

**EMD Coalbed Methane Committee Report
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EXECUTIVE SUMMARY

Coalbed methane (CBM; also known as coal-bed methane, coalbed natural gas, coal seam gas) is a type of unconventional natural gas generated and stored in coal beds. Sorbed gas is released and produced from coal following the reduction of hydrostatic pressure with the removal of water from coal cleats and other fractures during drilling. Coal mine methane (CMM), on the other hand, is gas produced in association with coal mining operations.

Production of natural gas from coal beds in the United States continued to decline in 2015. CBM is still an important resource globally. Research on CBM remains active, however, as indicated by the 40 technical papers published in 2017. These references have been added to the 88-page CBM bibliography available on the EMD Coalbed Methane Committee web site (<http://www.aapg.org/about/aapg/overview/committees/emd/articleid/24810/committee-emd-coalbed-methane>).

Mastalerz (2014, figure 7.3) included a map showing world CBM resources, production, and exploration activities as summarized below, modified by data from Kelafant (2016).

CBM Resources by Country		
Country	Mastalerz (2014) 2010 Resources, Tcf	Kelafant (2016) Tcf
Russia	2,824	
China	1,100	1,300
Alaska	1,037	
U.S. (minus Alaska)	700	
Australia	500	203
Canada	500	801
Indonesia	435	
Poland	424	
France	368	
Germany	100	
UK	100	
India	70	120
Ukraine	60	

Zimbabwe	40	
Kazakhstan	25	27
Southern Africa		110

Annual CBM Production by Country (2010 data) (from Mastalerz, 2014)	
Country	Production, Bcf
U.S. (minus Alaska)	1,886
Canada	320
Australia	190
China	50
Alaska	1
Russia	0.5
India	0.4
Kazakhstan	0.4

STATUS OF U.S. COALBED METHANE ACTIVITIES

EIA (2009a) shows a map of U.S. lower 48 states CBM fields (as of April 2009). U.S. annual CBM production peaked at 1.966 Tcf in 2008 (EIA, 2009b, 2010, 2016a). CBM production declined to 1.269 Tcf in 2015 (EIA, 2016a), the lowest level since 2001, representing 4.7% of the U.S. total natural gas production of 27.1 Tcf (EIA 2017c; **Figure 1**). Note that U.S. CBM production in EIA (2016a, Table 15) is different than in EIA (2017a, Table 1). According to EIA (2016a, Table 15; **next release date is December 2017**), the top 8 CBM producing U.S. states during 2015 (production in Bcf) were Colorado (392), New Mexico (344), Wyoming (207), Virginia (106), Alabama (72), Oklahoma (48), Utah (42), and Kansas (25). Annual CBM production decreased for each state over the previous year (EIA 2016a, c; **Figure 2**). Cumulative U.S. CBM production from 1989 through 2015 was 34.7 Tcf. CBM production continues even though few new wells are being completed, reflective of the very long productive lives of CBM wells. As many U.S. CBM fields approach late maturity in an environment of low commodity price, operators are working to optimize operations and reduce lifting costs. In the Black Warrior Basin of Alabama, for example, compressors are being used to produce large numbers of mature wells on vacuum, which has resulted in increased gas production and reduced pumping and water handling costs.

According to EIA (2016b, data through 2015), annual peak CBM production in the top 8 CBM producing U.S. states during 2015 occurred in the following years: Colorado (533 Bcf in 2010), New Mexico (597 Bcf in 1997), Wyoming (573 Bcf in 2008), Virginia (111 Bcf in 2009), Oklahoma (82 Bcf in 2007), Alabama (123 Bcf in 1998), Utah (103 Bcf in 2002), and Kansas (47 Bcf in 2008)(Figure 2). The web site <http://www.wyohistory.org/essays/coalbed-methane-boom-bust-and-hard-lessons> provides a history of Wyoming CBM production. U.S.G.S. (2014) includes hyperlinks to USGS CBM assessment publications and web pages.

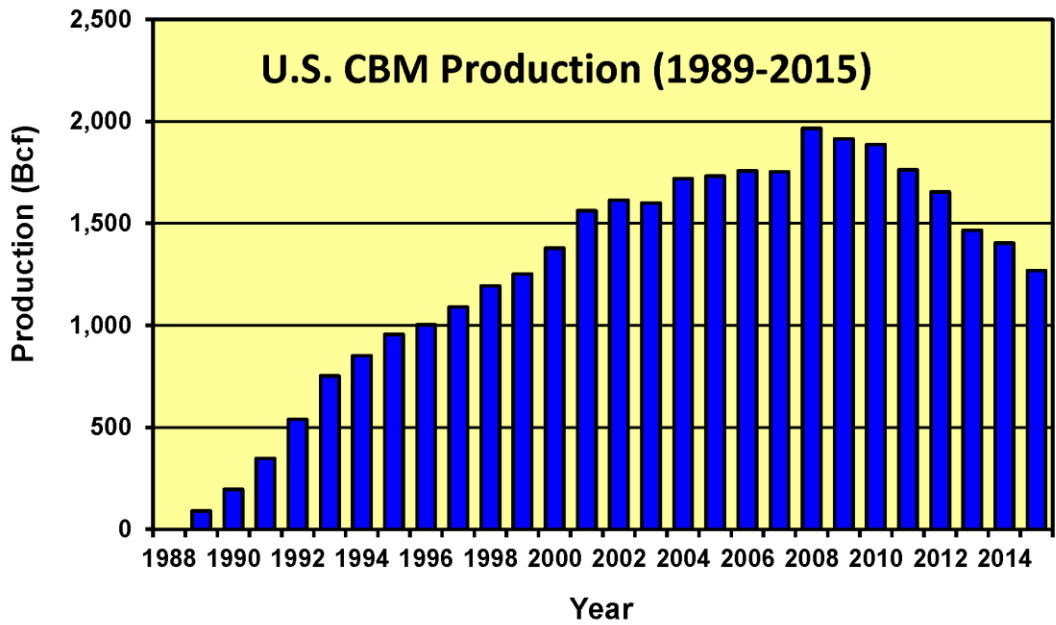


Figure 1. United States CBM production (1989–2015; compiled from EIA).

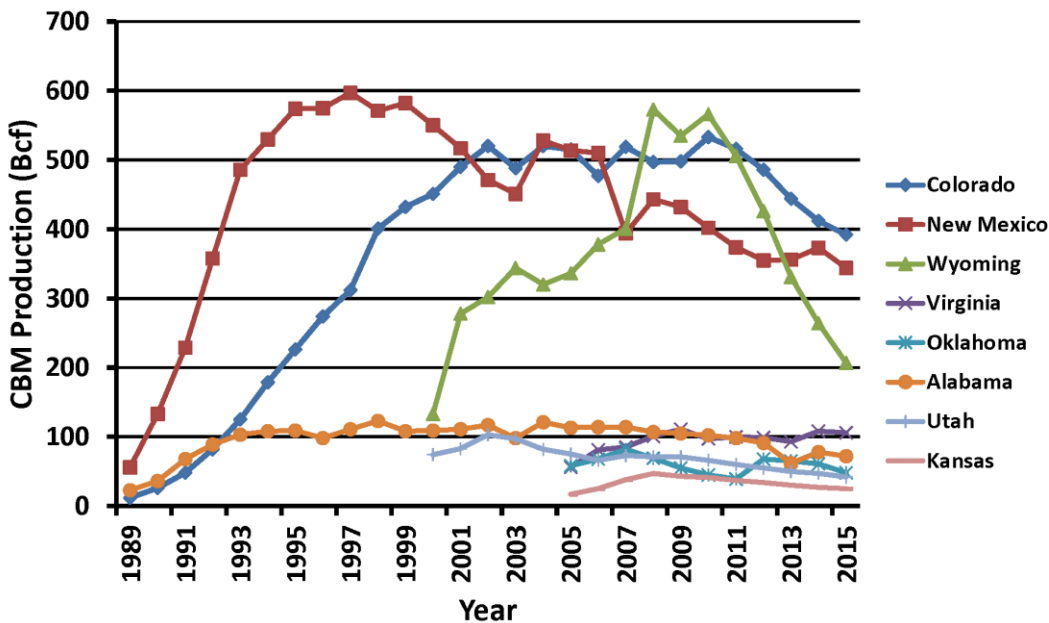


Figure 2. Annual CBM production of the top 8 U.S. states during 2015 (1989–2015; compiled from EIA, 2016a, Table 15).

According to the Potential Gas Committee Press Release (2017), the United States has 158.7 Tcf CBM resources (15.0 Tcf, probable resources [current fields], 48.0 Tcf, possible resources [new fields], and 95.7 Tcf, speculative resources [frontier]) for 2016, an increase of 0.6 Tcf CBM resources since 2014. By region, 152.3 Tcf “most likely” CBM resources are distributed as follows: 57.0 Tcf, Alaska; 52.6 Tcf, Rocky Mountain; 17.3 Tcf, Atlantic; 11.6 Tcf, North Central; 7.8 Tcf, Mid-Continent; 3.4 Tcf, Gulf Coast; and 2.6 Tcf, Pacific.

United States annual CBM proved reserves peaked at 21.874 Tcf in 2007 (EIA, 2009b, 2010, 2016c), with 12.517 Tcf in 2015 (EIA, 2016c) representing 4.1% of the U.S. total natural gas reserves of 308 Tcf (EIA, 2016d; **Figure 3**). Annual CBM proved reserves by U.S. state (through 2015) is available at EIA (2016c).

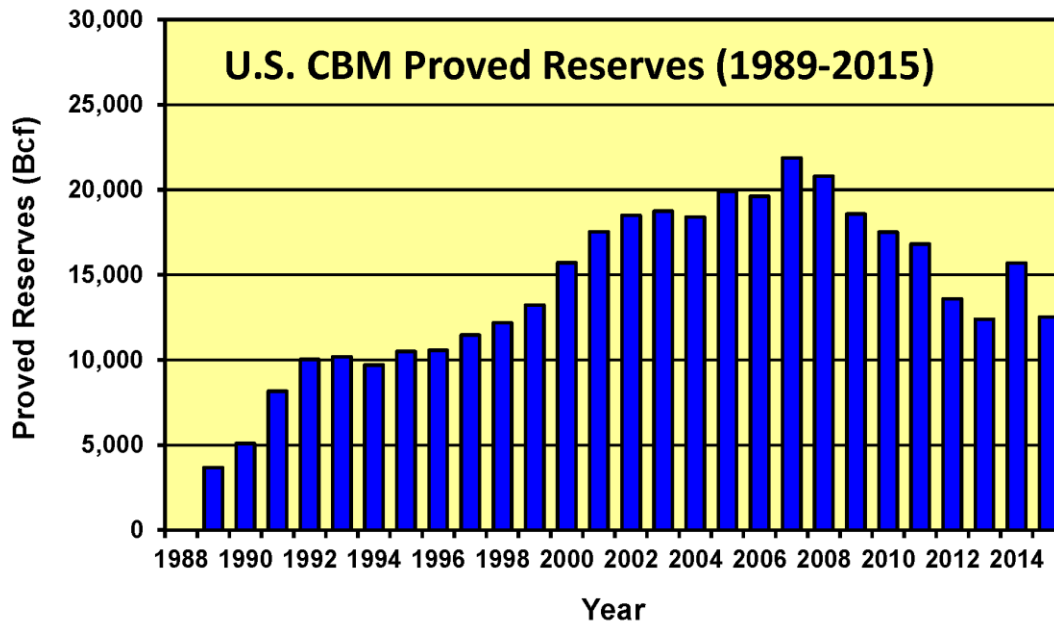


Figure 3. United States CBM proved reserves (1989-2015; compiled from EIA).

The EPA Coalbed Methane Outreach Program (<https://www.epa.gov/cmop>) has information on U.S. coal mine methane, including a map of CMM recovery at active and abandoned U.S. coal mines.

STATUS OF INTERNATIONAL COALBED METHANE ACTIVITIES

Australia

Information on Australian coal seam gas is available on the Australian Government Geoscience Australia web sites (<http://www.ga.gov.au/scientific-topics/energy/resources/petroleum-resources/coal-seam-gas>; <http://www.ga.gov.au/data-pubs/data-and-publications-search/publications/oil-gas-resources-australia/2005/coalbed-methane>). According to the EIA (2017b, p. 8; updated March 7, 2017), “Geoscience Australia estimated total proved plus probable commercial reserves at 114 Tcf (62% conventional natural gas, 38% coal bed methane (CBM), and less than 1% tight gas) as of 2014.” “CBM resources, equivalent to about 43 Tcf, are primarily located in the northeastern Queensland Province in the Bowen Basin and the Surat Basin. Geoscience Australia anticipates the resource distribution of natural gas will shift from the offshore traditional gas production to CBM or other sources in the next few decades because key CBM developers are aggressively exploring and drilling in several areas.” “Commercial production from CBM, which began in 1996, rose to 424 Bcf in 2015, 50% higher than in 2014. This production increase corresponds with the

commencement of the country's first CBM-to-LNG export terminals in Queensland over the past two years" (p. 11).

Towler et al. (2016, p. 254) provided "An overview of the coal seam gas developments in Queensland", in which they reported "In the 2014/2015 fiscal year Queensland produced 469 Bcf of gas, of which 430 Bcf was CSG" from the Bowen and Surat basins. The most recent Queensland Government petroleum and coal seam gas report is available at <https://publications.qld.gov.au/dataset/queensland-petroleum-and-coal-seam-gas>.

Flores (2013, figure 9.15) included a map showing coal seam gas (CSG) potential in Australia noting that the coal beds range in age from Permian to Tertiary in about 30 coal-bearing basins. Blewett (2012) included maps showing the distribution of demonstrated black coal resources and gas resources in Australia. CSG reserves in 2012 are divided into six coal basins in eastern Australia: Surat Basin (69%), Bowen Basin (23%), Gunnedah Basin (4%), Gloucester Basin (2%), Sydney Basin (1%), and Clarence-Moreton Basin (1%)(Flores, 2013). The Australia country analysis brief is available at EIA (2015a).

An interactive map of coal seam gas wells in New South Wales as of November 13, 2017 is available at <http://www.resourcesandenergy.nsw.gov.au/landholders-and-community/coal-seam-gas/facts-maps-links/map-of-csg-wells>. Relatively few wells are producing gas, while most of the wells are either "permanently sealed" or "not producing gas".

China

In 2017, by the end of August, the CBM production in China was 4.46 billion m³ with a growth of 3.3%, of which the production in August alone was 0.59 billion m³ with a growth of 7.2%, as reported by the China Coal Bed Methane Industry Market Research Report (<http://www.china5e.com/news/news-1004285-1.html>). Shanxi province has the most CBM production of 2.92 billion m³ in the eight months of 2017, of which in August 2017 the CBM production was 0.41 billion m³, accounting for 70% of the total production in the whole country. According to the news from the Shanxi province Land and Resources Department of August 23, 2017, the Yushe-wuxiang coalbed methane resource survey project made breakthrough progress with a new discovery of CBM and shale gas resources of 181.2 billion m³ in an area of 388.51 km³. Ignition tests show that daily production is up to 1000 m³. Burial depth of the coal bed in this area is more than 1300 m. The project shows a great innovation in production technology of deeply buried CBM (http://www.inengyuan.com/2017/nynews_0825/3338.html). By the end of August 2017, North China Petroleum Company drilled 107 CBM wells and is planning to drill 157 more wells. By 2020, annual CBM production in North China Petroleum Company is estimated to be 20 billion m³.

CMM in China is available at EPA (2017). The China country analysis brief is available at EIA (2015b).

Canada

Canada contains diverse CBM resources, which are concentrated chiefly in the Carboniferous strata in the intermontaine basins of the Canadian Maritime Provinces, Mesozoic-Cenozoic strata in intermontaine basins of British Columbia, and in Cretaceous strata of the Western Canada Sedimentary Basin of the Cordilleran foreland in Alberta. The vast majority of the resource and reserve base are in Alberta, where the Alberta Geological Survey estimates OGIP on the order of 500 Tcf. The bulk of the production comes from the Horseshoe Canyon play, and development is active in a variety of Cretaceous coal-bearing formations. Early production operations focused on vertical wells completed in multiple coal seams, and expansion of the industry between 2005 and 2007 was buoyed by the advent of lateral and multilateral drilling in single seams.

Remaining reserves in Alberta are estimated to be about 2 Tcf according to the Alberta Energy Regulator, indicating that, although development is widespread, potential exists for a major expansion of the industry given a favorable economic climate. Development activity, however, has decreased significantly in recent years in response to low natural gas prices. According to the International Energy Agency, Canadian CBM production peaked at 8.9 Bcm (315 Bcf) in 2010. Production was 7.2 Bcm (254 Bcf) in 2014, and the annual rate of decline has increased from 3.7% in 2011 to 6.8% in 2014 (**Figure 5**). Accordingly, the current economic climate remains challenging for the development of new CBM reserves in Canada.

General information on CBM in Alberta is available from the Alberta Energy Regulator (2015), Alberta Geological Survey (2017), and Alberta Energy (2017).

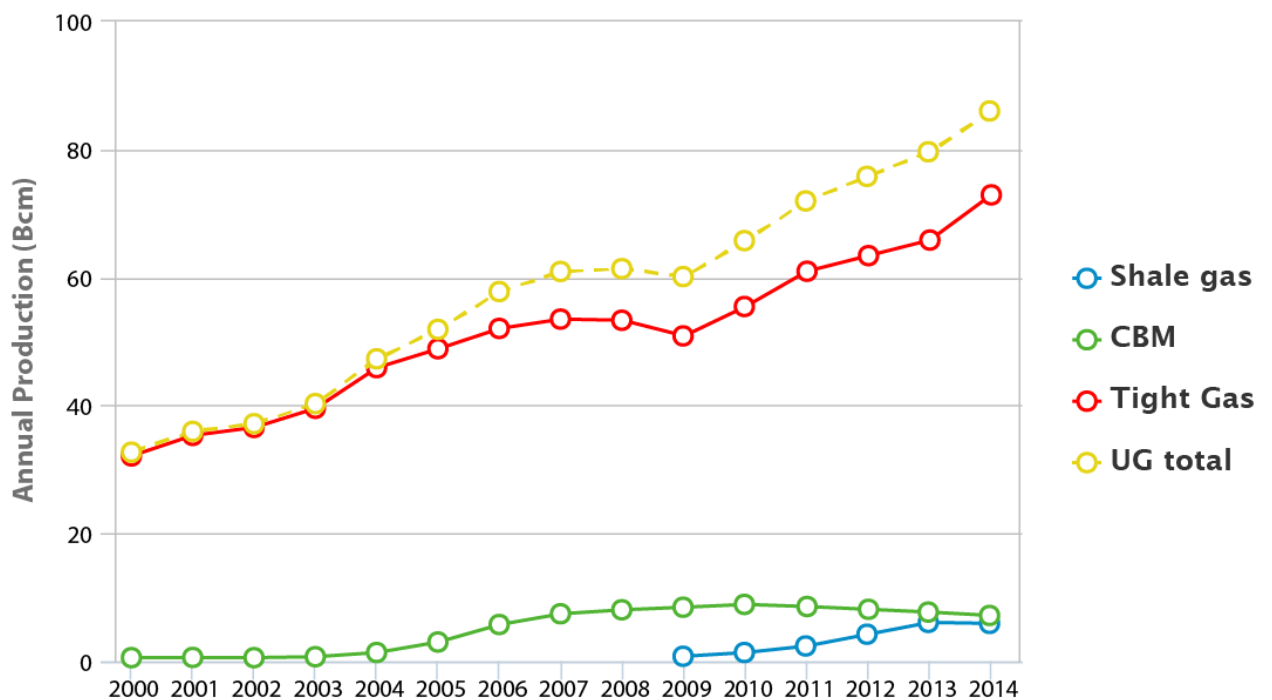


Figure 5. Canadian unconventional gas production, 2000-2014 (source: International Energy Agency). Coalbed methane production peaked in 2010, and

the rate of decline has been increasing since 2011 as Canadian natural gas markets are challenged by decreasing natural gas prices.

India

Bhattacharya (2016, p. 51) reported that “India contains 60.6 billion tonnes of coal...could contain up to 4.6 trillion m³ of gas.” Of 33 CBM exploration blocks awarded since 2001, only three blocks are producing gas. “The lack of commercial production stems from factors including the lack of detailed reservoir characterization, the lack of professional training for domestic companies, and the lack of equipment and advanced CBM technology in the most productive basins” (Bhattacharya, 2016, p. 51).

Russia

Information on prospects for CBM production in Russia is at <http://www.gazprom.com/about/production/extraction/metan/> (accessed November 13, 2017).

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- EIA, 2015a, Australia country analysis brief: U.S. Energy Information Administration, <http://www.eia.gov/beta/international/analysis.cfm?iso=AUS> (accessed October 20, 2015).
- EIA, 2015b, China country analysis brief: U.S. Energy Information Administration, <http://www.eia.gov/beta/international/analysis.cfm?iso=CHN> (last updated May 14, 2015).
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- EIA, 2017b, Country analysis brief: Australia: U.S. Energy Information Administration, 24 p. <https://www.eia.gov/beta/international/analysis.cfm?iso=AUS>
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- Potential Gas Committee Press Release, 2017, Potential supply of natural gas in the United States (December 31, 2016). (accessed November 2, 2017) https://urldefense.proofpoint.com/v2/url?u=http-3A_r20.rs6.net_tn.jsp-3Ff-3D001IziK7N4K4reARd1jxRQ-5FJ8QSQHOIAJBxC9Ye8v-2D6e9WaTSsI0SSH7HZUZoJ82J2TLxCMeT0-5FOcsEIKgA-2DbnCuWziTujpINn9R1sVhTdOp4O9SO1iDy7sHZZ-5FeRrKz9UtN-2DfVHnynFEtCp-5Fm2h93JwQ2sml1LFSUCMBJtCNRMrNJVZnmDI-5FpWWFKhCI-5Fa0Zd4xtcRo-5F47-2DCt8NQAjePBOGWXK58CCF4J-5F6jIDi5jzOWq-3D-26c-3DpRACQcbsIQRQHpuUMwkFDW1qf2JufW-2D5lr6NnAGtJTL36-2DfXiJJpXw-3D-3D-26ch-3DPXhQNPIdAXV23XwulC2HEdqGoleb0y1qOQAHM7yoRFzTALR4OWwzoA-3D-3D&d=DwMFaQ&c=qKdtBuuu6dQK9MsRUVJ2DPXW6oayO8fu4TfEHS8sGNk&r=gBMxFLM6DvXO2RTbLAPC9Q&m=aqxW6NIKBS8F4nJtEUn_j5NLhQeAXahwyWWyZFDtD3g&s=6ZTVuKEXbnDjPj7howo-tAvjWBqIsj6SThNQVktPcW&e

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U.S.G.S., 2014, Map of assessed coalbed-gas resources in the United States, 2014: U.S. Geological Survey Digital Data Series 69-II. <http://pubs.usgs.gov/dds/dds-069/dds-069-ii/> (accessed November 2, 2017).

Coalbed Methane Calendar

None

EMD Coalbed Methane Committee Web Links

General

Coalbed Methane Links:

http://explorationgeology.com/public_html/General_Geology/General_Geology_CBM.html

North American Coalbed Methane Forum: <http://www.nacbmforum.com>

Data

U.S. Bureau of Mines CBM Content Database: <http://gswindell.com/blmcoalb.htm>

Government

U.S. EPA Coalbed Methane Outreach Program: <https://www.epa.gov/cmop>

U.S. EIA Coalbed Methane Maps: <http://www.eia.gov/maps/maps.htm#coalbed>

U.S. Geological Survey:

<http://energy.usgs.gov/OilGas/UnconventionalOilGas/CoalbedGas.aspx>

U.S. Geological CBM Fact Sheets:

Coal-bed methane: Potential and concerns: <http://pubs.usgs.gov/fs/fs123-00/>

Water produced with coal-bed methane: <http://pubs.usgs.gov/fs/fs-0156-00/>

Coalbed methane project in the Powder River Basin, Wyoming:

<http://pubs.usgs.gov/fs/2006/3132/>

U.S. EIA CBM Reserves and Production (Table 15):

<http://www.eia.gov/naturalgas/crudeoilreserves/index.cfm>

U.S. EIA CBM Production:

http://www.eia.gov/dnav/ng/NG_ENR_COALBED_A_EPG0_R52_BCF_A.htm

U.S. EIA CBM Reserves:

http://www.eia.gov/dnav/ng/ng_enr_coalbed_a_EPG0_R51_Bcf_a.htm

Montana Coalbed Methane: <http://bogc.dnrc.mt.gov/coalbedmeth.asp>;

http://bogc.dnrc.mt.gov/webmapper_intro_cbm.asp

Oklahoma coalbed methane: <http://www.ou.edu/content/ogs/research/energy/coal.html>

Wyoming Oil & Gas Conservation Commission CBM: <http://wogcc.state.wy.us/>

Alberta CBM Resources and Production:

<http://www.albertacanada.com/business/industries/og-natural-gas-and-coal-bed-methane.aspx>

Alberta Department of Energy:

<http://www.energy.alberta.ca/>

Alberta Geological Survey CBM:

<http://ags.aer.ca/activities/coalbed-methane.htm>

CBM Asia (Specializing in Indonesian CBM): <http://www.cbmasia.ca/What-Is-CBM>

Australian Government:

<http://www.ga.gov.au/data-pubs/data-and-publications-search/publications/oil-gas-resources-australia/2005/coalbed-methane>

New South Wales Government:

<http://www.resourcesandenergy.nsw.gov.au/landholders-and-community/coal-seam-gas/the-facts>

Australia Coal Seam Gas:

<http://www.naturalcsg.com.au/>

Education/Information

Coalbed Methane Association of Alabama: <http://coalbed.com/>

Coalbed Methane Education (British Columbia):

<http://www.empr.gov.bc.ca/MINING/GEOSCIENCE/COAL/Pages/default.aspx>

<http://www.empr.gov.bc.ca/Mining/Geoscience/Coal/CoalBC/CBM/Pages/default.aspx>

Coalbed Methane on Wikipedia: http://en.wikipedia.org/wiki/Coalbed_methane

Coalbed Methane Basics: <https://www.spec2000.net/17-speccbm.htm>

Coalbed Methane Primer: <http://bogc.dnrc.mt.gov/PDF/Web%20Version.pdf>

World Coal Association:

<http://www.worldcoal.org/coal/coal-seam-methane/coal-bed-methane/>

Montana Earth Science Picture of the Week: <http://formontana.net/coalbed.html>

Coal Seam Gas Australia: <http://www.aplng.com.au/home/what-coal-seam-gas>