MEMORANDUM

DATE: April 29, 2013

TO: Andrea Reynolds, President, AAPG Energy Minerals Division

FROM: Jack C. Pashin, Government Representative,
Coalbed Methane Committee

SUBJECT: Coalbed Methane Commodity Report

EMD Coalbed Methane Activities:

Coalbed methane continues to be a topic of interest to the membership of AAPG and EMD. Last year's AAPG Annual Convention and Exposition in Long Beach, featured a limited coalbed methane program, although presentations on environmental impacts, coal-seam CO_2 storage, and seismic characterization of coalbed methane reservoirs were scattered through the convention program. This year's program in Pittsburgh is more robust, featuring an oral presentation on produced water and five poster presentations covering a range of topics from resource evaluation to stable isotopes in coalbed methane reservoirs.

One of the goals of the EMD Coalbed Methane Committee for 2012 is to expand our membership and to start compiling more international data from a variety of sources and to monitor international CBM activities more closely. The chairmanship of the coalbed methane committee remains open, and the search for a new chair continues. I have been serving as the Government Representative to the Coalbed Methane Committee. However, I retired from the Geological Survey of Alabama this year and have begun a professorship at Oklahoma State University. Thus, my involvement in the committee will continue as Academic Representative.

Coalbed Methane Activity:

The U.S. remains the world leader in coalbed gas exploration, booked reserves, and production. Currently, there is commercial coalbed gas production or exploration in approximately 12 U.S. basins and several basins in Canada, although activity has slowed substantially in response to low gas prices. The major producing areas are the Powder River, San Juan, Black Warrior, Central Appalachian, Raton, and Uinta (Ferron and Book Cliffs) basins. Other U.S. areas with significant exploration or production are the Cherokee, Arkoma, Illinois, Hanna, Gulf Coast, and Greater Green River basins. Exploration continues in all major U.S. basins, and the principal environmental issue confronting development is water disposal. Production operations are maturing in U.S. coalbed methane basins, and the U.S. Department of Energy (DOE) has

sponsored a series of studies on produced water management and CO_2-enhanced coalbed methane recovery. Of major interest is a new pilot program that is being led by Virginia Tech in the Appalachian basin of Virginia, which is scheduled to begin injection of up to 20,000 tons of CO_2 into multiple coal seams to determine the viability of enhanced recovery and geologic storage.

The Energy Information Administration has released coalbed methane production and reserve numbers through the end of 2010. Annual coalbed methane production in 2010 was 1,886 Bcf, decreasing by 1.5 percent from the previous year (Figure 1; Table 1). Coalbed Methane reserves decreased from 18,578 Bcf in 2009 to 17,508 Bcf in 2010 representing a decrease of 1,070 Bcf (5.7%) (Figure 2; Table 2). Coalbed methane represented 8.5 percent of 2010 dry-gas production and 5.7 percent of proved dry-gas reserves in the US. Interestingly, coalbed methane production is declining only slightly as a proportion of US gas production but is declining significantly in terms of proved dry gas reserves. This decline is related to the booking of major shale gas reserves in recent, which is significantly changing US gas markets (fig. 3).

Most of the coalbed methane activity in the eastern U.S. is focused on the Appalachian Basin of Southwestern Virginia and the Black Warrior Basin of Alabama, with several companies actively developing joint CBM and CMM projects. In southwestern Virginia, production has decreased substantially from 111 Bcf in 2009 to 97 Bcf in 2010 (Table 1). West Virginia underwent a production decline from 31 to 17 Bcf over the same time period. In Pennsylvania, production decreased from 16 to 3 Bcf. In Alabama, production decline was less pronounced, with 105 Bcf being produced in 2009 and 102 Bcf being produced in 2010.

The Midcontinent region consists of the Cherokee, Forest City, Arkoma, and Illinois Basins, and production and reserves appear to be declining. Horizontal drilling is proving to be an effective development strategy, although major increases of production in recent years are now being offset by decline. Production for Kansas decreased modestly from 43 Bcf in 2009 to 41 Bcf in 2010, whereas production decreased in Oklahoma from 55 Bcf in 2009 to 45 Bcf in 2008 (an 18.2% decrease), continuing a steep decline trend that began in 2007. The principal issues affecting CBM development in the eastern and midcontinental U.S. is competition with shale gas, which has introduced significant price pressure. Although production operations continue to persist, few wells are being drilled, and proved reserves are not being replaced.

Infill drilling of Fruitland CBM wells in the San Juan Basin (Colorado and New Mexico) decreased markedly in 2009 due to recession, but activity is starting to turn around. The States of Colorado and New Mexico continue to dominate CBM production and reserves (Tables 1 and 2). Cumulative production for Colorado and New Mexico represents 50% of total U.S. CBM production. In 2010, CBM production in Colorado increased from 498 to 533 Bcf, and production in New Mexico declined slightly from 432 to 402 Bcf. Activity is also rebounding in

the Powder River Basin of Wyoming, and production increased in 2010 from 535-566 Bcf, accounting for 30% of U.S. CBM production.

International activity has been on the rise, and operations in the Qinshui Basin of China remain active, thus proving the CBM potential of intensely fractured semi-anthracite and anthracite. As in the U.S., depressed natural gas prices are slowing Canadian development. Exploration and development efforts are intensifying in the Bowen, Surat, and Sydney Basins of Australia, as well as the Karoo Basin of South Africa. Coalbed methane in eastern Australia is being produced from high-permeability coal seams that can contain large quantities of oil-prone organic matter, and produced gas is being considered for export into Asian LNG markets. A number of LNG plants (up to 5 or 6) are being considered in Australia so many of these companies are striving to book CBM reserves to justify the expenditure for LNG plant development as quickly as possible. Significant potential exists in the Gondwanan coal basins of India, and some fields have been developed.

Significant potential also exists in the coal basins of Europe and the Russian platform, and development in these areas is focusing mainly on coal-mine methane. Russia is continuing to promote CBM exploration and development but defining a market for the gas and predicting gas prices are problematic for future development. However, the coal basins in Russia may contain the largest CBM resources in the world so once a market for this gas, internally or internationally, is identified, then CBM exploration in Russia should increase significantly. Some significant exploration programs have been initiated within the past year to explore for coalbed methane in the structurally complex European coal basins of western Europe, including Germany.

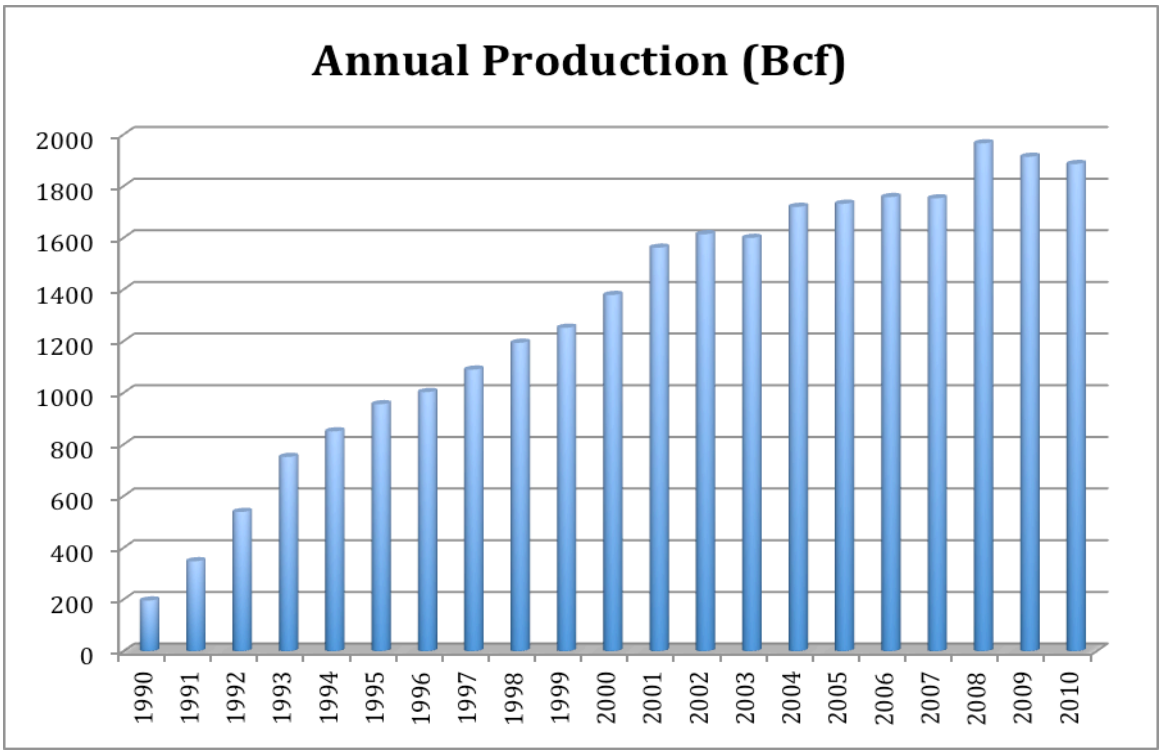

Figure 1. Historic U.S. coalbed methane production 1990-2010. Data from the Energy Information Administration (EIA).

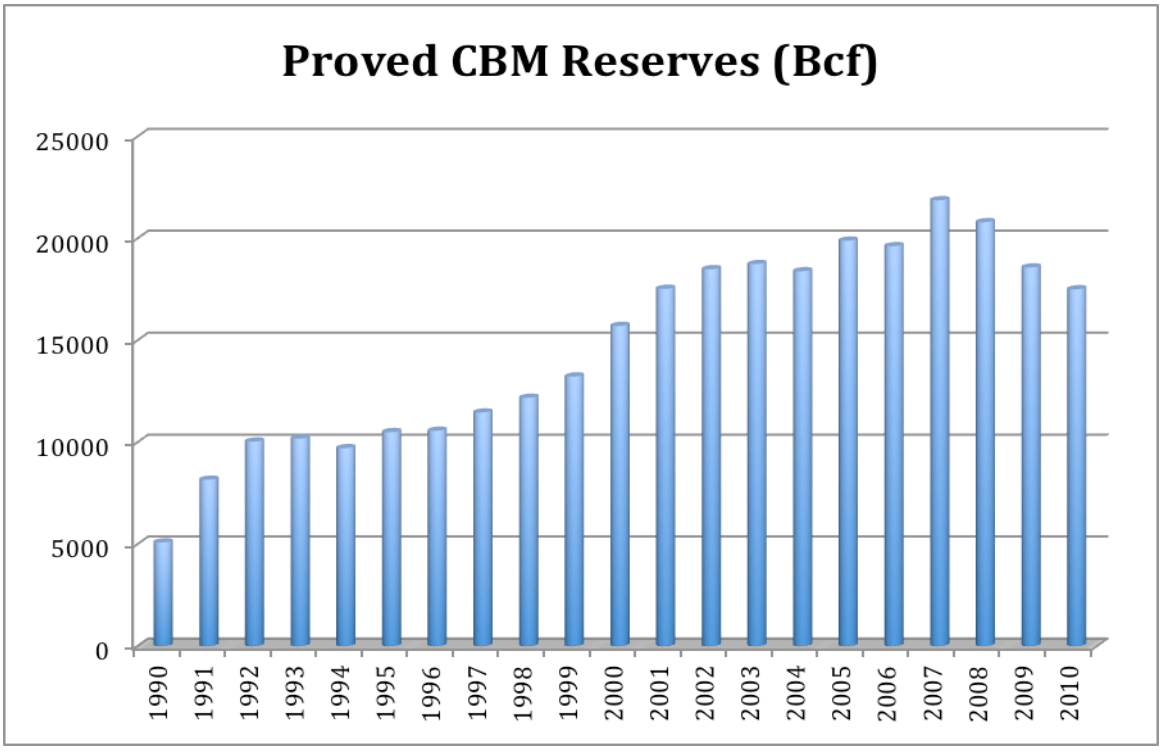

Figure 2. Historic U.S. coalbed methane reserve trends 1990 to 2010. Data from Energy Information Administration (EIA).

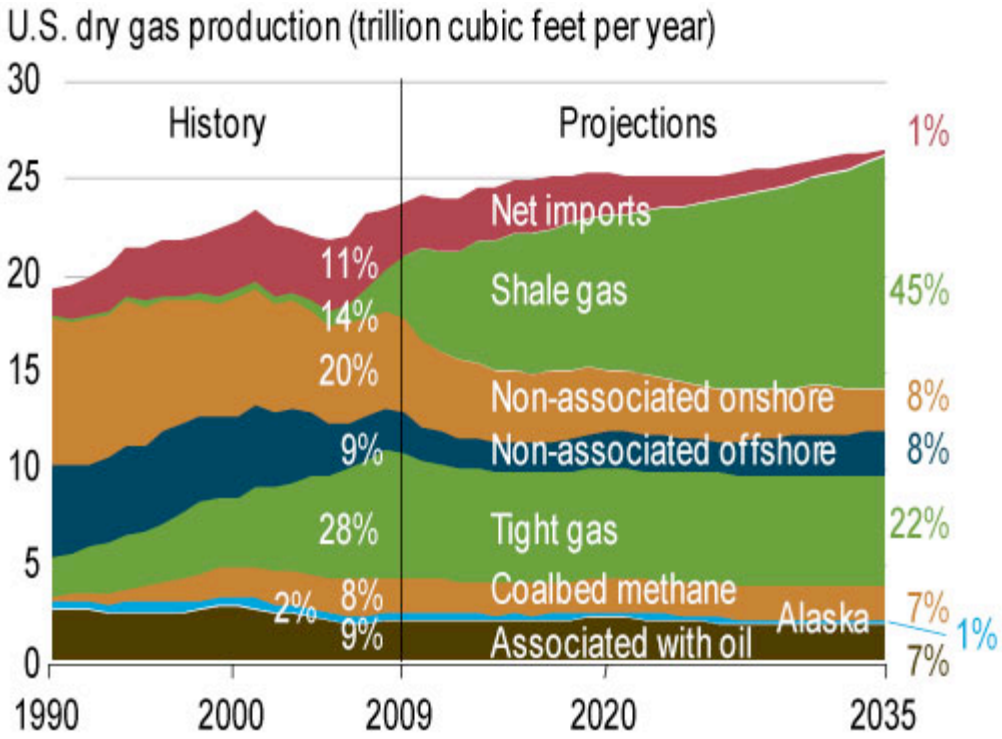

Figure 3. Sources of U.S. Natural gas production showing projected steady coalbed methane supply concurrent with major increase of shale gas supply (Source: Energy Information Administration).

Table 1. Historic U.S. coalbed methane production by year (1989-2009; Bcf). Data from the Energy Information Administration (EIA)

Year	US	AL	CO	NM	OK	UT	VA	WV	WY	Others
1990	196	36	26	133						1
1991	348	68	48	229						3
1992	539	89	82	358						10
1993	752	103	125	486						38
1994	851	108	179	530						34
1995	956	109	226	574						47
1996	1003	98	274	575						56
1997	1090	111	312	597						70
1998	1194	123	401	571						99
1999	1252	108	432	582						130
2000	1379	109	451	550		74			133	62
2001	1562	111	490	517		83			278	83
2002	1614	117	520	471		103			302	101
2003	1600	98	488	451		97			344	122
2004	1720	121	520	528		82			320	149
2005	1732	113	515	514	58	75	56	30	336	35
2006	1758	114	477	510	68	66	81	18	378	46
2007	1753	114	519	394	82	73	85	25	401	60
2008	1966	107	497	443	69	71	101	28	573	77
2009	1914	105	498	432	55	71	111	31	535	76
2010	1886	102	533	402	45	66	97	17	566	58

Table 2. Historic U.S. coalbed methane proven reserves by year (1989-2009; Bcf). Data from the Energy Information Administration (EIA)

Year	US	AL	CO	NM	OK	UT	VA	WV	WY	Others
1990	5087	1224	1320	2510						33
1991	8163	1714	2076	4206						167
1992	10034	1968	2716	4724						626
1993	10184	1237	3107	4775						1065
1994	9712	976	2913	4137						1686
1995	10499	972	3461	4299						1767
1996	10566	823	3711	4180						1852
1997	11462	1077	3890	4351						2144
1998	12179	1029	4211	4232						2707
1999	13229	1060	4826	4080						3263
2000	15708	1241	5617	4278		1592			1540	1440
2001	17531	1162	6252	4324		1685			2297	1811
2002	18491	1283	6691	4380		1725			2371	2041
2003	18743	1665	6473	4396		1224			2759	2226
2004	18390	1900	5787	5166		934			2085	2518
2005	19892	1773	6772	5249	568	902	1572	186	2446	424
2006	19620	2068	6344	4894	684	750	1813	194	2448	425
2007	21874	2126	7869	4169	1265	922	1948	255	2738	582
2008	20798	1727	8238	3991	511	893	1851	246	2781	560
2009	18578	1342	7348	3646	338	725	2261	220	2328	370
2010	17508	1298	6485	3532	325	718	1752	220	2683	495