

Virginia Oil and Gas Association



Informational Handbook 2016



*Virginia's Natural Gas Industry
Powering America...Fueling Virginia Communities.*

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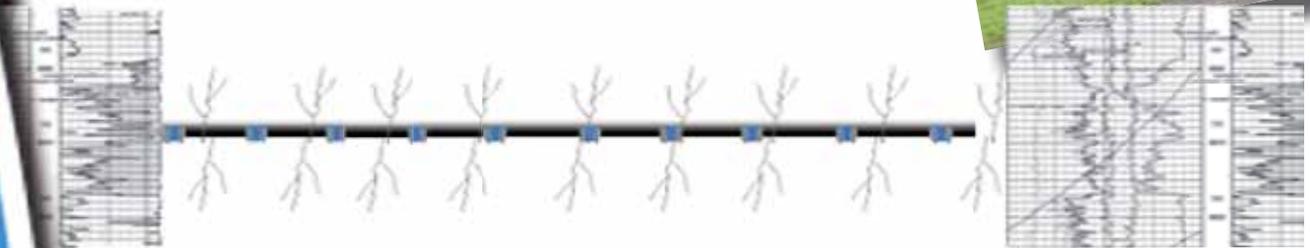


Natural Gas the Building Block of Everyday Life

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 surgical equipment, electronics, computers, phones, CDs, paint, make-up or clothing, the natural gas and 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) 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 133.6 billion cubic feet of gas in 2014 alone?

To put that into perspective, it's enough fuel to provide electricity to power more than 1.2 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 oil and gas 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
- \$57,549: average annual oil & gas industry salary in Virginia (non-gas station worker)
- \$71,327: 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.



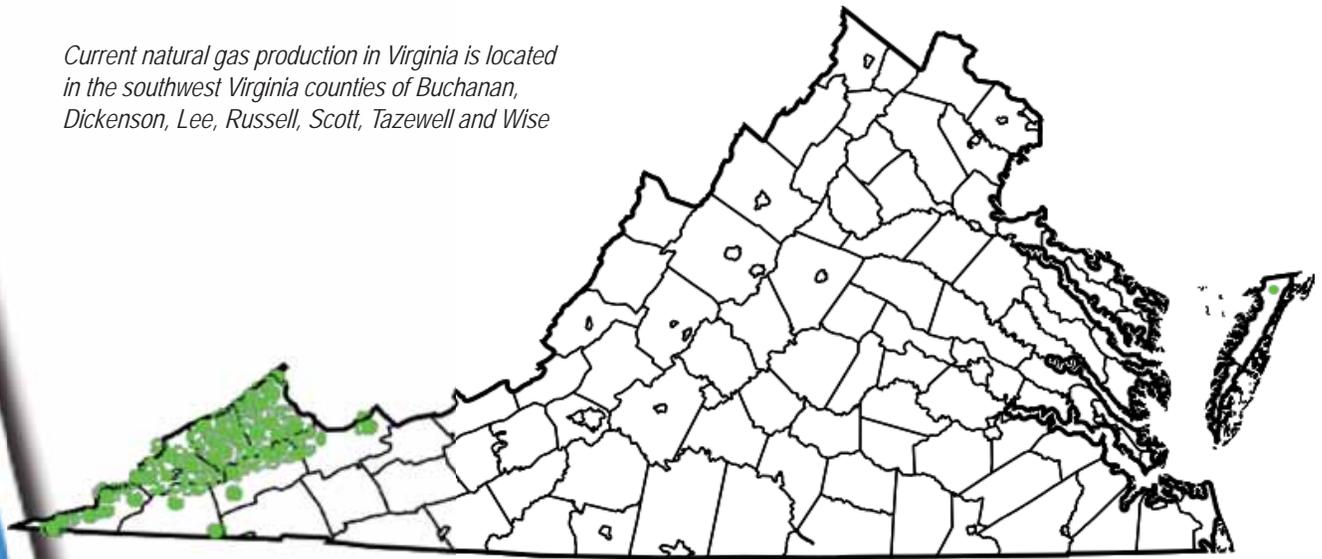
Focus on Communities

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 2014 alone.

8,062 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) 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

**Requires
Regulatory
Oversight**

- Geologic mapping to determine well spot
- Surface/mineral owner mapping
- Lease land within unit
- 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 in which fluid pressure is applied to reservoir rock causing fracturing. The fluid carries a proppant (usually sand) into the fractures. The fractures close on the sand, which generally has a higher porosity than the reservoir rock. Natural gas can then flow more freely to the wellbore.

Hydraulic fracturing was first used in 1903 with widespread commercial use beginning in 1948. Since then, more than 2 million frac treatments have taken place. 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 fracking 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.”

Dr. Richard Muller, University of California - Berkeley: “Environmentalists who oppose the development of shale gas and fracking are making a tragic mistake.”



Hydraulic Fracturing in Virginia

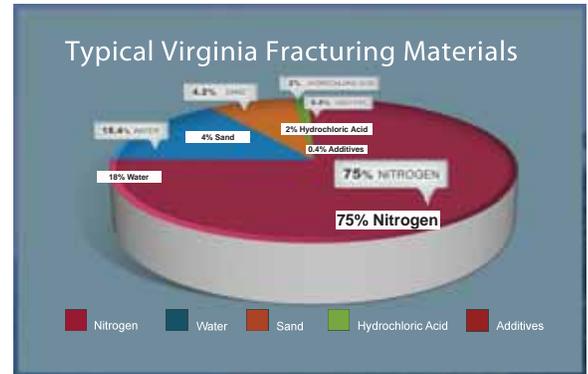
Did you know:

Did you know the Ground Water 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 for fracturing it.

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



Typical water usage is 25-35,000 gallons which is 1% of what a typical frac uses in other areas.

- **75% Nitrogen:** an inert gas, makes up 78% of the air we breathe
- **18% Water:** approximately 25-35,000 gallons per frac job
- **4% Sand:** Common uses include: mortar for masonry, water treatment filtration, general construction
- **2% Hydrochloric Acid:** Typically a 15% solution. Also known as Muriatic Acid and is the same thing as gastric acid. Commonly used in medicines and other pharmaceuticals, 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:

Guar Gum – 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

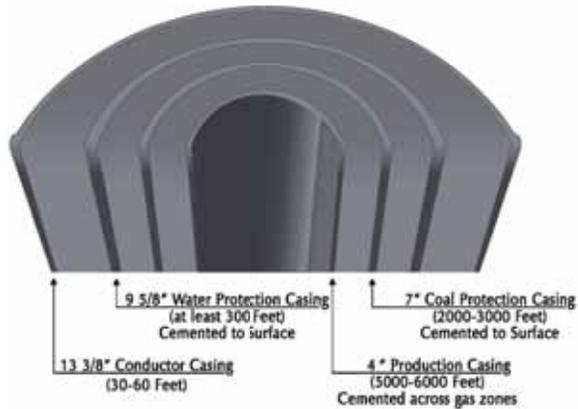
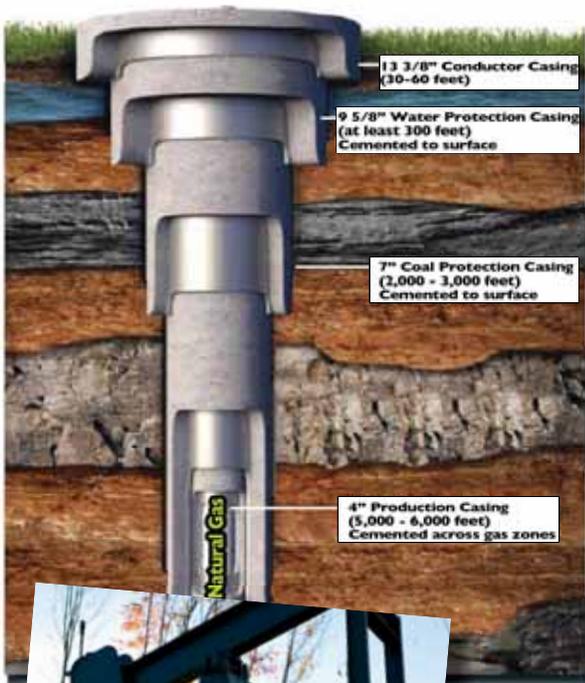


Protecting Virginia's Groundwater

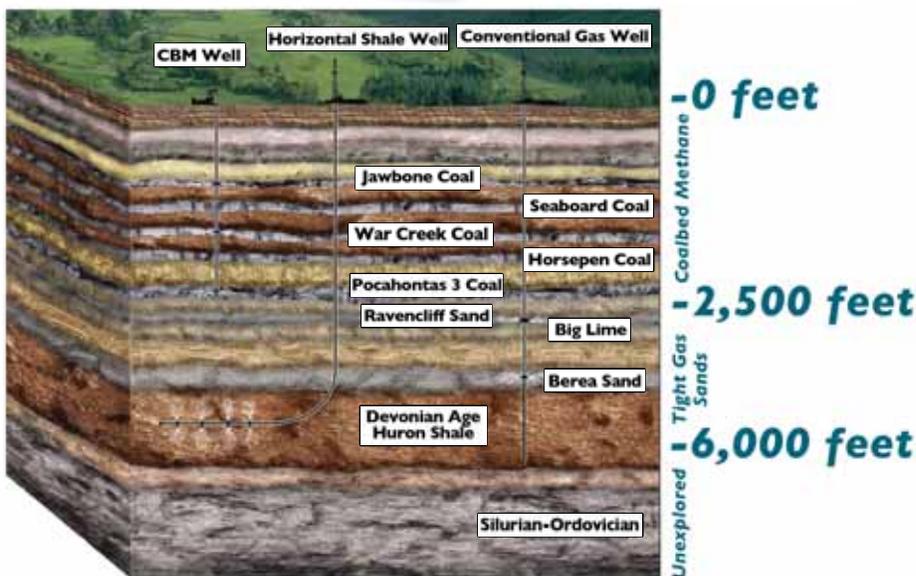
Regulation of Virginia's Natural Gas Industry

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.

Casing Schematic - Not to Scale



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 casings are cemented to surface to isolate natural gas from coming into contact with 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.

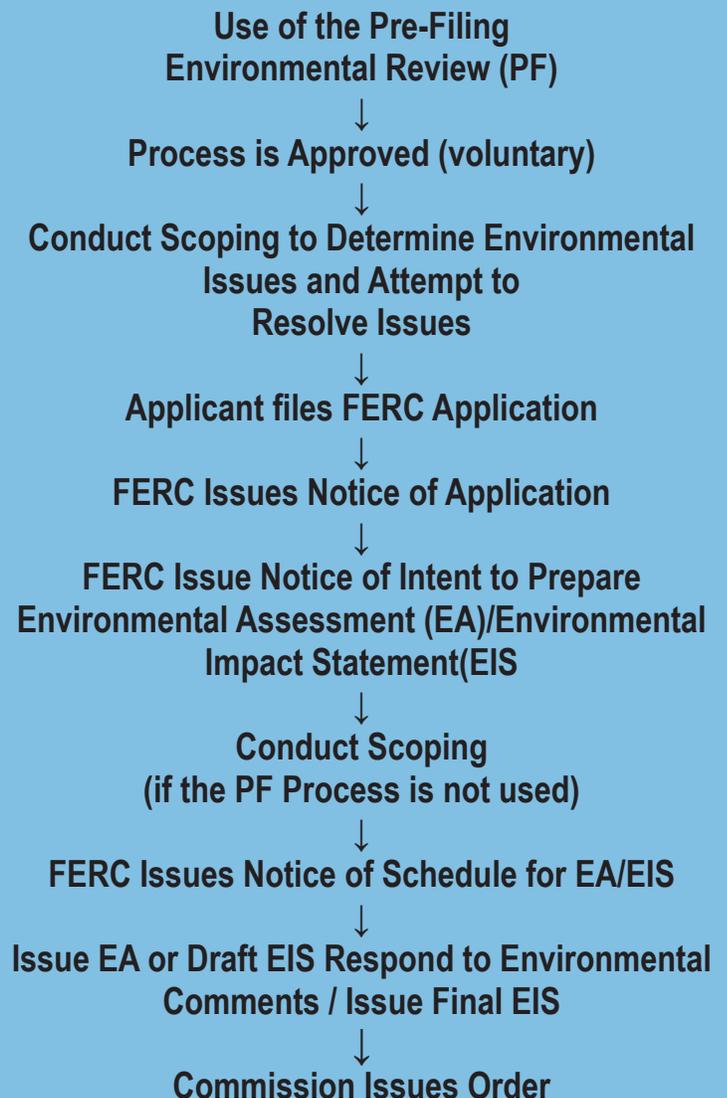
The natural gas pipeline infrastructure is a proven, safe, way to transport energy across the state and country. Pipeline operators take proactive steps to ensure that health, safety, security, and environmental concerns are addressed at all stages, including the planning, construction and operational 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



Virginia's Energy Opportunity

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.

Increased infrastructure needs:

Virginia's growing demands for reliable energy that also meets new regulations are at the forefront of several new projects in Virginia. Natural gas is leading the way to provide that energy due to the fact that it has **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.



"I applaud Governor McAuliffe's goal of making Virginia the manufacturing hub of the Mid-Atlantic, and for pledging to leverage the Atlantic Coast Pipeline to achieve it. Growing our economy in the face of federal cuts will require bringing new industries here, and this pipeline will be an outstanding asset as we work to bring manufacturers here who need access to clean and abundant natural gas."

-- Delegate Lionell Spruill, Chesapeake

"In order to compete globally to attract businesses and create jobs, Virginia must have world-class energy infrastructure that provides abundant access to low-cost energy sources. New natural gas pipelines, like the Mountain Valley Pipeline, will diversify our energy mix, reduce our Commonwealth's carbon emissions, and help build a new Virginia economy."

-- Virginia Governor Terry McAuliffe

Impact of Natural Gas Development

“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

“Today, the number one oil and gas producer in the world is no longer Russia or Saudi Arabia; it’s America. We’re doing it so fast that two years ago, I set a goal to cut our oil imports in half by 2020 — and we will meet that goal this year... Meanwhile, our 100-year supply of natural gas is a big factor in drawing jobs back to our shores. Many are in manufacturing – the quintessential middle-class job.”

-- President Barack Obama, October 2014

“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.”

-- EPA Administrator Gina McCarthy



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