FRACKING 101

What You Need To Know

Nina M. Kaktins, MS, RN

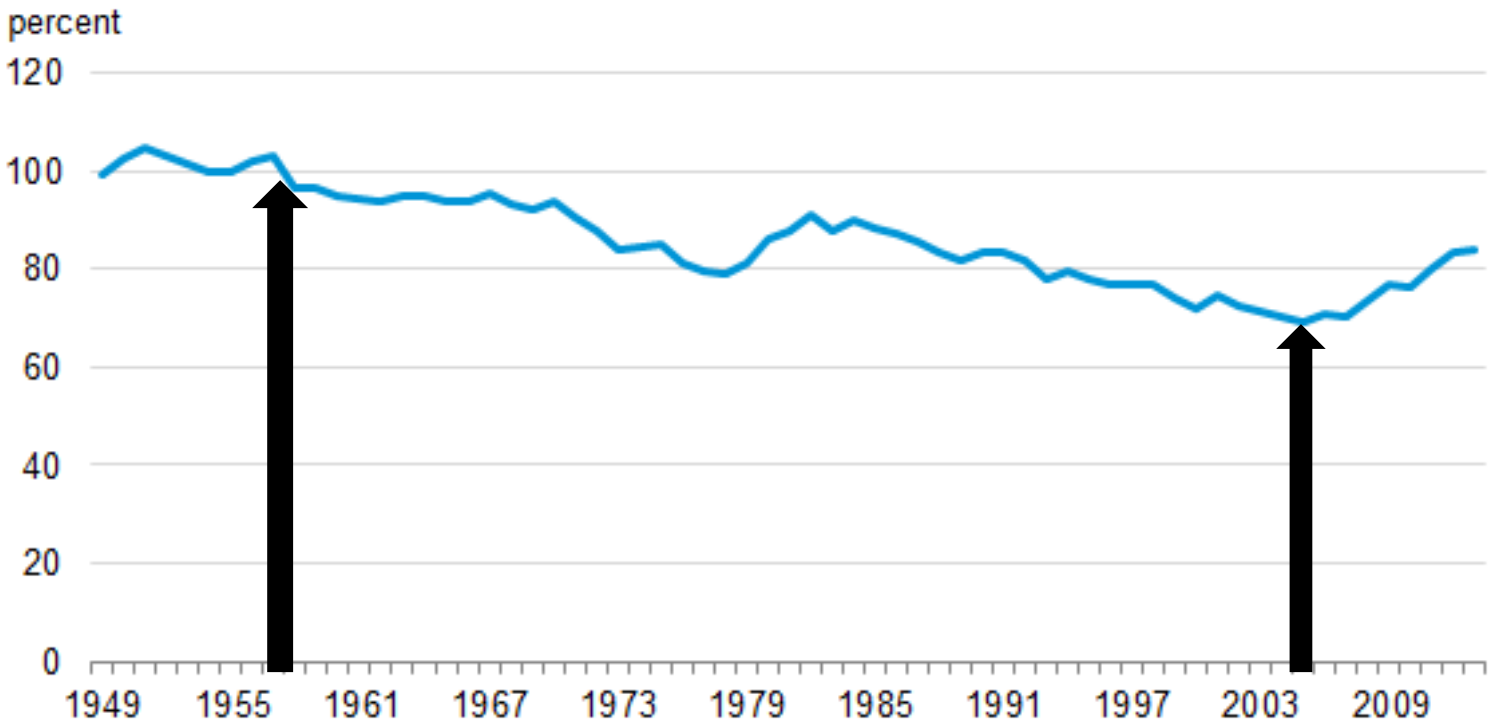
Adjunct Nursing Professor, Chatham University

The Search for Energy

- **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%)

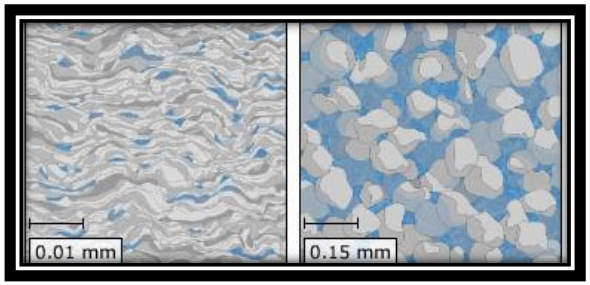
http://www.eia.gov/energy_in_brief/article/major_energy_sources_and_users.cfm

Ratio of domestic energy production to consumption
(1949 - 2013)



Unconventional Resources
Oil & Natural Gas

- **Rock formations with low permeability**
  - Shale
  - Tight "sands"
  - Coalbed methane



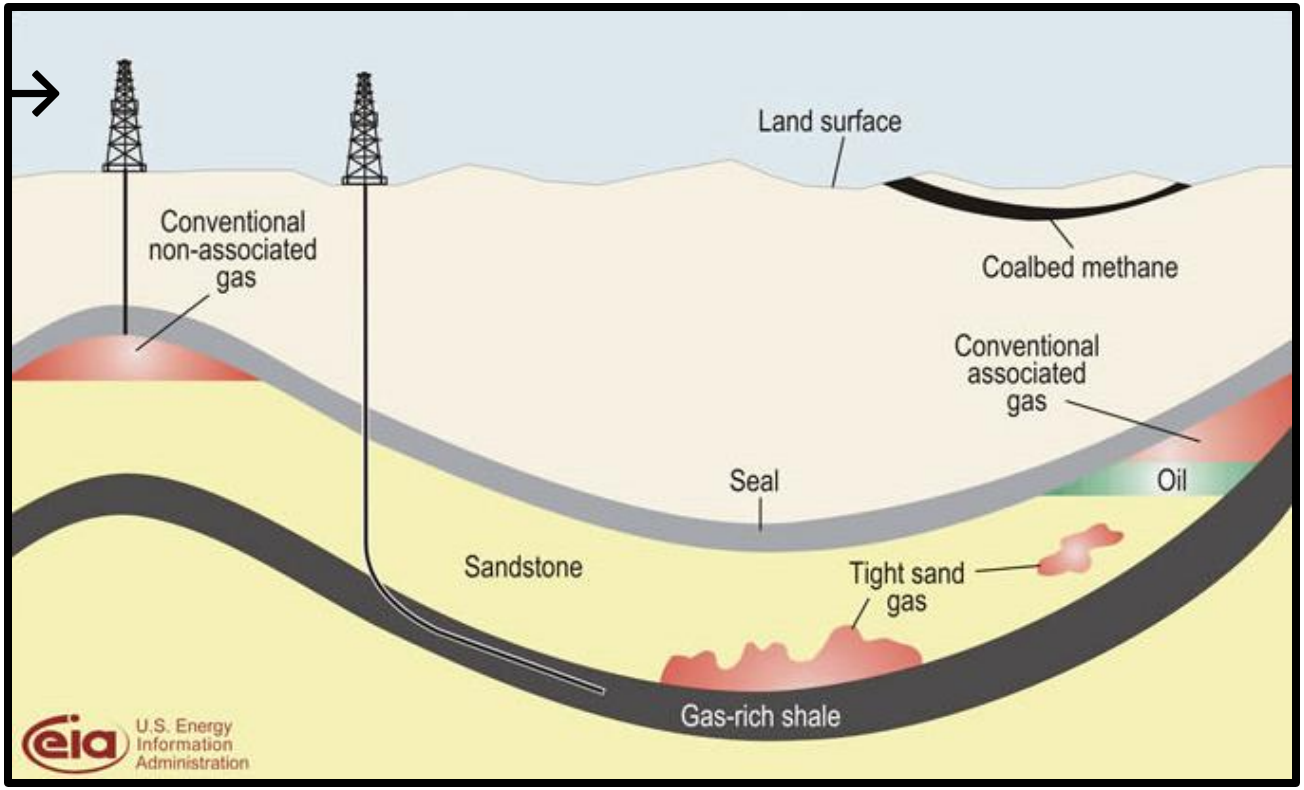
shale sandstone

- **Resource development**
  - ↑ price of natural gas
  - Technological advances
    - Horizontal drilling
    - High volume hydraulic fracturing, aka **"fracking"**

Unconventional versus Conventional
Natural Gas Resources

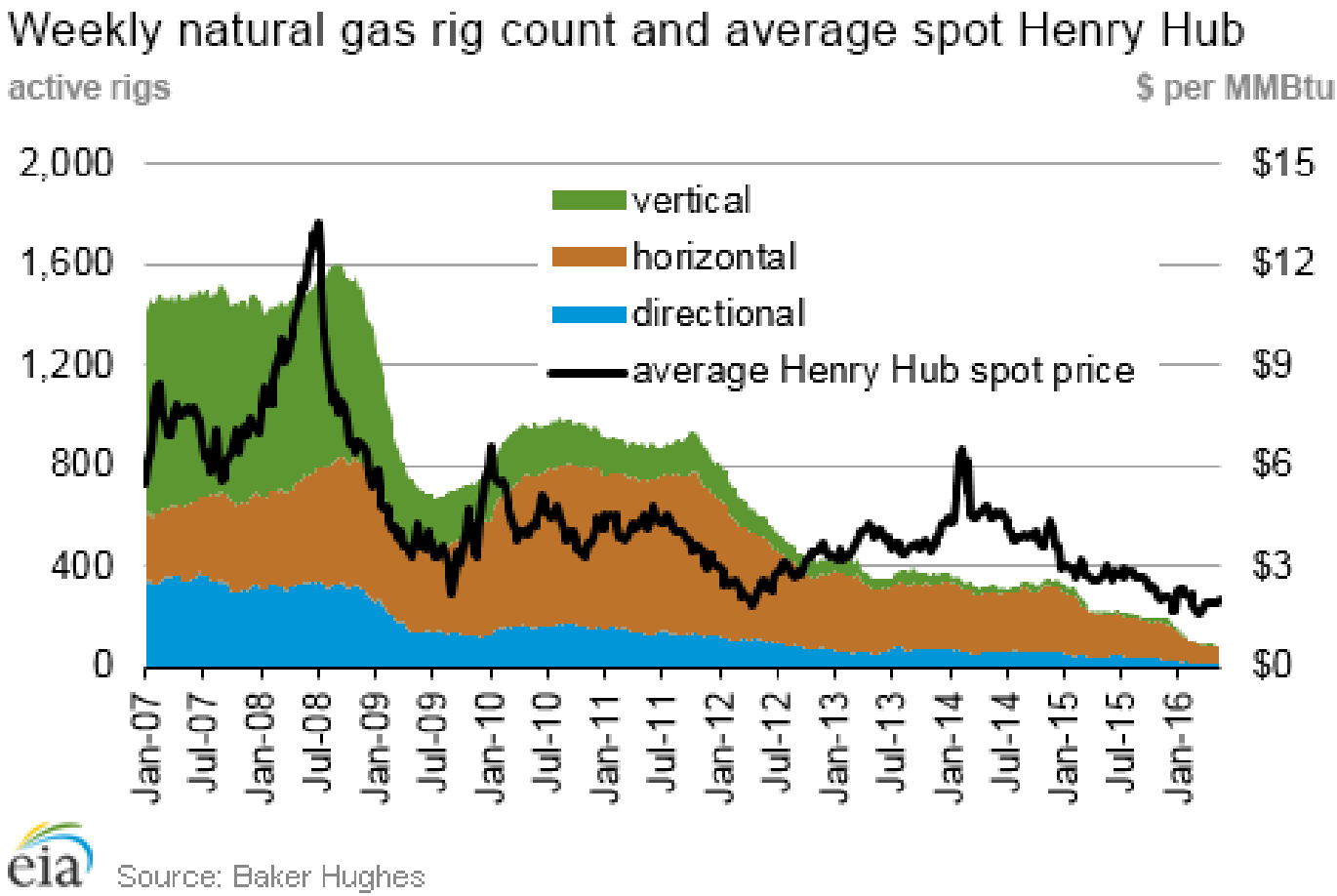
↓ Horizontal well

Vertical well →



http://www.eia.gov/oil_gas/natural_gas/special/ngresources/ngresources.html

Price of Natural Gas Drives Drilling

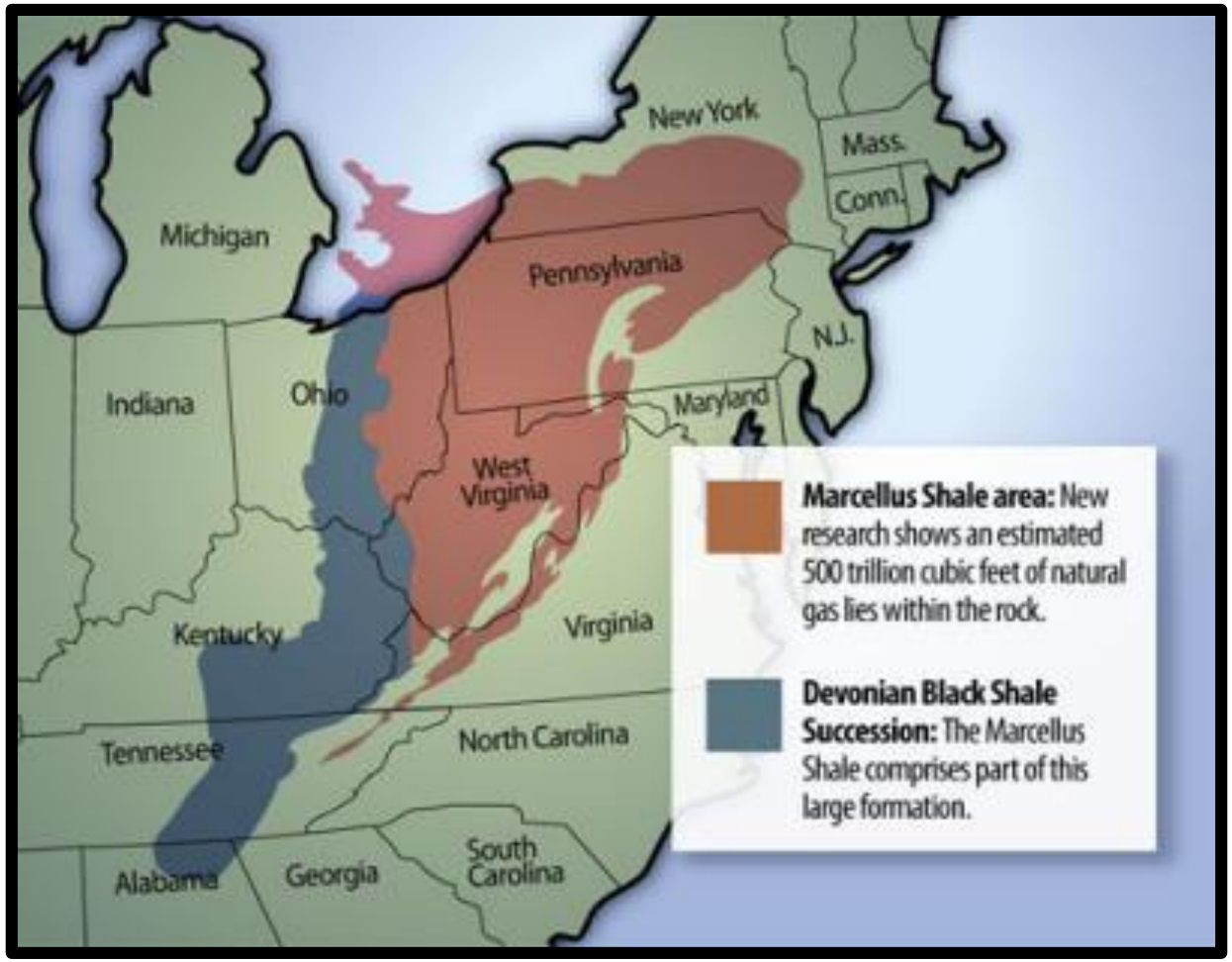


http://www.eia.gov/naturalgas/weekly/#tabs-prices-1

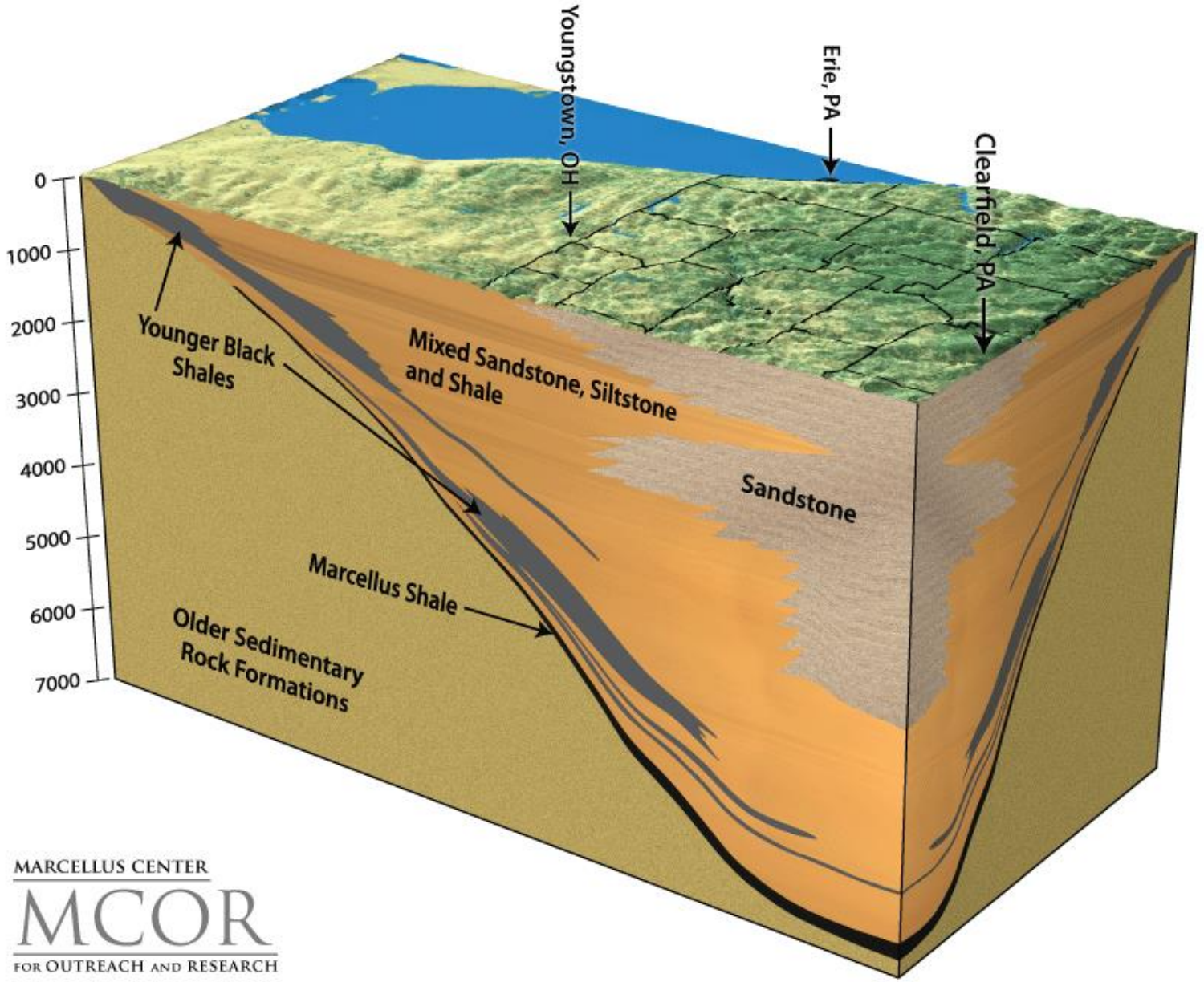
The Marcellus Shale

- 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



Generalized Geologic Cross Section Showing Marcellus Shale in Western Pennsylvania



MARCELLUS CENTER
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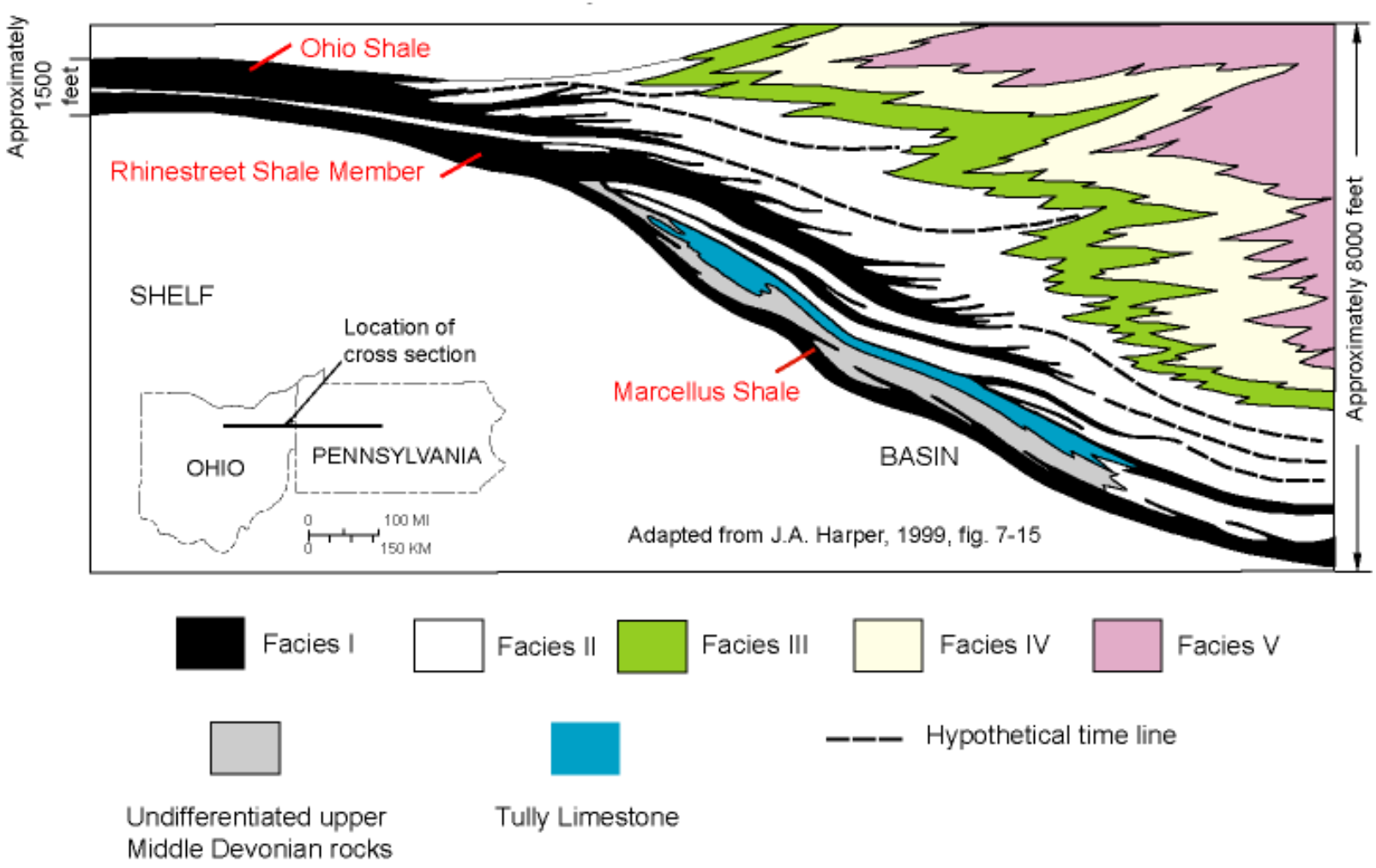
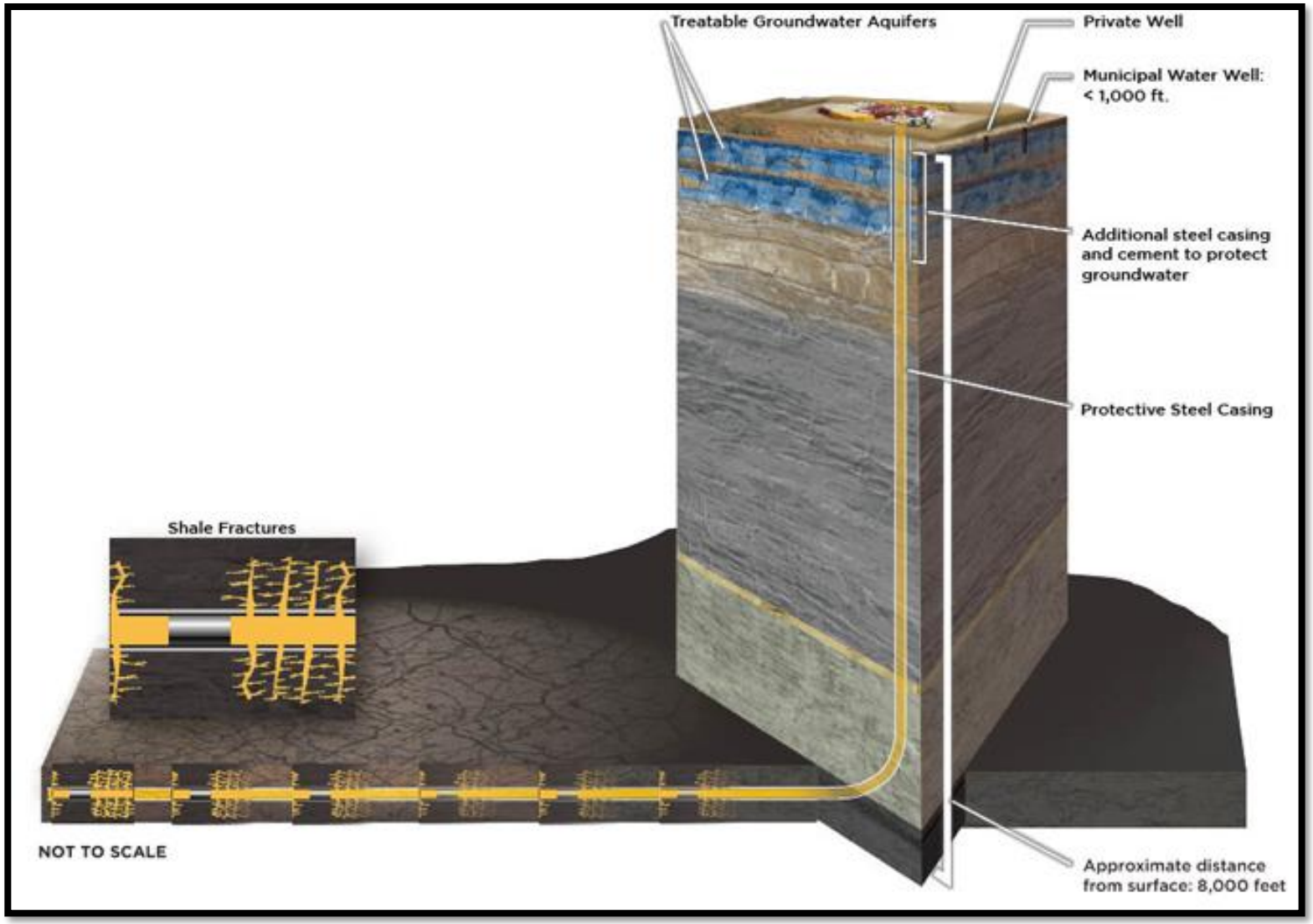
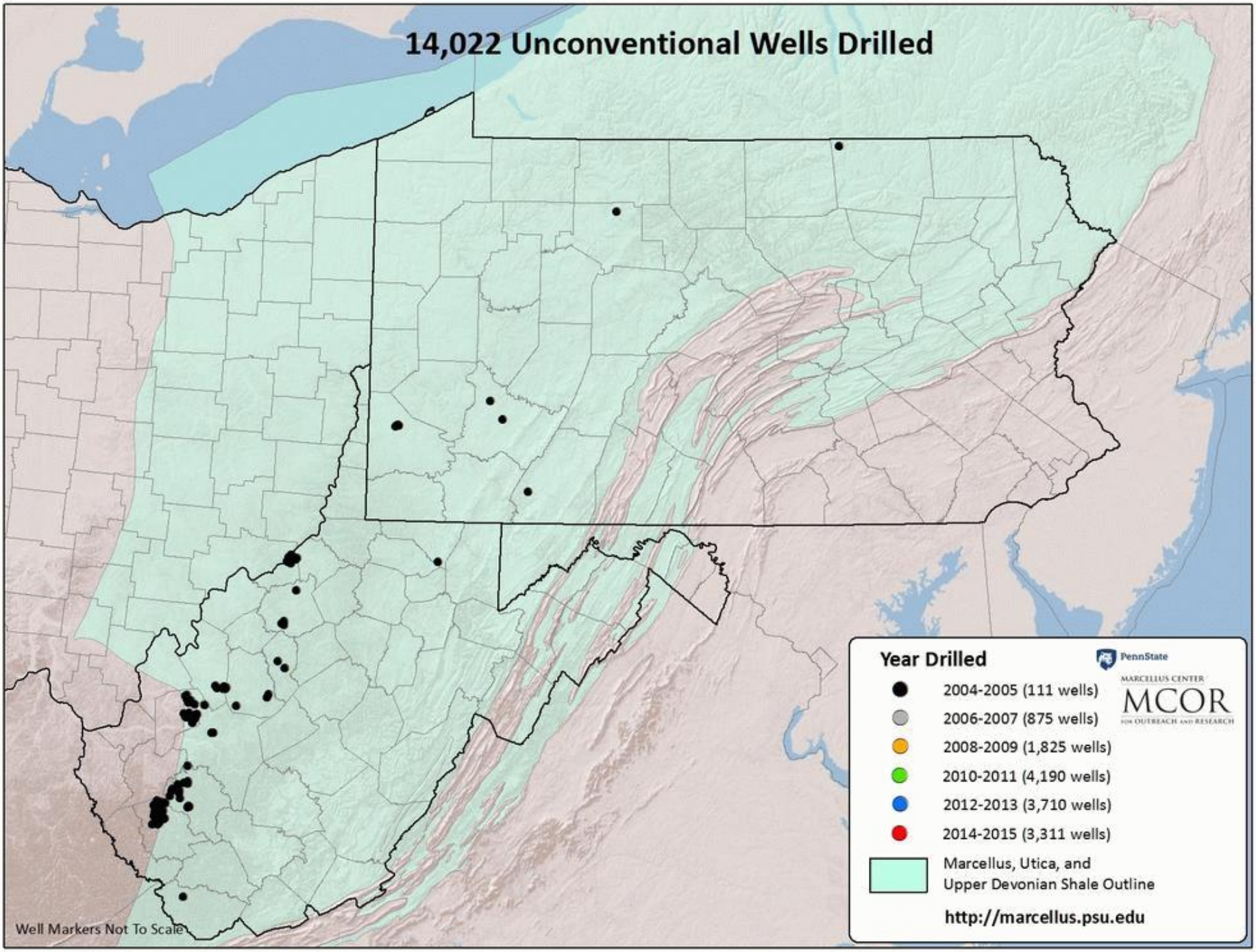
Cross Section of Marcellus Shale



Robert C. Milici, USGS, 2005

High-Volume Hydraulic Fracturing




14,022 Unconventional Wells Drilled
Year Drilled
2004-2005 (111 wells)
2006-2007 (875 wells)
2008-2009 (1,825 wells)
2010-2011 (4,190 wells)
2012-2013 (3,710 wells)
2014-2015 (3,311 wells)
Marcellus, Utica, and
Upper Devonian Shale Outline
http://marcellus.psu.edu
PennState
MARCELLUS CENTER
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Well Markers Not To Scale

PA Fracking Operation

http://www.marcellus-shale.us/drilling_wastewater.htm

Overview of Fracking Process

- **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

Typical Fracking Operation

- 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

http://www.fractracker.org/

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

Fracking Chemicals	Health Effects (dose-related)
2,2-Dibromo-3-Nitrilopropionamide	Corrosive to eyes; throat/lung irritation; pulmonary edema
Ethyl benzene	Kidney and reproductive problems
Ethylene Glycol (antifreeze component)	Kidney function; acid/base balance; nervous system, lungs, cardiac
Glutaraldehyde	Asthma; throat/lung irritation, wheezing; conjunctivitis
Naphthalene	Damage to liver, kidneys, eyes; anemia
Xylene	CNS, eyes, skin, respiratory system, GI tract, blood, liver, kidneys
Toluene	Cardiovascular, neurological

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
  - NO_x & VOCs react with sunlight, form ozone
  - With new EPA regulation, 33 PA counties will be in nonattainment for ground-level ozone
- $PM_{2.5}$
- SO_2


OCT 17 2008

Drilling Waste in PA, 3,922 Wells

Jan-Jun 2012

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

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

http://un-naturalgas.org/image_gallery.htm

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**

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

Company	Environmental and Health Violations	Rank
CABOT OIL & GAS CORP	265	1
CHESAPEAKE APPALACHIA LLC	253	2
RANGE RESOURCES APPALACHIA LLC	174	3
CHIEF OIL & GAS LLC	150	4
SWEPI LP	119	5
XTO ENERGY INC	113	6
ANADARKO E&P ONSHORE LLC	92	7
SOUTHWESTERN ENERGY PROD CO	88	8
WPX ENERGY APPALACHIA LLC	86	9
SENECA RESOURCES CORP	85	10 (tie)
CARRIZO (MARCELLUS) LLC	85	10 (tie)
EXCO RESOURCES PA LLC	82	12
EQT PRODUCTION CO	80	13 (tie)
PA GEN ENERGY CO LLC	80	13 (tie)
TALISMAN ENERGY USA INC	65	15
CHEVRON APPALACHIA LLC	63	16
ULTRA RESOURCES INC	52	17
EOG RESOURCES INC	38	18
CNX GAS CO LLC	36	19
SNYDER BROS INC	31	20

http://environmentamerica.org/sites/environment/files/reports/EA_PA_fracking_scrn.pdf

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

www.marcellus-shale.us

http://wri.eas.cornell.edu/gas_wells_waste.html

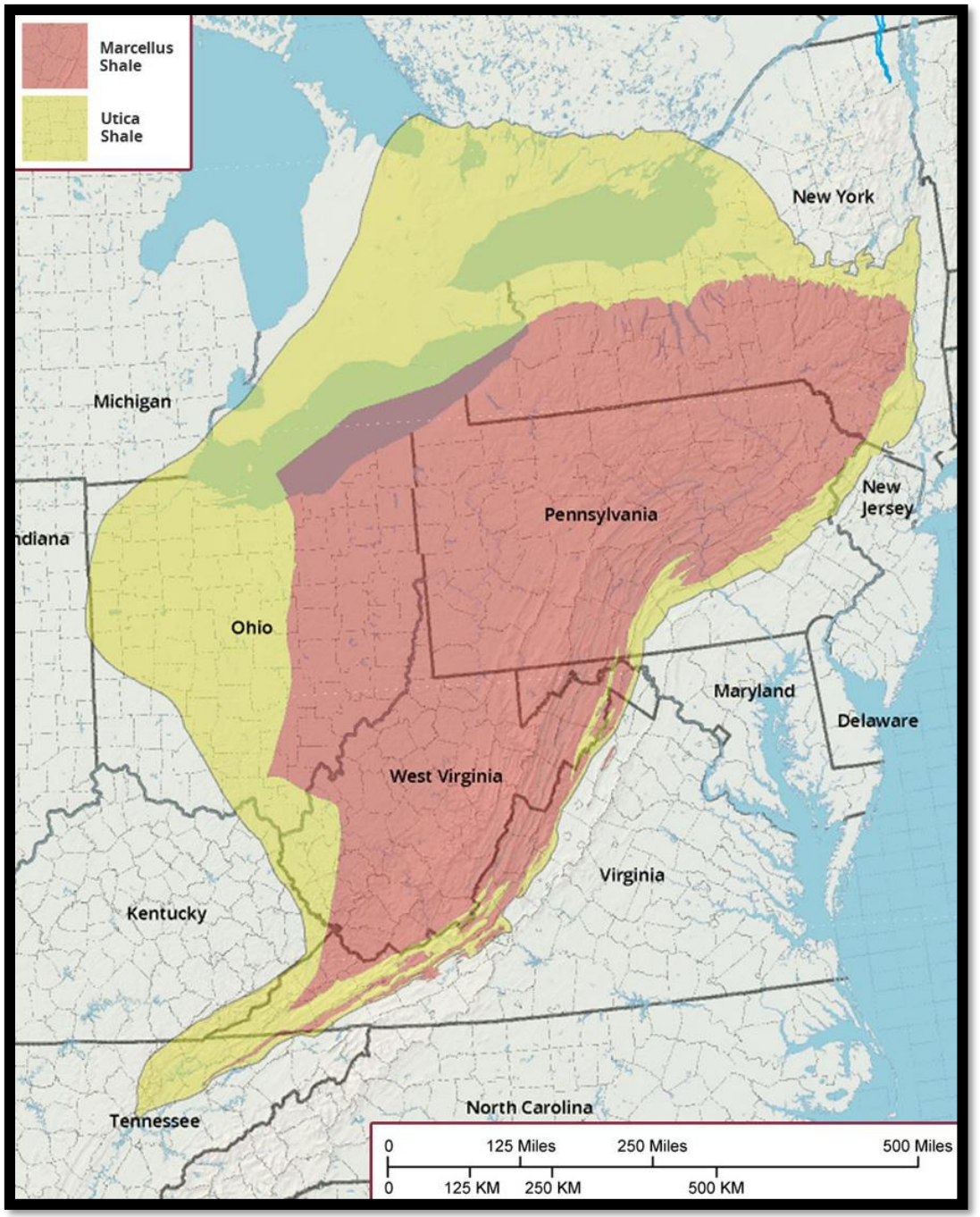

PA DCNR July 2010
Loyalsock State Forest

www.marcellus-shale.us

Drilling
in the

Utica Shale

…is just
beginning



http://www.caimanenergy.com/where-we-work/maps

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