FRACKING 101

What You Need To Know

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Energy needs in the U.S.
- Consumption continues to outpace production
- Reliance on unstable foreign sources (primarily affects OIL supplies)

Sources of energy (% of total consumption in 2014)
- Petroleum (35%)
- Natural Gas (28%)
- Coal (18 %)
- Renewables (10%)
- Nuclear Electric Power (8%)

http://www.eia.gov/energy_in_brief/article/major_energy_sources_and_users.cfm
Ratio of domestic energy production to consumption
(1949 - 2013)
Unconventional Resources
Oil & Natural Gas

- Rock formations with low permeability
  - Shale
  - Tight “sands”
  - Coalbed methane

- Resource development
  - ↑ price of natural gas
  - Technological advances
    - Horizontal drilling
    - High volume hydraulic fracturing, aka “fracking”
Unconventional versus Conventional Natural Gas Resources

↓ Horizontal well

Vertical well

[Diagram showing comparison between vertical and horizontal wells, including layers such as Land surface, Coalbed methane, Conventional associated gas, Conventional non-associated gas, Seal, Sandstone, Tight sand gas, Gas-rich shale, Oil, and U.S. Energy Information Administration logo.]

http://www.eia.gov/oil_gas/natural_gas/special/ngresources/ngresources.html
Price of Natural Gas Drives Drilling

Weekly natural gas rig count and average spot Henry Hub

active rigs

$ per MMBtu

Source: Baker Hughes
The Marcellus Shale

- Named after Marcellus, NY
- ~384 million years old
- ~2000 to 9000+ ft below surface
- Formed from organic-rich mud
  - Shallow sea environment
  - Natural gas and brine trapped in rock pores
  - Highly radioactive
Marcellus Shale Area

Marcellus Shale area: New research shows an estimated 500 trillion cubic feet of natural gas lies within the rock.

Devonian Black Shale Succession: The Marcellus Shale comprises part of this large formation.
High-pressure injection of special fluids
- Occurs in ~4 to 20 intervals along horizontal section
- ~3 to 5 million gallons of water used per well

Composition of fracking fluid
- Water (90 – 95%), sand as proppant (7 – 9.5%)
- Chemicals, hazardous and nonhazardous (.5 – 3%)

“Wastewater” and solid waste produced
- ~10 to 70% fracking fluid flows back to surface
- Includes brine, contaminants from Marcellus shale
Five-acre well pad
Road construction
24/7 work schedule
3-4 months to complete
Open, lined pit for wastewater
Extensive diesel truck traffic, ~1000 trips/well
Cost of drilling ranges from $5-7 million
Chemicals Used in Fracking Fluids

- >300 chemicals identified by NYSDEC
- Proprietary chemical compounds, mixtures
- 80 to 350 tons of chemicals per well
- Types of chemicals, examples
  - **Acids**: dilute hydrochloric acid
  - **Biocides**: bromine-based, glutaraldehyde
  - **Scale inhibitors**: ethylene glycol
  - **Friction reducers**: polyacrylamide
<table>
<thead>
<tr>
<th>Fracking Chemicals</th>
<th>Health Effects (dose-related)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,2-Dibromo-3-Nitrilopropionamide</td>
<td>Corrosive to eyes; throat/lung irritation; pulmonary edema</td>
</tr>
<tr>
<td>Ethyl benzene</td>
<td>Kidney and reproductive problems</td>
</tr>
<tr>
<td>Ethylene Glycol (antifreeze component)</td>
<td>Kidney function; acid/base balance; nervous system, lungs, cardiac</td>
</tr>
<tr>
<td>Glutaraldehyde</td>
<td>Asthma; throat/lung irritation, wheezing; conjunctivitis</td>
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<tr>
<td>Naphthalene</td>
<td>Damage to liver, kidneys, eyes; anemia</td>
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<tr>
<td>Xylene</td>
<td>CNS, eyes, skin, respiratory system, GI tract, blood, liver, kidneys</td>
</tr>
<tr>
<td>Toluene</td>
<td>Cardiovascular, neurological</td>
</tr>
</tbody>
</table>
Environmental Health Issues

- Water contamination
- Air pollution
- Waste disposal (solid & liquid)
- Traffic
- Noise, lights
- Economic, social conditions
- Healthcare infrastructure
- Drilling accidents, violations
Groundwater Pollution Issues

- **Methane migration**
  - Faulty casing, excessive well pressures
  - Cement fails over time
  - Simple asphyxiant
  - Forms explosive mixture with air at <5%

- **Leaky wastewater pits**

- **Accidental spills, blowouts, violations**
Onsite Wastewater Pits
Surface Water Pollution Issues

- Treated wastewater discharged to streams
  - Treatment inadequate
  - ↑TDS, radioactive elements
  - Bromide reacts with chlorine to produce THM
    - THM linked to cancer, birth defects
- Accidental spills, blowouts
- Illegal dumping (affects surface and groundwater)
Local & Regional Air Pollution

- Formation of ground-level ozone
  - Production of ozone precursors at drilling sites
    - Diesel exhaust
    - Methane emissions
    - Flaring of gas wells, venting of condensate tanks
  - $\text{NO}_x$ & VOCs react with sunlight, form ozone
  - With new EPA regulation, 33 PA counties will be in nonattainment for ground-level ozone

- $\text{PM}_{2.5}$
- $\text{SO}_2$
## Drilling Waste in PA, 3,922 Wells

### Jan-Jun 2012

<table>
<thead>
<tr>
<th>Waste Type</th>
<th>Barrels (42 gal/bbl)</th>
<th>Tons</th>
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<tbody>
<tr>
<td>Basic sediment</td>
<td>3,746</td>
<td></td>
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<tr>
<td>Drill cuttings</td>
<td></td>
<td>618,272</td>
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<tr>
<td>Drilling fluid</td>
<td>1,162,880</td>
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<tr>
<td>Flowback fluid</td>
<td>3,818,866</td>
<td></td>
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<tr>
<td>Flowback fracturing sand</td>
<td></td>
<td>13,429</td>
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<tr>
<td>Produced fluid</td>
<td>7,153,833</td>
<td></td>
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<tr>
<td>Servicing fluid</td>
<td>6,233</td>
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<tr>
<td>Spent lubricant</td>
<td>2,521</td>
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<tr>
<td><strong>Totals</strong></td>
<td><strong>12,148,081</strong></td>
<td><strong>631,707</strong></td>
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<tr>
<td></td>
<td>(510,219,402 gal)</td>
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</tbody>
</table>
Traffic Issues

- ~1000 truck trips per well
- Damage to infrastructure
- ↑ accidents, spills, traffic violations
Noise Issues

- 24/7 truck traffic during well development
- Low-frequency noise from completed wells
  - Annoyance, stress, irritation, unease
  - Fatigue
  - Headache, adverse visual functions
  - Disturbed sleep
Economic Issues

- **BOOM**
  - Decreased unemployment, skill dependant
  - Increased revenue for some businesses, landowners
  - Increased homelessness, competition for housing
  - Increased needs for healthcare

- **BUST**
  - Economic uncertainty
  - Decrease in population
  - Ecological, human health costs to communities
Social Issues

- Divided communities
- Vulnerability to mental health problems
  - ↑ Stress
  - Anxiety
  - Depression
- Potential ↑ STDs

[Image: Support American Energy, Lets Frack!]

[Image: Division and vulnerability to mental health problems with arrows up for stress, anxiety, and depression.]
Healthcare Infrastructure Issues

- ↑ Emergency response in rural areas
- ↑ Psychological, psychiatric healthcare needs
- Unknown public & occupational health problems
  - Lack of transparency in drilling chemicals used
  - Lack of research
- Act 13 became law on February 14, 2012
  - Protects proprietary information on chemical compounds
  - Healthcare workers must sign confidentiality statements
# Drilling Violations

**January 2011 - August 2014**

<table>
<thead>
<tr>
<th>Company</th>
<th>Environmental and Health Violations</th>
<th>Rank</th>
</tr>
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<tbody>
<tr>
<td>CABOT OIL &amp; GAS CORP</td>
<td>265</td>
<td>1</td>
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<tr>
<td>CHESAPEAKE APPALACHIA LLC</td>
<td>253</td>
<td>2</td>
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<tr>
<td>RANGE RESOURCES APPALACHIA LLC</td>
<td>174</td>
<td>3</td>
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<tr>
<td>CHIEF OIL &amp; GAS LLC</td>
<td>150</td>
<td>4</td>
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<tr>
<td>SWEPI LP</td>
<td>119</td>
<td>5</td>
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<tr>
<td>XTO ENERGY INC</td>
<td>113</td>
<td>6</td>
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<tr>
<td>ANADARKO E&amp;P ONSHORE LLC</td>
<td>92</td>
<td>7</td>
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<tr>
<td>SOUTHWESTERN ENERGY PROD CO</td>
<td>88</td>
<td>8</td>
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<tr>
<td>WPX ENERGY APPALACHIA LLC</td>
<td>86</td>
<td>9</td>
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<tr>
<td>SENECA RESOURCES CORP</td>
<td>85</td>
<td>10 (tie)</td>
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<tr>
<td>CARRIZO (MARCELLUS) LLC</td>
<td>85</td>
<td>10 (tie)</td>
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<tr>
<td>EXCO RESOURCES PA LLC</td>
<td>82</td>
<td>12</td>
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<tr>
<td>EQT PRODUCTION CO</td>
<td>80</td>
<td>13 (tie)</td>
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<tr>
<td>PA GEN ENERGY CO LLC</td>
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<td>13 (tie)</td>
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<tr>
<td>TALISMAN ENERGY USA INC</td>
<td>65</td>
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<td>CHEVRON APPALACHIA LLC</td>
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<td>16</td>
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<td>ULTRA RESOURCES INC</td>
<td>52</td>
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<tr>
<td>EOG RESOURCES INC</td>
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<td>18</td>
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<tr>
<td>CNX GAS CO LLC</td>
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<td>19</td>
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<tr>
<td>SNYDER BROS INC</td>
<td>31</td>
<td>20</td>
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</table>
Role of Healthcare Professionals in Drilling Areas

- ANA and PSR position on fracking
  - Precautionary principle
  - Moratorium until safety can be ensured

- Environmental health competencies
  - ↑ knowledge of environmental hazards, risks
  - Health promotion through patient teaching

- Environmental health assessments
Fracking Near Beaver Run Reservoir
Drilling in the Utica Shale...is just beginning


