Virginia Oil and Gas Association

Informational Handbook
2017

Virginia's Natural Gas Industry

Powering America...Fueling Virginia Communities.

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Natural Gas: Building Block of Everyday Life

Natural Gas not only heats our homes, but it is also an important feedstock for many other items we use each day. For more than 100 years, Americans have relied on natural gas and oil to enhance their quality of life. The cars we drive, the food we eat, the medicines we take – each product is touched in some way by America's oil and natural gas industry. Natural gas is a key component in a vast majority of manufactured goods. Whether it's life saving medicines, surgical equipment, electronics, computers, phones, CDs, paint, make-up or clothing, the natural gas and oil industry support our day-to-day lives.

History of Natural Gas in Virginia

1898: Virginia's first natural gas well drilled in Wise County (not commercial)

1931: First commercial gas well in Virginia drilled in Scott County

1940s: Pipelines begin to develop in Virginia

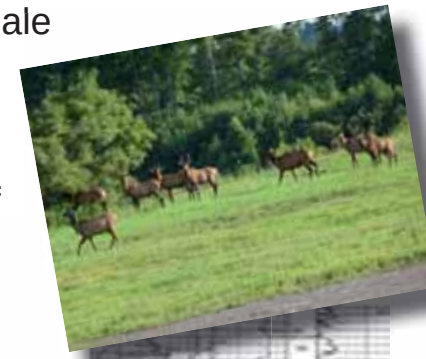
1950s: Hydraulic fracturing begins in Virginia

1972: Conventional drilling programs ramp up

1988: Coalbed Methane (CBM) gas development begins

2007: Horizontal drilling begins in the Huron shale

2012: Virginia natural gas industry members win IOGCC Environmental Stewardship Award for assisting with reintroduction of Virginia's elk



Virginia's Natural Gas Industry Providing Energy for Millions.

Did you know: **Virginia produced 127.6 billion cubic feet of gas in 2015 alone?**

To put that into perspective, it's enough fuel to provide electricity to power approximately 1 million households -- nearly one-third of Virginia's needs for a year.

Economic Impact of Natural Gas and Oil in Virginia

- **More than 18,000 jobs are supported by unconventional gas and oil development**
- **Development provides more than $2 billion in economic activity and more than $190 million in state and local taxes**
- **More than $8 million paid directly to local Virginia communities in Southwest Virginia through severance taxes**
- **More than $10 million paid directly to local Virginia communities in property and mineral taxes**
- **Hundreds of millions paid in royalties**
- **Support of VCEDA through gas production taxes, assisting with economic diversification efforts in Southwest Virginia**
- **141,600: direct, indirect, induced jobs provided by oil & gas industry in Virginia**
- **$62,183: average annual oil & gas industry salary in Virginia (non-gas station worker)**
- **$75,819: average annual exploration and production (E&P) sector industry salary in Virginia**

Sources: Bureau of Labor Statistics, Quarterly Census of Employment and Wages, Accessed 6/25/2015, Energy Information Administration, and "The Economic Impacts of the oil and natural gas industry on the U.S. economy in 2011: employment, labor income and value added," PriceWaterhouseCoopers, July 2013. Based on 2011 IMPLAN database.

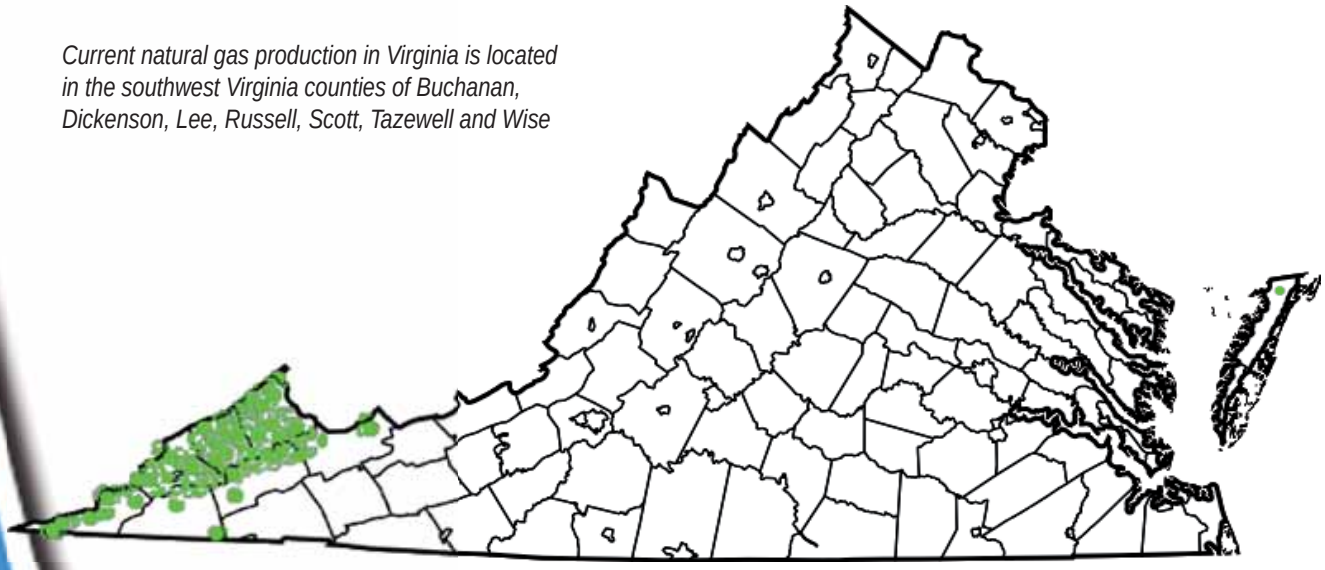
Focus on Communities

Virginia's natural gas industry producers, suppliers and contracting companies have offices here in Virginia and employ thousands of Virginia residents, providing them with family wage-sustaining jobs and benefits. Industry members live in Virginia and work in Virginia.

VOGA member companies donated approximately $10,000,000 to Virginia charities in 2015 alone.

8,113 Producing Virginia Wells

Current natural gas production in Virginia is located in the southwest Virginia counties of Buchanan, Dickenson, Lee, Russell, Scott, Tazewell and Wise



- Coalbed Methane (CBM) Gas Wells
  - Natural gas in coal seams
  - Produced above 3,000 ft
  - Accounts for 80% of Virginia's production
- Tight Gas Sand Wells
  - Non-coal formations (sandstone & limestone)
  - Deeper than 3,000 ft (typically 3,000-6,000 ft)
- Horizontal Wells (shale and tight gas sands)
  - Target single formation (4,000-6,000 ft deep)

Virginia is Unconventional - An unconventional reservoir cannot be produced economically without stimulation (hydraulic fracturing). In Virginia, more than 9,700 wells have been drilled with no cases of groundwater contamination associated with hydraulic fracturing.

Life Cycle of a Natural Gas Well

- Geologic mapping to determine well spot
- Surface/mineral owner mapping
- Lease land within unit

Requires Regulatory Oversight

- Board hearing if necessary
- Permit well/pipeline through DMME
- Build well location (1-2 weeks)
- Drill well (5-10 days)
- Complete well - Includes Hydraulic Fracturing (1-2 days)
- Build pipeline
- Maintain well and location
- Approximate life of a well = 20-60 years

Facts on Hydraulic Fracturing

What is Hydraulic Fracturing? Hydraulic fracturing is the process through which fluid pressure is applied to reservoir rock causing fracturing. The fluid system carries a proppant (typically sand) into the fracture network. Upon completion of the frac job, the fracture system begins to close on the sand layer, which generally has a greater porosity than the unstimulated reservoir rock. Through the establishment of this fracture network, natural gas can then flow more freely to the wellbore.

Even though the birth of fracking began in the 1860s, the introduction of modern day hydraulic fracturing began in 1947. Since then, nearly 3 million frac treatments have taken place, and up to 90 percent of all wells drilled in the U.S. are hydraulically fractured each year with no record of harm to groundwater.

Expert Opinions on Hydraulic Fracturing

Gina McCarthy, Environmental Protection Agency Administrator: "There's nothing inherently dangerous in fracking that sound engineering practices can't accomplish."

Dr. Mark Zoback, Stanford University: "Fracturing fluids have not contaminated any water supply and with that much distance to an aquifer, it is very unlikely they could."

Lisa Jackson, former Environmental Protection Agency Administrator: "I'm not aware of any proven case where the fracklng process itself has affected water."

Heather Zichal, former Climate Advisor to President Obama: "We know that natural gas can safely be developed, and to the credit of the industry there are many companies that are leaning into this challenge and promoting best practices for safer and more efficient production."

Dr. Stephen Holditch, Texas A&M University: "I have been working in hydraulic fracturing for 40 plus years and there is absolutely no evidence hydraulic fractures can grow from miles below the surface to the fresh water aquifers."

Ken Salazar, former Secretary of the Interior: "I would say to everybody that hydraulic fracking is safe."

Sally Jewell, Secretary of the Interior: "By using directional drilling and fracking, we have an opportunity to have a softer footprint on the land."

Steven Chu, former Secretary of Energy: "This is something you can do in a safe way,...It is a false choice to say that the country can either preserve the environment or acquire cheap natural gas."

Hydraulic Fracturing in Virginia

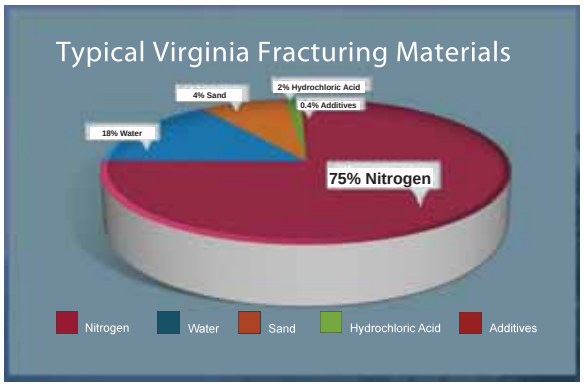
Did you know there is a website where companies disclose the materials they used during each hydraulic fracturing operation?

Did you know the Groundwater Protection Council and the Interstate Oil and Gas Compact Commission created a web site where the public can learn more about chemicals being used for hydraulic fracturing? Visit the site and learn more about hydraulic fracturing at: www.fracfocus.org.

Hydraulic Fracturing Components in Virginia

Most horizontal shale wells in Virginia are stimulated (fractured) using only nitrogen. The rock properties of the Lower Huron shale are different from other Appalachian Basin shales and make the use of nitrogen the best method to utilize.

Vertical wells in Virginia are mainly stimulated using fresh water and nitrogen. Water and nitrogen are combined at different percentages to create a foam based material. Typical foam in Virginia is made up of 70-75% nitrogen and 25-30% water and other components (described below by volume).

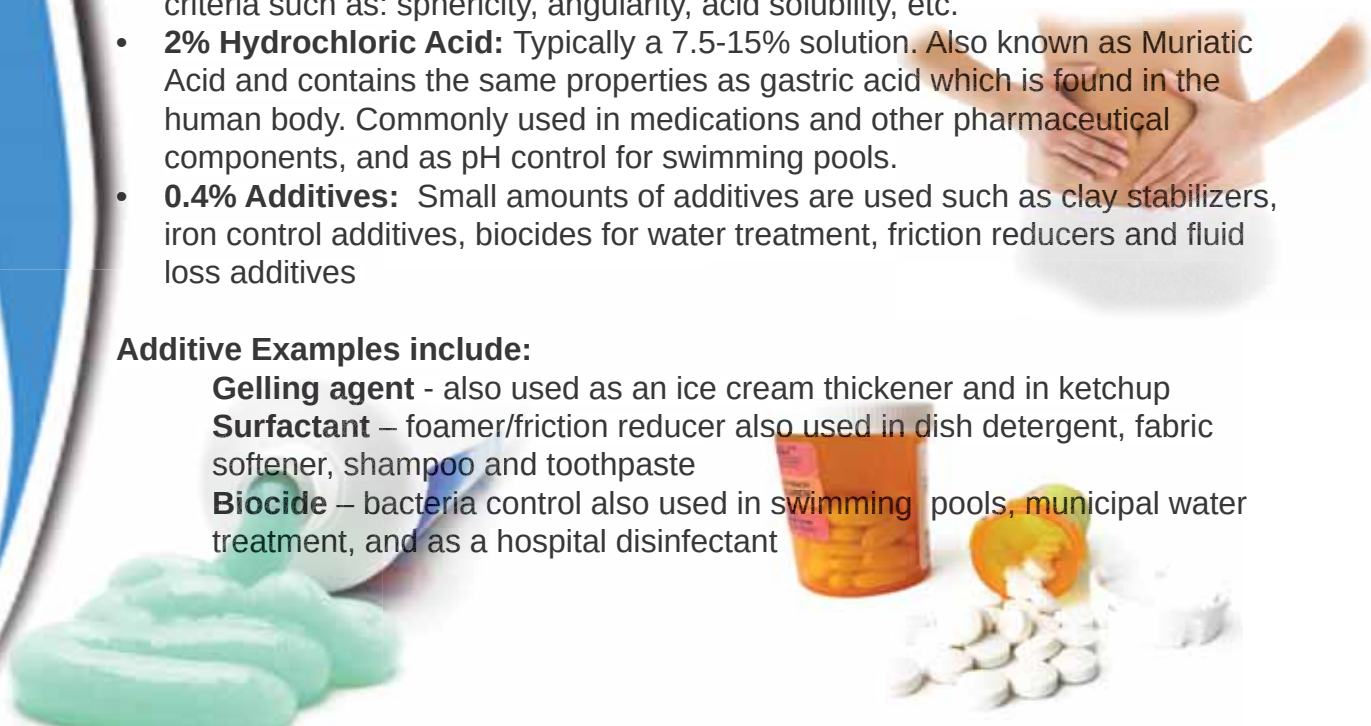


Typical water usage is approximately 45,000 gallons which is significantly lower than a typical frac uses in other areas.

- **70-75% Nitrogen:** An inert commonly occurring gas in the atmosphere which makes up ~78% of the air we breathe.
- **18-24% Water:** An average of approximately +/- 45,000 gallons depending on treatment/stimulation design.
- **4-9% Sand:** A specialty sand with strict quality control parameters regulating criteria such as: sphericity, angularity, acid solubility, etc.
- **2% Hydrochloric Acid:** Typically a 7.5-15% solution. Also known as Muriatic Acid and contains the same properties as gastric acid which is found in the human body. Commonly used in medications and other pharmaceutical components, and as pH control for swimming pools.
- **0.4% Additives:** Small amounts of additives are used such as clay stabilizers, iron control additives, biocides for water treatment, friction reducers and fluid loss additives

Additive Examples include:

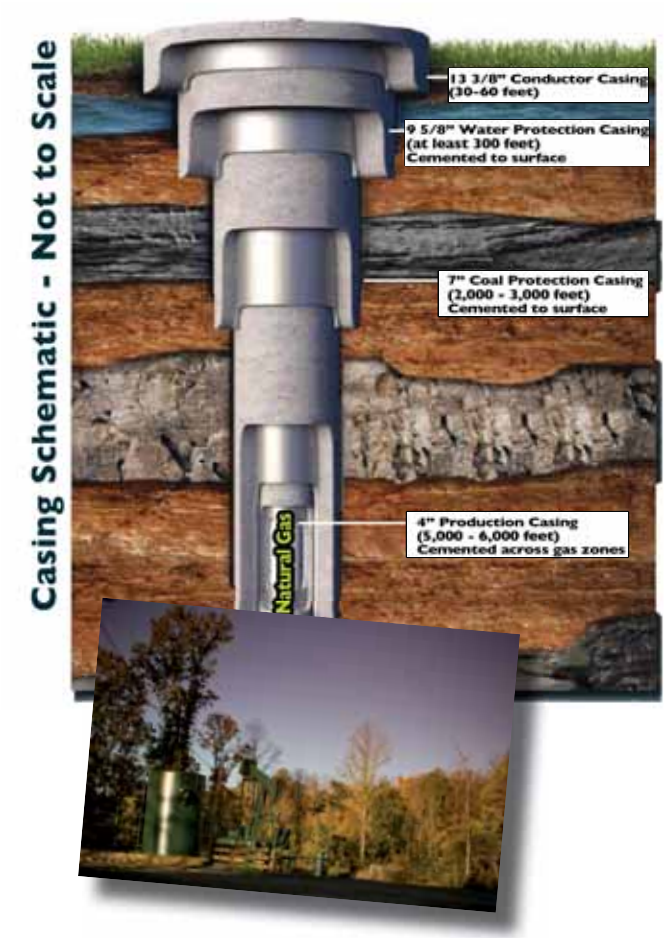
Gelling agent - also used as an ice cream thickener and in ketchup
Surfactant – foamer/friction reducer also used in dish detergent, fabric softener, shampoo and toothpaste
Biocide – bacteria control also used in swimming pools, municipal water treatment, and as a hospital disinfectant

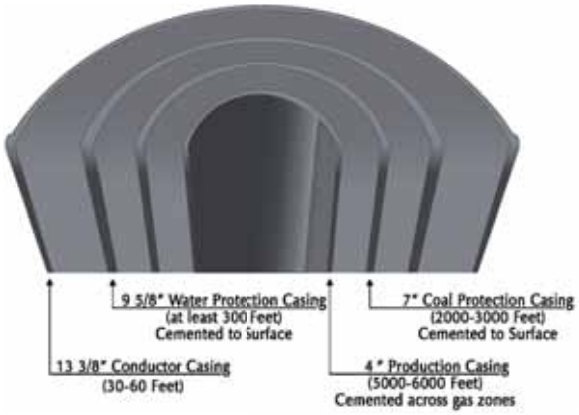


Protecting Virginia's Groundwater

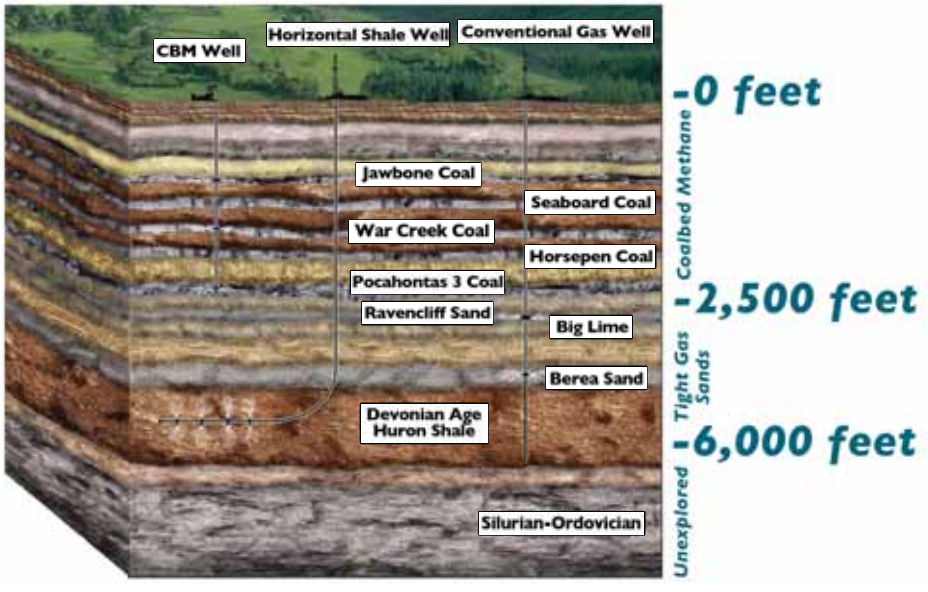
Regulation of Virginia's Natural Gas Industry

The Virginia Department of Mines, Minerals and Energy's Division of Gas and Oil regulates all aspects of natural gas drilling in Virginia. Other regulating bodies include: Virginia Department of Environmental Quality, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, Virginia Marine Resource Commission, Virginia Department of Conservation and Recreation, and the Virginia Department of Labor and Industry. The industry is also regulated under the Clean Water Act and Clean Air Act.





Fresh water in Virginia is generally less than 300 feet deep. Rock formations containing natural gas are several thousand feet to more than a mile deep. Several casing strings are cemented to surface to isolate natural gas from contacting fresh water sources as illustrated in the diagram at left and above.



Safe Transportation

Natural gas and liquid pipelines are a critical component of Virginia's energy infrastructure. The Commonwealth is currently a net importer of natural gas and yet there is more demand for natural gas than can be served with the current pipeline infrastructure. In addition, Virginia-based manufacturers are looking to expand and new companies are looking to move to the United States because of the abundance of cheap natural gas energy.

The natural gas pipeline infrastructure is a proven, safe, way to transport energy across the state and country. Pipeline operators take proactive steps to ensure that health, safety, security, and environmental concerns are addressed at all stages, including the planning, construction and operational phases of any pipeline installation and operation. Together, pipeline companies fund millions of dollars worth of research into new facility inspection technologies and spend millions of dollars on pipeline and public safety initiatives each year. Pipeline operators spend significant dollars on corrosion inspection technology and engaging the general public and landowners to help them understand the importance of pipeline safety and protecting pipeline facilities from third-party damages through the use of the 811 call before you dig law.

The Federal Energy Regulatory Commission (FERC) is charged by Congress with evaluating and recommending approval of all interstate natural gas pipelines.

For more information on the FERC Process visit www.ferc.gov

FERC Process

Use of the Pre-Filing Environmental Review (PF)

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Process is Approved (voluntary)

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Conduct Scoping to Determine Environmental Issues and Attempt to Resolve Issues

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Applicant files FERC Application

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FERC Issues Notice of Application

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FERC Issue Notice of Intent to Prepare Environmental Assessment (EA)/Environmental Impact Statement(EIS

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Conduct Scoping (if the PF Process is not used)

↓

FERC Issues Notice of Schedule for EA/EIS

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Issue EA or Draft EIS Respond to Environmental Comments / Issue Final EIS

↓

Commission Issues Order

Powering America

Every American has benefitted from America's energy revolution in the last several years. Affordable energy impacts people's wallets. A 2016 comprehensive study from IHS Economics and the National Association of Manufacturers (NAM) reveals how natural gas has strengthened manufacturing, encouraged U.S. manufacturing growth and employment and highlights the positive impact to communities around the United States. Manufacturers use natural gas for fuel, machine drive and space heating as well as a feedstock in refining, chemicals and primary metals sectors. Domestic natural gas has transformed the U.S. economy, made our companies more competitive, created jobs and put money back in the pockets of working Americans.

- Expanded energy access—1.9 million jobs economy-wide in 2015
- Shale gas put an extra $1,337 back in the pocket of the average American family
- New pipelines meant more than 347,000 jobs, with 60,000 in manufacturing
- Total natural gas demand is poised to increase by 40% in the next decade. Key drivers will be manufacturing and power generation. U.S. supply is expected to increase by 48% in the next decade to meet new demand

Virginia's Opportunity

Increased infrastructure needs:

Virginia's growing demand for reliable energy that also meets new regulations is at the forefront of several new projects in Virginia. Natural gas is leading the way to provide that energy due to the fact it has the **smallest physical footprint of all other energy sources**, while also providing affordable and reliable energy.

Projects to meet Virginia's needs include several pipeline projects including the proposed Atlantic Coast Pipeline and the Mountain Valley Pipeline. These pipeline projects, along with the creation of several new natural gas power plants, will provide energy to thousands of Virginia homes and businesses, including new manufacturing.

Projected Pipeline Economic Benefits:

- More than $17 million paid in taxes annually
- Hundreds of millions in Virginia infrastructure development costs (equipment, materials, labor, and services)
- Thousands of new permanent jobs due to both operational and expected growth in manufacturing and industry sectors due to increased availability of reliable and affordable energy source.

Virginia natural gas consumption is almost 3 times statewide production.

Continued reliable production is needed to keep pace with increasing demand. Natural gas production in the Commonwealth:

- Provides high-paying jobs for Virginians;
- Benefits producing counties through tax base;
- Supports business activity across the state;
- Is price competitive due to proximity to expanding markets.

Impact of Natural Gas Development

"Over the next decade our nation's demand for natural gas is only going to grow and much of that growth is from manufacturing...this study (Energizing Manufacturing, IHS Economics and the National Association of Manufacturers) unequivocally shows that if our growing demand is not taken seriously by policy makers we will have a serious lack of infrastructure that will jeopardize our growth."

-- NAM President and CEO Jay Timmons, May 2016

"The U.S. natural gas revolution has strengthened our energy independence, bolstered our economic competitiveness, reduced our carbon emissions, and given us a foreign policy tool that can help reduce the world's energy reliance on hostile regimes."

-- U.S. Senator Tim Kaine, January 2015

"As (former) secretary of defense, I can tell you how dependent the security of our country is on the (energy/petroleum) industry... The Department of Defense is the single-largest energy user in the nation...I think we can go one of two paths, I believe deeply we could have an America in renaissance - a strong America in the 21st century... We could also have an America in decline, that operates by crisis after crisis after crisis."

-- Former CIA Director and Secretary of Defense Leon Panetta

"I think natural gas is going to remain, in many ways, the most desirable traditional fuel-both for its cleanliness and for its relative efficiency."

-- Former Speaker of the House of Representatives Newt Gingrich

"Responsible development of natural gas is an important part of our work to curb climate change and support a robust clean energy market at home. It also has huge potential to help power our factories and our vehicles, while at the same time cutting our dependence on foreign oil."

-- 2016 EPA Administrator Gina McCarthy

VOGA

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