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Coal Mine Methane Country Profiles

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Global Methane Initiative

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UNITS AND CONVERSIONS

Units	
t	tonnes
Mt	thousand tonnes
Mmt	million tonnes
Mmt CO_2e	million tonnes CO_2 equivalent
bt	billion tonnes
kg	kilograms
Mg	megagram
Gg	gigagram
m	meters
m^3	cubic meters
Mm^3 or MMCM	million cubic meters
Bm^3 or BCM	billion cubic meters
km	kilometers
MCM	thousand cubic meters
Mmcf	million cubic feet
TCM	trillion cubic meters
Tcf	trillion cubic feet
kW	kilowatts
MW	megawatts
MW_e	megawatt electrical
kWhr	kilowatt-hours
J	joule
KJ	kilojoule
MJ	megajoule
PJ	petajoule
Btu	British thermal unit
Kpa	kilopascals
psia	pounds per square inch absolute
Conversions	
1 t	1.102 US ton/short ton
1 m	3.28 feet
1 km	0.62 miles
1 m^3	35.32 cubic feet
1 kg	2.21 pounds
1 kg CH_4	1.47 m^3 CH_4
1 t CH_4	21 Mmt CO_2e
1 MJ	0.28 kilowatt-hours
1 Btu	1055 joules

EXECUTIVE SUMMARY

In 2004, 14 countries came together to launch the Methane to Markets (M2M) Partnership ─which was re-launched as the Global Methane Initiative (GMI) in 2010─with the aim of reducing emissions of methane, a potent greenhouse gas (GHG), by promoting the development of projects that recover and use methane as a clean energy source. This international public-private partnership is currently working with government agencies around the world to facilitate project development in four key methane-producing sectors: agricultural operations, coal mines, landfills, and oil and gas systems. The efforts of this collaboration are yielding important and diverse benefits across the globe, such as enhancing economic growth and energy security, improving air quality and industrial safety, and reducing GHG emissions.

The Global Methane Initiative has grown over the past six years to include 37 partner countries and the European Commission, representing about 70 percent of the world's anthropogenic methane emissions. The GMI also includes a vibrant Project Network of more than 1,000 members from diverse sectors such as international finance, development, the policy arena, and non-profit institutions whose common goal is to promote methane recovery and use projects around the world.

This report was prepared to assist GMI's Coal Mine Technical Subcommittee in its goal of reducing methane emissions in the coal mine sector. The study scopes out the opportunities across the world for coal mine methane (CMM) recovery projects, serving as a guide for the Coal Subcommittee in developing future CMM projects. The study profiles a total of 37 countries—GMI partner countries and otherwise—most of which are actively producing coal or have significant coal reserves (Table 1).

Countries Profiled in the Report

Argentina*	Germany*	Poland*
Australia*	Hungary	Republic of Korea*
Botswana	India*	Romania
Brazil*	Indonesia*	Russia*
Bulgaria*	Italy*	South Africa
Canada*	Japan*	Spain
China*	Kazakhstan*	Turkey*
Colombia*	Mexico*	Ukraine*
Czech Republic	Mongolia*	United Kingdom*
Ecuador*	New Zealand	United States*
Finland*	Nigeria*	Vietnam*
France	Pakistan*	
Georgia*	Philippines*	

* GMI partner countries

Each country profile includes an overview of its coal industry and characterizes and quantifies its CMM emissions. Brief descriptions of individual coal mines also have been provided wherever possible. All information has been sourced from publicly available literature, or from in-country experts.

Global Overview at a Glance

Table 1 summarizes estimated coal reserves in the profiled countries. The United States, Russia, and China are the top three ranking countries together accounting for more than half of the total global coal reserves of 844,065 million tonnes (Mmt) (429,313 Mmt anthracite and bituminous; 414,752 Mmt sub-bituminous and lignite). The United States alone holds roughly 28 percent of the world's total or 239,298 Mmt.

Table 1. Estimated Coal Reserves (2006)

Country	**Anthracite & Bituminous** (million tonnes)	**Sub-bituminous & Lignite** (million tonnes)	**Total** (million tonnes)	**Profiled Country Rank** (# and %)
Argentina	0	424	424	23 (0.5%)
Australia	37,100	39,500	76,600	4 (9.4%)
Botswana	40	0	40	31 (0.005%)
Brazil	0	7,068	7,068	10 (0.9%)
Bulgaria	5	1,991	1,996	17 (0.2%)
Canada	3,471	3,107	6,578	13 (0.8%)
China	62,200	52,300	114,500	3 (14.1%)
Colombia	6,578	381	6,959	11 (0.9%)
Czech Republic	1,673	2,828	4,501	14 (0.6%)
Ecuador	0	24.0	24.0	32 (0.003%)
Finland	N/A	N/A	N/A	34 (tie) (0)
France	N/A	N/A	N/A	34 (tie) (0)
Germany	152	6,556	6,708	12 (0.8%)
Georgia	N/A	N/A	N/A	34 (tie) (0)
Hungary	199	3,103	3,302	16 (0.4%)
India	52,240	4,258	56,489	5 (6.9%)
Indonesia	1,721	2,607	4,328	15 (0.5%)
Italy	0	10	10	33 (0.001%)
Japan	355	0	355	25 (0.04%)
Kazakhstan	28,170	3,130	31,300	8 (3.8%)
Mexico	860	351	1,211	20 (0.1%)
Mongolia	N/A	N/A	N/A	34 (tie) (0)
New Zealand	33	538	571	21 (0.07%)
Nigeria	21	169	190	27 (0.02%)
Pakistan	1.0	1981	1982	18 (0.2%)
Philippines	41	275	316	26 (0.04%)
Poland	6,012	1,490	7,502	9 (0.9%)
Republic of Korea	0	135	135	30 (0.02%)
Romania	12	410	422	24 (0.05%)
Russia	49,088	107,922	157,010	2 (19.3%)
South Africa	48,000	0	48,000	6 (5.9%)
Spain	200	330	530	22 (0.07%)
Turkey	0	1,814	1,814	19 (0.2%)
Ukraine	15,351	18,522	33,873	7 (4.2%)
United Kingdom	155	0	155	28 (0.02%)
United States	110,668	128,620	239,298	1 (29.4%)
Vietnam	150	0	150	29 (0.02%)
Profiled Countries Total	**424,506**	**389,844**	**814,350**	
World Total	429,313	414,752	844,065	

Source: *International Energy Annual 2006*. U.S. Energy Information Administration (EIA), Washington, DC, table posted October 17, 2008. http://www.eia.doe.gov/pub/international/iea2006/table82.xls

Note: EIA calculates U.S. reserves only. It reproduces international reserves data from World Energy Council (WEC), *Survey of Energy Resources*. See http://www.eia.doe.gov/emeu/iea/Notes%20for%20Table%208_2.html for more information. WEC reserves data depend on each reporting country's interpretation of assessment criteria and defines "Proved Recoverable Reserves" as the tonnage within the Proved Amount in Place that can be recovered under present and expected local economic conditions with existing available technology. International conventions about the economic mineability of energy resources may vary.

Table 2. Coal Production (2007)

Country	**Anthracite & Bituminous** (million tonnes)	**Sub-bituminous** (million tonnes)	**Lignite** (million tonnes)	**Total** (million tonnes)	**Profiled County Rank (Less Lignite)** (# and %)	**Profiled Country Rank (With Lignite)** (# and %)
Argentina	0.1	0	0	0.1	28 (0.002%)	31 (0.002%)
Australia	287.5	36.2	65.6	389.4	4 (6.1%)	4 (6.4%)
Botswana	1.0	0	0	1.0	25 (0.02%)	29 (0.02%)
Brazil	0.2	3.4	2.3	6.0	21 (0.07%)	24 (0.1%)
Bulgaria	0.04	0	28.4	28.4	29 (0.0007%)	18 (0.5%)
Canada	32.8	25.1	10.5	68.4	12 (1.1%)	13 (1.1%)
China	2,352.9	0	0	2,352.9	1 (44.2%)	1 (38.9%)
Colombia	69.9	0	0	69.9	10 (1.3%)	12 (1.2%)
Czech Republic	7.7	5.2	49.7	62.6	16 (0.2%)	14 (1.0%)
Ecuador	0	0	0	0	33 (tie) (N/A)	34 (tie) (N/A)
Finland	0	0	0	0	33 (tie) (N/A)	34 (tie) (N/A)
France	0	0	0	0	33 (tie) (N/A)	34 (tie) (N/A)
Germany	24.2	0	180.4	204.6	14 (0.5%)	8 (3.4%)
Georgia	0.01	0	0	0.01	30 (0.0003%)	32 (0.0002%)
Hungary	0	0	9.8	9.8	33 (tie) (N/A)	22 (0.2%)
India	448.2	0	34.0	482.2	3 (8.4%)	3 (8.0%)
Indonesia	230.2	30.2	4.3	264.8	5 (4.9%)	6 (4.4%)
Italy	0.2	0	0	0.2	27 (0.003%)	30 (0.003%)
Japan	0	0	0	0	33 (tie) (N/A)	34 (tie) (N/A)
Kazakhstan	93.5	0	4.3	97.8	8 (1.8%)	10 (1.6%)
Mexico	2.1	10.5	0	12.5	17 (0.2%)	21 (0.2%)
Mongolia	0.3	0	9.1	9.4	26 (0.006%)	23 (0.2%)
New Zealand	2.0	2.6	0.3	4.8	19 (0.09%)	25 (0.8%)
Nigeria	0.008	0	0	0.008	32 (0.0002%)	33 (0.0001%)
Pakistan	4.1	0	0	4.1	20 (0.08%)	26 (0.07%)
Philippines	3.4	0	0.003	3.4	22 (0.06%)	27 (0.06%)
Poland	87.4	0	57.5	144.9	9 (1.6%)	9 (2.4%)
Republic of Korea	2.9	0	0	2.9	24 (0.05%)	28 (0.05%)
Romania	0	0.01	35.8	35.8	31 (0.0002%)	17 (0.6%)
Russia	217.9	0	71.1	289.0	7 (4.1%)	5 (4.8%)
South Africa	247.7	0	0	247.7	6 (4.7%)	7 (4.1%)
Spain	7.9	3.1	6.2	17.2	18 (0.2%)	19 (0.3%)
Turkey	2.5	0.8	72.1	75.4	23 (0.06%)	11 (1.2%)
Ukraine	58.7	0	0.2	58.9	11 (1.1%)	15 (1.0%)
United Kingdom	16.5	0	0	16.5	15 (0.3%)	20 (0.3%)
United States	492.8	475.1	71.3	1,039.2	2 (18.2%)	2 (17.2%)
Vietnam	42.5	0	1.8	44.3	13 (0.8%)	16 (0.7%)
Profiled Countries Sum	**4,737.2**	**592.2**	**714.8**	**6,044.2**		
World Total	9,467.5	1,184.5	1,429.6	12,081.5		

Source: *International Energy Agency Energy Statistics – Coal* at http://www.iea.org/Textbase/country/index.asp.

As seen in Table 2 above, China and the United States are by far the world's largest coal producers, together accounting for just over half of the production of profiled countries. China alone produces more than a third of the total for profiled countries. Of the countries evaluated in this study, Ecuador, Finland, France, and Japan are currently not producing any coal.

Table 3. Methane Emissions from Coal Mining ($MmtCO_2e$)

Country	1990	1995	2000	2005*	Rank as of 2005
Argentina	0.2	0.1	0.25	0.23	29
Australia	15.8	17.5	19.6	21.8	5
Botswana	N/A	N/A	N/A	N/A	N/A
Brazil	1.2	1.1	1.3	1.2	19
Bulgaria	1.6	1.4	1.2	1.3	18
Canada	1.9	1.7	1.0	0.9	23 (tie)
China	126.1	149.1	117.6	135.7	1
Colombia	1.9	2.0	3.0	3.4	13
Czech Republic	7.6	5.8	5.0	4.8	12
Ecuador	0	0	0	0	34 (tie)
Finland	0.01	0.01	0.01	0	34 (tie)
France	4.3	4.4	2.6	2.6	15
Germany	25.8	17.6	10.2	8.4	8
Georgia	0.007	0.001	0	0	34 (tie)
Hungary	1.1	0.7	0.6	0.49	27
India	10.9	13.7	15.8	19.5	6
Indonesia	0.3	0.4	0.4	0.5	26
Italy	0.1	0.06	0.07	0.07	31
Japan	2.8	1.3	0.8	0.8	25
Kazakhstan	24.9	17.2	10.0	6.7	11
Mexico	1.5	1.8	2.2	2.5	16
Mongolia	0.2	0.1	0.07	0.05	32
New Zealand	0.3	0.3	0.3	0.4	28
Nigeria	1.8	2.9	1.2	0.02	33
Pakistan	0.9	1.0	1.0	1.1	22
Philippines	0.2	0.2	0.2	0.2	30
Poland	16.8	15.6	11.9	11.3	7
Republic of Korea	4.8	1.6	1.2	0.9	23 (tie)
Romania	3.7	3.9	2.7	2.8	14
Russia	60.9	36.8	29	26.2	4
South Africa	6.7	6.7	7.1	7.4	9
Spain	1.8	1.4	1.2	1.2	20
Turkey	1.6	1.6	1.7	1.8	17
Ukraine	55.3	30.1	28.3	26.3	3
United Kingdom	18.3	12.6	7.0	6.7	10
United States	81.9	65.8	56.2	55.3	2
Vietnam	0.5	0.8	1.0	1.2	21
Profiled Countries Total	482	416	340	329	

Source: *Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990–2020*, U.S. EPA, Office of Atmospheric Programs, Climate Change Division, June 2006 revised. Available at http://www.epa.gov/nonco2/econ-inv/international.html.

*2005 emissions: Extrapolated based on changes in coal production from 1995 to 2000.

In Table 3 above, total methane emissions from coal mining are estimated for 1990, 1995, 2000 and 2005. China, which has the world's highest coal production, also emits the greatest amount of CMM, estimated at more than 136 $MmtCO_2e$ per year. Other large CMM emitters (>10 $MmtCO_2e$ per year) based on 2005 estimates are the United States, Russia, Ukraine, Australia, India, and Poland.

Table 4 provides a worldwide snapshot of CMM recovery and utilization activities—both operating and in development—and the amount of CMM emissions avoided. Ongoing CMM projects can be found in 16 of the 37 countries profiled in this report. China, Australia, Czech Republic, Germany, Poland, United Kingdom, and the United States in particular host numerous projects at active mines, while Germany, Ukraine, United Kingdom, and the United States host many projects at abandoned mines. Countries that are in early development stages include: New Zealand, which is exploring project development; India, which has developed a demonstration project for power generation; and South Africa, which has developed one thus far. These three countries have conducted methane drainage in addition to ventilation at active coal mines, and Italy is currently assessing the feasibility of drainage at an abandoned mine. All of these countries have strong potential to recover and utilize drained gas in the future.

Table 4. Coal Mine Methane Recovery and Utilization Projects (2010)

Country	CMM Projects in Operation or Development (Yes or No)	Projects at Active Mines (# Range)	Projects at Abandoned Mines (# Range)	Project End-Uses	Total Emissions Avoided ($MmtCO_2e$)
Argentina	No	-	-	-	-
Australia	Yes	13	5	Boiler fuel, flare, power generation, pipeline injection, ventilation air methane (VAM) oxidization	9.1
Botswana	No	-	-	-	-
Brazil	No	-	-	-	-
Bulgaria	No	-	-	-	-
Canada	No	-	-	-	-
China	Yes	82 (+1 unknown)	-	Boiler fuel, combined heat and power (CHP), industrial use, power generation, town gas, VAM destruction, vehicle fuel	31.8
Colombia	No	-	-	-	-
Czech Republic	Yes	6 (+9 unknown)	5	CHP, pipeline injection	2.3
Ecuador	No	-	-	-	-
Finland	No	-	-	-	-
France	Yes	-	3	Pipeline injection, industrial use	2.8
Germany	Yes	9 (+2 unknown)	36	CHP, power generation	4.2
Georgia	No	-	-	-	-
Hungary	No	-	-	-	-
India*	Yes	1	-	Fuel for power generation	-
Indonesia	No	-	-	-	-
Italy**	No	-	-	-	-
Japan	Yes	-	2	Industrial use, power generation	0.002
Kazakhstan	Yes	1	-	Boiler fuel	0.17 (2000)
Mexico	Yes	3	1	Boiler fuel, power generation	1.3

Country	CMM Projects in Operation or Development (Yes or No)	Projects at Active Mines (# Range)	Projects at Abandoned Mines (# Range)	Project End-Uses	Total Emissions Avoided ($MmtCO_2e$)
Mongolia	No	-	-	-	-
New Zealand*	No	-	-	-	-
Nigeria	Yes	3	1	Boiler fuel, power generation	1.3
Pakistan					
Philippines	No	-	-	-	-
Poland	Yes	19	2	Boiler fuel, power generation, coal drying, CHP, industrial use	5.2
Republic of Korea	No	-	-	-	-
Romania	Yes	1	-	Boiler fuel	0.5
Russia	Yes	7	-	Power generation, boiler fuel	0.3
South Africa*	Yes	1	-	Flaring	0.2
Spain	No	-	-	-	-
Turkey	No	-	-	-	-
Ukraine	Yes	4	18	Boiler fuel, flaring, CHP, industrial use, power generation, vehicle fuel	4.8
United Kingdom	Yes	16	18	Boiler fuel, flaring, heating or cooling, industrial use, power generation, pipeline injection	2.8
United States	Yes	16	26	Coal drying, heating and cooling, power generation, pipeline injection, VAM destruction, other	7.0
Vietnam	No	-	-	-	-
				Total	73.6
				GMI Partners Total	67.9 (92%)

* Have conducted or are conducting drainage in addition to ventilation
** Currently assessing the feasibility of conducting drainage in addition to ventilation
Annual estimate indicates annual emissions avoided based on current power generation and pipeline sales of CMM
Source: International Coal Mine Methane Projects Database, Global Methane Initiative (formerly Methane to Markets Partnership), accessed September 14, 2010. http://www2.ergweb.com/cmm/index.aspx

As seen in Table 4, Australia, China, Germany, Poland, Ukraine, and the United States avoid a considerable amount of methane emissions from their coal mines. Australia, Czech Republic, France, Germany, Japan, Mexico, Nigeria, Poland, Ukraine, United Kingdom, and the United States get a portion of their reductions through recovery at abandoned mines. Based on the available data, an estimated total of 68 $MmtCO_2e$ are recovered from GMI partner countries annually.

INTRODUCTION

Methane is a potent greenhouse gas (GHG) that is more than 20 times as powerful as carbon dioxide (CO_2) at trapping heat in the atmosphere, on a mass-basis over a 100-year timeframe. It accounted for 15 percent of all global GHG emissions[1] in 2005, with more than 60 percent of the total methane emissions coming from human-related activities, such as agriculture, coal mining, landfills, and oil and natural gas systems. Since methane has a much shorter atmospheric lifetime than CO_2 (about 12 years compared to about 200 years for CO_2), reducing methane emissions can achieve significant climate benefits over the next 25 years.

The Methane to Markets (M2M) Partnership was formed in 2004 as an agreement amongst 14 countries to work toward minimizing methane emissions from major sources. The goal of this international public-private partnership is to reduce emissions of methane by advancing the development of projects that recover and use methane as a clean energy source. Membership has expanded to 37 countries (and the European Commission) as of September 2010, representing about 70 percent of the world's anthropogenic methane emissions, and was re-launched as the Global Methane Initiative (GMI) in October 2010. Public and private sector organizations around the world are now working together with government agencies to facilitate project development in the four key methane-producing sectors: agricultural operations, coal mines, landfills, and oil and gas systems. These efforts of collaboration are yielding important benefits across the globe, including enhanced economic growth and energy security, improved air quality and industrial safety, and reduced GHG emissions.

Global Methane Initiative (formerly Methane to Markets) Partners

Argentina	Ethiopia	Kazakhstan	Russia
Australia	European Commission	Mexico	Serbia
Brazil	Finland	Mongolia	Thailand
Bulgaria	Georgia	Nicaragua	Turkey
Canada	Germany	Nigeria	Ukraine
Chile	Ghana	Pakistan	United Kingdom
China	India	Peru	United States
Colombia	Indonesia	Philippines	Vietnam
Dominican Republic	Italy	Poland	
Ecuador	Japan	Republic of Korea	

Methane released from coal mining activities in underground and surface mines is of particular concern as methane is explosive in nature and poses a safety hazard to coal miners. Constituting 6 percent of the global anthropogenic methane emissions in 2005, coal mine methane (CMM) if recovered and utilized not only provides valuable clean fuel and environmental benefits, but also improves mine safety and productivity.

CMM varies in quality depending on the source of emission. The CMM drained from underground mine workings through ventilation systems to avoid concentration build-up is very diluted. Referred to as ventilation air methane (VAM), it however accounts for the largest source of CMM emissions globally. In some instances, it is necessary to supplement the ventilation with a degasification system consisting of a

[1] *Global Mitigation of Non-CO_2 Greenhouse Gases,* U.S. Environmental Protection Agency, Office of Atmospheric Programs, June 2006.

network of boreholes and gas pipelines that may be used to capture methane before, during, and after mining activities to keep the methane concentration within safe limits. "Abandoned" or closed mines may also continue to emit methane, typically of low to medium quality, from ventilation pipes or boreholes.

A number of technologies are readily available to recover and use methane from active or abandoned coal mines, while a technology has been demonstrated to recover the energy content of dilute methane emissions from coal mine ventilation shafts. Specific uses for recovered CMM depend on the gas quality, especially the concentration of methane and the presence of other contaminants in the drained gas. CMM is typically used worldwide 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, including coal drying, as a heat source for mine ventilation air or supplemental fuel for boilers, for vehicle fuel as compressed natural gas (CNG) or liquefied natural gas (LNG), as manufacturing feedstock, or as a fuel source for fuel cells and internal combustion engines.

Although there are significant benefits and scope for CMM recovery, developing CMM projects face several challenges. These include access to appropriate technology to assess resources, effectively installing drainage systems, and selecting appropriate end use technologies. Market barriers include appropriate price signals and adequate infrastructure to transport the gas. Lastly, regulatory and policy issues such as clear establishment of property rights to the gas and access to capital or financing also impede CMM project development.

Purpose of the Report

This report has been prepared under the aegis of the GMI Coal Mine Technical Subcommittee, responsible for guiding GMI efforts to reduce methane emissions from coal mines. The Subcommittee identified the lack of information about project opportunities in different countries as a major barrier to initiating global CMM project development.

Coal Mine Methane Country Profiles was prepared by Coalbed Methane Outreach Program, an initiative of the U.S. Environmental Protection Agency (U.S. EPA) that supports GMI's efforts in promoting development of CMM projects in coal-producing countries. The information in this report was based on country profiles submitted by GMI partner countries, as well as on publicly available data and consultation with in-country experts.

Organization of the Report

The following sections in the report profile 37 countries in alphabetical order. Each country's overview addresses the following broad topical areas:

☑ Summary of the Coal Industry
- Coal production and the importance of coal in the country's economy and energy sector
- Key stakeholders in CMM project development
- Status of the coal mining Industry

☑ Overview of CMM Emissions, Projects, and Potential
- CMM from Operating Mines
- CMM from Abandoned Mines
- CBM from Virgin Coal Seams

☑ Opportunities and Challenges to Greater CMM Recovery and Use

☑ Profiles of Individual Mines

1 ARGENTINA

1.1 Summary of Coal Industry

1.1.1 ROLE OF COAL IN ARGENTINA

Although Argentina is a significant energy producer and a net energy exporter, it has limited coal reserves. Its energy resources are dominated by oil and natural gas, with coal playing a minor role in the national energy mix. Only 1.5 percent of the primary energy supply came from coal and peat combined in 2007 (IEA, 2007a). Argentina has only one power plant in the country that is coal-fired; located in the Buenos Aires province, the plant has a total installed capacity of 350 megawatts (MW) (Perczyk, 2007).

As shown in Table 1-1, total coal production in Argentina amounted to only about 0.11 million tonnes (Mmt) in 2007. Argentina's consumption in 2004 was 0.8 Mmt, with exports from the United States, Australia, and South Africa (EOEARTH, 2008).

Table 1-1. Argentina's Coal Reserves and Production

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2006)*	0	424	424	23 (0.1%)
Annual Coal Production (2007)**	0.11	0	0.11	30 (0.0018%)

Source: *EIA (2008); **IEA (2007b)

Coal and related organic-rich deposits are widely distributed in Argentina; however, its coal reserves are not extensive (Brooks and Willett, 2004). Almost 99 percent of Argentina's reserves are located in the locales of the Pico Quemado mine in Rio Negro Province (estimated reserves – 75 Mmt) and Rio Turbio mine in Santa Cruz Province (estimated reserves – 750 Mmt) (Perczyk, 2007). Rio Turbio has the only operational coal mine in Argentina. Figure 1-1 shows the location of these coal deposits.

Figure 1-1. Argentina's Coal Fields

Source: SATG (nd)

1.1.2 STAKEHOLDERS

Little information on business stakeholders in Argentinean coal mine methane (CMM) development is available. Other potentially interested parties include natural gas transmission and distribution companies and ENARGAS, the gas regulatory agency. Key stakeholders are listed in Table 1-2.

Table 1-2. Key Stakeholders in Argentina's CMM Industry

Stakeholder Category	Stakeholder	Role
Mining Companies	▪ Yacimiento de Carbón de Río Turbio	Potential host mine
Natural Gas Transmission & Distribution (T&D) Companies	▪ Transportadora do Gas del Norte ▪ Transportadora del Gas del Sur (controlled by Petrobras)	CMM pipeline distribution
Regulatory Agencies	▪ ENARGAS ▪ Department of Environment and Sustainable Development ▪ Department of Energy ▪ Department of Mining	Permitting, gas sale, and distribution

Stakeholder Category	Stakeholder	Role
Developers	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Project opportunity identification and planning
Engineering, Consultancy, and Related Services	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Technical assistance
Professional Associations	▪ Argentine Petroleum and Gas Institute ▪ Association of Sanitary Engineering and Environmental Sciences	Facilitate government/ industry interaction
Other	▪ Natural gas T&D companies	

1.1.3 Status of Coal and the Coal Mining Industry

Only one underground mine is active in Argentina – the Rio Turbio mine – currently operated by Yacimientos Carboníferos Río Turbio, a company owned by the Argentine National State. It was previously run by Yacimientos Carboniferos Fiscales but at a low production rate. The Rio Turbio mine produces sub-bituminous coal, some of which is consumed onsite in a rail car repair forge and the remainder is sent to Buenos Aires for power generation (Perczyk, 2007).

Annual production statistics reveal a decline in production over the past two decades, from a reported high of slightly more than 500,000 tonnes per year in 1982 to 200,000 tonnes in 2003. Although five underground operations were actively exploiting high-volatile sub-bituminous coal at Pico Quemado in the 1950s (M2M Workshop - Argentina, 2005), they are now closed.

Coal production is, however, projected to increase as Argentina is expanding its electric grid to connect the remote Río Turbio mine to Río Gallegos, a big city and potential consumption center for coal-generated power (Perczyk, 2007).

Gas reserves in place at the currently operating Rio Turbio mine are not known.

1.2 Overview of CMM Emissions and Development Potential

1.2.1 CMM Emissions from Operating Mines

Country-wide methane emissions reported in Argentina's Revised National Communication under the United Nations Framework Convention on Climate Change (UNFCCC) clearly equate with the Rio Turbio mine, the only active mine in the country. Those emissions are presented in Table 1-3.

Table 1-3. Argentina's CMM Emissions (million cubic meters)

Emissions	1990	1995	2000	2005
Total emitted (= Total liberated – recovered & used)	0.2	0.1	0.25	0.23

Source: USEPA (2006)

Argentina's Department of Mining estimates that the emission factor could be in the range of 0.8–1.2 cubic meters (m^3) of methane per tonne of coal (Perczyk, 2007).

1.2.2 CMM Emissions from Abandoned Coal Mines

The five underground operations at Pico Quemado—that were active in the 1950s, but have ceased to operate—could be a potential source of abandoned mine emissions. However, no data on the gassiness of the workings or quantifying methane emissions from these are currently available.

1.2.3 CBM from Virgin Coal Seams

No data is currently available on coalbed methane resources in Argentina.

1.3 Opportunities and Challenges to Greater CMM Recovery and Use

Argentina, a non-Annex I country, has signed and ratified the UNFCCC and the Kyoto Protocol, as indicated in Table 1-4. Argentina is a potential candidate site for Clean Development Mechanism (CDM) projects, which provides the incentive of carbon emission reduction revenues, thus improving the overall project cash flow and attractiveness to investors.

Table 1-4. Argentina's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC	June 12, 1992	March 11, 1994
Kyoto Protocol	March 16, 1998	September 28, 2001

Source: UNFCCC (2004); UNFCCC (2005)

1.3.1 Market and Infrastructure Factors

Argentina has come a long way from its financial crisis in 2002 when energy prices dipped dangerously low and the country's economy declined. In response, the Argentinean government minimized the devaluation effect in the energy sector by freezing tariffs for gas and electricity and removing taxes from exports. Local producers benefited from frozen tariffs while devaluation improved Argentina's competitiveness in the global market. The government committed to increase the regulated tariffs to industrial customers in an agreement signed with natural gas producers in 2004, allowing for gradual recovery of natural gas prices in the country. This strategy of controlling tariffs helped Argentina emerge as competitive, providing a favorable climate for investments (Perczyk, 2007).

Argentina also experienced an energy crisis in 2004 in which demand outstripped supply, leading to a default on a gas export contract with Chile. In an effort to avoid future such scenarios, the country instituted additional energy sector reforms. It established the Energía Argentina Sociedad Anónima (ENARSA), a state-owned energy company that will be involved in all aspects of the energy sector, while the government made plans to liberalize energy pricing and provide downstream investment incentives (Perczyk, 2007).

The business climate for energy enterprises in Argentina has also improved significantly from the regional integration of Latin American economies. MERCOSUR's (South American Common Market – Argentina, Uruguay, Paraguay, and Brazil) development in 1995 and its subsequent amendments have spurred the investment climate; MERCOSUR members have achieved the greatest degree of energy sector integration to date. Power system integration has occurred between Argentina and Brazil, thereby providing the physical infrastructure necessary to facilitate exchange of electricity between the two countries. Further, Argentina is a member of Organization Latinoamericana de Energia, a Latin American Energy Organization, which provides a framework for developing, integrating, selling, etc. of energy resources in the region.

Argentina has also initiated steps to conserve the environment. In 2000, Argentina was South America's third largest energy consumer and second largest carbon dioxide (CO_2) emitter from fossil fuel consumption (EIA, 2005). With environmental protection growing in importance, the government has entered into cooperative relationships with the industry to facilitate environmental restoration. Requirements to repair a legacy of abandoned drilling wells, production mud pits, and leaking natural gas infrastructure, and to reduce gas-flaring were put in place. As of 2008, only Argentina had accepted a voluntary target for reduction of GHG emissions in Latin America and had 10 registered CDM projects (IADB, 2008).

Currently, Argentina has one of the most competitive and deregulated power sectors in South America. Argentinean government has opened up generation, transmission, and distribution to the private sector, and guarantees suppliers access to the grid. In a bid to meet its increasing electricity demands, Argentina is seeking to expand its thermal generation capacity and released a tender in 2006 for a new 240-MW coal-fired power plant in Santa Cruz province (EOEARTH, 2008).

These changes in business environment and government requirements are creating a favorable market for CMM development in Argentina. An added incentive is Argentina's substantial gas in place resources. With natural gas being Argentina's primary energy source and with the third largest gas reserves in South America, there is an extensive pipeline network not only domestically but to the neighboring countries of Chile, Bolivia, Brazil, and Uruguay. The pipeline network provides access to both domestic and international markets for gas produced from coalfields (EOEARTH, 2008). Argentina already has several landfill methane projects on the ground. A starting point for identifying and quantifying CMM/abandoned mine methane development potential in Argentina would be gathering basic information on the methane content of Argentinean coals. Similarly, site-specific data on methane emissions from individual mines, active and abandoned, would be required.

1.3.2 Regulatory Information

While ownership of most minerals in Argentina does not rest with the surface owner, the national government nevertheless is bound to grant a mining license to the discoverer of new deposits. In return, the licensee pays an annual royalty, invests a minimum amount of capital, and can execute reasonable exploitation (MEOSP, nd).

In the natural gas sector, gas distribution is enhanced by open access to the distribution pipeline system for producers and distributors, with transport rates regulated by ENARGAS (Natural Gas Regulatory Authority). Gas users may build a pipeline at their own cost, connect it to the distribution network, and purchase gas directly from producers to avoid distribution costs (MEOSP, nd).

The following federal bodies regulate environmental compliance: Secretaria de Mineria (Department of Mining), Secretaria de Ambiente y Desarrollo Sostenible (Department of Environment and Sustainable Development), and Secretaria de Energia (Department of Energy). Provincial authorities also play a role in ensuring environmental compliance, having established their own policies that largely mirror the federal requirements.

1.4 Profiles of Individual Mines

Source: Perczyk, 2007

Rio Turbio Mines

General Overview

Rio Turbio, an active mine located in the Austral Basin in Santa Cruz Province in southern Argentina, is considered to be developed in an extension of the Magallanes Basin to the west (in Chile).

General Information

Total mineable reserves (thousand tonnes)	750,000

General Geologic Information

Number of coal seams above currently mined	None. Five coal-bearing units (mantos) are present: Manto Inferior (lowermost); Manto Superior, Manto B, Manto A, and Manto Doreta (uppermost). At present, only Manto Doreta (1.92 meters [m] thick) is being mined.
Aggregate thickness of coal seams above currently mined	None.

Geologic and Mining Conditions

Rank of coal	Bituminous
Pitch, degrees	5–10 degrees, east dipping
Ash content, % (coal in place, run-of-mine)	12.05%
Moisture, % (coal in place, run-of-mine)	7.65%

Coal Production, Methane Emissions, and Degasification (and Use) Statistics

	1990	1991	1992	1993	1994	1995	1996
Coal Production (million tonnes)	0.28	0.29	0.20	0.16	0.14	0.30	0.31
Methane Emissions (billion m^3)	0.13	N/A	N/A	N/A	N/A	0.007	N/A
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Coal Production (million tonnes)	0.25	0.29	0.35	0.26	0.19	0.04	0.20
Methane Emissions (billion m^3)	N/A	N/A	N/A	0.018	N/A	N/A	N/A

Pico Quemado Mines

General Overview

This mine, located in the south central part of the country, is currently abandoned.

General Information

Total mineable reserves (thousand tones)	75,000 (estimated as regional total less Rio Turbio reserves)

General Geologic Information

Number of coal seams above currently mined	N/A; volcanic intrusions overlay the coal seams
Faults?	Yes, minor

Geologic and Mining Conditions

Ash content, % (coal in place, run of mine)	47.03%
Moisture, % (coal in place, run of mine)	17.61%

Coal Production, Methane Emissions, and Degasification (and Use) Statistics

	1990	1991	1992	1993	1994	1995	1996
Coal Production (million tonnes)	None	None	None	None	None	None	None
Degasification	None	None	None	None	None	None	None
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Coal Production (million tonnes)	None	None	None	None	None	None	None
Degasification	None	None	None	None	None	None	None

1.5 References

Brooks and Willett (2004): *Update: World Coal Quality Inventory – Argentina*, William E. Brooks and Jason C. Willett, U.S. Geological Survey, Reston, Virginia, Open-File Report 2004-1022.

EIA (2005): Country Analysis Brief – Argentina. U.S. Energy Information Administration, Washington, DC, January 24, 2005.

EIA (2008): Data obtained from International Energy Annual 2006, U.S. Energy Information Administration, Washington, DC, table posted October 2008. http://www.eia.doe.gov/pub/international/iea2006/table82.xls (reserves)

EOEARTH (2008): Energy Profile of Argentina, The Encyclopedia of Earth, September 2008. http://www.eoearth.org/article/Energy_profile_of_Argentina

IADB (2008): Sustainable Development: Environment, Climate Change and Energy, Inter-American Development Bank, 2008. www.iadb.org/document.cfm?id=35216941

IEA (2007a): Share of Total Primary Energy Supply in 2007 – Argentina, International Energy Agency, 2007. http://www.iea.org/stats/pdf_graphs/ARTPESPI.pdf

IEA (2007b): Coal and Peat in Argentina, International Energy Agency, 2007. http://www.iea.org/stats/coaldata.asp?COUNTRY_CODE=AR

MEOSP (nd): Investment Opportunities, Ministerio de Economía y Obras y Servicios Públicos, The Consulate General of the Republic of Argentina in Montreal. http://www.consargenmtl.com/invest3.htm#gas

M2M Workshop - Argentina (2005): *Methane to Markets Partnership, Argentina, Coal Mine Methane*, presented at the Methane to Markets Regional Workshop, December 2, 2005, Beijing, China.

Perczyk (2007): Coal Industry Situation in Argentina, Daniel Perczyk, Instituto Torcuato Di Tella, 2005. http://www.methanetomarkets.org/documents/partners_argentina_coal_update.pdf

SATG (nd): http://www.southamericatravelguide.org/archives/images/argentina-map.shtml

UNFCCC (2004): United Nations Framework Convention on Climate Change - Status of Ratification, May 24, 2004.

UNFCCC (2005): Kyoto Protocol - Status of Ratification, September 19, 2005. http://unfccc.int/files/essential_background/kyoto_protocol/application/pdf/kpstats.pdf

USEPA (2006): *Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990–2020*, U.S. Environmental Protection Agency, Office of Atmospheric Programs, Climate Change Division, June 2006. http://www.epa.gov/nonco2/econ-inv/international.html

2 AUSTRALIA

2.1 Summary of Coal Industry

2.1.1 ROLE OF COAL IN AUSTRALIA

Australia is the fourth largest producer of coal in the world, behind China, the United States, and India. Although rich in energy resources with significant petroleum, natural gas, and coal reserves, its energy consumption is dominated by coal, which fuels most of the country's power generation. Coal accounts for 85 percent of the country's electricity generation (IEA, 2009).

Australia ranks sixth in black coal (all non-lignite coal) production, with its current economic reserves estimated to sustain production for the next 200 years. About 97 percent of Australia's black coal production comes from Queensland and New South Wales. Australia also produces about 8 percent of the world's brown coal and ranks third after Germany and the United States. All of its brown coal (lignite) production comes from Victoria, with more than 98 percent sourced from the La Trobe Valley (ACA, 2008; M2M-Australia, 2005).

Australia is the world's largest coal exporter. It exported 261 million tonnes (Mmt) in 2008–2009, comprising 28 percent of total world coal exports. As of 2008, Australia exported about 60 percent of its annual coal production, about 46 percent of it to Japan. Other markets included Taiwan, South Korea, and India (ACA, 2008; EIA, 2009).

Table 2-1 quantifies Australian coal reserves and recent production.

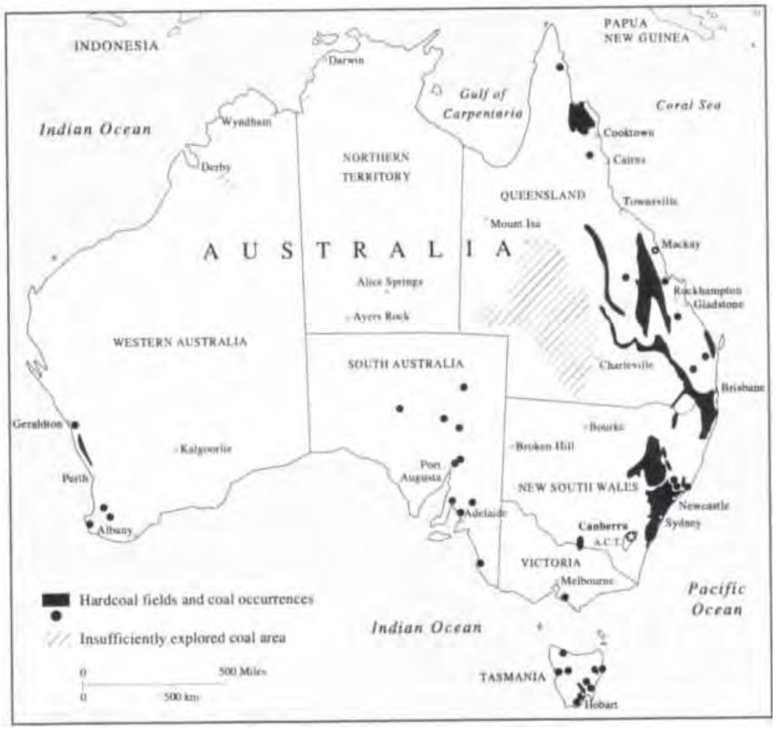
Table 2-1. Australia's Coal Reserves and Production

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2009)	36,800	39,400	76,200	4 (9.2%)
Annual Coal Production (2009)	348.00*	61.2**	409.2	4 (6.7%)

Source: BP (2010); *ABARE (2010) – all black coal; **ABARE (2010) – lignite only

Australia has large deposits of both brown and black coals, located on the east coast in the states of Queensland, New South Wales (NSW), and Victoria (see Figure 2-1). The Bowen Basin in Queensland contains the largest reserves at 37.8 billion tonnes (Bt). Reserves in the Sydney-Gunnedah Basin and surrounding areas of northern NSW contain about 32.1 Bt (EIA, 2009). Minor reserves are also located in Southern and Western Australia, as well as Tasmania (USGS, 2002).

Figure 2-1. Australia's Coal Fields



Source: Schwochow (1997)

2.1.2 STAKEHOLDERS

Table 2-2 identifies potential key stakeholders in Australian coal mine methane (CMM) development.

Table 2-2. Key Stakeholders in Australia's CMM Industry

Stakeholder Category	Stakeholder	Role
Mining Companies	▪ BHP-Billiton ▪ Rio Tinto (Coal & Allied Industries Limited; Pacific Coal) ▪ Xstrata ▪ Anglo Coal ▪ Peabody Energy ▪ Vale ▪ Ensham Resources ▪ Anglo Coal Australia Pty Ltd ▪ Illawarra Coal Holdings Pty Ltd ▪ Planet Gas Ltd. ▪ Centennial Coal	Project hosts/Potential project hosts
Developers	▪ Arrow Energy ▪ BG Group ▪ Santos ▪ Queensland Gas Company (QGC) – a BG subsidiary ▪ Petronas ▪ Energy Developments Ltd. ▪ See http://www.epa.gov/coalbed/networkcontacts.html	Project opportunity identification and planning

Stakeholder Category	Stakeholder	Role
Equipment Manufacturers	▪ BCCK ▪ BOC Gases ▪ Caterpillar ▪ ComEnergy ▪ Cummins Engine ▪ Engelhard ▪ Ingersoll-Rand ▪ MEGTEC Systems ▪ Northwest Fuels Development ▪ Solar Turbines ▪ Waukesha Engines	Methane treatment and utilization equipment
Engineering, Consultancy, and Related Services	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Technical assistance
Natural Gas Transmission & Distribution Companies; Power Companies	▪ Stanwell Corporation ▪ CS Energy ▪ Tarong Energy Corporation ▪ AGL Energy ▪ Epic ▪ Ergon ▪ Energex	
Universities, Research Establishments	▪ Australian Coal Association Research Program ▪ Commonwealth Scientific and Industrial Research Organization (CSIRO) ▪ Energy Development Limited	Technical assistance
Regulatory Agencies	▪ Queensland Department of Natural Resources and Mines ▪ NSW Department of Primary Industries Minerals	Project identification and assessment support
Government Groups	▪ Department of Industry, Tourism, and Resources ▪ Australian Greenhouse Gas Office ▪ Department of Environment, Water, Heritage, and the Arts	Licensing and permitting
Other	▪ Large-scale industrial applications ▪ Fertilizer plants (Incitec) ▪ Retail consumers	

2.1.3 Status of Coal and the Coal Mining Industry

Australia's coal production has increased by 34 percent over the last two decades, with more operations coming online every year (EIA, 2009). There are 112 black coal mines located across Australia – 70 open pit and 42 underground operations (M2M-Australia, 2010). Underground mines account for 59 percent of coal production in NSW and 10 percent of coal production in Queensland. Table 2-3 breaks up Australia's coal production by mining method and region (ACA, 2008).

In addition to Australian private mining companies, international companies also play a large role in Australian coal production. Major coal companies operating in Australia include: BHP-Billiton, Rio Tinto Coal, Xstrata, Peabody, Vale and Anglo Coal. Australia mostly produces high-quality coking and steaming coals that are high in energy content and low in sulfur, ash, and other contaminants.

Table 2-3. Australia's Coal Production by Mining Method and Region (million tonnes)

Mining Method	Black Coal (Saleable Production)	
	2006–20007	2007–2008
Underground	73.6	83.8
Open pit	251.6	243.0
Total	325.2	326.8
States Production		
NSW	130.9	135.0
Queensland	184.1	180.9
South Australia	3.6	3.8
Western Australia	6.1	6.4
Tasmania	0.4	0.4
Total Australian Production	325.2	326.8

Source: ACA (2008)

2.2 Overview of CMM Emissions and Development Potential

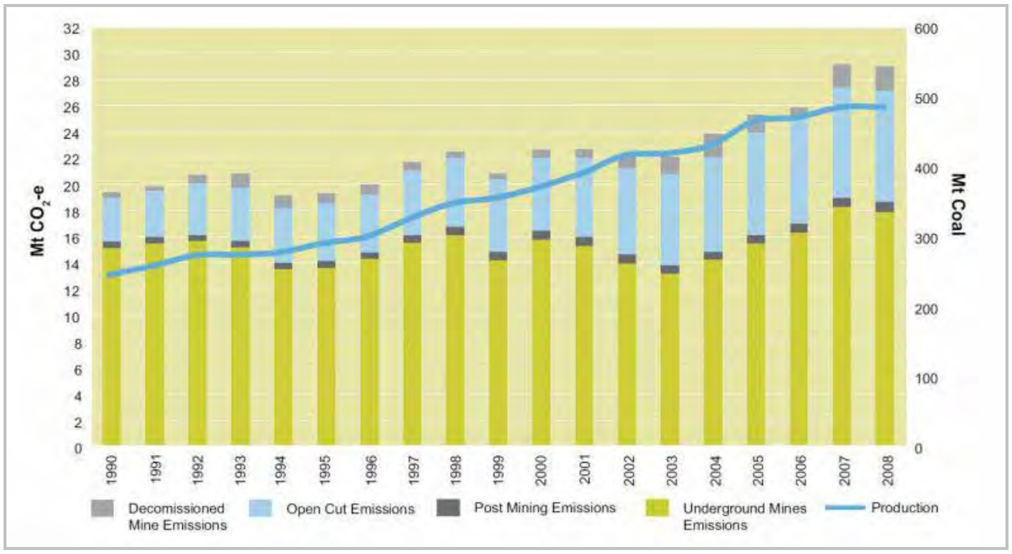
Australia has the second largest (after the United States) commercially advanced CMM and coalbed methane (CBM) industry.

2.2.1 CMM Emissions from Operating Mines

In 2008, net emissions associated with coal mining and handling, and decommissioned mines were 28.8 million tonnes of carbon dioxide equivalent ($MmtCO_2e$) and accounted for just more than 5 percent of Australia's total greenhouse gas (GHG) emissions of 549.5 $MmtCO_2e$ (DCCEE, 2010). Coal sector methane emissions increased 65 percent between 1990 and 2007, while coal mine production doubled. Emissions per 1000 tonnes of coal produced decreased by 16.5 percent from 67 tonnes CO_2e to 56 tonnes CO_2e over the same time period and this reduction is primarily attributed to the mining of less gassy coal reserves and the expanding implementation of methane recovery, use, and flaring technologies (M2M-Australia, 2010).

The Australian government estimates that ventilation air methane (VAM) is responsible for 64 percent of Australia's coal mine emissions, with a typical gassy mine producing VAM at a rate of 150–300 cubic meters (m^3) per second (M2M-Australia, 2005). Figure 2-2 shows Australia's CMM emissions (including emissions from abandoned mines) from 1990 to 2008.

Figure 2-2. Australia's Fugitive Emissions from Coal Mining, 1990–2008



Source: DCCEE (2010)

There are currently 17 CMM projects registered in Australia at 15 mines, 10 of which are active underground mines and five are abandoned mines. Three of the projects involve flaring recovered gas, nine projects generate electricity using reciprocating engines, four projects destroy ventilation air methane (VAM), and one project involves injection of high quality CMM into a sales pipeline (M2M-Projects, 2010).

Seven projects use CMM to generate 215 MW of electricity sold into the national grid, with a resultant annual emissions reduction of 6.5 $MmtCO_2e$ (M2M-Australia, 2010). The largest CMM power station is located at BHP Billiton's Appin and Tower mines near Sydney. Commissioned in 1996, this project consists of 94 1-MW reciprocating engines and consumes 600,000 m^3 of CMM a day. Other large power plants, built and operated by Energy Developments Ltd., include a 32-MW project at the German Creek coal mine (uses 16 2-MW engines and came on-line in November 2006) and the $60 million 45-MW plant at Anglo's Moranbah North coal mine (uses 15 3-MW engines and started operation in late 2008). Both of these plants are located in the Bowen Basin in central Queensland (Energy Developments, 2010).

In one landmark CMM project, BHP Billiton was awarded up to $6 million from the Australian Greenhouse Office to construct a CMM power station at the Westcliff Colliery, near Wollongong, NSW, to allow the combustion of VAM (BHP, 2010). The West Cliff VAM Project (WestVAMP) officially opened on September 14, 2007 and was the first to generate commercial power solely from VAM. The project burns 0.9 percent VAM concentration to produce 6 MW of electricity via a conventional steam turbine. Along with displacing coal-fired electricity generation, WestVAMP is estimated to reduce emissions by up to 0.250 $MmtCO_2e$ each year (MEGTEC, 2008, 2010).

2.2.2 CMM Emissions from Abandoned Coal Mines

The latest report on Australia's GHG emission trends, released by the Department of Climate Change, notes that emissions from decommissioned mines are small (relative to total emissions), at 1.4 $MmtCO_2e$

in 2008. Emission levels vary with mine closures, but are projected to be 1.3 $MmtCO_2e$ in 2020 (DCC, 2009).

2.2.3 CBM from Virgin Coal Seams

Australia has the most active development of unconventional gas outside of North America. CBM recovery activity predominately has been in NSW and Queensland, Australia's two largest coal-producing states, but exploration for CBM is also occurring in Victoria (M2M-Australia, 2005). Drained CBM has been used to generate electricity in NSW since the 1980s, while commercial CBM production began in Queensland in 1996, providing pipeline-quality gas to three coastal cities (Schwochow, 1997).

Annual CBM production in Australia more than doubled between 2003 and 2006, from 538 million m^3 to 1.6 billion m^3 (Bcm). The rapid rate of increase in production has continued with 2.9 Bcm produced in 2007 and 3.7 Bcm in 2008. At the same time, proved and probable reserve estimates have risen rapidly to 435 Bcm in 2008 with 95 percent of reserves located in Queensland and the rest in New South Wales (AIMR, 2009). In 2008, 96 percent of Australia's CBM production came from the Bowen and Surat Basins in Queensland and provided 60 percent of Queensland's gas demand for that year. Analysts believe CBM could provide up to 50 percent of the Australian east coast natural gas supply by 2020 (AIMR, 2009).

From 2007 to 2008, CBM exploration in Queensland continued at record levels with about 600 CBM wells drilled, compared to 70 natural gas wells. The Bowen, Galilee, and Surat Basin continue to be the main areas of focus, while the Sydney, Gunnedah, Gloucester, and Clarence-Morton Basin are being targeted in NSW.

Driving much of the recent CBM activity, several major international companies have acquired stakes in Australia's CBM industry with plans to convert CBM into liquid natural gas (LNG) for export to the energy hungry markets of Southeast Asia. The BG Group, Santos Ltd., (with Petronas), ConocoPhilips (with Origin Energy), and Royal Dutch Shell are planning four separate CBM-to-LNG projects in Queensland (Dow Jones Newswires, 2010).

For details on all ongoing CBM operations and the vested companies, visit the Australian Mines Atlas at http://www.australianminesatlas.gov.au/aimr/commodity/coal_bed_methane_09.jsp.

2.3 Opportunities and Challenges to Greater CMM Recovery and Use

Source: M2M-Australia (2005), unless otherwise noted

Australia is a signatory to the United Nations Framework Convention on Climate Change (UNFCCC) and ratified the Kyoto Protocol in 2007 (see Table 2-4). Australia is committed to meeting its Kyoto target to reduce GHG emissions by 60 percent of 2000 levels by 2050 and will be engaged in the negotiations for a new agreement when Kyoto expires (Kyoto, 2007).

Table 2-4. Australia's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC	June 4, 1992	December 30, 1992
Kyoto Protocol	April 29, 1998	December 3, 2007

Source: UNFCCC (2004); UNFCCC (2005)

Having ratified the Kyoto Protocol, Australia is now able to take advantage of the revenues generated by its carbon emission reductions. Other opportunities for project financing include the Greenhouse Gas Abatement Program (GGAP), providing up to $43.47 million to support the development of power stations using CMM. GGAP aims to reduce Australia's net GHG emissions by limiting emissions to 108 percent of 1990 levels between 2008 and 2012. The country is on track to meet this target. The Australian government is funding four CMM projects (for seven individual power stations) in Queensland and NSW under the GGAP (IEA, 2009).

Similar to GGAP, the Australian Coal Mine Methane Reduction Program (ACMMRP), sponsored by the Australian Greenhouse Office, was created to reduce methane emissions to help Australia meet its Kyoto targets. The goal was to reduce emissions by 0.9 Mmt per year, amounting to 4.5 Mmt over the 2008–2012 period. Developers of CMM projects originally had $15.9 million available through grants beginning in 2008 (ACMMRP, 2008). In 2008, the Strategic Review of Australian Government Climate Change Programs found that both the GGAP and ACMMRP had difficulties finding suitable, viable projects despite the potential impact of CBM/CMM mitigation projects (Strategic, 2008). In the 2009–2010 budget, the ACMMRP was terminated because it no longer aligned with the proposed Carbon Pollution Reduction Scheme (CPRS), but existing commitments from the program would still be honored (Budget, 2009). Legislation for the CPRS has not yet passed the Australian Parliament and has been delayed until the end of the current Kyoto Protocol commitment period in 2012 (CPRS, 2010).

Australia has included coal seam methane in its Renewable Energy Target definition for a transitional period to greater renewable production (Renewable Energy, 2010). Aside from the federal level support for CMM/CBM development, the governments of NSW and Queensland provide further incentives for their development. Queensland is promoting a transition to gas supplies via its Smart Energy Policy. Starting in 2010, 15 percent of all electricity sold in Queensland has to be from gas-fired generation, which may be increased to 18 percent by 2020 (Smart Energy, 2010). NSW has had a Greenhouse Gas Reduction Scheme since 2003 that encourages a switch from coal-based energy production to natural gas-based production, including CBM/CMM (GHG Reduction, 2010).

2.3.1 Market and Infrastructure Factors

Although Australia's CMM development has been primarily driven by mine safety concerns, the industry has received a boost from the country's GHG emissions reduction obligations and accompanying incentives from the national government (see GGAP discussion in section 2.1). State-based schemes have also provided additional incentives to encourage a shift in energy use towards natural gas, including CBM and CMM.

Electricity generation has provided the main market for drained CMM and based on expected growth in the industry, there is potential to double generating capacity over the next decade (M2M-Australia, 2010). Growth in the coal mining industry is robust with six new coal mine projects, valued at more than $1.5 billion, completed in 2008–2009, and a further 21 projects scheduled for completion in the near to medium term (ACA, 2009).

While Queensland produces more than 90 percent of CBM volumes, NSW coal basins hold greater potential for CMM development with greater coal production from underground mines in NSW than in Queensland (51.6 thousand tonnes [Mt] versus 30.8 Mt respectively – NSWMC,2009; GSQ, 2010) and generally gassier mines. With natural gas infrastructure in place and serving the Sydney-Newcastle corridor, local major energy markets are conveniently accessible.

In contrast with eastern NSW, gas transport infrastructure is more limited in Queensland, and CBM projects have historically been sited near existing gas pipelines, such as the 750-km Wallumbilla-Ballera pipeline which connects the gas fields of the Cooper Basin to eastern Queensland. But major pipeline projects are in development, driven by planned CBM to LNG projects. The BG Group is planning a 380 km underground pipeline from the Surat Basin to the port of Gladstone to deliver CBM to its proposed LNG plant. Additional pipeline capacity will be built to link BG's CBM resources to the new transmission pipeline. In 2009, BG Group signed an LNG Project Development Agreement with China National Offshore Oil Corporation (CNOOC) who is the intended customer for the produced LNG (BG Group, 2010). Santos Ltd reports that it plans to upgrade field infrastructure at the Fairview CBM field and also build a pipeline to Gladstone as part of its proposed CBM to LNG project (OGJ, 2010).

Major pipeline operators such as Epic Energy and the APA Group have been active in expanding the capacity of existing pipelines in Queensland and NSW, adding compression facilities, building links between the major pipelines and adding new inlet stations to receive CBM from new production areas (AGL, 2009; APA, 2010).

Australia has been a world leader in work on the development and trial of technologies to capture and use CMM, VAM and CBM. Commonwealth Scientific and Industrial Research Organization (CSIRO), Energy Development Limited, and BHP Billiton are some of the Australian organizations who have conducted research, development, and demonstration work related to the recovery and utilization of CMM and VAM.

BHP Billiton's WestVAMP (see section 2.2.1) was the first commercial demonstration using a thermal flow-reversal oxidizer for VAM-fueled power generation, while CSIRO has funded the development of new lean-fuel catalytic gas turbines designed to capture 1–2 percent of methane from ventilation air (VAMCAT). The first trial of the technology, sponsored by Australian Greenhouse Office (AGO), is taking place at the Huainan mine in China. Other VAM mitigation technologies being researched include catalytic flow reverse reactors; catalytic monolith combustors; and recuperative gas turbines.

CSIRO is also investigating enhanced CBM techniques to increase methane drainage from coal seams before opencast mining takes place. Other research topics include gas drainage systems improvement and cogeneration of electricity using CMM in coal-fired power plants (M2M-Australia, 2010; M2M-Australia, 2005).

As a member of the GMI Coal Subcommittee, Australia has generated and maintains a CMM Technology Database. The database serves as a reference for CMM technologies and holds company contact info. The database can be found at
http://methanetomarkets.org/documents/partners_australia_cmm_tech_database.pdf.

2.3.2 Regulatory Information

The legal framework governing resource ownership and licensing in Australia is complex because there is currently no national legislative framework in place for CMM. Each state has its own legislation and licensing arrangements.

In Queensland, a Mining Lease for coal does not provide rights to the contained coal seam gas. CMM production comes under the *Petroleum and Gas (Production and Safety) Act of 2004* and requires a Production License, which can co-exist with a Mining Lease covering the same area. The Queensland government had released a new regimen in November 2002 to address issues that arise where CBM and coal exploration and production activities may occur under different tenures granted over the same area. To implement the regimen, a new *Petroleum and Gas (Production and Safety) Act* was passed in 2004 to replace the *Petroleum Act of 1923*. Recent amendments to legislation in Queensland have established a clear distinction between resources administered under the *Mineral Resources Act of 1989* and those coming under the *Petroleum and Gas (Production and Safety) Act of 2004.*

In NSW, a Mining Lease or Exploration License is required before mining operations commence. If the holder of the lease wants to extract coal seam gas, an application must be made for the inclusion of petroleum in the Mining Lease. Although CMM extraction and utilization currently falls under a coal extraction or Mining Lease, more specific regulation is being drafted. The *Mining Act of 1992* is the principal legislation governing mineral exploration in NSW. Under the *Mineral Resources Act 1989 (NSW)*, where CMM is produced as a by-product of coal mining, there is no provision for payment of royalties on VAM, or on pre- or post-drainage methane that is flared. Waste methane flaring in NSW has been standard, but further legislative changes to the *Mineral Resources Act* now require that pre- and post-drainage methane is used or flared rather than simply being vented. CBM is however considered a petroleum product in NSW and hence, falls under the *Petroleum (Onshore) Act of 1991*.

In Queensland, where an oil and gas exploration tenement co-exists with a coal mining lease, and production testing within that exploration tenement yields in excess of 3 million m^3 of gas, the tenement holder is liable for royalty payments. However, in order to facilitate the development of deep coal seams in and around Sydney, the NSW state government has not been imposing royalties on the capture and utilization of waste gases from coal mining and is providing a 5-year exemption for stand-alone coal seam gas operations.

In Victoria, CBM resources are administered under the legislation for mineral resources development.

2.4 Profiles of Individual Mines

Some of Australia's most productive underground coal mines are listed in Table 2-5. Individual mine profiles, showing CMM production are unavailable.

Table 2-5. Major Australian Underground Coal Mines

Mine	Location	Operator	Annual Coal Production (million tonnes)
Broadmeadow	Bowen Basin, Queensland	BMA (BHP Billiton Mitsubishi Alliance)	4
Moranbah North	Bowen Basin, Queensland	Anglo Coal	4.5
German Creek mines	Bowen Basin, Queensland	Anglo Coal	6
Kestrel	Bowen Basin, Queensland	Rio Tinton Coal Australia	4
North Goonyella	Bowen Basin, Queensland	Peabody Energy	2-3
Oaky Creek	Bowen Basin, Queensland	Xstrata	11 (Run of Mine)
Beltana	Hunter Valley, NSW	Xstrata	7.6
Clarence	Western Coalfield, NSW	Centennial Coal	2.5
Springvale	Western Coalfield, NSW	Centennial Coal	7
Mandalong	Newcastle Coalfield, NSW	Centennial Coal	5

2.5 References

ABARE (2010): Australian mineral statistics 2010, March quarter 2010. Australian Bureau of Agricultural and Resource Estimations, Canberra, Australia.

ACA (2009): Black Coal Australia – Statistical Summary. Australian Coal Association, 2009. http://www.australiancoal.com.au/

ACMMRP (2008): "Australia Coal Mine Methane Reduction Program." Australian Government: Department of Environment, Water, Heritage and the Arts. February 2008.

AGL (2009): Opening of major expansion of eastern Australian gas grid by AGL Energy and Epic Energy. AGL Energy website, 11 May 2009. http://agl.com.au/about/media/archive/Pages/May09.aspx

AIMR (2009): Coal Bed Methane Fact Sheet, Australia's Identified Mineral Resources 2010. Australian Atlas of Mineral Resources, Mines and Processing Centres. http://www.australianminesatlas.gov.au/aimr/index.jsp

APA (2010): Gas transmission & distribution – Queensland, NSW. APA Group website, accessed August 2010. http://apa.com.au/our-business/gas-transmission-and-distribution.aspx

Baker and Skerman (2006): The Significance of Coal Seam Gas in Eastern Queensland. *APPEA Journal* 329:342, presented by Grahame Baker and Ross Skerman, APPEA Conference. May 2006.

BG Group (2010): BG Group Operations website. Accessed August, 2010. www.bg-group.com

BHP (2010): WestVAMP, BHP Billiton website, accessed June 2010. http://www.bhpbilliton.com/bb/ourBusinesses/metallurgicalCoal/illawarraCoal/aboutillawarracoal/westvamp.jsp

BP (2010): BP Statistical Review of World Energy - June 2010. Accessed August, 2010. http://www.bp.com/subsection.do?categoryId=9023763&contentId=7044548

Budget (2009): Budget - Part 2: Expense Measures: Environment, Water, Heritage and the Arts, Australian Government, 2009. http://www.ato.gov.au/budget/2009-10/content/bp2/html/bp2_expense-12.htm

CPRS (2010): Carbon Pollution Reduction Scheme, Department of Climate Change and Energy Efficiency, Australian Government, May 5, 2010. http://www.climatechange.gov.au/en/media/whats-new/cprs-delayed.aspx

DCC (2009): Tracking to Kyoto and 2020, Australia's Greenhouse Emissions Trends, 1990 to 2008–2012 and 2020. August 2009. Department of Climate Change, Canberra, Australia.

DCCEE (2010): National Greenhouse Gas Inventory - accounting for the KYOTO target, May 2010. Australian National Greenhouse Accounts, Australian Government Department of Climate Change and Energy Efficiency, Canberra, Australia. http://www.climatechange.gov.au/

Dow Jones Newswires (2010): BG Group Project Approved by Australia's Queensland State. By Ross Kelly, Dow Jones Newswires, June 24, 2010. http://www.foxbusiness.com/markets/2010/06/24/bg-group-lng-project-approved-australias-queensland-state/

EIA (2009): EIA Country Analysis Brief: Australia - Coal. U.S. Energy Information Administration, Washington, DC. September 2009. http://www.eia.doe.gov/emeu/cabs/Australia/Coal.html

Energy Developments (2010): German Creek and Moranbah North poject fact sheets. Energy Developments website, accessed August, 2010. http://www.energydevelopments.com/01_cms/details.asp?ID=4

GHG Reduction (2010): Greenhouse Gas Reduction Scheme, New South Wales Government, Australian Government, accessed July 30, 2010. http://www.greenhousegas.nsw.gov.au

GSQ (2010): Queensland's Coal – Mines and Advanced Projects – Industry Update, June 2010. Department of Employment, Economic Development and Innovation, Geological Survey of Queensland.

IEA (2009): Coal Mine Methane in Russia – Capturing the Safety and Environmental Benefits. International Energy Agency, http://www.iea.org/papers/2009/cmm_russia.pdf

Kyoto (2007): "Rudd Takes Australia Inside Kyoto." BBC World News. December 3, 2007. http://news.bbc.co.uk/2/hi/asia-pacific/7124236.stm

M2M-Australia (2005): *Methane to Markets Partnership Coal Mine Methane Technical Subcommittee Country Specific Profile – Australia,* Australian Government, Department of Industry, Tourism and Resources &

Department of the Environment and Heritage, 2005. http://www.methanetomarkets.org/documents/events_coal_20050427_australia_profile.pdf

M2M-Australia (2010): *Australia's Experience and its Impact on Coal Mine Methane Project Development*, Presented by John Karas. Methane to Markets Partnership Expo, New Delhi, India. March 2010. http://www.methanetomarkets.org/expo/docs/postexpo/coal_karas.pdf

M2M Projects (2010): Methane to Markets International Coal Mine Methane Projects Database, 2010 http://www2.ergweb.com/cmm/projects/projectlist.aspx?sortField=country&sortOrder=A

MEGTEC (2008): MEGTEC Wins 2008 EPA Climate Protection Award, MEGTEC, May 21, 2008. http://www.megtec.com/news_article.php?news_id=40

MEGTEC (2010): MEGTEC to build world's largest coal mine ventilation methane emissions abatement system in China, MEGTEC, June 8, 2010. http://www.megtec.com/news_article.php?news_id=58

Mineral Resources (2009): Australia's Identified Mineral Resources 2009, Geoscience Australia, Australian Government, December 15, 2009. http://www.ga.gov.au/servlet/BigObjFileManager?bigobjid=GA16805

OGJ (2010): Santos lets contract for CSG-LNG project in Queensland. Oil and Gas Journal online, May 2010.

NSWMC (2009): Key Industry Statistics 2009. NSW Minerals Council. Sydney, Australia. www.nswmin.com.au

Renewable Energy (2010): RET – The Basics, Office of the Renewable Energy Regulator, Australian Government, July 2010. http://www.orer.gov.au/publications/ret-overview.html

Schwochow (1997): The International Coal Seam Gas Report, Cairn Point Publishing, Steve Schwochow, editor. 1997.

Smart Energy (2010): Smart Energy Policy, Queensland Government, Australian Government, May 31, 2010. http://www.dme.qld.gov.au/Energy/energy_policy.cfm

Strategic (2008): Strategic Review of Australian Government Climate Change Programs, Australian Government, July 31, 2008. http://www.finance.gov.au/publications/strategic-reviews/index.html

Technology (2007): International Coal Mine Methane Projects Database.

UNFCCC (2004): United Nations Framework Convention on Climate Change - Status of Ratification. May 24, 2004.

UNFCCC (2005): Kyoto Protocol - Status of Ratification. September 19, 2005. http://unfccc.int/files/essential_background/kyoto_protocol/application/pdf/kpstats.pdf

USGS (2002): *The Mineral Industry of Australia*, U.S. Geological Survey, Country Profiles. http://minerals.usgs.gov/minerals/pubs/country/2002/asmyb02.pdf

3 BOTSWANA

3.1 Summary of Coal Industry

3.1.1 ROLE OF COAL IN BOTSWANA

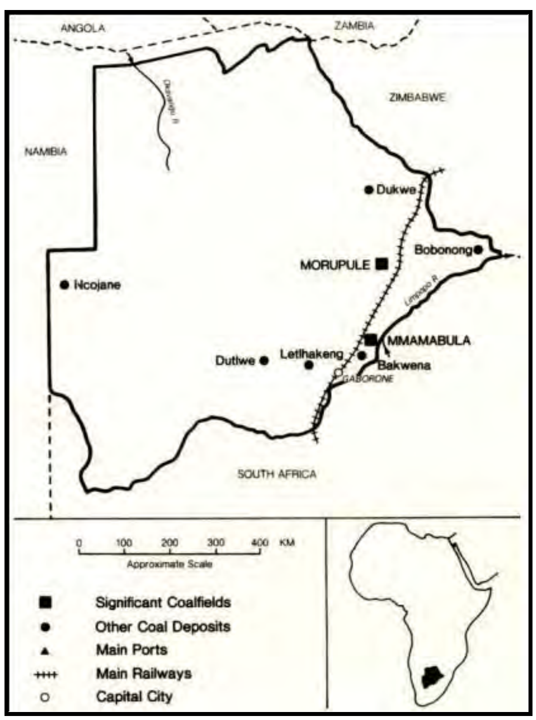
Botswana possesses huge coal resources estimated at greater than 200 billion tonnes. However, only three to five billion tonnes can be economically mined (Mmegi, 2009). The quality of coal in these deposits is suitable for power generation and is the feedstock for 99.4 percent of electricity generated (eStandards Forum, 2009). Table 3-1 quantifies total recoverable reserves and recent coal production in Botswana.

Table 3-1. Botswana's Coal Reserves and Production

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2007)*	40	0	40	54 (0.005 %)
Annual Coal Production (2007)**	1.0	0	1.0	45 (0.02%)

Source: *WEC (2009); **EIA (2010)

Figure 3-1. Botswana Coalfields Map



Source: IEA Coal Research (1983)

In 2007, coal represented 36.2 percent of Botswana's total primary energy supply (IEA, 2009). At present, all coal mined is used domestically for power production, but studies are under way to explore the possible exportation of coal mined at the Morupule mine, the country's only operating mine (Mining Journal, 2005).

The Morupule Mine is located in the Morupule coalfield near the town of Serowe (Figure 3-1) and is the most thoroughly explored of Botswana's fields. The only other major coal field to be explored in some detail is Mmamabula, situated about 81 miles south of Morupule (IEA, 2010).

3.1.2 STAKEHOLDERS

Table 3-2 identifies potential key stakeholders in Botswana's coal mine methane (CMM) and coalbed methane (CBM) development.

Table 3-2. Key Stakeholders in Botswana's CMM Industry

Stakeholder Category	Stakeholder	Role
Developers	▪ Kalahari Energy ▪ TLOU ▪ Anglo Coal Botswana ▪ SAFGAS ▪ Many other small developers ▪ See http://www.epa.gov/coalbed/networkcontacts.html	Project opportunity
Engineering, Consultancy and Related Services	▪ Scales & Associates ▪ Advanced Resources International (ARI) ▪ See http://www.epa.gov/coalbed/networkcontacts.html	Technical assistance
Government and Research Organizations	▪ Botswana Ministry of Minerals, Energy, and Water Affairs ▪ Botswana Geologic Survey ▪ Botswana Power Corporation ▪ Botswana Gas Corporation.	Regulatory

3.1.3 STATUS OF COAL AND THE COAL MINING INDUSTRY

There is only one operating coal mine in Botswana, the Morupule Mine, which is 93 percent owned by Debswana (a joint venture of DeBeers and the Government of Botswana) and supplies coal to Botswana's only coal-fired power station. Production from the mine is relatively stable (0.8–1 million tonnes [Mmt] per year) as it is essentially a captive mine for the Morupule Power Station. The mine also supplies coal to hard rock mining operations at Selebi-Phikwe and to the Sua Pan soda ash plant, and coal is exported to Zimbabwe, Zambia and the Democratic Republic of the Congo.

Debswana announced plans to increase coal production at the Morupule Mine to 3.4 Mmt a year to accommodate Botswana Power Corporation's (BPC) plans to add four 150-megawatts (MW) coal-fired power stations alongside the existing four 33-MW units currently at Morupule (eStandards Forum, 2009). CIC Energy is also proposing to develop the Mmambula Energy Project, which involves a 1,200-MW power station and integrated coal mine planned to provide power mainly to South Africa (CIC, 2010).

3.2 Overview of CMM Emissions and Development Potential

The Global Methane Initiative (formerly Methane to Markets Partnership) International CMM Projects Database currently identifies no CMM recovery projects for Botswana, in operation or development (M2M Projects, 2008).

3.2.1 CMM Emissions from Operating Mines

Botswana has no reported CMM emissions from active mines. Activity to date has been limited to CBM operations because of the absence of deep, gassy mines in the country.

3.2.2 CMM Emissions from Abandoned Coal Mines

There are no reported emissions from abandoned mines in Botswana.

3.2.3 CBM from Virgin Coal Seams

A CBM feasibility study conducted for Botswana Department of Geological Study estimated that Botswana contains about 5.6 trillion cubic meters (Tcm) of CBM reserves in the Central Kalahari Karoo Basin (ARI, 2003). However, these estimates are tenuous as they were derived from only a few core holes drilled into the coals of the basin. Recoverable reserves are estimated at 1.7 Tcm with some of the most prospective areas being found in the eastern portions of the basin (ARI, 2008).

Over the past few years, there has been a tremendous increase in interest in developing CBM projects in Botswana. The Department of Geological Survey (DGS) reported a 50 percent increase in the number of exploration licenses issued between January and December 2009 for various energy minerals, which includes coal and CBM (UGC, 2010). This interest is being driven by the favorable investment climate in Botswana, coupled with an increasingly dire power situation in the region. However, out of more than 50 companies who have taken out CBM leases in the country, very few carried out any substantial resource assessment work to date.

The main companies to have carried out significant CBM exploration activity in Botswana are Kalahari Energy, Anglo Coal Botswana and Saber Energy Corporation. Kalahari Energy (KE) has been actively pursuing CBM development since 2000, and in 2008 drilled a five-well pilot program which is currently in the production testing phase. This was financed with a U.S. Overseas Private Investment Corp $8.5 million investment guarantee for the purchase of equipment and the drilling of wells. In 2009, KE formed a joint venture with Exxaro Resources to perform ongoing exploration work and is on track to complete a five-well production test in late 2010 (KE, 2010).

Anglo Coal Botswana has embarked on a major CBM exploration drive, started in late 2008, with the aim of delineating gas reserves totaling at least 110 billion m^3 (Bcm), sufficient to justify construction of a dedicated synfuels plant. The company holds 47 CBM prospecting licenses in north and central Botswana and exploration activities are ongoing. All projects are at the early reconnaissance phase which involves continuous acquisition of geological information and drilling, to build a regional geological model of the areas and assess the CBM potential (Ryan, 2009). Saber Energy has drilled more than 80 exploratory holes on their lease areas since 2008 to test coal gas content and permeability.

3.3 Opportunities and Challenges to Greater CMM Recovery and Use

Botswana, a non-Annex I country, has signed and ratified the UNFCCC and Kyoto Protocol as shown in Table 3-3.

Table 3-3. Botswana's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC	June 12, 1992	April 27, 1994
Kyoto Protocol		August 8, 2003

3.3.1 Market and Infrastructure Factors

It is doubtful whether Botswana will have significant CMM emissions in the foreseeable future. This is because there are abundant reserves of coal at relatively shallow depths and the overall demand for coal in the country is limited. Currently, the prospects for exporting coal are not good, given the distances to available ports in South Africa and limited rail infrastructure. However, in cooperation with the government of Namibia, Botswana is considering the construction of a $6 billion, 1,500-mile rail link between the Mmamabula Coalfields of southeastern Botswana to either the ports of Walvis Bay or Luderitz in Namibia (Mmegi, 2009).

Since there is negligible domestic demand and support infrastructure for natural gas, the market for methane in Botswana is fairly limited currently (EIA, 2007).

However, CBM projects may see increased attention thanks to a report titled, *Botswana Technology Needs Assessment on Climate Change*, jointly produced by several Ministries and the UN Development Programme. The report acknowledges Botswana's CBM reserve potential, and advises that Botswana determine such resource potential. CBM, it concludes, may be used to provide fuel for cars and power generation, and alleviate potential power crises. CBM may also be exported to Mozambique through the Maputo pipeline and to the Secunda Sasol Plant in South Africa (TNA, 2004).

3.3.2 Regulatory Information

As there are no existing CMM projects, a legal framework regulating them does not exist at present.

3.4 Profiles of Individual Mines

Morupule

Morupule is the only active mine in the country. It is located along the eastern margin of the Kalahari Basin. Production began in 1973, and the mine has a production capacity of 1 Mmt per year.

General Information

Total mineable reserves (thousand tonnes)	44,000

General Geologic Information

Coal seams (thickness)	Morupule Main (6.5–9.5 meters [m]) Lotsane (0.6–4.5 m) Serowe Bright (average 1.8 m)
Faults	Minor. Some dolerite dyke intrusives

Geologic and Mining Conditions

Ash content, % (coal in place, run of mine)	40–50%
Moisture, % (coal in place, run of mine)	5–10%

Coal Production, Methane Emissions, and Degasification (and Use) Statistics

	2000	2001	2002	2003	2004	2005	2006
Coal Production (million tonnes)*	0.95	0.95	0.96	0.81	0.9	0.99	1
Degasification	None	None	None	None	None	None	None

Source: *SGU (2009)

3.5 References

ARI (2003): Results of the Central Kalahari Karoo Basin Coalbed Methane Feasibility Study, prepared for the Department of Geologic Survey, Botswana, Lobatse.

ARI (2008): Technical and Economic Feasibility Study for Coalbed Methane Development in Eastern Botswana. Prepared for Botswana Development Corporation and U.S. Trade and Development Agency by Advanced Resources International, Arlington, Virginia, USA 2008.

CIC (2010): Mmamabula Energy Project. CIC Energy Corp. May 2010. http://cicenergycorp.com/project/info_mmamabula/index.php?content_id=62&page_number=1

EIA (2007): International Energy Annual 2005. U.S. Energy Information Administration (EIA), Washington, DC, table posted June 21, 2007. http://www.eia.doe.gov/pub/international/iea2005/table82.xls (reserves)

EIA (2010): Botswana Energy Profile. U.S. Energy Information Administration (EIA), Washington, DC. http://tonto.eia.doe.gov/country/country_energy_data.cfm?fips=BC

eStandards Forum (2009): Country Brief Botswana. 27 August 2009. http://www.estandardsforum.org/system/briefs/237/original/brief-Botswana.pdf?1254987832

KE (2010): Kalahari Energy's Joint Venture – Exploration Progress. Accessed July 2010. http://www.kalaharigas.com/news.php?id=36

IEA (2007): International Energy Agency Energy Statistics – Coal. International Energy Agency, Paris, France. http://www.iea.org/stats/coaldata.asp?COUNTRY_CODE=BW

IEA (2009): IEA Energy Statistics: Share of Total Primary Energy Supply in 2007 – Botswana. International Energy Agency, Paris, France. http://www.iea.org/stats/pdf_graphs/BWTPESPI.pdf

IEA (2010): Coal Online. IEA Clean Coal Center. Accessed June 2010. http://www.coalonline.org/site/coalonline/content/browser/81343/Coal-resources

IEA Coal Research (1983): Concise Guide to the World Coalfields, Cope, J.H.R., Duckworth, N.A., Duncan, S.V., Holtom, J.E.B., Leask, A.L., McDonald, K.A. and Woodman, S.P., compiled by Data Bank Service, World Coal Resources and Reserves, IEA Coal Research, London, England, 1983

M2M Projects (2008): Methane to Markets International Coal Mine Methane Projects Database, Methane to Markets, accessed August 2008. http://www2.ergweb.com/cmm/index.aspx

Mining Journal (2005): "A message from MC Tibone, Minister of Minerals, Energy and Water Resources." Mining Journal: Special Publication. London, October 2005.

Mmegi (2009): "Botswana Sees Coal Alternative to Diamonds." Mmegionline, 9 February 2009, Vol. 26, No. 20. http://www.mmegi.bw/index.php?sid=4&aid=20&dir=2009/February/Monday9

Ryan (2009): Angol Coal on Botswana gas hunt. Ryan, B. – miningmx website, 28 August, 2009. http://www.miningmx.com/news/energy/anglo-coal-on-botswana-gas-hunt.htm

SGU (2009): Botswana, Namibia & South Africa – Overview for SGU Raw Materials Group. Swedish Geological Survey, Stockholm. Sweden. August, 2009, by Ericsson, M. and Lof, F. http:/www.meetingpoints-mining.net/pdf/NamibiaBotswanaOverview.pdf

TNA (2004): "Botswana Technology Needs Assessment on Climate Change." Botswana Ministry of Environment, Wildlife, and Tourism; Botswana Department of Meteorological Services; UN Development Programme. 2004

UGC (2010): "Botswana Energy Minerals Most Sought After in 2000." Unconventional Gas Center, 5 February 2010.

WEC (2009): Survey of Energy Resources: Interim Update 2009. World Energy Council. http://www.worldenergy.org/publications/survey_of_energy_resources_interim_update_2009/default.asp

4 BRAZIL

4.1 Summary of Coal Industry

4.1.1 ROLE OF COAL IN BRAZIL

Brazil is the world's tenth largest energy consumer and the third largest in the Western Hemisphere, trailing the United States and Canada. Total primary energy consumption in the country has been increasing in recent years. Coal accounts for approximately 5.8 percent of Brazil's total primary energy supply. The country's domestic annual coal production is approximately 6.0 million tonnes (Mmt) (IEA, 2007). However, Brazil's annual coal consumption was estimated at 25.7 Mmt in 2008, relying on 19.3 Mmt of coal imports for its energy requirements (EIA, 2010).

Brazil has recoverable coal reserves of approximately 7 billion tonnes, the second largest reserves in the Western Hemisphere, behind the United States. Brazilian coal is generally characterized by high ash and sulfur, as well as low caloric values (EIA, 2004). Table 4-1 presents most recent statistics for coal mining in Brazil.

Table 4-1. Brazil's Coal Reserves and Production

Indicator	**Anthracite & Bituminous** (million tonnes)	**Sub-bituminous & Lignite** (million tonnes)	**Total** (million tonnes)	**Global Rank** (# and %)
Estimated Proved Coal Reserves (2006)*	0	7,068.0	7,068.0	10 (0.9%)
Annual Coal Production (2007)**	0.2	5.7	6.0	24 (0.1%)

Source: *EIA (2008); **IEA (2007)

There are generally two types of coal produced in Brazil: steam coal used primarily by industry to generate steam and energy, and coking coal used in the steel industry. Most of domestic production (84 percent) is used for power generation. However, there was a significant increase of about 26 percent in the production of steam coal between 1992 and 2002 (EIA, 2004).

The companies that produce coal mainly for steam production and electrical generation have their production concentrated in the southern states of Rio Grande do Sul, Santa Catarina, and Paraná (see Figure 4-1) (MST, 2002).

Figure 4-1. Brazil's Coal Fields

Coal mine operations are concentrated in the three southernmost states of Santa Catarina, Rio Grande do Sul,

Source: Maps of World (2010)

4.1.2 STAKEHOLDERS

Table 4-2 lists potential stakeholders in Brazilian coal mine methane (CMM) development.

Table 4-2. Key Stakeholders in Brazil's CMM Industry

Stakeholder Category	Stakeholder	Role
Government Groups	▪ Ministry of Mines and Energy ▪ Department of Energy, Mines and Communications (SEMC) ▪ Coal Mining Industry Union of the State of Catarina	Licensing and permitting
Developers	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Project opportunity identification and planning
Mining companies	▪ Companhia Riograndense de Mineracao (CRM) ▪ Copelmi Mineracao S.A. ▪ Carbonifera Palermo Ltda. ▪ Nova Prospera Mineracao S.A. ▪ Carbonifera Metropolitana S.A. ▪ Carbonifera Criciuma S.A.	Project hosts

Stakeholder Category	Stakeholder	Role
	▪ Companhia Carbonifera de Urussanga ▪ Carbonifera Treviso S.A. ▪ Carbonifera Barro Branco S.A. ▪ Ibracoque Mineracao Ltda. ▪ Companhia Brasileira Carbonifera Ararangua ▪ Copue Cararinese Ltda ▪ Industriaa Carbonifera Rio Deserto Ltda. ▪ Carbonifera Belluno ▪ Companhia Carbonifera Catarinese ▪ Campanhia Carbonifera do Cambui ▪ Klabin do Parana Mineracao S.A.	
Engineering, Consultancy, and Related Services	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Technical assistance
Universities	▪ Federal University of the State of Rio Grande do Sul	Technical assistance

4.1.3 Status of Coal and the Coal Mining Industry

The Brazilian coal industry's mining operations are concentrated in the three southernmost states of Santa Catarina (46 percent), Rio Grande do Sul (53 percent), and Paraná (1 percent). It has 15 coal mining companies, all owned by Brazilian investors. The main producers that have underground mines are the following:

Companhia Riograndense de Mineraçao (CRM) (State of Rio Grande do Sul) – CRM is the largest Brazilian coal producer and is a state-owned company. Its current output is nearly 2.4 Mmt per year of processed coal. Most of this output comes from surface mines. It has two underground mines. Mina do Leão I is 125 meters deep, has two shafts, and is highly mechanized, but underground production halted in 2002 due to high costs. The mine remains open as an opencast mine. Mina do Leão II is six km from Mina do Leão I and has a projected capacity of 2.4 Mmt peryear of run-of mine (ROM) coal, using the longwall method at an average depth of 200 meters. The area is mined by Carbonifera Criciuma SA, who in 2002, signed a 30-year rental contract. The mine will reopen in 2009, and CRM retains the right to the royalties from the sale of coal produced.

Carbonifera Criciuma S.A. (State of Santa Catarina) – Verdinho, the company's underground mine, began operations in 1982, is approximately 150 m deep, and has a capacity of 2.8 Mmt per year ROM. The company is building a second underground mine (Rio Queimado) to be located in the municipality of Lauro Muller in the same state. This project calls for investments of US$30 million to produce 1.0 Mmt of ROM annually, using room and pillar extraction.

Industria Carbonifera Rio Deserto Ltda (State of Santa Catarina) – This company has two underground mines: Mina do Trevo in the municipality of Siderópolis producing 1.6 Mmt ROM annually; and Mina Barro Branco in the municipality of Lauro Muller producing 0.85 Mmt of ROM annually. Both are room and pillar mines.

Carbonífera Metropolitana (State of Santa Catarina) – This company has an annual output of nearly 1.2 Mmt ROM and 0.6 Mmt of processed coal. It has two underground room and pillar mines, Esperança and Fontanella, both in the municipality of Treviso. The Esperança mine was opened in 1984 with a nominal annual capacity of 3.0 Mmt ROM, and the Fontanella mine was opened in 1985 with a nominal annual capacity of 2.4 Mmt ROM.

Carbonífera Belluno Ltda. (State of Santa Catarina) – This company has three coal mines, only one of which is underground (Meia Encosta Fiorita), located in the municipality of Sidirópolis. The company's total output is nearly 0.24 Mmt of processed coal. Its underground mine has a nominal capacity for 0.36 Mmt ROM annually. This company has recently invested US$1.5 million to open a second underground mine (Mina Catão) in the same area, which started operations in late 2001 with the same capacity as the old mine.

Companhia Carbonifera Catarinense (CCC) (State of Santa Catarina) – It has two underground mines, named Bonito I and Novo Horizonte. Both are room and pillar mines (Vasconcelos, 2006).

Table 4-3 presents a summary of coal production by state, mining company, and mine type from 1990 to 1994.

Table 4-3. Brazil's Production of Run-Of-Mine Coal (tonnes)

State	Company	Mine	Mine Type	1990	1991	1992	1993	1994
Rio Grande do Sul	CRM	Candiota	Surface	1,398,361	1,574,819	1,311,721	1,103,310	1,508,865
		Leao I	Underground	127,241	134,255	179,843	139,406	100,820
		Taquara	Surface	-	-	29,356	65,212	80,459
	Copelmi	Recreio	Surface	975,213	898,172	1,147,588	959,028	1,075,990
		Charqueadas	Underground	66,470	-	-	-	-
		Butia Leste	Surface	239,972	160,047	15,803	436,096	412,304
		Faxinal	Surface	408,167	154,428	277,757	25,637	13,758
		Seival	Surface	-	-	-	-	7,027
	Palermo	Capane	Surface	196,108	180,353	161,114	229,757	188,486
Santa Catarina	Prospera	Mine A – Sangao	Underground	482,815	-	169,903	730,036	692,335
		Mine B – Morro Albino	Underground	269,427	-	-	-	-
	Metropolitana	Esperanca	Underground	1,160,902	1,933,467	1,365,760	1,040,936	1,029,264
		Fontanella	Underground	-	-	19,374	60,149	81,134
	Criciuma	Rio Queimado	Surface	6,472	-	-	-	-
		Verdinho	Underground	1,258,750	783,936	513,780	608,751	708,704
	CCU*	Sangao	Surface	4,653	-	-	-	-
		Santa Augusta	Underground	926,629	799,022	-	-	-
		Sao Geraldo	Underground	98,608	169,838	869,996	992,320	889,634
		Santana	Underground	-	747,373	358,368	182,377	92,141
	Treviso	Portao	Surface	-	-	-	117,740	-
		Possenti	Underground	-	-	43,742	34,863	-
		Rossi	Underground	-	-	-	-	24,966
		Itanema II	Surface	310,964	162,797	161,482	79,367	-
	Barro Branco	Barro Branco	Surface	8,806	25,459	17,483	16,517	96,090
		Mine 3 G	Underground	251,180	402,082	387,422	305,384	103,442
		Mine 3 E/F	Underground	64,057	-	-	-	-

State	Company	Mine	Mine Type	1990	1991	1992	1993	1994
		Bonito	Surface	-	-	54,370	105,290	259,604
	Ibramil	Lageado	Underground	60,556	118,267	101,413	73,354	20,977
		Figueira	Underground	27,266	-	-	-	-
	CBCA[†]	Sao Pedro	Underground	99,220	101,883	50,121	72,664	62,630
		Verdinho	Underground	339,692	561,324	565,040	529,870	457,016
		Sao Simao	Underground	109,369	112,305	55,248	80,097	69,037
	Cocalit	Rio Fiorita	Surface	NA	NA	NA	NA	NA
		Estiva	Surface	NA	NA	NA	NA	NA
	Rio Deserto	Rio Deserto	Underground	-	124,890	152,370	131,396	120,606
	Belluno	Malha II – CA	Surface	-	-	-	-	5,346
		Malha II – SS	Underground	-	-	-	-	19,337
		Vila Irapua	Underground	-	-	-	19,958	50,375
	CCC	Rio Maina	Underground	284,124	289,956	311,393	306,439	338,934
		Catarinense	Underground	8,657	-	-	-	-
Parana	Cumbui	Amando Simoes	Underground	125,605	159,541	154,363	176,028	203,763
		Mine 115	Underground	54,371	50,627	46,241	59,907	72,622
		Mine 830	Underground	-	-	1,496	4,722	-
		Frente 20	Underground	18,984	34,172	26,186	6,442	-
	Klabin	Mine 2	Underground	18,144	18,425	14,174	6,458	-

[*] Companhia Carbonifera de Urussanga [†] Companhia Brasileira Carbonifera Ararangua

Source: MST (2002)

Brazil plans to reverse its status as a net importer of coal. The country's national development bank, Banco National de Desenvilovimento Economico e Social (BNDES), hopes to make Brazil self-sufficient in coal by 2010 and eventually a net coal exporter (EIA, 2004).

Coal demand increased mainly because the thermoelectric plants were operating at full capacity in the three coal-producing states. In 2003, domestic coal sales reached almost 6.0 Mmt, of which Santa Catarina used 52 percent; Rio Grande do Sul, 47 percent; and Paraná, 1 percent. Brazil's metallurgical coal demand was met by importing 13 Mmt in 2003, valued at $633 million. Total coal consumption reached 17.1 Mmt, which was about the same as that of 2002. The steel industry consumed 64.7 percent of metallurgical-grade coal; thermoelectric generation, 33 percent; and the petrochemical and pulp and paper industries, 2.3 percent.

Coal-fired plants in Brazil's coal-producing states have a generation capacity of 1,455 megawatts (MW) (Power Mag, 2010). The number of coal-fired plants remained unchanged for 20 years, until 2005 when new projects were approved.

- Candiota III, run by CRM, will have a capacity of 350 MW and will open in September 2010 in Candiota City, Rio Grande do Sul. A fourth stage is expected to further expand capacity (Global Energy, 2010).
- Jacui I will also have a capacity of 350 MW and was originally scheduled to open in 2009 (BNAmericas, 2006a). The plant has seen continued delays and needs additional capital to be completed (Rio Grande do Sul, 2010).

- In 2006, a 650 MW coal-fired thermoelectric power plant, named CTSul, had its environmental impact statement approved for Rio Grande do Sul state (BNAmericas, 2006b).
- In 2009, two new coal-fired power plants (Pecém I at 720 MW and Itaqui at 360 MW) were approved with funding from the Inter-American Development Bank with expected completion dates of 2012 (Temas, 2009).
- Carbonífera Criciúma plans a 440 MW plant in the municipality of Treviso (Santa Catarina) (USITESC, 2010).
- Tractebel Energia started building a 340 MW plant in 2009 for start-up in 2012, near the Candiota coal plants (Power Mag, 2010).
- Electrobras' subsidiary CGTEE plans to expand its 126 MW and 320 MW Candiota coal power plants (Power Mag, 2010).
- MPX Energia and Energias de Portugal (EdP) will build a 720 MW coal-fired plant in the state of Ceará (IFandP, 2010).

4.2 Overview of CMM Emissions and Development Potential

The Global Methane Initiative (formerly Methane to Markets Partnership) International CMM Projects Database currently identifies no projects in Brazil, in operation or development. Updates on future CMM projects in Brazil can be found at http://methanetomarkets.org/projects/index.aspx.

4.2.1 CMM Emissions from Operating Mines

Methane emissions in Brazil were estimated to total 86.7 million m^3 in 1990 but decreased to 77.9 million m^3 in 1994. Underground mining accounted for 89 percent of the total 1994 emissions, surface mines for 2 percent, and post-mining activities for 9 percent (see Table 4-4).

Table 4-4. Brazil's CMM Emissions (million cubic meters)

Emission Category	1990	1994	1995	2000
Underground coal mines – total emissions	77	69.5		
Post-underground emissions	8	7		
Surface mine emission (total)	1	1		
Post-surface mining emissions	0.1	0.1		
Total liberated (= sum of all above)	86	78	77*	91*

Source: MST (2002); *USEPA (2006)

4.2.2 CMM Emissions from Abandoned Coal Mines

No data were found quantifying methane emissions from abandoned mines.

4.2.3 CBM from Virgin Coal Seams

No data were found quantifying production from virgin coal seams.

4.3 Opportunities and Challenges to Greater CMM Recovery and Use

Brazil has signed and ratified both the UNFCCC and the Kyoto Protocol (see Table 4-5). As a party to the Kyoto Protocol, CMM projects in Brazil can be expected to benefit from revenues deriving from the sale of carbon emission reduction credits.

Table 4-5. Brazil's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC	June 4, 1992	February 28, 1994
Kyoto Protocol	April 29, 1998	August 23, 2002

Source: UNFCCC (2004); UNFCCC (2007)

4.3.1 Market and Infrastructure Factors

Brazil's coal mining industry has become increasingly important in recent years attributable to periods of economic uncertainty, instability in the energy sector, and a resulting shift in energy policy. Santa Catarina, the largest coal-producing state, has been the primary beneficiary of the industry's increase in status and importance. However, it also faces increased scrutiny from environmental groups concerned about the negative socioeconomic and environmental impacts caused by the growing industry.

Brazil became party to the Global Methane Initiative (formerly Methane to MarketsPartnership) in July of 2004. One coalbed methane (CBM) solicitation was submitted in an attempt to receive funding from GMI Funding Opportunities, but the project was not chosen. The majority of GMI projects funded in Brazil involve landfill and agriculture methane capture (CBM, 2006). A model is needed to incorporate both faults and erosional features to achieve a detailed estimate of the CBM potential of the Santa Terezinha coalfield in Rio Grande do Sul state and to select an optimum location for the first CBM test well. In the Santa Terezinha coalfield, the seams occur in a succession of sandstones, mudstones, and shale (Burger et al., nd).

On the technology front, currently, groups are working in Brazil's mining regions to implement Integrated Resource Management techniques. These technical improvements are intended to reduce transportation costs, reduce waste and harmful emissions, and increase the scale of production to increase domestic coal supplies and reduce reliance on imports. Thus far, efforts have resulted in the establishment of an association of coal mining companies in the State of Santa Catarina, the Sindicato da Industria da Extracao de Carvao do Estado de Santa Catarina (SIECESC). SIECESC actively works with the Brazilian Ministry of Environment, the Ministry of Mines and Energy, the National Department of Mineral Production, and several international organizations to devise strategies to implement regional and global sustainable mining and industry development. To date, however, there are no efforts by SIECESC to explore CMM capture (Geraldo, 2005).

4.3.2 Regulatory Information

No information on regulations pertaining to CMM development in Brazil was found.

4.4 Profiles of Individual Mines

No information profiling individual Brazilian mines was found.

4.5 References

BNAmericas (2006a): Eleja to start building 350MW coal-fired plant in early Feb, Business News Americas, January 20, 2006. http://www.bnamericas.com/news/electricpower/Eleja_to_start_building_350MW_coal-fired_plant_in_early_Feb

BNAmericas (2006b): Environ authority clears EIS for CTSul 650MW coal-fired project, Business News Americas, February 9, 2006. http://www.bnamericas.com/news/electricpower/Environ_authority_clears_EIS_for_CTSul_650MW_coal-fired_project

Burger, et al. (nd): *The Impact of Sequence Stratigraphy on 3D-Modeling of a Coal Basin*, Burger, H., Schauf, A., Prissang, R., Holz, M., Kaldreuth, W., not dated.

CBM (2006). "Coalbed Methane Extra." U.S. EPA, Office of Air and Radiation. Spring, 2006 http://www.epa.gov/cmop/docs/spring_2006.pdf

EIA (2004): Country Analysis Briefs, *Brazil*, August 2004.

EIA (2008): Data obtained from International Energy Annual 2006, U.S. Energy Information Administration, Washington, DC, table posted October 2008. http://www.eia.doe.gov/pub/international/iea2006/table82.xls (reserves)

EIA (2010): International Energy Statistics, U.S. Energy Information Administration, 2010. http://tonto.eia.doe.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=1&pid=1&aid=2

Geraldo (2005): Geraldo, Milioli. "Mining, environment, and development in southern Santa Catarina, Brazil: non-governmental organization, "Terra Verde" and its ideas for sustainability." Environments, August 2005. http://www.entrepreneur.com/tradejournals/article/134857445_1.html

Global Energy (2010): New Stage for Candiota, Global Energy, May 7, 2010. http://www.energiahoje.com/globalenergy/2010/07/05/413520/new-stage-for-candiota.html

IEA (2007): International Energy Agency Energy Statistics – Coal and Peat in Brazil in 2007. International Energy Agency, http://www.iea.org/stats/coaldata.asp?COUNTRY_CODE=BR

IFandP (2010): Brazil in Hot Water, Industrial Fuels and Power, January 26, 2010. http://www.ifandp.com/article/001372.html

Maps of World (2010): Brazil Mineral Map, Mapsofworld.com, accessed July 26, 2010. http://www.mapsofworld.com/brazil/brazil-mineral-map.html

MST (2002): First Brazilian Inventory of Anthropogenic Greenhouse Gas Emissions, Ministry of Science and Technology, 2002.

Power Mag (2010): Brazil: Latin America's Beacon, Powermag.com, January 1, 2010. http://www.powermag.com/renewables/hydro/Brazil-Latin-Americas-Beacon_2363_p4.html

Rio Grande do Sul (2010): SEMC Hosts Transfer of Control of Jacuí I/Tractebel for Carbonífera Criciúma, July 26, 2010. http://www.riograndedosul.rs.gov.br/master.php?capa=1&int=noticia&notid=33493&pag=1&editoria=&midia=&orig=1

Temas Blog (2009): IDB Funds Coal-Fired Power Plants in Brazil, The Temas Blog, March 20, 2009. http://www.temasactuales.com/temasblog/environmental-protection/climate-change/idb-funds-coal-fired-power-plants-in-brazil-o-bid-vai-financiar-usinas-termeletricas-a-carvao-no-brasil/

USITESC (2010): USITESC, Carbonífera Criciúma, 2010. http://www.carboniferacriciuma.com.br/site/ped/usitesc/

UNFCCC (2004): United Nations Framework Convention on Climate Change - Status of Ratification, May 24, 2004.

UNFCCC (2007): Kyoto Protocol - Status of Ratification, Last Modified: December 12, 2007.

USEPA (2006): *Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990–2020*, U.S. Environmental Protection Agency, Office of Atmospheric Programs, Climate Change Division, June 2006. http://www.epa.gov/nonco2/econ-inv/international.html

Vasconcelos (2006): Vasconcelos, Mauricio. "Coal Mining in Brazil." U.S. & Foreign Commercial Service, July 2006. www.buyusa.gov/northcarolina/coalminingbrazil.pdf

5 BULGARIA

5.1 Summary of Coal Industry

5.1.1 ROLE OF COAL IN BULGARIA

Most of the coal consumed in Bulgaria is used for power production. A substantial portion of its thermal electric power plants, which produce more than one-half of the country's total production of about 45 billion kilowatts, operate on domestic coal (Steblez, 2000). A reliable supply of higher-quality hard coal is, however, necessary for Bulgaria's metallurgical industries, and such coal is obtained from as near as Ukraine and as far away as Australia (USDOE, 2004). Bulgaria's annual coal production and consumption have both been relatively constant since 1991 and the country is expected to remain a net coal importer.

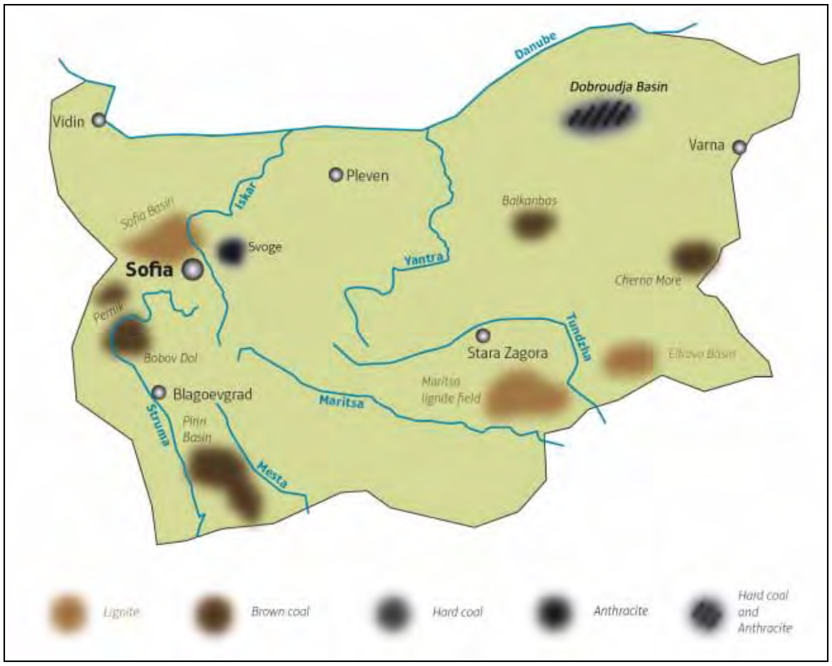
Bulgaria's coal reserves include about 88.7 percent lignite, 10.9 percent brown coal, and 0.4 percent hard coal. Bulgaria's coal is heavy with a low calorific value, and used mainly for heating in the residential sector, although households are gradually switching to natural gas and electricity (Euracoal, 2008). Much of the household coal heating is with briquettes, especially in the vicinity of the state-owned briquette factory, Stara Zagora (see Figure 5-1). About 9 percent of Bulgaria's coal production is used for making briquettes (USDOE, 2004).

Table 5-1. Bulgaria's Coal Reserves and Production

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2005)	5.44	1991.3	1995.8	22 (0.24%)
Annual Coal Production (2008)	0.033	0	28.7 28.8	23 (0.44%)

Source: EIA (2009)

Figure 5-1. Bulgaria's Coal Fields



Source: Euracoal (2008)

5.1.2 STAKEHOLDERS

Table 5-2 summarizes key stakeholders in Bulgaria's coal mine methane (CMM) industry.

Table 5-2. Key Stakeholders in Bulgaria's CMM Industry

Stakeholder Category	Stakeholder	Role
Mining companies	▪ Mining companies (see Table 5-3)	Project host
Universities, Research Establishments	▪ University of Mining and Geology "St. Ivan Rilski" - Bulgaria ▪ Geological Institute "St. Dimitrov"	Consulting assistance
Government Groups	▪ Ministry of Energy and Economy	Permitting and licensing
Other	▪ Bulgaria's Energy Efficiency Center in the Industry Efficiency Agency (executive agency to the Minister of Energy and Energy Resources)	Transfer of technologies, knowledge, and experience in the field of energy efficiency and use of renewable energy sources

5.1.3 STATUS OF COAL AND THE COAL MINING INDUSTRY

Bulgaria produced 28.7 million tonnes (Mmt) of coal in 2008 (EIA, 2009). Bulgaria's largest coal mining complex, Maritsa East Mines, plans an output of 26 Mmt of lignite in 2010 and up to 30 Mmt in 2011 from three open cast mines (Euracoal, 2008). The mines' output in 2008 reached 24.7 Mmt of coal, up from 23.9 Mmt in 2007 (EIA, 2006; SeeNews, 2009). Their supplies feed 2,240 megawatts electrical (MW_e) of three mine-mouth power plants (USDOE, 2004).

Other mines in Bulgaria have much lower production rates. The brown coal from the one open cast and two underground Bobov Dol Mines, in southwestern Bulgaria, and the lignite from the Stanyantsi, Bely

Brag, and Choukourovo Mines are used mostly at the 630-MW_e Bobov Dol power plant. The two open cast Pernik Mines, west of Sofia, have been supplying mainly for the Republica power plant (USDOE, 2004; Euracoal, 2008). Table 5-3 summarizes coal production by type of mine and from individual mines in Bulgaria.

Table 5-3. Most Recent Statistics for Bulgaria's Coal Mining

Company/Mine Name	Coalfield	Mine Type	Coal Type	Annual Production (million tonnes)
Mini Maritsa Iztok EAD	Maritsa East	3 Opencast	Lignite	23.9
Bely Brag Mine AD	Sofia	1 Opencast	Lignite	
Choukourovo Mine AD	Sofia	1 Opencast	Lignite	1.3
Stanyantsi Mine AD	Sofia	1 Opencast	Lignite	
Kanina Mine	Gotsedelchev	1 Opencast	Lignite	-
Vagledobiv Bobov Dol EOOD	Bobov Dol	1 Opencast, 2 Underground	Brown	0.92
Otkrit Vagledobiv Mines EAD	Pernik	2 Opencast	Brown	1.2
Balkan MK OOD	Oranovo	Underground	Brown	0.2
Kausto-gold AD	Katrishte	-	Brown	0.14
Cherno More Mine EAD	Black Sea	Underground	Brown	0.3
Vitrin				0.1
Anthra				0.015

Source: Euracoal (2008), USDOE (2004)

Most mining in Bulgaria is currently open cast, after deep lignite mining operations were liquidated in 2002 (Euracoal, 2004). Currently, there are 17 coal licensees and as of 2005, there were 19 companies operating mines (Ilkova, 2005).

Bulgarian coal industry has been restructured and certain mines have closed down, mainly underground, that have proven to be inefficient. The closing of mines is consistent with government rules and regulations. These mines namely are Zdravets, Antra, Marbas, Pirin, Bistritsa, Balkanbas, Balkan mine, Ivan Roussev mine, and Kolosh mine (Ilkova, 2005).

There are five mines considered potentially gassy – Bobov dol (two underground mines), Minior, and Balkan-2000 (two deposits are operated there – Tvarditsa and Paisii). The gas emissions are measured regularly (Ilkova, 2005).

5.2 Overview of CMM Emissions and Development Potential

5.2.1 CMM Emissions from Operating Mines

Table 5-4 summarizes CMM emissions from operating mines in Bulgaria. The data in this table may vary slightly from the U.S. EPA data presented in the Executive Summary due to differences in inventory methodology and rounding.

Table 5-4. Bulgaria's CMM Emissions (million cubic meters)

Emission Category	1990	1995	2000	2001	2002	2003
Underground mining activities—all	66.3	58.3	46.9	47.5	49.3	46.5
Post-underground emission (total)	9.48	8.33	6.70	6.79	7.04	6.64
Surface mine emission (total)	32.9	32.4	28.0	28.2	27.37	29.08
Post-surface mining emissions	2.74	2.70	2.34	2.35	2.28	2.42
Total liberated (= sum of all above)	111.4 (111.5)*	101.8 (101.8)*	83.9 (84.0)*	84.8	86.0	84.6

Emission Category	2004	2005	2006	2007	2008	2010 (projected)
Underground mining activities—all	49.0	42.9	47.0	51.5	46.0	
Post-underground emission (total)	7.00	6.13	6.71	7.35	6.57	
Surface mine emission (total)	27.9	26.3	27.1	30.1	30.9	
Post-surface mining emissions	2.33	2.19	2.26	2.51	2.57	
Total liberated (= sum of all above)	86.3	77.5 (93.8)*	83.1	91.4	86.0	115.7*

Source: UNFCCC (2010); *USEPA (2006)

5.2.2 CMM Emissions from Abandoned Coal Mines

No data quantifying CMM emissions from abandoned mines were found.

5.2.3 CBM from Virgin Coal Seams

Table 5-5 summarizes coalbed methane (CBM) resources in Bulgaria's Dobroudja Basin.

Table 5-5. CBM Resources of Bulgaria's Dobroudja Basin

CBM Resource	Proven	Probable	Possible	Total
Billion m^3	3.2	81.6	80.8	195.6
Coal Resource	**Measured**	**Indicated**	**Inferred**	**Total**
Billion tonnes	2.8	6.8	11.8	21.4

Source: Marshall (2001)

5.3 Opportunities and Challenges to Greater CMM Recovery and Use

Bulgaria signed and ratified the Kyoto Protocol (see Table 5-6) as an Annex 1 country. As such, it is eligible to host Joint Implementation projects that generate revenue by creating emission reduction credits. Bulgaria's greenhouse gas (GHG) emission reduction target under the Kyoto Protocol is 8 percent of base year 1988 emissions during the first commitment period from 2008 to 2012 (UNFCCC, 2000; UNFCCC, 2002).

Table 5-6. Bulgaria's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC	June 5, 1992	May 12, 1995
Kyoto Protocol	September 18, 1998	August 15, 2002

Source: UNFCCC (2004); UNFCCC (2005)

5.3.1 Market and Infrastructure Factors

Bulgarian coal industry has been restructured, shifting the focus to privatization and compliance with environmental standards. Certain mines, mainly underground, that have proven to be inefficient per government rules and regulations, have closed, and a gradual shift toward the privatization of Bulgaria's mines has encouraged foreign investment. AES Corporation, of the United States, took over operations of Maritsa Unit 1 in late 2008. As part of the transaction, AES is financing the construction of a 2 x 300-megawatt (MW) lignite-fired power plant. The new plant will replace an older, inefficient, 500-MW plant. To date, the effort marks one of Bulgaria's largest foreign investment projects, and helps the coal industry comply with European Union environmental standards (EBRD, 2005; AES, 2010). Also, the Kanina Mine, Oranovo Mine, and Otkrit Vagedobiv Mines were privatized in 2004. The Stanyantsi Mines, Bely Brag Mines, Choukourovo Mines, and Pernik Mines have also been privatized (Euracoal, 2008).

The Maritsa East Mines and the Bobov Dol Mines, are state-owned and sell coal at state-regulated prices to consumers. Similarly, the briquette factory at Maritsa East sells briquettes to consumers at state-regulated prices (USDOE, 2004).

Besides these state-owned mines, there are some coal mines that sell their products at contracted prices. The largest of these are the Pirin Mine, the Maritsa Basin Mine, the Balkan Mine, the Cherno More Mine, the Vitren Mine, and the Anthra Mine (USDOE, 2004).

5.3.2 Regulatory Information

No regulatory information was found specifically applicable to CMM development in Bulgaria.

5.4 Profiles of Individual Mines

See Table 5-3 above for information on individual mines in Bulgaria.

5.5 References

AES (2010): Bulgaria, accessed June 14, 2010. http://www.aes.com/aes/index?page=country&cat=BULGARIA

EBRD (2005): "Maritza East I Power Company." European Bank for Reconstruction and Development. Date disclosed: May 12, 2005. http://www.ebrd.com/projects/psd/psd2005/11865.htm

EIA (2005): *Southeastern Europe Country Analysis Brief,* Energy Information Agency, Washington, DC, March 11, 2005.

EIA (2006): *Southeastern Europe Country Analysis Brief,* Energy Information Agency, Washington, DC, August 2006. Available in archive from http://web.archive.org/web/20060510162440/http://www.eia.doe.gov/emeu/cabs/seeurope.html

EIA (2009): International Energy Statistics. U.S. Energy Information Administration, Independent Statistics and Analysis. 2009. http://tonto.eia.doe.gov/cfapps/ipdbproject/IEDIndex3.cfm

Euracoal (2008): Euracoal Country Profiles: Bulgaria, accessed June 10, 2010, http://www.euracoal.be/pages/layout1sp.php?idpage=69

Ilkova (2005): Information provided by Stephania Ilkova, Ministry of Energy and Economy, 2005.

Marshall (2001): *Coalbed Methane Opportunities in Bulgaria.* World Coal, 1 September 2001, James Marshall, 2001.

SeeNews (2009): "Bulgaria's Maritsa East Coal Mines Plans 26 Mln T Output in 2010, 30 Mln T in 2011." SeeNews – The Corporate Wire. December 23, 2009. http://www.seenews.com/

Steblez (2000): *The Mineral Industrial of Bulgaria and Romania – The USGS Minerals Yearbook.* [online]. Walter Steblez, 2000. http://minerals.usgs.gov/minerals/pubs/country/2000/9408000.pdf

UNFCCC (2000): In-depth review of the second national communication. Available from http://unfccc.int/resource/docs/idr/bul02.htm

UNFCCC (2002). *Third National Communication on Climate Change.* [online]. Available from http://unfccc.int/resource/docs/natc/bulnc3.pdf

UNFCCC (2004): United Nations Framework Convention on Climate Change - Status of Ratification, May 24, 2004. http://unfccc.int/resource/conv/ratlist.pdf

UNFCCC (2010). *Annex I Party GHG Submissions 2010.* [submitted May 27, 2010; cited June 10, 2010]. http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5270.php

UNFCCC (2005): Kyoto Protocol - Status of Ratification, September 19, 2005. http://unfccc.int/files/essential_background/kyoto_protocol/application/pdf/kpstats.pdf

USDOE (2004). *Energy Overview of Bulgaria.* [updated 15 November 2004; cited August 2005]. Available in archive from http://web.archive.org/web/20050917083321/http://fossil.energy.gov/international/CentralEastern+Europe/bulgover.html

USEPA (2006): *Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990–2020*, U.S. Environmental Protection Agency, Office of Atmospheric Programs, Climate Change Division, June 2006. Available from http://www.epa.gov/nonco2/econ-inv/international.html

6 CANADA

6.1 Summary of Coal Industry

6.1.1 ROLE OF COAL IN CANADA

Coal is the most abundant fossil fuel in Canada, comprising 66.5 percent of all its fossil fuel reserves (CAC, 2003a). Coal accounted for 10 percent of the primary energy produced in 2006 (EIA, 2009). Canada exports more than 40 percent of its tonnage as coking coal for steelmaking to Asian countries and some to Europe and Latin America. Conversely, Canada imports coal for electricity generation—estimated at about 20 million tonnes (Mmt) in 2007—primarily from the United States, Colombia, Venezuela, and Russia (NRC, 2008). About 89 percent of the coal consumed in Canada is for thermal power generation and the remainder is used in the steel (7 percent), cement, and other industries.

The recoverable coal reserves in the country are estimated at 6.6 billion tonnes. Though Canada's coal production had been declining, dropping from 78.7 Mmt in 1997 to 66.4 Mmt in 2002 (EIA, 2005), coal production is again on the rise, reaching 68 Mmt in 2007 from 66 Mmt in 2004 and 62 Mmt in 2003 (IEA, 2007).

Table 6-1 quantifies recoverable reserves and recent coal production in Canada.

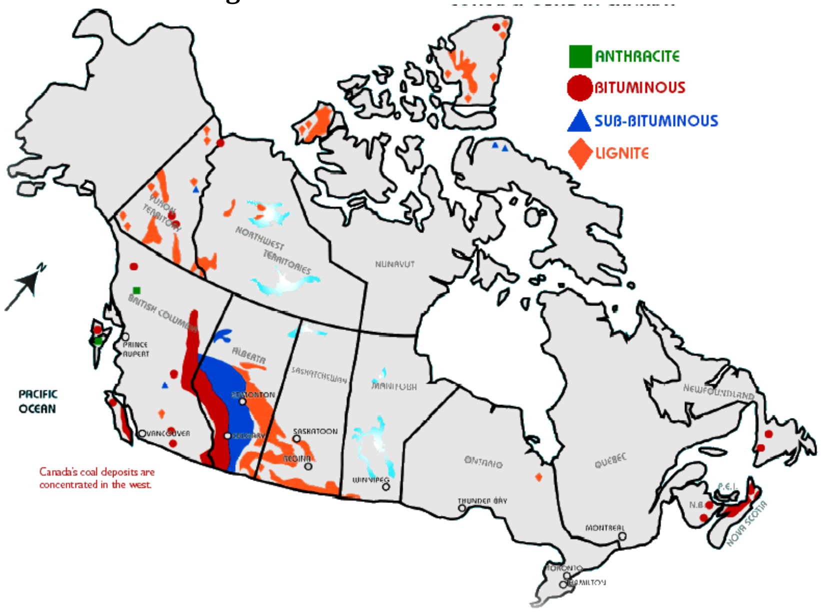
Table 6-1. Canada's Coal Reserves and Production

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2006)*	3,471	3,107	6,578	13 (0.8%)
Annual Coal Production (2007)**	32.8	35.6	68.4	13 (1.1%)

Source: *EIA (2008); **IEA (2007)

Production occurs mainly in Alberta (43 percent), British Columbia (35 percent), and Saskatchewan (11 percent), as shown in Figure 6-1. Coal mines in eastern Canada, New Brunswick, and Nova Scotia are small operations.

Figure 6-1. Canada's Coal Fields



Source: CAC (2006)

6.1.2 STAKEHOLDERS

Table 6-2 identifies potential key stakeholders in coal mine methane (CMM) development in Canada.

Table 6-2. Key Stakeholders in Canada's CMM Industry

Stakeholder Category	Stakeholder	Role
Mining Companies	▪ The three giants in the coal industry (Luscar Ltd., Teck Cominco Ltd., and Fording Inc.) have merged to form the Elk Valley Coal Corp., with Teck Cominco as the managing partner. ▪ Western Canadian Coal Corp. ▪ Grande Cache Coal Corp. ▪ EnCana ▪ MGV Energy Inc. ▪ Apache Canada Ltd. ▪ Trident Exploration Co. ▪ Burlington ▪ Nexen ▪ Anadarko ▪ Talisman ▪ CDX ▪ Thunder ▪ Dominion ▪ APF ▪ Vectren ▪ Others	Project hosts

Stakeholder Category	Stakeholder	Role
Developers	▪ VWVulcan Energy of Canada, Ltd. ▪ Trident Exploration ▪ Husky Energy ▪ Nexen ▪ Red Willow ▪ Also see http://www.epa.gov/coalbed/networkcontacts.html	Project opportunity identification and planning
Engineering, Consultancy, and Related Services	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Technical assistance
Universities, Research Establishments	▪ University of Montana (Water Quality Management) ▪ Alberta Research Council ▪ Natural Resources Canada ▪ Canadian Mineral and Energy Technologies (CANMET)	Technical assistance
Government Groups	▪ Natural Resources Canada ▪ Alberta Ministry of Energy ▪ British Columbia Ministry of Energy, Mines, and Petroleum Resources	Permitting and licensing
Professional Associations	▪ Canadian Association of Petroleum Producers (CAPP)	Technical assistance

Source: AAPL (2005)

6.1.3 Status of Coal and the Coal Mining Industry

Practically all coal mined in Canada (97 percent) is extracted by surface mining methods. Vancouver Island in British Columbia has the only operational underground mine in Canada (CAC, 2003a). Table 6-3 provides statistics on Canadian coal mining.

Table 6-3. Canada's Most Recent Statistics for Coal Mining

Type of Mine	Production (million tonnes)	Number of Mines
Underground (active) mines – total	*0.47 (2001)	**1 (2003)
Surface (active) mines – total	*70 (2001)	**19 (2003)

Source: *Coal Stats (2001); **CAC (2003a)

The country largely produces bituminous coal, which accounted for 48 percent of its entire coal production in 2001. Sub-bituminous coal, mined in Alberta, forms the next largest component in Canada's coal production at 35 percent. No anthracite currently is mined in Canada, although some has been discovered in British Columbia. Lignite occurs in Saskatchewan and Alberta and is used to produce 65 percent of Saskatchewan's electricity.

The operational status of Canadian coal mines is illustrated in Figure 6-2, while Table 6-4 lists mine status by region.

Figure 6-2. Status of Canada's Coal Mines

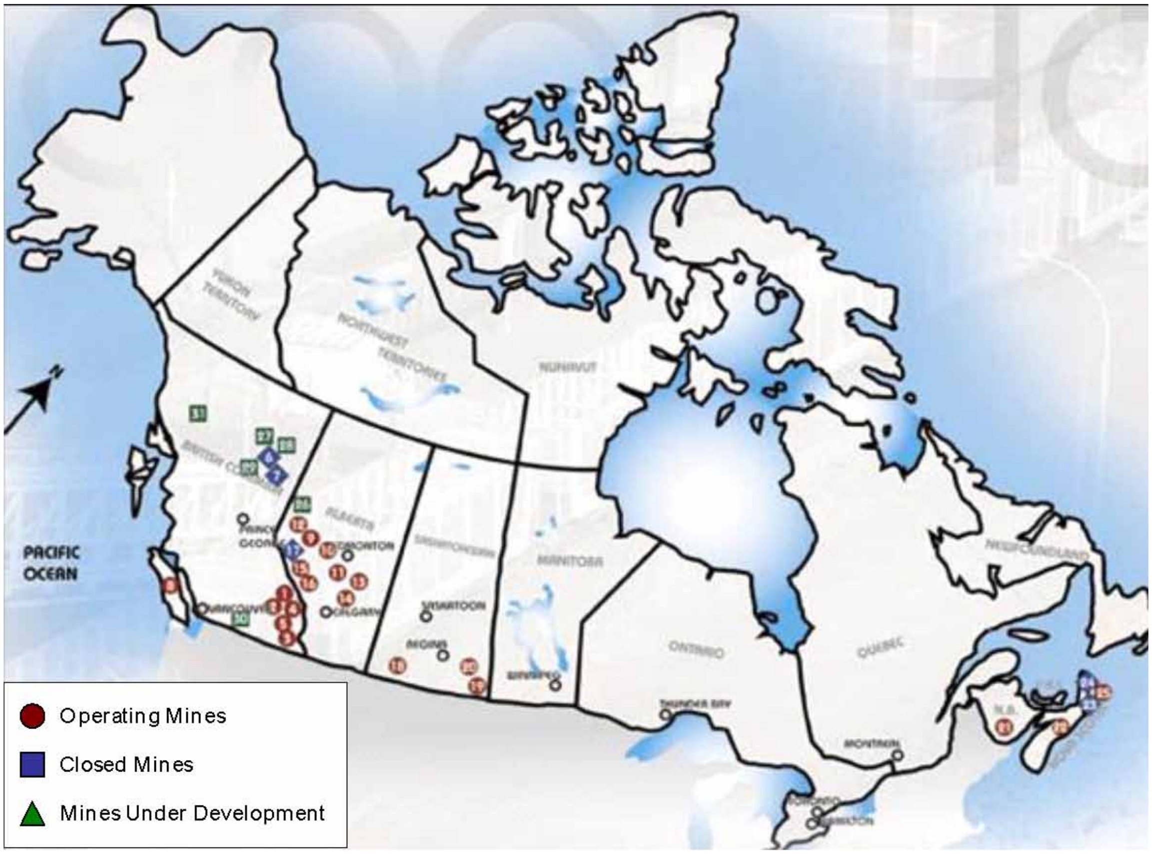


Table 6-4. Status of Canada's Coal Mines

Region	Operating Mines		Closed Mines	Mines Under Development
British Columbia	1. Fording River 2. Greenhills 3. Coal Mountain Trend*	4. Line Creek 5. Elkview 8. Quinsam 29. Wolverine Creek 27. Willow Creek (Brule)	6. Bullmoose (2003) 7. Quintette (2000) Basin Coal Mine (2008)	28. Burnt River 30. Tulameen 31. Mount Klappan
Alberta	9. Highvale 10. Whitewood 11. Genesee 12. Obed Mountain	13. Paintearth 14. Sheerness 15. Cardinal River (Cheviot Creek) 16. Coal Valley 26. Grande Cache	17. Gregg River (2000) Luscar (2004)**	
Saskatchewan	18. Poplar River 19. Bienfait	20. Boundary Dam		

Region	Operating Mines		Closed Mines	Mines Under Development
New Brunswick			21. Salmon Harbour (2009)	
Nova Scotia	22. Stellarton (nee Pioneer) Greenhills Development - Florence***	25. Point Aconi/Brogan***/ Sullivan and Toronto Road Mines**	23. Phalen (1999) 24. Prince (2001) Evans (2003) **	

Note: Number by mine name indicates location on Figure 6-2
Source: CAC (2006); *USGS (2008); **Atlas (2009); ***Nova Scotia (2009)

The coal deposits in central and southern parts of Alberta and Saskatchewan lie in blankets of uniform thickness close to the surface, while the coal around the British Columbia/Alberta border run into mountainous terrain and the seams can be as thick as 15 meters, deeply buried and inclined, making mining a challenge. In eastern Canada, Nova Scotia contains the largest coal deposits. The largest one, Sydney coalfield, has 11 seams that are 1.0 to 4.5 m thick and is located under the ocean. Economics posed challenges to extracting that coal, however, and the mines were closed. Furthermore, the mining conditions are quite difficult and dangerous in the region as evidenced by an explosion and fatalities at the Westray mine. The coal in Ontario has a low-heat value and is not exploited. Finally, the potential of coal deposits in the northern half of the country have yet to be explored (CAC, 2003a).

The Canadian coal industry has undergone major restructuring recently with the consolidation of mining companies starting in 2003. The three giants in the coal industry – Luscar Ltd., Teck Cominco Ltd., and Fording Inc. – merged to form the Elk Valley Coal Corp. (EVCC), with Teck Cominco as the managing partner of EVCC. As part of the deal, Luscar Energy Partnership bought the thermal coal assets of Fording to become the largest producer of thermal coal in Canada. Luscar's assets include the undeveloped coalfields, royalty interests, mining service contracts, and an interest in a joint mining venture. With these mergers, Luscar Coal Ltd. and EVCC are in charge of 99.5 percent of the entire Canadian coal production, operating all 15 large-scale mining operations (>1 Mmt per year) (NRC, 2005). In 2008, Teck bought out the Fording Canadian Coal Trust (Mining Exploration News, 2008).

Although domestic consumption of coal has declined recently, coking coal exports are on the rise with an increasing demand for metallurgical coal worldwide, especially as China turns into an importer of coking coal. EVCC has increased metallurgical coal production and opened the Cheviot Creek Pit near Hinton, Alberta. The production was 2.0 Mmt peryear of coking coal in 2008. In recent years, six more mining projects have been or are under development by individual companies, five in British Columbia (Licensees: Western Canadian Coal Corp., Northern Energy and Mining, and Aurora Coal) and one in Alberta (the now active Grande Cache). In eastern Canada, Nova Scotia is taking steps to restart coal mining, although a contract has not yet been assigned.

6.2 Overview of CMM Emissions and Development Potential

6.2.1 CMM Emissions from Operating Mines

There are no CMM utilization projects in Canada. Table 6-5 summarizes the country's CMM emissions.

Table 6-5. Canada's CMM Emissions (million cubic meters)

Emission Category	1990	1995	2000	2005	2006	2007	2008
Underground mine	84.54	67.15	20.29	4.60	6.61	6.64	5.66
Post-underground mine	-	-	-	-	-	-	-
Surface mine	49.50	52.79	46.15	46.22	43.03	46.87	47.14
Post-surface mine	-	-	-	-	-	-	-
Total	134.03	119.94	66.44	50.82	49.65	53.51	52.80

Source: UNFCCC (2010)

6.2.2 CMM Emissions from Abandoned Coal Mines

In 2003, there were at least three abandoned underground mines in Canada (CAC, 2003b). No specific information about CMM from abandoned mines is available at this time.

6.2.3 CBM from Virgin Coal Seams

Assessing the extent of coalbed methane (CBM) prospects in Canada has only recently started. The results are illustrated in Figures 6-3, 6-4, and 6-5 on following pages. According to the Canadian Gas Potential Committee, however, they could be anywhere between 5.3 and 13 trillion cubic meters (TCM). These estimates are from exploration mainly in the Western Canada Sedimentary Basin. Table 6-6 lists the major Canadian CBM exploration sites.

Table 6-6. Canada's Major CBM Reserves

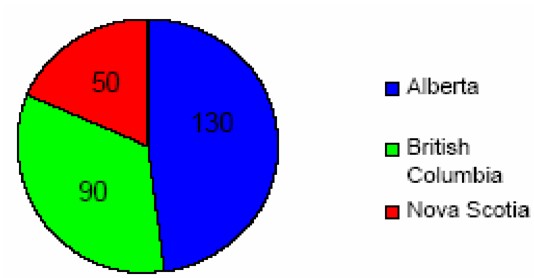
Location	Reserves (trillion cubic meters)
Horseshoe Canyon	1.04
Pembina (including Ardley)	0.84
Mannville	4.76
Alberta/BC Foothills (Gates/Mist Mtn)	3.7

Source: AAPL (2005)

Alberta's reserves could range from 3.8 to 11.6 TCM (ACR, 2003). The primary CBM potential areas in Alberta are the Ardley, Horseshoe Canyon, and the Mannville coal zones, with the Upper Manville being the gassiest zone. Alberta offers particularly favorable conditions for CBM development as the geology of CBM deposits are relatively simple and uniform over a wide area (Amazouz, 2006). Within British Columbia, the major concentration is in the northeast and to a much lesser extent in the southeast of the province, amounting to a total of 2.5 TCM (BC, 2002). Nova Scotia forms the third largest portion of the Canadian CBM reserve.

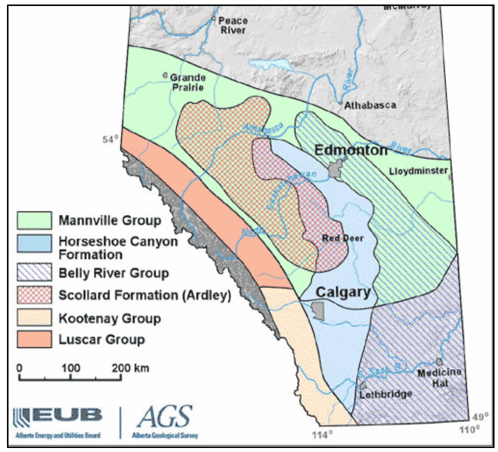
Figure 6-3. Location of Probable Economically Recoverable CBM Reserves in Canada

(trillion cubic feet)



Source: Alberta Energy and Utilities Board (2004)

Figure 6-4. Primary CBM Potential Areas in Alberta



Source: Alberta Energy and Utilities Board (2004)

The CBM industry is very new in Canada compared to its neighbor, the United States. However, in Alberta alone, there were more than 3,500 CBM wells in place by 2004, with most of these concentrated in Alberta and British Columbia (Snyder, 2005). A forecast report projected annual CBM production of 14.5 billion m^3 by 2015 for all of Canada (NAEWG, 2005; Amazouz, 2006).

The first Canadian methane production began in 2002 in the Horseshoe Canyon region in Alberta. The Horseshoe Canyon coals are dry and relatively close to the surface, enabling easy gas recovery. Therefore, these fields accounted for 90 percent of the producing wells in Alberta in 2005 (Snyder, 2005), generating more than 2.8 million m^3 per day of methane. Alberta's CBM production in 2005 totaled 2.5 billion m^3 (Amazouz, 2006). By 2008, there were 6000 wells producing 5.2 billion m^3 per year, all located in Alberta (International, 2008). By 2010, a total of 14,000 wells had been drilled (not all of which are active) and production is approximately 7.2 billion m^3 per year (Ember, nd).

Table 6-7 provides highlights of significant methane production projects in Canada.

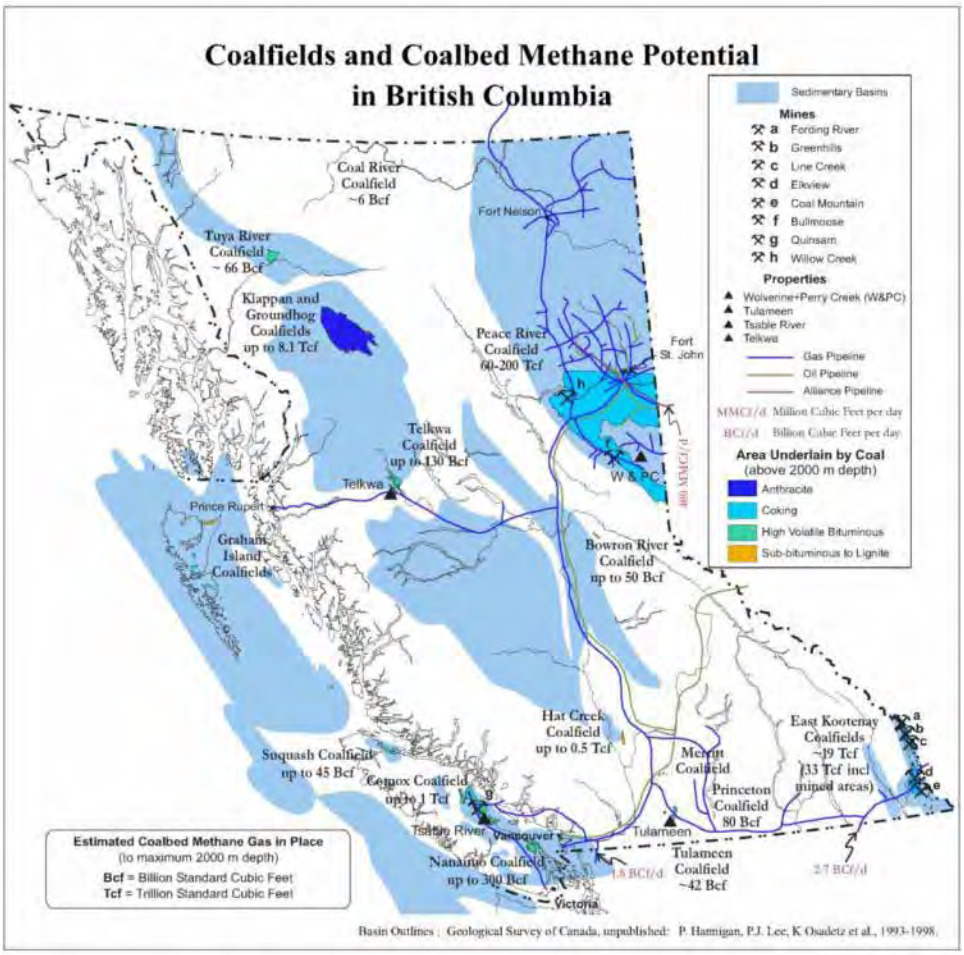
Table 6-7. Profile of a Joint Venture between EnCana and MGV Energy, the Most Productive Project in Canada

Site	**Mine Type** (active/abandoned, etc.)	**Average Methane (CH_4) Used / Emissions Avoided** (million m^3/day) (2004)	**Project Operating Period**	**Use of Methane**
Horseshoe Canyon, Alberta	N/A	0.48 from 577 wells (1.68 from 1,000 wells predicted for 2005)	2003–present	N/A
Nevis field, Southern Alberta	N/A	.98	2003–present (expected to last 15–20 years)	N/A

Site	Mine Type (active/abandoned, etc.)	Average Methane (CH_4) Used / Emissions Avoided (million m^3/day) (2004)	Project Operating Period	Use of Methane
Between Campbell River and Nanaimo in Vancouver Island, British Columbia	Active underground mine	Peak production of 2.24 in 2009–2010 (on average, 4.2 thousand m^3/day per well)	2002–2017	Homes, business and industry

Source: EnCana (2004); Apache (2005); VWV (2001)

Figure 6-5. CBM Potential in British Columbia



Source: BC (2002)

Additional CBM Exploration and Production

A number of companies have explored CBM projects on Vancouver Island where the coal rank is bituminous with cumulative coal seam thickness of 23 feet. Priority Ventures Ltd. conducted some test drilling in 2001, while Quinsam Coal Corporation allied with CornerStone Gas to explore CBM development on the island (BC, 2009).

West Fraser Timber Co, with VWVulcan Energy of Canada, Ltd., applied for freehold rights on the island. VWVulcan planned for tests in 2002 with 10 wells to explore the regional production capacity; an additional 500 to 600 production wells were also planned to be drilled in the following five to six years. With an expected well life of 15 years, total gas to be recovered over the period was estimated at 7 million m^3 (of the projected 14–28 million m^3 of total recoverable resource). These projects have stalled, however, with fluctuations in natural gas prices and the worldwide economic downturn.

Trident Exploration worked with Husky Energy to develop CBM in the Fenn Rumsey area. The joint venture started in 2002, was extended in 2004, and planned to drill some 400 exploratory wells by 2006 (Husky, 2005). In a second project, Trident worked with Nexen and Red Willow to start the first CBM venture in the Mannville formation in Alberta (Jones, 2005), and by 2008, they had completed 650,000 m of drilling in Mannville (Trident, 2008). Royal Dutch Shell has licenses for tenure to explore for CBM in the Kaplan area of northwest British Columbia (Shell, nd). BP has tenure at its CBM project at Mist Mountain in southeast British Columbia (BP, 2010).

By mid-2008, approximately 60 CBM exploration wells had been drilled outside of Alberta but no commercial production existed. The British Columbia and Nova Scotia coals generally exhibited low permeability, and coals in Ontario and Saskatchewan showed insufficient gas for commercial production (International, 2008). But by December 2008, GeoMet Inc. began the first commercial delivery of CBM from the Peace River project in British Columbia (Allbusiness, 2009). By January 2009, Nova Scotia also had three CBM projects, two of which are Stealth Ventures Inc. projects in Cumberland and Stellarton basins. The third project is in the Sydney basin of northern Nova Scotia (Prospect Profile, 2009).

6.3 Opportunities and Challenges to Greater CMM Recovery and Use

Canada is a signatory to both the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol (see Table 6-8). As an Annex I Party, its emissions target under the Kyoto Protocol is to achieve a 6 percent reduction of 1990 greenhouse gas (GHG) emission levels by 2010.

Table 6-8. Canada's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC	June 12, 1992	December 4, 1992
Kyoto Protocol	April 29, 1998	December 17, 2002

Source: UNFCCC (2004); UNFCCC (2005)

Canada promotes clean energy projects to reduce its GHG emissions and emission credits could be one form of CBM project financing (ASB, 2004).

6.3.1 Market and Infrastructure Factors

The major issues that concern the Canadian CBM industry are geology, land consolidation and access, freehold leases, water disposal (both brine and fresh), regulatory matters, and CBM technology (Ziff, 2004). In general, all CBM projects are private-industry-driven in Canada, with companies typically forming partnerships to commercially develop CBM projects.

Canada joined the Global Methane Initiative (formerly Methane to Markets Partnership) in July 2005. Canada's efforts thus far, however, have been largely limited to the oil and gas industry (Canada is a member of the Oil and Gas Subcommittee). Long-term consumption of natural gas is expected to grow steadily in Canada, while domestic production of conventional natural gas is believed to have peaked in 2003 (Amazouz, 2006). The expected shortfall will be met by a number of alternative natural gas resources:

- Mackenzie Delta and Beaufort Sea fields
- Other remote gas fields (north of 60^{th} parallel)
- Liquefied natural gas importation
- Offshore East Coast and West Coast gas fields
- CBM reserves estimated at 4.7 TCM (CAPP, 2004)

Canada is also pursuing other avenues of alternative gas resources. In 1996, Natural Resources Canada's Canmet Energy Technology Centre – Varennes initiated the development of a catalytic reactor that could, both technically and economically, recover the methane of coal mine ventilation air. The technology, called CH4MIN, recovers the energy of the dilute ventilation air methane, with an efficiency varying between 40 and 95 percent, depending on the methane concentration in the ventilation air (Amazouz, 2006). Researchers at Canadian Mineral and Energy Technology in Quebec developed CH4MIN technology in 1995. CH4MIN is currently at the industrial demonstration development stage and has run large pilot-scale projects at the Phalen Coal Mine in Nova Scotia. The company is exploring the economic viability of CH4MIN in China, but no commercial-scale implementation is planned in Canada (CH4MIN, 2003).

Further on the research and development (R&D) front, the Alberta Research Council has been collaborating with the American, Canadian, and other governments to improve CBM recovery efficiency (ACR, 2003). Non-nuclear government research and development spending is managed by Natural Resources Canada. The Program of Energy Research and Development (PERD), managed by Natural Resources Canada's Office of Energy Research (OERD15), is the major source of government funding for non-nuclear public and private research and development. Natural Resources Canada's Energy Technology Branch (ETB), which includes three laboratories in the Canada Centre for Mineral and Energy Technology, is the largest federal participant in, and manager of, non-nuclear science and technology programs. ETB receives a large share of PERD funds.

Canadian infrastructure is also being adapted to keep in step with its growing CBM/CMM industry. The Alberta Energy and Utilities Board recently approved Canada's major pipeline network for natural gas transportation, TransCanada PipeLines, to reconfigure its system to allow the low-pressure intake of CBM (Jones, 2005). CBM has to compete with other sources of Canadian gas in order for it to be purchased by pipelines that transport the gas to the United States or Canadian consumers.

6.3.2 Regulatory Information

Initially, there was controversy regarding the ownership of CBM rights in Canada since coal and natural gas come under different jurisdictions. CBM rights in both British Columbia (BC) and Alberta now follow the legal framework for natural gas. The provinces own and can sell the rights to develop CBM at their discretion. The *Coalbed Gas Act* clearly attributes all CBM rights to the owners of natural gas mineral rights and none to the owner of coal rights (ASB, 2004). Canadian regulations enforce consultation with affected stakeholders and governments before development begins (CAPP, 2003). In BC, a potential producer must get Petroleum and Natural Gas tenure rights before production (BC, nd). In Nova Scotia, the *Petroleum Resources Act* recognizes coal gas as a distinct resource but has included it with the definition of petroleum as "coal gas, existing in its natural condition in strata." A specific coal gas agreement is also required before exploration, development, or production of CBM (Blakes, 2006). In

Saskatchewan, CBM is defined by The Petroleum and Natural Gas Regulations of 1969 and is administered just like any other petroleum or natural gas development (Saskatchewan, nd).

Canada does not have federal tax credit incentives in place to stimulate investment in CBM technologies because legislative power rests largely with provincial governments. BC relies on a royalty incentive program to encourage CBM production. Recent amendments to the BC Petroleum and Natural Gas Royalty Freehold Production Tax Regulation allow water treatment costs to be included in the producer's cost of service allowances for CBM wells, place the production threshold at 17,000 m^3 per day before a royalty is imposed on a CBM well, and raise the royalty credit on each well to $50,000 (BC Royalty, nd).

In the *Petroleum and Natural Gas Act*, CBM projects are not subject to well-spacing regulations (more wells are often required per field compared to natural gas resources) and CBM production data can stay confidential for an extended period (ASB, 2004).

CBM producers are subject to strict rules that apply at every stage of project development. All the federal and provincial wildlife and environmental laws and the elaborate industry-specific regulations apply to the CBM producers as well (CAPP, 2003).

6.4 Profiles of Individual Mines

Ardley and Lower Edmonton Mines, Alberta

General Overview

Total mining area, squared kilometers (km^2)	Several hundreds
No. of coal seams	1–30
Total methane resource	0.84 trillion cubic meters
Rank of coal	Sub-bituminous, high-volatile
Cumulative thickness	Up to 25 meters
Depth of mining	200 to 700 meters
Moisture	Dry
Gas content average	1.87 m^3/tonne
Mining method	Surface

Upper Mannville Mines, Alberta

General Overview

No. of coal seams	2–5
Total methane resource	4.76 TCM
Rank of coal	Bituminous
Cumulative thickness	Up to 20 meters
Depth of mining	800 to 1500 meters
Moisture	High (dewatering required)
Gas content average	9.4–15.6 m^3/tonne
Mining method	Surface

Source: Sproule (2004)

6.5 References

AAPL (2005): Regulation of the CBM Industry in the United States and Canada, AAPL Annual Meeting – July 2, 2005 in Banff Alberta

ACR (2003): *Coal bed methane the energy industry's next big play?*, Alberta Chamber of Resources, 2003. http://www.acr-alberta.com/Featured/Black_Gold.htm

Alberta Energy and Utilities Board (2004): EnerFAQs 10: Coalbed Methane, February 11, 2004. http://www.ercb.ca/docs/public/EnerFAQs/PDF/EnerFAQs8-CoalbedMethane.pdf

Allbusiness (2009): GeoMet Announces Commencement of Gas Deliveries from British Columbia Coalbed Methane Project, Allbusiness.com, January 5, 2009. http://www.allbusiness.com/legal/banking-law-banking-finance-regulation/11737289-1.html

Amazouz (2006): Information provided by Mouloud Amazouz, Natural Resources Canada, 2006.

Apache (2005): Second Quarter 2005 Update. http://www.apachecorp.com/ir/downloads/Apache_20052Q_report.pdf?surveyid=1

ASB (2004): *Coal Bed Methane: the Past, Present and Future of Alberta's Most Abundant Non-traditional Source of Natural Gas* (a report from Alberta School of Business). http://www.bus.ualberta.ca/cabree/pdf/2004%20Fall%20UG%20Projects/Casandra%20Brown.pdf

Atlas (2009): The Atlas of Canada – Table 1. Some Major Mines by Ecozone, Natural Resources Canada, February 24, 2009. http://atlas.nrcan.gc.ca/auth/english/maps/environment/ecology/humanactivities/mines_table.html

BC (2002): Coal in British Columbia, Government of British Columbia. http://www.em.gov.bc.ca/Mining/Geolsurv/coal/coalinbc/coal_bc.htm

BC (2009): British Columbia Oil and Gas Exploration Report 2007–2008, Legislative Assembly of British Columbia, 2009. http://www.llbc.leg.bc.ca/public/pubdocs/bcdocs/405260/exploration_report_2007_2008.pdf

BC (nd): Coalbed Gas, Ministry of Energy, Mines, and Petroleum Resources, Government of British Columbia, not dated. http://www.empr.gov.bc.ca/OG/oilandgas/petroleumgeology/UnconventionalOilAndGas/CoalbedGas/Pages/default.aspx

BC Royalty (nd): Coalbed Gas Royalty Program, Ministry of Energy, Mines, and Petroleum Resources, Government of British Columbia, not dated. http://www.empr.gov.bc.ca/OG/OILANDGAS/ROYALTIES/Pages/CoalbedGas.aspx

Blakes (2006): Coalbed Methane - Split Title, Blakes.com, March 1, 2006. http://www.blakes.com/english/view_disc.asp?ID=112

BP (2010): Mist Mountain Coalbed Gas Project Overview, BP, 2010. http://www.bp.com/sectiongenericarticle.do?categoryId=9020101&contentId=7037492

CAC (2003a): Coal Kit: Module #1. http://www.coal.ca/content/images/stories/documents/module_1_-_evolution.pdf

CAC (2003b): Coal Kit: Module #2. http://www.coal.ca/content/images/stories/documents/module_2_-_economics.pdf

CAC (2006): "Coal Related Maps." *The Coal Association of Canada.* http://www.coal.ca/content/index.php?option=com_content&task=view&id=32&Itemid=55

CAPP (2003): http://www.csug.ca/faqs.html#Un

CAPP (2004): Outlook for Natural Gas Supply from Western Canada. http://www.capp.ca/raw.asp?x=1&dt=PDF&dn=79520

CH4MIN (2003): Hristo, Sapoundjiev; Jean Gilles. "Introduction of Catalytic Flow-Reversal Reactor (CH4MIN) Technology and its Potential in China Coal Mines." CANMET Energy Technology Center. November 2003. http://www.coalinfo.net.cn/coalbed/meeting/2203/papers/coal-mining/CM051.pdf

Coal Stats (2001): http://www.coal.ca/coalincan.htm

EIA (2005): Country Analysis Briefs – Canada, 2005.

EIA (2008): *International Energy Annual 2006*. U.S. Energy Information Administration, Washington, DC, October 2008. http://www.eia.doe.gov/pub/international/iea2008/table82.xls

EIA (2009): Country Analysis Briefs – Canada, 2009, U.S. Department of Energy, July 2009. http://www.eia.doe.gov/cabs/Canada/Background.html

Ember (nd): Information on Coalbed Methane and CBM Drilling, Ember Resources, not dated. http://www.emberresources.com/coalbed-methane-production-background

EnCana (2004): Resource Play Portfolio. http://www.encana.com/investor/financial_info/annual2004/resourceplays/CBM.html

Husky (2005): Husky Energy Announces 2005 Third Quarter Results, Lexdon – The Business Library, October 18, 2005. http://www.lexdon.com/article/Husky_Energy_announces_2005_third/13947.html

IEA (2007): Coal and Peat in Canada in 2007, International Energy Agency, 2007, http://www.iea.org/stats/coaldata.asp?COUNTRY_CODE=CA

International (2008): International Geological Congress – Oslo 2008, Ministry of Mines and Energy – Brazil, August 2008. http://www.cprm.gov.br/33IGC/1324175.html

Jones (2005): Canadian Energy Investment Backgrounder. http://www.bennettjones.ca/Images/Guides/update1832.pdf

Mining Exploration News (2008): Teck Cominco, Coal Mine Industry Company, Buyout Fording Canadian Coal Trust, Paguntaka.org, July 30, 2008. http://paguntaka.org/2008/07/30/teck-cominco-coal-mine-industry-company-buyout-fording-canadian-coal-trust/

NAEWG (2005): North American Natural Gas Vision Report 2005, North American Energy Working Group Experts Group on Natural Gas Trade and Interconnections, January 2005. http://www.pi.energy.gov/pdf/library/NAEWGGasVision2005.pdf

Nova Scotia (2009): Location Map Showing Mining Operations in Nova Scotia in 2009, Government of Nova Scotia, Canada, 2009. http://www.gov.ns.ca/natr/meb/download/mg/ofi/htm/ofi_2010-001.asp

NRC (2005): *Year in Review* (Natural Resources Canada). http://www.nrcan.gc.ca/mms/cmy/2003revu/coal_e.htm

NRC (2008): Energy Sources – About Coal, http://nrcan.gc.ca/eneene/sources/coacha-eng.php

Prospect Profile (2009): Nova Scotia Prospect Profile Onshore 2009, Government of Nova Scotia, January 2009. https://www.gov.ns.ca/energy/resources/RA/onshore/NS-Prospect-Profile-Onshore-Jan-2009.pdf

Saskatchewan (nd): Natural Gas in Coal, Energy and Resources, Government of Saskatchewan, not dated. http://www.ir.gov.sk.ca/Default.aspx?DN=5108,3384,2936,Documents#sect2a

Shell (nd): Klappan Coalbed Methane Exploration Program, Shell, not dated. http://www.shell.ca/home/content/can-en/aboutshell/our_business/business_in_canada/e_and_p/e_and_p_canada/klappan/

Snyder (2005): North American Coalbed Methane Development Moves Forward, World Oil Magazine, Robert E Snyder, Executive Engineering Editor, July 2005. http://www.worldoil.com/Magazine/MAGAZINE_DETAIL.asp?ART_ID=2657

Sproule (2004): *Overview of Coalbed Methane in Canada*. *http://www.sproule.com/news/downloads/CBM%20Presentation.pdf*

Trident (2008): Trident Resources Corp. – About Us, Trident, 2008. http://www.tridentexploration.ca/about.asp?PageID=0

UNFCCC (2004): United Nations Framework Convention on Climate Change - Status of Ratification, May 24, 2004, http://unfccc.int/resource/conv/ratlist.pdf

UNFCCC (2005): Kyoto Protocol - Status of Ratification, September 19, 2005. http://unfccc.int/files/essential_background/kyoto_protocol/application/pdf/kpstats.pdf

UNFCCC (2010): Annex I Party GHG Inventory Submissions 2010, United Nations Framework Convention on Climate Change, 2010. http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5270.php

USGS (2008): 2008 Minerals Yearbook - Canada, U.S. Geological Survey, 2008. http://minerals.usgs.gov/minerals/pubs/country/latin.html#ca

VWV (2001): Coal Bed Methane. VWV website. http://www.venueview.com/vv_design/VWVulcan/vwv_original/index.htm

Ziff (2004): Coalbed Methane - A Significant Gas Supply from Western Canada, Ziff Energy Report. http://www.ziffenergy.com/media/pressrelease.asp?PressReleaseID=%7B455F09BE-BB4D-4F23-BB33-251827C4D45A%7D

7 CHINA

7.1 Summary of Coal Industry

7.1.1 ROLE OF COAL IN CHINA

Coal accounts for 69.91 percent of total national energy consumption in China (EIA, 2007a). Ranking first in the world in production of coal, China exported 82.6 million tonnes (Mmt) of coal in 2005 (EIA, 2007b); however, exports have been on the decline in more recent years (EIA, 2010). Table 7-1 provides recoverable reserve and recent coal production data for China.

Table 7-1. China's Coal Reserves and Production

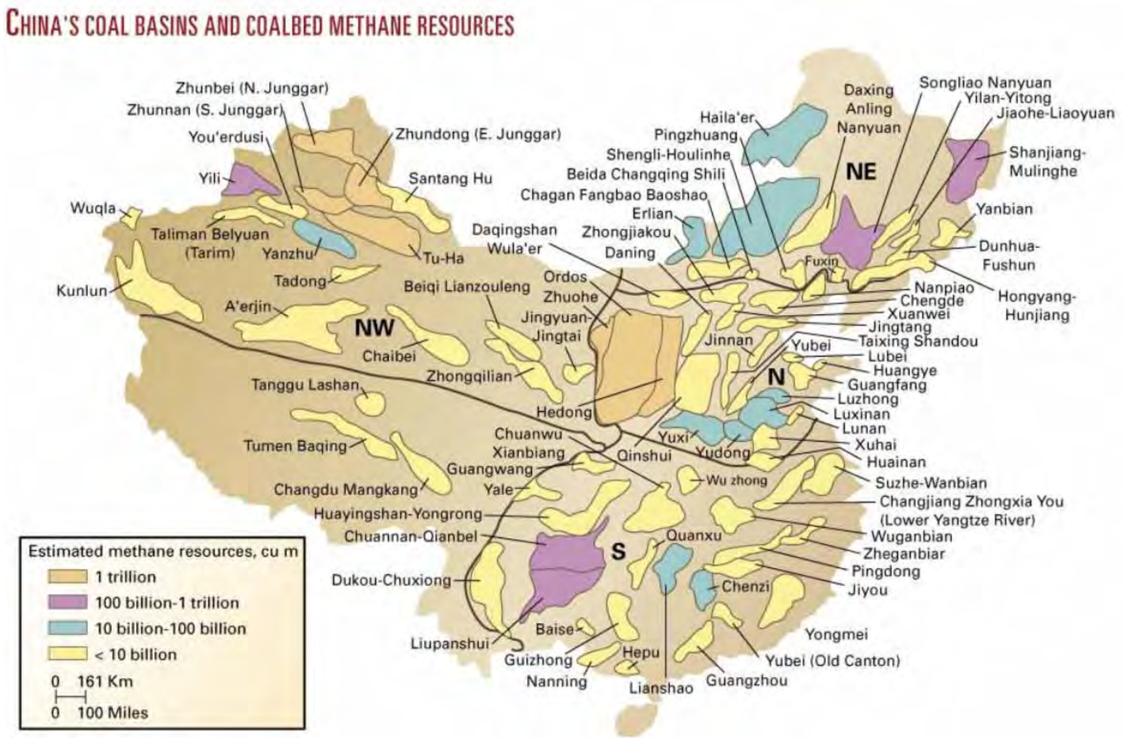
Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2005)*	62,200.4	52,300.3	114,500.7	3 (13.7%)
Annual Coal Production (2008)**	2,482.5	101.1	2,583.6	1 (39.17%)

Source: *EIA (2007c); **EIA (2009a) Note: Numbers may not add due to rounding

As shown in Figure 7-1, the following major coal basins are located in four regions of China (USEPA, 1996):

- Sanjuang-Mulinghe, Songliao, Donhua-Fushun, and Hongyang-Hunjiang basins in the Northeast;
- Taixing-Shandou, Qinshui, Daning, Ordos, Hedong, Yuxi, Xuhuai, and Huainan basins in the North;
- Chuannon-Qianbei, Huayingshan-Yongrong, and Liapanshui basins in the South; and
- Tarim, Qaidam, and Junggar basins in the Northwest.

Figure 7-1. China's Coal Fields



Source: Liu (2007)

7.1.2 STAKEHOLDERS

Table 7-2 identifies some of the key stakeholders for coal mine methane (CMM) project development in China.

Table 7-2. Key Stakeholders in China's CMM Industry

Stakeholder Category	Stakeholder	Role
Mining companies	Large coal groups, such as: ▪ Fushun Mining Group ▪ Hebi Coal Industry Group ▪ Huaibei Mining Group ▪ Huainan Mining Group ▪ Jincheng Anthracite Coal Group ▪ Panjiang Coal & Power Group ▪ Shuicheng Mining Group ▪ Songzao Coal & Power Group ▪ Tiefa Mining Group ▪ Yangquan Coal Group	Project hosts
Equipment manufacturers	▪ Shengli Power Machinery	Methane treatment and utilization equipment

Stakeholder Category	Stakeholder	Role
Developers	▪ China National Petroleum Corporation ▪ China United Coalbed Methane Corporation Ltd. ▪ CBM Exploitation and Development Company of the PetroChina Company Ltd. ▪ Lanyan CBM Company of the Jincheng Anthracite Coal Mining Group ▪ See also www.epa.gov/coalbed/networkcontacts.html	Project opportunity identification and planning
Engineering, consultancy, and related services	▪ China Coalbed Methane Clearinghouse, affiliated with the China Coal Information Institute ▪ Guizhou International Cooperation Center for Environmental Protection ▪ See also www.epa.gov/coalbed/networkcontacts.html	Technical assistance
Universities, Research Establishments	▪ China Coal Research Institute ▪ China University of Mining and Technology ▪ China University of Petroleum, Beijing ▪ China National Administration of Coal Geology ▪ China Coal Information Institute	Technical assistance
Regulatory Agencies and Government Groups	▪ National Development and Reform Commission ▪ National Institute for Occupational Safety ▪ State Administration of Coal Mine Safety, within State Administration of Work Safety ▪ China National Coal Association ▪ International Exchange Center of National Work Safety Administration	Project identification and assessment support

Source: M2M-China (2006); Huang (2007)

7.1.3 Status of Coal and the Coal Mining Industry

China is the world's leading producer of coal, producing more than 2.5 billion tonnes of coal in 2008 (Table 7-1). Coal is produced throughout China in 27 provinces. Northern China, especially Shanxi Province, contains most of China's easily accessible coal and virtually all of the large state-owned mines (EIA, 2009b).

China has a large number of coal mines but has been attempting consolidation. It is estimated that in the mid-1990s, there were nearly 100,000 coal mines in China (IEA, 2009). The majority of these mines belonged to villages and towns. In the last decade, China has implemented a program to close down underperforming or unsafe mines, especially town and village coal mines. For example, an initiative in Henan Province aims to close all mines with annual capacity below 150,000 tonnes (GLG, 2010). Shanxi Province is also closing a number of small mines, and Guizhou Province is closing 78 mines in 2010 (Steel News, 2010).

As of the end of 2009, there are 12,122 coal mines operating in China. Of these, 2,059 mines are owned by large, state-owned coal mine groups (known as "key coal mine groups"), accounting for 61.7 percent of total coal production. An additional 10,067 mines are operated by villages and towns (Guoquan, 2010). See Table 7-3 below.

Table 7-3. China's Mines by Category and Percent of Total Production (2004)

Mine Category	Number of Mines	% of Total Production
Local State-owned Key Coal Mine Groups	1,190	12
Other State-owned Key Coal Mine Groups	869	49.7
Mines Belonging to Villages and Towns	10,067	38.2

Source: Guoquan (2010)

Most coal mines in China are underground mines. In 1996, underground mining accounted for 95 percent of Chinese coal production (USEPA, 1996); more recently, underground mines produced about 90 percent of Chinese coal (Tu, 2007).

7.2 Overview of CMM Emissions and Development Potential

Large, state-owned coal mines dominate Chinese coal production and CMM emissions. About 46 percent of large, state-owned mines are considered gassy (Huang, 2008). Large, state-owned mines accounted for more than 86 percent of CMM emissions (2000), and produced 42 percent of total national coal production in 2004 (Zhang et al., 2004).

7.2.1 CMM Emissions from Operating Mines

Increasing numbers of Chinese mines are installing drainage (degasification) systems. By 2006, more than 300 mines had installed CMM drainage systems, which collectively removed more than 3.24 billion cubic meters (m^3) of CMM. Approximately 80 percent of all CMM drained was from key, state-owned coal mines (Huang, 2007). In 2009, China's CMM drainage volume nearly doubled, and reached 6.17 billion m^3. The volume of CMM recovered and used in 2009 exceeded 1.77 billion m^3, almost triple 2005 levels (Huang, 2010).

Table 7-4 shows historical data (where available) for CMM emissions, drainage, and utilization levels in China.

Table 7-4. China's CMM Emissions (million cubic meters)

Year	CMM Emissions	CMM Drainage	CMM Utilized
1987	6450		
1990	8830*		
1992	8320		
1993	8550		
1994	8950		
1995	8,900; 10,441*		
1996	9,280		
1997		760	
1998		740	361.78
1999		790	362
2000	9,630; 8,235*	870	318.4
2001		980	458.28

Year	CMM Emissions	CMM Drainage	CMM Utilized
2002	9,871	1,150	455.67
2003	11,674	1,521	629.21
2004	13,535	1,929	603
2005	9,500*		
2008			
2009		6,170**	1,770**
2010 (projected)	10,767*		

Source: M2M-China (2006); *USEPA (2006a); **Huang (2010)

In China, the main types of CMM use projects are town gas, electricity generation, industrial boiler fuel feed, vehicle fuel, and thermal applications (e.g., office space heating). Some Chinese CMM projects involve multiple end uses. As of 2009, China's CMM use projects utilized 1.72 billion m^3 of methane. CMM-to-power projects generated a total of more than 900 megawatts (MW) of power by the end of 2008. Additionally, approximately 4,000 vehicles operate on CMM as fuel (Huang, 2010).

As technology has advanced, the utilization efficiencies of CMM projects have also improved, increasing the size of individual projects (Huang, 2007).

The largest CMM power project in the world is at the Sihe Mine in Jincheng, Shanxi Province. This project uses Caterpillar engines to generate electricity at a 120-MW capacity power plant. The project utilizes 180 million m^3 of both coalbed methane (CBM) and CMM from the Sihe mine (USEPA, 2006b; Huang, 2008). The Sihe project avoids the release of 2.5 million tonnes of carbon dioxide equivalent ($MmtCO_2e$) annually (M2M, 2010).

Internal and external investments in Chinese projects are increasing, with involvement of companies such as China Shandong Shengdong, Jenbacher, and Deutz (Huang, 2007). Furthermore, use of CMM resources is being expanded for application in the chemical industry in China. For example, formaldehyde and carbon black are being produced using CMM in Fushun, Huainan, Zhongliangshan, Songzao, and Tianfu.

Information on individual CBM/CMM use projects in China can be found in the Global Methane Initiative (formerly Methane to Markets Partnership) International CMM Projects Database, which includes information on more than 200 current and planned CMM projects around the world (M2M Projects, 2010). The database includes 55 active or proposed CMM projects in China, all at active underground mines. Of these projects, four use CMM as boiler fuel; three provide methane for industrial use; 24 use CMM for power generation; 12 provide town gas; three provide vehicle fuel; and five are ventilation air methane (VAM) mitigation projects (M2M Projects, 2010).

China is host to the first VAM project approved by the United Nations Framework Convention on Climate Change (UNFCCC). The VAM abatement and energy recovery project was commissioned in October of 2008 in Zhengzhou and provides hot water for local use (Mattus, 2010). Annual emission reductions average 382 thousand tonnes of carbon dioxide equivalent ($MtCO_2e$) (UNFCCC, 2008). Additionally, at the Datong mine in Chongqing Municipality, a project is being developed that will be the largest VAM abatement system in the world. This system is expected to reduce greenhouse gas (GHG) emissions by up to 200,000 tons of CO_2e per year (CMOP, 2010). An additional four VAM projects are in development throughout China (M2M Projects, 2010).

The world's largest CMM to liquefied natural gas (LNG) plant was recently announced. Chongqing Energy Investment Group Corporation, Chongqing Songzao Coal and Electricity Co., Ltd. and Hong Kong and China Gas, a wholly owned subsidiary of ECO Environmental Investments Limited, signed a joint venture in Hong Kong for construction and operation of a CMM liquefaction project at the Songzao coal mines. This project is a result of a feasibility study funded by the U.S. Environmental Protection Agency. The project will be built in Songzao, Qijiang and will utilize 110 million m^3 of CMM annually. Construction of this project is expected to be completed in 2011 (CQEIG, 2009).

7.2.2 CMM Emissions from Abandoned Coal Mines

The China Coal Information Institute (CCII) established the Abandoned Mine Methane Project Advice Centre (AMMPAC) to advise and promote the country's abandoned mine methane (AMM) use (Sage, 2003). Information about this program is available at http://www.coalinfo.net.cn/cnuk/eprojects/05.htm.

The closing of state-owned coal mines and town and village coal mines that do not meet production and safety requirements has left a large number of abandoned mines throughout China. Hundreds of coal mines have been abandoned since the 1950s and abandoned reserves are estimated at more than 30 billion tonnes. To date, no AMM projects have been initiated in China.

The China Coal Research Institute has also studied AMM resources in China, focusing on detailed geological conditions, characteristics of AMM reservoirs, gob/goaf area and coal reserve estimation, ground water study and mine gas sampling, and AMM resource estimation.

7.2.3 CBM from Virgin Coal Seams

China's CBM resources contained in bituminous and anthracite coal deposits at depths between 300 and 2000 meters are estimated to be 36.8 trillion m^3 (Huang, 2010). Of these CBM resources, more than 68 percent are found in eastern China (CCII, 2005).

The total production of CBM has increased dramatically within the last decade. Total Chinese CBM production was estimated to be 1.4 billion m^3 in 2006, and almost 5 billion m^3 in 2008. The national production target for CBM is 10 billion m^3 by 2010 (Huang, 2007; EIA, 2009b; Merrill, 2007).

By the end of 2008, a total of 3,400 CBM wells had been drilled in China. Of these, 1,453 CBM wells were drilled by the Jincheng Anthracite Mining Group with a total production capacity of 600 million m^3. In 2009, CBM produced by this Mining Group alone reached 376 million m^3 (Huang, 2010).

Between 2011 and 2015, China National Petroleum Corp. (CNPC), China's largest oil and gas producer, plans to invest $1.14 billion between in drilling 371 horizontal wells in the Zhengzhuang, Qinnan, Mabi, and Xiadian blocks of the Qinshui Basin in Shanxi Province to increase annual production capacity by 1.9 billion m^3. CNPC estimates that its CBM output in Qinshui Basin will reach 2 billion m^3 in 2015 (China Coal Resource, 2010).

7.3 Opportunities and Challenges to Greater CMM Recovery and Use

China is a signatory to both the UNFCCC and the Kyoto Protocol (Table 7-5). As a Non-Annex I Party to the Kyoto Protocol, China is eligible to host GHG mitigation projects, such as CMM projects, under the Clean Development Mechanism (CDM). The CDM can create additional revenues for CMM projects in China through carbon credits trading. As of July 2010, China had 883 registered CDM projects. Of these, 27 are CMM projects. An additional 52 CMM projects are at various stages in the CDM pipeline, including 34 at validation (UNEP, 2010).

Table 7-5. China's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC	June 11, 1992	January 5, 1993
Kyoto Protocol	May 29, 1998	August 30, 2002

Source: UNFCCC (2010)

Though China has no emissions targets under the UNFCCC or Kyoto Protocol, China's government announced in November of 2009 that it would cut emissions of carbon relative to economic growth by 40 percent to 45 percent by 2020 compared with 2005 levels (Huang and Wu, 2010).

7.3.1 Market and Infrastructure Factors

China is implementing several efforts to promote CMM projects. The State Council, China's highest organ of State administration, allocated a fund of 3 billion Yuan in 2005 to support gas control projects in key state-owned mines, and established a CBM/CMM Engineering Research Center. The State Council has also mandated methane emission monitoring at 45 large, state-owned, gassy coal mines (Huang, 2005b). Furthermore, the Chinese government included the development of CBM in China's 11^{th} Five-Year Energy Development Plan (2005–2010) (CCII, 2005). End-use options for CMM projects include power generation, feedstock for chemicals industry (e.g., methanol, formaldehyde, carbon black, fertilizer), natural gas-fueled vehicles, and VAM used as part of mixed fuel for coal-fired boilers and gas turbines (Zhang et al., 2004).

Many organizations in China and abroad have financially sponsored the research and development of CMM projects (M2M-China, 2006). They include the China Coalbed Methane Clearinghouse of CCII, National Development and Reform Commission, State Administration of Coal Mine Safety (SACMS), U.S. Trade and Development Agency, World Bank, Asian Development Bank (ADB), Global Environment Fund, Clean Development Mechanism, and Japan Development Fund.

Relatively few of China's underground coal mines have installed degasification systems. Even where degasification systems have been installed, they have encountered challenging geologic conditions for which existing degasification technologies are often insufficient (Huang, 2005c).

Even where there are drainage systems in place, a number of challenges still impede effective recovery and use of methane from mine drainage systems. These barriers include small project sizes, unstable methane supplies, and the high capital cost of power generation projects.

Furthermore, China lacks an extensive natural gas pipeline infrastructure for gas delivery, so there is very limited access for CMM that is recovered and upgraded. Most of the mines in China are located in remote mountain areas, where the geology makes it difficult to construct long-distance pipelines to deliver the drained CMM to cities. The West-East (W2E) Natural Gas Pipeline began operating in October 2004, and has a capacity of 17 billion m^3 of natural gas, which is supplied to 10 provinces across China's Eastern and Western regions. However, only a few coal mining areas are close enough to the pipeline to have the possibility of accessing it for delivery of CMM.

A pipeline from Duanshi County to Qinshui County in Shanxi Province and to Boai County in Henan Province has been in construction since September 2009, and is estimated to be finished in 2010. The total investment for the project is approximately 458 million RMB (US$67.6 million) (Guoquan, 2010).

Further, PetroChina expanded the pipeline network by connecting four main pipelines – the W2E pipeline, the Shaanjing pipeline, the Zhongwu pipeline, and the Seninglan pipeline. PetroChina is also developing a CBM pipeline from Taiyuan to Yangquan to Shijiazhuang with a total length of 250 km and investment of 400 million RMB (US$59 million) (Guoquan, 2010).

The ADB also funded a local pipeline in the southern Qinshui basin to transport low-quality gas from mines to more central locations to increase the gas quality (e.g., methane concentration) by supplementing with higher-quality gas from other mines to meet PetroChina's pipeline quality specifications.

There is increasing interest in China in converting CMM to LNG. Low-temperature liquefaction reduces the volume of CMM by a factor of 625; a standard liquefied gas tanker can hold 21,000 m^3 of CMM. Cryogenic technologies used commercially in the United States provide liquefaction rates of 1,000 to 10,000 gallons per day. The Yangquan Coal Industry Group and the Cryogenics System Key Technology Group of the Technical Institute of Physics and Chemistry of the Chinese Academy of Sciences have been exploring the separation and liquefaction of CMM, and by July 2007, had shown success in concentrating the liquid to 99 percent (Huang, 2007). These efforts resulted in the D-O2TE process developed by the Dalian Institute of Chemical Physics with the Chinese Academy of Sciences. The process is described as oxygen-methane catalytic deoxidation technology and will be utilized at the upcoming CMM liquefaction project at the Songzao coal mines (Bloomberg, 2009; DNL, 2009).

7.3.2 Regulatory Information

In China, recovery and utilization of CMM can only be exercised by coal enterprises with legal mining licenses. CMM projects require approval from the National Development and Reform Commission (NDRC) at the county, provincial, and central government level, depending on the size and type of project. CMM power generation projects that are connected to the power grid must be approved by the investment administration of the provincial government. CMM projects generating power used only by the mining company must be recorded by the investment administration of the local government. The investment administration of provincial government shall report both approved and recorded projects to the investment administration of the State Council (NDRC, 2007).

A CBM or CMM pipeline project with the capacity to transport more than 500 million m^3 a year or crossing provincial boarders shall be approved by the investment administration of the State Council. A CBM or CMM pipeline project with capacity to transport less than 500 million m^3 a year shall be approved by the investment administration of the provincial government (GOSC, 2006).

China has established a number of financial incentives to encourage CMM projects.

- For example, no royalties are assessed on CMM consumed by projects developed by coal mine enterprises with approved mining licenses.
- Coal enterprises conducting CMM recovery and utilization projects with approved mining licenses receive preferential state policies on the resources tax, value-added tax (VAT), income tax of enterprises, and the tariff tax, as well as other benefits.
- China's Central Government provides 3 billion RMB for coal mine safety projects each year, most of which is used for mine gas recovery projects. Coal mines can collect 15–20 RMB per ton from coal sales to be applied to mine safety projects (Huang and Wu, 2010).
- On October 25, 2006, the Ministry of Finance, the State Administration of Taxation, and China Customs exempted import tariffs and VATs for CMM equipment, instruments, spare parts, and tools. Since January 1, 2007 the same bodies have implemented a "levy-first-refund-later" policy on CMM drainage and sales (Huang, 2007).

- Additionally, CMM projects may be eligible to deduct 50 percent of the cost of research on new technologies or processes before income tax (Huang and Wu, 2010).

The rights to exploration and development of CMM or CBM projects in China have been modified to be more inclusive. Initially, the China United Coalbed Methane Corporation (CUCBM) had the monopoly rights to CMM or CBM exploration, development, and production in cooperation with foreign firms. If a commercial CBM field was found, CUCBM and the foreign party would jointly establish an organization and conduct development and production. However, on September 24, 2007, the State Council modified the relevant regulations, "Regulations of the People's Republic of China on Exploitation of On-shore Petroleum Resources in Cooperation with Foreign Countries," to effectively eliminate the CUCBM monopoly. The law now includes the option for "other companies designated by the State Council" to join with foreign businesses in exploiting CMM resources (Huang, 2007). Alternatively, if a CMM development project is to be realized by foreign grants or free technical assistance (i.e., if the projects are non-profit and non-commercial in nature), it is not necessary to involve CUCBM (CBMC, 2004).

All CMM projects must conform to relevant environmental and safety regulations before operating. Projects should focus on waste water drainage, atmospheric pollution, and noise pollution. Energy use during the projects should be in accordance with the "Energy Conservation Law of the People's Republic of China" and the energy-saving regulations and measures of the state and local governments. The State Administration of Work Safety (SAWS) monitors worker safety in China. Laws and regulations such as the "Coal Mine Safety Regulation" should be followed when developing CMM exploitation and utilization projects.

The price structure in China favors use of CMM over natural gas, with the consumer price of CMM for civil and industrial consumption set far lower than that of natural gas (M2M-China, 2006). In 2004, the average price of natural gas for residential and commercial users in China was 1.6 Yuan/m^3 and the average price for industrial users was 1.9 Yuan/m^3. The wellhead gas price is about 1.3 Yuan/m^3 for 100 percent methane. As a further boost, in April 2007, the Ministry of Finance provided a subsidy of 0.2 Yuan/m^3 for CMM exploitation enterprises; the local finance departments are allowed discretion to increase their own subsidies based on this standard (Huang 2007; Guizhou, 2008).

Effective January 1, 2005, SAWS and SACMS released a Coal Mine Safety Regulation relevant to the CDM. Section 148 requires that in order for CMM projects to be registered as CDM projects, gas concentrations must be at least 30 percent methane. Many coal mines in China recover only low concentration gas (i.e., less than 30 percent methane concentration), the regulation and would therefore be unable to qualify for CDM projects (Guizhou, 2007).

7.4 Profiles of Individual Mines

Feasibility studies for CMM projects at a few Chinese mines, profiles of some individual mines in China, and descriptions of CMM project opportunities are available on the following websites:

Global Methane Iniative (formerly Methane to Markets Partnership):
http://www.methanetomarkets.org/projects/index.aspx
US EPA: http://www.epa.gov/cmop/resources/international.html
China Coal Information Institute: http://www.nios.com.cn/cbmproject.html

7.5 References

Bloomberg (2009): Chongqing Energy Investment Group and the ECO Environmental Investment to Build 91 Million Cubic Meters CBM Liquefaction Project in Chongqing, Bloomberg Business Week, December 3, 2009. http://investing.businessweek.com/research/stocks/private/snapshot.asp?privcapId=28718920

CCII (2005): CBM Resources in China. Transmitted via e-mail by China Coal Information Institute, May 2006.

China Coal Resource (2010): CNPC coalbed methane project in Shanxi sets production goals for 2020, China Coal Resource, April 28, 2010. http://en.sxcoal.com/NewsDetail.aspx?cateID=174&id=30504

CMBC (2004): Investment Guide for China CMM/CBM. China Coalbed Methane Clearinghouse, Beijing, China. http://www.epa.gov/cmop/docs/guildline3.doc

CMOP (2010): CBM Note - MEGTEC Systems to build world's largest coal mine ventilation methane emissions abatement system in China, June 10, 2010.

CQEIG (2009): Chongqing Energy cooperation with the Hong Kong and China Gas Company building the world's largest gas liquefaction project, Chongqing Energy Investment Group, December 4, 2009. http://www.cqenergy.com/nyxw/6010.htm

DNL (2009): Oxygen-methane catalytic oxygen technology (D-O2TE) identified by the results (Chinese), Dalian National Laboratory for Clean Energy, November 20, 2009. http://www.dnl.ac.cn/manage/kydt/20091120.asp

EIA (2007a): Data obtained from *International Energy Annual 2005*. U.S. Energy Information Administration, Washington, DC, tables posted September 21 and 17, 2007, respectively.
http://www.eia.doe.gov/pub/international/iealf/tablee1.xls (total consumption)
http://www.eia.doe.gov/pub/international/iealf/tablee4.xls (coal consumption)

EIA (2007b): Data obtained from *International Energy Annual 2005*. U.S. Energy Information Administration, Washington, DC, table posted September 17, 2007.
http://www.eia.doe.gov/emeu/international/RecentCoalSupplyDispositionBtu.xls

EIA (2007c): Data obtained from *International Energy Annual 2005*. U.S. Energy Information Administration, Washington, DC, table posted June 21, 2007. http://www.eia.doe.gov/pub/international/iea2005/table82.xls (reserves)

EIA (2009a): International Energy Statistics. U.S. Energy Information Administration, Independent Statistics and Analysis, 2009. http://tonto.eia.doe.gov/cfapps/ipdbproject/IEDIndex3.cfm

EIA (2009b): EIA Country Analysis Brief: China - Coal. U.S. Energy Information Administration, Washington, DC. July 2009. http://www.eia.doe.gov/emeu/cabs/China/Coal.html

EIA (2010): China Country Energy Profile, U.S. Energy Information Administration, Washington, DC, updated May 18, 2010. http://tonto.eia.doe.gov/country/country_energy_data.cfm?fips=CH

GLG (2010): China launching the second wave of coal industry consolidation in Henan, Gerson Lehrman Group, May 25, 2010. http://www.glgroup.com/News/China-launching-the-second-wave-of-coal-industry-consolidation-in-Henen-48616.html

GOSC (2006): On Accelerating CBM (CMM) Drainage and Utilization, Guo Fa Ban [2006] No. 47, General Office of State Council, June 15, 2006.

Guizhou (2007): The Insider, CMM Recovery and Utilization Initiative Guizhou Province, China, Autumn Issue, 2007. http://www.gzcmm.org/en/admin/web_edit/uploadfile/20071017174327765.pdf

Guizhou (2008): The Insider, CMM Recovery and Utilization Initiative Guizhou Province, China, Winter Issue, January 2008. http://www.gzcmm.org/Newsletter/Winter_2007_English.pdf

Guoquan (2010): Information provided via personal communication with Guoquan Zhao from China Coal Information Institute, July, 2010.

Huang (2005a): CMM Drainage and Utilization to Improve Coal Mine Safety in China, Huang Shengchu, presented at the 2005 International Workshop on CMM/VAM Recovery and Utilization, Chengdu, Sichuan Province, China, April 6–7, 2005.

Huang (2005b): Overview of Coal Mine Methane to Markets Partnership in China, Huang Shengchu, China Coal Information Institute & National Institute for Occupational Safety, presented at the Methane to Markets Regional Workshop, Beijing, China, December 2, 2005.

Huang (2005c): Potential of Developing Coal Mine Methane CDM Projects, Huang Shengchu, President, China Coal Information Institute & National Institute for Occupational Safety, October 21–23, 2005. http://cdm.ccchina.gov.cn/UpFile/File410.PDF

Huang (2007): Progress and Project Opportunities of the CMM Development and Utilization in China, Huang Shengchu, presented at the Methane to Markets Partnership Expo, Beijing, China, October 30 - November 1, 2007.

Huang (2008): Development and Utilization of Coal Mine Methane in China, Huang Shengchu, presented at the 9th International Symposium on CBM/CMM and Carbon Trading in China, Beijing, China, December 4, 2008.

Huang (2010): Great Potential for CBM/CMM Recovery and Utilization and Preferential Policies, Huang Shengchu, presented at the Methane to Markets Partnership Expo, New Delhi, India, March 3, 2010. http://www.methanetomarkets.org/expo/docs/postexpo/coal_shengchu.pdf

Huang and Wu (2010): Current Status and Policy from Works of Methane Emission Reduction in China, Huang Shengchu and Wu Jianmin, presented at the Methane to Markets Partnership Expo, New Delhi, India, March 3, 2010. http://www.methanetomarkets.org/expo/docs/postexpo/china_huang.pdf

Huang et al. (2005): New Development of CMM Projects in China, Huang Shengchu, Liu Wenge, Zhao Guoquan, Sun Qinggang, Liu Xin, and Dou Xiaodong, China Coal Information Institute & National Institute for Occupational Safety, presented at the 5th International Symposium on CBM.CMM in China, Beijing, China, November 30 - December 2, 2005.

IEA (2009): Coal Mine Methane in China: A Budding Asset with the Potential to Bloom, International Energy Agency, Paris, France, February, 2009. http://www.iea.org/papers/2009/china_cmm_report.pdf

Liu (2007): Case Study on CMM/CBM projects in China, Liu Wenge, China Coal Information Institute, presented at CMM Development in the Asia-Pacific Region: Perspectives and Potential, Brisbane, Australia 4–5 October 2006.

Merrill (2007): CBM - Another green solution (Industry Overview), David Yip and Joseph Jacobelli, Merrill Lynch, June 18, 2007. http://www.ml.com/media/79662.pdf

M2M (2010): Success Stories - China's Sihe Mine: Proving the Power of Coal Mine Methane Projects, Methane to Markets website, accessed July 6, 2010. http://www.methanetomarkets.org/successstories.aspx

M2M Projects (2010): Methane to Markets International Coal Mine Methane Projects Database, Methane to Markets, 2008. http://www2.ergweb.com/cmm/index.aspx

M2M-China (2006): Methane to Markets, 2006, China Profile. http://www.methanetomarkets.org/events/2006/coal/docs/china.pdf

NDRC (2007): A Notice on Using CBM (CMM) for Power Generation issued by National Development and Reform Commission (NDRC), Fagai Nengyuan [2007] No.721, April 2, 2007.

Ren (2004): Methane Extraction And Utilisation From Abandoned Coal Mines- China/UK Technology Transfer, T X Ren, and Wardell Armstrong, University of Nottingham, 2004. http://www.berr.gov.uk/files/file20542.pdf

Sage (2003): Reducing The Environmental Impacts Of Abandoned Coal Mines In China, P.W. Sage, D.P. Creedy, and Wardell Armstrong, Future Energy Solutions, 2003. http://www.coalinfo.net.cn/coalbed/meeting/2203/papers/coal-mining/CM015.pdf

Steel News (2010); Guizhou to close down 78 small coal mines, Steel News, June 7, 2010. http://www.steelorbis.com/steel-news/latest-news/guizhou-to-close-down-78-small-coal-mines-535917.htm

Sun and Liu (2006): Information provided by Sun Qinggang and Liu Wenge, CCII, 2006

Tu (2007): Coal Mining Safety: China's Achilles' Heel, Tu JianJun, China Security, Vol 3 No 2 pp. 36–53, 2007 World Security Institute. http://www.wsichina.org/cs6_3.pdf

UNEP (2010): CDM Pipeline Spreadsheet, UNEP Risoe Centre, July 1, 2010. http://cdmpipeline.org/

UNFCCC (2008): Zhengzhou Coal Industry (Group) Co., Ltd. Coalmine Methane Utilization Project PDD, Version 2.5, completed August 8, 2008. http://cdm.unfccc.int/UserManagement/FileStorage/ZG3RM2OP7D5LJVYKC8XB06WH1NIQ94

UNFCCC (2010): Ratification Status, accessed June 16, 2010. http://maindb.unfccc.int/public/country.pl?country=CN

USEPA (1996): Reducing Methane Emissions from Coal Mines in China: The Potential for Coalbed Methane Development, U.S. Environmental Protection Agency, Coalbed Methane Outreach Program, 1996. http://www.epa.gov/cmop/docs/int004.pdf

USEPA (2006a): *Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990–2020*, U.S. Environmental Protection Agency, Office of Atmospheric Programs, Climate Change Division, June 2006. http://www.epa.gov/nonco2/econ-inv/downloads/GlobalAnthroEmissionsReport.pdf (Appendix B-2)

USEPA (2006b): Power Plant to be Largest Run on Coal Mine Methane, Coalbed Methane Notes, U.S. Environmental Protection Agency, Coalbed Methane Outreach Program, May, 18, 2006. http://yosemite.epa.gov/opa/admpress.nsf/4d84d5d9a719de8c85257018005467c2/8ec89e33e48a863f852571720063e8d7!OpenDocument

Zhang et al. (2004): Potential for Development of CMM Projects in China, Zhang Binchuan, Huang Shengchu, Hu Yuhong, Liu Wenge, and Liu Xin, 2004, China Coal Information Institute, 2004. http://cdm.ccchina.gov.cn/english/UpFile/File6.DOC

8 COLOMBIA

8.1 Summary of Coal Industry

8.1.1 ROLE OF COAL IN COLOMBIA

Coal accounted for 8 percent of Colombia's energy consumption in 2007 and one-fourth of total exports in terms of revenue in 2009 (EIA, 2010a). Production trends indicate that coal could become the country's largest export product (M2M-Colombia, 2005). Colombia is the fourth largest world coal exporter, behind Australia, Indonesia and Russia, and provides 6.9 percent of the world's coal exports (EIA, 2010b). It exports 97 percent of its domestically produced coal, primarily to the United States, the European Union, and Latin America (EIA, 2010a).

Colombia had 6,814 million tonnes (Mmt) of proven recoverable coal reserves in 2009, consisting mainly of high-quality bituminous coal and a small amount of metallurgical coal (Table 8-1). The country has the second largest coal reserves in South America, behind Brazil, with most of those reserves concentrated in the Guajira peninsula in the north (on the country's Caribbean coast) and the Andean foothills (EIA, 2010a). Its reserves of high-quality bituminous coal are the largest in Latin America (M2M-Colombia, 2005).

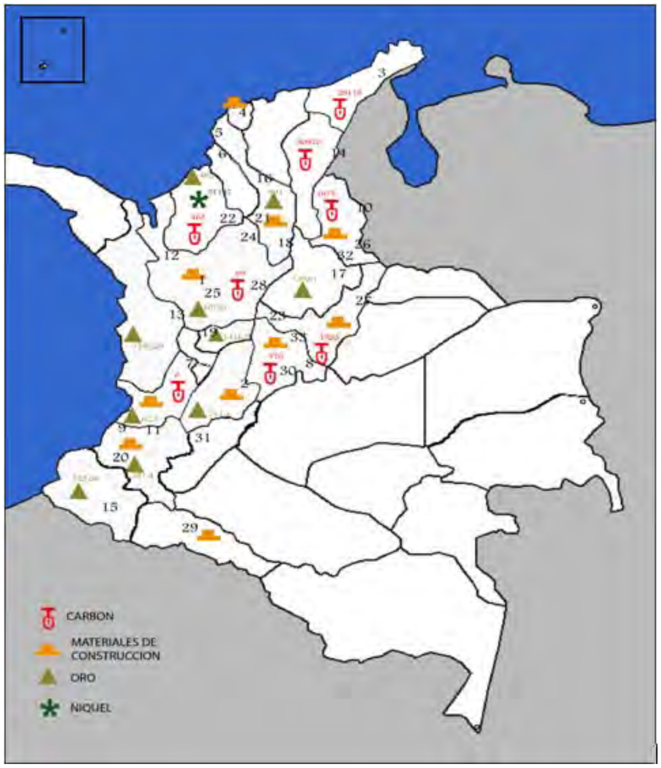
Table 8-1. Colombia's Coal Reserves and Production

Indicator	**Anthracite & Bituminous** (million tonnes)	**Sub-bituminous & Lignite** (million tonnes)	**Total** (million tonnes)	**Global Rank** (# and %)
Estimated Proved Coal Reserves (2009)*	6,434	380.0	6,814.0	11 (0.8%)
Annual Coal Production (2009)	72.1	0	72.1	12 (1.4%)

Source: BP (2010)

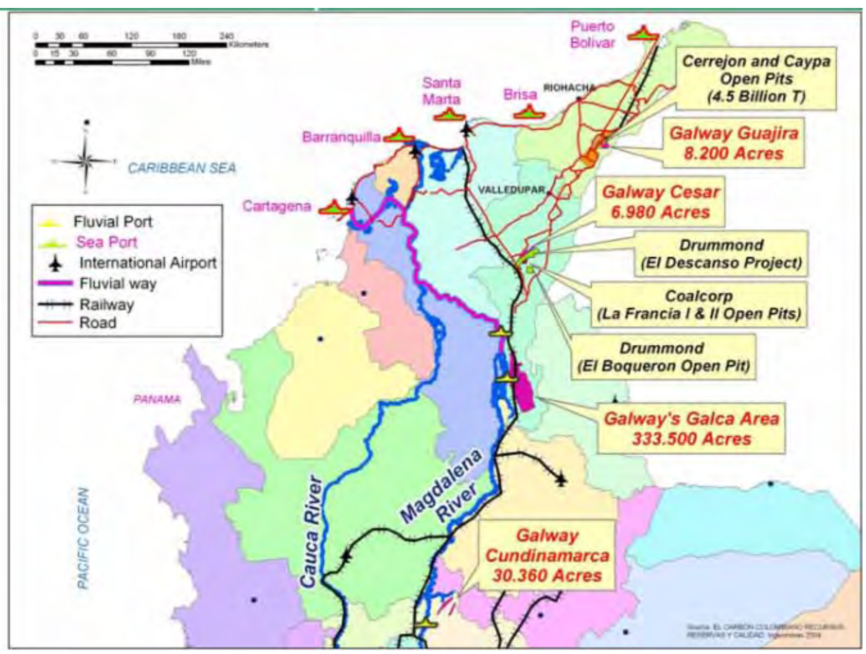
Coal production for export occurs mainly in the northern states of Guajira (Cerrejón deposit) and Cesar, and in Cordoba, but there also are widespread small and medium-size coal producers in Norte de Santander (metallurgical coal), Cordoba, Santander, Antioquia, Cundinamarca, Boyaca, Valle del Cauca, Cauca, Borde Llanero, and Llanura Amazónica (MB, 2005; M2M-Colombia, 2005). Figures 8-1 and 8-2 illustrate the locations of coal deposits and mines in Colombia.

Figure 8-1. Map of Colombian Minerals



Source: ANDI (2010)

Figure 8-2. Map of Colombian Coal Mines



Source: Galway (2007a)

8.1.2 Stakeholders

Table 8-2 lists potential stakeholders in Colombia's coal mine methane (CMM) industry.

Table 8-2. Key Stakeholders in Colombia's CMM Industry

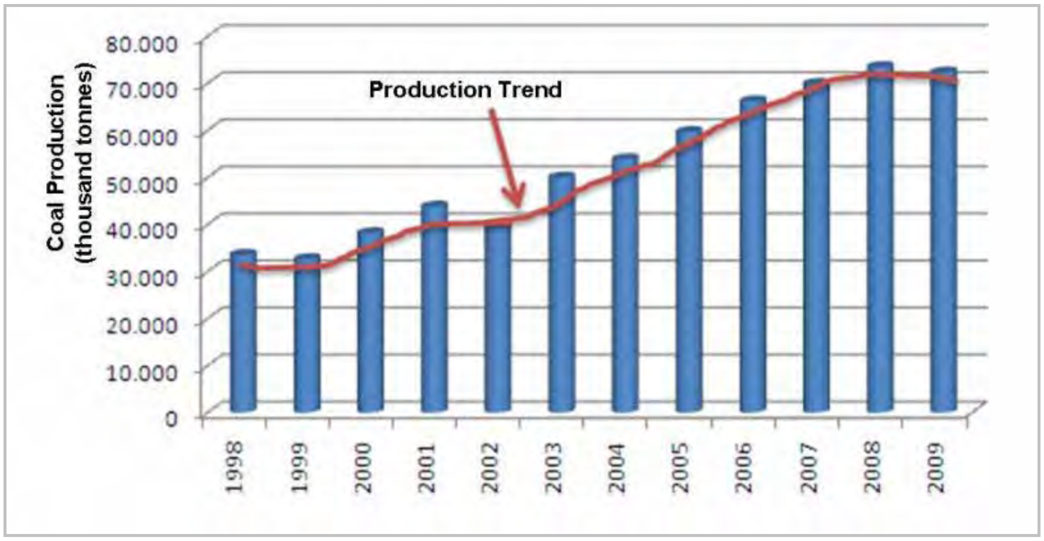
Stakeholder Category	Stakeholder	Role
Mining Companies	▪ Prodeco (owned by Xstrata) ▪ Carbones de La Jagua (owned by Glencore) ▪ Cerrejón Coal Company (joint venture of Anglo American [AA], BHP Billiton [BHB], and Xstrata) ▪ AA ▪ BHB ▪ Glencore International ▪ Vale SA ▪ Carbones del Cerrejón LLC ▪ C.I. Prodeco S.A. ▪ Carbones de La Jagua S.A. ▪ CoalCorp ▪ Drummond Ltd. ▪ Acerías Paz del Río, S.A.	Project hosts
Equipment Manufacturers	▪ Wood Group Power Solutions, Inc. (part of the Gas Turbine Services Division of John Wood Group PLC ▪ GE Transportation Systems – Electric drive systems (loaders and haulage) ▪ Goulds Pumps – Slurry and process pumps (pumps, compressors, valves and actuators) ▪ Grindex – Submersible drainage, sludge and slurry pumps (pumps, compressors, valves and actuators) ▪ Hansen Transmissions – Gear units and power transmission products (power supply, engines, transmission and drives) ▪ Voith Turbo GmbH & Co. KG – Start-up components (power supply, engines, transmission and drives)	Methane treatment and utilization equipment
Developers	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Project opportunity identification and planning
Engineering, Consultancy, and Related Services	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Technical assistance
Natural Gas Transmission & Distribution Companies; Power Companies	▪ Andina Electrica ▪ Gas Natural Fenosa	Pipeline sales for power generation
Natural Gas Production and Transport	▪ Chevron ▪ Ecopetrol	
Universities; research facilities	▪ Colombia National University – Mining Department ▪ Colombia Institute of Geology and Mining	
Government Groups	▪ Ministry of Mines and Energy ▪ National Agency of Hydrocarbons (ANH) ▪ Energy and Gas Regulatory Commission (CREG)	Regulation and policymaking

Source: MT (2007)

8.1.3 STATUS OF COAL AND THE COAL MINING INDUSTRY

Colombia's coal production has been steadily rising, and over the past decade, has more than doubled from 32.8 Mmt in 1999 to more than 72 Mmt in 2009, as shown in Figure 8-3. The 2009 global recession led to a production decrease for the first time since 2002, but it is expected that Colombia's coal production will continue to increase in coming years as exploration and profitable developments continue throughout the north and interior of the country. Colombia is recognized for its vast, high grade coal resources along with its highly motivated and skilled labor force.

Figure 8-3. Colombia Historical Coal Production



Source: ANDI (2010); BP (2010)

Colombian coal mines are privately owned. Tables 8-3 and 8-4 list available specifics on Colombia's coal mining companies as of 2009. The Cerrejón Coal Company operates the Cerrejon Zona Norte Project, the largest coal mining operation in Latin America. It consists of three shareholding entities: Anglo-American, BHP Billiton, and Xstrata (leased from Glencore, which in turn purchased ExxonMobil's 50 percent stake in 2001). The open pit mine produces 28.4 Mmt per year (2006) and plans to increase production up to 50 Mmt per year are being considered, owing to the $1 billion investment by Carbones del Cerrejon (MT, 2007).

The country's second largest coal mine, La Loma, is a mine-railway-port project operated by Drummond, which produced 21.7 Mmt in 2009 (Drummond, 2010). In 2008, Colombia gave Drummond permission to open the El Descanso Mine, which is expected to produce 6 Mmt in 2010 (Fox Business, 2010). Also in 2008, Galway began drilling exploration in the Carboluis project in San Luis Coal basin located in Santander, Colombia—an area with some 300 Mmt of coal (Galway, 2007b)—but the company has put that project on hold while it looks for equity partners (Union, 2010).

Colombia's coal is relatively clean-burning, with a sulfur content of less than 1 percent.

Table 8-3. Major Colombian Coal Producing Companies\Regions

Mine	Production in 2009 (million tonnes)
Cerrejón Coal Company	30.2
Drummond	20.6
Prodeco	10.2
Otros	3.8
Boyacá	2.2
Cundinamarca	2.4
Norte de Santander	2.0
Total	72.3

Source: ANDI (2010)

Table 8-4. Major Colombian Coal Mines

Mine	Type	Location	Owner	Production (million tonnes/ year)	Mineable Reserves (million tonnes)
Cerrejón Zona Norte	surface	La Guajira	Cerrejón Coal Company	28.4 (2006)	1,600
Carbones del Cerrejón	surface	-	-	-	-
EI Cerrejón Corte	surface	-	-	-	-
Mina Pribbenow /La Loma	surface	Cesar	Drummond	21.7 (2009)	485
El Descanso	surface	Cesar	Drummond	6 (2010)	960
El Hatillo	surface	Cesar	Vale S.A.	1.8 (2008)	500
Calenturitas	surface	Cesar	Glencore/Prodeco	5.0 (2005) 3.7 (2009)	
La Jagua	surface	Cesar	Glencore/Prodeco	8.5 (2003) 4.4 (2009)	260
La Jagua	underground	Cesar	Glencore/Prodeco	0.9 (1994)	(closed)
GALCA	exploratory	Cesar	Galway/Prodeco	exploratory	60–200
La Francia	surface	Cesar	Goldman Sachs (from CoalCorp Mining)	1.5	
Caypa	surface	Cesar	Carbones Colombianos del Cerrejon /CoalCorp Mining	0.175 (2007)	8.8
Río de Oro		Norte de Santander	Geominas		60–320
Paz del Río		Boyaca	Acerías Paz del Río S.A.	0.6 (2005)	
Puerto Libertador	surface	Cordoba			

Source: Jahnig (2007); USGS (2008); ANDI (2010); Mining Weekly (2008); Mining Weekly (2010); MB (2005)

8.2 Overview of CMM Emissions and Development Potential

8.2.1 CMM Emissions from Operating Mines

The current potential for CMM projects in Colombia is limited as more than 90 percent of coal production is surface mined and most underground mines are relatively small. The mining department at Colombia's National University estimates there are 3,000 underground mines in Colombia that produce 6 thousand tonnes (Mt) of coal per year for the domestic market (MAC, 2010). These mines are not well regulated and have only basic ventilation systems and no methane drainage systems in place. Mining depths can be greater than 600 meters (m) and mines appear to be dangerously gassy as evidenced by the many methane explosions reported at underground mines back to the 1970s.

A methane gas build-up is believed to be the cause of the June 2010 explosion at the San Fernando mine in the town of Amaga, south of Medellin in Antioquia province that resulted in the deaths of 73 miners. The mine produces 240,000 tonnes a year of thermal coal from depths greater than 800 m (MAC, 2010). Amaga is also the site of a 1977 explosion which killed 86 people, while nine miners died in an explosion at a mine in the same province in 2009. Mine explosions have claimed 71 lives in Colombia from 2004 to 2009, according to emergency-management officials.

A pilot project to measure methane emissions is underway at the La Loma/Pribbenow Mine, operated by U.S.-based Drummond Company, Inc., one of the largest coal producers in Colombia. Located near La Loma in Cesar Departamento; the mine has estimated reserves in excess of 534 Mmt of high-Btu, low-ash and low-sulfur coal. There have been no published results although the project was confirmed by a general engineer at Drummond Inc., USA.

Table 8-5 shows Colombia's estimated CMM emissions.

Table 8-5. Colombia's CMM Emissions (million cubic meters)

Emission Category	1990	1995	2000	2005	2010 (estimated)	2015 (projected)
Total emitted (= Total liberated – recovered & used)	130	139	207	241	282	328

Source: USEPA (2006)

8.2.2 CMM Emissions from Abandoned Coal Mines

No data on CMM from abandoned mines are available for Colombia at this time.

8.2.3 CBM from Virgin Coal Seams

Colombian coalbed methane (CBM) assessments put potential reserves in the range of 85–480 billion m^3. Potential major CBM basins are the Bogota, Cauca, Catatumbo, Llanos, Middle Magdelena, and Cauca River basins. (Correa et al., 2009)

A CBM test well, considered the first in South America, was drilled to a depth of 910 m in the Cerrejon coal field in north-east Colombia in 1996. Desorbed gas contents ranged from 5 cubic meters (m^3) per tonne at 200 m deep, to 12 m^3 per tonne at 550 m (Schwochow, 1997).

In October 2004, the Drummond Company announced that it would begin drilling for CBM at its properties in the country. While most of the gas will fuel power generation at its facilities, Drummond also planned to sell any surpluses on the open market. Drummond estimates that there are 62.2 billion m^3

(2.2 trillion cubic feet) of methane in its mines and it has signed a contract with Ecopetrol to extract CBM from the La Loma and El Descanso mines (EIA, 2010a).

8.3 Opportunities and Challenges to Greater CMM Recovery and Use

Colombia has signed and ratified the UNFCCC and Kyoto Protocol, as indicated in Table 8-6. As a Non-Annex I Party to the Kyoto Protocol, Colombia has no national emissions targets and is eligible to host mitigation projects under the Clean Development Mechanism. Therefore, Colombia is eligible to secure project revenues from the sale of greenhouse gas (GHG) emission reduction credits.

Table 8-6. Colombia's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC*	June 13, 1992	March 22, 1995
Kyoto Protocol**	---	November 30, 2001

Source: *UNFCCC (2010a); **UNFCCC (2010b)

8.3.1 Market and Infrastructure Factors

Colombia has enjoyed a boom in energy and mining investment over the past 5 years as the government has driven back rebels who once controlled large parts of the country and targeted oil pipelines as part of a long running insurgency (MAC, 2010). Although there is ongoing civil conflict with guerrillas and paramilitary organizations, the government has reestablished its presence in all of the country's 1,099 municipalities. Attacks by insurgents against rural towns decreased by 91 percent from 2002 to 2005 and attacks on the country's infrastructure dropped by 60 percent between 2002 and 2006 (Haynesboone, 2008).

The natural gas market in Colombia has grown rapidly as the government has increasingly encouraged gas use as part of its energy diversification policy. The main gas consumer is heavy industry followed by electricity generation, residential use, and conversion to CNG for vehicle use. Gas use as a percentage of overall energy use has risen from 6.8 percent in 1998 to 16.8 percent in 2007 (Diaz, 2009).

ECOGAS was formed in 1997 to develop and operate more than 3,600 km of natural gas trunk pipelines in Colombia. Three main lines form the back bone of the transmission network: one links the gas fields on the north-east coast to the central Colombia area; another links Bogota to the transmission network; and the third transports gas through the western Andean foothills. ECOGAS was privatized in 2006 and Transportadora de Gas Internacional (TGI) and Promigas are now the two largest pipeline operators carrying 95 percent of volumes. Six other small private firms operate the remaining small stretches of the system (EIA, 2010a; Diaz, 2009).

8.3.2 Regulatory Information

The key governmental body involved in the energy sector in Colombia is the Ministry of Mines and Energy, which is responsible for the overall policy making and supervision of the electricity sector in Colombia. It regulates generation, transmission, trading, interconnection, and distribution, and approves generation and transmission programs. The ministry delegates supervisory authority over the electricity sector to a number of its agencies, specifically Comisión Reguladora de Energía y Gas (CREG) and Unidad de Planeación Minero Energética (the Union of Mineral and Energy Planning). CREG regulates the transportation and distribution of electric power and gas and adjusts policies and procedures by which these services can reach consumers and allow market competition between providers (DOE, 2005).

The National Hydrocarbons Agency (ANH) was created in 1999 to administer and integrate the country's hydrocarbon reserves. It had the effect of generating a higher level of confidence in Colombia's hydrocarbon potential as an attractive investment target (Diaz, 2008). ANH grants exploration and exploitation rights to private entities and provides overall management of Colombia's hydrocarbon reserves.

In 1997, the National Counsel of Social and Economic Policies approved the "Strategies for Strengthening the Colombian Mining Sector," which favored modernization of the sector. As a result, the Code of Mines clarified the State's role as resource manager, regulator, and controller of coal exploitation; included the concept of sustainable development in the coal mining industry; and provided greater clarity with respect to contractual issues. Decentralization of the mining industry resulted in the creation of governing bodies, which were assigned certain functions of the mining authority.

8.4 Profiles of Individual Mines

No profiles of underground mines are available for Colombia at this time. See Table 8.4 for details of the major surface mines.

8.5 References

ANDI (2010): Colombia Mining Outlook, Asociación Nacional De Empresarios De Colombia, April 2010. http://www.andi.com.co/downloadfile.aspx?Id=b4aa8a65-ab0c-4c81-b38e-29908a2304a0

AP (2010): 70 Feared Dead in Colombia Coal Mine Explosion. Associate Press, June 2010. Accessed August 2010, http://www.cbsnews.com/stories/2010/06/18/world/main6594431.shtml

BP (2010): BP Statistical Review of World Energy - June 2010. Accessed August, 2010. http://www.bp.com/subsection.do?categoryId=9023763&contentId=7044548

Correa et al (2009): Unconventional Gas Reservoirs. Correa Gutierrez, T.F., Osorio, N. and Restrepo Restrepo, D.P., 2009. Energética, Num 41, Dec-Jul 2009, pp. 61–72. Universidad Nacional de Colombia, Colombia.

Diaz (2009): Natural Gas in Colombia. Diaz, D.A.F., 2009. Technische Universitat Berlin.

DOE (2005): Energy Overview of Colombia, website accessed March 21, 2008. http://www.geni.org/globalenergy/library/national_energy_grid/colombia/EnergyOverviewofColombia.shtml

Drummond (2010): Coal Operations – Colombia, Drummond Company Inc., 2010. http://www.drummondco.com/operations/coal/Colombia.aspx

EIA (2008): International Energy Annual 2006, Department of Energy, Energy Information Agency, December 2008. http://www.eia.doe.gov/emeu/iea/contents.html

EIA (2009): Country Analysis Briefs – Colombia, Energy Information Administration, May 2009. http://www.eoearth.org/article/Energy_profile_of_Colombia

EIA (2010a): Country Analysis Briefs – Colombia, Energy Information Administration, Washington, DC, March 2010. http://www.eia.doe.gov/cabs/Colombia/Coal.html

EIA (2010b): International Energy Statistics – Total Coal Exports, U.S. Energy Information Administration, Washington, DC, accessed June 30, 2010. http://tonto.eia.doe.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=1&pid=1&aid=4

Fox Business (2010): UPDATE: Drummond To Produce 24 Million Tons Coal In Colombia In ‘10, Fox Business.com, June 25, 2010. http://www.foxbusiness.com/story/markets/commodities/update-drummond-produce--million-tons-coal-colombia/

Galway (2007a): Galway Resources Announces A New Colombian Exploration Initiative, Galway Resources, December 18, 2007. http://www.galwayresources.com/i/common/slide_2.jpg

Galway (2007b): Carboluis, Galway Resources, 2007. http://www.galwayresources.com/s/Carboluis.asp

Haynesboone (2008): The Oil & Gas Industry in Colombia and the Ecopetrol Partial Privatization. Presentation to the Dallas Bar Association – International Law Section, March 2008 by Hayne and Boone LLP and Francisco Reyes & Asociados.

Jahnig (2007): Coal Deposits of Colombia, Freiberg University of Mining and Technology, 2007. http://www.geo.tu-freiberg.de/oberseminar/os07_08/andrea_j%E4hnig.pdf

M2M-Colombia (2005): Methane to Markets – Colombia Profile, Coal Mine Technical Subcommittee Meeting, 27–28 April 2005. http://www.methanetomarkets.org/documents/partners_colombia_coal_update.pdf

MapsOfWorld (2010): Colombia Mineral Map, MapsOfWorld.com, 2010. http://www.mapsofworld.com/colombia/colombia-mineral-map.html

MAC (2010): Colombia: 73 workers die in coal mine blast. Mine and Communities website, June 2010 http://www.minesandcommunities.org//article.php?a=10196&highlight=colombia

MB (2005): Coal Mining in Colombia, MBendi Information Services, January 2005. http://www.mbendi.com/indy/ming/coal/sa/cb/p0005.htm

Mining Top News (2008): Galway options Colombian Coal project; drilling on project to commence shortly, Mining Top News, October 31, 2008. http://www.miningtopnews.com/galway-options-colombian-coal-project-drilling-on-project-to-commence-shortly.html

Mining Weekly (2008): Vale Buys Colombia Coal Assets, MiningWeekly.com, December 24, 2008. http://www.miningweekly.com/article/vale-buys-colombia-coal-assets-2008-12-24

Mining Weekly (2010): Glencore to Buy Back Colombia Coal Mine from Xstrata, MiningWeekly.com, March 5, 2010. http://www.miningweekly.com/article/glencore-to-buy-back-colombia-coal-mine-from-xstrata-2010-03-05

MT (2007): El Cerrejon Norte Coal Mine, Colombia, Mining Technology, website accessed July 1, 2010. http://www.mining-technology.com/projects/cerrejon

Schwochow (1997): The International Coal Seam Gas Report, Cairn Point Publishing, Steve Schwochow, editor. 1997.

USEPA (2006): *Global Anthropogenic Non-*CO_2 *Greenhouse Gas Emissions: 1990–2020*, U.S. Environmental Protection Agency, Office of Atmospheric Programs, Climate Change Division, June 2006. http://www.epa.gov/climatechange/economics/downloads/GlobalAnthroEmissionsReport.pdf

UNFCCC (2010a): United Nations Framework Convention on Climate Change - Status of Ratification, accessed June 28, 2010. http://unfccc.int/essential_background/convention/status_of_ratification/items/2631.php

UNFCCC (2010b): Kyoto Protocol - Status of Ratification, accessed June 28, 2010. http://unfccc.int/kyoto_protocol/status_of_ratification/items/2613.php

Union (2010): Colombia – Renewing the Search for Eldorado, Union Securities, April 30, 2010. http://www.union-securities.com/CMResearchFiles/1_96_Colombia%20Report.pdf

USGS (2008): Minerals Yearbook – Colombia, U.S. Geological Survey, 2005–2008, 2008. http://minerals.usgs.gov/minerals/pubs/country/sa.html#co

9 CZECH REPUBLIC

9.1 Summary of Coal Industry

9.1.1 ROLE OF COAL IN THE CZECH REPUBLIC

The Czech Republic domestically provided for 1.154 Quad of its total energy consumption of 1.808 Quad in 2006 (EIA, 2010). Coal comprises 45.1 percent of the country's indigenous energy supplies (IEA, 2009). The Czech Republic ranks 14th globally in coal production, producing 62.6 million tonnes (Mmt) of coal in 2007. Its total recoverable coal reserves are estimated at approximately 4.5 billion tonnes (see Table 9-1).

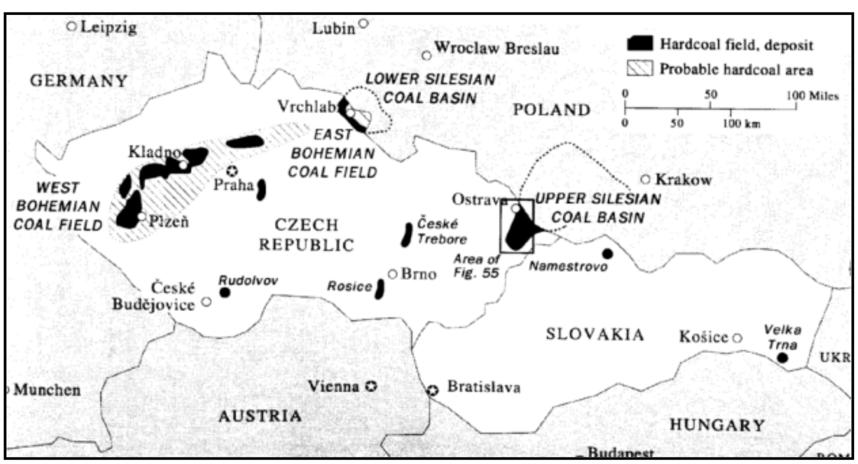
Table 9-1. The Czech Republic's Coal Reserves and Production

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2006)*	1,673	2,828	4,501	14 (0.6%)
Annual Coal Production (2007)**	7.67	55.0	62.6	14 (1.0%)

Source: *EIA (2006); **IEA (2007)

Hard coal occurs mainly in the eastern Silesian region, with the Ostrava-Karviná district (OKR) in the Upper Silesian Coal Basin being the most important black coal field in the country. Brown coal (lignite) is found mostly in the northwest Bohemian Basin (Fossil Energy, 2003). Other coal basins include the Lower Silesian coal basin (Zacler coal field) and the East Bohemian Coal Field (Kladno district) (Schwochow, 1997). The Republic is a net exporter of coal with mainly Slovakia, Austria, Hungary, and Poland as its customers for coking coal for the iron and steel industries, and Germany, Austria, and Slovakia for steam coal (IEA, 2005). See Figure 9-1 for locations of coal deposits.

Figure 9-1. Coal Basins of the Czech Republic



Source: Schwochow (1997)

9.1.2 STAKEHOLDERS

Table 9-2 lists potential coal mine methane (CMM) development stakeholders in the Czech Republic.

Table 9-2. Key Stakeholders in the Czech Republic's CMM Industry

Stakeholder Category	Stakeholder	Role
Mining companies	▪ Ostravsko-Karvinske Doly ▪ Mostecka Uhelna Spolecnost ▪ Severoceske Doly a.s. ▪ Litvinovska Uhelna a.s. ▪ Sokolovska Uhelna a.s. ▪ Dul Koh-i-noor a.s. ▪ Lignit Hodonin s.r.o.	Project hosts
Energy Companies	▪ Green Gas DPB ▪ GPO, Inc. ▪ Energie Kladno ▪ Unigeo a.s. ▪ CEZ Group ▪ Czech Power Company	CMM project identification and investment
Engineering, Consultancy, and Related Services	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Technical assistance
Developers	▪ Essar Global ▪ See http://www.epa.gov/coalbed/networkcontacts.html	Project opportunity identification and planning
Natural Gas Transmission & Distribution Companies	▪ RWE TransGas ▪ RWE TransGas Net ▪ Moravske Naftove Doly	Gas storage and trade Gas transmission Gas production and storage
Regulatory Agencies and Government Groups	▪ Ministry of the Environment ▪ Ministry for Regional Development ▪ Ministry of Industry and Trade ▪ Energy Regulatory Office	Regulation, licensing, and permitting

Source: USEPA (1998), IEA (2005), Euracoal (2010)

9.1.3 STATUS OF COAL AND THE COAL MINING INDUSTRY

Table 9-3 characterizes Czech coal mining, stating production tonnage for each mine type.

Table 9-3. The Czech Republic's Coal Mines and Coal Production

Type of Mine	Production (million tonnes)	Number of Mines
Underground (active) mines – total	14.7 (2003) *13.8	7 (2003) *7
Surface (active) mines – total	48.9 (2003) *49–50	7 (2003) *~8

Source: IEA (2005); *Combined from OKD (2008) and Euracoal (2007)

The country extracts all bituminous coal through underground mining, using the longwall method, primarily in the Upper Silesian Basin (USGS, 1994), commonly referred to as the Ostrava-Karviná coalfields or OKR (see Figure 9-2). Lignite comprises less than 1 percent of the total coal produced, most of which (90 percent) is extracted through surface mining.

Figure 9-2. The Czech Republic's Coal Infrastructure

Source: IEA (2001)

In 2003, the Czech coal industry was consolidated under seven companies (IEA, 2005). The following two were engaged in hard coal mining:

- Ostravsko-Karvinske Doly – operates five underground mines, producing 12.8 Mmt annually (OKD, 2008).
- Ceskomoravske Doly – operated one underground mine, producing 2.3 Mmt in 2003; mine was closed and the site was taken over by the state in 2004 (www.mpo.cz/dokument15047.html).

The remaining five companies mined lignite:

- Mostecka Uhelna Spolecnost – operated three surface mines, producing 16 Mmt of brown coal in 2003; two surface mines produced 14.6 Mmt in 2007, and one underground mine produced 0.5 Mmt in 2007.
- Severoceske Doly – operated two surface mines, producing 22.8 Mmt of brown coal in 2003; two surface mines produced 23.8 Mmt in 2007.
- Sokolovska Uhelna – operated two surface mines and one lignite gasification plant that produced 10.1 Mmt in 2003 (Fossil Energy, 2003; BERR/DTI, 2004); the two surface mines produced 10.3 Mmt in 2007 (Euracoal, 2010).
- Důl Koh-i-noor, a.s. – operated one underground mine, producing 0.5 Mmt in 2003; mine was closed and the site was taken over by the state in 2004 (www.mpo.cz/dokument15047.html).
- Lignit Hodonín s.r.o. – operated one underground mine in Hodonin, producing 0.5 Mmt of lignite in 2003; it produced 0.5 Mmt in 2007.

The Czech Republic's accession to the European Union (EU) has driven several structural reforms for the country's energy industry, beginning in 1999. Its coal mining industry was restructured with all mines being part of joint-stock companies (i.e., initially partially government owned). By 2003, five of the seven operating coal companies had been privatized. Government interests in the two remaining companies, Severoceske Doly and Sokolovska Uhelna, were 55.4 percent and 50 percent, respectively (IEA, 2005). The government stake in Sokoloyska Uhelna was sold to Sokolovska tezebni in 2004 (Radio, 2004), and Severoceske Doly was sold to Czech Power Company in October 2005 (SEC, 2005). By 2006, the only remaining hard coal company was Ostravsko-Karvinske Doly with its five mines producing 12.8 Mmt annually (European Economics, 2006).

Further, in an effort to align itself with the EU market standards, the country reduced its reliance on coal from 54 percent of total primary energy consumption in 1993 to a low of 32 percent in 2004, but then returned to 39 percent in 2008 (EIA, 2010). The availability of cheap coal imports is also contributing to the decline of the Czech domestic coal production.

9.2 Overview of CMM Emissions and Development Potential

The Global Methane Initiative (formerly Methane to Markets Partnership) International CMM Projects Database identifies one CMM project in place in an active underground mine in the Upper Silesian Basin. The methane is injected into a gas pipeline for delivery, using 77 million cubic meters (m^3) of CMM and 32 million m^3 of abandoned mine methane (AMM)—avoiding a total of approximately 1.56 million tonnes of carbon dioxide equivalent ($MmtCO_2e$) of emissions (M2M Projects, 2008).

9.2.1 CMM Emissions from Operating Mines

The Czech Republic has been utilizing CMM for more than a century from both active and abandoned black coal mines of the OKR region, the country's largest coalfield and the most important site for mine gas production. Gas drainage plants have been used to mitigate explosion hazards since the mid-19th century. It is estimated that the country uses about 100 million m^3 of CMM per year for domestic purposes and for sale to European markets (USEPA, 2005).

Table 9-4 summarizes CMM emissions in the Czech Republic. The data in this table may vary from the EPA data presented in the Executive Summary due to differences in inventory methodology and rounding of digits.

Table 9-4. The Czech Republic's CMM Emissions (million cubic meters)

Emission Category	1990	1991	1992	1993	1994	1995	1996	1997	1998
Underground mine	384.39	333.74	323.27	314.49	301.52	297.18	286.39	279.72	275.80
Post-underground mine	50.46	43.78	42.76	41.29	39.75	39.13	37.73	36.92	36.39
Surface mine	89.48	86.87	77.13	75.77	67.48	64.76	64.98	65.08	55.08
Post-surface mine	7.78	7.55	6.71	6.59	5.87	5.63	5.65	5.66	4.79
Total	532.11	471.94	449.86	438.14	414.62	406.71	394.75	387.38	372.06
Additional Recovered and Used						*151.71			
Emission Category	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Underground mine	252.16	259.62	265.60	258.65	245.71	239.55	238.69	275.80	232.39
Post-underground mine	33.35	34.33	35.17	34.51	32.88	32.06	31.95	36.39	31.11
Surface mine	47.04	52.85	54.33	51.52	52.38	50.41	50.55	55.08	51.73
Post-surface mine	4.09	4.60	4.72	4.48	4.56	4.38	4.39	4.79	4.50
Total	336.64	351.40	359.84	349.16	335.53	326.41	325.58	372.06	319.73
Additional Recovered and Used					*116.14				

Source: UNFCCC (2009a); *UNFCCC (2005)

The OKR mining basin, the gassiest region of the Czech Republic, accounts for 99.8 percent of methane emissions from all the Czech mines combined. The basin measures 1,600 square kilometers (km^2) in area and has 255 coal seams with a cumulative net coal thickness of 150 meters (m). Its coalbed methane (CBM) resource from seams less than 1,200 m deep has been estimated to range from 50 to 370 billion m^3 (USEPA, 2005) with an estimate by Green Gas DPB of 440 Mmt of reserves (Green Gas, 2007). Forty-nine coal deposits are documented as virgin coal seams (USEPA, 1992), while several mines have been closed because of their inefficiency. As per 1998 data, about 120 million m^3 of methane is drained from these seams annually, inclusive of both abandoned coal mines and virgin seams (USEPA, 1998).

Green Gas DPB has been a major player in CMM development in the Czech Republic since 1992. It holds licenses to recover methane from abandoned and virgin coal seams in the Upper Silesian Coal Basin (in the Karviná, Frýdek-Místek, and Nový Jičín regions). It holds CBM exploration licenses for nine blocks with a total area of about 200 km^2 and has tested CBM production from several in-mine shafts at the Frenstat Mine. By 2009, it had operations at 19 sites in the Czech Republic (both active and abandoned mines) (Green Gas, 2010).

Recognizing the importance and value of CMM, starting in 2004, Green Gas DPB began installing combined heat and power (CHP) units at active and abandoned mines. A total of 28 TEDOM CHP units were in operation by 2008, producing 320 terrawatt hours annually while avoiding 1.3 $MmtCO_2$ per year. Through 2012, an additional 17 CHP units will be installed with the eventual target of 40 megawatts (MW) of commercially available output (PowerGen, 2009).

Other vested companies include a British company, Marine & Mercantile Securities, and Energie Kladno, who have entered into a joint venture as Eurogas a.s., to explore existing wells and drill new ones in OKR fields between Ostrava's abandoned mines and the Polish border centered around Cesky Tesín and in the south below Frydlandt (see Figure 9-2).

9.2.2 CMM Emissions from Abandoned Coal Mines

Green Gas DPB utilizes AMM from four production areas in the OKR region with 10 abandoned shafts and 4 wells producing 25 million m^3 of methane annually (Green Gas, 2007).

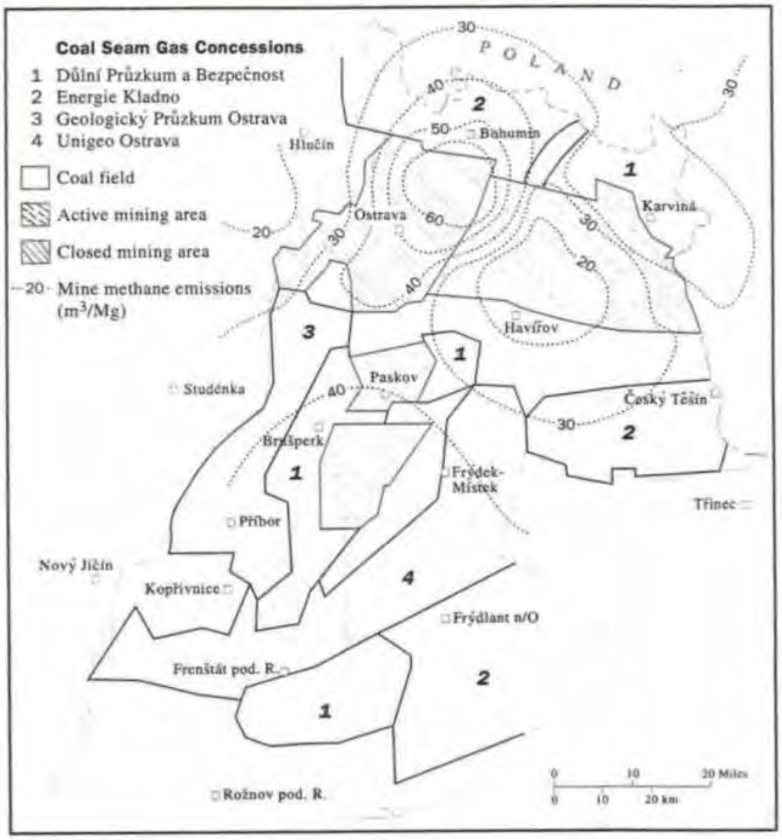
9.2.3 CBM from Virgin Coal Seams

The Czech lignite mines offer no potential for production of CBM from virgin seams or CMM from existing mines (BERR/DTI, 2004).

In 2004, a British study of CBM potential in the Czech Republic reported on the gas in virgin coal seams in OKR fields between 1991 and 1998. Twenty surface boreholes were drilled and hydrofracturing was carried out to stimulate gas flow. The survey concluded that the commercial potential for CBM was not viable and further development plans were tabled (BERR/DTI, 2004).

The Czech Ministry for Regional Development and TransGas were funding coal seam gas explorations conducted by four companies that received licenses for gas exploration in the OKR coalfields: Green Gas DPB, Energie Kladno, GPO, and Unigeo Ostrava. Figure 9-3 shows the regions of these gas recovery projects (Schwochow, 1997). If drilling resulted in viable gas recovery, separate production licenses would be granted. Green Gas DPB held exploration licenses for multiple CBM blocks and has tested CBM production (USEPA, 2005).

Figure 9-3. Mining Areas & Coal Seam Gas Concessions in the OKR Coalfield



Source: Schwochow (1997)

9.3 Opportunities and Challenges to Greater CMM Recovery and Use

The Czech Republic under the Kyoto Protocol is committed to an emissions reduction of 8 percent below 1990 levels (UNFCCC, 2006). Its environmental policies are in accord with those stated in "An Environment for Europe," by the United Nation's Economic Commission for Europe, which limits mining activities that are hazardous to human health and environment and promotes efficient use of non-renewable natural resources. The Czech Republic is an Annex I party to the UNFCCC (see Table 9-5). Many registered Joint Implementation projects have been submitted to the Czech Ministry of Environment but none involve CMM (ENV, 2008). The Republic has not yet implemented any Clean Development Mechanism projects (UNFCCC, 2009b).

Table 9-5. The Czech Republic's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC*	June 18, 1993	October 7, 1993
Kyoto Protocol**	November 23, 1998	November 15, 2001

Source: *UNFCCC (2007a); **UNFCCC (2007b)

9.3.1 MARKET AND INFRASTRUCTURE FACTORS

The Czech Republic faces a number of barriers to achieving greater CMM recovery. First, the continuing trend of declining coal production in the Republic is detrimental to the growth of CMM development. Second, unusual topography in the coalfields hinders CBM recovery projects. Still, because of its large coal deposits, the Czech Republic ranks high globally in its potential for CMM development.

The Czech Republic's electricity price structure favors generation from mine gas fired power plants. The Republic's legislation provides for a "green bonus" for AMM and a "surcharge" for use of CMM in electricity generation (Green Gas, 2007).

New technologies for CMM recovery are available and being implemented, but not broadly. No significant research and development (R&D) projects were found in place to enhance the current CMM recovery technologies.

Green Gas DPB captures gas from the four active mines in the OKR district and from closed mines (with special licenses) and distributes this gas through its 160 km gas pipeline network that supplies 50 million m^3 per year to customers (Schultz, 2009). Currently, they have 19 active sites producing 23,717 kilowatts (kW) and avoiding 753,000 tons of CO_2e, annually (Green Gas, 2010).

9.3.2 REGULATORY INFORMATION

The Czech coal industry is no longer subsidized. Companies that are no longer operating active coal mines receive subsidies only to pay for rehabilitation of the environment at mine sites, technical liquidation of the mines, and healthcare for former workers (IEA, 2005).

In the 1990s, the Czech government placed restrictions on the extent and impact that coal mining could have on surrounding regions. These restrictions limit the expansion of some coal mines and new coal mine development. In June of 2010, the new coalition government announced that the restrictions would remain for at least four years (Prague Post, 2010).

Starting on January 1, 2005, the Czech natural gas industry began its liberalization (EC, 2007). Vertical unbundling was also accomplished during this period. Producers, distributors, and natural gas storage companies were separated and regulations enforced to prevent possible conflicts of interests of regulated utilities and to improve service costs, transparency, and competition (Mejstrik, 2004).

Although Czech Republic relies on domestic coal for almost half of its energy needs, it also imports substantial amounts of gas. This makes domestic generation of CMM and CBM an attractive proposition. The Czech government has therefore been encouraging its development through direct finance as well as lenient leasing policies (USEPA, 2005). Holders of CBM production licenses pay a fixed annual fee per unit area and a variable royalty (about 5 percent) based on a percentage of production. However, the gas prices are set centrally by the Energy Regulatory Office, which is hindering the development of the CMM market (Pilcher, 2003).

9.4 Profiles of Individual Mines

Some information on individual hard coal mines can be found at the Ostravsko-Karvinske Doly website: http://www.okd.cz/en/coal-mining/how-coal-is-mined-in-okd/, and information on both hard and brown/lignite mines can be found in the USGS 2008 Minerals Yearbook – Czech Republic (http://minerals.usgs.gov/minerals/pubs/country/2008/myb3-2008-ez.pdf).

9.5 References

BERR/DTI (2004): Assessment of Cleaner Coal Technology Market Opportunities in Central and Eastern Europe, Department of Business and Regulatory Reform, 2004, Project Report R270, DTI/Pub URN 04/1852.

EC (2007): Communication from the Commission to the Council and the European Parliament – Prospects for the internal gas and electricity market, European Commission, October 1, 2007. http://ec.europa.eu/energy/energy_policy/doc/10_internal_market_country_reviews_en.pdf

EIA (2006): Data obtained from *International Energy Annual 2006*, U.S. Energy Information Administration, Washington, DC, table posted October 2008. http://www.eia.doe.gov/pub/international/iea2006/table82.xls (reserves)

EIA (2010): Czech Republic Energy Profile – Total Primary Energy Production, U.S. Energy Information Administration, Washington, DC, April 1, 2010. http://tonto.eia.doe.gov/country/country_energy_data.cfm?fips=EZ

ENV (2008): List of JI projects submitted to the Ministry of the Environment, Ministry of the Environment, Prague, Czech Republic, 2008. http://www.env.cz/AIS/web-pub-en.nsf/$pid/MZPOBFJDN4N6/$FILE/JI%20registered_EN.pdf

Euracoal (2007): Czech Republic, Profile, Euracoal, Brussels, Belgium, 2007. http://www.euracoal.be/pages/layout1sp.php?idpage=70

European Economics (2006): Evaluation of State aid for the coal industry – Czech Republic, Europe Economics and Fraunhofer ISI with BSR Sustainability and the Krakow Institute for Sustainable Energy, October 6, 2006. http://ec.europa.eu/energy/coal/studies/doc/2006_10_report_europe_economics_annex.pdf

Fossil Energy (2003): *An Energy Overview of Czech Republic*, Office of Fossil Energy, 2003. www.fossil.energy.gov/international/CentralEastern%20Europe/czekover.html

Green Gas (2007): Case Study: Green Gas DPB, Czech Republic – Integrated, large scale Mine Gas Management, Green Gas DBP, Methane to Markets Partnership Expo, Beijing, China, October 30–November 1, 2007. http://www.methanetomarkets.org/expo_china07/docs/postexpo/coal_mader.pdf

Green Gas (2010): Global Operations – Czech Republic, Greengas.net, 2010. http://www.greengas.net/output/page199.asp

IEA (2001): Czech Republic 2001 Review, International Energy Agency, Paris, France, 2001. http://www.iea.org/textbase/nppdf/free/2000/czech2001.pdf

IEA (2005): Czech Republic 2005 Review, International Energy Agency, Paris, France, 2005. http://www.iea.org/textbase/nppdf/free/2005/CzechRep.pdf

IEA (2007): Coal in Czech Republic, International Energy Agency Energy Statistics – Coal, International Energy Agency, Paris, France, 2007. http://www.iea.org/Textbase/stats/coaldata.asp?COUNTRY_CODE=CZ

IEA (2009): Share of Total Primary Energy Supply in 2007 – Czech Republic, International Energy Agency, Paris, France, 2009. http://www.iea.org/textbase/stats/pdf_graphs/CZTPESPI.pdf

M2M Projects (2008): Methane to Markets International Coal Mine Methane Projects Database, Methane to Markets, 2008. http://www2.ergweb.com/cmm/index.aspx

Mejstrik (2004): Regulation and Deregulation of Regulation and Deregulation of Utilities in EU and CR: Utilities in EU and CR: Expectations and Facts, Michal Mejstřík, EEIP a.s., May 26, 2004. http://www.eeip.comp.cz/18_Utilities_eng.pdf

OKD (2008): About Us, Ostravsko-Karvinske Doly a.s., 2008. www.okd.cz

Pilcher (2003): *Recent Trends in Recovery and Use of Coalmine Methane*, Raymond C. Pilcher, Raven Ridge Resources Incorporated, 2003. http://www.coalinfo.net.cn/coalbed/meeting/2203/papers/coal-mining/CM056.pdf

PowerGen (2009): Coalmine methane projects in the Czech Republic waste gas used to fuel operations, Richard Choleva, PowerGen Worldwide, 2009. http://www.powergenworldwide.com/index/display/articledisplay/357197/articles/cogeneration-and-on-site-power-production/volume-10/issue-1/features/coalmine-methane-projects-in-the-czech-republic-waste-gas-used-to-fuel-operations.html.

Prague Post (2010): Mining limits will remain, Stephan Delbos, The Prague Post, June 16, 2010. http://www.praguepost.com/business/4759-mining-limits-will-remain.html

Radio (2004): Czech government agrees to sell off stakes in two coal-mining companies, Radio Praha, Czech Radio, March 24, 2004. http://www.radio.cz/en/article/52020.

SEC (2005): Press Release: Severoceske doly - New Members in CEZ Group, Report of Foreign Private Issuer, Commission File Number 333-7182-01, Securities and Exchange Commission, Washington, DC, October 24, 2005. http://www.secinfo.com/dsvrz.znp.htm

Schultz (2009): Meeting Expectations?, World Coal, May 2009. http://www.greengasinternational.com/files/World%20Coal%20-%20Meeting%20Expectations_Karl%20Schultz%20May09.pdf

Schwochow (1997): *The International Coal Seam Gas Report*, Denver, Colorado, Cairn Point Publishing, Schwochow, Steve. (ed), 1997.

UNFCCC (2005): Czech Republic National Inventory Report 2005, United Nations Framework Convention on Climate Change, Annex I Party GHG Inventory Submission, May 25, 2005. http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/2761.php

UNFCCC (2006): Czech Republic's Initial Report under the Kyoto Protocol, United Nations Framework Convention on Climate Change, Annex I Party National Reports, October 2006. http://unfccc.int/files/national_reports/initial_reports_under_the_kyoto_protocol/application/pdf/initial_report_aau_unfccc_cze.pdf

UNFCCC (2007a): United Nations Framework Convention on Climate Change - Status of Ratification, August 17, 2007. http://unfccc.int/files/essential_background/convention/status_of_ratification/application/pdf/unfccc_conv_rat.pdf

UNFCCC (2007b): Kyoto Protocol - Status of Ratification, United Nations Framework Convention on Climate Change, December 12, 2007. http://unfccc.int/files/kyoto_protocol/background/status_of_ratification/application/pdf/kp_ratification.pdf

UNFCCC (2009a): Czech Republic National Inventory Report 2009, United Nations Framework Convention on Climate Change, Annex I Party GHG Inventory Submission, 2009. http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/4771.php

UNFCCC (2009b): Fifth National Communication of the Czech Republic on the UN Framework Convention on Climate Change, United Nations Framework Convention on Climate Change, Annex I Party National Reports, November 30, 2009. http://unfccc.int/resource/docs/natc/czenc5.pdf

USEPA (1992): Assessment of the Potential for Economic Development of Coalbed Methane in Czechoslovakia, U.S. Environmental Protection Agency, Coalbed Methane Outreach Program, EPA/430/R-92/1008, October 1992.

USEPA (1998): Seminar and Roundtable on Coalbed Methane Development and Potential, 1998.

USEPA (2005): Coalbed Methane Outreach Program – Czech Republic, U.S. Environmental Protection Agency, 2005.

USGS (1994): U.S. Geological Survey – Mineral Information. http://minerals.usgs.gov/minerals/pubs/country/1994/9410094.pdf

10 ECUADOR

10.1 Summary of Coal Industry

10.1.1 ROLE OF COAL IN ECUADOR

Ecuador is neither a consumer nor a producer of coal. Ecuador has maintained its position as Latin America's fifth largest producer of oil and is one of the top three exporters of oil in the region. Oil is the keystone to the country's economy and represents nearly one-half of all export revenues (EIA, 2009).

There are estimated reserves of 24 million tonnes (Mmt) of recoverable lignite and sub-bituminous coal, ranking Ecuador 31st worldwide in total coal reserves (EIA, 2008).

Table 10-1. Ecuador's Coal Reserves and Production

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2006)*	0	24	24	31 (0.003%)
Annual Coal Production (2007)**	0	0	0	n/a

Source: *EIA (2008); **IEA (2007)

Figure 10-1 shows the location of Ecuador's coal reserves.

Figure 10-1. Location of Ecuador's Coal Reserves

Source: Adapted from Biewick et al. (1995)

10.1.2 STAKEHOLDERS

Table 10-2 identifies potential stakeholders in Ecuadorian coal mine methane (CMM) development.

Table 10-2. Key Stakeholders in Ecuador's CMM Industry

Stakeholder Category	Stakeholder	Role
Mining Companies	▪ Carbones del Cerrejon ▪ BHP Billiton, Newmont ▪ Rio Tinto ▪ Aurelian Resources, Inc.	Coal operators in neighboring countries/mining operators in Ecuador
Equipment Manufacturers	▪ Breaker Technology, Inc. ▪ Kluane International Drilling, Inc.	Provide equipment to other mining industries in Ecuador
Developers	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Project opportunity identification and planning
Engineering, Consultancy, and Related Services	▪ Entrix, Inc. ▪ MPC Construcciones e Ingenieria ▪ See http://www.epa.gov/coalbed/networkcontacts.html	Consultant to other mining industries
Natural Gas Transmission & Distribution Companies	▪ Noble Energy	Pipeline sales
Regulatory Agencies and Government Groups	▪ Ministry of the Environment ▪ National Committee on Climate ▪ Ministry of Non-Renewable Natural Resources	Regulation, permitting, and licensing
Professional Associations	▪ ARPEL - Regional Association of Oil and Natural Gas Companies in Latin America and the Caribbean	Project network

Source: Infomine (2005)

10.1.3 STATUS OF COAL AND THE COAL MINING INDUSTRY

Ecuador's mineral industry includes mining of gold, silver, copper, and steel. Crude petroleum and petroleum refinery products are extracted as well. However, no coal exploration is known and all coal reserves remain unutilized (USGS, 2008).

10.2 Overview of CMM Emissions and Development Potential

10.2.1 CMM EMISSIONS FROM OPERATING MINES

There are no operating coal mines in Ecuador.

10.2.2 CMM EMISSIONS FROM ABANDONED COAL MINES

Ecuador has no abandoned coal mines.

10.2.3 CBM FROM VIRGIN COAL SEAMS

There is no commercial coalbed methane (CBM) development at this time. Ecuador, however, has a fledging natural gas industry. Reserves are relatively small, but the Amistad field in the Gulf of Guayaquil produces 26 million cubic feet (0.7 million cubic meters) a day to produce electricity at a nearby power plant. With little natural gas pipeline infrastructure, all other gas is flared in oil operations (EIA, 2009).

10.3 Opportunities and Challenges to Greater CMM Recovery and Use

Table 10-3 summarizes Ecuador's climate change mitigation commitment. As a Non-Annex I Party to the Kyoto Protocol, Ecuador has no national emissions targets and is eligible to host mitigation projects under the Clean Development Mechanism (CDM).

Table 10-3. Ecuador's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC	June 9, 1992	February 23, 1993
Kyoto Protocol	January 15, 1999	January 13, 2000

Source: UNFCCC (2010)

In the context of the Kyoto Protocol, Ecuador has proposed two objectives regarding CDM:

1. Definition and implementation of the CDM Project Validation Process at the national level.
2. Promotion and implementation of national capacity (public and private) to prepare CDM projects and to generate significant Certified Emission Reduction Units (UNFCCC, 2000).

Ecuador's climate change position will be conducive to development of CMM projects, should they arise from future utilization of coal reserves.

10.3.1 Market and Infrastructure Factors

Currently, the market for methane in Ecuador is fairly limited as there is weak domestic demand and support infrastructure for natural gas (EIA, 209). However, Ecuador became a partner and member of the Global Methane Initiative (formerly Methane to Markets Partnership) Steering Committee in 2005 and plans to explore methane capture opportunities in its oil and possibly agriculture industries.

Methane emissions, typically from the flaring of natural gas during oil drilling, currently make up 15 percent of the country's annual greenhouse gas emissions. To date, there are no records of projects underway (M2M, 2005; EIA, 2009).

10.3.2 Regulatory Information

As there are no existing CMM projects, a legal framework regulating them does not exist at present. The oil and natural gas industries are regulated by the Ministry of Non-Renewable Natural Resources, Hydrocarbons National Directorate. Full text in Spanish of hydrocarbon regulations can be downloaded from the Ministry of Energy and Mines at: http://www.recursosnorenovables.gov.ec/es/descargas/doc_download/2-proyecto-de-ley-hidrocarburos.html.

Mining laws and regulations can be found at: http://www.recursosnorenovables.gov.ec/es/descargas/cat_view/79-documentos-oficiales/60-ley-de-mineria.html.

Information regarding regulatory information, forms, and other documents needed for hydrocarbon projects can be found at the Ministry of Energy and Mines under Services at: http://www.recursosnorenovables.gov.ec/es/descargas/cat_view/79-documentos-oficiales/60-ley-de-mineria.html.

10.4 Profiles of Individual Mines

There are no coal mines in Ecuador.

10.5 References

Biewick, Laura R. H. and Weaver, Jean N., 1995: The Digital Coal Map of South America in ARC/INFO Format: U.S. Geological Survey Open-File Report 95-235, U.S. Geological Survey, Denver, Colorado. Adapted by Raven Ridge Resources.

EIA (2008): *International Energy Annual 2006.* U.S. Energy Information Administration (EIA), Washington, DC, table posted October 17, 2008. http://www.eia.doe.gov/pub/international/iea2006/table82.xls (reserves)

EIA (2009): Ecuador Country Analysis Brief, website accessed June 22, 2010. http://www.eia.doe.gov/emeu/cabs/Ecuador/Full.html

IEA (2007): Coal and Peat in Ecuador, International Energy Agency, 2007. http://www.iea.org/stats/coaldata.asp?COUNTRY_CODE=EC

Infomine (2005): Mining Ecuador – CountryMine, website accessed December 8, 2005. http://www.infomine.com/countries/Ecuador.asp

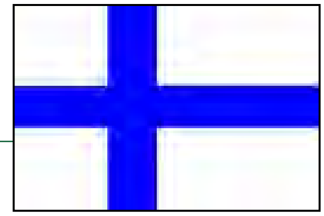
M2M (2005): "Methane International: Methane to Markets Partnership Quarterly Update." Methane to Markets. November, 2005. http://www.methanetomarkets.org/documents/newsevents_mi5.pdf

UNFCCC (2000): National Communication Republic of Ecuador, website accessed June 22, 2010. http://unfccc.int/resource/docs/natc/ecunc1.pdf

UNFCCC (2010): Parties and Observer States: Ecuador, 2010. http://maindb.unfccc.int/public/country.pl?country=EC

USGS (2008): 2008 Minerals Yearbook: Ecuador [Advance Release], U.S. Geologic Survey, 2008. http://minerals.usgs.gov/minerals/pubs/country/2008/myb3-2008-ec.pdf and http://minerals.usgs.gov/minerals/pubs/country/2008/myb3-2008-ec.xls

11 FINLAND



11.1 Summary of Coal Industry

11.1.1 ROLE OF COAL IN FINLAND

Finland is not a producer of coal and imports all of its coal for domestic energy consumption. Approximately 75 percent of coal consumption is used for maintaining the electricity and heating sectors. It should be noted that annual domestic coal consumption varies due to the hydrological condition of Finland (IEA, 2007a). Finland has no reported coal reserves (Table 11-1).

Table 11-1. Finland's Coal Reserves and Production

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves*	-	-	-	33 (-)
Annual Coal Production**	0	0	0	32 (0)

Source: *EIA (2008); **IEA (2007b)

Figure 11-1. Location of Finland's Coal Reserves

Source: CIA World Factbook (2010)

11.1.2 Stakeholders

There are currently no coal mine methane (CMM) stakeholders in Finland.

11.1.3 Status of Coal and the Coal Mining Industry

Finland's mineral industry includes (but is not limited to) the mining of gold, nickel, cobalt, copper, zinc, diamonds, phosphate rock, wollastonite, and talc (USGS, 2008). Finland does not presently have any identified coal reserves; therefore, no coal mining occurs in Finland.

11.2 Overview of CMM Emissions and Development Potential

The Global Methane Initiative (formerly Methane to Markets Partnership) International CMM Projects Database currently identifies no CMM recovery projects for Finland, in operation or development (M2M Projects, 2010).

11.2.1 CMM Emissions from Operating Mines

There are no operating coal mines in Finland.

11.2.2 CMM Emissions from Abandoned Coal Mines

Finland has no abandoned coal mines.

11.2.3 CBM from Virgin Coal Seams

There are no commercial coalbed methane (CBM) development projects in Finland at this time.

11.3 Opportunities and Challenges to Greater CMM Recovery and Use

Table 11-2 summarizes Finland's climate change mitigation commitment. Finland is an Annex I Party to the Kyoto Protocol. Finland has an emissions reduction target of 6 percent below the 1990 levels for 2008–2012.

Table 11-2. Finland's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC*	June 4, 1992	May 3, 1994
Kyoto Protocol**	April 29, 1998	May 31, 2002

Source: UNFCCC (2007)*; UNFCCC (2005)**

11.3.1 Market and Infrastructure Factors

Finland joined the Global Methane Iniative (formerly Methane to Markets Partnership) in 2008 and is working with stakeholders to recover and utilize methane produced by Finland's 33 landfills. Finland is also providing funding support for other international projects in countries such as Honduras and Nicaragua (EPA, 2008). Finland currently sits on the GMI Landfills and Agriculture Subcommittees.

11.3.2 Regulatory Information

The *Mining Act of 1965* provides the legal framework for mining operations in Finland. In late 2008, a working group was formed by the Finnish government to revise the outdated Act. The newly revised Act, when completed, will enable the government of Finland to ensure that "the preconditions [are met] for mining and ore prospecting in a socially, economically and ecologically sustainable manner." Specifically, the revised Act would strengthen environmental protection and citizens' rights, and give landowners and localities greater influence in the [mining] decision-making process (MEE, 2008).

11.4 Profiles of Individual Mines

There are no coal mines in Finland.

11.5 References

CIA (2010): CIA World Factbook. https://www.cia.gov/library/publications/the-world-factbook/geos/fi.html

EIA (2008): International Energy Annual 2006, U.S. Energy Information Administration, Washington, DC, table posted October 2008. http://www.eia.doe.gov/pub/international/iea2006/table82.xls (reserves)

IEA (2007a): Energy Policies of IEA Countries – Finland 2007 Review. International Energy Agency, http://www.iea.org/textbase/nppdf/free/2007/finland2007.pdf

IEA (2007b): International Energy Agency Energy Statistics – Coal and Peat in Brazil in 2007. International Energy Agency, http://www.iea.org/stats/coaldata.asp?COUNTRY_CODE=FI

M2M Projects (2010): Methane to Markets International Coal Mine Methane Projects Database, Methane to Markets, accessed 2010. http://www2.ergweb.com/cmm/index.aspx

MEE (2008): Mining Act Working Group issues proposal for overall reform of the act, Ministry of Employment and the Economy, accessed July 2010. http://www.tem.fi/?89511_m=92858&89511_o=10&l=en&s=2468

UNFCCC (2005): Kyoto Protocol - Status of Ratification, September 19, 2005. http://unfccc.int/files/essential_background/kyoto_protocol/application/pdf/kpstats.pdf

UNFCCC (2007): United Nations Framework Convention on Climate Change - Status of Ratification, August 17, 2007. http://unfccc.int/files/essential_background/convention/status_of_ratification/application/pdf/unfccc_conv_rat.pdf

USEPA (2008): Finland Joins Methane to Markets Partnership to Curb Greenhouse Gas Emissions. U.S. Environmental Protection Agency, 2008. http://yosemite.epa.gov/opa/admpress.nsf/a883dc3da7094f97852572a00065d7d8/56878f6829e34bb88525748f00573e84!OpenDocument

USGS (2008): 2008 Minerals Yearbook – Finland. U.S. Geological Survey. http://minerals.usgs.gov/minerals/pubs/country/2008/myb3-2008-fi.pdf

12 France

12.1 Summary of Coal Industry

12.1.1 Role of Coal in France

Coal has become less important in France's energy supply, constituting only 5 percent of the nation's total energy consumption in 2007. Nuclear power has replaced most of France's coal-fired power plants. France consumed 23.3 million tonnes (Mmt) of coal in 2008, ranking tenth amongst the European Union's 27 member countries. Its largest sources of coal imports are South Africa, Australia, and the United States (EIA 2008a; EIA 2007).

France has negligible coal reserves; the country's coal production has declined in the past few years, having closed its last coal mine in April 2004 (BBC, 2004; IEA 2007). The country's 1999 total coal production was 6.2 Mmt, reduced to only 0.16 Mmt in 2004.

Table 12-1. France's Coal Reserves and Production

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2008b)*	0	0	0	32 (0.000%)
Annual Coal Production (2007)**	0	0	0	n/a

Source: *EIA (2008b); **IEA (2007)

Power plants represented about half of France's coal consumption in 2007, with most of the remainder being consumed by the steel industry (EIA, 2008a; IEA 2007).

There are three main coal-producing areas in France: the Nord-Pas de Calais, the Lorraine basin, and the Central Massif basins.

12.1.2 Stakeholders

Table 12-2 lists key potential stakeholders in French coal mine methane (CMM) development.

Table 12-2. Key Stakeholders in France's CMM Industry

Stakeholder Category	Stakeholder	Role
Mining companies	▪ Charbonnages De France ▪ European Gas Limited ▪ Future Corporation Australia ▪ PanTerra ▪ Compagnie Nationale à Portefeuille S.A. ▪ Transcor Astra Group	Project host
Natural Gas Transmission & Distribution Companies	▪ Gaz De France	Gas distribution

Stakeholder Category	Stakeholder	Role
Developers	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Project opportunity identification and planning
Engineering, Consultancy, and Related Services	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Technical assistance
Government Groups	▪ Ministry for the Economy, Industry and Employment ▪ Minister of Ecology, Energy, Sustainable Development and Sea ▪ Commission of Regulation of the Energy (CRE)	Regulatory

Source: USEPA (2005)

12.1.3 Status of Coal and the Coal Mining Industry

As of now, France does not produce any coal (BBC, 2004; IEA, 2007). The country is left with many abandoned coal mines, since the coal mining industry in France dates back hundreds of years.

The steady decline in the country's coal sector over the past several decades is attributable to cheaper imports replacing the domestic sources, its shift to nuclear power, and its concern for the environment. The state-owned coal monopoly, Charbonnages de France, closed its last production facility in April 2004.

Most of the coal seams are high volatile in rank and gassy, containing up to 16 cubic meters (m^3) of methane per tonne (USEPA, 2005).

12.2 Overview of CMM Emissions and Development Potential

12.2.1 CMM Emissions from Operating Mines

Over the last century, there have been a number of CMM projects in France utilizing gob gas from active and abandoned mines for power generation and heating applications. However, these projects at active mines closed as the coal mining sector declined overall.

Before domestic production stopped, the majority of the CMM activity to date focused on the coal seams of the Nord-Pas de Calais basin.

12.2.2 CMM Emissions from Abandoned Coal Mines

Emissions from France's abandoned mines have declined over time, as reflected in Table 12-3.

Table 12-3. France's CMM Emissions ($MmtCO_2e$)

Emission Category	1995	2000	2004	2005	2006	2007	2008
Underground mining activities—all	256.13	152.69	10.34	8.57	6.85	5.48	4.39
Post-underground emissions	30.79	12.02	0.68	0.00	0.00	0.00	0.00
Surface mine emission (total)	0.99	0.71	0.00	0.00	0.00	0.00	0.00
Post-surface mining emissions	0.46	0.25	0.00	0.00	0.00	0.00	0.00
Total liberated (= sum of all above)	288.36	165.67	11.02	8.57	6.85	5.48	4.39

Source: UNFCCC (2010a) (converted from gigagrams [Gg]).

In France, several CMM use projects are reported to be operating at abandoned mines. The Global Methane Initiative (formerly Methane to Markets Partnership) International CMM Projects Database currently identifies three methane recovery and utilization projects at abandoned mines in France. Two projects utilize the recovered methane for industrial use and the third one for pipeline injection (M2M, 2010). Their level of methane emission mitigation is not reported.

Among the projects at abandoned mines, Gazonor is a venture of European Gas Limited wholly acquired from Charbonnages de France. Several mines are sources for extraction, including Divion, Avion, and Désirée. European Gas is permitted for 579 square kilometers (km^2) and further permits are under application for an additional 1500 km^2. Since CMM extraction began in 1979, a total of 2,189 million m^3 have been extracted as of 2008 with an approximate methane content of 54 percent. Annual production for the last five years has averaged 72.1 million m^3.

European Gas is also operating several wells at Lons le Saunier in eastern France, producing about 83.7 million m^3 annually. At Lorraine, European Gas estimates that 1,104 million m^3 of methane is available. The permit covers 988 km^2, but actual production had not begun as of 2008. The Gardanne project in L'Arc Base, northeast of Marseille, is estimated to hold up to 20 seams with up to 2,800 million m^3 of gas resource. Finally, a joint-venture with Transcor Astra Group, a subsidiary of Compagnie Nationale à Portefeuille S.A., has been formed for the Benelux Project (EGL, 2010).

Figure 12.1. CMM Projects in France

Source: EGL (2010)

SNET, a subsidiary of Charbonnages de France, operates two power production facilities that utilize co-fired CMM – Hournaing and Emile Huchet Groupe V.

12.2.3 CBM from Virgin Coal Seams

In an inventory of coalbed methane (CBM) in the Lorraine Basin, the gas in place is assessed at 11.8 billion m^3 in the Saint Avold area and at 16.3 billion m^3 in the Alsting area (Kimberley, 2005). No data quantifying CMM recovery from virgin coal seams are currently available.

12.3 Opportunities and Challenges to Greater CMM Recovery and Use

France signed and ratified the UNFCCC and Kyoto Protocol, as indicated in Table 12-4.

Table 12-4. France's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC	June 13, 1992	March 25, 1994
Kyoto Protocol	April 29, 1998	May 31, 2002
Copenhagen Accord	December 18, 2009	Not formally ratified

Source: UNFCCC (2009); UNFCCC (2010b); UNFCCC (2010c)

12.3.1 Market and Infrastructure Factors

There are few companies involved in the potential development of CBM projects in France. Schlumberger, a technology and project management consultant company, offers CBM consulting services. It offers its ECLIPSE CBM model which examines CBM potential of a particular mining site. Total S.A., the French petroleum giant is exploring CBM opportunities in the Ukraine as of 2010 (Schlumberger, 2008).

12.3.2 Regulatory Information

France actively encourages its CMM development industry by including mine methane as recoverable energy in renewable tariffs; including it with landfill and sewage methane in renewables targets; treating it as a secure energy resource; and promoting CMM technology as climate change technology in world markets (ACMMO, 2007).

In France, CMM is covered under the Electricity Act 2000 which was modified to include recoverable energy from mine methane, landfills, biomass, and sewage digesters. The feed-in tariff with premium prices for renewable electricity generated from these sources has provided strong incentive to the methane mitigation industry and a large number of new projects are already under way (CRE, 2010; ACMMO, 2007; EREC, 2009).

12.4 Profiles of Individual Mines

Data profiling gassy mines in France are unavailable. The last active coal mine in France closed in 2004.

12.5 References

ACMMO (2007): "UK Mine Methane Facts and Figures," The United Kingdom's Association of Coal Mine Methane Operators, website accessed June 29, 2010. http://www.coal.gov.uk/media/BFA/7A/CCT_-_UK_Mine_Methane_-_Facts_and_Figures_-_ACMMO_General_Brief_10_08_07.pdf

BBC (2004): "France Closes its Last Coal Mine" www.news.bbc.co.uk, website accessed June 28, 2010. http://news.bbc.co.uk/1/hi/world/europe/3651881.stm

CRE (2010): "Guidelines and Laws," Commission of Regulation of the Energy (CRE), Paris, France, website accessed June 29, 2010. http://www.cre.fr/fr/documents/reglementation/directives_et_lois

EIA (2007): France, Country Briefs, Energy Information Agency. Hosted by Friends of Earth Encyclopedia, website accessed June 28, 2010. http://www.eoearth.org/article/Energy_profile_of_France

EIA (2008a): International Energy Statistics: Coal Consumption, France. Energy Information Administration, Washington, DC, 2008. http://tonto.eia.doe.gov/cfapps/ipdbproject/IEDIndex3.cfm.

EIA (2008b): International Energy Annual 2006, Energy Information Administration, Washington, DC, table posted October 2008. http://www.eia.doe.gov/pub/international/iea2006/table82.xls (reserves)

EREC (2009): Renewable Energy Policy Review, France, European Renewable Energy Council (EREC), Brussels, Belgium, 2009. http://www.erec.org/fileadmin/erec_docs/Projcet_Documents/RES2020/FRANCE_RES_Policy_Review_09_Final.pdf

IEA (2007): International Energy Agency Energy Balances – France. International Energy Agency, Paris, France, 2007. http://iea.org/stats/balancetable.asp?COUNTRY_CODE=FR

Kimberley (2005): Initial Coalbed Methane Gas in Place Estimates for Lorraine Permit, France, Kimberley Oil NL, 2005. www.europeangas.com.au/pdf/283763.pdf

M2M Projects (2010): Methane to Markets International Coal Mine Methane Projects Database, Methane to Markets, accessed June 2010. http://www2.ergweb.com/cmm/index.aspx

Schlumberger (2008): ECLIPSE Coalbed Methane Program, website accessed June 28, 2010. http://www.slb.com/services/software/reseng/eclipse_options/cbm.aspxUNFCCC (2010b): United Nations Framework Convention on Climate Change - Status of Ratification, June, 2010. http://unfccc.int/essential_background/convention/status_of_ratification/items/2631

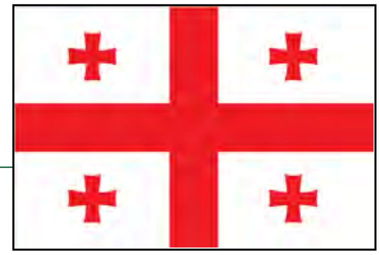
UNFCCC (2009): United Nations Framework Convention on Climate Change - Copenhagen Accord, December 2009. www.unfccc.int/resource/docs/2009/cop15/eng/l07.pdf

UNFCCC (2010a): Annex Party I 2010 Submissions, 2010. http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5270.php

UNFCCC (2010b): United Nations Framework Convention on Climate Change - Status of Ratification, June 2010. http://unfccc.int/essential_background/convention/status_of_ratification/items/2631.php http://unfccc.int/resource/conv/ratlist.pdf

UNFCCC (2010c): Kyoto Protocol - Status of Ratification, June 2010. http://unfccc.int/kyoto_protocol/status_of_ratification/items/2613.php

USEPA (2005): Coalbed Methane Outreach Program website, U.S. Environmental Protection Agency.



13 GEORGIA

13.1 Summary of Coal Industry

13.1.1 ROLE OF COAL IN GEORGIA

Coal deposits were discovered in Georgia in the first half of the 19th century, although until the 1930s geological exploration of these deposits was sporadic. Rapid development of the coal deposits in Georgia began after World War II, with produced coal being supplied to the Rustavi iron and steel works. Seven coal deposits have been discovered in Georgia, but only three of them are of commercial importance: the Tkibuli-Shaori and Tkvarcheli bituminous coal deposits and the Akhaltsikhe brown coal deposit (Figure 13-1). Most of the republic's coal reserves are concentrated in these deposits and the Tkibuli-Shaori deposit accounts for more than 75 percent of Georgia's coal reserves, followed by Akhaltsikhe and then Tkvarcheli (UNFCCC, 2009).

Table 13-1. Georgia's Coal Reserves and Production

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2005)*	NA	NA	405	NA
Annual Coal Production (2008)**	0.012	0	0.012	NA

Source: *GIEC (2007); **EIA (2010)

Figure 13-1. Georgia's Main Coal Fields

Source: Adapted from UN (2004)

13.1.2 STAKEHOLDERS

Potential stakeholders in Georgia's coal mine methane (CMM) industry are listed in Table 13-2.

Table 13-2. Key Stakeholders in Georgia's CMM Industry

Stakeholder Category	Stakeholder	Role
Coal Producing Enterprise	▪ Georgian International Energy Corporation (GIEC) ▪ Saknakhshiri LLC ▪ Both these companies are subsidiaries of Georgian Investment Group (GIG)	Project Hosts
Developer	▪ Georgian International Energy Corporation (GIEC) ▪ See http://www.epa.gov/coalbed/networkcontacts.html	Project opportunity identification and planning
Engineering or Consultancy Services	▪ Covalent Energy ▪ Global Methane Partners ▪ See http://www.epa.gov/coalbed/networkcontacts.html	Technical assistance
Universities and Research Centers	▪ National Academy of Sciences of Georgia ▪ Georgia National Science Foundation ▪ Tbilisi State University ▪ Ministry of Education and Science - Mining Institute	Technical assistance
Other	▪ KazTransGaz-Tbilisi ▪ OPIC	
Government Groups	▪ Ministry of Energy ▪ Ministry of Environmental Protection and Natural Resources	Licensing and permitting

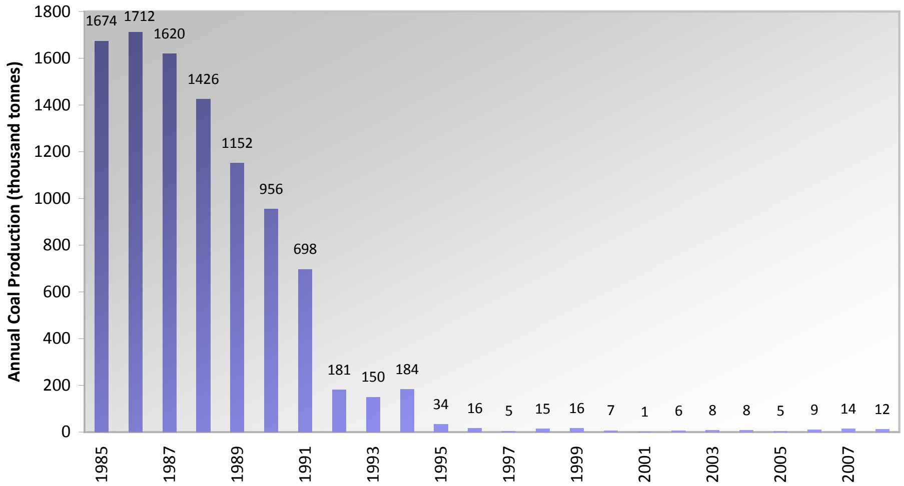
13.1.3 STATUS OF COAL AND THE COAL MINING INDUSTRY

Coal mining in Georgia is made difficult by the depth of the coal seams, the locations of deposits in mountainous areas and, in some areas, the relatively high methane content (14+ cubic meters [m^3] per tonne) of the coal. Insufficient financing of mines in the late 1990s to early 2000s (as State subsidies dried up because of the country's economic crisis); a lack of markets; and costly extraction, led to minimal production at that time. The Georgian government has prioritized the revitalization of the coal mining sector, in the hope of providing much needed jobs and some economic resurgence in the Tkibuli-Shaori and Akhaltsikhe regions (UNFCCC, 2009).

The only underground mine currently producing coal in Georgia is the Mindeli mine in the Tkibuli-Shaori coalfield. The mine, operated by Saknakhshiri LLC, resumed coal extraction in 2008 after a 15-year break. In partnership with the Georgian International Energy Corporation (GIEC), the mine's flooded tunnels have been pumped dry and restored, shaft development projects have taken place, mine buildings have been refurbished, and the mine railway line has been repaired. The total cost for the redevelopment of the mine came to more than $10.8 million (GEL20 million) (GIEC, 2010).

Coal from the project currently supplies cement factories in Kaspi and Rustavi, but future plans call for production to levels, previously reached before 1990, of more than 1 million tonnes (Mmt) per year (Figure 13-2), which could fuel a potential nearby power generation plant. Saknakhshiri also holds a license for coal extraction from the Vale coalfield near Akhaltsikhe, in southern Georgia, estimated to have coal reserves of more than 75 Mmt available for open cast mining.

Figure 13-2. Georgia Coal Production (thousand tonnes)



Source: UNFCCC (1999); EIA (2010)

An operating open-cast mine is located at Tvarcheli, in the breakaway republic of Abkhazia. Produced coal from this mine is used to supply iron and steel works in Rustavi.

13.2 Overview of CMM Emissions and Development Potential

The Global Methane Initiative (formerly Methane to Markets Partnership) International CMM Projects Database currently has no record of any active CMM projects in Georgia (M2M Projects, 2010). One feasibility study, sponsored by the U.S. Trade and Development Association (USTDA), is being carried out on the possible development of a CMM drainage and utilization project in the Tkibuli-Shaori coal field.

13.2.1 CMM Emissions from Operating Mines

Limited data are available about Georgia's CMM emissions. Table 13-5 shows data available from Georgia's second Communication to the United Nations Framework Convention on Climate Change (UNFCCC). 18.79 million m^3 of CMM are estimated to have been emitted in 1990, at which time coal production was 956,000 tonnes per year.

Table 13-3. Georgia's CMM Emissions (million cubic meters)

Emission Category	1990	2000	2006
Underground coal mines – ventilation emissions	18.79	0.139	0.139
Underground coal mines – drained emissions	0	0	0
Total liberated (= sum of all above)	18.79	0.139	0.139
Recovered & Used	0	0	0
Total emitted (= Total liberated – recovered & used)	18.79	0.139	0.139

Source: UNFCCC (2009)

Coal production operations at the Mindeli mine are being ramped up after being idle for almost 20 years. Production is expected to exceed 200,000 tonnes per year in the near future and when longwall operations are active it is planned to produce 1 Mmt of coal per year. At that time, CMM emissions would be expected to reach their 1990 levels. CMM is not currently drained from the mine, either by in-seam boreholes or via gob drainage. Methane is diluted in ventilation air and carried to the surface where it is emitted to the atmosphere. An explosion at the mine in March 2010, which killed four miners and attributed to a build-up of methane (Georgian Times, 2010), illustrates the need for improved methane drainage at the mine.

13.2.2 CMM Emissions from Abandoned Coal Mines

There are a number of abandoned mines in the Tkibuli-Shaori coalfield, but there are currently no methane recovery projects operating or planned in Georgia.

13.2.3 CBM from Virgin Coal Seams

Georgia does not currently produce coalbed methane (CBM) from virgin coal seams. The USTDA feasibility study evaluating the possible development of a CMM project at the Tkibuli-Shaori mine is also examining potential CBM extraction from the coalfield. The coal in this area is found in nine distinct layers that vary in thickness from 1 to 10 m, at depths of 500–1,500 m. Total coal thickness ranges from 20 to 50 m and in some places exceeds 75 m. Gas contents range from 6 to 20 m^3 per tonne and gas-in-place for the field is estimated to be 11.5 billion m^3 (ARI, 2009). The feasibility of CBM drilling is also been studied in the Vale coalfield in southern Georgia. Possible reserves for this area have not yet been estimated.

13.3 Opportunities and Challenges to Greater CMM Recovery and Use

Georgia ratified the UNFCCC in 1994 (Table 13-4) as a non-Annex I Party and since then has been actively engaged in the fulfillment of its obligations under the Convention. The government supports the implementation of any projects and programs that will lead to the reduction of greenhouse gas (GHG) emissions, facilitate the drawing of additional environmentally sound investments and transfer the country to a sustainable development pathway (MEP, 2009).

Table 13-4. Georgia's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC	NA	July 29. 1994
Kyoto Protocol	NA	June 16, 1999

Source: UNFCCC (2010)

13.3.1 Market and Infrastructure Factors

Georgia currently operates with a severe energy deficit, producing less than six percent of its domestic fuel requirements from its own resources (USTDA, 2008). All of Georgia's natural gas supply is imported, with the majority historically coming from Russia. As a result of gas supply interruptions during the brief war with Russia in 2008 and the subsequent doubling of prices of imported Russian gas, Georgia has looked increasingly to Azerbaijan for its gas supplies.

The Georgian government is looking to further diversify its energy base and is encouraging the continued redevelopment of the coal industry, along with potential development of thermal power stations near coalfields. Georgia also has sizeable hydropower capacity, which is a growing component of its energy supplies. The continuing renovations of old hydropower plants, along with development of new ones, has gone a long way to overcoming the chronic energy shortages of the past (CIA, 2010).

Utilization options for produced methane include on-site electricity generation or direct use by local residents, a policy in line with the government's recent push to supply gas to rural areas. But CMM will have to compete with hydroelectric power and other renewable energy resources such as geothermal energy (currently used for district heating) and wind power.

13.3.2 Regulatory Information

Georgia does not have any specific laws or regulations pertaining to CMM extraction. Potential issues concerning ownership of drained methane from coal mines or coal areas are not seen as a problem, as it is currently only coal owners who are looking at potential CBM/CMM projects.

13.4 Profile of Individual Mines

Coalfield data for the Mindeli and Dzidziguri mines is presented in Table 13-5, with a general profile of the Tkibuli-Shaori coal field shown in Table 13-6.

Table 13-5. Tkibuli-Shaori Coal Properties

Mine	Coal Property				
	Ash content (%)	Moisture Content (%)	Sulfur (%)	Volatile Material (%)	Heat Capacity (calories)
Mindeli	37–43	14.0	1.0–1.5	39.5–42.2	4,200–4,600
Dzidziguri	29–35	14.5	1.0–1.5	40–42.8	4,100–4,500

Source: ARI (2009)

Table 13-6. Tkibuli-Shaori Coal Field Profile

Tkibuli-Shaori Field - Mindeli and Dzidziguri Mines			
Mine Status	Active	Operator/Owner	Saknakhshiri LLC
Mine Area	47 square kilometers (km^2)	Coal Field	Tkibuli-Shaori
Mining Method	Room and pillar / Longwall	Location	50 km northeast of Kutaisi, Imereti region
Reserves (coking coal)	330 thousand tonnes (Mt)	2006 VAM volume	0.139 million m^3
No. of seams mined	9	2006 Drained methane (CH_4) volume	0
Depth of seams	500–1,500 m	2006 Utilized CH_4 volume	0
Annual coal production capacity	500,000 + tonnes	Utilization method	None

13.5 References

ARI (2009): CMM and CBM development in the Tkibuli-Shaori Region, Georgia. Advanced Resources International, Inc., 2009. Prepared for GIG/Saknakhshiri and U.S. Trade and Development Agency.

BP (2010): Statistical Review of World Energy June 2010. http://www.bp.com/productlanding.do?ctegoryId=6929&contentId=7044622

CIA (2010): CIA World Factbook – Georgia. Accessed July, 2010 https://www.cia.gov/library/publications/the-world-factbook/geos/gg.html

EIA (2010): International Energy Statistics - Georgia Coal Production. U.S. Energy Information Administration. Accessed July 2010, http://tonto.eia.doe.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=1&pid=7&aid=1

Georgian Times (2010): March 4 is day of mourning in Georgia. The Georgian Time webpage, March 4, 2010. http://www.geotimes.ge/index.php?m=home&newsid=20684

GIEC (2007): Georgia Energy Projects. Presented by Turnava, N., GIEC, at the Institut Europeen des Hautes Etudes Internationales - Club de Nice, 2007. www.iehei.org/Club_de_Nice/2007/TURNAVA.pdf

GIEC (2008): Saknakhshiri resumes coal extraction after 15-year break. News Release – GIEC website. Accessed July 2010. http://giec.ge/Newsinfo.aspx?news_id=72

GIEC (2009): News Release – GIEC website. Accessed July 2010. http://giec.ge/Newsinfo.aspx?news_id=72

IEA (2010): IEA Energy Statistics: Coal Statistics for Georgia. International Energy Agency, Paris, France. Accessed June, 2010. http://www.iea.org/stats/coaldata.asp?COUNTRY_CODE=GE

M2M Projects (2010): Methane to Markets International Coal Mine Methane Projects Database, Methane to Markets, 2010, at http://www2.ergweb.com/cmm/index.aspx.

UN (2004). Map of Georgia. United Nations Cartographic Department website. www.un.org/Depts/Cartographic/map/profile/georgia.pdf

UNFCCC (1999):Georgia's Initial National Communication to the UNFCC, Tbilisi, 1999. http://unfccc.int/resource/docs/natc/geonc1.pdf

UNFCCC (2009):Georgia's Second National Communication to the UNFCC, Tbilisi, 2009. http://unfccc.int/resource/docs/natc/geonc2.pdf

UNFCCC (2010): Kyoto Protocol - Status of Ratification, Accessed June 2010. http://maindb.unfccc.int/public/country.pl?country=GE

USEPA (2006): *Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990–2020*, U.S. Environmental Protection Agency, Office of Atmospheric Programs, Climate Change Division, June 2006, at http://www.epa.gov/climatechange/economics/downloads/GlobalAnthroEmissionsReport.pdf

USGS (2010): The Mineral Industry of Georgia, 2007 Minerals Yearbook. U.S. Geological Survey. By Levine, R.M., Brininstool, M. and Wallace, G.J. May 2010 http://minerals.usgs.gov/minerals/pubs/country/2007/myb3-2007-gg.pdf

USTDA (2008): USTDA Director Walther travels to Georgia. USTDA Press Releases August 25, 2008. http://www.ustda.gov/news/pressreleases/2008/EuropeEurasia/Georgia/WaltherGeorgiaOverview_082508.asp

14 GERMANY

14.1 Summary of Coal Industry

14.1.1 ROLE OF COAL IN GERMANY

Germany is the world's largest producer of brown coal (lignite), accounting for an estimated 19 percent of global output in 2006 (EIA, 2007). Brown coal is also Germany's most important indigenous energy resource, accounting for approximately 40.6 percent of the country's total primary energy production as of 2007, while hard coal comprised 16.3 percent (EURACOAL, 2007). Although the total coal production in Germany has dropped off considerably from 481.7 million tonnes (Mmt) in 1989 (including both former West and East Germanys) to 204.6 Mmt in 2007 (Statistik, 2007; IEA, 2007), brown coal production has started to increase in recent years. This is mainly due to increased demand from power plants such as RWE's (Germany's leading power producer) Niederaußem power plant. Table 14-1 summarizes Germany's coal reserves and production.

Table 14-1. Germany's Coal Reserves and Production

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2006)*	152.4	6,556.2	6,707.7	12 (0.8%)
Annual Coal Production (2007)**	24.2	180.4	204.6	7 (3.75%)

Source: *EIA (2007); **IEA (2007)

Coal's role in Germany's energy sector is significant but decreasing, from 30 percent of total primary energy consumption in 1991 to 25.9 percent in 2007 (Statistik, 2007; EURACOAL, 2007). With declining domestic coal production, Germany is becoming a significant net-importer of coal, importing 45.9 Mmt of hard coal in 2007 (EURACOAL, 2007). The country's largest suppliers in 2005 were South Africa, Poland, and Russia (EIA, 2006).

Germany's most important hard coal production is from underground mines located in the Ruhr and Saar basins in western Germany (USEPA, 2005), while all brown coal production is located in surface mines in basins across the country (Figure 14-1).

Figure 14-1. Germany's Coal Fields

Hard Coal Fields | **Brown Coal Fields**

Source: Statistik (2007)

14.1.2 STAKEHOLDERS

Table 14-2 lists potential stakeholders in coal mine methane (CMM) development in Germany.

Table 14-2. Key Stakeholders in Germany's CMM Industry

Stakeholder Category	Stakeholder	Role
Mining Companies	▪ RAG Aktiengesellschaft	Operator of hard coal mines
Equipment Manufacturers	▪ GE Jenbacher, Deutz Power Systems GmbH & Co. KG ▪ ETW-Energietechnik GmbH ▪ Pro2-Anlagentechnik GmbH ▪ G.A.S. Energietechnik GmbH ▪ LAMBDA-Gesellschaft für Gastechnik mbH ▪ Lennetal Industrie Service	Power generation equipment supplier Power plant engineering and construction
Developers	▪ Minegas GmbH und Mingas Power GmbH ▪ A-TEC GmbH ▪ Evonik New Energies GmbH ▪ Stadtwerke Herne AG ▪ See http://www.epa.gov/coalbed/networkcontacts.html	Project opportunity identification and planning

Stakeholder Category	Stakeholder	Role
Engineering, Consultancy, and Related Services	▪ Deutsche Montan Technologie GmbH ▪ ATEMIS GmbH ▪ Umwelttechnik Bojahr ▪ See http://www.epa.gov/coalbed/networkcontacts.html	Testing, consulting, and engineering
Natural Gas Transmission & Distribution Companies	▪ Consol Gas	Pipeline sales for power generation
Universities, Research Establishments	Fraunhofer UMSICHT RWTH Aachen Deutsche Montan Technologie GmbH	Examining, developing, and optimizing technical processes in the areas of environmental, safety, process, and energy technology
Regulatory Agencies	State Ministry for the Environment Nature Conservation and Reactor Safety	Project identification and assessment support
Government Groups	Bezirksregierung Arnsberg / Abt. 8 Bergbau und Energie	Mining authority
Professional Associations	IVG e.V. Landesinitiative Zukunftsenergien NRW	Establishes project network, advises members on technical, economic, and legal issues
Other	▪ KfW Banking Group ▪ Emissions-Trader ET ▪ Emissions-Trader ET ▪ Future Camp ▪ Daldrup & Söhne AG ▪ Anger's Söhne ▪ RAG-Stiftung	Investment finance, emissions trading Drilling contractors Coal Mining Foundation

14.1.3 Status of Coal and the Coal Mining Industry

Germany has experienced a recent increase in lignite production after a post-reunification downturn, due to an increased demand from power plants. However, there has been a concurrent downsizing of the hard coal sector due to incremental reduction of subsidies between 1998 and 2005 (hard coal extraction is very expensive and requires subsidies). In 1991, Germany operated 26 hard coal mines and employed 122,871 miners, while in 2007, only 7 mines were in operation and 30,054 miners employed (EURACOAL, 2007). Since 2006, the German government has continued downsizing and rationalizing the coal industry, and intends to phase out the last of its coal mines by 2018 (EIA, 2006; WI, 2008). All hard coal subsidies are scheduled to expire in 2018 (Mining Technology, 2007). Until then, the operation and financial liabilities of all hard coal mines is invested in RAG-Stiftung.

Table 14-3 provides recent statistics on German coal mines.

Table 14-3. Germany's Coal Mining Statistics

Type of Mine	**Production** (million tonnes)	Number of Mines

Underground (active) mines - total	20.7 (2006)	8
Surface (active) mines - total	176.3 (2004)	8 (by 2001)

Source: Statistik (2007)

14.2 Overview of CMM Emissions and Development Potential

The Global Methane Initiative (formerly Methane to Markets Partnership) International CMM Projects Database currently identifies 47 CMM projects in Germany: 36 are in place in abandoned mines, nine are in active, underground mines, and two are undetermined. The methane in 33 projects is being used for power generation, while the remaining 14 projects use the methane for combined heat and power (M2M Projects, 2008).

14.2.1 CMM Emissions from Operating Mines

Table 14-4 quantifies Germany's recent methane emissions from coal mining. The data in this table may vary from the EPA data presented in the Executive Summary due to differences in inventory methodology and rounding of digits. According to the IEA, Germany's methane emissions from coal mining amounted to 336 million m^3 or 4.8 Mmt of carbon dioxide equivalent in 2006 (IEA, 2009).

Table 14-4. Germany's CMM Emissions (million cubic meters)

Type of Mine	1990	1991	1992	1993	1994	1995	1996	1997
Underground mine	1283.56	1218.35	1011.45	1030.72	891.12	876.50	824.62	815.00
Post-underground mine	59.42	56.30	55.81	49.36	44.38	45.36	40.82	39.04
Surface mine	5.77	4.52	3.91	3.59	3.35	3.12	3.03	2.86
Total liberated (= sum of all above)	1348.74	1279.17	1071.17	1083.67	938.85	924.98	868.46	856.90
Type of Mine	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Underground mine	665.10	750.54	675.10	595.92	596.24	550.17	449.40	395.23
Post-underground mine	34.69	33.47	28.45	23.17	22.33	21.91	21.92	21.09
Surface mine	2.68	2.61	2.71	2.84	2.94	2.90	2.94	2.88
Total liberated (= sum of all above)	702.48	786.62	706.26	621.93	621.50	574.98	474.26	419.20

Source: UNFCCC (2007a)

14.2.2 CMM Emissions from Abandoned Coal Mines

There is substantial abandoned mine methane (AMM) recovery and utilization activities underway in Germany, with 36 individual projects reportedly in operation. The vast majority of these projects involve power generation, and together account for almost 175 MW of electricity. German AMM/CMM use projects mitigate more than 200 million cubic meters (m^3) of methane emissions annually (Evonik, 2006a).

14.2.3 CBM from Virgin Coal Seams

There are no coalbed methane (CBM) recovery efforts from virgin coal seams in Germany at present. The absence is attributable to high exploration and production costs, along with inadequate technology available thus far. However, with German energy demand and energy prices on the rise, the Technical University of Aachen is currently reevaluating German CBM potential. These efforts are primarily motivated by advances in drilling and simulation technologies. Germany has potential in-place CBM resources of 3 trillion m^3, of which 2 million m^3 is concentrated in the mining fields in the Ruhr area alone. Prospects for CBM recovery are thus poised to develop (GRA, 2009).

14.3 Opportunities and Challenges to Greater CMM Recovery and Use

Germany has ratified the Kyoto Protocol. Under the European Union Burden Sharing Agreement, Germany has agreed to a reduction target of 21 percent from 2008 to 2012. Table 14-5 summarizes Germany's commitment to international climate change mitigation agreements. Ratifying the Kyoto Protocol has made Germany eligible to benefit from the growing world market for carbon emission reduction credits.

Table 14-5. Germany's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC*	June 12, 1992	December 9, 1993
Kyoto Protocol**	April 29, 1998	May 31, 2002

Source: *UNFCCC (2007b); **UNFCCC (2007c)

Germany has 94 projects operating under the Clean Development Mechanism (CDM) and Joint Implementation (JI) programs. Of those projects, 48 are CMM projects, all operating under JI. Table 14-6 shows the breakdown by project type and domestic versus non-domestic project hosting.

Table 14-6. Germany's CDM and JI Projects

Project Types	CDM Projects	JI (Non-Domestic)	JI (Domestic)	Total
Biogas	4		2	6
Landfill gas	3		1	4
Fuel Switch and Energy Efficiency	1	1	6	8
Renewable Energy: Solar	2			2
Renewable Energy: Hydro	8			8
Biomass	10			10
Renewable Energy: Wind	1	2		3
HFC_{23}	2			2
Laughing Gas (Nitrous Oxide [N_2O])	2		1	3
Mine Gas (Methane Use)		1	47	48
			Total	94

Source: Seidel (2007)

14.3.1 Market and Infrastructure Factors

German legislation recognizes CMM as a regenerative energy source and incentivizes electricity generation from it, though not thermal energy production (see Section 1.3.2). On the research and development (R&D) front, although the public energy R&D budget decreased by 75 percent from 1981 to 1997, R&D for renewable energies and natural gas have fared better than other energy programs as a result of the Renewable Energy Sources Act of 2004 (EEG).

Potential CMM end uses in Germany include both mono- and co-firing boiler systems, combined heat power generation from gas and diesel engines and gas turbines, and secondary fuel sources including methanol, liquid gas, and substitution of natural gas. A 110-kilometer (km) long CMM network in the Saar District currently supplies CMM to a steel plant, the local chemical industry, a coking plant, electrical power plants, and central heating installations (Evonik, 2006b).

14.3.2 Regulatory Information

The legal framework for the economic utilization of mine gas in Germany is set by the *Federal Law on Mining* and the EEG. Exploration, extraction, and processing of mine gas are administered by the Federal Mining Authority. During the operation of the mine, the mining authorization designates mine gas as being the property of the mining company. When the mining authorization expires, the capture of mine gas requires a renewed license in its own right for at least another 30 years. According to the guidelines defined in the EEG, CMM is a regenerative energy source from which electrical power production (not thermal energy production) is supported by federal legislation (Schloenbach and Schluter, 2005).

The EEG has provided for a number of mechanisms to promote recovery and use of methane from coal mining activities. For example, it provides priority of dispatch to electricity generated from CMM and requires grid operators to connect CMM installations to their network and bear the costs of the grid upgrade. CMM operators have the authority to sell the carbon emissions mitigated by the project, and have the added incentive of paying out no local taxes or royalties on CMM projects. Since CMM is included in the Renewable Energy Sources category, all CMM projects receive priority attention at all stages of the project development (IEA, 2009).

The EEG creates a guaranteed fixed payback tariff for a period of 20 years (Schloenbach and Schluter, 2005). The regulation provides at least 7.67 Euro cents per unit for capacity up to 500 kilowatts (kW) at CMM-based power plants, at least 6.65 Euro cents per unit for power plants of capacity between 500 kW and 5 megawatts (MW), and 6.65 Euro cents per unit for power plants above 5 MW (Federal, 2004). More recent information is unavailable.

14.4 Profiles of Individual Mines

There are three main hard coal fields in Germany as listed in Table 14-7.

Table 14-7. Germany's Mine Overview

Coalfield	Mine
Ruhr Coalfield	▪ August Victoria ▪ West ▪ Lippe ▪ Ost ▪ Prosper-Haniel ▪ Walsum

Coalfield	Mine
Ibbenburen Coalfield	▪ Ibbenbüren
Saar Coalfield	▪ Saar

Source: Statistik (2007)

14.5 References

EIA (2004): Germany Country Analysis Brief, U.S. Energy Information Administration, Washington, DC, 2004.

EIA (2006): Germany Country Analysis Brief, U.S. Energy Information Administration, Washington, DC, December 2006. http://www.eia.doe.gov/emeu/cabs/Germany/Background.html

EIA (2007): *International Energy Annual 2006.* U.S. Energy Information Administration, Washington, DC, table posted October 2008. http://www.eia.doe.gov/iea/coal.html

EURACOAL (2007): Germany, EURACOAL, website accessed June 11, 2010. http://www.euracoal.be/pages/layout1sp.php?idpage=72

Evonik (2006a): Evonik New Energies GmbH (formerly STEAG Saar Energie) and mining authorities (personal conversation), June 2006.

Evonik (2006b): Energy from coal mine gas, Evonik New Energies GmbH (formerly STEAG Saar Energie), January 2006. http://www.steag-saarenergie.de/de/05_Download/pdf/Grubengas_ENG.pdf

Federal (2004): The Renewable Energy Sources Act, Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety, Germany, August 2004. http://www.bmu.de/english/renewable_energy/doc/6465.php

GRA (2009): Coal Bed Methane Production in the Münsterland Basin, Germany – Past and the Future, Geophysical Research Abstract, 2009. http://meetingorganizer.copernicus.org/EGU2009/EGU2009-4267.pdf

IEA (2007): Coal and Peat in Germany in 2007, International Energy Agency, 2007. http://www.iea.org/stats/coaldata.asp?COUNTRY_CODE=DE

IEA (2009): Coal Mine Methane in Russia, International Energy Agency, 2009. http://www.iea.org/papers/2009/cmm_russia.pdf

M2M Projects (2008): Methane to Markets International Coal Mine Methane Projects Database, Methane to Markets, accessed 2008. http://www2.ergweb.com/cmm/index.aspx

Mining Technology (2007): *Hard Coal Mining, Germany*, Mining Technology, SPG Media PLC, 2007. http://www.mining-technology.com/projects/germany

Schloenbach and Schluter (2005). Gob Gas Drainage, Schloenbach, M. and R. Schluter, presented at the 2005 International Workshop on CMM / VAM Recovery and Utilization, Chengu, Sichuan Province, China. April 6–7, 2005.

Seidel (2007): Project Proposals on the Increase, Wolfgang Seidel, German Emissions Trading Authority, JIKO Newsletter, January 2007. http://www.bmu.de/files/pdfs/allgemein/application/pdf/jiko_info0107_en.pdf

Statistik (2007): Der Kohlenbergbau in der Engergiwirtshaft der Budesrepublick Deutschland im Jahre 2006 (Coal Mining in the Energy Industry in Germany in 2006), Statistik der Kohlenwirtschaft e.V. (Coal Industry Statistics, Inc.), November 2007. http://www.kohlenstatistik.de/download/Komplett_Kohlenwirtschaft.pdf

USEPA (2005): International Activities - Germany, U.S. Environmental Protection Agency, Coalbed Methane Outreach Program, 2005.

UNFCCC (2007a): German National Inventory Submission, Annex I Party GHG Inventory Submissions, United Nations Framework Convention on Climate Change, 2007. http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/3929.php

UNFCCC (2007b): United Nations Framework Convention on Climate Change - Status of Ratification, August 17, 2007. http://unfccc.int/files/essential_background/convention/status_of_ratification/application/pdf/unfccc_conv_rat.pdf

UNFCCC (2007c): Kyoto Protocol - Status of Ratification, December 12, 2007. http://unfccc.int/files/kyoto_protocol/background/status_of_ratification/application/pdf/kp_ratification.pdf

WI (2008): The Afterlife of German Coal Mining, Worldwatch Institute, 2008. http://www.worldwatch.org/node/5834

15 HUNGARY

15.1 Summary of Coal Industry

15.1.1 ROLE OF COAL IN HUNGARY

Hungary uses three categories to classify its coal – hard coal (bituminous), brown coal, and lignite. It primarily produces brown coal and lignite, used mainly in its thermal electric power plants. These plants cannot use higher quality coal and therefore rely on the supplies of lower-quality domestic coal. Seventy-five percent of the coal consumption in Hungary is thus domestic (EIA, 2008).

Hungarians are making efforts to convert from coal to cleaner burning fuels such as natural gas or oil. Overall production of lignite (including brown coal) declined 13 percent from 2004 to 2007 (IEA, 2007). Brown coal production declined more sharply and bituminous production has ceased due to declining reserves (Steblez, 2005). Table 15-1 summarizes Hungary's coal reserves and recent production.

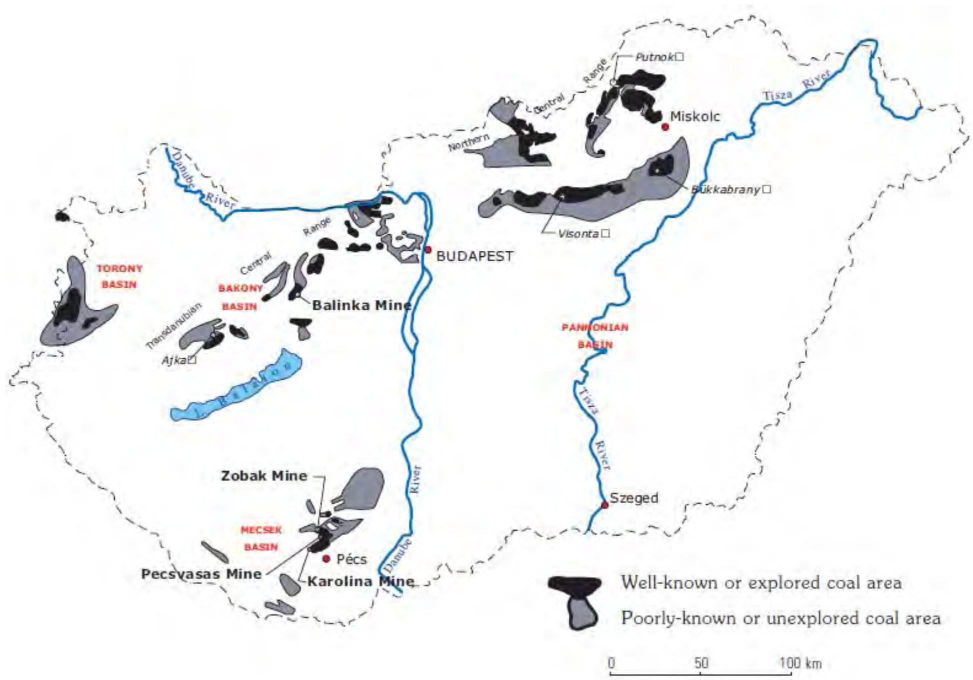
Table 15-1. Hungary's Coal Reserves and Production

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2006)*	199.0	3,103.0	3,302.0	16 (0.4%)
Annual Coal Production (2007)**	0	9.8	9.8	22 (0.2%)

Source: *EIA (2008); **IEA (2007)

Hungary's principal bituminous coal basin is the Mecsek Basin in the Mecsek Mountains of Baranya Province (Figure 15-1). Other coalfields include the sub-bituminous/lignite coalfields of Borsad, Nograd, Dorog, Matraalsa, and Varpolata.

Figure 15-1. Hungary's Coal Basin Fields



Source: USGS (2002)

Source: Perger (2009)

15.1.2 STAKEHOLDERS

As indicated in Table 15-2, Magyar Olaj es Gaz (MOL), the state oil and gas monopoly, is a prospective stakeholder in the development of Hungary's coal mine methane (CMM) industry.

Table 15-2. Key Stakeholders in Hungary's CMM Industry

Stakeholder Category	Stakeholder	Role
Natural Gas Transmission & Distribution Companies	▪ Magyar Olaj es Gaz	Pipeline sales
Energy Companies	▪ MVM Group	CMM project identification and investment
Developers	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Project opportunity identification and planning
Engineering, Consultancy, and Related Services	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Technical assistance
Government Groups	▪ Energy Centre Hungary ▪ Ministry of Economic Affairs ▪ Ministry of the Environment ▪ Hungarian Energy Office ▪ Mining Bureau of Hungary	Development of energy policy, project implementation, regulatory

15.1.3 STATUS OF COAL AND THE COAL MINING INDUSTRY

The coal mining industry in Hungary is privatized. Coal production from deep mines has all but ended (Euracoal, 2008). No information was found quantifying the proportion of underground mines considered gassy. Recent coal mining statistics for Hungary are provided in Table 15-3.

Table 15-3. Hungary's Recent Coal-Mining Statistics

Type of Mine	**Production** (million tonnes)	Number of Mines
Underground (active) mines - total	*4.74 (2003) **1.50 (2004) †1.2 avg. (2009)	†,‡0 black, 0 brown (2008) †1 lignite (2009)
Surface (active) mines - total	*8.56 (2004)	‡2 lignite (2009) †0 black (2009)

Source: *UNFCCC (2005a); **Molnar (nd); †Perger (2009); ‡Euracoal (2008)

15.2 Overview of CMM Emissions, Projects, and Potential

There are significant recoverable gas reserves from coalbeds in Hungary (see Table 15-4).

Table 15-4. Hungary's Largest Recoverable CMM / Coalbed Methane (CBM) Resources

Location	Amount (million cubic meters)
Algyő	12,700
Hajdúszoboszló	1,500
Pusztaföldvár	1,700
Üllés	2,800
Szank	700
Szeghalom	800
Nagykörű	2,600
Mezősas	3,300
Kisújszállás	800
Lovászi	200
Total	27,100

Source: Foldessy (2006)

15.2.1 CMM Emissions from Operating Mines

Table 15-5 summarizes CMM emissions for Hungary.

Table 15-5. Hungary's CMM Emissions (million cubic meters)

Emission Category	1985–1987 (average)	1990	1995	2000	2004‡	2005	2006	2007	2008
Underground mining activities—all	58.47	41.55	21.64	19.79		1.39	1.46	1.44	1.34
Underground coal mines—ventilation emissions					3.0–4.5				
Post-underground emissions	6.16	4.61	2.33	2.02		0.14	0.15	0.14	0.13
Surface mine emission (total)									
Post-surface mining emissions									
Total liberated (= sum of all above)	64.62	46.15	23.98	21.81	3.0–4.5	1.53	1.61	1.59	1.48
Recovered and used					0				
Total emitted (= total liberated – recovered and used)					3.0–4.5				

Source: UNFCCC (2010); ‡Molnar (nd)

15.2.2 CMM Emissions from Abandoned Coal Mines

No information on methane emissions from abandoned mines in Hungary was found.

15.2.3 CBM FROM VIRGIN COAL SEAMS

Overall CBM resources in the country are estimated at 152–159 billion cubic meters (m^3), of which 142 billion m^3 are in the Mecsek Coal Basin. The Mecsek region is thus the target area for CBM development. The potential of CBM was examined in Hungary in 2006 (Molnar, nd). Various factors such as coal rank, gas content, natural fracturing, history of gas emissions, proximity to guaranteed markets, and the relative dryness of coal and deep mines identify the Mecsek basin as a site for potential CBM development (Schwochow, 1997).The gas in the seams is approximately 95 percent pure, 70–90 percent of which is solid solution and sorbed, and contains 0.8 percent carbon dioxide (Foldessy, 2006).

Four drillhole tests were done between 1994 and 1995, all of which experienced fracturing by fluid carbon dioxide and failed. New projects, proposed by the University of Miskolc, would use steam gas extraction through medium radius drilling to access methane stores. If the gas were successfully mined, Pannon Power, which already operates using natural gas and biofuels, would use the CBM for electricity generation. More field tests were planned for completion in 2009 (Foldessy, 2006).

15.3 Opportunities and Challenges to Greater CMM Recovery and Use

As expressed in Table 15-6, Hungary ratified both the UNFCCC and the Kyoto Protocol, under which it has committed to a reduction of 6 percent of emissions from the base period 1985–1987 (UNFCCC, 2005a). Hungary is an Annex 1 country and is eligible to host Joint Implementation projects.

Table 15-6. Hungary's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC	June 13, 1992	February 24, 1994
Kyoto Protocol	---	August 21, 2000

Source: UNFCCC (2004); UNFCCC (2005b)

15.3.1 MARKET AND INFRASTRUCTURE FACTORS

Historic changes in natural gas prices in Hungary are reflected in Table 15-7. Natural gas prices have risen dramatically to $15.90 per million British thermal units (Btu) for industrial use and to $18.47 per million Btu for residential use, as of 2009 (EIA, 2010).

Table 15-7. Hungary's Natural Gas Prices (US$ per million Btu)

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009
Industrial Customers	3.11	3.62	5.94	7.25	8.71	11.38	14.73	18.99	15.90
Residential Customers	3.78	4.43	6.14	5.66	6.18	7.52	15.52	18.88	18.47

Source: EIA (2010)

In the 1990s, the Hungarian government privatized the coal industry, dividing the existing coal mines into supposedly profitable and unprofitable groups. The profitable ones were contracted to power plants and have been supported by government subsidies to varying degrees in the form of price guarantees, subsidies for fuel switching, and government responsibility for most existing liabilities. The introduction of European Union (EU) regulations and requirements has not changed the landscape for these factors significantly, so continued support for standard fuel sources and systems will likely continue to impede investment in alternatives like CMM (Perger, 2009).

15.3.2 Regulatory Information

No regulatory information regarding development or sales of CMM in Hungary was found.

15.4 Profiles of Individual Mines

Márkushegyi Bányaüzem, Oroszlány Coal Basin, Oroszlány

General Information:

Depth of shafts	250 meters (m)
Mining capacity	4,167 tonnes/day

General geologic Information

Coal seam gas content range	2–3 m^3/tonne
Faults	Yes
Total methane resource	0.3–0.5 billion m^3 (coal seams)

Geologic and Mining Conditions

Rank of coal	Sub-bituminous
Depth of mining	250 m
Ash content	Coal in place, run of mine - 30.8%
Sulfur content	3.3%
Gas content	2–3 m^3/tonne coal
Mining method	Longwall
Roof control method	Caving

Source: Molnar (nd)

15.5 References

EIA (2008): *International Energy Annual 2006*. U.S. Energy Information Administration (EIA), Washington, DC, table posted October 17, 2008. http://www.eia.doe.gov/pub/international/iea2006/table82.xls

EIA (2010): International Natural Gas Prices, Energy Information Administration, 2010. http://www.eia.doe.gov/emeu/international/gasprice.html

Euracoal (2008): Hungary – Profile. European Association for Coal and Lignite, 2008. http://www.euracoal.be/pages/layout1sp.php?idpage=74

Foldessy (2006): "Coalbed methane and CO_2 sequestration potential of the Mecsek Mts. Coalfields, S-Hungary." Janos Foldessy, University of Miskolc, Hungary. Institute of Mineralogy and Geography. 2006. http://fold1.ftt.uni-miskolc.hu/pdf/060330.pdf

IEA (2007): Coal and Peat in Hungary, International Energy Agency, 2007. http://www.iea.org/stats/coaldata.asp?COUNTRY_CODE=HU

Molnar (nd): Mr. Laszlo Molnar of Energy Centre Hungary. http://www.energiakozpont.hu

Perger (2009): Perger, András. The Role of Coal in the Hungarian Electricity Sector with Special Attention to the Use of Lignite, Energia Klub, November 2009. http://www.energiaklub.hu/dl/kiadvanyok/lignite_hungary.pdf

Schwochow (1997): The International Coal Seam Gas Report, Cairn Point Publishing, Steve Schwochow, 1997.

Steblez (2005): Steblez, Walter G. "The Mineral Industries of Central Europe (Czech Republic, Hungary, Poland, and Slovakia)." U.S. Geological Survey Minerals Yearbook – 2005. http://minerals.usgs.gov/minerals/pubs/country/2005/myb3-2005-ez-hu-pl-lo.xls

UNFCCC (2005a): Annex I Party GHG Inventory Submissions 2005, United Nations Framework Convention on Climate Change, 2005. http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/2761.php

UNFCCC (2005b): Kyoto Protocol - Status of Ratification, September 19, 2005. http://unfccc.int/files/essential_background/kyoto_protocol/application/pdf/kpstats.pdf

UNFCCC (2010): Annex I Party GHG Inventory Submissions 2010, United Nations Framework Convention on Climate Change, 2010. http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5270.php

USGS (2002): Coalbed Gas in Hungary— A Preliminary Report. U.S. Geological Survey, 2002. http://pubs.usgs.gov/of/2001/ofr-01-473/OF01-473.pdf

16 INDIA

16.1 Summary of Coal Industry

16.1.1 ROLE OF COAL IN INDIA

In 2007, coal represented 40.8 percent of India's total primary energy supply (IEA, 2009). Coal is the most important source of energy for electric power generation in India, which consumes more than 70 percent of India's coal production (EIA, 2004a). About three quarters of the domestic electricity is generated from coal-fired plants. Steel, cement, fertilizer, chemical, paper, and industrial plants are also major coal users, while coal has largely been phased out from the rail transport sector. India imports most of its coking coal needs—20 million tonnes (Mmt) in 2005—with another 17 Mmt of steam coal, since its domestic coal is of low quality (high-ash, low-calorific value), making it undesirable for coking coal (WEC, 2007). Even with high domestic production, India imported 10.8 percent of its total coal consumption in 2005.

As of April 2009, the Geological Survey of India estimates 267 billion tonnes of total coal resources (MOC, 2010a). BP (2010) estimated 58.6 billion tonnes of proved recoverable reserves at the end of 2009. Table 16-1 provides statistics on India's coal reserves and production.

Table 16-1. India's Coal Reserves and Production

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2009)*	54,000	4,600	58,600	5 (7.1%)
Annual Coal Production (2007)**	448.2	34.0	482.2	3 (7.8%)***

Source: *BP (2010); **IEA (2010); ***EIA (2010)

India's coal consumption increased by 35 percent between 2005 and 2009 (EIA, 2010a) and is expected to increase at an approximate annual rate of 4.1 percent to 2020 (WEO, 2008). Despite this increased consumption, the expanding demand for power has reduced the fraction of energy consumption provided by coal from approximately 68 percent in 2002 to 41 percent by 2007 (IEA, 2009).

The coal-bearing formations of India occur in two geological horizons:, the Lower Gondwana (Permian) and the Tertiary sediments (Eocene-Oliocene) of northeastern India, Rajasthan, Gujarat, Jammu, and Kashmir (Chand, 2001). Coal resources are found in 17 major coalfields in India (GSI, 2007). Reserves in these coal fields are provided in Table 16-2. Figure 16-1 shows the location of major coal deposits in India.

Table 16-2. Coal Distribution in India's Major Coalfields (million tonnes)

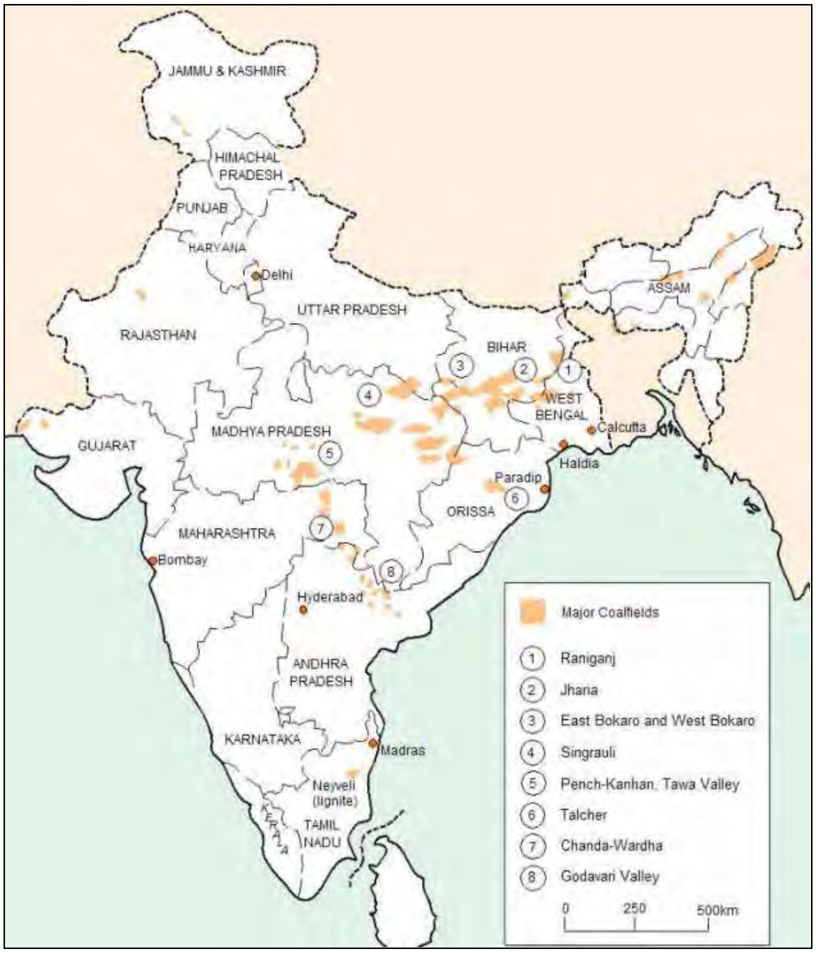
State	Coal Field	Resource	Proved Reserves
Orissa	Talcher	40869.47	12311.10
West Bengal	Raniganj	25558.85	12877.90
Orissa	Ib-river	22364.11	5401.83
Jharkhand	Jharia	19430.06	15077.57
Chattisgarh	Mand-raigarh	19106.04	1953.88
Andhra Pradesh	Godavari Valley	17714.46	8791.13
Jharkhand	N. Karanpura	15860.43	8077.77
Jharkhand	Rajmahal	14275.91	2077.97
Madhya Pradesh	Singrauli	13478.31	5002.52
Chattisgarh	Korba	10115.21	4980.58
Jharkhand	E. Bokaro	7067.47	2896.98
Jharkhand	S. Karanpura	6036.79	2542.18
Maharashtra	Wardha Valley	5669.63	2944.42
Jharkhand	W. Bokaro	5004.99	3488.10
Chattisgarh	Hasdo-arand	4972.96	1183.36
West Bengal	Birbhum	4683.02	0
Madhya Pradesh	Sohagpur	4602.63	1688.54

Source: GSI (2007) Note: Where coalfields overlap state borders, the state with the dominant share of resources is shown.

Hard coals (anthracite and bituminous) account for 77 percent of the country's proved reserves (WEC, 2007). The principal deposits of hard coal are in the eastern half of the country, ranging from Andhra Pradesh, bordering the Indian Ocean, to Arunachal Pradesh in the extreme northeast. The States of Jharkhand, Orissa, West Bengal, Chattisgarh, and Andhra Pradesh together account for about 85 percent of reserves. The Damodar Valley basins include the significant Jharia and Raniganj coalfields in the east and the Bokaro, Ramgarh, and north and south Karanpura fields in the west.

The high-rank coal seams in deeper coalfields represent a significant target for future coal mine methane (CMM) and coalbed methane (CBM) development. In some of the coalfields of the Damodar Valley, there are around 25 coal seams, or even in excess of 40 in some areas, with cumulative thickness of more than 100 meters (M2M - India, 2005).

Figure 16-1. India's Coal Fields



Source: Walker (2000)

16.1.2 STAKEHOLDERS

Table 16-3 identifies potential stakeholders in Indian CMM development.

Table 16-3. Key Stakeholders in India's CMM Industry

Stakeholder Category	Stakeholder	Role
Mining companies	▪ Coal India, Ltd. (CIL) and its eight regional subsidiaries ▪ Bharat Coking Coal, Ltd. (BCCL) - a subsidiary of CIL ▪ Singareni Collieries, Ltd	Project hosts
Engineering, Consultancy, and Related Services	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Technical assistance
Developers	▪ Reliance Industries ▪ Essar Oil Ltd. ▪ Oil and Natural Gas Corporation (ONGC) ▪ See http://www.epa.gov/coalbed/networkcontacts.html	Project opportunity identification and planning

Stakeholder Category	Stakeholder	Role
Universities, Research Establishments	▪ Central Institute of Mining and Fuel Research ▪ Central Mine Planning and Design Institute	Technical assistance CBM/CMM Clearinghouse
Government Groups	▪ Ministry of Petroleum and Natural Gas (For CBM only) ▪ Directorate General of Hydrocarbons ▪ Ministry of Coal (For CBM/CMM)	Oversight of resources, licensing

16.1.3 STATUS OF COAL AND THE COAL MINING INDUSTRY

In 2000, 27 percent of coal production in India came from underground mines and by 2008, that number had declined to 13 percent (MOC, 2009). Deep mines continue to be developed, but more surface mines are also being developed due to the country's vast resource of shallow, low-rank coal deposits. Table 16-4 summarizes the available statistics on coal production by mine type.

Table 16-4. India's Hard Coal Production by Mine Type

Type of mine	Production (million tonnes)	Number of mines (3/31/08)
Underground (active) mines	59.0	337
Surface (active) mines	433.9	186
Mixed	-	36
Total Active Mines	492.9	559

Source: MOC (2009)

There is a 3-tier classification system for underground mines, as reflected in Table 16-5.

Table 16-5. India's Classification System and Estimates of Mine Gassiness

Class	Rate of Emission Volume of Flammable Gas / tonne of Coal Produced	Number of Mines (as of 2007)
Degree I	>0.01 and < 1 cubic meter (m^3)	222
Degree II	> 1 and < 10 m^3	102
Degree III	> 10 m^3	18

Source: M2M (2008)

India's coal production faces challenges of low productivity, distribution problems, and increasing loss of domestic market share to higher-quality, less-expensive imports. India's government embarked on a series of economic reforms in the 1990s, including relaxation of restrictions on foreign ownership and privatization of some industrial enterprises. In 2004, some of these economic reforms were curtailed and continued at a slower pace. In April 2004, 470 of India's 576 mines were under the control of Coal India, Ltd. (CIL), a state-owned entity. Private mines, or investments in mines owned by Indian companies, are allowed only if "captive" to a power plant or factory (MOC, 2004); that is, the captive coal is used for power generation, steel, or cement. Private companies were allocated 60 blocks for exploration and mining in 2006–2007. Further coal-sector liberalization has been attempted, in the form of the Coal Mines Nationalisation Amendment Bill, introduced in 2000, but under pressure from labor unions the bill has stalled and is still under consideration a decade later (MOC, 2010).

At the end of 2009, a total of 208 coal blocks—with reserves of 49 billion tonnes—had been allocated for exploration and mining to eligible companies. The government is in the process of amending the Mines and Mineral (Development and Regulation) Act of 1957 to introduce an auction system of competitive bidding on future allocations of coal blocks. This is intended to be a more transparent system of awarding a decreasing number of available coal blocks to an increasing number of applicant companies (MOC, 2010).

16.2 Overview of CMM Emissions and Development Potential

India's carbon emissions increased by 61 percent between 1990 and 2001, a rate surpassed only by China. In 1994, annual emissions were 1,228.54 million tones of carbon dioxide equivalent (MmtCO$_2$e) (UNFCCC, 2004) and as of 2007 had risen another 41 percent to 1,727.71 MmtCO$_2$e. 2007 methane emissions from coal mining, and venting, flaring, storage, and transportation of oil and natural gas are calculated at 20.56 MmtCO$_2$e (MOE, 2010). Large increases in emission from the electricity, cement, and waste sectors—along with rises in the transport and residential sectors—have made India the world's fifth largest emitter after China, the United States, Europe, and Russia. More than a third of India's emissions come from low efficiency, coal-fired power plants. High capital costs of replacing existing plants, a scarcity of capital, and the long lead time required to introduce advanced coal technologies point to the likelihood that most of India's highly polluting coal-fired power plants will remain in operation for the next couple of decades (EIA, 2004b).

16.2.1 CMM Emissions from Operating Mines

Table 16-6 summarizes India's CMM emissions.

Table 16-6. India's CMM Emissions (million cubic meters)

Source	1990	1994	1995	2000	2005	2010	2015
CMM emissions (no utilization)	763*	957.3	959*	1,106*	1,363*	1,616*	1,987*

Source: UNFCCC (2004); *USEPA (2006) – estimates and projections

While there is some drainage of CMM, there are currently no commercial projects for its recovery or use in India. A US$14.9 million project of the United Nations Development Programme (UNDP), the Global Environmental Facility (GEF), and the Indian Ministry of Coal called "Coalbed Methane Recovery & Commercial Utilisation" has successfully demonstrated the commercial feasibility of utilizing methane gas recovered before, during, and after coal extraction. Recovered CBM/CMM is currently used to generate up to 250 kilowatts (kW) to meet local power needs (with a maximum capacity of 500 kW), as well as being used in 50-ton mine dump trucks, powered by converted bi-fuel engines (UNDP, 2009). Future results of the project could lead to expanded application of CMM technologies, such as the production of compressed natural gas fuel for mine vehicles and commercial scale projects.

In 2008, the U.S. EPA and the U.S. Trade and Development Association (USTDA) assisted in the establishment of the CMM/CBM Clearinghouse located at the Central Mine Planning and Design Institute's (CMPDI) campus in Ranchi (www.cmmclearinghouse.cmpdi.co.in). The Clearinghouse seeks to promote the deployment of CMM recovery and end-use technologies in India to reduce methane emissions.

The Global Methane Initiative (formerly Methane to Markets Partnership) International CMM Projects Database currently identifies 21 potential CMM recovery projects in India. The majority of these are at the "initial idea" stage, but several have moved to a planning stage and are actively searching for funding.

At the Moonidih Mine in Jharkhand, a pre-feasibility study on electricity generation using ventilation air methane (VAM) was completed in 2009. Another pre-feasibility study has been completed by AES Chhattisgarh Energy (AEC) at the Sayang mine block in the Trans Raigarh coal basin. AES plans to explore a CMM production and utilization program to mitigate methane emissions from mine workings, generate carbon credits and improve overall mine safety (M2M Projects Database, 2010). As of March 2010, a demonstration project was in place and operating at the Moonidih and Sudamdih mines in the Jharia field. The project produces fuel which is then used in power generation (Essar, 2010).

Through the former M2M Partnership, USEPA awarded a grant to the Central Institute of Mining and Fuel Research to conduct a feasibility study on the recovery and utilization of CMM in the Jharia, Bokaro and Raniganj coalfields. The project is intended to provide data on CMM/VAM/abandoned mine methane (AMM) emissions in key gassy coal regions of India. VAM data would come from 10 working mines.

16.2.2 CMM Emissions from Abandoned Coal Mines

About 5 percent of abandoned mines in India are considered gassy, assuming the same percentage as active mines reported in the First National Communication to the United Nations Framework Convention on Climate Change (UNFCCC). No additional information is available on AMM in India at this time, although several studies are proposed to gain more information on AMM emissions volumes in India's major coalfields (M2M Projects Database, 2010).

16.2.3 CBM from Virgin Coal Seams

Estimates of India's CBM potential vary. One source estimates up to 2 trillion m^3 of CBM in 56 coal basins covering 64,000 square kilometers (km^2). Coal in these basins ranges from high-volatile to low-volatile bituminous with high ash content (10–40 percent), and its gas content is between 3 and 16 m^3/tonne (Singh, 2002). The Directorate General of Hydrocarbons estimates that deposits in 44 major coal and lignite fields in 12 states of India, covering an area of 35,330 km^2, contain 3.4 trillion m^3 of CBM depending on the rank of the coal, depth of burial, and geotectonic settings of the basins as estimated by the CMPDI.

In the Jharia Coalfield, the gas content is estimated to be between 7.3 and 23.8 m^3 per tonne of coal within the depth range of 150–1200 m. Analysis indicates every 100-meter (m) increase in depth is associated with a 1.3 m^3 increase of methane content (M2M - India, 2005).

India has been attempting to develop its CBM resources for several years. In 1997, the government formed a CBM policy that established the Ministry of Petroleum and Natural Gas as the CBM administrative agency and offered several incentives (see section 1.3.1).

In May 2001, the Indian government for the first time offered blocks for exploration and production of CBM through an international bidding process. Reliance Industries, Essar Oil Ltd., and ONGC won the bids for the blocks. The government launched a second round of bidding on nine CBM blocks in May 2003. Eight blocks were awarded to Reliance and ONGC. The Directorate General of Hydrocarbons offered an additional 10 CBM blocks during a third round of open international competitive bidding that closed in June 2006. Contracts for this third round of bidding were signed in November 2006. These 26 prospective CBM blocks in the first three rounds of bidding cover an area of around 13,590 km^2 and are estimated to contain 1.45 trillion m^3 of CBM resources (Table 16-7). Expected total production from these blocks is estimated at 39.7 million m^3 per day at their peak production level (DGH, 2010).

Over the last few years, more than 130 exploratory (test) and 80 pilot wells have been drilled in the awarded blocks. Commercial production began in the Raniganj (South) CBM block in July 2007 and commercial production in the Sohagpur (East) and Sohagpur (West) CBM blocks is expected to commence in the near future. Current gas production from these three blocks is 0.14 million m^3 per day and by 2013, production is expected to increase to 7.4 million m^3 per day. The fourth round of bidding on 10 new CBM blocks took place in the fall of 2009. The blocks cover an area of approximately 5000 km^2 and are spread over seven States. 26 bids were received for eight of the blocks on offer. Essar Oil Limited, Arrow Energy, and Great Eastern Energy Corporation Ltd. were the successful bidders (DGH, 2010).

Table 16-7. CBM Project Blocks Offered for Lease

Bidding Round for CBM Blocks	**Blocks Offered**	**Area** (km^2)	**CBM Resource** (billion cubic meters)	**Expected Production** (MMcmd)
First	5	1,930	235	9
Nomination Basis	3	643	163	5
Second	8	5,234	427	10.5
Third	10	5,784	624	15.2
Fourth	10	5,000	NA	NA
Total	36	18,591	1,449+	39.7+

Source: DGH (2010)

Table 16-8 contains a list of some of the CBM activity by private companies currently taking place in India.

Table 16-8. CBM Projects Proposed or in Development

Company	**Coalfield**	**Status**	**Notes**
Great Eastern Energy Corporation Ltd (GEECL)	Raniganj	Moved to development phase after completing CBM exploration	CBM sales begun. GIP estimated at 56.6 billion m^3 (Bcm).
	Mannargudi Block	Block awarded to GEECL in 4th bidding round	Estimated GIP is 28 Bcm.
Reliance Industries	Raniganj		
	Sohagpur	In development phase	USTDA grant for technical assistance on commercial development of CBM.
Essar Oil Ltd.	Raniganj	15 CBM production test wells drilled – CBM production and sales expected by end of 2010	Project scope is 500 wells. GIP is estimated to be 130 Bcm with recoverable reserves of 28 Bcm.
ONGC	Parbatpur, Jharkhand	Pilot project – expected to start production in 2010	Holds 5 CBM blocks in Jharkhand and 1 in Raniganj – all in exploration stage.
BP, Arrow, Geopetrol and more		Various stages of CBM exploration	

Source: M2M Expo (2010)

Commercial production of CBM started in 2008 and averaged 0.15 million m^3 per day (MMcmd) through 2008–2009. The Directorate General of Hydrocarbons projects CBM production to increase to 3.6 MMcmd by 2011–2012 and to 7.14 MMcmd by 2014.

16.3 Opportunities and Challenges to Greater CMM Recovery and Use

India is a non-Annex 1 country under the UNFCCC and it is not obligated to reduce carbon and greenhouse gas (GHG) emissions. In 2004, its first national communication provided emissions estimates for 1994. The emissions are projected to continue to grow as the economy expands (EIA, 2004a). India accepted the Kyoto Protocol in 2002 (see Table 16-9). As a non-Annex 1 party, India is eligible to receive financing for GHG mitigation projects such as CMM projects under the Clean Development Mechanism.

Table 16-9. India's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC*	June 10, 1992	November 1, 1993
Kyoto Protocol**	---	August 26, 2002 (Acceptance)

Source: *UNFCCC (2007a); **UNFCCC (2007b)

16.3.1 Market and Infrastructure Factors

Gas demand is rising sharply in India, with consumption rising from 36 Bcm in 2005 to 51 Bcm in 2009 (EIA, 2010). Gas production rates (29.9 Bcm to 38.6 Bcm over the same time frame) are increasingly lagging consumption rates and the shortfall is made up with imported natural gas and liquefied natural gas (LNG). 12.6 Bcm of gas was imported in 2009 and CIL estimates a supply gap of approximately 40 billion m^3 will eventually be reached that must be met by imports.

Current prices for imported coal, gas, and LNG make CMM and CBM an economically attractive alternative energy source, provided deliverability infrastructure is developed (Dube, 2010). Investments in coal and gas transportation infrastructure—including gas gathering, transportation, and distribution—are necessary to move CMM and CBM from coal fields to local and more distant end-use markets. One such project is in development by GAIL (India) Limited, India's principal gas transmission and marketing company, which is building a natural gas pipeline in north-east India running through many of the major coal regions. End-use markets for CMM/CBM include rural power generation, commercial power generation, and transportation fuels.

Limitations in cost and investment capital, however, remain significant barriers to technology development, application, and CMM and CBM project development in India. CMPDI and the Central Institute of Mining and Fuel Research are among the few research and development resources available.

The following actions were identified as necessary in order to fully develop India's CBM/CMM potential (M2M Workshop - India, 2005), and also reflect areas the recently established clearinghouse addresses:

- Delineation of prospective CBM/CMM blocks
- Development of coal field-specific databases
- Provision of technical and other training
- Promotion of CBM/CMM research and development
- Transfer of CBM/CMM development technologies

- Provision of substantive measures to encourage CBM/CMM development entrepreneurs and to maintain constant interaction with and among CBM/CMM developers
- Establishment of a clear policy regarding CMM development

16.3.2 Regulatory Information

A memorandum of understanding between the Ministry of Coal and Ministry of Petroleum & Natural Gas governs the procedures for allotment of blocks for CBM exploration and exploitation. CBM blocks are allocated after mutual consultations between the two ministries (Prasad, 2006). The Ministry of Coal oversees coal resources while the Ministry of Petroleum and Natural Gas oversees CBM resources.

India's heavy reliance on coal, much of it low-quality, is a major cause of the country's relatively high carbon intensity level. However, environmental standards for limiting gas emissions from surface or underground coal mining operations, as well as emissions from coal and gas combustion, are largely lacking. Current guidelines governing CMM emissions apply only to methane concentrations, and not on volume released. Other issues affecting CMM/CBM drainage and use include clarifying gas ownership, expediting private participation and possible government mandates for pre-mining degasification (Dube, 2010). A regulatory framework for CMM is under formation by the Government of India (M2M, 2008).

India has offered several incentives to attract foreign investment for CBM development. The Indian government formed a CBM policy in 1997 that established the Ministry of Petroleum and Natural Gas as the CBM administrative agency and offered following key benefits:

- No upfront payment
- No signature bonus
- No participating interest of the government of India
- CBM development blocks allotted through a competitive bidding process
- A 7-year tax holiday, beginning with the date of commercial CBM production
- Freedom to market in domestic market at market determined prices
- Imported equipment for CBM development exempted from customs duties
- Walkout option at the end of Phases I & II

Incentives also allow no limitation on cost recovery, unincorporated joint ventures, accelerated depreciation, and securitization of interest. India has implemented policy changes to encourage foreign investment, including lowering or eliminating tariffs on capital goods, such as electric power generation equipment (EIA, 2004a).

16.4 Profiles of Individual Mines

Moonidih Mine, Jharkhand

Mine Status	Active	**Mine Owner**	Bharat Coking Coal Limited (BCCL)
Mining Method	Longwall	**Parent Company**	Coal India Limited (CIL)
Depth of seams	To 500 m	**Location**	Jharia Coalfield, Dhanbad District
2008 coal production	173,268 tonnes	**2008 VAM volume**	13.1 million m^3
		2008 Drained Methane (CH_4) volume	0
		2008 Utilized CH_4 volume	0

Musilia Unit, Ghusick Colliery, West Bengal

Mine Status	Active	Mine Owner	Eastern Coalfields Limited (ECL)
Mining Method	Room-and-Pillar	**Parent Company**	Coal India Limited (CIL)
Depth of seams	50–65 m	**Location**	Burdwan District
No. of seams	2 (additional 4 to be mined)	**2008 VAM volume**	1.899 Mm^3
2008 coal production	25,458 tonnes	**2008 Drained CH_4 volume**	0
		2008 Utilized CH_4 volume	0

Other mine profiles are located in the Global Methane Initiative (formerly Methane to Markets Partnership) International CMM Projects Database.

16.5 References

BP (2010): Statistical Review of World Energy June 2010, 2006. Coal – Reserves Table, London, 2005, http://www.bp.com/productlanding.do?categoryId=6929&contentId=7044622

Chand (2001): Coalbed Methane: Policies / Regulation for Exploration in India, Chand, S.K., TERI Newswire July, 2001.

DGH (2008): Petroleum Exploration & Production Activities, Annual Report 2007–08, Directorate General of Hydrocarbons, Ministry of Petroleum and Natural Gas, New Delhi, India. http://www.dghindia.org/pdf/07-08.pdf

DGH (2010): CBM Exploration, Directorate General of Hydrocarbons, Ministry of Petroleum and Natural Gas, New Delhi, India, March 18, 2008. http://www.dghindia.org/Index.aspx

Dube (2010): Coal Mine Methane Projects and Opportunities in India. Presented by Sanjay Dube, ICF, at M2M Partnership Expo, New Delhi, India. March 2010. http://www.methanetomarkets.org/expo/docs/postexpo/coal_dube.pdf

EIA (2004a): India: Environmental Issues, U.S. Energy Information Administration, Washington, DC, February 2004.

EIA (2004b): India Country Analysis Brief, U.S. Energy Information Administration, Washington, DC, October 2004.

EIA (2007a): Data obtained from International Energy Annual 2005. U.S. Energy Information Administration, Washington, DC, June 21, 2007. http://www.eia.doe.gov/pub/international/iea2005/table82.xls (reserves)

EIA (2007b): India Country Analysis Brief, U.S. Energy Information Administration, Washington, DC, January 2007. http://www.eia.doe.gov/cabs/India/Background.html

EIA (2007c): World Dry Natural Gas Imports, 1990–2005, U.S. Energy Information Administration, Washington, DC, June 21, 2007. http://www.eia.doe.gov/pub/international/iealf/table43.xls

EIA (2010): India Energy Profile. U.S. Energy Information Administration (EIA), Washington, DC. http://tonto.eia.doe.gov/country/country_energy_data.cfm?fips=IN

EIA (2010a): International Energy Statistics – Coal Consumption – India. U.S. Energy Information Administration, Washington D.C. website accessed July 2010.

Essar (2010): Developments in India - CMM/CBM at the Coal Mine Methane 'Project Development Status and Trends for the Methane to Markets' EXPO, Essar Exploration & Production Ltd., March 3, 2010. http://www.methanetomarkets.org/expo/docs/postexpo/coal_sawhney.pdf

GEF (2008): India: Coal Bed Methane Recovery and Commercial Utilization, Global Environment Facility, Washington, DC, accessed March 2008. http://www.gefonline.org/projectDetailsSQL.cfm?projID=325

GSI (2007): Inventory of Geological Resource of Indian Coal, Geological Survey of India, Ministry of Mines, Calcutta, India, January 4, 2007.

IEA (2002): *Coal in the Energy Supply of India*, International Energy Agency, Paris, France, 2002, at http://www.iea.org/textbase/nppdf/free/2000/coalinindia2002.pdf

IEA (2007): International Energy Agency Energy Statistics – Coal. International Energy Agency, Paris, France. http://www.iea.org/subjectqueries/index.asp

IEA (2009): International Energy Agency Energy Statistics – Share of total primary energy supply in 2007. International Energy Agency , Paris France. Accessed 15 June 2010. http://www.iea.org/stats/pdf_graphs/INTPESPI.pdf

IEA (2010): International Energy Agency Energy Statistics – Coal and Peat in India in 2007. International Energy Agency , Paris France. Accessed 14 June 2010. http://www.iea.org/stats/coaldata.asp?COUNTRY_CODE=IN

IEA Coal Research (1983): Concise Guide to the World Coalfields, Cope, J.H.R., Duckworth, N.A., Duncan, S.V., Holtom, J.E.B., Leask, A.L., McDonald, K.A. and Woodman, S.P., compiled by Data Bank Service, World Coal Resources and Reserves, IEA Coal Research, London, England, 1983

M2M-India (2005): Methane to Markets Partnership – CMM: India Profile, submitted to Methane to Markets International by the Government of India, 2005.

M2M Partnership (2007): Coal Mine Projects in India, Methane to Markets Partnership Expo: A Forum for Projects, Technology, Financing and Policy — Project Opportunity Posters and Flyers, Methane to Markets International, October 30 to November 1, 2007. http://www.methanetomarkets.org/tools-resources/coal_techproceeds.aspx

M2M Projects (2008): Methane to Markets International Coal Mine Methane Projects Database, Methane to Markets, 2008. http://www2.ergweb.com/cmm/index.aspx

M2M Projects (2010): Methane to Markets International Coal Mine Methane Projects Database, Methane to Markets, 2010. http://www.methanetomarkets.org/projects/index.aspx

M2M (2008): Strategies for promoting CMM project development in India. Methane to Markets Coal Subcommittee meeting at Cagliari, Italy 29–30 April 2008. http://www.methanetomarkets.org/documents/coal_cap_india.pdf

M2M Expo (2010): Coal proceedings – Methane to Markets Partnership Expo. New Delhi, India. March 2010. http://www.methanetomarkets.org/expo/coal.htm

M2M Workshop - India (2005): *Status Paper on India's CBM/CMM Development*, presented at the Methane to Markets Regional Workshop, December 2, 2005, Beijing, China, at http://www.methanetomarkets.org

MOC (2004): No .of Mines – Company Wise as on 31.03.2004, Ministry of Coal, New Delhi, India, at http://www.coal.nic.in/abtmines.htm

MOC (2009): Provisional Coal Statistics 2008–2009, Ministry of Coal, Government of India, Kolkata, India, 2009. http://coal.nic.in/provcoalstat0809.pdf

MOC (2010a): Inventory of Coal Resources of India. Ministry of Coal. Accessed 17 June 2010. http://coal.nic.in/reserve2.htm

MOC (2010b): Coal Annual Report, Ministry of Coal, Government of India, Kolkata, India, 2009. http://coal.nic.in/annrep0910.pdf

MOE (2010): India: Greenhouse Gas Emissions 2007, Ministry of Environment and Forests (INCCA Indian Network for Climate Change Assessment), Government of India, Kolkata, India, 2010. http://moef.nic.in/downloads/public-information/Report_INCCA.pdf

Prasad (2006): Personal communication with D.N. Prasad, Ministry of Coal, May 16, 2006.

Singh (2002): Progress of Coalbed Methane in India, Singh, U.P., Coal India, Ltd., presentation to North American Coalbed Methane Forum, November, 2002.

UNDP (2009): Coal Bed Methane Recovery and Commercial Utilization – Factsheet, United Nations Development Programme – India, New Delhi, India, March 2009. http://data.undp.org.in/factsheets/ene/Coal-Bed-Methane-Recovery-Commercial-Utilization.pdf

UNFCCC (2004): India Initial National Communication to United Nations Framework Convention on Climate Change, 2004, at http://unfccc.int/resource/docs/natc/indnc1.pdf

UNFCCC (2007a): United Nations Framework Convention on Climate Change - Status of Ratification, August 17, 2007. http://unfccc.int/files/essential_background/convention/status_of_ratification/application/pdf/unfccc_conv_rat.pdf

UNFCCC (2007b): Kyoto Protocol - Status of Ratification, United Nations Framework Convention on Climate Change, December 12, 2007. http://unfccc.int

USEPA (2004): Coalbed Methane Extra, United States Environmental Protection Agency, Washington, DC, July 2004, p. 5.

USEPA (2005): Coal Mine Methane: A Valuable Energy Resource for the International Community, U.S. Environmental Protection Agency, Washington, DC, February 2005. http://www.epa.gov/cmop/docs/cmm_veric.pdf

USEPA (2006): *Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990–2020*, U.S. Environmental Protection Agency, Office of Atmospheric Programs, Climate Change Division, June 2006. http://www.epa.gov/climatechange/economics/international.html

WEC (2007): 2007 Survey of World Energy Sources, World Energy Council, 2007. http://www.worldenergy.org/documents/ser2007_final_online_version_1.pdf

WEO (2008): World Energy Outlook 2008. International Energy Agency, Paris, France. http://www.worldenergyoutlook.org/docs/weo2008/WEO2008.pdf

Walker (2000): Major coalfields of the world. CCC/32, London, UK, IEA Coal Research, 131 pp (2000)

17 INDONESIA

17.1 Summary of Coal Industry

17.1.1 ROLE OF COAL IN INDONESIA

Coal is a critically important export commodity for Indonesia. The country has 5 billion tonnes of recoverable coal reserves, of which 58.6 percent is lignite, 26.6 percent sub-bituminous, 14.4 percent bituminous, and 0.4 percent anthracite (EIA, 2004; EIA, 2008).

Indonesia produced close to 265 million tonnes (Mmt) of coal in 2007 (see Table 17-1). Coal production has increased dramatically over the past several years, increasing by more 250 percent since 2002 (EIA, 2005). Continued growth in coal production is attributable to growing international demand, as well as rising domestic electricity consumption (US Embassy, 2007; US Embassy, 2000). Exports are primarily to Japan and Taiwan, but also to South Korea, the Philippines, and China (USGS, 2007).

Coal provided for 17 percent of Indonesia's energy consumption in 2005 (IEA, 2008). Power plants consume the largest portion of coal in Indonesia, followed by cement plants (US Embassy, 2004).

Table 17-1. Indonesia's Coal Reserves and Production

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2006)*	1,721	2,607	4,328	15 (0.5%)
Annual Coal Production (2007)**	230.2	34.5	264.7	6(4.4%)

Source: *EIA (2008); **IEA (2007) Note: Numbers may not add due to rounding

Coal is found in 11 distinct basins on the four major portions of the archipelago that comprise Indonesia (Figure 17-1). Sumatra contains roughly two-thirds of Indonesia's total coal reserves, with the balance located in Kalimantan, West Java, and Sulawesi. However, most production (75 percent) takes place in East Kalimantan, which has higher quality coal deposits (US Embassy, 2000).

Figure 17-1. Indonesia's Coal Fields

Source: Stevens et al. (2001)

17.1.2 STAKEHOLDERS

Coal mine operators in Indonesia include state-owned enterprises, private national companies, and foreign mining companies (USGS, 2007).

Table 17-2. Indonesia's Major Coal Producers

Contract Operators	2007 Production (million tonnes)
PT Kaltim Prima Coal	38.7
PT Adaro Indonesia	36.0
PT Arutmin Indonesia	15.4
PT Kideco Jaya Agung	20.5
PT Berau Coal	11.8
PT Indominco Mandiri	11.5
PT Bukit Asam (State-owned)	8.5

Source: IEA (2008)

Other key stakeholders involved with the coal industry, the coal mine methane (CMM) and coalbed methane (CBM) industries are listed in Table 17-3.

Table 17-3. Key Stakeholders in Indonesia's CMM Industry

Stakeholder Category	Stakeholder	Role
Developer	▪ PT Caltex Pacific ▪ PT Bumi Resources ▪ Rio Tinto ▪ British Petroleum ▪ Eni ▪ CBM Asia Development Corp. ▪ Arrow Energy ▪ McLaren Resources ▪ Churchill Mining ▪ Perusahaan Gas Negara ▪ PT Medco Energi CBM Indonesia ▪ Vico Indonesia ▪ PT Ridlatama Mining Utama ▪ PT Samantaka Mineral Prima ▪ BP Indobararambai Gas Methane ▪ PT Barito Basin Gas ▪ PT Pertamina Hulu Energi Metana Kalimantan ▪ Sangatta West CBM Inc. ▪ KutaiWest CBM Inc. ▪ Newton Energy Capital Ltd. ▪ Indon CBM Ltd. ▪ PT Ogan Interior gas ▪ PT Visi Muti Artha ▪ PT ArthaWidya Persada ▪ PT Triskati Gas Methane ▪ PT Sigma Energy Burni ▪ PT Satu Basin Gas ▪ PT East Ogan Methane ▪ See http://www.epa.gov/coalbed/networkcontacts.html	Project opportunity identification and planning
Engineering, Consultancy, and Related Services	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Technical assistance
Mining Company	▪ Broken Hill Proprietary	Australian mining company with major interest in Indonesian coal mining
	▪ Clough Group	Australian company
	▪ Perusahaan Tambang Batubara Bukit Asam	State-owned coal company responsible for roughly 25% of coal production in 1999
Government Groups	▪ Ministry of Energy and Mineral Resources ▪ Directorate of Mineral and Coal Enterprises	Licensing

17.1.3 Status of Coal and the Coal Mining Industry

Since 1981, the central government has been ceding greater autonomy to the regional coal administrators. The government maintains ownership of coal and associated methane gas but contracts mine operations to private companies. The latest revision of the model contract is royalty-based. Fifteen contractors produced more than 75 percent of Indonesia's total coal production in 1999. Another 15 percent was mined by state-owned coal company Perusahaan Tambang Batubara Bukit Asam, operating in Sumatra (US Embassy, 2000). Indonesia's new production will come mostly from private mines.

Foreign companies are involved in Indonesia's coal industry. The Clough Group of Australia was awarded a $215 million contract for improvements at Gunung Bayan Pratama's (commercial producer of coal beginning 1999) Kutai mine in E. Kalimatan. Furthermore, Rio Tinto and partner British Petroleum (BP) were divested in July 2003 from their joint venture in Kaltim Prima Coal. The shares were sold to PT Bumi Resources for $500 million. According to several reports, the divestment was prolonged and acrimonious because the government objected to Rio Tinto's divestment plan and threatened to mobilize public action to block the mine's operations. Ultimately, Rio Tinto and BP sold their combined 100 percent stake for about half of its assessed value (EIA, 2004).

There were three active, underground mines in Indonesia in 2004. In 1999, 99 percent of coal production, roughly 131 Mmt, came from surface mines. Production has expanded in recent years via the expansion of existing surface mines, as well as the addition of new surface mines.

Indonesian coal in general has relatively low gas content because of its low rank and shallow depth. Evaluated gas content in potential CBM areas ranged from 3 to 9 m^3 per tonne (Stevens et al., 2001).

17.2 Overview of CMM Emissions and Development Potential

The Global Methane Initiative (formerly Methane to Markets Partnership) International CMM Projects Database currently identifies no CMM recovery projects in Indonesia, in operation or development (M2M Projects, 2010).

17.2.1 CMM Emissions from Operating Mines

In its first National Communication with the United Nations Framework Convention on Climate Change (UNFCCC) in 1994, Indonesia reported fugitive methane emissions from solid fuel in 1994 to be 131 Mmt. U.S. Environmental Protection Agency provides data for additional years as reflected in Table 17-4 below.

Table 17-4. Indonesia's CMM Emissions (million cubic meters)

Emission Category	1990	1995	2000	2005 (estimated)
Total emitted (= Total liberated – recovered & used)	21	28	35	34

Source: USEPA (2006)

17.2.2 CMM Emissions from Abandoned Coal Mines

No information about CMM from abandoned mines in Indonesia is available at this time.

17.2.3 CBM from Virgin Coal Seams

Estimated CBM resources in Indonesia range from 337 trillion cubic feet (Tcf) to 453 Tcf (Stevens et al., 2001; Stevens and Hadiyanto, 2004). Table 17-5 describes the CBM Resources in Indonesia. Some of the most promising areas for exploration are believed to include the Barito and Kutei basins in Kalimantan, the south and central basins in Sumatra, and the Jatibarang basin in Java (Stevens et al., 2001).

The Minister of Energy and Mineral Resources has authorized the Directorate General of Oil and Gas (MIGAS) to develop CBM in Indonesia (US Embassy, 2000). Several companies have developed partnerships and taken initial steps toward CBM development in Sumatra and Kalimantan. These include PT Caltex Pacific, Arrow Energy, McLaren Resources, Churchill Mining, and Perusahaan Gas Negara (US Embassy, 2000; Arrow Energy, 2006; McLaren, 2006; ADVFN, 2007; US Embassy, 2007). Some of the contracts awarded recently include:

- PT Medco Energi CBM Indonesia and Arrow Energy agreed to jointly explore the conventional oil and gas area in SSE1 Block in South Sumatra in February 2009 (Shift, 2009).
- Vico Indonesia is performing a feasibility study in the Sanga Sanga block in East Kalimantan as of March 2009 (Shift, 2009).
- PT Ridlatama Mining Utama won a contract to extract gas from coal seams in a block in East Kalimantan in June 2008 (Contracts, 2009).
- PT Samantaka Mineral Prima began developing a block in Riau province in June 2008 (Contracts, 2009).
- Four CBM blocks were tendered to companies in November 2008 for exploration: the Barito Banjar-1 block to BP Indobararambai Gas Methan, the Barito Banjar-2 block to PT Barito Basin Gas, the Sangatta block to PT Pertamina Hulu Energi Metana Kalimantan and Sangatta West CBM Inc., and part of the Kutai block to KutaiWest CBM Inc. and Newton Energy Capital Ltd (Shift, 2009).
- Rengat CBM block in Riau, Central Sumatra was contracted to the Canadian company Indon CBM Ltd. in November 2009 (Recent CBM, 2010).
- Barito CBM block in South Kalimantan was contracted to the consortium formed by Trans Asia Resources and Jindal Stainless Steel Indonesia in November 2009 (Recent CBM, 2010).
- Sanga-Sanga CBM block in East Kalimantan was contracted to Vico Indonesia in November 2009, which overlaps the Sanga-Sanga oil and gas block that it is already working (Recent CBM, 2010).

CBM contracts were signed for the following coal basins from May to August 2009 (Recent CBM, 2010):

- South Sumatra basin by PT Ogan Interior Gas;
- Kutei basin by PT Visi Muti Artha and PT ArthaWidya Persada;
- Barito basin by PT Triskati Gas Methane and PT Sigma Energy Burni;
- Asem Asem basin by PT Satu Basin Gas; and
- South Sumatra basin by PT East Ogan Methane and Arrow Energy (Tanjung Enirn)

Further, CBM Asia Development Corp. has interest in production sharing contracts (PSCs) for the South Sumatra and Kutai Basins and is investigating commercial feasibility of CBM in the Kutai-West PSC (CBM Asia, 2010).

Figure 17-2. Indonesia's CBM Basins

Source: CBM Asia (2010)

Table 17-5. Indonesia's CBM Resources

Region/Basin	*Prospective Area (square kilometers)	CBM Resources (trillion cubic meters)	CBM Resources (trillion cubic feet)
Kalimantan			
▪ Barito	15,000	2.88	101.6
▪ Berau	2,000	0.24	8.4
▪ Kutei	10,000	2.53	89.4
▪ N. Tarakan	6,500	0.50	17.5
▪ Pasir Asam-Asam	1,000	0.085	3.0
▪ Ombilin	1,500	0.014	0.5
Sumatra			
▪ Central	15,000	1.49	52.5
▪ South	20,000	5.18	183.0
▪ Bengkulu	3,000	0.10	3.6
Java			
▪ Jatibarang	500	0.023	0.8
Sulawesi			
▪ Sengkang	1,000	0.057	2.0
Total	**74,000**	**9.47**	**336**

Source: *Stevens et al. (2001); Jakarta Post (2010)

17.3 Opportunities and Challenges to Greater CMM Recovery and Use

Indonesia is a signatory to both the UNFCCC and the Kyoto Protocol. As a Non-Annex I Party to the Kyoto Protocol, Indonesia has no national emissions targets and is eligible to host a mitigation project under the Clean Development Mechanism (see Table 17-6).

Table 17-6. Indonesia's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC	June 5, 1992	August 23, 1994
Kyoto Protocol	July 13, 1998	December 3, 2004

Source: UNFCCC (2004); UNFCCC (2005)

17.3.1 Market and Infrastructure Factors

Oil and gas infrastructure exists in several coal basins with significant potential. It is lacking, however, in the key Barito Basin. Indonesia's service industry appears to have the capability to support CBM developments consisting of roughly hundreds of thousands of low-cost wells (Stevens et al., 2001). The existing extensive pipeline infrastructure in the many major target basins could be used to move produced gas to domestic or export markets. A key market opportunity could be to conduct CBM development adjacent to high value Jakarta, Central Sumatra, or other gas demand centers. Alternatively, CMM or CBM recovered could be utilized by the steamflooding oil recovery or power generator industries or be exported to Singapore or Malaysia. One challenge to CBM/CMM development is the heavy government subsidization of competing domestic petroleum products (Stevens et al., 2001). CBM and CMM must also be able to compete with Indonesia's "stranded" conventional gas reserves, although a factor favoring CBM/CMM production may be the fact that conventional gas reserves have high levels of carbon dioxide (CO_2). Production from CBM "sweet spots" could be cheaper to develop than deep and structurally more complex conventional gas reservoirs with high CO_2 concentrations (Stevens et al., 2001).

17.3.2 Regulatory Information

Coal and gas resources are owned by the State. Private companies wishing to extract resources are required to develop a production-sharing contract with Indonesia, which historically has been considered to have one of the toughest contract terms in the world (countrydata.com, 1992). Production splits for oil and natural gas directed 60–80 percent of profits to the government and the remainder to the contractor. In 2003, production splits were adjusted to 65/35 for oil and 55/45 for gas (USGS, 2003). In 2007, the government announced that it would offer a 45 percent production split for CBM developments in order to encourage investors.

CBM is to be treated on the same terms as oil and gas and will be controlled by MIGAS (Reuters, 2007). Regulation No. 36 of 2008 on Business Undertaking of Coal Bed Methane is the current primary regulation for CBM development. Under the new regulation, oil and gas contractors have precedence over coal mining contractors in overlapping areas, though there are some exceptions for contracts made prior to the passage of the regulation. The CBM block agreements made since its passage have been made with a 55/45 split in favor of the government with cost recovery ceilings and other governmental participation options (Recent CBM, 2010).

17.4 Profiles of Individual Mines

No mine profiles are available at this time for Indonesia.

17.5 References

ADVFN (2007): "Churchill Mining and Partner Wins Indonesia Coal Bed Methane JEA License," May 9, 2007. http://www.lse.co.uk/ShareNews.asp?shareprice=CHL&ArticleCode=yprsdrdshoa13et&ArticleHeadline=Churchill_Mining_and_partner_wins_Indonesia_coal_bed_methane_JEA_licence

Arrow Energy (2006): Quarterly Report for the Quarter Ended Dec 31, 2006, Arrow Energy, N.L. http://www.arrowenergy.com.au/icms_docs/29920_Second_Quarter_Activities_Report_06.pdf

BP (2009): "BP Captures Coalbed Methane Resources in Indonesia," November 30, 2009. http://www.bp.com/genericarticle.do?categoryId=2012968&contentId=7058156

CBM Asia (2010): CBM Asia, CBM Asia Development Corp., accessed July 30, 2010. http://www.cbmasia.ca/s/Home.asp

Contracts (2009): CoalBed Methane (CBM) Contracts Offered in Indonesia, Future Energy Events, January 20, 2009. http://www.futureenergyevents.com/coalbedmethane/2009/01/20/coalbed-methane-cbm-contracts-offered-in-indonesia/

Countrydata.com (1992): "Indonesia- A Country Study, Petroleum, Liquefied Natural Gas, and Coal," Based on the Country Studies Series by Federal Research Division of the Library of Congress. http://www.country-data.com/cgi-bin/query/r-6275.html

EIA (2004): Indonesia Country Analysis Brief, U.S. Energy Information Administration, July 2004. http://www.eia.doe.gov/cabs/indonesia.html

EIA (2005): International Energy Annual 2003. U.S. Energy Information Administration, Washington, DC, table posted June 13, 2005. http://www.eia.doe.gov/pub/international/iealf/table25.xls (production)

EIA (2008): International Energy Annual 2006, Energy Information Agency, December 2008. http://www.eia.doe.gov/emeu/iea/contents.html

IEA (2007): Coal and Peat in Indonesia. International Energy Agency, 2007. http://www.iea.org/stats/coaldata.asp?COUNTRY_CODE=ID

IEA (2008) Energy Policy Review of Indonesia, International Energy Agency, 2008. http://www.iea.org/textbase/nppdf/free/2008/Indonesia2008.pdf

Jakarta Post (2010): RI set to be the first CBM-LNG producer, The Jakarta Post, June 7, 2010. http://www.thejakartapost.com/news/2010/06/07/ri-set-be-first-cbmlng-producer.html

M2M Projects (2010): Methane to Markets International Coal Mine Methane Projects Database, Methane to Markets, accessed June 2010. http://www2.ergweb.com/cmm/index.aspx

McLaren (2006): "Management's Discussion and Analysis," McLaren Resources, Inc, December 31 2006. http://www.mclarenresources.com/images/uploads/2009%2012%2031%20McLaren%20MDA.pdf

Recent CBM (2010): Recent CBM Developments in Asia, HIS Inc., March 2010. http://energy.ihs.com/source/international/mar10/CBM_Developments.htm

Reuters (2007): "Indonesia Seeks Investors for Coal Bed Methane Sector," *Reuters*, Nov 6, 2007.

Shift (2009): Indonesia - The Shift To CBM, AllBusiness.com, March 16, 2009. http://www.allbusiness.com/company-activities-management/company-structures-ownership/11815119-1.html

Stevens et al. (2001): Indonesia's 337 TCF CBM Resource a Low Cost Alternative to Gas, LNG, Stevens, Scott H., K. Sani, and S. Hardjosuwiryo, *Oil & Gas Journal*, October 22, 2001.

Stevens and Hadiyanto (2004): "Indonesia: Coalbed Methane Indicators and Basin Evaluation," Society of Petroleum Engineers, Paper SPE 88630.

UNFCCC (2004): United Nations Framework Convention on Climate Change - Status of Ratification, May 24, 2004. http://unfccc.int/kyoto_protocol/status_of_ratification/items/2613.php

UNFCCC (2005): Kyoto Protocol - Status of Ratification, September 19, 2005. http://unfccc.int/files/essential_background/kyoto_protocol/application/pdf/kpstats.pdf

US Embassy (2000): Coal Report: Indonesia 2000, Embassy of the United States of America, Jakarta, October 2000.

US Embassy (2004): "INDONESIA'S COAL OUTPUT INCREASES IN 2004." http://jakarta.usembassy.gov/econ/coal/coal-2004.html

US Embassy (2007): "Indonesia: Energy Highlights February 2007," 2007. http://jakarta.usembassy.gov/econ/Feb%2007%20Energy%20highlights.pdf

USEPA (2006): *Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990–2020*, U.S. Environmental Protection Agency, Office of Atmospheric Programs, Climate Change Division, June 2006.

USGS (2003): The Mineral Industries of Indonesia and East Timor (Timor-Leste), Pui-Kwan Tse, U.S. Geological Survey, Reston, VA, 2003. http://minerals.usgs.gov/minerals/pubs/country/2003/idttmyb03.pdf

USGS (2007): "Geochemistry of Selected Coal Samples from Sumatra, Kalimantan, Sulawesi, and Papua, Indonesia," H. Belkin and S. Tewalt. U.S. Geological Survey, 2007. http://pubs.usgs.gov/of/2007/1202/

18 ITALY

18.1 Summary of Coal Industry

18.1.1 ROLE OF COAL IN ITALY

Italy is severely deficient in coal resources and relies almost entirely on imports for its coal supply. Coal's contribution to total energy use in the country was about 9.5 percent in 2007, amounting to a consumption of 28 million tonnes (Mmt) (IEA, 2007; EIA, 2008a). The bulk of coal consumed is used for electricity generation. Italy imports coal primarily from South Africa (20 percent), Colombia (13 percent), and Australia (12 percent) (EIA, 2008b).

Italy produces about 0.158 Mmt of coal annually (see Table 18-1), sourced entirely from Miniera Monte Sinni, Italy's only active underground coal mine, located in the Sulcis Basin in the south-west of Sardinia Island (Figure 18-1). Estimates of Italy's sub-bituminous and lignite reserves are about 10 Mmt of mineable coal (out of a worldwide total of 600 Mmt) (EIA, 2008a; World Energy Council, 2007). Another source places total reserves at more than 1,000 Mmt. To date, a total of 80 Mmt has been produced from the basin (Heritage Petroleum, 2007).

Table 18-1. Italy's Coal Reserves and Production

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2006)*	0	10		32 (0.00001%)
Annual Coal Production (2007)**	0.158	0	0.158	29 (0.0026%)

Source: *EIA (2008a); **IEA (2007)   Note: Numbers may not add due to rounding

Figure 18-1. The Only Underground Coal Mine in Italy

Source: IEA Clean Coal Center (2005)

18.1.2 Stakeholders

Table 18-2 lists potential stakeholders in Italy's coal mine methane (CMM) industry. SOTACARBO, a 50-percent state-owned company, has joined Carbosulcis in promoting methane recovery from the Sulcis Basin. SOTACARBO partners with University of Caligari and the Istituto Italiano di Geofisica e Vulcanologia (INGV).

Table 18-2. Key Stakeholders in Italy's CMM Industry

Stakeholder Category	Stakeholder	Role
Mining Companies and CBM Developers	▪ SOTACARBO ▪ Kimberley Oil ▪ Carbosulcis ▪ European Gas Limited ▪ Heritage Petroleum ▪ Independent Resources plc ▪ Vico Indonesia (Eni S.p.A. subsidiary) ▪ Shell ▪ Future Corporation Australia ltd	Project hosts
Developers	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Project opportunity identification and planning
Engineering, Consultancy, and Related Services	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Technical assistance
Universities, Research Establishments	▪ The Istituto Italiano di Geofisica e Vulcanologia ▪ University of Caligari ▪ National Institute for Geophysics and Vulcanology.	Technical assistance
Government Groups	▪ Ministry of Productive Activities – Directorate for Energy and Mineral Resources ▪ Ministry of Environment , Environment, Land and Sea ▪ Energy Authority (Autorità per l'Energia Elettrica e il Gas, AEE).	Licensing, monitoring, and control

18.1.3 Status of Coal and the Coal Mining Industry

Carbosulcis' Miniera Monte Sinni is currently the only operating coal mine in Italy (Table 18-3), and its concession is owned by the Regional Government of Sardinia (M2M, 2005). Production declined sharply from Italy's single source of lignite, the Santa Barbara Mine in Tuscany, from 156 thousand tonnes in 1998 to an estimated 10 thousand tonnes in 2002. The mine was operated by Enel (Ente Nazionale per l'energia Elettrica), the state-owned electricity company (USGS, 2002; USGS, 2003). The mines closed in 2003 and were still closed, as of 2007 (USGS, 2007a; IEA, 2003).

Table 18-3 Recent Coal-Mining Statistics

Type of Mine	Production (million tonnes/year)	Number of Mines
Underground (active) mines – total	0.158	1
Surface (active) mines – total	None	N/A

Italy's European Union (EU) membership has initiated privatization of the country's energy sector. Ente Nazionale Idrocarburi (ENI), the state-held oil and gas giant, and Enel became joint-stock companies in 1992. The state still has a 30 percent stake in each company. Consequently, several new participants have emerged in Italy's energy markets this past decade, and both companies have an international presence (ENI, 2010; ENEL, 2010).

Italy is the fourth highest consumer of energy in Europe, with consumption at 8.1 quadrillion Btu in 2006 (EIA, 2007). Fueled by the rising demand for power, Italy has increased its dependence on coal for power generation over the past decade. But consumption has recently plateaued as natural gas use has expanded, and Italy currently relies on coal for only 7 percent of its overall energy needs (EIA, 2008b). Planned coal mine and power plant projects have been abandoned in some cases due to political and administrative barriers (USGS, 2007b).

18.2 Overview of CMM Emissions and Development Potential

18.2.1 CMM Emissions from Operating Mines

Although the current mining operations in the Sulcis Basin are conducted at an average depth of 400 meters below the surface, only modest methane emissions have been recorded at these depths (see Table 18-4).

Table 18-4. Italy's CMM Emissions (million cubic meters)

Emission Category	1995	2000	2004	2005	2006	2007	2008
Underground mining activities—all	0.00	1.73	1.45	1.40	0.31	2.33	1.73
Post-underground emissions	0.00	0.05	0.04	0.04	0.01	0.07	0.05
Surface mine emission (total)	0.71	0.03	0.00	0.00	0.00	0.00	0.00
Post-surface mining emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total liberated (= sum of all above)	0.71	1.81	1.49	1.45	0.32	2.40	1.78

Source: USEPA (20010); UNFCCC (2010a) (converted from gigagrams [Gg])

18.2.2 CMM Emissions from Abandoned Coal Mines

Future Corporation Australia recently announced that it will begin three methane projects in Italy in partnership with several other European companies. However, as of June 2010, the projects have not begun (FUT, 2010a; FUT, 2010b).

18.2.3 CBM from Virgin Coal Seams

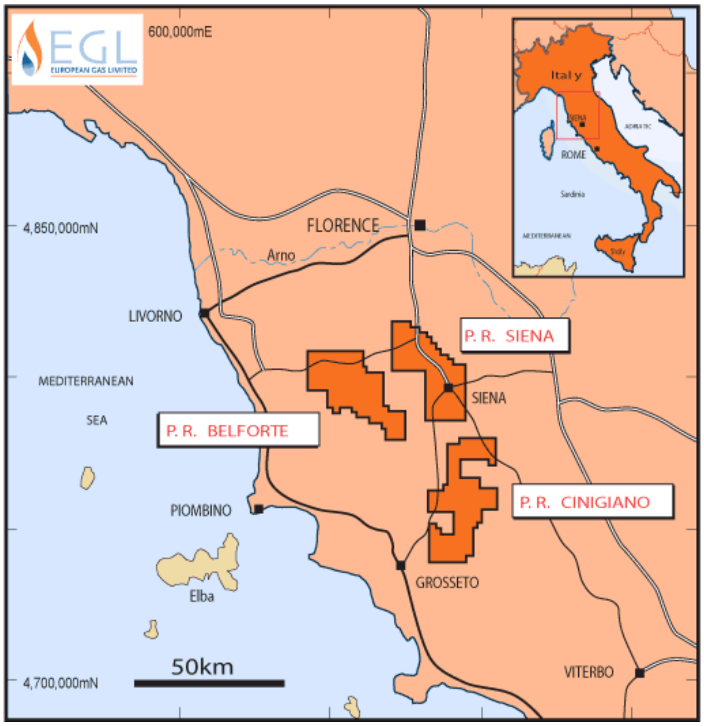
Key companies involved in coalbed methane (CBM) exploration in Italy include European Gas Limited (formerly known as Kimberley Oil NL) and Heritage Petroleum. They have targeted the Sulcis Basin as well as three areas in southern Tuscany. Nearby volcanic centers and geothermal activity in these locations are believed to have created high concentrations of gas (Heritage Petroleum, 2007).

The Sulcis Basin is estimated to have as much as 1,000 Mmt of sub-bituminous coal from the Eocene age. Along with a 150-meter (m) thick coal sequence, substantial thicknesses of impure coal and carbonaceous shale also exist, which have the capability to generate significant methane aside from the coal seams. Although coal mining in the eastern region did not indicate much methane, the geological conditions are different in the western region, suggesting significant gas reserves. The Porduttivo formation in the west is overlain by the Oligocene-Miocene volcanic centers. Geothermal activities from this condition would lead to strong maturation of coal seams and high concentrations of gas (Heritage Petroleum, 2007).

Also, SOTACARBO has partnered with Carbosulcis and University of Caligari to promote CBM production. Their main activities include sampling and analyzing Sulcis coal, finding new deeper coal seams, checking the use of CBM methods currently in place in the region, and updating enhanced CBM technologies.

Meanwhile, European Gas Limited and Heritage Petroleum have been granted three research permits in Tuscany (Figure 18-2). These permits cover 1,500 square kilometers (km^2) of three basins containing Miocene coal. Mining in this area was discontinued in 1959 due to a methane gas explosion that killed 42 people. As with the Sulcis Basin, it is believed that geothermal activities and enhanced heat flow in the area have created conditions for high levels of methane production (Heritage Petroleum, 2007; EGL, 2010).

Figure 18.2. European Gas Limited's Tuscany Projects



Source: EGL (2010)

18.3 Opportunities and Challenges to Greater CMM Recovery and Use

Italy is an Annex I partner under the Kyoto Protocol (see Table 18-5) and has agreed to reduce its carbon dioxide emissions by 2008–2012. However, it will do so as a collective target for all the EU countries. Under EU commitment, Italy must reduce its emissions by 6.5 percent below the 1990 level. However, Italy is not on track, unlike other EU countries, to meet its pledge. During the 2009 UNFCCC Copenhagen Conference, the EU community, speaking through the European Commission, pledged to reduce emissions 20 percent unconditionally by 2020. They further pledged a 30 percent cut by 2020 if an international accord was reached (EC, 2009).

Table 18-5. Italy's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC	June 5, 1992	April 15, 1994
Kyoto Protocol	April 29, 1998	May 31, 2002

Source: UNFCCC 2009; UNFCCC (20010b)

18.3.1 MARKET AND INFRASTRUCTURE FACTORS

Currently, Italy is pursuing several technical issues related to CMM recovery. Developing an effective methane survey system and analysis models for recovery of CMM from the Sulcis Basin is the top priority. Improving gas drainage, identifying CMM utility and measuring emissions at surface mines are among other issues facing Italy. In general, Italy is not prepared for CMM projects in terms of public attitude, R&D efforts, or private financing. The country will benefit by networking with countries with advanced CMM experience.

Italy's natural gas market is highly evolved, providing for about 40 percent of the total energy consumed by the country (IEA, 2007). Therefore, Italy has a well-established network of pipelines extending for 30,000 km—the third largest pipe network in Europe—and offers open access. However, as of now, Sardinia is not connected to this gas transportation system. Plans are in place to connect southern Sardinia for gas imports from Algeria by 2012 (EIA, 2008b; Snam Rete Gas, 2010). This would be strategic for implementing CBM marketing in Italy, since the Sulcis Basin in southern Sardinia is the most promising site for CBM.

18.3.2 REGULATORY INFORMATION

Italy's energy and natural resources policies allow both government and private companies to operate production. Companies may be given concessions that need periodic renewal to recover methane or mine coal. For a given coal basin, mining coal and draining methane can be executed by separate companies.

The CMM recovery work is still in its infancy in Italy, and the country lacks legal regulation for the CMM industry. An extension of the natural gas legal framework may, therefore, apply. ENI has been controlling the gas industry almost completely. But, since 2000, the gas industry is slowly being liberalized in compliance with the EU policies, including freeing of gas prices and decentralizing production and distribution. Italy still has the state involved in response to public opinion. There is no domestic private investment, but foreign private sector investments are involved (EIA, 2008b).

All natural resources are owned by the government. Licenses may be given at discretion to private companies for exploration and production; terms of such deals appear open for negotiation. An exploration permit is granted for six years and has to be renewed twice, every three years. A production license runs for 20 years and is renewable. For a license to be granted, the company at hand must possess local knowledge. Royalties are set at 7 percent of the annual net production and the corporate tax rate is set at 34 percent.

Italy is gradually defining stronger environmental regulations, not only to be in compliance with EU standards, but also to respond to domestic opinions. The legal text of EU's environmental laws is in the process of being incorporated into Italian law (EIA, 2008b). Contributing to sustainable development, the CMM project outputs (electricity and pipeline gas) may enjoy competitive pricing in a free trade market.

18.4 Profiles of Individual Mines

Sulcis Basin, Sardinia

General Information

Total mineable reserves, million tones	1000 (Heritage Petroleum, 2003); 600 (World Energy Council, 2007)
Total mining area	615 km^2
Depth of shafts	400 m
Mining capacity	400,000 tonnes/year

Geologic and Mining Conditions

Rank of coal	Sub-bituminous coal
No. of seams	Up to 13
Seam thickness	35–40 m cumulative thickness over 13 seams
Depth of mining	150 m
Calorific Value	5,000 kcal/kilogram (kg)
Ash content	Poor quality
Sulfur content	Poor quality
Mining equipment	Longwall

Source: Heritage Petroleum (2007); IEA (2002)

18.5 References

EC (2009): *Fifth National Communication From The European Community Under The UNFCCC*, European Commission Brussels, Belgium. December 12, 2009. http://ec.europa.eu/environment/climat/pdf/fifth_comm_unfccc.pdf

EGL (2010): "Tuscany Projects," European Gas Limited, 2010. http://www.europeangas.com.au/tuscany.php

EIA (2007): *World Primary Energy Consumption by Region, 1997–2007*, U.S. Energy Information Administration, Washington, DC, 2007. http://www.eia.doe.gov/emeu/aer/txt/stb1102.xls

EIA (2008a): Data obtained from *International Energy Annual 2006*, U.S. Energy Information Administration, Washington, DC, table posted October 2008. http://www.eia.doe.gov/pub/international/iea2006/table82.xls (reserves)

EIA (2008b): EIA Country Analysis Briefs – Italy. Hosted by Encyclopedia of Earth, 2008. http://www.eoearth.org/article/Energy_profile_of_Italy#

ENEL (2010): Shareholders, ENEL, Rome, Italy, 2010. http://www.enel.com/en-GB/investor/shareholders/

ENI (2010): "Corporate Governance, Major Shareholders," ENI, Rome, Italy, 2010. http://www.eni.com/en_IT/governance/shareholders/relevant-participation/relevant-participation.shtml

FUT (2010a): "Future Corporation Australia Invests in European Coal Seam Methane Opportunities," Future Corporation Australia, ASX Release. September 8, 2009. http://www.futurecorp.com.au/files/announcements/ASX%20EGL%20FINAL%20RELEASE.pdf

FUT (2010b): Current Projects, Future Corporation Australia. http://www.futurecorp.com.au/projects.html

Heritage Petroleum (2007): *Company Information: Heritage Petroleum*, Heritage Petroleum, January 2007. http://www.unquoted.co.uk/companyinfo/Heriatge%20Petroleum%20Plc.pdf

IEA (2002): 2002 In-Depth Review – Italy. http://www.seenergy.org/index.php?/countries&stat=10&type=3&col=2123

IEA (2003): Energy Policies of IEA Countries, 2003. http://www.iea.org/textbase/nppdf/free/2000/italy2003.pdf

IEA (2007): *2007 Energy Balance for Italy*. International Energy Agency, Paris, France, 2007. http://www.iea.org/stats/balancetable.asp?COUNTRY_CODE=IT

IEA Clean Coal Center (2005): Second International Conference on Clean Coal Technologies for our Future, 2005. http://www.iea-coal.org.uk/publishor/system/component_view.asp?LogDocId=81265&PhyDocId=5654

M2M (2005): Coal Mine to Market Subcommittee Country Profile – Italy, Methane to Market Partnership, 2005. http://www.methanetomarkets.org/documents/events_coal_20050427_italy_profile.pdf

Snam Rete Gas (2010): "The Network," Snam Rete Gas, accessed June 2010. http://www.snamretegas.it/it/rete_e_mercato/retemercato_rete.shtml.

UNFCCC (2009): United Nations Framework Convention on Climate Change - Copenhagen Accord, December 2009. http://unfccc.int/resource/docs/2009/cop15/eng/l07.pdf

UNFCCC (2010a): Annex Party I 2010 Submissions, 2010. http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5270.php

UNFCCC (2010b): United Nations Framework Convention on Climate Change - Status of Ratification, June 2010. http://unfccc.int/essential_background/convention/status_of_ratification/items/2631.php

USEPA (2006): *Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990–2020*, U.S. Environmental Protection Agency, Office of Atmospheric Programs, Climate Change Division, June 2006. http://www.epa.gov/climatechange/economics/international.html

USGS (2002): The Mineral Industry of Italy, 2002. http://minerals.usgs.gov/minerals/pubs/country/2002/itmyb02.pdf

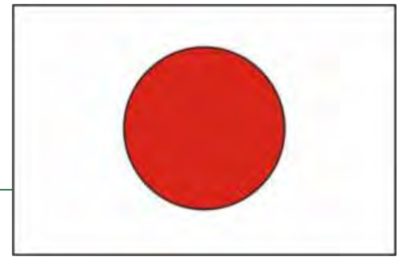
USGS (2003): Italy Production of Mineral Commodities, 2003. http://minerals.usgs.gov/minerals/pubs/country/2002/itmyb02.xls

USGS (2007a): The Mineral Industry of Italy, 2007. http://minerals.usgs.gov/minerals/pubs/country/2007/myb3-2007-it.pdf

USGS (2007b): 2005 Minerals Yearbook – Italy, U.S. Geological Survey, Reston, VA, 2007. http://minerals.usgs.gov/minerals/pubs/country/2005/itmyb05.pdf

World Energy Council (2007): World Energy Council, *2007 Survey of Energy Resources*, based on year 2005 estimates. http://www.worldenergy.org/documents/ser2007_final_online_version_1.pdf

19 JAPAN



19.1 Summary of Coal Industry

19.1.1 ROLE OF COAL IN JAPAN

Coal accounts for 22 percent of Japan's primary energy supply (IEA, 2007). However, Japan does not have any active coal mines and imports 100 percent of its coal. Japan accounts for about 20 percent of total world coal imports and is by far the world's largest importer of steam coal and the second largest importer of coal for steel industry, only recently overtaken by China (WCI, 2008a; WCI, 2008b). Sources of imported steam coal are Australia, South Africa, the United States, and China, while coking coal imports come mainly from Australia, Canada, the United States, and Russia (M2M-Japan, 2008). Overall, Australia provides for 60 percent of Japan's total coal imports (EIA, 2008a).

While Japan does not have any active coal mines at this time, it operated as much as 600 coal mines in the 1960s (M2M-Japan, 2008b). Its total coal reserves are estimated at 396 million tonnes (Mmt) (Table 19-1) and lie primarily on the Hokkaido and Kyushu islands (see Figure 19-1 on next page).

Table 19-1. Japan's Coal Reserves and Production

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2008)*	396	0	396	25 (0.04%)
Annual Coal Production (2007)**	0	0	0	NA

Source: *EIA (2008a); **IEA (2007) Note: Numbers may not add due to rounding

19.1.2 STAKEHOLDERS

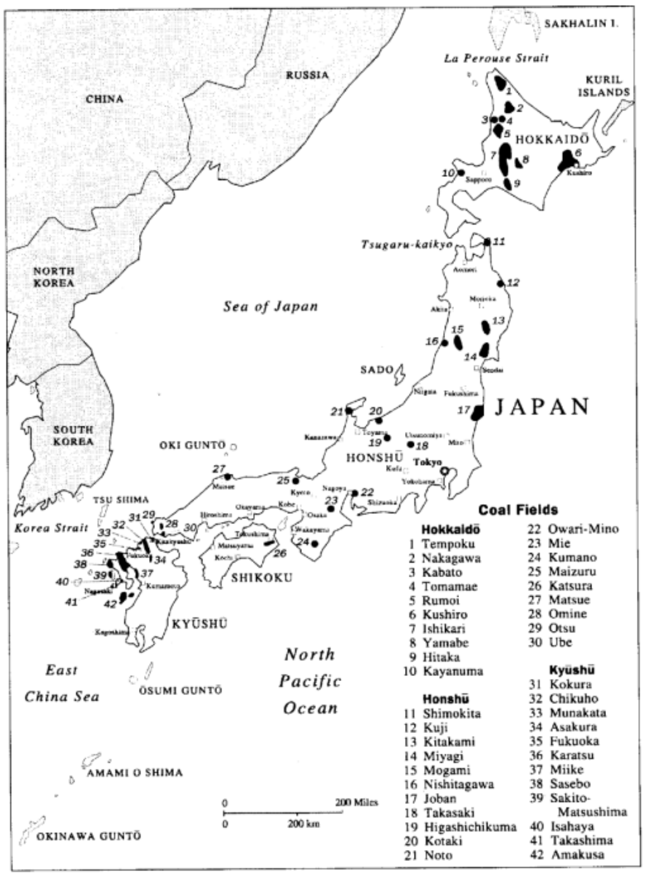
Table 19-2 identifies potential stakeholders in Japanese coal mine methane (CMM) development.

Table 19-2. Key Stakeholders in Japan's CMM Industry

Stakeholder Category	Stakeholder	Role
Developers	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Project opportunity identification and planning
Engineering, Consultancy, and Related Services	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Technical assistance
Government Groups	▪ Ministry of Economy, Trade, and Industry ▪ Environment Management Bureau – Ministry of the Environment	Permitting, outreach efforts

Stakeholder Category	Stakeholder	Role
Other	▪ Japan Bank for International Cooperation ▪ New Energy and Industrial Technology Development Organization ▪ Japan Coal Energy Center ▪ Macquarie Bank Limited ▪ Mitsui Mining Co. ▪ Mitsubishi Materials Co. ▪ Mizuho Corporate Bank, Ltd.	Finance providers, development assistance providers, carbon credit purchasers

Figure 19-1. Japan's Coal Fields



Source: Schwochow (1997)

19.1.3 STATUS OF COAL AND THE COAL MINING INDUSTRY

Japan's coal industry has declined steadily in the last 50 years. In the 1960s, Japan had about 600 coal mines and produced about 55 Mmt of coal annually. Due to competition with coal imports, production declined to about 3.5 Mmt in 2001 (EIA, 2008b). Production ceased entirely in January 2002 with the closure of the last remaining Kushiro coal mines (EIA, 2008a).

19.2 Overview of CMM Emissions and Development Potential

19.2.1 CMM Emissions from Operating Mines

Table 19-3 details CMM emissions from active coal mines until 2003. The data in this table may vary slightly from the data presented in the Executive Summary due to differences in inventory methodology and rounding of digits.

Table 19-3. Japan's CMM Emissions (million cubic meters)

Emission Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Underground mining activities—all	179.47	160.67	142.06	129.49	105.06	80.08	77.06	61.96	53.07	52.64
Post-underground emissions	16.42	16.44	16.39	15.49	14.45	13.63	13.38	8.03	7.59	7.52
Surface mine emission (total)	1.49	21.98	23.29	22.08	22.15	23.91	24.48	23.46	23.62	19.67
Post-surface mining emissions	0.12	0.12	0.09	0.07	0.07	0.07	0.06	0.06	0.06	0.06
Total liberated (= sum of all above)	197.50 *196	199.21	181.83	167.14	141.73	117.70 *91.0	114.98	93.51	84.34	79.89

Emission Category	2000	2001	2002	2003	2004	2005	2006	2007	2008
Underground mining activities—all	47.60	34.15	5.86	4.05	2.22	2.74	2.22	1.30	0.99
Post-underground emissions	5.73	5.04	1.77	1.79	1.79	1.78	1.80	1.49	1.29
Surface mine emission (total)	20.65	20.78	20.17	21.43	0.60	0.58	0.69	0.75	0.85
Post-surface mining emissions	0.06	0.07	0.06	0.06	0.05	0.05	0.06	0.07	0.07
Total liberated (= sum of all above)	74.04 *56.0	60.04	27.87	27.32	4.66	5.15	4.77	3.60	3.21

Source: UNFCCC (2010a) (converted from gigagrams [Gg])

19.2.2 CMM Emissions from Abandoned Coal Mines

Two CMM use projects that were operating at abandoned coal mines in Japan in the early 2000s have since closed (M2M – Japan, 2008).

19.2.3 CBM from Virgin Coal Seams

There is no commercial development of coalbed methane (CBM) in Japan at this time.

19.3 Opportunities and Challenges to Greater CMM Recovery and Use

Under the Kyoto Protocol, Japan has pledged to reduce its national greenhouse gas (GHG) emissions by 6 percent in the period 2008–2012, relative to base year 1990 (UNFCCC, 2003). Table 19-4 summarizes Japan's climate change mitigation commitment. It further pledged to cut emissions 25 percent below 1990 levels by 2020 during the 2009 Copenhagen UNFCCC meeting (UNFCCC, 2009).

Table 19-4. Japan's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC	June 13, 1992	May 28, 1993 (Acceptance)
Kyoto Protocol	April 28, 1998	June 4, 2002 (Acceptance)

Source: UNFCCC (2009); UNFCCC (2010b)

19.3.1 Market and Infrastructure Factors

Japan has developed considerable technical resources to develop CMM, including high efficiency CMM recovery and power generation systems, well-developed town gas systems for subsidence areas in coal mining regions, and technologies for dimethyl ether production from CMM (M2M – Japan, 2005).

Financing for CMM projects could potentially be acquired through the Japan Bank for International Cooperation (JBIC). JBIC has been increasing financing for projects that address global environmental problems, including global warming and environmental projects, such as those aimed at reducing pollution. JBIC's Official Development Assistance loans give preference to projects that support environmental efforts in developing countries. For example, JBIC is supporting a CMM recovery project in Shanxi province, China. The project has been developed to qualify as a Clean Development Mechanism project; Japanese firms are expected to purchase carbon credits generated from the project (JBIC, 2010).

19.3.2 Regulatory Information

Japan lacks specific regulations for CMM industry and gives CMM ownership rights to coal mine owners. The Mining Law provides a basic system that governs mining of mineral resources, while the Mine Safety Law addresses mine safety issues and promotes the safe development of the mineral resources.

19.4 Profiles of Individual Mines

No information profiling individual underground mines in Japan was found.

19.5 References

EIA (2008a): Country Analysis Briefs, Japan. http://www.eia.doe.gov/emeu/cabs/Japan/Full.html (accessed June 2010)

EIA (2008b): World Coal Production, Most Recent Annual Estimates – Japan, Energy Information Administration, Washington, DC, June 18, 2010. http://tonto.eia.doe.gov/cfapps/ipdbproject/iedindex3.cfm?tid=1&pid=7&aid=1&cid=&syid=2000&eyid=2008&unit=TST

IEA (2007): 2007 Energy Balances for Japan. U.S. International Energy Agency, Paris, France. http://www.iea.org/stats/balancetable.asp?COUNTRY_CODE=JP (accessed June 2010)

JBIC (2010): Japan Bank for International Cooperation, 2010. http://www.jbic.go.jp/en/special/environment/001/index.html

M2M-Japan (2005): Japan Profile submitted to Methane to Markets.

M2M-Japan (2008): Japan Profile submitted to Methane to Markets. http://www.methanetomarkets.org/documents/toolsres_coal_overview_ch17.pdf

Schwochow (1997): *The International Coal Seam Gas Report*, Cairn Point Publishing, Steve Schwochow, Chief Editor, 1997.

UNFCCC (2003): In-depth review of the third national communication, United Nations Framework Convention on Climate Change, 2003. http://unfccc.int/resource/docs/idr/jpn03.pdf

UNFCCC (2009): Copenhagen Accord. unfccc.int/resource/docs/2009/cop15/eng/l07.pdf

UNFCCC (2010a): Annex Party I 2010 Submissions. http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5270.php

UNFCCC (2010b): United Nations Framework Convention on Climate Change - Status of Ratification, 2010. http://unfccc.int/essential_background/convention/status_of_ratification/items/2631.php

UNFCCC (2010c): Kyoto Protocol - Status of Ratification, 2010. http://unfccc.int/kyoto_protocol/status_of_ratification/items/2613.php

WCI (2008a): Coal & Steel Statistics, World Coal Institute, http://www.worldcoal.org/resources/coal-statistics/coal-steel-statistics/ (last accessed June 2010)

WCI (2008b): Coal Facts 2008 Edition with 2007 data, World Coal Institute, http://www.worldcoal.org/bin/pdf/original_pdf_file/coalfacts2008(04_06_2009).pdf (last accessed June 2010)

20 KAZAKHSTAN

20.1 Summary of Coal Industry

20.1.1 ROLE OF COAL IN KAZAKHSTAN

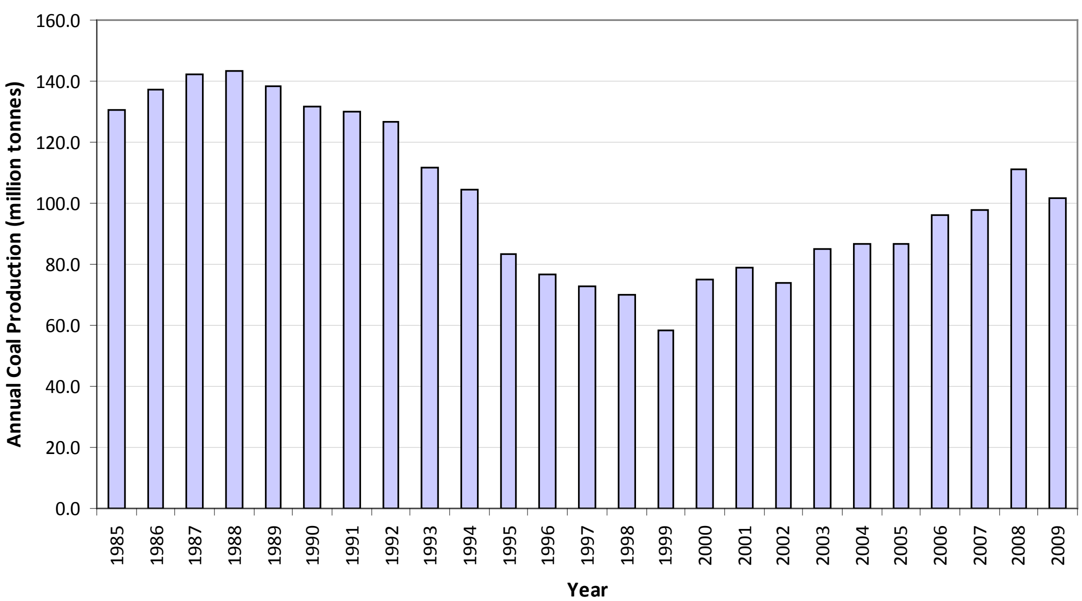
Kazakhstan ranks tenth in the world in coal production, supplying 46.5 percent of its total energy consumption in 2007 (IEA, 2009). It exported 26.4 percent of the coal produced, primarily to Russia and Ukraine. Most power generation (80 percent) is coal-fired, including the largest generator, Ekibastuz No.1 at 4,000 megawatts (MW) (EIA, 2008). Table 20-1 summarizes Kazakhstan's coal resources and recent production, while Figure 20-1 shows historical annual coal production,

Table 20-1. Kazakhstan's Coal Reserves and Production

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2009)	28,170	3,130	31,300	7 (3.8%)
Annual Coal Production (2009)			101.5	9 (1.5%)

Source: BP (2010)

Figure 20-1. Kazakhstan Annual Coal Production (million tonnes)



Kazakhstan has registered 49 coal deposits in its state reserve balance (USGS, 2010). The main producing regions are located in the central and northern regions of Kazakhstan in the Ekibastuz, Karaganda, Maykuben, Shubarkol and Turgay basins (Table 20-2).

Table 20-2. Kazakhstan's Major Coal Basins

Basin	Ekibastuz	Karaganda	Maykuben	Shubarkul	Turgay
Annual Estimated Production Capacity (million tonnes)	95	50	10	6.5	1

Source: USGS (2010)

20.1.2 STAKEHOLDERS

Thirty-four companies operate coal mines in Kazakhstan, including 28 of domestic origin, five foreign companies and one joint venture (EOK, 2010). The major companies are listed in Table 20-3. The table also lists other potential stakeholders in Kazakhstan's coal mine methane (CMM) industry.

Table 20-3. Key Stakeholders in Kazakhstan's CMM Industry

Stakeholder Category	Stakeholder	Role
Coal Producing Enterprise	▪ JSC "ArcelorMittal Termirtau" ▪ OJSC "Ispat-Karmet" ▪ Bogatyr-Access-Komir, Ltd. ▪ OJSC "Eurasian Natural Resources Corporation" ▪ OJSC "Borly" ▪ "Maykuben-West" joint venture ▪ KomirInvest, Ltd. ▪ Transenergo, Ltd ▪ "Gefest" Association ▪ Shubarkol Komir	Project Hosts
Developer	▪ TOTAL Kazakhstan, LLP ▪ See http://www.epa.gov/coalbed/networkcontacts.html	Project opportunity identification and planning
Engineering or Consultancy Services	▪ Azimut Energy Services, Ltd. ▪ See http://www.epa.gov/coalbed/networkcontacts.html	Technical assistance
Universities and Research Centers	▪ National Coalbed Methane Center ▪ Climate Change Coordination Center http://www.climate.kz/engl/	Technical assistance
Other	▪ Kazakhstan National Innovation Fund http://www.nif.kz/eng	
Government Groups	▪ Ministry of Energy and Mineral Resources	Licensing and permitting

Source: KazNIIMOSK (2002); EOK (2010); Alekseev (2010)

20.1.3 STATUS OF COAL AND THE COAL MINING INDUSTRY

Kazakhstan's coal mining industry was restructured and largely privatized between 1995 and 1997 (State, 2005). The Karaganda and Ekibastuz mining associations were dissolved and the mines put up for sale or lease. Many of the coal mining enterprises were closed or reorganized (USGS, 2010; KazNIIMOSK, 2002).

Coal production in Kazakhstan declined by more than 50 percent in the years following independence from the Soviet Union in 1991 (BP, 2010). During the Soviet era, coal production was subsidized and mines were not structured to maximize profits. When subsidies were removed and mines had to operate competitively, it became extremely difficult to obtain foreign investment to maintain their economic viability. This fundamental lack of profitability was compounded by other problems, such as restructuring, mine problems, and accidents. Government efforts to significantly improve production by 2015, by encouraging foreign interest in the coal mining industry, appear to have been successful. Since the low point in 1999, annual production has steadily increased to rates above 100 million tonnes (Mmt), although the world-wide economic downturn in 2009 also affected Kazakhstan coal production with a resultant 8.6 percent decline in production from 2008. Consumption has also declined, largely offsetting the impact of the production decline, thus helping to sustain the level of exports.

Underground mining only occurs in the Karaganda basin, which produces the coking coals essential to the steel and iron sectors and coke plants in Kazakhstan, Russia, Ukraine, and Georgia, and also to the phosphoric and ferroalloy industries. The share of production from underground mines decreased from about 27 percent in 1990 to just 11 percent in 2000 (KazNIIMOSK, 2002), and back up to 30 percent in 2010 (Alekseev, 2010), following new investment from companies such as the ArcelorMittal Group (USGS, 2010). The ArcelorMittal Coal Division operates eight underground mines in the Karaganda Basin producing 12 Mmt annually (Baimukhametov, 2009). Twenty-six underground mines were reportedly in operation in 1990 (KazNIIMOSK, 2002), with 15 now currently producing (EOK, 2010). Four mines operated by KomirInvest and Transenergo have nearly stopped production. ArcelorMittal's eight underground mines (originally operated by Ispat-Karmet) were expanded in 1986 to stabilize production levels.

Table 20-4 provides mine statistics for Kazakhstan.

Table 20-4. Kazakhstan Mine and Production Statistics

Type of mine	Production (million metric tonnes)	Number of major mines
Underground (active)	31.5 (2009)	15 (2010)
Surface (active)	69.9 (2009)	6 (2010) 3 mines in the Ekibastuz Basin - Bogatyr, Severny, Vostokny (80% of surface production) 3 others - Borlinskoe deposit, Maykuben Basin, Karaganda Basin (15–20% of surface production)

Source: Alekseev (2010); EOK (2010)

20.2 Overview of CMM Emissions and Development Potential

The Global Methane Initiative (formerly Methane to Markets Partnership) International CMM Projects Database currently identifies one CMM project, in place at the Kazakhstanskaya underground mine in the Karaganda basin. The methane currently drained from the mine is being used for boiler fuel in five neighboring mines (M2M Projects, 2010). The mine is planning an expansion of its degasification systems by 8.5 kilometers (km) along with the installation of three KVTS-10 boilers utilizing 13 million cubic meters (m^3) methane per year. Current coal production is 1 Mmt per year (Mmt/year) with plans to increase production to 1.8 Mmt/year by 2012.

20.2.1 CMM EMISSIONS FROM OPERATING MINES

The Kazakh coal mines are particularly gassy and prone to violent gas outbursts, and must be degasified and ventilated to prevent explosions and promote worker safety. The underground mines in the Karaganda basin use a variety of pre-mining and post-mining methane drainage techniques. Most of the mines are operated at a depth of more than 500 meters (m) and gas contents in these mines average between 18 and 24 m^3/tonne (Baimukhametov et al, 2009) with specific emissions averaging 33 m^3/tonne (KazNIIMOSK, 2002). Pre-drainage has historically been carried out using in-seam boreholes. Advance degassing from the surface has been trialed with limited success because of the low permeability of the coal seams. The Arcelor Temirtau Coal Division has had recent success in increasing degasification rates, and hence coal production rates, by drilling cross-measure boreholes from a roadway driven 8–12 m below the coal seam. Gob gas is drained with vertical wells from the surface or via galleries driven 20–30 m above the seam (Baimukhametov et al., 2009).

Current drained methane emissions are estimated to be approximately 130 million m^3 resulting from increased underground coal production rates (Alekseev, 2010), However, the level of methane utilization is very low, only about 25 million m^3 annually, which is recovered and combusted in the boiler houses of five mines for mine heating. Surface mines are heavily ventilated and ventilation air with methane concentrations of about 1 percent is vented to the atmosphere (KazNIIMOSK, 2002).

Table 20-5 details Kazakhstan's measured and estimated CMM emissions. The data in this table may vary from the U.S. EPA data presented in the Executive Summary due to differences in inventory methodology and rounding.

Table 20-5. Kazakhstan's CMM Emissions (million cubic meters)

Emission Category	1990	1991	1992	1993	1994	1995
Underground coal mines – ventilation emissions	983.66	914.75	915.52	957.82	678.12	671.37
Underground coal mines – drained emissions	189.84	200.83	179.87	162.96	148.31	115.8
Post-underground emissions	34.8	36.4	33.9	30.6	28.7	23
Surface mine emission	560.1	554.1	529.3	488.8	452.0	411.9
Total liberated (= sum of all above)	1768.4	1706.08	1658.69	1640.18	1307.13	1222.07
Recovered & Used	8.8	10.9	11.0	13.0	5.6	5.9
Total emitted (= Total liberated – recovered & used)	1759.6	1695.18	1647.69	1627.18	1301.53	1216.17

Emission Category	1996	1997	1998	1999	2000	2005 (estimated)	2009** (estimated)
Underground coal mines – ventilation emissions	408.0	347.45	303.45	227.32	286.23		400
Underground coal mines – drained emissions	55.4	48.2	42.6	27.2	41		130
Post-underground emissions	14.9	12.7	9.0	7.1	8.0		
Surface mine emission	381.7	350.2	304.3	277.3	381		450
Total liberated (= sum of all above)	860	758.55	659.35	538.92	716.23		980
Recovered & Used	3.5	4.0	10.5	11.3	12.2		25
Total emitted (= Total liberated – recovered & used)	856.5	754.55	648.85	527.62	704.03	467*	955

Source: KazNIIMOSK (2002); *USEPA (2006); **Shultz & Alekseev (2010)

20.2.2 CMM Emissions from Abandoned Coal Mines

At least 14 underground coal mines in Kazakhstan have been abandoned since 1996. All are considered gassy. No specific information about methane recovery projects at abandoned mines is available.

20.2.3 CBM from Virgin Coal Seams

According to the Ministry of Energy and Mineral Resources, Kazakhstan's coalbed methane (CBM) resources are some of the highest among the coal basins of the world, as illustrated in Table 20-6.

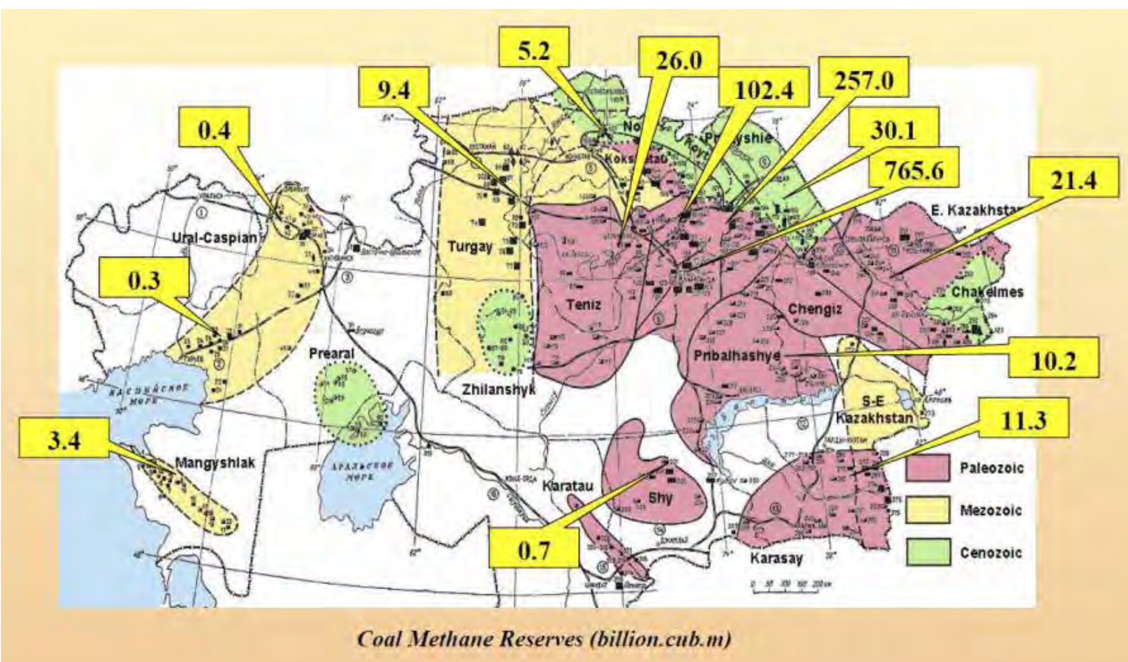
Table 20-6. Summary of Kazakhstan's Selected CBM Resources

Basin or Field	CBM Resources (est.) (billion cubic meters)
Karaganda Basin	550–750
Ekibastuz Basin	75–100
Zavialov Field	14.6–16.8
Samarskiy Field	11.0–14.2

Source: Stoupak and Zhukovskiy (2001)

Kazakhstan is one of the few countries with commercial CBM production. In 2000, 12.5 million m^3 of CBM were produced from 134 wells (Alekseev, et al., 2003). Figure 20-2 shows Kazakhstan's coal regions with estimated methane reserves for each region.

Figure 20-2. Kazakhstan Coal Regions and Coal Methane Reserves



Source: Alekseev, et al. (2003)

TOTAL Kazakhstan, LLP was awarded the State tender for exploring and mining CBM in the Taldykuduk area of the Karaganda coal field in late 2004. The exploration stage, now ongoing, includes drilling six test wells. The Kazakhstan National Innovation Fund and TOTAL hope to attract foreign investment of $180–$220 million in the second (commercialization) phase of the effort to hasten development of a new CBM industry for the country (USEPA, 2005).

In April 2003, the Ministry of Energy and Mineral Resources recommended that BogatyrAccess Komyr, Ltd. and Azimut Energy Services, Ltd. pursue a CBM development effort in the Ekibastuz basin. These efforts would include attracting domestic and international investors to assess the resources (including seismic studies) and conduct a pilot project including five to six test wells, to identify and select development technologies, and to book recoverable CBM resources as proved reserves (ROK, 2003).

Kazakh firm, Zhumys Stroyservice, announced (May2010) an agreement with the Australian company Arrow Energy Ltd., to perform a feasibility study on the commercial production of CBM in the Karaganda coal basin. Funding would be provided by Arrow Energy with plans for a pilot project to be launched in 2014. (SteelGuru, 2010)

20.3 Opportunities and Challenges to Greater CMM Recovery and Use

Kazakhstan is a signatory to both the UNFCCC and the Kyoto Protocol (see Table 20-7). Kazakhstan applied for Annex I status in June 1999, withdrew its application in June 2000, but finally ratified the Protocol in June 2009. With Annex I status obtained, new CMM projects in Kazakhstan are eligible to earn and sell emission reduction credits through the Clean Development Mechanism. Kazakhstan is currently awaiting status as an Annex B country, to qualify for Joint Implementation. Investment for CMM projects could also come from the National Innovation Fund, mine operators, and foreign investors.

Table 20-7. Kazakhstan's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC	June 8, 1992	May 17, 1995
Kyoto Protocol	March 12, 1999	June 19, 2009–

Source: UNFCCC (2010)

20.3.1 Market and Infrastructure Factors

Opportunities to develop the country's CBM and CMM resources are a potentially significant source of investment, and Kazakhstan is working to establish an attractive investment climate. The Kazakhstan government prioritizes CMM projects as a means of achieving measurable and verifiable greenhouse gas (GHG) emission reductions. Recently, the government approved proposals for establishing criteria and procedures for screening, review, and approval of GHG emission reduction projects. It also approved similar proposals relating to baseline assessment and validation; emission reduction calculation; monitoring, verification, and registering emission reduction projects; and allocating 5 million tonnes of carbon dioxide equivalent (MmtCO$_2$e) for transfer to investors in GHG reduction projects. As a next step, the government will promulgate regulations (USEPA, 2005).

Kazakhstan will require significant infrastructure investments to commercialize CBM/CMM development. Gas gathering systems will be required as well as interconnects with distribution pipelines. Some synergies may be available with rapidly developing gas production associated with expanding oil production. Kazakhstan produced 1.18 trillion cubic feet (Tcf) of natural gas in 2008 while domestic consumption was at 1.19 Tcf (EIA, 2009). Production has been growing at 22 percent annually over the last decade, compared to consumption growth of 9 percent annually and so Kazakhstan is expected to become a net exporter of gas within the next few years. Current and proposed major gas distribution pipelines are routed mainly in the west and south of the country and so opportunities for local CMM/CBM projects in the central and northern coal-fields may arise as a result of proximity to underserved markets in these areas. Regional gas demands are increasing, especially from neighboring China, suggesting adequate markets for all methane that can be produced. Possible end uses for recovered methane include industrial boilers, power generation, heating, and transportation fuel (for fleets and private vehicle conversions).

In 2005, 14,609 million KZT was invested in the mining industry. A large portion of those investments, 5,997.7 million KZT, went into coal production and improvement (CMAR, 2006). In 2007, the Arcelor-Mittal Group pledged to invest 500 million USD to increase coal production in the Karaganda region by around 5 Mmt (EIA, 2008). These large investments in the nation's coal production could lead to increased CMM development projects.

20.3.2 Regulatory Information

The Government owns all subsurface gas and minerals but has allocated coal reserves to private mine operators as part of their contracts and CMM to contracted coal operators. CMM and CBM project developers must enter into agreements with the coal operators for development and sale of the gas resources (KMIC, nd). Upcoming petroleum legislation and provisional rules for exploration and development will provide a comprehensive and consistent legal framework for CBM exploration and exploitation. At this time, no legislation is in place which distinguishes CMM production from that of natural gas. A recent law, "In Support of the Use of Renewable Energy Resources" introduced in July 2009, does not include references to CMM (Alekseev, 2010).

Mining companies understand the safety issues and are increasingly understanding of the environmental issues associated with CMM. Coal mine safety is a key concern in surface and underground mines—numerous deaths due to mine explosions and methane outbursts underscore the importance of this problem. Environmental and safety standards are improving, but are also driving up development costs.

20.4 Profile of Individual Mines

Kazakhstanskay Mine

Mine Status	Active	**Operator/Owner**	ArcelorMittal Temirtau Coal Division
Mine Area	47 square kilometers (km^2)	**Coal Basin**	Karaganda
Mining Method	Conventional Longwall	**Location**	Shakhtinsk District, 30 km west of the city of Karaganda
Reserves (coking coal)	103.4 Mmt	**2009 VAM volume**	36.5 million m^3/year
No. of seams mined	2 (D6 & D10)	**2009 Drained volume**	7.8 million m^3/year
Depth of seams	650–700 m	**2009 Utilized volume**	7.8 million m^3/year
		Utilization method	Boilers

20.5 References

Alekseev, et al. (2003): Coal Methane: Potential Energy Prospects for Kazakhstan, Alekseev, E.G., R.K. Mustaffin and N.S. Umarhajleva, presented to UNECE Ad Hoc Group of Experts on Coal in Sustainable Development, Almaty, November 2003. www.unece.org/ie/se/pp/coal/mustafin.pdf.

Alekseev (2010): Personal communication.

Baimukhametov, D., Polchin, A., Dauov, T. & Ogay, S. (2009): Gate Road Development in High Gas Content Coal Seams at Karaganda Basin Coal Mines, Kazakhstan. In Aziz, N (ed) Coal 2009: Coal Operators' Conference, University of Wollongong & the Australasian Institute of Mining and Metallurgy, 2009, 90–95. http://ro.uow.edu.au/coal/85

BP (2010): Statistical Review of World Energy June 2010. http://www.bp.com/productlanding.do?categoryId=6929&contentId=7044622

CMAR (2006): Strategy of Territorial Development of the Karaganda Oblast Until 2015, Center for Marketing and Analytical Research, JSC., 2006.

EIA (2007): Data obtained from *International Energy Annual 2005*. U.S. Energy Information Administration, Washington, DC, table posted June 21, 2007 at http://www.eia.doe.gov/pub/international/iea2005/table82.xls (reserves).

EIA (2009): Kazakhstan Country Analysis Brief. U.S. Energy Information Administration, November 2009, http://www.eia.doe.gov/emeu/cabs/Kazakhstan/Full.html.

EOK (2010): Energy Sector - Coal. Embassy of Kazakhstan, Washington, D.C. website. Accessed July 2010. http://www.kazakhembus.com/index.php?page=energy-sector

IEA (2009): IEA Energy Statistics: Share of Total Primary Energy Supply in 2007 – Kazakhsatan. International Energy Agency, Paris, France. http://www.iea.org/stats/pdf_graphs/KZTPESPI.pdf

IEA (2010): IEA Energy Statistics: Coal Statistics for Kazakhstan. International Energy Agency, Paris, France. Accessed 17 June 2010. http://www.iea.org/stats/coaldata.asp?COUNTRY_CODE=KZ

KazNIIMOSK (2002): Kazakhstani GNG Emissions Inventory from Coal Mining and Road Transportation – Final Project Report, Kazakh Research Institute for Environment Monitoring and Climate (KazNIIMOSK), Almaty, July, 2002.

KMIC (nd): Pilot CBM Extraction Project in Taldykuduk Area of Central Kazakhstan, Kazakhstan Methane Information Center, not dated.

M2M Projects (2010): Methane to Markets International Coal Mine Methane Projects Database, Methane to Markets, 2010, at http://www.methanetomarkets.org/projects/projectDetail.aspx?ID=1079

ROK (2003): Proceedings of a Meeting of the Republic of Kazakhstan Vice Minister of Energy and Mineral Resources, Astana, April 9, 2003.

State (2005): 2005 Investment Climate Statement – Kazakhstan, U.S. Department of State, 2005

Shultz, K. and Alekseev, E. (2010): The Role of Policy on CMM Project Development: Ukraine and Kazakhstan as Case Studies. Presented at International Investment Forum: Funding of CMM Project in Ukraine. Donetsk, Ukraine June 3, 2010.

Stoupak and Zhukovskiy (2001): Coalbed Methane in Kazakhstan: Investment Opportunities. Stoupak, Serguei and Valeriy Zhukovskiy, presentation, January 2001.

UNFCCC (2010): Kyoto Protocol - Status of Ratification, Accessed June 2010. http://maindb.unfccc.int/public/country.pl?country=KZ

USEPA (2005): Correspondence between Saule Arapova, Director, National Innovation Fund, and Mr. Clark Talkington, U.S. Environmental Protection Agency, Coalbed Methane Outreach Program, 2005.

USEPA (2006): *Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990–2020*, U.S. Environmental Protection Agency, Office of Atmospheric Programs, Climate Change Division, June 2006, at http://www.epa.gov/climatechange/economics/downloads/GlobalAnthroEmissionsReport.pdf

USGS (2010): The Mineral Industry of Kazakhstan, 2007 Minerals Yearbook. U.S. Geological Survey. By Levine, R.M., Brininstool, M. and Wallace, G.J. May 2010 http://minerals.usgs.gov/minerals/pubs/country/2007/myb3-2007-kz.pdf

21 MEXICO

21.1 Summary of Coal Industry

21.1.1 ROLE OF COAL IN MEXICO

Coal is a relatively small component of Mexico's energy production and consumption, compared to petroleum and natural gas. In 2007, coal accounted for only five percent of total energy consumption while oil and natural gas made up 55 percent and 33 percent, respectively. Coal is used primarily for steel production and electric power generation. According to Mexico's Energy Secretariat, while natural gas is still the dominant feedstock for electricity generation, coal consumption by the electricity sector had risen to 205 trillion British thermal units (Btu) in 2008 (EIA, 2010).

Annual coal production in Mexico increased from 10.8 million tonnes (Mmt) in 2005 to 12.5 Mmt in 2007, with estimated proved coal resources of 1,211 Mmt at the end of 2009 (see Table 21-1).

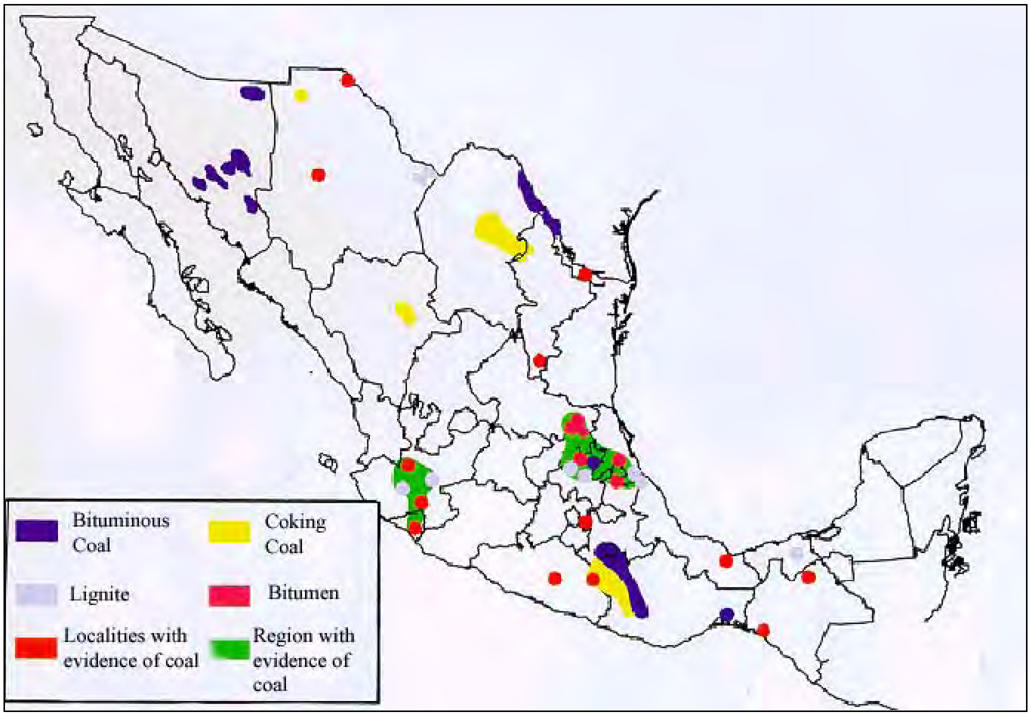
Table 21-1. Mexico's Coal Reserves and Production

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2009)*	860	351	1,211	22 (0.1%)
Annual Coal Production (2007) **	2.1	10.50	12.5	23 (0.2%)

Source: *BP (2010); **IEA (2010)

Figure 21-1 shows the distribution of coal fields, while Table 21-2 outlines the key characteristics of the major coal basins. As seen, the majority of Mexico's coal reserves are located in Coahuila State in the northeast part of the country. Additional resources are located in Sonora (in northwest Mexico) and Oaxaca (southern Mexico).

Figure 21-1. Mexico's Coal Fields



Source: Adapted from Santillan (2006)

Table 21-2. Mexico's Major Coal Basins

State	Basin / Sub-basin	Age	Usage	Resources (million tonnes)	
Coahuila	Coahuila / Sabinas-Saltillito-Monclova	Maestrichtian	Metallurgical	1,180	3,154
	Fuentes-Rio Escondido	Maestrichtian	Steam	1,216	
	Colombia-San Ignacio	Eocene		252	
Oaxaca	Mixteca	Triassic - Jurassic	Bituminous	163	66
Sonora	Barranca	Triassic - Jurassic		143	83
	Cabullona	Maestrichtian		80	
Chihuahua	San Pedro Corrallitos	Maestrichtian		6	17
Total				***3,040**	****3,320**

Source: *Querol-Sune (2001); **UMEC (2009)

21.1.2 STAKEHOLDERS

The key stakeholders involved with the coal industry and the coal mine methane (CMM) and coalbed methane (CBM) industries are listed in Table 21-3.

Table 21-3. Key Stakeholders in Mexico's CMM Industry

Stakeholder Category	Stakeholder	Role
Mining Company	Minera del Norte, SA de CV (MINOSA)	Major mining company in Mexico. MINOSA produces a large percentage of Mexico's coking coal. It is part of Grupo Acerero del Norte (GAN).
	Minera Carbonifera Rio Escondido (MICARE)	MICARE produces steam coal and is also a part of GAN.
	Grupo México S.A.B. de C.V. (Sociedad Anónima Bursátil de capital variable - limited liability stock corporation with variable capital)	Largest mining corporation (mainly copper) in Mexico
	Mission Energy Co.	A U.S. mining company
Developers	See http://www.epa.gov/coalbed/networkcontacts.html	Project opportunity identification and planning
Engineering, Consultancy and Related Services	See http://www.epa.gov/coalbed/networkcontacts.html	Technical assistance
Government Agencies	Mexican Electricity Commission (CFE) Energy Regulatory Commission (CRE) Petróleos Mexicanos (PEMEX) Secretariat of Economy Secretariat for Environment and Natural Resources Ministry of Energy	Regulatory

21.1.3 Status of Coal and the Coal Mining Industry

Coal has contributed substantially to the development of industry in Mexico, starting with the development of the railroad industry. Although coal was largely replaced by oil from 1910 to 1954, it remained a major raw material for the steel industry. The mining of iron-ore and coal started formally with the development of Mexican steel industry in 1930. Coal mining in Mexico increased considerably with the opening of coking facilities in 1954 and in 1959, a fertilizer plant was opened in Monclova that used gas emitted from the coking facilities.

Starting in 1960, the Energy Regulatory Commission developed a program to generate electricity through two coal-operated thermoelectric power stations, which were installed in Nava, Coahuila, between the late 1970s and the early 1990s. This program led to extensive coal exploration in the Fuentes-Rio Escondido Basin of Northern Coahuila and an increase in coal mining activities (Verdugo, 1991).

In 1992, passage of the Mexican Mining Law allowed 100 percent private ownership of coal mines by both Mexican interests and foreign mining companies. Government-owned Minera Carbonifera Rio Escondido (MICARE) was privatized in 1992 and is now a subsidiary of Altos Hornos de Mexico (AHMSA), a large integrated steel company based in Coahuila state. Minera del Norte (MINOSA), Mexico's principal producer of metallurgical coal, is also a subsidiary of AHMSA, which is in turn controlled by Grupo Acerero del Norte (GAN), a corporation focusing on steel production, and the mining of coal and copper.

MINOSA was formerly the name of the subsidiary operating AHMSA's iron ore mines and Minerales Monclova (MIMOSA) operated AHMSA's coal interests. GAN now operates all their mines under MINOSA. MICARE and MINOSA together produced about 82 percent of Mexico's coal in 2007. Other important mining companies with coal interests include Grupo Mexico and Carbonifera de San Patricio (Santillan, 2006; Wallace, 2008; AHMSA, 2010; Brunner, 2010).

21.2 Overview of CMM Emissions and Development Potential

The Global Methane Initiative (formerly Methane to Markets Partnership) International CMM Projects Database currently identifies one active and two proposed CMM recovery projects in Mexico. All of the projects are designed for active underground mines. The operational project uses captured methane for boiler fuel, while the two proposed projects are designed to use captured methane for power generation (M2M Projects, 2010).

21.2.1 CMM Emissions from Operating Mines

Emissions reporting in Mexico has matured over the years. In its first National Communication with the United Nations Framework Convention on Climate Change (UNFCCC) in 1997, Mexico reported fugitive methane emissions from "oil industry leaks and coal exploitation" as 21.83 Mmt of carbon dioxide equivalent (CO_2e) for 1990. On November 11, 2006, the third UNFCCC National Communication reported 1.39 MmtCO_2e of fugitive methane emissions from solid fuels for 2002 (IPCC Source Category 1B1) and another 36.69 MmtCO_2e from petroleum and natural gas (Category 1B2) (UNFCCC, 2006). The National Greenhouse Gas Inventory 1990–2002 reported 1.56 MmtCO_2e from coal mining activities in 2002 (Category 1B1a) (UNFCCC, 2007a).

Other estimates have produced slightly higher numbers. One source estimates emission from the mines in the Sabinas Sub-basin—the region where most Mexican coal mining takes place—as 400,000 cubic meters (m^3) of methane each day or 2.09 MmtCO_2e per year in 1999 (Brunner, 1999). According to the Mexican environment ministry's undersecretary for environmental norms, approximately 2.14 MmtCO_2e of methane had been liberated from coal mines into the air each year (Bremer, 2006). Both these numbers conform with U.S. Environmental Protection Agency (U.S. EPA) estimates for CMM emissions of 2.15 MmtCO_2e in 2000. U.S. EPA estimated emissions of 2.47, 2.84 and 3.26 MmtCO_2e for the years 2005, 2010, and 2015 respectively (USEPA, 2006).

Table 21-4 shows CMM emissions in Mexico. The data in this table may vary from the EPA data presented in the Executive Summary due to differences in inventory methodology and rounding.

Table 21-4. Mexico's CMM Emissions (million cubic meters)

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Underground mining	82.04	73.52	65.72	78.07	87.92	87.92	101.45	92.78	92.19
Surface mining	2.50	2.94	2.94	3.38	3.68	4.26	5.15	4.85	4.41
Underground Post-mining	4.70	4.12	3.82	4.12	5.29	5.29	5.73	5.73	6.18
Total	89.10	80.57	72.63	85.72	96.89	97.48	112.33	103.22	102.77

	1999	2000	2001	2001	2003	2005*	2010*	2015*
Underground mining	97.33	109.54	92.63	87.48	85.57			
Surface mining	5.00	4.70	4.12	3.68	3.82			
Underground Post-mining	6.18	6.76	6.76	6.47	5.73			
Total	108.51	121.01	103.51	97.63	95.28	172.9	198.8	228.2

Source: Flores (2007); *USEPA (2006) – estimated and projected

MINOSA (formerly MIMOSA) operates five underground mines in the gassy coals of the Upper Cretaceous Los Olmos Formation in the state of Coahuila in northern Mexico and has been draining the coalbeds prior to mining through in-seam horizontal boreholes since 1992, with efficiency above 30 percent (Brunner, 1999). MINOSA has been preparing methane projects for almost a decade to recover and use some of the gas drained from their underground mines and has been working with the Federal Administration to implement the project under current laws.

The MINOSA CMM project involves its No.5 (Esmeralda), No.6 and No.7 mines located in the Sabinas coal basin in Coahuila State. Total methane emissions from the three mines was 134.8 million m^3 in 2008, with 128.4 million m^3 (95 percent) emitted from ventilation systems and 6.41 million m^3 (5 percent) liberated from drainage systems (Santillan, 2010a). Average ventilation air methane (VAM) concentrations are 0.8 percent. A total of almost 10 kilometers (km) of in-seam drainage holes have been drilled at the three mines, along with 52 gob wells in Mine 5 and 23 gob wells in Mine 6. (Santillan, 2010b). The project is proposing to utilize drained methane from the in-seam and gob boreholes to generate 7 megawatts (MW) of electricity for on-site use, offsetting some of the 27 MW currently purchased from the grid. The possibility of flaring excess drained gas along with ventilation air methane (VAM) electricity generation is also being explored. An estimated reduction in greenhouse gas (GHG) emissions of 4.18 $MmtCO_2e$ per year is projected once the project is implemented (Santillan, 2010a).

In 1991, more than 3000 meters (m) of in-seam horizontal drainage boreholes were drilled in advance of mining development at the Pasta de Conchos mine in the Coahuila coal region. The project was successful in reducing the methane concentration in return ventilation air from 1 percent to 0.8 percent and had a peak methane production rate of 45,000 m^3 per day (WME, 1994). An expanded CMM/CBM development program was under consideration by the mine owners, Grupo Mexico, including analysis of various end-use options. However, in February 2006, the mine experienced a lethal methane explosion that killed 65 miners and the mine was closed (El Universal, 2007). This mine disaster lead to increased awareness of CMM drainage issues and a revision of Mexican mining law (see section 19.3.2).

21.2.2 CMM Emissions from Abandoned Coal Mines

No definitive data about abandoned mine methane (AMM) in Mexico is available at this time, although a 2010 presentation by MINOSA suggests the company is looking at a project at their No.2 mine in the Sabinas basin. Emissions from the mine are estimated at 4.1 million m^3 per year (100 percent methane). The project envisions utilizing the methane in power generation and selling produced electricity to the grid or using it to power maintenance depots at the mine site (Santillan, 2010b).

21.2.3 CBM from Virgin Coal Seams

The coal in Mexico can be quite gassy. MINOSA reports an average *in situ* content of gas in the coals of the Sabinas Sub-basin at 10–14 m^3 per tonne and 12–18 m^3 per tonne in the coals of the Saltillito Sub-basin (Santillan-Gonzalez, 2004). Methane content in the gas is usually above 97 percent. Total gas resources in the Maestrichtian coals of Coahuila are estimated between 122 and 220 billion m^3 (Santillan-Gonzales, 2004).

Very little published data were found on CBM in Mexico. It is apparent from the quality of coal that the basins of Coahuila are the most promising sources of CBM because of their bituminous characteristics and the relatively shallow structural setting of the coalbeds. Mexico's coalbed methane reserves are estimated at between 4.2 and 7.5 trillion cubic feet and are concentrated in the northern states of Coahuila and Sonora, according to the Economic Ministry's mining division.

Until the change in the mining law in 2006, only the state owned oil and gas monopoly, Petróleos Mexicanos (PEMEX) had the right to exploit Mexico's natural gas resources, including CBM. PEMEX has done several studies on the potential of CBM in the Sabinas Basin region, but their data are not publically available. They have invested little in CBM extraction, focusing on their core business of oil and conventional gas extraction (Barclay, 2006). The major coal companies had little incentive to research CBM drilling prior to 2006, focusing instead on CMM emissions. MINOSA has done significant research regarding the potential of CMM in the Sabinas Basin and appears, at this time, to be following up on potential CMM projects rather than ones involving CBM extraction.

21.3 Opportunities and Challenges to Greater CMM Recovery and Use

Mexico is a signatory to both the UNFCCC and the Kyoto Protocol (see Table 21-5). As a Non-Annex I Party to the Kyoto Protocol, Mexico has no national emissions targets but is eligible to host mitigation projects under the Clean Development Mechanism (CDM). The MINOSA CMM project is currently the only CMM/CBM project in Mexico registered under the CDM (UNEP, 2010).

Table 21-5. Mexico's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC*	June 13, 1992	March 11, 1993
Kyoto Protocol**	June 9, 1998	September 7, 2000

Source: *UNFCCC (2007b); **UNFCCC (2007c)

21.3.1 Market and Infrastructure Factors

PEMEX's natural gas network currently exceeds 9,173 km (includes Sistema Nacional de Gasoductos and Naco Hermosillo) and has 12 compression stations. There were 10 natural gas interconnection stations between Mexico and the United States at the end of 2007 (EIA, 2010). Natural gas import capacity was increased when two new pipelines came on-stream during 2003 and in 2009 Mexico imported 9.5 billion m^3 (Bcm) of natural gas from the United States while also exporting 0.8 Bcm to the United States (EIA, 2010). Currently, all proposed CMM utilization projects are limited to coal mine operations and local power generation and not to pipeline sales.

If it were on the market, CMM would compete directly with other supplies of natural gas in Mexico, which come from various natural gas basins and as associated gas from increasing onshore and offshore oil production. Rising natural gas prices and increasing gas demand for expanding power generation capacity are expected to make CMM and CBM prices competitive with natural gas and other resources, including coal. Market access for CMM is currently limited by legal requirements that hydrocarbon resources be handled through contracts with PEMEX.

21.3.2 Regulatory Information

Mineral exploration and mining in Mexico are regulated by the Mining Law of 1992 (as amended in 2006), which establishes that all minerals found in Mexican territory are owned by the Mexican nation, and that private parties may exploit such minerals (except oil and nuclear fuel minerals) through mining licenses, or concessions, granted by the Federal Government.

Before 2006, Mexico's Constitution (Article 27), enacted through the Ruling Law on the Subject of Hydrocarbons, required that all exploration, recovery, processing, and sales of methane were to be managed by PEMEX. Therefore, coal mines did not have the right to sell CMM or to use CMM to generate heat or electricity on site.

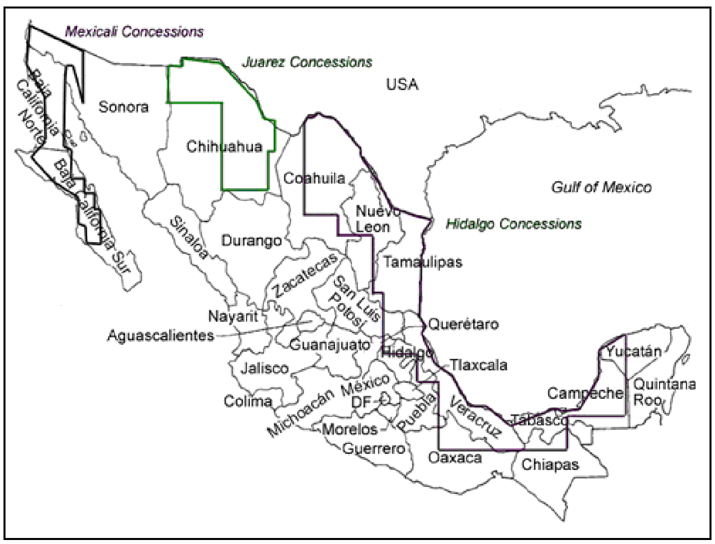
However, changes to this regulatory barrier have been made. Media attention to the dangers posed by CMM was triggered by an explosion at Pasta de Conchos coal mine in Coahuila in February 2006 that killed 65 miners. Following this disaster, the Congress and the Senate quickly passed an amendment to the Mining Law (April 20, 2006), allowing coal mines to recover and use CBM, CMM, AMM, and ventilation air methane from their coal mining operations for any purpose. The amendment also allowed the concessionaires to sell the gas to PEMEX through a contract (Flores, 2007).

The regulations were further adjusted by an amendment to the Mining Law on June 26, 2006 which allows holders of coal mineral concessions to recover and use methane in order to stop methane venting. Methane can be used on-site and/or delivered to PEMEX, which is required to pay justifiable market rates for recovery, transportation, operation and maintenance plus a reasonable profit. Holders of CMM concessions are contracted to report on the start and suspension of any activities, collect geological data, report on discovery of non-associated gas, and deliver captured, non-self-consumed CMM to PEMEX (Flores, 2007; LatinPetroleum, 2006).

A new law, "Safety for Underground Mines" (NOM-STPS-032-2008), was passed in 2008 and contained rules for obtaining permits and authorizations that grant the use and recovery of coal mine gas (Cabrera, 2009; Briseno, 2009). The Secretaria de Energía (SENER) is the agency in charge of authorizing and monitoring CBM/CMM activity, and issues permission for the recovery and utilization of CBM. SENER will also issue contracts for the delivery of gas to PEMEX; establish terms for payment for the delivery of gas, and is charged with developing policies for recovery and utilization of CBM (Roldan, 2009).

The Mexican government recently staked out three large regions and designated them for CBM development. The staking is a response to the changes to the Mining Law passed in 2006, and seeks to assert the primacy of CBM resources in these areas. Until the concessions are put up for auction, the reservation of these areas will be an impediment to other mining development (Wood, 2007). Figure 21-2 shows an estimate of the outlines of the staked regions.

Figure 21-2. Estimated Boundaries of Recent CBM Staking by the Mexican Government



Source: Wood (2007)

21.4 Profiles of Individual Mines

Mexico has seven significant coal basins spread across the country. Two-thirds of the country's resources are located in Coahuila where most of the active mining is taking place. Table 21-6 shows the coal characteristics of the different coal basins in Mexico, followed by a joint profile of three MINOSA mines in the Sabinas basin.

Table 21-6. Coal Characteristics of Mexican Coal Basins

Site	Carbon %	Volatile Matter %	Ash %	Sulfur Total %	Moisture %	Calorific Value Btu / kg	Resources on Site (million tonnes)
Sabinas-Saltillito-Monclova Sub-Basins, Coahuila	45.61	16.97	40.43	1.0	1.26	5,897	1180
Fuentes-Rio Escondido Basin, Coahuila	32.07	30.50	33.27		4.16	3,740	1216
Colombia-San Ignacio Basin, Coahuila	32.4	42.6	44.0	3.5	4.10	5,053	252
Mixteca Basin, Oaxaca. Areas:							
- Plaza de Lobos							
- Plancha-el Consuelo	31.11	6.92	60.30	0.26	1.05		163
- San Juan Viejo	29.75	6.02	63.11	0.25	0.82		
	40.14	10.07	49.13	0.28	0.47		
Barranca Basin, Sonora	77.3	4.8	10.6	0.37	8.0	5,216	143
Cabullona Basin, Sonora	67.45	9.92	18.86	0.00	3.76	4,107	80
San Pedro Corralitos Basin, Chihuahua	27.37	26.75	45.86	0.34	18.2		6
Total							**3040**

Source: Flores-Galicia (2001)

MINOSA Mines - V, VI, VII

Mine Status	Active	**Mine Owner**	MINOSA Mines
Mining Method	Longwall	**Parent Company**	Altos Hornos de Mexico
Depth of Seams	120–150 m	**Location**	Sabinas Coal Basin, Coahuila
No. of Seams	2 – Olmos Fmtn	**2008 VAM Volume**	128. Mm^3
Seam Thickness	1.2–3.5 m (total)	**2008 Drained Methane (CH_4) Volume**	6.41
2008 Coal Production	3.5 million tonnes	**2008 Utilized CH_4 Volume**	0

	1997	**1998**	**1999**	**2000**	**2001**	**2002**
Coal Production (thousand tonnes/year)	335.8	947.0	1345.8	1714.6	2093.7	1910.9
Methane (million m^3/year)						
Emitted from ventilation systems	57.12	63.55	50.35	42.40	81.13	107.73
Liberated from drainage systems	9.82	5.55	4.15	3.90	4.82	13.44
Total Methane Emissions	66.94	69.1	54.5	46.3	85.95	121.17
	2003	**2004**	**2005**	**2006**	**2007**	**2008**
Coal Production (thousand tonnes/year)	1319.7	1814.2	1641.9	2676.9	1897.2	2586.9

Methane (million m^3/year)						
Emitted from ventilation systems	101.18	107.7	128.2	118.1	102.3	128.4
Liberated from drainage systems	20.11	4.82	13.4	20.1	14.18	6.41
Total Methane Emissions	121.29	112.52	141.6	138.2	116.4	134.8

21.5 References

AHMSA (2010): Altos Hornos de Mexico – company website. Accessed July 2010. http://www.ahmsa.com/Steel/company/Comp_subdid.htm

BP (2010): Statistical Review of World Energy June 2010, 2006. Coal – Reserves Table, London, 2005, http://www.bp.com/productlanding.do?categoryId=6929&contentId=7044622

Barclay (2006): Mexico may open niche for private business. Barclay, E. Houston Chronicle business section web page. Accessed July 2010. http://www.chron.com/disp/story.mpl/business/3726554.html

Bremer (2006): Mexico Pushes Law to Help Rid Mines of Toxic Gas, Catherine Bremer, Reuters, at http://www.redorbit.com/news/science/419391/mexico_pushes_law_to_help_rid_mines_of_toxic_gas/

Briseno (2009): Methane to Markets Partnership meeting. Presented at M2M Partnership meeting, Monterrey, Mexico. January 2009. http://www.methanetomarkets.org/documents/events_coal_20090127_techtrans_briseno.pdf

Brunner (1999): Methane Drainage at the Minerales Monclova Mines in the Sabinas Coal Basin, Coahuila, Mexico, D.J. Brunner and J.R. Ponce, in *Proceedings of the 8th U.S. Mine Ventilation Symposium*, Rolla, Mo. June 11–17, 1999. pp 123–29, at http://www.reidrilling.com/pdf/8th%20US%20Vent%20Symposium%201999%20MIMOSA%20Degasification.pdf.

Brunner (2010): Personal communication. Brunner, D., REI Drilling. July 2010.

Cabrera (2009): Methane Market M2M – Invest Coahguila. Presented at M2M Partnership meeting, Monterrey, Mexico. January 2009. http://www.methanetomarkets.org/documents/events_coal_20090127_techtrans_cabrera.pdf

EIA (2007b): Data obtained from *International Energy Annual 2005*. U.S. Energy Information Administration, Washington, DC, table posted June 21, 2007 at http://www.eia.doe.gov/pub/international/iea2005/table82.xls (reserves).

EIA (2010): Mexico Country Analysis Brief, U.S. Energy Information Administration, June 2010. http://www.eia.doe.gov/cabs/Mexico/pdf.pdf

El Universal (2007): Pasta de Conchos case closed after payments, El Universal Mexico News, April 19, 2007, at http://www.eluniversal.com.mx/miami/24291.html.

Flores (2007): Recovery and Use of Methane Associated to Mexican Coal Mines, Ramón Carlos Torres Flores, General Director for Energy and Mining, Secretariat of Environment and Natural Resources, Mexico, April 3, 2007, at http://methanetomarkets.org/documents/events_coal_20070402_mexico.pdf

Flores-Galicia (2001): Exploracion y recourses de carbon en la Republica Mexicana (Geology and reserves of coal deposits in Mexico), The Geology of North America, v. P-3, Economic Geology, The Geological Society of America, Chapter 11, p. 131–160.

IEA (2010): International Energy Agency Energy Statistics – Coal and Peat in Mexico in 2007. International Energy Agency, Paris France. Accessed June 2010. http://www.iea.org/stats/coaldata.asp?COUNTRY_CODE=MX

LatinPetroleum (2006): Mexico reforms Mining Law, Leopoldo Burguete Stanek; Partner with González Calvillo S.C., via LatinPetroleum.com, July 23, 2006, at http://www.latinpetroleum.com/new/newsdetail.php?aid=13&cid=20&content=F&pagename=article&page=28.

M2M Partnership (2010): Coal Mine Methane Projects in Mexico. Methane to Markets Partnership website at http://www.methanetomarkets.org/projects/index.aspx

M2M Projects (2010): Methane to Markets International Coal Mine Methane Projects Database, Methane to Markets, 2010, at http://www2.ergweb.com/cmm/index.aspx.

Querol-Sune, (2001): Exploration and Coal Resources of Mexico. Summary in: GSA Abstracts with programs, Vol. 33, num. 6, p. A-354., see http://gsa.confex.com/gsa/2001AM/finalprogram/abstract_26383.htm

Roldan (2009): Coalbed Methane Regulation. Presented at M2M Partnership meeting, Monterrey, Mexico. January 2009. http://www.methanetomarkets.org/documents/events_coal_20090127_techtrans_roldan.pdf

Santillan-Gonzalez (2004): Potencial uso del gas Metano del carbón como Energía (Potential Use of Methane Gas for Coal-based Energy) Draft Report, M.A. Santillan-Gonzalez, 2004.

Santillan (2006): Information provided by Mario Santillan-Gonzalez, Minerales Monclova, 2006.

Santillan (2010a): CMM Recovery and Utilization at Minosa Mines. Poster presented at M2M Expo, New Delhi, 2010 by Santillan, M. http://www.methanetomarkets.org/Data/Coal_MX_Minosa_Poster.pdf

Santillan (2010b): Mexico's experience reducing barriers and developing new CMM recovery and use projects. Presentation at M2M Expo, New Delhi, 2010 by Santillan, M. http://www.methanetomarkets.org/expo/docs/postexpo/coal_santillan.pdf

UMEC (2009): Coahuila presentation to M2M Meeting, Monterrey, Mexico, 2009. Coal resource figures sourced from the Undersecretariat of Mining and Energetics of Coahuila. http://www.methanetomarkets.org/documents/events_coal_20090127_techtrans_cabrera.pdf

UNFCCC (2006): Mexico's Third National Communication to the United Nations Framework Convention on Climate Change, Non-Annex I national communications, November 11, 2006, Annex, at http://unfccc.int/resource/docs/natc/mexnc3.pdf.

UNFCCC (2007a): Inventario Nacional de Emisiones de Gases de Efecto Invernadero 1990–2002 (National Greenhouse Gas Inventory 1990–2002 Report of Mexico), Greenhouse gas inventory submissions from non-Annex I Parties, United Nations Framework Convention on Climate Change, April 12, 2007, Executive Summary p. 12, at http://unfccc.int/ghg_emissions_data/items/3962.php.

UNFCCC (2007b): United Nations Framework Convention on Climate Change - Status of Ratification, August 17, 2007, http://unfccc.int/files/essential_background/convention/status_of_ratification/application/pdf/unfccc_conv_rat.pdf.

UNFCCC (2007c): Kyoto Protocol - Status of Ratification, December 12, 2007, http://unfccc.int/files/kyoto_protocol/background/status_of_ratification/application/pdf/kp_ratification.pdf.

UNEP (2010): Mexico CDM Project Search. United Nations Environment Programme – Risoe Centre on Energy, Climate and Sustainable Development, Roskilde, Denmark. Accessed July 2010, at http://cdmpipeline.org/publications/CDMPipeline.xlsx

USEPA (2005): U.S. Environmental Protection Agency, Coalbed Methane Outreach Program, International Activities – Mexico, April 2005, previously at www.epa.gov/cmop/intl/mexico.html.

USEPA (2006): *Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990–2020*, Draft, U.S. Environmental Protection Agency, Office of Atmospheric Programs, Climate Change Division, June 2006, at http://www.epa.gov/climatechange/economics/international.html.

Verdugo (1991): *The Fuentes-Rio Escondido Coal Basin, Coahuila*, F.D. Verdugo and M.C. Ariciaga, In: Salas, G.C., ed., Economic Geology, Mexico; Boulder, The Geological Society of America (Decade of North American Geology), Geology of North America, V. P-3, p. 107–128.

Wallace (2008): Coal in Mexico. Wallace, R.B. Professor of Economics – Universidad Nacional Autonoma de Mexico. http://www.economia.unam.mx/publicaciones/econinforma/pdfs/359/brucelish.pdf

Wood (2007): Mexico Plans Coalbed Methane Auction in Wake of Massive Land Grab, Tim Wood, Resource Investor, September 6, 2007, at http://www.resourceinvestor.com/pebble.asp?relid=35420.

WME (1994): Directional drilling techniques for exploration in advance of mining. Reprint from the January 1994 issue of World Mining Equipment. Published by Industrial Minerals, U.K. http://www.targetdrilling.com/pdf/pubs/Directional-Drilling-Techniques-World-Mining-Equip.pdf

22 MONGOLIA

22.1 Summary of Coal Industry

22.1.1 ROLE OF COAL IN MONGOLIA

Coal accounts for 73 percent of total national energy consumption in Mongolia (EIA, 2007). Mongolia presently ranks 29th worldwide in production of coal. Coal production in Mongolia has more than doubled since 2000 (EIA, 2010). Table 22-1 provides proven coal reserves and recent coal production data for Mongolia.

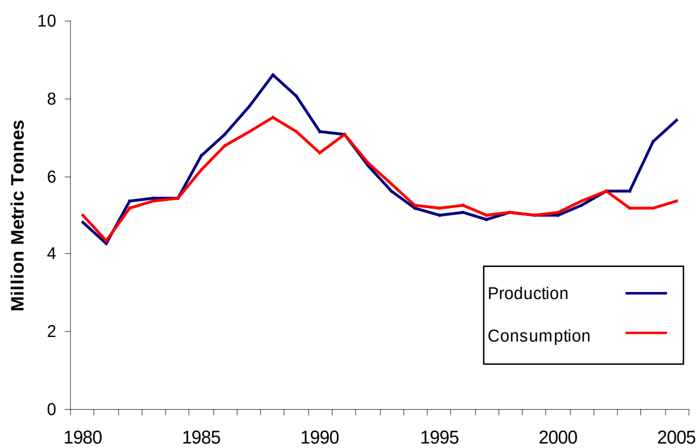
Table 22-1. Mongolia's Coal Reserves and Production

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2008)			12,200	
Annual Coal Production (2008)*	1.10	9.01	10.1	

Source: Ganbaatar (2008); *EIA (2009)

In recent years, Mongolia's coal consumption has remained relatively constant while production has increased, indicating that Mongolia is shifting from a coal importing nation to an exporter. Increased production is attributed in part to privatization of several state-owned mines and expanded output to meet increasing coal demand in China (Tse, 2007). Figure 22-1 below shows Mongolia's production and consumption from 1980 to 2005.

Figure 22-1. Mongolia's Coal Production and Consumption (million tonnes)



Source: Modified from EIA (2008)

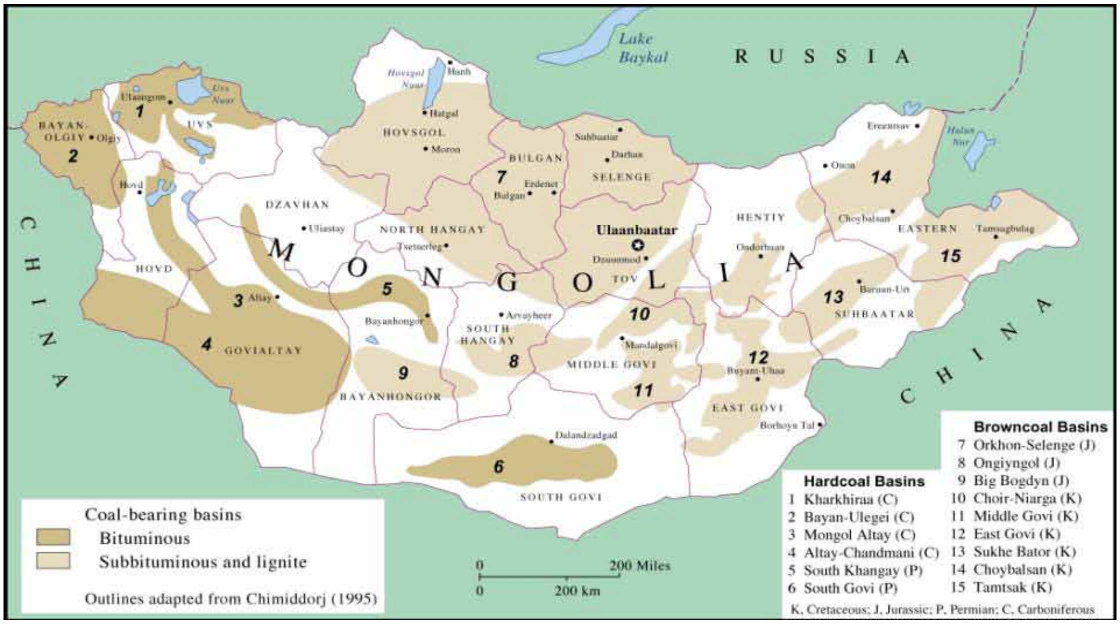
Mongolia has vast coal reserves estimated at a total of 152 billion tonnes (Purevsuren and Drebenstedt, 2004). Preliminary and detailed exploration activities estimated economically recoverable reserves of 22.3 billion tonnes. Proved coal reserves are 12.2 billion tonnes, including 2 billion tonnes of coking coal and 10.1 billion tonnes of thermal coal (Ganbaatar, 2008). Table 22-2 summarizes the reserves found in major coal deposits of Mongolia. There are 200 coal deposits within 15 coal basins in Mongolia (shown in Figure 22-2).

Table 22-2. Proven Coal Reserves Found in Major Coal Deposits

Region	Coal Deposit	Estimated Reserves (tonnes)	Mineable Reserves (tonnes)	Coal Rank	Coal Basin
Central Mongolia	Shivee Ovoo	2.7 billion	564.1 million*	Brown	Choir-Nyalga
	Tevshiin Govi		587.7 million*		Choir-Nyalga
	Tugrugnuur and Tsaidannuur	2 billion		Brown	Choir-Nyalga
	Baganuur		511.4 million*	Brown	Choir-Nyalga
	Khoot		85.0 million*		Choir-Nyalga
	Sharyn Gol		32 million*		Orkhon-Selenge
	Ulaan-Ovoo		23.6 million*		Orkhon-Selenge
East Mongolia	Adduunchuluun		230 million*	Brown	Choybalsan
	Tugalgatai	3 billion		Sub-bituminous	Choir-Nyalga
	Chandgana Tal		122.9 million*		Choir-Nyalga
	Talbulag		48.6 million*		Sukhbaatar
West Mongolia	Hushuut	300 million		Bituminous and metallurgical	Mongol Altay
	Uvurchuluut		3.7 million*		Big Bogdyn
South Gobi	Tavan Tolgoi		7.5 billion	Bituminous	South Gobi
	Baruun Naran	155 million		Thermal and metallurgical	South Gobi
	Nariin Sukhait	250 million	220 million†	Bituminous	South Gobi
	Ovoot Tolgoi	150 million			South Gobi

Source: Ganbaatar (2008); *Purevsuren and Drebenstedt (2004); †Mongolyn Alt Corporation (2010)

Figure 22-2. Mongolia's Coal Basins



Source: Schwochow (1997), modified from Chimiddorj (1995)

22.1.2 Stakeholders

Table 22-3 identifies potential key stakeholders in coal mine methane (CMM) development in Mongolia.

Table 22-3. Key Stakeholders in Mongolia's CMM Industry

Stakeholder Category	Stakeholder	Role
Mining companies	▪ QGX, Ltd. ▪ Tethys Mining LLC ▪ SouthGobi Energy Resources ▪ Red Hill Energy, Ltd. ▪ BHP Billiton Mongolia LLC ▪ Leighton Mining & Infrastructure Mongolia LLC ▪ MAK/Qinhua ▪ Baganuur Joint Stock Company ▪ Erdenes Mongol ▪ Sharyn Gol JSC ▪ Mongolyn Alt MAK Group ▪ Mongolian Holdings Corporation ▪ Rio Tinto ▪ Peabody ▪ Sodgazar LLC ▪ Mon En Co LLC ▪ Energy Resources LLC ▪ Xanadu Mines Mongolia LLC ▪ SGS LLC	Project hosts

Developers	▪ KOGAS	Project opportunity identification and planning
Engineering, consultancy, and related services	▪ Geomaster Engineering LLC ▪ MegaWatt Company Ltd. ▪ Center of Mongolian Mining Professional Engineers ▪ Sproule	Technical assistance
Universities, Research Establishments	▪ National University of Mongolia ▪ Mongolian University of Science and Technology ▪ Mongolian Technical University	Technical assistance
Regulatory Agencies and Government Groups	▪ Ministry of Mineral Resources and Energy ▪ Ministry of Nature, Environment, and Tourism ▪ Mineral Resources and Petroleum Authority of Mongolia ▪ Ministry of Trade and Industry ▪ Millennium Challenge Account – Mongolia ▪ National Development and Innovation Committee	Project identification and assessment support
Non-governmental Organizations	▪ Mongolian Nature and Environment Consortium ▪ Mongolian National Mining Association ▪ Mongolian Coal Association ▪ Federation Of Energy, Geology And Mining Workers' Trade Unions Of Mongolia – MEGM	

Source: MRPAM (2008); MNMA (2008); CMUC (2008); UNFCCC (2005)

22.1.3 Status of Coal and the Coal Mining Industry

Mongolia produced a total of 10.1 million tonnes (Mmt) of coal in 2008 (Table 22-1). There are more than 30 surface (or open cast) mines in Mongolia, providing almost 99 percent of Mongolia's coal production. Three large coal mines—Baganuur, Shivee Ovoo, and Sharyn Gol —provide Mongolia's greatest quantity of coal, supplying fuel to five combined heat and power plants in Ulaanbaatar, Darkhan, and Erdenet (Davaatsedev and Tunga, 2005).

In Mongolia, many of the more substantial deposits of proven coal reserves remain undeveloped due to the lack of infrastructure (APO, 2006). Several infrastructure improvements are planned to accommodate an increase in coal mining as well as mining of other vast and valuable mineral reserves such as copper and gold. A 220-kV DC power transmission line is planned for construction and will connect Ulaanbaatar to the southern mining regions. A power plant is also planned for construction in order to meet the electricity demands of the mining developments (Tserenpurev, 2008). These measures, including the gradual elimination of electricity generating plants in Ulaanbaatar due to concentrated air pollution problems in the city, are identified as long-term objectives of the South Gobi Power Development Corporation (Homma, 2009).

Mongolia's Ministry of Fuel and Energy has outlined a number of policy goals including increased government support in coal export, reductions in customs taxes for coal export, reduction of rail transport tariffs and appropriate changes in relevant laws, all of which will encourage increased coal production (Ganbataar, 2005).

Several new surface coal mine developments are planned. The Tavan Tolgoi deposit, located in the South Gobi Basin in the Umnugovi province of southern Mongolia, has estimated reserves of 1.9 billion tonnes of coking coal out of a total of 7.5 billion tonnes of reserves. This deposit is expected to produce as much as 20 Mmt per year (Ganbaatar, 2008; MIT, 2008). A number of international coal mining companies are involved in negotiations with the Mongolian government hoping to invest and develop the reserves. Other potential coal deposits for development include Tevshiin Govi, Tsaidam, and Tugrong Nuur, located in Central Mongolia (Tse, 2007).

QGX Ltd. of Canada acquired license to the Baruun Naran deposit adjacent to the Tavan Tolgoi deposit in 2002. The exploration program began in 2005 and continues at present (QGX, 2008).

Tethys Mining LLC recently announced that it has discovered a large coal deposit, Tugalgatai, in Murun, the eastern Mongolian province of Khentii (spelled Hentiy on the map in Figure 22-2), with recoverable reserves estimated at 2.7 billion tonnes, which would make it the country's second-largest deposit, exceeded only by Tavan Tolgoi (Daly, 2008).

South Gobi Energy Resources is planning a surface mine project to be supplemented by underground mining at the Ovoot Tolgoi coal project also located in the Umnugovi province. The project is next to the existing MAK/Qinhua coal mine, approximately 45 kilometers north of the Mongolian/Chinese border and the Chinese town of Ceke. South Gobi plans to use Ceke as the main distribution center for Ovoot Tolgoi coal, as Ceke is home to a new automated coal-loading terminal and existing railway infrastructure (Edgar Online, 2008).

The Mongolian government is presently funding a study of the Kharkhiraa coal basin in northwestern Mongolia. The study will collect coal quality and gas content data down to 1,800 meters (m) depth and delineate the best deposits for exploitation.

Mongolia's largest underground coal mine, Nalaikh, near Ulaanbaatar, was closed in 1993 due to a major mine fire (World Bank, 2004). Official underground mining in this area ceased at this time; however, a number of the displaced miners began informal or artisanal mining in the area. The World Bank estimates that around 1,000 people are working at informal operations near Nalaikh. These operations often involve digging more than 100 m underground, which poses a significant safety concern (GEUS, 2004). There is interest in CMM recovery and utilization at the Nalaikh mine, particularly when commercial underground mining activities resume as planned in 2011. Plans call for a design production capacity of 600,000 tonnes per year for a 17-year mine life.

Although the Sharyn Gol mine is principally an opencast mine, the mining company began some underground exploration and development in 2005. Since that time, between 60 and 70,000 tonnes of coal have been mined underground. Maximum annual underground production has been 20,000 tonnes. At times, gas build up in the underground workings has been serious enough to cause work to stop until methane concentrations are reduced. Presently the mine is carrying out initial research on coalbed methane (CBM) resources to identify the best extraction technology and how to best transition from surface to underground mining.

22.2 Overview of CMM Emissions and Development Potential

Other than the minor production from the Nalaikh mine (still formally closed), all of Mongolia's coal production is from surface mines. Thus, CMM development potential in Mongolia lies predominantly in pre-mine drainage in advance of surface mining operations. Underground CMM recovery and utilization at the Nalaikh mine may occur if a project proves to be economically feasible.

22.2.1 CMM Emissions from Operating Mines

In Mongolia's first National Communication under the United Nations Framework Convention on Climate Change (UNFCCC), the analysis of greenhouse gas (GHG) emissions by fuel type estimates that methane emissions released during coal mining activities, coal mining, and post-mining activities comprise 1.6–3.5

percent of all methane emissions (UNFCCC, 2001). As new mining areas are developing, this is expected to increase. Table 22-4 summarizes Mongolia's estimated CMM emissions from 1990 to 2010.

Table 22-4. Mongolia's CMM Emissions (million cubic meters)

Year	CMM Emissions
1990	13.7
1991	12.4
1992	9.7
1993	8.1
1994	7.1
1995	6.8
1996	6.5
1997	6.8
1998	6.8
2000	4.7*
2005	3.7*
2010 (projected)	2.9*

Source: UNFCCC (2001); *USEPA (2006)

At present, a detailed calculation of methane emissions for Mongolian coal mines and coal deposits is not possible, because this information has not been made public (UNFCCC, 2001). Some limited data for the Nalaikh coal deposit is available; the methane content for this mine is estimated to be 3–5 cubic meters (m^3) per tonne (Chimiddorj, 1995; MNEC, 2010).

A pre-feasibility study has been completed for the Nalaikh mine, assessing the potential for power generation using the CMM once underground mining operations resume, scheduled for 2011 (MNEC, 2010). Based on a 3.6-megawatt (MW) capacity design using two internal combustion engines, GHG emissions reductions for this project are estimated to be about 96,000 tons of carbon dioxide equivalent (CO_2e) annually for such a power generation project, for a 17-year project life.

The expected increases in Mongolia's coal production due to planned infrastructure improvements and policy incentives identified by the Ministry of Fuel and Energy, as well as several upcoming surface mine developments could lead to an increase in CMM emissions unless pre-mine drainage is implemented.

22.2.2 CMM Emissions from Abandoned Coal Mines

Emissions estimates from the closed Nalaikh coal mine indicate that the mine workings are now completely flooded and there are negligible emissions from the abandoned mine (MNEC, 2010). When the mine was operating, the excess mine gas was vented. Emissions rates from the mine prior to its closure (for the period from 1988 to 1993) have been estimated to be as high as 355 liters methane per second (MNEC, 2010).

22.2.3 CBM from Virgin Coal Seams

As no natural gas infrastructure exists in Mongolia, CBM activity is in its infancy. Currently neither conventional natural gas nor CBM is produced or consumed in Mongolia. Based on coal characteristics, the South Gobi, Kharkhiraa, and Altay-Chamandi basins in southern and western Mongolia appear to be the most likely areas for future CBM development, should it become a viable resource (Schwochow, 1997).

A Canadian company, Storm Cat Energy Corp., acquired a CBM exploration license in the Noyon Uul region of the South Gobi basin in 2004 through a Production Sharing Contract (PSC) with the Petroleum Authority of Mongolia. Results of coring and desorption revealed a total coal thickness of 76.6 meters and gas contents ranged from 2.34 m^3/tonne to 11.8 m^3/tonne. Storm Cat estimated the potential CBM resource of the area to range from 17 billion m^3 to 34 billion m^3, with a best estimate of 25.5 billion m^3 (Storm Cat, 2005). This resource estimate was based on the volume of coal estimated at depths shallower than the 1,500-meter drill depth, combined with average gas contents obtained from desorption analyses. While the potential resource is relatively large, no gas production has occurred. Storm Cat has determined that further geological review is necessary. Sproule, a Canadian consulting company, also reports to have evaluated CBM resources in Mongolia (Sproule, 2010). The Ministry of Mineral Resources and Energy has signed a Memorandum of Understanding with Korean Gas (KOGAS) of South Korea to evaluate CBM potential in Mongolia.

22.3 Opportunities and Challenges to CMM Recovery and Use

Mongolia is a signatory to the UNFCCC (Table 22-5). As a Non-Annex I Party to the Kyoto Protocol, Mongolia has no national emissions targets. Mongolia is eligible to host GHG mitigation projects under the Clean Development Mechanism (CDM). The CDM may create additional revenues for CMM projects in Mongolia through carbon credits trading.

Table 22-5. Mongolia's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC	June 12, 1992	September 30, 1993
Kyoto Protocol		December 15, 1999

Source: UNFCCC (2005)

The greatest challenge to CMM recovery and utilization in Mongolia is the lack of current markets or infrastructure to support it. With no natural gas production or imports, other fuel sources, primarily coal, are on the principle sources for heat and power. Possible markets for onsite heat and/or power generation include industrial sites and coal mines, based on both their intense electricity demands and extremely harsh winter weather conditions. For example, the Tavan Tolgoi coal mine development will require an estimated 100 MW (Tserenpurev, 2008). In addition, high and steadily increasing costs of petroleum imports to Mongolia may create potential new market demand for liquefied natural gas (LNG) as a vehicle fuel.

From a policy and regulatory standpoint, Mongolia is favorable for foreign investment. The Mongolian Parliament adopted the Law on Foreign Investment in 1993. According to the law, at the request of the investor intending to undertake a project, the Mongolian Cabinet Member responsible for taxation policy may sign either of two kinds of Stability Agreements, depending on amount of investment (the categories are not less than US$2 million and US$10 million). The Agreement provides the investor a legal guarantee for a stable fiscal environment for 10–15 years. This protects the contractor from any changes of taxation policy (Chimiddorj, 2006).

The Parliament also passed Resolution #140 on June 27, 2001, which approves a list of favored industries in which foreign investment and involvement will be encouraged. Of these, oil and gas production as well as transmission pipeline construction are included. Mongolia's Department of Fuel Regulation Policy has outlined various development goals that include extraction of petroleum products from coal (Ganbaatar, 2005).

The Constitution of Mongolia indicates that mineral resources in Mongolia are owned by the state. Coal exploration and production are regulated by the Law of Mineral Resources while natural gas and CBM are regulated by the Petroleum Law (Tumurbaatar and Altanchimeg, 2009).

In 1991, the Petroleum Law of Mongolia was ratified by the Parliament. The Law established a legal foundation for new development of petroleum exploration in Mongolia. In 2004, the Mineral Resources and Petroleum Authority of Mongolia (MRPAM) was formed and authorized by the Government of Mongolia to enter into contracts on the matters of oil and gas exploration, development, production, processing, marketing and supply of petroleum products in Mongolia, and to exercise supervision and assistance towards the implementation of such contracts (MIF, 2006). According to Parliament Resolution #43 and Government Resolution #64, MRPAM has been reorganized and divided into the Mineral Authority and Petroleum Authority under the Ministry of Minerals and Energy (MRAM, 2009).

The primary form of petroleum exploration contracts are PSC. A contractor shall submit an application to the Petroleum Authority which shall sign a PSC with the contractor on the recommendation of the National Security Council and with permission of the Mongolian Government. All materials and equipment necessary to conduct petroleum operations, imported by contractors, are exempt from all customs taxes, value-added taxes and excise taxes. The earnings of contractors from their share of petroleum are also exempt from income taxes (Chimiddorj, 2006).

22.4 Profiles of Individual Mines

Table 22-6 below identifies the largest mines currently operating in Mongolia. Mineable reserves are estimated as of 2004 and production is for 2004 or 2005.

Table 22-6. Major Mines Currently Operating in Mongolia

Mine Name	Coal Basin	Mining Method	Annual Production (million tonnes)
Sharyn Gol	Orkhon-Selenge	Surface	0.7*
Baganuur	Choir-Nyalga	Surface	3.0***
Adunchuluun	Choybalsan	Surface	0.25**
Shivee-Ovoo	Choir-Nyalga	Surface	1.3**
Chandgana Tal	Choir-Nyalga	Surface	0.02†
Tevshiin Govi	Choir-Nyalga	Surface	
Talbulag	Sukhbaatar	Surface	
Ulaan-Ovoo	Orkhon-Selenge	Surface	
Uvurchuluut	Big Bogdyn	Surface	
Khoot	Choir-Nyalga	Surface	
Eldev	Choir-Nyalga	Surface	0.5††
Nariin Sukhait	South Gobi	Surface	

Source: Purevsuren and Drebenstedt (2004); *Davaatsedev and Tunga (2005); **Ganbaatar (2005); ***BusinessMongolia.com (2009); †Red Hill (2010); †† Mongolyn Alt Corporation (2010)

22.5 References

APO (2006): Mining Background Sector Brief, presented by Asia Policy Research Co. Ltd., Central Asia Regional Economic Cooperation Business Development Forum, October 16–17, 2006. http://www.adb.org/Documents/Events/2006/CAREC-BDF/

BusinessMongolia.com (2009): Coal Industry Update (2): Baganuur Coal Mine has Debt of ₮89.9 billion, BusinessMongolia.com, November 19, 2009. http://www.business-mongolia.com/?p=5334

Chimiddorj (1995): Coal Resources in Mongolia and Some Probably Potential Areas for Coalbed Methane, presented by Ayurzana Chimiddorj, International Conference on Coalbed Methane Development and Utilization, Proceedings – Beijing, China, October 17–21, 1995: United Nations Development Programme and PRC Ministry of Coal and Industry, Volume B, Paper B102.

Chimiddorj (2006): Petroleum Potential of Mongolia and Government Policy on Petroleum Exploration, presented by Battumur Chimiddorj, Head, Production Sharing Contracts and New Ventures Department, Mineral Resources and Petroleum Authority of Mongolia (MRPAM), presented at the Mongolia Investors Forum, September 14–15, 2006. http://www.investmongolia.com/forum/proj.htm

CMUC (2008): Consortium of Mongolian Universities and Colleges, http://www.cmuc.edu.mn/cmuc_m2.htm

Daly (2008): Mongolia, coal, and inflation, by John C. K. Daly, United Press International, May 14, 2008. http://www.upi.com/International_Security/Energy/Analysis/2008/05/14/analysis_mongolia_coal_and_inflation/1654/

Davaatsedev and Tunga (2005): Coal Mining and Transportation Situation in Mongolia and Infrastructure Development Issues, presented by L. Davaatsedev and G. Tulga, Mongolian Coal Association, at JAPAC (Japanese Committee for Pacific Coal Flow) International Symposium, September 26, 2005.

Edgar Online (2008): Excerpt from 6-K SEC Filing by Ivanhoe Mines LTD, January 3, 2008. http://sec.edgar-online.com

EIA (2007): Data obtained from *International Energy Annual 2005*. U.S. Energy Information Administration, Washington, DC, tables posted September 21 and 17, 2007, respectively;
http://www.eia.doe.gov/pub/international/iealf/tablee1.xls (total consumption)
http://www.eia.doe.gov/pub/international/iealf/tablee4.xls (coal consumption)

EIA (2009): International Energy Statistics. U.S. Energy Information Administration, Independent Statistics and Analysis. 2009. http://tonto.eia.doe.gov/cfapps/ipdbproject/IEDIndex3.cfm

EIA (2010): Mongolia Energy Profile. Updated May 18, 2010. http://tonto.eia.doe.gov/country/country_energy_data.cfm?fips=MG

Ganbaatar (2005): Energy Policy and Coal Policy of Mongolian Government presented by B. Ganbaatar, Department of Fuel Regulation Policy at Mongolia Ministry of Fuel and Energy, at JAPAC (Japanese Committee for Pacific Coal Flow) International Symposium, September 26, 2005.

Ganbaatar (2008): Current Status and Prospects for Energy Resources and Infrastructure Development of South Gobi in Mongolia. Presented by Mr. Ganbaatar Badgaa, Department of Fuel Policy and Regulation, Ministry of Fuel and Energy Mongolia. Presented at International Symposium on 'Energy Resources Cooperation and Corporate Strategy in Northeast and Central Asia,'. July 3, 2008, http://www.keei.re.kr/keei/download/seminar/080703/s1-4.pdf

GEUS (2004): Small-scale mining in Mongolia, Geological Survey of Denmark and Greenland, Report 2005/4. http://www.geus.dk

Homma (2009): The Current State of Electricity in Mongolia, Kunioki Homma, Representative Director, South Gobi Power Development Corporation, December 1, 2009, Economic Research Institute for Northern Asia (ERINA). http://www.erina.or.jp/en/Opinion/2009/Russia/homma.htm

IEA (2005): Data obtained from International Energy Agency Energy Statistics - Coal. Table posted 2005, http://www.iea.org/Textbase/stats/coaldata.asp?COUNTRY_CODE=MN

MIF (2006): Introduction of the Petroleum Sector of Mongolia, Government Investment Project Brief Profiles, presented at the Mongolia Investors Forum, September 14–15, 2006, http://www.investmongolia.com/forum/proj.htm

MIT (2008): Minerals and Infrastructure Development in the South, presented by Mongolia Ministry of Industry and Trade, at the Infrastructure Strategy for Southern Mongolia Round Table Discussion of the World Bank, May 15, 2008, http://go.worldbank.org/GLQKP25890

MNEC (2008): Information provided to Methane to Markets by Mongolia Nature and Environment Consortium, 2008.

MNEC (2010). Mongolia Nature and Environment Consortium. Final Technical Report of a Pre-Feasibility Study of Methane Recovery and Utilization in the Nalaikh Mine Area, Mongolia, under Cooperative Agreement XA-833970 with US Environmental Protection Agency. January 2010.

MNMA (2008): Mongolian National Mining Association. www.miningmongolia.mn

Mongolyn Alt Corporation (2010): Mongolyn Alt Corporation "Mak." Accessed February, 2010. http://www.mak.mn/

MRAM (2009): Organization History, Mineral Resources Authority of Mongolia, 2009, http://mram.gov.mn/en/index.php?option=com_content&task=view&id=43&Itemid=37

MRPAM (2008): Mineral Resources and Petroleum Authority of Mongolia, website: http://mrpam.gov.mn/en/

Purevsuren and Drebenstedt (2004): Actual aspects of lignite mining in Mongolia, in *Mine Planning and Equipment Selection*, edited by Monika Hardygora, Gabriela Paszkowska, and Marek Sikora, Thirteenth International Symposium on Mine Planning and Equipment Selection, Proceedings – Wroclaw, Poland, September 1–3, 2004.

QGX (2008): Baruun Naran Coal Project. http://www.qgxgold.com/html/shtml/bn_baruun_naran.shtml

Red Hill (2010): Chandgana Tal & Khavtgai. Accessed February, 2010. http://www.redhillenergy.com/projects/coal/chandgana_tal/

Schwochow (1997). The International Coal Seam Gas Report, Cairn Point Publishing, Stephen Schwochow, editor, 1997.

Sproule (2010): Sproule Projects Asia. Accessed February, 2010. http://www.sproule.com/Asia#title

Storm Cat (2005): Storm Cat Energy Corporation News Room, July 13, 2005 Press Release, www.stormcatenergy.com/news

Tavan Tolgoi (2010): Tavan Tolgoi Incorporated Company. Accessed February, 2010. http://www.tavantolgoi.mn/?lang=english#153622MetawiseCMS

Tse (2007): US Geological Survey Minerals Yearbook 2005, Mongolia-2005, US Department of Interior, USGS, Pui-Kwan Tse, June, 2007.

Tserenpurev (2008): Energy Development in the South Gobi Region, presented by Tserenpurev T., State Secretary of the Ministry of Fuel and Energy, at the Infrastructure Strategy for Southern Mongolia Round Table Discussion of the World Bank, May 15, 2008. http://go.worldbank.org/GLQKP25890

Tumurbaatar and Altanchimeg (2009): Law and Regulation for Coal Mine Methane Utilization and Expect, Z. Tumurbaatar and D. Altanchimeg Ph.D., Mongolia Ministry of Fuel and Energy, Methane Recovery and Utilization Opportunities, Methane to Markets Partnership, Ulaanbaatar, 2009. http://www.methanetomarkets.org/documents/partners_mongolia_methane_opportunity.pdf

UNFCCC (2001): Mongolia. Mongolia's First National Communication, National Agency for Meteorology, Hydrology, and Environment Monitoring, http://unfccc.int/essential_background/library/items/3599.php?rec=j&priref=3195

UNFCCC (2005): Parties and Observer States: Mongolia, http://maindb.unfccc.int/public/country.pl?country=MN

USEPA (2006): *Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990–2020*, U.S. Environmental Protection Agency, Office of Atmospheric Programs, Climate Change Division, June 2006. http://www.epa.gov/nonco2/econ-inv/downloads/GlobalAnthroEmissionsReport.pdf (Appendix B-2).

World Bank (2004): Mongolia Mining Sector Sources of Growth Study, prepared by the World Bank East Asia and Pacific Region, April 2004. http://go.worldbank.org/EXUFR17XZ1

23 NEW ZEALAND

23.1 Summary of Coal Industry

23.1.1 ROLE OF COAL IN NEW ZEALAND

Coal is New Zealand's most abundant fossil fuel and has been an important energy source since the late nineteenth century. Today, the majority of New Zealand's coal is used for electricity generation and industrial processes, with the steel and dairy sectors being the largest industrial consumers of coal (Coal Association, 2009). Electricity generation consumes about 50 percent of New Zealand's domestic coal supply (MOED, 2008). Further, coal exportation has been a major growth area since about 1990 and is likely to continue being a good prospect for the future.

Table 23-1 indicates New Zealand's recoverable coal reserves to be about 570 million tonnes (Mmt). The resource itself is far more extensive and may offer greater recovery, ultimately. The total in-ground resource is estimated to be 15,600 Mmt, of which about 8,700 Mmt (56 percent) is recoverable (Barry et al., 1994).

Table 23-1. New Zealand's Coal Reserves and Production

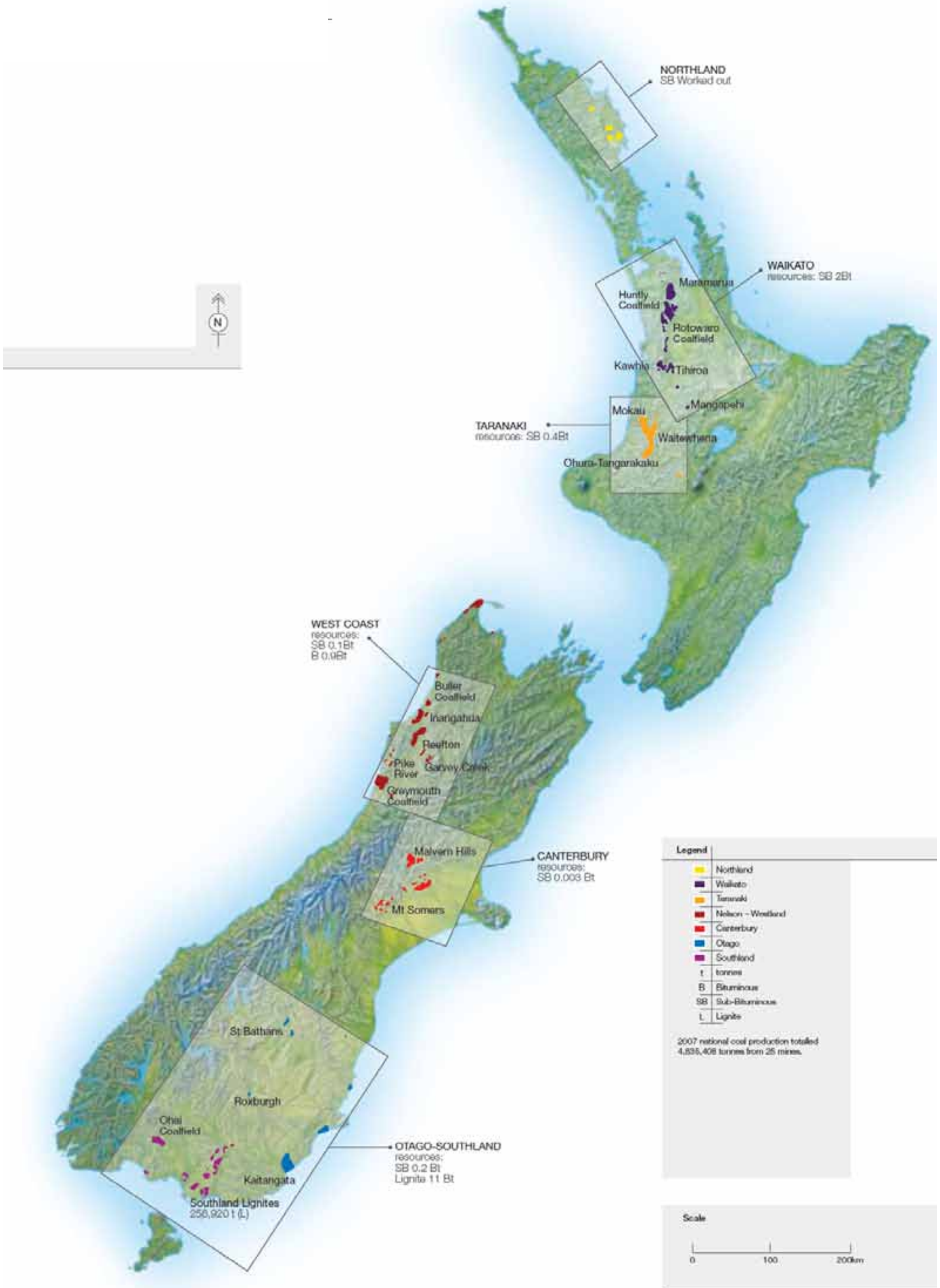
Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2006)*	33.0	538.0	571.0	21 (0.07%)
Annual Coal Production (2007)**	2.0	2.8	4.8	25 (0.08%)

Source: *EIA (2008); **IEA (2007)

Note: New Zealand Ministry of Economic Development puts coal production at 4.5 million tons for 2009 due to reduced production at the largest production mines because of operator strikes (MOED, 2010a).

New Zealand is divided up in to North Island and South Island (Figure 23-1). Coal is found in the Northland, Waikato, and Taranaki Coal Regions of the North Island. On the South Island, coal is found in the Nelson, West Coast, Canterbury, Otago, and Southland Coal Regions (USGS, 2004). Most of the resource is in the South Island; more than 13,000 Mmt (84 percent) of the in-ground coal are lignite deposits. The North Island in-ground resource is about 2,500 Mmt (16 percent) and consists of almost entirely sub-bituminous coal.

Figure 23-1. New Zealand's Coal Fields



Source: MOED (2010b)

23.1.2 STAKEHOLDERS

Only a handful of companies operate coal mines in New Zealand. Most of New Zealand's coal is produced by Solid Energy, NZ (MOED, 2010c). Major operators include the ones listed in Table 23-3 and L&M Mining, which partners with Kenham Holdings, Ltd.

Key stakeholders involved in New Zealand's coal and the coal mine methane (CMM) development industries are outlined in Table 23-2.

Table 23-2. Key Stakeholders in New Zealand's CMM Industry

Stakeholder Category	Stakeholder	Role
Developer	▪ Comet Ridge	Licenses and partners with other coalbed methane (CBM) companies.
	▪ Kenham Holdings	Partners with L&M Mining. Holds 11 of 16 licenses for exploratory CBM drilling.
	▪ Bridge Petroleum	Holds two licenses for exploratory CBM drilling with Westech Energy.
	▪ Westech Energy	Holds two licenses for exploratory CBM drilling with Bridge Petroleum.
	▪ Resource Development Technology, Ltd.	Holds one license for exploratory CBM drilling.
	▪ L&M Coal Seam Gas Ltd.	Exploratory licenses holder
	▪ L&M Energy Ltd. (LME)	Recently acquired L&M Coal Seam Gas Ltd. and its licenses.
	▪ Macdonald Investments Ltd. (MIL)	Partners with Comet Ridge and Chartwell Energy Ltd. on CBM licenses.
	▪ Chartwell Energy Ltd.	Partners with MIL and Comet Ridge on CBM licenses.
	▪ CRL Energy, Ltd.	Developing technologies for CBM production in the low rank coals.
	▪ See http://www.epa.gov/coalbed/networkcontacts.html	
Mining Companies	▪ Solid Energy NZ Limited	Project hosts
Universities and Research Centers	▪ University of Auckland	Technical assistance
	▪ CSIRO	
Government Groups	▪ Ministry of Commerce – Energy and Resources Division	Licensing

23.1.3 STATUS OF COAL AND THE COAL MINING INDUSTRY

New Zealand's coal industry is vested in 21 surface and underground mines. Nine of these mines produced more than 100,000 tonnes per year in 2005 (MOED, 2005). Coal production statistics for 2009 by mine type are presented in Table 23-3. The total number of mines has steadily decreased, and surface mining methods have become more popular.

Table 23-3. New Zealand's Production and Mine Statistics (million tonnes)

Type of Mine	2009 Production	Number of Mines
Underground (active)	0.84	4
Surface (active)	3.73	17
Total	4.56	21

Source: MOED (2010a)

Despite increasing competition from hydroelectric power and from imported oil, annual coal production has been sustained at or above the 2 Mmt level since 1910. Production has exceeded 3 Mmt since 1993, and it reached a peak of almost 5.8 Mmt in 2006 (MOED, 2010a).

Table 23-4 lists all major coal mines in operation in New Zealand.

Table 23-4. New Zealand's Major Operating Coal Mines

Coal Field	Mine	Coal Rank	Mine Type	Operator
Waikato				
▪ Huntly	▪ O'Reilly's	sub-bituminous	surface	O'Reilly's Opencast
▪ Maramarua	▪ Kopako	sub-bituminous	surface	Glencoal Energy Ltd.
▪ Rotowaro	▪ Awaroa	sub-bituminous	surface	Solid Energy Ltd.
West Coast				
▪ Buller	▪ Stockton	bituminous	surface	Solid Energy Ltd.
▪ Buller	▪ Cascade	bituminous	surface	Cascade Coal
▪ Buller	▪ New Creek	bituminous	surface	New Creek Mining
▪ Buller	▪ Rockies	bituminous	surface	Rockies Mining
▪ Reefton	▪ Burkes Creek	bituminous	surface	RJ Banks
▪ Garvey Creek	▪ Island Block	bituminous	surface	Solid Energy Ltd.
▪ Garvey Creek	▪ Echo	bituminous	surface	Francis Mining
▪ Inangahua	▪ Giles Creek	sub-bituminous	surface	Birchfield Coal.
▪ Inangahua	▪ Berlins Creek	sub-bituminous	surface	Heaphy Mining
Canterbury				
▪ Canterbury	▪ Canterbury Coal	sub-bituminous	surface	Canterbury Coal
Otago				
▪ Kaitangata	▪ Castle Hill	sub-bituminous	surface	Kai Point Coal
▪ Roxburgh	▪ Harliwich	lignite	surface	Harliwich Carrying Co.
Southland				
▪ Ohai	▪ Nightcaps	sub-bituminous	surface	Rochfort Coal
▪ Waimumu	▪ New Vale	lignite	surface	Solid Energy Ltd.
▪ Ohai	▪ Wairaki No.6	sub-bituminous	surface	Solid Energy Ltd.

Source: MOED (2010d)

Currently, little exploration for new reserves is taking place, and the industry is concentrating on improving knowledge of reserves within the existing license areas. New Zealand's coal exports will continue to grow—although there has been demand for premium-quality bituminous coal, there is also a growing international market for thermal coals, such as New Zealand's lower-grade bituminous and sub-bituminous coals (USGS, 2004). In February 2010, the Pike River Coal Mine produced its first shipment of 20,000 tonnes of hard coking coal for export to India. The mine is expected to produce 1 Mmt of coal annually from seams with 58.5 Mmt of total coal (Pike River, 2010).

23.2 Overview of CMM Emissions and Development Potential

The Global Methane Initiative (formerly Methane to Markets Partnership) International CMM Projects Database currently identifies no CMM recovery projects for New Zealand.

23.2.1 CMM Emissions from Operating Mines

Most New Zealand coal production is from surface mines producing low rank coals at shallow depths with low methane concentrations. Methane emissions from these coals are vented. The few deep underground mines have high methane concentrations and are generally degasified with ventilation and surface gob wells. To date, no current projects have been identified in surface or underground mines where captured gas is utilized or marketed rather than vented. New Zealand's CMM emissions are summarized in Table 23-5.

Table 23-5. New Zealand's CMM Emissions (million cubic meters)

Emission Category	1990	1995	2000	2005	2006	2007	2008
Underground mining emissions	14.97	14.81	18.40	14.40	23.19	11.69	17.00
Post-underground mining emissions	1.90	1.59	2.08	1.68	2.59	1.46	1.99
Surface mining emissions	2.01	3.13	3.06	5.11	5.28	4.77	4.60
Post-surface mining emissions	0.17	0.27	0.27	0.44	0.46	0.42	0.40
Total	19.05	19.81	23.81	21.63	31.52	18.33	23.99

Source: UNFCCC (2010)

23.2.2 CMM Emissions from Abandoned Coal Mines

No data about methane emissions from abandoned mines in New Zealand are available at this time.

23.2.3 CBM from Virgin Coal Seams

Recent estimates indicate New Zealand has a total of more than 2,000 petajoules or 53 billion cubic meters (m^3) of coalbed methane (CBM) reserves (Clark, 2008). No commercial wells are in production, but numerous exploratory and test wells have been drilled.

At least 16 licenses have been issued for exploratory drilling and development of coal seam gas in New Zealand as of October 2009 (L&M, 2009). L&M CSG Ltd. holds 6, which covers coal resources ranging in rank from lignite to bituminous, with the bulk being in the low rank coals. L&M CSG has drilled 52 exploratory wells and has started their first pilot project. Currently, L&M estimates they have about 1,500 petajoules (40 billion m^3) of CBM reserves (L&M, 2009). L&M Energy recently acquired L&M Coal Seam Gas Ltd. increasing its number of permits (now 12), exploration sites, and resources (L&M, 2010a). The company now has New Zealand's first certified reserves of CBM (172 petajoules of 3P reserves) (L&M, 2010b).

Other licenses are held by Resource Development Technology (1), Bridge Petroleum and Wastech Energy (2), and Solid Energy (2). A detailed assessment of these license areas and the work to date by Kenham, L&M & CRL was published in 2004 (Manhire and Hayton, 2004).

23.3 Opportunities and Challenges to Greater CMM Recovery and Use

As reflected in Table 23-6, New Zealand is a signatory to both the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. New Zealand is an Annex I Party, and its emissions target under the Kyoto Protocol is to achieve 1990 levels by 2010.

Table 23-6. New Zealand's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC*	June 4, 1992	September 16, 1993
Kyoto Protocol**	May 22, 1998	December 19, 2002

Source: *UNFCCC (2007a); **UNFCCC (2007b)

23.3.1 Market and Infrastructure Factors

New Zealand gas demand is projected to continue to increase significantly as domestic conventional gas supplies decline more rapidly than expected. New domestic production from CBM/CMM is therefore encouraged. New Zealand has considered imposing a carbon tax, however, in 2005, the government decided to abandon their plans because emission savings were not justified by the cost.

CMM and CBM infrastructure in New Zealand is not well developed; gas gathering, compression, and transmission infrastructure will require significant investments.

Any methane recovered in the future could be utilized by the power generation, heating, and transportation sectors, as well as by the industrial sector for boilers, but it would have to compete against gas suppliers and importers. The University of Auckland, the Commonwealth Scientific and Industrial Research Organization, and other technology organizations are helping to address technology issues associated with recovery of CMM and CBM resources.

23.3.2 Regulatory Information

New Zealand coal mining industry has undergone major changes over the last 25 years. State-owned coal mines were converted into a government-owned corporation. Natural gas regulations are governed by the "Gas Act" which can be found at www.legislation.govt.nz.

23.4 Profiles of Individual Mines

See MOED (2005) for links to available mine production data. Updates on future CMM projects in New Zealand can be found at http://www.methanetomarkets.org/coal-mines/index.aspx.

23.5 References

Barry et al., (1994): Coal Resources of New Zealand. Resource Information Report 16, Barry, J.M., Duff, SW, MacFarlane, DAB, Energy and Resources Division, Ministry of Commerce, New Zealand, p.73.

Clark (2008): Gas Riches from our Coal. Clark, Lindsay, Contrafed Publishing, Energy Ez No. 7, Summer 2008. http://www.contrafedpublishing.co.nz/Energy+NZ/Issue+7+Summer+2008/Gas+riches+from+our+coal.html

Coal Association (2009): World Coal Institute Country Profile - New Zealand, Coal Association of New Zealand, February 2009. http://www.coalassociation.org/profile.htm

EIA (2008): *International Energy Annual 2006*. U.S. Energy Information Administration (EIA), Washington, DC, table posted October 17, 2008. http://www.eia.doe.gov/pub/international/iea2006/table82.xls

IEA (2007): Coal and Peat in New Zealand, International Energy Agency, 2007. http://www.iea.org/Textbase/stats/coaldata.asp?COUNTRY_CODE=NZ

L&M (2009): L&M Coal Seam Gas Ltd – Presentation, L&M Coal Seam Gas Ltd, October 2009. http://lmgroup.net.nz/content/Coal%20Seam%20Gas/Papers%20%26%20Presentations/5424/L%26M%20CSG%20Ltd%20%5bRead-Only%5d%20%5bCompatibility%20Mode%5d.pdf?cid=5424

L&M (2010a): L&M Energy – Investor Presentation, L&M Energy, February 2010. http://www.lmenergy.co.nz/468a1.page

L&M (2010b): L&M Energy – Investor Presentation, L&M Energy Ltd., June 9, 2010. http://www.lmenergy.co.nz/495a1.page

Manhire and Hayton (2004): Coal Seam Gas in New Zealand: Perspectives From New Zealand's Most Active CSG Explorers, Manhire, D.A. and S. Hayton, 2003.

MOED (2005): Crown Minerals website, New Zealand Ministry of Economic Development, 2005. http://www.crownminerals.govt.nz/cms/coal/facts-and-figures

MOED (2008): Coal - Energy Data Tables for Coal Production and Consumption, Ministry of Economic Development, 2008. http://www.med.govt.nz/templates/StandardSummary____21117.aspx

MOED (2010a): Facts and Figures - Coal production statistics, Ministry of Economic Development, 2010. http://www.crownminerals.govt.nz/cms/coal/facts-and-figures

MOED (2010b): New Zealand Coal Deposits, Ministry of Economic Development, 2010. http://www.crownminerals.govt.nz/cms/coal/overview/new-zealand-coal-deposits

MOED (2010c): Coal Overview, Ministry of Economic Development, 2010. http://www.crownminerals.govt.nz/cms/coal/overview

MOED (2010d): Operating coal mines, Ministry of Economic Development, 2010. http://www.crownminerals.govt.nz/cms/coal/overview/operating-coal-mines

Pike River (2010): Pike River Mine Information and Quarterly Reports, Pike River Coal, 2010. http://www.pike.co.nz/home.php

UNFCCC (2007a): United Nations Framework Convention on Climate Change - Status of Ratification, August 22, 2007. http://unfccc.int/files/essential_background/convention/status_of_ratification/application/pdf/unfccc_conv_rat.pdf

UNFCCC (2007b): Kyoto Protocol - Status of Ratification, December 12, 2007. http://unfccc.int/files/kyoto_protocol/background/status_of_ratification/application/pdf/kp_ratification.pdf

UNFCCC (2010): New Zealand National Inventory Report 2010, United Nations Framework Convention on Climate Change, Annex I Party GHG Inventory Submission, 2010. http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5270.php

USGS (2004): U.S. Geological Survey Fact Sheet 2004 – 3089; New Zealand Coal Resources, September 2004. http://pubs.usgs.gov/fs/2004/3089/fs2004-3089.html

24 NIGERIA

24.1 Summary of Coal Industry

24.1.1 ROLE OF COAL IN NIGERIA

Nigeria ranks low in worldwide coal production, with less than 10 thousand tonnes of coal production in 2007 (Table 24-1). Nigeria estimates its coal reserves at more than 2 billion tonnes, with approximately 650 million tonnes (Mmt) as proven (OnlineNigeria, 2010). Other sources cite different estimates, however (as in Table 24-1). Although coal was the first energy resource to be exploited by Nigeria, a transition to diesel fuel for rail transport and to gas for electricity generation led to a decrease in coal production. Coal production has dropped to insignificant levels from its high of almost 1 Mmt in 1959.

Table 24-1. Nigeria's Coal Reserves and Production

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2006)*	21.0	169.0	‡190.0	26 (0.02%)
Annual Coal Production (2007)**	0.008	0	0.008	31 (0.0001%)

Source: *EIA (2008); **IEA (2007)

‡ Nigeria cites total in-place coal reserves of 396 million tonnes, but the entire defined coal resource is estimated as 1.5 billion tonnes (MMSD, 2010).

Nigeria's coal resources are located in the Cretaceous Anambra and Makurdi Basins, and Afikpo Syncline (see Figure 24-1) and occur in two levels: the lower Mamu Formation and the upper Nsukka Formation. Coal seams occur in three main stratigraphic levels (Ogunsola, 2008):

- The brown coals (lignite) of Ogwashi-Asaba Formation of Miocene to Pliocene ages
- The upper and lower sub-bituminous coal measures of Maastrichtian age
- The bituminous coals of the Awgu shales of Coniacian age

Its sub-bituminous coal is low in sulfur and ash content, making it attractive for import by Ghana and Egypt and by European nations as well. Nigeria has Africa's largest deposits of lignite. Reserves from coal seams in excess of 1 meter thick are: Ogboyoga (100 Mmt) in the north, and Okaba (70 Mmt), Orupka (60 Mmt), Ezimo (50 Mmt), and Enugo (50 Mmt) in the south (NOGO, nd).

Figure 24-1. Nigeria's Coal Fields

Source: CIA (2010); *EarthByte (2008); **GeoSurvey (2006)

24.1.2 STAKEHOLDERS

Table 24-2 identifies potential stakeholders in Nigerian coal mine methane (CMM) development.

Table 24-2. Key Stakeholders in Nigeria's CMM Industry

Stakeholder Category	Stakeholder	Role
Mining Companies/Equity Owners	▪ Kogi State Government	Owner/operator
	▪ Nigerian Coal Corporation (NCC)	Owner/operator
	▪ Behre Dolbear and Company Inc.	Technical expertise
Developers, Engineers, Consultancy and Related Services	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Project opportunity identification, planning, and assistance

Stakeholder Category	Stakeholder	Role
Natural Gas Transmission & Distribution Companies	▪ British Gas	Gas distribution
	▪ BP	
	▪ ChevronTexaco	Technical assistance
	▪ Conoco	
	▪ Deminex	
	▪ ENI/Agip	
	▪ ExxonMobil	
Regulatory Agencies	▪ Nigerian National Petroleum Corporation – Department of Petroleum Resources	CMM project promotion, registration of exploration and development companies
Government Groups	▪ Ministry of Mines and Steel Development	Granting and approval of leases
	▪ National Chamber of Commerce, Industries – Mining and Agriculture	
	▪ Federal Ministry of the Environment	
	▪ Mining Cadastre Office	Responsible for mineral titles
	▪ Mines Inspectorate Department	Health and Safety administration and enforcement
	▪ Small Scale Mining Department	Organization, support, and assistance to small scale miners

Source: EIA (2008); USGS (2010)

24.1.3 Status of Coal and the Coal Mining Industry

The Nigerian government is seeking to increase the country's level of coal utilization to help stem the loss of its forests to domestic fuel-wood harvesting and to help reduce its overdependence on oil. At present, however, coal remains the smallest contributor to the overall fuel mix. As per the Energy Information Administration, coal is not part of Nigeria's energy consumption mix (EIA, 2009).

Current uses for coal in the country are in cement production, brick factories, foundries, laundries and bakeries, tire manufacture, battery manufacture, and domestic cooking fuel (i.e., smokeless coal briquettes). Nigerian coal can be blended with imported coals for coke production, and it is projected that as much as 200,000 tonnes per year of Nigerian coal could be directed to supply coke to the Ajaokuta Steel Plant once it begins full operation. Using coal to manufacture smokeless briquettes for home cooking fuel has the added benefit of producing by-products such as gases, ammonia, tar oils, and various aromatics that can be used as chemical feedstocks. Nigeria has also determined that its coal is suitable fuel for use at the abandoned Oji Power Station, as well as at other proposed power generation facilities.

A feasibility study conducted for Nigeria by Behre Dolbear in 2006 indicates that electricity demand in Nigeria is projected to increase from the current 3.5 gigawatts (GW) to between 12 and 15 GW in 2025. Coal is expected to provide for a significant portion of the projected electric power demand (about 6 GW to 7.5 GW). Consequently, coal demand is projected to increase to 19–24 Mmt by 2025 (Ogunsola, 2008). World Bank reports underground and surface coal production potential to be 200,000–600,000 tonnes per year and 400,000–800,000 tonnes per year, respectively (World Bank, 1983). This will be significantly higher in the future if coal is to play a major role in meeting the country's projected increase in electric power demand (Ogunsola, 2008). In addition to such domestic uses, Nigeria estimates that export demand for its coal could reach 15 Mmt per year (M2M Workshop – Nigeria, 2005). For more information on the coal mining potential in Nigeria, see *Coal - Exploration and Power Generating Opportunities in Nigeria* (MMSD, 2010).

Table 24-3 provides an overview of coal mines and mining methods used in Nigeria.

Table 24-3. Nigeria's Coal Mines

Mine	Coal Type	Estimated Reserves (million tonnes)	Proven Reserves (million tonnes)	Depth of Coal (m)	Mining Method(s)
Okpara	Sub-bituminous	100	24	180	Underground
Onyeama	Sub-bituminous	150	40		Underground
Ihioma	Lignite	40	N/A	20–80	Surface
Ogboyoga	Sub-bituminous	427	107	20–100	Surface and underground
Ogwashi Azagba/Obomkpa	Lignite	250	63	15–100	Surface and underground
Ezimo	Sub-bituminous	156	56	30–45	Surface and underground
Inyi	Sub-bituminous	50	20	25–78	Surface and underground
Lafia/Obi	Bituminous (cokable)	156	21.42	80	Underground
Oba/Nnewi	Lignite	30	N/A	18–38	Underground
Afikpo/Okigwe	Sub-bituminous	50	N/A	20–100	Underground
Amasiodo	Bituminous	1,000	N/A	563	Underground
Okaba	Sub-bituminous	250	73	20–100	Surface and underground
Owukpa	Sub-bituminous	75	57	20–100	Surface and underground
Ogugu/Awgu	Sub-bituminous	N/A	N/A	N/A	Underground
Afuji	Sub-bituminous	N/A	N/A	N/A	Underground
Ute	Sub-bituminous	N/A	N/A	N/A	Underground
Duho	Sub-bituminous	N/A	N/A	N/A	Underground
Kurumu	Sub-bituminous	N/A	N/A	N/A	Underground
Lamja	Sub-bituminous	N/A	N/A	N/A	Underground
Garin Maigunga	Sub-bituminous	N/A	N/A	N/A	Underground
Gindi Akwati	Sub-bituminous	N/A	N/A	N/A	Underground
Janata Koji	Sub-bituminous	N/A	N/A	N/A	Underground

Source: M2M Workshop – Nigeria (2005); Ogunsola (2008)

24.2 Overview of CMM Emissions and Development Potential

The Global Methane Initiative (formerly Methane to Markets Partnership) International CMM Projects Database currently identifies no CMM recovery projects in Nigeria. However, two methane capture projects with potential for power generation are being sought for development, both in the Anambra Coal Basin. The Okpara Mines, one of the project sites, had ceased coal production in 2003 but was expected to restart in 2010 under private ownership.

The methane drainage from this mine is estimated to generate 1.24 megawatts (MW) of electricity, reducing 6.9 million m^3 of methane emissions annually (M2M, 2010).

24.2.1 CMM Emissions from Operating Coal Mines

Table 24-4 reports Nigeria's historical CMM emissions.

Table 24-4. Nigeria's CMM Emissions (million cubic meters)

Emission Category	1990	*1994	1995	2000	2005 (projected)
Surface Mining		195.8			
Underground Mining		4.2			
Total emitted (= Total liberated – recovered & used)	126	200.0	203	86.8	1.0

Source: USEPA (2006); *UNFCCC (2003)

24.2.2 CMM Emissions from Abandoned Coal Mines

No data quantifying methane emissions from abandoned mines were found.

24.2.3 CBM from Virgin Coal Seams

No data quantifying methane production from virgin coal seams were found.

24.3 Opportunities and Challenges to Greater CMM Recovery and Use

Nigeria has signed and ratified the UNFCCC and has ratified the Kyoto Protocol (see Table 24-5). As a non-Annex 1 country, Nigeria is eligible to host Clean Development Mechanism projects that can earn revenue from the sale of carbon credits.

Table 24-5. Nigeria's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC*	June 13, 1992	August 29, 1994
Kyoto Protocol**	---	December 10, 2004 (Acceptance)

Source: *UNFCCC (20010a); **UNFCCC (20010b)

24.3.1 Market and Infrastructure Factors

Nigeria's robust natural gas industry provides a market conducive to CMM development. The expected increase in gas infrastructure will enhance the ability to move drained CMM from the wellhead to market. On the other hand, Nigeria has such substantial gas resources that supplemental streams captured at coal fields may appear relatively insignificant in comparison, thereby diluting interest in CMM development. Also, the amount of CMM that can be recovered in conjunction with coal mining has been reduced over time.

24.3.2 Regulatory Information

Nigeria has the largest natural gas reserves in Africa and is among the top 10 in the world. However, due to inadequate gas infrastructure, Nigeria has flared as much as 75 percent of the gas it produces, accounting for about 20 percent of all gas flared worldwide. New Nigerian policy seeks to reduce gas flaring by using the gas as feedstock in liquefied natural gas (LNG) processing facilities. Beginning

January 1, 2008, the Nigerian Government enacted a policy to force companies to stop flaring gas. Since that time, the termination date has been pushed back repeatedly (EIA, 2009). Some of the gas that is typically flared is expected to help supplement the gas required at the LNG processing facilities on Bonny Island; however, no quantitative data could be found. Additional plans are underway to construct a number of other LNG processing facilities in the country and to expand its domestic and cross-border (e.g., Benin, Togo, and Ghana) natural gas pipeline infrastructure, with the specific intention of increasing domestic access to and use of natural gas by the resident population (EIA, 2009; NOGO, nd).

The national government, specifically the Nigerian Coal Corporation (NCC), owns 100 percent of the Nigerian coal industry, but the government's monopoly of coal mining is being relaxed. Beginning in 1990, the NCC initiated efforts to privatize the coal industry by entering into several different joint venture arrangements. While the initial joint ventures have not been successful, the privatization efforts are still being pursued (Ogunsola, 2008).

As part of Nigeria's general privatization plan for the energy sector, the NCC is itself being put up for sale by the Bureau of Public Enterprises (BPE) with some assets being sold individually to pay off accumulated debt (Compass, 2009a; Compass, 2009b). Also as part of the privatization plans, the coal resources of Nigeria have been divided into 10 prospective blocks and put up for auction. Nine of the blocks were bid for and won by four companies, one Nigerian and three foreign, with the expertise and finances to make use of the resources (Africa, 2010). These sales to capable companies should improve the investment and development climate.

The government also regulates and supervises natural gas production through the Nigerian National Petroleum Corporation (NNPC) formed in 1977, and its subsidiary, the Nigerian Gas Company Ltd., which currently operates 12 gas supply systems in Nigeria (NNPC, 2010). The Department of Petroleum Resources within NNPC registers companies that wish to conduct gas exploration and development (NOGO, nd).

Currently, there exist two types of gas operator agreements in Nigeria: joint operating agreements and production sharing agreements. Coal mining leases can be obtained either through an approved (by the Ministry of Mines and Steel Development) acquisition of an existing mining property or by applying for a Prospecting Right or License. Gas producers must perform gas field optimization analyses on their concessions and the government is responsible for optimization of gas field development overall.

Nigeria's efforts to wean its population away from harvesting timber for cooking fuel may stimulate coal production and CMM development. As mentioned above, however, the current low level of coal production in the country is not conducive to a robust CMM development industry.

24.4 Profiles of Individual Mines

Adequate data to profile individual mines is not available.

24.5 References

CIA (2010): The World Factbook - Nigeria, Central Intelligence Agency, June 2010. https://www.cia.gov/library/publications/the-world-factbook/geos/ni.html

Compass (2009a): New Lease of Life for Coal Corporation, Nigerian Compass Newspaper, April 7, 2009. http://www.compassnewspaper.com/NG/index.php?option=com_content&view=article&id=14675:new-lease-of-life-for-coal-corporation&catid=43:news&Itemid=799

Compass (2009b): Nigerian Coal Corporation not for winding up, says BPE, Nigerian Compass Newspaper, October 8, 2009. http://www.compassnewspaper.com/NG/index.php?option=com_content&view=article&id=30108:nigerian-coal-corporation-not-for-winding-up-says-bpe&catid=111:energy&Itemid=712

EarthByte (2008): ICONS atlas: AFR - Anambra Basin, EarthByte.org, March 8, 2008. http://www.earthbyte.org/Resources/ICONS/AFR/AnambraBasin/AFR.AnambraBasin.html

EIA (2008): International Energy Annual 2006, Department of Energy, Energy Information Agency, December 2008, http://www.eia.doe.gov/emeu/iea/contents.html

EIA (2009): Country Analysis Brief – Nigeria, U.S. Energy information Administration, May 2009. http://www.eia.doe.gov/emeu/cabs/Nigeria/Background.html

GeoSurvey (2006): Mineral Resources Map of Nigeria, Nigerian Geological Survey Agency, Federal Republic of Nigeria, 2006. http://www.savannahgold.co.uk/nigeria.php

IEA (2007): Coal and Peat in Nigeria, International Energy Agency, Paris, France, 2007. http://www.iea.org/stats/coaldata.asp?COUNTRY_CODE=NG

Africa (2010): Nigeria's Coal Deposits Identified, How We Made It In Africa, May 19, 2010. http://www.howwemadeitinafrica.com/nigerian-coal-deposits-identified /

M2M Workshop - Nigeria (2005): *Nigeria's Country Report on Coal Mine Methane Recovery and Use*, presented at the Methane to Markets Regional Workshop, December 2, 2005, Beijing, China. http://methanetomarkets.org/documents/events_coal_20060525_nigeria.pdf

M2M Project (2010): Methane to Markets Projects, 2010. http://www.methanetomarkets.org/projects/index.aspx

MMSD (2010): Coal Exploration and Power Generating Opportunities in Nigeria, The Ministry of Mines and Steel Development – Nigeria, 2010. http://mmsd.gov.ng/Downloads/Coal.pdf

NNPC (2010): Nigerian Gas Company Limited (NGC) – Profile, Nigerian National Petroleum Corporation, 2010. http://www.nnpcgroup.com/nnpc-group/ngc

NOGO (nd): Natural Gas, Nigerian Oil and Gas Online, not dated.

Ogunsola (2008): Personal communication with Dr. Olubunmi Ogunsola, TEMEC. July 7, 2008.

OnlineNigeria (2010): Coal and Lignite, OnlineNigeria, accessed June 29, 2010. http://www.onlinenigeria.com/geology/?blurb=510

UNFCCC (2003): Nigeria's Initial National Communication on Climate Change, Government of The Federal Republic of Nigeria, United Nations Framework Convention on Climate Change, Non-Annex I National Communications, November 17, 2003. http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php

UNFCCC (2010a): United Nations Framework Convention on Climate Change - Status of Ratification, accessed June 28, 2010. http://unfccc.int/essential_background/convention/status_of_ratification/items/2631.php

UNFCCC (2010b): Kyoto Protocol - Status of Ratification, accessed June 28, 2010. http://unfccc.int/kyoto_protocol/status_of_ratification/items/2613.php

USEPA (2006): *Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990–2020*, Draft, U.S. Environmental Protection Agency, Office of Atmospheric Programs, Climate Change Division. June, 2006. http://www.epa.gov/climatechange/economics/international.html

USGS (2010): 2008 Minerals Yearbook – Nigeria, U.S. Geological Survey, U.S. Department of the Interior, April 2010. http://minerals.usgs.gov/minerals/pubs/country/2008/myb3-2008-ni.pdf

World Bank (1983): Nigeria: Issues and Options in the Energy Sector, Report by The World Bank. August 1983.

25 PAKISTAN

25.1 Summary of Coal Industry

25.1.1 ROLE OF COAL IN PAKISTAN

Coal had historically been the primary fossil fuel for Pakistan with the major consumers being railways, cement, fertilizer, and power plants. This held true until large deposits of oil and natural gas were discovered in the 1960s (PakistanEcon, 2001). As of 2006, coal provided for only 7 percent of Pakistan's total primary energy consumption, compared to natural gas at 45 percent, oil at 33 percent, and hydroelectricity at 13 percent (EIA, 2008). Given the increasing costs of imported energy, Pakistan is, however, now seeking to expand the share of coal in its energy mix to 19 percent by 2030 and to 50 percent by 2050. The Energy Security Action Plan has set a target of generating 20,000 megawatts (MW) power from coal by 2030. There is presently only one power plant in the country that uses coal as fuel – the 150 MW Lakhra power plant in Lower Sindh (BOI, 2007).

Pakistan has one of the world's largest lignite reserves in the Tharparkar district of Sindh, found in early 1990s and estimated at more than 185 billion tonnes (PakTribune, 2010). Its proven reserves are, however, much lower and production of coal is low due to a combination of factors including cheap alternative fuels and a lack of domestic demand, transportation and energy infrastructure, capital investment, and natural resources like water which support or enable extraction (EOEarth, 2008).

Table 25-1 indicates Pakistan's recoverable coal reserves to be about 1,982 million tonnes (Mmt). Total estimated resources are far more extensive and may offer greater recovery ultimately. The total in-ground resource is estimated to be 185,000 Mmt, of which about 11,000 Mmt are indicated and 3,300 Mmt are proven or measured (PakGeoSurvey, 2005).

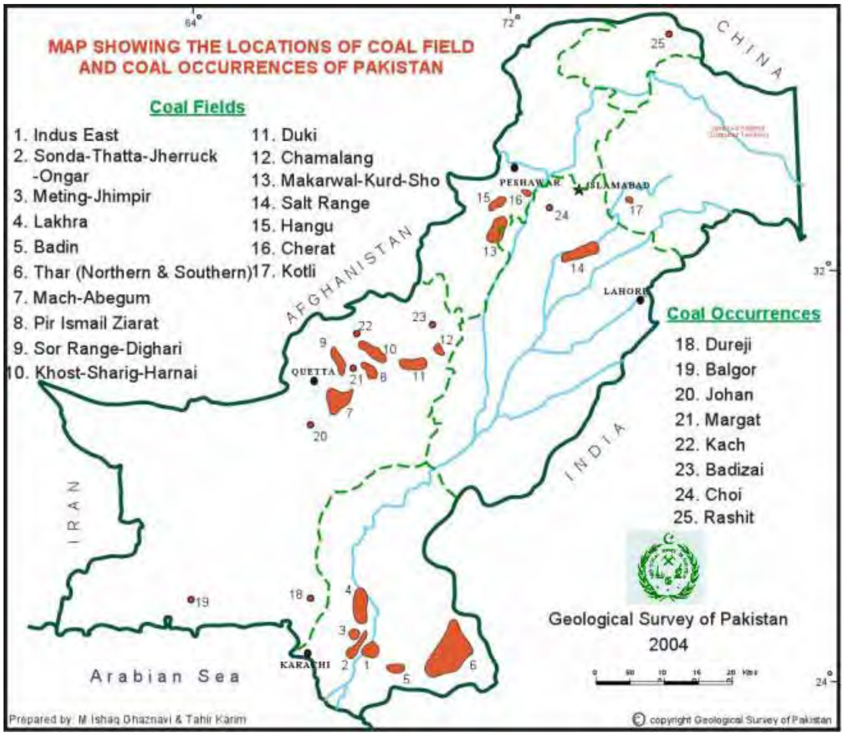
Table 25-1. Pakistan's Coal Reserves and Production

Indicator	**Anthracite & Bituminous** (million tonnes)	**Sub-bituminous & Lignite** (million tonnes)	**Total** (million tonnes)	**Global Rank** (# and %)
Estimated Proved Coal Reserves (2006)*	1.0	1,981.0	1,982.0	18 (0.2%)
Annual Coal Production (2007)**	4.1	0	4.1	26 (0.07%)

Source: *EIA (2008); **IEA (2007)

Pakistan is divided up into four provinces and four federal territories. Coal is found in all four provinces, but the bulk (around 98 percent) is in Sindh province, where the Thar coalfield is located (Figure 25-1).

Figure 25-1. Pakistan's Coal Fields



Source: PakGeoSurvey (2004)

25.1.2 STAKEHOLDERS

While private companies can own and produce most other mineral resources in Pakistan, energy resources are the responsibility of the Ministry of Petroleum and Natural Resources (USGS, 2008). The Government of Sindh and the Thar Coal Development Authority are other governmental bodies that claim ownership and/or control over the resources.

Key stakeholders involved in Pakistan's coal and the coal mine methane (CMM) development industries are outlined in Table 25-2.

Table 25-2. Key Stakeholders in Pakistan's CMM Industry

Stakeholder Category	Stakeholder	Role
Developer	▪ Cathay Oil & Gas Ltd.	Holds rights to coalbed methane and groundwater in Sindh
	▪ M/s Rheinbraun Engineering	Mining feasibility studies
	▪ Lakhra Coal Development Authority (LCDC)	Project development
	▪ Pakistan Mineral Development Corporation	Project development
	▪ Deep Rock Drilling (pvt) Ltd.	Mining feasibility studies
Mining Companies	▪ Kathwai Coal Mines Pvt Ltd	Project hosts
	▪ Habibullah Mines Ltd.	
	▪ United Musakhel Mining Company (Pvt) Limited	

Universities and Research Centers	▪ Pakistan Institute of Engineering and Applied Sciences, Islamabad ▪ National University of Sciences & Technology Rawalpindi ▪ Ghulam Ishaq Khan Institute of Engineering, Swabi ▪ University of Engg. & Technology (UET), Lahore	Technical assistance
Energy Companies	▪ Habibullah Energy Limited (HEL) ▪ Pak Energy (Pvt) Ltd ▪ Pakistan Electric Power Company (PEPCO)	Investment, energy production
Investment Groups	▪ Al Abbas Group	Investment
Government Groups	▪ Ministry of Petroleum and Natural Resources	Licensing, exploration, production
	▪ Thar Coal Development Authority, Government of Sindh,	Licensing, exploration, production
	▪ Geological Survey of Pakistan	Technical assistance
	▪ Hydrocarbon Development Institute of Pakistan (HDIP)	Technical assistance

25.1.3 Status of Coal and the Coal Mining Industry

The contest between the national and provincial governments over the energy resources of Pakistan has stalled some development efforts. As part of a larger government plan to boost private sector ownership and involvement in industry and energy sectors, some government-created entities like the Lakhra Coal Development Authority (LCDC) have been transitioned to public-private entities. The goal is to encourage development and take advantage of market efficiencies, but these efforts have not been entirely successful. In 2007, the LCDC had 44 mines fully developed and capable of each producing 40–50 tonnes of coal per day, with another 39 mines under development (PakMinPet, 2007). After 17 years of operation, LCDA had developed less than 30 percent of the potential 149 mines in the Lakhra field and is able to meet only 60 percent of the coal requirements of the associated Lakhra power plant, which is often forced to operate below capacity (Siddiqui, 2008).

Additionally, American, Chinese, and German companies, among others, have been brought in to provide mining feasibility studies to encourage international investment, but questions over coal quality, infrastructure, and government support have caused many potential international investors to pull out of major projects (Haider, 2007; PakTribune, 2010).

Pakistan is still in the process of drafting a national coal policy. There have been repeated attempts to draft a policy since at least 2001, but they have not been successful as yet (Bhuta, 2010; Siddiqui, 2008). This lack of policy has hurt the development of the Thar deposits found in the 1990s and has impeded Pakistan's progress in developing mining technologies and attracting coal mine methane investments (Chaudhry, 2007).

Table 25-3 lists some of the major coal mines in operation in Pakistan.

Table 25-3. Operating Coal Mines in Pakistan

Coal Field	Mine	Coal Rank	Mine Type	Operator
Lakhra Coal Field	Lakhra Collieries	Sub-bituminous to lignite	underground	PMDC
Degari- Sor-Range	Degari Collieries	Sub-bituminous-A to high volatile B-bituminous	underground	PMDC
Degari- Sor-Range Field	Sor- Range	Sub-bituminous-A to high volatile B-bituminous	underground	PMDC
Shahrig- Khost- Harnai Coal Field	Shahrig	Sub-bituminous B to heavy volatile Bituminous-A	underground	PMDC
Lakhra Coal Field	Multiple	Sub-bituminous to lignite	underground	LCDC

Source: PMDC (nd)

25.2 Overview of CMM Emissions and Development Potential

The Global Methane Initiative (formerly Methane to Markets Partnership) International CMM Projects Database currently identifies no CMM recovery projects for Pakistan, in operation or development (M2M Projects, 2010).

25.2.1 CMM Emissions from Operating Mines

Most Pakistan coal production is from underground mines, and most emissions are from active coal mining. Pakistan's CMM emissions are summarized in Table 25-4.

Table 25-4. Pakistan's CMM Emissions (million cubic meters)

Emission Category	1993–1994
Mining emissions	69.40

Source: UNFCCC (2003)

25.2.2 CMM Emissions from Abandoned Coal Mines

No data about methane emissions from abandoned mines in Pakistan are available at this time.

25.2.3 CBM from Virgin Coal Seams

In 2007, Cathay Oil & Gas Ltd. acquired sole rights to coalbed methane (CBM) and groundwater in Sindh, including the Thar coal field. The field has an estimated 1.0 trillion m^3 of CBM resource and up to 0.6 trillion m^3 of recoverable gas (EPA, 2007).

25.3 Opportunities and Challenges to Greater CMM Recovery and Use

As reflected in Table 25-5, Pakistan is a signatory to both the UNFCCC and the Kyoto Protocol. Pakistan is a Non-Annex I Party.

Table 25-5. Pakistan's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC*	June 13, 1992	June 1, 1994
Kyoto Protocol**	-	January 11, 2005

Source: *UNFCCC (2010a); **UNFCCC (2010b)

25.3.1 Market and Infrastructure Factors

Pakistan has experienced low domestic demand for coal resources, though this is beginning to change as domestic oil and natural gas suppliers reach production limits and as international energy prices increase. Despite this improving environment, conflicts between the various controlling interests within the Pakistani government have prevented a unified approach to coal resources and coal mining and thus to CMM/CBM utilization. Until there is a national coal policy and strong government interest in and focus on developing coal resources, there will not be a strong domestic market for development, nor strong international interest or confidence for investment.

Further, CMM/CBM infrastructure in Pakistan is practically non-existent currently; gas gathering, compression, and transmission infrastructure will be needed before any significant production is viable. Significant investment in coal mining infrastructure including basic resource survey and access to key supporting resources like water, roads, and electrical transmission lines will be needed before there is sufficient capability and potential for CMM/CBM development.

25.3.2 Regulatory Information

Pakistan is transitioning many of the minerals and natural gas entities from government ownership and control to private ownership or public-private ownership. This is part of a larger effort toward deregulation, reducing government debt burden, and taking advantage of the improved efficiency of market forces. The Privatization Commission (http://www.privatisation.gov.pk/) is responsible for the transition.

The Ministry of Petroleum and Natural Resources governs the activities and regulations for the coal mining industry and CMM/CBM industry. The ministry recently released a National Petroleum Policy (PakMinPet, 2009) and is drafting a National Coal Policy.

25.4 Profiles of Individual Mines

Individual mine profiles are unavailable.

25.5 References

Bhutta (2010): New refinery, oil storage facility planned in 2010–11, Zafar Bhutta, Business Recorder, June 13, 2010. http://www.brecorder.com

BOI (2007): Energy – Project Profile, Pakistan Board of Investment, 2007. http://www.pakboi.gov.pk/pdf/Project_Profiles/Energy.pdf

Chaudhry (2007): EOIs for National Coal Policy, Muhammad Bashir Chaudhry, DAWN, October 29, 2007. http://www.dawn.com/2007/10/29/ebr10.htm

EIA (2008): International Energy Annual 2006, Department of Energy, Energy Information Agency, December 2008. http://www.eia.doe.gov/emeu/iea/contents.html

EOEarth (2008): Energy Profile of Pakistan, The Encyclopedia of Earth, March 13, 2008. http://www.eoearth.org/article/Energy_profile_of_Pakistan

EPA (2007): Coalbed Methane Extra, Fall 2007, U.S. Environmental Protection Agency, Coalbed Methane Outreach Program, 2007. http://www.epa.gov/cmop/docs/fall_2007.pdf

IEA (2007): Coal and Peat in Pakistan in 2007, International Energy Agency, Paris, France, 2007. http://www.iea.org/stats/coaldata.asp?COUNTRY_CODE=PK

Haider (2007): China Quits $1.5bn Pakistan Coal Project, Syed Fazl-e-Haider, Asia Times, May 18, 2007. http://www.atimes.com/atimes/South_Asia/IE18Df04.html

M2M Projects (2010): Methane to Markets International Coal Mine Methane Projects Database, Methane to Markets, accessed June 2010. http://www2.ergweb.com/cmm/index.aspx

PakGeoSurvey (2004): Map Showing the Locations of Coal Field and Coal Occurrences of Pakistan, Pakistan Geological Survey, 2004. http://www.gsp.gov.pk/

PakGeoSurvey (2005): Coal, Granite, China Clay and other Resources of Thar – Workshop, Geological Survey of Pakistan, 2005. http://www.gsp.gov.pk/resources/seminars2.htm

PakistanEcon (2001): Coal, Pakistan & Gulf Economist, July 2001. http://www.pakistaneconomist.com/database2/cover/c2001-41.asp

PakMinPet (2007). Year Book 2006–2007, Pakistan Ministry of Petroleum & Natural Resources, 2007. http://202.83.164.26/wps/portal/Mopnr/!ut/p/c1/04_SB8K8xLLM9MSSzPy8xBz9CP0os_hQN68AZ3dnIwN_PwMDA6NQA0PnIE93A3cDY_1wkA4kFRbmwaYGRq6efsYmhr6GBoYmEHkDHMDRQN_PIz83Vb8gOzvN0VFREQD-SAoI/dl2/d1/L2dJQSEvUUt3QS9ZQnB3LzZfVUZKUENHQzIwR0VTNTAyNTQ1SkE5RTBMNDE!/?WCM_GLOBAL_CONTEXT=/wps/wcm/connect/PNRDivCL/division/information+and+services/year+book+2006-07

PakMinPet (2009): Petroleum Policy 2009, Pakistan Ministry of Petroleum & Natural Resources, 2009. http://202.83.164.26/wps/portal/Mopnr/!ut/p/c1/04_SB8K8xLLM9MSSzPy8xBz9CP0os_hQN68AZ3dnIwML82BTAyNXTz9jE0NfQwNDE_1wkA6zeAMcwNFA388jPzdVvyA7rxwAicV1Mg!!/dl2/d1/L2dJQSEvUUt3QS9ZQnB3LzZfVUZKUENHQzIwODdTNTAyRUlOMzQxTTEwTTA!/?WCM_GLOBAL_CONTEXT=/wps/wcm/connect/MopnrCL/ministry/highlights/apetroleum+policy+2009

PakTribune (2010): World Bank Not to Fund Thar Coal Project, PakTribune, May 29, 2010. http://www.paktribune.com/news/index.shtml?228032

PMDC (nd): Coal Mines, Pakistan Mineral Development Corporation, accessed June 25, 2010. http://www.pmdc.gov.pk/pmdc-final/cm.htm

Siddiqui (2008): Viability of Thar Coal Mining Company, Hussain Ahmad Siddiqui, Business Recorder, March 27, 2008. http://www.defence.pk/forums/economy-development/10639-viability-thar-coal-mining-company.html

UNFCCC (2003): Pakistan's Initial National Communication on Climate Change, Government of Islamic Republic of Pakistan Ministry of Environment, United Nations Framework Convention on Climate Change, Non-Annex I National Communications, 2003. http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php

UNFCCC (2010a): United Nations Framework Convention on Climate Change - Status of Ratification, accessed June 28, 2010. http://unfccc.int/essential_background/convention/status_of_ratification/items/2631.php

UNFCCC (2010b): Kyoto Protocol - Status of Ratification, accessed June 28, 2010. http://unfccc.int/kyoto_protocol/status_of_ratification/items/2613.php

USGS (2008): 2008 Minerals Yearbook – Pakistan, U.S. Geological Survey, November 2009. http://minerals.usgs.gov/minerals/pubs/country/2008/myb3-2008-pk.pdf

26 PHILIPPINES

26.1 Summary of Coal Industry

26.1.1 ROLE OF COAL IN THE REPUBLIC OF THE PHILIPPINES

Currently, coal-fired thermal power plants remain the number one producer of electricity and account for a total of 3,967 megawatts (MW), or 25 percent, of the Republic of the Philippines' total installed power generating capacity (PDOE, 2006). The Philippine Energy Plan projects coal demand to grow from 12 million tonnes (Mmt) in 2008 to around 15 Mmt in 2014. Of this, 13 Mmt are projected for power generation with the remaining 2 Mmt expected for industries. In 2007, about 75 percent of the 10 Mmt of coal consumed in the Philippines came from other countries. The country's main source was Indonesia (4.5 Mmt), followed by China (2.1 Mmt) with other sources including Australia and Vietnam (PDI, 2009; PDOE, 2006).

The country's recoverable coal reserves, as shown in Table 26-1, are estimated at 316 Mmt, with most reserves as lignite. Total coal resources compiled by the Geothermal and Coal Resources Development Division (GCRDD) of the Department of Energy of the Philippines, are estimated at a minimum of 2,268.4 million tonnes (USGS, 2006).

The Philippines produced 2.4 Mmt of coal in 2008. Production was highest in 2007 at 3.4 Mmt, as production has ramped up from 1.4 Mmt in 2000 (EIA, 2009).

Table 26-1. Philippines's Coal Reserves and Production

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2005)*	275	41	316	39 (0.04%)
Annual Coal Production (2008)**	2.36	0.003	2.36	43(0.04%)

Source: EIA (2009)

The combined lignite and sub-bituminous coal reserves of the Philippines, including indicated and inferred reserves, are about 1,899.2 Mmt, which make up about 84 percent of the total coal reserves of the Philippines. The remaining reserves are composed of bituminous and semi-anthracite coal (USGS, 2006).

The Philippines has 19 coal districts. The largest total coal resource is estimated at 550 Mmt of sub-bituminous coal and is located in the Semirara coal district located on Semirara Island, which is located approximately 280 kilometers (km) to the south of Manila and can be seen in Figure 26-1 below, just south of Mindoro. The northern part of the Semirara is dominated by the Panian coalfield, the largest of three coalfields on the island. Other coalfields on Semirara include the Himalian and Unong coalfields (USGS, 2006). Other coal districts with large reserves include Cagayan-Isabella of northern Luzon and Sultan-Kudarat of Mindanao. Reserves and coal rank for all of the Philippines' coal districts are shown in Table 26-2 below.

Figure 26-1. Philippines's Coal Resources

Source: Modified from Schwochow (1997); USGS (2006)

Table 26-2. Philippines' Coal Districts

Coal District	Coal Rank	**Coal Reserves** (million tonnes)
Samar-Leyte	Lignite	27.0
Cotabato	Sub-bituminous/Lignite	230.4
Quirino	Sub-bituminous/Lignite	0.7
Cagayan-Isabella	Sub-bituminous/Lignite	336.0
Sarangani	Sub-bituminous/Lignite	120.0
Sultan-Kudarat	Sub-bituminous/Lignite	300.3
Sorsogon	Sub-bituminous	1.0
Negros	Sub-bituminous	4.5
Davao	Sub-bituminous	100.0
Batan Island	Sub-bituminous	11.8
Masbate	Sub-bituminous	2.5
Quezon-Polilio	Sub-bituminous	6.0
Semirara	Sub-bituminous/Bituminous	550.0
Surigao	Sub-bituminous/Bituminous	209.0
Zamboanga-Sibugay (Malangas)	Sub-bituminous/Bituminous	45.0
Cebu	Sub-bituminous/Bituminous	165.0
Catanduanes	Bituminous/Anthracite	1.2
Bukidnon	Unknown	50.0
Maguindanao	Unknown	108.0

Source: USGS (2006)

26.1.2 Stakeholders

Table 26-3 identifies potential key stakeholders in the Philippines' coal mine methane (CMM) development.

Table 26-3. Key Stakeholders in the Philippines' CMM Industry

Stakeholder Category	Stakeholder	Role
Mining companies	▪ Semirara Mining Corporation ▪ San Miguel Energy Corporation ▪ Titan Exploration and Development Corporation ▪ Rock Energy International ▪ Ibalong Resources and Development Corporation ▪ Philippine National Oil Company	Project hosts
Developers	▪ Endesa Carbono S.L.	Project opportunity identification and planning
Engineering, consultancy, and related services	▪ R.M.B. Earth Science Consultants Ltd.	Technical assistance

Stakeholder Category	Stakeholder	Role
Universities, Research Establishments	▪ Philippine Council for Industry and Energy R&D ▪ Cebu Institute of Technology	Technical assistance
Regulatory Agencies and Government Groups	▪ Philippine Department of Energy ▪ Philippine National Oil Company ▪ Philippine Department of Environment and Natural Resources – Mines and Geosciences Bureau	Project identification and assessment support

Source: PDOE (nd); PMEA (nd); M2M (2010); TFL (2009); USGS (2006)

26.1.3 Status of Coal and the Coal Mining Industry

The Philippines' largest coal producer is Semirara Mining Corp., which accounts for about 92 percent of local coal production (DOE, nd). Additional resources are being mined in Cebu, Zamboanga Sibugay, Albay, Surigao del Norte, and Negros provinces.

Currently most of the coal mined in the Philippines is from the large surface mine at Semirara; however, most mines are underground (ASEAN, 2010). Smaller, underground operations exist such as the Integrated Little Baguio colliery which is the Philippines' largest semi-mechanized underground mine and is located in Malangas, Zamboanga-Sibugay (BIM, 2010).

In 2004, the Philippines consumed all of its domestically-produced coal as well as coal imported from abroad to meet the needs of its coal-fired power plants and cement industry (Ewart, 2004). As of 2009, the country was operating nine coal-fired power plants with combined capacity of 4,213 MW (Jcmiras.net, 2009). A number of additional plants are in the works as well. San Miguel Corp. plans to build a 150–300 MW coal-fired plant in southern Philippines that will come online in 2012 (abs-cbnNEWS.com, 2010). State-owned Philippines National Oil Company Exploration Corp. is to build a 30–100 MW coal-fired power plant in Isabella which will begin operating by 2013 (UPI.com, 2010). The joint venture of Korea Electric Power Company (Kepco) and SPC Power Corporation is on track to complete the first 100 MW of a 200 MW coal-fired power plant in Naga, Cebu by early 2011, with the remaining capacity to be completed in mid-2012 (Power-Gen Worldwide, 2010).

26.2 Overview of CMM Emissions and Development Potential

The Global Methane Initiative (formerly Methane to Markets Partnership) International CMM Projects Database currently identifies no CMM recovery projects in the Philippines; however, in 2007, Sultan Energy Philippines Corp. announced plans to develop the extensive coalbed methane (CBM) resources of the company's coal operating contracts located in the Daguma Mountain range in Mindanao, estimated to be about 100 billion cubic feet in a 7,000-hectare area. The company plans to use the CBM to generate electricity. At the time, the company noted degasification of the mine as a co-benefit of the project (USEPA, 2007; MST, 2007). Updated information regarding this potential project has not been found.

Another project is planned by Semirara Mining Corp. which signed a memorandum of agreement in late 2009 with Endesa Carbono S.L. to implement a CMM project. The project will take place on Semirara Island and will include CMM extraction, flaring, and power generation (TFL, 2009). Updates on future CMM projects in Philippines can be found at http://www.methanetomarkets.org/coalmines/index.htm#profiles.

26.2.1 CMM EMISSIONS FROM OPERATING MINES

Table 26-4 summarizes the Philippines' CMM emissions.

Table 26-4. Philippines' CMM Emissions (million cubic meters)

Emission Category	1990	1995	2000	2005	2010 (projected)
Total emitted	11.2	15.2	15.4	15.7	15.9

Source: USEPA (2006)

The Philippines has a number of gassy coal mines, as indicated by a number of methane-related mine accidents. An explosion in the town of Imelda in Zamboanga Sibugay province caused the death of a worker and injured four others in December 2009. In 1995, a coal mine tunnel in Malangas was destroyed by a massive methane gas explosion, which killed more than 100 people (Mining-Technology.com, 2009).

26.2.2 CMM EMISSIONS FROM ABANDONED MINES

No information relating to recovery or use of CMM from abandoned mines was found.

26.2.3 CBM FROM VIRGIN COAL SEAMS

The U.S. Geological Survey (USGS) and the Philippines Department of Energy (PDOE) launched a collaboration to determine the methane gas content and adsorptive capacity of Philippine coal. The study entitled "Assessment of Philippine Coal Bed Methane" identified several coals, from lignite to semi-anthracite, in the country that possess large gas storage capacity. In Table 26-5 below, the results of the study are summarized. Total potential minimum CBM in-place resources in the Philippines are estimated at 16,416 million cubic meters (m^3).

There are currently no CBM projects in the Philippines.

Table 26-5. Philippines' CBM Assessment

Coal District Area	Coal Rank	Potential CBM In-place Resources (million cubic meters)
Samar-Leyte	Lignite	183
Cotabato		1,037
Cagayan-Isabella		652–2,400
Negros	Sub-bituminous	5
Semirara		3,361
Surigao		1,120
Bataan Island	Bituminous	119
Catanduanes		36
Cebu		2,670–3,530
Zamboanga – Sibuguey (Malangas)	Semi-Anthracite	580–1,033

The potential minimum CBM in-place resources (in million cubic meters [MMCM]) estimated for Philippines coal districts based on ideal gas storage capacity (100 percent gas saturation).

Source: USGS (2006)

26.3 Opportunities and Challenges to Greater CMM Recovery and Use

The Philippines is a signatory to both the UNFCCC and the Kyoto Protocol (see Table 26-6). As a Non-Annex I Party to the Kyoto Protocol, it has no national emissions targets and is eligible to host mitigation projects under the Clean Development Mechanism.

Table 26-6. Philippines' Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC*	June 12, 1992	August 2, 1994
Kyoto Protocol**	April 15, 1998	November 20, 2003

Source: UNFCCC (2010)

26.3.1 Market and Infrastructure Factors

As mentioned in section 26.1.1, the Philippine Energy Plan projects coal demand to grow from 12 Mmt in 2008 to around 15 Mmt in 2014. With the increase in power demand, coal mining is expected to remain a steady source for power plants. Additionally, natural gas demand is expected to grow in the Philippines, opening up opportunities for CMM and CBM. As of 2007, installed natural gas power generation capacity was 2,834 MW or an 18 percent share of overall generating capacity (PDOE, 2007). Natural gas is also used in buses and at a Shell refinery (PDOE, 2008). The Philippine Energy Plan indicates natural gas demand of existing facilities estimated to increase from 2.92 billion m^3 (2003) to 5.61 billion m^3 (2012) (Tamang, 2003). Additional demand from new facilities is expected in the power sector with conversion of existing power plants to natural gas. Additionally, further use of compressed natural gas (CNG) in public transport vehicles is expected. Industrial and residential uses are also expected to increase (Tamang, 2003).

26.3.2 Regulatory Information

The Philippine Department of Energy (PDOE) is the primary regulatory entity involved with CMM development. The PDOE regulates mine safety and sets limits for methane concentration in mine workings and ventilation air (PDOE, 1981). In 2007, at the Association of Southeast Asian Nations Forum on Coal, the Philippines discussed modifying the contracts and licenses for CBM development under coal operating contracts instead of service petroleum contracts (ASEAN, 2007). No guidelines or circulars concerning CBM development are available from the PDOE.

26.4 Profiles of Individual Mines

No profiles are available at this time for the Philippines.

26.5 References

abs-cbnNEWS.com (2010): San Miguel plans to build 150–300 MW coal plant, abs-cbnNEWS.com, March 2010. http://www.abs-cbnnews.com/business/03/05/10/san-miguel-plans-build-150-300-mw-coal-plant

ASEAN (2007): Report of the Fifth Meeting of the ASEAN Forum on Coal (AFOC) Council, Association of Southeast Asian Nations, July 2007.

http://www.aseanenergy.org/download/reports/energy_organisastion/afoc/summary%20record%205th%20AFOC%20Council%20Meeting%20final.pdf

ASEAN (2010): Final Summary Report of the Observation Tour, Association of Southeast Asian Nations, April 13, 2010. http://www.aseanenergy.org/download/reports/energy_organisastion/afoc/Final%20Report%20of%20the%20Observation%20Tour%20in%20Japan%208-12.pdf

BIM (2009): SMC-PNOC-EC talks on for mine-mouth plant in Isabela, Business Insight Malaya, 2010. http://www.malaya.com.ph/06092010/index.html

EIA (2009): International Energy Statistics, December 31, 2009. http://www.eia.doe.gov/emeu/international/contents.html

Ewart (2004): Southeast Asian Coal Developments, Donald L. Ewart, Jr., Marston & Marston, Inc. Reprinted from World Coal, 2004. http://www.marston.com/Portals/0/MARSTON_Southeast_Asian_Coal_Developments.pdf

Jcmiras.net (2009): Coal-fired Power Plants in the Philippines, Jcmiras.net, January 2009. http://www.jcmiras.net/surge/p160.htm

M2M (2010): Project Network Members in Philippines, accessed June 2010. http://methanetomarkets.org/partners/countryPartners.aspx?country=philippines

Mining-Technology.com (2009): Philippine coal mine explosion kills one, injures four, Mining-Technology.com, December 2009. http://www.mining-technology.com/news/news71946.html

MST (2007): Sultan Energy to use gas to produce electricity, Manila Standard Today, March 15, 2007. http://www.manilastandardtoday.com/2007/mar/15/business4.htm

PDI (2009): Coal is fuel of choice for power generation, Philippine Daily Inquirer, August, 2009. http://newsinfo.inquirer.net/inquirerheadlines/nation/view/20090818-220815/Coal-is-fuel-of-choice-for-power-generation

PDOE (nd): Energy Resources – Coal, Philippine Department of Energy, no date. http://www.doe.gov.ph/ER/Coal.htm

PDOE (1981): BED Circular No. 81-11-10 "Guidelines for Coal Operations in the Philippines," Philippine Department of Energy, November 1981. http://www.doe.gov.ph/PECR/Coal/Laws&Issuances/Text%20-%20Guidelines%20for%20RP%20Coal%20Operation.pdf

PDOE (2006): FAQs - Coal. Philippine Department of Energy, 2006. http://www.doe.gov.ph/FAQ%27S/coal.htm

PDOE (2007): Philippine Power Development Plan, Luzon Public Consultation Series, Philippine Department of Energy, 2007. http://www.doe.gov.ph/PEP/consultations/PLENARY%20%28A.M.%29/Power/Power%20-%20Luzon.pdf

PMEA (nd): PMEA Blog, Philippine Mineral Exploration Association, no date. http://www.pmea.com.ph/blog/index.php/category/coal/

Power-Gen Worldwide (2010): Philippine coal fired power project on track for 2011 completion, Power-Gen Worldwide, March 2010. http://www.powergenworldwide.com/index/display/articledisplay.articles.powergenworldwide.coal-generation.new-projects.2010.03.philippines_-coal.QP129867.dcmp=rss.page=1.html

Schwochow (1997): The International Coal Seam Gas Report, Cairn Point Publishing, Steve Schwochow, editor, 1997.

Tamang (2003): The Philippine Natural Gas Industry, Jesus T. Tamang, Natural Gas Office, Department of Energy, 2003. http://www.doe.gov.ph/ER/archives/pcr/Pdf/pdf%20Philippine%20natural%20gas%20industry.pdf

TFL (2009): Philippines: Semirara inks MOA for methane project The Free Library, 2009, retrieved June 30, 2010. www.thefreelibrary.com/Philippines: Semirara inks MOA for methane project.-a0199924587

UNFCCC (2010): Philippines Ratification Status, Accessed June 2010. http://maindb.unfccc.int/public/country.pl?country=PH

UPI.com (2010): Filipino coal-fired power plant goes ahead, UPI.com, April 2010. http://www.upi.com/Science_News/Resource-Wars/2010/04/28/Filipino-coal-fired-power-plant-goes-ahead/UPI-58241272485589/

USEPA (2006): *Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990–2020*, U.S. Environmental Protection Agency, Office of Atmospheric Programs, Climate Change Division, June 2006. http://www.epa.gov/climatechange/economics/downloads/GlobalAnthroEmissionsReport.pdf (Appendix B-2).

USEPA (2007): Coalbed Methane Extra – Spring 2007, U.S. Environmental Protection Agency, Coalbed Methane Outreach Program, 2007. http://www.epa.gov/cmop/docs/spring_2007.pdf

USGS (2006): The Republic of the Philippines Coalbed Methane Assessment: Based on Seventeen High Pressure Methane Adsorption Isotherms, U.S. Geological Survey and Philippine Department of Energy, Open File Report 2006–1063, 2006. http://www.usgs.gov/of/2006/1063

27 POLAND

27.1 Summary of Coal Industry

27.1.1 ROLE OF COAL IN POLAND

Poland ranks ninth globally in coal production and produced 144.9 million tonnes (Mmt) in 2007, accounting for 2.4 percent of global production (Table 27-1). Hosting Europe's largest coal reserves, coal provides for two-thirds of Poland's energy demand and more than 85 percent (inclusive of peat) of its primary energy production (EIA, 2010; IEA - CCC, 2007; IEA, 2007a).

Table 27-1. Poland's Coal Reserves and Production

Indicator	**Anthracite & Bituminous** (million tonnes)	**Sub-bituminous & Lignite** (million tonnes)	**Total** (million tonnes)	**Global Rank** (# and %)
Estimated Proved Coal Reserves (2006)*	6,012	1,490	7,502	10 (1.6%)
Annual Coal Production (2007)** (2006)	87.4	57.5	144.9	9 (2.4%)

Source: *EIA (2008); **IEA (2007b)

In contrast to the above table, the World Energy Council estimates proven Polish coal reserves in 2005 at 15,291 Mmt for anthracite and bituminous and 1,878 Mmt for lignite (WEC, 2007), while an in-country estimate from 2002 puts these reserves at 63,000 Mmt and 14,000 Mmt, respectively (Palarski, 2003).

As seen in Figure 27-1, Poland's hard coal reserves are located in three fields: the Upper and Lower Silesian Basins, and the Lublin Basin. Currently, only the Upper Silesian Basin (USB) is the major coal producer, while the Lower Basin is completely abandoned and only one mine is operational at the Lublin Basin. Lignite basins are located in central and western Poland, with four of them being currently used for production (WEC, 2010).

Figure 27-1. Poland's Major Coal Basins

Location of Hard Coal Basins

Poland's Lignite Deposits

Source: Volkmer (2008)

27.1.2 Stakeholders

Table 27-2 lists potential stakeholders in coal mine methane (CMM) development in Poland.

Table 27-2. Key Stakeholders in Poland's CMM Industry

Stakeholder Category	Stakeholder	Role
Mining Companies	▪ Kompania Weglowa ▪ Katowki Holding Weglowy ▪ Jastrzebska Coking Coal Company ▪ Independent Mines: Budryk, Bogdanka and Jaworzno ▪ Siltech	Project hosts
Equipment Manufacturers	▪ MEGTEC Systems	Ventilation air oxidation equipment supplier
Regulatory Agencies	▪ Polish Geological Institute	Project identification and assessment support
Natural Gas Transmission & Distribution Companies	▪ Polish Oil and Gas Company or PGNiG (http://www.pgnig.pl/?s,main,language=EN), OGP GAZ-SYSTEM (http://en.gaz-system.pl/)	Gas distribution and storage
Government Groups	▪ Ministry of Natural Resources ▪ Ministry of Economy ▪ Central Mining Institute	Licensing

Stakeholder Category	Stakeholder	Role
Other	▪ U.S. Trade and Development Agency ▪ AMOCO Poland Ltd. ▪ McCormick Poland Ltd. ▪ Elektrogaz Ventures Ltd. ▪ Metanel S.A. ▪ PolTex Methane ▪ Vikelt Ltd. ▪ World Bank ▪ U.S. Environmental Protection Agency, www.epa.gov/coalbed/networkcontacts.html ▪ U.S. Agency for International Development, European Investment Bank ▪ European Union's PHARE Program ▪ Institute for Ecology of Industrial Areas (IETU) ▪ Strata Mechanics ▪ LNG Silesia	Project identification and assessment support

27.1.3 Status of Coal and the Coal Mining Industry

Coal is one of Poland's largest industries and employers, but inefficiencies resulted in large annual losses, spurring the government to reform the sector. In 1998, the government introduced a five-year (1998–2002) Hard Coal Sector Reform Program, which reduced employment from 248,000 to 140,000 by the end of 2002. In February 2003, the Polish government consolidated several failing coal firms to form Kompania Weglowa, which is now one of Europe's largest coal companies. Kompania Weglowa includes mines from five firms: Bytomska, Rudzka, Gliwicka, Nadwislanska, and Rybnicka. Table 27-3 illustrates Poland's declining mine statistics from 2004 to 2008. In November 2003, the government introduced a second program—Restructuring of the Hard Coal Mining Sector for 2003–2006—to further consolidate and reform Poland's coal sector (World Bank, 2004). Poland received a World Bank loan of US$100 million in 2004 to support the restructuring program, requiring a workforce reduction of 25,500 mining sector jobs from 2004 to 2006 and for voluntary closure of inefficient mines (World Bank, 2007).

The restructuring program also planned to privatize the country's coal industry by 2006. Privatization of Polish coal mines began with a sale of 45 percent of the Bogdanka mine to Management Bogdanka, a private company of investors. Other privatizations followed, with PricewaterhouseCoopers advising the Ministry of the Economy. Privatization of the coal industry was, however, halted by the Polish government in 2006. The World Bank-supported restructuring program had been suspended by the Polish government in 2006 because the coal industry had become more profitable and only two mines had been closed through the project. The Polish government decided that any further mine closures would be handled by the mine companies and not by the Mine Restructuring Company (SRK) so the loan balance was returned (World Bank, 2007).

The restructuring program has led to substantial changes in Poland's three major coal basins. Specifically, the Lower Silesian Coal Basin was closed and there were significant reductions of coal production in the Upper Silesian Basin, leaving only the efficient Lublin Coal basin open for production and subsequent expansion. Post-restructuring, the Polish coal industry has experienced "periods of profitability." However, market forces and increasing foreign coal imports have acted to threaten its domestic coal industry. Poland's goal of commercializing and privatizing the mining companies was completed by 2009 (Suwala, 2010).

Table 27-3. Poland's Coal Mines, 2004 versus 2008

Company	Number of Mines, 2004*	Number of Mines, 2008**
Kompania Weglowa (KW)	23 (51 Mmt/year)	16
Katowki Holding Weglowy (KHW)	9 (19 Mmt/year)	6
Jastrzebska Coking Coal Company (JSW)	5 (14 Mmt/year)	6
Independent Mines: Bogdanka, Budryk, and Jaworzno	3 (11 Mmt/year)	NA

Source: *World Bank (2004); **DOC (2008)

As per Poland's Central Mining Institute of Katowice, there are 33 coal mines in operation, with 29 of them classified as gassy, 20 of them utilizing degasification, and 14 of them utilizing the drained methane, as of 2008 (IEA, 2008).

27.2 Overview of CMM Emissions and Development Potential

The Global Methane Initiative (formerly Methane to Markets Partnership) International CMM Projects Database currently identifies 21 CMM recovery projects in Poland, all in place in active underground mines in the USB. The methane is used for boiler fuel in eight projects, for coal drying in four, for combined heat and power in five, for industrial use in three, and for power generation in one project (M2M Projects, 2008). Poland has extensive experience in CMM recovery and utilization as demonstrated by JSW's unique project at Pniowek mine that implements three onsite end uses: electricity, heating, and cooling. A Cogeneration Power-Cooling System supplies power to the central air conditioning system and was the first of its kind upon its launch (UNECE, 2009).

27.2.1 CMM Emissions from Active Mines

In Poland, coal mining is the source of 25.7 percent of the country's overall methane emissions (UNFCCC, 2007a), with the top 20 percent of underground mines accounting for 90 percent of the CMM emissions (USEPA, 2005). Table 27-4 summarizes Poland's CMM emissions by mining category. The data in this table may vary from the U.S. EPA data presented in the Executive Summary due to differences in inventory methodology and rounding of digits.

Table 27-4. Poland's CMM Emissions (million cubic meters)

Emission Category	1990	1992	1994	1995	2000	2003	2005	2006
Underground coal mines – ventilation emissions	N/A	N/A	N/A	N/A	399*	N/A	N/A	578‡
Underground coal mines – all emissions	N/A	N/A	N/A	N/A	N/A	722	N/A	251‡
Post-underground emissions	N/A	N/A	N/A	N/A	N/A	110	N/A	N/A
Surface mine emission (total)	N/A	N/A	N/A	N/A	N/A	1.15	N/A	N/A
Total liberated (= sum of all above)	1175	923	1064	N/A	N/A	833	N/A	829‡
Recovered & Used	N/A	N/A	N/A	N/A	N/A	363	N/A	145‡
Total emitted (= Total liberated – recovered & used)	1175†	N/A	N/A	1092†	833†	470	794†	684‡

Source: UNFCCC (1998); *USEPA (2003); †USEPA (2006); 2003 data from UNFCCC (2007a); ‡Skiba (2007)

As of 1997, about 300 million cubic meters (m^3) was being drained from Polish coal mines annually, with 65–70 percent of drainage being used at the mine sites or sold to outside consumers, and the rest vented (Schwochow, 1997). Methane recovery, however, has reduced over the years. Of an estimated 870 million m^3 of methane emissions in 2006, less than 30 percent was removed through degasification (IEA, 2008). In 2008, 269 million m^3 was removed through degasification, with about 166 million m^3 utilized and 103 million m^3 released into the atmosphere (Skiba, 2009).

Although the number of gassy mines has decreased in Poland by 48 percent from 1989 to 2005, absolute gassiness has dropped by only 19 percent over the period, indicating an increasing share of gassy coal mines in the country. This scenario represents an increasing opportunity for CMM recovery and utilization projects (IEA, 2008). CMM capture is forecasted to increase to 320.5 million m^3 by 2015, with an estimated utilization potential of 1068 gigawatt-hours (GWh) (Skiba, 2009)

Poland has an open, emerging market economy that should be conducive to CMM project implementation, and Polish mining authorities are supportive of CMM development initiatives (IRG, 2003). Actions similar to the World Bank's industry restructuring loan should also constitute positive factors favoring project development.

The former M2M Partnership awarded a grant in 2008 to the Central Mining Institute of Katowice, Poland to provide "Detailed Characteristics of the Ventilation Air Methane Emissions from Twenty Nine Gassy Underground Coal Mines in Poland," and another in 2009 to perform a "Pre-feasibility Study for Degasification and Methane Capture Before Mining at the Pawlowice I Coal Field." A third grant was awarded to the Institute for Ecology of Industrial Areas in 2008 to perform an "Abandoned Mine Feasibility Study and Coal Mine Methane to Liquefied Natural Gas Assessment" at the Zory Coal Mine in the Silesian region (M2M Agreements, 2008; M2M Agreements, 2009).

27.2.2 CMM Emissions from Abandoned Coal Mines

No data quantifying emissions from abandoned Polish mines are currently available, though the methane volume in abandoned coal mines in the USB was estimated in 2006 to range from 150 to 200 billion m^3 (Nagy, 2006).

27.2.3 CBM from Virgin Coal Seams

Estimated in-place coal seam gas resources in Poland are summarized in Table 27-5. One estimate of resources in actively mined and undeveloped coals in the USB yields 1,300 billion m^3 of coalbed methane (CBM) to a depth of 1,500 meters (m). A different method used by the Polish Geological Institute yields a more conservative estimate of 350 billion m^3, of which 210 billion m^3 exists in virgin coal. Including the Lower Silesian and Lublin basins, total in-place CBM resources range from 425 to 1,450 billion m^3 (Schwochow, 1997).

Table 27-5. Poland's In-Place CBM Resources

Coal Basin	Gas Content		Gas in Place	
	m^3/ megagram (Mg)	m^3/tonne (t)	billion m^3	trillion cubic feet (Tcf)
Upper Silesian, first estimate*				
Active mines to 1,000 m (3,280 feet [ft])	—	—	370	13.1
Undeveloped coal to 1,000 m (3,280 ft)	—	—	340	12.0
Coal at 1,000–1,5000 m (3,280–4,920 ft)	—	—	590	20.8
Subtotal	≤ 22	≤ 20	1,300	45.9
Upper Silesian, second estimate†				

Coal Basin	Gas Content		Gas in Place	
	m3/ megagram (Mg)	m3/tonne (t)	billion m3	trillion cubic feet (Tcf)
Coal to 1,500 m (4,920 ft)	≤ 20	≤ 18.1	350	12.4
Lower Silesian‡	≤ 30	≤ 27.2	25–50	0.9–1.8
Lublin‡	25	22.7	50–100	1.8–3.5
Total	≤ 97	≤ 88	425–1,450	15–51

Source: *Hoffman and Weil (1993); †Surówka (1993); ‡Grzybek (1996), as presented in Schwochow (1997)

The USB first attracted CBM developers in early 1990s. Several CBM concessions were granted from 1991 to 1997, but none of these could establish commercial production of CBM. After several years of inactivity, commercial interest picked up again as new drilling and completion technologies emerged and energy prices rose. In 2006, EurEnergy (a U.S.-based company) acquired sizeable area in the USB to tap into the CBM opportunity and they are investigating a combined CMM/CBM project with JSW. Although the opportunity is huge, CBM production in Poland is contingent on the availability of highly specialized equipment, as well as expertise (Hadro, 2008).

27.3 Opportunities and Challenges to Greater CMM Recovery and Use

Poland has signed and ratified the UNFCCC and Kyoto Protocol, as indicated in Table 27-6. As an Annex 1 country, Poland is eligible to host Joint Implementation projects that can acquire revenue from the sale of carbon credits. As of February 1, 2008, Poland had one project to capture and utilize CMM at the KWK Borynia Coal Mine (JI, 2008).

Table 27-6. Poland's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC*	June 5, 1992	July 28, 1994
Kyoto Protocol**	July 15, 1998	December 13, 2002

Source: *UNFCCC (2007b); **UNFCCC (2007c)

27.3.1 Market and Infrastructure Factors

There are a number of potential factors blocking CMM development in Poland (USEPA, 1998). The first of these is a lack of technology, which prohibits expanded gas storage and improved methane drainage systems. Second, more favorable tax conditions are needed to spur CBM utilization. The continuing struggle to adapt to a market economy poses additional barriers. In 1998, the inefficient hard coal industry was struggling to adapt to the market economy and government controlled coal prices and "social employment" were serious barriers. However, these barriers have been mitigated to some degree by the reorganization and privatization projects.

On the positive side, drained gas can be used at mine sites in a variety of ways including heat, power, and coal drying. Additionally, the gas sold to consumers can be used for oil refineries, chemical plants, and steel mills (Schwochow, 1997). These options provide a variety of reasons for development of CMM projects.

Poland is also working toward ventilation air methane (VAM) utilization and recovery through the use of advanced technologies and creating market conditions that can spur VAM project development. The Central Mining Institute of Katowice is researching VAM emissions from 10 gassy hard coal mines in Poland and their potential end use (Skiba, 2009).

The transmission network of the Polish Oil and Gas Company (PGNiG) also plays a favorable role. It is extensive, with 17.9 thousand km of pipes covering almost all of Poland. PGNiG has two main gas transmission networks: one for low-methane gas and another for high-methane gas. The distribution networks include approximately 105 thousand km of gas pipelines that cover the urban areas of the country. PGNiG also has seven underground gas storage facilities (PGNiG, 2006). PGNiG is thus well-situated to make use of CMM projects.

27.3.2 Regulatory Information

The *Geological and Mining Law of February 4, 1994* regulates the ownership of natural resources, including the right to explore for and extract them. The *Energy Law* requires energy enterprises to supply and connect customers, meet demands, and initiate actions for reducing consumption. There are 27 licenses for exploration fields reported in the USB and 68 licenses for coal mines.

Poland is currently providing support for methane use by promoting the use of Combined Heat and Power (CHP) systems through the "CHP Certificates" mechanism and is also providing excise tax exemptions for electricity generation (Skiba, 2009).

Polish Licensing Authority
The Ministry of Natural Resources Ul. Wawelska 52/54 00-922 Warszawa Contact: Jacek Wroblewski Phone: 48 22 251503, 48 22 250001 int. 335 Fax: 48 22 251503, 48 22 253972 Email jwroble@mos.gov.pl website http://www.mos.gov.pl/

27.4 Profiles of Individual Mines

Detailed profiles of gassy Polish mines are available through the GMI website at http://www.methanetomarkets.org/partners/poland.aspx.

27.5 References

DOC (2008): Poland Coal Mining Industry, US Commercial Service – Warsaw, 2008. https://www.buyusa.gov/pittsburgh/1076.pdf

EIA (2008): Data obtained from *International Energy Annual 2006*, U.S. Energy Information Administration, Washington, DC, table posted October 2008. http://www.eia.doe.gov/pub/international/iea2006/table82.xls (reserves)

EIA (2010): Country Energy Profile – Poland Energy Profile: 2007, Energy Information Administration, website accessed June 7, 2010. http://tonto.eia.doe.gov/country/country_energy_data.cfm?fips=PL

Hadro (2008): "A New Approach to Coalbed Methane Exploration in the Upper Silesian Coal Basin," Jerzy Hadro, Eurenergy Resources Corporation, 2008. imf.net.pl/files_imf/uploads/www.imf_.net_.pl_Jerzy%20Hadro.pdf

IEA (2007a): Data obtained from International Energy Agency Energy, Poland: Statistics, 2007. http://www.iea.org/textbase/stats/pdf_graphs/PLPROD.pdf

IEA (2007b): Coal and Peat in Poland, International Energy Agency, 2007. http://www.iea.org/stats/coaldata.asp?COUNTRY_CODE=PL

IEA (2008): New Trends in CMM Recovery and Utilization - Workshop Report, Szczyrk, Poland, Supported by International Energy Agency, February 2008. http://www.iea.org/textbase/papers/2008/methane_recovery.pdf

IEA – CCC (2007): Profiles – Prospect for Coal and Clean Coal technologies in Poland, Energy Information Administration, website accessed June 7, 2010. http://www.iea-coal.org.uk/publishor/system/component_view.asp?LogDocId=81559

IRG (2003): Information obtained in performing a CMM project feasibility assessment for a confidential commercial client, International Resources Group.

JI (2008): UNEP Risoe CDM/JI Pipeline Analysis and Database, February 1, 2008. http://cdmpipeline.org/publications/JIpipeline.xls

M2M Agreements (2008): 2008 EPA Methane to Markets Cooperative Agreement Awards, Methane to Markets Partnership, 2008. http://www.epa.gov/methanetomarkets/grants08.htm#

M2M Agreements (2009): 2009 EPA Methane to Markets Cooperative Agreement Awards, Methane to Markets Partnership, 2009. http://www.epa.gov/methanetomarkets/grants09.htm

M2M Projects (2008): Methane to Markets International Coal Mine Methane Projects Database, Methane to Markets, accessed 2008. http://www2.ergweb.com/cmm/index.aspx

Nagy (2006); Impact of inactive hard-coal mines processes in Silesian Coal Basin on greenhouse gases pollution, Stanilaw Nagy, Stanis Awrychlicki, and Jakub Siemek, *Acta Geologica Polonica*, vol. 25, no. 2, 2006, pp. 221–228, Warsaw.

Palarski (2003): The Mineral Sector and Sustainable Development: a Polish Perspective, Jan Palarski, Technical University of Silesia in Gliwice, Poland, 2003. http://www.mineprofs.org/info/industry/SOMP-03-Industry-Poland-Palarski.pdf

PGI (2005): Coal Bed Methane, Polish Geological Institute, Office of Economical Geology, website updated December 2005. http://www.pgi.gov.pl/mineral_resources/cbm.htm

PGNiG (2006): PGNiG Annual Report, 2006. http://www.pgnig.pl/pgnig/ri/838/840

Schwochow (1997): *The International Coal Seam Gas Report*, Cairn Point Publishing, editor, 1997.

Skiba (2007): Poland in the Methane to Markets Partnership, Jacek Skiba, Central Mining Institute of Katowice, Poland, April 3, 2007. http://www.methanetomarkets.org/documents/events_coal_20070402_poland.pdf

Skiba (2009): Methane to Markets Coal Subcommittee Report Poland, Jacek Skiba and Rafał Wojciechowski, January 2009. http://www.methanetomarkets.org/documents/events_coal_20090127_subcom_poland.pdf

Suwala (2010): Lessons Learned from the Restructuring of Poland's Coal-Mining Industry, Wojciech Suwala, Global Subsidies Initiative of the International Sustainable Development, March, 2010. http://www.globalsubsidies.org/files/assets/poland_casestudy_ffs.pdf

UNECE (2009): Spółka Energetyczna "Jastrzębie" S.A., 5th Session of the UNECE Ad Hoc Group of Experts on Coal Mine Methane, October 12–13, 2009. http://www.unece.org/energy/se/pp/coal/cmm/5cmm_oct09/11_matysiak_sej_e.pdf

UNFCCC (1998): Second national report to the conference of the parties to the United Nations Framework Convention on Climate Change (Second National Communication). http://unfccc.int/resource/docs/natc/polnc2.pdf

UNFCCC (2007a): *Poland National Inventory Report 2007*, United Nations Framework Convention on Climate Change, Annex I Party GHG Inventory Submission, 2007. http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/3929.php

UNFCCC (2007b): United Nations Framework Convention on Climate Change - Status of Ratification, August 17, 2007. http://unfccc.int/files/essential_background/convention/status_of_ratification/application/pdf/unfccc_conv_rat.pdf

UNFCCC (2007c): Kyoto Protocol - Status of Ratification, December 12, 2007. http://unfccc.int/files/kyoto_protocol/background/status_of_ratification/application/pdf/kp_ratification.pdf

USEPA (1995): Reducing Methane Emissions from Coal Mines in Poland: A Handbook for Expanding Coalbed Methane Recovery and Utilization in the Upper Silesian Coal Basin, U.S. Environmental Protection Agency, EPA/430-R-95-003, April 1995. http://www.epa.gov/cmop/docs/int002.pdf

USEPA (1998): Poland Country Fact Sheet, from the Seminar and Workshop on Coalbed Methane Development and Potential, Washington, DC, September 10, 1998. www.epa.gov/coalbed//pdf/int001.pdf

USEPA (2003): Assessment of the Worldwide Market Potential for Oxidizing Coal Mine Ventilation Air Methane, U.S. Environmental Protection Agency, EPA 430-R-03-002, July 2003. http://www.epa.gov/cmop/docs/ventilation_air_methane.pdf

USEPA (2005): U.S. Approach to Estimating Fugitive Methane Emissions from Coal Mining, U.S. Environmental Protection Agency, 2005.

USEPA (2006): *Global Anthropogenic Non-*CO_2 *Greenhouse Gas Emissions: 1990–2020*, Draft, U.S. Environmental Protection Agency, Office of Atmospheric Programs, Climate Change Division, June, 2006. http://www.epa.gov/nonco2/econ-inv/downloads/GlobalAnthroEmissionsReport.pdf

Volkmer (2008): Coal deposits of Poland, including discussion about the degree of peat consolidation during lignite formation, TU Bergakademie Freiberg, 2008. www.geo.tu-freiberg.de/oberseminar/os07_08/Gerald_Volkmer.pdf

WEC (2007): 2007 Survey of World Energy Sources, World Energy Council, 2007. http://www.worldenergy.org/documents/ser2007_final_online_version_1.pdf

World Bank (2004): PROJECT INFORMATION DOCUMENT (PID) - APPRAISAL STAGE, Report No.: AB883, April 26, 2004. http://www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/2004/06/08/000104615_20040608110157/Original/PID010as0for0appr1negs.doc

World Bank (2007): Implementation Completion and Results Report: Hard Coal Mine Closure Project, May 14, 2007. http://www-wds.worldbank.org/servlet/WDSContentServer/IW3P/IB/2007/07/18//000020953_20070718104822/Rendered/PDF/ICR0000494.pdf

28 Republic of Korea

28.1 Summary of Coal Industry

28.1.1 The Role of Coal in Korea

The Republic of Korea (Korea) relies on imports for 96 percent of its energy needs because of its severely limited mineral resources (IEA, 2007a; EIA, 2008). Coal supplies about 24 percent of the country's total energy, amounting to an estimated coal consumption of 105 million tonnes (Mmt) in 2007 (EIA, 2007; IEA 2007b). However, only about 2.8 Mmt were produced domestically in 2007 (Table 28-1); about 97 percent of the country's coal requirements was imported, mainly from China, Australia, and the United States (EIA, 2007). Indigenous coal reserves were estimated at 135 Mmt in 2006 (EIA, 2008), comprising primarily low-quality anthracite, used in home heating and small boilers (USGS, 2007).

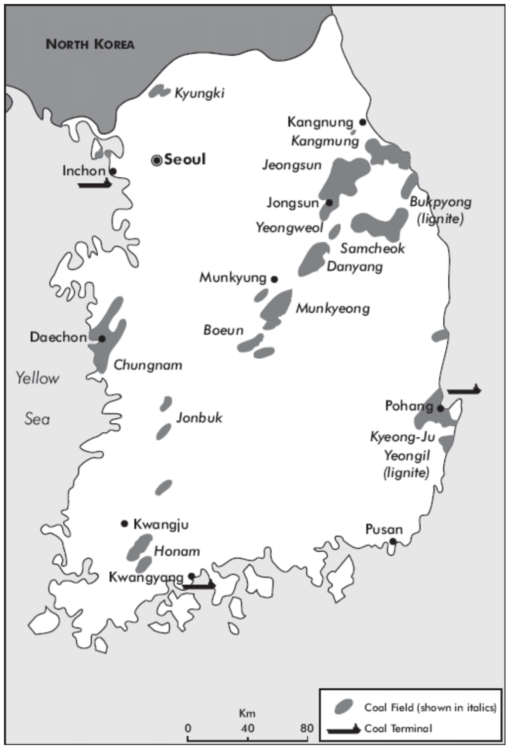
Table 28-1. Korea's Coal Reserves and Production

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2006)*	0	135	135	29 (0.01%)
Annual Coal Production (2007)**	2.8	0	2.8	27 (0.05%)

Source: *EIA (2008); **IEA (2007b) Note: Numbers may not add due to rounding

Figure 28-1 illustrates the locations of coal basins and mines in Korea. As seen, Korea's coal is concentrated in four of its nine provinces: North and South Chungcheong, Gangwon (location of Samcheok, the largest coalfield in Korea), and to a small extent in South Jeolla (NationMaster, nd).

Figure 28-1. Korea's Coal Fields and Major Coal Terminals



Source: IEA (2002)

28.1.2 STAKEHOLDERS

Table 28-2 lists potential stakeholders in the development of Korea's coal mine methane (CMM) industry.

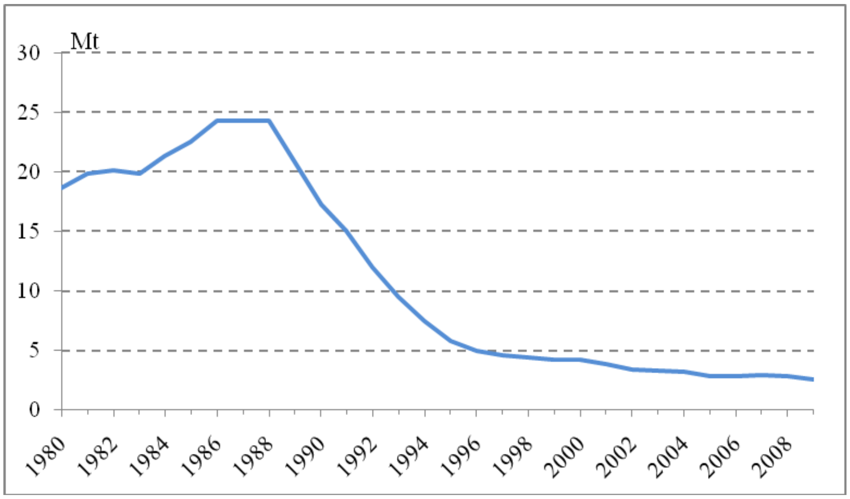
Table 28-2. Key Stakeholders in the Republic of Korea's CMM Industry

Stakeholder Category	Stakeholder	Role
Engineering, Consultancy, and Related Services	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Technical assistance
Mining Companies and Coalbed Methane (CBM) Developers	▪ Korea Resources Corporation ▪ Korean Coal Corporation ▪ See http://www.epa.gov/coalbed/networkcontacts.html	Project hosts/promoters
Universities, Research Establishments	▪ Korea Institute of Energy Research ▪ Korea Electrotechnology Research Institute ▪ Korea Institute of Science and Technology ▪ Korea Institute of Geology, Mining and Minerals ▪ Korea Electric Power Research Institute	Technical assistance
Government Groups	▪ Ministry of Education, Science, and Technology ▪ Ministry of Knowledge Economy ▪ Global Green Growth Institute	Licensing, monitoring, and control
Other	▪ Korea Energy Management Corporation ▪ Korea Energy Economics Institute	Policy

28.1.3 STATUS OF COAL AND THE COAL MINING INDUSTRY

As seen in Figure 28-2, Korean coal production has declined drastically in the last 20 years, with many coal mines closing. According to one source, coal production has declined 89 percent from its peak in the late 1980s (EIA, 2009). Currently, Korea produces only anthracite, importing all its bituminous requirements.

Figure 28-2. Korea's Coal Production (million tonnes)



Source: EIA (2009)

The state-owned Korea Coal Corporation (KOCOAL) is responsible for about 53 percent of the total coal produced by the country, with main facilities at Dogye, Jangseong, and Hwasun (KOCOAL, 2010b). The remaining coal production in Korea is from two privately owned mines.

Coal production in Korea is costly; most coal is located in thin seams in mountainous areas, and labor productivity is relatively low. In order to compete with coal imports, domestic coal production is supported by several government measures, such as subsidies, low-interest loans to coal producers, tariffs on coal imports of 1 and 5 percent, and a 10 percent value-added tax on imported coal and price ceilings. These subsidies have been on the rise, effecting high production costs for the government. As part of streamlining the country's coal supply, the government has been closing its mines (WTO, nd), planning to maintain a small level of domestic production; however, the minimum annual production volume has not been established (IEA, 2006).

The Korean government is encouraging investments in foreign coal mining ventures as a measure to secure its future energy needs. Korea has made several such equity investments through the Korea Resources Corporation, Korean Coal Corporation, and some private companies (IEA, 2006). Under government direction, KOCOAL has numerous overseas projects and imports 73 Mmt of steam coal annually. Korea's relationship with coal is thus unique in that it plans to increase its dependence on coal for electricity needs while moving toward a reduced domestic supply of coal (IEA, 2006). As of 2009, Korea's reserve-to-domestic production ratio was estimated to be 53 years (EIA, 2009).

28.2 Overview of CMM Emissions and Development Potential

28.2.1 CMM Emissions from Operating Mines

Korea produced approximately 56 thousand tonnes (8.2 cubic meters [m^3]) of methane in 2000 from coal mining, and about 1.5 Mmt (2.2 billion m^3) from combined sources of landfill sites, underground coal mines, and natural oil and gas systems. Table 28-3 illustrates the decline in CMM emissions, reflecting the substantial decline in the coal mining industry in Korea.

Table 28-3. Korea's CMM Emissions (thousand tonnes)

Emission Category	2000	2010	2020 (projected)
Total liberated	55.5	34.0	20.8

Source: USEPA (2006)

28.2.2 CMM Emissions from Abandoned Coal Mines

The number of operating coal mines has dwindled from 70 in 1993 to only five in 2010 (KEEI, 2009; KOCOAL, 2010). Although the potential for methane to be found in so many abandoned mines may likely be attractive, no specific data were found.

28.2.3 CBM from Virgin Coal Seams

No data were found for virgin coal seams.

28.3 Opportunities and Challenges to Greater CMM Recovery and Use

Rapid industrialization, growth in income, and the resultant increase in cars on the road have led to serious environmental concerns for Korea, such as acid rain and a rise in greenhouse gas (GHG) emissions. After the Asian financial crisis of 1997–1998, Korea began aligning itself with more secure and environmentally sound energy development. It established goals for promoting green development via its *National Vision for Environmental Policies in the 21st Century*. It has also established a Global Green Growth Institute, a Five-Year Action Plan, and several other policies to foster green energy and mitigate emissions.

Korea signed the Kyoto Protocol in September 1998 (see Table 28-4). Although Korea has no formal Kyoto commitment to cap its GHG emissions, it announced in 2009 to unilaterally cut its emissions 4 percent below 2005 levels by 2020, which is a 30 percent cut in emissions under a business as usual scenario.

Table 28-4. Korea's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC	June 13, 1992	December 14, 1993
Kyoto Protocol	September 25, 1998	November 8, 2002

Source: UNFCCC (2010a); UNFCCC (2010b)

28.3.1 MARKET AND INFRASTRUCTURE FACTORS

Alternative sources of energy are still commercially not competitive with conventional fossil fuel energy in Korea. The Korean government plays a central role in setting prices for the energy market. With the country's push toward sustainable development, the government is taking significant steps to improve market penetration of renewable energy. There are direct and government-funded subsidies available for renewable energy projects. The Ministry of Knowledge Economy (MKE) is also concerned with regulating economic policy, particularly in the industrial and energy sectors, and is involved in encouraging foreign investment in Korea.

Several organizations are vested in energy-related R&D besides MKE, such as the Ministry of Education, Science and Technology. The Korea Institute of Energy Research and the Korea Electrotechnology Research Institute are two more major public institutes for energy technology research and are government funded. Other government-supported research institutes include the Korea Institute of Science and Technology (KIST) and the Korea Institute of Geology, Mining and Minerals (KIGAM). KIST is the leading Korean institute for research in fundamental and applied science, which plays an essential role in developing energy-efficient industrial technologies. KIGAM, the premier Korean geosciences and resource research institute, provides support in analyzing geophysical data on offshore oil and gas and also develops technology to store liquid natural gas (LNG) in natural repositories.

The Korea Energy Economics Institute (KEEI) is Korea's main energy policy research organization. KEEI conducts basic research on energy policy options. It provides energy information and statistics and produces energy balances; formulates policies for the government on reforms in the electricity and gas supply industries, energy efficiency, and demand management; produces energy supply and consumption forecasts; and is also involved in climate change studies. The Korea Energy Management Corporation plays a key role in implementing R&D policy objectives for energy efficiency, energy conservation, and clean energy technologies.

No data are available on CMM operations in Korea. However, projects utilizing methane from landfills are well under way and may help in drawing parallel to CMM projects (NREL, 2006). The MKE has partnered with the U.S. Environmental Protection Agency to form the Climate Change Technology Program to assist with implementing methane recovery and energy-efficient technologies in Korea. The plan involves government-supported project development and technology implementation through private sector collaboration between Korean and international firms. More recently, the government has announced a green growth initiative to expand clean energy technologies, ranging from energy-efficient practices, a smart grid, and cleaner cars to developing renewable energy such as solar and wind (Green Growth, 2010).

28.3.2 REGULATORY INFORMATION

Although Korea initiated privatization of the natural gas companies, the Korea Gas Company (KOGAS) and several other state-owned enterprises in 1999, the State still retains a 25 percent stake (EIA, 2007). KOGAS was to be split into three competitive retail gas suppliers; however, the government decided to revise its plans.

Under Korea's constitution, the land and natural resources are protected by the state and the government plans for the best development and utilization of its resources. The State may grant licenses for temporary periods to private companies for tapping into the natural wealth (Constitution, nd).

Korea practices at least two key occupational safety and health laws in mining operations: The Industrial Safety and Health Act and the Act Relating to Prevention of Pneumoconiosis and Protection of

Pneumoconiosis Workers. The former act provides for occupational safety of both employers and the employees. The latter act concerns prevention of Pneumoconiosis and provisions for the affected workers (MSHA, nd).

The government provides a 5 percent tax credit for implementing energy-efficient or renewable energy technologies. Additionally, 5.5–7.5 percent low-interest loans are offered for investment in these facilities. Also, a reference price system was deployed in 2002 that subsidizes excess costs of power generated from alternative sources (WTO, nd).

CMM recovery is justifiably a key element of energy conservancy and is environmentally crucial. Therefore, although CMM projects have yet to develop in Korea and the government is pursuing other clean technologies, it is possible that the Korean government would contribute by providing incentives and tax breaks to encourage CMM use and ease its entry into the energy market.

28.4 Profiles of Individual Mines

Gyeongwon Coal Mine, Chungnam

General Overview

Coal excavation started here in 1896. The mine was abandoned in 1992.

General Information

Mine ID	1491
Total estimated mineable reserves	6,896 thousand tonnes

Geologic and Mining Conditions

Rank of coal	Anthracite
Coal quality	4,599 kcal/kilogram (kg)
Seam thickness	0.9 meters (m)

Coal Production, Methane Emissions, and Degasification (and Use) Statistics

	1985	1987	1988	1989	1990	1991
Coal Production (thousand tonnes)	28	42	57	76	86	38

Source: KIGAM (nd)

28.5 References

Constitution (nd): South Korean Constitution – Chapter IX The Economy, Article 120. http://english.ccourt.go.kr/home/att_file/download/Constitution_of_the_Republic_of_Korea.pdf

EIA (2007): Country Analysis Briefs – South Korea, U.S. Energy Information Administration, Washington, DC, June 2007. http://www.eia.doe.gov/emeu/cabs/skorea.html

EIA (2008): International Energy Annual 2006, U.S. Energy Information Administration, Washington, DC, table posted October 2008. http://www.eia.doe.gov/pub/international/iea2006/table82.xls (reserves)

EIA (2009): Total Primary Coal Production, U.S. Energy Information Administration, Washington, DC, 2009. http://tonto.eia.doe.gov/country/country_energy_data.cfm?fips=KS

Green Growth (2010): "Sub-National Policy," Green Growth Korea, Seoul, Korea, 2010. http://www.greengrowth.go.kr/english/en_subpolicy/en_greenhouse/en_greenhouse.cms

IEA (2002):http://www.iea.org/textbase/nppdf/free/2000/korea2002.pdf

IEA (2006): International Energy Agency, *Energy Policies of IEA Countries,*: *The Republic of Korea 2006 Review.* http://www.iea.org/textbase/nppdf/free/2006/korea2006.pdf

IEA (2007a): Energy Balance for Korea, Republic of, International Energy Agency, Paris, France, website accessed July 1, 2010. http://iea.org/stats/balancetable.asp?COUNTRY_CODE=KR

IEA (2007b): *Coal and Peat in Korea, Republic of*, International Energy Agency, Paris, France, website accessed July 1, 2010. http://iea.org/stats/coaldata.asp?COUNTRY_CODE=KR

KEEI (2009): Yearbook of Energy Statistics 2009, Korea Energy Economics Institute, Kyonggi-do, Korea, December, 2009. http://www.keei.re.kr/keei/download/YES2009.pdf

KIGAM (nd): Korea Institute of Geosciences and Mineral Resources, not dated.

KOCOAL (2010a): Overseas Mine Development, Korea Coal Corporation, Seoul, Korea, website accessed July 1, 2010. https://www.kocoal.or.kr/english/introduction_09.php

KOCOAL (2010b): Location of KOCOAL's offices, Korea Coal Corporation, Seoul, Korea, website accessed July 1, 2010. https://www.kocoal.or.kr/english/introduction_08.php

MSHA (nd): Synopsis of Mining Law for South Korea, not dated. http://www.msha.gov/minelink/compend/skorea.htm

NationMaster (nd): Online compilation of data on countries from CIA World Factbook, United Nations, World Bank, World Health Organization, and other sources, not dated.
http://www.nationmaster.com/encyclopedia/South-Chungcheong
http://www.nationmaster.com/encyclopedia/Administrative-divisions-of-South-Korea

NREL (2006):U.S. National Renewable Energy Laboratory, Colorado, December 2006, http://www.nrel.gov/docs/fy07osti/40428.pdf

UNFCCC (2003): Second National Communication of the Republic of Korea Under the United Nations Framework Convention on Climate Change. http://unfccc.int/resource/docs/natc/kornc02.pdf

UNFCCC (2007a): United Nations Framework Convention on Climate Change - Status of Ratification, June, 2010. http://unfccc.int/essential_background/convention/status_of_ratification/items/2631

UNFCCC (2010b): Kyoto Protocol - Status of Ratification, June, 2010. http://unfccc.int/kyoto_protocol/status_of_ratification/items/2613.phpp

USEPA (2006): *Global Anthropogenic Non-*CO_2 *Greenhouse Gas Emissions: 1990–2020*, U.S. Environmental Protection Agency, Office of Atmospheric Programs, Climate Change Division, June 2006. http://www.epa.gov/climatechange/economics/international.html

USGS (2007): *Mineral Industry of the Republic of Korea*, U.S. Geological Survey, Reston, VA, 2007, http://minerals.usgs.gov/minerals/pubs/country/2007/myb3-2007-ks.pdf

WTO (nd): Trade Policies by Sector for South Korea, not dated. http://www.wto.org/english/tratop_e/tpr_e/s137-4_e.doc

29 ROMANIA

29.1 Summary of Coal Industry

29.1.1 ROLE OF COAL IN ROMANIA

Coal accounts for 29 percent of energy production in Romania. Romania's proven coal reserves are estimated at about 420 million tonnes (Mmt) and the country ranks seventeenth worldwide in coal production (see Table 29-1). More than 80 percent of Romanian lignite reserves can be mined profitably in opencast mines, while the remaining 20 percent require underground mining (WEC, 2000).

Table 29-1. Romania's Coal Reserves and Production

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2006)*	12.0	410.0	420.0	24 (0.05%)
Annual Coal Production (2007)**	0	35.8	35.8	17 (0.6%)

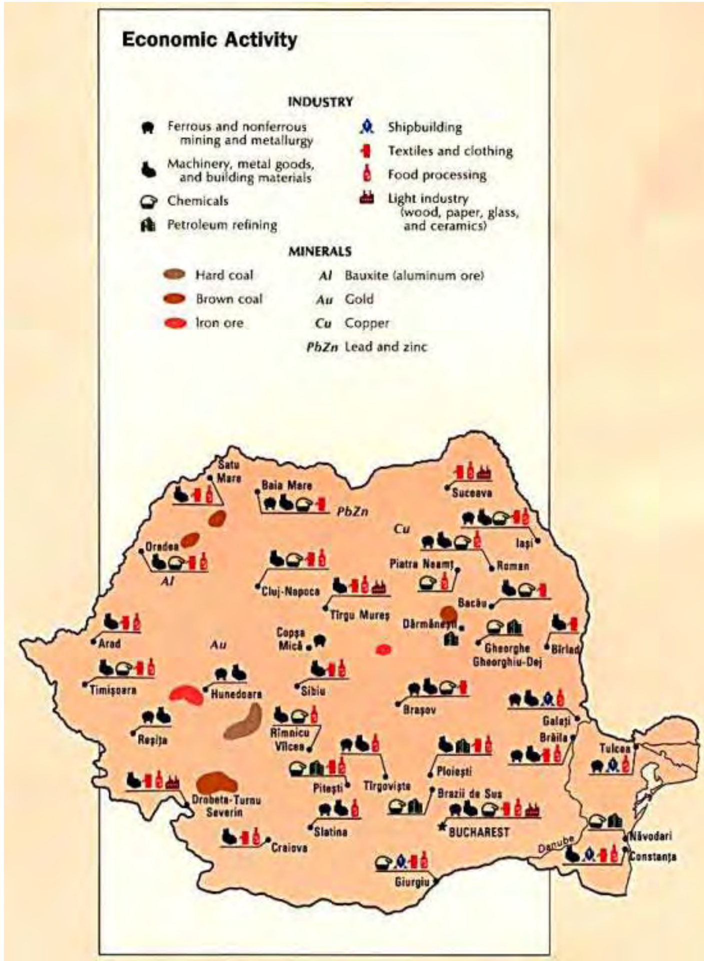
Source: *EIA (2008); **IEA (2007)

Figure 29-1 shows the distribution of hard and brown coalfields in Romania. The coal deposits are grouped into four zones:

- **Zone I**, mainly located in the Southern Carpathian Mountains, includes all the high-grade coal such as anthracite, pit coal (higher ranking than brown coal – bituminous and sub-bituminous), and brown coal (lignite) from the Petrosani, Anina, and Tebea-Brad basins.
- **Zone II**, located within the Pre-Carpathian creep, between the Olt and Valea Buzaului rivers, includes the lignite deposits of Campulung, Sotanga, Filipestii de Padure, and Ceptura. The coal basins of the Eastern Carpathian are also included within this zone: Baraolt-Virghis (lignite) and Comanesti-Bacau (brown coal). More than 90 percent of Romanian coal reserves are located within Zone II, namely in the mining basins of the Oltenia Region.
- **Zone III** is located in the Sub-Carpathian creep of the Getic Plateau, between the river Olt and the Danube, including the lignite deposits of Rovinari, Motru, Jilt, Berbesti-Alunu, and Mehedinti.
- **Zone IV** is located in the Panonian creep in the northwestern part of Transylvania and includes the brown coal and lignite deposits of Sarmasag, Voievozi, Surduc, and Borod.

As of January 2006, the eight active mines in the Jiu Valley were as follows: Petrila, Lonea, Livezeni, Paroşeni, Vulcan, Aninoasa, Lupeni, and Bărbăţeni (Jiu Valley, 2007).

Figure 29-1. Romania's Coalfields



Source: Jiu Valley (2001)

29.1.2 STAKEHOLDERS

Table 29-2 lists potential stakeholders in Romania's coal mine methane (CMM) industry.

Table 29-2. Key Stakeholders in Romania's CMM Industry

Stakeholder Category	Stakeholder	Role
Governmental Mining Companies	▪ National Lignite Company OLTENIA, Târgu-Jiu ▪ National Hard Coal Company – Petrosani ▪ National Coal Company, Ploiesti	Project hosts
Other Mining Companies/License Holders	▪ Asociatia Mina Borod ▪ Complexul Energetic Rovinari S.A. ▪ Complexul Energetic Turceni S.A. ▪ Ermo Exploatarea Resurselor Minerale Oltenia S.R.L.-Motru ▪ SC Complexul Energetic Craiova S.A.	Project hosts

Stakeholder Category	Stakeholder	Role
Developers	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Project opportunity identification and planning
Engineering, Consultancy, and Related Services	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Technical assistance
Regulatory Agencies and Government Groups	▪ National Agency for Mineral Resources ▪ Ministry of Industry and Trade	Management of mineral resources, issue and enforce government policy

Source: USGS (2010)

29.1.3 Status of Coal and the Coal Mining Industry

Three national companies are active in the Romanian coal industry: National Company of Lignite OLTENIA, Târgu-Jiu; National Hard Coal Company, Petrosani; and National Coal Company, Ploiesti (WEC, 2000).

- The National Company of Lignite OLTENIA, Târgu-Jiu has five main fields: Rovinari (14.9 Mmt/year), Jilț (7.6 Mmt/year), Motru (6.6 Mmt/year), Berbeşti (2.6 Mmt/year), and Husnicioara (3.1 Mmt/year). It has reserves of around 2 billion tonnes and produces 35 Mmt of lignite and 4 Mmt of anthracite annually (USGS, 2010; EURACOAL, 2010; NCL, 2010).
- The National Hard Coal Company, Petrosani operates seven coal mines: Lonea, Petrila, Livezeni, Vulcan, Paroseni, Uricani, and Lupeni. It has approximately 350 Mmt of total reserves and produces 3 Mmt/year of bituminous coal (USGS, 2010; EURACOAL, 2010; CNH, 2010).
- National Coal Company (NCC), Ploiesti operates mainly in seven small opencast pits and one underground mine. The pits are located in the southeast, central, and northwest basins of the country near Campulung, Baraolt City, Sarmasag, Popesti Commune, Comanesti Commune, Filipestii de Padure Commune, Sotanga Commune, and the underground mine is in Borsec City. NCC has about 59 Mmt of reserves and produces around 2 Mmt/year of bituminous coal (USGS, 2010; EURACOAL, 2010; NCC, 2010).

Romania has suffered from declines in production, outdated infrastructure, and labor unrest; however, the Romanian government is hoping for a resurgence of the coal industry and for increased output from existing mines. The first sign of improvement came in 2000, as Romanian coal mine output improved over the previous year's total for the first time in several years. Since then, average production has risen but fluctuated, as shown in Table 29-3.

Table 29-3. Romania's Annual Coal Production

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Production (million tonnes)	22.88	29.29	33.29	30.41	33.06	31.79	31.11	34.92	35.78	34.73	29.73

Source: EIA (2010)

Table 29-4 lists Romania's coal production by mine type.

Table 29-4. Romania's Recent Coal Mining Statistics

Type of Mine	Production (million tonnes)
Underground (active) mines - total	*7.98
Surface (active) mines - total	**26.45

Source: *UNFCCC (2005a); **EIA (2003)

29.2 Overview of CMM Emissions and Development Potential

The Global Methane Initiative (formerly Methane to Markets Partnership) International CMM Projects Database currently identifies no CMM recovery projects in Romania, in operation or development (M2M Projects, 2010).

29.2.1 CMM Emissions from Operating Mines

Table 29-5 quantifies Romania's recent historical CMM emissions. The data in this table may vary slightly from the U.S. Environmental Protection Agency (U.S. EPA) data presented in the Executive Summary due to differences in inventory methodology and rounding of digits.

Table 29-5. Romania's CMM Emissions (million cubic meters)

Emission Category	1990	1995	2000	2005	2006	2007	2008
Underground mining activities—all	192.81	206.89	139.20	126.92	129.46	133.33	135.34
Post-underground emissions	26.99	28.96	19.49	17.77	18.12	18.67	18.95
Surface mine emission (total)	33.60	36.24	25.89	27.50	31.60	32.72	32.67
Post-surface mining emissions	2.92	3.15	2.25	2.39	2.75	2.85	2.84
Total liberated (= sum of all above)	256.33	275.24	186.82	174.57	181.93	187.56	189.80

Source: UNFCCC (2010a)

All mines in the Jiu Valley have ventilations systems (UNECE, 2006), and the total amount of methane emissions from the valley is estimated at 49 million cubic meters (m^3) per year from ventilation systems and another 4 million per year from other degasification systems (WEC, 2008).

Romania has one CMM utilization project at an active mine. At the Lupeni mine, 39 percent of the methane drained is being utilized (a rate of 1,325–6,000 m^3per day was reported in 2006). In 2008, the degassing station at the Lupeni mine was operating at 3,400 $m^3$of methane per day (WEC, 2008). The project is summarized below in Table 29-6. Romania is seeking partners to develop other projects.

Table 29-6. Romania's CMM Utilization Projects

Site	Project Operator	Mine Type	Project Operating Dates	Use of Methane	Output
Lupeni Mine	NHC Petrosani	Active	N/A	Boiler Fuel	2 x 15 Gcal/hour

Source: Insemex Petrosani (2006); UNECE (2006)

29.2.2 CMM Emissions from Abandoned Coal Mines

The U.S. Trade and Development Corporation has solicited a plan for a CMM cogeneration plant and methane recovery project at two abandoned mines in Caras-Severin. Evaluation of project submissions is currently underway (USTDA, 2010).

29.2.3 CBM from Virgin Coal Seams

Galaxy Energy Corp had been planning for years to evaluate a 21,538-acre concession held in the Jiu Valley. 13,715 acres of the concession have coalbed thicknesses greater than 5 m and are currently considered to be prospective for coalbed methane (CBM) production. The area contains 18 coal seams with a cumulative thickness up to 50 m at depths of between 300–1,000 m, and the main target seam averages 22 m in thickness. These exploratory wells were to be in close proximity to earlier wells that had located gas. The test wells would also have been less than 2 miles from a 20-inch gas trunk pipeline, and in close proximity to an electrical generation plant that uses both natural gas and coal as fuel (Galaxy, 2008). However, in March 2008, Galaxy Energy filed for bankruptcy protection; the status of its exploration activities is unknown (RedOrbit, 2008).

29.3 Opportunities and Challenges to Greater CMM Recovery and Use

Romania ratified the Kyoto Protocol as an Annex 1 country and is eligible to host Joint Implementation projects that reduce greenhouse gas (GHG) emissions. Table 29-7 summarizes Romania's climate change commitment.

Table 29-7. Romania's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC*	June 5, 1992	June 8, 1994
Kyoto Protocol**	January 5, 1999	March 19, 2001

Source: *UNFCCC (2010b); **UNFCCC (2010c)

The National Strategy on Climate Change (NSCC) 2005–5007 outlines Romania's policies in meeting the international obligations of the Kyoto Protocol and Romania's own national priorities (RMO, 2008a). The National Action Plan on Climate Change outlines the implementation methodology for the NSCC (RMO, 2008b).

29.3.1 Market and Infrastructure Factors

The natural gas transmission system is run by the state-owned company TRANSGAZ. Romania had previously increased imports of Russian gas due to depletion of domestic sources (Transgaz, 2002); however, more recently Romania is increasingly looking elsewhere to diversify it sources of gas to avoid supply interruptions or price pressures (Upstream, 2010). Both of these situations indicate favorability toward developing domestic alternative gas sources like CMM/CBM.

The Romanian government ended subsidies for lignite and metals mining in 2007, closed some unprofitable mines, and privatized profitable mines, but has continued (under European Union [EU] Council Regulation [EC] no. 1407/2002) to subsidize hard coal extraction through 2010 (USGS, 2010). Key remaining challenges include the continued closure of unprofitable mines, modernization of remaining mines, and reduction in employment/manpower (EURACOAL, 2010). Additionally, the major obstacle against further CMM development, in the case of the Jiu Valley at least, has been the lack of investment (WEC, 2008).

29.3.2 REGULATORY INFORMATION

Romania instituted a national energy plan for 2007 through 2020 that includes the privatization of the energy sector. The law requires that all mining activities be based on licenses for either administration or specific concessions. All enterprises with ongoing mining exploitation and exploration activities must apply for licenses in areas where they are active, and as part of the restructuring process are required to relinquish all inactive areas to be reorganized and offered up to competitive Romanian and foreign investment. The National Agency for Mineral Resources (NAMR) has been appointed as the controlling authority for coal extraction in Romania. NAMR has the power, on behalf of the State, to manage the mineral resources of the country and to enforce the provisions of the exploration and utilization of mineral resources. The Ministry of Industry and Trade issues and enforces government policy in the mining field and administers and monitors public property in the field of mineral resources (WEC, 2000).

Romania entered the EU in 2007 and has to meet energy production and other requirements of EU law. The new national energy plan was designed in part to meet the requirements of membership including: the above mentioned privatization of the energy sector; changes to gas restrictions, oil and coal imports; the completion of two new power generation units at the Cernavoda nuclear power plant; expansion of hydroelectric energy and nonconventional energy resources; and the extension of the power grid and natural gas pipelines (EURACOAL, 2010). Romania also passed a Renewable Energy Law (no. 220/2008) in 2008, in part to meet the EU regulatory requirements, to promote investment and to meet the goals of the national energy plan (EBRD, 2009).

29.4 Profiles of Individual Mines

Some basic capacity numbers can be found in the 2008 Minerals Yearbook for Romania (USGS, 2010) and in a report on Jiu Valley Mine Potential (Lupu, 2006). Updates on future CMM projects in Romania can be found at http://www.methanetomarkets.org/coalmines/index.htm#profiles.

29.5 References

CNH (2010): National Hard Coal Company, Romania, 2010. http://www.cnh.ro/

EBRD (2009): Country Profiles – Romania, European Bank for Reconstruction and Development (EBRD), 2009. http://www.ebrdrenewables.com/sites/renew/countries/Romania/profile.aspx

EIA (2003): Annual Energy Review, Table 11.13 World Recoverable Reserves of Coal (Million Short Tons), Energy Information Administration, 2003.

EIA (2008): International Energy Annual 2006, Department of Energy, Energy Information Agency, December 2008. http://www.eia.doe.gov/emeu/iea/contents.html

EIA (2010): International Energy Statistics – Romania, U.S. Energy Information Administration, Washington, DC, accessed July 6, 2010. http://tonto.eia.doe.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=1&pid=7&aid=6

EURACOAL (2010): Country Profiles – Romania, European Association for Coal and Lignite, website accessed 2010. http://www.euracoal.be/pages/layout1sp.php?idpage=77

Galaxy (2008): Jiu Valley – Romania: Coalbed Methane Project, Galaxy Energy Corporation, accessed May 26, 2008. http://www.galaxyenergy.com/romania.php

IEA (2007): Coal in Colombia, International Energy Agency Energy Statistics – Coal, International Energy Agency, Paris, France, 2007. http://www.iea.org/Textbase/stats/coaldata.asp?COUNTRY_CODE=RO

Insemex Petrosani (2006): Information provided by Constantin Lupu - General Director, Emilian Ghicioi- Scientific Director, and Liviu Jurca – Head of Laboratory, Insemex Petrosani, 2006.

Jiu Valley (2001): Jiu Valley Portal, Map Galleries – Romania. http://www.jiuvalley.com/data/Map_Galleries/album/1_Romania/index.html

Jiu Valley (2007): http://www.jiuvalley.com/engl/tourism/history.asp

Lupu (2006): Methane Emissions from Hard Coal Mines of Jiu Valley - Romania - Use Possibilities. Constantin Lupu and Emil Ghicioi, INSEMEX, Romania, January 31–February 1, 2006. http://www.unece.org/energy/se/pdfs/cmm/sessfebdec06/Topic11/Lupu_Ghicioi_INSEMEX.pdf

M2M Projects (2010): Methane to Markets International Coal Mine Methane Projects Database, Methane to Markets, 2010. http://www2.ergweb.com/cmm/index.aspx

Maps Of World (2010): Romania Mineral Map, MapsOfWorld.com, 2010. http://www.mapsofworld.com/romania/romania-mineral-map.html

NCC (2010): National Coal Company, Ploiesti, 2010. http://www.snc-ploiesti.ro/ro/prezentare.htm

NCL (2010): National Company of Lignite, OLTENIA, 2010. http://www.cnlo.ro/index.html

RedOrbit (2008): Galaxy Energy Corporation Files for Bankruptcy Court Protection, RedOrbit.com, March 17, 2008. http://www.redorbit.com/news/business/1299603/galaxy_energy_corporation_files_for_bankruptcy_court_protection/index.html

RMO (2008a): Romania Ministry of the Environment's National Strategy on Climate Change of Romania. http://www.mmediu.ro/dep_mediu/schimbari_climatice/The_National_Strategy_of_Romania_on_Climate_Change.pdf

RMO (2008b): Romania Ministry of the Environment's National Action Plan on Climate Change (NAPCC). http://www.mmediu.ro/dep_mediu/schimbari_climatice/HG_PNASC_eng.pdf.

Transgaz (2002): Outlining the Role of Romania in the European Gas Transit Chain: Current Status and Prospective, Transgaz/Gas Dispatch Centre of Romania, 2002. http://www.iea.org/textbase/work/2002/seegas/NMCGHEO.PDF

UNECE (2006): Committee on Sustainable Energy – Report, United Nations Economic Commission for Europe, April 12, 2006. http://www.unece.org/ie/se/pdfs/cmm/cmm2/ECE.ENERGY.GE.4.2006.2_e.pdf

UNFCCC (2010a): National Inventory Submissions 2010, Annex I Party GHG Inventory Submissions, UNFCCC, April 15, 2010. http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5270.php

UNFCCC (2010b): United Nations Framework Convention on Climate Change - Status of Ratification, accessed June 28, 2010. http://unfccc.int/essential_background/convention/status_of_ratification/items/2631.php

UNFCCC (2010c): Kyoto Protocol - Status of Ratification, accessed June 28, 2010. http://unfccc.int/kyoto_protocol/status_of_ratification/items/2613.php

Upstream (2010): Romania Lowers Russian Gas Price, Upstreamonline.com, June 17, 2010. http://www.upstreamonline.com/live/article218085.ece

USEPA (2006): *Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990–2020*, Draft, U.S. Environmental Protection Agency, Office of Atmospheric Programs, Climate Change Division, June 2006. http://www.epa.gov/nonco2/econ-inv/international.html

USGS (2010): 2008 Minerals Yearbook – Romania, U.S. Geological Survey, May 2010. http://minerals.usgs.gov/minerals/pubs/country/europe.html

USTDA (2010): Regional Europe/Eurasia: Coal Mine Methane/Coal Bed Methane/Shale Gas Definitional Mission, U.S. Trade and Development Agency, March 31, 2010. https://www.fbo.gov/utils/view?id=e254ea5b1f740d921ec1e2cf86500c16

WEC (2000): Restructuring the Coal Industries in Central and Eastern Europe, World Energy Council, not dated. http://www.worldenergy.org/documents/coalfinal.pdf

WEC (2008): Possibilities for Using CMM in Jiu Valley Coal Basin, WEC Regional Energy Forum, World Energy Council, June 15–19, 2008. http://www.cnr-cme.ro/foren2008/CD_ROM_1/s5_en/S5-2-en.pdf

30 RUSSIA

30.1 Summary of Coal Industry

30.1.1 ROLE OF COAL IN RUSSIA

Russia's coal industry became a principal sector of the country's economy at the end of the 1930s. By 1950, coal accounted for 59 percent of Russia's fuel balance. The discovery of huge oil and natural gas reserves in the 1960s, however—along with the development of nuclear power—led to decreasing dependence on coal. As of 2007, 15.2 percent of Russia's total primary energy supply came from coal/peat (IEA, 2007a). More than 40 percent of coal consumed in Russia is used for heat and power generation. Natural gas is the principal competitor with coal in these end uses.

Russia is ranked fifth in global coal production and has coal reserves of approximately 157 billion tonnes, which is second worldwide only to the United States (see Table 30-1). Russia exported 104.5 million tonnes (Mmt) of coal in 2008 (EIA, 2008a). Russia's 2009 energy strategy estimates an increase in coal exports by 160 percent from 2008 to 2020 (IEA, 2009).

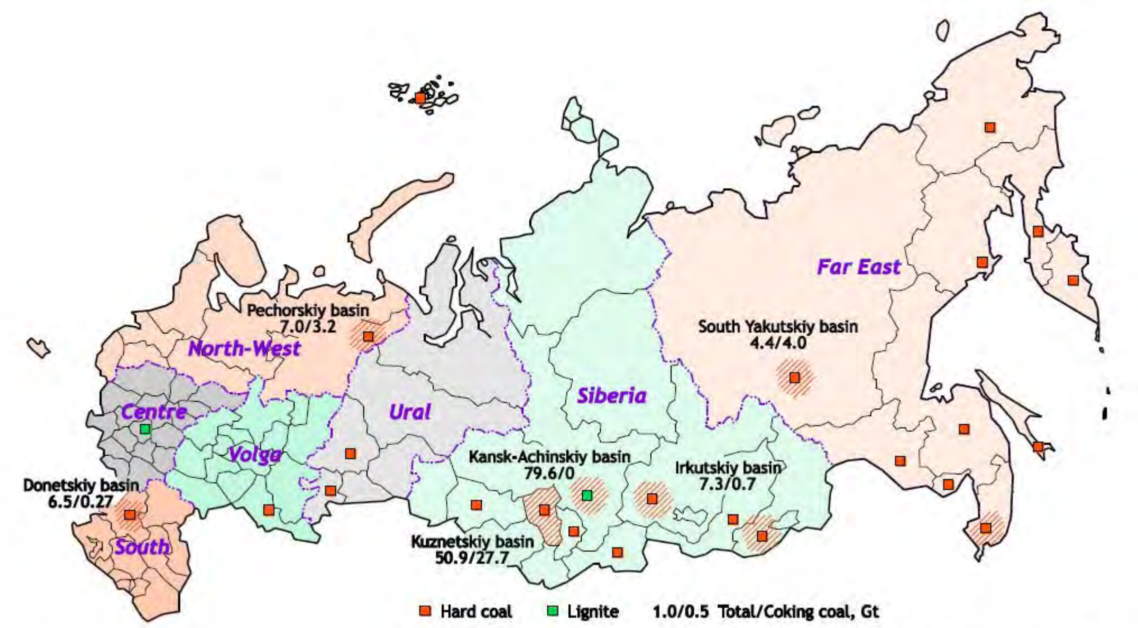
Table 30-1. Russia's Coal Reserves and Production

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank # (%)
Estimated Proved Coal Reserves (2006)*	49,088.0	107,922.0	157,010.0	2 (19.3)
Annual Coal Production (2007)**	217.9	71.1	289.0	5 (4.8)

Source: *EIA (2007b); **IEA (2007b)

Russia's coal resources are primarily concentrated in Siberia (80 percent), followed distantly by the Far East region (10 percent), as seen in Figure 30-1. The main coal-producing basins in Siberia are the Kuznetskiy and Kansko-Achinskiy, along with the South Yakutsly basin in the Far East region (IEA, 2009).

Figure 30-1. Russia's Coal Fields



Source: IEA (2009)

30.1.2 STAKEHOLDERS

Table 30-2 lists potential stakeholders in coal mine methane (CMM) development in Russia.

Table 30-2. Key Stakeholders in Russia's CMM Industry

Stakeholder Category	Stakeholder	Role
Mining Companies	▪ Severstal-Resource ▪ Evraz Holding ▪ MDM ▪ Ural Mining and Metallurgical Company ▪ Sibirsky Delovoy Soyuz ▪ Sibuglemet ▪ Belon ▪ Mechel ▪ Siberian Coal Energy Company	Project hosts
Equipment Manufacturers	▪ Kyshtym Machine Works ▪ Druzhkov Machine Works ▪ Artemovsk Machine Works ▪ VENTPROM ▪ Yurga Machine Works	Power generation equipment supplier
Developers	▪ Uglemetan ▪ See http://www.epa.gov/coalbed/networkcontacts.html	Project opportunity identification and planning
Engineering/Consultancy	▪ Uglemetan ▪ See http://www.epa.gov/coalbed/networkcontacts.html	Technical assistance

Stakeholder Category	Stakeholder	Role
Universities/Research Establishments	▪ Institute of Coal and Coal Chemistry ▪ Russian Academy of Sciences Skochinsky Mining Institute ▪ Russian Academy of Sciences URO Mining Institute ▪ Moscow State Mining University ▪ Promgas ▪ VostNII ▪ Skochinsky Mining Institute	Technical assistance
Natural Gas Transmission & Distribution Companies	▪ Gazprom	Distribution and pipeline sales
Government Groups	▪ Federal Ministry of Natural Resources ▪ Russian Federation Ministry of Energy ▪ Russian Federal Mining and Industrial Inspectorate (RosTechNadzor) ▪ Regional administrations	▪ Licensing ▪ Project approval ▪ Safety standards for mines ▪ Regional environmental and safety rules and requirements

30.1.3 Status of Coal and the Coal Mining Industry

Between 1996 and 2001, Russia worked with the World Bank to restructure the country's coal industry, which is now privatized. As a result, the state monopoly, formally known as RosUgol, has been dissolved and roughly 80 percent of domestic coal production now comes from independent producers (EIA, 2008b). Table 30-3 presents production statistics for Russian coal mining.

Table 30-3. Russia's Recent Coal Mining Statistics (2007)

Type of Mine	**Production**(million tonnes)	Number of Mines
Underground (active) mines – total	109.2	97
Surface (active) mines – total	205.3	143
Total mines	314.5	240

Source: USGS (2007)

Russia's coal mines are extremely gassy with an average of 11.6 cubic meters (m^3) of methane per tonne of coal (IEA, 2009). As of 2005, 78 out of 92 underground mines were considered gassy (Tailakov, 2005a). Another report from the Moscow State Mining University estimates that there are 82 coal mines of "potential methane hazard" operating, of which 50 can be considered "abundant" in methane—22 out of these 50 mines are using degasification technology (M2M Symposium, 2006).

30.2 Overview of CMM Emissions and Development Potential

The Global Methane Initiative (formerly Methane to Markets Partnership) International CMM Projects Database currently identifies seven CMM projects in Russia, all of which are in active underground mines. Four projects in the Pechora basin and one in the Kuznetsk basin (also known as the Kuzbass) provide boiler fuel, and two remaining projects (one in the Kuzbass) provide power generation (M2M Projects, 2008).

30.2.1 CMM EMISSIONS FROM OPERATING MINES

CMM in Russia is primarily located in three coal basins: Kuzbass, Pechora, and Donetsk (also known as Donbass, the majority of which is situated in Ukraine). According to UNFCCC's National Inventory Submissions of Greenhouse Gases, CMM from underground coal mines in Russia totaled 1.8 billion m^3 in 2005 (UNFCCC, 2009). The Kuzbass accounts for 78 percent of CMM reserves located in former Union of Soviet Socialist Republics (USSR), and the Pechora Basin accounts for 12 percent (Uglemetan, 2004a). Data from 2008 collected by IPKON RAN[2] estimates 1.5 billion m^3 of CMM from these two coal basins alone (IEA, 2009).

Methane emissions from all Russian coal mines are summarized in Table 30-4. The Kuzbass had 47 active mines in 2003 (Tailakov, 2003) and their methane emissions are quantified in Table 30-5. The data in these tables may vary from the U.S. EPA data presented in the Executive Summary due to differences in inventory methodology and rounding of digits.

Table 30-4. Russia's CMM Emissions (million cubic meters)

Emission Category	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Underground coal mines	3325.80	2090.97	1688.20	1780.28	1639.55	1743.92	1845.21	1886.34	2047.22	2028.11
Post-underground mine	0.51	0.32	0.26	0.28	0.26	0.28	0.29	0.31	0.32	0.32
Surface mines	1381.08	958.56	1059.45	1103.61	1059.45	1154.05	1147.75	1229.73	1267.56	1299.10
Post-surface mine	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	4707.40	3049.86	2747.92	2884.17	2699.26	2898.26	2993.25	3116.37	3315.10	3327.53

Source: UNFCCC (2009)

Table 30-5. Kuzbass CMM Emissions (million cubic meters)

Emission Category	1990	1991	1992	1993	1994	1995	1996
Underground coal mines – ventilation emissions	860.5	797.1	774.7	761.3	704.5	627.7	704.5
Post-underground emissions	31.3	24.1	25.9	23	21.3	20.9	19
Surface mine emission (total)	376.3	407	269.2	248.1	239.4	249.5	251.8

Emission Category	1997	1998	1999	2000	2001	2002
Underground coal mines – ventilation emissions	627.7	1399	1483	1458	1446	1443
Post-underground emissions	18.8	16.4	–	–	–	–
Surface mine emission (total)	266	294	–	–	–	–

Source: Tailakov (2005a)

Methane drainage was first initiated in the Kuzbass in 1951 and in the Pechora basin in 1956 (at the Severnaya, Komsomolsksya, Vorkutinskaya, and Zapolyarnaya mines). Degasification, however, reached its peak in 1990 when many of these mines had to shut down due to financial losses. The mines in the Pechora basin vented 289.8 million m^3 of methane in 1998 (RRR, 2001). In 2000, vented methane in the

[2] Research Institute of Comprehensive Exploitation of Mineral Resources at the Russian Academy of Sciences

Pechora basin decreased to 42.05 million m^3 (Uglemetan, 2005). The wide disparity between the ventilation emissions was the result of mine closures between 1998 and 2000. In 1998, the seven Pechora basin mines had an average degasification efficiency of about 0.5. By 2000, three of the mines in the basin were closed and only Severnaya, Komsomolsksya, Vorkutinskaya, and Zapolyarnaya mines have continued mining operations. The average degasification efficiency of those mines is significantly higher, accounting for degasification efficiency of 0.7 on average, resulting in more drainage and less ventilation emissions in 2000.

In recent years, the rate of methane recovery from CMM drainage has been roughly 27–30 percent on average, with only 25 percent of active mines utilizing degasification system as of 2009. As of 2008, total methane drained from mines in the Kuzbaas and Pechora basins was estimated to be 320 million m^3. Being drained primarily for the purpose of safety, the recovered methane has typically been of poor concentration (less than 25 percent). Currently, only methane drained from the Vorkuta mines in the Pechora basin is being used for boiler fuel (40 million m^3 in 2006) (IEA, 2009).

The following CMM-related activities are underway in Russia:

- CMM project potential is being studied by the not-for-profit organization Uglemetan and by ICF Consulting Ltd. Their joint involvement resulted in a United Nations Development Program/Global Environment Facility project titled "Russian Federation - Removing Barriers for CMM Recovery & Utilization," which started in 2003 and is scheduled to end in December 2010. The expected project financing will amount to about US$11 million. The project aims to mitigate greenhouse gas (GHG) emissions by removing barriers to implementing and financing CMM recovery and utilization projects in Russia. Its initial focus is on the Kuzbass region, with replication potential expected in other coal-producing areas in Russia and elsewhere (Uglemetan, 2010).
- Plans for a CMM project at active underground mines in Prokopyevsk, Kuzbass are in development. The recovered methane is intended for use in boilers for heat generation. The potential methane reduction is estimated to be 2.0 million m^3 or 29,346 million tons carbon dioxide equivalent ($MmtCO_2e$) (M2M, 2010).

30.2.2 CMM Emissions from Abandoned Coal Mines

There are 43 abandoned mines in the Kuzbass, 39 of which are monitored for methane concentrations. Methane is registered at 32 mines, 14 of which have dangerous levels of methane gas and five with methane concentrations that could be explosive (Uglemetan, 2005).

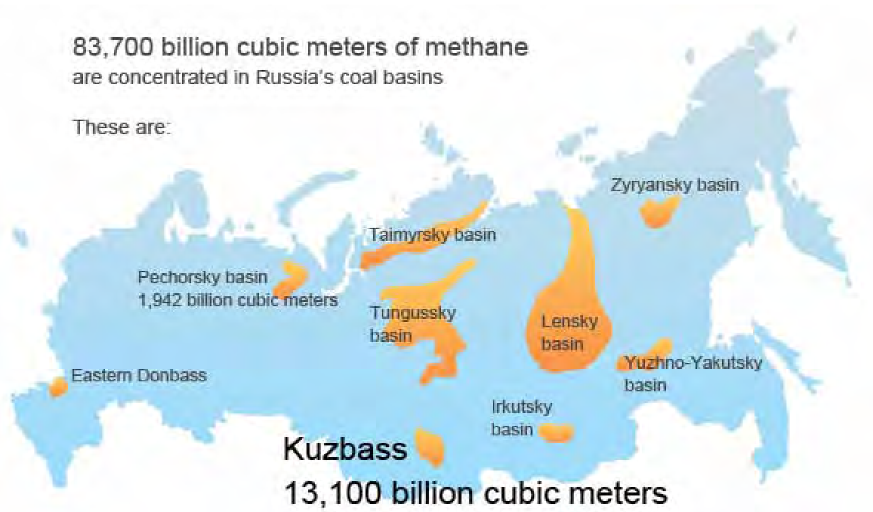
30.2.3 CBM from Virgin Coal Seams

Russia is estimated to have significant coalbed methane (CBM) resources – 75–80 trillion m^3 in coal seams, with the Kuzbass basin providing possibly one of the largest CBM resource development opportunities in the world. Gazprom estimates 13.1 trillion m^3 of CBM in Kuzbass (see Figure 30-2), accessible at 1,800–2,000 meter (m) depth (Gazprom, 2010). Another source estimates Kuzbass CBM resources to be 94 billion m^3 in active degasification areas and 120 billion m^3 in areas where degasification is expected to be conducted in the future, for a total of 214 billion m^3 (M2M Workshop – Russia, 2005). The Pechora basin's CBM resource is estimated at 2.26 to 3.40 trillion m^3, but the area's harsh climate may limit exploitation of this resource. Overall CBM resource is estimated at 48 trillion m^3. The breakdown for individual basins is provided in Table 30-6 (M2M Symposium, 2006). It is estimated that if appropriate technology is deployed and if an economic environment favorable for CBM is created, Russian CBM production could increase to up to 2 billion m^3 per year (M2M Workshop – Russia, 2005).

Table 30-6. Estimate of CBM Resources

Basin	CBM Resources (trillion cubic meters)
Kuzbass	13.085
Pechora	1.942
Eastern Donbass	0.097
South Yakutia	0.92
Ziryank	0.099
Tunguska	20.0
Lensk	6.0
Taymir	5.5
Total resources	47.643

Figure 30-2. CBM Distribution in the Kuzbass Basin in Russia



Source: Gazprom (2010)

The following activities are promoting CBM development in Russia:

- Gazprom is running a pilot operation at eight exploratory wells in Taldinskoye field in the Kuzbaas basin. The recovered CBM is being supplied to gas filling stations. Gazprom aims to reach 4.0 billion m^3 of CBM production from expanded operations by 2021. The project was initiated in 2003, when Gazprom implemented a pilot well drilling program to assess the feasibility of establishing a new CBM-based fuel and energy complex in southern West Siberia, and to identify priority areas in the Kuzbass for CBM/CMM development (Gazprom, 2010).
- In early 2005, the Rosnauka (a.k.a. Federal Agency for Science and Innovation [FASI]), a federal agency in the Ministry of Science and Higher Education, began an effort to accelerate CBM/CMM development projects to improve mine safety and reduce GHG emissions. This activity involved improving stimulation techniques to enhance methane desorption and drainage, improving methane production and utilization technologies, organizing a scientific and educational center for CBM/CMM development and coordinating same with foreign experts, and

developing a CBM/CMM business plan (M2M Partnership – Beijing, 2006). FASI was disbanded as an independent agency in March 2010 but its operations were rolled back into the Ministry (ERAWATCH, 2010). One of FASI's projects, which started in 2007, is a joint operation with private industry (Siberian Coal Energy Company) and implemented by the IPKON RAN research institute. The project will develop operating procedures for CMM recovery for use in gassy mines. The procedures will conform to the Kyoto Protocol, increase productivity of coal seams with high gas content, and use CMM to generate electricity, heat, and emission reductions for carbon trading (IEA, 2009). The project is on-going and will be used as a model for future projects.

- The Uglemetan International Coal & Methane Research Center works actively to promote the development of CBM recovery in Russia by providing information and assistance to interested companies and government agencies. The non-profit organization was formed in 2002 expressly for this purpose.

30.3 Opportunities and Challenges to Greater CMM Recovery and Use

It was Russia's ratification of the Kyoto Protocol that brought it into force worldwide in 2004 (see Table 30-7). Russia has accepted a GHG emission reduction target of 15–25 percent by 2020, with 1990 as its baseline emissions (UNFCCC, 2010a). As an Annex I country, Russia is eligible to host Joint Implementation (JI) projects. On May 28, 2007, Directive No. 332 enabled full participation in JI projects. Russia's Economic Development and Trade Ministry is coordinating the JI program. Under the directive, companies planning to implement JI projects must apply for approval from the Ministry; applications will be accepted through December 31, 2012. In January 2007, the Trade Ministry also drafted general regulations on the JI program and emission credits trading (USEPA, 2007). Currently, Russia is actively working to fulfill requirements to be eligible for JI Track 1 projects[3] and International Emissions Trading, which would hugely incentivize CMM and CBM development in the country.

Table 30-7. Russia's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC	June 13, 1992	December 28, 1994
Kyoto Protocol	March 11, 1999	November 18, 2004

Source: UNFCCC (2010b); UNFCCC (2010c)

30.3.1 Market and Infrastructure Factors

Table 30-8 lists total consumption by potential CMM markets in Kuzbass. According to a 2009 report, CMM recovery and utilization is a huge economic opportunity in Russia and estimates US$130 million in revenue if all of its 1.9 billion m^3 CMM were to be recovered and used (based on 2008 regulated wholesale natural gas prices in Russia) (IEA, 2009). However, safety concerns would remain the principal driver for CMM projects.

[3] Track 1 procedure for JI projects voids the need for external verification in reporting of emission reduction units by the project host country.

Table 30-8. Total Consumption by Potential CMM Markets

Market	Electrical Power (million kilowatt hours)	Thermal Power (thousand Gcal)	Natural Gas (million cubic meters)
All sectors*	21,343	31,113	3,010
Industry	18,387	23,940	2,971
Fuel industry	4,385	5,570	N/A

Source: *Tailakov (2005b)

Russia has many barriers to expanded CMM/CBM development. First, CMM and CBM must compete with large, in-country proven gas resources with low-cost production capacity. Second, state regulations keep the large gas supply at a low sale price, making it difficult for a CMM project to achieve financial viability. In 2009, the wholesale natural gas price was US$70 per 1,000 m^3 (IEA, 2009), which is relatively cheap compared to other energy sources. Further, power generation projects are not financially viable; the price per kWhr of electrical power for industrial entities ranges from 0.43 to 0.98 RUR. Coal prices (for ROM D-grade coal) vary from 450 to 600 RUR without a value-added tax (VAT). Third, the region lacks the technological capability to extract CBM economically from saturated, low-permeability coal seams (M2M Workshop-Russia, 2005).

However, there are many positive aspects that favor CMM development in Russia. Mining and geological conditions are similar to those in Australia, Canada, and the United States. Further, expected CBM production rates are promising and natural gas infrastructure and markets exist within 20–100 km of high-priority CBM/CMM production areas (M2M Workshop-Russia, 2005). Also, Russia is working toward establishing a favorable legislative climate for CMM development (see below).

30.3.2 Regulatory Information

CBM, like any other mineral resource in Russia, is owned by the state. A license is required for methane extraction. There are three types of licenses: exploration license, production license, and combined license. The license is applied for at the Territorial Authority representing the Federal Ministry of Natural Resources, which publishes a tender announcement. The tender is held with a minimum starting price determined by the Federal Agency and it typically takes about a year to obtain a license. As for CMM, licensing for ownership and use currently lacks clarity, which hinders investments from third parties looking to utilize the recovered gas. Licensing processes for CMM activities are also unclear. While an additional license is not required for CMM recovered from and used within the mine, new mineral extraction licenses are needed if the recovered CMM is sold to another party or used for heat and power generation that is sold to another party (IEA, 2009).

Russia offers significant opportunity for foreign investment in CMM projects because of its large CMM resources and a significant market for clean energy. Although rules and regulations on foreign investment in Russia are complex, the investment climate is improving (Tailakov, 2005c). CMM projects are expected to be pursued through Production Sharing Agreements (PSAs), which provide exemptions from all federal taxes with the exception of certain payments for subsoil use, a modified profits tax, VAT and excise on domestic purchases, and unified social tax during the period of PSA validity (Uglemetan, 2004b). Methane extraction from virgin seams and sale is taxed at 7 percent and is subject to a single license fee. There are no royalties if methane is used for the mine's onsite needs. Uglemetan, as an organization devoted to the promotion of CMM and CBM development projects, provides investors with the latest information on the current investment climate in Russia.

Russian mines are subject to safety regulations, but lack the resources to ensure their enforcement. A "Guide for Safe Operation of CMM Energy Units" has been prepared by the local mine safety institute in

Kuzbass to provide guidelines to coal mines for the safe installation of CMM recovery and utilization systems. According to the regulations, drained gas must have a minimum methane concentration of 30 percent to ensure that it is not within the explosive range. In addition, the regulations cover various aspects of flame safety (e.g., using flame arresters), but Kuzbass mines do not flare gas emissions at this time (Tailakov, 2005c).

Russia's recent regulatory and energy market developments are poised to stimulate CMM utilization on a larger scale. Initiatives such as a government decision on gradual price increases for natural gas for industrial and residential users, liberalization of the electricity market, and renewable energy targets inclusive of CMM will facilitate the creation of a market where CMM could become competitive with other energy sources. The Decree on Main State Policy Areas to Increase the Energy Supply from Renewable Power Generation by 2020, passed in January 2009, has specifically incentivized CMM recovery and use by setting targets for increased share of renewable energy—inclusive of CMM—in the electric power supply. More supporting regulations and clarity are needed though to further leverage this legislation for CMM development (IEA, 2009).

30.4 Profiles of Individual Mines

Baidaevskaya Mine, Kuzbass

Total no. of coal seams: 24

Thickness of mined seams: Average – 3.31 m; Range 2.6–3.7 m

Overburden: Thickness – 50 m ; No. of seams – 8–17

Coal reserves: 92.5 million tonnes

Coal quality and rank:	Ash (%): 24.7	Sulfur (%): 0.44
	Heating Value (kcal/kg): 8,343	Volatile Matter (%): 39.5
	Moisture (%): 5.4	Rank: high volatile bituminous

Chertinskaya Mine, Kuzbass

Total no. of coal seams: 4

Thickness of mined seams: Average – 2.14 m; Range 1.5–3.0 m

Overburden: Thickness – 50–365 m ; No. of seams – N/A

Coal reserves: 70.5 million tonnes

Coal quality and rank:	Ash (%): 29.5	Sulfur (%): 0.30
	Heating Value (kcal/kg): 8,370	Volatile Matter (%): 38.8
	Moisture (%): 6.6	Rank: high volatile bituminous

Source: USEPA (1996)

Although mining and methane emissions and recovery data is outdated, geologic profiles on more coal mines are available in "Reducing Methane Emissions from Coal Mines in Russia: A Handbook for Expanding Coalbed Methane Recovery and Use in the Kuznetsk Coal Basin" at http://www.epa.gov/cmop/docs/int005.pdf (USEPA, 1996).

30.5 References

Coal (2008): Coal International, Mining and Quarry Operating Companies Worldwide Database, accessed February 2008. http://www.quarryworld.co.uk/minesquarries.php

EIA (2007a): Russia Country Analysis Brief, U.S. Energy information Administration, Washington, DC. July 2007. http://www.eia.doe.gov/emeu/cabs/Russia/Background.html

EIA (2007b): Data obtained from International Energy Annual 2005. U.S. Energy Information Administration, Washington, DC, table posted June 21, 2007. http://www.eia.doe.gov/pub/international/iea2005/table82.xls (reserves).

EIA (2008a): International Energy Statistics, Coal Exports, U.S. Energy Information Administration, 2008. http://tonto.eia.doe.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=1&pid=1&aid=4

EIA (2008b): U.S. Energy information Administration Independent Statistics and Analysis, Russia, 2008. http://www.eia.doe.gov/emeu/cabs/Russia/Coal.html

ERAWATCH (2010): National Profile – Russian Federation, ERAWATCH, 2010. http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.content&topicID=619&parentID=44&countryCode=RU

IEA (2007a): Share of total primary energy supply in 2007, IEA Energy Statistics, International Energy Agency, 2007. http://www.iea.org/stats/pdf_graphs/RUTPESPI.pdf

IEA (2007b): Coal and Peat in Russian Federation, International Energy Agency, 2007. http://www.iea.org/Textbase/stats/coaldata.asp?COUNTRY_CODE=RU

IEA (2009): Coal Mine Methane in Russia, International Energy Agency, 2009. http://www.iea.org/papers/2009/cmm_russia.pdf

Gazprom (2010): Russian Forecasted CBM Resources, Gazprom, 2010. http://www.gazprom.com/production/extraction/metan/

Lawson (2002): An Introduction of the Russian Coal Industry, Peter Lawson, Marshall Miller and Associates, 2002. http://www.mma1.com/company/pdf/papers/An%20Introduction%20of%20the%20Russian%20Coal%20Industry.pdf

M2M Partnership (2007): Coal Mine Projects in Mexico, Methane to Markets Partnership Expo: A Forum for Projects, Technology, Financing and Policy — Project Opportunity Posters and Flyers, Methane to Markets Partnership, October 30 to November 1, 2007. http://www.methanetomarkets.org/expo_china07/coal.htm

M2M Partnership – Beijing (2006): Report on Participation by Developing/Transitional Countries, Regional Workshop Beijing, PRC, Methane to Markets Partnership, January 2006. http://methanetomarkets.org/documents/events_coal_20060525_beijing.pdf

M2M Projects (2008): Methane to Markets International Coal Mine Methane Projects Database, Methane to Markets. 2008. http://www2.ergweb.com/cmm/index.aspx

M2M Projects (2010): Methane to Markets International Coal Mine Methane Projects Database, Methane to Markets, 2010. http://www.methanetomarkets.org/projects/projectDetail.aspx?ID=1085

M2M Symposium (2006): Methane Recovery and Utilization from Coal Seams in Russia. The Present State of Affairs, Coal Mines Subcommittee Meeting and the 2006 International Coal Bed Methane (CBM) Symposium, 2006. http://www.methanetomarkets.org/documents/events_coal_20060525_russia.pdf http://www.methanetomarkets.org/events/2006/coal/docs/russia.pdf

M2M Workshop-Russia (2005): Current state and prospective of CMM/CBM production and utilization in Russia, Nikolay M. Storonskiy, Ph.D., Deputy Director of PROMGAZ, Methane-to-Markets Partnership Technical Workshop, Beijing, China, December 2, 2005.

Malyshev (2000): Fundamental’no prikladnye metody reshenija problemy metana ugol’nyh plastov (Fundamental and Applied Methods in Solving the Problem of Coalbed Methane), Malyshev Y., Trubetskoj K., Ajruni, A, information provided by Oleg Tailakov of International Coal & Methane Research Center – Uglemetan, 2000.

RRR (2001): Data obtained during a visit to the Pechora Basin, Raven Ridge Resources, September 11–13, 2001.

Tailakov (2003); Coal Mine Methane Emissions Reduction Projects in Kuzbass: Selection of Methane Utilization Options, Economical Efficiency Assessments and Finance Sources, Oleg Tailakov, et al., Third International Methane & Nitrous Oxide Mitigation Conference, Beijing, China, November 17–21, 2003. http://www.coalinfo.net.cn/coalbed/meeting/2203/papers/coal-mining/CM053.pdf

Tailakov (2005a): Rosinformugol Information Bulletin, Oleg Tailakov, International Coal & Methane Research Center – Uglemetan, 2005.

Tailakov (2005b): Opportunities and Barriers for CMM Development: A Perspective from Developing Countries and Transition Economies (Part II), Oleg Tailakov, International Coal & Methane Research Center, 2005. http://methanetomarkets.org/documents/events_coal_20041115_tailakov.pdf

Tailakov (2005c): Information provided by Oleg Tailakov, International Coal & Methane Research Center – Uglemetan, 2005.

Uglemetan (2004a): White Paper - Status of Coalbed Methane Recovery and Utilization in FSU, International Coal & Methane Research Center - Uglemetan

Uglemetan (2004b): White Paper - Russian Coal Mine Methane Foreign Investment Issues part 1, International Coal & Methane Research Center - Uglemetan

Uglemetan (2005): Report by Kuzbass Monitoring Center for Industrial and Ecological Safety (1 qtr 2005). Information compiled by Oleg Tailakov of NPO International Coal & Methane Research Center – Uglemetan, 2005.

Uglemetan (2010): Russia - Removing Barriers to Coal Mine Methane Recovery and Utilization, International Coal & Methane Research Center – Uglemetan, 2010. http://www.uglemetan.ru/undp.htm

UNFCCC (2009): Russian Federation National Inventory Report 2009, United Nations Framework Convention on Climate Change, Annex I Party GHG Inventory Submission, September 11, 2009. http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/4771.php

UNFCCC (2010a): Quantified economy-wide emissions target, United Nations Framework Convention on Climate Change, 2010. http://unfccc.int/home/items/5264.php

UNFCCC (2010b): United Nations Framework Convention on Climate Change - Status of Ratification, 2010. http://unfccc.int/essential_background/convention/status_of_ratification/items/2631.php

UNFCCC (2010c): Kyoto Protocol - Status of Ratification, 2010. http://unfccc.int/kyoto_protocol/status_of_ratification/items/2613.php

U.S. Congress (1994): *Fueling Reform: Energy Technologies for the Former East Bloc*, U.S. Congress, Office of Technology Assessment, Washington, DC, July 1994. http://govinfo.library.unt.edu/ota/Ota_1/DATA/1994/9411.PDF

USEPA (1996): Reducing Methane Emissions from Coal Mines in Russia: A Handbook for Expanding Coalbed Methane Recovery and Use in the Kuznetsk Coal Basin, U.S. Environmental Protection Agency, Coalbed Methane Outreach Program, September 1996. http://www.epa.gov/cmop/docs/int005.pdf

USEPA (2007): Russian Government Enables JI Projects, Coalbed Methane Outreach Program International News, June 21, 2007. http://epa.gov/coalbed/newsroom/international_2007.html

USGS (2007): 2007 Minerals Yearbook – Russia, U.S. Geological Survey, June 2010. http://minerals.usgs.gov/minerals/pubs/country/2007/myb3-2007-rs.pdf

Yuzhannikova (2008): Personal communication with Nadia Yuzhannikova, McKinsey & Company, May 15, 2008.

31 SOUTH AFRICA

31.1 Summary of Coal Industry

31.1.1 ROLE OF COAL IN SOUTH AFRICA

South Africa is the world's seventh largest coal producer and dominates the African coal industry, producing 250 million tonnes (Mmt) of coal in 2009 (BP, 2010). It is the third largest coal exporter in the world (GCIS 2010), and responsible for about 99 percent of all coal production in Africa (BP, 2010). South Africa's coal resources are estimated at 115 billion tonnes, based on a survey conducted in 1987 (DME, 2010a). As seen in Table 31-1, its reserves are estimated at about 30.4 billion tonnes which consist almost entirely of hard coals (i.e., anthracite and bituminous) (BP, 2010).

Table 31-1. South Africa's Coal Reserves and Production

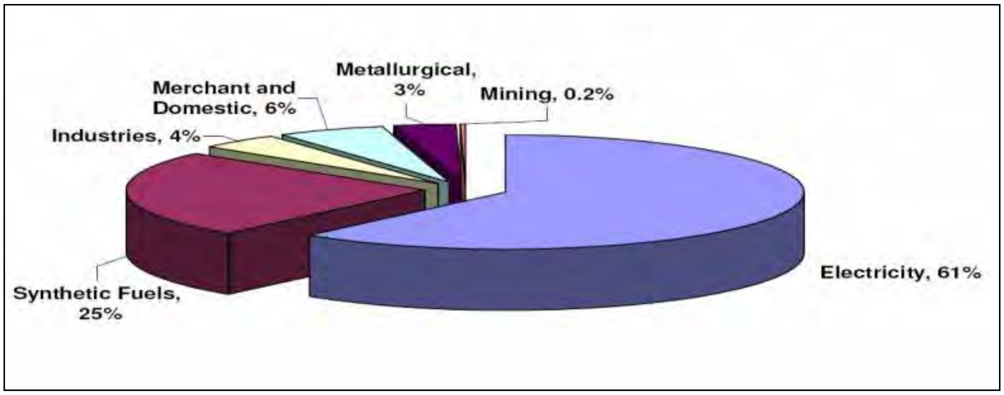
Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2009)	30,408	0	30,408	8 (3.7%)
Annual Coal Production (2009)	250	0	250	7 (4.1%)

Source: BP (2010)

Coal is the primary fuel produced and consumed in South Africa, accounting for 72 percent of total primary energy supply in 2007 (IEA, 2009). Three quarters of its production is consumed internally and one quarter is exported to the European Union and East Asia (EIA, 2010). The industrial sector, including mining, consumed 4.2 percent, the metallurgical industry used 3 percent, and merchants bought 6 percent of domestic coal (Figure 31-1) (DME, 2008). Internal consumption is primarily for electric power generation (about 61 percent of locally sold coal in 2007). The second most important use is conversion to synthetic liquid petrol and diesel fuels (25 percent).

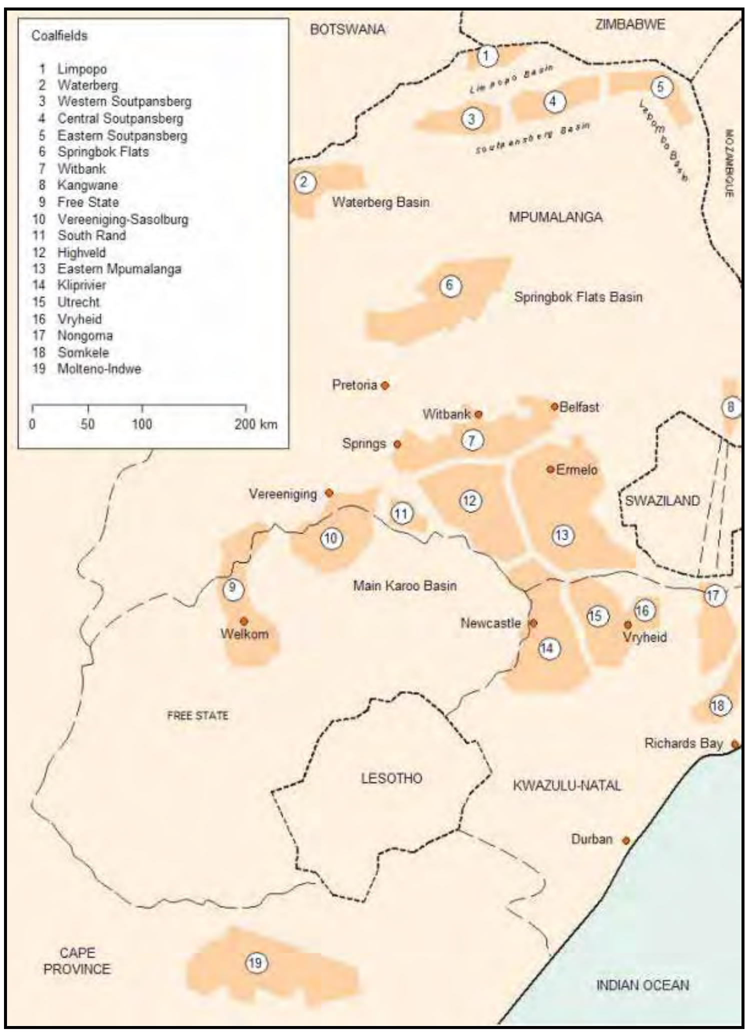
Figure 31-2 illustrates the distribution of coal deposits in the country. Seventy percent of South Africa's recoverable coal reserves lie in the Highveld, Waterberg, and Witbank fields. The great bulk of the coal reserves are concentrated in 19 Karoo (Permian) coalfields in the Mpumalanga region of the country and underlay an area of about 115,000 square miles (EIA, 2005).

Figure 31-1. South Africa's Domestic Coal Consumption by Sector



Source: DME (2008)

Figure 31-2. South Africa's Coal Basins

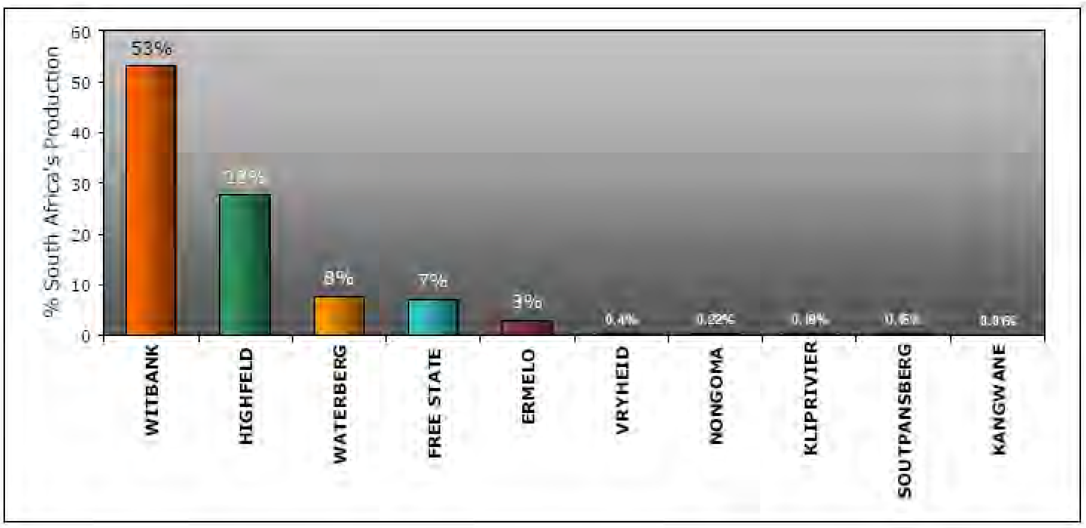


Source: Walker (2000)

In 2007, South Africa's production of bituminous coal increased by 0.5 Mmt (0.2 percent) and exports by 1.4 Mmt (2.1 percent). Due to very high international prices, revenue from exports increased by 11.9 percent. South African coal was exported to 34 countries in 2007, of which 84.5 percent went to European nations, with Great Britain, Spain, France and Germany as the largest customers. South Africa's coal exports to Europe decreased by 3.5 percent, but exports to the Middle and the Far East increased from 7 percent of total exports in 2006 to 11.8 percent in 2007, with South African coal exports to India increasing by 403 percent (DME, 2008).

In 2007, South Africa's run-of-mine (ROM) coal production was 312.3 Mmt, 236 kt less than in 2006. Some 247.6 Mmt of this production were of saleable quality (DME, 2008). ROM output for 2006 by coalfield is illustrated in Figure 31-3 (Ntlou, 2008). As seen in the figure, the Witbank Coalfield remains the largest producer, followed by the Highveld Coalfield, both in the Central Basin. They produced more than 80 percent of the total country's output for 2006 (Ntlou, 2008).

Figure 31-3. 2006 Coalfields Run-of-Mine Production

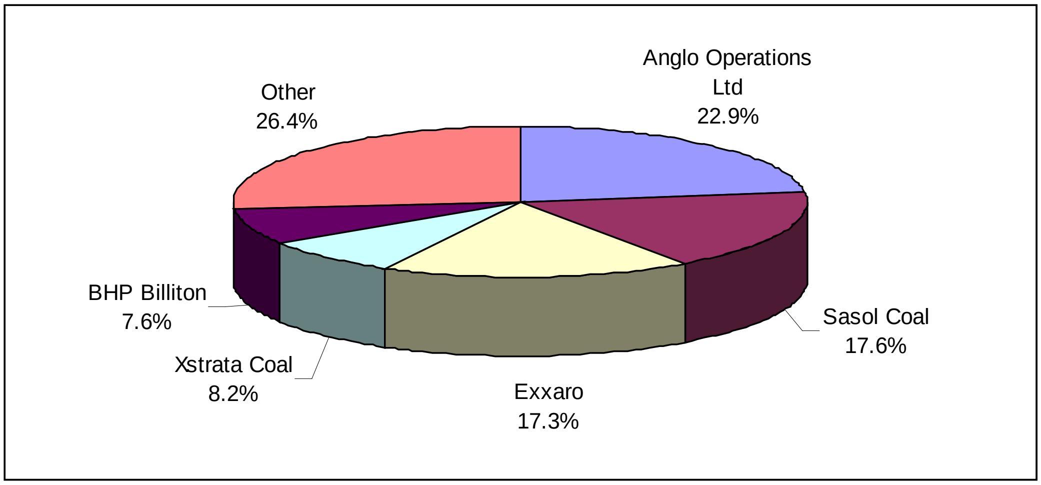


Field	Witbank	Highfeld	Waterberg	Free State	Ermelo
Production (Mmt)	174	70	36	19	11
Field	Kliprivier	Nongoma	Vryheid	Soutpansberg	Kangwane
Production (Mmt)	1.5	0.7	0.6	0.3	0.01

Source: Ntlou (2008)

In 2008, almost 74 percent of the saleable coal production was supplied by mines controlled by the five largest mining groups: Anglo Coal, BHP Billiton, Exxaro, Sasol, and Xstrata (see Figure 31-4) (CM, 2008).

Figure 31-4. 2008 Saleable Coal Production by Mining Company



Source: CM (2008)

31.1.2 STAKEHOLDERS

The coal mine methane (CMM) industry has significant potential to develop as deeper, gassier seams are targeted for mining. Table 31-2 lists potential stakeholders in CMM development in South Africa.

Table 31-2. Key Stakeholders in South Africa's CMM Industry

Stakeholder Category	Stakeholder	Role
Mining companies	▪ Ingwe Colliers Limited ▪ Anglo Coal ▪ Xstrata ▪ Eyesizwe ▪ SASOL ▪ Exxaro Coal	Project host
Government Groups	▪ Department of Minerals and Energy	Licensing
Developers and Consultancy	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Project opportunity identification, planning and technical assistance
Organizations	▪ Chamber of Mines of South Africa ▪ South African Mining Development Association	
Universities, Research Establishments	▪ (See Table 26-6)	

Source: DME (2010a, 2010b)

31.1.3 STATUS OF COAL AND THE COAL MINING INDUSTRY

There are currently 93 operating coal mines as per recent statistics for coal mining in South Africa (see Table 31-3). Forty operations use only surface mines, 18 combine surface and underground mining operations, and 35 are solely underground mining operations. (DME, 2009). About 47 percent of South Africa's coal production is from underground mines and about 53 percent is from surface mines (GCIS, 2009).

Table 31-3. South Africa's Recent Production and Mine Statistics

Type of mine	Production (million tonnes)	Number of mines
Underground	NA	35 (2008)
Opencast / Surface	NA	40 (2008)
Combined Opencast and Underground	NA	18 (2008)
Total production	239.3 (2003)	93 (2008)

Source: DME (2009)

The coal mining industry is operated by private companies. Increasingly these companies are consolidating and multinational coal mining companies are joining large domestic companies. Forty-two companies currently operate coal mines in South Africa (DME, 2009), although only six companies—Anglo Coal, BHP Billiton, Kumba Resources, SASOL Mining, Exxaro Coal and Xstrata Coal—are responsible for about 90 percent of the country's saleable coal production. The eight largest mines account for 61 percent of output (GCIS, 2009).

Asset sales have been conducted to achieve government-set targets for black ownership under South Africa's black economic empowerment program (BEE). For example, South Africa's procurement policies for Eskom, the parastatal electric utility, grant preferences to companies owned by previously disadvantaged communities. In November 2000, Anglo Coal and Ingwe sold assets for US$222 million to the black empowerment group Eyesizwe Coal, creating what was at the time South Africa's fourth largest coal mining company. Subsequent deals included the splitting of Kumba resources and the formation of Exxaro Resources, which contains assets from both Kumba and Eyesizwe (DME, 2008b). Exxaro is now the largest black mining firm and the fourth largest coal producer in South Africa (DME, 2006).

Future new coal developments are expected to be located mainly in the northern provinces of Limpopo and Mpumalanga. Anglo and Sasol began operation of the Kriel South coalfield, Mpumalanga province in 2005 and produces 5.0 Mmt per year (Anglo, 2005). Coal of Africa (COA, 2009) is progressing with plans for two mines in the Limpopo province, which at full capacity will produce a total of 10 Mmt per year (combined investment US$755 million). ESKOM estimate that 40 new mines will be necessary over the next decade to produce enough coal to fuel future electricity demand (SAinfo, 2009).

The percentage of operating mines considered "gassy" is very low. It is estimated that in the shallower fields, methane loss could have approached 80 percent of initial gas content in the coalification process (UNFCCC, 2000). However, newer underground mines that may be developed in deeper zones are likely to be gassier.

31.2 Overview of CMM Emissions and Development Potential

In the mid-1990s, South Africa was ranked as one of the world's top five CMM emitters attributable to its high coal production and estimates placed the gas content of South Africa's coals on a par with Australia's. Since then, it has been shown that these original estimates were overstated. In 2008, its rank in worldwide CMM emissions dropped to ninth with estimated emissions of almost 10 million tonnes of carbon dioxide equivalent (MmtCO_2e) (EPA, 2008).

The Global Methane Initiative (formerly Methane to Markets Partnership) International CMM Projects Database currently identifies one CMM recovery project in South Africa (M2M Projects, 2010). The recovery project is a flaring project at Anglo American Thermal Coal's New Denmark colliery near Standerton. The operation involves the incorporation of two enclosed Swiss-designed mobile flares into the mine's methane drainage system. A small diesel blower delivers the methane to four flaring nozzles, where the gas is mixed with air to a concentration that enables it to be safely burnt. The process can be monitored remotely via the flare's solar-powered communication system. The project reportedly cost US$1.2 million and the project developers are pursuing carbon credits under the Clean Development Mechanism (Creamer, 2010).

31.2.1 CMM Emissions from Operating Mines

A national greenhouse gas (GHG) inventory for South Africa was initially prepared for the years 1990–1994 for South Africa's First National Communication Report to the UNFCCC, published in 2000. Work is currently underway by the Climate Change Division of the Department of Environmental Affairs and Tourism (DEAT) to design a process and approach for preparation of an updated inventory (DEAT, 2010).

In the energy sector, fugitive emissions contributed 323 gigagrams (Gg) (475 million cubic meters [m^3]) of methane in 1990 and 327 Gg (481 million m^3) in 1994, which represents about 16 percent of the total methane emissions. In 1990, methane emissions from coal mining contributed almost 100 percent of the fugitive emissions and 97 percent in 1994 when emissions from natural gas processing were included in the total. Of the coal mining fugitive emissions, 88 percent were from underground mines (UNFCCC, 2000). Methane emissions for South Africa are summarized in Table 31-4.

Table 31-4. South Africa's CMM Emissions (million cubic meters)

Emission Category	1990	1994	1995	2000	2005	2010	2015
Underground coal mines – drained emissions	418	423					
Surface mine emissions (total)	57	58					
Total emitted (= Total liberated – recovered & used)	471*	-	466*	495*	519*	520*	521*

Source: UNFCCC (2000); *USEPA (2006) – estimates and projections

A detailed industry-funded study, *Coal Tech 2020*, was conducted in 2004, to more accurately assess South Africa's CMM emissions. This study, conducted by the Council for Scientific and Industrial Research (CSIR), measured ventilation air methane concentrations from most major mines (USEPA, 2004a). The final report is only available to CoalTech members, but a summary of its principal results by study participants Alan Cooke and Philip Lloyd provides key insights as to South Africa's likely CMM emissions levels. An excerpt from their findings is provided below in Figure 31-5.

Figure 31-5. *Coal Tech 2020* Summary Results

During the course of this work most of the production shafts on underground mines have been sampled repeatedly. In total there were 243 measurements of methane in the return air from 27 different shafts. As we have seen, a wide scatter was observed, but taken as a whole the results give us some measure of the quantities involved. For each shaft the average methane concentration was multiplied by the known ventilation rate, which gave a contribution to the total methane emission of 40.8 Gg CH_4/a (with an error of ±30.2 Gg).

Seam gas contents had been determined for about 72% of the coal production. Assuming 50% was lost underground, and contributed to the methane in the return air, and that the mines for which data were missing were represented by the mines for which there was data, then the total lost after leaving underground mines was about 28.6 Gg CH_4/a (with an error of about 24 Gg).

Thus the best present estimate of the release of methane from South African coalmines is:

- 40.8 Gg CH_4/a in ventilation air from underground mines;
- 28.6 Gg CH_4/a from coal after it has left the mine; and
- <3 Gg CH_4/a from surface mining operations,

or approximately 72 Gg/a.

However, there are very large errors associated with these estimates. The source of these errors is largely the physical processes responsible for the release of much of the methane from South African coalmines, particularly the sporadic release of free methane. This causes huge fluctuations in the measurable concentrations of methane in the return air. To improve the estimates will require effectively continuous measurements over several weeks on each shaft. Further errors arise from the considerable variation in the seam gas content of the coal, and it will require repeated measurements of the residual gas in coal coming from underground in each mine before these errors can be reduced significantly.

Source: Excerpted from Lloyd and Cook (2004)

The coal seams of the main Karoo coalfields—being relatively shallow—are generally not regarded as being very gassy. Accordingly, little attention has been paid to CMM recovery and end-use. There are, however, several individual examples of gassy mines in South Africa. The most noted example is the Majuba Colliery, which has experienced higher than expected levels of methane in the mine workings. Gas desorption tests showed that the coal contains up to 300 cubic feet per ton. In the early 1990s, several in-mine horizontal wells were drilled to degasify the coal in advance of mining. The mine operators were contemplating various CMM drainage and end-use scenarios, but the mine was eventually closed due to other reasons (USEPA, 2004b).

Some South African mines have been known to drain methane prior to mining through surface holes and the feasibility of recovering this methane for use in local heating has been widely investigated (UNFCCC, 2000).

31.2.2 CMM Emissions from Abandoned Mines

South Africa has a number of abandoned coal mines, the number of operating mines having declined by about one half between 1986 and 2004 (Limpitlaw and Aken, 2005). No data quantifying emissions from abandoned mines in South Africa were found. However, the percentage of gassy mines is thought to be low as most of the gassy areas of South Africa's coal resources have not yet been developed. It does not appear that any company is currently extracting methane resources from abandoned mines. Key barriers are legal and regulatory constraints; many companies are concerned that once they have received a mine closure certificate, further work in and around the mine could expose them to legal liabilities.

31.2.3 CBM FROM VIRGIN COAL SEAMS

The country's coalbed methane (CBM) resource is estimated to be 0.14–0.28 trillion m^3. Currently there is no commercial CBM production reported for South Africa; however, there is significant discussion about possible future projects, and several pilot wells have been installed and are undergoing testing. Moreover, adoption of CBM/CMM technologies could become increasingly likely as additional mines are expected to open in gassy coal fields.

The most promising areas for CBM are the deeper, thicker, and gassier coal resources. The Waterberg Basin in the northwest Mpumalanga region of the country and the southwest portion of the Highveld coalfield near Paardekop-Amersfoort are deeper (> 1,000 feet) and gassier (4–10 m^3/tonne at 1000–1200 ft) and appear to have the best potential for CBM development (ARI, 1992).

Anglo Coal has been conducting a CBM exploration program in the Waterberg Basin for the past several years. As part of this program, a series of core wells were drilled and tested and a five-well pilot production project is currently underway. Barriers to project progress include its remote location, delays in rights conversions, lack of prior experience among government authorities, and lack of incentives (DME, 2006; Merwe, 2007). Other CBM licenses are held by Badimo, NT Energy Africa, Molopo/Highland Energy, Msix, and numerous smaller companies, but little work has been done to date.

While there is only one active CMM recovery and end-use activity in South Africa, there are several reports from the gold mining sector of companies utilizing methane coming from gold mine shafts. For example, at the Harmony Gold Mine in the Free State province, the kitchen stoves and bath houses were fueled by captured mine methane for more than 20 years (USEPA, 2004b). The Beatrix Gold Mine, also in the Free State province, has applied for a methane capture project under the Clean Development Mechanism (CDM) of the Kyoto Protocol (Le Roux, 2007). Methane emanates from faults and fissures intersected during normal mining operations and a pipeline drainage system is currently being installed to capture the methane at source underground and transport it to the surface where the gas will be flared (Creamer, 2010b). The mine estimates that for an initial outlay of US$5.5 million, US$27 million in carbon credits will be earned over 7 years through flaring alone, with resultant emission reductions estimated to be 2.6 $MmtCO_2e$. Plans are also in place to begin construction of a methane-fueled 5 megawatt (MW) power plant in 2011.

31.3 Opportunities and Challenges to Greater CMM Recovery and Use

As reflected in Table 31-5, South Africa is a signatory to both the UNFCCC and the Kyoto Protocol. As a non-Annex 1 country, South Africa is eligible to host CDM projects that reduce GHG emissions. Carbon credits could be available if South Africa reduces total emissions below 1990 levels (USEPA, 1998).

Table 31-5. South Africa's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC	June 15, 1993	August 8, 1997
Kyoto Protocol	---	July 31, 2002 (Accession)

Source: UNFCCC (2004); UNFCCC (2005)

31.3.1 MARKET AND INFRASTRUCTURE FACTORS

Significant research and development (R&D) organizations exist in South Africa to assist in the assessment of CMM emissions, recovery potential, and technology. Coaltech 2020 is an industry-led consortium of coal mine research and technology organizations (see Table 31-6).

Table 31-6. Coaltech 2020 Consortium Members

Anglo Coal	Kumba Resources
CSIR Mining Technology	National Union of Mineworkers (NUM)
Department of Minerals and Energy (DME)	National Research Foundation (NRF)
Department of Trade and Industry (DTI-THRIP)	Sasol Coal
Xstrata (producer)	The Chamber of Mines of South Africa
Eskom (state utility)	Total
Eyesizwe	University of Pretoria
Ingwe	University of Witwatersrand*

*Note: The University of Witwatersrand has for more than a decade conducted research on coal seam gas content, gas emission rates, permeability, and other coal properties (Schwochow, 1997).

The potential end uses for CMM in South Africa include electric power generation, boiler fuel, transportation fuel, and petrochemical feedstocks. CMM could offset or reduce growing requirements for gas imports to meet growing gas demand. It could also provide an effective fuel substitute for coal and firewood.

Where mines are shallow and less gassy, collected CMM could be used for local heating purposes, but infrastructure would be required. In new areas, where virgin seams are deeper and gassier, CBM development could precede mining. Higher gas volumes from CBM and subsequent CMM in commercial quantities would require infrastructure investments for development of deeper mines, installation of gas collection technologies, and construction of gas pipelines to move the methane to markets.

Evidence of the gas potential in South African coals has evolved from a long record of gas-related mine explosions. Mines experience problems with gas and dust explosions and fires because the coals are hard and highly prone to sparking, as are the sandstone roof rocks. The proportion of mine deaths related to explosions increased from 3 percent in 1955 to 21 percent in 1993 (Schwochow, 1997).

31.3.2 REGULATORY INFORMATION

In South Africa, CBM is defined by law as a unique mineral, so rights to its exploration and development can be separate from those of coal in the same seam. Under the latest Minerals Act, all mineral rights are vested with the government. Companies that held mineral rights under old orders, however, can apply for an extension to retain those rights. Technically, development licenses are required by law after commercially successful exploration, but many mines currently operate under exploration licenses. Licensing requirements and applications are available for review on the Department of Minerals and Energy's website (www.dme.gov.za).

Electricity, petroleum pipelines, and piped gas including CBM are regulated by the independent National Energy Regulator of South Africa (NERSA), which—among other things—issues licenses for construction and operation of gas transmission, storage, distribution, liquefaction, and re-gasification facilities (Gas Act, 2001). The piped gas industry is regulated by the Gas Act as amended by the National Energy Regulatory Act, which was brought into operation in 2005. Prior to 2005, the gas industry was not regulated and companies had to negotiate a regulatory agreement with the South African Government. The Piped-Gas Regulations Act came into effect in 2007. The Act is continuously reviewed by NERSA with the aim of suggesting possible amendments to the Minister of Minerals and Energy should these be deemed necessary (NERSA, 2009).

31.4 Profiles of Individual Mines

A comprehensive inventory of coal mines and coal production in South Africa can be found on the DME website (DME, 2010c). Detailed spreadsheets of mines and contact information are also available online at http://www.dme.gov.za. Profiles for individual mines are not available.

31.5 References

Anglo (2005): Production starts at Anglo American's Isibonelo coal mine in South Africa. AngloAmerican press releases, July 2005. http://www.angloamerican.com/aal/media/releases/2005pr/2005-07-04/

ARI (1992): Coalbed Gas -2: Vast Resource Potential Exists in Many Countries, Kuuskraa, Vello A., and Jonathan R. Kelafant., *Oil & Gas Journal*, November 2, 1992. (Reprint)

BP (2010): Statistical Review of World Energy June 2010. http://www.bp.com/productlanding.do?categoryId=6929&contentId=7044622

CM (2008): Facts and Figures 2008. Chamber of Mines of South Africa. http://www.bullion.org.za/Publications/Facts&Figures2008/Text2008.pdf

COA (2009). Coal of Africa Limited, Annual Report 2009. http://www.coalofafrica.com/-Annual-Reports-.html

Creamer (2010). "Methane flaring mitigating climate change – Anglo Thermal Coal." Mining Weekly, 12 May 2010. http://www.miningweekly.com/article/methane-flaring-mitigating-climate-change-anglo-thermal-coal-2010-05-12

Creamer (2010b). "Gold Fields turns killer-gas methane curse into R200m Beatrix revenue stream." Mining Weekly, 26 May 2010. http://www.miningweekly.com/article/gold-fields-turns-killer-gas-methane-curse-into-r200m-beatrix-revenue-stream-2010-05-26

DEAT (2010): National Greenhouse Gas Inventory - Department of Environmental Affairs and Tourism climate change web page. Accessed July 2010. http://www.environment.gov.za/ClimateChange2005/National_Greenhouse_Gas_Inventory.htm

DME (2005a): "Aggregate Energy Balances" South Africa Department of Minerals and Energy, 2005, http://www.dme.gov.za/energy/documents.stm#6..

DME (2006): South Africa's Mineral Industry 2005/2006. South Africa Department of Minerals and Energy, 2006

DME (2008); South Africa's Mineral Industry 2007/2008. South Africa Department of Minerals and Energy, 2007. http://www.dme.gov.za/pdfs/minerals/SAMI%202007%202008.pdf

DME (2009): Operating Mines and Quarries and Minerals Processing Plants in the Republic of South Africa, 2009. Pretoria: South Africa Department of Minerals and Energy, 2009. Also available online at http://www.dme.gov.za/pdfs/minerals/D1%20Information%202009.pdf

DME (2010): "Aggregate Energy Balances" South Africa Department of Minerals and Energy, 2006. Accessed 16 June 2010. http://www.dme.gov.za/pdfs/energy/statistics/Me/Ag.xls

DME (2010a): "Coal" South Africa Department of Minerals and Energy, http://www.dme.gov.za/energy/coal.stm

DME (2010b): "Overview of the Minerals Industry," South Africa Department of Minerals and Energy, http://www.dme.gov.za/minerals/mineral_info.stm

DME (2010c): "Mineral Directories," South Africa Department of Minerals and Energy, http://www.dme.gov.za/minerals/minerals_information.stm

Dykes (2006): Information provided by Arthur Dykes, advisor to NERSA, 2006.

EIA (2007): Data obtained from *International Energy Annual 2005*. U.S. Energy Information Administration, Washington, DC, table posted June 21, 2007 at http://www.eia.doe.gov/pub/international/iea2006/table82.xls (reserves)

EIA (2010): U.S. Energy Information Administration, "South Africa Country Analysis Brief" March, 2010. http://www.eia.doe.gov/emeu/cabs/South_Africa/Coal.html

Gas Act (2001): Act No. 48 of 2001, Published in the Government Gazette of the Republic of South Africa. February 21, 2002.

GCIS (2009): *South Africa Yearbook 2008/2009 – Minerals, Energy and Geology*. Government Communication and Information System, 2009. http://www.gcis.gov.za/resource_centre/sa_info/yearbook/index.html

Hill (2007): "Government Teams up with Private Firm to Develop New Methane Projects," *Mining Weekly Online*, Mathew Hill, Dec 2007. http://www.engineeringnews.co.za/article.php?a_id=123548

IEA (2005): *International Energy Agency Energy Statistics – Coal*. International Energy Agency, Paris, France, table posted at http://www.iea.org/Textbase/country/index.asp

IEA (2009): International Energy Agency Energy Statistics – Share of total primary energy supply in 2007. International Energy Agency , Paris France. Accessed 15 June 2010. http://www.iea.org/stats/pdf_graphs/ZATPESPI.pdf

IEA (2010): International Energy Agency Energy Statistics – Coal and Peat in South Africa in 2007. International Energy Agency , Paris France. Accessed 14 June 2010. http://www.iea.org/stats/coaldata.asp?COUNTRY_CODE=ZA

Limpitlaw and Aken (2005): "Post Mining Rehabilitation, Land Use, and Pollution at Colliers in South Africa, Presented at the Colloquium: Sustainable Development in the Life of Coal Mining, Boksburg, 13 July, 2005. http://www.csmi.co.za/library_research/papers/2005/Post_mining_landuse_Collieries_jul05.pdf

Le Roux (2007); "Gold Mine Pursues Carbon Credits for Methane Capture," *Mining Weekly Online*, Helene Le Roux, May 2007. http://www.miningweekly.com/article/gold-mine-pursues-carbon-credits-for-methane-capture-2007-05-04

Lloyd and Cook (2004): Methane Release from South African Coal Mines, Lloyd, Philip and Alan Cook, http://www.erc.uct.ac.za/publications/Methane%20release%20from%20South%20African%20coal%20mines.pdf

M2M Projects (2010): Methane to Markets International Coal Mine Methane Projects Database, Methane to Markets, accessed July 2010. http://www2.ergweb.com/cmm/index.aspx

Merwe (2007): "Interest in Coal Bed Methane on the Increase," Mining Weekly Online. Christy van der Merwe, March 2007. http://www.miningweekly.com/article/interest-in-coalbed-methane-on-the-increase-2007-03-16

NERSA (2009): NERSA Annual Report for 2008/09. http://www.nersa.org.za/Admin/Document/Editor/file/News%20and%20Publications/Publications/Current%20Issues/NERSA%20Annual%20Report%202009.pdf

SAinfo (2009): South Africa 'needs 40 new coal mines'. August, 2009. http://www.southafrica.info/news/business/832012.htm

Schwochow (1997): The International Coal Seam Gas Report, Cairn Point Publishing, Steve Schwochow, editor, 1997

UNFCCC (2000): South Africa "Initial National Communication to UN Framework Convention on Climate Change," October 2000, p.77. http://unfccc.int/resource/docs/natc/zafnc01.pdf

UNFCCC (2004): United Nations Framework Convention on Climate Change - Status of Ratification, May 24, 2004, http://unfccc.int/resource/conv/ratlist.pdf

UNFCCC (2005): Kyoto Protocol - Status of Ratification, September 19, 2005, http://unfccc.int/files/essential_background/kyoto_protocol/application/pdf/kpstats.pdf

USEPA (1998): "South Africa Country Fact Sheet" World Bank / U.S. EPA Seminar and Roundtable on Coalbed Methane Development Potential, September 1998.

USEPA (2004a); Coalbed Methane Outreach Program South Africa Trip Report, March 1–13, 2004

USEPA (2004b): International Activities – South Africa, U.S. Environmental Protection Agency, Coalbed Methane Outreach Program.

USEPA (2006): *Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990–2020*, Draft, U.S. Environmental Protection Agency, Office of Atmospheric Programs, Climate Change Division, June, 2006. Available at http://www.epa.gov/nonco2/econ-inv/international.html.

USEPA (2008): Coal Mine Methane Project Development: Global Update. Presentation by Franklin, P., at the UNECE Ad Hoc Group of Experts on CMM, Geneva, October 2008. http://www.unece.org/energy/se/pdfs/cmm/4ahge_cmm/4_Franklin.pdf

32 SPAIN

32.1 Summary of Coal Industry

32.1.1 ROLE OF COAL IN SPAIN

Spain has experienced significant industrialization since the 1970s, spurred on by its European Union (EU) membership in 1986. These factors have contributed to a 100 percent increase in energy demand since the mid-1970s. Spain depends upon imports for the bulk of its energy needs (EIA, 2005). Coal (inclusive of peat) represented about 13.9 percent of the nation's primary energy supply in 2007 (IEA, 2007), with domestic coal supplying less than half of the nation's coal demand (EIA, 2010).

Coal is Spain's most plentiful indigenous energy source, with reserves estimated at 530 million tonnes (Mmt). In 2004, Spain produced 20.5 Mmt of coal, while consuming 44.2 Mmt, relying on imports for the balance (EIA, 2005). Overall coal consumption has remained relatively flat over the past decade, with Spain's electricity sector constituting the largest share. Table 32-1 summarizes Spain's coal reserves and production.

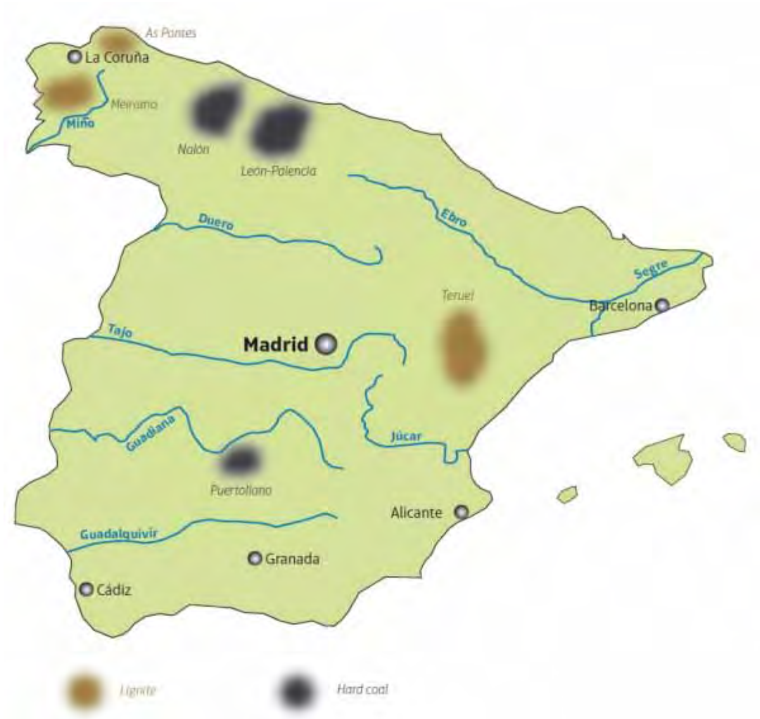
Table 32-1. Spain's Coal Reserves and Production

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2006)*	200	330	530	22 (0.1%)
Annual Coal Production (2007)**	7.8	9.2	17	19 (0.28%)

Source: *EIA (2008); **IEA (2007)

Spain's hard coal mining occurs primarily in northwestern Spain in Asturias, Castilla-León, Aragón, and León-Palencia, and also in the southern areas of Ciudad Real and Cordoba. The important opencast operations are located in Aragón, Ciudad Real, and at the border between Asturias and León. Teruel has the largest sub-bituminous coal reserves in the country, while most of the lignite is located in Galicia (see Figure 32-1). In recent years, mines of all sizes are at risk of closure because of high coal production costs (EURACOAL, 2007).

Figure 32-1. Spain's Coal Fields



Source: EURACOAL (2007)

32.1.2 Stakeholders

Table 32-2 lists Spain's key stakeholders in the development of coal mine methane (CMM) industry.

Table 32-2. Key Stakeholders in Spain's CMM Industry

Stakeholder Category	Stakeholder	Role
Mining Companies	▪ HUNOSA ▪ ENDESA (Empresa Nacional de Electricidad S.A.)	Project host
Developers	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Project opportunity identification and planning
Engineering, Consultancy, and Related Services	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Technical assistance
Universities/Research Establishments	▪ Instituto Geologico y Minero de Espagne	Technical assistance
Government Groups	▪ Ministry of Industry, Tourism, and Commerce – Directorate of Power Policy and Mines	Regulatory

32.1.3 Status of Coal and the Coal Mining Industry

Government-owned companies produce most of the coal in Spain. The single largest company is Empresa Nacional Hulleras del Norte, S.A. (abbreviated as HUNOSA) (EIA, 2005); HUNOSA is owned by the government through the Sociedad Estatal de Participaciones Industriales holding company. HUNOSA was founded in 1967 to direct most of Spain's coal mining, and it gradually took over the larger coal companies.

Endesa is the largest power generating and distributing company in Spain, with more than 21,600 megawatts (MW) of installed generating capacity. The majority of Endesa's generating capacity is supplied by coal-fired plants (42 percent), followed by nuclear (28 percent).

Similar to other EU members, Spain's coal industry has struggled to remain competitive vis-à-vis imported coal and other energy sources. The National Energy Plan (Plan Energético Nacional or PEN), the basic statement of official energy policy first formulated in 1978, was revised in 1983 to cover the 1984–93 period and aimed at a rationalization of energy consumption and a reduction in Spain's dependence on imported energy. Since 1970, about 100 subsurface coal mines have been closed. In line with the energy rationalization policies set by PEN, the government sought to increase the efficiency of the coal mining sector by closing down high-cost mines and by providing financial aid for the industry's modernization. To encourage the cement and other industries to convert from oil to coal, the government allowed them to import duty-free coal. The government also made efforts to substitute the use of oil for coal in urban areas.

In 1997, a 1998–2005 "Plan for the Future of Coal Mining" was negotiated and signed by the government, the Trade Union Confederation of Workers' Commissions (Comisiones Obreras, CC.OO), and the General Workers' Confederation (Unión General de Trabajadores, UGT) (ES9707119N). The plan provided for the progressive reduction of public aid to the industry, a 30 percent reduction in production (to be introduced gradually), a plan for the regeneration of mining areas, and a 30 percent reduction in employment (from 25,000 to 18,000 jobs) from 1997 to 2005. Under the plan, production would fall from 18 Mmt nationwide in 1997 to 13 Mmt in 2005 (Eironline, 2003).

As the trend is toward decreasing coal extraction, ENDESA is gearing to increase its coal production at its hard coal operations in Puertollano, near Cordoba. Spain is, of late, exploring increasing coal production as it has several power plants in the pipeline (EURACOAL, 2007).

Table 32-3 summarizes Spain's coal mining industry. There are 41 companies operating mines in Spain (Energia, 2004), with more companies being consolidated as the restructuring is progressing. Hard coal production continues to decline in favor of increased production from lignite.

Table 32-3. Spain's Coal Mines

Type of Mine	Production (million tonnes)	Number of Mines
Underground (active)	10.81 (2003)	NA
Surface (active)	13.43 (2003)	NA
Abandoned underground	N/A	100+ (since 1970)

No information on the number or percentage of operating mines that are considered gassy was found.

32.2 Overview of CMM Emissions and Development Potential

The Global Methane Initiative (formerly Methane to Markets Partnership) International CMM Projects Database currently identifies no projects in Spain, in operation or development. Updates on future CMM projects in Spain can be found at http://methanetomarkets.org/projects/index.aspx.

32.2.1 CMM Emissions from Operating Mines

In 2000, it was estimated that active coal mines in Spain were emitting about 120 million cubic meters (m^3) of methane. A comprehensive evaluation of methane emissions from coal mining was initiated in 2004, but is not complete (Martinez, 2004). Table 32-4 summarizes Spain's CMM emissions.

Table 32-4. Spain's CMM Emissions (million cubic meters)

Emission Category	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008
Underground mine	102.80	79.50	62.13	54.44	50.01	50.23	46.55	43.83	43.38	40.05	30.80
Post-underground mine	17.90	17.12	19.43	16.64	18.41	17.13	16.82	16.33	16.30	16.51	12.56
Surface mine	4.44	4.42	3.71	3.83	3.90	3.62	3.83	3.43	3.31	3.14	3.13
Post-surface mine	0.47	0.58	0.67	0.67	0.78	0.68	0.79	0.76	0.66	0.76	0.64
Total	125.63	101.63	85.94	75.58	73.10	71.66	67.99	64.34	63.65	60.46	47.12

Source: UNFCCC (2010)

32.2.2 CMM Emissions from Abandoned Coal Mines

At least 100 underground coal mines have been abandoned since 1970, but emissions from none of them are being exploited (Martinez, 2004).

32.2.3 CBM from Virgin Coal Seams

A "Spanish National Inventory of Coalbed Methane (CBM) Resources" was initiated in 2002 (Martinez, 2004).

Although none of the CMM or abandoned mine methane emissions are being exploited in any coal basin, either in active or abandoned mines, future projects may emerge from the Inventory of CBM Resources (see above) and the evaluation of CMM Emissions that are currently in progress (Martinez, 2004).

32.3 Opportunities and Challenges to Greater CMM Recovery and Use

As reflected in Table 32-5, Spain ratified the Kyoto Protocol as an Annex 1 country. The country's Kyoto emission reduction target is +15 percent of its baseline emissions.

Table 32-5. Spain's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC*	June 13, 1992	December 21, 1993
Kyoto Protocol**	April 29, 1998	May 31, 2002

Source: *UNFCCC (2007a); ** UNFCCC (2007b)

32.3.1 Market and Infrastructure Factors

Spanish coal is too expensive to be competitive in a free energy market. The Spanish government has subsidized coal production, but the EU required that mining subsidies be phased out by 2002. Spain's "Plan for Coal" intends to restructure the industry, reducing production and employment in the sector, but probably will fall short of fulfilling the EU rules. The budget for coal subsidies is expected to decrease by 4 percent per year. There will be increased pressure on coal, however—as the electricity market privatizes, electricity generation will no longer be a captive market for domestic coal. Imports of foreign coal already are on the rise (NIGC/EIA, 2004).

Spain's high levels and costs of gas imports ensure a significant market for any domestically produced natural gas that can compete on a cost basis with liquid natural gas imports and other high cost gas imports. Possible end uses for CMM in Spain include electric power generation and support for mine operations.

32.3.2 Regulatory Information

Mineral resources including gas are owned by the state and licensed for production by quasi-private enterprises and private operators.

Current subsidies for coal production are being phased out. No current subsidies are known for coalbed methane or CMM production.

32.4 Profiles of Individual Mines

No individual mine profiles are available at this time for Spain.

32.5 References

EIA (2005): Spain Country Analysis 2005, U.S. Energy Information Administration. http://www.eia.doe.gov/emeu/cabs/iberian.html

EIA (2008): International Energy Annual 2006, U.S. Energy Information Administration, Washington, DC, table posted October 2008. http://www.eia.doe.gov/pub/international/iea2006/table82.xls (reserves)

EIA (2010): International Energy Statistics, U.S. Energy Information Administration, 2010. http://tonto.eia.doe.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=1&pid=7&aid=1

Eironline (2003): http://www.eiro.eurofound.eu.int/2002/03/feature/es0203208f.html

Energia (2004): La Energia en Espagna, 2004, Secretaria Generale de Energia, Ministeria de Industria, Turismo, y Comercia, 2005.

EURACOAL (2007): Spain, EURACOAL, website accessed June 25, 2010. http://www.euracoal.be/pages/layout1sp.php?idpage=81

IEA Coal Research (1983): Concise Guide to World Coalfields, IEA Coal Research, London, 1983.

IEA (2007): Coal and Peat in Spain. International Energy Agency, 2007. http://www.iea.org/stats/coaldata.asp?COUNTRY_CODE=ES

Martinez (2004): Presentation to UNECE Ad Hoc Group of Experts on Coal Mine Methane, Martinez, Roberto, Instituto Geologico y Minero de Espagne (IGME), December 6, 2004. http://www.unece.org/ie/se/pdfs/cmm/ppp09dec/IGME_Martinez_UNECECMM.pdf

NIGC/EIA (2004): Country Analysis: Western Europe: Spain, NIGC/EIA, 2004.

UNFCCC (2004): United Nations Framework Convention on Climate Change - Status of Ratification, May 24, 2004.

UNFCCC (2007a): United Nations Framework Convention on Climate Change - Status of Ratification, April 11, 2007. http://unfccc.int/files/essential_background/convention/status_of_ratification/application/pdf/unfccc_conv_rat.pdf

UNFCCC (2007b): Kyoto Protocol - Status of Ratification, September 19, 2005. http://unfccc.int/files/kyoto_protocol/background/status_of_ratification/application/pdf/kp_ratification.pdf

UNFCCC (2010): Spain National Inventory Report 2010, United Nations Framework Convention on Climate Change, Annex I Party GHG Inventory Submission, 2010. http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5270.php

USEPA (2006): *Global Anthropogenic Non-*CO_2 *Greenhouse Gas Emissions: 1990–2020*, Draft, U.S. Environmental Protection Agency, Office of Atmospheric Programs, Climate Change Division, June, 2006. http://www.epa.gov/nonco2/econ-inv/international.html

33 TURKEY

33.1 Summary of Coal Industry

33.1.1 ROLE OF COAL IN TURKEY

Coal accounts for just more than half of Turkey's total primary energy production, but it is not clear what role coal will play in Turkey's future energy makeup. Coal production and consumption has risen dramatically over the past few years, but so has the country's natural gas use as Turkey is emerging as a major energy transport hub connecting central Asia and Europe (EIA, 2009). Much of Turkey's coal is low-quality lignite.

Coal represents about 20.8 percent of Turkey's total power generation, with lignite comprising 66 percent of that or 13 percent of the total power generation (EURACOAL, 2007). The role of domestic coal is projected to increase in Turkey's primary energy supply to almost 30 percent over the next few years. As of 2007, Turkey's coal production had reached 75 million tonnes (Mmt) (EIA, 2007). In 2006, Turkey imported 16.5 Mmt hard coal for steel production, mainly from Australia, South Africa, and Russia (EURACOAL, 2007).

Table 33-1 summarizes Turkey's proved coal reserves and production.

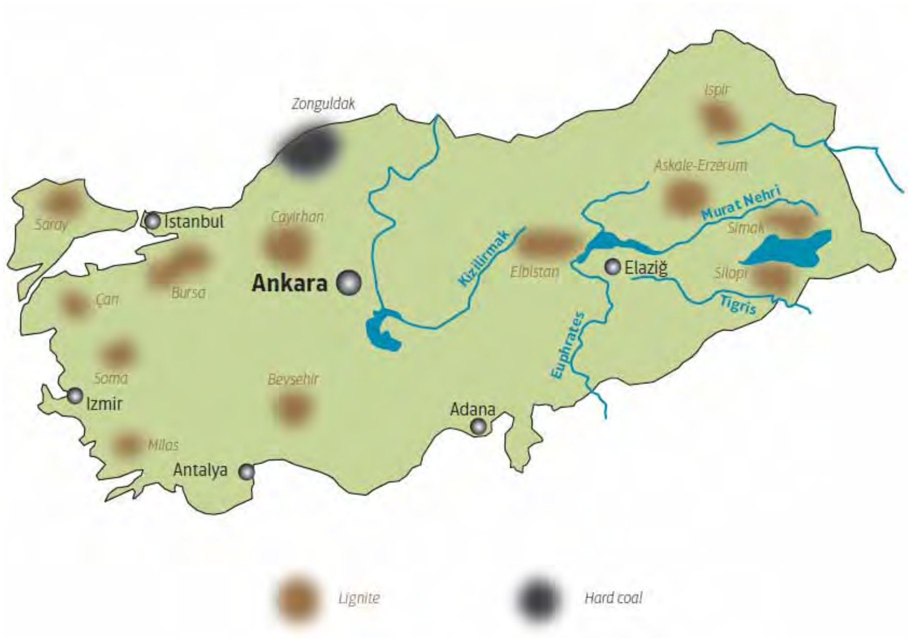
Table 33-1. Turkey's Coal Reserves and Production

Indicator	**Anthracite & Bituminous** (million tonnes)	**Sub-bituminous & Lignite** (million tonnes)	**Total** (million tonnes)	**Global Rank** (# and %)
Estimated Proved Coal Reserves (2006)	0 [†]860	1,814 [†]534	1,814	19 (0.2%)
Annual Coal Production (2007)*	2.4	72.9	75.4	11 (1.2%)

Source: EIA (2008); [†]EURACOAL (2007); *IEA (2007)

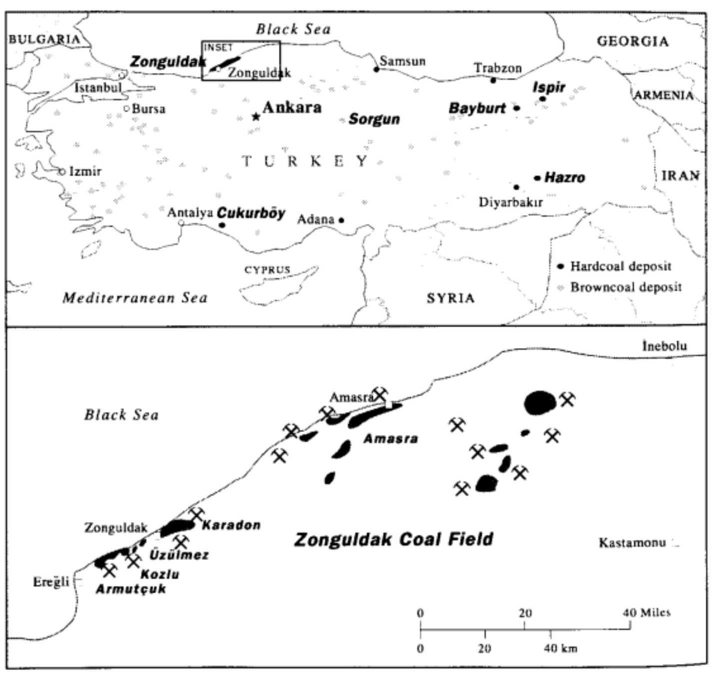
Figure 33-1 shows locations of coalfields in Turkey. Lignite deposits are widespread with proven reserves at just under 2 billion tonnes (the sixteenth largest in the world) and an estimate of total resources at 3.14 billion tonnes (EIA, 2008; EURACOAL, 2007). The Turkish Ministry of Energy and Natural Resources estimates lignite reserves at 4.6 billion tonnes (MEN, 2010a). Most of these reserves are economically mineable, though only about 7 percent has a heat content of more than 3,000 kilocalories per kilogram. About 40 percent of Turkey's lignite is in the Elbistan Basin (EIA, 2006; EURACOAL, 2007). Turkey's hard coal deposits are mostly located in the western part of the country, in the Zonguldak Basin (see Figure 33-2). Hard coal reserves vary in estimates from an insignificant amount to 860 Mmt (EURACOAL, 2007). It is estimated that about 80 percent of these reserves can be coked.

Figure 33-1. Turkey's Coal Fields



Source: EURACOAL (2007)

Figure 33-2. Turkey's Zonguldak Coal Basin



Source: Schwochow (1997)

33.1.2 STAKEHOLDERS

Table 33-2 lists potential stakeholders in Turkey's coal mine methane (CMM) industry. Other than the government-run companies, Turkish Coal Enterprise and Turkish Hard Coal Enterprise, no information on potential stakeholders was found.

Table 33-2. Key Stakeholders in Turkey's CMM Industry

Stakeholder Category	Stakeholder	Role
Mining Companies	▪ Turkish Hard Coal Enterprise (Türk Taşkömürü işletmeleri) ▪ Turkish Coal Enterprise	Project host
Government Groups	▪ Ministry of Energy and Natural Resources ▪ Organization of Aegean Lignite ▪ Turkey Hard Coal Authority ▪ Representation of Turkish Coal Enterprises	Preparation and implementation of mining and energy policies, plans and programs
Developers	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Project opportunity identification and planning
Engineering, Consultancy, and Related Services	▪ See http://www.epa.gov/coalbed/networkcontacts.html	Technical assistance

33.1.3 STATUS OF COAL AND THE COAL MINING INDUSTRY

The Turkish government has complete control over coal mines, power stations, and the grid. The Turkish Coal Enterprises (TKI) and Turkish Hard Coal Enterprises (TTK) are both government run, and the government has a defacto monopoly over coal production. TKI was established in 1957 to operate the coal mines of Turkey and it is the major brown coal producer in the country, operating approximately 40 mines. The coal is relatively low quality. TKI is also an important producer of lignite for the power plants. TTK was established in 1983 to operate hard coal mines in Zonguldak basin and is operating five deep mines as of 2007. This enterprise carries out the exploration, production, and marketing of domestic hard coal (TTK, 2010; EURACOAL, 2007).

Turkey has both active surface and underground mines. However, about 90 percent of the country's lignite production comes from surface mines (MBendi, 2010). More specific details about mines, reserves, and location of Turkey's coal can be found on an interactive Google Map developed by the Ministry of Energy and Natural Resources (MEN, 2010b).

33.2 Overview of CMM Emissions and Development Potential

The Global Methane Initiative (formerly Methane to Markets Partnership) International CMM Projects Database currently identifies no CMM projects in Turkey, in operation or in development (M2M Projects, 2010).

33.2.1 CMM EMISSIONS FROM OPERATING MINES

Limited information was found on CMM emissions from operating mines in Turkey (Table 33-3).

Table 33-3. Turkey's CMM Emissions (million cubic meters)

Emission Category	1995	2000	2004	2005	2006	2007	2008
Underground mine	38.75	41.24	33.55	37.40	39.98	42.44	44.84
Post-underground mine	NA	NA	NA	NA	NA	NA	NA
Surface mine	62.45	71.96	52.52	66.40	73.22	86.18	90.79
Post-surface mine	NA	NA	NA	NA	NA	NA	NA
Total emitted (= Total liberated – recovered & used)	101.20	113.20	86.07	103.80	113.19	128.62	135.63

Source: UNFCCC (2010a) (converted from gigagrams [Gg])

33.2.2 CMM Emissions from Abandoned Mines

No information was found on CMM emissions from abandoned mines in Turkey.

33.2.3 CBM from Virgin Coal Seams

Coalbed methane (CBM) from the Zonguldak hard coal region could play a very significant role in Turkey's energy economy. The CBM in-place resources in two districts of the Zonguldak hard coal region are presently estimated to be at least 3 trillion cubic meters (m^3) (Mustafa and Balat, 2004).

33.3 Opportunities and Challenges to Greater CMM Recovery and Use

As indicated in Table 33-4, Turkey has acceded to the UNFCCC.

Table 33-4. Turkey's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC*	---	February 24, 2004 (Accession)
Kyoto Protocol**	---	---

Source: *UNFCCC (2007); **UNFCCC (2010b)

33.3.1 Market and Infrastructure Factors

In May 2001, Turkey enacted a new Natural Gas Law. Prior to this law, most of the natural gas market and infrastructure was dominated by the Petroleum Pipeline Corporation (a.k.a., BOTAS, a state-owned company). The new gas law requires that the natural gas transmission, storage, and distribution networks be open to competition and monopolistic elements be unbundled. BOTAS still owns the majority of the transmission infrastructure and most of the market, but distribution, storage, and import is open to competition. BOTAS has begun transferring ownership of its import contracts to private entities to comply with its mandated 20 percent of total market share. Revisions to the Natural Gas Law are being debated to improve the privatization effort and to further reduce dominance of BOTAS (MONDAQ, 2010).

Although Turkey has moved toward liberalizing its coal industry and no rules ban private sector involvement, no foreign companies have made investments (Kayıkçı, 2010). Seeking to increase its domestic electricity generation, Turkey is looking to expand its domestic lignite production instead of relying on external natural gas resources. With potential for thermal power generation, Turkey has opened up six of its lignite fields to the private sector under royalty model (MBendi, 2010).

Turkey has several international natural gas lines that bring the resource into the country, which may make Turkey a major player in energy transit (EIA, 2009).

33.3.2 Regulatory Information

The Ministry of Energy and Natural Resources is the main body of the Turkish mining and energy sector, responsible for the preparation and implementation of mining and energy policies, plans and programs, in coordination with its dependent and related institutions, and other public and private entities. The Ministry's duties related to the mining sector mainly include organizing and controlling the mining license for production of in-country natural resources, in order to contribute to the economy.

There have been several updates to laws regulating mining in recent years. They have, however, been struck down in court, and licenses and permits are still regulated from one law dating back to 1985 and two others from 2005. Three licenses exist: a prospecting license, an operation license, and an operation permit (Kayıkçı, 2010).

33.4 Profiles of Individual Mines

No information profiling individual Turkish coal mines was found. Updates on future CMM projects in Turkey can be found at http://www.methanetomarkets.org/partners/index.aspx.

33.5 References

EIA (2006): Turkey, Country Briefs, U.S. Energy Information Administration, Washington, DC, October, 2006. http://www.eia.doe.gov/cabs/Turkey/Coal.html

EIA (2007): Turkey Energy Profile, U.S. Energy Information Administration, Washington, DC, website accessed June 28, 2010 at http://tonto.eia.doe.gov/country/country_energy_data.cfm?fips=TU

EIA (2008): International Energy Annual 2006. U.S. Energy Information Administration, Washington, DC, table posted October 2008. http://www.eia.doe.gov/pub/international/iea2006/table82.xls (reserves)

EIA (2009): Turkey, Country Briefs, U.S. Energy Information Administration (EIA), Washington, DC, April, 2009. http://www.eia.doe.gov/emeu/cabs/Turkey/Full.html

EURACOAL (2007): European Association for Coal and Lignite, Brussels, Belgium, website accessed June 29, 2010. http://www.euracoal.be/pages/layout1sp.php?idpage=475

IEA (2007): Coal and Peat in Turkey in 2007. International Energy Agency, Paris, France, 2010. http://iea.org/stats/coaldata.asp?COUNTRY_CODE=TR

Kayıkçı (2010): Turkey: A Brief Overview of the Licenses and Permits in the Turkish Mining Sector, Gencin Kaya Kayıkçı, June 2010, hosted by Mondaq, website accessed June 30, 2010. http://www.mondaq.com/article.asp?articleid=103124

M2M Projects (2008): Methane to Markets International Coal Mine Methane Projects Database, Methane to Markets. 2008. http://www2.ergweb.com/cmm/index.aspx

MBendi (2010): Coal Mining in Turkey – Overview, 2010. http://www.mbendi.com/indy/ming/coal/as/tr/p0005.htm

MEN (2010a): Coal, Turkey Ministry of Energy and Natural Resources, Ankara, Turkey, website accessed June 30, 2010. http://www.enerji.gov.tr/index.php?dil=tr&sf=webpages&b=komur&bn=511&hn=&nm=384&id=40692

MEN (2010b): Energy and Natural Resources Map (Enerji ve Tabii Kaynaklar Haritası), Turkey Ministry of Energy and Natural Resources, Ankara, Turkey, website accessed June 30, 2010. http://www.enerji.gov.tr/harita/santral.html#

MONDAQ (2010): Turkey: Prospective Amendments on Natural Gas Market Law in Turkey, MONDAQ, June 29, 2010. http://www.mondaq.com/article.asp?articleid=104024

Mustafa and Balat (2004): Turkey's Coal Reserves, Potential Trends and Pollution Problems of Turkey, Balat, Mustafa and Gunhan Ayar, in ENERGY EXPLORATION & EXPLOITATION, Volume 22, Number 1, 2004. http://multi-science.metapress.com/content/r79q68u863354352/fulltext.pdf

Schwochow (1997): The International Coal Seam Gas Report, Cairn Point Publishing, Steve Schwochow, editor, 1997.

TTK (2010) "Coal Production." http://www.taskomuru.gov.tr/index.php?page=sayfagoster&id=25

UNFCCC (2007): United Nations Framework Convention on Climate Change - Status of Ratification, April 11, 2007. http://unfccc.int/files/essential_background/convention/status_of_ratification/application/pdf/unfccc_conv_rat.pdf.

UNFCCC (2010a): Annex Party I 2010 Submissions, 2010. http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5270.php

UNFCCC (2010b): Kyoto Protocol - Status of Ratification, June 2010. http://unfccc.int/essential_background/convention/status_of_ratification/items/2631

34 UKRAINE

34.1 Summary of Coal Industry

34.1.1 ROLE OF COAL IN UKRAINE

Ukraine produced approximately 1 percent of total world coal production in 2007 (see Table 34-1), making it the eleventh largest producer of coal in the world (IEA, 2010; BP, 2010). BP ranked Ukraine as twelfth in production in their 2010 survey report with total production of 73.7 thousand tonnes in 2009 (BP, 2010).

Table 34-1. Ukraine's Coal Reserves and Production

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2009)*	15,351	18,522	33,873	6 (4.1%)
Annual Coal Production (2010)**	58.7	0.2	58.9	11 (1.2%)

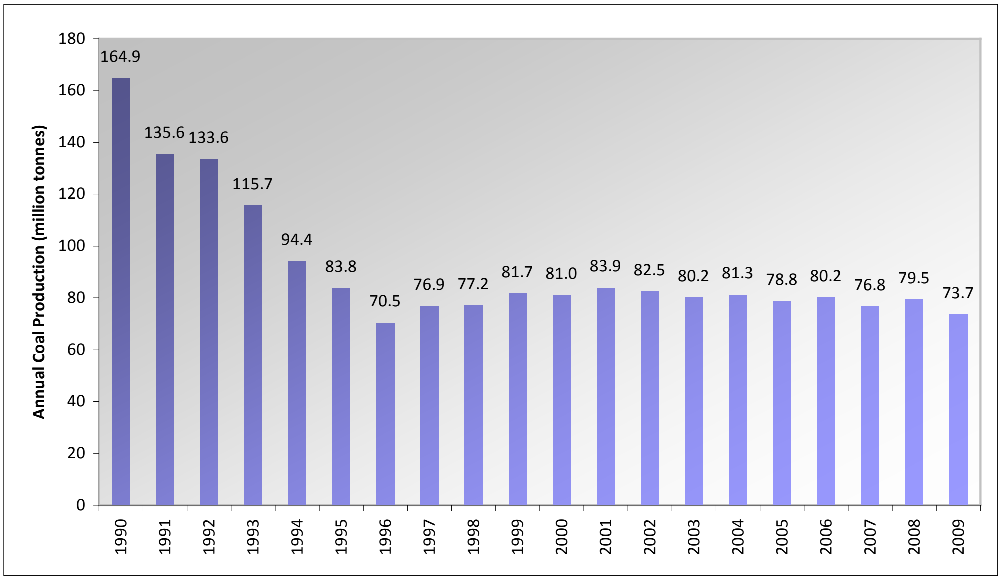
Source: *BP (2010); **IEA (2010)

In 2007, almost all of Ukraine's production was hard coal—0.2 million tonnes (Mmt) of lignite was produced comprising only 0.3 percent of total coal production (IEA, 2010). As reflected in Table 34-1, Ukraine's total coal reserves as of 2009 were 33.9 billion tonnes, of which about 15.3 billion tonnes were hard coals and 18.5 billion tonnes were soft coals (sub-bituminous and lignite) (BP, 2010). However, contrary to the data reported in Table 34-1, another estimate puts Ukraine's coal reserves total at a much higher 213 billion tonnes (M2M Workshop – Ukraine, 2005). Coal in 330 seams have been explored to a depth of 1,800 meters (m), with 130 seams exceeding 0.45 m in thickness. Only 10 seams are suitable for development with the remainder being too deep or too thin to mine (M2M Workshop – Ukraine, 2005).

It should be noted that Table 34-1 contains data on raw coal production. To understand actual coal production in Ukraine, it is more useful to consider washed coal statistics. In 2004, Ukraine produced 80.5 Mmt of raw coal but only 60 million tons of washed coal. Ukrainian coal undergoes substantial washing because of typically high levels of contaminants, which can result in as much as a 25 percent product loss (Raptsun, 2008).

Coal production in Ukraine declined significantly from 1990 to 1996, falling by more than 50 percent from 164.9 million tonnes (Mmt) in 1990 to 70.5 Mmt in 1996, as seen in Figure 34-1. Coal production has since stabilized at an approximate average of 80 Mmt per year (BP, 2010).

Figure 34-1. History of Ukraine's Coal Production



Source: BP (2010)

Ukraine remains critically reliant on coal as its primary resource for electric power generation since its domestic energy sector is plagued by limited alternative energy sources, increasing foreign debt, and outdated, inefficient equipment (PEER, 2005). In 2007, coal supplied 29.4 percent of Ukraine's total energy supply (IEA, 2009). Ukraine is not among the world's major coal exporters because of a lack of progress on deregulation. along with underinvestment in coal production leading to high coal production costs. Despite its sizeable resources, Ukraine is a net importer of coal and in 2008 imported a net 8.5 Mmt (EIA, 2010). In 2005, 45.4 percent of the country's rated generating capacity was in thermal sources (coal, oil, and gas-fired), compared to nuclear at 47.5 percent and hydroelectric at 7.0 percent (EIA, 2005). Thermal production's role has been steadily declining as nuclear generation capacity has increased. In 1998, thermal generation provided 47 percent of demand compared to hydroelectric at 12.2 percent and nuclear at 36.3 percent (WEC, 2000).

Coal is produced in two major basins in Ukraine: the Donetsk Basin (60,000 square kilometers [km^2]) in southeastern Ukraine (and western Russia) and the Lviv-Volyn basin (7,500 km^2) in western Ukraine, which continues into Poland (Sachsenhofera, 2002; M2M–Ukraine, 2005). The Donetsk Basin is commonly referred to as "the Donbass" (Figure 34-2).

Figure 34-2. Ukraine's Coal Fields

Source: PEER (2000)

34.1.2 STAKEHOLDERS

Potential stakeholders in coal mine methane (CMM) development in Ukraine are listed in Table 34-2.

Table 34-2. Key Stakeholders in Ukraine's CMM Industry

Stakeholder Category	Stakeholder	Roles
Coal associations	▪ Makeyevugol Coal Association ▪ Donugol ▪ Donetsk Regional Administration	Project host
	▪ Dobropolyengol ▪ Dobropolye ▪ Luganskugol ▪ Pervomayskugol ▪ Krasnodonugol ▪ Oktyabrugol	Potential project host
Equipment manufacturers	▪ Caterpillar, USA ▪ Zeppelin Ukraine (Ukrainian division of Caterpillar) ▪ GE Jenbacher (Austria)	Power generation equipment supplier

Stakeholder Category	Stakeholder	Roles
Developers	▪ EcoMetan ▪ EnergoImpex ▪ EuroGas (Lviv-Volyn Basin) ▪ Green Gas International ▪ See http://www.epa.gov/coalbed/networkcontacts.html	Project opportunity identification and planning
Engineering, consultancy, and related services	▪ REI Drilling (USA) ▪ Advanced Resources International Inc. (USA) ▪ See http://www.epa.gov/coalbed/networkcontacts.html	Technical assistance
Government Groups	▪ Ministry of Fuel and Energy of Ukraine ▪ Coal Industry Ministry	Project approval
Universities, Research Establishments	▪ Donetsk Coal Research Institute ▪ Ukrainian Natural Gas Research Institute ▪ Dnipropetrovsk Mining University of Ukraine ▪ National Academy of Sciences	Technical assistance

34.1.3 Status of Coal and the Coal Mining Industry

Ukraine experienced a steep decline in coal production from 1990 to 1996 (see Table 34-1), but production has since stabilized at approximately 80 Mmt annually (BP, 2010). About one-half of the production is steam coal and the remainder is coking coal. Stabilization and a slight increase in coal production resulted from the closure of uneconomical mines, increased cash receipts for coal sales, and a reduction in barter transactions. 2009 production figures were down as a result of the worldwide economic slowdown in 2008, which severely impacted Ukraine's steel industry, one of the coal industry's biggest markets. However, with current reserves sufficient to last for more than 400 years, the coal mining industry should remain stable for the foreseeable future, although commercialization and rationalization of Ukraine's coal industry has not yet been accomplished.

In 1997, a Ukraine mine closure plan was adopted that called for the closure of the most inefficient of the country's 284 active mines (PEER, 2002). By 1999, there were 244 active mines (PEER, 2001).In 2000, the number had dropped to only 232 (USEPA, 2008) and by 2005, 167 operating coal mines remained in Ukraine, of which 164 were underground and three were surface mines (UA, 2005; UNFCCC, 2007).

Most of the mines in Ukraine are underground (Table 34-3) producing bituminous coal. Ninety-two percent of the active mines in 2002 were in the Donetsk basin (all but three underground), while the remaining 8 percent were found in the Lviv-Volyn basin (PEER, 2002). The three surface mines all produce low-methane content, sub-bituminous coal or lignite (PEER, 2002).

Table 34-3. Ukraine – Number of Coal Mines by Type

Type of mine	Production (tonnes)	Number of mines
Underground (active) mines – total (2004)	79.8	164
Surface (active) mines – total (2004)	0.8	3

Source: PEER (2005); UNFCCC (2007)

In 2001, 77 percent of operating mines were considered gassy. At some mines, the natural gas content can exceed 35 cubic meters (m^3) per tonne of dry ash-free coal (PEER, 2002).

34.2 Overview of CMM Emissions and Development Potential

The Global Methane Initiative (formerly Methane to Markets Partnership) International CMM Projects Database identifies 15 CMM projects in Ukraine, involving eight active, underground mines and two surface mines in the Donbass, and one underground mine in the Lugansk basin. The methane is used for boiler fuel in five of these projects, for combined heat and power in six, and for industrial use, power generation, vehicle fuel and flaring in the remaining four projects (M2M CMM Projects, 2010). GMI's 2010 General Projects Database lists a further seven projects proposed to expand activities, and improve CMM capture and utilization (M2M Partnership, 2010).

A new CMM degasification and utilization project at the Sukhodolska-Vostochnaya Coal Mine in Krasnodon was announced by Green Gas International in February 2010. The mine currently operates at depths up to 1,000 meters and the project plans to enhance the gas drainage system to provide a steady source of methane for heat and power production for use at the mine. The project is expected to be operational by the end of 2010 and to yield an estimated 20 million m^3 per year of methane, resulting in annual greenhouse gas (GHG) reductions of 200,000–250,000 tonnes of carbon dioxide equivalent ($mtCO_2e$) (GreenGas, 2010).

34.2.1 CMM Emissions from Operating Mines

Ukraine is considered to be the world's third largest emitter of methane emissions from coal mining activities (USEPA, 2006), even though emissions have been significantly reduced by mine closures and reduced coal production (see Table 34-4). The data in this table may vary from the U.S. EPA data presented in the Executive Summary due to differences in inventory methodology and rounding.

Table 34-4. Ukraine's CMM Emissions (million cubic meters)

Emission Category	1990	1991	1992	1993	1994	1995	1996	1997	1998
Underground mining - active	3557.51	3276.00	3161.00	2615.28	2414.07	1945.49	1881.85	1839.08	1852.92
Underground - post-mining	306.41	253.07	251.81	219.87	180.82	160.20	138.05	146.72	146.72
Surface mining - active	12.79	9.91	7.97	5.72	3.68	3.16	2.19	1.97	1.93
Surface - post-mining	1.83	1.41	1.14	0.82	0.52	0.45	0.31	0.28	0.27
Total Emissions	3878.53	3540.40	3421.92	2841.69	2599.10	2109.30	2022.41	1988.05	2001.84
Additional Recovered and Flared	144.77	137.97	88.22	69.38	94.89	89.03	48.06	56.74	83.26
Emission Category	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2010***	**2015***
Underground mining - active	1819.07	2039.44	1684.68	1911.38	1864.53	1890.53	1837.13		
Underground - post-mining	157.36	156.06	163.33	160.77	156.83	159.02	154.53		
Surface mining - active	1.63	1.47	1.43	1.23	0.88	0.77	0.43		
Surface - post-mining	0.23	0.21	0.20	0.18	0.13	0.11	0.06		
Total Emissions	1978.29	2197.18	1849.65	2073.55	2022.37	2050.42	1992.14	1713.60	1663.9
Additional Recovered and Flared	78.93	72.91	134.28	152.35	148.62	150.69	146.43		

Source: UNFCCC (2007); *USEPA (2006) – estimated and projected

Another source estimates that in 2004, 1,221 million m^3 of CMM was emitted by underground coal mines, 357 million m^3 of which was drained by degasification systems and 179 million m^3 of which was utilized (M2M Workshop – Ukraine, 2005). At that time, 42 mines employed degasification. The low percentage of capture can be attributed to numerous factors, including poor degasification system maintenance and lack of investment in new degasification infrastructure.

Most of the attention to potential CMM development has focused on the Donbass due to its vast coal and methane reserves, large number of coal mines, high ranked coal deposits, and the depth of the mines, which are often in excess of 2,000 feet. Numerous projects have been conceptualized for development in Ukraine, including several for which detailed business plans were drafted. To date, however, very few have come to fruition and only a small number are being actively considered. However, the continuing evolution of new mining laws, tax benefits, privatization efforts and private domestic and multi-national collaborative efforts offer promise for increased implementation of CMM and coalbed methane (CBM) projects.

In August 2005, the U.S. Trade and Development Agency (USTDA) awarded a US$585,570 grant to the Donetsk Regional Administration to conduct a feasibility study on commercial development of CBM/CMM in the Donbass region. The project aimed to increase the domestic supply of natural gas, increase mine safety, and improve local environmental quality. The analysis focused on developing the best technical and economic approach for methane drainage at mines, evaluating the technical and economic merits of producing CMM, and assessing the most likely markets and infrastructure required to utilize CMM/CBM (USTDA, 2005). The study focused on two mines, Bazhanov and South Donbass No. 3, which were found to have average CMM emissions of 9.9 and 8.8 million m^3 per year respectively. Economic analysis suggests these emissions are sufficient to power on-site electricity generators with capacities of 1.7 megawatts (MW) and 3.3 MW. The Bazhanov mine already utilizes 5.5 million m^3 per year of drained methane in onsite boilers for heating purposes. (USTDA, 2008) The two mines are currently searching for further financial and technical assistance to move their CMM projects to the development stage (M2M Partnership, 2010).

34.2.2 CMM Emissions from Abandoned Coal Mines

Hundreds of mines have been closed and abandoned in Ukraine since the inception of its coal industry. Between 1990 and 2004, 119 underground mines were abandoned or were in the process of closure in a major effort by the state to increase mine efficiency, improve mine safety, and achieve mine profitability (UNFCCC, 2007). The mine closure rate has declined in recent years, as the government attempts to bolster national coal production with technical upgrades at coal mines rather than closure, and has investigated opening some previously closed mines (Euracoal, 2008). By some estimates, the amount of methane released by abandoned mines could be as high as 23,000 tonnes per year per km of excavated mine.

In Ukraine, 77 percent of abandoned mines are considered gassy (i.e., assuming the same percentage as active operating mines) (PEER, 2002). The number of projects at abandoned coal mines is unknown but thought to be zero at present, although several mines are being evaluated for abandoned mine methane potential.

34.2.3 CBM from Virgin Coal Seams

Ukraine's CBM resource is approximately 1.7 trillion m^3 (ARI, 1992; Thomas, 2002). The USTDA grant awarded to the Donetsk Regional Administration in 2005 aimed to assess the most likely markets and infrastructure required to utilize virgin CBM (USTDA, 2005). The study looked at the feasibility of drilling CBM wells in the areas surrounding the Bazahnov and South Donbass No. 3 mines. Multiple seams of coal are present in a section 500–900 meters (m) deep and with gas contents ranging from 15 to 20 m^3 per tonne. Markets for potential produced gas include direct pipeline sales and compressed natural gas (CNG) projects (USTDA, 2008).

EuroGas Inc. was the first foreign company to drill for CBM in 1998, but has had no commercial success. In 2008, they formed a joint venture with one of Ukraine's largest industrial holding groups to explore and develop CBM leases in east and west Ukraine, although this project is still in the planning stages (EuroGas, 2010).

Ukraine has very limited research and development (R&D) resources available for pursuing CMM or CBM research, namely lack of technology for and experience in applying hydro-fracturing to stimulate CBM production. A more favorable investment climate along with clarity on CBM ownership issues are needed before more foreign companies are likely to commit to CBM projects in Ukraine.

34.3 Opportunities and Challenges to Greater CMM Recovery and Use

Ukraine has signed and ratified both the UNFCCC and the Kyoto Protocol (see Table 34-5). As an Annex I country, Ukraine is eligible to host Joint Implementation (JI) projects.

Table 34-5. Ukraine's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC	June 11, 1992	May 13, 1997
Kyoto Protocol	March 15, 1999	April 12, 2004

Source: UNFCCC (2005); UNFCCC (2007a)

Per the Kyoto Protocol, Ukraine must stabilize greenhouse gas (GHG) emissions at the 1990 level of 55.4 million tonnes of carbon dioxide equivalent ($MmtCO_2e$). Emission reductions since 1990 due largely to coal mine closures have resulted in current estimated emissions of 28.5 $MmtCO_2e$ (UNFCCC, 2007).

34.3.1 Market and Infrastructure Factors

In Ukraine, mineral resources and mines are owned by the state. Existing mines are operated under licenses. While methane in coal is owned by the state, it is assigned to companies, mines, and individuals. CBM/CMM development is subject to the approval of the Coal Industry Ministry (M2M Workshop - Ukraine, 2005).

Most CMM that is not flared is currently used for basic applications such as boiler firing and mine air heating. There is significant potential, however, for CMM to fuel power generation in gas or dual-fuel power plants, to supplement supplies for other residential, commercial, and industrial uses, or to be converted into transportation fuel. In 2008, Ukraine imported 79.4 percent of its natural gas requirements (EIA, 2010) and so the potential markets for CMM in Ukraine are significant, especially as prices for natural gas increase. The principal barrier to expanding the use of CMM is poor market access, including the lack of modern infrastructure to gather and transport methane produced by CMM processes to internal end use markets and to existing international pipelines that serve foreign markets, mainly Western Europe.

34.3.2 Regulatory Information

The state typically owns coal mines and coal resources, including methane, but many successful mines are leased or are privatized. Approximately 25 coal mines have been privatized, which represent roughly 40 percent of Ukraine's annual coal production (IEA, 2006). The remaining mines are state owned and are referred to as Joint Stock Holding Companies (Triplett, 2006). Independent mines include the Komsomokts Donbassa Mine, the Yuzhnodonbasskaya #1 and #3 Mines, and the Zasyadko Mine.

State programs to advance CMM production, have previously relied mainly on private investment. Government support has taken the form of various tax incentives to attract investment in coal regions and exempting foreign-manufactured materials and equipment used in CMM development from Ukraine's value-added tax.

On February 22, 2006, the Ukrainian Cabinet officially approved a set of Joint Implementation procedures formally outlining the federal government's procedures for consideration, approval, and implementation for domestic companies such as coal mines to carry out JI projects under Article 6 of the Kyoto Protocol; several projects have already been submitted under these guidelines.

More recently, Ukraine has undertaken several important policy steps to promote the capture and use of CMM. On September 25, 2008, the Ukrainian Parliament passed a law on green electricity tariffs. The law provides incentives for electricity produced from alternative sources like CMM. It guarantees access to the grid for such power facilities, and it provides a special tariff for alternative power that is about twice the normal wholesale power price. When implemented, this law should help attract investment to several proposed CMM power projects in Ukraine. The National Electricity Regulatory Commission must set the specific tariff for each approved type of alternative energy for the law to become effective (USEPA, 2009a).

In early 2009, Ukraine's Parliament passed the first reading of the Law on Gas (Methane) from Coal Beds. The draft law would not allow new mines to begin operating unless they brought concentrations of methane down to acceptable levels. Existing mines would also face restrictions on releasing methane to the atmosphere. In addition, the draft law clarifies ownership issues, making it easier for third parties to obtain licenses to use vented CMM. Finally, it clarifies that CMM owners can sell their gas into the natural gas transmission system when the gas meets system requirements (USEPA, 2009a).

In June 2009, Ukrainian President Viktor Yuschenko signed important coal mine legislation that includes a tax exemption for Ukrainian CMM projects. Starting in 2010 and continuing through January 2020, profits from the production and use of CMM earned by Ukrainian enterprises will no longer be subject to taxation. Additionally, the Ukrainian National Electricity Regulatory Commission is authorized to set price limits for methane if its production is funded from the state budget. The government plans to grant state support and guarantees to the producers and suppliers of energy from CMM to help increase the production and use of methane from coal deposits (USEPA, 2009b).

34.4 Profiles of Individual Mines

Twenty-nine mines have been identified as primary opportunities for CBM/CMM development in Ukraine. These mines have been profiled in great detail by the Partnership for Energy and Environmental Reform in its *Handbook on Opportunities for Production and Investment in the Donetsk Basin* (PEER, 2001).

The Yuzhno-Donbasskaya #3 Mine is profiled below. Other updated profiles are available on the M2M website under "Projects" (M2M Partnership, 2010).

Yuzhno-Donbasskaya #3 Mine

Mine Status	Active	**Mine Owner**	Donetskya Vulgina Energetichna Kompanya
Mining Method	Longwall	**Parent Company**	State
Depth of Seams	585–940 m	**Location**	Vugledar, Donetsk
No. of Seams	2 – C_{11} & C_{10}	**2008 VAM Volume**	30.32. Million m^3
Seam Thickness	1.5–1.7 m	**2008 Drained Methane (CH_4) Volume**	2.9 Million m^3
2008 Coal Production	1.2 million tonnes	**2008 Utilized CH_4 Volume**	0

	1997	1998	1999	2000	2001	2002
Coal Production (thousand tonnes/year)	1019	1053	1224	1273	1569	1510
Methane (million m^3/year)						
Emitted from ventilation systems	15.56	23.70	15.27	12.31	31.23	49.66
Liberated from drainage systems	2.58	1.00	2.89	2.9*	2.9*	2.9*
Total Methane Emissions	18.14	24.70	18.16	15.21	34.13	52.56
	2003	**2004**	**2005**	**2006**	**2007**	**2008**
Coal Production (thousand tonnes/year)	1289	1190	1266	1200*	1200*	1200*
Methane (million m^3/year)						
Emitted from ventilation systems	46.97	53.75	47.97	35.00	32.90	30.32
Liberated from drainage systems	2.9*	2.9*	2.9*	2.9*	2.9*	2.9*
Total Methane Emissions	49.87	56.65	50.87	37.90	35.80	33.12

Source: M2M Partnership (2010)

34.5 References

ARI (1992): Hunt for Quality Basins Goes Abroad, Vello A. Kuuskraa and Jonathan R. Kelafant, in *Oil & Gas Journal*, October 5, 1992.

BP (2010): Statistical Review of World Energy June 2010. http://www.bp.com/productlanding.do?categoryId=6929&contentId=7044622

EIA (2005): Data obtained from U.S. Energy Information Administration, Washington, DC, table posted 2005 at http://www.eia.doe.gov/emeu/world/country/cntry_UP.html.

EIA (2010): Ukraine Energy Profile. U.S. Energy Information Administration (EIA), Washington, DC. http://tonto.eia.doe.gov/country/country_energy_data.cfm?fips=UP

Euracoal (2008): Ukraine – European Association for Coal and Lignite. Brussels, Belgium. http://www.euracoal.org/pages/layout1sp.php?idpage=269

EuroGas (2010): CBM & Natural Gas Joint Venture Ukraine. website accessed July 2010. http://www.eurogasinc.com/joint-venture-ukraine_85.html

Green Gas (2010). "Green Gas to provide new coal mine gas degasification and utilization system in Ukraine to eliminate methane emissions". Feb 02, 2010. Retrieved June 2010 from: http://www.greengas.net/output/NewsPage.aspx?PageID=536

IEA (2006): Ukraine: Energy Policy Review 2006, International Energy Agency, 2006, at http://www.iea.org/Textbase/publications/free_new_Desc.asp?PUBS_ID=1819

IEA (2009): IEA Energy Statistics: Share of Total Primary Energy Supply in 2007 – Ukraine. International Energy Agency, Paris, France. http://www.iea.org/stats/pdf_graphs/UATPESPI.pdf

IEA (2010): International Energy Agency Energy Statistics – Coal and Peat in Ukraine in 2007. International Energy Agency, Paris France. Accessed 14 June 2010. http://www.iea.org/stats/coaldata.asp?COUNTRY_CODE=UA

M2M Partnership (2010): Coal Mine Methane Projects in Ukraine. Methane to Markets Partnership website at http://www.methanetomarkets.org/projects/index.aspx

M2M Projects (2010): Methane to Markets International Coal Mine Methane Projects Database, Methane to Markets, 2010. http://www2.ergweb.com/cmm/index.aspx

M2M-Ukraine (2005): Ukraine Country Profile – Methane to Markets Partnership, July 2005, at www.methanetomarkets.org/events/2005/coal/docs/ukraine_profile.pdf.

M2M Workshop - Ukraine (2005): *Prospects for CBM (CMM) Industry Development in Ukraine*, V. Lukinov, National Academy of Sciences of Ukraine, presented at the Methane to Markets Regional Workshop, December 2, 2005, Beijing, China. www.methanetomarkets.org/events/2006/coal/docs/beijing.pdf.

M2M Expo (2010): Project Ideas and Activities. http://www.methanetomarkets.org/projects/index.aspx

PEER (2001): *Coal Mine Methane in Ukraine: Opportunities for Production and Investment in the Donetsk Coal Basin.* Partnership for Energy and Environmental Reform, Triplett, Jerry, Alexander Filippov, and Alexander Pisarenko, January 2001. http://www.epa.gov/cmop/docs/ukraine_handbook.pdf

PEER (2002): *Coal Mine Methane Recovery in Ukraine: Inventory of Coal Mine Methane Emissions from Ukraine 1990 – 2001*, Partnership for Energy and Environmental Reform, Triplett, Jerry, Alexander Filippov, and Alexander Pisarenko , 2002. www.epa.gov/cmop/docs/inventory2002.pdf

PEER (2005): Ukraine Energy Facts - 2005. Partnership for Energy and Environmental Reform.

Raptsun (2008): Personal communication with Mykola Raptsun, Agency for Rational Energy Use and Ecology, Kyiv, Ukraine, June 25, 2008.

Sachsenhofera (2002): The Donets Basin (Ukraine/Russia): coalification and thermal history, R. F. Sachsenhofera, et al., International Journal of Coal Geology Volume 49, Issue 1, February 2002, Pages 33–55.

Thomas (2002): *Coal Geology*, Larry Thomas, John Wiley and Sons, 2002, 384 pp.

Triplett (2006): Personal communications with Jerry Triplett, Partnership for Energy and Environmental Reform, June 13, 2006.

UA (2005): Coal Industry. Government drafting concept of coal mining industry's development throughout 2030, Web-portal of Ukrainian Government, posted May 12, 2005. http://www.kmu.gov.ua/control/en/publish/article?art_id=16592161&cat_id=2291893

UNFCCC (2005): Kyoto Protocol - Status of Ratification, February, 2005. http://unfccc.int/playground/items/5524.php

UNFCCC (2007): Ukraine National Inventory Report 2007, United Nations Framework Convention on Climate Change, Annex I Party GHG Inventory Submission, July 23, 2007. http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/3929.php (Common Reporting Format, 1990–2005, Tables 1.B.1).

UNFCCC (2007a): United Nations Framework Convention on Climate Change - Status of Ratification, August 22, 2007. http://unfccc.int/files/essential_background/convention/status_of_ratification/application/pdf/unfccc_conv_rat.pdf

USEPA (2006): *Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990–2020*, Draft, U.S. Environmental Protection Agency, Office of Atmospheric Programs, Climate Change Division, June, 2006. http://www.epa.gov/climatechange/economics/international.html

USEPA (2008): Ukraine International Page, U.S. Environmental Protection Agency, Coalbed Methane Outreach Program. http://www.epa.gov/cmop/international/ukraine.html

USEPA (2009a): Ukraine makes progress on CMM legislation and green electricity tariff. CBM Extra May 2009, pp.1–3. U.S. Environmental Protection Agency, Coalbed Methane Outreach Program. http://www.epa.gov/cmop/docs/spring_2009.pdf

USEPA (2009b): Ukraine passes coal mine methane legislation. CBM Extra September 2009, p.8. U.S. Environmental Protection Agency, Coalbed Methane Outreach Program. http://www.epa.gov/cmop/docs/september_2009.pdf

USTDA (2005): *USTDA Awards Grant For Coal Bed/Coal Mine Methane Project in Ukraine*, U.S. Trade and Development Agency Press Release, August 31, 2005. http://www.ustda.gov/USTDA/Press%20Release%20Archive/Press%20Releases/2005/Ukraine/August31_05Ukraine.htm.

USTDA (2008): Coal Mine Methane and Coalbed Methane Development in the Donetsk Region, Ukraine. U.S. Trade and Development Association, Arlington, USA. May 2008.

WEC (2000): Shidlovsky, A. and G. Pivnyak, "Restructuring the Coal Industries: Central and Eastern Europe and the CIS – Part II – Country Profiles: Ukraine," World Energy Council, 2000, p.174. http://www.worldenergy.org/publications/314.asp

35 UNITED KINGDOM

35.1 Summary of Coal Industry

35.1.1 ROLE OF COAL IN THE UNITED KINGDOM

Coal use in the United Kingdom (UK) has declined steadily since the 1980s, though the decline has not been uniform. Production and consumption has held steady in the past few years as other alternative energy sources such as natural gas have become more expensive, making coal more economically attractive. Coal still accounts for 16.9 percent of the UK's total energy needs (DECC, 2008). The bulk of coal use goes toward power generation, supplying approximately 35 percent of UK's power needs (EURACOAL, 2010). UK is the seventh largest coal importer worldwide (WCI, 2008). Its primary importer is Russia; Columbia, United States, South Africa, and Australia play minor roles (DECC, 2009a).

Ranking twentieth globally in coal production, the UK produced 16.5 million tonnes (Mmt) of coal in 2007, while holding proved reserves of 155 Mmt (Table 35-1). Coal is located in a number of regions in the UK, as shown in Table 35-2 and Figure 35-1. A more detailed map is provided by the UK Confederation of Coal Producers (UKCoalpro, nda).

Table 35-1. UK's Coal Reserves and Production

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2005)*	155	0	155	27 (0.019%)
Annual Coal Production (2007)**	16.54	0	16.54	20 (0.27%)
(2009)***			17.88	

Source: *EIA (2008); **IEA (2007); ***EIA (2010a)

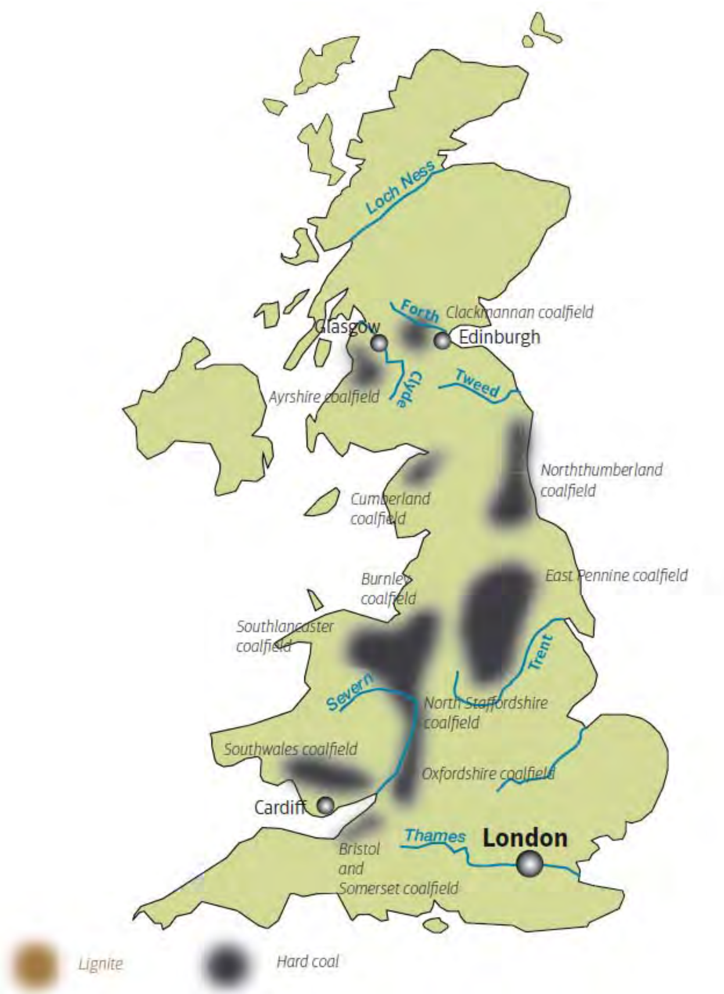
Table 35-2. UK's Coal Fields

Basin / Location	Coal Field	
Midland Valley, Southern Scotland	▪ Fife ▪ Central ▪ Lothians ▪ Firth of Forth	▪ Ayrshire ▪ Douglas ▪ Sanquhar ▪ Machrihanish
Northern England, between the Southern Uplands and Craven	▪ Canonbie ▪ Cumberland ▪ Northwest Northumberland ▪ Midgeholme	▪ Northeastern (Durham) ▪ Ballycastle ▪ Ingleton
East Pennine Basin Central England, north of the Wales	▪ Nottinghamshire ▪ Yorkshire	▪ East Lincolnshire ▪ Scarborough

Basin / Location	Coal Field	
West Pennine Basin Central England, north of the Wales	▪ Lancashire ▪ Chester Plains ▪ Anglesey ▪ North and South Staffordshire ▪ South Derbyshire ▪ Leicestershire ▪ Warwickshire	▪ Shropshire ▪ Cannock ▪ Coalbrookdale ▪ Wyre Forest ▪ Osfordshire ▪ Flintshire ▪ Denbighshire
Southern England, between the Wales-London-Brabant Massif and Variscan Tectonic Front	▪ Pembrokeshire	
Southern England, between the Wales	▪ South Wales ▪ Forest of Dean ▪ Bristol	▪ Somerset (Nailsea and Avonmouth), ▪ Berkshire ▪ Kent

Source: Schwochow (1997)

Figure 35-1. UK's Coal Fields



Source: EURACOAL (2010)

35.1.2 STAKEHOLDERS

Table 35-3 identifies potential key stakeholders in the UK's coal mine methane (CMM) development industry.

Table 35-3. Key Stakeholders in the UK's CMM Industry

Stakeholder Category	Stakeholder	Role
Mining companies	▪ ATH Resources Limited ▪ Celtic Energy ▪ Energybuild ▪ Goitre Tower Anthracite ▪ H J Banks & Company Limited ▪ J D Flack & Sons Ltd ▪ Maltby Colliery Ltd ▪ Powerfuel Plc ▪ Scottish Coal Company Ltd ▪ Scottish Resources Group ▪ The Kier Group - Kier Mining ▪ The Miller Group - Miller Argent (South Wales) Limited ▪ UK Coal Mining Limited	Project hosts
Equipment manufacturers	▪ MAN B&W Diesel ▪ Hamworthy Combustion Engineering ▪ ALSTOM Power UK ▪ Peter Brotherhood ▪ EDECO Petroleum Services	Methane treatment and utilization equipment
Developers	▪ Abmec ▪ Alkane Energy plc ▪ Clarke Energy Ltd. ▪ Coalbed Methane Ltd. ▪ Coastal Oil and Gas Ltd. ▪ Db Schenker ▪ DEUTZ UK Ltd. ▪ Edinburgh Oil & Gas plc ▪ Energy Developments (UK) Ltd. ▪ Evergreen Resources UK Ltd. ▪ Federation Of Independent Mines ▪ First Energy Ltd. ▪ GeoMet UK Ltd. ▪ Harworth Power Ltd. ▪ Mines Rescue Service Ltd ▪ Octagon Energy Ltd. ▪ R J Blasting (Scotland) Ltd ▪ Renewable Power Systems ▪ Rolls-Royce Power Ventures Ltd. ▪ Scottish and Southern Energy plc ▪ Terex Distribution Ltd ▪ The Solid Fuel Association ▪ UK Coal Mining Ltd. ▪ UK Gas Ltd.	Project opportunity identification and planning

Stakeholder Category	Stakeholder	Role
	▪ Warwick Energy Ltd. ▪ Workington Gas & Light Ltd. ▪ See http://www.epa.gov/coalbed/networkcontacts.html	
Engineering, consultancy, and related services	▪ ACA Howe International Ltd. ▪ AEA Technology Environment ▪ Cadogan Consultants Ltd. ▪ Celtic Energy Ltd. ▪ EDECO Petroleum Services Ltd. ▪ Farley Engineering Ltd. ▪ Harworth Mining Consultancy Ltd. ▪ Harworth Power Ltd. ▪ International Mining Consultants ▪ Knight Energy Services Ltd. ▪ PR Marriott Drilling Ltd. ▪ Pipeline Services Ltd. ▪ Reeves Wireline Services Ltd. ▪ Schlumberger Oilfield Services Ltd. ▪ Scientific Analysis Ltd. ▪ StrataGas plc ▪ UK Coal Mining Ltd. ▪ Wardell Armstrong ▪ WS Atkins Consultants Ltd. ▪ See http://www.epa.gov/coalbed/networkcontacts.html	Technical assistance
Universities, Research Establishments	▪ British Geological Survey ▪ Cranfield University ▪ Imperial College of Science, Technology, and Medicine (ICSTM) ▪ Loughborough University ▪ University of Cardiff ▪ University of Nottingham	Technical assistance
Regulatory Agencies and other Government Groups	▪ UK Coal Authority ▪ UK Department for Business, Innovation and Skills (BIS) ▪ Department of Energy and Climate Change	Regulation of methane rights
Other	▪ European CO_2 Network ▪ CoalPro, Confederation of UK Coal Producers ▪ The Association of Coal Mine Methane Operators (ACMMO) (defunct)	

Source: UKCoalpro (ndb); BERR/DTI (2001a); UK Nat Stats (nd)

There have been many pilot drilling projects in the UK in the last few years, but there had been no large-scale projects (Coal Authority, 2007; DECC 2010). Table 35-4 lists current licenses or agreements for coalbed methane (CBM) sites.

Table 35-4. UK's Current CBM Licenses/Agreements

Licensee	Name	Authority
Alkane Energy UK Ltd.	Glasshoughton Methane	Wakefield
	Old Mill Lane Industrial Estate	Nottinghamshire
	PPG Industries Site	Wigan

Licensee	Name	Authority
	Rexam Glassworks Site	Barnsley
Coal Bed Methane Ltd.	Arns Farm Development	Clackmannanshire
	River Forth Valley	Fife
Evergreen Resources (UK) Ltd.	Bersham (South Dee)	Wrexham
	Cronton	Knowsley
	Halewood	Knowsley
	Knowle Basin	Solihul
	Mersey Sealand	Cheshire
	Mersey Sealand Supplemental	Flintshire
	North Ouse	York
	Rhuddlan No. 1 Borehole	Denbighshire
	South Dee	Wrexham
	South Staffs	Staffordshire
	Vale of Clwyd	Denbighshire
	West Lancs	Cheshire
Nexen	Doe Green	NA
	Potteries	NA
Octagon (CBM) Ltd.	Old Boston	St. Helens
	Taff Merthyr – Penallta Project	Caerphilly

35.1.3 Status of Coal and the Coal Mining Industry

Coal production in the UK has declined steadily and dramatically over the past several decades, down 86 percent since 1980 (EIA, 2010a). UK's production was 17.6 Mmt in 2008 (DECC, 2009a).

Table 35-5. UK's Recent Coal Mine Statistics (2008)

Type of Mine	Coal Production (million tonnes)	Number of Mines
Underground (active) mines - total	8.1 (2008)	33
Surface (active) mines - total	9.5 (2008)	13

Source: DECC (2009b)

The UK coal mining industry is private but subsidized by the government's Coal Investment Aid program that was launched in June 2003. As of 2006, UK's Department of Energy and Climate Change (DECC) has reported that ₤162 million has been paid out to 26 different organizations (DECC, 2006).

Tables 35-6 and 35-7 provide information on major operating coal mines in the UK as of 2009.

Table 35-6. UK's Major Underground Mines in Production as of 2009

Licensee	Site	Location
Aardvaark TMC Ltd	Glenmuckloch	Dumfries & Galloway
(trading as ATH Resources)	Grievehill Site	East Ayrshire
	Leigh Glenmuir Site	East Ayrshire
	Muir Dean	Fife
	Skares Road	East Ayrshire

Bryn Bach Coal Ltd	Cwm Yr Onen Colliery Reclamation	Neath Port Talbot
Celtic Energy Ltd	East Pit	Neath Port Talbot
	Nant Helen	Powys
	Selar	Neath Port Talbot
Energybuild Ltd	Nant-y-Mynydd Site	Neath Port Talbot
H J Banks (Mining) Ltd	Shotton	Northumberland
Hall Construction Services Ltd	Wilsontown	South Lanarkshire
Holgate Aggregates Ltd	Temple Quarry	Kirklees
Kier Minerals Ltd	Greenburn Project	East Ayrshire
Miller Argent (South Wales) Ltd	Ffos-y-Fran Land Reclamation Scheme	Merthyr Tydfil
Shires Developments (Engine) Ltd	Engine	Derbyshire
Shires Developments Ltd	Corporal Lane Quarry	Halifax
The Scottish Coal Company Ltd	Broken Cross	South Lanarkshire
	Chalmerston	East Ayrshire
	Chapelhill Site	South Lanarkshire
	Glentaggart	South Lanarkshire
	Greenbank (St Ninians)	Fife
	Thornton Wood (St Ninians)	Fife
	House of Water	East Ayrshire
	Dalquhandy Residual	South Lanarkshire
	Poniel	South Lanarkshire
	Powharnal	East Ayrshire
	Shewington	Midlothian
	Spireslack	East Ayrshire
UK Coal Mining Ltd	Cutacre	Bolton
	Lodge House	Derbyshire
	Long Moor	Leicestershire
	Steadsburn	Northumberland

Source: DECC (2009b)

Table 35-7. UK's Surface Mines in Production as of 2009

Licensee	Name	Location
Blanentillery Mining Partnership	Blanentillery No.2 Colliery	Torfaen
Eckington Colliery Partnerships	Eckington Colliery	Derbyshire
Energybuild Mining Ltd	Aberpergwm Colliery	Neath Port Talbot
J Flack Ltd	Hay Royds Colliery	Kirklees
Maltby Colliery Ltd	Maltby Colliery	Rotherham
NH Colliery Ltd	Nant Hir No.2 Colliery	Neath Port Talbot
Powerfuel Mining Ltd	Hatfield Colliery	Doncaster
Ray Ashly, Richard Daniels and Neil Jones	Monument Colliery	Gloucestershire
S Harding & R Harding	Cannop Drift Mine	Gloucestershire
UK Coal Mining Ltd	Daw Mill Colliery	Warwickshire
	Kellingley Colliery	North Yorkshire
	Thoresby Colliery	Nottinghamshire
	Welbeck Colliery	Nottinghamshire

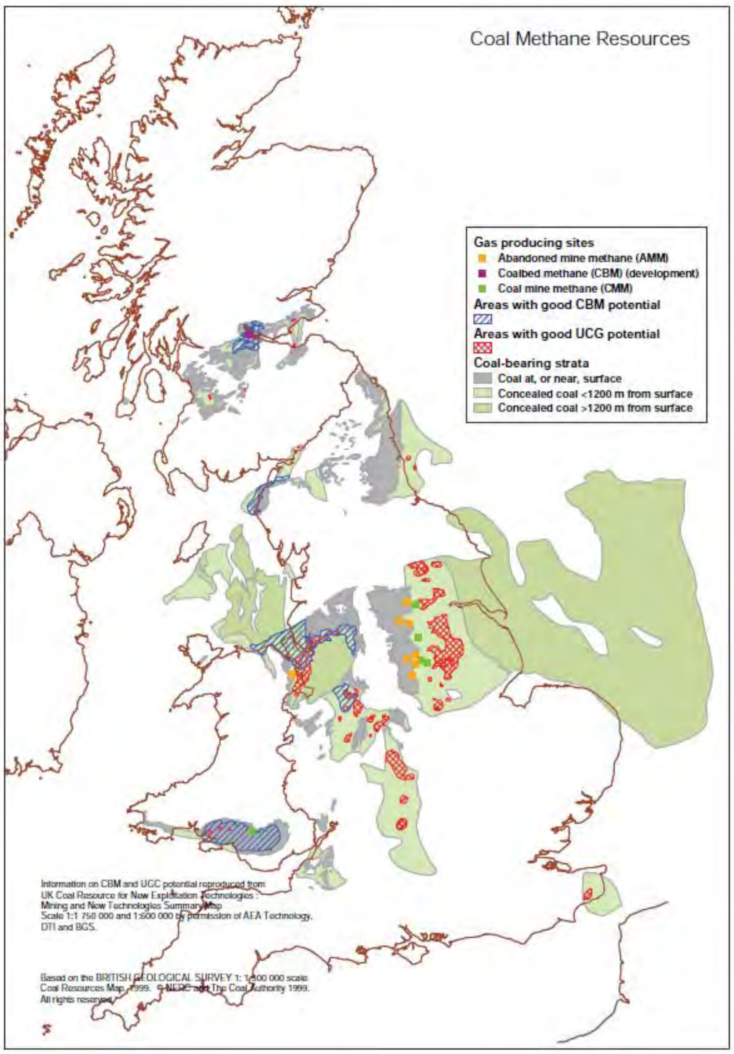
Source: DECC (2009b)

35.2 Overview of CMM Emissions and Development Potential

Note: Most UK documents refer to CBM activities as virgin CBM or "VCBM", and often use CBM to refer to all CMM activities.

The Global Methane Initiative (formerly Methane to Markets Partnership) International CMM Projects Database currently identifies 33 CMM recovery and use projects. Of the 33, 18 are in place in abandoned mines, and the remaining are at active underground mines. Five of these latter projects have likely shut down or have changed their status to abandoned mine projects, upon the termination of mine operations. Of the 33 projects, four projects use the methane for boiler fuel, four for flaring, one for heating or cooling, one for industrial use, one for pipeline injection, and 22 for power generation (M2M Projects, 2010).

Figure 35-2. UK's Coal Methane Resources



Source: BGS (2006)

35.2.1 CMM Emissions from Operating Mines

Table 35-8 summarizes methane emissions in the UK in recent years. CMM emissions from active mines have been steadily reducing reflecting the declining trend in mining; however, CMM recovery and use has risen since the UK began its first methane capture project in 1990. The data in this table may vary from the U.S. Environmental Protection Agency (U.S. EPA) data presented in the Executive Summary due to differences in inventory methodology and rounding of digits.

Table 35-8. UK's CMM Emissions (million cubic meters)

Emission Category	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Underground mining activities—all	1,268.13	1,278.12	1,270.93	1,197.35	812.85	872.57	807.99	772.90	661.67	561.90
Post-underground emissions	122.10	122.72	109.86	83.88	52.57	58.17	54.73	51.43	43.70	35.48
Surface mine emission (total)	9.06	9.31	9.09	8.50	8.39	8.18	8.15	8.34	7.15	7.63
Post-surface mining emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total liberated (= sum of all above)	1,390.23	1,400.84	1,380.79	1,281.23	865.42	930.73	862.72	824.33	705.37	597.38
Recovered and used	120.08	95.01	86.44	76.77	69.43	58.17	53.98	50.35	45.20	45.87
Total emitted (= total liberated – recovered and used)	1,270.16	1,305.83	1,294.35	1,204.45	795.99	872.56	808.74	773.97	660.17	551.50
Emission Category	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	
Underground mining activities—all	500.00	476.14	478.48	414.74	404.55	336.34	316.11	235.78	236.89	
Post-underground emissions	29.19	29.46	27.84	26.55	21.30	16.24	16.04	13.03	13.75	
Surface mine emission (total)	6.70	7.08	6.57	6.06	5.99	5.22	4.31	4.43	4.75	
Post-surface mining emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Total liberated (= sum of all above)	529.19	505.60	506.32	441.30	425.85	357.80	336.46	253.24	255.39	
Recovered and used	46.54	69.62	69.62	66.00	87.26	72.19	71.91	68.38	60.56	
Total emitted (= total liberated – recovered and used)	482.65	435.99	436.70	375.30	338.59	285.61	264.55	184.86	194.83	

Source: UNFCCC (2010a) (converted from gigagrams [Gg])

35.2.2 CMM Emissions from Abandoned Coal Mines

The UK has approximately 900 coal mines (Coal Authority, 2007). In 2008, the country produced and consumed 635 gigawatt-hour (GWh) or 59.5 million m^3 of CMM, down from 810 GWh or 76 million m^3 in 2004 (DECC, 2009c). It is estimated that 31,000 tonnes of methane have been recovered and used annually from abandoned mines (BERR/DTI, 2004c). Table 35-9 identifies current abandoned mine methane (AMM) projects in the UK.

Table 35-9. UK's AMM Projects

Stakeholder	Site	Extracted Methane Flow (liter per second)	Project Operating Dates	Use of Methane (type)	Electric Generation (MW)	Potential GWP* Avoided (tonnes CO_2e)
Alkane Energy Plc.	Bevercotes, North Nottinghamshire	N/A	2006–present	N/A	4.05	138,155
Alkane Energy Plc	Whitwell, North Derbyshire	N/A	2006–present	N/A	1.35	46,052
Alkane Energy Plc	Warsop, North Nottinghamshire	N/A	2006–present	N/A	1.35	46,052
Alkane Energy Plc.	Wheldale, West Yorkshire	[e]409	[a]2001–present	Electric generation	4.5 ([b]10.3) ([e]5.8)	153,054 ([e]184,000)
Alkane Energy Plc	Mansfield, North Nottinghamshire	N/A	pre-2006–present	N/A	3.7	126,216
Alkane Energy Plc	Sherwood, North Nottinghamshire	N/A	pre-2006–present	N/A	0.66	20,467
[e]Green Gas Power Ltd.	Silverdale, North Staffordshire	200	1999–	Burner tip use and electric generation via pipeline	[d]9	90,000
[e]Green Park Energy	Hickleton, South Yorkshire	250	[a]2000–	Electric generation	3.6 ([b]5.4)	112,500
[c]Green Park Energy	Grimethorpe (planning) Brodsworth (planning) Frickley (proposed) Bentley (proposed) Houghton Main (proposed)	N/A	N/A	N/A	approx. 5 (per site)	N/A
[e]Warwick Energy	Annersley Bentinck, Nottinghamshire	140	[a]2000–	Electric generation	2.0 ([b]10.5)	63,000
Likely Inactive						
[e]Alkane Energy Plc.	Markham, North Derbyshire	51	[a]1999–	Via pipeline to boilers	[d]6 ([b]3)	23,000
[d]Alkane Energy Plc.	Steetley, North Nottinghamshire	NA	[a]1999–	[d]Electric generation	[d]3	NA
[e]Alkane Energy Plc.	Shirebrook, North Derbyshire	372	[a]2000–	Electric generation	5.3 ([b]9.5)	167,400
[e]Alkane Energy Plc.	Monk Bretton, West Yorkshire	33	N/A	Burner tip use	[b]2 ([c]5)	14,900

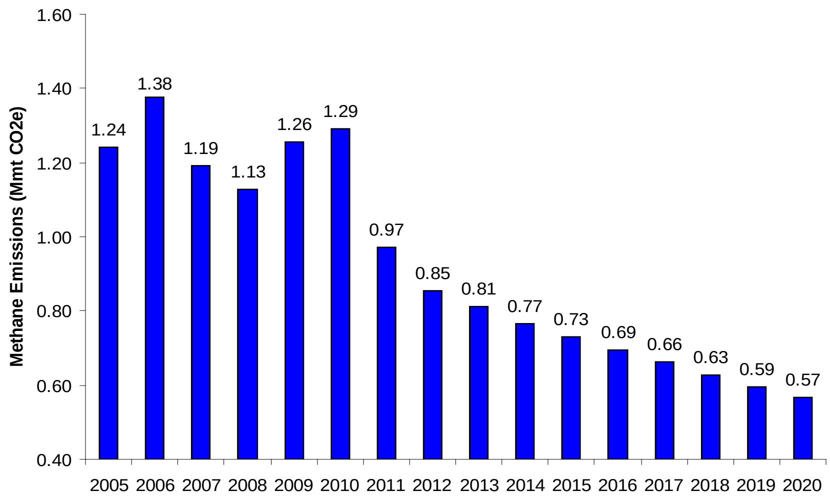
* GWP – Global Warming Potential

Sources cover entire row unless otherwise noted:

a) Alkane (2003)
b) BERR/DTI (2004a)
c) Coal Authority (2008)
d) BERR/DTI (2001b)
e) BERR/DTI (2004c)

Figure 35-3 shows a projection of total methane emissions from current and future abandoned mines through 2020.

Figure 35-3. Projected Methane Emissions from Abandoned Mines



Source: DEFRA (2005)

35.2.3 CBM from Virgin Coal Seams

There is a very substantial technical resource of virgin CBM in the UK totaling 2.45 trillion m^3. This would give the UK a 24-year supply under 2008 consumption levels. A 2001 estimate suggested that only 30 billion m^3 would be economically recoverable (BERR/DTI, 2001b). However, given that the natural gas price in the UK was roughly US$2.80 per million Btu in 2001 and has steeply risen to US$9 per million Btu as of 2008, the economic viability for CBM recovery would be far more favorable now (EIA, 2010b). Recent technological advancements associated with hydraulic fracturing would also likely further expand recoverable reserves. The highest gas contents of more than 20 m^3 per tonne can be found in South Wales and is the focus of most commercial interest (ACMMO, nd).

35.3 Opportunities and Challenges to Greater CMM Recovery and Use

Source: BERR/DTI (2001a) unless otherwise noted

The UK is a signatory to both the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol (Table 35-10). As an Annex I Party to the Kyoto Protocol, its emissions target is 20 percent below 1990 levels by 2020.

Table 35-10. UK's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC*	June 12, 1992	December 8, 1993
Kyoto Protocol**	April 29, 1998	May 31, 2002

Source: *UNFCCC (2010b); **UNFCCC (2010c)

The first and second phases (2005–2008 and 2008–2012, respectively) of the European Union Emissions Trading Scheme (EU ETS) only consider CO_2 emissions. Methane was considered for inclusion in the second phase, but the available estimates and projections were not sufficiently advanced (Global, 2008). The Department of Food and Rural Affairs commissioned a study exploring coal mine methane and incorporating it into the EU ETS, highlighting its challenges (DECC, 2005b). No further action has occurred. The Department of Energy and Climate Change (DECC) recently noted that better policies are needed to help the UK meet its climate change mitigation commitments (DECC, 2009d).

35.3.1 Market and Infrastructure Factors

British coal mining as a nationalized industry was self-sufficient with regards to research and development (R&D). Companies downsized when the British government privatized the industry in the mid-1990s, and emphasis moved away from long-term R&D to more immediate issues. The industry position has stabilized and some long-term mining-related R&D effort has been taken over by the universities.

New CMM utilization projects tend to be power generation projects. The technology is usually standard modules of 1–2 megawatts electrical (MW_e) internal combustion engines as used in the landfill gas industry. Landfill gas is a strong and growing sector in the UK with more than 908 MW_e installed capacity (DECC, 2009e). Pipeline sales can occur if the infrastructure stays in place from previous mining enterprises. However, CMM gas is generally not of sufficient quality to enter the national natural gas network without upgrading, so the economic viability of pipeline injection is not typically strong. In some cases, CBM may be of adequate quality to enter the public distribution system, but there is no evidence of this (Coal Authority, 2007).

35.3.2 Regulatory Information

Ownership of the methane in coal rests with the UK government, but it passes to the licensee when the methane is captured. The rights to the methane gas are regulated by the Department of Business Enterprise & Regulatory Reform under the Petroleum Act of 1998 (Coal Authority, 2007). Petroleum Exploration and Development Licenses (PEDLs) are awarded in a series of “rounds,” the most recent being the 13^{th} Landward Licensing round, which accepted applications on February 6, 2008 (Oil and Gas, 2008a). Methane Development Licenses (MDLs) are used primarily for operating mines. An MDL grants permission to get gas “in the course of operations for making and keeping safe mines whether or not disused.” It grants no exclusive rights, so it can overlap geographically with one or more PEDLs. MDLs generally cover much smaller areas than PEDLs; typically each covers one mine, although the Coal Authority holds a license that covers the whole country (Oil and Gas, 2008b). Coal licensing—and through it, the responsibility for environmental and safety standards—is handled by the Coal Authority.

CMM currently enjoys an exemption from the UK Climate Change Levy (CCL), a tax on fossil fuels that have not otherwise been taxed (as is the case with oil) (OPSI, 2003). When used for power generation, it currently represents an incentive of £4.41 per MW_e (Customs, 2007a). The CCL was indexed to inflation starting April 1, 2007 (Customs, 2007b).These savings are shared with the distribution company that accepts the power into its system; the net benefit to the generator is likely being closer to £3.0 per MW_e and is realized by the sale of CCL Certificates. With the exception of this benefit, power from CMM must compete equally with that from all other generators in the electricity market. This has proved difficult in recent times due to the low price of electricity on the wholesale market. Recently, however, prices have risen, generating increased interest in CMM projects.

CMM projects are normally developed by private capital. Recent natural gas price volatility has meant a downturn in activity due to poor projected returns. Future development may be fueled by EU trading. At least one UK carbon credit trading company has started work on identifying sources that would be suitable for power generation.

CO_2 sequestration into the coal seam is often cited as a possible means of making CBM carbon neutral. CO_2 sequestration technology is immature at present and its potential application in the UK cannot be assessed. However, there are vast areas of coal at depths below 1,200 m that are possibly too deep for mining and thus may be suitable sites for sequestration.

35.4 Profiles of Individual Mines

Information on individual mines can be found at the UK Department of Business Enterprise & Regulatory Reform website (BERR, 2006).

35.5 References

ACMMO (nd): Association of Coal Mine Methane Operators. http://www.coal.gov.uk/media/BFA/7A/CCT_-_UK_Mine_Methane_-_Facts_and_Figures_-_ACMMO_General_Brief_10_08_07.pdf

Alkane (2003): Sustainable Energy from Abandoned Coal Mines, Alkane Energy Plc., presented to the UNECE Ad Hoc Group of Experts on Coal in Sustainable Development, November 17, 2003. http://www.unece.org/ie/se/pp/coal/alkane.pdf

BGS (2006): Coal and Coal Bed Methane, British Geological Survey, United Kingdom, 2006. www.bgs.ac.uk/downloads/start.cfm?id=1354

BERR (2006): Coal Industry in the UK, Department of Business Enterprise & Regulatory Reform, United Kingdom, 2006. http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/energy/sources/coal/industry/page13125.html

BERR/DTI (2001a): Coalbed Methane Extraction and Utilization. Department of Business Enterprise & Regulatory Reform, United Kingdom, October 2001. http://www.coal.gov.uk/media/4442D/dticbmdoc.pdf

BERR/DTI (2001b): A Review of the Worldwide Status of Coalbed Methane Extraction and Utilisation, Department of Business Enterprise & Regulatory Reform, United Kingdom, 2001. http://www.berr.gov.uk/files/file18654.pdf and http://www.berr.gov.uk/files/file18655.pdf

BERR/DTI (2004a): Methane Extraction and Utilisation from Abandoned Coal Mines - China/UK Technology Transfer, Department of Business Enterprise & Regulatory Reform, February 2004. http://webarchive.nationalarchives.gov.uk/tna/+/http://www.berr.gov.uk/files/file20542.pdf, http://webarchive.nationalarchives.gov.uk/tna/+/http://www.berr.gov.uk/files/file20543.pdf/, and http://webarchive.nationalarchives.gov.uk/tna/+/http://www.berr.gov.uk/files/file20544.pdf/

BERR/DTI (2004b): UK Coal Production Outlook: 2004–16, Department of Business Enterprise & Regulatory Reform, United Kingdom, March 2004. http://www.berr.gov.uk/files/file14151.pdf

BERR/DTI (2004c): Coal Mine Methane – Review of the Mechanisms for Control of Emissions, Department of Business Enterprise & Regulatory Reform, United Kingdom, February 2004. http://webarchive.nationalarchives.gov.uk/tna/+/http://www.berr.gov.uk/files/file19081.pdf/

Coal Authority (2007): Methane Associated with Coal Seams, The Coal Authority, October 2007. http://www.coal.gov.uk/publications/miningtechnology/coalmineandbedmethane.cfm

Coal Authority (2008): Coal Mine Methane Activity in the UK, The Coal Authority, 2008. http://www.coal.gov.uk/publications/miningtechnology/coalminemethaneukactivity.cfm

Customs (2007a): Climate Change Levy (CCL) - rates to rise at 1 April 2007, HM Revenue and Customs, United Kingdom, March 2007. http://customs.hmrc.gov.uk/channelsPortalWebApp/channelsPortalWebApp.portal?_nfpb=true&_pageLabel=pageExcise_ShowContent&id=HMCE_PROD1_027187&propertyType=document

Customs (2007b): Climate Change Levy (CCL) change to rates, HM Revenue and Customs, United Kingdom, March 2007. http://customs.hmrc.gov.uk/channelsPortalWebApp/channelsPortalWebApp.portal?_nfpb=true&_pageLabel=pageExcise_InfoGuides&id=HMCE_PROD1_027235&propertyType=document

DECC (2005): *Mechanisms For Reducing Methane And HFC Emissions From Four Selected Sectors*, Department of Energy and Climate Change, website accessed July 1, 2010. http://www.decc.gov.uk/assets/decc/what%20we%20do/a%20low%20carbon%20uk/crc/policy/aeat-reducing-emissions-report.pdf

DECC (2006): UK Coal Operating Aid Scheme (Ukcoas), Department of Energy and Climate Change, website accessed July 1, 2010. http://www.decc.gov.uk/assets/decc/what%20we%20do/uk%20energy%20supply/energy%20mix/coal/1_20090812125344_e_@@_ukcoaspayments.xls

DECC (2008): Inland consumption of primary fuels and equivalents for energy use, 1970 to 2008. Department of Energy and Climate Change, London England, website accessed July 1, 2010. http://www.decc.gov.uk/assets/decc/statistics/source/total/dukes1_1_1.xls

DECC (2009a): *UK Energy Sector Indicators 2009: Reliable Supplies of Energy Dataset*, Department of Energy and Climate Change, October 2009. http://www.decc.gov.uk/en/content/cms/statistics/publications/indicators/indicators.aspx

DECC (2009b): (DUKES [Tables] 2.7, 2.10, and 2.11), Department of Energy and Climate Change, London England, website accessed July 1, 2010. http://www.decc.gov.uk/en/content/cms/statistics/source/coal/coal.aspx

DECC (2009c): Supply and Consumption Of Natural Gas and Colliery Methane (DUKES [Table] 4.2), Department of Energy and Climate Change, London England, website accessed July 1, 2010. http://www.decc.gov.uk/en/content/cms/statistics/source/gas/gas.aspx

DECC (2009d): Third Overview of the work of the UK Coal Forum: August 2008 to December 2009, Department of Energy and Climate Change, London England, website accessed July 1, 2010. http://www.decc.gov.uk/assets/decc/what%20we%20do/uk%20energy%20supply/energy%20mix/coal/uk_forum/1_20100111145024_e_@@_ukcoalforumthirdoverview.pdf

DECC (2009e): Capacity of, and electricity generated from, renewable sources (DUKES 7.4), Department of Energy and Climate Change, London England, website accessed July 1, 2010. http://www.decc.gov.uk/assets/decc/statistics/source/renewables/dukes7_4.xls

DECC (2010): "Upstream Field Development," Department of Energy and Climate Change, London England, website accessed July 1, 2010. https://www.og.decc.gov.uk/upstream/field_development/index.htm

DEFRA (2005): Projected Methane Emissions from Abandoned Coal Mines in the UK, Department for Environment, Food, and Rural Affairs, December 2005. http://randd.defra.gov.uk/Document.aspx?Document=GA01039_3320_PRO.pdf

Deloitte (2006): Environmental Taxes: Climate Change Levy, Deloitte & Touche LLP, 2006. http://www.ukbudget.co.uk/ukbudget2006/Business/budget06_climatechangelevy.cfm

EIA (2006): United Kingdom Country Analysis Brief. U.S. Energy Information Administration, Washington, DC, May 2006. http://www.eia.doe.gov/emeu/cabs/United_Kingdom/Background.html

EIA (2008): Data obtained from International Energy Annual 2006, U.S. Energy Information Administration, Washington, DC, table posted October 2008. http://www.eia.doe.gov/pub/international/iea2006/table82.xls (reserves)

EIA (2010a): International Energy Statistics, 2010. U.S. Energy Information Administration, Washington, DC, website accessed July, 2010. http://tonto.eia.doe.gov/cfapps/ipdbproject/IEDIndex3.cfm

EIA (2010b): Natural Gas Prices for Electricity Generation, U.S. Energy Information Administration, Washington, DC, website accessed July, 2010. http://www.eia.doe.gov/emeu/international/ngasprie.html

EURACOAL (2010): "Country Profiles: United Kingdom," European Association for Coal and Lignite, Brussels, Belgium, website accessed July 1, 2010. http://www.euracoal.be/pages/layout1sp.php?idpage=82

IEA (2007): *International Energy Agency Energy Statistics – Coal*. International Energy Agency, Paris, France, website accessed July, 1, 2010. http://www.iea.org/stats/coaldata.asp?COUNTRY_CODE=GB

Global (2008): European Union Emissions Trading Scheme, Global Carbon, 2008. http://www.global-carbon.com/en/services/euets.html

M2M Projects (2010): Methane to Markets International Coal Mine Methane Projects Database, Methane to Markets, 2010. http://www2.ergweb.com/cmm/index.aspx

M2M-UK (2008): Methane to Markets Partners – United Kingdom, Methane to Markets Partnership, 2005.

Oil and Gas (2008a): 13th Landward Licensing Round, Oil and Gas, Department for Environment, Food, and Rural Affairs (fmr. Department of Trade and Industry), 2008, website accessed July 1, 2010. https://www.og.decc.gov.uk/upstream/licensing/onshore_13th/index.htm

Oil and Gas (2008b): Licensing: License Types, Oil and Gas, Department for Environment, Food, and Rural Affairs, 2008. https://www.og.decc.gov.uk/upstream/licensing/lictype.htm

OPSI (2003): The Climate Change Levy Regulations 2003, Office of Public Sector Information, United Kingdom, October 9, 2003. http://www.opsi.gov.uk/si/si2003/20032633.htm

Schwochow (1997): The International Coal Seam Gas Report, Cairn Point Publishing, Steve Schwochow, editor, 1997.

UKCoalPro (nda): Britain's Coalfields, Detailed Map, UK Coal Producers, Wakefield UK, website accessed July 1, 2010. http://www.coalpro.co.uk/documents/UK%20Coalfields.ppt

UKCoalPro (ndb): Members, UK Coal Producers, Wakefield UK, website accessed July 1, 2010. http://www.coalpro.co.uk/members.shtml

UK Nat Stats (nd): *Energy Production and Consumption, UK National Statistics Publication Hub*, UK National Statistics

UNFCCC (2010a): Annex I Party GHG Inventory Submissions, United Nations Framework Convention on Climate Change, 2010. http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5270.php

UNFCCC (2010b): United Nations Framework Convention on Climate Change - Status of Ratification, June, 2010. http://unfccc.int/essential_background/convention/status_of_ratification/items/2631

UNFCCC (2010c): Kyoto Protocol - Status of Ratification, June, 2010. http://unfccc.int/kyoto_protocol/status_of_ratification/items/2613.php

WCI (2008): "Coal Statistics, Top Coal Importers," World Coal Institute, London, United Kingdom, http://www.worldcoal.org/resources/coal-statistics/

36 UNITED STATES

36.1 Summary of Coal Industry

36.1.1 ROLE OF COAL IN THE UNITED STATES

Coal accounts for 29.6 percent of energy production in the United States (EIA, 20010a). The United States exports 5.5 percent of its coal production (EIA, 2010b). Imports equal 2.3 percent of its total domestic consumption (EIA, 2010b). Table 36-1 quantifies recoverable reserves and recent coal production in the United States.

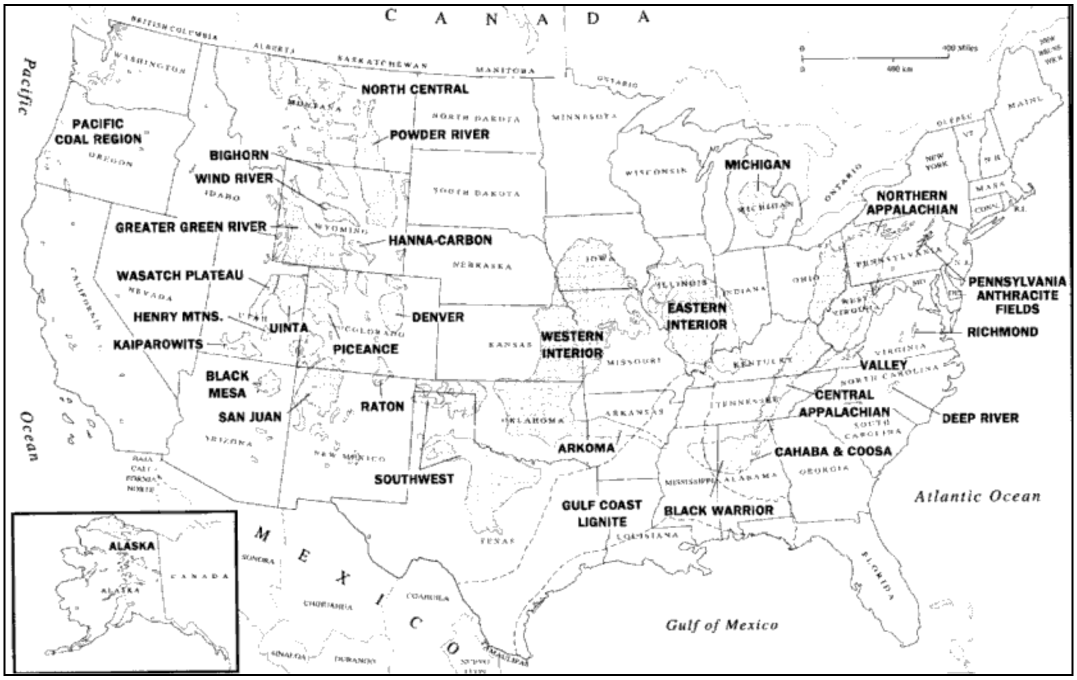
Table 36-1. U.S. Coal Reserves and Production

Indicator	**Anthracite & Bituminous** (million tonnes)	**Sub-bituminous & Lignite** (million tonnes)	**Total** (million tonnes)	**Global Rank** (# and %)
Estimated Proved Coal Reserves (2005)*	110,667.9	128,620.2	239,298.1	1 (28.4%)
Annual Coal Production (2008)**	505.3	557.8	1063.0	2 (16.1%)

Source: *EIA (2010c); **EIA (2010d)

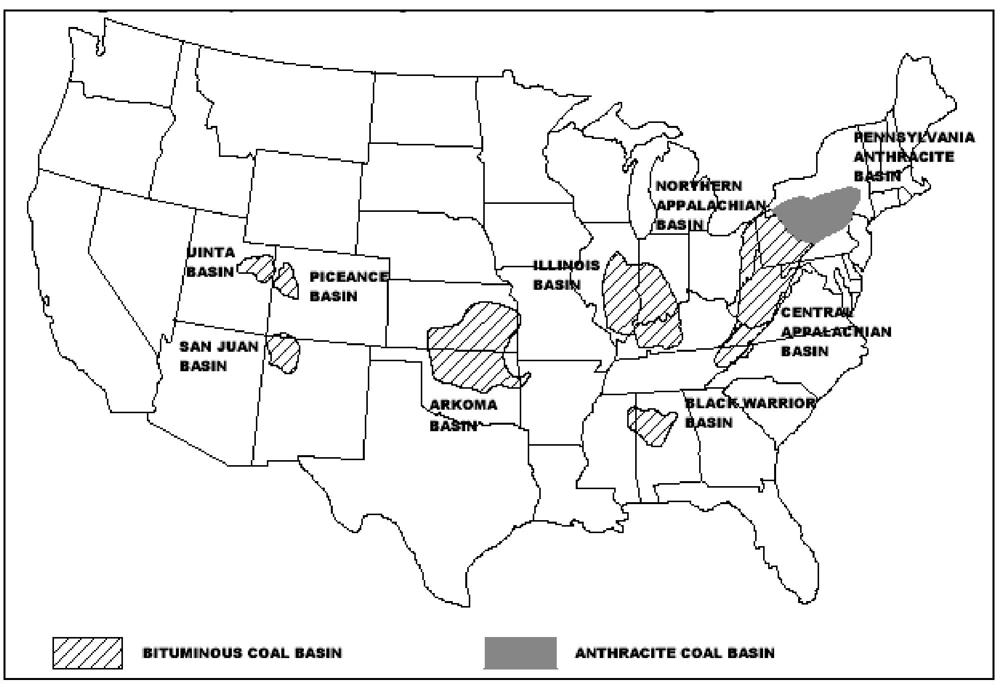
Figure 36-1 highlights all U.S. coal basins, while Figure 36-2 illustrates the locations of gassy U.S. coal basins. The gassy coal seams of the United States are found in four geographic regions: the Appalachian Basins of the eastern United States (medium to high volatile bituminous and anthracite); the Illinois Basin in the Midwest (medium to high volatile bituminous); the Rocky Mountain Basins in the western United States (lignite, sub-bituminous to medium/high volatile bituminous); and the Gulf Coast and Anadarko Basins of the South/Southwest (lignite, sub-bituminous to medium/high volatile bituminous).

Figure 36-1. Map of All U.S. Coal Basins



Source: Schwochow (1997)

Figure 36-2. Map of U.S. Gassy Coal Basins with Underground Coal Mines



Source: USEPA (2004)

36.1.2 STAKEHOLDERS

Table 36-2 identifies potential key stakeholders in U.S. coal mine methane (CMM) development.

Table 36-2. Key Stakeholders in the U.S. CMM Industry

Stakeholder Category	Stakeholder	Role
Mining companies	▪ Allegheny Energy (Electric Power) ▪ Arch Coal ▪ BHP Billiton ▪ Black Warrior Methane (natural gas production) ▪ CONSOL Energy ▪ CNX Gas ▪ Drummond Coal ▪ Eastern Associated Coal (Peabody subsidiary) ▪ Jim Walter Resources ▪ Oxbow Minerals ▪ Peabody Energy ▪ USX Corp. ▪ National Mining Association ▪ Alpha Natural Resources	Project hosts
Equipment manufacturers	▪ Advanced Extraction Technologies ▪ BCCK Engineering ▪ Biothermica ▪ BOC Gases ▪ Caterpillar ▪ Cummins Engine ▪ D'Amico Technologies ▪ Engelhard/Guild Associates ▪ Engineered Gas Systems Worldwide ▪ Gas Separation Technology ▪ HNNG Development ▪ MEGTEC Systems ▪ Membrane Technology and Research ▪ Prometheus Energy ▪ Solar Turbines ▪ Velocys ▪ Waukesha Engines	Methane treatment and utilization equipment
Developers	▪ See www.epa.gov/coalbed, Network Contacts	Project opportunity identification and planning
Engineering, Consultancy, and Related Services	▪ See www.epa.gov/coalbed, Network Contacts	Technical assistance
Universities, Research Establishments	▪ U.S. Geological Survey ▪ Gas Technology Institute ▪ University of Montana (Water Quality Management) ▪ U.S. Department of Energy	Technical assistance
Regulatory Agencies	▪ Mine Safety & Health Administration ▪ Bureau of Land Management ▪ U.S. Forest Service	Project approval Leasing on federal land

Stakeholder Category	Stakeholder	Role
Other	▪ Emissions Marketing Association ▪ Less Carbon ▪ See www.epa.gov/coalbed, Network Contacts	Emissions credits brokers

Source: M2M-US (2005), Marshall (2008)

36.1.3 Status of Coal and the Coal Mining Industry

The U.S. coal industry is privatized. Table 36-3 summarizes coal mining in the country by mine type. In 2005, there were 8,000 abandoned underground mines, 440 of which are considered gassy (USEPA, 2004).

Table 36-3. Recent U.S. Coal Statistics

Type of Mine	**Production** (million tonnes)	Number of Mines
Underground (active) mines - total	357.1	583
Surface (active) mines - total	813.3	852

Source: EIA (2010e)

36.2 Overview of CMM Emissions and Development Potential

The Global Methane Initiative (formerly Methane to Markets Partnership) International CMM Projects Database currently identifies 39 operating CMM projects, 13 of which are in place in active underground mines and 26 in abandoned mines. Thirty-two projects use the methane for pipeline injection, one for coal drying, one for heating or cooling, two for power generation, one in ventilation air methane (VAM) destruction, and two for other uses (M2M Projects, 2010).

36.2.1 CMM Emissions from Operating Mines

Table 36-4 quantifies methane emissions from the U.S. mining industry in recent years. The data in this table may vary from the U.S. Environmental Protection Agency (U.S. EPA) data presented in the Executive Summary due to differences in inventory methodology and rounding of digits.

Table 36-4. U.S. CMM Emissions (million cubic meters)

Emission Category	1990	1995	2000	2005	2006	2007	2008
Underground Mining	4363.9	3272.9	2767.1	2452.5	2501.0	2514.2	3143.5
Surface Mining	843.4	806.3	861.2	930.8	982.2	968.8	1000.5
Post-Mining (Underground)	541.5	485.1	467.7	449.8	438.9	425.8	429.3
Post-Mining (Surface)	137.0	131.0	140.0	151.3	159.5	157.5	162.6
Total	5885.6	4694.7	4235.9	3984.5	4081.6	4065.4	4735.8

Source: USEPA (2010a)

There are a limited number of CMM-to-power projects currently in existence or planned at U.S. mines (M2M-US, 2005). CONSOL Energy and Allegheny Energy operate a combined power project at the VP#8 and Buchanan mines in Virginia. The 88 megawatts (MW) power generation station is currently the second largest CMM power plant in the world, although it is used only for power peaking and operates very infrequently. This CMM project uses large turbines (two 44-MW turbines) where most projects use small ones. In addition, CONSOL recovers approximately 56,620 cubic meters (m^3) per day from these mines to use in drying coal (USEPA, 2005). Another CMM power project is operating at CONSOL's Bailey/Enlow Fork mining complex in Pennsylvania. This demonstration of a 70-kW microturbine running off of the mine's ventilation air will be developed as a full VAM project with Green Holdings (CONSOL, 2010a).

There is currently one VAM project in operation in the United States. It began operation in 2009, destroying VAM at the Jim Walter Resources Mine No.4 in Alabama. In February 2010 the equipment supplier, Biothermica, announced that the project had been listed with the Climate Action Reserve as the carbon registry's first CMM project. The project is expected to generate 27,000 carbon offset credits in its first year, and 35,000 per year at full capacity (Biothermica, 2010). The project captures 51,000 m^3 per hour, reducing emissions by 40,000 tons carbon dioxide equivalent (CO_2e) (Biothermica, 2009).

In addition to the Bailey/Enlow Fork project, CONSOL has announced plans for a 2011 VAM project in conjunction with Verdeo Group, Inc. at its McElroy Mine in West Virginia (CONSOL, 2010b). Additionally, from 2007 to 2008 the U.S. EPA and the U.S. Department of Energy (DOE) were co-funding a demonstration project using simulated ventilation air (diluted drainage gas) from the abandoned Windsor Mine in West Liberty, West Virginia (USEPA, 2007).

In the United States, flaring has been used at closed mines but has not been widely implemented at active mines. The coal industry has expressed concerns about the safety of flaring due to the potential for the flame to propagate back down to the mine and cause an underground explosion. Implementing flaring at active mines requires greater acceptance by miners, union parties, mine owners, and the Mine Safety and Health Administration (MSHA). It should be noted, however, that at two active mines, drainage gas is used to preheat incoming ventilation air in cold months to both condition the incoming air and prevent the formation of large icicles at the ventilation shaft opening; these heaters essentially constitute horizontal flares.

36.2.2 CMM Emissions from Abandoned Mines

Currently, there are 26 projects using gas from approximately 36 abandoned U.S. coal mines for direct gas sales and pipeline injection. Table 36-5 quantifies methane emissions from abandoned mines in the United States (USEPA, 2004).

Table 36-5. U.S. Abandoned Mine Methane Emissions (million cubic meters)

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Inventory 1990–2002	238	242	270	303	319	357	413	392	341
Inventory 1990–2003	425	436	466	492	583	591	606	568	502
Inventory 1990–2004	420								483
Inventory 1990–2005	420					574			
Inventory 1990–2006	423					577			

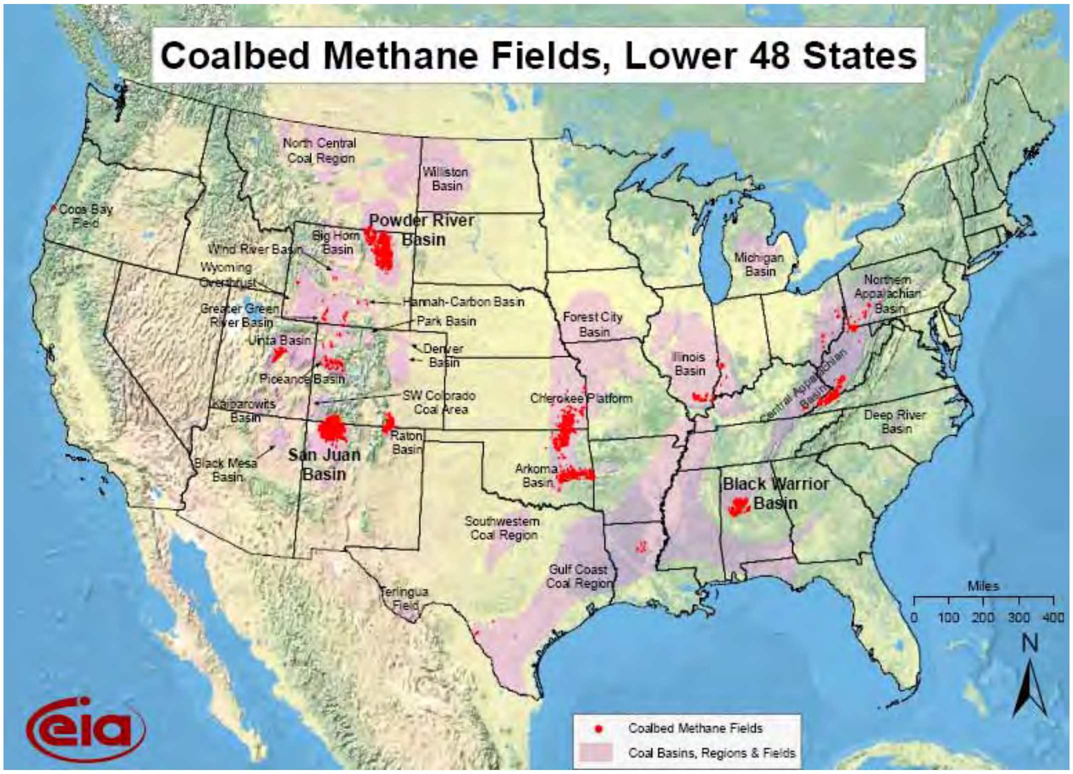
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Inventory 1990–2002	311	311	296	290						
Inventory 1990–2003	514	544	488	448	448					
Inventory 1990–2004	490	504	455	420	406	392				
Inventory 1990–2005		511	462	427	420	406	392			
Inventory 1990–2006		515	469	431	417	406	389	378		
Inventory 2010*				431.2	416.9	407.6	390.4	387.9	395.9	412.7

Source: USEPA (2004); Marshall (2008); *UNFCCC (2010a) Note: Revisions of calculation methods, map information, and mine closing information resulted in adjusted emissions figures from previous years' inventories.

36.2.3 CBM FROM VIRGIN COAL SEAMS

The United States is the world's leading producer of coal seam gas. Production has been established in 10 coal basins nationwide (primarily San Juan, Black Warrior, and Central Appalachian) as shown in Figure 36-3 (UNFCCC, 2010a; EIA, 2009a). Total annual production of coalbed methane (CBM) in 2007 was estimated at 49,668 million m^3 (EIA, 2009b). Table 36-6 summarizes the proved U.S. CBM reserves up to 2007.

Figure 36-3. Map of U.S. Coalbed Methane Fields



Source: EIA (2009a)

Table 36-6. U.S. CBM Proved Reserves (billion cubic meters)

Date	USA	Alabama	Colorado	New Mexico	Utah	Wyoming	Virginia*	Eastern States	Western States	Other States
1989	104.1	15.2	31.6	57.3						0.0
1990	144.0	34.7	37.4	71.1						0.9
1991	231.2	48.5	58.8	119.1						4.7
1992	284.1	55.7	76.9	133.8						17.7
1993	288.4	35.0	88.0	135.2						30.2
1994	275.0	27.6	82.5	117.1						47.7
1995	297.3	27.5	98.0	121.7						50.0
1996	299.2	23.3	105.1	118.4						52.4
1997	324.6	30.5	110.2	123.2						60.7
1998	344.9	29.1	119.2	119.8						76.7
1999	374.6	30.0	136.7	115.5						92.4
2000	444.8	35.1	159.1	121.1	45.1	43.6		39.6	1.2	
2001	496.4	32.9	177.0	122.4	47.7	65.0		41.1	10.1	
2002	523.6	36.3	189.5	124.0	48.8	67.1		42.1	15.7	
2003	530.7	47.1	183.3	124.5	34.7	78.1		43.3	19.8	
2004	520.7	53.8	163.9	146.3	26.4	59.0		45.9	25.4	0.0
2005	563.3	50.2	191.8	148.6	25.5	69.3		51.6	26.3	
2006	555.6	58.6	179.6	138.6	21.2	69.3	51.3	7.7	29.2	
2007	619.4	60.2	222.8	118.1	26.1	77.5	55.2	11.1	48.4	

Source: EIA (2009b)

36.3 Opportunities and Challenges to Greater CMM Recovery and Use

Source: M2M-US, 2005 unless otherwise noted

The United States is a signatory to the UNFCCC and the Kyoto Protocol, but currently, does not intend to ratify the Kyoto Protocol (see Table 36-7). Therefore, it is not subject to Kyoto emissions targets. There are no alternative national emission restrictions or regulations limiting carbon dioxide or other greenhouse gas (GHG) emissions in the United States at this time, but some states have begun establishing emissions limits. EPA has issued regulatory actions under the Clean Air Act and in some cases other statutory authorities to address issues related to climate change (USEPA, 2010b). In the spring of 2010, EPA finalized the GHG Tailoring Rule, which specifies that beginning in 2011, projects that will increase GHG emissions substantially will require an air permit (USEPA, 2010c). In addition, some firms are voluntarily engaging in the carbon market through self-imposed carbon emissions reductions or financial investments in GHG emission reductions.

Table 36-7. U.S. Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC*	June 12, 1992	October 15, 1992
Kyoto Protocol**	November 12, 1998	No

Source: *UNFCCC (2010b); **UNFCCC (2010c)

Utilities in 41 U.S. states offer their customers "green pricing," in which customers opt to pay a premium on their electric bills to have a portion or all of their power provided from renewable sources (EERE, 2010). Four states include CMM in their renewable/alternative energy standards: Pennsylvania, West Virginia, Ohio, and Utah (Colorado is considering) (World Coal, 2010; DSIRE, 2010). Pennsylvania does not have a green pricing program in place at this time.

There are four major voluntary GHG registries in the United States that accept CMM offset projects: the Voluntary Carbon Registry (VCS), the Chicago Climate Exchange (CCX), the Climate Action Reserve (CAR), and the American Carbon Registry (ACR). The specifics of each CMM project will determine its full eligibility for each of these registries (World Coal, 2010).

36.3.1 Market and Infrastructure Factors

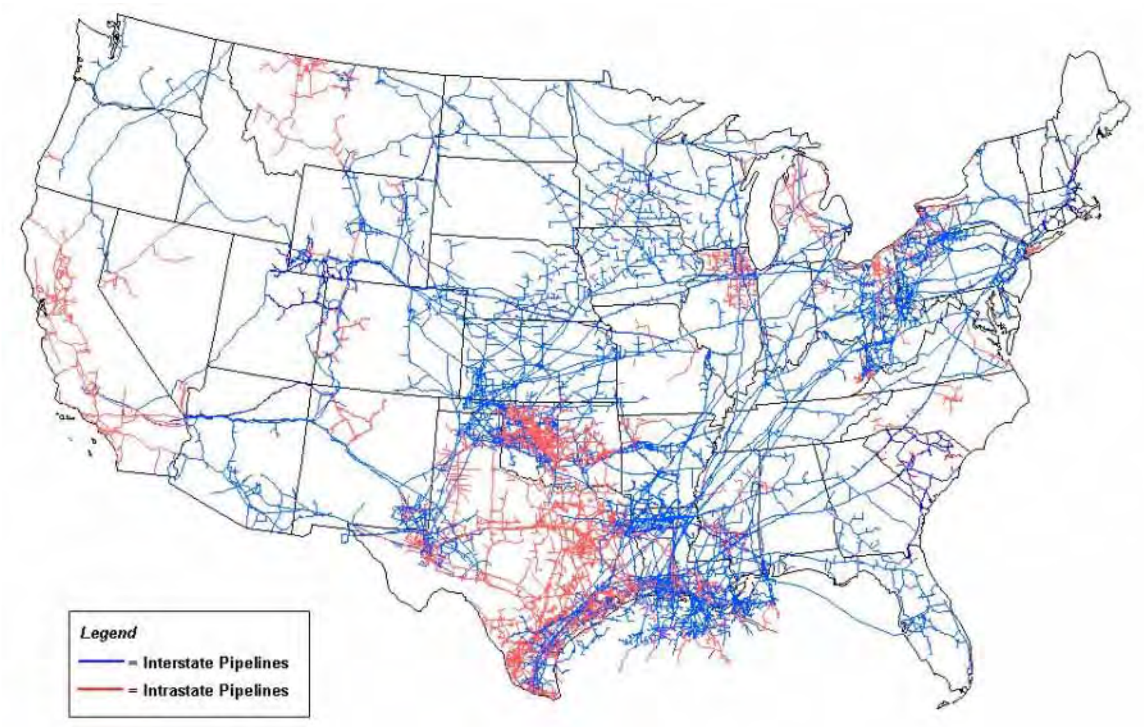
Infrastructure Issues

The majority of CMM recovery projects in the United States involve selling the methane directly to natural gas pipelines. Generally, only gas from wells drilled into virgin seams in advance of mining is suitable to meet the high-quality gas standards required by pipelines (usually 95 percent or greater methane with minimal contaminants). If necessary, lower-quality CMM (e.g., gob well gas) can be processed to remove contaminants and upgraded to pipeline quality. Several technologies for upgrading methane are now easily available through vendors (USEPA, 2008a).

The existing gas pipeline infrastructure in the United States plays an important role in determining if and where pipeline sales are feasible. In the eastern United States, the natural gas pipeline system is more extensive and is located closer to gassy coal mines than in the western United States. In some instances, mines may need to construct a feeder pipeline to transport the CMM to the pipeline from the wellhead or from the gas upgrading/processing facility. Mines in the western United States often have little or no access to pipelines and thus the option for pipeline sales is limited, since building feeder pipelines would be cost prohibitive. Unlike Europe or China, large population centers in the United States are not typically located in close proximity to coal mines. Thus, in the absence of reasonably accessible long-distance pipelines, there are not readily accessible methane markets near most mines.

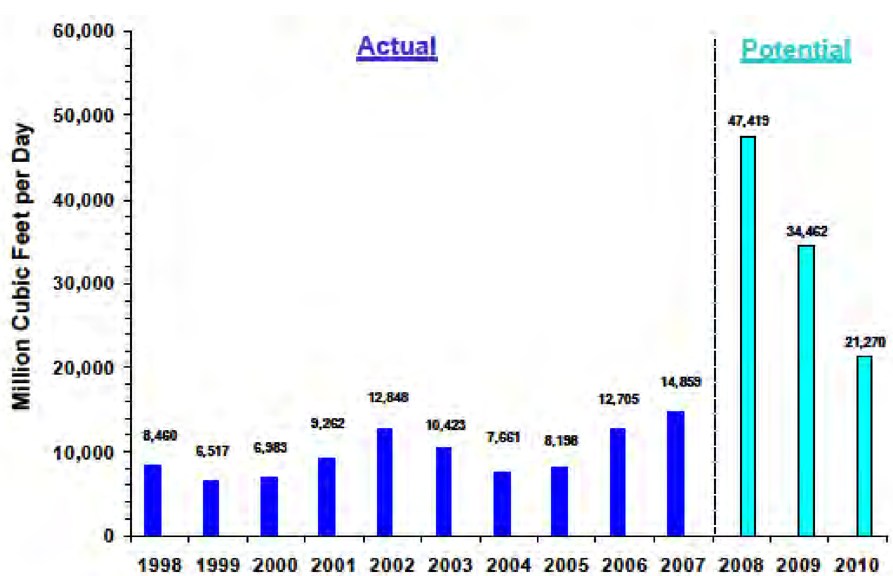
Figure 36-4 illustrates interstate and intrastate natural gas pipelines in the United States in 2009. Figures 36-5 and 36-6 summarize the U.S. natural gas pipeline expansion from 1998 to 2007, with estimations through 2010. From 1998 to 2008 more than 32,000 kilometers (20,000 miles) of new natural gas transmission pipeline were placed in service. New major gathering systems and interstate natural gas pipelines were built to accommodate the expansion of CBM and tight-sands natural gas production in the Powder River, Green River, Piceance, and Uintah basins of Wyoming, Colorado, and Utah. Nearly 400 million m^3 (14 billion cubic feet) per day of interstate natural gas pipeline capacity and almost 170 million m^3 (6 billion cubic feet) per day of new intrastate headers and laterals were built to transport this additional gas (Tobin, 2008).

Figure 36-4. U.S. Interstate Natural Gas Pipelines, 2009



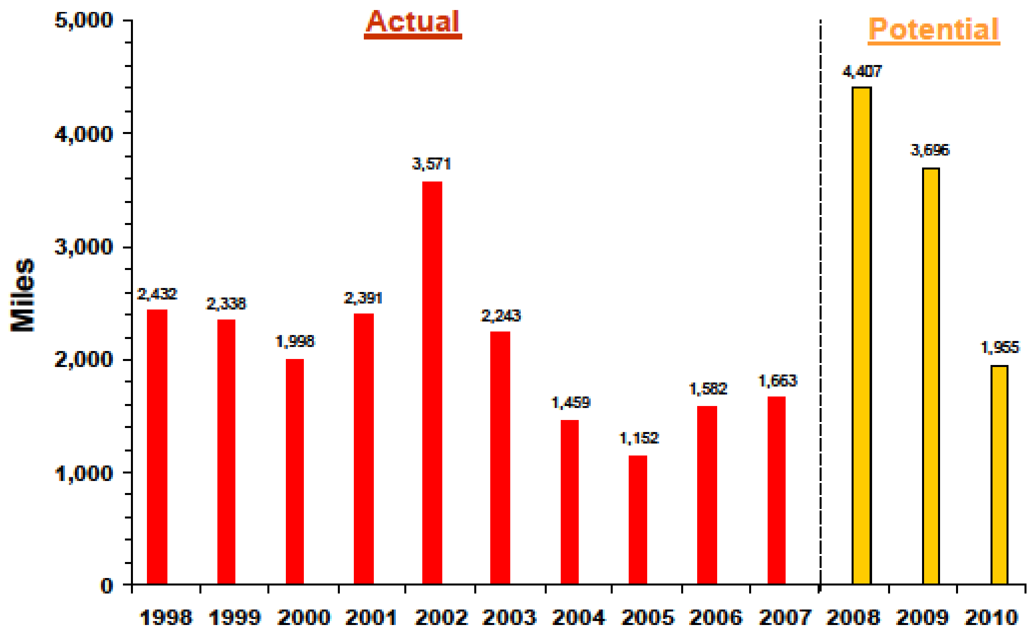
Source: EIA (2009c)

Figure 36-5. Annual Increases in U.S. Natural Gas Pipeline Capacity



Source: EIA (2008b)

Figure 36-6. Annual Increases in U.S. Natural Gas Pipeline Length



Source: EIA (2008b)

Institutional Issues

Disputes over ownership of methane produced from coal seams present one of the most significant barriers to further development of the CMM industry in the United States. Ownership of carbon-based mineral rights is often divided between the oil/natural gas estate and the coal estate. Whether on public or private land, the coal lessee has had the right to capture and discharge methane without paying royalties to maintain safe working conditions. Although some states have attempted to clarify the ownership issue through legislation, the U.S. government has only done so in specific regions. U.S. government agency Bureau of Land Management (BLM) in the Department of the Interior has setup an incentive in Wyoming's Powder River Basin that encourages pre-mine gas drainage prior to surface mining in return for reduced natural gas royalty payments to the U.S. government. The areas in which this incentive applies are called Conflict Administration Zones (CAZ). The CAZs were established with BLM Instruction Memorandum No. 2003-253 in 2003 and were recently re-delineated in December of 2009 (BLM, 2010). Other disputes are settled on a case-by-case basis.

For in-mine boreholes and gob wells at active mines, mine operators receive approval directly from the MSHA. However, licenses are granted by the state in cases where the wells are drilled for exploration and production for pre-mine drainage on property outside the jurisdiction of MSHA and for production of methane from abandoned mines that are no longer under MSHA's jurisdiction.

Mineral leases are either owned by the U.S. government, as is the case in many parts of the West, or privately owned, as is the case in the other areas of the country and in parts of the West. For private leases, laws in each individual state govern ownership of the resource. Federal law governs U.S. government leases, and the BLM manages the mineral rights on those properties.

The markets for coal, gas, and electricity have been largely deregulated. Power generation is deregulated, and there is free and open access in the wholesale market. Power transmission rates are regulated, but there is open access to transmission lines. Power distribution (retail) also continues to be regulated, the prices of electricity being regulated closely by regional public utility commissions. For natural gas, generation and distribution are deregulated and there is open access in the wholesale market, with free and open competition. However, transportation of coal and natural gas is regulated by the federal government for interstate transport and by states for intrastate transport.

U.S. natural gas prices rose fairly steadily from 2001 until they peaked in 2008, as shown in Table 36-8 (EIA, 2010f). Natural gas prices have tended to rise more slowly than oil prices and are expected to steadily rise again as the economy recovers from the 2008–2009 recession (EIA, 2010g). Higher natural gas prices will thus continue to spur interest in CMM development projects.

Table 36-8. Recent U.S. Natural Gas Prices

Year	**Nominal Annual Wellhead Gas Price** (per million cubic meters)
2009	$ 131.02
2008	$ 281.10
2007	$ 220.72
2006	$ 225.66
2005	$ 258.86
2004	$ 192.82
2003	$ 172.34
2002	$ 104.18
2001	$ 141.26

Source: EIA (2010f)

In 2008, coal delivered to the U.S. steam-electric utility plants averaged $45.55 per tonne, while coal delivered to coke plants (metallurgical) averaged $130.17 per tonne (EIA, 2009d).

Financing

Capital investment costs for CMM projects vary greatly depending on the project scope and site-specific requirements. Similarly, operating costs vary greatly depending on the site characteristics (M2M, 2005). The vast majority of direct project funding has come from the private sector, especially mining companies or private investment firms that have provided the capital investment for gas processing, blending, and transport for pipeline sales.

Several U.S. government agencies provide funding resources for CMM recovery and utilization projects located in the United States. DOE grants have provided funding for a number of demonstration projects. The Small Business Administration operates a loan fund that assists small businesses engaged in energy technology and energy efficiency by guaranteeing loans if key conditions are met. U.S. EPA's Environmental Finance Program assists communities in funding environmental projects by helping to lower costs, increase investment, and build partnerships.

The United States does not receive foreign assistance or assistance under multilateral organizations. However, there are three key export-financing agencies within the U.S. government to provide financing for projects based outside the country that result in significant exports: the U.S. Trade & Development Agency, the U.S. Export Import Bank, and the Overseas Private Investment Corporation.

Research and development associated with methane capture and use is funded by two U.S. government agencies: U.S. DOE, which focuses on gas production and utilization, and the National Institute of Occupational Safety & Health, which focuses on mine safety research.

36.3.2 Regulatory Information

Tax credits were used to encourage the production of so-called "unconventional" sources of natural gas, including virgin coal seam CBM and CMM. Known as "Section 29" tax credits (referring to the chapter of the Internal Revenue Service tax code), they allowed for tax credits beginning at nominally US$3 per barrel of oil equivalent and gradually being reduced. The credits were enacted in 1980 and expired on December 31, 2002. The Section 29 tax credit is widely believed to have spurred CBM production throughout the U.S. Reauthorization of Section 29 (now Section 45) credits was removed before the Energy Independence and Security Act of 2007 was passed in the 110th Congress (NBSA, 2007). The tax credits, however, were reinstated and revised under the Energy Improvement and Extension Act of 2008 (IRS, 2009). The current credit is US$4.375 per ton of qualified refined coal.

Although royalty fees are negotiable for private leases, a standard royalty of 12.5 percent of revenues on sales is usually paid by the operator/lessee to the owner of the mineral estate. Severance taxes are paid to state governments on revenues from natural gas sales. Power sales and other uses generating revenues are also taxed. The United States does not have a Production Sharing Agreements regime. The United States has removed all gas tariffs for gas exports / imports to or from Mexico and Canada through the North American Free Trade Agreement enacted in 1994.

Methane recovery projects must comply with stringent environmental standards, especially in environmentally sensitive areas and near urban centers. Environmental protection measures generally can be categorized as pollution control measures and habitat/land use protection. Pollution control requirements include (1) air quality standards for production of nitrous oxides, sulfur oxides, and particulate matter; (2) water quality standards limiting stormwater and wastewater discharge from facilities; and (3) noise abatement. Habitat/land-use restrictions include compliance with the Endangered Species Act and protection of forests and habitat such as limiting access in roadless areas. In some instances, especially on federal lands, it may be necessary to prepare a formal environmental impact assessment.

Safety relating to operating a CMM recovery project is governed by two regulatory agencies. MSHA has jurisdiction over mining-related matters including operation of any in-mine drilling and gas gathering equipment. MSHA also retains jurisdiction over most surface equipment. The Occupational Safety & Health Administration has jurisdiction over worker health and safety for equipment unrelated to the mining operation (e.g., gas engines away from mine facilities).

36.4 Profiles of Individual Mines

Profiles of individual mines in the United States can be found in the U.S. EPA report, "Identifying Opportunities for Methane Recovery at U.S. Coal Mines" at http://epa.gov/cmop/docs/profiles_2008_final.pdf.

36.5 References

Biothermica (2009): First-of-Kind Coal Mine Methane Mitigation System in America Now Fully Operational, Biothermica, April 13, 2009. http://www.biothermica.com/brochure_pdf/biothermica_release_13-04-09.pdf

Biothermica (2010): Biothermica Lists First Coal Mine Methane Project with the Climate Action Reserve, Biothermica, February 2, 2010. www.biothermica.com/brochure_pdf/first_vam_project_2010.pdf

BLM (2010): Coal & Coalbed Natural Gas Conflict Administration Zone, United States Bureau of Land Management, updated January 26, 2010, accessed August 27, 2010. http://www.blm.gov/wy/st/en/programs/energy/CAZ.html

CONSOL (2010a): CONSOL Energy in Partnership to Develop Largest Ventilation Air Methane Abatement Project in U.S., Consol Energy Inc., January 6, 2010. http://phoenix.corporate-ir.net/phoenix.zhtml?c=66439&p=irol-newsArticle_print&ID=1371473&highlight

CONSOL (2010b): CONSOL Energy and Verdeo Group to Develop First Large Coal Mine Ventilation Air Methane Abatement Project in West Virginia, Consol Energy Inc., June 2, 1010. http://phx.corporate-ir.net/phoenix.zhtml?c=66439&p=irol-newsArticle&ID=1433419&highlight

DSIRE (2010): Incentives/Policies for Renewable Energy, Database of State Incentives for Renewables and Efficiency (DSIRE), U.S. Department of Energy, Washington, DC, 2010. http://www.dsireusa.org/Index.cfm?RE=1&EE=0

EERE (2010): Green Pricing Utility Programs by State, U.S. Department of Energy, Energy Efficiency and Renewable Energy, Washington, DC table updated June 22, 2010. http://apps3.eere.energy.gov/greenpower/markets/pricing.shtml?page=1

EIA (2008a): International Energy Annual 2008. U.S. Energy Information Administration, Washington, DC, October 17, 2008. http://www.eia.doe.gov/pub/international/iea2008/table82.xls

EIA (2008b): Additions to Capacity on the U.S. Natural Gas Pipeline Network: 2007, U.S. Energy Information Administration, Washington, DC, posted 2008 at http://www.eia.doe.gov/pub/oil_gas/natural_gas/feature_articles/2008/ngpipelinenet/ngpipelinenet.pdf

EIA (2009a): Coalbed Methane Fields, Lower 48 States, U.S. Energy Information Administration, Washington, DC, April 8, 2009. http://www.eia.gov/oil_gas/rpd/coalbed_gas.pdf

EIA (2009b): Coalbed Methane Proved Reserves, Energy Information Administration, table updated January 10, 2009. http://tonto.eia.doe.gov/dnav/ng/ng_enr_cbm_a_EPG0_r52_Bcf_a.htm

EIA (2009c): U.S. Natural Gas Pipeline Network, 2009, U.S. Energy Information Administration, Washington, DC, 2009. http://www.eia.doe.gov/pub/oil_gas/natural_gas/analysis_publications/ngpipeline/ngpipelines_map.html.

EIA (2009d): Annual Coal Report 2008, U.S. Energy Information Administration, Washington, DC, September 18, 2009. http://www.eia.doe.gov/cneaf/coal/page/acr/table34.xls

EIA (20010a): Annual Energy Review 2009, U.S. Energy Information Administration, Washington, DC, August 19, 2010. http://www.eia.doe.gov/aer/txt/stb0102.xls; http://www.eia.doe.gov/aer/txt/stb0101.xls

EIA (2010b): Annual Energy Review 2009, U.S. Energy Information Administration, Washington, DC, August 19, 2010. http://www.eia.doe.gov/aer/txt/stb0701.xls

EIA (2010c): International Energy Statistics – Total Recoverable Coal, U.S. Energy Information Administration, Washington, DC, January 1, 2009. http://tonto.eia.doe.gov/cfapps/ipdbproject/iedindex3.cfm?tid=1&pid=9&aid=6&cid=&syid=2005&eyid=2005&unit=MST

EIA (20010d): Annual Energy Review 2009, U.S. Energy Information Administration, Washington, DC, August 19, 2010. http://www.eia.doe.gov/aer/txt/stb0702.xls

EIA (2010e): Annual Coal Report 2008, U.S. Energy Information Administration, Washington, DC, September 18, 2009. http://www.eia.doe.gov/cneaf/coal/page/acr/table1.xls

EIA (2010f): U.S. Natural Gas Prices, U.S. Energy Information Administration, Washington, DC, table updated May 28, 2010. http://tonto.eia.doe.gov/dnav/ng/ng_pri_sum_dcu_nus_a.htm

EIA (2010g): Annual Energy Outlook 2010, U.S. Energy Information Administration, Washington, DC, May 11, 2010. http://www.eia.doe.gov/oiaf/aeo/demand.html

IEA (2007): Coal and Peat in the United States in 2007, International Energy Agency, 2007. http://www.iea.org/stats/coaldata.asp?COUNTRY_CODE=US

IRS (2009): Production Tax Credit for Refined Coal, U.S. Internal Revenue Service, December 7, 2009. http://www.irs.gov/pub/irs-drop/n-09-90.pdf

Marshall (2008): Personal communication with James Marshall, Raven Ridge Resources, June 25, 2008.

M2M Projects (2010): Methane to Markets International Coal Mine Methane Projects Database, Methane to Markets, 2010, at http://www2.ergweb.com/cmm/index.aspx

M2M-US (2005): Methane to Markets U.S. Profile, 2005, http://www.methanetomarkets.org/events/2005/coal/docs/us_profile.pdf

NBSA (2007): Pres. Bush to Sign Energy Legislation, America's Small Business Advocate, December 19, 2007 at http://www.nsba.biz/content/1615.shtml

Reuters (2010): Senate Defeats Move to Stop EPA CO_2 Regulation, Reuters, 2010.

Schwochow (1997): The International Coal Seam Gas Report, Cairn Point Publishing, Steve Schwochow, editor, 1997.

Tobin (2008): Major Changes in Natural Gas Transportation Capacity, 1998–2008, James Tobin, Oil and Gas Office of the U.S. Energy Information Administration, November 2008. http://www.eia.doe.gov/pub/oil_gas/natural_gas/analysis_publications/ngpipeline/comparemapm.pps

UNFCCC (2010a): U.S. National Inventory Report 2010, United Nations Framework Convention on Climate Change, Annex I Party GHG Inventory Submission, 2010. http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/5270.php

UNFCCC (2010b): United Nations Framework Convention on Climate Change - Status of Ratification, accessed June 28, 2010. http://unfccc.int/essential_background/convention/status_of_ratification/items/2631.php

UNFCCC (2010c): Kyoto Protocol - Status of Ratification, accessed June 28, 2010. http://unfccc.int/kyoto_protocol/status_of_ratification/items/2613.php

USEPA (2004): Methane Emissions From Abandoned Coal Mines in the United States: Emission Inventory Methodology and 1990–2002 Emissions Estimates, U.S. Environmental Protection Agency, Coalbed Methane Outreach Program, 2004. http://www.epa.gov/cmop/docs/amm_final_report.pdf

USEPA (2005): Identifying Opportunities for Methane Recovery at U.S. Coal Mines: Profiles of Selected Gassy Underground Coal Mines 1997–2003. U.S. Environmental Protection Agency, Coalbed Methane Outreach Program, EPA 430-K-04-003, September 2005, www.epa.gov/cmop/docs/profiles_2003_final.pdf

USEPA (2007): U.S. to Test New Coal Mine Methane Venting Technology, U.S. Environmental Protection Agency, April 27, 2007. http://yosemite.epa.gov/opa/admpress.nsf/eebfaebc1afd883d85257355005afd19/8e330c7fc36194b9852572ca004d2ba1!OpenDocument&Highlight=2,vam

USEPA (2008): Upgrading Drained Coal Mine Methane to Pipeline Quality: A Report on the Commercial Status of System Suppliers, U.S. Environmental Protection Agency, Coalbed Methane Outreach Program, EPA-430-R08-004, January 2008. http://www.epa.gov/coalbed/docs/red24.pdf

USEPA (2010a): *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2008*, U.S. Environmental Protection Agency, Office of Atmospheric Programs, Climate Change Division, April 2010. http://epa.gov/climatechange/emissions/usinventoryreport.html

USEPA (2010b): Climate Change, U.S. Environmental Protection Agency website, visited 2010. http://epa.gov/climatechange/index.html

USEPA (2010c): EPA Proposes Rules on Clean Air Act Permitting for Greenhouse Gas Emissions, U.S. Environmental Protection Agency, August 12, 2010. http://yosemite.epa.gov/opa/admpress.nsf/e77fdd4f5afd88a3852576b3005a604f/708bd315d348b5568525777d0060c5da!OpenDocument

World Coal (2010): Managing Methane, Jayne Somers and Michael Cote, WorldCoal.com, May 2010. http://www.epa.gov/cmop/docs/World-Coal-article_May2010.pdf

37 VIETNAM

37.1 Summary of Coal Industry

37.1.1 ROLE OF COAL IN VIETNAM

Coal accounted for 12 percent of Vietnam's electricity generation in 2007 (EIA, 2007). Although Vietnam has historically relied on hydropower for electricity, coal-fired power plants are expected to eventually account for 25 percent of Vietnam's total electricity production. Vietnam suffered a shortage of electricity of 8–10 Terawatt-hours in 2008–2009. By 2020, the shortage could be 115–225 Terawatt-hours (Baruya, 2010). Vietnam Electricity (EVN), Vietnam's national electric utility has plans to build 17 new coal-fired power stations by 2020 (EIA, 2007).

The country's coal reserves, as shown in Table 37-1, are estimated at 150 million tonnes (Mmt), with almost all of the reserves as anthracite. Since the 1980s, Vietnam has become a major player in coal production in Southeast Asia. In 2004, Vietnam ramped up production to 16.42 Mmt, which was approximately 42 percent more than in 2000. Coal production for 2005 increased further, raising the total to 32.4 Mmt. In 2008, coal production reached 39.9 Mmt (EIA, 2009). Vietnam exported 4.5 Mmt of coal, primarily to Japan and China, in 2002. This number increased to approximately 15 Mmt in 2005; however, the country is expected to decrease these exports in coming years (Phuoc Ha, 2006). Other export markets for Vietnamese coal include Thailand, the European Union, Mexico, and Brazil.

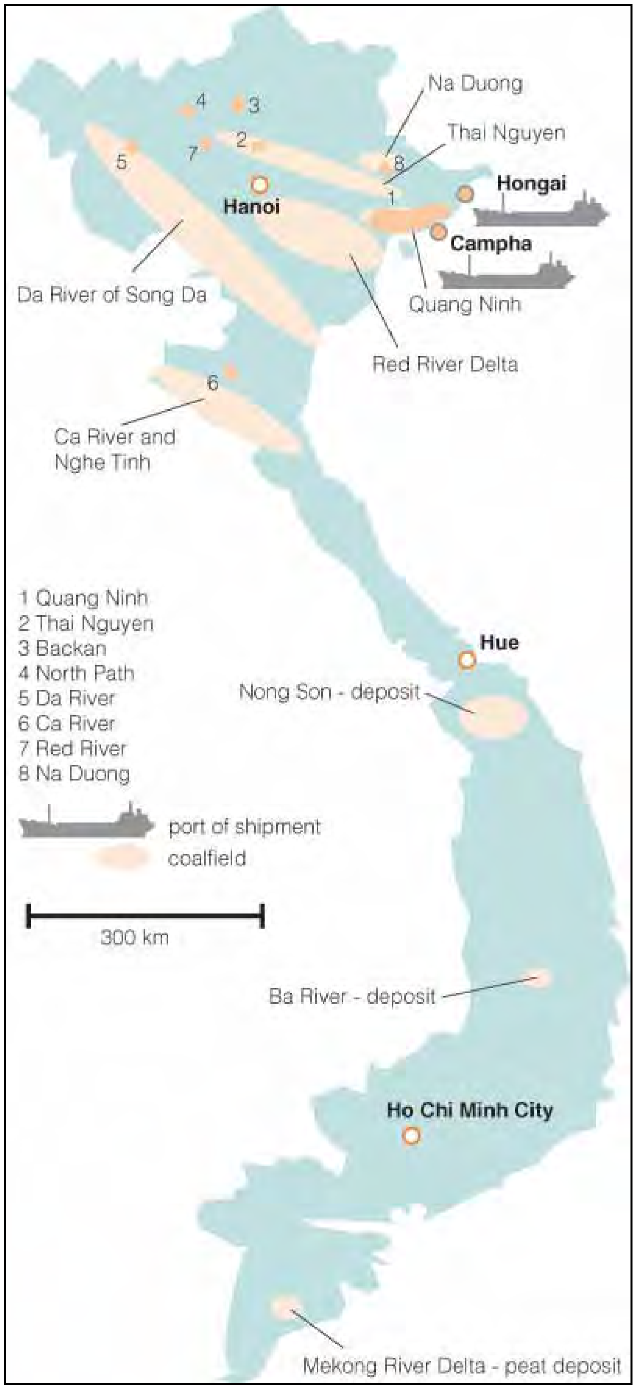
Table 37-1. Vietnam's Coal Reserves and Production

Indicator	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Global Rank (# and %)
Estimated Proved Coal Reserves (2005)	150	0	150	48 (0.02%)
Annual Coal Production (2008)	39.9	0	39.9	19 (0.6%)

Source: EIA (2009)

Most of Vietnam's coal resources are located in the north. The Quang Yen anthracite region basin, east of Hanoi near the Red River Delta, is the central mining area where coal deposits cover a total area of 3,500 square kilometers (km^2). These deposits are estimated to be 190–272 billion tonnes, lying 250–1,200 meters beneath the basin. The dip makes about half of it suitable for surface mining while the other half must be deep mined. Plans for 2010 include beginning pilot projects to exploit the reserves of the Red River Delta Basin (Omdahl et al., 2009). Figure 37-1 below shows Vietnam's coal resources.

Figure 37-1. Vietnam's Coal Resources



Source: Baruya (2010)

37.1.2 STAKEHOLDERS

Vietnam's coal mining industry is owned and operated by the state coal mining company, Vinacomin (Vietnam National Coal and Mineral Industries Group), which was created by the merger of the Vietnam Coal Corporation (Vinacoal) and Vietnam Minerals Corporation. Vinacomin operates 100 percent of all coal mines.

Table 37-2. Key Stakeholders in Vietnam's CMM Industry

Stakeholder Category	Stakeholder	Role
Mining companies	▪ Vinacoal	Project hosts
Equipment Manufacturers	▪ Vietnam Research Institute of Electronics, Informatics and Automation	
Universities, Research Establishments	▪ Institute of Mining Science and Technology, Hanoi, Vietnam ▪ University of Mining and Geology, Hanoi, Vietnam	Technical assistance
Regulatory Agencies and Government Groups	▪ Vinacoal ▪ PetroVietnam ▪ PetroVietnam Exploration Production Corporation	Project identification and assessment support

37.1.3 STATUS OF COAL AND THE COAL MINING INDUSTRY

Coal production from underground mines in past years has reached 30–35 percent of capacity and will increase in the coming years. As of 2009, Vietnam had 20 underground mines, seven of which have an annual production capacity of more than 1 Mmt. The remaining underground mines have an annual capacity between 300,000 and 800,000 tonnes per mine (Omdahl et. al., 2009). Vietnam is seeking to increase production of its deeper anthracite reserves for high-quality export grade coals, as well as for its expanding coal power sector. Purchases of heavy mining equipment from Australia have enabled the expansion of existing underground mines and development of new underground mines.

Some of Vietnam's surface mines have been closed; however, 29 remain open. Six surface mines have an annual production capacity from 0.8 to 1.5 Mmt per mine. The remaining mines each have an annual capacity of 200,000–400,000 tonnes (Omdahl et.al., 2009).

As of 2008, Vietnam had 27 total thermal power plants, 10 of which are coal-fired and 13 are gas-fired. Coal-fired plants include Na Duong (110 megawatts [MW]), Cao Ngan (110 MW), Cam Pha (two 340-MW) and Son Dong (220 MW). Vietnam has plans to build an additional 12 thermal power plants in the northern economic regions by 2015. Coal-fired plants currently under construction include Mao Khe (220 MW) and Nong Son (30 MW). Vietnam plans to import coal to meet power demand after 2011 (Omdahl et. al., 2009).

37.2 Overview of CMM Emissions and Development Potential

The Global Methane Initiative (formerly Methane to Markets Partnership) International CMM Projects Database currently identifies no CMM projects; however, the coalbed methane (CBM) industry is emerging in areas where mining is poised to take place, and thus may evolve into CMM projects as CBM activity intersects with mining.

A recent study of Vietnam's 25 gassy hard coal mines was commissioned to determine gas content of coals and to forecast methane release into the mines. Seven mines were classified as especially gassy. The results of the forecasts and a study of the capacities of these mines' ventilation systems are being used to estimate the amount of methane that may be captured by drainage systems. Additionally, the gassiest

mine, Mao Khe, was equipped with an automatic methane content measurement control system (Somers, 2010).

37.2.1 CMM Emissions from Operating Mines

With increasing coal production and the mining of deeper seams, CMM emissions in Vietnam have also increased. Table 37-3 summarizes Vietnam's CMM emissions.

Table 37-3. Vietnam's CMM Emissions (million cubic meters)

Emission Category	1990	1994	1995	2000	2005	2010 (projected)
Total Emissions from Underground Coal Mines		49.80				
Total Emissions from Surface Mines		3.18				
Total liberated		52.98				
Recovered & Used		0				
Total emitted	32.4*	52.98	58.5*	69.7*	83.2*	99.3*

Source: UNFCCC (2003); *USEPA (2006)

37.2.2 CMM Emissions from Abandoned Mines

No information relating to recovery or use of CMM from abandoned mines was found.

37.2.3 CBM from Virgin Coal Seams

A number of potential areas for CBM development exist in Vietnam. The Red River Basin is an economically important area of northern Vietnam. The area has coal deposits lying at depths of 250–1,200 meters spread over a 3,500 km^2 area. Gas content of the basin's sub-bituminous coal is estimated at 0.94–1.6 m^3 per tonne (30–50 standard cubic feet [scf]/ton), with conservative resource estimates ranging from 170 to 280 billion m^3 (6–10 trillion cubic feet [Tcf]). Another area of interest is the Quang Yen Basin, which extends over 200 kilometers (km) from east to west in northeast Vietnam and covers approximately 5,000 km^2. Though yet undetermined, CBM and CMM potential of this area is a target for study (Thai, 2008).

Most of Vietnam's CBM activity to date has been confined to the Red River Basin. Keeper Resources has been working on the first CBM extraction projects. The negotiated CBM concession with PetroVietnam and PetroVietnam Exploration Production Corporation (PVEP) covers approximately 3,600 km^2 of the Red River Basin to the southeast of Hanoi. Three years of negotiations were concluded with the signing of a CBM Production Sharing Contract (PSC) in early 2010. The project proceeded with the signing of drill site construction and preparation contracts after acquiring land access approvals (Dragon Capital, 2008; Dragon Capital, 2010). A scoping study of the CBM potential in the Red River Basin commissioned by Keeper estimated prospective gas resources to be 55 billion m^3 in the study area, which represents 28 percent of Keeper's concession (Keeper, 2005).

In addition, Arrow Energy has signed a PSC with PVEP in a CBM concession of 2,743 km^2 in the Red River Basin. The PSC requires Arrow to drill eight wells on the block. Exploration drilling began in January 2009 (Arrow, 2009).

37.3 Opportunities and Challenges to Greater CMM Recovery and Use

Vietnam is a signatory to both the UNFCCC and the Kyoto Protocol (see Table 37-40). As a Non-Annex I Party to the Kyoto Protocol, it has no national emissions targets and is eligible to host mitigation projects under the Clean Development Mechanism.

Table 37-4. Vietnam's Climate Change Mitigation Commitment

Agreement	Signature	Ratification
UNFCCC	June 11, 1992	November 16, 1994
Kyoto Protocol	December 3, 1998	September 25, 2002

Source: UNFCCC (2010)

37.3.1 Market and Infrastructure Factors

No information pertaining to market and infrastructure barriers could be sourced from the Vietnamese Ministry of Natural Resources and Environment website or the Ministry of Industry and Trade's website, as of June 2010. However steady and increasing coal mining as well as increased demand for natural gas makes CBM and CMM attractive in Vietnam. Coal mining is poised to continue escalating in Vietnam to meet the demand of 200 Mmt by 2020 (MONRE, 2010a). There have also been recent discussions within the country surrounding the use of natural gas to fuel additional power plants as well as the use of natural gas in the form of compressed natural gas (CNG) to operate vehicles (MONRE, 2010b; MONRE, 2010c). Between 2008 and the first half of 2009, Vietnam commissioned 5 GWe of new electric capacity, much of which was gas-fired (2.7 GWe) (Baruya, 2010). Currently, natural gas is not commonly used outside of the industrial and power generation sectors (EIA, 2007).

37.3.2 Regulatory Information

Vietnam's natural gas sector is dominated by the state-owned Vietnam Oil & Gas Corporation, Petrovietnam, which is under the control of the Ministry of Industry (EIA, 2007). Current CBM activity is conducted through production sharing contracts.

Coal production in Vietnam exceeded growth expectations from 2001 to 2005. Various sources have reported that the Vietnamese government would like to slow this growth and retain coal reserves for domestic utilization.

37.4 Profiles of Individual Mines

The Vietnam Coal Corporation reports coal reserves of 6.5–7 billion tonnes in the Quang Nimh coalmine (Phuoc Ha, 2006); however no information regarding CMM projects could be obtained. Updates on future CMM projects in Vietnam can be found at http://www.methanetomarkets.org/coalmines/index.htm#profiles.

37.5 References

Arrow (2009): Vietnam – Arrow Energy. http://www.arrowenergy.com.au/page/Projects/Vietnam/

Baruya (2010): Prospects for Coal in Vietnam. Paul Baruya, IEA Clean Coal Centre. CCC/164, ISBN 978-92-9029-484-9, February 2010. http://www.iea-coal.org.uk/site/ieacoal/publications/newsletter/current-issue/prospects-for-coal-in-vietnam

Dragon Capital (2008). Vietnam Resource Investments. Dragon Capital Markets Limited Monthly Report March 2008. http://www.dragoncapital.com/UserFiles/File/monthly%20report/2008/Mar/MR_200803VRI.pdf?PHPSESSID=e1fc9daa1d3bfa3ae589ab41f43ad982

Dragon Capital (2010): Vietnam January 2010 Update. Dragon Capital Markets Limited. January, 2010. http://www.dragoncapital.com/UserFiles/File/monthly%20report/2010/Jan/MR_201001.pdf

EIA (2007): Vietnam Country Analysis Brief, U.S. Energy Information Administration, July 2007. http://www.eia.doe.gov/emeu/cabs/Vietnam/Full.html

EIA (2009): International Energy Statistics. U.S. Energy Information Administration, Independent Statistics and Analysis. 2009. http://tonto.eia.doe.gov/cfapps/ipdbproject/IEDIndex3.cfm

IEA (2007): *International Energy Agency Energy Statistics – Coal*. International Energy Agency, Paris, France, table posted at http://www.iea.org/Textbase/country/index.asp

IEA Coal Research (1983): Concise Guide to World Coalfields, IEA Coal Research, London, 1983.

Keeper (2005): Vietnam CBM Review. Keeper Resources. 2005. http://www.keeperresources.com/Vietnam%20CBM%20Review.pdf

MONRE (2010a): *Coal sector urged to ensure occupational health and safety.* Viet Nam Ministry of Natural Resources and Environment. January 25, 2010. http://www.monre.gov.vn/monreNet/Default.aspx?tabid=256&ItemID=79305

MONRE (2010b): *US offers to help Vietnam exploit gas reserves.* Viet Nam Ministry of Natural Resources and Environment. March 19, 2010. http://www.monre.gov.vn/monreNet/Default.aspx?tabid=256&ItemID=81570

MONRE (2010c): *Greater government support needed for natural gas.* Viet Nam Ministry of Natural Resources and Environment. April 2, 2010. http://www.monre.gov.vn/monreNet/Default.aspx?tabid=259&ItemID=82302

Omdahl et. al. (2009):*Vietnam's Coal, Mining, and Coal-fired Power Generation*. Brent Omdahl, Nguyen Dzung, and Jason Card, U.S. Embassy Hanoi, Vietnam, presented June 10, 2009, available from United States Commercial Service, United States Department of Commerce. http://www.buyusa.gov/vietnam/en/259.html

Phuoc Ha (2006): *Vetnamnet Bridge*. http://english.vietnamnet.vn/biz/2006/09/608994/

Somers (2010): Coal Mine Methane Project Opportunities: Globally and in Viet Nam, Jayne Somers and Charlee Boger, presented at Advanced Mining for Sustainable Development, Ha Long Bay, Viet Nam September, 2010.

Thai (2008): Coal Bed Methane in Vietnam is Hot. Thai Son Do, Research Associate, Energy & Power Systems Practice, Frost & Sullivan. August 7, 2008. http://www.frost.com/prod/servlet/market-insight-top.pag?docid=140182389

UNFCCC (2003): Socialist republic of Viet Nam, Ministry of Natural Resources and Environment: "Vietnam Initial National Communication" 2003. p. 18, 27–28. http://unfccc.int/resource/docs/natc/vnmnc01.pdf

UNFCCC (2010): Ratification Status, accessed June 15, 2010. http://maindb.unfccc.int/public/country.pl?country=VN

USEPA (2006): *Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990–2020*, Draft, U.S. Environmental Protection Agency, Office of Atmospheric Programs, Climate Change Division, June 2006. Available at: http://www.epa.gov/nonco2/econ-inv/international.html