**U.S. Senate Committee on Energy and Natural Resources**
**Full Committee Hearing**
**February 8, 2018 Hearing: Evolution of Energy Infrastructure**
**Questions for the Record Submitted to Dr. Kenneth Medlock, III**

**Questions from Chairman Lisa Murkowski**

**<u>Question 1</u>: You mention in your testimony that one of the reasons for great success in US shale production is the relatively seamless process to allow for natural gas delivery infrastructure development– through FERC – and there is a comparatively straightforward regulatory approval process for pipelines.**

- **In foreign countries with significant shale resources, how do those nations grant permits to build out their pipeline infrastructure?**

To be clear, the process varies across countries and has resulted in very different infrastructure legacies around the world. In generality, infrastructure projects outside the US are typically done in cooperation with the foreign government, the local national energy company, and a multi-government institution (such as the European Union) when such over-arching interests exist. This process typically includes the conduct of a feasibility study and assessment of local environmental and economic impact, usually with the national energy company and other project developer input. If the pipeline infrastructure is directly tied to an upstream project, then the domestic portion of the facility is generally treated as part of the entire venture, in a vertically integrated manner. On the upstream portion of the investment, mineral resources are generally considered national property so any wealth generated from the extraction and sale of extracted resources contributes directly to government coffers, after cost recovery. Hence, the development of in-country pipeline infrastructure is often considered jointly with the upstream development activity as it is a vehicle for monetization and/or distribution of national wealth. However, if the pipeline infrastructure is destined to cross borders/jurisdictions, then the respective governments in each region are involved in the process.

We can see in very recent history how other governments are involved in pipeline infrastructure development. It is often the case that governments will react to a specific event by funding/ordering a feasibility study and the eventual streamlining of certain infrastructure developments, but there is very little in the way of competitive enterprise in these developments. This is also why costs are generally higher in other part of the world. We see this currently in Australia with the natural gas supply shortages in South Australia while other regions of the country are ramping up LNG exports. We also have seen this in Europe where concerns over Russian hegemony have prompted responses allowing greater flexibility in supply sourcing and delivery – ranging from LNG import infrastructure to pipeline flow reversal. And, we see this in Brazil where a large amount of associated natural gas in unable to move onshore for domestic use (and is re-injected) due to a lack of adequate pipeline capacity. To be clear, these are *infrastructure* issues.

The development of such infrastructure in the US is facilitated by the existence of pricing signals that are clear and transparent and the ability for market participants to compete for the ability to trade across regions. According to FERC, the US has seen approval of over 20,000 miles of natural gas pipeline with nameplate capacity totaling 195 billion cubic feet per day since 2000 (see https://www.ferc.gov/industries/gas.asp). This scale of infrastructure approval is indicative of the scale of filed applications, all of which are motivated by market signals that prompt developers. Moreover, this is evidence of the manner in which markets in the US allow relatively rapid response to emerging local market imbalances if unimpeded. To be clear, this does not mean unexpected events, such as demand spikes or pipeline outages, will not occur and have significant implications for local prices. Indeed, these sorts of things will occur. However, the flexibility that has been observed in the US renders market access for both consumers and producers relatively seamless.

- **We have heard arguments that the FERC permitting process for pipelines should return, at least to some extent, to the era where there was a regulatory finding of need. Do you think that requiring such a finding or other administrative proxy is wise? In any event, how can these calls for more administrative process be reconciled with your testimony that the FERC process is a source of success?**

Historically, the "finding of need" was part of the rate-making process for regulated monopoly entities. Natural gas pipelines would buy gas from a *production* area and sale it in a *market* area in the absence of competition for the commodity transportation services. This rendered the pipeline to have monopoly power over the transport of the commodity. Hence, a regulatory authority would act to minimize the incentive to extract monopoly rents, but it had to also ensure the pipeline company adequately invested in capacity, which could be accomplished by providing a guaranteed rate of return to the pipeline asset. This, then, effectively de-risked the pipeline. Accordingly, if pipelines were to be guaranteed a rate of return, it was necessary to determine that pipeline developers only proposed projects that were actually needed to prevent them from over-building and inefficiently adding to their rate base. This type of regulated rate-making still exists today in regulated monopoly utility areas across electricity and natural gas markets, or where competition has not been introduced.

With the introduction of competition and the associated unbundling of capacity rights from facility ownership, the risk associated with pipeline construction was effectively transferred to developers. As a result, developers will now generally only move forward with pipeline development if sufficient open interest is nominated for new pipeline capacity. As a result, the "finding of need" is now effectively proxied by market participants demonstrating demands for new capacity, which is signaled by existing or anticipated price dislocations between regions. Hence, the existence of well-functioning and liquid markets provides adequate evidence of need. Anything that inhibits the translation of price signals to investment will effectively inhibit

investment on both sides of any trade that a pipeline facilitates – from upstream activity to power plant development. These secondary impacts are important, especially when one considers their ramifications for supply-demand balance in various regional markets as well as environmental goals. So, a clear understanding of this should be part of any calculus aimed at moving the FERC process backwards.

The US pipeline market is a model for the international natural gas market. Stakeholders in other parts of the world (for example, from China, the Baltics and various countries especially in central and eastern Europe, and Australia) consistently seek out information – from us here at the Baker Institute and others (such as consulting firms) – regarding the operation and development of pipeline infrastructure in the US. Regarding the meetings held with Baker Institute fellows and scholars, in every case there is a clear desire expressed in these meetings for an ability to proxy what occurs here, alongside a recognition that the domestic regulatory overlay in those countries will not allow it.

**Question 2: Your testimony defines the relationship between our nation's energy security and well-functioning energy markets and infrastructure.**

- **Can you discuss how physical infrastructure enhances markets across regions and impacts delivered prices between regions when there are short-term movements in supply and demand?**

Physical infrastructure is necessary to facilitate trade between regions. When prices move in response to short-term demand or supply changes, an ability to connect to a neighboring region allows markets to rebalance much more quickly. We see evidence of this in the North American natural gas market. In previous analysis of the local price impacts of new pipeline infrastructure, it has been shown that both price level and price volatility are lower in the destination market when new delivery capacity is added (see, for example, http://www.cleanskies.org/wp-content/uploads/2011/08/LNGMarketGlobalizationImpact.pdf). The existence of adequate pipeline capacity alleviates the short-term constraints that arise when demand surges in response to stimuli such as weather. Given demand for energy in general is not constant – through a year, season or day – it is important that the delivery of energy services be very flexible. While such flexibility is certainly provided by pipeline capacity, it is also provided by other infrastructures – such as storage – as well as technologies and services that make demand more flexible.

- **It would seem that the lack of infrastructure contributes to something less than the most productive use of any fuel, suggesting that infrastructure can sometimes be a valuable tool in combating climate change and other environmental concerns. Do**

**you agree? Either way, please describe how infrastructure allows oil and gas to be sent to where it can provide society with the greatest value.**

Infrastructure allows trade to occur between parties and for those who place the highest value on a particular commodity to receive it. In the case of climate change, infrastructure allows natural gas, for example, to displace more carbon intensive fuels in the generation of electricity and heat for industrial, commercial and residential use. If adequate infrastructure is not present, then those demands will be met through alternative means, which can include rail or freight (in the case of coal) and tanker or truck (in the case of heating oil). Note that this also holds for renewable energy sources in the electric power sector. In the absence of adequate transmission infrastructure, renewable resources simply cannot deliver generated electricity to market. This is raised in my written testimony with regard to the $7 billion infrastructure investment that was needed to allow Texas wind generation to reach consumers in the eastern half of the state.

**<u>Question 3</u>: In Alaska, energy infrastructure has transformed our state --- from production on the North Slope to the small hydropower and microgrids that are moving our small and remote communities away from diesel.**

- **Alaska is rich in mineral and energy resources, yet tapping those resources is often delayed by challenges in permitting. One example is the Donlin Creek Mine –a project that is almost 20 years in development, and which involves permitting a 320-mile natural gas pipeline in order to deliver affordable energy needed to operate the mine – infrastructure that could benefit the region as a whole.**
- **Can you address how insufficient energy infrastructure – domestically and globally – stands as a barrier to economic growth?**

If infrastructure to deliver energy to market is not available, an alternative form of energy will be sought, albeit usually at higher cost. If the cost of the alternative is high enough, then no energy will be delivered and the intended use will be foregone. This effectively kills the productive enterprise that was the intended point of use for the delivered energy. In turn, this inhibits economic growth by not allowing the multiplier effects of the original productive enterprise to matriculate to the broader economy. The above referenced example of the Donlin Creek Mine is a case in point. Namely, absent the needed infrastructure, the activity is less productive and hence cannot progress at the intended pace. Of course, the environmental costs must be reconciled, but as is evidenced by data available from PHMSA at DOT or NTSB, while not void of incidents, pipeline deliveries remain a very safe means of providing energy.

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**Question from Senator Debbie Stabenow**

**Question: Currently, U.S. natural gas prices are largely determined by domestic supply and demand. This has helped keep prices low and attract new investments in the United States. In fact, cheap gas has helped bring $160 billion in new manufacturing investments to the U.S. since 2012. In Michigan, this means new jobs.**

**However, if we export a lot of LNG and it becomes linked to the global LNG market, our prices will be impacted by global demand – rather than domestic demand – which presumably could drive up the cost that our consumers and businesses pay for gas.**

**In your testimony, you associate increased U.S. LNG exports with energy security. Yet just last month, a tanker carrying Russian LNG docked in Boston to deliver gas because of supply crunches in the Northeast following prolonged cold winter weather.**

**So, we have Russian LNG being shipped to U.S. markets and Chinese state-owned companies investing large amounts of capital in U.S. gas projects; and just this week, the Energy Information Administration projecting that 69 percent of all U.S. gas will be consumed by 2050 – partly because we are sending more gas overseas. Considering all of this, could you help me understand how ramping up U.S. LNG exports is good for our economy, our manufacturers, our consumers, and our nation's energy security? I just don't see how that is possible.**

Low cost fuels are critical stimulus for new capital investments and employment opportunities. Indeed, capital investments in energy-using manufacturing are part of the full infrastructure value chain that is required to realize the economic potential of US resource wealth. This is something I alluded to in my response to a question during testimony – that it is important to recognize infrastructure connects all aspects of the energy value chain both within and across energy sources, from producer to consumer, and should be considered as fully interconnected.

The statement, "if we export a lot of LNG and it becomes linked to the global LNG market, our prices will be impacted by global demand – rather than domestic demand – which presumably could drive up the cost that our consumers and businesses pay for gas" has a major presumption in it. Namely, the impact on domestic price will depend on the relative elasticity of domestic supply. When we introduce trade into a market, the implications for price are dictated by the elasticities, or price responsiveness, of foreign demand and domestic supply. If supply is relatively elastic, as research suggests is the case in North America, then the majority of the price impact from exports will occur abroad. I have written extensively on this subject (see, for example, https://www.bakerinstitute.org/research/us-lng-exports-truth-and-consequence/), including analysis performed for the US Department of Energy for its national interest determination regarding LNG exports (see https://www.bakerinstitute.org/research/macroeconomic-impact-increasing-us-lng-exports/).

Central to this is an important premise of trade. Namely, increased US LNG exports will only occur if price is supportive of the trade. In other words, large scale LNG exports will not occur if price abroad is not high enough to support a profitable shipment of natural gas from US ports. Thus, if there is a cold winter in the US and domestic prices rise, capacity through LNG export terminals will be released back into the US market as exports will not be profitable on certain volumes (because, importantly, *capacity* to export does not guarantee *flow* of export). This acts as an effective injection of supply back into the US market that dampens upward price pressure by meeting demand. Importantly, this only occurs if LNG export infrastructure is in place because it allows for greater market fungibility. Consider, for example, the case where LNG export infrastructure is not developed. This would also result in less gathering and pipeline infrastructure and lower levels of upstream investment, thus affecting the entire value chain (hence everything is connected). In turn, this results in less supply that is available to be delivered to consumers in the event of a winter demand spike. Hence, in the absence of LNG export infrastructure, investments all the way through the value chain are dis-incentivized thereby resulting in less flexible domestic supply. So, yes, expanding the set of potential trades (fungibility) facilitates investment throughout the value chain thereby rendering domestic supply more responsive to short term price movements.

An important exception to the above thesis arises when there are factors that limit the set of opportunities for trade. You referenced the case of Russian LNG volumes reaching the US coast. The volumes, which were re-shipped from the UK, did originate in Russia, but they only arrived in the US because there was a profitable trading opportunity. In fact, the only reason Russian-sourced gas arrived in the US is because it was the lowest cost short-term option, which begets a different line of questioning. If Russian volumes to the US are deemed an issue, security or otherwise, then if a solution is to be affected, the appropriate questions are, "why was there a profitable trade opportunity to deliver those volumes to the US and why were Russian volumes the preferred source of supply?" The answer to this question is rooted in the seasonal price movements that grip the northeastern US almost every winter. When demand spikes due to weather, there is generally insufficient pipeline capacity to move volumes from the Middle Atlantic to New England. This results in sometimes extreme price movements that subsequently incentivize LNG imports and short term storage withdrawals from the limited storage capacity in the region, as well as some demand response from large users in the New England market area. These factors all simultaneously act to rebalance demand and supply, albeit at a higher price. Fortunately, these price pressures are short-lived because the weather-driven demand impetus is also short-lived. Nevertheless, the profitable import opportunity is created because LNG imports provide the next viable source of supply to meet demand when domestic supply cannot reach the New England market.

To be sure, LNG imports are not the only arbitrage mechanism that is theoretically available, although it is the only one in practice. For example, another potential option if pipeline capacity remains difficult to build (for commercial or policy reasons) would be to source LNG from the Gulf Coast. However, that option is not currently viable due to Jones Act provisions. So, given

markets must balance, as price rises with demand, supply will ultimately be sourced from somewhere, in this case LNG from abroad. The alternative is for demand to be reduced until markets rebalance. This so-called "demand destruction" is not generally associated with positive economic outcomes.

Another point worth adding regards the potential role of storage in the Middle Atlantic region for meeting seasonal demand movements in the New England market. If adequate market access via pipeline were available from the Middle Atlantic to New England, the ability to arbitrage price movements in New England would provide Middle Atlantic storage developers additional incentive to expand natural gas storage capacity to capture seasonal arbitrage opportunities. This is especially true since there is very little storage capability in New England aside from LNG peak shaving facilities. Again, prices transmit signals for arbitrage that infrastructure investments – in pipelines and storage – allow to be captured.

You also raise the EIA's projection of natural gas depletion by 2050. If depletion begins to occur more rapidly, then domestic supply costs will rise. This will, in turn, abate exports because their profitability will be challenged. In sum, the dynamic market response is much more complicated as market participants will respond to price movements in a variety of ways that ultimately keep markets in balance and re-establish price equilibria.

While not explicit in your question, this highlights another issue related to sanctions. If sanctions are not adopted by a broad enough set of parties, then access to global markets for the sanctioned entity can render the policy much less effective. The sanctioned entity can deliver volumes to the global market. While these volumes may not actually reach the US, the volumes do create displacement opportunities for other volumes on the water to reach the US. In other words, while Russian natural gas itself may not arrive in New England, it does help other volumes to reach New England by displacement.

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**Questions from Senator Joe Manchin III**

**<u>Question 1</u>: The decline of the coal industry has been devastating to my home state. We lost businesses and population. So, we are looking for ways to revitalize our home state economy. I have been working for some time with Senator Capito to bring stakeholders together to help realize the potential of an Appalachian Storage Hub – an innovative energy infrastructure project that will attract manufacturing investment and create jobs. Our area is primed for this sort of energy project because of our abundant natural gas, natural gas liquids and natural geologic storage. This is exactly the type of effort is what Congress envisioned when it created the Title Seventeen loan program. The Loan Program Office (LPO) helps provide low cost capital to innovative energy projects in order to help alleviate investor concerns and get the project into development. The future of this program is currently in question though. So, I'm concerned that Congress is going to unwittingly tie the hands of many energy infrastructure projects – not just this one – if we don't ensure this program is funded going forward.**

**As you reviewed the evolution of energy infrastructure in this country, do you believe the US government has had a role in innovating us to the next stage?**

Yes, the US government has impacted infrastructure in a variety of ways. Going back to the earliest stages of infrastructure development, the regulatory architecture across the oil and gas landscape facilitated the development of a fairly robust backbone infrastructure. However, the redesign of regulation and oversight beginning in the late 1970s triggered a virtual revolution, allowing for better price signaling and more trade and hence greater infrastructure investment.

With regard to the LPO, historically energy infrastructure was controlled as part of a vertically integrated monopoly system. This owed largely to the fact that there are high costs of entry, meaning not just anyone can carry a balance sheet sufficient to underwrite infrastructure investment to enter the energy market. Thus, regulated rates of return were often the norm as regulators approved projects. Remnants of this legacy still exist today, but competitive bidding for large scale infrastructures is much more the norm. This, in turn, highlights the risks associated with financing infrastructure, particularly when banks and private equity is involved. Loan guarantees reduce the capital and financing burden of infrastructure investment and hence, market entry, thereby having the potential to enhance the competitive landscape. Of course, not all projects bear commercial success, but this does not render such programs "out-of-the-money." Rather, the portfolio of government-backed guarantees should be evaluated to determine if there is a positive return on investment. Single cases of failure, while headline grabbing, are not the relevant measures of success for such programs.

I have not rigorously evaluated the programs in this way, but my understanding is that they have seen both successes and failures. If greater risk aversion is desired, then, at the very least, a

reassessment of how guarantees are awarded may be in order. But, such programs have a high enough potential that, in my assessment, they warrant remaining in place in at least some form.

**Is it fair to say that the loan program has had a profound impact on the evolution of how electricity is produced and delivered in this country today?**

This is an interesting question that requires a much deeper, case-by-case examination of the evolution of the electricity system. I am aware of work done by energy historians in this vein. For example, a recent book by Dr. Julie Cohn ("The Grid" available at https://mitpress.mit.edu/books/grid) explores the origins of the US electrical grid and how it evolved into the massive interconnected system that exists today. There is a mixed history of Federal and local government interaction with this process, including direct investment and financing support, which began as a series of many relatively small grids aimed at the provision of local electricity services and evolved through interconnection to provide more reliable service to all consumers. In effect, growth in fungibility through infrastructure and enhanced trading opportunities across regions increased reliability in the delivery of energy services.

**Question 2: On January 28, the Washington Post reported that a tanker carrying liquefied natural gas (LNG) from Russia arrived in Boston Harbor. That tanker had gas on it from the Yamal facility – a project largely financed by the Russian company Novatek. In July of 2014, after Russia annexed Crimea, the US Treasury Department issued sanctions that were specifically targeted at weakening the Russian energy sector – those sanctions forbid any financing for projects belonging to Novatek. Recognizing Boston was not its first step along the journey, it seems though that these sanctions do not prohibit the purchase of gas from this Russian project in the Arctic. So – in short – there is Russian LNG being turned back into gas at one of our ports and then being used to power American homes. Earlier this week, the Energy Information Administration released its Annual Energy Outlook for 2018. In the Reference case, natural gas production accounts for the largest share of total energy production - 39% by 2050. That's domestic fuel.**

**My question is simple: Why, when we have one of the world's greatest reserves of natural gas sitting right under West Virginia, are we importing it at the risk of bolstering Russia's energy sector?**

Please see my answer to the question posed by Senator Stabenow. It is the result of a lack of adequate pipeline infrastructure and policy overlays in the New England market area that limit access to US Lower 48 production. A point worth re-emphasizing is that if adequate market access were available from the Middle Atlantic region to New England, the ability to arbitrage price movements in New England would provide Middle Atlantic storage developers additional incentive to expand natural gas storage capacity.