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Liquefied Natural Gas (LNG) in U.S. Energy Policy: Infrastructure and Market Issues

Paul W. Parfomak, Resources, Science, and Industry Division

January 31, 2006

Abstract. This report reviews the status of U.S. LNG imports, including projections of future U.S. LNG demand within the growing international LNG market. The report summarizes recent policy activities related to LNG among U.S. federal agencies, as well as private sector plans for LNG infrastructure development. The report also introduces key policy considerations in LNG infrastructure and market structure, highlighting current market information and key uncertainties. Finally, the report identifies key questions in LNG import policy development.

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Liquefied Natural Gas (LNG) in U.S. Energy Policy: Infrastructure and Market Issues

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Summary

Liquefied natural gas (LNG) imports to the United States are increasing to supplement domestic gas production. Recent actions by Congress and federal agencies have promoted greater LNG supplies by changing regulations, clarifying siting authorities, and streamlining the approval process for LNG import terminals. Were these policies to continue and gas demand to grow, LNG might account for as much as 21% of U.S. gas supply by 2025, up from 3% in 2005. Congress is examining the infrastructure and market implications of greater U.S. LNG demand.

There are concerns about how LNG capacity additions would be integrated into the nation's gas infrastructure. Meeting projected U.S. LNG demand would require six to ten new import terminals in addition to expanding existing terminals. Twelve new terminals, most in the Gulf of Mexico, are approved, but public opposition has blocked many near-to-market terminals which might save billions of dollars in gas transportation costs. New LNG terminals can also require more regional pipeline capacity to transport their supply, although this capacity may not be available in key markets. Securing LNG infrastructure against accidents and terrorist attacks may also be a challenge to public agencies. Since import terminals process large volumes of LNG, a breakdown at any facility has the potential to bottleneck supply.

LNG's effectiveness in moderating U.S. gas prices will be determined by global LNG supply, the development of a "spot" market, potential market concentration, and evolving trading relationships. There appears to be sufficient interest among LNG exporters to meet global demand projections, although some new export projects may not be built. An LNG spot market, which may help U.S. companies import LNG cost-effectively, is also growing. Although some analysts believe a cartel may influence the future LNG market, the potential effectiveness of a such a cartel is unclear. Whether exporters cooperate or not, an integrated global LNG market may change trading and political relationships. Individual country energy polices may affect LNG price and supply worldwide. Trade with LNG exporters perceived as unstable or inhospitable to U.S. interests may raise concerns about supply reliability.

Recent measures before Congress seek to encourage both domestic gas supply and new LNG terminal construction. The Energy Policy Act of 2005 (P.L. 109-58) includes incentives for domestic gas producers and grants the Federal Energy Regulatory Commission "exclusive" authority to approve onshore LNG terminal siting applications, among other provisions. Other proposals in the 109th Congress, including H.R. 4318, H.R. 3918, and H.R. 3811 would lift federal restrictions on natural gas development on the Outer Continental Shelf. As Congress debates U.S. natural gas policy, three questions emerge: (1) Is expanding LNG imports the best option for meeting natural gas demand in the United States? (2) What future role, if any, should the federal government play in facilitating the development of LNG infrastructure domestically and abroad? (3) How might Congress mitigate the risks of the global LNG trade within the context of national energy policy?

This report will be updated as events warrant.

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Liquefied Natural Gas (LNG) in U.S. Energy Policy: Infrastructure and Market Issues

Introduction

The United States is considering fundamental changes in its natural gas supply policy. Faced with rising natural gas demand and perceived limitations in North American gas production, many in government and industry are encouraging greater U.S. imports of liquefied natural gas (LNG). Recent activities by Congress, the Federal Energy Regulatory Commission, the Department of Energy, and other federal agencies to promote greater LNG supplies have included changing regulations, clarifying regulatory authorities, and streamlining the approval process for new LNG import terminals. While forecasts vary, many analysts expect LNG to account for 12% to 21% of total U.S. gas supply by 2025, up from approximately 3% in 2005. If these forecasts are correct, U.S. natural gas consumers will become increasingly dependent upon LNG imports to supplement North American pipeline gas supplies.

Recent measures before Congress seek to encourage both domestic gas supply and new LNG terminal construction. The Alaska Natural Gas Pipeline Act of 2004 (15 U.S.C. § 720, *et seq*.) provides loan guarantees (Sec. 116) and other incentives for an Alaska gas pipeline. The Energy Policy Act of 2005 (P.L. 109-58) includes various incentives for domestic natural gas producers (Title III, Subtitle E). The act also amends Section 3 of the Natural Gas Act of 1938, granting the Federal Energy Regulatory Commission (FERC) explicit and "exclusive" authority to approve onshore LNG terminal siting applications (Sec. 311c) among other provisions. Other proposals in the 109th Congress, including H.R. 4318, H.R. 3918, and H.R. 3811 would lift federal restrictions on natural gas exploration and production on federal submerged lands of the Outer Continental Shelf. S. 1310 would authorize the expansion of a natural gas transmission pipeline on federal lands in the Northeast.

While an increase in LNG imports is already underway, federal officials and Members of Congress have been debating the merits and risks of U.S. LNG dependency. In April, 2005, for example, President Bush stated that "One of the great sources of energy for the future is liquefied natural gas.... We need more terminals to receive liquefied natural gas...."[1] In June, 2005 Department of Energy Secretary Samuel Bodman remarked that "LNG seems to offer a solution to ... the growing demand for natural gas that we will see all around the globe."[2] In November, 2005 Federal Reserve Chairman Alan Greenspan testified before

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[1] President George W. Bush. Press conference. April 29, 2005.

[2] Samuel Bodman, U.S. Energy Secretary. Remarks to the USEA/Center for LNG Conference. National Press Club. Washington, DC. June 16, 2005.

Congress that "severe reaction of natural gas prices to the production setbacks that have occurred in the Gulf highlights again the need to ... import large quantities of far cheaper, liquefied natural gas (LNG) from other parts of the world."[3] Some in Congress have questioned the implications of such a policy, however, drawing analogies to the consequences of U.S. dependency on foreign oil and citing potential instability among foreign LNG suppliers.[4] Others have expressed concern about LNG safety and vulnerability to terrorism.[5]

Specific questions are emerging about the implications of greater LNG imports to the United States. LNG has substantial physical infrastructure requirements and there are uncertainties about how this infrastructure would be integrated into North America's existing gas network. The potential effects of larger LNG imports on U.S. natural gas prices will be driven by the global LNG market structure, although that market structure is still evolving. Political relationships among countries in the LNG trade may also change as LNG becomes increasingly important to their economies.

This report will review the status of U.S. LNG imports, including projections of future U.S. LNG demand within the growing international LNG market. The report will summarize recent policy activities related to LNG among U.S. federal agencies, as well as private sector plans for LNG infrastructure development. The report also will introduce key policy considerations in LNG infrastructure and market structure, highlighting current market information and key uncertainties. Finally, the report will identify key questions in LNG import policy development.

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Background

Natural gas is widely used in the United States for heating, electricity generation, industrial processes, and other applications. In 2005, U.S. natural gas consumption was 22 trillion cubic feet (Tcf), accounting for 23% of total U.S. energy consumption.[6] Until recently, nearly all U.S. natural gas was supplied from North American wells and transported through the continent's vast pipeline network to regional markets. In 2003, however, due to constraints in North American natural gas production, the United States sharply increased imports of natural gas from overseas in the form of liquefied natural gas (LNG). While absolute levels remain limited today, growth in LNG imports to the United States is expected by many

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[3] Greenspan, A., Chairman, U.S. Federal Reserve Board. "Economic Outlook." Testimony before the Joint Economic Committee, U.S. Congress. Nov. 3, 2005.

[4] Hon. Peter Domenici. "U.S. Must Build LNG Ports to Avoid Spiraling Natural Gas Prices, Sen. Domenici Says." Press release. Feb. 15, 2005; Hon. John E. Peterson. Remarks at the Hearing of the House Resources Committee, Energy and Mineral Resources Subcommittee on " U.S. Energy and Mineral Needs, Security and Policy." March 16, 2005.

[5] Hon. Edward Markey. "Democratic Reaction to the 9/11 Commission's Final Report and its Security Recommendations for Preventing Further Attacks." Press conference. Dec. 5, 2005.

[6] Energy Information Administration (EIA). *Annual Energy Outlook 2006.* (Early release). Dec. 2005. Table 1. p11.

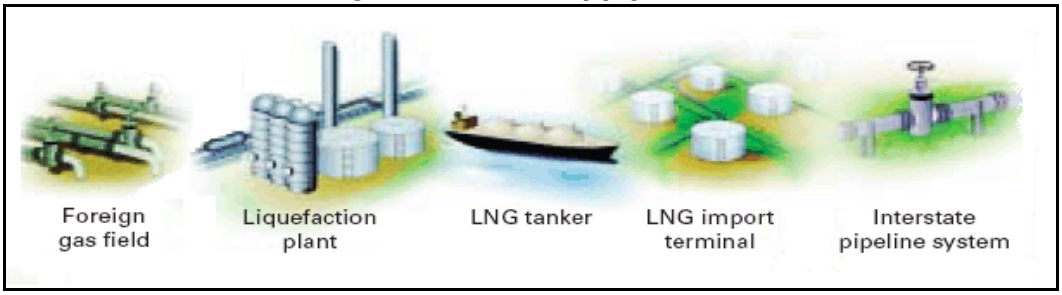
analysts to accelerate over the next 20 years, reflecting growing domestic demand and expectations for a global expansion in LNG trade.

What Is LNG?

When natural gas is cooled to temperatures below minus 260°F it condenses into liquefied natural gas, or "LNG." As a liquid, natural gas occupies only 1/600th the volume of its gaseous state, so it is stored more effectively in a limited space and is more readily transported by tanker ship. A typical tanker, for example, can carry 138,000 cubic meters of LNG — enough to supply the daily energy needs of over 10 million homes.[7] When LNG is warmed, it "regasifies" and can be used for the same purposes as conventional natural gas.

The physical infrastructure of LNG includes several interconnected elements as illustrated in **Figure 1**. In producing countries, natural gas is extracted from gas fields and transported by pipeline to central liquefaction plants where it is converted to LNG and stored. Liquefaction plants are built at marine terminals so the LNG can be loaded onto special tanker ships for transport overseas. Tankers deliver their LNG cargo to import terminals in other countries where the LNG can again be stored or regasified and injected into pipeline systems for delivery to end users. This LNG infrastructure requires large capital investments. In addition to gas field development costs, a new liquefaction plant costs approximately $2-$3 billion, and an import terminal costs $500 million to $1 billion. One LNG tanker costs $150-$200 million.[8]

Figure 1: LNG Supply Chain



Source: *Oil & Gas Journal.* Nov. 10, 2003. p64.

Due to the high capital costs of LNG infrastructure, LNG trade has traditionally relied upon long-term fuel purchase agreements in order to secure project financing for the entire supply chain. Of over 160 major LNG supply contracts in force around the world as of June 2005, well over 90% had a contract term of 15 years or longer.[9]

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[7] Energy Information Administration (EIA). *The Global Liquefied Natural Gas Market: Status & Outlook.* DOE/EIA-0637. Dec. 2003. p30.

[8] Clark, Judy. "CERA: Natural Gas Poised to Overtake Oil Use by 2025." *Oil & Gas Journal*. Mar. 1, 2004. p22.

[9] Suzuki, T. "The Changing World LNG Market and its Impact on Japan" The Institute of Energy Economics, Japan. Summary of the 392nd Regular Research Session. June 21, 2005; "LNG Contracts." *LNG OneWorld* website. [http://www.lngoneworld.com] Drewry (continued...)

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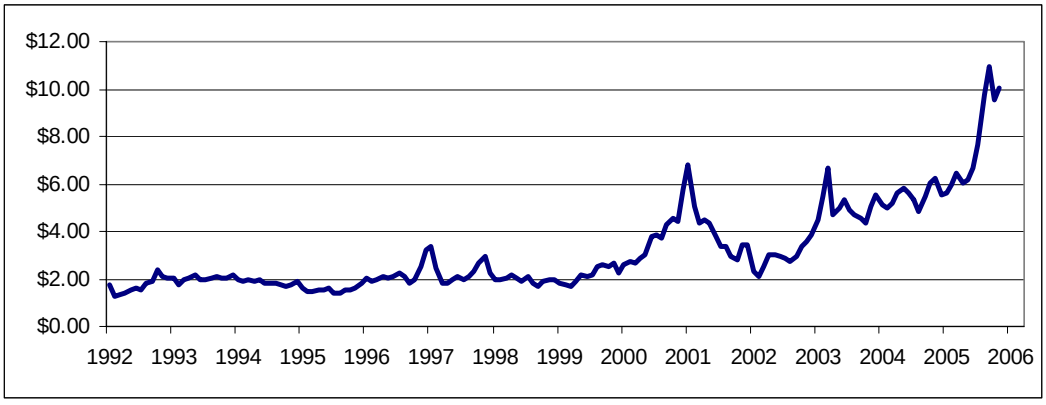
While these contracts have increasingly incorporated some flexibility by accommodating extra LNG deliveries, for example, or allowing shipments to be diverted, they have only allowed for a limited supply-demand response compared to other global commodities markets.

U.S. LNG Import Experience and Projections

The United States has used LNG commercially since the1940s. Initially, LNG facilities stored domestically produced natural gas to supplement pipeline supplies during times of high gas demand. In the 1970's LNG imports began to supplement domestic gas production. Between 1971 and 1981, developers built four U.S. import terminals: in Massachusetts, Maryland, Georgia, and Louisiana.[10] Due primarily to a drop in domestic gas prices, however, two of these terminals quickly closed. Imports to the other two terminals remained small for the next 30 years. In 2002, U.S. LNG imports were only 0.17 Tcf, less than 1% of U.S. natural gas supply.[11]

Figure 2: U.S. Natural Gas Wellhead Price ($/Mcf)



Source: Energy Information Administration. *Natural Gas Weekly Update*. Jan. 19, 2006.

United States demand for LNG has been increasing dramatically since 2003. This growth in LNG demand has been occurring in part because North American natural gas production appears to have plateaued, so it has not been able to keep pace with growth in demand. As a result, U.S. natural gas prices have become higher and more volatile. As **Figure 2** shows, gas prices at the wellhead have risen from around $2.00/Mcf through most of the 1990s to an average above $6.00/Mcf and a peak above $10.00/Mcf in 2005.[12] At the same time, international prices for LNG have fallen because of increased supplies and lower production and transportation costs,

[9] (...continued)
Shipping Consultants. London, England. Mar. 9, 2004.

[10] An LNG terminal was also built at Kenai, Alaska in 1969 for exports to Japan.

[11] EIA. DOE/EIA-0383(2005). Feb. 2005. Table A13. p159. Tcf = trillion cubic feet.

[12] Mcf = thousand cubic feet

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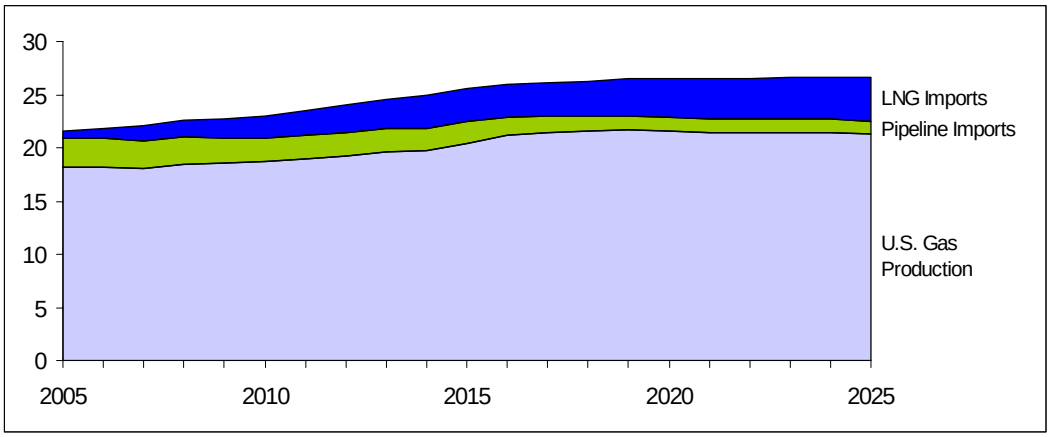
making LNG more competitive with domestic natural gas.[13] While cost estimation is speculative, some industry analysts believe that LNG can be economically delivered to U.S. pipelines for approximately $2.50 to $3.50/Mcf.[14]

Forecasts by the Energy Information Administration (EIA), National Petroleum Council, and other groups project expansion in U.S. LNG imports over the next 20 years. Specific LNG forecasts vary based on methodology and market assumptions, but most expect LNG to account for 12% to 21% of U.S. natural gas supplies by 2025.[15] EIA's reference forecast projects U.S. LNG imports to reach 4.13 Tcf in 2025, which equates to approximately 16% of total U.S. gas supply for that year, up substantially from the 2005 market share of about 3%.[16] **Figure 3** details projected U.S. LNG imports relative to other natural gas supplies in EIA's forecast.

Figure 3: Projected U.S. Natural Gas Production and Imports (Tcf)



Source: Energy Information Administration. *Annual Energy Outlook 2006.* Dec. 2005. Table A13.

Global LNG Market Development

Projections of accelerated growth in U.S. LNG demand reflect a general expansion in the global natural gas market. According to the EIA's most recent international forecast "natural gas is expected to be the fastest growing component of world primary energy consumption."[17] EIA projects global natural gas demand to rise by an average 2.3 percent annually for the next 20 years, with "the largest increases ... projected for the transitional economies of Eastern Europe and the

[13] Sen. Colleen Taylor. "LNG Poised to Consolidate its Place in Global Trade." *Oil & Gas Journal*. Jun. 23, 2003. p73.

[14] Hughes, Peter. "Outlook for Global Gas Natural Markets." BP, Gas Power & Renewables Division. Presentation to the World Bank Energy Week 2004 Conference. Mar. 8, 2004.

[15] For a comparison of major forecasts see EIA. *Annual Energy Outlook 2005.* DOE/EIA-0383(2005). Feb. 2005. Table 36. p118.

[16] Energy Information Administration (EIA). *Annual Energy Outlook 2006.* (Early release). Dec. 2005. Table 13.

[17] Energy Information Administration (EIA). *International Energy Outlook 2005.* DOE/EIA-0484(2005). Jul. 2005. p37.

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former Soviet Union ... and for emerging Asia," much of it to fuel electricity generation.[18] A significant part of this global gas demand growth is expected to be met by new supplies of LNG. Long-term projections of global LNG growth vary, but most major energy companies and industry analysts expect global LNG demand to roughly triple by 2020, from 6 Tcf in 2003, to 18 Tcf or more in 2020.[19] According to EIA projections, 18 Tcf would account for approximately 13% of global natural gas consumption in 2020.[20]

LNG Safety and Security

Natural gas is combustible, so an uncontrolled release of LNG poses a hazard of fire or, in confined spaces, explosion. LNG also poses hazards because it is so cold. Because LNG tankers and terminals are highly visible and easily identified, they may also be vulnerable to terrorist attack. Assessing the potential risk from LNG releases is controversial. A 1944 accident at one of the nation's first LNG facilities, for example, killed 128 people and initiated public fears about LNG hazards which persist today.[21] But technology improvements and standards since the 1940's appear to have made LNG facilities safer. Between 1944 and 2006, LNG terminals experienced approximately 13 serious accidents, with two fatalities, directly caused by LNG.[22] Since international LNG shipping began in 1959, tankers have carried 40,000 LNG cargoes without a serious accident at sea or in port.[23] In January 2004, however, a fire at an LNG processing facility in Algeria killed an estimated 27 workers and injured 74 others.[24] The Algeria accident raised new questions about LNG facility safety and security.

A number of technical studies since the terror attacks of September 11, 2001, have been commissioned to reevaluate the safety hazards of LNG terminals and associated shipping. These studies have caused controversy because, due to differences in analytic assumptions, some have reached inconsistent conclusions

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[18] DOE/EIA-0484(2005). Jul. 2005. p37.

[19] See, for example: Cambridge Energy Research Associates (CERA). "LNG Dvelopment Question Becomes 'How' Rather than 'Whether.'" Press release. Nov. 17, 2005; Cook, L., Royal Dutch Shell. "The Role of LNG in a Global Gas Market." Presentation to the Oil & Money Conference. London. Sept. 21, 2005; Nauman, S.A. ExxonMobil. "The Outlook For Energy: A 2030 View." Irving, TX. Slide presentation. Jan. 25, 2005.

[20] DOE/EIA-0484(2005). Jul. 2005. p37.

[21] Bureau of Mines (BOM). *Report on the Investigation of the Fire at the Liquefaction, Storage, and Regasification Plant of the East Ohio Gas Co., Cleveland, Ohio, October 20, 1944.* February, 1946.

[22] CH-IV International. *Safety History of International LNG Operations, Revision 2*. TD-02109. Millersville, MD. November, 2002. p6-12; *Hazmat Transportation News*. "Commission Weighs Safety, Security Issues In Rulings on LNG Terminals in Urban Areas." Vol. 02, No. 336. Sept.16, 2005.

[23] Center for LNG. "LNG Security and Safety: Ships." Fact sheet. Jan. 23, 2006. [http://www.lngfacts.org/issues/lng_updates/CLNG_FLYER_SHIPS.pdf]

[24] Junnola, Jill *et al.* "Fatal Explosion Rocks Algeria's Skikda LNG Complex." *Oil Daily*. Jan. 21, 2004. p6.

about the potential public hazard of LNG terminal accidents or terror attacks. In an effort to resolve these inconsistencies, the Department of Energy commissioned a comprehensive LNG hazard study from Sandia National Laboratories. The Sandia report, released in December 2004, determined that a worst-case, "credible" LNG tanker fire could emit harmful thermal radiation up 2,118 meters (1.3 miles) away.[25] Although, the report concluded that "risks from accidental LNG spills ... are small and manageable," it also concluded that "the consequences from an intentional [tanker] breach can be more severe than those from accidental breaches."[26] Both proponents and opponents of new LNG terminals have cited the Sandia findings to support their positions. The controversy continues.

LNG Policy Activities of the Federal Government

The federal government has been actively promoting increased LNG imports. Through new regulation, administrative actions, and legislation, federal agencies and Congress have tried to foster LNG capital investment, streamline the LNG terminal approval process, and promote global LNG trade.

FERC Regulations. The Federal Energy Regulatory Commission (FERC) grants federal approval for the siting of new onshore LNG facilities and interstate gas pipelines, and also regulates prices for interstate gas transmission.[27] In December, 2002, the FERC exempted LNG import terminals from rate regulation and open access requirements. This regulatory action, commonly called the "Hackberry decision" allowed import terminal owners to set market-based rates for terminal services, and allowed terminal developers to secure proprietary terminal access for corporate affiliates with investments in LNG supply.[28] These regulatory changes greatly reduced investment uncertainty for potential LNG developers, and assured access to their own terminals.[29] In February 2004, FERC streamlined the LNG siting approval process through an agreement with the U.S. Coast Guard and the Department of Transportation to coordinate review of LNG terminal safety and security. The agreement "stipulates that the agencies identify issues early and quickly resolve them."[30] FERC also announced a new branch devoted to LNG within its Office of Energy Projects.[31]

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[25] Sandia National Laboratories (SNL). *Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water*. SAND2004-6258. Albuquerque, NM. Dec. 2004. p51.

[26] SNL. Dec. 2004. p14.

[27] Natural Gas Act of 1938 (NGA), June 21, 1938, ch. 556, 52 Stat. 812, (codified as amended at 15 U.S.C. §§ 717 *et seq*).

[28] Open access required terminal owners to offer services on a first come, first served basis, and could not discriminate against service requests to protect their own market activities.

[29] Vallee, James E. "FERC Hackberry Decision Will Spur More U.S. LNG Terminal Development." *Oil & Gas Journal*. Nov. 10, 2003. p64.

[30] Federal Energy Regulatory Commission (FERC). Press release. R-04-3. Feb.11, 2004.

[31] Lorenzetti, M. "LNG Rules." *Oil & Gas Journal*. Apr.5, 2004. p32.

Between 1999 and 2005, FERC approved the reactivation of the two idled U.S. LNG terminals, and subsequently approved the expansion of the four existing import terminals in the continental United States. In September, 2003, FERC approved the Cameron LNG project in Hackberry, LA, the first new LNG import terminal to be sited in the continental United States in over 25 years.[32] The commission has since approved eight additional terminals (in Texas, Louisiana, and Massachusetts), and as of January, 2006 has received 12 additional terminal siting applications.[33] In 2004, FERC also approved the construction of two new gas pipelines connecting Florida to proposed LNG import terminals in the Bahamas.[34] The terminals and pipelines approved to date by FERC could increase total U.S. LNG import capacity to approximately 7.0 Tcf per year.

Offshore Terminal Regulations. In November, 2002, Congress passed the Maritime Transportation Security Act of 2002 (P.L. 107-295), which transferred jurisdiction for offshore LNG terminal siting approval from the FERC to the Maritime Administration (MARAD) and the U.S. Coast Guard (USCG). According to the Department of Energy, the act

> ... streamlined the permitting process and relaxed regulatory requirements. Owners of offshore LNG terminals are allowed proprietary access to their own terminal capacity, removing what had once been a major stumbling block for potential developers of new LNG facilities.... The streamlined application process ... promises a decision within 365 days....[35]

The proprietary access provisions for offshore terminals are similar to those set by FERC for onshore terminals to ensure equal treatment for both kinds of facilities. In November, 2003, the MARAD and USCG approved the Port Pelican project, the first offshore LNG terminal ever to be sited in U.S. waters. The agencies have subsequently approved Energy Bridge (January, 2004) and Gulf Landing (February, 2005), two additional offshore LNG projects. All three terminals would be located in the Gulf of Mexico. Their combined annual capacity would be approximately 1.2 Tcf. As of January, 2006, the agencies were reviewing seven additional offshore terminal applications, two off the California coast, four in the Gulf of Mexico, and two off the coast of Massachusetts.

Congressional Activities. In 2005, Congress passed and President Bush signed the Energy Policy Act of 2005 (P.L. 109-58). The Energy Policy Act is generally seen as promoting new LNG terminal development in several ways. As noted earlier in this report, the act resolved certain state-federal jurisdictional disputes by granting the FERC explicit and "exclusive" authority to approve onshore

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[32] Eckert, Toby. "Sempra Gets Final OK for Louisiana Gas Import Facility." Copley News Service. Sep. 10, 2003.

[33] Federal Energy Regulatory Commission (FERC). "Existing and Proposed North American LNG Terminals." Office of Energy Projects. Washington, DC. Jan. 4, 2006. [http://www.ferc.gov/industries/lng/indus-act/exist-prop-lng.pdf].

[34] "Cheyenne Plains, Tractebel's Calypso Pipelines Get Green Light." *Natural Gas Intelligence*. Mar. 24, 2004.

[35] EIA. DOE/EIA-0383(2004). Jan. 2004. p15.

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LNG terminal siting applications (Sec. 311c). The act also codifies the “Hackberry decision”discussed above (Sec. 311c). The act designates the FERC as the "lead agency for the purposes of coordinating all applicable Federal authorizations" and for complying with federal environmental requirements (Sec. 313a). It also establishes the FERC's authority to set schedules for federal authorizations and establishes provisions for judicial review of FERC's siting decisions in the U.S. Court of Appeals, among other administrative provisions (Sec. 313b). The act also requires FERC to promulgate regulations for pre-filing of LNG import terminal siting applications and directs FERC to consult with designated state agencies regarding safety considerations in considering such applications. It permits states to conduct safety inspections of LNG terminals in conformance with federal regulations, although it retains enforcement authority at the federal level. The act also requires LNG terminal operators to develop emergency response plans including cost-sharing to reimburse state and local governments for safety and security costs (Sec. 311d).

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Key Issues in U.S. LNG Import Policy

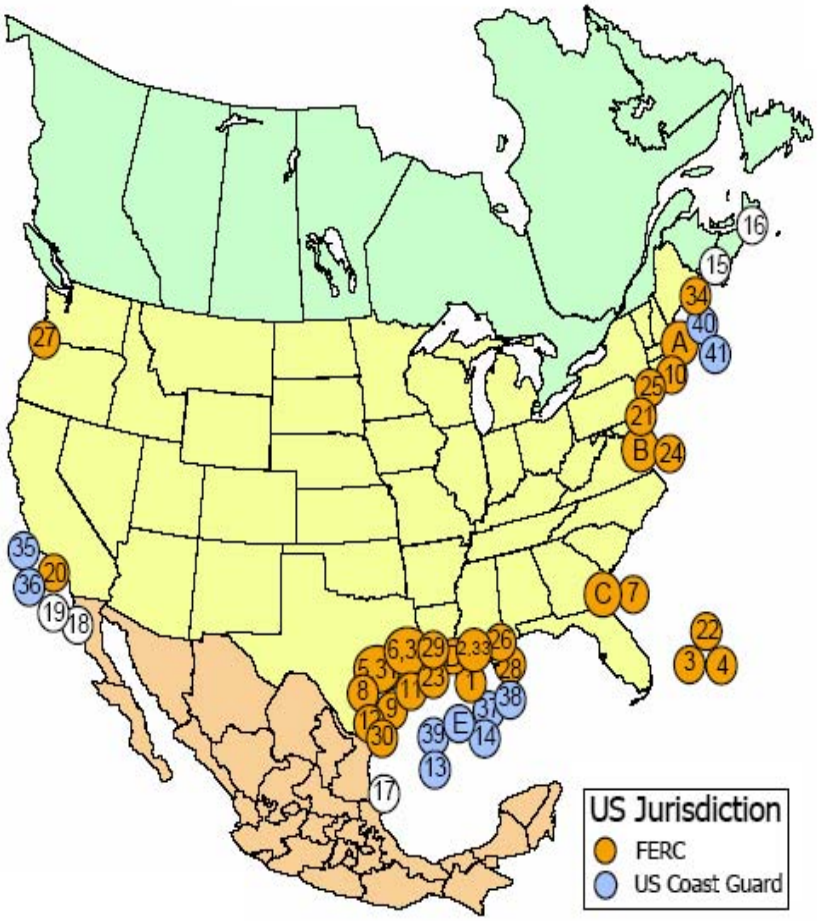
Federal actions are facilitating greater U.S. LNG imports, and the private sector is responding with plans for new LNG facilities. Nonetheless, concerns are emerging about the infrastructure needs of LNG, the future structure of global LNG trade, and the relationship between the United States and other LNG market participants.

Physical Infrastructure Requirements

To meet U.S. LNG imports of 4.13 Tcf in 2025 as projected by the EIA would require significant additions to North American import terminal capacity. Along with expansions at four existing terminals, six to ten new import terminals would be needed. LNG developers have proposed over 30 new terminals with a combined import capacity far exceeding what would likely be needed the meet the projections (**Figure 4**).[36] These developers include multi-national corporations with the financial resources and project experience to develop such facilities. At issue is where these terminals would be built, how they would be integrated into the nation’s existing gas infrastructure, and how they might be secured against accident or terrorist attack.

[36] These proposals include several proposed terminals in Canada, Mexico and the Bahamas.

Figure 4: Existing and Proposed LNG Import Terminals in North America



CONSTRUCTED
A. Everett, MA : 1.035 Bcfd (Tractebel - DOMAC)
B. Cove Point, MD : 1.0 Bcfd (Dominion - Cove Point LNG)
C. Elba Island, GA : 0.68 Bcfd (El Paso - Southern LNG)
D. Lake Charles, LA : 1.2 Bcfd (Southern Union - Trunkline LNG)
E. Gulf of Mexico: 0.5 Bcfd, (Gulf Gateway Energy Bridge - Excelerate Energy)

APPROVED BY FERC
1. Lake Charles, LA: 0.6 Bcfd (Southern Union - Trunkline LNG)
2. Hackberry, LA : 1.5 Bcfd, (Sempra Energy)
3. Bahamas : 0.84 Bcfd, (AES Ocean Express)*
4. Bahamas : 0.83 Bcfd, (Calypso Tractebel)*
5. Freeport, TX : 1.5 Bcfd, (Cheniere/Freeport LNG Dev.)
6. Sabine, LA : 2.6 Bcfd (Cheniere LNG)
7. Elba Island, GA: 0.54 Bcfd (El Paso - Southern LNG)
8. Corpus Christi, TX: 2.6 Bcfd, (Cheniere LNG)
9. Corpus Christi, TX : 1.0 Bcfd (Vista Del Sol - ExxonMobil)
10. Fall River, MA : 0.8 Bcfd, (Weaver's Cove Energy/Hess LNG)
11. Sabine, TX : 1.0 Bcfd (Golden Pass - ExxonMobil)
12. Corpus Christi, TX: 1.0 Bcfd (Ingleside Energy - Occidental Energy Ventures)
APPROVED BY MARAD/COAST GUARD
13. Port Pelican: 1.6 Bcfd, (Chevron Texaco)
14. Louisiana Offshore : 1.0 Bcfd (Gulf Landing - Shell)
CANADIAN APPROVED TERMINALS
15. St. John, NB : 1.0 Bcfd, (Canaport - Irving Oil)
16. Point Tupper, NS 1.0 Bcf/d (Bear Head LNG - Anadarko)
MEXICAN APPROVED TERMINALS
17. Altamira, Tamulipas : 0.7 Bcfd, (Shell/Total/Mitsui)
18. Baja California, MX : 1.0 Bcfd, (Sempra)
19. Baja California - Offshore : 1.4 Bcfd, (Chevron Texaco)
PROPOSED TO FERC
20. Long Beach, CA : 0.7 Bcfd, (Mitsubishi/ConocoPhillips - Sound Energy Solutions)
21. Logan Township, NJ : 1.2 Bcfd (Crown Landing LNG - BP)
22. Bahamas : 0.5 Bcfd, (Seafarer - El Paso/FPL)
23. Port Arthur, TX: 1.5 Bcfd (Sempra)
24. Cove Point, MD : 0.8 Bcfd (Dominion)
25. LI Sound, NY: 1.0 Bcfd (Broadwater Energy - TransCanada/Shell)
26. Pascagoula, MS: 1.0 Bcfd (Gulf LNG Energy LLC)
27. Bradwood, OR: 1.0 Bcfd (Northern Star LNG - Northern Star Natural Gas LLC)
28. Pascagoula, MS: 1.3 Bcfd (Casotte Landing - ChevronTexaco)
29. Cameron, LA: 3.3 Bcfd (Creole Trail LNG - Cheniere LNG)
30. Port Lavaca, TX: 1.0 Bcfd (Calhoun LNG - Gulf Coast LNG Partners)
31. Freeport, TX: 2.5 Bcfd (Cheniere/Freeport LNG Dev. - Expansion)
32. Sabine, LA: 1.4 Bcfd (Cheniere LNG - Expansion)
33. Hackberry, LA : 1.15 Bcfd (Cameron LNG - Sempra Energy - Expansion)
34. Pleasant Point, ME : 0.5 Bcfd (Quoddy Bay, LLC)
PROPOSED TO MARAD/COAST GUARD
35. California Offshore: 1.5 Bcfd (Cabrillo Port - BHP Billiton)
36. So. California Offshore : 0.5 Bcfd, (Crystal Energy)
37. Louisiana Offshore : 1.0 Bcfd (Main Pass McMoRan Exp.)
38. Gulf of Mexico: 1.0 Bcfd (Compass Port - ConocoPhillips)
39. Gulf of Mexico: 1.5 Bcfd (Beacon Port Clean Energy Terminal - ConocoPhillips)
40. Offshore Boston, MA: 0.4 Bcfd (Neptune LNG - Tractebel)
41. Offshore Boston, MA: 0.8 Bcfd (Northeast Gateway - Excelerate Energy)

* *US pipeline approved; LNG terminal pending in Bahamas*

Source: Federal Energy Regulatory Commission (FERC). "Existing and Proposed North American LNG Terminals." Office of Energy Projects. Washington, DC. Jan. 23, 2006. [http://www.ferc.gov/industries/lng/indus-act/exist-prop-lng.pdf]

Terminal Siting. Choosing acceptable sites for new LNG terminals has proven controversial. As noted earlier in this report, federal agencies have approved the siting of ten new terminals in the Gulf of Mexico as well as two new Florida pipelines for proposed terminals in the Bahamas. But many developers have sought to build terminals nearer to major consuming markets in California and the Northeast, as **Figure 4** shows. Developers have proposed terminals near consuming markets to avoid pipeline bottlenecks and to minimize transportation costs. In 2003, soon after LNG deliveries to the Cove Point resumed, natural gas for the local Maryland market was priced well below conventional gas supplies transported by pipeline from the Gulf of Mexico.[37] If new terminals are built far from key consumer markets, delivered gas might cost more than if LNG terminals were built locally.

As of January, 2006, federal agencies have approved only one new LNG import terminal outside the Gulf of Mexico, in Massachusetts. Such near-to-market terminal proposals have struggled for approval due to community concerns about LNG safety, effects on local commerce, and other potential negative impacts. LNG terminal opposition is not unlike that experienced by some other types of industrial and utility facilities. Due to local community opposition, LNG developers have already withdrawn terminal projects recently proposed in California, Maine, North Carolina, Florida, and Mexico. Other terminal proposals in Rhode Island, New York, New Jersey and Canada are facing stiff community opposition. In Alabama, a state assumed by many to be friendly to LNG development, community groups have effectively blocked two onshore terminal proposals and have called for LNG import terminals to be built only offshore.[38]

In some cases state and local agencies are at odds with federal agencies over LNG terminal siting approval. For example, Delaware's environmental secretary has blocked the development of an LNG terminal on the Delaware-New Jersey border ruling that part of the terminal would extend into Delaware's waters and violate Delaware's Coastal Zone Act.[39] The United States Supreme Court has appointed a special master to resolve the dispute.[40] In January, 2005, Massachusetts and Rhode Island filed petitions in federal court to reverse FERC's approval of an LNG import terminal to be sited in Fall River, Massachusetts.[41] In 2004, the California Public Utilities Commission (CPUC) sued FERC in federal court over FERC's assertion of sole jurisdiction over the siting of an LNG terminal in Long Beach. The CPUC dropped its suit, however, after the passage of P.L. 109-58 mooted its arguments.

Local opposition for LNG terminals has been strong in the Northeast, which has a constrained gas transmission infrastructure. Northeast gas prices are higher than in other parts of the country. In Maine, for example, the monthly average wholesale

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[37] Jowdy, M. and Haywood, T. "LNG Imports Undermine Premiums Near US Terminals." *World Gas Intelligence*. Nov. 25, 2003.

[38] Editorial. "Move ExxonMobil's LNG Plant Offshore." *Mobile Register*. Nov. 30, 2003.

[39] Fifield, A. "Del. Hands BP a Setback on Pier." *Philadelphia Enquirer*. Feb. 4, 2005.

[40] U.S. Supreme Court. Order list:546 U.S. New Jersey v. Delaware. Jan. 23, 2006.

[41] "Rhode Island, Massachusetts Officials Ask Court to Block Weaver's Cove LNG Project." *Natural Gas Intelligence*. Jan. 30, 2006.

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price of gas delivered between October, 2004 and October, 2005 was $12.09/Mcf, compared to $8.27/Mcf in Louisiana.[42] Were the same price differential to hold in the future, Maine consumers would have to pay $3.81/Mcf, or 46 percent, more for LNG delivered to Louisiana rather than the Maine coast. Many factors like weather, pipeline tariffs, and new natural gas supplies from Canada could significantly change relative prices. Nonetheless, if recent regional pricing patterns persist, displacing a handful of proposed LNG terminals from consumer markets to the Gulf of Mexico could cost regional gas consumers billions of dollars in extra pipeline transportation charges. On the other hand, siting new terminals in more receptive locations could help bring them into service more quickly, and could still exert downward pressure on gas prices while alleviating community safety concerns.

Pipeline Infrastructure. LNG supplies to the United States have been such a small share of the total market that they have had little discernible influence on the development of North America's gas pipeline network. If projections of U.S. LNG growth prove correct, however, LNG terminals may have more impact on pipeline infrastructure in the future. As additional LNG import capacity is approved, how new terminals will be physically integrated into the existing pipeline network becomes a consideration.

LNG terminals may affect pipeline infrastructure in two ways. First, new terminals and terminal expansions must be connected to the interstate pipeline network through sufficient "takeaway" pipeline capacity to handle the large volumes of imported natural gas. Depending upon the size, location and proximity of a new terminal to existing pipelines, ensuring adequate takeaway capacity may require new pipeline construction. For example, the owner of the Elba Island, GA terminal intends to build a 191-mile pipeline to transport additional gas volume from the terminal's planned expansion.[43] Energy experts have expressed concern, however, that interstate pipeline capacity may not be sufficient to handle future LNG supplies without substantial new pipeline additions.[44] The availability of pipeline capacity directly affects pipeline transportation costs, so it is an important consideration in evaluating the economics of LNG versus traditional pipeline supplies in specific markets.

Second, if gas imported as LNG cannot move freely through interstate pipeline systems, consumers may not realize the lower prices that result from additional gas availability. One industry observer remarked, "without more infrastructure, gas may face the kind of glut plaguing the electric utility industry, with too much generating capacity and too few connections."[45] For this reason, some LNG developers advocate building LNG terminals in traditional gas producing regions, where pipeline nodes

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[42] Energy Information Administration (EIA). "Natural Gas City Gate Price." website data series. [http://tonto.eia.doe.gov/dnav/ng/ng_pri_sum_dcu_nus_m.htm]. Jan. 25, 2005.

[43] El Paso Corp. "El Paso Corporation Announces Elba Island Expansion and Related Pipeline Project." Press release. Houston, TX. Dec. 21, 2005.

[44] "LNG Importers Face Supply, Pipeline Constraints." *Gas Daily*. April 8, 2005. p1.; "LNG Expansion Requires Adequate Takeaway Capacity and Market Integration." *Foster Natural Gas Report*. Feb. 5, 2004. p15.

[45] *Foster Natural Gas Report*. Feb. 5, 2004. p15

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are located. According to one industry executive, "it doesn't make a lot of sense to build a terminal and then have to build a huge pipeline."[46] Others argue that the most costly constraints in the gas pipeline network are at the ends of the pipelines, not the beginnings. Gas is expensive in Boston, for example, because there are few pipelines supplying the region — a transportation constraint that would not be alleviated by pumping more gas into pipelines in the Gulf of Mexico. As one senior FERC official has reportedly remarked, "putting more and more LNG plants in the Gulf, while it may be good for the overall gas supply situation in this country, won't do a whole lot for the regional gas needs of New England."[47] It is not clear, therefore, whether adding LNG supplies to traditional producing regions would be less costly for consumers than building in-market terminals and adding to regional pipeline capacity.

In addition to requiring sufficient takeaway capacity, LNG terminals likely will influence pipeline network flows. Major U.S. pipeline systems were designed primarily to move gas from traditional producing regions (e.g., Gulf Coast, Appalachia, Western Canada) to consuming regions (e.g, Northeast, Midwest). If most new LNG capacity is built in the Gulf of Mexico, then traditional gas flows would be maintained. If a number of new terminals are built in consuming regions, however, they may change historical gas transportation patterns, potentially displacing traditional production and changing infrastructure constraints. Among other potential impacts, some analysts have suggested that new LNG terminals will result in "less market leverage and probably lower cash flows" for some existing pipelines because new LNG supplies may be able to reach consumer markets by alternate routes.[48] Predicting the overall effects of long term changes in gas flows is a complex problem, although such changes may have important implications for current pipeline utilization and for future pipeline investments.

Interchangeability. LNG consists primarily of methane, but it may also contain significant quantities of other hydrocarbon fuels, such as ethane, propane and butane. The quantity of these other fuels in LNG affects the overall heat content in the LNG and varies depending upon its source. In markets outside the United States, LNG contains more non-methane fuels and, therefore, has a higher heat content than traditional U.S. natural gas supplies. LNG with a high heat content can cause problems when imported into the United States because it may damage pipelines and natural gas-fired equipment (e.g., electric power turbines) which are designed for a lower heat content. There are a number of potential technical solutions to LNG interchangeability problems, such as stripping out the non-methane fuels, blending the LNG with domestic natural gas, and "diluting" the LNG with nitrogen.[49] These solutions may involve significant added expense to LNG processing, however, which

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[46] "For Sponsors, Stake in Supply is Key to Getting LNG Terminals Built, says ExxonMobil Head." *Inside F.E.R.C.* Feb. 16, 2004. p20.

[47] S. L. Paulson. "Promoting the Promise of LNG." *American Gas*. American Gas Assoc. June, 2005.

[48] "Consultant: LNG Will Cut Transportation Values, Put Downward Pressure on Prices." *Natural Gas Intelligence*. Dec. 29, 2003.

[49] Rogers, D. "Gas 'Interchangeability' and Its Effects On U.S. Import Plans." *Pipeline & Gas Journal*. Aug. 2003. pp21-24.

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could be reflected in higher natural gas prices. The FERC has been working with natural gas trade associations to establish appropriate national policies for natural gas interchangeability and quality. The FERC has addressed some interchangeability issues on a case by case basis, and has proposed more general regulations on natural gas quality and interchangeability, but the commission's expressed preference is that the gas industry and gas quality stakeholders reach their own consensus on interchangeability.[50]

Safety and Physical Security. To protect the public from an LNG accident or terrorist attack, the federal government imposes numerous safety and security requirements on LNG infrastructure. The nature and level of risk associated with LNG is the subject of ongoing debate among industry, government agencies, researchers and local communities.[51] Whatever the specific risk levels are determined to be, they could multiply as the number of LNG terminals and associated tanker shipments grows. Likewise, the costs associated with mitigating these risks are also likely to increase. To the extent these costs are not borne by the LNG industry, they may represent an ongoing burden to public agencies such as the Coast Guard, law enforcement, and emergency response agencies.

Securing tanker shipments against terrorist attacks may be the most significant public expense associated with LNG. CRS has estimated the public cost of security for an LNG delivery to the Everett terminal to be on the order of $80,000, excluding costs incurred by the terminal owner.[52] Marine security costs at other LNG terminals could be lower than for Everett because they are farther from dense populations and may face fewer vulnerabilities, but could still be on the order of $20,000 to $40,000 per shipment. If LNG imports increase as projected, the number of vessels calling at LNG terminals serving the United States would increase from 99 (0.17 Tcf) in 2002 to over 2300 (4.13 Tcf) in 2025.[53] At current levels of protection, marine security costs would then be in the range of $46 million to $92 million annually.[54] Recognizing the added security needs associated with the LNG trade, the Coast Guard's FY2006 budget includes an additional $11 million in general maritime security funding over FY2005 levels. These resources are for new small response boats and associated crew to increase the Coast Guard's operational presence and

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[50] Federal Energy Regulatory Commission (FERC). "LNG - Issues - Gas Quality." Web page. Jan. 25, 2005. [http://www.ferc.gov/industries/lng/indus-act/issues/gas-qual.asp]

[51] For further discussion see CRS Report RL32205: *Liquefied Natural Gas (LNG) Import Terminals: Siting, Safety, and Regulation* by Paul W. Parfomak and Aaron Flynn.

[52] CRS Report RL32073. *Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress* by Paul W. Parfomak.

[53] Increasing tanker size may reduce the actual number of future shipments, but are assumed not to reduce associated security costs since the hazard associated with each ship and time in port would increase proportionately.

[54] Note that security costs associated with LNG terminals in Canada, Mexico and the Bahamas (built primarily to serve U.S. markets) would not be a direct U.S. responsibility, although such costs might still priced into LNG supplied from those terminals.

response posture, enforce security zones, and escort LNG tankers and other high interest vessels.[55]

Congress included provisions in P.L. 109-58 requiring new LNG terminal applicants to include plans for security cost-sharing with state and local government agencies (Sec. 311d). The public costs of LNG security also may decline as federally mandated security systems and plans are implemented. Nonetheless, because the accounting of security costs is ambiguous and may be tied to uncertain sources of federal funding, such as Department of Homeland Security grants, some policy makers remain concerned about LNG security costs and the potential diversion of Coast Guard and safety agency resources from other activities.

Supply Bottlenecks. Because U.S. LNG terminals process large volumes of LNG, the potential for one facility to bottleneck supply might not be recognized. A disruption at a U.S. import terminal (or at an associated supplier's export terminal) could effect regional gas availability.

Hurricanes Katrina and Rita, which struck the Gulf of Mexico in 2005, forced the temporary closure of the Lake Charles LNG terminal and raised questions about the vulnerability to future hurricanes of multiple new LNG import terminals in the same region.[56] In March, 2004, striking workers at an export terminal in Trinidad stopped all LNG operations — interrupting shipments from the largest U.S. supplier and the sole supplier to the Everett terminal. Although the strike ended quickly and U.S. gas demand at the time was moderate, one gas trader stated that if the strike had occurred during the heart of winter it might have exacerbated already high Northeast gas prices.[57] Similarly, when LNG shipments to the Everett LNG terminal were suspended after the terror attacks of September 11, 2001, markets analysts feared shortages of gas for heating and curtailments of gas deliveries to regional power plants in New England.[58]

Some industry analysts view the Gulf hurricanes, Trinidad strike, and September 11, 2001 events as new supply risks the United States could face as LNG becomes a larger share of gas supply. Others view these kinds of events as ordinary supply uncertainties readily managed in other fuel markets. As one consultant stated,

> they are not problems that should make the industry shy away from developing LNG trade ... they are just problems that should make you consider how you are going to structure long-term LNG contracts and estimate what kind of premiums you are going to pay over indigenous pipeline supply.[59]

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[55] Dept. of Homeland Security (DHS). *Budget-in-Brief, Fiscal Year 2006*.

[56] O'Driscoll, M. "LNG: Hurricane Raises Questions on Gulf Terminal Clusters. *Greenwire*. Sept. 6, 2005.

[57] Reuters News Service. "U.S. Gas Traders Shrug Off Trinidad LNG Strike." Mar. 9, 2004.

[58] "LNG Ban Could Spell Higher Power Prices." *Gas Daily*. Oct. 5, 2001. p5.

[59] "Trinidad Strike Settled in Two Days, But Raises Red Flags." *Natural Gas Intelligence*. Mar. 15, 2004. p1.

The future sensitivity of U.S. natural gas markets to LNG terminal disruptions is difficult to forecast and will be driven by factors such as supply diversity and pipeline development. Nonetheless, the concentration of incremental gas supplies among perhaps a dozen major import facilities may raise new concerns about the security of U.S. natural gas supply.

Global LNG Market Structure

In his 2003 congressional testimony, Federal Reserve Chairman Alan Greenspan asserted that increasing LNG import capacity would create "a price-pressure safety valve" for North American natural gas markets which would be "likely to notably damp the levels and volatility of American natural gas prices."[60] Basic market economics suggest that increasing marginal gas supplies from any source would tend to lower gas prices. But the long-term effectiveness of LNG in moderating gas prices will be significantly influenced by global LNG supply, the development of an LNG spot market, and potential market concentration.

Global LNG Supply. The belief that LNG can serve as a "price-pressure safety valve" by setting a price ceiling on natural gas assumes that sufficient LNG would be available at that price to satisfy all incremental gas demand. Otherwise, gas prices would be capped by potentially more costly North American production alternatives. The question, then, is whether there will be sufficient LNG production abroad to supply incremental U.S. demand and sufficient global infrastructure to distribute it.

Table 1 summarizes basic characteristics of existing or potential LNG exporters. As the table shows, 2005 global LNG production capacity currently operating totaled approximately 9.1 Tcf per year. **Table 1** also shows an additional 15.8 Tcf of global capacity proposed for service by 2015, with more proposals likely in the future. If all these proposed facilities were constructed, total global production capacity could exceed 24 Tcf annually, exceeding EIA's projected global LNG demand of 18 Tcf in 2020.

Global tanker capacity also appears to be keeping up with LNG demand growth. Current tanker orders will add 130 ships to the current operating fleet of 191, increasing the overall number of LNG vessels 250% from the fleet size of 127 tankers in 2001.[61] Based on these figures, there appears to be sufficient interest among existing and potential exporters to meet both short-term and long-term global LNG demand projections. It remains to be seen which of these export projects will be constructed and how they will be integrated into the global LNG trade.

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[60] Greenspan, A., Chairman, U.S. Federal Reserve Board. "Natural Gas Supply and Demand Issues." Testimony before the House Energy and Commerce Committee. Jun. 10, 2003.

[61] "LNG Fleet." *LNG OneWorld* website. [http://www.lngoneworld.com] Drewry Shipping Consultants. London, England. Jan. 30, 2006.

Table 1: Global Natural Gas Reserves and LNG Production Capacity

Country	2005 Gas Reserves (Tcf)	Share of World Gas Reserves (%)	LNG Production Capacity (Bcf/yr)		OPEC Member?
			Estimated 2005	Projected 2015	
Russia	1,680	27.5	0	3,145	No
Iran	971	15.9	0	1,743	Yes
Qatar	911	14.9	1,470	3,812	Yes
Saudi Arabia	242	4.0	0	0	Yes
U.A.E.	214	3.5	292	292	Yes
United States	193	3.1	73	19	No
Nigeria	185	3.0	1,020	3,406	Yes
Algeria	161	2.6	1,069	1,264	Yes
Venezuela	151	2.5	0	229	Yes
Iraq	112	1.8	0	0	Yes
Indonesia	98	1.6	1,431	2,030	Yes
Norway	84	1.4	0	204	No
Malaysia	75	1.2	1,105	1,436	No
Egypt	59	1.0	609	1,027	No
Libya	53	0.9	34	156	Yes
Oman	29	0.5	321	502	No
Australia	28	0.5	570	2,566	No
Trinidad	26	0.4	735	1,003	No
Bolivia	24	0.4	0	341	No
Yemen	17	0.3	0	302	No
Brunei	14	0.2	351	516	No
Peru	9	0.1	0	214	No
Angola	2	<0.1	0	487	No
Eq. Guinea	1	<0.1	0	166	No
Others	776	12.7	0	0	No
OPEC Total	**3,098**	**50.7**	**5,316**	**12,932**	
World Total	**6,205**	**100.0**	**9,080**	**24,861**	

Sources: "World LNG Map: 2005 Edition." *Petroleum Economist*. 2005; "Major LNG Gas Projects to 2015." *Reuter's News.* Jan. 5, 2006; *Oil & Gas Journal*, Vol. 103, No. 47. Dec. 19, 2005. Energy Information Administration; Trade press.

Spot Market Growth. Some gas market analysts believe that a robust short-term or "spot" market for LNG is essential for U.S. importers to manage price and supply risk, and to do business cost-effectively. An LNG spot market could allow for short-term balancing of physical supply and demand. It could also offer greater LNG price discovery and transparency, benefitting companies negotiating long-term LNG contracts and potentially serving as a more relevant index for LNG contract

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price escalators than traditional petroleum indexes.[62] A spot market might also support financial trading and derivatives, important tools for managing price risk, especially during periods of volatile prices.[63]

In recent years, the global LNG market has seen limited, but increasing short-term trade. Short-term contracts accounted for 11% of global LNG transactions in 2005, up from less than 2% in 1998, and have already enabled physical market balancing. In 2005, for example, just after Hurricanes Katrina and Rita struck the Gulf of Mexico, Suez Energy (owner of the Everett LNG terminal) purchased a spot LNG cargo to meet its obligations to its New England customers.[64] In 2003-2004, South Korea purchased 36 spot cargoes of LNG to meet extra residential heating demand during winter.[65] In December, 2003, Indonesia sought four LNG cargoes from rival producers to meet delivery contracts following production problems at its Bontang plant.[66]

Unlike petroleum markets where all prices are essentially short-term, analysts believe LNG trade will stabilize with some mix of long and short-term contracts since infrastructure costs are so high. No new LNG liquefaction project yet has been launched without a long term contract. The likely size of an LNG spot market is difficult to predict, however at least one major exporter expects 30% of global LNG capacity will ultimately trade on the spot market.[67] Coupled with projections of overall LNG demand growth, a 30% spot market share implies a tripling in spot market volumes by 2020. It is an open question, however, whether this volume of spot trade in LNG will materialize and if it will offer the full range of benefits realized in comparable commodity markets.

A concern related to LNG spot market development is the potential role of market intermediaries. In the late 1990's, independent marketers like Enron and Dynegy emerged to participate in trading of natural gas, electricity, and other energy commodities. These market participants increased market liquidity, selling risk management services to both producers and consumers. Many marketers fell into bankruptcy, however, following the California electricity crisis in 2001 and subsequent scandals. A handful of major banks are beginning to pursue new partnerships with LNG terminal companies (e.g., Morgan Stanley - Cheniere Energy) to facilitate LNG trading and marketing, but such partnerships have yet to fully

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[62] For an alternative view see J.T. Jensen, "The LNG Revolution," *The Energy Journal*, Vol. 24. No. 2. 2003. p14.

[63] J. Roeber, "The Development of the UK Natural Gas Spot Market," *The Energy Journal*, Vol. 17. No. 2. 1996. p2.

[64] Kirkland, J. "LNG Spot Market Burgeoning but Chaotic as U.S. Importers Gird for Battle." *Inside F.E.R.C.* Jan. 9 2006.

[65] "Asia Lures Natural Gas Cargoes From Trinidad, Nigeria, Boosts Prices," *Africa News*, Oct. 19, 2004.

[66] Mike Hurle, "Indonesia Seeks LNG Cargoes to Cover Bontang Shortfall," *World Markets Analysis*, Dec. 23, 2003.

[67] Hand, Marcus. "Petronas Head Says 30% of LNG Trade Will be Spot Deals." *Lloyd's List* Feb. 5, 2004. p2.

develop.[68] It is unclear, therefore, which entities may ultimately succeed in providing the LNG industry with the capabilities needed for a fully functioning market.

Market Concentration. Some industry analysts believe the future LNG market may be susceptible to concentration-related inefficiencies. They note that only a limited number of buyers and sellers can effectively participate in LNG trade because the capital requirements are so great.[69] Many analysts also believe that a relatively small number of exporting countries are likely to account for the majority of LNG trade in the foreseeable future.

Based on LNG's similarity to the world oil trade, some observers are concerned about the possible emergence of a natural gas export cartel analogous to the Organization of Petroleum Exporting Countries (OPEC). One analyst remarked:

> Might a few countries come to dominate the supply of LNG and adopt policies harking back to the confrontational OPEC of the 1970's? An association of some kind among LNG exporters is likely. Many of them are also oil exporters, and the desire to compare fiscal terms will be irresistible.[70]

In March, 2004, at the Fourth Annual Gas Exporting Countries Forum, 15 major natural gas exporters established an "executive bureau" to develop common policies and joint initiatives regarding natural gas exports. According to press accounts, some forum members viewed the bureau as "a major step toward creating an OPEC-like organization to regulate gas production."[71] Some analysts have also pointed to apparent efforts by Russian gas company, Gazprom, "to sketch out the basic terms for broad cooperation in the gas sector between Russia and Iran" the two countries controlling the largest natural gas reserves in the world.[72] Other analysts are more skeptical of a potential natural gas cartel, citing the predominance of long-term contracts for LNG trade, divergent national interests, and other factors as barriers to collaboration.[73]

The ability of a cartel to play a similar role in gas as OPEC does in oil is debatable. OPEC member countries currently control over 75% of the world's proven oil reserves and approximately 40% of global oil supply.[74] By comparison, OPEC members control approximately 50% of proven world gas reserves and approximately 59% of global LNG production capacity projected for 2015 **(Table 1**).

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[68] Jura, M. "Banks Developing Taste For LNG Trade -- Physical And Financial." *Natural Gas Week*. Jan. 2, 2006.

[69] J.T. Jensen, 2003, p. 25. For example, the natural unit of trade, an LNG tanker cargo, is several hundred times the size of a commodity contract for pipeline natural gas.

[70] Daniel Yergin and Stoppard Michael, "The Next Prize," *Foreign Affairs*, Nov./Dec. 2003.

[71] M. Schmidt, "Former DOE Policy Chief: U.S. Focusing on Importing LNG from Nearest Locales," *Inside Energy*, Apr. 5, 2004, p. 10.

[72] "Gazprom's Iran Strategy," *World Gas Intelligence*, Feb. 2, 2005.

[73] Haines, L. "A Gas OPEC." *Oil & Gas Investor*. Oct. 1, 2005.

[74] Organization of Petroleum Exporting Countries (OPEC), "About OPEC," at [http://www.opec.org], visited Feb. 10, 2005.

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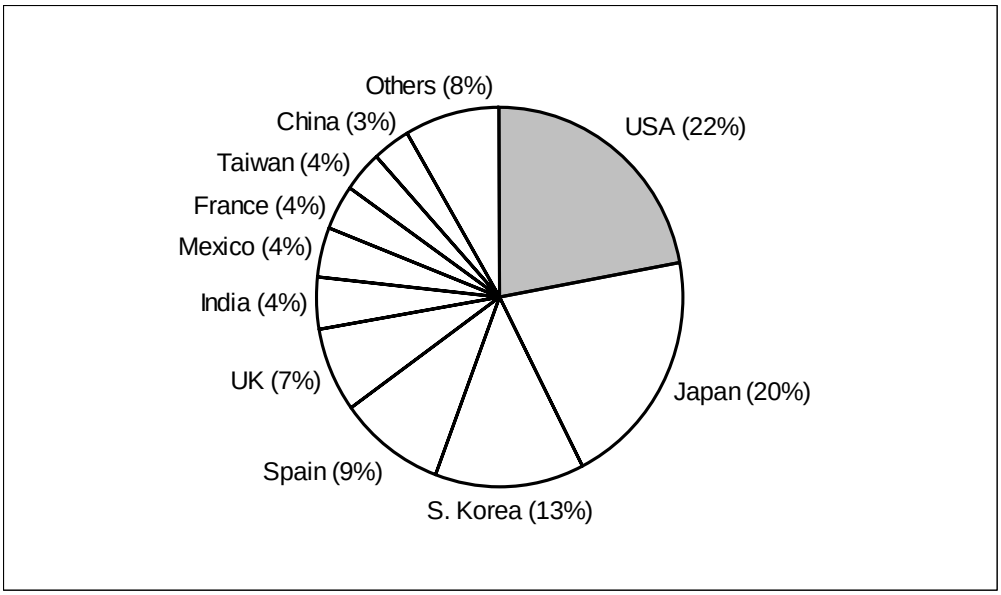
When non-LNG sources are accounted for, however, OPEC countries' share of global gas supply would be approximately 5% in 2015. Based on these figures alone, it is difficult to draw conclusions about the potential market power of an association of LNG exporters. It is possible, however, that the diversity of LNG suppliers, and the competitive relationship between LNG and traditional pipeline gas could make the world LNG market somewhat different than that of oil.

Global Trade and Politics. Continued growth of United States demand in an integrated global LNG market may affect trading and political relationships with key market participants. According to one estimate, by 2015 the United States may be the world's largest LNG importer, accounting for 22% of global volumes (**Figure 5**). South Korea, Spain, and the UK will also be importing large quantities of LNG, and may be joined by developing nations including India and China, seeking greater imports for rapidly growing economies.

Figure 5: Global LNG Import Market Shares Projected for 2015



Source: Deutsche Bank Securities, Inc. "Global LNG: Exploding the Myths." July 22. 2004. p2.

In an integrated global LNG market, individual country energy polices may significantly affect LNG price and availability worldwide. In 2001 and 2002, for example, after the Japanese government forced Tokyo Electric Power to shut down over a dozen nuclear plants for safety reasons, Japanese utilities relied more heavily on fossil fuels for electricity generation. According to the EIA:

> the result was a significant increase in Japan's demand for LNG, so that the majority of world spot cargoes were delivered to the Japanese market. Japan's increased reliance on LNG probably contributed to the reduction in short-term deliveries of LNG to the United States... [75]

[75] Energy Information Administration (EIA), *International Energy Outlook 2004*, DOE/EIA-0484(2004), Apr. 2004, p. 53.

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Japan's nuclear energy policies also affected South Korea, which depends on flexible spot LNG supplies to meet winter heating demand. With LNG supplies in Asia suddenly scarce, South Korea had to pay a substantial premium to attract spot cargoes originally destined for Spain.[76] In 2004-2005, Spain attracted numerous LNG spot cargoes "at the expense of the US" in response to record cold weather and inadequate hydroelectric power supplies.[77] Despite record cold temperatures and record high natural gas prices after the Gulf hurricanes, U.S. LNG terminals were operating at less than 50% capacity in December, 2005.[78]

Trade with LNG exporters such as Iran, Nigeria, and Venezuela may also raise geopolitical concerns. According to one analyst, "question remains on the merits of increasing reliance on imported energy ... if supply sources are from a region perceived as politically unstable or inhospitable to U.S. interests."[79] In part to mitigate such risks, the DOE has been encouraging the development of LNG supplies in South America and West Africa rather than the Middle East. According to the former DOE Assistant Secretary for Policy and International Affairs, "DOE is trying to make countries like Equatorial Guinea as attractive as possible to investors while aiming to limit the countries' potential political instability through contract and regulatory reform."[80]

LNG trade may also be linked to broader trading and political relationships among key LNG partners. For example, in the fall of 2004, China's interest in securing LNG supplies from Iran "put it in direct conflict with U.S. efforts to force Iran to renounce its ambitions to become a nuclear weapons state."[81] In a 2004 meeting with U.S. Energy Secretary Spencer Abraham, the Prime Minister of Trinidad reportedly used his country's status as the largest U.S. LNG supplier to seek most favored nation status for Trinidad's energy exports, duty free U.S. access for all Trinidadian-packaged products, and U.S. aid to offset gas exploration costs.[82] Russia's brief withholding of natural gas supplies to Ukraine and parts of the European Union in January, 2006 in what was widely perceived as both an economic and political dispute have raised additional concerns about political linkages among future natural gas market participants.[83] It is interesting to note that several European countries, including Italy, Ukraine, Poland, Hungary, Croatia, have since proposed

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[80] M. Schmidt, "Former DOE Policy Chief: U.S. Focusing on Importing LNG from Nearest Locales," *Inside Energy*, Apr. 5, 2004, p. 10.

[81] I. Bremmer, "Are the U.S. and China on a Collision Course?," *Fortune*, Jan. 25, 2005.

[82] Lucy Hornby, "Trinidad to Expand Role as Top Supplier of US LNG." *Oil Daily*, Apr. 21, 2004, p. 4.

[83] Champion, M. and Chazan, G. "Russia's Tough Gas Tactics Force Neighbors to Diversify *Wall Street Journal Europe*. Jan. 30 2006.

the construction of new LNG imports terminals to reduce their dependence on Russian pipeline natural gas supplies. Russia's plans to become a major LNG exporter may further complicate the global natural gas trade.

It is difficult to predict the nature of trading and political relationships either among LNG importers, or between specific LNG importing and exporting countries over a 20-year time frame. Nonetheless, experience suggests that global LNG trade may introduce new risks and opportunities among trading countries that warrant consideration in LNG policy debate.

Conclusions

As long as domestic demand outpaces North American natural gas production, the option of developing LNG import capacity appears economically attractive. Currently, LNG supplies 3% of U.S. natural gas, but both industry and government project this figure to rise to as much as 21% by 2025. Such an increase would pose a number of practical, immediate challenges, such as ensuring adequate production and import capacity, integrating LNG efficiently into the existing natural gas supply network, and securing LNG infrastructure against accident or terrorist attack. Public opposition to LNG-related facilities and new trading relationships in an increasingly integrated global gas market will also bear upon the expansion of the industry.

As the practical challenges to LNG import expansion are addressed, the policy discussion turns to the long-term implications of increased LNG imports in the nation's energy supply. Intentionally or not, the United States may be starting down a path of dependency on LNG imports similar to its current dependency on foreign oil. Such a dependency would represent a major shift in the nation's energy policy, and may have far-reaching economic impact. Because U.S. natural gas markets are regional, major consuming areas such as California and the Northeast might be particularly affected.

Some energy analysts believe that U.S. dependency on imported LNG is inevitable; the only uncertainty is how quickly it will occur. Others disagree, promoting instead familiar alternatives such as greater domestic gas production, switching to oil or other energy sources, and conservation. Recent measures before Congress affect LNG imports by providing incentives for domestic gas production and for new LNG terminal construction. If Congress considers the relative merits of LNG and other energy supply alternatives, three overarching policy questions may emerge.

- Is expanding LNG imports the best option for meeting long-term natural gas demand in the United States?
- What future role, if any, should the federal government play in facilitating the ongoing development of LNG infrastructure in the United States and abroad?
- How might Congress mitigate the risks of the global LNG trade within the context of national energy policy?

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The answers to these questions may flow from enhanced understanding of the infrastructure and market structure issues discussed in this report. With incomplete information and limited policy analysis, LNG imports may look unrealistically attractive to some, but unreasonably risky to others. The reality probably lies somewhere in between. It may not be possible to predict the LNG future 20 years from now, but choices made now can substantially affect that future.

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