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Quantifying America's Economic and Energy Opportunity through LNG Exports

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Quantifying America's Economic and Energy Opportunity through LNG Exports

Executive Summary

US liquefied natural gas ("LNG") exports have grown significantly in recent years, reaching a historical high of 11.9 billion cubic feet per day ("bcf/d") in 2023. The increased demand for natural gas has spurred investment in exploration and production activities, further boosting job creation and economic activity. The development of LNG export facilities, natural gas production, and related infrastructure has led to employment opportunities across sectors, including construction, engineering, manufacturing, logistics, and more.

The National Association of Manufacturers ("NAM") engaged PwC to quantify the economic contribution of US LNG exports historically and prospectively. The historical analysis focuses on the most recent historical year, 2023, while the prospective analysis projects the results to 2044, under two of the latest projected paths of future US LNG exports published by the US Energy Information Administration ("EIA") in March 2023 based on laws and regulations as of November 2022.

Key findings

This study finds that the US LNG export sector in 2023 had a significant contribution to the US economy.

- **Job Creation:** It directly or indirectly supported **222,450 jobs**. These jobs earned **\$23.2 billion** in labor income.
- **Economic Output:** It directly or indirectly contributed **\$43.8 billion** to US GDP.¹
- **Tax and Royalty Revenue:** It directly or indirectly generated **\$11.0 billion** in tax and royalty revenues, benefiting federal, state, and local governments.

Looking ahead to the future, under the EIA's *Reference* case, which does not consider regulatory guidance or provisions issued after November 2022 like the US Department of Energy's temporary pause on review of pending applications, it is projected that in 2044 the US LNG export sector will directly or indirectly:

- Support **516,000 jobs** and **\$59.0 billion** in labor income.
- Contribute **\$122.5 billion** to US GDP² and generate **\$26.9 billion** in taxes and royalties.

Under the more optimistic *High Growth* case, it is projected that in **2044** the US LNG export sector will directly or indirectly:

- Support over **900,000 jobs** and **\$103.9 billion** in labor income.
- Contribute **\$215.7 billion** to US GDP³ and generate **\$47.7 billion** in taxes and royalties.

Table E-1, below, summarizes these results.

Table E-1. Economic Contribution of US LNG Exports: 2023 and 2044

Item	2023	2044	
		Reference Case	High Growth Case
Employment (jobs)	222,450	515,960	901,250
Labor Income (\$billions) ^b	\$23.2	\$59.0	\$103.9
GDP (\$billions)	\$43.8	\$122.5	\$215.7
Tax and Royalty Payments (\$billions) ^c	\$11.0	\$26.9	\$47.7

Source: PwC calculations using the IMPLAN modeling system and data from the US Energy Information Administration.

^a Employment is defined as the number of payroll and self-employed jobs, including part-time jobs.

^b Labor income is defined as wages and salaries and benefits as well as proprietors' income.

^c Includes federal, state, and local income and nonincome taxes.

¹ The total contribution of the US LNG export sector in 2023 accounted for 0.2 percent of the national GDP.

² Under the EIA's Reference case, the contribution of the US LNG export sector in 2044 is projected to account for 0.3 percent of national GDP.

³ Under the EIA's High Growth case, the contribution of the US LNG export sector in 2044 is projected to account for 0.5 percent of national GDP.

Quantifying America's Economic and Energy Opportunity through LNG Exports

I. Introduction

Over the past decade, the United States has transformed itself from a net importer of natural gas to a leading global exporter of liquefied natural gas ("LNG"), driven by technological advancements in hydraulic fracturing and horizontal drilling, which have unlocked vast reserves of natural gas from shale formations across the country. This shift has had significant economic implications.

The National Association of Manufacturers ("NAM") engaged PwC to quantify the current and projected economic contributions of US LNG exports. This report explores the benefits the LNG exports bring to the US economy today and offers a forward-looking perspective on their potential to shape the economic landscape in the next two decades.

Scope and Objectives

The primary objective of this report is to quantify the economic contribution of US LNG exports in terms of employment, labor income, GDP, and tax payments, both now and in the future. Key areas of focus include:

Economic Growth: Assessing the total contribution, including direct, indirect, and induced contribution, of US LNG exports to US GDP in 2023 and 2044.

Employment: Evaluating the role of US LNG exports in supporting total employment, including direct and indirect employment, across various sectors of the US economy in 2023 and 2044.

Tax and Royalty Contribution: Quantifying the fiscal support provided by the US LNG export sector to the federal, state, and local governments in 2023 and 2044.

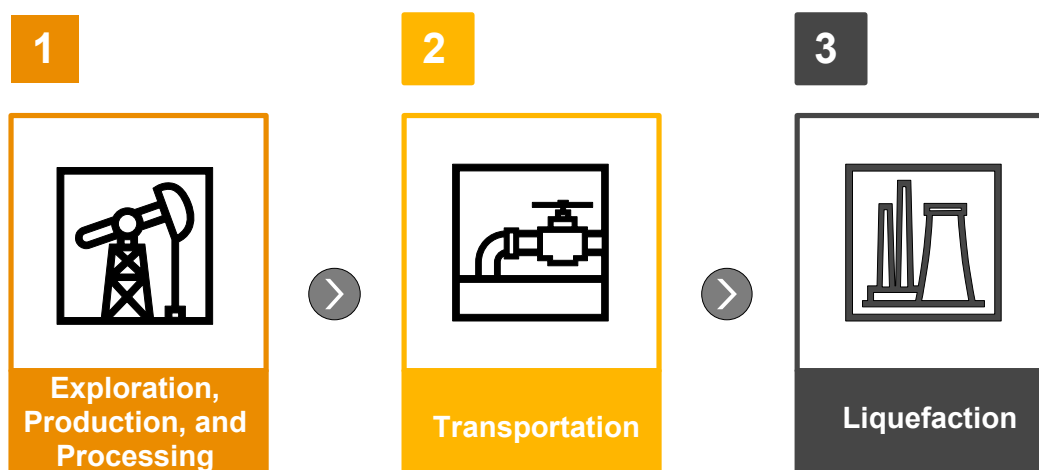
In short, the goal of this report is to examine the present and future projected total economic contributions of US LNG exports, offering a valuable resource for understanding their role in shaping the economic and energy future of the United States.

The next section presents the domestic value chain of the US LNG exports, followed by the economic contribution estimates in **Section III**. Data and methodology are provided in **Appendix A**. More detailed results of the study are presented in **Appendix B**.



II. Value Chain of LNG Exports

The domestic value chain of natural gas from exploration to exports in the form of LNG involves several stages, each with distinct activities.



1. Exploration, Production, and Processing

The exploration and production stage involves locating natural gas reserves, drilling wells, and extracting natural gas. Natural gas reserves are identified through advanced technologies and geological expertise, with exploration teams utilizing methods like seismic surveys to map underground formations. The gas is described as either associated (found alongside crude oil) or nonassociated (found in standalone gas fields). Once the reserves are located, drilling wells are used to extract the natural gas. The extracted gas undergoes a processing phase to eliminate impurities such as water, carbon dioxide, sulfur compounds, and other hydrocarbons like propane and butane. This processing results in the production of "dry natural gas," which predominantly comprises methane (CH₄). Advanced purification techniques are employed to ensure the desired levels of purity are achieved.

2. Transportation

Processed natural gas is transported from the production sites to LNG export facilities through an extensive network of pipelines. These pipelines are designed to transfer the gas over long distances efficiently, often spanning across regions. The transportation infrastructure includes compressor stations that facilitate the movement of the gas through the pipelines.

3. Liquefaction

LNG export facilities receive natural gas by pipeline and liquefy the gas for transport on special ocean-going LNG ships, or tankers.⁴ Specifically, the dry natural gas is cooled to approximately -162 degrees Celsius (-260 degrees Fahrenheit) at atmospheric pressure. The liquefaction process allows the gas to be transformed into a liquid state, significantly reducing its volume and making it feasible for efficient ocean transport. The liquefied natural gas is then loaded onto specialized LNG ships or tankers, equipped with advanced cryogenic systems to maintain the low temperatures during transit.

Upon reaching its destination, LNG is often regasified (converted back to its gaseous state) for use in residential, commercial, and industrial applications, or for injection into the natural gas distribution network. This regasification activity, however, is not considered in this study, as our focus is on the domestic value chain of LNG exports. In the next section, we will present the estimated employment, labor income, GDP, and tax payments directly or indirectly related to the domestic value chain of LNG exports in 2023 (the most recent historical year) and 2044 (under two alternative projected paths of US LNG exports).

⁴ According to the Federal Energy Regulatory Commission, there are eight existing US LNG export terminals located in the following five states, with more locations approved but not yet built: Alaska (Kenai), Georgia (Elba Island), Louisiana (Sabine, Hackberry, and Cameron Parish), Maryland (Cove Point), and Texas (Corpus Christi and Freeport).

III. Economic Contribution Analysis

This section presents the estimated **total** economic contribution of US LNG exports now and in the future. The total contribution described in this analysis includes the **direct contribution** (the economic activities throughout the domestic value chain of US LNG exports), the **indirect contribution** (the economic activities occurring throughout the supply chain of the LNG export sector), and the **induced contribution** (the economic activities resulting from household spending of income earned either directly or indirectly from LNG exports).

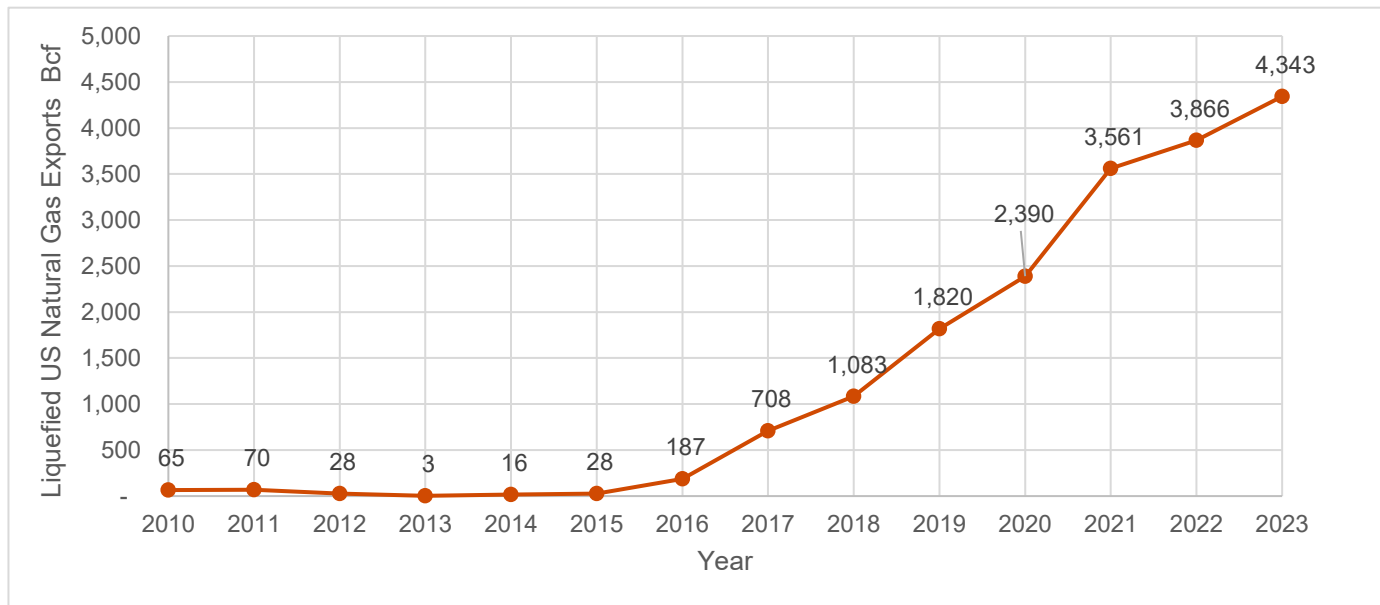
To measure the economic contribution of LNG exports, the analysis considers four separate metrics: employment, labor income, GDP, and tax payments, as defined below.

Employment	The number of full-time and part-time payroll and self-employed jobs averaged over the year.
Labor Income	Total wages, salaries, and benefits, as well as proprietors' income.
GDP	A monetary measure of the market value of all the final goods and services produced and rendered in a specific time period.
Tax Payments	Fiscal support through taxes to the federal government and state and local governments.

A. Historical Analysis

For many years, the United States was not a key player in the global LNG export market, consistently exporting less than 0.5 percent of its natural gas production. Between 2010 and 2015, US LNG exports ranged from 3 billion cubic feet ("Bcf") in 2013 to 70 Bcf in 2011.⁵ Starting in 2016, the lower 48 states began exporting the fuel through the commencement of operations at Sabine Pass LNG terminal, the first LNG export terminal in that region. This led to a significant increase in total US LNG exports, surpassing five-fold compared to the previous year, with 187 Bcf exported, accounting for 0.7 percent of the US natural gas production in 2016 (see **Figure III-1**, below).

Figure III-1. US LNG Exports in Bcf, 2010-2023



Source: U.S. Energy Information Administration, *Liquefied U.S. Natural Gas Exports*.

As the Sabine Pass LNG terminal expanded its capacity and new terminals like Cove Point in Maryland became operational, the United States experienced rapid growth in LNG export capacity and volumes. In 2017, US LNG exports reached over 700 Bcf, and by 2018, the United States emerged as one of the top three LNG exporters globally, alongside Qatar and Australia, exporting approximately 1,100 Bcf (or about 3.5 percent of the US natural gas production in 2018). The following year, with the addition of new terminals, including at Corpus Christi in Texas and Cameron LNG in Louisiana, US LNG exports surged to over 1,800 Bcf, accounting for 5.4 percent of the US natural gas production in 2019.

⁵ According to the EIA, the historical lower level in 2013 can be attributed to two factors: (1) the Kenai LNG export terminal became inactive in November 2012 because of limited natural gas supply for liquefaction from the mature North Cook Inlet gas field; and (2) LNG re-exports decreased by 86% in 2013. See: <https://www.eia.gov/naturalgas/importsexports/annual/archives/2014/#tabs-supply-2>.

Despite the challenges posed by the COVID-19 pandemic, the strong growth in US LNG exports continued, reaching an all-time high of 4,343 Bcf in 2023, accounting for 11.5 percent of the US natural gas production that year. The United States further solidified its position as a key global LNG supplier with ongoing construction projects, such as the Golden Pass LNG terminal in Texas.

Table III-1, below, shows the direct economic contribution of US LNG exports in 2023, the latest year for which data are available. Employment in exploration, production, and processing for LNG exports is estimated to be 16,560 jobs, earning \$3.4 billion in labor income and contributing \$12.9 billion to GDP in 2023. These activities directly generated \$3.2 billion in tax revenues for the federal, state, and local governments.

Employment in pipeline transportation for LNG exports in 2023 is estimated to be 4,060 jobs. These jobs are estimated to have earned \$3.3 billion in labor income and contributed \$4.0 billion to GDP. These activities directly generated \$1.2 billion in tax revenues for the federal, state, and local governments in 2023.

Employment in LNG export facilities (liquefaction) in 2023 is estimated to be 5,310 jobs. These jobs are estimated to have earned \$0.5 billion in labor income and contributed \$0.4 billion to GDP. These activities directly generated \$0.1 billion in tax revenues for the federal, state, and local governments in 2023.

Combined, the direct employment related to LNG exports in 2023 is estimated to be 25,930 jobs. These jobs are estimated to have earned \$7.2 billion in labor income. The LNG export sector also contributed \$17.3 billion to GDP and generated \$4.5 billion of federal, state, and local taxes in 2023.

Table III-1. The Value Chain of LNG Exports and Its Direct Economic Contribution, 2023

	Employment (jobs)	Labor Income (\$billion)	GDP (\$billion)	Tax Payments (\$billion)
Exploration, Extraction, and Processing	16,560	\$3.4	\$12.9	\$3.2
Pipeline Transportation	4,060	\$3.3	\$4.0	\$1.2
LNG Export Facilities: Liquefaction	5,310	\$0.5	\$0.4	\$0.1
Total LNG Export-Related	25,930	\$7.2	\$17.3	\$4.5

Source: PwC calculations using data from US Energy Information Administration, US Bureau of Labor Statistics, and the IMPLAN modeling system.

Note: Details may not add to totals due to rounding.

Table III-2, below, shows the total economic contribution of US LNG exports in 2023. Including all economic multiplier effects, the contribution of US LNG exports to employment in 2023 is estimated to be 222,460. The total labor income, GDP, and tax contributions attributable to US LNG exports in 2023 are estimated to be \$23.2 billion, \$43.8 billion, and \$10.8 billion, respectively (see **Appendix B** for a breakout of the economic contribution by direct, indirect, and induced effects).

Table III-2. Total Economic Contribution of US LNG Exports, 2023

	Employment (jobs)	Labor Income (\$billion)	GDP (\$billion)	Tax Payments (\$billion)
Total Contribution	222,460	\$23.2	\$43.8	\$10.8

Source: PwC calculations using data from US Energy Information Administration, US Bureau of Labor Statistics, and the IMPLAN modeling system.

^a Employment is defined as the number of payroll and self-employed jobs, including part-time jobs.

^b Labor income is defined as wages and salaries and benefits as well as proprietors' income.

Tax contributions at the federal, state, and local level support the financing of governments and public programs and services. Notable services supported by taxes include public education, maintenance of infrastructure such as roads and public transportation, and public health. Displayed in **Table III-3**, below, including the direct, indirect, and induced effects, the US LNG export sector's total fiscal support to the federal government, state, and local governments in 2023 was \$10.8 billion. The largest tax payment was personal income taxes (\$3.2 billion), followed by social insurance contributions

(\$2.3 billion) and sales/use taxes (\$2.1 billion). Property taxes were \$1.7 billion, while corporate income tax was \$0.9 billion (see **Appendix B** for a breakout of the tax contribution by direct, indirect, and induced effects). The LNG export industry also pays federal royalties on natural gas produced on federal lands. We estimate that the federal royalties on the LNG exports in 2023 were \$0.2 billion.⁶ Combined, the total tax and royalty contributions attributable to the LNG exports in 2023 were \$11.0 billion.

Table III-3. Federal, State, and Local Tax Contribution of US LNG Exports: 2023

	Total Contribution (\$billions)
Personal Income Taxes	\$3.2
Social Insurance Contributions	\$2.3
Sales/Use Taxes	\$2.1
Property Taxes	\$1.7
Corporate Income Taxes	\$0.9
Other Tax Payments	\$0.6
Total Tax Contribution	\$10.8
Federal Royalties	\$0.2
Total Tax Contribution and Royalties	\$11.0

Source: PwC calculations using the IMPLAN modeling system and data from the US Energy Information Administration. Details may not add up to totals due to rounding.

B. Prospective Analysis

This report projects the LNG export sector's economic contribution to 2044, based on two of the projected alternative paths of future US LNG exports provided by the EIA in its latest annual forecast.⁷

In its *Reference* case, described in more detail below, the EIA projects rising natural gas production, thanks to international demand for LNG exports. The growth favors areas that have better access to terminals. The EIA notes that dry natural gas production will grow in the Gulf Coast region where five of the existing eight LNG export terminals are located, and in the Southwest region, which has easy pipeline transportation to the Gulf Coast.

In the EIA forecast, shale gas and associated dissolved natural gas from oil formations are the primary sources of long-term growth of domestic natural gas production through 2050. Increased production from wells in the Permian Basin (Southwest Region) is the primary driver behind associated dissolved natural gas growth. Increases in shale gas production mainly comes from the Texas-Louisiana Salt Basin (Gulf Coast Region) and the Appalachian Basin (East Region).

The EIA cautions that energy market projections are inherently uncertain because many of the events that will shape future energy markets—including developments in policy, technology, demographics, and resources—are not known. Thus, in addition to its Reference case forecast, the EIA provides a number of so-called “side cases,” where each side case represents a one-factor change to the *Reference* case, including demand-side changes (macroeconomic growth affecting energy demand) and supply-side changes (renewables costs affecting generating capacity deployment). For this study, we will focus on the baseline *Reference* case and one of the side cases: the *High Growth* case.

1. Reference Case

The baseline *Reference* case assesses how US and world energy markets would operate through 2050 under current laws and regulations as of November 2022 under certain technological growth assumptions. The key assumptions in the *Reference* case provide a baseline, or experimental control, for exploring long-term trends. Case assumptions were frozen in mid-November 2022, and they do not include regulatory guidance or provisions issued after that time.

⁶ The minimum royalty rate on oil and natural gas produced on federal lands is 12.5 percent. According to the Bureau of Land Management of the US Department of Interior (“DOI”), approximately 10 percent of all US natural gas was produced from the Federal mineral estate in 2023 (<https://www.blm.gov/programs/energy-and-minerals/oil-and-gas/about>). DOI also reported that \$2.7 billion in federal royalties were collected from the production of gas and natural gas liquids (see <https://revenue.data.doi.gov/>) in 2023, with \$1.9 billion being federal royalties collected from gas.

⁷ See the Energy Information Administration, *Annual Energy Outlook 2023*, at: <https://www.eia.gov/outlooks/aeol/>.

Importantly, the projections considered in this study do not reflect the effect of the temporary pause on review of pending applications to export LNG announced by the US Department of Energy (“DOE”) on January 26, 2024, and subsequent legal proceedings.⁸

In the *Reference* case, the EIA assumes that up to three natural gas liquefaction trains,⁹ each with 200 Bcf capacity, are built each year (a maximum of 600 Bcf of LNG capacity). This constraint on new capacity represents the EIA’s assessment of the logistical challenges in building such large, complex facilities. For the *Reference* case, the EIA further assumes that annual GDP growth will be 1.9 percent and that world natural gas prices start at their recent historical ratio to the world oil price. Over time, the price of LNG becomes less tied to the world oil price as the ratio of flexibly priced LNG to the representative regional net natural gas demand increases relative to its base year level. The ratio reflects the tightness or looseness of the world LNG market pushing or pulling, respectively, world natural gas prices toward or away from the world oil price. In the *Reference* case, annual US LNG exports reach 9,996 Bcf in 2044.

Table III-4, below, shows the total economic contribution of US LNG exports in 2044 under the EIA’s *Reference* case. Including all economic multiplier effects, the total contribution to employment of projected US LNG exports in 2044 is estimated to be 515,960 under the EIA’s *Reference* case. The total labor income, GDP, and tax contributions attributable to projected US LNG exports in 2044 are estimated to be \$59.0 billion, \$122.5 billion, and \$26.1 billion, respectively (see **Appendix B** for a breakout of the economic contribution by direct, indirect, and induced effects).

Table III-4. Total Economic Contribution of US LNG Exports, 2044: Reference Case

	Employment (jobs)	Labor Income (\$billion)	GDP (\$billion)	Tax Payments (\$billion)
Total Contribution	515,950	\$59.0	\$122.5	\$26.1

Source: PwC calculations using data from US Energy Information Administration, US Bureau of Labor Statistics, and the IMPLAN modeling system.

^a Employment is defined as the number of payroll and self-employed jobs, including part-time jobs.

^b Labor income is defined as wages and salaries and benefits as well as proprietors’ income.

Displayed in **Table III-5**, below, including the direct, indirect, and induced effects, the US LNG export sector’s total fiscal support to the federal government, state, and local governments in 2044 is projected to be \$26.1 billion under the EIA’s *Reference* case. The largest tax payment was personal income taxes (\$7.8 billion), followed by social insurance contributions (\$5.4 billion) and sales/use taxes (\$5.0 billion). Property taxes were \$4.1 billion, while corporate income tax was \$2.2 billion (see **Appendix B** for a breakout of the tax contribution by direct, indirect, and induced effects). We estimate that under the EIA’s *Reference* case, the federal royalties on the LNG exports in 2044 will be \$0.8 billion. Combined, under the EIA’s *Reference* case, the total tax and royalty contributions attributable to the LNG exports in 2044 are projected to be \$26.9 billion.

⁸ The DOE noted that the temporary pause will only affect its review of any pending or newly filed LNG export applications to non-free trade agreement countries and that the temporary pause will not affect current or near-to-medium-term planned supply. See: https://www.energy.gov/sites/default/files/2024-02/The%20Temporary%20Pause%20on%20Review%20of%20Pending%20Applications%20to%20Export%20Liquefied%20Natural%20Gas_0.pdf. On July 1, a judge issued a stay of the pause. <https://www.ag.state.la.us/Files/Article/111/Documents/No.72-PIOrder.pdf>. On August 5, the DOE announced plans to appeal the judge’s ruling.

⁹ A natural gas liquefaction train is a series of interconnected equipment and processes used to convert natural gas from its gaseous state into a liquid form.

Table III-5. Federal, State, and Local Tax Contribution of US LNG Exports: 2044, Reference Case

	Total Contribution (\$billions)
Personal Income Taxes	\$7.8
Social Insurance Contributions	\$5.4
Sales/Use Taxes	\$5.0
Property Taxes	\$4.1
Corporate Income Taxes	\$2.2
Other Tax Payments	\$1.6
Total Tax Contribution	\$26.1
Federal Royalties	\$0.8
Total Tax Contribution and Royalties	\$26.9

Source: PwC calculations using the IMPLAN modeling system and data from the US Energy Information Administration. Details may not add up to totals due to rounding.

2. High Growth Case

From 2022 to 2050, the EIA's *High Growth* case assumes the compound annual growth rate for US GDP is 2.3 percent (versus 1.9 percent in the *Reference* case). It also assumes that LNG prices in Europe and Asia are higher by an average of nearly 25 percent relative to the *Reference* case in 2050. In addition, it is assumed that four natural gas liquefaction trains, each with 200 Bcf capacity, can be built each year (a maximum of 800 Bcf of LNG capacity). In the *High Growth* case, US LNG exports reach 17,596 Bcf in 2044 (versus 9,996 Bcf in the *Reference* case).

Table III-6, below, shows the total economic contribution of the projected US LNG exports in 2044 under the *High Growth* case. Including all economic multiplier effects, the contribution of projected US LNG exports to employment in 2044 is projected to be 901,260. The total labor income, GDP, and tax contributions attributable to projected US LNG exports in 2044 are estimated to be \$103.9 billion, \$215.7 billion, and \$46.0 billion, respectively.

Table III-6. Economic Contribution of US LNG Exports, 2044: High Growth Case

	Employment (jobs)	Labor Income (\$billion)	GDP (\$billion)	Tax Payments (\$billion)
Total Contribution	901,260	\$103.9	\$215.7	\$46.0

Source: PwC calculations using data from US Energy Information Administration, US Bureau of Labor Statistics, and the IMPLAN modeling system.

^a Employment is defined as the number of payroll and self-employed jobs, including part-time jobs.

^b Labor income is defined as wages and salaries and benefits as well as proprietors' income.

Displayed in **Table III-7**, below, including the direct, indirect, and induced effects, the US LNG export sector's total fiscal support to the federal government, state, and local governments in 2044 is projected to be \$46.0 billion under the EIA's *High Growth* case. The largest tax payment was personal income taxes (\$13.8 billion), followed by social insurance contributions (\$9.6 billion) and sales/use taxes (\$8.9 billion). Property taxes were \$7.2 billion, while corporate income tax was \$4.0 billion (see **Appendix B** for a breakout of the tax contribution by direct, indirect, and induced effects). We estimate that under the EIA's *High Growth* case, the federal royalties on the LNG exports in 2044 will be \$1.7 billion. Combined, under the EIA's *High Growth* case, the total tax and royalty contributions attributable to the LNG exports in 2044 are projected to be \$47.7 billion.

Table III-7. Federal, State, and Local Tax Contribution of US LNG Exports: 2044, High Growth Case

	Total Contribution (\$billions)
Personal Income Taxes	\$13.8
Social Insurance Contributions	\$9.6
Sales/Use Taxes	\$8.9
Property Taxes	\$7.2
Corporate Income Taxes	\$4.0
Other Tax Payments	\$2.5
Total Tax Contribution	\$46.0
Federal Royalties	\$1.7
Total Tax Contribution and Royalties	\$47.7

Source: PwC calculations using the IMPLAN modeling system and data from the US Energy Information Administration. Details may not add up to totals due to rounding.

C. Summary

US LNG exports have grown significantly in recent years, reaching an all-time high of 4,343 Bcf in 2023, the most recent historical year for which data are available.

Taking into consideration all the economic multiplier effects, US LNG exports supported an estimated total of 222,450 jobs in 2023. These jobs earned \$23.2 billion in labor income, added \$43.8 billion to GDP, and contributed more than \$11.0 billion of tax and royalty revenues to the federal, state, and local governments in 2023 (see **Table III-8**, below).

Looking ahead to 2044, including the direct, indirect, and induced effects, the US LNG export sector is projected to support 515,960 jobs and \$59.0 billion in labor income, add \$122.5 billion to US GDP, and contribute \$26.9 billion in tax and royalty revenues to the federal, state, and local governments in 2044 under the EIA's *Reference* case. Under the more optimistic *High Growth* alternative scenario, total employment contribution is projected to exceed 900,000 jobs, adding \$103.9 billion to labor income and \$215.7 billion to US GDP and contributing \$47.7 billion in tax and royalty revenues to the federal, state, and local governments.

Table 8. Economic Contribution of US LNG Exports: Summary Results

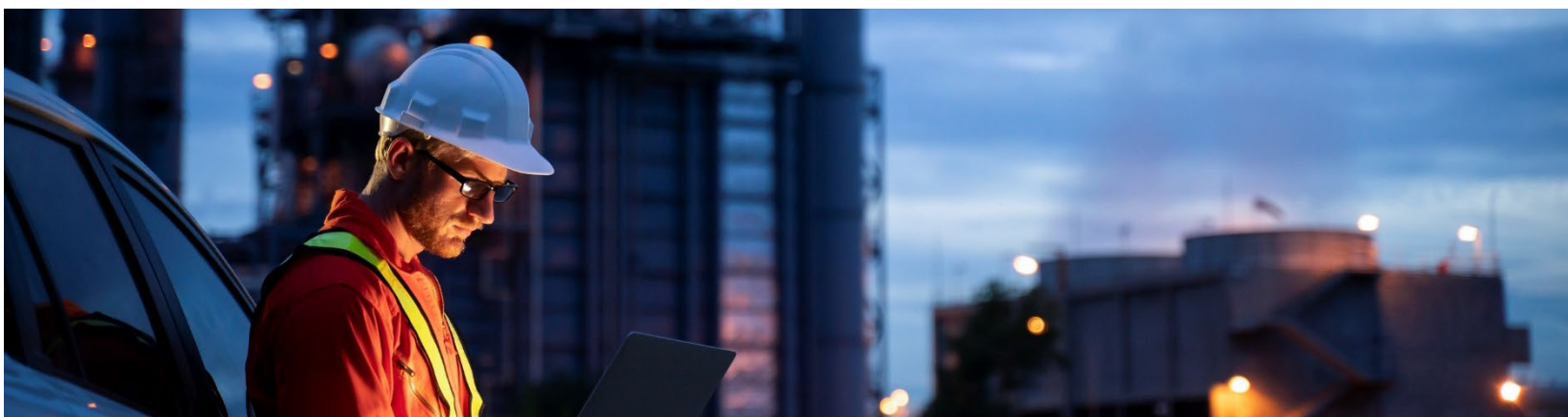
Item	2023	2044	
		Reference Case	High Growth Case
Employment (jobs)	222,450	515,960	901,250
Labor Income (\$billions)^b	\$23.2	\$59.0	\$103.9
GDP (\$billions)	\$43.8	\$122.5	\$215.7
Tax and Royalty Payments (\$billions)^c	\$11.0	\$26.9	\$47.7

Source: PwC calculations using the IMPLAN modeling system and data from the US Energy Information Administration.

^a Employment is defined as the number of payroll and self-employed jobs, including part-time jobs.

^b Labor income is defined as wages and salaries and benefits as well as proprietors' income.

^c Includes federal, state, and local income and nonincome taxes.



Appendix A: Data and Methodology

This appendix describes the data sources and methodology used to derive the results for the study. It first discusses the data sources PwC utilized for the contribution analysis. It then describes the development of the indirect and induced economic contribution estimates.

I. Data Sources

For the historical economic contribution analysis, data on annual LNG exports are taken from the EIA.¹⁰ Data on employment provided by the US Bureau of Labor Statistics and the IMPLAN model were used to estimate the level of employment at each stage of the domestic value chain of US LNG exports. The IMPLAN model is used to estimate the related labor income, GDP, and tax payments.

The prospective economic contribution analysis relies on the projected level of US LNG exports in the EIA's *Annual Energy Outlook 2023* ("AEO2023").¹¹ Among the various projection scenarios considered by the EIA, we have only studied two cases: the *Reference* case and the *High Growth* case. All cases use the macroeconomic outlook from S&P Global IHS Markit as of September 2022.

II. Estimates of Indirect and Induced Economic Contributions

The initial round of output, income, and employment generated by the LNG export sector leads to successive rounds of spending in the chain of production. Such indirect and induced economic contributions can be measured using various approaches. The most common is multiplier analysis. In broad terms, a multiplier is an index that indicates the overall change in the level of economic activity that results from a given initial change. It effectively adds up all of the responding, based on a number of assumptions that are embedded in the method of estimation.

There are different methods available for calculating multipliers. The method used in this report is input-output analysis. It is the most commonly used approach in regional economic contribution studies. The input-output model developed by the IMPLAN Group, LLC is one of the best-known input-output models for regional economic studies in the United States and is widely used by government, academics, and private-sector researchers.

The IMPLAN models are built around an input-output table that relates the purchases that each industry has made from other industries to the value of the output of each industry. To meet the demand for goods and services from an industry, purchases are made in other industries according to the patterns recorded in the input-output table. These purchases in turn stimulate more purchases by the industry's suppliers, and so on. Additionally, employees and business owners make personal purchases out of the additional income that is generated by this process, adding more new demand throughout the economy. Multipliers quantify these effects. The Type I multiplier measures the direct and indirect effects of a change in economic activity. It captures the inter-industry effects only, i.e., industries buying from local industries. The Type II (Social Accounting Matrix or SAM) multiplier captures the direct and indirect effects, and, in addition, it also reflects induced effects (i.e., changes in spending from households as income increases or decreases due to the changes in production). The indirect and induced contributions by the LNG export sector on other sectors of the economy in terms of employment, labor income (including wages and salaries and benefits as well as proprietors' income), and contribution to GDP were calculated through the multiplier effects built in each model.

III. Limitations

A study using input-output models with fixed coefficients (such as the IMPLAN model used in this study) has certain limitations.

Firstly, the assumption of fixed coefficients implies that the technology and production processes remain constant over time. However, this may not reflect real-world dynamics, such as technological advancements or changes in production methods in the projection period.

Secondly, IO models assume linear relationships between inputs and outputs, whereas in reality, these relationships are often nonlinear and can vary depending on specific circumstances. This can result in less precise model outputs. Additionally, these models do not account for changes in relative prices, substitution effects, or shifts in consumer demand, all of which can significantly influence economic outcomes.

¹⁰ See <https://www.eia.gov/dnav/ng/hist/n9133us2M.htm>.

¹¹ At the time of this report, the 2023 forecast is the latest available from the EIA. The EIA has announced that because its National Energy Modeling System ("NEMS"), which is used to produce its AEO, requires substantial updates to better model hydrogen, carbon capture, and other emerging technologies, it will not publish an AEO in 2024.

Thirdly, IO models assume rational behavior of economic agents. However, the behavior of consumers and firms are influenced by various social, psychological, and cultural factors that may not be fully accounted in these models. As a result, the accuracy of projections may be affected.

Considering these limitations, it is important to interpret the projections from IO models with caution. While they can provide valuable insights, actual effects may diverge from the model's predictions due to the complexity and variability of real-world economies.

Appendix B: Detailed Contribution Results

This appendix presents the breakout of the US LNG export sector's economic contributions by direct, indirect, and induced effects in 2023 and 2044.

Table B-1. Economic Contribution of US LNG Exports, 2023

	Direct Contribution	Indirect Contribution	Induced Contribution	Total Contribution	Total / Direct ("Multiplier") ^c
Employment (jobs) ^a	25,930	86,410	110,120	222,460	8.6
Labor Income (\$billions) ^b	\$7.2	\$8.8	\$7.2	\$23.2	3.2
GDP (\$billions)	\$17.3	\$13.4	\$13.1	\$43.8	2.5
Tax Payments (\$billions)	\$4.5	\$3.2	\$3.1	\$10.8	2.4

Source: PwC calculations using data from US Energy Information Administration, US Bureau of Labor Statistics, and the IMPLAN modeling system.

Note: Details may not add to totals due to rounding.

^a Employment is defined as the number of payroll and self-employed jobs, including part-time jobs.

^b Labor income is defined as wages and salaries and benefits as well as proprietors' income.

^c Economic multiplier represents the overall contribution (including direct, indirect, and induced effects) relative to the direct contribution.

Table B-2. Federal, State, and Local Tax Contribution of US LNG Exports: 2023

	Direct Contribution	Indirect Contribution	Induced Contribution	Total Contribution
Total Tax Contribution (\$billions)	\$4.5	\$3.2	\$3.1	\$10.8
Personal Income Taxes	\$1.1	\$1.2	\$1.0	\$3.2
Social Insurance Contributions	\$0.5	\$1.0	\$0.8	\$2.3
Sales/Use Taxes	\$1.2	\$0.4	\$0.5	\$2.1
Property Taxes	\$1.0	\$0.3	\$0.4	\$1.7
Corporate Income Taxes	\$0.4	\$0.2	\$0.3	\$0.9
Other Tax Payments	\$0.4	\$0.1	\$0.1	\$0.6

Source: PwC calculations using the IMPLAN modeling system and data from the US Energy Information Administration. Details may not add up to totals due to rounding.

Table B-3. Economic Contribution of US LNG Exports, 2044: Reference Case

	Direct Contribution	Indirect Contribution	Induced Contribution	Total Contribution	Total / Direct ("Multiplier")
Employment (jobs) ^a	59,670	198,860	257,420	515,950	8.6
Labor Income (\$billions) ^b	\$21.2	\$21.0	\$16.8	\$59.0	2.8
GDP (\$billions)	\$58.6	\$32.9	\$31.0	\$122.5	2.1
Tax Payments (\$billions)	\$10.8	\$7.7	\$7.6	\$26.1	2.4

Source: PwC calculations using data from US Energy Information Administration, US Bureau of Labor Statistics, and the IMPLAN modeling system.

Note: Details may not add to totals due to rounding.

^a Employment is defined as the number of payroll and self-employed jobs, including part-time jobs.

^b Labor income is defined as wages and salaries and benefits as well as proprietors' income.

^c Economic multiplier represents the overall contribution (including direct, indirect, and induced effects) relative to the direct contribution.

Table B-4. Federal, State, and Local Tax Contribution of US LNG Exports: 2044, Reference Case

	Direct Contribution	Indirect Contribution	Induced Contribution	Total Contribution
Total Tax Contribution (\$billions)	\$10.8	\$7.7	\$7.6	\$26.1
Personal Income Taxes	\$2.6	\$2.9	\$2.3	\$7.8
Social Insurance Contributions	\$1.2	\$2.3	\$1.9	\$5.4
Sales/Use Taxes	\$2.9	\$0.9	\$1.2	\$5.0
Property Taxes	\$2.3	\$0.8	\$1.0	\$4.1
Corporate Income Taxes	\$1.0	\$0.5	\$0.7	\$2.2
Other Tax Payments	\$0.8	\$0.3	\$0.5	\$1.6

Source: PwC calculations using the IMPLAN modeling system and data from the US Energy Information Administration. Details may not add up to totals due to rounding.

Table B-5. Economic Contribution of US LNG Exports, 2044: High Growth Case

	Direct Contribution	Indirect Contribution	Induced Contribution	Total Contribution	Total / Direct ("Multiplier") ^c
Employment (jobs) ^a	105,050	350,070	446,140	901,260	8.6
Labor Income (\$billions) ^b	\$37.3	\$37.0	\$29.6	\$103.9	2.8
GDP (\$billions)	\$103.2	\$57.9	\$54.6	\$215.7	2.1
Tax Payments (\$billions)	\$19.1	\$13.6	\$13.3	\$46.0	2.4

Source: PwC calculations using data from US Energy Information Administration, US Bureau of Labor Statistics, and the IMPLAN modeling system.

Note: Details may not add to totals due to rounding.

^a Employment is defined as the number of payroll and self-employed jobs, including part-time jobs.

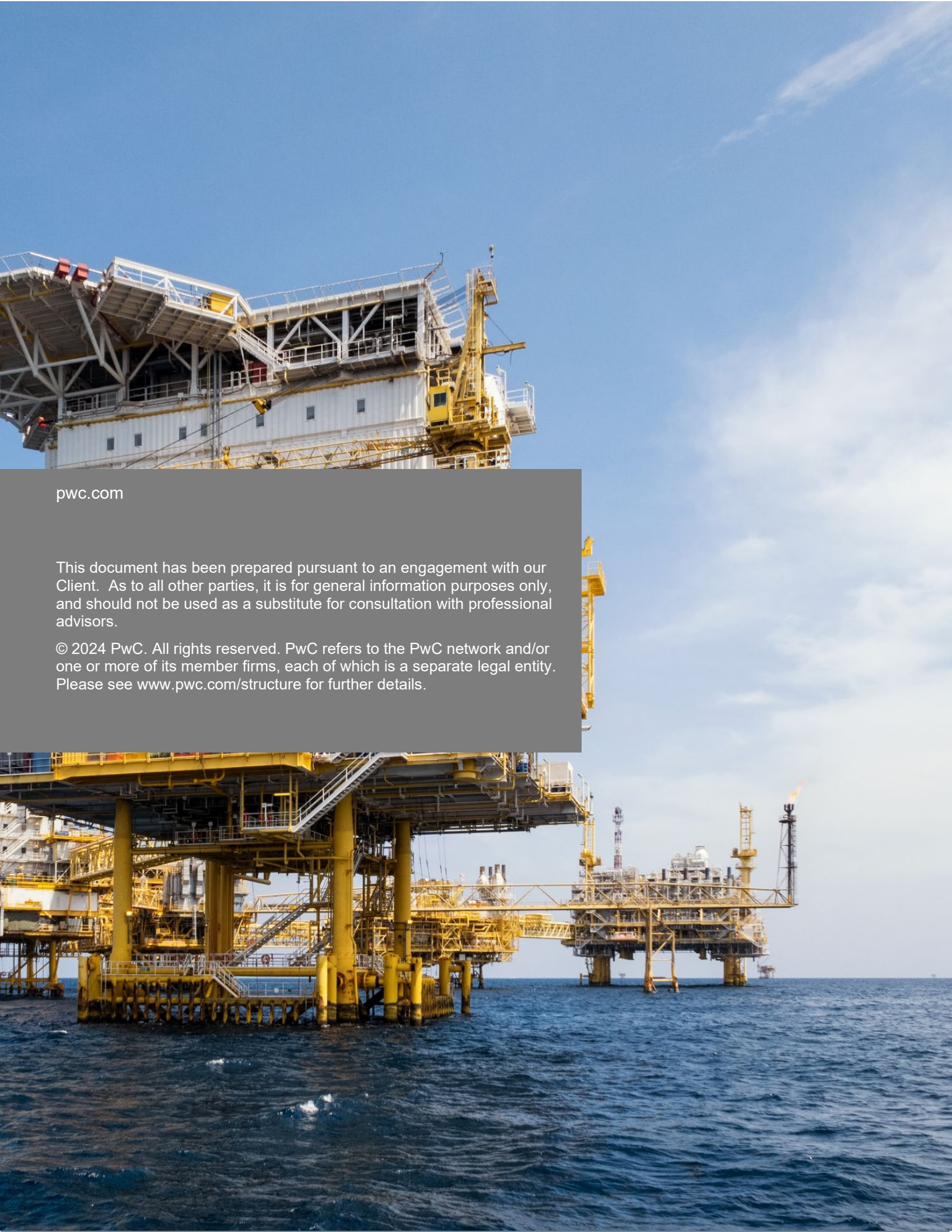
^b Labor income is defined as wages and salaries and benefits as well as proprietors' income.

^c Economic multiplier represents the overall contribution (including direct, indirect, and induced effects) relative to the direct contribution.\

Table B-6. Federal, State, and Local Tax Contribution of US LNG Exports: 2044, High Growth Case

	Direct Contribution	Indirect Contribution	Induced Contribution	Total Contribution
Total Tax Contribution (\$billions)	\$19.1	\$13.6	\$13.3	\$46.0
Personal Income Taxes	\$4.6	\$5.1	\$4.1	\$13.8
Social Insurance Contributions	\$2.1	\$4.1	\$3.4	\$9.6
Sales/Use Taxes	\$5.1	\$1.6	\$2.2	\$8.9
Property Taxes	\$4.1	\$1.3	\$1.8	\$7.2
Corporate Income Taxes	\$1.8	\$1.0	\$1.2	\$4.0
Other Tax Payments	\$1.4	\$0.5	\$0.6	\$2.5

Source: PwC calculations using the IMPLAN modeling system and data from the US Energy Information Administration. Details may not add up to totals due to rounding.



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