Paper #4-1a

ADDENDUM: GHG CONSTRAINED CASES

Prepared by the Emissions Team
of the
Carbon and Other End-Use Emissions Subgroup

On September 15, 2011, The National Petroleum Council (NPC) in approving its report, *Prudent Development: Realizing the Potential of North America's Abundant Natural Gas and Oil Resources*, also approved the making available of certain materials used in the study process, including detailed, specific subject matter papers prepared or used by the study's Task Groups and/or Subgroups. These Topic and White Papers were working documents that were part of the analyses that led to development of the summary results presented in the report's Executive Summary and Chapters.

These Topic and White Papers represent the views and conclusions of the authors. The National Petroleum Council has not endorsed or approved the statements and conclusions contained in these documents, but approved the publication of these materials as part of the study process.

The NPC believes that these papers will be of interest to the readers of the report and will help them better understand the results. These materials are being made available in the interest of transparency.

The attached paper is one of 57 such working documents used in the study analyses. Also included is a roster of the Team that developed or submitted this paper. Appendix C of the final NPC report provides a complete list of the 57 Topic and White Papers and an abstract for each. The full papers can be viewed and downloaded from the report section of the NPC website (www.npc.org).

Emissions Team		
Members		
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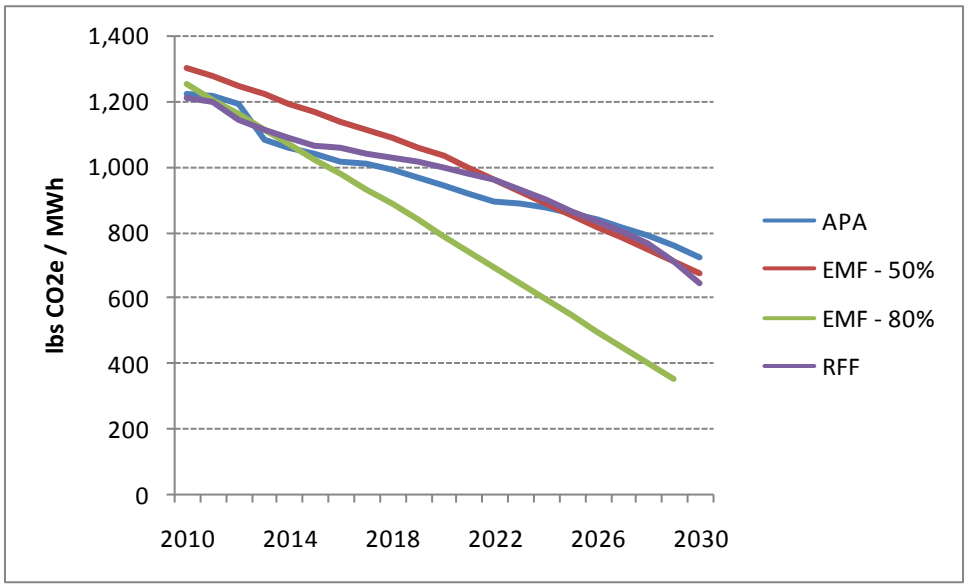
* Individual has since changed organizations but was employed by the specified company while participating in the study.

The study team also explored the impacts of GHG constraints on the economy, and specifically, natural gas demand. There are no studies in the public domain that incorporate the potential increased natural gas reserves in the range presented in the *AEO2011*.[1] To study the relationship of GHG constraints and the larger gas supplies from unconventional sources, the NPC study team reviewed *EMF 22: Climate Change Control Scenarios*,[2] *The Future of Natural Gas*,[3] *Natural Gas: A Bridge to a Low-Carbon Future*,[4] EIA's analysis of the *American Power Act of 2010 (APA),*[5] specifically, the **APA High Natural Gas Resource case,[6] and private modeling results provided by Wood Mackenzie. Our conclusions are:**

i. GHG emissions constraints result in lower energy consumption on an economy-wide basis, and power sector emissions intensity declines over time (Figure 1).

Figure 1: Power Sector Emissions Intensity – GHG Constrained Scenarios



ii. Past studies showed that GHG constraints typically resulted in reduced total energy demand, including economy-wide demand for natural gas. But as shown in Figure 2, GHG constraints result in the increased market share of natural gas in the power sector (although total electricity demand is lower), as shown in three of the four studies used. Additionally, in cases with higher

[1] *AEO2011* early release estimates the technically recoverable shale gas resource at 827 Tcf.

[2] Please see http://emf.stanford.edu/research/emf22/ for more information. EMF 22 is a compilation of results from six modeling teams that focused on 50% and 80% GHG emissions reductions from 1990 levels. As part of this study, we have averaged results from the following model outputs (ADAGE, MRN-NEEM, EPPA, MERGE-Optimistic, and MiniCAM-EERE) to represent the outcomes from EMF.

[3] Interim report, Massachusetts Institute of Technology (MIT), 2010. http://globalchange.mit.edu/pubs/abstract.php?publication_id=2066

[4] Stephen P.A. Brown, Alan J. Krupnick, and Margaret A. Wall, Issue Brief 9-11, December 2009.

[5] As released by Senators Kerry and Lieberman on May 12, 2010. http://www.eia.doe.gov/oiaf/servicerpt/kgl/requestsummary.html#analysis

[6] Employs the High Shale Gas Resource sensitivity case in the *AEO2010*, with the shale resources base at 652 trillion cubic feet in the reference case.

gas supplies, natural gas consumption, on an economy-wide basis, may increase in absolute terms (Figure 3, EIA-APA and Wood Mackenzie) relative to a case without GHG constraints. This may be due to lower gas prices as a result of the increased gas supplies combined with the associated "carbon penalty" on GHG emissions intensive fuel choices, and as a result, natural gas becomes an economical energy choice. However, we are unable to draw definitive conclusions about whether higher levels of gas reserves (such as those used in AEO2011) and GHG constraints would indeed result in higher gas consumption in the economy.

Figure 2: Natural Gas Generation - % of Total Generation

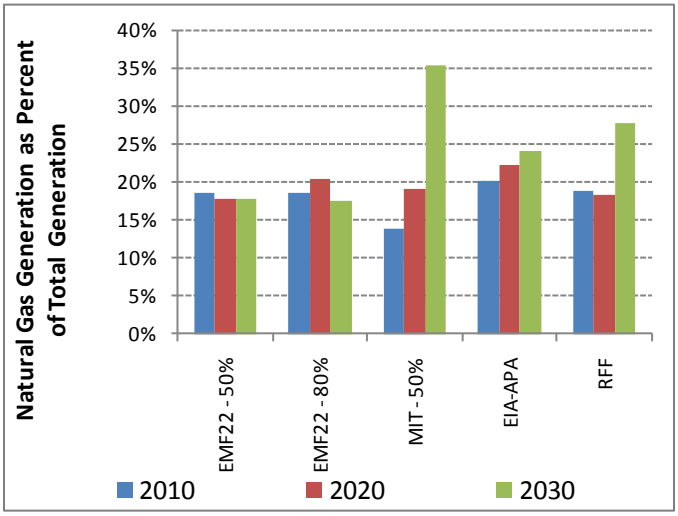
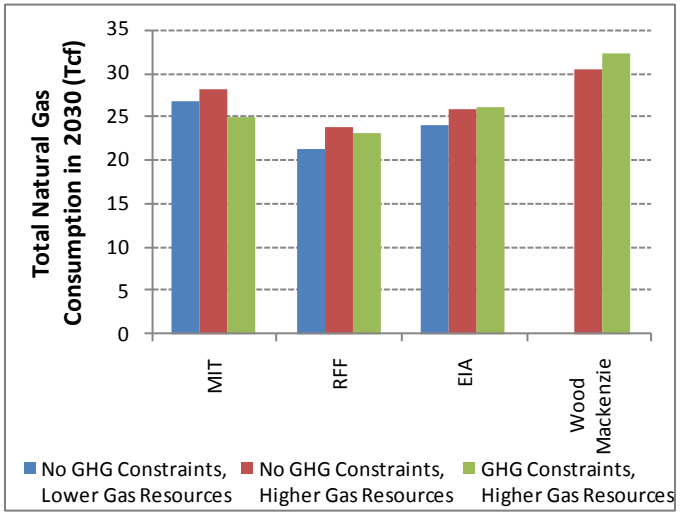


Figure 3: Total Natural Gas Consumption in 2030 (Tcf)



iii. Even with updated natural gas supply estimates, the electricity mix in a GHG constrained economy will be comprised of a diverse mix of low-carbon resources. Power sector natural gas demand will depend not only on natural gas supply and price but also on its competition with other low-emitting electricity technologies; policies designed to increase renewable technologies such as Renewable Energy Standards (RES) would alter that competition. Different assumptions of technology competition yield vastly different power generation mixes (Figure 4). Most studies indicate the limited ability of natural gas to meet more aggressive, longer-term reduction targets and hence a penetration of CCS technologies beyond 2030 was observed, albeit, minimal. The MIT study does indicate the potential of higher gas supplies and reduced energy use to diminish any need for CCS in a 50% reduction scenario, but an 80% reduction target would require a near "de-carbonization of the power sector." Hence, it is imperative that RD&D efforts related to lower-carbon technologies, including CCS continues if an 80% target were established. Also as noted in the MIT study, "it would also be a mistake to encourage, via policy and long-term subsidy, more costly technologies to crowd out natural gas in the short- to medium- term, as this could significantly increase the cost of CO_2 reduction."

Figure 4: Generation Mix with Carbon Policy