U.S. LNG Exports:

State-Level Impacts on Energy Markets and the Economy

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Submitted by:
ICF International
9300 Lee Highway
Fairfax, VA USA

ICF Contact
Harry Vidas
703-218-2745

Other ICF Contributors
Briana Adams
William Pepper
Robert Hugman
Warren Wilczewski
Thu Nguyen

Submitted to:
American Petroleum Institute
1220 L Street NW
Washington, D.C. 20005

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Key Findings on State-Level Economic Impacts of U.S. LNG Exports

This state-level study follows a national-level study on the economic and employment impacts of liquefied natural gas (LNG) exports from the United States done on behalf of the American Petroleum Institute (API).[1]

National study assessed LNG export impacts on three export levels:

- ***ICF Base Case (4 Bcfd)***
- ***Middle Exports Case (8 Bcfd)***
- ***High Exports Case (16 Bcfd)***

Note: Bcfd denotes billion cubic feet per day.

This state-level analysis allocates national-level LNG export impacts among each U.S. state. Similar to the national-level study, which found overwhelmingly positive economic and employment impacts associated with LNG exports, this study concludes that LNG exports have a net positive impact, or negligible net impact, across all states.

Largest impacts found in states with:

- ***Natural gas, oil, and natural gas liquids (NGL) production***
- ***LNG production***
- ***Ethylene manufacturing***
- ***Industries supplying materials, products, and services to the oil and gas and petrochemical industries***
- ***Consumer spending activity generated by gas- and petrochemical-related activities***

Economic Impacts: Of the up to $115 billion net Gross Domestic Product (GDP) value added generated by LNG exports in 2035, natural gas-producing states such as Texas, Louisiana and Pennsylvania are expected to see increases in state income up to $10-$31 billion that year. Non-natural-gas-producing states with a large manufacturing base, such as Ohio, California, New York, and Illinois, see significant impacts, up to $2.6-$5.0 billion in 2035.

Employment Impacts: LNG exports are expected to contribute up to 665,000 net job gains nationwide in 2035, with all states seeing net positive employment impacts from LNG exports.[1] As with state income impacts, gas-producing states are expected to see the largest employment impacts, with Texas, Louisiana, and Pennsylvania expected to achieve up to 60,000-155,000 job gains in 2035. Large manufacturing states such as California and Ohio could see up to 30,000-38,000 job gains in 2035.

2035 State Income and Employment Impacts for Top Ten States

State	2035 Maximum State Income Changes ($2010 Billion)			2035 Maximum State Employment Changes (No.)		
	ICF Base Case	Middle LNG Exports Case	High LNG Exports Case	ICF Base Case	Middle LNG Exports Case	High LNG Exports Case
TX	$5.2	$12.1	$31.4	28,019	61,752	155,713
LA	$5.0	$11.8	$16.2	21,795	52,568	74,218
PA	$2.8	$6.7	$10.3	16,650	38,565	59,289
AK	$0.0	$0.0	$10.0	99	88	36,622
OH	$1.2	$2.6	$5.1	7,483	14,819	30,124
CA	$1.1	$2.3	$5.0	8,756	15,701	38,981
NY	$0.8	$1.6	$3.3	5,688	10,602	24,985
WY	$0.7	$1.7	$3.3	4,302	9,454	17,854
AR	$0.9	$2.1	$3.1	5,321	12,438	18,285
IL	$0.6	$1.2	$2.6	3,995	7,117	17,341

Note: Calculated using an economic multiplier of 1.9.

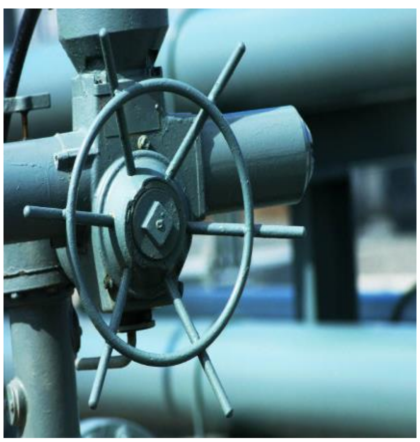
[1] Study available at http://www.api.org/~/media/Files/Policy/LNG-Exports/API-LNG-Export-Report-by-ICF.pdf.

Manufacturing Across the LNG Value Chain

Upstream
- **Natural gas and liquids drilling and production manufacturing needs: Drill pipe and steel casing, cement, compressor equipment, tanks, control systems**

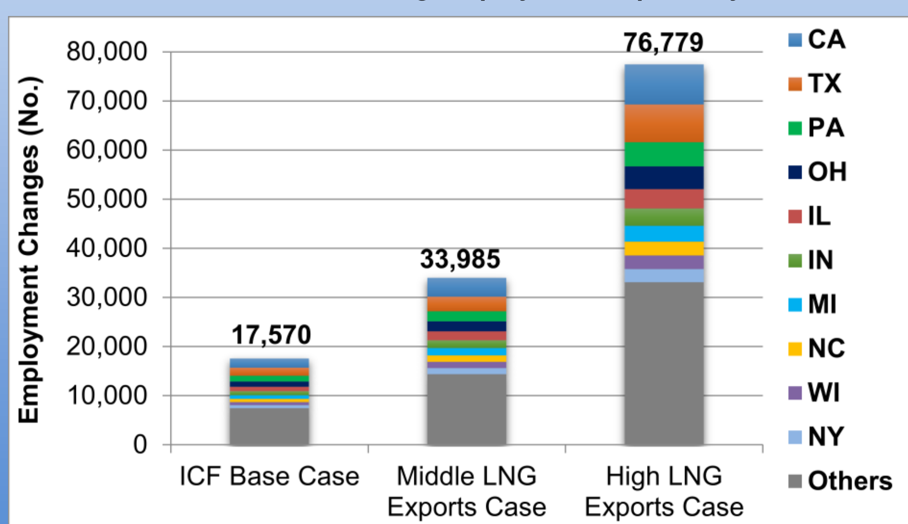
Midstream
- **Natural gas processing and transport manufacturing needs: Pipeline, materials for processing facility construction**

Down-stream
- **Liquids refining, petrochemical processing, liquefaction plant manufacturing needs: Construction materials and equipment, LNG port facilities**



Manufacturing Employment Impacts: Of the up to net 77,000 manufacturing jobs generated by LNG exports by 2035, states such as California, Texas, Pennsylvania, and Ohio are expected to see gains of up to 4,600-8,200 in 2035. In addition to the in-state construction and maintenance generating manufacturing jobs for gas-producing states such as Texas and Pennsylvania, out-of-state manufacturing is required for production of steel, cement, and equipment.

2035 State Manufacturing Employment Impacts by State



Note: Calculated using an economic multiplier of 1.9. The table shows maximum impacts for all states, and shows maximum impacts for states with a potential LNG export terminal.

Key Takeaways:

- ***Economic and employment impacts to states positive, or negligible***
- ***Manufacturing of natural gas production equipment and materials is expected to generate significant job gains in a number of states***
- ***The largest overall impacts are found in states with natural gas production, liquefaction plants, and petrochemical industries, as well as states providing goods and services (e.g., manufacturing) to those sectors***

Glossary

Abbreviations

AEO	EIA Annual Energy Outlook
Bcf/day (or Bcfd)	Billion cubic feet of natural gas per day
Btu	British thermal unit, used to measure fuels by their energy content.
DES	Delivered Ex Ship
EIA	U.S. Energy Information Administration, a statistical and analytical agency within the U.S. Department of Energy
FOB	Free on Board
GDP	Gross Domestic Product
GTL	Gas-to-liquids
LNG	Liquefied Natural Gas
Mcf	Thousand cubic feet (volume measurement for natural gas)
MMcf	Million cubic feet (of natural gas)
MMBtu	Million British Thermal Units. Equivalent to approximately one thousand cubic feet of gas
MMBOE	Million barrels of oil equivalent wherein each barrel contains 5.8 million Btus.
MMbbl	Million barrels of oil or liquids
NAICS Codes	North American Industrial Classification System Codes
NGL	Natural Gas Liquids
Tcf	Trillion cubic feet of natural gas

Terms Used

Consumer Surplus – an economic concept equal to the area below the demand curve down to a horizontal line drawn at the market price. Used in this report to measure the benefits provided to consumers brought about by lower natural gas prices, lower electricity costs, and lower manufacturing prices.

Direct Impacts – immediate impacts (e.g., employment or value added changes) in a sector due to an increase in output in that sector.

Horizontal Drilling – the practice of drilling a horizontal section in a well (used primarily in a shale or tight oil well), typically thousands of feet in length.

Indirect Impacts – impacts due to the industry inter-linkages caused by the iteration of industries purchasing from other industries, brought about by the changes in direct output.

Induced Impacts – impacts on all local and national industries due to consumers' consumption expenditures rising from the new household incomes that are generated by the direct and indirect effects flowing through to the general economy. The term is used in industry-level input-output modeling and is similar to the term Multiplier Effect used in macroeconomics.

Multiplier Effect – describes how an increase in some economic activity produces a cascading effect through the economy by producing "induced" economic activity. The multiplier is applied to the total of direct and indirect impacts to estimate the total impact on the economy. The term is used in macroeconomics and is similar to the term Induced Impacts as used in industry-level input-output modeling.

Natural Gas Liquids – components of natural gas that are in gaseous form in the reservoir, but can be separated from the natural gas at the wellhead or in a gas processing plant in liquid form. NGLs include ethane, propane, butanes, and pentanes.

Original Gas-in-Place – industry term that specifies the amount of natural gas in a reservoir (including both recoverable and unrecoverable volumes) before any production takes place.

Original Oil-in-Place – industry term that specifies the amount of oil in a reservoir (including both recoverable and unrecoverable volumes) before any production takes place.

Oil and Gas Value Chain

- **Upstream Oil and Gas Activities –** consist of all activities and expenditures relating to oil and gas extraction, including exploration, leasing, permitting, site preparation, drilling, completion, and long term well operation.
- **Midstream Oil and Gas Activities –** consist of activities and expenditures downstream of the wellhead, including gathering, gas and liquids processing, and pipeline transportation.

- **Downstream Oil and Gas Activities** – activities and expenditures in the areas of refining, distribution and retailing of oil and gas products.

Oil and Gas Resource Terminology

- **Conventional gas resources** – generally defined as those associated with higher permeability fields and reservoirs. Typically, such as reservoir is characterized by a water zone below the oil and gas. These resources are discrete accumulations, typified by a well-defined field outline.

- **Economically recoverable resources** – represent that part of technically recoverable resources that is expected to be economic, given a set of assumptions about current or future prices and market conditions.

- **Proven reserves** – the quantities of oil and gas that are expected to be recoverable from the developed portions of known reservoirs under existing economic and operating conditions and with existing technology.

- **Technically recoverable resources** – represent the fraction of gas in place that is expected to be recoverable from oil and gas wells without consideration of economics.

- **Unconventional gas resources** – defined as those low permeability deposits that are more continuous across a broad area. The main categories are coalbed methane, tight gas, and shale gas, although other categories exist, including methane hydrates and coal gasification.

- **Shale gas and tight oil** – recoverable volumes of gas, condensate, and crude oil from development of shale plays. Tight oil plays are those shale plays that are dominated by oil and associated gas, such as the Bakken in North Dakota.

- **Coalbed methane** (CBM) – recoverable volumes of gas from development of coal seams (also known as coal seam gas, or CSG).

- **Tight gas** – recoverable volumes of gas and condensate from development of very low permeability sandstones.

Conversion Factors

Volume of Natural Gas

1 Tcf = 1,000 Bcf

1 Bcf = 1,000 MMcf

1 MMcf = 1,000 Mcf

Energy Content of Natural Gas (1 Mcf is one thousand cubic feet)

1 Mcf = 1.025 MMBtu

1 Mcf = 0.177 barrels of oil equivalent (BOE)

1 BOE = 5.8 MMBtu = 5.65 Mcf of gas

Energy Content of Crude Oil

1 barrel = 5.8 MMBtu = 1 BOE

1 MMBOE = 1 million barrels of crude oil equivalent

Energy Content of Other Liquids

Condensate

1 barrel = 5.3 MMBtu = 0.91 BOE

Natural Gas Plant Liquids

1 barrel = 4.0 MMBtu = 0.69 BOE (actual value varies based on component proportions)

Example Gas Compositions and Conversion Factors (based on 14.7 psi pressure base)

Natural Gas Component	US Pipeline Gas Composition (%)	LNG Made from US Pipeline Gas (%)	LNG from Australia NWS Gas Composition (%)	Btu/scf	Pounds/ Mscf
Methane	95.91%	97.56%	87.3%	1,030	42.3
Ethane	1.45%	1.48%	8.3%	1,743	79.3
Propane	0.48%	0.49%	3.3%	2,480	116.3
C_4+	0.16%	0.16%	1.0%	3,216	153.3
CO_2 *	1.70%	0.00%	0.0%	-	116.0
N_2	0.30%	0.31%	0.0%	-	73.8
Sum	100.00%	100.00%	100.00%		
Btu/scf	1,030	1,048	1,159		
Pounds / Mscf	44.50	43.26	48.95		
Metric tonnes per million scf	20.18	19.62	22.20		
Bil. scf per million metric tonnes	49.54	50.96	45.04		
Bil scf/day per mm MT/year (Bcfd/MTPA)	0.136	0.140	0.123		
MTPA/Bcfd	7.37	7.16	8.10		

Source: ICF estimates

* US pipelines have 2% or 3% limit on inerts (carbon dioxide and nitrogen). To make LNG all CO_2 must be removed.

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1 Executive Summary

In order to inform the current policy debate surrounding the granting of licenses for U.S. exports of liquefied natural gas (LNG), the American Petroleum Institute (API) commissioned ICF International to undertake a study of the energy market and economic impacts of LNG exports. That study was released in May 2013. The original national-level study assessed the economic and employment impacts of three LNG export scenarios: the ICF Base Case of 4 Bcfd, the Middle LNG Exports Case of 8 Bcfd, and the High LNG Exports Case of 16 Bcfd.

More recently, API tasked ICF with undertaking a follow-up study to assess the economic and employment impacts on a state-level basis, allocating the national-level impacts among states. This study concludes that LNG exports have a net positive, or negligible, impact across all states.[2]

Economic Impacts of LNG Exports

Largest economic gains found in states with the largest natural gas production impacts. However, states with LNG export terminals and states with equipment manufacturing would also see significant positive impacts.

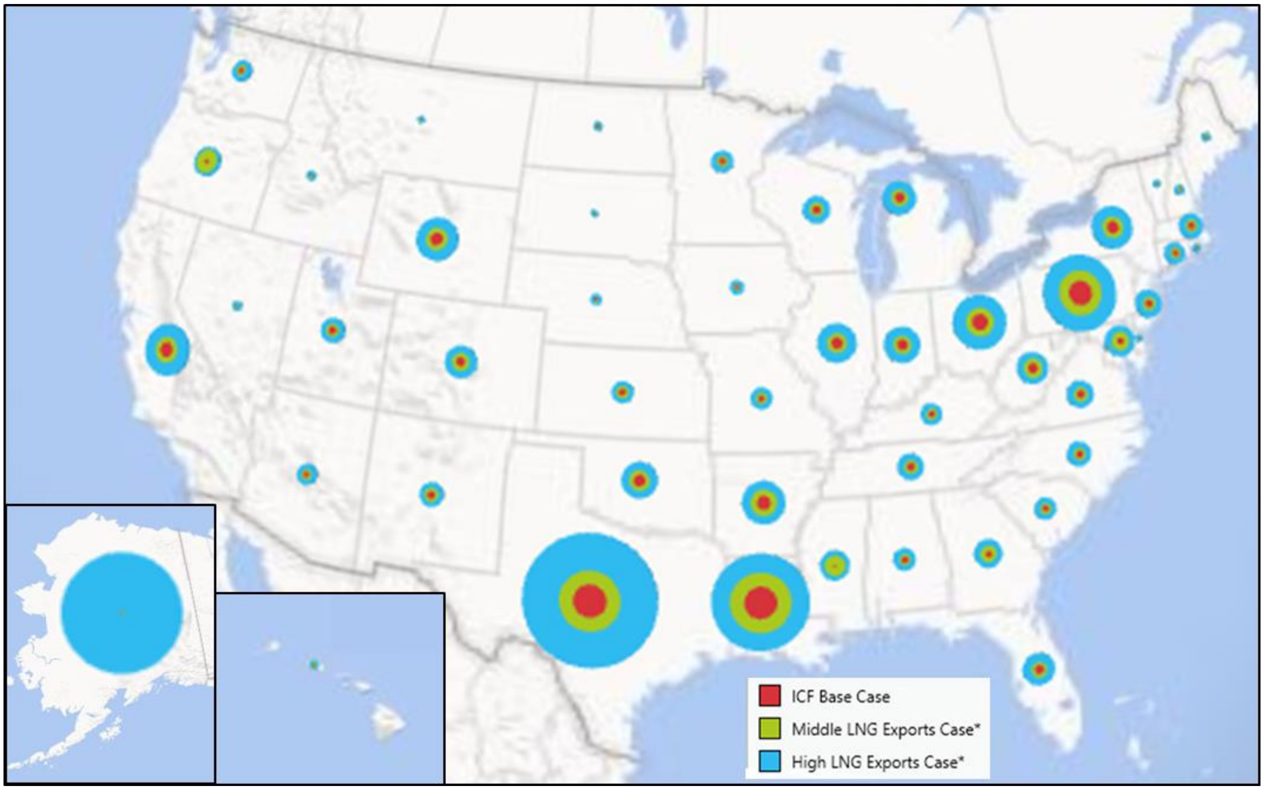
- Significant economic gains found across states: Economic impacts for natural gas-producing states such as Texas, Louisiana and Pennsylvania see increases ranging from $10-$31 billion in 2035. Non-producing states such as California, New York, and Illinois see state income gains up to $2.6-$5.0 billion in 2035.[3]
- Largest level impacts are seen across a diverse number of states: Texas, Louisiana, and Alaska benefit from large-scale hydrocarbon production and in-state LNG export terminals. Other large hydrocarbon producers such as Pennsylvania, Wyoming, Arkansas, and Oklahoma also experience large gains as do manufacturing-intensive states, such as Ohio, Indiana, and California.
- LNG terminals generate significant in-state economic activity: LNG terminals are a long-term investment, requiring significant capital outlays and continuing labor and material inputs. States with LNG terminals see large increases in state incomes resulting from LNG exports. Alaska is a good example. Without an in-state LNG terminal, Alaska shows negligible income and employment impacts from LNG exports. The construction of a 2.25 Bcfd terminal which begins to export in 2023 in the High LNG Export Case generates significant income for the state. Alaska could see up to $10 billion in state income and over 36,000 jobs in 2035 resulting from LNG exports.

[2] "Negligible" defined for this report as less than 0.05% (positive or negative) of the base year state income (2010) or state employment (2012) as projected for the year 2035.

[3] State income is the sum of all income earned in the state, including employee compensation, proprietors' income, other property-type income, and indirect business taxes. State income can differ from gross state product (GSP) in that state income includes proprietor and other property-type income based on the location of business owners and shareholders, rather than the location of the economic activity as measured in GSP.

Exhibit 1-1 below shows the general economic impacts by state for each of the three LNG export cases by state. While states such as Alaska have a significant impact only in one case, Texas shows significant impacts in all three LNG export cases.

Exhibit 1-1: Map of 2035 Relative Income Impacts from LNG Exports (By State Income)



Source: ICF estimates

Note: Calculated using an economic multiplier of 1.9. The circle sizes represent the relative income impact of each state for each LNG export case.

* The Middle Case values are the average of four Terminal Location Cases (TLCs) and the High Case values are an average of five TLCs except that values for the seven LNG terminal states (AK, GA, LA, MD, MS, OR, TX) show impacts with at least one in-state LNG export terminal.

Employment Impacts

- Net positive employment impacts: Nationwide, LNG exports are expected to generate a net increase of up to 665,000 job gains by 2035, with all states expected to see net positive employment impacts from LNG exports.[4]
- Oil and gas jobs generate the largest impacts: The largest job gains are in states with natural gas production, liquefaction plants, and petrochemical industries. Texas and

[4] Calculated assuming an economic multiplier of 1.9. Given the significant uncertainty surrounding the actual level of consumer spending generated by a change in the economy (such as LNG exports), ICF developed a range of potential impacts, based on previous ICF work. The multiplier effect in the original study ranged from 1.3 to 1.9, meaning that every $1 of direct and indirect income generated would produce an addition $0.30 to $0.90 in consumer spending throughout the economy. The 1.3 multiplier represents the lower-bound estimate of total economic impacts, and the 1.9 multiplier represents the upper-bound estimate. Annual values for the seven LNG terminal states (AK, GA, LA, MD, MS, OR, TX) show impacts with an in-state LNG export terminal. All dollar amounts herein are in 2010 dollars, unless otherwise specified.

Louisiana, benefiting from natural gas production, LNG export terminals, and petrochemical facility construction are expected to see gains up to 74,000-155,000 jobs in 2035.

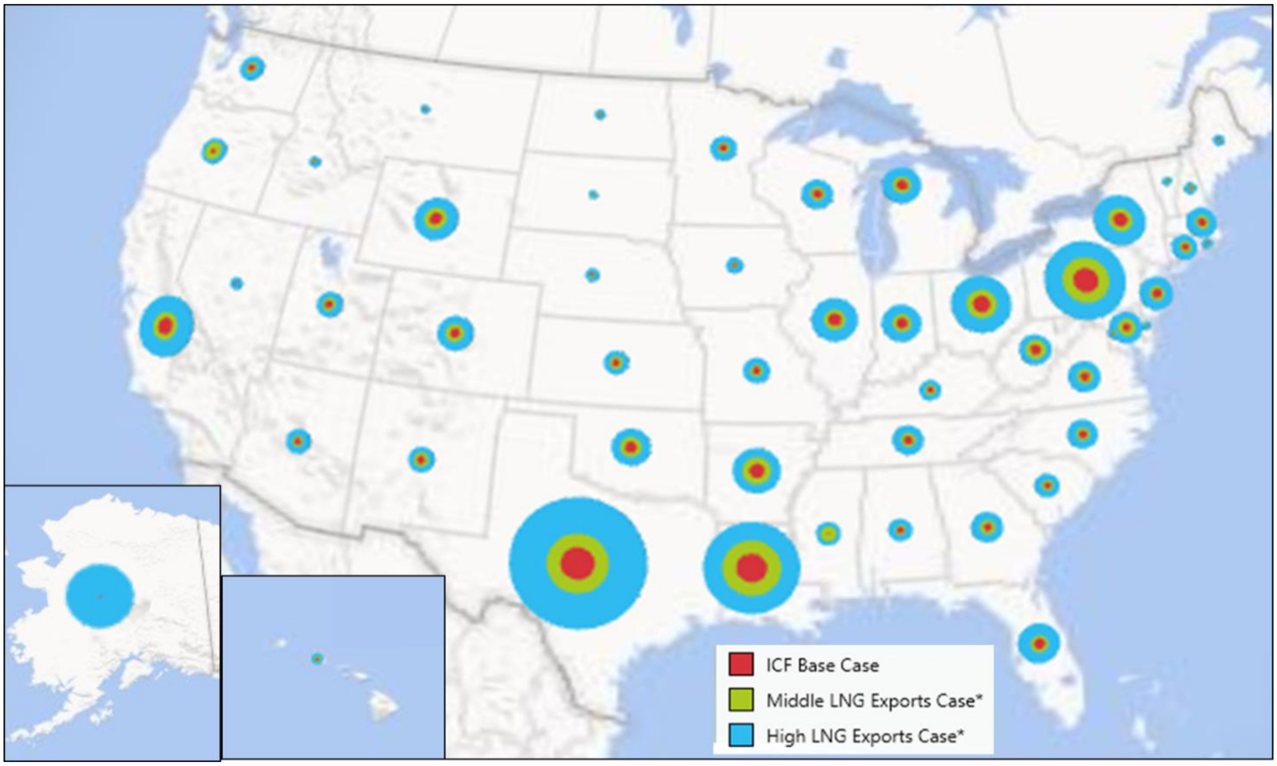
- Significant multiplier effect generated in consumer-oriented states: States such as California and New York that do not directly participate significantly in unconventional natural gas production and/or LNG-related industries see positive net job gains, reaching up to 40,000 and 25,000 jobs, respectively, by 2035. This comes about because job gains from a larger U.S. economy offset job losses stemming from higher energy costs. Job losses occur in consumer-related activities such as retail, housing, food, entertainment, and consumer products as more of consumers' income goes to natural gas and electricity bills due to a slight increase in natural gas and electricity costs.

States with natural gas production, liquefaction plants, and petrochemical processing are expected to see significant employment gains with LNG exports.

- However, the positive economic impacts in states such as New York would be significantly greater if unconventional energy production were allowed.

Exhibit 1-2 below shows the relative employment impacts of LNG exports by state for each case. Similar to the state income impacts, employment gains are concentrated in areas with large natural gas production (e.g., Texas, Louisiana, Pennsylvania), as well as large manufacturing states (such as California, Ohio, New York, and Indiana).

Exhibit 1-2: Map of 2035 Relative Employment Impacts from LNG Exports (By State Employment)



Source: ICF estimates

Note: Calculated using an economic multiplier of 1.9. The circle sizes represent the relative employment impact of each state for each LNG export case.

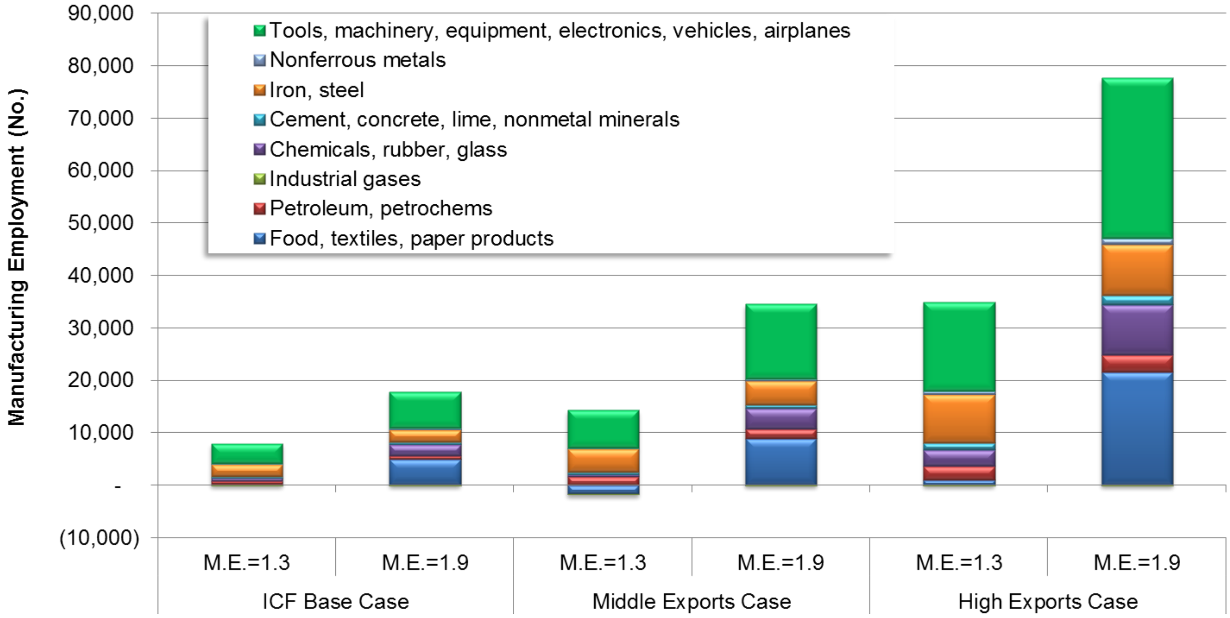
* The Middle Case values are the average of four Terminal Location Cases (TLCs) and the High Case values are an average of five TLCs except that values for the seven LNG terminal states (AK, GA, LA, MD, MS, OR, TX) show impacts with at least one in-state LNG export terminal.

Manufacturing Impacts

> ***Manufacturing of gas/oil equipment and servicing are expected to generate the largest manufacturing impacts, though consumer spending will generate demand for consumer goods, further stimulating manufacturing.***

- <u>Manufacturing-intensive states show strong gains associated with natural gas-related activities</u>: <u>Consumer spending also generates manufacturing job gains</u>: Manufacturing states, such as Ohio and Indiana, benefit from LNG exports by manufacturing steel products (e.g., drill pipe, casing and structural steel), cement (for well and industrial plant construction), and various kinds of production equipment (pumps compressors, turbines, heat exchangers, pressure vessels, tanks, meters, control systems, etc.) required for natural gas/oil production, processing, transport, and construction of LNG export terminals. Ohio and Indiana see up to 4,600 and 3,500 manufacturing employment gains from LNG exports by 2035, respectively. Exhibit 1-3 below shows the general categories of manufacturing job impacts attributable to LNG exports. Machinery and tools make up the largest share of manufacturing.

Exhibit 1-3: 2035 Manufacturing Jobs Changes



Source: ICF

- Consumer spending generates manufacturing job gains: As employees of natural gas production companies, LNG export terminals, and equipment manufacturers generate additional consumer spending, demand for consumer-related manufacturing (such as cars and electronics) will further stimulate U.S. manufacturing. California, with the largest number of U.S. manufacturing jobs for consumer-oriented products such as food, textiles, paper products, tools, machinery, electronics, and vehicles is expected to see manufacturing employment gains exceeding 8,000 by 2035.[5]

Factors Driving Changes by State

Economic and employment impacts of LNG exports varies across states for a number of reasons:

- Natural gas and hydrocarbon liquids production changes: LNG exports lead to an increase in natural gas production, which also results in additional oil and natural gas liquids (NGL) productions; thus states with production activities see significant economic and employment impacts.
- LNG export facility location: LNG export terminals require billions of dollars in long-term investment. ICF assumed a range of potential locations for the LNG export terminals

[5] Based on 2012 employment data by sector from the U.S. Bureau of Labor Statistics. Data based on North American Industry Classification System (NAICS) codes including manufacturing of food, textile, paper products, tools, machinery, equipment, electronics, vehicles, and airplanes.

throughout the U.S., given the uncertainty surrounding export permits. States assumed for LNG exports in at least one case in this study include Alaska, Georgia, Louisiana, Maryland, Mississippi, Oregon, and Texas.

> ***Economic and employment impacts of LNG exports varied by state primarily due to:***
> - ***Location of natural gas production increases***
> - ***LNG export facilities' location***
> - ***Where supporting industries are located***
> - ***Size of natural gas and electricity consumer base***
> - ***Size of the state economy***

- Location of natural gas-related industries: Natural gas processing and petrochemical facilities are typically located near natural gas production areas; thus, states with natural gas production benefited from these increases. Drilling equipment and production materials are often located out-of-state. States manufacturing these types of equipment (e.g., Ohio, Wisconsin, Michigan) benefit from gas production activities.
- Natural gas and electricity consumer base: LNG exports may lead to a slight increase in natural gas and electricity costs, or an increase of roughly $0.10 per million British Thermal Units (MMBtu) for every one billion cubic feet per day (Bcfd) of LNG exports. Thus, states with large natural gas and electricity consumer bases with little or no offsetting direct natural gas industry impacts do not experience as large of a positive impact from the induced impact of LNG exports.
- Size of the state economy: Most income from natural gas-related activities remains within the producing state and in states supplying needed materials, and products and services. Income is also earned throughout the country in the form of stockholder dividends and capital gains (see Section 3 for more details). Thus, a portion of natural gas-related earnings was assumed to move out-of-state, and were apportioned by the relative size of each state's economy. For example, it is assumed that New York has more natural gas-related stockholders than Montana, based on the relative sizes of the two economies.
- Consumer spending generates job gains: Additional consumer spending is created as employees of natural gas production companies, LNG export terminals, and equipment manufacturers purchase consumer-related goods and services. This activity further stimulates the U.S. economy, with larger states such as California and New York seeing the greatest impacts.

2 Introduction

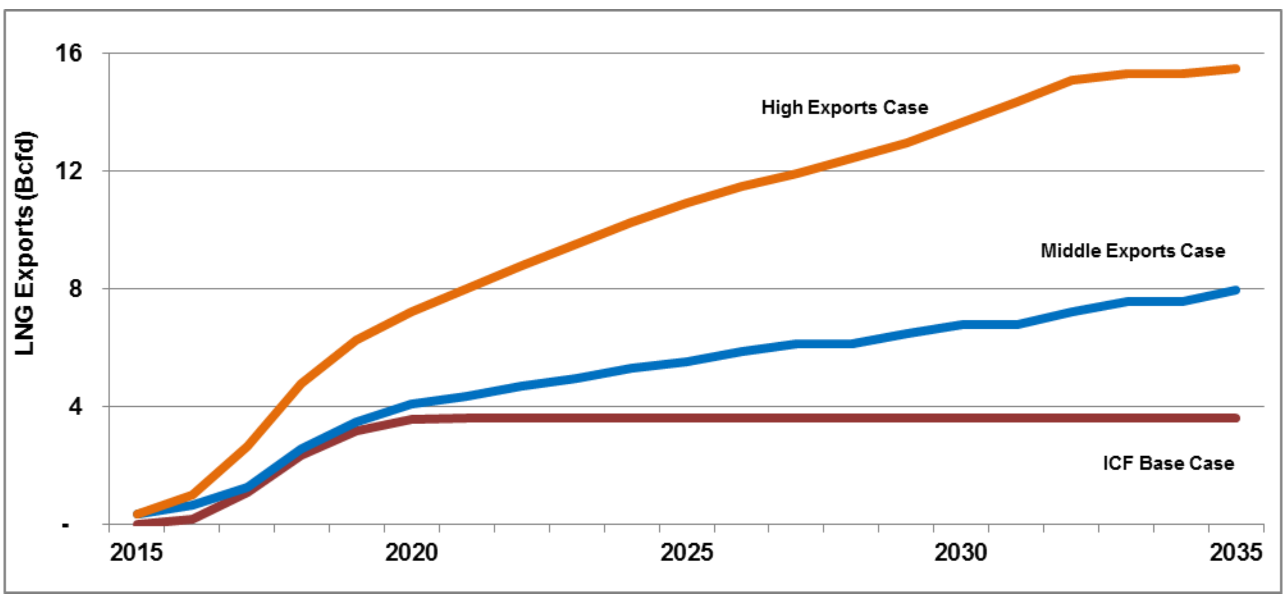
In order to inform the current policy debate surrounding the granting of licenses for U.S. exports of liquefied natural gas (LNG), the American Petroleum Institute (API) commissioned ICF International to undertake a study of the energy market and economic impacts of LNG exports. That study was released in May 2013. More recently, API tasked ICF with undertaking a follow-up study to assess the economic and employment impacts on a state-level basis.

The scope of this study is to estimate the state-level impacts of LNG exports on the U.S. economy for the timeframe through the year 2035 using the databases, algorithms, and models typically employed by ICF in analyzing U.S. and international natural gas markets.

The original U.S. LNG exports study assessed four fixed LNG export scenarios, which were analyzed in ICF's proprietary Gas Market Model (GMM), providing forecasts of North American natural gas markets. Cases include one assuming no exports, another case based upon ICF's own Second Quarter 2013 Base Case, and two additional LNG export cases that assumed moderately higher and significantly higher amounts of LNG exports as compared to the ICF Base Case.

i. *Zero Exports Case:* designated as the "Reference Case" for this study
ii. *ICF Base Case:* ~4 Bcfd of U.S. LNG exports in 2035
iii. *Middle Exports Case:* ~8 Bcfd of U.S. LNG exports in 2035
iv. *High Exports Case:* ~16 Bcfd of U.S. LNG exports in 2035

Exhibit 2-1: LNG Export Cases Relative to Zero LNG Exports Case (Bcfd)



Source: ICF estimates

The national-level impacts of LNG exports from the original API study are included in Exhibit 2-2. This follow-on study allocates these national economic and employment changes by state.

Exhibit 2-2: Key Economic Impacts Relative to the Zero Exports Case

Impact (2016-2035 Averages)*	LNG Export Case (Change from Zero Exports Case)		
	ICF Base Case (up to ~4 Bcfd)	Middle Exports Case (up to ~8 Bcfd)	High Exports Case (up to ~16 Bcfd)
Employment Change (No.)	73,100-145,100	112,800-230,200	220,100-452,300
GDP Change (2010$ Billion)	$15.6-$22.8	$25.4-$37.2	$50.3-$73.6
Henry Hub Price (2010$/MMBtu)	$5.03	$5.30	$5.73
Henry Hub Price Change (2010$/MMBtu)	$0.32	$0.59	$1.02

*Source: ICF estimates. Note: * Includes direct, indirect, and induced impacts*

This report is organized in the following sections:

- Section 1: Executive Summary
- Section 2: Introduction
- Section 3: Study Methodology and Assumptions
- Section 4: Economic and Employment Impacts on the U.S. Economy
- Section 5: Key Conclusions
- Section 6: Bibliography

3 Study Methodology and Assumptions

This follow-on state-level study distributes national-level impacts of LNG exports among 50 U.S. states. The following section describes ICF's methodology for allocating these impacts among states. Note that, as with the national-level impacts in the original study, all state-level impacts are the *incremental* impacts associated with LNG exports, relative to the Zero LNG Exports Case, rather than absolute levels in the state.

Assessing national-level impacts is a more straightforward process than allocating impacts among each state, given the significant uncertainty surrounding which states the LNG exports terminals will be located and from which states materials, equipment, and services will be purchased. For example, LNG export terminals require turbines to power compressors used for refrigeration. There are multiple states (in addition to international manufacturers) producing turbines and turbine parts. Thus, determining which state will receive the economic gain associated with turbine purchases is difficult. In addition, impacts allocated among the states exclude a certain level of assumed imports, the level of which is also uncertain. This study assumed 16% of value added from LNG exports will go toward imported materials, equipment, and services, and thus, do not contribute to U.S. economic gains. This was also assumed in the national impacts assessment.[6]

Significant uncertainty surrounding actual inter-state purchases makes state-level analysis a more difficult process than conducting national-level economic analysis.

For this study, in order to distribute national-level economic and employment impacts across states, a number of state-level "allocators" were needed. The allocation matrices were based either on model results (e.g., changes in natural gas production by year and state), historical relationships between national and state incomes (e.g., location of the iron and steel factories), or published industry plans (e.g., location of new ethylene plants). There were several allocation matrices that were applied individually or in combination to allocate each type of projected GDP and job change.

ICF used proprietary modeling or publicly available state-level data as "allocators" to distribute national-level economic and employment impacts of LNG exports across 50 U.S. states and the District of Columbia.

State-by-state allocations for gas-related activities are based on both the physical location of activities (e.g., locations of LNG export terminals and petrochemical plants) and the location of gas-related company stockholders. For the former, ICF relied on forecasts on gas-related activity, such as locations of LNG export terminals, oil and gas production activity, gas-related processing and petrochemical plants, and gas-related equipment manufacturing facilities. For the latter, ICF assumed that large-scale companies such as oil and gas producers, LNG export terminal operators, owners of petrochemical plants have shareholders throughout the country. Thus, the portion of economic impacts of these activities related to company stockholders was allocated among states using the distribution of state income. For example, while a major U.S. oil and gas producer may focus production in a small number of

[6] Based on the U.S. national average ratio of imports to GDP.

states, the company's stockholders are distributed throughout the country. Thus, ICF uses a number of allocators to account for the economic activity generated in production states, as well as economic gains to the firm's stockholders outside the state.

The methodology for this study consisted of 8 main steps, which are highlighted in Exhibit 3-1 and explained in further detail in this section.

Exhibit 3-1: Study Steps

Step #	Description
1	Extract GDP and employment data by sector from prior API study for allocation by state.
2	Extract gas production from prior API study to estimate gas production increases by state.
3	Create state-level allocators for economic and employment data.
4	Create state-level allocators for gas-to-liquids (GTLs), chemicals, and petrochemicals based on data for actual and planned plants.
5	Create state-level allocators for all planned LNG export terminal locations.
6	Create alternative cases based on the original LNG export scenarios, varying location of the liquefaction terminals.
7	Create alternative case for inclusion of Alaska LNG project in only the High LNG Exports Case.
8	Process each of the three export scenarios (approximately 4, 8, or 16 Bcfd) across the various terminal location cases to determine the range of possible state-level income and employment impacts.

Each task for this study is discussed below.

Step 1: Extract GDP and employment data by sector from prior API work and organize into matrices.

The original LNG exports study assessed the GDP value added and employment contributions of LNG exports, dividing up impacts by source. The main sources of economic and employment changes are as follows:

***Direct Impacts** represent the impacts (e.g., employment or output changes) in Sector A due to greater demand for and output from Sector A (e.g., LNG exports).*

***Indirect Impacts** represent the impacts outside of Sector A in those industries that supply or contribute to the production of intermediate goods and services to Sector A (e.g., natural gas production equipment required to generate natural gas and later LNG).*

1) Direct and indirect changes

i. Impacts associated with an increase in physical volumes of oil, gas, and NGLs: The positive economic impacts are led by LNG production (i.e., the value of LNG exports), followed by gains to natural gas and electricity producers, and hydrocarbon liquids production. Gas, oil, and NGL production (e.g., value of LNG, value of liquids, value of petrochemicals produced), the manufacturing equipment required for production, the materials manufacturing required for production (e.g., sand for hydraulic fracturing proppants, steel for drill pipe, cement for drilling, construction materials for LNG export terminals, among others). In addition, gains to stockholder dividends and capital gains from LNG export activities also generate activity around the country.

ii. Impacts associated with increasing natural gas costs due to LNG exports: The negative economic impacts are associated with the consumer impacts of slightly higher natural gas and electricity costs that result from LNG exports. Natural gas cost increases reduce natural gas demand (and gas-fired electricity consumption), meaning consumers must allocate an increasing share of income to natural gas and electricity outlays (rather than on other consumer purchases). In addition, with higher energy costs, economic contributions from energy-intensive industrial producers (e.g., chemical and petrochemicals, glass, industrial gases) may decrease.

The sources from which impacts arise include the change in GDP and employment from LNG exports, NGL production, additional petrochemicals production (due to increased NGL volumes), and consumer impacts. While increased natural gas and NGL production will generate additional value added and employment, the increase in natural gas costs associated with LNG exports will translate to higher natural gas and electricity costs for consumers. Higher costs will reduce consumption of natural gas and electricity, particularly in the case of energy-intensive consumers.

2) Multiplier effect changes

i. Cumulative impacts, including additional consumer spending generated by direct and indirect activities: The cumulative impacts of spending of income earned in the direct and indirect sectors and subsequent spending of income in each successive round. The net positive direct and indirect changes in economic and employment activity will generate additional consumer spending, producing induced economic and employment activity.

Induced or "Multiplier Effect" Impacts ***represent the cumulative impacts of spending of income earned in the direct and indirect sectors and subsequent spending of income in each successive round. Examples include a restaurant worker who takes a vacation to Florida, or a store owner who sends children to college, based on higher income that arises from the initial activity of LNG exports.***

After assessing these direct and indirect impacts, ICF then applied a range of multiplier effects to assess the induced economic activity from people earning higher income through the direct and indirect activity spending that income. There is significant uncertainty surrounding the actual level of multiplier effect impacts generated in the economy; thus, ICF developed a range to show the potential impacts on the larger economy generated by direct and indirect LNG export activities. ICF quantified the net economic impacts of an exogenous change to the U.S. economy (i.e., a policy to permit LNG exports) by calculating the resulting output change in various products (e.g., increasing LNG exports, liquids production, petrochemical manufacturing, and decreases in electricity consumption and consumer spending). Then, the multiplier effect range is applied – the lower-bound (1.3) representing significant crowding out effect, while the upper-bound (1.9) is consistent with a very slack economy and/or an elastic supply of labor and other factors of production. Both measures of GDP impacts (direct and indirect alone *versus* direct, indirect, and induced) are then converted to job impacts using input-output relationships, wherein the number of jobs per dollar of value added vary among economic sectors.

Estimation of Multiplier Effect

This study employs a range of multiplier effects to estimate the lower-bound and upper-bound for "induced" activities in the U.S. economy, resulting from the spending of personal income generated by the direct and indirect activities. The equation below shows the hypothetical GDP multiplier effect from any incremental increase of purchases (from business investment, exports, government spending, etc.) MPC is marginal propensity to consume, and is estimated at 0.900 using a post-World War II average for the U.S. This means that for every dollar of personal income generated, $0.90 goes toward consumption, and the remaining $0.10 is saved. The MPI is the marginal propensity to import, estimated at 0.162, based on the average for recent years. The effective tax rate is $0.269 per dollar of income/GDP. Inputting the MPC, MPI, and tax rate into the equation below shows that every dollar of income stemming from direct and indirect activity hypothetically could produce a total of $1.984, meaning that $0.984 is "induced" economic activity, or the amount produced as the multiplier effect.

$$\Delta GDP = \Delta Exports * 1 / (1-MPC*(1-TAX) + MPI)$$

Multiplier Effect Input	Value
Marginal Propensity to Consume after Taxes (MPC)	0.900
Marginal Propensity to Import (MPI)	0.162
Tax Rate	0.269
Resulting Multiplier	**1.984**

Because of this uncertainty in the multiplier effect, a range is used in this study. A value of1.9 is used as the multiplier for the upper-bound limit, and 1.3 [1.6 – (1.9-1.6)] for the lower-bound estimate.

Source: American Clean Skies Foundation (ACSF), based on analysis conducted by ICF International. "Tech Effect: How Innovation in Oil and Gas Exploration is Spurring the U.S. Economy." ACSF, October 2012: Washington, D.C. Available at: http://www.cleanskies.org/wp-content/uploads/2012/11/icfreport_11012012_web.pdf

Exhibit 3-2 lists the major categories of GDP and employment changes that were distributed among the states.

Exhibit 3-2: Key Economic and Employment Impacts

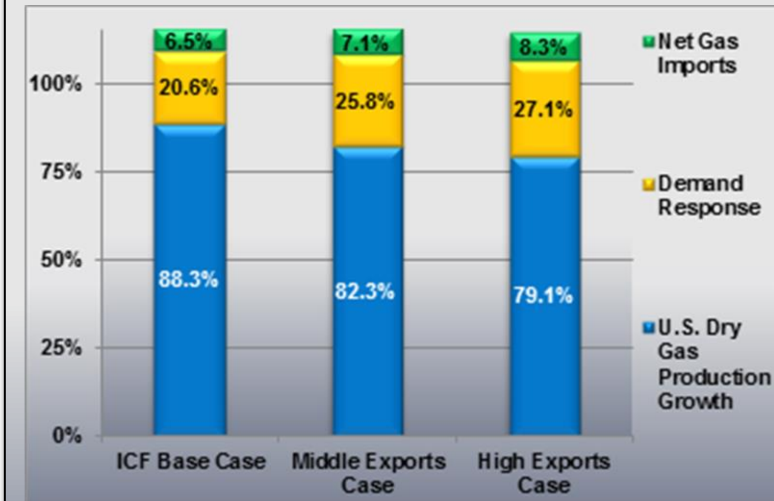
1) GDP by Source	2) Jobs by Source
LNG's Contribution to US GDP	Related to Oil, Gas, NGL Production Changes
Liquids Contribution to GDP (value added in US)	Related to LNG Production
Methanol Production	Related to Switch to Coal
Ammonia Production	Related to Gas Consumer Accounts: Consumers
GTL Production	Related to Gas Consumer Accounts: Producers
Ethylene/Polyethylene Production	Related to Electricity Consumer Accounts: Consumers
Propylene/Polypropylene Production	Related to Electricity Consumer Accounts: Producers
Contribution to GDP from Reduced Industrial Production	Related to Power Generation (switch to coal, lower demand)
Net US GDP Effect to Natural Gas Consumers	Methanol Production
Net US GDP Effect to Natural Gas Producers	Ammonia Production
Net US GDP Effect to Electricity Consumers	GTL Production
Net US GDP Effect to Electricity Producers	Ethylene/Polyethylene Production
	Propylene/Polypropylene Production
	Other Industrial Output Changes
Direct and Indirect Total	***Direct and Indirect Total***
Multiplier Effect at 1.3	Multiplier Effect at 1.3
Total GDP Change with Multiplier Effect at 1.3	**Total Employment Change with Multiplier Effect at 1.3**
Multiplier Effect at 1.9	Multiplier Effect at 1.9
Total GDP Change with Multiplier Effect at 1.9	**Total Employment Change with Multiplier Effect at 1.9**

Step 2: Extract gas production data by basin/node from prior API study and estimate gas production by state and organize into matrices.

LNG exports require a combination of additional supplies, in the form of domestic production increases, a reduction in consumption (i.e., demand response), and changes in pipeline trade with Canada and Mexico. ICF's original modeling showed that for each of the three export cases, the majority of the incremental LNG exports (79%-88%) are offset by increased domestic natural gas production. Another 21%-27% in consumer demand response (i.e., cost increases lead to a certain decrease in domestic gas demand), and an additional 7%-8% comes from shifts in the trade with Canada (more exports into the U.S.) and Mexico (fewer imports from the U.S.). The sum of the three supply sources exceed actual LNG export volumes by roughly 15% to account for fuel used during processing, transport, and liquefaction, as shown in the text box below.

The original LNG export cases included assumptions on natural gas requirements for the LNG export plants. These production factors, along with a range of gas market changes, such as gas consumption and pricing changes, were modeled in ICF's Gas Market Model (GMM). The specific market effects of LNG exports quantified in the GMM included:

Exhibit 3-3: Supply Sources that Rebalance Markets



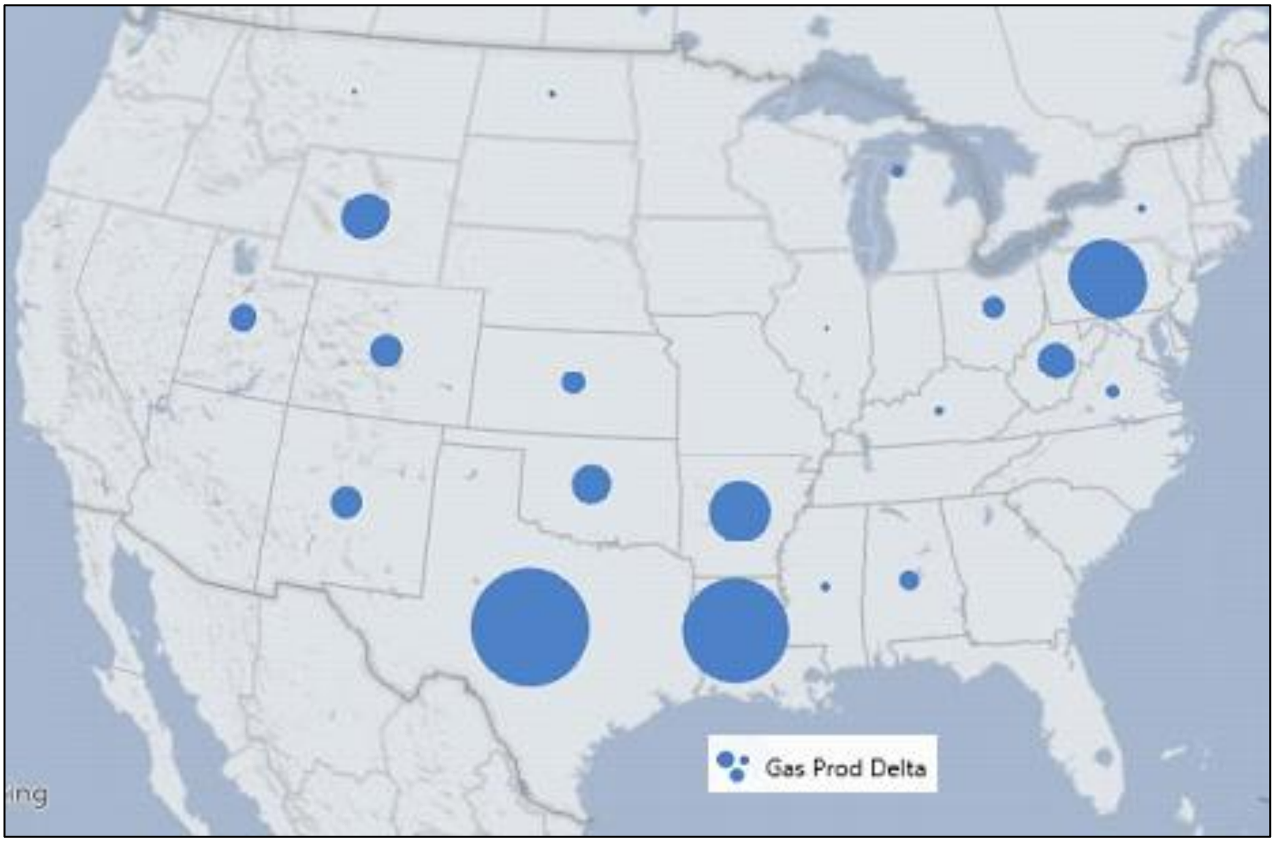
Source: ICF estimates

Note: Each 1.0 Bcfd of LNG exports requires total dry wellhead supplies of 1.15 Bcfd for liquefaction, lease and plant fuel, and LNG exports.

- Gas production changes in various North American basins caused by shifts in natural gas costs.
- Gas consumption changes by region and sector caused by shifts in gas costs (including fuel substitution, conservation, and reduced industrial output).
- Gas flow adjustments among regions caused by the new demand for gas at liquefaction plants, cost-induced changes in regional gas production and in regional gas consumption.
- Changes in regional delivered-to-pipeline natural gas costs and changes to regional end-user costs.
- Adjustments to regional electricity costs, sales volumes, and power generation input fuel mix.

Exhibit 3-4 illustrates the general trend in gas production by state. The exhibit shows the relative natural gas production changes in the ICF Base Case in 2025 by states. States with the most natural gas production changes in the ICF Base Case, such as Texas, Louisiana, and Pennsylvania, which together comprise 67% of the change in U.S. natural gas production that year for the ICF Base Case, have the largest circles.

Exhibit 3-4: Map of Relative Natural Gas Production Changes by State in 2025



Source: ICF GMM

Note: The map above shows the relative natural gas production changes in the ICF Base Case in 2025 (relative to the Zero LNG Exports Case).

Step 3: Create state-level allocators by GDP and employment categories using ICF's proprietary models and other data sources.

Exhibit 3-5 shows the 20 allocator categories used to distribute GDP value added and employment associated with LNG exports across each state. In most GDP and employment categories, multiple allocators were used. The actual allocations across all GDP and employment categories are done in step 8.

Exhibit 3-5: Allocator Methods for GDP and Jobs by Source

Allocator #	Allocator Name	*Allocator Source by State*
1	Ammonia	*Planned ammonia production plant locations as compiled by ICF[7]*
2	Coal Mining	*Coal mining and coal-mining support jobs in the base year of 2010[8]*
3	Coal to Gas Switching	*Price-sensitive coal demand of coal-switching economics by state[9]*
4	Crude Production Delta (yr)	*ICF GMM crude and condensate production forecasts by year through 2035*
5	Electricity All Consumers 2011	*EIA 2011 end-use electricity consumption[10]*
6	Ethylene	*Planned ethylene production plant locations as compiled by ICF[11]*
7	Gas All Consumers 2011	*EIA 2011 end-use natural gas consumption[12]*
8	Gas Industrial Consumers 2011	*EIA 2011 industrial sector natural gas consumption (volume delivered to industrial consumers)[13]*
9	Gas Production 2011	*EIA 2011 U.S. natural gas production[14]*
10	Gas Production Delta (yr)	*ICF GMM condensate production forecasts by year through 2035*
11	GTL	*Planned GTL production plant locations as assumed by ICF[15]*
12	Indirect Industrial Jobs	*Weighted average of industries that support construction and equipping industrial activities based on IMPLAN input-output model and U.S. Bureau of Labor statistics data*
13	Indirect Oil Gas Jobs	*Weighted average of industries that support oil and gas activity based on IMPLAN input-output model and U.S. Bureau of Labor statistics data*
14	LNG	*Based on LNG exports terminals by state; study includes various cases based on 7 states, based on U.S. Department of Energy (DOE) list by LNG exports filing dates (see Exhibit 3-8) and explained in Task 5*
15	Methanol	*Planned methanol production plant locations as compiled by ICF[16]*
16	NGPL Prod Delta (yr)	*ICF GMM NGL production forecasts by year through 2035*
17	Propylene	*Planned propylene production plant locations as compiled by ICF[17]*
18	MECS Job Losses	*2012 annual manufacturing employment by state from the U.S. Bureau of Labor Statistics[18]*
19	State Personal Income 2010	*State personal income in 2010[19]*
20	Calculated Direct + Indirect	*State-by-state distributions based on total direct and indirect state-level allocations (used, in part, to calculated state-level multiplier effects)*

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[7] Appendix C of original API LNG export report (May 2013). ICF International. "U.S. LNG Exports: Impacts on Energy Markets and the Economy." ICF International, 17 May, 2013: Washington, DC. Available at: http://www.api.org/~/media/Files/Policy/LNG-Exports/API-LNG-Export-Report-by-ICF.pdf

[8] PricewaterhouseCoopers. "The Economic Contributions of U.S. Mining in 2008." PricewaterhouseCoopers, prepared for the National Mining Association: October 2010.

[9] ICF estimates

[10] U.S. Energy Information Administration (EIA). "End-use electricity consumption." EIA: Washington, DC. Available at: http://www.eia.gov/state/seds/hf.jsp?incfile=sep_fuel/html/fuel_use_es.html

[11] Appendix C of original API LNG export report (May 2013)

[12] U.S. Energy Information Administration (EIA). "Natural Gas Consumption by End Use." EIA: Washington, DC. Available at: http://www.eia.gov/dnav/ng/ng_cons_sum_a_EPG0_vgt_mmcf_a.htm

[13] U.S. Energy Information Administration (EIA). "Natural Gas Consumption by End Use." EIA: Washington, DC. Available at: http://www.eia.gov/dnav/ng/ng_cons_sum_a_EPG0_vgt_mmcf_a.htm

[14] U.S. Department of Energy (DOE). "Applications Received by DOE/FE to Export Domestically Produced LNG from the Lower-48 States (as of September 19, 2013)." DOE, September 11, 2013: Washington, DC. Available at: http://energy.gov/sites/prod/files/2013/09/f2/LNG%20Export%20Summary_1.pdf

[15] Appendix C of original API LNG export report (May 2013)

[16] *Ibid.*

[17] *Ibid.*

[18] U.S. Bureau of Labor Statistics (BLS). "Quarterly Census of Employment and Wages." BLS: Washington, DC. Available at: ftp://ftp.bls.gov/pub/special.requests/cew/2012/state/

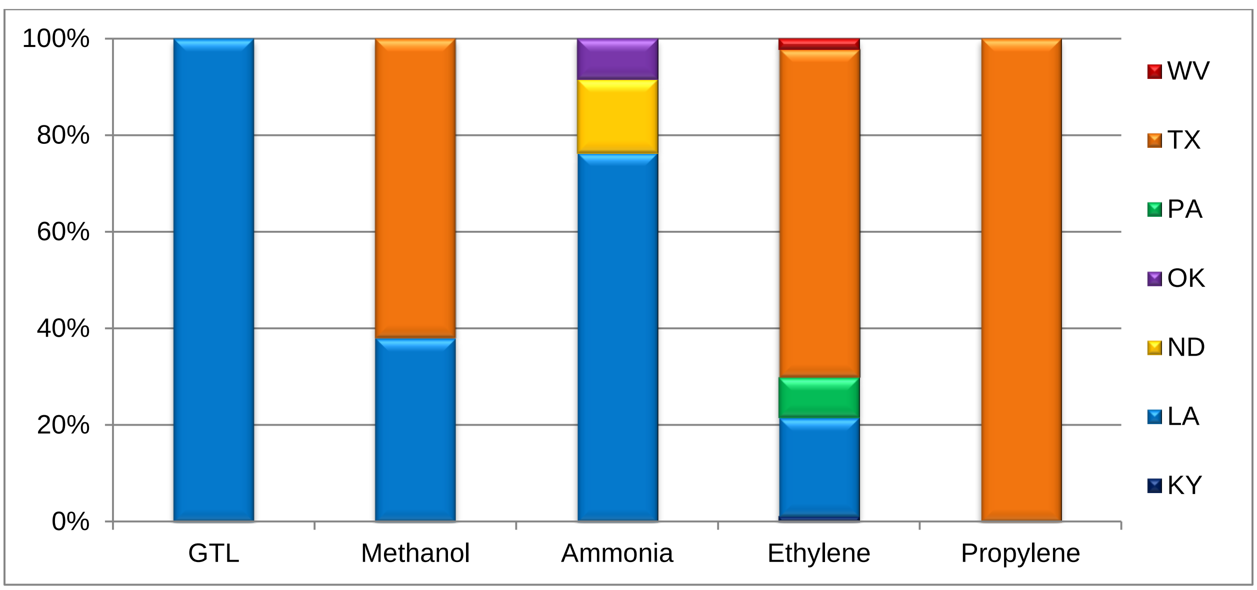
[19] Tax Policy Center (Urban Institute and Brookings Institution). "State and Local General Revenue as a Percentage of Personal Income 2004-2011." Tax Policy Center, 20 September, 2013: Washington, DC. Available at: http://www.taxpolicycenter.org/taxfacts/displayafact.cfm?Docid=510

Step 4: Create state-level allocators for gas-to-liquids (GTLs), chemicals, and petrochemicals using data for actual and planned plants.

ICF compiled a list of planned petrochemical plants and plant expansions to provide the basis for allocating petrochemical use for additional natural gas, NGLs, and oil (i.e., methanol, ammonia, GTL, ethylene/polyethylene, and propylene/polypropylene production). The list of planned plants and plant expansions are found in Appendix C of the original API LNG export report.

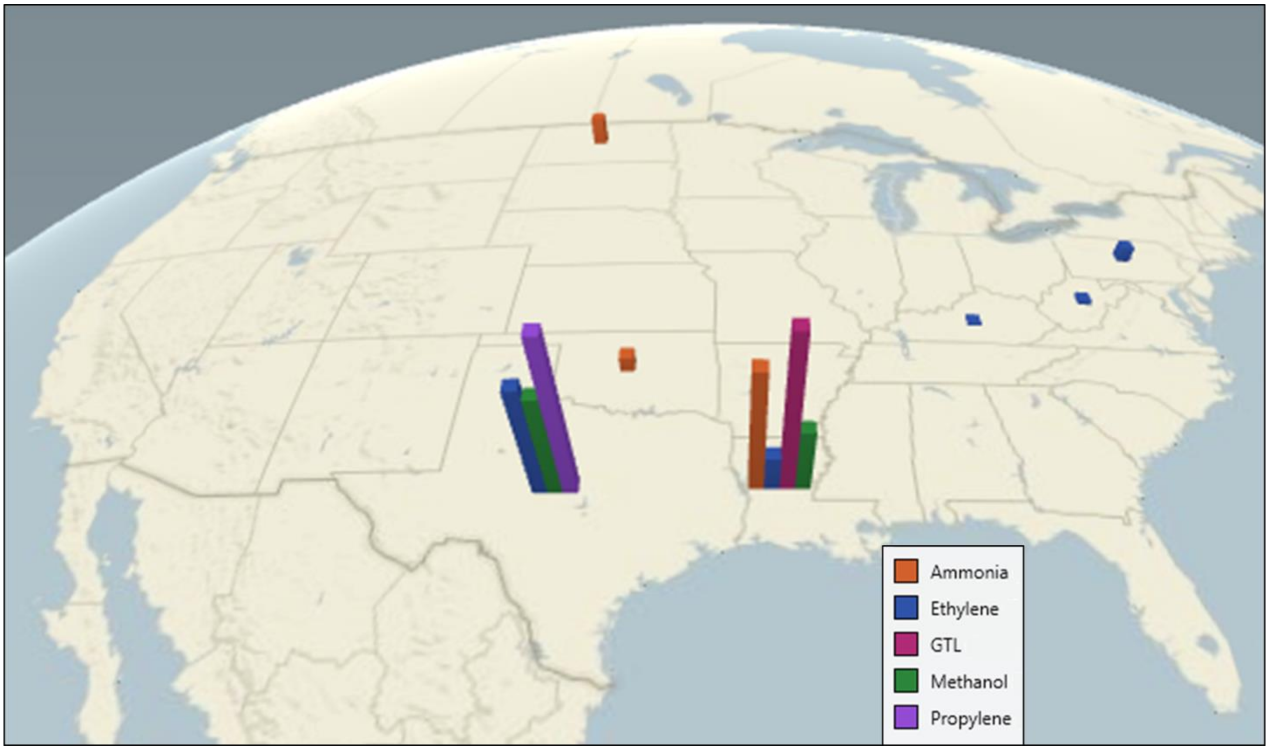
These plant location-specific allocators were used in conjunction with other allocators such as indirect industrial jobs and natural gas/NGL production by state to allocate each petrochemical category across the states. While the location of these plants generates a certain level of economic activity for that state, the indirect industrial jobs allocator reflects the impact of the plant construction on industrial sectors throughout the country, as many such indirect industrial jobs (e.g., manufacturing plant equipment) takes place outside the host state. In addition, natural gas and NGL production by state are additional allocators used to show the economic activity generated to produce the physical volumes of natural gas and NGLs used in the petrochemical facilities. Exhibit 3-6 and Exhibit 3-7 highlight the locations of petrochemical facilities assumed for this study, based on the list compiled in Appendix C of the original API study. Exhibit 3-7 shows the location and relative capacity volume additions of anticipated petrochemical plants, indicated by the relative height of columns. The map is meant to show spatially the information illustrated in Exhibit 3-6.

Exhibit 3-6: Assumed Methanol, Ammonia, GTL, Ethylene, and Propylene Plant Additions, Conversions, and Expansions (By Relative Proportion of Capacity)



Source: Various compiled by ICF

Exhibit 3-7: Map of Assumed Methanol, Ammonia, GTL, Ethylene, and Propylene Plant Additions, Conversions, and Expansions (By Relative Proportion of Capacity)



Source: Various compiled by ICF

Note: The height of each column represents the relative capacity increases of each plant type assumed for this study.

Step 5: Create state-level allocators for LNG export terminal locations.

ICF developed LNG terminal location allocators to apportion the impacts of LNG exports among the states. ICF used a combination of its GMM assumptions in the original LNG export cases (i.e., ICF Base Case, Middle LNG Exports Case, High LNG Exports Case) and the U.S. Department of Energy's (DOE) list of LNG export terminal applications by filing date. ICF made no assumptions on which applications will be approved or denied, and used the filing dates as the primary indicator of the order in which the terminals might be built. In addition to the physical LNG export terminal locations (explained in further detail in Task 6), allocating LNG contributions to economic and employment activity also took into account which states would experience increases in natural gas production and which states would see additional economic activity due to indirect purchases from the oil and gas sector and other affected industries.

Exhibit 3-8 shows the list of potential LNG export terminals ranked by filing date.

Exhibit 3-8: Potential LNG Export Terminals Ranked by DOE Filing Order

Rank	Company	Owners	Location	Year In-Service	Est. Export Capacity (Bcfd)*
1	Sabine Pass Liquefaction, LLC	Cheniere	Sabine, LA	2015	2.20
2	Freeport LNG Expansion, L.P. and FLNG Liquefaction, LLC	Freeport LNG Investments, Zachry Hastings, Dow Chemical, Osaka Gas	Freeport, TX	2017	1.40
3	Lake Charles Exports, LLC	BG, Energy Transfer Partners	Lake Charles, LA	2018	2.00
4	Carib Energy (USA) LLC	Carib Energy	N/A	Unknown	0.03
5	Dominion Cove Point LNG, LP	Dominion	Cove Point, MD	2017	1.00
6	Jordan Cove Energy Project, L.P.	Veresen, Energy Projects Development	Coos Bay, OR	2018	1.20
7	Cameron LNG, LLC	Sempra	Hackberry, LA	2017	1.70
8	Freeport LNG Expansion, L.P. and FLNG Liquefaction, LLC	Freeport LNG Investments, Zachry Hastings, Dow Chemical, Osaka Gas	Freeport, TX	2017	1.40
9	Gulf Coast LNG Export, LLC (i)	Gulf Coast LNG Export	Brownsville, TX	Unknown	2.80
10	Gulf LNG Liquefaction Company, LLC	Kinder Morgan, GE	Pascagoula, MS	2018	1.50
11	LNG Development Company, LLC (d/b/a Oregon LNG)	Leucadia Corporation	Astoria, OR	2018	1.25
12	SB Power Solutions Inc.	Seaboard Corporation	N/A	Unknown	0.07
13	Southern LNG Company, L.L.C.	Kinder Morgan	Elba Island, GA	2016	0.50
14	Excelerate Liquefaction Solutions I, LLC	George Kaiser, RWE Supply & Trading	Lavaca Bay, TX	2018	1.38
15	Golden Pass Products LLC	ExxonMobil, Qatar Petroleum	Sabine Pass, TX	2018	2.60
16	Cheniere Marketing, LLC	Cheniere	Corpus Christi, TX	2018	2.10
17	Main Pass Energy Hub, LLC	Freeport-McMoran, United LNG	Offshore LA	2018	3.22
18	CE FLNG, LLC	Cambridge Energy	Plaquemines Parish, LA	2018	1.07
19	Waller LNG Services, LLC	Waller Marine	Cameron Parish, LA	Unknown	0.16
20	Pangea LNG (North America) Holdings, LLC	Statoil, Pangea LNG	Corpus Christi, TX	2017	1.09
21	Magnolia LNG, LLC	LNG Limited	Lake Charles, LA	2018	0.54
22	Trunkline LNG Export, LLC (same facility as Lake Charles)	BG, Energy Transfer Partners	Lake Charles, LA	2018	2.00

Rank	Company	Owners	Location	Year In-Service	Est. Export Capacity (Bcfd)*
23	Gasfin Development USA, LLC	Gasfin Development	Cameron Parish, LA	Unknown	0.20
24	Freeport-McMoRan Energy LLC (same facility as Main Pass)	Freeport-McMoran	Offshore LA	2018	3.22
25	Sabine Pass Liquefaction, LLC	Cheniere	Sabine Pass, LA	2018	0.28
26	Sabine Pass Liquefaction, LLC	Cheniere	Sabine Pass, LA	2018	0.24
27	Venture Global LNG, LLC	Venture Global	Cameron Parish, LA	Unknown	0.67
28	Advanced Energy Solutions	Advanced Energy Solutions	Baltimore, MD	Unknown	0.02
29	Argent Marine Management	Argent Marine, Maersk Line	Unknown	Unknown	0.003
30	Eos LNG LLC	Eos LNG	Brownsville, TX	Unknown	1.60
31	Barca LNG LLC	Barca LNG	Brownsville, TX	2016	1.60
32	Sabine Pass Liquefaction, LLC	Cheniere	Sabine Pass, LA	2015	0.86
33	Delfin LNG	Fairwood Group, Peninsula Group	Offshore GOM	2017	1.80
34	Magnolia LNG, LLC	LNG Limited	Lake Charles, LA	2018	1.08

Sources: Various compiled by ICF

* Includes export volume estimates for Free Trade Agreement (FTA) export applications and non-FTA export applications

** Lake Charles Exports, LLC (LCE) and Trunkline LNG Export, LLC (TLNG), the owner of the Lake Charles Terminal, have both filed an application to export up to 2.0 Bcf/d of LNG from the Lake Charles Terminal. The total quantity of combined exports requested between LCE and TLNG does not exceed 2.0 Bcf/d (i.e., both requests are not additive and only 2 Bcf/d is included in the bottom-line total of applications received).

*** Main Pass Energy Hub, LLC (MPEH) and Freeport McMoRan Energy LLC (FME), have both filed an application to export up to 3.22 Bcf/d of LNG from the Main Pass Energy Hub. (The existing Main Pass Energy Hub structures are owned by FME). The total quantity of combined FTA exports requested between MPEH and FME does not exceed 3.22 Bcf/d (i.e., both requests are not additive and only 3.22 Bcf/d is included in the bottom-line total of FTA applications received). FME's application includes exports of 3.22 Bcf/d to non-FTA countries and is included in the bottom line total of non-FTA applications received, while MPEH has not submitted an application to export LNG to non-FTA countries.

(a) Actual applications were in the equivalent annual quantities.

(b) FTA – Applications to export to free trade agreement (FTA) countries. The Natural Gas Act, as amended, has deemed FTA exports to be in the public interest and applications shall be authorized without modification or delay.

(c) Non-FTA applications require DOE to post a notice of application in the Federal Register for comments, protests and motions to intervene, and to evaluate the application to make a public interest consistency determination.

(d) Requested approval of this quantity in both the FTA and non-FTA export applications. Total facility is limited to this quantity (i.e., FTA and non-FTA volumes are not additive at a facility).

(e) Lake Charles Exports, LLC submitted one application seeking separate authorizations to export LNG to FTA countries and another authorization to export to Non-FTA countries. The proposed facility has a capacity of 2.0 Bcf/d, which is the volume requested in both the FTA and Non-FTA authorizations.

(f) Carib Energy (USA) LLC requested authority to export the equivalent of 11.53 Bcf per year of natural gas to FTA countries and 3.44 Bcf per year to non-FTA countries.

(g) Jordan Cove Energy Project, L.P. requested authority to export the equivalent of 1.2 Bcf/d of natural gas to FTA countries and 0.8 Bcf/d to non-FTA countries.

(h) DOE/FE received a new application (11-161-LNG) by FLEX to export an additional 1.4 Bcf/d of LNG from new trains to be located at the Freeport LNG Terminal, to non-FTA countries, and a separate application (12-06-LNG) to export this same 1.4 Bcf/d of LNG to FTA countries (received January 12, 2012). This 1.4 Bcf/d is in addition to the 1.4 Bcf/d FLEX requested in dockets (10-160-LNG and 10-161- LNG).

(i) An application was submitted by Gulf Coast on January 10, 2012, seeking one authorization to export LNG to any country not prohibited by U.S. law or policy. On September 11, 2012, Gulf Coast revised their application by seeking separate authorizations for LNG exports to FTA countries and Non-FTA countries.

(j) Total does not include 2.0 Bcf/d.

Step 5: Create alternative cases based on the original four LNG export scenarios, varying location of the liquefaction terminals in such states as Oregon, Mississippi, Georgia, and Alaska (on the Outer Continental Shelf, OCS).

An LNG export terminal is a large-scale, long-term investment, providing thousands of jobs and billions of dollars in capital expenditures. ICF estimates that a typical 1-Bcfd LNG export terminal costs roughly $4.8 billion (2010$), and requires 34,300 person-years for direct and indirect construction and operations.[20] This estimate includes all labor required for manufacturing the materials and equipment, and approximately 200 annual (direct) jobs for plant operation and another 350 annual (indirect) jobs for maintenance and non-feedstock supplies. The construction of a new LNG export terminal can have a significant impact on a state's economy. Given the large number of LNG export terminal applications currently in the DOE's queue, ICF opted to provide a number of terminal location cases (TLCs) to provide a range of impacts for a number of states. The ICF Base Case is made up of only one terminal location case, given that LNG exports of 4 Bcfd are approved from Louisiana and Texas. On the other hand a number of terminal location cases for the Middle LNG Exports Case (8 Bcfd) and the High LNG Exports Case (16 Bcfd) are provided. The 10 case assumptions include Louisiana and Texas as terminal locations in all cases. The Middle and High Cases alternate between a number of other states for the remaining LNG export volumes, based largely on the DOE application queue. The terminal location cases are as follows:

1) ICF Base Case include only terminals in LA and TX

2) Middle LNG Exports Case includes 4 TLC scenarios:

   i. TLC 1 +MD: LA, MD, TX

   ii. TLC 2 +OR: LA, OR, TX

   iii. TLC 3 +GA: GA, LA, TX

   iv. TLC 4 +MS: LA, MS, TX

3) High LNG Exports Case includes 5 TLC scenarios:

   i. TLC 1 +MD: LA, MD, TX

   ii. TLC 2 +OR: LA, OR, TX

   iii. TLC 3 +GA: GA, LA, TX

   iv. TLC 4 +MS: LA, MS, TX

   v. TLC 5 +AK: AK, LA, TX

[20] Based on greenfield project.

Exhibit 3-9 illustrates the 10 terminal location cases, including the associated minimum and maximum values. Minimum values assume an LNG export terminal is not located in-state, while maximum values include at least one LNG export terminal in the state.

Exhibit 3-9: Terminal Location Cases (TLCs)

State Terminal Assumed	ICF BASE CASE	MIDDLE EXPORTS CASES				HIGH EXPORTS CASES				
		1: MD	2: OR	3: GA	4: MS	1: MD	2: OR	3: GA	4: MS	5: AK
TX	X	X	X	X	X	X	X	X	X	X
LA	X	X	X	X	X	X	X	X	X	X
MD		X				X				
OR			X				X			
GA				X				X		
MS					X				X	
AK										X

X: Indicates terminal located in-state for that case

No min/max across LNG export case (i.e., all states in ICF Base Case (only one scenario); TX, LA, MD (included in all other cases), AK mid cases)

Mid Exports cases MIN VALUES

Mid Exports cases MAX VALUES

High Exports cases MIN VALUES

High Exports cases MAX VALUES

Exhibit 3-10 shows the relative location of LNG terminal location cases assumed in this study, based upon the DOE filings, with the relative heights indicating the export volume capacities.

Exhibit 3-10: Map of Potential LNG Export Terminals Assumed in this Study (By Export Volume)

Sources: Various compiled by ICF

Note: The height of each column represents the relative volume of terminal export capacity.

Step 7: Create alternative case for inclusion of Alaska LNG project in the High LNG Exports case.

As mentioned above, the High LNG Export Case also includes a terminal location case in Alaska. While the other six states assumed for LNG export terminals have similar specifications with regard to natural gas production locations, employment mix, and other factors, the Alaska case is quite different for a number of reasons:

1) Natural gas production: Given Alaska's prolific level of proven natural gas resources on the North Slope, all natural gas production for Alaska's LNG export facility would be produced in-state, whereas an LNG export facility in states such as Oregon would rely on gas imports from other states and Canada. In addition, U.S. natural gas costs would not rise as much as if production took place in the lower 48 states. This would mean a smaller natural gas and electricity consumption decrease, including among energy-intensive industrial consumers. The North Slope natural gas reserves are isolated from U.S. natural gas markets, and thus, production of the North Slope natural gas reserves would have little to no impact on U.S. Lower 48 natural gas costs.

2) Pipeline and gas processing requirements: Alaska will require a substantial investment in a gas-processing plant to remove carbon dioxide from the natural gas and a very large pipeline to deliver the gas to the liquefaction plant.

3) Employment mix: In contrast to the lower 48 states in terms of LNG export terminals, there will be fewer upstream (production) oil and gas jobs because most of the natural gas is already being produced and recycled now. However, because of the need to construct the natural gas processing plant and pipeline, there will be more jobs in the construction sector.

Alaska LNG Project

Among terminal projects already proposed or being discussed, the South Central Alaska LNG Export Project holds a unique position. Alaska has vast natural gas resources and already has a long history of exporting LNG through the small ConocoPhillips export terminal in Kenai using Cook Inlet gas in South Alaska. Recent interest in LNG export has brought the state's attention to commercializing natural gas in the North Slope, which could hold up to 200 Tcf of potential resource (of which 35 Tcf is proven) of gas recoverable, to boost economic development and job creation. Although North Slope gas potential is well-known, the distance from North Slope producing fields to demand centers in Alaska and the lower 48 states, as well as difficult geology and climate conditions make the resource expensive to monetize without the high appetite of Asian importers.

The South Central Alaska LNG export project, if built, will consist of a 800-mile, 42-inch natural gas pipeline running from Point Thomson to South Alaska and a LNG terminal with capacity of three 5.8 mtpa trains (or 17.4 mtpa in total). The project is jointly developed by ExxonMobil, BP, ConocoPhillips and TransCanada. Alaska LNG may take a long time to complete, requiring 9-10 years after the pre-FEED stage.[21] Nevertheless, being closer to Asia than any other state means Alaska LNG will still hold an advantage in lower transportation costs as the project comes online.

There are multiple studies on the potential economic benefits of the South Central Alaska LNG Export Project. A 2011 study was carried out by Wood Mackenzie to evaluate the economics of the Alaska LNG project. [22] This study concluded that Alaska LNG could be delivered to Japan economically at an advantage over Lower-48 LNG. The study also concluded that revenues to the state would range from $220 to $419 billion over a 30 year period. [23]

In a 2012 study, the Brookings Institute evaluated the economics of U.S. LNG export projects, including Alaska LNG, and found that such exports were very competitive with other world projects. [24]

Recently, Alaska's Department of Natural Resources stated that Alaska LNG exports could be delivered to Asia at a cost of under $10 per MMBtu, while most Australian projects were in the range of $10 to $12 per MMBtu. [25]

[21] Alaska South Central LNG Project. "Alaska South Central LNG Project – Overview for Alaska Legislators," presentation by North Slope project sponsors, February, 2013. Available at: http://gasline.alaska.gov/newsroom/Presentations/SCLNG%20-%20HRES%20Lunch%20&%20Learn%202.19.13.pdf

[22] Wood Mackenzie, 2011. "Alaska LNG Exports Competitiveness Study." July, 2011. Available at: http://www.arlis.org/docs/vol1/AlaskaGas/Present/Present_WoodM_2011_AK_LNG.pdf

[23] Walker, B. "Recent Studies Supports All-Alaska Gas Line". Anchorage Daily News, March 3, 2012: Anchorage, AK. Available at: http://www.adn.com/2012/03/03/2350478/recent-studies-support-all-alaska.html

[24] Brookings Institution. "Assessing the Case for U.S. Exports of Liquefied Natural Gas." Brookings Institution, May 2012: Washington, DC. Available at: http://www.brookings.edu/~/media/research/files/reports/2012/5/02%20lng%20exports%20ebinger/0502_lng_exports_ebinger.pdf

[25] Alaska Department of Natural Resources. "Commercializing Alaska LNG." DNR, 17 April, 2013, presented at the LNG 17 Conference in Houston, TX. Available at: http://www.gasline.alaska.gov/newsroom/Presentations/LNG_17_4_17_13.pdf

Step 8: Modify state allocation model and run cases through the state allocation processor. This step includes 10 alternatives for liquefaction plant location (among the 3 study cases.

Exhibit 3-11 shows the allocation methods for each source of GDP and employment attributable to LNG exports. For example, the LNG contributions to the GDP category includes three allocators: the location of LNG terminals has 20% of the allocation, the location of natural gas production has 47%, and indirect oil and gas jobs generated by LNG export terminals has 33%. The proportions of each allocator are based on a combination of ICF proprietary modeling, publicly-available data where available, and previous ICF work. Thus, for every $1 of LNG export sales adding value to the U.S. economy, $0.20 will be allocated among states based on the location of LNG export terminals, $0.47 allocated among states based on the location of gas production (which changes annually through 2035), and $0.33 allocated among states by the location of industries that provide indirect materials, equipment and services to the oil and gas production and terminal operations sectors.

Exhibit 3-11: Allocation Methodologies

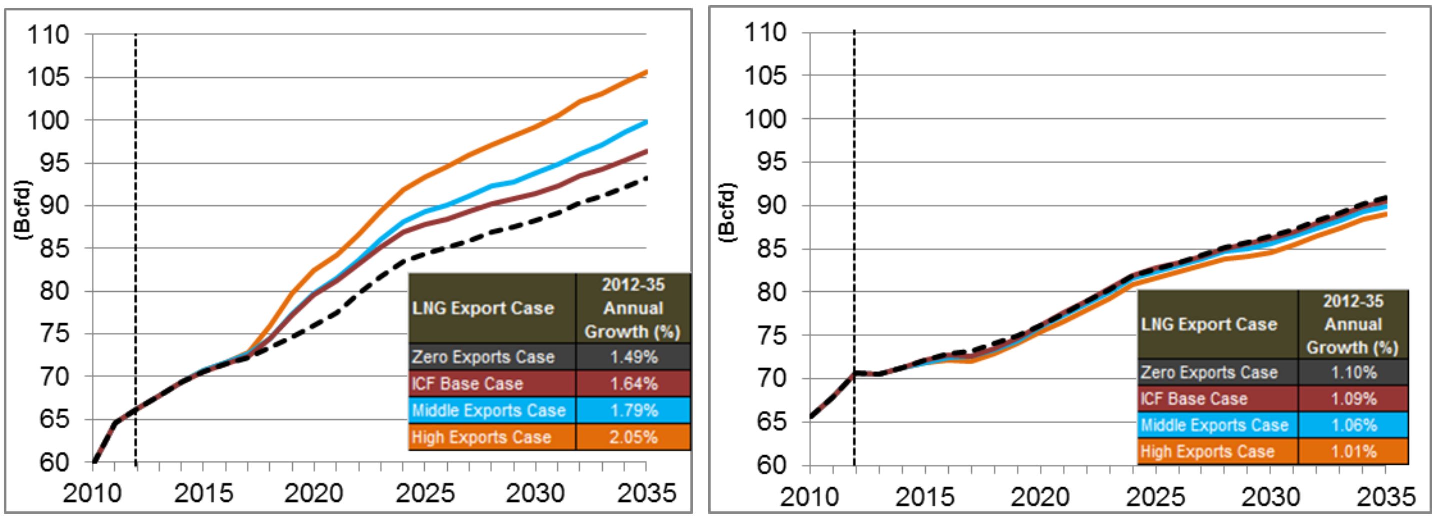
Source to be Allocated	Allocation Method #1	Fraction #1	Allocation Method #2	Fraction #2	Allocation Method #3	Fraction #3
GDP Categories (Income Earned)						
LNG's Contribution to US GDP	LNG	20%	Gas Prod Delta (yr)	47%	Indirect Oil Gas Jobs	33%
Liquids Contribution to GDP (value added in US)	NGPL Prod Delta (yr)	60%	Indirect Industrial Jobs	40%	NONE	0%
Methanol Production	Methanol	29%	Indirect Industrial Jobs	45%	Gas Prod Delta (yr)	26%
Ammonia Production	Ammonia	29%	Indirect Industrial Jobs	45%	Gas Prod Delta (yr)	26%
GTL Production	GTL	29%	Indirect Industrial Jobs	45%	Gas Prod Delta (yr)	26%
Ethylene/Polyethylene Production	Ethylene	29%	Indirect Industrial Jobs	45%	NGPL Prod Delta (yr)	26%
Propylene/Polypropylene Production	Propylene	29%	Indirect Industrial Jobs	45%	NGPL Prod Delta (yr)	26%
Contribution to GDP from Reduced Industrial Production	MECS Job Losses	80%	Indirect Industrial Jobs	20%	NONE	0%
Net US GDP Effect to Natural Gas Consumers	Gas All Consum 2011	60%	State Personal Income 2010	40%	NONE	0%
Net US GDP Effect to Natural Gas Producers	Gas Prod Delta (yr)	40%	State Personal Income 2010	60%	NONE	0%
Net US GDP Effect to Electricity Consumers	Elec All Consum 2011	60%	State Personal Income 2010	40%	NONE	0%
Net US GDP Effect to Electricity Producers	Elec All Consum 2011	60%	State Personal Income 2010	40%	NONE	0%
Multiplier Effect GDP	Calculated Direct + Indirect	40%	State Personal Income 2010	60%	NONE	0%
Employment Categories						
Related to Oil, Gas, NGL Production Changes	Gas Prod Delta (yr)	52%	NGPL Prod Delta (yr)	8%	Indirect Oil Gas Jobs	40%
Related to LNG Production	LNG	40%	Indirect Industrial Jobs	60%	NONE	0%
Related to Switch to Coal	Coal to Gas Switching	70%	Indirect Oil Gas Jobs	30%	NONE	0%
Related to Gas Consumer Accounts: Consumers	Gas All Consum 2011	60%	State Personal Income 2010	40%	NONE	0%
Related to Gas Consumer Accounts: Producers	Gas Prod Delta (yr)	40%	State Personal Income 2010	60%	NONE	0%
Related to Electricity Consumer Accounts: Consumers	Elec All Consum 2011	60%	State Personal Income 2010	40%	NONE	0%
Related to Electricity Consumer Accounts: Producers	Elec All Consum 2011	60%	State Personal Income 2010	40%	NONE	0%
Related to Power Generation (switch to coal, lower demand)	Coal Mining	100%	NONE	0%	NONE	0%
Methanol Production	Methanol	40%	Indirect Industrial Jobs	60%	NONE	0%
Ammonia Production	Ammonia	40%	Indirect Industrial Jobs	60%	NONE	0%
GTL Production	GTL	40%	Indirect Industrial Jobs	60%	NONE	0%
Ethylene/Polyethylene Production	Ethylene	40%	Indirect Industrial Jobs	60%	NONE	0%
Propylene/Polypropylene Production	Propylene	40%	Indirect Industrial Jobs	60%	NONE	0%
Other Industrial Output Changes	MECS Job Losses	80%	Indirect Industrial Jobs	20%	NONE	0%
Multiplier Effect Jobs	Calculated Direct + Indirect	40%	State Personal Income 2010	60%	NONE	0%

4 Economic and Employment Impacts on the U.S. Economy

The following section describes the economic and employment impacts of LNG exports, relative to the Zero Export Case on a state-level basis. Exhibit 4-1 shows the total natural gas production and consumption changes in volume terms. The economic impacts of LNG exports are derived from these volumetric changes. The exhibit illustrates that while domestic natural gas production increases significantly to account for LNG exports, U.S. consumption changes are much more subtle.

Exhibit 4-1: U.S. Domestic Natural Gas Market Changes by LNG Export Case

U.S. Domestic Gas Production Changes *U.S. Domestic Gas Consumption Changes*



Source: ICF estimates

Note: "U.S. Domestic Gas Consumption Changes" chart (right) does not include LNG export volumes, but does include domestic fuel used for liquefaction.

While the national-level study identified the sources of activity, the state-level analysis attempted to identify both the source of activity by state and estimate where the income is earned. For instance, while most income from natural gas, oil, and NGL production remains within the producing state, there is income earned throughout the country in the form of stockholder dividends and capital gains. ICF allocated each GDP source through use of multiple allocators to capture the various components of income earned, as mentioned in Section 3.

This study concludes that LNG exports have a net positive, or negligible, impact across all states.[26] In general, the largest impacts are found in states with gas, oil, and NGL production; LNG production; ethylene manufacturing; and industries that supply materials, products, and services to the oil and gas and petrochemical industries. Additionally, consumer spending

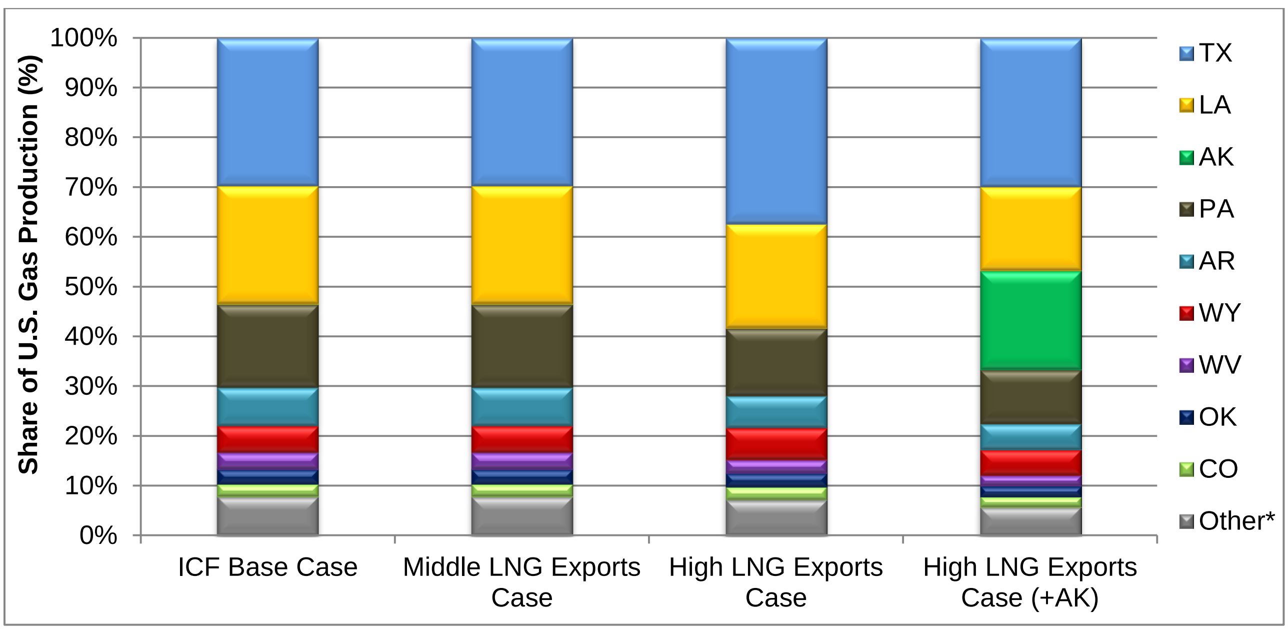
[26] "Negligible" defined for this report as less than 0.05% (positive or negative) of the base year state income (2010) or state employment (2012) as projected for the year 2035.

activity generated by these gas- and petrochemical-related activities contributes significant inter-state activity, providing economic and employment gains to states with little to no gas- or petrochemical-related activity. Economic and employment impacts of LNG exports vary considerably by state for a number of reasons, which are discussed below.

<u>Natural gas and hydrocarbon liquids production changes</u>

LNG exports require an increase in natural gas production, which also results in additional oil and natural gas liquids (NGL) productions. States with production activities see significant increases in economic and employment impacts, as production requires significant capital outlays and labor. For example, some of the largest gas-producing states such as Texas, Louisiana, Pennsylvania, Colorado, and Wyoming see large economic and employment impacts attributable to LNG exports due largely to the state's hydrocarbon production. Exhibit 4-2 shows the main natural production states by LNG export case (including a separate High LNG Exports Case that includes Alaska as an export terminal site, which would source gas in-state). These states see significant economic and employment gains attributable to the increase in hydrocarbon production required for LNG exports.

Exhibit 4-2: 2035 Share of U.S. Natural Gas Production Changes by LNG Export Case (%)



Source: ICF estimates

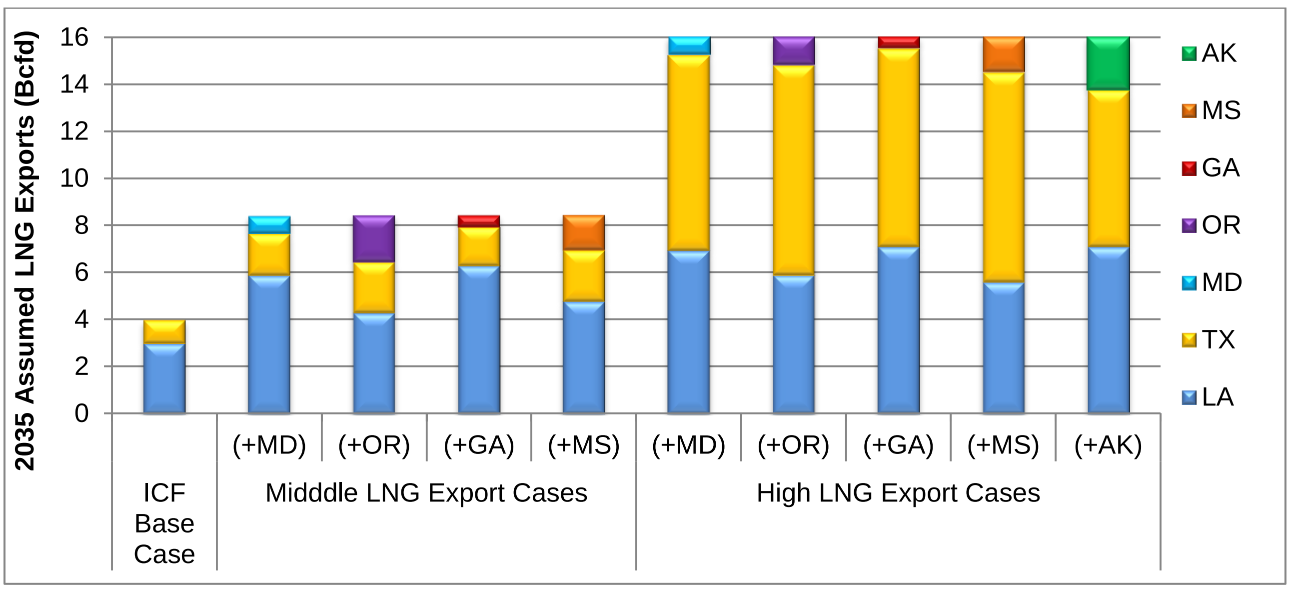
* Includes states with 2% of U.S. total gas production or less (AL, IL, KS, KY, MI, MS, MT, NM, NY, ND, OH, UT, VA).

<u>LNG export facility location</u>

ICF estimates that a typical 1-Bcfd LNG export terminal costs roughly $4.8 billion (2010$), and requires thousands of jobs to construct and operate the plant. LNG export terminals are large-scale, long-term investments that provide significant economic and employment gains to a state's economy. Thus, states that are assumed to have LNG export terminals in this study see significant impacts. As there is significant uncertainty over LNG export locations, ICF assumed a range of potential locations within seven states (Alaska, Georgia, Louisiana, Maryland, Mississippi, Oregon, and Texas). Exhibit 4-3 shows the proportion of LNG export volumes for each case.

As selected terminals in Louisiana and Texas already have approval for LNG exports (Cheniere Energy - Sabine Pass, LA; Freeport LNG – Freeport, TX; Southern Union/BG Group – Lake Charles, LA), these states provide the basis for the ICF Base Case. The Middle LNG Exports Case includes four subcases, altering LNG exports between Maryland[27], Oregon, Georgia, and Mississippi (in addition to Louisiana and Texas). The High LNG Exports Case includes the same four terminal location subcases, as well as Alaska as a potential LNG export location. ICF makes no assumptions on LNG export locations among these states. Thus, the economic and employment impacts for these seven states reports the impacts *including* an LNG export facility in-state to show the potential impacts. For example, rather than illustrating four Middle LNG Export Cases (reflecting the changing states), the exhibits herein show the maximum impacts for each of these states (i.e., assuming an in-state LNG export terminal in each of the seven states). The LNG export distributions assumed for each case are included below. Exhibit 4-4 includes a map of natural gas production assumed in 2035 for each LNG export case.

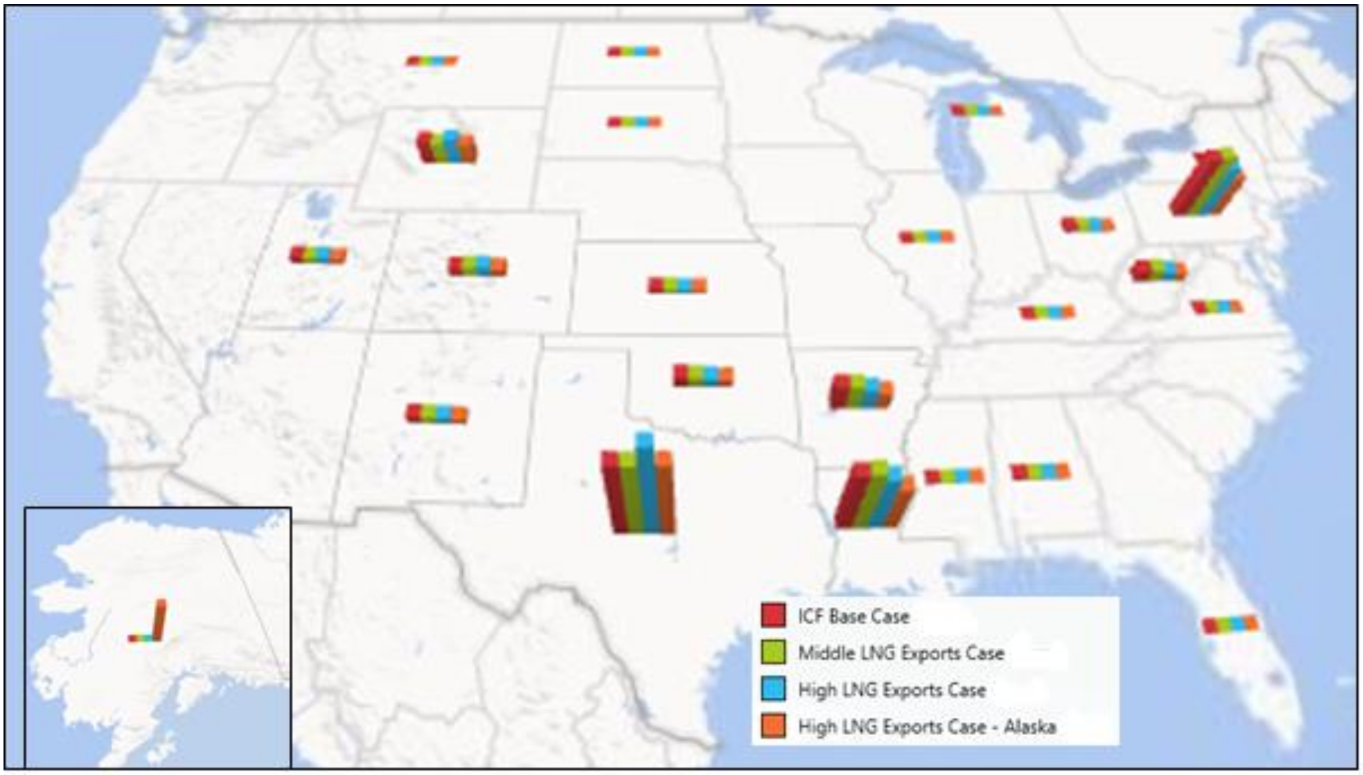
Exhibit 4-3: 2035 LNG Exports by State and Case (Bcfd)



Source: ICF estimates

[27] Dominion Resource recently gained DOE export approval from its Cove Point, MD terminal.

Exhibit 4-4: 2035 Change in Natural Gas Production by State and Case (By Bcfd Volume)



Source: ICF estimates

<u>Location of gas-related industries</u>

Gas processing and petrochemical facilities are typically located near gas production areas; thus, states containing and near gas production largely benefited from these increases. However, drilling equipment, drilling services, and production materials such as steel products, sand and other proppants, drilling and stimulation equipment, and cement typically come from manufacturing-intensive states (e.g., Ohio, Wisconsin, Michigan). These states benefit from gas production activities.

<u>Natural gas and electricity consumer base</u>

As detailed in the original study, LNG exports may lead to a slight increase in natural gas and electricity costs, potentially reducing total economic and employment gains associated with LNG exports. Thus, states with large gas and electricity consumption were more adversely affected by cost increases to residential, commercial and industrial users. But in all states, the size of this impact was offset by positive impacts.

<u>Size of the state economy</u>

While most income from gas-related activities remains within the producing state and in states supplying needed materials, products and services, there is income earned throughout the country in the form of stockholder dividends and capital gains. Thus, a portion of gas-related earnings was assumed to move out-of-state, and apportioned by the relative size of each state's economy. In addition, as income earned through gas-related activities multiplies, through the economy, additional consumer spending is created. States such as New York and California, with diverse but large economies, benefit from LNG exports from resident gas-related stockholders, as well as the inter-state consumer spending purchases.

4.1 Economic Impacts on the U.S. Economy

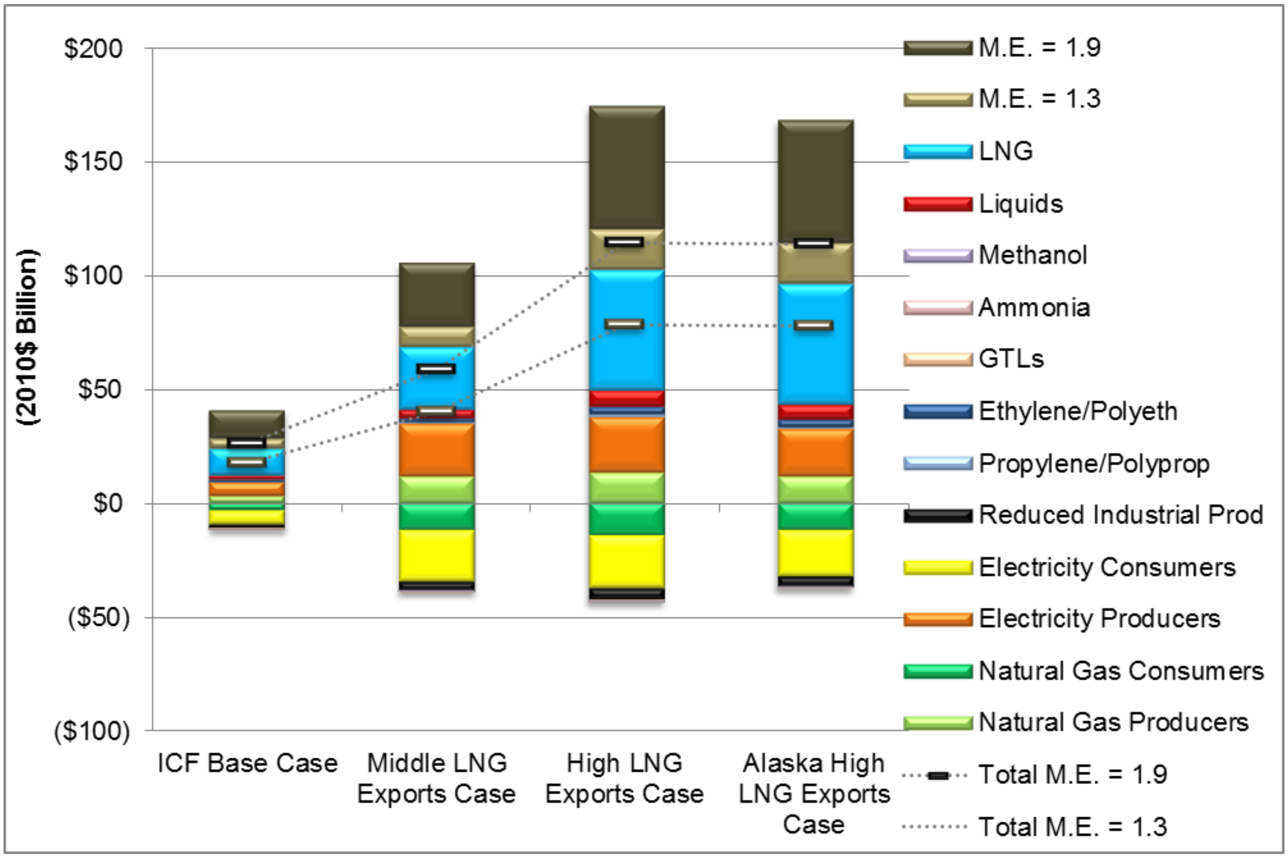
Economic impacts in the original study were computed first by the source of activity and then using input/output matrices allocated to the ultimate sectors within which the jobs take place. For example, ICF quantified the natural gas production increase that will take place for a given LNG export scenario, the required capital and operating and maintenance expenditures, and the resulting economic impact changes. Some gas-production-related impacts will take place in the manufacturing sector (e.g., sand mining for hydraulic fracturing, steel production for drill pipe). While these activities are not considered oil and gas production sectors, they are included in the job totals that are “sourced” by these activities.

This state-level analysis identifies both the source of activity by state and estimate where the income is earned from that activity. For instance, while most income from natural gas, oil, and NGL production remains within the producing state, there is income earned throughout the country in the form of stockholder dividends and capital gains. ICF allocated each GDP source through use of multiple allocators to capture the various components of income related to each GDP source. The total state impacts are calculated by combining the positive economic impacts with the potential negative impacts for each state. The total economic impacts for this study are comprised of production-related factors (such as gas production and LNG export terminals), demand response factors (such as consumer responses to increase natural gas and electricity prices), and multiplier effects (as the additional income generated by LNG exports reverberates through the economy).

Exhibit 4-5 shows the breakouts of each economic impact category, each of which was allocated among the 50 U.S. states and the District of Columbia to assess the economic impacts of LNG exports by state. While there are both positive and negative economic impacts associated with LNG exports, the net impacts are overwhelmingly positive. The positive economic impacts are attributable to an increase in natural gas production, while the economic losses are associated with a loss in consumer spending.

The positive economic impacts are led by LNG production (i.e., the value of LNG exports), which comprised the bulk of direct and indirect impacts (i.e., excluding multiplier effects), followed by gains to natural gas and electricity producers, and liquids production. The negative economic impacts are associated with the natural gas and electricity cost increases. As a result, gas-fired heating and electricity bills for residential/commercial consumers rise, as do energy-intensive manufacturers, translating to a reduction in consumption and industrial output.

Exhibit 4-5: 2035 U.S. GDP Contributions from LNG Exports by Source



Source: ICF estimates

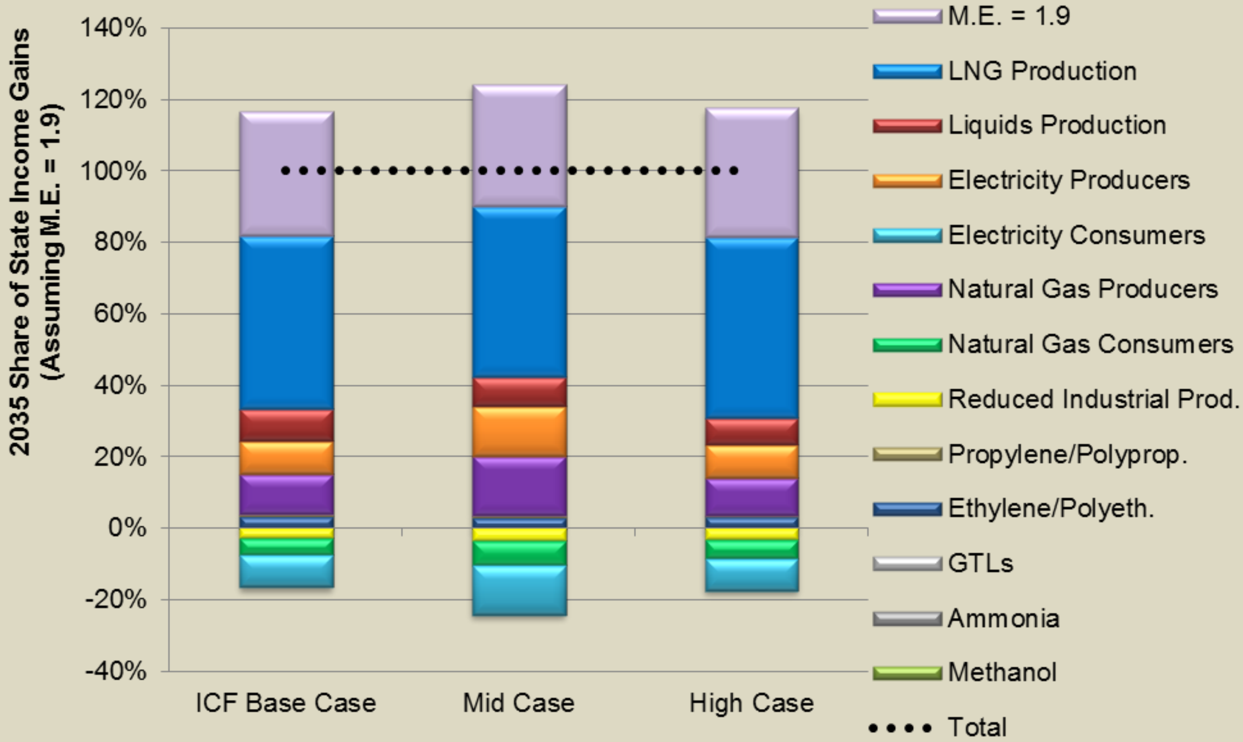
Of the total U.S. GDP changes attributable to LNG exports, ranging from $18b-$115b annually by 2035, all states see positive, or negligible in a few cases, net changes, despite slight losses in consumer-oriented sectors, which experience lower activity caused by higher natural gas and electricity costs.

States with the largest economic impacts from LNG exports include Texas, Louisiana, and Alaska benefit from large-scale oil and gas production, as well as in-state LNG export terminals (only in the High LNG Export Case for Alaska). Alaska could see up to $10 billion in state income in 2035 resulting from LNG exports (assuming an in-state LNG export terminal). Other large hydrocarbon producers such as Pennsylvania, Wyoming, Arkansas, and Oklahoma also see large gains, as do manufacturing-intensive states such as Ohio and Indiana. California, with a large manufacturing presence and diverse economy also sees large gains from LNG exports.

The largest economic impacts are generated in gas-producing states. The production of natural gas, oil, and natural gas liquids (NGLs) generates significant economic impacts for producing states, including Texas, Louisiana, Pennsylvania, and Alaska (if an LNG terminal is built in Alaska, requiring in-state gas production).

Producing-State Profile: Pennsylvania

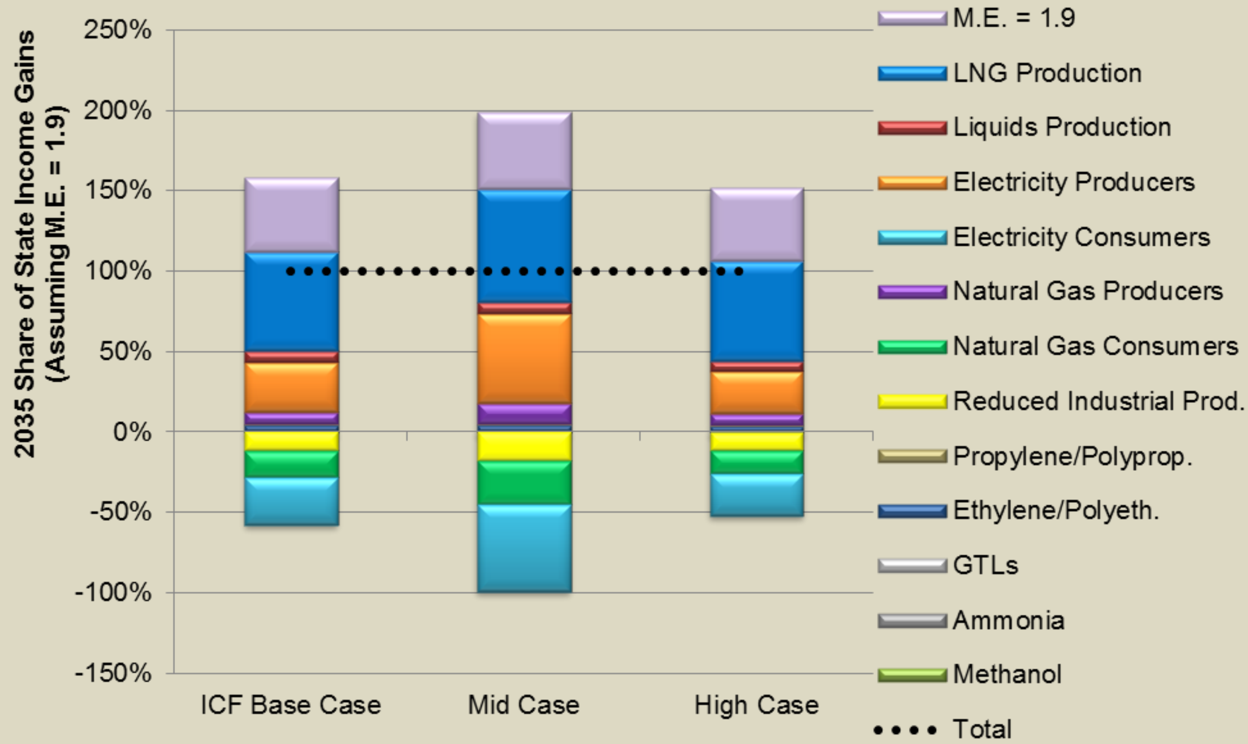
LNG and liquids production comprise a significant share of net economic impacts for Pennsylvania, or nearly 60% of total state income changes for the state in 2035, with total state income impacts reaching $2.1-$10.5 billion that year.



However, gas production activities also require materials, services, personnel, processing, and transportation, benefiting manufacturing-intensive states such as Ohio, Indiana, and Illinois, as well. In particular, non-natural gas-producing states with a large manufacturing base, such as Indiana and Wisconsin, see significant impacts, with the total economic gains in 2035 reaching $2.6 billion and $1.3 billion, respectively.

Manufacturing State Profile: Indiana

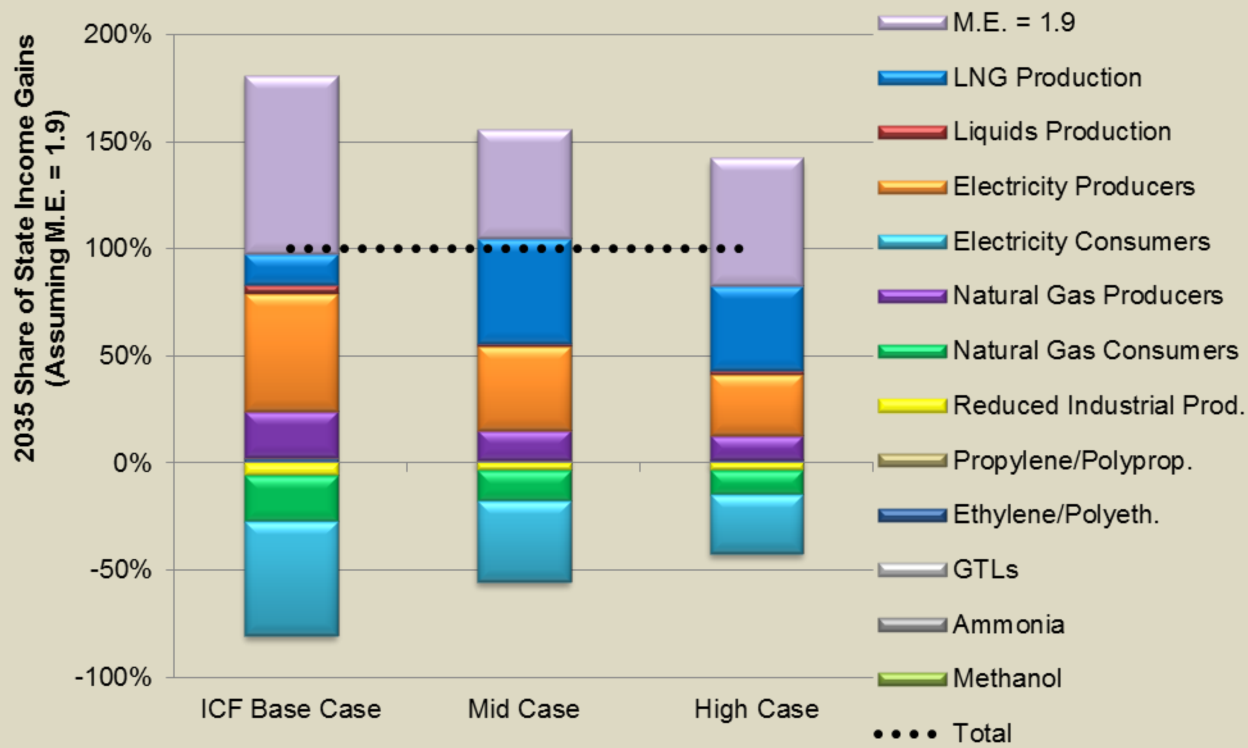
Indiana sees net positive economic impacts ranging from $300 million to $2.2 billion annually by 2035, attributable in large part by the manufacturing equipment required for hydrocarbon production and liquefaction operations.



In addition, states in which LNG terminals are located see significant economic impacts, as well. LNG terminals are a long-term investment, requiring significant capital outlays, labor, materials, and services. States with LNG terminals see significant increases in state incomes resulting from LNG exports.

LNG Export State Profile: Maryland

LNG comprises between 40%-50% of net economic impacts for Maryland in the Mid and High cases assuming an in-state LNG export facility, with total state income impacts reaching between $100 million to $1.6 billion by 2035 over the three LNG export cases.

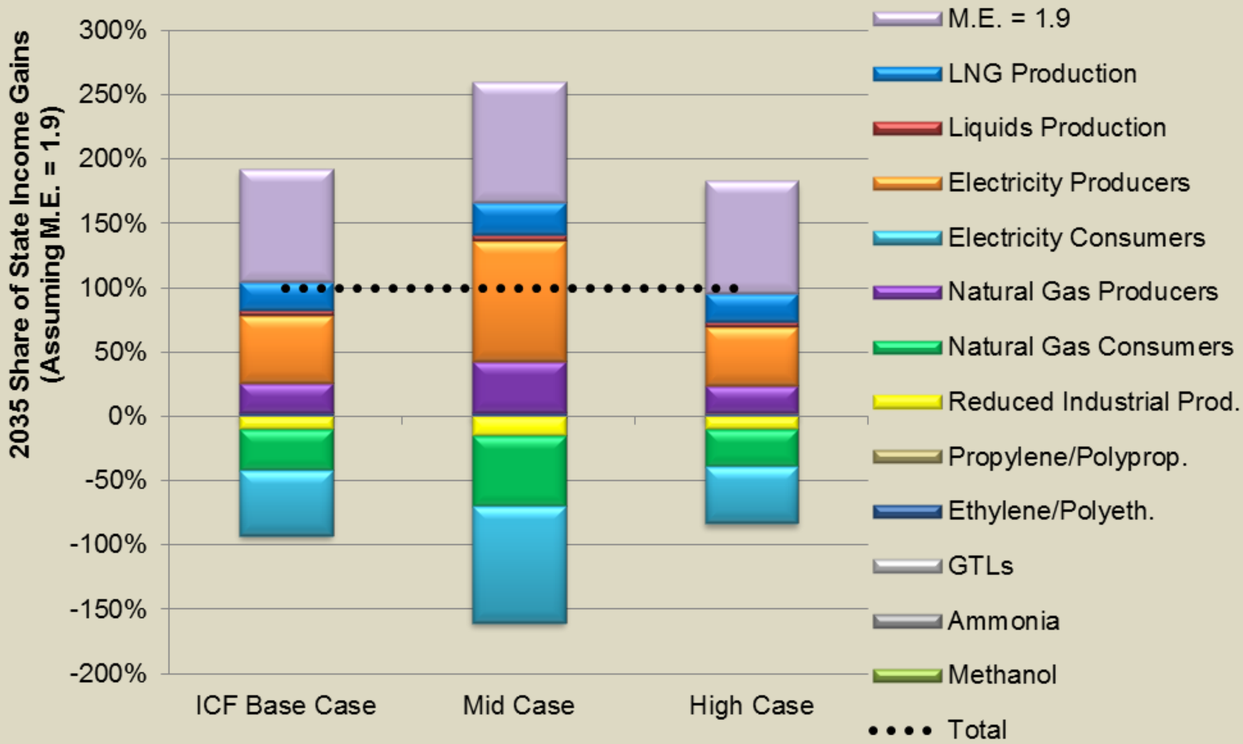


The one High LNG Export Case with the Alaska terminal generates significant income for the state, given that the LNG export terminal of 2.25 Bcfd starting in 2023 will require large capital outlays and rely exclusively on Alaskan natural gas as feedstock (as opposed to using gas production from the lower 48 states). Alaska could see over 36,000 jobs in 2035 resulting from LNG exports (assuming an in-state LNG export terminal). In the other cases wherein no Alaskan LNG terminal is assumed, Alaska shows negligible income and employment impacts.

California, with a large manufacturing presence and diverse economy also sees large gains from LNG exports.

State Profile of Large Economy: California

California comprised nearly 13% of the U.S. GDP in 2010, the largest share of any U.S. state. This study found net state income impacts of between $500 million to $5.0 billion in 2035. LNG-related activities (e.g., engineering services, equipment manufacturing) contribute roughly one-quarter of net state income impacts that year.



States with little exposure to gas-related activities or associated manufacturing see net positive impacts of LNG exports through the multiplier effect. States with large natural gas and electricity consumption, while most adversely affected by the increase in natural gas and electricity costs, see net positive economic impacts. When oil and gas employees, for instance, spend additional earnings through inter-state consumer purchases, these activities further generate economic activity elsewhere.

State Profile of Large Gas and Electricity Consumption: Florida

Florida consumes a higher proportion of U.S. natural gas and electricity consumption than average (5% and 6% in 2011, respectively - EIA). Despite this, Florida shows net economic gains of $100 million to $1.9 billion by 2035.

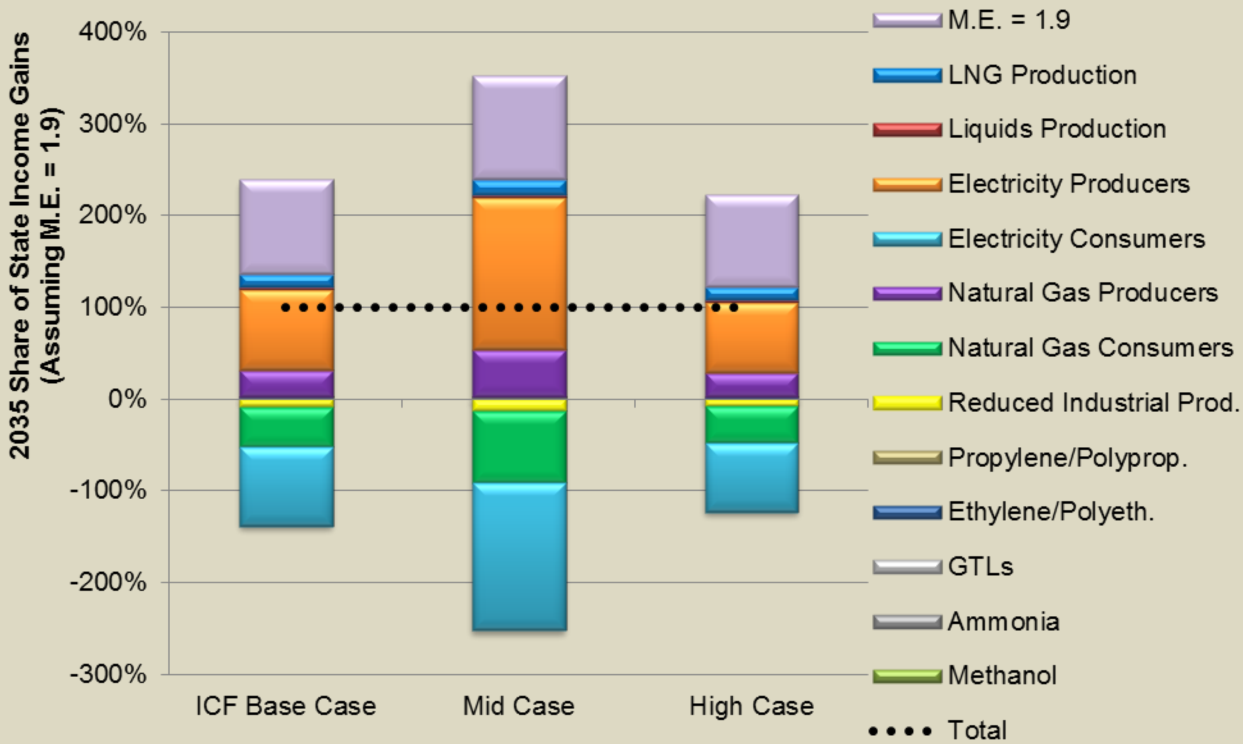
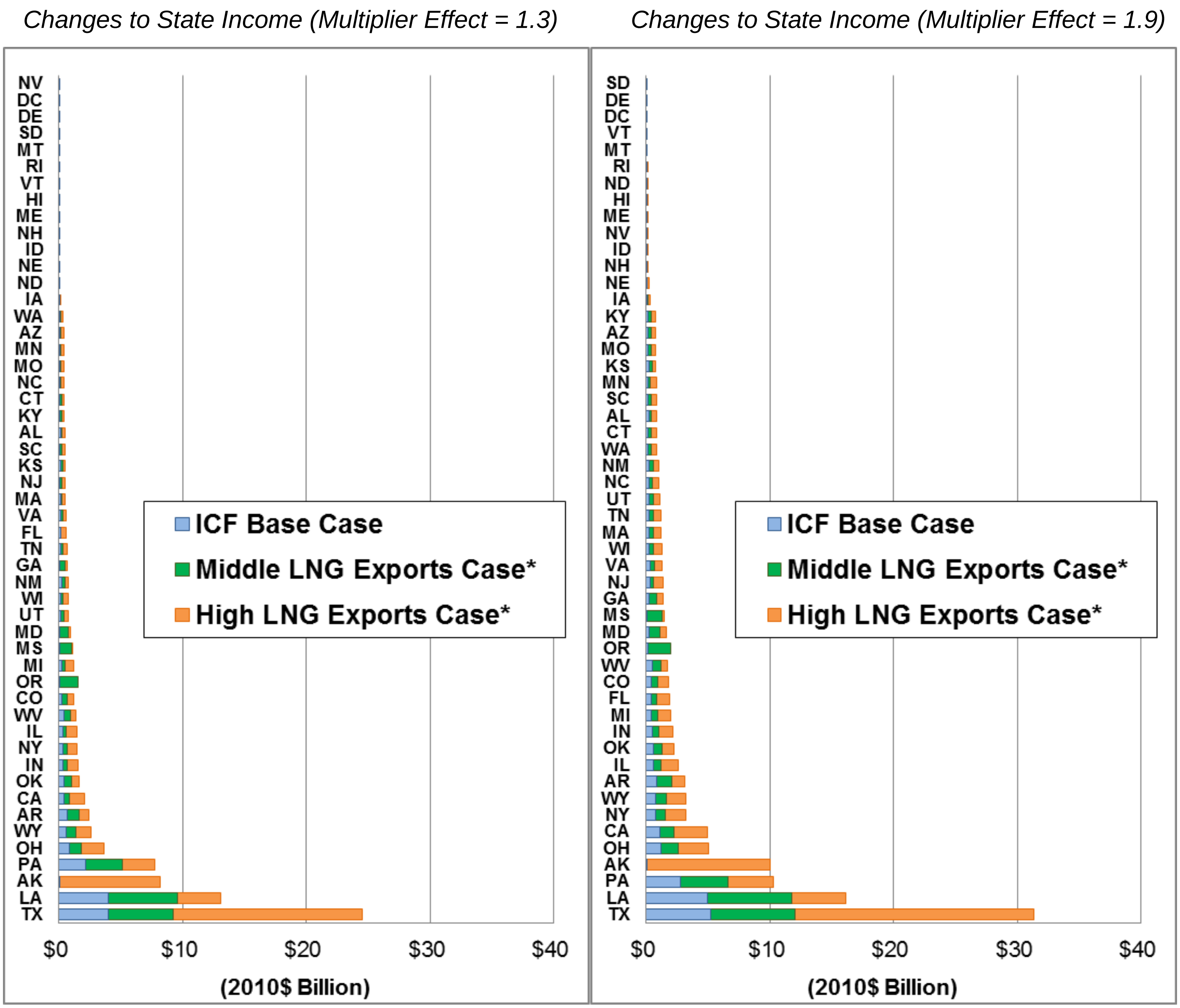


Exhibit 4-6 and Exhibit 4-7 show the distribution of total state income changes associated with LNG exports. Exhibit 4-7 is meant to show spatially the information illustrated in Exhibit 4-6.

Exhibit 4-6: 2035 State Income Impacts from LNG Exports (relative to Zero Exports Case)

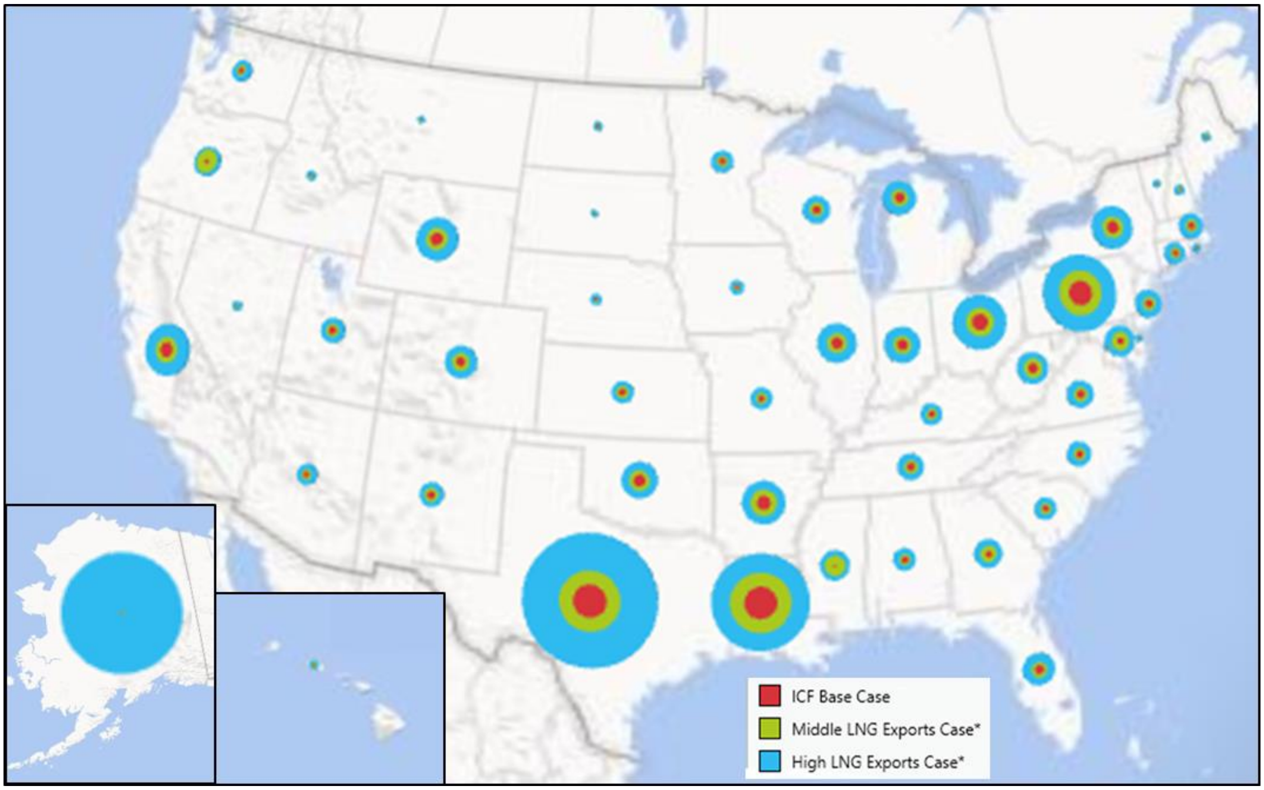


Source: ICF estimates

Note: Ranked by High LNG Exports Case.

* The Middle Case values are the average of four Terminal Location Cases (TLCs) and the High Case values are an average of five TLCs except that values for the seven LNG terminal states (AK, GA, LA, MD, MS, OR, TX) show impacts with at least one in-state LNG export terminal.

Exhibit 4-7: Map of 2035 Relative Income Impacts from LNG Exports (By State Income)



Source: ICF estimates

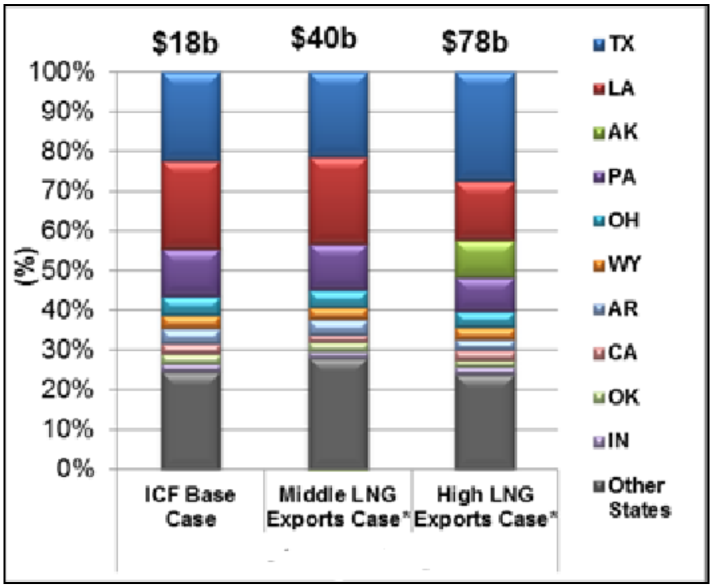
Note: Calculated using an economic multiplier of 1.9. The circle sizes represent the relative income impact of each state for each LNG export case.

* The Middle Case values are the average of four Terminal Location Cases (TLCs) and the High Case values are an average of five TLCs except that values for the seven LNG terminal states (AK, GA, LA, MD, MS, OR, TX) show impacts with at least one in-state LNG export terminal.

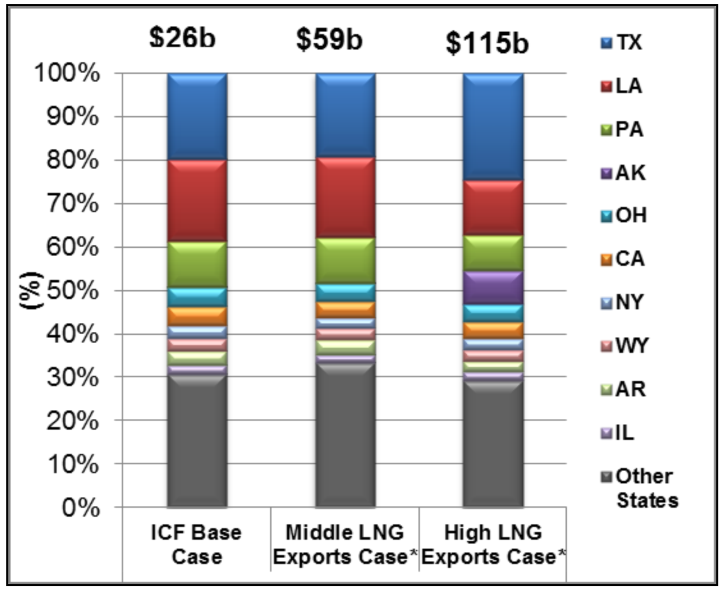
Exhibit 4-8 shows the proportion of income impacts by the 10 states that capture the bulk of the economic impacts in both the 1.3 and 1.9 multiplier effect cases. While large gas producers such as Texas, Louisiana, and Alaska (in the High Alaska Case) capture a large share of the total economic impacts, non-producing states such as California, Indiana, and New York see significant positive impacts, as shown below.

Exhibit 4-8: 2035 State Income Impacts Share of Top 10 States

Changes to State Income (Multiplier Effect = 1.3)



Changes to State Income (Multiplier Effect = 1.9)



Source: ICF estimates

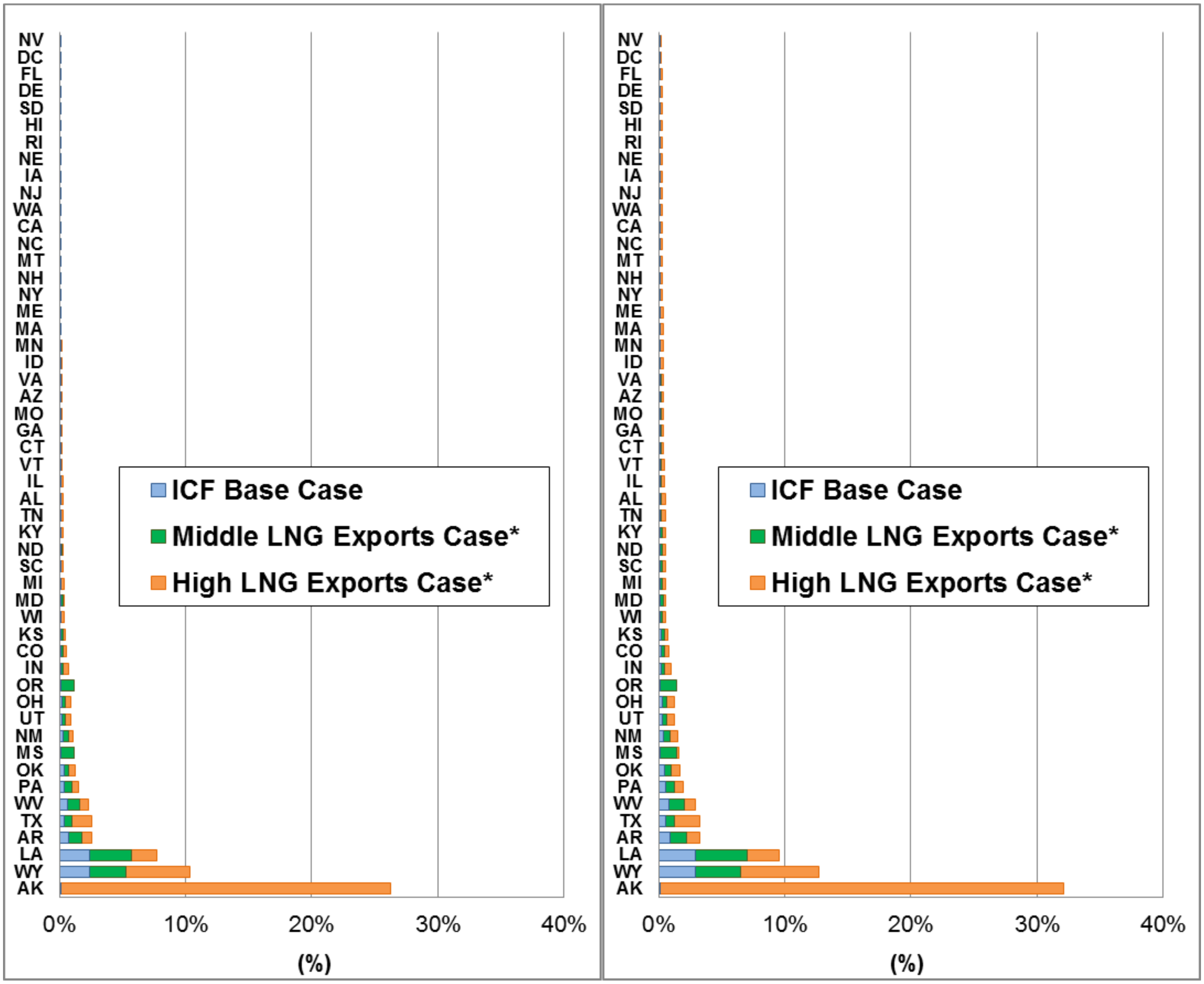
Note: Ranked by High LNG Exports Case.

* The Middle Case values are the average of four Terminal Location Cases (TLCs) and the High Case values are an average of five TLCs except that values for the seven LNG terminal states (AK, GA, LA, MD, MS, OR, TX) show impacts with at least one in-state LNG export terminal.

The 2010 state income is used here to illustrate the relative economic impacts on states. Exhibit 4-9 shows 2035 total economic impacts by state as a proportion of 2010 state income. While economic impacts for producing states such as Texas, Louisiana and Pennsylvania see 2035 total economic impacts ranging from 5%-10% of 2010 state income, states such as Indiana, and Wisconsin, among others, see significant impacts, as well.

Exhibit 4-9: 2035 State Income Impacts as a Proportion of 2010 State Income

Changes to State Income Share (Multiplier Effect = 1.3) *Changes to State Income Share (Multiplier Effect = 1.9)*



Source: ICF estimates

Note: Ranked by High LNG Exports Case.

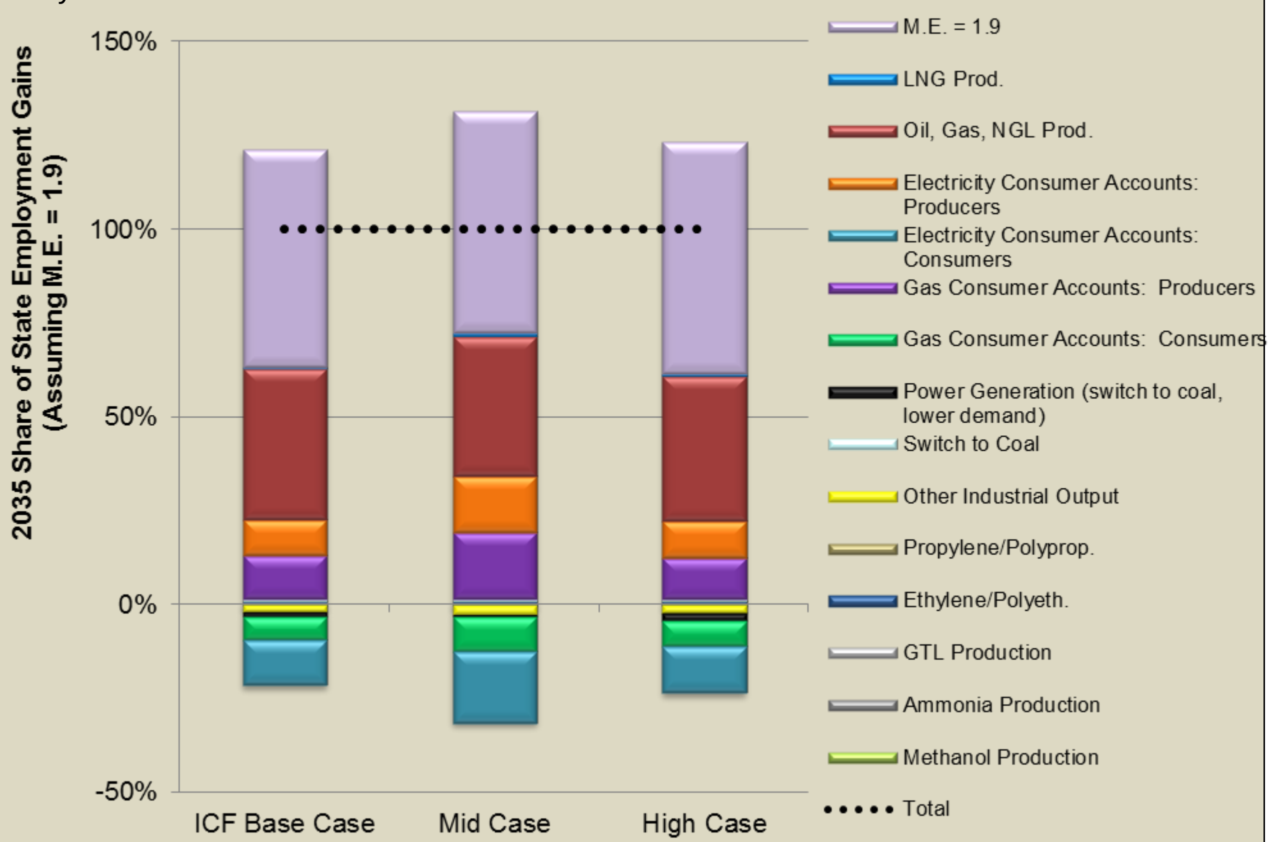
* The Middle Case values are the average of four Terminal Location Cases (TLCs) and the High Case values are an average of five TLCs except that values for the seven LNG terminal states (AK, GA, LA, MD, MS, OR, TX) show impacts with at least one in-state LNG export terminal.

4.2 Employment Impacts on the U.S. Economy

As mentioned in the national-level report, the ICF methodology calculates direct and indirect job impacts (relative to no LNG exports) by multiplying the change in production in a given sector (measured in dollars or physical units) times the labor needed per unit of production. Employment impacts in this study (as with the original study) were computed first by the source of activity and then using input/output matrices allocated to the ultimate sectors within which the jobs take place. Just as with the economic impacts, ICF quantified the employment impacts resulting from natural gas production increases that will take place for a given LNG export scenario and the required capital and operating and maintenance expenditures. Some gas-production-related employment will take place in the manufacturing sector (e.g., sand mining for hydraulic fracturing, steel production for drill pipe). While these activities are not considered part of the oil and gas production sectors, they are included in the job totals that are "sourced" by these activities.

Producing-State Profile: Pennsylvania

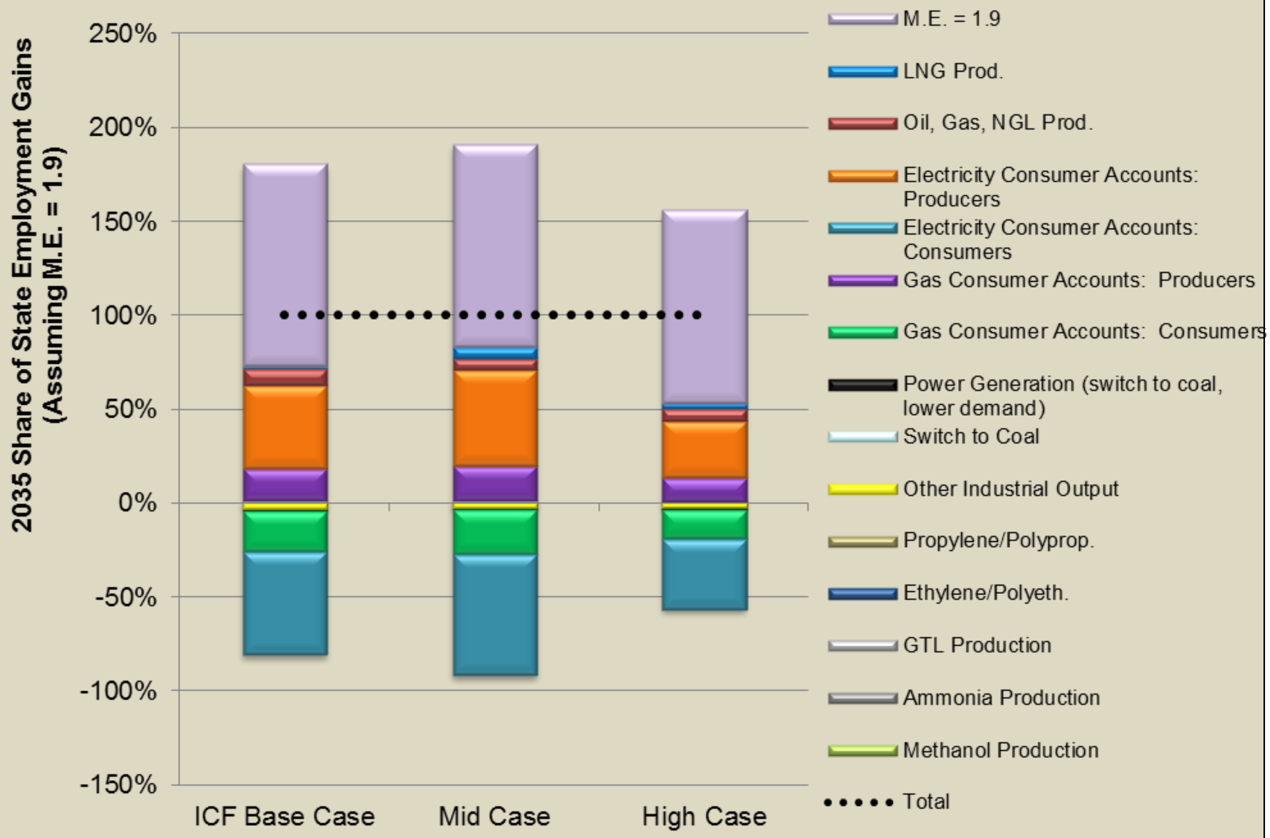
Natural gas and other hydrocarbon production comprise roughly 60% of Pennsylvania's total employment changes by 2035, with total state employment impacts ranging from 10,000-61,000 that year.



Of the 72,000-665,000 net job gains from LNG exports by 2035 nationwide, all states see net positive employment impacts from LNG exports, including states with a potential LNG export terminal, such as Maryland.[28]

LNG Export State Profile: Maryland

Total employment impacts to Maryland range from 480 to 9,500 jobs in 2035 over the three LNG export cases.



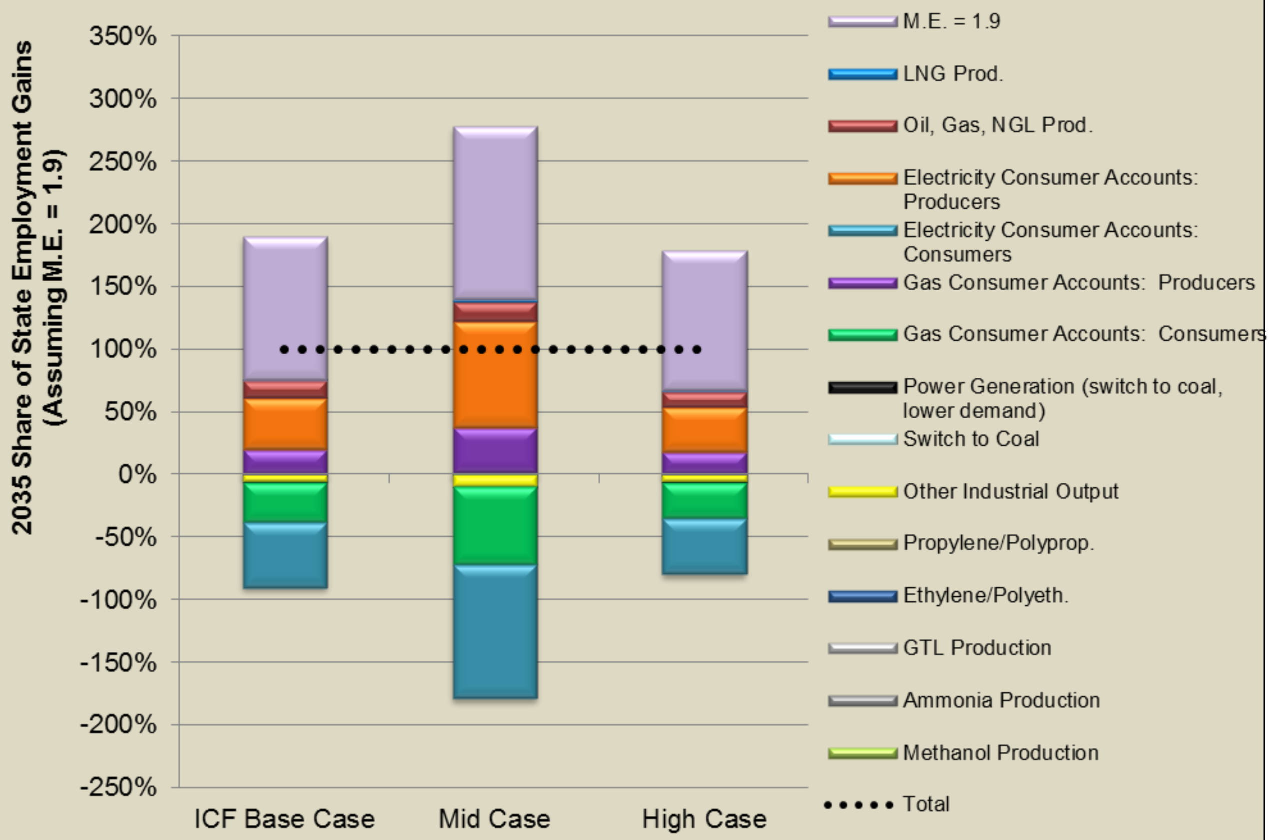
As with economic activity, the biggest job gains are in states with natural as production, liquefaction plants and petrochemical industries. However, states providing indirect goods and services to the natural gas producers, liquefaction plants, and petrochemical industries (such as steel from Ohio, machinery from Indiana, etc.) also see significant job gains, as well.

Generally, producing states saw the largest benefits, though a certain portion of income generated by LNG exports is spent out-of-state, such as the inter-state sale of goods and services (e.g., tourism, cars, and other manufactured goods). Thus, it is possible for states with little direct and indirect employment to benefit in terms of multiplier effect activity. In addition, the stockholder income from gas-related activities is distributed throughout the country, rather than concentrated within a state. This generates further spending and employment throughout the U.S.

[28] Calculated assuming an economic multiplier of 1.9.

State Profile of Large Economy: California

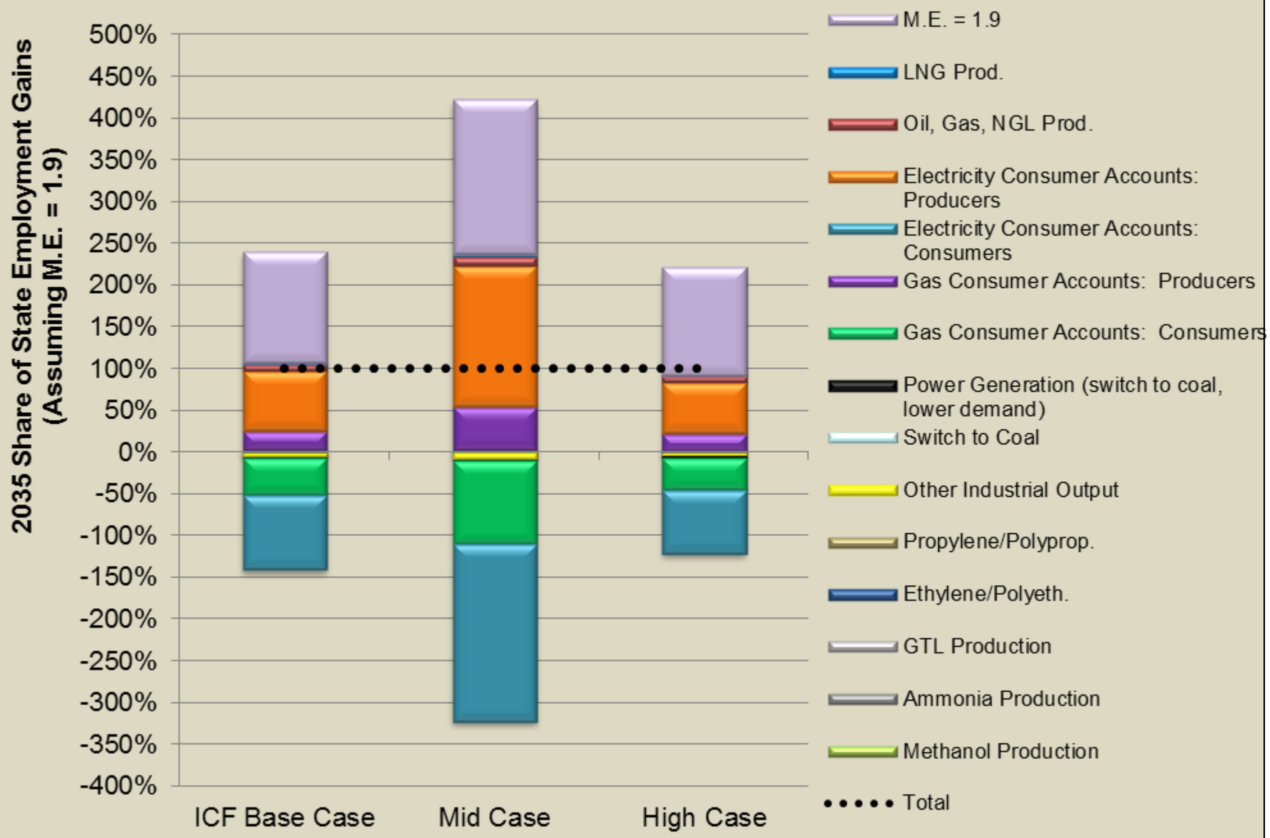
California comprised nearly 12% of total U.S. employment in 2012, the largest share of any U.S. state. This study found net employment impacts of between 2,000 and nearly 40,000 jobs in 2035.



The majority of states that do not directly participate in LNG-related industries see small, net job gains. This comes about because job losses (stemming from higher energy costs) are offset by job gains from a larger US economy. The job gains come from higher indirect purchases from the LNG-related industries; higher income of in-state stockholders of LNG- and petrochemical-related industries; and consumer spending of out-of-state employees of oil, gas, and related industries. A small number of states, however, see negligible job contractions in some cases, as employment gains do not fully offset the consumer impacts from slightly higher natural gas and electricity costs.

State Profile of Large Gas and Electricity Consumption: Florida

Florida consumes a higher proportion of U.S. natural gas and electricity consumption than average (5% and 6% in 2011, respectively - EIA). While Florida sees net positive employment gains reaching over 3,000 in the ICF Base Case and up to nearly 15,000 jobs in the High Case, the Mid Case net jobs ranges from a reduction of 1,200 to a net increase of 5,000.



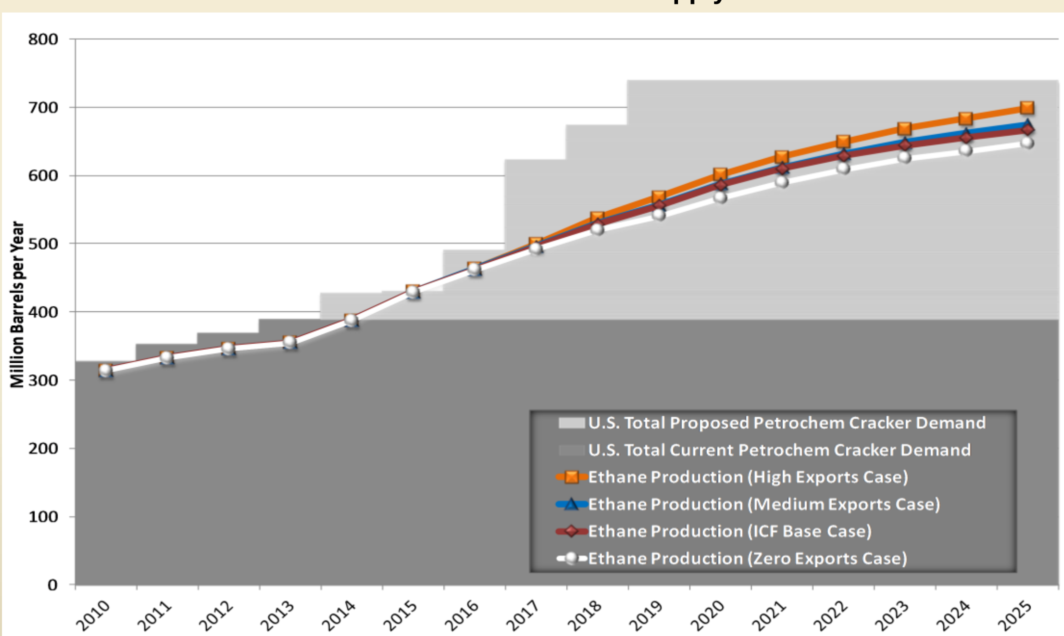
Increased LNG exports lead to increased availability of ethane for the petrochemical industry

The natural gas production levels ICF forecasts for the three LNG export scenarios also lead to different production levels of associated natural gas liquids, and particularly ethane, the largest component of the NGL mix. Used primarily as a feedstock for the petrochemical industry, ethane is "cracked" into ethylene, an essential building blocks in organic chemistry. As precursor to such materials as polyethylene or monoethylene glycol, ethylene is by far the most commonly produced chemical in the world, and a vital feedstock in manufacturing materials that eventually make their way to the consumer market. Form plastic bottles and home insulation to antifreeze and pantyhose, ethylene finds its way into a wide variety of every-day products.

Winners in this space will not be limited to just the plants located in the traditional petrochemical cluster on the Gulf of Mexico coast. With shale resources found throughout the country, and natural gas liquids production forecasted to grow in areas as wide-spread as the Bakken in North Dakota/Montana, Eagle Ford in Texas, and Marcellus/Utica in the Northeast, there is scope for manufacturers to locate their facilities in myriad locations. ICF's list of planned petrochemical facilities (see Appendix C of national-level report) shows projects well outside the Gulf Coast region. The Northeast, for example, is in line for at least two major petrochemical facilities. A region more accustomed to the hollowing-out of its industrial base is being reenergized by its proximity to a prolific supply basin. While the draw for the ethylene crackers is the ready supply of cost-advantaged feedstock, the benefits will spread far and wide – from the employees at these plants and the municipalities benefiting from the income and property taxes, to the companies that use these precursor chemicals in their processes.

The surge in ethane production since 2009, after decades of falling output, and forecasts for continuing growth, have led petrochemical producers to plan for an unprecedented level of capacity expansion. Between 2012 and 2020, should all projects proceed to completion, the U.S. will see its ethylene production capacity grow by over 40%. Using ethane as their feedstock, rather than the naphtha used by most of their international competitors, will give companies operating in the United States a cost advantage relative to their global peers. That lower costs of production will in turn be passed on to their customers, creating a ripple effect that will spur not only the development of derivatives production, but also lead to lower prices of consumer goods derived from these intermediate products.

U.S. Historical and Forecast Ethane Supply and Demand

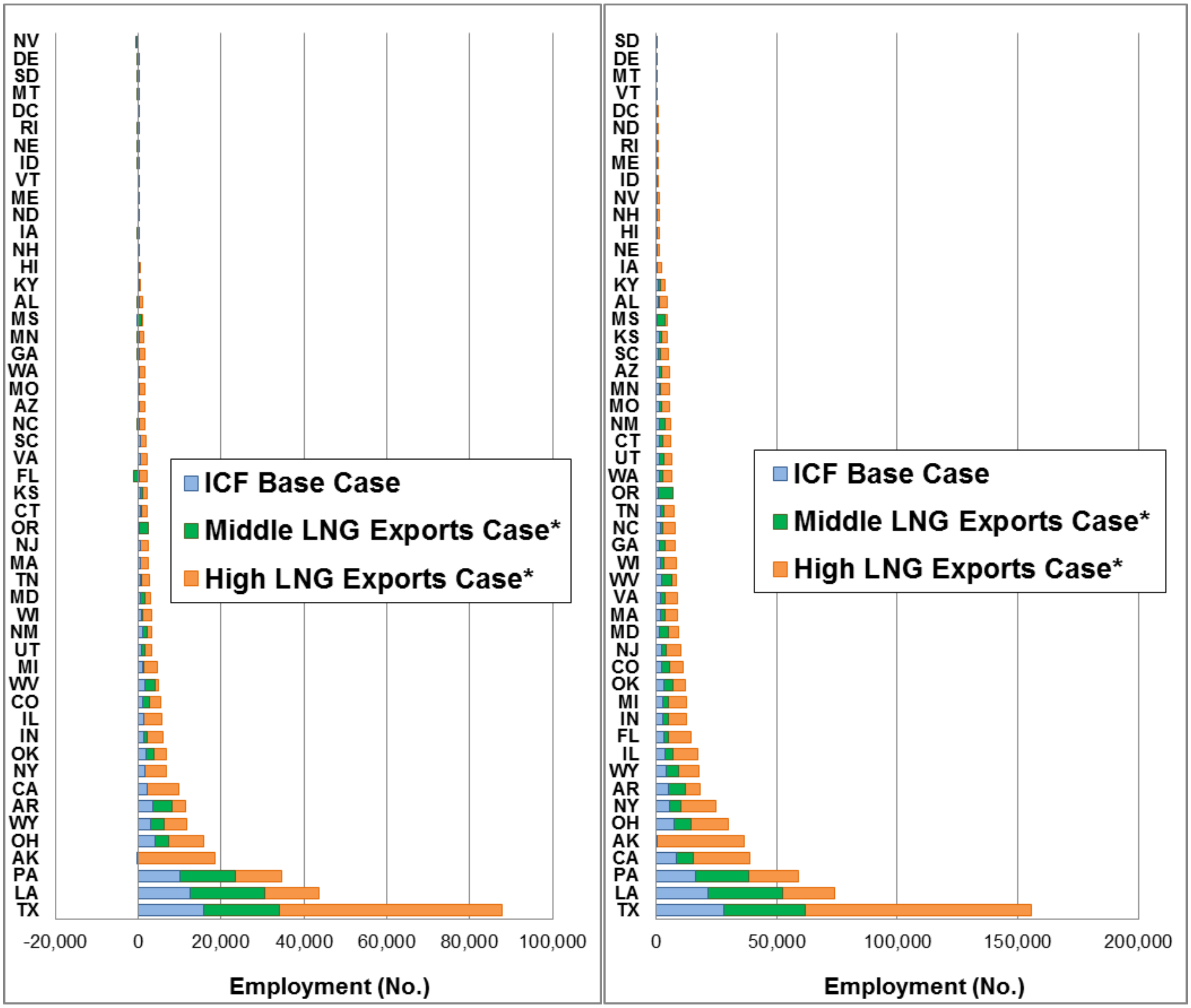


As shown in the chart above, potential demand for ethylene brought about by proposed ethylene production capacity between 2013 and 2020 will easily exceed supply past 2016. While supply is expected to grow organically even in the Zero Exports case, by the end of the forecast period the difference in supply between the Zero Exports case and the ICF Base Case and the Medium Exports Case will amount to the equivalent of at least one world-scale ethylene cracker. With the price-tag for such facility nearing $1.5 billion, this is a significant amount of foregone investment. Moving up to the High Exports case, the incremental supply of ethane grows by the equivalent of another two world-scale crackers. With each such project bringing with it not only the ethylene plant but also derivatives production, ICF estimates that in 2025 the impact of increased availability of ethane stemming from increased natural gas production will range between $1.1 and $3.2 billion, and generate an additional 1,800 to 6,000 jobs above the Zero Exports case.

Exhibit 4-10 and Exhibit 4-11 show the distribution of total state employment impacts of LNG exports in 2035. Exhibit 4-11 is meant to show spatially the information illustrated in Exhibit 4-10.

Exhibit 4-10: 2035 Total Employment Impacts from LNG Exports (relative to Zero Exports Case)

Changes to State Employment (Multiplier Effect = 1.3) *Changes to State Employment (Multiplier Effect = 1.9)*

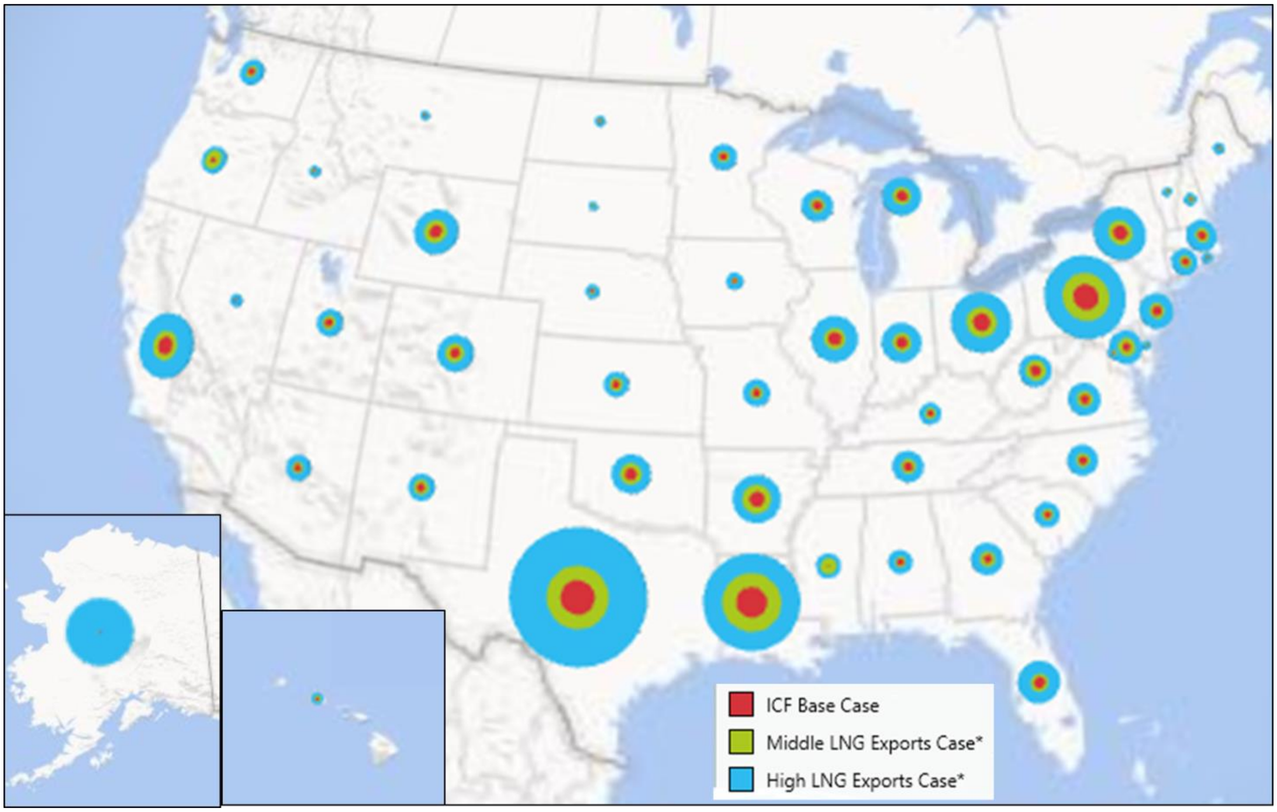


Source: ICF estimates

Note: Ranked by High LNG Exports Case.

* The Middle Case values are the average of four Terminal Location Cases (TLCs) and the High Case values are an average of five TLCs except that values for the seven LNG terminal states (AK, GA, LA, MD, MS, OR, TX) show impacts with at least one in-state LNG export terminal.

Exhibit 4-11: Map of 2035 Relative Employment Impacts from LNG Exports (By State Employment)



Source: ICF estimates

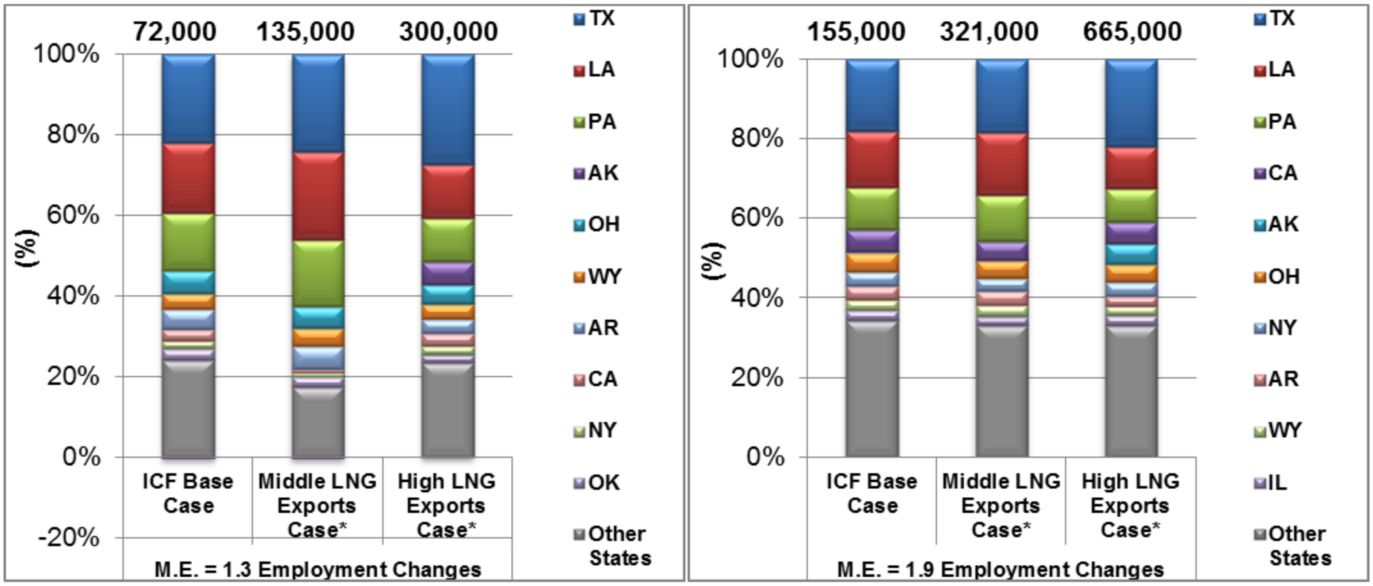
Note: Calculated using an economic multiplier of 1.9. The circle sizes represent the relative employment impact of each state for each LNG export case.

* The Middle Case values are the average of four Terminal Location Cases (TLCs) and the High Case values are an average of five TLCs except that values for the seven LNG terminal states (AK, GA, LA, MD, MS, OR, TX) show impacts with at least one in-state LNG export terminal.

Exhibit 4-12 shows the distribution of total employment by the top 10 states and the other states. The top 10 states receive the bulk of total employment impacts, and include large-scale natural gas producers such as Texas, Louisiana, and Pennsylvania (due to the large direct and indirect impacts and the large portion of multiplier effect activity that remains in-state). States such as California and New York that do not directly participate significantly in LNG-related industries see small net job gains. This comes about because job losses (stemming from higher energy costs) are offset by job gains from a larger US economy. The job gains come from higher indirect purchases from the LNG-related industries, higher income of in-state stockholders of LNG-related industries, and consumer spending of out-of-state employees of oil, gas, and related industries.

Exhibit 4-12: 2035 Total Employment Impacts Share of Top 10 States

Changes to State Employment (Multiplier Effect = 1.3) *Changes to State Employment (Multiplier Effect = 1.9)*



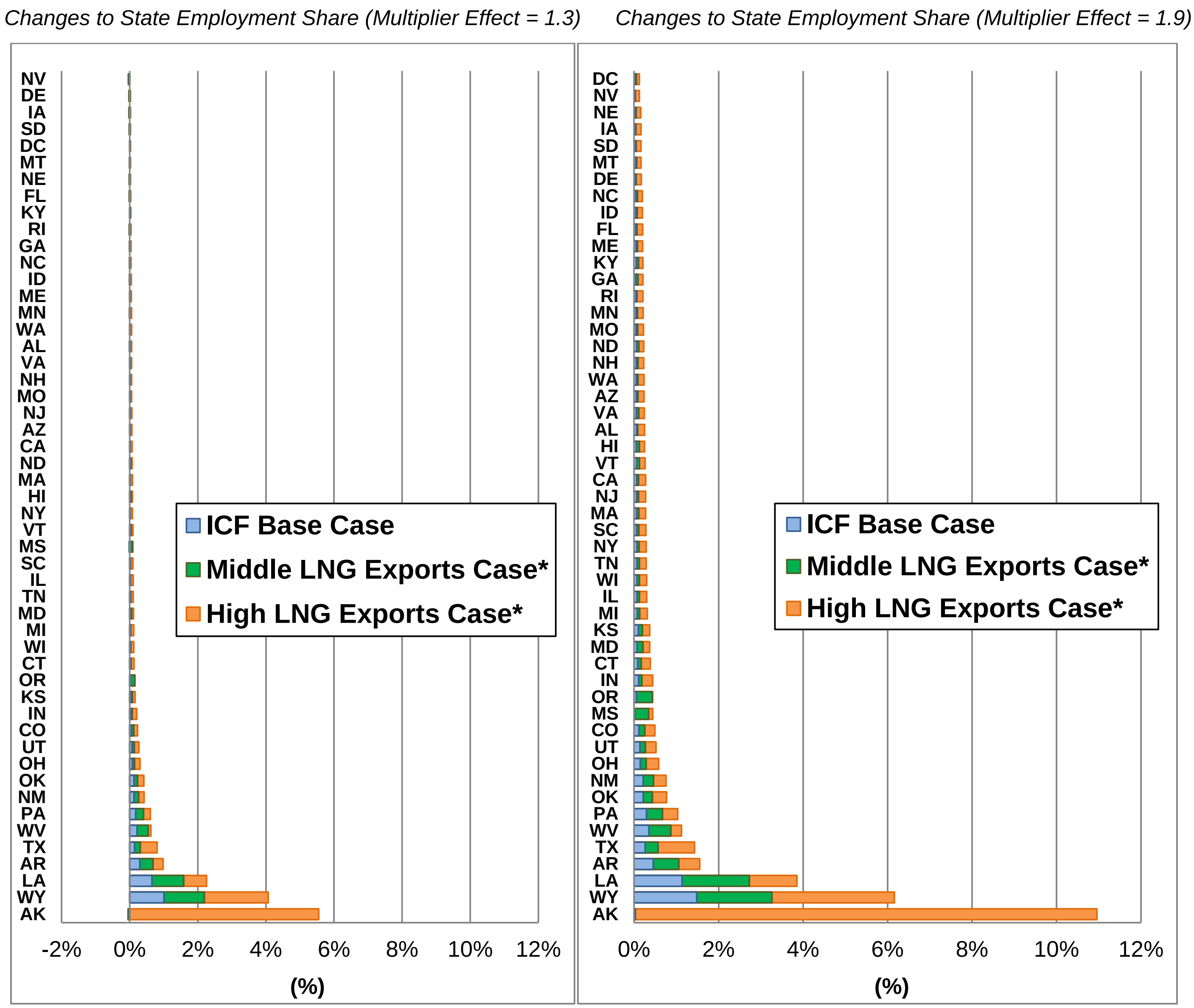
Source: ICF estimates

Note: Ranked by High LNG Exports Case.

* The Middle Case values are the average of four Terminal Location Cases (TLCs) and the High Case values are an average of five TLCs except that values for the seven LNG terminal states (AK, GA, LA, MD, MS, OR, TX) show impacts with at least one in-state LNG export terminal.

ICF used 2012 state employment levels to illustrate the relative employment impacts on states. Exhibit 4-13 shows 2035 total employment impacts by state as a proportion of 2012 state employment. Employment impacts for producing states such as Alaska, Wyoming, and Louisiana range from 2%-11% of 2012 state employment.

Exhibit 4-13: 2035 Employment Impacts as a Proportion of 2012 State Employment



Source: ICF estimates

Note: Ranked by High LNG Exports Case.

* The Middle Case values are the average of four Terminal Location Cases (TLCs) and the High Case values are an average of five TLCs except that values for the seven LNG terminal states (AK, GA, LA, MD, MS, OR, TX) show impacts with at least one in-state LNG export terminal.

4.2.1 Manufacturing Employment Impacts on the U.S. Economy

LNG exports lead to increases in manufacturing-related jobs. In particular, manufacturing of natural gas production equipment such as metals, cement, and machinery drives manufacturing changes. However, consumer-oriented manufacturing sectors such as food and textile manufacturing see a decline (relative to no LNG exports), as higher natural gas costs cause consumers to allocate a higher share of spending toward natural gas and electricity consumption rather than miscellaneous consumer goods and services.

LNG exports affect U.S. manufacturing in three key areas:

1) Increased manufacturing in producing states and LNG export locations: Gas and other hydrocarbon production, as well as construction of LNG export facilities, will require in-state labor and a large number of supplies such as steel, cement, machinery.

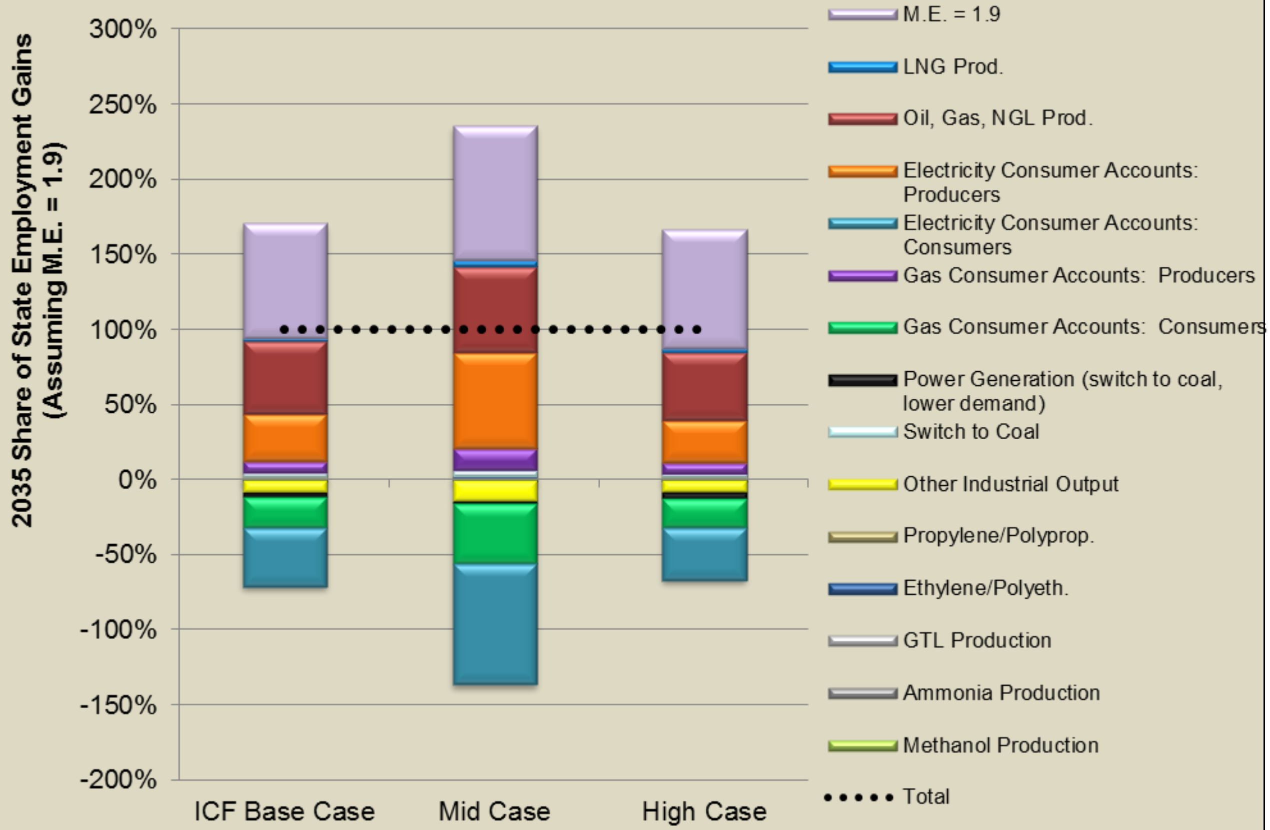
2) Increased activity in manufacturing-intensive states: The equipment needed for production and plant construction is typically produced out-of-state, and thus provides manufacturing employment in states without terminals. These states manufacture goods such as steel products (e.g., drill pipe, casing and structural steel), cement (for well and industrial plant construction), and various kinds of production equipment (pumps compressors, turbines, heat exchangers, pressure vessels, tanks, meters, control systems, etc.). In addition, as employees of LNG export terminals, gas production companies, and equipment manufacturers generate additional consumer spending, demand for consumer-related manufacturing (such as cars and electronics) will further stimulate U.S. manufacturing in these states.

3) Reduced industrial production attributable to higher gas/electricity input costs: Consumer-oriented manufacturing sectors such as food and textile manufacturing, as well as energy-intensive industries such as some petrochemical processing see production input costs rise (i.e., fuel and feedstocks), as higher natural gas costs cause consumers to allocate a higher share of spending toward natural gas and electricity consumption, rather than miscellaneous consumer goods and services.

The manufacturing industry sees net employment gains from LNG exports because the positive impact of increases in the demand for manufacturing output outweighs the adverse impacts of slightly higher natural gas and electricity costs for manufacturers. In particular, manufacturing to supply materials and equipment necessary for natural gas production, processing and transport, liquefaction plant construction and maintenance, and olefin plant construction and maintenance drives manufacturing job growth. While producing states capture a large share of the employment growth from LNG exports, manufacturing states, such as Ohio and Indiana also benefit from LNG exports, as well.

Manufacturing State Profile: Indiana

Employment changes attributable to LNG exports in Indiana range from 1,500-12,800 annual jobs by 2035 in sectors such as oil and gas production and sees net positive economic impacts ranging from $300 million to $2.2 billion annually by 2035.

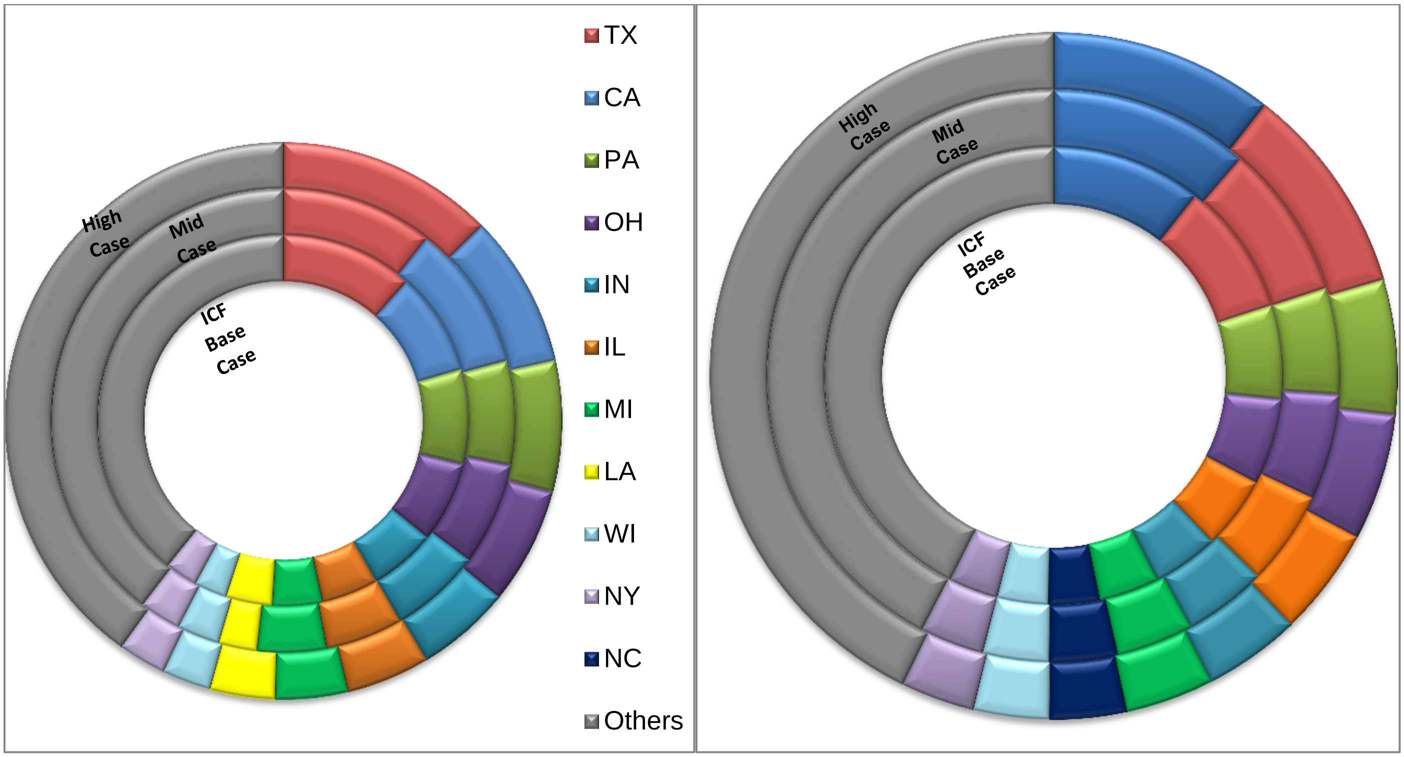


States with large manufacturing bases also benefit considerably. For example, California sees significant gains in manufacturing employment resulting from LNG exports. While manufacturing employment makes up just 8% of state's total employment, compared with manufacturing-intensive states such as Indiana, Wisconsin, Michigan, and Ohio (where manufacturing makes up 12%-17% of total state employment), California has a significant manufacturing presence. California comprises roughly 12% of total U.S. manufacturing, with manufacturing employment increasing up to 40,000 jobs in 2035 due to LNG exports.[29] Exhibit 4-14 shows the states with the largest manufacturing employment changes. This includes natural gas producers such as Texas and Pennsylvania, large economies (with large manufacturing employment sectors) such as California, and manufacturing-intensive states such as Ohio, Indiana, Illinois, and Michigan.

[29] U.S. Bureau of Labor Statistics (BLS). "Quarterly Census of Employment and Wages." BLS: Washington, DC. Available at: ftp://ftp.bls.gov/pub/special.requests/cew/2012/state/

Exhibit 4-14: 2035 Largest Manufacturing Employment Impacts from LNG Exports (relative to Zero Exports Case)

Changes to Manufacturing Employment (Multiplier Effect = 1.3) *Changes to Manufacturing Employment (Multiplier Effect = 1.9)*



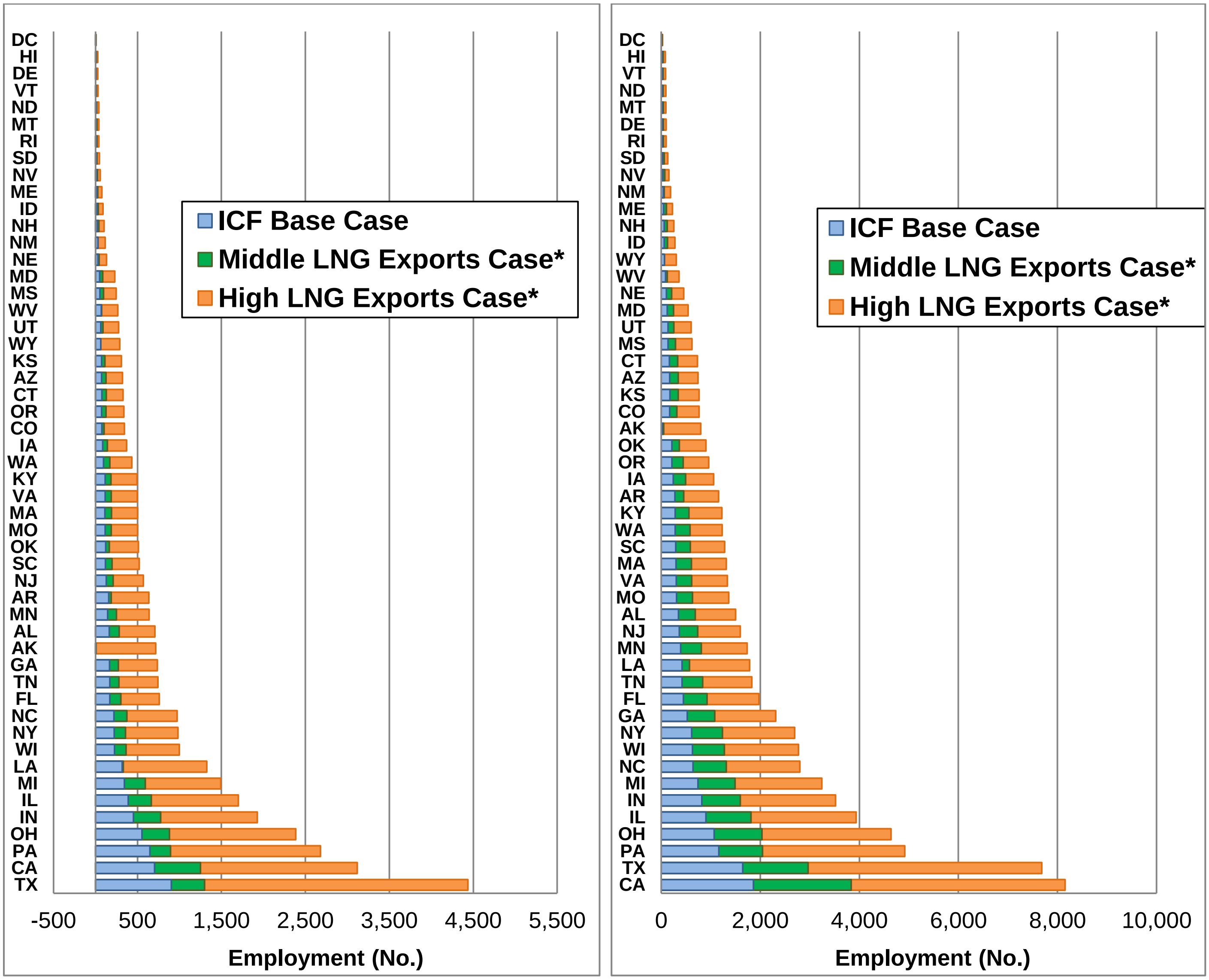
Source: ICF estimates

Note: The Middle Case values are the average of four Terminal Location Cases (TLCs) and the High Case values are an average of five TLCs except that values for the seven LNG terminal states (AK, GA, LA, MD, MS, OR, TX) show impacts with at least one in-state

Exhibit 4-15 highlights the potential impact of consumer spending-driven manufacturing, as California makes up the largest share of manufacturing jobs. This means that despite having little in-state gas production impact or LNG export terminals, the state still sees significant manufacturing job gains.

Exhibit 4-15: 2035 Total Manufacturing Employment Impacts from LNG Exports (relative to Zero Exports Case)

Changes to Manufacturing Employment (Multiplier Effect = 1.3) *Changes to Manufacturing Employment (Multiplier Effect = 1.9)*



Source: ICF estimates

Note: Ranked by High LNG Exports Case.

* The Middle Case values are the average of four Terminal Location Cases (TLCs) and the High Case values are an average of five TLCs except that values for the seven LNG terminal states (AK, GA, LA, MD, MS, OR, TX) show impacts with at least one in-state LNG export terminal.

5 Key Conclusions

This study concludes that LNG exports have a net positive, or negligible, impact across all states. In general, the largest impacts are found in states with gas, oil, and NGL production, LNG production, ethylene manufacturing and industries that supply the oil and gas and petrochemical industries. However, consumer spending activity generated by these gas- and petrochemical-related activities contributes significant inter-state activity, providing economic and employment gains to states with little to no gas- or petrochemical-related activity.

Economic Impacts

Of the total U.S. GDP changes attributable to LNG exports, ranging from $18-$115 billion annually by 2035, all states see positive, or negligible in a few cases, net income changes. State income impacts for producing states such as Texas, Louisiana and Pennsylvania in 2035 range from 5%-10% of 2010 state income, estimated at up to $10-$31 billion that year.

Texas, Louisiana, and Alaska benefit from significant oil and gas production, as well as in-state LNG export terminals (only in the High LNG Export Case for Alaska). Non-natural-gas-producing states with a large manufacturing base, such as California, see state income gains up to $5.0 billion in 2035.

Employment Impacts

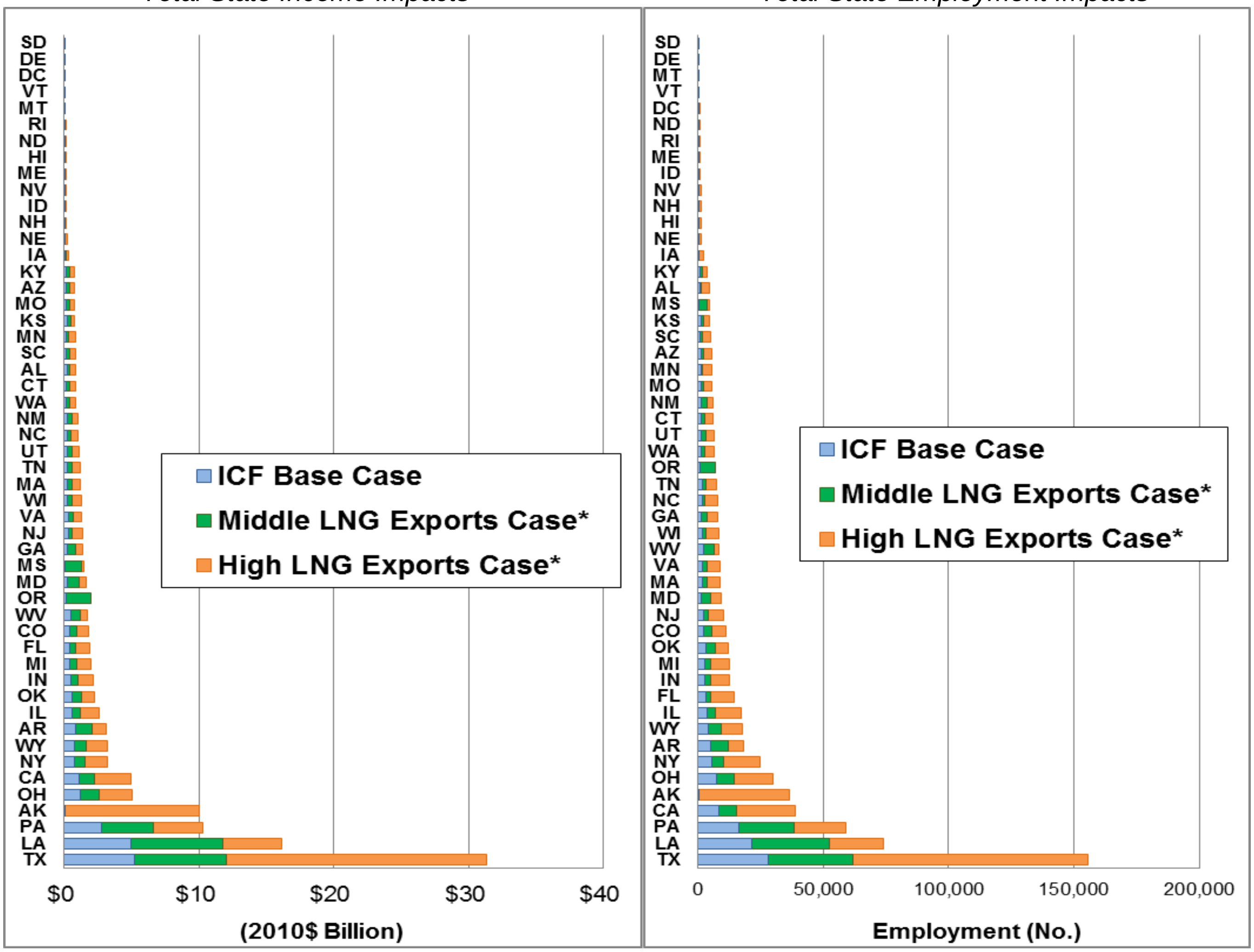
Of the 72,000-665,000 national net job gains from LNG exports by 2035, all states see net positive employment impacts from LNG exports.[30] The largest job gains are in states with natural gas production, liquefaction plants and petrochemical industries. Natural gas-consuming states, such as Massachusetts, benefit from significant multiplier-induced economic activity, due to the inter-state consumer spending. Employment impacts for producing states such as Alaska, Wyoming, and Louisiana range from 2%-11% of 2012 state employment.

States such as California and New York that do not directly participate in LNG-related industries see positive, albeit small, net job gains. This comes about because job gains from a larger U.S. economy are more than enough to offset any job losses associated with higher energy costs. Exhibit 5-1 shows 2035 state income and employment changes attributable to LNG exports.

[30] Calculated assuming an economic multiplier of 1.9.

Exhibit 5-1: 2035 Total Impacts from LNG Exports (relative to Zero Exports Case)

Total State Income Impacts *Total State Employment Impacts*



Source: ICF estimates

Note: Calculated using an economic multiplier of 1.9. Ranked by High LNG Exports Case.

* The Middle Case values are the average of four Terminal Location Cases (TLCs) and the High Case values are an average of five TLCs except that values for the seven LNG terminal states (AK, GA, LA, MD, MS, OR, TX) show impacts with at least one in-state LNG export terminal.

Manufacturing Impacts

The manufacturing industry sees net employment gains from LNG exports. In particular, manufacturing to supply materials and equipment for natural gas production processing and transport, liquefaction plant construction and maintenance, and olefin plant construction and maintenance drives manufacturing job growth. While producing states capture a large share of the employment growth from LNG exports, manufacturing states, such as California, could see up to 8,200 manufacturing jobs in 2035.

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