U.S. DEPARTMENT of ENERGY | Office of Fossil Energy and Carbon Management

Energy, Economic, and Environmental Assessment of U.S. LNG Exports: Response to Comments

May 2025

Response to Comments

May 2025

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FREQUENTLY USED ACRONYMS

AAEDA	Americans Against Eminent Domain Abuse
AEO	Annual Energy Outlook
API	American Petroleum Institute
AXPC	American Exploration & Production Council
Bcf/d	Billion Cubic Feet per Day
Bcf/yr	Billion Cubic Feet per Year
CLNG	Center for LNG
CATF	Clean Air Task Force
DOE	U.S. Department of Energy
DRN	Delaware Riverkeeper Network
EIA	U.S. Energy Information Administration
EIS	Environmental Impact Statement
E.O.	Executive Order
FE	Office of Fossil Energy (prior to July 4, 2021)
FECM	Office of Fossil Energy and Carbon Management
FERC	Federal Energy Regulatory Commission
FTA	Free Trade Agreement
GCAM	Global Change Analysis Model
GWP	Global Warming Potential
IECA	Industrial Energy Consumers of America
IEEFA	Institute for Energy Economics and Financial Analysis
LCA	Life Cycle Analysis
LNG	Liquefied Natural Gas
LNG Allies	U.S. LNG Association
MMT	Million Metric Tons
NEMS	National Energy Modeling System
NEPA	National Environmental Policy Act
NGA	Natural Gas Act
NRDC	Natural Resources Defense Council
OIES	Oxford Institute for Energy Studies
PAGE	Partnership to Address Global Emissions
RFF	Resources for the Future
SCC	Social Cost of Carbon
SFOC	Solutions For Our Climate
Tcf	Trillion Cubic Feet

INTRODUCTION

On December 17, 2024, the Office of Fossil Energy & Carbon Management (FECM) of the U.S. Department of Energy (DOE) gave notice of availability of the *2024 LNG Export Study: Energy, Economic, and Environmental Assessment of U.S. LNG Exports* (Study or 2024 LNG Export Study). The Study is composed of a Summary Report and four appendices.

First, *Appendix A: Global Energy and Greenhouse Gas Implications of U.S. LNG Exports* presents an analysis of the global market demand for U.S. liquefied natural gas (LNG) exports across a range of scenarios, along with the global emissions impacts of increased U.S. LNG exports through 2050. The three defining variables in the scenario design are (1) global climate policies and policy ambition, (2) technology availability, and (3) U.S. LNG export levels. This analysis used the Global Change Analysis Model (GCAM), which is an integrated multisector model of global energy, economy, agriculture, land use, water, and climate systems. DOE's Pacific Northwest National Laboratory (PNNL) conducted the principal modeling work in Appendix A.

Second, *Appendix B: Domestic Energy, Economic, and Greenhouse Gas Assessment of U.S. LNG Exports* presents an analysis of the implications of the various U.S. LNG export levels on the U.S. economy and greenhouse gas (GHG) emissions. The analysis in Appendix B was conducted using an updated and adapted version of the U.S. Energy Information Administration's (EIA) National Energy Modeling System (NEMS) and Industrial Economics' Household Energy Impact Distribution Model (HEIDM). OnLocation, Inc. and Industrial Economics, Incorporated performed the principal modeling work in Appendix B.

Third, *Appendix C: Consequential Greenhouse Gas Analysis of U.S. LNG Exports* presents an analysis of global GHG emissions in response to increased U.S. LNG Exports. The Appendix describes a potential approach for considering consequential market effects in project application review process with respect to GHG emissions. DOE's National Energy Technology Laboratory (NETL) performed the principal modeling work in Appendix C.

Finally, *Appendix D: Addendum on Environmental and Community Effects of U.S. LNG Exports* is a literature review of the effects of upstream, midstream, and downstream natural gas production, transportation, and exports on the environment and on local communities. Staff in DOE headquarters, with support from NETL, prepared the summary information in Appendix D.

The Notice of Availability was published in the *Federal Register* on December 20, 2024. The Notice of Availability informed the public that DOE intended to use the Study to inform its public interest review of, and ultimately decisions in, pending and future applications to export LNG to countries with which the United States does not have a free trade agreement (FTA) requiring national treatment for trade in natural gas and with which trade is not prohibited by U.S. law or policy (non-FTA countries). The Notice of Availability also invited submission of comments regarding the Study and how it should be applied to DOE's public interest determinations, and entered the Study into the administrative record of the non-FTA export proceedings identified in the caption of the Notice. DOE initially invited public comment for a 60-day period and subsequently extended it for an additional 30 days. In total, the comment period began on December 20, 2024, and extended until 4:30 PM on March 20, 2025. DOE received over 100,000 comments on the Study from a variety of sources, including participants in the natural gas industry, industrial users, environmental organizations, think-tanks, academics, and individuals.

DOE, with support from the aforementioned laboratories and contractors, analyzed the submissions and prepared a narrative summary of the in-scope and substantive ideas, issues, and concerns expressed within the comments.

The Comment Summaries and Technical Response section that follows are organized into themes and sub-themes, as indicated in the Table of Contents. Within each comment sub-theme area, DOE provides a Technical Response summarizing DOE's view of commenters' observations and opinions. At times, DOE's Technical Response also contains programmatic insights, such as DOE conclusions and/or expressions of how DOE intends to utilize relevant findings in future non-FTA export adjudications.

Where specific submissions are referenced or quoted, footnotes are provided that include the name of the commentor and the comment identification number. The comment identification number corresponds to the ID field for the comment as listed on the 2024 LNG Export Study webpage (available at https://fossil.energy.gov/app/docketindex/docket/index/30).

Following the Comment Summaries and Technical Response section is a section that provides DOE's key findings and conclusions, in consideration of the comments received. The Key Findings and Conclusions section reflects the programmatic opinion of the Study's main points for the purpose of supporting the evaluation of individual non-FTA export applications. DOE intends to utilize the Key Findings, in conjunction with the other record evidence included in each individual non-FTA export proceeding, when determining whether proposed LNG exports are consistent with the public interest.

Based on the record evidence from the 2024 LNG Export Study and the public comments, as explained in detail throughout the Response to Comments, DOE concludes that the complete record from the 2024 LNG Export Study, inclusive of the Study, the comments received, and this Response to Comments, supports the proposition that exports of LNG from the United States will not be inconsistent with the public interest.

COMMENT SUMMARIES AND TECHNICAL RESPONSES

DOE has evaluated the comments received during the public comment period. In this section, DOE discusses the relevant comments received on the Study and provides DOE's technical response to those comments.

1. General Study Scope Comments

a. Scope of factors considered

Comment Summary

Several commenters expressed views about the scope or focus of the Study. These comments included views about the components of DOE's public interest review, how DOE should view the Study considering direction provided by executive orders, and the appropriate scope of DOE's review under the National Environmental Policy Act (NEPA).

Several comments expressed views relating to the scope of DOE's public interest review under the Natural Gas Act (NGA). For example, Sempra Infrastructure Partners, LP and Port Arthur LNG Phase II, LLC (collectively, Sempra) stated that DOE's review should not consider the sufficiency of global demand for U.S. LNG (*i.e.*, "market need"), upstream and downstream environmental

effects including GHG emissions related to LNG export, GHG emissions from market changes modeled in the Study's consequential life cycle analysis (LCA), or potential community impacts of LNG development. Sempra asserts that prior case law established that the principal purpose of the NGA is to encourage the "development of plentiful supplies of natural gas at reasonable prices" and that consideration of other factors, such as environmental issues, under DOE's public interest analysis should not be weighted more heavily over the NGA's principal purpose.[1] Center for LNG (CLNG) *et al.* (Industry Trades)[2] expressed that "DOE should not consider environmental factors such as greenhouse gas emissions in its public interest determination" as those considerations are outside the scope of DOE's authorities under the Natural Gas Act.[3] Additionally, Venture Global LNG, Inc. (Venture Global) commented that DOE should follow its longstanding approach of allowing market forces to determine export levels and should not consider the destinations of U.S. LNG exports.[4] Further, the Center for Environmental Accountability asserts that the "public interest" under the NGA should be read narrowly to "focus only on economic and energy supply considerations directly related to the export of natural gas as a commodity."[5]

Commenters also expressed views about how DOE should interpret recently issued executive orders and apply them to its public interest analysis. For example, Public Citizen stated that Executive Order (E.O.) 14156, *Declaring a National Energy Emergency*, "decisively supports the . . . conclusions that increasing the volume of LNG exports exacerbates domestic supply and demand shortages, exposing Americans to unjust and unreasonable price increases," adding that DOE "cannot authorize additional LNG exports, as doing so is inconsistent with the public interest."[6] Citing E.O. 14154, *Unleashing American Energy*, Venture Global commented that DOE, in its consideration of the 2024 Study, should focus "particularly on the aspects of the public interest that President Trump has directed DOE to consider in its review of export applications: *i.e.*, 'the economic and employment impacts to the United States and the impact to the security of allies and partners that would result from granting the application.'"[7]

In addition, Venture Global commented on the appropriate scope of the DOE's review under NEPA. The comment stated that "[i]ssues related to the impacts of natural gas production and transportation … are beyond the scope of DOE's NEPA review of LNG exports" because "DOE has consistently held that indirect effects of upstream natural gas production are not 'reasonably foreseeable' effects," and also noting that "natural gas production and transportation are subject

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1 Comments of Sempra Infrastructure Partners, LP and Port Arthur LNG Phase II, LLC (ID: 79945), at 4-9 (Mar. 20, 2025).

2 One comment document was submitted on behalf of a group calling itself "Industry Trades" and consisting of CLNG, American Petroleum Institute (API), the United States Chamber of Commerce, Interstate Natural Gas Association of America (INGAA), U.S. LNG Association (LNG Allies), American Exploration & Production Council (AXPC), and Natural Gas Supply Association (NGSA).

3 Comments of Industry Trades (ID: 79961), at 22 (Mar. 20, 2025).

4 Comments of Venture Global LNG, Inc. (ID: 79972), at 17 (Mar. 20, 2025).

5 Comments of the Center for Environmental Accountability (ID: 79988), at 10-18 (Mar. 20, 2025).

6 Comments of Public Citizen, Inc. (ID: 79973), at 2 (Mar. 20, 2025).

7 Comments of Venture Global, *supra* note 4, at 1-2 (citing Exec. Order No. 14154, *Unleashing American Energy*, 90 Fed. Reg. 8353, § 8(a) (Jan. 29, 2025)).

to a wide range of Federal and State environmental regulations and policies; it is emphatically not DOE's role or duty to try to regulate in those areas indirectly."[8]

Response

The Study evaluates a diverse range of topics and does not address the scope of DOE's public interest analysis in non-FTA authorizations. However, DOE notes that, as affirmed by the U.S. Court of Appeals for the District of Columbia Circuit (D.C. Circuit), it has consistently interpreted NGA section 3(a) as creating a rebuttable presumption that a proposed export of natural gas is in the public interest.[9] Accordingly, DOE will conduct an informal adjudication and grant a non-FTA application unless DOE finds that the proposed exportation will not be consistent with the public interest.

Additionally, DOE observes that NGA section 3(a) does not define "public interest" or identify criteria that must be considered in evaluating the public interest. Therefore, in evaluating whether an export application is not inconsistent with the public interest, DOE applies the principles described in DOE's 1984 Policy Guidelines[10] and other matters found to be appropriate to a public interest determination, such as the domestic need for the natural gas proposed to be exported. To conduct this review, DOE looks to record evidence developed in the application proceeding. Before reaching a final decision, DOE must also comply with NEPA.[11]

Additionally, DOE notes that E.O. 14154, *Unleashing American Energy*, states that, "[i]n assessing the 'Public Interest' to be advanced by any particular application, the Secretary of Energy shall consider the economic and employment impacts to the United States and the impact to the security of allies and partners that would result from granting the application."[12] DOE has implemented this directive—which is consistent with DOE's approach to date—in non-FTA export authorizations issued recently to Commonwealth LNG, LLC (Commonwealth) and Venture Global CP2 LNG, LLC.

In sum, in evaluating the public interest in non-FTA export proceedings going forward, DOE will consider the Study and comments received, the evidence developed and submitted in each application proceeding, and all other applicable laws and precedent, including but not limited to executive orders. Likewise, any decisions regarding the utility of the Study findings in meeting DOE's obligations under NEPA will be addressed in DOE's final orders on individual applications.

b. Uncertainty and absence of probabilities

Comment Summary

Several commenters noted that the Study was designed in a way that led to higher levels of uncertainty and suggested the Study was deficient because it did not assign probabilities to outcomes. Commenters such as Americans for Prosperity, Commonwealth, and Industry Trades

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8 *Id.* at 24-25.

9 *Sierra Club v. Dep't of Energy*, 867 F.3d 189, 203 (D.C. Cir. 2017) (*Sierra Club I*).

10 U.S. Dep't of Energy, New Policy Guidelines and Delegations Order Relating to Regulation of Imported Natural Gas, 49 Fed. Reg. 6684 (Feb. 22, 1984).

11 In most cases, FERC leads the environmental review for LNG export facilities.

12 Exec. Order No. 14,154 of January 20, 2025, *Unleashing American Energy*, 90 Fed. Reg. 8353, 8357 (Jan. 29, 2025) (§ 8(a)).

noted that the Study does not include probabilities associated with any of the scenarios.[13] The American Exploration & Production Council (AXPC) asserted that, considering the high levels of uncertainty, extending the Study to 2050 weakened the projection's credibility.[14]

Commonwealth emphasized the high uncertainty associated with the study and the lack of probabilities assigned to the model scenarios and outcomes. Commonwealth stated,

> "Indeed, so great are the uncertainties surrounding the Study's findings that, unlike prior studies including DOE's 2018 'Macroeconomic Outcomes of Market Determined Levels of U.S. LNG Exports' ('2018 Study'), the Study does not assign probabilities to any of the modeled scenarios or outcomes. The Study does not even attempt to explain why probabilities could not be assessed or even estimated in this instance; rather, the Study states simply that it is not attaching probabilities 'to any of the modeled scenarios' and instead 'explores a range of conditions that rely on described assumptions.'"[15]

Some commenters, on the other hand, praised the Study. Sophie Rocheleau stated that "[t]he updated studies released by DOE . . . improve upon outdated datasets that have been used to fast-track LNG permits in the past."[16] And Lisa Chipkin commented that "[t]he 2024 analysis has much needed improvements over previous analyses," listing aspects of the Study she found to be "particularly strong." These points of strength include a "breakdown of the economic impact…across geographies and sectors," findings related to "[t]he global energy and emissions analysis presented in Appendix A," and "[t]he inclusion of Appendix D."[17]

Commenters made suggestions to improve the report and also questioned its value for public interest determinations as presented. For example, the Institute for Policy Integrity proposed a scenario with a global carbon price equal to the social cost of carbon.[18] Americans for Prosperity claimed that, given the "inherent uncertainty" expressed in the Study's conclusions and the lack of quantifiable standards in which to measure the public interest, the Study seemed to have little practical application, if any.[19] The Louisiana Midcontinent Oil and Gas Association similarly suggested taking seriously the Study's limits and uncertainties in any application.[20]

Response

DOE acknowledges the uncertainty inherent in any modeling exercise involving long-range projections, including the 2024 Study. As noted on page S-v, the Study cautioned that "[g]iven the global scope and timeframe examined in this study, there should be recognition of the inherent uncertainty in conclusions, especially given their size relative to the overall global economy and energy system." DOE also specifically noted its decision not to attempt to assign a likelihood or probability to any scenario, stating that, "[f]or the portions of this study that have modeled results, the study does not attach probabilities to any of the scenarios examined." DOE will consider

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[13] Comments of Americans for Prosperity (ID: 79843), at 1 (Mar. 18, 2025); Comments of Commonwealth LNG, LLC (ID: 79964), at 7 (Mar. 20, 2025); Comments of Industry Trades, *supra* note 3, at 15.
[14] Comments of AXPC (ID: 79963), at 15 (Mar. 20, 2025).
[15] Comments of Commonwealth LNG, LLC, *supra* note 13, at 7.
[16] Comment of Sophie Rocheleau (ID: 48296) (Jan. 16, 2025).
[17] Comment of Lisa Chipkin (ID: 50843) (Jan. 18, 2025).
[18] Comments of Institute for Policy Integrity (NYU Law) (ID: 3301), at 3 (Jan. 17, 2025).
[19] Comments of Americans for Prosperity, *supra* note 13, at 1.
[20] Comments of the Louisiana Midcontinent Oil and Gas Association (ID: 79913), at 3-4 (Mar. 19, 2025).

uncertainties in considering the Study's results as it reviews individual non-FTA LNG export applications. DOE continues to hold the position, stated on page S-v of the Study, that scenario analysis is a well-established analytical approach for exploring complex relationships across a range of variables. The inclusion or exclusion of probabilities as part of the analysis does not undermine the utility of the Study for adjudicating applications.

2. Global Energy and GHG Implications of U.S. LNG Exports

a. International natural gas supply and demand projections

Comment Summary

Several commenters had concerns with the Study's projected levels of gas supply and demand in various regions of the world, and with projected LNG exports in particular. Some commenters found the projected U.S. LNG export levels to be too high, claiming projected demand would not materialize. A report from the Oxford Institute for Energy Studies (OIES)[21] analyzed this issue in detail and was cited by several commenters, including the Institute for Policy Integrity (NYU Law) and the U.S. LNG Association (LNG Allies). The OIES report stated, "[DOE] has published key scenarios on the outlook for US LNG exports which draw conclusions that are implausible and outliers in comparison with scenarios developed by industry players and reputable consultants, especially as regards the projected growth in LNG trade to 2050."[22] It criticized "[t]he DOE scenarios includ[ing] very aggressive growth in long-term gas demand in India and hence its LNG imports, much too high a level of LNG imports into Japan and China, as well as Argentina, Brazil and Pakistan."[23] The price of U.S. LNG relative to other exporters' LNG or competing fuels was cited as an explanation for the Study's projected U.S. LNG export levels being too high. The OIES report stated that Qatar's LNG has "a delivered cost, to Europe and Asia, which is half the delivered cost of US LNG."[24] Further, according to the report, "[t]he only way that an expansion of LNG exports would lead to a displacement of coal and oil would be to drive spot gas prices down to very low levels – maybe $5 or less – as we saw in 2019."[25] The report also contends that, "[i]n order to displace renewables, these [low spot] prices would need to be sustained for a long period."[26] Meanwhile, the Delaware Riverkeeper Network cited the high cost of imported LNG in China, stating, "it is unlikely that future LNG pricing will close the $30-40/[megawatt-hour] price gap between LNG and Chinese coal."[27]

Other commenters highlighted declining demands from Europe and Asia, due to climate and energy policies in these regions. Deutsche Umwelthilfe / Environmental Action Germany commented, "[p]eak LNG has been reached and Europe will continue to reduce its import dependency from REPowerEU."[28] Delaware Riverkeeper Network added that "Europe's climate policies and energy security priorities are central to this downward trend," and that "[t]he European

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21 The Oxford Institute for Energy Studies, DOE Report on US LNG Exports: Implausible Scenarios and Flawed Assumptions (ID: 2357) (Jan. 8, 2025).
22 *Id.* at 2.
23 *Id.*
24 *Id.*
25 *Id.*
26 *Id.*
27 Comments of Delaware Riverkeeper Network (ID: 3334) at 19 (Jan. 19, 2025).
28 Comments of Deutsche Umwelthilfe (ID: 3262), at 4 (Jan. 17, 2025).

Union's 'Fit for 55' and 'REPowerEU' set goals to reduce gas demand and accelerate the transition to renewable energy sources."[29] Focusing on Asia, Delaware Riverkeeper Network noted the following:

> "Japan's 2020 Sixth Strategic Energy Plan aims to achieve carbon neutrality by 2050. The Strategic Plan emphasizes that utilization of renewable energy as the major power source is the top priority, as well as major advancements in nuclear generation. By increasing nuclear and renewable energy's share in the power generation mix, Japan targets a 10% reduction in LNG by 2030."[30]

Solutions For Our Climate (SFOC) stated that "recent data and policy trends indicate a notable decline in gas demand projection in [Korea and Japan], alongside a broader shift across Asia towards alternative energy sources."[31]

Several comments noted that currently approved U.S. LNG export levels are higher than projected demand levels for U.S. LNG (at least through 2040 in all scenarios, and through 2050 in all scenarios except Defined Policies: Model Resolved). According to Resources for the Future (RFF), "[t]he main finding is that DOE-approved LNG export capacity is large enough (43.6 Bcf/d) to meet demand in all but the [business-as-usual] (BAU) scenario[, a]nd even in that case, demand is more than met through 2040."[32] Similarly, the Institute for Policy Integrity (NYU Law) commented that "the existing 43.6 Bcf/d capacity threshold is unlikely to become binding in the foreseeable future," asserting that "this conclusion indicates that additional export authorizations would be inconsistent with the public interest."[33]

On the other hand, others found the Study's projected U.S. LNG exports to be too low and claimed projected demand levels should be higher. For example, Industry Trades suggested that the Study's "projections understate future demand, are inconsistent with real-world expectations in multiple world markets, and fail to present realistic economic demand for natural gas and LNG in major U.S. LNG export destinations."[34] Industry Trades highlighted reasons for higher LNG demand, including "increased power demand in developed nations due to emerging trends such as artificial intelligence and data center proliferation."[35] Industry Trades also highlighted increased demand from Europe, as "key to fully eliminating its reliance on Russian fossil fuels with about 40 to 50 [billion cubic meters]/year of Russian gas still flowing into the region."[36] Other commenters noted strong LNG demand in Asia. For example, the US-ASEAN Business Council stated that "[d]emand for LNG in key markets in ASEAN is strong, influenced by specific but often similar factors: strong population and economic growth, replacement of coal-fired generation with natural gas, and declining indigenous gas production,"[37] and cited examples in the Philippines, Thailand, Myanmar and Vietnam. Another commenter, the U.S. India Strategic Partnership Forum asserted

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[29] Comments of Delaware Riverkeeper Network, *supra* note 27, at 15.
[30] *Id.* at 18.
[31] Comments of Solutions for Our Climate (ID: 3331), at 1 (Jan. 19, 2025).
[32] RFF, *Unpacking the Department of Energy's Report on US Liquefied Natural Gas Exports* (ID: 40169), at 4 (Mar. 2025).
[33] Comments of Institute for Policy Integrity (NYU Law), *supra* note 18, at 5.
[34] Comments of Industry Trades, *supra* note 3, at 16.
[35] *Id.*
[36] *Id.*
[37] Comments of US-ASEAN Business Council (ID: 79915), at 1 (Mar. 19, 2025).

that the Study's conclusion that "'future demand for natural gas and LNG is uncertain' does not pertain to India," as "India is currently the world's fourth-largest LNG market and will be one of the biggest drivers of future LNG demand growth."[38]

Response

DOE intended the scenario analysis to capture a broad range of international gas demand levels and the related U.S. LNG export levels. Table 4 on page A-19 of Appendix A shows modeled global natural gas consumption levels by 2050 across all scenarios, which range from 175 billion cubic feet (Bcf) per day (Bcf/d) to 543 Bcf/d. Table 5 on page A-22 of Appendix A shows U.S. LNG export levels by 2050 across all scenarios, which range from 17.2 to 56.3 Bcf/d. Beyond demand levels driven by scenario assumptions, international gas supply and demand levels are reflective of parameters put in place to calibrate LNG infrastructure assumptions, policies, and recent historical trends. These include representation of emissions policies in the rest-of-world, consistent with previously published studies[39,40] (Table 2 on page A-13); planned and existing LNG capacity additions in major economies including the U.S., Middle East, Australia, Canada, Southeast Asia, and Africa (page A-16); constraints on Russian exports to better align with recent trends and impacts of sanctions (page A-16); and historical natural gas producer prices (Table A-1.1 on page A-48). Energy system policies or trends that go beyond these parameters were not included.

In addition to these main scenarios, additional sensitivity analyses (pages A-34 to A-41) were conducted to test alternative supply assumptions (differing natural gas resource availability at each price point in the U.S. and Middle East). Such sensitivity analyses allowed for an exploration of the competitiveness of U.S. LNG exports compared to exports from other major suppliers. The scenario and sensitivity analyses were designed to capture a broad range of factors affecting demand for U.S. LNG exports.

However, a comprehensive uncertainty assessment, weighing specific factors affecting international gas supplies and demands, such as the impact of various specific regions' energy policies (*e.g.*, REPowerEU, Fit for 55, Japan's 2020 Sixth Strategic Energy Plan), was not within the scope of the Study's analysis. As stated in the Study's Summary Report, DOE did not attempt to assign probabilities to any of the scenarios, but only to present a broad range to explore different trajectories of U.S. LNG exports.[41] This approach provides DOE with information about the global energy system response across the scenarios. DOE acknowledges that scenarios with the highest U.S. and global LNG demand show LNG demand developing to a higher level than in other major projections, as illustrated, for example, in the comment submitted by the OIES.

When evaluating individual applications for export to non-FTA countries, DOE has consistently subscribed to the principle that, under most circumstances, the market is the most efficient means

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[38] Comments of US-India Strategic Partnership Forum (ID: 79931), at 2 (Mar. 20, 2025).

[39] Yang Ou, Gokul Iyer, *et al.*, *Can updated climate pledges limit warming well below 2° C?*, Science, Vol. 374, Issue 6568 (Nov. 4, 2021).

[40] Gokul Iyer, Yang Ou, *et al.*, *Ratcheting of climate pledges needed to limit peak global warming.*, Nature Climate Change, Vol. 12, Issue 12 (Nov. 10, 2022).

[41] *See* Energy, Economic, and Environmental Assessment of U.S. LNG Exports: Summary Report, at S-1 (Dec. 2024), https://www.energy.gov/sites/default/files/2024-12/LNGUpdate_SummaryReport_Dec2024_230pm.pdf.

of allocating natural gas supplies. Ultimately, market forces will determine which (and how many) U.S. LNG export projects will be constructed and operate. Authorization to export LNG does not guarantee that any particular project will succeed, and given the lack of probabilities attached to any of the export levels examined, DOE takes the approach of enabling the market flexibility to choose among various export projects to determine the market-derived level of U.S. LNG exports.

b. Carbon capture and storage (CCS) projections

Comment Summary

Some comments expressed concern that the carbon capture and storage (CCS) levels projected in the report are too high or driven by unclear assumptions. For example, James Stock and Constanza Abuin (Harvard University) stated that "it is not possible to infer from the DOE LNG Study whether this higher deployment of CCS in the Defined Policies scenario is itself driven by technological cost assumptions, by climate policy assumptions, or by both."[42] Additionally, the Center for Biological Diversity commented, "CCS remains uneconomical and unproven at scale, which calls into question the 2050 CCS projections that DOE relied upon in the LNG Export study."[43] Despite these concerns, the Center for Biological Diversity expressed support for the Study's characterization of GHG impacts in the High CCS versus Moderate CCS scenarios:

> "The DOE study in some regards correctly characterizes the potential impact of over-reliance on CCS, at least qualitatively. For instance, in comparing two of the study's scenarios— Commitments (High CCS), which assumes relatively high CCS deployment while meeting commitments to [GHG] emissions reductions, and Commitments (Mod CCS), which assumes limited CCS deployment but higher deployment of renewable energy while meeting commitments to [GHG] emissions reductions—the modeling reveals that LNG exports and cumulative GHG emissions between 2020 and 2050 will be higher in the High CCS scenario than in the Mod CCS scenario. This result is purportedly because higher levels of CCS allow for an increase in fossil fuel demand while still meeting climate commitments."[44]

Response

DOE acknowledges that availability of CCS is an important assumption across scenarios modeled in the Study. An explanation of the levels of CCS deployment in GCAM are detailed on pages S-16 and S-17 of the Summary Report. As stated in the Summary Report,

> "[i]n GCAM, levels of [CCS] deployment in 2050 under assumptions about the availability of the full portfolio of technologies are higher than comparable scenarios in the literature and current levels. There is currently 0.051 $GtCO_2$/yr of operating CCS projects, an additional 0.051 $GtCO_2$/yr under construction, 0.180 $GtCO_2$/yr in advanced development, and 0.134 $GtCO_2$/yr in early-stage development, for a total of 0.416 $GtCO_2$/yr operating or in development."[45]

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[42] Comments of Constanza Abuin and James Stock (ID: 79924), at 5 (Mar. 19, 2025).
[43] Comments of Center for Biological Diversity (ID: 3212), at 3 (Jan. 16, 2025).
[44] *Id.* at 2.
[45] Global CCS Institute, *Global Status of CCS 2024: Collaborating for a Net-Zero Future* (Nov. 2024), https://www.globalccsinstitute.com/wp-content/uploads/2024/11/Global-Status-Report-6-November.pdf.

The Summary Report further describes the assumptions that lead to the levels of CCS deployment in GCAM, these include:

- An expanded set of CCS applications in the power generation, hydrogen production, refining, and industrial and manufacturing sectors.[46,47,48,49]
- Representation of the Inflation Reduction Act, which has provisions that incentivize CCS deployment in the U.S., and assumptions in the Commitments and Net Zero scenarios to reduce economy-wide GHG emissions in the U.S. by 51% in 2030 and 100% by 2050 relative to 2005 without limits on technology deployment.
- Representation of policies enacted outside of the U.S. consistent with previous published studies.[50,51]

Thus, the deployment of CCS in the Defined Policies scenario (which is the lowest level across scenarios modeled (as shown in Figure 2 in Appendix A)) is driven by a combination of technological cost assumptions and climate policy assumptions.

DOE explored sensitivity in CCS levels using scenarios that varied assumptions of technology availability (High CCS versus Moderate CCS levels). The technology assumptions in the High CCS versus Moderate CCS scenarios are detailed in Table 4 on page S-18 of the Summary Report. "Default levels of CCS availability in GCAM" refers to the model-resolved (or unconstrained) level of CCS that results from the set of assumptions detailed in Table 4 for the High CCS scenario. In contrast, the Moderate CCS scenario includes CCS constraints that reach "8.7 $GtCO_2$ per year globally by 2050, consistent with average deployment of CCS levels in IPCC AR6 scenarios that limit global warming to 1.5°C (with >50% probability) by 2100 with no or limited overshoot."[52]

However, a comprehensive assessment about the availability of CCS was not within the scope of the Study's analysis. The Study explored scenarios with varying assumptions about future climate -driven policy, technology availability, and the level of U.S. LNG exports. The technology availability assumptions - High CCS and Moderate CCS - while useful for the development of the Study, are not factors that directly inform DOE's public interest determination.

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46 Siddhartha Durga, Simone Speizer, and Jae Edmonds, *The role of the iron and steel sector in achieving net zero US CO_2 emissions by 2050*, Energy and Climate Change, Vol. 5, art. 100152 (Dec. 2024).

47 Matteo Muratori *et al.*, *Carbon capture and storage across fuels and sectors in energy system transformation pathways*, Int'l J. of Greenhouse Gas Control, Vol. 57 (Feb. 2017), https://www.sciencedirect.com/science/article/pii/S1750583616304637.

48 Matthew Binsted *et al.*, *Carbon management technology pathways for reaching a US Economy-Wide net-Zero emissions goal*, Energy and Climate Change, Vol. 5, art. 100154 (Dec. 2024), https://www.sciencedirect.com/science/article/pii/S2666278724000308.

49 Molly Charles *et al.*, *The role of the pulp and paper industry in achieving net zero US CO_2 emissions in 2050*, Energy and Climate Change, Vol. 5, art. 100160 (Dec. 2024), https://www.sciencedirect.com/science/article/pii/S2666278724000369.

50 *See* Ou, Iyer, *et al.*, *supra* note 39.

51 *See* Iyer, Ou, *et al.*, *supra* note 40.

52 Summary Report, *supra* note 41, at S-18 (tbl. 4).

c. Displacement effects and impact on global GHG emissions

Comment Summary

Several commenters offered opinions of the potential energy system displacement effects of increased U.S. LNG exports and the resulting implications for global GHG emissions.

Some comments highlighted the results of scenarios that found that increased U.S. LNG exports would displace more low-carbon sources than they would other fossil fuels. Senator Jeffrey A. Merkley and other members of Congress stated, "[t]he findings show that additional U.S. LNG exports displace more renewables than coal globally."[53] Citizens for Pennsylvania's Future stated, "any argument that US LNG exports will offset coal-fired energy globally (13%) pales in comparison to the conclusion that LNG will displace global investment in zero- or low-carbon energy by 25%."[54] And Marc Silverman commented that "[t]he global energy and emissions analysis presented in Appendix A … shows that LNG exports compete more with climate-safe compatible energy sources and technology than coal, leading to increased global greenhouse gas emissions."[55]

Some comments stated that the net increase in global GHG emissions, as found in the Study, was modest. Mexico Pacific Limited LLC commented, "DOE asserts in its Study that cumulative global GHG emissions (2020-2050) would increase by just ~0.05% (barely measurable and well within margins of error when accounting for numerous other model factors)."[56]

Several other commenters disagreed with the Study's findings on displacement, stating that increased U.S. LNG exports would displace more fossil fuels (including other LNG) than low-carbon sources, resulting in decreased GHG emissions. For example, RFF cited a study by S&P Global and compared the displacement effects identified in the S&P and DOE studies, noting:

> "In S&P's analysis, 35 percent of the added US LNG production displaces new planned LNG projects in [Rest of World] ROW and another 14 percent reduces other gas production (local gas and gas shipped by pipeline). Together, this is almost 50 percent of the added US LNG exports replacing ROW gas production. In contrast, DOE finds that only 37 percent of US LNG production displaces ROW sources and that 13 percent spurs additional energy consumption."[57]

A comment from Venture Global LNG, Inc. cited a 2019 study by the International Energy Agency (IEA), which stated "[s]ince 2010, coal-to-gas switching has saved around 500 million tonnes of CO_2."[58] Partnership to Address Global Emissions (PAGE) cited a 2024 study from ICF International (ICF), stating:

> "[ICF] concluded that without U.S. LNG exports abroad, global greenhouse gas emissions would have increased in 2022 by over 112 million metric tons, mostly produced by coal.

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[53] Comments of Sen. Jeffrey Merkley & colleagues (ID: 3366), at 1 (Jan. 14, 2025).
[54] Comments of Citizens for Pennsylvania's Future (ID: 3292), at 3 (Jan. 17, 2025).
[55] Comment of Marc Silverman (ID: 55493) (Jan. 19, 2025).
[56] Comments of Mexico Pacific Limited (ID: 79987), at 7 (Mar. 20, 2025).
[57] Comments of RFF, *supra* note 32, at 7 (citing S&P Global, *Major New US Industry at a Crossroads: A US LNG Impact Study – Phase 1* (2024)).
[58] Comments of Venture Global, *supra* note 4, at 19 (citing IEA, *The Role of Gas in Today's Energy Transitions* (2019), https://www.iea.org/reports/the-role-of-gas-in-todays-energy-transitions).

> The same study shows that without U.S. LNG exported abroad, 88% of that energy would be replaced with higher emitting fuels (54% coal and 34% fuel oil). And if the Energy Information Administration's expectation that U.S. LNG exports increase 74% by 2030 is correct, U.S. LNG would be responsible for a reduction of 194 million tons of CO_2e per year."[59]

A working paper authored by Constanza Abuin of Harvard University and attached to a comment described both types of energy system displacements occurring, but on different time frames. According to the working paper, "[i[n the rest of the world, short-term emissions fall as reliance on coal drops, yet delayed renewable uptake drives long-term emissions up."[60]

Response

DOE intended the range of scenarios presented in the Study to highlight a range in levels of displacement effects including zero/low-carbon-to-gas substitution, unabated fossil-to-gas substitution, gas-to-gas substitution, and a net change in total energy use. Scenarios with differing levels of each type of displacement were shown and discussed in Section B-1 of Appendix A (pages A-23 to A-29). The resulting impacts on GHG emissions are shown in Table 6 on page A-28.

DOE acknowledges the importance of considering the temporal dimension in energy system displacement effects and DOE's 1984 Policy Guidelines that seek to "promote a balanced and mixed energy resource system."[61] Indeed, as described in Constanza Abuin's working paper, the displacement effects could vary over time. While the figures presented in the Study focus on the cumulative projected effects from 2020 to 2050, detailed data tables in Appendix A (on pages A-52 to A-212) provide the energy system changes over the full modeling period. In regard to comparisons of modeled renewable energy associated with growing U.S. LNG exports, DOE notes that, considering gas, coal, and oil substitution, the Study shows more fossil resources than renewable resources being displaced. DOE also notes that, as pointed out by Mexico Pacific Limited, the increases in GHG emissions found in the Study were relatively small percentages of total global emissions, and that, given the considerable uncertainty in projecting complex market effects decades into the future, there is no certainty that GHG emissions would increase with higher levels of U.S. LNG exports.

While the Study presents important insights into the potential displacement effects and emissions implications of increased U.S. LNG exports, DOE emphasizes the inherent uncertainty in long-term market forecasting and recognizes that outcomes may vary significantly over time. Given that the Study found increases in GHG emissions from higher U.S. LNG exports to be minimal, and dependent on which energy sources the LNG displaces, DOE concludes that it can't definitively determine whether GHG emissions would increase with rising levels of U.S. LNG exports. Furthermore, the GHG emissions discussed in the report are not expected to affect DOE's public interest determinations in pending or future non-FTA authorizations.

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[59] Comments of Partnership to Address Global Emissions (ID: 79977), at 3 (Mar. 20, 2025) (citing ICF, *An America First Future for LNG Exports* (2017)).

[60] Constanza Abuin, "Power Decarbonization in a Global Energy Market: The Climate Effect of U.S. LNG Exports" (working paper) (ID: 79924), at 1 (Mar. 18, 2025).

[61] 1984 Policy Guidelines, *supra* note 10.

d. Price response and feedback between models

Comment Summary

Commenters expressed concerns about the manner in which the GCAM and NEMS models were linked. For example, Stock and Abuin (Harvard University) stated that a "[m]ethodological disconnection between domestic and international modules creates potential for result inconsistencies."[62] Stock and Abuin further stated,

> "[T]he economic competitiveness of any natural gas supply region is tightly linked to the shape of its natural gas resource supply curve, which determines the rate of increase of domestic natural gas prices as production levels increase. Thus, export levels and domestic prices are intrinsically linked and should not be analyzed in isolation. Given that DOE is not using a unified modeling framework for its analysis of the domestic and international effects of U.S. LNG exports, it would be important to ensure that U.S. LNG export levels predicted by GCAM are consistent with domestic prices projected by FECM24-NEMS under these export levels. In the Defined Policies with reference U.S. supply scenario, the expansion of U.S. LNG exports comes at the expense of a 30% increase in Henry Hub prices. It is unclear whether GCAM would yield a comparable level of exports given that price increase."[63]

A related comment was made by Hashimoto and Yanagisawa of the Institute of Energy Economics, Japan (IEEJ). Hashimoto and Yanagisawa stated that "[w]hile the study is based on analysis of multiple scenarios, it should have included potential reactions to the projected outcomes of those scenarios and their pragmatic and realistic likelihood."[64] Further, "when domestic prices are higher, gas sellers in the country tend to sell gas in the domestic market rather than shipping it to the international market in the form of LNG."[65]

Response

In the Study, the models were coupled in a one-directional manner, from GCAM to NEMS. For each *Model Resolved* scenario, GCAM was first used to estimate global demand for U.S. LNG exports. As noted on page A-7 of Appendix A, "GCAM operates in five-year time-steps by solving for equilibrium prices and quantities in various energy, agricultural, water, land use, and GHG markets in each period and in each region." Thus, GCAM solved for the equilibrium price and quantity of U.S. LNG exports demanded in the rest of the world. The equilibrium quantity (*i.e.*, *Model Resolved)* level of U.S. LNG exports was then passed as an input to NEMS and HEIDM to evaluate domestic impacts, including domestic natural gas prices for scenario-derived levels of exports. Due to inherent structural differences between the models, fully harmonizing U.S. LNG exports and prices between the two models would require building new computational frameworks that were beyond the scope of the Study.

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62 Comments of Abuin and Stock, *supra* note 4242, at 2.
63 *Id.* at 2-3.
64 Comments of Hiroshi Hashimoto and Takafumi Yanagisawa (ID: 79928), at 2 (Mar. 20, 2025).
65 *Id.*

e. Lock-in effects

Comment Summary

Some comments highlighted concerns about lock-in effects due to increased U.S. LNG exports. For example, Constanza Abuin of Harvard University stated in a working paper attached to a comment that "[t]his finding highlights the risk of carbon lock-in in a setting with sunk investments and long-lived assets: once importing countries have invested in building new gas power infrastructure because of lower LNG prices, this early capacity increase permanently increases gas generation even under higher future LNG prices."[66]

Response

The lifetimes of LNG infrastructure are modeled within GCAM, thereby capturing any potential knock-on or secondary effects of near-term investment in LNG infrastructure for the energy system in the long term. This was generally not a focus area of the Study; however, the results shown do take into account this phenomenon. This aspect of the modeling is documented in a peer-reviewed manuscript,[67] cited in the Study. However, while acknowledging that infrastructure investments can have long-term impacts on the energy system, DOE disagrees with the characterization of energy system changes as being "permanent" or the notion that the use of natural gas will be locked in as energy infrastructure typically has a finite useful lifetime. Additionally, industry innovation and investment over time can result in changes to the purpose or use of energy infrastructure in response to market forces. For example, investments made to import LNG into the U.S. were leveraged as part of the build out of LNG export infrastructure.

f. Requests for additional data related to assumptions and results

Comment Summary

A few comments stated concerns related to the lack of GCAM model input or output data provided in the Study. Robert Kleinberg of Columbia University and Boston University stated, "GCAM is presented as a black box, with limited information provided with respect to its inner workings or its computational or parameter choices."[68] The Clean Air Task Force (CATF) had a specific request for additional data for regional results to be provided:

> "While these waterfall charts provide valuable global insights, understanding regional impacts is also critical. Tables A-3.23 and A-3.24 break down natural gas consumption and production by region/country, allowing partial reconstruction of waterfall charts. However, without data on coal, oil, renewables, and total energy consumption, regional replication is incomplete. We request that DOE make the full model results publicly accessible at the most granular level available in the model (country or region)."[69]

Response

DOE acknowledges comments about the level of model data availability. For inputs to the GCAM analysis (Appendix A), DOE relied on parameter descriptions in the GCAM documentation,[70] as

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66 Abuin working paper, *supra* note 60, at 5.
67 Yarlagadda, B., *et al.*, *The future evolution of global natural gas trade*, Vol. 27, Issue 2, Art. 108902 (Feb. 16, 2024).
68 Comment of R.L. Kleinberg (ID: 47052), at 3 (Jan. 14, 2025).
69 Comments of Clean Air Task Force (ID: 79970), at 3 (Mar. 20, 2025).
70 Available at http://jgcri.github.io/gcam-doc/.

well as within other peer-reviewed GCAM studies. In cases where input parameter assumptions differed from the existing documentation or were unique to this study, descriptions were included in Appendix A.

Related to the results, the Study provides global data on the changes in the energy system due to increased U.S. LNG exports in Appendix A Table A-3.7 through Table A-3.10 (pages A-58 to A-69) by model year. The Study provides regional data on natural gas production and consumption, and LNG and pipeline import and export data in Table A-3.23 and Table A-3.24 (pages A-87 to A-212 of the Appendix A report). DOE finds the level of documentation appropriate and reasonable for the Study purpose.

g. GCAM modeling resolution

Comment Summary

Some comments expressed concern with GCAM's sectoral and temporal resolution. For example, Industry Trades cited analysis from the OIES stating, "the model is calibrated to 2015 with the model parameters fitted to the IEA historical data. A lot has happened between 2015 and now, so projecting from 2015 means it is almost certain the model is diverging in its projections between 2015 and now compared to what has actually happened. This automatically builds in divergences which get amplified going forward."[71] Industry Trades had further concerns with the resolution at which GCAM models sectors of the economy. They stated,

> "[T]here is an additional issue with DOE's use of the GCAM model, which has significant limitations. The model is based on broad-brush modeling that does not allow differentiation at finer scales. The emissions figures involved in the analysis are large while some of the differences in emissions figures identified are very small (*e.g.*, the difference in emissions figures between the Defined Policies case and the Existing/FID case is 0.05%)."[72]

Response

DOE acknowledges these comments related to GCAM's sectoral and temporal resolution. Regarding the temporal resolution, as stated on page A-16 of Appendix A, "While GCAM's energy system is calibrated through 2015 to historical data from IEA, [t]his study includes updates to key parameters to calibrate LNG infrastructure assumptions, policies, and other assumptions and outcomes of the model to recent historical trends and data." This includes, among other assumptions, "planned and existing LNG capacity additions in major economies including the United States, the Middle East, Australia, Canada, Southeast Asia, and Africa."

Regarding the sectoral resolution, DOE notes that GCAM is a global model that covers the full energy system, each sector of which contains significant technological details. Page A-7 of Appendix A details examples of the technological detail found within sectors of GCAM, and points to the model's documentation, which contains the full list of technologies in various sectors in GCAM.[73] It is correct that the technological detail represented in any given sector in GCAM may be at a coarser resolution than in a single-sector model. However, GCAM's representation of the

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[71] The Oxford Institute for Energy Studies, DOE Report on US LNG Exports: Implausible Scenarios and Flawed Assumptions, *supra* note 21, at 5.

[72] Comments of Industry Trades, *supra* note 3, at 31.

[73] *See* http://jgcri.github.io/gcam-doc/.

full energy system enables modeling of the competition of U.S. LNG with other sources of natural gas and the competition of natural gas with other fuels (*e.g.*, coal, oil, renewables) across sectors (*e.g.*, electricity generation, hydrogen production, various industries, residential and commercial buildings, and transportation). GCAM is also able to model the implications of different levels of U.S. LNG for global GHG emissions. Single-sector models would not be able to evaluate the full impact of U.S. LNG exports on global energy systems and emissions. This broader coverage was a driving factor in DOE's choice of GCAM for this comprehensive global study, which DOE still judges to be the best available National Laboratory model for this Study.

The use of GCAM helped DOE evaluate the effects of different levels of U.S. LNG exports, including how different levels of U.S. LNG exports could affect global energy mix in the future. However, the model alone is not a determining factor in the individual adjudications of non-FTA applications.

3. Domestic Energy, Economic, and GHG Assessment of U.S. LNG Exports

a. Impacts on domestic natural gas prices

Comment Summary

Comments were mixed on the validity of the Study's projection of how U.S. LNG exports will impact natural gas prices. For example, Ellen Wald asserted that increased demand would incentivize increases in domestic natural gas production and advancements in technology, which would lower prices domestically and abroad.[74] Energy Transfer, among other commenters, asserted that prices would remain steady or decline when there is adequate supply.[75] Other commenters, such as the Industry Trades[76] and Mexico Pacific Limited,[77] asserted that according to historical data, LNG exports are not correlated with price increases and may even be associated with price decreases. And Commonwealth noted that "since 2010, while the volumes of domestic LNG exports have increased by over 500%, Henry Hub gas prices have decreased by 40%, and domestic natural gas prices remain one of the only commodities to resist inflation and remain flat."[78]

Several commenters noted that the Study included infrastructure constraints that limited the ability of additional low-cost supply to mitigate price increases. EQT Corp. (EQT) claimed the study did not account for "the immense supply and low-cost potential of unleashing East Coast gas supplies in EQT's footprint in the Appalachian Basin."[79] Mexico Pacific Limited stated that "domestic supply resilience and infrastructure expansion will offset price pressures," adding that "[t]he U.S. natural gas market is highly elastic—increased production from low-cost basins (such as the Permian and Appalachian) will mitigate price hikes."[80] They also asserted that the study did not account for new pipeline infrastructure that would expand supply access and stabilize prices. Industry Trades claimed that "it is not LNG exports, but the need for additional pipeline capacity, which is

[74] Comment of Ellen Wald (ID: 3724), at 2 (Feb. 5, 2025).
[75] Comments of Energy Transfer LP (ID: 79969), at 20 (Mar. 20, 2025).
[76] Comments of Industry Trades, *supra* note 3.
[77] Comments of Mexico Pacific Limited, *supra* note 56, at 4.
[78] Comments of Commonwealth LNG, *supra* note 13, at 9 (footnote omitted).
[79] Comments of EQT Corp. (ID: 79978), at 3 (Mar. 20, 2025).
[80] Comments of Mexico Pacific Limited, *supra* note 56, at 5.

the greatest potential impediment to increased production and the greatest factor for potential consumer costs."[81]

However, other commenters maintained that the price impacts of LNG exports found in the Study were not steep enough. For example, RFF asserted that the projected price response was too low, stating that, "[i]t appears that DOE's model used a very large implicit elasticity of gas supply of about 1, which implies that each 1 percent increase in gas demand is associated with a 1 percent increase in price—a very flat supply curve for a commodity that is traditionally considered inelastically supplied" and a much higher elasticity than RFF and others found.[82] And a number of commenters expressed concern over anticipated increases in domestic natural gas prices, such as Rebecca Shedd, who commented that "[d]omestic natural gas prices will rise for households, institutions, and businesses as more LNG exports increase."[83]

The Industrial Energy Consumers of America (IECA) expressed concern that LNG exports peak during the winter, which accelerates the reduction of domestic natural gas inventories and can lead to higher prices.[84]

Regarding potential natural gas price fluctuations, commenters such as Industry Trades[85] and the LNG Allies[86] did not support findings that LNG exports have influenced natural gas prices.

Some commenters expressed the view that increasing LNG exports could increase natural gas price volatility. For example, Beaver County Marcellus Awareness Community stated that "[a]pproving additional LNG exports will exacerbate energy price volatility."[87] And Joe Franklin commented that "t]he expected price volatility of LNG is a huge concern and would most certainly be felt by domestic consumers."[88] The Institute for Energy Economics and Financial Analysis (IEEFA) stated that "the absence of a mechanism to incorporate or adjust to future volatility changes indicates that the 2024 LNG Export Study is making projections about price with a material component of price inadequately represented."[89]

Response

As expressed in the Summary Report, "there has not been a consistent relationship between domestic prices and export levels to date."[90] This difficulty is caused, in part, by many simultaneous changes that have occurred in natural gas production and markets in recent years that make it challenging to parse out separate effects. Therefore, rather than employing an econometric model, DOE used a fundamentals-based economic model of natural gas supply, demand, and prices.[91] The study used a variation of the EIA's NEMS used for the 2023 Annual

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81 Comments of Industry Trades, *supra* note 3, at 12.
82 Comments of RFF, *supra* note 32, at 2.
83 Comment of Rebecca Shedd (ID: 44052) (Jan. 5, 2025).
84 Comments of IECA (ID: 79950), at 2 (Mar. 20, 2025).
85 Comments of Industry Trades, *supra* note 3, at 13.
86 Comments of LNG Allies (ID: 79940), at 8 (Mar. 20, 2025).
87 Comments of Beaver County Marcellus Awareness Community (ID: 40591), at 1 (Mar. 13, 2025).
88 Comment of Joe Franklin (ID: 31189) (Feb. 23, 2025).
89 Comments of IEEFA (ID: 2344), at 1 (Jan. 7, 2025).
90 Summary Report, *supra* note 41, at S-4.
91 Econometric models use statistical methods and historical data to quantify relationships between economic variables, often testing existing economic theories. Fundamental-based economic models,

Energy Outlook (AEO 2023). Outside of the key differences noted in Table 1 of Appendix B, the model is essentially the same as that used in EIA's AEO 2023 that has been extensively vetted and documented.[92]

DOE is confident that the natural gas supply curves incorporated in the Study were soundly developed based on EIA's assessment of the best available data.[93] The oil and gas sector of the NEMS model includes an extensive representation of oil and gas resources and reserves and responds to oil and gas demands as well as prices to project development of reserves and production. It uses a discounted cash flow methodology to determine which oil and gas projects to develop and estimates market clearing prices for each level of supply. As demand increases, either domestically or for export, the model's logic will develop additional projects. Because the lowest-cost projects are developed first, higher natural gas demand will lead to the development of more expensive projects relative to lower natural gas demand and result in some increase in market clearing prices. NEMS also considers that technology improvements over time will lead to lower recovery costs that mitigate the impact of depletion of the lowest cost resources. The Study relied on the best available information about gas supplies and recovery costs from EIA, as expressed in the AEO 2023, at the time the Study was conducted.[94]

Regarding comments asserting that new pipeline infrastructure would result in lower natural gas prices, the NEMS model does include the potential for expansion of natural gas pipelines between regions. Within the model, expansion occurs when the price differentials are sufficient to support investment in new pipeline capacity. DOE acknowledges that different assumptions on the cost and pace of building natural gas infrastructure could potentially expand the pool of low-cost supply for LNG exports and could yield different natural gas price trajectories. Such an expansion would reduce the impact of increased LNG exports on U.S. natural gas prices.

Regarding commenters' discussion of the impact of seasonality and price volatility on gas prices, DOE acknowledges that the Study did not directly examine the impacts of increasing LNG exports on short-term natural gas price volatility due to either global prices or seasonal patterns of exports and consumption. However, by using long-term equilibrium models calibrated on historical data, the natural gas price trajectories presented in the Study reflect the impact of short-term fluctuations on average annual price.

Given that authorizations for export extend over several decades and planning for new facilities takes several years, DOE expects that production volumes in the U.S. will increase in response

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on the other hand, rely on economic theories and assumptions to create representations of economic and physical systems. For example, NEMS bases its projections of production on various factors like drilling and production costs, regulatory impacts, and technological advancements.

92 NEMS has been used extensively by EIA, other government offices, and non-government organizations for many years. The model is subject to rigorous internal scrutiny and peer review processes within EIA, an independent agency within DOE. The model documentation is extensive with a volume for each energy sector, as well as documentation specific to the assumptions for each AEO.

93 For a description of the development of technically recoverable resources, *see* Energy Info. Admin., *Assumptions to the Annual Energy Outlook: Oil and Gas Supply Module*, at 2-8 (Mar. 2023), https://www.eia.gov/outlooks/aeo/assumptions/pdf/OGSM_Assumptions.pdf.

94 *Id.* at 9.

to increased LNG exports, minimizing the potential for LNG exports to lead to price spikes. As discussed on page S-36 of the Study:

> "The long timelines of constructing and operationalizing LNG facilities allow for U.S. natural gas producers to increase output to supply the new liquefaction facilities and, ultimately, to ensure that the feedgas flows to the export terminals are highly predictable. In addition, U.S. LNG export facilities typically enter into long-term export agreements with off-takers for 75-80% of the project's nameplate capacity to support the capital investment needed to construct liquefaction facilities. As a result, the U.S. natural gas market typically prices in additional LNG export capacity with production rising to meet the incremental demand, resulting in gradual increases in domestic natural gas prices."[95]

b. Impacts on domestic GHG emissions

Comment Summary

Several commenters asserted that increased LNG exports would be detrimental to climate mitigation in the U.S. through an increase in domestic GHGs. Slocum and Vanasse asserted that the domestic increase in GHG emissions projected in the Study contradicts a previous NEPA analysis performed by FERC of the CP2 LNG and CP Express pipeline projects.[96] Sierra Club stated that adding all of the planned and under construction LNG terminals would undermine progress in reducing GHG emissions in the U.S.[97] The Clean Air Council maintained that increasing natural gas production and transportation would increase both natural gas leakage and other harmful pollutants.[98]

Response

DOE acknowledges there are a number of ways to consider the change in GHG emissions from increased U.S. LNG exports. Appendix B of the Study provides information on U.S. energy-related CO_2 emissions. Since these are national rather than project-specific energy-related CO_2 emissions estimates, they are not directly comparable to the NEPA analysis of specific projects mentioned by commenters.

Appendix A offers a more expansive estimation of GHGs globally. The results from Appendix A were used in the consequential analysis found in Appendix C. The U.S. GHG results from NEMS were not used to assess the potential environmental effects of LNG Exports as part of this analysis.

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[95] Summary Report, *supra* note 41, at S-36 (footnotes omitted).

[96] Comments of Abigail Vanasse and Tyson Slocum (ID: 40175), at 2 n.9 (Mar. 12, 2025) (citing Fed. Energy Regul. Comm'n, *Draft Supplemental Environmental Impact Statement for Venture Global CP2 LNG, LLC's CP2 LNG and CP Express Pipeline Projects under CP22-21 et al.* (Feb. 7, 2025), https://elibrary.ferc.gov/eLibrary/filelist?accession_number=20250207-3023).

[97] Comments of Sierra Club and Natural Resources Defense Council (ID: 79984), at 6 (Mar. 20, 2025).

[98] Comments of Clean Air Council (ID: 79975), at 6 (Mar. 20, 2025).

c. Availability of U.S. natural gas for domestic consumption

Comment Summary

Many commenters agreed with the finding that there is an adequate supply of natural gas in the U.S. to meet modeled domestic natural gas demand as well as LNG export demand.[99] EQT "applaud[ed] the study's authors for finding that domestic natural gas production is sufficient to meet domestic needs and supply LNG exports through 2050."[100] Venture Global, highlighting "the tremendous growth in American natural gas production following the shale gas renaissance,"[101] stated that "[w]hile LNG exports have grown dramatically over that time period [2011-2024], natural gas production has grown by significantly larger amounts, providing ample supplies for both LNG production for exports and all other domestic needs."[102] PAGE stated that "the United States maintains an abundance of recoverable natural gas and must leverage it to uphold our responsibilities to U.S. consumers, our allies, and the global climate."[103] PAGE emphasized that the Study's findings on natural gas supply align with industry and independent studies and data previously published.

Americans Against Eminent Domain Abuse (AAEDA) did not agree with the Study or other commenters on the adequacy of U.S. natural gas supply to meet projected demand because of the increasing difficulty and diminishing returns of extracting from less productive wells. AAEDA critiqued the Study's use of the EIA's forecasting of natural gas supply in the domestic analysis described in Appendix B. For instance, AAEDA stated: "[t]he Report relies on 'Assumptions to the [EIA] Annual Energy Outlook 2023; Oil and Gas Supply Module (OGSM) for its available resource when calculating the impact to our economy,"[104] but fails to "consider whether much of the gas in place will be produced as it may not be economically profitable to do so as explained by the EIA's definitions of Technically Recoverable Resources (TRR)."[105] AAEDA further points to a study[106] indicating that Marcellus [Shale] production is over-estimated relative to EIA's assumptions. Finally, AAEDA states the U. S. Geological Survey (USGS) report "United States Assessments of Undiscovered Oil and Gas Resource" published on August 6, 2024, showed total resource in place of 1,637 Tcf and argues that is incompatible with EIA's "reference case scenario" TRR level of 2,528 Tcf.[107]

However, Industry Trades asserted that, because "[t]he United States is estimated to have 4,032 trillion cubic feet of technically recoverable natural gas, available resources will not be a problem for generations."[108]

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[99] Comments of LNG Allies, *supra* note 86, at 8; Comments of Western States and Tribal Nations Energy Initiative (ID: 40170), at 2; Comment of Ellen Wald, *supra* note 7474, at 2.
[100] Comments of EQT, *supra* note 79, at 3.
[101] Comments of Venture Global, *supra* note 4, at 7.
[102] *Id.* at 8.
[103] Comments of PAGE, *supra* note 59, at 3.
[104] Comments of AAEDA (ID: 3735), at 3 (Feb. 6, 2025).
[105] *Id.*
[106] Saputra *et al.*, Forecast of economic gas production in the Marcellus Shale, American Association of Petroleum Geologists, Vol. 1, Issue 1 (Jan. 2024), https://fossil.energy.gov/App/DocketIndex/Docket/DownloadFile/771.
[107] Comments of AAEDA, *supra* note 104, at 3.
[108] Comments of Industry Trades, *supra* note 3, at 10 (footnote omitted).

Response

Based on the Study and the views of commenters that DOE found to be persuasive, DOE has found that there is an adequate supply of natural gas to support exports.[109] The results presented in the Study indicate that natural gas supply is sufficient to meet domestic natural gas demand and increasing natural gas exports across all scenarios.

EIA's OGSM uses numerous factors in its derivation of natural gas supply curves. These include drilling and production costs, regulatory or legislatively mandated environmental costs, and key taxation provisions such as severance taxes, state or federal income taxes, depreciation schedules, and tax credits.[110] The OGSM uses a discounted cash flow methodology to determine which projects to develop and to develop market clearing prices for each level of supply.[111] In particular, the treatment of financial resources within the OGSM allows for explicit consideration of the financial aspects of upstream capital investment in the petroleum industry.[112] These characteristics make OGSM well suited for this analysis.

DOE acknowledges that some commenters expressed differing views of the domestic natural gas resource base, but DOE believes the Study was based on a sound assessment of reserves. Assumptions for AEO2023, can be found in the document "Assumptions to the Annual Energy Outlook 2023: Oil and Gas Supply Module."[113] EIA incorporates numerous data sources, including the USGS, in developing estimates of technically recoverable resources used in the AEO.[114] These estimates were valid as of January 1, 2021, and represent the best available information at the time the study was conducted.

[109] Summary Report, *supra* note 41, at S-4.
[110] Energy Info. Admin., *Oil and Gas Supply Module of the National Energy Modeling System: Model Documentation 2023*, at 3 (May 2023), https://www.eia.gov/outlooks/aeo/nems/documentation/ogsm/pdf/m063(2023).pdf.
[111] *Id.* at 6.
[112] *Id.* at 3.
[113] Energy Info. Admin., *Assumptions to AEO 2023*, at 2-8 (Mar. 2023), https://www.eia.gov/outlooks/aeo/assumptions/pdf/OGSM_Assumptions.pdf.
[114] *See id.*

d. National economic impacts of LNG exports

Comment Summary

Many commenters agreed that increased LNG exports would raise U.S. GDP. Sempra, Energy Transfer LP., and Cheniere supported the position that LNG exports increase GDP.[115] The United Association of Journeymen and Apprentices of the Plumbing and Pipe Fitting Industry of the United States and Canada (United Association) quoted DOE's 2018 LNG Export Study to point out that "[l]evels of GDP are also most sensitive to assumptions about U.S. supply, with high natural gas supply driving higher levels of GDP" and that "[f]or each supply scenario, higher levels of LNG exports in response to international demand consistently lead to higher levels of GDP."[116] AXPC reviewed the results of the Study, drawing from it that increased LNG exports would increase industrial output by 1.3% (or $203 billion in 2050), with increased oil and gas activity driving 72% of this growth.[117] Industry Trades referenced a study by S&P Global and stated that U.S. LNG industry growth is expected to double its U.S. economic footprint by 2040 to $1.3 trillion in GDP.[118]

However, not all commenters agreed that there is a positive correlation between GDP and LNG exports. Earthjustice, Natural Resources Defense Council, Sierra Club, and We Act For Environmental Justice (Earthjustice *et al.*) identified a study[119] in the journal *Energies* that found that permitting higher levels of LNG exports reduced GDP while increasing both domestic GHG emissions and electricity prices.[120]

Both Cheniere and Venture Global discussed the positive impacts of U.S. LNG exports on trade. Cheniere asserted that LNG exports help re-align the U.S. balance of trade. Both Venture Global and Cheniere stated that this benefit, while missing from the Study, was highlighted as a benefit in DOE's 2018 LNG Export Study.[121] In particular, Venture Global asserted that "[i]n its just-issued order for CP2 LNG, DOE calculated that a project of its size exporting at peak capacity for a year could reduce the trade deficit by approximately $9.3 billion annually assuming 2024 observed average U.S. LNG export prices."[122]

Commenters also noted the positive impact on federal and state revenue. PAGE, quoting a PwC study, asserted that this metric was approximately $11 billion in tax and royalty revenues in 2023.[123]

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[115] Comments of Sempra and Port Arthur, *supra* note 1, at 4; Comments of Cheniere Energy (ID: 79971), at 5 (Mar. 20, 2025); Comments of Energy Transfer, *supra* note 75, at 17.
[116] Comments of United Association (ID: 31016), at 2 (Feb. 14, 2025).
[117] Comments of AXPC, *supra* note 14, at 4-5.
[118] Comments of Industry Trades, *supra* note 3, at 13.
[119] Kemal Sarica & Wallace Tyner, *Economic Impacts of Increased U.S. Exports of Natural Gas: An Energy System Perspective*, Energies, Vol. 9, Issue 6 (May 2016), https://www.researchgate.net/publication/303531193_Economic_Impacts_of_Increased_US_Exports_of_Natural_Gas_An_Energy_System_Perspective.
[120] Comments of Earthjustice *et al.* (ID: 3294), at 11 (Jan. 17, 2025).
[121] Comments of Venture Global, *supra* note 4, at 13; Comments of Cheniere, *supra* note 115, at 6.
[122] Comments of Venture Global, *supra* note 4, at 14.
[123] Comments of PAGE, *supra* note 59, at 7.

Friends of the Earth asserted that foreign investors are the true beneficiaries of U.S. LNG exports.[124] Alyssa Portaro stated, "LNG export projects are primarily designed to serve corporate and foreign market interests."[125] Earthjustice *et al.* stated that GDP is not a perfect measure of overall economic welfare, as it neglects important other factors.[126] LNG exports "may result in fluctuating prices,"[127] causing large bills for businesses and households. Earthjustice *et al.* further asserted that prioritizing natural gas may "impede the shift toward renewable energy sources"[128] and increased natural gas production might increase economic disparities between regions. Earthjustice *et al.* also recommended using additional measures of economic welfare.[129]

Response

In the Study, DOE indicated that one result of the configuration of NEMS "is that increases in energy production in response to LNG exports generally yield increases in GDP in the modeling framework."[130] With that qualification, DOE found that increased LNG exports led to increased GDP. Page S-29 of the Summary provides estimates of the cumulative increase in GDP with increasing U.S. LNG exports across scenarios. These estimates in increased GDP vary from $94 billion (discounted at 3% through 2050) for the Defined Policies High US Supply relative to the Existing/FID Exports High US Supply scenarios to $410 billion for the Defined Policies relative to the Existing/FID Exports scenarios with reference to U.S. supply assumptions.

DOE recognizes the additional modeling of GDP, including modeling conducted by Industrial Trades, indicates that GDP impacts may be larger than those estimated in the Study using NEMS. DOE does not find the 2016 analysis submitted by Earthjustice *et al.* suggesting a negative impact of LNG exports on GDP to be compelling as it was conducted before LNG exports had begun and uses an outdated view on the available natural gas supply in the U.S.

DOE acknowledges that GDP is one of several metrics that could be used to estimate the economic impact of increased U.S. LNG exports. The Study did not directly quantify estimates of the impact of increased exports on the trade balance or of changes in tax revenue or jobs resulting from increased LNG exports, but DOE acknowledges the comments addressing these issues.

DOE acknowledges that national GDP is only one measure of general welfare. Other metrics, such as incremental household energy burden, additional energy costs to industry, and sectoral GDP growth due to expanded natural gas production were included in the Study. Furthermore, a qualitative review of the economic impacts of LNG facilities may be found in Appendix D. Combined, the Study as well as comments received, provided multiple economic metrics to assess the effects of increased U.S. LNG export levels to address limitations of any single reported metric.

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[124] Friends of the Earth and Public Citizen, *Gassed Up: Trump Aims to Quickly Approve 14 Climate-Destroying Methane Gas Export Terminals, Enriching LNG Investors While Raising Prices for Americans* (ID: 3281), at 15 (Jan. 17, 2025), https://fossil.energy.gov/App/DocketIndex/Docket/DownloadFile/732.

[125] Comment of Alyssa Portaro (ID: 3312) (Jan. 17, 2025).

[126] Comments of Earthjustice *et al.*, *supra* note 120, at 13.

[127] *Id.*

[128] *Id.*

[129] *Id.*

[130] Summary Report, *supra* note 41, at S-5.

DOE concludes that increased LNG exports have a positive impact on GDP and have additional economic benefits that result from improving the balance of trade and increasing federal and state tax revenue.

e. Impacts to households

Comment Summary

Several commenters, including Delaware Riverkeeper Network (DRN), the Center for Coalfield Justice (CCJ), and the Pennsylvania Utility Law Project (PULP), as well as many individuals, expressed concern about the impact of potentially higher natural gas prices and resulting higher electricity prices on household expenditures, especially for low and middle-income households. The DRN noted:

> "[t]he Study shows gas prices for consumers here at home would increase with increased exports. Wholesale domestic natural gas prices could increase by over 30% if LNG exports are not constrained. Increased gas prices in turn would also increase the cost of domestically consumed electricity because so much natural gas is used to run the nation's electric generating stations. Additional knock-on impact would be felt in the costs of goods for consumers because higher manufacturing costs would be passed through."[131]

PULP recommended that "[t]o weigh consumer harm against increased gas production, … the Department [should] develop a distributional analysis of retail-level energy prices and energy burdens for residential and commercial customers when determining whether to approve new LNG export facilities."[132]

IECA also stated that current natural gas prices have already exceeded those found in the Study in 2050.[133] Members of Congress also expressed concern that increased LNG exports would raise costs for small businesses and industries that rely heavily on natural gas.[134]

Pat Rolston commented that "LNG exports projects will raise energy costs for American households, small businesses, and manufacturers…."[135] Michele Rizza stated that DOE's "recent analysis makes it pretty clear that exporting [LNG] … drives up energy prices for families…."[136] And Ashley Rowley stated, "The DOE study found that the prices could go up more than 30%, resulting in an increase of more than $100 on average annually per household. DOE must heed its own findings and protect families from increased energy costs."[137]

On the other hand, AXPC commented that the "2024 Report indicates an increase in energy burden (with increasing exports) of between 0.05% and 0.5% depending on U.S. region which is within the 0.5% margin of error in some of the data."[138] The group also stated, "HEIDM takes gas and electricity prices from NEMS and models the change on each income group. This in our view

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[131] Comments of Delaware Riverkeeper Network, *supra* note 27, at 2.
[132] Comments of Pennsylvania Utility Law Project (ID: 79921), at 3 (Mar. 20, 2025).
[133] Comments of IECA, *supra* note 84, at 2.
[134] Comments of Sen. Jeff Merkley *et al.* (ID: 3366), at 1 (Jan. 14, 2025).
[135] Comment of Pat Rolston (ID: 43187) (Jan. 3, 2025).
[136] Comment of Michele Rizza (ID: 78542) (Jan. 11, 2025).
[137] Comment of Ashley Rowley (ID: 79635), at 1 (Feb. 22, 2025).
[138] Comments of AXPC, *supra* note 14, at 9.

is a reasonable approach and gives a high-level overview of the impacts on each group."[139] Further, "[a]ny increase in electricity and [natural gas] prices would increase household energy burden. But the 2024 Report should consider the statistical significance of model outputs, contextualize the findings, and appropriately caveat these when discussing the results."[140]

Response

DOE acknowledges the concerns raised about the potential impact of higher natural gas and electricity prices on households and the potentially disproportionate impact on low-income households. The Study employed the HEIDM tool for the specific purpose of examining impacts by income class. DOE recognizes that the projected price increases in some regions may be as small as the margin of error of the analysis.

With respect to changes in the price of industrial inputs such as natural gas, DOE notes that the impact of any price changes on industrial inputs and thus the cost of other goods is uncertain in a dynamic economy over a period of 25 years, and current natural gas prices may not be reflective of the long-term equilibrium. In particular, the price impacts are projected to be greatest in 2050, which, as the most distant date, has the greatest uncertainty in the Study period, therefore diminishing in utility.

DOE judges that impacts on household and industrial energy expenditures, which may be as small as the margin of error of the analysis, to be insufficient to overcome the other economic benefits associated with increased LNG exports, including GDP, balance of trade, tax revenue, and employment effects.

f. Job and employment effects

Comment Summary

Many commenters highlighted the contribution of LNG exports to jobs and income. Citing a study by S&P Global, the United Association stated that "[s]pecifically, LNG is expected to support an annual average of 495,373 jobs, providing over $560.5 billion in wages between 2025 and 2040."[141] PAGE stated that exports supported 222,450 jobs and directly or indirectly contributed $43.8 billion to U.S. GDP.[142] The National Association of Manufacturers (NAM), citing its own study, estimated that LNG exports could support 500,000 to 900,000 jobs by 2044, generating $59–104 billion in wage income.[143] The Louisiana Oil & Gas Association commented that construction of the three terminals in Louisiana created 17,000 jobs, over $1.2 billion in labor income, and $1.5 billion in GDP.[144] Industry Trades cited a study by the Perryman Group finding that "the construction and pre-operation phases of the proposed facilities alone are projected to

[139] *Id.* at 8.
[140] *Id.* at 9.
[141] Comments of United Association, *supra* note 116, at 2 (quoting S&P Global, *Major News for US Industry at a Crossroads: A US LNG Impact Study—Phase 1*).
[142] Comments of PAGE, *supra* note 59, at 3.
[143] Comments of NAM (ID: 79793), at 2-3 (Mar. 10, 2025).
[144] Comments of Louisiana Oil & Gas Association, (ID: 80126), at 1 (Mar. 18, 2025).

generate $4.4 billion in Louisiana and Texas state tax revenues and $3.8 billion for local taxing entities."[145]

Commenters also discussed the distribution of jobs. While Clean Air Council highlighted a quote in the Study[146] that many jobs may not go to local workers, NAM asserted that "DOE makes the bald assertion that there is insufficient job creation in the local communities where the LNG export industry operates"[147] while noting that additional research is needed. NAM further states that "there is readily available information on the positive impacts the U.S. LNG export industry has had on its local communities, including on the websites of each major U.S. LNG exporter currently in operation."[148]

Response

The Study did not quantify job or wage revenues attributable to the construction and operation of LNG facilities. DOE notes that several commenters provided quantitative estimates of the positive effects of U.S. LNG exports on employment and wages. While Appendix D of the Study provided a literature review on local impacts of U.S. LNG exports, DOE acknowledges that determining whether jobs go to local residents may be challenging to quantify, and notes that commenters such as NAM and Industry Trades provided details and references assessing the local impacts of LNG export facilities.[149]

Based on the balance of information provided by commenters, DOE concludes that increased LNG exports support increased jobs and related investment in the oil and gas and construction sectors.

g. NEMS model infrastructure response

Comment Summary

Commenters raised concerns that the projected regional natural gas price differences were unrealistically large. Citing Appendix B, AXPC commented that in 2050 the natural gas price difference between the East and the Gulf Coast regions ranged from $1.4/MMBtu in the High U.S. Supply Case, $2.1/MMBtu Model Resolved Case to $4.2/MMBtu in the Low U.S. Supply Case. AXPC asserts that, historically, such large basis differentials would stimulate additional infrastructure that would mitigate price differences.[150] Similarly, AXPC and EQT more generally suggested that domestic prices should reflect their low-cost East Coast supply, as does RFF, which asserts that "[t]he US supply response to gas export demand comes disproportionately from basins with low estimated methane leak rates, led by Appalachia."[151] However, in the Baker Institute report "Scenarios for Global Natural Gas Markets to 2050" submitted by Sempra and Port

[145] Comments of Industry Trades, *supra* note 3, at 34-35 (citing The Perryman Group, *The Potential Economic and Fiscal Impact of Planned LNG Facilities Along the Texas and Louisiana Gulf Coast*, at 11 (Mar. 2025). For a list of facilities included in this study, *see id.* at 2).
[146] Comments of Clean Air Council, *supra* note 98, at 6 (quoting Summary Report at S-8).
[147] Comments of NAM, *supra* note 143, at 3.
[148] *Id.* (footnote deleted).
[149] *Id.*; Comments of Industry Trades, *supra* note 3, at 34-35.
[150] Comments of AXPC, *supra* note 14, at 9-10.
[151] Brian C. Prest (c/o Resources for the Future), *Where Does the Marginal Methane Molecule Come From? Implications of LNG Exports for US Natural Gas Supply and Methane Emissions* (working paper), at ii (Mar. 2025), https://media.rff.org/documents/WP_25-05_rZCBTY7.pdf.

Arthur, by 2050, almost 70% of incremental growth in natural gas production occurred in the Permian Basin.[152]

Response

Appendix B notes that, for the purposes of the Study, LNG terminals were modeled as being located in Texas and Louisiana, with most of the incremental gas supplied from the close onshore supply regions, including the Gulf Coast and Southwest.[153] With additional pipeline infrastructure, economic theory suggests more natural gas would flow between regions and prices would rise in the East and decline in the Southwest. However, it is difficult to build pipeline infrastructure, and interstate pipelines are subject to a variety of non-economic factors. As the S&P report states,

> "Expansions within states, not subject to U.S. federal permitting jurisdiction, have occurred in a largely timely manner, unlocking the Haynesville and Permian resources and enabling the development of the gas export sector to date. However, pipeline expansions crossing state boundaries, subject to federal jurisdiction, have often faced delays, discouraging even potentially highly economic pipeline projects."[154]

NEMS includes a simplified pipeline capacity expansion representation;[155] however, it does not necessarily equilibrate prices across supply regions. DOE acknowledges that in the Study, differentials between supply regions grow throughout the forecast, and it is uncertain whether sufficient infrastructure could be built to mitigate regional price differences, but that market signals would likely exist to help support such activity. Further, DOE finds that if interregional pipeline connections were constructed more efficiently, regional price differences would likely decrease. For example, the S&P report found that increasing pipeline capacity to allow additional gas flow out of the Appalachian basin was associated with price decreases at the Henry Hub.[156]

DOE finds that, to the extent additional interstate pipeline infrastructure is constructed to provide access to lower cost resources, the Henry Hub price impacts would be less than those modeled in the study.

h. Study design and presentation

Comment Summary

Commenters had concerns about the Study and its presentation design. AXPC stated that reporting prices to the nearest cent adds a level of accuracy that may not be warranted.[157] AXPC proposed that the Study's analysis should focus on the high-level trends rather than the precise figures.[158] Industry Trades argued that focusing the discussion on the natural gas price impact

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[152] Comments of Sempra and Port Arthur, *supra* note 1 (referencing the Baker Institute Report "Scenarios for Global Natural Gas Markets to 2050" at 14).

[153] Appendix B at B-17, https://www.energy.gov/sites/default/files/2024-12/LNGUpdate_AppendixB_Dec2024.pdf.

[154] S&P Commodity Insights and Market Intelligence, *Major New US Industry at a Crossroads: A US LNG Impact Study - Phase 2*, at 27 (Mar. 2025).

[155] Energy Info. Admin., Natural Gas Market Module of the National Energy Modeling System: Model Documentation 2022, at 36 (Aug. 2022), https://www.eia.gov/outlooks/aeo/nems/documentation/ngmm/pdf/ngmm(2022).pdf.

[156] S&P Commodity Insights and Market Intelligence, supra note 154, at 27-29.

[157] *Id.*

[158] *Id.*

outcomes associated with higher levels of U.S. LNG exports using data for 2050 did not give a range of outcomes for policy-makers to consider.[159]

Industry Trades also asserted that the "Low Supply" scenario was unrealistic, claiming that "the overwhelming consensus from many studies conducted over an extended period of time is that the U.S. has abundant low-cost resources. Therefore, this scenario should be disregarded as being unrealistic and unsupported."[160]

Response

Regarding comments on the expressed precision of the results, as a modeling exercise, the Study was intended to be consistent with EIA output and highlight comparison between scenarios by expressing currency with dollars and cents.

Regarding criticism on the likelihood of the "Low Supply" scenario, this scenario is not intended to reflect a projection of future conditions but rather explore the effects on markets if natural gas supply is lower than the reference levels. The likelihood of any scenario was not considered within the Study. Including a low supply scenario along with a high supply scenario is also consistent with EIA's modeling approach of Low and High oil supply cases. Per EIA, "[t]hese cases [Low and High oil and gas supply] do not represent a confidence interval for future domestic oil and natural gas supply, but rather they provide a framework to examine the effects of higher and lower domestic supply on energy demand, imports, and prices."[161] DOE finds that the Study reasonably sought to be consistent with EIA's output, including high and low oil and gas supply cases.

4. Consequential GHG Analysis of U.S. LNG Exports

a. GHG emission factors

Comment Summary

Various commenters suggested that the bottom-up derived GHG emissions levels and intensities associated with producing natural gas and/or LNG used in the Study (and from a recently published NETL baseline study of natural gas[162]) were either higher or lower than those reported by other sources. In particular, various comments specifically referred to past work from Dr. Howarth[163] and separately a paper by Dr. Sherwin *et al.*[164] comparing LNG to coal, and to top-down—*i.e.*, aerial or satellite survey based—estimates of methane emissions near natural gas

[159] Comments of Industry Trades, *supra* note 3, at 13.

[160] NERA, *Analysis of the U.S. Department of Energy's Liquefied Natural Gas Study ("Energy, Economic, and Environmental Assessment of U.S. LNG Exports")*, at 41 (Mar. 18, 2025) (in Comments of Industry Trades, *supra* note 3).

[161] EIA, *Assumptions to AEO 2023*, *supra* note 113, at 19.

[162] Harshvardhan Khutal *et al.*, c/o Nat'l Energy Tech. Lab., *Life Cycle Analysis of Natural Gas Extraction and Power Generation: U.S. 2020 Emissions Profile*, https://www.netl.doe.gov/projects/files/LifeCycleAnalysisofNaturalGasExtractionandPowerGenerationUS2020EmissionsProfile_012425.pdf.

[163] R.W. Howarth, *The greenhouse gas footprint of liquefied natural gas (LNG) exported from the United States*, Energy Science & Engineering, Vol. 12, Issue 11 (Nov. 2024), *available at* https://scijournals.onlinelibrary.wiley.com/doi/epdf/10.1002/ese3.1934.

[164] Evan D. Sherwin *et al.*, *US Oil and Gas System Emissions from Nearly One Million Aerial Site Measurements*, Nature 627 (Mar. 13, 2024), https://doi.org/10.1038/s41586-024-07117-5.

producing regions that report rates of methane emissions several times higher than those used for the U.S. in the Study.

For example, Clean Air Council[165] stated that

> "[i]t is largely known that actual upstream methane leakage rates are higher than industry-reported rates. A frequently-cited study[166] by Dr. Robert Howarth used a 2.8% leakage rate and empirical satellite measurements of major oil and gas basins in the United States found methane loss rates between 0.9% and 7.9%. The Study instead assumed a baseline upstream methane leakage rate of 0.56%. Actual GHG emissions from LNG that can be attributed to upstream sources will likely be higher than what DOE concluded."

Similarly, CATF said that "[t]he consequential [LCA] and the underlying LCA assume a 0.54% leak rate for natural gas production, gathering, processing, and transmission and storage. This parameter badly underestimates the national average leak rate for natural gas systems and wholly understates emissions from large gas-producing basins such as the Permian."[167]

Commenters also suggested that the GHG emissions, along with the intensities of the natural gas and/or LNG supply chain, were higher than warranted when compared with other studies. For example, AXPC commented:

> "A recent peer-reviewed study using Cheniere's proprietary LCA model offers an important benchmark. This study, which relied on GHGRP data and similar U.S. supply chain assumptions . . . estimated the 2022 U.S. average life cycle emissions intensity for the production-through-transmission network at . . . [a value of 7.76 g CO_2e/MJ, which is] . . . 10% lower than NETL's 2020 estimate of 8.63 g CO_2e/MJ, indicating that emissions intensity may already be declining."[168]

In addition to general comments about the GHG emissions and/or intensity being lower or higher than expected, additional comments specifically suggested that the emissions associated with ocean shipping are lower than estimates presented in other literature. Specifically, DRN commented that "[t]he Study also does not meaningfully address the methane slippage from tankers carrying LNG overseas[, and i]nstead of incorporating, or even acknowledging, recent studies showing that tanker engines emit far more methane than previously understood, the Study relies on outdated estimates from a 2019 study."[169]

Response

Top-down GHG studies of oil and gas production basins that use aerial surveys and satellite measurements of methane releases generally assign emissions to combined oil and gas products

[165] Comments of Clean Air Council, *supra* note 98, at 6.
[166] *See supra* note 163.
[167] Comments of Clean Air Task Force, *supra* note 69, at 1.
[168] Comments of AXPC, *supra* note 14, at 13.
[169] Comments of Delaware Riverkeeper Network, *supra* note 27, at 3.

and estimate higher emissions than the bottom-up estimates used in this Study.[170,171,172,173,174,175] While one could conclude from these studies that bottom-up inventories might be missing some of the total emissions, there is no generally accepted scientific methodology to apportion these emissions specifically to natural gas production. The Howarth study[176] referenced by commenters, in part, estimates higher life cycle emissions of LNG due to its use of top-down methane measurements for upstream natural gas.

In some cases, these top-down measured emissions are in areas with very little oil production and so the methane emissions can be reasonably assigned wholly to natural gas production (the focus of this analysis). This is the case in the Appalachian basin, which shows top-down measurements of 0.4[177]-0.6%,[178] similar to the confidence interval from the latest NETL bottom-up study[179] (0.3-0.54%) and this Study.

In others, like the Permian Basin, the regions can contain a high share of wells that produce both oil and gas. The methane emissions from this combined production need to be allocated between both products. Section 9 of the NETL Natural Gas Report for 2020[180] graphically compares these studies for five U.S. basins.

Standard LCA practice is to create unit processes using site level data, which requires measurements to be made and assigned at the site level.[181] The top-down studies currently available have not done this allocation at a site level. Allocation performed at any higher level of aggregation (*e.g.*, basin-level, energy-based allocation) could potentially allocate basin-level emissions from what would be considered oil wells with little to no gas production to natural gas under the assumption that methane emissions are proportional to the ratio of oil and natural gas production within a basin. This is true in basins that only produce one product but not true for basins that produce both oil and natural gas. Researchers from the University of Texas at Austin

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[170] Sherwin *et al.*, *supra* note 164.

[171] Z.R. Barkley *et al.*, *Quantifying Methane Emissions from Natural Gas Production in North-Eastern Pennsylvania*, Atmospheric Chemistry and Physics, Vol. 17, Issue 22 (Nov. 23, 2017), https://doi.org/10.5194/acp-17-13941-2017.

[172] Yuzhong Zhang *et al.*, *Quantifying Methane Emissions from the Largest Oil-Producing Basin in the United States from Space*, Science Advances, Vol. 6, Issue 17 (Apr. 22, 2020), https://doi.org/10.1126/sciadv.aaz5120.

[173] J. Peischl *et al.*, *Quantifying Methane and Ethane Emissions to the Atmosphere From Central and Western U.S. Oil and Natural Gas Production Regions*, Journal of Geophysical Research: Atmospheres, Vol. 123, Issue 14 (July 2, 2018), https://doi.org/10.1029/2018JD028622.

[174] Xiao Lu *et al.*, *Observation-Derived 2010-2019 Trends in Methane Emissions and Intensities from US Oil and Gas Fields Tied to Activity Metrics*, Proceedings of the National Academy of Sciences, Vol. 120, Issue 17 (Apr. 17, 2023), https://doi.org/10.1073/pnas.2217900120.

[175] Oliver Schneising *et al.*, *Remote Sensing of Methane Leakage from Natural Gas and Petroleum Systems Revisited*, Atmospheric Chemistry and Physics, Vol. 20, Issue 15 (Aug. 3, 2020), https://doi.org/10.5194/acp-20-9169-2020.

[176] Howarth, *supra* note 163.

[177] Barkley *et al.*, *supra* note 171.

[178] Sherwin *et al.*, *supra* note 164.

[179] *See supra* note 162.

[180] *Id.*

[181] ISO Standard 14044:2006, Environmental Management - Life Cycle Assessment - Requirements and guidelines (International Organization for Standardization, 2006), https://www.iso.org/standard/38498.html (last accessed May 19, 2025).

and Northwestern University evaluated the impact of allocation choice on basin-level methane emissions in the U.S. and determined, based on the characteristics of the ratio of products produced within the basin, that applying a generic basin-wide energy allocation scheme introduces up to 25% error from incorrect allocation to each product.[182]

Despite the challenges in directly comparing the results of bottom-up estimates with top-down estimates, the LNG Study contains a sensitivity analysis in Appendix C, page C-36, "Sensitivity Analysis 1: Upstream Methane Emissions Intensity," that provides results under varying levels of methane emissions associated with natural gas production, which shows very little effect: less than 2% change in the consequential GHG intensity as reported in Table 29 of Appendix C.

Additionally, literature specifically related to emissions associated with ocean shipping continues to evolve. Recent peer reviewed research by the Queen Mary University of London[183] and the University of Texas at Austin[184] demonstrates the variability in ocean shipping emissions based on the type and engine design of the ship. Results demonstrate both higher and lower emissions based on different vessel characteristics. Shipping emissions were modeled within GCAM based on the change in intensity of international ocean shipping demand and not directly modeled from port of export to port of import based on specific product commodities. GHG emissions modeling parameters associated with ocean shipping were not modified due to the non-product specific modeling design of international ocean shipping within GCAM.

DOE finds that the GHG emission factors used in the analysis were derived using a sound methodology using the best available information to represent U.S. national average emissions for natural gas production at the time the Study was conducted. Ultimately, given the wide-range of data and literature reviewed on this subject, DOE is comfortable with its findings and is further persuaded of its current path forward.

b. Methodology

Comment Summary

Commenters remarked on several aspects of the methodology associated with accounting for future emissions reductions when forecasting future emissions intensity of natural gas, the choice of average versus marginal GHG emission profiles for upstream natural gas production, and the lack of uncertainty and sensitivity modeling. For example, several commenters noted that industry participation in methane mitigation efforts are expanding, and that satellite-based measurements

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[182] Qining Chen Jennifer B. Dunn, and David T. Allen, *Allocation and aggregation of greenhouse gas emissions in oil and gas production from shale resources: Implications for life-cycle greenhouse gas burdens*, ACS Sustainable Chemistry & Engineering, Vol. 7 (2019), https://par.nsf.gov/servlets/purl/10430726.

[183] Paul Balcombe, Dalia A. Heggo, and Matthew Harrison, *Total Methane and CO_2 Emissions from Liquefied Natural Gas Carrier Ships: The First Primary Measurements*, Environmental Science & Technology, Vol. 56, Issue 13 (2022), https://pubs.acs.org/doi/epdf/10.1021/acs.est.2c01383?ref=article_openPDF.

[184] Kirsten Rosselot *et al.*, *Simulating the Variability of Methane and CO_2 Emissions from Liquefied Natural Gas Shipping: A Time-in-Mode and Carrier Technology Approach*, ACS Sustainable Chemistry & Engineering, Vol. 11, Issue 43 (Oct. 19, 2023), https://pubs.acs.org/doi/10.1021/acssuschemeng.3c04269.

show methane reductions over time. The effect of these ongoing and future reductions would be to further reduce the GHG intensity of natural gas (and LNG) production in the future.

Specifically, a comment from AXPC stated,

> "In recent years, industry participation in voluntary methane reduction initiatives has expanded, improving measurement, reporting, and mitigation strategies… 90% of AXPC members have quantitative emission reduction goals tied to corporate compensation. 100% of AXPC members have a commitment to end routine flaring by 2030 or have already eliminated the practice from their operations. The Clean Air Task Force estimated in a 2024 report that the U.S. upstream industry had reduced its NGSI Methane Intensity by 57% since 2015… The Final New Source Performance Standards (NSPS) and Emissions Guidelines (EG) under 40 CFR part 60 subparts OOOOb and OOOOc [promulgated by the U.S. Environmental Protection Agency] are projected to reduce 58 million short tons of methane emissions from 2024 to 2038 . . . Satellite-based methane observations from oil and gas production regions in North America indicate a steady decline in methane emissions intensity from 2010 to 2019 . . . U.S. average methane emissions intensity fell 0.13% per year, decreasing from 3.7% in 2010 to 2.5% in 2019."[185]

Similarly, Industry Trades commented, "the Study uses an unsupportable assumption regarding future emissions intensity, *i.e.*, the study unreasonably assumes that U.S. LNG emissions intensity will not decrease over time."[186]

On the choice of average versus marginal natural gas GHG emissions profiles, a commenter noted that the representation and modeling of natural gas should be considered on a marginal rather than an average basis, given the differences in methane leakage rates among high-supply oil and gas regions. With respect to the upstream methane leakage rate used centrally in the Study, RFF stated that "[t]he appropriate value would take into account the economics of oil and gas markets and reflect the marginal source of gas supply that rises to meet increased LNG export demand. The Permian basin is primarily an oil play, and the 'associated' gas that comes out of the ground with the oil is not the main reason operators drill those wells. An RFF working paper . . . finds that gas export demand is likely to be met primarily by low-leak Appalachian supply (followed by the Haynesville shale), but very little of it will likely be met by higher gas production in the high-leak, oil-focused Permian basin."[187]

With respect to the lack of uncertainty and sensitivity modeling, several commenters suggested that various aspects of the presentation of life cycle GHG intensity results and the consequential analysis should have been presented with improved consideration of uncertainty. For example, according to another comment from AXPC,

> "The uncertainty range in life cycle emissions intensity is just as important as the central estimate and should be considered when the results are employed. The 2024 Report Appendix C uses only the central estimate from the NETL Report. This ignores uncertainty in the project direct GHG emissions, which has implications for the overall consequential

[185] Comments of AXPC, *supra* note 14, at 13.
[186] Comments of Industry Trades, *supra* note 3, at 27.
[187] Comments of RFF, *supra* note 32, at 2.

emissions…Any users of these estimates should ensure that the characterization of uncertainty fits their goals and that the uncertainty is incorporated into their analyses…Incorporating the published uncertainty range from NETL into the overall project direct emissions calculated results in a range of 11 to 19 g CO_2e/MJ on a 100-yr GWP basis. This means the 'true' average U.S. LNG emissions intensity could fall anywhere within this range. Further, when considering uncertainty in the U.S. production through transmission supply chain emissions, several 'breakeven emission intensities' overlap with the 95% [confidence interval]. This indicates in some scenarios that consequential emissions intensity could be net negative, meaning a global decrease in emissions relative to the reference case. The uncertainty range is just as important as the central estimate in interpreting results."[188]

Response

With respect to comments regarding future LNG-linked emissions being lower than present levels, DOE notes that the 2024 LNG Export Study incorporated reductions in global natural gas production methane intensity within GCAM using marginal abatement cost curves to model mitigation technology deployment.[189] Within GCAM, the model applied methane emissions reduction based on the applicable policy scenario.

The GCAM model does not differentiate where specific sources of natural gas ultimately end up in the U.S. market—domestic use, LNG export, or otherwise. Therefore, the use of the U.S. average in terms of the consequential analysis is justified and ultimately represents the variety of ways natural gas is produced in the U.S. When evaluating a specific project, the specific source of natural gas for LNG exports should be known and accounted for, to the extent possible. Examples were provided in the report of how a project with higher or lower emissions from upstream natural gas might be evaluated to account for project specific differences -- see Appendix C, page C-25, Step 9: Add Project Direct Emissions to Project Non-Direct Emissions to Determine Individual Project GHG Emissions Intensity Inclusive of Consequential Market Effects.

DOE acknowledges that a marginal versus average representation could lead to different GHG intensities given the differences in methane leakage rates. However, in line with the sensitivity analysis on upstream methane leakage provided in the Study, the net effect on the consequential GHG intensity would be expected to be small when comparing results across scenarios.

Regarding the lack of uncertainty and sensitivity modeling in the Study, DOE acknowledges that including the 95% confidence intervals (or some other range of values) in the upstream natural gas intensity, as well as potentially the liquefaction emissions estimates, in the project direct emissions calculation, could improve understanding of the (range of) life cycle and consequential emissions identified in the Study. As noted by the commenters, DOE, in past work assessing the natural gas supply chain, has shown uncertainty ranges for key emissions results, such as the GHG intensity of upstream natural gas. In the Study, only the mean emissions estimates were used. The Foreword in the Study Summary Report on page S-v and each Appendix provides the

[188] Comments of AXPC, *supra* note 14, at 10-11.

[189] *See* GCAM on-line documentation, https://jgcri.github.io/gcam-doc/emissions.html (last accessed May 19, 2025).

following statement that modeling of uncertainty for each scenario was beyond the scope of this Study:

> "The scenarios explored in this study span a range of U.S. LNG export outcomes. Each scenario relies on input assumptions regarding many domestic, international, economic, and non-economic factors, such as future socioeconomic development, technology and resource availability, technological advancement, and institutional change. A full uncertainty analysis encompassing all underlying factors is beyond the scope of this study."

Analysis of the sensitivity of results to variation in natural gas production methane emissions intensity and liquefaction plant emissions representation were included in the Study at pages C-36 through C-38 of Appendix C (Results section). DOE acknowledges that additional sensitivity analysis on other modeling parameters could have been performed to assess model results interpretation. However, upstream natural gas methane intensity and liquefaction GHG emissions intensity are the two primary sensitivities as it relates to potential increases in U.S. LNG exports GHG intensity and both were analyzed as part of the study.

Given the recognition of uncertainty and the inclusion of primary sensitivities within the Study, DOE concludes that the methodology used for the consequential LCA is robust and appropriate for conducting a global consequential life cycle assessment. However, while the consequential LCA was important for the Study, DOE does not expect to use the consequential LCA results in its review of pending or future non-FTA applications.

c. Report documentation

Comment Summary

Several commenters expressed a desire for the results associated with the Study to be made in a more accessible format or in more detail than provided in the published Study.

Robert Kleinberg said the following:

> "I recommend that if this report is to be relied on to inform policy in the future, a supplement should be issued with granular data showing exactly how greenhouse gas emissions change over time for the various energy sources. Moreover, carbon dioxide equivalent reporting should be avoided to the maximum extent possible. Instead, individual greenhouse gas-specific emission forecasts should be tabulated."[190]

CATF stated that:

> "[T]he cumulative consequential GHG emissions intensity for LNG exports ranges from 1.2 to 12.6 g CO_2e/MJ (6.3 g CO_2e/MJ in the central "Defined Policies: Model Resolved – Existing/FID Exports" case). The reduction from 76 to 6.3 g CO_2e/MJ is significant (a 92% decrease), but the report text does not quantitatively describe the specific reductions that lead to this decrease… Moreover, it is vitally important that DOE makes this important

[190] Comment of R.L. Kleinberg, *supra* note 68, at 1.

result transparent and understandable, so it is critical that the drivers of this decrease are quantitatively documented in the report."[191]

CATF also stated that "[t]his rough analysis implies that a consequential analysis should result in at most a 72% lower intensity (21 g CO_2e/MJ, rather than 76 g CO_2e/MJ) compared to the attributional analysis (even given the erroneously low leak rate that DOE assumes for natural gas, as described above)," and that "the 92% drop from 76 to 6.3 g CO_2e/MJ [therefore] appears to be unwarranted."[192]

Response

DOE notes that a large volume of data was presented as results from this Study and that the Study provided results in a readable format (*i.e.*, ability to copy text and tables) to enhance public access to the reported results. DOE also acknowledges commenters' points on preference for additional details about underlying modeling results. The Study results are provided at the level of resolution (detail) that aligns to the purpose of the study (global consequences of changes in U.S. LNG export levels) to support interpretation of scenario results.

DOE acknowledges CATF's comment to mix full life cycle attributional style study results, as reported in DOE's 2019 LCA Update, with the consequential style study results presented here within the 2024 LNG Export Study. Appendix C, pages C-4 and C-5, describes the differences and limitations of each type of life cycle assessment, attributional and consequential. Page C-5 specifically remarks the following:

> "A trade-off of the consequential modeling approach used in this study is a reduction in attribution for specific source-to-consumption pathways, as previously modeled and used by DOE. Therefore, as a result of the consequential life cycle modeling approach, this study does not present comparative results of natural gas compared to coal for production of a MWh of electricity, or other direct source-to-consumption pathways."

Appendix C describes the approach for integrating natural gas production and liquefaction project specific data with the broader consequential modeling results to avoid double counting of emissions. This is a novel process and recognizes the challenge commenters had in attempting to mix attributional and consequential study results together from the previous 2019 LCA Update with the current Study. Table 35 in Appendix C was created to help connect the positive and negative sources of emissions, including project direct and non-direct emissions, as well as substitution effects, modeled to illuminate the difference in attributional and consequential modeling results using one hypothetical natural gas combined cycle (NGCC) without carbon capture and sequestration (CCS) as the end use application for the imported natural gas.

DOE finds the level of documentation appropriate and reasonable for the Study purpose and agrees with CATF's comment that attributional and consequential LCA results should not be directly compared as they each provide insights to different Study purposes.

[191] Comments of Clean Air Task Force, *supra* note 69, at 3.
[192] *Id.* at 4.

d. Reporting metrics

Comment Summary

Comments were received on both the choice of global warming potential (GWP) time horizon as the Study basis for reporting GHG emissions on a carbon dioxide equivalent (CO_2e) basis, and on the methodology for reporting social cost of GHGs.[193]

Commenters raised concerns about the choice of 100-year time horizon GWP values used as the basis for results interpretation in the Study Summary Report and the Appendices. Commenters recommended that the 20-year GWP should have been used to recognize the near-term global warming contribution of methane. For example, DRN commented that "[GHG] life cycle assessments should use [a] 20-year horizon rather than a 100-year horizon in order to accurately capture methane's warming power."[194] Similarly, the Evergreen Collaborative commented that "DOE should use a 20-year Global Warming Potential (GWP) for methane and apply the precautionary principle when evaluating climate pollution data – meaning that it should determine that more LNG export authorizations are not in the public interest."[195]

Comments on the methodology for calculating the social cost of GHGs varied from supportive of the inclusion of the metric to concerns regarding the applicable discount rate used when monetizing climate damages. Abuin and Stock provided supportive feedback, remarking that "[t]he use of the ratio of the Social Cost of Methane to the Social Cost of Carbon as a method to compute CO_2-equivalents is warranted, based on the best scientific literature, and a significant improvement over using arbitrary 20, 50, or 100 year Global Warming Potentials."[196] In contrast, DRN commented that "[t]he Study should use a low discount rate, such as 1.5% or lower, to address the value of ecological diversity and more effectively account for the [Environmental Protection Agency's] underestimation of the SCGHG."[197] The Center for Environmental Accountability also commented,

> "The LNG Export Study does not contextualize the inherent uncertainty surrounding its SCC calculations. Its failure to do so leaves the public with the impression that LNG will result in tens of billions of dollars of damages from climate change. The DOE should withdraw the study and must not allow the [social cost of carbon's] methodological flaws to inform whether LNG exports are consistent with the public interest."[198]

Response

DOE used the 100-year methane GWP of 29.8, as set forth in the IPCC's Sixth Assessment Report (or AR6),[199] as the primary GWP reporting metric, as defined in Appendix C-2. DOE also

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[193] Both methods were outlined in Appendix C. *See* Appendix C: Consequential Greenhouse Gas Analysis of U.S. LNG Exports, at C-25 to C-28 (Dec. 2024), https://www.energy.gov/sites/default/files/2024-12/LNGUpdate_AppendixC_Dec2024.pdf.

[194] Comments of Delaware Riverkeeper Network, *supra* note 27, at 10.

[195] Comments of Evergreen Collaborative (ID: 47857), at 9 (Jan. 15, 2025).

[196] Comments of Abuin and Stock, *supra* note 42, at 5.

[197] Comments of Delaware Riverkeeper Network, *supra* note 27, at 11.

[198] Comments of the Center for Environmental Accountability, *supra* note 5, at 36.

[199] IPCC, *Climate Change 2021: The Physical Science Basis*, Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, available at https://www.ipcc.ch/report/ar6/wg1/.

provided all scenario results in AR6 20-year time horizon in Appendix C-4. The choice of primary reporting metric is consistent with the current consensus of the international scientific and policy communities.

For example, the United Nations Framework Convention on Climate Change (UNFCCC)[200] declared by decision in January 2014 that "from 2015 until a further decision is adopted by the Conference of the Parties, the [GWP] values used by Parties [in country level reporting of GHGs should be]…based on the effects of [GHGs] over a 100-year time horizon, as contained in annex III."[201] The IPCC established in its First Assessment Report in 1990 the calculation of the GWP on a 100-year time horizon and established itself as the most common used metric in LCA.[202,203] The U.S. Environmental Protection Agency further acknowledges the use of the IPCC's use of global warming potentials and the common use of 100-year time horizon for reporting.[204] This is further evidenced by the U.S. EPA's application of the 100-year time horizon for reporting GHGs in the Greenhouse Gas Reporting Program (GHGRP)[205] and the Greenhouse Gas Inventory (GHGI)[206] submitted to the UNFCCC each year.

In 2022, the National Academy of Sciences issued a report[207] summarizing a scientific consensus process that occurred from 2014 to 2016 and focused on developing consensus-based metrics for use in LCAs for climate change. The report found that the international consensus-finding workshop recommended the use of two different indicators in parallel: GWP for 100 years (GWP100) for shorter-term impacts and Global Temperature Potential (GTP) for 100 years for long-term impacts, including climate–carbon feedback for both.[208]

For very short-term impacts, another recommendation from the international consensus-finding workshop was to perform a sensitivity analysis using GWP for 20 years.[209]

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[200] United Nations Framework on Climate Convention, Reporting requirements, https://unfccc.int/process-and-meetings/transparency-and-reporting/reporting-and-review-under-the-convention/greenhouse-gas-inventories-annex-i-parties/reporting-requirements (last accessed May 19, 2025).

[201] United Nations Framework on Climate Convention, Decision 24/CP.19: Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention, https://unfccc.int/resource/docs/2013/cop19/eng/10a03.pdf#page=2 (last accessed May 19, 2025).

[202] National Academies of Sciences, Engineering, and Medicine, *Current Methods for Life-Cycle Analyses of Low-Carbon Transportation Fuels in the United States* (2022), available at https://nap.nationalacademies.org/read/26402/chapter/1.

[203] A. Levasseur *et al.*, *Greenhouse gas emissions and climate change impacts*, in R. Frischknecht and O. Jolliet, eds., *Global Guidance for Life Cycle Impact Assessment Indicators - Volume 1* (pp. 60–79): United Nations Environment Programme (Jan. 2017), available at https://www.researchgate.net/publication/319402340_Greenhouse_gas_emissions_and_climate_change_impacts.

[204] U.S. Environmental Protection Agency, Understanding Global Warming Potentials, www.epa.gov/ghgemissions/understanding-global-warming-potentials (last accessed May 19, 2025).

[205] U.S. Environmental Protection Agency, Greenhouse Gas Reporting Program (GHGRP), https://www.epa.gov/ghgreporting (last accessed May 19, 2025).

[206] U.S. Environmental Protection Agency, Inventory of U.S. Greenhouse Gas Emissions and Sinks, https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks (last accessed May 19, 2025).

[207] *See supra* note 202.

[208] *See id.*

[209] *See id.*

The LNG Study assessed GHG emissions from 2020 through 2050, a 31-year time period. This time horizon aligns with the international scientific community's recommendation to use 100-year GWP for reporting and to provide sensitivity analysis using 20-year GWP. This was accomplished within the DOE study by providing results for all scenarios in both 100-year and 20-year AR6 GWP values in Appendix C-4.

DOE acknowledges that the time horizon selected for reporting GHG emissions in terms of carbon dioxide equivalents using the International Panel for Climate Change (IPCC) global warming potential (GWP) values embodies a difference in the equivalence factor for methane from 29.8 for 100-year time horizon to 82.5 for 20-year time horizon. The difference in carbon dioxide equivalence for methane based on 100-year or 20-year GWP would change the total carbon dioxide equivalence magnitude reported. However, the overall resulting comparative difference between global scenario results may not be significant. For example, the difference in GHG emissions reported for the Defined Policies: Model Resolved (GCAM-NETL-Aligned, AR6-100 Basis), as reported in Table C-4.2, compared to the Defined Polices: Existing/FID Exports (GCAM-NETL-Aligned, AR6-100 Basis) in Table C-4.1 is an increase in +711 Tg CO_2e, AR6, 100-year. The same set of results are presented in 20-year time horizon (AR6-20 Basis) in Tables C-4.23 and Table C-4.22 report a change in GHG emissions of +718 Tg CO_2e, AR6-20 basis. The difference is +7 Tg CO_2e; less than 0.0005% change in comparative scenario results.

With respect to the social cost of GHG reporting metric, DOE notes that E.O. 14154[210] of January 20, 2025, *Unleashing American Energy*, disbanded the Interagency Working Group on the Social Cost of Greenhouse Gases (IWG) established under E.O. 13990.[211] E.O. 14154 states that any guidance, instruction, recommendation, or document issued by the IWG is withdrawn as no longer representative of governmental policy.[212] E.O. 14154 also directs agencies to "adhere to only the relevant legislated requirements for environmental considerations" and instructs the Environmental Protection Agency to issue guidance that includes consideration of eliminating the "social cost of carbon" calculation from any Federal permitting or regulatory decision.[213]

The SCC-GHG has not been used in the public interest determination of prior non-FTA adjudications. And while the SCC-GHG was useful for the development of the Study, DOE does not expect it to inform its public interest determination in pending or future non-FTA adjudications.

e. Project level application

Comment Summary

Several commenters suggested that the consequential GHG intensity of increased U.S. LNG production should not be used to evaluate individual projects.

For example, Cheniere stated,

> "Consequential LCA modeling is complex and should not be used for individual project permitting to determine the net GHG emissions intensity. The practical implementation of computing the consequential and attributional GHG intensity for permitting at the project

[210] 90 Fed. Reg. 8353.
[211] 86 Fed. Reg. 7037.
[212] E.O. 14154, § 6(b), 90 Fed. Reg. at 8356.
[213] *Id.* (§ 6(a)).

level is flawed for several reasons: namely, in the assumption that project non-direct emissions would be held constant, that project direct emissions can be reasonably estimated for a project ex-ante, and lack of guidance on which scenario or scenarios would form the reference and counterfactual case for a given project."[214]

Similarly, Venture Global "submits that the 'consequential' LCA provided in the 2024 Study is too speculative and too susceptible to questionable assumptions to be of any reliable use in future non-FTA authorization decisions."[215]

Response

DOE acknowledges that the initial creation of a consequentially-modeled result associated with review of LNG exports is a new addition to the literature. The demonstration of how to incorporate the results of this Study was intended as an example.

DOE does not expect to use the consequential results to review pending or new applications.

5. Energy Security

f. U.S LNG exports increase energy security of allies and trading partners

Comment Summary

A number of commenters emphasized that U.S. LNG exports promote energy security for American allies and trading partners. For example, Industry Trades believed that the Study did not assess energy security properly. Their comment stated that "[m]uch of the Study's Energy Security Considerations section fails to focus on the relevant aspects of why U.S. LNG exports fit squarely in the public interest."[216] Noting that "[s]upporting U.S. allies and trading partners is one of the primary benefits of increasing U.S. LNG exports," Industry Trades contended that, "[b]etween Europe's general rejection of Russian natural gas after Russia's invasion of Ukraine in 2022, and U.S. tensions with China, U.S. LNG exports are in a prime position to protect U.S. allies and trading partners from energy security concerns in the coming years."[217] PAGE commented that, "[u]ltimately, the war in Ukraine and the subsequent energy crisis proved that without U.S. LNG there can be no energy security in Europe," adding, "[t]o the contrary, the public interest requires continu[ing] LNG exports in order to ensure the continued geopolitical benefits for the U.S. energy security [sic] for our allies…."[218] In addition, LNG Allies stated:

> "The DOE Study highlights US LNG as a cost-competitive and stable energy source in the global market. We concur. The Study recognizes that destination flexibility—allowing offtakers to re-sell contracted cargoes—enhances global energy security…. For many users, this adaptability makes USLNG more valuable than LNG from other nations."[219]

[214] Comments of Cheniere, *supra* note 115, at 20.
[215] Comments of Venture Global, *supra* note 4, at 23.
[216] Comments of Industry Trades, *supra* note 3, at 18.
[217] *Id.* at 19 (internal citations omitted).
[218] Comments of PAGE, *supra* note 59, at 8.
[219] Comments of LNG Allies, *supra* note 86, at 9.

Response

DOE agrees that LNG exports from the United States contribute to global energy security. The 2024 LNG Study Summary Report provides support for this conclusion, stating:

> "As LNG re-gasification and associated import infrastructure is built out globally, increasing U.S. LNG exports could enhance global energy security. Most U.S. LNG contracts include a destination flexibility clause in which the buyer can deliver LNG to any destination, if it complies with DOE export authorizations and U.S. law. Accordingly, U.S. LNG goes to where the global market most demands it."[220]

g. Geopolitical power

Comment Summary

Several commenters highlighted the role U.S. LNG exports can play in geopolitics. Some felt that increasing exports risks ceding international power. For example, Heather Bryse-Harvey commented that the 2024 Study stated that "…future demand for natural gas and LNG is uncertain and the demand centers are expected to shift." Bryse-Harvey went on to criticize the prospect of exporting LNG to China, stating that, "[i]n this era of great competition with China, providing China with the energy it needs to fuel its industry and AI data centers is counter to the goals of the US government."[221] Similarly, Earth Justice *et al.* commented that the 2024 Study found that China could be a large receiving country for U.S. LNG exports in the future, stating that "China is now a very likely destination for U.S. LNG," and that "[t]he national security and trade benefits of exporting LNG to China compared to close U.S. allies like Europe, Japan, or South Korea are starkly different. Therefore, DOE should differentiate the expected national security and trade benefits of U.S. LNG exports based on the likely destinations."[222]

In contrast, the AXPC noted that the 2024 Study's Executive Summary implied that the U.S. would supply China with LNG in the future, despite only supplying about four percent of China's LNG imports in 2023.[223] Venture Global commented that it was inappropriate for DOE to assess the possible destinations of U.S. LNG exports: "[r]elated portions of the 2024 Study… expend considerable effort in attempting to analyze where in the world demand for U.S. LNG will come from in the future…. Speculation about the specific locations of future demand for LNG exports, however, is not a topic that should concern future DOE decisions regarding LNG export authorizations."[224]

Other commenters believed that LNG exports increase American geopolitical influence. Mexico Pacific Limited, for example, commented that "LNG exports strengthen U.S. geopolitical power and energy dominance, for they reduce global dependence on Russian and Middle Eastern gas, reinforcing American strategic influence over Europe and Asia…."[225] Mexico Pacific Limited also referred to and attached a study by S&P Global, which stated, "[t]he impact of US LNG exports goes beyond economic benefits. US LNG provides a new dimension of influence for the United

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[220] Summary Report, *supra* note 41, at S-43 (internal citation omitted).
[221] Comment of Heather Bryse-Harvey (ID: 72647) (Feb. 5, 2025).
[222] Comments of EarthJustice *et al.*, *supra* note 120, at 5.
[223] Comments of AXPC, *supra* note 14, at 1.
[224] Comments of Venture Global, *supra* note 4, at 16 (internal citation omitted).
[225] Comments of Mexico Pacific Limited, *supra* note 56, at 6.

States, supporting its geopolitical interests and influence globally."[226] Freeport LNG stated that U.S. LNG exports serve the public interest by enabling natural gas resources to be provided where they are needed, including to our allies without domestic energy supplies or in allied countries facing energy crises due to geopolitical events.[227]

Response

Geopolitical considerations are relevant in public interest determinations. One of DOE's long-standing principles is that the market is generally the most efficient means for allocating natural gas supplies. Therefore, DOE's non-FTA authorizations are destination flexible, as long as the destination is not prohibited by law or policy. As Freeport LNG pointed out, U.S. LNG exports enable natural gas resources to be provided where they are needed, as has been the case with the United States supplying the majority of Europe's LNG since the beginning of the war in Ukraine. Further, as Venture Global observes, the free market can be relied on to allocate LNG efficiently between sellers and buyers in the global market, rather than DOE attempting to divine future market patterns. Moreover, as Mexico Pacific Limited suggests, having a robust supply of natural gas and being the world leader in exports could act generally to increase U.S. influence. For these reasons, DOE considers the global energy security benefits from U.S. LNG exports to weigh favorably in public interest determinations for applications to export LNG to non-free trade agreement countries.

h. Future need for U.S. LNG to support European energy security

Comment Summary

Some commenters stated that energy security is no longer a factor supporting U.S. LNG exports because European demand for LNG is likely to decrease. For example, DRN stated that, "[c]ommitted to decarbonization through increased renewable power production, Europe is set to significantly lower its reliance on fossil gas imports, aligning its energy system with long term climate and energy security goals,"[228] citing the European Union's "Fit for 55" climate strategy and the "REPowerEU" plan to reduce reliance on Russian imports.[229] DRN added that expanded LNG exports from the United States would lead to an "[a]n oversupply of LNG" which would both render further U.S. exports not worth their purported negative impacts and "jeopardize[] energy security."[230] Irene Bean also commented that "Europe is the primary destination for US LNG [but] European policies are quickly shifting to reduce the usage of fossil fuels. Across all scenarios China will be the largest importer of US LNG by 2050."[231]

On the other hand, the American Consumer Institute for Citizen Research pointed out the following:

> "The Study also references Europe's legislation to phase out fossil fuels in favor of renewable energy and low-carbon gas. While LNG exports to Europe have slowed, newly elected leadership may alter or weaken green measures, especially in the face of

[226] *Id.* (citing S&P Global, *Major New Industry at a Crossroads: A US LNG Impact Study – Phase 1*).
[227] Comments of Freeport LNG. (ID: 79982), at 8 (Mar. 20, 2025).
[228] Comments of Delaware Riverkeeper Network, *supra* note 27, at 13.
[229] *Id.* at 16-17.
[230] *Id.* at 2.
[231] Comment of Irene Bean (ID: 79447) (Feb. 17, 2025).

skyrocketing electricity prices, energy insecurity and unreliability, and deindustrialization; many experts point to a rapid transition to renewable energy as the leading cause. The EU's need for inexpensive and reliable U.S. LNG could last longer than anticipated."[232]

Response

Regarding comments on the possible global oversupply of LNG, DOE has consistently taken the position that market forces will determine which (and how many) U.S. LNG export projects will ultimately be constructed and operate. Having authorization to build or operate a facility (from the Federal Energy Regulatory Commission and/or the U.S. Maritime Administration), let alone authorization to export LNG (from DOE), does not guarantee that any particular project will succeed. Furthermore, DOE has a decidedly limited role in assessing the market need for proposed natural gas or LNG exports.

Market conditions can change over time for numerous reasons, causing governments to adjust policy positions and private sector actors to alter strategies. It is therefore difficult to predict European LNG demand with certainty. DOE does note, however, the continuing concern about energy security for Europe and Central Asia, given the relative share of Russian natural gas supplies flowing into those regions until recently, along with heightened risk due to the now-expired volumes of Russian natural gas supply to Europe.[233]

To the extent that enhancing energy security for allies in Europe is a factor in DOE's public interest determination, DOE believes that, regardless of Europe's future natural gas consumption, a higher level of U.S. LNG exports will increase energy supplies globally *and* enhance energy security for all U.S. allies, whether in Europe or elsewhere. DOE does not therefore consider the exact level of future European demand for LNG to be a significant factor diminishing the weight it gives energy security considerations in public interest decisions.

i. Domestic energy security

Comment Summary

Some commenters stated that exporting LNG risks U.S. energy security by sending a key resource abroad rather than retaining it for domestic use. For example, AAEDA asserted that "[i]t is way past time for Congress to think in terms of U.S. energy security for decades, rather than accommodate the wishes of energy companies' short-term profits…."[234] In addition, IECA commented, under the heading of "LNG volumes under long-term contracts for up to 25 years decrease U.S. energy independence," that "[t]he LNG contracts guarantee physical natural gas molecules will exit the U.S., even if U.S. inventories are low and falling and prices are increasing, directly impacting reliability of natural gas and electricity and prices consumers [sic] nationwide."[235]

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[232] Comments of the American Consumer Institute (ID: 3755), at 6 (Feb. 10, 2025) (internal citations omitted).

[233] *Venture Global CP2 LNG, LLC*, Order No. 5264, Docket No. 21-131-LNG, Order Conditionally Granting Long-Term Authorization to Export Liquefied Natural Gas to Non-Free Trade Agreement Nations, at 44-45 (Mar. 19, 2025) (internal citations omitted).

[234] Comments of AAEDA, *supra* note 104, at 14.

[235] Comments of IECA, *supra* note 84, at 4.

Other commenters had the opposite opinion. For example, Industry Trades, in a comment section titled "U.S. LNG exports strengthen domestic energy security," faulted the Study's treatment of energy security, stating, "[a]dditional exports of U.S. LNG promote energy security globally and domestically. The Study overlooks the significance of these considerations…."[236] Industry Trades also stated, "Authorizing increased U.S. LNG exports to meet global demand benefits domestic energy security by incentivizing and ensuring development of a reliable, continuous supply of natural gas and the attendant transportation and other infrastructure. Strong natural gas exploration, production, and infrastructure building will serve the U.S. economy both for exports and for domestic use purposes."[237]

Response

In response to comments that exporting natural gas reduces the resource's availability for domestic use, DOE notes that market forces work to match supply and demand, such that enough natural gas would be produced to satisfy U.S. demand regardless of export levels, given the very large American resource base. In fact, this is a key finding of the 2024 Study: "[a]cross all scenarios, modeled U.S. domestic natural gas supply is sufficient to meet modeled global demand for U.S. LNG while continuing to meet domestic demand. This result holds across sensitivity scenarios on U.S. oil and gas supply."[238]

DOE also acknowledges comments that stronger emphasis could be placed on the domestic energy security benefits of increased natural gas production capacity that could be developed to serve export markets, even as it recognizes that the 2024 Study did not identify significant resource constraints or domestic energy security risks of increased LNG exports. In consideration of the above, DOE finds that the U.S. has sufficient supply in all scenarios examined, and that having a domestic industry in place poised to supply both U.S. and export demand for natural gas only strengthens domestic energy security, as the industry would be prepared to meet potential elevated domestic consumption as well as supply exports.

6. Addendum on Environmental and Community Effects of U.S. LNG Exports

Comment Summary

In addition to comments received on the three core analyses (Appendices A through C), DOE also received comments on the Addendum on Environmental and Community Effects of U.S. LNG Exports (Appendix D). The comments received ranged from sharing data, reports and studies to personal observations and experiences that emphasize or build upon the literature summarized in Appendix D. Commenters provided feedback on specific topics, including the impacts on human health and safety resulting from increased health risks (*e.g.*, cancer, asthma, heart disease) as well as decreases in community safety (*e.g.*, accidents), especially in communities with higher concentrations of heavy industrial operations. DOE also received some comments focused on environmental impacts, including air and water pollution, as well as disruptions to habitats, ecosystems, and wildlife. Additionally, some commenters mentioned the economic benefits of increased U.S. natural gas exports to communities, such as through local job creation.

[236] Comments of Industry Trades, *supra* note 3, at 21.
[237] *Id.* at 25 (internal citation omitted).
[238] Summary Report, *supra* note 41, at S-4.

A number of commenters focused on the human health impacts associated with air pollution. For example, DRN emphasized that breathing ozone-polluted air can cause coughing and shortness of breath, aggravate asthma, and cause other symptoms, and that airborne particles can become embedded in the lungs or enter the bloodstream, causing serious health issues.[239] Putman Tyler commented that "LNG pollutes and harms public health," going on to list a number of purported hazards,[240] as did Daniela Rossi, who also stated that "LNG is harmful across its entire lifecycle from [extracting] the methane that is then liquefied which risks the air quality of local communities…."[241] Commenters also noted that oil and gas operations and LNG terminals release harmful air pollutants that can contribute to increased incidences of respiratory disease, heart disease, and cancer. For example, FracTracker Alliance acknowledged that, while correlational studies cannot definitively establish causation, they believed that data collected on oil and gas shows overwhelmingly negative effects relating to exposure.[242] In addition, Vet Voice Foundation highlighted recent analysis by the Sierra Club and Greenpeace USA finding that air pollution from both operating and planned LNG terminals could result in premature deaths and public health costs.[243] However, LNG Allies pointed out methodological limitations in that analysis, noting that it relied entirely on model outputs rather than using actual health outcome data for validation.[244]

Even though most comments focused on health impacts, some commenters also raised impacts of upstream production and LNG facilities on the environment, including air and water pollution, ecosystems, and wildlife. For example, DRN shared that in 2023, each day in the United States, more than two billion gallons of pressurized hydraulic fracturing (fracking) fluids were pumped underground for the purpose of extracting oil and gas. They also noted that after the fracking is finished, extracted wastewater is injected into disposal wells.[245] Further, the Habitat Recovery Project and Fishermen Involved in Sustaining our Heritage noted that pipeline construction often necessitates the clearing of wetlands, which provide essential functions including water filtration, carbon sequestration, and flood mitigation.[246] Additionally, John Wert commented that "[y]our own DOE analysis shows increased U.S. natural gas production will result in adverse impacts to water, air, and land. Natural gas extraction processing and transportation require the use of valuable resources, like water, and cause significant land disruptions through fracking."[247]

Several commenters also raised topics related to community safety, including explosion risks and seismic activity. For example, the Pipeline Safety Trust commented that safety should be a factor considered in Appendix D given their belief that LNG poses a higher risk than many other forms of methane transportation.[248] Mark Smith asserted that "DOE states that these land use changes are strongly connected to increased seismic activity in Midwestern states."[249] In addition, the

[239] Comments of Delaware Riverkeeper Network, *supra* note 27, at 22-23.
[240] Comment of Putman Tyler (ID: 2619) (Jan. 14, 2025).
[241] Comment of Daniela Rossi (ID: 71780) (Jan. 29, 2025).
[242] *See* Comments of FracTracker Alliance, (ID: 79962), at 5-6 (Mar. 20, 2025).
[243] Comments of Vet Voice Foundation (ID: 79271), at 2 (Feb. 13, 2025).
[244] Comments of LNG Allies, *supra* note 86, at 6-8.
[245] Comments of Delaware Riverkeeper Network, *supra* note 27.
[246] Comments of Habitat Recovery Project (ID: 3311) (Jan. 17, 2025).
[247] Comment of John Wert (ID: 72825) (Feb. 5, 2025).
[248] Comments of Pipeline Safety Trust (ID: 79499), at 1 (Feb. 18, 2025).
[249] Comment of Mark Smith (ID: 72653) (Feb. 5, 2025).

Louisiana Bucket Brigade commented that current regulatory frameworks fail to adequately assess explosion risks associated with heavier-than-air hydrocarbon releases in zero-wind.[250] However, the American Petroleum Institute (API) highlighted that other federal government agencies are responsible for overseeing LNG safety procedures, regulating everything from the siting and construction of LNG terminals, to ensuring that the facilities are built with safety systems to prevent explosions, leaks, and other potential hazards.[251] As an example, API highlighted that the Pipeline and Hazardous Materials Safety Administration regulates the implementation of numerous safety features into LNG terminal design, operation, and emergency response procedures, and the U.S. Coast Guard oversees safety onboard the ships and on the waterways adjacent to a terminal.[252]

Various commenters emphasized that the United States, at the federal, state, and local levels, has an extensive suite of statutory frameworks and regulatory requirements governing emissions and discharges. For example, Industry Trades noted that these statutes aim at minimizing any impacts of oil and gas production, transportation, and LNG facility construction and operation on human health and the environment.[253] They further expressed that DOE's public interest determination should focus on issues other than these types of potential environmental impacts, particularly given that other agencies have responsibility for addressing such impacts.[254] In addition, some commenters highlighted various economic benefits of LNG exports. For example, API provided examples of economic benefits of specific LNG projects across the U.S., including workforce development in host communities and creation of thousands of permanent high-paying jobs as well as increases in tax payments and royalties.[255]

Response

As with DOE's 2014 Environmental Addendum, Appendix D was intended to provide the public with a more comprehensive understanding of the potential impacts associated with natural gas production and export. Many of the comments often emphasized points that were discussed in the Appendix and encouraged DOE to take action based on the reported impacts. However, DOE's regulatory jurisdiction is limited, extending only to the act of exportation.[256] As emphasized by some of the commenters, other federal and state agencies have jurisdiction over health, environmental, and associated safety impacts discussed in Appendix D. The management of these issues falls within the purview of these other federal, state, and local regulators, and they are in the best position to balance the benefits and challenges associated with natural gas production, pipeline transportation, and liquefaction.

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[250] Comments of Louisiana Bucket Brigade (ID: 79877) (Mar. 18, 2025).
[251] Comments of American Petroleum Institute (ID: 81425), at 32 (Mar. 20, 2025).
[252] *Id.*
[253] Comments of Industry Trades, *supra* note 3.
[254] *Id.*
[255] Comments of American Petroleum Institute, *supra* note 251.
[256] 15 U.S.C. § 717b(a) ("The [Secretary] shall issue such order upon application, unless, after opportunity for hearing, [he] finds that the **proposed exportation** [] will not be consistent with the public interest.") (Emphasis added).

7. Other Comments

j. Comment Process

Comment Summary

The Marcellus Shale Coalition (MSC) raised concerns about DOE's process for presenting the Study. MSC stated that "the Secretarial Statement which accompanied the study seeks to espouse negative implications of increased U.S. LNG exports," but that "many of the conclusions alluded to in the statement are not supported by the study itself."[257] MSC also commented negatively on the fact that the Study was presented as a final study and comments were not sought before the Study was finalized, stating that "[a] hallmark of any legitimate public policy is a willingness to solicit and thoughtfully consider the input of a diverse set of perspectives before finalizing a final policy."[258]

Response

DOE acknowledges commenters' desire to have been able to provide input during the preparation of the Study. By providing an opportunity for comment after the Study's release, however, DOE believes it ensured that the insights and concerns of stakeholders could still be considered. DOE has reviewed the comments received and is providing a formal response in this document. Additionally, as previously stated in its notice, the comments received in response to the Study are to inform DOE's public interest determinations in current and future non-FTA proceedings. Comments therefore have a meaningful opportunity to influence the guidance DOE takes from the Study.

KEY FINDINGS AND CONCLUSIONS

To conduct the public interest review for applications to export U.S. LNG to non-FTA countries, DOE relies on record evidence developed in each application proceeding. Since 2012, DOE has commissioned multiple studies to help evaluate whether U.S. LNG exports are consistent with the public interest. These studies, updated when appropriate and described in detail in each non-FTA authorization, have been critical to DOE's decision-making in non-FTA orders issued to date.

1. Key Findings

DOE commissioned the 2024 LNG Export Study and invited submission of responsive comments. Upon consideration of the material reviewed (*i.e.*, the Study, comments, and materials submitted in support of comments), DOE's key findings are:

1. U.S domestic natural gas supply is sufficient to meet domestic and market-based global demand for U.S. natural gas (including LNG).
2. Increasing U.S. LNG exports increases U.S. GDP.
3. Higher levels of U.S. LNG exports will have a beneficial impact on the U.S. trade balance.
4. Increased LNG exports are projected to have relatively modest impacts on prices and there has not been a consistent effect of U.S. LNG exports on prices to date. The potential price impacts from increased LNG exports modeled in the 2024 Study are within the range

[257] Comments of Marcellus Shale Coalition (ID: 79794), at 1 (Mar. 10, 2025).
[258] *Id.* at 2.

of prices observed over the past five years, and those price impacts are below the price increases from U.S. LNG exports modeled in DOE's 2018 LNG Export Study.

5. Increased U.S. LNG exports would enhance national and energy security for the United States, as well as U.S. allies and trading partners.
6. If U.S. LNG exports more than triple from current levels and reach the model-resolved level of exports, 56.3 Bcf/d, the cumulative increase in global GHG emissions to 2050 would be no greater than 0.1%. Given the uncertainties inherent in modeling the global energy system, DOE cannot conclude that the change in GHG emissions would be significantly different from zero.
7. Increased U.S. exports of LNG are more likely to displace other sources of natural gas, along with coal and oil, than to replace renewable energy.
8. Natural gas production and the development of natural gas export infrastructure provide economic support to the communities in which they occur, including increased levels of employment.
9. Natural gas production, processing, and transportation have environmental effects. Federal, state, and local regulatory requirements, that are outside DOE's authority over LNG exports, include measures to reduce or mitigate any potential related impacts.

The comments received either support or do not provide a sufficient basis to invalidate or undermine these findings.

2. Conclusions

The 2024 LNG Export Study is an analysis of the implications of various U.S. LNG export levels on the U.S. energy market and economy, global energy security, GHG emissions, and community impacts of LNG development. DOE undertook the Study in a broad effort to identify and assess potential effects of continued expansion of U.S. LNG exports. DOE does not affirm, however, that all potential effects studied are necessarily appropriate bases for DOE's public interest determinations.

1. U.S domestic natural gas supply is sufficient to meet domestic and market-based global demand for U.S. natural gas (including LNG).

A primary finding of the Study is that domestic natural gas supply is sufficient to meet both domestic demand and the modeled global demand for U.S. LNG in all scenarios, including sensitivity scenarios on U.S. oil and gas supply. As some commenters noted, natural gas supply curves used in modeling show the ability to add significant supply with only small changes in price.

2. Increasing U.S. LNG exports increases U.S. GDP.

The Study showed that expanding U.S. LNG exports increases GDP in all cases. For example, for the Reference Case oil and gas supply assumptions, cumulative additional U.S. GDP for the period 2020 to 2050 is estimated at $410 billion. Several commenters supported this finding.

3. Higher levels of U.S. LNG exports will have a beneficial impact on the U.S. trade balance.

Other things equal, an increase in the quantity of U.S. products sold abroad works to improve the balance of trade. While the Study does not highlight this topic, some commenters raised the point, and DOE agrees that an improved trade balance would be an important benefit of greater LNG exports.

4. Increased LNG exports are projected to have relatively modest impacts on prices and there has not been a consistent effect of U.S. LNG exports on prices to date. The potential price impacts from increased LNG exports modeled in the 2024 Study are within the range of prices observed over the past five years, and those price impacts are below the price increases from U.S. LNG exports modeled in DOE's 2018 LNG Export Study.

As noted by several commenters, any domestic price impact is expected to be minimal due to the abundant U.S. supply of natural gas. Further, the relationship between domestic natural gas prices and LNG export levels has not been consistent to date, and the impacts vary by region. DOE also notes that modeled price increases in the 2024 LNG Export Study are lower than DOE's previous analysis on this topic and are lower than price levels observed in the market in recent years.

5. Increased U.S. LNG exports would enhance national and energy security for the United States as well as U.S. allies and trading partners.

U.S. LNG's ability to provide energy security benefits is an important part of DOE's public interest review of LNG export applications. These benefits provide significant support for the public interest value of exports. To begin with, increasing the overall supply of LNG in global markets will increase global energy security by making more energy available. And as the 2024 LNG Study Summary Report found, US LNG's destination flexibility is a key attribute:

> "As LNG re-gasification and associated import infrastructure is built out globally, increasing U.S. LNG exports could enhance global energy security. Most U.S. LNG contracts include a destination flexibility clause in which the buyer can deliver LNG to any destination, if it complies with DOE export authorizations and U.S. law. Accordingly, U.S. LNG goes to where the global market most demands it."[259]

This flexibility ultimately further enhances global energy security, regardless of region. DOE also notes that, as commenters explained, the Study could have explored to a greater extent the potential positive impact that increased natural gas production capacity developed to serve export markets could have on domestic energy security.

To the extent that enhancing energy security for allies in Europe specifically is a factor in DOE's public interest determination, DOE believes that, regardless of Europe's future natural gas consumption, a higher level of U.S. LNG exports will increase energy supplies globally *and* enhance energy security for all U.S. allies, whether in Europe or elsewhere. DOE does not therefore consider the exact level of future European demand for LNG to be a significant factor diminishing the weight it gives energy security considerations in public interest decisions.

Additionally, DOE believes that increasing U.S. energy production and exports can only enhance the nation's geopolitical influence and promote U.S. interests.

6. If U.S. LNG exports more than triple from current levels and reach the model-resolved level of exports, 56.3 Bcf/d, the cumulative increase in global GHG emissions to 2050 would be no greater than 0.1%. Given the uncertainties inherent in modeling the global energy system, DOE cannot conclude that the change in GHG emissions would be significantly different from zero.

The Study used a consequential life cycle analysis to help assess how the availability of U.S. LNG could influence those market effects on GHG emissions. However, in consideration of all the comments and additional supporting documentation provided, DOE concludes that market effects, such as changes in energy demand and the sources used to meet that demand, ultimately determine the consequences of U.S. LNG exports on global GHG emissions. The Study concluded that across all supply assumptions, higher LNG export levels increase energy-related cumulative global GHG emissions for the entire modeled period of 2020 to 2050 no more than one-tenth of one percent (0.1%). Thus, considering the uncertainty in the underlying estimates and the time period evaluated, DOE recognizes that there could be no change or even a reduction in emission based on a number of possible outcomes (*e.g.*, increased coal displacement), and DOE cannot conclude that global emissions would necessarily increase. Therefore, the GHG emissions discussed in the Study are not expected to affect DOE's public interest determination in pending or future non-FTA authorizations.

7. Increased U.S. exports of LNG are more likely to displace other sources of natural gas, along with coal and oil, than to replace renewable energy.

In all modeled scenarios, the Study found that expanded U.S. LNG exports are more likely to displace fossil fuels than renewable energy resources. Including displacement of natural gas sourced from other countries along with coal and oil, modeled displacement effects for fossil fuels are larger than for resources such as wind and solar power.

8. Natural gas production and the development of natural gas export infrastructure provide economic support to the communities in which they occur, including increased levels of employment.

Developments related to LNG exports provide an economic benefit to the areas surrounding these developments. The Study did not quantify job or wage revenues attributable to the construction and operation of LNG facilities, but quantitative estimates of LNG export-related employment and wages were provided by several commenters. Based on those reports, DOE postulates that LNG export facilities have a positive impact on the U.S. job market.

9. Natural gas production, processing, and transportation have environmental effects. Federal, state, and local regulatory requirements that are outside DOE's authority over LNG exports include measures to reduce or mitigate any potential related impacts.

With respect to environmental impacts, DOE acknowledges that natural gas production and related issues must be carefully managed. However, DOE emphasizes that its jurisdiction is limited. As noted in DOE's response to comments on this topic, there are local, state, and federal agencies that have authority to balance the benefits and burdens of natural gas production, transport, and liquefaction to address most of the environmental, health, and safety concerns

discussed in the Study. Moreover, as DOE has previously noted, the denial of LNG export authorizations would be too blunt an instrument to address the concerns raised in Appendix D.[259]

Among other topics, Appendix D included a discussion of impacts to local communities of natural gas production, transportation, and export. This discussion was based, in part, on direction in various executive orders that have since been revoked.[260] Under current policy direction in executive orders issued since publication of the Study,[261] environmental justice factors will not be considered by DOE as part of its public interest evaluations under section 3(a) of the Natural Gas Act.

DOE notes that section 3(a) of the Natural Gas Act[262] does not define "public interest" or identify criteria that DOE must consider. Rather, the statute leaves the public interest determination to the agency's technical expertise and establishes a *presumption* favoring export authorizations.[263]

Ultimately, DOE continues to endorse the principle set forth in its 1984 Policy Guidelines[264] that the market is generally the most efficient means of allocating natural gas supplies. Thus, under most circumstances, market forces will determine which and how many U.S. LNG export projects will succeed. In addition, technological innovations and industry investment, two factors that influence market demand, will contribute to determining which U.S. LNG export projects succeed.

DOE finds that the record evidence from 2024 LNG Export Study and the public comments received support the proposition that exports of LNG from the United States will not be inconsistent with the public interest. DOE will consider each application as required under the NGA and NEPA, based on the administrative record compiled in each individual proceeding, which now includes the record evidence from the 2024 LNG Export Study, all comments received in response to the study, documents and information provided in support of comments, and this Response to Comments Report.

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[259] *E.g.*, *Freeport LNG Expansion, L.P., et al.*, DOE/FECM Order No. 4961, Docket No. 21-98-LNG, Order Granting Long-Term Authorization to Export Liquefied Natural Gas to Non-Free Trade Agreement Nations, at 67 (Mar. 3, 2023).

[260] Specifically, Exec. Order No. 12898, 59 Fed. Reg. 7629 (Feb. 16, 1994); Exec. Order No. 13985, 86 Fed. Reg. 7009 (Jan. 25, 2021); Exec. Order No. 14008, 86 Fed. Reg. 7619 (Feb. 1, 2021); Exec. Order No. 14096, 88 Fed. Reg. 25,251 (Apr. 26, 2023).

[261] Exec. Order No. 14148, *Initial Rescissions of Harmful Executive Orders and Actions* (Jan. 20, 2025) (revoked Exec. Order Nos. 13985 and 14008); Exec. Order No. 14154, *Unleashing American Energy* (Jan. 20, 2025) (revoked Exec. Order No. 14096); and Exec. Order No. 14173, *Ending Illegal Discrimination and Restoring Merit-Based Opportunity* (Jan. 21, 2025) (revoked Exec. Order No. 12898).

[262] 15 U.S.C. § 717b(a).

[263] *See Sierra Club v. U.S. Dep't of Energy*, 867 F.3d 189, 203 (D.C. Cir. 2017) ("We have construed [section 3(a)] as containing a 'general presumption favoring [export] authorization.'") (quoting *W. Va. Pub. Serv. Comm'n v. U.S. Dep't of Energy*, 681 F.2d 847, 856 (D.C. Cir. 1982)).

[264] 1984 Policy Guidelines, *supra* note 10.