Exhibit A

NERA Report

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Updated Macroeconomic Impacts of LNG Exports from the United States

Prepared for:

Cheniere Energy, Inc.

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List of Acronyms

AEO	Annual Energy Outlook	**JCC**	Japanese Customs-cleared crude
AGR	Agricultural sector	**LEUR**	Low Estimated Ultimate Recovery
CBO	Congressional Budget Office	**LNG**	Liquefied natural gas
CES	Constant Elasticity of substitution	**M_V**	Motor vehicle manufacturing sector
COL	Coal sector	**MAN**	Other manufacturing sector
CRU	Crude oil sector	**Mcf**	Thousand cubic feet
DOE/FE	U.S. Department of Energy, Office of Fossil Energy	**MMBtu**	Million British thermal units
EIA	Energy Information Administration	**MMTPA**	Million metric tons per annum
EIS	Energy-intensive sector	**NAICS**	North American Industry Classification System
ELE	Electricity sector	**NAIRU**	Non-accelerating Inflation Rate of Unemployment
FSU	Former Soviet Union	**NEMS**	National Energy Modeling System
GAS	Natural gas sector	**NGL**	Natural Gas Liquid
GDP	Gross domestic product	**NBP**	National Balancing Point
GIIGNL	International Group of LNG Importers	**OIL**	Refining sector
GNGM	Global Natural Gas Model	**SRV**	Commercial sector
GPL	Gas Plant Liquid	**Tcf**	Trillion cubic feet
HEUR	High Estimated Ultimate Recovery	**TRK**	Commercial trucking sector
IEA WEO	International Energy Agency World Energy Outlook	**TRN**	Other commercial transportation sector
IEO	International Energy Outlook	**WTI**	West Texas Intermediate

Scenario Naming Convention

The following is the naming convention used for all the scenarios. Lists of all the possible U.S., international, and U.S. LNG export cases are shown below.

Generic Naming Convention:

U.S. Case_International Case_U.S. LNG Export Case

U.S. Cases:

USREF	U.S. Reference case
HOGR	High Oil and Gas Resource
LOGR	Low Oil and Gas Resource

International Cases:

INTREF	International Reference case
D	International Demand Shock
SD	International Supply/Demand Shock

U.S. LNG Export Cases

NX	No Export Capacity	LS	Low/Slow	HS	High/Slow
LSS	Low/Slowest	LR	Low/Rapid	HR	High/Rapid
NC	No Export Constraint				

N_{ew}ERA Baselines:

Bau_USREF	No LNG export expansion case derived from *AEO 2013* Reference case
Bau_HOGR	No LNG export expansion case derived from *AEO 2013* High Oil and Gas Resource case
Bau_LOGR	No LNG export expansion case derived from *AEO 2013* Low Oil and Gas Resource case

Scenarios Analyzed by N_{ew}ERA:

USREF_INTREF_NC	U.S. Reference case with International Reference and No Constraint on exports
USREF_D_NC	U.S. Reference case with International Demand Shock and No Constraint on exports
USREF_SD_NC	U.S. Reference case with International Supply/Demand Shock and No Constraint on exports
USREF_D_LSS	U.S. Reference case with International Demand Shock at Low/Slowest export levels
USREF_D_LR	U.S. Reference case with International Demand Shock at Low/Rapid export levels
HOGR_INTREF_NC	U.S. High Oil and Gas Resource case with International Reference and No Constraint on exports
HOGR_INTREF_LSS	U.S. High Oil and Gas Resource case with International Reference at Low/Slowest export levels
HOGR_INTREF_LR	U.S. High Oil and Gas Resource case with International Reference at Low/Rapid export levels
HOGR_INTREF_HR	U.S. High Oil and Gas Resource case with International Reference at High/Rapid export levels
HOGR_D_NC	U.S. High Oil and Gas Resource case with International Demand Shock and No Constraint on exports
HOGR_SD_NC	U.S. High Oil and Gas Resource case with International Supply/Demand Shock and No Constraint on exports
HOGR_SD_HS	U.S. High Oil and Gas Resource case with International Supply/Demand Shock at High/Slow export levels
LOGR_SD_NC	U.S. Low Oil and Gas Resource case with International Supply/Demand Shock and No Constraint on exports
LOGR_SD_LSS	U.S. Low Oil and Gas Resource case with International Supply/Demand Shock at Low/Slowest export levels

EXECUTIVE SUMMARY

A. What NERA Was Asked to Do

NERA Economic Consulting (NERA) was retained by Cheniere Energy, Inc. (Cheniere) to perform an analysis of the impacts of liquefied natural gas (LNG) exports on the U.S. economy. This study is an update to a previous study by NERA for the U.S. Department of Energy, Office of Fossil Energy (DOE/FE) that was released in December 2012. The scenarios for the DOE study were based on the U.S. Energy Information Administration's (EIA's) *Annual Energy Outlook* (*AEO) 2011* and *International Energy Outlook (IEO) 2011*, while the scenarios for this study are based on EIA's *AEO 2013* and *IEO 2013*.

NERA's analysis in the previous study addressed 63 scenarios for potential LNG exports.[1] Those scenarios incorporated three different assumptions about U.S. natural gas supply, three different assumption about international supply/demand, and seven different assumptions about the future capacity and rate of growth of U.S. LNG exports.

Consistent with NERA's previous study, a total of 63 scenarios were generated to analyze potential U.S. LNG exports. The three U.S. natural gas supply scenarios in this study are based on the EIA's *AEO 2013* Reference, High Oil and Gas Resource, and Low Oil and Gas Resource cases. The three international scenarios include a Reference case based on the EIA's *IEO 2013*, a Demand Shock (D) scenario which assumed greater levels of natural gas demand in Asia caused by shutdowns of some nuclear capacity, and a Supply/Demand Shock (SD) scenario in which the Demand Shock scenario was coupled with a Supply shock that assumed key LNG exporting regions did not increase their exports above current planned levels.

The scenarios that investigate levels of U.S. LNG export capacity[2] are based on the same limits as those specified by DOE/FE for NERA's previous study. In the current study, we also provide a complete analysis of scenarios in which no limitations are put on the level of U.S. LNG exports and LNG exports exceed the 12 billion cubic feet per day (Bcf/d) maximum export capacity specified in the DOE/FE study.

Before conducting its macroeconomic analysis, NERA had to estimate the prices at which various quantities of U.S. LNG exports could be sold to foreign buyers, taking into account the effect that U.S. LNG exports would have on the global market. In all of the 63 scenarios, prices

[1] "Macroeconomic Impacts of LNG Exports from the United States," NERA Economic Consulting, Prepared for U.S. Department of Energy, Office of Fossil Energy, 2012.

[2] U.S. LNG export levels reflecting either slow or rapid increases to limits of: 6 Bcf/d at the Low Level, and 12 Bcf/d at the High Level. NERA also examined a slower export level, with capacity rising at a slower rate to 6 Bcf/d. NERA also examined scenarios in which U.S. LNG exports were not constrained.

received for LNG exports were high enough that some exports of LNG occurred in at least one year, but in a number of cases the world natural gas market would not accept the full amount of exports allowed under that scenario. In other cases, U.S. LNG exports could be very competitive in the global market and sold at prices high enough such that unconstrained LNG exports would exceed the maximum level of U.S. LNG exports allowed in those scenarios.

NERA used the Global Natural Gas Model (GNGM) to estimate the market-determined export price that would be received by exporters of natural gas from the United States in each of the 63 scenarios, combining U.S. and global market conditions with limits on export capacity.

Of the 63 total cases generated, NERA selected 14 scenarios that spanned the range of price and export levels found in all the cases, and eliminated scenarios that had essentially identical outcomes for LNG exports and prices.[3] These scenarios are described in Figure 1. NERA then analyzed impacts on the U.S. economy of these levels of exports and the resulting changes in the U.S. trade balance and in natural gas prices, supply, and demand.

In addition, we added three variations on the HOGR_ INTREF _NC, HOGR_D_NC, and HOGR_SD_NC cases, in which we assumed a more rapid transition in the global market to gas-on-gas competition.

[3] The scenarios not presented in this report had nearly identical macroeconomic impacts to those that are included, so that the number of scenarios discussed could be reduced to make the exposition clearer and less duplicative.

Figure 1: Feasible Scenarios Analyzed in the Macroeconomic Model

U.S. Market Outlook	**Reference**			**High Oil and Gas Resource**			**Low Oil and Gas Resource**
Int'l Market Outlook	**No Int'l Shock**	**Demand Shock**	**Supply/Demand Shock**	**No Int'l Shock**	**Demand Shock**	**Supply/Demand Shock**	**Supply/Demand Shock**
Export Volume/ Pace				**Scenario Name**			
Low/ Slowest		**USREF_D_LSS**		**HOGR_ *INTREF* _LSS**			**LOGR_SD_LSS**
Low/Slow							
Low/Rapid		**USREF_D_LR**		***HOGR_ INTREF _LR***			
High/Slow						***HOGR_SD_HS***	
High/Rapid				**HOGR_ *INTREF* _HR**			
No Export Constraint	*USREF_INTREF _NC*	*USREF_D_NC*	*USREF_SD_NC*	*HOGR_ INTREF _NC*	*HOGR_D_NC*	*HOGR_SD_NC*	*LOGR_SD_NC*

Scenarios in bold use DOE/FE defined export volumes to limit exports.
Scenarios in italics have no export limits.
Results for all cases are provided in Appendix C.

B. Key Assumptions

All the scenarios were derived from the EIA's *AEO 2013*, and incorporated the assumptions about energy and environmental policies, baseline coal, oil and natural gas prices, economic and energy demand growth, and technology availability and cost in the corresponding AEO cases.

Consistent with the previous study's assumptions, all exporters in the global LNG market except the United States are characterized as initially exercising some degree of production restraint, with one dominant supplier, Qatar, where exports are assumed to be fixed no matter what the level of U.S. exports. U.S. exports compete with those from other natural gas suppliers, who are assumed to adjust their exports in light of the prevailing market price in order to maintain a margin of price above marginal cost.[4] In this market, LNG exports from the U.S. necessarily lower the international sales price received by U.S. exporters below levels that might be calculated based on current prices or prices projected without U.S. exports. Our analysis found in particular that U.S. natural gas prices do not become linked to world oil prices.

There is considerable debate regarding how the introduction of LNG exports from U.S. markets will influence international price formation and the behavior of other LNG suppliers.[5] As a result, we did analyze an alternative scenario in which production restraint breaks down and increased global competition drives world natural gas prices lower until the markup above marginal cost for all exporters becomes zero. This alternative assumption was applied to the three international scenarios with High Oil and Gas Resources in the U.S. (HOGR) and no export constraints.

We also constructed a No Exports scenario that differs from the EIA's 2013 Reference case.[6] The No Exports scenario is constructed solely to make possible discussion of the cumulative impact of LNG exports from a base in which no exports are allowed. It does not represent a "current policy" case, as one LNG facility, the Sabine Pass Liquefaction project, is already permitted and under construction, and DOE has issued conditional export licenses for several other LNG projects.[7]

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[4] The margin for each exporter to each importing region was determined in the calibration stage of the model, to make observed bilateral trade in LNG consistent with assumed demand and supply curves for each region.

[5] See Stanley Reed, "Gas Prices Moving Away from Link to Oil," *New York Times*, June 18, 2013; Karen Boman, "US LNG Exports Could Speed Transition from Oil Price Indexing," *Rigzone*, January 9, 2013; Keith Schaefer, "Asia Pushes for free-market liquefied natural gas," *Christian Science Monitor*, June 7, 2013.

[6] In EIA's *AEO 2013* Reference case LNG is exported from the U.S. In EIA's *AEO 2011* cases, there were no LNG exports from the United States.

[7] DOE/FE has issued conditional licenses for export to non-free trade nations to Freeport LNG, Lake Charles Exports, and Dominion Cove Point LNG, contingent upon those projects' approval by the Federal Energy Regulatory Commission.

Key assumptions about the business model for LNG export projects were as follows: prices for natural gas used for LNG production were based on the U.S. wellhead price plus a percentage markup, the LNG tolling fee was based on a return of capital to the developer, and financing of investment was assumed to originate from U.S. sources. In order to remain consistent with the EIA analysis in the *AEO 2013*, the N_{ew}ERA model was calibrated to give the same results for natural gas prices as EIA at the same levels of LNG exports so that the parameters governing natural gas supply and demand in N_{ew}ERA were consistent with EIA's National Energy Modeling System (NEMS) model.

Results are reported in five-year intervals starting in 2018. These calendar years should not be interpreted literally, but represent intervals after exports begin. Thus if the United States does not begin LNG exports until 2019 or later, one year should be added to the dates for each year that exports commence after 2018.

Like other general equilibrium models, N_{ew}ERA is a model of long-run economic growth such that in any given year, prices, employment, or economic activity might fluctuate above or below projected levels. It is used in this study not to give unconditional forecasts of natural gas prices, but to indicate how under different conditions for U.S. supply and global markets, constrained or unconstrained LNG exports could affect the performance of the U.S. economy. In this kind of comparison, computable general equilibrium models generally give consistent and robust results.

The original study done for DOE/FE did not address two key issues:

1. How rapidly the U.S. economy will recover from the recession, as it was assumed that aggregate unemployment rates would remain the same in all cases; and
2. How particular subsectors of manufacturing industries could be affected by different levels of LNG exports.

In the new version of the N_{ew}ERA model used for this study, it was assumed that recovery from the recession would occur as forecasted by the Congressional Budget Office (CBO) and that during the remaining period of recovery, LNG export projects could affect aggregate employment and bring some unemployed workers back to work more quickly than otherwise.

In addition, the updated N_{ew}ERA model segmented the chemicals sector into four subsectors. This allowed a more detailed analysis of the impacts that LNG exports would have for discrete subsectors resulting from impacts on the price and supply of both natural gas and natural gas liquids (NGLs) processed from wellhead production that are used as feedstock by certain chemical subsectors.

C. Key Results

The conclusions from this study are consistent with those in NERA's previous study for the DOE/FE.[8] In discussing changes in prices, welfare, GDP and other metrics, we calculate the difference between the metric in the specified scenario and the metric in the zero LNG exports scenario. NERA's zero LNG exports scenario is not the same as the EIA's *AEO 2013* Reference case,[9] but does provide insights in the new NERA study into the cumulative impact of LNG exports for a given case compared to a future without LNG exports. For example, natural gas prices in the U.S. High Oil and Gas Resource, International Demand Shock, unlimited export scenario (HOGR_D_NC) are compared to natural gas prices in the U.S. High Oil and Gas Resource, International Demand Shock, No Export scenario (HOGR_D_NX).

1. Impacts of LNG Exports on U.S. Natural Gas Prices

In its analysis of global markets, NERA found that the U.S. would be able to market LNG successfully in at least some years in all scenarios. However, the market limits how high U.S. natural gas prices can rise owing to LNG exports because importers will not purchase U.S. exports if the U.S. wellhead price rises above the cost of competing global supplies. In some scenarios, we found LNG exports would actually fall below the levels of EIA's *AEO 2013* Reference case. In no case did the U.S. natural gas price become linked to oil prices.

2. Macroeconomic Impacts of LNG Exports are Positive in All Scenarios

In all of the scenarios analyzed in this study, NERA found that the U.S. would experience net economic benefits from increased LNG exports.[10] In six of the nine scenarios in which U.S. LNG exports were not constrained,[11] potential U.S. LNG exports would exceed in at least one year the lower level (6 Bcf/d) of LNG export capacity assumed in the earlier study for DOE. In five of the nine scenarios, potential U.S. LNG exports would exceed the higher export capacity (12 Bcf/d) assumed in that study.

NERA also estimated economic impacts for each case with no constraint on exports, and found that there were net economic benefits resulting from allowing unlimited exports in all cases.

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[8] "Macroeconomic Impacts of LNG Exports from the United States," NERA Economic Consulting, Prepared for U.S. Department of Energy, Office of Fossil Energy, 2012.

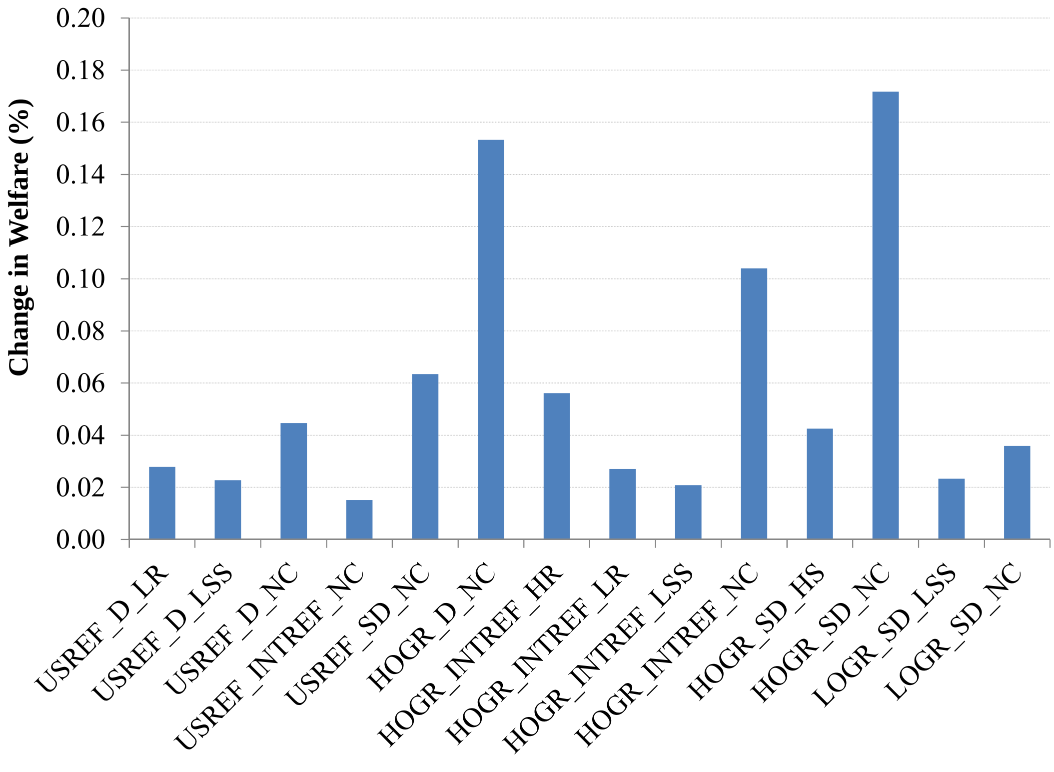
[9] EIA projects positive levels of LNG exports in *AEO 2013* Reference case, in contrast to *AEO 2011*, which did not project LNG exports.

[10] NERA did not run the EIA High Growth case because the results would be similar to the Reference case.

[11] Of the total 63 core scenarios analyzed, nine scenarios assumed no constraints on the level of U.S. LNG exports. These scenarios were intended to provide an estimate of the potential upper limit for LNG exports from the U.S.

Across the scenarios, U.S. economic welfare consistently increases as the volume of natural gas exports increases. This includes scenarios in which there are unlimited exports. Unlimited exports always create greater benefits than limited exports in comparable scenarios. The reason for this is that even though domestic natural gas prices increase owing to LNG exports, the value of those exports also rises, so that there is a net gain for the U.S. economy as measured by a broad metric of economic welfare (Figure 2) or by more common measures, such as real household income or real GDP. Although there are costs to consumers in the form of higher energy prices and lower consumption, and producers incur higher costs to supply the additional natural gas for export, these costs are more than offset by increases in export revenues, along with wealth transfers from overseas received in the form of payments for liquefaction services. The net result is an increase in U.S. households' real income and welfare.[12]

Figure 2: Percentage Change in Welfare (%)[13]



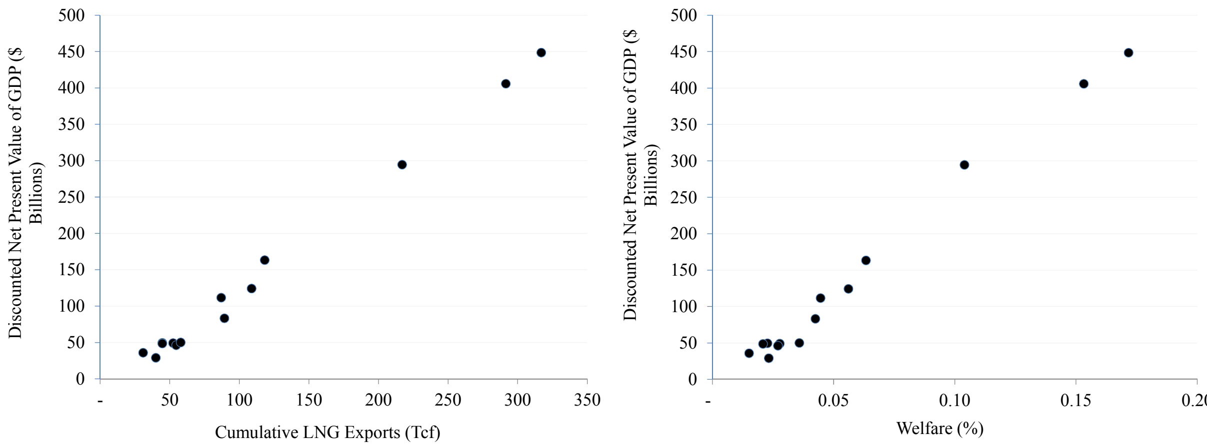
[12] In this report, the measure of welfare is technically known as the "equivalent variation" and it is the amount of income that a household would be willing to give up in the case without LNG exports in order to achieve the benefits of LNG exports. It is measured in present value terms, and therefore captures in a single number benefits and costs that might vary year by year over the period.

[13] Welfare is calculated as a single number that represents in present value terms the amount that households are made better (worse) off over the entire time horizon from 2018 to 2038.

Net benefits to the U.S. economy could be larger if U.S. exporters were to take more of a merchant role. Based on business models now being proposed, this study assumes that foreign purchasers take title to LNG when it is loaded at a United States port, so that any profits that could be made by transporting and selling in importing countries accrue to foreign entities. In the cases where exports are constrained to maximum permitted levels, this business model sacrifices additional value from LNG exports that could accrue to the United States.

Figure 3 illustrates how the change in GDP is positively correlated with LNG exports and welfare. Increasing LNG exports leads to greater gains in GDP and welfare. Figure 3 also shows that within the range of the scenarios considered, any restrictions on LNG exports would decrease GDP and welfare relative to unconstrained scenarios.

Figure 3: Discounted Net Present Value of GDP as a Function of Cumulative LNG Exports and Percentage Change in Welfare



3. Sources of Income Would Shift

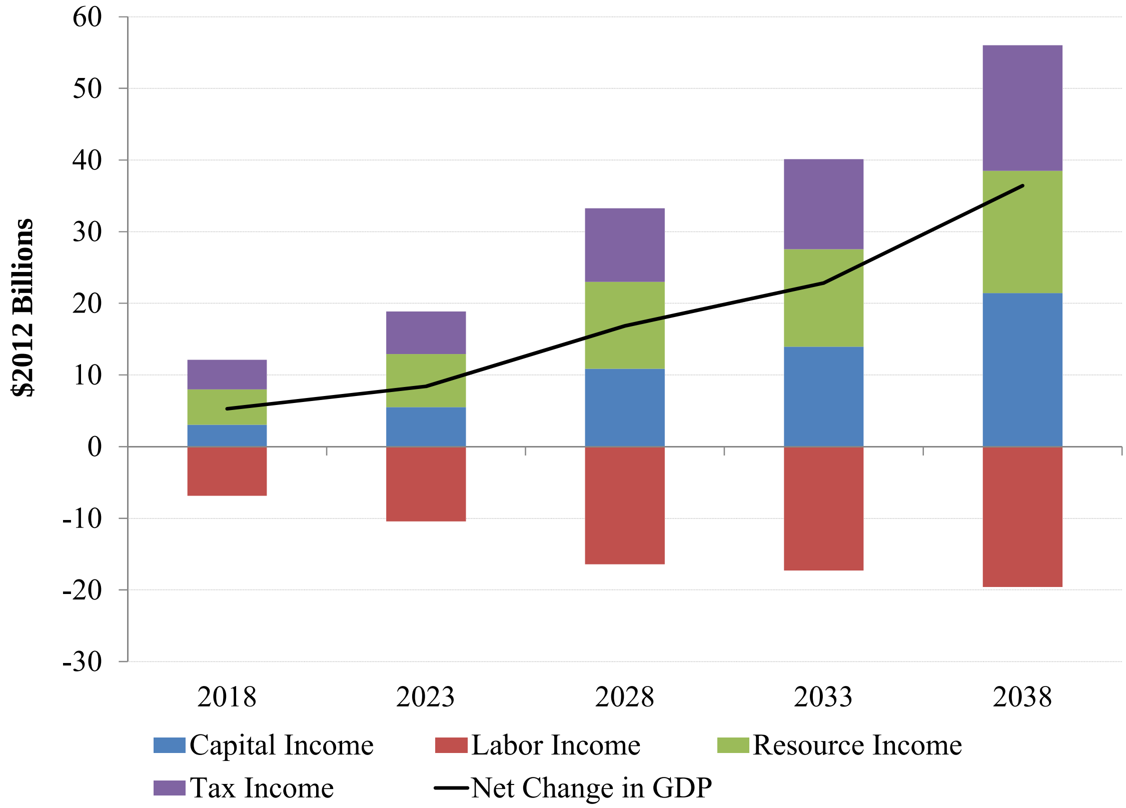
At the same time that LNG exports create higher income in the United States, they shift the composition of income so that labor income grows more slowly than in the No Exports scenario, and capital and resource income grow more rapidly. We measure total income from the income side of GDP by adding up income from labor, capital, and natural resources and adjusting for taxes and transfers. There are offsetting effects for each of these categories of income. In the case of labor income, increases in U.S. natural gas prices lead to lower real wages in general because of their effect on the cost of living relative to nominal wages. However, workers with specialized skills required in the natural gas industry and for construction and operation of LNG export facilities will experience a gain in real wages. The effect of LNG exports and higher natural gas prices on capital income is even more complex. While higher natural gas prices may decrease the return on existing capital in some energy-intensive industries that will grow more slowly, the return on capital in the natural gas industry will increase. On balance, income from investment increases because the higher returns in industries associated with the expansion of LNG exports exceeds the reduction in returns in other industries.

Increases in natural gas production and wellhead prices will also generally increase the income of owners of natural gas resources, as has been clearly seen in regions where unconventional development such as shale gas is underway.

Since all these categories of income eventually accrue to the U.S. households that own the businesses and resources and supply labor, there is an overall increase in household income. This increment comes from several sources. First, additional income comes in the form of higher export revenues and wealth transfers from incremental LNG exports at higher prices paid by overseas purchasers. Second, U.S. households benefit from higher natural gas resource income or rents. These benefits distinctly differentiate market-driven expansion of LNG exports from actions that only raise domestic prices without creating additional sources of income. Third, capital income increases because all tolling charges are represented as returns to capital for liquefaction plants. Moreover, natural gas production is more capital-intensive than labor intensive and an increase in natural gas production benefit capital returns more than labor returns. The benefits that come from export expansion more than outweigh the losses from reduced wage income to U.S. consumers, and hence LNG exports have net economic benefits in spite of higher natural gas prices. This is exactly the outcome that economic theory describes when barriers to trade are removed.

Figure 4 illustrates these shifts in income components for the USREF_SD_NC scenario, though the pattern is the same in all scenarios. Figure 4 shows that GDP increases in all years in this case, as it does in other cases (see Appendix C). Labor income is reduced by about $7 billion in 2018 and $20 billion in 2038, offset by increases in resource income to natural gas producers and property owners, increases in investment or capital income, and by net transfers that represent the improvement in the U.S. trade balance due to exporting a more valuable product (natural gas). Note that these are positive net effects of about $5 billion in 2018, increasing to $36 billion in 2038, but, on the scale of the entire economy, these net effects are relatively small.

Figure 4: Change in Income Components and Total GDP in USREF_SD_NC (Billions of 2012$)



Capital income, resource income, and indirect tax revenues (including net transfers associated with LNG export revenues) increase, while labor income decreases. Wage income declines are caused by high fuel prices, leading to reductions in output and hence lower demand for input factors of production. However, there is positive income from capital income, higher resource value, and net wealth transfer. The increase in capital income comes about from two key sources: First, all tolling charges are represented as returns to capital for liquefaction plants. Second, gas extraction is more capital intensive than labor intensive, so increases in gas production benefit capital returns more than labor returns. These additional sources of income are unique to the export expansion policy. These sources lead to the total increase in household income exceeding the total decrease. The net positive effect in real income translates into higher GDP and consumption.

4. There would be Net Economic Benefits to the United States with Unlimited Exports

NERA also estimated economic impacts associated with unlimited exports. In these cases, LNG exports and prices were determined by global supply and demand. Even in these cases, U.S. natural gas prices did not rise to oil parity or to levels observed in consuming regions, and net economic benefits to the United States increased over the corresponding cases with limited exports. Even under a scenario in which exports exceed 53 Bcf/d and result in higher prices than in the constrained cases, net economic benefits result from allowing unlimited exports.

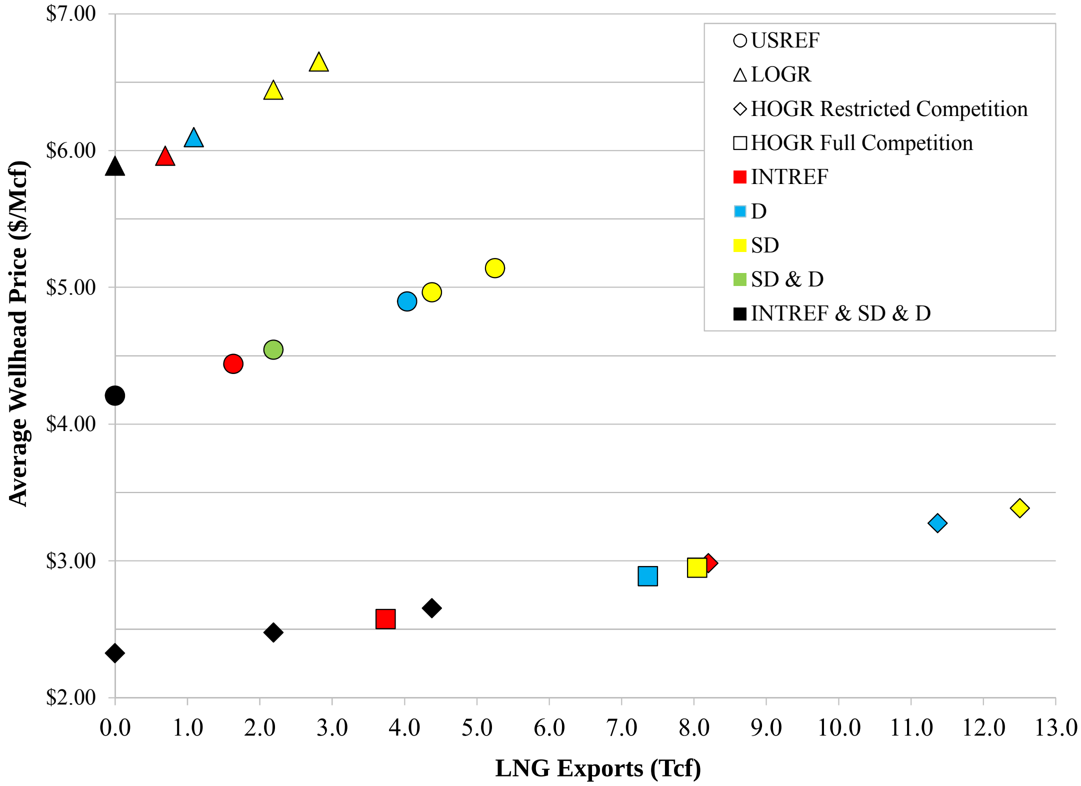
The diamonds and squares in Figure 4 represent combinations of domestic wellhead prices and LNG exports in the U.S. High Oil and Gas Resource (HOGR) cases. EIA's assumptions about U.S. natural gas supply in those cases are very bullish, so that even with 13 trillion cubic feet (Tcf) of exports in 2028, wellhead prices remain around $3.50 per thousand cubic feet (Mcf), or below recent price levels.[14] In the U.S. Low Oil and Gas Resource (LOGR) cases (triangles), wellhead prices in 2028 are around $6.00 per Mcf even without LNG exports, and unlimited LNG exports would be no more than 3 Tcf in 2028 and lead to wellhead prices about $0.75 per Mcf higher than in the No Export scenarios. Thus we see clearly that if U.S. production costs for natural gas turn out to be higher than expected, then exports would be limited by the lack of buyers willing to pay those higher prices. Conversely, were resources to be abundant at costs lower than expected, very high levels of exports can be sustained without raising prices above current levels.

The squares in Figure 5 show the level of LNG exports if rivals respond to the U.S.'s large amount of exports by lowering their prices to recapture some of their lost market share. When rivals respond in this manner, the demand for U.S. exports declines, lowering the total demand for U.S. natural gas and resulting in a decline in U.S. wellhead prices.

[14] Natural gas for 12-month delivery at the Henry Hub in 2014 averaged approximately $4.30 per million Btu at year-end 2013 on the New York Mercantile Exchange.

Figure 5: U.S. LNG Exports in 2028 under Different Assumptions

Note that each point may represent multiple non-binding LNG export capacity scenarios



1 Bcf/d = 2.74 * Tcf/Year

2 Legend labels with combinations of scenarios indicate identical resulting price and LNG export combinations across scenarios

3 Multiple points with identical color coding and shapes indicate distinct quota cases.

5. Comparison of Results with Previous Study

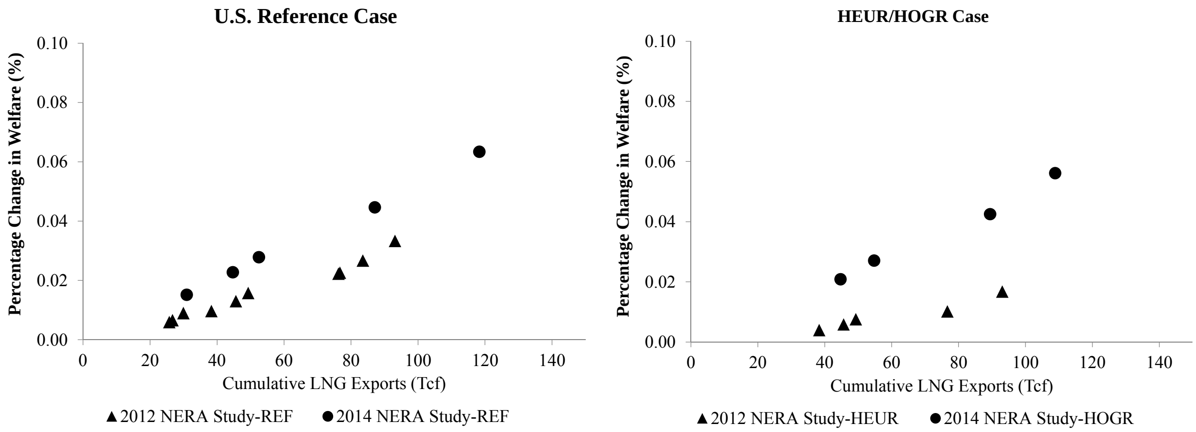
A comparison of NERA results between the current study and the DOE/FE study indicates greater LNG export potential at lower prices than previously estimated. This reflects EIA's more optimistic views on U.S. natural gas supply, as well as its projections of more rapid growth in domestic natural gas demand. The current NERA study results indicate that LNG exports would be greater in most years than estimated in the NERA study for DOE/FE. In the U.S. Reference (USREF) scenarios, with the exception of two years, U.S. LNG exports are between 0.3 and 3.5 Tcf per year higher than the results generated in the NERA study for DOE/FE. These additional LNG exports are achieved in nearly all scenarios at lower prices than in the previous study. With the exception of one year, the estimated wellhead price in the U.S. Reference scenarios is between $0.24/Mcf and $1.58/Mcf lower than in the DOE/FE study. These results imply that the United States can be expected to produce a greater level of LNG exports at a lower price than was estimated in the previous NERA study.

Using the most optimistic *AEO 2013* assumptions (from the High Oil and Gas Resource case) about the outlook for U.S. natural gas leads to projections of LNG export levels in the unconstrained cases much larger than any reported in the previous study. Even in these cases, economic benefits of unlimited exports are larger than the benefits of any lower level of exports. However, for the United States to achieve such high levels of exports, it would be necessary for other exporting countries to forego the opportunity to increase profitable sales as global demand increases, leaving room for the U.S. to take an increasing share of the future market. We consider it more likely that the threat of such large levels of U.S. exports would lead other exporters of natural gas – Russia and Qatar in particular – to accept considerably lower prices based on gas-on-gas competition in order to maintain their export sales. Under these circumstances, prices received by U.S. suppliers and U.S. LNG exports in the unconstrained cases would be considerably lower than projected when the more optimistic supply assumptions in *AEO 2013* are combined with the same assumptions about output responses from rivals in the global market made in the prior NERA study.

The more optimistic outlook embedded in the *AEO 2013* natural gas supply projections relative to the *AEO 2011* outlook is the key driver of higher net benefits observed in the current analyses. Our study suggests that for a given level of cumulative LNG exports, the new 2014 NERA study projects net benefits (as represented by the percentage change in welfare) to be relatively higher than corresponding cases simulated in the 2012 study. Figure 6 shows change in welfare for the Reference and High Resource outlook cases between the two studies. At the lower cumulative LNG export levels under the Reference outlook, in the updated NERA study welfare change is revised higher by about 0.006%; while at higher export levels, the welfare difference could be higher by about 0.011%. Similarly, welfare in the updated NERA study is higher by about 0.015% and 0.026% at lower and higher export levels for the High Resource outlook cases, respectively.[15]

[15] Only scenarios that have comparable export volumes between the two studies are reflected in the figures.

Figure 6: Comparison of Percentage Change in Welfare between 2012 and 2014 NERA Studies for the Reference and High Resource Outlook Cases



6. Greater Global Natural Gas Competition Would Serve to Limit U.S. LNG Exports

Consistent with the NERA study for DOE/FE, the current study assumes that all exporters in the global LNG market except the United States initially exercise some degree of production restraint. However, our alternative scenario demonstrates that, were production restraint to break down and increased global competition emerged, then less LNG could be profitably exported from the United States. In our analysis, increased global competition would serve to limit U.S. LNG exports even in scenarios in which the United States has plentiful low-cost resources (HOGR). The reason for this is that other exporters also have abundant low-cost natural gas supplies that can be developed, and some of these exporters are more proximate to large LNG consuming markets than the United States. These conditions enable those suppliers to compete more effectively than the United States in many regions for future LNG demand if they are willing to accept lower prices in return for more market sales. Greater global competition therefore would result in lower U.S. LNG export levels than presented under the imperfect market conditions assumed in the current study.

7. U.S. Manufacturing Renaissance is Unlikely to be Harmed by LNG Exports

Our analysis suggests that there is no support for the concern that LNG exports, even in the unlimited export case, will obstruct a chemicals or manufacturing renaissance in the United States. These concerns would require that the United States move so far up the global supply curve that competitors in natural gas-importing regions will have lower costs. In all cases, the chemicals subsectors that use natural gas for energy and feedstock continue to see very slightly slower but still robust growth (growth rates during the period 2018 through 2038 range from 2.00% to 2.04% across all the cases). At the same time, the subsectors that benefit from increased NGL supply and lower prices, particularly for ethane, resulting from exports will grow more rapidly.

8. LNG Exports Could Accelerate the Return to Full Employment

Based on Okun's Law and the expected growth of investment related to LNG exports, we estimate that LNG exports could reduce the average number of unemployed by as much as 45,000 workers between 2013 and 2018, and that, as a result, full employment could be achieved as much as one month earlier than without LNG export expansion.

I. INTRODUCTION

Cheniere retained NERA to perform an analysis of the impacts of LNG exports on the U.S. economy. This study is an update of a previous study by NERA for the U.S. DOE/FE that was released in 2012.[16]

This section describes the issues that relate to the export of LNG from the United States and the scope of NERA's analysis, including both what is similar to the DOE/FE analysis, and the new issues that are addressed.

A. Statement of the Problem

1. What is the LNG Export Potential from the United States?

An analysis of U.S. LNG export potential requires consideration of not only the impact of additional demand on U.S. natural gas production costs, but also consideration of the price levels that would make U.S. LNG economical in the world market. For the U.S. natural gas market, LNG exports would represent an additional component of natural gas demand that must be met from domestic supplies. For the global market, U.S. LNG exports represent another component of supply that must compete with supply from other regions of the world. As the demand for U.S. natural gas increases, so will the cost of producing incremental volumes. At some U.S. price level, it will become more economical for a region other than the United States to provide the next unit of natural gas to meet global demand. A worldwide natural gas supply and demand model assists in determining under which conditions and limits this pricing point is reached.

The level of U.S. LNG exports will depend not only upon future events within the United States, but also events that occur outside the United States. Therefore an analysis of the potential LNG export levels should include a set of cases that bracket the supply potential within the U.S. for natural gas production (particularly shale gas), and also consider international events that could materially affect international natural gas demand and supply.

2. What are the Economic Impacts on the United States of LNG Exports?

U.S. LNG exports have positive impacts on some segments of the U.S. economy and negative impacts on others. On the positive side, U.S. LNG exports provide an opportunity for natural gas producers to realize additional profits by selling incremental volumes of natural gas. Exports of natural gas will improve the U.S. balance of trade and result in a wealth transfer into the United States. Construction of the liquefaction facilities to produce LNG will require capital investment. If this capital originates from sources outside the United States, it will represent

[16] "Macroeconomic Impacts of LNG Exports from the United States Enter," NERA Economic Consulting, prepared for U.S. Department of Energy, Office of Fossil Energy, 2012.

another form of wealth transfer into the country. U.S. households will benefit from the additional wealth transferred into the country. If they, or their pensions, hold stock in natural gas producers, they will benefit from the increase in the value of their investment.

On the negative side, producing incremental natural gas volumes will increase the marginal cost of supply and therefore raise domestic natural gas prices and increase the value of natural gas in general. Households will be negatively affected by having to pay higher prices for the natural gas they use for heating and cooking. Domestic industries for which natural gas is a significant component of their cost structure will experience increases in their cost of production, which will adversely impact their competitive position in a global market and harm U.S. consumers who purchase their goods.

Many natural gas wells produce not only methane, which is the principal component of natural gas, but also higher hydrocarbon by-products referred to as NGLs. Some types of NGLs, especially ethane, are an important petrochemical feedstock. The pricing of ethane can be influenced by the price of natural gas. Increasing natural gas prices may affect the price of ethane. Of equal importance is that greater production of natural gas will mean greater supplies of domestically produced petrochemical feedstocks that can result in an expansion of the petrochemical industry in the United States.

Natural gas is also an important fuel for electricity generation, providing 25% to 30% of the fuel inputs to electricity generation.[17] Moreover, in many regions and times of the year, natural gas-fired generation sets the price of electricity such that increases in natural gas prices can impact electricity prices. These price increases will also propagate through the economy and affect both household energy bills and costs for businesses.

B. Scope of the NERA Study

Cheniere asked NERA to use its N_{ew}ERA model of the U.S. economy to evaluate the macroeconomic impact of LNG exports on the U.S. economy with an emphasis on the energy and petrochemical sectors.[18] NERA relied upon the EIA's *AEO 2013* output generated from the NEMS as input into the natural gas production module in the N_{ew}ERA model by calibrating natural gas supply and cost curves in the N_{ew}ERA macroeconomic model. NERA's task was to use this model to evaluate the impact that LNG exports could have on multiple economic factors, primarily U.S. gross domestic product (GDP), employment, and real income.

NERA relied on EIA's *AEO 2013* to characterize how U.S. natural gas supply, demand, and prices would respond if the specified levels of LNG exports were achieved. The first question

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[17] Source: U.S. EIA, *AEO 2013*.

[18] N_{ew}ERA is a general equilibrium model of the U.S. economy.

that NERA was asked to address was: At what price could U.S. LNG exports be sold in the world market, and how much would this change prices as the amount of exports offered into the world market increased?

The level of U.S. LNG exports is dependent not only on the development of shale gas potential in the United States, but also global events which affect the global demand and supply of natural gas. In addition, U.S. LNG exports may also be limited by the extent of development of new LNG export capacity in the United States. As a result, part of this study evaluated U.S. economic impacts resulting from lower levels of LNG exports.

We divided the factors affecting exports into three categories: U.S. domestic supply potential, U.S. LNG export capacity, and international factors. For the U.S. domestic supply potential we considered three cases:

1. A Reference case based upon the supply assumptions contained in the EIA's *AEO 2013* Reference Case;
2. The High Oil and Gas Resource potential case (HOGR) in which the supply curve is based upon the EIA's *AEO 2013* High Oil and Gas Resource case; and
3. The Low Oil and Gas Resource potential case (LOGR) in which the supply curve is based upon the EIA's *AEO 2013* Low Oil and Gas Resource case.

For U.S. LNG export capacity, we considered the same build rates that were used in our previous DOE/FE Study:

1. No U.S. LNG exports;
2. 6 billion cubic feet per day (Bcf/d), phased in at a rate of 1 Bcf/d per year (Low/Slow scenario);
3. 6 Bcf/d phased in at a rate of 3 Bcf/d per year (Low/Rapid scenario);
4. 12 Bcf/d phased in at a rate of 1 Bcf/d per year (High/Slow scenario);
5. 12 Bcf/d phased in at a rate of 3 Bcf/d per year (High/Rapid scenario);
6. 6 Bcf/d phased in at a rate of 0.5 Bcf/d per year (Low/Slowest scenario); and
7. No Export Constraint: No limits on U.S. LNG export capacity were set, and therefore our GNGM determined exports based entirely on the relative economics.

For the international supply and demand outlook we considered three cases:

1. The International Reference scenario (INTREF) is an outlook for global supply and demand based upon EIA's *International Energy Outlook 2013* (*IEO 2013*) with countries aggregated to the regions in the NERA GNGM;

2. The Demand Shock scenario (D) creates an example of increased demand by assuming that South Korea and Japan convert all of their nuclear power generation to natural gas-fired generation; and
3. The Supply/Demand Shock scenario (SD) assumes that both South Korea and Japan convert their nuclear demand to natural gas, and that no new liquefaction projects will be built in Oceania, Southeast Asia, or Africa.

In order to remain tied to the EIA's *AEO 2013* analysis, the N$_{ew}$ERA model was calibrated to give the same natural gas price responses as EIA for the same assumptions regarding the level of LNG exports.[19] This was done by incorporating into N$_{ew}$ERA the same assumptions regarding how U.S. natural gas supply and demand would be affected by changes in the U.S. natural gas wellhead price as implied by the NEMS model underlying the EIA's *AEO 2013* results.

We also added three new cases based on the HOGR case in which we assumed a different global pricing regime from that in the 63 basic cases and in the prior study. In these cases, all forms of oil-linked pricing in the global LNG market are abandoned rapidly, and all suppliers compete as price-takers in gas-on-gas competition for a share of the global market.

C. Organization of the Report

This report begins by discussing what NERA was asked to do and the methodology followed by NERA. The discussion of methodology in Section II includes the key assumptions made by NERA in its analysis and a description of the models utilized. Section III describes the construction of scenarios for U.S. LNG exports: assumptions about U.S. natural gas supplies, international scenarios, and LNG export constraints. Section IV describes NERA's GNGM, which is used to estimate world impacts of the various scenarios. A reporting of the results of these scenarios follows the model description. Section V compares these results to those in our previous study. After this section, the report concentrates on the impact of LNG export levels on the U.S. First a discussion of economic issues and export policy appear in Section VI. Then the macroeconomic impacts on the U.S. of the LNG export scenarios are reported in Section VII. A deeper look at impacts on the chemicals sector and employment are provided in Sections VIII and IX, respectively. The report concludes with the key findings and insights in Section X.

[19] *AEO 2013* projects in its Reference case that net U.S. LNG exports will total 1.93 Tcf in 2020 and grow to 3.37 Tcf by 2040.

II. DESCRIPTION OF GLOBAL NATURAL GAS MARKETS AND NERA'S ANALYTICAL MODELS

A. Natural Gas Market Description

1. Global

The global natural gas market consists of a collection of distinctive regional markets. Each regional market is characterized by its location, availability of indigenous resources, pipeline infrastructure, accessibility to natural gas from other regions of the world, and its rate of growth in natural gas demand. Some regions are connected to other regions by pipelines, others by LNG facilities, and some operate relatively autonomously.

In general, a region will meet its natural gas demand first with indigenous production, second with deliveries by pipelines connected to other regions, and third with LNG shipments. In 2012, natural gas consumption worldwide reached about 116 Tcf.[20] Most natural gas demand in a region is met by natural gas production in the same region. As shown in Figure 7, only a small portion of total gas demand is met by imports (pipelines and LNG) from other regions. LNG imports are important in a few select regions of the globe. In 2012, approximately 11 Tcf, or almost 10% of demand, was met by LNG.[21]

[20] *IEO 2013*.

[21] "The LNG Industry 2012," GIIGNL. Available at: http://www.giignl.org/publications.

Figure 7: 2012 Global Natural Gas Production and Consumption (Tcf)

	Production	Consumption	Excess (Shortfall)
Africa	6.97	3.57	3.40
Alaska	0.32	0.32	-
Canada	5.10	2.84	2.26
China/India	5.36	6.61	(1.25)
C & S America	5.99	5.11	0.88
Europe	9.89	19.56	(9.67)
FSU	25.91	20.83	5.08
Korea/Japan[22]	0.17	6.52	(6.35)
Mexico	1.80	2.51	(0.71)
Middle East	18.75	14.30	4.45
Oceania	2.28	1.33	0.95
Sakhalin	0.83	-	0.83
Southeast Asia	9.44	7.65	1.79
U.S.	23.59	25.31	(1.72)
Total World	116.40	116.46	-

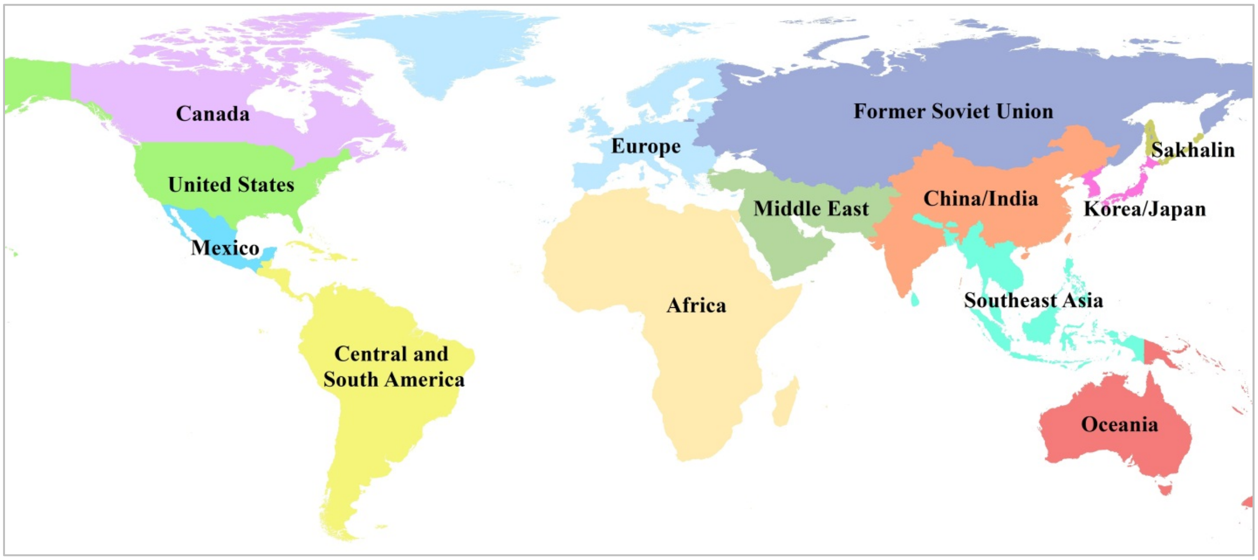
Source: *IEO 2013*

Some regions are rich in natural gas resources and others are experiencing rapid growth in demand. The combination of these two characteristics determines whether a region operates as a net importer or exporter of natural gas. The characteristics of a regional market also have an impact on natural gas pricing mechanisms. The following describes the characteristics of the regional natural gas markets considered in this report.

We present our discussion in terms of regions because we have grouped countries into major exporting, importing, and demand regions for our modeling purposes. For our analysis, we grouped the world into 13 regions: United States, Canada, Korea/Japan, China/India, Europe, Oceania, Southeast Asia, Africa, Central and South America, Mexico, Former Soviet Union (FSU), Middle East, and Sakhalin. These regions are shown in Figure 8.

[22] Korea refers to South Korea only.

Figure 8: Regional Groupings for the Global Natural Gas Model



South Korea and Japan are countries that have little indigenous natural gas resources and no prospects for natural gas pipelines connecting to other regions. Both countries depend almost entirely upon LNG imports to meet their natural gas demand. As a result, both countries are very dependent upon reliable sources of LNG. Their contracting practices and willingness to have LNG prices tied to petroleum prices (petroleum is a potential substitute for natural gas) reflect this reliance. This dependence has become even more acute as Japan appears to be implementing a policy to move away from nuclear power generation and toward greater reliance on natural gas-fired generation. Recent concerns about the safety of nuclear power plants in South Korea may cause this country to also reconsider the role of nuclear power.[23]

In contrast, China and India are countries that have some indigenous natural gas resources, but these resources alone are insufficient to meet their natural gas demand. Both countries are situated such that additional natural gas pipelines from other regions of the world could possibly be built to meet a portion of their natural gas demand, but such projects face geopolitical challenges. Pipelines today carry natural gas from central Asia into western China, and there are several potential pipelines being discussed to bring natural gas from the FSU into China. Likewise, various Middle Eastern countries, principally Iran, have contemplated shipping gas to India via pipeline. Natural gas demand in these countries is growing rapidly as a result of expanding economies, improving wealth, and a desire to use cleaner burning fuels. LNG will likely continue to be an important component of their natural gas supply portfolio. These countries demand more than they can produce and the pricing mechanism for their LNG purchases reflects this.

[23] "Stung by scandal, South Korea weighs up cost of curbing nuclear power," http://www.reuters.com/article/2013/10/28/us-korea-energy-nuclear-idUSBRE99R0BR20131028.

Europe also has insufficient indigenous natural gas production to meet its natural gas demand. It does, however, have extensive pipeline connections to both Africa and the FSU. Despite having a gap between production and consumption, Europe's growth in natural gas demand is modest. As a result, LNG is one of several options for meeting natural gas demand. The competition among indigenous natural gas supplies, pipeline imports, and LNG imports has resulted in a market in which there is growing pressure to move away from petroleum index pricing toward natural gas index pricing.

The FSU is one of the world's leading natural gas producers. It can easily accommodate its own internal natural gas demand in part because of its slow demand growth. It has ample natural gas supplies that it exports by pipeline (in most instances pipelines are a more economical method to transport natural gas than LNG) to Europe and could potentially export by pipeline to China. The FSU has subsidized pricing within its own region but has used its market power to insist upon petroleum index pricing for its exports.

Though Africa represents less than 3% of world natural gas demand, it is a key participant in the world LNG market in which it represents about 16.5% of global supplies. Because of the close proximity between Africa and Europe, Africa exports about one-half of its natural gas production to Europe via pipeline or LNG. Africa, like the Middle East, is a low-cost provider of exports.

The Middle East (primarily Qatar and Iran) has access to vast natural gas resources, which are inexpensive to produce. These resources are more than ample to supply a relatively small but growing demand for natural gas in the Middle East. Since the Middle East is located relatively far from other major natural gas demand regions in Asia and would need to traverse through multiple countries to reach Europe, natural gas pipeline projects have not materialized, although they have been discussed. LNG represents one attractive means for Qatar to monetize its natural gas resource, and it has become the world's largest LNG producer. However, Qatar has decided to restrain its sales of LNG.

Southeast Asia and Oceania are also regions with abundant low-cost natural gas resources. They can in the near term accommodate their respective domestic demands while still having additional volumes to export (Southeast Asia, with its rapid economic growth, will require increasing natural gas volumes in the future). Given the vast distances and the isolation by water, pipeline projects that move natural gas to primary Asian markets are not practical. As a result, LNG is a very attractive means to monetize their resource.

The combined market of Central and South America is relatively small for natural gas. The region has managed to meet its demand with its indigenous supplies. It has exported some LNG to European markets. Central and South America has untapped natural gas resources that could result in growing LNG exports. Argentina, in particular, has a potentially large shale gas resource.

The North American countries (Canada, United States, and Mexico) have a large natural gas demand, but have historically been able to satisfy their demand predominantly with indigenous resources. Historically, the region has had a small LNG import/export industry driven by specific niche or regional markets. Thus, the North American natural gas market has functioned as a semi-autonomous market, separate from the rest of the world. However, with unconventional gas development such as shale, that could all change. There are currently a large number of potential projects under consideration designed to export LNG onto the global market. In addition, Mexico is considered a relatively large potential U.S. export market with new pipelines proposed to carry natural gas from Texas and the U.S. Southwest to Mexico.

2. LNG Trade Patterns

LNG trading patterns are determined by a number of criteria, including: short-term demand, availability of supplies, and proximity of supply projects to markets. A significant portion of LNG is traded on a long-term basis using dedicated supplies, transported with dedicated vessels to identified markets. Other LNG cargoes are traded on an open market moving to the highest-valued customer. Southeast Asian and Australian (Oceania) suppliers often supply Asian markets, whereas African suppliers most often serve Europe. Because of their relative location, Middle Eastern suppliers can and do ship to both Europe and Asia.

Figure 9 lists 2012 LNG shipping totals with the leftmost column representing the importers and the top row representing the exporting regions.

Figure 9: 2012 LNG Trade (Tcf)

To \ From	Africa	C & S America	Europe	FSU	Middle East	Oceania	Southeast Asia	**Total Imports**
Canada			0.03		0.03			**0.06**
China/India	0.14	0.04	0.01	0.02	0.73	0.18	0.20	**1.33**
C & S America	0.04	0.01	0.31		0.06			**0.42**
Europe	0.78	0.09	0.19		1.05			**2.10**
Korea/Japan	0.55	0.17	0.08	0.50	1.94	0.81	1.90	**5.95**
Mexico	0.04	0.05	0.01		0.06		0.01	**0.17**
Middle East	0.25		0.02		0.13			**0.41**
Southeast Asia	0.08	0.03	0.01		0.29	0.02	0.26	**0.69**
U.S.	0.01	0.02	0.16		0.03			**0.22**
Total Exports	**1.88**	**0.42**	**0.81**	**0.52**	**4.34**	**1.00**	**2.38**	**11.35**

Note: Regions with negligible LNG exports or imports are omitted.
Source: "The LNG Industry 2012," GIIGNL.

3. Basis Differentials

The basis between two different regional gas market hubs reflects the difference in the pricing mechanism for each market hub. If pricing for both market hubs were set by the same mechanism and there were no constraints in the transportation system, the basis would simply be the cost of transportation between the two market hubs. Different pricing mechanisms, however, set the price in each regional market, so the basis is often not set by transportation differences alone. For example, the basis between natural gas prices in Japan and Europe reflects the differences in natural gas supply sources for both markets. Japan depends completely upon LNG as its source for natural gas and currently indexes the LNG price to crude oil. For Europe, LNG is only one of several potential sources of supply for natural gas, others being interregional pipelines and indigenous natural gas production. The pricing at the National Balancing Point (NBP) reflects the competition for market share between these three sources. Because of its limited LNG terminals for export or import, North American pricing at Henry Hub has been for the most part set by competition between different North American supply sources of natural gas and has been independent of pricing in Japan and Europe. If the marginal supply source for natural gas in Europe and North America were to become LNG, then the pricing in the two regions would be set by LNG transportation differences.

B. NERA's Global Natural Gas Model

The GNGM is a partial-equilibrium model designed to estimate the amount of natural gas production, consumption, and trade by major world natural gas consuming and/or producing regions. The model maximizes the sum of consumers' and producers' surplus less transportation costs, subject to mass balancing constraints and regasification, liquefaction, and pipeline capacity constraints.

The model divides the world into the 13 regions described above. These regions are largely adapted from the EIA's *IEO 2013* regional definitions, with some modifications to address the LNG-intensive regions. The model's international natural gas consumption and production projections for these regions are based upon the EIA's *AEO 2013* and *IEO 2013* Reference cases.

The supply of natural gas in each region is represented by a constant elasticity of substitution (CES) supply curve. The demand curve for natural gas has a similar functional form as the supply curve. As with the supply curves, the demand curve in each region is represented by a CES function (see Appendix A).

C. $\mathrm{N_{ew}ERA}$ Macroeconomic Model

NERA developed the $\mathrm{N_{ew}ERA}$ model to forecast the impact of policy, regulatory, and economic factors on the energy sectors and the economy. When evaluating policies that have significant impacts on the entire economy, one needs to use a model that captures the effects as they ripple through all sectors of the economy and the associated feedback effects. The version of the

N_{ew}ERA model used for this analysis includes a macroeconomic model with all sectors of the economy.

The macroeconomic model incorporates all production sectors, including liquefaction plants for LNG exports, and final demand of the economy. The consequences are transmitted throughout the economy as sectors respond until the economy reaches equilibrium. The production and consumption functions employed in the model enable gradual substitution of inputs in response to relative price changes, thus avoiding all-or-nothing solutions.

There are great uncertainties about how the U.S. natural gas market will evolve, and the N_{ew}ERA model is designed explicitly to address the key factors affecting future natural gas demand, supply, and prices. One of the major uncertainties is the availability of shale gas in the United States. To account for this uncertainty and the subsequent effect it could have on the domestic markets, the N_{ew}ERA model includes resource supply curves for U.S. natural gas. The model also accounts for foreign imports, in particular pipeline imports from Canada, and the potential build-up of liquefaction plants for LNG exports. The N_{ew}ERA model also has a supply (demand) curve for U.S. imports (exports) that represents how the global LNG market price would react to changes in U.S. imports or exports. On a practical level, there are also other important uncertainties about the ownership of LNG plants and how the LNG contracts will be formulated. These have important consequences on how much revenue can be earned by the U.S. and hence overall macroeconomic impacts. In the N_{ew}ERA model, it is possible to represent these uncertainties in domestic versus foreign ownership of assets and appropriately assign export revenues to better understand these issues.

U.S. wellhead natural gas prices are not precisely the same in the GNGM and the N_{ew}ERA model. Supply curves in both models were calibrated to the EIA's implicit supply curves from the EIA's *AEO 2013*, but the GNGM has a more simplified representation of U.S. natural gas supply and demand than the more detailed N_{ew}ERA model so that the two models solve for slightly different prices with the same levels of LNG exports. The differences are not material to any of the results in the study.

We balance the international trade account in the N_{ew}ERA model by constraining changes in the current account deficit over the model horizon. The condition is that the net present value of the foreign indebtedness over the model horizon remains at the benchmark year level. This prevents distortions in economic effects that would result from a perpetual increase in borrowing or lending, but does not overly constrain the model by requiring the current account to balance in each year.

This treatment of the current account deficit does not mean that there cannot be trade benefits from LNG exports. Although trade will be in balance over time, the terms of trade shift in favor of the U.S. because of LNG exports. That is, by exporting goods of greater value to overseas customers, the United States is able to import larger quantities of goods than it could if the same domestic resources were devoted to producing exports of lesser value. Allowing exports of high value goods to proceed has a similar effect on terms of trade as would an increase in the world price of existing exports or an increase in productivity in export industries. In all these cases, the U.S. gains more imported goods in exchange for the same amount of effort being devoted to production of goods for export. The opposite is also possible, in that a drop in the world price of U.S. exports or a subsidy that promoted exports of lesser value would move terms of trade against the United States, in that with the same effort put into producing exports the United States would receive less imports in exchange, and terms of trade would move against the United States. The fact that LNG will be exported only if there is sufficient market demand ensures that terms of trade will improve if LNG exports take place.

The N_{ew}ERA model outputs include demand and supply of all goods and services, prices of all commodities, and terms of trade effects (including changes in imports and exports). The model outputs also include GDP, consumption, investment, disposable income, and changes in income from labor, capital, and resources.

III. DESCRIPTION OF SCENARIOS

Since this study is intended to be an update of NERA's prior study for DOE/FE, the scenarios were designed to be similar to the earlier study. The scenarios' assumptions were varied regarding international supply and demand for LNG, U.S. availability of natural gas, and the U.S.'s ability to export LNG, consistent with the updated supply and demand forecasts from EIA's *AEO 2013* and *IEO 2013*. Future global demand for LNG exports from the United States depends upon many domestic and international factors. NERA designed scenarios for global supply and demand to capture international uncertainties in a way that was intended to examine instances that would favor the creation of additional opportunities for LNG exports from the U.S. These opportunities were based on different sets of assumptions about natural gas supply and demand outside the United States. The international scenarios included both a case where demand for LNG was increased, and another where both demand was increased and supply of LNG from sources other than the U.S. was limited. The U.S. scenarios were intended to capture the range of potential natural gas resource available to meet domestic demand, pipeline exports, and LNG exports. The combination of assumptions about maximum permitted levels of exports, U.S. supply and demand conditions, and global supply and demand conditions yielded 63 distinct scenarios to be considered. The remainder of this section discusses this range of scenarios.

A. Design of International and U.S. Scenarios

1. World Outlooks

The international scenarios were designed to examine the role of U.S. LNG in the global market (Figure 10). Before determining the macroeconomic impacts in the United States, one must know the circumstances under which U.S. LNG would be absorbed into the global market, the level of exports that would be economic on the global market, and the value (netback) of exported U.S. LNG. In order to accomplish this, we developed several international scenarios that allowed for growing worldwide demand for natural gas and an increasing market for LNG. These were of more interest to this particular study because the alternative of lower worldwide demand would mean little or no U.S. LNG exports, which would have little or no impact on the U.S. economy. How other exporting regions respond in their pricing of their exports could have a significant effect on the demand for U.S. LNG exports. These responses would have the greatest impact in the presence of high potential U.S. LNG exports. Therefore, this study considers this sensitivity as well.

Figure 10: International Scenarios

Name	Japan Nuclear Plants Retired	Korean Nuclear Plants Retired	Planned Liquefaction Capacity in Other Regions Is Built
International Reference	Yes*	No	Yes
Demand Shock	Yes**	Yes	Yes
Supply/Demand Shock	Yes**	Yes	No

* Japanese nuclear plants are retired as per *IEO 2013*. In 2012, all but 2.0 GW of nuclear generation was deactivated. By 2038, 37 GW of nuclear generation is forecasted to be in service.
** All Japanese nuclear plants are retired and are not reactivated

a. International Reference Scenario

The International Reference Scenario is intended to provide a plausible baseline forecast for global natural gas demand, supply, and prices from today through 2038. The supply and demand volumes are based upon *IEO 2013* with countries aggregated to the regions in the NERA GNGM. The regional natural gas pricing is intended to model the pricing mechanisms in force in the regions today and their expected evolution in the future. Data to develop these pricing forecasts are derived from both the EIA and the IEA. Our specific assumptions for the global cases are described in Appendix A.

b. Uncertainties about Global Natural Gas Demand and Supply

To reflect some of the uncertainty in demand for U.S. LNG exports, we analyzed additional scenarios that would potentially increase U.S. LNG exports. Increasing rather than decreasing exports is of more interest in this study because this study is concerned with the impacts of LNG exports on the U.S. economy. Scenarios that decrease world demand or increase world supply would cause U.S. LNG exports to decline and therefore reduce the impact of LNG exports. The two additional international scenarios increase either world demand alone or increase world demand while simultaneously constraining the development of some new LNG supply sources outside of the United States. Both scenarios would result in a greater opportunity for U.S. LNG to be sold in the global market.

- The first additional international scenario (Demand Shock) creates a market with increased demand by assuming that South Korea and Japan convert all of their nuclear power generation to natural gas-fired generation.[24] This scenario creates additional demand for LNG in the already tight Asian market. Because Japan and South Korea lack

[24] The *IEO 2013* assumes most of Japan's nuclear plants are replaced by natural gas-fired generation. The resulting natural gas demand is included as part of our International Reference case. We assume that the few Japanese nuclear facilities that are built later in the *IEO 2013* are replaced with natural gas-fired units in our Demand Shock case.

domestic natural gas resources, the incremental demand could only be served by additional LNG volumes.

- The second international scenario (Supply/Demand Shock) is intended to test a boundary limit on the international market for U.S. LNG exports. This scenario extends the Demand Shock scenario (Japan and South Korea convert their entire nuclear demand to natural gas) by also assuming that no new liquefaction projects that are currently in the planning stages will be built in Oceania, Southeast Asia, or Africa. The precise quantitative shifts assumed in world supply and demand are described in Appendix A.

Neither of these international scenarios is intended to be a prediction of the future. Their apparent precision as to where the shocks occur is only there because differential transportation costs make it necessary to be specific about where non-U.S. demand and supply are located in order to assess the potential demand for U.S. natural gas. Many other, and possibly more likely, scenarios could be constructed, and would lead to higher or lower levels of exports. The international scenarios that we modeled are intended as only one possible illustration of conditions that could create higher demand for U.S. LNG exports.

c. Global Competitive Responses

At present, both European and Asian importers of LNG pay prices linked to crude oil prices, even though those prices now exceed by a substantial margin the cost of producing, liquefying, and transporting natural gas to their locations. This translates into profits for LNG exporters that could be competed away. The system of oil-linked prices appears to be sustained by long term contracts that were signed when natural gas and oil prices were much closer together, by current LNG export capacity, and likely by the decisions of some producers, in particular Russia and Qatar, to limit their export levels and capacity in order to maintain high prices. This imperfectly competitive market could be disrupted by high levels of exports from the United States. Thus in this study we add another dimension to our international scenarios, that represents an outbreak of competition in the world market driven by the threat that U.S. exports could take a large share of world LNG trade. It represents the possibility that rival suppliers will drop their prices to levels close to their marginal cost of production due to the competitive threat from U.S. exports.

2. U.S. Scenarios Address Three Factors

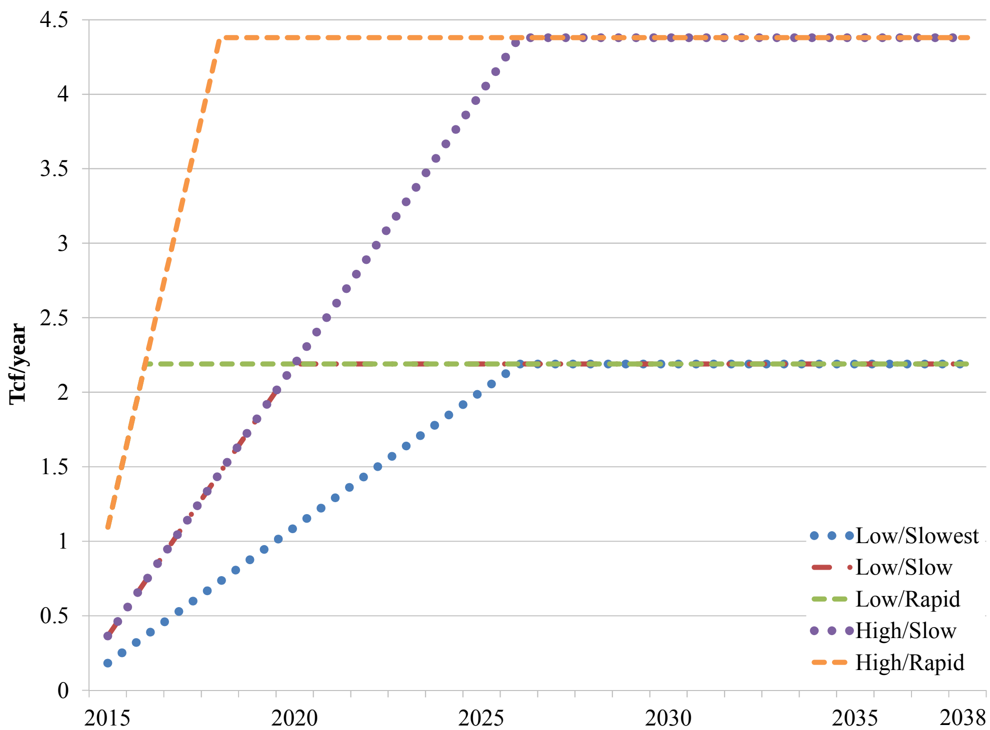
a. Decisions about the Upper Limit on Exports

One of the primary purposes of this study is to evaluate the impacts of different levels of LNG exports on the U.S. economy. An emphasis in this study was to evaluate an unconstrained export scenario, with no limits places on LNG exports, in order to determine the maximum quantity of exports that would be demanded based purely on the economics of the global natural gas market. We also evaluated a set of intermediary scenarios in which the levels of LNG export capacity that are used in constructing the U.S. scenarios are the same levels as those used in our prior study. Even though the *AEO 2013* reference case includes LNG exports, we also constructed a scenario with no LNG exports in order to provide a benchmark against which the cumulative impact of exports could be measured.

For the LNG export quotas, we considered six different LNG export quota trajectories (and one no U.S. LNG exports scenario), all starting in 2015 (also see Figure 11):

1. No Exports: No U.S. exports of LNG;
2. Low/Slow: 6 Bcf/d, phased in at a rate of 1 Bcf/d per year;
3. Low/Rapid: 6 Bcf/d phased in at a rate of 3 Bcf/d per year;
4. High/Slow: 12 Bcf/d phased in at a rate of 1 Bcf/d per year;
5. High/Rapid: 12 Bcf/d phased in at a rate of 3 Bcf/d per year;
6. Low/Slowest: 6 Bcf/d phased in at a rate of 0.5 Bcf/d per year; and
7. No Export Constraint: No limits on U.S. LNG export capacity were set and therefore our GNGM determined exports entirely based on the relative economics.

Figure 11: LNG Export Capacity Limits by Scenario



b. Uncertainties about U.S. Natural Gas Supply

The advances in drilling technology that created the current U.S. shale gas boom are still sufficiently recent that there remains significant uncertainty as to the long-term natural gas supply outlook for the United States. In addition to the uncertain geological resource, there are also other uncertainties such as how much it will cost to extract the natural gas, and many regulatory uncertainties, including concerns about seismic activity and impacts on water supplies that may lead to limits on shale gas development. Evidence of this is the changing perspective for the potential for shale gas in the United States as presented by the EIA in its *AEO*. For the last several years, EIA has consistently upgraded its outlook by lowering its projected cost of shale gas and raising expected supply recovery in the United States. Uncertainties about the U.S. outlooks for natural gas supply results in a wide range of projections for the prices at which natural gas may be available for export.

To reflect this uncertainty, the EIA, in its *AEO 2013*, included several sensitivity cases in addition to its Reference Case. For natural gas supply, the two most significant are the Low Oil and Gas Resource (LOGR) and High Oil and Gas Resource (HOGR) sensitivity cases. We also adopt these cases, in addition to the Reference Case supply conditions, in evaluating the potential for exports of natural gas. The three U.S. supply scenarios are summarized in Figure 12.

Figure 12: U.S. Supply Scenarios

Case Name	U.S. Gas Resource	Scenario Description
LOGR	*AEO 2013* Low Oil and Gas Resource Case	Estimated ultimate recovery per shale gas and tight gas well is 50% lower than in the Reference case
USREF	*AEO 2013* Reference Case	*AEO 2013* Reference case
HOGR	*AEO 2013* High Oil and Gas Resource Case	Shale gas and tight gas well estimated recoveries are 100% higher than in the Reference case, and the maximum well spacing is assumed to be 40 acres. Also includes 50% higher undiscovered resources in lower 48 offshore and Alaska than in the Reference case.

B. Matrix of U.S. Scenarios

The full range of potential U.S. scenarios is constructed based on two factors: 1) U.S. supply and 2) LNG export quotas (the pace that new LNG export facilities are constructed). The combination of these two factors results in the matrix of 18 (3 supply forecasts for each of 6 export quota trajectories) potential U.S. scenarios in Figure 13.

Figure 13: Matrix of U.S. Scenarios

U.S. Supply	LNG Export Capacity	U.S. Supply	LNG Export Capacity	U.S. Supply	LNG Export Capacity
Reference	Low/Slow	HOGR	Low/Slow	LOGR	Low/Slow
Reference	Low/Rapid	HOGR	Low/Rapid	LOGR	Low/Rapid
Reference	High/Slow	HOGR	High/Slow	LOGR	High/Slow
Reference	High/Rapid	HOGR	High/Rapid	LOGR	High/Rapid
Reference	Low/Slowest	HOGR	Low/Slowest	LOGR	Low/Slowest
Reference	No Export Constraint	HOGR	No Export Constraint	LOGR	No Export Constraint

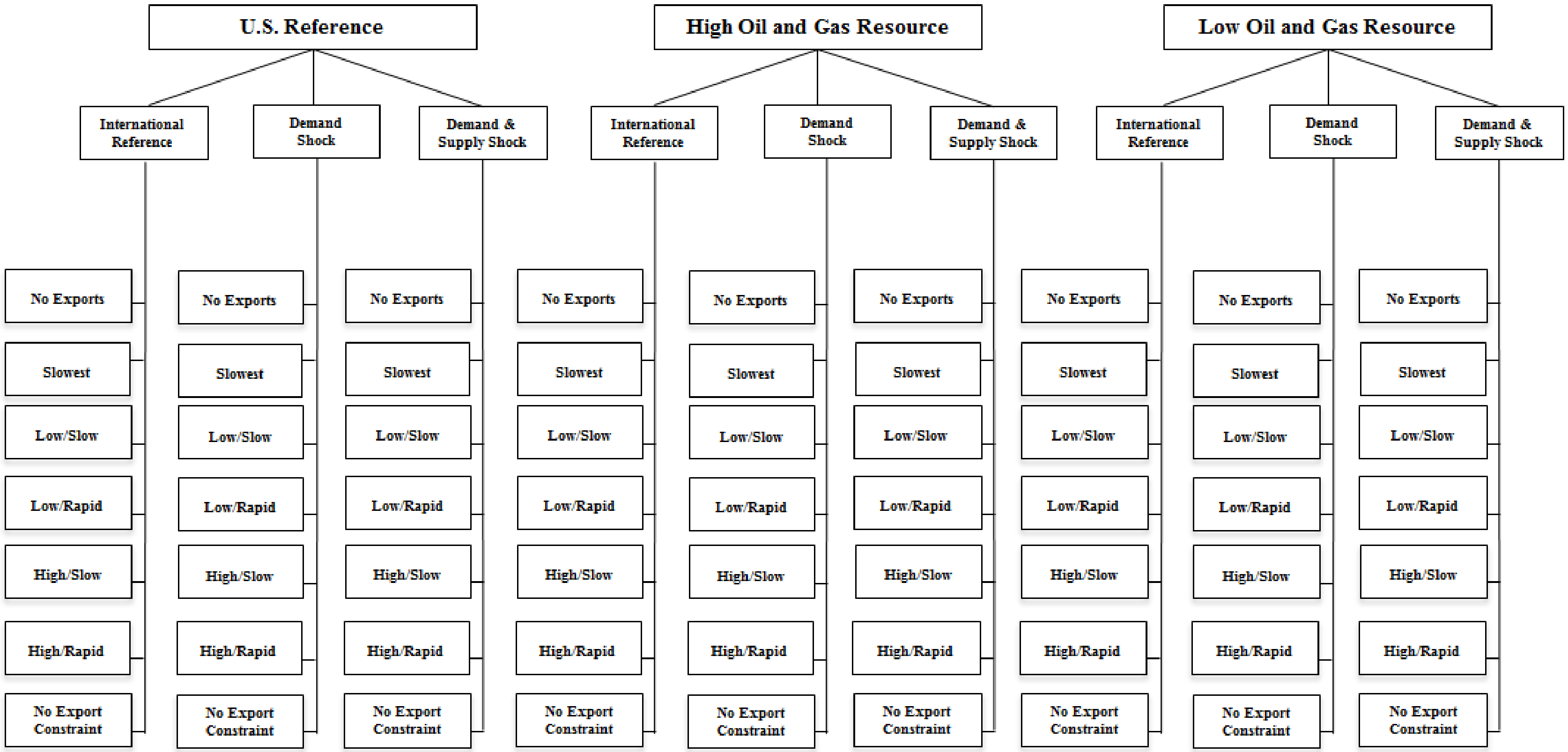
In addition, we created a No Exports scenario for each of the three U.S. supply cases.

C. Matrix of Core 63 Worldwide Natural Gas Scenarios

As shown in Figure 14, a matrix of scenarios combining the three worldwide scenarios with three U.S. supply scenarios and the seven rates of U.S. LNG capacity expansion resulted in a total of 63 different scenarios that were analyzed. NERA used its GNGM to analyze international impacts resulting from potential U.S. LNG exports under these 63 scenarios.

These 63 scenarios replicate the design of the previous study, and characterize the pricing mechanisms in the world market in the same way in all 63 cases; therefore, they are referred to as the core scenarios. We have also performed a sensitivity analysis that assumes a different pricing regime. This new pricing regime is based on movement to a fully competitive global market. We consider this pricing regime under the HOGR conditions when the United States would be able to take a large share of the market away from rival producers if they did not lower their export prices to compete with the lower U.S. wellhead prices.

Figure 14: Tree of 63 Core Scenarios



IV. GLOBAL NATURAL GAS MODEL RESULTS

A. NERA Worldwide Supply and Demand Baseline

NERA used essentially the same methodology in this study as it used in the 2012 DOE/FE study.[25] NERA's baseline is based upon EIA's projected production and demand volumes from its *IEO 2013* and *AEO 2013* Reference cases with some modifications as detailed in Appendix A.

To develop a worldwide supply and demand baseline, we first adjusted the *IEO 2013*'s estimates for production and consumption in the 11 non-North American regions. Then we adjusted the *IEO 2013's* projections for the North American regions. For the 11 non-North American regions, we computed the average of the *IEO 2013's* estimate for worldwide production and demand excluding North American production, consumption, and LNG imports. Then we scaled the production in each of these 11 regions individually by the ratio of this average and the original production in the 11 regions. We used a similar methodology for determining demand in the 11 regions.

Next, we calibrated the U.S.'s net imports from Canada, net exports to Mexico, and U.S. LNG imports. U.S. pipeline imports from Canada varied for each of the three U.S. supply cases: USREF, HOGR, and LOGR. Pipeline exports to Mexico were calibrated for the same three cases. U.S. LNG imports were then calculated as the difference between total U.S. imports and pipeline imports. This calculation was repeated for each U.S. supply case. The calculated LNG imports are consistent with the official *AEO 2013* numbers.

For LNG exporting regions, we checked that they had sufficient liquefaction capacity so that their calibrated production was less than or equal to their demand plus their liquefaction and inter-regional pipeline capacity. If it was not, we adjusted the region's liquefaction capacity so that this condition held with equality. For the Middle East, we imposed a limit on the level of its LNG exports equal to today's exports of 4.88 Tcf. Since its liquefaction capacity exceeds its export limit, the Middle East supply must be less than or equal to its demand plus its LNG export limit. If this condition failed to hold, we adjusted Middle East supply until Middle East supply equaled its demand plus its LNG export limit.

In calibrating the FSU, NERA assumes that the recalibrated production (as per the above adjustment made to the *IEO 2013* data) is correct and any oversupply created by the calibration of supply and demand is exported by pipeline.

For LNG importing regions, we checked to determine if, after performing the recalibration described above, the demand in each importing region was less than the sum of their domestic

[25] "Macroeconomic Impacts of LNG Exports from the United States," NERA Economic Consulting, prepared for U.S. Department of Energy, Office of Fossil Energy, 2012.

natural gas production, regasification capacity, and inter-regional pipeline capacity. In each region where this condition failed, we expanded its regasification capacity until this condition held with equality. Figure 15 reports the resulting natural gas productions to which we calibrated each region in our GNGM. Figure 16 reports the resulting natural gas demand to which we calibrated each region in our GNGM.

Figure 15: Baseline Natural Gas Production (Tcf)

	2018	2023	2028	2033	2038
Africa	8.65	9.84	10.41	11.85	13.18
Canada	5.28	5.67	6.13	6.48	7.14
C & S America	7.08	7.72	8.29	9.17	10.26
China/India	5.48	6.24	7.85	9.96	11.99
Europe	8.01	7.60	8.10	8.74	9.41
FSU	29.65	32.92	37.00	40.13	41.49
Korea/Japan	0.16	0.15	0.15	0.15	0.15
Mexico	1.92	1.84	2.16	2.88	3.59
Middle East	21.45	23.54	25.34	27.12	29.26
Oceania	3.37	4.43	5.12	5.78	6.40
Sakhalin	0.90	0.97	1.05	1.21	1.21
Southeast Asia	9.57	9.80	10.56	11.74	13.13
U.S.	25.87	27.74	29.46	30.67	32.46
World	**127.39**	**138.46**	**151.61**	**165.88**	**179.66**

Figure 16: Baseline Natural Gas Demand (Tcf)

	2018	2023	2028	2033	2038
Africa	3.99	4.63	5.53	6.73	8.14
Canada	3.36	3.90	4.21	4.57	4.88
C & S America	5.70	6.32	7.06	7.78	8.64
China/India	9.49	11.99	15.07	18.23	21.00
Europe	20.11	20.58	21.59	22.89	23.95
FSU	22.45	24.15	26.20	28.31	30.04
Korea/Japan	6.20	6.59	7.00	7.38	7.72
Mexico	3.03	3.69	4.49	5.32	6.42
Middle East	16.82	18.96	20.82	22.60	24.37
Oceania	1.46	1.62	1.80	1.97	2.13
Sakhalin	0.00	0.00	0.00	0.00	0.00
Southeast Asia	8.39	9.34	10.47	11.74	13.13
U.S.	26.38	26.69	27.39	28.35	29.24
World	**127.39**	**138.46**	**151.61**	**165.88**	**179.66**

NERA developed a set of global natural gas price projections based upon a number of data sources. The approach focuses on the wellhead price forecasts for net export regions and city gate price forecasts for net import regions.

U.S. wellhead natural gas prices are not precisely the same in the GNGM and the N_{ew}ERA model. Supply curves in both models were calibrated to the EIA's implicit supply curves, but the GNGM has a more simplified representation of U.S. natural gas supply and demand than the more detailed N_{ew}ERA model so that the two models solve for slightly different prices with the same levels of LNG exports. The differences are not material to any of the results in the study.

In natural gas-abundant regions like the Middle East and Africa, the wellhead price is assumed to equal the natural gas development and lifting cost. City gate prices are estimated by adding a transportation cost to the wellhead prices. In the major Asian demand markets, natural gas prices are determined on a near oil-parity basis using crude oil price forecasts. The resultant prices are highly consistent with relevant historical pipeline import prices and LNG spot market prices as well as various oil and natural gas indices (*i.e.*, JCC, WTI, Henry Hub, AECO Hub indices, and UK NBP).[26] U.S. wellhead and average city gate prices are adopted from *AEO 2013*. Canadian wellhead prices are projected to initially be $0.35/Mcf less than the U.S. prices in the USREF scenario. The prices in these countries are projected to converge over time and by 2028 Canadian wellhead prices are projected to be $0.06/Mcf below that of U.S. wellhead prices. The resulting city gate and wellhead prices are presented in Figure 17 and Figure 18.

Figure 17: Projected Wellhead Prices (2012$/Mcf)

	2018	2023	2028	2033	2038
Africa	$1.97	$2.18	$2.37	$2.56	$3.00
Canada	$3.30	$4.00	$4.50	$4.80	$6.42
C & S America	$2.25	$2.50	$2.72	$3.05	$3.43
China/India	$8.36	$8.34	$8.94	$9.67	$10.56
Europe	$11.77	$12.07	$12.08	$12.01	$13.21
FSU	$4.92	$5.44	$5.97	$6.31	$6.57
Korea/Japan	$11.59	$11.56	$11.84	$12.67	$13.98
Mexico	$6.94	$7.32	$7.67	$8.11	$8.80
Middle East	$1.39	$1.55	$1.68	$1.87	$2.14
Sakhalin	$1.39	$1.54	$1.67	$2.18	$1.99
Oceania	$4.55	$4.79	$5.01	$5.75	$6.50
Southeast Asia	$2.25	$2.50	$3.10	$3.96	$4.89
U.S.	$3.44	$4.03	$4.44	$4.88	$6.48
World Avg	**$3.99**	**$4.31**	**$4.72**	**$5.13**	**$5.89**

[26] German BAFA natural gas import border price, Belgium Zeebrugge spot prices, TTF Natural Gas Futures contracts, *etc*.

Figure 18: Projected City Gate Prices (2012$/Mcf)

	2018	2023	2028	2033	2038
Africa	$2.99	$3.20	$3.39	$3.59	$4.03
Canada	$4.70	$5.40	$5.90	$6.20	$7.82
C & S America	$4.80	$5.05	$5.27	$5.60	$5.98
China/India	$9.89	$9.87	$10.47	$11.20	$12.09
Europe	$12.79	$13.09	$13.10	$13.04	$14.24
FSU	$5.95	$6.46	$6.99	$7.34	$7.60
Korea/Japan	$12.10	$12.08	$12.35	$13.19	$14.50
Mexico	$8.47	$8.85	$9.20	$9.65	$10.34
Middle East	$4.28	$4.43	$4.57	$4.76	$5.03
Oceania	$6.08	$6.32	$6.54	$7.28	$8.04
Sakhalin	$3.89	$4.04	$4.17	$4.68	$4.49
Southeast Asia	$3.27	$3.52	$4.12	$4.99	$5.91
U.S.	$4.46	$5.05	$5.46	$5.90	$7.49
World Avg	**$6.80**	**$7.12**	**$7.46**	**$7.85**	**$8.69**

After calibrating the GNGM to the above prices and quantities, we allowed the model to solve for the least-cost method of transporting gas so that supplies and demands are met. Figure 19, Figure 20, and Figure 21 display the pipeline flows between model regions, LNG exports, and LNG imports for all model years in the baseline.

Figure 19: Baseline Inter-Region Pipeline Flows (Tcf)

Origin	Destination	2018	2023	2028	2033	2038
Africa	Europe	1.29	1.40	1.14	1.22	1.19
Africa	Middle East	0.36	0.36	0.36	0.36	0.36
Canada	U.S.	1.73	0.91	0.97	1.03	0.63
Europe	Europe	8.01	7.60	8.10	8.74	9.41
FSU	China/India	1.05	1.26	1.41	1.52	1.66
FSU	Europe	6.17	7.28	8.30	8.92	9.78
Sakhalin	FSU	0.21	0.28	0.18	0.00	0.00
Middle East	FSU	0.08	0.06	0.00	0.00	0.00
Middle East	Europe	0.03	0.00	0.00	0.00	0.37
Southeast Asia	China/India	0.51	0.32	0.09	0.00	0.00
U.S.	Mexico	1.02	1.29	1.59	1.88	2.28

Figure 20: Baseline U.S. LNG Exports (Tcf)

Export to	2018	2023	2028	2033	2038
Europe	-	-	0.85	0.46	0.06
Korea/Japan	0.36	0.83	0.79	1.17	1.67
World	**0.36**	**0.83**	**1.63**	**1.63**	**1.73**

Figure 21: Baseline U.S. LNG Imports (Tcf)

Import from	2018	2023	2028	2033	2038
C & S America	0.17	0.17	0.19	0.17	0.17

B. Calibration of the NERA Baseline to the EIA Reference Case

The NERA Baseline (USREF_INTREF_NC) was based upon, but not intended to be identical to, the EIA's *AEO 2013* Reference case. Figure 22 compares several key metrics for the NERA model Baseline and EIA's *AEO 2013* Reference case.

Figure 22: Comparison of NERA Baseline to EIA's *AEO 2013* Reference Case

		2018	2023	2028	2033	2038
LNG Exports (Tcf)	*AEO 2013*	0.43	0.83	1.63	1.63	1.63
	NERA	0.36	0.83	1.63	1.63	1.73
	Difference	*-0.07*	*0.00*	*0.00*	*0.00*	*0.10*
Indigenous Production (Tcf)	*AEO 2013*	25.92	27.75	29.47	30.70	32.39
	NERA	25.87	27.74	29.46	30.67	32.46
	Difference	*-0.05*	*-0.01*	*-0.01*	*-0.03*	*0.07*
Wellhead Price (Lower 48) ($/Mcf)	*AEO 2013**	$3.43	$4.00	$4.44	$4.87	$6.44
	NERA	$3.44	$4.03	$4.44	$4.88	$6.48
	Difference	$*0.01*	$*0.03*	$*0.01*	$*0.01*	$*0.04*
Indigenous Demand (Tcf)	*AEO 2013*	26.23	26.57	27.30	28.31	29.24
	NERA	26.38	26.69	27.39	28.35	29.24
	Difference	*0.15*	*0.12*	*0.09*	*0.04*	*0.00*

*Calculated from EIA *AEO 2013* projections for Henry Hub. Wellhead price equals Henry Hub price less basis differential.

C. No U.S. LNG Exports Scenarios

Unlike EIA's *AEO 2011* Reference case, EIA's *AEO 2013* Reference case forecasts LNG exports from the United States. Since the economic impacts due to U.S. LNG exports are measured relative to a scenario in which there are no U.S. LNG exports, NERA developed a set of no U.S. LNG export (NX) scenarios, one for each of the three U.S. resource scenarios studied. These No Export cases were derived from the NERA Baseline described in detail above. The one change in the scenario from the NERA Baseline was restricting U.S. LNG export capacity to zero in every year studied. This change effectively restrained U.S. natural gas production and reduced prices relative to EIA's *AEO 2013* Reference case because forbidding exports effectively reduces demand for U.S. natural gas. The macroeconomic impacts that are presented later are stated relative to this set of no LNG export cases.

D. Behavior of Market Participants

In a market in which existing suppliers are collecting profits, the potential entry of a new supplier creates an issue concerning how the existing suppliers should respond. Existing suppliers have three general strategy options:

1. Existing suppliers can voluntarily reduce their own production, conceding market share to the new entrant in order to maintain market prices;
2. Existing suppliers can choose to produce at previously planned and higher levels with the hope of discouraging the new potential supplier from entering the market by driving prices below levels acceptable to the new entrant; or
3. Existing suppliers can act as price takers, adjusting their volume of sales until prices reach a new, lower equilibrium.

How much the United States will be able to export, and at what price, depends critically on how other LNG producers would react to the appearance of a new competitor in the market. Our model of the global natural gas market assumes a single dominant low-cost supplier, Qatar, which has the largest shares of LNG exports and is thought to be limiting output, and competing fringe suppliers that adjust production to market prices.[27] Our calculations of U.S. benefits from trade assume that the dominant supplier continues to limit its production and thus its exports (Strategy 2). If instead they increased production so as to increase exports, then these additional exports would leave no room for U.S. exports until prices were driven low enough to stimulate sufficient additional demand to absorb economic exports from the United States. Since the competitive fringe does reduce output (Strategy 3) as prices fall due to U.S. LNG exports, there is an opportunity for the United States to enter the market but only by driving delivered LNG prices in key markets below what they are today. Should these countries respond instead by cutting production below planned levels to maintain prices, the United States could gain greater benefits and a larger market share. If the dominant supplier chooses to cut prices, then exporting LNG from the United States would become less attractive to investors.

Another consideration is the behavior of LNG consumers. At this point in time, countries like Japan and South Korea appear to be paying a substantial premium over the price required to obtain supplies from regions that have not imposed limits on planned export capacity. At the same time, those countries are clearly looking into arrangements in the United States that would

[27] We consider the dominant supplier to be Qatar, with a 32% share of the market in 2012, while also exercising some production restraint.

provide natural gas at a delivered cost substantially below prices they currently pay for LNG deliveries. To date, several long-term contracts have been signed to export LNG to Asian customers.[28] This could be because they view the United States as a uniquely secure source of supply, or it could be that current high prices reported for imports into Japan and South Korea are for contracts that will expire and be replaced by more competitively priced supplies. If countries like Japan and South Korea became convinced that they could obtain secure supplies without long-term oil-based pricing contracts, and ceased paying a premium over marginal cost, the entire global LNG price structure could shift downward. Since the United States does not appear to be the world's lowest-cost supplier, this could have serious consequences for the profitability of U.S. exports.

In this study, we address issues of exporter responses by assuming that there is an imperfectly competitive market with export limits chosen by each exporting region other than the United States. This assumption allows us to explore different scenarios for supply from the rest of the world when the United States begins to export. This is a middle ground between assuming that the dominant producer would limit exports sufficiently to maintain the current premium apparent in the prices paid in regions like Japan and South Korea, or that dominant exporters would remove production constraints because, with U.S. entry, their market shares fall to levels that do not justify propping up prices for the entire market.

In order to address the possibility that high levels of potential U.S. LNG exports could break the tacit collusion among rival suppliers or lead to renegotiation of oil-linked contracts, we also include three sensitivity cases in which the global LNG market is assumed to be fully competitive with export prices in all regions based on the marginal cost of production. This amounts to all exporters becoming price takers, adopting Strategy 3.

E. Available LNG Liquefaction and Shipping Capacity

This analysis did not investigate the technical feasibility of building new liquefaction capacity in a timely fashion outside of the United States to support the level of exports the model found optimal. In all cases, the GNGM assumed no limits on either LNG liquefaction capacity additions outside of the United States or global LNG shipping capacity. The only LNG export capacity limits were placed on the United States and the Middle East.

[28] Long-term contracts for LNG delivery to Asia from the Freeport LNG Project have been signed with Osaka Gas Co. Ltd (Japan), Chubu Electric Power Co. Inc. (Japan), Toshiba Corp. (Japan) and SK E&S LNG LLC (South Korea). Long-term contracts for LNG delivery to Asia from the Sabine Pass Liquefaction Project have been signed with GAIL (India) Ltd and Korea Gas Corp. (South Korea). Long-term contracts for LNG delivery to Asia from the Cameron LNG Project have been signed with affiliates of Mitsubishi Corp. and Mitsui & Co. Ltd.

F. The Effects of U.S. LNG Exports on Regional Natural Gas Markets

When the United States exports LNG, the global and domestic natural gas markets are affected in the following ways:

- U.S. LNG exports add more natural gas to the global supply, which lowers city gate prices in regions importing LNG. The lower city gate prices lead to increased natural gas consumption in the importing regions.
- When U.S. LNG exports increase above baseline levels, some LNG exports from other regions are displaced, which results in lower production levels in many of the other exporting regions.
- Exporting regions with lower LNG or pipeline exports, and hence lower production levels, experience a drop in wellhead and city gate prices because of the lower demand for their gas.
- Natural gas production rises in the United States because there is additional demand for its gas.
- Wellhead natural gas prices rise in the United States because of the increased global demand for its gas, which leads to higher city gate prices.
- Higher U.S. prices cause a reduction in U.S. natural gas consumption.

Whether or not a region's exports would be displaced by U.S. LNG exports depends on several factors:

- Restrictions on U.S. exports;
- The difference in delivered costs between an exporting region and the United States;
- The magnitude of the demand shock or increased demand; and
- The magnitude of the supply shock or reduction in global supply.

Because the Middle East is the lowest-cost producer, U.S. LNG exports have the smallest effect on their exports. Also, the Middle East's exports are limited by our assumption that Qatar continues to limit its exports of natural gas at its announced levels. Thus, there are pent-up LNG exports, which mean that the Middle East can still export its same level of LNG even with a decline in international gas prices.

Since the cost of exports is higher in some other regions, they are more vulnerable to having their exports displaced by U.S. LNG exports. In the International Reference case, U.S. LNG exports displace LNG exports from all regions to some extent in many of the years. U.S. exports also cause reductions in inter-regional pipeline exports from Africa to Europe.

In comparing the International Reference case to the Demand Shock case, we find that global LNG exports increase because the global demand for natural gas is greater. Total U.S. LNG exports increase, as do exports from other LNG exporting regions. LNG imports into South Korea/Japan increase due to the local demand shock. However, LNG imports into China/India and Europe decline because higher international prices dampen demand in those regions.

In the Supply/Demand Shock scenarios, Oceania, Southeast Asia, and Africa have their LNG exports restricted. This scenario was intended to provide a measure of an upper limit of U.S. LNG exports. We find in this case that the United States and other regions, which do not have their LNG exports limited, absorb much of the slack created by the limited LNG supplies from the restricted regions. However, because the options for LNG supplies are restricted, global prices increase and thus, lower global demand slightly.

When the United States enters the global LNG market, each region's supply, demand, wellhead price, and city gate price for natural gas respond as expected. More precisely, importing regions increase their demand for natural gas, and exporting regions either reduce or maintain their supply of natural gas. The wellhead and city gate prices for natural gas decline in all importing regions and remain the same in exporting regions except for in the United States and Canada, which are now able to export LNG.

G. Factors Impacting U.S. LNG Exports

To understand the economic impacts on the United States resulting from LNG exports, it is necessary to understand the circumstances under which U.S. natural gas producers will find it profitable to export LNG. To accomplish this, we used GNGM to run a series of cases for all combinations of the three U.S. scenarios (Reference, HOGR, and LOGR) and three international scenarios (International Reference, Demand Shock, and Supply/Demand Shock). In these runs, we varied the constraints on LNG export levels across seven settings (No Exports, Low/Slowest, Low/Slow, Low/Rapid, High/Slow, High/Rapid, and No Export Constraint). Based upon these 63 runs, we found the following:

- For the scenarios that combined the International Reference and U.S. Reference cases, U.S. LNG exports are similar to those forecast in the *AEO 2013*. This outcome also implies that U.S. LNG exports under a U.S. Reference scenario have a lower cost than some LNG produced in other regions of the world.
- When there is additional growth in global natural gas demand beyond that of the International Reference scenario, then the U.S. exports greater volumes of LNG to help meet this incremental demand. The degree to which the U.S. exports LNG depends upon the abundance and quality of the U.S. resource base.
- When U.S. gas supplies are more abundant and lower cost than in the U.S. Reference case, the U.S. can competitively export LNG either to meet incremental global demand or to displace planned LNG supplies in other regions.
- Should the U.S. natural gas resource base prove less abundant or cost effective to produce, then U.S. LNG exports will be minimal in the early years and overall much less than in the U.S. Reference scenarios.

In the next sections, we present the modeling results for each of the three U.S. cases that served as the basis for arriving at these conclusions.

1. Findings for the U.S. Reference Scenario

This section reports the level of U.S. LNG exports under the 21 scenarios (includes no LNG export scenario) that fall under the U.S. Reference scenario. These scenarios consider different international assumptions about international demand and supply of natural gas, as well as different assumptions about the U.S.'s ability to export LNG. Figure 23 reports the U.S.'s maximum export capacity for each LNG export capacity scenario.

Figure 23: U.S. LNG Export Capacity Limits (Tcf)

LNG Export Capacity Scenarios	2018	2023	2028	2033	2038
Low/Slowest	0.73	1.64	2.19	2.19	2.19
Low/Slow	1.46	2.19	2.19	2.19	2.19
Low/Rapid	2.19	2.19	2.19	2.19	2.19
High/Slow	1.46	3.28	4.38	4.38	4.38
High/Rapid	4.38	4.38	4.38	4.38	4.38
No Constraint	∞	∞	∞	∞	∞

Figure 24 reports the level of U.S. LNG exports under the U.S. Reference scenario. Viewing Figure 23 and Figure 24, one can see the effect of the LNG export capacity limits on restraining U.S. exports and the effect of these limits under different assumptions about the International scenarios.

Figure 24: U.S. LNG Exports –U.S. Reference Scenarios (Tcf)

Bold numbers indicate that the U.S. LNG export limit is binding

U.S. Scenario	International Scenario	LNG Export Capacity Scenarios	2018	2023	2028	2033	2038
U.S. Reference	International Reference	Low/Slowest	0.36	0.83	1.63	1.63	1.73
		Low/Slow	0.36	0.83	1.63	1.63	1.73
		Low/Rapid	0.36	0.83	1.63	1.63	1.73
		High/Slow	0.36	0.83	1.63	1.63	1.73
		High/Rapid	0.36	0.83	1.63	1.63	1.73
		No Constraint	0.36	0.83	1.63	1.63	1.73
	Demand Shock	Low/Slowest	**0.73**	**1.64**	**2.19**	**2.19**	**2.19**
		Low/Slow	**1.46**	**2.19**	**2.19**	**2.19**	**2.19**
		Low/Rapid	1.74	**2.19**	**2.19**	**2.19**	**2.19**
		High/Slow	**1.46**	2.37	4.04	4.30	**4.38**
		High/Rapid	1.74	2.37	4.04	4.30	**4.38**
		No Constraint	1.74	2.37	4.04	4.30	4.97
	Supply/ Demand Shock	Low/Slowest	**0.73**	**1.64**	**2.19**	**2.19**	**2.19**
		Low/Slow	**1.46**	**2.19**	**2.19**	**2.19**	**2.19**
		Low/Rapid	2.13	**2.19**	**2.19**	**2.19**	**2.19**
		High/Slow	**1.46**	3.17	**4.38**	**4.38**	**4.38**
		High/Rapid	2.13	3.17	**4.38**	**4.38**	**4.38**
		No Constraint	2.13	3.17	5.25	6.01	7.10

Figure 24 shows that in the U.S. Reference case, the United States can be expected to have LNG exports under all the scenarios in which they are allowed. The United States exports more LNG when higher levels of world demand are assumed and exports even greater amounts of LNG when both world demand increases and planned non-U.S. supply expansions are not built (units denoted as "under construction" are still assumed to be built).

Under the Demand Shock scenarios from 2023 onward, the economic level of U.S. LNG exports do not reach export capacity limits until 2038 for the two highest quota scenarios. For the three low quota scenarios, LNG exports are constrained by the limitations on LNG export capacity. Therefore, the level of exports in the years 2023 through 2038 is different for the Low and High scenarios. Under the Supply/Demand Shock scenarios, however, the LNG export capacity limits are often binding.[29] The low U.S. LNG capacity export limits are binding for all rates of

[29] The U.S. LNG export capacity binds when the market equilibrium level of exports as determined by the model exceeds the maximum LNG export capacity assumed in that scenario.

expansion (Low/Slowest, Low/Slow, and Low/Rapid) for all years except 2018 for the Low/Rapid case. For the high LNG export levels, some years are binding and some are not. Under the Supply/Demand Shock scenarios, LNG exports are always greater than or equal to LNG exports in the Demand Shock cases.

The U.S. LNG export capacity binds when the optimal level of exports as determined by the model (see rows denoted “No Constraint”) exceeds the LNG export capacity level. The difference between the value of LNG exports in the “No Constraint” row and a particular case with a LNG export capacity constraint defines the quantity of LNG exports prohibited from coming onto the world market. The greater this number, the more binding the LNG export capacity, and the more valuable an LNG terminal would be. In 2028 for the Supply/Demand Shock example, the U.S. would choose to export more than 5 Tcf of LNG, but if its export capacity limit followed one of the low-level cases (Low/Slowest, Low/Slow, or Low/Rapid), there would be a shortfall of almost 3 Tcf of export capacity. If the export capacity followed one of the high-level cases (High/Slow or High/Rapid) then the shortfall would be reduced to about 1 Tcf.

2. Findings for the U.S. Low Oil and Gas Resource Scenario

Figure 25: U.S. LNG Export – U.S. Low Oil and Gas Resource Scenarios (Tcf)

Bold numbers indicate that the U.S. LNG export limit is binding

U.S. Scenario	International Scenario	LNG Export Capacity Scenarios	2018	2023	2028	2033	2038
Low Oil and Gas Resource	International Reference	Low/Slowest	0.00	0.00	0.69	0.69	0.80
		Low/Slow	0.00	0.00	0.69	0.69	0.80
		Low/Rapid	0.00	0.00	0.69	0.69	0.80
		High/Slow	0.00	0.00	0.69	0.69	0.80
		High/Rapid	0.00	0.00	0.69	0.69	0.80
		No Constraint	0.00	0.00	0.69	0.69	0.80
	Demand Shock	Low/Slowest	0.01	0.01	1.09	1.17	1.17
		Low/Slow	0.01	0.01	1.09	1.17	1.17
		Low/Rapid	0.01	0.01	1.09	1.17	1.17
		High/Slow	0.01	0.01	1.09	1.17	1.17
		High/Rapid	0.01	0.01	1.09	1.17	1.17
		No Constraint	0.01	0.01	1.09	1.17	1.17
	Supply/ Demand Shock	Low/Slowest	0.42	1.04	**2.19**	**2.19**	**2.19**
		Low/Slow	0.42	1.04	**2.19**	**2.19**	**2.19**
		Low/Rapid	0.42	1.04	**2.19**	**2.19**	**2.19**
		High/Slow	0.42	1.04	2.82	3.43	3.90
		High/Rapid	0.42	1.04	2.82	3.43	3.90
		No Constraint	0.42	1.04	2.82	3.43	3.90

Figure 25 shows all combinations of International scenarios and LNG export capacity scenarios under which the U.S. exports LNG for the U.S. LOGR scenario. U.S. supplies are more costly under the U.S. LOGR scenario and U.S. LNG exports, as a result, are a little more than 1 Tcf in the Demand Shock scenario. Under the Supply/Demand shock scenarios, U.S. LNG export capacity is binding in the U.S. LOGR cases for the low quota cases from 2028 onward.

3. Findings for the core U.S. High Oil and Gas Resource Scenario

Figure 26: U.S. LNG Exports – Core High Oil and Gas Resource Scenarios (Tcf)

Bold numbers indicate that the U.S. LNG export limit is binding

U.S. Scenario	International Scenario	LNG Export Capacity Scenarios	2018	2023	2028	2033	2038
High Oil and Gas Resource	International Reference	Low/Slowest	**0.73**	**1.64**	**2.19**	**2.19**	**2.19**
		Low/Slow	**1.46**	**2.19**	**2.19**	**2.19**	**2.19**
		Low/Rapid	**2.19**	**2.19**	**2.19**	**2.19**	**2.19**
		High/Slow	**1.46**	**3.28**	**4.38**	**4.38**	**4.38**
		High/Rapid	4.26	**4.38**	**4.38**	**4.38**	**4.38**
		No Constraint	4.26	6.15	8.20	10.40	14.40
	Demand Shock	Low/Slowest	**0.73**	**1.64**	**2.19**	**2.19**	**2.19**
		Low/Slow	**1.46**	**2.19**	**2.19**	**2.19**	**2.19**
		Low/Rapid	**2.19**	**2.19**	**2.19**	**2.19**	**2.19**
		High/Slow	**1.46**	**3.28**	**4.38**	**4.38**	**4.38**
		High/Rapid	**4.38**	**4.38**	**4.38**	**4.38**	**4.38**
		No Constraint	6.25	8.86	11.5	13.51	17.59
	Supply/ Demand Shock	Low/Slowest	**0.73**	**1.64**	**2.19**	**2.19**	**2.19**
		Low/Slow	**1.46**	**2.19**	**2.19**	**2.19**	**2.19**
		Low/Rapid	**2.19**	**2.19**	**2.19**	**2.19**	**2.19**
		High/Slow	**1.46**	**3.28**	**4.38**	**4.38**	**4.38**
		High/Rapid	**4.38**	**4.38**	**4.38**	**4.38**	**4.38**
		No Constraint	6.64	9.70	12.51	15.05	19.51

Analogous to Figure 25, Figure 26 shows LNG export levels for the U.S. HOGR scenarios and a combination of international market conditions and LNG export capacity scenarios. Under the U.S. HOGR scenarios, abundant natural gas supplies are available at lower prices, and it is therefore cost-effective to export U.S. LNG with or without any international supply or demand shocks. The LNG export capacity limits are binding in all but one HOGR scenario: the International Reference case in 2018 with High/Rapid LNG export capacity limits. For all other scenarios with export capacity limits, the export levels equal their respective U.S. LNG export capacity limits.

The restrictiveness of U.S. LNG export capacity limits become larger as the international shocks lead to greater demand for U.S. LNG exports. Under the International Supply/Demand Shock scenarios, U.S. LNG export capacity limits bind in all years under the U.S. HOGR case. By 2023, the capacity limits restrict between 5.3 Tcf and 8.1 Tcf of U.S. exports. Limited LNG export capacity restricts exports and reduces potential exports by between 15.1 Tcf and 17.3 Tcf by 2038. However, as we discuss in the next section, the levels of U.S. LNG exports projected in the unconstrained export cases with HOGR are only possible if rival exporters severely limit their expansion of capacity and sales. Under these conditions of low-cost U.S. resources and exporter restraint, rival exporters would cede a large share of the future LNG market to the United States without a competitive response. This is unlikely given the level of U.S. exports projected in these cases. The alternative U.S. LNG export projections with fully competitive responses from rivals may therefore provide a more realistic scenario for the HOGR cases.

4. Findings for the U.S. High Oil and Gas Resource, International Supply/Demand Shock Scenario with Full Competition (No Export Constraints) by Rivals

There is much debate regarding how LNG will be priced in the future and, in particular, how the introduction of LNG exports from U.S. markets will influence price formation in LNG markets. The 63 core scenarios in this study use the same methodology for pricing as used in NERA's 2012 FE/DOE study, but with updated data. That methodology includes an LNG pricing regime in Asia indexed to petroleum prices, but with steeper discounts over time to reflect greater competition among suppliers. European pricing is a hybrid system based upon some supplies indexed to petroleum prices, and other sources priced on regional gas-on-gas competition. Neither of these pricing regimes, used in the core 63 scenarios and the 2012 FE/DOE study, leads to full gas-on-gas competition, or to export prices that are driven down to the marginal cost of production in all exporting regions.[30] These possibilities are addressed in the alternative HOGR cases, discussed below, that assume a fully competitive market with gas-on-gas competition and pricing based on marginal cost of production.

The introduction of North American LNG on the scale projected in the HOGR cases and the development of additional projects in other parts of the world could result in an excess supply of LNG in the market if the assumed pricing regimes prevail. This would likely lead to the breakdown of the traditional pricing relations based on export restraints adopted by rival exporters such as Qatar and Russia. Abandonment of these export constraints and acceptance by rival exporters of lower prices would create more competition for the Asian and European markets. This competition could take many forms, with one example being a willingness of suppliers to reduce their price as low as their marginal cost of production in order to hold or increase their LNG or gas pipeline volumes sales. In this scenario, the higher level of competition could eliminate any markup beyond marginal cost that would otherwise accrue to LNG suppliers. In this scenario, the choice of suppliers would be based solely on their ability to deliver low-cost LNG to the market.

To better understand the consequences for U.S. LNG exports of enhanced competition, we reran three of the HOGR scenarios assuming that natural gas suppliers could not demand any profit

[30] All exporters in the global LNG market except the United States are assumed to initially exercise some degree of production restraint in response to U.S. LNG exports.

above marginal cost, plus a return on capital. All three scenarios assumed no constraint for LNG export capacity (NC) from the U.S. The scenarios differed in their outlook for the international market (INTREF, D, SD). In these scenarios global natural gas prices would be determined by gas-on-gas competition, and oil-linked pricing practices that led to delivered prices greater than the marginal cost of natural gas production in the exporting region plus the cost of liquefaction, transportation, and regasification would be abandoned. This outcome could come about as a result of a decision by exporters to increase output to competitive levels rather than restricting output and receiving prices higher than their marginal production cost. LNG importers also could demand price concessions from exporters as an alternative to competitive LNG supplies from the United States, reducing international prices closer to marginal production cost. This breakdown of the present production restraint, which we refer to as full competition, is more likely with potential U.S. exports on the scale projected for the HOGR scenarios.

Figure 27 compares the levels of U.S. LNG exports and wellhead price of these three scenarios under restricted and full competition. LNG exports from the U.S. are lower on average by between 41% and 63% in a given year when rivals remove their export restraints and compete aggressively to export gas. Full competition could lower U.S. LNG exports by about 3 Tcf in 2018 and about 9 Tcf in 2038 compared to restricted competition. Over all years and cases, annual U.S. LNG exports would be about 5 Tcf lower on average with full compared to restricted competition.

This result is indicative of a market where, over time, other regions of the world have lower-cost sources of natural gas that can be brought on line to displace some U.S. LNG exports. The drop in demand for U.S. LNG exports results in lower domestic prices for natural gas (roughly $0.50/Mcf in all years). Lower natural gas prices induce an average increase in domestic consumption of 1.3 Tcf to 1.5 Tcf. But on net, U.S. production falls on average between 3.3 and 3.6 Tcf/year due to lower export demand not offset by domestic consumption increases.[31]

[31] Detailed results for the Full Competition Cases are provided in Appendix C, Figures 166-168.

Figure 27: U.S. LNG Export, U.S. Production/Demand, and Wellhead Prices under HOGR with no Export Constraints: Comparison between Restricted and Competitive Pricing by Rivals

			2018	2023	2028	2033	2038	Avg
LNG Exports (Tcf)	HOGR_INTREF_NC	Restricted competition	4.3	6.2	8.2	10.4	14.4	8.7
		Full competition	1.1	1.9	3.7	4.9	4.9	3.3
	HOGR_D_NC	Restricted competition	6.3	8.9	11.4	13.7	18.1	11.7
		Full competition	3.5	5.0	7.4	9.0	9.1	6.8
	HOGR_SD_NC	Restricted competition	6.6	9.7	12.5	15.1	19.5	12.7
		Full competition	3.6	5.6	8.0	9.8	10.1	7.4
Wellhead Price (2012$)	HOGR_INTREF_NC	Restricted competition	$2.73	$2.87	$2.98	$3.29	$4.10	$3.19
		Full competition	$2.27	$2.40	$2.57	$2.86	$3.43	$2.71
	HOGR_D_NC	Restricted competition	$3.05	$3.19	$3.27	$3.55	$4.37	$3.49
		Full competition	$2.61	$2.74	$2.89	$3.16	$3.72	$3.02
	HOGR_SD_NC	Restricted competition	$3.12	$3.30	$3.38	$3.66	$4.48	$3.59
		Full competition	$2.62	$2.79	$2.95	$3.22	$3.78	$3.07

All three cases with competitive rivals are consistent with the assumption that U.S. exports of more than 5 Tcf of LNG drive the global LNG market away from oil-indexed pricing. Under the threat of increased competition from the United States, other exporters may achieve better economic outcomes if they lower their prices to increase exports rather than restrain their exports by maintaining high oil-indexed pricing. When all regions move away from oil-indexed pricing, U.S. LNG exports decrease in 2038 to between 4.9 Tcf and 10 Tcf. The resulting level of exports is less than any of the unconstrained HOGR cases in which competitors cut their output to make room for U.S. exports so as to maintain oil-linked pricing. This drop in LNG exports suggests that if the United States has large supplies of low-cost gas, and the global market responds to these large supplies by moving to gas-on-gas competition, then the level of U.S. LNG exports would be far less than anticipated if prevailing international prices continued.

In other words, should the markup beyond marginal costs associated with the sale of LNG be bid away by rival exporters into the global market, then the United States will export less LNG than it would otherwise. This result is attributable to the lower cost of natural gas supplies in other regions of the world which would take market share from the United States if international developers were willing to exploit those reserves and invest in liquefaction facilities and pipelines without receiving any markup beyond marginal costs for their natural gas. For example, some U.S. LNG exports to Europe would be displaced by pipeline imports from the FSU. City gate prices will decline, and result in greater demand overall.

If U.S. exports were unconstrained and pricing moved to gas-on-gas competition, U.S. natural gas prices under the HOGR scenario would rise very little no matter what the level of U.S. exports (see Figure 28), while prices in the rest of the world would decline. The resulting global economic impacts have not been modeled, but they could be of a scale to provide significant reductions in the cost of imports to U.S. consumers and provide an additional improvement in the U.S. terms of trade. The reduction in world LNG prices would erode some of the cost advantages of gas-intensive manufacturers over those in gas-importing countries, while making U.S. consumers unambiguously better off.

Figure 28: Average U.S. Wellhead Price under the HOGR_INTREF without Exports and with Unlimited Exports and Full Competition (2012$/Mcf)

	2018	2023	2028	2033	2038
Full Competition	$2.28	$2.47	$2.68	$2.96	$3.52
No exports	$2.15	$2.23	$2.32	$2.56	$3.15

5. Netback Pricing and the Conditions for "Rents" or "Profits"

When LNG export capacity constrains exports, rents or profits are generated for someone in the supply chain. These rents or profits are the difference in value between the netback and the wellhead price. The netback price is the value of the LNG exports in the consuming market, less the costs incurred in transporting natural gas from the wellhead to the consuming market. In the case of LNG, these costs consist of: pipeline transportation from the wellhead to the liquefaction plant, liquefaction costs, transportation costs by ship from the liquefaction plant to the regasification plant, regasification costs, and pipeline transportation from the regasification facility to the city gate.

Exports will be profitable if the netback price is either greater than or equal to the average wellhead price. It cannot be lower, or otherwise there would be no economic incentive to produce the natural gas. In cases where the U.S. LNG exports are below the binding LNG export capacity limits, the netback prices the United States receives for its exports equal the U.S. wellhead price. However, when the LNG export limit binds so that LNG exports equal the LNG export capacity constraint, the U.S. market becomes disconnected from the world market, and the netback prices that the United States receives exceed its wellhead prices. In this event, the difference between the netback price and the wellhead price leads to a positive profit or rent.

6. LNG Exports: Relationship between Price and Volume

Figure 29 indicates the range of LNG exports and U.S. natural gas prices that were estimated across all 63 global scenarios.[32] Based on Figure 29, NERA selected 14 scenarios for detailed U.S. economic analysis. These 14 scenarios spanned the full range of potential impacts and provided discrete points within that range for discussion. In this section, we describe the analysis performed to select the 14 scenarios.

[32] In order to keep the discussion of macroeconomic impacts as concise as possible, this report does not discuss in detail all the scenarios that were run.

Because each of the 63 scenarios was characterized by a U.S. and international dimension (as well as different U.S. LNG export capacity), shapes and colors were used to denote the different combinations:

- Shapes are used to differentiate among the different U.S. scenarios: U.S. Reference (circle), U.S. HOGR (diamond and square), and U.S. LOGR (triangle); and
- Colors are used to differentiate among the International cases: International Reference (red), Demand Shock (blue), and Supply/Demand Shock (yellow). In some instances, the same level of U.S. LNG exports and wellhead prices existed for multiple International cases. In these instances, the naturally combined color of the multiple cases is used (*e.g.*, a green symbol (combination of blue and yellow) if the Demand Shock and Supply/Demand Shock scenarios yield the same results.

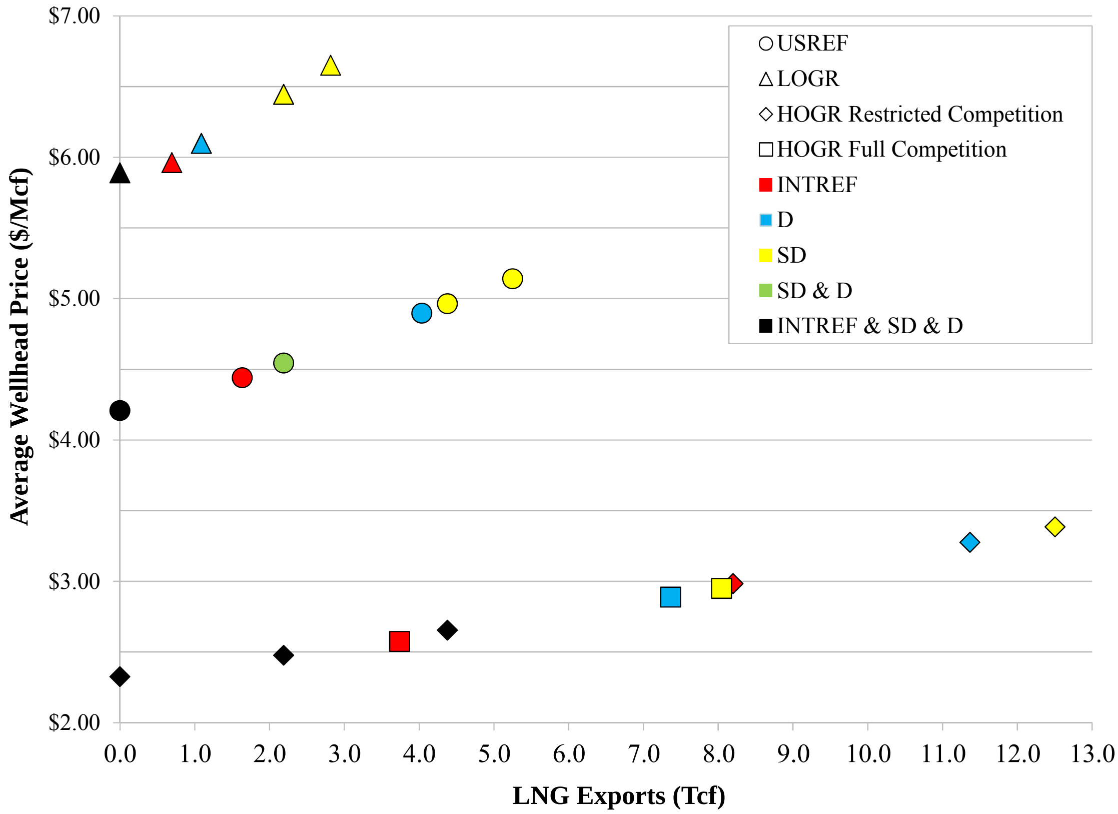
Therefore, each point on Figure 29 conveys the U.S. and International scenarios, which may correspond to multiple LNG export capacity scenarios. For example, the upper left yellow triangle (2.9 Tcf of exports) corresponds to the High/Slow, High/Rapid, and unconstrained LNG export capacity cases for the U.S. LOGR scenario. In our detailed U.S. analysis, we only need to consider one of the multiple scenarios. Thus, we can greatly reduce the number of scenarios because Figure 29 suggests there are far fewer than 63 unique LNG export levels.

The yellow markers (scenarios that include the International Supply/Demand shock) yield the highest levels of LNG exports and U.S. natural gas prices and form the upper right hand boundary of impacts. The upper right red, blue, and yellow markers for each shape represent the cases where LNG exports are unconstrained. For the scenarios where the LNG exports are below the export capacity limits, the marker represents multiple scenarios.

The diamonds and squares (scenarios that include the U.S. High Oil and Gas Resource, or HOGR) form a line that represents the recovery of larger quantities of natural gas at lower prices. This essentially traces out the U.S. supply curve for LNG exports under the HOGR scenario. These scenarios combine the lowest U.S. natural gas prices with the highest levels of exports, as would be expected. With HOGR assumptions, U.S. natural gas supply can be increased at relatively low cost, enabling larger levels of exports to be economic. For the detailed U.S. economic analysis, we used the HOGR cases to provide the high end of the range for U.S. LNG exports. Since under the HOGR, the results are nearly identical across all international cases, we included the seven export capacity scenarios under the Supply and Demand Shock (SD) because they yielded slightly higher exports.

Figure 29: U.S. LNG Exports in the Year 2028 for Different Scenarios

Note each point can correspond to multiple LNG export capacity scenarios



1 Bcf/d = 2.74 * Tcf/Year
2 Legend labels with combinations of scenarios indicate identical resulting price and LNG export combinations across scenarios
3 Multiple points with identical color coding and shapes indicate distinct quota cases.

As discussed earlier, the export levels in the HOGR cases could be sustained only if rival exporters do not respond to the United States capturing an ever larger market share, which is unlikely. The squares show the level of exports and corresponding wellhead prices if rivals fully compete with the United States. It can be seen that these cases fall in the same supply curve as the HOGR cases in more profitable market conditions, but that both export levels and prices are much lower. For example, the red square has lower exports and wellhead prices than that represented by the red diamond. The levels of exports and wellhead prices in each fully competitive case pull back by a considerable amount from those reached in the original cases (red square compared to red diamond, blue to blue, and yellow to yellow.

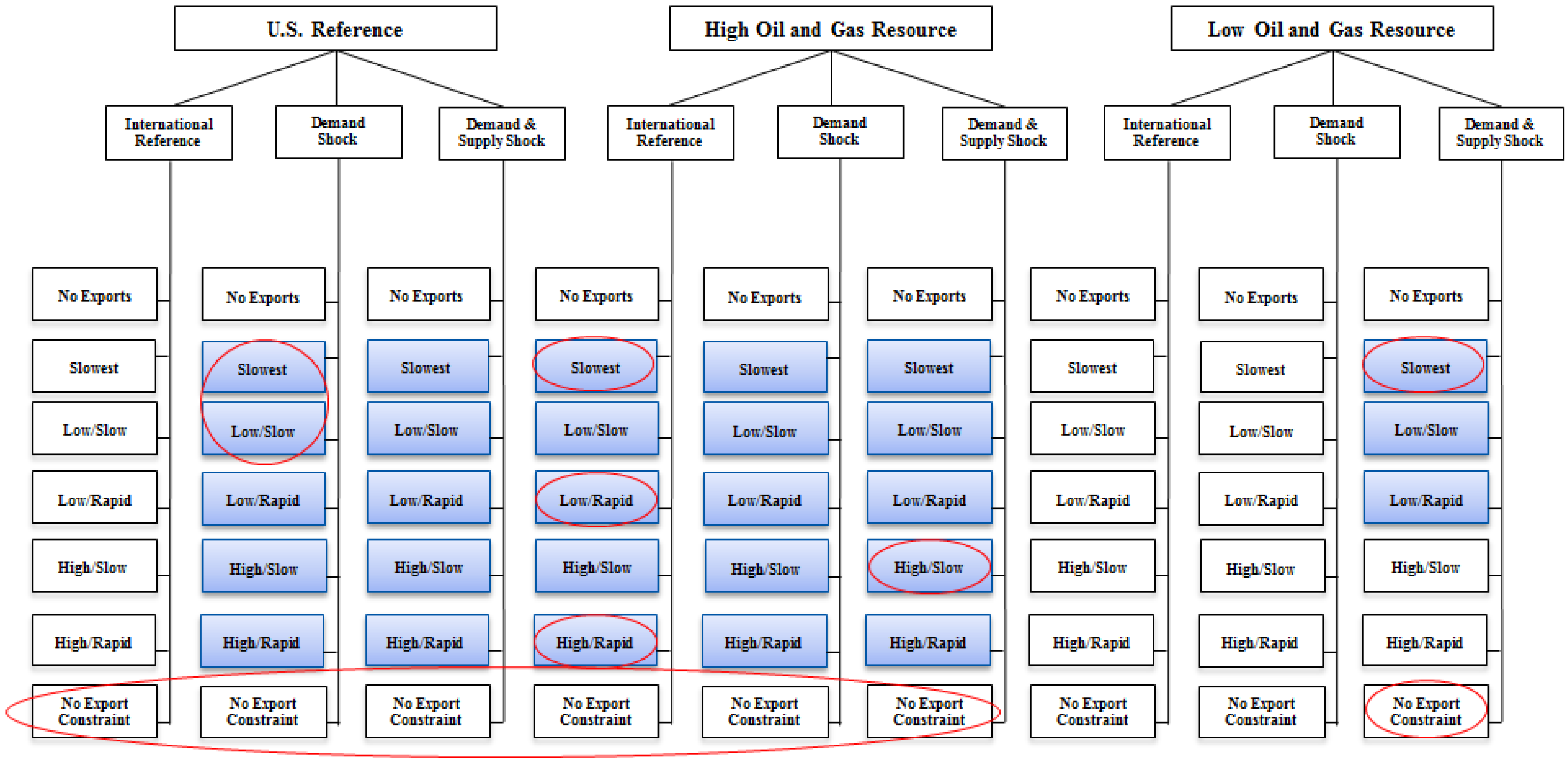
The supply curve traced out by the scenarios that include the U.S. Reference case scenarios (USREF, represented by circles) are higher than in the HOGR scenarios because domestic gas is less plentiful. When only an International Demand shock exists, the LNG export capacity limits are binding at the low level and non-binding at the high level, so the level of exports (the lone blue circle) is the same for both high LNG export capacity scenarios and the unlimited exports scenario under the U.S. Reference case. Raising the limits on LNG exports in the presence of the

International Demand Shock and Supply/Demand Shock, however, causes actual exports to increase and reach the LNG export constraint levels as exhibited by the two yellow circles that move along a northeast line. In the U.S. Reference case, the exports are less than the LNG export constraints under International Reference assumptions as represented by the red circle.

A line joining the triangles in Figure 29 traces the 2028 supply curve for the LOGR scenarios. The trajectory of the wellhead prices is the highest compared to other scenarios because of the high underlying baseline wellhead prices. Under the LOGR scenarios, the U.S. wellhead price ranges from $5.90/Mcf to about $6.65/Mcf in 2028. The combination of LOGR and an International Supply and Demand shock leads to a combination of higher U.S. natural gas prices and lower exports than in the corresponding HOGR or U.S. Reference scenarios. For the LOGR scenarios, we considered two cases: the most binding case (LOGR with Supply/Demand Shock under the Low/Slowest LNG export capacity) and no LNG export capacity constraint, in the detailed U.S. economic analysis. These scenarios provide the low end of the export range.

H. Findings and Core Scenarios Chosen for N$_{ew}$ERA Model

Figure 30: Scenario Tree with Maximum Feasible Export Levels Highlighted in Blue and N$_{ew}$ERA Scenarios Circled



The first use made of the GNGM was to determine the level of exports in each of these scenarios that would be accepted by the world market at a price high enough to buy gas at the prevailing wellhead price in the United States, transport it to a liquefaction facility, liquefy it, and load it onto a tanker. In all of the cases we analyzed, we found that there was at least some minimum level of LNG exports in some years. In a number of cases, we found that the amount of LNG exports that met this profitability test was below the LNG export capacity level assumed in that case. In others, we found that the assumed limit on exports would be binding. In a few cases, we found that the market if allowed would accept more than any of the export limits.

In Figure 30 under the assumptions for U.S. Reference/International Reference case, we found that there would be some export volumes that could be sold profitably into the world market. In the case that combined HOGR and International Reference, LNG export volumes reached the LNG capacity constraint in almost every year for each scenario.

The blue colored boxes in Figure 30 designate the cases in which we observed constraints on LNG exports owing to quota limitations for that combination of U.S. and International assumptions. Cases with export levels and U.S. prices that fall below the quota limits are identified by the clear box (see Figure 30). The scenarios considering U.S. HOGR supply conditions combined with any International Supply/Demand conditions demonstrates that LNG exports potential far exceeded both the High/Rapid export limits as well as the more constraining High/Slow limits. We therefore used the No Export capacity cases to provide a benchmark to which the impacts of increased levels of exports could be compared.

Based on the results of these scenarios, we pared down the scenarios to analyze in the N_{ew}ERA macroeconomic model. Taking into account the possible world natural gas market dynamics, the GNGM model results suggest 28 scenarios in which LNG exports reached the LNG export capacity limit.[33] These scenarios were further reduced to 14 scenarios by excluding scenarios with similar levels of exports across the international outlooks. This was done because the N_{ew}ERA model does not differentiate among the various international outlooks. For N_{ew}ERA, the critical issue is the level of U.S. LNG exports and U.S. natural gas production. Of the 14 N_{ew}ERA scenarios (circled in Figure 15), five scenarios reflect the U.S. Reference case, seven reflect the HOGR case with full U.S. LNG export capacity utilization, and two are from the LOGR case with the lowest export expansion.

[33] Only cases with a positive export limit are considered.

V. COMPARISON OF STUDY RESULTS WITH PREVIOUS STUDY FOR THE DEPARTMENT OF ENERGY

This study is intended as an update to a previous study done by NERA for the Department of Energy.[34] The two studies have the same objective of determining the economic impacts on the United States from LNG exports. Both studies used the same basic modeling structure for global LNG supply/demand with the principal difference being updated data inputs. The earlier study relied upon the best, most recent and most complete datasets available at the time the analysis was performed. This included EIA's *AEO 2011* for characterizing the domestic market and EIA's *IEO 2011* for characterizing the global market. In the previous study, we developed three scenarios designed to capture the breadth of possible outlooks for U.S. natural gas supply. These scenarios were based upon EIA's *AEO 2011* scenarios: Reference, High Estimated Ultimate Recovery scenario (HEUR), and Low Estimated Ultimate Recovery (LEUR).

The current study relies upon more recent versions of the same sources, namely EIA's *AEO 2013* and EIA's *IEO 2013*. In the current study the three scenarios for U.S. natural gas supply are based upon three similar *AEO 2013* scenarios: Reference, HOGR, and LOGR.

Given the two different studies, it is possible to compare their results to assess how perceptions of the prospects for U.S. LNG exports have evolved with time. For that purpose, it is possible to arrange comparisons between the Low, Reference, and High resource scenarios used in each of the two NERA studies.

A. Natural Gas Markets

As an initial observation, we note that EIA's view on U.S. LNG exports has evolved from the *AEO 2011*, when no U.S. LNG exports occurred in any of their cases, to the *AEO 2013* outlook in which U.S. LNG exports occur in all three scenarios. EIA's views on U.S. natural gas production have also evolved, with a more optimistic outlook for the volume and costs of producing natural gas domestically. For instance, projected domestic natural gas production in 2028 grew from 25.2 Tcf in the *AEO 2011* to 30.1 Tcf in the *AEO 2013*, while projected 2028 Henry Hub prices declined from $6.68/Mcf in the *AEO 2011* to $5.41/Mcf in the *AEO 2013*.

The lower projected natural gas prices induced an increase in domestic consumption from 23.6 Tcf in the *AEO 2011* to 24.5 Tcf in the *AEO 2013*, both again for the year 2028. Figure 31 shows the distribution of changes in consumption across the different areas of the economy. Residential, commercial, and industrial demand are lower in the *AEO 2013* than the *AEO 2011* forecast, but a greater increase in consumption occurs in the electric and transportation sectors, leading to a net increase in demand of about 0.9 Tcf from 2028 onward.

[34] "Macroeconomic Impacts of LNG Exports from the United States," NERA Economic Consulting, Prepared for U.S. Department of Energy, Office of Fossil Energy, 2012.

Figure 31: Domestic Natural Gas Consumption Forecasts (Tcf)

		2018	2023	2028	2033	2038	Average (2018-2033)
Residential	*AEO 2013*	4.56	4.47	4.39	4.29	4.17	4.43
	AEO 2011	4.83	4.83	4.84	4.80	N/A	4.83
	Diff	*-0.27*	*-0.37*	*-0.45*	*-0.50*	*N/A*	*-0.40*
Commercial	*AEO 2013*	3.31	3.33	3.39	3.48	3.55	3.38
	AEO 2011	3.46	3.53	3.62	3.76	N/A	3.59
	Diff	*-0.14*	*-0.20*	*-0.23*	*-0.28*	*N/A*	*-0.21*
Industrial	*AEO 2013*	7.54	7.80	7.79	7.81	7.86	7.74
	AEO 2011	8.16	8.13	8.04	8.04	N/A	8.09
	Diff	*-0.62*	*-0.33*	*-0.26*	*-0.23*	*N/A*	*-0.36*
Electric Power	*AEO 2013*	8.30	8.26	8.75	9.29	9.54	8.65
	AEO 2011	7.00	6.67	6.95	7.69	N/A	7.08
	Diff	*1.30*	*1.59*	*1.80*	*1.61*	*N/A*	*1.57*
Transportation	*AEO 2013*	0.07	0.09	0.19	0.44	0.86	0.20
	AEO 2011	0.06	0.09	0.12	0.15	N/A	0.11
	Diff	*0.01*	*0.01*	*0.07*	*0.28*	*N/A*	*0.09*
Total	*AEO 2013*	23.78	23.95	24.51	25.31	25.98	24.39
	AEO 2011	23.50	23.26	23.58	24.44	N/A	23.69
	Diff	*0.28*	*0.70*	*0.93*	*0.87*	*N/A*	*0.69*

A comparison of the NERA results in the two studies reflects EIA's more optimistic views on natural gas supply as well as its projections of much more rapid growth in domestic natural gas demand.

Figure 32 presents the level of LNG exports and average wellhead prices for the reference cases in the two studies. The scenarios represented in the figure are based on the U.S. Reference case, with range derived from the three international scenarios that have been described elsewhere in this report. These scenarios assume no limitation on U.S. LNG exports in any year. The 2013 study results indicate that LNG exports would be greater in most years compared to estimates for the corresponding period in the 2012 study. With the exception of two periods, U.S. LNG exports in the Reference scenarios are between 0.3 Tcf and 3.5 Tcf per year higher than the results obtained in the original NERA study. Over a 20-year period, U.S. LNG exports in the Reference scenarios average between 0.4 Tcf to 2.3 Tcf higher than previously forecasted. Furthermore, with the exception of one period, the estimated wellhead price across the forecast range is between $0.24/Mcf and $1.58/Mcf lower than in the earlier study. Wellhead prices over 20 years average from $0.77/Mcf to $1.26/Mcf lower. These results imply that the United States can be expected to produce a greater level of LNG exports at a lower price than was estimated in the earlier NERA study.

Figure 32: U.S. Reference Unconstrained Export Scenarios: LNG Exports (Tcf) and Average Wellhead Prices ($/Mcf)[35]

	Int. Shock	Study	2018	2023	2028	2033	2038	Average
U.S. LNG Exports (Tcf)	INTREF	2014 Study	0.36	0.83	1.63	1.63	1.73	1.24
		2012 Study	0.07	0.00	0.00	0.00	0.00	0.01
		Difference	0.29	0.83	1.63	1.63	1.73	1.22
	D	2014 Study	1.74	2.37	4.04	4.30	4.97	3.48
		2012 Study	0.99	1.13	1.25	1.28	1.46	1.22
		Difference	0.75	1.24	2.79	3.02	3.51	2.26
	SD	2014 Study	2.13	3.17	5.25	6.01	7.10	4.73
		2012 Study	2.54	3.42	4.24	5.14	6.35	4.34
		Difference	-0.41	-0.25	1.01	0.87	0.75	0.39
U.S. Wellhead Price ($/Mcf)	INTREF	2014 Study	$3.44	$4.03	$4.44	$4.88	$6.48	$4.65
		2012 Study	$4.43	$5.00	$5.61	$6.11	$6.72	$5.57
		Difference	-$0.99	-$0.97	-$1.17	-$1.23	-$0.24	-$0.92
	D	2014 Study	$3.76	$4.36	$4.90	$5.34	$7.09	$5.09
		2012 Study	$4.72	$5.32	$5.92	$6.37	$6.96	$5.86
		Difference	-$0.96	-$0.96	-$1.02	-$1.03	$0.13	-$0.77
	SD	2014 Study	$3.86	$4.53	$5.14	$5.65	$7.52	$5.34
		2012 Study	$5.26	$6.03	$6.72	$7.18	$7.82	$6.60
		Difference	-$1.40	-$1.50	-$1.58	-$1.53	-$0.30	-$1.26

As shown in Figure 33, a similar pattern exists when the comparison is made between the two corresponding LOGR scenarios. Under the LOGR comparisons, U.S. LNG exports in the 2013 study are equal to or greater than those in every period in the earlier study, ranging from between 0.0 and 3.2 Tcf per year. The average wellhead prices show a similar pattern as before, and are lower in all cases and all periods with one exception. Wellhead prices over 20 years average from $1.12/Mcf to $1.52/Mcf lower in the LOGR scenarios, indicating that the expectation of greater U.S. LNG exports at lower prices also holds true even though the resource prospects are diminished.

[35] The NERA 2012 study results were interpolated for comparisons with the 2014 study results since the model years are different for the two studies. The NERA 2012 study results were extrapolated for the year 2038.

Figure 33: U.S. Low Oil and Gas Resource, Unconstrained Scenarios: LNG Exports and Average Wellhead Prices[36]

	Int. Shock	Study	2018	2023	2028	2033	2038	Average
U.S. LNG Exports (Tcf)	INTREF	2014 Study	0.00	0.00	0.69	0.69	0.80	0.44
		2012 Study	0.00	0.00	0.00	0.00	0.00	0.00
		Difference	0.00	0.00	0.69	0.69	0.80	0.44
	D	2014 Study	0.01	0.01	1.09	1.17	1.17	0.69
		2012 Study	0.00	0.00	0.00	0.00	0.00	0.00
		Difference	0.01	0.01	1.09	1.17	1.17	0.69
	SD	2014 Study	0.42	1.04	2.82	3.43	3.90	2.32
		2012 Study	0.39	0.84	0.59	0.40	0.65	0.57
		Difference	0.03	0.20	2.23	3.03	3.25	1.78
U.S. Wellhead Price ($/Mcf)	INTREF	2014 Study	$4.26	$5.19	$5.96	$6.63	$8.78	$6.16
		2012 Study	$6.17	$7.03	$7.77	$8.34	$9.07	$7.68
		Difference	-$1.91	-$1.83	-$1.81	-$1.71	-$0.29	-$1.52
	D	2014 Study	$4.26	$5.19	$6.10	$6.79	$8.92	$6.25
		2012 Study	$6.17	$7.03	$7.77	$8.34	$9.07	$7.68
		Difference	-$1.91	-$1.83	-$1.67	-$1.55	-$0.15	-$1.43
	SD	2014 Study	$4.39	$5.52	$6.65	$7.48	$9.86	$6.78
		2012 Study	$6.36	$7.41	$8.02	$8.47	$9.26	$7.90
		Difference	-$1.97	-$1.89	-$1.37	-$0.98	$0.60	-$1.12

The most striking contrasts occur when comparing the HOGR scenarios (Figure 34). In this instance, the U.S. LNG exports are greater for all cases and in all periods. The difference in U.S. LNG exports is greatest in the outer years of the two studies, reaching from between 10 Tcf and 12 Tcf in 2038. Wellhead prices are also lower in all cases and in all periods compared to the earlier study by between $1.18/Mcf and $2.13/Mcf across the forecast range. The average wellhead prices over 20 years are lower than the 2012 study by between $1.56/Mcf and $1.82/Mcf. The HOGR scenarios are consistent with the other U.S. supply outlooks in that the U.S. LNG exports are higher while wellhead prices are lower.

[36] The NERA 2012 study results were interpolated for comparing with the 2014 study results since the model years are different for the two studies. The NERA 2012 study results were extrapolated for the year 2038.

Figure 34: U.S. High Oil and Gas Resource, Unconstrained Export Cases: LNG Exports and Average Wellhead Prices[37]

	Int. Shock	Study	2018	2023	2028	2033	2038	Average
U.S. LNG Exports (Tcf)	INTREF	2014 Study	4.26	6.15	8.20	10.40	14.40	8.68
		2012 Study	2.60	3.37	3.28	3.08	3.68	3.20
		Difference	1.71	2.78	4.92	7.32	10.72	5.48
	D	2014 Study	6.27	8.87	11.37	13.71	18.10	11.66
		2012 Study	3.62	4.41	4.73	5.10	6.12	4.80
		Difference	2.65	4.46	6.57	8.61	11.98	6.86
	SD	2014 Study	6.64	9.70	12.51	15.05	19.51	12.68
		2012 Study	4.84	6.08	6.81	7.64	9.14	6.90
		Difference	1.80	3.62	5.70	7.41	10.37	5.78
U.S. Wellhead Price ($/Mcf)	INTREF	2014 Study	$2.73	$2.87	$2.98	$3.29	$4.12	$3.20
		2012 Study	$3.97	$4.42	$4.84	$5.11	$5.51	$4.77
		Difference	-$1.24	-$1.55	-$1.86	-$1.82	-$1.39	-$1.57
	D	2014 Study	$3.06	$3.19	$3.28	$3.56	$4.39	$3.48
		2012 Study	$4.24	$4.65	$5.10	$5.41	$5.80	$5.04
		Difference	-$1.18	-$1.46	-$1.82	-$1.85	-$1.41	-$1.56
	SD	2014 Study	$3.12	$3.30	$3.38	$3.66	$4.50	$3.59
		2012 Study	$4.58	$5.04	$5.51	$5.79	$6.15	$5.41
		Difference	-$1.46	-$1.74	-$2.13	-$2.13	-$1.65	-$1.82

B. Changes to Components of GDP

In this study, changes were made to how the income subcomponents of GDP are computed. These changes do not affect the value of total GDP, but these changes cause the value of the components to differ between the two scenarios and make comparing the changes in the value of the GDP components inappropriate. The computation of the components in the current study differs from the previous study in three key ways:

- The previous study reported transfer income, which included tolling charges, explicitly. The current study includes tolling charges as part of capital income because tolling charges can be thought of as return on investment in LNG facilities.[38]

[37] The NERA 2012 study results were interpolated for comparing with the 2014 study results since the model years are different for the two studies. The NERA 2012 study results were extrapolated for the year 2038.

[38] Tolling charges reflect fees collected by the project developer for its investment and can be aggregated as part of capital income.

- The current study does not model royalties explicitly. Indirect tax revenue, however, includes corporate income tax on the resource sector.
- In the model, resource income for the coal, natural gas, and crude oil sectors represents sector-specific capital and labor in addition to natural resources.[39]

Resource for the extractive sectors (coal, natural gas, and crude oil) is modeled to represent sector-specific capital and labor in addition to natural resource. We disaggregate these individual subcomponents and augmented the incomes into their respective income category. In addition, we also assume that the resource sector pays corporate income tax of 39.2% (federal statutory rate) on the resource base. In the NERA 2012 study, resource income represented income from natural resources and fixed factors associated with the resource sectors. These changes in the computation of the GDP components lead to a qualitative shift in capital and tax revenue income, turning these from negative to positive.

[39] In general, the natural resource sector uses mobile capital and labor that are easily substitutable in the rest of economic sectors; and sector-specific capital and labor are highly specialized capital and labor that are unique to these sectors. These specialized factors of production are highly dependent on the sectoral output. We made these changes to better capture the use of sector-specific capital and labor in the natural resource sector.

VI. KEY ECONOMIC ISSUES

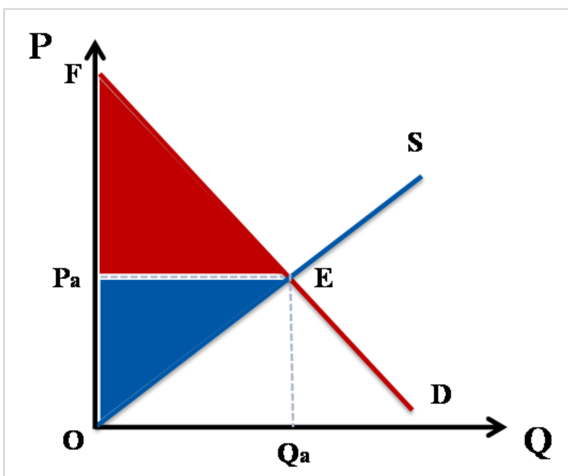
A. General Economic Theory of Trade

1. Impacts on Consumer/Producer Surplus and Trade Balance

To explain the general economic theory of trade, it is useful to begin with a simple illustration of the natural gas market with a closed economy where no trade exists. Consumers and producers interact in the natural gas market with demand and supply establishing a market equilibrium that determines the market price and the quantity exchanged. Figure 35 shows a supply and demand diagram in which demand for natural gas is represented by a downward-sloping line, D, characterizing decreasing willingness to pay as consumption increases, and supply by an upward-sloping line, S, characterizing increasing marginal cost of production as output increases. For illustrative convenience, we employ straight lines for demand and supply.[40]

Demand and supply cross at point E, which denotes market or competitive equilibrium prices and quantities. At the competitive equilibrium, consumers' willingness to pay for an additional unit is equal to its cost of production. Demand will exceed supply at lower prices, and supply will exceed demand at higher prices. Therefore, the market stabilizes with equilibrium price P_a and quantity Q_a.

Figure 35: Market Equilibrium in a Closed Economy



Economic surplus refers to monetary gains or "welfare." Consumer surplus denotes the value consumers receive from consumption over and above the amount which they pay. Graphically, this is the red triangle in Figure 35 which sits above the price and below the demand line.

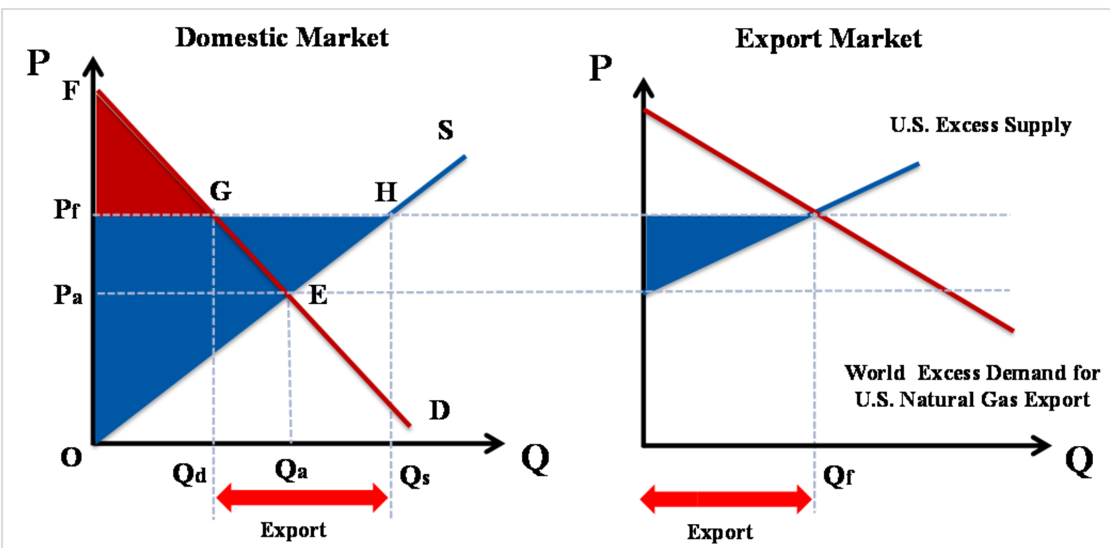
[40] Iso-elastic curves might offer a more realistic characterization, where marginal cost grows at an increasing rate and marginal benefits fall at a decreasing rate. Qualitatively, the simple linear representation used in this analysis generalizes to any regular system, where supply is upward sloping and demand is downward sloping.

Likewise, producer surplus represents the value that producers gain in excess of the cost of production. The area below the price and above the supply line (blue triangle) in Figure 35 denotes the producer surplus. Total surplus or social welfare is the sum of consumer surplus and producer surplus.

Free trade equates domestic prices with global prices (appropriately adjusted for transportation cost to market). When domestic prices, and production costs, for a good are less than the global price, moving from a no-trade position to a free-trade position implies an increase in domestic price by some amount. Analogously, the domestic price falls when a country becomes an importer and replaces more costly domestic production with cheaper imports.

For the case of the U.S. natural gas industry, we include a diagram for the export market along with one for the domestic market to illustrate the changes when the United States moves from a no trade to a free trade position (see Figure 36). The export market is represented by the U.S. excess supply of natural gas and the global excess demand for the U.S. natural gas export. The competitive equilibrium in the export market finds a price (P_f) that equates the global excess demand with the U.S. excess supply, and at which the excess supply, the amount of natural gas U.S. producers are willing to produce in excess of the amount of domestic consumption (Q_s – Q_d), is equal to the equilibrium export in the export market (Q_f).

Figure 36: Market Equilibrium with Free Trade



Social surplus changes along with the price movement. When a country becomes an exporter, a domestic price increase reduces domestic consumption, resulting in a loss of consumer surplus. In the domestic market diagram of Figure 36, consumer surplus shrinks from P_aEF to P_fGF. Producers receive more profit on every unit of output sold to both the domestic and world market, generating a gain in producer surplus, which not only offsets the loss in consumer surplus (the trapezoid P_aEGP_f) but also adds a net gain on each unit sold to the world market (the triangle EHG). From the social welfare perspective, part of consumer surplus transfers to producer surplus and producers gain more profits from exporting. It is worth noting that the net gain, shown as the triangle EHG in the domestic market diagram, is equivalent to the blue triangle that exporters gain in the export market diagram. It is earned by producers who are able to export and charge a higher price than in the domestic market. What we have shown in this simple illustration is a form of "The Gains-from-Trade Theorem," which is the cornerstone of international trade theory.[41]

2. The Distribution of Gains from Trade - Winners and Losers

The gains-from-trade theorem posits that the net gains from trade will be positive; it does not indicate how the gains will be distributed. In fact, as in our illustration above with producers and consumers, it is likely that the gains will be distributed unevenly. This is true, however, of any change that affects relative prices, including all policies that are strictly intra-national in scope. This represents the fundamental dilemma and challenge of economic policy-making. Any change that increases total national income generally leaves some group worse off, and any change that reduces national income (*e.g.*, protectionist policies, subsidies) generally makes some group better off. If this last point were not true, then it is unlikely that we would ever observe a government making changes that reduced total national income.

Dividing the economy into producers and consumers is convenient for exposition of gains from trade, but does not represent sources of income and economic interests accurately. In the tradition of contemporary public economics, it is more useful to consider the functional distribution of income.[42] That is, to determine how a policy change affects actual people, it is necessary to divide the economy based on the amount and sources of income. The categories of national income used in this study consider after-tax earnings from employment, after-tax earnings from investment, tax payments, and resource rents. Some categories will increase due to producing and exporting more natural gas, and others may fall. For example, real labor income may go down, but income from capital and resource rents may go up by more. What a household gains from investment or resource ownership will fully offset their cost disadvantage in natural gas consumption, when the net change in income is positive.

To summarize, in our "frictionless" world, gains and losses are not associated with industries, they are associated with factor owners and therefore with households. The concept of a change in an industry's "producer surplus" is not meaningful in this context. The impact must be traced back to an actual agent participating in the economy. Sticking with the assumption of perfect competition, a focus on the gains and losses to industries makes much more sense in a world of specific factors. Let us focus on capital and assume that a large portion of capital in each industry is sector specific and has no use outside of that sector. Prior to investment taking place

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[41] See James R. Markusen, James R. Melvin, Keith E Maskus, &William Kaempfer, 1995. International trade: theory and evidence (McGraw-Hill, New York).

[42] Harvey Rosen and Ted Gayer, 2008. Public Finance (McGraw-Hill, New York) p. 303.

in a particular industry, there may be an integrated national or world capital market consisting of relatively homogeneous financial capital: this represents money that can be lent for investment. But when a firm in a sector borrows (homogeneous) money, it converts that money into sector-specific physical capital: machinery, structures, or resource rights. If there are few subsequent changes, the equity owners of the now-sector-specific capital stocks all make about the same, normal rate of return on their capital. That is, return on equity is about the same across all industries.

Now suppose a "shock" to the system transpires, such as a technological advance in gas extraction, trade liberalization, or any other change in the world, which changes prices unevenly across industries. The result will be gains to the owners of physical capital in those sectors that benefit from the "shock" and a loss to the owners in those sectors whose growth rate declines as a result of the shock. In the case of increased gas production brought about by new technologies, the owners of capital tied up in shoe machinery, for example, would love to convert it into drill rigs but they cannot do so. Of course, some portion of labor may also have sector-specific ties to a given industry, due to particular skills or geographical immobility.

We will see clearly that output and employment in some industries will grow more slowly in scenarios where natural gas production and exports grow more rapidly. This is a natural process of economic growth, where resources reallocate to their most valued use. When the economy is operating at its potential, with unemployment at the natural rate, this shock does not result in a change in the aggregate level of employment. Industries with comparative advantage and the most profitable markets grow faster and add more workers and others more slowly and add fewer.

B. Export Policy

While international trade is an important source of income and welfare gains for a country, it does not follow that export promotion policies are always a good idea. Exports should not be viewed as a goal in themselves and exports should not be confused with welfare. Taken by themselves, exports transfer valuable goods to foreigners. The only reason to do so is if we can get something more valuable in return.

More specifically, added trade that is generated by "distortionary" policies such as export subsidies is generally welfare reducing. Some groups benefit, of course, but total national income is reduced. An export subsidy means that the price we charge to foreigners is less than the domestic price of the good. In most industries and markets, the domestic price accurately reflects the cost of production. An export subsidy therefore means that we are selling to foreigners for less than the cost of production. A country maximizing the net gains from trade will export just to the point that the marginal cost of production equals the marginal export revenue, but no more.

When a country is a large seller in a particular industry, it will have a unilateral incentive to act strategically. From the perspective of a country that is large enough that its exports can move the world price, an increase in its export volume drives down the price of its exports, to its disadvantage. In such cases, completely free trade is not the policy that maximizes national income. Some level of export (or import) restrictions can drive up the relative export price more than it drives down export volume, hence improving welfare. The one caveat to this caveat to free trade is that many countries can play this game and, if they all do, then everyone is worse off. One of the primary goals of multilateral trade negotiations is to prevent this sort of "beggar-thy-neighbor" outcome. The global gains from trade are maximized when countries agree to a cooperative policy solution of completely free trade.

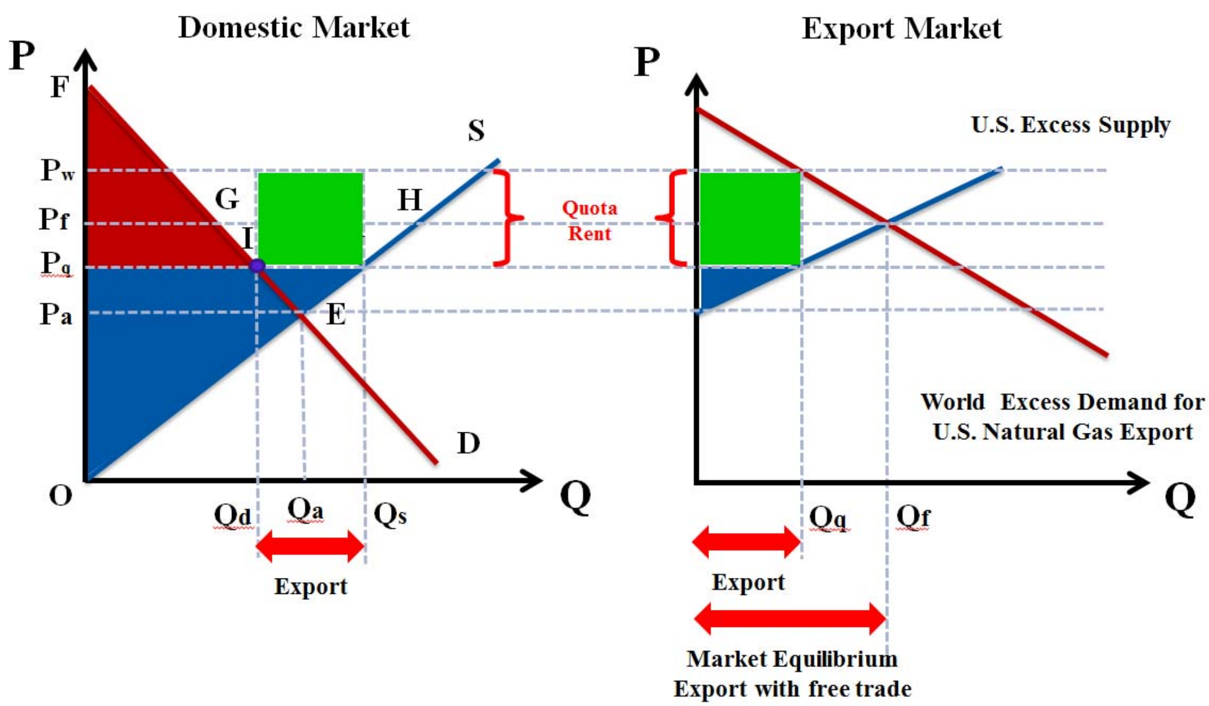
1. Export Limits and Quota Rents

Sometimes, an exporter may impose a limit on how much to export. Such a limit prevents trade from achieving a competitive equilibrium, thus generating a rent that creates a differential between the domestic and world price. We call the limit the "export quota" and the associated rent the "quota rent." An export quota will only lead to increased welfare or national income if a country's exports are large enough to have a material effect on the world price and the quota rents are captured by domestic agents. Essentially, a large exporter can leverage its market power to transfer some of the foreign gains from trade into domestic rents.

The export quota works through its impact on price and social welfare. Relative to free trade, the domestic price falls from P_f to P_q in Figure 37 as more supply is available for the domestic market. Domestic consumers thus gain additional surplus denoted by the trapezoid P_qIGP_f with more consumption at lower prices. The price drop leads to lower production as each unit earns less profit, translating into producer loss measured by the trapezoid P_qJHP_f in the domestic market diagram in Figure 37.

In the export market, the world price rises from P_f to P_w with the level of U.S. exports lower than the equilibrium exports with free trade. A differential appears between the domestic and world price, representing a quota rent created by the export constraint. The quota revenue is generated as the amount of exports multiplied by the quota rent on each unit of export, shown as the green rectangle in the export market diagram in Figure 37. This is the same size as the green rectangle in the domestic market diagram. Social welfare is then calculated as the sum of consumer surplus, producer surplus and the quota rent that is gained by the United States.

Figure 37: Market Equilibrium with Export Limits



There are different ways to create export quota rents. The government can issue licenses for exports, either in the form of a free give-away or by auctioning off to the highest bidder. Quota rents are gained by exporters in the former case and collected by government in the latter. If foreign-owned firms take title to natural gas at the wellhead in the United States, or pay a fixed charge for liquefaction that does not reflect the netback price, then the entire quota rent from free allocation will leave the United States and benefit only foreign entities. Foreign ownership of the natural gas resources or of the liquefaction facility would also move some share of quota rents earned by natural gas resources and liquefaction capital to foreign entities and thus would not be added to the U.S. social welfare accounting.

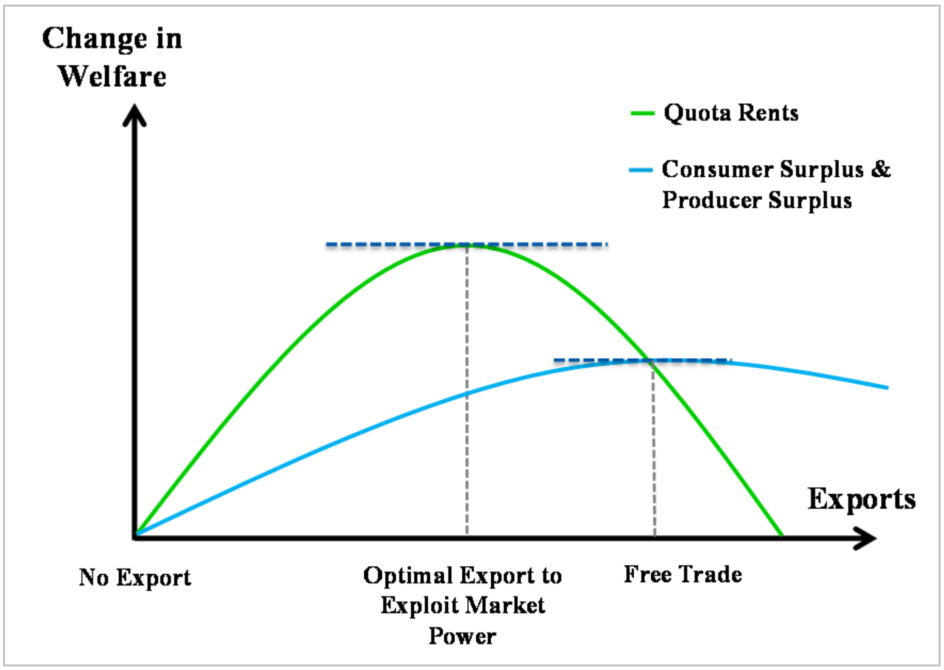
Since under the U.S. Constitution, export tariffs are prohibited and auctions of export licenses have been held to be equivalent to tariffs, it appears inevitable that quota rents created by restriction of LNG exports will largely go to foreign entities unless U.S. companies integrate forward from liquefaction into shipping, and either merchant sales of LNG or sales on contracts indexed to natural gas prices at the point of use.

2. Tradeoffs between Higher Exports and Higher Fuel Prices

In cases in which the export level is lower than free trade, would determine, quota rents are created and the amount collected by the domestic entities is added to the social welfare. The quota rent changes the level of exports as well as the differential between the domestic and world price. It starts to increase with a small amount of exports and becomes zero when the domestic price is equalized to the world price in free trade, reflecting a trade-off between higher exports and higher rents.

Figure 38 shows welfare changes with the level of exports going from zero to the market equilibrium level with free trade. The blue area denotes the gains from trade due to higher profit earned on each unit of export and monotonically increases with the level of exports. The green shuttle shaped area represents quota rents. Combining the total surplus from domestic consumers and producers with quota rents, we can find an optimal export level that maximizes the social welfare. The trade-off between quota rents and surplus of consumers and producers implies that the optimal export is less than the free trade level. It must be emphasized, though, that the green area only exists if exports from a single country are large enough to have a material effect on the world market price. Otherwise, there is no net economic benefit from restricting exports except under special conditions that do not apply in the case of natural gas.

Figure 38: Welfare Changes with Level of Exports



3. Implicit Collusion and Potential Outbreak of Competition

This analysis of the optimal export level for an exporter large enough to profitably influence the price by restricting output is the basis for theories of how a market with several exporters of such size will operate. In a fully competitive market, all exporters choose the "free trade" level of exports, in which the marginal cost of production equals the price and global welfare is maximized.

The simplest representation of a less-than-full-competitive market is one in which each exporter takes the export level of others as given and determines its optimal exports given its share of the market. The theory of monopolistic or imperfect competition applies to such a market, as developed by Robinson and Chamberlain in the 1930s.[43,44] Each exporter in such a market will produce less than the free trade amount, so that its marginal cost of production will be less than the market price, and the deviation between marginal cost and price will shrink as the number of exporters grows. If one large exporter enters the market, the deviation between optimal exports and unconstrained exports, in the sense developed above, will also shrink.

All these conclusions follow from the principle that the optimal export level for any producer is directly proportional to the elasticity of demand in the market as a whole and inversely proportional to its individual producer's market share. Thus the smaller an exporter's market share, the less incentive it has to limit exports. Most of the benefit of its export restraint will go to other exporters who are either numerous or larger than the exporter with a small market share. This pecuniary spillover effect or externality limits the amount of profit that can be earned by any exporter in an imperfectly competitive market.

If all exporters could collude, tacitly or openly as a cartel, then the optimal level of global exports would be even less than that in the imperfectly competitive market because the cartel could restrict its total exports to a level that maximized the profits of the group and then set quotas for each member of the cartel. Such cartels have appeared in many commodity markets over the past century, but most have been unstable.[45,46,47] OPEC may be an exception, but its failure to implode is probably due to Saudi Arabia's share of world oil exports. Applying the formula for optimal exports of a large supplier to Saudi Arabia leads to the conclusion that it is impossible to reject the hypothesis that Saudi Arabia is behaving as an imperfectly competitive exporter and choosing its optimal level of exports based on its share of the market, with no strategic effort to maintain export discipline among other members of OPEC.

The history of cartels and theory thus suggest that if the United States had low enough natural gas production costs and sufficient capacity to take a large share of world LNG trade, it would move the optimal export levels of other suppliers to points much closer to their unconstrained export levels at which their netback from exports equals their marginal cost of supplying LNG exports.

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[43] Joan Robinson, The Economics of Imperfect Competition, Cambridge, 1933.

[44] Edward Chamberlain, The Theory of Monopolistic Competition, Cambridge, MA 1933.

[45] Frederick I. Johnson On the Stability of Commodity Cartels The American Economist Vol. 27, No. 2 (Fall, 1983), pp. 34-36.

[46] David McNicol Commodity Agreements and Price Stabilization, Lexington (Mass.), 1978.

[47] Robert S. Pindyck, Cartel Pricing and the Structure of the World Bauxite Market, Bell Journal of Economics, Vol.8, 1977, pp. 343-360.

4. Balance of Payments and Capital Flows

The balance of payments keeps record of monetary transactions between a country and the rest of the world. The two main components of the transaction include imports and exports of goods and services on the current account and capital flows and transfers on the capital account. The current account is the sum of balance of trade, factor income and cash transfers. If the country is a net exporter of goods and services, selling more abroad than buying from abroad will contribute a surplus to the current account. More dividends from investing abroad than payments made to foreign investors also add credit to the current account. The capital account shows the net change in ownership of foreign assets. A capital account surplus means more money flowing into the country to claim ownership of the domestic assets than money flowing out for asset acquisition.

In general, the balance of payments is in balance. If a country runs a current account deficit, the capital account will be in a surplus position, meaning more foreign ownership of the domestic assets. Our analysis assumes that the net present value of foreign indebtedness holds at the baseline level, allowing for increases and decreases in the merchandise trade balance but requiring that all additional foreign borrowing be repaid by the end of the period. We set this limit on the present value of the current account deficit over the horizon to avoid infinite borrowing and to avoid either the costs or benefits of trade from being pushed out beyond the model horizon and therefore disappearing from our measures of economic impact. This rule of closure provides us consistent estimates of welfare.

C. Industrial Development Policy

There are frequent debates about whether raw material exports should be restricted in order to achieve a greater advantage for downstream industries. This has been an aspect of development plans in many developing countries[48] and has been given as an argument for limiting exports of natural gas from the United States.

Export restrictions will lower the relative price of natural gas, which will stimulate activities that use natural gas relatively intensively. To the extent that market prices reflect economic value, however, the expansion of these activities must on net be detrimental to the economy as resources are misallocated. In fact, to the extent that expansion of these activities fulfills some social objective, direct subsidies will be less costly (less distortionary) than any export restriction or other trade policy.

As illustrated above, moving from no trade to exports leads to an increase in the domestic price, which adversely affects consumers (consumer surplus) while incomes grow to more than offset this loss (producer surplus). The natural gas price increase hurts domestic consumers of gas by

[48] See World Trade Organization, World Trade Report 2010: Trade in natural resources.

various degrees, depending on how intensively natural gas is used by these industries and agents. For example, the electricity sector, which relies on natural gas to supply approximately 25% of the power supply, would have to adjust its technology mix and fuel mix to minimize the impact of natural gas prices on the cost of generation. The fertilizer industry, which has little possibility to substitute natural gas with other inputs, would have to reduce its production and raise its price to cover the fuel price increase. Even goods produced without natural gas will become more costly as the price increase will pass through all intermediate inputs produced with natural gas. On the consumption side, consumers lose in the sense that they face higher retail gas prices.

Natural gas producers, however, are incentivized to produce more with profit coming from each additional unit of output. Resource holders will also benefit from additional demand and higher prices for natural gas. The producer surplus grows by the amount consumers lose due to the price increase, which we call a surplus transfer from consumer to producer, plus additional profit earned, on output for export, which we call gains from trade. From the economy-wide perspective, the social surplus increases by the amount of gains from trade with a zero sum surplus transfer from consumer to producer.

This is only part of the story, however, because as gas-intensive activities contract (or grow slower) resources reallocate such that other activities could grow more rapidly as resources shift from production that is gas-intensive to production that is not.

The critical question for public policy is to ask if the trade-induced reallocation of resources is desirable, and if not, what policy instrument should be used to limit the reallocation. Economic theory is clear on these points. Starting from a competitive equilibrium, trade-induced resource reallocations are, on net, beneficial. Furthermore, trade distortions are inferior policy instruments in their ability to achieve a given resource allocation.

Consider a competitive market economy that, at given international prices, exports natural gas. Under free trade, and assuming no externalities, the world price of natural gas reflects its real cost. Export restrictions depress the price of natural gas below its real cost (in this case the opportunity cost associated with exporting). This generates a distortion. In effect, the trade restriction subsidizes natural gas use while simultaneously taxing the production of natural gas. Real income is maximized at an allocation where each activity faces prices that reflect the real resource cost of each commodity used. In the distorted equilibrium, the users of natural gas value it as an input at less than what producers can sell it on world markets. Producers would gain by selling (exporting) gas at the market price. Inherent in the trade restriction is the fact that someone is leaving money (gains from trade) on the table, whether it is the extraction industry or the domestic users of natural gas.

What if there are other distortions that make it desirable to stimulate demand for natural gas in the domestic economy? The policy goal is to encourage natural gas use. Then would it not be desirable to restrict exports? The answer from economic theory is no. Although the trade restrictions encourage natural gas use in the domestic economy, they cause an unnecessary production-side distortion that is completely avoidable. Export restrictions reduce incomes from natural gas extraction (and associated input activities). A direct subsidy on natural gas consumption can achieve the same level of domestic natural gas use (as an export restriction) with no production-side distortion. That is, as long as the price received by natural gas producers is the world price, they are not adversely affected by the policy.

To give an example of how trade restrictions have unintended distortionary effects, consider the following: If we have a negative externality associated with carbon emissions, and our electricity sector includes coal, natural gas, and renewable activities, what are the effects of a natural gas export restriction relative to an efficient carbon pricing scheme? Under a carbon pricing scheme, utilities will engage in fuel switching (natural gas activities are favored over coal), but they will also switch away from fossil generation and into renewables. The export restriction does encourage fuel switching away from coal, but utilities will also move away from renewables in reaction to the lower natural gas prices. Trade restrictions are a blunt policy instrument because they impact multiple markets in the economy indirectly. Direct policy instruments that target the specific market failure are more efficient.

While market failures and strategic efforts to promote specific activities are best addressed through direct domestic policies, there is one strategic role for trade restrictions. As outlined above, a large supplier country can restrict trade in order to tip international prices in its favor. As suggested in Figure 38, some export intensity between no trade and free trade will be optimal if the world market price is significantly depressed by the penetration of the U.S.'s natural gas exports.

Again, this is a dangerous move for a country as it signals to trade partners a willingness to shirk on cooperative trade agreements. The result could be retaliatory restrictions.

VII. ECONOMIC IMPACTS

A. Organization of the Findings

There are many factors that influence the amount of LNG exports from the United States into the global market. These factors include supply and demand conditions in the global market and the availability of gas in the United States. The GNGM analysis, discussed in the previous section, identified 14 distinct export volume cases under different world gas market dynamics, U.S. natural gas resource outlooks, and rates of U.S. LNG export expansions. These cases are implemented as 14 NewERA scenarios[49] and are grouped according to the outlook for U.S. natural gas resources:

- Reference U.S. natural gas resource outlook (USREF): We analyzed Low/Slowest and Low/Rapid export expansion volumes with International Demand Shock, referred to as USREF_D_LSS and USREF_D_LR. In addition, all three international cases are run with no export constraints, referred to as USREF_INTREF_NC, USREF_D_NC, and USREF_SD_NC.
- High U.S. Oil and Gas Resource outlook (HOGR): We analyzed Low/Slowest, Low/Rapid, and High/Rapid GNGM export expansion volumes for the International Reference scenario referred to as HOGR_INTREF_LSS, HOGR_INTREF_LR, and HOGR_INTREF_HR. Under the International Supply and Demand Shock, we analyzed the High/Slow case, or HOGR_SD_HS. In addition, all three international cases are run with no export constraints, referred to as HOGR_INTREF_NC, HOGR_D_NC, and HOGR_SD_NC.
- Low U.S. Oil and Gas Resource outlook (LOGR): We analyzed two cases assuming International Supply and Demand Shock: the Low/Slowest and no liquefaction constraints, which are referred to as LOGR_SD_LSS and LOGR_SD_NC.

All economic impacts presented in this section of the report were determined relative to a scenario in which there was no U.S. LNG exports (NX). For each of the three U.S. scenarios (USREF, LOGR, and HOGR), a corresponding No Export scenario (NX) was developed. For the USREF scenario, a baseline with no U.S. LNG export volume was derived from the *AEO 2013* Reference case (Bau_USREF) by setting a constraint that prohibited U.S. exports of LNG. The resulting No Export scenario had lower level of natural gas demand compared to the *AEO 2013* Reference case because of the elimination of LNG exports, which resulted in less natural gas production and lower natural gas prices.

Similarly, for the LOGR scenarios, a No Export scenario (NX) was derived from the *AEO 2013* Low Oil and Gas Resource (Bau_LOGR) scenario by prohibiting U.S. LNG exports. Here again, natural gas demand, production and prices were lower than those in the *AEO 2013* Low Oil and

[49] NERA also ran three cases in which the LNG export capacity was assumed to be unlimited.

Gas Resource case. The same methodology was used for the HOGR scenarios; a scenario with zero U.S. LNG export was derived from the *AEO 2013* High Oil and Gas Resource (Bau_HOGR) with the same result: zero LNG exports results in lower natural gas demand, production, and prices.

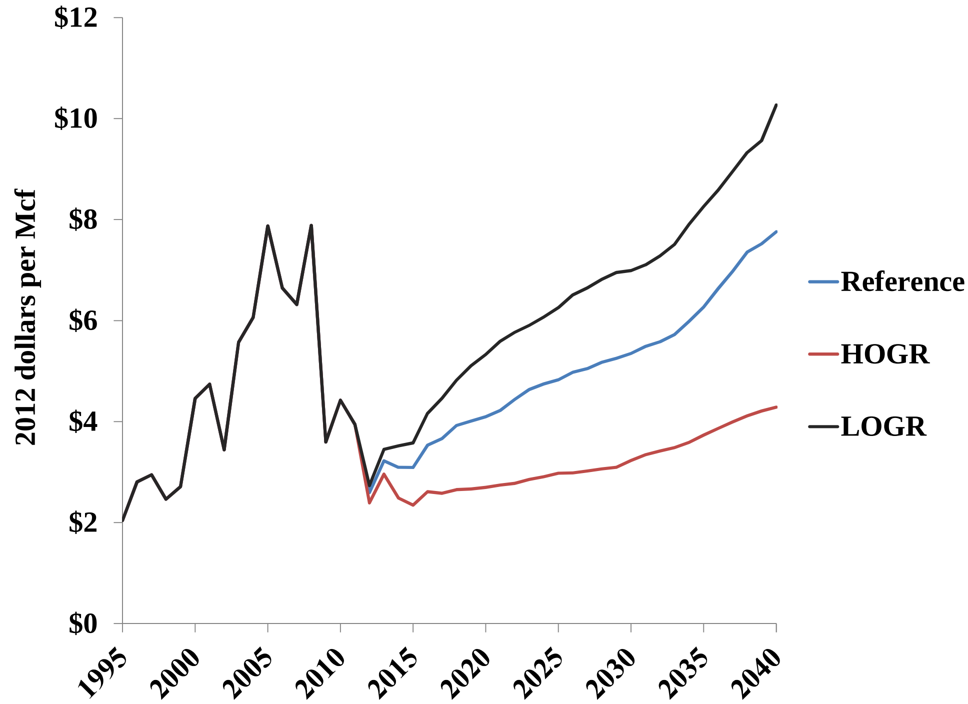
The next section discusses the impacts on the U.S. natural gas markets and the overall macroeconomic impacts for these 14 scenarios. The economic impacts for each scenario are measured relative to a baseline without any U.S. LNG exports. The economic impacts of the scenarios, as measured by different economic measures, are compared with each other. We used economic measures such as welfare, aggregate consumption, disposable income, GDP, and wage income to estimate the economic impacts of the scenarios. The scenario results provide a range of outcomes that reflect key sources of uncertainties in the international and the U.S. natural gas markets.

B. Natural Gas Market Impacts

1. Price, Production, and Demand

As shown in Figure 39, the wellhead natural gas price increases steadily after 2015 in all three of the AEO scenarios. Under the EIA *AEO 2013* Reference case, the wellhead price increases from about $3.00/Mcf in 2013 to $7.26/Mcf in 2040, while under the EIA's High Oil and Gas Resource and the EIA's Low Oil and Gas Resource cases, the wellhead price increases to about $4.28/Mcf and $10.27/Mcf, respectively. Comparing the projected natural gas price under the three baseline cases with historical natural gas prices, we see that the prices exceed recent historical highs only under the EIA's Low Oil and Gas Resource case beyond 2038 (see Figure 39). The natural gas price path and its response in the scenarios with LNG exports will depend on the availability and accessibility of natural gas resources. Additionally, the price changes will be influenced by the expansion rate of LNG exports. The lower level of supply under the EIA's Low Oil and Gas Resource case results in a higher projected natural gas price path while the EIA's High Oil and Gas Resource case, with abundant natural gas resources, results in a lower projected natural gas price path.

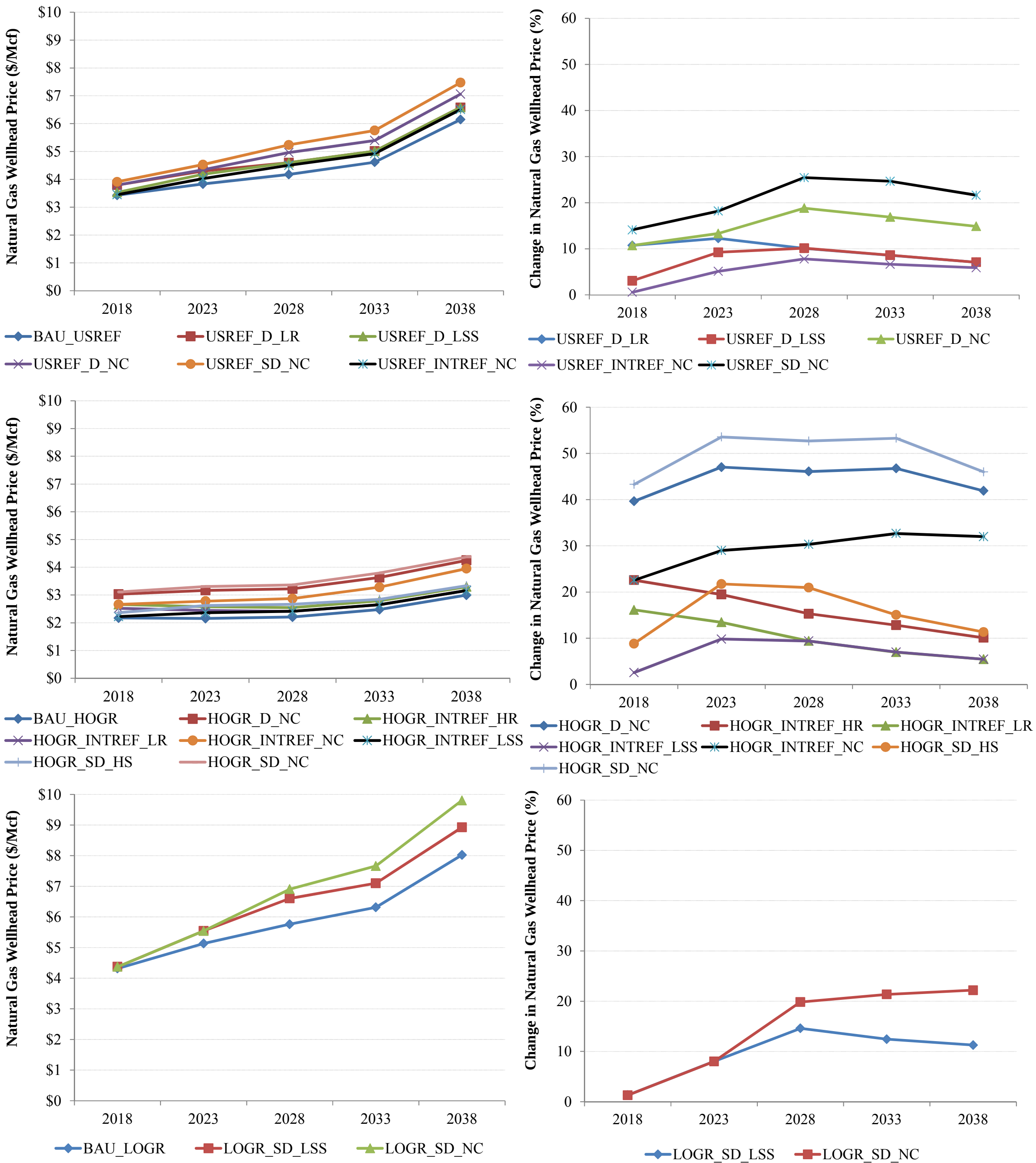
Figure 39: Historical and Projected Wellhead Natural Gas Price Paths from *AEO 2013*



Source: EIA AEO 2013

The extent of the natural gas price response to an expansion of LNG exports depends upon the supply and demand conditions and the corresponding baseline price. For a given baseline, the higher the level of LNG exports, the greater the change in natural gas price. Similarly, the natural gas price rises much faster under a scenario that has a quicker rate of expansion of LNG exports. From Figure 40, we can see that under the No Export Constraint scenario, USREF_D_NC, the price rises by about 11% in 2018 while under the slowest expansion scenario, USREF_D_LSS, the price rises by about 3% in 2018. The demand for LNG exports in the no constraints scenario (1.7 Tcf) is much greater than in the slowest scenario (0.73 Tcf); hence, the pressure on the natural gas price in the unconstrained scenario is higher. The difference in LNG export volumes between these two cases dips in 2023 and then increases over time leading to larger price differences; the difference in the percentage increase in the wellhead price peaks in 2028. In 2038, the wellhead price rises dramatically in the no constraint scenario; therefore, though the absolute price continues to increase with more exports, the percentage increase in price is tempered by the higher baseline price (7% for the slowest scenario and 15% for the unconstrained scenario).

Figure 40: Wellhead Natural Gas Price and Percentage Change for NERA Core Scenarios



For the same baseline, the wellhead natural gas price varies by export level scenarios. This relationship can best be seen by comparing the following three scenarios from the HOGR baseline: HOGR_INTREF_LSS, HOGR_INTREF_LR, and HOGR_INTREF_HR. The High/Rapid export scenario (HOGR_INTREF_HR) leads to the largest price increases of about 23% in 2018 ($0.49/Mcf) and 10% in 2038 ($0.30/Mcf) relative to the HOGR baseline. The increase in the wellhead price is the smallest for the NERA Low/Slowest export scenarios (HOGR_INTREF_LSS). The Low/Slowest export scenario has a 2018 increase of about 2.6% ($0.06/Mcf) and a 2038 price increase of about 65.5% ($0.16/Mcf).[50]

A higher natural gas price in the scenarios has four primary impacts on the overall economy. First, it tends to increase the cost of producing goods and services that are dependent on natural gas, which leads to decreased economic output. Second, the higher price of natural gas leads to an increase in export revenues, which improves the U.S.'s balance of payment position. Third, it provides wealth transfers in the form of take-or-pay tolling charges that support the income of consumers. Fourth, higher prices also lead to more wealth creation for landowners/royalty interests, more related tax revenue, and more natural gas industry employment. The overall macroeconomic impacts depend on the magnitudes of these three effects as discussed in the next section.

Figure 41: Change in Natural Gas Price Relative to the Corresponding Baseline of Zero LNG Exports (2012$/Mcf)

Scenario	2018	2023	2028	2033	2038
USREF_D_LR	$0.37	$0.47	$0.42	$0.40	$0.43
USREF_D_LSS	$0.10	$0.35	$0.42	$0.40	$0.43
USREF_D_NC	$0.37	$0.51	$0.79	$0.78	$0.91
USREF_INTREF_NC	$0.02	$0.20	$0.33	$0.31	$0.36
USREF_SD_NC	$0.48	$0.70	$1.06	$1.14	$1.33
HOGR_D_NC	$0.86	$1.01	$1.02	$1.16	$1.25
HOGR_INTREF_HR	$0.49	$0.42	$0.34	$0.32	$0.30
HOGR_INTREF_LR	$0.35	$0.29	$0.21	$0.17	$0.16
HOGR_INTREF_LSS	$0.06	$0.21	$0.21	$0.17	$0.16
HOGR_INTREF_NC	$0.49	$0.62	$0.67	$0.81	$0.96
HOGR_SD_HS	$0.19	$0.47	$0.46	$0.37	$0.34
HOGR_SD_NC	$0.94	$1.15	$1.16	$1.32	$1.38
LOGR_SD_LSS	$0.06	$0.41	$0.84	$0.79	$0.90
LOGR_SD_NC	$0.06	$0.41	$1.14	$1.35	$1.78

Natural gas production increases under all three baseline cases to partially support the rise in export volumes in all of the scenarios. In the Reference case, the high export scenarios (USREF_D_NC and USREF_SD_NC) have production steadily increasing by about 14% to 19%, respectively, in 2038 above baseline levels. The scenarios with the lowest level of exports because of either low international demand for LNG (USREF_INTREF_NC) or low export quotas (USREF_D_LSS) experience the slowest growth in production. USREF_INTREF_NC and USREF_D_LSS see production increases of between 5% and 6% in 2038 from baseline

[50] Since the results are shown for three baselines with three different prices, comparing percentage changes across these baseline cases can be misleading since they do not correspond to the same level value changes. In general, when comparing scenarios between Reference and HOGR cases, the level change would be smaller under the HOGR case for the same percentage increase in price.

levels (see the first two panels in Figure 42). The rise in production under the HOGR for the unlimited export cases is much larger than the corresponding Reference case scenarios. Under the International Supply and Demand shock, production increases by 44% relative to its baseline in the HOGR case, compared to the 19% increase in the Reference case against its baseline. Just as the Reference case sees about half of the increase in production compared to the high case, the LOGR_SD_NC case experiences about half the percent increase in production relative to its baseline (10%) compared to the similar comparison of the USREF_SD_NC case (19%).

The response in natural gas production depends upon the nature of the supply curve. Production is much more constrained in the short run as a result of drilling needs and other limitations. Over the long run, gas producers are able to overcome these constraints. Hence there is more production response over the long run than the short run.[51] Figure 42 shows that in 2018 for the USREF cases, the increase in production accounts for about 18% to 60% of the export volume, while in 2038, due to gas producers overcoming production constraints, the share of the increase in production in export volumes increases to about 85%.

[51] In the short run, the natural gas supply curve is much more inelastic than in the long run.

Figure 42: Natural Gas Production and Percentage Change for NERA Core Scenarios

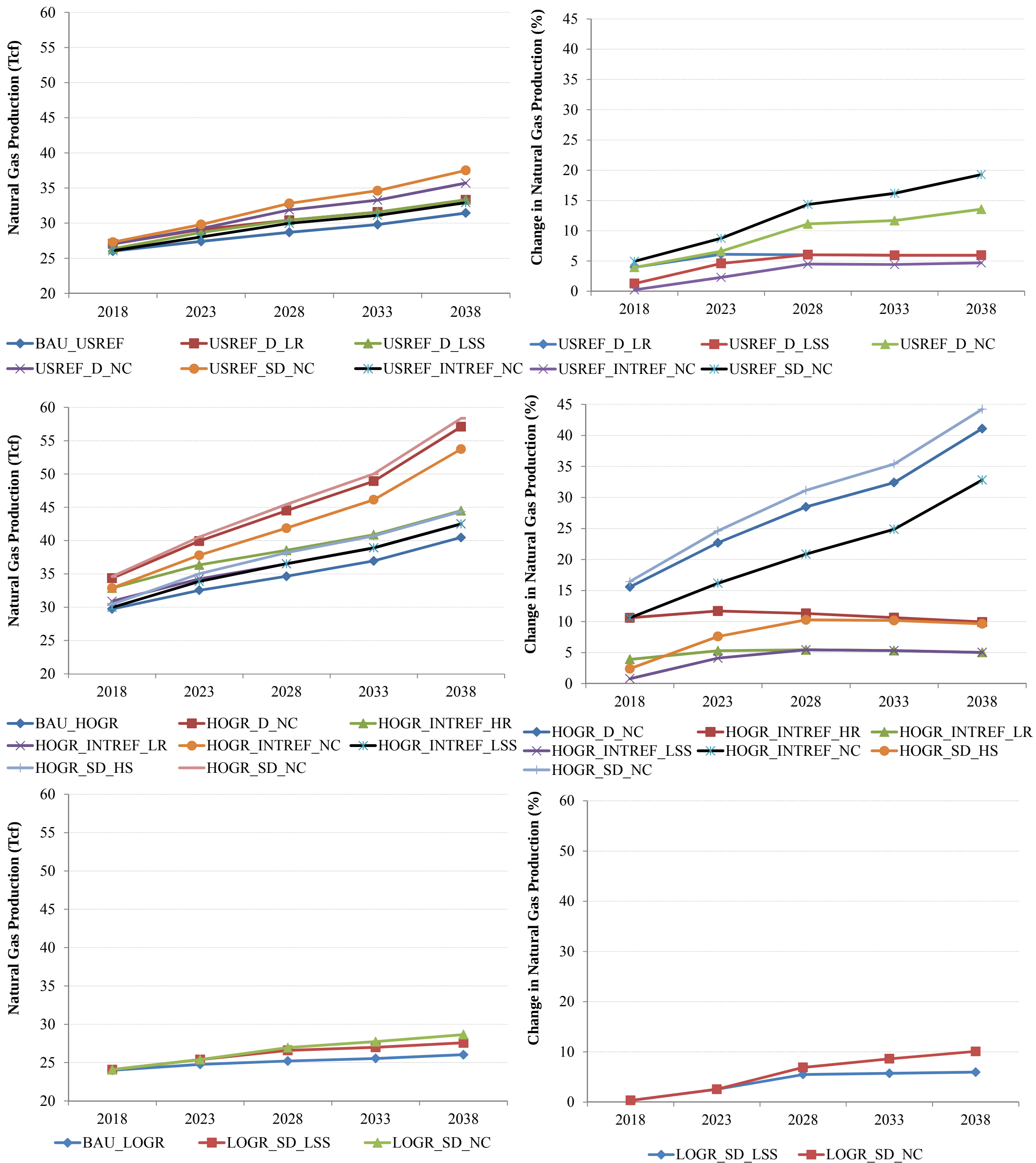


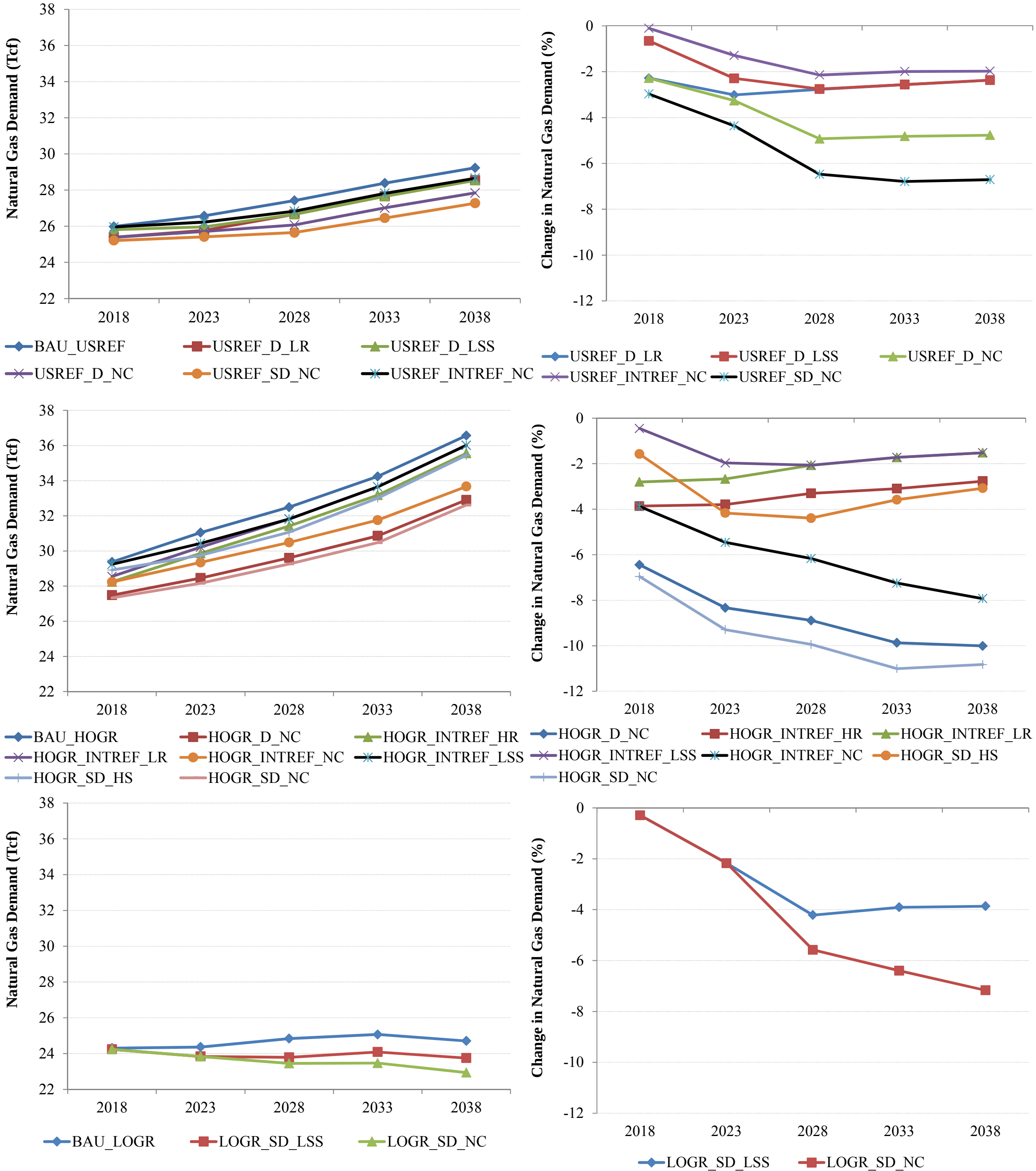
Figure 43: Change in Natural Gas Production Relative to the Corresponding Baseline (Tcf)

Scenario	Increase in Production (Tcf)					Ratio of Increase in Production to Export Volumes				
	2018	**2023**	**2028**	**2033**	**2038**	**2018**	**2023**	**2028**	**2033**	**2038**
USREF_D_LR	0.87	1.22	1.41	1.44	1.47	50%	56%	64%	66%	67%
USREF_D_LSS	0.36	0.91	1.41	1.44	1.47	50%	56%	64%	66%	67%
USREF_D_NC	0.87	1.32	2.52	2.76	3.24	50%	56%	62%	64%	65%
USREF_INTREF_NC	0.18	0.46	1.08	1.10	1.18	50%	55%	66%	67%	69%
USREF_SD_NC	1.07	1.77	3.26	3.85	4.63	50%	56%	62%	64%	65%
HOGR_D_NC	3.53	5.64	7.76	9.67	13.04	56%	64%	68%	71%	72%
HOGR_INTREF_HR	2.38	2.74	2.98	3.05	3.07	56%	63%	68%	70%	70%
HOGR_INTREF_LR	1.21	1.36	1.52	1.54	1.54	55%	62%	69%	70%	70%
HOGR_INTREF_LSS	0.40	1.02	1.52	1.54	1.54	55%	62%	69%	70%	70%
HOGR_INTREF_NC	2.38	3.88	5.57	7.28	10.29	56%	63%	68%	70%	71%
HOGR_SD_HS	0.81	2.05	2.98	3.05	3.10	55%	62%	68%	70%	71%
HOGR_SD_NC	3.74	6.18	8.56	10.65	14.09	56%	64%	68%	71%	72%
LOGR_SD_LSS	0.19	0.52	1.31	1.34	1.37	47%	51%	60%	61%	63%
LOGR_SD_NC	0.19	0.52	1.65	2.04	2.36	47%	51%	59%	59%	60%

The increase in natural gas price has three main impacts on the production of goods and services that primarily depend upon natural gas as a fuel. First, the production processes would switch to fuels that are relatively cheaper. Second, the increase in fuel costs would result in a reduction in overall output. Lastly, the price increase would induce new technology that could more efficiently use natural gas. All of these impacts would reduce the demand for natural gas. The extent of this demand response depends on the ease of substituting away from natural gas in the production of goods and services. Pipeline imports into and exports out of the United States are assumed to remain unchanged between scenarios within a given baseline case. Pipeline imports for the Reference, HOGR, and LOGR cases are calibrated to the EIA's *AEO 2013* projections. Figure 44 shows the natural gas demand changes for all cases and scenarios. For almost all cases, the largest drop in natural gas demand occurs in the 2028 to 2033 time period when the natural gas price increases the most.

In the Reference and HOGR cases, the high scenarios are projected to have the largest demand response because overall prices are the highest. The largest drop in natural gas demand in 2028 for the Reference, HOGR, and LOGR scenarios is about 6.5%, 10.0%, and 5.6%, respectively. Over the long run (2038), natural gas demand drops by about 6.7%, 10.8%, and 7.2%, respectively, for the Reference, HOGR, and LOGR cases in which there is an International Supply and Demand shock along with no constraints on exports. In general, the largest drop in natural gas demand corresponds to the year and scenario in which the price increase is the largest. For the unconstrained scenario under the International Supply and Demand shock with the HOGR case, the largest drop occurs in 2033. Given that the implied price elasticity of demand is similar across all cases, the long-run demand impacts across cases tend to converge for the corresponding scenarios. Figure 44 shows the demand for all scenarios.

Figure 44: Natural Gas Demand and Percentage Change for NERA Core Scenarios



C. Macroeconomic Impacts

1. Welfare

Any significant change in international trade, such as expansion of LNG exports, will have effects throughout the economy. The immediate consequence of LNG exports is that the U.S. sellers of natural gas and liquefaction services receive payment in dollars from foreign purchasers. Everything else being equal, including the amount of borrowing by the United States from foreign sources, this causes the value of the dollar to increase. The increase in the value of the dollar and the increase in U.S. natural gas prices that accompanies the expansion of LNG exports will raise the cost of other exports to foreign customers, leading to a shift in the composition of exports. In addition, the dollar price of goods imported into and consumed in the United States will fall, leading to an increase in imports that balances the net increase in exports. These changes will in turn affect wage rates, returns on investment in different industries, and the prices of goods and services purchased by consumers.

The broadest measure of net economic benefits to U.S. residents is the measure of economic welfare known as the "equivalent variation." The equivalent variation is defined as the amount of money that would have to be given to U.S. households to make them indifferent between receiving the money and experiencing the changes in prices and income associated with LNG exports.[52] The more money it takes to provide an equal benefit to that conferred by greater LNG exports, the larger the benefits of LNG exports must be.

We report the change in welfare relative to the baseline in Figure 45 for all the scenarios. A positive change in welfare means that the policy improves welfare from the perspective of the consumer. All export scenarios are welfare-improving for U.S. consumers. The welfare improvement is the largest under the high export scenarios even though the changes in U.S. natural gas prices are also the largest. Under these export scenarios, U.S. households[53] receive additional income from several sources. To the extent that LNG exports displace exports from other industries, they do so because there are larger profits from producing and exporting LNG than from producing and exporting the goods that are displaced (we discuss this in Chapter VIII for the case of the chemicals industry), which on balance increases investment income for households. Higher natural gas prices raise income from resource ownership, which goes to households, and increase government royalty and tax revenues, which reduces other taxes needed to be collected from households to finance government spending. These additional sources of

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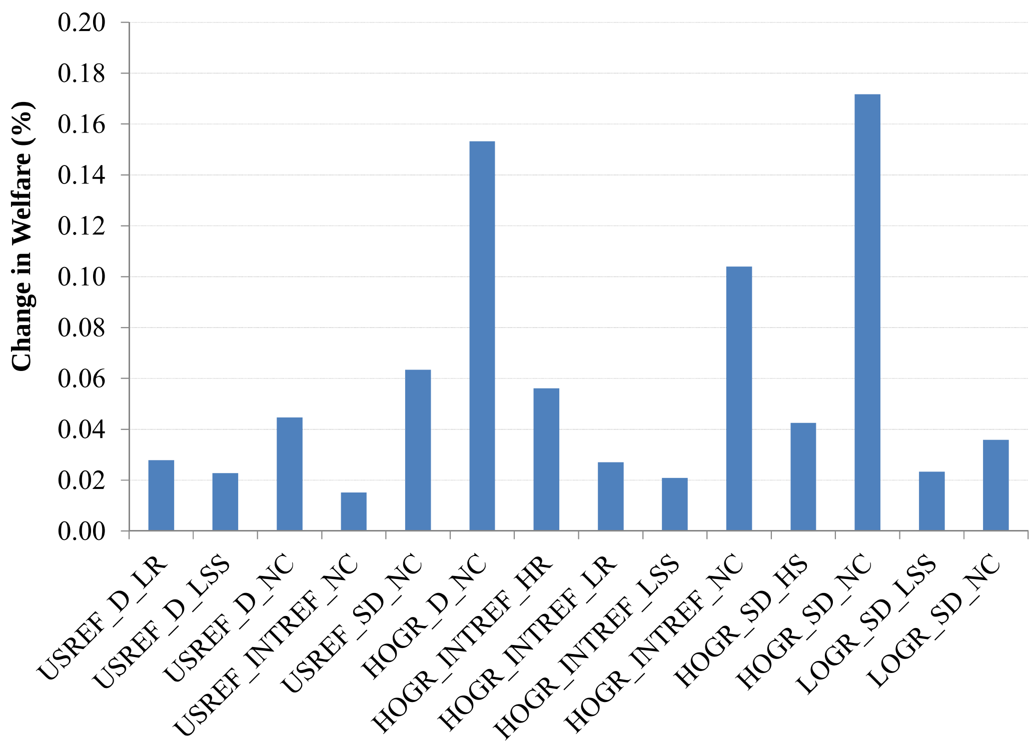
[52] *Intermediate Microeconomics: A Modern Approach*, Hal Varian, 7th Edition (December 2005), W.W. Norton & Company, pp. 255-256. "Another way to measure the impact of a price change in monetary terms is to ask how much money would have to be taken away from the consumer *before* the price change to leave him as well off as he would be *after* the price change. This is called the **equivalent variation** in income since it is the income change that is equivalent to the price change in terms of the change in utility." (emphasis in original).

[53] Households own all production processes, industries and resources by virtue of direct private ownership or by owning stock in them.

after-tax income for U.S. households outweigh the loss associated with higher energy prices. Consequently, consumers, in aggregate, are better off as a result of opening up LNG exports.

Comparing welfare results across the scenarios, the positive change in welfare in the No Constraint export scenarios for the HOGR case is more than double that of the corresponding No Constraint scenarios for the Reference case (see Figure 45). A similar relationship exists between Reference and equivalent LOGR scenarios (*i.e.*, the SD_NC scenarios), representing a 0.063% increase in welfare in the Reference case without export constraints compared to a 0.036% increase in the Low scenario. For the same corresponding international case and export scenarios, the HOGR case experiences the most positive change in welfare, followed by the Reference case and lastly the LOGR case. Likewise, for each U.S. resource case (USREF, HOGR, and LOGR), greater levels of resource development lead to greater increases in welfare. Again, the amount of wealth transfer under high export volume scenarios drives the higher welfare impacts. In fact, U.S. consumers are better off in all of the export volume scenarios that were analyzed.

Figure 45: Percentage Change in Welfare for NERA Core Scenarios[54]



[54] Welfare is calculated as a single number that represents in present value terms the amount that households are made better (worse) off over the entire time horizon from 2018 to 2038.

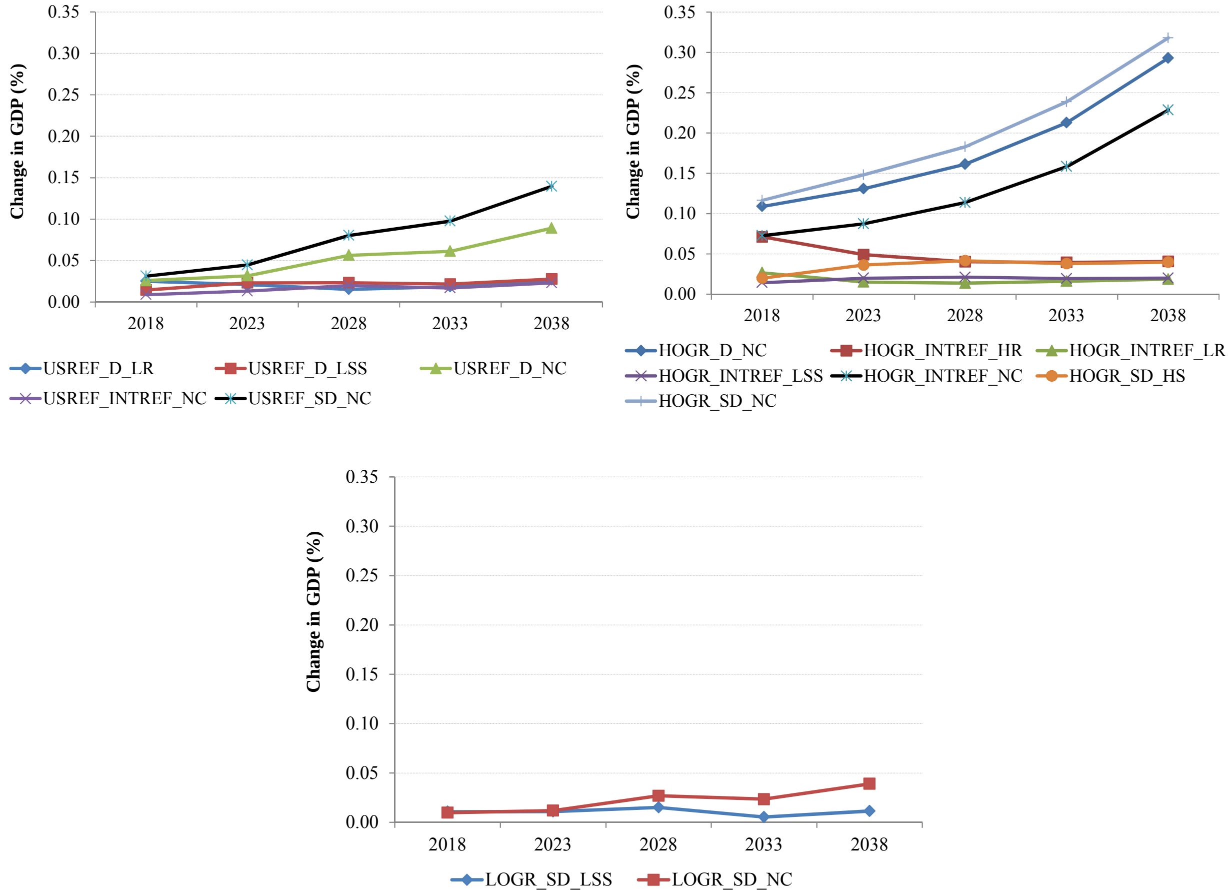
2. GDP

GDP is another economic metric that is often used to evaluate the effectiveness of a policy by measuring the level of total economic activity in the economy. In the short run, the GDP impacts are positive as the economy benefits from investment in the liquefaction process, export revenues, resource income, and additional wealth transfer in the form of tolling charges. In the long run, GDP impacts are smaller but remain positive because of higher resource income.

A higher natural gas price does lead to higher energy costs and impacts industries that use natural gas extensively. However, the effects of higher price do not offset the positive impacts from wealth transfers and result in higher GDP over the model horizon in all scenarios. In the high scenarios and especially in periods with high natural gas prices, the export revenue stream increases while increasing the natural gas resource income as well. These effects combined with wealth transfer lead to the largest positive impacts on GDP. In general, the impact on GDP over time follows the pattern of LNG exports over time. Therefore, as exports increase, GDP generally increases. If export volumes stabilize, then changes in GDP stabilize. In a subsequent section, we discuss changes in different sources of household income.

Under the Reference case, the change in GDP in 2018 is between 0.01% for the Low/Slowest scenario to 0.03% in the NC scenario. By 2038, the change in GDP converges in the two scenarios to a 0.03% increase. The change in GDP across all Reference case scenarios ranges from an increase of 0.03% to 0.14% above baseline levels. The increase in GDP in the HOGR cases is as large as 0.32% by 2038 because resource income and LNG exports are the greatest. Overall, GDP impacts are positive for all scenarios with generally higher impacts in the long run. For some scenarios, there is a spike in GDP in 2018 followed by a slight decline or leveling off.

Figure 46: Percentage Change in GDP for NERA Core Scenarios

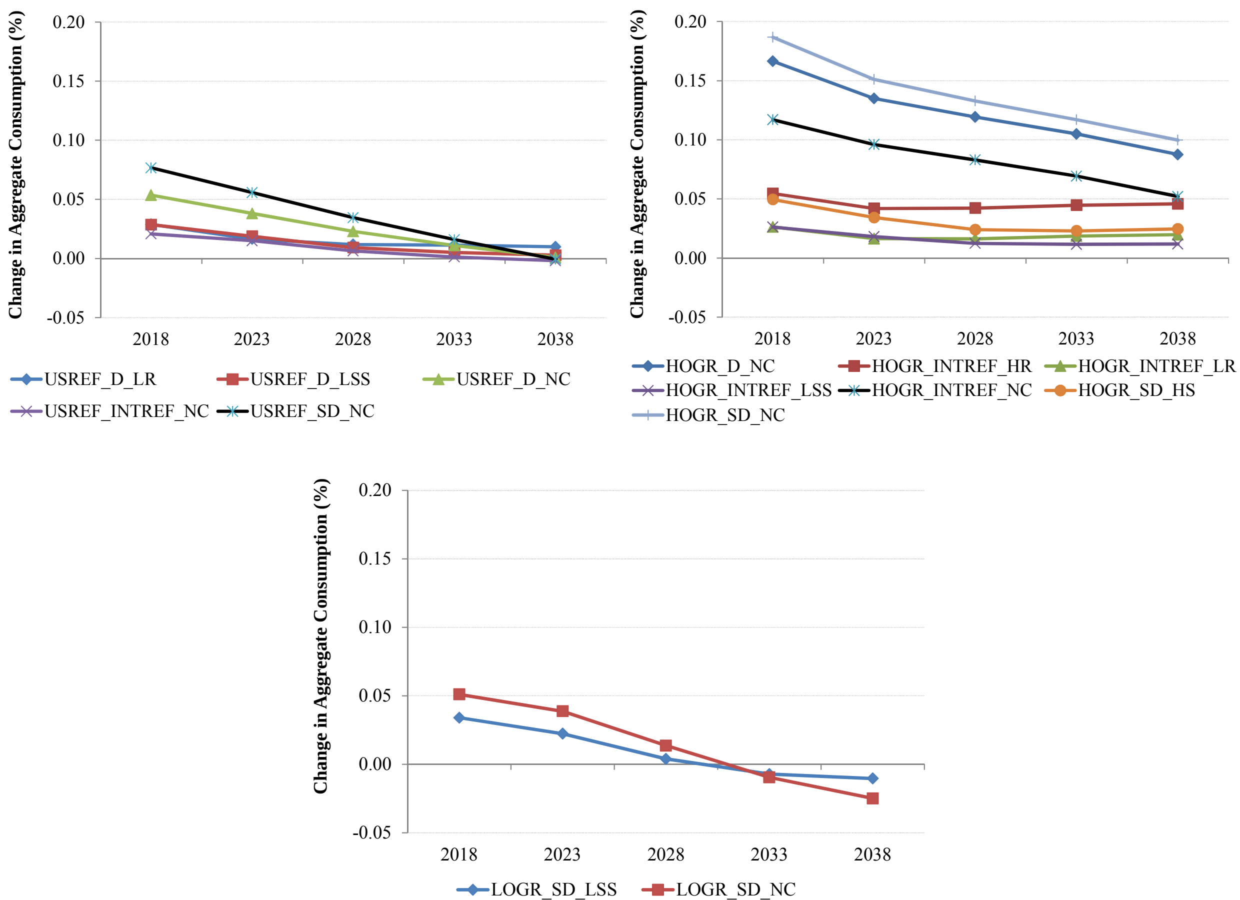


3. Aggregate Consumption

Aggregate consumption measures the total spending on goods and services in the economy. In 2018, consumption increases from the No Export case between 0.05% for the LOGR scenarios to 0.19% for the HOGR scenarios (Figure 47). Under the HOGR High/Rapid scenario, the increase in consumption in 2018 is about twice as great as that in the HOGR Low/Slowest scenario because higher export volumes result in much larger export revenue impacts.

Higher aggregate spending or consumption resulting from a policy suggests higher economic activity and more purchasing power for consumers. The scenario results of the Reference case, seen in Figure 47, show that the change in consumption is positive for almost all years for almost all of the scenarios. After 2028, the LOGR scenarios see the change in consumption turn negative while all other scenarios experience positive changes or effectively no net change in consumption throughout the model time horizon. These results suggest that the wealth transfer from exports of LNG provides net positive income for consumers to spend after taking into account potential decreases in capital and wage income from reduced output.

Figure 47: Percentage Change in Aggregate Consumption for NERA Core Scenarios



4. Aggregate Investment

Investment in the economy occurs to replace old capital and augment new capital formation. In this study, additional investment also takes place to expand natural gas production and to build liquefaction capacity at either existing LNG import terminals or for new greenfield projects. Direct investment to support the expansion of LNG export capacity peaks between 2013 and 2018, and then continues at a steady pace until maximum exports are reached.[55] Overall macroeconomic investment also grows, as capacity is added in industries that supply the machinery and equipment used in natural gas production, used for construction and installed in the export facilities themselves, and in industries that will supply industries producing machinery and equipment with raw materials and components. The investment outlay under each of the LNG export expansion scenarios is discussed in Appendix C. Aggregate macroeconomic investment peaks in 2018.

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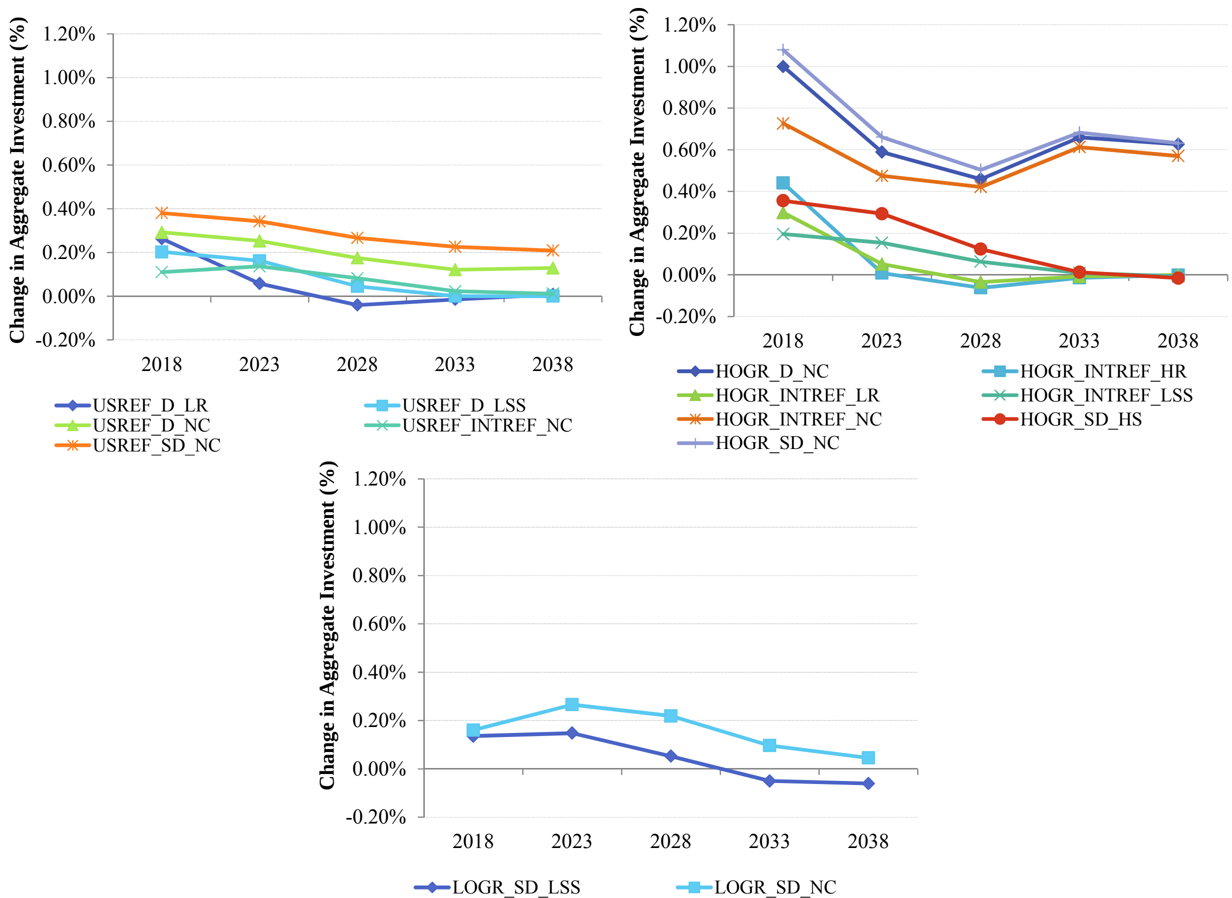
[55] Each model year represents a span of five years, thus the investment in 2018 represents an average annual investment between 2018 and 2022.

The increase in investment in the natural gas sector is partially offset by a decline in investment in other sectors. Increases in LNG exports lead to an increase in domestic gas prices and hence production costs. The increase in production costs results causes consumers to demand fewer U.S. produced goods, thus lowering investment in other sectors.

But as Figure 48 shows, the change in aggregate investment is positive in most or all years for all scenarios. For the HOGR scenarios with no export restrictions, there is even an uptick in investment in the later years as LNG exports greatly expand.

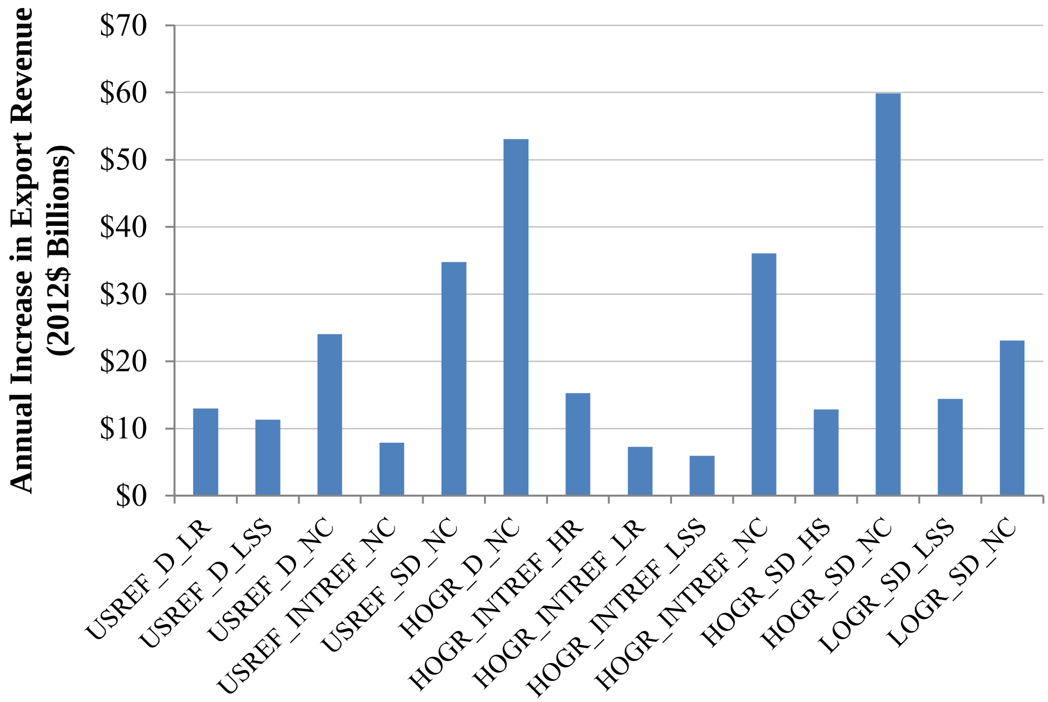
Figure 48: Percentage Change in Aggregate Investment for NERA Core Scenarios



5. Natural Gas Export Revenues

As a result of higher levels of natural gas exports and increased natural gas prices, LNG export revenues offer an additional source of income. Depending on the baseline case and scenario used, the average annual increase in revenues from LNG exports ranges from about $6 billion (2012$) to almost $60 billion (2012$) as seen in Figure 49. Unsurprisingly, the high end of this range is from the unconstrained scenario, while the low end is the Low/Slowest scenario. The average revenue increase in the HOGR unconstrained export scenario relative to its No Export baseline is roughly triple the increase in the low scenario compared to its No Export baseline under the same international case. The difference in revenue increases between comparable low and high export scenarios is about 100%. The export revenues from the low scenarios exceed that of the constrained high scenario export cases because the price of gas is two to three times as great.

Figure 49: Average Annual Increase in Natural Gas Export Revenues from 2018 to 2038



6. Range of Sectoral Output Changes for Some Key Economic Sectors

Natural gas production grows more rapidly in every other scenario than it does in the corresponding No Export scenario, and capital and labor inputs to natural gas production must grow at the same rate as production. This use of capital and labor inputs is the opportunity cost of natural gas production, and it implies that some other sectors will grow more slowly so that the overall demand for factor inputs does not exceed their supply.

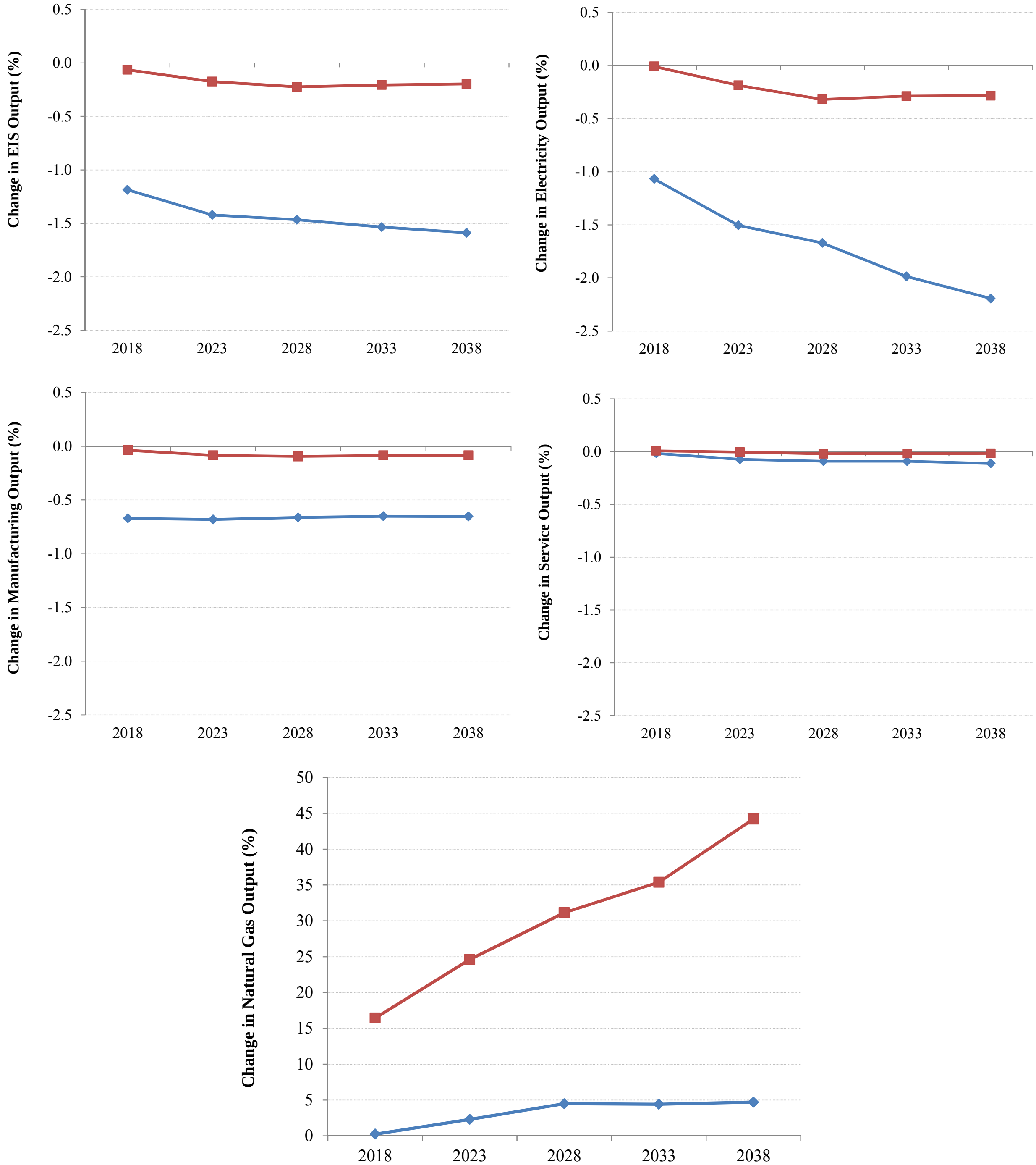
The slightly higher price of natural gas with LNG exports causes these changes in the rate of growth in output to be concentrated in economic sectors such as energy-intensive sectors (EIS), the manufacturing sector, and the services sector that depend on natural gas as a fuel. The relative effect on these particular sectors from higher gas prices depends on their gas intensity (*i.e.*, the value share of gas as an input to their production). Growth in electricity generation is slowed for three reasons: reduced consumption due to the effect of natural gas prices on electricity prices, slower growth of energy-intensive industries that consume electricity, and the relatively low electricity-intensity of natural gas production. The latter effect is important because the shift of factors of production to natural gas production and away from other sectors lowers aggregate electricity demand.

These varying impacts will shift income patterns among economic sectors. The overall effect on the economy depends on the degree to which the economy adjusts by fuel switching, introducing new technologies, or mitigating costs by compensating parties that are disproportionately impacted. It should also be noted that the increase in natural gas exports is accompanied by faster growth of imports of goods produced by sectors whose domestic output is growing less rapidly. Since the U.S. has a comparative advantage in natural gas production, the sum of domestically produced and imported goods consumed by households is larger with LNG exports than without. This is the fundamental reason for the increase in economic welfare as LNG exports increase.

Figure 50 illustrates the minimum and maximum range of changes in some economic sectors by comparing levels of output in different LNG export scenarios to level of output in their corresponding No Export scenario (*e.g.*, output for LOGR_DS_LSS is compared against the LOGR No Export scenario). The range of impacts on sectoral output varies considerably by sector. But in every scenario, the affected sectors continue to grow robustly, just at slightly lower rates of increase.

Figure 50: Minimum and Maximum Percentage Change in Output from Baseline for Some Key Economic Sectors

Red lines represent the smallest impacts or best case; blue lines represent largest impacts or worst case



Changes in output from the EIS sector relative to the No Exports scenarios are the largest among manufacturing sectors. Levels of EIS output with LNG exports could be from 0.20% to 1.6% below levels in the zero exports baseline. The manufacturing sector, being less gas-intensive, sees a narrower range of impacts ranging from a loss in output of 0.085% to 0.65%. Since the services sector is the least gas-intensive, the impact of LNG exports on this sector's output is minimal. Less electricity will be needed when resources are shifted from electricity intensive sectors to electricity-intensive natural gas consumption, leading to a savings of from 0.28% to 2.2% in electricity generation on a cumulative basis. On the opposite side is the natural gas sector, which sees an increase in output ranging from 4.7% to 44% by 2038.

7. Wage Income and Other Components of Household Income

Sectoral output, discussed in the previous section, translates directly into changes in input levels for a given sector. In general, if the output of a sector increases, so do the inputs associated with the production of this sector's goods and services. An increase in natural gas output leads to more wage income in the natural gas sector as domestic production increases. In the short run, industries are able to adjust to changes in demand for output by increasing employment if the sector expands or by reducing employment if the sector contracts. This section discusses the changes in total wage, capital, resource, and tax incomes for the scenarios of interest.

The overall macroeconomic impacts are driven by the changes in the sources of household income. Households derive income from capital, labor, and resources. These value-added income sources also form a large share of GDP and aggregate consumption. Hence, to tie all the above impacts together, we illustrate the magnitude of each of the income subcomponents and how they relate to the overall macroeconomic impacts in Figure 51.

Figure 51: Changes in Subcomponents of GDP in 2018 and 2038 (Billions of 2012$s)

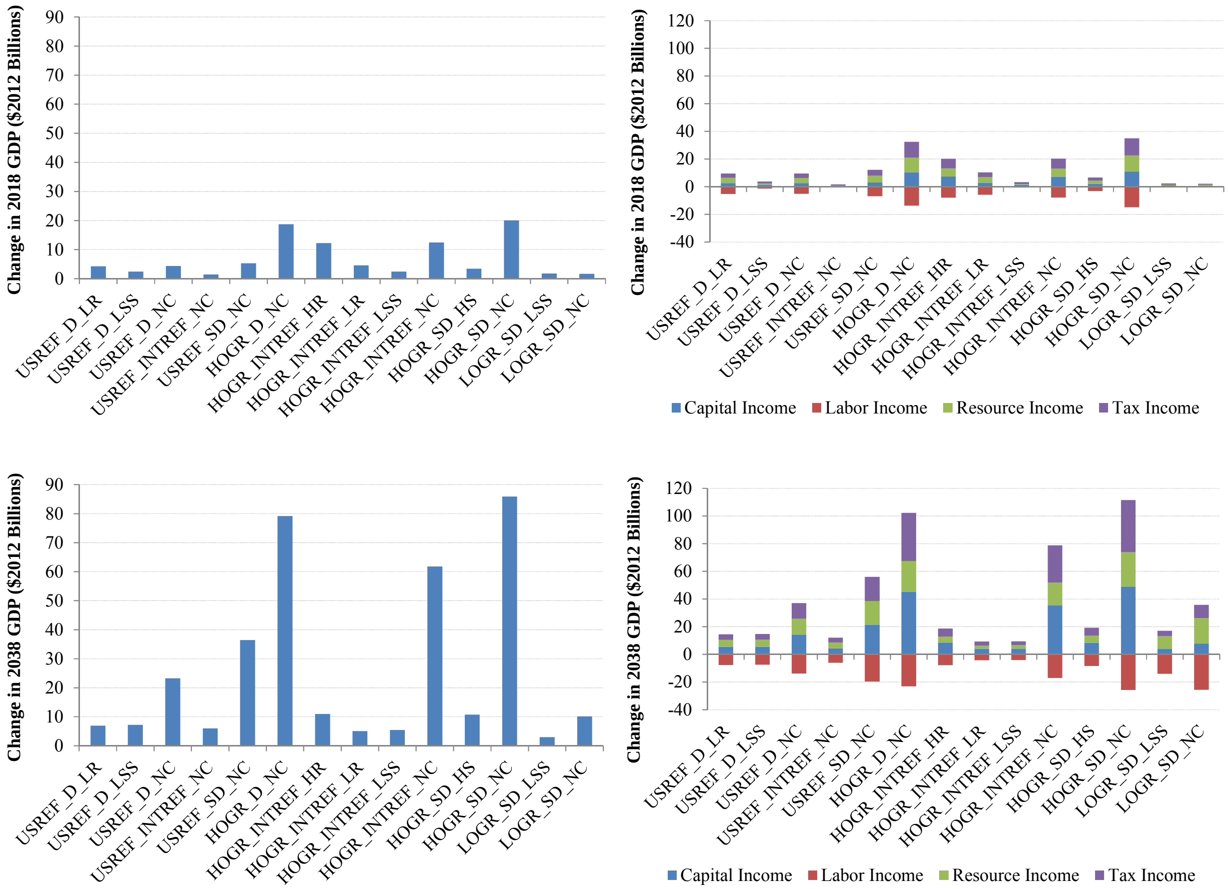


Figure 51 shows a snapshot of changes in GDP and household income components in 2018 and 2038. Net GDP impacts become more positive over time. Under the Reference case, GDP increases could range from $1.5 billion in 2018 to $36 billion in 2038. Under the HOGR case, GDP could increase from $2.5 billion to $20 billion in 2018 and to as much as $86 billion in 2038. Under the LOGR case, GDP increases range from $1.6 billion in 2018 to $10 billion by 2038. Capital income, resource income, and indirect tax revenues (including net transfers associated with LNG export revenues) increase in all scenarios, while labor income decreases in all scenarios.[56] As previously discussed, wage income declines are caused by high fuel prices leading to reductions in output and hence lower demand for input factors of production. However, there is positive income from capital income, higher resource value, and net wealth transfer.

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[56] The resource used in each of the extractive sectors (coal, natural gas, and crude oil) represents the sector-specific capital and labor in addition to natural resource required for production in these sectors. We disaggregate these individual subcomponents and augmented the incomes into their respective income categories. In addition, we also assume that the resource sector pays corporate income tax of 39.2% (federal statutory rate) on the resource base. In the NERA 2012 study, resource income represented income from natural resource and fixed factors associated with the resource sector. These income adjustments, in this study, lead to positive capital and tax revenue income.

The increase in capital income comes about from two key sources. First, all tolling charges are represented as returns to capital for liquefaction plants. Second, gas extraction is more capital intensive than labor intensive so increases in gas production benefit capital returns more than labor returns. These additional sources of income are unique to the export expansion policy.

Resource income accounts for income associated with the development and production of the natural resources of crude oil, coal, and natural gas. When comparing changes in resource income between the No Export baseline and other scenarios, resource income associated with natural gas increases because of the increases in natural gas production brought about by allowing LNG exports. The resource income associated with coal and crude oil changes minimally; therefore, the total change in resource income is positive for all scenarios and the changes in resource income increase with the level of LNG exports.

This leads to the total increase in household income exceeding the total decrease. The net positive effect in real income translates into higher GDP and consumption.[57]

D. Impacts on Energy-Intensive Sectors

1. Output and Wage Income

The EIS sector includes the following five energy consuming subsectors identified in the IMPLAN[58] database:

1. Paper and pulp manufacturing (NAICS 322);
2. Chemical manufacturing (NAICS 326);
3. Glass manufacturing (NAICS 3272);
4. Cement manufacturing (NAICS 3273); and
5. Primary metal manufacturing (NAICS 331) that includes iron, steel, and aluminum.[59]

As the name of this sector indicates, these industries are very energy intensive and depend on natural gas as a key input.[60]

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[57] The net transfer income increases even more in the case where the U.S. captures quota rents, leading to a net benefit to the U.S. economy.

[58] The IMPLAN dataset provides inter-industry production and financial transactions for all U.S. states. (www.implan.com).

[59] The North American Industry Classification System (NAICS) is the standard used to classify business establishments.

[60] For this study, we have represented the EIS sector based on a 3-digit classification that aggregates upstream and downstream industries within each class. Thus, in aggregating at this level the final energy intensity would be less than one would expect if we were to aggregate only the downstream industries or at higher NAICS-digit levels.

The model results for the growth rate of EIS industrial output is shown in Figure 52 for all scenarios. Because of the heavy reliance on natural gas as an input, changes in natural gas prices affect the growth of output in this sector. The average annual growth rate over 2013 to 2038 ranges from 2.43% to 2.45% per annum for the USREF scenarios with LNG exports. The average annual growth rate for the USREF baseline with no exports (USREF_Bau) is 2.45% per annum. Therefore, the drop in the average annual growth rate is negligible, being at most two basis points (0.03%). The changes are slightly larger under the HOGR and LOGR scenarios at four basis points (0.04%) points (see Figure 52). Therefore, the level of LNG exports has a negligible effect on how quickly the EIS sector grows.

Restricting LNG exports leads to lower domestic gas prices, which leads to slightly higher growth in the EIS sector: for example, the USREF_D_LSS scenario results in an average annual growth rate of 2.45% compared to the USREF_D_NC scenario's growth rate of 2.44%. In scenarios with LNG exports, sectors that experience lower returns grow more slowly because sectors with higher returns can attract more labor and capital. Generally, a lower growth rate in EIS output is accompanied by a higher growth rate in the natural gas sector. The change in returns to labor and capital in different industries is brought about by the change in LNG export policy. This shift in resources leads to an increase in overall economic activity as measured by GDP and welfare.

Figure 52: Annual Growth Rate in EIS Output for NERA Core Scenarios – USREF, HOGR, and LOGR

	U.S. Reference Scenarios					
	USREF Bau	USREF D_LR	USREF D_NC	USREF D_LSS	USREF INTREF NC	USREF SD_NC
2013-2017	2.34%	2.37%	2.34%	2.39%	2.33%	2.34%
2018-2022	2.66%	2.64%	2.65%	2.66%	2.64%	2.66%
2023-2027	2.54%	2.53%	2.51%	2.52%	2.50%	2.54%
2028-2032	2.45%	2.45%	2.45%	2.44%	2.44%	2.45%
2033-2038	2.26%	2.26%	2.25%	2.25%	2.24%	2.26%
2013-2038	**2.45%**	**2.45%**	**2.44%**	**2.45%**	**2.43%**	**2.45%**

	High Oil & Gas Resource Scenarios							
	HOGR Bau	HOGR D_NC	HOGR INTREF HR	HOGR INTREF LR	HOGR INTREF NC	HOGR INTREF LSS	HOGR SD_HS	HOGR SD_NC
2013-2017	2.72%	2.60%	2.65%	2.67%	2.70%	2.65%	2.69%	2.59%
2018-2022	2.91%	2.87%	2.91%	2.91%	2.89%	2.88%	2.87%	2.86%
2023-2027	2.70%	2.69%	2.71%	2.71%	2.69%	2.69%	2.69%	2.69%
2028-2032	2.54%	2.53%	2.55%	2.55%	2.54%	2.52%	2.55%	2.53%
2033-2038	2.44%	2.43%	2.45%	2.45%	2.45%	2.42%	2.45%	2.43%
2013-2038	**2.66%**	**2.62%**	**2.65%**	**2.66%**	**2.65%**	**2.63%**	**2.65%**	**2.62%**

	Low Oil & Gas Resource Scenarios		
	LOGR_Bau	LOGR_SD_NC	LOGR_SD_LSS
2013-2017	2.23%	2.21%	2.22%
2018-2022	2.58%	2.53%	2.53%
2023-2027	2.49%	2.44%	2.41%
2028-2032	2.46%	2.46%	2.44%
2033-2038	2.28%	2.28%	2.26%
2013-2038	**2.41%**	**2.39%**	**2.37%**

E. Economic Implications of Restricting LNG exports

1. Lost Values from Quota Rents

When scarcity is created in natural gas, there is value associated with supplying an additional unit of gas. In economic terms, a quantity restriction to create this scarcity is called a quota. By enacting a quota, one creates a price difference between the world supply price (netback price) and the domestic price. This generates economic rent referred to as the "quota rent." Mathematically, a quota rent is the quota amount times the difference between the world net back price and the domestic price. A quota rent provides an additional source of revenue to the seller.

The quota levels for the 14 scenarios analyzed and discussed in this study correspond to the export volumes assumed in the original NERA analysis for DOE, plus No Constraint LNG export scenarios. We assume that the quota rents are held by foreign parties. That is, the rents do not recycle back into the U.S. economy. In this section, we look at how the welfare results would change if the quota rents were recycled back to the United States.

Figure 53 shows the quota price in 2012 dollars per Mcf for all 14 scenarios determined in the GNGM. The quota price is the marginal price of the quota, or the quota rents divided by the level of exports. The quota price is zero for scenarios that have a non-binding quota constraint (*i.e.*, the entire NC or no liquefaction capacity constraint cases). All of the scenarios, those with quotas, have binding quota constraints leading to a positive quota price. The quota price is highest in the scenarios in which the domestic natural gas price is the lowest (*i.e.*, the low scenarios for the HOGR outlook). The largest quota price results in the HOGR case with the High/Slow export expansion scenario (HOGR_SD_HS). For this scenario, the quota price is around $3.36/Mcf by 2038.

Figure 53: Quota Price (2012$/Mcf)

Scenario	Quota Price (2012$/Mcf)				
	2018	2023	2018	2033	2018
HOGR_INTREF_NC	$0.00	$0.00	$0.00	$0.00	$0.00
HOGR_D_NC	$0.00	$0.00	$0.00	$0.00	$0.00
HOGR_SD_NC	$0.00	$0.00	$0.00	$0.00	$0.00
HOGR_INTREF_HR	$0.00	$0.49	$0.87	$1.16	$2.13
HOGR_INTREF_LSS	$1.01	$1.16	$1.38	$1.60	$2.66
HOGR_INTREF_LR	$0.61	$1.03	$1.38	$1.60	$2.66
HOGR_SD_HS	$1.46	$1.62	$1.88	$2.24	$3.36
USREF_INTREF_NC	$0.00	$0.00	$0.00	$0.00	$0.00
USREF_D_NC	$0.00	$0.00	$0.00	$0.00	$0.00
USREF_SD_NC	$0.00	$0.00	$0.00	$0.00	$0.00
LOGR_SD_NC	$0.00	$0.00	$0.00	$0.00	$0.00
LOGR_SD_LSS	$0.00	$0.00	$0.52	$0.81	$1.00
USREF_D_LSS	$0.41	$0.26	$0.70	$0.82	$1.33
USREF_D_LR	$0.00	$0.07	$0.70	$0.82	$1.33

Figure 54: Quota Rents (Billions of 2012$)

Scenario	Quota Rents (Billions of 2012$)*				
	2018	2023	2028	2033	2038
HOGR_INTREF_NC	$0.00	$0.00	$0.00	$0.00	$0.00
HOGR_D_NC	$0.00	$0.00	$0.00	$0.00	$0.00
HOGR_SD_NC	$0.00	$0.00	$0.01	$0.00	$0.00
HOGR_INTREF_HR	$0.00	$2.04	$3.67	$4.88	$8.97
HOGR_INTREF_LSS	$0.57	$1.71	$2.76	$3.22	$5.38
HOGR_INTREF_LR	$1.24	$2.08	$2.76	$3.22	$5.38
HOGR_SD_HS	$1.88	$5.06	$7.86	$9.45	$14.16
USREF_INTREF_NC	$0.00	$0.00	$0.00	$0.00	$0.00
USREF_D_NC	$0.00	$0.00	$0.00	$0.00	$0.00
USREF_SD_NC	$0.00	$0.00	$0.00	$0.00	$0.00
LOGR_SD_NC	$0.00	$0.00	$0.00	$0.00	$0.00
LOGR_SD_LSS	$0.00	$0.00	$0.90	$1.64	$2.01
USREF_D_LSS	$0.23	$0.38	$1.41	$1.65	$2.68
USREF_D_LR	$0.00	$0.13	$1.41	$1.65	$2.68

** The quota rents are based on net export volumes.*

The quota rents on the other hand, depend on the price and quantity. Even though the price is higher under the HOGR_INTREF_LR and HOGR_INTREF_LSS cases than the HOGR_INTREF_HR case, as seen in Figure 53, quota rents are larger under HOGR_INTREF_HR because of the greater spread between what it costs to produce natural gas in the U.S. in an optimistic supply scenario and the amount foreign buyers are willing to pay. Under the High/Rapid scenario, HOGR_INTREF_HR, the average annual quota rents range from $2.0 billion to $9.0 billion compared to the Low/Rapid and Slowest cases which range from

$0.57 billion to $5.4 billion. The HOGR_SD_HS case experiences the highest quota prices and quota rents. Over the model horizon, 2018 through 2038, maximum total quota rents amount to about $192 billion (Figure 55). This is an important source of additional income that would have potential benefits to the U.S. economy. However, in the event that U.S. companies are unable to capture these rents, this source of additional income would not accrue to the U.S. economy.

Figure 55: Total Lost Values (Billions of 2012$)

Scenario	Total Lost Value from 2018-2038 (Billions of 2012$)	Average Annual Lost Value (Billions of 2012$)
HOGR_INTREF_NC	$0	$0.00
HOGR_D_NC	$0	$0.00
HOGR_SD_NC	$0	$0.02
HOGR_INTREF_HR	$98	$3.90
HOGR_INTREF_LSS	$68	$2.70
HOGR_INTREF_LR	$73	$2.90
HOGR_SD_HS	$192	$7.70
USREF_INTREF_NC	$0	$0.00
USREF_D_NC	$0	$0.00
USREF_SD_NC	$0	$0.00
LOGR_SD_NC	$0	$0.00
LOGR_SD_LSS	$23	$0.90
USREF_D_LSS	$32	$1.30
USREF_D_LR	$29	$1.20

Under a pure tolling or utility model, U.S. investors only receive a normal return on investment in natural gas production and liquefaction, and the remaining difference between the price of natural gas FOB a U.S. terminal and the netback price to that point (the quota rent) is all taken by the foreign buyer. The quota rents, if captured by U.S. consumers, provide additional income to households in the form of a wealth transfer from foreign sources that would increase investment income. As quota rents increase, so does the change in net transfers leading to higher real income. This increase in economic activity leads to higher aggregate consumption and GDP. The impacts are highest when allowing for maximum quota rent transfer. As a result, capturing higher quota rents would lead to more imports, more consumption, higher GDP, and ultimately greater well-being of U.S. consumers. The ability to extract quota rents unequivocally benefits U.S. consumers.

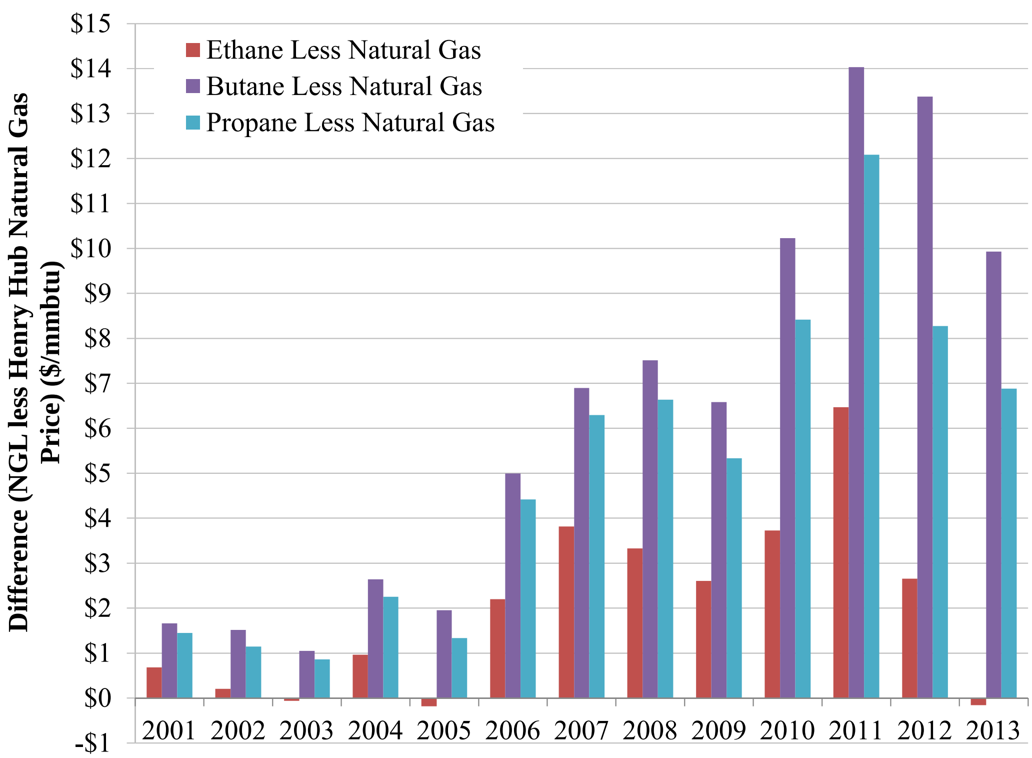
VIII. CHEMICALS

A. Overview

Since release of the study of LNG exports done by NERA for DOE/FE, questions have been raised about whether increases in natural gas prices resulting from LNG exports would affect the competitiveness of the U.S. chemical industry.

To place these questions in perspective, we started by examining basic data on the U.S. chemical industry and its overseas competitors. The U.S. chemical industry and other manufacturing industries not only benefit from lower natural gas prices, but also from lower prices for NGLs such as ethane, propane and butane that are separated from natural gas during processing.[61] The price of U.S. ethane in particular has declined relative to natural gas since 2011, and in 2013 traded below parity with average U.S. natural gas prices (Figure 56).

Figure 56: Difference between Prices of NGLs and Natural Gas ($/MMBtu)



Source: Thomson Reuters (via Datastream); NGLs' prices traded at Mont Belvieu, Texas.

[61] U.S. pipelines have standards for the Btu content of natural gas delivered into their systems. Natural gas that meets these standards is referred to as "dry gas" or "pipeline quality gas." NGLs generally have higher energy content than allowed by pipelines, and must be extracted from methane before introduction in the pipeline network.

NGLs serve many applications, from heating and cooking fuel (propane) to petrochemical feedstock (ethane, propane, butane, isobutane) and refinery blending agents (butane, pentane). Ethane use is limited to one critical function: ethane serves as the primary input to ethylene, which is one of the major basic chemicals produced in the United States.

Ethylene is commonly produced around the world from either ethane or naphtha, a light refined petroleum product. The cost of ethylene derived from naphtha is closely tied to the price of crude oil,[62] while the cost of ethylene derived from ethane is more closely tied to the price of natural gas. Therefore, global competitiveness in producing ethylene depends on the price and supply of the feedstock (ethane or naphtha) used in one region relative to another.

Figure 57 compares the cost of production for ethylene in various regions of the world in the latest year 2012 versus 2005. Figure 57 shows that from 2005 to 2012, the cost to produce ethylene in the United States declined by more than half, from about $0.55/lb in 2005 to about $0.25/lb in 2012. The reason for this shift is that growing production of natural gas from unconventional reservoirs in the United States has created a concurrent increase in the supplies of ethane removed during natural gas processing. Reduced prices for both natural gas and ethane have incentivized the use of ethane to produce ethylene by the U.S. chemicals sector. Producers in Europe and Asia, however, widely depend on cracking naphtha to produce ethylene, and production costs in such regions of the world increased as crude oil prices rose. As U.S. ethane and natural gas prices declined relative to global crude oil prices (Figure 58), the United States transitioned from among the world's highest-cost ethylene producers in 2005, to near parity with the Middle East as the world's lowest-cost producer of ethylene in 2012.[63]

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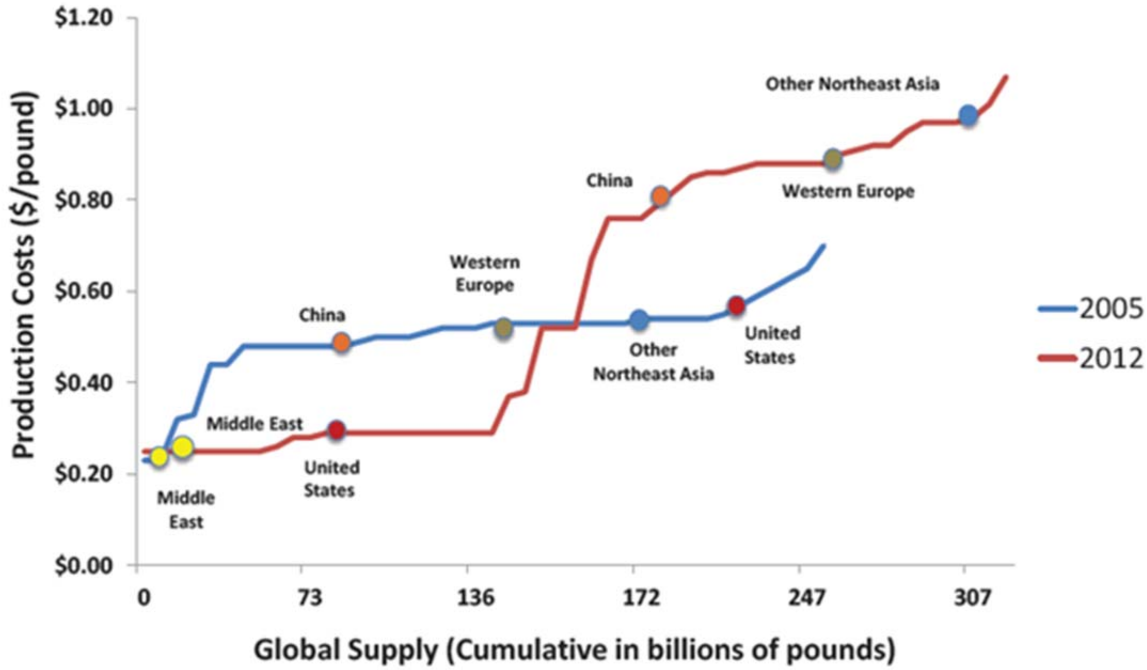
[62] The highest value alternative use of naphtha is primarily to make high octane gasoline, and as such its value is related to that of crude oil.

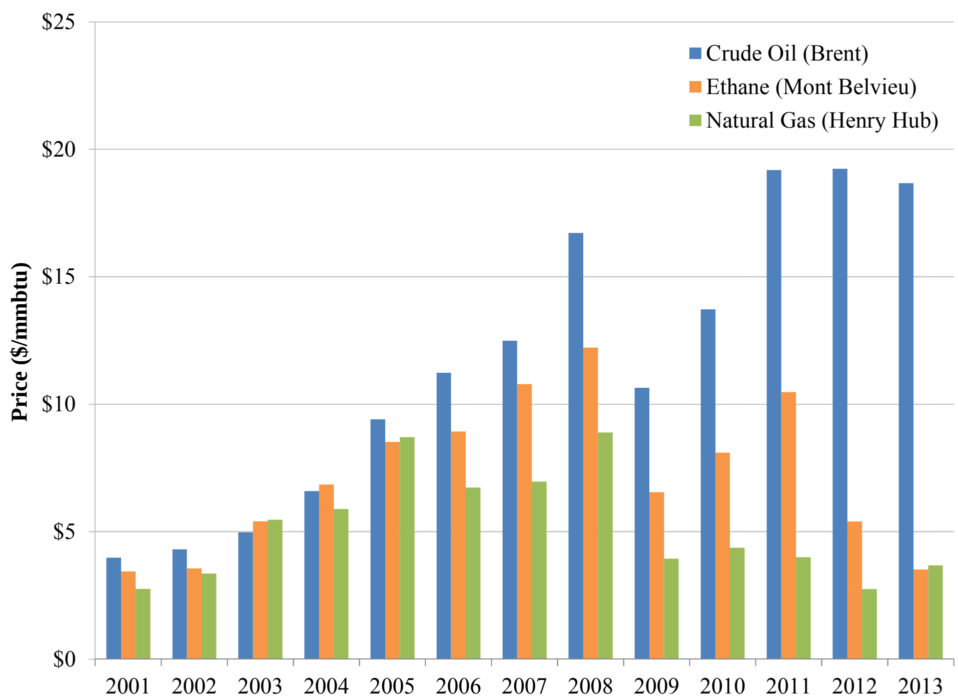
[63] In 2005, all regions besides the Middle East, where natural gas prices were much lower than the rest of the world, had similar production costs because crude oil and gas prices were similar.

Figure 57: Global Supply Curve for Ethylene



Source: American Chemistry Council[64]

Figure 58: Price of Mont Belvieu Ethane, Brent Crude Oil, and Henry Hub Natural Gas



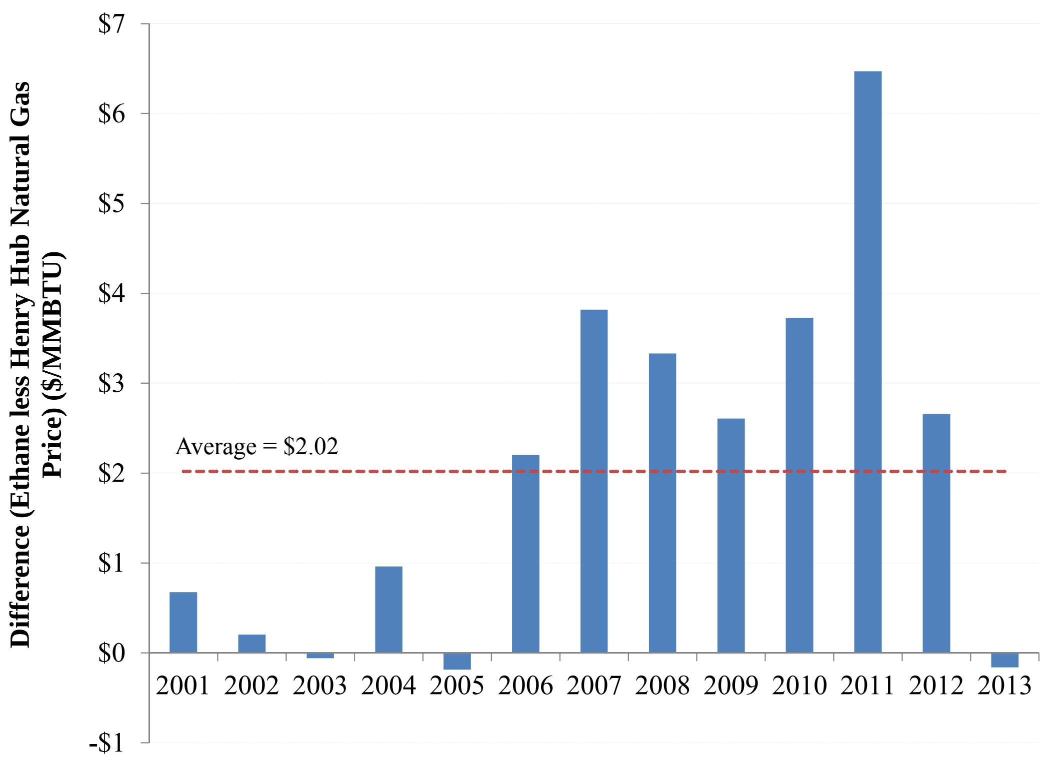
Sources: Thomson Reuters (via Datastream); Bloomberg

[64] "Change in the Global Cost Curve for Ethylene and Renewed US Competitiveness," Economics & Statistics, American Chemistry Council, May 2013, Figure 11.

U.S. facilities that consume ethane have gained an even greater advantage over foreign facilities that use naphtha than the decline in U.S. natural gas prices would suggest. The U.S. ethane spot price declined relative to the price of natural gas by about $7/MMBtu between 2011 and 2013, dropping from almost triple the natural gas price in 2011 to approximate parity in 2013 (see Figure 56 and Figure 59). This price drop has occurred because natural gas from many unconventional resource deposits is particularly rich in NGLs.[65]

Ethane averages about 45% of the NGL barrel in liquid-rich U.S. reservoirs, and could be as high as 65%.[66] Growth in supplies of ethane processed from rich natural gas has exceeded the capacity of the chemicals sector to consume it, leading to a decline in U.S. ethane prices relative to natural gas.

Figure 59: Difference in Price of Ethane less Natural Gas Price ($/MMBtu)



Source: DTN Energy via Bloomberg

[65] The NGL content of natural gas produced in liquids-rich basins varies between 2.5 gal/Mcf and 3.5 gal/Mcf in the Barnett Shale to between 6 gal/Mcf and 12 gal/Mcf in the Bakken formation. NGL content per Mcf of gas in the Eagle Ford, Niobrara, and Marcellus/Utica ranges from 4 to 9 gal/Mcf. See "Natural Gas Briefing Document #1: Natural Gas Liquids," Brookings Energy Security Initiative, Natural Gas Task Force, C. K. Ebinger and G. Avasarala, March 2013.

[66] E. Russell Braziel, "Infrastructure Projects Connect Marcellus Shale To Ethane," NGL Market, March 2011. http://www.aogr.com/index.php/magazine/cover-story/infrastructure-projects-connect-marcellus-shale-to-ethane-ngl-markets.

A detailed study of NGLs and their implications for the chemical sector is beyond the scope of this study. We limit this analysis to estimating the effects of LNG exports on the supply of ethane and dry natural gas, and the cost implications for three chemicals subsectors, discussed below. In particular, we analyzed whether overall macroeconomic impacts would change when we disaggregated chemical sectors, the impacts of LNG exports on ethane prices and the sector that produces ethylene, and the effects of natural gas prices on both the gas-intensive chemicals subsector and non-gas-intensive chemicals subsector. We also use the global supply curve for ethylene to determine the magnitude of the competitive advantage conferred by lower natural gas and ethane prices, and how that competitive advantage could be affected by LNG exports.

B. Representation of the Chemicals Subsectors and Feedstock Prices

In order to improve our understanding of the impacts on the chemical sector from increased gas production that arises with LNG exports, we disaggregated the bulk chemicals sector from the EIS sector described in the previous sections. The bulk chemicals sectors consist of 22 chemicals subsectors grouped under the 3-digit NAICS 325 classification. These subsectors of the chemical industry rely on natural gas in different ways. To simplify the analysis, we first disaggregate bulk chemicals into gas-intensive and non-gas-intensive subsectors, with petrochemicals being a gas-intensive subsector (Figure 60).[67]

When we model these subsectors in the N_{ew}ERA model, we distinguish the ethylene and polyethylene petrochemicals of the gas-intensive chemicals (use natural gas co-products (*i.e.*, ethane as a feedstock) and group this portion of petrochemicals into a separate subsector called ECHM (Ethylene Chemicals). We group the remaining sectors into the gas-intensive chemicals subsector GCHM (Gas-Intensive Chemicals). The non-gas-intensive or remaining chemicals are called RCHM (Remaining Chemicals).

Polyethylene is the next stage in the processing of ethylene, and it is the product most extensively traded. Neither ethane nor ethylene is readily transported internationally, so that global competition takes place predominantly at the polyethylene stage, which is readily transported as a dry bulk cargo.[68] Ethane input represents about 40% of the shipment value for ECHM.[69] The ethane input and shipment value of this sector is estimated to be about $6.7

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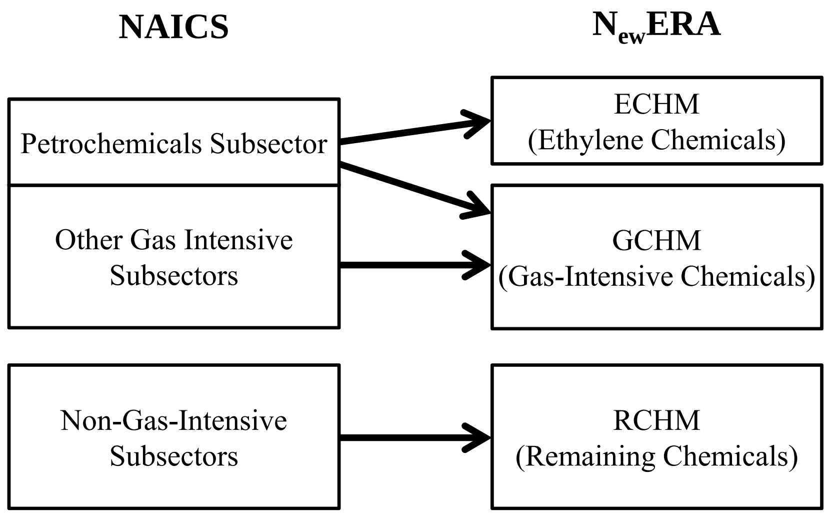
[67] A detail list of the 22 chemicals subsectors grouped under the 3-digit NAICS 325 classification is presented in Appendix B, section C and shown in Figure 97.

[68] "Ethane is difficult to transport, so it is unlikely that the majority of excess ethane supply would be exported out of the United States. As a result, it is also reasonable to assume that the additional ethane supply will be consumed domestically by the petrochemical sector to produce ethylene." Economics & Statistics, American Chemistry Council, March 2011, "Shale Gas and New Petrochemicals Investment: Benefits for the Economy, Jobs, and US Manufacturing."

[69] Economic cost model of natural gas to ethane-ethylene based on "Shale gas, Reshaping the US chemical industry," PwC, October 2012, which suggests ethane feedstock costs ($192 per ton) to total ethylene cost excluding by-product credits ($468 per ton) to be about 41%.

billion and $17 billion, respectively. The value of shipments from this sector is about 10% of shipments by the petrochemical sector[70] as a whole and about 1% of the total bulk chemicals.

Figure 60: Chemical Industry Subsectors as Modeled in N_{ew}ERA



NGL supply is created either by extracting ethane, propane and butane from the natural gas stream as gas plant liquids (GPL) or as a by-product in the petroleum refining process. This study focuses strictly on ethane produced as GPL during the processing of natural gas, which can be influenced by future LNG exports. This is represented by the blue line in Figure 61. Hence, we project ethane production to increase from 1.4 to 1.9 quadrillion Btu from 2013 to 2023, and then decline to about 1.7 quadrillion Btu by 2038. Historically, on average ethane has sold for a price approximately $2.00/MMBtu higher than dry gas (Figure 59).[71] The reason for this differential is that there is a cost to extracting ethane and other NGLs from the wet wellhead gas stream. When the supply of NGLs is limited or demand for ethane by the petrochemical sector is high, the price of ethane must cover this cost, or it will be left in the gas stream up to limits set by pipeline quality standards[72] and sold at its heating value.

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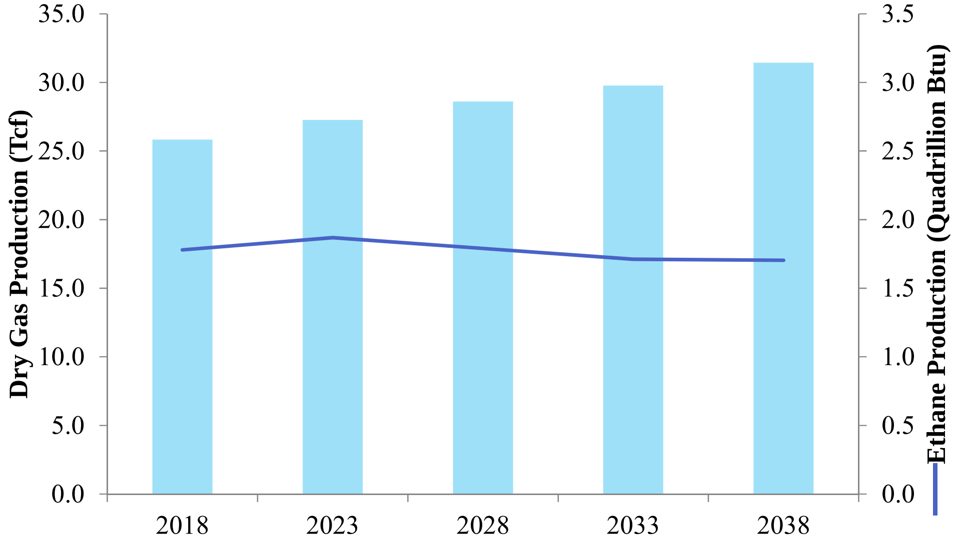
[70] Splitting the petrochemical sector between ECHM and GCHM means that 10% of its value is included in ECHM, and the remaining 90% in GCHM. In other words, GCHM includes nine other gas-intensive sectors as well as 90% of the value of the petrochemicals sector.

[71] The difference between the average annual spot price for ethane and natural gas from January 2001 through October 2013, as reported by Bloomberg.

[72] Pipeline quality standards regarding content shares of different hydrocarbons are set to ensure fungibility of gas supplies. There are quality standards for non-hydrocarbon components of natural gas as well. These standards serve to protect the pipeline and end-user equipment from damage and ensure consistent flow of gas through the pipeline.

Figure 61: No Export Reference Case Dry Gas and Ethane Production (Tcf)



How NGL markets in general, and the ethane market in particular, will develop is uncertain. Presently, an oversupply of ethane has driven its price near or below parity with the price of natural gas. For this analysis, we assumed that the price of ethane would adjust to ensure that the ethane extracted from the natural gas stream could be sold to ethane crackers or for other basic chemicals processes. In the No Export Reference case, we assume that ethane is sold at a premium over natural gas. This premium (Margin) rises slowly over time from about $0.50/Mcf in 2018 to near its historical value of $2.00/Mcf by 2038. The expected high concentration of NGLs in many natural gas reservoirs keeps this differential below its historical average throughout the forecast period.

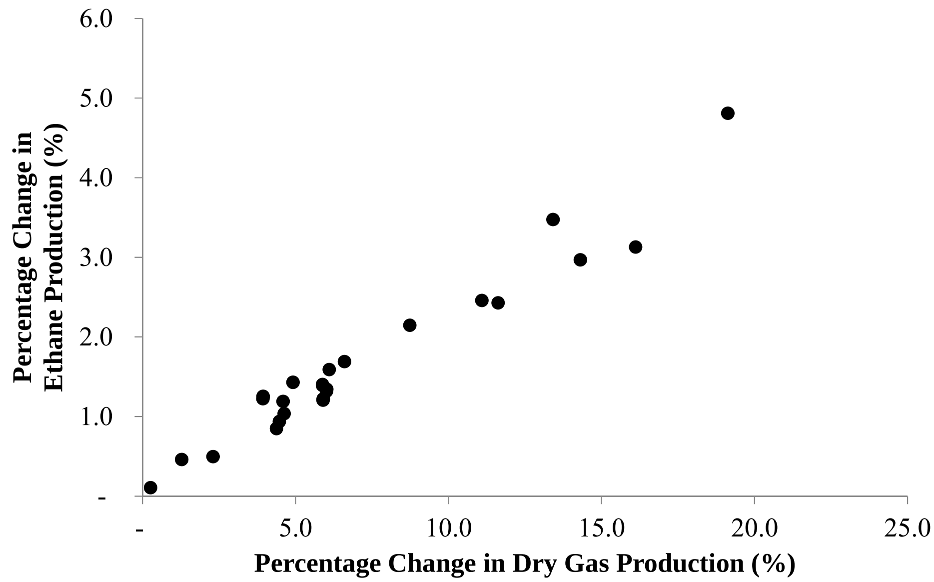
C. Increase in LNG Exports Results in Lower Feedstock Prices

Increased LNG exports result in higher production of dry natural gas and ethane. For the Reference cases, Figure 62 shows a positive correlation between an increase in dry gas and ethane production. The limited opportunities for direct export of ethane and a lack of attractive alternative uses for ethane other than in ethylene crackers cause the differential between ethane and dry gas prices to narrow,[73] as seen in Figure 63. As more LNG is exported, domestic wellhead production increases (see Chapter IV) and the difference between the supply of ethane and what can be blended into dry pipeline-quality natural gas grows. This leads to progressively lower ethane prices as LNG exports expand in the U.S. Reference supply cases, and to increasing output of chemical products based on ethane. In the unlimited export case with maximum global demand (the REF_SD_NC case), the demand and supply responses assumed lead to ethane

[73] Natural gas prices increase and ethane prices decrease, which causes the differential to narrow because the price of ethane exceeds that of natural gas.

prices below those for dry gas due to oversupply of ethane. This is not likely to be sustainable, as ethane prices this low would provide a substantial incentive to build additional petrochemical facilities in the U.S. to use ethane as a feedstock in ethylene production, as well as incentivize efforts to overcome barriers to export ethane. Both of these actions would serve to increase ethane demand, thereby raising ethane prices and likely increasing petrochemical industry output compared to our projections for the REF_SD_NC case.

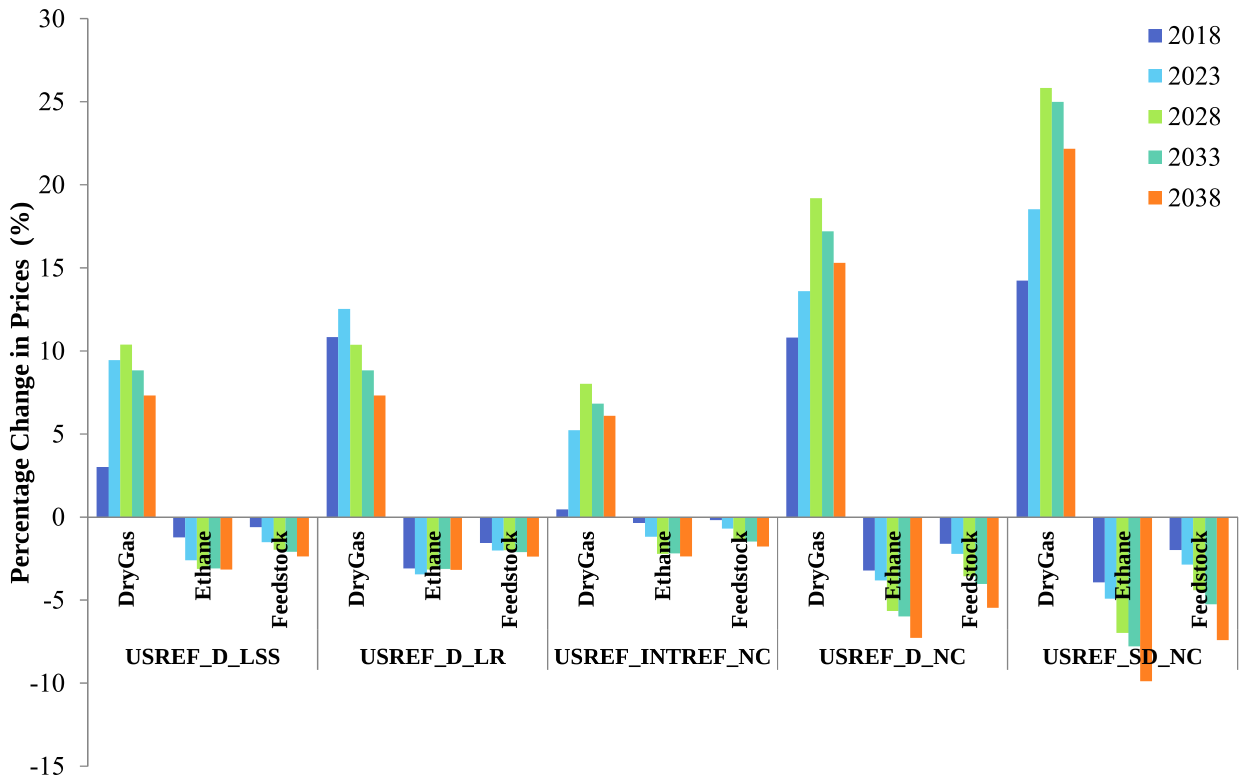
Figure 62: Percentage Change in Dry Gas and Ethane Production (%)



Ethane prices on average decrease by 2.6% under the slowest export case (USREF_D_LSS) to a 6.7% decrease under the largest export case (USREF_SD_NC). For the same cases, natural gas prices increase by about 7.8% and 21%, respectively. Thus, an increase in the overall supply of wet gas results in additional supply of ethane, resulting in ethane price being discounted by about 10% to about 28%, respectively, under the slowest export case and the largest export case (Figure 63).

In general, looking across the different LNG export levels in the U.S. Reference case, we find that the price of NGLs declines with greater exports even though dry natural gas prices increase. Thus for NGL-intensive processes, the effect of LNG exports would be beneficial as a result of lower feedstock cost. More exports lead to greater supplies and lower feedstock prices and a greater competitive advantage for those manufacturing processes that rely on NGL feedstock.

Figure 63: Percentage Change in Dry Gas, Ethane, and Feedstock Prices in the U.S. Reference Case Relative to the No Export Case (%)



D. Ethylene and Polyethylene Sectors Benefit from Lower Feedstock Prices

The N$_{ew}$ERA model was run for the different levels of LNG exports with three disaggregated chemicals subsectors: the ethylene/polyethylene subsector (ECHM), the gas-intensive chemicals subsector (GCHM) and non-gas-intensive or remaining chemicals subsector (RCHM), which were described previously.

The GCHM sector includes 90% of the value of the petrochemicals sector and the value of the other nine gas-intensive subsectors shown in the gas-intensive category in Figure 60. The RCHM subsector includes all subsectors under the non-gas-intensive category in Figure 60. To highlight impacts on the chemicals sector as a whole (referenced as bulk chemicals), we aggregate the impacts on ECHM, GCHM, and RCHM. Lower feedstock prices induce more demand for ethane and hence more ethylene/polyethylene production in the ECHM subsector. Other chemical subsectors that do not use NGLs as feedstocks, GCHM and RCHM, would be impacted only to the extent LNG exports influence natural gas markets.

Figure 64 compares average annual rates of growth in ethylene, other chemicals subsectors, and the total chemicals sector (ALL_CHCM) across all the levels of exports for the U.S. Reference cases modeled. The table shows that the ECHM subsector grows faster with unlimited exports, while growth for the GCHM and RCHM subsectors decrease marginally. However, we find that the chemical sector as a whole and all of its subsectors continue to grow robustly regardless of the level of LNG exports, even when we ignore the influence of potentially lower NGL prices relative to dry gas owing to LNG exports. When we take that possibility into account, we find that growth in output of ethylene chemicals (ECHM) accelerates while growth of other chemical subsectors (GCHM and RCHM) is slightly less rapid when there are larger exports of LNG.

Figure 64: Average Annual Growth Rate of Sectoral Output (%, 2018-2038)

Scenario	Ethylene/Polyethylene ECHM	Gas-intensive GCHM	Non-gas intensive RCHM	Bulk chemicals ALL_CHM[74]
BAU_INTREF	1.37	2.03	2.46	2.29
USREF_D_LSS	1.40	2.01	2.45	2.28
USREF_D_LR	1.37	2.04	2.46	2.29
USREF_INTREF_NC	1.41	2.01	2.45	2.28
USREF_D_NC	1.45	2.01	2.45	2.28
USREF_SD_NC	1.49	2.00	2.45	2.27

The average annual growth rate of the ethylene chemicals subsector (ECHM) increases from 1.37% in the No Export case to 1.49% in the No Constraint export case. This is because LNG exports induce additional natural gas development (see Section IV), which creates additional processing needs and more NGL supply to be separated from dry natural gas. As LNG exports increase, more ethane is available above quantities that can be safely blended into the natural gas stream on pipelines, thus increasing ethane supply relative to demand and lowering its price. The average annual growth rate of the gas-intensive chemicals subsector (GCHM) drops marginally from 2.03% to 2.00%. Similarly, the average annual output of the entire bulk chemicals sector (ALL_CHM) decreases from 2.29 % to 2.27% for the highest LNG export case. Although the rate of growth declines slightly as more LNG is exported, the chemicals industry still grows robustly in all cases.

In the aggregate, by looking at how the large increase in NGL production associated with exports of natural gas might affect the economics of the chemical industry, we see that some parts of the chemical industry will benefit from LNG exports and associated increased supplies of key feedstock, and that the availability of lower-cost ethane will mitigate the natural gas price impacts of any given level of LNG exports on those chemical industries, and provide additional benefits resulting from greater feedstock availability.

Our analysis suggests that there is no support for the concern that LNG exports, even in the unlimited export case, will obstruct a chemicals or manufacturing renaissance by moving the United States so far up the global supply curve that competitors in natural gas-importing regions will have lower costs. As long as U.S. natural gas prices remain below those in competing

[74] Bulk chemicals are the sum of ECHM, GCHM, and RCHM. Therefore, the growth rate in bulk chemicals represents the average growth rate in the chemicals sector.

countries and below crude oil prices, this advantage in chemicals production will remain (Figure 57). As discussed previously, the price of natural gas in LNG-importing countries will exceed the price of natural gas in exporting countries by at least a differential sufficient to cover liquefaction, transportation, and regasification costs. In this study, we estimate that those costs will sustain a cost advantage for U.S. chemical producers of at least $5/Mcf even if no limit is placed on LNG exports

E. Welfare and GDP Impacts are Positive in All Cases

With the disaggregated chemicals sector and separation of NGL production from dry gas, it remains the case that welfare improves with increased levels of LNG exports. Although the overall macroeconomic impacts, as measured by change in GDP, are small in magnitude for the U.S. Reference cases, our analysis suggests that there is a net benefit from LNG exports, and GDP increases as LNG export levels increase over time. Figure 65 and Figure 66 show impacts on welfare and GDP, respectively, for Reference case LNG export scenarios.

Figure 65: Percentage Change in U.S. Welfare with Chemical Sector Disaggregation Relative to the No Export Case (%)

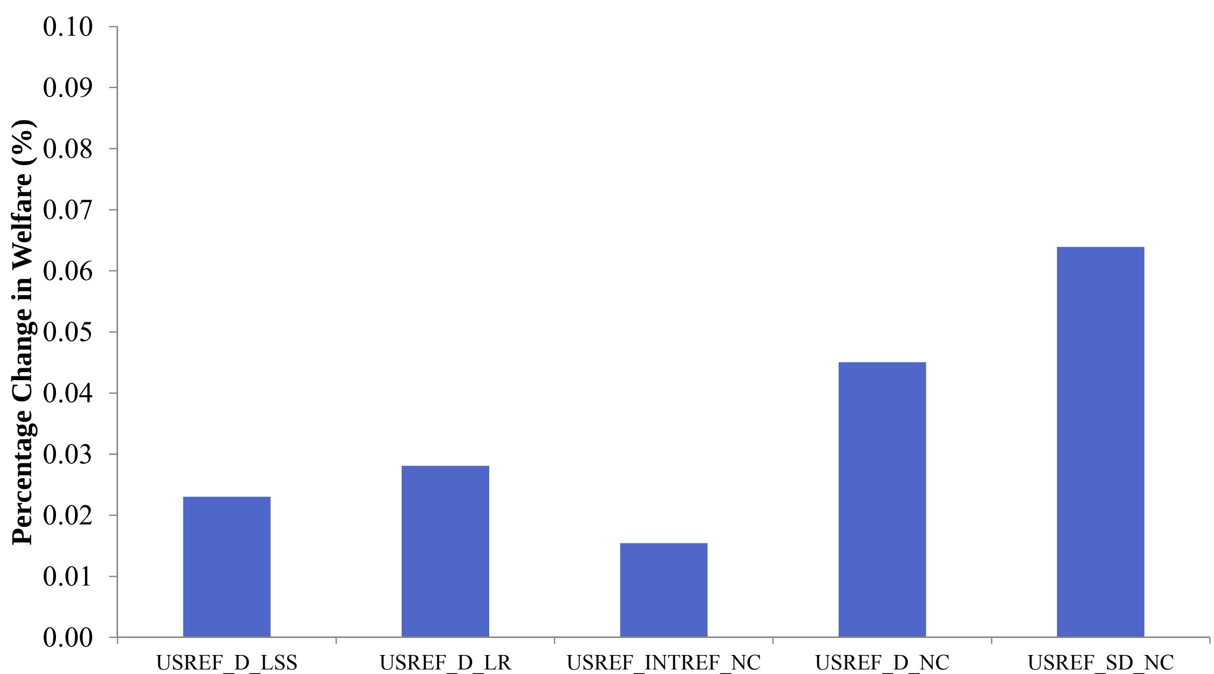
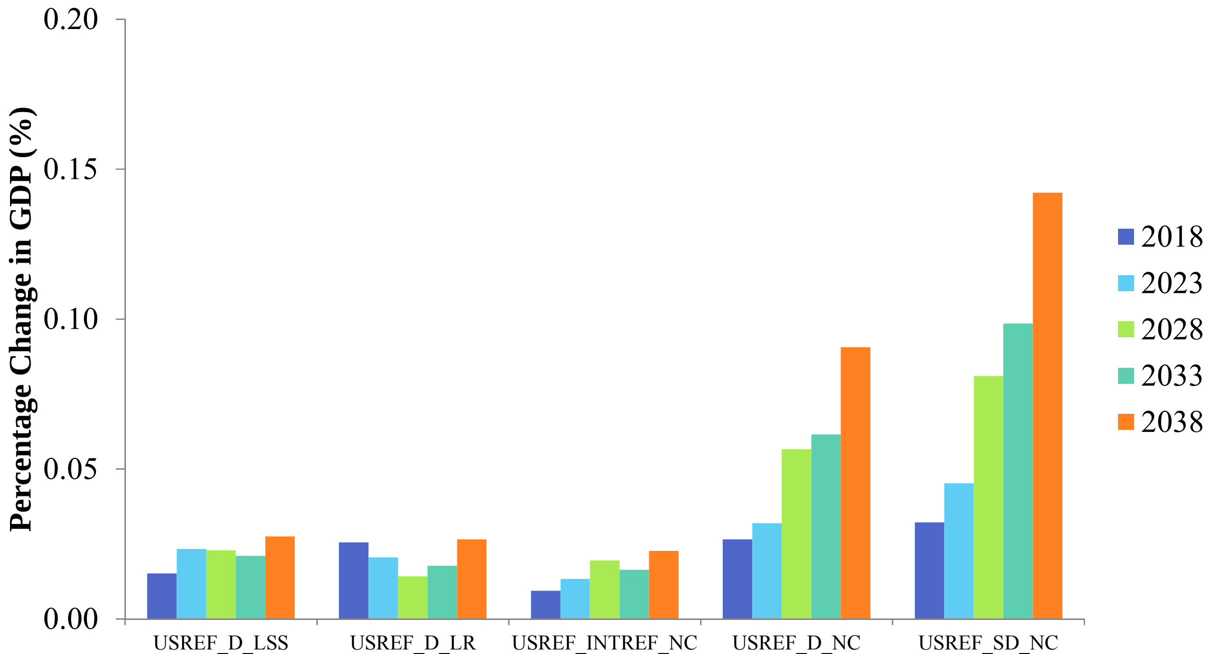


Figure 66: Percentage Change in U.S. GDP with Chemical Sector Disaggregation Relative to the No Export Case (%)



F. Welfare and GDP Impacts are Invariant to Sectoral Disaggregation

When NERA's 2012 analysis was released, the question arose whether the analysis captured the full impacts on the U.S. economy, since the model did not have a detailed representation of the gas-intensive sectors. This updated analysis answers this question by comparing the model results for welfare and GDP with and without a detailed representation of the chemicals sector. Specifically, this section compares the macroeconomic results from N_{ew}ERA where the chemicals sector is disaggregated into subsectors with those model runs described in Chapter IV where the chemical sector remains aggregated. Figure 67 shows the welfare impacts are consistent and vary by no more than 1% between the cases with or without disaggregating the chemical subsectors. The difference in GDP impacts across all LNG export scenarios is also minimal (Figure 68). We find that representing the chemicals subsectors in a model leads to virtually identical welfare and GDP benefits as those observed in a more aggregated model. Disaggregating the chemicals into subsectors provides more detail on which chemical subsectors gain and which are harmed when LNG exports are allowed. But the overall economic impacts are basically indistinguishable; therefore, these modeling results suggest that the macroeconomic findings from the model are independent of the level of disaggregation. Concerns that excessive aggregation of energy-intensive manufacturing leads to errors in estimating overall macroeconomic impacts, such as GDP and welfare, are unfounded and not supported by our analysis.

Figure 67: Percentage Change in Welfare Relative to No Export Case With Disaggregation and Without Disaggregation of the Chemicals Sector

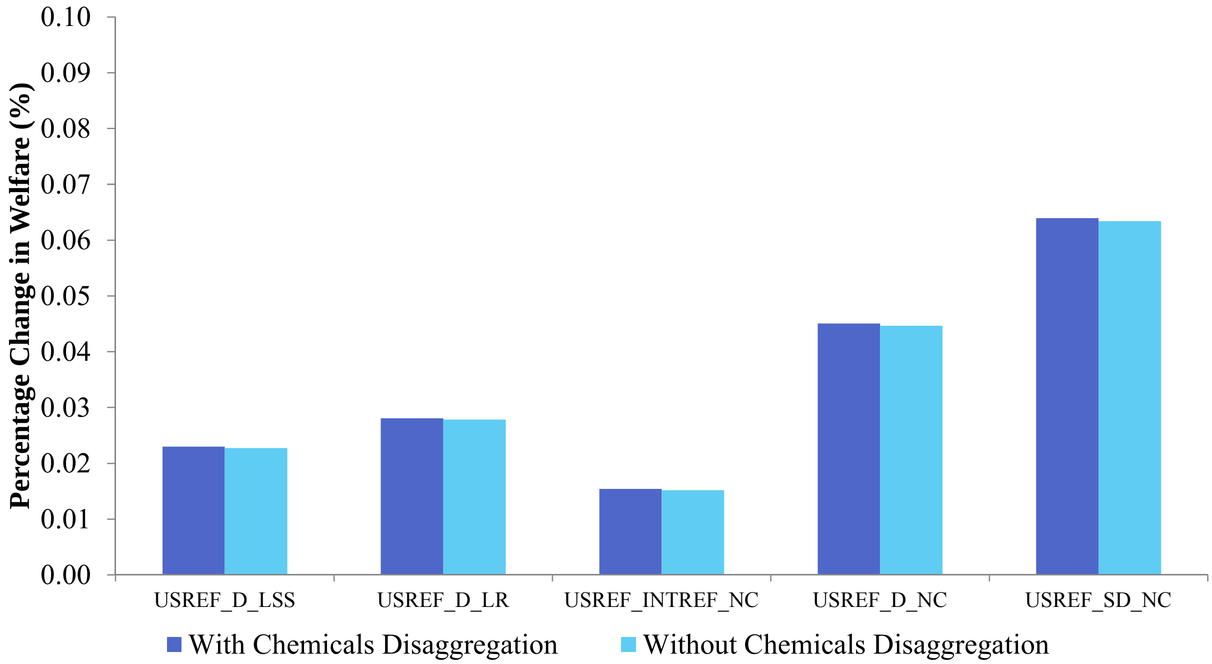
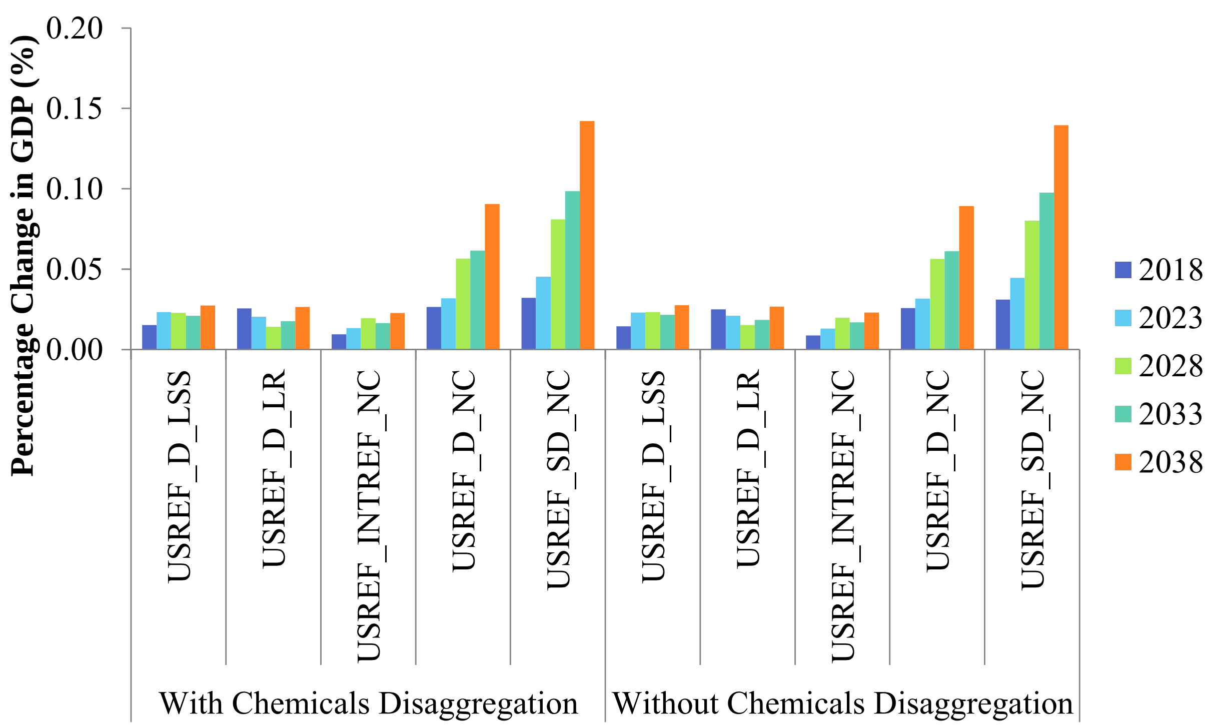


Figure 68: Percentage Change in GDP Relative to No Export Case With Disaggregation and Without Disaggregation of the Chemicals Sector



IX. SHORT-TERM ECONOMIC IMPACTS ON EMPLOYMENT

As a long-term model of economic growth, the N_{ew}ERA model does not address issues of business cycles and unemployment, assuming instead that real and potential GDP coincide and that labor markets are in equilibrium like all other markets. As the U.S. economy is still recovering slowly from the recession, and is not expected to return to full employment until 2018, according to the CBO, it is likely that policies toward LNG exports could affect the speed at which the recovery progresses.

For each Bcf/d of capacity constructed, a typical LNG export project employs an average of 2,500 job-years of labor spread over 48 months, with about 1,500 workers on site during the peak 12 months of construction, based on estimates submitted to the U.S. DOE by applicants.[75] By 2018, the total amount of capacity that would have been built after 2013 or under construction would be from 1.8 Bcf/d to 23 Bcf/d across the scenarios examined in this study, for a total of 3,300 to 52,500 job-years of direct employment on site between 2014 and 2017.

Since 2018 is also the first year that we report impacts projected by the N_{ew}ERA model, the effects of LNG exports on the speed of recovery will occur in the gap between the present and the first year modeled in N_{ew}ERA. To cover this important topic, we use a model of unemployment based on Okun's Law to link reductions in unemployment to the increases in GDP projected for 2018 under different LNG export scenarios.[76] We find that, depending on the speed at which export capacity is built, the unemployment rolls could be reduced by as many as 45,000 workers on average over the period from 2013 to 2018.

A. Direct Employment

Based on a sample of data in three applications for export permits submitted to DOE, it is possible to develop a profile of direct employment associated with each of the expansion scenarios studied.[77] Each project will have an employment profile that peaks between the 24th and 36th month of construction. Depending on the study, construction of 1 Bcf/d of capacity will provide between 2,500 and 4,000 job-years of direct employment over the 48-month construction period.

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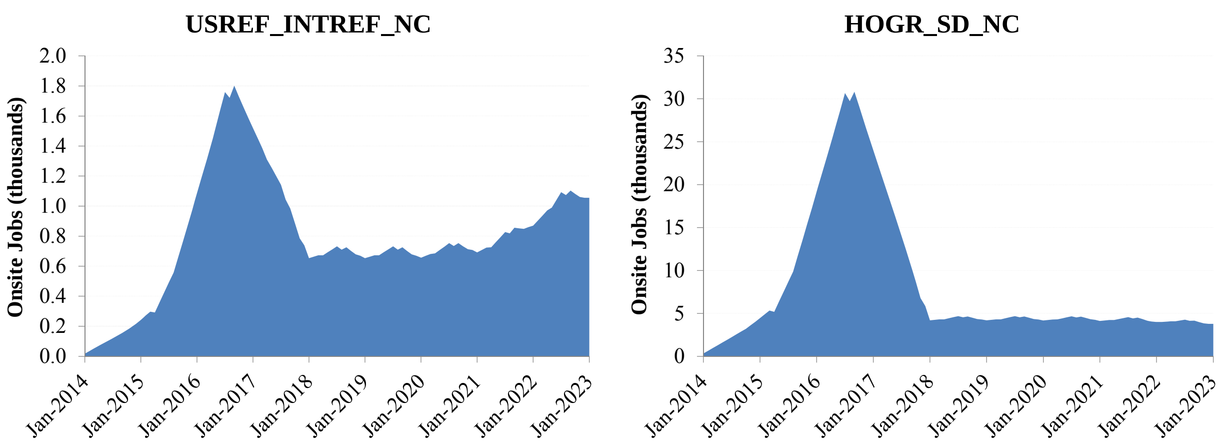
75 Black and Veatch, http://www.fossil.energy.gov/programs/gasregulation/authorizations/2011_applications/11_162_lng.pdf.

76 Arthur Okun first reported in 1962 a negative relationship between economic output and unemployment. Arthur Okun, "Potential GNP: Its Measurement and Significance." Reprinted as *Cowles Foundation Paper* 190, 1962.

77 ICF International conducted the economic analysis for Dominion's Cove Point project, Black & Veatch conducted the economic impact analysis cited above for Sempra's Cameron LNG facility, and The Perryman Group conducted the economic impact analysis for Exxon's Golden Pass LNG (2.0 Bcf/d output) application, http://www.fossil.energy.gov/programs/gasregulation/authorizations/2011_applications/11_162_lng.pdf.

Figure 69 shows this profile for reference case levels of LNG capacity construction and for a scenario with the maximum expansion rate across all scenarios analyzed for the next nine years. In both of these scenarios, the projects construction would proceed rapidly between 2014 and 2017 to provide sufficient capacity to meet projected levels of exports in 2018, and then slow to a pace sufficient to meet capacity needs in 2023 and beyond. Employment between 2014 and 2022 includes both jobs to construct LNG export capacity required in 2018 and the bow wave of construction to meet export requirements from 2023 onward. We assume that capacity needed in 2018 is built by the end of 2017. Likewise, the incremental capacity needed in 2023 is built by the end of 2022. It can be seen that employment in the period from 2014 through 2017 will peak around late 2016, when between 1.5 Bcf/d and 18.3 Bcf/d of LNG export capacity would be under construction in the two scenarios. A total of 7,200 to 74,000 job-years of employment would be provided for on-site construction during the entire period spanning 2014 through 2022.

Figure 69: Total Onsite Employment for Select Scenarios



In addition to these on-site jobs, manufacturing of machinery and equipment for the LNG plant, including compressors, pipes, and compressor vessels, will also provide employment, and exploration and production for natural gas will need additional workers over the life of the facility to support the required net increase in U.S. natural gas production.

The peak in direct workforce requirements would occur prior to the predicted return of the U.S. economy to full employment. Thus LNG projects are likely to put unemployed workers back on the job during that period and hasten the end of the recession.[78]

[78] Other studies have computed directed, indirect, and induced jobs associated with the development of shale gas in particular and oil and gas sector in general. Cheniere (http://www.cheniere.com/lng_industry/changing outlook for lng.pdf) approximates 30,000 to 50,000 jobs per 2 Bcf/d of additional natural gas production. Michael Levi in "A Strategy for U.S. Natural Gas Exports," The Hamilton Project, Discussion Paper 2012-04, June 2012, estimates approximately 25,000 jobs in the natural gas industry along with approximately 40,000 jobs in the rest of the economy for a 6 Bcf/d increase in exports based on the assumption that each increase in 1 Bcf/d in natural gas production supports approximately 5,300 jobs in the oil and gas industry, and about 8,900 indirect jobs in the rest of the economy (see footnote 8). Whether these jobs will draw workers from the ranks of the unemployed or from

B. Transitional Unemployment

The N_{ew}ERA model used in this study assumes full employment in the U.S. economy over the long time horizon covered by the model. This assumption is consistent with the long-term performance of the U.S. economy, which has generally operated at full employment since the Second World War, and recognizes the impossibility of predicting the timing or depth of future downturns. The CBO's baseline forecast has the economy returning to full employment in 2018, and states, "For the second half of the coming decade, CBO does not attempt to predict the cyclical ups and downs of the economy; rather, CBO assumes that GDP will stay at its maximum sustainable level."[79]

The assumption of full employment does not imply that the measured unemployment rate will be zero. CBO's estimate of the natural (or equilibrium) rate of unemployment that corresponds to "full employment" is "the 'nonaccelerating inflation rate of unemployment' (NAIRU), which is the rate of unemployment consistent with a stable rate of inflation."[80] CBO estimates the NAIRU using the historical relationship between the unemployment rate and changes in the rate of inflation. This level of unemployment is also referred to as the "natural rate." The natural rate is not zero because of frictions in the labor market, which include time spent on job searches when workers move from one job to another; structural factors, including disincentives for work such as long-term unemployment compensation and income-tested transfer payment; and mismatches between skills and labor demand, especially in the presence of minimum wage laws that make it uneconomic to fill jobs with low productivity.

"Potential" GDP is another important concept that influences unemployment. Potential GDP is based on the productive potential of the economy, which grows over time with capital investment, productivity improvement, and resource discoveries. When actual GDP equals potential GDP, unemployment will be at the natural rate.

CBO projects that the unemployment rate will remain above the NAIRU until 2018 (Figure 70), as the economy recovers slowly from the recession:

> *… underlying economic factors will lead to more rapid growth, CBO projects—3.4 percent in 2014 and an average of 3.6 percent a year from 2015 through 2018. In particular, CBO expects that the effects of the housing and financial crisis will continue to fade and that an upswing in housing construction (though*

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other occupations and industries depends on the overall state of employment in the economy. During the recession, some share of the jobs will undoubtedly be filled by the unemployed, but once the economy returns to its potential growth path and the natural rate of unemployment, they will have to be drawn from other activities.

[79] CBO, "The Budget and Economic Outlook: Fiscal Years 2013 to 2023," February 5, 2013.

[80] Robert Arnold, "REESTIMATING THE PHILLIPS CURVE AND THE NAIRU," Congressional Budget Office, Washington, DC, August 2008, pg. 3.

from a very low level), rising real estate and stock prices, and increasing availability of credit will help to spur a virtuous cycle of faster growth in employment, income, consumer spending, and business investment over the next few years.

Nevertheless, under current law, CBO expects the unemployment rate to remain high—above 7½ percent through 2014—before falling to 5½ percent at the end of 2017.[81]

Figure 70: Historical and CBO Projected Unemployment Rates (%)[82]

	2013	2014	2015	2016	2017	2018
Unemployment Rate, Civilian, 16 Years or Older	7.9	7.8	7.1	6.3	5.6	5.5

Since 2018 is the first year reported in our study, our assumptions for the years from 2018 onwards -- that the economy remains at full employment and that there are no aggregate employment effects of LNG exports -- are consistent with the CBO projection that "GDP will stay at its maximum sustainable level" from 2018 onwards.

When the economy is operating at its potential, job growth may be increased in one sector and lowered in another when changes like LNG exports occur, but overall total employment will not change. For this reason, we do not project total employment changes as a result of increased LNG exports in the period after 2018. And, as discussed in NERA's 2012 report for DOE/FE, even sectoral shifts in employment in the cases with the largest changes in relative growth rates would never lead to year-over-year declines in employment in any industry, only different rates of growth.

However, between 2014 and 2018, CBO projects that the economy will continue operating below its potential and that unemployment will gradually fall to the "natural" or full employment rate of 5.5% by 2018. During this period of time, the increase in GDP caused by LNG exports would lead to reductions in unemployment and a more rapid achievement of full employment.

C. Okun's Law and the Relationship between GDP Growth and Unemployment

During the period between now and the return to full employment, policy changes that boost GDP will lead to faster reductions in unemployment. The relationship between short-run

[81] CBO, "The Budget and Economic Outlook: Fiscal Years 2013 to 2023," February 5, 2013.

[82] CBO, "The Budget and Economic Outlook: Fiscal Years 2013 to 2023," February 5, 2013.

movements in output and employment is known as Okun's Law. Current estimates of the coefficient are about 0.5.[83]

D. Results

As discussed in Chapter VI, we find that in all cases, increased LNG exports cause GDP to be larger in 2018 than it would be with zero LNG exports. This increase in GDP is driven by the investment taking place in LNG export terminals and in natural gas production and infrastructure to supply those terminals during the period from 2013 to 2018. Thus, we expect both the increase in GDP and the increase in employment to accelerate from 2013 to 2018 in all cases that LNG exports transpire.

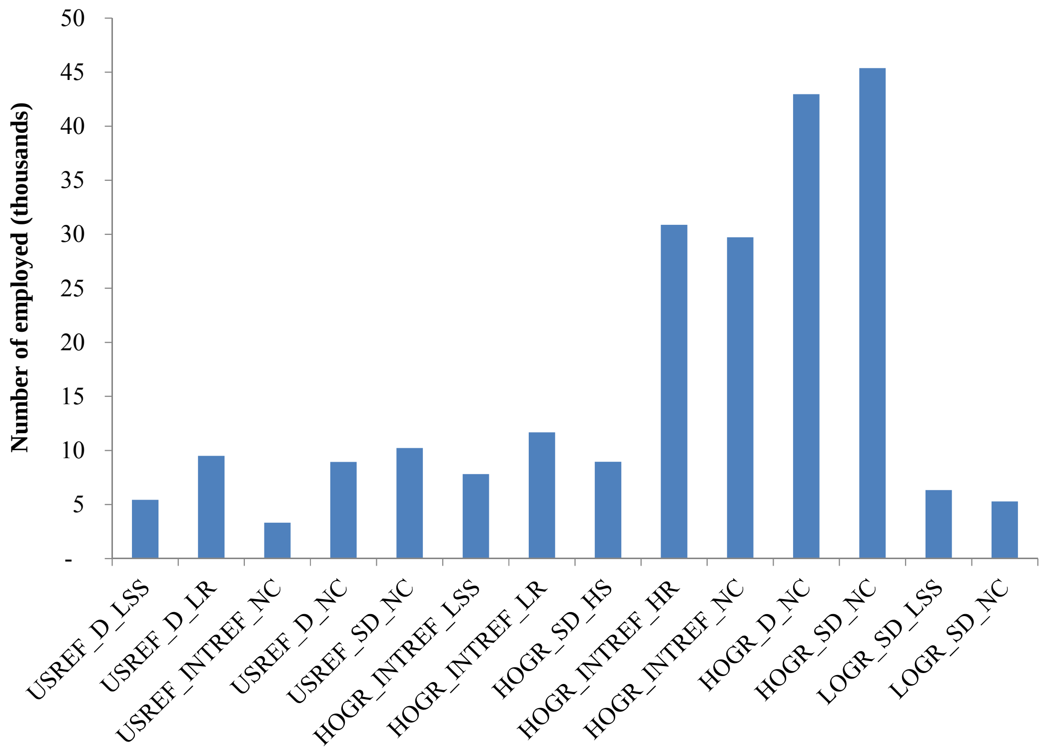
Based on Okun's Law and this acceleration in investment, we estimate that LNG exports could reduce the average number of unemployed by as much as 45,000 workers between 2013 and 2018 (Figure 71), and that as a result, full employment could be achieved as much as one month earlier than without LNG export expansion.[84]

This method of estimating the reduction in unemployment is an application of the general macroeconomic principle that the level of unemployment is determined by macroeconomic forces, including aggregate demand, investment spending, programs like unemployment compensation that make it more difficult to attract the unemployed back to work, and structural shifts in the economy.

[83] "Okun's Law: Fit at 50?" Lawrence Ball, Daniel Leigh, and Prakash Loungani, paper presented at the 13th Jacques Polack Annual Research Conference, IMF, Washington, DC. November 8-9, 2012 (available at http://www.imf.org/external/np/res/seminars/2012/arc/pdf/BLL.pdf) summarizes recent discussions of Okun's Law, estimates the ratio for the U.S. to be 0.45, and concludes that Okun's Law remains a "strong and stable relationship."

[84] Other studies have computed directed, indirect, and induced jobs associated with the development of shale gas in particular and oil and gas sector in general. Cheniere (http://www.cheniere.com/lng_industry/changing outlook for lng.pdf) approximates 30,000 to 50,000 jobs per 2 Bcf/d of additional natural gas production. Michael Levi in "A Strategy for U.S. Natural Gas Exports," The Hamilton Project, Discussion Paper 2012-04, June 2012, estimates approximately 25,000 jobs in the natural gas industry along with approximately 40,000 jobs in rest of the economy for a 6 Bcf/d increase in exports based on the assumption that each increase in 1 Bcf/d in natural gas production supports approximately 5,300 jobs in the oil and gas industry, and about 8,900 indirect jobs in the rest of the economy (see footnote 8).

Figure 71: Average Net Reduction in Unemployment (2013 – 2018)



The net job creation estimated here includes the direct and indirect job creation that is frequently cited from studies that apply RIMS and IMPLAN multipliers to planned investments.[85] But they do not correspond in magnitude to the job impacts that would be calculated by applying such multipliers to the investments associated with the LNG facilities and natural gas production levels associated with each scenario. Indeed, they are much less.[86] There are three reasons that impacts on unemployment bear little resemblance to such "job creation" numbers:

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[85] RIMS (Regional Impact Multiplier System) multipliers were calculated by the U.S. Department of Commerce and provided at no cost to users, but this service has been discontinued. IMPLAN multipliers are offered by a private company and are accompanied by software to facilitate calculation of job and other impacts.

[86] Simple calculations of job gains or losses based on such multipliers frequently provide gross overestimates of job impacts, which can be either positive or negative, because they ignore the opportunity cost of investment in one project versus another and potential economy-wide effects of policy changes. A full model of the economy like N_{ew}ERA is required to account for all the effects of a project, policy or market change and constraints imposed by the productive potential of the economy. See Anne Smith, Will Gans and Mei Yuan, "Estimating Employment Impacts of Regulations: A Review of EPA's Methods for Its Air Rules," prepared for U.S. Chamber of Commerce, NERA Economic Consulting, February 2013, http://www.nera.com/nera-files/PUB_Smith_Chamber_FinalReport_0213.pdf. It is particularly unreasonable to talk about job gains or losses for the economy as a whole in the context of long-term forecasts that by their nature are based on the assumption that unemployment on average will stay at the natural rate.

1. Even with full employment, job creation must equal the number of new workers entering the labor force, so that only job creation over and above the increase in the labor force reduces unemployment.
2. The NERA calculations, which relate job creation to net increases in GDP during a period of unemployment, take into account both the job increases due to the projects associated with LNG exports and any reduction in job creation in other industries that might grow more slowly due to higher natural gas prices or competition for inputs from industries that also serve natural gas expansion.
3. The NERA method of estimating job impacts takes explicit account of the state of the labor market, and provides an estimate of how many of the jobs created by investment in LNG facilities and natural gas production will be filled by workers who would otherwise be unemployed, and how many are filled by workers who would otherwise be working in other industries.

From 2018 onward, NERA assumes that potential and actual GDP will coincide and that unemployment will remain at the natural rate. Our finding over this period of time is that there will be changes in relative wage rates, the return on capital, and other components of income. These changes come about because of structural shifts in the economy as natural gas exploration and production, LNG exports and industries that support those activities grow more rapidly while other industries grow more slowly, and increase both potential and actual GDP in the process.

In Chapter VI we reported that total labor earnings grow more slowly and capital, resource and tax income grow more rapidly as LNG exports expand. This is consistent with the maintenance of full employment, because it is the real wage rate that adjusts rather than the level of employment.

X. CONCLUSIONS

NERA used its GNGM and N_{ew}ERA model to evaluate the effect of LNG exports on the U.S. economy. These two models allowed us to estimate export levels, characterize the international gas market conditions, and evaluate overall macroeconomic effects. Given the wide range in possible export expansion outcomes, it is not surprising to find great variation in the macroeconomic impacts and natural gas market changes. Nevertheless, several insights may be distilled from the patterns that emerged.

A. The Extent of LNG Exports from the United States Will Depend upon the Relative Cost and Abundance of U.S. Natural Gas Relative to Other Regions of the World, and the Demand for Natural Gas in LNG-Importing Regions

Our study shows that there could be a very wide range of U.S. LNG exports depending upon conditions in the United States and elsewhere. In all scenarios in which U.S. LNG exports were allowed, some level of U.S. LNG exports occurred. The wide range of export levels reflects the breadth of natural gas supply, both its cost and abundance, assumed in the different U.S. scenarios, as well as variation in global demand for U.S. LNG exports assumed in the international scenarios. The highest levels of exports projected in the HOGR cases are not as likely as the lower levels projected in the HOGR sensitivity case that assumes a more competitive global market in which gas-on-gas competition drives natural gas prices lower in importing countries. Whereas the HOGR case could lead to LNG exports in 2038 as high as 19.5 Tcf, in the alternative HOGR case with gas-on-gas competition, the maximum level of LNG exports is 11.5 Tcf.

B. U.S. Natural Gas Prices Do Not Rise to World Prices

LNG exports will not drive the price of domestic natural gas to levels observed in countries that are willing to pay oil parity-based prices for LNG imports. U.S. exports will drive prices down in regions where U.S. supplies are competitive so that export prices will decline at the same time that U.S. domestic prices rise.

Moreover, basis differentials due to transportation costs from the United States to high-priced regions of the world will still exist, and U.S. prices will never get closer to those prices than the cost of liquefaction plus the cost of transportation to, and regasification in, the final destination market. Thus, even in the scenarios with no binding export levels, the wellhead price in the United States is several dollars below the import price in Japan, where the United States sends some of its exports.

C. Consumer Well-being Improves in All Scenarios

The macroeconomic analysis shows that there are consistent net economic benefits across all the scenarios examined and that the benefits are strongly correlated with export volumes. That is, economic benefits generally become larger as the amount of exports increases. These benefits are measured most accurately in a comprehensive measure of economic welfare of U.S. households that takes into account changes in their income from all sources and the cost of goods and services they buy. This measure gives a single indicator of relative overall well-being of the U.S. population, and it consistently ranks all the scenarios with LNG exports above the scenarios without exports. Welfare improvement is highest under the high export volume scenarios because U.S. consumers benefit from an increase in wealth transfer and export revenues. In other words, forbidding LNG exports in cases when world demand for LNG and U.S. supplies are highest creates the greatest harm to the U.S. economy; therefore, allowing exports in those cases yields the greatest benefits.

D. There are Net Benefits to the United States

A related measure that shows how economic impacts are distributed over time is GDP. Like welfare, GDP also increases as a result of LNG exports. The increases in GDP generally increase over time with the increase in LNG exports over time. Near-term GDP is boosted by additional value added in the economy as capital and labor shifts from unproductive sectors of the economy to more productive sectors. In addition, the U.S. economy benefits through higher export revenues as a result of liquefaction service fees. Under the Reference case, GDP increases could range from $1.5 billion in 2018 to $36 billion in 2038. Under the HOGR case, GDP could increase from $2.5 billion to $20 billion in 2018 and to as much as $86 billion in 2038. Under the LOGR case, GDP increases range from $1.6 billion in 2018 to $10 billion by 2038. Every scenario with LNG exports shows improvement in GDP over the No Export cases, with GDP improvements being well correlated with increases in LNG exports.

Even at the very high levels of exports that are projected in the HOGR cases with imperfectly competitive global markets, unlimited exports provide larger benefits to the U.S. economy than any restricted level of exports. When the characterization of the global market is changed to one with perfect gas-on-gas competition, the U.S. economy continues to gain greater benefits from unlimited exports than it would from any limited export case. Although the patterns are not perfectly consistent across all scenarios, the increase in investment in the natural gas extraction sector and increase in labor productivity in the economy provides near-term stimulus to the economy. In the long run, significant LNG export revenues along with higher resource income help sustain higher economic growth.

E. Some Industries Gain from Additional Natural Gas Production to Supply Exports

The U.S. petrochemical industry already has a large cost advantage over foreign competitors because of the low cost of natural gas in the United States. That advantage has increased with growth in unconventional gas production because the U.S. petrochemical industry utilizes a co-product of natural gas production, namely NGLs, as a principle feedstock. NGLs consist of ethane, butane, pentane, and other heavier hydrocarbon molecules. Since the amount of NGLs that can be blended with natural gas in the U.S. pipeline system is limited, LNG exports can raise the quantity of NGLs produced and potentially drive down their cost, thereby further improving the competitive position of certain U.S. chemicals. This study specifically demonstrates this effect in its analysis of a subsector of the petrochemicals comprised of ethylene and polyethylene. The output of this subsector increases with increasing levels of LNG exports.

F. There is a Shift in Resource Income between Economic Sectors

The United States has experienced many fluctuations in trade patterns as a result of changing dynamics of comparative advantage in global trade. Each of these changes has had winners and losers. For example, grain exports raised the income of farmers and transferred income from U.S. consumers to farmers, steel imports lowered the income of U.S. steel companies and lowered the cost of steel for U.S. manufacturing, *etc*.

The U.S. economy will experience some shifts in output by industrial sectors as a result of LNG exports. Compared to the No Export case, incomes of natural gas producers will be greater, and labor compensation in the natural gas sector will increase, while output from other industrial sectors and labor compensation decreases. The natural gas sector could experience an increase in production between 0.6 Tcf and 8.0 Tcf by 2023 and between 1.4 Tcf and 10.8 Tcf by 2038 to support LNG exports. LNG exports could lead to an average annual increase in natural gas export revenues between $6 billion and $62 billion. The growth rates for other sectors continue at nearly the same growth rate as they do when LNG exports are prohibited. The growth rate in the energy-intensive sectors ranges from 2.43% to 2.45% per annum in the USREF cases, which is a decline of one to two basis points from the No Export USREF baseline. The electric sector grows from 0.73% to 0.75% per annum, which reflects a decline of two to five basis points. The manufacturing sector grows at almost the same rate with or without LNG exports. With LNG exports, its growth rate averages 2.48% per annum as opposed to 2.49% per annum without LNG exports. Though these results are for the USREF cases, the change in growth rates under the LOGR and HOGR cases are similar. These small changes in output translate to small changes in industry labor compensation.

Harm is likely to be confined to narrow segments of the energy-intensive sector, and vulnerable industries are not high-value-added industries. The electricity sector, energy-intensive sector, and natural gas-dependent goods and services producers will all be negatively impacted by price rises. Conversely, the natural gas sector will benefit. Some segments of the chemicals sector will also benefit from additional supply of petroleum liquids, such as ethane, co-produced with natural gas for exports. Labor wages will likewise decrease or increase, respectively, depending on the sector of the economy. The overall impact on the economy depends on the tradeoff between these sectors.

In terms of natural gas-intensive industries, producers switch to cheaper fuels or use natural gas more efficiently as natural gas prices rise. In general, production declines in natural gas-intensive sectors, except for the petrochemical sector that consumes NGLs such as ethane, as capital and labor shift toward the natural gas sector. This shift results in the loss in output in the rest of the economy with lower value-added income and tax revenue. However, increases in capital and labor in the natural gas and the petrochemical sectors yield higher capital and labor income in these sectors. Capital and labor income increase in these sectors on average. Overall, economy-wide capital income and tax revenue increases, in 2038 by $3.9 (LOGR_SD_LSS) to $49 (HOGR_SD_NC) billion and by $2.8 (LOGR_SD_LSS) to $38 (HOGR_SD_NC) billion, respectively. These shifts in economic incomes from less productive sectors to more productive sectors lead to additional value-added activity, or more GDP in the economy.

The costs and benefits of natural gas price increases are shifted in two ways. Costs and benefits experienced by industries do not remain entirely with the companies paying the higher energy bills or receiving higher revenues. Part of the cost of higher energy bills will be shifted forward onto consumers, in the form of higher prices for goods being produced. The percentage of costs shifted forward depends on two main factors: first, how demand for those goods responds to increases in price; and second, whether there are competitors who experience smaller cost increases. The remainder of the cost of higher energy bills is shifted backwards onto suppliers of inputs to those industries, to their workers, and to owners of the companies. As each supplier in the chain experiences lower revenue, its losses are also shifted back onto workers and owners.

Gains from trade are shifted in the same way. Another part of the increased income of natural gas producers comes from foreign sources. Therefore, it is a net benefit to the U.S. economy and is also shifted back to the workers and owners of businesses involved directly and indirectly in natural gas production and exports.

Consumers gain an additional benefit in the form of lower prices for imported goods, as the expansion of exports leads to increased demand for dollars to pay for natural gas, and therefore an increase in the value of the dollar. This lowers the cost of imports to U.S. companies and consumers.

In the end, all the costs and benefits of any change in trade patterns or prices are shifted back to labor and capital income and to the value of resources in the ground, including natural gas resources. One of the primary reasons for the development of computable general equilibrium models like N_{ew}ERA is to allow analysts to estimate how impacts are shifted back to the different sources of income and their ultimate effects on the economy at large. In conclusion, the range of aggregate macroeconomic results from this study suggests that LNG export has net benefits to the U.S. economy when one accounts for all impacts associated with exporting LNG.

G. U.S. Manufacturing Renaissance is Unlikely to be Harmed by LNG Exports

Our analysis suggests that there is no support for the concern that LNG exports, even in the unlimited export cases, will obstruct a chemicals or manufacturing renaissance by moving the United States so far up the global supply curve that competitors in natural gas-importing regions will have lower costs. The average annual growth rate in EIS declines by at most 0.04

percentage points when LNG exports are unrestricted. As for the chemicals sector, the U.S.'s major competitors in chemicals are in natural gas-importing regions, and those regions will always have natural gas prices higher than in the United States because of the cost of liquefying and transporting LNG to those respective markets. Thus, LNG exports cannot erase the advantage that lower-cost natural gas provides to U.S. chemicals industries.

In the updated version of N_{ew}ERA, three subsectors of the chemicals industry are represented. Of those, two that rely on natural gas for heat and power continued to grow robustly but slightly more slowly in all scenarios. The subsector that relies on NGLs, principally ethane, for feedstock will benefit from increased supply and lower prices of NGLs caused by LNG exports, and will grow more rapidly, the higher the level of exports.

H. LNG Exports Could Accelerate the Return to Full Employment

Based on Okun's Law and the acceleration of investment related to LNG exports, we estimate that LNG exports could reduce the average number of unemployed by as many as 45,000 workers between 2013 and 2018 (Figure 71), and that, as a result, full employment could be achieved as much as one month earlier than without LNG export expansion.

I. Results from this Study are Quite Similar to NERA's 2012 Study

This current study indicates greater LNG export potential at lower prices than previously estimated. This reflects EIA's more optimistic views on U.S. natural gas supply, as well as its projections of more rapid growth in domestic natural gas demand. The current NERA study results indicate that LNG exports would be greater and average wellhead prices would be lower in most years than estimated in the NERA study for DOE/FE. These results imply that the United States can be expected to produce a greater level of LNG exports at a lower price than was estimated in the previous NERA study.

Though the level of production, consumption, and LNG exports are greater, the macroeconomic results from this study are qualitatively similar to those of our 2012 DOE/FE study. The economic benefits of LNG exports increase with increasing levels of exports. Therefore, just as we found in our 2012 study, raising the export quota leads to greater increases in GDP and welfare, and GDP and welfare are consistently higher in unconstrained export scenarios compared to those cases with quotas. Since exports were higher in this study, economic gains were greater. Furthermore, this finding of increasing GDP and welfare with increasing LNG exports is robust under a more detailed representation of the chemicals sector.

J. Movement Towards Full Competition by U.S. Rivals Leads to Lower Levels of U.S. Exports

Using the most optimistic *AEO 2013* assumptions regarding the outlook for U.S. natural gas supply leads to projections of LNG export levels in the unconstrained cases much larger than any reported in the previous study. However, for the United States to achieve such high levels of exports, it would be necessary for other exporting countries to forego the opportunity to increase profitable sales as global demand increases, leaving room for the United States to take an increasing share of the future market. We consider it more likely that the threat of such large levels of U.S. exports would lead other exporters of natural gas – Russia and Qatar in particular – to accept considerably lower prices based on gas-on-gas competition in order to maintain or even increase their export sales. Under these circumstances, U.S. LNG exports in the unconstrained cases would be considerably lower than projected were exporting rivals in the global market to restrain output, as assumed in both the prior NERA study and in the core scenarios of this study. A movement towards greater global competition would significantly reduce U.S. LNG exports even under conditions in which the United States could produce large quantities of natural gas at a low cost (HOGR).

APPENDIX A: TABLES OF ASSUMPTIONS AND NON-PROPRIETARY INPUT DATA FOR GLOBAL NATURAL GAS MODEL

A. Region Assignment

Figure 72: Global Natural Gas Model Region Assignments

Region	Countries
Africa	Algeria, Angola, Egypt, Equatorial Guinea, Ghana, Kenya, Libya, Morocco, Mozambique, Nigeria, Tunisia
Canada	Canada
China/India	China, Hong Kong, India
Central and South America	Andes, Argentina, Bolivia, Brazil, Central America and Caribbean, Chile, Colombia, Dominican Republic, Peru, Southern Cone, Trinidad & Tobago, Uruguay, Venezuela
Europe	Albania, Austria, Belgium, Bulgaria, Croatia, Denmark, France, Germany, Greece, Ireland, Italy, Netherlands, North Sea, Norway, Poland, Portugal, Romania, Spain, Sweden, Switzerland, United Kingdom
Former Soviet Union	Armenia, Azerbaijan, Belarus, Estonia, Georgia, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan
Korea/Japan	South Korea, Japan
Mexico	Mexico
Middle East	Abu Dhabi, Cyprus, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, Turkey, United Arab Emirates, Yemen
Oceania	Australia, New Zealand, Papua New Guinea
Sakhalin	Sakhalin Island
Southeast Asia	Afghanistan, Brunei, Indonesia, Malaysia, Myanmar, Pakistan, Philippines, Singapore, Taiwan, Thailand
U.S.	Puerto Rico, United States

B. EIA *IEO 2013* Natural Gas Production and Consumption

Figure 73: EIA *IEO 2013* Natural Gas Production (Tcf)

	2018	2023	2028	2033	2038
Africa	8.67	9.85	10.44	11.91	13.18
Canada	5.30	5.69	6.18	6.73	7.39
C & S America	7.11	7.75	8.37	9.23	10.24
China/India	5.61	6.42	8.00	10.16	12.38
Europe	8.02	7.61	8.11	8.75	9.41
FSU	29.72	32.99	37.17	41.00	43.61
Korea/Japan	0.16	0.15	0.15	0.15	0.15
Mexico	1.64	1.58	1.86	2.47	3.26
Middle East	21.61	23.71	25.67	27.46	29.25
Oceania	3.37	4.50	5.31	5.95	6.53
Sakhalin	0.91	0.98	1.06	1.15	1.25
Southeast Asia	9.61	9.85	10.21	10.70	11.25
U.S.	25.86	27.65	29.46	30.69	32.35

Figure 74: EIA *IEO 2013* Natural Gas Consumption (Tcf)

	2018	2023	2028	2033	2038
Africa	3.99	4.63	5.51	6.69	8.15
Canada	3.35	3.89	4.18	4.46	4.78
C & S America	5.70	6.32	7.05	7.78	8.66
China/India	9.48	11.98	15.14	18.32	21.00
Europe	20.10	20.57	21.57	22.85	23.95
FSU	22.43	24.13	26.15	28.06	29.42
Korea/Japan	6.20	6.59	6.99	7.38	7.71
Mexico	3.22	3.92	4.76	5.66	6.70
Middle East	16.83	18.98	20.82	22.59	24.44
Oceania	1.46	1.61	1.78	1.95	2.12
Sakhalin	0.00	0.00	0.00	0.00	0.00
Southeast Asia	8.38	9.33	10.61	12.19	13.99
U.S.	26.45	26.81	27.44	28.41	29.34

C. Pricing Mechanisms in Each Region

1. Korea/Japan

Korea/Japan was assumed to continue to rely upon LNG to meet its natural gas demand. LNG was assumed to continue to be supplied under long-term contracts with index pricing tied to crude oil prices. It was assumed that with time, supplier competition would result in some softening in the LNG pricing relative to crude.[87] This Reference case assumes some growth in Korea/Japan demand and includes recent shifts from nuclear to gas-fired generation but does not incorporate significant additional shifts away from currently operational nuclear power to natural gas-fired generation.

2. China/India

LNG pricing for China/India is also assumed to be linked to crude oil prices but at a discount to Korea/Japan. The discount was intended to reflect that China/India, although short of natural gas supplies, have other sources of natural gas that compete with LNG. As a result, we assume that China/India would have some additional market leverage in negotiating contracting terms.

3. Europe

Europe receives natural gas from a variety of sources. The prices of some supplies are indexed to petroleum prices. Other sources are priced based upon regional gas-on-gas competition. In our analysis, we assumed that European natural gas prices would reflect a middle point with prices not tied directly either to petroleum or to local natural gas competition. We assumed that European prices would remain above the pricing levels forecast for North America but not as high as in Asia. Europe was also assumed to remain dependent upon imported supplies of natural gas to meet its moderately growing demand.

4. United States

The United States was assumed to follow the forecast for supply, demand, and pricing as presented in the EIA's *AEO 2013* Reference case.

5. Canada

The analysis assumed that Canada is part of an integrated North American natural gas market. As a consequence, Canadian pricing is linked to U.S. prices by a basis differential. We assumed that Canadian production was sufficient to meet Canadian demand plus exports to the United States as forecast in the EIA *AEO 2013*. We allow for Canadian exports of LNG in the Reference case. Also, we held net exports to the United States constant within each U.S. resource scenario so as to be able to eliminate the secondary impacts on the U.S. economy that result from changes in trade between Canada and the United States.

[87] This is consistent with the IEA *WEO 2011*, which forecasts the LNG to Crude index will decline from 82% to 63% between now and 2035.

6. Africa, Oceania, and Southeast Asia

These three regions were assumed to produce natural gas from remote locations. The analysis assumed that these natural gas supplies could be produced economically today at a price between $1.00 and $2.00/Mcf. The EIA's *IEO 2013* was used as the basis for forecasting production volumes.

7. Mexico

We held net exports from the United States to Mexico constant in all U.S. resource scenarios so as to eliminate the secondary impacts that changes in pipeline exports to Mexico could have on U.S. LNG exports and the U.S. economy. A basis differential was used between the United States and Mexico to establish wellhead prices in Mexico.

8. Middle East

Qatar is assumed to be the low-cost producer of LNG in the world. It is assumed that although Qatar has vast natural gas resources, it decides to continue to limit its annual LNG exports to its forecasted 2013 exports of 4.88 Tcf during the forecast horizon.

9. Former Soviet Union

The FSU was assumed to grow its natural gas supply at rates that far exceed its domestic demand. The resulting excess supplies were assumed to be exported mostly to Europe and, to a lesser degree, to China/India.

10. Central and South America

Central and South America was assumed to produce sufficient natural gas to meet its growing demand in every year during the forecast horizon. The region also has the potential for LNG exports that the model considered in determining worldwide LNG flows.

11. Summary of World Prices

Figure 75 and Figure 76 report the wellhead and city gate prices, respectively, for the regions represented in GNGM.

Figure 75: Projected Wellhead Prices (2012$/Mcf)

	2018	2023	2028	2033	2038
Africa	$2.01	$2.22	$2.45	$2.71	$2.99
Canada	$3.34	$4.04	$4.58	$5.12	$6.74
C & S America	$2.30	$2.54	$2.80	$3.09	$3.41
China/India	$9.24	$9.21	$9.47	$10.19	$11.38
Europe	$11.83	$12.13	$12.18	$12.18	$13.23
FSU	$4.96	$5.48	$6.05	$6.68	$7.38
Korea/Japan	$11.64	$11.62	$11.93	$12.83	$14.33
Mexico	$3.64	$4.34	$4.87	$5.42	$7.04
Middle East	$1.44	$1.59	$1.75	$1.93	$2.13
Oceania	$4.59	$5.07	$5.60	$6.18	$6.83
Sakhalin	$1.44	$1.59	$1.75	$1.93	$2.13
Southeast Asia	$2.30	$2.54	$2.80	$3.09	$3.41
U.S.	$3.43	$4.00	$4.44	$4.88	$6.45

Source: U.S. wellhead prices are projected using data from EIA *AEO 2013*.

Figure 76: Projected City Gate Prices (2012$/Mcf)

	2018	2023	2028	2033	2038
Africa	$3.01	$3.22	$3.45	$3.71	$3.99
Canada	$4.74	$5.44	$5.98	$6.52	$8.14
C & S America	$4.80	$5.04	$5.30	$5.59	$5.91
China/India	$9.94	$9.91	$10.17	$10.89	$12.08
Europe	$12.83	$13.13	$13.18	$13.18	$14.23
FSU	$5.99	$6.50	$7.07	$7.69	$8.38
Korea/Japan	$12.14	$12.12	$12.43	$13.33	$14.83
Mexico	$5.14	$5.84	$6.37	$6.92	$8.54
Middle East	$4.27	$4.42	$4.58	$4.76	$4.96
Oceania	$6.09	$6.57	$7.10	$7.68	$8.33
Sakhalin	$3.94	$4.09	$4.25	$4.43	$4.63
Southeast Asia	$3.30	$3.54	$3.80	$4.09	$4.41
U.S.	$4.43	$5.00	$5.43	$5.87	$7.44

Source: U.S. city gate prices are project using data from EIA *AEO 2013*.

D. Cost to Move Natural Gas via Pipelines

Figure 77: Cost to Move Natural Gas through Intra- or Inter-Regional Pipelines ($/Mcf)

From	To	Cost
Africa	Africa	$1.02
Africa	Europe	$1.02
Canada	Canada	$1.22
Canada	U.S.	$1.33
C & S America	C & S America	$2.55
China/India	China/India	$1.53
Europe	Europe	$1.02
FSU	China/India	$1.02
FSU	Europe	$1.02
FSU	FSU	$1.02
Korea/Japan	Korea/Japan	$0.51
Middle East	Middle East	$2.89
Oceania	Oceania	$1.53
Sakhalin	Sakhalin	$0.51
Southeast Asia	Southeast Asia	$1.02
U.S.	Mexico	$1.53
U.S.	U.S.	$1.02

E. LNG Infrastructures and Associated Costs

1. Liquefaction

The world liquefaction plants data is based upon the International Group of LNG Importers' (GIIGNL's) 2012 LNG Industry report and the July-August 2013 issue of the *LNG Journal*. The dataset includes 47 existing liquefaction facilities worldwide, totaling 14.92 Tcf of export capacity. The future liquefaction facility dataset includes 50 LNG export projects and totals 20.24 Tcf of planned export capacity. This dataset covers worldwide liquefaction projects from 2011 to 2020. Beyond 2020, each region's liquefaction capacity is assumed to grow at the average annual growth rate of its natural gas supply.[88]

The liquefaction cost per Mcf can be broken down into three components:

[88] Rates are adopted from EIA's *IEO 2013*.

1. An operation and maintenance cost of $0.16;
2. A capital cost that depends on the location of the facility; and
3. A fuel use cost that varies with natural gas prices over time.

To derive the capital cost per Mcf, we obtained a set of investment costs per million metric tons per annum (MMTPA) by region (Figure 78).[89] The U.S.'s investment cost per MMTPA is competitive because most domestic projects convert existing idle regasification facilities to liquefaction facilities. This implies a 30% to 40% cost savings relative to greenfield projects. Offshore LNG export projects are more costly, raising the investment costs per unit of capacity in Southeast Asia and Oceania.

Figure 78: Liquefaction Plants Investment Cost by Region ($Millions/MMTPA Capacity)

	$Millions/MMTPA	Capital Cost ($/Mcf produced)
Africa	$1,031	$3.05
Canada	$1,145	$3.39
C & S America	$802	$2.37
Europe	$802	$2.37
FSU	$802	$2.37
Middle East	$859	$2.54
Oceania	$1,317	$3.90
Sakhalin	$802	$2.37
Southeast Asia	$1,145	$3.39
U.S.	$544	$1.61

The total investment cost is then annualized assuming an average plant life of 25 years and a discount rate of 10%. The capital cost per Mcf of LNG produced is obtained after applying a 72% capacity utilization factor to the capital cost per Mcf of LNG capacity. Figure 79 shows the liquefaction fixed cost component in $/Mcf LNG produced.

$$\text{Equivalent Annual Cost} = \frac{\text{Asset Price} \times \text{Discount Rate}}{1-\left(1+\text{Discount Rate}\right)^{-\text{Number of Periods}}}$$

[89] From Paul Nicholson, a Marsh & McLennan company colleague (NERA is a subsidiary of Marsh & McLennan Companies).

In the liquefaction process, 9% of the LNG is burned off. This fuel use cost is priced at the wellhead and included in the total liquefaction costs.

Figure 79: Liquefaction Costs by Region (2012$/Mcf)

	2018	2023	2028	2033	2038
Africa	$3.46	$3.47	$3.50	$3.52	$3.54
Canada	$3.92	$3.98	$4.03	$4.08	$4.23
C & S America	$2.79	$2.81	$2.84	$2.86	$2.89
Europe	$3.65	$3.67	$3.68	$3.68	$3.77
FSU	$3.03	$3.08	$3.13	$3.18	$3.25
Middle East	$2.89	$2.90	$2.91	$2.93	$2.95
Oceania	$4.55	$4.60	$4.64	$4.70	$4.75
Sakhalin	$2.71	$2.73	$2.74	$2.76	$2.78
Southeast Asia	$3.83	$3.85	$3.87	$3.90	$3.93
U.S.	$2.11	$2.16	$2.20	$2.24	$2.38

2. Regasification

The world regasification plants data is based upon the GIIGNL's annual LNG Industry report, 2012, the July-August 2013 issue of the *LNG Journal*, and the July 2013 Gas LNG Europe Investment Database. The dataset includes 98 existing regasification facilities worldwide, totaling 31.86 Tcf of annual import capacity. South Korea and Japan together own 13.44 Tcf or 42% of today's world regasification capacities. The GNGM future regasification facility database includes 84 LNG import projects totaling 11.69 Tcf of planned import capacity, and covers regasification projects from 2012 to 2022 worldwide. Beyond 2022, each region's regasification capacity is assumed to grow at the average annual growth rate of its natural gas demand.[90]

LNG regasification cost can also be broken down into three components: an operation and maintenance cost of $0.21/Mcf, a fixed capital cost of $0.47/Mcf, and a fuel use cost that varies with natural gas demand prices by region and time. The capital cost assumes a 65% capacity utilization factor, and the fuel use component assumes a 1.5% LNG loss in regasification. LNG regasification cost in GNGM is shown in Figure 80.

[90] Rates adopted from *IEO 2013*.

Figure 80: Regasification Costs by Region (2012$/Mcf)

Region	2018	2023	2028	2033	2038
Canada	$0.75	$0.76	$0.77	$0.77	$0.80
China/India	$0.83	$0.83	$0.83	$0.84	$0.86
C & S America	$0.75	$0.75	$0.76	$0.76	$0.77
Southeast Asia	$0.73	$0.73	$0.73	$0.74	$0.74
Africa	$0.72	$0.72	$0.73	$0.73	$0.74
Mexico	$0.75	$0.76	$0.77	$0.78	$0.81
Korea/Japan	$0.86	$0.86	$0.86	$0.88	$0.90
Middle East	$0.74	$0.74	$0.74	$0.75	$0.75
FSU	$0.77	$0.77	$0.78	$0.79	$0.80
Europe	$0.87	$0.88	$0.88	$0.88	$0.89
U.S.	$0.74	$0.75	$0.76	$0.76	$0.79

3. Shipping Cost

GNGM assumes that the shipping capacity constraint is non-binding. There are sufficient LNG carriers to service any potential future route in addition to existing routes.

Shipping cost consists of a tanker cost and a LNG boil-off cost, both of which are a function of the distance between the export and import regions. An extra Panama Canal toll of 13 cents roundtrip is applied to U.S. Gulf Coast to Asia Pacific shipments.[91] Tanker costs are based on a $65,000 rent per day and average tanker speed of 19.4 knots. Fuel use costs assume a 0.15% per day boil off rate and an average tanker capacity of 149,000 cubic meters of LNG. LNG boil-off cost is valued at city gate prices in importing regions. Shipping distances for existing routes are based upon the GIIGNL's 2010 LNG Industry report while distances for potential routes are calculated with the Sea Rates online widget.[92]

[91] $0.13 roundtrip toll calculated based upon a 148,500 cubic meter tanker using approved 2011 rates published at http://www.pancanal.com/eng/maritime/tolls.html.

[92] http://www.searates.com/reference/portdistance/.

Figure 81: 2018 Shipping Rates (2012$/Mcf)

From / *To*	**Canada**	**C & S America**	**China/ India**	**Europe**	**Korea/ Japan**	**Mexico**	**Middle East**	**South -east Asia**	**U.S.**
Africa	2.60	1.67	1.79	0.48	2.34	1.62	1.47	2.38	1.25
C & S America			2.31	1.77	2.42	1.65	2.53	2.99	0.46
Canada		1.59	1.36		1.10	0.55		1.63	
Europe		1.44	1.19		2.60		0.87	2.71	1.28
FSU		2.20		0.48				0.82	
Middle East	2.10	2.35	0.93	1.41	1.46	2.40		1.27	2.00
Oceania		2.47	0.70		0.81		1.34	0.68	
Sakhalin			0.69		0.23			0.51	
Southeast Asia			0.47		0.56	1.79			
U.S.		1.56	2.30	1.31	2.15			2.76	

The Gulf Coast has a comparative disadvantage in accessing the Asia Pacific market due to the long shipping distances and Panama Canal tolls.

4. LNG Pipeline Costs

A pair of pipeline transport costs is also included in LNG delivery process to account for the fact that pipelines are necessary to transport gas from wellheads to liquefaction facilities in supply regions and from regasification facilities to city gates in demand regions.

Figure 82: Costs to Move Natural Gas from Wellheads to Liquefaction Plants through Pipelines (2012$/Mcf)

Region	Cost
Africa	$1.02
Canada	$0.71
C & S America	$0.51
China/India	$1.53
Europe	$1.02
FSU	$1.02
Korea/Japan	$1.02
Mexico	$0.51
Middle East	$1.44
Oceania	$0.51
Sakhalin	$0.51
Southeast Asia	$1.02
U.S.	$1.02

Figure 83: Costs to Move Natural Gas from Regasification Plants to City Gates through Pipelines (2012$/Mcf)

Region	Cost
Africa	$1.02
Canada	$0.51
C & S America	$0.51
China/India	$1.53
Europe	$1.02
FSU	$1.02
Korea/Japan	$0.51
Mexico	$0.51
Middle East	$1.44
Oceania	$0.51
Southeast Asia	$1.02
Sakhalin	$0.51
U.S.	$1.02

5. Total LNG Costs

Costs involved in exporting LNG from the Gulf Coast to demand regions are aggregated in Figure 84. The largest cost components are liquefaction and shipping.

Figure 84: Total LNG Transport Cost, 2018 (2012$/Mcf)

	China/India	Europe	Korea/Japan
Regas to city gate pipeline cost	$1.53	$1.02	$0.51
Regas cost	$0.83	$0.87	$0.86
Shipping cost	$2.30	$1.31	$2.15
Liquefaction cost	$2.11	$2.11	$2.11
Wellhead to liquefaction pipeline cost	$1.02	$1.02	$1.02
Total LNG transport cost	**$7.79**	**$6.33**	**$6.65**

F. Elasticity

1. Supply Elasticity

The supply elasticity varies across regions depending on the ease of accessing gas resources. For the majority of the regions, we start with a value of 0.25 in 2018 and a long-run elasticity of 0.43 in 2038, except for Africa, Europe, U.S., and Canada. Elasticities in the intermediate years are interpolated with a straight line method, and the 2038 elasticity is extrapolated assuming the same increase from 2030 to 2035 exists from 2035 to 2038.

North America is assumed to behave as a fairly integrated market. Therefore, Canada takes on the same values as the U.S. for supply elasticity.

After numerous test runs, we found that the behavior in the African and European markets are best represented by imposing a supply elasticity of 0.1 for all years. Supply elasticity in GNGM is:

Figure 85: Regional Supply Elasticity

	2018	2023	2028	2033	2038
Africa/Europe	0.10	0.10	0.10	0.10	0.10
U.S./Canada	0.30	0.39	0.49	0.59	0.68
All other regions	0.25	0.29	0.33	0.38	0.43

2. Demand Elasticity

All regions are assumed to have a short-run demand elasticity of -0.12 in 2018 and a long-run demand elasticity of -0.22 in 2038 except North America and Korea/Japan. The demand elasticities for Canada and the U.S. are derived based on average delivered price and consumption fluctuations reported in the EIA Study.[93] The demand elasticity in Korea/Japan is lowered below that of other regions to reflect greater inflexibility in these economies.

Figure 86: Regional Demand Elasticity

	2018	2023	2028	2033	2038
Korea/Japan	-0.06	-0.07	-0.08	-0.09	-0.11
U.S./Canada	-0.38	-0.41	-0.45	-0.48	-0.53
All other regions	-0.12	-0.14	-0.16	-0.19	-0.22

[93] U.S. EIA, “The Effects of Increased Natural Gas Exports on Domestic Energy Markets.”

G. Adders from Model Calibration[94]

Figure 87: Pipeline Cost Adders (2012$/Mcf)

Exporter	Importer	2018	2023	2028	2033	2038
Africa	Europe	$9.80	$9.89	$9.71	$9.46	$10.22
Africa	Middle East	$1.26	$1.20	$1.13	$1.06	$0.98
Canada	Canada	$0.18	$0.18	$0.18	$0.18	$0.18
FSU	China/India	$3.95	$3.41	$3.09	$3.18	$3.68
FSU	Europe	$6.85	$6.63	$6.11	$5.48	$5.83
FSU	FSU	$0.00	$0.00	$0.00	$0.01	$0.00
Korea/Japan	Korea/Japan	$0.00	$0.00	$0.00	$0.01	$0.01
Middle East	Europe	$10.40	$10.54	$10.43	$10.25	$11.09
Middle East	FSU	$3.55	$3.92	$4.32	$4.76	$5.25
Southeast Asia	China/India	$6.64	$6.38	$6.36	$6.79	$7.67
Sakhalin	FSU	$3.55	$3.92	$4.32	$4.76	$5.25
Sakhalin	Sakhalin	$1.99	$1.99	$1.99	$1.99	$1.99
U.S.	Mexico	$0.18	$0.31	$0.42	$0.52	$0.57

[94] Appendix B provides details on the generation of cost adders in GNGM.

Figure 88: LNG Cost Adders Applied to Shipping Routes (2012$/Mcf)

Exporter	Importer	2018	2023	2028	2033	2038
Africa	China/India	$0.00	$0.00	$0.00	$0.00	$0.19
Africa	Europe	$3.97	$4.03	$3.83	$3.56	$4.25
Africa	Korea/Japan	$1.95	$1.69	$1.73	$2.26	$3.30
Canada	Korea/Japan	$1.70	$0.90	$0.62	$0.88	$0.52
C & S America	China/India	$0.00	$0.00	$0.00	$0.00	$0.35
C & S America	Europe	$3.57	$3.58	$3.34	$3.03	$3.63
C & S America	Korea/Japan	$2.76	$2.47	$2.47	$2.96	$3.95
FSU	Europe	$1.44	$1.17	$0.60	$0.00	$0.16
Middle East	China/India	$0.88	$0.70	$0.75	$1.23	$2.14
Middle East	Europe	$3.76	$3.88	$3.75	$3.55	$4.30
Middle East	Korea/Japan	$3.55	$3.36	$3.48	$4.12	$5.29
Oceania	Korea/Japan	$0.31	$0.00	$0.00	$0.00	$0.44
Southeast Asia	China/India	$0.00	$0.00	$0.00	$0.03	$0.82
Southeast Asia	Korea/Japan	$3.07	$2.78	$2.79	$3.35	$4.44
Sakhalin	China/India	$2.23	$2.04	$2.10	$2.59	$3.51
Sakhalin	Korea/Japan	$5.88	$5.69	$5.82	$6.50	$7.74
U.S.	Europe	$3.07	$2.73	$2.31	$1.82	$1.09
U.S.	Korea/Japan	$2.06	$1.41	$1.23	$1.56	$1.21

H. Scenario Specifications

Figure 89: Domestic Scenario Conditions

	2018	2023	2028	2033	2038
Reference Case					
Production (Tcf)	25.86	27.65	29.46	30.69	32.35
Wellhead price ($/Mcf)	$3.43	$4.00	$4.44	$4.88	$6.45
Net Pipeline imports from Canada (Tcf)	1.73	0.91	0.97	1.03	0.63
Pipeline exports to Mexico (Tcf)	1.02	1.29	1.59	1.88	2.28
High Oil and Gas Resource					
Production (Tcf)	29.52	32.92	35.76	38.83	43.09
Wellhead price ($/Mcf)	$2.17	$2.23	$2.33	$2.65	$3.22
Net Pipeline imports from Canada (Tcf)	1.61	0.49	0.42	0.55	0.41
Pipeline exports to Mexico (Tcf)	1.09	1.46	1.86	2.29	2.87
Low Oil and Gas Resource					
Production (Tcf)	23.97	24.81	25.62	26.07	26.60
Wellhead price ($/Mcf)	$4.32	$5.26	$6.06	$6.64	$8.39
Net Pipeline imports from Canada (Tcf)	1.73	0.91	0.97	1.03	0.63
Pipeline exports to Mexico (Tcf)	0.97	1.19	1.42	1.61	1.87

Figure 90: Incremental Worldwide Natural Gas Demand under International Demand Shock and Supply/Demand Shock Scenarios (in Tcf of Natural Gas Equivalents)

	2018	2023	2028	2033	2038
Japan and Korea convert nuclear to gas	4.18	4.74	5.26	5.52	5.66

Sources: EIA *IEO 2013* Nuclear energy consumption, reference case

Figure 91: Scenario Export Capacity (Tcf)

LNG Export Capacity Scenarios	2018	2023	2028	2033	2038
Low/Slowest	0.73	1.64	2.19	2.19	2.19
Low/Slow	1.46	2.19	2.19	2.19	2.19
Low/Rapid	2.19	2.19	2.19	2.19	2.19
High/Slow	1.46	3.28	4.38	4.38	4.38
High/Rapid	4.38	4.38	4.38	4.38	4.38
No Constraint	∞	∞	∞	∞	∞

Source: EIA Study

APPENDIX B: DESCRIPTION OF MODELS

A. Global Natural Gas Model

The GNGM is a partial-equilibrium model designed to estimate the amount of natural gas production, consumption, and trade by major world natural gas consuming and/or producing regions. The model maximizes the sum of consumers' and producers' surplus, less transportation costs, subject to mass balancing constraints and regasification, liquefaction, and pipeline capacity constraints.

1. Model Calibration

The model is calibrated to match the EIA's *IEO 2013* and *AEO 2013* Reference case natural gas production, consumption, wellhead, and delivered price forecasts, after adjusting the *AEO 2013* and *IEO 2013* production and consumption forecasts so that:

- Global supply equaled global demand;
- U.S. pipeline trade with Canada equaled total U.S. net imports with Canada as defined by the *AEO 2013* Reference case;
- U.S. pipeline trade with Mexico equaled total U.S. net exports with Mexico as defined by the *AEO 2013* Reference case;
- Middle East LNG annual exports were capped at 4.88 Tcf, which meant that for the Middle East:
    - Production ≤ Demand + Min(Liquefaction capacity, LNG export cap);
- FSU pipeline capacity satisfied the expression:
    - Production ≤ Demand + Pipeline Export Capacity;
- Regasification capacity satisfied the expression for LNG importing regions:
    - Production ≤ Supply + Regasification Capacity; and
- Sufficient liquefaction capacity exists in LNG exporting regions :
    - Production ≤ Demand + Liquefaction Capacity + Pipeline Export Capacity.

The GNGM assumes that the global natural gas market is composed of a perfectly competitive group of countries with a dominant supplier that limits exports. Therefore, if we simply added the competitive transportation costs to transport natural gas among regions, the model would not find the market values and would be unable to match the EIA's forecasts because the global natural gas market is not perfectly competitive and, at its current scale, includes important risks and transaction costs. For example, the city gate prices in the Korea/Japan region represent not only the cost of delivering LNG to this region but also this region's willingness to pay a premium above the market price to ensure a stable supply of imports.

Therefore in order to represent the reality of today's imperfectly competitive market and to calibrate the GNGM to the EIA's price and volume forecasts, we had to introduce cost adders that represented the real world cost differentials, including these transaction costs. To derive these cost adders, we developed a least-squares algorithm that solved for these adders. The least-squares algorithm minimized the sum of the inter-region pipeline and LNG shipping cost adders subject to matching the EIA's natural gas production, consumption, wellhead, and city gate prices for each region (see Appendix A for the resulting cost adders).

These pipeline and LNG shipping cost adders were added to the original pipeline and LNG shipping costs, respectively, to develop adjusted pipeline and LNG shipping costs. The GNGM made use of these adjusted transportation costs in all the model runs.

These adders can be interpreted in several ways consistent with their function in the GNGM:

- As transaction costs that could disappear as the world market became larger and more liquid, in the process shifting downward the demand curve for assured supplies in the regions where such a premium now exists;
- As a leftover from long-term contracts and therefore a rent to producers that will disappear as contracts expire and are renegotiated; and
- As a rent taken by natural gas utilities and traders within the consuming regions, that would either continue to be taken within importing countries or competed away if there were more potential suppliers.

Under all of these interpretations, the amount of the adder would not be available to U.S. exporters, nor would it be translated into potentially higher netback prices to the United States.

2. Input Data Assumptions for the Model Baseline

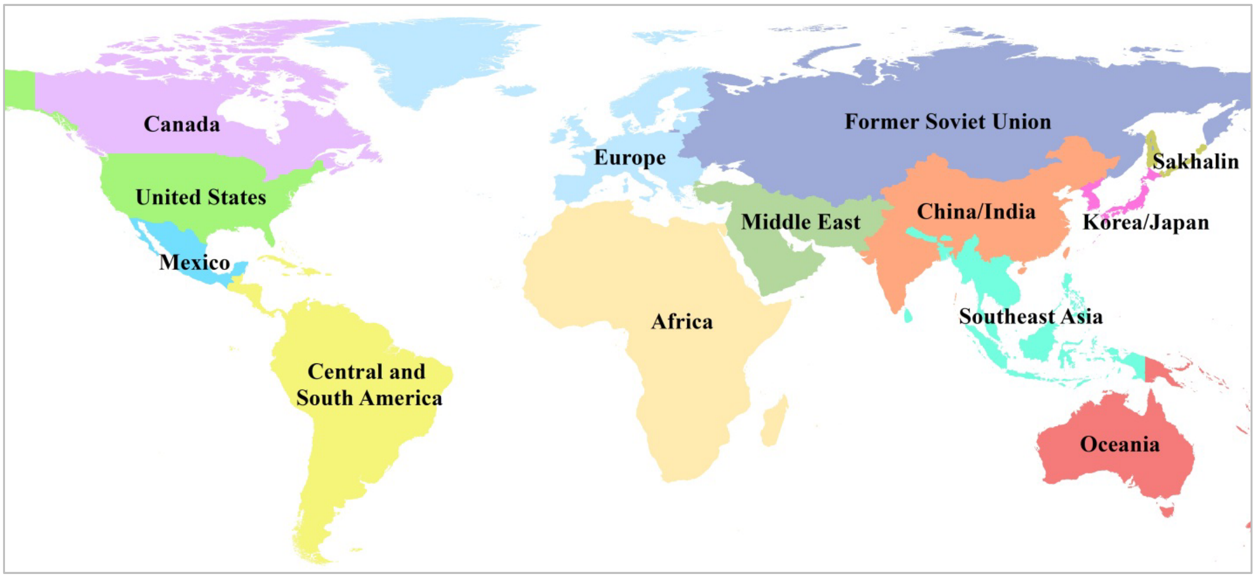
a. GNGM Regions

The GNGM regional mapping scheme is largely adapted from the EIA's *IEO 2013* regional definitions with modifications to address the LNG-intensive regions.

- OECD Regions: the OECD region of Americas maps to GNGM regions United States, Canada, Mexico, and Central and South America; OECD Europe maps to GNGM Europe; OECD Asia maps to GNGM Korea-Japan and Oceania.
- Non-OECD Regions: the non-OECD regions of Eurasia and Europe map to GNGM regions FSU and Sakhalin; Non-OECD Asia maps to China-India and Southeast Asia; Middle East maps to GNGM Middle East; Africa to GNGM Africa; Non-OECD Central and South America maps to GNGM Central and South America.

- Sakhalin is a Russian island just north of Japan. All Russian or FSU LNG exports in 2012 were produced in Sakhalin.[95] This island is characterized as a pure supply region with zero demand and adopted as a separate GNGM region from the rest of the FSU for its proximity to the demand regions. Its LNG production in 2010 is set equal to the FSU's LNG exports in 2010 and grows at a rate of 1.6% per annum for the subsequent years.[96]

Figure 92: Map of the Thirteen Regions in the GNGM



b. Time Horizon

GNGM reads in forecast data from each year and outputs the optimized gas trade flows. The model's input data currently covers years 2018 through 2038, but can be readily extended given data availability. For this analysis, we solved the model in five-year time steps starting with 2018.

c. Projected World Natural Gas Production and Consumption

The model's international natural gas consumption and production projections are based upon the *IEO 2013* Reference case. GNGM assumes three different future U.S. natural gas markets: the *AEO 2013* Reference case is adopted as the baseline and two other U.S. futures are obtained with the following modifications.

- HOGR: U.S. natural gas production and wellhead prices are replaced by the *AEO 2013* High Oil and Gas Resource projections.

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[95] "The LNG Industry 2012," GIIGNL. Available at: http://www.giignl.org/publications.

[96] The 1.6% per annum rate corresponds to *IEO 2013* projected Russian natural gas production average annual growth rate for 2010 through 2040.

- LOGR: U.S. natural gas production and wellhead prices are replaced by the *AEO 2013* Low Oil and Gas Resource projections.

d. Natural Gas Production and Consumption Prices

NERA has developed a set of world natural gas price projections based upon a number of data sources. The approach focuses on the wellhead price forecasts for net export regions and city gate price forecasts for net import regions. In naturally gas-abundant regions like the Middle East and Africa, the wellhead price is assumed to equal the natural gas extraction cost or lifting cost. City gate prices are estimated by adding a transportation cost to the wellhead prices.

In the major demand markets, natural gas prices are determined on an oil-parity basis using crude oil price forecasts from International Energy Agency's World Energy Outlook (IEA's *WEO) 2013*. The resultant prices are highly consistent with the relevant historical pipeline import prices[97] and LNG spot market prices, as well as various oil and natural gas indices (*i.e.,* JCC, WTI, Henry Hub, AECO Hub indices, and UK NBP). U.S. wellhead and average city gate prices are adopted from *AEO 2013*. Canadian wellhead and city gate prices are projected to be $0.35 less than the U.S. prices in the Reference case. A region-by-region price forecast description is presented later.

e. Natural Gas Transport Options

Pipelines

GNGM assumes that all intra-regional pipeline capacity constraints are non-binding. Each region is able to transport its indigenously-produced natural gas freely within itself at an appropriate cost.

Twenty six inter-regional pipeline routes are acknowledged in GNGM. The following pipelines are a sample of the pipelines found in the GNGM: the Africa-to-Europe route, including the Greenstream Pipeline, Trans-Mediterranean Pipeline, Medgaz Pipeline, Maghreb–Europe Gas Pipeline, and Galsi Pipeline, is assigned a total capacity of 2.51Tcf/year (connecting Northern Africa to Spain, Portugal, and Italy); the Turkmenistan–China Gas Pipeline, connecting FSU to China/India, has a maximum discharge of 1.41 Tcf/year; and the U.S.–Canada pipeline route, which is open and assumed to have unlimited capacity.

LNG Routes

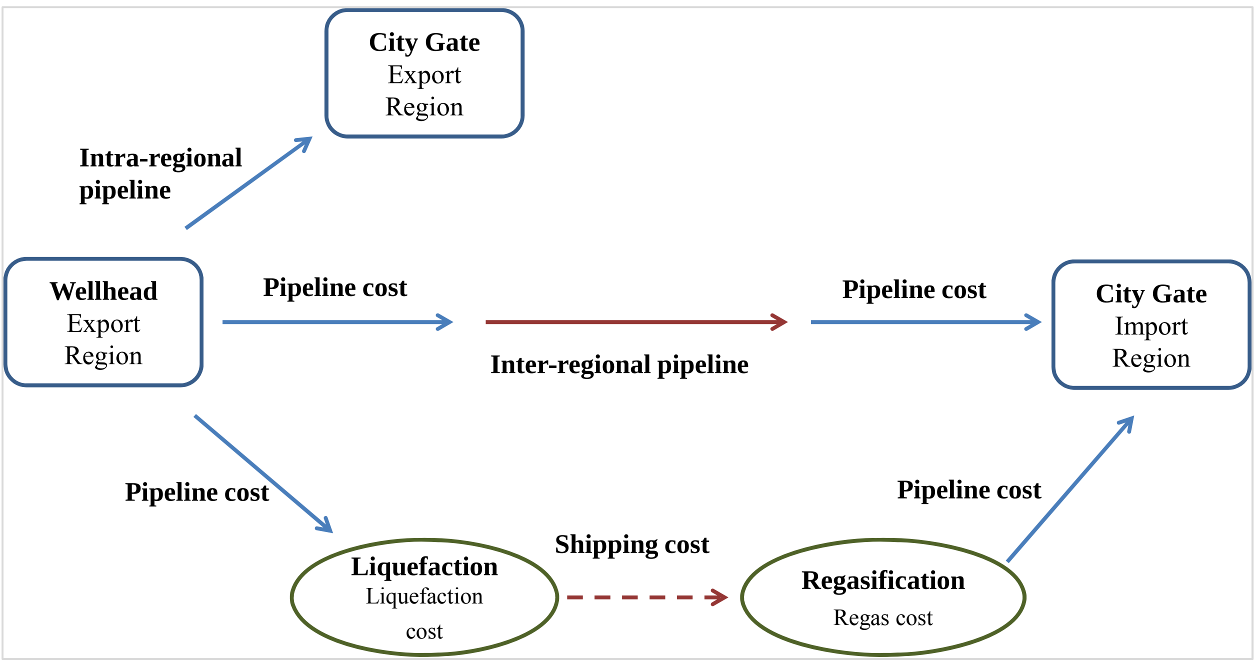
GNGM sets two constraints on LNG transportation. Each export region is subjected to a liquefaction capacity constraint and each import region to a regasification capacity constraint. There are five components in transporting LNG (Figure 93), and capacity constraints on the

[97] German BAFA natural gas import border price, Belgium Zeebrugge spot prices, TTF Natural Gas Futures contracts, *etc*.

wellhead to liquefaction pipeline, LNG tankers, and regasification to city gate pipeline are assumed to be non-binding.

LNG transportation costs are generally four to seven times higher than the pipeline alternative since, to satisfy natural gas demand with LNG, shipments incur five segments of costs: 1) pipeline shipping cost to move gas from the wellhead to the liquefaction facility, 2) liquefaction cost, 3) shipping cost between the liquefaction to regasification facilities, 4) regasification cost and 5) the pipeline shipping cost to move gas from the regasification facility to the city gate terminal in the demand region. A detailed cost breakdown for each leg of this process is presented in Appendix A.

Figure 93: Natural Gas Transport Options



f. Fuel Supply Curves

The supply of natural gas in each region is represented by a CES supply curve (see Equation 1). The supply curve provides a relationship between the supply of gas (Q) and the wellhead price of gas (P). The elasticity of the supply curves dictates how the price of natural gas changes with changes in production.

Equation 1: CES Supply Curve

$$\mathbf{Q(t) / Q_{0,t} = (P(t) / P_{0,t})^{\text{elasticity of supply}}}$$

Each supply curve is calibrated to the benchmark data points ($Q_{0.t}$, $P_{0.t}$) for each year t, where the benchmark data points represent those of the EIA's adjusted forecasts. $Q_{0.t}$ represents the EIA's adjusted forecasted quantity of natural gas production for year t, and $P_{0.t}$ represents the EIA's forecasted wellhead price of gas for year t. The elasticity of supply for all regions is included in Appendix A.

g. Fuel Demand Curves

The demand curve for natural gas has a similar functional form as the supply curve. As with the supply curves, the demand curve in each region is represented by a CES function (see Equation 2). The demand curve provides a relationship between the demand for gas (Q) and the city gate price of gas (P). The demand curves dictate how the price of natural gas changes with changes in demand in each region.

Equation 2: CES Demand Curve

$$Q(t) / Q_{0,t} = (P(t) / P_{0,t})^{\text{elasticity of demand}}$$

Each demand curve is calibrated to the benchmark data points ($Q_{0.t}$, $P_{0.t}$) for each year t, where the benchmark data points represent those of the EIA's adjusted forecasts. $Q_{0.t}$ represents the EIA's adjusted forecasted demand for natural gas for year t and $P_{0.t}$ represents the EIA's forecasted city gate price of gas for year t. The elasticity of demand for all regions except the U.S. is based on the elasticities used in MIT's Emissions Prediction and Policy Analysis (EPPA) model.[98] For the U.S., the demand elasticity was estimated by using the percentage changes in natural gas demand and city gate prices between the EIA *AEO 2011* Reference scenario and the different shale gas scenarios.

3. Model Formulation

The GNGM is formulated as a non-linear program. The following text describes at a high level the GNGM's non-linear objective function and linear constraints.

Maximize: Consumer Surplus + Producer Surplus – Transportation Costs
Subject to:

$$Supply(s) = \sum_{d} PipeGas(s,d) + LNG(s,d)$$
$$Demand(d) = \sum_{s} PipeGas(s,d) + LNG(s,d)$$
$$\sum_{d} LNG(s,d) \leq LiquefactionCapacity(s)$$
$$\sum_{s} LNG(s,d) \leq RegasificationCapacity(d)$$
$$PipeGas(s,d) \leq PipelineCapacity(s,d)$$
$$PipeGas('Canada', 'USA') = BaselinePipeGas('Canada', 'USA')$$

98 "The MIT Emissions Prediction and Policy Analysis Model: Version 4," Sergey Paltsev, John M. Reilly, Henry D. Jacoby, Richard S. Eckaus, James McFarland, Marcus Sarofim, Malcolm Asadoorian and Mustafa Babiker, August 2004.

Scenario Constraints
* Quota Constraint

$$\sum_{d} LNG('USA', d) \leq Quota$$

* Supply Shock

$$\sum_{d} LNG('Oceania', \mathrm{d}) + LNG('Africa', d) + LNG('SouthEastAsia', d) \leq MaxExports$$

Consumer Surplus = $\int CityGatePrice(d)\ x\ (\frac{Demand(d)}{Demand0(d)})^{(\frac{1}{ElasOfDemand(d)})}$

Producer Surplus= $\int WellheadPrice(s)\ x\ (\frac{Supply(s)}{Supply0(s)})^{(\frac{1}{ElasOfSupply(s)})}$

Transportation Costs =

$$\sum_{s,d} ShipCost(s,d)\ x\ LNG(s,d) + \sum_{s,d} PipeLineCost(s,d)\ x\ PipeGas(s,d) + \sum_{s,d} RegasCost(d)\ x\ LNG(s,d) + \sum_{s,d} LiquefactionCost(s)\ x\ LNG(s,d)$$

where,
LiquefactionCost(s) = Cost to liquefy natural gas in region s + transport the gas from the wellhead to the liquefaction facility within region s.
RegasCost(d) = Cost to re-gasify natural gas in region d + transport the gas from the regasification facility to the city gate within region d.
PipelineCost(s,d) = Cost to transport natural gas along a pipeline from supply region s to demand region d.
ShipCost(s,d) = Cost to ship natural gas from supply region s to demand region d.
Quota = Maximum allowable amount of U.S. LNG exports. This varies by time period and scenario.

The supply curves capture the technological issues (penetration rate, availability, and cost) for natural gas in each region. The demand curves for natural gas capture the change in utility from consuming natural gas.

The main constraints are applied to all cases while scenario constraints are case specific. The demand shocks are modeled by changing the baseline level of natural gas demand ($Demand_0(d)$).

B. N$_{ew}$ERA Model

1. Overview of the N$_{ew}$ERA Macroeconomic Model

The N$_{ew}$ERA macro model is a forward-looking, dynamic, computable general equilibrium model of the United States. The model simulates all economic interactions in the U.S. economy, including those among industry, households, and the government. The economic interactions are based on the IMPLAN[99] 2008 database for a benchmark year, which includes regional detail on economic interactions among 440 different economic sectors. The macroeconomic and energy forecasts that are used to project the benchmark year going forward are calibrated to the most recent *AEO 2013* produced by the EIA. Because the model is calibrated to an internally-consistent energy forecast, the use of the model is particularly well-suited to analyze economic and energy policies and environmental regulations.

2. Model Data (IMPLAN and EIA)

The economic data is taken from the IMPLAN 2008 database, which includes balanced Social Accounting Matrices for all states in 2008. These inter-industry matrices provide a snapshot of the economy. Since the IMPLAN database contains only economic values, we benchmark energy supply, demand, trade, and prices to EIA historical statistics to capture the physical energy flows. The integration of the EIA energy quantities and prices into the IMPLAN economic database results in a balanced energy-economy dataset.

Future economic growth is calibrated to macroeconomic GDP, energy supply, energy demand, and energy price forecasts from the EIA *AEO 2013*. Labor productivity, labor growth, and population forecasts from the U.S. Census Bureau are used to project labor endowments along the baseline and ultimately employment by industry.

3. Brief Discussion of Model Structure

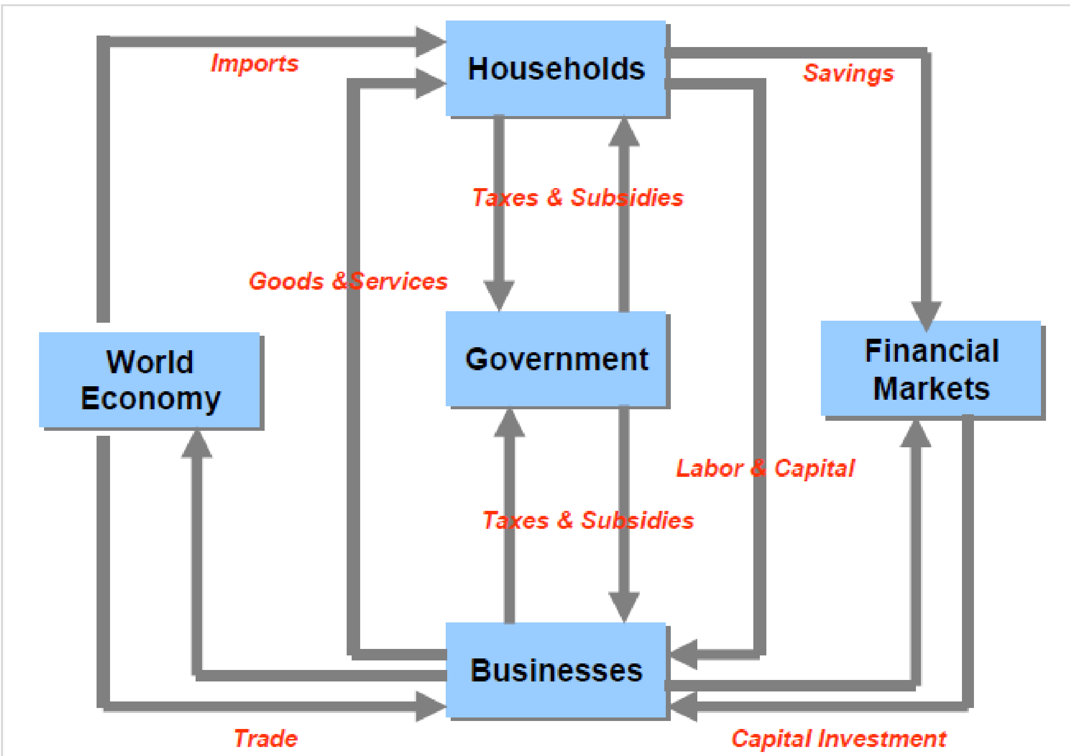
The theoretical construct behind the N$_{ew}$ERA model is based on the circular flow of goods, services, and payments in the economy (every economic transaction has a buyer and a seller whereby goods/service go from a seller to a buyer and payment goes from the seller to the buyer). As shown in Figure 94, the model includes households, businesses, government, financial markets, and the rest of the world economy as they interact economically in the global economy. Households provide labor and capital to businesses, taxes to the government, and savings to financial markets, while also consuming goods and services and receiving government subsidies. Businesses produce goods and services, pay taxes to the government and use labor and capital. Businesses are both consumers and producers of capital for investment in the rest of

[99] IMPLAN produces unique set of national structural matrices. The structural matrices form the basis for the inter-industry flows which we use to characterize the production, household, and government transactions, see www.implan.com.

the economy. Within the circular flow, equilibrium is found whereby goods and services consumed is equal to those produced and investments are optimized for the long term. Thus, supply is equal to demand in all markets.

The model assumes a perfect foresight, zero profit condition in production of goods and services, no changes in monetary policy, and full employment within the U.S. economy.

Figure 94: Circular Flow of Income

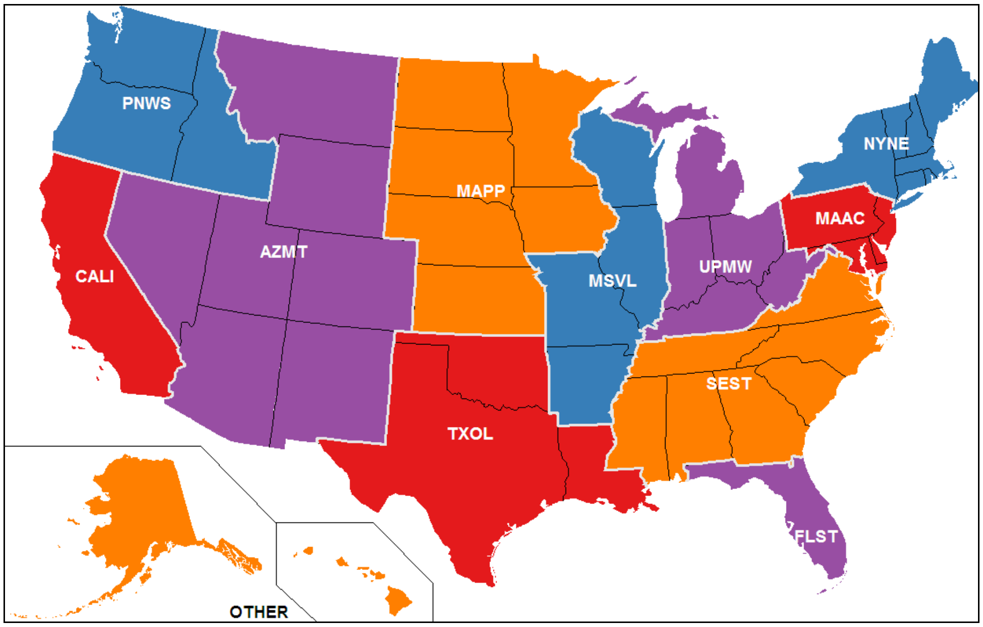


a. Regional Aggregation

The N$_{ew}$ERA macro model includes 11 regions: NYNE-New York and New England; MAAC-Mid-Atlantic Coast; UPMW-Upper Mid-West; SEST-South East; FLST-Florida; MSVL-Mississippi Valley; MAPP-Mid America; TXOL-Texas, Oklahoma, and Louisiana; AZMT-Arizona and Mountain states; CALI-California; and PNWS-Pacific Northwest.[100] The aggregate model regions are built up from the 50 U.S. states' and the District of Columbia's economic data. The model is flexible enough to create other regional specifications, depending upon the need of the project. The 11 N$_{ew}$ERA regions and the States within each N$_{ew}$ERA region are shown in the following figure. For this Study we aggregate the 11 N$_{ew}$ERA regions into a single U.S. region.

[100] Hawaii and Alaska are included in the PNWS region.

Figure 95: N$_{ew}$ERA Macroeconomic Regions



b. Sectoral Aggregation

The N$_{ew}$ERA model includes 14 sectors: six energy sectors (coal, natural gas, ethane, crude oil, electricity, and refined petroleum products) and eight non-energy sectors (services, manufacturing, energy-intensive, petrochemicals, agriculture, and commercial transportation excluding trucking and motor vehicles). These sectors are aggregated up from the 440 IMPLAN sectors to 28 sectors, defined as the *AEO 2013* sector in Figure 96. These 28 sectors' economic and energy data are consistent with IMPLAN and EIA, respectively. For this study, we further aggregate these 28 production sectors into 14 sectors. The mapping of the sectors is shown below in Figure 96. The model has the flexibility to represent sectors at any level of aggregation.

For this project, we divided natural gas production into dry gas and ethane. Ethane can only be consumed by the petrochemicals sector.

Figure 96: N_{ew}ERA Sectoral Representation in Core Scenarios[101]

	N_{ew}ERA	AEO	
Final Demand	C	C	Household consumption
	G	G	Government consumption
	I	I	Investment demand
Energy Sectors	COL	COL	Coal
	GAS	GAS	Natural gas
	OIL	OIL	Refined Petroleum Products
	CRU	CRU	Crude oil
	ELE	ELE	Electricity
Non-Energy Sectors	AGR	AGR	Agriculture
	TRN	TRN	Transportation
	TRK	TRK	Trucking
	M_V	M_V	Motor vehicle
	SRV	SRV	Services
	SRV	DWE	Dwellings
	EIS	PAP	Paper and Pulp
	EIS	CHM	Chemicals
	EIS	GLS	Glass Industry
	EIS	CMT	Cement Industry
	EIS	I_S	Primary Metals
	EIS	ALU	Alumina and Aluminum
	MAN	CNS	Construction
	MAN	MIN	Mining
	MAN	FOO	Food, Beverage and Tobacco Products
	MAN	FAB	Fabricated Metal Products
	MAN	MAC	Machinery
	MAN	CMP	Computer and Electronic Products
	MAN	TRQ	Transportation Equipment
	MAN	ELQ	Electrical Equip., Appliances, and Components
	MAN	WOO	Wood and furniture
	MAN	PLA	Plastics
	MAN	OMA	Other Manufacturing sectors

In order to improve our understanding of the impacts on the chemical sector from increased gas production that arises with LNG exports, we disaggregated the bulk chemicals sector from the EIS sector described in the previous sections. The bulk chemicals sectors consist of 22 chemicals subsectors grouped under the 3-digit NAICS 325 classification. These subsectors of the chemical industry rely on natural gas in different ways. To simplify the analysis, we first disaggregate bulk chemicals into gas-intensive and non-gas-intensive subsectors, shown in Figure 60, based on the value share of natural gas as an input. We classify a chemicals subsector to be gas-intensive if the natural gas input value share is greater than 1%: otherwise we group it into the non-gas-intensive subsector. Based on this assumption, ten subsectors are grouped into a gas-intensive sector and 12 subsectors are grouped as a non-gas-intensive sector (Figure 97).

[101] We expand our default sectoral definition for the chemicals analysis to include ethane as an additional commodity and three additional sectors representing chemicals subsectors. We describe these additions in detail in Chapter VIII.

Based on the underlying economic data from the IMPLAN dataset, the gas-intensive subsector accounted for about 40% of the bulk chemicals' shipment value in 2008, which rose to about 50% in 2011, according to the Census Bureau data (Figure 60). The gas-intensive subsector accounted for about 30% of the total chemicals sector employment of 848,000 in 2008.

Figure 97: Comparison of Chemical Industry Subsectors

Chemicals Sector	Subsector Description	NAICS Code	2008*				2011**		
			Employment ('000s)	Output ($Billions)	Value Added ($Billions)	Natural gas input share (%)	Employment ('000s)	Value Added ($Billions)	Output ($Billions)
Gas intensive	Petrochemical manufacturing	32511	27.2	155.6	27.9	2.8			87.3
	Synthetic dye and pigment manufacturing	32513	16.6	12.2	2.5	1.4			8.0
	Alkalies and chlorine manufacturing	325181	7.8	9.3	1.7	4.7			6.8
	Carbon black manufacturing	325182	1.8	2.0	0.4	5.0			1.7
	Other basic organic chemical manufacturing	32519	44.1	106.6	9.8	3.0			101.1
	Synthetic rubber manufacturing	325212	13.1	10.4	2.0	1.6			8.9
	Fertilizer manufacturing	325311-4	22.2	25.5	3.3	13.2			24.1
	Industrial gas manufacturing	32512	18.1	21.9	6.4	1.9			7.4
	Plastics material and resin manufacturing	325211	60.8	64.3	13.0	2.6			87.6
	All other basic inorganic chemical manufacturing	325188	32.3	26.8	6.6	1.7			27.9
	Sub-total		244.0	434.6	73.7			-	360.9
Non-gas intensive	Artificial and synthetic fibers and filaments manufacturing	32522	31.6	24.0	4.2	1.0			8.0
	Pesticide and other agricultural chemical manufacturing	325320	14.3	27.1	7.7	0.4			12.2
	Medicinal and botanical manufacturing	325411	23.9	15.0	5.5	0.3			10.9
	Pharmaceutical preparation manufacturing	325412	225.4	314.7	105.6	0.2			122.1
	In-vitro diagnostic substance manufacturing	325413	15.8	7.6	2.4	0.1			11.4
	Biological product (except diagnostic) manufacturing	325414	24.4	25.4	7.5	0.2			22.8
	Paint and coating manufacturing	32551	42.5	26.4	5.7	0.1			22.1
	Adhesive manufacturing	32552	20.8	11.5	2.5	0.2			10.2
	Soap and cleaning compound manufacturing	32561	52.2	62.9	18.1	0.4			51.0
	Toilet preparation manufacturing	32562	53.9	49.5	15.1	0.7			35.8
	Printing ink manufacturing	32591	11.6	5.6	1.2	0.1			5.7
	All other chemical product and preparation manufacturing	32592, 32599	87.6	48.2	11.5	0.4			43.1
	Sub-total		604.0	618.1	187.2	4.1		-	355.1
	Total		848.0	1,052.7	260.9	4.1	785.0	253.5	716.0

* IMPLAN

** Industrial Statistics Portal, Census Bureau. http://www.census.gov/econ/isp/sampler.php?naicscode=325&naicslevel=3

c. Production and Consumption Characterization

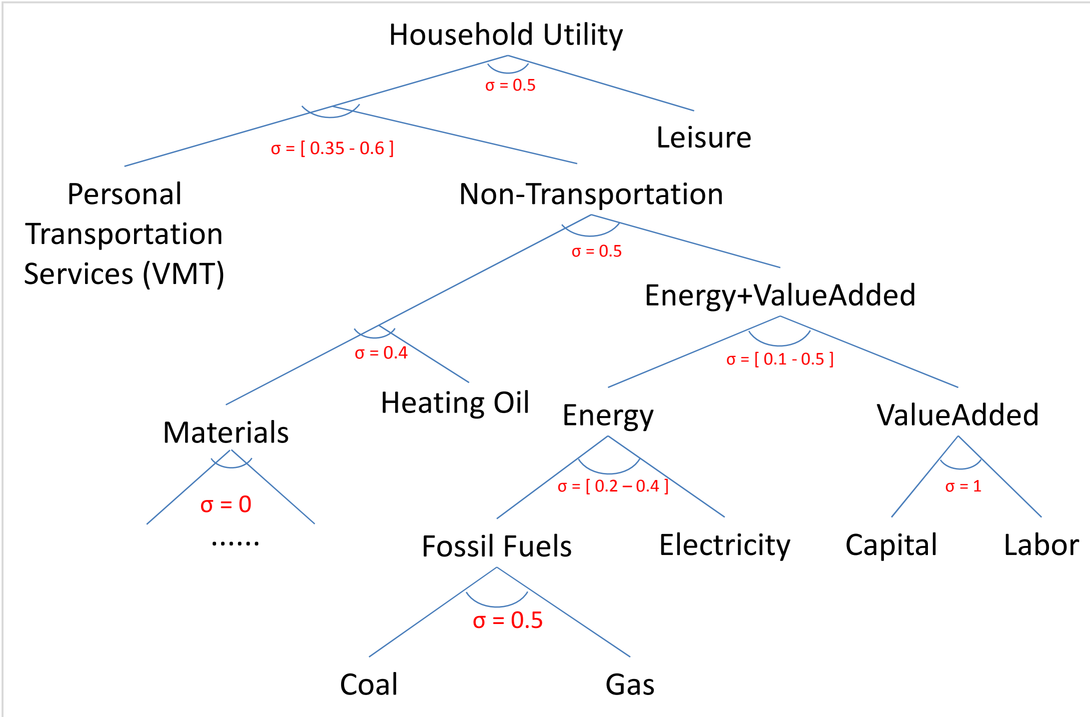
Behavior of households, industries, investment, and government is characterized by nested CES production or utility functions. Under such a CES structure, inputs substitute against each other in a nested form. The ease of substitutability is determined by the value of the elasticity of substitution between the inputs. The greater the value of the substitution elasticity, between the inputs, the greater the possibility of tradeoffs.

The CES nesting structure defines how inputs to a production activity compete with each other. In the generic production structure, intermediate inputs are aggregated in fixed proportion with a composite of energy and value-added inputs. The energy input aggregates fossil and non-fossil energy sources, and the value-added input combine capital and labor. Sectors with distinctive production characteristics are represented with structures different from the generic form. For alternative transportation fuels, such as ethanol and bio-diesel, inputs are demanded in fixed proportion. The characterization of nonrenewable resource supply adds a fixed resource that is calibrated to a declining resource base over time, so that it implies decreasing returns to scale. This also implies rising marginal costs of production over time for exhaustible resources. The detailed nesting structure of the households and production sectors, with assumed elasticity of substitution parameters, is shown in figures below.

i. Households

Consumers are represented by a single representative household. The representative household derives utility from both consumption of goods and services, transportation services, and leisure. The utility is represented by a nested CES utility function. The elasticity of substitution parameters between goods are shown in Figure 98.

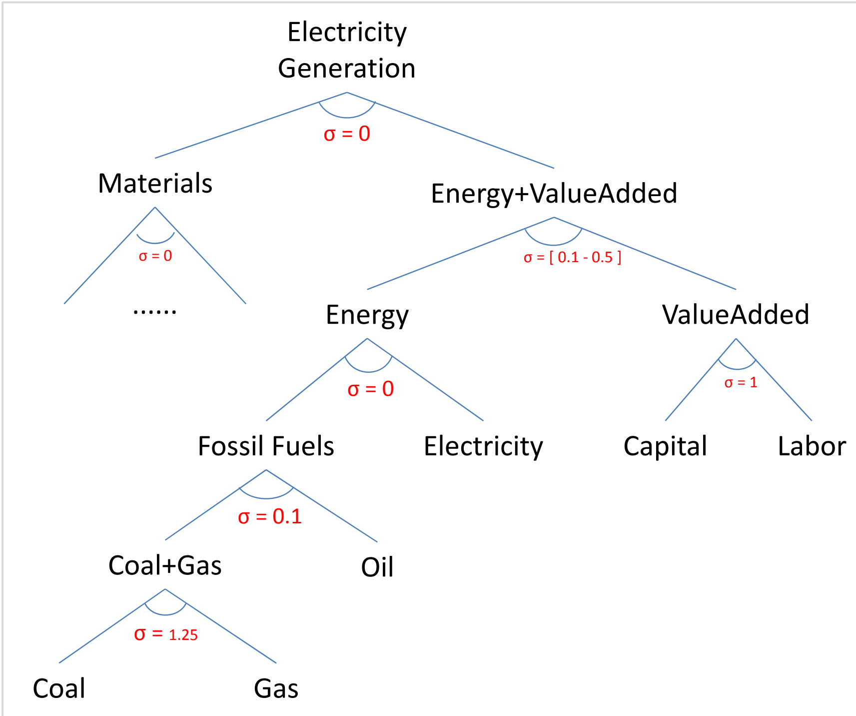
Figure 98: N$_{ew}$ERA Household Representation



ii. Electric Sector

We assume a simple representation of the electric sector. The electric sector models natural gas, coal, and oil-fired generation. The representation of the production is shown below.

Figure 99: N_{ew}ERA Electricity Sector Representation



iii. Other Sectors

The trucking and commercial transportation sector production structure is shown in Figure 100. The trucking sector uses diesel as transportation fuel. This sector has limited ability to substitute other fossil fuels. The other industrial sectors (agriculture, manufacturing, energy-intensive, motor vehicles) and the services sector production structure, with assumed elasticity of substitution, are shown in Figure 101.

Figure 100: N$_{ew}$ERA Trucking and Commercial Transportation Sector Representation

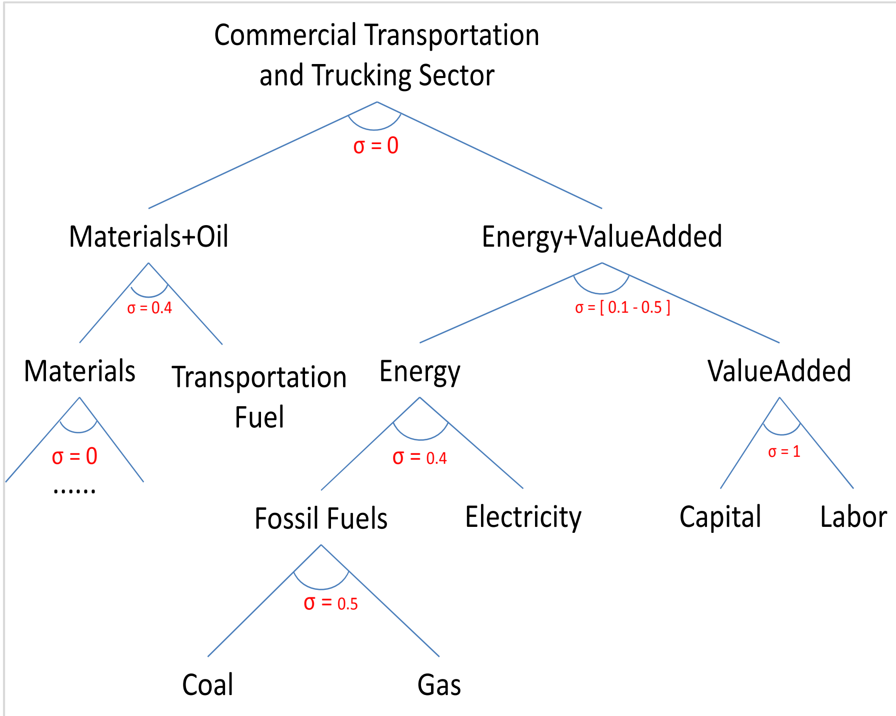
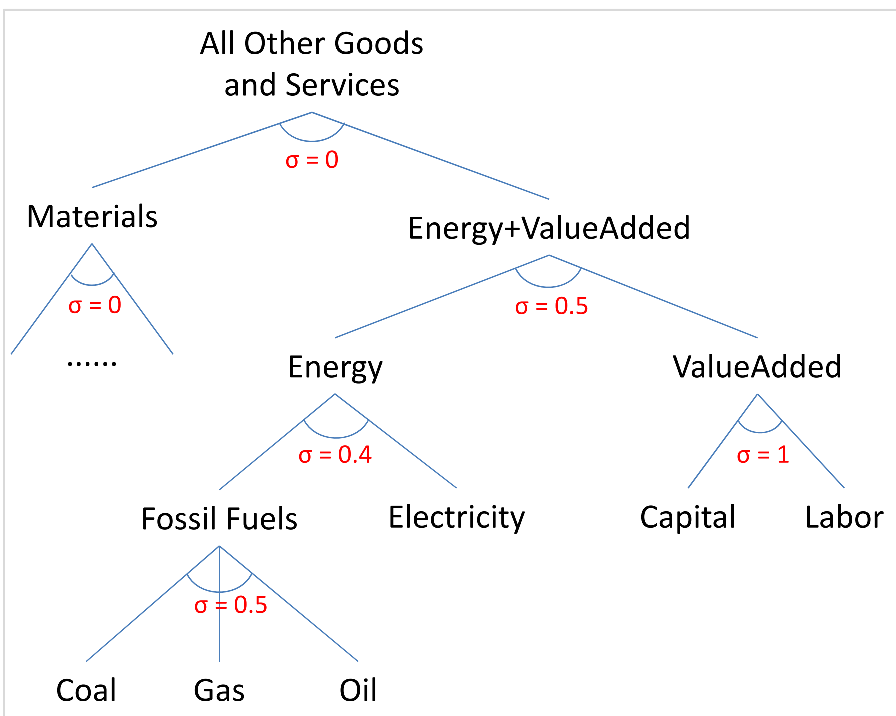


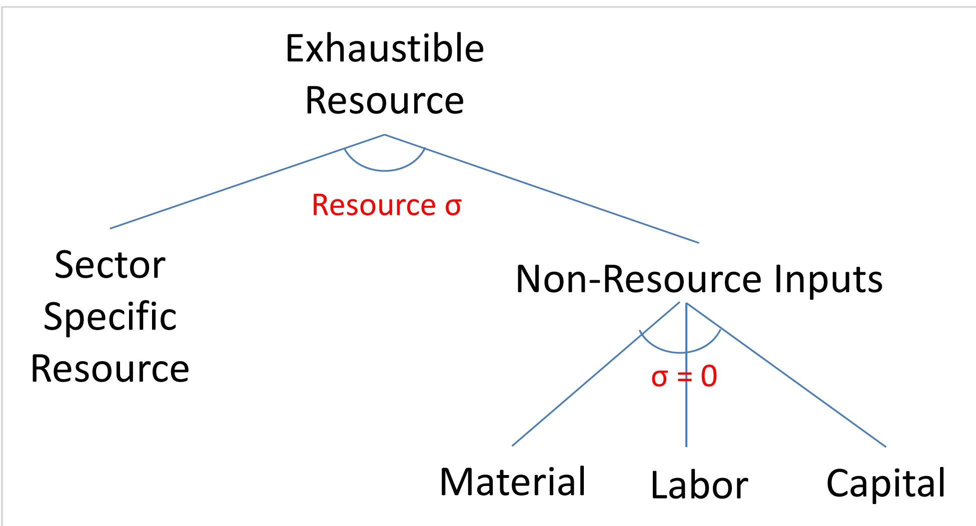
Figure 101: N$_{ew}$ERA Other Production Sector Representation



iv. Exhaustible Resource Sector

The simplest characterization of non-renewable resource supply adds a fixed resource that is calibrated to decline over time, so that the decreasing returns to scale implied for the non-resource inputs lead to rising marginal costs of production over time. The top level elasticity of substitution parameter is calibrated to be consistent with resource supply elasticity. We assume the natural gas resource supply elasticity varies with the U.S. natural gas supply scenario. For the Reference scenario, the elasticity of supply for natural gas begins at 0.3 and increases to 0.7 by 2038. Crude oil and coal supply elasticities are invariant across the natural gas supply baselines. Crude oil supply elasticity is assumed to be 0.3 in 2013 and 1.0 in 2038. Coal supply elasticity is assumed to be 0.4 in 2010 and 1.5 in 2038. The production structure of natural gas, crude oil, and coal is shown below.

Figure 102: N_{ew}ERA Resource Sector Representation



d. Trade Structure

All goods and services, except crude oil, are treated as Armington goods, which assume that domestic and foreign goods are differentiated and thus, are imperfect substitutes. The level of imports depends upon the elasticity of substitution between the imported and domestic goods. The Armington elasticity among imported goods is assumed to be twice as large as the elasticity between domestic and aggregate imported goods, characterizing greater substitutability among imported goods.

We balance the international trade account in the N_{ew}ERA model by constraining changes in the current account deficit over the model horizon. The condition is that the net present value of the foreign indebtedness over the model horizon remains at the benchmark year level. This prevents distortions in economic effects that would result from perpetual increases in borrowing, but does not overly constrain the model by requiring current account balances in each year.

This treatment of the current account deficit does not mean that there cannot be trade benefits from LNG exports. Although trade will be in balance over time, the terms of trade shift in favor of the U.S. because of LNG exports. That is, by exporting goods of greater value to overseas customers, the U.S. is able to import larger quantities of goods than it would able to if the same domestic resources were devoted to producing exports of lesser value. Allowing high-value exports to proceed has a similar effect on terms of trade as would an increase in the world price of existing exports or an increase in productivity in export industries. In all these cases, the U.S. gains more imported goods in exchange for the same amount of effort being devoted to production of goods for export. The opposite is also possible, in that a fall in the world price of U.S. exports or a subsidy that promoted exports of lesser value would move the terms of trade against the U.S., in that with the same effort put into producing exports the U.S. would receive less imports in exchange and terms of trade would move against the U.S. The fact that LNG will be exported only if there is sufficient market demand ensures that terms of trade will improve if LNG exports take place.

e. Investment Dynamics

Periods in the model are linked by capital and investment dynamics. Capital turnover in the model is represented by the standard process that capital at time $t + 1$ equals capital at time t plus investment at time t minus depreciation. The model optimizes consumption and savings decisions in each period, taking account of changes in the economy over the entire model horizon with perfect foresight. The consumers forego consumption to save for current and future investment.

f. Model Assumptions

The underlying assumptions of labor growth and initial capital stock drive the economy over time in the model.

The model assumes full employment in the labor market. This assumption means total labor demand in a policy scenario would be the same as the baseline labor projection. The baseline labor projections are based on population growth and labor productivity forecasts over time. Hence, the labor projection can be thought to be a forecast of efficient labor units. The model assumes that labor is fungible across sectors. That is, labor can move freely out of a production sector into another sector without any adjustment costs or loss of productivity. Capital, on the other hand, is vintaged in the model. We assume two types of capital stock to portray the current technology and more advanced technologies that develop over time. A non-malleable capital (the clay) is used in fixed proportion in the existing production activity. The clay portion of the capital decays over time as new capital replaces it. A malleable capital (the putty) is used in new production activity. The putty capital in the new production activity can substitute against other inputs. The replacement of the clay capital depends upon the extent of use of new capital. This gradual capital turnover of the fixed capital stock and costs associated with it is represented by the putty-clay formulation.

Energy intensities are calibrated to the EIA projections. The differentiated energy intensities across regions result in different responses in energy supply and demand as energy price changes.

The N_{ew}ERA macroeconomic model includes a simple tax representation. The model includes only two types of input taxes: marginal tax rates on capital and labor. The tax rates are based on the NBER TAXSIM model. Other indirect taxes such as excise and sales are included in the output values and not explicitly modeled.

The N_{ew}ERA macro model is solved through 2038, starting from 2018 in five-year time intervals.

g. Some Key Model Features

There are great uncertainties about how the U.S. natural gas market will evolve, and the N_{ew}ERA model is designed explicitly to address the key factors affecting future natural gas demand supply, and prices. One of the major uncertainties is the availability of shale gas in the United States. To account for this uncertainty and the subsequent effect it could have on the domestic markets, the N_{ew}ERA model includes resource supply curves for U.S. natural gas. The model also accounts for foreign imports, in particular pipeline imports from Canada, and the potential build-up of liquefaction plants for LNG exports. N_{ew}ERA also has a supply (demand) curve for U.S. imports (exports) that represents how the global LNG market price would react to changes in U.S. imports or exports. On a practical level, there are also other important uncertainties about the ownership of LNG plants and how the LNG contracts will be formulated. These have important consequences on how much revenue can be earned by the U.S. and hence overall macroeconomic impacts. In the N_{ew}ERA model it is possible to represent these variations in domestic versus foreign ownership of assets and capture of export revenues to better understand the issues.

In addition, we assume that natural gas is a homogenous good, similar to crude oil price. Hence, if there was a no-export constraint on LNG exports, domestic natural gas price will converge with the world net-back price.

Consumption of electricity as a transportation fuel could also affect the natural gas market. The N_{ew}ERA model is able to simulate impacts on the supply and disposition of transportation fuels (petroleum-based, biofuels, and electricity), along with responses to the personal driving behavior of the consumer. The personal driving or personal transportation services in the model are represented by vehicle miles traveled (VMT), which takes vehicles' capital, transportation fuels, and other driving expenditures as inputs. The model chooses among changes in consumption of transportation fuels, changes in vehicle fuel efficiency, and changes in the overall level of travel in response to changes in the transportation fuel prices.

h. Advantages of the Macro Model Framework

The N_{ew}ERA model incorporates EIA energy quantities and energy prices into the IMPLAN Social Accounting Matrices. This in-house developed approach results in a balanced energy-economy dataset that has internally consistent energy benchmark data, as well as IMPLAN consistent economic values.

The macro model incorporates all production sectors and final demanders of the economy and is linked through terms of trade. The effects of policies are transmitted throughout the economy as all sectors and agents in the economy respond until the economy reaches equilibrium. The ability of the model to track these effects and substitution possibilities across sectors and regions makes it a unique tool for analyzing policies, such as those involving energy and environmental regulations. These general equilibrium substitution effects, however, are not fully captured in a partial equilibrium framework or within an input-output modeling framework. The smooth production and consumption functions employed in this general equilibrium model enable gradual substitution of inputs in response to relative price changes, thus, avoiding all or nothing solutions.

Business investment decisions are informed by future policies and outlook. The forward-looking characteristic of the model enables businesses and consumers to determine the optimal savings and investment while anticipating future policies with perfect foresight. The alternative approach on savings and investment decisions is to assume agents in the model are myopic, thus, have no expectations for the future. Though both approaches are equally unrealistic to a certain extent, the latter approach can lead the model to produce inconsistent or incorrect impacts from an announced future policy.

The CGE modeling tool such as the N_{ew}ERA macro model can analyze scenarios or policies that call for large shocks outside historical observation. Econometric models are unsuitable for policies that impose large impacts because these models' production and consumption functions remain invariant under the policy. In addition, econometric models assume that the future path depends on the past experience and therefore fail to capture how the economy might respond under a different and new environment. For example, an econometric model cannot represent changes in fuel efficiency in response to increases in energy prices. However, the N_{ew}ERA macro model can consistently capture future policy changes that envisage having large effects.

The N_{ew}ERA macro model is also a unique tool that can iterate over sequential policies to generate consistent equilibrium solutions starting from an internally consistent equilibrium baseline forecast (such as the *AEO 2013* reference case). This ability of the model is particularly helpful to decompose macroeconomic effects of individual policies. For example, if one desires to perform economic analysis of a policy that includes multiple regulations, the N_{ew}ERA modeling framework can be used as a tool to layer in one regulation at a time to determine the incremental effects of each policy.

i. Model Outputs

The N_{ew}ERA model outputs include supply and demand of all goods and services, prices of all commodities, and terms of trade effects (including changes in imports and exports). The model outputs also include gross regional product, consumption, investment, disposable income, and changes in income from labor, capital, and resources.

APPENDIX C: TABLES AND MODEL RESULTS

In this section, we present the numerical results from both the GNGM and the N_{ew}ERA model for all the scenarios that were run as part of the study.

A. Global Natural Gas Model

We evaluated a total of 63 cases with all possible combinations of the following:

- Three domestic outlooks: Reference (USREF), High Oil and Gas Resource (HOGR), Low Oil and Gas Resource (LOGR);
- Three international outlooks: Reference (INTREF), Demand Shock (D), Supply/Demand Shock (SD); and
- Seven quota schedules: No-Export Capacity (NX), Low/Slowest (LSS), Low/Slow (LS), Low/Rapid (LR), High/Slow (HS), High/Rapid (HR), No-Export Constraint (NC).

Out of the 45 cases where a quota is enforced, 28 had projected U.S. LNG exports at a level comparable to the LNG export quota allotted for each year as shown in Figure 103. Detailed results for each case are shown in Figure 104 through Figure 166.

The U.S. Reference, International Reference, and the No Export Capacity cases (Figure 104) are the ultimate baselines to which all other GNGM cases are compared. It assumes no U.S. and Canadian LNG export capacities. After relaxing the North American export constraints the GNGM model determines that the United States exports in at least one year in all cases. Running the International Reference outlook with all three domestic outlooks, GNGM found that the United States is able to export under the USREF, HOGR, and LOGR scenarios (Figure 110, Figure 131, and Figure 152). Only in the HOGR case does the projected level of exports equal the low/high LNG export quota scenarios under the International Reference outlook. We have thus developed two international shocks that favor U.S. LNG export.

The No-Export Constraint series shows the optimal amounts of U.S. exports under each domestic and international outlook as determined in GNGM. Since GNGM assumes a perfectly competitive natural gas market, all quota rents are zero if the No Export Constraint is in effect. A positive rent is collected, however, when the country supplies less than its perfectly competitive volumes – Figure 128 is one example. When the number of export licenses available is greater than the optimal export level as determined by the natural gas market, the remaining licenses are unutilized and export rent drops to zero (Figure 116). The quota rent per Mcf reaches the maximum under the HOGR, Supply/Demand Shock, Low/Slowest quota scenario, where the conditions for U.S. exports are most favorable. However, the quota is highly restrictive (Figure 140). A high marginal price on an additional unit of export quota is thus generated.

In addition to the 63 scenarios described above, we reran three of the HOGR scenarios in order to better understand the consequences for U.S. LNG exports of enhanced competition. These three HOGR scenarios assume that natural gas suppliers could not demand any margin above marginal cost. All three scenarios assumed no constraint for LNG export capacity (NC) from the United States. The scenarios differed in their outlook for the international market (INTREF, D, SD). The summary tables for these three scenarios are presented at the end of this section.

Figure 103: Scenario Tree with Feasible Cases Highlighted

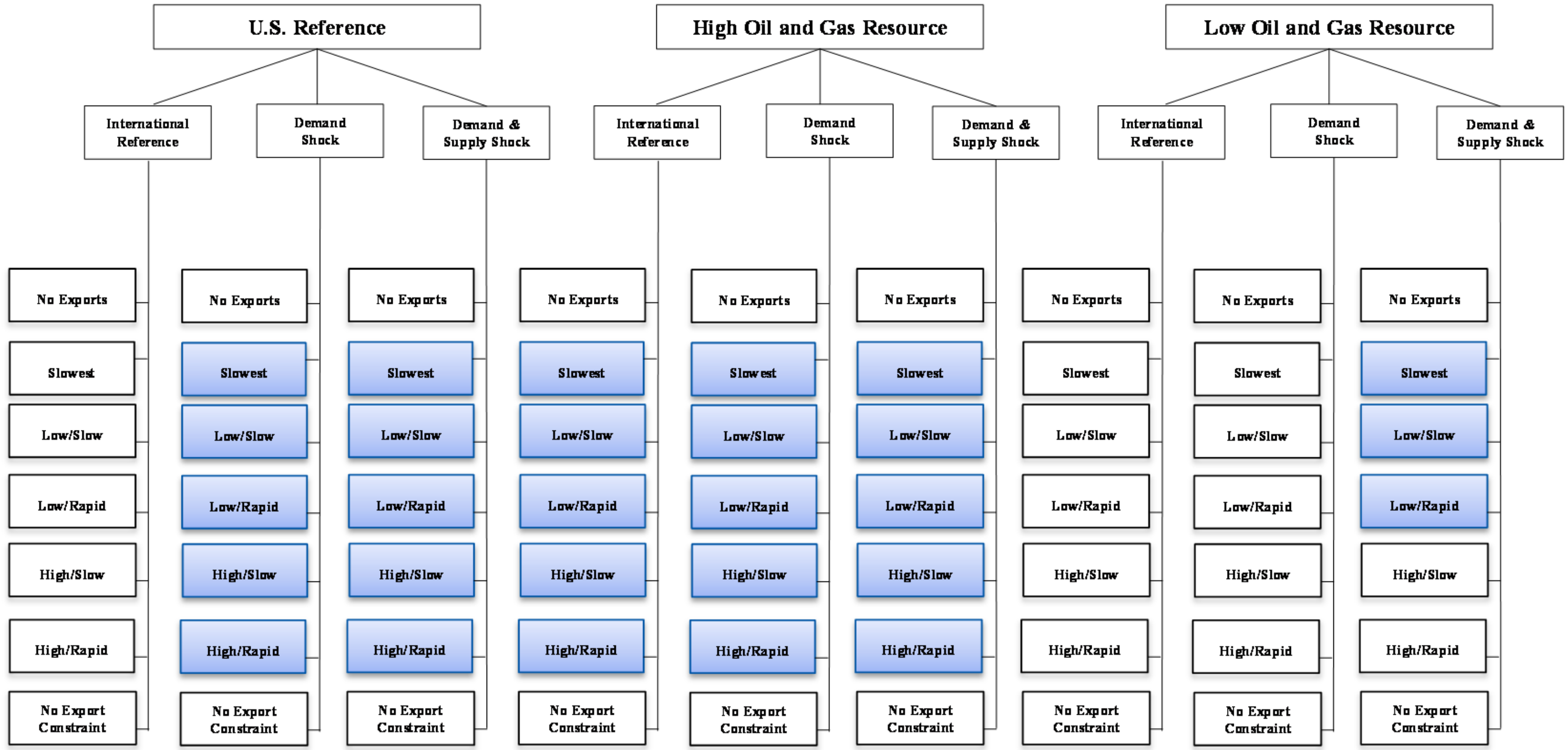


Figure 104: Detailed Results from Global Natural Gas Model, USREF_INTREF_NX

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**27.59**	**28.36**	**29.55**	**30.78**	**32.07**
Domestic Demand	25.64	26.57	27.06	27.95	28.89	29.79
Pipeline Exports to Mexico	0.62	1.03	1.30	1.60	1.88	2.28
Total LNG Exports	0.03	-	-	-	-	-
China India	-	-	-	-	-	-
Europe	-	-	-	-	-	-
Korea Japan	-	-	-	-	-	-
Total Supply (Tcf)	**26.23**	**27.59**	**28.36**	**29.55**	**30.78**	**32.07**
Domestic Production	24.06	25.69	27.28	28.38	29.57	31.27
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$3.36**	**$3.86**	**$4.27**	**$4.72**	**$6.29**
Netback Price ($2012/Mcf)	**-**	**$4.13**	**$4.57**	**$5.19**	**$5.50**	**$7.43**
Quota Rent ($2012/Mcf)	**-**	**$0.77**	**$0.71**	**$0.92**	**$0.78**	**$1.14**

Figure 105: Detailed Results from Global Natural Gas Model, USREF_INTREF_LSS

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**27.77**	**28.82**	**30.61**	**31.87**	**33.26**
Domestic Demand	25.64	26.38	26.69	27.39	28.35	29.24
Pipeline Exports to Mexico	0.62	1.03	1.30	1.60	1.88	2.28
Total LNG Exports	0.03	0.36	0.83	1.63	1.63	1.73
China India	-	-	-	-	-	-
Europe	-	-	-	0.85	0.45	0.07
Korea Japan	-	0.36	0.83	0.79	1.18	1.67
Total Supply (Tcf)	**26.23**	**27.77**	**28.82**	**30.61**	**31.87**	**33.26**
Domestic Production	24.06	25.87	27.74	29.46	30.67	32.46
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$3.44**	**$4.03**	**$4.43**	**$4.87**	**$6.45**
Netback Price ($2012/Mcf)	**-**	**$3.44**	**$4.03**	**$4.43**	**$4.87**	**$6.45**
Quota Rent ($2012/Mcf)	**-**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**

Figure 106: Detailed Results from Global Natural Gas Model, USREF_INTREF_LS

	EIA Ref	NERA Projections				
	2012	2018	2023	2028	2033	2038
Total Demand (Tcf)	**26.29**	**27.77**	**28.82**	**30.61**	**31.87**	**33.26**
Domestic Demand	25.64	26.38	26.69	27.39	28.35	29.24
Pipeline Exports to Mexico	0.62	1.03	1.30	1.60	1.88	2.28
Total LNG Exports	0.03	0.36	0.83	1.63	1.63	1.73
China India	-	-	-	-	-	-
Europe	-	-	-	0.85	0.45	0.07
Korea Japan	-	0.36	0.83	0.79	1.18	1.67
Total Supply (Tcf)	**26.23**	**27.77**	**28.82**	**30.61**	**31.87**	**33.26**
Domestic Production	24.06	25.87	27.74	29.46	30.67	32.46
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$3.44**	**$4.03**	**$4.43**	**$4.87**	**$6.45**
Netback Price ($2012/Mcf)	**-**	**$3.44**	**$4.03**	**$4.43**	**$4.87**	**$6.45**
Quota Rent ($2012/Mcf)	**-**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**

Figure 107: Detailed Results from Global Natural Gas Model, USREF_INTREF_LR

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**27.77**	**28.82**	**30.61**	**31.87**	**33.26**
Domestic Demand	25.64	26.38	26.69	27.39	28.35	29.24
Pipeline Exports to Mexico	0.62	1.03	1.30	1.60	1.88	2.28
Total LNG Exports	0.03	0.36	0.83	1.63	1.63	1.73
China India	-	-	-	-	-	-
Europe	-	-	-	0.85	0.45	0.07
Korea Japan	-	0.36	0.83	0.79	1.18	1.67
Total Supply (Tcf)	**26.23**	**27.77**	**28.82**	**30.61**	**31.87**	**33.26**
Domestic Production	24.06	25.87	27.74	29.46	30.67	32.46
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$3.44**	**$4.03**	**$4.43**	**$4.87**	**$6.45**
Netback Price ($2012/Mcf)	**-**	**$3.44**	**$4.03**	**$4.43**	**$4.87**	**$6.45**
Quota Rent ($2012/Mcf)	**-**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**

Figure 108: Detailed Results from Global Natural Gas Model, USREF_INTREF_HS

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**27.77**	**28.82**	**30.61**	**31.87**	**33.26**
Domestic Demand	25.64	26.38	26.69	27.39	28.35	29.24
Pipeline Exports to Mexico	0.62	1.03	1.30	1.60	1.88	2.28
Total LNG Exports	0.03	0.36	0.83	1.63	1.63	1.73
China India	-	-	-	-	-	-
Europe	-	-	-	0.85	0.45	0.07
Korea Japan	-	0.36	0.83	0.79	1.17	1.67
Total Supply (Tcf)	**26.23**	**27.77**	**28.82**	**30.61**	**31.87**	**33.26**
Domestic Production	24.06	25.87	27.74	29.46	30.67	32.46
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$3.44**	**$4.03**	**$4.43**	**$4.87**	**$6.45**
Netback Price ($2012/Mcf)	**-**	**$3.44**	**$4.03**	**$4.43**	**$4.87**	**$6.45**
Quota Rent ($2012/Mcf)	**-**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**

Figure 109: Detailed Results from Global Natural Gas Model, USREF_INTREF_HR

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**27.77**	**28.82**	**30.61**	**31.87**	**33.26**
Domestic Demand	25.64	26.38	26.69	27.39	28.35	29.24
Pipeline Exports to Mexico	0.62	1.03	1.30	1.60	1.88	2.28
Total LNG Exports	0.03	0.36	0.83	1.63	1.63	1.73
China India	-	-	-	-	-	-
Europe	-	-	-	0.85	0.45	0.07
Korea Japan	-	0.36	0.83	0.79	1.17	1.67
Total Supply (Tcf)	**26.23**	**27.77**	**28.82**	**30.61**	**31.87**	**33.26**
Domestic Production	24.06	25.87	27.74	29.46	30.67	32.46
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$3.44**	**$4.03**	**$4.43**	**$4.87**	**$6.45**
Netback Price ($2012/Mcf)	**-**	**$3.44**	**$4.03**	**$4.43**	**$4.87**	**$6.45**
Quota Rent ($2012/Mcf)	**-**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**

Figure 110: Detailed Results from Global Natural Gas Model, USREF_INTREF_NC

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**27.77**	**28.82**	**30.61**	**31.87**	**33.25**
Domestic Demand	25.64	26.38	26.69	27.39	28.35	29.24
Pipeline Exports to Mexico	0.62	1.03	1.30	1.60	1.88	2.28
Total LNG Exports	0.03	0.36	0.83	1.63	1.63	1.73
China India	-	-	-	-	-	-
Europe	-	-	-	0.85	0.46	0.06
Korea Japan	-	0.36	0.83	0.79	1.17	1.67
Total Supply (Tcf)	**26.23**	**27.77**	**28.82**	**30.61**	**31.87**	**33.25**
Domestic Production	24.06	25.87	27.74	29.46	30.67	32.46
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$3.44**	**$4.03**	**$4.43**	**$4.87**	**$6.45**
Netback Price ($2012/Mcf)	**-**	**$3.44**	**$4.03**	**$4.43**	**$4.87**	**$6.45**
Quota Rent ($2012/Mcf)	**-**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**

Figure 111: Detailed Results from Global Natural Gas Model, USREF_D_NX

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**27.59**	**28.36**	**29.55**	**30.78**	**32.07**
Domestic Demand	25.64	26.57	27.06	27.95	28.89	29.79
Pipeline Exports to Mexico	0.62	1.03	1.30	1.60	1.88	2.28
Total LNG Exports	0.03	-	-	-	-	-
China India	-	-	-	-	-	-
Europe	-	-	-	-	-	-
Korea Japan	-	-	-	-	-	-
Total Supply (Tcf)	**26.23**	**27.59**	**28.36**	**29.55**	**30.78**	**32.07**
Domestic Production	24.06	25.69	27.28	28.38	29.57	31.27
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$3.36**	**$3.86**	**$4.27**	**$4.72**	**$6.29**
Netback Price ($2012/Mcf)	**-**	**$4.86**	**$5.45**	**$6.78**	**$7.16**	**$9.14**
Quota Rent ($2012/Mcf)	**-**	**$1.50**	**$1.59**	**$2.51**	**$2.44**	**$2.85**

Figure 112: Detailed Results from Global Natural Gas Model, USREF_D_LSS

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**27.95**	**29.27**	**30.94**	**32.21**	**33.54**
Domestic Demand	25.64	26.20	26.33	27.16	28.13	29.07
Pipeline Exports to Mexico	0.62	1.03	1.30	1.60	1.88	2.28
Total LNG Exports	0.03	0.73	1.64	2.19	2.19	2.19
China India	-	-	-	-	-	-
Europe	-	-	-	1.39	0.53	-
Korea Japan	-	0.73	1.64	0.80	1.66	2.19
Total Supply (Tcf)	**26.23**	**27.95**	**29.27**	**30.94**	**32.21**	**33.54**
Domestic Production	24.06	26.06	28.19	29.79	31.01	32.75
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$3.52**	**$4.20**	**$4.53**	**$4.96**	**$6.54**
Netback Price ($2012/Mcf)	**-**	**$3.93**	**$4.46**	**$5.24**	**$5.78**	**$7.86**
Quota Rent ($2012/Mcf)	**-**	**$0.41**	**$0.26**	**$0.71**	**$0.82**	**$1.32**

Figure 113: Detailed Results from Global Natural Gas Model, USREF_D_LS

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**28.32**	**29.58**	**30.94**	**32.21**	**33.54**
Domestic Demand	25.64	25.84	26.09	27.16	28.13	29.07
Pipeline Exports to Mexico	0.62	1.03	1.30	1.60	1.88	2.28
Total LNG Exports	0.03	1.46	2.19	2.19	2.19	2.19
China India	-	-	-	-	-	-
Europe	-	-	-	1.39	0.53	-
Korea Japan	-	1.46	2.19	0.80	1.66	2.19
Total Supply (Tcf)	**26.23**	**28.32**	**29.58**	**30.94**	**32.21**	**33.54**
Domestic Production	24.06	26.43	28.50	29.79	31.01	32.75
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$3.69**	**$4.32**	**$4.53**	**$4.96**	**$6.54**
Netback Price ($2012/Mcf)	**-**	**$3.80**	**$4.38**	**$5.24**	**$5.78**	**$7.86**
Quota Rent ($2012/Mcf)	**-**	**$0.11**	**$0.06**	**$0.71**	**$0.82**	**$1.32**

Figure 114: Detailed Results from Global Natural Gas Model, USREF_D_LR

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**28.46**	**29.58**	**30.94**	**32.21**	**33.54**
Domestic Demand	25.64	25.70	26.09	27.16	28.13	29.07
Pipeline Exports to Mexico	0.62	1.03	1.30	1.60	1.88	2.28
Total LNG Exports	0.03	1.74	2.19	2.19	2.19	2.19
China India	-	-	-	-	-	-
Europe	-	-	-	1.39	0.53	-
Korea Japan	-	1.74	2.19	0.80	1.66	2.19
Total Supply (Tcf)	**26.23**	**28.46**	**29.58**	**30.94**	**32.21**	**33.54**
Domestic Production	24.06	26.57	28.50	29.79	31.01	32.75
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$3.76**	**$4.32**	**$4.53**	**$4.96**	**$6.54**
Netback Price ($2012/Mcf)	**-**	**$3.76**	**$4.38**	**$5.24**	**$5.78**	**$7.86**
Quota Rent ($2012/Mcf)	**-**	**$0.00**	**$0.06**	**$0.71**	**$0.82**	**$1.32**

Figure 115: Detailed Results from Global Natural Gas Model, USREF_D_HS

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**28.32**	**29.68**	**32.06**	**33.52**	**34.93**
Domestic Demand	25.64	25.84	26.01	26.42	27.34	28.27
Pipeline Exports to Mexico	0.62	1.03	1.30	1.60	1.88	2.28
Total LNG Exports	0.03	1.46	2.37	4.04	4.30	4.38
China India	-	-	-	-	-	-
Europe	-	-	-	3.18	0.95	-
Korea Japan	-	1.46	2.37	0.86	3.34	4.38
Total Supply (Tcf)	**26.23**	**28.32**	**29.68**	**32.06**	**33.52**	**34.93**
Domestic Production	24.06	26.43	28.60	30.90	32.33	34.14
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$3.69**	**$4.36**	**$4.89**	**$5.33**	**$6.95**
Netback Price ($2012/Mcf)	**-**	**$3.80**	**$4.36**	**$4.89**	**$5.33**	**$7.20**
Quota Rent ($2012/Mcf)	**-**	**$0.11**	**$0.00**	**$0.00**	**$0.00**	**$0.25**

Figure 116: Detailed Results from Global Natural Gas Model, USREF_D_HR

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**28.46**	**29.68**	**32.06**	**33.52**	**34.93**
Domestic Demand	25.64	25.70	26.01	26.42	27.34	28.27
Pipeline Exports to Mexico	0.62	1.03	1.30	1.60	1.88	2.28
Total LNG Exports	0.03	1.74	2.37	4.04	4.30	4.38
China India	-	-	-	-	-	-
Europe	-	-	-	3.18	0.95	-
Korea Japan	-	1.74	2.37	0.86	3.34	4.38
Total Supply (Tcf)	**26.23**	**28.46**	**29.68**	**32.06**	**33.52**	**34.93**
Domestic Production	24.06	26.57	28.60	30.90	32.33	34.14
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$3.76**	**$4.36**	**$4.89**	**$5.33**	**$6.95**
Netback Price ($2012/Mcf)	**-**	**$3.76**	**$4.36**	**$4.89**	**$5.33**	**$7.20**
Quota Rent ($2012/Mcf)	**-**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.25**

Figure 117: Detailed Results from Global Natural Gas Model, USREF_D_NC

	EIA Ref	NERA Projections				
	2012	2018	2023	2028	2033	2038
Total Demand (Tcf)	**26.29**	**28.46**	**29.68**	**32.06**	**33.53**	**35.31**
Domestic Demand	25.64	25.70	26.01	26.42	27.34	28.06
Pipeline Exports to Mexico	0.62	1.03	1.30	1.60	1.88	2.28
Total LNG Exports	0.03	1.74	2.37	4.04	4.30	4.97
China India	-	-	-	-	-	-
Europe	-	-	-	3.18	0.91	-
Korea Japan	-	1.74	2.37	0.86	3.40	4.97
Total Supply (Tcf)	**26.23**	**28.46**	**29.68**	**32.06**	**33.53**	**35.31**
Domestic Production	24.06	26.57	28.60	30.90	32.33	34.51
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$3.76**	**$4.36**	**$4.89**	**$5.33**	**$7.07**
Netback Price ($2012/Mcf)	**-**	**$3.76**	**$4.36**	**$4.89**	**$5.33**	**$7.07**
Quota Rent ($2012/Mcf)	**-**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**

Figure 118: Detailed Results from Global Natural Gas Model, USREF_SD_NX

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**27.59**	**28.36**	**29.55**	**30.78**	**32.07**
Domestic Demand	25.64	26.57	27.06	27.95	28.89	29.79
Pipeline Exports to Mexico	0.62	1.03	1.30	1.60	1.88	2.28
Total LNG Exports	0.03	-	-	-	-	-
China India	-	-	-	-	-	-
Europe	-	-	-	-	-	-
Korea Japan	-	-	-	-	-	-
Total Supply (Tcf)	**26.23**	**27.59**	**28.36**	**29.55**	**30.78**	**32.07**
Domestic Production	24.06	25.69	27.28	28.38	29.57	31.27
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$3.36**	**$3.86**	**$4.27**	**$4.72**	**$6.29**
Netback Price ($2012/Mcf)	**-**	**$4.86**	**$6.85**	**$9.05**	**$10.13**	**$11.64**
Quota Rent ($2012/Mcf)	**-**	**$1.50**	**$2.99**	**$4.78**	**$5.41**	**$5.35**

Figure 119: Detailed Results from Global Natural Gas Model, USREF_SD_LSS

	EIA Ref	NERA Projections				
	2012	2018	2023	2028	2033	2038
Total Demand (Tcf)	**26.29**	**27.95**	**29.27**	**30.94**	**32.21**	**33.54**
Domestic Demand	25.64	26.20	26.33	27.16	28.13	29.07
Pipeline Exports to Mexico	0.62	1.03	1.30	1.60	1.88	2.28
Total LNG Exports	0.03	0.73	1.64	2.19	2.19	2.19
China India	-	-	-	-	-	-
Europe	-	-	-	0.51	0.05	-
Korea Japan	-	0.73	1.64	1.68	2.14	2.19
Total Supply (Tcf)	**26.23**	**27.95**	**29.27**	**30.94**	**32.21**	**33.54**
Domestic Production	24.06	26.06	28.19	29.79	31.01	32.75
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$3.52**	**$4.20**	**$4.53**	**$4.96**	**$6.54**
Netback Price ($2012/Mcf)	**-**	**$4.14**	**$4.83**	**$6.04**	**$6.86**	**$9.57**
Quota Rent ($2012/Mcf)	**-**	**$0.62**	**$0.63**	**$1.51**	**$1.90**	**$3.03**

Figure 120: Detailed Results from Global Natural Gas Model, USREF_SD_LS

	EIA Ref	NERA Projections				
	2012	2018	2023	2028	2033	2038
Total Demand (Tcf)	**26.29**	**28.32**	**29.58**	**30.94**	**32.21**	**33.54**
Domestic Demand	25.64	25.84	26.09	27.16	28.13	29.07
Pipeline Exports to Mexico	0.62	1.03	1.30	1.60	1.88	2.28
Total LNG Exports	0.03	1.46	2.19	2.19	2.19	2.19
China India	-	-	-	-	-	-
Europe	-	-	-	0.51	0.05	-
Korea Japan	-	1.46	2.19	1.68	2.14	2.19
Total Supply (Tcf)	**26.23**	**28.32**	**29.58**	**30.94**	**32.21**	**33.54**
Domestic Production	24.06	26.43	28.50	29.79	31.01	32.75
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$3.69**	**$4.32**	**$4.53**	**$4.96**	**$6.54**
Netback Price ($2012/Mcf)	**-**	**$3.99**	**$4.72**	**$6.04**	**$6.86**	**$9.57**
Quota Rent ($2012/Mcf)	**-**	**$0.30**	**$0.40**	**$1.51**	**$1.90**	**$3.03**

Figure 121: Detailed Results from Global Natural Gas Model, USREF_SD_LR

	EIA Ref	NERA Projections				
	2012	2018	2023	2028	2033	2038
Total Demand (Tcf)	**26.29**	**28.66**	**29.58**	**30.94**	**32.21**	**33.54**
Domestic Demand	25.64	25.51	26.09	27.16	28.13	29.07
Pipeline Exports to Mexico	0.62	1.03	1.30	1.60	1.88	2.28
Total LNG Exports	0.03	2.13	2.19	2.19	2.19	2.19
China India	-	-	-	-	-	-
Europe	-	-	-	0.51	0.05	-
Korea Japan	-	2.13	2.19	1.68	2.14	2.19
Total Supply (Tcf)	**26.23**	**28.66**	**29.58**	**30.94**	**32.21**	**33.54**
Domestic Production	24.06	26.77	28.50	29.79	31.01	32.75
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$3.85**	**$4.32**	**$4.53**	**$4.96**	**$6.54**
Netback Price ($2012/Mcf)	**-**	**$3.85**	**$4.72**	**$6.04**	**$6.86**	**$9.57**
Quota Rent ($2012/Mcf)	**-**	**$0.00**	**$0.40**	**$1.51**	**$1.90**	**$3.03**

Figure 122: Detailed Results from Global Natural Gas Model, USREF_SD_HS

	EIA Ref	NERA Projections				
	2012	2018	2023	2028	2033	2038
Total Demand (Tcf)	**26.29**	**28.32**	**30.13**	**32.26**	**33.58**	**34.93**
Domestic Demand	25.64	25.84	25.67	26.29	27.31	28.27
Pipeline Exports to Mexico	0.62	1.03	1.30	1.60	1.88	2.28
Total LNG Exports	0.03	1.46	3.17	4.38	4.38	4.38
China India	-	-	-	-	-	-
Europe	-	-	-	0.74	0.12	-
Korea Japan	-	1.46	3.17	3.64	4.26	4.38
Total Supply (Tcf)	**26.23**	**28.32**	**30.13**	**32.26**	**33.58**	**34.93**
Domestic Production	24.06	26.43	29.05	31.11	32.38	34.14
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$3.69**	**$4.53**	**$4.96**	**$5.34**	**$6.95**
Netback Price ($2012/Mcf)	**-**	**$3.99**	**$4.53**	**$5.34**	**$6.25**	**$8.75**
Quota Rent ($2012/Mcf)	**-**	**$0.30**	**$0.00**	**$0.38**	**$0.91**	**$1.80**

Figure 123: Detailed Results from Global Natural Gas Model, USREF_SD_HR

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**28.66**	**30.13**	**32.26**	**33.58**	**34.93**
Domestic Demand	25.64	25.51	25.67	26.29	27.31	28.27
Pipeline Exports to Mexico	0.62	1.03	1.30	1.60	1.88	2.28
Total LNG Exports	0.03	2.13	3.17	4.38	4.38	4.38
China India	-	-	-	-	-	-
Europe	-	-	-	0.74	0.12	-
Korea Japan	-	2.13	3.17	3.64	4.26	4.38
Total Supply (Tcf)	**26.23**	**28.66**	**30.13**	**32.26**	**33.58**	**34.93**
Domestic Production	24.06	26.77	29.05	31.11	32.38	34.14
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$3.85**	**$4.53**	**$4.96**	**$5.34**	**$6.95**
Netback Price ($2012/Mcf)	**-**	**$3.85**	**$4.53**	**$5.34**	**$6.25**	**$8.75**
Quota Rent ($2012/Mcf)	**-**	**$0.00**	**$0.00**	**$0.38**	**$0.91**	**$1.80**

Figure 124: Detailed Results from Global Natural Gas Model, USREF_SD_NC

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**28.66**	**30.13**	**32.80**	**34.61**	**36.70**
Domestic Demand	25.64	25.51	25.67	25.95	26.72	27.32
Pipeline Exports to Mexico	0.62	1.03	1.30	1.60	1.88	2.28
Total LNG Exports	0.03	2.13	3.17	5.25	6.01	7.10
China India	-	-	-	-	-	-
Europe	-	-	-	0.92	0.23	-
Korea Japan	-	2.13	3.17	4.33	5.79	7.10
Total Supply (Tcf)	**26.23**	**28.66**	**30.13**	**32.80**	**34.61**	**36.70**
Domestic Production	24.06	26.77	29.05	31.64	33.42	35.91
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$3.85**	**$4.53**	**$5.13**	**$5.64**	**$7.49**
Netback Price ($2012/Mcf)	**-**	**$3.85**	**$4.53**	**$5.13**	**$5.64**	**$7.49**
Quota Rent ($2012/Mcf)	**-**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**

Figure 125: Detailed Results from Global Natural Gas Model, HOGR_INTREF_NX

	EIA Ref	NERA Projections				
	2012	2018	2023	2028	2033	2038
Total Demand (Tcf)	**26.29**	**31.11**	**33.44**	**35.92**	**38.36**	**42.61**
Domestic Demand	25.64	30.04	31.99	34.08	36.08	39.76
Pipeline Exports to Mexico	0.62	1.08	1.45	1.85	2.27	2.85
Total LNG Exports	0.03	-	-	-	-	-
China India	-	-	-	-	-	-
Europe	-	-	-	-	-	-
Korea Japan	-	-	-	-	-	-
Total Supply (Tcf)	**26.23**	**31.11**	**33.44**	**35.92**	**38.36**	**42.61**
Domestic Production	24.06	29.34	32.77	35.32	37.64	42.04
Net Pipeline Imports from Canada	1.99	1.61	0.49	0.42	0.55	0.41
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$2.14**	**$2.22**	**$2.35**	**$2.58**	**$3.17**
Netback Price ($2012/Mcf)	**-**	**$3.48**	**$4.51**	**$4.96**	**$5.20**	**$7.26**
Quota Rent ($2012/Mcf)	**-**	**$1.34**	**$2.29**	**$2.61**	**$2.62**	**$4.09**

Figure 126: Detailed Results from Global Natural Gas Model, HOGR_INTREF_LSS

	EIA Ref	NERA Projections				
	2012	2018	2023	2028	2033	2038
Total Demand (Tcf)	**26.29**	**31.52**	**34.45**	**37.44**	**39.90**	**44.15**
Domestic Demand	25.64	29.71	31.36	33.41	35.43	39.11
Pipeline Exports to Mexico	0.62	1.08	1.45	1.85	2.27	2.85
Total LNG Exports	0.03	0.73	1.64	2.19	2.19	2.19
China India	-	-	-	-	-	-
Europe	-	-	0.20	1.48	1.55	1.68
Korea Japan	-	0.73	1.45	0.71	0.64	0.51
Total Supply (Tcf)	**26.23**	**31.52**	**34.45**	**37.44**	**39.90**	**44.15**
Domestic Production	24.06	29.74	33.79	36.84	39.18	43.58
Net Pipeline Imports from Canada	1.99	1.61	0.49	0.42	0.55	0.41
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$2.23**	**$2.38**	**$2.47**	**$2.69**	**$3.28**
Netback Price ($2012/Mcf)	**-**	**$3.24**	**$3.55**	**$3.85**	**$4.29**	**$5.94**
Quota Rent ($2012/Mcf)	**-**	**$1.01**	**$1.17**	**$1.38**	**$1.60**	**$2.66**

Figure 127: Detailed Results from Global Natural Gas Model, HOGR_INTREF_LS

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**31.92**	**34.79**	**37.44**	**39.90**	**44.15**
Domestic Demand	25.64	29.39	31.16	33.41	35.43	39.11
Pipeline Exports to Mexico	0.62	1.08	1.45	1.85	2.27	2.85
Total LNG Exports	0.03	1.46	2.19	2.19	2.19	2.19
China India	-	-	-	-	-	-
Europe	-	-	0.62	1.48	1.55	1.68
Korea Japan	-	1.46	1.57	0.71	0.64	0.51
Total Supply (Tcf)	**26.23**	**31.92**	**34.79**	**37.44**	**39.90**	**44.15**
Domestic Production	24.06	30.15	34.14	36.84	39.18	43.58
Net Pipeline Imports from Canada	1.99	1.61	0.49	0.42	0.55	0.41
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$2.33**	**$2.44**	**$2.47**	**$2.69**	**$3.28**
Netback Price ($2012/Mcf)	**-**	**$3.14**	**$3.47**	**$3.85**	**$4.29**	**$5.94**
Quota Rent ($2012/Mcf)	**-**	**$0.81**	**$1.03**	**$1.38**	**$1.60**	**$2.66**

Figure 128: Detailed Results from Global Natural Gas Model, HOGR_INTREF_LR

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**32.33**	**34.79**	**37.44**	**39.90**	**44.15**
Domestic Demand	25.64	29.06	31.16	33.41	35.43	39.11
Pipeline Exports to Mexico	0.62	1.08	1.45	1.85	2.27	2.85
Total LNG Exports	0.03	2.19	2.19	2.19	2.19	2.19
China India	-	-	-	-	-	-
Europe	-	-	0.62	1.48	1.55	1.68
Korea Japan	-	2.19	1.57	0.71	0.64	0.51
Total Supply (Tcf)	**26.23**	**32.33**	**34.79**	**37.44**	**39.90**	**44.15**
Domestic Production	24.06	30.55	34.14	36.84	39.18	43.58
Net Pipeline Imports from Canada	1.99	1.61	0.49	0.42	0.55	0.41
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$2.43**	**$2.44**	**$2.47**	**$2.69**	**$3.28**
Netback Price ($2012/Mcf)	**-**	**$3.04**	**$3.47**	**$3.85**	**$4.29**	**$5.94**
Quota Rent ($2012/Mcf)	**-**	**$0.61**	**$1.03**	**$1.38**	**$1.60**	**$2.66**

Figure 129: Detailed Results from Global Natural Gas Model, HOGR_INTREF_HS

	EIA Ref	NERA Projections				
	2012	2018	2023	2028	2033	2038
Total Demand (Tcf)	**26.29**	**31.92**	**35.48**	**38.90**	**41.41**	**45.69**
Domestic Demand	25.64	29.39	30.75	32.68	34.75	38.45
Pipeline Exports to Mexico	0.62	1.08	1.45	1.85	2.27	2.85
Total LNG Exports	0.03	1.46	3.28	4.38	4.38	4.38
China India	-	-	-	-	-	-
Europe	-	-	1.45	3.60	3.49	3.72
Korea Japan	-	1.46	1.83	0.78	0.89	0.66
Total Supply (Tcf)	**26.23**	**31.92**	**35.48**	**38.90**	**41.41**	**45.69**
Domestic Production	24.06	30.15	34.82	38.30	40.69	45.11
Net Pipeline Imports from Canada	1.99	1.61	0.49	0.42	0.55	0.41
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$2.33**	**$2.55**	**$2.65**	**$2.84**	**$3.42**
Netback Price ($2012/Mcf)	**-**	**$3.14**	**$3.31**	**$3.52**	**$4.00**	**$5.55**
Quota Rent ($2012/Mcf)	**-**	**$0.81**	**$0.76**	**$0.87**	**$1.16**	**$2.13**

Figure 130: Detailed Results from Global Natural Gas Model, HOGR_INTREF_HR

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**33.49**	**36.17**	**38.90**	**41.41**	**45.69**
Domestic Demand	25.64	28.16	30.34	32.68	34.75	38.45
Pipeline Exports to Mexico	0.62	1.08	1.45	1.85	2.27	2.85
Total LNG Exports	0.03	4.26	4.38	4.38	4.38	4.38
China India	-	-	-	-	-	-
Europe	-	0.45	2.30	3.60	3.49	3.72
Korea Japan	-	3.81	2.08	0.78	0.89	0.66
Total Supply (Tcf)	**26.23**	**33.49**	**36.17**	**38.90**	**41.41**	**45.69**
Domestic Production	24.06	31.71	35.51	38.30	40.69	45.11
Net Pipeline Imports from Canada	1.99	1.61	0.49	0.42	0.55	0.41
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$2.73**	**$2.67**	**$2.65**	**$2.84**	**$3.42**
Netback Price ($2012/Mcf)	**-**	**$2.73**	**$3.16**	**$3.52**	**$4.00**	**$5.55**
Quota Rent ($2012/Mcf)	**-**	**$0.00**	**$0.49**	**$0.87**	**$1.16**	**$2.13**

Figure 131: Detailed Results from Global Natural Gas Model, HOGR_INTREF_NC

	EIA Ref	NERA Projections				
	2012	2018	2023	2028	2033	2038
Total Demand (Tcf)	**26.29**	**33.49**	**37.30**	**41.49**	**45.64**	**52.91**
Domestic Demand	25.64	28.16	29.70	31.45	32.97	35.65
Pipeline Exports to Mexico	0.62	1.08	1.45	1.85	2.27	2.85
Total LNG Exports	0.03	4.26	6.15	8.20	10.40	14.40
China India	-	-	-	-	-	-
Europe	-	0.45	3.57	7.32	7.93	11.63
Korea Japan	-	3.81	2.58	0.88	2.46	2.77
Total Supply (Tcf)	**26.23**	**33.49**	**37.30**	**41.49**	**45.64**	**52.91**
Domestic Production	24.06	31.71	36.65	40.89	44.92	52.33
Net Pipeline Imports from Canada	1.99	1.61	0.49	0.42	0.55	0.41
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$2.73**	**$2.87**	**$2.98**	**$3.29**	**$4.10**
Netback Price ($2012/Mcf)	**-**	**$2.73**	**$2.87**	**$2.98**	**$3.29**	**$4.10**
Quota Rent ($2012/Mcf)	**-**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**

Figure 132: Detailed Results from Global Natural Gas Model, HOGR_D_NX

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**31.11**	**33.44**	**35.92**	**38.36**	**42.61**
Domestic Demand	25.64	30.04	31.99	34.08	36.08	39.76
Pipeline Exports to Mexico	0.62	1.08	1.45	1.85	2.27	2.85
Total LNG Exports	0.03	-	-	-	-	-
China India	-	-	-	-	-	-
Europe	-	-	-	-	-	-
Korea Japan	-	-	-	-	-	-
Total Supply (Tcf)	**26.23**	**31.11**	**33.44**	**35.92**	**38.36**	**42.61**
Domestic Production	24.06	29.34	32.77	35.32	37.64	42.04
Net Pipeline Imports from Canada	1.99	1.61	0.49	0.42	0.55	0.41
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$2.14**	**$2.22**	**$2.35**	**$2.58**	**$3.17**
Netback Price ($2012/Mcf)	**-**	**$4.22**	**$5.26**	**$6.32**	**$6.94**	**$9.05**
Quota Rent ($2012/Mcf)	**-**	**$2.08**	**$3.04**	**$3.97**	**$4.36**	**$5.88**

Figure 133: Detailed Results from Global Natural Gas Model, HOGR_D_LSS

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**31.52**	**34.45**	**37.44**	**39.90**	**44.19**
Domestic Demand	25.64	29.71	31.36	33.41	35.44	39.15
Pipeline Exports to Mexico	0.62	1.08	1.45	1.85	2.27	2.85
Total LNG Exports	0.03	0.73	1.64	2.19	2.19	2.19
China India	-	-	-	-	-	-
Europe	-	-	-	1.46	0.62	-
Korea Japan	-	0.73	1.64	0.73	1.57	2.19
Total Supply (Tcf)	**26.23**	**31.52**	**34.45**	**37.44**	**39.90**	**44.19**
Domestic Production	24.06	29.74	33.79	36.84	39.19	43.62
Net Pipeline Imports from Canada	1.99	1.61	0.49	0.42	0.55	0.41
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$2.23**	**$2.38**	**$2.47**	**$2.69**	**$3.26**
Netback Price ($2012/Mcf)	**-**	**$3.74**	**$4.15**	**$4.50**	**$4.99**	**$6.51**
Quota Rent ($2012/Mcf)	**-**	**$1.51**	**$1.77**	**$2.03**	**$2.30**	**$3.25**

Figure 134: Detailed Results from Global Natural Gas Model, HOGR_D_LS

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**31.92**	**34.79**	**37.44**	**39.90**	**44.19**
Domestic Demand	25.64	29.39	31.16	33.41	35.44	39.15
Pipeline Exports to Mexico	0.62	1.08	1.45	1.85	2.27	2.85
Total LNG Exports	0.03	1.46	2.19	2.19	2.19	2.19
China India	-	-	-	-	-	-
Europe	-	-	-	1.46	0.62	-
Korea Japan	-	1.46	2.19	0.73	1.57	2.19
Total Supply (Tcf)	**26.23**	**31.92**	**34.79**	**37.44**	**39.90**	**44.19**
Domestic Production	24.06	30.15	34.14	36.84	39.19	43.62
Net Pipeline Imports from Canada	1.99	1.61	0.49	0.42	0.55	0.41
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$2.33**	**$2.44**	**$2.47**	**$2.69**	**$3.26**
Netback Price ($2012/Mcf)	**-**	**$3.64**	**$4.09**	**$4.50**	**$4.99**	**$6.51**
Quota Rent ($2012/Mcf)	**-**	**$1.31**	**$1.65**	**$2.03**	**$2.30**	**$3.25**

Figure 135: Detailed Results from Global Natural Gas Model, HOGR_D_LR

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**32.33**	**34.79**	**37.44**	**39.90**	**44.19**
Domestic Demand	25.64	29.06	31.16	33.41	35.44	39.15
Pipeline Exports to Mexico	0.62	1.08	1.45	1.85	2.27	2.85
Total LNG Exports	0.03	2.19	2.19	2.19	2.19	2.19
China India	-	-	-	-	-	-
Europe	-	-	-	1.46	0.62	-
Korea Japan	-	2.19	2.19	0.73	1.57	2.19
Total Supply (Tcf)	**26.23**	**32.33**	**34.79**	**37.44**	**39.90**	**44.19**
Domestic Production	24.06	30.55	34.14	36.84	39.19	43.62
Net Pipeline Imports from Canada	1.99	1.61	0.49	0.42	0.55	0.41
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$2.43**	**$2.44**	**$2.47**	**$2.69**	**$3.26**
Netback Price ($2012/Mcf)	**-**	**$3.57**	**$4.09**	**$4.50**	**$4.99**	**$6.51**
Quota Rent ($2012/Mcf)	**-**	**$1.14**	**$1.65**	**$2.03**	**$2.30**	**$3.25**

Figure 136: Detailed Results from Global Natural Gas Model, HOGR_D_HS

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**31.92**	**35.48**	**38.90**	**41.41**	**45.72**
Domestic Demand	25.64	29.39	30.75	32.68	34.75	38.48
Pipeline Exports to Mexico	0.62	1.08	1.45	1.85	2.27	2.85
Total LNG Exports	0.03	1.46	3.28	4.38	4.38	4.38
China India	-	-	-	-	-	-
Europe	-	-	-	3.60	1.35	1.13
Korea Japan	-	1.46	3.28	0.78	3.03	3.25
Total Supply (Tcf)	**26.23**	**31.92**	**35.48**	**38.90**	**41.41**	**45.72**
Domestic Production	24.06	30.15	34.82	38.30	40.69	45.14
Net Pipeline Imports from Canada	1.99	1.61	0.49	0.42	0.55	0.41
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$2.33**	**$2.55**	**$2.65**	**$2.84**	**$3.40**
Netback Price ($2012/Mcf)	**-**	**$3.64**	**$4.00**	**$4.24**	**$4.67**	**$6.07**
Quota Rent ($2012/Mcf)	**-**	**$1.31**	**$1.45**	**$1.59**	**$1.83**	**$2.67**

Figure 137: Detailed Results from Global Natural Gas Model, HOGR_D_HR

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**33.56**	**36.17**	**38.90**	**41.41**	**45.72**
Domestic Demand	25.64	28.10	30.34	32.68	34.75	38.48
Pipeline Exports to Mexico	0.62	1.08	1.45	1.85	2.27	2.85
Total LNG Exports	0.03	4.38	4.38	4.38	4.38	4.38
China India	-	-	-	-	-	-
Europe	-	-	-	3.60	1.35	1.13
Korea Japan	-	4.38	4.38	0.78	3.03	3.25
Total Supply (Tcf)	**26.23**	**33.56**	**36.17**	**38.90**	**41.41**	**45.72**
Domestic Production	24.06	31.78	35.51	38.30	40.69	45.14
Net Pipeline Imports from Canada	1.99	1.61	0.49	0.42	0.55	0.41
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$2.75**	**$2.67**	**$2.65**	**$2.84**	**$3.40**
Netback Price ($2012/Mcf)	**-**	**$3.32**	**$3.87**	**$4.24**	**$4.67**	**$6.07**
Quota Rent ($2012/Mcf)	**-**	**$0.57**	**$1.20**	**$1.59**	**$1.83**	**$2.67**

Figure 138: Detailed Results from Global Natural Gas Model, HOGR_D_NC

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**34.64**	**39.06**	**43.69**	**48.03**	**55.65**
Domestic Demand	25.64	27.30	28.75	30.48	32.05	34.70
Pipeline Exports to Mexico	0.62	1.08	1.45	1.85	2.27	2.85
Total LNG Exports	0.03	6.27	8.87	11.37	13.71	18.10
China India	-	-	-	-	-	-
Europe	-	-	2.08	7.68	6.57	10.34
Korea Japan	-	6.27	6.79	3.69	7.13	7.76
Total Supply (Tcf)	**26.23**	**34.64**	**39.06**	**43.69**	**48.03**	**55.65**
Domestic Production	24.06	32.87	38.41	43.08	47.31	55.08
Net Pipeline Imports from Canada	1.99	1.61	0.49	0.42	0.55	0.41
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$3.05**	**$3.19**	**$3.27**	**$3.55**	**$4.37**
Netback Price ($2012/Mcf)	**-**	**$3.05**	**$3.19**	**$3.27**	**$3.55**	**$4.37**
Quota Rent ($2012/Mcf)	**-**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**

Figure 139: Detailed Results from Global Natural Gas Model, HOGR_SD_NX

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**31.11**	**33.44**	**35.92**	**38.36**	**42.62**
Domestic Demand	25.64	30.04	31.99	34.08	36.08	39.76
Pipeline Exports to Mexico	0.62	1.08	1.45	1.85	2.27	2.85
Total LNG Exports	0.03	-	-	-	-	-
China India	-	-	-	-	-	-
Europe	-	-	-	-	-	-
Korea Japan	-	-	-	-	-	-
Total Supply (Tcf)	**26.23**	**31.11**	**33.44**	**35.92**	**38.36**	**42.62**
Domestic Production	24.06	29.34	32.77	35.32	37.64	42.04
Net Pipeline Imports from Canada	1.99	1.61	0.49	0.42	0.55	0.41
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$2.14**	**$2.22**	**$2.35**	**$2.58**	**$3.17**
Netback Price ($2012/Mcf)	**-**	**$4.49**	**$6.31**	**$8.57**	**$10.12**	**$11.59**
Quota Rent ($2012/Mcf)	**-**	**$2.35**	**$4.09**	**$6.22**	**$7.54**	**$8.42**

Figure 140: Detailed Results from Global Natural Gas Model, HOGR_SD_LSS

	EIA Ref	NERA Projections				
	2012	2018	2023	2028	2033	2038
Total Demand (Tcf)	**26.29**	**31.52**	**34.45**	**37.44**	**39.90**	**44.19**
Domestic Demand	25.64	29.71	31.36	33.41	35.44	39.15
Pipeline Exports to Mexico	0.62	1.08	1.45	1.85	2.27	2.85
Total LNG Exports	0.03	0.73	1.64	2.19	2.19	2.19
China India	-	-	-	-	-	-
Europe	-	-	-	0.93	0.17	-
Korea Japan	-	0.73	1.64	1.26	2.02	2.19
Total Supply (Tcf)	**26.23**	**31.52**	**34.45**	**37.44**	**39.90**	**44.19**
Domestic Production	24.06	29.74	33.79	36.84	39.19	43.62
Net Pipeline Imports from Canada	1.99	1.61	0.49	0.42	0.55	0.41
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$2.23**	**$2.38**	**$2.47**	**$2.69**	**$3.26**
Netback Price ($2012/Mcf)	**-**	**$3.92**	**$4.36**	**$4.94**	**$5.52**	**$7.08**
Quota Rent ($2012/Mcf)	**-**	**$1.69**	**$1.98**	**$2.47**	**$2.83**	**$3.82**

Figure 141: Detailed Results from Global Natural Gas Model, HOGR_SD_LS

	EIA Ref	NERA Projections				
	2012	2018	2023	2028	2033	2038
Total Demand (Tcf)	**26.29**	**31.92**	**34.79**	**37.44**	**39.90**	**44.19**
Domestic Demand	25.64	29.39	31.16	33.41	35.44	39.15
Pipeline Exports to Mexico	0.62	1.08	1.45	1.85	2.27	2.85
Total LNG Exports	0.03	1.46	2.19	2.19	2.19	2.19
China India	-	-	-	-	-	-
Europe	-	-	-	0.93	0.17	-
Korea Japan	-	1.46	2.19	1.26	2.02	2.19
Total Supply (Tcf)	**26.23**	**31.92**	**34.79**	**37.44**	**39.90**	**44.19**
Domestic Production	24.06	30.15	34.14	36.84	39.19	43.62
Net Pipeline Imports from Canada	1.99	1.61	0.49	0.42	0.55	0.41
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$2.33**	**$2.44**	**$2.47**	**$2.69**	**$3.26**
Netback Price ($2012/Mcf)	**-**	**$3.78**	**$4.28**	**$4.94**	**$5.52**	**$7.08**
Quota Rent ($2012/Mcf)	**-**	**$1.45**	**$1.84**	**$2.47**	**$2.83**	**$3.82**

Figure 142: Detailed Results from Global Natural Gas Model, HOGR_SD_LR

	EIA Ref	NERA Projections				
	2012	2018	2023	2028	2033	2038
Total Demand (Tcf)	**26.29**	**32.33**	**34.79**	**37.44**	**39.90**	**44.19**
Domestic Demand	25.64	29.06	31.16	33.41	35.44	39.15
Pipeline Exports to Mexico	0.62	1.08	1.45	1.85	2.27	2.85
Total LNG Exports	0.03	2.19	2.19	2.19	2.19	2.19
China India	-	-	-	-	-	-
Europe	-	-	-	0.93	0.17	-
Korea Japan	-	2.19	2.19	1.26	2.02	2.19
Total Supply (Tcf)	**26.23**	**32.33**	**34.79**	**37.44**	**39.90**	**44.19**
Domestic Production	24.06	30.55	34.14	36.84	39.19	43.62
Net Pipeline Imports from Canada	1.99	1.61	0.49	0.42	0.55	0.41
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$2.43**	**$2.44**	**$2.47**	**$2.69**	**$3.26**
Netback Price ($2012/Mcf)	**-**	**$3.67**	**$4.28**	**$4.94**	**$5.52**	**$7.08**
Quota Rent ($2012/Mcf)	**-**	**$1.24**	**$1.84**	**$2.47**	**$2.83**	**$3.82**

Figure 143: Detailed Results from Global Natural Gas Model, HOGR_SD_HS

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**31.92**	**35.48**	**38.90**	**41.41**	**45.72**
Domestic Demand	25.64	29.39	30.75	32.68	34.75	38.48
Pipeline Exports to Mexico	0.62	1.08	1.45	1.85	2.27	2.85
Total LNG Exports	0.03	1.46	3.28	4.38	4.38	4.38
China India	-	-	-	-	-	-
Europe	-	-	-	1.70	0.36	-
Korea Japan	-	1.46	3.28	2.68	4.02	4.38
Total Supply (Tcf)	**26.23**	**31.92**	**35.48**	**38.90**	**41.41**	**45.72**
Domestic Production	24.06	30.15	34.82	38.30	40.69	45.14
Net Pipeline Imports from Canada	1.99	1.61	0.49	0.42	0.55	0.41
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$2.33**	**$2.55**	**$2.65**	**$2.84**	**$3.40**
Netback Price ($2012/Mcf)	**-**	**$3.78**	**$4.18**	**$4.52**	**$5.09**	**$6.77**
Quota Rent ($2012/Mcf)	**-**	**$1.45**	**$1.63**	**$1.87**	**$2.25**	**$3.37**

Figure 144: Detailed Results from Global Natural Gas Model, HOGR_SD_HR

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**33.56**	**36.17**	**38.90**	**41.41**	**45.72**
Domestic Demand	25.64	28.10	30.34	32.68	34.75	38.48
Pipeline Exports to Mexico	0.62	1.08	1.45	1.85	2.27	2.85
Total LNG Exports	0.03	4.38	4.38	4.38	4.38	4.38
China India	-	-	-	-	-	-
Europe	-	-	-	1.70	0.36	-
Korea Japan	-	4.38	4.38	2.68	4.02	4.38
Total Supply (Tcf)	**26.23**	**33.56**	**36.17**	**38.90**	**41.41**	**45.72**
Domestic Production	24.06	31.78	35.51	38.30	40.69	45.14
Net Pipeline Imports from Canada	1.99	1.61	0.49	0.42	0.55	0.41
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$2.75**	**$2.67**	**$2.65**	**$2.84**	**$3.40**
Netback Price ($2012/Mcf)	**-**	**$3.43**	**$4.07**	**$4.52**	**$5.09**	**$6.77**
Quota Rent ($2012/Mcf)	**-**	**$0.68**	**$1.40**	**$1.87**	**$2.25**	**$3.37**

Figure 145: Detailed Results from Global Natural Gas Model, HOGR_SD_NC

	EIA Ref	NERA Projections				
	2012	2018	2023	2028	2033	2038
Total Demand (Tcf)	**26.29**	**34.85**	**39.61**	**44.49**	**49.01**	**56.71**
Domestic Demand	25.64	27.14	28.46	30.14	31.68	34.35
Pipeline Exports to Mexico	0.62	1.08	1.45	1.85	2.27	2.85
Total LNG Exports	0.03	6.64	9.70	12.51	15.05	19.51
China India	-	-	-	-	-	-
Europe	-	-	1.51	6.66	5.80	9.85
Korea Japan	-	6.64	8.19	5.84	9.25	9.66
Total Supply (Tcf)	**26.23**	**34.85**	**39.61**	**44.49**	**49.01**	**56.71**
Domestic Production	24.06	33.08	38.95	43.88	48.29	56.13
Net Pipeline Imports from Canada	1.99	1.61	0.49	0.42	0.55	0.41
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$3.12**	**$3.30**	**$3.38**	**$3.66**	**$4.48**
Netback Price ($2012/Mcf)	**-**	**$3.12**	**$3.30**	**$3.38**	**$3.66**	**$4.48**
Quota Rent ($2012/Mcf)	**-**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**

Figure 146: Detailed Results from Global Natural Gas Model, LOGR_INTREF_NX

	EIA Ref	NERA Projections				
	2012	2018	2023	2028	2033	2038
Total Demand (Tcf)	**26.29**	**25.71**	**25.69**	**26.09**	**26.73**	**27.44**
Domestic Demand	25.64	24.76	24.52	24.71	25.15	25.60
Pipeline Exports to Mexico	0.62	0.95	1.17	1.38	1.58	1.84
Total LNG Exports*	0.03	-	-	-	-	-
China India	-	-	-	-	-	-
Europe	-	-	-	-	-	-
Korea Japan	-	-	-	-	-	-
Total Supply (Tcf)	**26.23**	**25.71**	**25.69**	**26.09**	**26.73**	**27.44**
Domestic Production	24.06	23.81	24.61	24.93	25.53	26.64
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$4.26**	**$5.19**	**$6.01**	**$6.68**	**$8.80**
Netback Price ($2012/Mcf)	**-**	**$4.18**	**$4.64**	**$5.47**	**$5.94**	**$8.34**
Quota Rent ($2012/Mcf)	**-**	**-**	**-**	**-**	**-**	**-**

* All U.S. LNG exports occur from Alaska.

Figure 147: Detailed Results from Global Natural Gas Model, LOGR_INTREF_LSS

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**25.71**	**25.69**	**26.57**	**27.21**	**28.00**
Domestic Demand	25.64	24.76	24.52	24.49	24.94	25.36
Pipeline Exports to Mexico	0.62	0.95	1.17	1.38	1.58	1.84
Total LNG Exports	0.03	-	-	0.69	0.69	0.80
China India	-	-	-	-	-	-
Europe	-	-	-	-	-	-
Korea Japan	-	-	-	0.69	0.69	0.80
Total Supply (Tcf)	**26.23**	**25.71**	**25.69**	**26.57**	**27.21**	**28.00**
Domestic Production	24.06	23.81	24.61	25.41	26.01	27.20
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports*	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$4.26**	**$5.19**	**$6.01**	**$6.68**	**$8.80**
Netback Price ($2012/Mcf)	-	**$2.83**	**$3.26**	**$3.74**	**$4.35**	**$5.98**
Quota Rent ($2012/Mcf)	-	-	-	-	-	-

* All U.S. LNG exports occur from Alaska.

Figure 148: Detailed Results from Global Natural Gas Model, LOGR_INTREF_LS

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**25.71**	**25.69**	**26.57**	**27.21**	**28.00**
Domestic Demand	25.64	24.76	24.52	24.49	24.94	25.36
Pipeline Exports to Mexico	0.62	0.95	1.17	1.38	1.58	1.84
Total LNG Exports*	0.03	-	-	0.69	0.69	0.80
China India	-	-	-	-	-	-
Europe	-	-	-	-	-	-
Korea Japan	-	-	-	0.69	0.69	0.80
Total Supply (Tcf)	**26.23**	**25.71**	**25.69**	**26.57**	**27.21**	**28.00**
Domestic Production	24.06	23.81	24.61	25.41	26.01	27.20
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$4.26**	**$5.19**	**$6.01**	**$6.68**	**$8.80**
Netback Price ($2012/Mcf)	**-**	**$2.83**	**$3.26**	**$3.74**	**$4.35**	**$5.98**
Quota Rent ($2012/Mcf)	**-**	**-**	**-**	**-**	**-**	**-**

* All U.S. LNG exports occur from Alaska.

Figure 149: Detailed Results from Global Natural Gas Model, LOGR_INTREF_LR

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**25.71**	**25.69**	**26.57**	**27.21**	**28.00**
Domestic Demand	25.64	24.76	24.52	24.49	24.94	25.36
Pipeline Exports to Mexico	0.62	0.95	1.17	1.38	1.58	1.84
Total LNG Exports*	0.03	-	-	0.69	0.69	0.80
China India	-	-	-	-	-	-
Europe	-	-	-	-	-	-
Korea Japan	-	-	-	0.69	0.69	0.80
Total Supply (Tcf)	**26.23**	**25.71**	**25.69**	**26.57**	**27.21**	**28.00**
Domestic Production	24.06	23.81	24.61	25.41	26.01	27.20
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$4.26**	**$5.19**	**$6.01**	**$6.68**	**$8.80**
Netback Price ($2012/Mcf)	**-**	**$2.83**	**$3.26**	**$3.74**	**$4.35**	**$5.98**
Quota Rent ($2012/Mcf)	**-**	**-**	**-**	**-**	**-**	**-**

* All U.S. LNG exports occur from Alaska.

Figure 150: Detailed Results from Global Natural Gas Model, LOGR_INTREF_HS

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**25.71**	**25.69**	**26.57**	**27.21**	**28.00**
Domestic Demand	25.64	24.76	24.52	24.49	24.94	25.36
Pipeline Exports to Mexico	0.62	0.95	1.17	1.38	1.58	1.84
Total LNG Exports*	0.03	-	-	0.69	0.69	0.80
China India	-	-	-	-	-	-
Europe	-	-	-	-	-	-
Korea Japan	-	-	-	0.69	0.69	0.80
Total Supply (Tcf)	**26.23**	**25.71**	**25.69**	**26.57**	**27.21**	**28.00**
Domestic Production	24.06	23.81	24.61	25.41	26.01	27.20
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$4.26**	**$5.19**	**$6.01**	**$6.68**	**$8.80**
Netback Price ($2012/Mcf)	**-**	**$2.83**	**$3.26**	**$3.74**	**$4.35**	**$5.98**
Quota Rent ($2012/Mcf)	**-**	**-**	**-**	**-**	**-**	**-**

* All U.S. LNG exports occur from Alaska.

Figure 151: Detailed Results from Global Natural Gas Model, LOGR_INTREF_HR

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**25.71**	**25.69**	**26.57**	**27.21**	**28.00**
Domestic Demand	25.64	24.76	24.52	24.49	24.94	25.36
Pipeline Exports to Mexico	0.62	0.95	1.17	1.38	1.58	1.84
Total LNG Exports*	0.03	-	-	0.69	0.69	0.80
China India	-	-	-	-	-	-
Europe	-	-	-	-	-	-
Korea Japan	-	-	-	0.69	0.69	0.80
Total Supply (Tcf)	**26.23**	**25.71**	**25.69**	**26.57**	**27.21**	**28.00**
Domestic Production	24.06	23.81	24.61	25.41	26.01	27.20
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$4.26**	**$5.19**	**$6.01**	**$6.68**	**$8.80**
Netback Price ($2012/Mcf)	**-**	**$2.83**	**$3.26**	**$3.74**	**$4.35**	**$5.98**
Quota Rent ($2012/Mcf)	**-**	**-**	**-**	**-**	**-**	**-**

* All U.S. LNG exports occur from Alaska.

Figure 152: Detailed Results from Global Natural Gas Model, LOGR_INTREF_NC

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**25.71**	**25.69**	**26.57**	**27.21**	**28.00**
Domestic Demand	25.64	24.76	24.52	24.49	24.94	25.36
Pipeline Exports to Mexico	0.62	0.95	1.17	1.38	1.58	1.84
Total LNG Exports*	0.03	-	-	0.69	0.69	0.80
China India	-	-	-	-	-	-
Europe	-	-	-	-	-	-
Korea Japan	-	-	-	0.69	0.69	0.80
Total Supply (Tcf)	**26.23**	**25.71**	**25.69**	**26.57**	**27.21**	**28.00**
Domestic Production	24.06	23.81	24.61	25.41	26.01	27.20
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$4.26**	**$5.19**	**$6.01**	**$6.68**	**$8.80**
Netback Price ($2012/Mcf)	**-**	**$2.83**	**$3.26**	**$3.74**	**$4.35**	**$5.98**
Quota Rent ($2012/Mcf)	**-**	**-**	**-**	**-**	**-**	**-**

* All U.S. LNG exports occur from Alaska.

Figure 153: Detailed Results from Global Natural Gas Model, LOGR_D_NX

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**25.71**	**25.69**	**26.09**	**26.73**	**27.44**
Domestic Demand	25.64	24.76	24.52	24.71	25.15	25.60
Pipeline Exports to Mexico	0.62	0.95	1.17	1.38	1.58	1.84
Total LNG Exports*	0.03	-	-	-	-	-
China India	-	-	-	-	-	-
Europe	-	-	-	-	-	-
Korea Japan	-	-	-	-	-	-
Total Supply (Tcf)	**26.23**	**25.71**	**25.69**	**26.09**	**26.73**	**27.44**
Domestic Production	24.06	23.81	24.61	24.93	25.53	26.64
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$4.26**	**$5.19**	**$6.01**	**$6.68**	**$8.80**
Netback Price ($2012/Mcf)	**-**	**$4.96**	**$5.73**	**$7.27**	**$7.76**	**$9.82**
Quota Rent ($2012/Mcf)	**-**	**$0.70**	**$0.54**	**$1.26**	**$1.08**	**$1.02**

* All U.S. LNG exports occur from Alaska.

Figure 154: Detailed Results from Global Natural Gas Model, LOGR_D_LSS

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**25.71**	**25.69**	**26.80**	**27.50**	**28.24**
Domestic Demand	25.64	24.75	24.51	24.34	24.75	25.22
Pipeline Exports to Mexico	0.62	0.95	1.17	1.38	1.58	1.84
Total LNG Exports	0.03	0.01	0.01	1.09	1.17	1.17
China India	-	-	-	-	-	-
Europe	-	-	-	0.25	0.16	-
Korea Japan	-	0.01	0.01	0.84	1.02	1.17
Total Supply (Tcf)	**26.23**	**25.71**	**25.69**	**26.80**	**27.50**	**28.24**
Domestic Production	24.06	23.82	24.62	25.65	26.31	27.44
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$4.26**	**$5.19**	**$6.09**	**$6.78**	**$8.88**
Netback Price ($2012/Mcf)	**-**	**$4.18**	**$4.63**	**$6.09**	**$6.78**	**$8.88**
Quota Rent ($2012/Mcf)	**-**	**-**	**-**	**$0.00**	**$0.00**	**$0.00**

Figure 155: Detailed Results from Global Natural Gas Model, LOGR_D_LS

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**25.71**	**25.69**	**26.80**	**27.50**	**28.24**
Domestic Demand	25.64	24.75	24.51	24.34	24.75	25.22
Pipeline Exports to Mexico	0.62	0.95	1.17	1.38	1.58	1.84
Total LNG Exports	0.03	0.01	0.01	1.09	1.17	1.17
China India	-	-	-	-	-	-
Europe	-	-	-	0.25	0.16	-
Korea Japan	-	0.01	0.01	0.84	1.02	1.17
Total Supply (Tcf)	**26.23**	**25.71**	**25.69**	**26.80**	**27.50**	**28.24**
Domestic Production	24.06	23.82	24.62	25.65	26.31	27.44
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$4.26**	**$5.19**	**$6.09**	**$6.78**	**$8.88**
Netback Price ($2012/Mcf)	**-**	**$4.18**	**$4.63**	**$6.09**	**$6.78**	**$8.88**
Quota Rent ($2012/Mcf)	**-**	**-**	**-**	**$0.00**	**$0.00**	**$0.00**

Figure 156: Detailed Results from Global Natural Gas Model, LOGR_D_LR

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**25.71**	**25.69**	**26.80**	**27.50**	**28.24**
Domestic Demand	25.64	24.75	24.51	24.34	24.75	25.22
Pipeline Exports to Mexico	0.62	0.95	1.17	1.38	1.58	1.84
Total LNG Exports	0.03	0.01	0.01	1.09	1.17	1.17
China India	-	-	-	-	-	-
Europe	-	-	-	0.25	0.16	-
Korea Japan	-	0.01	0.01	0.84	1.02	1.17
Total Supply (Tcf)	**26.23**	**25.71**	**25.69**	**26.80**	**27.50**	**28.24**
Domestic Production	24.06	23.82	24.62	25.65	26.31	27.44
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$4.26**	**$5.19**	**$6.09**	**$6.78**	**$8.88**
Netback Price ($2012/Mcf)	**-**	**$4.18**	**$4.63**	**$6.09**	**$6.78**	**$8.88**
Quota Rent ($2012/Mcf)*	**-**	**-**	**-**	**$0.00**	**$0.00**	**$0.00**

Figure 157: Detailed Results from Global Natural Gas Model, LOGR_D_HS

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**25.71**	**25.69**	**26.80**	**27.50**	**28.24**
Domestic Demand	25.64	24.75	24.51	24.34	24.75	25.22
Pipeline Exports to Mexico	0.62	0.95	1.17	1.38	1.58	1.84
Total LNG Exports	0.03	0.01	0.01	1.09	1.17	1.17
China India	-	-	-	-	-	-
Europe	-	-	-	0.25	0.16	-
Korea Japan	-	0.01	0.01	0.84	1.02	1.17
Total Supply (Tcf)	**26.23**	**25.71**	**25.69**	**26.80**	**27.50**	**28.24**
Domestic Production	24.06	23.82	24.62	25.65	26.31	27.44
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$4.26**	**$5.19**	**$6.09**	**$6.78**	**$8.88**
Netback Price ($2012/Mcf)	**-**	**$4.18**	**$4.63**	**$6.09**	**$6.78**	**$8.88**
Quota Rent ($2012/Mcf)	**-**	**-**	**-**	**$0.00**	**$0.00**	**$0.00**

Figure 158: Detailed Results from Global Natural Gas Model, LOGR_D_HR

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**25.71**	**25.69**	**26.80**	**27.50**	**28.24**
Domestic Demand	25.64	24.75	24.51	24.34	24.75	25.22
Pipeline Exports to Mexico	0.62	0.95	1.17	1.38	1.58	1.84
Total LNG Exports	0.03	0.01	0.01	1.09	1.17	1.17
China India	-	-	-	-	-	-
Europe	-	-	-	0.25	0.16	-
Korea Japan	-	0.01	0.01	0.84	1.02	1.17
Total Supply (Tcf)	**26.23**	**25.71**	**25.69**	**26.80**	**27.50**	**28.24**
Domestic Production	24.06	23.82	24.62	25.65	26.31	27.44
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$4.26**	**$5.19**	**$6.09**	**$6.78**	**$8.88**
Netback Price ($2012/Mcf)	**-**	**$4.21**	**$4.63**	**$6.09**	**$6.78**	**$8.88**
Quota Rent ($2012/Mcf)	**-**	**-**	**-**	**$0.00**	**$0.00**	**$0.00**

Figure 159: Detailed Results from Global Natural Gas Model, LOGR_D_NC

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**25.71**	**25.69**	**26.80**	**27.50**	**28.24**
Domestic Demand	25.64	24.75	24.51	24.34	24.75	25.22
Pipeline Exports to Mexico	0.62	0.95	1.17	1.38	1.58	1.84
Total LNG Exports	0.03	0.01	0.01	1.09	1.17	1.17
China India	-	-	-	-	-	-
Europe	-	-	-	0.25	0.15	-
Korea Japan	-	0.01	0.01	0.84	1.02	1.17
Total Supply (Tcf)	**26.23**	**25.71**	**25.69**	**26.80**	**27.50**	**28.24**
Domestic Production	24.06	23.82	24.62	25.65	26.31	27.44
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$4.26**	**$5.19**	**$6.09**	**$6.78**	**$8.88**
Netback Price ($2012/Mcf)	**-**	**$4.18**	**$4.63**	**$6.09**	**$6.78**	**$8.88**
Quota Rent ($2012/Mcf)	**-**	**-**	**-**	**$0.00**	**$0.00**	**$0.00**

Figure 160: Detailed Results from Global Natural Gas Model, LOGR_SD_NX

	EIA Ref	NERA Projections				
	2012	2018	2023	2028	2033	2038
Total Demand (Tcf)	**26.29**	**25.71**	**25.69**	**26.09**	**26.73**	**27.44**
Domestic Demand	25.64	24.76	24.52	24.71	25.15	25.60
Pipeline Exports to Mexico	0.62	0.95	1.17	1.38	1.58	1.84
Total LNG Exports*	0.03	-	-	-	-	-
China India	-	-	-	-	-	-
Europe	-	-	-	-	-	-
Korea Japan	-	-	-	-	-	-
Total Supply (Tcf)	**26.23**	**25.71**	**25.69**	**26.09**	**26.73**	**27.44**
Domestic Production	24.06	23.81	24.61	24.93	25.53	26.64
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$4.26**	**$5.19**	**$6.01**	**$6.68**	**$8.80**
Netback Price ($2012/Mcf)	**-**	**$5.24**	**$7.37**	**$11.54**	**$12.70**	**$14.42**
Quota Rent ($2012/Mcf)	**-**	**$0.98**	**$2.18**	**$5.53**	**$6.02**	**$5.62**

* All U.S. LNG exports occur from Alaska.

Figure 161: Detailed Results from Global Natural Gas Model, LOGR_SD_LSS

	EIA Ref	NERA Projections				
	2012	2018	2023	2028	2033	2038
Total Demand (Tcf)	**26.29**	**25.90**	**26.21**	**27.39**	**28.07**	**28.81**
Domestic Demand	25.64	24.53	24.00	23.82	24.30	24.78
Pipeline Exports to Mexico	0.62	0.95	1.17	1.38	1.58	1.84
Total LNG Exports	0.03	0.42	1.04	2.19	2.19	2.19
China India	-	-	-	-	-	-
Europe	-	-	-	0.37	-	-
Korea Japan	-	0.42	1.04	1.82	2.19	2.19
Total Supply (Tcf)	**26.23**	**25.90**	**26.21**	**27.39**	**28.07**	**28.81**
Domestic Production	24.06	24.00	25.14	26.24	26.87	28.01
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$4.38**	**$5.52**	**$6.43**	**$7.09**	**$9.23**
Netback Price ($2012/Mcf)	**-**	**$4.38**	**$5.52**	**$6.89**	**$7.90**	**$10.22**
Quota Rent ($2012/Mcf)	**-**	**$0.00**	**$0.00**	**$0.46**	**$0.81**	**$0.99**

Figure 162: Detailed Results from Global Natural Gas Model, LOGR_SD_LS

	EIA Ref	NERA Projections				
	2012	2018	2023	2028	2033	2038
Total Demand (Tcf)	**26.29**	**25.90**	**26.21**	**27.39**	**28.07**	**28.81**
Domestic Demand	25.64	24.53	24.00	23.82	24.30	24.78
Pipeline Exports to Mexico	0.62	0.95	1.17	1.38	1.58	1.84
Total LNG Exports	0.03	0.42	1.04	2.19	2.19	2.19
China India	-	-	-	-	-	-
Europe	-	-	-	0.37	-	-
Korea Japan	-	0.42	1.04	1.82	2.19	2.19
Total Supply (Tcf)	**26.23**	**25.90**	**26.21**	**27.39**	**28.07**	**28.81**
Domestic Production	24.06	24.00	25.14	26.24	26.87	28.01
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$4.38**	**$5.52**	**$6.43**	**$7.09**	**$9.23**
Netback Price ($2012/Mcf)	**-**	**$4.38**	**$5.52**	**$6.89**	**$7.90**	**$10.22**
Quota Rent ($2012/Mcf)	**-**	**$0.00**	**$0.00**	**$0.46**	**$0.81**	**$0.99**

Figure 163: Detailed Results from Global Natural Gas Model, LOGR_SD_LR

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**25.90**	**26.21**	**27.39**	**28.07**	**28.81**
Domestic Demand	25.64	24.53	24.00	23.82	24.30	24.78
Pipeline Exports to Mexico	0.62	0.95	1.17	1.38	1.58	1.84
Total LNG Exports	0.03	0.42	1.04	2.19	2.19	2.19
China India	-	-	-	-	-	-
Europe	-	-	-	0.37	-	-
Korea Japan	-	0.42	1.04	1.82	2.19	2.19
Total Supply (Tcf)	**26.23**	**25.90**	**26.21**	**27.39**	**28.07**	**28.81**
Domestic Production	24.06	24.00	25.14	26.24	26.87	28.01
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$4.38**	**$5.52**	**$6.43**	**$7.09**	**$9.23**
Netback Price ($2012/Mcf)	**-**	**$4.38**	**$5.52**	**$6.89**	**$7.90**	**$10.22**
Quota Rent ($2012/Mcf)	**-**	**$0.00**	**$0.00**	**$0.46**	**$0.81**	**$0.99**

Figure 164: Detailed Results from Global Natural Gas Model, LOGR_SD_HS

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**25.90**	**26.21**	**27.73**	**28.76**	**29.79**
Domestic Demand	25.64	24.53	24.00	23.54	23.76	24.05
Pipeline Exports to Mexico	0.62	0.95	1.17	1.38	1.58	1.84
Total LNG Exports	0.03	0.42	1.04	2.82	3.43	3.90
China India	-	-	-	-	-	-
Europe	-	-	-	0.44	0.03	-
Korea Japan	-	0.42	1.04	2.38	3.39	3.90
Total Supply (Tcf)	**26.23**	**25.90**	**26.21**	**27.73**	**28.76**	**29.79**
Domestic Production	24.06	24.00	25.14	26.58	27.57	28.99
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$4.38**	**$5.52**	**$6.64**	**$7.47**	**$9.83**
Netback Price ($2012/Mcf)	**-**	**$4.38**	**$5.52**	**$6.64**	**$7.47**	**$9.83**
Quota Rent ($2012/Mcf)	**-**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**

Figure 165: Detailed Results from Global Natural Gas Model, LOGR_SD_HR

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**26.29**	**25.90**	**26.21**	**27.73**	**28.76**	**29.79**
Domestic Demand	25.64	24.53	24.00	23.54	23.76	24.05
Pipeline Exports to Mexico	0.62	0.95	1.17	1.38	1.58	1.84
Total LNG Exports	0.03	0.42	1.04	2.82	3.43	3.90
China India	-	-	-	-	-	-
Europe	-	-	-	0.44	0.03	-
Korea Japan	-	0.42	1.04	2.38	3.39	3.90
Total Supply (Tcf)	**26.23**	**25.90**	**26.21**	**27.73**	**28.76**	**29.79**
Domestic Production	24.06	24.00	25.14	26.58	27.57	28.99
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$4.38**	**$5.52**	**$6.64**	**$7.47**	**$9.83**
Netback Price ($2012/Mcf)	**-**	**$4.38**	**$5.52**	**$6.64**	**$7.47**	**$9.83**
Quota Rent ($2012/Mcf)	**-**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**

Figure 166: Detailed Results from Global Natural Gas Model, LOGR_SD_NC

	EIA Ref	NERA Projections				
	2012	2018	2023	2028	2033	2038
Total Demand (Tcf)	**26.29**	**25.90**	**26.21**	**27.73**	**28.76**	**29.79**
Domestic Demand	25.64	24.53	24.00	23.54	23.76	24.05
Pipeline Exports to Mexico	0.62	0.95	1.17	1.38	1.58	1.84
Total LNG Exports	0.03	0.42	1.04	2.82	3.43	3.90
China India	-	-	-	-	-	-
Europe	-	-	-	0.44	0.03	-
Korea Japan	-	0.42	1.04	2.38	3.39	3.90
Total Supply (Tcf)	**26.23**	**25.90**	**26.21**	**27.73**	**28.76**	**29.79**
Domestic Production	24.06	24.00	25.14	26.58	27.57	28.99
Net Pipeline Imports from Canada	1.99	1.73	0.91	0.97	1.03	0.63
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$4.38**	**$5.52**	**$6.64**	**$7.47**	**$9.83**
Netback Price ($2012/Mcf)	**-**	**$4.38**	**$5.52**	**$6.64**	**$7.47**	**$9.83**
Quota Rent ($2012/Mcf)	**-**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**

Figure 167: Detailed Results from Global Natural Gas Model, HOGR_INTREF_NC - With No Export Constraints by Rivals

	EIA Ref	NERA Projections				
	2012	2018	2023	2028	2033	2038
Total Demand (Tcf)	**25.50**	**31.71**	**34.60**	**38.52**	**41.87**	**46.12**
Domestic Demand	24.85	29.55	31.27	32.93	34.66	38.39
Pipeline Exports to Mexico	0.62	1.08	1.45	1.85	2.27	2.85
Total LNG Exports	0.03	1.09	1.89	3.74	4.93	4.88
China India	-	-	-	-	-	-
Europe	-	1.07	1.02	2.00	1.83	1.48
Korea Japan	-	0.02	0.87	1.74	3.10	3.40
Total Supply (Tcf)	**26.23**	**31.71**	**34.60**	**38.52**	**41.87**	**46.12**
Domestic Production	24.06	29.94	33.94	37.90	41.15	45.54
Net Pipeline Imports from Canada	1.99	1.61	0.49	0.42	0.55	0.41
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$2.27**	**$2.40**	**$2.57**	**$2.86**	**$3.43**
Netback Price ($2012/Mcf)	**-**	**-**	**-**	**-**	**$0.48**	**$1.58**
Quota Rent ($2012/Mcf)	**-**	**-**	**-**	**-**	**-**	**-**

Figure 168: Detailed Results from Global Natural Gas Model, HOGR_D_NC - With No Export Constraints by Rivals

	EIA Ref	NERA Projections				
	2012	**2018**	**2023**	**2028**	**2033**	**2038**
Total Demand (Tcf)	**25.50**	**33.06**	**36.59**	**40.95**	**44.74**	**49.14**
Domestic Demand	24.85	28.50	30.11	31.74	33.43	37.14
Pipeline Exports to Mexico	0.62	1.08	1.45	1.85	2.27	2.85
Total LNG Exports	0.03	3.49	5.04	7.36	9.03	9.15
China India	-	-	-	-	-	-
Europe	-	0.73	0.65	1.61	1.41	1.06
Korea Japan	-	2.76	4.39	5.75	7.62	8.09
Total Supply (Tcf)	**26.23**	**33.06**	**36.59**	**40.95**	**44.74**	**49.14**
Domestic Production	24.06	31.27	35.93	40.33	44.02	48.56
Net Pipeline Imports from Canada	1.99	1.61	0.49	0.42	0.55	0.41
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$2.61**	**$2.74**	**$2.89**	**$3.16**	**$3.72**
Netback Price ($2012/Mcf)	**-**	**-**	**$0.46**	**$0.70**	**$0.86**	**$1.83**
Quota Rent ($2012/Mcf)	**-**	**-**	**-**	**-**	**-**	**-**

Figure 169: Detailed Results from Global Natural Gas Model, HOGR_SD_NC - With No Export Constraints by Rivals

	EIA Ref	NERA Projections				
	2012	2018	2023	2028	2033	2038
Total Demand (Tcf)	**25.50**	**33.13**	**36.93**	**41.41**	**45.29**	**49.84**
Domestic Demand	24.85	28.44	29.92	31.52	33.21	36.86
Pipeline Exports to Mexico	0.62	1.08	1.45	1.85	2.27	2.85
Total LNG Exports	0.03	3.61	5.56	8.04	9.81	10.12
China India	-	-	-	-	-	-
Europe	-	0.71	0.59	1.54	1.33	0.96
Korea Japan	-	2.89	4.98	6.50	8.47	9.16
Total Supply (Tcf)	**26.23**	**33.13**	**36.93**	**41.41**	**45.29**	**49.84**
Domestic Production	24.06	31.34	36.26	40.80	44.57	49.26
Net Pipeline Imports from Canada	1.99	1.61	0.49	0.42	0.55	0.41
Total LNG Imports	0.17	0.17	0.17	0.19	0.17	0.17
Africa	-	-	-	-	-	-
C & S America	0.11	0.17	0.17	0.19	0.17	0.17
Europe	0.01	-	-	-	-	-
Middle East	0.05	-	-	-	-	-
Wellhead Price ($2012/Mcf)	**$2.66**	**$2.62**	**$2.79**	**$2.95**	**$3.22**	**$3.78**
Netback Price ($2012/Mcf)	**-**	**-**	**$0.55**	**$0.80**	**$0.93**	**$1.90**
Quota Rent ($2012/Mcf)	**-**	**-**	**-**	**-**	**-**	**-**

B. N_{ew}ERA Model Results

The following figures (Figure 170 through Figure 186) contain detailed macroeconomic outputs for all modeled baselines, scenarios, and sensitivities. For each figure, the "Level Values" section depicts the numerical results from the scenario or baseline, and the "Percentage Change" section shows the percentage change in the Level Values for a given scenario relative to its baseline case. Figure 170 through Figure 172 contain detailed results for the baselines. Figure 173 through Figure 186 contain results for the scenarios. Figure 187 through Figure 191 contain results for the sensitivities. All tables use the following acronyms defined in the following list:

AGR – agriculture sector
COL – coal sector
CRU – crude oil sector
EIS – energy-intensive sector
ELE – electricity sector
GAS – natural gas sector
M_V – motor vehicle manufacturing sector
MAN – other manufacturing sector
OIL – refining sector
SRV – commercial sector
TRK – commercial trucking sector
TRN – other commercial transportation sector
C – household sector
G – government sector

Figure 170: Detailed Results for U.S. Reference Baseline Case

			Scenario: BAU_USREF					
	Description		Units	**2018**	**2023**	**2028**	**2033**	**2038**
			Level Values					
Macro	Gross Domestic Product		Billion 2012$	$16,933	$18,862	$20,985	$23,405	$26,107
	Consumption		Billion 2012$	$13,128	$14,659	$16,360	$18,310	$20,546
	Investment		Billion 2012$	$3,440	$3,879	$4,324	$4,854	$5,432
Natural Gas	Wellhead Price		2012$ per Mcf	$3.43	$3.83	$4.18	$4.62	$6.15
	Production		Tcf	26.02	27.41	28.69	29.80	31.45
	LNG Exports		Tcf	-	-	-	-	-
	Total Demand		Tcf	25.98	26.58	27.42	28.38	29.24
	Sectoral Demand	AGR	Tcf	0.18	0.19	0.20	0.21	0.21
		COL	Tcf	-	-	-	-	-
		CRU	Tcf	-	-	-	-	-
		EIS	Tcf	3.35	3.58	3.59	3.61	3.64
		ELE	Tcf	8.25	8.31	8.86	9.42	9.66
		GAS [1]	Tcf	-	-	-	-	-
		M_V	Tcf	0.19	0.18	0.19	0.20	0.21
		MAN	Tcf	3.49	3.69	3.78	3.87	3.98
		OIL	Tcf	1.93	2.01	2.05	2.09	2.14
		SRV	Tcf	2.39	2.42	2.47	2.54	2.59
		TRK	Tcf	0.52	0.54	0.62	0.80	1.10
		TRN	Tcf	0.24	0.25	0.29	0.37	0.51
		C	Tcf	4.54	4.47	4.42	4.32	4.20
		G	Tcf	0.91	0.93	0.95	0.97	0.99
	Export Revenues		Billion 2012$	-	-	-	-	-
			Percentage Change					
Macro	Gross Domestic Product		%	-	-	-	-	-
	Gross Capital Income		%	-	-	-	-	-
	Gross Labor Income		%	-	-	-	-	-
	Gross Resource Income		%	-	-	-	-	-
	Consumption		%	-	-	-	-	-
	Investment		%	-	-	-	-	-
Natural Gas	Wellhead Price		%	-	-	-	-	-
	Production		%	-	-	-	-	-
	Total Demand		%	-	-	-	-	-
	Sectoral Demand	AGR	%	-	-	-	-	-
		COL	%	-	-	-	-	-
		CRU	%	-	-	-	-	-
		EIS	%	-	-	-	-	-
		ELE	%	-	-	-	-	-
		GAS	%					
		M_V	%	-	-	-	-	-
		MAN	%	-	-	-	-	-
		OIL	%	-	-	-	-	-
		SRV	%	-	-	-	-	-
		TRK	%	-	-	-	-	-
		TRN	%	-	-	-	-	-
		C	%	-	-	-	-	-

[1] natural gas usage amounts to liquefaction loss.

Figure 171: Detailed Results for U.S. High Oil and Gas Resource Baseline Case

	Description		Units	2018	2023	2028	2033	2038
			Scenario: BAU_HOGR					
			Level Values					
Macro	Gross Domestic Product		Billion 2012$	$17,199	$19,278	$21,552	$24,108	$27,029
	Consumption		Billion 2012$	$13,312	$14,911	$16,676	$18,683	$21,033
	Investment		Billion 2012$	$3,552	$4,014	$4,477	$5,034	$5,655
Natural Gas	Wellhead Price		2012$ per Mcf	$2.17	$2.15	$2.20	$2.47	$2.99
	Production		Tcf	29.73	32.54	34.64	36.95	40.46
	LNG Exports		Tcf	-	-	-	-	-
	Total Demand		Tcf	29.38	31.05	32.49	34.24	36.57
	Sectoral Demand	AGR	Tcf	0.19	0.20	0.21	0.23	0.25
		COL	Tcf	-	-	-	-	-
		CRU	Tcf	-	-	-	-	-
		EIS	Tcf	3.48	3.79	3.84	3.99	4.24
		ELE	Tcf	10.93	11.77	12.75	13.64	14.62
		GAS [1]	Tcf	-	-	-	-	-
		M_V	Tcf	0.19	0.19	0.20	0.22	0.24
		MAN	Tcf	3.64	3.90	4.04	4.27	4.64
		OIL	Tcf	2.01	2.13	2.20	2.30	2.49
		SRV	Tcf	2.50	2.58	2.66	2.75	2.85
		TRK	Tcf	0.57	0.61	0.69	0.90	1.21
		TRN	Tcf	0.26	0.28	0.32	0.42	0.56
		C	Tcf	4.65	4.61	4.56	4.48	4.38
		G	Tcf	0.95	0.99	1.02	1.05	1.09
	Export Revenues		Billion 2012$	-	-	-	-	-
			Percentage Change					
Macro	Gross Domestic Product		%	-	-	-	-	-
	Gross Capital Income		%	-	-	-	-	-
	Gross Labor Income		%	-	-	-	-	-
	Gross Resource Income		%	-	-	-	-	-
	Consumption		%	-	-	-	-	-
	Investment		%	-	-	-	-	-
Natural Gas	Wellhead Price		%	-	-	-	-	-
	Production		%	-	-	-	-	-
	Total Demand		%	-	-	-	-	-
	Sectoral Demand	AGR	%	-	-	-	-	-
		COL	%	-	-	-	-	-
		CRU	%	-	-	-	-	-
		EIS	%	-	-	-	-	-
		ELE	%	-	-	-	-	-
		GAS	%					
		M_V	%	-	-	-	-	-
		MAN	%	-	-	-	-	-
		OIL	%	-	-	-	-	-
		SRV	%	-	-	-	-	-
		TRK	%	-	-	-	-	-
		TRN	%	-	-	-	-	-
		C	%	-	-	-	-	-

[1] natural gas usage amounts to liquefaction loss.

Figure 172: Detailed Results for U.S. Low Oil and Gas Resource Baseline Case

			Scenario: BAU_LOGR					
	Description		Units	**2018**	**2023**	**2028**	**2033**	**2038**
			Level Values					
Macro	Gross Domestic Product		Billion 2012$	$16,834	$18,714	$20,809	$23,238	$25,950
	Consumption		Billion 2012$	$13,059	$14,562	$16,247	$18,197	$20,442
	Investment		Billion 2012$	$3,405	$3,845	$4,295	$4,839	$5,421
Natural Gas	Wellhead Price		2012$ per Mcf	$4.32	$5.13	$5.76	$6.31	$8.02
	Production		Tcf	23.99	24.76	25.21	25.53	26.03
	LNG Exports		Tcf	-	-	-	-	-
	Total Demand		Tcf	24.31	24.37	24.84	25.07	24.70
	Sectoral Demand	AGR	Tcf	0.18	0.18	0.19	0.19	0.20
		COL	Tcf	-	-	-	-	-
		CRU	Tcf	-	-	-	-	-
		EIS	Tcf	3.25	3.39	3.37	3.37	3.35
		ELE	Tcf	7.01	6.91	7.25	7.26	6.56
		GAS [1]	Tcf	-	-	-	-	-
		M_V	Tcf	0.18	0.17	0.18	0.19	0.19
		MAN	Tcf	3.40	3.49	3.55	3.61	3.67
		OIL	Tcf	1.87	1.91	1.93	1.95	1.97
		SRV	Tcf	2.33	2.31	2.35	2.41	2.46
		TRK	Tcf	0.49	0.51	0.55	0.65	0.87
		TRN	Tcf	0.23	0.24	0.26	0.30	0.41
		C	Tcf	4.48	4.38	4.32	4.22	4.09
		G	Tcf	0.89	0.88	0.90	0.92	0.94
	Export Revenues		Billion 2012$	-	-	-	-	-
			Percentage Change					
Macro	Gross Domestic Product		%	-	-	-	-	-
	Gross Capital Income		%	-	-	-	-	-
	Gross Labor Income		%	-	-	-	-	-
	Gross Resource Income		%	-	-	-	-	-
	Consumption		%	-	-	-	-	-
	Investment		%	-	-	-	-	-
Natural Gas	Wellhead Price		%	-	-	-	-	-
	Production		%	-	-	-	-	-
	Total Demand		%	-	-	-	-	-
	Sectoral Demand	AGR	%	-	-	-	-	-
		COL	%	-	-	-	-	-
		CRU	%	-	-	-	-	-
		EIS	%	-	-	-	-	-
		ELE	%	-	-	-	-	-
		GAS	%					
		M_V	%	-	-	-	-	-
		MAN	%	-	-	-	-	-
		OIL	%	-	-	-	-	-
		SRV	%	-	-	-	-	-
		TRK	%	-	-	-	-	-
		TRN	%	-	-	-	-	-
		C	%	-	-	-	-	-

[1] natural gas usage amounts to liquefaction loss.

Figure 173: Detailed Results for USREF_INTREF_NC

Scenario: USREF_INTREF_NC								
	Description		Units	**2018**	**2023**	**2028**	**2033**	**2038**
Level Values								
Macro	Gross Domestic Product		Billion 2012$	$16,935	$18,864	$20,989	$23,409	$26,113
	Consumption		Billion 2012$	$13,131	$14,662	$16,361	$18,311	$20,546
	Investment		Billion 2012$	$3,445	$3,885	$4,325	$4,855	$5,433
Natural Gas	Wellhead Price		2012$ per Mcf	$3.45	$4.03	$4.50	$4.92	$6.51
	Production		Tcf	26.08	28.04	29.98	31.12	32.92
	LNG Exports		Tcf	0.36	0.84	1.64	1.64	1.73
	Total Demand		Tcf	26.00	26.33	27.02	28.00	28.85
	Sectoral Demand	AGR	Tcf	0.18	0.19	0.19	0.20	0.21
		COL	Tcf	-	-	-	-	-
		CRU	Tcf	-	-	-	-	-
		EIS	Tcf	3.34	3.52	3.49	3.52	3.55
		ELE	Tcf	8.24	8.19	8.65	9.20	9.44
		GAS [1]	Tcf	0.04	0.09	0.18	0.18	0.19
		M_V	Tcf	0.19	0.18	0.19	0.20	0.20
		MAN	Tcf	3.49	3.62	3.68	3.77	3.89
		OIL	Tcf	1.93	1.98	2.00	2.04	2.09
		SRV	Tcf	2.39	2.40	2.44	2.50	2.55
		TRK	Tcf	0.52	0.54	0.62	0.79	1.09
		TRN	Tcf	0.24	0.25	0.29	0.37	0.51
		C	Tcf	4.54	4.44	4.36	4.27	4.15
		G	Tcf	0.91	0.92	0.93	0.95	0.97
	Export Revenues		Billion 2012$	1.62	4.39	9.61	10.48	14.69
Percentage Change								
Macro	Gross Domestic Product		%	0.01	0.01	0.02	0.02	0.02
	Gross Capital Income		%	0.02	0.03	0.05	0.05	0.06
	Gross Labor Income		%	(0.00)	(0.03)	(0.06)	(0.05)	(0.05)
	Gross Resource Income		%	0.34	3.05	4.30	3.28	3.26
	Consumption		%	0.02	0.02	0.01	0.00	(0.00)
	Investment		%	0.15	0.15	0.03	0.02	0.01
Natural Gas	Wellhead Price		%	0.58	5.28	8.06	6.86	6.08
	Production		%	0.25	2.38	4.64	4.57	4.86
	Total Demand		%	(0.11)	(1.33)	(2.22)	(2.06)	(2.04)
	Sectoral Demand	AGR	%	(0.21)	(1.91)	(2.95)	(2.62)	(2.51)
		COL	%	-	-	-	-	-
		CRU	%	-	-	-	-	-
		EIS	%	(0.21)	(1.88)	(2.92)	(2.62)	(2.51)
		ELE	%	(0.10)	(1.41)	(2.45)	(2.36)	(2.37)
		GAS	%					
		M_V	%	(0.13)	(1.40)	(2.39)	(2.27)	(2.28)
		MAN	%	(0.18)	(1.79)	(2.80)	(2.50)	(2.40)
		OIL	%	(0.14)	(1.67)	(2.62)	(2.33)	(2.20)
		SRV	%	(0.06)	(0.85)	(1.49)	(1.43)	(1.52)
		TRK	%	(0.04)	(0.41)	(0.78)	(0.79)	(0.90)
		TRN	%	(0.05)	(0.44)	(0.82)	(0.84)	(0.95)
		C	%	(0.02)	(0.70)	(1.25)	(1.20)	(1.30)

[1] natural gas usage amounts to liquefaction loss.

Figure 174: Detailed Results for USREF_D_LSS

	Description		Units	2018	2023	2028	2033	2038
Scenario: USREF_D_LSS								
Level Values								
Macro	Gross Domestic Product		Billion 2012$	$16,936	$18,866	$20,990	$23,411	$26,114
	Consumption		Billion 2012$	$13,132	$14,662	$16,361	$18,311	$20,547
	Investment		Billion 2012$	$3,448	$3,883	$4,324	$4,854	$5,432
Natural Gas	Wellhead Price		2012$ per Mcf	$3.53	$4.18	$4.60	$5.01	$6.58
	Production		Tcf	26.35	28.67	30.43	31.58	33.32
	LNG Exports		Tcf	0.73	1.65	2.20	2.20	2.20
	Total Demand		Tcf	25.90	26.15	26.91	27.90	28.79
	Sectoral Demand	AGR	Tcf	0.18	0.19	0.19	0.20	0.21
		COL	Tcf	-	-	-	-	-
		CRU	Tcf	-	-	-	-	-
		EIS	Tcf	3.31	3.47	3.46	3.50	3.54
		ELE	Tcf	8.20	8.11	8.59	9.14	9.40
		GAS [1]	Tcf	0.08	0.18	0.24	0.24	0.24
		M_V	Tcf	0.18	0.18	0.18	0.19	0.20
		MAN	Tcf	3.46	3.58	3.65	3.75	3.87
		OIL	Tcf	1.91	1.95	1.99	2.02	2.09
		SRV	Tcf	2.38	2.38	2.43	2.49	2.54
		TRK	Tcf	0.51	0.54	0.62	0.79	1.08
		TRN	Tcf	0.24	0.25	0.29	0.37	0.50
		C	Tcf	4.53	4.42	4.35	4.25	4.14
		G	Tcf	0.91	0.91	0.93	0.95	0.97
	Export Revenues		Billion 2012$	3.37	8.98	13.15	14.33	18.82
Percentage Change								
Macro	Gross Domestic Product		%	0.01	0.02	0.02	0.02	0.03
	Gross Capital Income		%	0.03	0.05	0.07	0.06	0.07
	Gross Labor Income		%	(0.02)	(0.06)	(0.08)	(0.07)	(0.07)
	Gross Resource Income		%	2.10	5.58	5.60	4.26	3.92
	Consumption		%	0.03	0.02	0.01	0.01	0.00
	Investment		%	0.26	0.11	(0.00)	0.00	(0.00)
Natural Gas	Wellhead Price		%	3.15	9.54	10.46	8.89	7.32
	Production		%	1.32	4.76	6.26	6.16	6.17
	Total Demand		%	(0.68)	(2.37)	(2.85)	(2.65)	(2.45)
	Sectoral Demand	AGR	%	(1.11)	(3.37)	(3.80)	(3.38)	(3.02)
		COL	%	-	-	-	-	-
		CRU	%	-	-	-	-	-
		EIS	%	(1.08)	(3.31)	(3.77)	(3.38)	(3.02)
		ELE	%	(0.66)	(2.50)	(3.15)	(3.03)	(2.83)
		GAS	%					
		M_V	%	(0.69)	(2.48)	(3.09)	(2.94)	(2.75)
		MAN	%	(1.01)	(3.17)	(3.60)	(3.21)	(2.88)
		OIL	%	(0.91)	(2.95)	(3.37)	(2.99)	(2.63)
		SRV	%	(0.40)	(1.53)	(1.93)	(1.84)	(1.82)
		TRK	%	(0.18)	(0.74)	(1.02)	(1.02)	(1.08)
		TRN	%	(0.20)	(0.79)	(1.08)	(1.09)	(1.15)
		C	%	(0.30)	(1.27)	(1.61)	(1.54)	(1.55)

[1] natural gas usage amounts to liquefaction loss.

Figure 175: Detailed Results for USREF_D_NC

Scenario: USREF_D_NC								
	Description		Units	**2018**	**2023**	**2028**	**2033**	**2038**
			Level Values					
Macro	Gross Domestic Product		Billion 2012$	$16,938	$18,868	$20,997	$23,420	$26,130
	Consumption		Billion 2012$	$13,136	$14,665	$16,364	$18,312	$20,546
	Investment		Billion 2012$	$3,448	$3,891	$4,327	$4,862	$5,438
Natural Gas	Wellhead Price		2012$ per Mcf	$3.79	$4.34	$4.96	$5.39	$7.06
	Production		Tcf	27.05	29.23	31.88	33.29	35.71
	LNG Exports		Tcf	1.74	2.38	4.05	4.32	4.98
	Total Demand		Tcf	25.58	25.97	26.52	27.50	28.40
	Sectoral Demand	AGR	Tcf	0.17	0.18	0.19	0.19	0.20
		COL	Tcf	-	-	-	-	-
		CRU	Tcf	-	-	-	-	-
		EIS	Tcf	3.23	3.42	3.36	3.39	3.43
		ELE	Tcf	8.06	8.02	8.38	8.90	9.13
		GAS [1]	Tcf	0.19	0.26	0.45	0.48	0.55
		M_V	Tcf	0.18	0.18	0.18	0.19	0.20
		MAN	Tcf	3.38	3.53	3.55	3.64	3.76
		OIL	Tcf	1.87	1.93	1.94	1.97	2.03
		SRV	Tcf	2.36	2.37	2.39	2.45	2.50
		TRK	Tcf	0.51	0.54	0.61	0.78	1.07
		TRN	Tcf	0.24	0.25	0.28	0.36	0.50
		C	Tcf	4.49	4.40	4.29	4.19	4.07
		G	Tcf	0.90	0.90	0.91	0.93	0.95
	Export Revenues		Billion 2012$	8.61	13.45	26.16	30.32	45.80
			Percentage Change					
Macro	Gross Domestic Product		%	0.03	0.03	0.06	0.06	0.09
	Gross Capital Income		%	0.05	0.08	0.14	0.15	0.20
	Gross Labor Income		%	(0.07)	(0.09)	(0.14)	(0.12)	(0.12)
	Gross Resource Income		%	7.63	8.05	10.69	8.61	8.56
	Consumption		%	0.06	0.04	0.02	0.01	0.00
	Investment		%	0.24	0.31	0.08	0.17	0.11
Natural Gas	Wellhead Price		%	11.07	13.76	19.46	17.45	15.38
	Production		%	4.09	6.85	11.51	12.09	14.01
	Total Demand		%	(2.36)	(3.37)	(5.10)	(4.98)	(4.93)
	Sectoral Demand	AGR	%	(3.73)	(4.81)	(6.79)	(6.35)	(6.07)
		COL	%	-	-	-	-	-
		CRU	%	-	-	-	-	-
		EIS	%	(3.63)	(4.75)	(6.74)	(6.34)	(6.07)
		ELE	%	(2.32)	(3.54)	(5.61)	(5.68)	(5.69)
		GAS	%					
		M_V	%	(2.30)	(3.53)	(5.55)	(5.52)	(5.53)
		MAN	%	(3.43)	(4.49)	(6.43)	(6.03)	(5.76)
		OIL	%	(3.18)	(4.18)	(5.99)	(5.62)	(5.28)
		SRV	%	(1.42)	(2.19)	(3.48)	(3.51)	(3.70)
		TRK	%	(0.60)	(1.07)	(1.86)	(1.96)	(2.22)
		TRN	%	(0.67)	(1.16)	(1.97)	(2.09)	(2.35)
		C	%	(1.16)	(1.80)	(2.91)	(2.94)	(3.18)

[1] natural gas usage amounts to liquefaction loss.

Figure 176: Detailed Results for USREF_D_LR

	Scenario: USREF_D_LR							
	Description		Units	**2018**	**2023**	**2028**	**2033**	**2038**
			Level Values					
Macro	Gross Domestic Product		Billion 2012$	$16,937	$18,866	$20,988	$23,410	$26,114
	Consumption		Billion 2012$	$13,132	$14,662	$16,362	$18,312	$20,548
	Investment		Billion 2012$	$3,446	$3,878	$4,322	$4,854	$5,433
Natural Gas	Wellhead Price		2012$ per Mcf	$3.80	$4.30	$4.60	$5.01	$6.58
	Production		Tcf	27.05	29.09	30.42	31.58	33.32
	LNG Exports		Tcf	1.74	2.20	2.20	2.20	2.20
	Total Demand		Tcf	25.59	26.02	26.91	27.90	28.79
	Sectoral Demand	AGR	Tcf	0.17	0.18	0.19	0.20	0.21
		COL	Tcf	-	-	-	-	-
		CRU	Tcf	-	-	-	-	-
		EIS	Tcf	3.23	3.43	3.46	3.49	3.54
		ELE	Tcf	8.06	8.04	8.59	9.14	9.40
		GAS [1]	Tcf	0.19	0.24	0.24	0.24	0.24
		M_V	Tcf	0.18	0.18	0.18	0.19	0.20
		MAN	Tcf	3.38	3.54	3.65	3.75	3.87
		OIL	Tcf	1.87	1.94	1.99	2.02	2.09
		SRV	Tcf	2.36	2.37	2.43	2.49	2.54
		TRK	Tcf	0.51	0.54	0.62	0.79	1.08
		TRN	Tcf	0.24	0.25	0.29	0.37	0.50
		C	Tcf	4.49	4.40	4.35	4.25	4.14
		G	Tcf	0.90	0.90	0.93	0.95	0.97
	Export Revenues		Billion 2012$	8.61	12.30	13.15	14.33	18.82
			Percentage Change					
Macro	Gross Domestic Product		%	0.03	0.02	0.02	0.02	0.03
	Gross Capital Income		%	0.05	0.06	0.06	0.06	0.07
	Gross Labor Income		%	(0.07)	(0.09)	(0.09)	(0.07)	(0.07)
	Gross Resource Income		%	7.71	7.43	5.55	4.24	3.90
	Consumption		%	0.03	0.02	0.01	0.01	0.01
	Investment		%	0.18	(0.04)	(0.04)	0.01	0.01
Natural Gas	Wellhead Price		%	11.09	12.67	10.45	8.89	7.31
	Production		%	4.09	6.33	6.25	6.16	6.17
	Total Demand		%	(2.36)	(3.12)	(2.86)	(2.65)	(2.45)
	Sectoral Demand	AGR	%	(3.68)	(4.41)	(3.83)	(3.40)	(3.04)
		COL	%	-	-	-	-	-
		CRU	%	-	-	-	-	-
		EIS	%	(3.57)	(4.35)	(3.81)	(3.40)	(3.04)
		ELE	%	(2.33)	(3.29)	(3.16)	(3.03)	(2.83)
		GAS	%					
		M_V	%	(2.27)	(3.23)	(3.12)	(2.96)	(2.77)
		MAN	%	(3.40)	(4.13)	(3.62)	(3.23)	(2.88)
		OIL	%	(3.18)	(3.87)	(3.37)	(3.00)	(2.63)
		SRV	%	(1.42)	(2.03)	(1.93)	(1.84)	(1.82)
		TRK	%	(0.59)	(0.99)	(1.03)	(1.03)	(1.08)
		TRN	%	(0.64)	(1.06)	(1.10)	(1.10)	(1.15)
		C	%	(1.19)	(1.70)	(1.60)	(1.53)	(1.54)

[1] natural gas usage amounts to liquefaction loss.

Figure 177: Detailed Results for USREF_SD_NC

	Description		Units	2018	2023	2028	2033	2038
			Scenario: USREF_SD_NC					
			Level Values					
Macro	Gross Domestic Product		Billion 2012$	$16,939	$18,870	$21,002	$23,428	$26,143
	Consumption		Billion 2012$	$13,139	$14,668	$16,365	$18,313	$20,546
	Investment		Billion 2012$	$3,451	$3,894	$4,332	$4,868	$5,441
Natural Gas	Wellhead Price		2012$ per Mcf	$3.91	$4.53	$5.24	$5.75	$7.47
	Production		Tcf	27.30	29.81	32.80	34.62	37.51
	LNG Exports		Tcf	2.14	3.17	5.27	6.03	7.12
	Total Demand		Tcf	25.45	25.77	26.23	27.13	28.07
	Sectoral Demand	AGR	Tcf	0.17	0.18	0.18	0.19	0.20
		COL	Tcf	-	-	-	-	-
		CRU	Tcf	-	-	-	-	-
		EIS	Tcf	3.19	3.36	3.29	3.30	3.34
		ELE	Tcf	8.01	7.93	8.23	8.69	8.92
		GAS [1]	Tcf	0.24	0.35	0.59	0.67	0.79
		M_V	Tcf	0.18	0.17	0.18	0.18	0.19
		MAN	Tcf	3.34	3.47	3.47	3.55	3.67
		OIL	Tcf	1.85	1.90	1.90	1.93	1.99
		SRV	Tcf	2.35	2.35	2.36	2.41	2.46
		TRK	Tcf	0.51	0.53	0.61	0.78	1.06
		TRN	Tcf	0.24	0.25	0.28	0.36	0.49
		C	Tcf	4.48	4.37	4.25	4.14	4.01
		G	Tcf	0.89	0.89	0.90	0.92	0.94
	Export Revenues		Billion 2012$	10.89	18.72	35.92	45.18	69.32
			Percentage Change					
Macro	Gross Domestic Product		%	0.03	0.05	0.08	0.10	0.14
	Gross Capital Income		%	0.06	0.10	0.18	0.21	0.30
	Gross Labor Income		%	(0.09)	(0.13)	(0.18)	(0.17)	(0.17)
	Gross Resource Income		%	10.08	11.13	14.70	12.92	12.83
	Consumption		%	0.08	0.06	0.04	0.02	(0.00)
	Investment		%	0.34	0.40	0.19	0.30	0.17
Natural Gas	Wellhead Price		%	14.58	18.82	26.31	25.50	22.37
	Production		%	5.12	9.06	14.84	16.74	19.95
	Total Demand		%	(3.07)	(4.51)	(6.69)	(7.02)	(6.94)
	Sectoral Demand	AGR	%	(4.86)	(6.44)	(8.89)	(8.92)	(8.52)
		COL	%	-	-	-	-	-
		CRU	%	-	-	-	-	-
		EIS	%	(4.73)	(6.35)	(8.83)	(8.91)	(8.52)
		ELE	%	(3.01)	(4.73)	(7.34)	(7.98)	(7.97)
		GAS	%					
		M_V	%	(3.01)	(4.73)	(7.28)	(7.78)	(7.78)
		MAN	%	(4.46)	(6.00)	(8.43)	(8.47)	(8.09)
		OIL	%	(4.13)	(5.59)	(7.85)	(7.90)	(7.42)
		SRV	%	(1.85)	(2.95)	(4.62)	(5.00)	(5.25)
		TRK	%	(0.80)	(1.46)	(2.49)	(2.82)	(3.17)
		TRN	%	(0.89)	(1.58)	(2.64)	(3.00)	(3.36)
		C	%	(1.51)	(2.43)	(3.86)	(4.21)	(4.54)

[1] natural gas usage amounts to liquefaction loss.

Figure 178: Detailed Results for HOGR_INTREF_NC

Scenario: HOGR_INTREF_NC								
	Description		Units	**2018**	**2023**	**2028**	**2033**	**2038**
			Level Values					
Macro	Gross Domestic Product		Billion 2012$	$17,211	$19,294	$21,576	$24,146	$27,090
	Consumption		Billion 2012$	$13,328	$14,925	$16,689	$18,696	$21,044
	Investment		Billion 2012$	$3,575	$4,031	$4,499	$5,074	$5,679
Natural Gas	Wellhead Price		2012$ per Mcf	$2.66	$2.78	$2.87	$3.28	$3.95
	Production		Tcf	32.87	37.80	41.87	46.14	53.73
	LNG Exports		Tcf	4.27	6.17	8.22	10.43	14.44
	Total Demand		Tcf	28.71	30.04	31.40	32.92	35.28
	Sectoral Demand	AGR	Tcf	0.18	0.19	0.19	0.21	0.22
		COL	Tcf	-	-	-	-	-
		CRU	Tcf	-	-	-	-	-
		EIS	Tcf	3.27	3.49	3.52	3.61	3.82
		ELE	Tcf	10.51	11.09	11.87	12.50	13.27
		GAS [1]	Tcf	0.47	0.69	0.91	1.16	1.60
		M_V	Tcf	0.19	0.18	0.19	0.20	0.22
		MAN	Tcf	3.43	3.61	3.72	3.89	4.20
		OIL	Tcf	1.90	1.98	2.03	2.11	2.27
		SRV	Tcf	2.45	2.50	2.57	2.63	2.70
		TRK	Tcf	0.56	0.60	0.68	0.88	1.18
		TRN	Tcf	0.26	0.28	0.32	0.41	0.55
		C	Tcf	4.57	4.50	4.43	4.32	4.20
		G	Tcf	0.93	0.95	0.98	1.00	1.03
	Export Revenues		Billion 2012$	14.78	22.32	30.74	44.55	74.32
			Percentage Change					
Macro	Gross Domestic Product		%	0.08	0.09	0.12	0.16	0.24
	Gross Capital Income		%	0.15	0.20	0.26	0.33	0.47
	Gross Labor Income		%	(0.10)	(0.14)	(0.14)	(0.14)	(0.15)
	Gross Resource Income		%	13.13	12.51	10.39	10.10	10.32
	Consumption		%	0.12	0.10	0.09	0.07	0.05
	Investment		%	0.67	0.43	0.51	0.82	0.44
Natural Gas	Wellhead Price		%	23.32	30.00	31.38	33.81	33.11
	Production		%	10.95	16.72	21.59	25.73	33.93
	Total Demand		%	(4.01)	(5.65)	(6.38)	(7.50)	(8.20)
	Sectoral Demand	AGR	%	(6.52)	(8.24)	(8.72)	(9.69)	(10.16)
		COL	%	-	-	-	-	-
		CRU	%	-	-	-	-	-
		EIS	%	(6.38)	(8.16)	(8.70)	(9.70)	(10.19)
		ELE	%	(3.96)	(6.00)	(7.12)	(8.62)	(9.56)
		GAS	%					
		M_V	%	(4.14)	(6.13)	(7.15)	(8.50)	(9.29)
		MAN	%	(6.07)	(7.76)	(8.28)	(9.26)	(9.71)
		OIL	%	(5.63)	(7.28)	(7.78)	(8.70)	(9.08)
		SRV	%	(2.20)	(3.23)	(3.73)	(4.55)	(5.22)
		TRK	%	(0.91)	(1.49)	(1.85)	(2.35)	(2.82)
		TRN	%	(1.02)	(1.65)	(2.02)	(2.54)	(3.03)
		C	%	(1.69)	(2.52)	(2.91)	(3.60)	(4.24)

[1] natural gas usage amounts to liquefaction loss.

Figure 179: Detailed Results for HOGR_INTREF_LSS

Scenario: HOGR_INTREF_LSS								
	Description		Units	**2018**	**2023**	**2028**	**2033**	**2038**
			Level Values					
Macro	Gross Domestic Product		Billion 2012$	$17,201	$19,281	$21,556	$24,113	$27,034
	Consumption		Billion 2012$	$13,316	$14,913	$16,678	$18,685	$21,036
	Investment		Billion 2012$	$3,560	$4,019	$4,478	$5,033	$5,655
Natural Gas	Wellhead Price		2012$ per Mcf	$2.22	$2.36	$2.41	$2.65	$3.16
	Production		Tcf	29.96	33.87	36.53	38.91	42.50
	LNG Exports		Tcf	0.73	1.65	2.20	2.20	2.20
	Total Demand		Tcf	29.32	30.62	32.07	33.90	36.26
	Sectoral Demand	AGR	Tcf	0.19	0.20	0.21	0.22	0.24
		COL	Tcf	-	-	-	-	-
		CRU	Tcf	-	-	-	-	-
		EIS	Tcf	3.46	3.68	3.73	3.90	4.16
		ELE	Tcf	10.88	11.53	12.45	13.37	14.36
		GAS [1]	Tcf	0.08	0.18	0.24	0.24	0.24
		M_V	Tcf	0.19	0.19	0.20	0.22	0.24
		MAN	Tcf	3.61	3.79	3.93	4.18	4.55
		OIL	Tcf	2.00	2.07	2.14	2.26	2.45
		SRV	Tcf	2.50	2.55	2.63	2.72	2.82
		TRK	Tcf	0.57	0.60	0.69	0.90	1.20
		TRN	Tcf	0.26	0.28	0.32	0.42	0.56
		C	Tcf	4.64	4.57	4.52	4.44	4.35
		G	Tcf	0.95	0.97	1.00	1.04	1.08
	Export Revenues		Billion 2012$	2.12	5.07	6.89	7.57	9.03
			Percentage Change					
Macro	Gross Domestic Product		%	0.01	0.02	0.02	0.02	0.02
	Gross Capital Income		%	0.03	0.05	0.06	0.06	0.06
	Gross Labor Income		%	(0.01)	(0.05)	(0.05)	(0.04)	(0.03)
	Gross Resource Income		%	1.40	4.07	3.04	1.96	1.53
	Consumption		%	0.03	0.02	0.01	0.01	0.01
	Investment		%	0.23	0.11	0.03	(0.01)	(0.01)
Natural Gas	Wellhead Price		%	2.65	10.16	9.73	7.23	5.64
	Production		%	0.81	4.23	5.63	5.49	5.20
	Total Demand		%	(0.47)	(2.03)	(2.13)	(1.78)	(1.57)
	Sectoral Demand	AGR	%	(0.79)	(2.94)	(2.89)	(2.30)	(1.96)
		COL	%	-	-	-	-	-
		CRU	%	-	-	-	-	-
		EIS	%	(0.77)	(2.90)	(2.87)	(2.31)	(1.97)
		ELE	%	(0.45)	(2.18)	(2.41)	(2.07)	(1.85)
		GAS	%					
		M_V	%	(0.50)	(2.18)	(2.35)	(2.00)	(1.79)
		MAN	%	(0.74)	(2.81)	(2.76)	(2.20)	(1.88)
		OIL	%	(0.66)	(2.65)	(2.62)	(2.08)	(1.75)
		SRV	%	(0.24)	(1.13)	(1.21)	(1.04)	(0.96)
		TRK	%	(0.10)	(0.50)	(0.58)	(0.52)	(0.51)
		TRN	%	(0.12)	(0.53)	(0.62)	(0.56)	(0.54)
		C	%	(0.16)	(0.89)	(0.96)	(0.82)	(0.76)

[1] natural gas usage amounts to liquefaction loss.

Figure 180: Detailed Results for HOGR_INTREF_LR

Scenario: HOGR_INTREF_LR								
	Description		Units	**2018**	**2023**	**2028**	**2033**	**2038**
Level Values								
Macro	Gross Domestic Product		Billion 2012$	$17,203	$19,280	$21,555	$24,112	$27,034
	Consumption		Billion 2012$	$13,316	$14,913	$16,678	$18,686	$21,037
	Investment		Billion 2012$	$3,559	$4,012	$4,476	$5,034	$5,655
Natural Gas	Wellhead Price		2012$ per Mcf	$2.52	$2.44	$2.41	$2.65	$3.16
	Production		Tcf	30.89	34.26	36.52	38.91	42.50
	LNG Exports		Tcf	2.20	2.20	2.20	2.20	2.20
	Total Demand		Tcf	28.80	30.46	32.07	33.90	36.26
	Sectoral Demand	AGR	Tcf	0.18	0.20	0.21	0.22	0.24
		COL	Tcf	-	-	-	-	-
		CRU	Tcf	-	-	-	-	-
		EIS	Tcf	3.33	3.64	3.73	3.90	4.16
		ELE	Tcf	10.62	11.44	12.45	13.37	14.36
		GAS [1]	Tcf	0.24	0.24	0.24	0.24	0.24
		M_V	Tcf	0.19	0.19	0.20	0.22	0.24
		MAN	Tcf	3.49	3.76	3.93	4.18	4.55
		OIL	Tcf	1.93	2.05	2.14	2.26	2.45
		SRV	Tcf	2.46	2.54	2.63	2.72	2.82
		TRK	Tcf	0.56	0.60	0.69	0.90	1.20
		TRN	Tcf	0.26	0.28	0.32	0.42	0.56
		C	Tcf	4.59	4.55	4.52	4.44	4.35
		G	Tcf	0.94	0.97	1.00	1.04	1.08
	Export Revenues		Billion 2012$	7.20	6.99	6.89	7.57	9.03
Percentage Change								
Macro	Gross Domestic Product		%	0.03	0.02	0.01	0.02	0.02
	Gross Capital Income		%	0.06	0.05	0.05	0.05	0.05
	Gross Labor Income		%	(0.08)	(0.07)	(0.05)	(0.04)	(0.04)
	Gross Resource Income		%	9.29	5.57	2.98	1.93	1.51
	Consumption		%	0.03	0.02	0.02	0.02	0.02
	Investment		%	0.19	(0.06)	(0.02)	(0.00)	(0.00)
Natural Gas	Wellhead Price		%	16.68	13.92	9.72	7.23	5.64
	Production		%	4.04	5.47	5.62	5.49	5.20
	Total Demand		%	(2.90)	(2.76)	(2.14)	(1.78)	(1.57)
	Sectoral Demand	AGR	%	(4.56)	(3.98)	(2.92)	(2.33)	(1.98)
		COL	%	-	-	-	-	-
		CRU	%	-	-	-	-	-
		EIS	%	(4.45)	(3.94)	(2.91)	(2.33)	(1.99)
		ELE	%	(2.91)	(2.96)	(2.41)	(2.07)	(1.85)
		GAS	%					
		M_V	%	(2.80)	(2.92)	(2.38)	(2.02)	(1.80)
		MAN	%	(4.28)	(3.77)	(2.77)	(2.22)	(1.89)
		OIL	%	(4.10)	(3.59)	(2.62)	(2.08)	(1.75)
		SRV	%	(1.60)	(1.56)	(1.22)	(1.04)	(0.96)
		TRK	%	(0.60)	(0.69)	(0.59)	(0.53)	(0.51)
		TRN	%	(0.65)	(0.75)	(0.64)	(0.58)	(0.55)
		C	%	(1.32)	(1.24)	(0.95)	(0.81)	(0.75)

[1] natural gas usage amounts to liquefaction loss.

Figure 181: Detailed Results for HOGR_INTREF_HR

Scenario: HOGR_INTREF_HR								
	Description		Units	**2018**	**2023**	**2028**	**2033**	**2038**
Level Values								
Macro	Gross Domestic Product		Billion 2012$	$17,211	$19,287	$21,560	$24,118	$27,039
	Consumption		Billion 2012$	$13,319	$14,917	$16,683	$18,691	$21,043
	Investment		Billion 2012$	$3,562	$4,011	$4,476	$5,033	$5,654
Natural Gas	Wellhead Price		2012$ per Mcf	$2.66	$2.57	$2.54	$2.79	$3.30
	Production		Tcf	32.88	36.35	38.56	40.88	44.48
	LNG Exports		Tcf	4.27	4.39	4.39	4.39	4.39
	Total Demand		Tcf	28.71	30.36	31.91	33.67	36.05
	Sectoral Demand	AGR	Tcf	0.18	0.19	0.20	0.22	0.24
		COL	Tcf	-	-	-	-	-
		CRU	Tcf	-	-	-	-	-
		EIS	Tcf	3.27	3.58	3.66	3.83	4.09
		ELE	Tcf	10.51	11.30	12.27	13.15	14.15
		GAS [1]	Tcf	0.47	0.49	0.49	0.49	0.49
		M_V	Tcf	0.19	0.18	0.20	0.21	0.23
		MAN	Tcf	3.43	3.70	3.87	4.10	4.48
		OIL	Tcf	1.90	2.02	2.11	2.22	2.42
		SRV	Tcf	2.45	2.53	2.61	2.70	2.80
		TRK	Tcf	0.56	0.60	0.69	0.89	1.20
		TRN	Tcf	0.26	0.28	0.32	0.42	0.56
		C	Tcf	4.57	4.53	4.50	4.41	4.32
		G	Tcf	0.93	0.96	1.00	1.03	1.07
	Export Revenues		Billion 2012$	14.78	14.72	14.53	15.96	18.86
Percentage Change								
Macro	Gross Domestic Product		%	0.07	0.05	0.04	0.04	0.04
	Gross Capital Income		%	0.15	0.13	0.12	0.11	0.11
	Gross Labor Income		%	(0.11)	(0.10)	(0.08)	(0.07)	(0.07)
	Gross Resource Income		%	13.36	8.21	4.93	3.61	2.84
	Consumption		%	0.06	0.04	0.04	0.05	0.05
	Investment		%	0.30	(0.08)	(0.04)	(0.01)	(0.01)
Natural Gas	Wellhead Price		%	23.36	20.14	15.82	13.27	10.46
	Production		%	10.96	12.10	11.70	10.99	10.26
	Total Demand		%	(4.00)	(3.92)	(3.41)	(3.20)	(2.86)
	Sectoral Demand	AGR	%	(6.37)	(5.70)	(4.68)	(4.19)	(3.62)
		COL	%	-	-	-	-	-
		CRU	%	-	-	-	-	-
		EIS	%	(6.21)	(5.64)	(4.68)	(4.20)	(3.64)
		ELE	%	(3.98)	(4.19)	(3.83)	(3.69)	(3.35)
		GAS	%					
		M_V	%	(4.01)	(4.21)	(3.83)	(3.65)	(3.30)
		MAN	%	(5.97)	(5.37)	(4.44)	(3.98)	(3.44)
		OIL	%	(5.62)	(5.08)	(4.17)	(3.72)	(3.17)
		SRV	%	(2.21)	(2.23)	(1.95)	(1.88)	(1.75)
		TRK	%	(0.87)	(1.01)	(0.96)	(0.97)	(0.95)
		TRN	%	(0.95)	(1.11)	(1.06)	(1.06)	(1.03)
		C	%	(1.77)	(1.76)	(1.52)	(1.46)	(1.37)

[1] natural gas usage amounts to liquefaction loss.

Figure 182: Detailed Results for HOGR_D_NC

	Description		Units	2018	2023	2028	2033	2038
			Scenario: HOGR_D_NC					
			Level Values					
Macro	Gross Domestic Product		Billion 2012$	$17,217	$19,303	$21,587	$24,159	$27,108
	Consumption		Billion 2012$	$13,334	$14,931	$16,695	$18,703	$21,051
	Investment		Billion 2012$	$3,583	$4,034	$4,500	$5,077	$5,681
Natural Gas	Wellhead Price		2012$ per Mcf	$3.03	$3.17	$3.22	$3.63	$4.25
	Production		Tcf	34.35	39.92	44.51	48.92	57.08
	LNG Exports		Tcf	6.29	8.90	11.40	13.75	18.15
	Total Demand		Tcf	28.18	29.45	30.87	32.39	34.93
	Sectoral Demand	AGR	Tcf	0.17	0.18	0.19	0.20	0.22
		COL	Tcf	-	-	-	-	-
		CRU	Tcf	-	-	-	-	-
		EIS	Tcf	3.13	3.33	3.38	3.48	3.71
		ELE	Tcf	10.24	10.73	11.49	12.10	12.92
		GAS [1]	Tcf	0.70	0.99	1.27	1.53	2.02
		M_V	Tcf	0.18	0.18	0.18	0.20	0.21
		MAN	Tcf	3.29	3.46	3.58	3.75	4.09
		OIL	Tcf	1.83	1.90	1.96	2.04	2.22
		SRV	Tcf	2.41	2.45	2.52	2.58	2.66
		TRK	Tcf	0.56	0.59	0.68	0.87	1.17
		TRN	Tcf	0.26	0.27	0.31	0.41	0.54
		C	Tcf	4.51	4.43	4.37	4.26	4.15
		G	Tcf	0.91	0.93	0.96	0.98	1.01
	Export Revenues		Billion 2012$	24.80	36.68	47.77	64.96	100.43
			Percentage Change					
Macro	Gross Domestic Product		%	0.11	0.14	0.17	0.22	0.30
	Gross Capital Income		%	0.21	0.28	0.36	0.44	0.60
	Gross Labor Income		%	(0.18)	(0.22)	(0.21)	(0.20)	(0.20)
	Gross Resource Income		%	23.92	21.16	16.52	15.06	14.04
	Consumption		%	0.17	0.14	0.12	0.11	0.09
	Investment		%	0.90	0.50	0.53	0.89	0.48
Natural Gas	Wellhead Price		%	41.02	48.67	47.69	48.37	43.37
	Production		%	16.10	23.47	29.46	33.51	42.50
	Total Demand		%	(6.67)	(8.62)	(9.20)	(10.21)	(10.36)
	Sectoral Demand	AGR	%	(10.69)	(12.46)	(12.49)	(13.16)	(12.84)
		COL	%	-	-	-	-	-
		CRU	%	-	-	-	-	-
		EIS	%	(10.44)	(12.35)	(12.47)	(13.18)	(12.89)
		ELE	%	(6.58)	(9.13)	(10.22)	(11.67)	(12.01)
		GAS	%					
		M_V	%	(6.80)	(9.32)	(10.28)	(11.57)	(11.77)
		MAN	%	(9.96)	(11.75)	(11.87)	(12.57)	(12.26)
		OIL	%	(9.29)	(11.06)	(11.16)	(11.80)	(11.43)
		SRV	%	(3.76)	(5.08)	(5.51)	(6.33)	(6.68)
		TRK	%	(1.55)	(2.37)	(2.76)	(3.32)	(3.66)
		TRN	%	(1.73)	(2.62)	(3.02)	(3.59)	(3.95)
		C	%	(2.96)	(4.01)	(4.33)	(5.03)	(5.42)

[1] natural gas usage amounts to liquefaction loss.

Figure 183: Detailed Results for HOGR_SD_NC

	Description		Units	2018	2023	2028	2033	2038
			Scenario: HOGR_SD_NC					
			Level Values					
Macro	Gross Domestic Product		Billion 2012$	$17,219	$19,306	$21,591	$24,166	$27,114
	Consumption		Billion 2012$	$13,337	$14,933	$16,698	$18,705	$21,054
	Investment		Billion 2012$	$3,587	$4,036	$4,502	$5,078	$5,681
Natural Gas	Wellhead Price		2012$ per Mcf	$3.11	$3.31	$3.36	$3.79	$4.37
	Production		Tcf	34.61	40.55	45.43	50.03	58.35
	LNG Exports		Tcf	6.66	9.73	12.54	15.09	19.57
	Total Demand		Tcf	28.07	29.24	30.66	32.15	34.79
	Sectoral Demand	AGR	Tcf	0.17	0.18	0.18	0.20	0.21
		COL	Tcf	-	-	-	-	-
		CRU	Tcf	-	-	-	-	-
		EIS	Tcf	3.10	3.28	3.32	3.42	3.67
		ELE	Tcf	10.18	10.62	11.34	11.93	12.79
		GAS [1]	Tcf	0.74	1.08	1.39	1.68	2.17
		M_V	Tcf	0.18	0.17	0.18	0.19	0.21
		MAN	Tcf	3.26	3.41	3.52	3.69	4.04
		OIL	Tcf	1.81	1.87	1.93	2.01	2.19
		SRV	Tcf	2.40	2.44	2.50	2.56	2.65
		TRK	Tcf	0.56	0.59	0.67	0.87	1.16
		TRN	Tcf	0.26	0.27	0.31	0.40	0.54
		C	Tcf	4.50	4.41	4.35	4.23	4.13
		G	Tcf	0.90	0.92	0.95	0.97	1.01
	Export Revenues		Billion 2012$	26.95	41.89	54.93	74.51	111.36
			Percentage Change					
Macro	Gross Domestic Product		%	0.12	0.15	0.19	0.25	0.33
	Gross Capital Income		%	0.22	0.31	0.40	0.49	0.65
	Gross Labor Income		%	(0.20)	(0.25)	(0.24)	(0.23)	(0.22)
	Gross Resource Income		%	26.25	24.41	19.20	17.48	15.64
	Consumption		%	0.19	0.16	0.14	0.12	0.10
	Investment		%	1.01	0.57	0.58	0.91	0.48
Natural Gas	Wellhead Price		%	44.81	55.42	54.51	55.13	47.60
	Production		%	17.00	25.45	32.22	36.61	45.74
	Total Demand		%	(7.20)	(9.61)	(10.29)	(11.38)	(11.20)
	Sectoral Demand	AGR	%	(11.54)	(13.87)	(13.94)	(14.64)	(13.89)
		COL	%	-	-	-	-	-
		CRU	%	-	-	-	-	-
		EIS	%	(11.27)	(13.73)	(13.91)	(14.66)	(13.94)
		ELE	%	(7.10)	(10.17)	(11.41)	(12.99)	(12.97)
		GAS	%					
		M_V	%	(7.35)	(10.39)	(11.49)	(12.88)	(12.74)
		MAN	%	(10.75)	(13.08)	(13.25)	(13.99)	(13.25)
		OIL	%	(10.02)	(12.31)	(12.46)	(13.13)	(12.35)
		SRV	%	(4.08)	(5.71)	(6.22)	(7.12)	(7.27)
		TRK	%	(1.69)	(2.68)	(3.13)	(3.76)	(4.01)
		TRN	%	(1.89)	(2.95)	(3.42)	(4.06)	(4.32)
		C	%	(3.21)	(4.53)	(4.91)	(5.68)	(5.90)

[1] natural gas usage amounts to liquefaction loss.

Figure 184: Detailed Results for HOGR_SD_HS

Scenario: HOGR_SD_HS								
	Description		Units	**2018**	**2023**	**2028**	**2033**	**2038**
Level Values								
Macro	Gross Domestic Product		Billion 2012$	$17,202	$19,285	$21,561	$24,117	$27,039
	Consumption		Billion 2012$	$13,319	$14,916	$16,680	$18,687	$21,038
	Investment		Billion 2012$	$3,567	$4,023	$4,479	$5,033	$5,654
Natural Gas	Wellhead Price		2012$ per Mcf	$2.36	$2.62	$2.66	$2.85	$3.33
	Production		Tcf	30.44	35.01	38.20	40.71	44.36
	LNG Exports		Tcf	1.46	3.29	4.39	4.39	4.39
	Total Demand		Tcf	29.08	30.12	31.56	33.50	35.93
	Sectoral Demand	AGR	Tcf	0.18	0.19	0.20	0.22	0.24
		COL	Tcf	-	-	-	-	-
		CRU	Tcf	-	-	-	-	-
		EIS	Tcf	3.40	3.56	3.61	3.80	4.08
		ELE	Tcf	10.76	11.25	12.12	13.07	14.09
		GAS [1]	Tcf	0.16	0.37	0.49	0.49	0.49
		M_V	Tcf	0.19	0.18	0.19	0.21	0.23
		MAN	Tcf	3.55	3.68	3.81	4.08	4.47
		OIL	Tcf	1.96	2.01	2.08	2.21	2.41
		SRV	Tcf	2.48	2.52	2.59	2.69	2.79
		TRK	Tcf	0.56	0.60	0.69	0.89	1.20
		TRN	Tcf	0.26	0.28	0.32	0.42	0.56
		C	Tcf	4.62	4.52	4.47	4.40	4.31
		G	Tcf	0.94	0.96	0.99	1.03	1.07
	Export Revenues		Billion 2012$	4.50	11.25	15.24	16.27	19.07
Percentage Change								
Macro	Gross Domestic Product		%	0.02	0.04	0.04	0.04	0.04
	Gross Capital Income		%	0.04	0.09	0.11	0.11	0.11
	Gross Labor Income		%	(0.04)	(0.10)	(0.10)	(0.08)	(0.07)
	Gross Resource Income		%	4.93	9.19	6.97	4.33	3.26
	Consumption		%	0.05	0.04	0.02	0.02	0.03
	Investment		%	0.43	0.23	0.05	(0.02)	(0.02)
Natural Gas	Wellhead Price		%	9.12	22.48	21.68	15.57	11.74
	Production		%	2.48	7.85	10.63	10.52	9.97
	Total Demand		%	(1.63)	(4.31)	(4.54)	(3.71)	(3.18)
	Sectoral Demand	AGR	%	(2.67)	(6.21)	(6.12)	(4.78)	(3.97)
		COL	%	-	-	-	-	-
		CRU	%	-	-	-	-	-
		EIS	%	(2.60)	(6.12)	(6.10)	(4.79)	(3.98)
		ELE	%	(1.61)	(4.61)	(5.11)	(4.29)	(3.74)
		GAS	%					
		M_V	%	(1.66)	(4.60)	(5.00)	(4.16)	(3.61)
		MAN	%	(2.49)	(5.91)	(5.86)	(4.58)	(3.80)
		OIL	%	(2.30)	(5.59)	(5.57)	(4.31)	(3.53)
		SRV	%	(0.87)	(2.46)	(2.64)	(2.20)	(1.96)
		TRK	%	(0.36)	(1.10)	(1.27)	(1.12)	(1.05)
		TRN	%	(0.40)	(1.17)	(1.36)	(1.20)	(1.12)
		C	%	(0.65)	(1.95)	(2.10)	(1.74)	(1.56)

[1] natural gas usage amounts to liquefaction loss.

Figure 185: Detailed Results for LOGR_SD_NC

	Description		Units	2018	2023	2028	2033	2038
			Scenario: LOGR_SD_NC					
			Level Values					
Macro	Gross Domestic Product		Billion 2012$	$16,836	$18,716	$20,814	$23,243	$25,960
	Consumption		Billion 2012$	$13,066	$14,568	$16,250	$18,195	$20,437
	Investment		Billion 2012$	$3,411	$3,856	$4,296	$4,839	$5,416
Natural Gas	Wellhead Price		2012$ per Mcf	$4.37	$5.54	$6.91	$7.66	$9.80
	Production		Tcf	24.08	25.39	26.95	27.74	28.65
	LNG Exports		Tcf	0.42	1.04	2.83	3.44	3.91
	Total Demand		Tcf	24.28	23.95	23.76	23.85	23.37
	Sectoral Demand	AGR	Tcf	0.17	0.18	0.17	0.18	0.18
		COL	Tcf	-	-	-	-	-
		CRU	Tcf	-	-	-	-	-
		EIS	Tcf	3.23	3.29	3.13	3.10	3.07
		ELE	Tcf	6.99	6.75	6.81	6.74	6.01
		GAS [1]	Tcf	0.05	0.12	0.31	0.38	0.43
		M_V	Tcf	0.18	0.17	0.17	0.17	0.18
		MAN	Tcf	3.38	3.39	3.30	3.33	3.37
		OIL	Tcf	1.87	1.86	1.80	1.81	1.82
		SRV	Tcf	2.32	2.28	2.26	2.29	2.32
		TRK	Tcf	0.49	0.50	0.54	0.63	0.84
		TRN	Tcf	0.23	0.23	0.25	0.29	0.39
		C	Tcf	4.48	4.32	4.16	4.04	3.88
		G	Tcf	0.89	0.87	0.86	0.87	0.88
	Export Revenues		Billion 2012$	2.37	7.51	25.42	34.27	49.88
			Percentage Change					
Macro	Gross Domestic Product		%	0.01	0.01	0.03	0.02	0.04
	Gross Capital Income		%	0.02	0.02	0.07	0.08	0.11
	Gross Labor Income		%	(0.01)	(0.07)	(0.18)	(0.20)	(0.23)
	Gross Resource Income		%	0.94	5.79	13.86	13.09	14.22
	Consumption		%	0.05	0.04	0.01	(0.01)	(0.03)
	Investment		%	0.16	0.30	0.02	(0.01)	(0.10)
Natural Gas	Wellhead Price		%	1.33	8.28	20.52	22.10	22.95
	Production		%	0.35	2.64	7.15	8.93	10.44
	Total Demand		%	(0.30)	(2.25)	(5.77)	(6.62)	(7.41)
	Sectoral Demand	AGR	%	(0.56)	(3.19)	(7.53)	(8.26)	(8.93)
		COL	%	-	-	-	-	-
		CRU	%	-	-	-	-	-
		EIS	%	(0.55)	(3.13)	(7.44)	(8.20)	(8.89)
		ELE	%	(0.28)	(2.33)	(6.27)	(7.46)	(8.57)
		GAS	%					
		M_V	%	(0.35)	(2.31)	(6.14)	(7.18)	(8.13)
		MAN	%	(0.49)	(2.98)	(7.16)	(7.89)	(8.57)
		OIL	%	(0.39)	(2.72)	(6.60)	(7.27)	(7.79)
		SRV	%	(0.17)	(1.54)	(4.26)	(5.05)	(5.97)
		TRK	%	(0.10)	(0.80)	(2.42)	(3.03)	(3.82)
		TRN	%	(0.13)	(0.85)	(2.52)	(3.16)	(3.98)
		C	%	(0.10)	(1.29)	(3.68)	(4.38)	(5.27)

[1] natural gas usage amounts to liquefaction loss.

Figure 186: Detailed Results for LOGR_SD_LSS

	Description		Units	2018	2023	2028	2033	2038
	Scenario: LOGR_SD_LSS							
			Level Values					
Macro	Gross Domestic Product		Billion 2012$	$16,836	$18,716	$20,812	$23,239	$25,953
	Consumption		Billion 2012$	$13,064	$14,565	$16,248	$18,196	$20,440
	Investment		Billion 2012$	$3,411	$3,852	$4,293	$4,836	$5,418
Natural Gas	Wellhead Price		2012$ per Mcf	$4.37	$5.54	$6.60	$7.10	$8.93
	Production		Tcf	24.08	25.39	26.59	26.99	27.58
	LNG Exports		Tcf	0.42	1.04	2.20	2.20	2.20
	Total Demand		Tcf	24.28	23.95	24.03	24.33	23.99
	Sectoral Demand	AGR	Tcf	0.17	0.18	0.18	0.18	0.19
		COL	Tcf	-	-	-	-	-
		CRU	Tcf	-	-	-	-	-
		EIS	Tcf	3.24	3.29	3.19	3.21	3.20
		ELE	Tcf	6.99	6.75	6.92	6.94	6.26
		GAS [1]	Tcf	0.05	0.12	0.24	0.24	0.24
		M_V	Tcf	0.18	0.17	0.17	0.18	0.18
		MAN	Tcf	3.38	3.39	3.36	3.44	3.50
		OIL	Tcf	1.87	1.86	1.83	1.86	1.89
		SRV	Tcf	2.32	2.28	2.28	2.34	2.38
		TRK	Tcf	0.49	0.50	0.54	0.64	0.85
		TRN	Tcf	0.23	0.23	0.25	0.30	0.40
		C	Tcf	4.48	4.32	4.20	4.11	3.98
		G	Tcf	0.89	0.87	0.87	0.89	0.91
	Export Revenues		Billion 2012$	2.37	7.51	18.89	20.30	25.53
			Percentage Change					
Macro	Gross Domestic Product		%	0.01	0.01	0.02	0.01	0.01
	Gross Capital Income		%	0.02	0.02	0.05	0.05	0.05
	Gross Labor Income		%	(0.01)	(0.07)	(0.14)	(0.13)	(0.12)
	Gross Resource Income		%	0.99	5.83	10.11	7.47	7.02
	Consumption		%	0.04	0.02	0.00	(0.01)	(0.01)
	Investment		%	0.15	0.17	(0.04)	(0.07)	(0.07)
Natural Gas	Wellhead Price		%	1.35	8.29	15.10	12.87	11.66
	Production		%	0.36	2.64	5.69	5.92	6.16
	Total Demand		%	(0.30)	(2.24)	(4.36)	(4.04)	(4.00)
	Sectoral Demand	AGR	%	(0.52)	(3.15)	(5.69)	(5.07)	(4.86)
		COL	%	-	-	-	-	-
		CRU	%	-	-	-	-	-
		EIS	%	(0.51)	(3.09)	(5.62)	(5.04)	(4.84)
		ELE	%	(0.28)	(2.34)	(4.75)	(4.57)	(4.64)
		GAS	%					
		M_V	%	(0.32)	(2.30)	(4.63)	(4.40)	(4.42)
		MAN	%	(0.47)	(2.95)	(5.40)	(4.83)	(4.65)
		OIL	%	(0.39)	(2.72)	(5.00)	(4.45)	(4.21)
		SRV	%	(0.18)	(1.55)	(3.20)	(3.05)	(3.18)
		TRK	%	(0.09)	(0.79)	(1.80)	(1.81)	(2.01)
		TRN	%	(0.11)	(0.84)	(1.88)	(1.90)	(2.10)
		C	%	(0.12)	(1.31)	(2.77)	(2.63)	(2.78)

[1] natural gas usage amounts to liquefaction loss.

Figure 187: Detailed Results for USREF_INTREF_NC - With Chemicals Disaggregation

			Scenario: USREF_INTREF_NC					
	Description		Units	**2018**	**2023**	**2028**	**2033**	**2038**
			Level Values					
Macro	Gross Domestic Product		Billion 2012$	$16,943	$18,871	$20,996	$23,417	$26,124
	Consumption		Billion 2012$	$13,134	$14,666	$16,368	$18,320	$20,559
	Investment		Billion 2012$	$3,441	$3,881	$4,322	$4,853	$5,434
Natural Gas	Wellhead Price		2012$ per Mcf	$3.56	$4.12	$4.56	$4.95	$6.53
	Production		Tcf	25.90	27.90	29.87	31.06	32.89
	LNG Exports		Tcf	0.36	0.84	1.64	1.64	1.73
	Total Demand		Tcf	23.69	23.99	24.78	25.81	26.71
	Sectoral Demand	AGR	Tcf	0.18	0.19	0.19	0.20	0.21
		COL	Tcf	-	-	-	-	-
		CRU	Tcf	-	-	-	-	-
		EIS	Tcf	1.18	1.30	1.33	1.38	1.44
		ELE	Tcf	8.18	8.15	8.61	9.18	9.43
		GAS [1]	Tcf	0.04	0.09	0.18	0.18	0.19
		M_V	Tcf	0.18	0.18	0.18	0.20	0.20
		MAN	Tcf	3.45	3.60	3.66	3.76	3.89
		OIL	Tcf	1.91	1.97	1.99	2.03	2.09
		SRV	Tcf	2.38	2.39	2.43	2.50	2.55
		TRK	Tcf	0.51	0.54	0.62	0.79	1.09
		TRN	Tcf	0.24	0.25	0.29	0.37	0.51
		C	Tcf	4.52	4.43	4.35	4.26	4.14
		G	Tcf	0.91	0.91	0.93	0.95	0.97
	Export Revenues		Billion 2012$	1.50	4.04	8.77	9.49	13.26
			Percentage Change					
Macro	Gross Domestic Product		%	0.01	0.01	0.02	0.02	0.02
	Gross Capital Income		%	0.02	0.03	0.05	0.05	0.06
	Gross Labor Income		%	(0.00)	(0.03)	(0.06)	(0.05)	(0.05)
	Gross Resource Income		%	0.28	3.16	4.41	3.32	3.29
	Consumption		%	0.02	0.02	0.01	0.00	(0.00)
	Investment		%	0.15	0.15	0.03	0.02	0.01
Natural Gas	Wellhead Price		%	0.48	5.41	8.29	7.06	6.30
	Production		%	0.28	2.39	4.63	4.53	4.79
	Total Demand		%	(0.09)	(1.38)	(2.29)	(2.13)	(2.12)
	Sectoral Demand	AGR	%	(0.18)	(1.96)	(3.03)	(2.70)	(2.60)
		COL	%	-	-	-	-	-
		CRU	%	-	-	-	-	-
		EIS	%	(0.17)	(1.77)	(2.79)	(2.55)	(2.48)
		ELE	%	(0.08)	(1.45)	(2.53)	(2.43)	(2.45)
		GAS	%					
		M_V	%	(0.12)	(1.44)	(2.47)	(2.35)	(2.37)
		MAN	%	(0.15)	(1.85)	(2.89)	(2.57)	(2.48)
		OIL	%	(0.11)	(1.73)	(2.72)	(2.41)	(2.28)
		SRV	%	(0.04)	(0.88)	(1.54)	(1.47)	(1.57)
		TRK	%	(0.03)	(0.43)	(0.81)	(0.82)	(0.93)
		TRN	%	(0.04)	(0.46)	(0.86)	(0.87)	(0.98)
		C	%	(0.01)	(0.73)	(1.29)	(1.23)	(1.34)

[1] Natural gas usage amounts to liquefaction loss.

Figure 188: Detailed Results for USREF_D_LSS - With Chemicals Disaggregation

			Scenario: USREF_D_LSS					
	Description		Units	**2018**	**2023**	**2028**	**2033**	**2038**
			Level Values					
Macro	Gross Domestic Product		Billion 2012$	$16,944	$18,873	$20,996	$23,418	$26,125
	Consumption		Billion 2012$	$13,135	$14,667	$16,368	$18,321	$20,560
	Investment		Billion 2012$	$3,445	$3,880	$4,321	$4,853	$5,434
Natural Gas	Wellhead Price		2012$ per Mcf	$3.65	$4.28	$4.66	$5.05	$6.60
	Production		Tcf	26.16	28.52	30.32	31.52	33.29
	LNG Exports		Tcf	0.73	1.65	2.20	2.20	2.20
	Total Demand		Tcf	23.60	23.84	24.68	25.73	26.66
	Sectoral Demand	AGR	Tcf	0.18	0.18	0.19	0.20	0.21
		COL	Tcf	-	-	-	-	-
		CRU	Tcf	-	-	-	-	-
		EIS	Tcf	1.17	1.28	1.32	1.37	1.43
		ELE	Tcf	8.14	8.06	8.55	9.12	9.39
		GAS [1]	Tcf	0.08	0.18	0.24	0.24	0.24
		M_V	Tcf	0.18	0.18	0.18	0.19	0.20
		MAN	Tcf	3.42	3.55	3.63	3.74	3.87
		OIL	Tcf	1.89	1.94	1.98	2.02	2.08
		SRV	Tcf	2.37	2.38	2.42	2.49	2.54
		TRK	Tcf	0.51	0.54	0.61	0.79	1.08
		TRN	Tcf	0.24	0.25	0.29	0.37	0.50
		C	Tcf	4.51	4.40	4.34	4.25	4.13
		G	Tcf	0.90	0.90	0.92	0.95	0.97
	Export Revenues		Billion 2012$	3.13	8.26	12.00	12.99	16.99
			Percentage Change					
Macro	Gross Domestic Product		%	0.02	0.02	0.02	0.02	0.03
	Gross Capital Income		%	0.03	0.05	0.07	0.06	0.07
	Gross Labor Income		%	(0.02)	(0.07)	(0.08)	(0.07)	(0.07)
	Gross Resource Income		%	2.11	5.75	5.71	4.30	3.95
	Consumption		%	0.03	0.02	0.01	0.01	0.00
	Investment		%	0.26	0.10	(0.00)	0.00	(0.00)
Natural Gas	Wellhead Price		%	3.12	9.77	10.74	9.14	7.57
	Production		%	1.33	4.75	6.23	6.11	6.09
	Total Demand		%	(0.68)	(2.45)	(2.95)	(2.73)	(2.54)
	Sectoral Demand	AGR	%	(1.11)	(3.46)	(3.91)	(3.47)	(3.12)
		COL	%	-	-	-	-	-
		CRU	%	-	-	-	-	-
		EIS	%	(0.98)	(3.11)	(3.61)	(3.28)	(2.99)
		ELE	%	(0.66)	(2.57)	(3.24)	(3.11)	(2.93)
		GAS	%					
		M_V	%	(0.68)	(2.55)	(3.19)	(3.02)	(2.85)
		MAN	%	(1.01)	(3.26)	(3.71)	(3.31)	(2.98)
		OIL	%	(0.92)	(3.06)	(3.49)	(3.09)	(2.73)
		SRV	%	(0.40)	(1.58)	(1.99)	(1.89)	(1.88)
		TRK	%	(0.18)	(0.78)	(1.06)	(1.06)	(1.12)
		TRN	%	(0.21)	(0.83)	(1.12)	(1.12)	(1.19)
		C	%	(0.30)	(1.31)	(1.66)	(1.58)	(1.60)

[1] Natural gas usage amounts to liquefaction loss.

Figure 189: Detailed Results for USREF_D_NC - With Chemicals Disaggregation

	Description		Units	2018	2023	2028	2033	2038
			Scenario: USREF_D_NC					
			Level Values					
Macro	Gross Domestic Product		Billion 2012$	$16,946	$18,875	$21,003	$23,427	$26,142
	Consumption		Billion 2012$	$13,138	$14,670	$16,371	$18,322	$20,559
	Investment		Billion 2012$	$3,444	$3,887	$4,324	$4,861	$5,440
Natural Gas	Wellhead Price		2012$ per Mcf	$3.93	$4.44	$5.03	$5.43	$7.09
	Production		Tcf	26.85	29.07	31.77	33.22	35.66
	LNG Exports		Tcf	1.74	2.38	4.05	4.32	4.98
	Total Demand		Tcf	23.34	23.70	24.36	25.38	26.32
	Sectoral Demand	AGR	Tcf	0.17	0.18	0.19	0.19	0.20
		COL	Tcf	-	-	-	-	-
		CRU	Tcf	-	-	-	-	-
		EIS	Tcf	1.15	1.27	1.29	1.33	1.39
		ELE	Tcf	8.00	7.97	8.34	8.88	9.12
		GAS [1]	Tcf	0.19	0.26	0.45	0.48	0.55
		M_V	Tcf	0.18	0.17	0.18	0.19	0.20
		MAN	Tcf	3.34	3.50	3.53	3.63	3.75
		OIL	Tcf	1.85	1.92	1.93	1.97	2.03
		SRV	Tcf	2.35	2.36	2.38	2.45	2.49
		TRK	Tcf	0.51	0.53	0.61	0.78	1.07
		TRN	Tcf	0.24	0.25	0.28	0.36	0.50
		C	Tcf	4.47	4.38	4.28	4.19	4.06
		G	Tcf	0.89	0.90	0.91	0.93	0.95
	Export Revenues		Billion 2012$	8.02	12.39	23.89	27.49	41.42
			Percentage Change					
Macro	Gross Domestic Product		%	0.03	0.03	0.06	0.06	0.09
	Gross Capital Income		%	0.05	0.08	0.14	0.15	0.20
	Gross Labor Income		%	(0.07)	(0.10)	(0.14)	(0.12)	(0.12)
	Gross Resource Income		%	7.86	8.27	10.84	8.63	8.55
	Consumption		%	0.06	0.04	0.02	0.01	0.00
	Investment		%	0.24	0.31	0.08	0.18	0.12
Natural Gas	Wellhead Price		%	11.18	14.06	19.85	17.79	15.84
	Production		%	4.07	6.83	11.48	12.02	13.88
	Total Demand		%	(2.42)	(3.48)	(5.23)	(5.09)	(5.08)
	Sectoral Demand	AGR	%	(3.80)	(4.94)	(6.93)	(6.47)	(6.23)
		COL	%	-	-	-	-	-
		CRU	%	-	-	-	-	-
		EIS	%	(3.32)	(4.46)	(6.40)	(6.12)	(5.97)
		ELE	%	(2.36)	(3.63)	(5.73)	(5.79)	(5.84)
		GAS	%					
		M_V	%	(2.34)	(3.62)	(5.67)	(5.64)	(5.70)
		MAN	%	(3.49)	(4.61)	(6.57)	(6.15)	(5.93)
		OIL	%	(3.27)	(4.32)	(6.16)	(5.76)	(5.45)
		SRV	%	(1.46)	(2.25)	(3.57)	(3.58)	(3.80)
		TRK	%	(0.63)	(1.12)	(1.92)	(2.01)	(2.29)
		TRN	%	(0.70)	(1.21)	(2.04)	(2.14)	(2.43)
		C	%	(1.20)	(1.86)	(2.98)	(3.01)	(3.28)

[1] Natural gas usage amounts to liquefaction loss.

Figure 190: Detailed Results for USREF_D_LR - With Chemicals Disaggregation

	Description		Units	2018	2023	2028	2033	2038
			Scenario: USREF_D_LR					
			Level Values					
Macro	Gross Domestic Product		Billion 2012$	$16,945	$18,873	$20,994	$23,417	$26,125
	Consumption		Billion 2012$	$13,135	$14,666	$16,369	$18,322	$20,561
	Investment		Billion 2012$	$3,442	$3,874	$4,319	$4,853	$5,434
Natural Gas	Wellhead Price		2012$ per Mcf	$3.93	$4.40	$4.66	$5.05	$6.60
	Production		Tcf	26.85	28.93	30.32	31.52	33.29
	LNG Exports		Tcf	1.74	2.20	2.20	2.20	2.20
	Total Demand		Tcf	23.34	23.73	24.68	25.73	26.66
	Sectoral Demand	AGR	Tcf	0.17	0.18	0.19	0.20	0.21
		COL	Tcf	-	-	-	-	-
		CRU	Tcf	-	-	-	-	-
		EIS	Tcf	1.15	1.27	1.32	1.37	1.43
		ELE	Tcf	8.00	7.99	8.55	9.12	9.39
		GAS [1]	Tcf	0.19	0.24	0.24	0.24	0.24
		M_V	Tcf	0.18	0.18	0.18	0.19	0.20
		MAN	Tcf	3.34	3.51	3.63	3.74	3.87
		OIL	Tcf	1.85	1.92	1.98	2.02	2.08
		SRV	Tcf	2.35	2.36	2.42	2.49	2.54
		TRK	Tcf	0.51	0.53	0.61	0.79	1.08
		TRN	Tcf	0.24	0.25	0.29	0.37	0.50
		C	Tcf	4.47	4.39	4.34	4.25	4.13
		G	Tcf	0.89	0.90	0.92	0.95	0.97
	Export Revenues		Billion 2012$	8.02	11.33	12.00	12.99	16.99
			Percentage Change					
Macro	Gross Domestic Product		%	0.03	0.02	0.01	0.02	0.03
	Gross Capital Income		%	0.05	0.06	0.06	0.06	0.07
	Gross Labor Income		%	(0.07)	(0.10)	(0.09)	(0.07)	(0.07)
	Gross Resource Income		%	7.94	7.65	5.66	4.28	3.93
	Consumption		%	0.03	0.02	0.01	0.01	0.01
	Investment		%	0.18	(0.05)	(0.04)	0.01	0.01
Natural Gas	Wellhead Price		%	11.20	12.96	10.73	9.13	7.57
	Production		%	4.08	6.32	6.22	6.11	6.09
	Total Demand		%	(2.42)	(3.22)	(2.96)	(2.73)	(2.54)
	Sectoral Demand	AGR	%	(3.75)	(4.53)	(3.94)	(3.50)	(3.14)
		COL	%	-	-	-	-	-
		CRU	%	-	-	-	-	-
		EIS	%	(3.26)	(4.07)	(3.65)	(3.31)	(3.02)
		ELE	%	(2.37)	(3.38)	(3.25)	(3.11)	(2.93)
		GAS	%					
		M_V	%	(2.31)	(3.32)	(3.21)	(3.04)	(2.87)
		MAN	%	(3.47)	(4.24)	(3.72)	(3.32)	(2.98)
		OIL	%	(3.27)	(4.01)	(3.49)	(3.09)	(2.73)
		SRV	%	(1.46)	(2.09)	(1.99)	(1.90)	(1.88)
		TRK	%	(0.62)	(1.03)	(1.07)	(1.06)	(1.13)
		TRN	%	(0.67)	(1.11)	(1.14)	(1.13)	(1.20)
		C	%	(1.23)	(1.76)	(1.66)	(1.58)	(1.60)

[1] Natural gas usage amounts to liquefaction loss.

Figure 191: Detailed Results for USREF_SD_NC - With Chemicals Disaggregation

	Scenario: USREF_SD_NC							
	Description		Units	**2018**	**2023**	**2028**	**2033**	**2038**
			Level Values					
Macro	Gross Domestic Product		Billion 2012$	$16,947	$18,877	$21,008	$23,436	$26,155
	Consumption		Billion 2012$	$13,141	$14,672	$16,372	$18,323	$20,559
	Investment		Billion 2012$	$3,448	$3,891	$4,329	$4,867	$5,443
Natural Gas	Wellhead Price		2012$ per Mcf	$4.05	$4.64	$5.31	$5.80	$7.52
	Production		Tcf	27.10	29.65	32.69	34.56	37.45
	LNG Exports		Tcf	2.14	3.17	5.27	6.03	7.12
	Total Demand		Tcf	23.23	23.52	24.11	25.07	26.03
	Sectoral Demand	AGR	Tcf	0.17	0.18	0.18	0.19	0.20
		COL	Tcf	-	-	-	-	-
		CRU	Tcf	-	-	-	-	-
		EIS	Tcf	1.13	1.25	1.26	1.30	1.36
		ELE	Tcf	7.95	7.87	8.19	8.67	8.90
		GAS [1]	Tcf	0.24	0.35	0.59	0.67	0.79
		M_V	Tcf	0.18	0.17	0.18	0.18	0.19
		MAN	Tcf	3.31	3.45	3.45	3.54	3.66
		OIL	Tcf	1.83	1.89	1.89	1.92	1.98
		SRV	Tcf	2.34	2.34	2.36	2.41	2.45
		TRK	Tcf	0.51	0.53	0.61	0.78	1.06
		TRN	Tcf	0.24	0.25	0.28	0.36	0.49
		C	Tcf	4.46	4.35	4.24	4.13	4.01
		G	Tcf	0.88	0.89	0.90	0.92	0.93
	Export Revenues		Billion 2012$	10.14	17.25	32.80	40.97	62.72
			Percentage Change					
Macro	Gross Domestic Product		%	0.03	0.05	0.08	0.10	0.15
	Gross Capital Income		%	0.06	0.10	0.18	0.22	0.30
	Gross Labor Income		%	(0.10)	(0.13)	(0.18)	(0.17)	(0.17)
	Gross Resource Income		%	10.40	11.42	14.86	12.90	12.79
	Consumption		%	0.08	0.06	0.04	0.02	(0.00)
	Investment		%	0.34	0.40	0.19	0.31	0.17
Natural Gas	Wellhead Price		%	14.73	19.17	26.72	25.85	22.93
	Production		%	5.09	9.04	14.81	16.67	19.79
	Total Demand		%	(3.16)	(4.64)	(6.83)	(7.14)	(7.11)
	Sectoral Demand	AGR	%	(4.95)	(6.58)	(9.04)	(9.04)	(8.69)
		COL	%	-	-	-	-	-
		CRU	%	-	-	-	-	-
		EIS	%	(4.33)	(5.95)	(8.36)	(8.54)	(8.34)
		ELE	%	(3.07)	(4.84)	(7.47)	(8.08)	(8.15)
		GAS	%					
		M_V	%	(3.06)	(4.84)	(7.42)	(7.90)	(7.97)
		MAN	%	(4.55)	(6.14)	(8.57)	(8.59)	(8.28)
		OIL	%	(4.25)	(5.75)	(8.03)	(8.05)	(7.61)
		SRV	%	(1.90)	(3.03)	(4.71)	(5.07)	(5.37)
		TRK	%	(0.83)	(1.52)	(2.56)	(2.88)	(3.26)
		TRN	%	(0.93)	(1.65)	(2.71)	(3.06)	(3.46)
		C	%	(1.56)	(2.51)	(3.94)	(4.28)	(4.64)

[1] Natural gas usage amounts to liquefaction loss.

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