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To:	LNGStudy
Cc:	Anderson, John; Tracy, Lisa
Subject:	2012 LNG Export Study - DCP Response Comments
Date:	Tuesday, February 26, 2013 11:50:43 AM
Attachments:	FILED - DCP Reply Comments on the 2012 LNG Study.pdf

Attached are Dominion Cove Point LNG, LP's response comments regarding the NERA Study.

Please do not hesitate to contact me with any questions.

Thanks,
Amanda

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February 25, 2013

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Re: 2012 LNG Export Study

Dear Mr. Anderson,

On December 5, 2012, the Department of Energy ("DOE") invited comments regarding the 2012 LNG Export Study to help to inform DOE in its public interest determinations of the authorizations sought in the 15 pending applications to export liquefied natural gas ("LNG") to non-free trade countries. The attached comments from Dominion Cove Point LNG, LP (DCP) are timely submitted in reply to the comments submitted to DOE during the initial comment period.

If you have any questions, please contact Matt Bley at (804) 771-4399 or Amanda Prestage at (804) 771-4416.

Respectfully submitted,

/s/ Matthew R. Bley

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UNITED STATES OF AMERICA
BEFORE THE DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY

In the Matter of

2012 LNG EXPORT STUDY

COMMENTS OF DOMINION COVE POINT LNG, LP ON
THE 2012 LNG EXPORT STUDY

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Filed: February 25, 2013

UNITED STATES OF AMERICA
BEFORE THE DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY

In the Matter of

2012 LNG Export Study

COMMENTS OF DOMINION COVE POINT LNG, LP ON
THE 2012 LNG EXPORT STUDY

Comments of Dominion Cove Point LNG, LP and its affiliates replying to public comments submitted in response to the 2012 LNG Export Study liquefied natural gas export cumulative impact study to inform the Department of Energy's decision on applications seeking authorization to export liquefied natural gas from the lower-48 states to non-free trade agreement countries.

Dominion Cove Point LNG, LP ("DCP") hereby submits reply comments on the 2012 LNG Export Study ("LNG Export Study") to help inform the Department of Energy ("DOE") in its public interest determinations of the authorizations sought in the fifteen pending applications to export liquefied natural gas ("LNG") to non-free trade countries.[1] The comments submitted today reply ("DCP Reply Comments") to public comments submitted to DOE on the LNG Export Study and are in addition to those comments DCP previously submitted in response to the request for initial comments related to the LNG Export Study ("DCP Initial Comments," attached hereto and incorporated herein as **Exhibit A**).

DCP appreciates the opportunity to present these comments and further reserves its right to present additional comments on the LNG Export Study during this and any additional comment periods and to address the LNG Export Study during any and all hearings and evaluations relating to DCP's Application for Long-Term Authorization to Export LNG to Non-Free Trade Agreement Countries ("DCP LNG Export Application").[2] DCP attaches as exhibits many of the specific references cited in these DCP Reply Comments for ease of DOE and the public's reference, and specifically requests that DOE incorporate all of the attachments and all internal references contained within these DCP Reply Comments into the administrative record for DCP's LNG Export Application.

Section I of the DCP Reply Comments describes both the legal and factual background by which DOE is constrained in its public interest determination analysis. Part II replies to comments critiquing the methodology of the LNG Export Study. Part III replies to comments challenging the economic benefit of LNG exports. Part IV replies to comments alleging that the LNG Export Study inappropriately failed to account for environmental impacts from increased shale production. Part V discusses the geopolitical advantages of LNG exports in response to comments to the contrary. Finally, Part VI

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[1] *See* 77 Fed. Reg. 73,627, 73,627 (Dec. 11, 2012).
[2] Dominion Cove Point LNG, LP, FE Docket No. 11-128-LNG, Application for Long-Term Authorization to Export LNG to Non-Free Trade Agreement Countries, hereinafter "DCP LNG Export Application."

recognizes and highlights the overwhelming support from elected officials for both the LNG Export Study and LNG exports.

I. LEGAL AND FACTUAL BACKGROUND

A. LEGAL BACKGROUND

Under Section 3(a) of the Natural Gas Act ("NGA"), no person shall export any natural gas from the United States ("U.S.") to a foreign country or import any natural gas from a foreign country without first *having secured an order of the [DOE Secretary] authorizing it to do so. The Secretary shall issue such order upon application, unless, after opportunity for hearing, it finds that the proposed exportation or importation will not be consistent with the public interest*."[3]

In 1977, the DOE Organization Act transferred the regulatory functions of Section 3 of the NGA to DOE. Subsequently, the Secretary of Energy delegated to the Federal Energy Regulatory Commission ("FERC") the authority to "[a]pprove or disapprove the construction and operation of particular facilities, the site at which such facilities shall be located, and with respect to natural gas that involves the construction of new domestic facilities, the place of entry for imports or exit for exports . . . ."[4] Under this delegation order, however, DOE, not FERC, maintained the authority to make the requisite public interest determination for the export of the natural gas commodity.

Section 3(a) creates a rebuttable presumption that a proposed export of natural gas is in the public interest, and DOE must grant such an application unless those who oppose the application overcome that presumption.[5] To evaluate LNG export applications, DOE uses the criteria set out in the "New Policy Guidelines and Delegation Orders From Secretary of Energy to Economic Regulatory Administration and Federal Energy Regulatory Commission Relating to the Regulation of Imported Natural Gas."[6] The Policy Guidelines indicate that DOE's goals in evaluating import and export applications are to minimize federal control and involvement in energy markets and promote a balanced and mixed energy source system. Specifically, the Policy Guidelines provide that:

> [t]he market, not government, should determine the price and other contract terms of imported [or exported] natural gas. The federal government's primary responsibility in authorizing imports [or exports] will be to evaluate the need for the gas and whether the import [or export] arrangement will provide the gas on a competitively priced basis for the duration of the contract while minimizing regulatory impediments to a freely operating market.[7]

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[3] 15 U.S.C. § 717b (emphasis added).

[4] DOE Delegation Order No. 00-004.00A (effective May 16, 2006).

[5] *See Phillips Alaska Natural Gas Corporation and Marathon Oil Company*, Order No. 1473, note 42 at 13, 2 FE 70,317 (in order to overcome the rebuttable presumption favoring export authorizations, opponents of an export license must make an affirmative showing of inconsistency with the public interest); *see also Panhandle Producers and Royalty Owners Association v. ERA*, 822 F.2d 1105, 1111 (D.C. Cir. 1987).

[6] 49 Fed. Reg. 6684-01 (1984) (herein "Policy Guidelines"); *see also* Order No. 1473 at 14 (DOE held that the Policy Guidelines apply to natural gas export applications).

[7] Policy Guidelines, 49 Fed. Reg. at 6685.

DOE Delegation Order No. 0204-111 also guides DOE's analysis of exports under Section 3 of the NGA. Specifically, Delegation Order No. 0204-111 directs DOE to regulate exports "based on a consideration of the domestic need for the gas to be exported and such other matters as the Administrator finds in the circumstances of a particular case to be appropriate."[8] Although DOE Delegation Order No. 0204-111 is no longer in effect, this agency's review of export applications in decisions under current delegated authority has continued to focus on the domestic need for the natural gas proposed to be exported; whether the proposed exports pose a threat to the security of domestic natural gas supplies; and any other issues determined to be appropriate, including whether the arrangement is consistent with DOE's policy of promoting competition in the marketplace by allowing commercial parties to freely negotiate their own trade agreements.[9]

More specifically, in making the public interest determination, DOE considers the following factors:[10]

1. Domestic need for the natural gas proposed for export;
2. Adequacy of domestic natural gas supply;
3. U.S. Energy Security;
4. Impact on U.S. economy (GDP);
5. Job creation;
6. U.S. balance of trade;
7. International (geopolitical) considerations; and
8. Environmental considerations.

These factors align directly with the specific and limited issues on which DOE requested public comment. Thus, in replying to the comments critiquing the LNG Export Study and opposing approval of LNG export applications, DCP focuses its discussion on those specific issues directly related to the public interest determination to further assist DOE in finalizing the LNG Export Study and making a public interest determination concerning DCP's LNG Export Application.

B. FACTUAL BACKGROUND

In May of 2011, DOE approved an application from Sabine Pass Liquefaction, LLC ("Sabine Pass Liquefaction Project") to export LNG from the lower-48 states to non-FTA nations.[11] In the order approving Sabine Pass' application, DOE cautioned that "it has a continuing duty to monitor supply and demand conditions in the U.S. in order to ensure that authorizations to export LNG do not subsequently lead to a reduction in the supply of natural gas needed to meet essential domestic need."[12] There are currently fifteen applications to export LNG to non-FTA countries pending with DOE ("LNG Export Applications"), one of which belongs to DCP.[13] As set forth in DCP's LNG Export Application, upon approval by DOE of export authority, DCP will operate the Cove Point Terminal (herein the "Cove Point

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[8] DOE Delegation Order No. 0204-111.
[9] *See Sabine Pass Liquefaction, LLC*, DOE Order No. 2961 at 28-29.
[10] *See* DOE Presentation, NARUC Winter Committee Meetings, Christopher Smith, "LNG: Out through the In Door," (Feb. 7, 2012)
[11] 77 Fed. Reg. at 73,628.
[12] *Id.*
[13] *See* http://fossil.energy.gov/programs/gasregulation/reports/summary_lng_applications.pdf.

Terminal") as a bidirectional facility.[14] As a bidirectional facility, the Cove Point Terminal will have the capability both to liquefy natural gas for export of natural gas from the U.S. market and to import and regasify that foreign-sourced natural gas for entry into the U.S. market.

In response to the influx of applications, DOE commissioned a two-part study to counsel its decision on the pending applications. These applications will not be processed until DOE has received and evaluated comments and responses to the LNG Export Study as requested by DOE in a Notice on December 5, 2012 which was published in the Federal Register on December 11, 2012. [15]

The U.S. Energy Information Administration ("EIA") performed the initial part of the LNG Export Study, entitled, *Effect of Increased Natural Gas Exports on Domestic Energy Market* (the "EIA Study").[16] EIA published the EIA Study in January 2012. The EIA Study analyzed how specific scenarios of increased natural gas exports might affect the domestic energy markets. In addition, DOE commissioned NERA Economic Consulting ("NERA") to conduct the second part of the LNG Export Study, entitled, *Macroeconomic Impacts of Increased LNG Exports From the United States* (the "NERA Study").[17] NERA published the NERA Study in December 2012. The NERA Study analyzed the macroeconomic impact of LNG exports on the U.S. economy with a focus on the energy sector, and in particular the natural gas sector. Collectively, these studies are referred to herein as the "LNG Export Study".

In its December 5, 2012 request for comments, DOE invited the public to comment on specific, limited, and identifiable issues and topics regarding the LNG Export Study to help inform DOE's decisions whether to authorize the pending fifteen applications. Because DOE commissioned the LNG Export Study for the specific purpose of conducting a public interest determination, DOE requested comments related to the criteria DOE evaluates in public interest determinations. Specifically, DOE requested comments on (and only on): (1) domestic energy consumption, production, and prices; (2) the macroeconomic factors identified in the NERA Study, including but not limited to the Gross Domestic Product ("GDP"), welfare, consumption, and impacts to the U.S. economic sector; and (3) U.S. LNG export feasibility.[18] DOE specifically noted that it will disregard "comments that are not germane to the present inquiry."[19] The comment period for initial comments closed on January 27, 2013. DCP timely filed initial comments.

Until February 25, 2013, DOE will accept reply comments, providing the public an opportunity to respond to issues and arguments submitted in the initial comment period. DCP herein submits its DCP Reply Comments.

II. METHODOLOGY IS SOUND[20]

DOE received comments challenging the methodology and data utilized to estimate the impacts from the pending LNG Export Applications. Specifically, commenters claim the following:

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[14] DCP LNG Export Application, at 11.
[15] 77 Fed. Reg. at 73,629.
[16] The EIA Study is available at www.eia.gov/analysis/requests/fe.
[17] The NERA Study is available at http://www.fossil.energy.gov/programs/gasregulation/LNGStudy.html.
[18] *See* 77 Fed. Reg. at 73,629.
[19] *Id.*
[20] *See* **Exhibit B, Comment 1** for the list of initial comments to which DCP replies in this Section II.

- NERA's reliance on data from EIA's 2011 Annual Energy Outlook ("AEO") undermines the results from the LNG Export Study, including underestimations regarding demand and production;
- NERA inappropriately failed to consider geographic impacts to particular domestic regions and locales; and
- NERA inappropriately failed to consider impacts to each economic sector and specific industry.

DCP disagrees with the concerns raised by the commenters.

With respect to the use of EIA's 2011 AEO data, DCP emphasizes three points. First, the LNG Export Study consists of two parts: (1) a study performed by EIA in January 2012 that assessed how specific scenarios of natural gas exports could affect domestic energy markets; and (2) the NERA study that analyzed macroeconomic impacts of LNG exports on the U.S. economy using a general equilibrium model and with a focus on the energy sectors and particularly the natural gas sector.[21] The EIA Study (completed in January 2012)—before the release of the EIA's 2012 AEO—utilized EIA's 2011 AEO data. NERA then strategically, and reasonably, used the EIA data from the 2011 reference case:

> NERA Economic Consulting used 2011 data because that was data used in the [EIA's] original study for DOE in January 2012. The use of the 2011 data was necessary to provide a baseline for the report's projections, and comprised the most recent and salient data available when the NERA study began in late 2011.[22]

Because the NERA Study builds off the scenarios and evaluations developed in the EIA Study, NERA's utilization of the same estimates ensures consistency between the studies and minimizes discrepancies between the two different, but related parts of the LNG Export Study.

Second, comments questioning the use of the 2011 AEO fail to consider the significant time necessary to complete a study of the magnitude and scope conducted by NERA. NERA's NewEra model, selected by DOE based upon its application to this particular economic analysis, is incredibly complex and requires significant time and effort to complete accurately. At the time that DOE requested the NERA Study (late 2011), the EIA's 2011 AEO data was the most up-to-date information available. That EIA revised its estimations in 2012 and may again revise its estimations in 2013 does not undermine the legitimacy, timeliness and value of the NERA Study. To require federal agencies such as DOE to incorporate revised information into each and every analysis it conducts (or contracts for) would lead to a never-ending and costly cycle of government analysis and bureaucracy.

Though several commenters argue that NERA should have utilized EIA's 2012 AEO data, others argue that NERA should revise the study to use EIA's recently-released (but not yet complete) 2013 AEO data. Were DOE to direct NERA to update the NERA Study with 2012 or 2013 information, those

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[21] 77 Fed. Reg. at 73,627.

[22] *See* Center for Liquefied Natural Gas, "Fact-Checking Senator Wyden's Letter to U.S. Secretary of Energy Steven Chu" (Jan. 30, 2013), **Exhibit C-1**, *available at* http://lnginitiative.org/2013/01/30/fact-checking-senator-wydens-letter-to-u-s-secretary-of-energy-steven-chu/.

opposed to LNG exports likely would claim – during the next public comment period on that revised study – that DOE should have used 2014 information, and so on and so on. DOE's analysis of the public interest must end at some point or outstanding LNG Export Applications will never be processed. In fact, several of the LNG Export Applications were filed well over a year ago. DOE cannot further delay its processing of those applications for the sake of more process. The LNG market will not continue to wait indefinitely for DOE action.

Third, the recommended revisions to the model inputs would not significantly alter the results of the NERA Study and in fact could enhance the benefits of LNG exports identified in the NERA Study. Specifically, many commenters attempt to undermine the NERA Study by alleging both that NERA underestimated demand, overestimated available natural gas reserves, and underestimated production. Commenters fail to acknowledge that increasing the estimated production will offset the proposed increases in demand. Thus, results from any such revised model will not differ substantially from those estimated by NERA.

In fact, if NERA had been able to use the latest data from EIA, the 2013 AEO, NERA would have found that EIA now projects that U.S. natural gas production will grow by over 40 percent from 2012 through 2040.[23] However, over the same period (2011 through 2040), U.S. consumption of natural gas is expected to grow by only 20 percent.[24] Because production of U.S. natural gas is projected to rise faster than consumption by 2040 even according to the most recent data, the U.S. has a natural gas surplus available for export and such export will not have detrimental impacts on the U.S. economy. Additionally, recent studies completed by other financial institutions, notably the Deloitte Center for Energy Solutions ("Deloitte"), have incorporated estimates similar to those proposed by the commenters (*i.e*., higher demand) while obtaining either similar or, in fact "better" economic results. In a recent study completed by Deloitte, entitled *Made In America: The economic impact of LNG exports from the United States*, Deloitte utilized a demand scenario – particularly for the power generation sector – considerably higher than the publicly available EIA forecast.[25] Even under this more conservative model, and without the offsetting, reasonable assumption that production would increase by a greater amount than estimated by EIA, Deloitte found that prices of natural gas will increase only slightly and thus, will not negatively impact U.S. industry or cause them to become uncompetitive in global markets.[26] As a result, no significant job losses will occur based upon LNG exports: to the contrary, LNG exports will result in the creation of tens of thousands of jobs, as explained below. Deloitte's analysis relies upon a fundamental assumption with which DCP agrees: producers of natural gas will anticipate the export volumes and resulting increased prices in making production decisions.[27]

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[23] U.S. Senate Energy and Natural Resources Committee, Testimony Submitted for "Opportunities and Challenges for Natural Gas" by Bill Cooper, Center for Liquefied Natural Gas, at 1 (Feb. 12, 2013), *see* **Exhibit C-2**.

[24] *Id.*

[25] Deloitte Center for Energy Solutions ("Deloitte"), "Exporting the American Renaissance: Global Impacts of LNG Exports from the Unites States," at 5 (Jan. 2013), *see* **Exhibit C-3**, *available at* https://www.deloitte.com/assets/Dcom-UnitedStates/Local%20Assets/Documents/Energy_us_er/us_er_GlobalImpactUSLNGExports_AmericanRenaissance_Jan2013.pdf.

[26] *Id.* at 12.

[27] *Id.* at 7, 9.

As a result, the market will not be surprised or unprepared for the volume of exports and will not have to ration fixed supplies to meet domestic demand. Instead, based on the long-lead time associated with LNG exportation, producers will bring more supplies online and ensure adequate supplies for domestic needs. DCP discusses this issue more thoroughly in Section III(A)(2) below.

With respect to claims that NERA failed to consider specific impacts to regions and economic and industry sectors, DCP contends that DOE's public interest determination does not require such an analysis. In DOE Delegation Order No. 0204-111 – an order DOE has indicated guides its public interest determinations and in the criteria set forth by DOE – analysis of specific economic impacts to regions, socio-economic sectors, and industry sectors are not required. As noted above, DOE's review of export applications focuses on:

> the domestic need for the natural gas proposed to be exported; whether the proposed exports pose a threat to the security of domestic natural gas supplies; and any other issues determined to be appropriate, including whether the arrangement is consistent with DOE's policy of promoting competition in the marketplace by allowing commercial parties to freely negotiate their own trade agreements.[28]

Consistent with the above statements by DOE in ruling on the Sabine Pass Liquefaction Project, DOE's public interest determination factors include: (1) domestic need for the natural gas proposed for export; (2) an assessment of the domestic natural gas supply; (3) U.S. energy security; and (4) the impact to the U.S. GDP. The NERA Study is entirely consistent with the criteria set forth by DOE and provides DOE adequate and valuable information to evaluate those factors as part of its public interest determination. That DOE does not require each and every economic analysis it conducts, contracts for or reviews as part of a public interest determination to address each and every possible regional, socio-economic and industrial sector is both consistent with the guidance set forth by DOE and common sense. Requiring such an in depth and detailed economic analysis for these LNG Export Applications would set an untenable precedent that DOE would then need to follow for all other applications requiring a similar public interest determination. DCP strongly encourages DOE to rely upon the valid and coordinated studies conducted by EIA and NERA (as well as other studies submitted in the DCP LNG Export Application) and make a favorable public interest determination based upon the information presented both in the LNG Export Studies and in each applicant's LNG Export Application.

III. ECONOMICS ARGUMENT[29]

On February 5, 2013, after all initial comments were submitted to DOE, the President of The Center for Liquefied Natural Gas, Bill Cooper, made the following statement at the House Energy and Commerce Committee's Subcommittee on Energy and Power hearing, "American Energy Security and Innovation: An Assessment of North America's Energy Resources":

> Participants in today's hearing confirmed again that the United States has abundant supplies of natural gas and more than enough to allow for exports while also meeting

[28] *See Sabine Pass Liquefaction, LLC*, DOE Order No. 2961 at 29.
[29] *See* **Exhibit B, Comments 2-4** for a list of initial comments to which DCP replies in this Section III.

> growing domestic demand. The ability to export natural gas represents a window of opportunity to create more jobs, generate more public revenues and reduce our trade deficit. We can reap those benefits as soon as the U.S. Department of Energy officially resumes the approval process for proposed LNG export projects.

DCP fully agrees with this statement.

A. The Export of U.S. LNG Is Economically Favorable to the U.S.

In short, the available empirical evidence does not support those opposing the LNG Export Study or opposing approval of the pending LNG Export Applications. The LNG Export Study concluded that the export of U.S. produced LNG will engender a net benefit to the U.S. economy:

> Net benefits to the U.S. would be highest if the U.S. becomes able to produce large quantities of gas from shale at low cost, if world demand for natural gas increases rapidly, and if LNG supplies from other regions are limited. If the promise of shale gas is not fulfilled and costs of producing gas in the U.S. rise substantially, or if there are ample supplies of LNG from other regions to satisfy world demand, the U.S. would not export LNG. Under these conditions, allowing exports of LNG would cause no change in natural gas prices and do no harm to the overall economy.[30]

Numerous sound independent studies support this conclusion; similarly finding that LNG exports will enhance the U.S. economic well-being in the aggregate, while at the same time anticipating modest changes to domestic natural gas prices, including but not limited to:[31] Charles Ebinger *et. al.*, "Liquid Markets: Assessing the case for U.S. Exports of Liquefied Natural Gas," Brooking Institution (May 2012); Michael Levi, "A Strategy for U.S. Natural Gas Exports," The Hamilton Project, Brookings Institution (June 2012); Kenneth B. Medlock II, Ph.D., "U.S. LNG Exports: Truth and Consequences," Energy Forum at the James A. Baker Institute for Public Policy, Rice University (August 2012); Deloitte, "Exploring the American Renaissance: Global Impacts of LNG Exports from the United States" (October 2012) – collectively attached hereto and incorporated herein as **Exhibit C-3 to C-6, respectively.**

Nonetheless, commenters raise two primary economic concerns in opposition to the LNG Export Study:

1. Domestic price increases will detrimentally harm consumers and certain industries; and

2. The LNG Export Study underestimates the amount of natural gas that will be consumed in the U.S., particularly in the domestic industrial sector.

DCP's provides its reply to each issue below.

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[30] NERA Study, at 1-2.

[31] *See* DOE Comments Submitted by Patrick D. Hedren, on behalf of Daniel C. Heintzelman, President & CEO of GE Oil & Gas (Jan. 24, 2013), *available at* http://www.fossil.energy.gov/programs/gasregulation/authorizations/export_study/Daniel_Heintzelman01_24_13.pdf; *see also* Paul Krugman and Maurice Obstfeld, "International Economics: Theory and Policy" (2008).

1. Any Change in the Domestic Price for Natural Gas will be Modest

To the first point, LNG exports will not raise domestic natural gas prices to a point that is economically harmful to either industry or consumers. DCP evaluated the LNG Export Study and several independent economic studies that estimated price effects as a result of LNG exports during 2015 through 2035 of 6 Bcf/day to demonstrate the span of estimated price increases as a result of LNG exports. *See* Table 2 – Price Effects During 2016-2035 from LNG Exports of 6 Bcf/day. The LNG Export Study as well as other independent studies concludes that domestic prices may rise by a minimal amount during periods of LNG exports, but not so much as to be economically harmful to industry or the consumer.

<u>Table 2:</u> **Price Effects During 2016-2035 from LNG Exports of 6 Bcf/day**

Study	Price Increase ($/MMbtu)	Percent Price Increase
EIA[32]	$0.50	9%
Deloitte[33]	$0.12	2%
Navigant[34]	$0.34	6%

A key finding of the LNG Export Study, which must be noted when reviewing Table 2, is that "[p]rices are projected to decrease fairly significantly in [global] regions importing U.S. LNG, but only marginally in the U.S." [35] The span of empirical evidence presented in Table 2 taken together shows a modest increase in domestic gas prices from LNG exports.

Regarding the impact of price on consumers, "[t]he net result is an increase in U.S. house-holds' real income and welfare."[36] Any modest increase in price will be offset by additional sources of income for U.S. consumers. Consequently, in the aggregate, consumers "are better off as a result of opening up LNG exports."[37]

As for the impacts on industries that use natural gas, industry representatives themselves concede that a modest increase in natural gas prices would not impact the competitiveness of their business. For example, at least one petrochemical company—which submitted comments in opposition

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32 EIA Study, at 6-7.
33 Deloitte, at 12-13 (representing the average effect on U.S. prices projections across regions of the country; for example, the average effect on the Henry Hub price is $0.22/MMBtu, while the average effect is less than $0.10 for the Midwest and Mid-Atlantic regions).
34 Navigant Consulting, "Jordan Cove LNG Export Project Market Analysis Study," (Aug. 23, 2010) (projecting the Henry Hub price and assumes 6.6 Bcf per day).
35 *See* Deloitte, at 2.
36 NERA Study, at 6.
37 NERA Study, at 55.

to the LNG Export Study—stated that if natural gas were available at a consistent, yet increased price, the company's competitiveness would not be impacted.[38]

> **Senator Murkowski:** If Congress were to enact legislation that somehow promoted natural gas use, and natural gas was available at a consistent $6-8 dollar per MMBtu range, how would that impact your competitiveness?
>
> **Petrochemical Company Response:** US petrochemical competitiveness depends on a multitude of factors, such as the relative cost of energy (including crude oil, coal, etc.), the relative cost of new facility construction, the strength of the economy in each global area, and the extent to which local industry is protected by local government policies. ***In general, we believe that if crude were in the $75-$100 range, and natural gas were available at a consistent $6-$8 dollar per MMBtu range, US petrochemical facilities could be globally competitive. We believe the best way to achieve consistent natural gas pricing is to adopt a comprehensive policy approach which considers all sources of demand in the context of both normal and extreme situations to ensure the market is resilient to both supply and demand shocks.***

In fact, because the liquefaction of natural gas and subsequent transportation of the LNG to foreign markets is such a costly endeavor, U.S. industrial users of domestic gas will retain a significantly competitive advantage over foreign competitors importing LNG from the U.S.

Recent empirical studies by the Brookings Institute support the petrochemical company's assessment: "the evidence suggests that the competitive advantage of U.S. industrial producers relative to its competitors in Western Europe and Asia is not likely to be affected significantly by the projected increase in natural gas prices resulting from LNG exports."[39] Brookings also found that "increased gas production for exports resulted in increased production of . . . natural gas liquids, in which case exports can be seen as providing a benefit to the petrochemical industry."[40]

Simply stated, concerns that LNG exports would raise domestic natural gas prices to levels economically harmful to either consumers or industry are unfounded.

Moreover, the market will offer a natural constraint of the volume of LNG exports; the LNG Export Study demonstrates that "LNG exports are only feasible under scenarios with high international demand and/or low U.S. costs of production."[41] Thus, global market forces and the availability of natural gas from other sources will limit price increases.

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[38] *See* Senate Energy Committee Hearing on "The Role of Natural Gas in Mitigating Climate Change" (Oct. 28, 2009).

[39] Charles Ebinger *et. al.*, "Liquid Markets: Assessing the case for U.S. Exports of Liquefied Natural Gas," Brookings Institution, at 35 (May 2012) (hereinafter, "Brookings May 2012"), attached hereto as **Exhibit C-4**. *Also available at* http://www.brookings.edu/~/media/research/files/reports/2012/5/02%20lng%20exports%20ebinger/0502_lng_exports_ebinger.pdf.

[40] *Id.*

[41] NERA Study, at 76.

In a market of surplus supply, access to large export markets will serve to balance supply and demand, thereby dampening price volatility, increasing natural gas prices moderately, and, over the long term, providing a sustainable natural gas market in North America—with the supply and price stability needed by North America industrial markets. It would seem, then, that industrial opposition to LNG exports, based on perceptions of price impact, is shortsighted.[42]

The domestic "natural gas market is highly integrated and all segments will work together to mitigate price impacts of demand changes."[43] As demands fluctuate, both domestically and globally, DCP will have the invaluable capability of responding to competitive market forces to better serve the public interest because the Cove Point Terminal will be a bidirectional LNG terminal. In other words, DCP will have the capability to export LNG during times of high domestic natural gas production and high world demand, and in contrast, import LNG for delivery into the domestic market during periods of low domestic supply or low foreign import prices. Overall, empirical evidence and dynamic market factors demonstrate that the impact of LNG exports would be fairly small to domestic gas markets, predictable, and almost indiscernible to the global power market.[44]

In order to foster an adequate supply of energy at reasonable costs, the U.S. government has adopted two principal strategies: (1) minimize federal control and involvement in energy markets, and (2) promote a balanced and mixed energy resource system.[45] DOE has traditionally taken the position that "the market, not the government" should determine the price of natural gas.[46] No national security or other public interest purpose indicates that DOE should not continue to maintain this economic and policy approach.

> While markets and economics will eventually determine the realistic scale of U.S. exports, one also has to take into account wider considerations in assessing policy regarding future LNG exports. For decades, the United States has made the free flow of energy supplies one of the cornerstones of foreign policy. It is a principle we have urged on many other nations. How can the United States, on one hand, say to a close ally like Japan, suffering energy shortages from Fukushima, please reduce your oil imports from Iran, and yet turn around and, on the other, say new natural gas exports to Japan are prohibited?[47]

The flexibility and strategic economic positioning produced by allowing LNG exports to coexist with import nominations will help in the long-run to moderate volatility of domestic prices and maintain reasonable prices during both periods of high and weak domestic demand in order to protect the public interest.

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[42] See Navigant Consulting, "North American LNG Export—A Positive Development," at 3 (July 2012).
[43] *See* Deloitte, at 10.
[44] *Id.* at 18.
[45] Policy Guidelines, 49 Fed. Reg. at 6685.
[46] *Id.*
[47] Daniel Yergin, Expert Witness Testimony, House Energy and Commerce Committee's Subcommittee on Energy and Power Hearing (Feb. 5, 2013).

2. The U.S. Has an Abundant Supply of Natural Gas Sufficient to Support Domestic Demand and Export

The second primary economic issue raised by opponents to the LNG Export Study is that the U.S. does not have an adequate supply of natural gas to provide for both domestic consumption and exports. DCP agrees with Deloitte insofar that this issue is secondary to the above discussion regarding price and "*[i]f price is not significantly affected, then scarcity and shortage of supply are not significant issues*."[48] Global market forces and the availability of natural gas from other sources will limit price increases and ensure that there will be adequate natural gas supply in the U.S. to meet domestic demands. Specifically, "U.S. LNG exports are projected to narrow the price difference between the U.S. and export markets and hence, the market will likely limit the volume of economically viable U.S. LNG exports" with the "spread projected . . . to be reduced by $0.84/MMBtu if 6 [billion cubic feet/day] of exports are sent to Europe under the business-as-usual scenario ($0.15/MMBtu average increase in the U.S. price and $0.69/MMBtu decrease in Europe)."[49]

Nonetheless, we note that natural gas production has substantially increased over the past several years; we point to sound evidence that the U.S. has an abundant supply of natural gas to diffuse concerns relating to supply shortages:

- Over the last decade U.S. natural gas reserves have climbed tremendously, 72% since 2000 and 49% since 2005. In recent years, the increase in reserves is mostly attributed to development of shale gas, which has grown from 10% of U.S. natural gas reserves in 2007 to 32% in 2010.[50]

- There have been a number of reports and studies that attempt to identify the total amount of technically recoverable shale gas resources—the volumes of gas retrievable using current technology irrespective of cost—available in the U.S. These estimates vary from just under 700 trillion cubic feet (tcf) of shale gas to over 1,800 tcf.[51]

- To put these numbers in context, the U.S. consumed just over 24 tcf of gas in 2010, suggesting that the estimates for the shale gas resource alone would be enough to satisfy between 25 and 80 years of U.S. domestic demand.[52]

Opponents' concerns regarding a shortage in domestic natural gas stem largely from arguments suggesting that the LNG Export Study underestimated the domestic demand for LNG, particularly from the energy-intensive industries. This concern, and these arguments, are unfounded. There is only a modest level of growth projected in various sectors of the domestic economy—even from the most recent 2012 studies—none of which should raise concern with regard to the approval of LNG exports as in the public interest.

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48 *See* Deloitte, at 1 (emphasis in original).
49 *Id.* at 2.
50 Congressional Research Service, "Natural Gas in the U.S. Economy: Opportunities for Growth" (Nov. 6, 2012).
51 Brookings May 2012, at 4.
52 *Id.* (*citing* Energy Information Administration, "U.S. Natural Gas Production, Consumption, and Net Imports" *available at* http://www.eia.gov/todayinenergy/detail.cfm?id=770).

- **Industrial Sector**: "Approximately one-third of total U.S. delivered energy, 24.0 quadrillion Btu, was consumed in the industrial sector in 2011. In the *AEO2013* Reference case, total industrial delivered energy consumption grows by 16 percent, to 27.8 quadrillion Btu in 2035 (0.8 quadrillion Btu higher than in the *AEO2012* Reference case) and 28.7 quadrillion Btu in 2040. ***The rate of growth in total industrial energy consumption is greater from 2011 to 2025 than after 2025 in* AEO2013*, as industry responds to the lower natural gas prices resulting from the expansion of shale gas production in the near term. After 2025, increased international competition and rising natural gas prices as a result of more modest growth in shale gas production lead to slower growth in industrial energy consumption.***"[53]

- **Residential Sector**: "Residential delivered energy consumption remains roughly constant in the *AEO2013* Reference case from 2011 to 2040, reflecting consumption levels lower than those in *AEO2012*. Delivered electricity consumption is 5.7 quadrillion Btu and natural gas consumption is 4.3 quadrillion Btu in 2035 in the *AEO2013* Reference case, compared with 5.9 quadrillion Btu and 4.8 quadrillion Btu, respectively, in the *AEO2012* Reference case."[54]

- **Commercial Sector**: "Growth in commercial electricity consumption averages 0.8 percent per year from 2011 to 2040 in *AEO2013*, lower than the 1.0-percent average annual growth in commercial floorspace . . . Growth of natural gas consumption in the commercial sector continues to average roughly 0.4 percent annually in the *AEO2013* Reference case, similar to the rate in the *AEO2012* Reference case."[55]

- **Transportation Sector**: "Delivered energy consumption in the transportation sector remains relatively constant at about 27 quadrillion Btu from 2011 to 2040 in the *AEO2013* Reference case."[56]

U.S. natural gas production is projected to increase more rapidly than domestic consumption, leaving a growing surplus supply of natural gas for export.[57] Observing the statistics more generally, the EIA's 2013 AEO projects that U.S. natural gas production will grow by roughly 40 percent from 2012 to 2040 while U.S. consumption of natural gas is projected to grow by less than 20 percent.[58] Even with this projected rate of total domestic consumption, the U.S. will have a surplus of natural gas that should be leveraged for export.

Opponents' concerns regarding a domestic shortage of natural gas also derive from the fact that there are fifteen LNG export applicants – meaning each plan to develop and operate an LNG export

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[53] AEO Early Release Overview, Report No. DEO/EIA-0383ER (2013) (Dec. 5, 2012) (emphasis added), *available at* http://www.eia.gov/forecasts/aeo/er/early_consumption.cfm.
[54] *Id.*
[55] *Id.*
[56] *Id.*
[57] *See* AEO2013 Early Release Overview *available at* http://www.eia.gov/forecasts/aeo/er/executive_summary.cfm.
[58] U.S. Senate Energy and Natural Resources Committee, at 4 (Feb. 12, 2013), **Exhibit C-2**.

terminal, raising concerns about the quantity of LNG that will be exported. The fact is that the global market will dictate the amount of LNG that can be exported, and the competitive market will only allow a few of these projects to come to fruition. As stated by Daniel Yergin, Vice Chairman of IHS, in his prepared testimony for the Energy and Power Subcommittee hearing:

> Many LNG projects for the United States have been announced. These would be expensive facilities to build – $10 billion or more. Only a handful, in our view, are likely to end up being financed and built. The reason is both cost and the scale of global competition. Currently, 95 million tons of new annual capacity around the world are either under construction or have been committed, which is equivalent to fully a third of existing capacity. Capacity in the U.S. that might be coming into a market late in this decade or early in the next will have to compete with new supply from existing exporters, such as Australia, and the new sources, such as off-shore East Africa and the Eastern Mediterranean. Moreover, western Canada is likely to become a major exporter of LNG to the main markets in Asia. This competition will create a global market offset on how many projects are actually built.[59]

U.S. LNG exports will be tempered by the dynamic global market; export of LNG is both technically and logically feasible, without causing a sharp price increase or supply shortfall.

B. Employment, GDP, and Welfare

U.S. Secretary of Energy, Steven Chu, stated in early 2012, "[e]xporting natural gas means wealth comes to the United States."[60] DCP agrees. Creating a demand on U.S.–produced natural gas will allow domestic gas producers to receive a higher price from foreign buyers. This will necessarily cause domestic natural gas to increase in value. In turn, and over time, domestic producers will therefore invest more in the exploration and production of natural gas, creating a significant number of stable, sustainable, high-paying jobs for millions of Americans.

In 2010, President Obama announced the National Export Initiative, the goal of which is to "double our exports over the next five years, an increase that will support two million jobs in America."[61] When the percentage of GDP is so intricately tied to exports, and the President has issued an initiative to double U.S. exports by 2014 in order to encourage economic growth and the creation of new jobs, the opportunity to export LNG could not come at a more opportune time and could not be more in line with U.S. policies and goals.[62]

According to the U.S. International Trade Administration, each $1 billion of exports could result in more than 5,000 new jobs, many of which are expected to be permanent, well-paying jobs.[63] LNG

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[59] Daniel Yergin, Expert Witness Testimony, House Energy and Commerce Committee's Subcommittee on Energy and Power Hearing (Feb. 5, 2013).
[60] U.S. Secretary of Energy, Steven Chu, February 2, 2012, Houston Community College Town Hall Meeting.
[61] President Obama, State of the Union Address (Jan. 27, 2010).
[62] *See also* U.S. International Trade Administration, "Exports Play Vital Role in Supporting U.S. Employment," *available at* http://trade.gov/publications/ita-newsletter/0510/exports-play-vital-role-in-supporting-us-employment-0510.asp.
[63] *Id.*

exports are projected to bring in between $13 billion and $25 billion. Consequently, LNG exports will likely create between 70,000 and 140,000 new American jobs.[64]

> The billions of dollars in wages generated by these well-paying jobs will be multiplied throughout communities across the country in the form of investment and taxes, which will in turn be used to support schools, fire stations, and other essential public services. This source of shared prosperity will provide a foundation for future growth.[65]

The benefits of LNG exports are not limited to the natural gas industry; the indirect benefits of increased natural gas production will support and stimulate various economic sectors including retail, hotel, restaurant, supply chain, manufacture, and other industries.

Moreover, all levels of government and certain landowners will benefit from the increased tax and revenues created by the increased production of natural gas and the development of LNG export terminals. These revenues would come from taxes, royalty payments, and economic development. Total U.S. taxes are estimated to increase by nearly $11 million per year from 2018 to 2040, not including income taxes, property taxes, or gross receipt taxes.[66] LNG exports are projected to create $25 billion in government royalty and tax revenues for federal, state, and local governments over a period of 25 years.[67]

The upward growth of trade in the expanding LNG global markets will generate significant opportunities for the U.S. economy, improving business competitiveness, employment, GDP, and the welfare of U.S. citizens. LNG exports are most certainly in the public interest.

IV. ATTENUATED CLAIMS OF ENVIRONMENTAL INJURY ARE NOT RELEVANT TO THE DISCUSSION [68]

Several commenters contend that the LNG Export Study must evaluate the environmental impacts and the associated environmental costs from any such impacts resulting from increased natural gas production. More specifically, several commenters contend that:

- LNG exports will increase hydraulic fracturing, which is bad for the environment and leads to enhanced costs.
- Enhanced natural gas production will increase costs from weather events associated with climate change.
- Renewed growth in coal-fired electricity will result as natural gas prices increase due to exports.

DOE and FERC have evaluated and dismissed the precise environmental claims raised in response to the LNG Export Study as recently as August 2012. In fact, Sierra Club raised the same

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64 *See* U.S. Senate Energy and Natural Resources Committee, at 4 (Feb. 12, 2013), **Exhibit C-2**.
65 Brad Karbowsky, United Association of Plumbers, Fitters and HVAC Techs *available at* http://www.lngfacts.org/recent-news/clng-small-business-and-labor-leaders-dominion-and-ge-hold-joint-staff-briefing-to-discuss-support-for-lng-exports/.
66 DCP LNG Export Application, at 18.
67 *Id.*
68 *See* **Exhibit B, Comment 5** for a list of initial comments to which DCP replies in this Section IV.

allegations in opposition to the LNG export facility proposed by Sabine Pass Liquefaction LLC. In Sabine Pass Liquefaction, LLC (FE Docket No. 10-111-LNG)—also referred to herein as the "Sabine Pass Liquefaction Project")—Sierra Club challenged the adequacy of the National Environmental Policy Act ("NEPA") analysis conducted by FERC and adopted by DOE on several grounds, including, among others:

- The EA did not recognize the LNG exports would induce additional shale gas extraction and did not examine the impacts of this extraction on the environment;

- The EA failed to consider that the likely domestic natural gas price increases resulting from DOE's authorization of gas exports could lead to fuel switching by generators of electricity from gas to coal, thereby increasing emissions of more hazardous pollutants and negatively affecting human health and the environment;

- The EA unlawfully failed to take a hard look at impacts on global warming because it improperly concluded that the export facility's greenhouse gas emission were insignificant and improperly failed to consider indirect effects on greenhouse gas emissions, including emissions over the lifecycle of the gas that is produced for liquefaction and gas that is related during the well completion process.

In an April 16, 2012 decision granting Section 3 authorization ("April 2012 FERC Order") to Sabine Pass Liquefaction, LLC, FERC responded to comments by Sierra Club and others that FERC disagreed that it must analyze in the cumulative impacts analysis the indirect effects of the increased shale gas production that the Sabine Pass Liquefaction Project would cause. As noted by FERC, NEPA regulations require analysis of indirect effects only if those effects are "reasonably foreseeable."[69] An impact is only "reasonably foreseeable" if it is "sufficiently likely to occur that a person of ordinary prudence would take it into account in reaching a decision."[70] After a thorough legal analysis, FERC determined that the "impacts which may result from additional shale gas development are not 'reasonably foreseeable' as defined by the CEQ regulations . . . [n]or is such additional development, or any correlative potential impacts, an 'effect' of the project, as completed by the CEQ regulations, for purposes of a cumulative impact analysis."[71]

In its determination, FERC acknowledged that the Sabine Pass Liquefaction Project would support increased shale-gas production, but noted that "no specific shale-gas play is identified" and Sabine Pass could receive natural gas from natural gas plays – both conventional and unconventional – throughout the U.S.[72] FERC further noted that it could not "estimate how much of the export volumes will come from current shale gas production and how much, if any, will be new production 'attributable' to the project."[73] Specifically, FERC found that:

[69] 40 C.F.R. § 1508.8; April 2012 FERC Order at #95.
[70] *City of Shoreacres v. Waterworth*, 420 F.3d 440, 453 (5th Cir. 2005); *see also* April 2012 FERC Order at #95.
[71] April 2012 FERC Order at #96.
[72] April 2012 FERC Order at #97; *see also id*. at #99 ("wells which could produce gas that might ultimately flow to this project might be developed in any of the shale plays that exist in nearly the entire eastern half of the United States").
[73] April 2012 FERC Order at #97.

> The project does not depend on additional shale gas production which may occur for reasons unrelated to the project and over which the Commission has no control, such as state permitting for additional gas wells. An overall increase in nationwide production of shale-gas may occur for a variety of reasons, but the location and subsequent production activity is unknown, and too speculative to assume based on the interconnected interstate natural gas pipeline system. Accordingly, the factors necessary for a meaningful analysis of when, where, and how shale-gas development will occur are unknown at this time.[74]

Based on all of these factors, FERC concluded that "it is simply impractical for the Commission to consider impacts associated with additional shale gas development as cumulative indirect impacts resulting from the project which must, under CEQ regulations, be meaningfully analyzed by this Commission."[75]

Immediately after release of the April 2012 FERC Order, Sierra Club requested a rehearing and a stay of the order(s). In evaluating the Sierra Club's request for a rehearing and stay, FERC issued an order (herein the "July 2012 FERC Order") reaffirming its findings in the April 2012 FERC Order. Specifically, FERC confirmed that the April 2012 FERC Order did not conclude that increased natural gas production was not reasonably foreseeable but rather that it is:

> virtually impossible to estimate how much, if any, of the export volumes associated with the Liquefaction Project will come from existing or new shale gas production. Moreover, while it may be the case that additional shale gas development will result from the Liquefaction Project, the amount, timing and location of such development is simply unknowable at this time.[76]

Additionally, FERC noted that it had recently addressed a similar issue in *Central New York Oil and Gas Company LLC*. 137 FERC 61, 121) (2011), reh'g denied, 138 FERC 61, 104 (2012), aff'd C*oalition for Responsible Growth and Resource conservation, et. Al. v. FERC*, No. 12-566, 2012 U.S. App. LEXIS 11847 (2d Cir. June 12, 2012) (*Central New York*). In *Central New York*, FERC held that the extent and location of future Marcellus Shale wells and the associated development were not reasonably foreseeable with respect to a proposed 39-mile long pipeline located in Pennsylvania – the heart of Marcellus Shale development.[77] Specifically, FERC held in *Central New York* that "while the Pennsylvania Department of Environmental Protection had issued and was continuing to issue, thousands of Marcellus well permits, it was unknown if, or when, any of these wells will be drilled, much less what the associated infrastructure and related facilities may be for those wells ultimately drilled."[78] In short, FERC concluded that too many uncertainties about future well development existed to assist in the decisionmaking

[74] *Id.* at #98.
[75] *Id.* at #99.
[76] July 2012 FERC Order at #9.
[77] *Id.* at #11.
[78] *Id.* at #11.

process.[79] The U.S. Court of Appeals for the Second Circuit affirmed FERC's decision in *Central New York Oil.*

In its evaluation of Sierra Club's request for rehearing, FERC noted that "'induced' shale development and its associated impacts are even more attenuated from the Liquefaction Project than in *Central New York*."[80] FERC continued, finding that even if FERC could confidently state the specific shale play from which production would be induced, FERC noted that the impacts that would result from such induced production are not reasonably foreseeable.[81] As in *Central New York*, "the location, scope, and timing of future wells that may ultimately be drilled, and the associated development (such as well pads, roads and other infrastructure) are unknowable at this time."[82] Accordingly, FERC again concluded "we are not in a position to provide a meaningful analysis of the potential environmental impacts of such development."[83]

DOE evaluated FERC's EA and the arguments presented by Sierra Club and concluded, similar to FERC, that "because the Commission examined all reasonably foreseeable impacts of the Liquefaction Project, DOE believes that the scope of the EA is appropriate and the EA provides a complete picture for purposes of meeting DOE's NEPA responsibilities and fulfilling its duty to examine environmental factors as a public interest consideration under the NGA."[84] DOE acknowledged that

> [i]n reaching this conclusion, DOE is mindful of the Sierra Club's argument that DOE cannot rely on FERC's NEPA review because FERC refused to evaluate the impacts of additional natural gas production that may be induced by allowing exports of LNG. The Commission determined that it is impossible to estimate how much, if any, of the export volumes associated with the Liquefaction Project will come from existing or new shale gas production, and that it is also impossible to know the amount, timing and location of such shale gas development activity.[85]

Ultimately DOE

> accept[ed] and adopt[ed] the Commission's determination that induced shale gas production is not a reasonably foreseeable effect for purpose of NEPA analysis, for the reasons given by the Commission. The Sierra Club has not identified any specific shale gas play that will be or is even projected as likely to be the source of gas processed in and exported through the Liquefaction Project. Additionally, as FERC noted in the April 16, order, there are multiple direct and indirect pipeline interconnections to the Liquefaction Project. In this regard, we agree with the FERC's determination that the Northern Plains case is inapposite because in the present circumstances it is unknown

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[79] *Id.*
[80] *Id.* at #12.
[81] *Id.* at #13.
[82] *Id.*
[83] *Id.*
[84] DOE/FE Order No. 2961-A at 27.
[85] *Id.* at 28.

> how much, if any, new shale gas production the Liquefaction Project will rely on for its export volumes, much less the location or timing of such production. The factors individually and, even more so when combined, make it impossible to meaningfully analyze when, where, and how shale-gas development will be affected by the Liquefaction Project and the proposed exports.[86]

As a result, DOE determined that "the existence of such concerns [over environmental effects of shale gas production] does not establish a causal connection capable of supporting meaningful analysis of the potential environmental impacts of whether or how the Liquefaction Project and the exports of natural gas from the Project will affect shale gas development."[87]

For the precise reasons FERC determined that environmental impacts from increased shale-gas production were not reasonably foreseeable during its analysis of the Sabine Pass Liquefaction Project, the environmental impacts associated with any increased shale-gas production associated with approval of the pending LNG Export Applications are not reasonably foreseeable. Because the environmental impacts of increased shale-gas production cannot be quantified and assessed, any economic costs associated with those environmental impacts cannot be quantified and assessed. Specifically, as in the Sabine Pass Liquefaction Project, the environmental impacts associated with increased shale-gas production from the pending LNG Export Applications are not reasonably foreseeable for reasons that include, but are not limited to:

- The fact that the LNG Export Applications do not rely upon any one specific shale-gas play;
- The proposed LNG facilities are located in different parts of the country and thus, to an even greater extent than in the Sabine Pass Liquefaction Project, would receive natural gas from natural gas plays – both conventional and unconventional – throughout the U.S.;
- DOE cannot estimate how much of the export volumes proposed in those pending LNG Export Applications will come from current natural gas production and how much, if any will be new production attributable to the proposed LNG facilities;
- An overall increase in nationwide production of natural gas may occur from a variety of reasons and it is impossible to allocate the specific production that would result from increased LNG exports associated with the pending applications; and
- The specific location, scope and timing of increased production are unknown and thus the specific environmental impacts from any increased production are unknown.

For these reasons, DOE should not include the costs associated with such attenuated environmental impacts in the LNG Export Study. DOE's reliance generally upon anticipated increases in shale gas production as part of the economic analysis conducted for its public interest determination is not inconsistent with FERC and DOE's decision not to analyze the environmental impacts (and similarly any environmental costs associated with those impacts). As FERC noted in the Sabine Pass Liquefaction Project, "DOE may well have quantified the overall economic benefits of additional shale gas production for purposes of meeting its separate NGA section 3 public interest finding, notwithstanding the act that

[86] *Id.*
[87] *Id.*

the environmental impacts of additional gas production cannot be similarly quantified because the impacts are not reasonably foreseeable."[88]

Additionally, as noted above, DOE's public interest determination includes consideration of the adequacy of domestic natural gas supply, the domestic need for natural gas and the impact on the GDP of the U.S. economy. Nothing in the criteria set forth by DOE requires consideration of attenuated environmental costs that may or may not occur. Analysis as proposed by the commenters would be never-ending and require consideration of all environmental costs and benefits along the entire chain associated with natural gas production – from supply to end-use. Such a detailed analysis is not reasonable in these circumstances or required.

V. INTERNATIONAL (GEOPOLITICAL) CONSIDERATIONS WEIGH IN FAVOR OF LNG EXPORT[89]

In making its public interest determination, DOE must consider the economic and political foreign-policy effects from LNG exports. Here: (1) energy security will increase; (2) the trade deficit with improve; and (3) international negotiations and trade will be improved. LNG exports cannot be viewed in isolation, but must be analyzed as a part of the government's overall trade policy.

First, increased domestic production of LNG will help reduce reliance on foreign sources of oil and strengthen U.S. energy security. Energy security can be realized where, as here, the global demand for U.S. LNG exports is significant; foreign countries have an increasing interest in U.S. LNG exports as economical and stable sources of supply. As other countries experience expansive increases in requirements for natural gas, the demand for gas has grown, increasing foreign interest in U.S. LNG. Japan, in particular, is the world's top importer of LNG in the wake of the Fukushima nuclear crisis.[90] Moreover, as countries have adopted (and continue to adopt) more environmentally strict regulations, and as the global trend to phase out coal as the primary source of electrical generation has become progressively accepted, U.S. LNG has become more valuable. The U.S. and its citizens, have a continuing and vested interest in promoting LNG exports.

Second, LNG exports can help to improve the balance of trade. From the period beginning in 1964 to 2011, the annual U.S. balance of payments in international trade in goods and services escalated from a positive $6 billion to a negative $560 billion.[91] The funds and investments generated by U.S. LNG exports will be able to begin to cure this deficit.

> Proceeding swiftly and responsibly to develop more American energy can help us immeasurably with our fiscal problems, but it can also do so much more for our country. We have more oil, gas, and coal than any other country and we are now the largest single natural gas producer in the world. We are now in a position to export liquefied natural gas and coal, and thus reducing our trade deficit and bringing billions of dollars

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88 July 2012 FERC Order at #20.

89 *See* **<u>Exhibit B, Comment 6</u>** for a list of initial comments to which DCP replies in this Section V.

90 Deloitte, at 4; *see also* Reuters, Japan's 2012 LNG Imports at Record High on Nuclear Woes (Jan. 23, 2013).

91 U.S. Census Bureau, U.S. Trade in Goods and Services – Balance of Payments (BOP) Basis (June 8, 2012) (The peak deficit was actually in 2006 at $753 billion).

> into the United States. The abundance of affordable natural gas is attracting good manufacturing jobs back to America, particularly in the chemical and steel industries. All of this adds up to a lot of jobs, growth, improved national security, and more revenues for government.[92]

By approving LNG exports and making it a part of the broader energy strategy, the U.S. can reduce the trade deficit, borrow less from other nations, and revitalize the domestic economy.

Finally, U.S. LNG as an export would give leverage to the U.S. in international negotiations and trade. For example, Russia has a stronghold on European natural gas markets. Increased U.S. LNG capacity in the global market would shift the economic and political global advantage in favor of the U.S. This would allow the U.S. to occupy a more central role in the global energy portfolio, which would in turn offset the political leverage exerted by other nations. LNG exports will also protect the U.S. from unfavorable geopolitical positioning:

> With 95 percent of the world's consumers outside the United States, export bans on any product, including LNG, can be expected to have far-reaching negative effects, including on domestic economic opportunities, employment and ultimately economic growth.
>
> The United States' ability to challenge other countries' existing exports restraints on agricultural, forestry, mineral and ferrous scrap products – just to name a few – will be virtually non-existent if the United States itself begins imposing its own export restrictions. Even worse, as the world's largest economy and largest trade country, U.S. actions are often replicated by our trading partners to our own dismay. If the U.S. were to go down the path of export restrictions, even more countries would quickly follow suit and could easily limit U.S. access to other key natural resources or inputs that are not readily available in the United States.[93]

LNG exports will give the U.S. momentum to protect energy security, improve the trade deficit, and leverage a more expansive global energy portfolio in international negotiations and trade.

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[92] Thomas Donohue, President and CEO, U.S. Chamber of Commerce, "Marcellus Shale Coalition: What Energy Producers, Manufacturers Are Saying About Natural Gas in the Global Economy" (Jan 10, 2013), *available at* http://lnginitiative.org/2013/01/11/marcellus-shale-coalition-what-energy-producers-manufacturers-are-saying-about-natural-gas-in-the-global-economy/.

[93] *See* U.S. Senate Energy and Natural Resources Committee, at 2 (Feb. 12, 2013), **Exhibit C-2**.

VI. THE SIGNIFICANT MAJORITY OF ELECTED OFFICIALS SUPPORT THE LNG EXPORT STUDY RESULTS AND ENCOURAGE THE DOE TO APPROVE LNG EXPORTS[94]

The following elected officials—220 in total—submitted comments supportive of the LNG Export Study and approval of the pending LNG Export Applications:

Mayor Annise Parkerm Houston (TX)	Mayor Charles P. Sammarone, City of Youngstown (OH)
State Senator Jake Corman (PA), 34th District on behalf of himself and 16 Senators	Mayor Donald L. Plusquellic, City of Akron (OH)
Matthew E. Baker, State Representative (PA-68), on behalf of himself and 8 Representatives	Daniel S. Sullivan, Commissioner, Department of Natural Resources (AK)
Linda S. Vassallo, Director, Department of Economic Development (Calvert County, MD)	Mayor, William J. Healy II, City of Canton (OH)
State Representative Pat Conway (MO-10)	Tom Nelson, Mayor of Lead (SD)
State Representative Doug Funderburk (MO-103)	State Senator Timothy J. Solobay, (PA-46)
Earl Ray Tomblin, Governor (WV)	Mayor Shari L. Buck, City North Las Vegas (NV)
Mayor, Richard P. Vilello, Jr., City of Lock Haven (PA)	Governor, Robert F. McDonnell (VA)
Mayor Benjamin Frederick, Owosso (MI)	Mayor, Rick Wetherell, Mayor, City of North Bend (OR)
Jimmy Hart, County Judge, Conway County (AR)	Mayor Ken Merrifield, Franklin (NH)
Governor Susana Martinez (NM)	Governor Mike Beebe (AR)
Commissioner Darieus K. Adams, Jasper County Commission, Western District Commissioner (MO)	State Representative Michael Stinziano (OH- 18)
Judge Michael Lincoln, White County Judge (AR)	Daniel St. Hilaire, Mayor Pro Temp, City of Concord (NH)
Alan Andreani, Mayor of Alliance (OH)	State Representative Tom Letson, (OH-64)
Phillip E. Dougherty, Vice Chairman Board of Supervisors, Cerro Gordo County (IA)	State Representative Sean J. O'Brien (OH-63)
State Senator Jonathan Dismang (AR-16)	Rodger Craddock, City Manager, City of Coos Bay (OR)
Preston Scroggin, Faulkner County Judge (AR)	U.S. Senator David Vitter (LA)
U.S. Senator James M. Inhofe (OK)	U.S. Representative Charles W. Boustany, Jr., (LA-3)
Ohio House of Representatives (14 State Representatives)	U.S. Senators Mary L. Landrieu, (LA) and Heidi Heitkamp (ND)
State Representative Drew Darby (TX-72)	U.S. Senator John Cornyn (TX)

[94] *See* **Exhibit B, Comment 7** for a list of initial comments to which DCP replies in this Section VI.

110 Members of Congress of the United States	Tommy Roberts, Mayor of Farmington (NM)
Governor Matthew H. Mead, Governor (WY)	Wayne Brosius, Clarion County Commissioner (PA)
Todd Staples, Commissioner, Texas Department of Agriculture	Dicki Bell, Virginia House of Delegates (20th District) (VA)
Governor Phil Bryant, Governor of Mississippi, Chair, Southern States Energy Board	Governors Mary Fallin (OK), John Hickenlooper (CO) and Rick Perry (TX)
U.S. Senator Lisa Murkowski (AK)	State Senator Tommy Williams, (TX-4) and State Representative Allan B. Ritter, (TX-21)
State Senator Jason Rapert (AR- 35)	Mayor Dewey F. Bartlett, Jr. of Tulsa, OK and a Coalition of (18) Mayors from OK, TX, AK and LA
Barry T. Smitherman, Chairman, Railroad Commission of Texas (TX)	

Positive affirmation of LNG exports from all the individuals listed above is significant. Leadership is consistently identified as a critical factor in effective economic development. That more than ninety percent (95%) of the elected officials that commented supported the LNG Export Study speaks volumes to the common vision among our nation's leaders – persons who were voted into office by the people.

The above-listed elected officials support the LNG Export Study and support the approval of the pending LNG Export Applications for five primary reasons. Specifically, LNG exports will (1) create a net economic benefit for the U.S. economy; (2) stabilize U.S. natural gas prices; (3) create American jobs; (4) improve geopolitical matters; and (5) increase taxes and revenues. Below are a few excerpts from various comments submitted by elected officials on each of these five issues.

1. Net Economic Benefit

- "Significantly, across each and every scenario analyzed, the report finds that the export of LNG results in net economic benefits to our economy, and moreover, that benefits increase the level of exports."[95]

- "[I]t was reassuring to see that that the report has concluded that each scenario examined resulted in a net benefit to our economy."[96]

- The LNG Export Study "provides a better understanding of how [LNG] exports provide positive benefits to the public interest, assist the expansion of domestic energy production,

[95] Letter in Support from U.S. Senator Lisa Murkowski, at 1, *available at* http://www.fossil.energy.gov/programs/gasregulation/authorizations/export_study/Lisa_Murkowski01_24_13.pdf
[96] Letter in Support from 110 Members of Congress of the United States, at 1, *available at* http://www.fossil.energy.gov/programs/gasregulation/authorizations/export_study/110MembersOfCongress01_24_13.pdf.

improve the competitiveness of a beleaguered manufacturing sector, and improve the national economy as a whole."[97]

- "As a State Senator from the heart of the Marcellus shale formation, I know first-hand about the transformative impact natural resource development can have on our economy . . . I believe it is imperative that [DOE] quickly approve all pending export applications for non-free trade agreement countries."[98]

2. U.S. Natural Gas Price Stability

- "The NERA study rightly looked at the question of price impacts. In every scenario analyzed, the positive economic impact of a vibrant exploration and production sector and the activity generated by the construction and operation of export terminals provide a net benefit to the economy."[99]

- "We can argue ad nauseam about the speculative impacts on domestic prices based on exporting, which would hold true for any raw material including timber, agricultural products, other minerals, and even refined products from shale gas and ethane. My concern is that the protectionist arguments represent a slippery slope that could exacerbate other efforts to crush exports by inappropriate extrapolation of our environmental laws. The realist is trade and exports are imperative to the success of the U.S. economy, and our deficits in trade and the national budget are fundamental challenges that cannot be resolved by closing the door on LNG or other domestic energy exports ."[100]

3. American Job Creation

- "In 2012, the United States sent $300 billion overseas to purchase oil and gas necessary to fuel the economy." By doing this, "[t]he United States fails to create wealth, jobs, and long-term economic growth by missing the opportunity to invest in and harness the economic potential of the undeveloped natural energy resources that exist domestically."[101]

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[97] Letter in Support from U.S. Sen. James M. Inhofe, at 1, *available at* http://www.fossil.energy.gov/programs/gasregulation/authorizations/export_study/holland_luke_Inhofe01_01_23_13.pdf.

[98] State Senator Jake Corman, (PA) 34th District on behalf of himself and 16 Senators, at 1, *available at* http://www.fossil.energy.gov/programs/gasregulation/authorizations/export_study/08.Senator_%20Jake_Corman01_04_13.pdf.

[99] Letter in Support from 110 Members of Congress of the United States, at 1, *available at* http://www.fossil.energy.gov/programs/gasregulation/authorizations/export_study/110MembersOfCongress01_24_13.pdf.

[100] U.S. Sen. David Vitter, Ranking Member, Committee on Environment and Public Works, at 1, *available at* http://www.fossil.energy.gov/programs/gasregulation/authorizations/export_study/Vitter.pdf.

[101] Letter in Support from U.S. Sen. James M. Inhofe, at 1, *available at* http://www.fossil.energy.gov/programs/gasregulation/authorizations/export_study/holland_luke_Inhofe01_01_23_13.pdf.

- "Oil and gas production directly employs more than 70,000 Oklahomans and contributes at least $26 billion to the state economy. "[102]

- "According to the U.S. International Trade Administration, each $1 billion of exports will result in more than 6,000 new jobs. These jobs would be at LNG facilities and throughout the value chain, including the steel industry, turbine manufacturing, construction and more."[103]

- "As governors representing different regions of the country, we have witnessed the natural gas supply revolution that is transforming our state and the nation. This surge in clean, domestic, affordable energy is stimulating local economies, creating millions of jobs, and enabling new opportunities for our nation."[104]

4. Geopolitical Considerations

- "Other nations are already at work trying to duplicate the success of America's shale industry. These advantages won't last forever."[105]

- "Just a few years ago, the nation was preparing to become a major importer of natural gas; today, the United States is on a path to energy independence in this generation."[106]

- "The global opportunity U.S. natural gas supplies could have in delivering geopolitical stability and national security cannot be overlooked. Stabilizing world energy markets with U.S. natural gas supplies could help free global economies from being forced to rely primarily on Russia or OPEC for energy needs."[107]

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[102] Letter in Support from U.S. Sen. James M. Inhofe, at 1, *available at* http://www.fossil.energy.gov/programs/gasregulation/authorizations/export_study/holland_luke_Inhofe01_01_23_13.pdf.

[103] State Senator Jake Corman, (PA) 34th District on behalf of himself and 16 Senators, at 1, *available at* http://www.fossil.energy.gov/programs/gasregulation/authorizations/export_study/08.Senator_%20Jake_Corman01_04_13.pdf.

[104] Governor Susana Martinez, State of New Mexico, at 1, *available at* http://www.fossil.energy.gov/programs/gasregulation/authorizations/export_study/susana_martinez_01_22_13.pdf.

[105] Letter in Support from 110 Members of Congress of the United States, at 2, *available at* http://www.fossil.energy.gov/programs/gasregulation/authorizations/export_study/110MembersOfCongress01_24_13.pdf.

[106] Letter in Support from U.S. Sen. James M. Inhofe, at 1, *available at* http://www.fossil.energy.gov/programs/gasregulation/authorizations/export_study/holland_luke_Inhofe01_01_23_13.pdf.

[107] Governor Susana Martinez, State of New Mexico, at 1, *available at* http://www.fossil.energy.gov/programs/gasregulation/authorizations/export_study/susana_martinez_01_22_13.pdf.

5. Increased Taxes and Revenues

- "The production of domestic fossil fuels as a direct result of private capital investment on lands not controlled by the federal government has had unequivocally positive effects for our nation in the creation of jobs, tax revenues, royalties, equipment orders, and the production of materials from domestic manufacturers."[108]

- "The growth of the natural gas industry drives job creation, increases tax revenues, royalties and supports domestic manufacturing."[109]

VII. CONCLUSION

Section 3(a) of the NGA creates a rebuttable presumption that an application for LNG exports are in the public interest. DOE must grant such application unless those in opposition overcome the presumption. No comments submitted to DOE in the initial comment period meets the burden of proof to demonstrate that the proposed authorizations for LNG exports would be inconsistent with the public interest, as would be required to deny the fifteen pending LNG Export Applications. LNG exports are in the public interest; benefits to the public include, but are not limited to, greater economic output, higher gas-industry profits, improved trade balance, increased employment, less price volatility, cleaner global environment, increased government revenues, improved trade relations, more balanced trade deficit, and increased U.S. leveraging in trade negotiations. The LNG Export Study provides DOE, the public, and the applicants the sound support and basis on which to make a public interest determination favorable to the LNG Export Applications. To do otherwise would be a missed opportunity.

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[108] U.S. Senator David Vitter, at 1 *available at* http://www.fossil.energy.gov/programs/gasregulation/authorizations/export_study/Vitter.pdf.

[109] U.S. Senators Mary L. Landrieu and Heidi Heitkamp, at 1, *available at* http://www.fossil.energy.gov/programs/gasregulation/authorizations/export_study/landrie.pdf.

Exhibit A

DCP INITIAL COMMENTS

From:	Amanda K Prestage
To:	LNGStudy
Cc:	Anderson, John; Tracy, Lisa
Subject:	2012 LNG Export Study
Date:	Thursday, January 24, 2013 9:59:01 AM
Attachments:	FILED - DCP Comments on the 2012 LNG Export Study .pdf

Attached are Dominion Cove Point LNG, LP's comments to the NERA Study.

Please let me know if you have any questions.

Thanks,
Amanda

Amanda K. Prestage
Regulatory and Certificates Analyst III

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January 24, 2013

Mr. John Anderson
U.S. Department of Energy
Office of Fossil Energy
Docket Room 3F-056, FE-50
Forrestal Building
1000 Independence Avenue, SW
Washington, DC 20585

Re: 2012 LNG Export Study

Dear Mr. Anderson,

On December 5, 2012, the Department of Energy (DOE) invited comments regarding the 2012 LNG Export Study to help to inform DOE in its public interest determinations of the authorizations sought in the 15 pending applications to export liquefied natural gas (LNG) to non-free trade countries. The attached comments Dominion Cove Point LNG, LP (DCP) is filing today address the results and conclusions of the 2012 LNG Export Study on the factors evaluated. Those factors include the impact of LNG exports on: domestic energy consumption, production and prices, and particularly the macroeconomic factors identified in the NERA analysis, including Gross Domestic Product (GDP), welfare analysis, consumption, U.S. economic sector analysis, and U.S. LNG export feasibility analysis, and other factors included in the analysis. DCP has also included comments on the feasibility of various scenarios used in the analyses.

If you have any questions, please contact Amanda Prestage at 804-771-4416.

Respectfully submitted,

/s/ Matthew R. Bley

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UNITED STATES OF AMERICA
BEFORE THE DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY

In the Matter of

2012 LNG EXPORT STUDY

COMMENTS OF DOMINION COVE POINT LNG, LP ON THE 2012 LNG EXPORT STUDY

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Filed: January 24, 2013

UNITED STATES OF AMERICA
BEFORE THE DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY

In the Matter of

2012 LNG Export Study

COMMENTS OF DOMINION COVE POINT LNG, LP ON THE 2012 LNG EXPORT STUDY

As requested by the Department of Energy ("DOE"), Dominion Cove Point LNG, LP ("DCP") submits the comments provided herein on the 2012 LNG Export Study (herein the "LNG Study"). DCP understands that both the LNG Study and the comments and responses thereto will inform DOE as it conducts public interest determinations on fifteen (15) applications, including DCP's application[1] (herein DCP's Application"), requesting approval to export liquefied natural gas ("LNG") to non-free trade countries. DCP appreciates the opportunity to present these comments and further reserves its right to present additional comments on the LNG Study during this and any additional comment periods; respond to any and all comments during the response period; and address the LNG Study during any and all DOE hearings and evaluations of DCP's Application.

As requested, these comments address the results and conclusions of the LNG Study with respect to: (1) domestic energy consumption, production and prices; (2) the macroeconomic factors identified in the NERA Economic Consulting report on the Macroeconomic Impacts of LNG Exports from the United States ("NERA Analysis"), including but not limited to its evaluation of Gross Domestic Product ("GDP"), welfare, consumption, impacts to the U.S. economic sector; and, (3) U.S. LNG export feasibility. DCP applauds DOE's efforts to conduct and release for public comment the NERA Analysis of macroeconomic impacts of LNG exports and the related Energy Information Administration Study ("EIA Study") on effects of increased natural gas exports on domestic energy markets. As DOE has acknowledged, the results of the EIA study were limited and reflected natural

[1] Dominion Cove Point LNG, LP, FE Docket No. 11-128-LNG, Application for Long-Term Authorization to Export LNG to Non-Free Trade Agreement Countries at P. 14-19.

gas supply, demand and corresponding prices based upon specified levels of LNG exports. In contrast, NERA, utilizing a macroeconomic general equilibrium model, projects results for numerous scenarios of LNG exports and concludes that "peak natural gas export levels, specified by DOE/FE for the EIA study, and resulting price increases are not likely."[2] As such, combining the NERA Analysis with the EIA Study provides vital and invaluable information that will assist DOE in its complex evaluation of the implications of approving pending applications for the export of LNG to non-free trade countries and its conclusions support DOE's approval of applications such as DCP's on both commercial and public interest bases.

Because the LNG Study as a whole presents information pertinent to DCP's Application, DCP's comments refer to specific data presented in its application; information that can be located at: Dominion Cove Point Application for Long-Term Authorization to Export LNG to Non-Free Trade Agreement Countries, FE Docket No. 11-128-LNG, including:

Appendix A: Navigant Supply Report

Appendix B: Navigant Price Report

Appendix C: ICF Economic Benefits Study

1. ***<u>Domestic energy consumption, production and prices</u>***

DCP strongly agrees with the following key finding in the NERA Analysis:

> Net benefits to the U.S. would be highest if the U.S. becomes able to produce large quantities of gas from shale at low cost, if world demand for natural gas increases rapidly, and if LNG supplies from other regions are limited. If the promise of shale gas is not fulfilled and costs of producing gas in the U.S. rise substantially, or if there are ample supplies of LNG from other regions to satisfy world demand, the U.S. would not export LNG. Under these conditions, allowing exports of LNG would cause no change in natural gas prices and do no harm to the overall economy.[3]

DCP agrees that global market forces and the availability of natural gas from other sources will limit price increases and ensure that there will be adequate natural gas supply in the U.S. to meet demand requirements.

[2] NERA Economic Consulting, "Macroeconomic Impacts of LNG Exports from the United States, at P. 9.
[3] Id. at P. 1-2.

Further, as noted in DCP's Application for its export project ("DCP Project") at its Cove Point LNG Terminal (herein the "Cove Point Terminal")[4], upon the necessary approval by DOE and FERC, DCP will operate the Cove Point Terminal as a bidirectional facility. As a bidirectional facility, the Cove Point Terminal will have the capability to export LNG during times of high domestic natural gas production and high world demand (the current market situation) and in contrast, import LNG (and vaporize it into natural gas) for delivery into the domestic interstate pipeline network during times of low domestic supply or low foreign prices as compared to domestic prices. Thus, DCP will have the ability to be responsive to competitive market forces and better serve both DCP's customers' commercial interests, as well as the public interest.

2. ***The macroeconomic factors identified in the NERA analysis***

The macroeconomic factors identified in the NERA Analysis and the resulting model outputs provide a realistic estimation of impacts on the domestic economy from LNG exports, including economic impacts that result from policy, regulatory and economic decisions and conditions stemming from LNG exports.

A. Gross Domestic Product (GDP)

DCP agrees that the near term impact on GDP will be very positive and further anticipates that the long-term contribution (2018 to 2040) to GDP from the DCP Project itself will be substantial. In support of the findings in the LNG Study, DCP provides data regarding the impacts that the DCP Project alone will have on the GDP.

The DCP Project will result in: (1) direct and indirect job creation; (2) direct economic stimulation from construction; (3) indirect economic stimulation; (4) promotion of domestic production of petroleum and liquid hydrocarbon; (5) improvement in the U.S. balance of trade; and (6) increased tax and royalty revenues.

The short-term economic impacts from construction and operation of the DCP Project have

[4] Dominion Cove Point LNG, LP, FE Docket No. 11-128-LNG, Application for Long-Term Authorization to Export LNG to Non-Free Trade Agreement Countries at P. 11.

the potential to support between 2,700 and 3,400 "job years"[5] in Calvert County, Maryland, as well as approximately 1,000 additional jobs in the rest of the State of Maryland. Moreover, the significant inter-linkage between various economic sectors provides the potential to support an additional 3,850 to 4,820 jobs in the rest of the Nation during peak construction. During operations from 2018 through 2040, the economic activity at the Cove Point Terminal is estimated to result in 320 jobs yearly across the Nation. Moreover, economic activity associated with the long-term upstream supply of natural gas for exports from the Cove Point Terminal would result in an average of over 18,000 new jobs annually.[6]

Additionally, the DCP Project has the potential to create significant short-term economic activity in the region and throughout the state during the construction and operation phases. In 2015, construction of the DCP Project will create between $183 and $230 million in "value added" (meaning the contribution to GDP, calculated as the difference between the outputs generated from expenditures and the expenditures for intermediate goods and services) within Calvert County and an additional $80 to $100 million in the rest of Maryland. Annual activities during operations from 2018 through 2040 are expected to generate an additional $22 million in value added annually for Calvert County, Maryland, and over $47 million for the U.S. in total.[7]

In aggregate, $44 billion in total value added is projected to result from anticipated upstream expenditures of $32 billion needed to supply the LNG exports over the 25-year period. The top sectors that will benefit, as a function of total value added, include real estate and equipment rentals; oil and gas support activities; educational, medical, hotel, food, and other services; wholesale and retail trade; and IT, scientific, environmental, and waste management services.[8]

Incremental production of hydrocarbon liquids from 2016 through 2040 associated with LNG exports by DCP is estimated at 8.5 million barrels per year, with an average projected market value of $1.2 billion per year. This increased domestic production will help reduce reliance on foreign

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[5] A “job-year” is defined as the amount of work performed by one full-time individual in one year (typically 2,080 hours). For ease of presentation, the DCP Project impacts in “job-years” are referred to herein simply as jobs.

[6] Dominion Cove Point LNG LP, FE Docket No. 11-128-LNG Application for Long-Term Authorization to Export LNG to Non-Free Trade Agreement Countries at P. 16.

[7] Id. at P. 16-17.

[8] Id. at P. 17.

sources of oil and help U.S. industry, particularly the petrochemical industry.[9]

LNG exports, along with associated natural gas liquids ("NGLs") production, will help realign the U.S. balance of trade by a range of $2.8 billion to nearly $7.1 billion per year. The value of the exports is estimated to reduce the total U.S. trade deficit (compared to the 2010 deficit) by between 0.6 and 1.4 percent.[10]

Estimated tax revenues generated as a result of the construction phase of the DCP Project peak in 2014 with a total of $130-$163 million nationally. Total U.S. taxes are estimated to increase by nearly $11 million per year from 2018-40, not including income taxes, property taxes, or gross receipt taxes. In addition, the long-term operation of the Cove Point Terminal is expected to produce up to $40 million per year of property tax revenues. Also, upstream economic activity associated with gas production to support the incremental LNG exports is associated with $25 billion in government royalty and tax revenues to federal, state, and local governments over the 25-year period, with an average of approximately $1 billion in annual revenues. Another $9.8 billion in royalty income over the 25 years will be provided to landowners in the form of mineral leases.[11]

Thus, not only will LNG exports nation-wide contribute favorably to the GDP, but DCP's proposed exports by themselves will result in favorable contributions to the GDP.

B. Welfare analysis

DCP agrees that positive changes will occur with respect to the U.S. economy, employment, trade and energy supply with the addition of LNG export capabilities in the continental U.S. The NERA Analysis concludes that the "U.S. would experience net economic benefits from increased LNG exports…and found that even with exports reaching levels greater than 12 Bcf/day and associated higher prices than in the constrained cases, there were net economic benefits from allowing unlimited exports in all cases."[12] DCP agrees with this conclusion.

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[9] Id. at P. 17.
[10] Id. at P. 17-18.
[11] Id. at P. 18.
[12] NERA Economic Consulting, "Macroeconomic Impacts of LNG Exports from the United States, at P. 6.

Further, DCP agrees with another observation expressed in the NERA Analysis that, "[n]et benefits to the U.S. economy could be larger if U.S. businesses were to take more of a merchant role."[13] Though DCP agrees, DCP has chosen to not take a merchant role in LNG export because the DCP Project makes business sense if DCP "provides a service to its customers of liquefying natural gas and loading onto LNG tankers at the Terminal for export, [which] may also include rights for the customers to import LNG for vaporization and send-out as regasified LNG into the domestic market, when it is desired by the customers."[14]

C. Consumption and U.S. economic sector analyses

As noted in the NERA Analysis, the modeling "results suggest that the wealth transfer from exports of LNG provides net positive income for the consumers to spend after taking into account potential decreases in capital and wage income from reduced output."[15] This conclusion is consistent with DCP's conclusions regarding consumption (defined by the NERA Analysis as total spending on goods and services in the economy) and the benefits of LNG exports from the Cove Point Terminal; conclusions detailed in the ICF Economic Benefits Study ("ICF Study") included as Appendix C to DCP's Application. As part of that study, ICF assessed the national and regional impacts of the DCP Project, quantifying both the direct and secondary benefits. The ICF Study discusses the results in the creation of new jobs and the impact on the existing economy (in terms of income, wages, taxes, etc.). The ICF Study also details the macro-level, national and international implications of the DCP Project, including the impact on the U.S. balance of trade and the economic impact of upstream expenditures due to the significant new demand for the gas to be exported. The ICF Study is premised on a project with inlet capacity of 0.75 Bcf/d, assumed to be operated at 90 percent of capacity. To the extent that DCP constructs a larger project — consistent with the requested export authorization for up to 1 Bcf/d — the economic benefits will be even greater. The

[13] Id.

[14] Dominion Cove Point LNG, LP, FE Docket No. 11-128-LNG, Application for Long-Term Authorization to Export LNG to Non-Free Trade Agreement Countries at P. 7-8.

[15] NERA Economic Consulting, "Macroeconomic Impacts of LNG Exports from the United States, at P. 57.

benefits of the DCP Project far outweigh any perceived detriment of modestly increased domestic natural gas prices.

The most basic benefit of the proposed LNG exports will be to encourage and support increased domestic production of natural gas and NGLs. The DCP Project would allow domestic natural gas that might otherwise be shut-in as a result of a lack of market demand to be available for sale into the global LNG market. The steady new demand associated with LNG exports can spur the development of new natural gas resources that might not otherwise be developed. In the recent order authorizing LNG exports from Sabine Pass, DOE concluded that it was "persuaded that directionally, natural gas production associated with exports... will result in increased production that could be used for domestic requirements if market conditions warrant such use. Overall, this will tend to enhance U.S. domestic energy security. "[16]

Moreover, the development of the gas resources for export by DCP will also result in the increased production of NGLs. In its *Sabine Pass* order, DOE/FE found that the applicant demonstrated that the production of domestic natural gas will yield NGLs which will, in part, offset the need to import oil. NGLs are used as home heating fuels, refinery blending and agricultural crop drying, and the U.S. petrochemical industry uses ethane in particular as a feedstock in numerous applications. New supplies of NGLs from shale production (including the Marcellus and Utica) create a new competitive advantage for the industry that presents a tremendous opportunity to strengthen U.S. manufacturing, boost economic output and create jobs. Indeed, the recent development of shale gas has already led the U.S. petrochemical industry to announce significant expansions of petrochemical capacity, reversing a decades-long decline. The DCP Project will further this trend by supporting additional natural gas development. ICF estimates that LNG exports from Cove Point Terminal will result in the incremental production of approximately 8.5 million barrels of hydrocarbon liquids per year, with a market value of approximately $1.2 billion per year (in real 2011 dollars). Of particular importance in the current economic climate, the DCP Project also

[16] *Sabine Pass,* Order No. 2961 at P. 35.

will result in new jobs for American workers that will lead to greater capacity for consumption across the economy.

3. ***U.S. LNG export feasibility analyses***

DCP agrees with the NERA Analysis that LNG exports depend upon the availability, demand and price for natural gas both globally and in the U.S. and that LNG exports will vary depending upon competitive market forces. DCP's proposal to operate its Cove Point Terminal as a bidirectional facility is entirely consistent with the NERA Analysis, its internal expectations as to the fluctuating nature of LNG exports, and the conclusions that the domestic economy will only benefit from LNG exports. Specifically, DCP states as follows in its application:

> Following the approval and construction of the liquefaction and export facilities, the Cove Point LNG Terminal will be operated as a bi-directional facility. The Terminal will retain the capability to import LNG and vaporize it into natural gas for delivery into the domestic interstate pipeline network, and add the capability of liquefying natural gas to export as LNG to foreign markets. Thus, the Cove Point LNG Terminal then will be responsive to competitive market forces. When U.S. gas prices are low compared to prices in other countries (as they are now), domestic gas can be exported from the Terminal. In contrast, if prices of LNG in other parts of the world fall below the U.S. prices, DCP's customers may utilize the Terminal to import LNG and supply the regasified natural gas to the domestic market.[17]

4. ***Conclusion***

The completed LNG Study, consisting of the EIA Study and NERA Analysis, has provided DOE, the public and the applicants for LNG export authorizations the extensive data and analysis necessary for DOE to evaluate (and approve) the pending applications for LNG export. The LNG Study demonstrates that "LNG exports are only feasible under scenarios with high international demand and/or low U.S. costs of production."[18] These findings demonstrate that concerns that LNG exports would raise domestic natural gas prices to economically harmful levels are unfounded. Instead, LNG exports will be constrained by global markets for natural gas and supply and government regulation of natural gas production and prices in other countries. Even more

[17] Dominion Cove Point LNG, LP, FE Docket No. 11-128-LNG, Application for Long-Term Authorization to Export LNG to Non-Free Trade Agreement Countries at P. 11.
[18] NERA Economic Consulting, "Macroeconomic Impacts of LNG Exports from the United States, at P. 76.

compelling, the NERA Analysis demonstrates that “consumer well-being improves in all [LNG export] scenarios…[and] there are net benefits to the U.S.”[19] Overall, the LNG Study demonstrates that LNG export to non-free trade countries will benefit the public interest in the U.S. and the current global supply and demand conditions indicate that DOE should proceed as expeditiously as possible to allow such exports to occur. Accordingly, DCP respectfully requests that based upon this extremely comprehensive and extensive analysis, DOE proceed to approve, as soon as possible, the Dominion Cove Point LNG, LP Application for Long-Term Authorization to Export LNG to Non-Free Trade Agreement Countries.

[19] NERA Economic Consulting, “Macroeconomic Impacts of LNG Exports from the United States, at P. 76 -77.

Exhibit B

Citations to Specific Initial Comments to Which Dominion Replies in these DCP Reply Comments

Initial Comment Author	Citation to Initial Comment	Reference to DCP Reply Comments Where DCP Specifically Replies to Issue Raise
Comment 1: Allegations that Methodology is Flawed		
U.S. Senator Ron Wyden (OR)	pp. 1 – 5	Section II, pp. 6 – 9
U.S. Representative Edward Markey (Mass.)	pp. 1 – 3	Section II, pp. 6 – 9
Yvette Colon, on behalf of Rick Bowen, President, Energy, Alcoa	pp. 2 – 3	Section II, pp. 6 – 9
Phillip Johnson, Executive Director, Oregon Shores Conservation Coalition	p. 2	Section II, pp. 6 – 9
Bertram Kalisch, President & CEO, American Public Gas Association	pp. 2 – 3	Section II, pp. 6 – 9
Peter A. Molinaro, Vice President, North America Government Affairs, The Dow Chemical Company	pp. 9 – 11, 26 – 28	Section II, pp. 6 – 9
Jody McCaffree, Individual/Executive Director, Citizens Against LNG Inc.	pp. 3 – 4	Section II, pp. 6 – 9
Marnie Satterfield, Industrial Energy Consumers of America	p. 3	Section II, pp. 6 – 9
Charles Johnson, VP, EH&S, The Aluminum Association	p. 3	Section II, pp. 6 – 9
Sean Dixon, Coastal Policy Attorney, Clean Ocean Action	p. 5	Section II, pp. 6 – 9
Brett Smith, American Iron and Steel Institute	pp. 2, 4	Section II, pp. 6 – 9
Katie Missimer, on behalf of Jerry Schwartz, Senior Director, Energy and Environmental Policy, American Forest & Paper Association	pp. 2 – 3	Section II, pp. 6 – 9
Save Our Supplies	p. 7	Section II, pp. 6 – 9
Jannette Barth, Ph. D, Pepacton Institute LLC	pp. 1 – 4	Section II, pp. 6 – 9
Wallace Tyner, Professor, Purdue University	pp. 2 – 5; pp. 28 – 33	Section II, pp. 6 – 9
Francis Eatherington, Conservation Director, Cascadia Wildlands	pp. 2 – 4	Section II, pp. 6 – 9

Initial Comment Author	Citation to Initial Comment	Reference to DCP Reply Comments Where DCP Specifically Replies to Issue Raise
Comment 2: Claims that Price Increase Will Harm Industry and Consumers		
Jennifer Diggins, Director, Public Affairs, Nucor Corporation	pp. 1 – 2	Section III, Subpart A(1), pp. 9 – 13
U.S. Representative Edward Markey (Mass.)	pp. 3 – 6	Section III, Subpart A(1), pp. 9 – 13
J. Clark Mica, Vice President of Government Relations, The Fertilizer Institute	All	Section III, Subpart A(1), pp. 9 – 13
Brett Smith, American Iron and Steel Institute	pp. 3 – 4	Section III, Subpart A(1), pp. 9 – 13
Katie Missimer, on behalf of Jerry Schwartz, Senior Director, Energy and Environmental Policy, American Forest & Paper Association	pp. 3 – 5	Section III, Subpart A(1), pp. 9 – 13
Jannette Barth, Ph. D, Pepacton Institute LLC	pp. 3 – 4	Section III, Subpart A(1), pp. 9 – 13
Carmen Legato, President, CarbonX Energy Company, Inc.	pp. 6 – 8	Section III, Subpart A(1), pp. 9 – 13
Comment 3: Claims that the LNG Export Study Underestimates Domestic Demand for LNG		
Jennifer Diggins, Director, Public Affairs, Nucor Corporation	p. 4	Section III, Subpart A(2), pp. 10, 14 – 16
Yvette Colon, on behalf of Rick Bowen, President, Energy, Alcoa	pp. 2 – 3	Section III, Subpart A(2), pp. 10, 14 – 16
Bertram Kalisch, President & CEO, American Public Gas Association	pp. 2 – 3	Section III, Subpart A(2), pp. 10, 14 – 16
Marnie Satterfield, Indstrial Energy Consumers of America	pp. 3 – 8	Section III, Subpart A(2), pp. 10, 14 – 16
Save Our Supplies	pp. 7 – 12	Section III, Subpart A(2), pp. 10, 14 – 16
Carmen Legato, President, CarbonX Energy Company, Inc.	pp. 27 – 28	Section III, Subpart A(2), pp. 10, 14 – 16
Comment 4: Allegations that Employment, GDP, and Welfare Will Suffer from LNG Export		
Marnie Satterfield, Indstrial Energy Consumers of America	pp. 9 – 13	Section III, Subpart B, pp. 16 – 17
U.S. Representative Edward Markey (Mass.)	pp.6 – 7	Section III, Subpart B, pp. 16 – 17
Yvette Colon, on behalf of Rick Bowen, President, Energy, Alcoa	p. 3	Section III, Subpart B, pp. 16 – 17
Bertram Kalisch, President & CEO, American Public Gas Association	pp. 2 – 7	Section III, Subpart B, pp. 16 – 17

Initial Comment Author	Citation to Initial Comment	Reference to DCP Reply Comments Where DCP Specifically Replies to Issue Raise
Peter A. Molinaro, Vice President, North America Government Affairs, The Dow Chemical Company	pp. 28 – 30, 34 – 40	Section III, Subpart B, pp. 16 – 17
Craig Segall, Staff Attorney, Sierra Club Environment Law Program	pp. 6 – 13	Section III, Subpart B, pp. 16 – 17
Sean Dixon, Coastal Policy Attorney, Clean Ocean Action	pp. 5 – 7	Section III, Subpart B, pp. 16 – 17
Francis Eatherington, Conservation Director, Cascadia Wildlands	pp. 2 – 3	Section III, Subpart B, pp. 16 – 17
Jannette Barth, Ph. D, Pepacton Institute LLC	pp. 2 – 4	Section III, Subpart B, pp. 16 – 17
Save Our Supplies	pp. 3, 17	Section III, Subpart B, pp. 16 – 17
Jody McCaffree, Individual/Executive Director, Citizens Against LNG Inc.	p. 8	Section III, Subpart B, pp. 16 – 17
Comment 5: Claims that Environmental Harms/Costs From Increased Shale Production Must Be Considered		
Katherine Kennedy, Clean Energy Counsel, NRDC	pp. 1 – 4	Section IV, pp. 17 – 22
Phillip Johnson, Executive Director, Oregon Shores Conservation Coalition	pp. 2 – 3	Section IV, pp. 17 – 22
Craig Segall, Staff Attorney, Sierra Club Environment Law Program	pp. 24 – 52	Section IV, pp. 17 – 22
Sean Dixon, Coastal Policy Attorney, Clean Ocean Action	p. 8	Section IV, pp. 17 – 22
Theodore Robinson, Staff Attorney, Citizen Power	pp. 1 – 2	Section IV, pp. 17 – 22
Olivia Thorne, President, League of Women Voters of Pennsylvania	pp. 1 – 3	Section IV, pp. 17 – 22
Judith K. Canepa, Co-Founder, New York Climate Action Group	All	Section IV, pp. 17 – 22
Save Our Supplies	pp. 19 – 20	Section IV, pp. 17 – 22
Environmental Working Group, Dusty Horwitt, Senior Counsel, Briana Dema, Pam Solo and Jill Wiener	pp. 3 – 6	Section IV, pp. 17 – 22
Francis Eatherington, Conservation Director, Cascadia Wildlands	pp. 3 – 5	Section IV, pp. 17 – 22
Jody McCaffree, Individual/Executive Director, Citizens Against LNG Inc.	pp. 5 – 6	Section IV, pp. 17 – 22

Initial Comment Author	Citation to Initial Comment	Reference to DCP Reply Comments Where DCP Specifically Replies to Issue Raise
Comment 6: Claims that LNG Export Will Harm International (Geopolitical) Relations		
Peter A. Molinaro, Vice President, North America Government Affairs, The Dow Chemical Company	pp. 31 – 32	Section V, pp. 22 – 23
Save Our Supplies	p. 18	Section V, pp. 22 – 23
Jannette Barth, Ph. D, Pepacton Institute LLC	p. 4	Section V, pp. 22 – 23
Francis Eatherington, Conservation Director, Cascadia Wildlands	pp. 2 – 5	Section V, pp. 22 – 23
Jody McCaffree, Individual/Executive Director, Citizens Against LNG Inc.	pp. 4 – 5	Section V, pp. 22 – 23
Comment 7: Certain Elected Officials Opposing the LNG Export Study and LNG Exports, Generally		
U.S. Representative Edward Markey (Mass.)	pp. 1 – 7	Section VI, pp. 24 – 28
U.S. Senator Ron Wyden (OR)	pp. 1 – 5	Section VI, pp. 24 – 28

Exhibit C

1. **Center for Liquefied Natural Gas, "Fact-Checking Senator Wyden's Letter to U.S. Secretary of Energy Steven Chu" (Jan. 30, 2013)**
2. **U.S. Senate Energy and Natural Resources Committee, Testimony Submitted for "Opportunities and Challenges for Natural Gas" by Bill Cooper, Center for Liquefied Natural Gas (Feb. 12, 2013)**
3. **Deloitte, "Exploring the American Renaissance: Global Impacts of LNG Exports from the United States" (October 2012)**
4. **Charles Ebinger et. al., "Liquid Markets: Assessing the case for U.S. Exports of Liquefied Natural Gas," Brooking Institution (May 2012)**
5. **Michael Levi, Counsel of Foreign Relations, "A Strategy for U.S. Natural Gas Exports," The Hamilton Project, Brookings Institution (June 2012)**
6. **Kenneth B. Medlock II, Ph.D., "U.S. LNG Exports: Truth and Consequences," Energy Forum at the James A. Baker Institute for Public Policy, Rice University (August 2012)**

<u>Exhibit C-1</u>

Center for Liquefied Natural Gas, “Fact-Checking Senator Wyden’s Letter to U.S. Secretary of Energy Steven Chu” (Jan. 30, 2013)

center for liquefied natural gas

Fact-Checking Senator Wyden's Letter to U.S. Secretary of Energy Steven Chu

During the recent public comment period, Senator Ron Wyden (D-Ore.) sent a letter to U.S. Secretary of Energy Steven Chu, dated January 10, 2013, which posed a series of questions and concerns regarding the U.S. Department of Energy's (DOE) third party study on exporting liquefied natural gas. The letter included several common misconceptions about the impact of LNG exports on American industries and domestic natural gas prices, and did not accurately characterize what the NERA study and countless other analyses have concluded about natural gas exports.

Contrary to Senator Wyden's claims, the overwhelming economic consensus is that the United States will experience "net economic benefits" as a result of increased LNG exports. The Center for Liquefied Natural Gas would like to thank Secretary Chu for previous statements made on the merits of exports to the U.S. economy. What follows is an in-depth look at Senator Wyden's letter, as well as a discussion about the economic benefits that exporting LNG abroad could bring into the United States.

WYDEN: *"The study used the Energy Information Administration's (EIA) Annual Energy Outlook 2011 reference case, which was released in 2010, as the foundation for its own LNG study."*

> **FACT**: NERA Economic Consulting used 2011 data because that was the data used in the Energy Information Agency's (EIA) original study for DOE in January 2012. The use of the 2011 data was necessary to provide a baseline for the report's projections, and comprised the most recent and salient data available when the NERA study began in late 2011.
>
> - If NERA had been able to use the latest data from EIA, the 2013 Annual Energy Outlook, they would have found that **U.S. natural gas production is projected to grow by over 40 percent** from 2012 – 2040. Over the same period, U.S. consumption of natural gas is expected to grow by only 20 percent. **Because production of U.S. natural gas is projected to rise faster than consumption by 2040, the U.S. has a natural gas surplus, some of which can be exported as LNG.**

WYDEN: *"The NERA study evaluates dozens of scenarios representing different market conditions, but it does not consider the significant domestic demand growth that outside experts and private industry expect to occur over the next decade."*

> **FACT**: The NERA study evaluated 63 export scenarios, finding that **the United States has more than enough natural gas to meet domestic demand while selling some natural gas to our allies abroad**. This is also consistent with what several other economic studies have concluded.

- EIA's 2013 Annual Energy Outlook concluded that U.S. natural gas production would grow at a rate of 40 percent from 2012-2014, while U.S. consumption would only grow 20 percent.
- Deloitte found in its LNG report, "Made In America: The economic impact of LNG exports from the United States," that "Producers can develop more reserves in anticipation of demand growth, such as LNG exports. Indeed, LNG export projects will likely be backed by long-term supply contracts, as well as long-term contracts with buyers. There will be ample notice and time in advance of the exports to make supplies available. The price impact is then determined by how

supply costs will change as a result of more rapid depletion of domestic resources." (Deloitte Report, pg. 8)

- The Baker Institute at Rice University concluded that "shale gas production in the United States has increased from virtually nothing in 2000 to over 10 billion cubic per day (bcfd) in 2010, and it is expected to more than quadruple by 2040, reaching over 50 percent of total U.S. natural gas production by the 2030s (see figure 1)." (Baker Institute Study, pg. 9, July 2011)

WYDEN: *"…with minimal analysis, the study concludes that a 'narrow' group of energy-intensive, trade-exposed industries would experience 'serious competitive impacts.'"*

FACT: The NERA report clearly states that the country as a whole would enjoy net economic benefits.

- "In all of these cases [studied], benefits that come from export expansion more than outweigh the losses …and hence **LNG exports have net economic benefits in spite of higher domestic natural gas prices**." (NERA Study, pg. 1, December 2012)

- "**Across the scenarios, U.S. economic welfare consistently increases as the volume of natural gas exports increases**." (NERA Study, pg. 6, December 2012)

- "First, additional income comes in the form of higher export revenues and wealth transfers from incremental LNG exports at higher prices paid by overseas purchasers. Second, U.S. households also benefit from higher natural gas resource income or rents. **These benefits distinctly differentiate market-driven expansion of LNG exports from actions that only raise domestic prices without creating additional sources of income**." (NERA Study, pg. 7, December 2012)

- "Even in the year of peak impact… **no sector analyzed in this study would experience reductions in employment more rapid than normal turnover**." (NERA Study, pg. 9, December 2012)

Other experts have similarly found that American businesses will not be hurt by LNG exports:

- The Brookings Institute said "the evidence suggests that the competitive advantage of U.S. industrial producers relative to its competitors in Western Europe and Asia is **not likely to be affected significantly** by the projected increase in natural gas prices resulting from LNG exports." (Brookings Report, p. 35, May 2012)

- Brookings also found that "increased gas production for exports resulted in increased production of […] natural gas liquids, in which case exports can be seen as providing a benefit to the petrochemical industry." (Brookings Report, p. 35, May 2012)

WYDEN: *"I remain deeply concerned that the Department has not articulated a set of criteria or procedures that will allow it to meet its obligations under the Natural Gas Act to make the required public interest determinations."*

FACT: The U.S. government – through DOE and FERC – has a robust regulatory review process in place for LNG exports. In fact, the Natural Gas Act requires DOE to make a "public interest determination" for natural gas exports to non-free trade agreement countries, a statute that has been in place literally for decades. DOE's recently commissioned and released macroeconomic study found that LNG exports would be a net benefit to the U.S. economy under all scenarios modeled.

<u>Exhibit C-2</u>

U.S. Senate Energy and Natural Resources Committee, Testimony Submitted for “Opportunities and Challenges for Natural Gas” by Bill Cooper, Center for Liquefied Natural Gas (Feb. 12, 2013)

U.S. Senate Energy and Natural Resources Committee

Testimony submitted for "Opportunities and Challenges for Natural Gas"

By Bill Cooper, Center for Liquefied Natural Gas

February 12, 2013

As President of the Center for Liquefied Natural Gas, I would like to thank Chairman Ron Wyden and Ranking Member Lisa Murkowski of the Senate Energy and Natural Resources Committee for accepting the following testimony, to be entered into the public record.

I will be focusing on the topic of liquefied natural gas (LNG) exports, specifically by identifying common myths and then providing a summary of the facts. As you will see from this testimony, the United States has abundant supplies of natural gas, more than enough to allow for exports while also meeting growing domestic demand.

The ability to export LNG represents a window of opportunity to create more jobs, generate more public revenues and reduce our trade deficit. A multitude of industries and communities will benefit from this opportunity to export some of America's abundant natural gas resources in global markets.

By resuming its approval process for LNG export applications, the U.S. Department of Energy can allow the United States to begin reaping those benefits, without hurting U.S. consumers.

MYTH 1: *We should use natural gas here in the United States instead of exporting it.*

Data compiled by the U.S. government and independent experts show clearly that the United States has an abundant supply of natural gas, more than enough to meet growing domestic demand and allow for exports.

For example, the U.S. Energy Information Administration's 2013 Annual Energy Outlook shows that U.S. natural gas production is projected to grow by roughly 40 percent from 2012 to 2040. Over the same period, U.S. consumption of natural gas is expected to grow by less than 20 percent. Because production of U.S. natural gas is projected to rise faster than consumption by 2040, the U.S. has a natural gas surplus available for export.

Meanwhile, a recent report from Deloitte observed the following:

> "Producers can develop more reserves in anticipation of demand growth, such as LNG exports. Indeed, LNG export projects will likely be backed by long-term supply contracts, as well as long-term contracts with buyers. There will be ample notice and time in advance of the exports to make supplies available."

Furthermore, reports from the Brookings Institution, the Congressional Research Service and the Baker Institute at Rice University – among many others – have stressed the enormous size of America's natural gas resource base, which in turn underscores the large surplus, a portion of which the United States can leverage for exports to create additional jobs, new tax revenues and a reduction in our trade deficit.

In addition to fundamental economic realities about the benefits of free trade, this large natural gas surplus is a key reason why a recent macroeconomic report from the U.S. Department of Energy concluded that "LNG export has net benefits to the U.S. economy." The DOE report also observed that exports would specifically benefit consumers by stating that the net result of allowing LNG exports "is an increase in U.S. households' real income and welfare." The report added that "consumers, in aggregate, are better off as a result of opening up LNG exports."

MYTH 2: *Natural gas exports would harm U.S. manufacturing.*

Many of the largest U.S. manufacturers have voiced support for LNG exports. Companies like General Electric and Caterpillar, for example, have both written to the U.S. Department of Energy urging approval for LNG export applications, stressing the economic benefits that exports would yield, as well as the potential economic harm from retaliatory trade restrictions that other countries could impose upon the United States.

In a blog post entitled "Banning LNG Exports Will Hurt Jobs and Economy," the National Association of Manufacturers observed the following:

> "Proposals that seek to limit LNG or coal or any other product would have far-reaching negative effects on the United States and should be rejected. Such restrictions limit economic opportunities and stifle job growth rather than provide a source of increased economic growth.
>
> "Export growth has created and saved manufacturing jobs over the past few years, which were tough economically for the United States. Export growth is vital not just for businesses across-the-board that directly export, but also for the many manufacturers in the supply chain."

In its Initial Comments to DOE on the NERA LNG Export Study, the National Association of Manufacturers also noted:

> "With 95 percent of the world's consumers outside the United States, export bans on any product, including LNG, can be expected to have far-reaching negative effects, including on domestic economic opportunities, employment and ultimately economic growth."
>
> "The United States' ability to challenge other countries' existing exports restraints on agricultural, forestry, mineral and ferrous scrap products – just to name a few – will be virtually non-existent if the United States itself begins imposing its own export restrictions. Even worse, as the world's largest economy and largest trading country, U.S. actions are often replicated by our trading partners to our own dismay. If the U.S. were to go down the path of export restrictions, even more countries would quickly follow suit and could easily limit U.S. access to other key natural resources or inputs that are not readily available in the United States."

As added proof, major chemical manufacturers that also support LNG exports are moving forward with plans to invest billions of dollars to expand their existing petrochemical operations. Put simply, companies would not be investing heavily in operations that rely on affordable and abundant supplies of natural gas and natural gas liquids (NGLs) if LNG exports truly posed a credible threat to that business.

MYTH 3: *Unfettered exports could undermine our economic competitiveness.*

In addition to the points outlined above, which detail how LNG exports would actually grow the U.S. economy, it's important to note that arguing against "unfettered" or "uncontrolled" exports is a straw man. ***There is no such thing as unfettered or uncontrolled LNG exports***.

The U.S. government – through the Department of Energy (DOE) and the Federal Energy Regulatory Commission (FERC) – has a robust regulatory review process in place for LNG exports. Absent affirmative evidence from opponents that the proposed project is not in the "public interest," DOE is required to approve the applications, thereby assuring a level playing field for all participants. Further studies are not warranted; the NERA study was robust with 63 scenarios including high and low side supply/demand cases. Every export scenario yielded positive net benefits for the U.S. economy. The

DOE has also been studying LNG exports for more than one year already. DOE needs to actively resume the review process for all projects in the permitting queue and it needs to move expeditiously on those applications.

The opportunity to export liquefied natural gas (LNG) will not remain on the table on the same scale, with the same benefits, indefinitely. The U.S. is not the only nation with abundant shale gas reserves. And while some debate the value of free trade in a global economy, other nations are trying to duplicate the success of America's shale industry.

Worldwide demand for LNG between 2020 and 2025 is projected to be around 60 billion cubic feet per day (bcf/d), up from approximately 37 bcf/d today. The sizeable gap between future demand and current capacity, 23 bcf/d, makes the global LNG market an attractive opportunity. However, the United States is not the only nation capable of seizing this opportunity.

The capacity of non-U.S. projects that are either planned, proposed or under construction is approximately 50 bcf/d. In fact, proposed foreign LNG capacity is more than double the expected global market opportunity in 2025. If you add on proposed U.S. LNG capacity, the global marketplace has a proposed supply of 80 bcf/d competing to fill only 23 bcf/d of demand. The longer the U.S. delays, the more likely other nations will satisfy that demand.

MYTH 4: *Exports will lead to significant price increases for natural gas in the United States.*

Numerous assessments of potential LNG exports have found that any impact on domestic prices would be minimal.

For example, the Brookings Institution observed that producers of natural gas "will likely anticipate future demand from LNG exports and will increase production accordingly, limiting price spikes." Brookings also noted that any price impact would be "modest." Kenneth Medlock with the Baker Institute has said: "The impact on U.S. domestic prices will not be large if [LNG] exports are allowed."

In a report commissioned for the U.S. Department of Energy, NERA Economic Consulting found that "price changes attributable to LNG exports remain in a relatively narrow range across the entire range of scenarios," adding that any such price changes "do not offset the positive impacts" from exports.

What many opponents of exports cite in reference to prices is the EIA's price impact study from 2012, which analyzed four different export scenarios. In the most dramatic (and most unlikely) scenario, the model suggested an extreme upper limit price impact of 54 percent. But the scenario that many experts agree is the most likely is that natural gas price impacts would peak at less than 10 percent. At least one analysis, from Deloitte, pegged the price impact at only two percent.

To provide a real-world example of how the price issue differs in rhetoric from reality, Methanex is relocating one of its methanol plants from Chile to Louisiana to take advantage of abundant and low-cost natural gas supplies. Addressing the export concern head on, Methanex CEO John Floren said it signed long-term supply contracts to hedge against any potential price impacts, reflecting a fundamental market reality of chemical manufacturing in the United States that undermines the suggestion that future price volatility would prevent the future growth of this industry.

Interestingly, at least one of the chemical companies that has voiced opposition to LNG exports on the basis of price impacts has stated that if "natural gas were available at a consistent $6-$8 dollar per MMBtu range, U.S. petrochemical facilities could be globally competitive." Current Henry Hub natural gas prices are less than $3.50 per MMBtu, meaning even in the worst-case and most unrealistic scenario modeled by EIA (where LNG exports increase domestic prices by 54 percent), the cost of natural gas would be $5.39 per MMBtu – below the price range that at least one major chemical manufacturer has said publicly would keep the industry competitive.

A common criticism by opponents of LNG exports is that natural gas production will lag demand, causing price spikes if there are LNG exports. Since 2008, we've seen production increase by 10 bcf/d and natural gas prices fall by more than $8 per thousand cubic feet (mcf). Clearly, natural gas production was running faster than demand or there wouldn't have been such a dramatic decline in natural gas prices. Given the new shale gas realities, producers should be able to ramp up production in anticipation of demand growth.

MYTH 5: *The "value-add" for exports is low.*

According to the U.S. International Trade Administration (ITA), each $1 billion of exports could result in more than 5,000 new jobs, many of which would be permanent manufacturing jobs. Thus, $13 billion to $25 billion worth of LNG exports – the current range of investment possibilities – could mean the creation of between 70,000 and 140,000 new American jobs. ITA has also observed that the value per export-supported job is almost $165,000.

Construction and operation of new LNG projects will create as many as 50,000 new jobs in design, engineering and construction, which translate into hundreds of millions of dollars in new wages for U.S. workers during the construction of the facility.

LNG exports will also lead to additional domestic natural gas production, which will in turn create hundreds of thousands of new jobs in the United States.

The enormous potential for new jobs is a major reason why labor unions have also voiced support for LNG exports. Brad Karbowsky with the United Association of Plumbers, Fitters and HVAC Techs said the following about potential jobs created as a result of LNG exports:

> "The billions of dollars in wages generated by these well-paying jobs will be multiplied throughout communities across the country in the form of investment and taxes, which will in turn be used to support schools, fire stations and other essential public services. This new source of shared prosperity will provide a foundation for future growth."

Harry Melander, President of the Minnesota State Building and Construction Trade Council, has also observed:

> "Exporting America's abundant natural gas to global markets is yet another excellent opportunity to increase job production and investment as a result of the burgeoning U.S. domestic energy production."

Nor are the benefits all directly related to the LNG industry. As natural gas production has expanded in recent years due to the responsible development of shale, local businesses like hotels and restaurants in production areas have benefitted from a growth in demand for their products and services. Adam Diaz, a small business owner in Susquehanna County, Pa., recently observed:

> "In the last three years since the natural gas industry came to Susquehanna County, Pennsylvania, my company has been able to grow from 30 employees to 250, while our revenue has increased from less than $2 million annually to almost $50 million today. This growth has led to an increased tax contribution of almost $3.5 million in federal, state and local taxes. Recently though, drilling rig counts have been falling in my area. LNG exports will increase demand, bring back the rigs and allow businesses like mine to grow and add much needed jobs to local economies to keep them strong."

With LNG exports, U.S. natural gas production will grow even more. That production will create U.S. jobs in support sectors that manufacture steel pipe, equipment, control panels, heavy duty trucks, and cement, in addition to well-paying jobs for welders, pipefitters, cement masons, plumbers, machinery mechanics, pump operators and engineers.

MYTH 6: *Exports could lead to competitive disadvantages of U.S. manufacturers in global trade*

The price of natural gas in the U.S. will be priced below what competitors will face in Asia, for example, even with U.S. exports. There is a substantial cost to liquefying natural gas and transporting it specialized tankers to distant markets (ranges from $8 billion to $20 billion per project of 2 bcf/d), and that fact means the U.S. domestic price for natural gas will be several dollars per thousand cubic feet lower than the price of natural gas in countries which import our LNG.

Rice University professor Ken Medlock notes in his 2012 LNG Export study that these costs will average $2.92/mcf for liquefaction and $2.15/mcf for transportation to Asia ($5.07/mcf total). Other studies show the cost range to be higher, including the NERA study that has a cost range between $6.30/mcf to $8.39/mcf.

Therefore, according to these studies, U.S. manufacturers would still enjoy a $5/mcf to $8/mcf cost advantage over Asian competitors, even if Asian prices and U.S. LNG delivered prices in Japan equalize. That provides a huge competitive advantage to U.S. manufacturers even with LNG exports from the United States.

MYTH 7: *LNG exports will back out the same amount of gas used by manufacturers.*

Critics assume a zero-sum game in natural gas markets, where 1 bcf of LNG exports takes exactly 1 bcf in supply away from the manufacturing sector. Those critics assert that supply doesn't increase; there is merely a reallocation of given volume of U.S. gas production. History shows that markets don't work that way. They adjust to increasing demands and gas supply can be expected to increase in response to any increase in demand. Of course, producers will respond to demand growth and changes in gas prices; they will develop more projects and produce more gas.

Critics never mention that there will be more gas production to feed LNG exports and to feed increased gas use by manufacturing. A more realistic view of the world actually takes into account that producers will respond to demand changes – i.e., that the supply curve is very elastic and not completely inelastic as in the zero sum mischaracterization of the critics. As producers increase gas production in response to growing demand, manufacturing use of gas can still increase.

An economically realistic depiction of what the shale gas revolution is all about would yield benefits of exports plus the value of the additional U.S. gas production and growth in manufacturing use. In fact, the discussions about the benefits of manufacturing asserted by critics are misleading because they try to make it appear that the choice is stark between either manufacturing or exports, when the real choice involves whether the U.S. wants to reap the benefits from exports plus more natural gas production plus more manufacturing use of gas.

This is not a zero sum game. The shale gas revolution requires a change in this zero-sum mind-set in which natural gas supplies are fixed or diminishing over time, and in which the policy issue is one of deciding which sector gets what share of an ever-diminishing natural gas resource. As Dr. Daniel Yergin, Vice Chairman of IHS and founder of IHS CERA, explained in his testimony before the House Energy and Commerce Committee's Subcommittee on Energy and Power on February 5, 2013:

> "[O]wing to the very large resource base, the market in the U.S. is demand-constrained, rather than supply-constrained. Larger markets – whether they be in electric power, industrial consumption, transportation, or exports – are required to maintain the investment flow into the development of the resources."

It is worth repeating: the natural gas market is not supply constrained as the zero sum mind set argues; it is demand constrained. If additional demand comes, additional natural gas supply will come along as well. The new shale gas reality is that there is an increasing gas supply available for LNG exports in addition to increasing domestic demand, including power generation, manufacturing and other gas consumers.

MYTH 8: *Natural gas deserves special restraints that apply to no other product.*

Critics argue that it is better for the economy to export finished products made using natural gas rather than exporting natural gas. Taken to its logical conclusion, that prescription would mean that it is not beneficial to export chemicals or aluminum or any intermediate product that is used by another manufacturer. American automobile makers use considerable materials made from chemicals, plastics and aluminum, so according to the critics' logic, exports of chemicals, plastics and aluminum should be restricted to ensure low U.S. prices of these products for the benefit of automakers or other consumers. The long history of support for free trade by Democrat and Republican administrations would be thrown out with this logic. There is no sound economic rationale for claiming natural gas is a special case requiring laborious study before exports are allowed; nor are chemicals, plastics, lumber, wheat, aluminum, and countless other manufacturing and agricultural products special cases calling out for extensive review and study before their exports are allowed. The U.S. economy would be a net beneficiary from unrestricted LNG exports, just as the U.S. is a net beneficiary of unrestricted exports of chemicals, plastics, and aluminum and countless other products.

Additionally, restraints on LNG exports run afoul of the United States' obligations under WTO and GATT, as well as the long-standing policy of the United States to support exports. As stated in the comments filed with DOE by the Peterson Institute for International Economics:

> "If the United States nevertheless does impose restraints [on LNG exports], U.S. actions will certainly be cited in the future by other countries that decide to flout international trade rules and restrict their own exports of natural resources as a means of subsidizing downstream industrial users. What's more, it is likely that countries that are not FTA partners will either retaliate with their own natural resource restrictions or challenge U.S. policies at the WTO."

As General Electric stated in its comments filed with the DOE:

> "[D]eclining to approve exports of natural gas would be squarely at odds with the United States' longstanding policy and international trade norms disfavoring export restraints (see GATT Article XI). Indeed the United States has been the vanguard of those challenging such restraints globally. (See US/EU/Mexico Challenge to China's Export Restraints on Raw Materials – WTO DS 394, 395, 398, successfully challenging China's export restraints on certain raw materials)…For the United States to now adopt such restrictions itself would fundamentally undermine its own international trade policy, which has served to preserve critical access to raw materials globally."

MYTH 9: *No clearly established criteria exist for DOE to apply the public interest standard in permitting applications for LNG exports.*

The DOE has provided regulatory clarity as to what constitutes the public interest, establishing a clear standard for future decisions.

For example, in the Kenai LNG case, the DOE concluded: "DOE considers domestic need for the gas and any other issue determined to be appropriate, including whether the arrangement is consistent with DOE's policy of promoting competition in the marketplace…" Since then, DOE has added several considerations to the "domestic need," but most appear to flow from the concept that the primary concern is to have enough natural gas to meet the domestic needs of U.S. consumers.

For instance, DOE has added the following considerations, quoting from the Federal Register notice in the Golden Pass Products LLC filing:

> "To the extent determined to be relevant or appropriate, these issues [considerations] will include the impact of LNG exports associated with this Application, and the cumulative impact of any other application(s) previously approved, on domestic need for the gas proposed for export, adequacy of domestic natural gas supply, U.S. energy security, and any other issues, including the impact on the U.S. economy (GDP), consumers, and industry, job creation, U.S. balance of trade, international considerations, and whether the arrangement is consistent with DOE's policy of promoting competition in the marketplace by allowing commercial parties to freely negotiate their own trade arrangements."

The record for the various proceedings at DOE overwhelmingly contains evidence that the U.S. has an abundance of natural gas, more than enough to meet growing domestic needs for years to come and allow LNG exports. That evidence is in the form of the factual studies filed in support of the various applications now pending before the DOE.

For further clarification, DOE issued its 1984 Policy Guidelines, which were later amended to include exports, stating:

> "[t]he market, not government, should determine the price and other contract terms of imported [or exported] natural gas. The federal government's primary responsibility in authorizing imports [or exports] will be to evaluate the need for the gas and whether the import [or export] arrangement will provide the gas on a competitively priced basis for the duration of the contract while minimizing regulatory impediments to a freely operating market."

DOE's three stated responsibilities are: One, "to evaluate the need for the gas"; two, assure that the "arrangement will provide the gas on a competitively priced basis for the duration of the contract"; and three, to "minimiz[e] regulatory impediments to a freely operating market."

As to the need for the gas, borrowing from the Sabine Pass order, there has been "substantial evidence showing an existing and a projected future supply of domestic natural gas sufficient to simultaneously support export and domestic natural gas demand both currently" and over the terms of the projects proposed.

Concerning competitive pricing, there is a very liquid, competitive domestic market for natural gas with a multitude of producers, marketers, sellers, and buyers, thus assuring that the natural gas is competitively priced in the U.S. market.

The third stated responsibility of DOE is to "minimize regulatory impediments to a freely operating market." Such a responsibility certainly cannot mean that any one market determinant, such as price or export volumes, could be used to impede the development of the free market. What it surely means is that applicants that meet the statutory and regulatory requirements should be granted the authorizations to export LNG from the United States without regulatory limitation as to export volumes. The "freely operating market" will then allocate scarce and finite economic resources such as financing and end-use contracts to determine which projects will be built and become operational. For as some projects will likely be built, others may not.

The role of the regulator is to assure a level playing field for all participants and to monitor developments for continued consistency with the public interest, not to be a predictor of future events. DOE's policy to allow a "freely operating market" to function with minimal regulatory impediments directly acknowledges the plain reading of the Natural Gas Act, which gives DOE the tools to respond to market conditions that adversely affect the public interest, not to predict future events during the authorization proceeding for projects with lifespans in excess of 20 years each. Those market conditions are not short-term phenomena such as temporary price increases.

Far from being vague in its regulatory framework, DOE has a clearly defined set of criteria for making its LNG export determinations, with that framework focusing on the domestic need for the natural gas proposed to be exported in order to protect the U.S. consumer.

MYTH 10: *DOE's process lacks opportunity for all affected stakeholders and the general public to comment on what constitutes the "public interest."*

Once DOE determines that an application is complete, it publishes a notice in the Federal Register informing the public of the opportunity to submit motions to intervene, protest, and/or to comment on the proceedings. The opponents complaining about the lack of opportunity to get involved have been publicly outspoken on the issue of LNG exports since prior to the closing of those public comment periods and have sufficient resources to monitor events and take such action as necessary to protect their interests. They simply chose not to do so.

Conclusion

LNG exports would provide the United States with enormous economic benefits – new jobs, new tax revenue, new economic growth and a reduced trade deficit. Better yet, these benefits will not come at the expense of domestic consumers of natural gas, whether they are industrial users or individual households.

Those opposed to LNG exports have employed a series of inaccurate characterizations about LNG and the impacts that would result from allowing exports. As such, I thank the Committee for providing me the opportunity to explain why such claims are myths, and that the overwhelming evidence shows that allowing LNG exports will be a net benefit to the United States. I respectfully request that the Committee urge DOE to commence issuing export approvals so the U.S. can reap all of the benefits of our natural gas resources.

Bill Cooper
President of the Center for Liquefied Natural Gas

Exhibit C-3

Deloitte, "Exploring the American Renaissance: Global Impacts of LNG Exports from the United States" (October 2012)

Deloitte.

Exporting the American Renaissance
Global impacts of LNG exports from the United States

A report by the Deloitte Center for Energy Solutions and Deloitte MarketPoint LLC

Deloitte Center for Energy Solutions

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Executive summary

In a startling about-face, natural gas market forces reversed course over the past several years. Expectations that the U.S. would become a major importer of liquefied natural gas ("LNG") have been replaced by the possibility of the U.S. becoming a major LNG exporter. As a result of a largely unforeseen surge in shale gas production, North American natural gas prices collapsed from over $10 per million British thermal units (MMBtu) in 2008, to under $3/MMBtu at various times during 2012. However, gas prices in Asia and Europe remain strong, creating huge spreads above U.S. prices.

Large price spreads between the U.S. and other regions have enticed foreign buyers seeking lower cost gas to consider U.S. supplies, while U.S. producers yearn for higher prices seen in foreign markets. As a result, U.S. LNG project developers seeking to arbitrage the large price spreads have submitted about 20 LNG export projects to the U.S. Department of Energy (DOE) for approval. The proposed projects represent approximately 27 billion cubic feet per day ("Bcfd") of LNG export capacity.[1]

Each world-scale LNG plant requires a multi-billion dollar investment to build, and given the enormity of the capital needed for development of U.S. LNG export facilities, project developers, regulators, and natural gas producers are keenly interested in understanding the potential impact of LNG exports on U.S. and worldwide natural gas markets. Clearly, not all or perhaps even a majority of the proposed projects are likely to come to fruition. But what would the impact be if the U.S. exported a significant volume of LNG?

To provide insight to this and other questions posed below, Cheniere Energy, Incorporated ("Cheniere") funded a study by Deloitte MarketPoint ("DMP") to conduct an objective, economic model based analysis of the potential impacts of LNG exports from the U.S. on domestic and global markets and prepare a report discussing the results of the analysis. Cheniere specifically requested that Deloitte MarketPoint make the report publicly available to inform interested parties. Cheniere provided no data or assumptions for inclusion in the report and did not request DMP to provide any viewpoint other than DMP's objective assessment of the potential market consequences.

While much attention has focused on the impact of U.S. LNG exports on the U.S. market, this study also specifically analyzes the potential economic consequences of those exports on global markets. It attempts to estimate the potential price impacts, gas supply changes, and flow displacements if the U.S. exported a given volume of LNG to either Asia or Europe. Key questions addressed in this report include:

- How could U.S. LNG exports affect prices in the U.S. and global markets?
- How much could price spreads narrow as a result of U.S. LNG exports and other market developments?
- Which countries might benefit from U.S. LNG exports and which ones might be disadvantaged?
- What future natural gas projects might be displaced?
- How could a more competitive global LNG market that is less dependent on oil-indexed gas prices affect projected results?

Although these highly speculative questions depend in part on actions of parties that do not always act according to free market principles, we developed market scenarios and tested alternative market behaviors to understand key drivers and obtain a sense of the magnitude of potential outcomes. We do not present our results as predictions of market outcomes or actions of particular parties, but rather as a study of how exports might alter the economic balance in global natural gas markets.

World Gas Model and assumptions

Deloitte MarketPoint utilized its World Gas Model to analyze prices and quantities in global markets under alternative market assumptions. The World Gas Model (WGM) includes disaggregated representations of supply and demand in North America, Europe, Asia, and other major global markets and their linkages through global LNG trade or export pipelines. It computes prices and quantities simultaneously across multiple markets on a monthly basis over a 30-year time horizon based on rigorous adherence to established microeconomic theories. Unlike many other models that assume all parties work together to achieve a single global objective, the WGM represents self-interested decisions made by each market "agent" along each stage of the supply chain. (More information about the World Gas Model is included in the Analytical Approach and Market Scenarios section and further detail can be obtained from DMP).

[1] http://www.fe.doe.gov/programs/gasregulation/reports/Long_Term_LNG_Export_10-12-12.pdf

Using the WGM, we analyzed the impact of a fixed volume of U.S. LNG exports on U.S. and global gas markets for two alternative hypothetical market scenarios. The first market scenario, "Business-as-usual," contemplates that global LNG markets will support prolonged oil-price indexation. The second scenario, "Competitive Response," assumes increased competition resulting from the influence of some newer sources of supply that will be coming on-line over the next decade.

For each market scenario, we specifically analyzed the impact of 6 Bcfd of U.S. LNG exports shipped to either Asia (2 Bcfd each to Japan, South Korea, and India) or Europe (3 Bcfd each to UK and Spain). The 6 Bcfd of exports is not a projection of the volumes that might be economic to export, but rather an assumption to enable evaluation of what impacts might arise. We compared the results of each export case to a reference case with no U.S. LNG exports to determine potential price impacts and supply displacements. Figure 1.1 summarizes the cases and scenarios we considered and present in this study.

Figure 1.1: Market scenarios and export cases

	Business-as-usual scenario	Competitive response scenario
No export case	• No LNG exports from U.S. • Prolonged oil-price indexation	• No LNG exports from U.S. • More competitively priced supplies
Asia export case (6 Bcfd)	• 2 Bcfd each to Japan, Korea, and India • Prolonged oil-price indexation	• 2 Bcfd each to Japan, Korea, and India • More competitively priced supplies
Europe export case (6 Bcfd)	• 3 Bcfd each to UK and Spain • Prolonged oil-price indexation	• 3 Bcfd each to UK and Spain • More competitively priced supplies

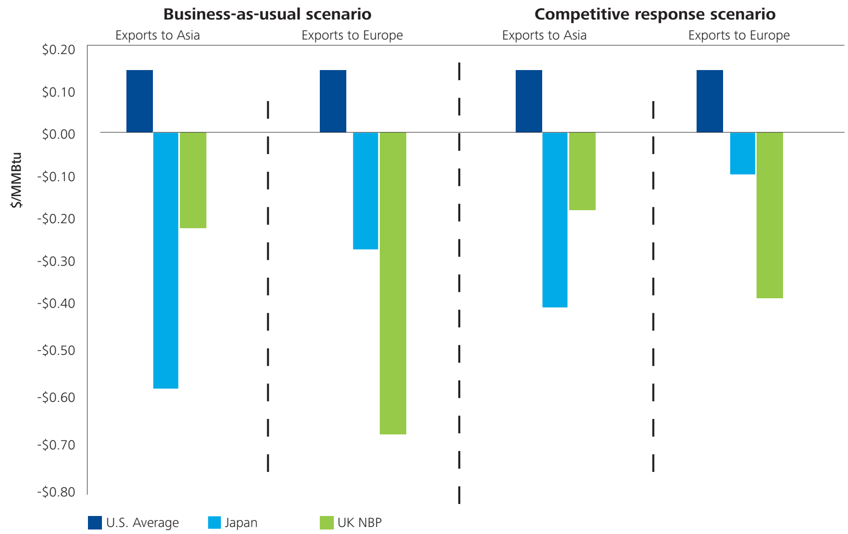
Key findings

The study reveals complex market dynamics, but under close examination, clear economic impacts with potential geopolitical implications become evident. Below are highlighted major findings resulting from 6 Bcfd of LNG being exported from the U.S.

- **U.S. LNG exports could hasten the transition away from oil price indexation of gas supply contracts.** Decoupling from oil-indexed prices is already occurring in some European markets and might happen in Asian markets, especially with the projected growth in Australian LNG. If Asian markets decouple from oil-indexed prices, their prices could drop sharply over the next several years. Since supplies for U.S. LNG exports are expected to be pegged to U.S. gas prices (e.g. Henry Hub), rather than oil prices, the incremental volumes could result in global gas markets transitioning more rapidly to prices set by "gas-on-gas" market competition.
- **Prices are projected to decrease fairly significantly in regions importing U.S. LNG, but only marginally increase in the U.S.** The projected increase of average U.S. prices from 2016 to 2030 is about $0.15/MMBtu, while the corresponding price decrease in importing countries could be several times higher (see Figure 1.2). Furthermore, the interconnectivity of gas markets causes price impacts to be felt globally, not just in the countries importing U.S. LNG.
- **U.S. LNG exports are projected to narrow the price difference between the U.S. and export markets and hence, the market will likely limit the volume of economically viable U.S. LNG exports**. As prices in the U.S. firm and prices in export markets soften, the margins between the U.S. and global markets will narrow and limit the LNG export volumes even without government intervention. For example, the spread is projected to be reduced by $0.84/MMBtu if 6 Bcfd of exports are sent to Europe under the Business-as-usual scenario ($0.15/MMBtu average increase in U.S. price and $0.69/MMBtu decrease in Europe).

- **U.S. LNG exports are projected to provide an economic benefit to gas importing countries.** While the price impact in the U.S. is projected to be fairly minimal because of the large size of the North American resource base and responsiveness of the U.S. gas market to price signals, the global impact could be more than what the relative size of 6 Bcfd of exports might indicate. Because of the embedded take-or-pay volumes in long-term gas supply contracts and limited regional production in many parts of the world, U.S. LNG exports could reduce global prices and cost of supplies for gas importers.
- **Gas exporting countries could suffer a decline in trade revenue due to price erosion and/or supply displacement.** Entry of new supply clearly benefits consumers, but negatively impacts suppliers through price reductions and/or direct displacement of their export volumes. Even if gas supply in a region is not directly displaced by U.S. LNG exports, its producers might suffer decline in revenues due to lower prices affecting the region. Furthermore, gas exporting countries could face increased pressure to adopt market-based gas prices in lieu of oil-indexed prices. As the world's largest gas exporter by both volume and revenue and a high cost gas provider into Europe, Russia appears to be particularly vulnerable, especially if U.S. LNG exports are sent to Europe.
- **U.S. LNG exports could also displace some oil consumption through increased gas-fired electric power generation.** The ultimate potential for oil displacement in electric generation may be as high as 5 million barrels per day globally. The availability of competitively priced gas could incentivize displacement of oil-fired power generation, which would also provide environmental benefits through lower carbon emissions.

Figure 1.2: Projected price impact from 2016 to 2030 by scenario ($/MMBtu, real 2012 $)



Source: DMP World Gas Model projection (October 2012).

Which countries are likely to benefit from U.S. LNG exports and which countries are disadvantaged? Figure 1.3 displays the top gas importing and exporting countries by volume in 2011. To highlight the dramatic changes that are occurring in the global natural gas market, it is interesting to note that although Australia appears well down the list of gas exporters in Figure 1.3, it is projected to become the global leader in LNG exports over the coming decade.

In Figure 1.4 we have listed the members of the Gas Exporting Countries Forum (GECF),[2] which cumulatively account for about half of the world's export volumes. GECF members include some of the world's largest gas exporting nations, as well as Iran and Venezuela, which could potentially be major future gas exporters if various political obstacles can be overcome. The GECF member countries are listed separately because its purpose is to promote collaboration among its members, and working together could wield particular influence on the dynamics of the global natural gas market.

As can be seen in Figure 1.3, the leading importing countries are generally stable, OECD member countries with longstanding trade relationships with the U.S. Most are also members of NATO or tend to have strong defense ties to the U.S. On the other hand, many current and potential gas exporting countries shown in Figures 1.3 and 1.4 are non-OECD members, including a few that have more challenged relationships with the U.S. This study examines the complex market dynamics and the possible economic impact of U.S. LNG exports to the global natural gas market, including those with important potential geopolitical implications.

Figure 1.3: Top gas importing and exporting countries

Top Gas Importers in 2011		Top Gas Exporters in 2011	
Country	Net Imports (Bcfd)	Country	Net Exports (Bcfd)
Japan	10.3	Russia	18.5
Germany	7.0	Qatar	11.8
Italy	6.7	Norway	9.4
US	5.4	Canada	5.6
South Korea	4.8	Algeria	5.0
France	4.3	Other Africa	4.1
Turkey	4.0	Indonesia	3.7
Ukraine	3.9	Netherlands	3.5
United Kingdom	3.6	Australia	2.5
Spain	3.4	Trinidad and Tobago	1.8

Source: BP Statistical Review (2012)

Figure 1.4: Gas Exporting Countries Forum members

Gas Exporting Countries Forum	
Algeria	Nigeria
Bolivia	Oman
Egypt	Qatar
Equatorial Guinea	Russia
Iran	Trinidad and Tobago
Libya	Venezuela

Source: GECF website

[2] According to their website: "The Gas Exporting Countries Forum (GECF) is a gathering of the world's leading gas producers and was set up as international governmental organization with the objective to increase the level of coordination and strengthen the collaboration among Member countries." http://www.gecf.org/

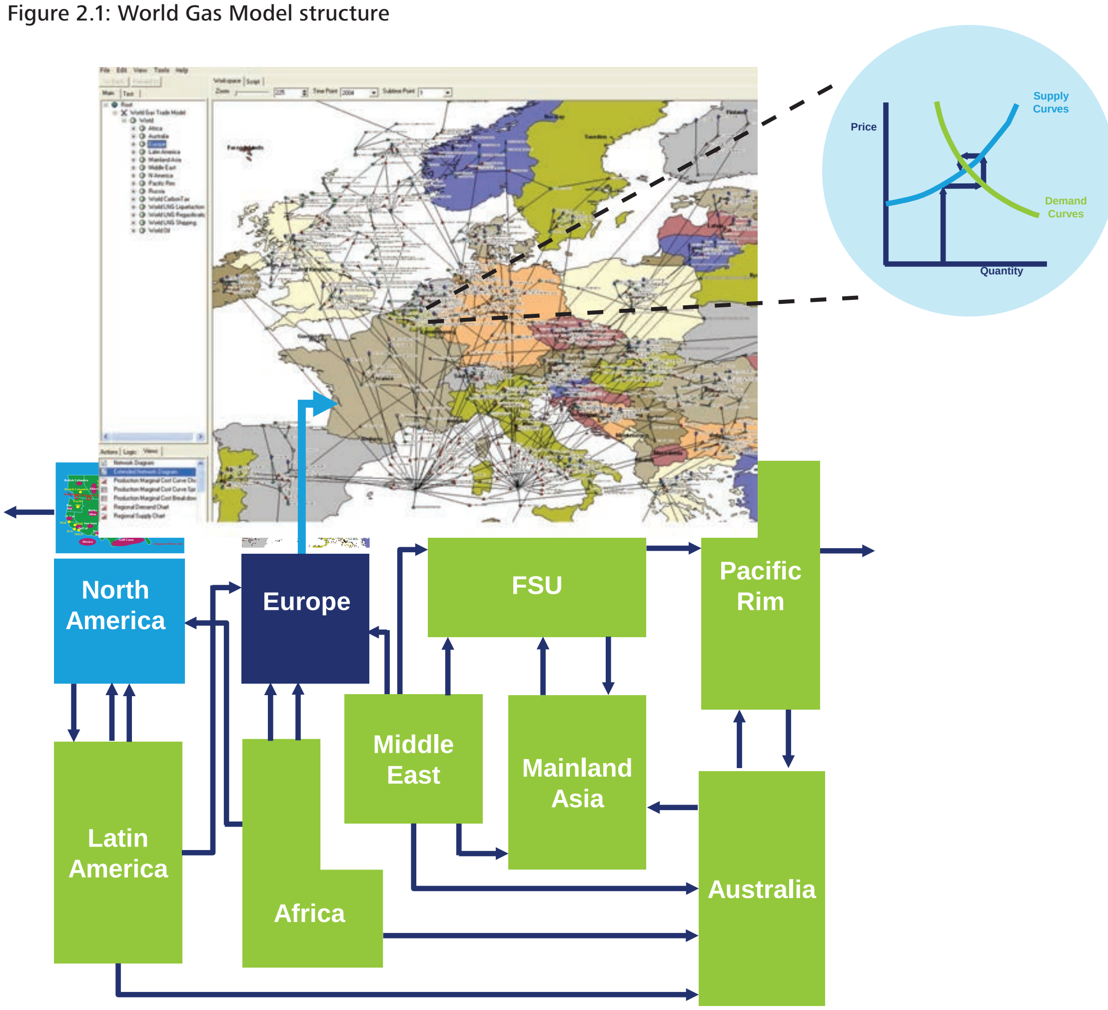
Analytical approach and market scenarios

Analytical approach

Deloitte MarketPoint applied its World Gas Model (WGM) to analyze the impact of U.S. LNG exports given alternative market scenarios. The WGM, an economic model of long-term global natural gas markets, projects gas prices, production volumes, and flows through 2046. The projected prices in the WGM reflect the economic value of gas, as opposed to contract or regulated prices.

The WGM includes disaggregated representations of supply and demand in global markets, including North America, Europe, and Asia, and their linkages through global LNG shipments or pipeline exports. Figure 2.1 illustrates the regional structure of the model including a screenshot of the WGM's high-level nodal detail for Europe. Each region (e.g., Europe) includes a detailed representation of the major countries within the region with inbound and outbound flows to other regions. Within each country are representations of its gas supply basins, pipeline and LNG infrastructure, storage facilities, and demand regions. In each market area, all sources compete against each other to serve demand downstream of the market. Market clearing prices and quantities are computed by solving for supply and demand equilibrium, as depicted in the supply-demand chart, simultaneously across all markets and over all time points. Unlike many other models which assume that all parties work together to achieve a single global objective, the WGM represents self-interested decisions made by each market "agent" along every stage of the supply chain.

Figure 2.1: World Gas Model structure



Exactly how much prices will change really depends on market dynamics including how the LNG export volumes affect the marginal source in each market. That is, price impact will depend on the elasticity of supply and, to a lesser degree, elasticity of demand. Rather than estimate supply response through a statistical function and estimated supply elasticity terms, the WGM represents gas supplier decisions given the various supplies competing in each market, including estimates of delivered costs for each supply into a market. With entry of new supply (e.g., U.S. LNG exports) into a market, the model computes what sources will be displaced and how that affects the price. The displaced supplies, in turn, seek other markets so there is a recalculation of supply demand balance throughout the world.

Furthermore, natural gas is a depletable resource, meaning that there is a fixed volume that cannot be replenished over time. What is produced in one period is not available for production in future periods. Unlike most models, which require assumptions on productive capacity over time, the WGM computes productive capacity over time by representing producer decisions given their resource endowments and anticipated forward prices. The resources are characterized by supply curves estimating the capital and operating costs to find and develop gas volumes. The model uses discounted cash flow to compute the value of reserve additions and production given the supply curves and projected wellhead prices. Through an iterative algorithm, the WGM computes the optimal timing of reserve additions and production that maximizes net present value to producers.

Vital to this analysis, WGM represents capital decisions regarding capacity additions for infrastructure such as LNG terminals and gas pipelines. These decisions require up-front capital expenditures plus finance charges, ongoing variable costs, and required rates of return. The model computes when and how much to build based on future margins that could be captured if capacity were added. Since we are analyzing long-term markets, we need to consider potential future market developments, not just against what currently exists. The WGM enables us to analyze how U.S. LNG exports might impact possible future projects.

Oil-price indexed contracts

Crucial to any global gas market analysis is a proper representation of long-term gas supply contracts, which in many parts of the world are indexed to the price of oil (e.g., Japan Customs-cleared Crude (JCC)). When oil price indexation was first adopted in markets, natural gas markets were thinly traded so it made economic sense to index price of natural gas to oil, which to a degree was a fuel substitute with similar delivered costs. However, over the years, oil prices have risen to the point where it trades at a premium over gas. For example, an oil price of $90 per barrel, which contains about 6 MMBtu, would be equivalent to about $15/MMBtu. Not coincidentally, $15/MMBtu is close to the current price[3] in Japan, which is dependent on oil-price indexed LNG supplies. Gas exporters would obviously like to maintain high prices afforded by oil-price indexation. However, gas exporters are facing increased challenges from new supplies trying to enter the market and buyers seeking better terms.

A major uncertainty facing global gas markets is how long gas prices will be tied to oil-indexed prices. U.S. LNG exports could have a significant impact in determining the outcome. One of the attractions of U.S. LNG to buyers, particularly in Asia, is that it is generally available under terms not indexed to oil prices. As such, U.S. LNG may help erode the hold of oil-price indexation and transition markets to more competitively set prices, which are likely to be significantly lower. One of the key results of our analysis is how U.S. LNG exports affect the ability of exporters to maintain oil-price indexation of gas prices in various regions.

[3] Federal Energy Regulatory Commission estimate for December 2012, http://www.ferc.gov/market-oversight/mkt-gas/overview/ngas-ovr-lng-wld-pr-est.pdf

In Figure 2.2, oil-price indexed contracts typically have a fixed volume that must be purchased by the buyer regardless of whether delivery is taken (i.e., minimum take volume) and a flexible volume, which a buyer can purchase at their own volition. The minimum take volume typically comprises the majority, around 80% to 90% of the contracted volume, and can be considered sunk cost since it must be paid regardless of whether volumes are actually taken. The flexible portion is crucially important to markets since it could be the marginal source that sets the market price. Historical prices at UK's National Balancing Point (NBP) can be explained by this structure. During peak periods, prices gravitate near oil-indexed price since flexible contracted volumes are required. However, during non-peak periods, prices fall well below contracted prices since the flexible volumes are not required and other competitively price supplies set the price.

The structure of oil-indexed price contracts leads to an important realization that the entire volume of contracted supply need not be displaced in order for markets to deviate from oil-price indexation. Since the marginal supply sets the market price, minimum take volumes, which only require incremental variable costs, would not likely be the marginal source setting market prices. Either the flexible volumes of contracts, pegged to oil price, or some uncontracted supply will set the market price, which we take to mean the spot price.

The implications of the contractual structure are profound. Since the bulk of supplies are contracted minimum take volumes, the transition to competitive prices, set by gas-on-gas competition, could be rapid once significant non-oil indexed supplies enter the market.

Figure 2.2: Representation of oil-price indexed contracts

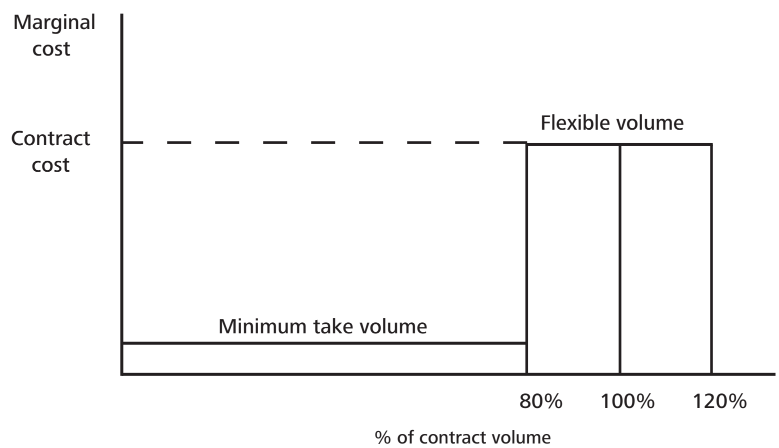


Figure 2.3: Aggregate supply and demand curves

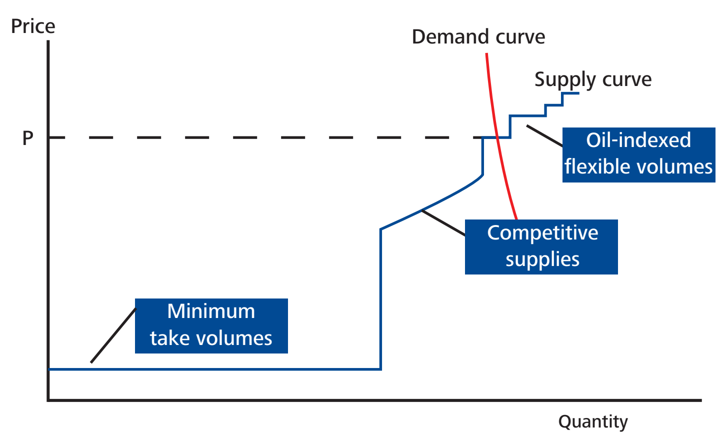
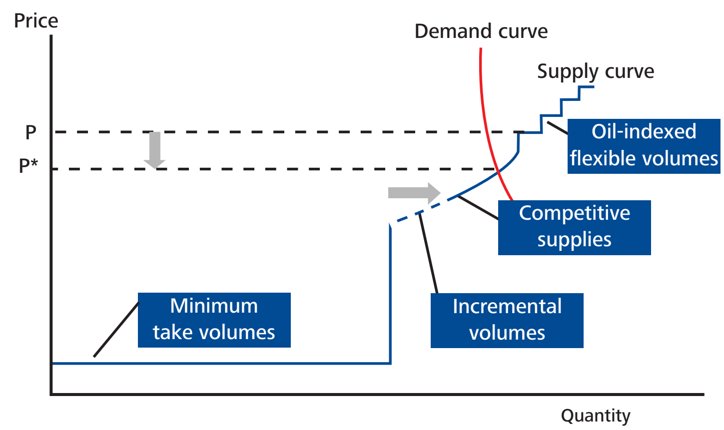


Figure 2.3 shows how an aggregate supply curve, including contracted minimum take volumes, competitively priced supplies, and flexible contract volumes available at oil-indexed, might look when stacked according to their marginal cost to market. The lowest cost section is comprised of minimum take volumes of long-term gas supply contracts. The volumes might have been contracted at high oil-indexed prices, but since the costs are sunk, the marginal costs are low. The next highest cost section is comprised of competitive supplies, which we have defined as non-contracted supplies that are priced according to market forces. The highest cost section of the supply curve is comprised of flexible oil-indexed contract volumes, which are volumes above minimum take contractual volumes that can be had at an oil-indexed price. The market clearing price is set by the intersection of the supply and demand curves. In this example, the demand curve intersects the supply curve at the least cost oil-indexed make up volume and its cost sets the market price, P. Notice that there are higher cost oil-indexed contract volumes that are not utilized because they are out of the money. Sellers of these high cost gas suppliers would just be selling their minimum take volumes.

Let us now examine what happens when we introduce additional volumes. Figure 2.4 illustrates what happens to price with the addition of competitively priced gas volumes to the supply curve. The section of supply curve that is available at higher cost than the incremental supply is shifted to the right by the incremental volumes. If demand is unchanged, the new market clearing price, P*, will then be set by the cost of a different marginal supply. In the figure, a competitive supply, rather than an oil-indexed supply, is now the marginal supply and its cost sets the market clearing price. As the diagram shows, the price drop could be significant since price is set by competitively priced supplies, which are estimated to be far lower cost than oil-indexed gas supply contracts in most markets. These charts indicate how sensitive gas prices could be to supply volumes. Competitively priced supplies do not need to displace all of the contracted volumes in a market, but just the flexible volumes indexed to oil prices to decouple markets away from oil-indexed gas prices. Furthermore, as gas suppliers see their volumes reduced to just minimum take volumes with the entry of increased competitive supplies, they might be willing to make more of their contracted volumes available at spot prices, further accelerating the transition.

There is widespread expectation that European and possibly Asian markets will eventually delink from oil-indexed prices, but the real question is how quickly this transition will occur. U.S. LNG exports might hasten this transition by applying competitive pressures on all gas suppliers. The timing of transition will depend partially on how gas exporters price their supplies to markets, which is difficult to gauge, so we developed alternative market scenarios.

Figure 2.4: Supply curve with incremental supply



Market scenarios and cases

While there are many market scenarios and assumptions that could be made, we felt that a key issue in global gas markets is how quickly markets will transition from gas prices set by oil-price indexation to competitively set prices based on gas-on-gas competition. Of course, there are a multitude of factors, such as demand growth, new pipeline and LNG projects, and gas supply development, that will help determine the timing of this transition, but we simply postulated two market scenarios based on how major exporters would react to supply competition:

1. **Business-as-usual (BAU) scenario:** Some major current gas exporters, such as Russia, Qatar, Algeria, and Indonesia, are assumed to maintain oil-price indexation of their gas supplies. As existing contracts expire, they are assumed to require oil-indexed prices for future volumes. Other producers, such as Australia, Nigeria, and Turkmenistan, are assumed to be more opportunistic and price their gas according to what the market will bear (e.g., price takers). That is, they are assumed to make production decisions that maximize profits given projected prices at their wellhead and their resource endowments.

2. **Competitive Response scenario:** Major gas exporters using oil-price indexation are assumed to respond to growing market competition by gradually increasing the volume of their supplies available on a competitive basis, as opposed to rigidly holding to oil-indexed prices. This scenario does not change the available supply volumes, but only the pricing of those volumes.

The goal in defining the scenarios was not to specify a reasonable range of market outcomes, but to test how different pricing behaviors might affect the impact of U.S. LNG exports. We do not view the two scenarios as extreme market scenarios that bound the range of potential outcomes. Moreover, one does not reflect continuation of oil-indexed prices and the other competitive markets. Rather, they both reflect a continuation of current market trends and an eventual transition to competitive markets. The difference between the two scenarios is the assumption of how current major gas exporters will react to increasing competitive pressures. The BAU scenario assumes strict adherence to oil-indexed pricing while the Competitive Response scenario reflects gradual adoption of competitive pricing by major exporters as a result of competitive pressures. In both scenarios, existing supply contracts are represented and hold strong influence over projected market prices. In both scenarios, producers are assumed to be able to develop as much supply as is economic for domestic markets (e.g., China, India) and some gas exporters, such as Australia and West African countries are assumed to be able to export as much LNG as is economic. Of course, one could argue that recent Australian contracts have been signed at oil-indexed prices by Asian buyers and future contracts will continue to do so. However, these contracts were signed when global LNG supplies were tight. With buyers having few options, LNG sellers were able to extract favorable terms. Our assumption is that future contracts will not need to strictly adhere to oil-indexed prices, but rather reflect competitive prices set by gas-on-gas competition. European contracts are already starting to reflect competitive prices as portions of contractual volumes are indexed to hub prices. Alternatively, contracts might still be indexed to oil prices, but instead of a coefficient that reflects oil price parity, the coefficient might be lower to build in a "discount" factor which reflects competitive gas prices. European supply contracts reflect a built-in discount due to the more competitive nature of its gas market than Asian LNG contracts, which are more closely pegged to oil-parity pricing.

Under each market scenario, we ran two cases, one without and one with U.S. LNG exports. For the purpose of this study, we have assumed no exports from Canada so that we can isolate the impact of U.S. LNG exports. In reality, U.S. and Canadian LNG exports will likely compete against each other to some degree, and the impact of U.S. LNG export would be partially mitigated by offsetting actions from Canadian exporters (e.g., increasing U.S. LNG exports would tend to decrease Canadian exports and vice versa). The market scenarios and export cases are summarized in Figure 2.5.

Figure 2.5: Market scenarios and export cases

	Business-as-usual scenario	Competitive response scenario
No export case	• No LNG exports from U.S. • Prolonged oil-price indexation	• No LNG exports from U.S. • More competitively priced supplies
Asia export case (6 Bcfd)	• 2 Bcfd each to Japan, Korea, and India • Prolonged oil-price indexation	• 2 Bcfd each to Japan, Korea, and India • More competitively priced supplies
Europe export case (6 Bcfd)	• 3 Bcfd each to UK and Spain • Prolonged oil-price indexation	• 3 Bcfd each to UK and Spain • More competitively priced supplies

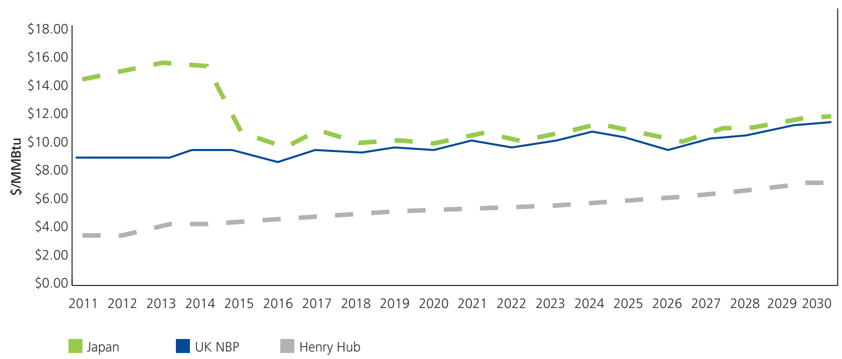
Market projections

Figure 2.6 shows projected prices in the BAU scenario, for three major gas markets: Henry Hub (Louisiana, U.S.), which is the world's most liquid market; UK NBP, a virtual hub reflecting prices in the UK; and Japan, which is marked by the delivered price of LNG. Japan prices are projected to remain high in the near term, as the shut-down of Japanese nuclear power plants and rapidly growing Asian gas demand maintains tight Asian LNG supply balance. However, Japanese prices are projected to fall sharply within several years, primarily due to an increase in Australian LNG exports, which are assumed to be priced competitively. With decline in European production, primarily from the North Sea, the UK is projected to rely more on LNG imports in the future. As global LNG supplies increase, UK NBP and Japan prices are projected to track each other closely starting around 2015.

The projected prices suggest that some regional markets will become more highly correlated with growth in global LNG and pipeline trans-shipments. However, evolution to a global gas price is highly unlikely because the transportation cost for gas, unlike for oil, is just too high for this convergence to occur. For example, a barrel of oil costs just a few dollars per barrel to transport around the world which means that at $100/barrel, the transportation costs are only a few percent of the commodity value. In contrast, the cost of liquefaction and shipping natural gas from the U.S. to Asia or Europe would exceed 100% of the supply price, currently in the mid-$3 range. Hence, the development of a global gas price is highly unlikely even with a large expansion of global LNG capacities. Nevertheless, there are likely to be greater linkages between markets as LNG supplies increase and more international pipelines are built. U.S. exports to one market (e.g., Japan) could have significant consequences to a distant, noncontiguous market (e.g., UK) and vice versa.

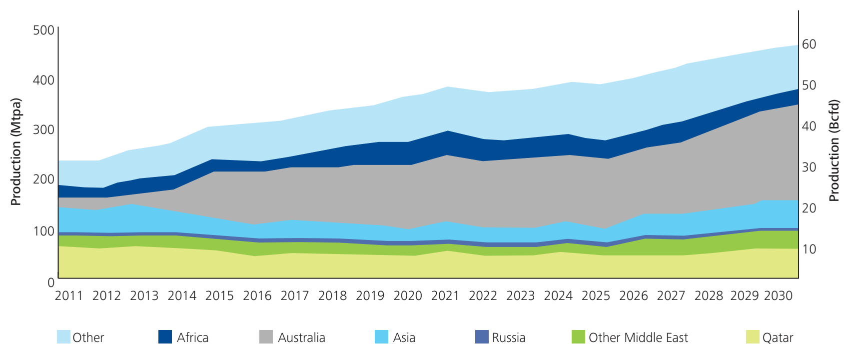
Figure 2.7 shows the projected LNG production assuming no U.S. LNG exports under the BAU scenario. Most prominent is the growth in Australian LNG, which is projected in this scenario to easily surpass Qatar as the world's largest LNG producer and dominate the Asia LNG market. In this scenario, Qatar LNG volumes are projected to decline over time as it loses market share to Australia and other suppliers. However, bear in mind that the BAU scenario assumes that Qatar holds to oil-indexed pricing while Australia is able to competitively price its supply and effectively undercut Qatar and other oil-indexed suppliers to capture greater market share.

Figure 2.6: Projected prices in key markets (BAU scenario with no U.S. Exports)



Source: DMP World Gas Model projection (October 2012).

Figure 2.7: Projected LNG production (BAU scenario assuming no U.S. exports)



Source: DMP World Gas Model projection (October 2012).

Whether Qatar and other suppliers will allow their multi-billion dollar supply infrastructures to suffer low utilization and see their market shares captured by competitive suppliers is questionable. That is why we created the Competitive Response scenario in which suppliers such as Qatar respond to market competition by making more of their supplies available at competitive prices that fall below oil-indexed prices. In the Competitive Response scenario, the projected LNG volumes from Qatar remain fairly constant over time as Qatar is assumed to price more of its supplies based on competitive prices to maintain high utilization of their plants. However, Qatar's market share is projected to decline since the global LNG market is increasing, but its liquefaction capacity is assumed to remain constant. Of course, since Qatar possesses such low-cost gas resources, it could lift its current moratorium on new builds and expand capacity to capture greater market share. We do not present either market scenario as more likely than the other, but rather to assess how U.S. LNG exports will affect global markets under each market scenario. However, the results strongly suggest that gas exporters will likely be forced to competitively price their supply in the future in order to maintain their volumes.

Currently, the highest natural gas prices are in Asia where major LNG importers, such as Japan, South Korea, and Taiwan, pay a premium in order to ensure peak month deliverability. Prices for spot LNG cargos sometimes shoot up in the winter months primarily because these Asian countries, with almost no other natural gas alternatives, vie against each other for the scarce available LNG cargos and bid up prices. For much of 2012, the landed price of LNG in Japan hovered around $15/MMBtu, or about five times higher than Henry Hub prices in the U.S. With growth in global LNG supplies, the highest priced markets will not be setting the price, since their demand will be the first to be satisfied and other, lower price markets will likely provide the marginal demand and set the price. Hence, the WGM projects a sharp decline in Japan prices coinciding with growth in Australian LNG exports.

In both the BAU and Competitive Response market scenarios, the price spreads between U.S. and foreign markets, especially in Asia, are projected to shrink from their current levels even without U.S. LNG exports. Increased global gas supplies, made accessible to markets by continued growth in global LNG liquefaction capacities and new international pipelines, are projected to apply competitive pressures on major producers supplying Asia and Europe. In both market scenarios, the current high prices in Asia were found to be unsustainable in the face of growing global gas supplies. Simply put, there is too much supply that can be brought to market at lower prices to sustain prices at current levels over the long run. Of course, with rapidly growing markets in China and India, Asian demand growth might stay ahead of supply growth and prolong high prices for some time.

Under assumptions in the Competitive Response scenario, projected prices for UK NBP and Japan each fall by about $0.70/MMBtu on average from 2016 to 2030 relative to the BAU scenario. The decline represents about 7-8% drop in projected prices. The impact might seem rather modest, but we remind the reader that the Competitive Response scenario does not introduce incremental supplies but rather enables current major exporters to respond to competitive pressures by pricing their supplies to reflect market conditions, instead of sticking to an oil-indexed price that the market might not be able to support. The market is projected to become more competitive over time even in the BAU case. The Competitive Response scenario is just a faster transition.

Impact of U.S. LNG exports

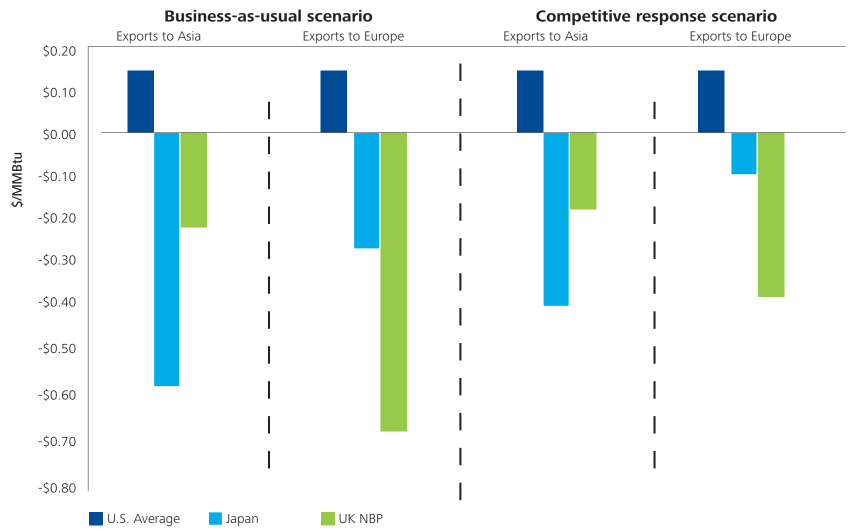
Based on the embodied economic logic and data assumptions, the World Gas Model (WGM) projected the price and quantity impacts of 6 Bcfd of LNG exports from the U.S. to either Asia (2 Bcfd each to Japan, South Korea, and India) or Europe (3 Bcfd each to UK and Spain) under two different market scenarios representing speed of transition to competitively set gas prices. The results show complex market dynamics with widespread impacts, but close examination reveals clear economic implications. U.S. LNG exports are projected to have global impacts, generally reducing costs for gas importers and reducing revenues for gas exporters.

Price impact due to U.S. LNG exports

U.S. LNG exports are projected to impact prices globally, not just in the countries importing U.S. LNG. While the U.S. export volumes considered in this analysis represent only a small fraction of the total global gas supply, their price impact might be much higher than their relative volume might indicate. The structure of long-term gas supply contracts, as discussed in the previous section, and available regional supplies are important factors in determining the price impact. Figure 3.1 shows the projected price impacts of 6 Bcfd of U.S. LNG exports to either Asia or Europe under the Business-as-usual or Competitive Response market scenarios. The figure shows impacts on average U.S. citygate, Japan, and UK National Balancing Point (NBP) prices. Japan and UK NBP serve as proxies for Asia and Europe since there is widespread price impacts, not just in those countries assumed to receive U.S. LNG exports.

The impact of U.S. LNG exports on U.S. citygate prices is projected to be minimal, only an average $0.15/MMBtu from 2016 through 2030. Abundant North American gas resources mitigate the impact of demand changes, including exports. Vast shale gas resources, that are now economically viable due to technological advancements in recent years, have effectively caused the aggregate U.S. supply curve to flatten, representing greater supply elasticity. Coupled with the market's demonstrated ability to respond to market changes, the availability of large North American supplies mitigates the price impact of exports. If sufficient reserves can be added by the time export terminals come into operations, then the price impact will be determined by how the increase in demand changes the cost of the marginal field produced. Given the abundance of U.S. gas supplies available at similar cost levels, the change in the cost of the marginal supply is estimated to be minimal, as described in our previous paper, *Made in America: The Economic Impact on LNG Exports from the United States*.[4]

Figure 3.1: Projected price impact from 2016 to 2030 by scenario ($/MMBtu, real 2012 $)



Source: DMP World Gas Model projection (October 2012).

The price impact of U.S. LNG exports is projected to be much higher in the import markets than in the U.S. For example, with U.S. LNG exports to Asia the price impact in Japan is projected to be several times higher than the impact in the U.S.under both market scenarios. Similarly, with U.S. LNG exports to Europe the price impact in the UK is projected to be several times higher than the impact in the U.S. under both market scenarios. The magnitude of price impact varies by market scenario, but under both scenarios, the impacts are significant. The relative price impacts underscore the size of the U.S. gas market (about 65 Bcfd in 2011), which is far larger than that of Japan (about 11 Bcfd in 2011), the UK (about 9 Bcfd in 2011), or any other country. In fact, the U.S. market is larger than the entire European or Asian market. Additionally, the North American market is highly integrated, unlike European and especially Asian markets, so the continent-wide market can help mitigate the price impacts. Finally, markets in Europe and Asia rely on imports that have varying delivered costs. For example, Russian pipeline imports are more costly than Algerian pipeline imports in Europe. Nigerian LNG imports to Japan are more costly than the delivered cost of LNG from Qatar. In essence, the supply curves are steeper (i.e., less elastic) in European and Asian markets and therefore the price impact is greater than in the U.S.

[4] Deloitte MarketPoint LLC, *Made in America: The Economic Impact of LNG Exports from the United States* (2011). www.deloitte.com/us/lngexports.

As the price spreads between the U.S. and other markets narrow, the favorable economics of U.S. LNG exports diminish. How much U.S. LNG ultimately could be exported is not the focus of this study, but clearly price feedback from export volumes and other market developments will limit how much is economic. Even without government intervention, market forces can determine the desired level of U.S. LNG exports. It is an obvious point, but worth stating, that the price spread between U.S. and global markets will shrink as U.S. prices rise and prices in importing countries decline. The spread will shrink by the sum of the absolute values of change in both markets.

Notice in Figure 3.1 that whether U.S. LNG exports are sent to Europe or Asia, both markets are projected to be impacted due to the interconnectivity of global markets. The markets in Japan and the UK are projected to become particularly interconnected over time. The projected decline in North Sea production and increase in global LNG supplies results in the UK market becoming increasingly dependent on LNG imports. With increasing LNG supplies that have destination flexibility in contracts or are available on a spot basis, global LNG prices are expected to move in close sympathy, although significant price spreads could persist between regions due to large differences in shipping costs.

Furthermore, the price impact is diminished under the Competitive Response scenario, which assumes that current major gas exporters gradually price more of their supplies on a competitive basis. With more competitively priced gas supplies available in the Competitive Response scenario, the price impact of U.S. LNG exports is less than in the BAU scenario. In the BAU scenario, oil-indexed contracts have a more prolonged influence over prices. U.S. LNG exports, which likely will be indexed to U.S. gas price (e.g., Henry Hub) rather than an oil-indexed price, could apply pressure on exporters to more competitively price their gas. While gas exporters would prefer an oil-linked price, such attempts likely will be met by diminished volume of sales as buyers have more alternatives. Given the high capital cost of LNG terminal and long-distance pipeline projects, there will be pressure to price supplies to ensure high levels of utilization. As global gas supplies increase, exporters likely will need to accept realities of a more competitive market or else see diminishing market shares.

Supply displacement due to U.S. LNG exports

This study assumes 6 Bcfd of U.S. LNG exports will be contracted (i.e., forced) into either Asian or European markets, causing displacement of a similar volume of supplies. (The volumes will not be exactly the same because of demand elasticity and transportation fuel use.) The supplies displaced in the LNG import markets will in turn seek other markets to find a home. Hence, there likely will be global impacts, not just impacts in the importing countries. The displaced volumes in each market will be the marginal sources, which likely will be high-cost supplies that are either not contracted or contracted, but above required minimum-take volumes specified in contracts. Due to their high cost, the first volumes displaced will likely be the contracted volumes above required minimum-take volumes which typically are pegged to an oil-indexed price.

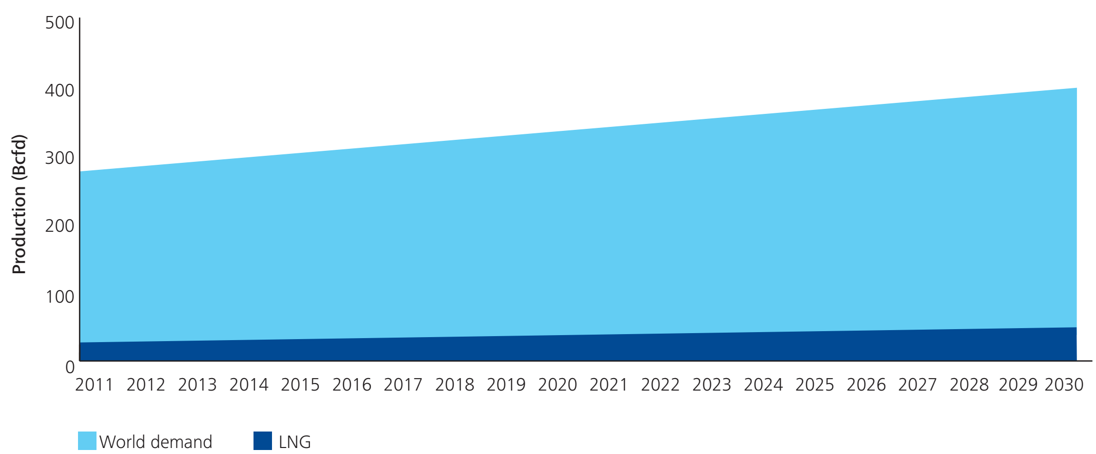
It is important to realize that not all gas exporters will be affected to the same degree by U.S. LNG exports. Finding which supplies will be displaced within each region is tantamount to finding the marginal source, which by definition is the first to exit the market when demand falls or some other source enters the market. The marginal sources will vary by region and over time, but likely will be the high-cost source that is uncontracted for firm delivery into a market. The analysis needs to take into account long-term gas supply contracts because they affect both the displaced volumes and price impacts of U.S. LNG exports.

Marginal sources in the future could include prospective new projects whose success hinges upon market conditions. A prime case in point is the vast, but high-cost Shtokman field in the Barents Sea which was planned to be developed and gas sent to Europe through a subsea pipeline, or liquefied and shipped to the U.S. When European and U.S. prices fell due to emergence of other supplies, Shtokman gas was economically displaced because it was no longer deemed economic. Other high-cost existing supplies or potential new projects could experience a similar result if the U.S. were to export LNG.

In Europe, which already imports large volumes of gas from Russia, North Africa, and LNG suppliers, the next big wave of supply could be from the Middle East or Caspian regions. Pipeline projects such as Nabucco and South Stream are designed to make these supply regions accessible to Europe. However, these prospective projects are high cost and fraught with political challenges. In Asia, major incremental supplies could come from Russia or the Middle East, as well as growth in domestic production in China and India. Again, prospective projects face formidable economic and political challenges. We analyzed which future supplies might be displaced by U.S. LNG exports. Furthermore, a project or supply from a politically problematic country, such as Iran or Venezuela, could have high implied costs because non-economic factors prevent or drive up the cost of entry into the market. They are more likely when prices are high, since economic incentives will help override political obstacles. High prices create incentives to overcome political obstacles. U.S. LNG exports could help keep these supplies from entering the market.

Furthermore, the LNG market is not a separate, niche market but rather a segment of a broader natural gas market. Even with strong growth in global LNG supplies over the past few years, LNG still comprised only about 9% of the total global gas supply in 2010.[5] In Figure 3.2, the WGM projects global LNG supplies to grow at a faster rate than global gas demand so that by 2030, LNG's share grows to about 15%, much larger than it is currently but still a relatively small percentage of the total gas market. Gas is gas, whether it is delivered through a pipeline or by a LNG tanker, and in the long term all gas supplies entering a market will compete for market share. Of course, there are short-term contractual rigidities and infrastructure constraints in some markets which will help determine how quickly competition will occur.

Figure 3.2: World gas demand and LNG production



Source: DMP World Gas Model projection (October 2012).

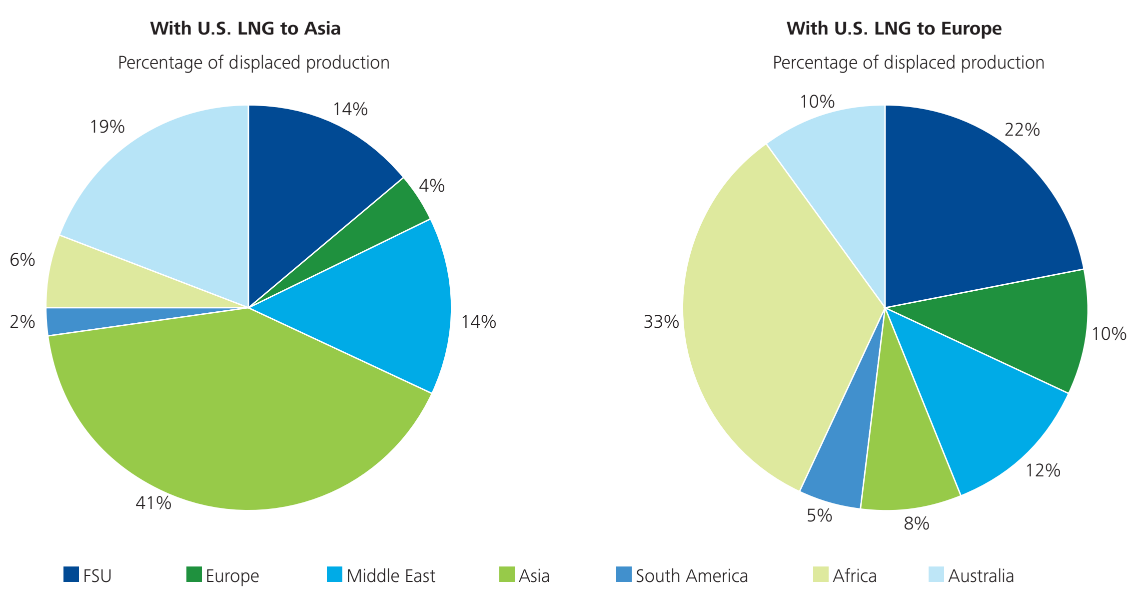
[5] International Energy Agency (http://www.iea.org/aboutus/faqs/gas/).

Given the relatively small size of the LNG market, the WGM projections show more displacement of non-LNG supplies than of LNG supplies due to U.S. LNG exports. Furthermore, most LNG supplies are tied up under long-term contracts with minimum-take volumes. If U.S. LNG is exported to Asia, the displaced volumes that are LNG supplies are about 30% of the total displaced supply. If U.S. LNG is exported to Europe, the displaced volumes that are LNG supplies is a little less, about 25% of the total displacement. The results make sense given the higher portion of Asian supply portfolio captured by LNG.

Figure 3.3 shows the displaced global volumes as a result of U.S. LNG exports sent to either Asia, shown in the chart on the left, or Europe, chart on the right, assuming the BAU scenario. The U.S. LNG export impacts under the Competitive Response scenario produce similar results. These charts show displaced production, rather than just volumes displaced out of the region in which U.S. LNG is exported. They represent the difference in total production by region between the cases with and without U.S. LNG exports. The displaced supplies will be the high cost non-committed supplies into each market. The non-committed volumes would include uncontracted supplies or the flexible volumes of contracted supplies. Contract minimum-take volumes, even if contracts were signed at high cost, would not be displaced since their costs would be considered sunk by buyers. Australian LNG exports to Asia and Russian exports to Europe look particularly vulnerable given their projected large volume of exports and high cost to markets they serve.

The largest LNG source that is displaced is Australian LNG. This result follows the rapid growth of Australian LNG projected by WGM, particularly in the BAU scenario in which Australian LNG grows from its current level of about 20 MTPA (3 Bcfd) to 130 MTPA (17 Bcfd) by 2030. By comparison, Qatar, currently the world's largest LNG producer, has 77 MTPA (10 Bcfd) of LNG production capacity. Due to its high supply costs, particularly from coal-bed methane sourced projects, and its distance from market, Australian LNG is partially displaced by U.S. LNG exports and comprises almost 20% of the total displaced volumes by U.S. LNG exports to Asia and 10% with exports to Europe. However, bear in mind that Australian LNG is still projected to grow rapidly and become the global leader in LNG production even with U.S. LNG exports. Australian LNG production is projected to grow, but just not quite as

Figure 3.3: Supplies displaced by U.S. LNG exports 2016-30 under BAU scenario



Source: DMP World Gas Model projection (October 2012).

high with U.S. LNG exports. Even in the case with U.S. LNG exports to Asia, Australia's projected LNG volumes are just reduced by a little over 10%. Asian LNG is little affected because it has a transportation cost advantage over other LNG sources and the fact that most Asian LNG supplies are already under contract for firm delivery.

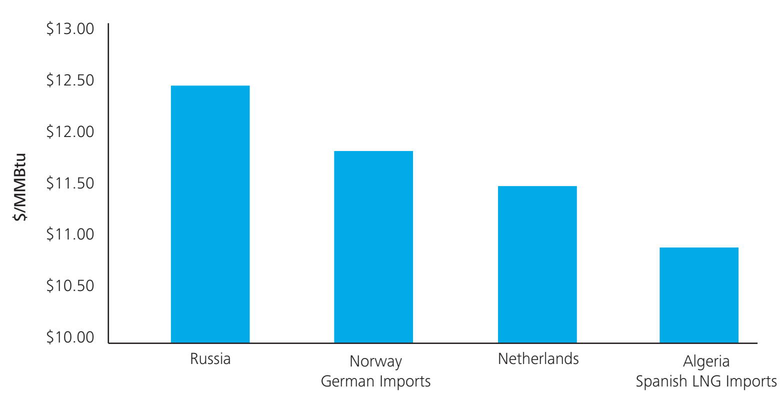
Asian sources are projected to bear about 40% of the total volume displaced by U.S. LNG exports to Asia. The displaced Asian sources are comprised primarily of indigenous production in China and India, as well as some Asian LNG supplies in Indonesia, Malaysia, and Brunei. Both China and India have significant gas resources including both conventional and unconventional, such as shale gas and coalbed methane, supplies, but their production costs are estimated to be quite high. China is estimated to possess 1,275 Tcf of technically recoverable shale gas, according to the EIA.[6] Some of their investments in North American upstream projects in recent years are thought to be at least partially motivated by a desire to learn U.S. shale gas production technology and processes so that they can develop their domestic resources. The Chinese government has announced aggressive goals for shale gas development. U.S. LNG exports will lower the cost of imported gas, thereby reducing the economic incentive for countries to develop their domestic supplies.

Notice also that even with U.S. LNG exports assumed to be shipped to Asia, projected supplies from the Former Soviet Union (FSU), including Russia and gas-rich Caspian republics such as Turkmenistan and Azerbaijan, and Middle East are displaced. The reductions in volumes are not a result of direct displacement by U.S. LNG exports but rather due to global rebalancing of gas supplies. Some of the supplies displaced out of Asia by U.S. LNG are diverted to European markets. For example, some of the Middle East LNG projected to be displaced in Asia are redirected to Europe and displace European sources, such as Russian gas imports. The interconnectivity and dynamics of global markets imply U.S. LNG exports will have global impacts.

If U.S. LNG exports are sent to Europe, the impacts are quite different. The WGM projects there to be less displacement of LNG supplies and more displacement of domestic and pipeline imports. The reason is simple: Europe imports far less LNG to meet its demand than does Asia. If U.S. LNG exports are sent to Europe instead of Asia, there is less displacement of Australian LNG and more displacement of African LNG, which includes supplies from Algeria, Egypt, Nigeria, Equatorial Guinea, and new supplies from Mozambique and Tanzania. Other displaced supplies include European sources, primarily contracted flexible supplies from Norway and the Netherlands, and FSU sources, including Russia and Caspian republics. Notice that Asian supplies are still affected by U.S. exports to Europe because of global gas supply displacement and lower prices.

Russia, the leading gas exporter to Europe, appears to be especially hard hit by U.S. LNG exports. Because of its huge volumes of gas exports, primarily to Europe, and their high cost to markets, Russia is vulnerable to supply competition. In Figure 3.4, Russian supplies are estimated to be the high-cost source into European markets and therefore Russian contract supplies above the minimum-take volumes would be the first to be displaced by incremental lower cost supply. With current slack European demand, there is already some displacement of Russian imports, as flexible volumes indexed to oil price have not been utilized by European buyers. U.S. LNG exports to Europe are projected to obviate the need for Russian and some other oil-indexed flexible supplies.

Figure 3.4: European gas supply contract prices for October 2012



Source: ICIS Heren European Gas Markets, October 31, 2012.

[6] EIA, http://www.eia.gov/countries/cab.cfm?fips=CH

Maintaining market share and oil-indexed prices are major concerns for Russia. Russia holds the world's largest natural gas reserves and was the largest producer until the U.S. overtook it in 2011 with the growth in U.S. shale gas production. Gas export is vital to the Russian economy, contributing about $64 billion in revenues in 2011.[7] Russia has jealously guarded its European market share through control of its pipeline transit capacities. By restricting access to its transit pipelines, Russia is able to prevent supplies from other countries, such as Turkmenistan which holds an estimated 500 Tcf of proved reserves, from reaching lucrative European markets and competing with Russian supplies. The strategy was working well until several years ago when economic recession caused European gas demand to stagnate and at the same time more LNG supplies, particularly from Qatar, became available. Qatar had increased its LNG liquefaction capacity in anticipation of exports to the U.S., but its plans were stymied by U.S. shale gas production which eliminated the need for imports. As a consequence, European prices fell and Russians were pressured to offer more competitive prices than the contractual oil-indexed prices. During the past year, several European companies successfully renegotiated their contracts and extracted discounts from Russia. U.S. LNG exports will likely apply greater pressure on Russia and other gas exporters to transition to competitively set prices.

Based on WGM projections using the two market scenarios, Russian revenues from exports to Europe are estimated to be significantly impacted by U.S. LNG exports, which will both displace some amount of Russian exports to Europe and reduce the price Russians receive in Europe. The table in Figure 3.5 shows the projected impact of U.S. LNG exports on Russian revenues (in 2012 U.S. dollars) from exports to Europe. Of course, the impact is higher when U.S. LNG exports are sent to Europe instead of Asia since there is direct competition with Russian supply and greater European price impact. Perhaps a bit surprisingly, the impact is higher under the Competitive Response case than in the BAU scenario. The reason is that under the BAU scenario, in which Russia and other major current gas exporters adhere to oil-price indexation, Russian exports to Europe are reduced down to the minimum take volumes as competitively priced supplies displace the oil-indexed flexible volumes. Hence, U.S. LNG exports have little impact on Russian volumes and most of the impact is through lower prices it receives in European markets for their exports. In the Competitive Response scenario, Russia is assumed to price more of its supplies on a competitive basis and therefore more Russian volumes are exported to Europe than under the BAU market scenario. With U.S. LNG exports, some of these non-minimum take volumes are displaced. Therefore, Russia is hit by both loss of volume and erosion of price under the Competitive Response scenario. These scenarios indicate that U.S. LNG exports may lead Russia to price its supplies on a competitive basis or be relegated to just selling its minimum take contracted volumes.

Figure 3.5: Impact of U.S. LNG exports on Russian revenues from exports to Europe

	Business-as-usual		Competitive response	
	Asia exports	Europe exports	Asia exports	Europe exports
Annual revenue impact ($ Billions)	$(2.1)	$(3.0)	$(2.2)	$(4.0)
% change	-3.4%	-5.0%	-4.0%	-7.2%

[7] The Central Bank of the Russian Federation (http://www.cbr.ru/eng/statistics/print.aspx?file=credit_statistics/gas_e.htm).

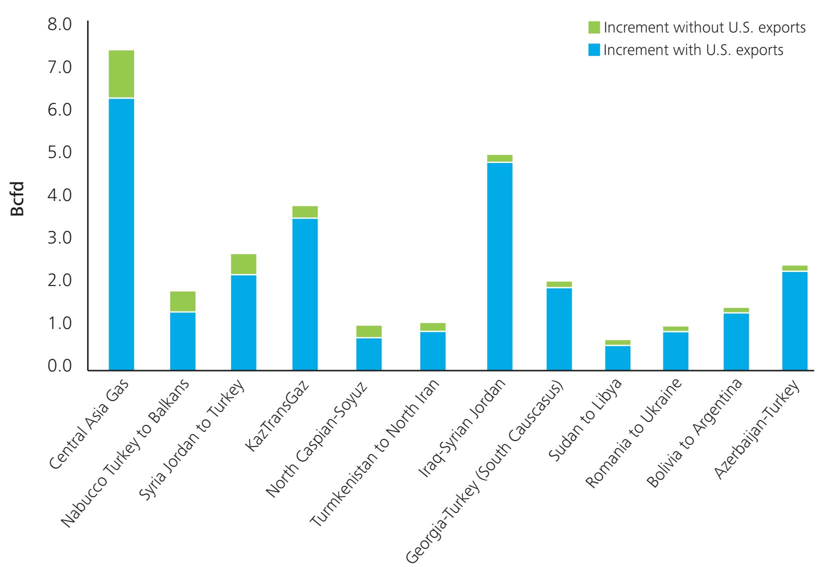
Displaced future projects

Since we are analyzing a long time horizon, we need to consider potential new projects that might be impacted by U.S. LNG exports. The WGM projects new infrastructure, including pipelines and LNG terminals, that would be economic to build based on financial considerations, such as capital and variable costs, discount rate, required rate of return, and projected future prices. The WGM projects potential future margins that could be captured if capacity were built to compute the optimal timing and size of capacity expansions for existing or prospective assets. U.S. LNG exports diminish the need for capacity expansions by depressing prices and margins that could be captured by expanding capacity.

Figure 3.6 shows the largest projected impacts on capacity expansions under the Business-as-usual market scenario out to year 2030. The expansions are ordered from left to right by impact due to U.S. LNG exports. The height of the bars represents total capacity expansion assuming no U.S. LNG exports. The bottom blue portion of the bars represents the expansion that is projected to occur with U.S. LNG exports. Therefore, the green bars (i.e., the difference) represent how much less expansion there would be with U.S. LNG exports.

An examination of the projected expansions that are impacted reveals that they are primarily projects designed to bring Central Asian or Middle Eastern supplies to Europe and Central Asian supplies to Asia. Potential displaced future projects could also include supplies from Mozambique and Tanzania, depending on their production and infrastructure development costs. These supplies are abundant and low cost, but remote and therefore seeking pathways to markets. For example, the Central Asia Gas Pipeline, which is a recent pipeline bringing gas from Turkmenistan and potentially other Central Asian countries to China, is projected to expand by 7.4 Bcfd without U.S. LNG exports. With U.S. LNG exports to Europe, the projected expansion reduces by 1.0 Bcfd to 6.4 Bcfd. If U.S. LNG exports are assumed to go to Asia, the projected expansion falls an additional 0.7 Bcfd to 5.7 Bcfd, relative to the case with no U.S. LNG exports. Once again, we see the global impacts of U.S. LNG exports. Another impacted project is projected to be the Nabucco pipeline, which has engendered much politically charged controversy. Nabucco is designed to transport gas supplies to Europe from either the Middle East or Caspian region. Some want the pipeline to access low cost resources and diversify European gas supply, but others have opposed it for economic and political reasons. Russians have proposed the South Stream pipeline as an alternative so that they can protect their dominant position in the European market. The WGM projects that Nabucco, or some form of it, will eventually be built, but U.S. LNG exports diminish the need for it.

Figure 3.6: Projected capacity expansions to 2030 (U.S. exports to Europe in BAU scenario)



Source: DMP World Gas Model projection (October 2012).

Impact on oil markets

U.S. LNG exports might also impact global oil markets, although obviously to a lesser degree than gas markets. LNG could displace oil in markets in which oil is burned for electricity generation. In some regions, oil-fired electricity generation is utilized because of lack of natural gas supply. In Figure 3.7, OECD countries consumed 1.6 million barrels of oil per day for oil-fired generation in 2008. Using estimated heat content in oil (40.4 trillion Btu per ton of oil) and average heat rates for oil- (11,100 Btu/kWh) and gas-fired (9,900 Btu/kWh) power plants, we estimate that about 8.2 Bcfd of gas would have been consumed if oil-fired generation were displaced by gas-fired generation. Non-OECD Asia consumed about 0.9 million barrels of oil per day, which would convert to about 4.8 Bcfd of gas consumption. Because gas has lower environmental emissions relative to oil, gas-fired generation would be preferred from an environmental perspective if gas supplies and generating capacities were available. For example, due primarily to increase in gas-fired generation, carbon-dioxide emissions in the U.S. in 2012 have dropped to their lowest level in 20 years.[8] Other countries could also realize substantial environmental benefits by shifting from oil to natural gas-fired generation. Potentially, there could be almost 5 million barrels of oil per day displaced if gas supply were more available.

Figure 3.7: Fuel burn for oil-fired power generation in 2008

Region	Oil-fired generation (Million barrels/day)	Gas equivalent (Billion cubic feet/day)
OECD	1.6	8.2
Middle East	1.3	6.9
Asia (Non-OCED)	0.9	4.8
Latin America	0.6	3.2
Africa	0.4	1.9
Total	**4.8**	**25.0**

Source: IEA World Energy Outlook 2010 and Deloitte MarketPoint

If U.S. LNG exports contribute to the decoupling of global gas prices from oil prices, it will increase the incentive to use gas-fired generation instead of oil-fired generation and global oil consumption might decrease. For example, in the aftermath of the devastating earthquake and tsunami that hit Japan in 2009, Japan shut down its nuclear power plants. To replace the lost power generation, Japan has increased both gas and oil imports to fuel gas- and oil-fired generation plants. In fact, Japan imports oil from Iran, after the U.S. exempted Japan from its financial sanctions against Iran.[9] At the current high, oil-indexed prices that Japan is paying for LNG, it does not have much incentive to switch to natural gas. However, if prices fall as projected by the WGM, the incentive will be much greater to switch to gas-fired generation and reduce oil consumption. Reduced oil demand would help reduce global oil prices. Greater global LNG supply might even help reduce oil price volatility since more substitutable fuel would be available and thereby increase supply elasticity.

Key findings

- U.S. LNG exports are projected to have a greater gas price impact in importing regions than in the U.S.
  - Gas importing countries benefit from gas supply cost savings.
  - U.S. LNG exports will narrow the price spread from the U.S. to export markets and hence limit the volume of U.S. LNG exports that will be economic.
  - Global gas markets are likely to transition away from oil-indexed prices to competitively set prices and U.S. LNG exports will hasten that transition.
- Gas exporting countries could suffer decline in revenues due to price erosion and/or supply displacement.
- U.S. LNG exports could also affect global oil markets by allowing displacement of oil-fired electric power generation.

[8] EIA, http://www.eia.gov/totalenergy/data/monthly/archive/00351206.pdf#page=171

[9] Reuters, October 23, 2012. http://www.reuters.com/article/2012/10/23/us-japan-meti-lng-idUSBRE89M08720121023

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Deloitte MarketPoint.

Exhibit C-4

Charles Ebinger *et. al.*, "Liquid Markets: Assessing the case for U.S. Exports of Liquefied Natural Gas," Brooking Institution (May 2012)

Energy Security Initiative
at BROOKINGS





Liquid Markets: Assessing the Case for U.S. Exports of Liquefied Natural Gas

Charles Ebinger
Kevin Massy
Govinda Avasarala

MAY 2012
Policy Brief 12-01

About The Brookings Energy Security Initiative

The Energy Security Initiative (ESI) is a cross-program effort by the Brookings Institution designed to foster multidisciplinary research and dialogue on all aspects of energy security today. ESI recognizes that public and private choices related to energy production and use will shape the global economic, environmental and strategic landscape in profound ways and that achieving a more secure future will therefore require a determined effort to understand the likely consequences of these choices and their implications for sound policymaking. The ESI Policy Brief Series is intended to showcase serious and focused scholarship on topical issues in one or more of these broad research areas, with an emphasis on targeted policy recommendations.

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Preface

In May 2011, The Brookings Institution Energy Security Initiative (ESI) began a year-long study into the prospects for a significant increase in liquefied natural gas (LNG) exports from the United States.

To inform its research ESI assembled a Task Force of independent natural-gas experts, whose expertise and insights provided the foundation for this study. The conclusions of this report are those of the authors and do not necessarily reflect the views of the members of the task force.

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Acknowledgments

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Executive Summary

Driven by technological breakthroughs in unconventional gas production, major increases in U.S. natural gas reserves and production have led to supply growth significantly outpacing forecasts in recent years. As a result, natural gas producers have sought new and additional sources of demand for the newfound volumes. One proposed end-use is the exportation of U.S. natural gas in the form of liquefied natural gas (LNG). While the United States already exports modest quantities of natural gas, mostly via pipeline, current proposals, some of which have already received full or partial approval from the federal government, would increase substantially the volume of LNG exports. There is a growing debate between policymakers, industry, and energy analysts as to the merits of exporting greater quantities of U.S. natural gas. Some domestic natural gas consumers contend that exporting U.S. gas would result in an increase in domestic natural gas prices and therefore in higher prices for businesses and households. Proponents of natural gas exports argue that they would provide valuable foreign exchange and would be a source of economic growth and job creation.

This report, the result of a year-long study, addresses the merits of increased LNG exports through an examination of the feasibility of exports and their likely implications. It concludes that, given current information on resources, increased LNG exports from the United States are technically feasible. While new policies may serve to change the logistics or economics of shale gas production, under current circumstances, the challenges to LNG exportation, including physical and human capacity and demands for natural gas from competing domestic sectors, are not insurmountable. It also finds that, in light of current global supply and demand projections, some amount of U.S. LNG exports is likely to be competitive in global markets. The study finds that U.S. LNG exports are likely to have a modest upward impact on domestic prices, and a limited impact on the competitiveness of U.S. industry and job creation. It finds that U.S. LNG is likely to make a positive, albeit relatively small, contribution to the U.S. gross domestic product (GDP), trade balance, and that the potential for U.S. LNG exports to make a positive impact on global greenhouse gas emissions is minimal. It further finds that there is potential for positive foreign policy impacts from U.S. entry in the global gas market, through both increased supply diversity for strategic gas-importing allies, and as a contributory factor in weakening the oil-linked contract pricing structure that works to the advantage of rent-seeking energy suppliers.

The study recommends that U.S. policy makers should refrain from introducing legislation or regulations that would either promote or limit additional exports of LNG from the United States. The nature of the LNG sector, both the costs associated with producing, processing, and shipping the gas, and the global market in which it will compete, will place upper bounds on the amount of LNG that will be economic to export. Incremental increases in the price of domestic gas (as a result of domestic demand or export) negatively impact the economics of each additional proposed export project, which even with government approval will still require private financing and interested buyers. Efforts to intervene in the market by policy makers are likely to result in subsidies to consumers at the expense of producers, and to lead to unintended consequences. They are also likely to weaken the position of the United States as a supporter of a global trading system characterized by the free flow of goods and capital.

Introduction

Less than a decade ago, the United States was facing a major shortfall in the supply of natural gas as declining conventional production and reserves were outpaced by rising demand. The situation was so acute that private companies, encouraged by federal-government policies, began constructing import terminals for LNG, which was regarded as the only way to meet growing demand.[1] Since 2005, the situation has dramatically reversed. Driven by advances in exploration and production technology and a precipitous rise in the price of natural gas to 2008, the U.S natural gas sector has undergone a revolution as vast amounts of previously uneconomic "unconventional" resources in shale formations across the Northeast, Midwest, and South have been developed.

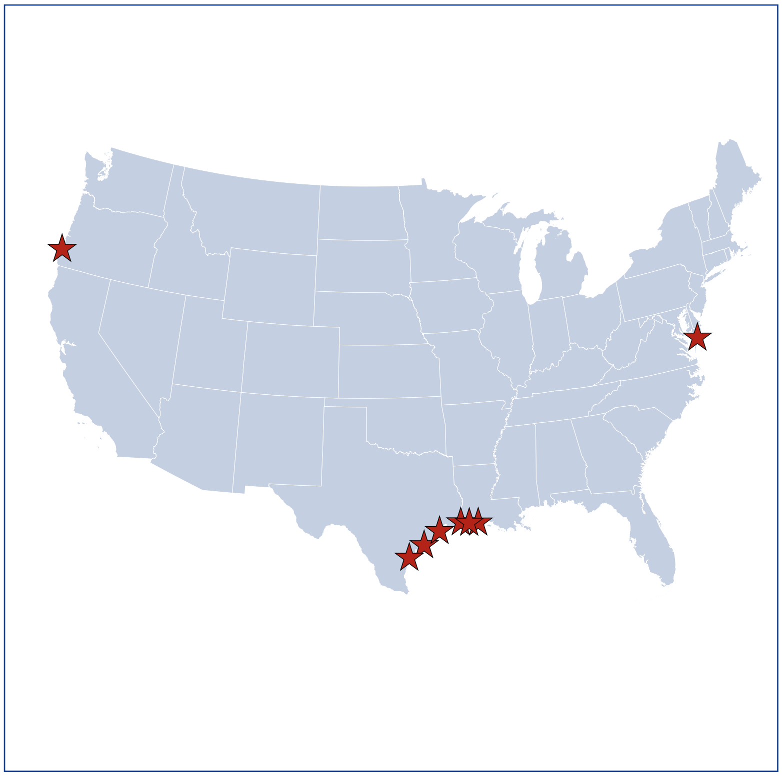
Early estimates of the size of the unconventional gas resource have varied. However, it is clear to producers and end users alike that the increased available volumes of shale gas mean that there is far more potential for natural gas in the U.S. energy mix than previously estimated. While the domestic focus has been on the potential for increased natural gas use in the power, industrial, petrochemical, and transportation sectors, there is also increased interest among policy makers and private investors in the prospect of the United States becoming a significant exporter of LNG (see **Figure 1** for a list of proposed and potential lower-48 LNG export terminals).

The United States already exports modest volumes of natural gas via pipeline to Mexico and Canada and, until November 2011, in the form of LNG from the Kenai Terminal in Alaska to Japan, although the latter facility has recently been temporarily idled.[2] Several projects currently under consideration would involve the development of liquefaction facilities to enable the export of LNG in increased quantities. These proposed projects, some of which have been given partial approval by the federal government over the past year, are currently evaluated by energy and environmental regulators on a case-by-case basis.

[1] The 2005 Energy Policy Act demonstrated Federal government support for a streamlined LNG import process through both codification of the 2002 "Hackberry Decision" by the Federal Energy Regulatory Commission (FERC), which absolved U.S. LNG import terminals from open-access requirements and allowed them to charge market based rates; and by granting FERC exclusive authority to approve siting, construction, expansion and operation of such import terminals.

[2] The Kenai liquefaction plant, inaugurated in 1969, exported to Japan modest amounts (30 bcf in 2010) of gas produced from the Cook Inlet. ConocoPhillips, the owner and operator of the facility, had initially planned on closing the plant in March 2011 due to an inability to renew supply contracts; however, following the earthquake and subsequent nuclear disaster in Japan, it decided to extend operations of the plant for six months to allow for additional shipments to Japan.

Figure 1: Proposed/Potential North American LNG Export Terminals (as of February 28, 2012)



Source: Federal Energy Regulatory Commission, Department of Energy

FTA and non-FTA Approved Projects (approval by Depaertment of Energy):

- Sabine Pass, Louisiana (Cheniere Energy): 2.2 bcf/day;proposed to FERC

FTA Approved Projects:

- Freeport, Texas (Freeport LNG): 1.8 bcf/day; proposed to FERC
- Lake Chalres, Louisiana (BG and Southern Union): 2.0 bcf/day
- Cove Point, Maryland (Dominion): 1.0 bcf/day
- Hackberry, Louisiana (Cameron LNG): 1.7 bcf/day
- Coos Bay, Oregon (Jordan Cove Energy): 1.2 bcf/day

Awaiting Approval

- Corpus Christi, Texas (Cheniere Energy): 1.8 bcf/day; proposed to FERC
- Brownsville Texas (Gulf Coast to LNG Export): 2.8 bcf/day

Note: two other companies are looking to export a total of 0.3 bcf/day of LNG from various locations.

Supporters of these projects maintain that they will provide a valuable source of economic growth, gains from trade, and job creation for the United States. Opponents contend that they will raise domestic natural gas prices to the detriment of U.S. consumers and negatively affect U.S. energy security.

The Brookings Institution's Energy Security Initiative has undertaken a year-long study to assess the feasibility and implications of an increase in U.S. LNG exports. To inform its research, ESI assembled a Task Force of independent natural gas experts, whose discussions and deliberations provide the basis of the project's conclusions. The conclusions of this report are the authors' alone and do not necessarily represent the views of the Task Force. This report represents the conclusion of the study, and is structured in two parts. Part I assesses the **feasibility** of LNG exports and the factors that are likely to have a bearing on the ability of the United States to export more gas. Part II looks at the **implications** of significantly increased LNG exports from the United States. Part III presents the study's findings and conclusions and offers recommendations to policy makers.

Part I: Feasibility

For the purpose of this study, the Brookings research team identified the various factors that affect the feasibility of increased U.S. LNG exports. These factors were divided into four main categories: domestic supply, domestic demand, international gas markets, and economic rationale. On the supply side, feasibility is defined as the physical capacity of the United States to have gas volumes available for export. Factors in this regard include: resource availability and production sustainability; regulatory and environmental considerations; and infrastructure issues, including pipeline availability, storage, and shipping capacity. On the demand side, feasibility of exports is defined by the extent to which potential exports compete with various domestic end uses for increased natural gas, including electricity generation, transportation, and industrial and petrochemical production. With regard to international markets, feasibility is the extent to which potential U.S. exports can compete with other LNG sources to meet demand, and includes an assessment of the potential markets that U.S.-origin LNG would serve. It also includes an assessment of the nature of contractual pricing agreements, particularly the linkage between natural gas prices and oil prices in target markets. Economic feasibility assesses factors other than feedstock costs that have a bearing on the extent to which LNG exports have a long-term positive return on investment, and includes the costs of liquefaction, transportation, and regasification, and the availability of financing.

Domestic Supply Factors

The domestic U.S. natural gas supply situation is determined primarily by three sets of factors: resource availability and production sustainability; policy, regulatory, and environmental considerations; and capacity and infrastructure constraints.

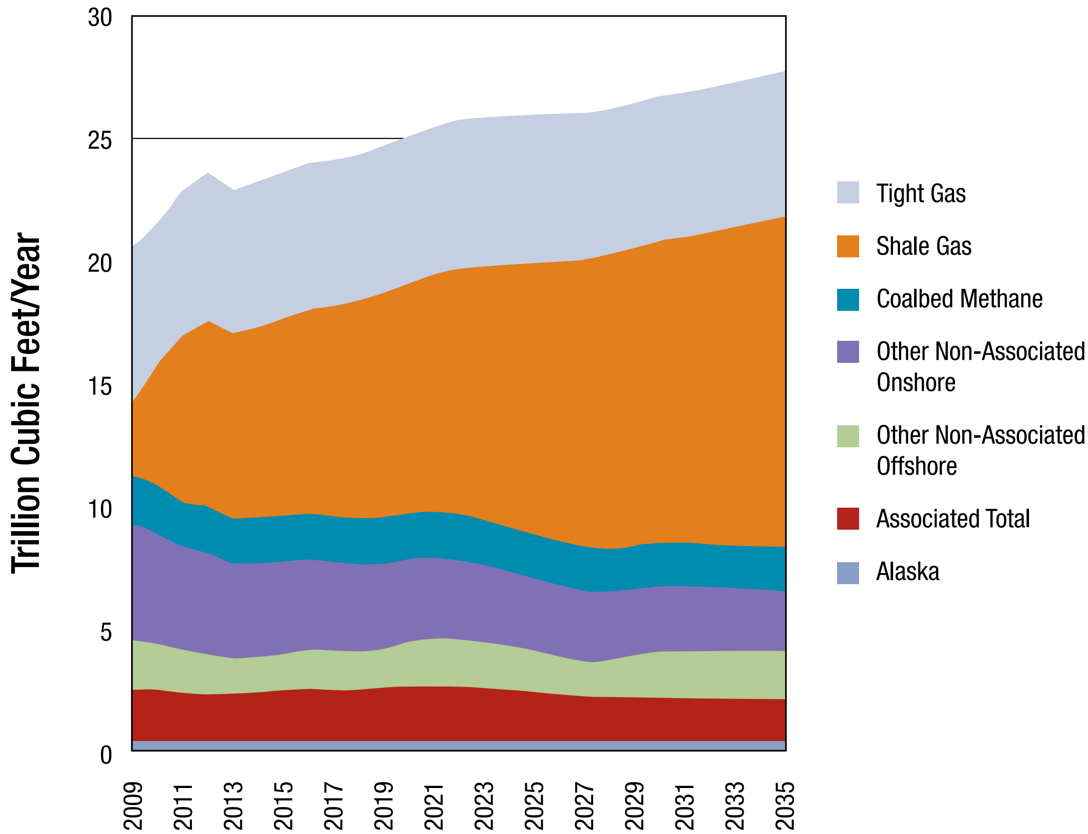
Resource Availability and Production Sustainability

For an increase in U.S. exports of LNG to be considered feasible, there has to be an adequate and sustainable domestic resource base to support it. Natural gas currently accounts for approximately 25 percent of the U.S. primary energy mix.[3] While it currently provides only a minority of U.S. gas supply, shale gas production is increasing at a rapid rate: from 2000 to 2006, shale gas production increased by an average annual rate of 17 percent; from 2006 to 2010, production increased by an annual average rate of 48 percent (see Figure 2).[4] According to the Energy Information Adminis-

[3] "AEO 2012 Early Release Overview," Energy Information Administration (EIA, 2012a).

[4] Annual Energy Outlook 2011 with Projections to 2035," Energy Information Administration, April 2011. pp. 37, 39. (EIA, April 2011a)

Figure 2: U.S. Natural Gas Production by Source, 2009-2035 (tcf/year)



Source: U.S. Energy Information Administration, Annual Energy Outlook 2011

tration (EIA), shale gas production in the United States reached 4.87 trillion cubic feet (tcf) in 2010, or 23 percent of U.S. dry gas production. By 2035, it is estimated that shale gas production will account for 46 percent of total domestic natural gas production.[5]

Given the centrality of shale gas to the future of the U.S. gas sector, much of the discussion over potential exports hinges on the prospects for its sustained availability and development. For exports to be feasible, gas from shale and other unconventional sources needs to both offset declines in conventional production and compete with new and incumbent domestic end uses. There have been a number of reports and studies that attempt to identify the total amount of technically recoverable shale gas resources—the volumes of gas retrievable using current technology irrespective of cost—available in the United States. These estimates vary from just under 700 trillion cubic feet (tcf) of shale gas to over 1,800 tcf (see **Table 1**). To put these numbers in context, the United States consumed just over 24 tcf of gas in 2010, suggesting that the estimates for the shale gas resource alone would be enough to satisfy between 25 and 80 years of U.S. domestic demand.[6] The estimates for recoverable shale gas

[5] Ibid.

[6] "U.S. Natural Gas Production, Consumption, and Net Imports," Energy Information Administration, (http://www.eia.gov/todayinenergy/detail.cfm?id=770)

resources also compare with an estimate for total U.S. gas resources (onshore and offshore, including Alaska) of 2,543 tcf.[7] Based on the range of estimates below, shale gas could therefore account for between 29 percent and 52 percent of the total technically recoverable natural gas resource in the United States.

Table 1. Comparison of shale gas estimates for the Lower 48 States, (Technically Recoverable Resources, excluding proven reserves; in tcf)

	Reserve Estimate (tcf)
ICF	1,842
Advanced Resources International	1,189
Energy Information Administration (EIA), 2011	827
Potential Gas Committee	687

Source: ICF International, Advanced Resources International, EIA, Potential Gas Committee.

Sustainability of Shale Gas Production

In addition to the size of the economically recoverable resources, two other major factors will have an impact on the sustainability of shale gas production: the productivity of shale gas wells; and the demand for the equipment used for shale gas production. The productivity of shale gas wells has been a subject of much recent debate, with some industry observers suggesting that undeveloped wells may prove to be less productive than those developed to date. However, a prominent view among independent experts is that sustainability of shale gas production is not a cause for serious concern, owing to the continued rapid improvement in technologies and production processes.

The sustained productivity of shale gas wells rests primarily on technological developments in two areas: the hydraulic fracturing ("fracking") process, in which water, sand, and other chemicals are forced at high pressure into rock formations to free trapped gas; and the length of horizontal wells ("laterals") drilled into the shale layer. Shale gas technologies and production processes have been developing rapidly in recent years, improving the economics of extraction. Companies now are drilling longer laterals and are increasing the number of frack stages—the number of different fracking sections in each lateral section—per well, leading to an increase in available reserves and well productivity.[8] An analysis of well-specific-data illustrates that both initial production rates and ultimate well recovery have been growing across all production regions (or "plays"), thereby driving down per unit costs of production.

A more immediate consideration with regard to production sustainability is the availability of drilling equipment and skilled labor. In addition to the demands for the latter from an increasing number of shale gas prospects, there is increasing competition from producers of shale oil and other "tight" oil resources, which use the same equipment to yield a product that is more valuable than gas at current market prices; and from producers who are more interested in plays rich in natural gas liquids, a valuable by-product of dry gas production. Formations such as the Eagle Ford Shale in Texas and the Utica Shale in Ohio and New York, which have higher condensate ratios—the ratio of liquids produced with gas production—have seen increasing interest from producers over the past two years. The displacement of rigs from "dry gas" prospects, such as the Haynesville Shale in Louisiana, to "wetter" prospects such as the Bakken field in North Dakota, is already occurring, as

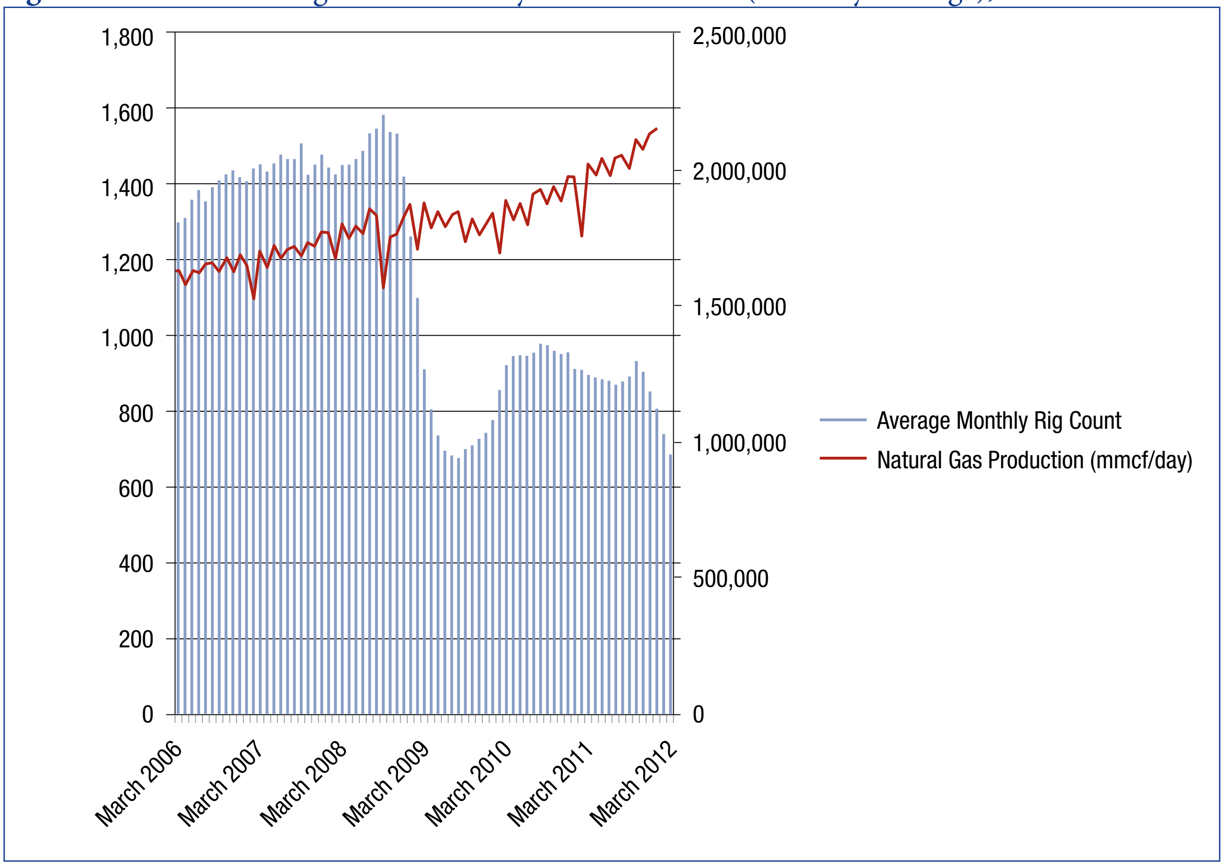
[7] "Assumptions to the Annual Energy Outlook 2011," Energy Information Administration, 2011.
[8] "U.S. Natural Gas Resources and Productive Capacity," Advanced Resources International, prepared for Cheniere Energy, April 26, 2010. "Exhibits to Application of Sabine Pass Liquefaction, LLC for Long-Term Authorization to Export Liquefied Natural Gas," U.S. Department of Energy. p. 275. Also see "Natural Gas Industry Fakes the Moon Landing," EPRINC Briefing Memorandum, Energy Policy Research Foundation, Inc., July 1, 2011. (EPRINC, July 2011)

evidenced by the declining gas rig count in the gas sector. Owing to technological improvements and the availability of associated dry gas at liquids-rich plays, dry production is keeping pace despite the declining rig count (see **Figure 3**).[9]

Environmental, Regulatory, and Stakeholder Considerations for Natural Gas Production

The case for U.S. LNG exports depends heavily on the continued development of unconventional gas. This development itself depends on the safe and sustainable continuation of the practice of fracking, a process that has been under intense public scrutiny since shale gas production increased. The conclusions of a 2011 report conducted by the Secretary of Energy's Advisory Board (SEAB) into the practices and oversight of shale gas development found that "absent action there will be little credible progress in reducing in the environmental impact of shale gas production, placing at risk the future of the enormous potential benefits of this domestic energy resource."[10] Concern around the negative environmental impact of shale gas development has led to the formation of local opposition groups, some of which call for outright bans on fracking. For its part, industry views the regulatory uncertainty around shale gas as among the greatest challenges to development.

Figure 3: Natural Gas Rig Count and Dry Gas Production (Monthly Average), 2006-2012



Source: Baker Hughes, EIA

[9] EPRINC, July 2011.

[10] "The SEAB Shale Gas Production Subcommittee Second Ninety-Day Report," Natural Gas Subcommittee of the Secretary of Energy Advisory Board, November 18, 2011. p.3. (SEAB, 2011)

Environmental Issues

There are three main environmental issues that need to be addressed if shale gas production is to continue at scale and provide the benefits many foresee: water, emissions, and other pollution such as noise and disruption caused by work-site activity.

The issue of water has been the most prominent to date, with the main focus being on the risk of contamination of surface water and water tables, the volume of water used in the process of fracking, and the disposal of waste water from the fracking process. The risk of groundwater contamination from fracking has been the subject of vigorous debate. Some environmental advocates charge that the technique can lead to seepage of gas and chemicals into water supplies, while energy companies maintain that correctly installed well casings combined with the depth of fracking operations—most of which are many thousand feet beneath the water table—make the process safe for drinking water supplies.

With regard to emissions, the major focus has been on unintentional leaks of natural gas, or "fugitive emissions," intentional venting of gas, and flaring. The latter issue is a particular concern in light of the developments at some shale oil plays, such as the Bakken and Niobrara. At both sites, the production of oil requires the production of large volumes of associated natural gas. Given the focus on the higher-value liquids production and the pace of development of these fields, the infrastructure for gathering and transporting this associated gas has not been adequately developed. The result is that large amounts of gas are being flared. In North Dakota, home of the Bakken shale oil field, roughly 30 percent of gas produced—over 3 billion cubic feet (bcf) per month—is currently flared; the percentage of flared gas from production at the Niobrara shale formation that straddles Colorado, Wyoming and Nebraska is considered by industry experts to be much higher.[11] There are concerns that the rapid development of NGL-rich shale plays, such as Eagle Ford and Utica, may similarly result in the flaring of associated dry gas, which is less valuable than natural gas liquids (NGLs).

A recent academic study suggested that, after considering "fugitive" methane emissions and venting, life-cycle emissions from natural gas production are higher than those from other fossil fuels, including coal. A number of studies by national laboratories, academics, and other analysts, however, have disputed this finding, concluding that the life-cycle emissions of shale gas used for power generation are still roughly 50 percent of those from coal.[12]

Other environmental issues that have been raised by opponents of fracking include the possibility of a link between fracking and seismic disruption, and issues of potential "fracture communication" through which fracking operations interact with existing natural geologic fractures, leading to a higher risk of groundwater contamination. There are also concerns that the disposal of wastewater through injection wells may cause seismic disruptions. The USGS has found that any seismic activity resulting from fracking is "almost always too small" to be a safety concern. The injection of wastewater from the fracking process into deep wells is the subject of further investigation.

[11] From the "Director's Cut" by the North Dakota Industrial Commission Department of Mineral Resources, July 21, 2011. (https://www.dmr.nd.gov/oilgas/directorscut/directorscut-2011-07-21.pdf)

[12] For the former study see Robert Howarth et al, "Methane and the greenhouse gas footprint of natural gas from shale formations," Climatic Change Letters, 2011. For examples of responses to this study or national laboratory studies on the issue see: Nathan Hultman et al, "The greenhouse impact of unconventional gas for electricity generation," Environmental Research Letters, Vol. 6, no. 4 (October-December 2011); Mark Fulton et al, "Comparing Life-Cycle Greenhouse Gas Emissions from Natural Gas and Coal," Worldwatch Institute and Deutsche Bank Group Climate Change Advisors, August 25, 2011; and "Life Cycle Greenhouse Gas Inventory of Natural Gas Extraction, Delivery and Electricity Production," National Energy Technology Laboratory, U.S. Department of Energy, October 24, 2011.

Regulatory Oversight for Natural Gas Production

A range of state and federal government agencies have jurisdiction over fracking and other aspects of natural gas development, and the extent to which, and the ways in which, these agencies implement regulations on shale gas production will have a major impact on the viability of exports.

Environmental Protection Agency

The Environmental Protection Agency (EPA) has a number of statutory authorities that apply to the regulation of shale gas production, including ensuring that harmful gases and pollutants are not released into the air (through the Clean Air Act) and that water supplies are kept free from waste water or methane leakages (through the Clean Water Act and Safe Drinking Water Act). The principal concerns for the EPA regarding shale gas production relate to water consumption, treatment, and storage.[13] Owing to the provisions of the 2005 Energy Policy Act, the EPA's regulation of underground injection of fluids relating to fracking under the Safe Drinking Water Act is limited to those operations that use diesel-based fracking fluids. However, the agency is addressing the issue of fracking through a variety of other statutory authorities.

As required by Congress, the EPA has begun a study on shale gas and fracking that focuses on five areas of water usage: water withdrawals, surface spills of fracking fluids, impacts of injection on drinking water, impacts of flowback and produced water, and wastewater treatment and disposal. The results of the study are due by the end of 2014, with an interim report scheduled for release in 2012. In October 2011, the EPA announced it would use the Clean Water Act to regulate the disposal of waste water produced by fracking. The agency is currently engaged in discussions with the various stakeholders and will announce a proposed rule by 2014.[14]

The EPA has also recently announced that it will use the Toxic Substances Control Act (TSCA) to "[initiate] a proposed rulemaking process … to obtain data on chemical substances and mixtures used in hydraulic fracturing."[15] Acknowledging that some states already engage in this practice, the EPA announced that it would complement, not duplicate, such efforts and that it would provide an "aggregate picture" of the chemical compounds used in fracking fluids.

In December 2011, the EPA released a draft analysis of data from an investigation into ground water quality in Pavillion, Wyoming. The draft report indicates that ground water in the aquifer under review contained "compounds likely associated with gas production practices including hydraulic fracturing," and that chemical samples were "generally below established health and safety standards."[16] The draft report has galvanized opponents of fracking. Responses to the report from gas industry representatives focus on the inconclusiveness of the findings and the possibility of the natural occurrence of some of the chemicals discovered in the samples. On March 8, 2012 the EPA, the State of Wyoming, and relevant Native American tribes in the region agreed that the peer review period would remain open until a report containing U.S. Geological Survey

[13] In November 2011, the EPA released its plan to study, at the request of Congress, the impacts of hydraulic fracturing on water resources. The report states that "many concerns about hydraulic fracturing center on potential risks to drinking water resources, although other issues have been raised." ("Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources," U.S. Environmental Protection Agency, November 2011. p. viii.)

[14] "Natural Gas Extraction—Hydraulic Fracturing," U.S. Environmental Protection Agency. (http://www.epa.gov/hydraulicfracture/).

[15] "Natural Gas Extraction—Hydraulic Fracturing," U.S. Environmental Protection Agency. (http://www.epa.gov/hydraulicfracture/).

[16] "EPA Releases Draft Findings of Pavillion, Wyoming Ground Water Investigation for Public Comment and Independent Scientific Review," Environmental Protection Agency, November 8, 2011.

(USGS) data becomes publicly available.[17] More recently, the EPA reported that it found no contamination levels that present health concerns at Dimock, Pennsylvania, the site of an existing lawsuit against a shale gas producer.

In addition to its focus on water, the EPA has several initiatives that focus on air quality and pollution. On April 17, 2012, it finalized rules for regulating air pollutants from fracking-related operations intended to significantly cut the amount of volatile organic compound (VOC) emissions from the completion of hydraulically fractured oil and gas wells. The regulations, which will come into effect in 2015, are expected by the EPA to reduce emissions from shale gas wells by as much as 95 percent.

Bureau of Land Management

The Bureau of Land Management (BLM) within the U.S. Department of Interior oversees the development of oil and gas resources on Federal land. While BLM does not need to approve "routine" fracking operations, such operations must be reported to the Bureau by the companies carrying them out within 30 days. "Non-routine" fracking operations require prior approval by the Bureau. However, as with the EPA's oversight of fracking, there is currently no definition for what constitutes a "routine" or a "non-routine" operation. Currently, BLM recommends and encourages the best land and water management practices for shale gas production. Secretary of the Interior Ken Salazar has also publicly stated that he is considering possible regulations for the disclosure of chemicals used in fracking on federal lands. Salazar announced in February 2012 that natural gas companies will be required to inspect wells after fracking on public lands to ensure safe drinking water supplies.[18]

Regional and State-Level Regulation

As large-scale shale gas production is a relatively new phenomenon, several aspects of the regulatory regime—including issues of federal-versus-state jurisdiction—have yet to be resolved. Currently, most states implement their own regulatory requirements for oil and gas production with the EPA having responsibility for ensuring that shale gas production meets national standards for air, dust, and water consumption and treatment. While many companies agree that a degree of regulation is necessary for certain practices, they are divided in their opinion on whether federal or state regulators should have jurisdiction over them: some think comprehensive federal oversight would stifle shale gas production, while others see the prospect of a single set of regulatory requirements as preferable to a patchwork of state-level rules.

Some notable state- and regional-level regulatory activity on shale gas production includes:

- The Texas Railroad Commission's June 2011 legislation that requires the development of regulations that mandate the disclosure of the composition of fluids used in hydraulic fracturing.[19]

- A commitment by Pennsylvania Governor Tom Corbett in October 2011 to implement a range of recommendations of that state's Marcellus Shale Advisory Commission, including provisions extending liability periods, increasing impact fees, and increasing the distance of shale-gas wells from private and public bodies of water.

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[17] "Statement on Pavillion, Wyoming groundwater investigation," Environmental Protection Agency, March 8, 2012. (http://yosemite.epa.gov/opa/admpress.nsf/d0cf6618525a9efb85257359003fb69d/17640d44f5be4cef852579bb006432de!opendocument)

[18] "Gas Well Inspections to be Required after Fracking, Salazar Says," *Bloomberg,* February 14, 2012. (http://www.bloomberg.com/news/2012-02-14/gas-well-inspections-to-be-required-after-fracking-salazar-says.html)

[19] Bill H.B. No. 3328, "An Act relating to the disclosure of the composition of hydraulic fracturing fluids used in hydraulic fracturing treatments," the 82nd Legislature, Government of the State of Texas. (http://www.capitol.state.tx.us/BillLookup/History.aspx?LegSess=82R&Bill=HB3328).

- New York's temporary moratorium on fracking, which halted new fracking operations in the state. The Governor's office has put forward a draft environmental impact study for public comment, the results of which will inform a decision on whether to permit fracking to continue with specific exemptions.

- West Virginia's Joint Select Committee on Marcellus Shale's passage of a bill that increases drilling permit fees, with increased revenues allocated to the hiring of more well inspectors. The bill, which also lays out new terms for compensation to surface owners for damage to property, and minimum distances between wells from homes and drinking water, still needs to be voted on by the full state legislature.

- Colorado and Wyoming's mandatory requirement for "green completion" of natural gas wells, through which gas and vapors that would usually escape into the atmosphere during the completion phase of a well are captured and sold.

- The Delaware River Basin Commission's (DBRC, a federal interstate government agency comprised of the four basin states), consideration of new regulations on oil and gas production—and the attendant water consumption and disposal—within the basin. According to the DRBC, about 36 percent of the basin lies over the Marcellus Shale.[20]

- Pennsylvania's passage of a bill in February 2012 to allow counties to levy fees on natural gas wells, which is expected to generate about $211 million in revenues a year. Most of the money will go to communities affected by the drilling in Pennsylvania's portion of the Marcellus.[21]

The importance of state-level regulation of shale gas development was highlighted by the SEAB report, which recommended increased federal funding for the State Review of Oil and Natural Gas Environmental Regulations (STRONGER), and the Ground Water Protection Council, two existing organizations that help states to develop regulations and best practice.[22]

Other inter and intrastate authorities with influence over the regulatory environment for the development of shale gas include other river basin commissions; and municipal, town and village governments. The extent to which state law supersedes or conforms to local-level rulings on fracking and other aspects of shale gas production will have a significant bearing on the sustainability of shale-gas development operations.[23]

Environment, Regulations, and the Feasibility of LNG Exports

While several studies are ongoing into the effects of shale gas production on the environment, there has been no conclusive evidence found to date that links the practice of fracking to ground water contamination or increased seismic activity. As long as the current regulatory environment re-

[20] "Natural Gas Drilling in the Delaware River Basin," Delaware River Basin Commission. (http://www.state.nj.us/drbc/naturalgas.htm)

[21] Romy Varghese, "Pennsylvania Set to Let Counties Put Fees on Natural-Gas Wells," *Bloomberg,* February 10, 2012. (http://www.businessweek.com/news/2012-02-10/pennsylvania-set-to-let-counties-put-fees-on-natural-gas-wells.html).

[22] SEAB, 2011, p.3.

[23] For an excellent analysis of the range of regulatory actors in the Marcellus Shale, see Andrew Blohme et al, "Impact of shale gas policy on domestic and international natural gas markets," Center for Integrative Environmental Research, University of Maryland, October 2011.

Table 2: Applications Received by the Department of Energy to Export LNG from the Lower-48 States (as of March 23, 2012)

Facility	Quantity	Location	FTA approved	Non-FTA approved
Sabine Pass	2.2 bcf/day	Louisiana	Yes	Yes
Freeport	1.4 bcf/day	Texas	Yes	Under Review
Lake Charles	2.0 bcf/day	Louisiana	Yes	Under Review
Carib Energy	FTA: 0.03 bcf/day Non-FTA: 0.01 bcf/day	various	Yes	Under Review
Dominion Cove Point	1.0 bcf/day	Maryland	Yes	Under Review
Jordan Cove Point	1.2 bcf/day	Oregon	Yes	Under Review
Cameron LNG	1.7 bcf/day	Louisiana	Yes	Under Review
Gulf Coast LNG Export	2.8 bcf/day	Texas	Under Review	Under Review
Cambridge Energy	0.27 bcf/day	various	Under Review	n/a

Source: U.S. Department of Energy

mains, shale gas development is likely to continue to produce the volumes that will make LNG exports feasible. However, a change in the regulatory landscape that imposes additional costs on producers could make marginal shale gas prospects uneconomic, reducing the size of the economically recoverable resource, thereby negatively affecting the feasibility of LNG exports. Conversely, well developed regulations, possibly based on sustainable best practice, could provide benefit to the public, the environment and industry. The recent announcement by the Obama Administration—in which it allocated $45 million to an interagency research and development program between the Department of Energy, Interior, and the EPA to identify ways to reduce the environmental impact of shale gas production—suggests that the Administration supports the sustainable development of shale gas resources.

Enforcement and Public Perception

Irrespective of the regulations in place or under consideration, an important aspect of the discussion around responsible and sustainable shale gas development is the effectiveness of enforcement and public perception on the safety of fracking. The interim findings of the SEAB report found that "while many states and several federal agencies regulate aspects of these operations, the efficacy of the regulations is far from clear."[24] The report emphasized the role for industry in the responsible development of shale gas and called for the formation of a "shale gas industry production organization" that would establish best practice for operations, share information with regulators, and act to build public trust. The latter consideration was of particular concern to the authors of the interim report, who noted that "some concerted and sustained action is needed to avoid excessive environmental impacts of shale gas production and the consequent risk of public opposition to its continuation and expansion."[25] The extent to which industry can act as a responsible stakeholder and standard setter and the extent to which public confidence in fracking can be retained will have a large bearing on the feasibility of continued shale gas development and therefore the feasibility of U.S. LNG gas exports.

[24] SEAB, 2011.
[25] Ibid.

Regulatory Approvals for Export Facilities

Companies looking to construct or expand facilities for the export of LNG from the United States need to satisfy a number of federal regulatory requirements. These include the requirement for companies to seek export authorization from the Department of Energy's Office of Fossil Energy if the importing country is not subject to a free-trade agreement (FTA) with the United States (see **Table 2**).[26] Operators looking to modify existing LNG import terminals must obtain approval from the Federal Energy Regulatory Commission (FERC).[27] Other federal agencies that have a role in approving LNG export facilities include the U.S. Coast Guard, which, among other responsibilities, provides escort security in and out of port facilities; and the Pipeline and Hazardous Materials Safety Administration, which has jurisdiction over all pipelines. Under the National Environmental Policy Act, LNG export facilities may also be subject to environmental reviews in the form of an Environmental Impact Statement, an Environmental Assessment or under the terms of the Clean Air Act, or the Endangered Species Act..[28] (See **Box 1**).

Capacity and Infrastructure Constraints

The feasibility of U.S. LNG exports depends upon the ability of the country's natural gas infrastructure to support the production, transportation, storage, and shipment of natural gas.

Pipeline and Storage Capacity

The development of shale gas plays is likely to have a profound effect on the regional dynamics of the U.S. natural gas market. Increased production from the Marcellus Shale is likely to displace some supplies from the Gulf Coast and other regions that currently serve the large Northeast market.[29] Moreover, if significantly increased LNG exports from the Gulf Coast go ahead, there may be a need to reverse the pipelines to allow gas to flow toward the Gulf Coast.

To maximize the economic potential of the U.S. shale gas endowment, whether for exports or for domestic use, there will be a requirement for significant expansion in the nation's continental natural gas pipeline network, particularly in the vicinity of the Marcellus Shale. In 2010, Marcellus producers predicted that fewer than half of the 1,100 wells drilled had pipeline access.[30] ICF International, a consultancy, estimates that 3,300 additional miles of pipeline will be built in the Northeast between 2009 and 2035.[31] There is currently 6 bcf/day of FERC-approved proposed pipeline capacity that will deliver gas from the Marcellus to demand centers. More than 2 bcf/day of this capacity is scheduled to be completed by the summer of 2012.[32] Another concern is whether a gas pipeline infrastructure network will be developed quickly enough in liquid-rich plays, such as the Eagle Ford, Niobrara, and Utica Shales, to fully capture the natural gas being produced. As out-

[26] This distinction was given greater weight by the November 2011 FTA between the United States and Korea, the world's second largest importer of LNG.
[27] Michael Ratner, Paul W. Parfomak, Linda Luther, "U.S. Natural Gas Exports: New Opportunities, Uncertain Outcomes," Congressional Research Service, November 2011. (Ratner, November 2011).
[28] See Ratner, November 2011 for a thorough examination of the federal regulations and approvals needed by LNG exporters.
[29] Tom Choi and Peter Robinson, "Navigating a fractured future: Insights into the future of the North American natural gas market" Deloitte Center for Energy Solutions, September 2011. (Deloitte, 2011).
[30] "The Beast in the East: Energy Market Fundamentals Report," Bentek Energy, March 19, 2010.
[31] Kevin Petak, David Fritsch, and E. Harry Vidas, "North American Midstream Infrastructure Through 2035—A Secure Energy Future," presentation and report prepared by ICF for the INGAA Foundation, June 28, 2011. (http://www.ingaa.org/File.aspx?id=14900).

Box 1: Approval Process for Natural Gas Exports

Under the Natural Gas Act (NGA) Section 3 (15 USC §717b), exporting natural gas from the United States requires authorizations from the Department of Energy's Office of Fossil Energy and from FERC. Below are some of the permits that must be approved before a facility can export natural gas:

File application with the DOE's Office of Fossil Energy for export authorization

1. Issuance of an export authorization is dependent upon the export being deemed consistent with the public interest. DoE can choose to issue permits up to a certain cumulative total volume, and then deny subsequent applications if it were found to be in the public's interest.

    a) A project is deemed consistent with the public interest if a free trade agreement exists between the U.S. and the LNG-recipient nation.

    b) If the U.S. does not have free trade agreements with the countries to which LNG is to be exported, the Office of Fossil Energy must issue the permit unless it finds it is not in the public interest after publishing a notice of the application in the Federal Register to seek public comments, protests, and notices of intervention.

File application with FERC for authorization to site, construct or operate LNG export facilities

1. Any proposals to site, construct or operate facilities for the use of exporting natural gas—or to amend an existing FERC authorization—must obtain approval from FERC. Certain activities may also require regulatory oversight from the U.S. Coast Guard or the Department of Transportation. Approved applications are issued a Certificate of Public Convenience and Necessity.

Environmental Review and Assessment

1. Both authorizations require an evaluation of the project's anticipated impact on the public and on the environment, in accordance with the National Environmental Policy Act (NEPA).
2. An Environmental Impact Statement is needed for every proposed major federal action that is expected to significantly affect the quality of the environment. Once the impacts are declared, the statement must be approved before a final Record of Decision can be issued.
3. Projects with less-than-significant impacts still require documentation. If the environmental impacts are uncertain, then an Environmental Assessment must be prepared in order to determine if an Environmental Impact Statement is necessary. If the Environmental Assessment finds that the project under consideration has no significant environmental impact, then a Finding of No Significant Impact report is provided.
4. Projects that are perceived to have no significant impacts at all on the environment can be processed as Categorical Exclusions. This means that those projects do not require the preparation of either an Environmental Impact Statement or an Environmental Assessment.

Other Considerations

1. During preparations for the documentation required under NEPA, the Department of Energy and FERC must also identify any other compliance requirements applicable to the authorization.

    a) For example, other regulations that are to be considered include the Clean Water Act, the Clean Air Act, the Endangered Species Act, and the National Historic Preservation Act. This may require the involvement or approval of other agencies at the federal, state or local level.

    b) Besides environmental requirements, LNG export projects may require compliance with safety or security-related requirements from various other agencies, including the Department of Transportation's Office of Pipeline Safety (which is situated within the Pipeline and Hazardous Materials Safety Administration), the National Fire Protection Association, and the Federal Emergency Management Agency.

Source: Adapted from Ratner, November 2011 lined above, vast quantities of natural gas are currently being flared at some shale sites in the U.S. mid-continent. One way to reduce such flaring is being considered by Wyoming's Office of State Lands and Investments, which has proposed a policy through which royalties payments would be required from operators of wells on state lands that continue to be flared for more than 15 days after completion. Absent strong state action on flaring, it is possible that the federal government will seek to regulate flaring at oil and natural gas wells. In addition to constraints on pipeline capacity, there are also concerns about the adequacy of natural gas storage infrastructure, particularly in the Northeast, although the investments in pipeline capacity should prompt similar investments in increased storage capacity.[33]

Drilling and Production Infrastructure

Even if there is sufficient transportation infrastructure to handle increased volumes and new regional bases for natural gas production, there may be limits on the amount of available equipment and qualified petroleum engineers to develop the gas. To date such a shortage of drilling rig availability in the U.S. natural gas sector has not materialized, as **Figure 3** illustrates. The increased productivity of new drilling rigs has served to ensure that supply has kept pace with demand. For example, in the Haynesville Shale play in Louisiana, the rig count fell from 181 rigs in July 2010 to 110 rigs in October 2011, yet production increased from 4.65 bcf/day to 7.58 bcf/day over the same period.[34] A similar trend is occurring in the Barnett Shale in Texas, where production rates have remained flat despite a declining rig count.[35] While the supply of drilling rigs remains adequate, the market for other equipment and services used for fracking—particularly high-pressure pumping equipment—is tight and likely to remain so for the near term.[36] Tight markets for drilling and completion equipment can result in increases in fracking costs.

Human Capacity

Human capital in the unconventional oil and gas development sectors is also in short supply. According to the National Petroleum Council (NPC), there has been a 75 percent decrease in petrochemical-related course enrollment since 1982 in the United States.[37] Moreover, within the next ten years, about 50 percent of the workforce in this industry will be eligible for retirement. The high demand for petroleum engineers, reflected in the high salaries of recent graduates in the field, is set to continue, with the NPC warning of a "considerable human resource challenge" in the oil and gas industry.[38]

Faculty at leading universities with petroleum-engineering departments point to a lack of research and development (R&D) funding, which they say is negatively affecting their capacity to adequately train people for jobs in the hydrocarbons sector. While some of the shortfall in public R&D funding has been made up by private-sector support,

[32] "Winter 2011-12 Energy Market Assessment," Federal Energy Regulatory Commission, Item No: A-3, October 20, 2011.
[33] MIT, 2011. p. 145.
[34] "Production Rises in Barnett, Haynesville Shales Even as Rig Counts Fall," *Platts,* October 11, 2011. (http://www.bentekenergy.com/InTheNews.aspx#Article5402)
[35] From an interview with Kenneth Medlock, Fellow, Energy Studies, James A. Baker III Institute for Public Policy, and member of the Brookings Energy Security Initiative Natural Gas Task Force, November 15-16, 2011.
[36] "Commodity Prices, Service Costs and Hedging: A guide to profit planning and protection in 2012", Maquarie Equities Research, November 11, 2011.
[37] Prudent Development - Realizing the Potential of North America's Abundant Natural Gas and Oil Resources," National Petroleum Council, September 15, 2011. p. 1.
[38] Ibid.

academics note the frequent mismatch between the specific needs of individual companies and the long-term needs of the sector. Even if sufficient funding for R&D and training is now provided, there may also be a time lag before there is an adequate supply of petroleum engineers in the market.

Shipping Capacity

The successful export of LNG will depend upon the necessary shipping infrastructure and capacity being in place. Cheniere Energy is looking to export up to 2.2 bcf/day of gas from its Sabine Pass LNG terminal in Louisiana.[39] Depending on the size of the LNG vessel, this would require between three and five supertankers per week. In order to accommodate this volume of large ships, some domestic U.S. ports will require additional dredging. Other shipping-related concerns include security of vessels and the adequacy of Coast Guard capacity to provide that security (exporters must meet Coast Guard Waterway Suitability, Security, and Emergency standards prior to approval); and the capacity of sea lanes, particularly to Asia. Increasing shipments to Asia will depend on the capacity of the Panama Canal, which is currently too small to accommodate most LNG tankers. However, after the planned expansion of the canal is completed—expected to be in 2014—roughly 80 percent of the world's LNG tankers will be able to pass through the isthmus, resulting in a dramatic decline in shipping costs to Asia.[40]

Most potential capacity obstacles to LNG exports are likely to be short-term consequences of infrastructure investment failing to keep pace with rapid increases in shale gas production. Over time, it is likely that such bottlenecks will be resolved as markets respond and allocate investment to infrastructure and capacity development as needed.

Domestic Demand Factors

In the United States, potential natural gas exports will compete with two primary markets for the consumption of natural gas: the power-generation sector and the industrial sector, including petrochemical production. The prospects for increased natural gas demand in the transportation, commercial and residential sectors as a result of increased shale gas production are less strong.

Power Generation

Demand for natural gas in the electricity sector has been stimulated by the increased supply—and therefore lower prices, and by environmental concerns over coal-fired generation. The EIA estimates that natural gas power plants will account for 60 percent of new electric capacity additions between 2010 and 2035.[41]

New and revised EPA regulations will play an important role in determining the amount of coal-fired generation that remains online in the United States, and, therefore, the number of natural gas power plants to be built. The EPA's Cross-State Air Pollution Rule (CSAPR), which is aimed at controlling sulfur dioxide (SO_2) and nitrous oxide (NOx) emissions from power plants in 27 U.S. states that contribute to fine-particulate pollution and ozone in adjacent states, was scheduled to be implemented on January 1, 2012. However on December 30, 2011 it was delayed by a federal court appeal and has since undergone two minor adjustments. At the time of writing, the regulation had not yet been reintroduced for approval.

[39] Cheniere Energy's export permit from the Department of Energy allows for initial production of 1bcf/day with the possibility of expansion to 2.2 bcf/day.
[40] "Medium-Term Oil and Gas Markets 2010," International Energy Agency, 2010. p. 264.
[41] EIA, April 2011a. p. 74

A second EPA regulation, regarding Mercury and Air Toxics Standards (MATS), is scheduled to go into effect on January 1, 2015. The MATS will apply to hazardous air pollutants (HAPs)—including mercury, hydrogen chloride, and other particulate matter— from all power plants. These standards, which were finalized on December 16, 2011, are projected to result in a 90 percent reduction in mercury emissions. The same day the EPA issued its final Maximum Achievable Control Technology (MACT) rule. The rule, to be promulgated under the Clean Air Act, requires coal-fired power plants to achieve pollution controls for mercury, acid gasses and other pollutants equal to the best 12 percent of operating plants. Other regulations proposed by the EPA include:

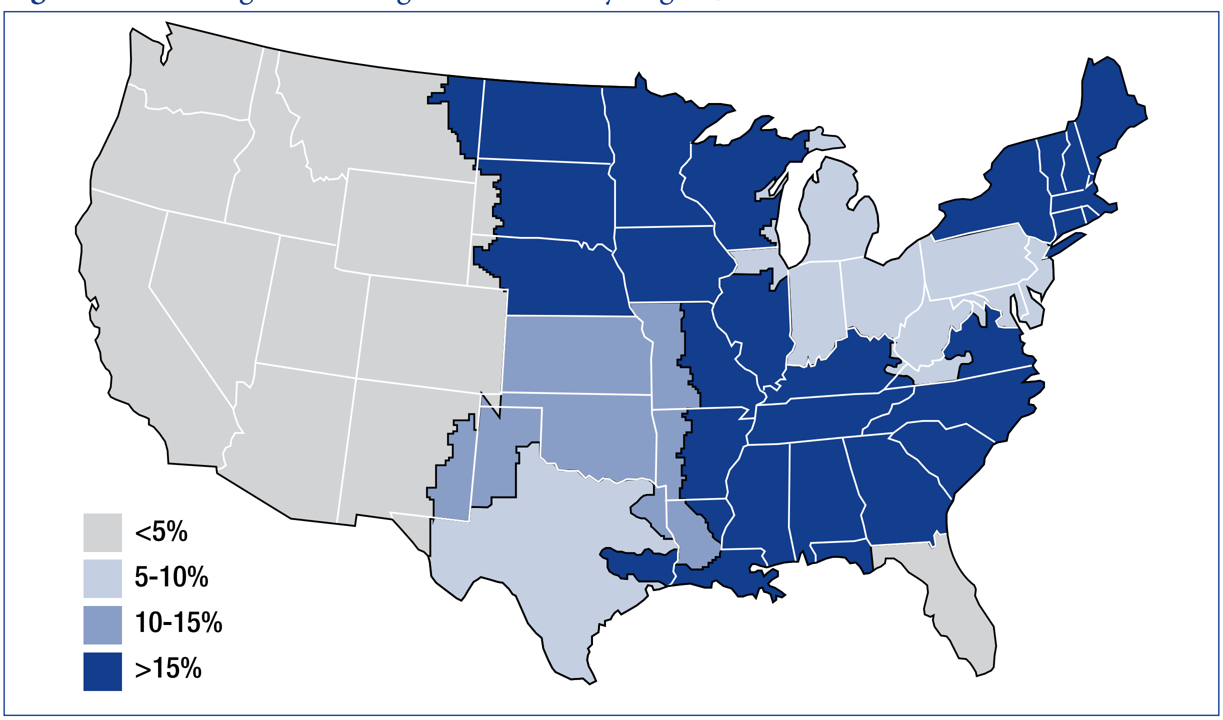
- Section 316b of the Clean Water Act: requiring cooling water intake structures to reflect Best Technology Available (BTA) to minimize environmental impacts;

- Coal Combustion Residuals (CCRs): changing the regulation of coal ash and waste by-products disposal;

- Greenhouse Gas (GHG) standards: proposing rules for GHG emissions standards for new and existing electric generation facilities. The GHG standards were released on March 27, 2012 and seek to set national limits on the amount of carbon dioxide that all new power plants can emit. The rules are expected to limit the construction of new coal-powered plants while making natural gas plants increasingly attractive.

ICF, a consultancy that has modeled gas penetration in the electricity sector and has made projections based on EPA's proposed regulations and the age of the existing coal power plant fleet, estimates that roughly 40 gigawatts (GW)—equivalent to

Figure 4: Percentage of Existing Coal Retired by Region, 2020



Source: ICF International

around 12 percent of the current coal-fired installed capacity—will be retired by 2020.[42]

Coal power plant retirements will vary by region: plants in the Southeast and Midwest (where many coal plants are located) will account for the bulk of reduction, as they are also located close to regions where natural gas is produced in larger volumes and the distribution networks are better developed (see **Figure 4**).

Various models have projections for what the displacement of coal-fired generation would mean for natural gas demand, which will be the primary replacement fuel. The estimates for the increase in natural gas demand in the power sector range from 1.1 tcf/year to 3.5 tcf/year. ICF projects that the increase in gas demand—either through the construction of new natural gas power plants or the use of existing idle natural gas combined cycle (NGCC) plants—could equal between 1.6 and 2 tcf/year.[43] Deloitte, a consultancy that also runs models on gas consumption, projects that gas demand for power generation can increase by as much as 10 bcf/day, or roughly 3.5 tcf/year.[44] Deutsche Bank estimates that 3 bcf/day of gas could replace about 80 of the least efficient, smaller, and older coal-fired power plants.[45]

While additional federal environmental policies inimical to coal-fired power plants are likely to be met with staunch opposition, most projections assume that such stringent environmental regulations will eventually be implemented. The result is likely to be additional retirements of older, less efficient coal-fired power plants, many of which will be replaced by more efficient natural-gas power plants.

Industrial Sector

The other major potential beneficiary of more abundant U.S. natural gas is the industrial sector. The sector currently consumes roughly 32 percent of total natural gas demand, 85 percent of which is consumed in manufacturing.[46] According to the EIA, demand for natural gas in the industrial sector is projected to grow by 27 percent between 2009 and 2035.[47]

The industrial sector is highly price-sensitive with respect to energy inputs. Because natural gas is a primary feedstock for many industrial consumers such as manufacturers or petrochemical producers, the industrial sector was heavily affected by the volatility in the natural gas market in the late 1990s and 2000s. According to Dow Chemical, one of the country's leading industrial companies, annual natural gas price rises of 167 percent from 1997 through 2008 resulted in an annual reduction of industrial demand of 22 percent.[48]

The shale gas boom has many industrial producers and chemical companies anticipating an increase in U.S. industrial and manufacturing competitiveness and petrochemicals production. A December 2011 report by PricewaterhouseCoopers, conducted in association with the National Association of Manufacturers, notes an increase in U.S. manufacturing activity due to shale gas development and suggests one million additional

[42] "Domestic Gas Usage in the Power Sector," presentation by John Blaney of ICF to the Brookings Natural Gas Task Force, August 3, 2011. A previous ICF assessment projected 51 GW of retirements, but the newly proposed regulations have shown more flexibility than earlier proposals, and more coal plants are expected to remain online.
[43] Ibid.
[44] Deloitte, 2011. p.5.
[45] "Unconventional Gas," presentation by Adam Sieminski of Deutsche Bank to the Cross Border Forum on Energy Issues, May 13, 2010.
[46] Ibid., p. 101.
[47] EIA, April 2011a. p. 68.
[48] U.S. Senate Committee on Energy and Natural Resources; "The Future of Natural Gas," testimony of George Biltz, Vice President, Energy and Climate Change, Dow Chemical; July 19, 2011.

manufacturing jobs could be created in EIA's high-shale gas recovery scenario (in which 50 percent more shale gas is recovered relative to the reference case) compared with its low shale recovery scenario (in which 50 percent less is recovered).[49] A particular area of interest is the resurgence in ethylene production and the manufacturing of ethylene-based goods in the United States. Ethylene, which is a principal component in a variety of goods ranging from anti-freeze to trash-bags, is produced from ethane, a byproduct of natural gas. Cheap domestic natural gas has provided chemical producers a global competitive advantage in ethane—and therefore ethylene—production, particularly compared with producers in Europe where ethylene is derived principally from naphtha, an oil-based product. Because crude oil prices have not dropped in parallel with gas prices in the United States, U.S. industrial producers are thus globally competitive again. As a result, a number of industrial producers are looking to reinvest in plants in the United States.[50] Bayer MaterialScience is opening an ethane cracker in West Virginia (the first cracker in the Marcellus) and Dow Chemical and Shell Chemical have announced plans to expand and open, respectively, crackers on the Gulf Coast. According to analysis by the American Chemistry Council (ACC), an industry trade association, a 25 percent increase in the supply of ethane in the United States could result in 17,000 direct new jobs in the chemical industry, 395,000 indirect jobs, and around $44 billion in additional federal, state, and local tax revenue over 10 years.[51] To achieve such returns ACC presumes an infusion of over $16 billion of private capital, and includes an assessment of induced impacts—"employment and output supported by the spending of those employed directly or indirectly by the sector." While the ACC does not make explicit assumptions about the shape of the U.S. natural gas supply curve or the future price of natural gas, it also assumes sustained low gas prices, and resultantly high oil-to-gas price ratio. While some analysts may take legitimate issue with the assumptions behind the projected job-creation figures, it is clear that the U.S. petrochemical and manufacturing sector will be a prominent competitor and potential beneficiary of abundant domestic natural gas. In Part II, the study will analyze the impact of U.S. LNG exports on the potential for a "renaissance" in the industrial sector.

Transportation Sector

Natural gas has also attracted a substantial amount of attention as a fuel for the transportation sector. Following his State of the Union address in January 2012, President Obama has been promoting the use of natural gas in both passenger and heavy-duty vehicles (HDV).[52] The New Alternative Transportation to Give Americans Solutions (NATGAS) Act which proposed legislation that would provide tax incentives to encourage the use of natural gas in the commercial trucking sector, has focused attention particularly on LNG use in the HDV fleet. (The legislation was defeated as an amendment to the Transportation Bill on March 14, 2012.)

Federal incentives have already been enacted for the purchase and operation of compressed natural gas (CNG) vehicles. The 2005 Energy Policy Act authorized credits for up to 80 percent of the incremental cost of purchasing CNG vehicles (the credits expired at the end of 2010); federal

[49] "Shale Gas: A Renaissance in U.S. Manufacturing," PricewaterhouseCoopers, December 2011.
[50] "Shale Gas and New Petrochemicals Investment: Benefits for the Economy, Jobs, and U.S. Manufacturing," American Chemistry Council, March 2011. p. 19. (American Chemistry Council, March 2011)
[51] Ibid.
[52] Charles Ebinger, "What Does the State of the Union Mean for Energy Policy," *Brookings Up-Front Blog,* January 27, 2012. (http://www.brookings.edu/opinions/2012/0127_sotu_energy_policy_ebinger.aspx)

tax credits for 30 percent of the cost of natural gas home refueling equipment, up to $1000, are in place until the end of 2011. However, despite the variety of existing and proposed policy incentives, a large-scale shift away from oil toward natural gas in the vehicle fleet is unlikely in the near term.

While LNG-powered HDVs can demonstrate competitive cost effectiveness and relatively short payback periods under certain circumstances, in most instances they require large fuel differentials between diesel and LNG, and high numbers of vehicle miles per year to realize savings that buyers would find acceptable.[53] A range of operational and cost issues—including limited range, a lack of existing refueling infrastructure, and an incremental cost premium for LNG trucks of around $70,000—are therefore likely to prevent a widespread conversion to natural gas absent the introduction of significant subsidies or mandates.[54] Moreover, many trucking companies depend on the truck resale market for revenues, particularly in Asia. Without a large LNG distribution infrastructure in Asia, LNG trucks will be unlikely to gain significant market penetration, further limiting U.S. interest in LNG trucks.

The logistical challenge of converting a large proportion of the passenger vehicle fleet to natural gas is even higher. Obstacles include those of range (the energy density of natural gas is lower than that of gasoline, requiring more frequent refueling in NGVs than in gasoline-powered cars) and longer refueling times for NGVs than their gasoline equivalents.

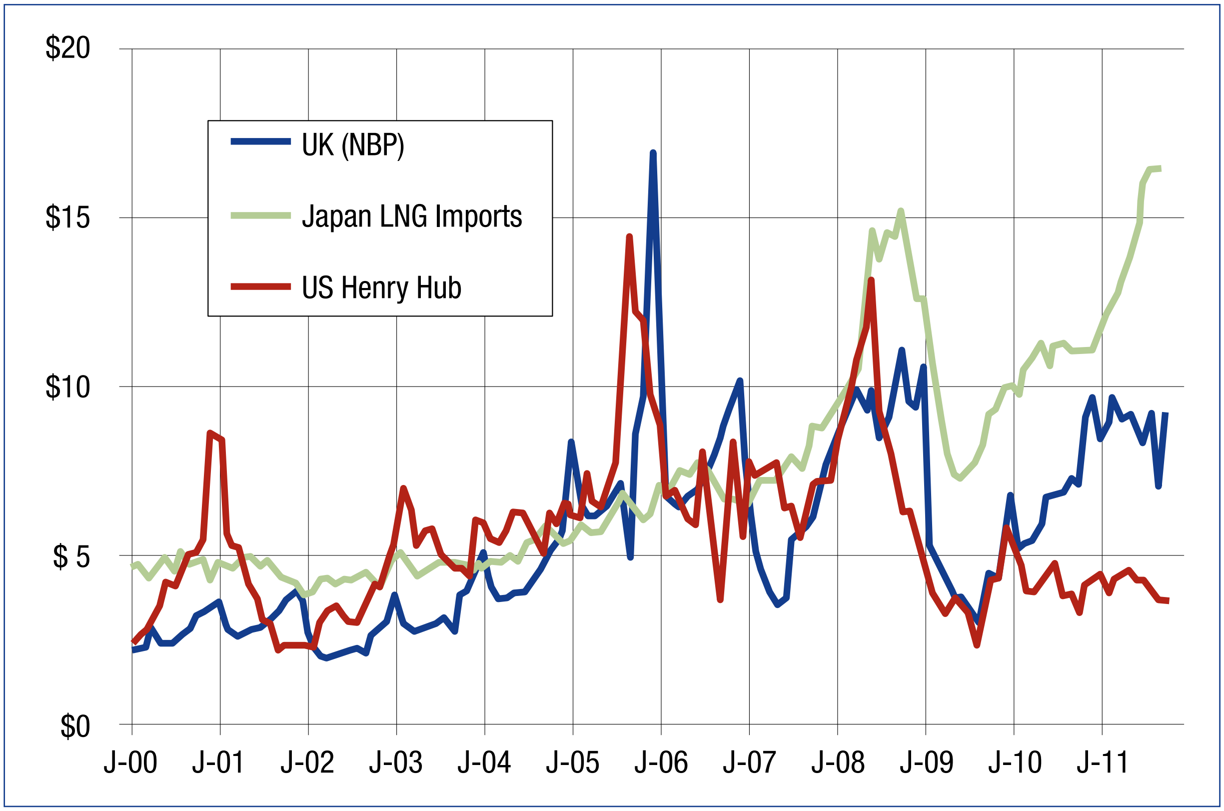
The prospects for vehicular fuels derived from gas-to-liquids (GTL)—a process that converts natural gas into high quality middle distillates that can serve as a supplement or substitute for diesel—in the transportation sector are also uncertain. There are significant upfront costs associated with GTL production, with a 20,000 barrel production plant costing the equivalent of $115,000 per barrel per day capacity.[55] Liquid fuels produced by GTL would compete directly with crude oil-derived fuels. A sharp fall in crude-oil prices would therefore make GTL instantly uneconomic. While the prospect of cheap and abundant shale gas has renewed interest in GTL production in the United States—with SASOL of South Africa announcing plans for a feasibility study of a $10 billion plant in Louisiana—the long lead time and substantial capital investment required, together with the risk of competing with a volatile oil market, present significant challenges to GTL-products in the vehicle fleet. Despite its technical feasibility and high public profile, natural gas usage in the U.S. commercial and passenger fleets—either as LNG, CNG, or derived from GTL production—is therefore likely to see limited growth in the foreseeable future in the absence of major policy incentives.

Commercial and Residential Sector Demand

The prospects for increased natural gas use in the commercial and residential sectors as a result of the availability of abundant shale gas reserves are also modest. EIA estimates show that widely varying assumptions for shale gas production levels in 2035 (5.5 tcf/year in the "Low Shale EUR" scenario versus 17.1/ tcf/year in the "High Shale EUR" scenario) result in relatively small changes in commercial and residential gas consumption (0.5 and 0.3 tcf, respectively).[56]

[53] Alan Krupnick, "Will Natural Gas Vehicles Be in Our Future?," Resources for the Future, May 2011. p.13
[54] MIT, 2011. pp. 123-124.
[55] Data from ClearView Energy Partners.

Figure 5: Benchmark Natural Gas Prices in the U.S., U.K. and Japan ($/MMBtu)



Source: ICF International

Global Gas Market

U.S. natural gas exports will not only compete with the domestic sources of demand listed above; they will also compete with other sources of gas—both LNG and pipeline gas—in the global market. The fundamental rationale for exporting natural gas is that the U.S. price is lower than the price in target markets, where natural gas is often purchased on more expensive long-term contracts that are indexed to the price of oil, leading to an opportunity for arbitrage. (See **Figure 5** for the difference between the three major global natural gas price benchmarks.)

A well-supplied global gas market will give U.S. exporters fewer opportunities for exports; similarly, a "tight" gas market, one where supplies are limited, will provide an economic opportunity for U.S. exporters. On the demand-side, gas exports will have to compete with other fuel substitutes such as coal, oil, and nuclear energy for electricity generation, and oil for transportation. Demand for gas imports may also be affected by the spread of unconventional gas development to additional countries.

The international gas market can be divided into two major regions in addition to North America: the Pacific Basin and the Atlantic Basin. Both of these markets are supplied by LNG shipments

[56] EIA, April 2011a.

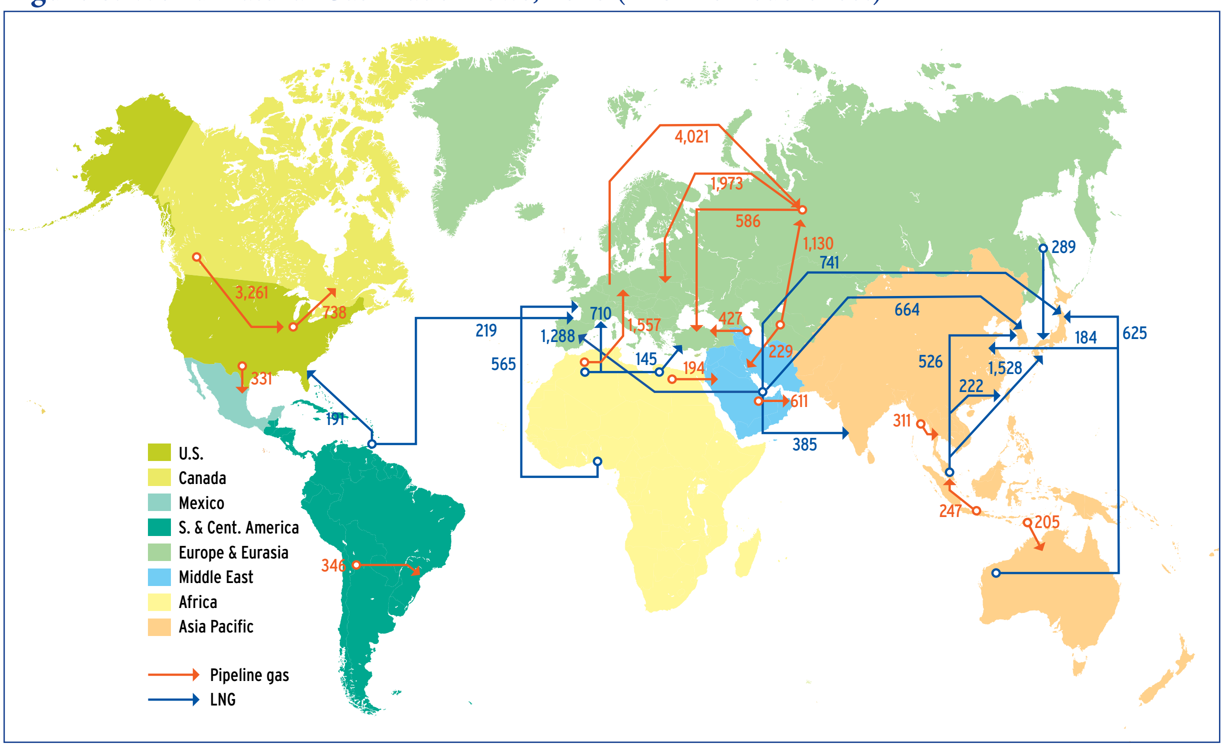
(much of which come from Qatar, Indonesia, Malaysia, Nigeria, and Australia) as well as by pipeline gas. Each importer and exporter has different supply and demand characteristics that will have a bearing on whether the United States will be able to compete against other sources of supply.

Pacific Basin

The Pacific Basin has historically been the cornerstone of the global LNG market. During the early and mid-1990s, Indonesia and Malaysia accounted for roughly half the LNG export market, and Japan and South Korea accounted for approximately 70 percent of the import market.[57] Today, Indonesia and Malaysia's supply dominance has been eroded by the emergence of new LNG exporters including Qatar (which has the largest liquefaction capacity in the world), Nigeria, and Australia. As a result, although both Indonesia and Malaysia were still, respectively, the second and third largest exporters of LNG in 2010, their share of the global natural gas market has dwindled to roughly 20 percent, and may decline further as domestic gas consumption increases. Nevertheless, Pacific Basin exports, which almost exclusively serve Pacific markets, are still projected to increase in quantity as a result of major liquefaction capacity additions in Australia, which is expected to have as much as 12 bcf/day of export capacity by 2020.[58]

While about 45 percent of the Pacific Basin's total gas demand is met by LNG imports from within the region, an additional 40 percent of its demand is met by LNG imports from outside the region,

Figure 6: World Natural Gas Trade Flows, 2010 (in billion cubic feet)



Source: BP Statistical Review of World Energy 2011

[57] "World LNG Report 2010," *International Gas Union (IGU),* September 2011. pp. 6-9 (International Gas Union, September 2011).
[58] From an interview with Luke Smith, Energy Analyst, Commonwealth Bank of Australia. March 19, 2012.

primarily from the Middle East and Russia.[59] Qatar alone accounted for 11 percent of Japanese LNG imports in 2010. Qatari production predominantly serves both the European (mostly the U.K.) gas market and the Pacific Basin gas market. Current uncontracted supply available on the spot market is likely to be sent to Asia to take advantage of the Pacific Basin's higher prices. However, other than meeting the existing spare capacity for LNG production, the Middle East will have little excess supply capacity. This is in part because Qatar is trying to preserve its price structure with the East Asian market and partly because there is a moratorium on further development of Qatar's North Field, which together with Iran's South Pars Field, is the largest gas field in the world. Another reason for the limited excess supply from the Middle East is that Oman, which is the second largest Middle Eastern LNG exporter to Asia, is experiencing declining LNG exports as more gas is being consumed domestically. Iran, which has the world's second largest gas reserves, has proposed several LNG projects, but has been unable to implement them because of sanctions.

Gas demand in Asia remains strong, led by Japan, South Korea, and Taiwan, which accounted for more than half of all global LNG imports in 2010.[60] Japan, the world's largest importer of LNG, has seen a particular increase in projected natural gas demand as a result of the accident at the Fukushima nuclear power plant following the earthquake in March 2011. The nuclear accident, which has caused a short-term shutdown of most of Japan's nuclear reactors, has also prompted a review of Japan's nuclear energy policy. The review comes largely at the demand of the public, which is wary of Japan's reliance on atomic power.[61] In the event of a move away from nuclear power, a significant amount of Japan's electricity production will likely be met by additional LNG shipments. It is estimated that in 2012, Japan will require an additional 974 bcf of LNG to make up for the electricity shortfall resulting from the Fukushima accident and the reduction in nuclear power generation.[62]

While Japan has traditionally been the focal point for natural gas consumption in Asia, the economic rise of China and India has begun to have an increasing impact on forecasts for the Asian gas market. Although energy and electricity supply in both countries has been dominated by coal, both countries have expressed interest in expanding the role of natural gas. The International Energy Agency predicts that gas demand in China and India may grow as fast as 7.7 percent and 6.5 percent, respectively, per year to 2035.[63] Over the past five years, both countries have become significant importers of natural gas, mostly—exclusively, in the case of India—in the form of LNG. Both China and India have made significant investments in LNG regasification infrastructure with six LNG import terminals currently under construction in China and two in India (with an existing terminal also undergoing expansion), and more expected in the near future. In addition to the LNG imports, China imports gas from Turkmenistan via a pipeline that traverses Uzbekistan and Kazakhstan, is in the process of developing a pipeline interconnection with

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[59] "BP Statistical Review of World Energy 2011," BP, June 2011. (BP, June 2011)

[60] Ibid. It is important to note that the United States in November 2011 entered into a free-trade agreement (FTA) with South Korea as all but one of the projects that have been approved for the export of natural gas are only allowed to export LNG to countries with whom the United States has a FTA. Other than South Korea, the only countries which have regasification capacity and an FTA with the United States are Canada, Chile, the Dominican Republic, and Mexico.

[61] A recent poll in Japan demonstrated that the majority of the Japanese public is in favor of phasing out the country's existing nuclear reactors. "Japan poll finds 74% support nuclear phase-out," *Nuclear Power Daily,* June 14, 2011. (http://www.nuclearpowerdaily.com/reports/Japan_poll_finds_74_support_nuclear_phase-out_999.html)

[62] "Energy Challenges in Japan after 3.11,"presentation by Ken Koyama, Chief Economist, Institute of Energy Economics—Japan, to a private meeting at Harvard University, October 21, 2011, in Boston, Massachusetts.

[63] "World Energy Outlook 2011 Special Report: Are We Entering a Golden Age of Gas" International Energy Agency, 2011. p. 23. (IEA, 2011)

Myanmar, and has long been engaged in discussions with Russia over a potential pipeline interconnection. India, which does not currently share a pipeline with any other country, is looking to develop various international pipeline projects, from Turkmenistan, Myanmar, Oman, and Iran.

How the demand for gas in these countries continues to grow will depend on a number of factors, including the pace of economic growth, the policies for substitute fuels—primarily coal, nuclear power, and oil—and the speed and scale at which unconventional gas can be developed. With electricity demand increasing at rapid rates in countries across South and East Asia, there is also a very real possibility that LNG consumption will not be sufficient and that substantial coal demand will persist. However, while coal and oil will continue to make up a large part of the energy mix, natural gas demand is projected to increase steadily, prompting the need for more investment in imports and in supporting domestic production, particularly of unconventional gas. The EIA's recent global estimate for shale gas reserves suggests that India and China have roughly 63 tcf and 1,275 tcf of shale gas reserves, respectively.[64] The coal-bed methane (CBM) gas reserves of each country are estimated to be equally vast: one assessment of China's CBM reserves is 1,306 tcf and estimates of India's CBM reserves range from 71 to 162 tcf.[65] For both countries, these estimates for unconventional gas have stimulated national interest in unconventional gas production. However, development of these resources is likely to be a mid-to-long term proposition. The regulatory and policy environment in both countries will need to be amended to accommodate shale gas and CBM production and to address issues related to hydraulic fracturing, such as water consumption, treatment, and disposal. The extent to which natural gas prices are deregulated will also have a bearing on how quickly domestic unconventional gas will be produced as production companies will require economic incentives to begin and sustain production. Unconventional gas production will also require technical capacity and physical infrastructure, both of which are currently in short supply in both China and India. The former concern is partially being addressed through Chinese and Indian investments in North American shale plays. The latter concern will require significant attention, particularly as the pipeline networks in both China and India are inadequately developed and as the investment climate for foreign operators remains uncertain.[66]

Export Feasibility to the Pacific Basin

Owing to growing gas demand, limited domestic supply, and a more rigid and expensive pricing structure, Asia represents a near-to-medium term opportunity for natural gas exports from the United States. The expansion of the Panama Canal by 2014 will allow for LNG tankers to traverse the isthmus, thereby improving the economics of U.S. Gulf Coast LNG shipments to East and South Asian markets. This would make U.S. exports competitive with future Middle Eastern and Australian LNG exports to the region.

However, challenges and uncertainties remain on both the demand and supply side. The development of indigenous unconventional gas in China or India may occur at a faster rate than

[64] "World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States," U.S. Energy Information Administration, April 2011. p. 4. (EIA, April 2011b)

[65] Estimate for China is from: Haijin Qiu, Strategic Research Center of Oil and Gas Resources, Ministry of Land Resources, "Coalbed Methane Exploration in China," adapted from an oral presentation at the AAPG Annual Convention in San Antonio, Texas, April 20-23, 2008. Estimates for India are from: M.P. Singh and Rakesh Saxena, "Status of Coal Bed Methane Investigations in India," *Glimpses of Geoscience Research in India*, p. 233.

[66] According to a report from Bernstein Research, a consultancy, July 7, 2011.

currently forecast, dampening demand for LNG imports to the region. A change in sentiment in Japan may see nuclear power restarted at a greater rate than currently anticipated; alternately, a greater-than-expected penetration of coal in the Japanese electricity sector would suppress gas demand. A change in the cost of Australian LNG production or a reversal of the Qatari moratorium on gas development could disrupt the current supply projections, as could the discovery of new conventional or unconventional resources. For instance, on December 29, 2010, Noble Energy, a U.S. oil and gas exploration company, discovered between 14 and 20 tcf of gas in Israel's offshore Leviathan gas field. Since then, other nations on the Eastern Mediterranean are exploring for potentially similarly large gas fields. A number of large natural gas discoveries in Mozambique have also prompted early interest in building significant liquefaction capacity in the Southeastern African nation. The high quality (low sulfur and carbon-dioxide content) and liquid-rich nature of Mozambican gas may make this resource a significant competitor in global LNG markets in the medium term.

Finally, the expansion of LNG export capacity from Alaska and the development of LNG export capacity in Western Canada may provide a source of strong competition for U.S. Gulf-coast origin LNG. Although Alaska's Kenai LNG export facility, which has been exporting small quantities of LNG to Northeast Asia for over 40 years, has been idled temporarily, some companies have demonstrated interest in large-scale exports of LNG from Alaska to East Asia. On March 30, 2012, ExxonMobil, along with its project partners BP and ConocoPhillips, settled a dispute with the Government of Alaska to develop its gas resources at Prudhoe Bay. The gas from this field is expected to travel from Alaska's North Slope to Valdez on Alaska's southern coast, where it will be liquefied and exported.[67] According to FERC, there are currently three Canadian export facilities under consideration in British Columbia: a proposed 1.4 bcf/day terminal at Kitimat (initial production would start at 0.7 bcf/day), which received a 20-year export license in October 2011; a proposed 0.25 bcf/day facility at Douglas Island; and a potential 1 bcf/day facility at Prince Rupert Island. Given the lower transportation costs (as a result of the shorter distance), Alaskan and West Canadian exports may prove to be a source of strong competition at the margin for U.S. LNG in the Pacific Basin.

Atlantic Basin

The Atlantic Basin comprises predominantly the gas markets in Europe, particularly the European Union. Other than Spain and the United Kingdom, which import 76 percent and 35 percent of their natural gas in the form of LNG, respectively, most European countries are dependent on pipeline imports from Russia, Norway, and Algeria. Algeria, Qatar, and Nigeria are the principal LNG exporters to the continent.[68]

European natural gas imports are dominated by the sale of Russian gas to European consumers at high, oil-indexed prices. Despite declines in Russia's two largest natural gas fields (Urengoy and Yamburg), its natural gas production is projected to increase by roughly one-third between 2010 and 2035.[69] According to the International Energy Agency, exports from Russia will increase by roughly 67 percent over the same period, with much of the growth coming from increased

[67] Yereth Rosen, "Alaska, Exxon deal opens way for LNG exports," *Reuters,* March 30, 2012. (http://www.reuters.com/article/2012/03/30/us-alaska-pipeline-idUSBRE82T12I20120330)
[68] BP, June 2011.
[69] IEA, November 2011. p. 306.

pipeline and LNG exports to Asia.[70] Norway is also a major supplier of natural gas to Europe and its production is projected to increase over the next two decades before reaching a plateau.[71] However, this will not compensate for the precipitous decline in domestic production in the U.K. and the Netherlands, two historically substantial producers of natural gas.[72]

As a result, for the near future it appears that the reliance on natural gas from Russia will continue—a trend underlined by the commissioning of the Nord Stream pipeline, the first pipeline that directly connects Russia with the EU. Russia accounts for about 31 percent of Europe's natural gas imports.[73] While it is clear that the gas relationship between Russia and European consumers will continue, the pricing relationship between the two parties will determine how much gas will be imported, and whether or not there will be an opportunity for U.S. LNG exports. Historically, most Russian gas exports to Europe are underpinned by long-term contracts with gas sold at oil-indexed prices. However, with new LNG cargoes previously destined for the U.S. now available on the global market, there has been an increase in spot-market trading of gas—with consumers in some cases finding it more economic to pay penalties for non-receipt of contract gas and to buy alternate supplies via LNG. The result has been increased pressure on the price of Russian gas exports and increased market power on the part of consumers to renegotiate oil-indexed contracts with Gazprom, the Russian state-owned gas company. Gazprom has agreed to renegotiate some contracts with its customers, primarily in Germany; however it has a number of arbitration cases under review and appears reluctant to renegotiate the terms for a large number of its contracts. Moreover, given Germany's recent decision to accelerate the phase out of its existing fleet of nuclear reactors, there is a strong likelihood that much of the resultant electricity shortage will be made up through increased natural gas consumption, thereby supporting demand and gas prices (for more on the foreign policy implications of potential U.S. LNG exports into Europe, see Part II).

In addition to Russian imports, Europe is likely to increase its LNG imports. Despite having excess regasification capacity—terminals ran at a 42 percent load factor in 2009—new regasification facilities are planned in a number of European countries.[74] In contrast to the developments in adding LNG import capacity, some of the international pipeline connections under consideration are experiencing development difficulties. Many of the various proposed pipelines from the Middle East, Central Asia and Russia, (Nabucco and South Stream, for instance) are considered to have either difficult economics or face technical and logistical obstacles and are not expected to be completed in the near term. However, some analysts find that other pipeline interconnections, such as the Trans-Adriatic Pipeline (TAP) are more likely in the mid-term. The TAP pipeline would transport gas from Azerbaijan's Shah Deniz gas field to continental Europe through Turkey, where the existing Southern Corridor Pipeline (SCP) ends.

As is the case in Asia, unconventional gas development in Europe may play a large role in the

[70] Ibid., p. 312.
[71] Ibid., p. 165.
[72] It is important to note that although U.K. production is declining, the exports from the U.K. to continental Europe through the Interconnector pipeline between the U.K. and Belgium continue to increase. ("Revolution in European Gas?" presentation by Pierre Noël, University of Cambridge to the Electricity Policy Research Group Energy Policy Dinner on February 24, 2011 in Cambridge, U.K.
[73] BP, June 2011.
[74] Anouk Honoré, *European Natural Gas Demand, Supply, and Pricing: Cycles, Seasons, and the Impact of LNG Price Arbitrage,* Oxford Institute for Energy Studies, (Oxford, UK: Oxford University Press, 2010). p. 167.

future of the Atlantic Basin gas market. Given Eastern Europe's dependence on Russia for natural gas supply, shale gas resources hold the prospect economic and geopolitical benefit. According to the EIA, Ukraine and Poland—with an estimated 42 and 187 tcf of shale gas resources, respectively—have been particularly interested in developing their shale gas assets. However, similar to unconventional gas development in Asia, regulatory and infrastructure obstacles will make large-scale shale gas production in the near-term difficult. Moreover, in some parts of Europe there is an active public opposition to shale gas production which may threaten the development of domestic resources in some countries and regions.[75] France has banned hydraulic fracturing and some environmental and public opposition groups are looking for sweeping, continental legislation against shale gas production.

Export Feasibility to the Atlantic Basin

The prospects for U.S.-origin exports to the Atlantic Basin rest on a range of factors. It primarily depends on the availability of pipeline gas from Russia, Algeria, and Norway and the availability of LNG from Algeria, Nigeria, and Qatar. It also depends on the demand for gas in the electricity sector. Germany's decision to accelerate the phase-out of its nuclear reactors was copied by Switzerland, which decided to phase out its nuclear reactors, and Italy, which decided against building new reactors. In the case of Italy, much of this demand will therefore be met by natural gas. A similar decision in France, a country that currently generates more than three-quarters of its electricity from nuclear power but which is in the midst of a presidential election where nuclear energy policy is one of the primary issues, would result in a significant demand disruption for the Atlantic Basin. The development of gas transportation infrastructure—both within the continent and with outside suppliers in Russia, the Middle East, and North Africa—will also have an impact on the prospect for LNG imports from the United States. With a greater diversity of gas supply leading to lower spot prices in Europe, the opportunity for LNG arbitrage of U.S. gas into the region is lower than in the Pacific Basin. The potential for Atlantic Basin shale gas development will also have a significant bearing on the long-term prospect for LNG imports to the European continent.

Central and Latin American Gas Markets

In addition to the Pacific and Atlantic basins, there are several smaller LNG export options for U.S. sourced-natural gas in the Caribbean, Mexico, and Chile. Many of the Caribbean nations currently burn refined oil products for power generation, a practice that is becoming increasingly expensive as oil prices rise. To diversify its energy mix, Jamaica is considering the construction of a floating LNG terminal; other Caribbean nations may follow. In addition to these smaller markets, both Mexico and Chile are potential markets for U.S. natural gas. While an increase in exports to Mexico would likely come via pipeline from Texas, Chile represents a potential opportunity for LNG imports from the United States. Chile, which has a free-trade agreement with the United States, currently imports more than 90 percent of its natural gas in the form of LNG (83 percent of which came from Equatorial Guinea, Egypt, and Trinidad and Tobago in 2010).[76] One factor that would impact Chile's natural gas imports will be the development of shale gas in Argentina. The EIA estimates that Argentina's shale gas reserves

[75] At the European Autumn Gas Conference in Paris on November 15-16, many speakers stated that the public opposition to hydraulic fracturing threatens to hinder shale gas production in Europe. ("Shale gas development to be slow in coming, speakers warn," *Platts Oil & Gas Journal,* November 28, 2011.)

[76] BP, June 2011.

are 774 tcf—the third largest shale gas reserves in the world.[77] If Argentina develops this resource in a timely manner, one logical export destination would be Chile, thereby reducing Chile's potential LNG import needs.

Economics and Financing

The fundamental economic calculation for natural gas exports is the price differential between domestic gas and that in overseas markets. In addition to the cost of the feedstock, there are several additional fixed costs that must be taken into consideration when assessing the economic feasibility of LNG exports, including those of liquefaction, transportation, and regasification. The construction of dedicated liquefaction facilities cost between $2 billion and $8 billion each, depending on capacity.[78] In order to secure financing for such facilities companies looking to export gas must have in place long-term contracts for the sale of LNG. Transportation costs depend on the size of vessel used to move the LNG, the cost of shipping fuel, and the distance the cargoes have to travel. Regasification can be the responsibility of either the supplier or the receiver according to the specific terms of a contract. While individual costs can vary as a function of size, local conditions, and fuel costs, MIT provides a profile of a typical cost structure for an LNG supply chain: for each MMBtu of gas, it estimates liquefaction costs at $2.15, shipping costs at around $1.25 (depending on fuel costs and transportation distance), and regasification costs at $0.70.[79] It is also important to consider that companies interested in exporting LNG will need to ensure that the price spread will need to remain for at least 10 to 12 years, to budget for pre-planning and facility construction. Based on current costs of liquefaction, transportation and regasification, the minimum difference between international LNG prices and the U.S. price of natural gas needs to remain at roughly $3.40 to ensure that U.S. LNG is competitive.

Many of the issues listed in the previous sections can have a bearing on the price of domestic gas. However, exports themselves are also likely to have an effect on the price of natural gas as they represent an additional source of demand. The actual price implication of LNG exports, as well as other economic and non-economic implications of LNG exports, is discussed in Part II.

[77] EIA, April 2011b.
[78] Ratner, November 2011.
[79] MIT, 2011. p. 25.

Part II: Implications of U.S. LNG Exports

Part I of this report focused on the factors that will affect the ability of the United States to export increased volumes of LNG. The following section addresses the implications of such exports.

From the perspective of the U.S. federal government, the issue of implications is viewed in terms of "public interest." Under existing legislation, exports of natural gas to countries with a free trade agreement (FTA) with the United States are, by law, deemed to be in the public interest and authorization is required to be given without modification or delay. Projects looking for authorization to export LNG to countries without an FTA, which account for roughly 96 percent of current global LNG demand, are required to be approved by the Secretary of Energy unless, after public hearing, the Department of Energy finds that such exports are *not* in the public interest.[80] Although the legal definition of "public interest" is not explicitly given in existing legislation, according to public statements by officials from the Department of Energy, "public interest" includes:

- Adequate domestic natural gas supply;
- Domestic demand for natural gas proposed for export;
- Economic impacts of exports (on GDP, consumers, and industry);
- U.S. energy security;
- Job creation;
- U.S. balance of trade;
- International considerations;
- Environmental considerations;
- Consistency with DoE's policy of promoting market competition through free negotiation of trade[81]

The first two of these criteria were addressed in Part I. The remainder focus on the various domestic and international implications of U.S. LNG exports.

Domestic Implications

The domestic implications of U.S. LNG exports include their impact on natural gas prices, natural gas price volatility, jobs and competitiveness, and on overall energy security.

Price of Domestic Natural Gas

The domestic price impact of natural gas exports will be a significant factor in determining

[80] LNG statistics from BP, June 2011; the 96 percent figure does not include South Korea which has signed but not ratified and implemented a FTA agreement with the United States. For the full text of the legislation pertaining to natural gas exports see Natural Gas Act (NGA) Section 3 (15 USC §717b), (http://uscode.house.gov/uscode-cgi/fastweb.exe?getdoc+uscview+t13t16+1440+12++%28%29%20%20)

[81] Redacted from a statement by Christopher Smith, Deputy Assistant Secretary for Oil and Natural Gas, Office of Fossil Energy, U.S. Department of Energy before the Senate Committee on Energy and Natural Resources on November 8, 2011.

whether or not the United States should export LNG. While it is generally acknowledged that a domestic price increase will result from large-scale LNG exports, the size of the price increase is the subject of debate, with a number of studies suggesting a range of possible outcomes. The important considerations when analyzing the results and conclusions of the various existing studies are the assumptions and models that are used when making price forecasts. Below are the results and methodologies of five major pricing studies done by the EIA and three consultancies: Deloitte, ICF International, and Navigant Consulting, which published two studies.

2012 Energy Information Administration Study

In January 2012, the EIA published a study entitled "Effect of Increased Natural Gas Exports on Domestic Energy Markets."[82] The study, conducted at the request of the Office of Fossil Energy of the Department of Energy, analyzed four different export scenarios across four different resource base or economic assumptions to project price responses to LNG exports. In addition to a "baseline" scenario, where no LNG is exported, the EIA model considered four different export scenarios:

- A low export/slow growth scenario, where 6 bcf/day of LNG is exported, phased in at a rate of 1 bcf/day per year;
- A low export/rapid growth scenario, where 6 bcf/day of LNG is exported, phased in at a rate of 3 bcf/day per year;
- A high export/slow growth scenario, where 12 bcf/day of LNG is exported, phased in at a rate of 1 bcf/day per year;
- A high export/rapid growth scenario, where 12 bcf/day of LNG is exported, phased in at a rate of 3 bcf/day per year.

Given the uncertainty over the actual size of the shale gas resource base and the future growth of the U.S. economy, each of these scenarios (both "baseline" and export) were applied to four alternate background cases:

- A reference case, based on the EIA's 2011 Annual Energy Outlook;
- A low-shale estimated ultimate recovery (EUR) case, in which shale gas production from new, undrilled wells is 50 percent below the reference case scenario;
- A high-shale EUR case, in which shale gas production from new, undrilled wells is 50 percent higher than the reference case;
- A high economic growth case, in which U.S. GDP grows at 3.2 percent as opposed to the 2.7 percent assumed in the reference case.

Given the range of assumptions, the range of results was unsurprisingly wide. The results range from a 9.6 percent increase (from $3.56 to $3.90/mcf) in domestic natural gas prices in 2025 due to exports (in the case of high shale gas recovery, low export volumes and a slow rate of export growth) to a 32.5 percent increase (in the case of low shale gas recovery, high export volumes and a high rate of export growth). The percentage premium for domestic natural gas prices in 2025 for each scenario relative to the baseline scenario price estimate is detailed in **Table 3**.

In addition to the price premium for exporting natural gas that exists in each case, the EIA study projected a short-term spike in natural gas prices as a result of LNG exports. As **Figure 7** below illustrates, in 2015, the first year that LNG exports occur, domestic natural gas prices rise rapidly until total export capacity is reached. In the "low-rapid" scenario prices peak in 2016, after the 6 bcf/day of export capacity is built over 2 years;

[82] "Effect of Increased Natural Gas Exports on Domestic Energy Markets," Energy Information Administration, January 2012. (EIA, 2012a).

Table 3: Percentage Increase in Domestic Natural Gas Price Relative to Baseline Scenario, 2025

Scenario ➔ / Case🡻	Baseline Scenario Projected Natural Gas Price in 2025 ($/mcf)	Low Export-Slow Growth	Low Export-Rapid Growth	High Export-Slow Growth	High Export-Rapid Growth
Reference Case	$4.70	10.0%	12.8%	14.3%	25.7%
High Shale EUR	$3.56	9.6%	12.9%	13.2%	24.2%
Low Shale EUR	$6.52	13.7%	17.0%	20.2%	32.5%
High Macroeconomic Growth	$4.99	11.0%	13.4%	15.6%	28.1%

Source: "Effect of Increased Natural Gas Exports on Domestic Energy Markets," Energy Information Administration, January 2012.

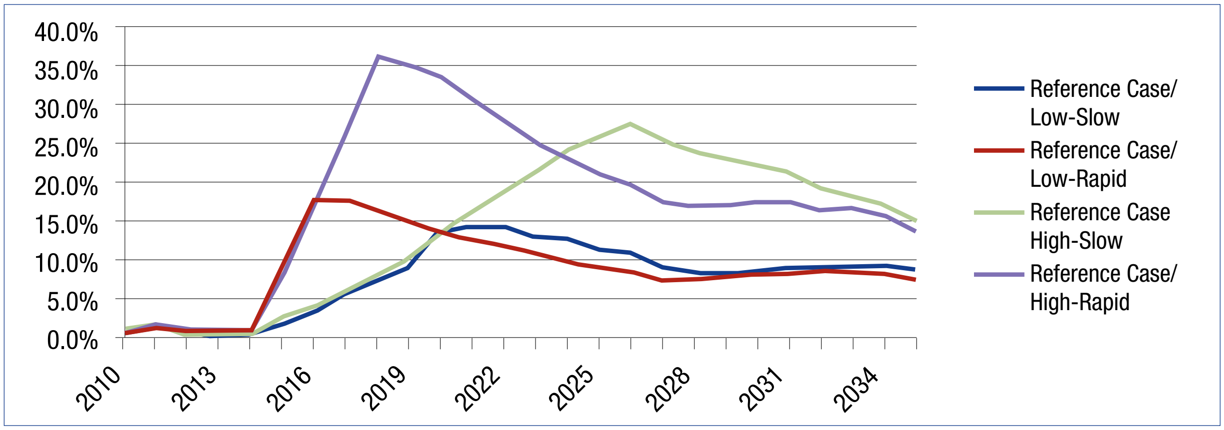
in the "high-slow" scenario, natural gas prices peak in 2026, after the 12 bcf/day of export capacity is built over 12 years. The immediate jump in price becomes more pronounced in the scenarios where LNG export capacity increases quickly. In the "low-rapid" scenario, the price of natural gas peaks at nearly 18 percent above the baseline case; in the "high-rapid" scenario, natural gas prices peak at 36 percent above the baseline case. This price impact is exacerbated in the Low Shale EUR and High Macroeconomic Growth cases, as LNG exports further tighten domestic natural gas markets. In the most extreme example, the high-rapid scenario for exports in a Low Shale EUR case, the price for natural gas peaks at more than 50 percent than the baseline case.[83]

There are two factors that should be considered when interpreting the results of this price impact study. The first is the assumption regarding the rate at which LNG could be exported. The results of EIA's analysis represent an extreme scenario for LNG exports. In the existing LNG market, it is particularly unlikely that either the "low-rapid" or the "high-rapid" scenarios would materialize. The former assumption stipulates that the United States would export 6 bcf/day of LNG by 2016. Given that, at the time of writing, only one facility has been approved to export 2.2 bcf/day to non-FTA countries starting in 2015, it is unlikely that another three plants would be approved and built in such a short time frame.[84] The latter scenario, that the United States would be exporting 12 bcf/day of LNG by 2018, suggests that in the next several years, the United States would grow from exporting negligible volumes of LNG to having roughly one-third of the global LNG export capacity. Not only would this supply growth outpace growth in global LNG demand, but this capacity addition would also have to compete with roughly

[83] Ibid.

[84] Of the major LNG export applications awaiting approval for non-FTA exports, it would require the next three plants—Freeport LNG, Lake Charles, and Dominion Cove Point—to be approved for the United States export capacity to cross the 6 bcf/day threshold.

Figure 7: Percentage Increase in Domestic Natural Gas Price Relative to Baseline Scenario, Reference Case 2010-2035



Source: "Effect of Increased Natural Gas Exports on Domestic Energy Markets," Energy Information Administration, January 2012.

11 bcf/day of Australian-origin LNG that is expected to hit the market around the same time.[85]

The second issue is the model's assumptions for incremental investment in natural gas production as a result of increased export capacity. The spike in price depicted in **Figure 7** occurs because investment from gas producers lags additional demand. In the model, producers respond to, rather than anticipate, additional demand. For this reason, prices peak once the export capacity is filled, before steadily decreasing. In reality, the expectation of future demand would likely induce gas producers to invest in additional production before incremental demand occurs. As a result, the increase in prices would likely begin earlier and peak at a lower level than suggested by the model.

Deloitte Study

An earlier study released in November 2011 from the Deloitte Center for Energy Solutions highlighted the producer-response in its model. In addition to finding that LNG exports would produce a smaller increase in gas prices than the EIA report suggests, the Deloitte study points out that "producers can develop more reserves in anticipation of demand growth, such as LNG exports. There will be ample notice and time in advance of the exports to make supplies available."[86] Using a dynamic model, in which production increased in anticipation of new demand, the Deloitte study found that 6 bcf/day of exports of LNG would result in, on average, a 1.7 percent increase (from $7.09 to $7.21/MMBtu) in the price of natural gas between 2016 and 2035.

Further, the Deloitte study noted that there would be regional variations to the increase in natural gas prices resulting from LNG exports. As most of the proposed liquefaction terminals are expected to be on the Gulf Coast, the price of Henry Hub gas, which is the key benchmark for natural gas from the Gulf Coast, will increase by $0.22/MMBtu by 2035 as a result of U.S. LNG exports. This is more than double the price increase projected in regions further away from the LNG export terminals. In New York and Illinois, natural gas prices are projected to increase by less than $0.10/MMBtu. This is particularly important

[85] Australia has approximately 10 bcf/day of LNG export projects that have already reached final investment decision. Most of this capacity is already contracted out with the remainder expected to be sold on the spot market. More than 90 percent of this capacity is expected to come online between 2014 and 2017. (Authors' interview with analysts at the Commonwealth Bank of Australia, March 19, 2012.)

[86] Deloitte, 2011.

in the Northeast, which historically experiences some of the highest natural gas prices in the country, but will benefit from the development and consumption of natural gas from the nearby Marcellus shale play.

Other Studies

Three other studies of note have analyzed the price impacts of U.S. LNG exports. In August 2010, Navigant Consulting found that 2 bcf/day of LNG exports would cause a price increase of between 7 and 7.9 percent from 2015 to 2035 relative to a scenario with no gas exports. ICF International found in August 2011 that 6 bcf/day of exports would result in an 11 percent ($0.64/MMBtu) increase in natural gas prices over the same period.[87] More recently, Navigant released another study that analyzed the impact of two separate export scenarios. The first scenario modeled the impact of 3.6 bcf/day of LNG exports from three terminals in North America: Sabine Pass in Louisiana, Kitimat in British Columbia, and Coos Bay in Oregon. The second scenario modeled the impact of 6.6 bcf/day of LNG exports from the three aforementioned export projects and 2 bcf/day of added exports from the Gulf Coast and 1 bcf/day from Maryland.[88] This Navigant study found that 6.6 bcf/day of LNG exports would result in a 6 percent ($0.35/MMBtu) increase in natural gas prices from 2015 to 2035.

As with the EIA and Deloitte studies, the results of both Navigant and ICF's studies must be analyzed in the context of their respective methodologies and assumptions. Navigant's first study uses a more static supply model, which, unlike dynamic supply models, does not fully take account of the effect that higher prices have on spurring additional production. As a result, it takes a conservative estimate of supply growth potential. The report acknowledges that the price outcomes modeled in its analysis "establish the upper range of impacts that exports […] might have on natural gas prices."[89] This study also did not factor in the reemergence of the industrial sector as a major consumer of natural gas following the shale gas "revolution." The study assumes that natural gas consumption by the industrial sector will decline by 0.3% per year to 2035. By contrast, the EIA model assumes that industrial sector demand will increase by roughly 1% per year over the same period.[90] The ICF study factors in various levels of production response from an increase in price. Under its 6 bcf/day export scenario, the price impact ranges from a $0.52/MMBtu increase in a more responsive drilling activity scenario to a $0.75/MMBtu increase in a less responsive drilling activity scenario.

Which Study is Right?

Given that these studies forecast natural gas prices two decades into the future, it is difficult to determine which study is most accurate. (**Table 4** shows a comparison of the price impact forecasts of the various models.) However, policymakers would benefit from having a better understanding of the results that are generated from each report. This includes choosing the most relevant results from each report. For instance, following the release of the EIA study, many commentators were quick to highlight that natural gas prices could increase by more than 50 percent as a result of LNG

[87] "Resource and Economic Issues Related to LNG Exports," *ICF International,* August 17, 2011; and "Markey Analysis for Sabine Pass LNG Export Project," *Navigant Consulting,* August 23, 2010. p. 5. (http://www.navigant.com/~/media/Site/Insights/Energy/Cheniere_LNG_Export_Report_Energy.ashx). It is important to note that both Navigant and ICF explored other scenarios and cases; however, for the purpose of this report, we analyzed the pricing impacts of the scenarios and cases that we thought were the most likely. For instance, the Navigant study analyzes price impacts for exports of 1 bcf/day and 2 bcf/day. Given that the Sabine Pass LNG export terminal is already contracted out for 2 bcf/day, this study focuses on that export scenario.

[88] "Jordan Cove LNG Export Project Market Analysis Study," *Navigant Consulting,* January 2012.

[89] Navigant Consulting, August 2010. p. 5.

[90] "Annual Energy Outlook 2011," Energy Information Administration, U.S. Department of Energy.

exports. However, this ignored the assumptions behind this number: it was based on the price of natural gas in one year under the most extreme assumptions of exports and domestic resource base. A more comprehensive analysis should include an assessment of the average price impact from 2015 to 2035. When distinguishing between the various studies, policymakers should identify which assumptions most resemble the existing natural gas market and its likely direction, and which models are most reflective of the complex nature of domestic and global natural gas trade. Assuming realistic volumes of natural gas exports as well as a reasonable supply response by natural gas producers are important considerations. It is important to note that the supply curves in the various studies reflect different interpretations of the economics of marginal production.

The Power Sector and Industrial Sector

Part I indicated that the power-generation and industrial sectors would account for most of the demand for newly available natural gas resources. As shown above, LNG exports are likely to increase domestic prices of natural gas, suggesting negative consequences for these two competing sectors. In their analyses, both Deloitte and EIA found that the majority—63 percent, according to both studies—of the exported natural gas will come from new production as opposed to displaced consumption from other sectors. By contrast, between 17 and 38 percent of supply of natural gas for export would be met by reduced demand, as higher prices pushes some domestic consumers to use less gas.

In the power generation and industrial sectors, the price impacts of LNG exports are likely to have modest impacts. In the power sector, natural gas has historically been used as a back up to coal and nuclear base-load generation. For such gas used at the margin, the increase in electricity prices as a result of LNG exports would be limited by its competitiveness relative to other fuels: as soon as it becomes more expensive than the alternative for back up generation, power producers will substitute away from gas.[91] According to ICF International, a $0.64/MMBtu increase in the price

Table 4: Study-by-study comparison of the Average Price Impact from 2015-2035 of 6 bcf/day of LNG exports (unless otherwise noted)

Study	Average Price without Exports ($/MMBtu)	Average Price with Exports ($/MMBtu)	Average Price Increase (%)
EIA*	$5.28	$5.78	9%
Deloitte	$7.09	$7.21	2%
Navigant (2010)** (2 bcf/day of exports)	$4.75	$5.10	7%
Navigant (2012)***	$5.67	$6.01	6%
ICF International***	$5.81	$6.45	11%

* Price impact figure for EIA study reflects the reference case, low-slow export scenario.
** The Navigant study did not analyze exports of 6 bcf/day.
*** Navigant (2010 and 2012) and ICF International studies are based on Henry Hub price.
Source: EIA, Deloitte, Navigant, ICF Internationa l.

[91] Information according to ICF International and Deloitte.

of natural gas would result in an electricity price increase of between $1.66 and $4.97/megawatt-hour (MWh), depending on how often gas is used as the marginal fuel for electricity. Deloitte estimates that the price increase of electricity would not be more than $1.65/MWh.[92] EIA estimates that electricity price impacts will be marginal as well (between $1.40/MWh and $2.90/MWh) except in the "high-rapid" export scenario.[93] The EIA Annual Energy Outlook 2011 estimates that, without exporting LNG, the average price of electricity (across all fuels) in 2035 will be $92/MWh.[94]

In the longer term, natural gas is itself likely to be used for more base-load generation. The rapid increase in shale gas production, coupled with the retirements of as much as 50 gigawatts (GW) of coal-fired electricity due to plant age or inability to adhere to possibly forthcoming EPA regulations is likely to increase the demand for natural gas in the power sector. According to some analysts, the near-term demand caused by the retirements of the oldest and least efficient coal-fired power plants could result in an additional natural gas demand of 2 bcf/day.[95] Given the lack of environmentally and economically viable alternatives, a moderate increase in gas prices is unlikely to result in a large move away from natural gas, although increased costs will be transferred to customers. Natural gas consumption in the power sector has been considered economic at prices much higher than those resulting from LNG exports in even the highest price-impact projections. Even prior to the shale gas "revolution," when natural gas prices were high, natural gas demand was increasing in the power sector. The EIA Annual Energy Outlook 2005—published in a year when average well head prices were over $7/MMBTU—projected that natural gas demand in the electricity sector would increase by 70 percent between 2003 and 2015.[96]

Unlike the power sector, which continued to build natural-gas fired generation during a period of increasing gas prices, the industrial sector was negatively affected by growing natural gas import dependence, high gas prices, and gas price volatility. Between 2000 and 2005, the price of natural gas increased by 99 percent and LNG imports more than doubled.[97] By 2005, the ratio of the price of oil to the price of natural gas was approximately 6:1, just below the 7:1 oil-to-gas price ratio at which U.S. petrochemical and plastics producers are globally competitive.[98] That same year Alan Greenspan, then-Chairman of the Federal Reserve, noted that because of natural gas price increases "the North American gas-using industry [was] in a weakened competitive position."[99]

Since then the price of natural gas has collapsed. In 2011, the oil-to-natural gas price ratio was more than 24:1. In 2012 it has been even higher. The decline in natural gas prices has galvanized the industrial sector. A joint study by PwC and the National Association for Manufacturers, an industry trade group, found that the development of shale gas could save manufacturers as much as $11.6 billion per year in feedstock costs through 2025.[100] New investments in petrochemical and plastics

[92] Deloitte, 2011.
[93] "Effect of Increased Natural Gas Exports on Domestic Energy Markets," Energy Information Administration, January 2012.
[94] EIA, April 2011a.
[95] According to a private ClearView Energy Partners Working Paper.
[96] "Annual Energy Outlook 2005," Energy Information Administration, U.S. Department of Energy. p. 159.
[97] According to EIA statistics.
[98] According to EIA statistics, in 2005 the price of Brent Crude oil was $54.57 per barrel and the price of natural gas at Henry Hub was $8.67 per MMBtu, giving an oil-to-gas price ratio (on a non-energy equivalent basis)n of approximately 6.3:1. The 7:1 threshold is according to the American Chemistry Council report, "Shale Gas and new Petrochemicals Investment," March 2011. (ACC, March 2011). One barrel of crude oil has nearly 6 MMBtu.
[99] Remarks by Alan Greenspan, Chairman of the Federal Reserve, before the National Petrochemical and Refiners Association Conference in San Antonio, Texas, April 5, 2005. (http://www.federalreserve.gov/boarddocs/speeches/2005/20050405/default.htm)
[100] "Shale Gas: A renaissance in U.S. manufacturing?" PwC with contribution from the National Association of Manufacturers, December 2011.

producing facilities are occurring throughout the East and Southeast, largely predicated on the availability of inexpensive natural gas.

Opponents of LNG exports contend that such investments would be deterred in the future as a result of increases in the price of natural gas. However, the evidence suggests that the competitive advantage of U.S. industrial producers relative to its competitors in Western Europe and Asia is not likely to be affected significantly by the projected increase in natural gas prices resulting from LNG exports. As European and many Asian petrochemical producers use oil-based products such as naphtha and fuel oil as feedstock, U.S. companies are more likely to enjoy a significant cost advantage over their overseas competitors. Even a one-third decline in the estimated price of crude oil in 2035 would result in an oil-to-gas ratio of 14:1.[101]

There is also the potential for increased exports to help industrial consumers. Ethane, a liquid byproduct of natural gas production at several U.S. gas plays, is the primary feedstock of ethylene, a petrochemical product used to create a wide variety of products. According to a study by the American Chemistry Council, an industry trade body, a 25 percent increase in ethane production would yield a $32.8 billion increase in U.S. chemical production. By providing another market for cheap dry gas, LNG exports will encourage additional production of natural gas liquids (NGL) that are produced in association with dry gas. According to the EIA, ethane production increased by nearly 30 percent between 2009 and 2011 as natural gas production from shale started to grow substantially. Ethane production is now at an all-time high, with more than one million barrels per day of ethane being produced.[102] Increased gas production for exports results in increased production of such natural gas liquids, in which case exports can be seen as providing a benefit to the petrochemical industry.

Natural gas price volatility

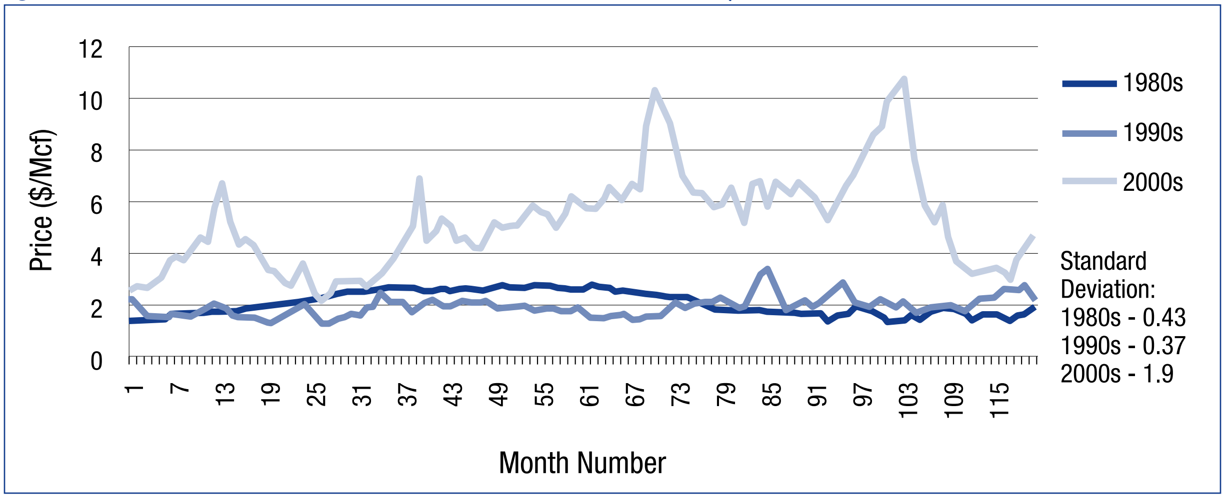
A major concern among domestic end users of natural gas is the possibility of an increase in natural gas price volatility resulting from an increase in U.S. LNG exports. As **Figure 8** demonstrates, the price volatility experienced during the 2000s was the highest the domestic gas market has experienced in the past three decades.

The volatility of the natural gas market in the 2000s was largely caused by a tight supply-demand balance. Natural gas demand increased substantially as the U.S. economy grew and natural gas was viewed as environmentally preferable to coal for power generation. This increase in demand coincided with a reduction in domestic supply and an increased reliance on imports. The recent surge in U.S. natural gas production has resulted in less market volatility since 2010. According to EIA, the standard deviation of the price of natural gas (a general statistical indicator of volatility) between 2010 and 2011 was one-third what it was during the 2000s.[103] Potential exports of U.S. LNG concerns some domestic consumers for two principal reasons: greater volatility in domestic natural gas prices; and exposure of domestic natural gas prices to higher international prices resulting in a convergence between low U.S. prices and high international prices.

There is an insufficient amount of data and quantitative research on the relationship between do-

[101] The International Energy Agency forecasts the price of oil in 2035 to be $140. The ratio of an oil price one-third that amount to EIA's forecasted gas price in 2035 (with 6 bcf/day of exports) is roughly 14:1 ($98/barrel:$6.98/MMBtu). Oil price from the International Energy Agency's World Energy Outlook 2011.
[102] Data from EIA "Natural Gas Plant Field Production" statistics.
[103] According to calculations of EIA natural gas price data, the standard deviation of domestic natural gas prices in 2010 and 2011 has been 0.54.

Figure 8: Natural Gas Prices in 1980s, 1990s, and 2000s, by month ($/Mcf)



Source: EIA

mestic natural gas price volatility and LNG exports. However, certain characteristics of the LNG market are likely to limit volatility. LNG is bound by technical constraints: it must be liquefied and then transported on dedicated tankers before arriving at terminals where a regasification facility must be installed. Liquefaction facilities have capacity limits to how much gas they can turn into LNG. If they are operating at or close-to full capacity, such facilities will have a relatively constant demand for natural gas, therefore an international price or supply shock would have little impact on domestic gas prices. Moreover, unlike oil trading, in which an exporter—theoretically—sells each marginal barrel of production to the highest bidder in the global market, the capacity limit on LNG production and export means that LNG exporters have an infrastructure-limited demand for natural gas leaving the rest of the natural gas for domestic consumption. As most LNG infrastructure facilities are built on a project finance basis and underpinned by long-term contracts, this demand can be anticipated by the market years in advance, reducing the likelihood of volatility.

The macroeconomy and jobs

The macroeconomic and job implications of LNG exports depend on two principal factors: the gains from trade from exploiting pricing differentials and inefficiencies of the global market; and the employment implications of those gains, higher domestic natural gas prices, and greater domestic natural gas production. The Department of Energy has commissioned a study on both the macroeconomic and employment implications of U.S. LNG exports, which will be released later this year. This study will provide a qualitative assessment of the implications of LNG exports to the U.S. economy and employment.

LNG exports are likely to be a net benefit to the U.S. economy, although probably not a significant contributor in terms of total U.S. GDP. Exports of U.S. natural gas will take advantage of the benefits of the existing producer's surplus resulting from the pricing differentials between the natural gas markets in the United States, Europe, and Asia. Contractual terms will determine how this surplus is shared between U.S. sellers and foreign buyers.[104] The benefit of this trade will likely outweigh the cost to domestic consumers of the increase in the price of natural gas as most of the natural gas demanded by exports will come from new natural gas production as opposed to displacing existing production from domestic consumers. On the other hand, LNG exports from the United States are likely to put marginal upward pressure on the relative value of the U.S. dollar. In March 2012, Citigroup released a report on North American hydrocarbon production that included a model of the macroeconomic impact of U.S. oil and gas exports. The Citi analysis found that oil and gas exports would cause a nearly two percent decline in the current account deficit by 2020, but that the exchange rate implications would be modest. By 2020, the U.S. dollar would appreciate by between 1.6 and 5.4 percent.[105]

The implications of LNG exports on job creation are similarly difficult to quantify. Other than temporary construction jobs created by the need to build liquefaction capacity, pipelines, and other ancillary infrastructure, the operation of the liquefaction facility will likely provide little permanent employment benefit. As outlined in the section on price impacts above, as much of the gas for export will come from new production, rather than the displacement of consumption in other sectors, the negative economic, and therefore job-related, effects on those sectors is likely to be limited. Beyond the labor required for additional gas production to satisfy LNG exports, the net impact of LNG exports is likely to be minimal. Further upstream, the job potential may be greater. By increasing domestic natural gas production, employment from additional oil and gas producers will increase, as will the demand for manufacturers of equipment for oil and gas production, gathering, and transportation.

Domestic energy security

Aside from the price impact of potential U.S. LNG exports, a major concern among opponents is that such exports would diminish U.S. "energy security"; that exports would deny the United States of a strategically important resource. The extent to which such concerns are valid depends on several factors, including the size of the domestic resource base, and the liquidity and functionality of global trade. As Part I of this report notes, geological evidence suggests that the volumes of LNG export under consideration would not materially affect the availability of natural gas for the domestic market. Twenty years of LNG exports at the rate of 6 bcf/day, phased in over the course of 6 years, would increase demand by approximately 38 tcf. As presented in Part I, four existing estimates of total technically recoverable shale gas resources range from 687 tcf to 1,842 tcf; therefore, exporting 6 bcf/day of LNG over the course of twenty years would consume between 2 and 5.5 percent of total shale gas resources. While the estimates for shale gas reserves are uncertain, in a scenario where reserves are perceived to be lower than expected, domestic natural gas prices would increase and exports would almost immediately become uneconomic. In the long-term, it is possible that U.S. prices and international prices will converge to the point at which they settle at similar levels. In that case, the United States would have more than adequate import capacity (through bi-directional import/export facilities) to import gas when economic.

[104] The amount of the producer's surplus depends on the structure of the LNG contract. Some contracts are free-on-board (FOB), whereby the buyer takes owner of the LNG once it is loaded onto a ship. The buyer is then responsible for delivery to the LNG facility, assuming both the price risk and the potential rents. Other contracts are delivered ex-ship (DES), where the buyer only takes ownership of the LNG once the cargo arrives at the receiving port. The seller is therefore responsible for the transportation and delivery, and assumes both the price risk and the potential rent.

[105] "Edward Morse et al, "Energy 2020: North America, the New Middle East?" Citigroup, March 20, 2012.

A further gas-related consideration with regard to energy security is the effects of increased production of associated natural gas with the increasing volumes of U.S. unconventional oil. As the primary energy-security concern for the United States related to oil, the application of fracking and horizontal drilling in oil production is reducing U.S. oil import dependence, while simultaneously producing substantial volumes of natural gas, which, given the relative economics of oil and gas, is effectively delivered at zero (or, in the case of producers who have to invest in equipment to manage flaring and venting, negative) cost. To the extent that associated gas from unconventional oil production is used for LNG export, it can be seen as a consequence of—rather than a threat to—increased U.S. energy security.

International Implications

The international implications of LNG exports from the United States can be divided into pricing, geopolitics, and environment.

International Pricing

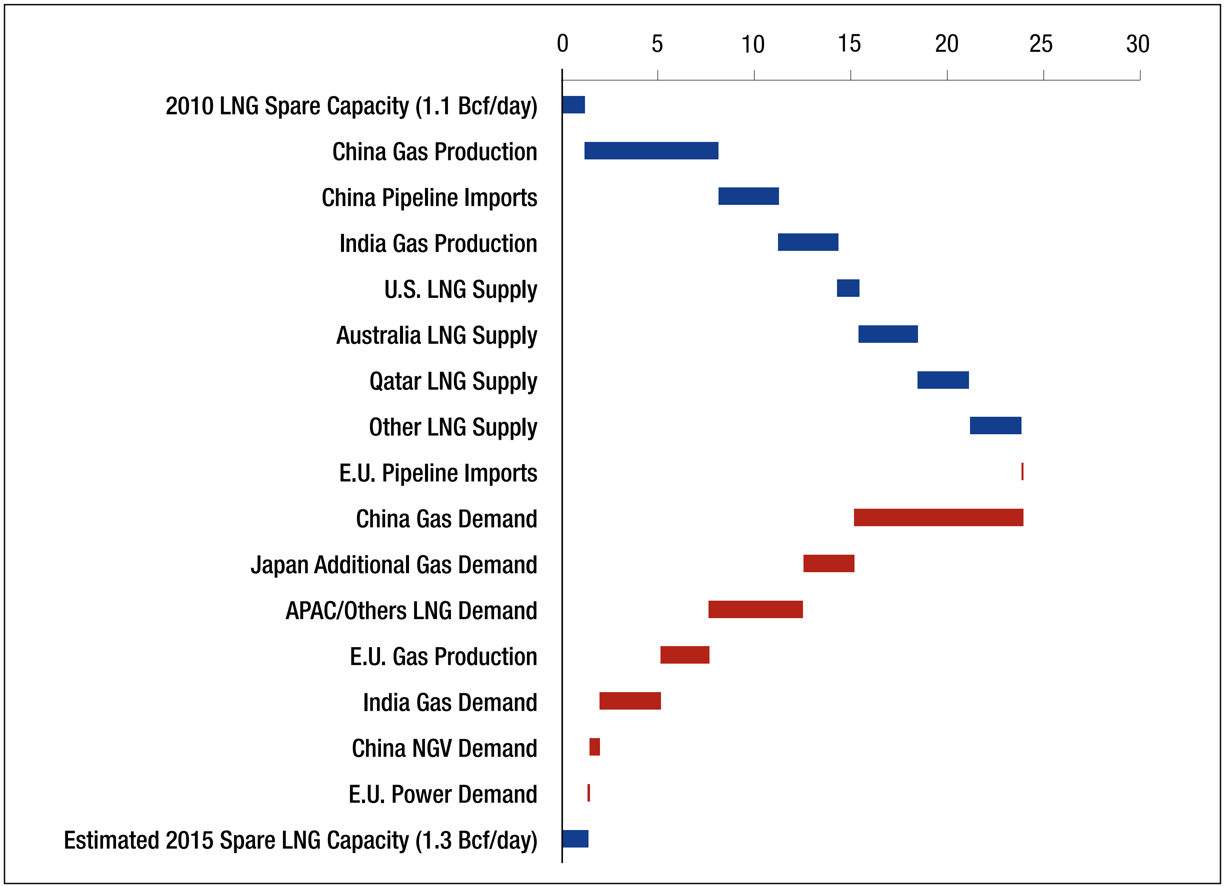
As discussed in Part I, the global LNG market is informally separated into three markets: North America, the Atlantic Basin (mostly Europe), and the Pacific Basin (including Japan, South Korea, Taiwan, China, and India). These markets are separated because of important technical differences that impact the pricing structure for LNG in each market. The North American natural gas market is competitive and prices are traded in a transparent and open market. The Atlantic Basin is dominated by European LNG consumers such as the United Kingdom, Spain, France, and Italy, and is a hybrid of a competitive U.K. market that was liberalized in the mid-1990s and a Continental European market that is dominated by oil-linked, take-or-pay contracts. In recent years, the U.K. hub, the National Balancing Point (NBP), has traded at a premium to the U.S. hub, the Henry Hub. The Pacific Basin is a more rigid market that depends heavily on oil-indexed contracts that are more expensive than those used in the Atlantic Basin. While they have no central trading hub, the Pacific Basin consumers such as Japan and South Korea (which is implementing its recently-signed free-trade agreement with the United States) currently import LNG based on a pricing formula known informally as the Japan Crude Cocktail, the average price of custom-cleared oil imports into Tokyo. Many Pacific Basin contracts have a built-in price floor and price ceiling depending on the price of oil.[106]

Without exporting any natural gas, the U.S. shale gas "revolution" has already had a positive impact on the liquidity of global LNG markets. Many LNG cargoes that were previously destined for gas-thirsty U.S. markets were diverted and served spot demand in both the Atlantic and Pacific Basins. The increased availability of LNG cargoes has helped create a looser LNG market for other consumers (see **Figure 9**). This in turn has helped apply downward pressure to the terms of oil-linked contracts resulting in the renegotiation of some contracts, particularly in Europe. Increased availability of LNG cargoes also accelerated a recent trend of increasing reliance of consumers on spot LNG markets. In 2010 short-term and spot contracts represented 19 percent of the total LNG market, up from only a fraction one decade earlier.[107] In this case, increasing demand for spot cargoes indicates that consumers are taking advantage of spot prices that are lower than oil-indexed rates.

[106] It is important to note that all oil-indexed contracts are not the same. While they are all indexed to oil prices, the formulae that determine the delivery price of LNG varies substantially from contract to contract.

[107] Howard Rogers, "The Impact of a Globalizing Market on Future European Gas Supply and Pricing: the Importance of Asian Demand and North American Supply," *Oxford Institute for Energy Studies,* January 2012. p. 9. (OIES, 2012)

Figure 9: Estimated LNG Spare Capacity from 2010-2015 (bcf/day)



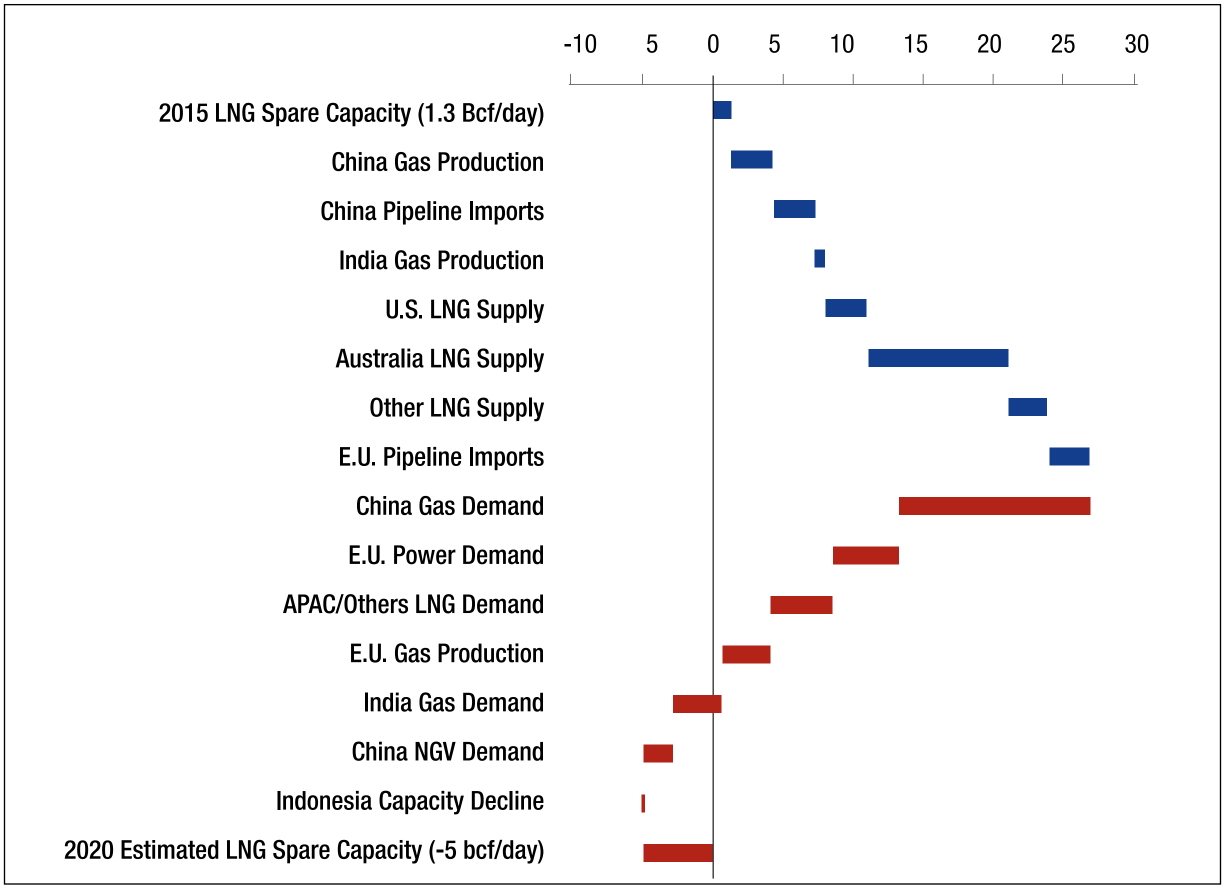
Source: Brookings analysis of Morgan Stanley research and data; IEA, EIA, ClearView Energy Partners

LNG exports will help to sustain market liquidity in what looks to be an increasingly tight LNG market beyond 2015 (see **Figure 10**). Should LNG exports from the United States continue to be permitted, they will add to roughly 10 bcf/day of LNG that is expected to emerge from Australia between 2015 and 2020. Nevertheless, given the projected growth in demand for natural gas in China and India and assuming that some of Japan's nuclear capacity remains offline, demand for natural gas will outpace the incremental supply. This makes U.S. LNG even more valuable on the international market.

Although it will be important to global LNG markets, it is unlikely that the emergence of the United States as an exporter of LNG will change the existing pricing structure overnight. Not only is the market still largely dependent on long-term contracts, the overwhelming majority of new liquefaction capacity emerging in the next decade (largely from Australia) has already been contracted for at oil-indexed rates.[108] The incremental LNG volumes supplied by the United States at floating Henry Hub rates will be small in comparison. But while U.S. LNG will not have a transformational impact, by establishing an alternate lower price for LNG derived through a different market mechanism, U.S. exports may be central in catalyzing future changes in LNG contract structure. As previously mentioned, this impact is already be-

[108] From an interview with Luke Smith, Energy Analyst, Commonwealth Bank of Australia. March 19, 2012.

Figure 10: Estimated LNG Spare Capacity from 2015-2020 (bcf/day)



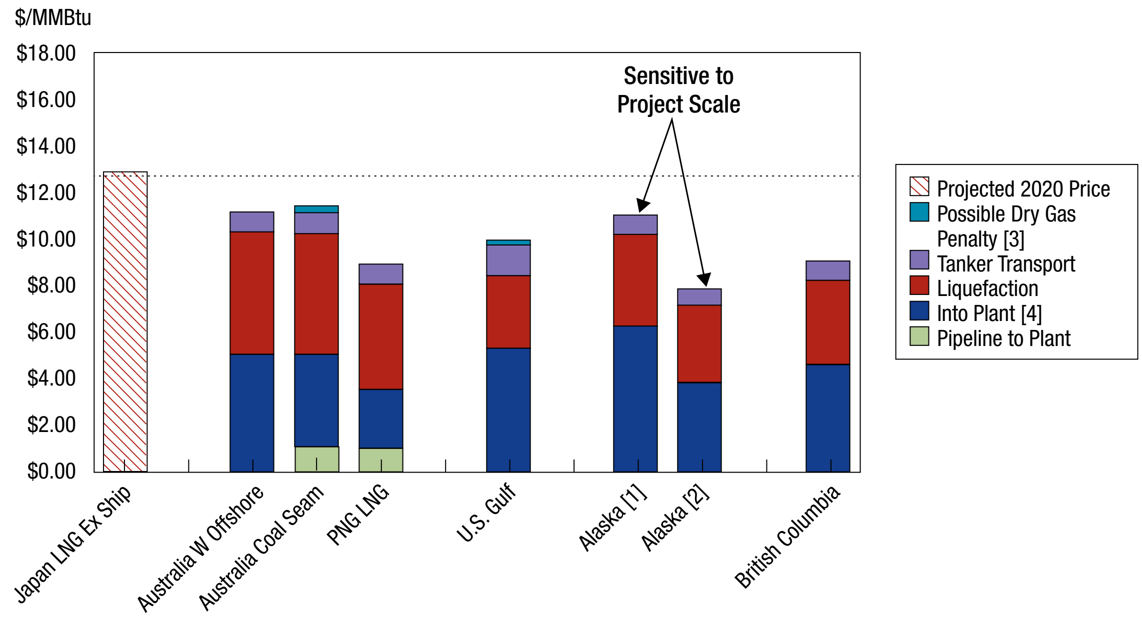
Source: Brookings analysis of Morgan Stanley research and data; IEA, EIA, ClearView Energy Partners

ing felt in Europe. A number of German utilities have either renegotiated contracts or are seeking arbitration with natural gas suppliers in Norway and Russia. The Atlantic Basin will be a more immediate beneficiary of U.S. LNG exports than the Pacific Basin as many European contracts allow for periodic revisions to the oil-price linkage.[109] In the Pacific Basin this contractual arrangement is not as common and most consumers are tied to their respective oil-linkage formulae for the duration of the contract.[110] Despite the increasing demand following the Fukushima nuclear accident, however, Japanese LNG consumers are actively pursuing new arrangements for LNG contracts.[111]

There are other limits to the extent of the impact that U.S. LNG will have on global markets. It is unlikely that many of the LNG export facilities under consideration will reach final investment decision. Instead, it is more probable that U.S. natural gas prices will have rebounded sufficiently to the point that exports are not commercially viable beyond a certain threshold. (**Figure 11** illustrates the estimated costs of delivering LNG to Japan in

[109] See Morten Frisch, "Current European Gas Pricing Problems: Solutions Based on Price Review and Price Re-opener Provisions," *University of Dundee Center for Energy Petroleum and Mineral Law and Policy,* for a thorough review of European natural gas contract structure.
[110] OIES, 2012. p. 5.
[111] "Fukushima's Impact on Global Gas," presentation by Leslie Palti-Guzman, Analyst for Global Energy and Natural Resources, Eurasia Group, at the Center for Strategic and International Studies in Washington, DC. March 2012.

Figure 11: Estimated Costs of Delivering LNG to Japan in 2020



Note: Gulf exports to Asia assume tankers travel through an expanded Panama Canal
[1]: Assumes 1 bcf/day from Valdez, Alaska
[2]: Assumes 3.1 bcf/day from Valdez, Alaska
[3]: Dry gas penalty is assumed at 2 percent
[4]: For Alaska and British Columbia, "Into Plant" refers to the opportunity cost relative to projections of Henry Hub price
Source: From a client presentation by James Jensen, Jensen Associates

2020.) This threshold, expected by many experts to be roughly 6 bcf/day by 2025, is modest in comparison to the roughly 11 bcf/day of Australian LNG export projects that have reached final investment decision and are expected to be online by 2020.

Also, the impact of U.S. LNG exports could be limited by a number of external factors that will have a larger bearing on the future of global LNG prices. For instance, a decision by the Japanese government to phase-out nuclear power would significantly tighten global LNG markets and probably displace any benefit provided by U.S. LNG exports. Conversely, successful and rapid development of China's shale gas reserves would limit the demand of one of the world's fastest-growing natural gas consumers. However, to the extent that U.S. LNG exports can help bring about a more globalized pricing structure, they will have economic and geopolitical consequences.

Geopolitics

A large increase in U.S. LNG exports would have the potential to increase U.S. foreign policy interests in both the Atlantic and Pacific basins. Unlike oil, natural gas has traditionally been an infrastructure-constrained business, giving geographical proximity and political relations between producers and consumers a high level of importance. Issues of "pipeline politics" have been most directly visible in Europe, which relies on Russia for around a third of its gas. Previous disputes between Moscow and Ukraine over pricing have led to major gas shortages in several E.U. countries in the winters (when demand is highest) of both 2006 and 2009. Further disagreements between Moscow and Kiev over the terms of the existing bilateral gas deal have the potential to escalate again, with negative consequences for E.U. consumers.

The risk of high reliance on Russian gas has been a principal driver of European energy policy in recent decades. Among central and eastern European states, particularly those formerly aligned with the Soviet Union such as Poland, Hungary, and the Czech Republic, the issue of reliance on imports of Russian gas is a primary energy security concern and has inspired energy policies aimed at diversification of fuel sources for power generation. From the U.S. perspective such Russian influence in the affairs of these democratic nations is an impediment to efforts at political and economic reform. The market power of Gazprom, Russia's state-owned gas monopoly, is evident in these countries. Although they are closer to Russia than other consumers of Russian gas in Western Europe, many countries in Eastern and Central Europe pay higher contract prices for their imports, as they are more reliant on Russian gas as a proportion of their energy mixes.

In the larger economies of Western Europe, which consume most of Russia's exports, there are efforts to diversify their supply of natural gas. The E.U. has formally acknowledged the need to put in place mechanisms to increase supply diversity. These include market liberalization approaches such as rules mandating third-party access to pipeline infrastructure (from which Gazprom is demanding exemption), and commitments to complete a single market for electricity and gas by 2014, and to ensure that no member country is isolated from electricity and gas grids by 2015.[112]

Despite these formal efforts, there are several factors retarding the E.U.'s push for a unified effort to reduce dependence on Russian gas. National interest has been given a higher priority than collective, coordinated E.U. energy policy: the gas cutoffs in 2006 and 2009 probably contributed to the acceptance of the Nord Stream project, which carries gas from Russia into Germany. Germany's decision to phase out its fleet of nuclear reactors by 2022 will result in far higher reliance on natural gas for the E.U.'s biggest economy. The environmental imperative to reduce carbon emissions—codified in the E.U.'s goal of essentially decarbonizing its power sector by the middle of century—mean that natural gas is being viewed by many as the short-to medium fuel of choice in power generation. Finally, the prospects for European countries to replicate the unconventional gas "revolution" that has resulted in a glut of natural gas in the United States look uncertain. Several countries, including France and the U.K., have encountered stiff public opposition to the techniques used in unconventional gas production, while those countries, such as Poland and Hungary, that have moved ahead with unconventional-gas exploration have generally seen disappointing early results. Collectively, these factors suggest that the prospects for reduced European reliance on Russian gas appear dim.

The one factor that has been working to the advantage of advocates of greater European gas diversity has been the increased liquidity of the global LNG market, discussed above. Russia's dominant position in the European gas market is being eroded by the increased availability of LNG. Qatar's massive expansion in LNG production in 2008, coupled with the rise in unconventional gas production in the United States as well as a drop in global energy demand due to the global recession, produced a global LNG glut that saw many cargoes intended for the U.S. market diverted into Europe. As mentioned previously, with an abundant source of alternative supply, some European consumers, mainly Gazprom's closest partners, were able to renegotiate their oil-linked, take-or-pay contracts with Gazprom. As **Figure 10** illustrates, however, in the wake of the Fukushima

[112] Note from the General Secretariat of the European Council to the Delegations on the Conclusions of the European Council, March 8, 2011. (http://register.consilium.europa.eu/pdf/en/11/st00/st00002-re01.en11.pdf); Paul Whitehead, "EU leaders commit to complete single energy market by 2014," *Platts,* December 9, 2011. (http://www.platts.com/RSSFeedDetailedNews/RSSFeed/NaturalGas/8686978)

natural disaster and nuclear accident in Japan and a return to growth in most industrialized economies, the LNG market is projected to tighten considerably in the short-term, potentially returning market power to Russia.

However, there is a second, structural change to the global gas market that may have more lasting effects to Russia's market power in the European gas market. LNG is one of the fastest growing segments of the energy sector. The growth of the LNG market, both through long-term contract and spot-market sales, is likely to put increasing pressure on incumbent pipeline gas suppliers. A significant addition of U.S. LNG exports will accelerate this trend. In addition to adding to the size of the market, U.S. LNG contracts are likely to be determined on a "floating" basis, with sales terms tied to the price of a U.S. benchmark such as Henry Hub, eroding the power of providers of long-term oil linked contract suppliers such as Russia. While U.S. LNG will not be a direct tool of U.S. foreign policy—the destination of U.S. LNG will be determined according to the terms of individual contracts, the spot-price-determined demand, and the LNG traders that purchase such contracts—the addition of a large, market-based producer will indirectly serve to increase gas supply diversity in Europe, thereby providing European consumers with increased flexibility and market power.

Increased LNG exports will provide similar assistance to strategic U.S. allies in the Pacific Basin. By adding supply volumes to the global LNG market, the U.S. will help Japan, Korea, India, and other import-dependent countries in South and East Asia to meet their energy needs. The desire on the part of Pacific Basin countries for the U.S. to become a gas supplier to the region has been underlined by the efforts of the Japanese government, which has attempted to secure a free-trade agreement waiver from the United States to allow exports. As with oil price-linked Russian gas contracts in Europe, U.S. LNG exports linked to a floating Henry Hub benchmark, have the potential to weaken the market power of incumbent LNG providers to Asia, increasing the negotiating power of consumers and decreasing the price. As U.S. foreign policy undergoes a "pivot to Asia," the ability of the U.S. to provide a degree of increased energy security and pricing relief to LNG importers in the region will be an important economic and strategic asset.

Beyond the basin-specific considerations of U.S. LNG exports, they would provide a source of predictable natural gas supply that is relatively free from unexpected production or shipping disruption. With Qatar representing roughly one-third of the global LNG market, a blockade or military intervention in the Strait of Hormuz or a direct attack on Qatar's liquefaction facilities by Iran would inflict chaos on world energy markets. While the United States government will be unable to physically divert LNG cargoes to specific markets or strategic allies that are most affected (gas allocation will be made by the market players), additional volumes of LNG on the world market will benefit all consumers.

International Environmental Implications

Proposed LNG exports from the United States have encountered domestic opposition on environmental grounds. As outlined in Part I, natural gas production causes greenhouse gas emissions in the upstream production process through leakages, venting, and flaring. The greenhouse gas footprint of shale gas production has been the subject of vigorous debate, with some studies suggesting that methane from the production process leads to shale gas having a higher global warming impact than that of other hydrocarbons including coal. While the methodology underlying such studies has been widely criticized, there is no doubt that leakage and venting of natural gas is a serious negative environmental consequence of natural gas production and transportation: EPA has estimated that worldwide leakages and venting volumes were 3,353.5 bcf in 2010.[113]

By contrast, some advocates of U.S. exports of LNG maintain that they have the potential to bring global environmental benefits if they are used to displace more carbon-intensive fuels. According to the IEA, natural gas in general has the potential to reduce carbon dioxide emissions by 740 million tonnes in 2035, nearly half of which could be achieved by the displacement of coal in China's power-generation portfolio. Natural gas—in the form of LNG—also has the potential to displace more carbon-intensive fuels in other major energy users, including across the EU and in Japan, which is being forced to burn more coal and oil-based fuels to make up for the nuclear generation capacity lost in the wake of the Fukushima disaster. In addition to its relatively lower carbon-dioxide footprint, natural gas produces lower emissions of pollutants such as sulfur dioxide nitrogen oxide and other particulates than coal and oil.

Natural gas—both in the form of LNG and compressed natural gas—is also being viewed as a potential replacement for oil in the vehicle transportation fleet, with large carbon dioxide abatement potential.[114] However, as discussed in Part I, even the United States with its low gas prices is unlikely to see any significant move toward natural gas vehicles in the absence of government policies; the prospects for such vehicles entering the European or Asian markets, where gas is several times as expensive, are remote. On the other hand, additional volumes of natural gas in the global power generation fleet may also have longer-term detrimental consequences for carbon emissions. According to the IEA, by backing out nuclear and renewable energy generation, natural gas could add 320Mt of carbon dioxide by 2035.[115]

Whether U.S. LNG exports contribute to reduced carbon dioxide emissions through the displacement of coal fired power generation or to the crowding out of renewable and nuclear energy in the global energy mix is something of a moot point. According to the IEA, global power generation is projected to exceed 27,000 terawatt hours per year by 2020.[116] Even assuming U.S. exports of 6 bcf/day (on the upper end of the range of expectations), zero losses due to transportation, regasification, and transmission, and a high natural gas power plant efficiency level of 60 percent, such volumes would account for just over one percent of total global power generation.[117] Therefore, although the domestic environmental impacts associated with shale gas extraction may, pending the outcome of further study, prove to be a cause for concern with respect to greenhouse gas emissions, the potential for U.S. LNG exports to make a meaningful impact on global emissions through changes to the global power generation mix is negligible.

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[113] "Global Anthropogenic Non-CO2 Greenhouse Gas Emissions: 1990-2020," Environmental Protection Agency, 2006.
[114] "Making the Green Journey Work: Optimised Pathways to Reach 2050 Abatement Targets with Lower Costs and Improved Feasibility," European Gas Advocacy Forum, February 2011, p. 32.
[115] IEA, 2011. p. 37.
[116] "World Energy Outlook 2011," International Energy Agency, 2011. p.178.
[117] Assuming heat content of natural gas of 1,000 Btu/cubic feet.

Part III: Conclusions and Recommendations

This paper has attempted to answer two questions: Are U.S. LNG exports feasible? If so, what are the implications of U.S. LNG exports?

For exports to be feasible, several demand and supply-related conditions need to be met. On the supply side, adequate resources must be available and their production must be sustainable over the long-term. The regulatory and policy environment will need to accommodate natural gas production to ensure that the resources are developed. The capacity and infrastructure required to enable exports must also be in place. This includes the adequacy of the pipeline and storage network, the availability of shipping capacity, and the availability of equipment for production and qualified engineers.

On the demand side, LNG exports will compete with two main other domestic end uses for natural gas: the power-generation sector, and the industrial and petrochemical sector. According to most projections, the U.S. electricity sector will see an increased demand for natural gas as it seeks to comply with policies and regulations aimed at reducing carbon-dioxide emissions and pollutants from the power-generation fleet. Cheaper natural gas in the industrial sector has the potential to lower the cost of petrochemical production and to improve the competitiveness of a range of refining and manufacturing operations. Advocates of natural gas usage in the transportation fleet – particularly in heavy-duty vehicles (HDVs) – see it as a way to decrease the country's dependence on oil, although absent major policy support, this sector is unlikely to represent a significant source of gas demand.

For increased U.S. LNG exports to be feasible, they will also need to be competitive with supplies from other sources. The major demand centers that would import U.S. LNG would be Pacific Basin consumers (Japan, South Korea, and Taiwan, and increasingly China and India), and Atlantic Basin consumers, mostly in Europe. The supply and demand balance in the Atlantic and Pacific Basins and, therefore the feasibility for natural gas exports from the United States, depend heavily on the uncertain outlook for international unconventional natural gas production. Recent assessments in countries such as China, India, Ukraine, and Poland indicate that each country has significant domestic shale gas reserves. If these reserves are developed effectively—which is likely to be difficult in the short-term due to a lack of infrastructure, physical capacity, and human capacity—many of these countries would dramatically decrease their import dependence, with negative implications for existing and newcomer LNG exporters.

Detailed analysis of the foregoing factors suggests that the exportation of liquefied natural gas from the United States is logistically feasible. Based on current knowledge, the domestic U.S. natural gas resource base is large enough to accommodate the potential increased demand for natural gas from the electricity sector, the industrial sector, the residential and commercial sectors, the transportation sector, *and* exporters of LNG. Other obstacles to production, including infrastructure, investment, environmental concerns, and human capacity, are likely to be surmountable. Moreover, the current and projected supply and demand fundamentals of the international LNG market are conducive to competitive U.S.-sourced LNG.

While LNG exports may be practically feasible, they will be subject to approval by policy makers if they are to happen. In making a determination on the advisability of exports, the federal government will focus on the likely implications of LNG exports: i.e. whether LNG exports are in the "public interest." The extent of the domestic implications is largely dependent upon the price impact of exports on domestic natural gas prices. While it is clear that domestic natural gas prices will increase if natural gas is exported, most existing analyses indicate that the implications of this price increase are likely to be modest. Natural gas producers will likely anticipate future demand from LNG exports and will increase production accordingly, limiting price spikes. The impact on the domestic industrial sector is likely to be marginal: to the extent that LNG exports raise domestic gas prices above the level at which they would have been in the absence of such exports, they will negatively affect the competitiveness of U.S. industry relative to international competitors. However, the competitiveness of natural-gas intensive U.S. companies relative to their counterparts is likely to remain strong, given the large differential between projected U.S. gas prices and oil prices, which are the basis for industrial feedstock by competitor countries. Further, LNG exports are likely to stimulate domestic gas production, potentially resulting in greater production of natural gas liquids such as ethane, a valuable feedstock for industrial consumers. LNG exports are also unlikely to result in an increase in price volatility. The volume of LNG exports is capped by the capacity limitations of liquefaction terminals. If liquefaction terminals are running at close to full capacity, an increase in international demand will do little to affect domestic demand for —and therefore domestic prices of —natural gas.

The potential benefits of U.S. LNG exports relate to trade, macroeconomics, and geopolitics. Exports of natural gas would bring foreign exchange revenues to the United States and have a positive effect on U.S. balance of payments, although in the context of overall U.S. trade, the impact of LNG revenues are likely to be small. The construction, operation, and maintenance of LNG export facilities and related infrastructure will also likely lead to some, limited, job creation. Exports may also serve as a stimulus to continue and even increase production of natural gas, which may result in an additional supply of employment. With some domestic production—mainly dry gas with little liquid content—being suspended due to gas prices being too low for continued economic extraction, exports may serve as an important source of incremental demand to support necessary volumes to stabilize gas prices. To the extent that gas for export is produced at zero or negative cost in association with unconventional oil, such gas can be seen as a consequence, rather than a detriment to increased U.S. energy security.

Additional volumes of U.S. LNG will be beneficial to the global gas market. While U.S. export volumes are unlikely to transform the existing fragmented structure of existing LNG trade, it will help to erode the basis of oil-linked contracts that have characterized it for decades, and to move the market toward global price convergence. In the short-term, the emergence of the United States as an exporter comes at a time of tightening global supply, meaning U.S. exports will provide much needed liquidity to natural gas consumers around the world, potentially improving the energy costs for consumers in LNG-dependent countries like Japan and India. While the economic benefits of this are clear, the progression towards a more global LNG market has substantial geopolitical implications as well. Although the U.S. government cannot directly influence the destination of each LNG cargo exported from the United States, U.S. foreign policy interests are served through a better-supplied global LNG market and through assistance to import-dependent strategic allies in Europe who will gain strategic leverage from the increased competition to Russian gas.

Beyond a simple cost-benefit analysis, there is a larger, more fundamental consideration that the U.S. government must consider when evaluating the merits of U.S. LNG exports. Policymakers should recognize that the non-exportation of U.S. LNG comes at the opportunity cost of forgoing the benefits of the free market. As a principal advocate and beneficiary of a global trading system characterized by the free flow of goods and capital, the United States has a long-term economic and political incentive to refrain from intervention in the market wherever possible. The economics of U.S. LNG exports—both the costs associated with producing, processing, and transporting LNG, and the competitive nature of the global market—are likely to impose market-determined boundaries on their viability. Irrespective of the status of permits, incremental additions to actual export capacity will be dependent on long-term financing and interest from contracting parties. Increases in domestic natural gas prices as a result of marginal increases in demand negatively impact the economics of additional export projects, thereby protecting domestic consumers from unlimited exports and price rises.

A proscription or limitation on LNG exports would constitute a de facto subsidy to domestic consumers at the expense of domestic producers. History suggests that government intervention in the allocation of rents can lead to inefficient outcomes and unintended consequences. To avoid these outcomes, the U.S. government should neither act to prohibit nor to promote LNG exports. In refraining from intervention in the gas market, the government will ensure that U.S. gas is allocated to its most efficient end uses, many of which will bring ancillary political and economic benefits to the United States and its partners and allies around the world.

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Exhibit C-5

Michael Levi, Counsel of Foreign Relations, "A Strategy for U.S. Natural Gas Exports," The Hamilton Project, Brookings Institution (June 2012)

DISCUSSION PAPER 2012-04 | JUNE 2012

THE HAMILTON PROJECT

A Strategy for U.S. Natural Gas Exports

Michael Levi

MISSION STATEMENT

The Hamilton Project seeks to advance America's promise of opportunity, prosperity, and growth.

We believe that today's increasingly competitive global economy demands public policy ideas commensurate with the challenges of the 21st Century. The Project's economic strategy reflects a judgment that long-term prosperity is best achieved by fostering economic growth and broad participation in that growth, by enhancing individual economic security, and by embracing a role for effective government in making needed public investments.

Our strategy calls for combining public investment, a secure social safety net, and fiscal discipline. In that framework, the Project puts forward innovative proposals from leading economic thinkers — based on credible evidence and experience, not ideology or doctrine — to introduce new and effective policy options into the national debate.

The Project is named after Alexander Hamilton, the nation's first Treasury Secretary, who laid the foundation for the modern American economy. Hamilton stood for sound fiscal policy, believed that broad-based opportunity for advancement would drive American economic growth, and recognized that "prudent aids and encouragements on the part of government" are necessary to enhance and guide market forces. The guiding principles of the Project remain consistent with these views.

THE HAMILTON PROJECT

THE HAMILTON PROJECT

A Strategy for U.S. Natural Gas Exports

Michael Levi
Council on Foreign Relations

JUNE 2012

NOTE: This discussion paper is a proposal from the author. As emphasized in The Hamilton Project's original strategy paper, the Project was designed in part to provide a forum for leading thinkers across the nation to put forward innovative and potentially important economic policy ideas that share the Project's broad goals of promoting economic growth, broad-based participation in growth, and economic security. The authors are invited to express their own ideas in discussion papers, whether or not the Project's staff or advisory council agrees with the specific proposals. This discussion paper is offered in that spirit.

BROOKINGS

Abstract

A surge in low-cost U.S. natural gas production has prompted a flurry of proposals to export liquefied natural gas (LNG). A string of permit applications are now pending at the Department of Energy (DOE), and more can be expected; lawmakers are also debating the wisdom of allowing LNG exports. This paper proposes a framework for assessing the merits of allowing LNG exports along six dimensions: macroeconomic (including output, jobs, and balance of trade), distributional, oil security, climate change, foreign and trade policy, and local environment. Evaluating the possibility of exports along all six dimensions, it finds that the likely benefits of allowing exports outweigh the costs of explicitly constraining them, provided that appropriate environmental protections are in place. It thus proposes that the DOE and the Federal Energy Regulatory Commission (FERC) approve applications to export natural gas. It also proposes steps that the United States should take to leverage potential exports in order to promote its broader trade and foreign policy agendas.

Table of Contents

Chapter 1: Introduction

U.S. natural gas production is booming. Five years ago, most experts assumed that U.S. natural gas output was in terminal decline; today, most believe the opposite. As recently as 2009, the U.S. Department of Energy was projecting indefinite dependence on imported natural gas along with rising prices for decades to come (EIA 2009a). By 2010, after breakthroughs in extracting natural gas from shale, conventional wisdom had flipped. Large-scale gas imports now seem unlikely, and abundant domestic supplies look like they will hold prices in check (EIA 2010a).

The market has signaled its endorsement of this development by hammering natural gas prices. U.S. benchmark natural gas dipped below $2 for a thousand cubic feet in early 2012, and as of mid-April 2012, delivery of the same amount in March 2015 could be assured for $4.43. Wellhead prices, meanwhile, fell to levels unseen since 1995.[1]

But the world looks different from overseas. In Europe, a thousand cubic feet of gas sold on the spot market for about $11 as of March 2012, and in East Asia, the price was north of $15 (Platts 2012). These prices are all the more striking since it costs roughly $4 to liquefy and ship a thousand cubic feet of natural gas from the United States to Europe, and only about $2 more to send it to Asia (Morse et al. 2012).

Yet the United States does not export natural gas to those markets. Many have thus argued that it is leaving money on the table. The potential profits from exports have prompted several companies to apply for permits to export liquefied natural gas (LNG) without restriction. In March 2011, the U.S. Department of Energy (DOE) approved the first such permit, for Cheniere Energy, and in April 2012, the Federal Energy Regulatory Committee (FERC) approved Cheniere's Sabine Pass, Louisiana facility. As of May 2012, another eight projects had applied to the DOE for similar permits, and four more had applied for permits to export LNG to countries with which the United States has free trade agreements (DOE 2012). The DOE has signaled that it will begin making decisions on these applications after receiving the results of a contractor study on the possible impacts of LNG exports in late summer 2012. The DOE can be expected to solicit input from several agencies, including the Departments of State and Commerce, the Environmental Protection Agency, and the Office of the U.S. Trade Representative, as well as from the National Economic Council, the National Security Council, and the Council on Environmental Quality in making its ultimate decisions.

Indeed, if currently anticipated price differences hold up, and fully free trade in natural gas is allowed, several developers will likely attempt to build LNG export terminals. A wide range of analysts have claimed that as many as six billion cubic feet of daily exports by the end of the decade is plausible. That trade could expand U.S. gas production substantially and, in principle, net U.S. producers, exporters, and their suppliers north of $10 billion a year.[2] Gas exports could help narrow the U.S. current account deficit, shake up geopolitics, and give the United States new leverage in trade negotiations. This has led many people to advocate for a U.S. policy that allows—or even encourages—natural gas exports.

But there is also great wariness in many quarters about the prospect of allowing exports of natural gas. Americans usually support exports, but natural gas, along with other energy commodities, has recently received special scrutiny. Some fear that allowing exports would dangerously drive up domestic natural gas prices while making the U.S. gas market more volatile. Others would prefer that domestic gas be directed toward boosting manufacturing at home, replacing coal-fired power plants, or taking the place of oil as the ultimate fuel for American cars and trucks. Still more oppose natural gas exports because those exports would result in greater U.S. natural gas production, potentially leading to social and environmental disruption. All of these parties oppose natural gas exports, or at least seek significant constraints. Some are driven by broad visions of the national interest to conclude that natural gas exports would have negative consequences that are not captured by simple economic logic. Others are motivated by more self-interested concerns, particularly the desire to secure cheap energy inputs for their industries.

There is also skepticism in some quarters over whether LNG exports, even if allowed, will ever get off the ground. Yet with a large docket of export applications pending, policymakers will have no choice but to step into this controversy. In this paper, I elaborate a framework for policymakers to use in deciding whether to allow LNG exports (a decision for regulators) or whether to take steps to constrain them (a decision for both regulators and lawmakers). This framework should focus on evaluating six questions:

1. What broad economic gains and losses might allowing LNG exports deliver?
2. How might exports affect energy bills for people of limited economic means?
3. Would LNG exports undermine U.S. energy security by preventing the United States from using more natural gas in its cars and trucks?
4. Would exports help or hurt the fight against climate change?
5. How would different U.S. decisions on exports affect U.S. foreign policy, including broad U.S. access to global markets in particular?
6. Would allowing exports lead to more U.S. natural gas production—and if production increases, what would the consequences be for the local environment?

This paper addresses these questions and argues that the benefits from allowing natural gas exports outweigh the commonly cited risks and costs, assuming that proper steps are taken to protect the environment.

The potential direct economic gains from LNG exports are significant but they are also smaller than many assume. Export terminal construction might employ as many as 8,000 people at different points over the next several years, but these jobs will be temporary. Expanding natural gas production in order to supply export markets could potentially support roughly 25,000 jobs in the natural gas industry, and perhaps 40,000 along the supply chain, but most of these positions would not materialize for at least five more years, and can thus be reasonably expected to be mostly offset by lower employment elsewhere. Profits from greater gas production and export activities could reach several billion dollars each year, while losses to other gas dependent industries would likely be at least an order of magnitude smaller. Indeed, the resurgent petrochemicals industry, which many have assumed would suffer from gas exports, would be more likely to benefit instead from modest export volumes.

Moreover, allowing LNG exports would have benefits for U.S. leverage in trade diplomacy, potentially delivering wider economic benefits. Conversely, placing curbs on U.S. LNG exports could undermine U.S. access to exports from other markets (including to Chinese rare earth metals, which are essential to many segments of the U.S. clean energy industry), and could potentially result in broader trade conflicts, leading to wider U.S. economic harm.

To be certain, changes in world gas markets could reduce opportunities for LNG exports, and thus any benefits from allowing them. But that would not change the fact that those benefits outweigh the costs of explicitly and directly constraining exports through government action.

What about the commonly claimed costs of *allowing* exports? This paper will show that integrating U.S. markets with global ones is as likely to tamp volatility as it is to increase it; that the gains to energy-intensive manufacturing from constraining natural gas exports would be much smaller than the economic opportunities that would be lost; that allowing natural gas exports would likely curb rather than increase global greenhouse-gas emissions; and that whether natural gas will be used to replace oil in U.S. cars and trucks depends little on whether exports are allowed. But the paper also offers warnings on two fronts. Natural gas exports would slightly raise U.S. natural gas prices, with disproportionate consequences for low-income consumers. (Increased tax revenues due to exports should be used to mitigate that effect insofar as possible.) Local environmental risks arising from natural gas production would also rise due to new production for exports. This can, in principle, be safely managed, but that is not inevitable; the prospect of exports should lead industry and regulators to redouble their efforts. This last factor is particularly important: as the controversy over the Keystone XL pipeline demonstrated, export-oriented resource extraction may be particularly vulnerable to local and environmental opposition; if allowing LNG exports were to lead to a backlash against natural gas production in general, the economic fallout could be vast. Conversely, if prudent regulation of natural gas extraction in the public interest raises natural gas prices and, as a result, makes some exports uneconomic, that should be accepted as a desirable outcome.

In light of this analysis, I propose that the United States allow LNG exports. In conjunction with this, the U.S. should take other steps to mitigate potential downsides and leverage these exports to its advantage.

The United States should approve applications to export LNG from the United States, several of which are currently pending, and more of which can be expected in the future. This does not mean that the U.S. government should encourage exports *per se*; it should simply allow them to occur if properly regulated markets steer the economy in that direction.

U.S. law distinguishes between LNG exports to countries with which the United States has relevant free trade agreements (FTAs), which are fast tracked for approval, and exports to other countries, which face more rigorous review and must be judged to be consistent with the U.S. national interest. Some have argued that this distinction should be abolished, since it interferes with free trade. The United States should maintain the distinction, which can give it leverage in trade negotiations without entailing any economic costs.

U.S. natural gas exports can also provide a platform for more effective U.S. foreign and trade policy. To that end, the United States should use foreign access to U.S. gas exports as leverage in trade negotiations, and actively seek to steer global gas trade toward greater transparency and market-based pricing.

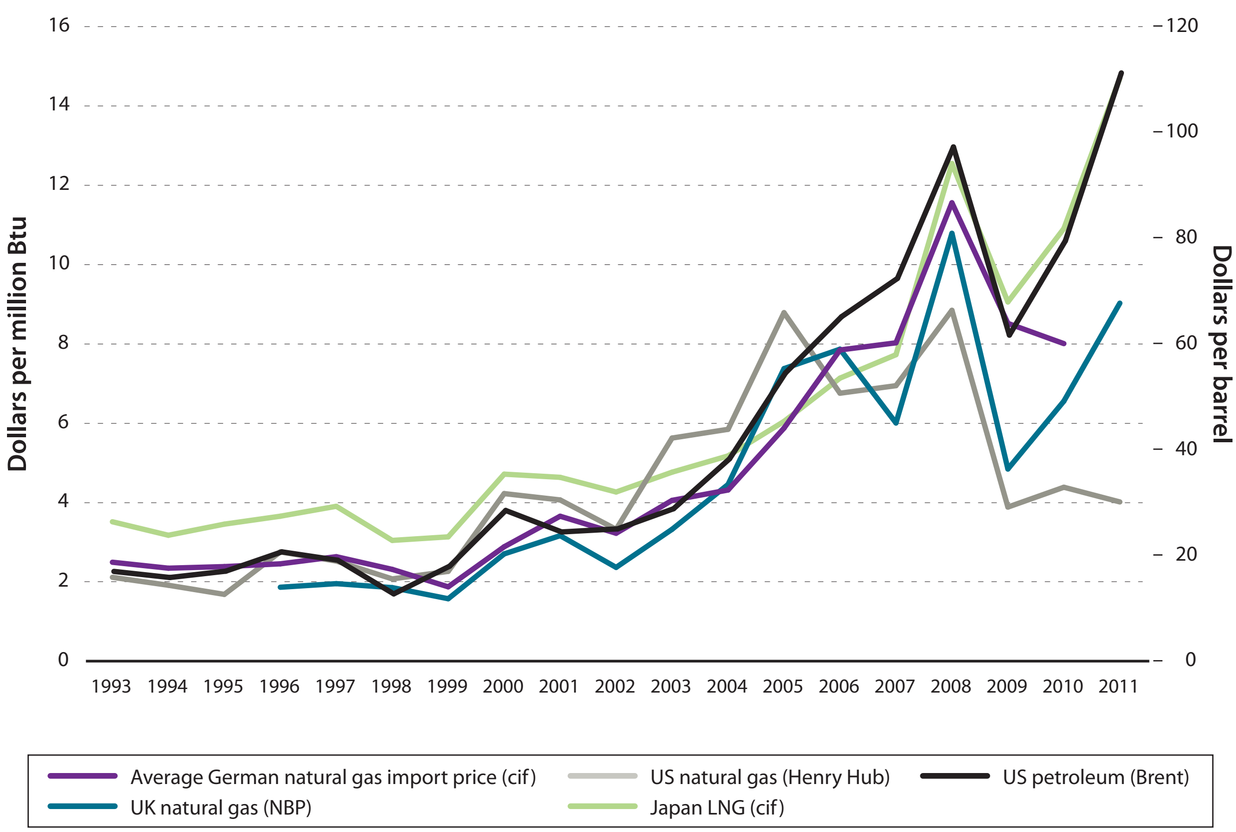
Chapter 2: Natural Gas Markets in the United States and Beyond

Any strategy toward U.S. LNG exports must be grounded in an understanding of the often odd workings of the world market for natural gas. (Readers who are familiar with natural gas markets, or who are willing to take on faith that global prices will continue to diverge, can skip to Chapter 3.) The market is dominated by state-owned or state-controlled firms in countries like Russia, Qatar, China, and Korea that make decisions regarding production and consumption based only in part on economics. Overland trade in natural gas is constrained by pipeline geography and capacity, which again gives governments a strong role in shaping outcomes. Seaborne trade in LNG requires large up-front capital investments—a fact that tends to encourage firms to enter long-term contracts that spread risk (Joskow 1987) but also add rigidity to markets. It also gives government-backed firms another edge due to their access to stable sources of long-term capital. Trade is largely regionalized, a result mainly of the high cost of shipping gas over long distances. Political concerns often motivate an opposition to transparency among major players, who seek to gain informational edges in bargaining, further steering global markets away from the economic ideal.

North America is an exception to this pattern. During the 1970s and 1980s, the U.S. market for natural gas was progressively deregulated. Robust pipeline networks, hub services, and futures markets developed. In 1994, the North American Free Trade Agreement (NAFTA) cemented a liberalized gas market across the continent.

FIGURE 1.

Select Prices of Natural Gas, LNG, and Brent Crude Oil, 1993–2011



Source: BP (2011); ENI (2012); EIA (2012f; 2012g); World Bank (2012).

Note: cif represents sum of cost, insurance and freight (average).

Yet despite extraordinary differences between U.S., European, and Asian gas markets, spot prices in all three have largely tracked each other for twenty years—and all three have also tracked the price of oil (Figure 1). While Figure 1 primarily shows spot prices, most natural gas trade in Europe and Asia does not occur on spot markets. Economists generally believe, however, that spot and contract prices cannot diverge much over the medium and long run, since those bound by contracts will insist on renegotiating. This intuition is reinforced by comparing U.K. spot prices and German import prices (which are dominated by contracts) in Figure 1.

The historical relationships between the three markets, however, appear to have broken down around 2009. U.S. natural gas output is on the rise as a result of breakthroughs in shale gas production. Total U.S. natural gas production rose from 23.5 trillion cubic feet in 2006 to 28.6 trillion cubic feet in 2011, equivalent to 78 billion cubic feet each day (EIA 2012b). This flood of production has depressed natural gas prices in the United States. Yet, since exports from the United States to Europe and Asia are generally not allowed, overseas prices have not followed.

It is this difference in prices that has sparked interest in U.S. LNG exports: before prices in the three markets blew wide apart, there was no economic incentive for anyone to build an LNG export facility in the United States. If a situation resembling the historical relationship returns, opportunities for exports will vanish.

Economists expect prices for commodities in a competitive environment to converge with the marginal cost of supplying them over the medium term. For natural gas this could mean ample low-priced competition from traditional suppliers within a few years, making U.S. LNG exports uneconomic. Several Middle Eastern producers have marginal costs of production close to zero (excluding shipping), either because natural gas is easy to extract or because it is a byproduct of oil production. Russian and Caspian gas generally costs more than Middle Eastern gas to produce, but, given sufficient pipeline infrastructure, delivering it could be much cheaper than shipping LNG.

Yet there is good reason to believe that prices will not converge any time soon. Global natural gas production is highly concentrated, and strategic producers, including Qatar and Russia, appear to restrain production for export; they would rather sell less gas at higher prices than more gas at lower ones. This restraint is not necessarily explicit: by simply insisting on linking gas prices to oil prices, they implicitly constrain supply by throttling demand. In addition, directing marginal production to subsidized domestic markets can keep export prices high.

Insofar as global natural gas supply and transport are constrained in part by noneconomic factors, prices will be determined by competition in consuming countries between natural gas and substitutes.[3] Prices should settle at levels that make gas competitive at the margin with other fuels and technologies than can be used instead. Consumers will not buy natural gas if producers raise prices so high that they would be better off using other fuels or technologies instead; if, however, natural gas is a better deal than the next best option, consumers will buy it.

This framework allows us to better assess whether prices in the three major regional gas markets might converge, and, hence, what the environment for potential U.S. exports might be. Indeed there are several possible ways (not mutually exclusive) for prices in the three big natural gas markets to return to similar levels. Examining them, however, reinforces the real possibility that prices will continue to diverge for the indefinite future.

The first way that prices could converge is through U.S. LNG exports, which could ultimately bring the various prices together, net of transport costs (including an indeterminate risk premium paid to investors in risky LNG projects). Indeed initial natural gas exports themselves will tend to shrink opportunities for subsequent exports. A recent DOE study projects that with moderate U.S. gas resources and twelve billion cubic feet a day of exports, U.S. benchmark prices would rise to more than $8 per thousand cubic feet by the middle of the next decade (EIA 2012c). When combined with the cost of moving natural gas from the United States to overseas markets, there is a strong chance that some exports would be unprofitable at that price. The same analysis found that if U.S. resources were lower than anticipated, prices could reach $14 per thousand cubic feet by 2020, making exports undoubtedly uneconomic at the margin. All that said, assuming U.S. LNG exports at the outset of this analysis would make no sense, since their very existence depends on the particular export policy that is adopted.

The second way that prices could converge is through a return of the historically tight link between oil and natural gas prices in the U.S. market. Until recently, high oil prices drove many U.S. manufacturers to substitute natural gas for distillate or residual fuel oil in their operations, while high natural gas prices did the reverse. As a result, natural gas prices followed oil prices up and down. The same thing occurred in Europe and Asia. Since oil prices were the same in all three markets, natural gas prices converged, too.

Today, though, there is very little switchable capacity left in U.S. industry: as of 2006, U.S. manufacturers only had enough switchable oil-based capacity to accommodate an additional

200 million cubic feet of daily natural gas consumption, a figure that has probably fallen since (EIA 2010b; author's calculations). Even if all nonswitchable capacity that currently uses fuel oil were retired and replaced with gas-based facilities (which would require sustained natural gas prices far below oil prices to offset the costs of new equipment), this would absorb less than one billion cubic feet of daily natural gas demand, around one percent of total U.S. production.

Natural gas and oil prices could also become re-linked in the United States through the robust use of natural gas in transportation. This could be more significant: displacing the equivalent of 150,000 barrels a day of refined petroleum products each year (about one percent of U.S. consumption and thus a reasonable prospect within a decade) could absorb the equivalent of about one billion cubic feet of incremental daily natural gas production.[4] But the link would be different from before: because the equipment needed to utilize natural gas to power cars and trucks is more costly than the equipment needed for oil, a big difference between oil and natural gas prices—as much as $6-7 per thousand cubic feet—would remain.[5]

The third way for natural gas prices in the three major international markets to converge is for them to all become linked to some new index other than oil. The most likely common anchor point is coal prices. Rising natural gas production is largely being directed toward displacing coal-fired power generation in the United States, and there is still enormous room for that to expand. Europe also uses limited amounts of oil in industry (IEA 2011), so natural gas may end up competing directly with coal there, too, so long as European climate policy or energy security policy do not squeeze both out simultaneously (a nontrivial possibility). Such a situation would tend to drive U.S. and European natural gas prices to similar levels. Because Europe and Asia share large swing LNG suppliers (most notably Qatar), Asian prices could follow.

The biggest barrier to developments along these lines may be institutional. Natural gas is currently sold to European and Asian customers on contracts that are largely tied to spot oil prices, with at most a small part of price tied to spot natural gas prices. This is in large part because no highly liquid spot markets for natural gas exist in either region. (Spot markets for oil, in contrast, are highly liquid and transparent.) Part of this, especially in Europe, is due to constraints in transnational pipeline networks that segment the market, which in turn are a result of European politics. Another part of it, in both regions, stems from the insistence of big suppliers on so-called "destination requirements," which prohibit buyers from reselling contracted cargoes on the spot market. The concentrated nature of the European and Asian natural gas markets has further enhanced the stability of such arrangements. Finally, there is a chicken-and-egg problem in expanding spot markets: the early movers put themselves at the mercy of idiosyncratic price movements and potential market manipulation, both of which are far less likely to occur once spot markets have eventually grown. The entire scheme has been sustainable in large part because oil-indexed natural gas prices have largely tracked spot market natural gas prices. But, if the two diverge for a sustained period, the pressure to abandon oil indexation could become large.

No sober analyst should confidently claim to be able to perfectly predict the future of global natural gas markets. The best one can say is that prices in the three regional markets could continue to diverge for the indefinite future, but that new developments could lead them to converge even absent U.S. exports. The lesson for those crafting policy toward U.S. LNG exports is that any strategy should be robust to the different possible courses.

Chapter 3: The Problem and Potential of LNG Exports

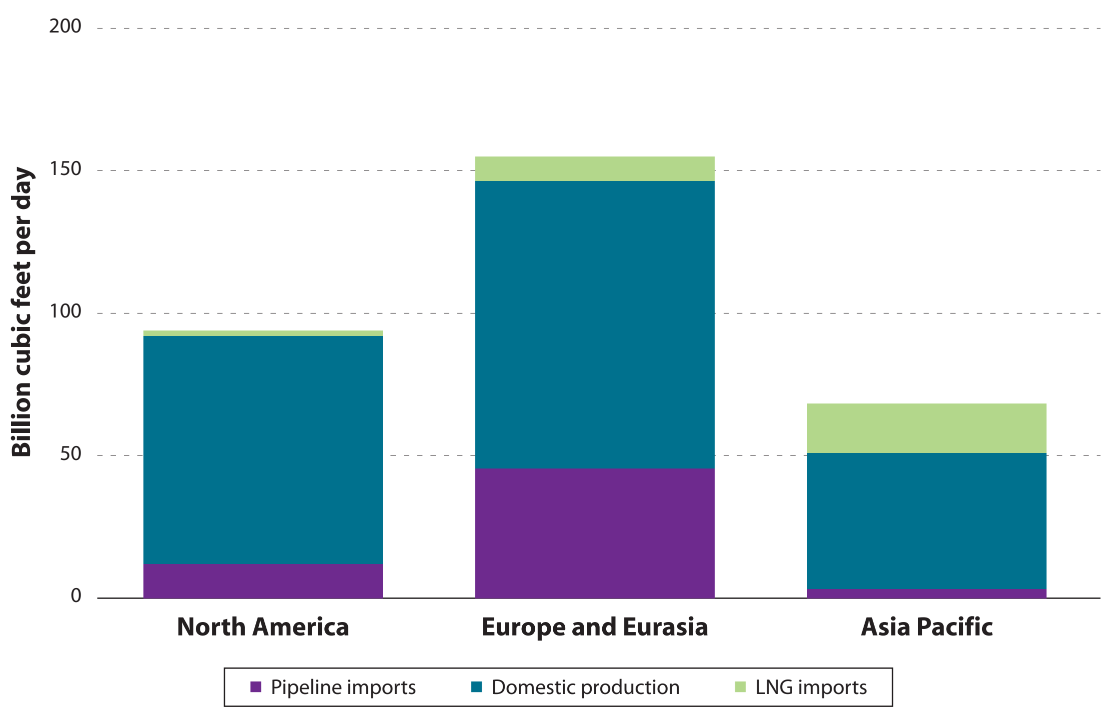
There is a real possibility that prices in the United States, Europe, and Asia will continue to diverge, creating opportunities for U.S. LNG exports. Yet exporting natural gas overseas is not a straightforward endeavor. Gas must be liquefied before it can be transported in specially built ships and then regasified at its destination. Building liquefaction facilities in particular can cost as much as $4 billion for each billion cubic feet of daily export capacity—several times the cost of building an import terminal of similar scale (Ratner et al. 2011). Investment on this scale can be risky: if natural gas price spreads collapse, multibillion-dollar investments can quickly become worthless. Adding to the dangers involved in building any terminal is regulatory risk associated with safety and security concerns.

Anticipating demand for LNG imports prior to the shale gas boom, several companies began to develop LNG import terminals. With the change in market conditions, most have applied for and received permits from the DOE to export LNG to countries with which the United States has applicable Free Trade Agreements (FTAs). These permits are essentially automatic.[6] The approved facilities, once fully built, could process 10.9 billion cubic feet of exports each day, and, as of May 2012, applications for another 2.8 billion cubic feet of daily exports were pending (DOE 2012).

However, no major LNG importer other than South Korea has an applicable FTA with the United States (Ratner et al. 2011). Would-be exporters have thus sought approval to export

FIGURE 2.

Regional Natural Gas Consumption by Type, 2010



Source: BP (2011).

Note: Natural gas consumption by region as of 2010. Figures for pipeline and LNG volumes include intraregional trade.

without restriction. Cheniere Energy's Sabine Pass Facility has received DOE and Federal Energy Regulatory Commission (FERC) approval for 2.2 billion cubic feet of daily LNG exports to non-FTA countries, and applications totaling another 10.3 billion cubic feet per day are under review. These combined applications involve total volumes similar to current U.S. LNG *import* capacity (Guegel 2010). Exports from the first facilities would start no earlier than 2015.

It is far from clear that all or even most of this export volume would be used even if it were approved. A recent MIT study looked at nine scenarios for U.S. and world natural gas markets; none of them led to the emergence of significant U.S. natural gas exports, in large part because other lower cost producers undercut prices offered by the United States in distant markets (MIT 2011). Other forces, discussed in Chapter 2, could also lead global natural gas prices to converge even without U.S. exports, removing opportunities for economically attractive U.S. LNG sales.

Indeed, most analysts anticipate that less LNG will be exported than currently pending permits would allow, even if all of those were approved. (They also expect to see more permit applications, since the plans behind many of the pending ones are expected to eventually fizzle.) For example, Citigroup analysts foresee up to 5 billion cubic feet a day of LNG exports by the end of the decade, barring regulatory barriers (Morse et al. 2012). UK gas producer BG has projected up to six billion cubic feet a day by then (Gismatullin 2012), the same volume that Deloitte (2011) analysts have focused their modeling on. Given this consistent view among market analysts on the maximum likely volume of LNG exports from the United States, the main analysis in this paper focuses on the possibility of up to six billion cubic feet of daily exports. This is approximately half the capacity currently awaiting approval and almost ten percent of current U.S. natural gas production. I consider the possibility of significantly greater or lesser exports in Chapter 6; the qualitative conclusions do not change, though the specific costs and benefits of allowing LNG exports do. To provide some context, Figure 2 shows natural gas consumption and LNG trade by region.

Chapter 4: Costs and Benefits of LNG Exports

Having been presented with a large docket of applications to ship LNG abroad, U.S. policy-makers are now faced with a simple question: should they approve large-scale exports of U.S. natural gas? Theory says yes: liberalized trade is desirable, since it delivers economic gains to all parties. Real-world complications, though, make the answer less straightforward.

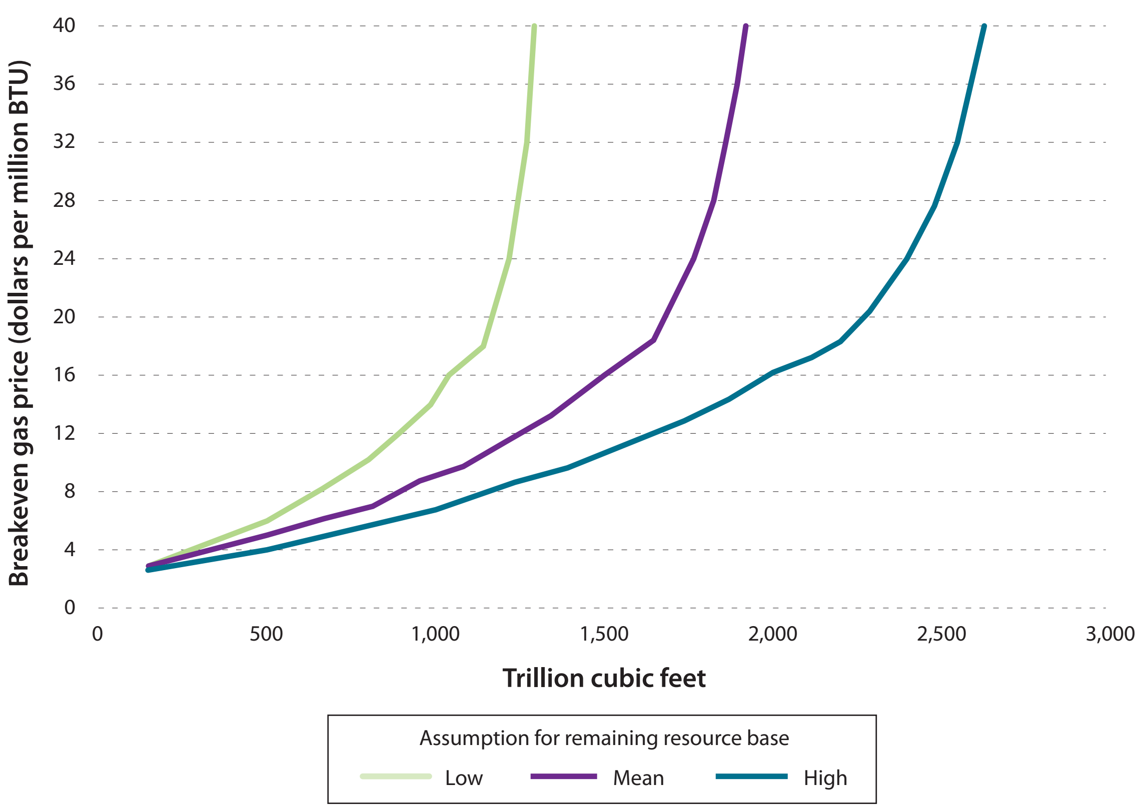
In this chapter, I put forward a framework for thinking about whether or not to approve U.S. LNG exports, centered around six questions:

1. What macroeconomic consequences would natural gas exports have?
2. What would the distributional impacts of natural gas exports be?
3. Would natural gas exports undermine U.S. oil security?
4. What impact would natural gas exports have on climate change?
5. What foreign policy consequences might natural gas exports entail?
6. What would the local environmental consequences of gas exports be?

The case for approving exports is strong only if the macroeconomic, climate, and foreign-policy benefits outweigh those distributional, oil security, and environmental downsides that cannot be effectively mitigated.

FIGURE 3.

Possible Shapes for the U.S. Natural Gas Supply Curve



Source: MIT (2011). Reprinted with permission of the MIT Energy Initiative.

ASSUMPTIONS AND LIKELY CONTRACT STRUCTURES

Allowing natural gas exports has the potential to help the U.S. economy by increasing U.S. economic output and, most likely, by narrowing the U.S. current account deficit, if actual exports occur. Yet the expected impact would be relatively small in the context of the overall U.S. economy. Exports would produce short-term employment gains but would have minimal impact on long-term employment.

To estimate the gains from trade in natural gas, one needs to estimate the long-run impacts of exports on U.S. natural gas prices. An increment of approximately 10 to 20 cents per thousand cubic feet for every billion cubic feet a day of exports is consistent with most published projections for the impact of gas exports (Pickering 2010; EIA 2012c). These projections reflect a broad range of possible shapes for the natural gas supply curve that are consistent with evidence from drilling done to date and current understanding of shale gas deposits. Deloitte (2011) is an outlier in projecting substantially smaller price impacts; I consider that possibility in detail in Chapter 6. Figure 3 shows several possibilities for the long-run U.S. supply curve.

One also needs to know how natural gas exports would affect domestic natural gas production and consumption. The Energy Information Administration (EIA) has projected that U.S. natural gas exports would draw roughly 20 percent from existing natural gas production and 80 percent from new production incentivized by access to export markets (EIA 2012c). The 20 percent drawn from existing production would come at the expense of power and industrial consumption in roughly equal amounts. These estimates are mostly insensitive to detailed assumptions about natural gas availability; they depend mainly on cost assumptions for well-understood applications of natural gas, including in power generation and industry. In any case, as I show below, they do not affect the net cost-benefit analysis here.

Estimating the specific economic benefits to the United States of natural gas exports also requires some assumptions about the prices that those exports will fetch. The prices at which natural gas currently sells in Europe and Asia provide a crude upper bound, but there are three large complications with assuming these prices. Overseas prices could fall substantially if the oil-linked pricing schemes currently used were substantially abandoned or modified; this would squeeze U.S. gains. Rising U.S. exports should also put downward pressure on overseas natural gas prices, eroding the potential gains from trade as exports expand. Perhaps most importantly, even if overseas natural gas prices were to hold up, the division of the surplus (the difference between prevailing U.S. and overseas prices) between the United States and gas-importing countries will depend on the arrangements that are used to price any exported natural gas.

Contracts concluded by Cheniere Energy, the only company that had received a permit to export LNG to non-FTA countries as of May 2012, provide some insight into how that pie might be divided. These contracts price exported natural gas at 115 percent of the Henry Hub spot price (the main U.S. benchmark), in addition to a fixed liquefaction fee of $2.25-$3/MMBtu; the 15 percent markup reflects the cost of natural gas used to fuel the liquefaction facility (SEC 2012; ICIS Heren 2012). (This price is "free on board" i.e. exclusive of shipping and regasification costs.) This pricing arrangement appears attractive to Cheniere because the arrangement keeps Cheniere's exposure to unexpected changes in U.S. or overseas natural gas prices minimal, which allows the company to secure financing. Its main source of risk is the credibility of its counterparties, something that it has likely insured (at least partially) against.

Most other sellers outside the United States have chosen to price their LNG differently. The Asian market, which may hold the greatest prospects for U.S. exporters, is particularly instructive. Asian LNG prices are tied to the price of oil, a pattern that prevails not only for traditional state-controlled suppliers, but for market-based producers, too. In particular, Australian companies, rather than rejecting the use of oil-linked prices, have followed it. So long as Australian production costs stay below Asian sales prices (net of transport costs), this approach will remain attractive there.

But there is good reason to expect that most U.S. exporters will follow a path similar to the one beaten by Cheniere. Would-be U.S. exporters who contract at Asian prices would be taking at least five risks: one tied to uncertainty over U.S. natural gas prices, another tied to uncertainty over overseas prices, a third associated with the unpredictable cost of LNG transport, a fourth tied to counterparty risk, and a fifth related to U.S. regulatory risk. Most companies that want to succeed prefer to take as few risks (ideally one) at a time as possible, and those considering extending financing to these companies tend to prefer that they minimize the number of sources of risk, too. All of this weighs in favor of U.S. exporters selling their natural gas at U.S. prices plus some fixed markup (including a charge for liquefaction services), thus eliminating most but not all sources of risk that they face.

Why expect different outcomes in the United States and Australia? Australia is a relatively small country in a large LNG market, which makes it safer for its customers to take prices from the broader market rather than to be exposed to potentially quirky domestic Australian prices. The U.S. situation is the opposite. Australian LNG business also tends to be vertically integrated, with natural gas producers participating in exports, too. Pricing exports off of foreign markets, rather than domestic ones, diversifies their exposure to changing prices. The U.S. market, in contrast, is currently far more vertically segmented, largely by an accident of history: U.S. LNG terminal owners originally planned to import gas, not export it, and hence had no reason to link up with U.S. gas producers. If more U.S. gas producers began to take ownership stakes in export terminal operators, one might see a partial move to different pricing structures evolve, for similar reasons to those that have driven Australian decisions. But this does not seem to be occurring yet on a significant scale.

Most of my calculations will thus assume a similar pricing approach to that adopted by Cheniere. Cheniere (2011) marketing materials estimate a fixed liquefaction cost of $1.75 per thousand cubic feet; I thus assume a markup of $1 per thousand cubic feet to reconcile this estimate with contracts that have been signed so far. (Other assumptions about the likely markup are also possible, though a zero markup beyond liquefaction costs, including profit, would probably not make business sense.) I will also examine what would happen if a substantial fraction of U.S. exporters ultimately contracted at overseas prices instead of U.S. prices.

I also assume a U.S. natural gas price of $5 per thousand cubic feet, exclusive of the domestic price impact of any exports. This is consistent with a wide range of opinions on where U.S. natural gas prices will likely settle: it is widely believed that a large part of the U.S. natural gas resource base is profitable to produce around this price.

MACROECONOMIC CONSEQUENCES

Gains from trade

Current U.S. gas prices are determined by U.S. supply and demand. If exports from the United States are allowed, the U.S. price will rise and the United States will produce more gas. The gains from trade are then the extra money earned by U.S. producers on what they would have sold anyway, minus the extra amount that U.S. consumers pay and what they lose from consuming less (for example, because they produce less steel), plus the net economic gain from the new production.

Consider first one billion cubic feet of daily LNG trade. Roughly 200 million cubic feet of natural gas will shift from the domestic market to exports. Producers will make $80 million to $90 million off these sales.[7] At the same time, higher prices will spur lower domestic natural gas consumption in power generation and industry, which will offset that amount by approximately $4 million to $7 million. Roughly 800 million cubic feet a day of new production will also find its way to export markets, delivering an additional surplus of approximately $300 million to $320 million. The net annual value to the U.S. economy of allowing a billion cubic feet a day of natural gas exports would thus be approximately $380 to $400 million. (The ranges in these estimates are due primarily to the fact that the impact of exports on domestic prices is uncertain.)

For a full six billion cubic feet a day of exports, using the same approach and assumptions as above, the estimated surplus for the U.S. economy would be $2.7 billion to $3.2 billion each year. The gains from selling gas overseas rather than at home would be approximately $700 million to $1 billion; the gains from new gas production would be roughly $2.3 billion to $2.8 billion; and the losses from lower domestic consumption would be approximately $300 million to $500 million. The precise numbers here depend on the sources of exported gas (displaced consumption or increased production), but the fact that the net economic impact is positive does not.

Additional gains would be realized because natural gas exports would exploit existing LNG infrastructure (i.e. some parts of existing import terminals) that would otherwise go unused and thus be worthless. These gains should approximately equal the value of the utilized LNG terminals (not including the value of their regasification facilities, which are not useful for exports), which are typically on the order of $1 billion for each billion cubic feet a day of capacity. Spread over a notional fifteen-year use period, this would add approximately $70 million a year for each billion cubic feet a day of exports. This brings the total estimated surplus from six billion cubic feet a day of exports to $3.1 billion to $3.7 billion.

How confident can we be in these figures? The largest remaining uncertainty is the price that U.S. producers fetch for their output. If U.S. gas were sold at domestic prices plus the cost of liquefaction services with no markup beyond normal profits (an extreme unlikely to be realized intentionally in practice, but a possibility if exporters underestimate their costs and thus misprice their services in long-term contracts), gains from trade would be far lower. Still, they would be positive.

On the other extreme, U.S. producers might fetch much higher prices. Imagine that half of U.S. LNG exports were sold on contracts tied to overseas prices rather than to the U.S. spot market, and assume that those overseas prices averaged $12 per thousand cubic feet over the long term, near the current European forward price. Assume further, as assumed earlier, that liquefaction, transport, and regasification collectively cost $5 for a thousand cubic feet of gas. Then the net surplus from six billion cubic feet a day of LNG exports would be approximately $3.9 billion to $4.1 billion, which is similar to the figure calculated above. (The two figures are similar because as U.S. exports expand, domestic prices rise, and margins in contracts that are based on overseas prices thus erode.) That surplus would increase by $1.1 billion for every one-dollar increase in the overseas natural gas price.

Current account balance

The impact of LNG exports on the U.S. current account balance depends again on how gas exports are priced. Superficially, using the same assumptions as above, six billion cubic feet a day of exports would yield export revenues of about $20 billion. This is equal to about 5 percent of the 2010 and 2011 current account deficits (BEA 2012). The actual impact of exports on the current account balance would be smaller (perhaps much smaller), since without changes in individual behavior, increased U.S. output would lead to increased U.S. consumption, part of which would be consumption of imports. Moreover, increased gas exports would reduce exports of other goods by raising the cost of producing gas-intensive products, and by diverting people and (to a lesser extent) capital from other productive activities.

Employment impacts

Building new LNG export facilities would create a substantial number of temporary construction jobs. Cheniere estimates that its 2.2 billion cubic feet per day facility will take roughly two years to build and support roughly 3,000 jobs at its peak (Oil & Gas Monitor). Scaling this up suggests that allowing LNG exports could lead to as many as 8,000 temporary construction jobs if enough capacity for six billion cubic feet of daily exports was developed in the next several years.

There is no reason to believe, however, that increased LNG exports would have a significant long-term impact on broader U.S. employment levels, which are determined by more fundamental factors. Still, one can crudely estimate the impact that LNG exports would have on industries that would be directly affected.

I estimate that expanded natural gas production due to a six-billion-cubic-foot-per-day increase in exports would support approximately 25,000 jobs in the natural gas industry, along with approximately 40,000 jobs along the supply chain, in areas like steel, rig manufacturing, and elsewhere.[8] At the same time, employment in energy-intensive manufacturing would contract. This impact is much more difficult to quantify, since a much more elaborate model is required to know the scale of output losses in those sectors. Still, I can put a loose upper bound on the potential impact. Aldy and Pizer (2009) estimate (in the context of studying carbon pricing) that an 8 percent increase in the price of electricity would cause a 0.2 percent decrease in overall manufacturing sector employment. The U.S. EIA (2012c) projects an ultimate increase of 1 percent to 2 percent in commercial electricity prices (and a transient increase of 2 percent to 4 percent in the early 2020s) from six billion cubic feet of daily LNG exports, which translates to a 0.025 percent to 0.050 percent decline in manufacturing employment. Total U.S. manufacturing employment in 2010 was approximately eleven million people (BEA 2011). These figures collectively suggest that higher natural gas prices due to exports could reduce manufacturing employment by between 3,000 and 6,000 jobs, primarily in energy intensive sectors like steel and cement. Impacts in these sectors would be partly offset by increased demand for their products by the natural gas industry—about one-fifth of shale gas capital expenditures, for example, go to purchasing steel, while about one-tenth are used to buy cement (IHS 2011).

These estimates should all be taken with a large grain of salt: the markets involved are complex and difficult to predict. The bottom line, though, is robust: job gains in directly affected markets are highly likely to be greater than job losses in markets hurt by higher natural gas prices.

...the total estimated surplus from six billion cubic feet a day of exports [is] $3.1 billion to $3.7 billion.

Natural gas exports would also affect employment through the price level and its impact on monetary policy. Allowing LNG exports would raise prices for natural gas and products produced with it, but would lower prices for imports by strengthening the dollar. The net impact is unclear, but since the impacts of exports on consumer prices and on the trade balance are both minimal, both effects would be very small.

Price volatility

These analyses of economic impacts have at least one important limitation. In principle, producers and consumers both anticipate volatility in natural gas supply and prices, and adjust their behavior accordingly. In practice, producers and consumers both tend to imperfectly anticipate volatility, exposing themselves and the broader economy to greater risk of harm. To the extent that allowing exports would increase volatility in domestic gas prices, the economic gains from increasing exports would be reduced.

This is not a significant risk for the foreseeable future. In order for volatility beyond North America to affect U.S. natural gas prices, there has to be a possibility that U.S. gas exports will change quickly as a result of shifts in international conditions. As long as potential U.S. exports are fully subscribed (i.e. form part of base-load U.S. demand), though, no such possibility exists. This will continue to be the case so long as natural gas prices in export markets exceed the sum of U.S. natural gas prices and transport costs (including liquefaction and regasification). Given current trends in international natural gas prices, this condition is likely to be comfortably satisfied for at least the next decade—though, as discussed in Chapter 6, it is not guaranteed.

This insulated state may eventually go away. Indeed one of the motivations behind interest in natural gas exports is the possibility of creating a more coherent global gas market in which prices in different markets partly converge. Such a market would be one in which U.S. prices become linked to global ones. Yet such a market would also bring a countervailing upside to the United States: the same arbitrage opportunities that could transmit international volatility into the U.S. market would also help absorb domestic supply and demand shocks. In the face of a sudden increase in domestic demand or decline in domestic supply, the United States could reduce exports, helping balance the market while limiting price hikes. The former might happen, for example, if a nuclear accident prompted a sudden increase in gas-fired generation, while the latter might result from extreme weather in gas drilling areas.

It is essentially impossible to predict whether full linkage between the U.S. and international markets would increase or decrease volatility in U.S. prices, particularly since such a development is likely to be at least a decade away. It thus makes little sense to alter near-term U.S. decisions regarding LNG exports based on volatility concerns.

> Exported natural gas is also likely to displace coal. Indeed, since allowing natural gas exports appears to primarily increase the volume of gas produced, rather than displace gas previously destined for domestic consumption, allowing natural gas exports could ultimately reduce global emissions.

DISTRIBUTIONAL CONSEQUENCES

Allowing natural gas exports could have small but regressive distributional consequences. As of 2005, households with less than $20,000 a year in income consumed an average of 8,700 kWh of electricity and 33,000 cubic feet of natural gas each year (EIA 2005a). A one-dollar rise in natural gas prices, near the upper end of likely impacts from the scenarios explored here, would cost each such household an average of $33 each year in natural gas costs. A corresponding 0.2-cent rise in electricity rates would cost such households another $17, for a total of $50 each year. The average household with income in excess of $100,000, in contrast, would see its natural gas bill rise by $59, and its electricity bill would rise by $31, for a total of $90, a far smaller share of its income. The gains from trade, in contrast, would accrue mostly to shareholders and to landowners in gas-rich regions, which would fail to even the balance sheet for most lower- and middle-class consumers. The impacts on both sets of consumers would of course rise (or fall) if natural gas exports had greater (or lower) impacts on domestic natural gas prices.

These consequences, in principle, should be addressed along with other inequalities through broad-based policies (such as adjustments to the tax code) that focus on ameliorating undesirable inequality regardless of its source. In practice, though, the U.S. political system has been averse to such policies in recent years. Earmarking slightly more than half of federal revenues from higher federal corporate tax collections due to exports (estimated in Chapter 6) could make consumers with household incomes under $40,000 whole (EIA 2005b).

A final notional option might be to levy a tax on natural gas exports and use that to assist low-income energy consumers. This would, however, be contrary to the U.S. Constitution, which asserts that "No Tax or Duty shall be laid on Articles exported from any State" (U.S. Constitution). The U.S. Supreme Court has reaffirmed this as recently as 1998 (*U.S. v. U.S. Shoe Corp*).

OIL SECURITY

The analysis of net economic benefits presented above ignores the potential positive externalities from substituting natural gas for oil in the transport sector, a development that might in principle be undermined by allowing natural gas exports.

Every time natural gas is used to back out a barrel of oil, the market price of crude falls, and the price paid by all U.S. consumers for oil imports drops as a result. The precise magnitude of this effect is a subject of considerable debate, but recent U.S. regulatory impact assessments have used a value of $12.91 for each barrel of oil displaced, or 31 cents for each gallon of gasoline, with a range of $4.67 to $23.40/bbl (NHTSA 2011, 647). In principle, then, it might make sense to reorient gas volumes destined for export to the domestic transport market.

Each thousand cubic feet of natural gas converted to gasoline or diesel and used in U.S. cars and trucks would deliver a positive externality of about $1.30.[9] This is less than the gain from selling the same natural gas overseas, even with conservative assumptions about pricing.

The same thousand cubic feet of natural gas used in compressed natural gas (CNG) vehicles would produce an external benefit of about $1.90 due to lower oil prices (CNG is a more energy efficient technology than gas-to-liquids), along with an estimated benefit of $1.10 due to reduced exposure to oil price volatility (NHTSA 2011, 647), for a total external benefit of about $3, though this would be offset in part if public spending were needed to establish CNG fueling infrastructure.[10] (This benefit of reduced exposure to volatile oil prices is not included in the previous estimate since the price of liquid fuels produced from natural gas will fluctuate with the price of oil.) This brings the benefits of directing natural gas into the transport sector closer into line with the benefits of allowing natural gas to be exported. The gains from allowing exports, though, are still likely to be larger than those of using the gas in cars and trucks.[11]

Some will likely observe that substituting natural gas for oil has the added benefit of reducing income for major oil exporters, many of whom are hostile to the United States. That is true, but displacing others' natural gas exports would do the same. Indeed many major oil exporters, like Iran and Russia, are also major natural gas exporters. That fact makes substitution of natural gas for oil an ineffective way to starve oil-exporting regimes of revenues.

In any case, barring exports would probably not push significant volumes of natural gas into the transport sector; instead, it would simply keep them in the ground. The main forces currently affecting decisions to invest in infrastructure to move natural gas into the transport sector are oil-price uncertainty, the risk associated with the large up-front capital investments required, and lack of policy promoting adoption of natural gas vehicles. For context, a one-dollar change in the price of natural gas—roughly what might eventually be expected from large-scale LNG exports—would be offset by a $7 to $10 dollar drop in oil prices. Actual uncertainty about future oil prices is much greater than that.

CLIMATE CHANGE

Natural gas is a mixed blessing for climate change. By displacing coal, it reduces greenhouse-gas emissions, but by undercutting renewable and nuclear energy and lowering energy prices, it increases greenhouse-gas emissions. It is generally agreed, though, that the main consequence of abundant gas in the U.S. energy system is displacement of coal.

A simple estimate indicates the likely scale of the impact of natural gas exports on U.S. emissions. I observed earlier that roughly 20 percent of U.S. LNG exports would be drawn from natural gas that would otherwise be used in the United States. If, for example, that exported gas was replaced 80 percent by coal and 20 percent by zero-carbon fuels and reduced energy consumption, and emissions for coal were double those for gas, the result would be approximately 2 million tons of additional U.S. greenhouse-gas emissions for each billion cubic feet of daily exports.[12] This is broadly consistent with estimates produced by complex models (EIA 2012c).

Natural gas, though, has the same climate consequences whether it is burned in the United States, Europe, or Asia. Exported natural gas is also likely to displace coal. Indeed, since allowing natural gas exports appears to primarily increase the volume of gas produced, rather than displace gas previously destined for domestic consumption, allowing natural gas exports could ultimately reduce global emissions. I estimate this impact as, at most, approximately 15 million tons of reduced global emissions for each billion cubic feet of daily natural gas exports. For six billion cubic feet a day of exports and a value for damages from emissions of a modest $21 per ton of carbon dioxide—the figure used in U.S. regulatory impact assessments (Greenstone, Kopits, and Wolverton 2011)—the avoided climate damages would be $2 billion annually. Global greenhouse-gas emissions from energy use would be reduced by 0.3 percent relative to 2008 levels. On the other hand, if exported natural gas displaced as much renewable energy and energy conservation as it did coal, the impact on non-U.S. emissions would be neutral.

Climate policy also has an important international political dimension. Global climate diplomacy tends to focus on what happens within individual countries' borders. If a U.S. decision to allow natural gas exports reduced global emissions but raised U.S. emissions—indeed the most likely outcome—the United States could, in principle, suffer diplomatically. But this is highly unlikely in practice. The export volumes examined here would raise U.S. emissions by at most approximately 0.3 percent, a trivial difference in the context of climate diplomacy, which tends to focus on changes on the order of 10 percent or more of national emissions.

FOREIGN AND TRADE POLICY

The surge in U.S. shale gas production has already had major consequences for geopolitics. There was a widespread expectation, only a few years ago, that the United States would become a major natural gas importer. Potential suppliers, most prominently Qatar, began to develop LNG export infrastructure in anticipation of serving the U.S. market. The U.S. shale boom, however, has quickly eliminated the prospect of significant U.S. demand for imported LNG (UPI 2011). (Some residual demand remains for logistical reasons.) With would-be suppliers to the United States looking for new markets, consumers have gained greater bargaining power. A leading indicator of this growing bargaining power has been the attempt, starting in 2011, of Germany's main natural gas importer, E.ON Ruhrgas, to renegotiate its politically charged gas contracts with Russia's Gazprom (Powell 2011). Many analysts now expect Europe to move gradually from a system of negotiated gas prices, which inevitably draws in politics, to a system where natural gas is priced transparently through markets.

Asia has not been so fortunate, and the reasons for this are not entirely clear. Asian natural gas prices are still tied closely to crude oil prices, normally through politically involved negotiations. Asian buyers still have fewer options for large-scale imports than European buyers do—key buyers, including Japan and Korea, do not have access to pipeline imports—which reduces their relative power. In addition, at the same time that European customers were gaining new leverage in 2011, Japan, the largest LNG importer in Asia, was paralyzed by the disaster at its Fukushima nuclear power plant. As that accident led to widespread nuclear shutdowns, Japan massively increased its demand for LNG to meet critical electricity needs. Japan, desperate to avoid further economic harm, was not in a position to negotiate aggressively with natural gas suppliers.

Many analysts in both the United States and Asia have speculated that U.S. entry into the Asian LNG market as a major supplier (along with others) could help create the conditions for a move toward market pricing of natural gas, or at least to a lessening of individual producers' market power and, hence, political influence. Predicting political influence is a near-impossible business, but to examine whether U.S. exports might help encourage such a transformation, it is useful to compare the potential magnitude of U.S. LNG deliveries to other important scales in the natural gas market. As of 2010, the world's top five LNG exporters were Qatar (8.2 bcf/d), Indonesia (3.3 bcf/d), Malaysia (3.3 bcf/d), Australia (2.7 bcf/d), and Nigeria (2.6 bcf/d) (IGU 2010). The top supplier to Japan was Indonesia (2.0 bcf/d), and the top supplier to Korea was Qatar (1.1 bcf/d). The spot market accounted for slightly more than a fifth of traded LNG, totaling slightly less than seven billion cubic feet a day.

All of these figures will increase in the future. EIA projections are far from definitive, but they are instructive. World natural gas production is projected to increase by 26 percent over the next decade (EIA 2011). Korean imports are expected to rise from to 4.1 billion cubic feet a day, while Japanese imports are expected to hold fairly steady at their present level. Chinese imports, including pipeline gas, are expected to rise from a negligible amount to over nine billion cubic feet each day by the end of the decade, while daily Indian imports are expected to reach three billion cubic feet per day.

These figures suggest that U.S. LNG exports could become influential if they increased to toward the higher end of the range discussed thus far in this paper, and if exports were priced off the U.S. benchmark. The United States could potentially assume a large market share in several pivotal markets, and perhaps be dominant in one or more. This would give consumers greater leverage in their negotiations with other suppliers. At a minimum, by diversifying the pricing of their imports, it would partly insulate LNG importers from oil market fluctuations.

Potential U.S. exports might also be exploited for wider strategic gain under the right conditions. Current U.S. law makes approval of exports to markets with which the United States has free-trade agreements essentially automatic, but requires extensive review and subsequent approval for exports to others. This ought to give the United States leverage in broader trade negotiations with would-be importers. For example, Japanese officials and market participants have noticed that the recent U.S.-South Korea free-trade agreement will give South Korea special access to U.S. natural gas exports, and have inquired as to whether Japanese participation in the Trans-Pacific Partnership (TPP) trade arrangement would give them similar privileges (Interviews 2011). Regardless of whether Japanese and other policymakers are wise in wanting direct access to U.S. exports, this sort of dynamic can only strengthen the U.S. hand in international trade negotiations, which can lead to broader gains for U.S. consumers and firms.

Conversely, if the United States were to restrain LNG exports, it would almost certainly face wider trade-related problems. The consequences could be broad, affecting support for open trade in general, but they would likely have special impact on other resource-related disputes. Article XI of the General Agreement on Tariffs and Trade (GATT) prohibits sustained quantitative restrictions on energy exports unless they are related "to the conservation of exhaustible natural resources if such measures are made effective in conjunction with restrictions on domestic production or consumption" (Selivanova 2007). U.S. policy would be the opposite: it would be made in conjunction with efforts to encourage both domestic production and consumption of natural gas.

Indeed, the United States has recently joined Europe and Japan in challenging Chinese restrictions on exports of rare earth metals—which are critical to a variety of defense, electronics, and energy technologies—at the World Trade Organization (WTO) (Palmer 2011). The arguments that the

United States would need to invoke in order to restrain LNG exports—particularly the prospects of environmental damage and harm to domestic industry—are precisely those that China would like to use to defend its own restrictions on rare earths exports; China could all but take the U.S. justification of curbs on LNG exports, change a few words, and use it in its own defense. It would likely be difficult for the United States to sustain limits to U.S. LNG exports while fighting Chinese limits on exports of rare earth metals.

Making U.S. curbs on LNG exports effective would also require actions that could precipitate significant conflict with Canada and Mexico. Even then, those curbs might be undermined. The North American natural gas market is tightly integrated. Constraints on U.S. LNG exports might thus be circumvented in a straightforward manner by sending natural gas by pipeline to Canada or Mexico before exporting it from there as LNG. In that case, the U.S. economy would suffer all the downsides of LNG exports (through higher prices and environmental risks from increased production), but would forgo most of the benefits (aside from small profits from new natural gas output).

The United States could, if it wished, attempt to block this export route: Chapter 6 of NAFTA allows the United States to require that any exports of natural gas to Canada or Mexico be consumed there so long as Washington "maintains a restriction" on exports of natural gas to some destinations outside North America (NAFTA 1993). This was written to facilitate the effective imposition of economic sanctions on specific countries, and the legality of its application in conjunction with a restrictive policy on LNG exports would be questionable. (There is no related case history upon which to base future expectations.) Independent of this legal question, the political fallout of such a move would likely be large—particularly with Canada—in the wake of the U.S. decision in early 2012 to deny a permit for the Keystone XL oil pipeline.

Even if the United States invoked its NAFTA privileges, the existence of otherwise integrated North American natural gas markets could undermine a U.S. effort to reap any benefits that might come from curbing LNG exports. Canada or Mexico could import U.S. natural gas by pipeline, consume it domestically, and export freed-up domestic natural gas as LNG. The United States would need to block pipeline exports in general to prevent this, creating severe political friction. Substantial cross-border natural gas pipeline capacity already exists, particularly between the United States and Canada: in 2011, an average of eleven billion cubic feet of natural gas flowed across the border each day (EIA 2012d, EIA 2012e).[13] Much of this capacity could ultimately be used to move U.S. natural gas to Canada, freeing up Canadian natural gas for export as LNG. As of 2009, roughly four billion cubic feet a day of capacity operated from the United States to Canada, and about three billion cubic feet a day of capacity ran to Mexico (EIA 2009b). Reversing additional pipelines would require modifications (such as new pumping stations) that would need to be approved by the U.S. FERC, which considers specific environmental risks as well as broader national interest issues in doing so (U.S. Department of State 2012). Obtaining approval has typically been a routine exercise; a pair of March 2011 applications to reverse pipeline flows and send gas from the Marcellus Shale (in Pennsylvania) to Canada were approved in October of that year (FERC 2011). Yet recent conflict over the Keystone XL oil pipeline, which was once also expected to face a routine regulatory process suggests that approval of future trans-border pipelines should not be taken for granted. That said, using the independent FERC to block exports to Canada and Mexico, thereby extensively fragmenting previously integrated markets, would be costly, both politically and potentially economically.

> Conversely, if the United States were to restrain LNG exports, it would almost certainly face wider trade-related problems. The consequences could be broad, affecting support for open trade in general, but they would likely have special impact on other resource-related disputes.

Ultimately, were the United States to restrain LNG exports while not blocking pipeline exports to Canada, the net impact would be to expose the United States to the downsides of LNG exports (particularly higher prices) while denying it most of the benefits (direct profits from trade as well as leverage in trade negotiations).

ENVIRONMENTAL IMPACTS

Shale gas production has attracted public criticism over environmental risks and local impacts. Allowing natural gas exports would expand production, which would only intensify that concern. Indeed, one need only look at the fight in 2011 over the Keystone XL pipeline, which would have transported diluted bitumen from Canada to Texas refineries in part to produce diesel fuel for sale abroad, to see that production

TABLE 1.

Costs and Benefits of Allowing Natural Gas Exports

		Benefits	Costs
What macroeconomic consequences would natural gas exports have?	Economic Output	Estimates suggest that the U.S. economy will gain up to $4 billion annually from exports, primarily from overseas sales of increased natural gas production.	Exports raise the cost of natural gas, resulting in less domestic gas consumption, and hence less economic output in some sectors. Estimates suggest that these losses are in the range of $500 million annually, primarily from reduced output in energy intensive industries.
	Current Account Balance	Total export revenues could be up to $20 billion higher each year, but the current account balance is likely to be unchanged absent more fundamental shifts in savings and consumption.	
	Employment	Exports could create up to 8,000 near-term jobs in export facility construction. In the long run, they could also support up to 60,000 jobs in natural gas production and along the supply chain.	Estimates indicate that approximately 6,000 jobs could be lost in energy intensive industries in the long run due to higher natural gas prices. In the long run as the economy returns to full employment, job gains due to LNG exports will be offset by losses elsewhere in the economy for no net impact on employment.
	Price Volatility	Allowing exports could help link U.S. natural gas markets with world markets. This provides a buffer against domestic shocks.	Linking domestic and world natural gas markets could increase U.S. exposure to overseas shocks in natural gas prices.
What would the distributional impacts of natural gas exports be?		None	Exports are projected to slightly raise the cost of domestic natural gas. This would have a disproportionate effect on lower-income households, who would face additional costs that are estimated to be around $50 annually.
How would natural gas exports affect U.S. oil security?		None	Domestic natural gas could in principle be used as a substitute for oil. If exports are constrained, the United States would use marginally less oil in transport.
What impact would natural gas exports have on climate change?		Natural gas exports could displace dirtier coal-fired power overseas. It could also, however, lead to greater energy consumption abroad by lowering energy costs.	Higher domestic prices would marginally weaken the incentive to displace coal-fired power in the United States, but would also lower U.S. electricity demand.
What foreign policy consequences might natural gas exports entail?		U.S. exports could disrupt opaque and politically entangled natural gas markets, potentially reducing revenues to Russia, Iran, and others. Exports also give the United States new leverage in trade negotiations. Finally, allowing exports avoids creating major ruptures in NAFTA and WTO, including in the ongoing U.S. efforts to remove Chinese minerals export quotas.	None
What would the local environmental consequences of natural gas exports be?		None	Increased shale gas production can have negative environmental consequences such as water contamination and local pollution in the absence of appropriate environmental regulation.

of fossil fuels for export is a ripe target for many concerned communities and environmental advocates. Moreover, some economic simulations suggest that a large part of increased production spurred by export demand would be in the Northeast, where opposition to shale gas development has been strongest (EIA 2012c).

Traditional environmental concerns have focused primarily on potential contamination of aquifers by methane migration, fluids injected during the hydraulic fracturing (or “fracking”) process, and poor disposal of contaminated water produced from wells. Worries have also centered on the impacts to local infrastructure, particularly roads, and on large inward migration to productive areas, which has disrupted communities. These issues have become far more pronounced since 2010 as natural gas development has expanded from states that have long been home to large-scale drilling, such as Texas, Arkansas, and Oklahoma, to states without the same oil and gas culture, particularly Pennsylvania and potentially New York.

The potential economic gains from natural gas trade are small compared to the potential losses from a large-scale backlash against shale gas development. The consultancy IHS-CERA, in a study prepared for a natural gas industry group, estimated that shale gas development (including the industry itself along with its suppliers) had added $51 billion to U.S. output in 2010, would add $81 billion in 2015, and could contribute $158 billion by 2035 (Bonakdarpour et al. 2011). This likely overestimates the supply side contribution of shale gas development, since it assumes that all net industry revenues represent new output, but it also underestimates the demand side impact, since it does not account for the economic benefits of lower natural gas prices. Taking the CERA numbers at face value, six billion cubic feet of daily natural gas exports would increase the net contribution of shale gas to U.S. GDP by less than 5 percent. Shale gas production itself is far more valuable than natural gas exports.

The prospect of exports thus strongly reinforces the importance of ensuring that shale gas development proceeds in ways that gain the support of local communities and environmental skeptics. Specific measures for doing that are beyond the scope of this paper, but a long list of wise steps that should be taken can be found in a recent report of the Secretary of Energy Advisory Board Natural Gas Subcommittee, “Improving the Safety and Environmental Performance of Hydraulic Fracturing” (DOE 2011). It will be several years at the earliest until natural gas exports might commence; authorities should use the intervening time to ensure that gas development is done to the highest standard.

OVERALL COSTS AND BENEFITS

Table 1 summarizes the overall costs and benefits of allowing natural gas exports in six different dimensions, as discussed in this chapter. The colors in the table correspond to their net effects, with green indicating that the benefits outweigh the costs, and purple indicating the opposite. Stronger shades indicate items where the imbalance between cost and benefit is more pronounced. These considerations will all inform the policy proposal detailed in the next chapter.

Chapter 5: Natural Gas Export Policy Recommendations

POLICY PROPOSAL: APPROVE PERMITS FOR LNG EXPORTS

In Chapter 4, I laid out a framework for consideration of the wisdom of allowing LNG exports. An examination of these components indicates that the benefits of allowing LNG exports outweigh the risks and costs, so long as downside risks to the local environment are mitigated, as discussed previously. Allowing exports would boost the U.S. economy, create jobs, reduce greenhouse-gas emissions, and create new geopolitical leverage for the United States. In particular, the likely benefits to the U.S. economy outweigh the benefits that would be realized by trapping natural gas in the United States in the hope that it will be used to replace oil. Barring exports would also weaken the U.S. hand in international trade diplomacy, including in the ongoing fight over Chinese restrictions on minerals exports. Strongly constraining U.S. gas exports would also require substantial interference in the currently integrated North American energy market, with the potential for economically and politically damaging fallout.

The most acute risks associated with allowing natural gas exports are distributional and environmental; both could also spur a backlash against natural gas production more broadly. Both can and should be mitigated, however, with appropriate policies, as outlined earlier. The details are largely beyond the scope of this paper, but options include the many steps outlined in DOE (2011), severance taxes or impact fees that fund infrastructure and regulatory capacity, and bonding requirements for drillers that help communities recover damages from bankrupt operators (Davis 2012).

I thus propose that, to facilitate potential natural gas exports, the DOE should approve applications for LNG exports to non-FTA countries that are pending before it, barring specific concerns about individual applications that are not related to the broader wisdom of allowing LNG exports. In doing so, the DOE is required to find that allowing exports is in the "public interest." The framework outlined in this paper provides one way of presenting such an assessment.

The FERC must also approve modifications to terminals in order for exports to be allowed (Ebinger et al. 2012). I propose that it approve any applications to operate export terminals that have been approved by the DOE, barring problems with individual applications that are unrelated to the broader wisdom of allowing LNG exports.

Implementing these steps will not require any new staffing, funding, or action by Congress, which has already put in place the legislative framework needed to approve and monitor LNG exports. Congress need only refrain from placing new statutory restrictions on LNG exports.

OTHER POLICY STEPS

Leverage Exports in Trade Talks

The prospect of further exports beyond those initially approved to non-FTA countries will be attractive to many potential importers, including Korea, Japan, India, and China. This will be the case even if the United States approves enough capacity to theoretically cover plausible export demands, since many firms that have received approval to export LNG may not actually succeed in building export facilities.

U.S. trade negotiators should use the prospect of preferential access to future exports in trade negotiations with those countries, which could create an opportunity to further increase the economic benefits to the United States of natural gas exports. In particular, the United States should make access to U.S. LNG a part of ongoing TPP negotiations with Japan, something Japan has signaled that it desires. The specific "asks" in return for preferential access should be determined by broader U.S. priorities in these negotiations. State Department diplomats should also emphasize the value of FTA access to U.S. LNG exports in their engagement with those Korean policy-makers who are skeptical of the U.S.-Korea Free Trade Agreement (KORUS).

Use Exports To Create More Transparent LNG Markets

The prospect of a more diverse LNG market—which U.S. entry as an exporter would contribute to—carries with it the prospect of introducing more transparent market-based pricing to gas trade, particularly in Asia. That would help disentangle natural gas trade from political relationships, particularly between Asian consumers and Middle Eastern suppliers, to the broader benefit of the United States. The U.S. government has limited influence over the geopolitical impact of LNG exports, but it can take several steps to improve the odds of success.

- ***Maintain a preference for exports that are likely to use market-based pricing.*** In selecting export permits to approve, the DOE should maintain a preference for applicants that foresee using transparent pricing based on U.S. (or emerging Asian) spot market prices (rather than traditional oil-linked pricing) in their contracts. Maintaining such a preference is consistent with the DOE mandate to approve only exports that are in the public interest.

- ***Support widening of the Panama Canal if necessary.*** The United States should provide any necessary support to the ongoing widening of the Panama Canal, which would lower the cost of U.S. LNG exports to Asia, and thus make them more likely and potentially more profitable. (LNG tankers departing the Gulf of Mexico or the East Coast of the United States currently need to travel all the way around South America to reach Asia, adding considerable cost to their trips and eroding potential gains from trade.) Slightly less than half of the Panama Canal Expansion Project is financed by governmental and intergovernmental institutions, including the Japan Bank for International Corporation (JBIC), the European Investment Bank (EIB), the Inter-American Development Bank (IDB), and the International Finance Corporation (IFC) (JBIC 2008). If additional public financing becomes necessary to successfully complete the project (currently an unlikely need), the United States should help ensure that financing is provided, either directly through the Export-Import Bank, or through its influence at the IDB and IFC.

- ***Lead initiatives and studies on the importance of transparent international natural gas markets.*** U.S. policymakers should also exploit available opportunities to promote transparent, market-based LNG trade. This would help the competitive position of U.S. exporters, who will likely be more transparent than many others, and leverage the new U.S. role in LNG markets for broader gain. There are no silver-bullet solutions here, but there are many opportunities to influence the political evolution of LNG trade at the margin. The DOE or State Department, for example, could fund an International Energy Agency (IEA) study of the benefits of transparent markets, and the United States could seek G8 or G20 agreement on increased transparency in LNG contracts and trade flows. U.S. diplomats, particularly in the new State Department Bureau of Energy and Natural Resources, should also maintain an active dialogue with their counterparts in Australia, the dominant LNG exporter in Asia and a potential partner in promoting transparent trade. At a minimum, this would enhance U.S. understanding of LNG market evolution; in principle, it might also reveal opportunities for focused cooperation.

Chapter 6: Questions and Concerns

WHAT HAPPENS IF GAS PRICES TURN OUT TO BE MORE OR LESS SENSITIVE THAN ASSUMED?

The analysis in this paper has focused on the potential for six billion cubic feet of daily natural gas exports. This is consistent with high end estimates of export potential by market analysts. It is also consistent with mainstream natural gas price projections: analysts widely expect such a volume of exports to largely close the gap between U.S. and overseas prices (net of liquefaction and transport costs).

If the current transformations under way in natural gas teach us anything, though, it is to be modest about our ability to predict the future course of energy markets. It is possible that U.S. natural gas prices could turn out to be either far more or far less sensitive to additional export demand than most assume.

If prices turned out to be far more sensitive to export demand than what was assumed in Chapter 4, the opportunity for exports would become correspondingly smaller, since the gap between U.S. and overseas prices would close quickly as export volumes rose. The potential benefits from exports would be lower as a result, but the potential downsides would fall, too. Exports would still remain attractive on balance, but their net value—economically and strategically—would be reduced.

More intriguing is the possibility that U.S. natural gas prices will turn out to be far less sensitive to export volumes than most expect. This might allow much larger quantities of exports. Deloitte (2011) projects a mere 12-cent increase in the price of a thousand cubic feet of natural gas were the United States to export six billion cubic feet of natural gas each day. Such high elasticity would likely mean that U.S. exports would rise until the gap between U.S. and overseas prices was fully closed, net of liquefaction and transport costs (including normal profits), through a combination of rising U.S. prices and falling prices overseas.

In this case, the macroeconomic benefits to the United States would be higher than those estimated above, both because of larger export volumes, and because export volumes would be sourced more from increased production than from decreased domestic use. The climate benefits might also be greater, because more natural gas would be available to displace coal overseas, and less would be drawn away from U.S. power plants. And the geopolitical and trade policy benefits would be larger, since greater U.S. LNG exports would give U.S. exporters a more dominant position in overseas markets. On the flipside, the consumer consequences would not change: the price impact of exports would remain the same; it is only export volumes that would increase. The greatest risk from much larger exports would be to the local environment; greater exports would further reinforce the importance of ensuring that proper protections for water, air, and local communities were in place.

WHY ASSUME THAT PRICE SPREADS BETWEEN MARKETS WILL REMAIN LARGE?

Chapter 2 discussed the possibility that prices might converge across markets absent large-scale U.S. LNG exports. Indeed, one should not assume that prices will remain sharply divergent in the different regional markets—and one should not assume that large-scale exports will materialize. This does not, however, change the bottom lines. The possibility of price convergence absent U.S. LNG exports lessens the benefits of allowing those exports, since actual U.S. exports would not occur if all markets had similar gas prices. The United States would thus miss out on gains in economic output and jobs, and not have the same impact on global geopolitics or greenhouse-gas emissions. At the same time, the possibility of price convergence absent U.S. LNG exports also reduces the costs of allowing exports, since there would be no harm to domestic industry, consumers, or the environment if no exports took place. Moreover, regardless of whether exports materialize, the United States will suffer if rejecting export permits causes fallout for its broader international trade agenda. Allowing exports remains the right policy choice, even given the possibility that no or few exports will occur.

WHAT IMPACT WOULD GAS EXPORTS HAVE ON GOVERNMENT REVENUES?

Allowing natural gas exports would increase government revenues by raising taxable U.S. output. In addition, increased natural gas production resulting from exports would raise state revenues in places that are home to drilling. I estimated earlier that allowing six billion cubic feet of daily U.S. natural gas exports would increase net annual U.S. output by approximately $4 billion. Assuming a 35 percent marginal tax rate on corporate profits, this would raise approximately $1.4 billion each year; in practice, since a part of the profits would accrue to individual property owners and workers who face lower rates, the net increase in revenues would be less. This total would, of course, be reduced if actual export volumes turned out to be lower.

Increases in state tax revenues would depend on the states in which production increased, but would total at most approximately $400 million each year (based on the corporate tax rate for Pennsylvania, which is the highest among major gas-producing states). More significantly, increased production would also boost state revenues from severance taxes. Typical severance taxes in major producing states are on the order of 5 percent to 8 percent of sales revenues (Allegheny Conference 2009). A full six billion barrels a day of natural gas exports could thus be expected to generate increased severance tax revenues of $1 billion to $2 billion each year, including revenues from new production and larger revenues from existing production due to higher prices.

WHAT IMPACT WOULD GAS EXPORTS HAVE ON GAS-DEPENDENT INDUSTRY?

Cheap natural gas fuels industry in two important ways. Natural gas is extracted together with ethane, which is used as a feedstock in chemicals manufacturing. Natural gas can also be used to generate inexpensive electricity for heavy industry, such as steel production. Analysts and industry advocates have generally assumed that both industries would suffer as a result of exports.

This conclusion is likely incorrect for chemicals feedstocks. Natural gas production that results from allowing natural gas exports will lead to increased production of natural gas liquids (NGLs), including ethane, that are extracted with the gas. When natural gas is used for domestic consumption, those NGLs are removed and sold separately. If the fraction of NGLs in the gas produced is low enough, though, the NGLs may be left in the gas when it is shipped, reducing domestic ethane supplies. However, if the fraction of NGLs is high enough, at least some must be removed prior to shipping as LNG to avoid problems with liquefaction. Those separated NGLs are then available on the domestic market. Indeed, NGL production increases by between 5 and 10 percent for all twelve export scenarios explored in a recent EIA analysis of natural gas exports. This suggests that allowing natural gas exports will benefit, rather than harm, domestic chemicals manufacturers.

In contrast, energy intensive manufacturers like steel producers will likely be harmed by natural gas exports as a result of higher natural gas prices, though only by a small amount. Those damages are far more likely to hurt corporate profits than to affect decisions regarding whether to locate plants in the United States. If natural gas exports raised domestic natural gas prices by $1 per thousand cubic feet, that would raise the cost of producing a ton of steel using a new state-of-the-art facility by approximately $8 (ABB 2011). That compares to typical steel prices on the order of $800 per ton.

Further insight can be gained by following the approach used in Chapter 4 and comparing the electricity price increase due to LNG exports to that due to a carbon price. I noted earlier that the EIA (2012c) projects a long-run increase in commercial electricity prices of 1 percent to 2 percent due to six billion cubic feet of daily LNG exports. Aldy and Pizer (2009) estimate that an 8 percent increase in electricity prices would reduce glass production by 3.4 percent, paper by 3.3 percent, iron and steel by 2.7 percent, aluminum by 2 percent, and other industries' outputs by smaller amounts. This translates into output reductions of less than 1 percent in each of these energy intensive industries as a result of LNG exports. (Employment losses would be even lower.) This reduction would come primarily from lower consumption of energy-intensive goods rather than through loss of competitiveness. It is fully accounted for in the estimates of macroeconomic consequences of natural gas exports presented above.

WOULD ALLOWING EXPORTS DEPLETE U.S. NATURAL GAS RESOURCES?

The amount of natural gas in the ground is finite and fixed. By increasing present consumption, U.S. natural gas exports would reduce the amount of natural gas left. Some may worry that the United States could become dependent on imports at an undesirably early date if, due to excessive consumption, production began to fall sooner than it would have otherwise.

This is not a large problem. According to recent EIA (2012c) modeling, were the United States to export LNG at the highest rates discussed in this paper, it would produce as much natural gas in nineteen years as it otherwise would have in twenty. If U.S. reserves were far smaller to start with than that analysis assumes, prices would rise and the economic incentive to export would erode.

WHY NOT APPROVE LNG EXPORTS BUT LIMIT THEIR QUANTITIES?

Experts involved in discussions of LNG exports occasionally suggest that approving LNG exports in limited quantities (perhaps the five to six billion cubic feet per day that most experts project is the likely maximum in the next decade) could provide a foundation for political compromise. Limiting export volumes would limit possible domestic price increases, along with their consequences for consumers and energy-intensive industry. It would also put a cap on new shale gas development resulting from export demand, thus assuaging local environmental concerns. At the same time, limiting

LNG exports could close off opportunities for job creation at export facilities and for economic gains from new natural gas production and overseas sales. Moreover, to the steps necessary to make any limits bind would still create problems for the United States within NAFTA and the WTO.

Regardless of the balance of costs and benefits associated with approving exports in limited quantities, there are practical difficulties associated with imposing a quota on exports. Such a quota would presumably be enforced by approving only a limited number of export permit applications. But how would the DOE choose which permits to approve? A "first-come, first-served" approach would likely lead to problems down the road when one or more of the approved facilities did not pan out. (Most firms that received permits to build LNG import facilities in the 1990s and 2000s were unable to put together viable business plans and financing schemes, and thus never reached actual construction.) Indeed, such an approach would likely prompt a stampede of applications from under-qualified operations. The DOE could evaluate applications and select those that it deemed to have the most promising business prospects, but this would be fraught with risk, ranging from weak DOE capacity to do such analysis to inevitable accusations of decisions made based on political connections rather than merit. To be certain, there is some precedent for similar feasibility evaluations in the context of utility regulation, but the uncertain and immature nature of the LNG export business would make it difficult to translate this method to the present challenge.

In principle, these problems might be partly mitigated by auctioning off export permits. Companies would be forced to carefully scrutinize their own prospects before attempting to grab part of any export allowance. Yet the courts would likely consider this tantamount to an export tax. As noted above, though, federal export taxes are unconstitutional.

In practice, to the extent that allowing exports leads to potentially worrisome rises in domestic natural gas prices, exports are likely to be self-limiting without quotas. Strong increases in domestic prices will make exports less attractive overseas. Large export volumes would also reduce overseas prices. The combination would most likely close off additional exports before U.S. prices could rise too far. In essence, export quotas would become relevant when they would have little effect anyway.

Chapter 7: Conclusions

A revolution in U.S. natural gas production has forced policymakers to decide whether they should allow exports of LNG from the United States. They should say yes, within prudent limits, and leverage U.S. exports for broader gain. Yet the mere fact that the benefits of allowing exports would outweigh the costs does not mean that the political fight over allowing LNG exports will be tame. Operators of natural gas power plants will likely oppose exports, as will energy intensive manufacturers, though chemicals producers, if they are sufficiently enlightened, may take a more moderate stance. Most environmental advocates who are concerned with the local impacts of shale gas development will likely join in opposition, as will those who are convinced that gas should be trapped for use in cars and trucks, and those who believe that any rise in consumer energy prices is unacceptable. The most prominent proponents of exports will likely be oil and gas companies and advocates of liberal trade, perhaps along with a broader group of foreign policy strategists that finds the prospect of disrupting relations between gas-producing and gas-consuming countries appealing, as well as supporters of renewable power who see cheap natural gas as competition (Schrag 2012). Any decision on LNG exports is likely to be controversial. Enlightened leadership and a strategy that mitigates downsides for poorer consumers and the local environment are essential to a smart strategy for constructively moving exports forward.

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The author thanks Charlie Warren for invaluable research assistance; Lucas Davis, Michael Greenstone, Adam Looney, an anonymous reviewer, and participants in a Hamilton Project workshop for valuable comments on drafts of the paper; and Blake Clayton and Billy Pizer for helpful conversations. Levi also is grateful for support from the Alfred P. Sloan Foundation for funding to support the basic research that underlies this proposal.

Endnotes

1. Based on EIA (2012a) data for wellhead prices deflated with BLS (2012) CPI data.
2. Estimate based on $4 gas price, $4 for liquefaction, shipping, and regasification, and $15 sale price. If one assumes that the full difference between U.S. and overseas prices is captured by U.S. producers, the estimated U.S. surplus is $20 billion. Contracts already concluded make clear, however, that the surplus will be divided between buyer, seller, and middlemen (such as shippers); in addition, prices in distant markets should fall due to trade.
3. This competition is not entirely based on simple economics, since many consuming countries do not have pure market economies, but economics plays a central role.
4. Based on a simple energy equivalence calculation. If GTL were used, a substantial efficiency penalty would increase the amount of natural gas needed.
5. Imagine, for example, that natural gas was used to displace oil through conversion of gas to liquid fuels (GTL). Jaramillo et al (2008) estimate that capital and operating costs would total about $20 per barrel of petroleum products produced. With natural gas priced at $5/MMBtu, the gas needed to operate the GTL facility would cost roughly another $20 per barrel of products (Jaramillo et al 2008; author's calculations). Even if all economic opportunities to convert natural gas to liquids were exploited, U.S. natural gas prices would thus remain about $6-$7/MMbtu below oil prices — certainly a wide enough gap to keep LNG exports attractive. A similar pattern should be expected for compressed natural gas vehicles, which are more expensive than conventional cars and trucks.
6. Most of the projects already have terminals built; one of the projects, at Jordan Cove, has not yet built an import terminal, but its backer had invested substantial effort in developing the project prior to the emergence of the U.S. natural gas glut.
7. This and all other estimates of gains and losses from exports are based on the simple assumption that the price paid to domestic gas producers is equal to their marginal cost of production, and the price paid by domestic consumers is equal to their marginal benefit from consumption.
8. To reach this estimate, I infer from the IHS (2011, pp. 15, 20) projections of shale gas output and employment from 2010 to 2030 that each increase of 1 bcf/d in natural gas production supports approximately 5,300 jobs in the oil and gas industry, and about 8,900 indirect jobs along the supply chain.
9. A thousand cubic feet of natural gas has roughly the same energy content as 0.17 barrels of oil. Assuming a typical conversion efficiency of 60 percent results in the reported figure.
10. This is based on an assumed energy penalty of 15 percent for CNG.
11. This estimate depends on the natural gas price impact of gas exports — and the cost of moving natural gas into CNG vehicles. The greater the price impact of gas exports, the larger the likely profits to the United States from exports; the same drivers of that dynamic would also imply larger costs for producing natural gas for use in cars and trucks. The cost of moving natural gas into CNG vehicles is also important to the net assessment, since it offsets the external benefit of any shift in that direction.
12. Emissions from natural gas are assumed to be 53 kgCO2/MMbtu.
13. This figure is gross, not net, since I am interested in knowing total pipeline capacity. Pipelines between the United States and Canada do not generally switch direction during the year.

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Highlights

Michael Levi of the Council on Foreign Relations weighs the economic and other benefits of liquefied natural gas (LNG) exports against the costs, and argues that the upsides of allowing LNG exports outweigh the downsides, providing that the U.S. government takes steps to mitigate risks to the local environment and low-income consumers. Levi proposes that the United States should allow exports of LNG, and offers recommendations for using access to exports to advance U.S. foreign and trade policy goals.

The Proposal

Apply a broad framework to assess the wisdom of liquefied natural gas exports. Federal regulators and lawmakers can determine the potential impacts of applications for natural gas exports by considering the following six questions:

- What macroeconomic consequences would natural gas exports have?
- What would the distributional impacts of natural gas exports be?
- How would natural gas exports affect U.S. oil security?
- What impact would natural gas exports have on climate change?
- What foreign policy consequences might natural gas exports entail?
- What would the local environmental consequences of natural gas exports be?

Unlock the gains from trade created by natural gas exports. Allowing LNG exports will allow U.S. producers and workers to extract additional natural gas and sell it overseas at higher prices, bringing economic benefits to the United States. Blocking exports could have consequences for broader U.S. access to foreign markets, damaging U.S. growth. Therefore, the Department of Energy should approve current applications to export LNG, and the Federal Energy Regulatory Commission should approve applications to build or modify export terminals.

Benefits

Using his framework, Levi estimates that allowing exports of LNG could result in roughly $4 billion in gains from trade annually, and bolster U.S. leverage in trade negotiations. Pushing for more transparent natural gas markets could reduce international dependence on the small group of countries that currently provide most natural gas. Finally, allowing exports of LNG would enhance ongoing U.S. efforts to promote access for U.S. firms and workers to other markets.

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Exhibit C-6

Kenneth B. Medlock II, Ph.D., “U.S. LNG Exports: Truth and Consequences,” Energy Forum at the James A. Baker Institute for Public Policy, Rice University (August 2012)

James A. Baker III Institute for Public Policy
Rice University

U.S. LNG Exports: Truth and Consequence

by

Kenneth B. Medlock III, Ph.D.

James A. Baker, III, and Susan G. Baker Fellow in Energy and Resource Economics
James A. Baker III Institute for Public Policy
Rice University

August 10, 2012

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Abstract

A decade ago, market players were making large capital investments to facilitate the import to the United States of liquefied natural gas (LNG) from distant locations, such as the Middle East, Africa, and Russia. This was predicated on the consensus at the time that U.S. domestic supply was becoming increasingly scarce. However, innovations involving hydraulic fracturing and horizontal drilling subsequently led to the dramatic growth of domestic production from shale gas. In fact, domestic production growth has been so strong that the U.S. is considered a possible exporter of LNG—an unthinkable notion just a few years ago. This new consensus is fueled by the current reality—one that features abundant supplies and low prices in North America relative to the rest of the world. Importantly, the commercial aspirations of firms that seek to seize the apparent profit opportunity offered by exports run headlong into concerns that allowing exports from the U.S. will force prices up, thereby negatively impacting industrial activity and household budgets. Hence, the issue of allowing LNG exports from the U.S. has entered the political realm.

Several groups—such as the U.S. Energy Information Administration, the Deloitte Center for Energy Solutions, and RBAC—have studied the impact of U.S. exports on domestic prices. These studies generally assume a particular volume of LNG exports from the U.S. when assessing the domestic price impact, but they do not allow interaction between domestic and international markets to influence the volume of trade. U.S. LNG exports will occur in a global setting, so it is an international trade issue. Thus, to separate *truth* from fiction one must apply the appropriate analytical framework grounded in international trade. Specifically, domestic market interactions with the market abroad will determine export volumes and therefore U.S. domestic price impacts.

After introducing a basic international trade framework, the *consequences* of U.S. LNG exports are discussed. This paper argues that (a) the impact on U.S. domestic prices will not be large if exports are allowed, and (b) the long-term volume of exports from the U.S. will not likely be very large given expected market developments abroad. The bottom line is that certification of LNG exports will not likely produce a large domestic price impact, although the entities involved may be exposed to significant commercial risk.

Introduction

During the past decade, innovative new techniques involving the use of horizontal drilling with hydraulic fracturing have resulted in the rapid growth in production of natural gas from shale in the United States. Although geologists have long known about the existence of shale formations, accessing those resources was long held to be an issue of technology and cost, and recent innovations have made shale gas production a commercial reality. In fact, shale gas production in the United States increased from virtually nothing in 2000 to over 14 billion cubic feet per day (bcfd) by 2010, representing over 25 percent of domestic dry gas production. Moreover, recent Baker Institute analysis indicates it could reach 50 percent of domestic production by the 2020s.

Without doubt, the natural gas supply picture in North America has changed substantially, and it has had a ripple effect around the globe, not only through displacement of supplies in global trade, but also by fostering a growing interest in shale resource potential in other parts of the world. Thus, North American shale gas developments are having effects far beyond the North American market, and these impacts are likely to expand over time. Prior to the innovations leading to the recent increases in shale gas production, huge declines were expected in domestic production in the United States and Canada, which comprise an integrated North American market. This foretold an increasing reliance on imported supplies of liquefied natural gas (LNG) at a time when natural gas was becoming more important as a source of energy.

Throughout the 1990s and early 2000s, natural gas producers in the Middle East and Africa, anticipating rising demand for LNG from the United States in particular, began investing in expanding LNG export capability, concomitant with investments in regasification being made in the United States. At one point in the early 2000s there were over 47 regasification terminals with certification for construction, which was a clear signal regarding industry-wide expectations for significant declines in future U.S. production. But rapid growth in shale gas production has since turned such expectations upside down and rendered many of those investments obsolete. Import terminals for LNG are now scarcely utilized, and the prospect that the United States will become highly dependent on LNG imports has receded.

Rising shale gas production has contributed to lower domestic natural gas prices, which recently dipped below $2 per thousand cubic feet (mcf) and are currently in low $3 per mcf range. In addition to rendering the import terminals virtually obsolete, this has led to greater use of natural gas in power generation through substitution opportunities with coal, and growth and renewal of industrial and petrochemical demands, some of which had previously moved offshore. There has also been interest in creating new demands through the use of natural gas in transportation, particularly as the price of crude oil remains substantially higher than the price of natural gas on an energy equivalent basis. Finally, and to the point of this exposition, there has been growing interest in developing LNG export capability to capture the arbitrage opportunity that currently exists with U.S. domestic natural gas prices substantially below prices in Europe and Asia.

When considering international natural gas trade, it is important to recognize that the issue is indeed *international*. Thus, we must not only consider what is happening in North America; we must also consider what is happening abroad. For one, the emergence of shale gas in the United States has already had an impact on natural gas markets in Europe and Asia. LNG supplies whose development was anchored to the belief that the United States would be a premium market have been diverted to European and Asian buyers. As discussed in Medlock, Jaffe, and Hartley (2011),[1] this has presented consumers in Europe with an alternative to Russian and North African pipeline supplies, and it is exerting pressure on the status quo of indexing gas sales to the price of petroleum products. In fact, Russia has already accepted lower prices for its natural gas and is even allowing a portion of its sales in Europe to be indexed to spot natural gas markets, or regional market hubs, rather than oil prices. This change in pricing terms signals a major paradigm shift in Europe, and could be the harbinger that oil-indexation will eventually become a thing of the past. In fact, as natural gas becomes an increasingly fungible commodity, which would be the case as the volume of global natural gas trade increases, the paradigm of oil-indexation will come under increasing pressure. This is an important factor when considering the current profit margin available to potential LNG exports.

[1] See the Baker Institute Energy Forum study entitled "Shale Gas and U.S. National Security" available online at http://www.bakerinstitute.org/news/shale-gas-and-us-national-security.

The policy discussion in the United States has heretofore centered on the domestic price impact of LNG exports, should they occur. The results of the various studies that have been commissioned to investigate this issue reveal for a pre-specified volume of exports of 6 billion cubic feet per day an impact of anywhere between $0.22 per mcf and $1.50 per mcf.[2] Interestingly, none of the recent studies performed by various groups in attempt to lend an analytical voice to the discussion actually considers whether or not exports will occur. Each simply takes as given particular export volumes under different scenarios. While this allows for a more direct comparison across studies, it belies a fundamental issue in determining the price impact of allowing exports. Namely, allowing exports does not mean exports will occur in any particular volume, and policymakers should understand this very salient point. Regional price differentials around the globe will be affected by LNG trade because prices both domestically *and* abroad will be influenced by the introduction of trade. As prices adjust to new volumes there will be a feedback that is important in determining the volume of trade that ultimately occurs. In other words, export volumes should be treated as *endogenous* in a context that allows prices both domestically and abroad to adjust. Previous studies have treated export volumes as *exogenous*, which is a critical assumption.

There are several key factors that determine the impact of LNG exports on domestic prices and whether or not LNG exports actually occur. Critical factors addressed herein are (i) the elasticity of domestic supply, (ii) the elasticity of foreign supply, (iii) the role of short-term capacity constraints, (iv) the cost of developing and utilizing export capacity, and (v) the value of the U.S. dollar, an oft ignored issue in this context.

The results of any analysis on the subject of U.S. LNG exports have important policy implications. At the core of the issue is whether or not the U.S. should export the raw material or the manufactured good. In this context, the political debate is really a matter of who collects the rents associated with an abundance of domestic natural gas resource. On the one hand, domestic

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[2] See, for example, U.S. Energy Information Administration, "Effect of Increased Natural Gas Exports on Domestic Energy Markets" (January 2012). Other notable studies on this issue are "Made in America: The Economic Impact of LNG Exports from the United States," a report by Deloitte Center for Energy Solutions and Deloitte MarketPoint LLC; "Using GPCM® to Model LNG Exports from the U.S. Gulf Coast," by Robert Brooks, RBAC (March 2012); "Liquid Markets: Assessing the Case for U.S. Exports of Liquefied Natural Gas," Charles Ebinger, Kevin Massy, Govinda Avasarala, Brookings Institution (May 2012).

producers can earn higher prices for their output by selling to a higher priced *foreign* market. On the other hand, domestic manufacturers can earn higher profits by selling their final output, produced with the aid of low cost natural gas, both domestically and abroad. In both cases, natural gas provides a competitive advantage, but the debate need not be so simple.[3] Specifically, if domestic supply is sufficiently abundant relative to supplies abroad, then rents can be shared on both fronts, meaning there is room for both exports and increased domestic manufacturing. Of course, we need to look at data and evidence to ascertain where the truth may lie.

We begin with a relatively simple discussion of U.S. LNG exports as a classic problem in international trade. This will allow an assessment of the likely price impacts of LNG exports should they occur, where the result is appropriately couched in the context of *international* trade. We then discuss whether or not LNG exports from the U.S. are likely to be a *profitable* long-term opportunity, and present results from the latest Reference Case of the Rice World Gas Trade Model (RWGTM) as support. This, of course, has implications for the position that policy-makers, many of whom have recently taken a strong interest in the question of LNG exports, should take. In particular, concerns about domestic price impacts may be overblown if market forces are likely to prevent any significant influence on domestic prices. In turn, the question the Department of Energy (DOE) faces regarding LNG export licenses is less contentious because market adjustments will ultimately limit the construction and/or utilization of terminal capacity, in much the same way they have done with LNG import facilities.

Importantly, there is a distinction that must be made between long-run and short-run market equilibrium. In fact, this distinction is vital to assessing the long-run viability of LNG exports from the U.S. For example, the current price for natural gas in the United States reflects some short-run, or transitory, features of the market. However, these features are not reflective of the central tendency about which price will converge. Specifically, the winter of 2011-12 was one of the warmest on record, which translated into a far below-normal winter heating demand for natural gas. Coupled with growth in production from shale gas, this triggered a large surplus in natural gas inventories, which, in turn, pushed price well below where it would typically be

[3] Although we do not explore it in any detail here, there is also the issue of economic efficiency that should be addressed. In particular, the efficient allocation of resource rents should fully reflect the opportunity costs of alternatives so that no other allocation would be overall welfare improving.

during winter. In fact, it touched below $2 per mcf this winter. The subsequent response in the U.S. market has been as expected—reductions in gas-directed rig counts and increases in natural gas demand at the expense of coal in power generation—thus pushing price up by early August to about $3.20 per mcf. While prices could fall over the next few months as inventory levels approach capacity, the long-term sustainable price must reflect the marginal cost of supply.[4] Our work at the Baker Institute indicates this is likely in the $4 to $6 per mcf range for the next couple of decades. Of course, unexpected events can cause short-term deviations from this, but market responses should generally push prices back toward their long-run equilibrium level.

Identifying unexpected, transitory events is crucial to characterizing the current natural gas market. As we shall argue below, in addition to the current weakness in U.S. market price, the strength seen in Asian prices coincides with the unexpected increase in demand due to the phased shutdown of all of Japan's nuclear reactors in the wake of the disaster at Fukushima in March 2011. This demand shock created tightness in the LNG market that has dramatically influenced the spot price of LNG in Asia. In general, unexpected changes in demand can create transitory price movements, both up and down, because supply cannot react quickly enough. We will present evidence below that this point is critical to understanding the current state of domestic and international natural gas markets, and how markets are likely to evolve over time.

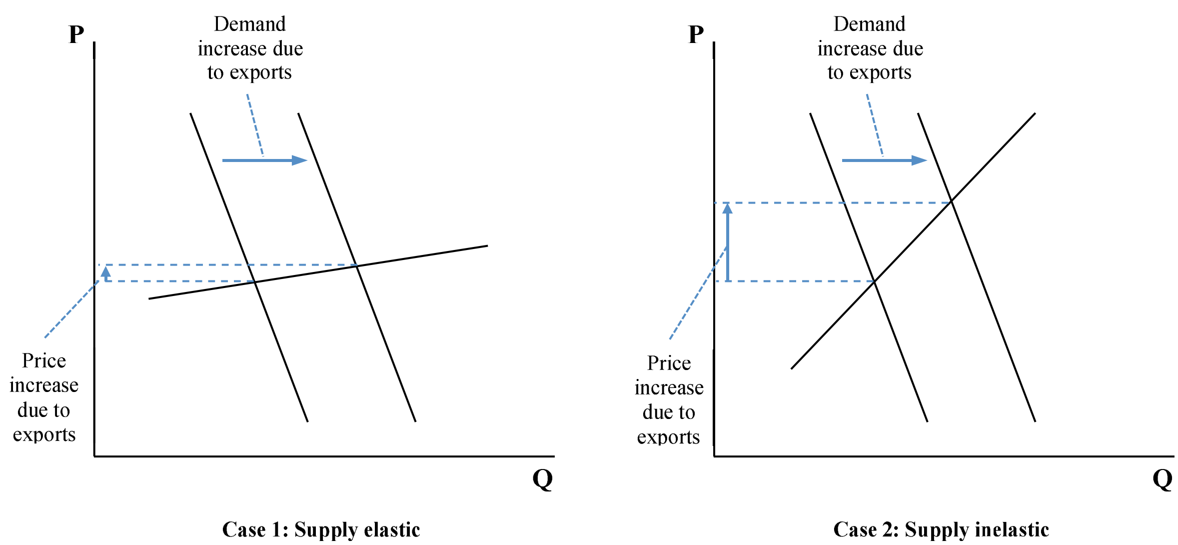
Finally, this paper will argue that the lens that has been offered to policymakers to address the question of U.S. LNG exports is inappropriate because it assumes a level of exports without accounting for the international market reaction. The question before policymakers is one of licensing a capability, not licensing a fixed volume. Therefore, this issue must be viewed in the context of international trade if informed policy decisions are to be made.

[4] In fact, the natural gas price could fall as we approach the end of the injection season. In particular, if summer electricity demands are not sufficient to offset production volumes, then inventories could approach capacity as October nears. This could result in the use of emergency balancing procedures, such as the issuance of operational flow orders, in which case price would likely fall dramatically. However, absent another warm winter, price should rise as the market rebalances going into 2013.

U.S. LNG Exports as a Simple Trade Problem: The Basic Paradigm

Generally, when analyzing this problem, an assumption is made that a certain quantity of exports will occur by a particular date. The resulting impact on domestic price is the centerpiece of the analysis, and the outcome is entirely driven by the responsiveness of domestic supply to the increase in "demand" implied by the export quantity. In other words, as indicated in Figure 1, we shift the demand curve out and the impact on price depends on the steepness of the supply curve. In short, the more *elastic* (flatter or price responsive) domestic supply is, the lower the impact on price for a given increase in exports.

Figure 1. The Elasticity of Domestic Supply and the Impact of Exports on Price



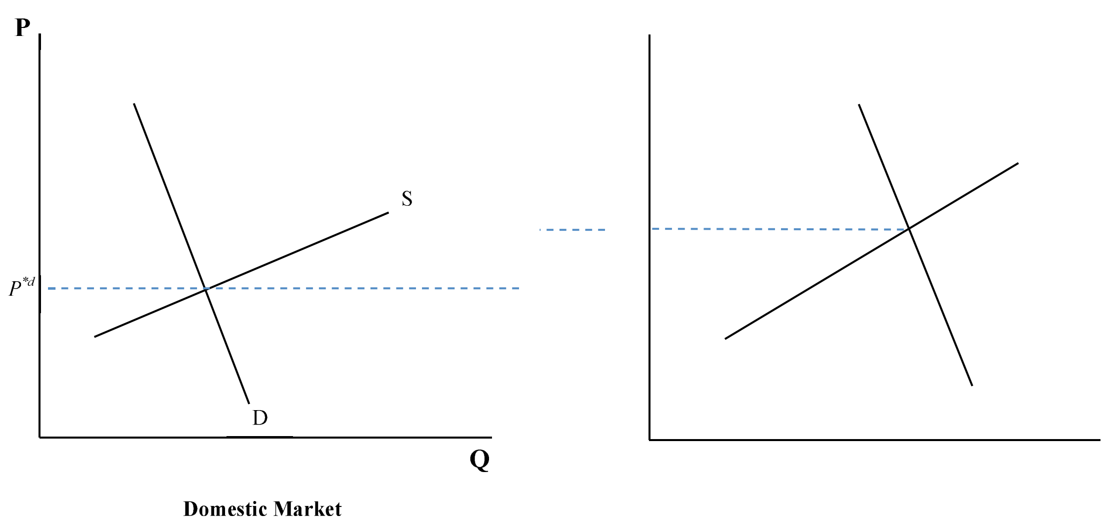
One fundamental flaw in this type of analysis is that it ignores the effects on price in the importing market and therefore any feedback that may occur. For example, consider Case 2 in Figure 1, where domestic price significantly increases for a given export volume. We then have to ask ourselves how likely it is that the assumed export volume (indicated by the increase in demand) would occur. The very reason the incentive to export exists is because there is a consumer in a foreign market that is willing to pay a certain margin (which covers the cost of the trade) above the domestic price. Will that price differential persist if the domestic price rises substantially? In addition, we have to ask, what if the price in foreign markets also falls as a result of the additional supply of exports from the U.S.? To answer these questions, we must assess both the domestic market *and* the foreign market in order to fully understand the implications of U.S. natural gas exports.

The answers to these questions are obviously very important for domestic export policy considerations. In particular, it could be that price adjustments both domestically and abroad render exports from the U.S. to be very small, in which case the subject of licensing firms to export would bear very little risk for higher domestic prices, but the exporting firms could bear a large commercial risk. In any case, it is important that the problem be analyzed in an appropriate manner so that policies are properly informed.

A Basic International Trade Model

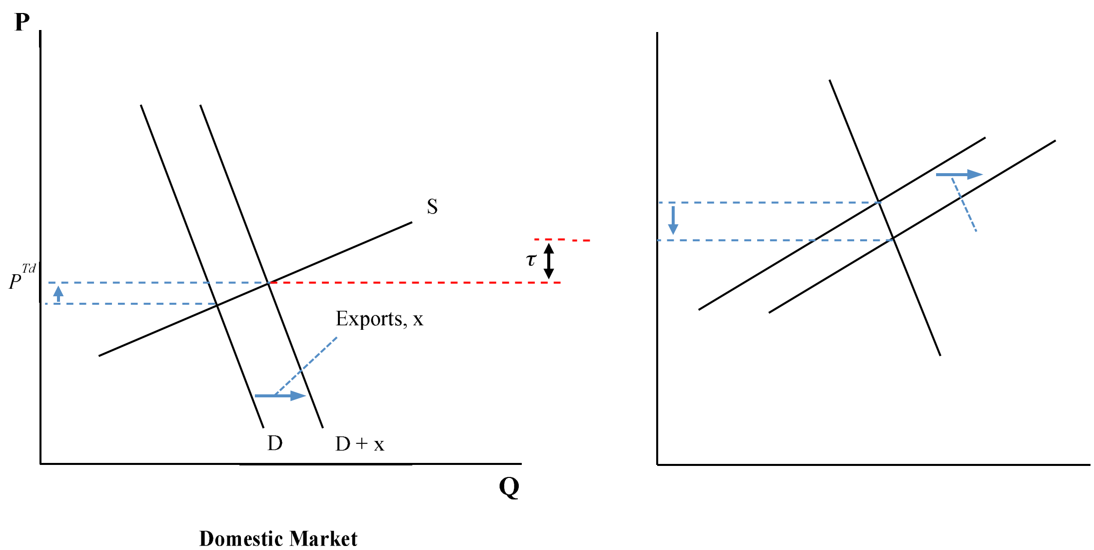
Let's consider our problem in the context of an international trade model. In Figure 2, we have a domestic and a foreign market. First consider an autarkic equilibrium, that is, one in which there is no trade. The supply-demand equilibrium in the domestic market yields a price below that of the supply-demand equilibrium in the foreign market. If the spread between the two prices, which is denoted as $P^{*f} - P^{*d}$ in Figure 2, exceeds the cost of liquefaction, shipping and regasification, it leads to an "arbitrage opportunity" that domestic suppliers would like to exploit.

Figure 2. Domestic and Foreign Market with No Trade



Once we establish there is indeed an arbitrage opportunity, we can now examine the impact of allowing trade between the domestic and foreign market. In Figure 3, we depict the effect of allowing exports from the domestic market to the foreign market.

Figure 3. Domestic and Foreign Market with Trade



Notice that price rises in the domestic market, as was indicated in Figure 1, but price also falls in the foreign market, a result not gleaned from the simple "domestic-only" analysis considered in Figure 1. If markets were left unconstrained by policy, an equilibrium would be reached in which price in the two markets only differs by the transport cost[5] associated with trade, indicated as τ in Figure 3. Importantly, if exports exceed x, the price difference will collapse such that $P^{Tf} - P^{Td} < \tau$, meaning trade will not be profitable because it will not cover transport costs. It is precisely this point that is explicitly not considered in the simple domestic-only analysis of the price impacts of LNG exports. Moreover, this point is extremely important from a policy perspective. If the price differential between the foreign and domestic markets is reasonably responsive to the introduction of trade, then licensing exports will not necessarily result in large export volumes.

[5] Henceforth, we refer to the sum of liquefaction, shipping, and regasification costs simply as "transport costs."

In general, trade theory tells us that in the long run, as market participants seize arbitrage opportunities, prices will adjust thereby eliminating additional trade. Thus, we must consider the possibility that not all of the export proposals that currently seek certification approval will move forward. Moreover, it is possible that at least some export capacity, once constructed, will remain underutilized. In the short run, however, demand shocks and other transitory factors may present profitable arbitrage opportunities that will see export volumes increase on occasion. But, these will generally be fleeting, and they certainly won't support large-scale capital investments in export capacity.[6]

The discussion above illustrates the importance of analyzing LNG exports from the U.S. in the context of *international* trade.[7] Importantly, the discussion around Figure 3 focuses on long-run equilibrium. As such, we will now refocus the discussion to include short-run factors so that we can expand on the framework introduced above to examine the current market environment and the implications for trade and domestic and international pricing.

U.S. LNG Exports: The Current Market Reality

To begin, we must comment on the shapes of the supply curves in the U.S. and abroad, in other words, what is the appropriate elasticity of supply to inform our analysis.[8] Without doubt, the elasticity of supply in the North American gas market is substantially larger since the emergence of shale. Using data from the recently completed Baker Institute study, "Shale Gas and U.S. National Security," we estimate that the elasticity of supply in the United States post-shale has

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[6] As an illustrative microcosm of the principles of trade theory in practice, we can consider what occurs in the U.S. domestic natural gas market. Arbitrage opportunities occasionally present themselves as large differences in regional prices. If pipeline capacity is sufficient between the two regions, marketers will quickly eliminate the pricing difference through trade by scheduling shipments across the pipeline. If pipeline capacity is not sufficient, pipeline developers will evaluate the opportunity to add capacity. In particular, if the regional price differences are due to short-term factors, capacity will not generally be added. But, if the regional price differences are due to more structural elements, then capacity will generally be added. In either case, the responsiveness of price to trade in both regional markets is a critical determinant to the capacity investment decision.

[7] The analysis uses a very basic construct in trade theory that can be complicated substantially if one wants to employ more modern tools of international trade theory. However, the basic lesson is the same, so for brevity and ease of exposition, we use a relatively basic analysis.

[8] Note that we do not focus on the elasticities of demand because in both the domestic and foreign markets, demand is being driven by growth in power generation requirements. Given the lack of technological differences, the availability of competing fuels and fact that demand for natural gas is relatively own-price inelastic in all major end-use markets—generally varying between 0.15 and 0.3 according to Baker Institute analysis—we focus instead here on the relative elasticities of supply. In fact, allowing for variable elasticities of demand will tend to reinforce the results herein.

risen over five-fold, from 0.29 to 1.52.[9] So, Case 1 from Figure 1 above is the most realistic representation of the supply picture in the U.S. In effect, additional shale resources can be exploited with only slightly increasing costs. This, in turn, has effectively stretched the domestic supply curve, rendering it relatively flat at a price between $4 and $6 per mcf.[10]

The aforementioned elasticity of supply in the U.S., so estimated using the RWGTM, is best characterized as a *long-run* elasticity. In other words, it is the elasticity that would apply if all actors in the market are able to fully respond to expected events. This contrasts to a *short-run* elasticity, which would be smaller and also more appropriate when gauging the price and supply response to an *unexpected* occurrence, such as a demand shock. When considering the price impact of *expected* events, such as the opening of an LNG export terminal, the long-run elasticity is a more appropriate representation of supply responsiveness. Producers know the additional market "demand" in the form of exports is coming as the development plans are common knowledge. Thus, the additional demand should not be treated as an unknown. This is an important and often misunderstood point when modeling the likely impacts of LNG exports from the U.S. In fact, using a short-run elasticity in this instance is akin to assuming LNG exports come as a surprise.

How do we characterize the current foreign market? Figure 4 indicates the effect of an increase in demand in the foreign market (a move from *D* to *D'*) in the face of a short-term constraint on the ability to deliver supplies (where the constraint is represented by the vertical portion of the supply curve, *S*). Deliverability constraints often arise in the short term, particularly when there is an *unexpected* increase in demand. The situation can be more pronounced when storage capacity is lacking and/or there is an inability to physically hedge against unexpected events. Basically, it takes time to develop new supply capacity and a sudden, unexpected increase in demand can result in short-term capacity constraints becoming binding.

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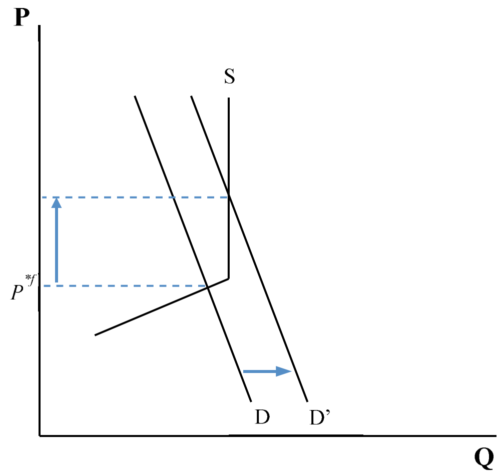
[9] "Shale Gas and U.S. National Security" was sponsored by the Office of International Policy and Affairs of the U.S. Department of Energy. The study was released in June 2011, and is available online at http://www.bakerinstitute.org/news/shale-gas-and-us-national-security.

[10] One might question the validity of this assertion given that the current price is below this range. However, as argued above, the current price environment is at least partly due to an unexpectedly below-normal winter heating demand coupled with continued growth in domestic supply; it does not reflect long-run marginal cost.

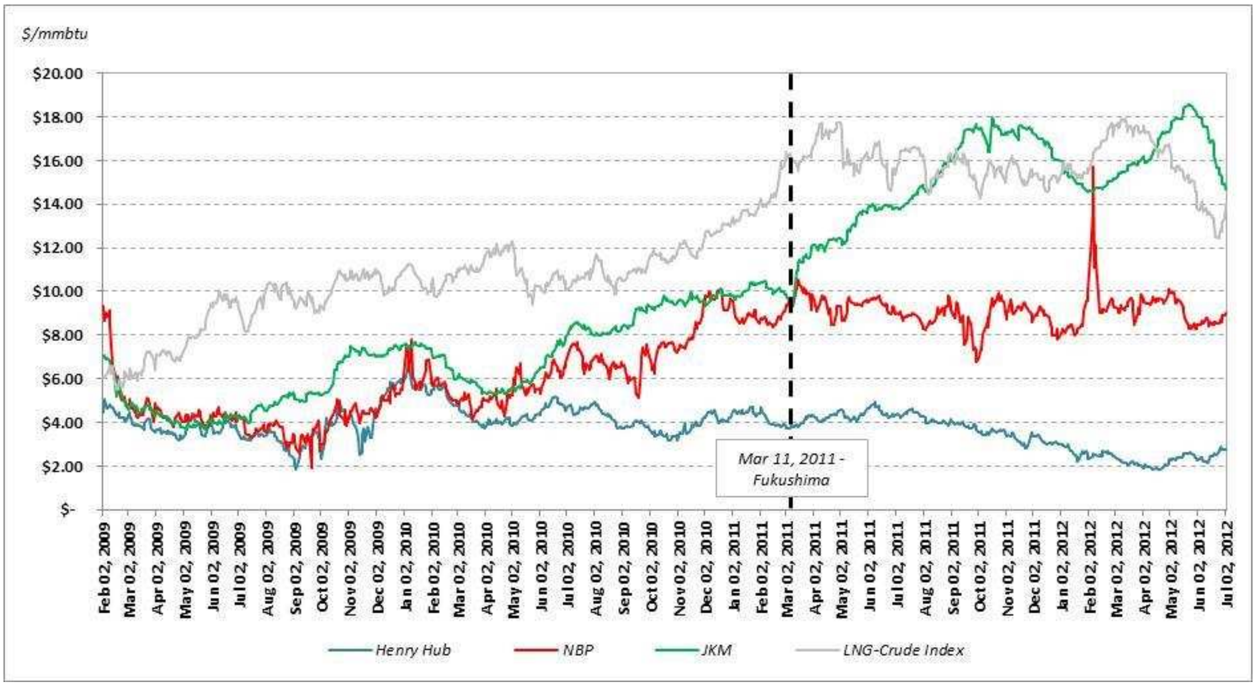
Figure 4. The "Foreign" Market for Natural Gas



This argument is illustrated by the aftermath of the disaster at Fukushima in Japan in March 2011. Following the tsunami, the resulting nuclear accident sparked safety concerns that ultimately led to the closure of all of Japan's nuclear power generating capacity by early 2012. This, in turn, dramatically increased Japanese utility demand for LNG. This is depicted in Figure 4 as a shift in the demand curve from *D* to *D'*. The subsequent increase in the price of LNG deliveries was substantial. In fact, the Platts Japan/Korea Marker price, which is the benchmark daily assessment of the spot price for cargoes of LNG delivered ex-ship to Japan or Korea, increased dramatically following the incident at Fukushima. Moreover, the price increase continued in the following months as the phased shutdown of all of Japan's nuclear plants commenced (see Figure 5).

Figure 5 indicates the prices of natural gas at the U.S. Henry Hub (HH), the UK National Balancing Point (NBP), the Platts Japan/Korea Marker (JKM), and a representative crude-indexed LNG price from 2009 to the present. Following the nuclear incident at Fukushima and the subsequent phased shutdown of all of Japan's nuclear reactors, the JKM price is markedly different. In fact, as can be seen in Figure 5, JKM jumps markedly relative to both NBP and HH after Fukushima, and, in fact, it approaches oil-indexed parity.[11] This is precisely what we would expect in the face of a constraint on deliverability of LNG to the Asian market.[12] The implication is that the price difference that currently exists between Asia and the rest of the world is at least partially the result of short-term constraints, or transitory factors, meaning they should not be expected to persist. In fact, the pre-Fukushima pricing relationship between JKM and NBP can be expected to re-emerge as both new LNG delivery capacity is brought online, new sources of supply are developed and, in particular, if Japan's nuclear reactors are restarted.

Figure 5. Global Marker Prices (Daily, Feb. 2, 2009–July 31, 2012)



Sources: Platts, U.S. Energy Information Administration, author's calculation

In general, dramatic increases in price will occur when demand increases unexpectedly in the presence of a supply constraint. This is consistent with *short-term* supply being highly *inelastic*. In other words, in the LNG market, supply was not capable of fully responding to the *unexpected* increase in demand, so price had to rise.

[11] Note, the LNG-Crude Index is constructed using the formula $\textit{LNG-Crude Index} = 0.14 \times \textit{Brent}$, so it should be viewed only as an approximation. The terms of specific oil-linked contracts will vary, sometimes dramatically, from this formula. Moreover, the Index so constructed is provided only as a point of reference.

[12] It is also worth noting that the standard deviation of the spread of daily prices between NBP and JKM is 2.12 times higher post-Fukushima. This is also consistent with the emergence of a constraint on deliverability to Asia.

This raises another very important point about liquidity and the evolution of regional gas markets—an ability to arbitrage regional price differentials will force prices into relative ranges defined by transportation costs. A lack of capability to arbitrage current regional price differences allows prices to drift apart dramatically. If the U.S. develops export capability, an additional arbitrage mechanism will be introduced. All else equal, this will force a shift in the relative nominal prices of gas in markets around the world to a long-run equilibrium set of differentials that is defined by transportation costs and currency values.

Figure 6. The "Foreign" Market Price Impact of LNG Exports from the United States

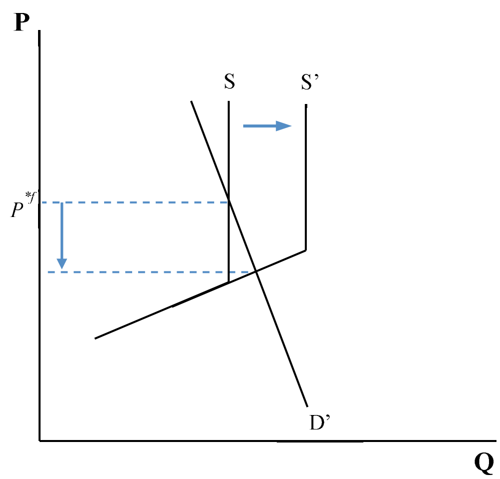


Figure 6 helps to illustrate this point. If one adds supply to a supply-constrained market, the price in that market will fall precipitously, all else equal. In the case of the Asian natural gas market, supply will almost certainly be added—whether it is as LNG exports from the U.S. or other sources of supply via pipeline or LNG to Asian consumers—precisely because the high near-term price encourages such a response. In Figure 6, we see that the price of natural gas paid by LNG importers in Asia will fall substantially when the current deliverability constraint on supply is relieved. Thus, to the extent that Figure 6 represents the Asian LNG market, the addition of, say, LNG supply from the U.S. will have a very large effect on prices paid by foreigners, as will the addition of any new incremental supplies. Moreover, the recommissioning of Japan's nuclear fleet, should it occur, will exacerbate the price decline by reducing demand.

The above becomes even more salient when one considers the volumes being discussed. Global LNG trade in 2011 totaled 32 bcfd, according to the *BP Statistical Review of World Energy, 2012*. Currently, in the U.S. alone there is over 17 bcfd of export capacity in various stages of proposal and development, which represents over 50 percent of current traded volume. If even one-third of this capacity is built and placed into operation, it will dramatically alter the ability to supply the Asian market with natural gas.

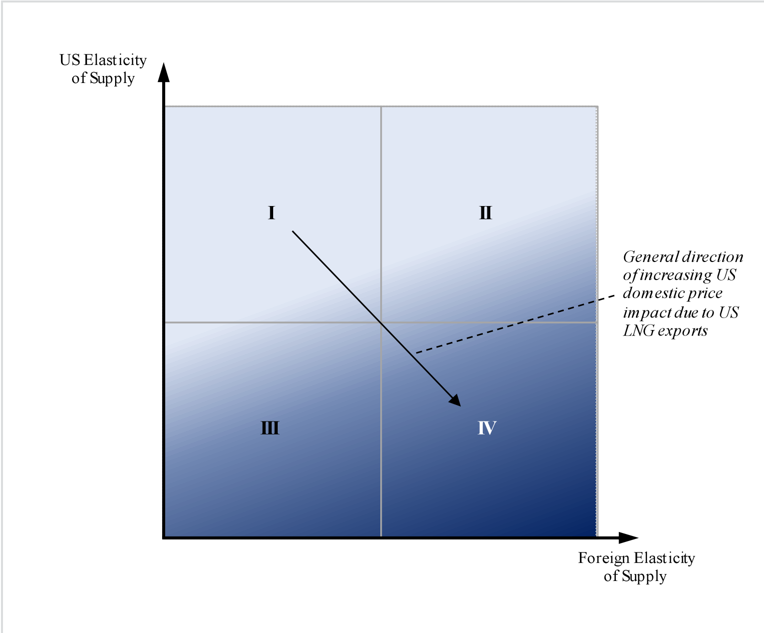
The preceding highlights a very important point when considering both the long- and short-run price effects of trade in domestic and foreign markets. The *relative* elasticities of supply will determine the extent to which prices rise (or do not rise) in the traded markets. This point is lost in a U.S.-centric analysis. Moreover, the point is of considerable importance when considering U.S. policy on exports. In particular, if the market abroad is short-term supply-constrained (meaning supply is inelastic) and the domestic market is supply elastic, then the majority of the price movement that will occur when trade is introduced will be abroad.

A Rule of Thumb Approach

A general approach to analyzing the effect of LNG exports on both foreign and domestic prices, and in fact the commercial viability of incremental export proposals, is illustrated in Figure 7. Figure 7 summarizes the incidence of U.S. exports on domestic price for a range of possible scenarios. Moving from the upper left-hand side of Figure 7 to the lower right-hand side (or moving from Quadrant I to Quadrant IV), we see an increasing impact of trade on U.S. price. So, the U.S. domestic price impact of U.S. LNG exports increases as the *relative* elasticity of supply in U.S. falls. In other words, if U.S. supply is highly elastic and foreign supply is highly inelastic, then the U.S. domestic price impact will be very small, but the price impact abroad would be substantial. Note that this situation would erode the current price difference that exists between the U.S. natural gas price and the price abroad quite substantially.

Figure 7, although it is only qualitatively illustrative, can also allow us to make some inference on the overall profitability of U.S. LNG exports. For example, if the elasticity of supply in the foreign market is very high *and* the elasticity of supply in the U.S. is very low, then the foreign price will not change much as a result of U.S. LNG exports, but the U.S. price would increase a lot. This is, of course, the scenario causing many policymakers concern, but it is the least likely outcome.

Figure 7. The Incidence of U.S. Exports on U.S. Price



To the discussion of Figure 7, as we move into Quadrant II, the price differential will remain the largest for a *given* volume of trade. Thus, if the elasticity of supply in both markets is large, the price in both markets should not change by a significant amount when trade commences, meaning there will be rents associated with export capacity. Importantly, this is not meant to represent that *any* trade is more profitable; rather, it is meant to indicate that the *marginal* trade is generally more profitable. The implication is that if Quadrant II describes the situation in the market, then a large volume of trade is possible with little effect on price in either market. This, in turn, means that owners of U.S. LNG export capacity will generally receive large rents.

An important point of caution is warranted here. A situation described by Quadrant II in Figure 7 can only persist in the long run if suppliers in the U.S. markets are willing to forego future LNG export capacity expansion in the face of large rents. In addition, it would be necessary for supply in the foreign market, given that it is highly elastic in this case, to be generally more costly than

U.S. supply. In other words, the foreign market must be characterized by a long, flat supply curve at a relatively high price.

However, neither of these conditions is likely to be true. For one, given the current push to license and ultimately construct LNG export terminals in the U.S., it is highly unlikely that developers would be willing to forego profits associated with LNG exports, unless of course they are unable to export due to a prohibitive act of a regulatory authority. Moreover, Baker Institute analysis of the quantity and cost of supply around the world indicates that there is a large amount of natural gas available outside of North America, assuming political and regulatory factors do not prohibit investment, and that the long-run development cost of that supply is certainly not substantially higher than supplies available in the U.S. This is particularly true in regions with high quantities of associated liquids, such as many currently producing regions in the Middle East and Africa.

As alluded to above, the scenario of most concern to policymakers is one where the U.S. spot price will rise to the *current* international price. This outcome can only be true if U.S. domestic supply is perfectly inelastic (meaning production is *absolutely* unresponsive to an increase in demand), and rest of world supply is perfectly elastic (meaning additional supply from the U.S. will not alter the price of the marginal supply abroad). If this is the case, then indeed the U.S. price would rise dramatically, and Quadrant IV in Figure 7 is the best descriptor of the market. Moreover, if this were the case, then the increase in domestic price would eliminate the profitability of trade, meaning that although price rises domestically, very little (if any) export would actually occur. Finally, if one adheres to the view that U.S. supply is perfectly inelastic, then it must also be true that any source of additional demand will cause price to rise, whether it is from the introduction of LNG exports or increased domestic use.

The Viability of U.S. LNG Exports

The prospect of exporting LNG from the U.S. to consumers in Asia and Europe arises from the fact that spot prices for natural gas in both Europe and Asia are well above the current spot price at Henry Hub, as indicated in Figure 5, so much so that any trade evaluated at current market conditions looks very profitable. However, *current* market conditions do not define long-term commerciality of a trade; *future* market conditions do. Therefore, we must develop an assessment of the future given our state of knowledge today. To evaluate the likelihood of long-term profitable LNG exports from the U.S., we used the latest Reference Case of Rice World Gas Trade Model (RWGTM). In short, the Baker Institute projects that the next three decades do not indicate a future in which exports from the U.S. Gulf Coast are profitable in the long term, at least not if developers are seeking a competitive rate of return to capital.[13]

As outlined above, we know from international trade theory that upon the introduction of U.S. LNG exports, the degree to which the price in the U.S. increases and the degree to which the price abroad decreases will be dependent on the relative elasticities in the two markets. So, we simply need to assess the relative elasticities in the two markets to determine what is likely to happen in practice.

In the U.S. market, domestic production has risen dramatically in the past few years resulting in prices being driven down from double-digit highs in 2008 to the current environment in the low $3 per mcf range. Aside from the lack of heating demand this past winter, the softening of price in North America since 2008 is the result of innovations that have made recovery of natural gas from shale a commercial reality, and is indicative, more generally, of a domestic supply curve that has become relatively elastic. Notice, when evaluating the domestic price impacts of LNG exports, this should push our focus into the upper half of the diagram in Figure 7.

An important point is worth emphasis here. We mention above that the long-term equilibrium price is likely to be in the $4 to $6 per mcf range. The current price environment is at least partly the result of an unexpected negative shock to demand in the U.S. In other words, we had a warm winter, which means demand is unexpectedly below normal, even with the current weakness in the U.S. economy. Being unexpected, producers can only respond after the fact. This is another example of a short-term constraint (on demand in this case) that has exacerbated the current price spread between North America and the rest of the world. It also means that the correct point of

[13] The Rice World Gas Trade Model (RWGTM) has been developed by Peter Hartley and Kenneth Medlock III of Rice University using the *MarketBuilder* software program available from Deloitte MarketPoint, Inc. More information on the RWGTM is available from the author upon request.

reference when considering the impact of LNG exports from the U.S. on domestic prices is the long-run equilibrium, since that is where prices will settle even without exports.

Also in the last couple of years, increases in demand in Asia have tended to push price up. Moreover, given the lack of alternatives/competition for Asian consumers in particular, large rents are being earned in the short run by LNG suppliers to the Asian market. This all stems from the realization of a short-run capacity constraint, or a situation where supply is highly inelastic. Again referring to Figure 7, this will tend to push us into Quadrant I, meaning the introduction of LNG exports from the U.S. will likely see most of the price response in the foreign market as the short-run capacity constraint abroad is relieved.

Under virtually every condition described by Figure 7, the current price differential that exists between the U.S. natural gas price and prices overseas will fall with the introduction of U.S. LNG exports. Of course the volumes associated with a particular decline in the price spread will depend on the relative elasticities. In particular, if we move to the far upper right corner of Quadrant II, a large volume would be needed to erode the price differential. However, moving toward virtually any other corner on the diagram will require very little traded volume to see the price difference collapse.

Given the short-run nature of the supply constraint in Asia, one should also expect that competing potential opportunities to provide natural gas supplies to the Asian market will be evaluated and perhaps even taken. Examples of competing projects could include development of unconventional resources in Asia, pipeline import options from Russia, Central Asia, and/or South Asia, and/or competing LNG supplies from Australia, East Africa, the Middle East, and/or North America. In other words, the current arbitrage opportunity is being aided by short-run *in*elasticity of supply in and to Asia. In the long run, this cannot be expected to persist, and the development of new supplies from outside the U.S. will only serve to further erode regional price differentials, all else equal.

Indeed, modeling at the Baker Institute indicates that prices outside of North America will likely soften relative to their current levels. This reflects several factors:

- For one, longer term shale developments in places such as China, India, Australia, and several countries in Europe will become commercially attractive in price environments in excess of $7 per mcf. Thus, foreign shale supplies effectively serves as a sort of backstop on long-term prices.
- Secondly, the development of pipeline supplies from Russia, Central Asia, and South Asia to China will displace the need for LNG. This frees up those supplies for consumers in Korea and Japan. So, pipes serve as another point of competition for LNG longer term, particularly in developing continental markets.
- Third, exchange rate movements will affect dollar-denominated supplies abroad. In particular, if the U.S. dollar strengthens relative to its recent historical lows against major traded currencies, the evaluation of dollar-denominated arbitrage opportunities will change. This will tend to lower the current spreads between the U.S. and Asia and the U.S. and Europe, but importantly, this will not be due to any fundamental shift in the physical value of the commodity. Effectively, a stronger dollar makes dollar-denominated commodities more expensive.
- Fourth, growth in competition will foster increased liquidity, and a movement away from the traditional pricing paradigm of long-term oil-linked contracts. Importantly, there is no guarantee that movement away from oil-indexation will result in natural gas prices falling longer term relative to crude oil; rather, a lack of oil-indexation should only mean that gas will be priced according to marginal cost.

Each of these points has implications for U.S. LNG exports to Asia and Europe.

Global Shale Gas Opportunities and Foreign Supply Developments

Relatively high prices in Europe and Asia have already encouraged supply responses from shale and other resources in those markets. While the initial forays into shale in Europe and other regions have proven to be more costly than the experience in the U.S., much of that is due to lack of equipment and personnel and will likely prove transitory as high quality opportunities are identified. The prospects for shale developments longer term in China, in Australia, and in Argentina (which could serve the Pacific basin via LNG) all look promising. With the Chinese natural gas market expected to be the primary source of growth for LNG suppliers in the coming decades, the large assessments for recoverable shale gas in China is certainly something to be considered.[14]

Aside from unconventional natural gas resources, recent finds in offshore basins in the Eastern Mediterranean and East Africa may prove to be highly competitive resources that can serve demands in both Europe and Asia. While these sources of supply in particular would have to be transported as LNG, there are also viable sources of supply in both Western Siberia and Eastern Russia that could be transported by pipeline to Asia. In addition, Iraqi supplies by pipeline to Europe also remain a potential. To make matters more complex, supplies from Central and South Asia already or soon will enjoy pipeline links to China, and discussions continue regarding alternatives for Central Asian supply routes to Europe.

Altogether, the evidence is substantial that the long-run supply curve outside of North America is much more elastic than the current market might indicate, and development of these supplies will ultimately bring prices down. In fact, this is a major point of competition for U.S. LNG export projects currently under consideration. Specifically, if shale opportunities in Europe and Asia, and other sources of imported pipeline and LNG supply can be brought to market, then growth in global production will put downward pressure on prices everywhere. Of course, geopolitical and regulatory uncertainties and constraints could overwhelm commercial considerations, but even if these "above-ground" constraints do exist, they would have to be substantial, widespread and persistent given the number of competing supply opportunities that exist in the longer term.

In sum, U.S. LNG exports face risk from foreign supply developments. This is eerily reminiscent of the rush to build LNG import capacity in the U.S. in the early 2000s, which ultimately turned out to be *ex post* ill-conceived investments due to U.S. domestic supply response.

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[14] In fact, the Baker Institute paper authored by Kenneth B. Medlock III and Peter Hartley entitled "Quantitative Analysis of Scenarios for Chinese Domestic Unconventional Natural Gas Resources and Their Role in Global LNG Markets" revealed that shale gas developments in China could be every bit as game-changing over the next couple of decades as shale gas developments in North America have been in the last decade. The study is available online at http://www.bakerinstitute.org/publications/EF-pub-RiseOfChinaMedlockHartley-120211-WEB.pdf.

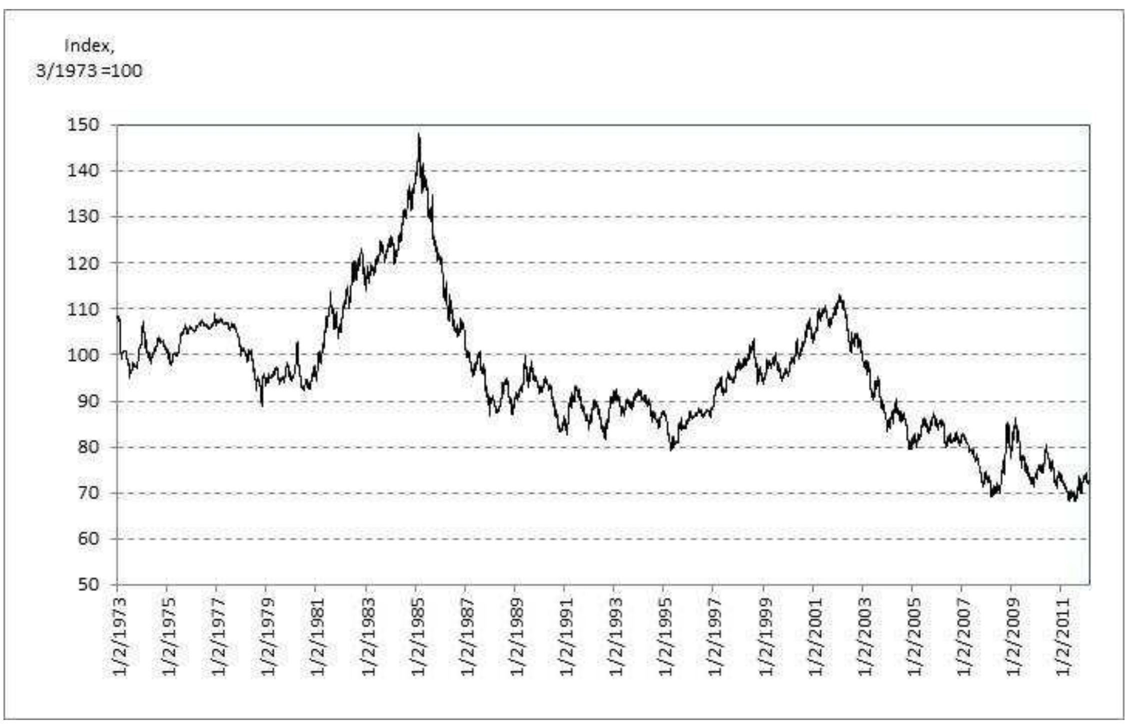
The Exchange Rate and Arbitrage Value

Another important factor to consider when evaluating arbitrage opportunities presented by current market conditions is the role the exchange rate plays. As a simple example, consider the potential for arbitrage between the U.S. and UK. Natural gas is traded in pence per therm in the UK and dollars per mmbtu in the U.S. In order to evaluate the benefits of trans-Atlantic arbitrage, one must first apply an exchange rate between the £UK and $US. In particular, we can represent the value of the trade as

$$P_{US} - P_{UK} \cdot XR \cdot HR = arb\ value$$

where *XR* is the exchange rate denominated as £/$ and *HR* is the heating conversion from therm to mmbtu. All else equal, if the dollar weakens against the pound, *XR* will decrease. In turn, the *arb value* will rise for no reason related to the physical gas market conditions in either location. Thus, the risk of exchange rate movements is very real for potential LNG exporters.

Figure 8. Trade-Weighted Value of U.S. $, Major Currencies (Daily, Jan. 1973–July 2012)



Source: U.S. Federal Reserve Bank

This issue is made more salient when one considers the value of the U.S. dollar against internationally traded currencies at the present time. Figure 8 indicates the U.S. dollar value against major currencies as reported by the U.S. Federal Reserve Bank. This indicates that, on a trade-weighted basis, the value of the U.S. dollar is lower than it has been in the last 40 years. Any reversion toward even a historical average will ultimately shrink calculated arbitrage returns, *ceteris paribus*.

The argument above, it turns out, holds even if LNG exporters can secure oil-indexed contracts for their supplies. In a recent paper, Hartley and Medlock (2012) show that exchange rates are important in determining the crude oil-natural gas price differential when (i) there is limited capability for direct international arbitrage of natural gas but not oil prices and (ii) fuel-switching capabilities are limited.[15] Thus, currently in the U.S. where both conditions are met, the exchange rate is a very important determinant of the relative price of natural gas to crude oil. This means that a strengthening of the U.S. dollar will erode the current oil-gas spread, leaving even oil-indexed flows potentially exposed to exchange rate risk.

Contract versus Spot Prices

Brito and Hartley[16] show that growth in physical liquidity also limits the ability of a single supplier to price above marginal cost. The relative abundance of LNG, prompted by the dramatic growth in shale, also puts downward pressure on demand for pipeline gas supplies, meaning Europe and Asia see increased competition. Importantly, this has implications for the pricing terms at which existing and future supplies are negotiated. In fact, as the natural gas supply curve becomes more elastic, as is the case with an increasing abundance of shale gas, it will become increasingly difficult to price natural gas above marginal cost, meaning oil-indexation is likely to lose some of its prominence.

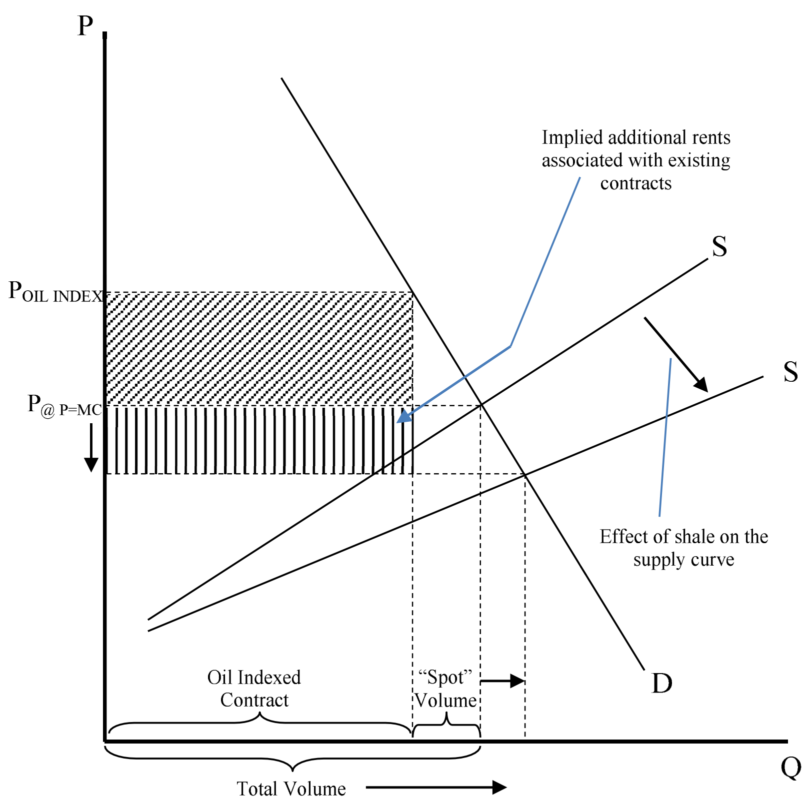
It should be noted that *spot* prices are the primary focus of this discussion. In point of fact, *contract* prices can be substantially different from spot market prices. This is particularly true

[15] See Peter R. Hartley and Kenneth B. Medlock III, "The Relationship between Crude Oil and Natural Gas Prices: The Role of the Exchange Rate," submitted to the *Energy Journal.* Manuscript available upon request.
[16] Peter Hartley with Dagobert Brito, "Expectations and the Evolving World Gas Market," *Energy Journal* 28, no. 1 (2007): 1-24.

when contracted supplies represent deliveries at prices that are not at the margin, meaning that they are infra-marginal. One can think of contracted deliveries, in this instance, as being the result of price discrimination.

Absent storage and physical liquidity, oil-indexation provides an element of price certainty. But, to be sure, oil-indexation can be viewed as a form of price discrimination. Figure 9 provides an illustration of price discrimination. Note that oil-indexation does not preclude the existence of spot transactions, but market structures that do not easily allow resale can severely limit them. In Figure 9, about 15 percent of the marketed volumes are sold on a spot basis, with the remaining 85 percent contracted above marginal cost.

Figure 9. The Supply Curve Effect of Shale and Implications for Price



In general, for a firm to be able to price discriminate, (1) it must be able to distinguish consumers and prevent resale, and (2) its consumers must have different elasticities of demand. Both of these conditions are met in Europe and Asia. However, an increased ability to trade between suppliers and consumers (i.e., increased physical liquidity) leads to a violation of condition (1). This is more likely to happen as the supply curve in Figure 9 becomes more elastic (flatter).[17]

Even now, evidence of a diminished ability to price discriminate is emerging in Europe as there have been multiple announcements of changes in contractual terms, with a propensity to index at least a portion of sales to spot prices. Thus, by displacement, the increase in shale production in North America has begun to have impacts on traditional pricing mechanisms in other markets. If shale resources are proven to be commercially viable in Europe and Asia, this will accelerate, and the "new normal" could very well be characterized by more intense competition.[18]

This shifting dynamic can be explained by the fact that shale gas has effectively made supply more elastic, the effect of which is indicated in Figure 9. As the elasticity of supply increases, the rents associated with contracts that are priced above marginal cost also increase. This, in turn, triggers calls for renegotiations of contracts between suppliers and demanders.

Of course, a critical element of this argument is that the increased elasticity of supply is directly related to new entrants to the global gas market. If the new supply from shale gas was in the hands of a single large producer, then that producer could continue to price discriminate effectively. It is critical that the increased elasticity be associated with multiple new market entrants so that liquidity is indeed enhanced. In the case of shale gas, there is considerable emergence of new suppliers to the global market as shale gas production increases.

The LNG Arbitrage Opportunity

Although the North American market remains one of the lowest priced regions globally, according to Baker Institute analysis using the Rice World Gas Trade Model (RWGTM), the

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[17] This will also happen in a liberalized market where trading of capacity rights is allowed, insomuch as the arbitrage allows price signals to clearly transmit. This promotes entry and, to the extent that hubs develop, financial liquidity. Once that occurs, the means to use capital markets to underwrite physical transactions increases and liquidity grows, thus making it difficult to price discriminate.

[18] For more detailed discussion of the competition of fuels and greenhouse gas implications, see "Energy Market Consequences of an Emerging U.S. Carbon Management Policy," published by the James A. Baker III Institute for Public Policy at http://bakerinstitute.org/programs/energy-forum/publications/energy-studies/energy-market-consequences-of-an-emerging-u.s.-carbon-management-policy. Baker Institute analysis showed that the United States was likely to make a major shift away from carbon-intensive coal use to a higher proportion of consumption of domestic natural gas, easing the increase in greenhouse gases that would come about from rising U.S. energy use.

differences between the JKM price and Henry Hub and the price at NBP and Henry Hub are not sufficient to support long-term baseload LNG exports from the U.S. Gulf Coast to these regions. Table 1 summarizes this point.

Table 1 indicates the cost of the gas at inlet to a generic terminal in the U.S. Gulf Coast for 2011 and then on a decadal annual average basis for the next three decades. To be sure, the inlet price can vary depending on location, but for this example we assumed a $0.20 discount to Henry Hub. Next, we add the cost of liquefaction, which is derived assuming a 10 percent real return on an $8 billion investment in liquefaction capacity with a 20-year plant life. Then, we add the cost of transporting the gas via LNG tanker to the market of destination, which for the purpose of this example is assumed to be either Tokyo or the UK. This yields a "Landed Cost" for LNG sourced from the U.S. Gulf Coast to each market. We then compare this cost to the spot market price, as simulated by the RWGTM, in both potential destinations to examine the margin on exports. Interestingly, the only time in which the export margin is positive, indicating a profitable trade including a return to capital, is in the very near term. The simulation results indicate that as current capacity constraints are alleviated, the export margin turns negative, indicating trade that becomes unprofitable.

Table 1. The Prospect of U.S. LNG Exports (LNG Export Margin – Averages)

	2011	2011-2020	2021-2030	2031-2040
Feed gas cost ($/mcf)	$ 3.80	$ 3.98	$ 4.69	$ 5.26
Liquefaction ($/mcf)	$ 2.92	$ 2.92	$ 2.92	$ 2.92
Transport cost ($/mcf)				
UK	$ 1.07	$ 1.07	$ 1.07	$ 1.07
Japan	$ 2.15	$ 2.15	$ 2.15	$ 2.15
Landed cost ($/mcf)				
UK	$ 7.79	$ 7.97	$ 8.67	$ 9.25
Japan	$ 8.87	$ 9.05	$ 9.75	$ 10.33
Market price ($/mcf)				
NBP	$ 8.84	$ 7.47	$ 7.44	$ 8.09
JKM	$ 11.73	$ 8.08	$ 7.98	$ 8.46
Export margin ($/mcf)				
UK	$ 1.06	$ (0.49)	$ (1.23)	$ (1.16)
Japan	$ 2.86	$ (0.96)	$ (1.77)	$ (1.87)

It is important to note that the focus in Table 1 is on the U.S. Gulf Coast. This is done due to the fact that installing liquefaction trains at existing regasification terminal locations generally bears a lower incremental fixed cost. In effect, developers seek to turn around terminals that were built initially as import locations. If we were to analyze other export opportunities, such as proposals at Jordan Cove on the West Coast, at Kitimat in Canada or from Cove Point on the East Coast, the fixed costs would be considerably higher. In fact, public statements indicate the fixed cost for the terminals in Canada are as much as twice the amount indicated in Table 1. This would, however, be offset somewhat by lower feed gas costs (in the case of Canada in particular the cost of gas sourced from shale in British Columbia), and lower transport costs to Asia in the case of West Coast terminals or to Europe in the case of East Coast terminals.

Importantly, even with wide variations in the various costs in Table 1, the trades do not appear profitable in the long term. In fact, it would appear that multiple factors must change in the analysis to render the U.S. Gulf Coast LNG export option commercially viable long term. This is, in fact, what drives the result in the RWGTM that no exports from the U.S. Gulf Coast occur. The RWGTM is considering *future* market conditions, not just *current* market conditions, in determining whether or not to add export capability. So, it is factoring in the full dynamic responsiveness of supply and demand in domestic *and* foreign locations.

Of course, this analysis is not considering a customer that may contract for natural gas supply at above marginal cost (in other words, “pay a premium”). This would mean, for example, that if a buyer in Japan is willing to pay upwards of $2.00 per mcf above full marginal cost, he could secure supplies from the U.S. Gulf Coast and the supplier would earn a sufficient rate of return. While most suppliers would be willing to agree to such terms, any buyer who did so would likely be holding a contract that is distinctly out-of-the-money over time.

It is entirely plausible that export capacity will be built on the expectation that current rents from arbitrage will persist long enough to “pay” for the upfront fixed cost. Moreover, once the fixed cost of a new export facility is sunk, the operating decision no longer hinges on the payment to capital; it only depends on whether or not operating costs are covered. In this case, it is likely that any terminal constructed will operate, but, according to the latest Reference Case of the

RWGTM, operation will not be at full capacity and the profit margin will not likely be sufficient to earn the *ex-ante* required rate of return, unless of course the off-take agreement includes a premium to cost.

Another possibility is that U.S. Gulf Coast LNG export capability could be intended to be used for seasonal delivery. While the annual facility load factor would be lower in this circumstance, thus raising the per unit cost, if seasonal price differences among the regional markets are sufficient, U.S. exports could in this case be profitable. Nevertheless, this does not represent a *baseload* arrangement, and would likely only be maintained as part of a portfolio arrangement for a large LNG supplier.

Finally, the opening LNG exports from the U.S. will inevitably link global markets to storage opportunities in the U.S. The U.S. has the most well-developed storage market in the world, and this is, in fact, a key factor that contributes to market liquidity. By providing a link for the rest of the world to U.S. storage capacity, the liquidity benefits could easily spill over to European and Asian markets. In fact, it would not be surprising to see Asian utilities taking storage positions in the U.S. to hedge seasonal price fluctuations. This could, in fact, accelerate the dissolution of current regional pricing paradigms, and provide more opportunities for seasonal arbitrage opportunities. But, again, this is a distinctly different type of arrangement from a baseload LNG supply deal.

Concluding Remarks

The global gas market has experienced many significant changes in the past decade. We have witnessed the emergence of shale in North America, a development that dramatically altered the global outlook for LNG markets. In fact, we have moved from a consensus view that the U.S. would be increasingly reliant on imported LNG, to one in which the prospect of U.S. LNG exports is now being discussed. In addition, most future LNG profit opportunities appear to be focused on the Asian market. But, this "all eggs in one basket" approach is not without risk, as future demands, policy-motivated fuel choices, supply-responsiveness, and unconventional gas development will each play competing roles to LNG imports in Asia.

However, it is important to recognize that the *prospect* of LNG exports from the U.S. does not equate to large scale reality. In general, regardless of the number of export licenses granted, U.S. LNG exporters face risks associated with exchange rate movements, the development of alternative foreign supplies, and the relative price impacts of introducing U.S. LNG volumes into a currently tight international LNG market. In fact, we have presented evidence above that the apparent profitable export option from the U.S. market based on *current* market conditions is transitory, as current market conditions beget a supply response abroad that erodes current price differentials. Moreover, data on regional spot prices are supportive of this notion.

Aside from the apparent commercial risks associated with LNG exports, the more salient question for U.S. policymakers regards the U.S. price response to U.S. LNG exports. This question is best answered in understanding the elasticity of the domestic supply curve. In particular, we estimate that domestic elasticity of supply is roughly 1.52 between a price of $4 and $6 per mcf, which represents a five-fold increase since the emergence of shale gas. In other words, a one percent increase in price will result in a one-and-a-half percent increase in domestic production. This means that the export of LNG in any reasonable volume from the U.S. should not have a significant impact on price at the margin. Rather, the analysis herein indicates that international market response will ultimately limit the amount of LNG that the U.S. exports as a matter of commercial rationing.

Finally, even with exports, the price in the U.S. will not likely increase dramatically. While the projected price is above today's price, this reflects a long-run sustainable price in line with the marginal cost of supply, not the impact of LNG exports. The current low price in North America reflects an oversupply that resulted partly from the abnormally warm winter of 2011-12 coupled with ill-timed domestic production growth. The marginal cost of supply is above the current price, as is evidenced by an increasing number of producers ramping down their domestic rig activities, so the price should be expected to rise before LNG exports ever eventuate. Our own simulations indicate a long-run equilibrium price in the $4 to $6 per mcf range is likely for many years to come.

The implication for policy is simple: market responses will ultimately limit export volumes. The hand-wringing about domestic price impacts is based largely on an incomplete assessment of what should be addressed as an international trade question. Even if ex-post unprofitable investments are made in LNG liquefaction capacity in the U.S., the establishment of a link from U.S. supplies to foreign markets will intensify pressure on traditional pricing paradigms, thus having potentially dramatic implications. Moreover, a direct link between the U.S. and abroad will invite foreign market players to consider taking positions in the U.S. storage market to hedge their physical positions. This will only serve to accelerate market liquidity thus lowering liquidity risk. In turn, this could alter the financing risk of LNG projects, reducing the importance of oil-linked bilateral relationships. As the story plays out, the international gas market will evolve into something dramatically different from what it is today.