Exhibit Z-2

October 21, 2019
U.S. Department of Energy (FE-34)
Attn: LCA GHG Update Comments
Office of Regulation, Analysis, and Engagement
Office of Fossil Energy, P.O. Box 44375
Washington, DC 20026-4375

SIERRA CLUB

Submitted via *https://fossil.energy.gov/app/docketindex/docket/index/21*

Dear Secretary Perry:

Please accept these comments on the Department of Energy's recent report titled Life Cycle Greenhouse Gas Perspective on Exporting Liquefied Natural Gas from the United States: 2019 Update. While we agree that the greenhouse gas impact of LNG approvals is a vital issue, and that DOE's prior analysis of this issue was outdated and in need of an update, the updated study repeats, rather than corrects, the flaws of its predecessor.

The purpose of this report is to inform DOE's decisionmaking about whether to grant, deny, or condition the numerous pending applications for additional LNG export projects. In this report, DOE has, fundamentally, asked the wrong question. Merely comparing the lifecycle emissions of electricity generated in foreign markets using various fossil fuels in the abstract does not answer the question of how *DOE*'s decision to approve *additional* US LNG exports, generally for 20-year licenses, will affect global greenhouse gas emissions throughout the approved project lifetimes. This comparison ignores the fact that US LNG exports will, to at least some extent, displace renewables or increase overall energy consumption, rather than exclusively displacing other fossil fuels. This comparison also ignore the fact that the Energy Information Administration and other informed observes have consistently predicted that increasing LNG exports will cause domestic gas-to-coal switching, and thus an increase in coal use, in addition to spurring additional gas production. For these and other reasons, increasing US LNG exports will result in increases in global GHG emissions not reflected in this study.

In addition, even within the improperly narrow scope of DOE's analysis, DOE underestimates the emissions associated with production, delivery, and use of US LNG. Multiple recent peer reviewed publications indicate that North American gas production and transportation emits significantly more methane than acknowledged in this study. And DOE ignores emissions associated with onshore transportation, possible re-export, and other additional overhead occurring after US LNG is first exported.

Avoiding catastrophic climate change will require immediate and drastic transition away from fossil fuels. Approving and constructing large, capital intensive, emission intensive, and long-lived fossil fuel infrastructure such as LNG export terminals is inconsistent with the steps the U.S. and the world need to be taking to reduce the impact of this crisis. Further expansion of U.S. LNG exports cannot be squared with the emission reduction trajectories the U.S. and would-be importers must achieve, and for this and other reasons, the proposed LNG export applications should be denied.

I. DOE Must Do More than Compare The Lifecycle Emissions of U.S. LNG with Other Fossil Fuels

As of October 4, 2019, DOE has already issued final approval for 32.8 billion cubic feet per day (bcf/d) of exports to non-free trade agreement countries.[1] The updated lifecycle perspective will inform DOE's decisions regarding sixteen additional export applications, for a total of roughly 23.3 bcf/d of additional exports.[2]

To determine whether to approve these export proposals, DOE must take a hard look at the impacts of *these* exports, and not LNG in the abstract. DOE must engage in reasonable forecasting, using the tools at its disposal, to consider how global markets will likely respond to increased availability of US LNG, starting with the basic economic truth that increased supply generally results in decreased price and thus increased demand and consumption. Conversely, DOE must reasonably forecast how US markets will respond to increased exports, starting with the multiple studies DOE has already commissioned which have uniformly concluded that increasing US LNG exports increases the price of domestic natural gas, leading to gas-to-coal switching and an increase in US coal consumption, with predictable effects DOE ignores in the present report.

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[1] https://www.energy.gov/sites/prod/files/2019/10/f67/Summary%20of%20LNG%20Export%20Applications.pdf, attached as Exhibit 1.

[2] https://www.energy.gov/sites/prod/files/2019/09/f66/LCG%20FR%20Notice_0.pdf

A. The Perspective Report Arbitrarily Ignores US Exports' Effects on Renewables and Overall Energy Consumption

Although predicting the exact disposition of marginal future US LNG exports is impossible, DOE can and must use available tools, such as the Energy Information Administration's forecasting tools and other public information, to reasonably predict how global energy markets will respond to added US LNG exports.

At the most basic level, DOE must acknowledge that increasing the supply of US LNG exports would be expected to decrease average global LNG prices, and thereby spur an increase in global gas consumption. There is no reason to assume that US LNG exports will solely substitute for other sources of gas without increasing overall gas demand and use. Nor is there a reason to assume that, insofar as an increase in gas consumption occurs, this increase will solely be due to displacement of coal. Putting aside specific information about global energy markets, basic economics demonstrate that the lifecycle report is not looking at the whole picture.

Considering information about potential end use markets further indicates that increasing US LNG exports will meaningfully increase energy use and/or compete with renewables. Global LNG markets are abundantly supplied. According to the International Energy Agency, "Demand from traditional LNG buyers, namely Japan and Korea, is likely to be flat or decline gradually depending on use in power generation;"[3] "demand from traditional buyers is expected to be stagnant."[4] Any growth in Asian LNG demand "is being driven by newer importers"[5] or "non-traditional emerging buyers, namely Bangladesh, China, India and Pakistan."[6] The Energy Information Administration also uses tools to estimate the extent to which foreign markets are actually likely to buy US LNG.[7]

The International Energy Agency predicts that in these likely and other markets for marginal US LNG exports, exports are likely to supply increased energy demand, rather than solely or even primarily displace existing generation.[8] EIA's International Energy Outlook

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[3] International Energy Agency, *Global Gas Security Review 2019* at 10 (Sept. 2019), *available at https://webstore.iea.org/download/direct/2832?fileName=Global_Gas_Security_Review_2019.pdf*, attached as Exhibit 2.

[4] *Id.* at 4.

[5] *Id.*

[6] *Id.* at 11.

[7] *See, e.g.,* https://www.eia.gov/outlooks/aeo/assumptions/pdf/natgas.pdf at 4, attached as Exhibit 3.

[8] International Energy Agency, *Golden Rules for a Golden Age of Gas*, Ch. 2 p. 91 (2012), attached as

predicts that global energy consumption will steadily increase in the coming decades, and that this increase will be satisfied by growth in renewables and gas, with renewables exceeding gas and coal by 2030.[9] Insofar as the primary question facing these markets is whether to meet increasing energy needs through gas or renewables, increasing international trade in international trade in LNG and other measures to increase global availability of natural gas will cause natural gas to displace use of wind, solar, or other renewables that would otherwise occur.[10] On the other hand, recent peer reviewed research concludes that US LNG exports are likely to play only a limited role in displacing foreign use of coal, and such that US LNG exports are likely to increase net global GHG emissions.[11]

Although the D.C. Circuit previously upheld the Department of Energy's reliance on assumption that U.S. LNG exports would principally displace other fossil fuels and therefore have a negligible impact on global greenhouse gas emissions, this recent research and information about global energy markets was not before the agency in those cases. *See, e.g., Sierra Club v. United States Dep't of Energy,* 867 F.3d 189, 202 (D.C. Cir. 2017). This new information demonstrates that there are now tools to perform a more careful and informative analysis than was done in that case.

DOE's updated report concludes that, at best, generating electricity with US LNG has lifecycle greenhouse gas emissions similar to use of other fossil fuel sources. Because all of these fossil energy sources have such high emissions, if even a small percentage of US LNG exports are instead used to increase overall energy consumption or displace zero or near-zero emission renewables, rather than substituting for other fossil generation, the result will be that US LNG exports cause a significant increase in greenhouse gas emissions. DOE has again failed to meaningfully acknowledge this fact. On the other hand, as the Intergovernmental Panel on Climate Change has once again recently confirmed, limiting global temperature rise to 1.5 degrees Celsius will require dramatic emission reductions in the near and long term, reductions which are

Exhibit 4.

[9] EIA, *International Energy Outlook 2019* at 31, *available at* https://www.eia.gov/outlooks/ieo/pdf/ieo2019.pdf, attached as Exhibit 5.

[10] International Energy Agency, *Golden Rules for a Golden Age of Gas*, Ch. 2 p. 91 (2012).

[11] Gilbert, A. Q. & Sovacool, B. K., *US liquefied natural gas (LNG) exports: Boom or bust for the global climate?*, Energy (Dec. 15, 2017), *available at* https://doi.org/10.1016/j.energy.2017.11.098, attached as Exhibit 6.

inconsistent with further development of long-lived fossil fuel infrastructure.[12]

B. Increasing Exports Will Increase Coal Use; Exports' Demand Is Met by Both Increased Gas Production *and* Gas-to-Coal Switching

Abstract comparison of US LNG to other energy sources on a lifecycle, per megawatt hour basis also ignores the fact that increasing US LNG exports will raise domestic gas prices, which will lead to both an increase in gas production and an increase in domestic coal use. In essence, some of the additional gas exported will be "supplied" not by new production, but by diverting gas that would have otherwise been used by other domestic consumers, who will switch to coal instead.

DOE has twice requested that the Energy Information Administration ("EIA") assess the effect of LNG exports generally on the domestic market. Both times, EIA offered robust predictions of how the additional demand created by exports will raise U.S. gas prices and cause electric utilities to replace some of their gas consumption with coal.[13] Accounting for this domestic gas-to-coal shifting undermines the Report's implication that increasing US LNG exports will not increase global greenhouse gas emissions.

In summary, while comparing the lifecycle emissions of US LNG with other fossil fuels can provide a useful perspective on the climate impacts of potential LNG exports, it does not answer a key question before DOE: how will greenhouse gas emissions change if DOE approves or disapproves LNG exports. If LNG is exported from the U.S., a small portion of the exported gas will come from production that would have occurred anyway, importing countries will not fully offset their use of U.S. LNG by decreasing consumption of other fossil fuels, and the U.S. will increase consumption of other, also harmful, fossil fuels in response to increased domestic gas prices. In reviewing applications for LNG exports, DOE must consider these broader effects.

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[12] Intergovernmental Panel on Climate Change, *Special Report: Global Warming of 1.5 C, Summary for Policymakers* at 13-17 (May 2019), *available at* https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_LR.pdf, attached as Exhibit 7.

[13] EIA, *Effect of Increased Natural Gas Exports on Domestic Energy Markets* ("2012 Export Study") at 19 (Jan. 2012), App. A, 6, attached as Exhibit 8; EIA, *Effects of Increased Levels of Liquefied Natural Gas Exports on U.S. Energy Markets* at 12 (Oct. 2014), *available at* https://www.eia.gov/analysis/requests/fe/pdf/lng.pdf, attached as Exhibit 9.

II. DOE Underestimates the Lifecycle Greenhouse Gas Emissions of U.S. LNG

Even within the report's myopic frame, the report underestimates the lifecycle emissions of US LNG. We focus on two sources of such underestimates here; understating the amount of methane emitted by U.S. gas production and transportation, and understating the emissions associated with delivering exported LNG to end users.

A. DOE Underestimates the Methane Leak Rate of Domestic Gas Production

DOE assumes that the "upstream emission rate" of US LNG exports—the amount of methane that is emitted to the atmosphere during production, processing, and transportation of gas to the export facility—is 0.7% of the gas delivered.[14]

This figure is drastically at odds with estimates provided in peer-reviewed, published literature. Indeed, it is unclear how this value is consistent with DOE's own supporting documentation. NETL's primary supporting document that "the national average CH4 emission rate is 1.24%."[15] The LNG Lifecycle report states that the 0.7% figure is meant to represent gas coming specifically from Appalachian shale. It is unclear why this assumption would be warranted for the export applications DOE is currently reviewing, which are concentrated in the Gulf Coast. Moreover, the supporting documentation provides a higher value for Appalachian Shale production as well, at 0.88% percent.

More broadly, the 0.7% estimate cannot be reconciled with the published literature. DOE principally relies on a "bottom up" method of analysis that is, as explained by multiple studies, known to "systematically underestimate total emissions."[16] "Bottom-up" studies use an estimate of the average emissions from an individual piece of equipment or individual event, such as a high-bleed pneumatic device or a well completion, and multiply that per-component value by an estimate of the total number of components or events of that type (*e.g.*, assuming that each well has X pneumatic controllers that emit Y tons of methane). A different method of estimating oil and gas sector methane emissions is a "top down" approach, where researchers measure the

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[14] *E.g.*, Life Cycle GHG Perspective at 27.

[15] https://www.netl.doe.gov/energy-analysis/details?id=3198 at 1.

[16] Alvarez, et al., *Assessment of methane emissions from the U.S. oil and gas supply chain*, 361 Science 186 (July 13, 2018), *available at* https://science.sciencemag.org/content/361/6398/186.full, attached as Exhibit 10; *see also* Tong et al., *Comparison of Life Cycle Greenhouse Gases from Natural Gas Pathways for Medium and Heavy-Duty Vehicles*, 49 Environ. Sci. Technol. 12, p. 7126 (2015) (estimating methane leakage rates of 1.5–3.3 percent), *available at* https://pubs.acs.org/doi/10.1021/es5052759, attached as Exhibit 11.

methane accumulation in the atmosphere in areas where oil and gas activity is occurring and then estimate the fraction of this methane attributable to emissions from oil and gas activity. For example, a researcher might measure methane concentrations upwind and downwind of gas activity and then subtract out the methane estimated to have been emitted from other sources. Certainty in source attribution has increased in recent years as scientists are better able to distinguish methane sources based on detected levels of co-occurring compounds such as ethane or isotopic composition of atmospheric methane.

Recently, peer-reviewed publications utilizing top-down techniques to estimate methane emissions from oil and gas have proliferated, and these studies provide compelling evidence that the aggregate methane emission estimates based on "bottom up" studies (such as those cited in the DSEIS) underestimate gas production methane emissions by a significant margin. For example, Two studies of Colorado's Denver-Julesberg Basin have concluded that during gas production alone (not including emissions from downstream segments of the industry - transmission and distribution), the gas leak rate was about 4%.[17] The same team of researchers found even higher methane leak rates in Utah's Uinta Basin, estimating escaped methane at 9 ± 3% of total production.[18] Other research has confirmed that this problem is not unique to the mountain west, and that North American emissions as a whole are understated.[19]

The peer reviewed literature offers compelling explanations for why bottom-up estimates are systemically too low. The bottom-up methodology relies on sampling methane leaks from

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[17] The 4% estimate is provided by Petron, *et al*., *A new look at methane and non-methane hydrocarbon emissions from oil and natural gas operations in the Colorado Denver-Julesburg Basin*, 119:9 J. Geophys. Res. Atmospheres (June 3, 2014), *abstract available at* http://onlinelibrary.wiley.com/doi/10.1002/2013JD021272/abstract, attached as Exhibit 12. This is consistent with an earlier study, by the same lead author, which estimated using top-down techniques that 2.3 to 7.7% of production was vented in the studied and concluded more generally that "the methane source from natural gas systems in Colorado is most likely underestimated by at least a factor of two." Petron, *et al.*, *Hydrocarbon emissions characterization in the Colorado Front Range: A pilot study*, 117:D4 J. Geophys. Res. Atmospheres 4304 (Feb. 21, 2012), *abstract available at* http://onlinelibrary.wiley.com/doi/10.1029/2011JD016360/abstract, attached as Exhibit 13.

[18] Karion, *et al.*, *Methane emissions estimate from airborne measurements over a western United States natural gas field*, 40:16 Geophysical Research Letters 4393 (Aug. 27, 2013), *abstract available at* http://onlinelibrary.wiley.com/doi/10.1002/grl.50811/abstract, attached as Exhibit 14. *See also* J. Tollefson, *Methane leaks erode green credentials of natural gas*, Nature (Jan. 2, 2013), *available at* http://www.nature.com/news/methane-leaks-erode-green-credentials-of-natural-gas-1.12123, attached as Exhibit 15.

[19] Brandt, *et al.*, *Methane leaks from North American natural gas systems Energy and environment*, Science Vol. 343, no. 6172 at pp. 733-735 (Feb. 14, 2014), *available at* https://nature.berkeley.edu/er100/readings/Brandt_2014.pdf, attached as Exhibit 16.

various pieces of equipment under “ideal operating conditions.”[20] However, evidence indicates that there are “a small number of ‘superemitters’” with emissions that are much higher than anticipated by the emission factors used in the bottom-up estimates.[21] For example, one analysis 75,000 components at five different facilities found that just 50 leaks and compressor seals were responsible for 58% of overall emissions.[22] These rare (one in a thousand or less) but extreme leaks are unlikely to be represented in the data used to inform bottom-up calculations, which may be based on surveys of a few dozen, or even a hundred, components. This is especially so because site and equipment operators can be expected to operate especially diligently when they know they are being surveyed, such that “there are reasons to suspect sampling bias” in the surveys used to develop the emission factors used in bottom up analysis.[23] On the other hand, these superemitters are likely to be captured by top-down estimates.

Recent, credible, peer-reviewed publications have determined that the likely average leak rate for U.S. natural gas production is 2.3% or more.[24] DOE’s assumed 0.7% leak rate drastically understates the likely climate impact of US LNG exports.

B. DOE Understates Emissions Occurring After Export

The report further underestimates emissions at other stages of the LNG lifecycle.

For one, DOE cannot ignore emissions associated with transporting LNG from the import terminal to the end user. The report states that “For this analysis, it was assumed that the natural gas power plant in each of the import destinations is located close to the LNG port, so no additional pipeline transport of natural gas is modeled in the destination country.”[25] This assumption is improper. Indeed, in China, LNG is being transported from terminal to end users by *truck*, a process that presumably entails significant emissions even greater than transportation by pipeline.[26] This is not a fringe or one-off occurrence: it already accounts for 12 percent of China’s

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[20] Alvarez 2018 at 2.

[21] Brandt 2014 at 733.

[22] EPA, *Cost-Effective Directed Inspection and Maintenance Control Opportunities at Five Gas Processing Plants and Upstream Gathering Compressor Stations and Well Sites*, at Table 2 (Mar. 2006), *available at* https://www.epa.gov/sites/production/files/2016-08/documents/clearstone_ii_03_2006.pdf, attached as Exhibit 17.

[23] Brandt 2014 at 734.

[24] *See, e.g.*, Alvarez 2018.

[25] Report at 4.

[26] Murtaugh, *Welcome to Gas Pipelines on Wheels*, Bloomberg Business (Nov. 5, 2018), *available at* https://www.bloomberg.com/news/articles/2018-11-05/china-gas-craze-gets-help-from-trucks-as-pipelines-can-t-

LNG use, and one developer "is using it as a primary way to move LNG from its new terminal."[27]

Even where LNG is moved by from the terminal to end users by pipelines, the emissions can potentially be significant. Even if the journey from regasification to end use may be shorter than the journey from the well to the liquefaction terminal, the emissions per pipeline mile may be higher for this leg of the journey. The Intergovernmental Panel on Climate Change's ("IPCC") most recent "Guidelines for National Greenhouse Gas Inventories" explains that, measured against emissions in North America and Western Europe, "in developing countries and countries with economies in transition . . . there are [generally] much greater amounts of fugitive emissions per unit of activity."[28] In light of the finite number of LNG import facilities, it is inappropriate for DOE to simply assume that end users are adjacent to import terminals, rather to examine whether this is in fact the case.

DOE must also account for the fact that LNG may not proceed directly from the export facility to the regasification. There is an emerging LNG resale market, which can involve additional steps in storing, moving, and shipping LNG, beyond the direct shipping routes assumed in DOE's analysis. For example, "[i]n 2019 Shizuoka Gas made an agreement with Clean Energy, a subsidiary of Chinese Dalian Inteh holdings, for the sale of LNG in ISO tanks to the Chinese market. Each ISO tank is filled with 18 tonnes of reloaded LNG, transported by truck to a container exporting terminal, and then shipped to Dalian Port with a voyage four days."[29]

III. Conclusion

Extracting, transporting, and burning natural gas—whether through domestic pipelines or through international trade in LNG—releases harmful climate pollution. While we appreciate that DOE acknowledges the importance of this issue, DOE's updated analysis, like the one that preceded it, asks the wrong question: comparing lifecycle emissions of US LNG with other fossil fuels does not address the actual marginal impact of US LNG exports, because DOE ignores the fact that additional exports will increase energy use, displace renewables abroad, and increase

keep-up, attached as Exhibit 18.

[27] *Id.*

[28] Intergovernmental Panel on Climate Change, *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Vol. 2 Ch. 4, at 4.46; *available at* https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_4_Ch4_Fugitive_Emissions.pdf, attached as Exhibit 19.

[29] International Energy Agency, Global Gas Security Review 2019, at 43.

coal use at home. Nor does DOE provide any discussion of whether these impacts are consistent with the emission reduction trajectories US and other countries must achieve to avoid catastrophic climate change. Approving and building long-lived fossil fuel infrastructure with lifecycle carbon emissions that are, at best, comparable to coal is not a climate solution, and DOE must acknowledge this fact when reviewing applications for LNG export authorizations.

Sincerely,

Nathan Matthews
Senior Attorney

Sierra Club Environmental Law Program