

**TESTIMONY OF JAMES BRADBURY**

**SENIOR ASSOCIATE, CLIMATE AND ENERGY PROGRAM  
WORLD RESOURCES INSTITUTE**

**HEARING BEFORE THE U.S. HOUSE OF REPRESENTATIVES ENERGY AND  
COMMERCE SUBCOMMITTEE ON ENERGY AND POWER:  
“U.S. ENERGY ABUNDANCE:  
EXPORTS AND THE CHANGING GLOBAL ENERGY LANDSCAPE”**

**May 7, 2013**

**Summary of Key Points:**

Liquefied natural gas (LNG) exports present both opportunities and risks. Producing and delivering natural gas to customers is highly energy- and emissions-intensive, particularly when LNG is involved. Research by the World Resources Institute has found that cuts in upstream methane leakage from natural gas systems are among the most important steps the U.S. can take toward meeting our greenhouse gas (GHG) emissions reduction goals by 2020 and beyond.

This testimony focuses on fugitive methane emissions and the many cost-effective solutions available for reducing them. It appears very likely that LNG exports from U.S. terminals would result in increased domestic GHG emissions from both upstream and downstream sources. Policymakers should more actively work to help achieve reductions in GHG emissions from throughout the natural gas value chain, if this valuable fuel and LNG are to be part of the solution to the climate change problem. Taking these actions offer economic, environmental, and geopolitical benefits, both in the U.S. and internationally. To this end, I offer the following policy recommendations:

- Expand applied technology research programs at the U.S. Department of Energy to help reduce the cost of leak-detection and emissions measurement technologies, and to develop new and lower-cost emission reduction strategies.
- Update emissions factors for natural gas systems using robust measurement protocols, public reporting by industry, and independent verification.
- Authorize and appropriate funding for the organization STRONGER (State Review of Oil and Natural Gas Environmental Regulations) to help states with timely development and evaluation of their environmental regulations.
- Support voluntary programs at the U.S. Environmental Protection Agency (EPA), including Natural Gas STAR and other programs which recognize companies that demonstrate a commitment to best practices.
- Support EPA’s efforts to provide technical and regulatory assistance to states with expanding oil and natural gas development, including through the Ozone Advance Program.
- Enact policies to support clean energy and address climate change. A clean energy standard or putting a price on carbon would provide clear signals to energy markets that energy providers and users need to recognize the environmental and social costs as well as the direct economic costs of energy resources.

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**May 7, 2013**

Good morning, and thank you for the opportunity to contribute to the deliberations of this Subcommittee. My name is James Bradbury, and I am a senior associate in the Climate and Energy Program at the World Resources Institute (WRI). WRI is a non-profit, non-partisan think tank that focuses on the intersection of the environment and socio-economic development. We go beyond research to put ideas into action, working globally with governments, business, and civil society to build transformative solutions that protect the earth and improve people’s lives. We operate globally because today’s problems know no boundaries. We provide innovative paths to a sustainable planet through work that is accurate, fair, and independent.

**Summary**

I am pleased to be here today to offer WRI’s perspective on the climate implications of U.S. liquefied natural gas (LNG) exports. I encourage this committee to weigh a complete consideration of the associated economic and geopolitical opportunities next to the potential risks, neither of which have been fully considered in the public debate. In particular, it appears very likely that LNG exports from U.S. terminals would result in increased domestic greenhouse

gas (GHG) emissions. For example, analysis by the Energy Information Administration (EIA)<sup>1</sup> concluded that any scenario of LNG exports would trigger an increase in domestic carbon dioxide (CO<sub>2</sub>) emissions, due to an increase in coal-fired electricity and use of natural gas for the energy-intensive liquefaction process at LNG terminals. The EIA also projected an increase in natural gas production from shale wells. Though not considered in the EIA study, an inevitable consequence would be greater upstream air emissions from natural gas infrastructure – that is, emissions that occur prior to fuel combustion – including fugitive methane, which is a potent global warming pollutant. While LNG exports from the U.S. are widely expected to marginally reduce global CO<sub>2</sub> emissions, modeling to date suggests that the scale of these reductions is less than ten percent of the total levels of global fugitive methane emissions from natural gas and oil systems.

These facts should raise the bar for policymakers and advocates for LNG exports to more actively work to achieve continuous improvement in GHG emissions from all life cycle stages (from extraction to use), if natural gas and LNG are to be part of the solution to our climate change problem. Furthermore, to the extent that substantial LNG exports from the U.S. move forward, our national policy objectives should be broader than simply improving our balance of trade vis-à-vis fossil fuel exports to increase our economic and geopolitical standing. We also have an important – indeed urgent – opportunity to improve our economic and geopolitical standing by showing leadership in addressing global climate change. We can do through policies

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<sup>1</sup> See: [http://www.fossil.energy.gov/programs/gasregulation/reports/fe\\_eia\\_lng.pdf](http://www.fossil.energy.gov/programs/gasregulation/reports/fe_eia_lng.pdf)

that promote the development, deployment, and export of low-carbon products and services<sup>2</sup> to help enable global GHG emissions reductions from all sectors, including through technologies and practices that allow the cleaner production and more efficient end-use of natural gas.

Today I will focus in particular on fugitive methane emissions<sup>3</sup> and the cost-effective solutions available for reducing them.<sup>4</sup> The case for policy action is particularly strong considering that recent research shows that climate change is happening faster than expected. In addition, the projected expansion in domestic oil and natural gas production increases the risk of higher GHG emissions if proper protections are not in place.

- Methane is the primary component of natural gas and also a potent greenhouse gas. Methane leaked from natural gas systems (i.e., fugitive methane) represent lost product and reduced revenue for companies and governments, with negative consequences for air quality and the environment.
- Fugitive methane emissions from natural gas systems represent roughly 3 percent of global warming pollution in the U.S. Reductions in methane emissions are urgently needed as part of the broader effort to slow the rate of global temperature rise.
- Although natural gas burns much cleaner than coal or oil, fugitive methane emissions significantly reduce this relative advantage, from a climate standpoint; therefore, cutting

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<sup>2</sup> For more information on low-carbon market opportunities, see Jennifer Morgan’s testimony, here: <http://www.wri.org/publication/testimony-american-energy-security-and-innovation-assessment-of-energy-resources>

<sup>3</sup> While this testimony focuses on greenhouse gas emissions – and methane emissions from natural gas systems, in particular – WRI is committed to minimizing the full scope of impacts cause by energy production and use. It is critical for U.S. energy policies to be developed with consideration to a broad range of risks and benefits.

<sup>4</sup> For more detailed analysis and discussion of this topic, see WRI’s recent working paper, “Clearing the Air: Reducing Upstream Greenhouse Gas Emissions from U.S. Natural Gas Systems.” Available at: <http://www.wri.org/publication/clearing-the-air>

fugitive emissions from natural gas systems would ensure that the climate impacts of natural gas are much lower than coal or diesel fuel over any time horizon.

- Recent emissions standards from the U.S. Environmental Protection Agency (EPA) will substantially reduce leakage from natural gas systems, but to help slow the rate of global warming pollution and improve air quality, further action by states and federal agencies should directly address fugitive methane from new and existing wells and equipment.
- Fortunately, most strategies for reducing fugitive methane emissions are cost-effective, with payback periods of three years or less. A recent WRI report found that cuts in methane leakage from natural gas systems are among the most important steps the U.S. can take toward meeting our GHG emissions reduction goals.<sup>5</sup>
- The process of liquefaction, transport, and regasification of LNG is highly emissions-intensive, increasing by 15 percent the total life cycle GHG emissions associated with exported U.S. natural gas, compared to natural gas that is produced and consumed domestically. These added upstream emissions also significantly reduce the relative advantage that natural gas would have over higher-emitting fuels, like coal and oil.
- The following policy actions by Congress would help reduce methane emissions as cost-effectively and quickly as possible:
  - Expand applied technology research programs at the U.S. Department of Energy (DOE) to help reduce the cost of leak-detection and emissions measurement technologies, and to develop new and lower-cost emission reduction strategies.

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<sup>5</sup> See: “Can the U.S. Get There from Here? Using Existing Federal Laws and State Actions to Reduce Greenhouse Gas Emissions,” available at: <http://www.wri.org/publication/can-us-get-there-from-here>.

- Update emissions factors for natural gas systems using robust measurement protocols, public reporting by industry, and independent verification.
- Authorize and appropriate funding for the organization STRONGER (State Review of Oil and Natural Gas Environmental Regulations) to help states with timely development and evaluation of their environmental regulations.
- Support voluntary programs at EPA, including Natural Gas STAR and other programs which recognize companies that demonstrate a commitment to best practices.
- Support EPA's efforts to provide technical and regulatory assistance to states with expanding oil and natural gas development, including through the Ozone Advance Program.
- Broader action on policies supporting clean energy and addressing climate change should also be on the table. A clean energy standard or putting a price on carbon would provide clear signals to energy markets that energy providers and users need to recognize the environmental and social costs as well as the direct economic costs of energy resources.

Finally, every day that we take no policy action on climate change, we make the policy choice to let climate change run its course. This ignores the overwhelming consensus of climate scientists who have been warning for decades that rising GHG emissions will cause the planet to warm, sea levels to rise, and weather to become more extreme. It is indisputable that these climate changes are happening today, in many cases much more quickly than expected. Action is urgently needed.

## **LNG Exports, the Public Interest, and Climate Change**

When reviewing grant applications for LNG export authorizations, DOE is required to determine if proposed exports “will not be consistent with the public interest.” In making this finding, DOE is considering a range of factors, including economic, energy security, and environmental impacts.<sup>6</sup> The climate change implications of LNG exports touches on each of these factors and therefore deserves more careful consideration by Congress and DOE.

The January 2012 study by EIA included a useful but limited assessment of the climate change implications of LNG exports, while the NERA Economic Consulting report (December 2012) was more narrowly focused on macroeconomic considerations.<sup>7</sup> This testimony focuses particular attention to how LNG exports – and increased production of natural gas more broadly – could affect domestic and international GHG emissions, which is clearly a question of relevance to the public interest.

There is no doubt that our climate is already changing in ways that are increasingly risky, difficult to manage, and harmful to public health and the environment.<sup>8</sup> Recent science assessments – including by the U.S. National Academy of Sciences and the U.S. Global Change Research Program<sup>9</sup> – agree that GHG emissions are very likely causing higher global temperatures, rising sea levels, and more frequent extreme weather events. National science

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<sup>6</sup> See: <http://www.fossil.energy.gov/programs/gasregulation/LNGStudy.html>

<sup>7</sup> Both reports are available here: <http://www.fossil.energy.gov/programs/gasregulation/LNGStudy.html>

<sup>8</sup> National Academies, Committee on Climate Choices, Final Report, 2011. <http://dels.nas.edu/Report/America-Climate-Choices-2011/12781>

<sup>9</sup> <http://ncadac.globalchange.gov/download/NCAJan11-2013-publicreviewdraft-fulldraft.pdf>

academies from over a dozen countries, including the U.S., have expressly urged governments to take urgent action to curb these harmful emissions.<sup>10</sup>

The current U.S. commitment to the international community is to reduce GHG emissions below 2005 levels by 17 percent in 2020 and 83 percent in 2050.<sup>11</sup> While a shift in electric generation to natural gas from coal has played a significant role in recent reductions in U.S. carbon dioxide emissions, this market-driven trend in the power sector has reversed somewhat in recent months, as natural gas prices have been increasing.<sup>12</sup> Furthermore, GHG emissions from all major sources will need to be addressed for the U.S. to help achieve climate stabilization at 2° Celsius, which the international community has agreed to be an appropriate and relatively safe target. A recent report by the World Bank<sup>13</sup> found that the world is on track for at least a 4° Celsius increase in global temperatures, which would be extremely damaging to global development goals and be “marked by extreme heat-waves, declining global food stocks, loss of ecosystems and biodiversity, and life-threatening sea level rise.” However, the World Bank also concluded that there is still time to enact policies that would help avoid this outcome.

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<sup>10</sup> G8+5 Academies’ joint statement: Climate change and the transformation of energy technologies for a low carbon future. <http://www.nationalacademies.org/includes/G8+5energy-climate09.pdf>

<sup>11</sup> See:

[http://unfccc.int/files/meetings/cop\\_15/copenhagen\\_accord/application/pdf/unitedstatescphaccord\\_app.1.pdf](http://unfccc.int/files/meetings/cop_15/copenhagen_accord/application/pdf/unitedstatescphaccord_app.1.pdf)

<sup>12</sup> See: <http://insights.wri.org/news/2013/03/new-data-reveals-rising-coal-use>

<sup>13</sup> See: <http://climatechange.worldbank.org/content/climate-change-report-warns-dramatically-warmer-world-century>



## **Concerns about the environmental impacts of shale gas development**

Natural gas production in the United States has increased rapidly in recent years, growing by 23 percent from 2007 to 2012.<sup>14</sup> This development has significantly changed projections of the future energy mix in the U.S. The shale gas phenomenon has also helped reduce energy prices, directly and indirectly supporting growth for many sectors of the U.S. economy, including manufacturing. The EIA projects that the United States will begin exporting LNG within 5 years and that the country will be a net natural gas exporter by the year 2020.<sup>15</sup>

Shale gas development has also triggered divisive debates over the near- and long-term environmental implications of developing and using these resources, including concerns about water resources, air quality, and land and community impacts.<sup>16</sup> Like all forms of energy, including conventional natural gas, there are public health and environmental risks associated with shale gas development. Chief among public concerns are drinking water contamination resulting from improper wastewater management, chemical spills, and underground methane migration into groundwater. There are also concerns regarding air emissions, and land-related impacts including habitat fragmentation and soil erosion. Other common concerns involve community impacts related to industrial development and extensive truck traffic. In 2011, the Secretary of Energy Advisory Board's Natural Gas Subcommittee warned<sup>17</sup> that "disciplined attention must be devoted to reducing the environmental impact" of shale gas development in the

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<sup>14</sup> See: <http://www.eia.gov/forecasts/aeo/index.cfm>

<sup>15</sup> *ibid*

<sup>16</sup> For more detailed discussions of the broader environmental impacts of natural gas development, see: <http://www.gao.gov/products/GAO-12-732>; and [http://www.rff.org/Documents/RFF-Rpt-PathwaystoDialogue\\_FullReport.pdf](http://www.rff.org/Documents/RFF-Rpt-PathwaystoDialogue_FullReport.pdf)

<sup>17</sup> [http://www.shalegas.energy.gov/resources/111811\\_final\\_report.pdf](http://www.shalegas.energy.gov/resources/111811_final_report.pdf)

face of its expected continued rapid growth, with as many as 100,000 more wells expected over the next few decades.

Of particular concern are the air emissions and climate change implications of shale gas development, including fugitive methane emissions, which reduce the net climate benefits of using lower-carbon natural gas as a substitute for coal and oil for electricity generation and transportation, respectively. Other air emissions from the natural gas sector include CO<sub>2</sub>, volatile organic compounds (VOCs, which are chemicals that contribute to ground-level ozone and smog), and hazardous air pollutants (HAPs). In 2012, EPA finalized air pollution standards for VOCs and HAPs from the oil and natural gas sector. These rules will improve air quality and have the co-benefit of reducing methane emissions. As discussed below (see p. 18, “Progress is Being Made but There is More Work to Be Done”), these standards should be complemented by additional actions to further reduce methane emissions, which will help slow the rate of global temperature rise in the coming decades.

From the standpoint of CO<sub>2</sub> emissions, shale gas development and lower natural gas prices have contributed to recent emissions reductions in the U.S. However, GHG emissions are projected to rise, and market forces and voluntary actions alone will not enable an effective response to climate change. Thus broad policy action will be needed. For example, analysis by the International Energy Agency (IEA)<sup>18</sup> found that a significant global increase in use of natural gas over the coming decades could have some net climate benefits compared to scenarios in which oil and coal play more prominent roles. However, the IEA’s “Golden Rules Case” scenario

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<sup>18</sup> International Energy Agency, “Golden Rules for a Golden Age of Gas.” Available at: [http://www.worldenergyoutlook.org/media/weowebiste/2012/goldenrules/weo2012\\_goldenrulesreport.pdf](http://www.worldenergyoutlook.org/media/weowebiste/2012/goldenrules/weo2012_goldenrulesreport.pdf)

would result in CO<sub>2</sub> concentrations in the atmosphere of 650 parts per million (ppm) and a global temperature rise of 3.5° Celsius, almost twice the internationally accepted 2° Celsius target.

Economic modeling conducted by researchers at MIT<sup>19</sup> and Resources for the Future<sup>20</sup> have also found that while greater use of natural gas may offer some climate benefits, climate and energy policies will be needed to reduce CO<sub>2</sub> emissions by anywhere near our 83 percent target by mid-century. While natural gas will likely play an essential bridging role in this transition, this will require both reducing the upstream GHGs produced during the extraction process, and — if gas-fired power plants are to be a part of a longer-term energy future — using carbon capture and storage (CCS) technology.

### **Why Focus on Methane Emissions?**

Though methane accounted for only 10 percent of the U.S. greenhouse gas emissions inventory in 2010 (Figure 1),<sup>21</sup> it represents one of the most important opportunities for reducing GHG emissions in the U.S.<sup>22</sup> In addition to the scale and cost-effectiveness of the reduction opportunities, climate research scientists have concluded that cutting methane emissions in the near term could slow the rate of global temperature rise over the next several decades.<sup>23</sup>

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<sup>19</sup> See: <http://globalchange.mit.edu/research/publications/2229>

<sup>20</sup> See: <http://www.rff.org/RFF/Documents/RFF-IB-09-11.pdf>

<sup>21</sup> Note: all GHG inventory numbers referred to in this testimony were adjusted to reflect a more current global warming potential (GWP) for methane of 25 (IPCC 2007). This is necessary because when EPA converts methane to carbon dioxide equivalents they use an out-of-date GWP for methane of 21 (IPCC 1995), for the sake of consistency with UNFCCC reporting guidelines.

<sup>22</sup> See: “Can the U.S. Get There from Here? Using Existing Federal Laws and State Actions to Reduce Greenhouse Gas Emissions,” available at: <http://www.wri.org/publication/can-us-get-there-from-here>.

<sup>23</sup> National Research Council, 2011. “Climate Stabilization Targets: Emissions, Concentrations, and Impacts over Decades to Millennia,” ISBN: 0-309-15177-5, 298 pages. <http://www.nap.edu/catalog/12877.html>

Rising methane concentrations in the atmosphere have a potent, near-term warming effect because this greenhouse gas has a relatively high global warming potential and short atmospheric lifetime (IPCC 2007). Global warming potential (GWP) is a measure of the total energy that a gas absorbs over a particular period of time (usually 100 years), compared to carbon dioxide. Key factors affecting the GWP of any given gas include its average atmospheric lifetime and the ability of that molecule to trap heat. By mass, the same amount of methane emissions is 25 times more potent than carbon dioxide emissions over a 100-year time horizon (IPCC 2007). In the 20-year time frame, studies estimate that methane's GWP is at least 72 times greater than that of carbon dioxide.

Scientists at the National Research Council of the U.S. National Academy of Sciences have concluded that global CO<sub>2</sub> emissions need to be reduced in the coming decades by at least 80 percent to stabilize atmospheric CO<sub>2</sub> concentrations and thereby avoid the worst impacts of global climate change.<sup>24</sup> However, given the slow pace of progress in the U.S. in this regard, it is valuable and important for policymakers to consider cost-effective mitigation strategies – such as cutting methane emissions – that would have a disproportionate short-term impact.

### **How Emissions-Intensive is U.S. Natural Gas?**

EPA estimates that total emissions from the development, transmission, and use of natural gas in the U.S. made up roughly a quarter of the total U.S. GHG inventory in 2011.<sup>25</sup> While natural gas emits about half as much carbon dioxide as coal at the point of combustion, the picture is more

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<sup>24</sup> Ibid.

<sup>25</sup> Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2011 (April 2013).  
<http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html>

complicated from a life cycle perspective. Three percent of the U.S. inventory is the result of fugitive methane emissions from natural gas systems<sup>26</sup> – i.e., natural gas lost to the atmosphere through venting and systemic leaks, prior to the point of combustion. To put this in perspective, in 2011, these methane leaks resulted in more GHG emissions<sup>27</sup> than all of the direct and indirect GHG emissions from U.S. iron and steel, cement, and aluminum manufacturing combined.<sup>28</sup>

EPA's 2013 GHG inventory implies a methane leakage rate of less than 2 percent of total natural gas production. Meanwhile, recent research<sup>29</sup> has shown that at less than a 3 percent leakage rate, natural gas produces fewer GHG emissions than coal over any time horizon. Additionally, reducing the methane leakage rate to below 1 percent would ensure that heavy-duty vehicles fueled by natural gas, like buses and long-haul trucks, would provide an immediate climate benefit over similar vehicles fueled by diesel. Thus, reducing total methane leakage to less than 1 percent of natural gas production is a sensible performance standard for the sector; an achievable benchmark that has not yet been reached.

Accurate estimates of the total leakage rate from the natural gas sector require reliable data for a broad range of industry activities and emissions factors associated with those activities. While EPA has recently updated industry activity data, most of the emissions factors rely on assumed emissions factors – as opposed to direct measurements, which are generally rare and often

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<sup>26</sup> The GHG inventory estimates 6.9 million metric tons of fugitive methane from natural gas systems in 2011.

<sup>27</sup> This estimate is based on an assumed global warming potential for methane of 25, which is the convention when considering the climate implications of methane compared to carbon dioxide, integrated over a 100-year time frame (IPCC, 2007).

<sup>28</sup> See:

<http://www.energetics.com/resourcecenter/products/roadmaps/Pages/USManufacturingEnergyUseandGreenhouseGasEmissionsAnalysis.aspx>

<sup>29</sup> See: <http://www.pnas.org/content/109/17/6435>

outdated. Some recently published research suggests that emissions levels may be higher than EPA estimates; this, coupled with high ground-level ozone levels in Colorado and Texas and rural parts of Utah and Wyoming (i.e., smog that is attributed to shale gas production activities), suggests that the emissions problem may be worse than we think, and certainly subject to regional variations.<sup>30</sup>

With hundreds of thousands of wells and thousands of natural gas producers operating in the U.S., the data quality issue will likely remain an active debate, even as forthcoming data from EPA and other sources in the coming months aims to clarify these questions.<sup>31</sup> In its November 2011 final report, the Secretary of Energy Advisory Board recommended that natural gas companies measure and disclose air emissions from shale wells.<sup>32</sup> Indeed, what remains lacking is a valid system for direct measurement and independent verification of emissions data reported by this sector.<sup>33</sup>

Nevertheless, while uncertainties remain regarding exact methane leakage rates, the weight of evidence suggests that significant leakage occurs during every life cycle stage of U.S. natural gas systems and much more can be done to reduce these emissions cost-effectively. A recent expert

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<sup>30</sup> Recent research based on field measurements of ambient air near natural gas well-fields in Colorado and Utah suggest that more than 4 percent of well production may be leaking into the atmosphere at some production-stage operations. For more discussion of questions regarding the quality and availability of methane emissions data, see Appendix 3 of “Clearing the Air,” here: <http://www.wri.org/publication/clearing-the-air>.

<sup>31</sup> For example, independent researchers at the University of Texas at Austin are teaming up with the Environmental Defense Fund and several industry partners to directly measure methane emissions from several key sources. When results are published in 2013 and 2014, these data will provide valuable points of reference to help inform this important discussion.

<sup>32</sup> See: <http://www.shalegas.energy.gov/>

<sup>33</sup> Such systems and protocols have been developed for tracking emissions from other sources. For example, see: <http://www.epa.gov/etv/vt-ams.html>

survey by Resources for the Future<sup>34</sup> identified methane emissions as a “consensus environmental risk” that should be addressed through government and industry actions.

### **How Will LNG Exports Affect Greenhouse Gas Emissions?**

To the extent that it is displacing higher-carbon fuels such as coal and oil, natural gas has the potential to help reduce total greenhouse gas emissions. This is particularly true as long as upstream emissions associated with natural gas are minimized and ideally methane leakage is kept below 1 percent of total production, as discussed above.

That said, the potential for LNG exports raises three primary concerns from a climate perspective.

- 1) The first area of concern involves upstream GHG emissions associated with increased onshore natural gas production. EIA projects that LNG exports would result in increased domestic production of natural gas, with roughly three quarters of this from shale sources. As shown in Figure 1, there are significant upstream GHG emissions (both CO<sub>2</sub> and methane) associated with shale gas production in the U.S. Given continued uncertainty around the actual level of methane emissions over the lifetime of both conventional and unconventional gas wells,<sup>35</sup> this projected market response could result in substantially higher levels of GHG emissions from throughout U.S. natural gas systems. The good news is that there are many ways to cost-effectively reduce upstream methane emissions; we encourage government and industry to do more to realize this

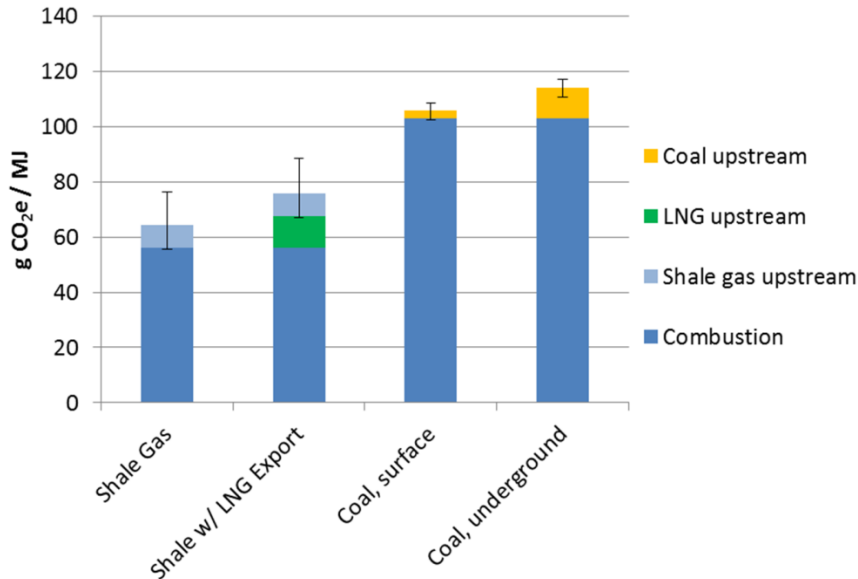
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<sup>34</sup> See: [http://www.rff.org/Documents/RFF-Rpt-PathwaystoDialogue\\_FullReport.pdf](http://www.rff.org/Documents/RFF-Rpt-PathwaystoDialogue_FullReport.pdf)

<sup>35</sup> Most studies estimate that upstream GHG emissions from conventional and unconventional gas sources are roughly comparable, within the margin of error.

opportunity (see p. 20 below, “Further Potential to Reduce Fugitive Methane Emissions”).

**Figure 1: Estimated Life Cycle Greenhouse Gas Emissions from U.S. Shale Gas, LNG Exports, and Coal**



Sources: Bradbury et al. 2013; Weber and Clavin, 2012; NETL, 2012; Burnham et al. 2011

2) The second area of concern is with respect to the liquefaction, transport, and regasification of LNG exports. According to a 2012 Natural Gas Technology Assessment by the National Energy Technology Lab (NETL),<sup>36</sup> these energy- and emissions-intensive processes would add roughly 15 percent<sup>37</sup> to total life cycle GHG emissions associated with U.S. onshore natural gas production (see Figure 1, above, “LNG upstream”). These added upstream emissions significantly reduce the relative advantage that natural gas

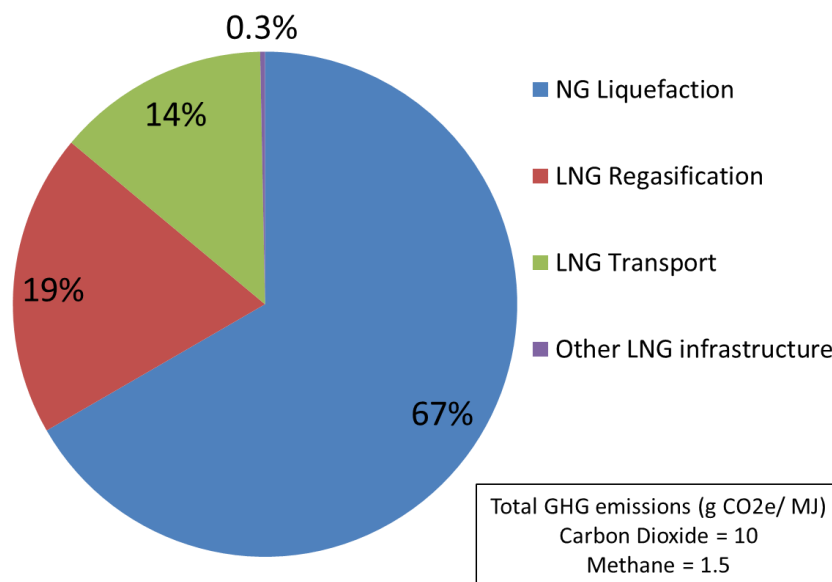
<sup>36</sup> NETL (National Energy Technology Laboratory). 2012. Role of Alternative Energy Sources: Natural Gas Technology Assessment. National Energy Technology Laboratory, U.S. Department of Energy. Available at: <http://www.netl.doe.gov/energy-analyses/refshelf/PubDetails.aspx?Action=View&PubId=435>

<sup>37</sup> Based on data provided in Appendix B of the NETL (2012) report, we calculate 11.5 grams of CO<sub>2</sub> equivalent per megajoule (g CO<sub>2</sub>e/MJ) of natural gas exported, which we added to estimated life cycle emissions associated with shale gas production, after the recent EPA rule takes effect (8.25 g CO<sub>2</sub>e/MJ), and typical estimate of final combustion of natural gas (56 g CO<sub>2</sub>e/MJ).



would have over higher-emitting fuels like coal.<sup>38</sup> The chart below illustrates the relative contributions of each process to total GHGs associated with LNG exports; liquefaction is the most emissions-intensive process, followed by regasification and transport. It is also worth noting that natural gas liquefaction emissions would occur at domestic LNG terminals, adding to total U.S. GHG emissions.

**Figure 2: Life Cycle GHG Emissions from LNG Terminals, Transport, and Infrastructure**



Source: Adapted from NETL, 2012

3) The third area of concern is the indirect domestic and international energy market implications of U.S. LNG exports. EIA’s 2012 report to DOE found that LNG exports would raise domestic prices for natural gas, making natural gas relatively less competitive compared to other energy sources in the U.S., resulting in greater use of coal

<sup>38</sup> Note that the data presented in Figure 1 show life cycle emissions estimates for the domestic production of natural gas and coal, with upstream LNG numbers assuming LNG exported from Trinidad and Tobago and imported in Louisiana. Ideally, this figure would offer a direct comparison between life cycle emissions from domestic shale gas production and export versus coal or fuel oil in the country of import. However, such data are not readily available at this time.

and higher levels of GHG emissions under all LNG export scenarios.<sup>39</sup> The global GHG implications of LNG exports from the U.S. is harder to assess, but the basic picture is that more gas would be sold into international markets, which would help reduce carbon dioxide emissions as long as it displaced higher-carbon fuel sources. Given the extensive scale of planned coal-fired power plants around the world<sup>40</sup> and accounting for the prevalence of energy-efficient technologies available for natural gas combustion,<sup>41</sup> this is a reasonable assumption. On the other hand, a greater abundance of lower-priced natural gas in global energy markets (supported by U.S. LNG exports) is also expected to increase total energy use and displace some lower-carbon renewable and nuclear energy sources, which will increase GHG emissions in markets where lower-carbon technologies have become relatively cost-effective. Taking all of these factors into consideration, IEA projections<sup>42, 43</sup> find that greater supplies of natural gas would lead to net annual reductions in global CO<sub>2</sub> emissions of 0.5 percent by 2035.<sup>44</sup> The report concludes that “while a greater role for natural gas in the global energy mix does bring environmental benefits where it substitutes for other fossil fuels, natural gas cannot on its own provide the answer to the challenge of climate change.”

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<sup>39</sup> The EIA estimates increases in U.S. CO<sub>2</sub> emissions between 9 and 75 MMt per year, from 2015 to 2035.

<sup>40</sup> See: <http://www.wri.org/publication/global-coal-risk-assessment>

<sup>41</sup> See: <http://www.c2es.org/technology/factsheet/natural-gas>

<sup>42</sup> See: <http://www.worldenergyoutlook.org/goldenageofgas/>

<sup>43</sup> See: [http://www.worldenergyoutlook.org/media/weowebiste/2011/WEO2011\\_GoldenAgeofGasReport.pdf](http://www.worldenergyoutlook.org/media/weowebiste/2011/WEO2011_GoldenAgeofGasReport.pdf)

<sup>44</sup> In their 2011 special report on natural gas, the IEA estimated that the GAS Scenario would lead to 35.3 gigatonnes (Gt) energy-related CO<sub>2</sub> emissions in 2035, with annual reduction of 160 million metric tons (MMt), in that year (compared to their “New Policies Scenario”). In their 2012 special report, the IEA reached a similar conclusion, estimating 184 MMt of annual reductions in global energy-related CO<sub>2</sub> emissions in 2035 with their “Golden Rules Case” (compared to a baseline), with global emissions rising to 36.8 gigatonnes (Gt) in the same year.

In summary, available evidence suggests that LNG exports from the U.S. would marginally reduce global CO<sub>2</sub> emissions, although the scale of these estimated GHG emissions savings is an order of magnitude lower than the total projected levels of global methane emissions from natural gas and oil systems.<sup>45</sup> Meanwhile, it appears very likely that LNG exports from U.S. terminals would result in increased domestic GHG emissions from both upstream and downstream sources.

These expected outcomes should raise the bar for policymakers and industry to more actively work to achieve continuous improvement in GHG emissions from all life cycle stages of natural gas development and use. Our research shows that reducing fugitive methane can be highly cost-effective – beneficial to customers and companies alike – and it is necessary if natural gas and LNG exports are to be part of the solution to our climate change problem, both in the U.S. and internationally.

### **Progress is Being Made but There is More Work to Be Done**

Now for the good news. Increased attention to the air emissions issue has resulted in significant recent progress toward reducing air pollution from natural gas systems.

In April 2012 EPA finalized regulations for New Source Performance Standards (NSPS) and National Emissions Standards for Hazardous Air Pollutants (NESHAP) that primarily target

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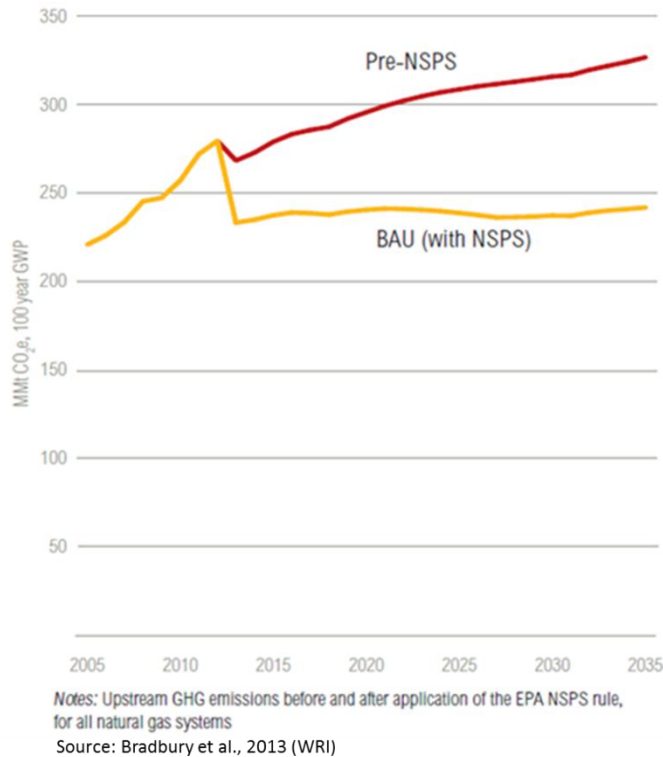
<sup>45</sup> By way of comparison, the EPA estimates that global annual fugitive methane emissions from natural gas and oil systems in 2030 will exceed 2,500 MMT carbon dioxide equivalent (CO<sub>2</sub>e), assuming a GWP of 25, over a 100 year time frame (see: <http://www.epa.gov/climatechange/EPAactivities/economics/nonco2projections.html>). The U.S. GHG inventory estimates that fugitive methane emissions from U.S. natural gas systems in 2011 were just over 170 MMT CO<sub>2</sub>e.

VOCs and air toxics emissions but will have the co-benefit of reducing methane emissions. The new EPA rules require “green completions,” which reduce emissions during the flow-back stage of all hydraulic fracturing operations at new and re-stimulated natural gas wells. The rules will also reduce leakage rates for compressors, controllers, and storage tanks.

EPA should be applauded for establishing these public health protections. Minimum federal standards for environmental performance are a necessary and appropriate framework for addressing cross-boundary pollution issues like air emissions. Federal Clean Air Act regulations are generally developed in close consultation with industry and state regulators and are often implemented by states. This framework allows adequate flexibility to enable state policy leadership and continuous improvement in environmental protection over time.

In our recent working paper, WRI estimated that these new rules will reduce methane emissions enough to cut all upstream GHG emissions from natural gas systems (including shale gas) by 13 percent in 2015 and 25 percent by 2035. As can be seen in Figure 3 below, the NSPS/NESHAP rules will make a big difference by helping to avoid a rise in upstream GHG emissions that would otherwise be likely given the projected growth in domestic natural gas production. The figure also shows that upstream carbon dioxide and methane emissions will remain a significant problem without further action.

**Figure 3: Upstream GHG Emissions from All Natural Gas Systems, 2006 to 2035**



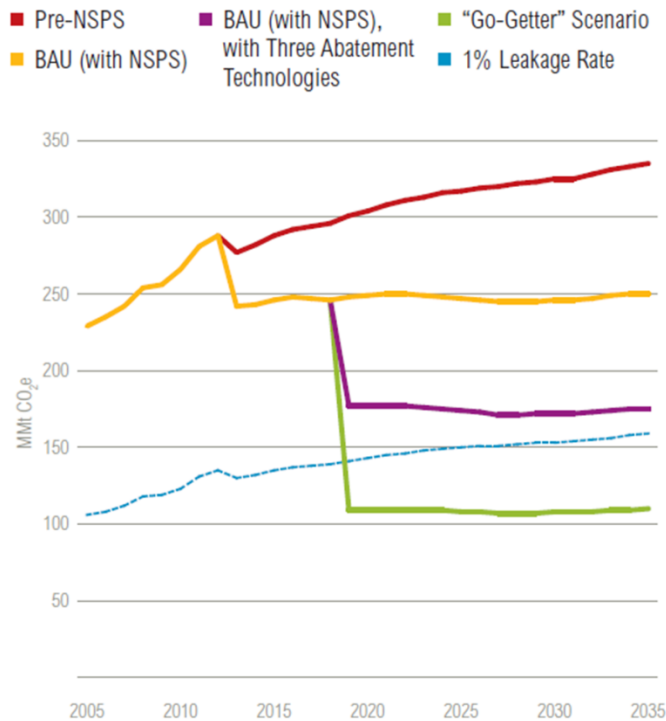
### **Further Potential to Reduce Fugitive Methane Emissions**

WRI estimates that by implementing just three technologies that capture or avoid fugitive methane emissions, upstream methane emissions across all natural gas systems could be cost-effectively cut by up to an additional 30 percent (see Figure 4, below). The technologies include (a) fugitive methane leak monitoring and repair at new and existing well sites, processing plants, and compressor stations; (b) replacing existing high-bleed pneumatic devices with low-bleed equivalents throughout natural gas systems; and (c) use of plunger lift systems<sup>46</sup> at new and existing wells during liquids unloading operations. By our estimation, these three steps would

<sup>46</sup> Note: new data from the most recent EPA emissions inventory suggests that these technologies are much more widely used than previously thought. See: <http://insights.wri.org/news/2013/05/5-reasons-why-its-still-important-reduce-fugitive-methane-emissions>

bring down the total life cycle leakage rate across all natural gas systems to just above 1 percent of total production. Through adoption of five additional abatement measures that each address smaller emissions sources (i.e., a “Go-Getter” Scenario), the 1 percent goal would be readily achieved. All eight of these technologies could be implemented cost-effectively with payback periods of three years or less.

**Figure 4: Upstream GHG Emissions from All Natural Gas Systems; with Additional Abatement Scenarios**



Source: Bradbury et al., 2013

### Policy Recommendations

New public policies will be needed to reduce methane emissions from both new and existing equipment throughout U.S. natural gas systems. WRI research has found that market conditions alone are not sufficient to compel industry to adequately or quickly adopt available best

practices. To the members of this committee, I recommend the following actions to help EPA and states cost-effectively reduce air emissions from natural gas systems.

*Expand applied technology research.* Efforts to reduce upstream GHG emissions from natural gas systems could be aided by applied technology research at DOE. Such research should be expanded, with a focus on advancement of technologies to reduce the cost of leak detection, improve emissions measurements, and develop new and lower-cost methane emission reduction strategies.

*Update emissions factors for key processes.* To help resolve questions regarding the scale of methane emissions from U.S. natural gas infrastructure and operations – and to inform critical domestic and international climate and energy policy decisions – the oil and gas sector should be required to directly measure and report their emissions, with results subject to independent verification and public disclosure.

*Assist with environmental regulations.* With more funding, the organization STRONGER (State Review of Oil and Natural Gas Environmental Regulations) could provide more states with timely assistance in developing and evaluating environmental regulations, including (but not limited to) those designed to reduce air pollution.

*Support best practices.* With more funding, EPA could do more through Natural Gas STAR and other programs to recognize companies that demonstrate a commitment to best practices. This program could further encourage voluntary industry actions by maintaining a clearinghouse for

technologies and practices that reduce all types of air emissions from the oil and natural gas sector.<sup>47</sup>

*Provide technical and regulatory assistance.* Recognizing the central role of state governments in achieving federal National Ambient Air Quality Standards, with more funding EPA could provide targeted technical and regulatory assistance to states with expanding oil and natural gas development. One example of a successful model that could be expanded is EPA's Ozone Advance Program. States concerned about smog and other air quality problems associated with oil and gas development voluntarily engage with this program, resulting in the co-benefit of reduced methane emissions.

*Reduce carbon dioxide emissions.* Broader action is also needed on policies supporting clean energy and addressing climate change. A clean energy standard or putting a price on carbon would provide clear signals to energy markets that energy providers and users need to recognize the environmental and social costs as well as the direct economic costs of energy resources.

## **Conclusions**

Some advocate for a free-market approach to managing energy production, transmission, and use. While I agree with the general virtues of free markets, I would also caution that there is no free lunch. The National Research Council has identified very significant costs associated with

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<sup>47</sup> An example of one existing clearinghouse can be found here: <http://cfpub.epa.gov/RBLC/>



fossil energy use that are hidden to most U.S. consumers.<sup>48</sup> Society pays when our health-care premiums rise due to harmful health effects caused by high ozone levels and other air pollution; taxpayers pick up the tab for climate change when the frequency and intensity of extreme weather events causes increasing damage to our communities and critical infrastructure.

Others highlight the energy and national security benefits of natural gas exports, which may reduce the political and economic influence of countries that do not share common interests with the U.S. and our allies. While such geopolitical benefits may be realized, LNG exports will do little to help avoid dangerous levels of climate change. We could also improve our geopolitical standing by demonstrating leadership in achieving greenhouse gas emissions reductions, much of which can be accomplished cost-effectively and with net benefits to the economy – starting with the policy actions recommended above. Meanwhile, the more we invest in fossil energy resources and infrastructure while delaying policy actions to significantly reduce GHG pollution, the more we expose ourselves and our allies to the destabilizing effects of climate change. In its 2010 Quadrennial Defense Review, the Department of Defense found that “climate change could have significant geopolitical impacts around the world.” The same report concludes that climate change could further weaken fragile governments and contribute to food scarcity, spread of disease, and mass migration. Meanwhile, 30 military installations already face elevated risk from sea-level rise.

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<sup>48</sup> NRC (National Research Council). 2010. “Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use.” Washington, DC: The National Academies Press. Available at: [http://www.nap.edu/catalog.php?record\\_id=12794](http://www.nap.edu/catalog.php?record_id=12794).

Every day that we take no policy action on climate change, we make the policy choice to let climate change run its course. This ignores the overwhelming consensus of climate scientists who have been warning for decades that rising GHG emissions will cause the planet to warm, sea levels to rise, and weather to become more extreme. It is indisputable that these climate changes are happening today, and in many cases much more quickly than expected. Action is urgently needed.