



Liquefied Natural Gas Exports: An Opportunity for America

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WORLD SHALE BOOM

Unconventional extraction techniques have changed the face of world energy production, consumption, and trade in unexpected ways. Shale oil and gas can now be accessed both for domestic use and traded. This Policy Brief focuses on natural gas extracted from shale and traded internationally, mainly as liquefied natural gas (LNG).¹

In 2011, some 18 countries exported LNG and 25 countries imported LNG. The biggest exporter was Qatar, accounting for about a third of global exports. The United States accounted for a mere 0.1 percent of the entire export market, but this share is expected to grow dramatically over the next decade. However, there are significant barriers to LNG trade: The gas, whether extracted from a shale field or otherwise, must first be converted to liquid, shipped in special tankers, and then reconverted to

gas for use. Apart from pipelines, which often exist, from shale gas sources to ports, additional fixed costs include liquefaction plants, which can cost up to \$10 billion each, LNG transportation tankers, costing \$300 million apiece, and regasification plants costing \$1 billion to \$2 billion each. Because of high fixed costs, relatively few countries now participate in the international LNG market. However, as more countries eye LNG trading opportunities on the horizon, whether exporting newly accessed shale gas or importing LNG to meet growing energy demands, the international market will change dramatically.

The United States is a major player in the shale revolution, following a dramatic shift in energy production and projections over the past five years. Only within the last decade has the production of natural gas from shale become economical. In the early 1980s, techniques in horizontal drilling were substantially improved and used in combination with hydraulic fracturing (or fracking). This made shale gas commercially viable, and production has dramatically increased. In 2007, shale gas accounted for just 8 percent of annual natural gas production; in 2011 it accounted for 30 percent of total production (EIA 2013a). Still, as recently as 2008, the United States had seven regasification plants in place for LNG imports, and 60 additional LNG import projects were on the drawing board. Only in the past year have companies begun to file permits to transform nine of those existing and planned plants into export facilities.² Updating its projections, the US Energy Information Administration (EIA) now forecasts that domestic natural gas supply will exceed demand by 2020. Furthermore, the *Annual Energy Outlook 2013* (EIA 2013b) projects that natural gas production will grow at twice the rate of natural gas demand at least through 2035.

While the debate over LNG exports is centered on shale gas, the natural gas entering a liquefaction plant comes from pipeline systems that mix shale gas with conventional gas. Incremental gas production generally comes from unconventional resources (shale gas and gas from tight sands), but none of the proposed export projects has announced that its gas supplies will come strictly from shale.

1. Between countries that share a land border, such as Canada, the United States, and Mexico, natural gas is transported mainly by pipeline.

2. A list of permit applications can be found on the Department of Energy (DOE) website, www.fossil.energy.gov/programs/gasregulation/index.html.

Table 1 Energy definitions and conversions

Units of power		
Unit	Definition	Conversion (energy to volume)
British thermal units (Btu)	Measures the energy content of fuels. 1 Btu is the quantity of heat required to raise the temperature of 1 pound of liquid water by 1 degree Fahrenheit.	1 Btu = 0.000001 Mcf 1 Btu = 0.000028 bcm
Million metric British thermal units (mmBtu)	Measures the energy content of fuels.	1 mmBtu = 0.9737 Mcf 1 mmBtu = 28 bcm
Megawatt hour (MWh)	Measures the energy expended per hour in terms of electrical power. A watt hour is the electrical energy unit equal to one watt of power supplied to, or taken from, an electric circuit for one hour.	1 MWh = 3.345 Mcf 1 MWh = 0.08 Mt 1 MWh = 0.00000008 bcm
Units of volume and weight		
Unit	Definition	Conversion (volume/weight to energy)
Thousand cubic feet (Mcf)	Unit of volume commonly used to measure production, consumption, and prices of natural gas (prices are expressed in dollars per Mcf).	1 Mcf = 1,023,000 Btu 1 Mcf = 0.301278 MWh
Billion cubic feet per day (Bcf/d)	Unit of volume commonly used to measure exports and imports of natural gas.	1 Bcf/d = 1,023 billion Btu per day 1 Bcf/d = 301,278 MWh per day
Trillion cubic feet (Tcf)	Unit of volume commonly used to measure reserves of natural gas.	1 Tcf = 1,000 billion cubic feet (Bcf) 1 Tcf = 1,023 trillion Btu 1 Tcf = 301,277,778 MWh
Billion cubic meters (bcm)	Metric unit of volume used to measure exports and imports of natural gas.	1 bcm = 35,314,700 Mcf 1 bcm = 36 trillion Btu 1 bcm = 1,313 MWh
Metric ton (Mt)	A unit of weight often used to measure greenhouse gas emissions such as methane and carbon dioxide.	1 Mt = 48.7 Mcf 1 Mt = 52,000,000 Btu (from natural gas) 1 Mt = 15 MWh (from natural gas)

Sources: EIA Energy Calculators, www.eia.gov; BP conversion factors, www.bp.com/conversionfactors.jsp; MIT Units and Conversions Fact Sheet, http://web.mit.edu/mit_energy/; authors' calculations.

Export Opportunities

US natural gas producers are eager to take advantage of tremendous price differentials between the United States and foreign markets. US prices are around \$3 per million metric British thermal units (mmBtu), while prices in Europe are \$11 to \$13 per mmBtu and as high as \$18 per mmBtu in Southeast Asia. Even considering the cost of liquefaction and ocean transportation at \$3.50 to \$9.00 per mmBtu, producers can export LNG and earn a significant profit over domestic sales.³ (Conversions and explanations of units can be found in table 1.)

Industry experts acknowledge that many countries have large shale reserves but believe that most countries are several years behind the United States in exploration and extraction. According to a BG Group (2011) report, in 2025, the biggest

importers are projected to be Japan, Korea, China, and India. Japan will curtail and may abandon nuclear energy in the aftermath of the Fukushima disaster and is thus expected to continue as a major LNG importer. Both Japan and Korea lack natural gas resources and are less likely to import natural gas via pipelines owing to geography. China and India, on the other hand, do have domestic natural gas resources, but they are several years behind the United States in extraction and infrastructure buildout and in any event lack sufficient shale resources to support their expanding manufacturing industries and rising living standards. Environmental opposition to shale extraction is strong in parts of Europe;⁴ moreover, shale reserves are not as extensive as in the United States, and Europe has

3. Some contracts are structured such that the price of LNG is fixed at the Henry Hub price plus a fixed liquefaction fee. In this case, producers would benefit if increased foreign demand raises Henry Hub prices.

4. Germany, Poland, and the United Kingdom seem to accept shale gas exploration; France has enacted a law in opposition but might reconsider. Gazprom, based in Russia, is said to provide support to environmental opponents of shale gas as a means of protecting its pipeline sales.

the alternative of importing natural gas by pipeline from North Africa or Russia.⁵

Numerous major LNG export projects have taken a final investment decision and are currently under construction off

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the coast of Western Australia and Queensland and scheduled for start-up between 2014 and 2018. Due to Australia's proximity to large Asian importers, US LNG exporters will face a transportation disadvantage in head-to-head competition.

Macroeconomic Impact

US industry stakeholders and government regulators are scrambling to evaluate the potential consequences of increased shale production and eventual LNG exports. The Obama administration, through the Department of Energy (DOE), commissioned an LNG impact report to inform policy decisions. The report, conducted by the private consulting firm NERA Economic Consulting, evaluates the effects of LNG trade on the US economy in several scenarios. The report conveys two major takeaways. First, natural gas extraction and trade will be influenced by exogenous factors, making it difficult to accurately predict specific outcomes or to narrowly project future prices and quantities. Second, every scenario delivers net positive macroeconomic outcomes for the United States. This chief finding represents a major victory for the domestic natural gas industry and clarifies the economics of large-scale LNG exports.

Proponents of natural gas extraction and exports identify several potential positive effects. Today, natural gas prices are low in the United States compared with other energy sources and prices in other countries. Increased production may spur recovery in the sluggish US economy. Industry officials claim that the booming industry has created over half a million new jobs; the NERA report assumes that aggregate employment remains the same in all scenarios (in other words, employment has shifted into shale production from other industries).⁶

In the United States, headline inflation, which reflects energy prices, has persistently exceeded core inflation owing to

the upward trend in petroleum prices. In the future, unlike oil, the international natural gas market may be less volatile, and prices may trend down, because supply is potentially enormous and less subject to political unrest or cartel control. As natural gas becomes a bigger part of world energy consumption, experts expect a smaller spread between headline and core inflation.

Natural gas as a fuel for electric power plants accounts for about 25 percent of US household electricity. In addition, natural gas consumers include fleet vehicles (taxis, delivery trucks, and buses), manufacturing plants, and chemical firms. These industries will definitely benefit in the short term from inexpensive natural gas and maintain an edge over foreign competitors that pay higher energy prices. US natural gas prices are expected to increase as LNG exports take a larger share of domestic supply. Even over the long term, however, so long as the United States remains a low-cost natural gas producer relative to other industrial countries, US industries will benefit simply because LNG liquefaction and transportation add \$4 to \$5 per mmBtu for delivery to Europe and closer to \$8 or \$9 per mmBtu for delivery to Asia. That said, downstream US industrial users of natural gas obviously prefer the lowest possible price: \$3 per mmBtu would be better for them than \$4 per mmBtu, no matter what the delivered price of LNG is to their foreign competitors.

In the medium term, larger domestic oil and gas production from shale, together with cost-induced increase of manufacturing at home, should both reduce US imports and increase US exports. These effects could narrow the US trade deficit from its counterfactual level in the absence of the energy revolution.⁷ As explained in the next section, a conservative estimate for US exports of LNG within a decade is 6 billion cubic feet per day (Bcf/d). If the wellhead price is then \$4 per thousand cubic feet (Mcf), and if the pipeline and liquefaction costs are \$3 per Mcf, arithmetic suggests that the annual value of LNG exports would be around \$15 billion. Furthermore, value-added products produced from wellhead natural gas, such as ethane, propane, and butane, are already being produced and exported. In addition, domestic consumption of natural gas from shale will reduce US imports of petroleum and may abate the rise in petroleum prices.

5. Many European leaders welcome LNG from the United States and elsewhere simply to diversify from Russia.

6. Put another way, NERA's model assumes full employment.

7. Theorists who believe that the capital account drives the trade account, through the workings of a flexible exchange rate, might argue that any narrowing of the US trade deficit on account of larger US energy production will be offset by an expanded trade deficit in other goods and services. We do not subscribe to this argument.

TRADE RULES AND LNG EXPORTS

As outlined in the previous section, domestic producers in the United States are eager to take advantage of the abundant LNG reserves and preferential price differentials between the United States and foreign markets. However, under current US law domestically produced natural gas may not be exported without the approval of the DOE. The DOE will automatically approve LNG exports to any US partner in a free trade agreement (FTA).

Prohibiting or restricting LNG trade not only is contrary to international norms agreed in the WTO but also destroys value in the United States by creating artificially low prices for domestic consumption of natural gas.

However, exports to non-FTA partners must be reviewed and meet a national interest test. The DOE approved the first LNG export terminal in May 2011 but subsequently put a hold on all other export applications (over 20 are currently awaiting approval), pending a large-scale review of the impact of LNG exports on the US energy market, as well as environmental and commercial concerns.⁸

Denying export permits is the wrong way to address concerns raised in the DOE review. Prohibiting or restricting LNG trade not only is contrary to international norms agreed in the World Trade Organization (WTO) but also destroys value in the United States by creating artificially low prices for domestic consumption of natural gas.

Below we discuss the trade rules that bear on LNG exports and policy considerations that support our conclusion: The United States should *not* prohibit or restrict LNG exports.

Five Unique Characteristics

The characteristics of natural resources differ from manufactures and services, and the differences are reflected both in national export policies and in the rules of the WTO and FTAs.

- First, natural resource prices fluctuate to a much larger extent than manufactured goods and services.⁹ Sharp price

8. We discuss the pending export applications and the prospects for US LNG exports in more detail in the following section.

9. The general explanation for greater price fluctuations in natural resource products is a less elastic supply response than for manufactured goods. For example, a 10 percent price increase might elicit only a 2 percent increase in

fluctuations can trigger intense public reaction, in turn prompting governments to impose special controls on both exports (when prices soar) and imports (when prices plunge), without necessarily allowing markets to balance in response to price signals.

- Second, some natural resources offer a handy springboard for downstream manufacturing activity. Vertical supply relationships tempt governments to limit exports as a means of encouraging downstream production even though such policies may run afoul of trade rules that limit industrial subsidies.
- Third, some natural resources are nonrenewable, and production entails a tradeoff between income today and income tomorrow. Governments sometimes fear that private markets will deplete nonrenewable resources too rapidly; accordingly they place limits on production or exports.
- Fourth, natural resource production sometimes creates “negative externalities”—social costs not reflected in market prices. In response, rules are created to limit these costs. An obvious example is the regulation of mining and drilling to restrict surface and subsurface water pollution.
- Fifth and finally, some natural resources—particularly petroleum and hard minerals—are unevenly distributed across the globe. Geographic concentration of production can encourage the formation of cartels that seek to lift prices above competitive norms.

Natural Gas as a Traded Commodity

Natural gas attracts some of these special considerations but not all. Price volatility and the impact of price spikes on downstream users are primary concerns. The record of natural gas prices in the United States over the past decade is one of large fluctuations around a descending trend: Prices peaked between \$10 per Mcf and \$11 per Mcf in October 2005 and July 2008; since then, prices have plunged and averaged about \$3 per Mcf in 2012 (EIA 2013a). Downstream users, particularly chemical firms, fear that abrupt shocks in world supply or demand for natural gas could be transmitted through export markets into future US price spikes. Natural gas producers argue that connecting to global trade brings the benefit of more diverse suppliers and consumers. To be sure, the shale revolution has vastly increased the quantity of recoverable natural gas and has

the quantity supplied of iron ore, but the same price increase might elicit an 8 percent increase in the quantity supplied of steel pipe. Hence, a given demand shock exerts a larger impact on the price that clears supply and demand for iron ore than the price that clears supply and demand for steel pipe.

probably stabilized prices at low levels. But since nothing is certain, downstream users want the assurance of continued export controls in the event of future price spikes.

Turning to the third characteristic, like many other natural resources, natural gas is nonrenewable. Critics of LNG exports argue that opening natural gas for exportation will more rapidly exhaust the US supply. However, reports from industry, government, and third party entities dismiss these concerns, both because the estimated supply is large (up to 95 years)¹⁰ and because, even in optimistic scenarios, exports will not exceed 18 percent of production.¹¹ In any event, if the underlying fear is “market failure”—namely that market forces will too rapidly deplete the supply—the appropriate response is to control production, not to control the destination of natural gas sales, discriminating between consumption abroad and consumption at home.

As for the fourth concern, in the absence of proper regulation, natural gas exports may increase the potential scope of negative externalities. To be sure, natural gas is cleaner than many other fuels used around the world. However, the concerns raised around extracting natural gas from shale include the risk of methane release (a greenhouse gas), groundwater pollution, and earth tremors. But these risks are no greater for consumption abroad than for consumption at home; they are inherent in the production process.

Turning to the fifth characteristic of some natural resources—namely concentrated geographic sources—the uneven distribution of natural gas worldwide ranks low on the list of concerns. Taking shale reserves into account, natural gas is far

10. Estimates of the US supply of natural gas vary greatly. The US EIA estimates that there are 2,203 trillion cubic feet (Tcf) of natural gas reserves in the United States and, at the 2011 rate of natural gas consumption of 24 Tcf, this will last 92 years. Similarly, in April 2011, the Potential Gas Committee, a group of petroleum engineers and geoscientists, released a report that calculates the supply at 95 years (estimating American reserves at 2,170 Tcf). See Potential Gas Committee, “Potential Gas Committee Reports Substantial Increase in Magnitude of US Natural Gas Resources Base,” press release, <http://potentialgas.org/press-release> (accessed on February 4, 2013). However, critics point out that, of the 2,170 Tcf figure, only 273 Tcf (12.5 percent) are “proved” reserves. An additional 537 Tcf are “probable” reserves. The remainder are “possible” reserves. Reports differ on what fraction of natural gas reserves should be “counted” in supply calculations as well as how other factors, such as changes in usage rates and new technology, may eventually play out.

11. A study conducted by the EIA (2012) examines four scenarios under which the United States would export natural gas: (1) 6 billion cubic feet per day (Bcf/d) phased in at a rate of 1 Bcf/d per year (low/slow); (2) 6 Bcf/d phased in at 3 Bcf/d per year (low/rapid); (3) 12 Bcf/d phased in at a rate of 1 Bcf/d per year (slow/rapid); and (3) 12 Bcf/d phased in at a rate of 3 Bcf/d per year (high/rapid). In 2011, the United States produced 66 Bcf/d of natural gas. Accordingly an increase in the level of natural gas exported, as outlined in the scenarios above, represent between 9 and 18 percent of current US production.

more widely distributed than petroleum and most hard minerals. Moreover, the United States, Canada, and Mexico—all with very large shale reserves—are hostile to cartels.

US Trade Law

Under US federal law the export of domestically produced oil and gas is regulated by the Departments of Commerce and Energy. The Department of Commerce’s Bureau of Industry and Security (BIS) must authorize all exports of oil to a foreign country, including those countries with which the United States has an FTA. However, domestically produced crude oil is generally not exported.¹² The BIS will grant export licenses for crude oil that

- is shipped on the Trans-Alaska Pipeline, or
- is of foreign origin, or
- is from the Strategic Petroleum Reserve, if those exports will result in the import of refined products not available elsewhere.

Additionally, the Energy Policy and Conservation Act of 1975 allows the president to authorize oil exports if they are determined to be in the country’s national interest. The export of refined oil products does not require a license and is generally permitted.

The export of natural gas is regulated by the US Natural Gas Act of 1938. Under section 3, all exports of natural gas from the United States to a foreign country must be approved by the US Federal Energy Regulatory Commission (FERC). According to section 3, §717b(a) (Exportation or Importation of Natural Gas), the FERC:

[S]hall issue such order upon application, unless, after opportunity for hearing, it finds that the proposed exportation [...] will not be consistent with the public interest.

In determining whether or not such exports are in the public interest, the FERC follows certain parameters, as outlined in the Secretary of Energy’s New Policy Guidelines and Delegation Orders of 1984. These guidelines include a consideration of the domestic need for the natural gas to be exported and other fac-

12. The United States exports refined oil products such as petroleum fuels. More recently, however, some domestic oil companies have applied for a license to export domestically produced crude oil. In 2012, BP received a license to export crude oil to Canadian refineries. Shell also applied for an export license in 2012 (Gregory Meyer and Ed Crooks, “Oil groups set to export US crude,” *Financial Times*, October 11, 2012).

tors considered on a case-by-case basis.¹³ In addition, the DOE has the authority to impose conditions on exports if a license is granted. Two types of licenses may be granted, depending on the nature of the exports. A blanket authorization permits exports on a short-term or spot market basis for a two-year period. Long-term authorization is granted when an exporter has a sales contract for a period longer than two years.

Currently the United States has a bifurcated natural gas trade policy. Under US federal law, natural gas trade with countries with which the United States has an FTA is given special consideration, compared with non-FTA countries. In 1992, the US Energy Policy Act amended the 1938 Natural Gas Act by adding section 3, §717(c), which expedited review of natural gas exports to FTA partner countries. Under section 3, §717(c):

[T]he exportation of natural gas to a nation with which there is in effect a free trade agreement requiring national treatment for trade in natural gas, shall be deemed to be consistent with the public interest, and [...] granted without modification.

LNG exports to non-FTA countries, on the other hand, require an assessment by the DOE regarding the impact on the national public interest of exporting LNG. At the time, the rationale for distinguishing between FTA and non-FTA countries was to bring US law into compliance with the US-Canada FTA, which ensured national treatment for natural gas trade. Additionally, natural gas exports at the time were not a major concern for US energy policy. In the early 1990s, the United States was a net importer of natural gas, and the small fraction of exports involved natural gas piped to eastern Canada and Mexico.¹⁴

The US-Canada FTA set an important precedent for the facilitation of global energy trade. Prior to the FTA, both the United States and Canada employed policies such as quotas, price controls, and taxes to restrict bilateral energy trade. During the oil shocks of the 1970s, Canada cut its oil and natural gas exports to the United States in order to meet growing domestic demand and conserve reserves (Verleger 1988). In the 1980s, Canadian efforts to increase its share of the US natural gas market were hindered by changes in contract terms permitted by the US FERC.¹⁵

13. Although the 1984 Policy Guidelines were intended for LNG *imports*, the DOE subsequently ruled that they apply also to exports.

14. In 1992, US exports of natural gas accounted for less than 10 percent of total natural gas (imports plus exports of LNG and pipeline gas). Some 76 percent of those exports went to Canada and Mexico. The remaining was LNG exported from Alaska to Asia.

15. FERC Order 380, issued in 1983, removed contract obligations that required gas distribution utilities to pay pipelines for a specific volume of gas,

Reacting against such impediments, the US-Canada FTA included provisions to limit export controls and ensure that trade in energy is governed by the same rules as trade in other commodities. Article 902 of the agreement affirms Canadian and US rights and obligations under the General Agreement on Tariffs and Trade (GATT) with respect to trade restrictions in energy products. The agreement, however, goes beyond GATT obligations by establishing “national treatment” as the governing principle at the state and provincial levels, as well as the national level, thereby ensuring two things: energy imports will be treated no less favorably than energy produced domestically, and energy exports will be treated no less favorably than energy consumed domestically. The agreement thus included precedent setting limits on export restrictions. Article 903 prohibits the use of taxes on energy exports, unless the same tax is applied to energy consumed domestically, while Article 904 requires that any reduction in supply be shared proportionally between the domestic and export markets (Calzonetti 1990, 174).

Similar provisions were included in the North American Free Trade Agreement (NAFTA). However, Mexico is exempt from certain prohibitions on the restriction of exports. Annex 603.6 gives Mexico the authority to restrict the granting of export licenses for specific energy and petrochemical goods, such as ethane, butanes, petroleum oils, and oils obtained from bituminous minerals.

Provisions on export controls are included in all US FTAs. However, these provisions are not specific to trade in energy or any particular good. Instead the agreements prohibit contracting parties from adopting or maintaining any restriction on the export of any good, except in accordance with GATT Article XI (General Elimination of Quantitative Restrictions).¹⁶ US FTAs also prohibit the use of taxes on exports, unless the same tax is applied to the same good consumed domestically.¹⁷ Exceptions to these rules are included in certain FTAs. For example, FTAs with Australia, Colombia, Korea, Morocco, Peru, and Singapore

regardless of whether it could be used. FERC Order 436, issued in 1985, established an open-access transportation program that required pipelines to act as common carriers in order to qualify for a blanket transportation certificate. Order 436 also allowed distribution utilities to convert purchase contracts to transportation-only contracts and reduced the minimum size of purchase contracts. The Orders collectively transformed the US gas market from a long-term to a spot basis, enabling a large volume of gas to be sold under short-term spot contracts. This made it difficult for Canadian gas producers to sell their supplies, because they were customarily sold under long-term contracts.

16. Article XI of the GATT allows export restrictions if they are: (a) applied to prevent or relieve critical shortages; or (b) necessary to the application of standards or regulations. These provisions are discussed later.

17. Article I section 9 of the US Constitution prohibits the federal government from imposing taxes or duties on exports from any state. This limitation is discussed later.

allow the United States to implement controls on the export of logs.¹⁸

The United States has FTAs with 20 countries and FTA partners accounted for 41 percent of US exports in 2010. These FTAs provide national treatment for trade in natural gas, except in the case of Israel and Costa Rica (under the Central American Free Trade Agreement–Dominican Republic [CAFTA-DR]). Among US FTA partners, Chile, Korea, the Dominican Republic, Canada, and Mexico have regasification plants in place to accept LNG imports, and plants are under construction in Singapore. Korea is the second-largest market for LNG imports, behind only Japan. Two US FTA partners, Australia and Oman, are currently exporting LNG, while a third FTA partner, Canada, is scheduled to begin exporting LNG in 2015. None of these countries are prospective markets for the United States.

As its top priority in 2013, the US Trade Representative (USTR) is negotiating the Trans-Pacific Partnership (TPP). If concluded, the TPP would expand the US FTA network to include Brunei Darussalam, Malaysia, New Zealand, and Vietnam (the other six TPP partners already have FTAs with the United States).¹⁹ Two of the prospective TPP members that are not already linked to the United States in FTA pacts will likely become LNG export markets in the near term. Malaysia has a regasification terminal scheduled to become operational in the second half of 2013, and Vietnam has plans to construct two LNG import terminals that could be operational as early as 2015.

In the medium term the United States could potentially establish FTA relations with other major prospective LNG importers, namely the European Union and Japan. The possibility of an FTA with the European Union gained momentum in 2012, with the publication of a joint high-level working group interim report and then in early 2013, when a final report was released by leaders on both sides of the Atlantic voicing their support for the launch of bilateral negotiations. Such an agreement could have a large impact on LNG markets. The EU member countries are eager to diversify their natural gas supplies. This is especially true in Eastern Europe, where countries rely almost exclusively on imports from Russia. Currently the EU regasification terminals have a capacity of 160 billion cubic meters (bcm). However, plans to expand existing terminals and construct new terminals would add another 80 bcm of capacity by 2020 (Natali 2012).

18. In an effort to conserve limited supplies of western red cedar for domestic lumber mills, the United States invoked the Export Administration Act of 1979 to limit exports of western red cedar logs from state and federal lands, found mostly in Washington state. By 1982 exports were completely phased out.

19. TPP partners that currently have an FTA with the United States are Australia, Canada, Chile, Mexico, Peru, and Singapore.

Japan is eager to tap the growing US LNG market. Following the earthquake and tsunami disaster of March 2011, and the movement away from nuclear energy, Japan faces the prospect of replacing some 12,000 megawatts of generating capacity.²⁰ In the short run Japan was able to meet its energy needs from European and Asian suppliers who diverted contract LNG cargos to Japan. However, in the long run, Japan is interested in locking up US LNG exports. The abundant US supply and the discount at which North American LNG trades compared with European LNG makes the United States an ideal source. Japanese efforts to import US LNG would be facilitated if Japan established a free trade relationship with the United States, in the context of the TPP agreement.

In the medium to long run, the United States does not have plans to establish FTAs with other major prospective LNG importers like China and India. Accordingly, US exports could be limited by the absence of FTAs—unless one of two events occurs: US law is further amended to provide LNG export parity to all WTO members, whether or not US FTA partners, or the DOE determines that the benefits of exports to such countries outweigh any negative side effects.

Currently the United States has just one LNG exporting facility, located in Kenai, Alaska, in operation since the late 1960s, but it has been inactive since December 2011. A second facility is under construction on the US Gulf Coast by Cheniere Energy Partners LP and was approved by the DOE in 2011 and the FERC in early 2012. Additionally, three LNG terminals are authorized to reexport LNG. As of the beginning of January 2013, approximately 20 export applications are pending at the DOE, including those that would allow for the reconfiguration of existing regasification plants.

WTO Trade Rules²¹

Article XI(1) (General Elimination of Quantitative Restrictions) of GATT prohibits export restrictions “other than duties, taxes or other charges” but allows exceptions when a country imposes temporary export restraints to alleviate critical shortages of foodstuffs or other essential items, or when the restrictions are necessary to enforce standards for the classification, grading, or marketing of commodities in international trade.

The basic text of GATT Article XI(1), allowing export duties and taxes, does not create an avenue for the United States to limit LNG exports because Article I section 9 of the US Con-

20. US EIA, “Country Analysis Briefs: Japan,” June 4, 2012, www.eia.doe.gov (accessed on January 14, 2013).

21. See “LNG Export Restrictions Could be Difficult to Defend Under WTO Rules,” *Inside US Trade*, February 1, 2013, www.insidetrade.com (accessed on February 1, 2013).

stitution proclaims that “[n]o Tax or duty shall be laid on Articles exported from any State.” Owing to their reliance on agricultural exports, this was an important clause for the southern states when they ratified the Constitution in the 18th century. The exception in GATT Article XI(1) for critical shortages cannot be invoked because the shale gas boom means that the United States cannot plausibly claim a critical shortage of natural gas. The exception in Article XI(1) for ensuring proper standards would, of course, allow proper safety and greenhouse gas emission regulations for LNG exports, but not a blanket prohibition.

However, GATT Article XX (General Exceptions) allows a country to ignore Article XI(1) (as well as other GATT articles) and impose export restrictions if they meet very specific requirements. To invoke GATT Article XX, a country must satisfy the “chapeau” of Article XX, which demands that export restraints not constitute a “disguised restriction on international trade” or a means of “arbitrary or unjustifiable discrimination between countries where the same conditions prevail.” Provided restraints are consistent with the chapeau, they can be imposed under GATT Article XX(b) if they are “necessary to protect human, animal or plant life or health” or under GATT Article XX(g) if they relate “to the conservation of exhaustible natural resources.” However, as an additional requirement, in order to qualify for an exception under either Article XX(b) or Article XX(g), the United States would also have to impose restrictions on domestic production and consumption of natural gas. The logic is straightforward: Without a parallel reduction in domestic production and consumption of natural gas, any negative impact on human, animal, or plant life and any efforts at conservation would be undercut. In sum, these escape hatches cannot be used to limit LNG exports while allowing natural gas production for domestic consumption.

Short History of US Export Restraints

The United States has long imposed export controls for national security purposes (and these are permitted under GATT Article XXI (Security Exceptions)). US federal laws restrict the export of “dual-use” items, defense-related articles, and goods that are considered to be in short supply. Short supply goods include crude oil, petroleum products, and certain species of trees. While the short supply restrictions have never been challenged in the GATT or the WTO, they are suspect, especially since they are permanent, not temporary, as GATT Article XI(1) requires.

Despite its own selective (and perhaps dubious) use of export controls, the United States has generally been a harsh critic of export controls imposed by other countries and, as mentioned, has generally insisted on limits conforming to GATT Article XI(1) in US FTAs. Below we recount some well-

known examples and, in the next section, summarize cases that illustrate long-standing US policy.

During the oil shocks of 1973–74, when Arab oil producers implemented an embargo, the Nixon administration discouraged other oil consumers—mainly Western Europe and Canada—from restricting their own oil exports. The United States urged countries to distribute their oil supplies in an equitable way, including on an ad hoc basis to the United States (Scott 1994). These efforts proved unsuccessful, and the OECD nations failed to effectively coordinate the use of oil stocks.

In 1973, the Nixon administration implemented a complete embargo on US exports of soybeans, cottonseeds, and related products to tame inflation, which spiked in the early 1970s. The United States faced harsh criticism. Japan, one of the largest importers of US soybeans at the time, was highly critical of US policy, especially since importing countries were not consulted prior to implementation of the embargo. Japan also criticized the United States for not giving preferential consideration to countries like Japan—which relied almost entirely on imports to meet domestic demand.

The 1973 embargo stands in stark juxtaposition to the US stance on food export restrictions that were implemented during the 2006–08 food shock. In a 2008 report to the US Congress Joint Economic Committee, US Department of Agriculture’s chief economist Joseph Glauber criticized countries like Argentina, China, India, Russia, the Ukraine, and Vietnam for imposing additional export taxes or other restrictions on the export of grains, rice, oilseeds, and other products. Glauber stated that export restrictions “only exacerbate the surge in global commodity prices” and are “ultimately self-defeating, reducing the incentive for producers to increase production” (Glauber 2008).

Precedents Set by WTO Decisions

Canada: Lumber Wars. Thirty years of US-Canada disputes over lumber trade—often referred to as “lumber wars”—began in the early 1980s. At the instigation of US lumber mills, the US Department of Commerce launched an investigation into Canadian timber practices in the provinces of Alberta, British Columbia, Ontario, and Quebec. Ever since, the United States and Canada have engaged in periodic battles over the conditions of lumber trade.

At issue are two aspects of the Canadian lumber industry: Canadian stumpage practices and restrictions on exporting raw logs. “Stumpage” is the name given to fees collected for harvesting timber. Stumpage fees are set by provincial governments since the majority of timber is located on provincial land. The United States argues that stumpage fees are often at below mar-

ket rates, thereby favoring Canadian lumber companies. The second issue relates to the Canadian system of forestry management, which requires Canadian logs taken from government land to be sold exclusively to provincial sawmills. The United States argues that export restrictions on logs give Canadian lumber mills a second unfair advantage.

The Department of Commerce's initial assessment, issued in 1983, determined that Canadian export restrictions did constitute a subsidy but that the subsidy was *de minimis*. The Department of Commerce also ruled that the stumpage fee system did not constitute a subsidy (Rahman and Devadoss 2002). A subsequent assessment by the department, issued in 1986, reversed the initial ruling and determined stumpage practices did constitute a subsidy, allowing the United States to levy a 15 percent countervailing duty on imports of Canadian lumber.

The case went through several hearings in US courts and NAFTA arbitration panels before landing on the doorstep of the WTO in 2001. An initial WTO ruling in 2004 determined that the United States did have the right to impose both antidumping and countervailing duties (AD/CVD) on Canadian lumber but that the duties imposed were miscalculated and therefore in violation of WTO rules.²²

The lumber dispute continued at the WTO and through the NAFTA dispute settlement system until an agreement was reached in 2006. Under the framework agreement, the United States promised to return 80 percent of the duties US Customs had collected over the last four years (roughly \$5 billion). Both countries agreed that Canadian-sourced lumber exports would be capped at 34 percent of the US lumber market. Additionally, Canada would be allowed to collect an export tax on lumber exported to the United States, if prices dropped below \$355 per thousand board feet.²³

China: Raw Materials Exports. In 2009, the United States filed a dispute with the WTO regarding China's trade practices as an exporter of several raw materials. The United States, joined by Argentina, Brazil, Canada, Chile, Colombia, Ecuador, the European Union, India, Japan, Korea, Mexico, Norway, Taiwan, Turkey, and Saudi Arabia claimed that Chinese limits on exports of bauxite, coke, fluorspar, magnesium, manganese, silicon carbide, silicon metal, yellow phosphorus, and zinc violated GATT Articles VIII, X, and XI, as well as China's Protocol of Accession to the WTO. The WTO Appellate Body agreed

with the complaint and recommended that China bring its measure into conformity with WTO rules.

Article VIII of the GATT states that fees imposed in connection with imports and exports should be simple, minimal, and reflect actual costs associated with trade. The level and administration of fees should not serve as a source of income or as a method of protecting domestic industries. Article X states that all laws, regulations, and judicial decisions that apply to imports and exports or any aspect of their sale must be published promptly, except when doing so is contrary to the public interest. Laws must be applied fairly and uniformly, and member countries must maintain tribunals and procedures to review administrative action related to customs matters. Article XI calls for the general elimination of quotas and outlines certain exceptions where quotas are appropriate.

The United States and other petitioners argued that China's export restraints created scarcity and higher prices in global markets, while downstream Chinese industries enjoyed an advantage from access to cheaper domestic raw materials. China defended its trade measures, insisting that export limits were necessary to conserve exhaustible natural resources, citing GATT Article XX. Article XX establishes general exceptions in which a WTO member may decide to ignore other GATT rules. Specific to the raw materials case, Article XX(g) states that the GATT is not intended to prevent measures "relating to the conservation of exhaustible natural resources if such measures are made effective in conjunction with restrictions on domestic production or consumption" (GATT 1947). China also claimed that restrictions were "necessary to protect human, animal or plant life or health," citing Article XX(b) of the GATT.

The WTO panel ruled in favor of the United States and other petitioners, finding that China's export quotas are inconsistent with WTO rules, as well as China's Protocol of Accession to the WTO. China was unable to demonstrate that it had imposed restrictions on domestic production and consumption in order to preserve natural resources. China was also unable to prove any causal relationship between production of raw materials and any short-term or long-term effect on pollution or the health of its population.

The Appellate Body of the WTO upheld the panel's ruling, with one exception: According to the WTO summary, "the Appellate Body saw nothing in the text of Article XX (g) to suggest that, in addition to being 'made effective in conjunction with restrictions on domestic production or consumption,' a trade restriction must be aimed at ensuring the effectiveness of domestic restrictions." China notified the WTO of its intention to implement changes in accordance with the ruling. The United States and China mutually agreed that the changes should be implemented by the end of 2012.

22. The United States used the so-called zeroing methodology to calculate duties. Under zeroing, a value of zero is used when the export price is higher than the home market price (rather than taking an average of the differences between the home market price), which can artificially inflate dumping margins. See US-Softwood Lumber III (DS236), www.wto.org.

23. "Softwood lumber dispute," CBC News Online, August 23, 2006, www.cbc.ca/news/background/softwood_lumber (accessed on January 8, 2013).

China: Rare Earths Exports. In March 2012, the United States requested consultation with China, with respect to its restrictions on the export of rare earths.²⁴ The United States alleges that China imposes export restrictions, including export duties, quotas, minimum export price requirements and export licensing requirements. The United States claims these export restrictions are inconsistent with Article VII (Valuation for Customs Purposes), Article VIII (Fees and Formalities Connected with Importation and Exportation), Article X (Publication and Administration of Trade Regulations), and Article XI (General Elimination of Quantitative Restrictions), as well as some aspects of China's Protocol of Accession to the WTO. The European Union, Japan, and Canada subsequently joined the consultations, and in July 2012, the WTO's dispute settlement body established a panel.

China accounts for roughly 97 percent of the global rare earths market but restricts market access through its export policies. China argues that its policies on rare earths are "aimed at protecting natural resources and achieving sustainable economic development" and that it has "no intention of protecting its domestic industry through means that would distort trade."²⁵ In our own view, the WTO panel and Appellate Body are likely to find China in violation of its obligations, just as in the *Raw Materials* case.

Lessons from Trade Rules and Cases

From this history and the cases, three important policy implications can be drawn for current US policy towards the domestic production and sale of LNG. First, the use of export restraints runs contrary to the central US stance. Historically, the United States has more often than not been a vocal opponent to the use of export restraints. This is embodied in Article I section 9 of the US Constitution, which proclaims "[n]o Tax or duty shall be laid on Articles exported from any state." It is also embodied in US actions in international trade negotiations. For example, during the WTO Doha Development Round of negotiations, the United States was a vocal proponent of imposing disciplines on the use of export controls. Along with Korea, the United States led an initiative to improve transparency with regard to export licensing (Kim 2010). The United States has also included disciplines on export controls through its bilateral FTAs, starting with the US-Canada FTA and later NAFTA, which include provisions to ensure that trade in energy is governed by the same

rules as trade in other commodities. What's more, the United States was a harsh critic of the use of export controls during the oil shocks in the 1970s and the 2006–08 food shocks.

Another important policy implication relates to WTO rules and dispute settlement. If the United States continues to impose restraints on the export of LNG while permitting unfettered domestic consumption of natural gas, the restraints will be in violation of WTO rules. As discussed, Article XI of the GATT permits export controls to "prevent or relieve critical shortages," but that exception does not countenance the

The use of export restraints runs contrary to the central US stance. Historically, the United States has been a vocal opponent of export restraints.

long-term subsidization of downstream domestic users (e.g., manufacturing firms) by restricting exports so as to reduce the domestic price of natural gas. Permanent US export restrictions on LNG—if imposed—would be principally designed to encourage greater domestic industrial use and household consumption (Levi 2012). Such restrictions run counter to WTO rules, and member countries would likely bring a case in the WTO if the United States does not allow reasonable LNG exports. Indeed, the WTO ruling in the *China Raw Materials* case was a major victory for the United States and other petitioners and stands as a landmark against export restrictions. In light of this precedent, it would be hypocritical and contrary to WTO rules for the United States to impose its own restraints on the export of LNG.

Finally, if US policy towards LNG production and exports has a restrictive tone, that could deter future investment. Investment in the natural gas industry is long-term and capital intensive. Without the possibility for domestic natural gas producers to compete fairly on the global LNG market, the incentive to continue investing and increase domestic production will be reduced. What's more, if the United States delays the removal of export restraints, potential major importers will likely find alternative suppliers such as Canada and Australia, which have abundant natural gas, both conventional and from shale, and allow unrestricted exports.

PROSPECTS FOR US EXPORTS

Between 2001 and 2011 seven LNG terminals were built, and three were expanded. In 2011, FERC approved the first LNG export terminal, and by the end of 2012 over 20 applications to

24. See WTO case DS431 at www.wto.org for more details.

25. "China blocks panel request by the US, EU and Japan on 'rare earths' dispute," WTO 2012 News Items, World Trade Organization, www.wto.org (accessed on January 11, 2013).

export LNG had been filed with the DOE.²⁶ Of these, 18 concern LNG exports to countries with which the United States has an existing FTA. Another 10 applications are companies seeking to export LNG to non-FTA countries. Of the 20 countries with which the United States has an FTA, only five—Canada, Chile, the Dominican Republic, Korea, and Mexico—are LNG importers.²⁷ Of these five FTA partners, Korea accounts for almost 70 percent of the total. While Korea represents a large export market for the United States, its current import capacity is roughly 4.5 billion cubic feet per day (Bcf/d) and therefore not large enough to absorb the 29.3 Bcf/d of LNG export capacity currently awaiting DOE approval (Houser and Mohan, forthcoming). US companies are therefore looking to expand export markets to non-FTA countries that represent major export opportunities, such as Japan, India, and possibly China.

Currently, the United States only ships LNG through reexports of imported LNG, which totaled roughly 53 Bcf in 2011.²⁸ The Kenai LNG terminal in Alaska was the only US LNG terminal that exported domestically produced LNG; however, it has been inactive since December 2011.

In May 2011, Cheniere Energy Partners LP received DOE authorization to export domestically produced LNG to non-FTA countries, from a liquefaction plant at Sabine Pass, bordering Texas and Louisiana. Subsequently, the DOE put a hold on all other export applications, pending a large-scale review of the impact of LNG exports on the US energy market and the wider economy. The DOE review includes two principal studies: (1) the US EIA's *Effects of Increased Natural Gas Exports on Domestic Energy Markets* (EIA 2012), which examines the effect on the US energy market; and (2) the National Economic Research Associates Economic Consulting's *Macroeconomic Impacts of LNG Exports from the United States* (NERA 2012), which examines the macroeconomic effects of large-scale US LNG exports. Following publication of the NERA study, the DOE began a 75-day comment period, divided into two segments, with the first deadline on January 23, 2013, and the second deadline on February 25, 2013. Following the comment period, the DOE will begin to review the pending applications seeking permission to export domestically produced LNG to FTA and non-FTA countries. Many planned LNG plants

will be profitable only if they have the flexibility to export to both destinations.

It is important to consider LNG exports within the context of other policy objectives. LNG exports would support three priorities announced by the Obama administration:

- *Addressing global warming and greenhouse gas emissions.* Natural gas has relatively low CO₂ emissions and is a cleaner alternative to coal. Environmental benefits (in contrast to coal) occur whether natural gas is consumed at home or abroad as LNG.
- *Reducing unemployment.* The NERA model assumes that the economy operates at full employment. In reality, the American economy has not been operating at full employment for four years and this condition is expected to last at least through 2015. For this reason, the potential employment benefits from larger natural gas production may be understated in the NERA report. By the same token, if lower gas prices spurred new investment in chemical or power plants, that too would reduce the unemployment rolls.
- *Doubling exports by 2014 (compared with 2009).* President Obama announced this goal in 2010. While it seems out of reach in a lackluster world economy, allowing LNG exports would help.

At the end of 2012, there was roughly 37 Bcf/d of LNG export capacity in operation worldwide, the majority located in the Middle East and Asia (see table 2). In terms of LNG export capacity currently in operation, the United States accounts for less than 1 percent of total global capacity. However, of the 62.6 Bcf/d of LNG liquefaction projects proposed, the United States accounts for nearly 20 percent. Together, the export capacity in operation, under construction, and planned totals 109 Bcf/d globally, a volume that far exceeds projections by the International Energy Agency (IEA 2012b) for world LNG demand in 2035, namely 55 Bcf/d.

LNG Export Forecasts

A vast literature examines potential US LNG exports, assuming that the DOE gives domestic firms a green light. Here we survey several microeconomic and macroeconomic studies. Estimates of the economic impact of LNG exports vary between studies, due to a variety of factors that may change unexpectedly. Studies do not attempt to predict potential policy changes, either at home or abroad. Yet policy changes can have strong upside and downside implications. For example, the United States may enter into more FTAs in the future, increasing the ease of obtaining permits for a wider range of export markets.

26. A list of applications can be found at the DOE's website, www.fossil.energy.gov/programs/gasregulation/authorizations/2012_Long_Term_Applications.html.

27. The United States' FTA partners include Israel, Canada, Mexico, Jordan, Singapore, Chile, Australia, the Dominican Republic, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua (CAFTA-DR), Bahrain, Morocco, Colombia, Panama, Korea, Peru, and Oman.

28. US EIA, "Projects sponsors are seeking Federal approval to export domestic natural gas," www.eia.gov/todayinenergy/detail.cfm?id=5970 (accessed on February 9, 2013).

Table 2 Global LNG liquefaction, end of 2012
(billion cubic feet per day of export capacity)

Region/country	Operating	Under construction	Planned
Asia	11.1	8.6	16.1
Australia	3.2	7.4	12.1
Brunei	1.0	—	—
China	—	—	0.1
Indonesia	3.9	0.3	1.4
Malaysia	3.2	—	0.8
Papua New Guinea	—	0.9	1.8
Middle East	13.2	—	9.5
Abu Dhabi	0.8	—	—
Iran	—	—	7.9
Oman	1.5	—	—
Qatar	10.2	—	1.5
Yemen	0.9	—	—
Europe and Eurasia	1.8	—	10.3
Norway	0.6	—	0.6
Russia	1.3	—	9.7
Africa	7.6	1.9	13.1
Algeria	2.6	1.3	—
Angola	—	0.7	0.7
Cameroon	—	—	0.5
Egypt	1.5	—	0.5
Equatorial Guinea	0.5	—	0.5
Libya	0.1	—	0.8
Mozambique	—	—	1.4
Nigeria	2.9	—	8.0
Tanzania	0.0	—	0.9
North America	0.2	—	11.4
United States	—	—	4.5
Canada	0.2	—	6.9
Latin America	2.6	—	2.3
Brazil	—	—	0.5
Peru	0.6	—	—
Trinidad	2.0	—	—
Venezuela	—	—	1.8
Total	36.7	10.5	62.6

Note: A dash (—) represents a value of zero.

Source: IEA (2012a); authors' calculations: 1 billion cubic feet per day = (1 billion cubic meters * 35.3)/365.

Nor can studies predict with certainty changes in natural gas prices over the next 20 years. Finally, estimates about the future of LNG markets cannot take into account changes in other

energy markets that may influence natural gas supply, demand, exploration, or capital investments. However, fair assumptions can be made: Several studies suggest that the impact of exports on US prices will be small and that natural gas price swings will exhibit less volatility than in oil markets.

Microeconomic Forecasts. A number of studies project low growth for US LNG exports over the next decade and beyond. In its biannual natural gas forecast, Navigant Consulting estimates the United States will become a net LNG exporter by 2016, with a total of 4.8 Bcf/d of LNG by 2020 (Pickering 2012). Research conducted at Rice University's Baker Institute concludes that "international market response will ultimately limit the amount of LNG that the US exports" due to the risks associated with "the development of alternative foreign supplies, and the relative price impacts of introducing US LNG volumes into a currently tight international LNG market" (Medlock 2012). Other forecasts, however, are more optimistic. A 2012 report by Citigroup estimates 10 Bcf/d or more of LNG exports from North America by 2020, with roughly 5 to 8 Bcf/d of that coming from the continental United States (Yuen et al. 2012).

Macroeconomic Forecasts. The macroeconomic analysis conducted by NERA Economic Consulting models different US market supply and global LNG demand scenarios, including a high and low shale gas resource base known as high and low estimated ultimate recovery, or HEUR and LEUR. The NERA study uses the EIA's *Annual Energy Outlook 2011* (EIA 2011a) as its reference scenario for the analysis of how US natural gas supply, demand, and prices would respond under different levels of LNG exports. NERA also uses the EIA's *International Energy Outlook 2011* (EIA 2011b) as the benchmark for its international outlook. In terms of global markets, the NERA study concludes that the United States would be able to export LNG only with higher global demand or lower US costs of production. In this scenario, the United States produces 61.4 Bcf/d of natural gas in 2015 and 72.3 Bcf/d in 2035. However, under NERA's "demand shock" scenario, in which all Japanese nuclear power plants are shut down and replaced with natural gas, the United States exports up to 2.8 Bcf/d (4.6 percent of total production) in 2015 and 3.8 Bcf/d (5.2 percent) by 2035. In NERA's "supply/demand shock" scenario, in which both Japan and Korea move from nuclear to natural gas and no new LNG export capacity is built in Africa, Australia, or Southeast Asia, US LNG exports rise to 5.9 Bcf/d (9.7 percent) in 2015 and 15.8 Bcf/d (21.8 percent) by 2035. NERA also concludes that in all of the scenarios analyzed, the US economy would experience net economic benefits from increased LNG exports (NERA 2012).

Table 3 Natural gas price impact of US LNG exports, measured from Henry Hub prices

Organization	Export quantity (billion cubic feet per day)	Total increase in price (percent)	Price change per billion cubic feet per day (percent)
EIA Reference	6–12	16.33 ^a	1.63
EIA Low Shale Gas Estimated Ultimate Recovery	6–12	16.17 ^a	1.65
EIA High Shale Gas Estimated Ultimate Recovery	6–12	15.80 ^a	1.55
Deloitte	6	3.50	0.60
Navigant Consulting	6.6	6.00	0.90
ICF International	6	11.00	1.80
RBAC Inc.	1–6	15.80 ^a	3.93

EIA = US Energy Information Administration

a. Calculated using a weighted average.

Sources: EIA (2012); Deloitte Center for Energy Solutions (2011); Ebinger, Massy, and Avasarala (2012); Brooks (2012).

Price Consequences

Studies that analyze the impact of LNG exports on domestic natural gas prices have largely focused on the export range of 6 to 12 Bcf/d. Judging from the microeconomic forecasts surveyed above, this range is ambitious. Moreover, without an international demand and/or supply shock, or very generous US supply conditions, the range is high even from the standpoint of NERA's macroeconomic forecasts.

The 2012 EIA report commissioned by the DOE (EIA 2012) analyzes 6 Bcf/d and 12 Bcf/d LNG export-related increases in natural gas demand. The study also looks at increased demand under the LEUR and HEUR scenarios. Using a weighted average, we have calculated the total price change and the price change per Bcf/d for each of these three scenarios. Our calculations are shown in table 3. The total increase in price varies slightly but is around 16 percent for all three scenarios. Similarly, the price change per Bcf/d is about 1.6 percent for all three scenarios.

Estimates reported by private sector studies such as Deloitte Center for Energy Solutions (2011) and ICF International (2013) vary considerably. Deloitte's estimate is the lowest at 0.6 percent per Bcf/d, and ICF International's estimate is the highest at 1.8 percent per Bcf/d. Estimates for overall price increases vary as the export quantity estimates vary from model to model. Differences between these estimates are attributable to differences in assumptions about the price elasticity of demand for natural gas in US industry and power generation and—most importantly—to differences in assumptions about the elasticity of supply and recoverable resources of domestic natural gas (Houser and Mohan, forthcoming).

OPPOSITION TO LNG EXPORTS

Opponents to LNG exports stress two objections: the impact on domestic natural gas prices and adverse environmental consequences. In this section we examine the price story and briefly summarize the environmental objections. We also summarize the objections posted on the DOE website prior to the deadline on January 23, 2013. In the next section we examine the environmental dimension in more detail.

Price Issues

Companies that benefit from keeping natural gas cheap and plentiful at home oppose the expansion of LNG exports. While Dow Chemical has been most vocal in its protests, price increases resulting from larger LNG exports would negatively affect any industry that uses significant quantities of natural gas. Estimates of potential price increases vary greatly and are summarized in table 3. On the other hand, stifling export opportunities would reduce natural gas extraction and depress the income of land owners and producing companies.

Fears of a significant increase in average domestic natural gas prices over a 20-year horizon are no more justified as a reason for limiting US exports of LNG than they would be as a reason for limiting exports of soybeans, corn, coal, or other natural resources. Historically, domestic price stabilization has not been an objective of US export policy. Rather, the overarching philosophy of a market economy is that prices for individual commodities should be allowed to fluctuate and thereby guide rational production and consumption decisions, both at home and abroad. At a macroeconomic level, of course,

the Federal Reserve is responsible for broad price stability, but that objective says nothing about price control of individual goods or services.

Temporary price spikes are a related source of concern in the LNG debate. As a general policy, the United States has condemned export restraints by other countries as an acceptable answer to price spikes. It would be hypocritical and inconsistent for the United States to interrupt LNG exports as a means of averting a domestic price spike. LNG export contracts are typically for long terms (10 to 20 years) because of the high capital costs in freezing, transporting, and regasifying natural gas. An interruption of export sales in the midst of a price spike by US government action would surely tell against future LNG exports; instead the importing countries would contract with reliable suppliers such as Australia, Canada, or Qatar.

In the context of the US economy as a whole, the price effects mentioned are relatively small. Downstream industries in the United States have criticized the NERA study for underestimating the economic benefits from using natural gas in downstream production rather than for export.²⁹ Alternative analysis may claim that LNG exports create a net economic loss; however, the underlying assumptions of such an analysis require careful review (Houser and Mohan, forthcoming).

One example of net economic loss is the study by Wallace Tyner and Kernal Sarica (2013), based on a “bottom up” energy model named MARKAL. The authors point out that allowing natural gas exports will shift income to owners of capital (pipelines, LNG terminals, etc.) and shale land and away from workers in energy-intensive industries such as metals, paper, and chemicals, as well as household consumers. The authors stress that income shifts will likely be large relative to net gains or net losses for the economy as a whole. Moreover, contrary to the NERA model, the MARKAL model suggests that LNG gas exports will entail net losses for the US economy as a whole. However, Tyner and Sarica are more concerned with the redistribution of income within the United States than national gains or losses. Based on the preview of the MARKAL model that appears on the DOE docket (dated January 14, 2013), we offer three comments.

First, it is hard to understand how selling natural gas domestically at a *lower* price than the gas would command internationally can actually *reduce* US national income. Perhaps the MARKAL calculation of small net losses depends on an embedded assumption that US employment will rise in downstream

industries if natural gas exports are prohibited. Few economists believe that protecting the national economy—either by tariffs on imports or controls on exports—will increase *national* employment over the medium term of three to five years. In the short term, protection may boost employment in firms that compete with imports and firms that are downstream users of potential exports (such as natural gas), but those employment gains will come at the expense of employment losses elsewhere in the economy.

Second, the implications of the logic advocated by Tyner and Sarica extend far beyond LNG exports. Many US exports use capital and natural resources more intensively than downstream industries. Examples include coal, petroleum, minerals, timber, cotton, soybeans, and others. Should these exports be controlled or prohibited as well to boost employment in other sectors of the US economy? Clearly this is a bad idea. Along that path lie huge distortions and bitter regional disputes.

Third, all relative price changes shift income between industries, individuals, and sectors of the national economy. That’s the very essence of a market economy: to provide price and income signals for some activities to expand and others to contract. If and when the American public decides that some people are too rich as a result of market forces and others are too poor, the federal government can deploy straightforward correctives: high individual income tax rates for the rich coupled with public assistance programs for the poor (Medicaid, food stamps, etc.). Using trade policy to redistribute income is both inefficient and ineffective. Moreover, export barriers would damage the economy of shale gas-producing states as well as port states that handle LNG exports.³⁰ Perhaps most importantly they would set the tone for “me-too” barriers abroad, on a variety of natural resource products, much to the detriment of the world trading system and, in the long run, US prosperity as a net importer of many natural resources.

Environmental Issues

Environmental concerns are centered on fracking, discussed later in this report. However, a few environmental aspects are specifically linked to LNG exports. Approving export permits would increase the profit margin on natural gas sold in inter-

29. Industrial Energy Consumers of America, “IECA Comments on Release of the DOE Study on LNG Exports,” press release, December 5, 2012, www.ieca-us.com/wp-content/uploads/12.05.12_DOE-LNG-Export-Study-Press-Release.pdf (accessed on February 4, 2013).

30. Such concerns were prominent when the US Constitution was enacted. Article I section 9 prevents the taxation of exports—at the insistence of southern states that worried that their exports of cotton, indigo, tobacco, and other farm products to Europe would be burdened by export taxes imposed by northern states to foster their own processing industries. The Supreme Court, in deciding *United States v. Curtiss-Wright Export Corp.*, 299 U. S. 304 (1936), held that this article did not preclude export *controls* for national security or other purposes, thereby severely limiting the role of Article I section 9 today.

national markets and encourage additional fracking operations and well construction. Energy used in the liquefaction process requires about 10 percent of the volume of gas being liquefied. Finally, some environmental activists, as a tactical device, oppose the conversion of import regasification plants to LNG liquefaction plants. The technical argument is that liquefaction requires additional infrastructure. This concern has a regional dimension: Gulf states welcome LNG export terminals to a much greater extent than West coast or mid-Atlantic states.

Arguments Posted on the DOE Website

Opponents of LNG exports have become increasingly vocal as the DOE moves to act on pending export applications. A number of individuals and groups took advantage of the DOE's initial 45-day comment period in December 2012 and January 2013 to argue that LNG exports may be bad for the United States or that the DOE should undertake additional analysis before making a decision. Here we summarize the major complaints.

The NERA model has significant limitations and has not been properly vetted. Many comments criticize the NERA model (commissioned by the DOE) and emphasize problems that NERA identified but, in the view of opponents, were not properly stressed. These include criticisms directed at forecasts of domestic employment, foreign direct investment, regional effects, and socioeconomic impacts. It is unrealistic to expect that NERA or any other consultant could create a model that would escape criticism—all models have their limitations. Furthermore, the room for error increases as a model attempts to forecast events further into the future. The big issues do not reside in the detail of the model but rather in the projected size of domestic demand, the size of LNG exports, and changes in the price of natural gas both at home and in international markets. Any forecast is likely to need frequent updates—just as investment banks and the International Monetary Fund (IMF) regularly update their forecasts of the global economy. NERA forecasts made in 2014 or 2015 will not be more certain as to events in 2020 than those made in 2012. Uncertainty is inherent in the exercise, but the correct response to uncertainty is not delay on the part of the DOE. Instead we recommend that the DOE make its decision on export applications based on the information at hand but undertake a periodic review as each generation of LNG terminals is considered, in order to ensure that scarcity has not become an overriding issue for domestic users of natural gas.

LNG exports will increase domestic natural gas production, which is bad for the environment. Some environmental groups oppose any hydro-fracking, whether for domestic consumption or exports. However, the relevant questions are different:

- Can regulation answer genuine environmental concerns?
- Is natural gas worse for the environment than other sources of energy?

Every commercial activity entails some degree of environmental risk. This is just as true of solar and wind energy as natural gas.³¹ Natural gas is cleaner than other fossil fuels and a good alternative to coal or petroleum. Whether natural gas is shipped abroad as LNG or used at home, it will substitute to a large extent for coal-fired power plants and thereby reduce world CO₂ emissions. The main new risks arise from the hydro-fracking process.³² State and federal agencies should coordinate their environmental assessments and maintain strict surveillance to identify water, seismic, methane, or other sources of environmental damage. With that in mind, the next section addresses environmental concerns at greater length.

High natural gas prices transfer wealth to land owners and gas companies. This is true. Several forecasts see an average cumulative increase in natural gas prices, solely on account of exports, of around 16 percent (see table 3). But prohibiting exports would not ensure that prices stay at present levels since rising domestic demand alone will push up prices. Federal and state governments would have to tax all natural gas royalties in order to effectively offset the transfer of wealth that arises from higher natural gas prices. There is no justification for a special restraint on exports alone.

Natural gas should be kept at home to bolster manufacturing production. By prohibiting or limiting exports, the United States could keep the available domestic supply of natural gas artificially high and the domestic price artificially low. In other words, export controls would act as a disguised subsidy to downstream industries that use natural gas as an input. While these industries would benefit, the US economy as a whole would

31. In any event, solar and wind are presently unable to meet domestic demand and are not expected to be competitive in the short or medium term. They create risks associated with transmission lines, bird strikes, and other aspects of the environment. Ethanol from corn probably releases more CO₂ into the atmosphere than petroleum, when the entire production cycle is considered.

32. That said, by far the biggest risks from natural gas occur at the point of combustion, in a home or power plant, as CO₂ is emitted into the atmosphere.

suffer. Instead of capturing the highest possible value from its natural gas, the economy would end up selling gas at artificially low prices. Disguised subsidies on natural gas or other inputs cannot boost national employment because what they give to one sector they take away from others. What disguised subsidies can do is shuffle employment between sectors. Reflecting this home truth, US policy has opposed export limits on natural resources as a device for bolstering downstream industries.

The supply of natural gas is insufficient to “share” with other countries. This objection reflects a combination of resource nationalism and natural gas pessimism. Restricting natural resource exports is a sure recipe for poor commercial relations abroad, and it will guarantee an inefficient economy at home. Most current models that estimate the depletion rate of US natural gas start with 2011 levels of domestic natural gas consumption, which is reasonably expected to increase in the next several years. Industrial demand for natural gas is expected to rise over the next decade in part due to gas to liquids projects, fleet vehicles substituting natural gas for diesel, and a decrease in the supply of fossil fuel substitutes. An additional, related concern of downstream industries is that a sharp spike in domestic demand for natural gas may spur aggressive production, resulting in a rollercoaster path for domestic prices. Demand spikes are a valid concern of domestic consumers of natural gas and should be monitored carefully by policymakers. Yet, the underlying fear of natural gas shortages seems misplaced. If the supply of natural gas is indeed insufficient over a reasonable period, prices will rise on a sustained basis, providing more incentive for improved unconventional drilling technologies over the next several years, thereby converting resources from the “probable” and “possible” categories to the designation of “proved.”³³ Moreover, LNG exports will very likely account for a relatively small share of total US natural gas production. In the NERA report, exports account for 5 to 20 percent of total production. The upper limit of this estimate occurs only in an extreme scenario.

Furthermore, “sharing” US energy resources with the rest of the world may have diplomatic benefits. Secretary of State Hillary Clinton addressed the LNG issue in the context of energy security at a talk at Georgetown University on October 18, 2012.³⁴ Clinton stressed that

energy monopolies create risks. Anywhere in the world when one nation is overly dependent on another for its

33. As a general point, it is worth noting that the rate of technological advance and subsequent use of those technologies may be either stunted or encouraged by market forces.

34. The full text of the speech, *Energy Diplomacy in the 21st Century*, can be found at www.state.gov/secretary/rm/2012/10/199330.htm (accessed on February 27, 2013).

energy, that can jeopardize its political and economic independence.

Secretary Clinton went on to argue that the United States was able to put “unprecedented economic pressure on Iran while minimizing the burdens to the rest of the world” by boosting oil production. Following Clinton’s thesis, LNG exports similarly provide an alternative energy source that lessens the world’s dependence on Middle Eastern oil and increases diplomatic flexibility.

THE ENVIRONMENTAL DIMENSION

Natural gas extraction has become a controversial activity, partly due to environmental concerns and decentralized regulation within the United States. The initial phase of extracting natural gas from shale involves drilling a well and injecting extremely high pressure water to fracture the shale rock (“fracking”) in a large horizontal area surrounding the drill hole. Then the natural gas flows to the surface, is gathered in local pipelines, transported in the extensive network of transmission pipelines crisscrossing the United States, and delivered to power plants, industrial, residential, and commercial users, and liquefaction plants for shipment abroad. All these steps entail some degree of environmental risk.

Drilling and injecting are relatively quick (a matter of weeks), but the planning and permitting process can be much longer, requiring multiple approvals and permits, which vary by state and locality (unless the shale is on federal land). Companies must conduct extensive emissions and hazardous materials modeling to comply with regulations issued by the Environmental Protection Agency (EPA). Additionally, state and local authorities consider a wide variety of factors including plans for waste management, safety, emergency response, site restoration, and other aesthetic aspects. Affected property owners must consent, meaning all property owners on the surface of the planned underground drilling and fracturing area. Due to the wide extent of horizontal drilling, a single planned well can encompass a large surface area and affect many property owners. Typically surface property owners outside the immediate drilling area are paid royalties.

Water Issues

A major concern about hydraulic fracturing is the use and disposal of water. A single well requires 3 million to 10 million gallons of water.³⁵ The use of water is of greatest concern in

35. The United States uses approximately 410 billion gallons of water per day.

states where water is scarce. On the other hand, the disposal of the water used in the fracking process is a major environmental issue for all wells. After hydraulic fracturing, a well can produce wastewater, which is collected on the surface, transported as needed, and recycled for future use or disposed of in compliance with the Clean Water Act, the Safe Drinking Water Act, and state regulations. Some of the water is recycled and some is disposed of using injection wells that are regulated by the EPA (often in cooperation with state authorities). Several investigations are underway to explore a potential link between disposal wells and seismic activity.

The recycling and disposal of wastewater incites fear about the contamination of drinking water. Since much of natural gas is extracted from shale rock at horizons well below drinking water aquifers, one opportunity for contamination is through leaky well pipes and poor well bore construction. From the industry perspective, managing the well bore and protecting against contamination has been a central feature of technology development.

Some states have curtailed or blocked fracking within their territory, using their zoning and permitting powers and sometimes explicit legislation. Governors in states with shale resources thus confront a pitched battle between proponents and opponents of fracking. Proponents cite the economic benefits while recognizing the need for prudential regulation; opponents stress unknown risks to water supplies and earthquake dangers, as well as CO₂ and methane leaks (methane, the main component of natural gas, is a powerful greenhouse gas). In Maryland, for example, Governor Martin O'Malley barred the Maryland Department of the Environment from issuing drilling permits until a scientific study was completed, but at the same time anti-fracking forces blocked funding (about \$1.5 million) for the study.³⁶

Chemical Issues

An aspect of hydraulic fracturing that has caused particular concern is the use of chemicals in the fracking process. While the particular chemicals and their volumes used were once kept confidential, it is becoming industry "best practice" to voluntarily disclose lists of chemicals through www.fracfocus.org. Some states require companies to disclose this information as a condition for fracking permits. Very few studies address the impact and safe levels of fracking chemicals, but full disclosure is a start.

36. Darryl Fears, "Maryland inches closer to decision time on hydraulic fracturing," *Washington Post*, December 8, 2012, A7.

Methane and CO₂ Issues

Another short-term environmental worry is methane leakage. Methane, the principal component of natural gas, is emitted both during the fracking and well completion processes. After the wells and pipes are established, methane can be collected and sold. Before that, methane is either released into the air through venting or burned and converted into CO₂ through flaring. According to the EPA, the impact of a metric ton of methane on climate change is 20 times greater than the impact of a metric ton of CO₂. Methane has a shorter life in the atmosphere than CO₂ (8 versus 100 years), but it makes a high-powered contribution to global warming. For this reason, producers (and some regulators) prefer to flare methane until it can be collected and sold commercially.

One environmental risk associated with the liquefaction and exportation of natural gas is the emission of CO₂ and methane especially during transportation. Here a different federal agency comes into play: the Federal Energy Regulatory Commission (FERC), which regulates interstate pipelines.

A longer-term environmental concern surrounds competition between natural gas and other energy sources. This is a "good news, bad news" story. Natural gas burns much cleaner than coal and petroleum in terms of CO₂ emissions per unit of energy, but it is not nearly as clean as nuclear, solar, or wind energy. CO₂ emissions in the United States have been steadily decreasing since 2006, in part due to the substitution of natural gas for coal in electric power plants. US carbon emissions in 2012 are estimated to have fallen to the lowest levels since 1994, and the United States is expected to meet its emission reduction commitments made at the 2009 UN climate conference well before the 2020 deadline. But the availability of cheap natural gas hinders commercial innovation in renewable energy industries. In 2012, the average price of natural gas was \$2.75 per Mcf at the well head. The price of natural gas may increase over the next decade to \$3 or \$4 per Mcf, but at those prices (and even higher) solar and wind energy cannot compete. On the other hand, wind and solar have benefited from state-level renewable portfolio standards and federal tax credits. Going forward, similar forms of market intervention may be required if the United States is to transition to cleaner energy sources than natural gas in the long run.

CONCLUSIONS AND RECOMMENDATIONS

Prohibiting or restricting the export of LNG is a bad idea. We urge the DOE to approve pending LNG export applications for projects at an advanced planning stage, in conjunction with appropriate regulation to limit environmental dangers from

wells to ports.³⁷ Our recommendation is supported by three strong considerations drawn from the history of US trade policy and WTO rules. First, the United States regularly opposes the imposition of export restraints on natural resources by other countries and has insisted on language in its own FTAs to prohibit such practices. Second, restricting exports without

Denying LNG export permits is not the appropriate tool to address environmental concerns.

limiting domestic consumption violates WTO rules. Contrary action by the United States would serve as an excuse for foreign nations to ignore the rules as well. Third, LNG export restrictions would flatly contradict the Obama administration's stated goal of growing US exports.

Denying LNG export permits is not the appropriate tool to address environmental concerns. Environmental dangers require strong and attentive regulation—not discrimination between natural gas production for domestic consumption and foreign markets. Briefly we offer three recommendations to improve the balance between the economic opportunities offered by large-scale LNG exports and environmental concerns:

- In this drama, LNG exports are the “tail” and natural gas sales to domestic users are the “dog.” Even in the most optimistic scenario, LNG exports will not exceed 20 percent of domestic production in 2035.³⁸ Hence it makes no sense to limit LNG exports as a means of answering environmental concerns. Appropriate regulation of all shale gas and oil production and transportation, whether destined for sale at home or abroad, is the right approach.
- The EPA should closely monitor wastewater recycling and disposal, and it should require complete disclosure of chemicals used in the fracking process. Moreover, the EPA should maintain a broad oversight role, and when mishaps occur or state and local authorities are not sufficiently diligent, the EPA should call out the shortcomings. As with current practice, the FERC should continue to ensure pipeline maintenance and safety.
- The right ways to encourage the eventual transition from natural gas to less CO₂ intensive energy sources are through

carbon taxes and/or subsidies to nuclear, solar, and wind power. The wrong way is to curtail fracking: Natural gas is not the cleanest energy source in terms of CO₂ and methane emissions, but it represents a huge improvement over coal and oil, whether used in the United States or abroad.

Limiting LNG exports has also been advocated as a sort of “industrial policy” to spur energy-intensive industries. This argument fundamentally contradicts the precepts of a market economy. Restricting exports to benefit downstream users would rob Peter to pay Paul. Natural gas-producing states would lose rightful revenue and the entire country would pay the price of economic distortion. Restrictions on LNG exports as a device for shifting income between sectors are no more justified than restrictions on exports of coal, timber, cotton, and a long list of other commodities.

The DOE decision to approve pending LNG projects will promote investment in the natural gas industry and signal to the world that the United States continues to be a reliable trading partner.

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37. The Secretary of Energy Advisory Board Shale Gas Production Subcommittee's report, published in November 2011, details specific recommendations for policy action and regulation.

38. In the most optimistic export scenario, in 2035, the United States would export 4.38 Tcf of LNG and produce 26.40 Tcf of natural gas. See NERA (2012, figures 18 and 23).

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