WRITTEN TESTIMONY
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Chairman Gosar, Ranking Member Lowenthal, and distinguished Members of the Subcommittee, thank you for the opportunity to appear before you and to present additional perspectives on the matters being discussed today.

My name is David Livingston and I serve as deputy director for climate and advanced energy in the Global Energy Center of the Atlantic Council. The Atlantic Council is a nonpartisan, nonprofit organization headquartered in Washington, D.C. My remarks and written testimony represent my views, and do not necessarily represent the views of my colleagues or institution.

Liquified Natural Gas and U.S. Geopolitics

U.S. natural gas production has been booming for nearly a decade, while recently U.S. liquified natural gas (LNG) exports have been increasing, as well. There are a number of benefits that accrue to the United States from exports of liquefied natural gas and the expansion of domestic natural gas production needed to support them. Increased LNG exports can help to narrow the U.S. current account deficit, expand economic activity and employment in the natural gas extraction, processing, and related industries, and aid broader American foreign policy goals insofar as they contribute to a diverse, sustainable, and affordable energy mix in recipient markets. As such, increased LNG exports would indeed appear to strengthen the U.S. position in global geopolitics.

Three commonly-raised caveats to the aforementioned view are that (1) U.S. economic and energy security interests may be better-served by keeping most, or all, of this gas at home as inputs into domestic activities, (2) local environmental risks could rise alongside increasing U.S. production needed to feed exports, particularly U.S. shale production, and (3) natural gas may not offer climate benefits, either due to high rates of methane leakage associated with its production and processing, or due to it "crowding out" opportunities for lower-carbon sources of energy such as renewables.

I will briefly address each of these caveats.

On the first, that the U.S. economy would be better-served by curbing exports, there is significant *ex-ante* analysis, before U.S. LNG export growth, and additional empirical evidence, now that LNG export growth is underway, that the economic benefits from exporting LNG outweigh the gains to energy-intensive manufacturing that might accrue if exports were to be curbed.[1]

On the second concern, environmental risks, it looks increasingly likely that local environmental risks are real and possible, but are not inevitable and can be avoided through responsible gas production, transport, processing, and utilization. However, this is unlikely to happen on its own in a uniform manner, and thus responsible regulation is both necessary and also serves to reward the most responsible, efficient U.S. operators with a competitive advantage.

On the third concern, interactions with decarbonization, the story is more complicated. Switching from coal to natural gas has been a major driver of recent greenhouse gas (GHG) emissions reductions in the United States. While the pace of coal-to-gas switching can be expected to slow in coming years, it will likely continue to be a positive story for the United States in providing energy not only with lower GHG emissions, but also delivering cleaner air, as well.

However, more can be done to ensure that gas maintains a clear edge over more carbon-intensive resources. The GHG emissions of natural gas, as a general rule of thumb, have traditionally been considered to be 40 percent lower than those of coal and 20 percent lower than those of oil on a per-unit of energy basis. However, as a recent report from the International Energy Agency has pointed out, the climate profile of gas depends upon responsible extraction, transportation, and utilization of the gas so as to avoid methane leakage. Methane is a potent greenhouse gas (GHG), with a short term radiative forcing (global warming) potential that is between 28 - 36 times more powerful than that of carbon dioxide over a 100 year timeframe, and around 85 times more powerful over a 20 year timeframe.

At current estimated average rates of methane leakage of gas production globally (a leakage rate of 1.7 percent of gas produced), the total climate impact of natural gas is still less than that of coal. However, the variance in methane leakage among different individual wells and operators is likely significant, again underscoring the importance of responsible regulations in order to ensure that American gas is some of the cleanest and most competitive in the world.

According to analysis by the International Energy Agency, producers can reduce greenhouse gas emissions by 75 percent simply by improving supply chain practices. About half of that can be

[1] Michael Levi, *A Strategy for U.S. Natural Gas Exports*, The Hamilton Project, Brookings, June 2012.

cut at no net cost - i.e., they pay for themselves over the long term by monetizing the methane that is captured.[2]

Moreover, implementing only net negative cost measures could result in an equivalent long-term climate benefit as would be achieved by immediately shutting all existing coal-fired power plants in China.[3]

The other decarbonization concern associated with natural gas is that it may "crowd-out" lower-carbon forms of energy. So far, this appears not to be the case in most regions. Under proper market design, natural gas can serve as a "force multiplier" for renewables that enhances the value of renewable energy to the grid by balancing out the intermittency of wind and solar.[4] Eventually, natural gas may also find new sources of demand that are consistent with long-term decarbonization trajectories, such as in the transport sector or vis-a-vis a hydrogen-based energy system that draws on existing natural gas infrastructure. Natural gas, then, can be a valuable tool in the transition to a more advanced energy economy in the United States and around the world.

Over time, it is possible that new technological advances and cost reductions will bring to bear lower-carbon options, such as renewables paired with energy storage or demand flexibility services, that compete directly with natural gas in some markets. Lithium ion battery costs were down to $230 per kilowatt-hour in 2016, compared with almost $1,000 per kilowatt-hour in 2010, and McKinsey & Co. projects that prices could reach $200 per kilowatt-hour by 2020 and $160 per kilowatt-hour or less by 2025.[5] Storage is already economical for many commercial customers, and is increasingly being deployed by companies on-site to reduce peak-demand and avoid demand charges.

Already, there are signs of faster-than-expected cost decline trajectories for utility-scale renewables plus storage, with a recent solicitation from Xcel Energy in Colorado resulting in median bids of $36 per megawatt-hour for solar-plus-storage, and $21 per megawatt-hour for wind-plus-storage. These bids are for projects that would be delivered in 2023, and thus represent anticipated, rather than realized, cost reductions.

Nevertheless, over the next ten years energy storage coupled with renewables and demand response may increasingly undercut the economics of coal as well as natural gas peaker plants.

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[2] International Energy Agency, *World Energy Outlook 2017*, 14 November 2017.
[3] Energy Institute, *Golden age of gas dependent on changing DNA of industry, new EI survey reveals*, press release, 19 February 2018, https://www.energyinst.org/media-relations/media-centre/1735
[4] NREL, *Opportunities for Synergy Between Natural Gas and Renewable Energy in the Electric Power and Transportation Sectors*, Technical Report, NREL/TP-6A50-56324, December 2012.
[5] Paolo D'Aprile, John Newman, and Dickon Pinner, *The New Economics of Battery Storage*, McKinsey & Company, August 2016, https://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/the-new-economics-of-energy-storage

This dynamic, however, would only seem to underscore the importance of focusing on the role of exports. LNG exports can be an important outlet for increasing domestic natural gas production as domestic U.S. gas demand growth begins to flatten. Over the next five years, the United States is poised to see a dramatic increase in LNG exports. With most outlooks foreseeing less than 6 billion cubic feet per day (Bcf/d) of demand growth, but nearly 18 Bcf/d of net supply growth, around 12 Bcf/d of new gas exports may be realized over the period. Of this, somewhere around 3 Bcf/d of the export increase is likely to be sent to Mexico via pipeline, while the remainder (8 - 10 Bcf/d) will be exported as LNG.

However, the United States is neither the least-cost LNG exporter, nor the closest to many key demand markets. In order to sustain and grow the global demand necessary to support continued U.S. LNG exports, it should support systemic drivers of global gas demand growth, including an accelerated transition from coal to gas in emerging markets. A number of studies have indicated that the lifecycle greenhouse gas emissions of U.S. LNG are lower than that of Russia, and as highlighted earlier there are ample opportunities to further reduce these lifecycle emissions over time. The United States is better-suited to deliver lower-carbon gas than many of its competitors, given both numerous homegrown technologies and innovations that help reduce emissions, as well as the comparatively more sophisticated environmental policy-making apparatus of the United States. The United States should not neglect these significant advantages.

Notably, the Paris Agreement on climate change may represent one of the most compelling opportunities to create future gas demand growth. A number of countries, including China, specifically identify natural gas as a GHG emissions reduction strategy to meet their Paris commitments, while others, such as India, do not mention natural gas but clearly have a compelling need for additional LNG imports if they are to enjoy an affordable, sustained supply of gas needed to wean the country off of coal. When the unambiguous clean air benefits of natural gas over coal are taken into account, its appeal for countries grappling with harmful smog and air pollution is all the more clear.

Latin America also represents a significant opportunity, and a logical nearby market, for U.S. LNG to contribute to decarbonization goals. LNG aided Brazil to maintain steady energy supplies during its historic drought periods of the mid-2010s, and many countries in the region are planning to expand LNG import capacity as part of their decarbonization strategies.

The United States should embrace, rather than retreat from, the broader trends shaping the global energy market in an increasingly climate-conscious world. Two additional points are worth making here: (1) advanced energy will represent the fastest growing segment of the energy market over coming decades and it is imperative that the United States play a leadership role, and (2) climate change not only shapes the energy market, but is a critical determinant of U.S. national security and likewise demands a leading role by the United States.

Advanced Energy, Innovation, and U.S. Leadership

American hydrocarbon abundance should not obscure the importance of focusing strategy on the largest growth opportunities in the global energy sphere.

Global renewables deployment has gone from less than $20 billion per year a decade ago to now enjoying the eighth consecutive year in which investment has been between $250 billion to $350 billion. The global head of the Blackrock Infrastructure Investment Group recently stated that renewables represent "almost 30 percent of the globally addressable market in infrastructure. This is no longer niche, it's fundamental to any infrastructure allocation."[6] Wood Mackenzie, the energy consultancy, forecasts an annualized growth rate of six percent for wind and eleven percent for solar, compared with half a percent for oil and around two percent for gas, over the next 20 years.[7] Last year, solar power grew by around 50 percent, with China accounting for approximately half of this growth.

Whereas Europe and the U.S. were once dominant players in renewable and advanced energy markets - and indeed, U.S. national labs played a critical role in the birth of modern photovoltaic solar technologies - other actors such as China are now playing a larger and larger role as they recognize not only the energy system and commercial opportunities of advanced energy, but also the geopolitical opportunities to shape markets early on, setting key standards and favoring certain technologies that accrue outsized domestic benefits. This is further magnified by concerns over energy security in countries less-rich in hydrocarbons than the United States.

Indeed, there may be limits to the heretofore exponential rise in China's liquified natural gas imports. In 2017, China became the world's second largest importer of natural gas, after Japan, with an average of five billion cubic feet per day. China also finds itself increasingly dependent on imported oil, which now accounts for around two-thirds of its total oil demand. As Chinese concerns over gas and oil imports continue to grow, this in turn will drive further support for renewables and other advanced energy technologies that can reduce energy import reliance. It was widely reported at the beginning of this year that the city of Shenzen in China has procured more electric busses - 17,000 - than the number of busses both conventional and electric in the five largest North American metropolitan fleets combined.[8]

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[6] CNBC, *Cost, not climate, is driving transition to renewables: BlackRock's Jim Barry*, 23 February 2018, https://www.cnbc.com/2018/02/23/cost-not-climate-is-driving-transition-to-renewables-blackrocks-jim-barry.html

[7] Wood MacKenzie, *Could Renewables be the Majors' Next Big Thing?*, 4 May 2017.

[8] Steve Hanley, *Shenzhen Completes Switch To Fully Electric Bus Fleet. Electric Taxis Are Next*, Clean Technica, 1 January 2018, https://cleantechnica.com/2018/01/01/shenzhen-completes-switch-fully-electric-bus-fleet-electric-taxis-next/

The United States is not yet losing the advanced energy race, and still represents a significant market for the deployment of advanced energy. Renewables now generate almost as much electricity as the U.S. nuclear fleet, and if Texas were a country, it would be the fourth largest global producer of wind power. The largest wind farm in the free world is being built in Oklahoma.

A key question, though, is whether the United States will invest in, and support, the historical source of its advanced energy edge - innovation. Deployment of today's technologies is not enough. From the Department of Energy's SunShot Initiative to the ARPA-E innovation agency and beyond, investment in advanced energy innovation today will continue to underwrite American energy security and competitiveness tomorrow. Energy innovation has been, and can continue to be, a defining strategic advantage of this country.

Climate Change and U.S. Leadership

Finally, I would like to highlight the importance of climate change to these discussions, not only as an exacerbating factor of the risk landscape but also as an area where the abdication of U.S. leadership could have deleterious effects on broader U.S. economic and energy interests.

A historical lens reveals that the recognition of climate change as a U.S. national security risk driver is not a new, nor a partisan, phenomenon. In 1969, Daniel Patrick Moynihan—then an adviser to President Richard Nixon—wrote a memo to the president raising concern over the possible "apocalyptic change" represented by anthropogenic climate disruption, and called it an issue that the "[Nixon] administration ought to get involved with" and a "natural for NATO."[9] Climate change first appeared in the National Security Strategy in 1991 as an identified environmental challenge that does not respect international boundaries, and has been included in the Worldwide Threat Assessment since 2009 and the Quadrennial Defense Review since 2010.

This is not limited to threats that will draw on the utilisation of our military assets abroad, but also poses challenges for our military's own capabilities and readiness. A Department of Defense (DoD) report published in January surveyed 3,500 military sites in the United States and found that over half have already experienced climate-related challenges. This builds upon a 2009 DoD report which found that 128 coastal installations, including 56 naval installations valued at over $100 billion, would be at risk if sea level rise of more than one meter were to occur. Recent projections of end-of-century sea level rise under current assumptions range from two-tenths of a meter to two meters.[10]

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[9] Nixon Library, *Memorandum from Daniel Patrick Moynihan*, 17 September 1969, https://www.nixonlibrary.gov/virtuallibrary/releases/jul10/56.pdf

[10] NASA,*Understanding Sea Level: Empirical Projections*, https://sealevel.nasa.gov/understanding-sea-level/projections/empirical-projections

How might the United States best deal with these risks? The purpose of this hearing is not to contest the most appropriate instrument or approach for dealing with the climate challenge, but I would note the recent words of George David Banks, a climate and energy advisor who has served in both the George W. Bush and the Trump administrations:

"The Paris agreement is a good Republican agreement. It's everything the Bush administration wanted...It's a climate policy based on U.S. national interest that the Bush team started and the Obama team kept…The climate agenda is not going to go away any time soon, and if you're not engaged aggressively, actively, there are going to be policies that are detrimental to the United States."[11]

I tend to agree with this assessment, and will briefly mention a number of ways in which lack of U.S. climate leadership may be detrimental to U.S. economic and national security interests.

Given that, if it were to leave the Paris Agreement, the United States would be the only country in the world not party to the Agreement, this would leave significant scope for future evolutions of the international climate governance regime over which the United States would have no say but would inevitably be impacted by. In the 1960s, when awareness of climate change was emerging, the United States accounted for 40 percent of global GDP. Today, it accounts for just over 20 percent. An isolated United States is not large enough to avoid the economic repercussions of agreements forged by the rest of the world.

For example, a number of foreign officials and politicians have floated the idea of tariffs, or even sanctions, being applied to the United States should it unilaterally withdraw from the Paris Agreement. With the opening of China's national carbon market this year, a growing share of the global economy is under a formal carbon price, increasing the dangers of tariffs or other measures to be levied against jurisdictions without formal carbon pricing.
The most punitive of these prospects would likely never occur. Some are distant but plausible. Others are already evident: the European Union is now refusing to complete a new trade agreement with any partner that has not only joined, but also officially ratified, the Paris Agreement. To take another angle, imagine if countries were to begin prioritizing LNG imports from countries that have ratified the Paris Agreement, just as the U.S. today provides preferential LNG export approval to countries which have a free trade agreement with the United States.

It is also worth noting that even in the absence of a federal carbon price, there exists a complex mosaic of *de-facto* carbon prices across the United States. A wide range of regulations, from methane rules to fuel efficiency standards, create compliance costs that equate to an implicit

[11] Lisa Friedman, *Former Trump Aide Calls Paris Climate Accord 'a Good Republican Agreement'*, 22 February 2018, https://www.nytimes.com/2018/02/22/climate/george-david-banks.html

price on carbon. For example, the 25 cent increase in the federal gas tax that has recently been debated is the equivalent of a transport sector carbon price of around $30 per ton.

A growing number of US companies are pricing carbon voluntarily, as well. In 2017, almost 1,400 firms were integrating an internal carbon price into business decisions, a more than eight-fold increase from 2013. Most large integrated oil companies now use internal carbon prices between $40 - $80 per ton.

While this patchwork of *de-facto* carbon prices is better than no climate action, it nonetheless suffers from opacity, asymmetry, and - undoubtedly - inefficiency. A far more efficient and effective approach would be an economy-wide carbon price. This would level the playing-field, encourage the lowest-cost carbon reductions to be harvested first, and would give the United States many more policy options for defending the competitiveness of its industry vis-a-vis competitors in countries both with and without carbon prices. A pragmatic, stable, predictable carbon price remains a prudent policy option for the United States.

Conclusion

In conclusion, the United States finds itself at a unique point in history in which its endowment of hydrocarbon resources, including natural gas, are re-shaping both domestic markets as well as, increasingly, the global energy landscape. While the growth of U.S. natural gas exports is poised to be a positive development for energy, economic, and climate security, this should be complemented by the strategies, investments, and policies necessary to ensure that gas maintains its relevance and value in the shift to more advanced and decarbonized energy systems in the United States and elsewhere. Moreover, excitement over the opportunities afforded by growing LNG exports should not distract from other critical priorities, including ensuring that innovation drives America’s energy edge well into the future. Thank you for the opportunity to provide my thoughts on U.S. energy and geopolitics. I look forward to taking your questions.