehole designs for surface and in-mine pre-drainage and gob wells.
- Review gas drainage systems and the efficiency of those systems.
- Evaluate mine ventilation systems.

Benefits of a Detailed Mine Evaluation

- Developing comprehensive knowledge of the mine operations and mine workings
- Engaging directly with mine staff through site visits and visually inspecting surface installations and potentially underground workings

The more accurate the data are that you are able to obtain, the more accurate the pre-feasibility study report will be.

Steps for a Detailed Mine Evaluation

The detailed mine evaluation typically requires additional data that may be obtained through numerous iterations.

Such data are relevant to the mine overview and characteristics, ventilation, and gas drainage.

Overview and Characteristics

- Mine Background – History and Culture
- Mine Overview
- Characteristics – Coal Production
- Characteristics – Mining Hazards
- Characteristics – Methane Emissions

Ventilation

- Ventilation – Requirements
- Ventilation – Mains
- Ventilation – Practices
- Ventilation – Methane Flow Distribution
- Ventilation – Source of Emissions

Gas Drainage

- Gas Drainage – Current Practices
- Gas Drainage – In-seam Analysis
- Gas Drainage – Gob Gas Analysis
- Gas Drainage – Capture Efficiency

Mine Background - History and Culture

A better understanding of the target mine and the local coal industry and mining practices is obtained by researching:

- Regional history and adjacent mining
- Method of coal handling and transport
- Detailed topography
- Surface access to all mine operations including gas pumping stations and ventilation shafts

- Surface rights and infrastructure
- Local industry

Mine Overview

Obtain detailed mine maps that show the mine layout and production plan.

<u>Purpose</u>

- Improve understanding of mine operations
- Identify future mining districts including reserve additions
- Identify ventilation circuits and existing boreholes
- Necessary to ultimately decide on placement and scheduling of boreholes for improved gas drainage

<u>Data Required</u>

- All mining levels
- Men and materials egress routes
- Coal production/belt routes
- Sealed areas
- Developments
- Longwalls
- Timing map

Coal Production

Obtain historical coal production data and the mine's production forecast, including:

- Run of Mine "ROM" production
- Clean or saleable production

These data are used to understand:

- Mine operational history
- Production capacity
- Future production plans that can impact a CMM project and mine gas production
- Possibly correlate trends in gas production to coal production

Mining Hazards

Identify mining hazards that can impact coal production, gas emissions and general mine safety, which may include the following:

Coal Production

- Methane related delays
- Methane ignitions
- Gas outbursts
- Spontaneous combustion

Structural Concerns

- Vertical stresses
- Horizontal stresses
- Potential for air pockets and water reservoirs (especially in karst formations)
- Igneous intrusions

Historical Information

- Methane-related explosions
- Mine fires

Methane Emissions

Obtain more detailed time-series methane emissions data. This provides a clear picture of historical methane production and the relationship between ventilation and gas drainage.

Important data include:

- Methane vented and methane drained
- Historical emissions
- Specific emissions (m^3 CH_4/t coal mined)
- Gas composition
- Percent methane vented and percent methane

Ventilation Requirements

Mine ventilation systems are essential to the underground workings and are required by regulation. They introduce fresh air and remove dust and gases, including methane.

Ventilation systems are the first step in removing methane from the mine. Mines will attempt to balance methane capture through ventilation and gas drainage systems to minimize costs while maximizing capture.

Data that are Necessary to Assess the Ventilation System

- Minimum airflow and maximum velocity
- Maximum methane concentration

- Beltways
- Gob ventilation (bleeder shafts)
- Sealed airways
- Booster fans and main fans

Ventilation Main

The ventilation main is the primary ventilation circuit to introduce fresh air into the mine working areas. It is important to understand the type of ventilation system and the capacity of the system. Data to collect include:

- The ventilation system
    - "Exhaust" system pulling air through the mine from the intake shafts
    - "Forcing" system pushing air through the mine to uptake exhaust shafts
- Main fan performance
- Main fan capacity

Ventilation Practices

Depending on the purpose of the pre-feasibility study, additional data on ventilation practices may benefit the study.

- Necessary for a VAM project pre-feasibility study
- May benefit a gas drainage-based CMM project pre-feasibility study if ventilation practices could impact the volumes and CH_4 concentrations in gas drainage

Ventilation Practice Data to Collect

- Ventilation surveys and network modeling
- Ventilation practice used for developments
- Ventilation practice used for longwall panels and longwall districts
- Ventilation measurement locations and methodology

Methane Flow Distribution

Methane flow distribution data contribute to understanding the gas balance of the mine. Methane flow distribution data:

- Support design of the gas drainage plan
- Provide the basis for potential improvements to the ventilation plan

Methane Flow Distribution Data to Collect

- Gas Flow/Concentration

- Development section
- Longwall districts, panels and faces

- Mine Wide
  - Gas flow distribution
  - Concentration distribution

Ventilation Sources of Emissions

It is very important to understand the source of emissions into the mine ventilation systems.

The full list of emission sources may not exist in every case, but effort should be made to identify the most significant contributing sources and the entry points of emissions into ventilation.

Potential Ventilation Sources of Emissions

In addition to distribution of emissions, a study should assess emission characteristics, location and source.

Ventilation Emissions Considerations:

Characteristics

- Operating coal faces
- Start of longwall panels
- Gas bearing underlying strata
- Charged deep underlying gas sources

Location

- Roof fractures
- Floor fractures
- Working seam
- Behind shields
- Gob, bleeders, belt, transported coal

Source

- Mining seam
- Gas bearing overlying strata
- Gas bearing underlying strata
- Charged deep underlying gas sources

Gas Drainage Practices

Gas drainage is the removal of CMM through a system of pre-mine or post-mine boreholes or drainage galleries, and the collection and movement of that gas through a pipeline network to the surface.

Understanding the existing drainage system is critical for a pre-feasibility study for the following reasons:

- Impacts mine gas balance
- Provides data on gas availability and drainage efficiency
- Provides basis for proposing improvements to gas drainage

Gas Drainage Current Practices: Boreholes

Various pre-drainage techniques exist and are dependent on mining operations, gas properties, typical practice and availability. The following lists common techniques employed by mines worldwide:

- Surface vertical pre-drainage boreholes
- Horizontal surface in-seam or in-mine gob boreholes
- Surface gob wells
- In-mine horizontal gob wells
- In-mine cross-measure boreholes
- Overlying or underlying drainage galleries

Borehole Data

For all existing boreholes, effort should be made to collect data on:

- The approach
- Borehole/well patterns
- Overall gas production
- Overall gas concentration
- Recovery duration

If available, review time series gas production and methane concentration data rather than single measurements.

For example, continuously monitored, hourly or daily measurements will be more accurate and provide greater confidence in the data.

Gas Drainage Current Practices: Gas Collection

A gas collection system is a network of pipeline and vacuum pumps that move produced CMM from boreholes to the surface to be used or vented. The system often includes dewatering and dust removal equipment.

Air ingress into the gas collection system can compromise mine safety, reduce efficiency of gas drainage and impact the operation of a CMM utilization project.

Data on Gas Collection

Gas collection data to obtain include:

- Approach
- Pipeline routes
- Pipeline characteristics
- Integrity monitoring
- Performance monitoring
- Overall production
- Overall performance
- Capacity

In-seam Analysis: Individual Borehole Performance

Individual borehole performance should be reviewed and assessed. Borehole-specific data derived from a consistent and regular monitoring program should be available for review.

Information regarding the following are required to assess in-seam drainage:

- Gas production rates
- Rate vs. time
- Residual gas content
- Effectiveness
- Costs

Drilling Techniques and Production Casing

Additional data on the drilling techniques and production casing will provide a more complete picture of the effectiveness of current drainage practices. Relevant data include:

Standpipe

- Specifications
- Grouting procedures
- Pressure testing

Drilling

- Technique

- Equipment
- Geomechanical properties of coal seam
- Friability/solubility of the coal

Production Wellhead and Gas Pipeline

Monitoring provisions should be in place to regularly check the gas flow at the wellhead and to ensure any leaks or emissions are addressed.

Improvements to wellhead performance and the pipeline network can increase gas availability for use.

Data on Production Wellheads and Gas Pipelines

Production wellhead data to collect:

- Gas/water separation
- Performance monitoring provisions
- Safety systems

Pipeline data to collect:

- Gas/water separation
- Performance monitoring provisions
- Gas flow distribution
- Concentration distribution
- Pressure distribution

Analysis of Gob Data

Collect and review data for each gob borehole or gallery, preferably continuously monitored data, average daily data, or data collected at the same locations and times each day, such as:

- Gas production rate (m3/min)
- Methane concentration
- Methane production rate in relation to:
    - Coal production rate
    - Location of the longwall face
- Effectiveness of the gob wells, including if gobs/galleries are:
    - Delivering methane flows at safe and useable concentrations (≥30% methane)
    - Maintaining safe methane concentrations in the mine ventilation air

Gob Gas Analysis: Individual Borehole Performance

- Significant volumes of methane can be released into the goaf (gob) area as the longwall panel is mined through.
- The zone of influence for gas-bearing coal and rock strata is 160-200m above and 40-70m below the mined seam.
- Gob gas may be removed from the mine by use of vertical surface boreholes, surface directionally drilled boreholes, in-mine directionally drilled boreholes, cross-measure boreholes and drainage galleries.

In-mine Drilling Techniques & Production Casing

Similar to in-seam drainage boreholes, in-mine drilling techniques used for gob gas boreholes (directionally drilled, cross-measure, overlying/underlying drainage galleries) and production casing should be reviewed for the pre-feasibility study.

<u>Development</u>

- Installation technique
- Geomechanical properties
- Friability/solubility
- Costs

<u>Standpipe/Connection</u>

- Specifications
- Procedures
- Pressure testing

Surface Wellhead & Production Casing

Use of vertical gob wells produce CMM at the surface where it is sent through a pipeline gathering system to an end-use.

A vacuum is eventually placed on the wellhead to create sufficient pressure to produce the gas.

Data on Surface Wellhead & Production Casing

Where surface gob wells are used, the following information should be analyzed.

<u>Production Wellhead</u>

- Mover (i.e., fan)
- Vacuum pressure
- Performance monitoring

Pipeline

- Wellhead vacuum
- Control provision
- Gas/water separation
- Gas flow distribution
- Concentration distribution
- Pressure distribution

Capture Efficiency of Gas Drainage System

"Capture Efficiency" of the drainage system is the share of drained gas as a percentage of total methane emissions produced. See the table below for an example chart that displays capture efficiency by month at a mine.

Capture Efficiency = CH_4 from drainage / (CH_4 from gas drainage + CH_4 from mine ventilation)

	Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Average Ventilation (m^3/min of CH_4)	23.7	21.9	24.5	21.6	17.9	20.7
Average Captured (m^3/min of CH_4)	78.4	102.2	91.2	94.1	99.6	105.7
Total (m^3/min of CH_4)	102.1	124.1	115.7	115.7	117.5	126.4
Capture Efficiency (%)	76.8	82.3	78.8	81.4	84.8	83.6

Capture Efficiency Considerations

Greater efficiency can indicate better designed boreholes and a more effectively operated gas collection system.

- Lower efficiency – potential for improvements to gas drainage that could increase gas quantity and quality.
- Higher efficiency – there may be limited improvements that can be made to gas drainage and it may not be cost-effective to do so.

Efficiency should also be considered with CH_4 concentrations in mine ventilation and gas drainage. High efficiency but very low methane concentrations may indicate an over-reliance on gas drainage.

Capture Efficiency Data

To accurately assess capture efficiency, obtain and review the following data.

System Efficiency

- In-seam drainage/panel/district
- Gob gas drainage/panel/district
- Overall methane drainage efficiency

Observations

- Overall effectiveness
- Contributions
- Concentrations
- Impact on mining

Module 2 Summary

In this module, you learned about the two stages of data collection that provide the person who prepares the pre-feasibility study report with an understanding of mine operations and methane management.

This allows for early-stage evaluation of CMM or VAM project potential before commitment of significant financial and labor resources for the pre-feasibility study.

While it is ideal to obtain all of the data identified in this module, it is rarely feasible to do so.

It is imperative to recognize, understand and account for the potential uncertainties of the data throughout the development of the pre-feasibility study.

The analysis and outcomes of a pre-feasibility study are only as good as the data that underpin the study.

Looking Ahead

The initial data request and detailed mine evaluation provide the basis for a thorough understanding of the sources and management of CMM at a mine. This will be supported through acquisition and evaluation of additional geologic data to define the gas resource available for CMM recovery and use as outlined in Module 3 - Resource Assessment.

Thank you!

You have completed Module 2.

Glossary of Terms

Behind Shield — Longwall shearer machines have a protective shield that prevents the floor and roof from collapsing onto the shearer during mining of the longwall panel. The gob area exists behind the shield and is a source of methane emissions into the mine workings.

Beltways — Pathways within the mine where belt conveyors carrying coal or other products move product.

Bleeder Shaft — A vertical shaft through which gas-laden air from working districts is discharged to the surface. Bleeder shafts are typically not man/material shafts and have higher allowable methane concentrations.

Booster Fan — An underground ventilation device installed in series with a main surface fan that is used to boost the pressure of the air current passing through it.

Borehole — A narrow shaft bored in the ground, either vertically or horizontally.

California Cap-and-Trade — The Cap-and-Trade Program is a key element of California's strategy to reduce greenhouse gas (GHG) emissions. It complements other measures to ensure that California cost-effectively meets its goals for GHG emissions reductions. The Cap-and-Trade Regulation establishes a declining limit on major sources of GHG emissions throughout California, and it creates a powerful economic incentive for significant investment in cleaner, more efficient technologies.

Carbon Registry — A publicly available system that tracks carbon offset projects and issues offsets for each unit of emission reduction or removal that is verified and certified.

Casing — A large diameter pipe that is assembled and inserted into a recently drilled section of a borehole.

Coal Mine Methane (CMM) — Methane released from coal due to mining activities. Like CBM, CMM is a subset of the methane found in coal seams, but it refers specifically to the methane found within mining areas (e.g., within a mining plan), while CBM refers to methane in coal seams that will never be mined. Because CMM would be released through mining activities, recovering and using CMM is considered emissions avoidance.

Concentration Distribution — A spatial representation of various coal mine methane concentrations within a given mine.

Degasification — The process of removing gases from a coal mine.

Drainage Galleries — Existing roadways or purpose-driven roadways above or below the mined seam that collect methane from gob areas. The galleries are sealed, and vacuum pressure is applied to draw the gas from the galleries into the pipeline system. These are also sometimes referred to as superjacent boreholes.

Flaring — Controlled combustion of natural gas. Flaring CMM at a coal mine can occur in an open flame, otherwise known as a candlestick flare, or in an enclosed flare, sometimes referred to as a ground flare.

Friability — When coal is easy to break or crumble it is said to be friable. This has a significant impact on gas management as gas drainage boreholes drilled in friable coals can easily collapse, thereby inhibiting degasification of the mine.

Gas Composition — The gas composition of any gas can be characterized by listing the pure substances it contains and stating for each substance its proportion of the gas mixture's molecule count.

Gas Content — Volume of gas contained in a unit mass of coal and is generally expressed in cubic meters, at standard pressure and temperature conditions, per ton of coal.

Gas Drainage — Methods employed by underground coal mines, abandoned mines, and occasionally surface mines, for capturing the naturally occurring gas in coal seams to prevent it entering mine airways. Gas drainage systems include a combination of drainage boreholes and/or galleries, a gathering network, and vacuum pumps to draw gas to the surface. Gas can be removed from coal seams in advance of mining using pre-drainage techniques and from coal seams disturbed by the extraction process using post-drainage techniques. It is often referred to as methane drainage if methane is the main gas component target to be captured. Gas drainage produces coal mine methane of a higher quality than ventilation, generally in the 25 — 100 percent range.

Gas Outbursts — An outburst is the sudden and violent ejection of coal, gas and rock from a coal face and surrounding strata in an underground coal mine. When outbursts occur, they can be very serious events, possibly even resulting in fatalities.

Gas Production — The quantity of gas produced by pre-mine drainage and post-mine drainage boreholes and drainage galleries.

Gas Production Forecast — An attempt to predict methane emissions from gas drainage systems using the following methods: basin-wide emission factors; generic gas content vs depth curves; mine-specific emission factors; probabilistic methods; engineering equations; reservoir simulation.

Global Methane Initiative (GMI) — Launched in 2004, the GMI is an international public-private initiative that advances cost-effective, near-term methane abatement and recovery and use of methane as a clean energy source in three sectors: biogas (including agriculture, municipal solid waste, and wastewater), coal mines, and oil and gas systems. Focusing collective efforts on methane emission sources is a cost-effective approach to reduce greenhouse gas (GHG) emissions and increase energy security, enhance economic growth, improve air quality and improve worker safety.

Gob (Goaf) — Broken, permeable ground where coal has been extracted by longwall coal mining and the roof has been allowed to collapse, thus fracturing and de-stressing strata above and, to a lesser extent, below the seam being worked. The term gob is generally used in the United States; elsewhere, goaf is generally used.

Historical Emissions — A record of the past volume of methane emissions associated with coal production.

Igneous Intrusions — Molten magma that rises from the mantle that thrust into existing rock formations.

International Centres of Excellence on CMM — The International Centres of Excellence on Coal Mine Methane (ICE-CMM) are designed as non-profit entities subject to the national laws of the host Member States and operating under the auspices of the UNECE Group of Experts on Coal Mine Methane. The Centres support capacity-building activities in United Nations Member States and serve as a platform for discussion on safety, environmental and economic aspects of coal mine methane (CMM). In particular, they focus on such issues as effective drainage and use of methane in coal mines and abatement of carbon emissions through cost-effective and socially responsible use or destruction of captured methane.

Karst — Terrain that has sinkholes, sinking streams, caves, and springs.

Longwall — One of three major underground coal mining methods currently in use. Employs a shearer which is pulled mechanically back and forth across a face of coal that is usually several hundred feet long. This mining method can produce large quantities of coal and gas.

Longwall Face — The end of the longwall panel that is being cut by the longwall shearer.

Longwall Panel — Large blocks of coal that are mined with a longwall shearer.

Methane — Methane is a potent greenhouse gas. Methane's lifetime in the atmosphere is much shorter than carbon dioxide, but it is 28 times as efficient at trapping radiation than CO2 over a 100-year period. Methane is the main precursor of ground level ozone pollution, and thus affects air quality. Methane is also an energy resource that can be captured and used. Methane in mines poses safety risks, due to its explosiveness when mixed with air.

Mining Seam — A bed of coal lying between a roof and floor.

Post-Mine Drainage — Drilling boreholes (vertical gob wells, cross-measure boreholes, directional horizontal boreholes, or gob drainage galleries) in advance of mining so that they are in place prior to under-mining but producing gas during and after the seam is being mined.

Post-Mine Drainage Boreholes — Boreholes drilled above or below the mined seam which produce methane from gob areas after the coal seam is mined. Post-mine drainage boreholes can be drilled from the surface or in-mine. Initially, methane concentrations can be high, but concentrations will decline relatively quickly as air from the gob area is drawn into the boreholes. There are also commonly referred to as post-drainage boreholes.

Pre-Feasibility Studies — Typically provide a detailed technical analysis of site-specific information and considers project financing. Provides a gas production forecast and a review of current gas drainage practices. However, this document provides less granularity than a full feasibility study. This document is typically not considered a “bankable” document.

Pre-Mine Drainage — Drilling in-seam boreholes to extract gas from the coal seam in advance of mining operations.

Pre-Mine Drainage Boreholes — Boreholes drilled into the mined seam or adjacent gas-bearing rock and coal strata in advance of mining to remove methane before mining occurs. Pre-mine drainage boreholes can be drilled from the surface or in-mine. Gas is produced in the boreholes before the coal seam is mined. Once mined-through, gas production ceases. Methane concentrations can be very high, and boreholes can produce gas for many years in advance of mining. These are also commonly referred to as pre-drainage boreholes.

Production Casing — Production Casing refers to the casing that is run across the reservoir in sections through which the well will be drilling. It is one of the final intervals of the casing which is performed during the casing of a well. The Production Casing is the deepest section of casing in a well just above the producing formation. It is used to isolate the zone which contains gas from other subsurface formations.

Residual Gas Content — The quantity of gas remaining in a sample of coal following a period of gas desorption.

ROM — Run of Mine coal production. It is the raw material produced from the mine and delivered to the coal preparation plant.

Sealed Airways— As coal is mined, mine-out districts are sealed off from the active workings to improve ventilation and reduce leakage of methane into the active workings.

Solubility — The property of a solid, liquid, or gaseous chemical substance called solute to dissolve in a solid, liquid, or gaseous solvent.

Specific Emissions — The volume of methane emissions per ton of coal mined.

Spontaneous Combustion — A condition in which oxygen in the air is absorbed into coal during mining and transporting of coal, reacting to some of the hydrocarbon in the coal and being oxidized. The oxidation of hydrocarbons results in combustion.

Standpipe — A system of pipes that connect the components of a gas drainage system.

Strata — A layer of sedimentary rock or soil; refers to a layer of coal in this instance.

The Commonwealth Scientific and Industrial Research Organization (CSIRO) — An Australian Government agency responsible for scientific research. CSIRO works with leading organizations around the world. From its headquarters in Canberra, CSIRO maintains more than 50 sites across Australia and in France, Chile and the United States, employing about 5,500 people.

United Nations Economic Commission for Europe (UNECE) — The United Nations Economic Commission for Europe (ECE or UNECE) is one of the five regional commissions under the jurisdiction of the United Nations Economic and Social Council. It was established in order to promote economic cooperation and integrations among its member states. The commission is composed of 56 member states, most of which are based in Europe, as well as a few outside of Europe. Its transcontinental Eurasian and non-European member states include: Armenia, Azerbaijan, Canada, Georgia, Israel, Kazakhstan, Kyrgyzstan, the Russian Federation, Tajikistan, Turkmenistan, the United States of America, and Uzbekistan.

United Nations Environment Program (UNEP) — The United Nations Environment Programme (UNEP) is the leading global environmental authority that sets the global environmental agenda, promotes the coherent implementation of the environmental dimension of sustainable development within the United Nations system, and serves as an authoritative advocate for the global environment.

United States Environmental Protection Agency (USEPA) — The Environmental Protection Agency is an independent executive agency of the United States federal government tasked with environmental protection matters.

Ventilation Air Methane (VAM) — CMM that is removed via ventilation systems which use fans to dilute the methane to safe levels by circulating fresh air through the mine. VAM is the largest source of methane emissions from underground coal mines.

Working Seam — The coal seam that is being mined is referred to as the working seam. Large mines may produce coal from multiple seams and each worked seam will have its own production plan.