

**EVOLVING GLOBAL NATURAL GAS MARKETS,
THE INCREASINGLY IMPORTANT ROLE OF
U.S. LIQUEFIED NATURAL GAS,
AND THE COMPETITIVE OUTLOOK**

**HEARING
BEFORE THE
COMMITTEE ON
ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE
ONE HUNDRED SIXTEENTH CONGRESS**

FIRST SESSION

JULY 11, 2019



Printed for the use of the
Committee on Energy and Natural Resources

Available via the World Wide Web: <http://www.govinfo.gov>

U.S. GOVERNMENT PUBLISHING OFFICE

WASHINGTON : 2021

COMMITTEE ON ENERGY AND NATURAL RESOURCES

LISA MURKOWSKI, Alaska, *Chairman*

JOHN BARRASSO, Wyoming

JAMES E. RISCH, Idaho

MIKE LEE, Utah

STEVE DAINES, Montana

BILL CASSIDY, Louisiana

CORY GARDNER, Colorado

CINDY HYDE-SMITH, Mississippi

MARTHA MCSALLY, Arizona

LAMAR ALEXANDER, Tennessee

JOHN HOEVEN, North Dakota

JOE MANCHIN III, West Virginia

RON WYDEN, Oregon

MARIA CANTWELL, Washington

BERNARD SANDERS, Vermont

DEBBIE STABENOW, Michigan

MARTIN HEINRICH, New Mexico

MAZIE K. HIRONO, Hawaii

ANGUS S. KING, JR., Maine

CATHERINE CORTEZ MASTO, Nevada

BRIAN HUGHES, *Staff Director*

KELLIE DONNELLY, *Chief Counsel*

JOHN CROWTHER, *Senior Counsel*

TRISTAN ABBEY, *Senior Professional Staff Member*

SARAH VENUTO, *Democratic Staff Director*

SAM E. FOWLER, *Democratic Chief Counsel*

RENAE BLACK, *Democratic General Counsel*

CONTENTS

OPENING STATEMENTS

	Page
Murkowski, Hon. Lisa, Chairman and a U.S. Senator from Alaska	1
Manchin III, Hon. Joe, Ranking Member and a U.S. Senator from West Virginia	10

WITNESSES

Winberg, Hon. Steven E., Assistant Secretary for Fossil Energy, U.S. Department of Energy	12
Arriola, Dennis V., Executive Vice President and Group President, Semptra Energy	23
Hart, Dr. Melanie, Senior Fellow and Director for China Policy, Center for American Progress	36
Riedl, Charlie, Executive Director, Center for Liquefied Natural Gas	90
Tsafos, Nikos, Senior Fellow, Energy and National Security Program, Center for Strategic and International Studies	102

ALPHABETICAL LISTING AND APPENDIX MATERIAL SUBMITTED

Arriola, Dennis V.:	
Opening Statement	23
Written Testimony	25
Responses to Questions for the Record	141
Hart, Dr. Melanie:	
Opening Statement	36
Written Testimony	38
Responses to Questions for the Record	142
Industrial Energy Consumers of America:	
Comments for the Record	149
Manchin III, Hon. Joe:	
Opening Statement	10
Murkowski, Hon. Lisa:	
Opening Statement	1
White paper entitled “‘With Powers So Disposed’: America and the Global Strategic Energy Competition” dated 7/11/19	3
Riedl, Charlie:	
Opening Statement	90
Written Testimony	92
Responses to Questions for the Record	145
Tsafos, Nikos:	
Opening Statement	102
Written Testimony	104
Responses to Questions for the Record	146
Winberg, Hon. Steven E.:	
Opening Statement	12
Written Testimony	14
Responses to Questions for the Record	137

EVOLVING GLOBAL NATURAL GAS MARKETS, THE INCREASINGLY IMPORTANT ROLE OF U.S. LIQUEFIED NATURAL GAS, AND THE COMPETITIVE OUTLOOK

THURSDAY, JULY 11, 2019

U.S. SENATE,
COMMITTEE ON ENERGY AND NATURAL RESOURCES,
Washington, DC.

The Committee met, pursuant to notice, at 10:02 a.m. in Room SD-366, Dirksen Senate Office Building, Hon. Lisa Murkowski, Chairman of the Committee, presiding.

OPENING STATEMENT OF HON. LISA MURKOWSKI, U.S. SENATOR FROM ALASKA

The CHAIRMAN. Good morning, everyone. The Committee will come to order.

We are meeting this morning to examine the evolving global natural gas markets, the increasingly important role of U.S. liquefied natural gas (LNG) as well as the competitive outlook for LNG.

American natural gas production has literally changed the game. We say that a lot around here about that, but it has been a game changer. Our production has soared to levels that many never even thought possible, and that was just about a decade ago. This, in turn, is boosting our economy as well as our national security. It is providing a long-term, low-cost, low-emission source of energy for our manufacturers and residential consumers alike, and we have such a massive resource base that we can send substantial volumes abroad.

We are now leading the world in natural gas production. Hopefully soon we will also lead in exports. Global demand for LNG, we know, is increasing. More U.S. LNG export facilities are coming online and more of our friends and allies around the world are building import facilities.

For the first time since the 1950s, we are now a net exporter of this abundant resource. Our production is driving the formation of a global spot market for natural gas. So again, the dynamic around natural gas, around LNG, is just extraordinary.

The consensus among experts is that LNG will continue to be a major driver of demand growth well into the next decade, from developed countries in Europe to fast-growing economies like India. A few of those experts are with us on today's panel. They are here to tell us what is driving these trends, where they may be headed, and how U.S. LNG fits into the equation.

We know that we are dealing with a very, very competitive global market, what I have referred to as a “narrowing window” of opportunity. I use this term quite frequently and it seems that I have been using it for a long period of time but it is, I believe, a “narrow window” of opportunity to establish leadership in the global gas trade. I hope we are going to hear ideas this morning on how to make our exports even more competitive.

I am particularly excited, coming from Alaska, about the role that my state can play. The Federal Energy Regulatory Commission (FERC) has just released the draft EIS for the Alaska LNG project, a great opportunity to move some tremendous reserves of conventional gas on the North Slope to market. It is a pretty important milestone for us in the federal permitting process, and we continue to recognize that Alaska’s gas is a remarkable resource that will add to the energy security of the U.S. and our allies.

As we look at our growing exports, we should also look at the ways that the U.S. can support imports by other countries to advance both our economic and our security interests. I have started to do that. So today, members will see at their seats a new white paper that we are releasing this morning. We have entitled it, “With Powers So Disposed.” This references a quote from President George Washington’s farewell address.

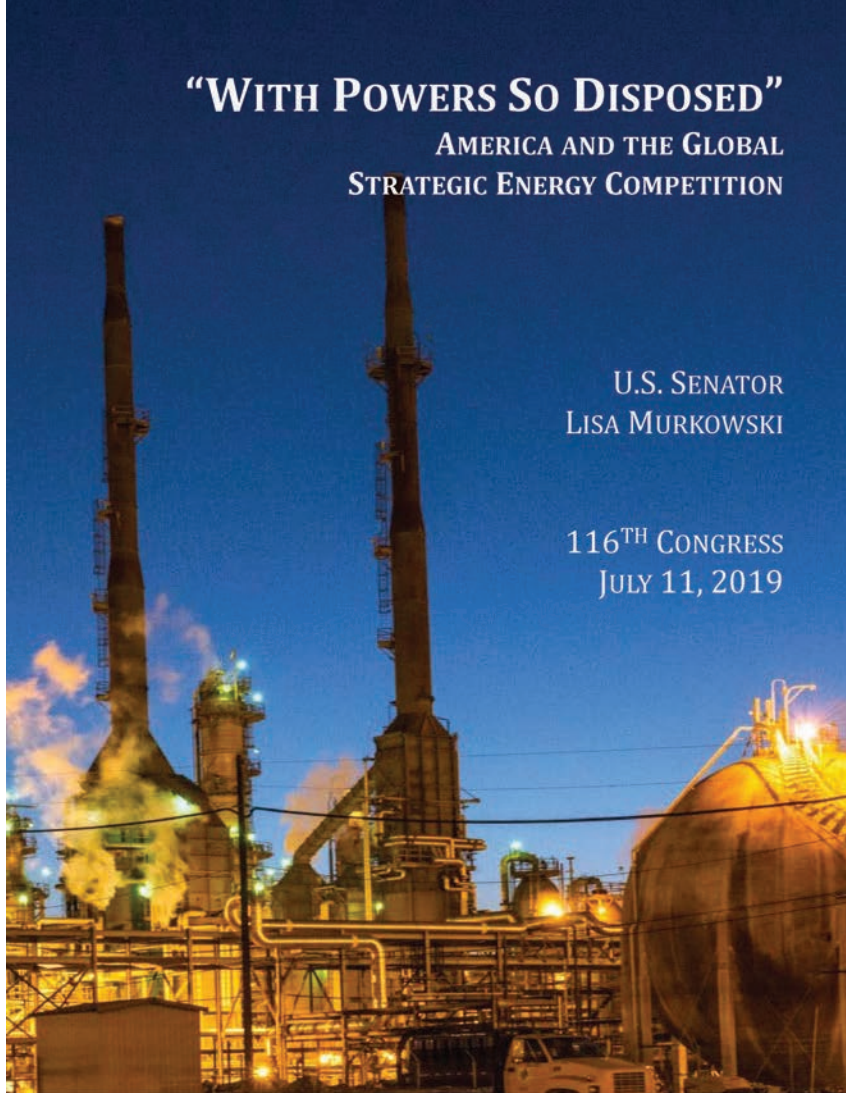
[The white paper “With Powers So Disposed” follows:]

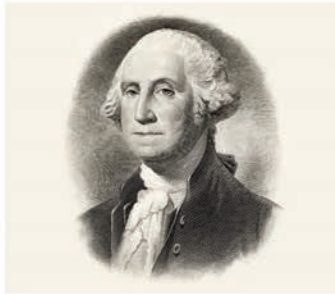
“WITH POWERS SO DISPOSED”

AMERICA AND THE GLOBAL
STRATEGIC ENERGY COMPETITION

U.S. SENATOR
LISA MURKOWSKI

116TH CONGRESS
JULY 11, 2019





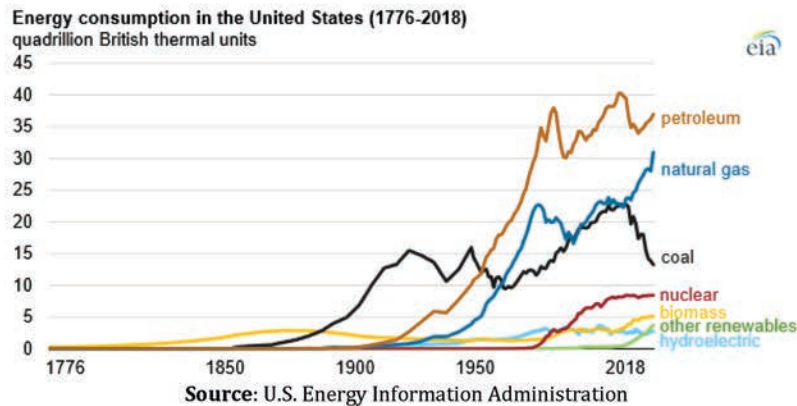
PRESIDENT GEORGE WASHINGTON
FAREWELL ADDRESS
SEPTEMBER 19, 1796

"[O]ur commercial policy should hold an equal and impartial hand . . . diffusing and diversifying by gentle means the streams of commerce, but forcing nothing . . . establishing (WITH POWERS SO DISPOSED, IN ORDER TO GIVE TRADE A STABLE COURSE, TO DEFINE THE RIGHTS OF OUR MERCHANTS, AND TO ENABLE THE GOVERNMENT TO SUPPORT THEM) conventional rules . . . the best that present circumstances and mutual opinion will permit . . . temporary, and liable to be from time to time abandoned or varied, as experience and circumstances shall dictate . . ."

INTRODUCTION

A Central Position

The President's *National Security Strategy* accurately refers to "America's central position in the global energy system as a leading producer, consumer, and innovator."¹ Previous generations strived to achieve the status we now enjoy, using all types of fuel to propel the economic growth of a superpower. Logistical networks and world-class infrastructure enabled this expansion.



The Competitive Environment

Some countries may generate or utilize more units of a particular type of energy than we do, but no nation delivers as much energy to as many people, as efficiently, safely, and cleanly – with as much productive effect – as the United States. Despite our dominant place, other countries – allies, trading partners, great powers, rivals – are working hard to secure their own positions of strength within that global energy system. Markets are dynamic and rankings are not static. Americans must compete every day for our prosperity.

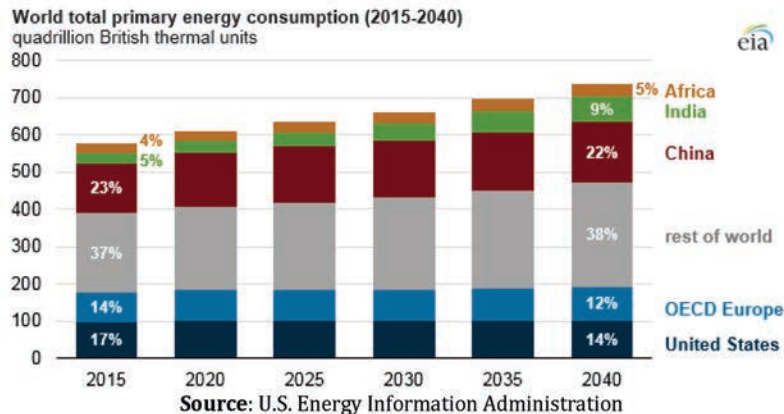
¹ *National Security Strategy of the United States of America* (The White House, December 2017), p. 22: <https://www.whitehouse.gov/wp-content/uploads/2017/12/NSS-Final-12-18-2017-0905.pdf>.

ASSESSMENT

A Signal to the World

Over the past decade, the United States energy sector has sent a “signal to the world.”² Executive and legislative action renovated the architecture of American energy – streamlining the regulatory review of natural gas exports, lifting the de facto ban on crude oil exports, opening up new areas in Alaska and the Outer Continental Shelf for development, investing in innovative advanced nuclear reactors, and much else. We produce (96 quadrillion Btu), consume (101 quadrillion Btu), and trade (46 quadrillion Btu) more energy than ever before.³

This revolution has occurred as regions outside of North America dominate worldwide energy consumption growth, a trend which suggests a global approach to the nation’s energy future may be required.

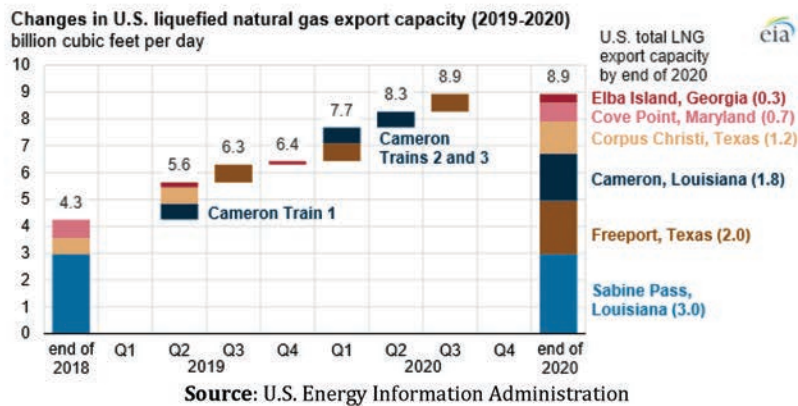


² U.S. Senator Lisa Murkowski, *A Signal to the World: Renovating the Architecture of U.S. Energy Exports* (January 7, 2014). See also the following reports prepared by the Republican staff of the U.S. Senate Energy and Natural Resources Committee: *Cross Currents: Iranian Oil and the U.S. Export Ban* (June 23, 2015); *Rendering Vital Assistance: Allowing Oil Shipments to U.S. Allies* (June 9, 2015); *A Ban for One: The Outdated Prohibition on U.S. Oil Exports in Global Context* (June 26, 2014); *Crude Pro Quo: The Use of Oil Exchanges to Increase Efficiency* (May 22, 2014); *License to Trade: Commerce Department Authority to Allow Condensate Exports* (April 2, 2014); and *Past is Precedent: Executive Power to Authorize Crude Oil Exports* (March 3, 2014).

³ U.S. Energy Information Administration, Table 1.1 Primary Energy Overview, *Monthly Energy Review* (June 2019). “Trade” includes the gross sum of imports and exports.

Long-Term Relationships

The signal our nation sends to the world must be followed by tangible results. Memoranda of understanding can be important, but tangible deals with secured financing, offtake agreements, and delivered cargoes are what guarantee jobs for Americans. Trade in raw commodities provides considerable economic benefit, and building terminals, processing plants, ports, and other infrastructure – domestically and internationally – offers innumerable cumulative gains.

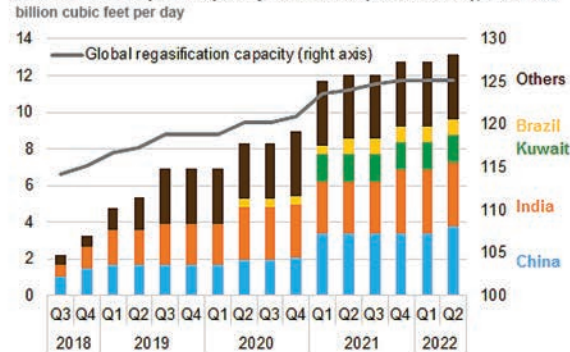


Case Studies: Natural Gas and Civil Nuclear

Energy-based prosperity requires long-term investments and relationships, which ultimately form the basis for any enhancement to our national security. For example:

- (1) Natural gas liquefaction and regasification facilities require decadal contracts, billions of dollars, and years of permitting and construction. Potential customers with which strategic relationships are critical abound in the Indo-Pacific region.

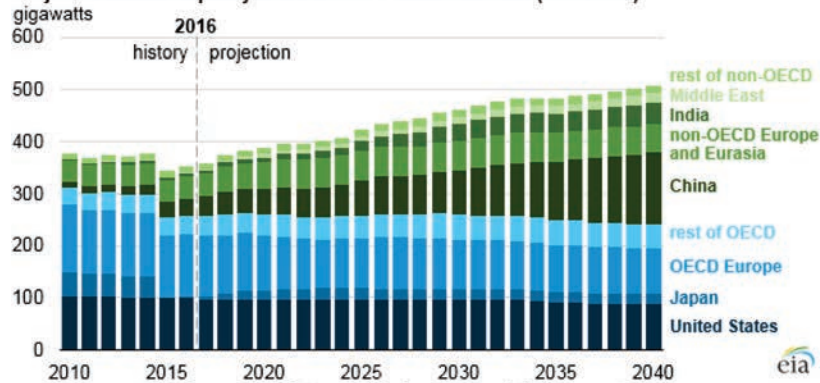
Global LNG import capacity additions (cumulative), 2018-22



Source: U.S. Energy Information Administration

- (2) Civil nuclear projects are impossible without diplomatic (“123”) agreements and often require substantial government-backed financing. The relationships that develop from such projects provide decades of further partnership.

Projected nuclear capacity in the IEO2017 Reference case (2010-2040)



Source: U.S. Energy Information Administration

eia

THE STRATEGIC ENERGY INITIATIVE

In his Farewell Address, President George Washington extolled the virtues of free trade and noted the natural industriousness of the nation. He cautioned that such trade should follow a “stable course” within a flexible set of rules. This adaptive architecture would change “as experience and circumstances” warrant. It is time for the United States government to refine its instruments of national power, “with powers so disposed,” to strengthen the ability of the American people to compete fairly in the global energy system.⁴

The *Strategic Energy Initiative* will sharpen and direct our tools of energy-related economic statecraft to enhance the geopolitical posture of the United States. These tools include federal departments and agencies, such as the Department of Energy, and trade and finance-related institutions such as the Trade Development Agency, the Export-Import Bank, and the Development Finance Corporation (as it evolves from the Overseas Private Investment Corporation). Congress is uniquely positioned to provide strategic direction through its constitutional responsibilities of oversight and legislation. By focusing on long-term relationships, tightly within the nexus of raw commodities and infrastructure domestically and internationally, the nation will enhance its security, improve its balance of trade, and secure America’s position at the center of the global energy system.

CONCLUSION

The strategic environment is a competitive environment. Expanding the global reach of American energy requires a robust *strategy* that harnesses our Nation’s vast *means* in effective *ways* to achieve secure and prosperous *ends*. The Strategic Energy Initiative seeks to accomplish just that.

ACKNOWLEDGMENTS

The cover image is a portion of a photograph taken by Carol M. Highsmith, “Dusk view of the Valero Energy Corporation’s refinery in Port Arthur, Texas.” Dated February 27, 2014, it is provided by the Library of Congress: <https://www.loc.gov/item/2014633835/>. The official engraved portrait of President George Washington is provided by the United States Mint.

⁴ Farewell Address (1796), United States Senate Historical Office (Senate Document No. 106-21).

The CHAIRMAN. So quite a few years back, but you are at a point in time where certainly President Washington could never have envisioned super-cooled methane molecules being shipped around the globe in giant tankers, but he did foresee that the American Government would have to work to open up opportunities for its businesses with other nations in a way that promotes both market forces as well as our national interests.

The paper effectively lays out a framework to strengthen America's geopolitical posture by sharpening our tools of economic statecraft. I think we are very uniquely positioned here in the Congress to provide a level of strategic direction to federal departments and agencies that are operating in this area.

Just one example is the EXIM Bank, the Export-Import Bank of the United States. It is nearing the sunset of its current authorization in September. This framework that you have in front of you is certainly going to guide my participation in that discussion.

For those who are sitting out there, the report is available on our Committee website, and I would be happy to refer you to energy.senate.gov. But stay tuned for more. I think as this conversation proceeds, we are going to have, kind of, an uptick in interest on these very important matters.

I want to thank our witnesses for joining us here today. I look forward to your testimony, as well as your insight on this very, very important topic.

With that, I turn to my Ranking Member, Senator Manchin.

**STATEMENT OF HON. JOE MANCHIN III,
U.S. SENATOR FROM WEST VIRGINIA**

Senator MANCHIN. Thank you, Madam Chairman, and thank you for convening the Committee today to discuss U.S. LNG and its role in the global marketplace. And I want to thank each and every one of the panelists here for trying to help us through this.

There has been an exponential growth in domestic natural gas production over the past decade, driven in large part by research and development from the Department of Energy (DOE). There is potential for more, including opportunities in my home State of West Virginia which sits on top of an ocean of energy, the Marcellus, Utica and now we find the Rogersville shales.

Production has increased as has the volume of natural gas exports. In fact, the United States became a net natural gas exporter in 2017 for the first time in 60 years which is pretty special. That is important for our economy and for geopolitical balance around the world.

Several more LNG export projects are expected to be completed in the coming years. Once completed, U.S. LNG export capacity is expected to reach nine billion cubic feet per day by the end of 2019, making our country the third largest exporter behind Australia and Qatar.

The U.S. Energy Information Administration (EIA) points to a near doubling of exports over the year before. U.S. LNG exports were made to 33 countries in 2018. Nearly 60 percent of those exports were shipped to just four countries: South Korea, Mexico, Japan and China.

The Department of Energy has approved over 20 billion cubic feet per day in export capacity with another 20 billion cubic feet per day in pending applications.

The U.S. LNG industry is also growing and reshaping regional markets toward a global one through more flexible and shorter-term contracts championed by U.S. businesses. I am encouraged by this growth and the geopolitical and diplomatic benefits of increased LNG exports from the U.S., particularly to our allies and friends in Europe.

But I also want to touch on a topic which concerns my colleagues and me deeply. That is the use of energy as a geopolitical weapon by countries such as China and Russia. Energy can be a tool for democracy, but it can also be a weapon.

Russia has for years relied on their energy resources to exert influence and exact concessions. Central and Eastern Europe are relying on Russia for approximately 75 percent of their gas import needs. Russia, in turn, uses this reliance for political coercion and influence, and that is why I oppose the Nord Stream 2 pipeline. We have got to get back in the game and lead in order to promote American energy and independence and serve as a bulwark against Russia and Chinese aggression.

I serve on the Armed Services Committee and previously served on the Intelligence Committee. I want to be very clear on the fact that nations have and, if allowed to, will continue to use their energy resources and infrastructure as geopolitical leverage in times of conflict and in times of peace to pressure our allies and try to divide us. It is unacceptable to me that our European allies can be held hostage by another nation because of its monopoly on natural gas.

Fortunately, U.S. natural gas is abundant and it is much more attractive for our allies in Europe to buy from a democracy than it is from an authoritarian regime.

Meanwhile, China is buying up energy and natural resources around the world from large parts of Africa, Latin America to Asia, to right here in the United States of America.

For certain commodities, including the critical minerals vital to energy technology, China has become the price setter and exerts enormous influence on rare earth minerals. They have also moved strategically to vertically integrate manufacturing in certain energy sectors—such as solar panels—to capture the economic value before selling into U.S. and other markets.

That is why I support the Appalachian Storage Hub, for example, to create industry and jobs around our natural gas liquids here at home rather than shipping them all to China. I just don't believe that we should be granting the Chinese government unfettered access to our natural resources when that access is not reciprocated. Both China and Russia use energy resources and show willingness to manipulate U.S. energy resources to advance their long-term strategic positions.

In a time when all countries need to focus on solutions to the common threat of climate change, including the use of natural gas to lower greenhouse gas emissions, gaming the global energy economy only benefits our adversaries.

With that, Madam Chairman, I look forward to hearing from our witnesses today and having a vital, important discussion.

The CHAIRMAN. Thank you, Senator.

We will now turn to our witnesses. Again, we appreciate that you have all joined us here this morning at our invitation.

We will lead off the panel this morning with Steven Winberg, who is the Assistant Secretary for Fossil Energy at the Department of Energy. Nice to have you here, Mr. Winberg.

Mr. Dennis Arriola is the Executive Vice President and the Group President for Semptra Energy. Thank you for being here.

Dr. Melanie Hart is the Senior Fellow and Director of the China Program at the Center for American Progress. We look forward to your input this morning.

Mr. Charlie Riedl is the Executive Director at the Center for LNG.

And finally, Mr. Nikos Tsafos, who is the Senior Fellow for the Center for Strategic and International Studies, CSIS, as we know around here.

We thank each of you for your participation here this morning.

Just for your information, we are scheduled to have a series of three votes at about 11 o'clock this morning. Senate time is less than certain around here, so we will see how that goes.

But what we would like to do is get your testimony here. We will have an opportunity to ask questions. I think you will see members coming and going. Don't take that as an indicator of lack of interest, just that there is a lot going on this morning. We will continue to move the Committee even through those votes, but we will give you more updates as those come.

We will begin with you, Mr. Winberg, and ask that you try to keep your comments to about five minutes. Your full statements will be included as part of the record.

Good morning.

STATEMENT OF HON. STEVEN E. WINBERG, ASSISTANT SECRETARY FOR FOSSIL ENERGY, U.S. DEPARTMENT OF ENERGY

Mr. WINBERG. Good morning.

Thank you, Chairman Murkowski, Ranking Member Manchin. It's always good to be here to be with you. And it's my pleasure to appear before you today to discuss the status of the natural gas market and the work being done by the Office of Fossil Energy to support record-setting, U.S. natural gas production.

I had the opportunity this morning, Senator Murkowski, to read "With Power So Disposed," and the Department of Energy stands ready to assist in whatever way we can.

As Senator Manchin said, the United States is now the world's largest producer of both natural gas and crude oil. Each month we're setting new record levels of production. The surge in natural gas production amounts to an increase of over 60 percent from 2009, and this year's production is on pace to exceed last year's by nearly 10 percent.

The LNG exports, we are now in our third consecutive year as a net exporter of natural gas and the EIA estimates that the United States will be an overall net exporter of energy next year.

These exports are reducing our trade deficit by billions of dollars each year and increasing our national security.

U.S. LNG cargos have landed in Europe, Asia, Africa, the Middle East, South America, North America and the Caribbean, 36 countries in total. And U.S. LNG, so far in 2019, has exceeded 55 cargos through April of this year. Asia has been the top importing region of U.S. LNG over the last three years, but much of the LNG this year has been going to Europe.

At the same time, natural gas has become the primary fuel used in electricity generation responsible for fuel in over 35 percent of the power generated in the United States in 2018. The increased use of natural gas has helped lower energy-related carbon emissions to levels not seen since the late 1980s. According to EIA, U.S. energy-related carbon dioxide emissions will be four percent below 2018 levels in 2050 as the use of natural gas in the United States continues to increase.

The Office of Fossil Energy works on both the research and development of natural gas technologies as well as the regulatory space. For R&D, we strive to enhance U.S. economic and energy security by managing and performing research that maximizes the efficient and environmentally sound production in the use of natural gas and other fossil fuels. In our regulatory program, we support the development of policy options that benefit the U.S. public by ensuring access to adequate supplies of affordable and clean energy.

The Administration and DOE have also made it a top priority to highlight the economic benefits of the Appalachian petrochemical industry made possible by the surge in natural gas production in the region. Industry has estimated that an Appalachian petrochemical industry can support a total of five ethane crackers, 100,000 jobs and contribute to the revitalization of the region.

These petrochemical plants would also bring in tax revenues to communities, provide opportunities for hard working Americans to fundamentally transform their lives and give our nation the opportunity to diversify its energy and petrochemical production.

DOE remains committed to working with stakeholders at all levels of government, industry and academia to promote these developments.

There's no doubt that natural gas has transformed our nation and the world for the better. It has grown our economy. It has created countless American jobs and made our air cleaner. Further, increased LNG exports also have given our allies a secure source of energy. Natural gas has proven to be and will continue to be a vital part of the Trump Administration's commitment to an all-of-the-above approach to energy.

So I thank you for the opportunity to appear before you today. I look forward to your questions.

And finally, I want to thank my wife, Ann Winberg, and our daughter, Rebecca Burns, for being here with me today. It's always good to have family backing you up.

Thank you.

[The prepared statement of Mr. Winberg follows:]

**Testimony of Steven E. Winberg
Assistant Secretary for Fossil Energy
U.S. Department of Energy**

**Before the
U.S. Senate Committee on Energy and Natural Resources**

July 11, 2019

Introduction

Thank you Chairman Murkowski, Ranking Member Manchin, and Members of the Committee. It is my pleasure to appear before you today to discuss the status of the natural gas market and the work being done by the Office of Fossil Energy to support record-setting U.S. natural gas production.

U.S. oil and gas production from shale resources has led us to now be the largest producer of both natural gas and crude oil in the world. Each month, new record-setting levels of production are being achieved. The most recent estimates from the Energy Information Administration's (EIA) Short-Term Energy Outlook show daily production of dry natural gas in 2019 and 2020 at 91.4 and 92.8¹ billion cubic feet per day, respectively. These amounts are an increase of over 60 percent from 2009², and this year's production is on pace to exceed last year's by nearly 10 percent.

These high production rates are expected to continue, and projections from EIA show dry natural gas production will reach over 111 billion cubic feet per day by 2040 and 119 billion cubic feet per day by 2050.³

The Office of Fossil Energy works on both the research and development (R&D) of natural gas technologies, as well as in the regulatory space. On the R&D front, we strive to enhance U.S. economic and energy security by managing and performing research that maximizes the efficient and environmentally sound production and use of natural gas and other fossil fuels. At the same time, via our

¹ <https://www.eia.gov/outlooks/steo/data/browser/>

² <https://www.eia.gov/dnav/ng/hist/n9070us2a.htm>

³ <https://www.eia.gov/outlooks/aeo/data/browser/#/?id=13-AEO2019&cases=ref2019&sourcekey=0>

regulatory program, we support the development of policy options that benefit the U.S. public by ensuring access to adequate supplies of affordable and clean energy.

Impacts of Unprecedented Production Gains

The impact of ongoing natural gas production gains, and the national security and economic prosperity they have ushered, should not be underestimated. We are now in our third consecutive year as a net exporter of natural gas, and projections from EIA estimate that the United States will be an overall net exporter of energy next year.⁴ These exports are not only reducing our trade deficit by billions of dollars each year⁵, but are also increasing our national security.

At the same time, over the last few years, natural gas has become the primary fuel used in electric generation, responsible for fueling over 35 percent of the power generated in the United States in 2018.⁶ More households are using natural gas as well, with the majority of U.S. households using natural gas for their space heating needs⁷. In 2017, natural gas was delivered to over 69 million residential customers in the U.S.⁸

Last year, natural gas spot prices averaged just \$3.15 per one million British Thermal Units (MMBtu), nearly two-thirds less than what natural gas sold for in 2008⁹. Prices during the first six months of 2019 are lower than last year's average spot price, and EIA is forecasting natural gas prices to be below \$3.00 per MMBtu through 2020.¹⁰

Lower energy prices are helping domestic households and businesses, but exports of natural gas are also helping our allies and trading partners with enhanced energy and economic security. According to the International Energy Agency, Europe saved \$8 billion on natural gas last year, largely due to US LNG.¹¹

⁴ <https://www.eia.gov/todayinenergy/detail.php?id=38152>

⁵ 2018 LNG Volume exported: https://www.eia.gov/dnav/ng/ng_move_poe2_a_EPG0_ENG_Mmcf_a.htm

2018 Price of LNG exported: https://www.eia.gov/dnav/ng/ng_move_poe2_a_EPG0_PNG_DpMcf_a.htm

In 2018, the U.S. exported 1,083.1 Bcf or just under 3 Bcf/d at an average price of \$5.20/Mcf.

Multiplying the two together, it's \$5.20/Mcf * 1,083.1 Bcf ---> \$5.63 B.

⁶ <https://www.eia.gov/electricity/data/browser/>

⁷ <https://www.eia.gov/todayinenergy/detail.php?id=37433>

⁸ https://www.eia.gov/dnav/ng/ng_cons_num_a_EPG0_VN3_Count_a.htm

⁹ https://www.eia.gov/dnav/ng/ng_pri_fut_s1_a.htm

¹⁰ <https://www.eia.gov/outlooks/steo/data/browser/#/?v=16&f=A&s=0&maptype=0&ctype=linechart>

¹¹ <https://www.reuters.com/article/us-gas-ia-Ing/europe-saved-8-billion-on-gas-bill-in-2018-due-to-Ing-reforms-jea-idUSKCN1T8QJR>

A recent study commissioned by DOE and prepared by NERA Economic Consulting shows that increasing U.S. LNG exports will continue to provide benefits to the American economy and the American worker for the foreseeable future.¹²

Additionally, the increased use of natural gas throughout our Nation's economy has helped lower energy-related carbon emissions to levels not seen since the late 1980s.¹³ Because natural gas is the least carbon-intensive fossil fuel, the expanded use of natural gas is reducing energy-related carbon dioxide emissions, particularly in the power sector. The most recent long-term projections from EIA show that U.S. energy-related carbon dioxide emissions will be 4 percent below their 2018 value in 2050 as the use of natural gas in the United States continues to increase.¹⁴

Role of R&D

The Department of Energy is focused on ensuring a reliable, affordable, and secure domestic supply of oil and natural gas through research into enhanced recovery and reduction of the risks associated with domestic oil and gas production, distribution, and storage.

The U.S. has the most extensive natural gas production, gathering, processing, storage, and pipeline delivery system in the world. DOE's Office of Fossil Energy is focused on the technologies needed to keep the national oil and natural gas system operating at the highest level of efficiency and reliability. This is done by developing next-generation pipeline materials; improving the reliability of gathering, compression, transmission and storage system components; creating sensor platforms capable of identifying and quantifying operational risks and methane emissions; advancing technologies for repairing pipeline damage without disruption of service; and developing cost-effective technologies for the capture and utilization of methane that would otherwise be flared or vented.

The Office of Fossil Energy is pursuing early-stage research on new enabling technologies for mitigating against methane emissions and enhancing the cyber-physical security and resilience of natural gas pipeline infrastructure. These methane emissions mitigation efforts are focused on a combination of

¹²

<https://www.energy.gov/sites/prod/files/2018/06/f52/Macroeconomic%20LNG%20Export%20Study%202018.pdf>

¹³

<https://www.eia.gov/totalenergy/data/browser/index.php?tbl=T12.06#/f=A&start=1973&end=2018&charted=0-1-6>

developments in new sensor technologies combined with artificial intelligence for real-time operational monitoring and early fault prediction as well as advanced materials for pipelines, including liners and coatings.

In addition to ensuring security and resilience of the current pipeline infrastructure, these technologies also support the Department's vision for a more flexible and intelligent pipeline network designed to meet future challenges.

Methane Emissions

Through real-time monitoring of operational conditions, including distributed chemical monitoring within the pipeline interior, multiple types of fluids and gases can be transported safely, securely, and in an environmentally responsible manner. Examples include natural gas and hydrogen transport for power generation as well as CO₂ transport for carbon sequestration and utilization.

In areas where natural gas is produced at oil wells but is not economical to transport for sale, it is often burned at well sites. Flaring and venting during routine system operations or planned system disruptions is recognized as a significant waste of a valuable resource. Reducing the amount of methane that is released to the atmosphere during natural gas production, processing and transportation is an important objective for the Program.

Fossil Energy's long-term objectives for this research are to develop alternatives to reduce flaring and venting during the production of oil and other routine oil and natural gas system operations through the conversion of natural gas into value-added, transportable products. This will enable flared, vented, or otherwise rejected gas to be monetized instead of lost as an asset.

Fossil Energy's research on unconventional oil and natural gas development is focused on the production of hydrocarbons, natural gas and oil, from shale formations. The portfolio of projects is balanced among efforts to indirectly reduce impacts by improving recovery efficiency; developing and testing cost-effective environmental regulatory compliance technologies; and more accurately quantifying and assessing the environmental risks associated with various elements of the exploration and production process.

Unconventional Oil and Natural Gas Research

Fossil Energy's unconventional oil and natural gas research is proceeding along three parallel paths. The first path is to identify and accelerate development of

economically-viable technologies to more effectively locate, characterize, and produce natural gas and oil resources, in an environmentally acceptable manner. The second is to characterize emerging supplies of oil and natural gas at the resource and reservoir level and publish this information in a manner that supports effective development. The third is to catalyze the development and demonstration of new technologies and methodologies for limiting the environmental impacts of unconventional oil and natural gas development activities. The program advances these objectives by identifying key research questions that present a challenge to industry and identifying enabling technologies to address these questions.

Basin-Specific Research

The Department is also pursuing basin-specific research through the establishment of field laboratories via public-private partnerships and in coordination with the National Labs. The Department currently has seven field laboratories in the Marcellus, Permian, Alaska, Tuscaloosa Marine, and Eagle Ford. These field labs are addressing ways to increase recovery of unconventional oil and gas resources and to improve operational efficiency. These projects are researching ways to improve recovery of light and heavy oil, using natural gas for enhancing oil recovery, and investigating the potential for multi-play production of unconventional reservoirs. Recently, we announced the selection of four additional field lab projects. Our goal is to have a field laboratory in every major basin in the United States.

Department of Energy's Statutory Authority

The Department of Energy's (DOE) authority to regulate the export of natural gas arises under section 3 of the Natural Gas Act (NGA), 15 U.S.C. § 717b. This authority is vested in the Secretary of Energy and has been delegated to the Assistant Secretary for Fossil Energy.

Section 3(a) of the NGA sets forth the standard for review of most LNG export applications:

[N]o person shall export any natural gas from the United States to a foreign country or import any natural gas from a foreign country without first having secured an order of the [Secretary of Energy] authorizing it to do so. The [Secretary] shall issue such order upon application, unless after opportunity for hearing, [he] finds that the proposed exportation or importation will not be consistent with the public interest. The [Secretary] may by [the Secretary's] order

grant such application, in whole or part, with such modification and upon such terms and conditions as the [Secretary] may find necessary or appropriate.

The Department has consistently interpreted section 3(a) as creating a rebuttable presumption that a proposed export of natural gas is in the public interest. Under this provision, DOE performs a thorough public interest analysis before acting on applications to export natural gas to non-free trade agreement countries. In addition, DOE must give appropriate consideration to the environmental effects of its proposed decisions under the National Environmental Policy Act (NEPA). Typically for LNG facilities planning to export to non-FTA countries, DOE acts as a cooperating agency to the Federal Energy Regulatory Commission who leads the preparation of environmental impact statements or environmental assessments for proposed LNG export facilities under NEPA.

In the Energy Policy Act of 1992, Congress enacted section 3(c) to the NGA. Section 3(c) created a different standard of review for applications to export natural gas to those countries with which the United States has in effect a free trade agreement requiring national treatment for trade in natural gas. Section 3(c) requires such applications to be deemed consistent with the public interest and granted without modification or delay.

The Federal Energy Regulatory Commission (FERC) has jurisdiction under the Natural Gas Act over the siting, construction, and operation of onshore LNG export terminals. For offshore LNG export terminals, this authority resides with the Maritime Administration (MARAD) in the U.S. Department of Transportation (DOT).

DOE Authorizations to Export Natural Gas

Since January 2017, DOE has granted authority to export natural gas to all non-sanctioned countries to several export projects including five new domestic large-scale liquefied natural gas (LNG) projects – Golden Pass and Port Arthur in Texas, Delfin LNG, which is proposed for offshore Louisiana; and Venture Global’s Calcasieu Pass as well as the Driftwood LNG project, both proposed in Louisiana. DOE has also authorized exports from Eagle LNG’s small-scale project in Maxville, Florida, authorized additional capacity at the Freeport LNG project in Texas as well as the proposed Lake Charles LNG project in Louisiana, and also authorized the re-export of U.S. natural gas as LNG from two LNG export projects proposed for siting in Mexico.

Since DOE began authorizing exports of LNG from the lower 48 states, 32.99 billion cubic feet per day of natural gas has been authorized under section 3(a) of the Natural Gas Act for export to anywhere in the world not prohibited by U.S. law or policy. These non-free trade agreement authorizations are primarily spread across 13 large scale export projects in the United States, seven of which are in various states of construction and operation in Texas, Louisiana, Georgia, and Maryland. One facility in the lower 48 states, Cheniere Energy's Sabine Pass facility in Louisiana, has been exporting LNG since February 2016. A second large-scale facility, Dominion Energy's Cove Point facility in Maryland, began exports in March 2018. Cheniere's Corpus Christi began exporting in December 2018, and the Cameron LNG project in Louisiana just exported its first cargo at the end of May. Two additional export projects, Freeport LNG and Elba Island, are expected to come online this year. And the Golden Pass project, which announced its final investment decisions earlier this year, plans to be online in 2024. At the time all seven projects online or under construction are completed, the U.S. will have approximately 14 billion cubic feet of export capacity, positioning the U.S. as the top global LNG exporter in the world.

At present, there are nine export projects with over 15 billion cubic feet per day of additional export capacity under review at both FERC and DOE. DOE remains committed to taking prompt final action following its thorough assessment of LNG export applications once FERC completes its review. This year, DOE has completed review and has taken final action on all projects that have received FERC approvals within two weeks of FERC's order.

U.S. LNG Exports – Current and Projected

Since LNG exports from the lower 48 began in February 2016, over 2.4 trillion cubic feet of U.S. natural gas has been exported as LNG. To put that into context, just last year, the U.S. exported enough LNG to supply all of Poland and Hungary's natural gas needs for the year.¹⁵ U.S. exported cargos have landed in Europe, Asia, Africa, the Middle East, South America, North America, and the Caribbean – 36 different countries in all. Europe has been the top destination for U.S. LNG so far in 2019, receiving 55 cargos through April of this year. And, led by imports into South Korea and Japan, Asia has been the top importing region of

¹⁵ 2018 US LNG Exports were 1,083 Bcf or 30 bcm. Per IHS, Poland's estimated 2018 NG demand was 19 bcm, and Hungary's was 10 bcm.

U.S. LNG over the last three years that the U.S. has been exporting LNG from the lower 48 states.

Along with the increased export capacity coming online, increased exports of U.S. LNG are expected to continue to grow. EIA's most recent Short-Term Energy Outlook shows that LNG exports will be 4.84 billion cubic feet per day in 2019 and are expected to rise to 6.86 billion cubic feet per day in 2020¹⁶. Looking long-term, EIA's Annual Energy Outlook 2019 projects that U.S. LNG exports will reach an average of 14.4 billion cubic feet per day by 2029. EIA's long-term projections show that U.S. LNG net exports will remain at approximately 14 billion cubic feet per day through 2040.¹⁷

Appalachian Petrochemical Industry

As mentioned earlier, the U.S. energy renaissance has transformed communities across the country. Through April of this year, natural gas production in the Appalachian Basin has represented 35¹⁸ percent of total U.S. natural gas production, and that number is expected to increase.¹⁹ With this surge in natural gas production throughout the Appalachian Basin comes the opportunity to foster a petrochemical industry renaissance in the region. Natural gas – especially the wet gas found in the Appalachian region – is a vital feedstock for the manufacturing of a wide array of consumer products that Americans use every day.

Industry has estimated that promoting an Appalachian petrochemical industry can support a total of five crackers, 100,000 jobs and contribute to the revitalization of the region.²⁰ Shell is currently constructing an ethane cracker plant in the Appalachian region, which is currently supporting more than 5,000 union construction jobs and will support 600 permanent jobs when it is finished. In addition to Shell's facility, one in Ohio is on the cusp of a final investment decision.

These ethane cracker plants support both direct and indirect jobs throughout the region, bring in tax revenues to communities, provide opportunities for

¹⁶ <https://www.eia.gov/outlooks/steo/data/browser/#/?v=15&f=A&s=0&ctype=linechart&maptype=0>

¹⁷ U.S. Energy Info. Admin., *Annual Energy Outlook 2019* (Jan. 24, 2019), available at: <https://www.eia.gov/outlooks/aeo/data/browser/#/?id=76-AEO2019&cases=ref2019&sourcekey=0>.

¹⁸ Sum of YTD Appalachian production from Drilling Productivity Report divided by total U.S. dry production <https://www.eia.gov/petroleum/drilling/#tabs-summary-2> and https://www.eia.gov/naturalgas/monthly/pdf/table_01.pdf

¹⁹ <https://www.eia.gov/todayinenergy/detail.php?id=38652>

²⁰ <https://www.americanchemistry.com/Appalachian-Petrochem-Study/>

hardworking Americans to fundamentally transform their lives and give our Nation the opportunity to diversify its energy and petrochemical production. DOE remains committed to working with stakeholders at all levels of government, industry and academia to promote these developments.

Conclusion

Natural gas has transformed our Nation and the world for the better. The increased use and production of natural gas has grown our economy, created countless American jobs, and made our air cleaner. Further, increasing exports of domestically produced natural gas to 36 countries around the world has given our allies a stable, reliable and secure source of clean energy. Natural gas has proven to be, and will continue to be, a vital part of this administration's commitment to an all of the above approach to energy.

Thank you for the opportunity to appear before you today and I look forward to your questions.

The CHAIRMAN. That is great. Thank you, Assistant Secretary, and we welcome your family as well.

Mr. Arriola, welcome.

**STATEMENT OF DENNIS V. ARRIOLA, EXECUTIVE VICE
PRESIDENT AND GROUP PRESIDENT, SEMPRA ENERGY**

Mr. ARRIOLA. Well, good morning. Thank you, Chairman Murkowski and Ranking Member Manchin and Senators that are here, part of the Committee. Again, I'm Dennis Arriola. I'm the Executive Vice President and Group President for Sempra Energy.

Sempra is based in San Diego. We've been in the natural gas business for over 150 years, and we're the largest utility holding company in the United States with nearly 20,000 employees and serving more than 40 million customers worldwide. Sempra is a leader in North America's growing LNG export market, and we're pursuing five strategic LNG export opportunities in North America with access to both the Atlantic and the Pacific Basins. Our projects include two in Louisiana, one in Texas and two on the West Coast of Mexico that together could export 45 million tons of American LNG in the future.

And so, this morning what I'd like to do is just spend a couple minutes on the U.S. natural gas supply and how we see its impact to the American economy, how LNG exports can reduce our trade deficits and benefit our foreign relations and the environmental benefits of LNG.

As mentioned, the U.S. became a net exporter of natural gas in 2017 for the first time since 1957. And that's really, it's thanks to American ingenuity and to the shale gas revolution. The supply of inexpensive natural gas is expected to increase to 90 billion cubic feet per day in 2020, which is a 30 percent increase from 2017. And this growth in natural gas is good for American consumers, our industries, for electric generation, but also for international buyers of LNG. And today, the U.S. accounts for about 22 percent of the global gas production and is on track to be the largest exporter of LNG by 2024, maybe sooner.

Growing natural gas production and LNG exports are having a strong, positive impact on our country and have the potential to add millions of jobs throughout the entire value stream to the U.S. economy. And we've seen this firsthand with the economic benefits at our Cameron LNG export facility in Hackberry, Louisiana. On May 14th, we produced our first LNG at our Cameron facility and we had the honor of being joined by the President of the United States, diplomats from the EU and Japan as well as by some of your colleagues. Senator Cassidy was able to attend as well. And then on May 31st, the first tanker departed Cameron with American LNG for the world market. So we're really proud of that moment.

The U.S. economic impact from Cameron LNG is estimated to be \$336 billion over the life of the project and should generate about 53,000 direct and indirect jobs annually over 20 years which is equal to about 1.1 million job years.

At our Port Arthur LNG project in Texas, which we're developing, we estimate the economic contribution at nearly \$290 billion, or slightly over \$11 billion annually over 25 years, with an average

of nearly 5,700 direct and indirect jobs in Texas and about 41,000 nationally through 2043.

So it's clear, LNG exports create a lot of jobs, good paying jobs, here in our country.

Now today, Asia accounts for about 70 to 75 percent of LNG demand and Europe about 15 percent. And while most, not all, but most of the U.S. export capacity exists today or is being developed in the Gulf Coast region, it takes an LNG tanker about 21 days to travel to Asia through the Panama Canal. That is impacting our competitiveness.

However, Semptra expects to cut that to 12 days or even less by developing two projects at our import facility in Baja, California, and Mexico. And when they are completed they will connect with pipelines from Texas to form, what we're calling, the Permian to Pacific Highway, and American LNG will be more competitive in Asia as a result.

Now, ten Asian countries account for over 80 percent of our trade deficit, and they happen to be countries that also need LNG. So exporting LNG, not just to China, which is the largest importer in the world, but to countries like Japan, South Korea, Vietnam, India and others, could be a true game changer for our trade deficit and since they all buy LNG, why not buy from the United States, as long as we're competitive?

Now at the same time, LNG trade can strengthen our relationships with foreign governments by providing alternatives to Russian gas. And so, Semptra has signed a 20-year LNG agreement with a Polish oil and gas company and we have preliminary agreements with several major natural gas companies in Europe and Asia. As a result of these contracts, the U.S. is going to benefit and the LNG exports will benefit our partners as well.

More than half of the countries in Asia have air quality challenges and need cleaner natural gas from LNG to displace less clean resources and combat climate change. So, the trend, obviously, is to phase out coal-fired power. Natural gas is a logical substitute because it's a comparatively low cost and environmental benefits and it emits 50 percent of the carbon dioxide of coal. And it also complements the growth of renewable resources like wind and solar. So as part of an overall portfolio, natural gas makes sense.

In conclusion, the role of LNG exports in the U.S.' global energy leadership, I think it's larger than any of us can actually imagine and it's going to continue to grow. Semptra Energy is focused on helping our country realize its full energy potential by being a leader in the LNG energy export market.

I appreciate the opportunity to be here and look forward to your questions.

[The prepared statement of Mr. Arriola follows:]

**Testimony by
Dennis V. Arriola
Executive Vice President and Group President
Sempra Energy
U.S. Senate Committee on Energy & Natural Resources
July 11, 2019
Hearing on The Important Role of U.S. LNG in Evolving Global Markets**

Chairman Murkowski, Ranking Member Manchin and members of the committee, thank you for the opportunity to testify before you regarding the evolving and exciting global gas market and the important role for U.S. LNG exports. Sempra Energy has been in the natural gas business for over 150 years and a leader in LNG for more than 15 years, so I am happy to be able to share our experience and outlook with you today. My name is Dennis Arriola and I am the Executive Vice President and Group President for Sempra Energy.

Sempra Energy is a Fortune 500 energy infrastructure company based in San Diego, California with revenues of more than \$11.6 Billion in 2018. We're the largest utility holding company in the U.S., serving more Americans their basic energy needs every day. With approximately 20,000 employees, Sempra serves more than 40 million customers worldwide. Our vision is to deliver energy with purpose, and our mission is to be North America's premier energy infrastructure company. Our company stands squarely at the intersection of two global trends: the trend toward cleaner energy, and the trend toward the U.S. as a dominant world energy supplier.

Our operating companies include Southern California Gas Company (SoCalGas), the largest natural gas distribution company in the U.S.; San Diego Gas & Electric (SDG&E) in

Southern California; Oncor Electric Delivery Company (Oncor) in Texas; and two electric utilities in South America.

Additionally, our businesses include Sempra LNG and IEnova, which was one of the first private companies to invest in the energy sector in Mexico following the reforms that opened the market for energy infrastructure development. Our IEnova assets provide some of the vital infrastructure necessary to support American natural gas producers in exporting U.S. natural gas to Mexico. Today, Mexico is the largest buyer of U.S. natural gas in the world and 67% of U.S. natural gas exports flow to Mexico, according to the U.S. Energy Information Administration (EIA).

Sempra Energy is a leader in North America's growing LNG export market, developing the infrastructure to bring cleaner, more reliable and more affordable energy to the world. We are pursuing five strategically located LNG opportunities in North America, with a goal of delivering 45 million tonnes per annum (mtpa) of clean natural gas to the largest world markets, and the ability to dispatch LNG into both the Atlantic and Pacific basins. Those projects include: Cameron LNG Phase 1, which began producing LNG in May; Cameron LNG Phase 2; Port Arthur LNG in Texas; and Energía Costa Azul LNG Phase 1 and Phase 2 in Mexico. We expect that Sempra's LNG projects have the potential to fuel the equivalent of the world's fifth largest economy, opening new markets to American producers and facilitating long-term demand for abundant, clean American natural gas.

Sempra's experience as a developer and operator of LNG import and export facilities has provided us with a keen perspective on the global market for LNG. That perspective and the opportunities we see ahead in the LNG export market for the U.S., will be the focus of my

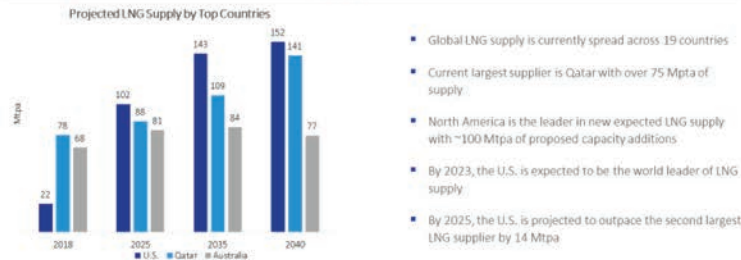
testimony today. I'll touch on U.S. supply, the impact to our economy, the global market, how LNG exports help reduce our trade deficits, the geopolitical benefits to the U.S. and our allies, and last but not least, the environmental benefits of LNG.

U.S. Natural Gas Supply

In 2017, the U.S. became a net exporter of natural gas for the first time since 1957.

Thanks to American ingenuity and technology advances, the shale gas revolution, the transition to cleaner energy resources, and pro-energy policies and legislation, natural gas supply is expected to increase to 90 billion cubic feet per day (bcf/d) in 2020, which is a 30% increase from 2017. Most of the increased natural gas is what's known as associated gas and directly related to the production of crude oil. As a result, the associated gas is an extra benefit to producers while they focus on the more valuable oil. If there is available infrastructure, the associated gas can either be processed and transferred into pipelines and used domestically or exported as LNG. The abundance of natural gas is great for domestic consumers as it means lower prices, and a welcome relief to international customers as they now have a strong, reliable and affordable supplier in the U.S. that can help countries meet their growing energy needs. The U.S. accounts for 22% of global gas production and is on track to be the largest exporter of LNG in the world by 2024. Qatar is today the largest LNG supplier globally (over 75 mtpa), although the U.S. is expected to outpace it by 14 mtpa by 2025.

U.S. Expected to be the LNG Supply Leader



Due to growing supply and advantaged pricing, the U.S. is projected to be the world leader in LNG exports by the mid-2020s with over 100 Mtpa of projected LNG supply

Source: Global Infrastructure Outlook (San Francisco, Long Beach, Houston 2018-2019 Report), January 2018



Increased LNG Exports Benefit the U.S. Economy

Becoming the world's leader in natural gas production and LNG exports will have a strong positive impact on the U.S. economy. Increased domestic natural gas production has the potential to add millions of jobs to the U.S. economy and help the global energy economy. We've already witnessed some of the economic benefits at our LNG facility in Louisiana.

On May 14, 2019, we produced our first LNG at our Cameron facility in Hackberry, Louisiana. We had the honor of being joined not only by the President of the United States and diplomats from the European Union and Japan, but also by some of your colleagues here today, including Senator Cassidy. This event truly had a global impact. Then, on May 31st, the first LNG tanker departed Cameron loaded with LNG produced at our facility, bringing American natural gas to the world market. It was a very proud and exciting day for Semptra, our partners and our country.

The total economic impact in the U.S. from Cameron LNG is estimated to be \$336 billion over the life of the project. The project is expected to generate an average of 53,000 direct and indirect jobs annually during the 20-year operations period, resulting in a total impact during the periods of construction and operation of 1.1 million job-years.

Over 11,000 highly skilled workers contributed to the construction of Cameron, including welders, iron workers, insulators, electricians, construction workers, logistics professionals and other important vocations.

And that's just one of our LNG export infrastructure facilities. Our consultant, ICF International, estimates the economic impact in the U.S. from our LNG export project in Port Arthur, Texas will be \$287 billion, or slightly over \$11 billion annually, over 25 years. Additionally, we anticipate that the Port Arthur LNG Project will help facilitate an average of nearly 5,700 direct and indirect jobs in Texas and 41,000 nationally through 2043, resulting in a cumulative impact of over 143,000 job-years for the state of Texas and one million job-years for the U.S. economy.

Servicing Global LNG Demand

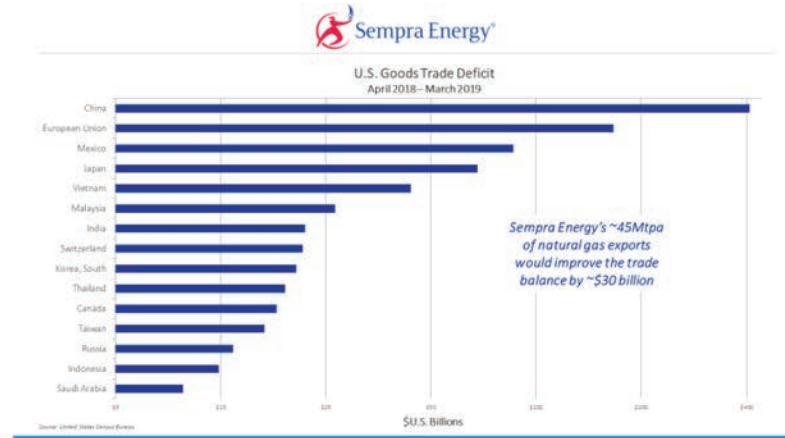
Asia today accounts for 70-75% of global LNG demand and Europe approximately 15%. Most experts agree that demand for natural gas, especially LNG, will continue to grow globally due to increased energy needs and the transition to cleaner fuels for electric generation. Forecasts expect the largest increases in LNG demand to come from China, India, South Korea, Japan, and Pakistan. In Europe, we're seeing several countries including Germany, Croatia and

Greece build new import terminals so that they can access different natural gas supplies and not be overly reliant on Russian gas through pipelines.

The majority of U.S. export capacity either exists today or is being developed in the Gulf Coast region where terminals have access to existing pipelines and storage infrastructure. On average, it takes an LNG vessel approximately 21 days to travel from the Gulf Coast to Asian markets as the ships need to go through the Panama Canal. Semptra Energy is in the process of developing two projects at our import facility at Energia Costa Azul, or ECA, which is less than 90 miles south of San Diego on the west coast of Mexico on the Pacific Ocean. When our two projects in Baja California are completed, they will connect with pipelines from Texas to help form the “Permian to Pacific” highway and will help reduce the time it takes for U.S. natural gas to get to Asian markets to approximately 12 days. As a result, Asian LNG buyers will have increased optionality with the ability to access multiple gas producing regions, with different pricing mechanisms. This will help the U.S. be even more competitive in the global LNG market.

Increased LNG Exports Will Help Reduce the U.S. Trade Deficit

The growth of U.S. LNG exports has the potential to improve our balance of trade and strengthen U.S. foreign policy. The Commerce Department recently reported that the deficit between the goods and services the U.S. sells versus what we purchase from foreign countries rose 8.4% to \$55.5 billion in May. Exports increased 2% to \$210.6 billion, but imports climbed even higher — 3.3% to \$266.2 billion. The deficit with China rose 12.2% to \$30.2 billion.



An increase in LNG exports could make a significant improvement in the U.S. trade balance, especially with countries that import large quantities of LNG and have substantial trade surpluses with the U.S., such as Japan, South Korea, Taiwan and China. The 45 mtpa of natural gas exports from Sempra's five planned LNG export facilities alone would improve the U.S. trade balance by approximately \$30 Billion.

Since ten countries in Asia account for over 80% of our trade deficit, selling them LNG could be a win-win outcome. Exporting LNG to China alone could be a game changer for our trade deficit. China became the world's largest importer of natural gas in 2018. As part of the Communist Party's Blue Skies policies to address air pollution, China will need to increase its purchases of foreign sourced natural gas. Why not from the U.S.?

Exports from Cameron LNG and Port Arthur LNG could help reduce the overall U.S. trade deficit by roughly \$16 billion annually and generate a combined cumulative value of

approximately \$303 to \$402 billion over the life of these projects. These and other U.S. export facilities will promote new pipelines and maintain natural gas production in the many producing states (e.g., Ohio, Pennsylvania, New Mexico, North Dakota, Texas and Louisiana); and at levels that will continue the current cost advantage that benefits U.S. consumers.

The U.S. has experienced positive trade benefits already from energy exports to Mexico over the last several years. In 2018, according to the EIA, the U.S. had net exports of petroleum related products (much of it natural gas) of approximately \$14.7 billion, helping to reduce our trade deficits with Mexico. As other foreign countries look for ways to competitively source LNG in the global markets, they will look to the U.S. markets.

Increased LNG Exports Will Allow the U.S. to Build Stronger International Relationships

In addition to the trade deficit, the U.S. can also use our abundant natural gas resources to further strengthen our relationships with foreign governments. LNG exports can help improve those relationships by providing competitive options to Russian gas and help us create new allies. Energy demand in Asia is expected to grow rapidly through 2040, while as we have discussed, the U.S. is expected to be a net energy exporter. In September and October of 2018, China was importing more than 12 bcf/d. In Europe, the need for natural gas is also rising, while internal production in Europe is faltering. And, Europe already has import facilities with plenty of room to increase their import capacity.

Sempra Energy is answering the call for LNG demand worldwide and helping to enrich the reputation of the U.S. along the way. For example, Sempra has signed a 20-year definitive agreement with Polish Oil & Gas (PGNiG) for 2 million mtpa of LNG, approximately 20% of Port

Arthur's planned export capacity, and preliminary agreements with major natural gas companies in other countries in Europe and Asia, including: Total, Mitsui & Co., Tokyo Gas and Kogas.

Furthermore, these agreements to offtake LNG from Sempra projects and other U.S. LNG export facilities are providing options to Russian gas in supplying LNG to Europe. These countries know that they can rely on the United States as a fair trading partner for reliable, long term energy security. As more U.S. export capacity comes on line and additional import capacity is developed, U.S. natural gas markets will continue to grow and evolve.

Growth in LNG Exports is a Net Positive for the Environment

The U.S. has an opportunity to lead a global transition to cleaner energy. LNG exports can help countries improve air quality and the environment by displacing less clean resources. More than half the countries in Asia have air quality concerns, so the demand is there for cleaner, more affordable natural gas.

The trend in the U.S. and abroad is to phase-out coal-fired power in favor of renewables and natural gas. A total of 39.64 gigawatts (GW) of coal power capacity – 21% of Europe's currently operational coal fleet – is located in countries which have committed to phase out coal. For example, Germany recently announced the phase-out of all coal-fired power plants by 2038. These countries are looking for alternatives to coal and oil and they are turning to natural gas because of the comparatively low cost and environmental benefits. While no source is perfect, natural gas emits less carbon dioxide (CO₂) than alternatives – half that of coal – it also

emits far less nitrous oxide (NOx), and virtually none of the other harmful emitted pollutants: sulfur dioxide (SO₂), mercury, or particulates.

When the transition to natural gas is implemented in Asia and Europe, the environmental benefits will be tremendous. Many of these countries are not meeting their climate pledges under the Paris Agreement and need U.S. LNG to achieve their climate goals.

For consumers in many Asian countries, dung and coal are still the primary source of energy for heating and indoor cooking in homes. Getting access to clean burning natural gas will improve their quality of life, their health, and provide them with energy justice that many first world countries take for granted.

The growth in LNG globally will also complement the growth of renewable sources of electric generation in foreign countries. Natural gas-fired electric generation is key to providing reliable and cost-effective baseload energy. As we've seen in the U.S., when the wind doesn't blow and the sun doesn't shine, it's important to have another clean and reliable source of energy. We can also expect natural gas to continue to make inroads in transportation markets globally. As has happened in most major cities in the U.S., the availability of LNG and natural gas will allow municipalities and fleet operators to displace diesel fuel and gasoline with a cleaner and low cost fuel. This is a positive for the environment and will help improve air quality in smog-choked cities around the world.

Conclusion

The U.S. is well positioned to be the global leader in energy exports. LNG exports provide a path to a cleaner environment worldwide, a reduction in our trade deficit with other

countries, an opportunity to build stronger international relationships, all while creating jobs in the U.S. and improving our domestic economy. Semptra is making significant investments in LNG export infrastructure to help realize our full potential as a country.

Thank you for the opportunity to appear before the committee today. I look forward to your questions.

The CHAIRMAN. Thank you, Mr. Arriola.
Dr. Hart, welcome.

**STATEMENT OF DR. MELANIE HART, SENIOR FELLOW AND
DIRECTOR FOR CHINA POLICY, CENTER FOR AMERICAN
PROGRESS**

Dr. HART. Thank you, Chairman Murkowski, Ranking Member Manchin, Senator Stabenow, thank you for the opportunity to testify here today.

I've worked as a China analyst for nearly two decades, and I am here to weigh in on China's role as a potential export destination for U.S. LNG.

As you know, China is a growing importer and there is tremendous speculation about the potential for large volume, U.S. LNG exports to China. Some analysts argue that exporting U.S. LNG to China will help rebalance the U.S.-China trade deficit, generate American jobs and help China transition away from coal. I'm here today to share a different view.

Arguments calling for the U.S. to export large volumes of LNG to China, unfortunately, reflect some deep misunderstandings about the way global LNG markets work and very deep understandings about China's national interests and how Beijing intends to pursue those interests.

I would like to focus my opening remarks on four key points.

First, transporting U.S. LNG to China is prohibitively expensive. There is currently not a strong commercial business case to do so in large volumes.

China does not desperately need U.S. LNG. They're already importing LNG from 17 different nations and the shipments they receive from the U.S. are among the most expensive in their supply chain. That is simply because the Gulf Coast is located far away from China's import locations, farther than China's other major suppliers.

It takes a tanker, when transporting natural gas to Shanghai, a tanker from the U.S. Gulf Coast must sail 10 days longer than one from Qatar and 15 days longer than one from Western Australia. As a result, shipping costs from the U.S. Gulf Coast to China are twice those from Qatar and almost three times those from Australia.

What we have to understand is that if China chooses to buy large volumes of U.S. natural gas, they are paying a price premium to do so. For that reason, we have to question what their intentions are in paying that price premium when they do have 17 different suppliers to choose from.

Secondly, the most bullish analysis of U.S.-China LNG trade potential are hoping that long-term infrastructure investment projects will make the trade economically feasible. Those are projects where a Chinese investor would come in, invest billions in a U.S. natural gas project and gain access to the gas it produces for a 10 to 20 year time horizon. Unfortunately, those deals are simply out of step with current market trends. The market is shifting toward short-term contracts, particularly in Asia and particularly with the Chinese purchases.

Also, technical innovations are making it possible to use floating gasification and floating liquefaction and floating re-gasification terminals so that we don't have to spend \$50 billion to develop a natural gas export facility. And anyone assessing the feasibility of those high-dollar, long-term, Chinese projects that require Chinese investment should question why we aren't considering some of the more flexible, cheaper alternatives that are emerging on the market.

Third, at best, U.S. LNG would be a short-term fix for China. Chinese leaders do not intend for their nation to be dependent on the United States for its energy supplies. In fact, the U.S. Energy Information Administration estimates that China may have more shale gas reserves than the United States. China is not doing a very good job at developing and exporting those reserves, but Beijing is determined to turn that around and to follow the U.S. example. We should not underestimate the probability that that determination will become reality given the amount of money that they're willing to invest in doing so. China is already the third largest global shale producer behind the United States and Canada. We should not put all of our eggs in the basket of expecting China to be a massive importer of LNG for decades to come.

Fourth, if Chinese leaders use state funds to pay a price premium for U.S. LNG that they do not need and do not intend to utilize over the longer term, they will expect something in return and we need to understand exactly what that is.

At a minimum, even if Beijing's intentions are completely pure, large export deals would increase U.S. economic dependence on China at a time when it could not be more clear that that dependence brings growing risks. U.S. states, companies, workers and families whose livelihoods depend on LNG shipments to China or continued Chinese investments in large development projects, could one day find themselves in the exact same situation that our soybean farmers are in today.

The United States should think twice before needlessly deepening our economic dependence on our biggest competitor. If China agrees to purchase U.S. LNG in large volumes or invest hundreds of billions of dollars in U.S. natural gas projects in exchange for the U.S. agreeing to back down on core trade complaints or any other critical U.S. national interests, a deal of that nature could undermine U.S. economic security for decades to come.

Thank you again and I look forward to your questions.

[The prepared statement of Dr. Hart follows:]

Statement before the U.S. Senate Energy and Natural Resources Committee

Hearing on the Important Role of U.S. LNG in Evolving Global Markets

July 11, 2019

Dr. Melanie Hart

Senior Fellow and Director for China Policy

Center for American Progress

Chairman Murkowski, Ranking Member Manchin, and distinguished Members of the Energy and Natural Resources Committee, thank you for the opportunity to testify before you today.

As you know, some analysts believe there is tremendous potential for U.S.-China natural gas trade. They argue that exporting U.S. liquefied natural gas (LNG) to China will help rebalance the U.S.-China trade deficit, generate American jobs, and help China transition away from coal. I am here to share a different view. Arguments calling for the United States to export large amounts of LNG to China reflect deep misunderstandings about the global LNG market. They also reflect a deep misunderstanding about China's own national interests and how Beijing seeks to position China in global energy markets.

The market fundamentals are clear: there is no strong commercial business case for exporting large quantities of U.S. LNG to China. To be sure, in the near term, if China leverages natural gas to replace high-emission coal as a bridge to eliminate net greenhouse gas emissions altogether, that would be a positive development. However, China would not need access to U.S. LNG to do so—it is already receiving imports from 25 other nations, most of which are cheaper than the shipments they receive from the United States.

From a Chinese perspective, a high-volume U.S. LNG purchase is not a wise commercial move, but it could be a brilliant diplomatic move. Beijing is using an array of industrial policies to siphon off U.S. technical know-how, privilege Chinese firms in global markets, and move China up the global value chain. Those policies undermine U.S. economic security and generate U.S.-China trade frictions. Beijing is looking for ways to ease the frictions without giving up its problematic industrial policies. If China can leverage LNG purchases to do so, that will be a massive strategic victory for Beijing. If Chinese representatives offer to pay a price premium for U.S. natural gas, Americans should pay close attention to what Beijing expects to receive in return.

My testimony will cover four main points:

1. Transporting U.S. LNG to China is prohibitively expensive.
2. Long-term Chinese investments in U.S. natural gas projects are out of step with the global LNG market and risk undermining U.S. national security.
3. China's long-term energy goals will reduce natural gas imports.
4. If Chinese leaders use state funds to pay a price premium for U.S. LNG, they will expect something in return.

(1) Transporting U.S. LNG to China is prohibitively expensive.

China imports natural gas from 26 nations via a combination of overland pipelines and seaborne (LNG) tankers. LNG currently accounts for around 60 percent of China's total natural gas imports. Australian LNG is highly competitive in China due to the relatively short distance from Darwin to China's eastern seaboard, which keeps tanker transport costs low. Australia is China's largest LNG supplier: it provided 41 percent of China's total LNG imports in the first quarter of 2019. Imports from Southeast Asian nations—which also benefit from short transport distances—accounted for 18.6 percent. Imports from Qatar accounted for 16.9 percent.

From a Chinese perspective, importing LNG from the United States generally is not commercially attractive. U.S. production costs are relatively low, but transport costs from the U.S. Gulf Coast ratchet up the price beyond what China would pay for comparable shipments from Australia and other close-in exporters. When transporting natural gas to Shanghai, tankers from the U.S. Gulf Coast travel 10 days longer than tankers from Qatar and 15 days longer than tankers from Western Australia. As a result, shipping costs from the U.S. Gulf Coast to China are twice the shipping costs from Qatar and almost three times the costs from Australia.

Houston-based Cheniere Energy has a unique business model that is shipping limited amounts of LNG to China from its Sabine Pass liquefaction facility. Those small-volume shipments can meet targeted Chinese demand needs, but scaling them up to a high-volume export relationship does not make commercial sense. Based on 2017 pricing, China's seaborne LNG imports from the United States are more expensive than 73.8 percent of its seaborne LNG imports from other nations. U.S. LNG has a better comparative advantage in markets that are located closer to the U.S. Gulf Coast.

The market fundamentals are clear: The United States does not have a natural comparative advantage in China's natural gas supply chain. If Chinese entities import large quantities of LNG from the United States, they will be paying a price premium to do so. That raises questions about the potential political intentions behind those purchases.

(2) Long-term Chinese investments in U.S. natural gas projects are out of step with the global LNG market and risk undermining U.S. national security.

The most bullish analyses of potential U.S. LNG exports to China are hoping for long-term infrastructure investment deals. With this business model, the buyer agrees to invest in production infrastructure and, in return, gains access to the natural gas the project produces at a set price over 10- to 20-year time

horizons. Since prices can shift substantially over a decade and the upfront capital costs are spread out over a long time frame, this approach can make sense even when current price alignments are less than favorable.

Beijing has demonstrated an interest in making long-term investments in West Virginia and Alaska. When President Trump visited Beijing in November 2017, the two presidents oversaw the signing of a preliminary agreement between Alaska and three Chinese state-owned enterprises—China Petrochemical Corp (Sinopec), China Investment Corp (China’s sovereign wealth fund), and Bank of China—in which the Chinese firms would bankroll Alaskan pipeline infrastructure in exchange for guaranteed access to 75 percent of the gas produced over the duration of the project. That same trip produced a memorandum of understanding between state-owned China Energy Investment Corporation and West Virginia. The West Virginia deal is particularly light on details, but some local leaders are hoping China Energy Investment Corp. will invest around \$83 billion in a suite of natural gas projects ranging from power stations to petrochemical plants.

Those deals are a concern for two reasons. First, even if Beijing’s intentions are pure, long-term investments are out of step with current market trends. Global LNG markets are shifting from oil-linked to hub-based pricing, and that is making long-term contracts less attractive. Natural gas infrastructure is also evolving. Technical innovations are making it possible to deploy cheaper and more flexible floating import and export terminals, which reduce the need for massive fixed-infrastructure investments. As more floating terminals come online, they are reshaping the global market. Nations keen to either buy or sell LNG in relatively small amounts—amounts that do not justify sinking billions into fixed infrastructure—can do so more cheaply using floating units. A rush of smaller buyers and sellers can have as big or more of an impact as the movements of one big player such as China. Between 2014 and 2017, 12 countries, taken together, drove more demand growth than China, and floating import terminals enabled three-quarters of that growth.

Second, the United States cannot assume Beijing’s intentions are pure. Chinese state-owned enterprises, including oil majors, answer to the Chinese Communist Party. Those firms are tools of the state and behave accordingly. If those firms obtain massive shares in U.S. natural resources—large enough to potentially control how those resources are used and effectively bankroll the state and local economies in which they operate—that raises important questions about how that might affect U.S. national security. If those deals move forward, the Chinese Communist Party will have tremendous leverage over local economies in two great American states. In future, Beijing could seek to use that leverage to deter the United States from taking actions to protect its own national interests vis-à-vis China.

(3) China’s long-term energy goals will reduce natural gas imports.

The U.S. Energy Information Administration estimates that China may have as much or more shale gas than the United States. Development has been sluggish, but Beijing is hoping to change that. The barriers are largely political: Beijing currently allows state-owned enterprises to dominate the sector, and state control inhibits market activity and technical innovation.

Going forward, if Chinese leaders get serious about reform, the next unconventional gas revolution could occur in China. China is already the third-largest global shale gas producer behind the United States and Canada. U.S. natural gas exporters should take China's production potential into account—and Beijing's growing determination to unlock that potential—when making investment decisions that hinge on a continued rise in Chinese import demand.

Chinese natural gas demand may also fall in time if it transitions to clean energy in order to eliminate net greenhouse gas emissions, as the Intergovernmental Panel on Climate Change has recommended.

(4) If Chinese leaders use state funds to pay a price premium for U.S. LNG, they will expect something in return.

China does not need U.S. LNG. It already has access to imports from at least 25 other nations, most of which are cheaper than what they pay for U.S. imports. Over the longer-term, Beijing does not want China to depend on LNG imports from the United States or any other nation—it wants China to produce its own energy supplies, just like the United States does today.

Beijing also wants continued U.S.-China economic integration on terms that allow China to continue tilting the playing field in its favor, boosting its own economic competitiveness at U.S. expense. Chinese leaders have already demonstrated that they are willing to devote trillions of dollars in state capital to achieve their economic goals. The United States should not be surprised to see some of that capital directed toward the U.S. natural gas sector.

When dealing with a non-market economy, it is critical to understand the exact terms of the deal being offered, as those terms often extend beyond the commercial sphere. If Beijing offers to pay a price premium for U.S. LNG—or invest billions of dollars in U.S. natural gas development projects—Americans must understand what they are giving China in return. At a bare minimum, even if Beijing's intentions are pure, those deals would increase U.S. economic dependence on China at a time when that dependence brings growing risks. U.S. states, companies, workers and families whose livelihoods depend on LNG shipments to China or Chinese investments in local natural gas projects could find themselves in the same position many American soybean farmers are in today.

The United States should think twice before needlessly deepening our economic dependence on our biggest competitor. If China is offering a deal that would also require the United States to back down on core trade complaints—or any other critical U.S. national interests—that deal could undermine U.S. economic security for decades to come.

Thank you and I look forward to your questions.



Do Not Fall for the Hype on U.S.-China Natural Gas Trade

By Melanie Hart, Luke Bassett, and Blaine Johnson April 2018

WWW.AMERICANPROGRESS.ORG



Do Not Fall for the Hype on U.S.-China Natural Gas Trade

By Melanie Hart, Luke Bassett, and Blaine Johnson April 2018

Contents

- 1 Introduction and summary
- 3 Beijing is currently leveraging natural gas imports to fill a reform gap
- 8 China already has 26 supplier nations, and U.S. shipments are more expensive than most
- 11 The United States has a geographical disadvantage exporting to China
- 15 The Trump administration is pushing investment deals that ignore current market trends
- 20 Trump administration's natural gas export obsession risks forfeiting a much bigger game
- 24 Conclusion
- 25 About the authors
- 26 Appendix A: U.S. LNG export shipments to China as of year-end 2017
- 29 Appendix B: China's natural gas reform timeline
- 35 Endnotes

Introduction and summary

The Trump administration frequently pushes natural gas exports in high-level talks with Beijing. Most recently, after threatening to impose tariffs on Chinese technology imports, some administration officials are stating that the tariffs can be reduced if China buys more U.S. natural gas.¹ The Trump administration is pitching a very simple argument: If China imports more natural gas from the United States, that will help rebalance the U.S.-China trade deficit—which rose to a record \$375.2 billion during President Donald Trump's first year in office—and generate American jobs.² In reality, that argument reflects a deep misunderstanding about how today's global energy markets actually work.

At first glance, the United States and China do have good synergies in this sector. China is consuming more natural gas than it can produce and seeking new imports; the United States is the world's largest producer, and the Trump administration wants to send more of that production overseas. Trump routinely uses his meetings with President Xi Jinping and other Asian leaders to push natural gas export deals. That push played a role in preliminary U.S.-China deals inked last November and is generating excitement on both sides of the Pacific about a potential U.S.-China natural gas trade boom.

Behind the hype, however, market realities suggest this will not pan out as promised. This report covers the following five factors that American observers need to understand about the Trump administration's push to export U.S. natural gas to China:

1. Beijing is currently leveraging natural gas imports to fill a reform gap: Demand-side reforms have thus far been more successful than the supply-side. If Chinese leaders can push forward needed reforms on the supply side, the nation's import dependence may decrease.
2. China already has 26 supplier nations, and the shipments it receives from the United States are more expensive than 83 percent of its import supply chain.³

3. The United States has a geographical disadvantage exporting to China and is better placed to serve other growing markets.
4. The Trump administration is pushing U.S.-China natural gas investment deals that ignore current market trends.
5. The Trump administration's fossil fuel obsession risks forfeiting a much bigger strategic game in clean energy technology.

Chinese President Xi has big ambitions. His vision for an ideal future U.S.-China economic relationship is one in which the United States exports commodities to China while China steadily edges the United States out as the dominant player in global high-tech markets, including clean energy markets. In that scenario, the United States gets the lower end of the value chain and China dominates the higher end, thus winning the best jobs. Chinese leaders know that, globally, the world is already installing more new renewable energy generation capacity than new fossil fuel-based capacity.⁴ Even major oil and gas exporters such as Saudi Arabia and the United Arab Emirates are investing billions in renewables—they see where the market is headed and do not want to be left behind. Chinese leaders view clean energy as a major battlefield in their nation's quest to surpass the United States as the new high-tech superpower, and entertaining the Trump administration's fossil fuel export initiatives is a useful tactic for keeping the United States occupied on the sidelines while China runs the field.

There is little question that China's rising natural gas consumption is an exciting trend. If Beijing leverages natural gas to replace coal and reduce the nation's overall fossil fuel emissions—neither of which is guaranteed—that could be good for the planet. However, this trend is unlikely to generate game-changing jobs for the United States, and the Trump administration's determination to promote fossil fuel exports at any cost undermines broader U.S. economic interests. If the administration accepts natural gas export promises from China in exchange for backing off from much broader U.S. trade complaints—as U.S. Secretary of Commerce Wilbur Ross is suggesting—that will undercut the U.S. economy even further.

Understanding these dynamics is critical for assessing what the current administration's U.S.-China natural gas initiatives are likely to produce over the longer term.

Beijing is currently leveraging natural gas imports to fill a reform gap

Demand-side reforms have thus far been more successful than the supply-side

China is a major natural gas producer and consumer. For decades, Beijing controlled pricing and activity on both sides of the market—production and consumption—and those controls hindered natural gas development in China. Natural gas currently accounts for just 7 percent of China's total energy consumption compared with 29.2 percent in the United States, 23.7 percent in Germany, and 22.5 percent in Japan.⁵ Over the past five years, Chinese leaders have rolled out a series of policy reforms designed to relax the old controls, create more room for market competition, and encourage more production and consumption.

Those reforms have been particularly successful on the consumption side. Beijing is aiming for natural gas to account for 10 percent of the nation's energy mix by 2020—up from 7 percent at year-end 2017—and 15 percent by 2030.⁶ To make that happen, Beijing is rolling out an array of environmental policies that provide new incentives—and in some cases mandatory requirements—for switching to natural gas as a substitute for more emission-intensive fossil fuels. That effort began with the 2013 Air Pollution Control Action Plan, which required major urban areas along China's eastern seaboard to reduce their overall coal consumption, close down coal-fired industrial boilers and power plants, and bring in natural gas and renewables as substitutes by 2017.⁷ That 2017 deadline, however, triggered major natural gas supply shortages last fall as some city planners—eager to meet their 2017 deadlines—shut down coal-fired power before they had substitutes in place to cover winter heating needs.⁸

In addition, Chinese leaders are also rolling out policies to encourage natural gas use for transport. Transport emissions account for around 25 percent of air pollution in China, and Beijing views switching to natural gas vehicles—both liquid and compressed natural gas—as a key lever for reducing pollution.⁹ China had

more than 5 million natural gas vehicles in 2017—accounting for more than 20 percent of the global total—and Beijing is pushing to double that to 10 million by 2020.¹⁰ To meet that target, local governments across China are providing consumers with a variety of subsidies for natural gas fuel and vehicle purchases.¹¹

These demand-side policies are having an impact. Between 2013—when Beijing first launched the Clean Air Action Plan—and 2017, China's total natural gas consumption grew 41 percent, averaging roughly 9 percent growth per year.¹² As consumption rises, Beijing is also rolling out three major supply-side reforms to drive domestic production—China has both onshore and offshore reserves—and imports.

First and foremost, Chinese leaders are taking steps to liberalize natural gas pricing. The first big shift occurred in July 2013, when Beijing rolled out a new pricing model for industrial-use gas that linked city-gate prices—or municipal-level distribution prices—to international market rates for fuel oil and liquid petroleum gas.¹³ Central planners used those international rates to set price ceilings and then allowed buyers and sellers in China to negotiate up to that ceiling. Beijing then took an even bolder step with unconventional gas, which is generally more expensive to develop in China. Starting in the second half of 2013, Beijing fully liberalized pricing for shale gas, coal bed methane, coal-to-gas, and imported liquefied natural gas (LNG)—suppliers in those sectors could charge whatever buyers were willing to pay.¹⁴ Over time, Beijing has also gradually broadened the band in which conventional natural gas prices could fluctuate, allowing more room for buyers and sellers to negotiate prices based on supply and demand.¹⁵

China's old natural gas price regime

Prior to the recent price reforms, government planners controlled prices at every step in China's natural gas value chain. Beijing dictated the ex-factory or production price on the upstream side, city-gate or city-level distribution prices on the downstream side, and at every other point natural gas changed hands. Beijing's primary goal was to keep natural gas affordable for end users, so prices varied by location and end use depending on what Beijing thought local people could pay. Producers could not charge higher prices during supply shortages and thus had no incentive to invest in additional exploration and development. Shortages were a persistent problem, and domestic production was particularly sluggish in unconventional gas plays—such as shale gas—that require significant upfront costs to get around unique technical challenges in China.¹⁶

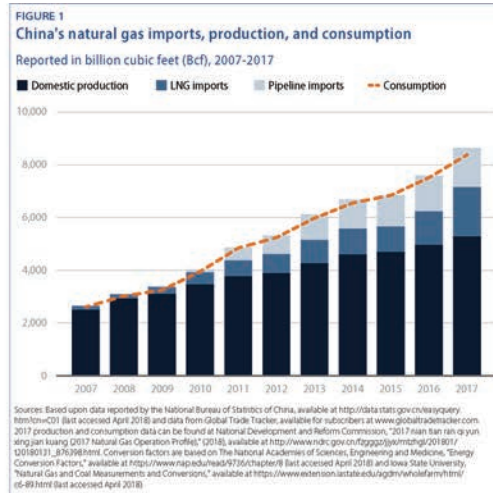
Price reform is still a work in progress, but these measures are already having an impact. Before the reforms commenced, China's city-gate prices were well below international rates.¹⁷ That was a serious problem for China's oil and gas majors who were signing import contracts with foreign suppliers and, due to the price spread between international and domestic rates, selling the imported gas at a loss in China. In 2012, PetroChina lost \$6.7 billion importing natural gas into the country and selling it at state-controlled rates.¹⁸ In 2013, PetroChina's losses increased to \$7.9 billion—including a \$4.6 billion loss on pipeline imports from Central Asia, a \$67 million loss on pipeline imports from Myanmar, and more than \$3.2 billion in losses on imported liquefied natural gas.¹⁹ Those losses declined when Beijing implemented the price reforms and domestic prices began to more closely track international rates.²⁰ On the consumer side, however, the initial reform-induced price increases dampened consumption, and that created an entirely different headache for Chinese leaders given their goal to expand natural gas use.²¹ Since 2014, a steady decline in global oil and gas prices has made it possible for Beijing to liberalize pricing while also maintaining affordability for end users.²² If global prices trend in the opposite direction, that will make things difficult for Beijing, but that is unlikely given that the global natural gas market appears to be entering a period of oversupply.²³

Second, in addition to price reform, Beijing also opened up liquefied natural gas imports for private sector participation. China's state-owned enterprises have a monopoly on pipeline imports and domestic production—they dominate the best gas plays—but private enterprises can now enter the upstream market via LNG. If those imports entailed the kind of multibillion-dollar losses PetroChina suffered in 2013, there would be few takers; however, from 2014 onward, the combination of declining global LNG prices and an increasingly liberalized domestic pricing regime made the LNG import business a more favorable proposition. From 2014 to 2016, China's average LNG import price fell from an all-time high of \$12.64 per thousand cubic feet to \$7.05 per thousand cubic feet; in 2017, prices ticked up 12 percent to \$7.91 per thousand cubic feet but remain much lower than previous years.²⁴ Private companies have two options for market entry: utilize existing terminals or build their own. Beijing's 13th Five-Year Energy Development Plan, issued in 2013, encouraged private companies to invest in the natural gas sector, with one private company even permitted to construct and operate its own import terminal beginning in 2012.²⁵ In 2014, Beijing ordered the nation's state-owned oil and gas majors to grant private companies access to their unused import terminal capacity so that more private companies

could take advantage of falling global LNG prices.²⁶ Back in 2012, China had just six import terminals across six ports with a total import capacity of less than 3 billion cubic feet per day (Bcf/d); by year-end 2017, China had 17 terminals across 14 ports with a total 7.4 Bcf/d of capacity.²⁷

Third, Beijing is taking steps to gradually relax state-owned enterprise control over domestic production. If Chinese leaders can break open their nation's upstream sectors, that will be the real game-changer. The U.S. Energy Information Administration estimates that China may have as much or more shale gas than the United States, but development has been sluggish.²⁸ Overall, China's annual domestic production growth has decelerated from more than 19 percent in 2005 to less than 12 percent in 2010 and just over 2 percent in 2015.²⁹ Chinese leaders are hoping to turn that trend around. Beijing's 13th Five-Year Plan for Natural Gas Development targets 7.3 trillion cubic feet of production by 2020, up from 4.8 trillion in 2015.³⁰ In 2016, year-on-year growth in China's reported domestic production bounced back to just more than 5 percent.³¹ In the United States, private sector competition played a key role in driving some of the technology and process innovations that unlocked shale gas development.³² For that to happen in China, Beijing will have to break down an array of market barriers that currently stifle competition in the nation's upstream sectors. For example, state-owned companies control the best oil and gas plays and, in some cases, sit on them without either developing them or allowing other companies to do so. China's geological data is classified, so private companies and investors have no idea how much natural gas the country has or where it is located. Plus, state-owned companies control the pipelines and often either deny pipeline access to private companies or charge exorbitant rates, thus making it hard to bring those extra supplies to market.

Beijing is taking steps to address these problems, but progress has been slow, so they are currently relying on imports to meet the nation's rising demand.³³ Going forward, however, if Chinese leaders get serious about supply-side reform, the next unconventional gas revolution could occur in China. As of 2017, China is already the third-largest global shale gas producer behind the United States and Canada.³⁴ Natural gas exporters should take China's production potential into account—and Beijing's growing determination to unlock that potential—when making investments that hinge on a continued rise in Chinese import demand.



China already has 26 supplier nations, and U.S. shipments are more expensive than most

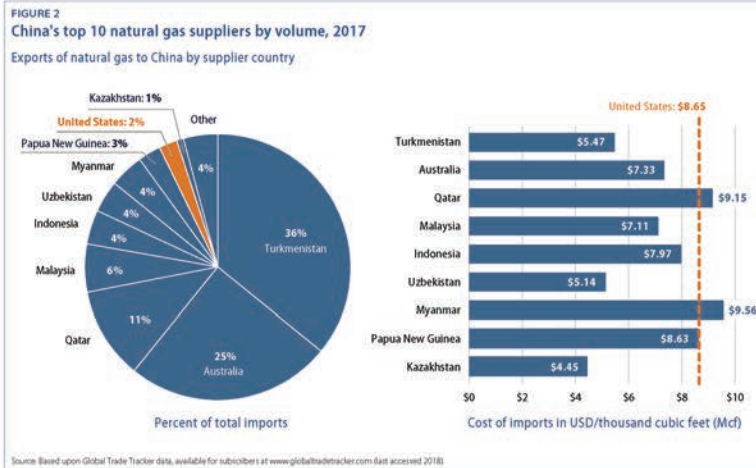
China has been a net natural gas importer since 2007, and the gap between domestic production and consumption has grown steadily since then. China imports natural gas via a combination of overland pipelines and seaborne tankers.³⁵ In 2017, 55.7 percent of China's natural gas imports by volume came in via LNG tanker and 44.3 percent via overland pipeline.³⁶

On the seaborne LNG side, China's first imports came from Australia in 2006.³⁷ In the late 2000s and early 2010s, smaller suppliers—including Algeria, Yemen, and Nigeria—also shipped LNG to China, but as of 2017, only Australia, Qatar, Malaysia, Indonesia, Papua New Guinea, and the United States occupy China's LNG import market shares above 3 percent. The United States did not join China's LNG supply chain in earnest until 2016. U.S.-to-China year-on-year LNG exports grew 217 percent in 2016 and 670 percent in 2017, at which point the United States edged out Nigeria to become China's sixth largest LNG supplier. Australia has retained its position as China's top LNG supplier by volume, except for the period from 2012-2015 when a bump in Qatari exports overtook Australia's.³⁸

On the pipeline side, China borders multiple onshore natural gas supply regions, and the nation's state-owned energy companies have invested billions of dollars to bring in natural gas via overland pipeline.³⁹ China generally pays less for pipeline gas than it does for seaborne LNG. For example, in 2017 China paid an average US\$5.75 per thousand cubic feet for pipeline gas and an average US\$7.91 per thousand cubic feet for seaborne LNG.⁴⁰ Currently, China's biggest pipeline supply route is from Turkmenistan, which supplied 80.5 percent of China's piped natural gas imports in 2017. The rest of China's pipeline natural gas imports come from Uzbekistan (8.5 percent), Myanmar (8.3 percent), and Kazakhstan (2.7 percent).⁴¹ Once the Myanmar and Kazakhstan pipelines came online in 2013, pipeline gas surpassed LNG as China's primary import source but that reversed again in 2017, following Turkmenistan pipeline supply problems and a dip in global prices that narrowed the price gap between LNG and pipeline gas and thus made seaborne

LNG more economical for Chinese buyers.⁴² China's first pipeline from Russia is scheduled to come online in December 2019; once that pipeline is flowing, Russia is expected to become China's top overland supplier, bumping Turkmenistan from the number one spot.⁴³

Overall, in 2017, China imported 3.35 trillion cubic feet of natural gas—of which 1.48 trillion cubic feet came in via pipeline and 1.87 trillion cubic feet as LNG—making China the world's second-largest natural gas importer, behind Japan.⁴⁴ In 2017, China's top five natural gas suppliers by volume—pipeline gas and LNG combined—were Turkmenistan (accounting for 36 percent of total imports), Australia (25 percent), Qatar (11 percent), Malaysia (6 percent), and Indonesia (4 percent). Beijing wants the nation's supply mix to prioritize diversity—importing from multiple nations across a variety of transport routes and contract structures—and affordability.⁴⁵ A diverse mix of suppliers and transport routes serves as a hedge against supply shocks and also provides multiple ports of entry to channel natural gas into different Chinese regional markets.⁴⁶ When China first became a net importer in 2007, it received shipments from just four nations; today, 26 nations supply natural gas to China.⁴⁷



U.S. natural gas exports to China did not begin in earnest until August 2016, when Houston-based Cheniere Energy began shipping LNG to Chinese buyers from its Sabine Pass liquefaction facility.⁴⁸ In 2016, China imported 17.2 billion cubic feet of LNG from the United States.⁴⁹ In 2017, that increased to 100 billion cubic feet,⁵⁰ making the United States China's ninth-largest natural gas supplier behind Papua New Guinea. All of the U.S.-to-China shipments departing in 2017—29 total cargoes totaling 100.01 billion cubic feet⁵¹—came from Cheniere's Sabine Pass facility.⁵² Cheniere has a unique toll gate business model: The company is not directly involved in production. Instead, it purchases gas from U.S. producers, liquefies it at Sabine Pass, and sends it overseas. When Cheniere signs long-term contracts, it is not agreeing to produce a set amount of gas but rather to procure and liquefy it on the buyer's behalf. In February, Cheniere Energy inked a long-term deal with China National Petroleum Corporation to supply up to 1.2 million tons—\$8.4 billion cubic feet—of LNG per year until 2043.⁵³ Cheniere can fill those shipments with a combination of spot market purchases—taking advantage of price dips wherever possible—and longer-term supply contracts with producers willing to supply larger shipments to Cheniere at wholesale rates.

Although Cheniere's unique business model is doing well exporting limited amounts of LNG to China, overall, the United States has not played a major role in China's supply chain because U.S. LNG is generally not cost competitive in China. In 2017, China paid an average US\$8.65 per thousand cubic feet for imports from the United States and an average US\$6.95 per thousand cubic feet for all other natural gas imports. Based on 2017 pricing, U.S. imports are more expensive than 83.6 percent of the natural gas China obtained from other suppliers.⁵⁴ Within China's seaborne LNG supply chain alone—not including pipeline gas—U.S. imports are more expensive than 73.8 percent of China's imports from other suppliers.⁵⁵

The United States has a geographical disadvantage exporting to China

The United States is better placed to serve other growing markets

The problem is that, although U.S. production costs are relatively low—U.S. benchmark prices have averaged \$3.14 per thousand cubic feet since March 2014 compared with \$4.35 per thousand cubic feet in Australia—transport costs from the U.S. Gulf Coast ratchet up the price beyond what China would pay for comparable shipments from Australia.⁵⁶ U.S. LNG export infrastructure is clustered along the Gulf Coast because those ports are closest to the nation's existing pipelines and other onshore natural gas infrastructure.⁵⁷ Shipping LNG from the U.S. Gulf Coast to China, one way, currently costs approximately twice as much as it does from Qatar and almost three times as much as from Australia. Geographical distance is the problem: When transporting natural gas to Shanghai, tankers from the U.S. Gulf Coast travel 10 days longer than tankers from Qatar and 15 days longer than tankers from Western Australia.⁵⁸ To reach Asian markets, tankers leaving Gulf Coast terminals must choose among four major maritime routes: Panama Canal, Suez Canal, Cape Horn in South America, or the southern tip of Africa. Even the shortest route from the Gulf Coast to Asia—through the Panama Canal—incurs substantial transit costs.⁵⁹

In contrast to the challenges involved in sending natural gas to Asia, the United States has a geographical advantage exporting to Canada and Mexico—and that is where the bulk of U.S. exports currently go. Pipeline exports to Canada and Mexico accounted for 78 percent of total U.S. natural gas exports in 2017.⁶⁰ Excluding continental pipeline trade, Mexico was also the leading export destination for U.S. LNG in 2017.⁶¹

TABLE 1
One-way transport costs between export plants and import terminals,
in USD/Million British thermal units

Calculations based on model of standardized shipping conditions

From	To							
	Tianjin, China	Shanghai, China	Tokyo, Japan	Incheon, South Korea	Altamira, Mexico	Aqaba, Jordan	Huelva, Spain	Mejillones, Chile
Sabine Pass (USA)	\$0.83	\$0.81	\$0.76	\$0.81	\$0.17	\$0.61	\$0.38	\$0.45
Cove Point (USA)	\$0.85	\$0.83	\$0.78	\$0.83	\$0.24	\$0.54	\$0.31	\$0.47
Qatargas (Qatar)	\$0.48	\$0.44	\$0.48	\$0.46	\$0.78	\$0.29	\$0.51	\$0.76
Darwin LNG (Australia)	\$0.31	\$0.28	\$0.30	\$0.30	\$0.86	\$0.49	\$0.71	\$0.61

Authors used a generic set of shipping condition assumptions to create a standardized comparison between shipments from different locations; exact rates could vary depending upon variables including vessel specifications, port fees, charter rates, and fuel-off prices, among other conditions.

Source: Shipping rates calculated using IHS Markit's LNG Shipping Calculator. The use of this content was authorized in advance. Any further use or redistribution of this content is strictly prohibited without written permission by IHS Markit.

Going forward, transport costs are likely to become even more important for U.S. export competitiveness because the capital costs required to bring new U.S. natural gas export terminals online are increasing, and that will make it harder for U.S. exporters to make a profit while also keeping their prices competitive in overseas markets. When the shale gas boom first made it possible for the United States to consider exporting natural gas in the mid-2000s, existing import terminals along the East and Gulf Coasts—which were already connected to the nation's pipeline network—offered early, limited opportunities for companies to retrofit those facilities for export instead of building new terminals from scratch.⁶² There are a limited number of existing import terminals available to retrofit, however, so new companies entering the market today are more likely to construct new terminals from scratch. That doubles their upfront capital costs: Constructing a new terminal runs between \$31 million and \$52 million per billion cubic feet of capacity; retrofitting an existing facility runs \$10 million to \$12.5 million per billion cubic feet of capacity.⁶³ Across the United States, there are currently 27 active terminal projects: two in operation—Cheniere's Sabine Pass and, as of March 2018, Dominion Energy Inc.'s Cove Point in Maryland; six terminals or terminal expansions under construction; four approved but not yet under construction; and an additional 16 in the approval or pre-filing stage with relevant regulatory authorities.⁶⁴ Of those 27 projects, only eight are retrofits.⁶⁵

If U.S. LNG export tankers departed from the Pacific Coast instead of the Gulf Coast, that would lower maritime transport costs to Asia—thus potentially balancing other costs, such as terminal construction costs—but that is not

where most U.S. natural gas production is located. If state and federal regulatory authorities approve the only LNG project currently proposed for the West Coast—the Jordan Cove project in Oregon—that would open up 1.04 billion cubic feet of West Coast export capacity with proximity to Asian markets.⁶⁶ However, that project is facing substantial opposition from Native American tribes, environmental groups, property owners, and some state leaders along the feeder pipeline’s proposed route.⁶⁷ Furthermore, adding substantial export capacity along the U.S. Pacific Coast would require sinking even more money into new pipeline infrastructure to connect those terminals to the closest production areas in states such as Wyoming or Colorado.⁶⁸ Expansions into the U.S. northeast make more commercial sense. The recently operational Cove Point terminal project in Maryland and the Elba Island project under construction in Georgia are located at preexisting import terminal sites with good pipeline connections and geographical proximity to production areas such as the Marcellus and Utica shale plays in Appalachia.⁶⁹ Once complete, those terminals will provide shorter transport distances to European and Mediterranean markets, but they will not lower transit costs to Asia.⁷⁰

Overall, exporting LNG from the United States to Asia is an expensive proposition. That can make sense for import markets such as Japan that can pay high prices. Japan, for example, paid an average of \$6.13 per thousand cubic feet for the LNG shipments it received from the United States in 2017. In comparison, China paid an average \$4.32 per thousand cubic feet,⁷¹ and even at that rate, the shipments it received from the United States were among its most expensive, as mentioned above.

It is important to note, however, that China is not the only rapidly growing demand market. As natural gas prices continue to fall and technology innovations offer cheaper and more flexible options for import infrastructure, there has been a rush of new market entrants that—when taken together—outweigh China’s demand growth. Between 2014 and 2017, 12 emerging markets—many of which are leveraging floating infrastructure—cumulatively drove more global LNG demand growth than China. Demand is rising across Europe, the Middle East, and the Americas—all of which are geographically closer to the United States and thus offer more favorable transport rates for U.S. exporters.⁷² Impressive growth in closer-in markets makes it difficult to justify investing in expensive U.S. projects designed to send LNG to more distant, and thus more costly, East Asian markets where U.S. exports do not enjoy the same comparative advantage.⁷³

These trends raise an important question about the Trump administration's China strategy: If the United States has better export alternatives, why would the White House put so much political capital into pushing for deals with Beijing? Furthermore, why would administration officials even consider accepting those deals as a major Chinese trade concession—as Secretary Ross is suggesting—instead of holding the line to demand Chinese action on much bigger trade policy issues?

If the United States
has better export
alternatives, why would
the White House put so
much political capital
into pushing for deals
with Beijing?

The Trump administration is pushing investment deals that ignore current market trends

Many of the voices that are bullish on U.S. LNG exports to China are hoping for long-term infrastructure investment deals. With this business model, the buyer agrees to invest in production infrastructure and, in return, gains access to the natural gas the project produces at a set price over 10- to 20-year time horizons. Since prices can shift substantially over a decade and the upfront capital costs are spread out over a long time frame, this approach can make sense even when current price alignments are less than favorable.

In Australia, for example, Chinese investment has been key for developing some of that nation's recent natural gas infrastructure.⁷⁴ Australia's natural gas resources are generally located in sparsely populated regions of the country or offshore, and the pipeline and processing infrastructure needed to link supply and demand would be costly relative to the country's small population. To address that challenge, Australia actively courted overseas investors—including Chinese corporations—willing to bankroll development projects in exchange for long-term access to the gas those projects produce.

Chinese firms are also acquiring shares in specific Australian gas plays. For example, China National Offshore Oil Corporation (CNOOC) has invested more than US\$8 billion in Australian LNG projects, including a 5.3 percent equity stake in Western Australia's North West Shelf reserves and a 25 percent equity stake in the Queensland Curtis LNG project, which provides CNOOC a guaranteed 175.32 billion cubic feet per annum.⁷⁵ Similarly, China's Sinopec owns a 25 percent stake in the Australia Pacific LNG project—also in Queensland—which provides Sinopec a guaranteed 370.12 billion cubic feet per annum.⁷⁶ In the Surat-Bowen Basin in Queensland, PetroChina, Sinopec, and CNOOC hold 12 percent, 8 percent, and 5 percent shares, respectively, of the basin's approximately 36.6 trillion cubic feet of proven and probable natural gas reserves.⁷⁷ Overall, as of 2017, these

investments and related contracts—which are public—give China exclusive rights to 20 percent of Australia's current annual natural gas export capacity of 2.99 trillion cubic feet per annum.⁷⁸ When nonpublic contracts are included, the total amount is likely much higher.⁷⁹

Chinese investors are also active in the United States. Since 2010, Chinese companies have invested \$12.34 billion in American oil and natural gas companies, approximately \$6.3 billion of which is invested in American companies solely working in natural gas.⁸⁰ Both the United States and Australia have prevented China's state-owned enterprises from controlling their domestic oil and gas resources: Those firms could make minority-share investments, but they could not control how much gas is pulled out of the ground or where it is sent. In the United States, however, President Donald Trump is aiming to change that arrangement.

When President Trump visited Beijing in November, the two presidents oversaw the signing of a preliminary agreement between Alaska and three Chinese state-owned enterprises—China Petrochemical Corp (Sinopec), China Investment Corp (China's sovereign wealth fund), and Bank of China—in which the Chinese firms would bankroll Alaskan pipeline infrastructure in exchange for guaranteed access to 75 percent of the gas produced over the duration of the project.⁸¹ According to Platts reporting, Alaska's state gas corporation, Alaska Gasline Development Corporation, "hopes to finalize the Sinopec contract by next December, begin construction in 2019 and to have LNG exports underway by 2024 or 2025."⁸² That same trip produced a memorandum of understanding between state-owned China Energy Investment Corporation and West Virginia.⁸³ The West Virginia deal is particularly light on details, but according to West Virginia Gov. Jim Justice (R), the state is hoping that China Energy Investment Corp. will invest around \$83 billion in a suite of natural gas projects ranging from power stations to petrochemical plants—more than the state's gross domestic product for all of 2016.⁸⁴

In reality, these deals should be viewed with a healthy dose of skepticism, because global markets are shifting in ways that make fixed infrastructure investments of this nature increasingly unattractive. Two big trends are having a particularly important impact: shifts in market pricing and technical innovations in natural gas import and export infrastructure.

On the pricing front, LNG markets are shifting from oil-linked to hub-based pricing, and that is making long-term infrastructure investment contracts less attractive. When trade first began in 1964, there was no standard pricing model for natural gas, so buyers and sellers generally used crude oil prices as a commonly accepted benchmark.⁸⁵ At that time, long-term contracts were a useful strategy for locking in price security against the volatile price of crude oil.

When the United States began to enter the global market on a large scale, that brought about a new approach to pricing. In the United States, natural gas trade developed primarily to serve domestic use. Since buyers and sellers were operating within the same domestic market, they could negotiate prices based on actual supply and demand rather than a crude oil benchmark.⁸⁶ The U.S. Henry Hub—the Gulf Coast trading platform where several pipelines intersect—allowed natural gas to compete with natural gas rather than with oil.⁸⁷ Now other regional markets are following that example and shifting toward hub-based trading, which is making prices more commoditylike and transparent. Buyers can now leverage hub-based trading to take advantage of low-price, short-term, or spot contracts for natural gas rather than relying only on long-term contracts designed to insulate natural gas deals from fluctuations in crude oil.⁸⁸ Long-term contracts still dominate global LNG trade, but short-term and spot-market contract shipments are rapidly gaining market share: They accounted for 28 percent of global trade volume in 2016, up from 16 percent in 2010. More than half of the spot-market activity is occurring in Asia.⁸⁹

Technology innovations are yet another force pushing the market away from long-term infrastructure investments. Instead of sinking billions of dollars into fixed import and export terminals—which can quickly become useless if markets shift the wrong way—technical innovations are making it possible to deploy cheaper and more flexible floating units. Floating liquefaction units—otherwise known as floating export terminals—can be constructed using retrofitted tanker ships, new near-shore barges or purpose-built vessels. These units cost \$12.5 million to \$20.8 million per billion cubic feet of capacity to construct, which is less than half the cost of building a new fixed export terminal in the United States.⁹⁰ Worldwide, there are already four of these projects under construction—with a total 423 billion cubic feet of capacity—and another 24 in the proposal pipeline, potentially adding another 7.6 trillion cubic feet to the supply side.⁹¹

Floating storage and regasification units—import terminals—are also showing up on the demand side of the market. They are less expensive than onshore import facilities by a factor of 4 for new vessels or up to 12.5 for retrofitted LNG tankers.⁹²

New import market entrants—including Colombia, Egypt, Jordan, Pakistan, and the United Arab Emirates—are already utilizing floating terminals. As of January 2017, total floating regasification capacity reached 4 trillion cubic feet across 21 terminals, a significant addition to the demand side.⁹³

As more floating terminals come online, they will have a big impact on the global market. For one thing, they will make expensive fixed export infrastructure investments—such as those under discussion in the United States—an even less attractive proposition. They will also bring in an array of new market entrants. When utilized for export, floating units still rely on proximity to natural gas supply, either via connection to onshore pipelines or offshore reserves; when utilized for import, floating units unlock potentially great demand from a new host of countries in regions closer to U.S. export facilities.⁹⁴ Nations keen to either buy or sell LNG in relatively small amounts—that is to say, amounts that do not justify sinking billions into fixed infrastructure—can do so more cheaply using floating units. A rush of smaller buyers and sellers can have as big or more of an impact as the movements of one big player such as China. Between 2014 and 2017, 12 countries, taken together, drove more demand growth than China, and floating import terminals enabled three-quarters of that growth.⁹⁵

These market and technical shifts—combined with unfavorable U.S.-to-China transport rates—explain why, as China's Vice Minister of Finance Zhu Guangyao put it: "The U.S. is more eager than China to sign long-term LNG contracts."⁹⁶ The economics are just not as favorable for China as they used to be, and that is one reason President Trump's November 2017 Beijing trip only produced vague memorandums rather than binding deals. The West Virginia deal provides almost no detail, and the Alaska deal is basically just a feasibility study.⁹⁷ It is worth noting that Exxon Mobil, ConocoPhillips, BP Plc, and TransCanada Corp. have already walked away from this same development project in Alaska based on estimates that it would cost up to US\$65 billion and take over a decade to construct.⁹⁸

If private companies are walking away from these infrastructure projects, that raises potential red flags about China's intentions. One senior Chinese government official interviewed by the authors of this report stated that China's only reason to sign LNG contracts of this nature with the United States is to win political concessions from President Trump. If Beijing is willing to pay more than \$100 billion—the combined costs of the Alaska and West Virginia projects—to get those concessions, the American public will need to know exactly what we are giving China in return.

Even if Beijing's only intention in potentially bankrolling U.S. infrastructure is to add to their nation's supply diversification—unlikely, given that China already has 26 suppliers—there are still valid concerns about giving China a controlling stake in U.S. production. Chinese state-owned enterprises, including oil majors, answer to the Chinese Communist Party. Those firms are tools of the state and behave accordingly.¹⁰⁹ If those firms obtain massive shares in U.S. natural resources—large enough to potentially control how those resources are used and effectively bankroll the state and local economies in which they operate—that raises important questions about how that might affect U.S. national security.

Alaskan LNG prospects: High costs despite market proximity

The first U.S. LNG exports departed from Kenai, Alaska, in 1969.¹¹⁰ The Kenai terminal exported LNG primarily to Japan. During its heyday from 2000 to 2006, Alaska exported more than 60 billion cubic feet on average per year.¹¹¹ Starting in the mid-2000s, however, Kenai encountered commercial headwinds. The state has a natural advantage in proximity to Japan and other Asian markets—including open ocean access rather than the necessity of transit through congestion points—but that does not overcome other market disadvantages it faces.

Alaskan natural gas is generally more expensive to develop than lower-48 shale gas due to the costs involved in transporting it to the coast for export. It is also disconnected from lower-48 pipeline networks and thus from the U.S. Henry Hub. Alaskan natural gas is an entirely separate market: Prices are pegged to global oil prices, and it is only profitable when oil prices are higher than \$75 per barrel.¹¹² Kenai exports fell to zero in 2013; the last shipments departed the terminal in 2015.¹¹³ Kenai simply does not appear to be commercially viable due to the combination of new LNG export terminals coming online in the Gulf Coast, declining global oil prices—particularly in late 2014 and 2015—and a global oversupply of natural gas. Despite receiving approval for non-FTA exports from the U.S. Department of Energy (DOE), ConocoPhillips has sought to sell its Kenai LNG export terminal and announced in July 2017 that it would mothball the facility.¹¹⁴ Based on current market conditions, the proposed \$50 billion Alaskan natural gas pipeline and associated export infrastructure may not be commercially feasible.¹¹⁵

Trump administration's natural gas export obsession risks forfeiting a much bigger game

If individual American companies find good commercial opportunities to export natural gas to China or other buyers, they should go forth—provided, of course, the United States has the regulatory structure in place to make sure those resources are extracted, processed and transported without damaging American health and property.

Problems arise, however, when the White House throws massive political capital into pushing deals that do not make good commercial sense. Those problems are magnified when the federal government does so at the expense of American companies and technologies that do have great commercial potential. Unfortunately, that is exactly what is currently happening on the clean energy front, and the ramifications could significantly undercut U.S. competitiveness over the longer term.

The Trump administration claims that boosting natural gas exports will create new American jobs, but that claim is problematic on multiple fronts. For one thing, the upstream side of the natural gas business—the production side—is becoming increasingly automated, so companies are hiring fewer workers to produce the same amount of gas. In the United States, new drilling technology is reducing labor needs by around 40 percent in the oil and gas business.¹⁰⁶ Oil and gas production is shifting toward remote monitoring and management, automation, and data analytics to streamline operations; those shifts improve efficiency but support a much smaller workforce than in years past.¹⁰⁷ For example, the World Economic Forum estimates that, industrywide, next-generation automation will displace 38,000 upstream jobs between 2016 and 2025 and the adoption of wireless sensors and other connected devices will displace another 76,000 jobs.¹⁰⁸

It is also possible that boosting exports will undermine other sectors of the U.S. economy. If the United States starts sending more natural gas overseas, that may reduce the supply available on the domestic market and drive up prices here at home. U.S. companies who utilize natural gas as a key manufacturing input benefit

when domestic U.S. prices are low because that gives them an edge over their competitors in overseas markets. According to one study commissioned by Dow Chemical, natural gas supports eight times more American jobs when it is used for manufacturing instead of export.¹⁰⁹ Of course, domestic price increases would also affect American consumers. In 2015, the Center for American Progress analyzed Energy Information Administration data on LNG exports and domestic natural gas prices and found that high levels of LNG exports may lead to \$7 billion in additional annual costs to consumers by 2020.¹¹⁰ One could argue that ratcheting up U.S. domestic natural gas prices via exports would make renewable power even more competitive and thus support renewable job growth; however, the Trump administration is disinvesting in renewables and seeking subsidies for coal, a sector that is facing its own job displacement problems due to automation and other market-induced job-loss trends that exceed what is happening in oil and gas.¹¹¹

Although there is no clear evidence to support claims that boosting natural gas exports will benefit the U.S. economy, it is becoming abundantly clear that clean energy is the real jobs generator. As of 2017, renewable energy is the cheapest source of electricity in the United States.¹¹² Even without taking pollution into account, fossil fuels simply cannot compete with declining renewable energy costs. As renewables become increasingly affordable, that expands use and jobs. At year-end 2016, there were 572,881 renewable electricity generation jobs and 398,235 natural gas-fired electricity generation jobs in the United States.¹¹³ In 2017 nearly half of all U.S. utility-scale generation capacity additions came from solar or wind, and the Federal Energy Regulatory Commission expects U.S. renewable generation to more than double over the next three years—despite the fact that the Trump administration is promoting fossil fuels at the expense of other energy sources.¹¹⁴ Globally, the world is already installing more new renewable capacity than fossil fuel capacity, and that gap is steadily expanding.¹¹⁵

This is why Beijing is launching an all-out effort to dominate global clean energy markets. Chinese leaders view clean energy as a key battlefield in the nation's much broader aim to become the new global high-tech superpower. Power generation and new-energy or energy-efficient vehicles are key focus areas for Beijing's Made in China 2025 initiative, which is channeling hundreds of billions of dollars in state-funded and state-directed capital to help Chinese companies take over these key technology markets.¹¹⁶ Beijing knows that more than 200 nations are gearing up to invest \$13 trillion in renewable energy over the next decade to meet their targets under the Paris climate agreement, and falling renewable energy prices are likely to generate even more investment as more and more nations—even the world's

biggest oil producers—transition to renewables.¹¹⁷ Chinese leaders want the bulk of those technologies and products to come from China. They expect this global renewable push to generate 13 million new Chinese jobs by 2020, and they are pulling every policy lever they can reach to make that happen.¹¹⁸

Unfortunately, at the very moment when the United States should be gearing up to face Chinese competition in the energy technology sectors of the future, the Trump administration is undercutting U.S. clean tech innovation on multiple fronts.¹¹⁹ Trump's budget proposals openly attack investment in clean energy and energy efficiency technologies: Across the DOE, clean energy research and development faced proposed cuts up to 70 percent in fiscal year 2018 and up to 66 percent in fiscal year 2019.¹²⁰ These cuts undermine not only the integrity of the individual offices focused on researching and developing efficiency, solar, wind, carbon capture, grid, and nuclear technologies but also the national laboratories that support that work. Each budget proposal has also called for the termination of vital research, development, and commercialization programs such as the DOE's Advanced Research Projects Agency-Energy (ARPA-E) and Loan Programs.¹²¹ Furthermore, by terminating the Clean Power Plan, the Trump administration has removed carbon pollution standards for power plants that would have increased the amount of renewable energy and efficiency technologies in use in the United States.¹²² Secretary of the Department of Energy Rick Perry also proposed a rule to the Federal Energy Regulatory Commission that would have subsidized coal and nuclear power plants had it not been rejected by the commissioners.¹²³

When Trump administration officials frame natural gas exports as a major demand in U.S.-China trade talks that risks undercutting the U.S. economy even further, Beijing is deploying an array of nationalist economic policies—including the Made in China 2025 initiative—that leverage state resources to help Chinese companies push American competitors out of global high-tech markets. The Trump administration recently threatened to retaliate by levying tariffs against \$50 billion in Chinese imports. The tariff approach is problematic on multiple fronts—it will likely hit U.S. consumers as hard if not harder than China—but the Trump administration will wade into truly dangerous waters if it first threatens China with tariffs and then offers to reduce them if China buys more LNG from the United States. When the administration announced the new tariffs, U.S. Commerce Secretary Wilbur Ross stated that “we will end up negotiating these things rather than fighting over them.”¹²⁴ According to Secretary Ross, President Trump has asked President Xi for a \$100 billion reduction in the U.S. trade deficit, which, according to Secretary Ross, China can partially fulfill by shifting

its natural gas supply chain from other nations to the United States. In addition to the fact that—as outlined above—that does not make good commercial sense for either nation, if the administration accepts LNG deals as a major trade concession that will give Beijing a pass on much bigger trade issues that, if not adequately addressed, will undermine U.S. competitiveness for decades to come.

Conclusion

Natural gas consumption is rising in China. That is a good thing for China's energy transition and emission-reduction efforts. If individual American firms find commercial opportunities to provide some of that natural gas, they should go forth. At a national level, however, the U.S. federal government should not push export deals that do not make good commercial sense and risk undermining broader U.S. competitiveness vis-a-vis China.

Unfortunately, that is exactly what the Trump administration is currently doing. As Beijing is well aware, clean energy is the real battleground, and while China is doing everything it can to help its own companies dominate that rapidly growing global market, the Trump administration is undercutting U.S. clean-tech innovation and wasting federal government political capital pushing for natural gas deals that the United States does not actually need. If the administration takes this a step further—as Secretary Ross is recommending—by accepting U.S.-China natural gas deals in exchange for backing off on much broader U.S. trade concerns with China, that will further undercut the U.S. economy and play right into Beijing's hands.

About the authors

Melanie Hart is a senior fellow and the director for China Policy at the Center for American Progress. Luke H. Bassett is the associate director for Domestic Energy Policy at the Center. Blaine Johnson is the policy analyst for China and Asia Policy at the Center.

Appendix A: U.S. LNG export shipments to China as of year-end 2017

TABLE A1
U.S. LNG Shipments to China
Export Shipments as of Year-End 2017

Departure date	Name of exporter	Export plant	Charterer	Buyer	Import port	Shipment volume (Bcf)	Price at export point (\$/MMBtu)	Contract
2017-12-30	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Shell	CNOOC	Zhejiang Ningbo	3.32	\$3.54	Spot
2017-12-26	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Cheniere	PetroChina	Dalian	3.28	\$6.54*	Spot
2017-12-25	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Gunvor	CNOOC	Zhejiang Ningbo	3.27	\$3.54	Spot
2017-12-22	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Shell	PetroChina	Tangshan	3.46	\$6.54*	Spot
2017-12-16	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Shell	CNOOC	Tianjin (CNOOC)	3.40	\$3.54	Spot
2017-12-12	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Cheniere	CNOOC	Zhejiang Ningbo	3.40	\$5.48	Spot
2017-12-02	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Shell	PetroChina	Tangshan	3.30	\$3.54	Spot
2017-11-27	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Gas Natural Fenosa	PetroChina	Tangshan	3.62	\$4.37	Spot
2017-11-20	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Cheniere	CNOOC	Tianjin (CNOOC)	3.41	\$4.91	Spot
2017-11-12	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Cheniere	PetroChina	Tangshan	3.42	\$4.92	Spot
2017-11-11	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Shell	PetroChina	Jiangsu	3.39	\$3.17	Spot
2017-11-08	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Shell	CNOOC	Tianjin (CNOOC)	3.30	\$6.17*	Spot
2017-11-05	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Shell	CNOOC	Yuedong	3.72	\$3.17	Spot
2017-10-29	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Shell	CNOOC	Tianjin (CNOOC)	3.69	\$3.42	Long-term

continues

Departure date	Name of exporter	Export plant	Charterer	Buyer	Import port	Shipment volume (Bcf)	Price at export point (\$/MMBtu)	Contract
2017-10-23	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Shell	-	Zhejiang Ningbo	3.29	\$3.42	Long-term
2017-10-19	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Shell	PetroChina	Jiangsu	3.60	\$3.42	Long-term
2017-10-15	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Shell	CNOOC	Tianjin (CNOOC)	3.54	\$3.42	Long-term
2017-10-08	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Cheniere	CNOOC	Tianjin (CNOOC)	3.39	\$3.42	Spot
2017-10-08	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Shell	CNOOC	Yuedong	3.63	\$3.42	Long-term
2017-10-01	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Shell	CNOOC	Tianjin (CNOOC)	3.45	\$3.41	Spot
2017-09-23	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Shell	CNOOC	Zhuhai	3.55	\$3.41	Long-term
2017-09-10	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Shell	CNOOC	Tianjin (CNOOC)	3.11	\$3.41	Long-term
2017-07-24	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Shell	PetroChina	Jiangsu	3.63	\$3.53	Long-term
2017-07-10	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Shell	CNOOC	Tianjin (CNOOC)	3.58	\$3.53	Long-term
2017-05-06	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Shell	CNOOC	Tianjin (CNOOC)	3.51	\$4.40	Spot
2017-02-28	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Shell	CNOOC	Zhuhai	3.43	\$6.39*	Long-term
2017-02-17	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Shell	CNOOC	Tianjin (CNOOC)	3.44	\$3.90	Long-term
2017-02-12	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Shell	CNOOC	Zhejiang Ningbo	3.46	\$3.90	Long-term
2017-01-24	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Shell	CNOOC	Tianjin (CNOOC)	3.39	\$4.52	Long-term
2016-12-09**	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Shell	Beijing Gas	Tangshan	3.31	\$5.17	Spot
2016-12-05**	Sabine Pass Liquefaction, LLC***	Sabine Pass LNG	Shell	CNOOC	Zhuhai	3.34	\$3.72	Long-term
2016-11-25**	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Cheniere	PetroChina	Tangshan	3.71	\$3.18	Spot
2016-11-16**	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	BG	CNOOC	Zhejiang Ningbo	3.63	\$3.18	Long-term
2016-07-20**	Sabine Pass Liquefaction, LLC	Sabine Pass LNG	Shell	CNOOC	Guangdong	3.13	\$5.60	Spot

continues

Departure date	Name of exporter	Export plant	Charterer	Buyer	Import port	Shipment volume (Bcf)	Price at export point (\$/MMBtu)	Contract
2011-05-12**	ConocoPhillips Alaska****	Kenai LNG	ConocoPhillips	Shanghai LNG Co; Marathon; Shenergy	Shanghai Wuhaogou	0.62	\$10.50	Spot
2011-05-12**	Marathon****	Kenai LNG	ConocoPhillips	Shanghai LNG Co; Marathon; Shenergy	Shanghai Wuhaogou	0.51	\$10.50	Spot

*Export prices for cargo made pursuant to long-term sales and purchase agreements where the reported price includes liquefaction fees.

**The U.S. Department of Energy (DOE) reports on 2011 and 2016 shipments do not indicate whether or not liquefaction fees are included in the export prices. Prices listed for shipments during these years may or may not include liquefaction fees.

***This excludes an additional 0.09 Bcf of spot cargo reported by DOE. Authors were unable to confirm the charterer, buyer, and import port for this portion of the shipment and therefore excluded it from this table. Were this portion of the shipment to be included, the total volume of U.S. exports to China from 2011-2017 would reach 118.36 Bcf.

****For this May 2011 shipment to China, one tanker transported cargo sourced from both ConocoPhillips Alaska and from Marathon, in volumes of 0.62 Bcf and 0.51 Bcf respectively.

Source: Primary source for charterer, buyer, import port, and contract based upon data provided by IHS Market. The use of this content was authorized in advance. Any further use or redistribution of this content is strictly prohibited without written permission by IHS Market. Primary sources for departure date, name of exporter, export port, shipment volume, and price at export point were DOE reports as follows: Office of Oil & Natural Gas, "LNG Monthly (YTD—through December 2017)" U.S. Department of Energy Office of Fossil Energy, 2017, available at <https://www.energy.gov/sites/prod/files/2018/03/04/LNG%20Monthly%202017.pdf>; Office of Oil & Natural Gas, "LNG Monthly (YTD—through December 2016)" U.S. Department of Energy Office of Fossil Energy, 2016, available at https://www.energy.gov/sites/prod/files/2017/03/04/LNG%202016_0.pdf; Office of Natural Gas Regulatory Activities, "Exports of Liquefied Natural Gas (LNG)" U.S. Department of Energy Office of Fossil Energy, available at https://www.energy.gov/sites/prod/files/2013/06/01/LNG_2011_revised.pdf (last accessed April 2018). Authors cross-referenced these two sources to verify each tanker and its shipment.

Appendix B: China's natural gas reform timeline

Leveraging incremental liberalization to increase production and consumption growth

January 2013—*12th Five-Year Plan for Energy Development (2010-2015)*, *State Council*:¹²⁵ Sets new natural gas production and consumption targets for 2015, including: increasing the share of natural gas in the nation's energy mix from 5.3 percent at year-end 2010 to 7.5 percent by 2015; increasing natural gas production capacity 10.5 percent annually through 2015; increasing natural gas-fired electricity generation capacity 16.2 percent annually through 2015; and increasing the number of residential natural gas users by 6.8 percent annually to reach 250 million total users by 2015.

June 2013—*Notice Adjusting Natural Gas Prices*, *National Development and Reform Commission*:¹²⁶ Implements a net-back pricing model that pegs domestic city-gate rates to the market rates for fuel oil and liquid petroleum gas. Fuel oil accounts for 60 percent of the new price-guiding basket and liquid petroleum gas for 40 percent. Divides natural gas consumption into two buckets defined by volume: base and incremental. Rate increases for base gas—volumes equal to or less than 2012 consumption—are capped at 400 Chinese yuan per thousand cubic meters. Rates for incremental gas—for volumes exceeding 2012 consumption levels—follow the new pricing scheme. Grants special rate exemptions to the chemical fertilizer industry and residential users. The price increase for fertilizer industry purchases is capped at 250 Chinese yuan per thousand cubic meters, and local governments can provide additional financial relief if needed. Prices remain unchanged for all existing residential natural gas consumers; new users will pay the new city-gate rate for base gas. Liberalizes ex-factory prices for imported liquefied natural gas (LNG) and unconventional gas—including shale gas, coal-bed methane, and coal-based liquefied gas—except in cases where such gas is mixed with other sources in long-distance transmission pipelines, in which case city-gate rates apply to the mix.

September 2013—*Air Pollution Prevention Action Plan, State Council*:¹²⁷ Orders major urban areas along China's eastern seaboard to reduce coal consumption; close down coal-fired industrial boilers and power plants; and bring in natural gas and renewables as substitutes to meet new 2017 air pollution reduction and control targets. Calls for expanded natural gas pipeline capacity. Directs relevant ministries, agencies, and subnational governments to give residential users and coal-replacement projects priority access to new natural gas infrastructure and supplies.

February 2014—*Trial Supervision Measures for the Fair and Open Access to Oil and Gas Pipeline Networks, National Energy Administration*:¹²⁸ Orders state-owned oil and gas pipeline operators with surplus capacity to provide pipeline access and services—including transport, storage, gasification, liquefaction, and compression—to third-party entities in a fair and nondiscriminatory manner according to the order in which contracts are signed. The National Energy Administration will supervise the opening of oil and gas pipeline network facilities and will establish regulations on information disclosure and other issues relating to fair access.

February 2014—*Natural Gas Infrastructure Construction and Operation Management Measures, National Development and Reform Commission*:¹²⁹ Encourages both state-owned and private companies to invest in, construct, and integrate national gas infrastructure. Orders those activities to comply with relevant development plans—such as the national natural gas infrastructure development plan and the national main functional area plan—and to fit market supply and demand conditions. Imposes new information transparency requirements: Companies that own and operate natural gas infrastructure must publish their capacity and services available to third-party users as well as the conditions and procedures for third-party access. Orders infrastructure operators to provide third-party access in a fair and equitable manner.

March 2014—*Guiding Opinion on Establishing and Improving the Progressive Pricing Mechanism of Natural Gas for Residential Consumption, National Development and Reform Commission*:¹³⁰ Launches a new three-tier pricing mechanism for residential natural gas that bases residential rates on household consumption levels. Gives local governments the flexibility to determine whether to assess household consumption on a monthly, seasonal, or annual basis. Based on that assessment, high-volume users will be placed in a high-rate bucket, mid-volume users in a mid-rate bucket, and low-volume users in a low-rate bucket. Cities with existing natural gas connections are to roll out this new system by the end of 2015.

August 2014—*Notice Adjusting the Price of Nonresidential Base Natural Gas Use, National Development and Reform Commission*.¹³¹ Further liberalizes pricing for imported liquefied natural gas and unconventional gas including shale gas, coal-bed methane, and coal-based liquefied gas. Where such gas is mixed with other sources—such as domestic or imported conventional gas—prices for the entire mix can be negotiated according to supply and demand. Raises city-gate ceiling prices for base-use conventional natural gas. Exempts the chemical fertilizer industry from these price reforms until the fertilizer market improves.

June 2014—*Energy Development Strategic Action Plan for 2014-2020, State Council*.¹³² Signals that Beijing is significantly increasing its focus on the nation's natural gas development. Calls for natural gas to account for at least 10 percent of the nation's primary energy mix by 2020. Orders vigorous production development on all fronts: onshore and offshore; conventional and unconventional. Orders producers to develop eight large-scale natural gas production bases with annual outputs of more than 10 billion cubic meters. Calls for producers to increase the nation's conventional proven natural gas reserves to a cumulative 5.5 trillion cubic meters and reach a total annual output of 185 billion cubic meters by 2020, which would amount to an annual production growth rate of more than 6 percent. Encourages import expansion and calls for new demand-side measures including support for natural gas vehicles and ships.

February 2015—*Notice on Rationalizing the Price of Nonresidential Natural Gas, National Development and Reform Commission*.¹³³ Decreases the incremental rate by 440 Chinese yuan per thousand cubic meters and increases the base rate by 40 Chinese yuan per thousand cubic meters to create one unified natural gas rate for each province or municipality. Officially removes the prior pricing distinction between base and incremental gas. Implements pilot marketization for natural gas consumers—not including the chemical fertilizer industry—who purchase directly from producers. Those direct purchase rates can be negotiated based on supply and demand.

November 2015—*Notice on Reducing the City-Gate Price of Natural Gas for Nonresidential Use and Further Promoting Market-Oriented Price Reform, National Development and Reform Commission*.¹³⁴ Reduces nonresidential city-gate gas rates by 700 Chinese yuan per thousand cubic meters. Switches the price management regime from ceiling to benchmark, meaning prices can be negotiated below the benchmark and up to 20 percent above it. Exempts the chemical fertilizer industry from these changes.

October 2016—*Trial Natural Gas Pipeline Transportation Price Management Measures, National Development and Reform Commission*.¹³⁶ Sets principles for pipeline transportation price management based on permissible cost, reasonable return, transparency, and ease of operation. Orders pipeline operators to separate their pipeline transportation business from other business units and implement independent financial accounting. Defines a standard for annual allowable pipeline transportation revenue based on “permitted cost plus reasonable return.”

October 2016—*Trial Natural Gas Pipeline Transportation Pricing Cost Supervision and Auditing Measures, National Development and Reform Commission*.¹³⁶ Establishes new guidelines for pipeline transport cost supervision. Pipeline operators must set up an independent cost accounting system for gas transmission services; the State Council Pricing Department is responsible for organizing the implementation of pipeline transportation pricing supervision and inspection work.

November 2016—*Notice Promoting Marketization Reform of Chemical Fertilizer Gas Use Prices, National Development and Reform Commission*.¹³⁷ Fully liberalizes pricing for natural gas sales to chemical fertilizer producers. Prices are to be negotiated between producer and consumer based on supply and demand.

December 2016—*13th Five-Year Plan for Natural Gas Development, National Development and Reform Commission*.¹³⁸ Sets new targets and calls for vigorous market development across all fronts. By 2020, annual production must reach 207 billion cubic meters per year, including 120 billion cubic meters of conventional gas; 37 billion cubic meters of tight gas; 10 billion cubic meters of offshore gas; 30 billion cubic meters of shale gas; and 10 billion cubic meters of coal bed methane per year. Calls for national pipeline infrastructure to reach 104,000 kilometers by 2020—with a total capacity of 400 billion cubic meters—and underground natural gas storage capacity to reach 14.8 billion cubic meters by 2020. Calls for LNG import infrastructure projects to prioritize large demand centers in the Bohai Rim, Yangtze River Delta, and southeastern coastal areas. Promotes LNG fuel for transport use and sets multiple 2020 transport targets including: reaching a total of 10 million LNG vehicles, 12,000 gas stations, and more than 200 docking stations for ships. Calls for specific natural gas infrastructure expansions designed to support coal-to-gas switching such as small-scale LNG storage tanks in rural areas. Calls for multiple policy incentives to support natural gas supply and demand development projects, including preferential tax policies to support natural gas production and new market-based procedures for transferring exploration and development rights.

June 2017—*Opinions on the Acceleration of Natural Gas Use, National Development and Reform Commission, Ministry of Science and Technology, Ministry of Industry and Information Technology, Ministry of Finance, and Others*.¹³⁹ Sets 2030 natural gas targets. Calls for natural gas to account for 15 percent of China's energy mix by 2030 and for China to expand underground natural gas storage capacity to 35 billion cubic meters by 2030. The 2020 targets are 10 percent of the energy mix and 14.8 billion cubic meters of storage capacity. Outlines a cross-ministerial effort for meeting China's natural gas development goals, with a particular focus on addressing persistent market bottlenecks. Calls for new engineering and development projects to support natural gas use for winter heating, gas-fired electricity, industrial use, and expanded consumer access to natural gas filling and docking stations. Calls for additional environmental regulatory tightening to incentivize increased natural gas use, particularly coal-to-gas switching. Calls for additional progress toward natural gas market liberalization and additional financial support to incentivize production and consumption growth.

August 2017—*Notice Reducing the Nonresidential Natural Gas Reference City-Gate Prices, National Development and Reform Commission*.¹⁴⁰ Lowers the baseline city-gate natural gas rate by 100 Chinese yuan per thousand cubic meters. States that city-gate prices will be progressively reduced going forward and open trading will be promoted.

December 2017—*Letter Requesting Good Work on Integrated Coal Management to Ensure the People Stay Warm Through the Winter, Ministry of Environmental Protection Department of Air Environment Management*.¹⁴¹ Permits localities to continue using previous coal-fired heating methods—which were to be phased out by year-end 2017—and other alternative heating methods on an interim basis to prevent heating shortages where required coal phaseouts are not yet complete. Orders local officials to give residential natural gas users priority over industrial users and gas-fired power stations when shortages emerge. Warns officials that the Ministry of Environmental Protection will monitor winter heating conditions and hold localities accountable for disorderly pollution management work.

December 2017—*Notice Regarding the Issuance of a 2017–2021 Winter Clean Heating Plan for Northern Regions, National Development and Reform Commission, National Energy Administration, Ministry of Finance, Ministry of Environmental Protection, and Other Relevant Agencies*.¹⁴² Orders northern regions to fill winter heating gaps—from the phase-out of small coal boilers—with a range of clean-heating sources to avoid triggering seasonal natural gas supply shortages. The

northern region targeted by this plan includes Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Shandong, Shaanxi, Gansu, Ningxia, Xinjiang, Qinghai, and portions of Henan. This region also covers the “2+26” key cities of the Beijing-Tianjin-Hebei air pollution transmission channel, including Xiong’an New District. States that, as of 2016, 83 percent of floorspace in China’s northern regions is served by coal-fired heating and 17 percent by a mix of alternative heating sources, including natural gas-fired heating—which accounts for 11 percent total—electric power, geothermal, biomass, solar, and industrial waste heat. States that 34 percent of the total heat generation can be considered “clean” heating—including clean coal—as of 2016. Sets a new target to expand clean heating to cover 70 percent of the region’s total heated floor space by 2021. Northern regions are to meet that target by bringing new clean heating sources online to replace 150 million tons of dispersed coal, including low-efficiency small boiler coal use. Total clean-heating capacity targets for 2021 include: expanding biomass heating capacity to cover 2.1 billion square meters; expanding electric heating capacity to cover 1.5 billion square meters; expanding geothermal heating capacity to cover 1 billion cubic meters; expanding waste industrial heat to cover 200 million square meters; and expanding solar heating to cover 50 million square meters. The plan puts particular emphasis on clean coal heating, targeting the construction of 10 gigawatts of new back pressure combined heat and power units and retrofitting 120 gigawatts of existing units to reach 11 billion square meters of clean coal heating capacity. The “2+26” key cities are prioritized for new construction of natural gas heating: Between 2017 and 2021, new construction of natural gas heating capacity in these key cities should cover an additional 180,000 square meters. This plan also includes an annex, “General plan for winter coal-to-gas source protection for clean heating in key northern regions,” which formulates a safeguard plan for the six provinces/municipalities of the “2+26” key cities of the Beijing-Tianjin-Hebei air pollution transmission channel and orders the other northern region provinces to create their own natural gas resource guarantee policies for the “coal-to-gas” clean heating program based on this plan. This annex includes targets for the natural gas volume supplied by China’s three oil majors to the abovementioned six provinces/municipalities during 2021, in addition to targets for the construction of new natural gas storage capacity, LNG receiving station capacity, gasification output capacity (from 82 million cubic meters per day in 2017 to 165 million cubic meters per day by 2021), and pipelines.

Endnotes

- 1 Ryan Collins, Scarlet Fu, and Julia Chatterley, "Wilbur Ross to China: Import More U.S. Gas to Cut Trade Gap," Bloomberg News, March 22, 2018, available at <https://www.bloomberg.com/news/articles/2018-03-22/wilbur-ross-to-china-boost-u-s-gas-imports-to-please-trump>. Larry Kudlow, director of the White House National Economic Council, claims the White House intends to negotiate a trade resolution with China—rather than imposing the threatened tariff—and that "back channel discussions" are underway. Saleha Mohsin, "Kudlow Says U.S. and China are Holding Back-Channel Trade Talks," Bloomberg News, April 6, 2018, available at <https://www.bloomberg.com/news/articles/2018-04-06/kudlow-says-u-s-and-china-holding-back-channel-trade-talks>.
- 2 U.S. Census Bureau, "Trade in Goods with China," available at <https://www.census.gov/foreign-trade/balance/c5700.html> (last accessed March 2018); U.S. Department of Commerce, "U.S.-China Business Exchange, November 8-9, 2017," available at https://www.commerce.gov/sites/commerce.gov/files/department_of_commerce_u.s.-china_business_exchange_ceo_delegation_companies_signings_and_additional_company_signings.pdf (last accessed March 2018).
- 3 Authors' calculation based upon 2017 data from Global Trade Tracker, available for subscribers at www.global-tradetracker.com (last accessed April 2018).
- 4 International Energy Agency, "Renewables 2017," available at <https://www.iea.org/publications/renewables2017/> (last accessed March 2018).
- 5 Figures for Chinese and German percentages are based on year-end 2017 statistics and provisional data; Japanese and U.S. percentages are based on year-end 2016 statistics. For China, see China Coal Resource Network, "2017 Oil and Gas Industry Development Report" Released: Record Increase in Natural Gas Consumption ("2017 Nian guo nei wei you qi hang ye fa zhan bao gao fa bu: Tian ran qi xiao fei zeng liang shua xin ji lu), January 16, 2018, available at <http://www.zccol.com/news/4567292info>. For the United States, see U.S. Energy Information Administration, "Total Energy," available at https://www.eia.gov/totalenergy/data/browser/?tbl_id=10134/7&start=200001 (last accessed March 2018). For Germany, see Press Office, "Energieverbrauch steigt 2017 leicht an" ("Energy consumption increases slightly in 2017"), AG Energiebilanzen, 2017 Nr. 05, available at <http://ag-energiebilanzen.de/8-0-Primärenergieverbrauch.html> (last accessed March 2018). English summary charts available at Kerstin Appuhn, Felix Belex, and Julian Wetters, "Germany's energy consumption and power mix in charts," Clean Energy Wire, April 3, 2018, available at <https://www.cleanenergywire.org/factsheets/germany-energy-consumption-and-power-mix-charts>. For Japan, see BP, "BP Statistical Review of World Energy June 2017" (2017), available at <https://www.bp.com/content/dam/bp/en/corporate/pdf/energy-economics/statistical-review-2017/bp-statistical-review-of-world-energy-2017-full-report.pdf>.
- 6 The Energy Development Strategic Action Plan (2014-2020) set a target for natural gas to occupy 10 percent of the country's primary energy mix by 2020 and called for "vigorous development" of natural gas resources—at land and at sea, conventional, and unconventional—for an annual output of 185 billion cubic meters of conventional natural gas by 2020. In 2017, the Opinions on Accelerating Promotion of Natural Gas Use called for natural gas to reach a 15 percent share of the energy mix by 2030 and for underground gas storage volume to increase to 35.8 billion cubic meters by 2030.
- 7 China did meet the plan's pollution reduction targets by the 2017 deadline. Xinhua, "China Achieves Desired Results in Clean Air Action Plan Official," China Daily.com, January 31, 2018, available at <http://www.chinadaily.com.cn/a/201801/31/W5Sa71b4Ba106e7dc11b4641.html>. For the 2013 Action Plan, see PRC, China State Council, "Guo wu yuan guan yu yin fa da qi wu ran fang zhi xing dong ji hua de tong zhi" (State Council Notice on Issuing the Air Pollution Prevention and Control Action Plan), September 10, 2013, available at http://www.gov.cn/jzhengce/content/2013-09/13/content_4561.htm.
- 8 Lucy Hornby, "China gas shortages spread after botched coal conversion," Financial Times, December 12, 2017, available at <https://www.ft.com/content/8f4570c-d661-11e7-ab4d-ba106e7dc11b4641>. To address these sudden natural gas supply shortages and related price increases, China's Ministry of Environmental Protection issued a statement allowing urban areas to temporarily continue using coal-fired power in areas where pollution reduction projects were not yet complete and thus not yet prepared to serve as coal substitutes. For Chinese language reports on the statement, see Sina, "Huan bao bu qing zuo hao san mei zong he zhi li que bao qun zhong wen nuan guo dong gong zuo" (Ministry of Environmental Protection: Please do a good job on the comprehensive management of dispersed coal to ensure a warm winter for the masses), December 7, 2017, available at <http://finance.sina.com.cn/money/future/mnews/2017-12-07/doc-ifypikw4013143.shtml>; Changsha City Environmental Protection Agency, "Huan bao bu he jing zhong zhi mei gai qi wen wai di qu ke ji xu shao mei qu nuan" (Ministry of Environmental Protection Urgent Notice: Unfinished coal-to-gas areas can continue to burn coal for heating), December 8, 2017, available at http://hbj.changsha.gov.cn/hbdt/hbyw_30399/201712/20171208_21361703.html.
- 9 Mark Dworitzan, "Tackling air pollution in China," MIT News, May 17, 2017, available at <http://news.mit.edu/2017/tackling-air-pollution-in-china-0517>. This varies by city. For example, in 2017, the Ministry of Environmental Protection reported that of the 64 percent to 67 percent of Beijing's small-particulate (PM 2.5) pollution that is locally produced, vehicles account for 31.1 percent, coal burning for 22.4 percent, industrial production for 18.1 percent, and dust for 14.3 percent. PRC, China Ministry of Ecology and Environment, "Bei jing shi PM 2.5 lai yuan jie xi" (Beijing PM 2.5 Source Analysis), September 15, 2017, available at http://dshj.mep.gov.cn/dshj/dshjwxy/201709/120170915_421691.shtml. As of 2016, transport only accounted for 13.3 percent of China's natural gas consumption. Chen Hailong, "Jia kuan tian ran qi zi yuan gong ying gai shan wo guo neng yuan jie gou" (Accelerate the supply of natural gas resources, improve China's energy structure), China News, November 23, 2017, available at <http://www.chinanews.com/ny/2017/11-23/8383897.shtml>. The Natural Gas Development "13th Five Year" Plan also sets targets of twelve thousand natural gas refilling stations and 200 marine refilling stations for that year and calls for the studying and formulation of natural gas vehicle support policies and for the active support of the development of natural gas-fueled vehicles including city buses, taxis, logistic vehicles, passenger cars, sanitation vehicles, and trucks. PRC, China National Development and Reform Commission, "Tian ran qi fa zhan 'shi san wu' guai hua" (Natural Gas Development "13th Five Year" Plan), December 24, 2016, available at <http://www.ndrc.gov.cn/gzdt/201701/W020170119369186013264.pdf>. Document hosted by National Development and Reform Commission website at http://www.ndrc.gov.cn/gzdt/201701/20170119_835571.html.

- 10 P.R. China National Development and Reform Commission, "Tian ran qi fa zhan 'shi san wu' gui hua" (Natural Gas Development "13th Five Year" Plan).
- 11 For some examples of subnational government natural gas vehicle support policies, see Korla Municipal People's Government Office, "Guo yu tao zheng lu xue lei chi de yong tian ran qi ja cha zheng shou biao zhun he ja ge bu te biao zhun de tong zhi" (Circular on Adjusting Korla City's Automobile Natural Gas Price Spread Levy and Price Subsidy Standards), February 25, 2016, available at <http://www.kjw.gov.cn/gkzcfj/gfwj/fzbfw/127242.htm>; Development and Reform Commission of Shenzhen Municipality, "Shen zhen shi dao lu yun shu hang ye tui guang shi yong ye hua tian ran qi chi bu te zhi jin shen bao zhi ran" (Shenzhen City Road Transport Industry Promotion of the Use of Liquefied Natural Gas Vehicle Subsidies Reporting Guidelines), February 15, 2015, available at http://www.szdg.gov.cn/gkgl/qf/tqg/201502/20150215_2819021.htm.
- 12 Author's calculations based upon data reported by the National Bureau of Statistics of China, available at <http://data.stats.gov.cn/easyquery.htm> (last accessed April 2018).
- 13 This move tied Chinese prices to what similar commodities were selling for on the international market. Beijing first launched the net-back price reform scheme in December 2011 as pilot program in Guangdong and Guangxi. In 2013, China's National Development and Reform Commission (NDRC) rolled out the new pricing model by dividing natural gas consumption into two categories: stock—meaning equal to the amount consumed in 2012—and incremental—any additional amount consumed. The new pricing model initially applied only to the incremental portion of industrial use. Fertilizer companies and residential users were insulated from the initial roll-out and addressed via later reforms. For the text of the 2013 price adjustment notice, see P.R. China National Development and Reform Commission, "Guo ja fa zhan gai ge wei guan yu tao zheng tian ran qi ja ge de tong zhi" (National Development and Reform Commission Notice on Adjusting Natural Gas Prices), 2013 NDRC Price Reform No. 1246, June 28, 2013, available at http://www.gov.cn/gzdt/2013-06/28/content_2436328.htm. For the text of the subsequent residential price policy, see P.R. China National Development and Reform Commission, "Guo ja fa zhan gai ge wei guan yu jian li jian quan jumin sheng huo yong qi jie ti ja ge zhi du de zhi dao yi jian" (National Development and Reform Commission Guiding Opinions on Establishing and Perfecting Residential Gas Use Stairway Pricing System), 2014 NDRC Price Reform No. 467, March 20, 2014, available at http://bgtd.ndrc.gov.cn/zcfb/201403/20140321_603786.html.
- 14 P.R. China National Development and Reform Commission, "Guo ja fa zhan gai ge wei guan yu tao zheng tian ran qi ja ge de tong zhi" (National Development and Reform Commission Notice on Adjusting Natural Gas Prices), 2013 NDRC Price Reform No. 1246, June 28, 2013, available at http://www.gov.cn/gzdt/2013-06/28/content_2436328.htm; P.R. China National Development and Reform Commission, "Guo ja fa zhan gai ge wei guan yu tao zheng fei ju min yong cun liang tian ran qi ja ge de tong zhi" (National Development and Reform Commission Notice on Adjusting Non-Residential Pricing for Base Natural Gas Use), 2014 NDRC Notice No. 1835, August 10, 2014, available at http://www.ndrc.gov.cn/gzdt/201408/20140812_622009.html. Beijing fully liberalized natural gas for fertilizer manufacturing in 2016—sales to chemical fertilizer companies are also freely negotiated between buyer and seller. P.R. China National Development and Reform Commission, "Guo ja fa zhan gai ge wei guan yu tui jin hua fei yong qi ja ge shi chang hua de tong zhi" (National Development and Reform Commission Notice on Promoting Marketization Reform of Chemical Fertilizer Gas Use Prices), 2016 NDRC Price Reform No. 2350, November 5, 2016, available at http://www.ndrc.gov.cn/zcfb/zcfbtr/2016/11/20161110_826163.html.
- 15 When the NDRC initially launched the new city-gate pricing scheme in 2013, central planners used fuel oil and liquid petroleum gas rates to calculate two different city-level price ceilings for natural gas: one for base "stock" gas or existing consumption and another for incremental gas or "new" consumption. In 2015, the NDRC merged the two price ceilings into one and then shifted from a price ceiling management system to a benchmark price management system. As of November 2016, negotiated prices are allowed to float up to 20 percent above the state's benchmark and any lower. Residential pricing is determined by municipal and county-level governments based upon a tiered pricing system based on relative consumption levels. P.R. China National Development and Reform Commission, "Guo ja fa zhan gai ge wei guan yu tui jin hua fei yong qi ja ge shi chang hua de tong zhi" (National Development and Reform Commission Notice on Promoting Marketization Reform of Chemical Fertilizer Gas Use Prices), 2016 NDRC Price Reform No. 2350, November 5, 2016, available at http://www.ndrc.gov.cn/zcfb/zcfbtr/2016/11/20161110_826163.html. For the text of the residential price policy, see P.R. China National Development and Reform Commission, "Guo ja fa zhan gai ge wei guan yu jian li jian quan jumin sheng huo yong qi jie ti ja ge zhi du de zhi dao yi jian" (National Development and Reform Commission Guiding Opinions on Establishing and Perfecting Residential Gas Use Stairway Pricing System), 2014 NDRC Price Reform No. 467, March 20, 2014, available at http://bgtd.ndrc.gov.cn/zcfb/201403/20140321_603786.html.
- 16 Gordon Chang, "China Energy Flip: Beijing Slashes Shale Target for 2nd Time," *Forbes*, August 17, 2017, available at <https://www.forbes.com/sites/gordonchang/2017/08/17/china-energy-flip-beijing-slashes-shale-target-for-2nd-time/#7b8a3b062c0>; Melanie Hart and Daniel J. Weiss, "Making Fracking Safe in the East and West" (Washington: Center for American Progress, 2011), available at <https://www.americanprogress.org/issues/green/reports/2011/10/21/10407/making-fracking-safe-in-the-east-and-west/>.
- 17 China's average price for base gas in mid-2013 was \$9.65 per thousand cubic feet, while prices elsewhere tended to be higher, with Japan (J LNG) at \$16.77 per thousand cubic feet, Germany (AGP) at \$11.13 per thousand cubic feet, UK (Heron NBP index) at \$11.03 per thousand cubic feet, and US Henry Hub at \$3.85 per thousand cubic feet. For data on international natural gas prices (in US\$ per mmbtu), see BP, "Energy Chartist tool," available at https://tools.bps.com/energy-charting-tool.aspx?_ga=2.96573791.1371015392.1522438173-1386984846.1519154254&rep=natural_gas_prices/unit/5-mbtu/viewline/ (last accessed April 2018).
- 18 PetroChina reported a loss of 41,900 million RMB. US\$6.7 billion is author calculation based on the December 31, 2012 exchange rate of 6.23 RMB/\$US. PetroChina Company Limited, "2012 Annual Report" (2014), available at <http://www.petrochina.com.cn/pdf/ndbg/201404/04a3c1f9e8b449ea7a272d60da920b/f61e08acbaad0b634b529305620e053e35b1.pdf>.
- 19 PetroChina Company Limited, "2013 Annual Report" (2014), available at <http://www.petrochina.com.cn/pdf/ndbg/201404/04a3c1f9e8b449ea7a272d60da920b/f61e08acbaad0b634b529305620e053e35b1.pdf>. See also Song Yen Ling, "PetroChina's 2013 losses on imported natural gas hit roughly \$8 billion," *S&P Global Platts*, March 20, 2014, available at <http://www.platts.com/latest-news/natural-gas/hongkong/20140320-2013-losses-on-imported-natural-gas-21363390>.
- 20 In 2016, PetroChina lost \$2.37 billion importing natural gas into the country, down from approximately \$2.59 billion in losses the previous year. PetroChina Company Limited, "2016 Annual Report" (2017), available at <http://www.petrochina.com.cn/pdf/ndbg/201704/04b6c9312f70499e9f6d14a02323417/files/7033d8cc63642b4bf5d6fb1aee4897.pdf>.

- 21 When reformers first ratcheted up end-user prices in 2013 and 2014 to more closely track international market rates for fuel oil and liquid petroleum gas, provincial-level city-gate ceiling prices increased by several hundred yuan per cubic meter; in response, consumption growth fell to below 10 percent in 2014 and below 4 percent in 2015. This likely contributed to the NDRC decision to reverse direction and reduce city-gate station prices by 700 yuan per cubic meter in November 2015. For details, see P.R. China National Development and Reform Commission, "Guo ja fa zhan gai ge wei guan yu tiao zheng tian ran qi ja ge de tong zhi" (National Development and Reform Commission Notice on Adjusting Natural Gas Prices), 2013 NDRC Price Reform No. 1246, June 26, 2013, available at http://www.gov.cn/gzdt/2013/06/26/content_2438328.htm; P.R. China National Development and Reform Commission, "Guo ja fa zhan gai ge wei guan yu tiao zheng fei ju min yong cun liang tian ran qi ja ge de tong zhi" (National Development and Reform Commission Notice on Adjusting Non-Residential Pricing for Base Natural Gas Use), 2014 NDRC Notice No. 1835, August 15, 2014, available at http://www.ndrc.gov.cn/gzdt/2014/08/15/120140812_622009.html; P.R. China National Development and Reform Commission, "Guo ja fa zhan gai ge wei guan yu li shun fei ju min yong tian ran qi ja ge de tong zhi" (National Development and Reform Commission Notice Regarding the Rationalization of Natural Gas Price for Non-Residential Use), 2015 NDRC Notice No. 351, February 26, 2015, available at http://www.ndrc.gov.cn/zcfb/zcfbzt/201502/20150228_665694.html; P.R. China National Development and Reform Commission, "Guo ja fa zhan gai ge wei guan yu jiang di fei ju min yong tian ran qi men zhan ja ge bing jin yi bu tui jin ja ge shi chang hua gai ge de tong zhi" (National Development and Reform Commission Notice on Reducing the City-gate Price of Natural Gas for Non-Residential Use and Further Promoting Market-Oriented Price Reform), 2015 NDRC Notice No. 3688, November 18, 2015, available at http://www.ndrc.gov.cn/gzdt/2015/11/20151118_758904.html.
- 22 For global price trends, see BP, "BP Statistical Review of World Energy June 2017."
- 23 For global market analysis, see International Energy Agency, "Gas 2017: Analysis and Forecasts to 2022" (2017), Executive Summary available at <https://www.iea.org/textbase/nrsum/gas2017MRSum.pdf>.
- 24 Calculations based upon Global Trade Tracker data utilizing prices reported at import terminals in China prior to administration of VAT. Pricing data available for subscribers at www.globaltradetracker.com (last accessed April 2018).
- 25 P.R. China State Council, "Guo wu yuan guan yu yin fa nang yuan fa zhan 'shi er wu' guo hua de tong zhi" (State Council Notice on Issuing the "12th Five Year Plan" for Energy Development), January 1, 2013, available at http://www.xinhuanet.com/2013-01/28/c_132132808.htm; China Liquefied Natural Gas Web, "Cong ju feng LNG kan zhong guo min ying LNG je shou zhan" (China's Private LNG Receiving Stations as viewed from Jufeng LNG), June 26, 2015, available at <http://www.cnlng.com/bencandy.php?fid=266&id=39628>.
- 26 P.R. China National Development and Reform Commission, "Tian ran qi ji chu she shi jian she yu yunying guan li ban fa" (Natural Gas Infrastructure Construction and Operation Management Measures), February 28, 2014, available at <http://www.ndrc.gov.cn/zcfb/zcfbzt/201403/20140320/209286947631.pdf>. Document hosted by National Development and Reform Commission website at http://www.ndrc.gov.cn/zcfb/zcfbzt/201403/20140320_603521.html.
- 27 This expansion in import terminal capacity initially outpaced demand: Between 2013 and 2016, China only imported enough LNG to utilize around 50 percent of its terminal capacity. That changed in late 2017 when a sudden uptick in demand—driven by a combination of coal-to-gas switching mandates and seasonal winter heating needs—triggered a massive surge in import volumes. In late fall 2017, China's import terminal fleet operated at more than 100 percent capacity—with some terminals operating at 130 percent of their normal capacity—to keep supply chains moving. *LNG Journal* "Sixth Chinese LNG import terminal set for start-up as Qatari cool-down cargo arrives," September 21, 2012, available at <http://lngjournal.com/index.php/latest-news-mainmenu-47/item/3625-sixth-chinese-lng-import-terminal-set-for-start-up-with-qatari-cool-down-cargo>; Victoria Zaretskaya, "China becomes world's second largest LNG importer, behind Japan," U.S. Energy Information Administration, February 23, 2018, available at <http://www.eia.gov/todayinenergy/detail.php?id=35072>; Fan Shi Yun, "China's high LNG terminal capacity use tempers winter import growth," S&P Global Platts, November 30, 2017, available at <http://www.platts.com/latest-news/natural-gas/singapore/chinas-high-lng-terminal-capacity-use-tempers-26648653>.
- 28 Author's calculations based upon data reported by the National Bureau of Statistics of China, available at <http://data.stats.gov.cn/easyquery.htm> (last accessed April 2018).
- 29 Ibid.
- 30 Sun Wenyu, "China Now One of the World's Top-3 Shale Gas Producers," *People's Daily*, September 15, 2017, available at <http://en.people.cn/n3/2017/0915/c90000-9269522.html>; P.R. China National Development and Reform Commission, "Tian ran qi fa zhan 'shi san wu' guo hua" (Natural Gas Development "13th Five Year Plan").
- 31 Author's calculations based upon data reported by the National Bureau of Statistics of China, available at <http://data.stats.gov.cn/easyquery.htm> (last accessed April 2018).
- 32 Ed Crooks, "The U.S. Shale Revolution," *Financial Times*, April 24, 2015, available at <https://www.ft.com/content/2ded7416-e930-11e4-a71a-00144feab7de>.
- 33 Xinhua, "China unveils market reform for oil and gas industry," *China Daily*, May 22, 2017, available at http://www.chinadaily.com.cn/china/2017-05/22/content_20437500.htm; James Osborne, "Energy Prospects in China for U.S. Companies Remain Hazy," *Houston Chronicle*, October 13, 2017, available at <http://www.houstonchronicle.com/business/article/Energy-prospects-in-China-for-U-S-companies-12277613.php>.
- 34 *People's Daily*, "China Becomes World's Top Three Shale Gas Producer," August 29, 2017, available at <http://en.people.cn/n3/2017/0829/c90000-9261848.html>.
- 35 Natural gas transported via tanker is liquefied—transformed into LNG—for maritime transport and then regasified—or converted back to natural gas—at import terminals.
- 36 Author's calculations based upon Global Trade Tracker data, available for subscribers at www.globaltradetracker.com (last accessed April 2018).
- 37 Based upon data reported by the National Bureau of Statistics of China, available at <http://data.stats.gov.cn/easyquery.htm> (last accessed April 2018).

- its first LNG tanker shipment from the United States came from Alaska's now-mothballed Kenai LNG facility in May 2011, but that was a one-off shipment.

- 59 Transit costs include chartering fees, fuel costs, canal tariffs, port fees, and insurance and other transaction fees. David Stokes and Oly Spirakis, "US exports and the trans-Atlantic cost question," *Timera Energy*, May 16, 2016, available at <http://www.timera-energy.com/us-exports-and-the-trans-atlantic-cost-question/>.
- 60 Author's calculation based upon data from U.S. Energy Information Administration, "U.S. Natural Gas Exports and Re-Exports by Country."
- 61 Apart from small vessel shipments to the Caribbean, these cargoes left Cheniere's Sabine Pass terminal. U.S. Energy Information Administration, "U.S. Natural Gas Exports and Re-Exports by Country"; U.S. Energy Information Administration, "U.S. Natural Gas Exports and Re-Exports by Point of Exit" (2018), available at https://www.eia.gov/dnav/ng/ng_move_poe2_a_EPGO_ENG_Mmnd_a.htm.
- 62 Cheniere was the first to do so. Cheniere's Sabine Pass Train 1, which came online in February 2016, added a liquefaction train to an existing import terminal and took approximately five and a half years to complete. That timeline includes the investment process, permitting process, and more than three years for construction. See Scott DiSavino, "After six decades, U.S. set to turn natgas exporter amid LNG boom," *Reuters*, March 29, 2017, available at <https://www.reuters.com/article/us-usa-natgas-lng-analysis/after-six-decades-u-s-set-to-turn-natgas-exporter-amid-lng-boom-idUSKBN1700F1>; Clifford Krauss, "U.S. Company, in Reverse, Wants to Export Natural Gas," *The New York Times*, January 27, 2011, available at <http://www.nytimes.com/2011/01/28/business/economy/28gas.html>; Cheniere, "Top 5 Global Supplier of LNG by 2020," April 25, 2017, available at <http://www.cheniere.com/terminals/sabine-pass/trains-1-6/project-schedule/>; U.S. Energy Information Administration, "Monthly Energy Review March 2018, Table 4.1 Natural Gas Overview," available at https://www.eia.gov/totalenergy/data/monthly/pdf/sec4_3.pdf.
- 63 U.S. Department of Energy, "Global LNG Fundamentals" (2017), available at https://www.energy.gov/sites/prod/files/2017/10/07/Globa%20LNG%20Fundamentals_0.pdf; Argus, "Cheniere expects to expand US LNG plants: Correction," May 5, 2017, available at <http://www.argusmedia.com/news/article?id=1454979>.
- 64 The Federal Energy Regulatory Commission holds permitting authorities for LNG terminals sited on or near shore, and the U.S. Coast Guard and Maritime Administration hold permitting authorities for offshore LNG terminals. The U.S. Department of Energy authorizes the export of LNG volumes to free-trade and nonfree-trade agreement countries. U.S. Department of Energy, "U.S. Quadrennial Energy Review, Chapter IX, Siting and Permitting of TSL&I Infrastructure" (2014), available at <https://www.energy.gov/sites/prod/files/2015/08/125/IER%20Chapter%20IX%20Siting%20and%20Permitting%20April%202015.pdf>. The current status of permitting and export authorization can be found at the Federal Energy Regulatory Commission, "North American LNG Import/Export Terminals," available at <https://www.ferc.gov/industries/gas/industry/eng/existing.pdf> (last accessed April 2018) and U.S. Department of Energy, "Long Term Applications Received by DOE/FET to Export" (2018), available at <https://www.energy.gov/sites/prod/files/2018/01/146/Summary%20of%20LNG%20Export%20Applications.pdf>.
- 65 Currently two import-to-export conversions are operational, three are approved and under construction, two are approved and not yet under construction, and one is proposed. U.S. Federal Energy Regulatory Commission, "North American LNG Import/Export Terminals"; *Reuters*, "Dominion Maryland Cove Point LNG facility exports first cargo," March 2, 2018, available at <http://www.reuters.com/article/us-dominion-cove-point-lng/dominion-maryland-cove-point-lng-facility-exports-first-cargo-idUSKCN1GE15M>.
- 66 U.S. Permitting Dashboard, "Jordan Cove LNG Terminal and Pacific Connector Gas Pipeline" (2017), available at <https://www.permits.performance.gov/permitting-projects/jordan-cove-lng-terminal-and-pacific-connector-gas-pipeline>.
- 67 Don Gentry and Emma Marlis, "The Next Standing Rock? A Pipeline Battle Looms in Oregon," *The New York Times*, March 8, 2018, available at <https://www.nytimes.com/2018/03/08/opinion/standing-rock-pipeline-oregon.html>; Ted Sickingler, "Merkeley opposes Coos Bay LNG, setting off political row," *The Oregonian*, December 9, 2017, available at http://www.oregonlive.com/politics/index.ssf/2017/12/merkeley_opposes_coos_bay_lng_s.html.
- 68 U.S. Energy Information Administration, "U.S. Energy Mapping System," available at <https://www.eia.gov/state/maps.php> (last accessed March 2018).
- 69 Kinder Morgan, "Elba Liquefaction Project and EEC Modification Project," available at https://www.kindermorgan.com/business/gas_pipelines/projects/elbaLNG (last accessed March 2018); Dominion Energy, "Cove Point Project Details," available at <https://www.dominionenergy.com/about-us/natural-gas/projects/cove-point/project-details> (last accessed March 2018).
- 70 U.S. Federal Energy Regulatory Commission, "North American LNG Import/Export Terminals."
- 71 U.S. Energy Information Administration, "U.S. Natural Gas Exports and Re-Exports by Country."
- 72 Teddy Kott and Alex Lutz, "They Might Be Giants: How New and Emerging LNG Importers Are Reshaping the Waterborne Gas Market" (New York: Columbia Center on Global Energy Policy, 2017), available at http://energypolicy.columbia.edu/sites/default/files/pictures/CCEPTheMightBeGiantsLNG1017_1.pdf.
- 73 Industry reports show steady demand growth in Europe, even as China's import growth exceeded that of other countries. International Gas Union, "2017 World LNG Report" (2017), available at https://www.igu.org/sites/default/files/103419-World_IGU_Report_no%20crops.pdf.
- 74 Australian Petroleum Production and Exploration Association, "Australian LNG Projects," available at <https://www.appea.com.au/oil-gas-explained/operation/australian-lng-projects/> (last accessed March 2018); China National Offshore Oil Corporation (CNOOC) Australia, "CNOOC Group Overview," available at <http://www.cnooc.com.au/> (last accessed March 2018); ConocoPhillips Australia, "Australia Pacific LNG," available at <http://www.conocophillips.com.au/what-we-do/our-projects/activities/australia-pacific-lng/> (last accessed March 2018).
- 75 Australia China Business Review, "WRA to meet China rise in LNG demand," November 10, 2017, available at <https://acbr.com.au/wa-meet-china-rise-lng-demand>; Australian Energy Regulator, "State of the Energy Market, May 2017," available at <https://www.aer.gov.au/system/files/AER%20State%20of%20the%20Energy%20Market%202017%20-%20M4.pdf>.
- 76 *Reuters*, "Sinopec to pay \$1.1 billion for extra equity in APLNG," January 22, 2012, available at <https://www.reuters.com/article/us-origin/sinopec-to-pay-1-1-billion-for-extra-equity-in-aplng-idUSTREBOM3W20120123>; Australian Energy Regulator, "State of the Energy Market May 2017."
- 77 Australian Energy Regulator, *State of the Energy Market*, May 2017; U.S. Energy Information Administration, "Energy Units and Calculators Explained, Energy Conversion Calculators," available at https://www.eia.gov/energyexplained/index.cfm?page=about_energy_conversion_calculator (last accessed March 2018).

78. Government of Western Australia, Department of Jobs, Tourism, Science, and Innovation, "WA Liquefied Natural Gas Industry Profile" (2017), available at <https://www.jtsi.wa.gov.au/docs/default-source/default-document-library/wa-lng-profile-december-2017.pdf?sfvrsn=2>; Reuters, "Sinopec to pay \$1.1 billion for extra equity in ARLNG," Australian Energy Regulator, "State of the Energy Market May 2017."
79. For example, shipments totaling 277.59 billion cubic feet left Western Australia for China from November 2016 to November 2017; the difference between that total and the amount CNOC reported—38.4 billion cubic feet—indicates a gap filled by nonpublic contracts from that state. Government of Western Australia, Department of Jobs, Tourism, Science, and Innovation, "WA Liquefied Natural Gas Industry Profile."
80. For example, Sinopec invested approximately \$1 billion in a joint venture with Chesapeake Energy for oil and gas production in Mississippi in 2013 and \$2.2 billion in Devon Energy in 2012. Derek Scissors, "Chinese investments in the US" (Washington: American Enterprise Institute, 2018), available at <https://www.aei.org/feature/china-tracker/>; Ajay Maken, "Sinopec acquires stake in Chesapeake assets," *Financial Times*, February 25, 2013, available at <https://www.ft.com/content/8c527834-7f5b-11e2-89ed-00144feabdc0>.
81. Alex DeMarban, "Governor details China-Alaska LNG deal, but skeptics still have questions," *Anchorage Daily News*, November 23, 2017, available at <https://www.adn.com/business-economy/energy/2017/11/23/governor-reveals-china-alaska-lng-deal-but-skeptics-still-have-questions/>.
82. Platts, "Andevor buys Kenai LNG plant in Alaska from ConocoPhillips," February 5, 2018, available at <https://www.platts.com/latest-news/natural-gas/anchorage/andevor-buys-kenai-lng-plant-in-alaska-from-21241295>.
83. The investment may translate to power plants, petrochemicals, and other natural gas facilities, but the memorandum of understanding has no contractual obligation. With West Virginia Gov. Jim Justice (R) indicating the state has offered China Energy Investment Corporation no incentives for locating there, the question of what China may want in return remains open. West Virginia Department of Commerce, "China Energy and West Virginia announce framework to invest \$83 billion in shale gas and chemical manufacturing projects," Press release, November 9, 2017, available at <https://www.prnewswire.com/news-releases/china-energy-and-west-virginia-announce-framework-to-invest-83-billion-in-shale-gas-and-chemical-manufacturing-projects-300552702.html>.
84. Jim Polson, "West Virginia Gets China Energy Deal that Dwarf State's GDP," *Bloomberg*, November 9, 2017, available at <https://www.bloomberg.com/news/articles/2017-11-09/west-virginia-gets-china-energy-deal-that-dwarfs-state-s-gdp>; U.S. Bureau of Economic Analysis, "West Virginia" (2017), available at <https://www.bea.gov/regional/brief-facts/pdf/cfm?ip=44008&areatype=STATE&geotype=3>.
85. The Methane Princess tanker carried the first shipment from Algeria to the United Kingdom. Early regional markets developed in Asia through the 1980s and 1990s led by imports to Japan, Korea, and Taiwan. Since the 1980s, Japan has dominated Asian LNG demand, and the regional benchmark price was tied to a mix of Japanese crude oil imports colloquially called the "Japan Crude Cocktail" (UCCI). Craig Pirrong, "Fifty Years of Global LNG: Racing to an Inflection Point" (Amsterdam: Trafalgar, 2014), available at <https://www.trafalgar.com/media/1350/fifty-years-global-lng-craig-pirrong-research-tafigura-2.pdf>; Ship Technology, "Methane Princess LNG Carrier" (2018), available at <https://www.ship-technology.com/projects/methane-princess-lng-carrier/>; Takeo Kumagai and others, "Japan's Oil and LNG Price Evolution: On the Path to Transparency," (Platts, 2016), available at https://www.platts.com/IM/Platts_Content/InsightAnalysis/IndustrySolutionPapers/SR-Asia-japan-oil-lng-price-evolution-092016.pdf.
86. U.S. Department of Energy, "Quadrennial Energy Review 1.1, Natural Gas Appendix" (2015), available at https://www.energy.gov/sites/prod/files/2015/08/2015_QER_Appendix8_NaturalGas.pdf; Pirrong, "Fifty Years of Global LNG: Racing to an Inflection Point"; Alison Sides and Christopher M. Matthews, "Henry Hub Emerges as Global Natural Gas Benchmark," *The Wall Street Journal*, August 17, 2017, available at <https://www.wsj.com/articles/global-trade-trusts-louisiana-henry-hub-into-center-of-natural-gas-world-1502967607>.
87. Vikram Eswari, "LNG price sensitivity: Oil-linked contracts and proximity of LNG export facilities to the Henry Hub impact arbitrage opportunities," *Oil and Gas Financial Journal*, April 25, 2016, available at <http://www.ojfi.com/articles/print/volume-13/issue-4/features/lng-price-sensitivity.html>.
88. Additionally, recent analysis illustrates a growing role for emerging LNG import markets that may enhance the importance of short-term and spot-market contracts; they represent 57 percent of new import demand but individually do not command the market share or projected growth to require major long-term agreements. U.S. Energy Information Administration, "Natural gas prices in Asia mainly linked to crude oil, but use of spot indexes increases," September 28, 2015, available at <https://www.eia.gov/todayinenergy/detail.php?id=23132>.
89. Sriama Palagummi, Harry Vidas, and Eric Kuhle, "An America First Future for LNG Exports," *Oil & Gas Financial Journal*, April 25, 2016, available at <https://www.ojfi.com/resources/white-papers/2017/an-america-first-future-for-lng-exports>.
90. For example, Shell's Prelude, now moored off Western Australia's northern coast. Developed jointly among Shell, Japanese, Taiwanese, and Korea interests, the Prelude facility will produce 3.6 mtpa of LNG, or enough to meet 117 percent more than Hong Kong's entire annual demand. Brian Songhurst, "Floating Liquefaction (FLNG): Potential for Wider Deployment," (Oxford, England: Oxford Institute for Energy Studies, 2016), available at <https://www.oxfordenergy.org/wpcms/wp-content/uploads/2016/11/Floating-Liquefaction-FLNG-101.pdf>; International Gas Union, "2017 World LNG Report" (2017), available at https://www.igu.org/sites/default/files/103419-World_Igu_Report_n0%20crops.pdf; Shell Global, "Prelude FLNG," available at <https://www.shell.com/about-us/major-projects/prelude-flng.html> (last accessed March 2018); Shell Global, "Prelude FLNG in Numbers," available at <https://www.shell.com/about-us/major-projects/prelude-flng/prelude-flng-in-numbers.html> (last accessed March 2018); TechnipFMC, "The Shell Prelude facility has sailed away to Australia," Press release, June 29, 2017, available at <https://www.technipfmc.com/en/media/news/the-shell-prelude-facility-has-sailed-away-to-australia>.

- 91 International Gas Union, "2017 World LNG Report."
- 92 Teddy Kott and Akos Loiz, "They Might Be Giants: How New and Emerging LNG Importers Are Reshaping the Waterborne Gas Market" (New York: Columbia Center on Global Energy Policy, 2017), available at http://energypolicy.columbia.edu/sites/default/files/pictures/CGEPTheMightBeGiantsLNG1017_1.pdf
- 93 International Gas Union, "2017 World LNG Report."
- 94 Teddy Kott and Akos Loiz, "They Might Be Giants."
- 95 The 12 emerging importers include: Malta, Jamaica, Poland, Lithuania, Jordan, Egypt, Pakistan, Singapore, Indonesia, Thailand, the United Arab Emirates, and Kuwait. Kott and Loiz, "They Might Be Giants."
- 96 Dan Murtaugh, Albing Guo, and Ryan Collins, "China's Appetite for U.S. Energy Falls: Sky of Binding Deals," Bloomberg, November 9, 2017, available at <https://www.bloomberg.com/news/articles/2017-11-09/china-s-appetite-for-us-energy-falls-short-of-binding-deals>.
- 97 State of Alaska, Alaska Gasline Development Corporation, China Petrochemical Corporation, CIC Capital Corporation, and Bank of China Limited, "Joint Development Agreement for Alaska LNG" (2017), available at <https://s3.amazonaws.com/arc-wordpress-client-uploads/adrs/wp-content/uploads/2017/11/22061553/01-Signed-JDA-SDA-AG-DC-Sinopes-CIC-BOC.pdf>. Alaska Gasline Development Corp. estimates the project would cost \$43 billion; the idea is that China would pay half, but China has not actually committed to do so. Alaska Gasline Development Corporation, "Alaska and China Sign Historic Joint Development Agreement: Developing America's Largest Energy Export Project," Press release, November 9, 2017, available at <https://agdc.us/wp-content/uploads/2017/11/Alaska-and-China-Sign-Historic-Joint-Development-Agreement-Press-Release.pdf>.
- 98 Bruce Einhorn, "Dissecting the \$250 Billion China Deals Trump Got for U.S.," Bloomberg, November 9, 2017, available at <http://www.bloomberg.com/news/articles/2017-11-09/breaking-down-the-250-billion-china-deals-trump-got-for-america>.
- 99 Keith Zhai, "China Orders State-Run Companies to Make Profits," Bloomberg Markets, January 23, 2016, available at <https://www.bloomberg.com/news/articles/2016-01-24/china-is-said-to-order-state-run-companies-to-be-profitable.htm>, source=newletter&utm_medium=email&utm_campaign=stateemp&stories=Only this year did China's State-owned Assets Supervision and Administration Commission issue an order requiring these companies to make a profit. Even private companies in China are increasingly subject to party control.
- 100 Reuters, "U.S. approves ConocoPhillips LNG exports from Alaska," February 9, 2016, available at <https://www.reuters.com/article/us-conocophillips-lng-alaska/u-s-approves-conocophillips-lng-exports-from-alaska-idUSKCN02T>.
- 101 U.S. Energy Information Administration, "Natural Gas Annual 2003, Summary of U.S. Natural Gas Exports by Point of Exit, 1999-2003" (2003), available at https://www.eia.gov/naturalgas/annual/archive/2003/pdf/table_011.pdf; U.S. Energy Information Administration, "Natural Gas Annual 2005, Summary of U.S. Natural Gas Exports by Point of Exit, 2001-2005" (2005), available at https://www.eia.gov/naturalgas/annual/archive/2005/pdf/table_011.pdf; U.S. Energy Information Administration, "Natural Gas Annual 2009, Summary of U.S. Natural Gas Exports by Point of Exit, 2005-2009" (2009), available at <https://www.eia.gov/naturalgas/annual/archive/2009/pdf/table09.pdf>.
- 102 WoodMackenzie, "Alaskan LNG Exports Competitive-ness Study," July 27, 2011, last accessed March 8, 2018, available at <https://gov.alaska.gov/wp-content/uploads/sites/5/Wood-Mackenzie-Report-072711.pdf>.
- 103 U.S. Energy Information Administration, "Natural Gas Annual 2003, Summary of U.S. Natural Gas Exports by Point of Exit, 1999-2003"; U.S. Energy Information Administration, "Natural Gas Annual 2005, Summary of U.S. Natural Gas Exports by Point of Exit, 2001-2005"; U.S. Energy Information Administration, "Natural Gas Annual 2009, Summary of U.S. Natural Gas Exports by Point of Exit, 2005-2009."
- 104 Reuters, "U.S. approves ConocoPhillips LNG exports from Alaska"; Reuters, "ConocoPhillips seeks to sell Alaska Kenai LNG export terminal," November 18, 2016, available at <https://www.reuters.com/article/us-usa-conocophillips-alaska-lng/conocophillips-seeks-to-sell-alaska-kenai-lng-export-terminal-idUSKBN13D28F>; Rashah McChesney, "Facing global gas glut, ConocoPhillips to mothball Kenai LNG plant," Alaska Public Media, July 13, 2017, available at <https://www.alaskapublic.org/2017/07/13/facing-global-gas-glut-conocophillips-to-mothball-kenai-lng-plant/>.
- 105 U.S. Energy Information Administration, "Natural gas prices in Asia mainly linked to crude oil, but use of spot indexes increases," Elsewood Brahmes, "The Costs and Risks for Alaska LNG Project," Alaska Journal of Commerce, January 13, 2016, available at http://www.alaskajournal.com/2016-01-13/costs-and-risks-alaska-lng-project-WQJHJRNL_02_.
- 106 The U.S. oil industry lost more than 200,000 jobs during the most recent oil price crash, and although business is now improving, due to the trend toward greater automation, companies are not planning to bring those jobs back. Jordan Blum, "Fencer Jobs in Oil Patch as Automation Picks Up," Houston Chronicle, December 21, 2016, available at <https://www.houstonchronicle.com/business/energy/article/fewer-jobs-in-oil-patch-as-automation-picks-up-10812124.php>.
- 107 James Manyika and others, "A Future that Works: Automation, Employment, and Productivity" (New York: McKinsey Global Institute, 2017), available at <https://www.mckinsey.com~/media/McKinsey/Globa%20Themes/Digital%20Disruption/Harnessing%20Automation%20for%20the%20future%20of%20work/MGI-A-future-that-works-Full-report.pdf>; David G. Victor and Kasia Yoncoski, "The Next Energy Revolution: The Promise and Peril of High-Tech Innovation," Foreign Affairs, July/August 2017, available at <https://www.foreignaffairs.com/articles/2017-06-13/next-energy-revolution>; National Council on Compensation Insurance, "The Impact of Automation on Employment – Part 2," October 9, 2017, available at https://www.ncci.com/Articles/Pages/08_Insights_OEB_Impact-Automation-Employment-Q3-2017-Part2.aspx; David Werthe, "Robots Are Taking Over Oil Rigs," Bloomberg, January 24, 2017, available at <https://www.bloomberg.com/news/articles/2017-01-24/robots-are-taking-over-oil-rigs-as-roughnecks-become-expensable>.
- 108 World Economic Forum, "Digital Transformation Initiative: Oil and Gas Industry" (2017), available at <http://reports.weforum.org/digital-transformation/wp-content/blogs.dir/94/mp/files/page%20files/06-oil-and-gas-industry-white-paper.pdf>.

- [illegible]

- 123 U.S. Department of Energy, "18 CFR Part 35: Grid Reliability Pricing Rule" (2018), available at <https://www.energy.gov/sites/default/files/2017/09/13/notice%20of%20proposed%20rulemaking%20.pdf>. Gavin Bade, "FERC rejects DOE NOPR, kicking resilience issue to grid operators," *Utility Dive*, January 8, 2018, available at <https://www.utilitydive.com/news/ferc-rejects-doe-nopr-kicking-resilience-issue-to-grid-operators/514334/>.
- 124 David J. Lynch, "Trump moves to crack down on China trade with \$60 billion in tariffs on imported products," *The Washington Post*, March 22, 2018, available at https://www.washingtonpost.com/business/economy/trump-moves-to-crack-down-on-china-trade-with-50-billion-in-tariffs-on-imported-products/2018/03/22/c09309a6-20e3-11e8-ba6f-fbc5284f0e8_story.html?utm_term=.d4215cd21798.
- 125 P.R. China State Council, "Neng yuan fa zhan 'shi er wu' gui hua" (Energy Development "12th Five Year" Plan), National Energy Administration, January 1, 2013, available at http://www.nea.gov.cn/2013-01/28/_112132888.htm.
- 126 P.R. China National Development and Reform Commission, "Guo ja fa zhan gai ge wei guan yu tiao zheng tian ran qi ja ge de tong zhi" (National Development and Reform Commission Notice on Adjusting Natural Gas Prices), June 26, 2013, available at http://www.gov.cn/gzdt/2013-06/26/content_2456328.htm.
- 127 P.R. China State Council, "Da qi wu ran fang zhi xing dong ji hua" (Air Pollution Prevention Action Plan), September 10, 2013, available at http://www.gov.cn/zhengce/content/2013-09/13/content_4561.htm.
- 128 P.R. China National Energy Administration, "You qi guan wang she zhi gong gang kai fang jian guan ban fa (shi xing)" (Supervision Measures for the Fair and Open Access to Oil and Gas Pipeline Networks (Trial)), February 13, 2014, available at http://ztzq.kjnee.gov.cn/euro92/201402/20140224_1768.htm.
- 129 P.R. China National Development and Reform Commission, "Tian ran qi ji chu she zhi jian she yu yun jing guan li ban fa" (Natural Gas Infrastructure Construction and Operation Management Measures), February 28, 2014, available at <http://www.ndrc.gov.cn/zcfb/zcfb/201403/W0201403209286947631.pdf>. Document hosted by National Development and Reform Commission website at http://www.ndrc.gov.cn/zcfb/zcfb/201403/20140320_6033521.html.
- 130 P.R. China National Development and Reform Commission, "Guo ja fa zhan gai ge wei guan yu jian li jian quan ju min sheng huo yong qi jie ti ja ge zhi du de zhi dao yi jian" (National Development and Reform Commission Guiding Opinions on Establishing and Perfecting Residential Gas Use Stairway Pricing System), March 20, 2014, available at http://bgf.ndrc.gov.cn/zcfb/201403/120140321_603786.html.
- 131 P.R. China National Development and Reform Commission, "Guo ja fa zhan gai ge wei guan yu tiao zheng fei ju min yong cun liang tian ran qi ja ge de tong zhi" (National Development and Reform Commission Notice on Adjusting Non-Residential Pricing for Base Natural Gas Use), August 10, 2014, available at http://www.ndrc.gov.cn/gzdt/201408/20140812_622009.html.
- 132 P.R. China State Council, "Neng yuan fa zhan zhan lue xing dong ji hua (2014-2020 nian)" (Energy Development Strategic Action Plan (2014-2020)), June 7, 2014, available at http://www.gov.cn/zhengce/content/2014-11/19/content_9222.htm.
- 133 P.R. China National Development and Reform Commission, "Guo ja fa zhan gai ge wei guan yu li shun fei ju min yong tian ran qi ja ge de tong zhi" (National Development and Reform Commission Notice Regarding the Rationalization of Natural Gas Price for Non-Residential Use), February 26, 2015, available at http://www.ndrc.gov.cn/zcfb/zcfb/201502/20150228_666694.html.
- 134 P.R. China National Development and Reform Commission, "Guo ja fa zhan gai ge wei guan yu jiang di fei ju min yong tian ran qi men zhan ja ge bing jin yi bu tui jin ja ge zhi chang hua gai ge de tong zhi" (National Development and Reform Commission Notice on Reducing the City-gate Price of Natural Gas for Non-Residential Use and Further Promoting Market-Oriented Price Reform), November 18, 2015, available at http://gs.ndrc.gov.cn/zcfb/201511/20151118_758901.html.
- 135 P.R. China National Development and Reform Commission, "Tian ran qi guan dao yun shu ja ge guan li ban fa (shi xing)" (Natural Gas Pipeline Transportation Price Management Measures (Trial)), October 9, 2016, available at <http://www.ndrc.gov.cn/zcfb/gfkwj/201610/W020161012521116104067.pdf>. Document hosted by National Development and Reform Commission website at http://www.ndrc.gov.cn/zcfb/gfkwj/201610/120161012_822383.html.
- 136 *Ibid.*
- 137 P.R. China National Development and Reform Commission, "Guo ja fa zhan gai ge wei guan yu tui jin hua fei yong qi ja ge zhi chang hua de tong zhi" (National Development and Reform Commission Notice on Promoting Marketization Reform of Chemical Fertilizer Gas Use Prices), November 5, 2016, available at http://www.ndrc.gov.cn/zcfb/zcfb/201611/20161110_826163.html.
- 138 P.R. China National Energy Administration, "Tian ran qi fa zhan 'shi san wu' gui hua" (Natural Gas Development "13th Five Year" Plan), December 24, 2016, available at <http://www.ndrc.gov.cn/gzdt/201701/W020170119069186013264.pdf>. Document hosted by National Development and Reform Commission website at http://www.ndrc.gov.cn/gzdt/201701/120170119_835571.html.
- 139 P.R. China National Development and Reform Commission et al., "Jia kuai tui jin tian ran qi li yong de yi jian" (Opinions on Accelerating the Use of Natural Gas), June 23, 2017, available at <http://www.ndrc.gov.cn/gzdt/201707/W020170704625433808341.pdf>. Document hosted by National Development and Reform Commission website at http://www.ndrc.gov.cn/gzdt/201707/120170704_853939.html.
- 140 P.R. China National Development and Reform Commission, "Guo ja fa zhan gai ge wei guan yu jiang di fei ju min yong tian ran qi ji zhan men zhan ja ge de tong zhi" (NDRC Notice on Reducing the Non-Residential Natural Gas Reference Citygate Prices), August 29, 2017, available at http://www.ndrc.gov.cn/gzdt/201708/120170830_859333.html.

¹⁴¹ For Chinese language reports on the statement, see: Sina, "Huan bao bu qing zuo hao san mei zong he zhi li que bao qun zhong wen nuan guo dong gong zuo" [Ministry of Environmental Protection: Please do a good job on the comprehensive management of dispersed coal to ensure a warm winter for the masses], December 7, 2017, available at <http://finance.sina.com.cn/money/future/fmnews/2017-12-07/doc-fypkpw4013143.shtml>; Changsha City Environmental Protection Agency, "Huan bao bu ta ji tong zhi mei gai qi wei wan di qu ke ji xu shao mei qu nuan" [Ministry of Environmental Protection Urgent Notice: Unfinished coal-to-gas areas can continue to burn coal for heating], December 8, 2017, available at http://hbj.changsha.gov.cn/hbdt/hbyw_30339/201712/r20171208_2136170.html.

¹⁴² P.R. China National Development and Reform Commission and others, "Bei fang di qu dong ji qing jie qu nuan gui hua (2017-2021 nian)" [Northern Region Winter Clean Heating Plan (2017-2021)], December 5, 2017, available at <http://www.ndrc.gov.cn/zcfb/zcfbz/201712/W02017122035138513215.pdf>. Document hosted by the National Energy Administration website at http://www.nea.gov.cn/2017-12/27/c_136854721.htm.

Our Mission

The Center for American Progress is an independent, nonpartisan policy institute that is dedicated to improving the lives of all Americans, through bold, progressive ideas, as well as strong leadership and concerted action. Our aim is not just to change the conversation, but to change the country.

Our Values

As progressives, we believe America should be a land of boundless opportunity, where people can climb the ladder of economic mobility. We believe we owe it to future generations to protect the planet and promote peace and shared global prosperity.

And we believe an effective government can earn the trust of the American people, champion the common good over narrow self-interest, and harness the strength of our diversity.

Our Approach

We develop new policy ideas, challenge the media to cover the issues that truly matter, and shape the national debate. With policy teams in major issue areas, American Progress can think creatively at the cross-section of traditional boundaries to develop ideas for policymakers that lead to real change. By employing an extensive communications and outreach effort that we adapt to a rapidly changing media landscape, we move our ideas aggressively in the national policy debate.

Center for American Progress



The CHAIRMAN. Thank you, Dr. Hart.
Mr. Riedl.

**STATEMENT OF CHARLIE RIEDL, EXECUTIVE DIRECTOR,
CENTER FOR LIQUEFIED NATURAL GAS**

Mr. RIEDL. Good morning, Chairman Murkowski, Ranking Member Manchin, Senator Stabenow. Thank you for allowing me the opportunity to testify this morning. My name is Charlie Riedl, and I am the Executive Director at the Center for Liquefied Natural Gas, or CLNG.

CLNG represents the full LNG value chain providing us with unique insight on the benefits LNG brings to the U.S and global economies. CLNG operates within the Natural Gas Supply Association, a national trade association that's represented U.S. gas industry for more than 50 years. This gives us a deep understanding of the entire U.S. natural gas supply portfolio.

I appreciate the opportunity to address the Committee about the evolving global natural gas market and the many environmental and economic benefits of U.S. LNG exports. America's abundance of natural gas has led to our emergence as a world-class exporter of energy, creating U.S. jobs, growing our economy and significantly strengthening global energy security, all while reducing emissions and pollution.

The United States' vast supply of natural gas is the very reason we're here this morning and able to have this conversation about LNG exports. Without it, we would likely be having a conversation this morning focused on LNG imports.

It is this supply, growing by the year, that underpins the benefits we can achieve with exports. Technological breakthroughs in the oil and natural gas industry have unleashed an energy renaissance establishing the United States as the world's largest natural gas producer.

As I speak today, the U.S. natural gas resource has reached an all-time high according to the U.S. Potential Gas Committee. Amazingly, those increases are up 69 percent since 2005 according to EIA, all while prices of natural gas have fallen 64 percent over that same time period. So new domestic supplies of affordable natural gas have created this competitive advantage for U.S. manufacturers as well, leading to greater investment, industry growth and new jobs. And exports forecast that an additional industrial investment of roughly \$135 billion to build 59 new projects and 11 expansions between now and 2022.

According to studies from the Department of Energy, the exports will not compete with the manufacturing sector here in the United States. And it's important to understand that any new LNG exports will be met by new natural gas production.

So to better illustrate how quickly the U.S. has moved being a net exporter of natural gas, we really only need to look back 11 years. In 2008, the EIA's Annual Energy Outlook forecasted that by 2030 the United States would need to import roughly 8 billion cubic feet of LNG per day. Fast forward to the 2019 Annual Energy Outlook and the forecast is vastly different. We will be exporting by 2030, 13.5 BCF of LNG per day. That's a swing of 21.5 BCF

without having any material impact on the net price of natural gas here domestically.

So what we're finding is that LNG exports can and will react to the global marketplace. Worldwide demand for LNG export today is approximately 37 billion cubic feet and it's projected to increase to around 67 billion cubic feet per day by 2035.

U.S. LNG exports create numerous environmental and economic benefits for the United States and global consumers. I'd like to focus the remainder of my remarks this morning focused on those two areas.

A 2014 study conducted by the Department of Energy found that LNG exports could reduce global greenhouse gas emissions by displacing more carbon intensive fuels for importing nations. Those further studies have also shown how natural gas and renewables are ideal partners for improving air quality and emissions.

A prime example of where that's taking place is in India where it's believed some 400 million people lack access to reliable electricity. So to date, we've sent 36 cargos to India which is roughly 120 BCF of gas, and what we've seen in that time period, since 2016, the Cove Point facility has served that market and what we're seeing is greater adoption of natural gas for electricity generation there cleaning up the air.

In-depth research by the Department of Energy in 2015 and again in 2018, found that exports are a net benefit to the U.S. economy. That study by the Department of Energy found that results—the increase in the U.S. household incomes and their welfare. The Department study determined that increased production will drive investment to revitalize economically depressed regions that bring thousands of jobs to the area.

The promise of more LNG facilities in the United States also brings the promise of a new era benefiting the U.S. economy and our environment. Our enormous natural gas resource base is ideally positioned to help the United States compete on a global level for the LNG market share and still providing an environmentally and economically affordable, advantageous fuel source for the U.S. customers.

U.S. LNG exports benefit everyone with billions of dollars in investments and thousands of dollars of good paying jobs here at home while creating a cleaner future for our world.

In closing, I commend Chairman Murkowski and the Committee for their leadership and steadfastness in championing LNG. We're committed to helping find solutions to address our energy needs and I look forward to your questions.

Thank you for the opportunity this morning.

[The prepared statement of Mr. Riedl follows:]

**Testimony of Charlie Riedl, Executive Director of the Center for Liquefied Natural Gas, before
the U. S. Senate Committee on Energy and Natural Resources**
THE IMPORTANT ROLE OF U.S. LNG IN EVOLVING GLOBAL MARKETS

July 11, 2019

Good morning, Chairman Murkowski, Ranking Member Manchin, and members of the committee. Thank you for the opportunity to testify today. My name is Charlie Riedl, I am the Executive Director for the Center for Liquefied Natural Gas or CLNG.

CLNG represents the full LNG value chain, including LNG producers, shippers, terminal operators and developers, providing it with unique insight into the ways this abundant and versatile fuel can realize its vast potential, to the benefit of the U.S. economy and global energy security.

We appreciate the opportunity to address the committee about the evolving global natural gas market and the many environmental and economic benefits of U.S. LNG exports. America's abundance of natural gas has led to our emergence as a world-class exporter of natural gas, creating U.S. jobs, growing our economy, significantly strengthening global energy security -- all while reducing emissions and pollution.

The United States began exporting LNG in 2016 and has steadily solidified its position as a major global energy power. The U.S. is now home to four LNG export terminals in operation, six projects under construction, and seven projects that are permitted and awaiting Final Investment Decisions. There are another fourteen projects in the FERC queue.

Each of these projects individually represents billions of dollars of investment in America's energy future. By seizing and executing on the opportunity made possible by our enormous supply of natural gas, the U.S. LNG industry is poised to provide natural gas that will improve our trading partners' access to clean energy, while providing jobs and a stable supply of natural gas and revenues here in the United States.

The focus of my testimony will be on LNG and the incredible opportunity we have before us. However, I believe it is critically important to first understand the current and projected supply of natural gas here in the United States before speaking further about LNG and LNG exports. CLNG has a deep understanding of the entire U.S. natural gas supply portfolio and rising demand for natural gas both in domestic markets and abroad because of our position as a committee of the Natural Gas Supply Association, a national trade association that has represented top producers and marketers of U.S. natural gas for more than 50 years.

The United States has an abundant supply of natural gas. Underpinning the environmental, economic and security benefits we can achieve with exports is our abundant supply of natural gas. Technological breakthroughs in the oil and natural gas industry have unleashed an energy renaissance, establishing the United States as the world's largest natural gas producer – and domestic production continues to grow.

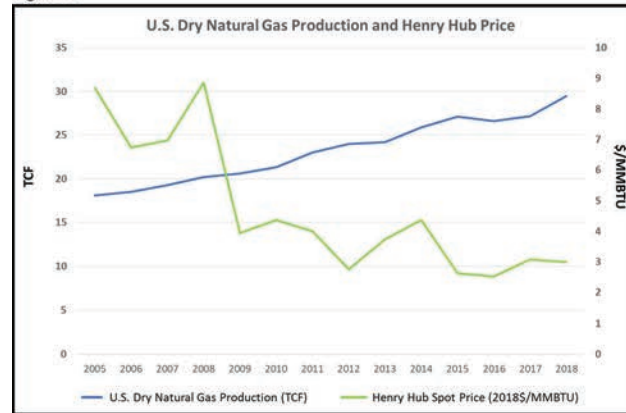
We have enough natural gas to supply affordable energy domestically for at least 100 years with current technology, as well as to significantly increase U.S. participation in the global market for LNG.

Natural gas companies understand that with this opportunity comes the responsibility to be dedicated stewards of local land, air and water. We are committed to responsible development to ensure that our natural resources are protected, while maximizing this great opportunity before us.

As I speak today, U.S. natural gas resources have reached an all-time high, according to the U.S. Potential Gas Committee.¹ Even as U.S. natural gas production continues to grow year over year, our total natural gas resource estimates continue growing as well, due to improvements in our ability to detect and extract natural gas.

In fact, if the Potential Gas Committee's 1966 estimate of 600 trillion cubic feet (Tcf) had remained static, the United States would have run out of natural gas in the 1990s. Instead, estimates doubled by 2002, to more than 1,200 Tcf, and by 2017 had exceeded 2,800 Tcf.²

Figure 1

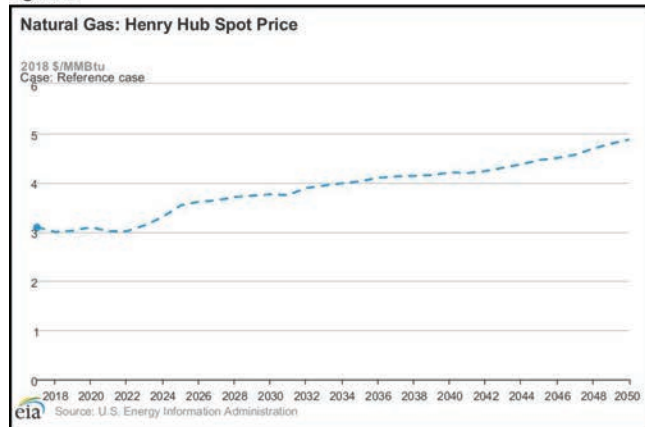


Concurrent with this nearly five-fold increase in the total resource base, U.S. natural gas production has increased by 69 percent since 2005, according to the U.S. Energy Information Administration (EIA) and yet prices have declined by 64 percent over the same time period. And EIA projects production to continue to grow well through 2050, while prices will stay below \$5 out to 2050. This is all due to the stability of our abundant supply. Based on EIA estimates, between 2008 and now, the United States will have effectively added **double** the LNG capability that Qatar has planned – by 2030. Put another way, we have grown our LNG by the equivalent of two Quatars in 2030. Remarkably, we will have done this with no increase in domestic prices.

¹ U.S. Potential Gas Committee, [Biennial Estimate of North American Natural Gas Resource Base](#), July 2017.

² U.S. Potential Gas Committee, [Biennial Estimate of North American Natural Gas Resource Base](#), July 2017.



Figure 2



Because our supply of natural gas is so abundant, operating and planned export capacity are helping provide stability to the domestic energy market. LNG exports offer an important new market for surplus natural gas production, which often occurs due to associated gas that is tied to oil production. Exports provide another demand outlet and thus help to keep natural gas production steady and predictable.

In fact, growth in exports sends market signals to incentivize domestic production, which benefits consumers here at home and benefits industries involved in the natural gas supply chain such as construction and manufacturing, spurring even more economic growth.

Figure 3

Demand: Customer Demand		
SUMMER SEASON Period-to-period Change	LAST SUMMER 2018 Actual	THIS SUMMER 2019 Forecast
Customer Gas Demand	79.6 Bcf/d	82.1 Bcf/d
▪ Electric	32.1 Bcf/d	31.3 Bcf/d
▪ Industrial	21.5 Bcf/d	22.1 Bcf/d
▪ Residential/Commercial	11.9 Bcf/d	11.0 Bcf/d
▪ Pipeline exports - Mexico	4.7 Bcf/d	5.5 Bcf/d
▪ LNG exports (net)	3.3 Bcf/d	6.0 Bcf/d
Change from previous year	+13.4 %	+ 3.1 %
Growth sector	Electric + 16.3%	Exports + 44%
Summer-to-summer pressure on natural gas prices		
		
		
2019 SUMMER OUTLOOK 5		
Data Source: Energy Ventures Analysis, Inc.		

The United States is poised to realize its potential as a major international gas supplier, but the window of opportunity to solidify our position is narrowing. Globally traded LNG volumes were 37 billion cubic feet per day (Bcf/d) in 2018, setting a new annual record. Worldwide demand for LNG is expected to increase to 67.7 Bcf/d by 2035.³ It is projected that 13.5 Bcf/d of liquefaction capacity will be added between now and 2023, to help meet world demand for LNG.⁴ Globally there is approximately 15 Bcf/d of new regasification capacity under construction and numerous countries are vying to serve this growing LNG market.⁵ The demand for LNG is clear, and that is why it is critical the United States be positioned to compete on a level playing field for access to these new and expanding markets.

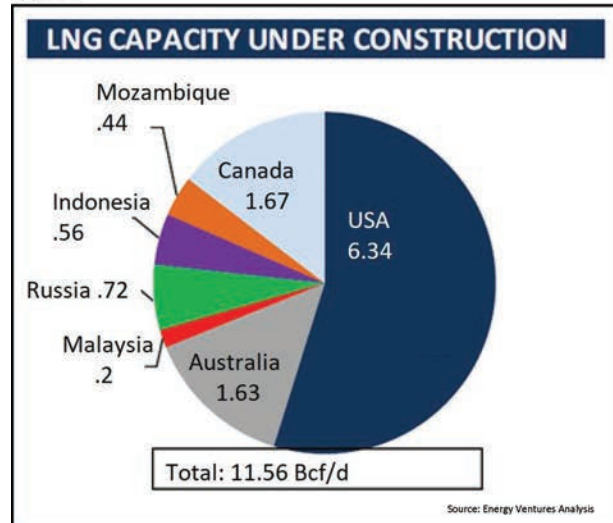
³ Energy Insight, McKinsey, [Global Gas & LNG Outlook to 2035](#), September 2018.

⁴ International Gas Union, [World LNG Report](#), 2019.

International Energy Agency, [Market Report Series Gas 2018](#), Executive Summary.

⁵ International Gas Union, [World LNG Report](#), 2019.

Figure 4



As study after study has shown, exports drive economic growth here at home, particularly in natural gas-producing regions. Most recently, in-depth research by NERA Economic Consulting for the U.S. Department of Energy (DOE) in 2018 found that exports are a net benefit to the U.S. economy. The DOE study determined that increased natural gas demand from exports will spur increased investment in domestic natural gas production, driving job growth in areas where production grows.

The 2018 DOE study concluded that export demand will not be met by existing production but rather be met almost entirely by additional production. This is an important point. Just as previous economic studies conducted for DOE found, the 2018 study also determined that increased production will drive investment in natural gas-producing regions and support thousands of additional jobs.⁶

Another study, conducted by ICF for the American Petroleum Institute, showed that exports could generate more than 450,000 jobs and more than \$73 billion for the economy by 2035.⁷

Finally, DOE's study showed that exports will result in an increase in U.S. households' real income and welfare that exceeds any potential impact that could come from marginally higher natural gas prices.⁸

Exports represent a tremendous geopolitical opportunity for the United States. LNG exports are already supporting our national security interests by strengthening the energy security of our allies and

⁶ Department of Energy, [The Macroeconomic Outcomes of Market Determined Levels of U.S. LNG Exports](#), June 2018

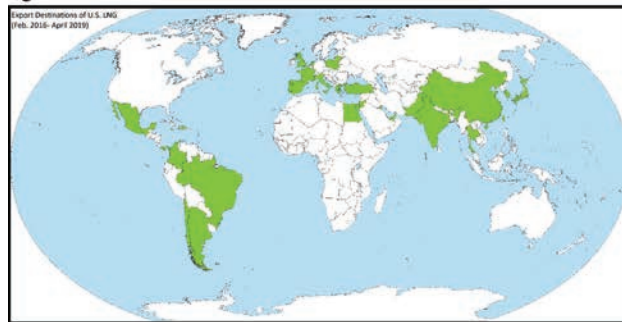
⁷ ICF, [Impact of LNG Exports on the U.S. Economy: A Brief Update](#), September 2017.

⁸ Department of Energy, [The Macroeconomic Outcomes of Market Determined Levels of U.S. LNG Exports](#), June 2018

weakening those nations who use natural gas exports as geopolitical leverage. For example, Europe remains highly dependent on Russia for natural gas, which supplies 35 percent of its total natural gas imports. For countries in Central and Eastern Europe (like Czech Republic, Hungary, Bulgaria, Greece), that share is much higher. Russia has demonstrated its willingness to use energy as a political tool, cutting off natural gas supplies to European consumers several times over the last decade, with Eastern European countries most harmed by Russian manipulations.

Fortunately, U.S. LNG exports provide an opportunity to diversify our allies' supply choices and expand the global natural gas market. Lithuania and Poland, for example, have already signed deals to import U.S. LNG. As Lithuanian President Dalia Grybauskaitė wrote, "U.S. gas imports to Lithuania and other European countries is a game changer in the European gas market. This is an opportunity for Europe to end its addiction to Russian gas and ensure a secure, competitive and diversified supply."⁹

Figure 5



Furthermore, exports reinforce our commitment to open trade. By allowing the open trade of U.S. LNG, we are sending an important signal to other commodity exporters. A commitment to unencumbered exports promotes U.S. leverage in trade negotiations, particularly with other commodities.¹⁰

LNG exports offer clear environmental benefits to overseas consumers. A 2014 study conducted by DOE found that LNG exports could reduce global greenhouse gas emissions by displacing more carbon intensive fuels in importing nations.¹¹

This was the conclusion of the Department of Energy in 2014, and its findings have been subsequently echoed in studies [that](#) compare greenhouse gas emissions of LNG and other fossil fuels over their full lifecycles¹². Furthermore, these studies show how natural gas and renewables are ideal partners for

⁹ Agnia Grigas, *Foreign Affairs Magazine*, "U.S. Natural Gas Arrives in Lithuania," September 12, 2017.

¹⁰ Michael Levi, Brookings, *A Strategy for U.S. Natural Gas Exports*, June 2012.

¹¹ Department of Energy, National Energy Technology Laboratory, *Lifecycle Greenhouse Gas Perspective Report on Exporting LNG from the United States*, 2014.

¹² Pace Global, *LNG and Coal Lifecycle Assessment of Greenhouse Gas Emissions*, October 2015.

improving air quality and emissions,¹³ and document case studies detailing enormous improvements in pollution and smog with increased use of natural gas.¹⁴ Current events further support that finding. For example, the Chinese have rapidly expanded their use of natural gas in order to reduce their reliance on other fossil fuels.

Today China has overtaken South Korea as the world's second largest LNG importer and U.S. LNG cargoes have already made their way to Chinese import terminals. In fact, before trade tensions between China and the United States began, China was the 3rd largest U.S. LNG customer, however now China has fallen to the 15th position.

Just last fall, LNG took center stage in trade negotiations during President Trump's visit to China, culminating in a deal between China Petrochemical Corp, China Investment Corporation, Bank of China, the State of Alaska and the Alaska Gasoline Development Corporation for the development of LNG export capacity in Alaska. The three state-owned Chinese companies would invest \$43 billion into the project. This type of partnership is important both from an environmental standpoint and to provide the financing for a project that will have huge job and economic benefits for the local Alaskan communities.

Countries like India, where it is believed up to 400 million people¹⁵ lack access to reliable electricity, desperately wish to ramp up their use of natural gas. 36 U.S. export cargoes have already made their way to India and the second operational U.S. LNG export terminal, Dominion Energy's Cove Point facility in Maryland, has a 20-year contract with GAIL India Ltd, the country's largest natural gas utility.

Greater use of natural gas in importing nations will help reduce carbon emissions but it will also help reduce traditional pollutants – burning natural gas creates little to no emissions of sulfur dioxide, nitrogen oxides or particulate matter that can lead to smog.¹⁶ Providing our trade partners with access to a cleaner-burning energy alternative reinforces our commitment to environmental progress.

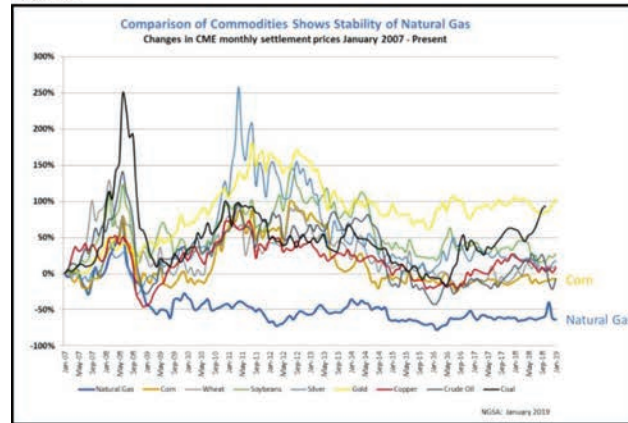
¹³ National Bureau of Economic Research, [Bridging the Gap: Do Fast-reacting Fossil Technologies Facilitate Renewable Energy Diffusion](#), July 2016.

¹⁴ International Gas Union, [Case Studies in Improving Urban Air Quality](#), 2016.

¹⁵ Asian Venture Philanthropy Network, [Addressing Energy Poverty in India](#), August 2018.

¹⁶ Leidos, Inc., [A Comparison of Emissions from Major Fuels Used to Generate Electricity in the U.S.](#), 2016.

Figure 6



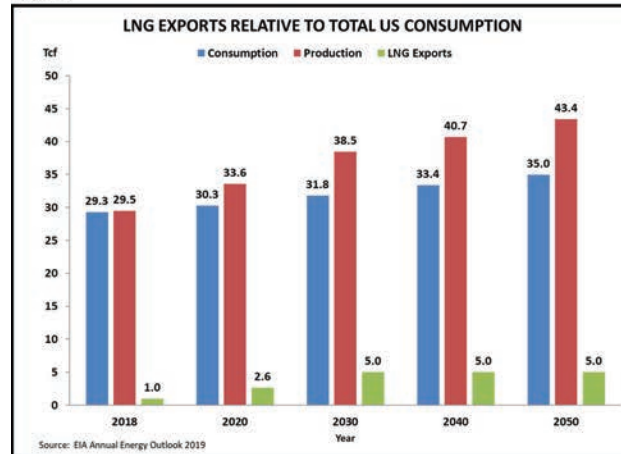
LNG exports and U.S. natural gas production provide support for the industrial renaissance and provide stability here at home. The past decade's dramatic increase in natural gas supply has occurred even as natural gas has enabled an industrial renaissance in the manufacturing sector, with demand for natural gas from that sector projected to reach an all-time high this summer.¹⁷ New domestic supplies of more affordable natural gas and natural gas liquids (NGLs) have created a competitive advantage for U.S. chemical manufacturers, leading to greater investment, industry growth, and new jobs. Companies from around the world are investing in new projects to build or expand their shale-advantaged capacity in the United States. Forty new industrial projects in the petrochemical, fertilizer, steel and gas-to-liquids sectors were completed between 2015 and 2018, and another 40 are expected to be completed by 2023, representing an investment of more than \$135 billion.¹⁸

Domestic gas supply can support increases across all sectors, with LNG exports and manufacturing living harmoniously. Because of our enormous domestic natural gas resource base, the United States is uniquely positioned to compete on a global level for LNG markets, while still providing an affordable and environmentally advantageous fuel source for American manufacturers. The United States needs new markets to encourage continued production of natural gas and NGLs to support our domestic manufacturing and encourage manufacturers to stay in the U.S. The resurgence in domestic industrial growth not only strengthens the U.S. economy, it also provides an opportunity to reduce CO₂ globally. This global CO₂ reduction is possible because the energy consumed in U.S. manufacturing is less carbon intensive than other manufacturing areas throughout the world.

¹⁷ Energy Ventures Analysis, Inc., *2019 Summer Outlook for Natural Gas*, May 2019.

¹⁸ Energy Ventures Analysis, Inc., *2019 Summer Outlook for Natural Gas*, May, 2019.

Figure 7



LNG is Cutting Emissions in the Transportation Sector. The expanded use of natural gas as a transportation fuel, whether in the form of LNG (or CNG), can help reduce air pollution and carbon emissions from the transportation sector, whether in the marine industry or in cars and fleet vehicles.

In the maritime sector, for example, new international emissions standards for ships¹⁹, in addition to the low cost of natural gas compared to more conventional fuels, has encouraged the use of LNG as a fuel by the shipping industry in recent years. This growth is expected to continue since LNG emits significantly lower levels of nitrogen oxide, sulfur oxides, particulate matter and carbon dioxide compared to oil-based alternatives currently used for marine fuel.²⁰

As a result of LNG's comparatively low emissions, the United States is projected to almost double its current fleet of LNG-fueled tankers from 2016 to 2019²¹, led by shipping investments made by Harvey Gulf and Tote, according to the U.S. Energy Information Administration. Even the cruise industry has embraced LNG in shipping, with cruise lines such as Carnival and Disney building new ships powered by LNG. Worldwide, the global fleet of LNG-powered ships is expected to grow more than 40-fold to almost 1,800 vessels by 2020.²²

On a well-to-wake lifecycle basis, marine vehicles powered by natural gas emitted up to 21 percent fewer greenhouse gas emissions compared to gasoline and diesel-powered vehicles²³. According to the DNV-GL's [Alternative Fuels Insight Map](#), there are more than 280 LNG stations for marine vehicles in operation or under construction and another 91 planned.

¹⁹ International Maritime Organization (IMO) has set new limits for sulphur in fuel oil used on board ships to take effect in 2020.

²⁰ U.S. Dept. of Transportation Maritime Administration, [Liquefied Natural Gas Bunkering Study](#), 2014.

²¹ LNG World News, "EIA: LNG Fueled Vessels on the Rise in the U.S." 2016.

²² DNV GL, "In Focus – LNG As A Ship Fuel," 2015

²³ SEALNG, [Life Cycle GHG Emission Study on the Use of LNG as Marine Fuel](#), 2019.

On a well-to-wheel lifecycle basis, land vehicles powered by natural gas emit also between 13 and 21 percent fewer greenhouse gas emissions compared to gasoline and diesel-powered vehicles²⁴. These natural gas-powered vehicles can further improve local air quality because they emit approximately 50 percent less NOx gas and other pollutants. According to the Alternative Fuels Data Center²⁵, there are more than 130 LNG stations for heavy duty trucks in operation or under construction and another 50 planned.

Continued growth in the use of natural gas as a vehicle fuel – the number of natural gas vehicles around the world increased by an estimated 300 percent between 2006 and 2014²⁶ – will help improve air quality and reduce carbon emissions. And more rapid growth is expected.

Conclusion

The promise of more LNG facilities in the United States brings the promise of a new era benefiting the economies of the United States and our global trading partners, as well as contributing to vast improvements in energy poverty abroad and the improved health and cleaner environment that accompanies that change.

The United States is fortunate that our enormous natural gas resource base ideally positions us to compete on a global level for LNG market share while still providing an affordable and environmentally advantageous fuel source for American households and manufacturers and benefiting the U.S. economy.

Streamlining the approval process for LNG export applications from the United States can create tens of thousands of American jobs and reduce global greenhouse gas emissions, while preserving a competitive advantage.

Thank you for the opportunity to testify on behalf of CLNG and NGSA and our members. We are committed to helping to find solutions to address the world's energy needs and look forward to working with the Committee to that end.

²⁴ NGV America, [Environmental Benefits of Natural Gas Vehicles](#), 2018.

²⁵ U.S. Department of Energy, [Alternative Fuels Data Center](#).

²⁶ U.S. Department of Energy, [Clean Cities Webinar Presentation](#), October 2014.

The CHAIRMAN. Thank you, Mr. Riedl.
Mr. Tsafos, welcome.

**STATEMENT OF NIKOS TSAFOS, SENIOR FELLOW, ENERGY
AND NATIONAL SECURITY PROGRAM, CENTER FOR STRA-
TEGIC AND INTERNATIONAL STUDIES**

Mr. TSAFOS. Thank you, Chairman Murkowski, Ranking Member Manchin, members of the Committee. Thank you for the opportunity to speak to you today.

As everyone has attested to, we're living in a transformational moment in global gas markets and the United States is at the center of that transformation. And so, the first thing I want to do is actually commend this Committee because its leadership and the actions that have taken place in this town over the past few years have made that possible.

What I want to leave you with is four things.

Number one, the global gas market is changing. There's no doubt about that. But that change is sometimes caricatured. The headlines don't quite do justice to the complexity of this system. So in my view I wanted to share four profound shifts that are taking place in the global gas market that, I think, should guide our thinking and our decisions.

The first shift is complexity. Twenty years ago, this used to be a simple system, a handful of producers, handful of consumers. Today we live in a world where about 20 countries export LNG and about 40 countries import it. This is an immensely more complicated system.

The second shift is in structure. We have more transactions that take place in the short-term and spot market, and that is a very encouraging trajectory. At the same time, the long-term market still dominates and if you look at the spot market for LNG it's about four percent of all the gas used in the world. So it's important to focus on that market, but it's also important to understand the broader context in which that market exists.

The third shift is in pricing. Even in 2018, less than half of the world's gas was priced according to market principles, what we call gas on gas competition. Regulated pricing, oil indexation are still very important. The price that Asian consumers pay for LNG still tracks the price of oil very well. It's important, whenever we talk about pricing, to look at the details, to look at the nuance because the headline stories sometimes don't do justice to what's really happening.

The fourth shift is in geography. We have a monumental shift where Qatar, Australia and the United States are going to be the top three suppliers with Russia emerging as a clear fourth. China has become the largest source of incremental LNG in the world. It's overtaken South Korea. In a few years, it will overtake Japan. So what happens in China is going to have a profound impact on this market, and we have to think about what that means. My point from these shifts is relatively clear. Change is taking place. That change is sometimes evolutionary, not revolutionary and we should understand and embrace the complexity of the system.

The second observation I want to make is about the current moment that we are at. We have a lot of gas on the market. Prices are really down for spot LNG in Asia, in Europe.

At the same time, companies are investing for the new wave of supply. But this new wave is going to be a lot more competitive. It's going to be a lot more diverse. It's going to be Qatar. It's going to be Russia. It's going to be Canada. It's going to be East Africa. It's going to be Southeast Asia. One of the key challenges will be to find a role for the United States to compete in that marketplace. Companies will change business models. They'll turn to states for support. We'll have geopolitical drivers for decisions. And so, this is going to be a very competitive market.

The third observation I want to leave you with is about institutions. We desperately need a common basis from which to talk. This means data, better data, publicly accessible data, data that everyone can rely upon to have a good conversation about what's happening in natural gas. We have questions from oil. When we talk about oil, we all can look at a certain number of reports and have a common foundation for discussion. We don't have the same thing for global gas. We really need it.

The second aspect of institutions is a conversation on gas and energy security. Different regions have different understandings of gas security, and I think it's incumbent upon the United States, through its partners and the International Energy Agency, to revitalize the conversation on how to measure gas security and also how to enhance it altogether.

My final observation is about enhancing and supporting U.S. LNG exports and my observation has been that if you want to build LNG anywhere else in the world, you can probably get the U.S. Government to help you. If you try to buy U.S. LNG you're, kind of, out of luck.

And so, I think we really need to have a better conversation about sharpening the tools that the U.S. Government already has—the BUILD Act, the EXIM Bank—and trying to figure out ways to get countries that want to import LNG, U.S. LNG, or just gas more broadly, give them the tools and the resources they want and need to make that possible.

Thank you very much for your time, and I look forward to answering your questions.

[The prepared statement of Mr. Tsafos follows:]



CENTER FOR STRATEGIC &
INTERNATIONAL STUDIES



**Statement before the
Senate Energy and Natural Resources Committee**

***“The Important Role of U.S. LNG in Evolving
Global Markets”***

A Testimony by:

Nikos Tsafos

Senior Fellow, Energy and National Security Program
Center for Strategic and International Studies (CSIS)

July 11, 2019

366 Dirksen Senate Office Building

Chairman Murkowski, Ranking Member Manchin and Members of the Senate Committee on Energy and Natural Resources, thank you for the opportunity to appear before you today to discuss the evolving global market for natural gas and the role that U.S. liquefied natural gas (LNG) plays in that market.

There is a profound transformation underway in global gas—with the United States at the center, as the world’s largest producer, consumer, and source of incremental LNG supply. This new era offers enormous opportunities for the United States to create prosperity at home, enhance ties with friends and challenge foes, and support a fuel that can make a material contribution to our fight against climate change—especially if the environmental side-effects from the natural gas value chain are limited. Leadership in Washington has played a major role in this success story; my goal today is to highlight some areas where further focus could yield additional results. I have four takeaways for the Committee:

The United States is entering a global market that is changing, and its entry will accelerate that change. But change is evolutionary and multi-layered—thus, broad generalizations can mislead rather than illuminate. There are new players, new business models, and new trade routes, but these exist alongside business practices and patterns that have persisted for decades. More than ever, it is important to understand each region and market on its own terms, with due regard to the idiosyncrasies that make it special.

We are, in mid-2019, at a unique moment in the business cycle. There is an oversupply of LNG on the market, leading to historically low prices in Europe and Asia; at the same time, there is record-level investment and interest in new LNG supply; and, meanwhile, LNG is becoming part of several high-level geopolitical disputes affecting U.S. relations with both China and Europe. The LNG market is thus becoming much more competitive and somewhat more politicized—it is in this ultra-competitive market that existing U.S. LNG projects will need to survive, and new projects find a way to succeed.

We need a new institutional focus on gas and LNG. Multilateral organizations have played a central role in governing markets like crude oil or civilian nuclear energy; the institutional arrangements for gas are far less developed. Information transparency and data availability are poor—at least compared to oil markets. Concepts of energy security and resilience vary, even among advanced economies, and there are few shared metrics on how to measure energy security, much less enhance it. This new gas market needs new instruments.

LNG could use more help, especially in emerging economies. Gas demand is rising sharply, and LNG demand is rising even faster. But gas is also struggling in some regions, especially emerging Asia outside China, which is relying on coal to meet its energy needs, with serious repercussions for human health and the environment. The United States has existing policy and financing tools that could be sharpened to facilitate gas use in that part of the world.

Transformation in Global Gas and LNG Markets

There are several concurrent transformations taking place in gas markets, but the most important change is that the global energy system is relying increasingly on natural gas to meet its energy

needs; that this gas is being transported more and more via LNG; and that the United States is becoming a major player in that LNG market.

In 2018, 24 percent of the world's energy came from gas in 2018, the highest value ever.¹ Since 2000, LNG has grown more than twice as fast as total gas demand—as a result, LNG accounted for 11 percent of total gas consumption in 2018, up from 6 percent in 2000. In five years, from 2013 to 2018, LNG has registered an unprecedented surge in supply, growing by about a third—and that is even before all U.S. projects have reached their full production potential. By 2024, the International Energy Agency (IEA) forecasts that the United States will overtake Australia and Qatar as the largest LNG exporter in the world.²

The growth in volume has been accompanied by several other shifts. The first is complexity.³ In the early 2000s, there were around ten countries that exported LNG and around ten countries that imported it. Trade routes were simple and routine: most LNG flowed either within the Atlantic and Pacific basins, or from the Middle East to the Pacific. By 2018, there were 19 exporters and 37 importers—with the latter, in particular, having grown sharply in recent years (10 countries started to import LNG from 2013 to 2018). And while intra-regional trade continues to dominate, there are new trade routes that have been created—and continue to be created with the rise of U.S. LNG exports as well as LNG shipped from the Arctic.

The structure of the LNG market is shifting too. In the early 2000s, most LNG was traded via long-term contracts, and the short-term market accounted for a mere 5 percent of all volumes. Over time, the short-term market has taken a bigger role, accounting for almost a third of the LNG trade since 2011 (the share has fluctuated between 27 and 31 percent).⁴ This shift has had profound implications for gas pricing and energy security. At the same time, the short-term market for LNG made up less than 4 percent of the world's gas consumption—as such, the dynamics in that market should not be assumed to represent the gas market more broadly.

The pricing of gas is changing as well. In its latest survey of global gas prices, the International Gas Union noted that less than half of the gas consumed in the world was priced based on gas-on-gas competition in 2018; ~20 percent was priced in some relation to oil, and regulated pricing accounted for ~30 percent (the balance, below 5 percent, is priced in others ways).⁵ And the big change is from regulated to gas-on-gas pricing (not away from oil indexation). In Asia, long-term LNG prices still track oil very closely.⁶ Nor is there evidence that prices in different parts of the world move together.⁷ As ever, gas pricing remains driven by micro, not macro factors.

¹ Data in this paragraph from BP, Statistical Review of World Energy, June 2019,

<https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html>.

² International Energy Agency (IEA), Gas 2019: Analysis and forecasts to 2024, <https://www.iea.org/gas2019/>.

³ International Gas Union (IGU), World LNG Report 2019, <https://www.igu.org/publications-page>.

⁴ IGU, World LNG Report 2019, <https://www.igu.org/publications-page>.

⁵ IGU, Wholesale Gas Price Survey 2019, <https://www.igu.org/publications-page>.

⁶ Nikos Tsafos, "Oil Still Drives Asian LNG Prices," Center for Strategic and International Studies (CSIS) Blog Post, June 19, 2019, <https://www.csis.org/blogs/energy-headlines-versus-trendlines/oil-still-drives-asian-lng-prices>.

⁷ Nikos Tsafos, "Is Gas Global Yet?," CSIS Commentary, March 23, 2018, <https://www.csis.org/analysis/gas-global-yet>. There is, however, evidence that spot prices in Asia and European hub prices are, at times, highly correlated.

The final major shift is in geography. For two decades, Indonesia was the world's largest LNG supplier, a position it lost to Qatar in 2006. Now Australia has overtaken Qatar, and the United States might soon overtake Australia. Russia will be fourth, driven by the Arctic,⁸ and having started LNG exports only a decade ago. These shifts are unprecedented. A similar transition is clear on the demand side. Japan has been the world's largest LNG importer since the early 1970s; South Korea has been second since the mid-1990s. Now China has overtaken South Korea and it might soon surpass Japan. China accounted for half the growth in LNG demand since 2012—and so China's strategy now has a disproportionate impact on LNG markets.⁹ The geography of both supply and demand are changing dramatically.

My first important takeaway for the Committee is to appreciate the changes in the global gas market and understand how the United States is interacting or accelerating those changes; and to do so without resorting to broad strokes or the caricatures that often dominate the public discourse but to pay due attention to complexity, nuance and circumstance.

Unique Moment in the Business Cycle—Interacting with Geopolitics

Today's LNG market is dominated by two stories.¹⁰ First, due to a surge in supply, there is a surplus of LNG looking for a destination—much of it is landing in Europe, leading to an above-average build-up in stocks. Hub prices in Europe, and prices for spot LNG in Asia have both fallen to their lowest point in a decade. At these price levels, there are serious questions about whether supply might be shut in; whether demand will respond; and whether the gap between long-term, oil-linked prices and spot prices will trigger a demand for contract renegotiations.

The second story is the unprecedented number of proposed LNG supply projects that might reasonably start construction over the next two years. Already, we have seen major projects take a final investment decision (FID) in Western Canada, the United States and Mozambique; and many projects are progressing towards FID. The geography of new supply will be dispersed, and the United States is unlikely to dominate it as much as it did the last wave. Instead, we will see supply growth from United States, Qatar, Russia, East Africa and Southeast Asia. The landscape is as competitive as ever—and several projects, including U.S. projects, are unlikely to make it to the finish line any time soon.

In this environment, we can expect to see companies tinkering with the business model in order to succeed.¹¹ We might see states step in and offer explicit or implicit support to their own projects. We might see countries that have stood on the sidelines, like Qatar, step in with big plans to recapture market share. We might also see a clearer interlinkage between LNG and broader geopolitical issues—like trade and sanctions, although how these will affect project

⁸ Nikos Tsafos, "Is Russia Winning the Race to Develop Arctic Energy?," CSIS commentary, March 22, 2019, <https://www.csis.org/analysis/russia-winning-race-develop-arctic-energy>.

⁹ Nikos Tsafos, "How Is China Securing Its LNG Needs?," CSIS commentary, January 9, 2019, <https://www.csis.org/analysis/how-china-securing-its-lng-needs>.

¹⁰ Nikos Tsafos, "Gas Line, Q1 2019," CSIS, April 3, 2019, <https://www.csis.org/analysis/gas-line-q1-2019>; and Nikos Tsafos, "Gas Line Q2, 2019," CSIS, July 1, 2019, <https://www.csis.org/analysis/gas-line-q2-2019>.

¹¹ Nikos Tsafos, "U.S. LNG 2.0 Takes Shape," CSIS Commentary, May 2, 2019, <https://www.csis.org/analysis/us-lng-20-takes-shape>.

development is far from clear.¹² In short, this new wave is not going to be merely driven by who can provide gas at the lowest cost—it will be a far more complex equation.

My second takeaway for the Committee is that despite historically low prices today, companies are betting billions to enable the next wave of LNG supply—and this wave will be far bigger, more diverse, and perhaps more politically complicated than earlier waves. The United States is still competitive in this expansion phase, but it will not dominate it. Instead, we can expect, over time, a market dominated by the United States, Qatar and Australia—with Russia in fourth place.

Renewed Multilateral Focus on Gas

Gas is often compared to oil, and one perennial question is when the global gas market will look more like oil. That conversation usually focuses on gas prices and when they might converge across regions; or when the spot market for LNG will become big enough to allow new projects to be built without having secured long-term contracts. Yet there is one area where gas lags far behind oil, but which gets far less attention: institutions. As gas becomes more global, driven by LNG, we will need to refresh and upgrade those institutions. I want to highlight two areas in particular.¹³

The first is data and information. We have a lot of data on gas and LNG, but it often comes with a time lag, it is dispersed, it resides behind paywalls, and is rendered inaccessible by differences in language, formats, and so on. In oil, everyone reads the monthly Oil Market Report from the IEA—that's a baseline that everyone starts from. Other organizations—the Energy Information Administration (EIA), the Organization of Petroleum Exporting Countries (OPEC)—release their own views as well, which give readers a range of possible assessments. We have specific metrics that we focus on—supply and demand growth, the level of storage in advanced economies, the shape of the forward curve, and so on.

In gas, that advanced information infrastructure mostly exists by private providers, which means it is often unavailable to policymakers and the public at large. Very simple tasks—comparing gas prices in the United States with Japan and the Netherlands—require relative sophistication by the reader to track down the information and convert the raw data to an understandable format. In some areas, the improvements in data have been significant; but often, these give us pieces of the puzzle, and thus we tend to over-focus on those pieces. Let me give one example.

The U.S. Department of Energy (DOE) and the EIA provide excellent information on U.S. LNG exports—we have good data on where U.S. LNG is going, and we have good data on the project pipeline (what project is online, what is under construction, etc.). But if you try to place those data points in context; for instance, if you ask, is more U.S. LNG going to Europe because it is displacing Russian gas right now, that's a difficult question to answer without proprietary data or without going through a very elaborate process of collecting data from open sources. Or, if you ask, these projects from the United States are just starting to export, what other projects in the

¹² Nikos Tsafos, "Will Chinese Tariffs Hurt U.S. LNG?," CSIS commentary, May 14, 2019, <https://www.csis.org/analysis/will-chinese-tariffs-hurt-us-lng>.

¹³ This section draws from Nikos Tsafos, "A Global Gas Strategy for the United States," CSIS commentary, May 9, 2019, <https://www.csis.org/analysis/global-gas-strategy-united-states>.

world are doing the same—again, that’s an answerable question but not something you can answer very quickly without third-party resources.

The second area I want to highlight is governance. The IEA was founded to promote the energy security of its members, and each member has made a commitment to hold stocks equivalent of 90 days of net oil imports. That measure may not be easily translatable to gas, but it is clear that we need to develop a more shared understanding of how to measure energy security. More importantly, we need a shared view on how to assess quantitatively the impact of possible shocks to the system. Let me give one example again.

In the world today, we are confronted with two possible physical shocks to the system: there is some turmoil in the Straits of Hormuz which could, in theory, disrupt LNG exports from the Gulf, as well as LNG inflows into the region; and there is a possible disruption to gas flows through Ukraine if there is no concrete agreement on transit of Russian gas once the existing contract expires on December 31, 2019.

On the former risk—a disruption from Hormuz—if you wanted a quick, publicly available assessment of what it might do to LNG markets, that’s not easy to find. If you look, for instance, at the latest IEA Gas Security Review, the word “Hormuz” does not appear at all.¹⁴ Of course, this is because the publication has a different purpose—to review the system’s ability to manage security dimensions. But it is perhaps something worth doing.

The contrast with Ukraine is noticeable. Here too, we have a lot of speculation about how Europe would be impacted by a disruption. But we have something more in this case. A few years ago, Europe ran some stress tests on different disruption scenarios—including a cut of gas flows through Ukraine.¹⁵ So we have a baseline for discussion, that one can update with more recent information. It is not perfect, but it is an important start.

My third takeaway for the Committee is that the United States will lead the world in LNG supply, and with that new position comes an opportunity to shape the conversation for a shared understanding of energy security, of what information needs to be collected and assessed, and on how energy security might be best pursued in a collective, multilateral framework. Creating this infrastructure is not about copying and pasting what works for oil. It will be different. But this conversation is still nascent, and the United States can help elevate it.

Supporting Gas Overseas

The U.S. government has a clear focus on supporting U.S. LNG exports.¹⁶ So far, this focus has come mostly through advocacy—encouraging countries to look to the United States for their needs. After all, LNG is a private-sector driven business, and this will not change. However, the U.S. government has supported many LNG export projects around the world. The Export-Import Bank of the United States has been involved with projects in Brunei, Malaysia, Trinidad, Qatar,

¹⁴ IEA, Global Gas Security Review 2018, October 2018, <https://webstore.iea.org/global-gas-security-review-2018>.

¹⁵ ENTSG, Security of Supply Simulation, 2017, <https://www.entsog.eu/security-of-supply-simulation>.

¹⁶ This section draws from Nikos Tsafos, “A Global Gas Strategy for the United States,” CSIS commentary, May 9, 2019, <https://www.csis.org/analysis/global-gas-strategy-united-states>.

Oman, Nigeria, Peru, Papua New Guinea and Australia.¹⁷ It is hard to imagine the LNG map looking like it does today without the support of the U.S. government.

But if a country wants to import U.S. LNG, and perhaps build some related infrastructure to regasify that LNG and burn it in a power plant—the U.S. government has a far less developed toolkit to help with that. In part, this is because import projects have not traditionally relied on external finance to begin with—although this is changing.¹⁸ In part this is because gas itself is often less competitive—which explains the lagging market share for gas in Asia outside China and the advanced economies.¹⁹ But this also a matter of emphasis; as I explained in a recent publication:

Ensuring that there are adequate financing or insurance products to meet the need for LNG imports should be a chief priority for the United States, especially allowing for equity participation as well as the financing of projects without major U.S. participation (both of which are allowed under the Better Utilization of Investment Leading to Development Act or the BUILD Act). Another possibility is to insure the sale of U.S. LNG. Earlier in 2019, OPIC provided insurance for a cross-border pipeline and gas sales from Israel to Egypt. The amounts are still small relative to what a long-term LNG contract might entail—but they show the growing ability to tailor products that respond to market needs. Often, when U.S. officials go overseas to promote U.S. LNG, the first question they encounter is: “where is the money?” The United States needs a better answer to that question to what it has offered so far (which is: “there is no money”).²⁰

My final takeaway for the Committee is that gas is often struggling to compete, and prospective importers of U.S. LNG are interested in tools that the U.S. government can bring to help them. The United States has some of these tools already, and it is important to ask how they might be repurposed to support the strategic goal of boosting gas consumption and, thus, also U.S. LNG exports.

¹⁷ See Congressional Research Service, “Export-Import Bank Financing of Liquefied Natural Gas-Related Transactions,” Memorandum to the Senate Energy and Natural Resources Committee, March 23, 2013, https://www.energy.senate.gov/public/index.cfm/files/serve?File_id=5CBE3406-2426-4615-83ED-9E2DDD71DCF2.

¹⁸ For examples: Nikos Tsafos, “A Global Gas Strategy for the United States,” CSIS commentary, May 9, 2019, <https://www.csis.org/analysis/global-gas-strategy-united-states>.

¹⁹ Nikos Tsafos, “The Center of Coal Demand Keeps Shifting,” CSIS commentary, October 15, 2018, <https://www.csis.org/analysis/center-coal-demand-keeps-shifting>; and Nikos Tsafos, “Is Gas Winning? It Depends,” CSIS commentary, June 25, 2018, <https://www.csis.org/analysis/gas-winning-it-depends>.

²⁰ Nikos Tsafos, “A Global Gas Strategy for the United States,” CSIS commentary, May 9, 2019, <https://www.csis.org/analysis/global-gas-strategy-united-states>.

The CHAIRMAN. Thank you, Mr. Tsafos.

Great perspectives here this morning, so we will begin with our questions. As I mentioned, when votes start we will just, kind of, figure it out from there.

I want to start my questioning by focusing on Alaska, because none of you have talked about it. We recognize that when we think about the strength of our natural gas in this country, we have extraordinary resources down there in the Gulf. We talk about how that is poised to move out in a significant way.

Mr. Tsafos, you recognized the good work of the Committee here in moving forward with an expedited process to help facilitate some of these exports.

Alaska is sitting up there. We have not been able to move out on our natural gas pipeline or a way to get our gas to market. But the recognition is that we have an opportunity to be a serious and a substantive contributor in this more global discussion because our market is not in the Lower 48. Our market is Asia.

Dr. Hart, you mentioned that one of the challenges when we think about United States' natural gas, LNG, going over to China is that it is expensive to move it from the Gulf. The time involved is more considerable than bringing it up from Qatar. If you are bringing it down from Alaska, it is seven to nine days, I am told. One of the advertising points that we have coming out of Alaska is we don't have any chokepoints, and we don't have pirates. There is no Strait of Hormuz that we need to worry about. But as Dr. Hart has pointed out, our gas is going to be more expensive, at least right now, given the design of our project, because of the geographic realities that we are dealing with in advancing, whether a gas line or some alternative to move.

So I want to talk about ways that Alaska LNG can be more competitive, and I would ask your views on that, Mr. Tsafos. And more specific, what do you think about the potential Chinese investment in the project?

Then I would like to go to you, Dr. Hart, for your views on this. It doesn't sound like you are necessarily advocating a ban on LNG imports to China, but you are certainly urging great caution. I would like your very specific views on the potential Alaska LNG project because of the agreement that our state signed with China, a Memorandum of Agreement to buy Alaskan gas.

So Mr. Tsafos and then Dr. Hart.

Mr. TSAFOS. Thank you, Senator.

When I think about Alaska I think about two challenges. One is getting the permits, and the second is getting the math to work.

The CHAIRMAN. Right.

Mr. TSAFOS. So—

The CHAIRMAN. We are working on the permit part.

Mr. TSAFOS. I'm very heartened on the permits, and I think there's a tremendous amount of work that has happened on that front.

I think the economics, in reality, are very difficult. In 2012, when the oil companies proposed to the state to jointly develop this project, this was a very different LNG market. The market has changed.

I think there is a, sort of, very narrow, commercial window in which this project can be successful.

I expect to see——

The CHAIRMAN. How narrow do you define?

I won't hold you to it, but I am curious to know how much time you think, given all that is happening globally.

Mr. TSAFOS. I apologize. I don't mean time.

The CHAIRMAN. Okay.

Mr. TSAFOS. The window of time always moves. So, that's——

The CHAIRMAN. Fair enough.

Mr. TSAFOS. The window that I'm talking about is the commercial margin. Can you make money delivering this gas to Asia?

And as you know very well, Alaska's challenges are in part the gas has a lot of CO₂ and a very long pipeline and those are the two main things that shadows the competitiveness of the project. So I look forward to see what the new governor, kind of, puts forward in terms of how to structure this project. I think there's a structure that can work.

My view, having worked on the Alaska project in a previous capacity, has been that there's a role for the state to take a leadership position as long as the risk and the reward are appropriately distributed.

Which brings me to my comment on China. The concerns that I've had in the past about a possible Chinese involvement in the project has been that the structures that were discussed put a lot of risk on the state maybe and the Chinese weren't bearing as much of the risk. So I think a successful model has to find a way for everyone to bear their fair share of risk and not for the project to have been made possible by one party taking a disproportionate lot of risk.

The CHAIRMAN. Dr. Hart.

Dr. HART. Thank you very much for the question.

As I understand the Alaska project, there is a preliminary agreement between the State of Alaska and three Chinese state-owned enterprises, that would be Sinopec, China Investment Corp and Bank of China. As I understand the project, the Chinese firms would, in theory, bankroll the pipeline infrastructure in Alaska in exchange for guaranteed access to 75 percent of the gas produced over the lifetime of the project.

I have a few concerns. I'll outline some of my concerns about that.

The first is that these are state-owned enterprises. They answer to the Chinese Communist Party. They answer to China's national interests. Right now, as part of the U.S.-China trade war, we see how the Chinese Communist Party is leveraging American business, American state, American worker dependence on the Chinese economy, on Chinese market access in a bid to bring the U.S. to heel and pressure the U.S. to back off.

Personally, I do not agree with the way that the United States is pursuing its trade interests right now, but it is an opportunity to watch China use the levers that it perceives it has over the United States and it clearly uses those levers strongly. And so, we should be very cautious about allowing a Chinese state-owned en-

terprise to control that degree of decision-making and financial resources in an American project.

Currently, the United States, the U.S. Congress—CFIUS—has allowed Chinese state-owned enterprises to have a minority stake in natural gas projects and oil projects. We have never allowed a state-owned enterprise to have a majority stake in a U.S. natural gas project. So that is something to think about very carefully.

Second, my understanding is that multiple commercial oil and gas firms have walked away from that particular project because of the costs required to bring it online. I would question why is it that a Chinese state-owned company is willing to pursue a project that individual, commercial companies viewed as not commercially feasible? We should have a lot of oversight over—ideally, we would have an open bidding process for all development projects in the United States and those would go to the best commercial bidder. If it wasn't something that was feasible commercially, but it's something that the Chinese Communist Party is willing to invest in, that, to me, speaks of more interest than commercial ones being involved in the deal. And so, that is something that would require a very serious U.S. Congressional oversight, in my opinion, to make sure that we aren't making a deal that would be bad for the United States over the longer-term.

Third—

The CHAIRMAN. I am going to have to ask you to wrap here.

Dr. HART. Sure.

Third, the finances. We would need a lot of oversight over that. We have examples from Sri Lanka and other countries about the risks of being in debt to China for infrastructure projects.

And then fourth, because of those risks I think we cannot have too much oversight for investments of that nature.

The CHAIRMAN. Well, we probably have some differences here in terms of the role that China would play outside of the financing, but I appreciate your views on it and I would like to talk to you a little bit more about it.

Let me turn to Senator Manchin.

Senator MANCHIN. Thank you, Madam Chairman, and thank all of you for being here. Again, I have tremendous concerns about China and Russia and their roles, geopolitical roles. Real quick, just a yes or no, and then I am going to go directly, Ms. Hart, to you, but do you all have the same concerns? Do you have doubt about what Russia and China are trying to do in the geopolitical arena with this energy they have? Do you all believe China is a threat?

Mr. Winberg.

Mr. WINBERG. Certainly Russia is a threat with the Nord Stream Pipeline you mentioned, Nord Stream 2.

Senator MANCHIN. Yes.

How about China?

Mr. WINBERG. I think with respect to China the Trump Administration is addressing a lot of the issues that were just talked about with respect to structural, fundamental structural changes that need to happen between our two countries and how we do business, things like force technology transfer.

I was on the negotiating team over there in November and again in January, and they are very interested in U.S. LNG, but we do need to fix the structural challenges that we have.

Senator MANCHIN. Let me go right into this, if I can then.

Are we, as Americans, allowed to go into Russia and buy their resources, develop their resources and control the flow of their resources back to the U.S.?

Dr. Hart?

Dr. HART. I can't speak to Russia but we are definitely not—

Senator MANCHIN. China, I mean China.

Dr. HART. —allowed to do so in China.

In fact, China's information about their shale gas resources is classified. So our companies are also not even allowed to fully assess what they have in the ground to understand how they might weigh in as a potential exporter over time.

Senator MANCHIN. You would think that in reciprocation, we would reciprocate.

You know, China is coming, and I wonder if you all know about this deal that they want to make with West Virginia, my State. They said they are going to invest \$83 billion over 20 years. You can imagine that type of carrot being swung out there, tremendous for a small state. Our budget is only \$4 billion a year. They are going to invest \$83 billion.

What would be their interest? We cannot find out one iota what the MOU is. I have asked them directly, their energy company, but we cannot get a direct answer about their investments. My gut tells me they want the LNG. They want propane, ethane, and butane, which we do not have CFIUS review on, to take away our building stock, you know, for our manufacturing. And I can't believe that this Administration would allow in any way, shape or form, that type of project to go on.

There is another problem, American Ethane. American Ethane is owned by a Russian oligarch and what they are doing here in America to take out our building stock. I don't know why we haven't stepped up and just absolutely slapped a stop and decess order on this. Do you have any comments on this, Doctor and anybody else?

Dr. HART. Well, on the issue of U.S. access in China, I would like to remind the Committee that President Obama actually signed a shale gas cooperation agreement with China in 2009, and that agreement was intended to give U.S. companies access to China's shale sector. Unfortunately, that access wasn't exactly forthcoming. So there is an agreement on the books and it was not fully honored by the Chinese side. Their geological data is still classified. We do not have anything like reciprocal access in the Chinese market.

And regarding the project with American—with the project in Beaumont, Texas, you know, I actually come from that town so I have a lot of personal and professional concern in the project.

Senator MANCHIN. Is that with American Ethane?

Dr. HART. Yes.

I would very much like to know many more details than have been released publicly. For example, they're counting on the Chinese counterpart to build cracker facilities in China to take the ethane.

Senator MANCHIN. They are not going to build the crackers in Texas or West Virginia to store here, no interest?

Dr. HART. They have no interest to do that, indeed. And I'm not clear that they have even received the permits to build those facilities in China. So even that may not be feasible.

Senator MANCHIN. Mr. Winberg, do you—I am sorry, Mr. Arriola?

Mr. ARRIOLA. Sir, I wanted to address your point on Russia, specifically.

You know, we did sign a contract with Poland. Poland didn't want to solely rely on Russia.

Senator MANCHIN. Correct.

Mr. ARRIOLA. And what we're finding is other countries, like Germany, like Croatia and Greece, are building LNG import terminals because they don't want to just deal with that one country.

So we think having U.S. LNG available to Europe is giving them optionality that's good from a competitive standpoint, but it's also good from an energy independence standpoint for those countries.

Senator MANCHIN. Mr. Tsafos, do you have any input on this whatsoever since you are looking at the market from a little different view?

Mr. TSAFOS. Yeah, I don't see it the same way. I mean, I think if you look at the European energy system, there's a lot of things happening—

Senator MANCHIN. Do you not see the threat from China and Russia, with their intent, especially China?

Mr. TSAFOS. I have a lot of concerns about China, absolutely.

Russia, I have some concerns. I think sometimes we overstate the concerns and I think there's, maybe, easier ways to neutralize those concerns. That's the very brief.

Senator MANCHIN. Mr. Riedl, real quick, anything?

Mr. RIEDL. Sure.

So I think from a standpoint from Russia I think what we're seeing with the projects from Nord Stream 2, as you referenced earlier in your opening remarks, there is, you have to look at, sort of, the broader European market and the decline in gas supply and their fields that they've historically relied on.

And to follow up on what Mr. Arriola was saying, the idea that U.S. LNG provides an alternative or a different outlet for these buyers in Europe really decreases the opportunity for Russia to behave in a manner that they have in the past. So it's, sort of, it creates an accountability issue for Russia to behave accordingly.

Senator MANCHIN. Your concern with China?

Mr. RIEDL. From a Chinese perspective, I think that when we look at what's happening, as Mr. Winberg, or Secretary Winberg, was saying, the issue with China that we continue to, sort of, be aware of is how they want to participate in these projects, right? And their participation in these projects thus far has been purely from a buy side. So as we look at what they're looking to buy, LNG from the United States or other competitors, really the only opportunity that we would look at is how competitive can U.S. gas be into those markets?

Senator MANCHIN. You are not concerned about the security of our nation or basically what their intent is?

Mr. RIEDL. So, I look at that from a——

Senator MANCHIN. Basically dollar and cents?

Mr. RIEDL. For now, we get it from an LNG perspective only which is why we're here to talk about it. I look at it from that standpoint.

Senator MANCHIN. Thank you.

The CHAIRMAN. Senator Lee.

Senator LEE. Thank you, Madam Chair. Thanks to each of you for being here.

Anytime we are having an inquiry, as we are today, into evolving global natural gas markets or the role that the United States might play in those markets, I think, we have to evaluate honestly what domestic laws we might have on our books that might have an impact on global LNG markets.

We have a lot of testimony that we have heard today and, Mr. Riedl, I appreciate that you referenced the fact that, in your testimony, the United States has an abundant supply of natural gas.

Unfortunately, and as MARAD has noted, the United States has no U.S.-flagged, LNG-specialty carriers that are, themselves, compliant with the Jones Act. As a result, there are some severe limitations in how LNG can be transported between U.S. ports. This ends up having a very significant impact, not only on our domestic supply and our domestic markets but also on international markets as well.

Mr. Riedl, is it true that the lack of LNG-specialty carriers has forced some states and U.S. territories to have to import gas from other countries, even in—including Russia, to meet their energy needs, notwithstanding our abundant supply of natural gas?

Mr. RIEDL. That is accurate, Senator.

There is a concern as it relates to the Jones Act that does not allow gas to leave from, say, Cheniere's facility in Sabine Pass and travel to other destinations within the United States.

Senator LEE. In addition, it seems that these requirements are forcing us to consider more expensive solutions. Solutions that in many cases threaten to inhibit our own energy needs domestically. Does this end up affecting the price for consumers?

Mr. RIEDL. Ultimately you look at a region like the Northeast where they are constrained from a pipeline issue of natural gas, yes, that could be an impact on the price of gas there.

Senator LEE. Alright.

Because natural gas is very valuable to us. We have it in great supply. We consume a lot of it. We produce even more of it, and we are slight net exporters of it.

But in order for it to benefit American consumers in the way that it should and for us to be able to develop this resource, we have to be able to get it from Point A to Point B. Sometimes our own domestic laws interfere with our ability to do that.

Given these circumstances, do you think we should reform our 100-plus-year-old cabotage laws, especially the Jones Act, so as to give us more flexibility, the kind of flexibility that we need for LNG transport?

Mr. RIEDL. Absolutely. I think that if you look at scenarios, as you're outlining, of the ability to move gas, especially into areas that are either pipeline-constrained but are heavily reliant on nat-

ural gas, especially for heating or electricity generation, the ability to do so—we've got a facility here in Maryland, just down the street in Cove Point, that I think would be a very logical opportunity to move LNG that is coming out of the Marcellus in that large play, move gas from the Marcellus into the Northeast where they are pipeline-constrained. And it is an alternative until pipelines and infrastructure are developed in the United States to reach those markets.

Senator LEE. In fact, what would be the argument against doing that? In other words, why, on what planet, in what universe would it make sense for us to keep those laws and to not even amend them so as to allow for a commodity that Americans produce in great abundance and rely on in great abundance to be transported from one U.S. port to another without a Jones Act-compliant ship that doesn't even exist? What could be the plausible public policy justification for keeping such a law and not creating an exception to a law like that?

Mr. RIEDL. That's a great question and one that I think is probably one, as we look at it from trying to answer that question. I don't know but I've got a real good one for you as I think about the opportunity that exists and the cost associated.

The GAO actually took a look at this and the cost of building an LNG carrier in a U.S. shipyard was so cost prohibitive that delivering gas, to your point, it's cheaper to bring it from other countries than our flag vessels. So when you think about that from the point that you were making, a security standpoint, it doesn't make good sense.

Senator LEE. International trade is important in energy and in so many other areas. We believe in international trade. Sometimes it makes sense to import certain things from another country.

One thing, Mr. Riedl, and Madam Chairman and to all my colleagues who are here, that makes no sense is for us to be importing gas from Russia to New England simply because of a 100-plus-year-old law that makes no sense. That law needs to be reformed. I would prefer that it be repealed altogether. At a minimum, it needs to be amended so that we can send natural gas from one U.S. port to another without a U.S.-flagged, Jones Act-compliant ship, capable of transporting such shipments, that today does not exist.

Thank you, Madam Chair.

The CHAIRMAN. Thank you, Senator Lee.

We will turn to Senator Stabenow. I am going to run off and go vote. When Senator Stabenow has concluded, Senator Gardner, you will have an opportunity to ask your questions. But I should be back in a couple minutes.

Senator Stabenow.

Senator STABENOW. Well, thank you, Madam Chair, and thank you for the hearing and to all of our witnesses.

I want to talk about something else that I have concern about, whether or not it makes a lot of sense and this is from the standpoint of the State of Michigan, a great manufacturing state and, specifically, I want to ask a few questions that build on what Senator Manchin talked about in terms of ethane which is a critical feedstock for American manufacturers.

In November 2017, President Trump presided over a series of trade agreements with Chinese companies. One of the biggest was a \$26 billion deal to supply liquid ethane to China, a critical feedstock for American manufacturers that we certainly don't want to go up in price in terms of American jobs.

There is no question that China is interested in access to U.S. ethane and is intent on increasing its ownership stakes in this critical feedstock as a way to bolster its own manufacturing sector and attract new manufacturing investments in their country, of course, being able to do finished products and then sell them back to the United States.

This is a relatively new dynamic. U.S. exports of ethane have increased 37 percent over just the last two years. It strikes me that before we continue this trend, now is the time for us to think hard about how further increasing exports of this critical feedstock for American jobs and manufacturers is done and the significant investments in the United States that have been made by our manufacturers because of affordable access to ethane.

I have three questions I would like to ask Dr. Hart and Mr. Tsafos. I am curious to hear your thoughts on several questions.

First, what is the importance of stable and affordable supplies of ethane to U.S. manufacturers? Second, are countries like China interested in having a firmer grasp on this U.S. feedstock and are they beginning, are we beginning, to see the critical resource to foreign powers that don't always have our best interests in mind? And then lastly, do you believe that this is an area where all of our agencies—Commerce, Energy, Defense, State—should be carefully looking at how we go forward to ensure our manufacturing interests, American manufacturing interests, and jobs are sufficiently considered as exports rise?

Dr. Hart.

Dr. HART. Thank you for the question.

You know, China is developing its petrochemical industry and one trend that we see across the industry is that they are interested to import the feedstock and do the refining, do the manufacturing within the Chinese market. And this fits that pattern.

Now, I'll leave it to my experts on the domestic U.S. energy sector to comment on what that might mean for the United States both from a jobs, from an environment, from a manufacturing industry perspective for us to be playing that role in China's value chain.

But in particular, the deal that is proposed, been proposed so far, based in Beaumont, Texas, where they are building, proposing three export terminals along the Neches River to export ethane to China.

As a China analyst, I'm unable to find many details about that deal myself. And therefore, as an analyst who comes from that area and has an interest in knowing whether it's a good deal for my home town and for the country, I don't have the access to that information to make that assessment.

And therefore, I would ask you, as Members of Congress, to please help American citizens understand what we're giving away, what we're getting and what we're risking, particularly deals that, as this one does, involve not only China but also Russia, two coun-

tries that are not exactly proven to be our best partners in the economic sphere.

Senator STABENOW. Well, I can just say that on behalf of manufacturers I talked to that the idea of us giving up that critical feedstock is something people are very concerned about in terms of American manufacturing jobs.

Mr. Tsafos.

Mr. TSAFOS. Senator, ethane is something I don't follow quite as much that will be, add too much substance, so I'll pass.

Senator STABENOW. Alright, thank you.

One final thing and that is, Dr. Hart, you talked about U.S. LNG exports to China in a parallel to our situation with our soybean farmers. I have a lot of soybean farmers who are deeply, deeply concerned and having tremendous problems and are sacrificing tremendously given what's happening. Could you lay out, sort of, what we are talking about here in terms of our dependence, reliance more on China on those things?

Dr. HART. Thank you for the question.

In the soybean sector, China is a massive source of demand. They have 1.4 billion people, so that demand market is really hard to replicate anywhere else. So for a soybean farmer or a corn farmer, you can have big sales into the China market that you just can't replicate anywhere else in the world.

In LNG, we don't have that situation right now, you know?

Senator STABENOW. Right now.

Dr. HART. Right now.

There's a broad, diverse global market. There are new importers coming online all the time that are using floating terminals to re-gasify LNG and create new sources of demand.

I am particularly concerned about the United States creating a false dependence on China that would risk putting some of our LNG companies, workers and communities in the same situation that our soybean farmers are in today.

I hate seeing what is happening to the families that depend on the Chinese agriculture market. We should think twice before extending that to other industries if we don't have to do so.

Senator STABENOW. Thank you very much.

Senator GARDNER. Thank you, Madam Chairman, for the opportunity to be here with all of you today. We are leaderless right now, so I was not sure who is yielding to us.

But thanks very much to the witnesses for being here today.

Mr. Arriola, I wanted to start with you, if I could, talking about your testimony where you talk about the benefits of a West Coast LNG export facility for Asian markets.

Congress passed last year and the President signed into law on December 31st legislation that Senator Markey and I introduced called the Asia Reassurance Initiative Act that created a U.S.-Asia energy partnership with the goal being to find ways to work with countries across Asia to export U.S. energy products and LNG, working with people in Taiwan for renewable energy, working with South Korea on LNG and others.

Obviously, with Colorado being in the Rockies in the West, we have a lot of competition for our natural gas and we have a lot of, sort of, barriers to Midwest markets because there is so much pro-

duction taking place there and pipeline capacity already getting there. So we need a Western outlet. That is what we look for in the Rockies. How do we get our gas out and to the West and to Asian markets?

So by placing this facility that you are talking about and have talked about on the West Coast, that would reduce shipping time by about 40 percent, you said. Would it make U.S. LNG exports more competitive with other exporting countries, it obviously would, that are closer to home, so to speak?

Mr. ARRIOLA. Yeah, it definitely would.

I think, you know, one of the things that does make the Gulf Coast gas not as competitive as it could be in Asia is the travel time. But it's not just the travel time, it's having to go through the Panama Canal, the congestion points, the reliability.

And I think that having some sites on the West Coast, on the Pacific, getting access, not just to Permian gas in Texas but also to Colorado and others, since we do have the infrastructure and the pipeline system to be able to draw the gas together—

Senator GARDNER. Right.

Mr. ARRIOLA. —I think provides a lot of optionality, not just for U.S. producers, but also for Asian buyers.

Senator GARDNER. Did your company consider building a facility in the United States? I noticed you talked about, in your testimony, the facility in Mexico, but what issues did you consider when you were looking at siting in the U.S.?

Mr. ARRIOLA. We, over time, have looked at different opportunities, say, on the West Coast of the United States, but we found that there were other parts of the country and of North America that were much more amenable to getting these projects done.

Senator GARDNER. Is that because of a hostile regulatory environment on the West Coast?

Mr. ARRIOLA. Yes.

Senator GARDNER. See, and I think that is something that is a huge concern, that you have production jobs and economic opportunity you can develop in states like Colorado, Wyoming, Utah that is basically being held up by anti-energy regulations on the West Coast that prevent us from reaching our full potential.

It is not just the full potential of jobs and opportunity in Colorado, but it is the opportunity to provide South Korea, Japan, Taiwan and beyond, with U.S. energy opportunities, affordable, abundant U.S. energy, creating U.S. jobs and wealth that we can't get out of this country because you have states like California or others that don't allow these to be built. That is a significant problem.

Mr. ARRIOLA. Well, what I would tell you is we tend to focus on those parts of the country, like where Senator Cassidy comes from, that welcome these opportunities, that understand the economic impact, the positive economic impact it can have and where these can get permitted and approved in a satisfactory manner.

Senator GARDNER. Thank you.

Obviously, Jordan Cove is a facility in Northwestern United States that I am very interested in and strongly supportive of, because of its potential to help Colorado producers and to help our Asia energy partners have access to U.S. produced energy.

Mr. Riedl, you described a limited window of opportunity because of competition the U.S. faces from other energy producing countries. Could you talk a little bit about the importance of a Jordan Cove and other facilities in that competition?

Mr. RIEDL. Sure, happy to, and I appreciate the question, Senator.

So when we think about a project like Jordan Cove on the West Coast in Coos Bay, that's a project that has had numerous challenges from the regulatory permitting process. And if we look at, sort of, the window of opportunity, you hear testimony today talking about the efforts from other countries that are producing LNG and Mr. Tsafos talking about it. But Qatar making commitments to increase their production by 20 percent. Australia increasing their production. So when we talk about these markets that a project like Jordan Cove, for instance, would be competing against, these projects from other countries, large producing countries of LNG, like Qatar and like Australia, that are already in the process of building and expanding their LNG infrastructure. And so, when we talk about a project like Jordan Cove, they are absolutely competing directly against those projects and will continue to compete against those projects. Any delay that they suffer in the regulatory process will obviously slow their opportunity to market and their opportunity to let them create contracts.

Senator GARDNER. Secretary Winberg, I am out of time but I would like to follow up with you on just personnel issues, coordinating issues with FERC and the work that you do there, making sure that we have the personnel necessary to get the job done and to carry out the analysis and the cooperating status that you have.

Jordan Cove, we mentioned. Do you have a timeline on Jordan Cove or know the rough estimate of when we could be looking at Jordan Cove?

Mr. WINBERG. Yes, according to FERC's schedule which they put out last year, about the middle of October of this year, they'll come out with their EIS, and then their final order will come out in mid-January of next year. And as the Department of Energy has done on the last several authorizations, we will expedite it, move it out. We're prepared and ready to move as quickly as we possibly can.

I would tell you the last couple that we have done, we've done in two weeks. Can't promise you that on Jordan Cove, but we will expedite it and move it through as quickly as we can.

Senator GARDNER. Expedite Jordan Cove, thank you very much. Thank you.

The CHAIRMAN. Thank you, Senator.

Senator Cortez Masto is next.

Senator CORTEZ MASTO. Thank you, Madam Chair. Thank you for this conversation. I really appreciate the opportunity to have this hearing today.

Let me ask you this, since becoming a net exporter of LNG in 2017, have U.S. consumers experienced fluctuations in costs? In other words, are consumers experiencing increases in energy costs as the U.S. grows in the global LNG market? I am curious if we are seeing that or if there are concerns about that, and I am going to open it up to the panel. Let's start here.

Mr. TSAFOS. Senator, U.S. gas prices are about as low and as non-volatile as they've been in recent memory, so 10, 15 years. So, they're—

Senator CORTEZ MASTO. But what about the impact to the consumer? What is the consumer seeing as a result of this? That is my question. Are there fluctuations in costs or the concerns that energy costs are going to increase when it comes to the actual consumer, the ratepayer, at the end of the day?

Mr. TSAFOS. I'm talking about the wholesale price of gas, so Henry Hub, the reference price is quite low, has been quite low in recent years. And that we have not seen any substantial increase as—

Senator CORTEZ MASTO. So, no fluctuations to the consumer? No impact to the consumer is what you are telling me?

Mr. TSAFOS. Not yet at least, yeah.

Senator CORTEZ MASTO. Okay. Anyone else?

Mr. RIEDL. Yeah, and so the Henry Hub price closed yesterday at \$2.46 which is lower than it's been in the last eight months. So, when we look at, sort of, the price of natural gas since we've had LNG exports come online, the cost for consumers has actually gone down.

Senator CORTEZ MASTO. Okay.

Do we have any concerns that as we continue to export and grow that there will be a negative impact to the consumer at some point in time in the future that it would grow?

Mr. RIEDL. So there's two points to make there.

The first is when you look at, sort of, the forecast that EIA puts out on a yearly basis, their Annual Energy Outlook that currently looks out through 2050, they project natural gas to be stable at \$5.00 per MBTU at the Henry Hub price. You will see a slight increase but that will, obviously, be tied to inflation and costs of operation. When you look at that, sort of, the window, you'll see big, sort of, fluctuations in percentages, but small fluctuations in the actual cost of gas.

Senator CORTEZ MASTO. Anybody else?

Mr. WINBERG. Yeah.

Senator CORTEZ MASTO. Yes?

Mr. WINBERG. With respect to natural gas, we've had—April 2019 of this year marks the 24th consecutive month that dry natural gas production increased from last year. We had a 12 percent increase this year over last year, and the EIA expects that we will be up at about 111 billion cubic feet per day. Currently, we're at about 91 billion cubic feet per day.

The other piece of this that we don't often talk about is we have not yet climbed the learning curve in this unconventional oil and gas in terms of productivity. And the Department of Energy has a number of projects and efforts underway in our R&D to increase that productivity. I'm quite sure that as we move forward in time we're going to see productivity increases.

Then finally, we also have the issue of stranded gas coming, primarily coming out of the Permian Basin. As we get that infrastructure built out to move that gas out of the Basin into the markets, I believe we're going to see long-term stabilized prices of natural gas.

The only issue that we have with respect to the consumer probably is up in the New England area, because we have a lack of infrastructure to get gas from the Marcellus area—Pennsylvania, Ohio and West Virginia—up into the New York, New England markets.

Senator CORTEZ MASTO. Thank you.

Let me ask Dr. Hart, jumping back to—thank you all for your written testimony.

I noted in your written testimony, your testimony today, you state if Chinese entities import large quantities of LNG from the United States, they will be paying a premium price to do so. That raises questions about the potential political intentions behind those purchases, and you say long-term Chinese investments in U.S. natural gas projects are out of step with the global LNG market and risk undermining U.S. national security. Can you address that for me?

I think we have all had this discussion where concerns about the United States' economic advantage over China and what we see with their Belt and Road Initiative and their massive investments around the world, including some now here in the United States, the impact.

So can you address that a little bit more for me? And if you would, touch on more flexible floating import/export terminals as that plays into this as well as Chinese state-owned enterprises that are actually making investments here in the United States.

Dr. HART. Absolutely, thank you for the questions.

So, because of the transport distance between the U.S. Gulf Coast and China, the shipments of LNG that China receives from the United States are more expensive than about 70 percent of its overall, the rest of its LNG supply chain. That can make sense to do for short, for small shipments from Cheniere Energy to meet times when the Chinese energy market is up and high. It doesn't make sense to do commercially in very large volumes. They would have to give up cheaper gas in exchange for more expensive gas, and a company isn't going to do that just for commercial reasons but they might do so if the Chinese Communist Party is supporting them with cash to do that for political reasons. So that would be a non-commercial decision that we should, we would, I would appreciate Congressional oversight over to make sure that there are not political considerations in that deal that are bad for U.S. national security.

The same thing applies when China is coming in to make investments in the United States. There's the proposed investment in Alaska. There's a proposed long-term investment in West Virginia. There's a proposed investment in Beaumont, Texas. And one angle that we should look at with those investments is, do the long-term investments actually make sense in today's market? The market is moving toward more short-term contracts instead of long-term ones. Short-term trading currently accounts for about one-third of natural gas trading, and it's particularly prevalent in Asia and particularly in China. So if the market is moving toward short-term anyways, is it a good choice for the United States to lock in long-term gas purchase agreements to make us dependent on our biggest economic competitor?

Senator CORTEZ MASTO. Thank you, I appreciate that.

The CHAIRMAN. Senator Cassidy.

Senator CASSIDY. Thank you.

First, Mr. Arriola, great event with President Trump down in Cameron Parish.

Mr. ARRIOLA. Thank you.

Senator CASSIDY. And Senator Gardner was speaking about the jobs and those three folks that spoke, the one with breast cancer, I think, the woman who had been unemployed, her husband was unemployed and went back to work and the third felt equally compelling and how the job opportunity at that LNG terminal changed their lives.

The Scripture says the sins of our parents can go down through generations. I say in this case the virtue of a great job with great opportunity and better opportunity for the children pays benefits throughout generations too. I just wanted to, kind of, stress that part of what both of you were referring to and what Senator Gardner was alluding to.

Perhaps related to that, Mr. Arriola, what would be, if you were able to send, or Dr. Hart, if you were able to send gas from Alaska or from the West Coast to Asia, what would be the price differential relative to coming out of the Gulf Coast? Any sense of that? Mr. Tsafos.

Mr. TSAFOS. If I can give a slightly different answer, Senator.

When you look at west from Canada coming from, sort of, north of British Columbia, because it's slightly cheaper gas but they have more infrastructure and they have to build a new facility, those things, sort of, offset the shorter transportation costs. So it's not a straightforward answer.

Senator CASSIDY. Well, it is green fields, but sooner or later you make the investment, right? And after you make the investment you then, basically, have the cost of production.

Mr. TSAFOS. So, operating costs would be lower because the—

Senator CASSIDY. And transportation costs.

Any sense of how much? If 70 percent of the gas the Chinese are buying is cheaper than that which is from the U.S. because of transportation from Australia?

Mr. TSAFOS. You would probably save about \$1.00 to \$1.50 in terms of the price, of cost, of shipping cost, if you didn't have to go through, sort of, Panama Canal and that long route.

Senator CASSIDY. And that is quite significant on something of that magnitude?

Yes, ma'am.

Dr. HART. If I can respond as well.

It is important to note that the cost to develop the gas is higher as well. And so, at the end of the day, based on a pure commercial transaction, you're paying less to ship it but more to pull it out of the ground. And that is why multiple commercial companies have walked away from that particular project.

The Chinese Communist Party appears to be interested. I have questions about why China, the Chinese Communist Party, is interested in a project that non-Chinese commercial companies view as potentially not feasible.

Senator CASSIDY. Well, one thing I have read is that, or have been told, and I know what I am told, not what I know, is the Chinese would be interested in building a terminal off the Panama Canal that they would ship gas to South America through that terminal. So, indeed, they would be purchasing it but they would be cannibalizing a market that presumably U.S. companies already had access to. Knowing that there is gas within South America, I don't know what they are doing in Argentina if that is only oil or if it is also gas, but that could be a purchase that would offset the negative balance of trade we have with them—but on the other hand, it would still, again, not be to our net ability. Do any of you know of such a project or is that just an urban myth that I was told?

Mr. Tsafos.

Mr. TSAFOS. It doesn't sound like something that the Chinese companies would do.

Senator CASSIDY. Okay.

I was told that by a government agency but that is not to say that it is necessarily true. No offense to you, Mr. Winberg.

I am also struck that one of the problems of selling more of our gas overseas with all the economic benefits for us and the environmental advantages for the world, if you are replacing coal as energy feedstock, there is a lack of infrastructure in other countries.

Is there some role for the EXIM Bank to contribute to building the infrastructure that might be used in Pakistan, for example, or someplace else?

Mr. Tsafos.

Mr. TSAFOS. Yes, Senator, very briefly.

Import infrastructure has historically been, sort of, paid for by the countries that do it. In recent years we've seen multilateral institutions, in particular, the International Finance Corporation, the IFC, as part of the World Bank, step in and finance. We've seen the Japanese and the Koreans starting to take a role in this financing the import projects and power plants. So I think there's absolutely a case to be made that the United States should be looking to do the same, and it has not really done so yet.

Senator CASSIDY. It seems to make sense. I do read where Pakistan basically brings up a boat that has both power generation as well as LNG upon it, and it uses that as a platform.

So there are imaginative solutions but still, it does seem as if that would be something that would be very good for our economy. And again, if you are replacing coal as feedstock, very good for the global greenhouse gas emissions.

I am out of time. I will yield.

Thank you.

The CHAIRMAN. Thank you, Senator Cassidy.

Senator King.

Senator KING. Madam Chair, there's an Alice in Wonderland quality to this hearing.

Have you guys ever heard of Australia? Australia's natural gas has a vast capacity. They started exporting in a big way about ten years ago. Their prices doubled for their consumers between 2015 and 2018.

The one law that this Congress cannot repeal is the law of supply and demand. The number of LNG terminal applications now approaches 50 or 60 percent of the total production in this country. And you are telling me it is not going to affect domestic prices, that doesn't pass the straight face test. You cannot argue that a dramatic increase in demand caused by LNG exports is not going to affect domestic prices.

You said it was \$2.50 in Henry Hub the other day. In Australia ten years ago, it was about \$3.00 a million BTUs. Today, it's \$8.00, \$9.00 and \$10.00. And they are talking about looming shortages of natural gas in one of the countries that has one of the great natural gas resources on Earth.

For the Department of Energy to continue issuing these permits which under the law are supposed to take into consideration the public interest without even doing, as I understand it, a recent study of what the elasticity of demand is and what the effect of prices, I think, is utterly irresponsible.

I am not opposed to all exports of natural gas. All I want is some analysis of what the effect would be on domestic prices and not warm, fuzzy assurances, don't worry, we are always going to make more. That has not happened in Australia and I realize there are some differences about West and East Coast, but the bottom line is you cannot tell me we are going to drastically increase the demand for a product and its price to local consumers is not going to increase. And if we get to a place where natural gas prices are internationally set as a commodity like oil, we are sunk.

Natural gas prices in this country right now are one of our major competitive advantages, if not our most major competitive advantage in terms of our industry, in terms of our consumers. To give that away to any country in the world, it just strikes me as totally outside the idea of what is in the public interest. Can you assure me that the Department of Energy is going to take seriously its public interest responsibility in making this kind of analysis?

Mr. WINBERG. Yes, Senator, I can assure you of that and we have.

Senator KING. When was the most recent time you did a study of the implications of exports of natural gas?

Mr. WINBERG. We did a study last year. It was the fifth study that was done. The preceding four studies were done in the previous Administration. All of those studies, all five of those studies, concluded that the overall economic benefit to the United States was a net positive, that the price of natural gas was not going to increase.

When you talk about Australia and you referenced it, to a large degree, that's an infrastructure issue, getting the natural gas from the producing centers to the demand centers.

With respect to—

Senator KING. Where are we now in terms of approved LNG projects vis-à-vis total natural gas production?

Mr. WINBERG. Right now we have, we're exporting about 4 billion cubic feet a day of natural gas. We are producing about 90 billion cubic feet a day. We have total capacity of about 6.5 billion cubic feet a day. So 6.5 out of 90 is, you know, six percent, seven percent.

Senator KING. If you can assure me or will accept an amendment or a law that says we won't go above 6.5 percent or 7 or 8 or I remember hearing where we said 9, I am happy. But that doesn't seem to be the direction we are headed in because the number of LNG terminal applications that are in the queue go way beyond 6.5, right?

Mr. WINBERG. Well, we have approved 33 billion cubic feet right now.

Senator KING. So, you have approved 33 billion feet so we are already five times where the six that you just mentioned.

Mr. WINBERG. Well, most of that has not reached final investment decision. So we have—

Senator KING. Yes, but we have to look beyond next week.

If you have approved 33, total production is 90. So you have now approved LNG exports of 30 percent of the total production in the country.

Mr. WINBERG. But we don't stop at 90. EIA projects that by 2040 we're going to be up at 111 billion cubic feet per day. And as I talked about earlier, we're just climbing the learning curve on unconventional oil and gas production in the United States.

Senator KING. How many million BTU per day are in the queue? You say 33 have been approved. How many are in the queue?

Mr. WINBERG. Right now, we have 14 BCF a day that is either in operation or under construction.

Senator KING. How many applications are pending?

Mr. WINBERG. There are 11 billion cubic feet of applications at FERC.

Senator KING. So, 33, plus 15, plus 11.

Mr. WINBERG. No, I'm sorry, no.

It would be in total right now there are 44 billion cubic feet of in construction that we have approved and FERC. That's a grand total, 44.

Senator KING. I have a hard time accepting that you are going to go to almost 50 percent of production in a new market, and it is going to have no substantial effect on consumer prices.

I hope that we can continue this discussion, but this is of grave concern to me. I think we are making a historic, historic mistake unless we put some control, some limit, based upon science and data, on this trend toward, what appears to me to be, unlimited export of natural gas.

Thank you, Madam Chair.

Mr. WINBERG. Happy to send the report to you.

Senator KING. Thank you.

The CHAIRMAN. Thank you, Senator King.

This is a subject of discussion that we have had here around this Committee, kind of the cumulative impact that we have with additional volumes that are being exported, what does that mean for pricing?

We have heard here that in terms of the pricing, we really haven't seen that bump, that jump and I think it is because, as you have pointed out, Secretary Winberg, our production is increasing.

At some point in time, maybe that production curve starts to go down a little bit, but we are certainly not seeing that at this point in time. It is something that we want. We want a level of vigilance.

We want to understand all the market conditions and forces out there, not only domestically, but what is happening with our global position out there.

But I think one thing that has been just so remarkable about the discussion of natural gas and LNG is we keep producing more, we keep finding more. Our technologies are allowing us to access more.

Senator KING. Which is great. I am just worried about the relative—

The CHAIRMAN. Fair enough. You know, at some point in time things cross, and we want to make sure that we are ahead of that, that we don't allow that to cross.

Senator KING. At some point in time demand starts to put pressure on supply, and prices go up. I remember that from Economics 101.

The CHAIRMAN. As you say, it is basic law of supply and demand and I think part of our role here as a Committee is to maintain a level of vigilance and understanding as to what is actually happening in that vein with the number of exports that have been approved.

As you have indicated, Mr. Winberg, you have some that have come before you but those projects haven't advanced because—Mr. Arriola, how expensive are these? These are not cheap propositions?

Mr. ARRIOLA. These, depending on the size, are \$10 to \$11 billion—

The CHAIRMAN. Yes, so this is not a light investment.

Mr. ARRIOLA. —and no one is going to start construction until they have contracts.

So, you know, although the numbers that Secretary Winberg talked about are a lot, potentially, I don't believe you're going to see that much capacity come onto the market without contracts.

The CHAIRMAN. Yes—

Senator KING. "Trust, but verify" is my motto.

Mr. ARRIOLA. Understand.

The CHAIRMAN. These are fair, these are good conversations to have. But again, I think, some of these economic drivers out there can also be a limiting factor to what you might be able to get the permit, but if you can't get that financing there, then nothing happens.

I want to ask one quick question, and then I will turn to Senator Hoeven, who has joined us.

This is back to you, Secretary Winberg.

Early in the Administration, the Department proposed a rule to increase the volume allowed for de minimis exceptions for the permitting requirements, and this was looking specifically to the opportunities to increase product to Caribbean and Latin American markets there. Has it opened up the opportunities that we were hopeful that it would do? Is this working?

Mr. WINBERG. Thank you, it's a good question.

We have not seen an uptick in small-scale LNG exports yet. We do have one facility, which is American LNG, out of Florida. They've done 278 shipments to Barbados, Bahamas, Haiti and Puerto Rico, and Haiti only, I think, within the last couple of months. So we are seeing shipments.

We have had one additional, potential, small-scale developer that has come to us. They have not made a decision yet.

Senator, I think the issue here is, perhaps, a chicken and an egg issue. And there was discussion earlier about EXIM Bank's role——

The CHAIRMAN. Right.

Mr. WINBERG. ——in developing import facilities and regasification facilities on these, in the small island communities and Central America, and a developer of LNG exports from the United States is not going to develop a facility if they don't have a customer.

And so, I think we've got a bit of chicken and an egg but I do think there is a role for the EXIM Bank and other U.S. entities to assist with that and then, I think, we will start to see more small-scale exports either in smaller ships or ISO containers.

The CHAIRMAN. Well, that was certainly the thought when we advanced that. So, understanding, kind of, where we are with that is appreciated.

Let me turn to Senator Hoeven.

Senator HOEVEN. Thank you, Madam Chairman.

Secretary Winberg, in North Dakota we are producing an incredible amount of natural gas. We don't drill for natural gas. We drill for oil in the Bakken shale and produce huge amounts of natural gas as a byproduct of that drilling.

But the challenge we have is monetizing it, getting it to markets and monetizing it.

How do we get more pipelines? How do we get more capacity, not only to move that natural gas around the country, but also to send it overseas, whether it is to the Pacific Rim or to Europe, which not only is a monetary or economic win for the United States but it is a national security win by supplying energy to our allies rather than having them get their energy from Russia or some other adversary?

Mr. WINBERG. Yes, sir, absolutely agree. It's an imperative.

We have no shortage of entities that want to obstruct natural gas pipelines and for that matter, oil pipelines. And so, we're moving oil by rail, when it's much, much safer to do it by pipe.

How do we expedite that? The President has an Executive Order for us to evaluate in certain parts of the country where we have seen pipeline infrastructure not being built and what can be done about that.

In the short-term, Senator, what the Department of Energy is doing and, in particular, my office, is we're evaluating development of small, modular units that can be placed in a field where there's this stranded gas and it will stay stranded until a pipeline gets built.

The attractiveness of these small, modular units to produce power or maybe even produce other products is that once the pipeline is built and that gas can go for a much higher value use, we can move that facility to another location because, as we build out the unconventional oil and gas, we're going to continue to have this issue until the pipelines, in effect, catch up with the production. And so, we have an opportunity to utilize that stranded gas.

Senator HOEVEN. We have the technology to capture it, it is the pipeline capacity and the LNG facility capacities to both move it around the country and to export it. That is the key.

The irony is here we are in a situation where our country is increasingly infrastructure-constrained and the biggest challenge to developing more infrastructure is the cost to build it, and here the companies will pay the full cost to build that pipeline infrastructure, taking vehicles, rail cars and everything else off, rail tracks, trucks off the road, in addition to all of the other benefits.

How do we get the consensus to get through some of the bottlenecks which, as you know, we are facing throughout the country whether it is in New England or the West Coast or wherever it may be?

Mr. WINBERG. Yeah, I think taking a good, hard look at interstate commerce and thwarting that interstate commerce might be a step in the right direction.

Senator HOEVEN. If you would, update me as to where you are on the fossil energy programs as regard your partnering in carbon capture projects like our Project Tundra and Allam Cycle, because the other thing is if we can't move the product to the market then how do we convert the product, whether it is natural gas or captured carbon, into a product onsite that we can monetize and use?

Mr. WINBERG. Yup.

We've had a long-standing relationship with the University of North Dakota, EERC continues to do great work, Senator.

As we look at the carbon capture, utilization, sequestration, we're cutting across coal, natural gas and even direct air capture. We've been at this for 25 years now. The Department of Energy is developing the technologies and reducing the cost.

The last time you and I met, I told you that the goal we had was to reduce the cost of capture by 50 percent and if we get to that point then there are opportunities for utilizing that CO₂ for enhanced oil recovery, enhanced natural gas recovery, perhaps even down the road, product development or product manufacturing. So across the slate of capture technologies, we're working very hard. In many cases, we're working with EERC on those.

Senator HOEVEN. Well, this is incredibly important right now and it really is the solution to the concern about capturing carbon example, as you said at one of our facilities, the Great Plains Syn-fuel Plant, as you know, we are capturing the carbon and using it for downhole, tertiary oil recovery.

But what the latest project they have engaged in is they now take a lot of that carbon they capture and they are making anhydrous ammonia and urea, making fertilizer which we can then use throughout the Midwest, okay. So there is another case of actually converting it to a different product that we can use more in the immediate vicinity to get rid of some of these transportation barriers we were talking about earlier. These are the solutions.

I mean, there is technological viability or technical viability and there is economic viability, commercial viability. That is where we have to crack the code. Just like we cracked the code with the shale play and look what has happened with oil. We need to crack this code. We need you to do it.

I would ask if you would be willing to come back out to North Dakota this summer and meet with some of our players again working on this. Would that be something you would consider doing?

Mr. WINBERG. Absolutely.

Senator HOEVEN. Alright, thank you very much.

The CHAIRMAN. Thank you, Senator Hoeven.

I was reading press clips last night and this morning and obviously there is a great deal of attention in the Persian Gulf. It seems like there always is, but now even more so. Yesterday, at least three armed Iranian boats reportedly tried to seize a British oil tanker in the Persian Gulf. They were unsuccessful. The tanker was crossing into the Strait of Hormuz when the Iranians ordered the ship to change course.

That is oil. But natural gas would also be out in these same areas and yet, the word Hormuz, the Strait of Hormuz, does not appear in the latest IEA Gas Security Review, which is, how can you not? How can you not include that as part of a security, a natural gas security review?

I guess the question, I will go to both ends of the table here, to Mr. Tsafos and Mr. Winberg, why not? Are we not discussing this? I am assuming that DOE has examined the potential impacts of a Hormuz incident on LNG flows and what that might mean to us. So if we can have a discussion here.

They have not called the second vote yet, so it just started, but that means I have a little bit of time.

This is the geopolitical reality. I mentioned earlier when I was asking about the Alaska situation, one of the benefits that we have is we don't have to go through the Panama Canal. We don't have the choke points. We don't have the pirates. We are not the Strait of Hormuz. But that factors into the discussion about availability of supply. Right now, we know what we know, geopolitically, but next week, it could all go to hell in a handbasket. So how do we factor this in as we are talking about LNG and the future of LNG exports from this country and more globally?

Mr. Tsafos, if you want to go first and then Secretary Winberg.

Mr. TSAFOS. Thank you, Senator.

I think what you highlight is incredibly important. And the way I think about it is, in this country, in particular, oil security, at least since 1973, people have been talking about it, thinking about it, writing about it, convening. And we just have not had the same exposure and experience with gas internationally and with LNG. So I think it's a matter of just the market advancing a little bit faster than our institutions.

The report that you referenced from the International Energy Agency, you know, to be fair to them, it's a review of gas security of what has happened.

The CHAIRMAN. Right, the past tense.

Mr. TSAFOS. But I think one of the examples that I wrote in my testimony is the European Union does the stress test. We may have, possibly on January 1st, a disruption of gas flows to Ukraine, and we have an idea of what that would do to different markets because there's an organization that runs stress tests to try to un-

derstand how different countries could cope with these kind of disruptions.

I think there's a role to play both on the United States side, but also multilaterally with the International Energy Agency, to develop more tools, more information to try to understand, for instance, if you did have a disruption in the Strait of Hormuz, who would be most exposed, what is the capacity of the citizen to respond, how would it respond, what kind of policy mechanisms might be required to make the response better?

These conversations are just far, far behind and I think it's time to elevate those. And I think that's one area where U.S. leadership with other countries of the IEA could play a very important role.

The CHAIRMAN. I appreciate that.

Secretary?

Mr. WINBERG. Clearly, the Strait of Hormuz is a very significant issue. It's primarily an oil issue more than it is a natural gas issue.

But I think it's also worthy of note that despite these attacks, well, if we had had these attacks ten years ago, I think you would have seen a massive spike in the price of oil. And we're not seeing that so much and that's because we have more distributed production coming out of the United States.

With respect, specifically to U.S. LNG, I said earlier, we're moving a lot of that into the European market so the Straits are not an impediment. There's talk about the constraints in the Panama Canal. Those are congestion constraints, not geopolitical constraints. But we have a wider variety of outlets and routes that we can move the LNG, whether it's through the Panama Canal or whether it's through the, around the Cape of Good Hope or straight over to Europe. So it's not so much affecting LNG. Again, that's not to say it's not critical and it's not important, but it is more of an oil issue than it is a natural gas issue at this point.

The CHAIRMAN. At this point.

Mr. WINBERG. Right.

The CHAIRMAN. I think that is important to recognize.

And I appreciate what you said, Mr. Tsafos, about the IEA report being, kind of, a look back instead of projecting forward. But I think this is something that we need to be thinking about, not just for the perspective of how do we move our gas, but how do others move their gas to supply those markets, whether it is Qatar to China or wherever. And if that is disruptive, what that then does to the broader mix.

Mr. Arriola.

Mr. ARRIOLA. Yes, Senator, what I would tell you is we're dealing with very sophisticated customers out there, that they don't just look at price. Price is obviously a very important driver, but they're looking at availability, the reliability of where it's coming from, the operator, the financial strength, you know, congestion points.

In the LNG market today, unlike the oil market, I think at the end of 2018 we only had, we had less than 600 tankers out there. In the oil market, there are thousands—

The CHAIRMAN. Yes.

Mr. ARRIOLA. —of different sizes.

So that's why you have more liquidity in the market as well, but I think that what we're finding is customers, especially in Asia and

in Europe, are becoming much more sophisticated and concerned from a risk management standpoint of all of those factors. We think that security of the supply is extremely important.

The CHAIRMAN. I mentioned that the IEA report is a look back. I am going to ask you to do a little gazing into the crystal ball here because we have heard some say that global LNG infrastructure could actually become stranded assets as we see the mix of the energy mix change in the years going forward. Is this a concern that you all think about? When you are talking about a regasification facility, export facilities, these are substantial investments.

And we have a case in point here in this country where about ten years or so ago we were talking about we need to build more import LNG terminals. We have turned that around and gone the other way with exports. So we know how things can change.

Is that something that you are worried about right now or is it just too far out on the horizon or are you just thinking about other things?

Dr. Hart.

Dr. HART. If I could comment from a China angle.

China is planning for renewable, non-fossil energy to account for 20 percent of their energy mix by 2030 and over 50 percent of their energy mix by 2050. So we should definitely take that long-term goal into account before getting too excited about what role LNG could play in their energy mix.

The CHAIRMAN. Mr. Arriola.

Mr. ARRIOLA. Yeah, I would tell you as a developer of export terminals, we look at diversity of supplier and/or diversity of customers very importantly.

At our Cameron LNG facility, for example, we've got three major customers that each take a third and they're diversified geographically and the customers that they serve because we want diversity.

And as we think about what we're doing in the other facilities in Louisiana, Texas or from Mexico, we want to make sure that we have multiple potential customers and maybe even potential equity investors so that you can reduce that risk of somebody walking away and you have an empty plant.

The CHAIRMAN. Mr. Tsafos or—go ahead, either one of you. Go ahead.

Mr. TSAFOS. Senator, I worry about this a little bit, in part, because I've done a lot of forecast in my life so I know how wrong they tend to be. Having said that, I think there's two reasons why other people don't worry as much as I do. One is if you look at most long-term scenarios, even in the transition of the energy system toward, sort of, a Paris "plus or minus" world, gas does well. That's, sort of, the base. The second thing that I think is even less understood is the system is, sort of, shifting from relying on power generation as a source of growth to relying on industry and buildings. Power generation is the area where gas has a lot of competition with renewables, the competition into buildings and then the industrial sector is less severe.

I think there are a lot of people that are comforted by the fact that they're not just relying on power generation that is very competitive for gas demand growth, but they have a broader, sort of,

customer base and that therefore, even in a transition of the energy system, those areas of consumption will remain.

So I think those are the things that people respond to me—to make me worry less, but I still worry about, you know, whenever you make 25-year bets, some people are bound to be wrong.

The CHAIRMAN. Mr. Riedl.

Mr. RIEDL. The only thing that I would add there, I think that those are fantastic points. The one thing that I would think is important also to talk about, and Dr. Hart actually touched on it earlier, is the development of technology on the import side, especially as Senator Cassidy was making suggestions about the EXIM Bank and their involvement.

The ability to invest in an asset that will no longer be an onshore asset, no longer stranded, so to speak, and especially in emerging markets where maybe creditworthiness might be a challenge for those countries that are looking to transition to natural gas. Having that ability to move a regasification that's floating rather than an onshore facility gives that sort of optionality that if we run into some sort of change, whether it be from a financial standpoint or technology standpoint that allows a different adoption of a different fuel. Now all of sudden we have the ability to move that asset to someplace else. So I would suggest that as technology on the import side continues to develop, it reduces that risk that you were asking about.

The CHAIRMAN. All very important points, I appreciate that.

This has been a great conversation. I am just thinking, some years back I tasked my energy team to help us put some focus on what we called our Energy 2020. It sounded so far away, and now we are working on 2030. But at that time, you know, it was just, it was really, kind of, a vision that we might be able to get to a point where, from an LNG perspective, we were actually a player, and we have gone from just dreaming about being a player to being the player in many ways.

And so, it is a reminder to us that the technologies have allowed us to do so much, but it is also a reminder, and you mentioned this Dr. Hart, to not assume that the markets that we are banking on today are still going to be those great customers for us ten years from now, because they may do just exactly what we did in this past decade in terms of our ability to ramp up.

And so, I think we recognize that a fair amount of this is a dynamic environment. I don't recall which one of you used the terminology as an "evolutionary rather than a revolutionary," but sometimes that evolution happens quicker than any of us could have imagined or dreamed.

Staying on top of things is critically important to us but also recognizing the role that we can play from a geopolitical perspective, our strategic role. Again, that is why we have rolled out this first of a series of white papers in terms of our global, strategic energy competition because we are at that place where we really can be engaged in that global competition. And how we assert that leadership is going to be an important part of the mix moving forward.

So thank you for the conversation. It has been very helpful to what we have been talking about here as members of this Committee, but I think you have challenged us to think a little more

broadly about the opportunities but also to be cautious about some of the hurdles or the pitfalls that may lie ahead.

Dr. Hart, you raise a fair and legitimate concern about when somebody is willing to pay a premium price, they are usually looking for something in return. I think that you certainly heard from Senator Manchin an air of caution there. Alaskans are clearly eyes wide open as they have looked to how they can move their natural gas.

We certainly don't want the Chinese to have control and that was made very, very clear, but again, you go into these agreements making no assumptions that it is going to be an easy road when you have partners that may have some different interests than you.

I am told that we are closing out the vote, so I am going to go do my duty there, but I thank you for joining us here today.

With that, we stand adjourned.

[Whereupon, at 11:57 a.m. the hearing was adjourned.]

APPENDIX MATERIAL SUBMITTED

U.S. Senate Committee on Energy and Natural Resources
An Examination of Evolving Global Natural Gas Markets, the Increasingly Important Role of U.S.
Liquefied Natural Gas, and the Competitive Outlook
Questions for the Record Submitted to the Honorable Steven E. Winberg
July 11, 2019

QUESTIONS FROM RANKING MEMBER JOE MANCHIN III

- Q1. When the U.S. started exporting greater amounts of LNG, there was concern that this would impact domestic gas prices, which could negatively affect American households and manufacturing. According to the International Energy Agency (IEA), almost half of the natural gas consumption increase globally through 2024 will be driven by the industrial sector – both for processes and feedstock. How does the Department of Energy’s public interest determination protect American consumers from price spikes?
- A1. Many studies commissioned by DOE have shown that scenarios with increased U.S. LNG exports will have a marginal impact on U.S. natural gas prices. The most recent study commissioned by DOE was completed by NERA Economic Consulting last year. The 2018 LNG Export Study (2018 Study) examined the probability and macroeconomic impact of various U.S. LNG export scenarios and includes baseline scenarios based on the U.S. Energy Information Administration’s (EIA) Annual Energy Outlook 2017. The 2018 study judged the more likely range of liquefied natural gas (LNG) exports in 2040 to range from 8.7 to 30.7 billion cubic feet per day (Bcf/d). This assessment was based on a probabilistic analysis of 54 different scenarios that were constructed for the study. Under reference case supply assumptions, prices are in a narrow range when international LNG demand varies across the scenarios considered.

The 2018 study also shows that any higher levels of natural gas exports are met by increases in domestic natural gas production over diversion from domestic uses which should serve to further insulate the U.S. market from price impacts due to exports.

The vast supplies of natural gas currently being produced in the United States, and the greater production levels expected in the future, support low and stable Henry Hub natural gas prices for the foreseeable future. The Energy Information Administration’s (EIA) most recent Annual Energy Outlook 2019 (AEO), released on January 24, 2019, shows steady increases in the level of dry natural gas production out to 2050, reaching 118 billion cubic feet per day in 2050 in the reference case, when LNG export levels are expected to be at 14.1 Bcf/d and Henry Hub prices at just \$4.87/MMBtu in 2018 constant dollars. In fact, in the period examined in AEO 2019 in the reference case, Henry Hub natural gas prices grow only an average 1.5% annually out to 2050. At

U.S. Senate Committee on Energy and Natural Resources
An Examination of Evolving Global Natural Gas Markets, the Increasingly Important Role of U.S. Liquefied Natural Gas, and the Competitive Outlook
Questions for the Record Submitted to the Honorable Steven E. Winberg
July 11, 2019

\$4.87/MMBtu in 2050 in 2018 constant dollars, the Henry Hub price in 2050 is projected to be less than the price of natural gas at Henry Hub in 2008, \$8.86/MMBtu.

Finally, allowing market-based LNG export levels means the market is self-regulating as higher U.S. natural gas prices will serve to make U.S. LNG exports less competitive in the global market and thus reduce export levels.

- Q2. As I mentioned in my opening statement, I am very concerned about energy being used as a geopolitical weapon. European gas consumption is set to remain close to flat, while their production is set to fall. This seems to present an opportunity for U.S. export contracts that would help some of the European countries pivot away from Russian gas.
- Q2a. Has our export capability thus far helped our European allies and reduced reliance on Russian gas?
- A2a. Even though Russian natural gas exports by pipeline to Europe reached record highs in 2018, there are already downward price pressures due to increased LNG availability, including from the United States. According to the International Energy Agency, in 2018 Russian natural gas exports to Europe were \$8 billion cheaper than they would have been because Russia had to change its natural gas pricing mechanism to compete with LNG, including U.S. LNG.

The International Energy Agency expects that natural gas supply diversification in Europe, including additional LNG supplies from the United States and elsewhere, will cause the market share of Russian natural gas in Europe to decline from its 2018 record high of 37 percent to a range of 33 – 36 percent through 2024.

Individual countries in Europe have benefited as well. For example, Poland, which has traditionally sourced the majority of its natural gas imports from Russia, is already planning to source a significant amount of its natural gas from LNG, particularly from U.S. suppliers, which will allow it to reduce the amount of natural gas it buys from Russia. PGNiG, Poland's state oil and gas company, has signed contracts with U.S. suppliers of LNG for 6.95 million tonnes annually, which is equivalent to approximately 55 percent of Poland's annual natural gas

U.S. Senate Committee on Energy and Natural Resources
An Examination of Evolving Global Natural Gas Markets, the Increasingly Important Role of U.S. Liquefied Natural Gas, and the Competitive Outlook
Questions for the Record Submitted to the Honorable Steven E. Winberg
July 11, 2019

consumption. So far in 2019, Poland has received 5 cargos of U.S. LNG, totaling 16.9 billion cubic feet of natural gas.

Q2b. What is the outlook for U.S. exports to capitalize on future opportunities compared to other exporters?

A2b. One reason U.S. LNG is attractive to importers is that the U.S. has a transparent market, aided by an extensive pipeline system that can transport natural gas nearly anywhere in America -- plus a vibrant spot market for natural gas deliveries.

Another reason that U.S. LNG is an attractive option is that nations know that they can rely on the rule of law and the sanctity of contracts when doing business with the United States. The U.S. LNG contracts are among the most flexible on the global market. Our contracts do not require destination clauses, allowing us to optimize deliveries according to up-to-the-minute market conditions. And while long-term contracts are the backbone of our LNG projects, we have seen a wide variety of successful models for contracts of varying volumes, durations, and financial arrangements, up to and including equity stakes in the projects.

While we see many U.S. LNG contracts indexed to Henry Hub, the benchmark of our vibrant spot market for natural gas, we're seeing a lot of innovation in contracting for LNG in the global market, including a recently announced LNG deal linked to coal prices; which shows how U.S. LNG can support a myriad of contractual arrangements. These contracting mechanisms are buttressed not only by the U.S. rule of law, but also by a transparent market and an expanding export infrastructure.

Q3. As highlighted during the hearing, in 2009 President Obama and Chinese President Hu Jintao launched the U.S.-China Shale Gas Resource Initiative. This Initiative was intended to facilitate the assessment of China's shale gas potential, encourage technical cooperation through jointly conducted studies to support accelerated development of shale gas resources in China, and promote shale gas investment in China through the U.S.-China Oil and Gas Industry Forum, study tours, and workshops focused on shale gas development. Please provide an update on the status of these activities. Did this Initiative achieve the reciprocal relationship with China as intended?

U.S. Senate Committee on Energy and Natural Resources
An Examination of Evolving Global Natural Gas Markets, the Increasingly Important Role of U.S.
Liquefied Natural Gas, and the Competitive Outlook
Questions for the Record Submitted to the Honorable Steven E. Winberg
July 11, 2019

- A3. Since 1998, the U.S. and China have annually convened the US-China Oil & Gas Industry Forum (OGIF), which brings together a couple hundred government and industry participants from both countries to focus on oil and natural gas issues. Shale gas development was a prominent theme of the forums from 2009 – 2016.

From the end of 2010 through 2015, DOE's Office of Oil and Natural Gas organized or participated in U.S. government interagency shale gas technical workshops, meetings, and site visits designed for Chinese government officials and industry executives, that focused on policies and regulations behind the success of the U.S. shale gas revolution to encourage their adaptation to China's shale gas resource development. DOE's Office of Oil and Natural Gas presented China's National Energy Administration with the DOE-funded publication "Meeting China's Shale Gas Goals," a white paper with recommendations for regulatory and market-based reforms needed to attract foreign investment in China's shale gas sector. DOE's Energy Information Administration released its "World Shale Gas Resources: An Initial Assessment of 14 Regions outside the United States" and "Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States," of which China was one of the countries assessed.

In recent years, U.S. and other international oil and gas majors discontinued their shale gas exploration efforts in China due to generally poor drilling results. China's national oil companies continue to dominate China's existing shale gas production.

U.S. Senate Committee on Energy and Natural Resources
July 11, 2019 Hearing: *An Examination of Evolving Global Natural Gas Markets, the Increasingly*
Important Role of U.S. Liquefied Natural Gas, and the Competitive Outlook
Questions for the Record Submitted to Mr. Dennis Arriola

Questions from Ranking Member Joe Manchin III

Questions: As I mentioned in my opening statement, I am very concerned about energy being used as a geopolitical weapon. European gas consumption is set to remain close to flat, while their production is set to fall. This seems to present an opportunity for U.S. export contracts that would help some of the European countries pivot away from Russian gas. Has our export capability thus far helped our European allies and reduced reliance on Russian gas? What is the outlook for U.S. exports to capitalize on future opportunities compared to other exporters?

Answer: As I discussed in my testimony, the U.S. natural gas supply is increasing, which has allowed U.S. businesses like Sempra Energy, to export American LNG. The U.S. produces 22% of global gas supply and by 2024, is expected to be the largest exporter of LNG in the world by 2024 (Qatar is currently the largest). And while U.S. supply is increasing, the need for natural gas in Europe and other countries is increasing and as you note, Senator, European natural gas production is down. Europe is primed to import U.S. LNG as they already have import facilities with plenty of room to increase their import capacity. This represents a tremendous opportunity for the U.S. to export natural gas to Europe and Asia.

Sempra Energy is answering the call for LNG demand worldwide, including in Europe. Our experience thus far has been that our U.S. allies in Europe are looking for an alternative to Russian gas. While the cost of LNG, including transportation, must be competitive with other natural gas providers, we know firsthand that many European LNG buyers are looking for alternatives to diversify their supply basin and geopolitical risks. Because of the growing supply of natural gas in the U.S. and its low cost, American LNG is a welcome alternative to Russian natural gas that is provided through a pipeline that can easily be curtailed. Sempra Energy has signed a 20-year definitive agreement with Polish Oil & Gas (PGNiG) for 2 million mtpa of LNG, approximately 20% of the planned export capacity of our Port Arthur project in Texas. In addition, we have entered into preliminary agreements with major natural gas companies in other countries in Europe and Asia, including Total of France and Mitsui & Co. from Japan. These firms are likely to ultimately re-market American LNG to other European and Asian countries searching for risk diversification.

Furthermore, as you alluded to in your question, these agreements to offtake LNG from Sempra Energy LNG projects and other U.S. LNG export facilities are providing options to Russian gas in supplying LNG to Europe. These countries know that they can rely on the United States as a fair trading partner for reliable, long term energy security. As more U.S. export capacity comes on line and additional import capacity is developed, the U.S.'s reach into global natural gas markets will continue to grow and evolve.

Answers to Questions for the Record from Ranking Member Joe Manchin III
U.S. Senate Committee on Energy and Natural Resources
Hearing on An Examination of Evolving Global Natural Gas Markets, the Increasingly Important
Role of U.S. Liquefied Natural Gas, and the Competitive Outlook
Dr. Melanie Hart
Center for American Progress
July 11, 2019

***Question 1:** Recent projections of demand growth in China have encouraged interest in U.S. exports, as well as interest from other major exporters. In the past several years, how has China's demand profile for natural gas changed? Where do you see new sources of demand in the Chinese market – the power sector, industrial uses, buildings? What other sources of imports have you observed on the horizon that may supply China's increasing demand?*

Beijing is seeking to reduce China's coal consumption to make progress on the nation's environmental protection and greenhouse gas emission-reduction goals. Natural gas is one energy source—along with renewable energy—that China is seeking to bring online in greater quantities to replace coal-fired power. Natural gas accounted for 7 percent of China's energy mix at year-end 2017. Beijing is aiming to increase that to 10 percent by 2020 and 15 percent by 2030.

According to the International Energy Agency, industrial users are China's biggest natural gas consumers (78 bcm in 2017), followed by residential/commercial users (58 bcm) and power generation (50 bcm). The IEA expects industrial use to continue to dominate Chinese demand through 2023. The IEA expects China's industrial gas consumption to reach 127 bcm in 2023. Residential/commercial use and power generation are expected to account for 89 bcm and 84 bcm respectively in 2023.

China's natural gas demand is clearly growing. However, that does not mean China must import more natural gas from the United States. China already imports natural gas from 26 nations via a combination of overland pipelines and seaborne (LNG) tankers. China has a wide array of supply options, and the shipments it receives from the United States are more expensive than 83 percent of its import supply chain.

The United States can only supply seaborne LNG to China. LNG imports account for 60 percent of China's total natural gas imports; the rest comes in via overland pipelines. Australia is China's largest seaborne LNG supplier, accounting for 41 percent of China's total LNG imports in the first quarter of 2019; Southeast Asian nations (18.6 percent) and Qatar (16.9 percent) came in second and third. Tankers from those regions have a cost advantage over tankers from the United States. Shipping LNG from the U.S. Gulf Coast to China, one way, costs approximately twice as much as it does from Qatar and almost three times as much as from Australia. Geographical distance is the problem: When transporting natural gas to Shanghai, tankers from the U.S. Gulf Coast travel 10 days longer than tankers from Qatar and 15 days longer than tankers from Western Australia.

In contrast to the challenges involved in sending U.S. natural gas to China, the United States has a geographical advantage exporting to closer-in demand regions such as Canada and Mexico—and that is where the bulk of U.S. exports currently go.

Answers to Questions for the Record from Ranking Member Joe Manchin III
U.S. Senate Committee on Energy and Natural Resources
Hearing on An Examination of Evolving Global Natural Gas Markets, the Increasingly Important
Role of U.S. Liquefied Natural Gas, and the Competitive Outlook
Dr. Melanie Hart
Center for American Progress
July 11, 2019

***Question 2:** The hearing outlined a stark difference between U.S. and Chinese economic policy-making and outlook. On the one hand, the flexibility of the U.S. market approach is reshaping formerly regional LNG markets into a global market that utilizes shorter-term or spot contracts to the benefit of exporters. On the other hand, China has shown in many economic sectors a willingness to invest heavily for long-term market strength even when short-term risks are apparent. In the context of the LNG market, can you provide your sense of the major differences between President Xi's economic and geopolitical outlook and that of the U.S. market actors? What are the long-term implications of those differences for the U.S.?*

The Chinese government controls many aspects of the nation's energy markets. In the natural gas sector, that is currently more a hindrance than a help. Some estimates suggest China may have the largest shale gas reserves in the world, but they remain largely un-tapped, partly due to problems stemming from state controls over natural gas development, pricing, transport, and sales.

China has made substantial progress reducing state controls and allowing market forces more play on the demand side, and those reforms are a driving factor behind China's surging natural gas demand. The supply side has been more difficult. Beijing is taking steps to gradually relax state-owned enterprise control over domestic production, but progress is slow. In the United States, private sector competition played a key role in driving some of the technology and process innovations that unlocked shale gas development. For that to happen in China, Beijing will have to break down an array of market barriers that currently stifle competition in the nation's upstream sectors. For example, state-owned companies control the best oil and gas plays and, in some cases, sit on them without either developing them or allowing other companies to do so. China's geological data is classified, so private companies and investors have no idea how much natural gas the country has or where it is located. Plus, state-owned companies control the pipelines and often either deny pipeline access to private companies or charge exorbitant rates, thus making it hard to bring those extra supplies to market. That is why China is importing natural gas: imports fill a gap between successful demand-side reform and sluggish supply-side reform.

The United States should be aware that if Beijing rolls out major supply-side reforms that open up its upstream sectors, China could shift from a major natural gas importer to a major exporter. As of 2017, China is already the third-largest global shale gas producer behind the United States and Canada. Natural gas exporters should take China's production potential into account—and Beijing's growing determination to unlock that potential—when making investments that hinge on a continued rise in Chinese import demand.

Answers to Questions for the Record from Ranking Member Joe Manchin III
U.S. Senate Committee on Energy and Natural Resources
Hearing on An Examination of Evolving Global Natural Gas Markets, the Increasingly Important
Role of U.S. Liquefied Natural Gas, and the Competitive Outlook
Dr. Melanie Hart
Center for American Progress
July 11, 2019

Question 3: *Although natural gas is a key fuel for industrial processes, it is also a key part of the refining processes for petrochemical products. The United States has long been a world leader in the petrochemical industry, including my home state of West Virginia, and the potential interest of China in developing new feedstock sources signals a move to compete in that arena. Can you provide us an overview of China's current uses of natural gas as well as its interest in increasing its own refining capacity, if any?*

China's domestic refining capacity is expanding rapidly, but crude oil is the predominant input rather than natural gas. China's vertically integrated national oil companies dominate the refining sector, accounting for around 70 percent of the nation's oil processing capacity. Independent (teapot) refiners are at a disadvantage, as they need special permission to input crude oil and other feedstocks.

China's refining sector faces multiple challenges including overcapacity (utilization rates are around 78% for the national oil companies and 58% for the independents, compared to 90% in the United States), narrow and declining profit margins, and access to crude oil and other inputs.

China has faced severe natural gas shortages in the recent past, particularly during the winter when heating demand needs are high. China is also dealing with natural gas pipeline bottlenecks that make it difficult to move natural gas resources to localities facing supply shortages. These factors will constrain China's ability to utilize natural gas as a refining feedstock in the near term.

Question 4: *As I mentioned in my opening statement, I am very concerned about energy being used as a geopolitical weapon. European gas consumption is set to remain close to flat, while their production is set to fall. This seems to present an opportunity for U.S. export contracts that would help some of the European countries pivot away from Russian gas. Has our export capability thus far helped our European allies and reduced reliance on Russian gas? What is the outlook for U.S. exports to capitalize on future opportunities compared to other exporters?*

My research has not adequately examined European energy needs to sufficiently respond to this question.

U.S. Senate Committee on Energy and Natural Resources
 July 11, 2019 Hearing: *An Examination of Evolving Global Natural Gas Markets, the Increasingly
 Important Role of U.S. Liquefied Natural Gas, and the Competitive Outlook*
 Questions for the Record Submitted to Mr. Charlie Riedl

Questions from Ranking Member Joe Manchin III

Question: As I mentioned in my opening statement, I am very concerned about energy being used as a geopolitical weapon. European gas consumption is set to remain close to flat, while their production is set to fall. This seems to present an opportunity for U.S. export contracts that would help some of the European countries pivot away from Russian gas. Has our export capability thus far helped our European allies and reduced reliance on Russian gas? What is the outlook for U.S. exports to capitalize on future opportunities compared to other exporters?

Answer: *Increasing U.S. natural gas exports has, and will continue to, introduce an alternative and reliable source of energy to the global marketplace, providing international customers with greater choice and helping to curb the use of energy as a political weapon. This is especially true in Europe. Europe is currently importing around 70% of the gas it needs, and that share is expected to increase in the coming years. LNG is an important part of the EU's energy diversification strategy; and as the second-largest single gas market in the world after the United States, Europe will need to continue to expand its importing options. While Europe will continue to rely on Russia for much of its gas, U.S. LNG has already forced Russia toward a more market-oriented approach, and it has adjusted its long-term oil-linked contracts to European customers for a hybrid formula that is more competitive. The more competitive the gas that Europe can access, the greater Europe's energy security will become.*

Further, Europe is a large market and there is plenty of demand for natural gas from various sources throughout Europe. U.S. LNG can continue to be an energy source now and into the future. Europe also has robust LNG import infrastructure currently in place that could be better utilized to increase its LNG buying potential. However, even with current infrastructure, the EU has additional LNG import terminals under development to meet growing and expected demand. In fact, since the United States began shipping LNG in 2016, it has sent about 20% (160 cargos) of its LNG exports to countries in Europe and Central Asia.¹ These numbers demonstrate the high value that EU energy officials place on energy diversity and their view of the United States as a stable and reliable supplier of LNG. In fact, the European Commission projects that U.S. LNG exports to the EU could more than double by 2023 compared to 2018 levels.² And the U.S. LNG industry is well-prepared to ensure that U.S. LNG is a readily available and competitive option for growing European demand.

¹ Department of Energy, *LNG Monthly Report*, July 2019.

² European Commission, *EU-U.S. LNG Trade U.S. Liquefied natural gas (LNG) has the potential to help match EU gas needs*, 2019.

U.S. Senate Committee on Energy and Natural Resources
 July 11, 2019 Hearing: *An Examination of Evolving Global Natural Gas Markets, the Increasingly Important Role of U.S. Liquefied Natural Gas, and the Competitive Outlook*
 Questions for the Record Submitted to Mr. Nikos Tsafos

Questions from Ranking Member Joe Manchin III

Questions: As I mentioned in my opening statement, I am very concerned about energy being used as a geopolitical weapon. European gas consumption is set to remain close to flat, while their production is set to fall. This seems to present an opportunity for U.S. export contracts that would help some of the European countries pivot away from Russian gas. Has our export capability thus far helped our European allies and reduced reliance on Russian gas? What is the outlook for U.S. exports to capitalize on future opportunities compared to other exporters?

Answer:

The United States is still a nascent presence in global gas markets—and so the full impacts of U.S. LNG exports have yet to be felt fully. In 2018, U.S. LNG accounted for just 7 percent of global LNG exports,¹ and according to the International Energy Agency, U.S. LNG exports will quadruple from 2018 to 2024, from 2.7 billion cubic feet a day (bcf/d) to almost 11 bcf/d.² U.S. LNG exports already impact global markets; but the effects will be more pronounced in a few years once all projects now under construction have come online.

Europe has not been a major destination for U.S. LNG, which has mostly landed in Asia and the Americas: in 2018, these two regions took in 80 percent of the LNG exported from the United States, while Europe received 14 percent.³ Exports to Europe started to rise in September 2018, largely due to insufficient demand in Asia, relative to the growth in LNG supply, which led to lower gas prices and an LNG push into Europe.⁴ We might therefore expect the 2019 numbers to differ somewhat, but the data from 2018 underscore some important realities.

First, LNG remains a minor part of the European gas system: it made up 13 percent of gas consumption in 2018, far behind indigenous supply and pipeline imports.⁵ Second, most LNG came from Qatar (34 percent), followed by Nigeria (19 percent), Algeria (19 percent) and Russia (10 percent).⁶ The United States was the sixth largest supplier into Europe, with a 5 percent market share (which is not surprising since the United States was just 7 percent of worldwide LNG supply). Third, the reliance on the United States varied: some countries, like Lithuania and Belgium, received no U.S. LNG in 2018; a few received just one cargo (Greece, Malta, and Poland); and some, like the United Kingdom, relied more heavily on U.S. LNG (18 percent of LNG imports).⁷

Even so, U.S. LNG interacts with European gas security through numerous channels. In the late 2000s, the United States impacted European gas by demanding less LNG itself—courtesy of the shale boom that took place in this country. That LNG was free to move to other destinations, including Europe. This influx intersected with several

¹ International Gas Union, World LNG Report 2019, <https://www.igu.org/publications-page>.

² International Energy Agency, Gas 2019: Analysis and forecasts to 2024, <https://www.iea.org/gas2019/>.

³ U.S. Department of Energy, Office of Fossil Energy, LNG Reports, <https://www.energy.gov/fe/listings/lng-reports>.

⁴ U.S. Department of Energy, Energy Information Administration, “U.S. LNG exports to Europe increase amid declining demand and spot LNG prices in Asia,” Today in Energy, July 29, 2019, <https://www.eia.gov/todayinenergy/detail.php?id=40213>.

⁵ Europe includes the European Union (EU), Turkey, Norway, Switzerland, Ukraine and other non-EU countries, mostly in the Balkans.

⁶ International Gas Union, World LNG Report 2019, <https://www.igu.org/publications-page>.

⁷ International Gas Union, World LNG Report 2019, <https://www.igu.org/publications-page>.

U.S. Senate Committee on Energy and Natural Resources
 July 11, 2019 Hearing: *An Examination of Evolving Global Natural Gas Markets, the Increasingly Important Role
 of U.S. Liquefied Natural Gas, and the Competitive Outlook*
 Questions for the Record Submitted to Mr. Nikos Tsafos

other forces in 2008-2009—weaker demand due to the economic crisis, rising supply from new LNG projects, a shift in marketing strategy among some European suppliers, a maturation of reforms that improved access to infrastructure in Europe, an inflection point in liquidity at major Continental hubs—these helped to produce a rapid shift in the competitive landscape in Europe and enhance energy security.

More recently, U.S. LNG has helped reshape the global supply-and-demand balance for LNG—which, in turn, has affected European markets. From 2012 to 2015, most of the newly sanctioned LNG capacity in the world came from the United States; and today, the majority of new LNG into the market is sourced from U.S. projects. This supply has been critical in bringing down prices, in offering countries another source of supply, and in allowing buyers to negotiate better terms with sellers. In short, by impacting the LNG market at large, the United States has impacted every country that relies on LNG for its import needs, including Europe.

In general, however, there is no evidence that LNG is displacing Russian gas in Europe—at least not in aggregate.⁸ In fact, Russia has been the major beneficiary of the decline in European gas production, followed by Norway, which has also boosted exports in recent years. LNG imports into Europe, meanwhile, rose in 2018 but were still below their 2010 peak. Pipeline imports from other sources—Algeria, Libya, Iran and Azerbaijan—are flat when taken together. As a result, Russia's market share jumped from about 23 percent of total supply in 2010 to 36 percent in 2018.

Yet Russia's rising market is taking place in a sharply changed environment.⁹ Price differentials among different countries have narrowed in recent years, while liquidity is rising in many European hubs. There is more infrastructure that connects markets, and that infrastructure is used more efficiently. More countries have access to multiple suppliers, and there is a general improvement across a number of energy security metrics (level of competition, ability to cope with a disruption, etc.). As I have written before "market share is a poor gauge for energy security or the geopolitical side-effects of an energy relationship. Competition and resilience are more important—meaning whether the gas is exchanged on market terms and whether a country has sufficient infrastructure to cope with a disruption in gas supplies."¹⁰

Looking ahead, the United States is expected to experience a second wave of LNG project approvals, which will be different from the first one: "The commercial model is not exactly the same, as companies adjust their pitch to match a rapidly changing market. The customer base is broadening, with European companies in particular

⁸ This is probably true in the case of Lithuania, where LNG imports have reduced net imports from Russia (net because Lithuania has acted as a transit country for Kaliningrad). In other cases, LNG imports have supplemented imports via pipeline—for example, there is no discernible decline (yet) in Poland's imports from Russia, even though LNG imports into Poland have increased.

⁹ For more information, see Agency for the Cooperation of Energy Regulators (ACER) and the Council of European Energy Regulators (CEER), 7th ACER Market Monitoring Report, Volume 2: Gas Wholesale Markets, October 2018, <https://www.acer.europa.eu/en/Electricity/Market%20monitoring/Pages/Current-Edition.aspx>.

¹⁰ Nikos Tsafos, "U.S. LNG into Europe after the Trump-Juncker Agreement," CSIS Critical Questions, August 9, 2018, <https://www.csis.org/analysis/us-lng-europe-after-trump-juncker-agreement>.

U.S. Senate Committee on Energy and Natural Resources
 July 11, 2019 Hearing: *An Examination of Evolving Global Natural Gas Markets, the Increasingly Important Role of U.S. Liquefied Natural Gas, and the Competitive Outlook*
 Questions for the Record Submitted to Mr. Nikos Tsafos

standing out for their interest ... The investment is likely to be concentrated in Texas and Louisiana, although this time around, Canada and Mexico will partake in the boom as well.¹¹

But the United States is also facing a far more competitive landscape for LNG. Projects in Qatar, Russia, Mozambique, Canada and Papua New Guinea—among others—are making rapid progress as well. Some have already reached a final investment decision (FID), the last milestone before starting construction at scale; others are targeting FID in 2019 and 2020. While the United States is well positioned to compete in international markets, it is unlikely to dominate this latest burst of investment activity, which will be far more geographically dispersed.

For Europe, the growth in global LNG supply will offer an additional option for meeting its rising need for imported gas. Europe's gas balance will change over the next decade. A new pipeline from Azerbaijan will bring new gas to Greece, Bulgaria, Italy and other countries in the region. Another pipeline, far less likely, might do the same for the finds in the Eastern Mediterranean.¹² Pipeline imports from North Africa and Norway are unlikely to rise and will possibly decline.¹³ This will largely leave Europe to turn to either Russia, LNG, or both to offset the decline in indigenous production.

In that market environment, it will be tempting to measure European energy security by looking at how much U.S. LNG goes to Europe. However, that would be misguided; as I have written elsewhere:

Whether U.S. LNG goes to Europe is less important than other considerations. For the United States, the key questions are: Is U.S. LNG competitive in the world market? Will companies want to invest here? And will buyers see the United States as an attractive source for gas, rather than a source that is too expensive or too politically prickly? For Europe, the question is: Is there sufficient infrastructure and a well-functioning market where gas can be sourced at the lowest possible cost? That is the conversation to have, not how much U.S. LNG might show up in Europe in one day or the next.¹⁴

The corollary to that observation is the need to move away from using Russia's market share in Europe as a shorthand for European energy security—or, for that matter, for Russian power and influence in Europe.¹⁵ The bottom line is that as long as Europe's internal market works properly—and more needs to be done in that regard—Russia will be unable to exert undue influence, either in markets or geopolitics. That should be the core objective and the yardstick for measuring Europe's energy security—and the context in which U.S. LNG exports should be understood.

¹¹ Nikos Tsafos, "U.S. LNG 2.0 Takes Shape," CSIS Commentary, May 2, 2019, <https://www.csis.org/analysis/us-lng-20-takes-shape>.

¹² Nikos Tsafos, "Can the East Med Pipeline Work?," CSIS Commentary, January 22, 2019, <https://www.csis.org/analysis/can-east-med-pipeline-work>.

¹³ The official forecasts from the Norwegian Petroleum Directorate show that the country's exports have plateaued and will decline in the 2020s. Norwegian Petroleum Directorate, "Expected volumes of sales gas from Norwegian fields (1995-2035)," <https://www.norskepetroleum.no/en/production-and-exports/exports-of-oil-and-gas/>.

¹⁴ Nikos Tsafos, "U.S. LNG into Europe after the Trump-Juncker Agreement," CSIS Critical Questions, August 9, 2018, <https://www.csis.org/analysis/us-lng-europe-after-trump-juncker-agreement>.

¹⁵ See Nikos Tsafos, "Who's Afraid of Russian Gas: Bridging the Transatlantic Divide," CSIS Brief, May 3, 2018, <https://www.csis.org/analysis/whos-afraid-russian-gas-bridging-transatlantic-divide>.

**HEARING ON THE IMPORTANT ROLE OF U.S. LNG IN
EVOLVING GLOBAL MARKETS**

**SENATE COMMITTEE ON ENERGY AND NATURAL
RESOURCES**

JULY 11, 2019

COMMENTS FOR THE RECORD

**PAUL N. CICIO
PRESIDENT
INDUSTRIAL ENERGY CONSUMERS OF AMERICA
1776 K STREET, NW, SUITE 720
WASHINGTON, DC 20006
WWW.IECA-US.ORG**

EXECUTIVE SUMMARY

1. The U.S. Department of Energy (DOE), nor the Federal Energy Regulatory Commission (FERC) has conducted an analysis to determine whether there is sufficient natural gas pipeline capacity to serve the LNG export market at volumes equal to existing approved applications of 55.9 Bcf/d to free trade agreement (FTA) countries and 28.5 Bcf/d to non-free trade agreement (NFTA) countries or the DOE's plan to approve up to 52.8 Bcf/d to NFTA countries and the growing domestic market.
2. The DOE plans to approve LNG export volumes to NFTA countries equal to 71 percent of U.S. demand is NOT in the public interest under the Natural Gas Act.
3. The case for U.S. LNG exports to counter Russia.
4. Implications of excessive LNG export volumes to U.S. manufacturers and other consumers.
5. The U.S. has only 57 years of technically recoverable natural gas and has decreased annually due to accelerated domestic and export demand.
6. FERC says that demand outpaced supply in 2018 and this resulted in storage levels that at times were the lowest in more than a decade.
7. IECA LNG export policy position.

COMMENTS FOR THE RECORD

1. The U.S. Department of Energy (DOE), nor the Federal Energy Regulatory Commission (FERC) has conducted an analysis to determine whether there is sufficient natural gas pipeline capacity to serve the LNG export market at volumes equal to existing approved applications of 55.9 Bcf/d to free trade agreement (FTA) countries and 28.5 Bcf/d to non-free trade agreement (NFTA) countries or the DOE's plan to approve up to 52.8 Bcf/d to NFTA countries and the growing domestic market.

We urge the Senate Committee on Energy and Natural Resources to hold an oversight hearing on this matter. Among other things, inadequate natural gas pipeline capacity jeopardizes national reliability of the electrical grid. Manufacturers already do not have sufficient pipeline capacity in various locations across the U.S. Inadequate pipeline capacity is a deterrent to economic growth and jobs, and prevents manufacturing companies from expanding production. The problem becomes especially acute during high summer or winter demand.

None of the DOE LNG export studies used to justify approval of applications under the NGA public interest provision considered whether there is sufficient cumulative pipeline capacity to simultaneously serve the LNG export market and U.S. consumers. The Committee knows very well that it is getting much harder to build pipelines.

The INGAA Foundation released a report in May 2019 that provides important insight which explicitly details the need for significant new pipeline capacity due to LNG exports and how LNG exports increase price volatility for natural gas and electricity for U.S. consumers.¹

The following information represents INGAA's Balanced Future Scenario.

INGAA: Under the Balanced Future Scenario, natural gas exports from LNG terminals and pipeline exports to Mexico will grow by approximately 15.7 Bcf/d between 2020 and 2040 to a total of nearly 24.5 Bcf/d.

- IECA response: The EIA states that total exports to Mexico and LNG exports are 7.6 Bcf/d in 2018. It is questionable that there is existing pipeline capacity to handle even the minimum growth demand of 15.7 bcf/day by 2020, let alone 24.5 Bcf/d by 2040.

INGAA: Up to 13 Bcf/d of take-away capacity from the Marcellus/Utica and 8 Bcf/d from the Permian Basin will be needed to transport this production to markets in the Gulf Coast, Florida, the Southeast, and New England.

- IECA response: It is questionable that the stated volume of needed carry-out capacity can be accommodated to match the significant build out of LNG export terminals due to

¹ "The Role of Natural Gas in the Transition to a Lower-Carbon Economy," The INGAA Foundation, May 2019.

the rise of opposition to building new pipelines. Several pipelines approved by FERC years ago have not been built because of opposition.

INGAA: LNG export terminal operators/tollers. These entities seek firm access to large low-cost gas production basins to supply gas to an LNG terminal.

- IECA response: Firm access pipeline arrangements lock in pipeline capacity for exporters and reduces available pipeline capacity for domestic consumers.

INGAA: Under the Balanced Future Scenario, eight LNG export terminals will be in operation in the Gulf Coast by 2040, with close to 9.2 Bcf/d of demand for incremental feed gas by 2020 and another 4.1 Bcf/d by 2040. The Atlantic Coast LNG terminals at Cove Point and Elba Island, will add 1.0 Bcf/d of feed gas demand by 2021 and remain flat through 2040. *This incremental gas demand will significantly affect the daily and seasonal utilization of pipelines along the eastern seaboard and the service offerings needed to meet the requirements of these LNG terminals.*

- IECA response: There is inadequate pipeline capacity along the eastern seaboard right now and becomes more severe during peak seasonal winter demand. As IECA has stated to the Committee many times, the large LNG buying countries have winter when we do. This means that exporters will be consuming pipeline capacity and pulling on our limited natural gas storage inventories when U.S. consumers need it most. The DOE LNG export studies did not consider impacts to price due to LNG seasonal demand or pipeline capacity constraints that drive up basis costs for consumers. Because natural gas and electricity are priced on the margin, price impacts will be larger.

INGAA: Higher ambient temperatures will require more feed gas to produce the same amount of LNG. The variation of daily feed gas could approach 12 percent during the peak summer months, which will translate into over 2 Bcf/d of extra feed gas demand on certain days.

- IECA response: First, this means that LNG demand will be higher than what DOE is saying, due to higher temperatures in the Gulf Coast. This also means that LNG exports will cause greater price and demand volatility during the summer months.

INGAA: Additional gas storage or pipeline no-notice services will be needed to help mitigate the types of intra-day swings that already have been observed at existing LNG liquefaction terminals.

- IECA response: Intra-day swings are already being observed even at the existing lower LNG export volumes.

INGAA: The destination markets for the LNG terminals currently under construction are in Asia and Europe. Because of significant seasonal demand variability in both markets, the volume of U.S. LNG exports could vary significantly. High U.S. demand for natural gas during the peak winter months to serve residential and commercial load *could place additional stress on the*

existing natural gas infrastructure, requiring new infrastructure to serve LNG exports for the global market. LNG export terminals have supported numerous dedicated pipeline projects to ensure that capacity will be available year-round.

- IECA response: This is additional confirmation of predicted significant seasonal demand variability, which also means price volatility for both natural gas and electricity. Many export terminals have dedicated lateral pipelines to serve the export facility. Export terminals still rely on the same interstate pipelines that all other consumers rely upon.

INGAA: For a Gulf Coast LNG liquefaction train, the feed gas rate can fluctuate throughout the day and seasonally. LNG liquefaction operators or tollers will need daily balancing services on pipelines and/or use instantaneous, no-notice storage services to mitigate diurnal feed gas rate swings in both directions.

Pipeline imbalance tolerances will allow a shipper to flow typically within +/-2.5 percent of daily variation; however, the daily swings for LNG liquefaction feed gas rates are expected to far exceed those thresholds during summer months. *Even if pipelines allowed a 5 percent nomination tolerance, the average daily variation would exceed that limit seven months of the year.*

- IECA response: Illustrates the disruption and volatility for seven months out of the year.

2. The DOE's plans to approve LNG export volumes to NFTA countries equal to 71 percent of U.S. demand is NOT in the public interest under the Natural Gas Act.

The DOE plans to approve all applications to export LNG to NFTA countries, a volume equal to 52.8 Bcf/d or 71 percent of U.S. demand. In the long-term, doing so threatens the manufacturing renaissance that has created millions of high paying jobs and started the reshoring of manufacturing facilities. The DOE plan to let global the market determine how much is exported - is no plan at all.²

In February 2019, IECA sent a letter to the Senate Energy and Natural Resources Committee requesting an oversight hearing on this matter. To date, no oversight has occurred.³

It is critically important that LNG export volumes are not so large that the U.S. price becomes connected to the global LNG market. This threat is not merely hypothetical, it happened in Australia, despite the fact that Australia has vast resources and growing production. The Australian example shows that using *market determined* levels of LNG exports is not in the

² "Study on Macroeconomic Outcomes of LNG Exports: Response to Comments Received on Study," U.S. Department of Energy, December 28, 2018, <https://www.federalregister.gov/documents/2018/12/28/2018-28238/study-on-macroeconomic-outcomes-of-lng-exports-response-to-comments-received-on-study>

³ IECA letter to Senate Committee on Energy and Natural Resources, February 5, 2019, https://www.ieca-us.com/wp-content/uploads/02.05.19_Letter-to-Hill-for-LNG-Oversight_Senate.pdf

public interest. They are over ten years ahead of the U.S. in exporting LNG. Australia has vast natural gas resources. Historically, the consumer prices have been around \$3.00 MMBtu. Now, because of LNG exports, the Australian consumer pays the *Asian LNG net back price*. This means that the Australian consumer pays the high Asian LNG price, less transportation and liquefaction costs, which has resulted in Australian domestic consumer prices at \$8, \$9, and \$10 MMBtu.

The Australian Competition and Consumer Commission started publishing LNG netback prices in order to boost price transparency.⁴ The Australian consumer net back prices have increased from 7.27 GJ in 2017 to 10.69 GJ YTD 2018, a 47 percent increase. In approving LNG export terminals, the Australian government let markets determine the volume of exports, which has now directly caused disastrous impacts to consumers and the manufacturing sector as jobs continue to decrease.

3. The case for U.S. LNG exports to counter Russia.

The political case has been made that the U.S. should use LNG as a way to counter Russian aggression in the EU. IECA supports such national security objectives. However, the DOE has already approved LNG export volumes capable of supplying the entire LNG import capacity of the EU. That being said, additional LNG export approvals cannot be justified on the basis of national security. Also, since the U.S. started exporting in 2016, China has been one of the largest buyers of U.S. LNG. Shipping U.S. LNG to China is inconsistent with national security arguments.

Congressional efforts to steer U.S. taxpayer monies to support studies and building of LNG import facilities in other countries should be opposed - because these same import facilities would be utilized by other LNG producing countries like Qatar and Russia. Tax payer money is already being used for this purpose under the United States Trade and Development Agency (USTDA). We urge Congress to stop funding such projects.

4. Implications of excessive LNG export volumes to U.S. manufacturers and other consumers.

The DOE LNG export studies have confirmed that LNG exports lower the price of natural gas to countries receiving the LNG, while increasing U.S. prices for both natural gas and electricity long term. This directly impacts competitiveness of the manufacturing sector negatively. If the DOE approves high volumes of LNG exports, U.S. manufacturers will lose their competitive advantage and this puts trillions of dollars of manufacturing assets at risk, a sector with over 12.5 million high paying jobs.

⁴ "Australian watchdog starts LNG netback price publication," October 2018, LNG World News https://www.lngworldnews.com/australian-watchdog-starts-lng-netback-price-publication/?utm_source=email&utm_medium=email&utm_campaign=daily-update-lng-world-news-2018-10-05&uid=55872

According to the U.S. Bureau of Labor Statistics (BLS), the oil and gas industry had only 415.1 thousand jobs in 2018 or 3.3 percent of that of the manufacturing sector. This means that even if oil and gas jobs doubled due to LNG exports, the gain in jobs would pale in comparison to what would be lost in the manufacturing sector.

Given the high concentration of petrochemical jobs in the Gulf coast region that rely on competitive natural gas and electricity costs, this area would be hardest hit by the lost manufacturing jobs. It is in the public interest to limit the volume of LNG exports.

The CFTC report of May 2018 issued warnings. In the Executive Summary it says, "Aside from limited pipeline gas traded with Canada and Mexico, U.S. natural gas has been relatively insulated from international market dynamics. Increasing exports of LNG from the U.S. may mean that the domestic market will be influenced more by global forces." And, under its three conclusions it says, "U.S. LNG export growth may put upward pressure on domestic (US) natural gas prices and expose a heretofore relatively isolated North American market to global market dynamics."⁵

5. The U.S. has 57 years of technically recoverable natural gas and has decreased annually due to accelerated domestic and export demand.

The U.S. has only 57 years of technically recoverable natural gas resources in the lower 48. The EIA's Annual Energy Outlook (AEO) for 2019 states that the U.S. total demand that includes net exports from 2018 to 2050 is 1,277 Tcf. The EIA says there is 2,215 Tcf of technically recoverable resources. The EIA report also says that 85 percent of U.S. natural gas resources in the lower 48 are unproven. Page 2 of the EIA's oil and gas assumptions states that the "Estimates of TRR (technically recoverable resources) are highly uncertain, particularly in emerging plays where relatively few wells have been drilled."

6. The FERC says that demand outpaced supply in 2018 and that resulted in storage levels that at times were the lowest in more than a decade.

The FERC's State of the Markets Report from April 2019 raises consumer concerns, especially considering that LNG exports are low relative to what volumes will occur in the next 2-3 years.

"In 2018, natural gas demand reached a record high, driven primarily by increased demand for natural gas-fired generation and liquefied natural gas (LNG) export growth. Record high demand was accompanied by record high production, with the largest growth from the Marcellus Shale and the Permian Basin. However, demand growth outpaced production growth, resulting in consistently lower-than-average storage levels that at times were the lowest in more than a decade. Low storage contributed to rising natural gas prices across the

⁵ "Liquefied Natural Gas Developments and Market Impacts," CFTC, May 2018, https://www.cftc.gov/sites/default/files/2018-05/CFTC_LNG0518_3.pdf

nation, although pipeline additions helped to broadly distribute growing production and ease tightness in some markets. In the electric markets, day-ahead on-peak prices increased across the country, reflecting the general increase in natural gas prices.”

7. IECA LNG export policy position.

The information above demonstrates the need for joint Congressional, DOE, and FERC action to develop answers to the question of whether there is sufficient pipeline capacity to serve domestic consumers plus exports – and with the very large pending increase in demand. This is a serious issue for national security, electric grid reliability, and the cost and reliability for home owners, farmers, and manufacturers nationwide. Without adequate pipeline capacity, economic growth is negatively impacted.

IECA supports LNG exports to countries with which the U.S. has an FTA. FTAs are countries with which U.S. manufacturers have a level playing field on trade. However, the majority of LNG demand is from NFTA countries. Exporting large amounts of LNG to NFTA countries undermines U.S. manufacturing competitiveness and our leverage to negotiate FTAs. In fact, U.S. manufacturers have already lost relative competitive advantage due to LNG exports.

IECA supports the NGA which requires applications to export LNG to NFTA countries must not be inconsistent with the public interest. The Congressional intent of the NGA is to place the U.S. consumer first and LNG exports second - but that is not how the DOE has interpreted this provision. In fact, the DOE LNG export studies have shown that it is only the natural gas producers and exporters who economically benefit from LNG exports. Everyone else in the economy loses. LNG exports shift significant risks without benefits to consumers.⁶

A fundamental reason why it is important for policymakers to fully intervene is because the global LNG market is not a free market. It does not play by free market rules because all of the LNG buyers are backed by governments. Buyers are state owned enterprises and government regulated utilities, all of which have automatic cost pass-through. This is important because when global LNG markets have more demand than supply, these players will pay any price for natural gas, no matter how high, to keep their countries supplied. They have the ability to literally *buy-away* natural gas from the domestic consumer.

IECA supports a time out on approvals of further LNG export applications to NFTA countries. Let those under construction come online and conduct a study to determine whether there is sufficient natural gas at affordable prices for the next 30 plus years to supply the domestic market and the pipeline capacity to serve the U.S. market and additional LNG exports. If the study indicates that there is not sufficient supply at affordable prices, DOE should not approve additional LNG applications to export.

⁶ “2012 LNG Export Study,” U.S. Department of Energy, <https://www.energy.gov/fe/services/natural-gas-regulation/lng-export-study>

The exception is LNG exports from Alaska. Alaskan natural gas is stranded and does not have access to the lower 48 states. This project should be a priority.

The DOE LNG export studies that are used to justify NGA public interest decisions, should not use proprietary economic models because they are non-transparent and cannot be challenged for accuracy. The DOE admits to using proprietary economic models.

Under no circumstances should U.S. LNG be shipped to countries that subsidize their manufacturing or power sectors.

