UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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Oil and Natural Gas Sector: Control Techniques for the Oil and Natural Gas Industry	)))	**Docket No. EPA-HQ-OAR-2010-0505**
	)	*Via email*
	))	*December 4, 2015*

Environmental Defense Fund appreciates the opportunity to submit these supplemental comments on EPA's Proposed New Source Performance Standards for the Oil and Natural Gas Sector ("NSPS Proposal"). All of the documents cited to in these comments are hereby incorporated as part of the record in this rulemaking proceeding. In addition to the joint comments we submitted along with other health and environmental groups, we submit these comments to provide additional information in three specific areas: 1) recent scientific evidence underscoring the harmful impacts of methane emissions and the benefits of reducing these emissions; 2) additional analysis that we believe supports the cost-effectiveness of more frequent, quarterly LDAR (or a tiered approach along the lines that Colorado has adopted); and 3) an analysis of liquids unloading emissions and recommendations for adopting performance based standards to reduce those emissions.

I. Methane is a Harmful, Potent Climate Forcer

As we note in the our joint comments, EPA is not required to make a pollutant-specific endangerment finding and ample evidence supports the EPA's rational basis for regulating methane emissions. Indeed, in the preamble to proposed subpart OOOOa, EPA provides a compelling summary of the present and projected impacts of climate change in the United States. Further, EPA has provided a detailed and rigorous analysis of the oil and natural gas sector's significant contribution to these harmful emissions.

We strongly support EPA's assessment of the scientific literature, EPA's characterization of the many impacts associated with climate change, and EPA's analysis of GHG emissions from the oil and natural gas sector. Below, we provide additional information further supporting the significant harms associated with greenhouse gases, including methane emissions from the oil and natural gas sector.

We strongly support EPA's summary of the key elements of the 2009 Endangerment Finding, as well as the Agency's evaluation of more recent scientific assessments issued by the National Research Council, IPCC, and U.S. Global Change Research Program (among others). EPA has clearly articulated how increasing GHG emissions are likely to harm human health and welfare, and the information we provide below only further strengthens and supports the agency's analysis by describing how addressing methane emissions from the oil and natural gas sector would provide additional climate benefits that are complementary to those achieved by regulation of carbon dioxide (CO_2).

We have identified several recent studies emphasizing the importance of reducing emissions of both "short-lived climate pollutants (SLCPs)" and CO_2 as a means to address near- and long-term climate change impacts. Because methane is a shorter-lived greenhouse gas than CO_2, the benefits of reducing methane emissions are realized on short (decadal) time scales. As a result:

> [C]uts in emissions of the shorter-lived non-CO_2 GHGs, primarily CH_4, could cause a rapid decrease in the radiative forcing attributable to these gases. Such a quick response time is not possible from CO_2 cuts alone. Reducing the peak climate forcing and minimizing the time during which it is enhanced could lessen the possibility that the climate irreversibly crosses a tipping point into a new state.[1]

Recent scientific literature has identified a number of important and complementary benefits associated with reducing emissions of SLCPs, many of which are driven by methane emission reductions. As discussed below, these benefits include the potential to (1) significantly reduce background levels of global ozone; (2) reduce near-term radiative forcing, delaying the timing of "peak temperature"; and (3) minimizing the pace of change and severity of several important climate impacts.

Reducing Background Levels of Global Ozone

In the subpart OOOOa preamble, EPA states that "compared to a future without climate change, climate change is expected to increase ozone pollution over broad areas of the US, especially on the highest ozone days and in the largest metropolitan areas with the worst ozone problems, and therefore increase the risk of mortality and morbidity."[2] We agree with EPA's projection that higher ozone levels will increase mortality and morbidity, and lead to adverse impacts to agriculture and ecosystems as ozone and climate worsen.

The connection between climate change and ozone is an important one, and below, we have provided additional information from several recent studies demonstrating that reducing methane emissions can reduce the risks of both climate change and ozone pollution. These studies have evaluated the potential benefits associated with reduced methane emissions on both human health and the environment.

- Anenberg, et al., for example, states that "controlling methane emissions may be a promising means of simultaneously mitigating climate change and reducing global ozone concentrations, compared with controlling shorter-lived ozone precursors [nitrogen

[1] Montzka, S.A., et al., *Non-CO_2 greenhouse gases and climate* change, Nature, 476: 43-50, 2011, p. 48.
[2] U.S. Environmental Protection Agency, *Oil and Natural Gas Sector: Emissions Standards for New and Modified Sources: Proposed Rule*, September 18, 2015, 80 FR 56602.

oxides (NOx), carbon monoxide (CO), and non-methane volatile organic compounds (NMVOCs)."[3] The paper concludes: "Relative to the 2030 reference scenario, implementing the methane measures would decrease seasonal (6-month) average 1-hr daily maximum ozone concentrations by 3-4 ppb. … [The authors] estimate that these measures could reduce global population-weighted average surface ozone concentrations by 4.71 – 11.0 ppb.[4]"

- Sarofim, et. al., makes similar points, stating that "reducing methane pollution will both slow anthropogenic climate change and reduce ozone-related mortality."[5] He further notes that because methane is globally well-mixed in the atmosphere, "the ozone response to methane emissions is mostly insensitive to the location in which the emissions were reduced."[6] Sarofim et al., concludes "the benefits of avoided cardiovascular and pulmonary mortality due to reduced methane emissions are substantial and are an important benefit to include when assessing the benefits of methane mitigation policies."[7]

- West, et. al., stresses that methane "affects global baseline (i.e., not affected by local sources) concentrations of ozone. In fact, methane is the dominant anthropogenic volatile organic compound (VOC) contributing to ozone formation in the global troposphere. Anthropogenic increases in emissions of methane and nitrogen oxides have been identified as the most important causes of the historic increases in background ozone concentrations since pre-industrial times."[8] Further, West notes that "reduced ozone concentrations would also provide benefits in … agricultural productivity, ecosystems and the global carbon cycle, and materials."[9] Similarly, Victor, et al., states that emissions of short-lived climate pollutants [methane, black carbon, and ozone] currently "degrade more than a hundred million tons of crops."[10]

These articles and others provide additional evidence on the harms associated with methane emissions and the benefit of reducing these emissions —both mitigating climate change and reducing global background ozone concentrations.

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[3] Anenberg, S.A., et. al., *Global Air Quality and Health Oo-benefits of Mitigating Near-Term Climate Change through Methane and Black Carbon Emission Controls*, Environmental Health Perspectives, 120:6, June 2012, p. 831.
[4] Ibid., p. 835.
[5] Sarofim, M.C., et. al., *Valuing the Ozone-Related Benefits of Methane Emission Controls*, Environmental Resource Economics, accepted 21 June 2015, p. 1.
[6] Ibid., p. 3.
[7] Ibid., p. 2.
[8] West, J.J., et. al., *Scenarios of methane emission reductions to 2030: abatement costs and co-benefits to ozone air quality and human mortality*, Climatic Change 114(3), 2012, p. 442.
[9] Ibid., p. 458.
[10] Victor, D.G., et al., *Commentary: Soot and short-lived pollutants provide political opportunity*, Nature Climate Change, Vol 5, September 2015, p. 796.

Reducing "Peak Warming"

A second important and complementary benefit of reducing methane emissions is the potential to reduce near-term climate warming and associated impacts. Many studies have highlighted the key role that minimizing methane emission can play in reducing "peak warming." For example, Shindell, et. al., states that "the combination of CH_4 and BC measures, along with substantial CO_2 emission reductions … has a high probability of limiting global mean warming to <2C during the next 60 years."[11] The study further notes "the CH_4 measures contribute more than half of the estimated warming mitigation and have the smallest relative uncertainty."[12] Similarly, a study by the United Nations Environment Program (UNEP) concludes "it is possible to slow down the pace of global warming very quickly … by reducing concentrations of 'short-lived climate forcers' in the atmosphere."[13]

The benefits of reducing emissions of both short-lived climate pollutants like methane, and longer-lived CO_2, are significant. As Montzka, et al., explains "cuts in emissions of shorter-lived non-CO_2 GHGs, primarily methane, could cause a rapid decreases in the radiative forcing attributable to these gases. Such a quick response is not possible from CO_2 alone."[14] Victor, et. al., states that "with available technologies, it is possible to cut these SLCPs drastically … This would avoid up to 0.6C of warming by mid-century, while also slowing rising sea levels, the melting of glaciers, and the retreat of the Arctic ice cap."[15] Similarly, Hu et al., highlights recent studies that "have estimated that the mid-century warming could be reduced by about 0.6C, leading to a delayed onset of the 2C warming by several decades."[16] This study also emphasizes that "in the near-term, SLCP mitigation is more effective than CO_2."[17] Finally, UNEP concludes "recent scientific results, including an assessment sponsored by UNEP and WMO, show that it is possible to slow down the pace of global warming very quickly (relative to a reference scenario) by reducing concentrations of 'short-lived climate forcers' in the atmosphere. These are substances that contribute to global warming and also have relatively short lifetimes in the atmosphere. They include methane, black carbon particles, tropospheric ozone, and many hydrofluorocarbons."[18]

Reducing Methane Emissions in the Near-Term Slows the Rate of Many Climate Impacts

[11] Shindell., D., et. al., *Simultaneously Mitigating Near-Term Climate Change and Improving Human Health and Food Security*, Science, 335, 2012, p. 184.
[12] Ibid., p. 186.
[13] United Nations Environment Program (UNEP), *Towards an Action Plan for Near-Term Climate Protection and Clean Air Benefits: Science Policy Brief*, June 2011, p. v.
[14] Montzka, S.A., et. al., *Non-CO2 greenhouse gases and climate* change, Nature, Vol. 476, 4 August 2011, p. 48.
[15] Victor, et. al., op cit., p. 796.
[16] Hu, A., et. al., *Mitigation of short-lived climate pollutants slows sea level rise*, Nature Climate Change, 2013, p. 1.
[17] Ibid., p. 2.
[18] UNEP, op cit., p. v.

As described above, methane emission reductions can play an important role in slowing the pace of change for many climate impacts. UNEP, for example, states "impacts of climate change are already observed and increasing, as in the case of diminishing Arctic summer ice or the shifting ranges of various plants and animals. Slowing down near-term climate change will dampen the quickening pace of impacts and help avoid risk of irreversible changes."[19] And UNEP explains "reducing near-term climate change will also allow more time for ecosystems to adapt to the changing climate and for societies to plan and implement adaptation measures. In general, the slower tempo of climate change, the easier it will be to adapt."[20]

Reducing methane emissions can also help slow the rate of sea level rise. In the preamble to the proposed rule, EPA notes that "the USGCRP [3rd National Climate Assessment] and multiple NRC assessments have projected future rates of sea level rise that are 40% larger to more than twice as large as the previous assessments from the 2007 IPCC Fourth Assessment Report."[21] In fact, a 2013 study by Hu, A., et al., found that "methane mitigation has the largest effect in mitigating sea level rise, with CO_2 next … Overall, the mitigation of CO_2 and short-lived climate pollutants could not only keep the global warming under check, but can also reduce the projected sea level rise by 31 – 50%, and reduce the projected sea level rise rate by 50 – 66% by 2100."[22] Hu, et al. concludes that delaying emission reductions from short-lived climate pollutants "could reduce the impact of the CO_2 and short-lived climate pollutant mitigation by about 30%."[23]

As EPA stated in the preamble to the proposed rule, "significant reductions in emissions would lead to noticeably less future warming beyond mid-century, and therefore less impact to public health and welfare."[24] We agree with EPA's conclusion, and the information we present here only further underscores substantial harms associated with methane emissions and the significant climate and public health benefits associated with reducing methane.

II. Cost-Effectiveness Analysis of Leak Detection and Repair

EDF commissioned ICF to develop a stochastic model to estimate the cost-effectiveness of leak detection and repair at different types of facilities, with the aim of better understanding variation across facility and equipment types. Accordingly, the analysis seeks to develop facility models that replicate real world situations and capture variations in these characteristics by using a Monte Carlo simulation to analyze facility emissions, reductions and costs. The attached power point describes the modeling concepts and model inputs in greater detail.

[19] Ibid., p. 5.
[20] Ibid.
[21] US EPA, op cit., 80 FR 56604.
[22] Hu, A., et al., op cit., p. 3.
[23] Ibid., p. 3-4.
[24] USEPA, op cit., 80 FR 56603.

Below, we have presented modeling results, including a table taken from the attached power point. The attached power point describes the model inputs and assumptions underpinning each of the analyzed scenarios set forth below ($3, $4, and $3/mcf one contractor).

TABLE 1: Total Three Year Mean Fugitive Results

	$/Metric Tonnes CO2e Reduced		
	$3/Mcf	$4/Mcf	$3/Mcf One Contractor
Annual	-4.76	-11.19	-7.86
Semi-annual	4.94	2.39	2.29
Quarterly	11.56	10.32	8.27

GWP=25

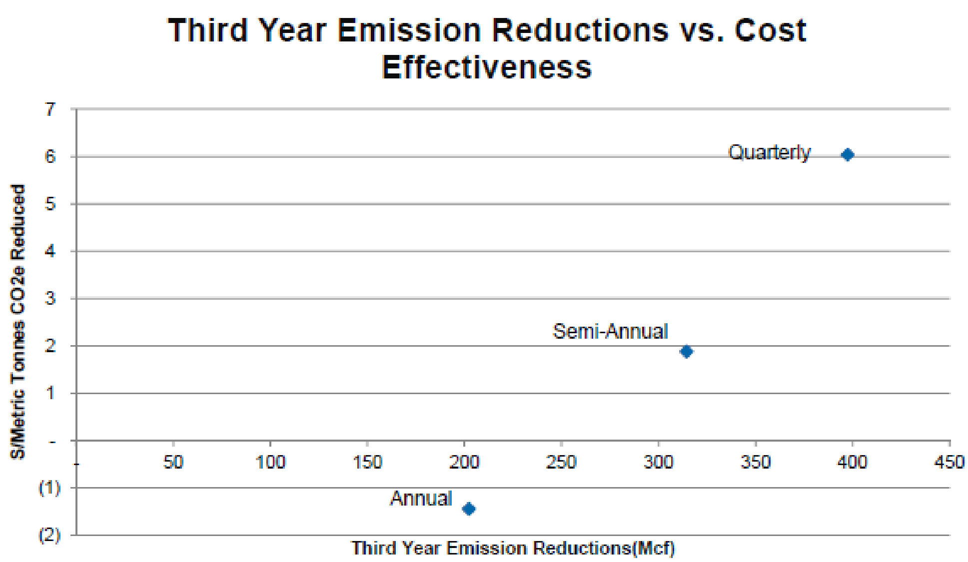
EDF believes that these results demonstrate that more frequently, quarterly monitoring is cost-effective. We converted ICF's cost effectiveness estimates into dollars per short tons of methane and compared these costs with the control costs EPA determined reasonable in the OOOOa proposal. Per our conversion, ICF's estimate of the control costs for quarterly LDAR are equal to $262 per short ton of methane reduced, assuming $3 gas; $234 per short ton of methane reduced, assuming $4 gas, and $187 per short ton of methane reduced assuming $3 gas and the use of a contractor to perform the inspection. These costs are lower than other costs EPA found reasonable under its single pollutant approach, even without considering any credit for gas savings. Specifically, EPA determined the following control costs reasonable, not accounting for any gas savings:

- $789 per ton of methane reduced to control piston pumps using existing control devices at production facilities.[25]
- $738 per ton of methane reduced to use instrument air to reduce emissions from pneumatic controllers at gas processing plants.[26]

[25] Id. at 56,629.
[26] Id. at 56,624.

Moreover, we believe that these results demonstrate significantly lower control costs to conduct quarterly LDAR than EPA found. Indeed, accounting for gas savings, EPA estimated quarterly cost-effectiveness numbers of $878 for gas wells and $4,402 for oil wells.[27] We believe that the more recent data used in the ICF analysis is more representative of new and modified facilities, and indeed, these different data inputs likely explain the differences in the cost-effectiveness determinations.

Finally, for the assumptions in this scenario, quarterly inspections result in over twice the emissions reductions as annual inspections conducted over the same period, and approximately 50% more reductions than semi-annual inspections conducted over the same period.



III. EPA Should Adopt Performance-Based Standards to Reduce Liquids Unloading Emissions

EPA has not proposed standards applicable to liquids unloading activities, but requests comment on possible approaches the agency could take to address these sources, including "technologies and techniques that can be applied to new gas wells that can reduce emissions from liquids unloading in the future."[28] As EPA recognizes in the proposal, liquids unloading emissions are significant and are dominated by a relatively discrete number of high emitting wells. Moreover, several technologies are capable of reducing (or eliminating) these emissions, including at wells both with and without plunger lift systems. Below, we discuss emissions associated with liquids unloading activity and present data to support development of liquids unloading standards. In

[27] EPA, "Background Technical Support Document for the Proposed New Source Performance Standards 40 CFR Part 60, Subpart OOOOa" (Aug. 2015).

[28] 80 Fed. Reg. at 56614.

light of this information, EPA should establish a numeric, performance-based annual venting limit of no more than 100 Mcf/year in order to reduce liquids unloading emissions.

A. Emissions from Liquids Unloading Activities are Significant, and Available Technologies Can Reduce These Emissions.

i. *Liquids Unloading Emissions are Significant*

Wells accumulate liquids when the reservoir gas pressure is insufficient for lifting liquids up the wellbore. The liquids settle at the bottom of the well tubing, obstructing gas flow and inhibiting production. Since reservoir pressure declines as wells age, liquids accumulation eventually becomes an issue in most wells, although when and how often wells require liquids unloading varies. Sometimes, operators remove these liquids by venting a well, which reduces the downward pressure on the liquids from pipeline to atmospheric pressure. If the reservoir pressure is higher than the liquid pressure, then some of the liquids will be lifted out of the wellbore, temporarily restoring gas flow. During this process, however, gas will also be vented, which depletes reservoir pressure and therefore exacerbates the problem in the long-term.

As EPA recognizes in the preamble, liquids unloading emissions are significant, and a small minority of wells contribute the majority of the sector's emissions.[29] Based on measurements of over 100 wells, Allen et al. (2014) estimates that 2012 unloading emissions in the United States were 270 Gg methane—the third largest emission source in the natural gas production segment.[30] Several other recent studies suggest nationwide liquids unloading emissions of approximately 300 Gg methane.[31] These emissions are dominated by a small number of high-emitting sites: Allen *et al.* found that less than 20 percent of wells (both with and without plunger lifts) accounted for the majority of emissions, and the most recent subpart W data suggests that 19 percent of wells are responsible for about 75 percent of the unloading venting emissions.

EPA specifically requests comment on the level of methane and VOC emissions per unloading event, the number of unloading events per year, and the number of wells that perform liquids unloading. EPA's recently released Subpart W data and the 2014 Allen study provide key insights in each of these areas, presented in Table 2 below:

[29] 80 Fed. Reg. at 56645.
[30] Allen, D. T., et al, (2014), "Methane Emissions from Process Equipment at Natural Gas Production Sites in the United States: Liquid Unloadings", *Environ. Sci. Technol.*, **2015**, *49* (1), pp 641–648, *available at* http://pubs.acs.org/doi/abs/10.1021/es504016r.
[31] ICF's estimate of 321,012 MT CH_4 is derived by scaling up an estimate derived from GHGRP data by 15%, based on EPA's estimate that 85 to 90% of emissions are covered by the GHGRP. The API/ANGA estimate of 319,664 MT CH_4, which is similar to ICF's estimate, was estimated using engineering equations along with survey data.

Table 2: Liquids Unloading Data Requested by EPA

Liquids Unloading Parameter	2014 Subpart W [1]		Allen *et al.* (2014)		
	With Plunger Lifts	*Without Plunger Lifts*	*Manual Plunger Lifts*	*Automatic Plunger Lifts*	*Without Plunger Lifts*
Methane Emissions Per Unloading Event	0.0002 – 16.0 Mg/event	0.002 - 118.7 Mg/event	0.004 – 0.94 Mg/event	0.001 – 0.15 Mg/event	0.011 – 2.6 Mg/event
Average Methane Emissions per Unloading Event	0.33 Mg/event (0.06 Mg/event[2])	1.16 Mg/event (0.29 Mg/event[2])	0.186 Mg/event	0.024 Mg/event	0.414 – 0.674 Mg/event [3]
Average Number of Unloading Events Per Year	67 events/well (range from 1 – 3,316 events)	14 events/well (range from 1- 2,008 events)	<100 events/well	1,870 events/well	<50 events/well [4]

[1] Figures only reflect reported data for wells with non-zero well count, events, and emissions values.

[2] Value represents the geometric mean of the reported data.

[3] The low end of the range corresponds to wells with fewer than 10 events per year and the higher end to those with fewer than 50 events per year.

[4] 1.1% of wells without plunger lifts undergo more than 50 events per year.

ii. *Available Technologies Can Reduce These Emissions.*

In response to EPA's Liquids Unloading White Paper,[32] several commenters provided extensive information on technologies available to restore production to wells with liquid unloading issues while eliminating or minimizing emissions.[33] We incorporate those analyses by reference and

[32] EPA White Paper, "Oil and Natural Gas Sector Liquids Unloading Process", (April 2014) (Report for Oil and Natural Gas Sector Liquids Unloading Processes Review Panel), *available at* http://www3.epa.gov/airquality/oilandgas/pdfs/20140415liquids.pdf.

[33] Oil and Natural Gas Sector Liquids Unloading Processes Peer Review Responses of Environmental Defense Fund, June 16, 2014, *available at* http://www3.epa.gov/airquality/oilandgas/2014papers/attachmenti.pdf.

briefly highlight a few salient aspects of each of these technologies.

Plunger lifts are one technology that can minimize or eliminate venting during liquids unloading by using a well's own reservoir pressure to overcome pressure differentials. However, plunger lifts do not always lead to low emissions. Some wells equipped with these devices have high emissions because plunger lifts are installed to increase gas production and not specifically to reduce emissions. For example, if a plunger lift fails to reach the surface by its own mechanics, then the well may be manually or automatically vented to lift the plunger up. However, an efficiently functioning plunger lift can unload liquids with zero emissions.

Allen et al. reports a higher average emission factor per event for non-plunger lift equipped wells than plunger lift wells,[34] though annual emissions can be higher for plunger lift wells due to higher frequency of venting. A separate study conducted by API/ANGA[35] included an industry survey of over 40,000 wells and concluded that only 21.1 percent of wells equipped with plunger lifts vent to the atmosphere. If the Allen et al. plunger lift emission factor is adjusted to account for the 78.9 percent of wells that do not vent, then automatic plunger lift and manual plunger lift wells have average annual methane emissions of 518 and 25 Mcf, respectively, compared to 1,011 Mcf from non-plunger lift wells.

Furthermore, total automatic plunger lift well emissions are highly influenced by the fact that many wells with automatic plunger lifts vent over 1,000 times per year. In fact, automatic plunger lift wells with high venting frequencies (i.e., those that vent over 100 times per year) are estimated to contribute the majority of all emissions from wells with venting for liquids unloading.[36] BP has demonstrated that optimization of plunger lifts with smarter automation can drastically cut emissions—reducing them from over 4 Bcf/year to less than 0.01 Bcf/year using these practices.[37] Accordingly, strategically operated plunger lifts are an effective means of reducing (or eliminating) the need for venting from most wells with liquids accumulation issues.

Beyond plunger lifts, other solutions are also available, such as installing velocity tubing or using compressor engines to lower the pressure differential between the reservoir and the wellhead. When the aforementioned technologies are insufficient to lift liquids, creating artificial lift can successfully remove liquids from wells with little or zero emissions. As we describe more fully below, flaring technology is also a feasible control option that could be applied where more

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[34] David T. Allen, *et al*., (2014) "Methane Emissions from Process Equipment at Natural Gas Production Sites in the United States: Liquids Unloading", 49 J. Environ. Sci. & Tech. 641, *available at* http://pubs.acs.org/doi/abs/10.1021/es504016r.

[35] Characterizing Pivotal Sources of Methane Emissions from Natural Gas Production: Summary and Analysis of API and ANGA Survey Responses, *available at* http://www.api.org/~/media/Files/News/2012/12-October/API-ANGA-Survey-Report.pdf

[36] David T. Allen, *et al*., (2014) "Methane Emissions from Process Equipment at Natural Gas Production Sites in the United States: Liquids Unloading", 49 J. Environ. Sci. & Tech. 641, *available at* http://pubs.acs.org/doi/abs/10.1021/es504016r.

[37] BP, Natural Gas STAR Production Technology Transfer Workshop "Managing Venting for Liquids Unloading," at 13, *available at* http://www3.epa.gov/gasstar/documents/workshops/denver-2014/Managing_Venting.pdf.

desirable technologies designed to capture or otherwise minimize these emissions are infeasible. We do, however, emphasize that operators should prioritize capture technology over flaring whenever possible.

B. EPA Should Establish an Annual, Performance-Based Venting Limit to Minimize Liquids Unloading Emissions.

Individual wells with liquids accumulation issues may respond differently to the various options for unloading those liquids in order to increase production. For instance, some wells may require a single blowdown to restore production, while others may require artificial lift because reservoir pressure is insufficient to effectively utilize a plunger lift. This makes it challenging to apply a single capture technology at all wells to minimize venting due to liquids unloading.

Accordingly, to address liquids unloading emissions consistent with its section 111 obligations, EPA should establish a quantitative emission limit that operators can satisfy with whichever technology is most appropriate. Moreover, due to the skewed distribution of well emission rates, a large fraction of total emissions can be reduced by setting an emission limit that only affects a relatively small fraction of wells.

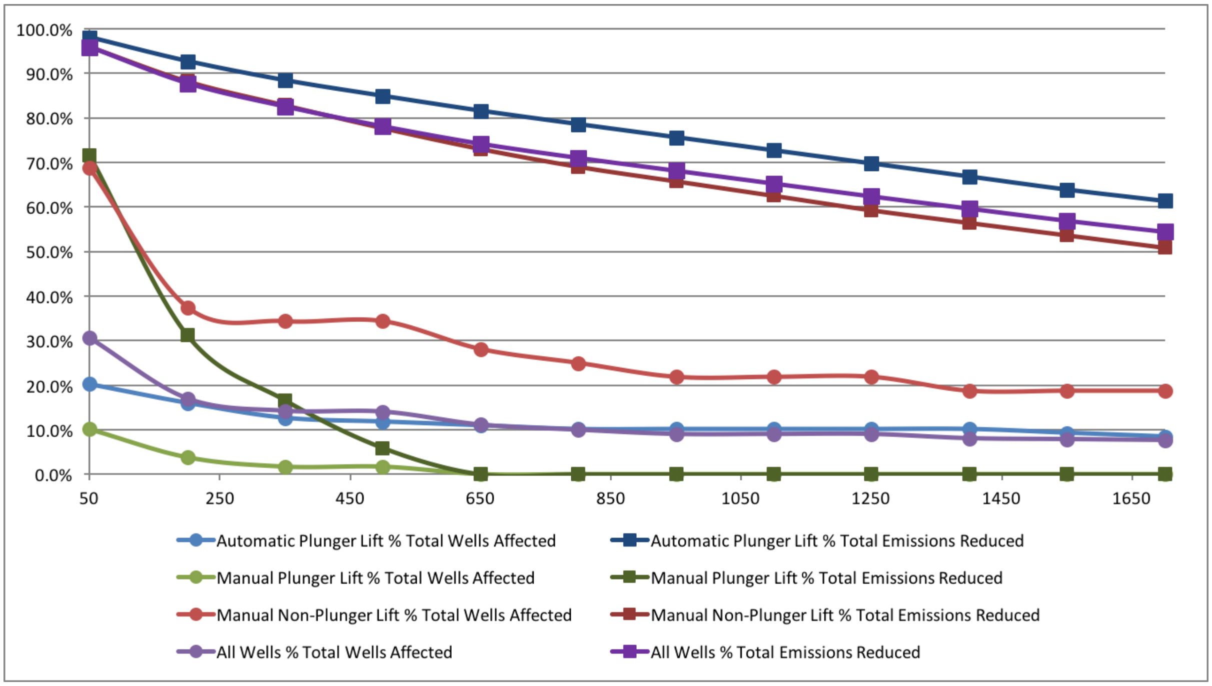
Below, we describe the available data that supports establishing such a limit and evaluate the cost-effectiveness of deploying flares to reduce methane emissions at wells above this limit. We likewise recommend several ways the agency should optimize these standards under section 111(b).

i. *Existing Data Supports Establishing a Performance-Based Annual Venting Limit.*

We have evaluated potential annual venting limits based both on data from the Allen et al. paper and recently released Reporting Rule data.

Based on Allen et al., we have estimated the percent of wells affected and percent of total emissions reduced at different emission limits, as shown in Figure 1below. For example, an annual emission limit of 1,000 Mcf/well/year would affect 9 percent of wells and reduce total emissions from liquids unloading by 67 percent if those wells exceeding the threshold reduced venting to the threshold. Alternately, this 1,000 Mcf limit would reduce emissions by 85 percent if those wells exceeding the threshold flared all emissions rather than reducing emissions to the threshold itself. Similarly, a threshold of 250 Mcf/well/year would affect about 16 percent of wells and reduce emissions by 86 percent (or by 93 percent if emissions are flared), while a 100 Mcf/well/year limit would affect 24 percent of wells and reduce emissions by about 93 percent (or by over 96 percent if emissions above the threshold are flared).

Fig. 1: The Percentage of Wells Affected and Emissions Reduced by Different Emission Limits (Mcf/well/year)[38]



We have likewise analyzed recently-released Reporting Rule data, and the percentage of wells and related emissions that fall above and below certain venting thresholds are similar to the findings in the Allen study. Figure 2 below depicts the percentage of wells and emissions at various thresholds based on Reporting rule data, and Table 3 compares results from Allen *et al*. and the Reporting Rule, demonstrating that the two data sources substantially agree.

Fig. 2: Percentage of Liquids Unloading Wells and Percentage of Emissions Based on 2014 Reporting Rule Data

[38] The data in this figure are based on 107 wells measured by Allen et al.

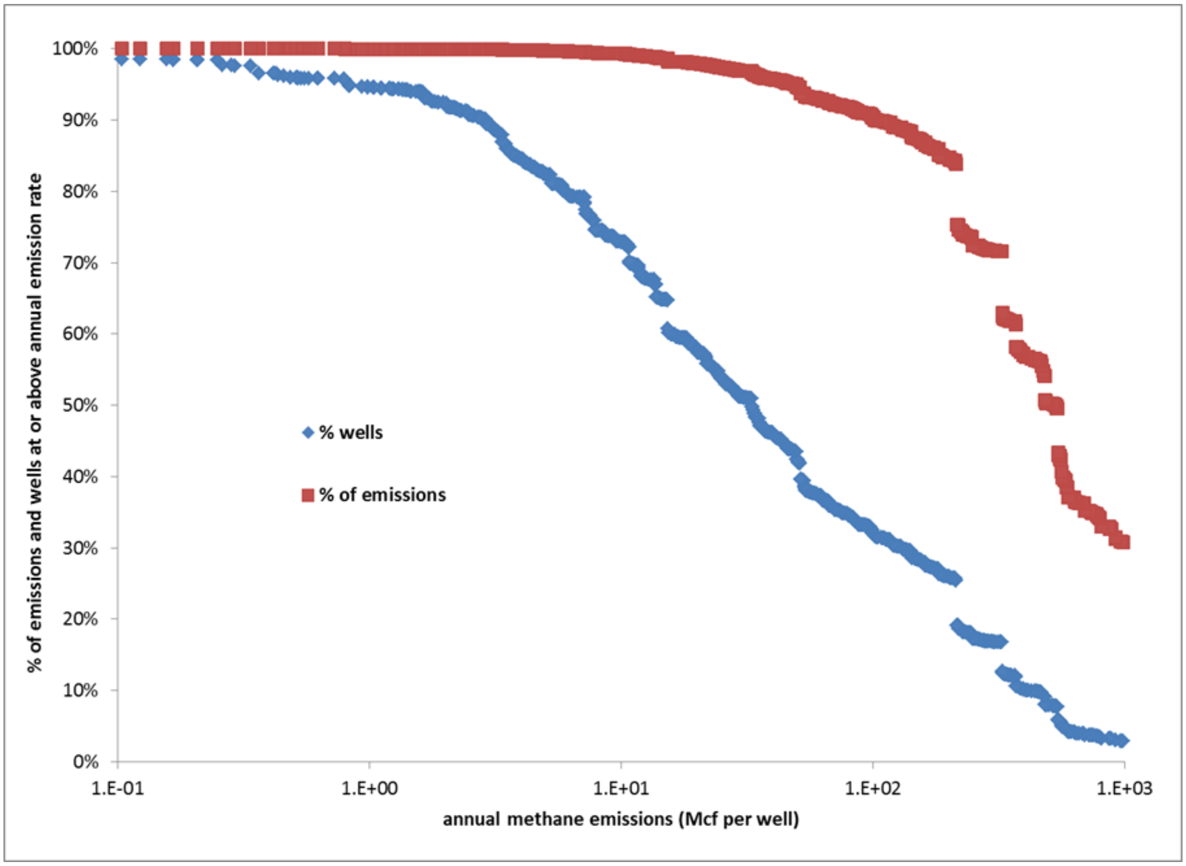


Table 3: Comparison of Liquids Unloading Thresholds from Allen *et al*. and Subpart W

Venting Threshold (Mcf CH4)	Allen *et al.* [1]			Subpart W (2014) [2]		
	% of Wells	% of Emissions reduced if flared [3]	% of Emissions reduced if reduced to threshold	% of Wells	% of Emissions reduced if flared [3]	% of Emissions reduced if reduced to threshold
1,000	9.1%	84.6%	67.2%	3.1%	30.9%	12.3%
250	16.3%	93.0%	85.9%	17.3%	70.2%	44.4%
100	**24.4%**	**96.5%**	**92.6%**	**33.0%**	**88.1%**	**69.3%**
50	30.6%	97.4%	95.9%	43.4%	92.7%	80.8%

[1] Allen et al. focused on wells with unloading events. Also, the values in this table include a correction for an assumed 78.9% of wells with plunger lifts that do not vent during unloading.

[2] The Reporting Rule data only incorporate reporting operators, excluding facilities with emissions below reporting thresholds.

[3] Assuming 98% DRE for flares applied to all emissions from wells above threshold.

ii. *Available Technology Can Reduce Emissions at Wells Above Annual Venting Limits.*

In addition, we examined the 107 liquids unloading wells measured by Allen, et al.[39] and evaluated the cost-effectiveness of deploying flares to reduce methane emissions at only those wells emitting above various thresholds. The range of control options for wells with and without plunger lifts is significant. Because flares can reduce emissions at all wells, our cost analysis focuses on this technology, though we emphasize that operators should use capture technology rather than flaring to meet these performance standards wherever feasible.

In this analysis, we evaluated the use of either mobile or stationary flares depending on well type,[40] using assumptions from existing literature concerning the cost and effectiveness of flaring technology. Although not universally applicable, other technologies may be available to some operators to meet performance standards. Because many of these technologies result in capture of natural gas that would otherwise be wasted, they can be expected to enhance cost-effectiveness beyond the numbers presented here.[41]

In the Allen study, wells that vented at least 100 Mcf per year of methane represented approximately 24 percent of the well population, but accounted for 98 percent of the total measured emissions in the study.[42] If flares with a combustion efficiency of 98 percent were deployed at this subset of wells, total measured emissions from all wells in the dataset would be reduced by over 96 percent, as outlined in Table 3 above. The average cost-effectiveness of these reductions would be $197–$429 per ton of methane abated. The distribution of emissions for the different well types is shown in Figure 3, below, for wells with liquids unloading emission rates greater than 100 Mcf per year.

[39] David T. Allen et al., (2014) "Methane Emissions from Process Equipment at Natural Gas Production Sites in the United States: Liquids Unloading", 49 J. Environ. Sci. & Tech. 641, *available at* http://pubs.acs.org/doi/abs/10.1021/es504016r.

[40] Where a producer determines that other more cost-effective technologies can effectively reduce emissions, however, it should be afforded latitude to deploy those technologies.

[41] For instance, IFC estimates that the cost effectiveness of deploying plunger lifts at uncontrolled wells is approximately $75/ton methane abated.

[42] Note that the Allen study only measured wells that *vent* for liquids unloading, not all wells with liquids loading activity. An API/ANGA study (Characterizing Pivotal Sources of Methane Emissions from Natural Gas Production: Summary and Analysis of API and ANGA Survey Responses) based on an industry survey of over 40,000 wells reports that only 21.1% of wells equipped with plunger lifts vent. Therefore, the estimated number of wells that vented at least 250 Mcf of methane per year assumes 78.9% of plunger lift wells do not vent.

Fig. 3: Distribution of Emissions by Well Type for Emission Rates Greater Than 100 Mcf

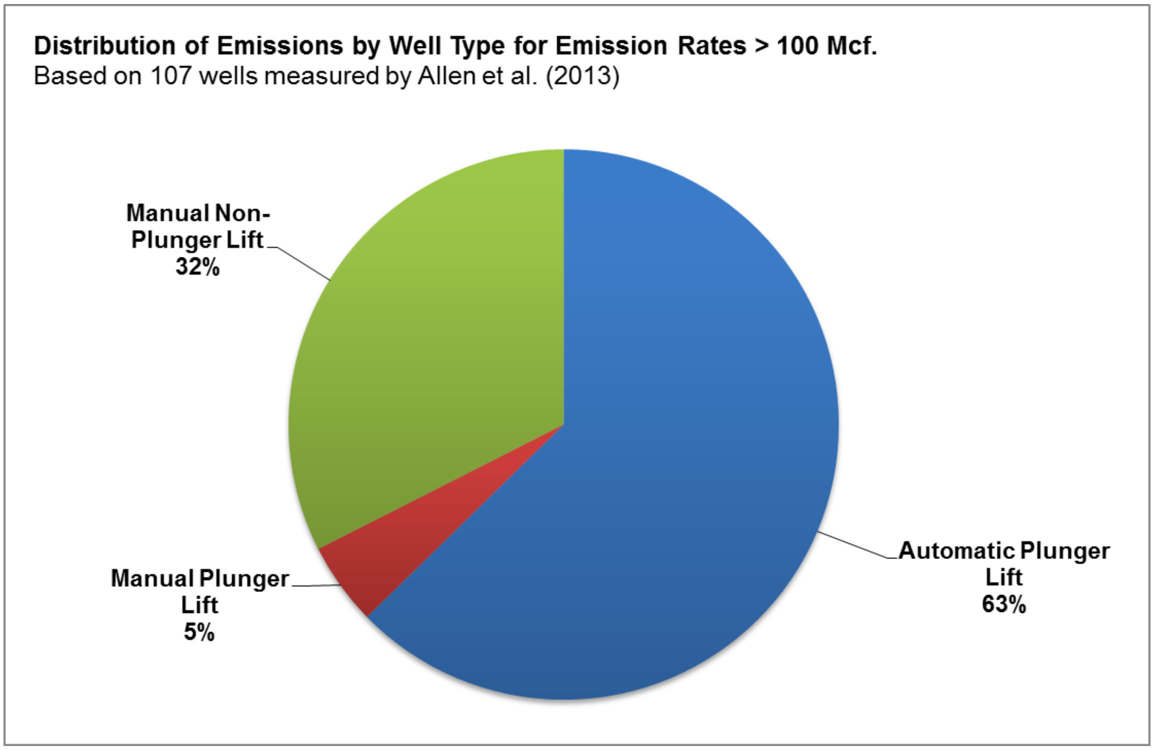


Table 4 below summarizes the cost-effectiveness of deploying flares to reduce emissions from each well type (automatic plunger lift, manual plunger lift, and manual non-plunger lift wells) at the 107 analyzed wells. For each well type (as described more fully below), the analysis assumes the deployment of flaring technologies (mobile vs. stationary; rented vs. purchased) according to certain well characteristics and provides a range of estimates for the cost-effectiveness of methane reduction.

Table 4: Cost Effectiveness of Flares for Liquids Unloading Emissions for all Well Types

Cost Effectiveness of Flares for Liquids Unloading. [1]

The analysis is based on 107 wells measured by Allen et al. 2013.

Annual Emissions Limit (Mcf methane)	Automatic Plunger Lift Wells		Manual Plunger Wells and Manual Non-Plunger Wells		All Wells		% Total Emissions Reduced [2]
	Stationary Flare [3]		Mobile flare for wells venting less than 20 times per year and stationary flare for wells venting more than 20 times per year [4]		Average Cost Effectiveness of Stationary Flares at Automatic Plunger Wells and a Combination of Mobile and Stationary Flares at Manual Plunger/Non-Plunger Wells		% Reduced by Flaring Emissions above Threshold [4]
	CH_4 LOW [$ / ton]	CH_4 HIGH [$ / ton]	CH_4 LOW [$ / ton]	CH_4 HIGH [$ / ton]	CH_4 LOW [$ / ton]	CH_4 HIGH [$ / ton]	
1600	$67	$118	$77	$136	$72	$127	81.8%
1000	$71	$125	$86	$151	$79	$138	84.6%
550	$81	$143	$148	$261	$115	$202	90.3%
250	$102	$180	$173	$347	$137	$264	93.0%
100	$129	$227	$266	$632	$197	$429	96.5%
50	$134	$236	$305	$752	$219	$494	97.4%
AVERAGE	$85	$150	$136	$277	$111	$213	88.0%

NOTES:

All flares:

[1] Emissions reductions are based on a 98% flare efficiency

[2] Percent emissions reductions are based on all measured emissions from wells above the threshold. It is assumed emissions from these wells are controlled to 98% per the flare, rather than controlled down to the threshold (e.g., a well venitng 1,400 Mcf with a 100 Mcf threshold will be reduced by 1,400*0.98 = 1,372 Mcf rather than 1,400-100 = 1,300 Mcf).

[3] Stationary Flare:

Low cost estimates are based on EPA annualized capital costs for completion combustion based on a 15 year equipment life and 7% interest plus annual operating cost estimates from CDPHE for pilot fuel and maintenance. See EPA NSPS Subpart OOOO RIA at 3-12 and TSD at 7-6 (April 2012). *See* Colorado Department of Public Health and Environment, Cost-Benefit Analysis, Submitted per § 24-4-103(2.5), C.R.S., at 7 (2014). High cost estimates are based on ICF data for capital costs for venting flares annualized, for consistency, based on EPA's assumptions of 15 year equipment life and 7% interest. Operating costs are also based on ICF estimates. See ICF International, "Economic Analysis of Methane Emission Reduction Opportunities in the U.S. Onshore Oil and Natural Gas Industries" at 3-22 (March 2014).

[4] Mobile Flare (rented):

Cumulative annual costs for all reported venting events are calculated based on mobile flare rental costs ranging from $250 - $850/day and labor costs of $100/hr. The number of rental days is assumed to equal the reported number of venting events. Estimated labor time is based on min/max reported average sampled event duration. See ICF International Memo from Don Robinson, Joel Bluestein, Hemant Mallya, Tarang Mehta, and Mike Polchert, ICF International, to Peter Zalzal and Tomas Carbonell, EDF, June 13, 2014

Automatic Plunger Lift Wells. Due to the greater frequency of unloading events at wells with automatic plunger lifts, we assumed stationary flares would be the most cost-effective flaring technology available to reduce emissions from such wells.[43]

In estimating the cost-effectiveness of stationary flares, this analysis assumes: (1) the "low cost" estimates are based on EPA data for annualized capital costs for completion combustion devices,

[43] Since stationary flares would likely be installed at the produced water tank, they also would control produced water flashing emissions.

based on a 15-year equipment life and 7 percent interest rate, plus annual operating costs estimated for Colorado's oil and gas rules, which include cost estimates for pilot fuel[44] and maintenance;[45] and (2) the "high cost" estimates are based on ICF International data for capital costs for completion and venting flares, annualized for consistency based on EPA's assumptions of a 15 year equipment life and 7 percent interest rate, plus annual operating cost estimates from ICF International.[46]

As shown in Table 4, based on the wells in the Allen et al. dataset, the average cost-effectiveness of employing a stationary flare at wells with automatic plunger lifts across all emission thresholds assessed ranges from $67 to $236 per ton of methane abated ($2.68 to $9.44 per ton CO_2-e, using a methane GWP of 25). The cost-effectiveness of employing a stationary flare to reduce emissions at wells with automatic plunger lifts with emissions above 100 Mcf methane ranges from $129 to $227 per ton of methane abated ($5.14 to $9.06 per ton CO_2-e, using a methane GWP of 25).

Manual Plunger Lift and Non-Plunger Lift Wells. For wells in the data set with manual plunger lifts and manually vented wells without plunger lifts, we assumed the use of either a mobile flare or stationary flare based on the frequency of unloading events reported at the wells. For manually vented wells, vented methane emissions in the dataset are generally lower than for the other measured wells, averaging around 100 Mcf per year for wells with manual plunger lifts and 1,000 Mcf per year for wells without plunger lifts, compared with an average of 2,500 Mcf per year for wells using automatic plunger lifts. (Note, however, that the emissions per event for non-plunger lift wells are much higher than at wells with either automatic or manual plunger lifts). Well venting also occurs relatively infrequently at these wells, with some averages as few as 10 reported venting events per year for wells with manual plunger lifts and 30 per year for wells without plunger lifts. By comparison, some automated plunger lift wells reported over 2,000 events per year. This analysis assumes that mobile flares would be deployed at manual plunger wells when the number of annual venting events is low—less than 20—and that stationary flares would be deployed at wells when annual venting events exceed 20.

In estimating the cost-effectiveness of flares at wells with manual plunger lifts, we relied on the stationary flaring assumptions set forth above. For mobile flares deployed at wells with fewer than 20 venting events per year, we assume: (1) cumulative annual costs for all reported venting events are calculated based on mobile flare rental costs ranging from $250/day to $850/day and labor costs of $100/hour; (2) the number of rental days is assumed to equal the reported number

[44] The flares may use auto-igniters instead of pilot fuel. An electric (often solar-powered) igniter regularly sparks to ignite intermittent emissions.
[45] Annualized capital costs = $3,523 and annual operating costs = $3,000. *See* EPA NSPS Subpart OOOO RIA at 3-12 and TSD at 7-6 (April 2012). *See* Colorado Department of Public Health and Environment, Cost-Benefit Analysis, Submitted per § 24-4-103(2.5), C.R.S., at 7 (2014).
[46] Annualized capital costs = $5,490 and annual operating costs = $6,000. *See* ICF International, "Economic Analysis of Methane Emission Reduction Opportunities in the U.S. Onshore Oil and Natural Gas Industries" at 3-22 (March 2014).

of venting events (i.e., a mobile flare only serves one well at a time and one event per day); and (3) estimated labor time is based on the minimum and maximum reported average sampled event duration rounded up to the next hour (labor costs are then calculated at a rate of $100/hour).[47]

As shown in Table 4, the average cost effectiveness of employing a combination of stationary and mobile flares at wells with and without manual plunger lifts across all emission limits assessed ranges from $77 to $752 per ton of methane abated. The cost effectiveness at this same subset of wells with emissions above 100 Mcf ranges from $266-$632 per ton of methane abated.

Taken together, these analyses demonstrate that flaring technology can secure low-cost reductions at both wells with and without plunger lifts.

iii. *Recommendations for Design of the Standards.*

By adopting certain definitions of "modification" and "affected facility" and establishing an annual venting limit, EPA can promulgate standards for liquids unloading at gas wells that secure substantial reductions at a reasonable cost to industry.

- Modification. As we describe above, many gas wells reach a point in their productive lives at which reservoir pressure is no longer sufficient to flow produced liquids to the surface, causing accumulation of liquids and inhibiting gas production. At this point, operators can take various actions to restore production, all of which constitute changes in the method of operating a well and some of which likewise constitute physical changes (i.e., installing a plunger lift system). To the extent that these changes are accompanied by venting during liquids unloading, EPA should define the regulatory term "modification" to encompass these activities.

- Affected facility. EPA should also define an "affected facility" for the purpose of its section 111 regulations to cover any liquids unloading facility as a well that vents in excess of 100 Mcf/year. This would ensure the majority of emissions are addressed by the standards, but would focus standards on only the highest emitting wells.

- Emission limit. EPA could establish an emission limit based on the conclusion that a combination of capture and flaring technologies constitutes BSER for both plunger and non-plunger wells. The standard could require affected liquids unloading facilities to meet an annual venting limit of at most 100 Mcf/year, or alternatively, to achieve a 95% reduction. Operators should be encouraged to meet this performance-based limit by deploying other technologies, like smart automation, to enhance environmental performance and further reduce costs.

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[47] *See* ICF International Memo from Don Robinson, Joel Bluestein, Hemant Mallya, Tarang Mehta, and Mike Polchert, ICF International, to Peter Zalzal and Tomas Carbonell, EDF, June 13, 2014.

Standards designed in this way would focus requirements on liquids unloading wells that vent in excess of 100 Mcf/year, securing substantial emission reductions while leaving the majority of liquids unloading wells unaffected. We urge EPA to move forward with standards along these lines.

IV. Conclusion

We greatly appreciate EPA's consideration of these comments and urge the agency to finalize rigorous, final standards to reduce oil and natural gas sector methane emissions.

Respectfully submitted,

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