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July 21, 2014

Mr. John Anderson
U.S. Department of Energy (FE-34)
Attn: LCA GHG Report Comments
Office of Oil & Gas Global Security & Supply
Office of Fossil Energy
Forrestal Building, Room 3E-042
1000 Independence Avenue, SW
Washington, DC 20585

RE: Comments of the American Petroleum Institute (API) on the Department of Energy's (DOE's) Life Cycle Greenhouse Gas Perspective on Exporting Liquefied Natural Gas from the United States *[79 Federal Register 32260; June 4, 2014]*

Dear Mr. Anderson,

API is a national trade association that represents over 600 companies involved in all aspects of the oil and natural gas industry. API's members include owners and operators of LNG import and export facilities in the United States and around the world, as well as owners and operators of LNG vessels, global LNG traders, and manufacturers of essential technology and equipment used all along the LNG value chain. Our members also have extensive experience with the drilling and completion techniques used in shale gas development and in producing America's natural gas resources in a safe and environmentally responsible manner.

For well over a decade, API has been a recognized worldwide leader in developing methodologies and providing guidance for assessing greenhouse gas (GHG) emissions, and emission reductions. API's publicly available best practice guideline documents are used by all segments of the global oil and natural gas industry. API's methodological recommendations have been also incorporated into voluntary programs such as Natural Gas Star and into the U.S. mandatory GHG Reporting Program, administered by the U.S. Environmental Protection Agency (EPA). API also participates annually in the EPA process of developing the U.S. GHG Inventory by conducting expert review and providing industry comments and pertinent data.

API reviewed DOE's National Energy Technology Laboratory (NETL) report *Life Cycle Greenhouse Gas Perspective on Exporting Liquefied Natural Gas from the United States* (LCA GHG Report) and is pleased to submit comments that could help inform DOE's decisions regarding approving LNG terminals for exports. However, API is compelled to note, as DOE agrees, that the LCA GHG Report goes well beyond the requirements of National Environmental Policy Act.[1]

API believes that NETL's result that exported U.S. LNG has a lower GHG intensity (GHG per MWh produced) than coal under all the power generation scenarios analyzed is reasonable. Based on the best available data and using standard assumptions, exported LNG generates GHG emissions 43% to 52% lower than coal. API recognizes the uncertainty associated with the simplifying assumptions used in NETL's LCA GHG Report. The complexity of undertaking a structured analysis of this magnitude and scope requires a significant amount of data and in the absence of such data necessitates simplifying assumptions. API believes that despite some of the simplifying assumptions, the results of the analysis presented in the LCA Report is indicative of the contribution of each of the major processes (e.g. extraction, transport, combustion) to the total life cycle GHG emissions. API also believes that adjusting some of the simplifying assumptions to reflect more current data would show even greater life cycle GHG benefits of U.S. LNG exports over domestic coal use for power generation.

Based on NETL's assessment API would like to offer the following summary observations:

- More recent data from EPA's U.S. GHG Inventory indicates that NETL was conservative in its assumptions about GHG emissions associated with U.S. natural gas production from both conventional and unconventional reservoirs. For example, NETL's assumptions for emissions associated with gas well completions from unconventional natural gas do not take into account new emission factors derived from the EPA's 2012 U.S. GHG Inventory as well as new regulations that would contribute to further reductions of methane emissions from several segments of the natural gas industry.
- The range of methane leakage rates (1.2% to 1.6%) assumed in NETL's analysis is realistic though higher than the rates indicated in the final 2012 U.S. GHG Inventory (1.09% relative to natural gas withdrawals) as published in April 2014. Other data cited by opponents of LNG exports is misleading since they are not results from "leak measurement studies," rather they are studies of atmospheric methane sampled from planes or high towers, which necessitate various statistical and analytical techniques to estimate where the methane is coming from; such statistical methods have not been validated for source attribution of emissions.
- NETL's analysis used two sets of global warming potential (GWP) coefficients. The currently accepted values in the U.S. and globally are from the IPCC Fourth Assessment Report (AR4), while NETL's report features GWP values from IPCC's Fifth Assessment Report (AR5). The AR5 GWPs are not used yet for official emission inventory documentation and policy decisions, and

[1] API has already extensively argued before DOE why it has no legal obligation to consider alleged upstream impacts of natural gas development. *See, e.g.,* API Reply Comments to DOE 2012 LNG Export Study (Feb. 25, 2013), *available at* http://www.fossil.energy.gov/programs/gasregulation/authorizations/export_study/reply_comments/Erik_G_Milito02_25_13.pdf, at pp. 35-67. Similarly, DOE has no legal obligation under NEPA to review GHG impacts, whether upstream or downstream of a given export facility,

merely contribute to increasing the emissions for the natural gas extraction, processing, and transport segments of the life cycle process when compared to the same results using the AR4 GWP values.

- Natural gas liquefaction, storage, and ship loading process data used in NETL's LCA model is derived from a specific facility in Australia (2005 process data) and adapted to represent Atlantic LNG in Trinidad and Tobago. API views the use of such outdated process information as the basis for NETL's assumptions about the GHG intensity of the LNG liquefaction process as overly conservative and not representative of the newer designs and higher efficiency liquefaction technologies proposed for the new U.S. export terminals. Using the more realistic GHG intensities for these new liquefaction technologies would lead to reduced GHG emissions from this part of the operations chain by 30 – 70%.

API contends that the summary results presented in tables 6-6 and 6-7 of NETL's LCA GHG Report support the finding that most of the observed differences are statistically significant, even when considering both the shorter (20 years) and the longer (100 years) time horizons for the GWPs. This enables the comparison of the perceived short term climate forcing effects of CH_4 to the longer term values used in standard comparison for official estimates:

(1) *100-yrs time horizon*- shows that there is no significant difference between the three NG scenarios with all three of them being significantly lower than regional coal for both the European and Asian scenarios (see Figure 6-6).

(2) *20-yrs time horizon* - shows that there is a difference between U.S. LNG and regional coal in Europe, though one cannot make the same statement for Asia due to too much overlap between the uncertainty ranges (See Figure 6-7).

In conclusion, API believes that for power generation use in Asia and Europe, U.S. LNG exports perform better than domestic coal in terms of life cycle GHG emissions. The NETL analysis supports this conclusion and the DOE should immediately approve all remaining LNG export applications to non-FTA countries.

API's more detailed comments on the LCA GHG Report are addressed in Attachment 1 to this letter. Please do not hesitate to contact us if we can be of further assistance.

Sincerely,

Erik Milito

Group Director and Industry Operations

Attachment 1- API's Review of NETL's LCA GHG Report

- API contends that differences between the U.S LNG, regional LNG, and Russian Natural Gas options may not be discernible due to the underlying uncertainties in the modeling data. Opponents of LNG exports have argued that a different representation of Methane leakage from U.S. Natural Gas Systems would tilt the balance of life cycle emissions in favor of coal. API strongly disagrees with this view and emphasizes that a correct representation would favor U.S LNG even more.
  (1) Table 5-4 in the NETL Report applies an outdated emission factor to well completions and workovers in the Marcellus Shale. In 2014 EPA updated (for use in the 2012 U.S. GHG Inventory) the emission factor for gas wells with hydraulic fracturing that was originally published in 2011 (2009 U.S. GHG Inventory). The current inventory applies a factor of approximately 2,500 Mscf gas/event, compared to 9,000 Mscf gas/event shown in Table 5-4. The emission factors shown in Table 5-4 for completions and workovers associated with conventional production are also significantly higher than the values used in the current U.S. GHG Inventory. Making this correction would favor U.S. LNG exports even more.
  (2) Table 5-4 indicates a total of 0.156 lb CH_4 /Mcf emissions for other vented and fugitive emission sources associated with natural gas extraction. This is a conservatively high estimate. A comparable value from the 2012 U.S. GHG Inventory is 0.112 lb CH_4 /Mcf. Making this correction would favor U.S. LNG exports even more.
  (3) The natural gas model parameters are also overestimating emissions associated with gas wells liquids unloading. The current U.S. GHG Inventory uses emissions data developed from an industry study, which indicates that approximately 1.8 Mcf gas is emitted per unloading event, compared to 3.57 Mcf/episode shown in Table 5-4. Although the analysis assumed liquids unloading are not applicable to production in the Marcellus Shale, data reported to EPA in the GHGRP indicates otherwise. This assumption biases the emission estimates for the U.S. for this one process but it is not significant enough to change the balance of the other assumptions discussed above, which overestimate emissions from natural gas produced in the U.S.
  (4) Based on NETL's assumptions for liquefaction (using AR4 coefficients), the GHG intensity of the LNG facility amounts to 0.44 tonnes of CO_2e per tonne of LNG produced. The data in NETL's model[2] is based on process data from a specific facility in Australia (representing an Australian 2005 process) and adapted to represent liquefaction at the Atlantic LNG facility in Trinidad and Tobago. This assumption is very conservative since the process used in the model is based on outdated technology. This is not an appropriate marker to represent GHG emissions from the liquefaction process associated with US LNG exports today, where new build technologies and improved-efficiencies are more relevant for the final results. For example, the proposed new

[2] NETL, Life Cycle Analysis of Natural Gas Extraction and Power Generation, Appendix A, Figure A-17 and Table A-15; Natural gas liquefaction, storage, and ship loading.

facilities at Sabine Pass[3], Cameron[4]; and Freeport[5] are expected to have GHG intensities of 0.26, 0.29, and 0.12 tonnes of CO2e per tonne of LNG, respectively. Using these lower GHG intensities for the liquefaction process as cited above would lead to lower overall GHG emissions from U.S. exported LNG.

(5) In 2009, Taglia *et. al*[6] analyzed the relative contribution of all the supply chain steps to total life cycle GHG emissions for bringing natural gas to Europe. Their analysis included both pipeline based natural gas transport and LNG production and transport to combined cycle turbine power generation plants. For the scenarios analyzed, Taglia *et. al.* concluded that the supply chains based on pipeline transport had higher fugitive and combustion GHG emissions than supply chains based on LNG.

(6) The range of leakage rates used in the NETL report to represent Unconventional gas production is 1.2% to 1.6%, while for Conventional gas production a range of values of 1.1% to 1.6% (Table 5-1) is used. These ranges encompass the leakage rates that may be derived from the U.S. GHG Inventory, where methane emissions from natural gas systems amounts to 1.6% and 1.09%, respectively, of natural gas withdrawals (production) in 2011 and 2012.

(7) In an addendum published by NETL[7] (Table 10 and Figure 4), a range of leakage rates published by other studies are shown. Based on this literature, NETL concluded that – on average - the leakage rate for Upstream U.S. oil and natural gas industry is 1.4% for unconventional resources and 1.3% for conventional resources. NETL has totally discounted the high leakage rates derived by Howarth *et. al*. due to technical issues with that analysis[8]. In addition to the technical shortcomings, Howarth *et. al.* were the only study that did not use the IPCC (AR4, 2007) GWP coefficients for converting methane emissions to CO2e; relying instead on Shindell et al. (2009)[9].

(8) Many other studies agree with NETL's assessment of Howarth's estimates. For example, Cathles[10] concludes that Howarth *et. al's* analysis provides unrealistically high estimates of fugitive emissions associated with unconventional gas. Cathles dismisses the validity of Howarth *et. al.* analysis because it relies on estimating production emissions on the basis of a cryptic presentation of relatively few and poor primary sources, and the fact that it did not take into account new technologies that are now in use to reduce such emissions. In addition, Cathles

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[3] http://energy.gov/sites/prod/files/EA-1845-FEA-2011.pdf

[4] http://energy.gov/sites/prod/files/2014/01/f6/EIS-0488-DEIS-Sections1-5-2014.pdf

[5] http://www.epa.gov/region6/6pd/air/pd-r/ghg/freeport_lng_app.pdf

[6] Taglia, A. and Rossi, N., *European Gas Imports: GHG Emissions from the Supply Chain,* Proceedings of the 2009 IAEE Conference; http://www.aaee.at/2009-IAEE/uploads/fullpaper_iaee09/P_238_Taglia_Antonio_31-Aug-2009,%2017:24.pdf

[7] NETL, Addendum to Environmental Review Documents Concerning Exports of Natural Gas from the United States, Draft Report, May 29, 2014

[8] Howarth, R., R. Santoro and A. Ingraffea. 2011. "Methane and the Greenhouse Gas Footprint of Natural Gas from Shale Formations". Climate Change [online]. Available at: http://www.springerlink.com/content/e384226wr4160653/

[9] Shindell, D.T., G. Faluvegi, D.M. Koch, G.A. Schmidt, N.Unger, and S.E. Bauer. 2009. "Improved Attribution of Climate Forcing to Emissions". Science, Vol. 326, No. 5953, p. 716-718. Available at: http://www.sciencemag.org/content/326/5953/716.abstract.

[10] L. M. Cathles, Assessing the greenhouse impact of natural gas, Geochemistry Geophysics and Geosystems, Volume 13, Number 6, 19 June 2012

emphasizes that Howarth *et. al.* comparison of natural gas to coal, on the basis of heat content rather than electricity, is basically irrelevant to evaluation of the relative greenhouse effects of these two power generation options.

(9) Data from ambient studies[11] that purport to derive an average methane leak rate is also misleading since these studies are based primarily on episodic ambient air measurements which have yet to be validated for use in deriving average leakage rates over longer time periods, such as represented by annual GHG inventories[12].

- API recognizes also that the uncertainties associated with the NETL LCA results are due to simplifications associated with the range of parameters selected and the choice of transport scenarios and final end-use locations. In particular, the analysis of the coal scenarios seems to be based on optimistic assumptions that lead to a calculated GHG intensity that is lower than would be expected under more realistic conditions.

  (1) It is not clear that it is appropriate to assume that methane leakage from coal extraction globally can be characterized by emission factors that are appropriate for U.S. coal production. The differences in emission factors are due to the type and relative quantities of coal produced (bituminous, sub-bituminous or lignite) and the type of mining techniques, be it surface strip mining or deep underground mines.

  (2) NETL's analysis assumes that the expected fugitive CH_4 emissions for all coal scenarios can be represented by an emission factor of 8 scfCH_4/ton. This value actually represents the expected value from a range of emission factors spanning 4 – 40 scfCH_4/ton for extraction of subbituminous coal from previously degassed surface mines in the U.S. Rocky Mountains area[13]. In contrast, NETL's established model for underground bituminous coal mines[14], assumes emissions in the range of 216 – 504 scfCH4/ton with an expected value of 360 scfCH_4/ton. Therefore, we do not understand NETL's rationale for using the low end value of 8 scfCH_4/ton to represent the range of expected values for coal production for power generation in the U.S. and globally. It seems that this assumption would tend to create a downward bias for the GHG intensity associated with coal production.

  (3) The report failed to recognize that a portion of the coal used for power generation in China and Europe is imported from the U.S. For example, the U.S. Energy Information Administration (EIA) AEO 2014 Reference Case projects that U.S. coal exports to Europe will grow from 58.1 million short tons in 2011 to 77.2 million short tons in 2040. Similarly, U.S. coal exports to Asia are expected to grow from 27.8 million short tons in 2011 to 51.6 million short tons by 2040.

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[11] Petron G, Frost GJ, Miller BR and 27 others (2012) Hydrocarbon emissions characterization in the Colorado Front Range- a pilot study, Jour. Geophys. Res., doi:10.1029/2011JD016360.
http://www.agu.org/journals/jd/jd1204/2011JD016360/2011JD016360.pdf

[12] Petron, G, Karion, Ann, et. al.,(2014), *A new look at methane and nonmethane hydrocarbon emissions from oil and natural gas operations in the Colorado Denver-Julesburg Basin,* Jour. of Geophys. Res: Atmospheres, Volume 119, Issue 11, 6836–6852, June 2014; DOI: 10.1002/2013JD021272

[13] NETL, Life Cycle Analysis of Natural Gas Extraction and Power Generation report, Appendix B, Figure B-15 and Table B-14 (data included in referenced Excel model)

[14] NETL, Life Cycle Analysis of Natural Gas Extraction and Power Generation report, Appendix C, Figure C-18 and Table C-17 (data included in referenced Excel model)

Therefore, the regional coal scenario would have to account for the additional GHG emissions that would be associated with its transport and thus result in higher emissions from domestic coal consumption.

- API recommends that note be taken of a recent compilation and review of 20 years of natural gas emissions studies - in the United States and Canada - that was performed by authors from major universities and national laboratories, and was published earlier this year[15]. One of the findings of this compilation is that many independent experiments suggest that a small number of "super-emitters" (or highly leaking components) are responsible for a large fraction of the overall leakage. The assessment of all of these studies concludes that recent regional atmospheric studies - with very high emissions rates - are unlikely to be representative of typical natural gas system leakage rates; and assessments using 100-year impact indicators show system-wide leakage is unlikely to be large enough to negate climate benefits of coal-to-natural gas substitution.

[15] A. R. Brandt, G. A. Heath, A. Kort, F. O'Sullivan, G. Pétron, S. M. Jordaan, P. Tans, J. Wilcox, A. M. Gopstein, D. Arent, S. Wofsy, N. J. Brown, R. Bradley, G. D. Stucky, D. Eardley, R. Harriss, *"Methane Leaks from North American Natural Gas Systems"*, Science 14 February 2014: Vol. 343 no. 6172 pp. 733-735 http://www.sciencemag.org/content/343/6172/733.summary