

The Global Methane Initiative - Advancing Coal Mine Methane Project Opportunities

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ABSTRACT

Methane is a potent greenhouse gas, accounting for a sizable percent of all global greenhouse gas emissions. Coal seams often contain significant quantities of methane which is released during and after coal mining activity, creating a health and safety hazard for coal mine workers. To mitigate these hazards, coal mine methane (CMM) is removed through ventilation and drainage systems and historically vented to the atmosphere. Many coal mines have realized that methane is a valuable clean energy resource that can be captured and used productively. This paper presents the sources of coal mine methane and how it can be collected for use in energy projects. Energy project opportunities are discussed, including power generation, natural gas pipeline injection, vehicle fuel, industrial process feed stocks, on-site mine boilers, mine heating, and home heating distribution systems. Example project economics are presented, in addition to a discussion of incentives, financing and the Global Methane Initiative that can assist in project development. This paper concludes with a discussion of opportunities for recovering methane from coal mines in Turkey.

1. INTRODUCTION

Methane is a potent greenhouse gas, accounting for a sizable percent of all global greenhouse gas emissions. Coal seams often contain significant quantities of methane which is released during and after coal mining activity, creating a health and safety hazard for coal mine workers. To mitigate these hazards, coal mine methane (CMM) is removed through ventilation and drainage systems and historically vented to the atmosphere. Many coal mines have realized that methane is a valuable clean energy resource that can be captured and used productively. At many mines, CMM is being utilized for power generation, natural gas pipeline injection, vehicle fuel, industrial process feed stocks, on-site mine boilers, mine heating, and home heating distribution systems. Upgrading mine degasification systems can often improve gas quality and create favorable project economics. Further, recent developments have increased opportunities for harnessing the energy in coal mine ventilation air, which contains very low concentrations of methane.

The Global Methane Initiative (GMI) (formerly Methane to Markets Partnership) was launched in 2004 to promote methane recovery projects. It is an international public-private initiative that advances cost effective recovery and use of methane as a clean energy source from agriculture, underground coal mines, landfills, and oil and gas systems. GMI now includes 39

countries, including its newest member Jordan. The potential for significant CMM recovery and utilization opportunities abound in Turkey and will be examined in further detail.

2. COAL MINE METHANE BASICS

Methane is a potent greenhouse gas (GHG), more than 20 times more powerful than carbon dioxide (CO₂) at trapping heat in the atmosphere on a mass basis over a 100-year time frame. In 2005, it accounted for 15 percent of all global GHG and more than 60 percent of total methane emissions from human-related activities, such as agriculture, coal mining, landfills, and oil and natural gas systems (U.S. EPA, 2006). While more potent than CO₂, methane has a much shorter atmospheric life span; approximately 12 years versus 200 years for CO₂. Reducing atmospheric methane emissions will achieve significant near-term climate benefits over the next 25 years.

Underground and surface coal mining activities release a significant amount of GHGs to the atmosphere each year. The primary GHG emitted from coal mining activities is methane. In 2005, worldwide CMM emissions equaled 30 billion cubic meters (400 million MgCO₂E)—accounting for 8 percent of total global methane emissions from human-related activity. This is expected to rise to 34 billion cubic meters (450 million MgCO₂E) by 2020 (Methane to Markets, 2008). More than 90 percent of these CMM emissions are from

underground mines and of these nearly 80 percent is emitted as very dilute concentrations in mine ventilation air—typically in concentrations less than 1 percent methane (United Nations, 2010).

3. COAL MINING'S ROLE IN GLOBAL GHG EMISSIONS

CMM is released from the coal and surrounding rock strata during mining activities. The primary concern of methane in underground mines is the safety and explosive hazards it poses to coal miners. To reduce these hazards, CMM is removed through large-scale ventilation systems that move massive quantities of air through the mines. These ventilation systems keep mines safe, but also release large amounts of methane at very low concentrations. In some instances, it is necessary to supplement the ventilation system with a degasification system (commonly referred to as a drainage 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. In all of these situations, any CMM that is not captured or destroyed is released to the atmosphere, contributing significantly to climate change problems. CMM emissions can be divided into four primary sources: premining, ventilation air methane (VAM), gob gas, and abandoned mines.

3.1 Premining

In-seam methane can be captured before mining activities commence through premining drainage (or premining). Premining uses either vertical surface boreholes or horizontal in-seam boreholes drilled from underground roadways and shafts to drain CMM from the seam before actual mining activity commences in that area. This has the benefit of removing much of the CMM entrapped in the coal seam before mining activities begin, lessening the subsequent load on the ventilation system. Premining is most effective in coal seams with medium- to high-permeability. Although much of premining drainage is vented to the atmosphere or flared, it can usually be extracted as relatively pure CMM (i.e., 80 to 95 percent methane) that is readily utilized or sold to natural gas pipelines.

3.2 Ventilation Air Methane

Ventilation air methane (VAM) refers to the very dilute methane that is released from underground mine ventilation shafts. To ensure mine safety, large volumes of fresh air are circulated through underground coal mines using ventilation systems to dilute in-mine concentrations of methane to

levels well below explosive levels. Mine safety authorities in each country regulate these concentrations. Typically, methane concentrations in ventilation air range from 0.1 percent to 1.0 percent. These large volumes of low methane concentration air are usually vented to the atmosphere. Despite this low methane concentration, VAM is the single largest source of CMM emissions, representing more than half of all coal mining emissions worldwide. It is possible to convert the dilute methane in ventilation air to useful energy, and several projects across the globe are demonstrating the commercial scale economic feasibility of VAM projects at this time.

3.3 Gob Gas

Gob gas (or goaf gas) is generated when longwall supports are moved or after pillar removal with the room and pillar mining method, allowing the roof and walls of the mined area to collapse and fill with debris. This debris, or gob, and relaxed overlying and underlying strata contain methane that is released into the mine as it collapses and the static pressure is reduced. The resulting gob gas is initially of high-quality, usually 30 to 80 percent methane. Over time its concentration decreases as the methane mixes with ventilation air. To maintain miner safety, gob gas is extracted through either surface gob wells or underground boreholes or drainage galleries. Lower-quality gob gas cannot be injected into pipelines unless it is enriched to remove the air, so gob gas is well-suited for applications that allow for lower methane contents, including power production and on site fuel use.

3.4 Abandoned Mines

When all coal removal activities cease, mine personnel leave, mine ventilation fans are turned off, and the mine is sealed up, the mine is referred to as closed or abandoned. Even though active mining activity no longer occurs, abandoned mines can still produce significant methane emissions at a near-steady rate over an extended period of time. Though if flooded, the mine will typically produce gas for only a few years. The methane migrates to the surface through diffuse vents, fissures, and boreholes, particularly if the mine has not been sealed adequately. These continued emissions are referred to as abandoned mine methane (AMM). AMM provides a good recoverable source of medium to high quality methane—methane content ranging from 60 to 80 percent—and therefore has a number of possible commercial uses, including as a substitute for conventional natural gas in pipelines and power generation systems. Recovering and utilizing AMM is technically feasible and often economically viable. With a sealed mine, vertical and horizontal

well drilling similar to that deployed in gob gas recovery can be used to recover AMM. These wells may already be present as a result of drainage gas recovery activity that took place at the site prior to and during mining. With vented mines, recovery can take place via pre-existing ventilation shafts similar to those from which ventilation air methane is drained in working mines.

4. INNOVATIVE USES AND TECHNOLOGIES FOR MITIGATING OR ABATING CMM

The majority of the CMM produced from the four primary sources discussed above can be recovered and utilized productively or destroyed through flaring or oxidation technologies. Both utilization and destruction mitigate the global warming effects of methane by converting it to less potent CO₂. CMM is an energy product and commodity that when captured can provide many environmental, safety, health, and financial benefits. Capturing and utilizing CMM can add significantly to the value of a mining operation. Directly utilizing the CMM at the mine to generate energy yields operational cost savings, while energy or gas sales bring in additional revenue that can be reinvested in mine safety equipment and operations. Good gas drainage systems and practices will generate high (usable) quality gas and help ensure mine safety.

Mines can use several reliable degasification methods to drain methane including: (1) vertical wells (drilled from the surface into the coal seam months or years in advance of mining), (2) gob wells (drilled from the surface into the coal seam just prior to mining), and (3) in-mine boreholes (drilled from inside the mine into the coal seam or the surrounding strata prior to mining). The quality (purity) of the gas that is recovered is partially dependent on the degasification method employed, and determines how the gas can be used. For example, only high quality gas (typically greater than 95 percent methane) can be used for injection into natural gas pipelines. Vertical wells and horizontal boreholes into the coal seam tend to recover nearly pure methane (greater than 95 percent methane). In very gassy mines, gob wells drilled into the gob zone of mined-out coal seams can also recover high-quality methane, especially during the first few months of production.

Medium-to-low quality methane, with concentrations ranging from 35 to 85 percent can also be used as an energy source in various applications. Potential applications that have been demonstrated in the U.S. and other countries for lower quality CMM include:

- Electricity generation with reciprocating engines, gas turbines or steam turbines (the electricity can be used either on-site or can be sold to utilities);
- As a boiler or dryer fuel in on-site preparation plants or mine vehicle fuel,
- As a medium-BTU fuel for nearby industrial or institutional facilities; and
- Cutting-edge applications, such as in fuel cells and chemical processes.

It is also possible to enrich lower quality gas to pipeline standards using technologies that separate methane from carbon dioxide, oxygen, and/or nitrogen. Several technologies for separating methane have been commonly used in the natural gas industry and are now being modified for use with CMM, including: cryogenic separation, pressure swing adsorption, solvent absorption, molecular gates, and membrane separation. Another option for improving the quality of low methane concentration mine gas is blending, which is the mixing of lower quality gas with higher quality gas whose heating value exceeds pipeline requirements.

Even mine ventilation air methane (VAM), which typically contains less than 1 percent methane, is being successfully used for energy recovery. At a mine in Australia, VAM was used as combustion air in gas-fired internal combustion engines. The technology for using mine ventilation air as combustion air in turbines and coal-fired boilers also exists. The first commercial-scale technology to oxidize VAM in the world, located in New South Wales, Australia, became operational in September 2007 (GMI, Project Profiles). The plant generates approximately 6 megawatts (MW) of electricity and reduces greenhouse gas emissions by more than 275,000 Mg of CO₂ equivalent (CO₂e) per year. Since 2008, a mine in China's Henan Province has received carbon credits for a VAM system processing approximately 60,000 Nm³/h of ventilation air, and generating hot water for local use (GMI, Project Profiles).

5. EXTENT OF CMM PROJECT EXPERIENCE

The Global Methane Initiative (GMI) has identified more than 240 current, planned, and former CMM/VAM projects at active and abandoned mines worldwide. Figure 1 summarizes the distribution of CMM/VAM project types, with power, natural gas pipeline, and boilers dominating. Taken together, the projects entail 1,263 megawatt (MW) of electricity generating

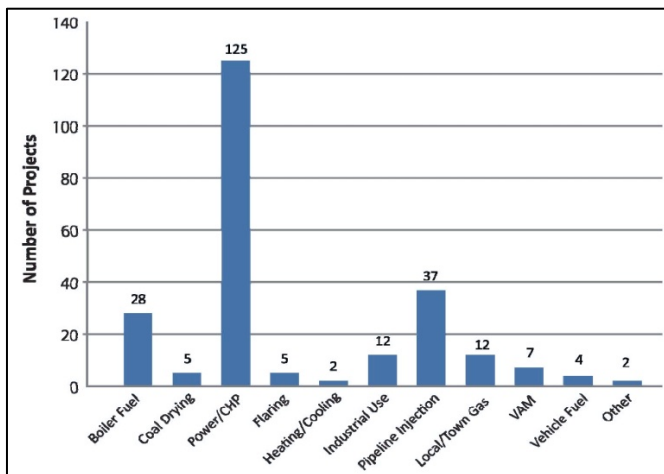


Figure 1. Distribution of CMM Projects Identified by GMI

(Source: *Methane to Markets*, 2009)

capacity and 156 MW of thermal energy capability, deliver 1,582 million m³ per year of natural gas sales, and yield annual emission reductions equivalent to 73 million MgCO₂e (*Methane to Markets*, 2009).

To date, the majority of projects making use of captured methane have occurred in Australia, China, Czech Republic, Germany, Poland, the Russian Federation, Ukraine, the United Kingdom, and the United States. With the advent of carbon markets, there is growing value for carbon emission reduction credits (or other environmental commodities) in addition to the energy commodities generated by such projects. This has spurred increased project activity in many countries, notably China, while also underpinning growth in project types solely dependent on carbon credits as the principal revenue source (e.g., flaring and VAM abatement). Table 1 summarizes a few of the CMM projects in the Eastern Europe Region.

6 CMM PROJECT DEVELOPMENT AND FINANCING

In modern coal mines, a sustained high level of coal production is necessary to obtain an acceptable financial return from investment. As coal extraction rates increase, mines often experience higher rates of methane emissions. The costs of draining these higher methane emissions are an intrinsic part of the total mining production and operating costs. Therefore, strong justification exists for investing in effective gas extraction to ensure that mines meet their production targets legally and safely. Once a gas drainage system is in place, investing in additional gas capture and utilization provides an opportunity

Table 1. Example CMM Utilization Projects In Eastern Europe

1. Czech Republic- Pipeline Injection

OKD DBP started collecting gas in 1997, capturing ~77 million m³/year of CMM and ~32 million m³/year AMM from a network of many mines; The AMM is ~75% CH₄ and the CMM is 50-55% CH₄.

2. Romania- Boiler Fuel

National Hard Coal Company began utilizing 14 million m³/yr of CMM in two on-site boilers at a coal mine in the Jiu Valley.

3. Ukraine- Vehicle Fuel

Prospekt Zasayadko installed a gas compression plant at Vostachnaya in 2004 to compress CMM into LNG for use in diesel and gasoline mine vehicles.

4. Poland- Coal Drying

In 2005 the coal preparation plant at the Morcinek Mine began utilizing 14 million m³/yr of CMM to dry coal.

5. Slovakia- Combined Heat and Power

The Hornonitrianske Mine is using 1.2 million m³/yr of CMM to fuel a reciprocating engine to produce 1.2 MW of electricity and heat for onsite use.

6. Ukraine- Combined Heat and Power

The Komsomolets Donbassa Mine is using 2.8 million m³/yr of CMM to fuel three reciprocating engines to produce 3.6 MW of electricity and 19 GJ of thermal output.

(*Methane to Markets*, 2009)

for savings or additional revenue, through a potential reduction in ventilation power cost or an increase in coal production potential.

The financial performance of a CMM energy recovery system depends on the availability of gas, the reliability of the equipment (and hence, operating hours), acceptance of energy by the user or local energy utility, and the energy revenue received (or savings to the mine through using the CMM-energy). These factors vary greatly from location to location. However, an important consideration can be the availability of emission reduction credits. Emission reduction credits provide an additional financing option in some countries to supplement conventional project financing through bank loans or private equity investment. There are a variety of emissions crediting regimes, such as the flexible Carbon Development Mechanism (CDM) and Joint Implementation (JI) under the Kyoto Protocol, as well as voluntary regimes that are the foundation of additional financing options. Other incentives to help finance methane utilization schemes include grants, tax credits, green investment schemes

(GIS), and feed-in tariffs (e.g., in Germany and Czech Republic).

Before choosing to take advantage of emission reduction credits and/or other incentives, issues to consider include the crediting mechanism, process and transaction costs, time, complexity, local rules, and price uncertainty of emission reduction credits, some of which are worth elaborating on further by using the CDM and JI as examples for illustration. The CDM, implemented under the Kyoto Protocol, allows developed countries to develop and claim reduction credits from application of approved methodologies in developing (non-Annex 1) countries. JI facilitates projects in non-CDM countries and/or countries with emission caps under the Kyoto Protocol. There are also various carbon markets for verified emission reductions (VER). VER projects are not subject to the rigorous and time-consuming validation and verification processes imposed on CDM and JI projects under the United Nations Framework Convention for Climate Change (UNFCCC); however, VERs face a smaller market and sell for considerably lower prices.

A robust proof of “additionality” is required for a project to qualify for the CDM and JI. An “additional” project is one that will reduce man-made GHG emissions below those that would have occurred in the absence of the project; for instance, compared with the business-as-usual case. Investment costs for CMM co-generation plants in terms of emission reduction potential during 10 years of operations are approximately US \$3 to US \$5/MgCO₂ equivalent avoided. Reduction credit generation involves CDM/JI project preparation, validation, verification, and service costs, together with the methane utilization/destruction equipment and its maintenance. When all the costs are taken into account, including cost of capital, financial risk, and specialist CDM/JI services, the total can amount to US \$10/MgCO₂ equivalent.

For example, a medium-level gassy mine (specific CH₄ emission of 10 m³/Mg) earns, in gross terms, 0.04 reduction credits per Mg of coal produced, while a very gassy mine (specific emission of 40 m³/Mg) yields 0.17 reduction credits per Mg of coal. This calculation assumes that 40 percent of the total gas is extracted, of which 80 percent is utilized. This level of performance would be expected as a minimum for projects where best practice methods and standards are applied and where there are no major geological or mining constraints. The actual value of the reduction credits depends on the market and the timing of

sale. The potential revenues for the example medium-level gassy mine discussed above are presented in Table 2 and demonstrate that carbon credits almost double the project revenues (United Nations, 2010).

Table 2. Revenues For An Electric Project At A Medium-Gassy Coal Mine

Parameter	Value
Annual coal production (Mtpa)	4
Coal methane content (m ³ /t)	10
Methane capture (%)	40
Project availability (%)	80
Electricity production (MWe)	5
Carbon credit price (US \$/MgCO ₂ e)	12
Electricity sales price (US \$/kWh)	0.05
Revenue- electricity sales (million US \$)	1.75
Revenue- carbon credit sales (million US \$)	<u>2.00</u>
Total revenues (million US \$)	3.75

7. GLOBAL METHANE INITIATIVE AND THE COAL SUBCOMMITTEE

The Global Methane Initiative (GMI) (formerly Methane to Markets Partnership) is an international public-private initiative that advances cost effective, near-term methane recovery and use as a clean energy source in four sectors: agriculture, underground coal mines, landfills, and oil and gas systems. These projects reduce greenhouse gas emissions in the near term and provide a number of important environmental and economic co-benefits such as:

- Stimulating local economic growth
- Creating new sources of affordable alternative energy
- Improving local air and water quality, with associated public health benefits
- Increasing industrial worker safety

The Initiative reduces the informational, institutional, and other market barriers to project development through the development of tools and resources, training and capacity building, technology demonstration, and direct project support. Special emphasis is given to bringing together all of the actors necessary for project development, including governments, financial institutions, project developers, and technology providers.

GMI is organized into technical subcommittees representing the four sectors. Each subcommittee is responsible for developing a sector-specific Action Plan that identifies the needs, opportunities

and priorities for project development globally, as well as key barriers and strategies to overcome them. In addition, the technical subcommittees are developing country-specific plans in each sector to provide more detailed information to assist project development. They also facilitate investment and financing opportunities and other cooperative activities and projects that advance the recovery of methane and its use as an energy source.

The Coal Subcommittee's Action Plan identified 5 key areas of activity for meeting its goals. These include:

1. Preparing materials that identify and describe methane recovery opportunities, available technologies, and best practices.
2. Identifying key barriers to project development and identifying potential solutions and best practices to overcome these barriers.
3. Identifying possible cooperative activities to increase methane recovery and use through regular meeting and contacts through the Project Network.
4. Learning the specific needs of partner countries.
5. Encouraging private sector organizations to join the Project Network.

GMI and the Coal Subcommittee provide extensive technical and outreach support to partners and the general public through the development of fact sheets, best management practices guides, presentations, case studies, country profiles, and policy white papers, all of which are available on the GMI website <www.globalmethane.org>. The website also houses the GMI Project Network database and the Projects database. The Project Network is a growing community of partners and private-sector entities, financial institutions, and other governmental and non-governmental organizations with an interest in methane capture and use projects. The Project Network database allows users to find contacts and make connections to promote and implement methane capture and use projects.

The Projects database is designed to help members seeking technical support, financial support or consultation by adding their project ideas and activities to this database. The database contains methane reduction projects from all GMI sectors, but is searchable by sector, geographic region, and the stage of the project (i.e., idea, planned, ongoing, completed).

GMI also funds feasibility studies to assess the technical, economic, and greenhouse gas reduction potential for implementing or improving the performance of coal mine methane (CMM) drainage and utilization projects at coal mines. Two such examples include studies prepared for the Liuzhuang coal mine in Anhui Province <www.epa.gov/cmop/docs/Final_Feasibility_Study_Liuzhuang.pdf> and the Songzao Coal and Electricity Company Coal Mines in the Chongqing Municipality <www.epa.gov/cmop/docs/feasibility_study.pdf> both in China.

GMI also hosted two Project Expos—Beijing, China 2007 and New Delhi, India 2010—for promoting methane recovery and use project opportunities and technologies. Both Expos were well attended and successful in matching several project sites with sponsors and investors. The possibility of hosting a third Project Expo is being considered at this time.

Since 2007, GMI, through funding provided by the U.S. Environmental Protection Agency, has awarded grants to spur project implementation. In 2010 EPA expected to award up to \$5 million to as many as thirty-five cooperative agreements, each receiving between \$100,000 and \$700,000 per award.

8. OPPORTUNITIES TO RECOVER CMM IN TURKEY

Coal accounts for nearly half of Turkey's primary energy production, with the vast majority of this—43 percent of total energy produced—coming from low quality lignite (Balat, 2008). The nation's estimated proven coal reserves in 2005 equaled 278 million Mg of anthracite and bituminous and 3,908 million Mg of sub-bituminous and lignite, representing 0.6 percent of the world reserves and placing it at 17th globally. During the same year, annual coal production was 2.2 million Mg of anthracite and bituminous coal and 56.2 million Mg of sub-bituminous & lignite, ranking 15th globally (GMI, 2011).

While Turkey's rich lignite deposits are spread across the country in almost every region, bituminous coal is only produced at the Zonguldak Hard Coal basin in the Western Black Sea region of Turkey. The depth of these deposits and local geology severely hamper coal production. Turkey is on a tectonically active region and many of the coal deposits in the Zonguldak Basin have been affected by faults and young volcanoes. These

tectonic activities have caused some deposits to become inclined, detached from each other, and even overturned, disintegrating the seams into big slab masses. Coal seams plunge up to 90 degrees in some locations and seam thickness varies from 0.8 to 30 meters. This makes tracing seams underground and production very difficult. Of the 52 coal seams that exist in the basin, only 22 are suitable for extraction. Approximately 66 percent of the current production comes from seams 1.5 to 4.0 meters thick that plunge at angles ranging from 20 to 60 degrees. The static life of the basin is 76 years when “possible” reserves are considered. Dynamic life can be calculated at 65 years with a 0.5 percent production increase, 57 years with a 1 percent increase, and 47 years with a 2 percent increase (Yilmaz and Aydiner, 2009).

Coalbed methane from Zonguldak hard coal region could play a significant role in Turkey’s energy economy as substantial amounts of coal bed methane (CBM) are continuously emitted from these mines. Coal mine methane (CMM) emission factors from underground mining operation in this region were estimated to be between 10 and 25 m³/Mg of coal produced in 2004 (Balat and Ayar, 2004) and total CMM emissions in 2008 were estimated to be 135 million m³ (GMI, 2011). One estimate of total in-place CBM resources in 2 of the basin’s districts is at least 3 trillion m³ (Balat and Ayar, 2004). Another study of the Amasra coalbed in the Zonguldak Basin using probabilistic simulation estimated that CBM reserves of 2.07 billion m³ possible, 1.35 billion m³ probable, and 0.86 billion m³ of proven, might be present in the region. About 10 percent of this CBM can be found in cleats as free gas (Sinayuc and Gumrah, 2009).

Even with these two estimates, total CMM potential is not well characterized and further data collection and analysis are needed to refine CMM recovery opportunities. The U.S. Environmental Protection Agency may assist with data collection to provide a clearer picture of such opportunities. TKI also has an active project (GAZPRO) aimed at identifying the gas potential of the Soma sub-bituminous coal fields.

Due to Turkey’s drastic economic growth and development in recent years—GNP growing at an average 5 percent annual rate between 1983 and 2008—the nation’s energy demand has been growing approximately 8 percent per year. (Balat, 2008) As a result, energy is one of the nation’s most important development priorities. Currently, Turkey has to import more than 60 percent of its total energy demand (Yilmaz and Aydiner, 2009). For economic, environmental, and geopolitical

reasons, Turkey has chosen natural gas as the preferred fuel for the new power plant capacity to be added in the coming years. As a result, natural gas consumption is the fastest growing primary energy source in Turkey (Hacisalihoglu, 2008). To supply this natural gas, Turkey relies on imports from Turkmenistan, Russia, Iran, Algeria, Nigeria, and other Middle East and Central Asian neighbors. In 2001, Turkey passed the “Natural Gas Market Law” that aimed to limit government influence on the natural gas energy sector and attempt to attract foreign investment in the energy infrastructure (Hacisalihoglu, 2008). Capturing and utilizing the vast reserves of Zonguldak basin CBM and CMM could help reduce natural gas imports.

9. CONCLUSION

Methane is a potent greenhouse gas that is released in significant quantities from underground coal mines. GMI and its partner countries are actively working to identify and implement projects to capture and utilize CMM in ways that reduce global climate impact and create new sources of affordable alternative energy, stimulate local economic growth, improve local environmental and public health quality, and increase mine safety. Over the past decade, many technologies have been commercially applied to recover the energy potential of CMM. With its vast coal reserves, Turkey has great potential for CMM capture and utilizations opportunities. As a result GMI efforts are currently underway to better characterize and define these opportunities in Turkey.

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