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Coal Mine Methane Country Profiles



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UNITS OF CONVERSIONS

Units	
t	tonnes
Mt	thousand tonnes
Mmt	million tonnes
Mmt CO ₂ e	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 ₂ e
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 continues to work with government agencies around the world to facilitate project development in five key methane-producing sectors: agriculture (manure management), coal mines, municipal solid waste (MSW), oil and natural gas systems, and wastewater. The efforts of this collaboration are yielding important and diverse benefits across the globe, such as enhanced economic growth and energy security, improved air quality and industrial safety, and reduced GHG emissions.

GMI has grown over the past 10 years to include 42 Partner Countries and the European Commission, representing about 70 percent of the world’s anthropogenic methane emissions. GMI also includes a vibrant Project Network of more than 1,300 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 Subcommittee in its goal of reducing methane emissions in the coal mines sector. The study scopes out opportunities across the world for coal mine methane (CMM) recovery projects, serving as a guide for the Coal Subcommittee to promote the development of future CMM projects. The study profiles 37 countries—GMI Partner Countries and otherwise—most of which are actively producing coal or have significant coal reserves (see Table ES-1).

Countries Profiled in the Report

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

*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 ES-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 857,937 million tonnes (Mmt) (397,026 Mmt anthracite and bituminous;

460,912 Mmt sub-bituminous and lignite). The United States alone holds roughly 28 percent of the world's total or 234,615 Mmt.

Table ES-1. Estimated Coal Reserves, 2011

Country	Anthracite & Bituminous (million tonnes)	Sub-bituminous & Lignite (million tonnes)	Total (million tonnes)	Profiled Country Rank (# and %)
Argentina	a	550	550	23 (0.064%)
Australia	37,100	39,300	76,400	4 (8.905%)
Botswana	40	0	40	34 (0.005%)
Brazil	0	6,630	6,630	13 (0.773%)
Bulgaria	2	2,364	2,366	17 (0.276%)
Canada	3,474	3,108	6,582	14 (0.767%)
China	62,200	52,300	114,500	3 (13.346%)
Colombia	6,746	0	6,746	12 (0.786%)
Czech Republic	181	871	1,052	21 (0.123%)
Ecuador	0	24	24	35 (0.003%)
Finland	0	0	0	36 (tie) (0.0%)
France	0	0	0	36 (tie) (0.0%)
Georgia	201	0	201	29 (0.023%)
Germany	48	40,500	40,548	6 (4.726%)
Hungary	13	1,647	1,660	19 (0.193%)
India	56,100	4,500	60,600	5 (7.063%)
Indonesia	0	28,017	28,017	10 (3.266%)
Italy	0	50	50	33 (0.006%)
Japan	337	10	347	25 (0.040%)
Kazakhstan	21,500	12,100	33,600	8 (3.916%)
Mexico	860	351	1,211	20 (0.141%)
Mongolia	1,170	1,350	2,520	16 (0.294%)
New Zealand	33	538	571	22 (0.067%)
Nigeria	21	169	190	30 (0.022%)
Pakistan	0	2,070	2,070	18 (0.241%)
Philippines	41	275	316	26 (0.037%)
Poland	4,178	1,287	5,465	15 (0.637%)
Republic of Korea, South	0	126	126	32 (0.015%)
Romania	10	281	291	27 (0.034%)
Russia	49,088	107,922	157,010	2 (18.301%)
South Africa	30,156	0	30,156	9 (3.515%)
Spain	200	330	530	24 (0.062%)
Turkey	322	8,380	8,702	11 (1.014%)

Table ES-1. Estimated Coal Reserves, 2011

Country	Anthracite &	Sub-bituminous		Profiled Country
Ukraine	15,351	18,522	33,873	7 (3.948%)
United Kingdom	228	0	228	28 (0.027%)
United States	107,276	127,340	234,615	1 (27.346%)
Vietnam	150	0	150	31 (0.017%)
Profiled Countries Total	397,026	460,912	857,937	

Source: *International Energy Statistics – Coal Reserves*, U.S. Energy Information Administration (EIA), Washington, DC, data as of 31 December 2014. <http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=1&pid=7&aid=6>

Note: EIA calculates U.S. reserves only. It reproduces international reserves data from World Energy Council (WEC) based on WEC’s definition of “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.

Table ES-2. Estimated Coal Production, 2012

Country	Anthracite & Bituminous	Lignite	Total	Profiled Country Rank (# and %)
Argentina	0.08	0.00	0.08	31(tie) (0.001%)
Australia	347.20	73.54	420.74	5 (5.49%)
Botswana	0.74	0.00	0.74	29 (0.01%)
Brazil	3.26	3.04	6.30	24 (0.08%)
Bulgaria	0.01	32.51	32.52	19 (0.42%)
Canada	57.00	9.50	66.50	13 (0.87%)
China	3,510.25	141.52	3,651.76	1 (47.63%)
Colombia	89.45	0.00	89.45	11 (1.17%)
Czech Republic	11.44	43.53	54.97	15 (0.72%)
Ecuador	0.00	0.00	0.00	33 (tie) (0.0000%)
Finland	0.00	0.00	0.00	33 (tie) (0.0000%)
France	0.00	0.00	0.00	33 (tie) (0.0000%)
Georgia	0.25	0.00	0.25	30 (0.003%)
Germany	11.56	185.43	196.99	8 (2.569%)
Hungary	0.00	9.29	9.29	22 (0.12%)
India	545.86	43.49	589.35	3 (7.69%)
Indonesia	442.81	0.00	442.81	4 (5.78%)
Italy	0.08	0.00	0.08	31 (tie) (0.001%)
Japan	0.00	0.00	0.00	33 (tie) (0.0000%)

Table ES-2. Estimated Coal Production, 2012

Country	Anthracite & Bituminous	Lignite	Total	Profiled Country Rank (# and %)
Kazakhstan	120.50	5.52	126.02	10 (1.64%)
Mexico	15.19	0.00	15.19	21 (0.20%)
Mongolia	23.63	9.98	33.61	18 (0.44%)
New Zealand	4.60	0.33	4.93	26 (0.06%)
Nigeria	0.03	0.00	0.03	32 (0.0004%)
Pakistan	1.92	1.17	3.09	27 (0.04%)
Philippines	8.00	0.00	8.00	23 (0.10%)
Poland	79.23	64.28	143.51	9 (1.87%)
Republic of Korea, South	2.09	0.00	2.09	28 (0.03%)
Romania	0.04	33.99	34.03	17 (0.44%)
Russia	276.09	77.85	353.94	6 (4.62%)
South Africa	259.30	0.00	259.30	7 (3.38%)
Spain	6.15	0.00	6.15	25 (0.08%)
Turkey	3.56	65.95	69.51	12 (0.91%)
Ukraine	64.63	0.00	64.63	14 (0.84%)
United Kingdom	16.29	0.00	16.29	20 (0.21%)
United States	850.51	71.60	922.12	2 (12.03%)
Vietnam	42.10	0.00	42.10	16 (0.55%)
Profiled Countries Total	6,793.84	872.52	7,666.37	
WORLD	6,854.2	1,033.5	7,887.7	

Source: *International Energy Statistics – Coal Production*, EIA, Washington, DC, data as of 31 December 2014.

<http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=1&pid=7&aid=1>

As seen in Table ES-2 above, China and the United States are by far the world's largest coal producers, together accounting for nearly 65 percent of profiled countries' production. China alone produces more than half of the profiled countries' total production. Of the countries evaluated in this study, Ecuador, Finland, France, and Japan are currently not producing any coal.

Table ES-3. Methane Emissions from Coal Mining (MmtCO₂e)

Country	2000	2005	2010	2015*	Profiled Country Rank (as of 2015)
Argentina	0.23	0.04	0.11	0.13	30
Australia	20.84	22.76	27.24	29.57	5
Botswana	0.27	0.27	0.31	0.32	28
Brazil	0.90	1.03	1.15	1.46	20
Bulgaria	1.32	1.23	1.45	1.52	19
Canada	0.97	1.00	0.94	0.98	23

Table ES-3. Methane Emissions from Coal Mining (MmtCO₂e)

Country	2000	2005	2010	2015*	Profiled Country Rank (as of 2015)
China	134.74	257.11	295.51	321.16	1
Colombia	3.28	5.08	7.29	9.26	8
Czech Republic	5.02	4.65	4.38	4.20	13
Ecuador	-	-	-	-	34 (tie)
Finland	-	-	-	-	34 (tie)
France	2.37	-	-	-	34 (tie)
Georgia	0.00	0.00	0.00	0.00	33
Germany	9.68	5.69	3.68	3.53	14
Hungary	0.31	0.02	0.02	0.02	32 (tie)
India	14.90	15.95	18.88	20.68	7
Indonesia	1.02	2.26	4.04	4.42	12
Italy	0.03	0.02	0.02	0.02	32 (tie)
Japan	0.77	0.07	0.05	0.05	31
Kazakhstan	18.32	17.51	22.30	23.28	6
Mexico	1.73	2.16	2.35	1.84	17
Mongolia	0.10	0.15	0.20	0.21	29
New Zealand	0.34	0.33	0.39	0.42	26
Nigeria	0.34	0.91	0.96	1.01	22
Pakistan	0.95	1.50	1.13	1.24	21
Philippines	0.20	0.43	0.38	0.41	27
Poland	10.96	9.58	7.90	7.58	10
Republic of Korea	1.16	0.79	0.81	0.88	24
Romania	2.67	2.49	2.73	2.85	15
Russia	41.95	45.39	48.82	50.97	3
South Africa	7.68	8.33	8.17	8.64	9
Spain	1.23	0.92	0.66	0.63	25
Turkey	1.62	1.48	1.90	1.82	18
Ukraine	31.38	29.90	29.71	31.02	4
United Kingdom	6.99	4.08	2.73	2.62	16
United States	60.41	56.91	67.47	69.98	2
Vietnam	1.87	5.23	6.91	7.57	11
Profiled Countries Total	386.56	505.28	570.58	610.31	
World Totals	401.41	521.57	588.55	629.74	

*2015 emissions: Extrapolated based on changes in coal production from 2000 to 2010.

Source: *Global Anthropogenic Non-CO₂ Greenhouse Gas Emissions: 1990–2030*, U.S. Environmental Protection Agency (U.S. EPA), Office of Atmospheric Programs, Climate Change Division, December 2012.

http://www.epa.gov/climatechange/Downloads/EPAactivities/EPA_Global_NonCO2_Projections_Dec2012.pdf

In Table ES-3 above, total historical and/or projected methane emissions from coal mining are shown for 2000, 2005, 2010, and 2015. China, which has the world's highest coal production, also emits the greatest amount of CMM, estimated at more than 321 MmtCO₂e per year. Other large CMM emitters (i.e., more than 10 MmtCO₂e per year) based on 2015 estimates are the United States, Russia, Ukraine, Australia, Kazakhstan, and India.

GMI's International CMM Project Database (<https://www.globalmethane.org/coal-mines/cmm/index.aspx>) 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 nearly half 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.

According to data found in the International CMM Projects Database, 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.

Introduction

Methane is a potent greenhouse gas (GHG) that is more than 28 to 34 times as powerful as carbon dioxide (CO₂) at trapping heat in the atmosphere, on a mass-basis over a 100-year timeframe.¹ By 2015, it is estimated that methane will account for 14 percent of global GHGs, with more than 60 percent of the total methane emissions coming from human-related activities, such as agriculture, coal mining, municipal solid waste (MSW), oil and natural gas systems, and wastewater.² Since methane has a much shorter atmospheric lifetime than CO₂ (about 12 years compared to about 200 years for CO₂), 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. M2M was re-launched as the Global Methane Initiative (GMI) in October 2010 and membership has expanded to 42 countries (and the European Commission) as of 2015 (see text box below), representing about 70 percent of the world's anthropogenic methane emissions. Public and private sector organizations around the world are also working together with government agencies to facilitate project development. These collaborative efforts 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 Partners (as of 2015)

Albania	Ethiopia	Kazakhstan	Republic of Serbia
Argentina	European Commission	Mexico	Russia
Australia	Finland	Mongolia	Saudi Arabia
Brazil	Georgia	Nicaragua	Sri Lanka
Bulgaria	Germany	Nigeria	Thailand
Canada	Ghana	Norway	Turkey
Chile	India	Pakistan	Ukraine
China	Indonesia	Peru	United Kingdom
Colombia	Italy	Philippines	United States
Dominican Republic	Japan	Poland	Vietnam
Ecuador	Jordan	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 8 percent of the global anthropogenic methane emissions by 2015, coal mine methane (CMM)—if recovered and utilized—not only provides valuable clean fuel and environmental benefits, but also improves mine safety and productivity.

¹ The fifth report of the Intergovernmental Panel on Climate Change (IPCC), released in the last year, included methane GWP values of 28 to 34. The United States and other developed countries are currently using the fourth report's GWP value of 25 to quantify the climate impact of U.S.-government-supported methane reduction projects.

² *Global Anthropogenic Emissions of Non-CO₂ Greenhouse Gases: 1990–2030*, U.S. Environmental Protection Agency (U.S. EPA), Office of Atmospheric Programs, Climate Change Division, December 2012.
http://www.epa.gov/climatechange/Downloads/EPAactivities/EPA_Global_NonCO2_Projections_Dec2012.pdf

CMM varies in quality depending on the source of emission. CMM drained from underground mine ventilation systems is very dilute. Referred to as ventilation air methane (VAM), it accounts for the largest source of CMM emissions globally. In some instances, it is necessary to supplement ventilation with a degasification system consisting of a 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 technology has been demonstrated to recover the energy content of dilute methane emissions from coal mine ventilation shafts (i.e., VAM). 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 (see text box).

Although there are significant benefits and scope for CMM recovery and use, developing CMM projects face several challenges. These include accessing 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.

CMM Uses

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

Purpose of the Report

This report has been prepared under the aegis of the GMI Coal 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 the Coalbed Methane Outreach Program (CMOP), an initiative of the U.S. Environmental Protection Agency (U.S. EPA) that supports GMI's efforts in promoting CMM project development in coal-producing countries. The information in this report is 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