"High Volume Hydraulic Fracturing" Natural Gas Development in Tight Shale

A Perspective:
Energy Production vs. Environmental Liability

Presented to:
New York Insurance Association, Inc.

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Agenda

- **Energy Overview**
  - Comparison of Energy Sources, Demand, Projections
  - Potential Environmental Impacts from Energy
- **Natural Gas**
  - Advantages and Disadvantages
- **Natural Gas in Shale**
  - The Drilling and HVHF Process
- **Environmental Considerations**
- **Specific Potential Environmental Risks**
- **Legal and Regulatory Control Measures**
- **BMPs/Risk Mitigation Strategies**
- **Insurance Industry Response**
- **Conclusions**

Energy Overview-
Understanding the Issue of Energy

Let's take a look at some global and US energy statistics…

Figure 1. World marketed energy consumption

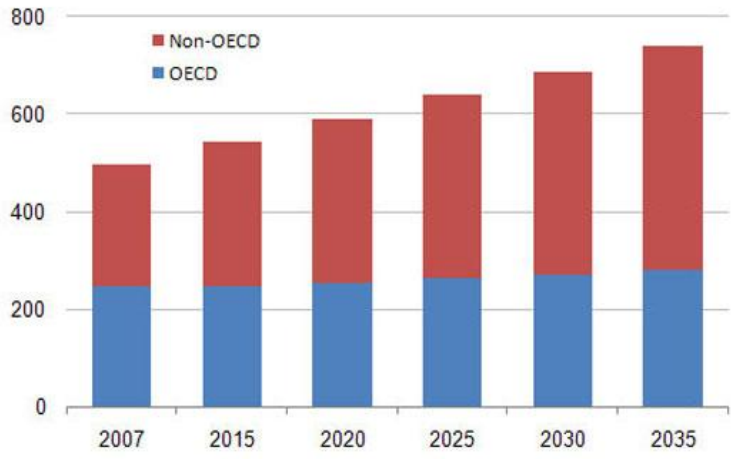
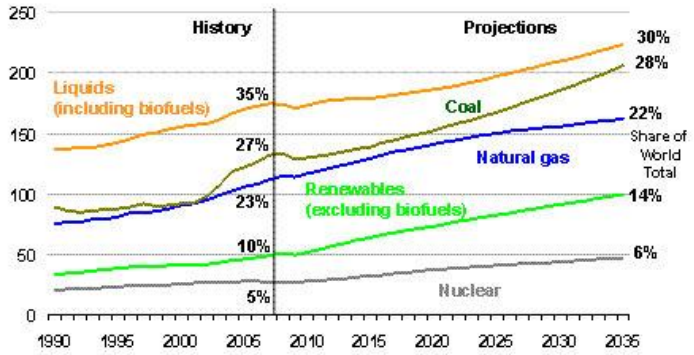


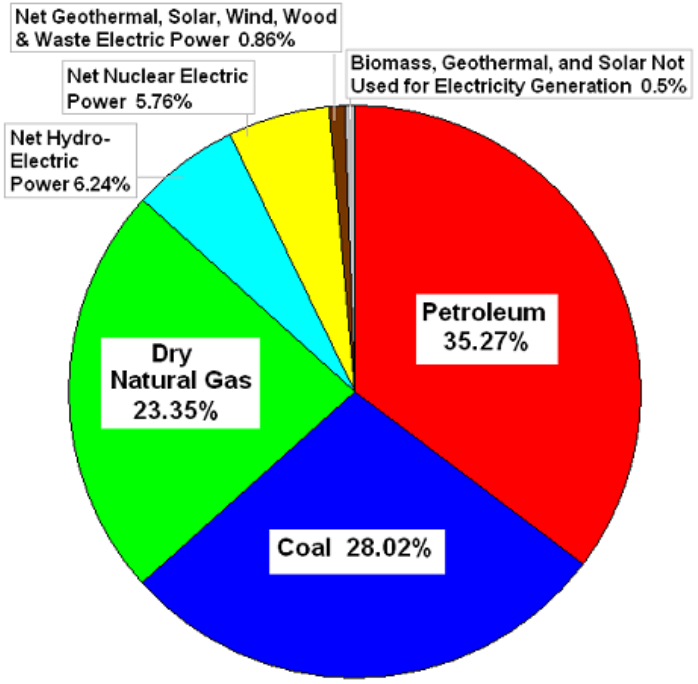
Figure 1. World marketed energy use by fuel type (quadrillion Btu)



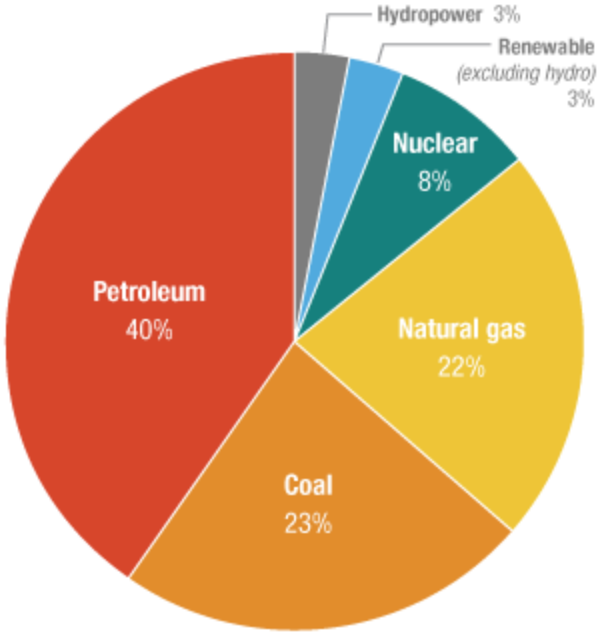
eia International Energy Outlook 2010

Source: EIA

Global Energy Use vs. U.S. Energy Use



World Consumption 2006



U.S. Consumption 2006

Source: EIA

Environmental Impacts from Energy

- ***Air Emissions from Combustion***

  CO_2, CO, NO_x, SO_2, particulates, Hg , VOCs

- ***Smog***

  Ground level O_3, and haze

- ***Acid Rain***

  SO_2 and NO_x

- ***Greenhouse Gases***

  Water vapor, O_3, CO_2, CH_4, NO_x, CFCs

Source: EPA

Other Potential Environmental Impacts From Energy Production and Use

- Production:
  - Land, and ecological impacts
  - Chemical and fuel management
  - Spills and releases
  - Explosion or fire
  - Water use
  - Waste management and disposal
- Transportation:
  - Fuel storage terminals, pipelines, rail, trucks
  - Infrastructure- roads, rail tracks, ROWs
  - Noise and traffic
  - Spills and releases
- Storage & Consumption:
  - Fuel storage and containment
  - Spills and releases

Other Potential Environmental Considerations

- Renewable energy sources have environmental impacts too!
- Based upon the fuel source- the risk of one impact may be “traded” for another
- Environmental risks may decrease for one “media” and increase for another

Non-Environmental Energy Drivers

- Energy security- political volatility
- U.S. reserves and ability to control the source
- Currency exchange factors
- Price
- Ability to deliver without interruption
- Cost to deliver
- Ability to meet demand

So What are the Advantages of Natural Gas?

- Burns cleaner than oil or coal (less emissions and specifically CO_2)
- Easily transportable by pipeline
- Available infrastructure for heating and power generation
- Can be used in mobile sources
- It is abundant in U.S. and price is less volatile
- Can be used for heating and electrical generation
- Generally more economical than oil or electricity
- Economic benefit to the drilling region

There are Some Disadvantages…

- Gas is a “fossil fuel” that has emissions- air pollutants from combustion and fugitive emissions from leaks
- Mostly methane which is a greenhouse gas (21x global warming potential of CO_2 but much less in quantity)
- Explosion and fire is a real risk
- Need infrastructure to use and transport
- Potential for leaks
- Exploration and production has potential impacts on land, ecosystems and water

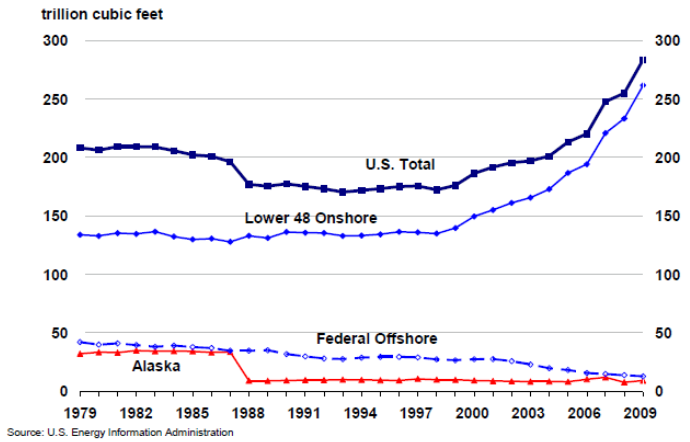
So the Challenge Is?

- ✓ …Two critical issues to balance:
  - energy reliability and security
  - environment protection
- ✓ Potential risks exist but the benefits could be huge
- ✓ The “hotbed” issue today- horizontal drilling with high volume hydraulic fracturing is needed to get the gas!

Natural Gas- Background Information

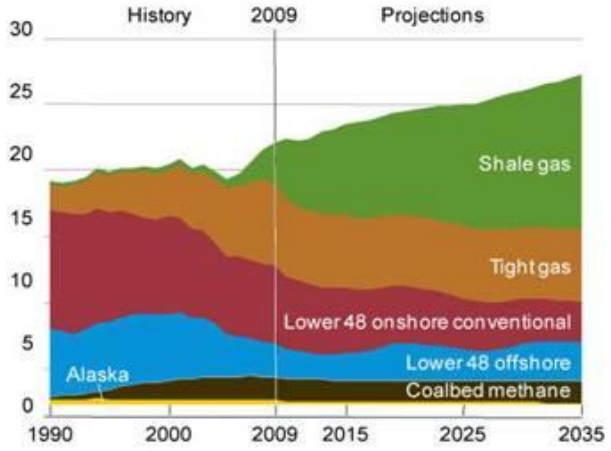
- The first natural gas well was drilled in the U.S. (in Fredonia) back in the 1821
- Huge amounts of natural gas were found in TX and OK in early 1900's
- Natural gas now supplies over 25% of our energy consumed
- Proven domestic natural gas reserves are increasing
- Projected natural gas production will increasingly come from unconventional sources like shale
- Marcellus shale reserves continue to rise as drilling expands
- Estimates and projections are large (as much as 500TCF) but continue to vary

Figure 1. U.S. Wet Natural Gas Proved Reserves, 1979-2009



Source: U.S. Energy Information Administration

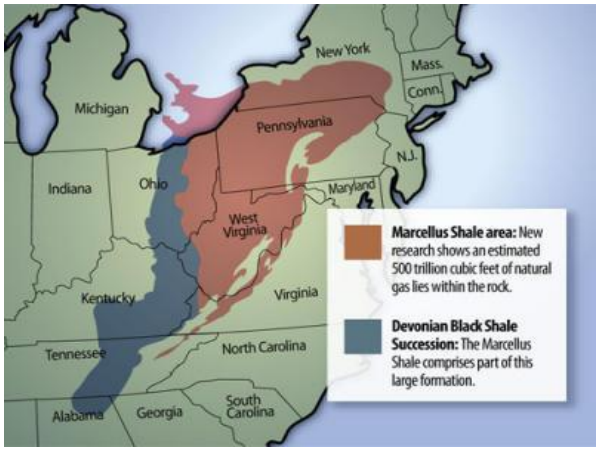
Figure 2. U.S. natural gas production, 1990-2035
(trillion cubic feet per year)



Source: EIA Annual Energy Outlook 2011

Marcellus Shale Formation

- Shale is a sedimentary rock formed from the compaction of clays, silt and minerals
- Shale is made of thin layers that split into thin pieces
- Gas is trapped in the tiny pore spaces of shale by the decay of organics
- The Marcellus shale is black, low-density organic rich shale located under WV,OH, PA and NY and is approximately ½- 1 mile below the surface.
- Several other shale formations sit above the Marcellus and separate it from the surface
- A deeper shale, the Utica shale, is also of interest and is deeper than the Marcellus
- Horizontal drilling utilizing hydrofracturing makes extracting this gas viable



Natural Gas Horizontal Well Drilling Process

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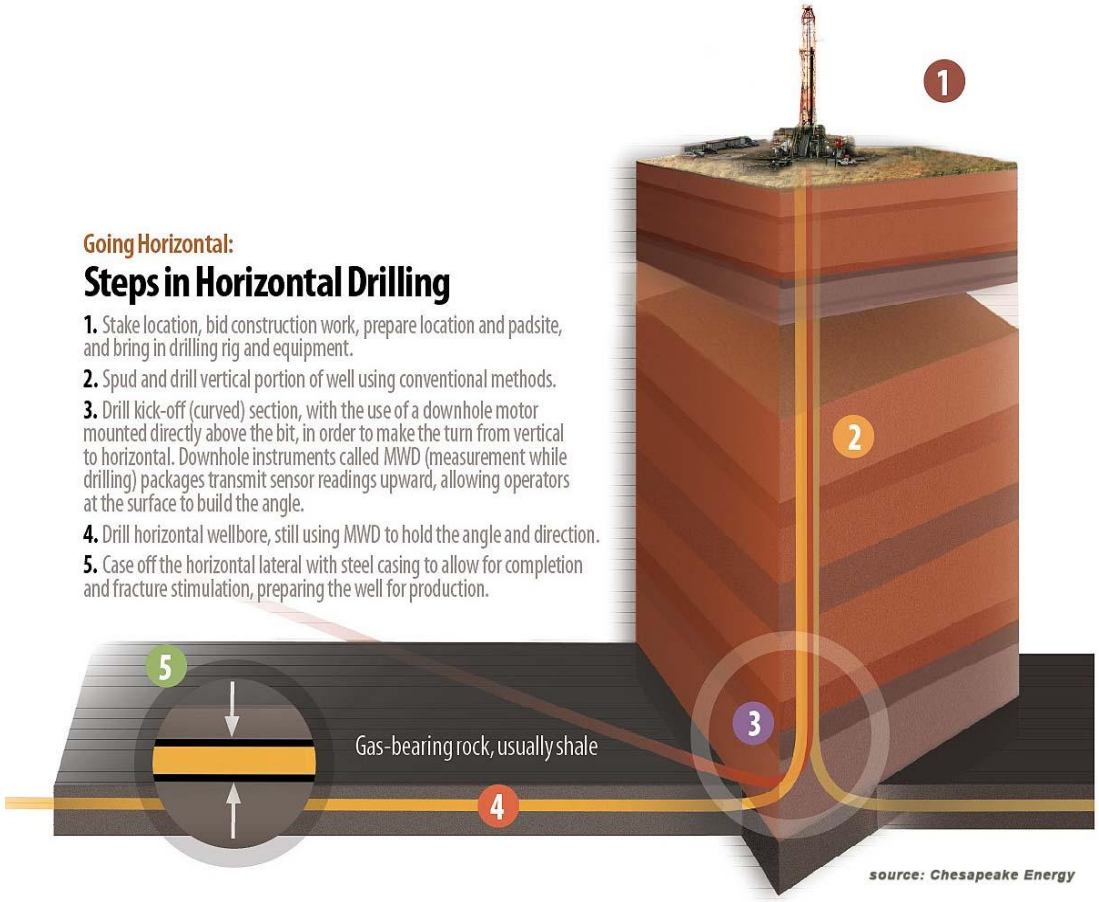


Natural Gas Horizontal Drilling Process

- The single well pad site is approx. 7 acres to access 640 acres of gas production and is prepared for drilling
- Drilling is performed in stages and lasts 21-28 days 24/7 using larger to progressively smaller drill bits until completion
- Large diameter hole 50-80 ft. deep- “conductor casing”- cemented
- Rotary air drilling to 100-200 ft. below the freshwater-bearing zone- “surface casing”- cemented
- Rock cuttings removed and disposed
- Install “blowout preventer” on well

Natural Gas Horizontal Drilling Process

- Continued drilling using drilling mud several thousand ft. and above the “target zone”
- Install the horizontal drilling tool to “turn” drilling to an additional 4000 ft. of drilling
- Install “production casing”- cemented
- Install production tubing
- Pressure testing throughout the drilling process

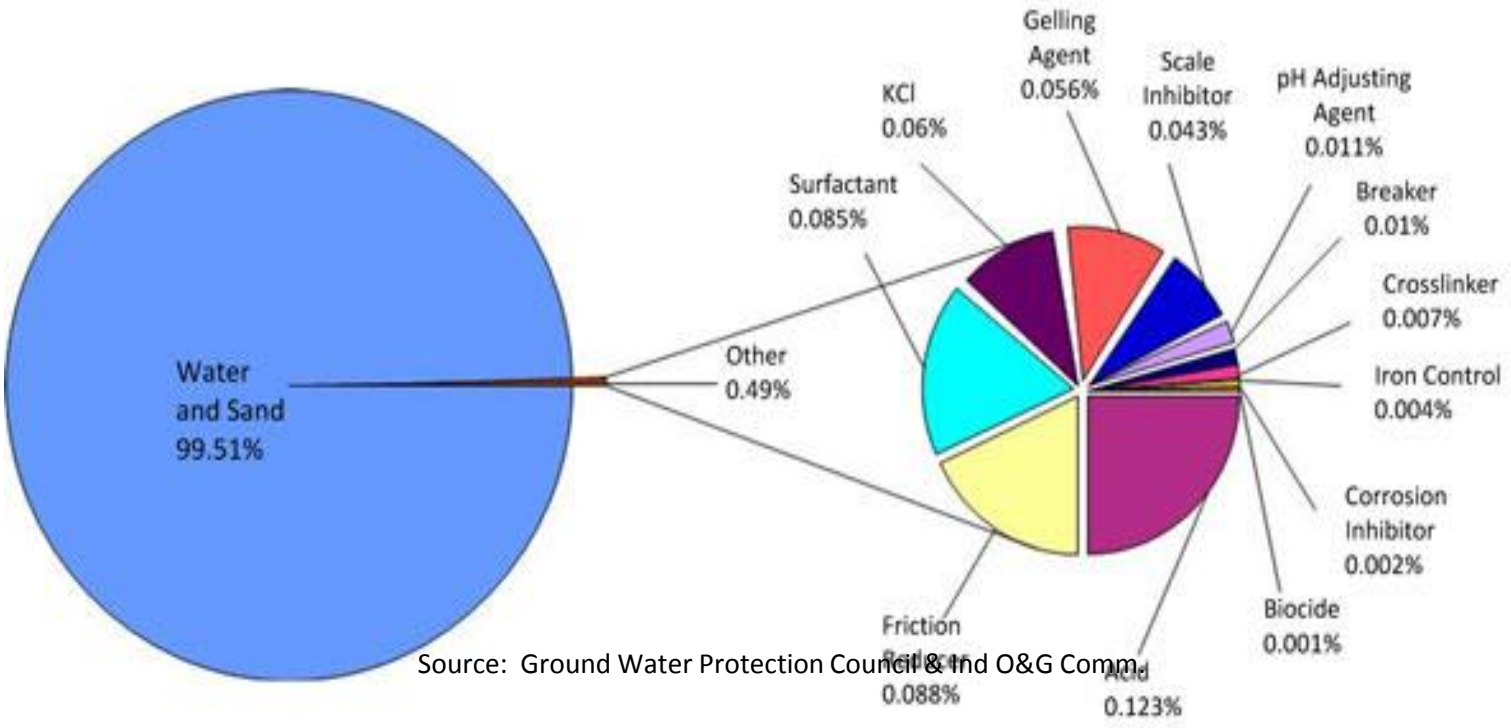
Method provides 7 layers of protection from the drilling process

High Volume Hydraulic Fracturing Process

High Volume Hydraulic Fracturing Process

- The horizontal portion of the casing is “perforated” at intervals using a perforating gun and explosive charges
- Water is blended with “proppant” (sand) and a small % of hydraulic fracturing fluid additives
- Fracturing fluid is pumped under high pressure into the well until the shale “fractures” along natural weaknesses
- Proppant solution is added to hold the fractures open
- Fracturing is repeated in contained zones
- 2- 8 million gallons of water may be required
- Fluid “flows back” to containment units for treatment, reuse or disposal.

Hydraulic Fracturing Fluid Contents



Source: Ground Water Protection Council & Ind O&G Comm.

See handout for list of commonly used chemical additives

CE Test Question:

What the heck is a RDSGEIS????

Environmental Considerations in EIS

- Water withdrawal from surface or ground water affecting water availability, ecosystems, wetlands – *"0.24% of NY's usage"*
- Runoff, spills or leaks from construction and operation
- Ground water impacts from drilling- possible releases to water sources considered *"highly unlikely"*
- Wastewater disposal- proper treatment and permits
- Methane gas migration- *"no new significant adverse impacts"*
- Flood concern- affect on pad site
- Disposal of well cuttings- proper disposal
- NORM in cuttings- *"not significant"*

Environmental Considerations (cont)

- Affect on endangered or threatened species
- Fragmentation of species habitat
- Transfer of invasive species
- Potential air contaminants- methane, carbon dioxide, sulfur dioxide, nitrous oxide, particulates, organics, hydrogen sulfide
  - Will require an air monitoring plan
- Climate Change- carbon dioxide, methane
  - Will require green house gas mitigation plan
- Affect on "viewscape", noise and traffic
- Radiation in systems
- Seismicity

Potential Environmental Risks and Liabilities

- Ecosystem damage during construction of well pad
- Excessive noise, dust or visual impact
- Impact on a water resource due to water withdrawal
- Impact on roadways and infrastructure
- Improper treatment and disposal of flowback water
- Improper disposal of drilling cuttings
- Contamination of water supply from casing failure
- Explosion and fire from the release of methane gas
- Release of fluids from storm events, spills or containment failure

Legal & Regulatory Control Measures

- **Ownership** of oil and gas rights- private landowner
- **Regulations**- Federal, State and Local
- **Agencies**- U.S. Dept. of Energy (DOE) and Federal Energy Regulatory Commission (FERC)
- **Federal Law**- Energy Policy Act of 2005
- **State Law**- Oil and Gas, Mining and Reclamation Law (Env. Conservation Law Article 23), State Environmental Quality Review Act- environmental review of process
- **Environmental Regulations** for permitting- DEC Mineral Resources group- protection of land, water and air

Legal & Regulatory Control Measures (cont)

- Other agencies involved:
  - Susquehanna River Basin Commission
  - Delaware River Basin Commission
- New York's State new water withdrawal law (2011)- permit for withdrawals > 100,000 GPD
- Local entities and laws:
  - NY City Department of Environmental Protection
  - Local laws being enacted to ban gas drilling and/or hydraulic fracturing

Best Practices MUST Be Employed

- Proper pad site construction with minimal land footprint, impacts, access, infrastructure
- Protection of ecological and cultural resources
- On-site chemical and water management to prevent releases to air, soil and groundwater
- Storm water management and spill containment
- Minimal noise, dust, viewscape, traffic impacts
- Proper well construction with multiple layers of cemented containment

Best Practices MUST Be Employed (cont)

- Hydraulic fracturing fluids with minimal additives
- Minimal water withdrawal for hydraulic fracturing
- Fluid containment, recycling, treatment and disposal
- Proper cutting containment and disposal
- Proper production, transmission and storage
- End of life pad restoration plan

- Emergency response planning and preparation

The “First” Best Practice…

… an aggressive, honest and interactive community communication campaign…

“Reputational risk” should be one of the top priority concerns!

Insurance Industry Response To Date

- Drilling in the Marcellus is an “emerging issue” requiring caution- coverage will slow and deliberate
- Exclusions for “fracking”
- Vast economic opportunity with potential environmental challenges- look to PA
- Use collective knowledge of industry, government and experts to allow drilling under stringent regulation and prevent impacts
- Carriers will require greater information and data in applications for environmental coverage
- Larger carriers will lead the way

Conclusion

- Horizontal drilling with HVHF must be examined in the context of overall energy sources, benefit and risk
- Potential environmental impacts exist and involve soil, land use, ecosystems, air and water
- Significant data related to natural gas drilling shows limited impacts to date
- Limited data in the Marcellus warrants diligence
- Strong regulatory oversight and controls with best practices in the industry
- Risk management and transfer techniques are evolving to respond to the need as drilling expands

Thank You!

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