High Natural Gas Prices Need Not Cook California's Economy: The Case for Liquefied Natural Gas

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Executive Summary

California is in the paradoxical position of being more economically dependent on natural gas than virtually any other state or nation, yet it faces limitations on available imports (restricted by transmission infrastructure capacity). The gap between growing demand and constrained supply has led to escalating prices. Since natural gas is fundamental to the production process of many products, these price increases have reduced output and employment.

Increasing the amount of natural gas delivered to California would thus stimulate the economy, particularly in several basic, high value added industries (which typically pay wages well above the state average). The most cost-effective way to achieve this is to create the necessary infrastructure to import natural gas shipped from foreign countries—where it exists in abundance--by sea. As several observers have suggested, California—and the nation—needs one or more West Coast terminals to receive Liquefied Natural Gas (LNG).

California imports 85% of its natural gas through a pipeline infrastructure that is being used to near-capacity. (The U.S. currently imports about 15%.) The West Coast is the area of the Continental U.S. most distant from the main North American natural gas deposits in Canada, the Rockies, and the Texas/Louisiana basin, meaning that transportation costs are at a maximum. For these reasons, California, Oregon, and Washington would have the most to gain from natural gas shipped by sea to a West Coast port.

The world has plentiful supplies of natural gas, which can be transported across oceans readily in liquefied form (LNG). All that is missing is a terminal that can receive the LNG, convert it back into gas, and transport it through existing pipelines to end-users. There are four such terminals on the U.S.' East Coast, but none on the West Coast. Eight proposed terminals (four in California) are undergoing regulatory review. Any of them would increase available gas supplies by between 7% and 22%, depending on capacity. Such a capacity increase would likely reduce gas prices by 10% to 20%.

The economic benefits of increased natural gas supplies were estimated using two different methods: (a) a "top down" macroeconomic method that used estimates of the economy's elasticity to oil price changes; and (b) a "bottom up" method that estimated the increase in disposable incomes form the price reductions that would be caused by increased supplies. The two different methods produced similar results, giving added credence to these estimates.

The top-down estimate suggested that a 10% reduction in natural gas prices would increase California gross state product (GSP) by $960 million to $3.45 billion. California employment would increase by 11,500 to 41,500 per year—roughly equivalent to two weeks to two months of growth for the entire state economy. Households' income would grow by $380 million to $1.38 billion, or roughly $43 to $160 per family of four, and state tax revenues would grow by $64 to $229 million per year.

The "bottom up" approach produced similar results: Gross state product would be increased by $2.3 to 4.6 billion. Corresponding gains in jobs would be between 27,700 and 55,300. A typical family of four would see an increase in income of between $102 and $204 per year. State revenues would grow by between $153 and $306 million.

In addition, to the degree that high natural gas prices contribute to California's above-average electricity prices (because the state is more dependent on natural gas for electricity production than the national average), they become an issue of interstate competitiveness. Throughout the past 15 years there have been many examples of firms which have emigrated out of the state, or located expansions elsewhere, because of high electricity rates. Natural gas price reductions would reduce this incentive to migrate away, and produce additional economic benefits not included here.

In a state economy of over $1.5 trillion with over 15 million workers, the numbers provided in this report may sound small, but they amount to between two weeks and three months of economic growth, every year for as long as an LNG terminal operates. As a recent Stanford University report notes, "the cost to California of delaying action on this issue is very high." A terminal to receive LNG is in the state's economic interest, and overdue.

High Natural Gas Prices Need Not Cook California's Economy

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To most people, natural gas is nothing more than the invisible vapor that fuels their cooktop, furnace, and water heater. In fact, it is also a vital feedstock to industries that employ more than one of every hundred California workers. In addition, it provides one-third of all electricity generated in the state, and virtually all of the growth in electric generation throughout the country. And unlike oil, whose long-term availability remains uncertain, there is no question that world natural gas supplies are ample for decades to come.

California is in the paradoxical position of being more dependent on natural gas than virtually any other state or nation, yet it faces limited available supplies (restricted by transmission infrastructure). The gap between growing demand and constrained supply has led to escalating prices. Since natural gas is fundamental to the production process of many products, these price increases have reduced output and employment.

Increasing the amount of natural gas delivered to California would thus stimulate the economy, particularly in several basic, high value added industries (which typically pay wages well above the state average). The simplest way to achieve this is to create the necessary infrastructure to import natural gas shipped from foreign countries—where it exists in abundance—by sea. As several observers have suggested, California—and the nation—needs one or more West Coast terminals to receive Liquid Natural Gas (LNG).

This paper has three main parts. The first part provides background on the economic importance of natural gas to California's economy, the reasons why insufficient supplies are being delivered, and the economic implications of the resulting inflated prices: implications expressed in terms of gross state product, jobs, and household income. The second part estimates the benefits that could accrue to the economy if one or more LNG terminals were built, using two very different methods with very similar results. The final section reiterates the paper's main findings and their policy implications.

I. The Role of Natural Gas in California's Economy

Most consumers use natural gas to cook and heat their homes. Beyond these pervasive uses, natural gas has two other important applications.

(a) *Electricity generation*. About one-third of California's electricity is generated at gas-fired facilities, from traditional, very large plants to very small generators that power individual homes or commercial buildings. National gas consumption for electricity generation has been growing faster than overall demand for gas (2.7% vs. 1.7% per year), in part because 94% of new plants constructed between 2001 and 2003 were

gas-fired. Overall, natural gas accounts for 23% of total U.S. energy use, a proportion which will continue to grow as more gas-fired plants come onstream and nuclear plants are shut down due to age.[2]

(b) *Industrial uses*. The U.S manufacturing sector uses 25% of total generated electricity. In addition, natural gas is a primary feedstock for several chemical industries (chemicals, plastics, and fertilizers), or is the heat source of choice in processes that require high temperatures (glass).[3] These industries employ 1.5% of the U.S. workforce, and 1.1% of California's.[4]

Combining the direct use of natural gas in production and the indirect use in electricity needed for manufacturing, the industrial sector consumes 34% of all natural gas in the U.S.

(A) Why Natural Gas Prices Are High

Since natural gas can often be a substitute for oil, and frequently is a byproduct of oil production, gas prices (in terms of dollars per million British Thermal Units, or MMBTU) have traditionally closely tracked oil prices (in dollars per barrel). That correlation began breaking down in the winter of 2000-01, which was colder and drier than normal. Cold weather drove up heating demand, and dry weather reduced the availability of hydropower, increasing demand for gas-fired electricity. U.S. gas prices that had remained in the range of $1.40 to $2.40 per MMBTU for 95% percent of the 1990s spiked to over $6.00 per MMBTU in late 2000.[5] Futures markets suggest that prices will remain above $6.00 per MMBTU for the foreseeable future.[6]

The spread between California and national prices, typically about $1.00 per MMBTU, began widening dramatically in December of 2000, surpassing $8.00 (bringing California prices to over $13.00 per MMBTU.)[7] At times California spot prices have been as much as four times national prices.

California imports 85% of its natural gas through a pipeline infrastructure that is being used to capacity.[8] (The U.S. currently imports about 15%.[9]) The West Coast is the area of the Continental U.S. most distant from North American natural gas deposits in Canada, the Rockies, and the Texas/Louisiana basin, meaning that transportation costs are at a maximum. For these reasons, California, Oregon, and Washington would have the most to gain from natural gas shipped by sea to a West Coast port.

(B) Economic Benefits of a Price Reduction

Consider for a moment a thought experiment: Given natural gas's ubiquitous and growing role in the economy—and most especially in California's economy—what would the economic benefit be if prices were reduced by making additional supply available? In this section, we will make the arbitrary assumption that price decreases by 10%. In a later section, we will estimate the plausible actual decline if new infrastructure were built.

Table 1 shows several estimates from other studies of the elasticity of the economy with respect to natural gas prices. This captures the change in overall economic output per one percent change in gas prices. Each of these sources' estimates was based on the equivalent

elasticity of the national economy with respect to oil prices. Below the national estimates are analogous estimates adjusted for California's higher dependence on natural gas. California produces 1.33 times as much economic output per cubic foot of natural gas as the U.S. does[10]

Table 1
Natural gas price elasticity of US economic output (GDP)
(% change in GDP per 1% change in natural gas price)

National estimates Source of estimate	Low Estimate	High Estimate
American Chemical Council, March 2003	0.467	
Federal Reserve Bank Dallas, Sept/Oct 2003	0.5	1.8
After California adjustment (x 1.33)	**0.67**	**2.4**

This means that, for example, a 10% reduction in natural gas prices will increase California gross state product (GSP) between 0.067% and 0.24%. Given that California's 2003 GSP was just under $1.5 trillion, this implies that a 10% price decline would increase state output by $960 million to $3.45 billion.

These impacts are large for two main reasons. First, as economic forecasting firm Global Insight has put it, high natural gas prices "destroy [aggregate] demand" because gas is used so pervasively. Corporate earnings and household disposable income decline and are unavailable for reinvestment or domestic consumption. Second, the resources being spent on natural gas are not simply transferred from one California economic actor to another; 85% leave the state to pay for imports. Lower prices reverse these effects, creating more retained earnings or disposable income that can be spent on California goods and services.

Such considerable changes in economic output will likewise affect employment and household income as well. Table 2 estimates these additional effects for an assumed 10% reduction in natural gas prices. California employment would increase by 11,500 to 41,500 per year—roughly equivalent to two weeks to two months of growth for the entire state economy. Households' income would grow by $380 million to $1.38 billion, or roughly $43 to $160 per family of four, and state revenues would grow by $64 to $229 million per year.

Table 2
California Output, Income, and Employment Effects
of a 10% change in natural gas prices
(macroeconomic, top-down estimates)

	Low Estimate		High Estimate
Change in California GSP ($ billions)	$0.96		$3.45
Change in GSP (%)	0.067%		0.24%
Overall jobs multiplier (jobs per million $ output)		12.03	
Change in CA employment (number of jobs)	11,500		41,500
Overall HH income multiplier (income per million $ output)		0.40	
Change in CA household income ($ billions)	$0.38		$1.38
Income gain per family of four ($/year)	$43		$160
Average State tax rate (taxes as % of GSP)		6.65%	
Change in state tax revenues (all funds)	$63.9 million		$229 million

Note: GSP= Gross State Product, the sum of all goods and services produced in the state. The "overall" multipliers shown are for the household sector, and are almost certainly lower than the relevant multipliers for this scenario. Most of the industries that would be most affected by natural gas price changes have high value added per worker, and therefore higher multipliers than households.

Lower gas prices would have similar national economic benefits of about 3/4ths the proportional magnitude of California's (because the nation's economy is 3/4ths as gas-intensive as California's.) Thus, a 4% change in, say, California output or household income would likely translate to a 3% change in the U.S. equivalents. A simplistic translation of the above California estimates to national numbers would suggest that a 10% reduction in natural gas prices would increase U.S. GDP by $7.4 billion to $26.5 billion. This is broadly consistent with the American Chemical Council estimate that a 100% increase in gas prices would depress the economy by about $200 billion.

All of the above estimates may be modestly inflated, for two reasons. First, they assume no changes in the structure of economic relationships after the price change, when in fact consumers and producers will adapt to moderate the effects of the change (e.g., by switching to substitutes). Second, additional gas supplies to the West Coast will benefit the Western states—at the end of the line in the current North American gas distribution system—the most. On the other hand, as Table 2's explanatory note explains, the jobs and income multipliers are

probably too low. These two countervailing biases should roughly balance. Overall, these economic estimates are probably reasonably accurate.

II. The Supply, Price, and Economic Benefits of LNG

(A) How LNG Works; Safety and Environmental Concerns

Within a contiguous land mass (e.g., within the continental U.S.), natural gas is normally transmitted via pipelines. However, when it is shipped across oceans, it is typically chilled to very low temperatures, where it reverts to a liquid state. In this form it is virtually inert and can be transported quite safely. In fact, in the over 45 years that natural gas has been shipped not a single significant accident has occurred. A recent report by Stanford University's Institute for Economic Policy Research (SIEPR) points out, "Although safety risks should not be underemphasized, it is important to note that regasification facilities have been in operation in European and Asian countries for a number of years…these countries have managed to address safety concerns satisfactorily. California…should learn from their experience."[11]

As the Stanford report further notes, "there is relatively little harm associated with a tanker spill. The LNG simply evaporates on contact with the warmer ocean water and turns to gas."[12] For this reason, the Federal Energy Regulatory Commission (FERC), which has primary jurisdiction over such facilities, "is satisfied with the safety of LNG and has given final approval to the construction of two new terminals in the past year," according to the Manufacturers' Alliance/MAPI's 2002 report on LNG and the future of manufacturing.[13]

At present, 100 billion cubic meters of gas are being flared off at oil fields throughout the world (gas is often a byproduct of oil production) for lack of a market, according the General Accounting Office.[14] LNG terminals in the U.S. would permit the export of this gas, rather than its wasteful introduction into the atmosphere. Venting gas into the atmosphere produces 23 times the warming effect of burning it efficiently. Nevertheless, misguided safety and environmental concerns "have led some state and local governments to oppose or delay action on proposals for LNG terminals."[15]

(B) Economic Benefits of a West Coast LNG Terminal

Eight LNG terminals are currently under consideration by regulatory authorities, including four in California. These terminals would have the capacity to through-put between 500 and 1,500 million cubic feet of gas per day[16], augmenting California supplies by 7.4% to 22.7%., so our hypothetical 10% augmentation of supplies is near the low end of possibilities.

The author has analyzed annual price and consumption data from 1989 to 2004 to determine how the first (price) affects the second (quantity consumed). Over that period, each 1% increase in price has corresponded to a 0.113% decrease in consumption. Conversely, a 1% increase in supply should correspond to a [1/0.113 = 8.83%] decrease in price. This approach implies that a 10% increase in supplies stemming from the construction of an LNG terminal should lead to up to an 88.3% reduction in prices. This is almost certainly an overestimate of the

likely reduction, since some of the augmented natural gas supply would be exported out of California; but it seems quite reasonable that a 10% supply augmentation would reduce prices by at least 10 to 20%; i.e., from $6.00 per MMcf to perhaps $4.80 to $5.40.

Table 3
California Output , Income, and Employment Effects
of a 10% increase in natural gas supplies
(market-based, bottom-up estimates)

	Low Estimate (10% price reduction)		High Estimate (20% price reduction)
Change in California GSP ($ billions)	$2.3		$4.6
Reduction in gas prices	-10% (60 cents/MMcf)		-20% ($1.20/MMcf)
Change in GSP (%)	0.16%		0.32%
Overall jobs multiplier (jobs per million $ output)		12.03	
Change in CA employment (number of jobs)	27,700		55,300
Overall HH income multiplier (income per million $ output)		0.40	
Change in CA household income ($ billions)	$0.92		$1.84
Income gain per family of four	$102		$204
Average State tax rate (taxes as % of GSP)		6.65%	
Change in state tax revenues (all funds)	$153 million		$306 million

Since total annual gas consumption in California exceeds 2 trillion cubic feet per year ($13.2 billion at $6.00 per MMcf), a 10% to 20% price reduction would save consumers between $1.3 and $2.6 billion. Using a relatively low multiplier (1.81) to compute indirect effects[17] suggests that gross state product would be increased by $2.3 to 4.6 billion. Corresponding gains in jobs would be between 27,700 and 55,300. A typical family of four would see an increase in income of between $102 to $204 per year. State revenues would grow by between $153 and $306 million. These estimates roughly bracket the top-down range of estimates from Table 2. The two different estimation methods yield roughly similar results.

III. Conclusions

By accident of geography, California is far from existing sources of natural gas, yet the state is one of the most dependent on this energy source. Increasing worldwide demand for natural gas is driving up prices, which the futures markets expect will continue. These price increases create a significant drag on both the state and national economy; as Global Insight puts it, they "destroy demand".

Fortunately, a solution is readily at hand. The world has plentiful supplies of natural gas, which can be transported across oceans readily in liquefied form (LNG). All that is missing is a terminal that can receive the LNG, convert it back into gas, and transport it through existing pipelines to end-users. There are four such terminals on the U.S.' East Coast, but none on the West Coast. Eight proposed terminals (four in California) are undergoing regulatory review. Any of them would increase available gas supplies by between 7% and 22%, depending on capacity.

If a terminal were built that augmented gas supplies by 10%, analysis of historical price data suggests that prices would decline by nearly 90%. However, to be very conservative, this analysis assumed that only a 10% to 20% price decline would occur. By two different methods (a macroeconomic approach based on analogous effects of oil price changes, and a more direct analysis of changes in natural gas consumption) produced similar results: an increase in gross state product of between $1 billion and $5 billion, and a gain of between 11,000 and 55,000 jobs. This additional economic activity would add between $60 and $300 million to state revenues. The two different estimation methods (top-down and bottom-up) produce similar, although not identical results, so readers can have some confidence in their rough accuracy.

In addition, to the degree that high natural gas prices contribute to California's above-average electricity prices (because the state is more dependent on natural gas for electricity production than the national average), they become an issue of interstate competitiveness. Throughout the past 15 years there have been many examples of firms which have emigrated out of the state, or located expansions elsewhere, because of high electricity rates. Natural gas price reductions would reduce this incentive to migrate away, and produce additional economic benefits not estimated here.

In a state economy of over $1.5 trillion with over 15 million workers, the numbers provided in this report may sound small, but they amount to between two weeks and three months of growth, every year for as long as an LNG terminal operates. As a recent Stanford University report notes, "the cost to California of delaying action on this issue is very high."[18]

Endnotes

[1] This analysis was performed under contract to Californians for Affordable, Safe Energy (Cal-CASE). The author is a professor of business administration at the University of Oregon business school, where he served as dean from 1999-2004. More pertinent to this report, from 1991-99 he served as chief economist to the governor of California, where he analyzed the economic impacts of a wide range of public policies. As such he is a generalist policy economist, not an energy specialist, and he approaches the subject without preconceptions. Views expressed herein are solely the author's and do not necessarily reflect those of the University of Oregon, Forward Observer, or Cal-CASE.

[2] Energy Information Administration, U.S. Dept. Of Energy, *Annual Energy Outlook 2004*, p. 82.

[3] Donald Norman, *Natural Gas and the Future of U.S Manufacturing,* Manufacturers Alliance, MAPI, Sept. 2002.

[4] Author's calculations from 2002 data (most recent available) in the Bureau of Labor Statistics' *Employment and Output by Industry, 1992, 2002, and projected 2012*, and California Dept. of Finance's *Statistical Abstract*. This computation is almost certainly an underestimate, since it includes only NAIC industries 325 (chemical manufacturing), 326 (plastics and rubber products manufacturing), and 3272 (glass and glass product manufacturing).

[5] Federal Reserve Bank of San Francisco, *FRBSF Economic Letter, 2001-04*, Feb. 9, 2001.

[6] NYMEX futures prices, 2005-08 in *Wall Street Journal,* Feb. 17, 2005.

[7] Frank Wolak, *Liquefied Natural Gas is Essential to California's Energy Future*, Policy Brief, Stanford Institute for Economic Policy Research, Dec. 2004.

[8] *FRBSF Economic Letter 2001-04.*

[9] Damien Gaul, *U.S. Natural gas Imports and Exports: Issues and Trends 2003*, Energy Information Administration, U.S. Dept. of Energy, August 2004.

[10] Natural gas consumption data from Energy Information Administration, U.S. Dept. of Energy, and GDP data from Bureau of Economic Analysis, U.S. Dept. of Commerce. California's economy produces $652 in output per million cubic feet of natural gas, while the U.S. produces $492. The difference is due to the California's unique composition of industries, and its lesser need to heat residences compared with the rest of the nation.

12 Wolak, *Liquefied Natural Gas (LNG) is Essential to California's Energy Future*, SIEPR, Dec. 2004.

13 From the Department of Energy's Energy Information Administration, "Pending Natural Gas Infrastructure Projects", www.eia.doe.gov.

[14] The multipliers used are weighted averages of household and industry average multipliers from the Dept. of Commerce's Regional Input-Output Modeling System (RIMS II). Weights are based on comparative consumption of natural gas in California (roughly 68% industrial/32% residential). The "industry" multiplier is RIMS' average multiplier for all industries in California.

[11] Wolak, *op. cit.*

[12] Wolak, *op. cit.*

[13] Norman, Donald, *Liquefied Natural Gas and the Future of Manufacturing,* September 2004.

[14] As cited in Norman, *op. cit.*

[15] Norman, *op. cir.*

[16] From the Department of Energy's Energy Information Administration, "Pending Natural Gas Infrastructure Projects", www.eia.doe.gov.

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[18] Wolak, *op. cit.*