“The Shifting Geopolitics of Oil and Gas”

Hearings
Subcommittee on Energy
Committee on Energy and Commerce
United States House of Representatives
115th Congress

Testimony on the Impact of U.S. Shale Revolution
Submitted by
Dr. Daniel Yergin
Vice Chairman IHS Markit

June 26, 2018

Mr. Chairman, Ranking Member, Members of the Subcommittee,

Thank you for the invitation to address this Subcommittee. It is an honor to come before you to discuss the dramatic changes in the energy position of the United States resulting from the unconventional revolution in oil and natural gas, and the impact these changes are having on the U.S. economy, geopolitics, and the position of the United States in the world.

This hearing is timely, of course, because it occurs during the World Gas Conference, an event that happens only once in three years, that moves around the world, but that is being held appropriately enough this year just a few blocks from here in Washington D.C. This year's location highlights the world class impact of changes in natural gas in the United States and the new position of leadership that these changes are providing for the United States. The theme of the conference this year is "Fueling the Future", and now it is a very different future because of the shale revolution in the United States.

What also makes these hearings particularly timely is that this is the tenth anniversary of what IHS Markit called, some years ago, the "Shale Gale". It was in the period, a decade ago, around 2008 that it became apparent that something significant was changing in the U.S. energy picture and that it would have profound consequences – although the scale of the consequences could not be foreseen.[1]

Major Changes

What has changed since 2008? In terms of natural gas, a county that was thought to be on the road to being the largest importer of natural gas is now on the road to being one of the major exporters of natural gas and indeed is the largest producer of natural gas in the world.

As for oil, political leaders had for four decades invoked "energy independence" as a national goal, meaning reducing oil imports. But that did not match the reality. The question only seemed to be how much higher would oil imports go as a share of total oil consumption. But, in a decade, we have gone from importing 60% of our oil down to just 16 %, on a net basis. We all recognize that there is major focus on the trade balance at this time. Thus is it noteworthy to observe that over the decade, the change in the U.S. oil position (along with changes in price) has reduced the nation's annual trade deficit by over $300 billion.[2] U.S. oil production has more

[1] This paper draws on the new IHS Markit report, *The Shale Gale Turns 10: A Powerful Wind at America's Back – What's Ahead for the Next Decade?", by Samuel Andrus and Daniel Yergin*

[2] *Monthly Energy Review,* May 2018, Table 1.5

than doubled in a decade, and in the next year the United States will likely become the world's largest oil producer, ahead of Saudi Arabia and Russia.

The shale revolution has been a major stimulus to the U.S. economy – not just in the oil and gas sector but across the entire economy because of the long supply chains. Industries that were expected to flee the United States because of high cost energy are now spending tens of billions to build new plants in the United States because of the availability and moderate cost of energy. Consumers have benefitted from the same availability and moderate costs, including in terms of electricity.

This revolution is having major geopolitical impacts that are constructive for the United States. It has introduced new positive dimensions in U.S. relations with many countries and provided the United States with new kind of influence.

Yet it was not obvious that such a revolution would ever take place. The development of the technology took decades and in some ways began with professional studies in the early 1980s. It was not until the period 1998-2003 that combining two technologies – horizontal drilling and hydraulic fracturing – enabled unlocking on an economic basis of resources heretofore thought permanently trapped in geological formations. While some, including one of your other witnesses today, were pursuing these technologies, it was considered rather fringe, something limited to some "independents". In the mid 2000s, literally dozens of projects were being developed to import liquefied natural gas (LNG) on the premise that the United States was entering an era of permanent shortage of gas. At the same time, there was great fear that the United States was dangerously vulnerable because of ever-higher oil imports.

But the signs that this revolution in production might have wider impact emerged in 2008 when it was noticed that U.S. natural gas production was going up, not down. A few years later, it became clear that U.S. oil production was increasing, not declining – the result of the application of these same technologies.

40% Growth in Natural Gas Output

The turnaround in natural gas production has been striking. For the eight-year period of 2000–07, total US natural gas production grew less than 1%. However, over the subsequent 10-year period of 2007–17, output grew by 40%, while prices went down. And the pace of growth is accelerating. For 2018, we expect natural gas production to be up 7 billion cubic feet per day (Bcf/d) relative to 2017. Altogether, we anticipate that US production could grow by another 60% over the next 20 years.

The Potential Gas Committee has estimated that US recoverable resources have increased by 70%, from 2,074 trillion cubic feet (Tcf) in 2008 to 3,141 Tcf in 2016, and those numbers will likely increase as hydraulic fracturing technology improves and more associated gas gets added to the ledger. Our current view, as of 2018, is that there is approximately 1,250 Tcf of resource that is economic below $4/MMBtu. In recognition of the change, as early as 2012, President Barack Obama stated: "We have a supply of natural gas that can last America nearly 100 years." He added: "The development of natural gas will create jobs and power trucks and factories that

are cleaner and cheaper, proving that we don't have to choose between our environment and our economy."[3]

With broad recognition of resource availability, supplies grew, and prices declined. What had been expected to become an increasingly scarce and expensive resource was now abundant and inexpensive. Between 2007 and 2017, US natural gas production grew from 51.7 Bcf/d to 72.6 Bcf/d. Gas's share of total US energy consumption rose from 22% in 2006 to 29% in 2017.

Impact on Electric Power

The impact of the Shale Gale on the domestic electric power industry has been particularly dramatic.

Prior to 1990, coal and nuclear dominated the growth in share of US electric power generation capacity and energy. Coal was inexpensive and regarded as a secure domestic energy source. The start-up of nuclear power plants was the result of investment decisions largely made in the 1970s. Owing to the natural gas shortages of the late 1970s, the use of natural gas was banned in new electric generation. That ban was lifted in 1987. But coal still dispatched ahead of natural gas and limited gas' share of domestic electric generation.

The shale gas revolution has transformed power generation economics in the United States, resulting in a rebalancing in fuel choice for electric generation. In 2007, coal provided 52% of US generation and natural gas provided 17%, and more than 10 gigawatts of coal generation was under construction. In 2016, natural gas overtook coal for the first time and supplied 33% of total electric generation while coal supplied 31%. A rivalry has developed between coal and natural gas, with the competitive advantage moving back and forth depending on relative prices. It is clear that gas has become, and will continue to be for the foreseeable future, a backbone of electric generation in the United States.

The shift from coal to natural gas has, because of falling natural gas prices and confidence in long-term gas supply, along with the addition of renewables, contributed to the reduction in US carbon dioxide (CO_2) emissions from power generation. We estimate that in 2017, CO_2 emissions from power generation were down 30% from 2005. More than half of that emission decline was from gas replacing coal.

Geographic Shift – the Marcellus, Utica and Permian

Prior to 2007, US natural gas production was predominantly from the Southwest and the Gulf of Mexico. Canadian imports accounted for about 16% of US consumption. Since producers first learned how to frack the shale source rock, there has been a continuous evolution in terms of new and prolific discoveries.

[3] State of the Union Address, January 24, 2012.

Appalachia's vast economic resource base comprises the massive and prolific Marcellus and Utica plays, each of which is now estimated to be able to supply the United States with two decades of natural gas. The Marcellus extends from Pennsylvania, West Virginia, and Ohio into Maryland and New York State, although shale gas development is prohibited in the last two states. Much of the Utica lies beneath the Marcellus. Production from these plays, currently at 24 Bcf/d, is expected to grow to almost 50 Bcf/d by 2050—rivaling the entire US production level prior to the Shale Gale. But this monumental growth will require more infrastructure to move gas production from supply basins to consuming markets within North America and to LNG terminals for export.

And now there is another new player, the Permian Basin in West Texas, which is the predominant source of growing shale oil and "associated gas" (gas that is produced with oil). This growing Texas oil production has helped boost the contribution of total associated gas to almost 30% of total US production. More than 8 Bcf/d of new pipeline capacity has been proposed to move this growing supply of Permian gas to market. However, the first 2 Bcf/d of expansion is not expected online until late 2019. It is likely that a significant portion of that gas will go to new industrial facilities on the Gulf Coast and to exports (of LNG and by pipeline to Mexico). The pace of growth in the Permian Basin, much like the Marcellus before it, is outstripping the pace of infrastructure expansion.

An unprecedented amount of incremental pipeline capacity (exceeding 30 Bcf/d) has been developed or proposed to connect supply from Appalachia and West Texas to growth markets throughout North America. The timely development of that infrastructure will be very important to capturing the full value of this new resource base. This wealth of economic resource has led to the price of natural gas falling below $3/MMBtu. One major consequence is that gas at lower prices has turned around the prospects for energy-intensive manufacturing in the United States – and the jobs that go with it.

Making U.S. Manufacturing Competitive

For years, energy-intensive manufacturing had been leaving the United States owing to high energy costs. But, as the reality of abundant and inexpensive natural gas came to be accepted, the direction of investment changed. The advantages in terms of thermal energy, feedstock, and electricity costs have driven a surge of new investment in US petrochemical and other industrial facilities. IHS Markit estimates that, from 2010 through 2020, more than $120 billion in new capital investments will be spent to expand petrochemical manufacturing capacity. Ancillary expenditures around the plant projects could easily double the total capital investment.

The economic benefits have not been limited to capital investments. Lower prices for raw materials and energy have increased industrial production. The United States has become competitive in energy-intensive products. It has been estimated that, by 2025, as many as four million jobs—direct, indirect, and induced—could be supported by unconventional activity.[4]

[4] See the IHS Markit study *America's New Energy Future: The Unconventional Oil and Gas Revolution and the U.S. Economy, Vol.3: A Manufacturing Renaissance, 2014.*

The Big Flip: from Imports to Exports of Natural Gas

As already noted, the informed assumption prior to 2007-8 was that the United States was going to be a major importer of LNG, perhaps the world's largest. On that basis, construction had already begun on facilities for importing LNG, regasifying it, and distributing it to US consumers.

But then, as the Shale Gale's intensity grew, it became obvious that higher-cost imported LNG would have no market in the United States. Not only were LNG imports not required, but US pipeline imports of natural gas from Canada declined from a peak of about 16% of domestic supply in 2005 to about 7% currently. Moreover, and contrary to what had seemed settled wisdom, it became clear that the growing volumes of gas were exceeding domestic demand and that the United States could sell natural gas into international markets while still easily meeting its own growing demand.

By the beginning of 2018, the United States was exporting 4.4 Bcf/d (worth about $5 billion per year) via new pipelines to Mexico—about 6% of domestic production but close to half of Mexican natural gas needs. For Mexico, this was the most immediate and tangible benefit of its own domestic energy reforms, because imported gas from the United States used in electric generation helped to bring down the cost of electricity for Mexican consumers, manufacturers, and voters.

In addition to Mexico, there is the growing global market. The dramatic expansion in US natural gas production has meant a 180-degree turn, enabling the United States to become an LNG exporter, rather than an LNG importer. Plants that were oiginally envisioned as LNG receiving terminals have been reconfigured as LNG liquefaction export terminals, at the cost of tens of billions of dollars. New greenfield projects have also been initiated. Some energy-intensive manufacturing companies expressed concerns about exporting LNG, fearing that this could crimp supplies for their own multibillion-dollar investment commitments. However, the continued growth in natural gas production allayed those fears.

One small export terminal in Alaska had, since 1969, exported limited volumes of LNG. But the first new major US LNG export terminal dispatched its first cargo in February 2016. Since then, up to 3 Bcf/d of US LNG has been delivered to a total of 26 countries: Argentina, Brazil, Chile, Malta, China, the Dominican Republic, Egypt, India, Italy, Japan, Jordan, Kuwait, Lithuania, Mexico, Portugal, South Korea, Spain, the Netherlands, Pakistan, Poland, Taiwan, Thailand, the United Arab Emirates, Britain, Turkey, and Colombia.

We expect that, over the next five years, the current 3.1 Bcf/d of LNG export capacity will grow by another 6.9 Bcf/d. Investment in these plants will total an estimated $56 billion. Instead of being a gas-short LNG importer, the United States is now on track to rank among the world's major LNG exporters. By 2025, the global LNG market is anticipated to be more than 400 million metric tons per year, with the top suppliers—Qatar, Australia, and the United States—exporting 60% of total supply.

Oil -- U.S. to Become World's Largest Crude Oil Producer

The Shale Gale may have begun with natural gas, but the shale revolution would be extended to oil, with enormous global impact. In the first several years of shale gas development, there had been skepticism about the applicability of the technology to oil. But around 2008-2009, that applicability came to be understood. Around 2012, U.S. oil production began to demonstrate the same kind of surge that had characterized natural gas. Between 2008 and 2018, US crude oil output more than doubled – going from 5 million barrels a day to almost 11 million barrels per day. Output has exceeded the previous high set in 1970. It is set to continue rising, and sometime over the next year will reach a level that makes the United States the world's largest crude oil producer, ahead of Saudi Arabia and Russia. On a net basis, the United States went from importing 60% of its liquid fuel at the peak to below 16% in March 2018, which is a level last seen in the late 1950s.

The rise in Texas is particularly striking. In 2008, Texas had produced approximately 1 million barrels per day. By 2018, it is producing close to 4 million barrels per day. The Permian basin in Texas and New Mexico is now one of the world's great centers for oil production. In the past 24 months, production from just this one region has grown far more than any other entire country in the world. Permian output in 2008 was 900,000 barrels per day. Last year it was 2.5 million barrels per day. IHS Markit projects that it will more than double, reaching 5.4 million barrels per day by 2023 – meaning that this one region in the United States will be producing more oil than every country in OPEC, except for Saudi Arabia.[5]

One other notable consequence of this growth: Owing to the mismatch between the typical quality of shale oil and America's existing refining capacity, the United States has become a significant exporter of oil (both crude oil and refined products), as well as an importer.

Overall Economic Benefits

The overall economic impacts of shale gas and shale oil have been very large. In February 2014, shortly after leaving the chairmanship of the Federal Reserve, Ben Bernanke said of the shale revolution, "It's clearly been one of the most beneficial—if not the most beneficial—developments" since the 2008 financial crisis and the onset of the Great Recession and "it's helping our economy in a number of ways."[6]

In 2014, IHS Markit estimated that the full unconventional value chain (from upstream energy through energy-related chemicals) associated with unconventional oil and natural gas development had supported more than two million jobs (direct, indirect, and induced), had generated over $75 billion in federal and state tax revenues, and had contributed more than $283 billion to US GDP, representing an increase in real GDP for 2012–14 in the range of 2–3%. Per average household, disposable income was raised by more than $1,000. Notably, the supply chains extended across the country, stimulating manufacturing (notably in the Midwest) and

[5] See IHS Markit Report, *The Permian: $308 Billion, 41,000 wells, and Other Key Ingredients in the IHS Markit Outlook to 2023.*

[6] Comments by Hon. Ben Bernanke at CERAWeek Conference, 2014.

service and technological industries across the United States. The development of the Marcellus play provided major economic stimulus in Pennsylvania, including such support industries as real estate, lodging, food, vehicle sales, construction, and local commerce. The Shale Gale was even creating jobs in New York State, despite that state's ban on shale gas development. At the peak, shale was responsible for about 15% of all the capital investment in the fixed equipment and structures sector for the United States.

The oil price collapse that began in late 2014 led to a dramatic cut in investment. However, prices have rebounded. US capital investment is once again increasing, and producers have increased well productivity and reduced costs. Indeed, the only place in the world where E&P investment is significantly rising is in the United States. Such expenditures are stagnant in the rest of the world.

Wide-ranging Impacts

Without the shale revolution, the United States would be importing large volumes of oil and gas, our trade balance would be dramatically different, millions of jobs would not exist, and the United States would be less competitive. The domestic US power markets and overall economy would look significantly different without the shale revolution. Similarly, the outlook would be different in terms of the global economy and international relations—both for countries that produce oil and natural gas and for countries that import them.

Certainly, without the Shale Gale, the United States would be in a very different position internationally. The Shale Gale and its consequent impact on oil have brought new elements of influence and independence for the United States. US LNG exports are becoming a significant and positive factor in the relations with many countries and a key element in discussions about trade.

The new outlook for oil and natural gas has created new possibilities for making progress toward national goals of energy efficiency, cost efficiency, environmental protection, global competitiveness, and energy security. It is also contributing jobs and revenues to the economy at the national, state, and local levels. In short, the Shale Gale has put a powerful new wind at America's back.