

**EMD Coalbed Methane Committee Report  
2018 EMD Annual Leadership Meeting  
Salt Lake City, Utah  
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Brian Cardott (Chair; Oklahoma Geological Survey)

Vice Chairs:

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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 and reserves of natural gas from coal beds in the United States continued to decline in 2016. CBM is still an important resource globally. Research on CBM remains active, however, as indicated by >50 technical papers published in 2017.

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).

<b>CBM Resources by Country</b>		
<b>Country</b>	<b>Mastalerz (2014) 2010 Resources, Tcf</b>	<b>Kelafant (2016) Tcf</b>
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

<b>Annual CBM Production by Country (2010 data)</b> (from Mastalerz, 2014)	
<b>Country</b>	<b>Production, Bcf</b>
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**

The 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 trillion cubic feet (Tcf; 55.67 billion m<sup>3</sup>) in 2008 (EIA, 2009b, 2010, 2018a). CBM production declined to 1.020 Tcf (28.88 billion m<sup>3</sup>) in 2016 (EIA, 2018a), the lowest level since 1997, representing 3.8% of the U.S. total natural gas production of 26.7 Tcf (756.1 billion m<sup>3</sup>; EIA 2018b; **Figure 1**). Note that U.S. CBM production in EIA (2018a, their Table 15) is different than U.S. CBM gross withdrawals in EIA (2017a, their Table 1). According to EIA (2018a, their Table 15), the top 7 CBM-producing U.S. states during 2016 (production in billion cubic feet, Bcf; or million m<sup>3</sup>) were Colorado (352; 9.97), New Mexico (253; 7.16), Wyoming (143; 4.05), Virginia (102; 2.89), Alabama (45; 1.27), Oklahoma (43; 1.22), and Utah (39; 1.10). Annual CBM production decreased for each state over the previous year (EIA 2018a, c; **Figure 2**). Cumulative U.S. CBM production from 1989 through 2016 was 35.7 Tcf (1.01 trillion m<sup>3</sup>).

According to EIA (2018c), annual peak CBM production in the top 7 CBM producing U.S. states during 2016 occurred in the following years: Colorado (2010), New Mexico (1997), Wyoming (2008), Virginia (2009), Alabama (1998), Oklahoma (2007), and Utah (2002)(Figure 2). Bleizeffer (2015) provides a history of Wyoming CBM production. U.S.G.S. (2014) includes hyperlinks to USGS CBM assessment publications and web pages.

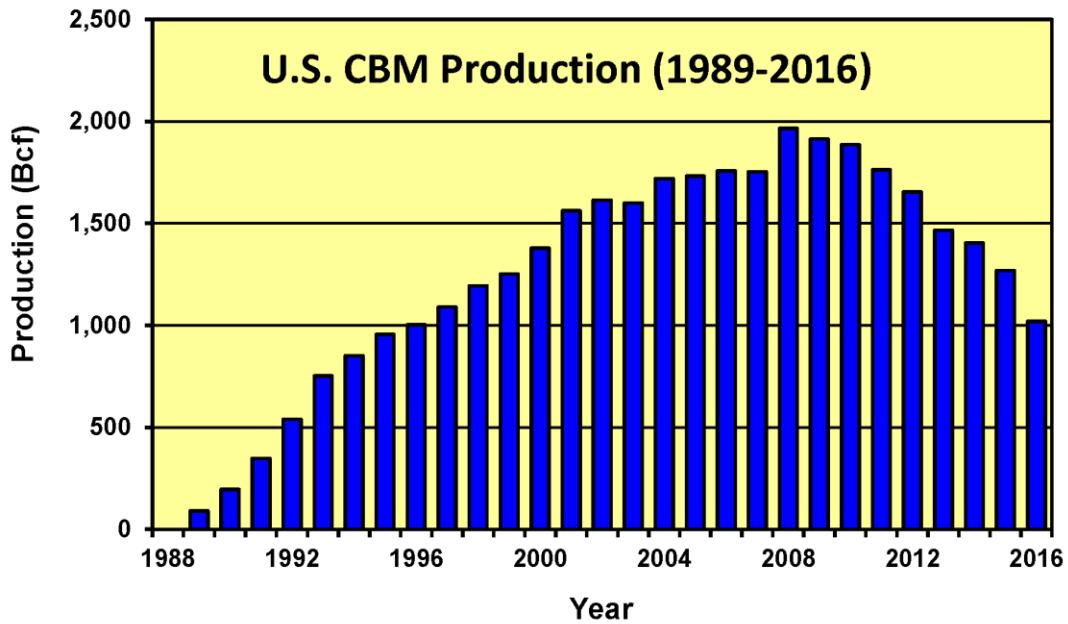


Figure 1. United States CBM production (1989–2016; compiled from EIA, 2018a).

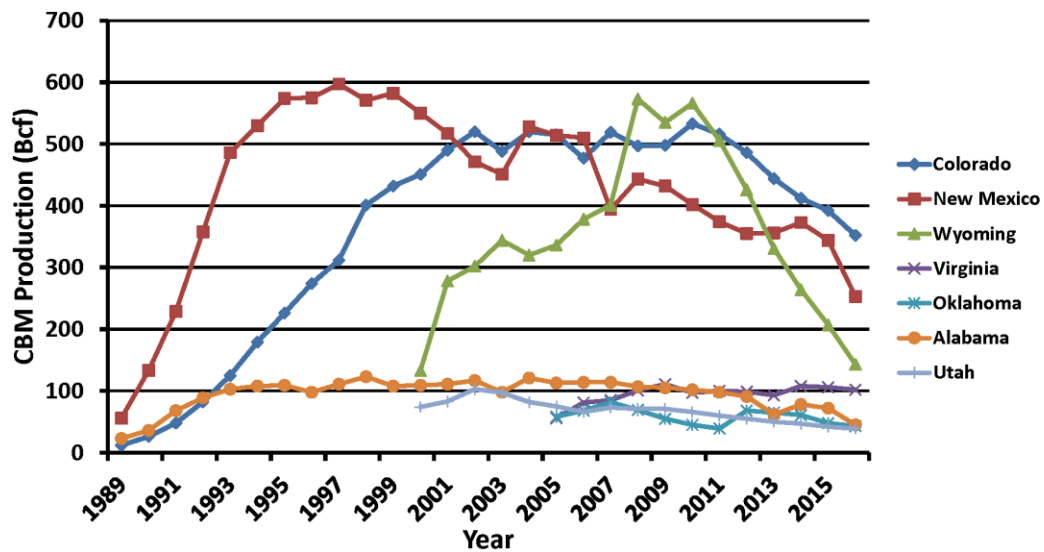


Figure 2. Annual CBM production of the top 7 U.S. states during 2016 (1989–2016; compiled from EIA, 2018a, c).

According to the Potential Gas Committee Press Release (2017), the United States has 158.7 Tcf (4.5 trillion m<sup>3</sup>) CBM resources (15.0 Tcf, 0.4 trillion m<sup>3</sup> probable resources [current fields], 48.0 Tcf, 1.4 trillion m<sup>3</sup> possible resources [new fields], and 95.7 Tcf, 2.7 trillion m<sup>3</sup> speculative resources [frontier]) for 2016, an increase of 0.6 Tcf (17.0 billion m<sup>3</sup>) CBM resources since 2014. By region, 152.3 Tcf (4.3 trillion m<sup>3</sup>) “most likely” CBM resources are distributed as follows: 57.0 Tcf (1.6 trillion m<sup>3</sup>), Alaska; 52.6

Tcf (1.5 trillion m<sup>3</sup>), Rocky Mountain; 17.3 Tcf (489.9 billion m<sup>3</sup>), Atlantic; 11.6 Tcf (328 billion m<sup>3</sup>), North Central; 7.8 Tcf (221 billion m<sup>3</sup>), Mid-Continent; 3.4 Tcf (96 billion m<sup>3</sup>), Gulf Coast; and 2.6 Tcf (74 billion m<sup>3</sup>), Pacific.

U.S. annual CBM proved reserves peaked at 21.87 Tcf (619 billion m<sup>3</sup>) in 2007 (EIA, 2009b, 2010, 2018d) and declined to 10.585 Tcf (300 billion m<sup>3</sup>) in 2016 (EIA, 2018d) representing 3.3% of the U.S. total natural gas reserves of 322 Tcf (9.1 trillion m<sup>3</sup>; EIA, 2018e; **Figure 3**). Annual CBM proved reserves by U.S. state (through 2016) are available at EIA (2018d).

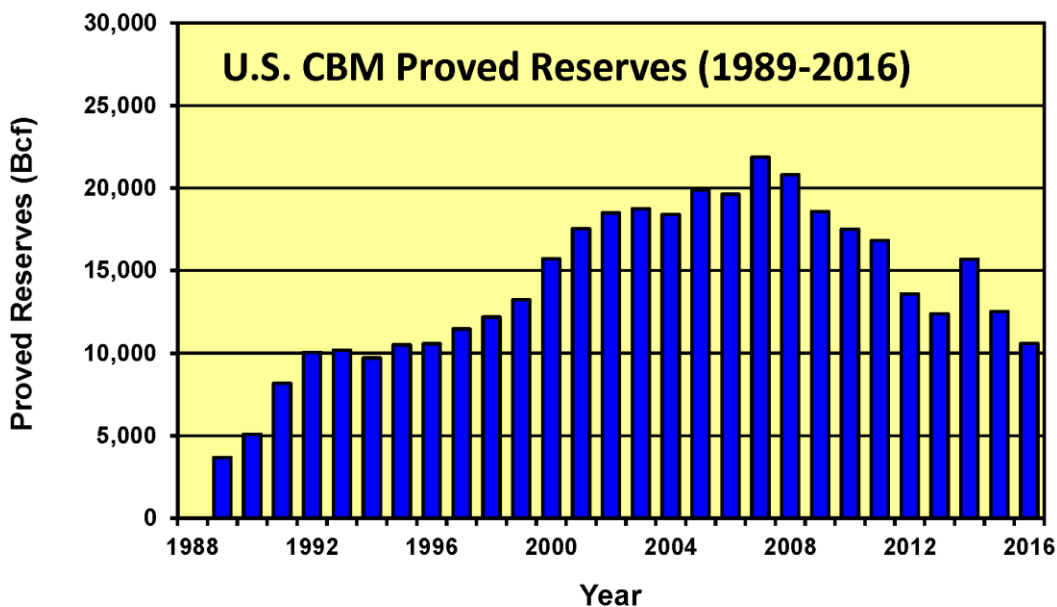


Figure 3. United States CBM proved reserves (1989-2016; compiled from EIA, 2009b, 2010, 2018d).

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.** Stark and Smith (2017) indicated the Walloon CBM play in the Bowen-Surat Basin (discovered in 2009) has gas resources of 503 million barrels of oil equivalent (MMBOE) while the Walloon CBM play in the Kumberilla Ridge Basin (discovered in 2001) has gas resources of 535 MMBOE.

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, 11; 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”.

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> (accessed February 16, 2018).

An interactive map of coal seam gas wells in New South Wales 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.** Stark and Smith (2017) indicated the Taiyuan CBM play in the Qinshui Basin (discovered in 2007) has gas resources of 717 MMBOE.

By the end of August 2017, the CBM production in China was 4.46 billion m<sup>3</sup> with a growth of 3.3%, of which the production in August alone was 0.59 billion m<sup>3</sup> 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 m<sup>3</sup> in the eight months of 2017, of which in August 2017 the CBM production was 0.41 billion m<sup>3</sup>, 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 m<sup>3</sup> in an area of 388.51 km<sup>3</sup>. Ignition tests show that daily production is up to 1000 m<sup>3</sup>. 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](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 m<sup>3</sup>.

CMM in China is available at EPA (2018). The China country analysis brief is available at EIA (2015).

**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 4**). 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 (2018), and Alberta Energy (2018).

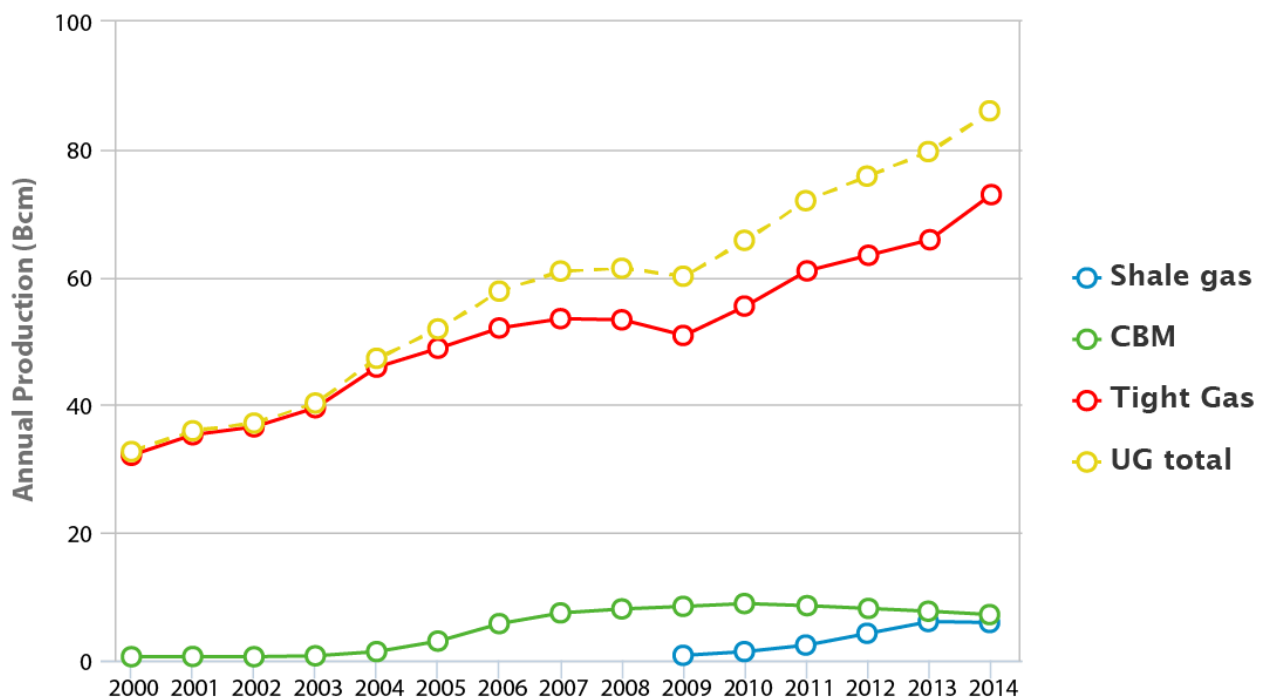


Figure 4. Canadian unconventional gas production, 2000-2014 (source: International Energy Agency). Coalbed methane production peaked in 2010, and the rate of decline has been increasing since 2011 as Canadian natural gas markets are challenged by decreasing natural gas prices.

**India.** Bhattacharya (2016, p. 51) reported that “India contains 60.6 billion tonnes of coal...could contain up to 4.6 trillion m<sup>3</sup> 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 February 16, 2018).

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<http://www.eia.gov/naturalgas/crudeoilreserves/index.cfm>
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## Coalbed Methane Calendar

April 18, 2018: North American Coalbed Methane Forum Conference, Canonsburg, PA.  
<http://www.nacbmforum.com/conference.html>

October 15-18, 2018: 35<sup>th</sup> Annual International Pittsburgh Coal Conference, Xuzhou,  
Jiangsu Province, China. <http://www.pccpitt.org>

### EMD Coalbed Methane Committee Web Links

#### General

Coalbed Methane Links:

[http://explorationgeology.com/public\\_html/General\\_Geology/General\\_Geology\\_CBM.html](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](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](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>

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>

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](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: <https://www.aplng.com.au/topics/coal-seam-gas.html>