Coalbed Methane Outreach Program

Reducing Greenhouse Gas Emissions
Advancing Sustainable Economic Growth

COALBED METHANE OUTREACH PROGRAM

Cover photo of flame by Chris Edwards, courtesy of National Renewable Energy Laboratory

"Addressing global climate change *will require a sustained effort, over many generations …. [S]ustained economic growth is the solution, not the problem—because a nation that grows its economy is a nation that can afford investments in efficiency, new technologies, and a cleaner environment."*

—President George W. Bush

Our Mission

The U.S. Environmental Protection Agency's Coalbed Methane Outreach Program (CMOP) is a voluntary program whose goal is to reduce 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, but is a valuable fuel source when collected and used for energy.

Since 1994, CMOP has worked cooperatively with the coal mining industry to reduce CMM emissions. By helping to identify and implement methods to recover and use CMM instead of emitting it to the atmosphere, CMOP has played a key role in the United States' efforts to reduce GHG emissions and address global climate change.

This guide provides a brief overview of CMM—what it is, how it can be used, and the benefits of using it. We also describe ventilation air methane, an important source of CMM that holds great potential for future emissions reductions. Finally, we summarize CMOP activities and highlight some of our accomplishments.

Program goals:

- Reduce GHG emissions
- Achieve the profitable recovery and use of CMM
- Promote use of a clean energy source

What Is Coal Mine Methane?

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 consisting of a network of boreholes and gas pipelines. In abandoned mines and surface mines, methane might also escape to the atmosphere through natural fissures or other diffuse sources.

Sources of CMM

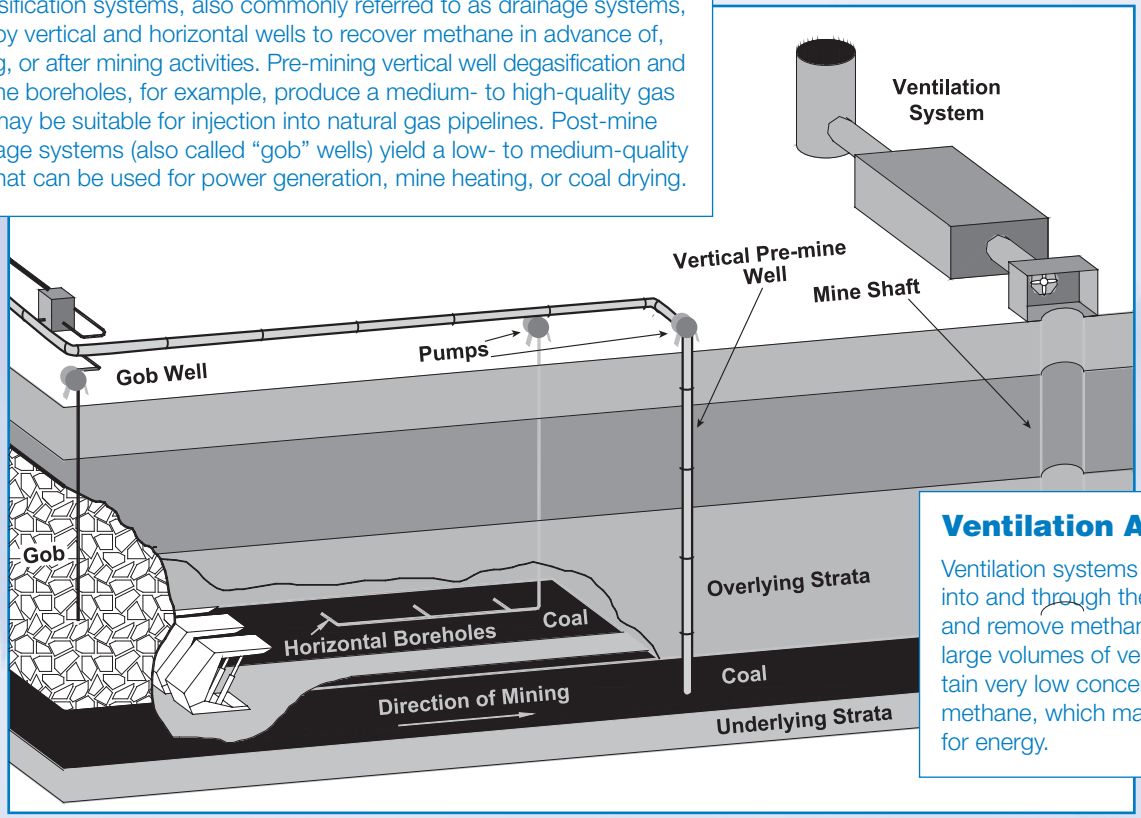
There are three main sources of CMM, which produce methane of different qualities and quantities.

- **Degasification systems** are employed before, during, and after mining activities:
  - —Premining (vertical wells): Produce medium- to high-quality gas that is often suitable for direct use in the natural gas pipeline system.
  - —In-mine (boreholes): Produce gas ranging from about 30 percent to more than 90 percent methane.
  - —Post-mine (gob wells): Produce low- to medium-quality gas.
- **Ventilation air methane (VAM)** produces dilute gas concentrations (only about 1 percent methane) but is emitted in large quantities. VAM constitutes nearly half of all CMM and is critical to global reduction of CMM emissions.
- **Abandoned or closed mines** produce emissions of low- to medium-quality gas from diffuse vents or via ventilation pipes or boreholes.

Ways in Which Methane is Removed from Active Coal Mines

Types of Degasification Systems

Degasification systems, also commonly referred to as drainage systems, employ vertical and horizontal wells to recover methane in advance of, during, or after mining activities. Pre-mining vertical well degasification and in-mine boreholes, for example, produce a medium- to high-quality gas that may be suitable for injection into natural gas pipelines. Post-mine drainage systems (also called "gob" wells) yield a low- to medium-quality gas that can be used for power generation, mine heating, or coal drying.



Ventilation Air Methane

Ventilation systems draw clean air into and through the mine to dilute and remove methane. As a result, large volumes of ventilation air contain very low concentrations of methane, which may be harnessed for energy.

How Can CMM Be Used?

Technology is readily available to recover methane (CH_4)—the major component of natural gas—from coal mines. Specific CMM end-uses depend on the gas quality, especially the concentration of methane and the presence of other contaminants.

CMM is often sold directly to natural gas pipeline systems.

Worldwide, CMM is most often used for power generation, district heating, boiler fuel, or town gas, or it is sold to natural gas pipeline systems.

CMM also can be used in many other ways:

- Coal drying
- Heat source for mine ventilation air
- Supplemental fuel for mine boilers
- Vehicle fuel as compressed or liquified natural gas (LNG)
- Manufacturing feedstock
- Fuel source for fuel cells and internal combustion engines

To date, almost all CMM captured and used from active U.S. mines is recovered from gas drainage systems.

Internal combustion engines using CMM. *Source: Northwest Fuels Development*

Example of a fuel cell that utilizes CMM. *Source: Northwest Fuels Development*

Benefits of Capturing CMM

There are numerous benefits to capturing CMM rather than simply emitting it to the atmosphere.

- **Methane is a potent GHG.** Extremely effective at trapping heat in the atmosphere, methane is more than 20 times more powerful (by weight) at warming the atmosphere than carbon dioxide. Coal mining is a significant source of methane: it contributes about 10 percent of all human-related methane emissions in the United States.

- **Methane is a valuable, clean burning energy source** that would otherwise be wasted.

- **Methane is an explosive gas** that poses a threat to mine and miner safety.

- **Recovering and using CMM is a win-win solution!**
  - Reduces GHG emissions
  - Increases mine productivity and generates revenue
  - Improves air quality
  - Utilizes skilled labor, resulting in job creation
  - Leads to greater energy independence

"Jim Walter Resources, Inc., a pioneer in the capture and utilization of both coalbed methane and coal mine methane, is convinced that degasification has been a critical element of its successful mining operation. The degas activities result in increased mining efficiency while at the same time the improved mining efficiency yields better degasification potential."

—Chuck Dixon
formerly with Jim Walter Resources

"The U.S. coal industry is a leader in CMM recovery techniques, and many of our companies have been working with EPA to improve recovery technologies."

—Jack Gerard, President and CEO
National Mining Association

What is VAM and Why Is It Important?

To ensure mine safety, mine ventilation air flow rates are maintained at very high levels to dilute in-mine methane concentration to well-below explosive levels. Typically, methane concentrations in ventilation air range from 0.1 percent to 1.0 percent.

Ventilation air methane (VAM) represents nearly half of all coal-mining emissions in the United States and worldwide, and—with few exceptions—is simply released to the atmosphere.

What are the potential markets for VAM?

The high volumetric flow rate and low concentrations of VAM make it difficult to utilize cost-effectively. Technologies to capture and harness the energy resource in VAM are currently being developed, demonstrated, and commercialized. These include thermal and catalytic oxidizers, turbines and microturbines, and fluidized beds.

What are potential uses of VAM?

- Methane oxidation, which reduces GHG emissions
- Heat recovery and use
- Power generation as primary or supplementary fuel in engines and turbines

Sources of U.S. Coal Mine Methane Emissions

Ventilation air methane (VAM) constitutes the largest portion of underground U.S. coal mine emissions, and represents a critical opportunity for GHG emissions reductions.

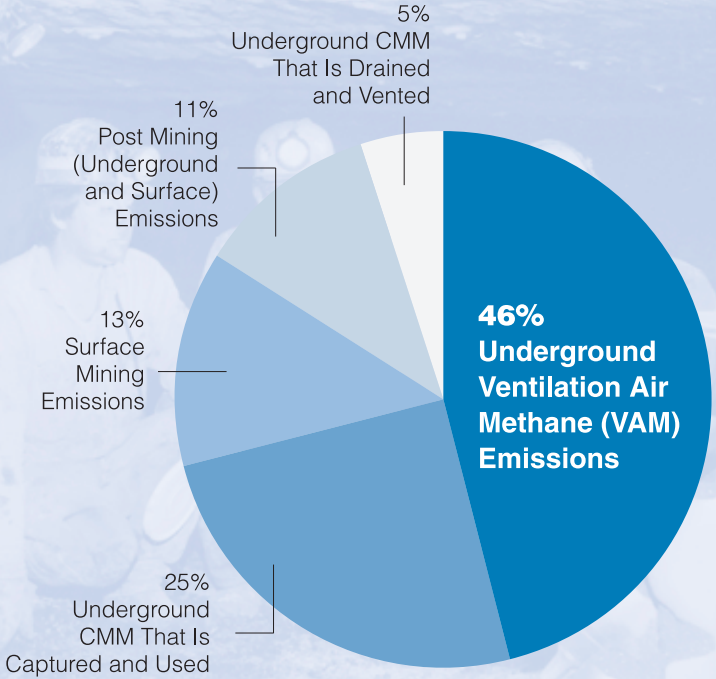


Photo by Ernie Sistek, Kennametal, courtesy of National Renewable Energy Laboratory

CMOP Activities

EPA's Coalbed Methane Outreach Program (CMOP) is engaged in numerous domestic and international outreach efforts.

Domestic Outreach

CMOP works cooperatively with the coal mining industry to support project development; overcome institutional, technical, regulatory, and financial barriers to implementation; and communicate the benefits of CMM recovery. Specific program activities include:

- Identifying, evaluating, and promoting methane reduction options, including technological innovations and market mechanisms to encourage project implementation.
- Conducting workshops to educate the mining industry on the environmental, mine safety, and economic benefits of methane recovery.
- Preparing and disseminating reports and other materials that address topics ranging from technical and economic analyses to overviews of legal issues.
- Interfacing with all facets of the mining industry to advance project development.
- Conducting feasibility and pre-feasibility studies for U.S. mines that examine a range of end-use options.
- Providing global access to information regarding latest development through the CMOP Web site and regular email updates and newsletters.

Photo by David Parsons, courtesy of National Renewable Energy Laboratory

How to reach CMOP:

www.epa.gov/cmop

Reports available online or by calling 800 STAR-YES

International Outreach

CMOP continues to develop partnerships, fund grants, and engage in international outreach to promote CMM recovery and reduce CMM emissions globally. We have established partnerships and helped set up information clearinghouses in several countries, including China, Russia, and Ukraine.

Methane to Markets Partnership

CMOP is actively engaged in implementing the Methane to Markets Partnership, which involves efforts by the Unites States and our international partners to reduce methane emissions from coal mines, landfills, and natural gas and oil systems. Using collaborative public-private partnerships, the initiative focuses on near-term methane recovery for use as a clean energy source.

CMOP International Activities

For more information on the partnership and CMOP international activities, visit <www.epa.gov/methane/international.html> or <www.epa.gov/methanetomarkets>.

CMOP Achievements— U.S. Emissions Reductions

CMOP has assisted the U.S. coal mining industry in successfully reducing its methane emissions by more than 19 percent since the program was launched in 1994. Most of this reduction is due to mines recovering and utilizing drained gas. Today, the U.S. coal industry recovers more than 80 percent of all drained CMM.

U.S. CMM reductions since 1994 have effectively removed the equivalent of more than 180 million tons of carbon dioxide (440 billion cubic feet) from the atmosphere.

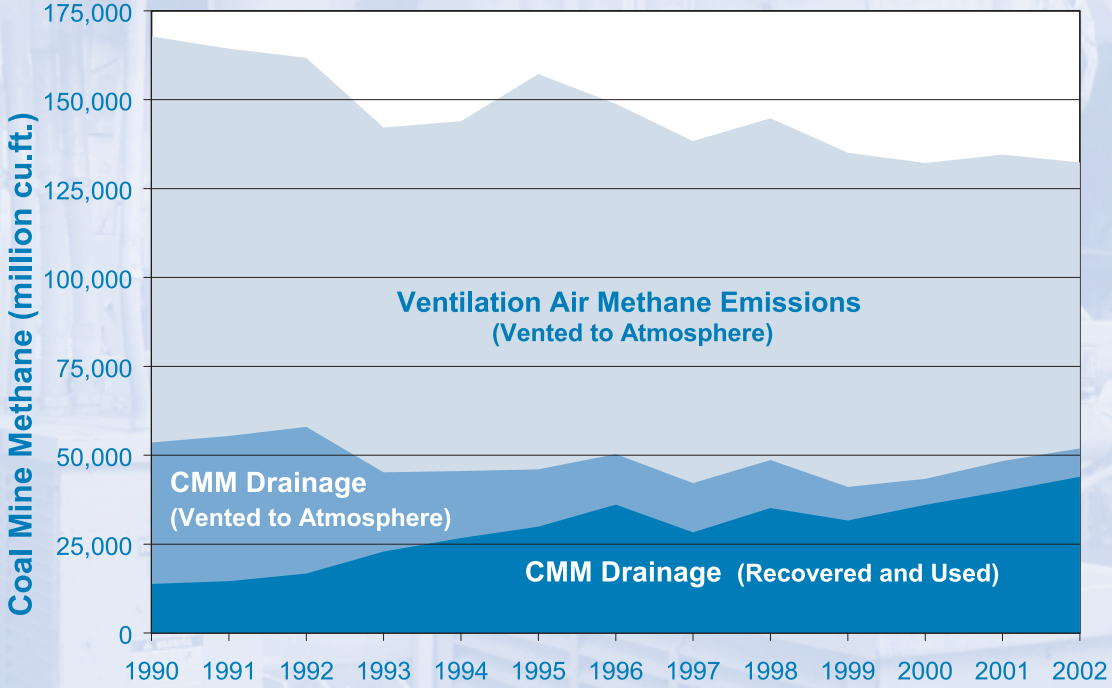
These emissions reductions have had an important economic impact as well. CMM gas sales nationally generate more than $50 million in revenue per year.

Total U.S. CMM emissions reductions since 1994 are equivalent to:

- Removing nearly 40 million automobiles per year from the roads
- Planting more than 54 million acres of trees
- Providing power to heat more than 6 million homes per year

U.S. CMM Emissions Are Decreasing

CMOP has played a significant role in decreasing U.S. CMM emissions since 1994, largely due to recovery and utilization of drained CMM.



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