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Panel Discussion Exploring the Challenges of Domestic Natural Gas Production:  
Environmental Risks Associated with Industrial Natural Gas Development and Fracking

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Kristin focuses on issues related to industrial gas development and fracking. This includes work to improve Virginia's oil and gas regulations, as well as to achieve strong local standards and oversight of gas drilling in Tidewater Virginia's Taylorsville Basin.

Kristin also works to protect important resources in the George Washington & Jefferson National Forests, including old growth forest, water quality of headwater streams, wildlife habitat, and remote roadless areas.

Prior to joining SELC in 2014, Kristin worked for McGuireWoods in Charlottesville where she focused on energy litigation and for K&L Gates in Boston where she concentrated on class action litigation.

Kristin earned her J.D. from Northeastern University School of Law and a B.A. from American University.
Virginians in communities that are considering the introduction of industrial gas development with high volume hydraulic fracturing ("fracking"), have significant concerns, including:

- **Environmental Impacts**
  - Water Quality & Water Quantity
  - Air Quality
  - Radioactive materials
  - Seismic activity
  - Associated infrastructure including pipelines

- **Community Impacts**
  - Changes to character of rural, agricultural communities
  - Increased costs for local govt. and taxpayers to absorb
  - Increased Noise
  - Increased Traffic
  - Declining property values

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**Groundwater contamination:**

Groundwater contamination stemming from industrial gas development and fracking is now well-documented in the scientific literature.

In assessing the potential impacts of fracking on drinking water, EPA recently issued new findings proving that fracking activities can lead to water contamination, sometimes rendering drinking water sources totally unusable.

EPA bases the conclusions in this long-awaited final report on more than 1,200 cited scientific sources, feedback from an independent peer review conducted by EPA’s Science Advisory Board, stakeholder input, and new research conducted as part of the EPA study.
EPA intends this report – the most complete compilation to date of national scientific data on this issue – to provide "the scientific foundation for local decision makers, industry and communities that are looking to protect public health and drinking water resources and makes more informed decision about [fracking] activities."

The report identifies conditions known to cause more severe or frequent harm to water resources. These risk factors include:

- Water withdrawals in times of, or in areas with, low water availability, particularly in areas with limited or declining groundwater resources;
- Spills of fracking fluids and produced water that cause large volumes/high concentrations of chemicals to reach groundwater;
- Injecting fracking fluids directly into underground drinking water resources;
- Injecting fracking fluids and chemicals into wells with inadequate mechanical integrity, allowing gases or liquids to move to groundwater resources;
- Discharge of inadequately treated fracking wastewater to surface waters; and
- Disposal or storage of fracking wastewater in unlined pits, resulting in contamination of groundwater resources.

See EPA Study at Executive Summary at 1 to 2.

Among other mechanisms, EPA confirmed 2 major subsurface ways that fracking adversely impacts drinking water resources:

(1) The unintended movement of gases or liquids from the production zone through subsurface geologic formations into drinking water.

"Figure ES-7. Examples of different subsurface environments in which hydraulic fracturing takes place."

See EPA Study at Executive Summary 23-24, 28 (Figure ES-7) and Report at Chapter 6.
And (2) the unintended movement of gases or liquids from the production zone through subsurface geologic formations into drinking water.

"Figure ES-6. Potential pathways for fluid movement in a cemented well. These pathways (represented by the white arrows) include:

(1) a casing and tubing leak into the surrounding rock,
(2) an uncemented annulus..., 
(3) microrannuli between the casing and cement,
(4) gaps in the cement due to poor cement quality, and
(5) microrannuli between the cement and the surrounding rock."

See EPA Study at Executive Summary at 26.

The EPA report includes several examples of adverse impacts on water quality, including:

- **Rainbridge, Ohio**: Inadequate cementing resulted in gas movement to local drinking water aquifers.
- **Killdeer, North Dakota**: After well casings ruptured during fracking, brine and tert-butyl alcohol in nearby water wells.
- **Northeastern Pennsylvania**: Multiple pathways for fluid movement into drinking water, including possible cement issues or sustained casing pressure.
- **Raton Basin, Colorado**: Fluid migration along natural rock features or faulty well seals.
- **East Mamm Creek area, Colorado**: Construction issues, sustained casing pressure, and natural faults/fractures, in conjunction with elevated pressure during fracking, worked together to create path for fluids to migrate into drinking water.

See EPA Study at Executive Summary 30: Report at 6-21, 6-23, 6-53 to 54, 6-71 to 6-72, 10-17, 9-23, 10-17.
Spills and pit failures frequently lead to water contamination.

Spills can occur because of tank ruptures, piping failures, equipment or surface impoundment failures, overfills, vandalism, accidents (including vehicle collisions), ground fires, drilling and production equipment defects, or improper operations.

Spilled fluids can then contaminate surface waters or groundwater, reaching subsurface soils and aquifers.

EPA analyzed spill reports from state agencies, oil and gas well operators, and fracking companies, characterizing 151 spills of fracking fluids or additives on or near well sites in 11 states between January 2006 and April 2012. These spills were primarily caused by:

- Equipment failure (34% of the spills) or
- Human error (25%).

More than 30% of the spills were from fluid storage units (e.g., tanks, totes, and trailers).

Among these 151 spills, the median volume of fluid spilled was 420 gallons, although the volumes ranged from 5 gallons to 19,320 gallons.

See EPA Study at Executive Summary 20.
Other potential impacts on water quality include:

- Polluted stormwater runoff
- Improper waste disposal
- Frack hits or "downhole communication" (i.e., when the fractures of two wells intersect. Fractures move towards the regions of lower pressure, which can be a nearby well bore. Once the channel is established, the pressure can push fracking fluids, as well as oil, gas, and produced water, up the old well bore. Fluids can then overflow at the surface or travel outside the well through a poor or aging cement job, thereby contaminating surface and/or groundwater.)

Water Quantity:
There are also significant concerns related to water quantity. Although the volume of water required for a single fracked well varies depending on many factors, it could be from 2 to 20 million gallons per well. Water for fracking could be obtained from surface water bodies or aquifers.

Cumulative water withdrawal impacts can include:

- Stream flow, surface water and groundwater depletion
- Loss of aquifer storage due to compaction
- Water quality degradation
- Wetland hydrology and habitat
- Fish and aquatic organism impacts
- Significant habitats, endangered, rare, or threatened species impacts
- Existing water users and reliability of their supplies.

Water Quantity Continued:

- The introduction of a new water-intensive industry like gas development using high volume hydraulic fracturing can place an extraordinary burden on already-taxed aquifers.
- Virginia's Northern Neck and the Middle Peninsula, where gas and oil development of the Taylorsville Basin is proposed, face particularly severe or frequent risks because of existing uses already taxing the region's aquifers. Declining water levels, reversal of the hydraulic gradient leading to saltwater intrusion, as well as subsidence and loss of storage are issues are concerns in this area.
- The area is part of the Eastern Virginia Groundwater Management Area. And in 2015, the General Assembly passed legislation to establish the Eastern Virginia Groundwater Management Advisory Committee to address many groundwater-related issues.


Air Quality:

- There is ample evidence of uncontrolled methane leakage, emissions of other volatile organic chemicals, and particulate matter from well pads and associated infrastructure.
- In addition, heavy vehicle traffic and trucks idling at well pads have been determined to be the likely sources of intermittently high dust and benzene concentrations.

This can have drastic adverse impacts on the health and safety of nearby communities, as well as the environment.

See N.Y. Public Health at § N.Y. PSLCEIS at 6:94 to 6:207; Md. Health at xxvii, 26-40.
Air Quality continued:

- These emissions can contribute to community odor problems, respiratory health impacts like asthma exacerbations, and longer-term climate change impacts from methane accumulation in the atmosphere.

- The University of Maryland School of Public Health has documented findings in peer-reviewed journals that those who lived within 1,500 feet of a gas development operation had increased risk of sub-chronic health effects, adverse birth outcomes including congenital heart defects and neural tube defects, as well as higher rates of "throat and nasal irritation, sinus problems, eye burning, severe headaches, persistent cough, skin rashes, and frequent nose bleeds" as compared with those living more than 1,500 feet away.

See R. V. Public Health at S. Md. Health at 13-17, xvi-xxi 26, 40; N. Y. FSGES at 6-94 to 6-207; see also Aaron W. Turtel et al., Associations Between Unconventional Natural Gas Development and Nasal and Sinus, Magnetic Headache, and Fatigue Symptoms in Pennsylvania, 125 Environmental Health Perspectives 189, 196 (2017) available at https://ehp.niehs.nih.gov/docs/content/uploads/125/7/EHP201 all.pdf.

Radioactive Materials:

- Another potential impact of industrial gas development relates to drilling muds and cuttings, which can contain naturally-occurring radioactive materials (NORM) and heavy metals that can leach into groundwater and contaminate soils. In 2013, researchers found that beta radiation levels in pits in Pennsylvania exceeded regulatory guideline values by over 800 percent.

- Virginia’s DMME has not adopted a NORM regulatory program to address the identification, use, storage, transfer, decontamination, or disposal of NORM in order to protect human health and the environment.

Seismic Activity:

- Research regarding the seismic impacts of industrial gas development and fracking is a rapidly evolving area of study. Whereas past research focused on seismic impacts of wastewater injection wells, recent research indicates a clear spatial and temporal correlation associated with fracking and increased seismic activity.

- The data suggests that there is a relationship between fracking and seismicity during the various production phases of a gas well.

- For example, the largest induced earthquake observed in a recent University of Calgary study occurred during the flowback phase of production. In Pennsylvania, four separate seismic events were recorded on April 25, 2016. All four of those events were located within a five mile radius where a gas well operator had begun fracking and stimulation activities at four different well pads. The level and scope of the seismic impacts of fracking is highly dependent on the underlying geology of a given area.


Associated infrastructure: In addition to well pads, the environmental impacts of natural gas infrastructure, including pipelines, is also of great concern to citizens, localities, and businesses throughout Virginia.
These concerns exist for pipeline construction on both public and private lands.

Below: Pipeline construction in Virginia’s Jefferson National Forest.

Above: The proposed route for the Atlantic Coast Pipeline went through the entrance to historic Fort Lewis Lodge in Bath County.

Related to environmental concerns, citizens and localities have significant concerns related to impacts of natural gas development with fracking may have on their communities.

For many, industrial gas development is incompatible with existing land uses.

For example, communities in Tidewater, which overlies the Taylorsville Basin, are largely rural and agricultural.
Traffic: It is estimated that, on average, a multistage well can require upwards of 1,000 truck round trips to deliver equipment (e.g., bulldozers, graders, pipe, chemicals, sand, and water needed for well development and fracturing). Additionally, the wastewater from drilling operations may be trucked offsite for disposal, resulting in even greater numbers of large trucks on local roads.

Potential impacts:
• Congestion,
• Increased collisions
• Air quality impacts from increased traffic
• Spills of hazardous materials and wastewater during transportation

See Md., Potential Public Health Impacts at 83. Id.: see also N.Y. ESGEIS at 6-305.

Noise:
• Industrial drilling operations cause severe adverse noise impacts. During construction of access roads and wells, problematic noise is associated with the use of use of bulldozers, backhoes, other construction equipment.
• Natural gas compressor stations can become a permanent source of noise in the area.
  o Studies have shown that both daytime and nighttime noise levels from compressor stations routinely exceeded maximum allowable noise levels.
  o This noise represents chronic noise exposure that community members would have to encounter for years or decades, not transient exposures that would end after completion of a well.

See N.Y. ESGEIS at 6-234 to 6-295. Md. Findings at 53, 57.
Noise Continued: During the fracking process, the primary sources of noise are:

- **Drill rigs**: typically powered by diesel engines, which generate noise from air intake, crankcase, and exhaust.
- **Air compressors**: typically powered by diesel engines and generate highest level of noise during drilling operations. Would be in operation virtually throughout drilling. More compressed air capacity is required as the drilling advances.
- **Tubular preparation and drilling**: workers physically hammer the outside of drill pipe as it is placed into the wellbore to displace internal debris. During evening hours, this seems to generate the most concern from adjacent landowners.
- **Elevator operation**: used to move drill pipe and casing and add additional pipe to the drill string as the depth decreases.
- **Drill pipe connections**: to connect additional pipe to the drill string. Most operators use air drilling, which generates noise.

See N.Y. FRCEIS at 6-292 to 6-300; 7-132 (drilling and fracking operations are the noisiest phase of gas development and usually continue 24 hours a day); Md. Health at 49-96.

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**Potential Costs to Local Governments and Taxpayers:**

Localities and taxpayers can incur significant expense as a result of industrial gas development, including:

- Costs to adequately train and prepare emergency responders. Many rural areas rely heavily on volunteer emergency response.
- Damage to local roads, bridges and other infrastructure-increased maintenance requirements.
- Costs to implement operational and safety improvements.
- Damage to investments in scenic and recreation-based tourism or ecotourism.
Property Values:

- Property values may be negatively affected by the impacts associated with gas development.
- After examining studies on this topic, Maryland's Department of the Environmental and Department of Natural Resources concludes that:

  "[D]rilling activity clearly has an impact on property values. This impact is generally negative, and results in a drop in property values. This impact is felt the most strongly for properties nearest active well sites. This can negatively affect resale values and property taxes, and can persist for many decades after drilling stops."

Md. Findings at 74-75; see also: See N.Y. EIS at 6-253 to 6-257

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Relevant Virginia Law
**Virginia Gas and Oil Act:**

- The Virginia Gas and Oil Act applies statewide. Va. Code Ann. §§ 45.1-361.1 to 45.1-361.44.
- "[N]o provision of this chapter shall be construed to limit or supersede the jurisdiction and requirements of .. local land-use ordinances[,]" § 45.1-361.5.

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**Gas Development in Tidewater:**

- Virginia Code also provides additional requirements for gas or oil development in Tidewater. Va. Code Ann. § 62.1-195.1
DMME REGULATIONS


- Amended regulations went into effect in December 2016. They include:
  - Mandatory disclosure of fracking chemicals,
  - Establishment of baseline water testing and monitoring, and
  - Implementation of spill prevention and response planning.
Local land use ordinances:

- In August 2016, King George County's Board of Supervisors unanimously voted to amend the County's zoning ordinance to restrict any future drilling to 9% of the County and enacted other restrictions.
- In February 2017, Augusta County's Board of Supervisors voted to amend the County's zoning ordinance to prohibit fracking and added special use permit conditions for any future traditional drilling.

Other Relevant Materials
U.S. EPA. Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States (Dec. 2016)

- Additional materials available at https://www.epa.gov/hfstudy

New York Environmental Analysis materials

- In 2015, the New York Dept. of Envl. Conservation, after 7 years of study and environmental review, prohibited fracking, concluding there are “no feasible or prudent alternatives that would adequately avoid or minimize adverse environmental impacts and that address the scientific uncertainties and risks to public health” from fracking.


• **Maryland Legislation and Environmental Analysis materials:**
  
  - In 2017, Maryland’s legislature voted to ban fracking.
  
  
  
  
U.S. marketed natural gas production increased more than 50 percent between the decade 2005 and 2015 and the U.S. has emerged as a world leader in natural gas production. If the 1966 resource estimate of 690 trillion cubic feet (TCF) had remained static, the U.S. would have run out of natural gas more than 10 years ago. Instead, estimates doubled by 2002 and in 2013 grew to nearly 2,400 TCF. There is more than enough natural gas to accommodate exports and domestic consumers to the benefit of the U.S. economy and environment.

Natural gas is spurring U.S. economic revitalization. Consumption of natural gas in the U.S. industrial sector now exceeds pre-recession levels, indicating an economic revival of U.S. manufacturing. Consumer demand for natural gas has been steadily growing since 2009, and for all the right reasons: it is abundant, burns clean and it is affordable. Responding to U.S. natural gas supply growth, U.S. industry is expected to invest $100 billion over the next half decade to restart previously shuttered industrial facilities or expand approximately 100 new U.S. facilities in the fertilizer, steel, petrochemical and paper industries. Access to abundant domestic natural gas has given U.S. industrial companies a competitive advantage over their global competition, leading to the resurgence of natural gas-intensive manufacturing in the United States and the creation of more jobs to construct and staff the resulting new and expanded industrial facilities.

These economic benefits do not stop at the U.S. border. U.S. natural gas exports extend the economic benefits that stem from robust U.S. natural gas production to the rest of the world, fueling the world economy that will in turn help continue U.S. economic growth. Additionally, LNG export capability assures a long-term and diverse market.

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2 The 2014 National Economic Research Associates (NERA) study cites the Progressive Policy Institute’s October 2014 Policy Memo “Exporting U.S. Natural Gas: The Benefits Outweigh the Risks” by Derrick Freeman explains the economic benefits that result from increased levels of liquefied natural gas (LNG) exports.
for natural gas, making U.S. supplies even more resilient to short-term changing U.S. market conditions.

Additionally, in recent years, greater use of natural gas for electricity generation has produced significant reductions in U.S. carbon emissions because, over its lifecycle, natural gas emits only about half the carbon of other fossil fuels when combusted, whether to make electricity, forge steel or provide heat. Because of these and additional advantages over other fuels in sulfur dioxide, mercury, nitrogen oxide and particulate matter emissions, natural gas is poised to become an even more important part of energy portfolios, thus facilitating achievement of climate objectives.

Market-driven natural gas consumption which is used to generate electricity helped the U.S. achieve power sector carbon emissions reductions that were below 2005 levels. \(^3\) Beyond serving as baseload and ramping units, natural-gas fired power generation also provides necessary back-up to intermittent resources that is essential to ensuring reliability. While fuel diversity is always essential and smart, natural gas remains the most economically and environmentally sound power generation investment available today.\(^4\)

Growth in natural gas supplies, expansive natural gas delivery infrastructure, unrivalled natural gas storage capability, and robust natural gas commodity markets have facilitated increased use of natural gas by U.S. industry and utilities. There is little doubt that natural gas is paving the way for reduced carbon emissions from the electricity generation sector and U.S. manufacturing growth.

Robust natural gas supplies and a well-functioning, transparent natural gas commodity market allow the achievement of climate objectives and economic revitalization to be accomplished “hand-in-hand.” It’s a match made in heaven. With the industry still exuberant from the newly realized economic and environmental potential, Fordham will highlight lurking market changes to spark a conversation about an emerging and essential role for natural gas industry leaders.


The U.S. would have run out of natural gas more than 10 years ago if the 1966 resource remained static.

Natural gas = “2 for 1” deal!
A study of 1,200 leaders found that 60% of senior execs admit that their organization had been blindsided by 3+ high-impact events within 5 years.

—Wharton Executive Education

"Hello, Emily. This is Gladys Murphy up the street. Fine, thanks... Say, Emily, could you go to your window and describe what's in my front yard!"
Natural gas positioned U.S. to lead world in cost-effective carbon emissions reductions

Yet, the economic and environmental potential of natural gas is at risk until we change the dialogue.
How natural gas is sourced has changed dramatically over the past decade. Ten years ago, the majority of natural gas delivered to the Mid-Atlantic region, and to Virginia specifically, was sourced from the Gulf of Mexico, and then traveled long-haul on the pipeline system for eventual delivery to the utilities in Virginia. With the advent of horizontal drilling and the ability to extract natural gas economically from newly discovered shale plays, the majority of our regional natural gas is now being sourced from West Virginia, Pennsylvania, and Ohio. This has completely changed the factors that impact natural gas pricing. Hurricanes in the gulf region, which could cause natural gas prices to swing more than a $1 per Dth, now only have a very small impact on prices, as less than 5% of our current natural gas production comes from the Gulf. Also, how natural gas is priced has changed dramatically. Typically, gas was cheaper the closer to the Gulf, and became more expensive the farther north the supply had to travel, making a delivery point such as Maryland more expensive than North Carolina. Since it is now a shorter haul to deliver gas from West Virginia to Maryland, and since most of the pipeline infrastructure developments started in the north to bring cheaper shale gas to large markets such as New York and New Jersey, prices to delivery points in the south are actually more expensive now.

This major change on how gas is sourced in our region has also led to significant changes to our pipeline grids. While most pipelines moved gas in only one direction, from the south to the north, with the ability to produce large amounts of gas in the north, we are seeing more and more projects to reverse flow on pipelines, to bring the cheaper shale gas to these now higher priced markets in the south. We are seeing several such projects to bring additional pipeline capacity to Virginia, including Williams’ Atlantic Sunrise project, Dominion’s Atlantic Coast Pipeline, and Mountain Valley Pipeline.
The Commonwealth has not had any significant interstate pipeline infrastructure development or upgrades since the 1980’s. Many portions of the state can only accept gas off of one pipeline, and areas such as Richmond, Chesterfield, Isle of Wight, Smithfield, and Portsmouth can only bring in natural gas on Columbia Gas Transmission, which has been fully subscribed for their firm pipeline capacity service to these areas since the 1980’s. Unfortunately, in the twenty years that I have worked with industrial clients to source natural gas supply and capacity in Virginia, I have seen several proposed plants as well as expansion plans for existing industrial sites in Virginia, end up going to other states where firm natural gas supply was available. It is imperative for our competitive edge and future growth opportunities for the Commonwealth to have available firm pipeline capacity to meet growing demand. Natural gas remains the energy supply source of choice for industrial, commercial, and residential demand in Virginia.

With our current large supply of natural gas in the U.S., natural gas pricing is also fairly stable. After seeing natural gas spike to a high NYMEX settle of $13.907 per Dth after Hurricanes Rita and Katrina, natural gas NYMEX pricing has averaged from $4.415 and below on an annual basis. Weather remains a strong driver for pricing, but instead of hurricanes, the focus is really on how cold the winter is, when we typically see our highest commercial and residential demand due to heating requirements. Now that we are seeing a great number of coal plant retirements for electricity generation, summer cooling load needs are also significantly impacting natural gas prices. In 2016, natural gas prices hit a 17-year low. Prices dropped so low, that several producers filed for bankruptcy production, and many of the major producers significantly cut back on their exploration and production budgets for 2017. Despite a more than $1 per Dth increase in NYMEX pricing, production levels have been slow to recover so far in 2017. Also, as we see new infrastructure projects connecting to cheaper shale pooling points, we are seeing a shift in pooling point pricing. Dominion South Pool has seen more than a 100% increase in pricing from its lows in 2016, as more takeaway capacity has allowed previously stranded gas to get to new and more expensive markets. In the Commonwealth, this has meant a significant increase in natural gas prices to industrial customers behind Virginia Natural Gas when compared to last year, but actually lower prices to industrial customers behind portions of Columbia Gas of Virginia.

Virginia is really a “Tale of Two Cities”, where portions of the state have very limited availability to firm pipeline capacity, causing delivered natural gas pricing to be as much as $.50- $1.00 per Dth higher than other portions of the Commonwealth. Our access to multiple sources of natural gas supply, on a firm, reliable pipeline capacity basis is essential for our ability to attract and keep new business in Virginia.