The Shale Gas Resource:
What are the Trends, Where is it Headed?

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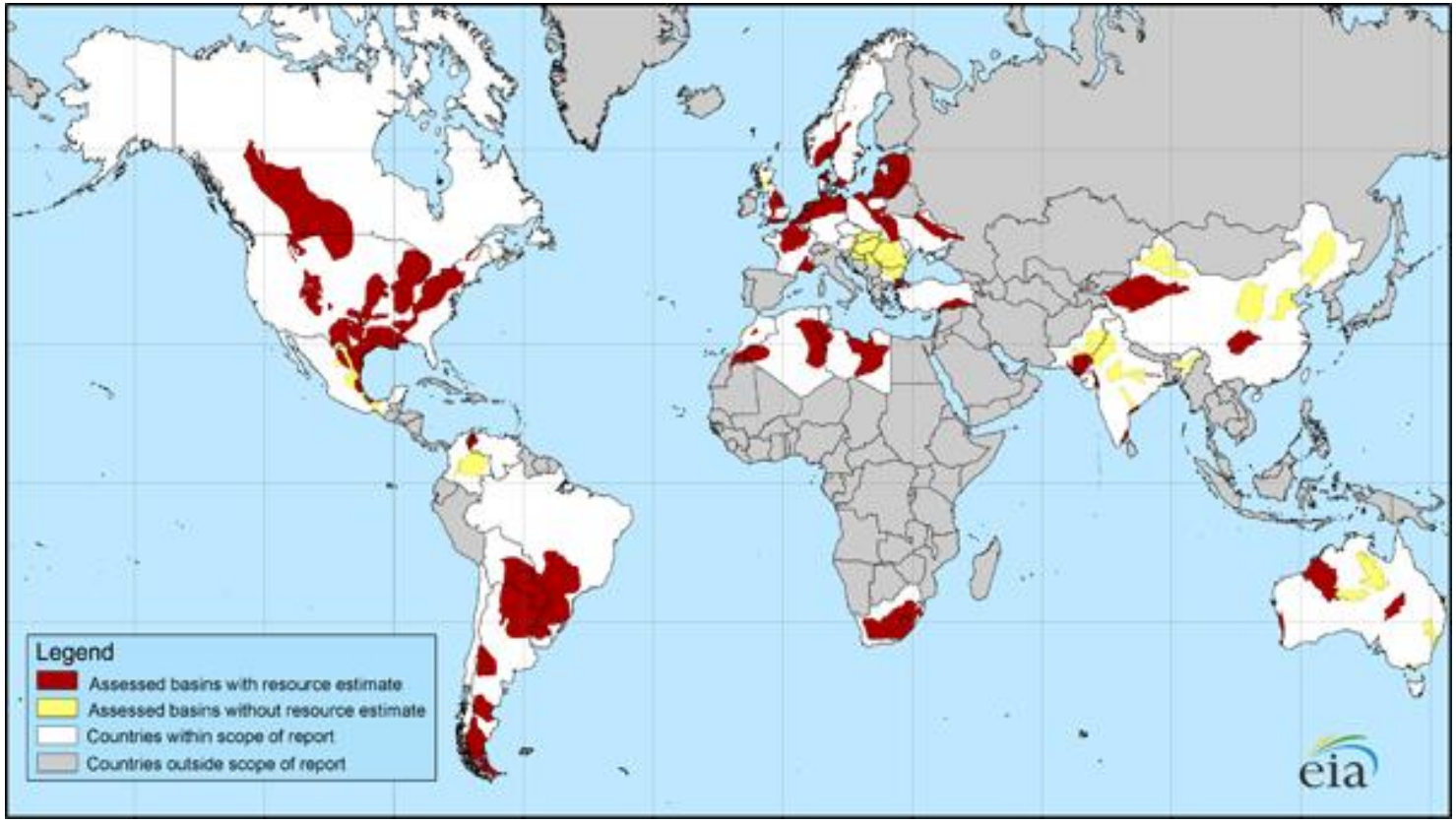
Global Shale Gas Reserves

U.S. Department of Energy released an assessment of 48 shale gas basins in 32 countries, containing almost 70 shale gas formations around the world.

http://www.eia.gov/analysis/studies/worldshalegas



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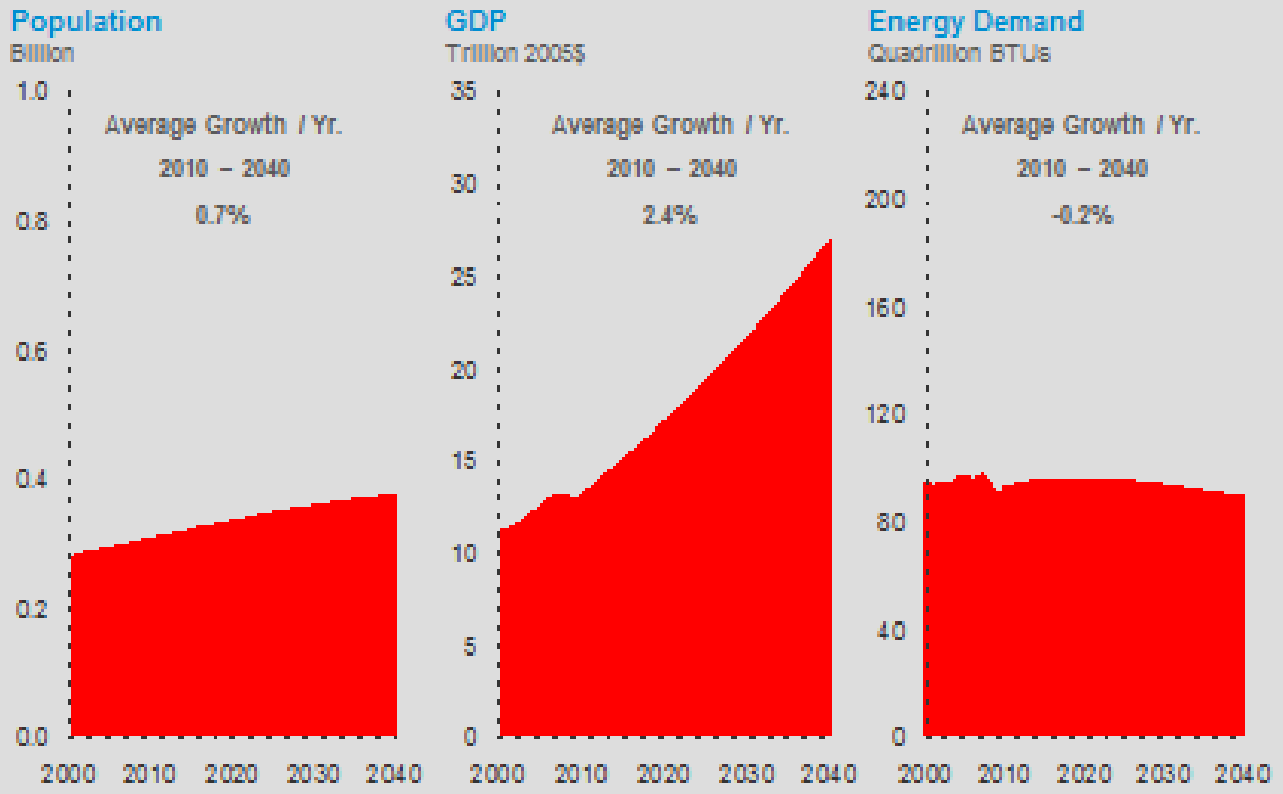
Global Energy Demand up 30% but…

United States Energy Trends



ExxonMobil

ExxonMobil 2012 Outlook for Energy

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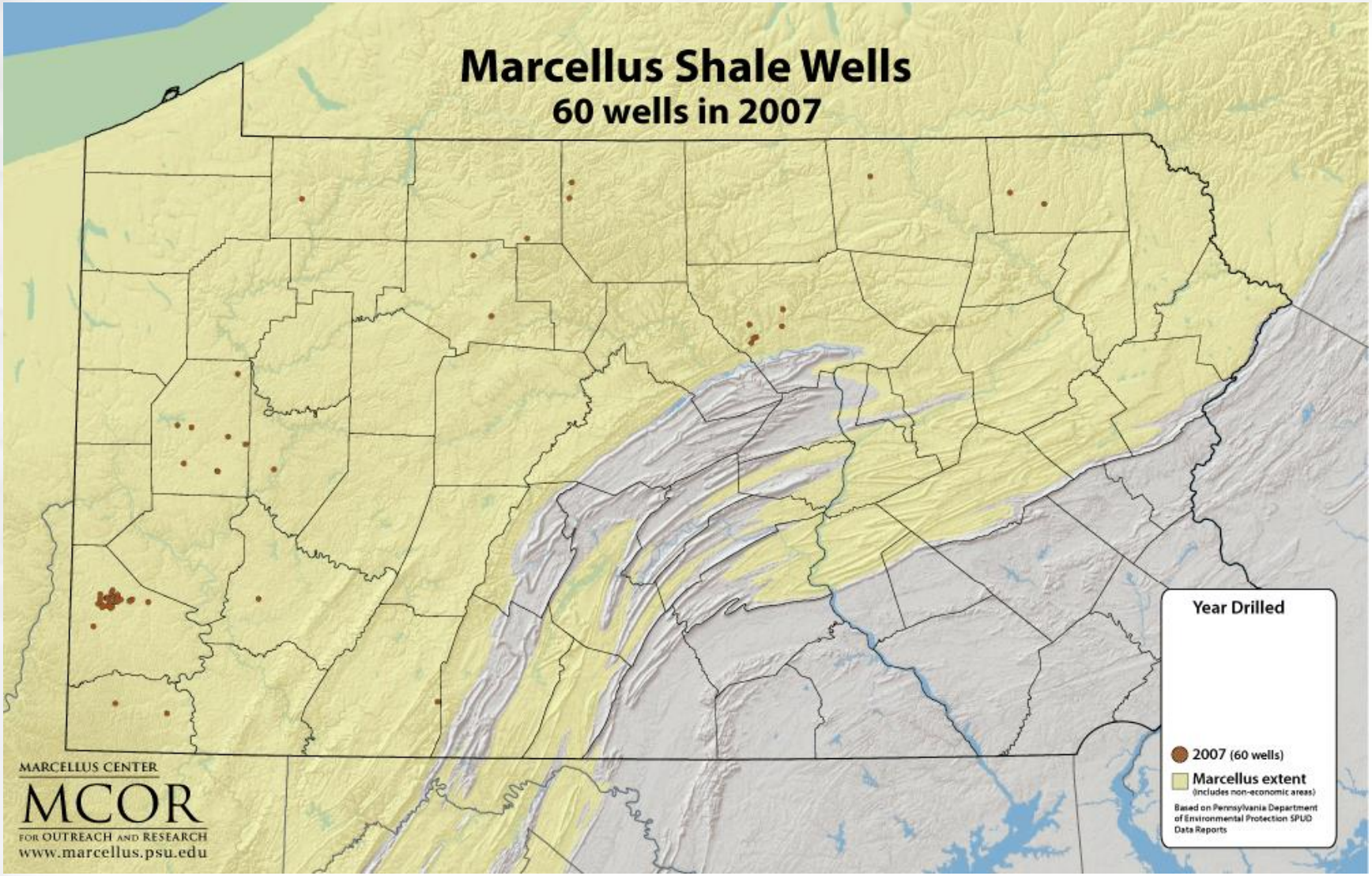
Marcellus Wells Drilled



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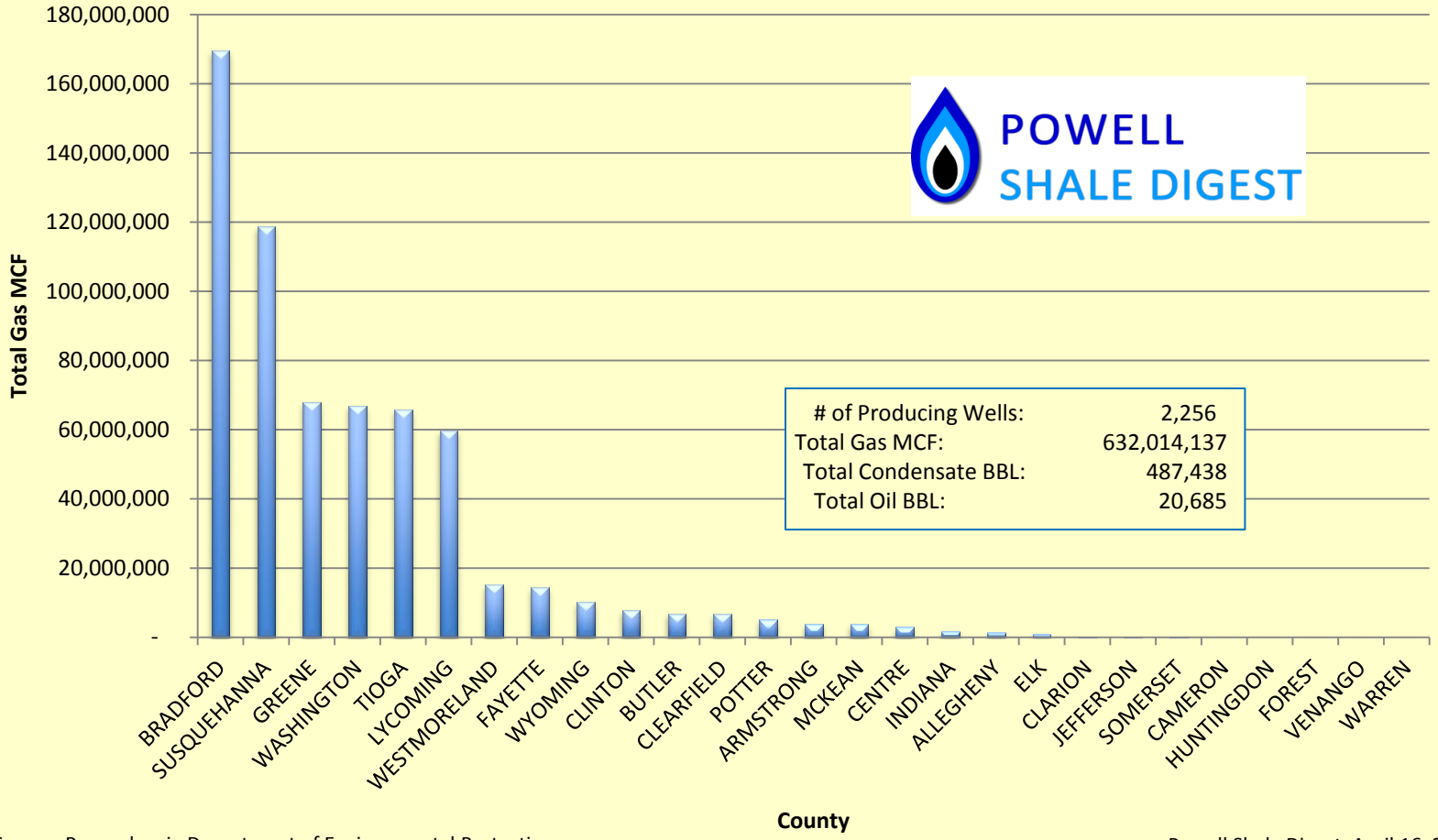
Pennsylvania Marcellus Shale Production July 1 - Dec. 31, 2011
Counties Sorted by Total Gas MCF



Source: Pennsylvania Department of Environmental Protection

Powell Shale Digest, April 16, 20

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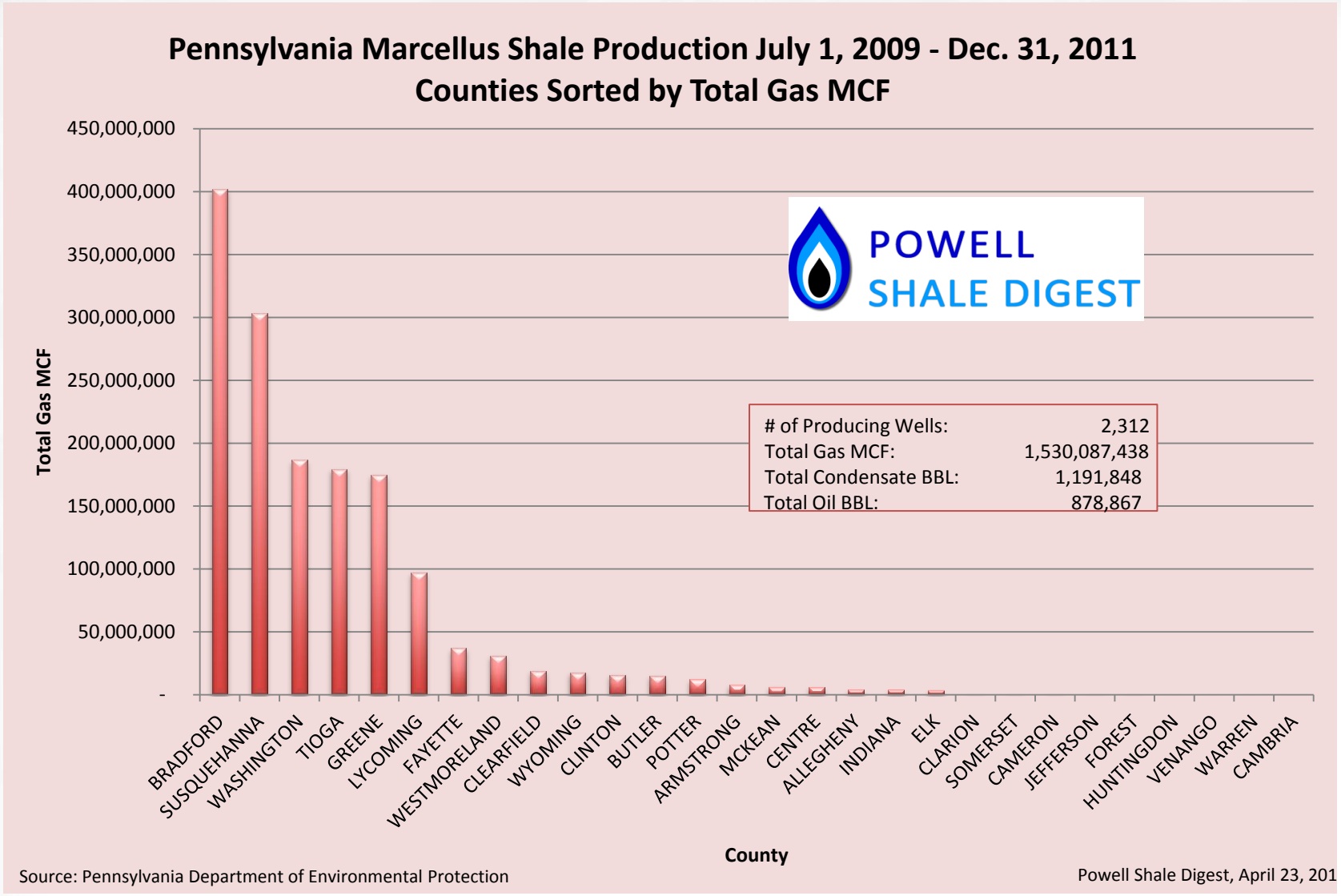

Source: Pennsylvania Department of Environmental Protection

Powell Shale Digest, April 23, 201

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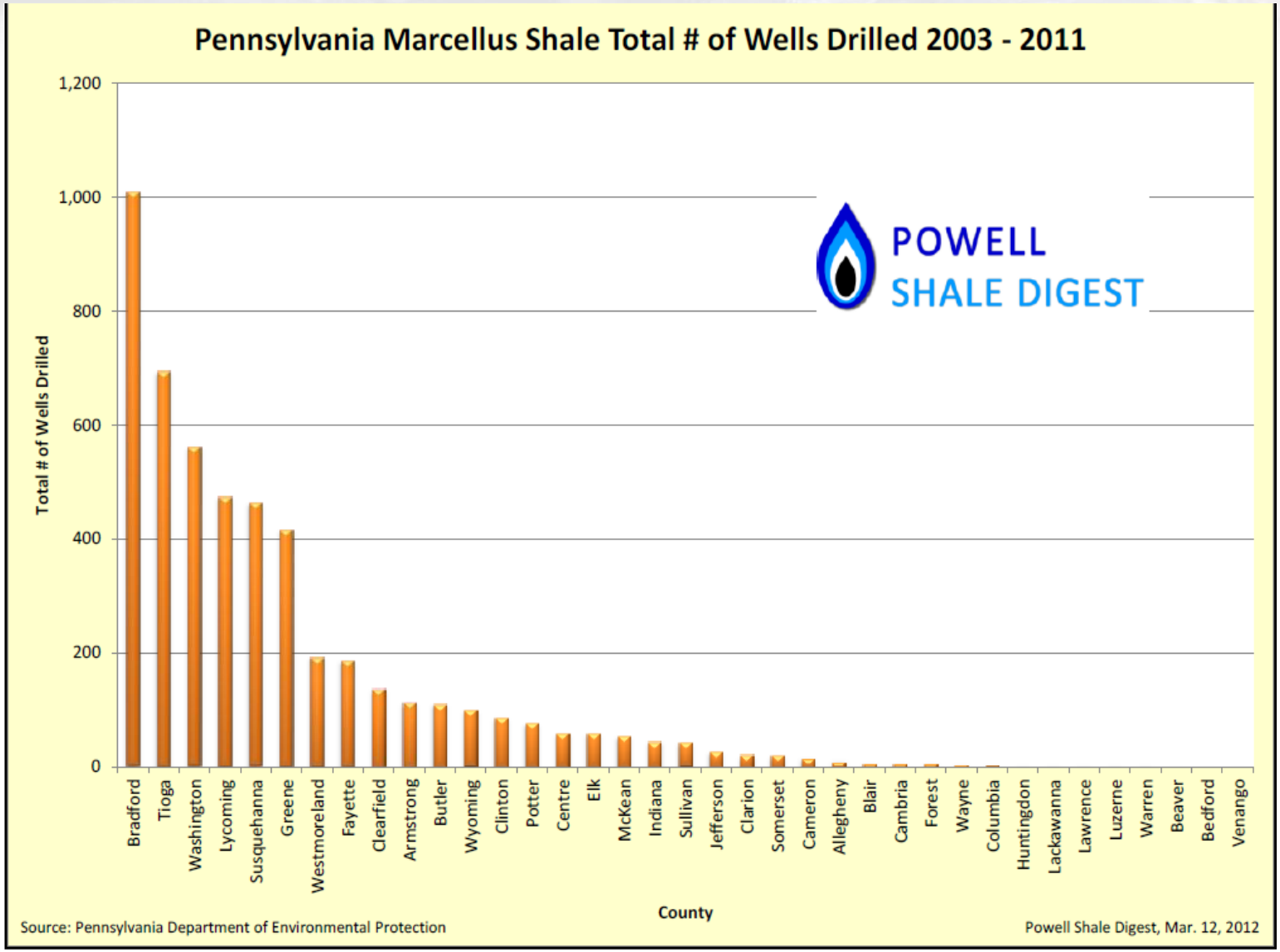

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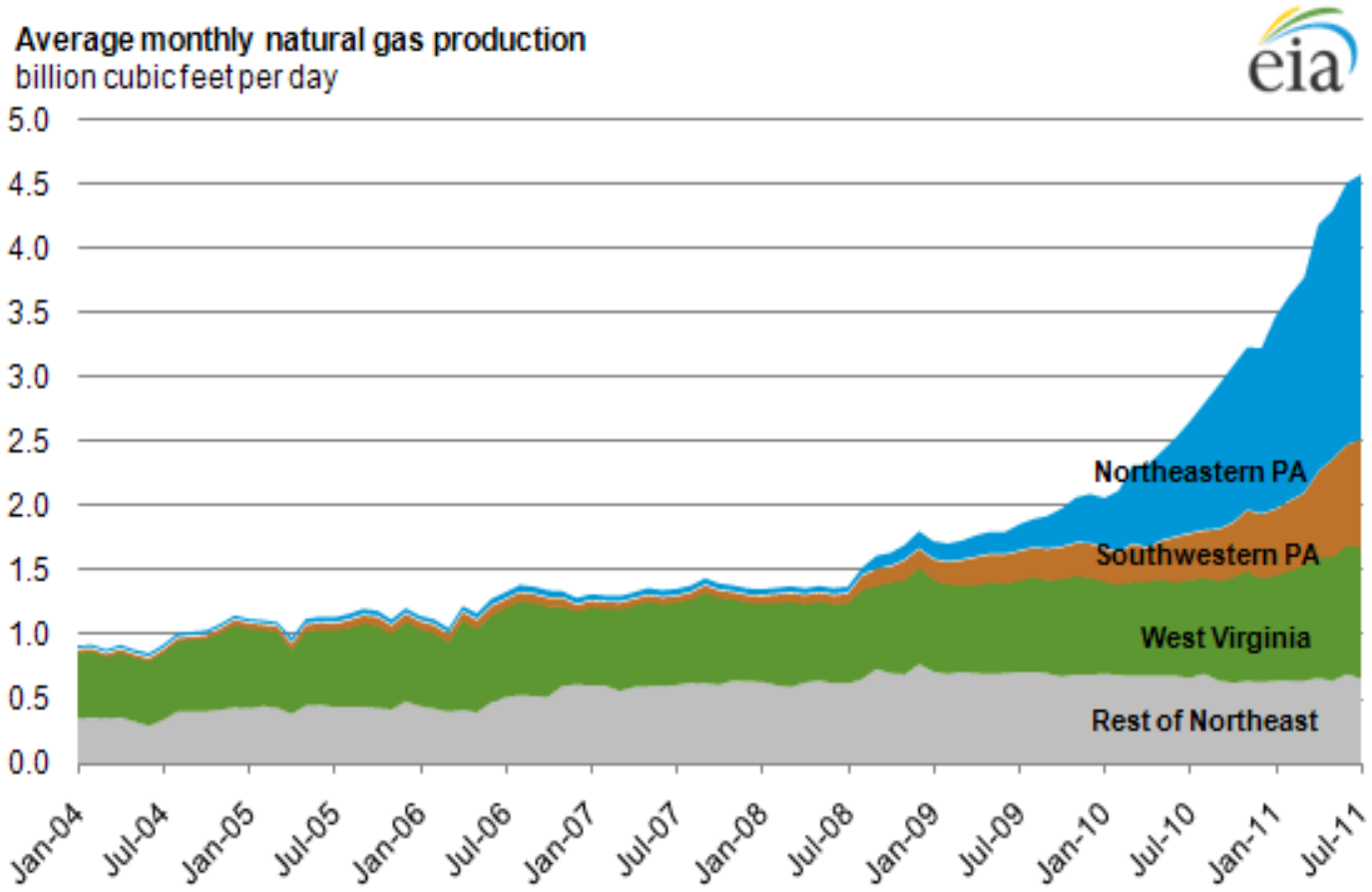
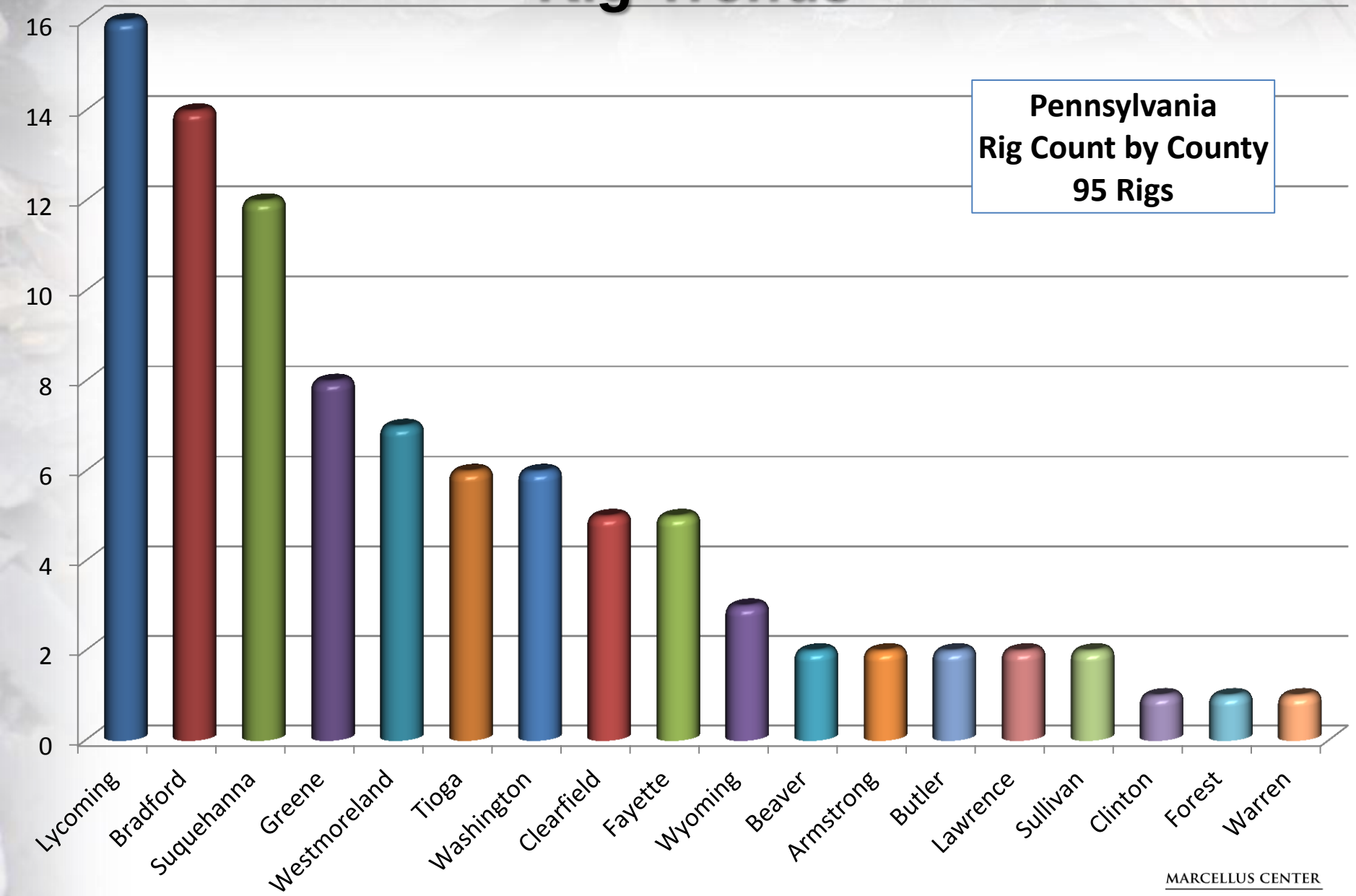
PA Production



Source: U.S. Energy Information Administration based on Bentek Energy, LLC.
Note: Rest of Northeast includes KY, MD, NY, OH, TN, VA.

Rig Trends



Sources: Baker-Hughes Investor Relations (May 11, 2012)

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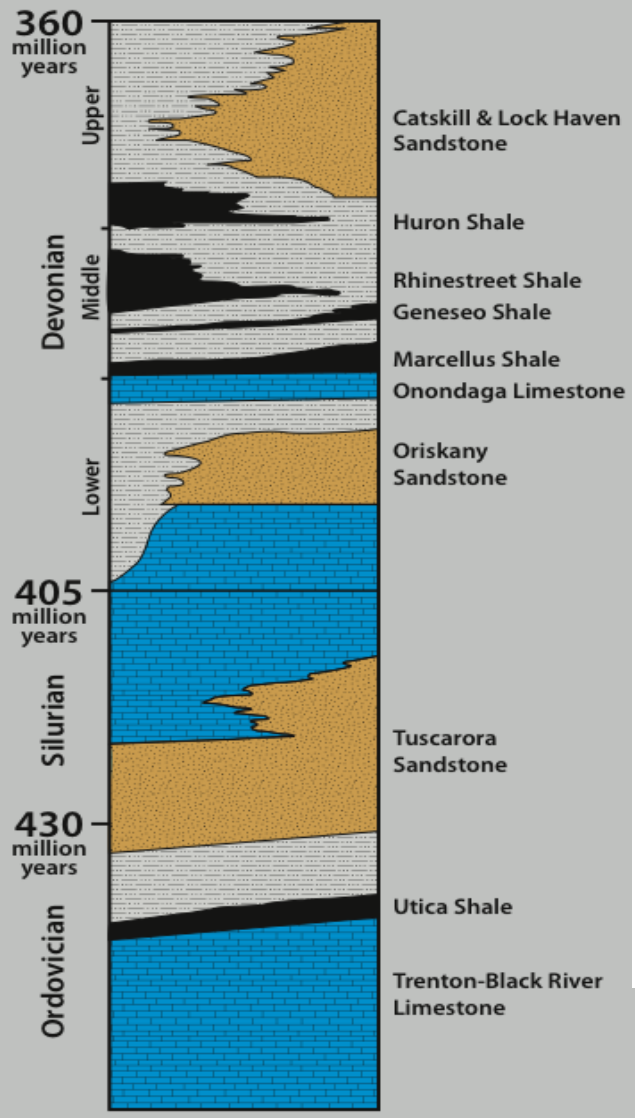
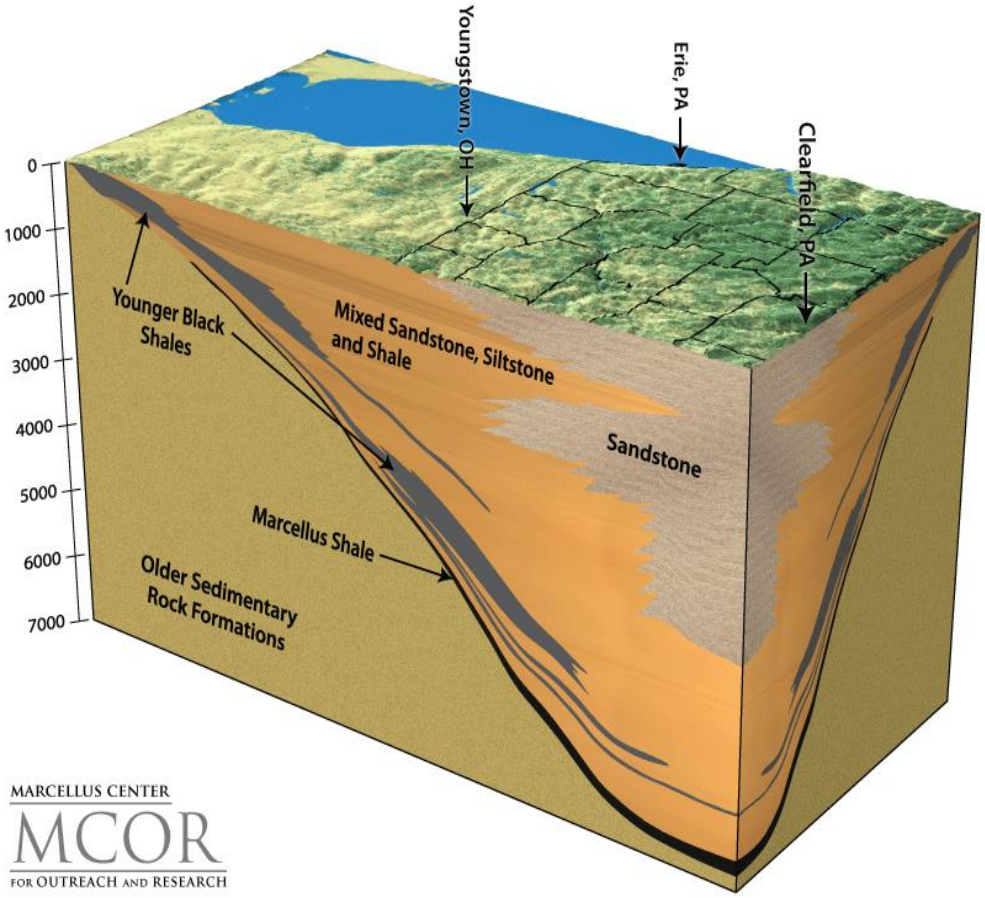
Other Shale Targets

Key Gas-Producing Formations in Pennsylvania



Generalized Geologic Cross Section Showing Marcellus Shale in Western Pennsylvania



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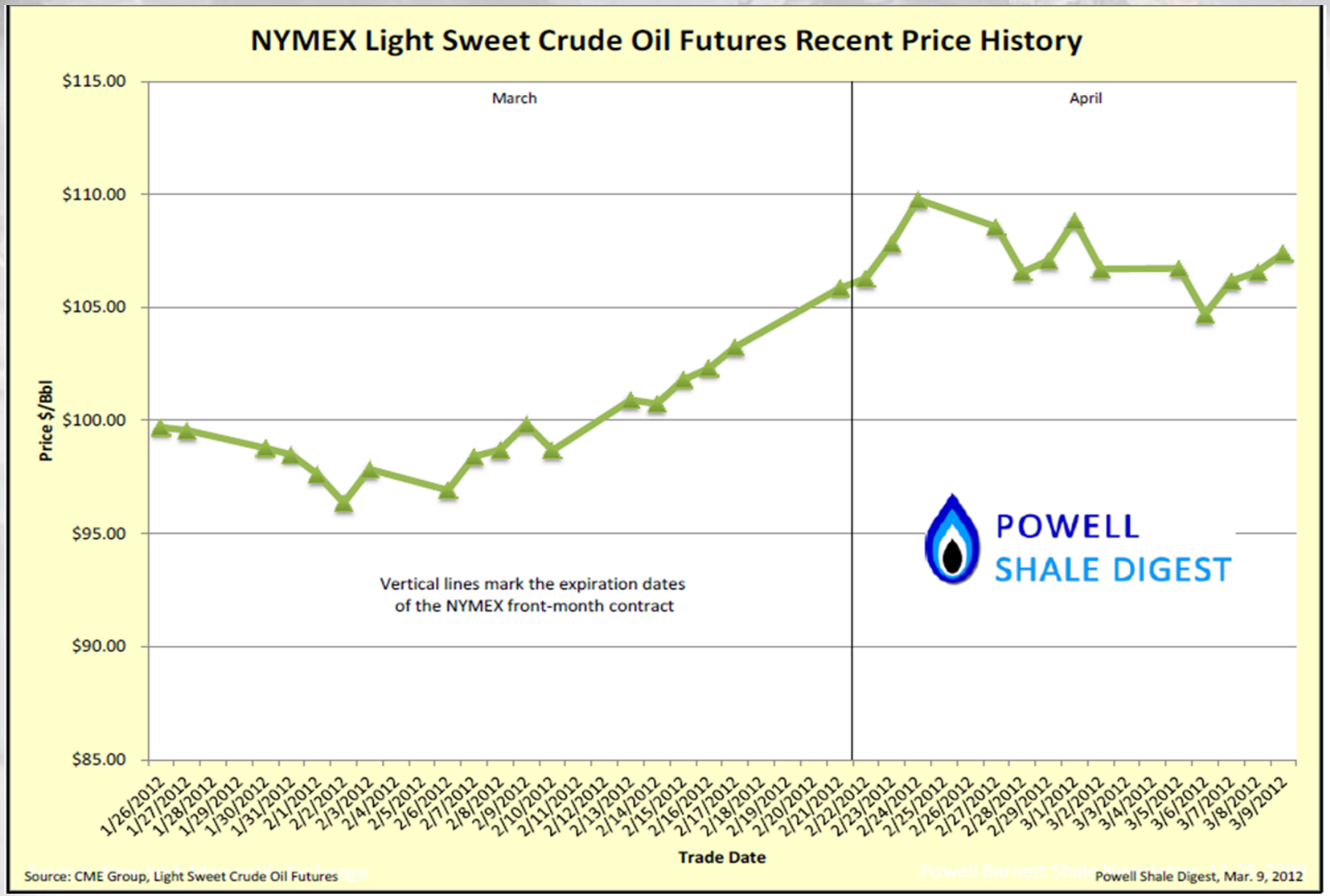

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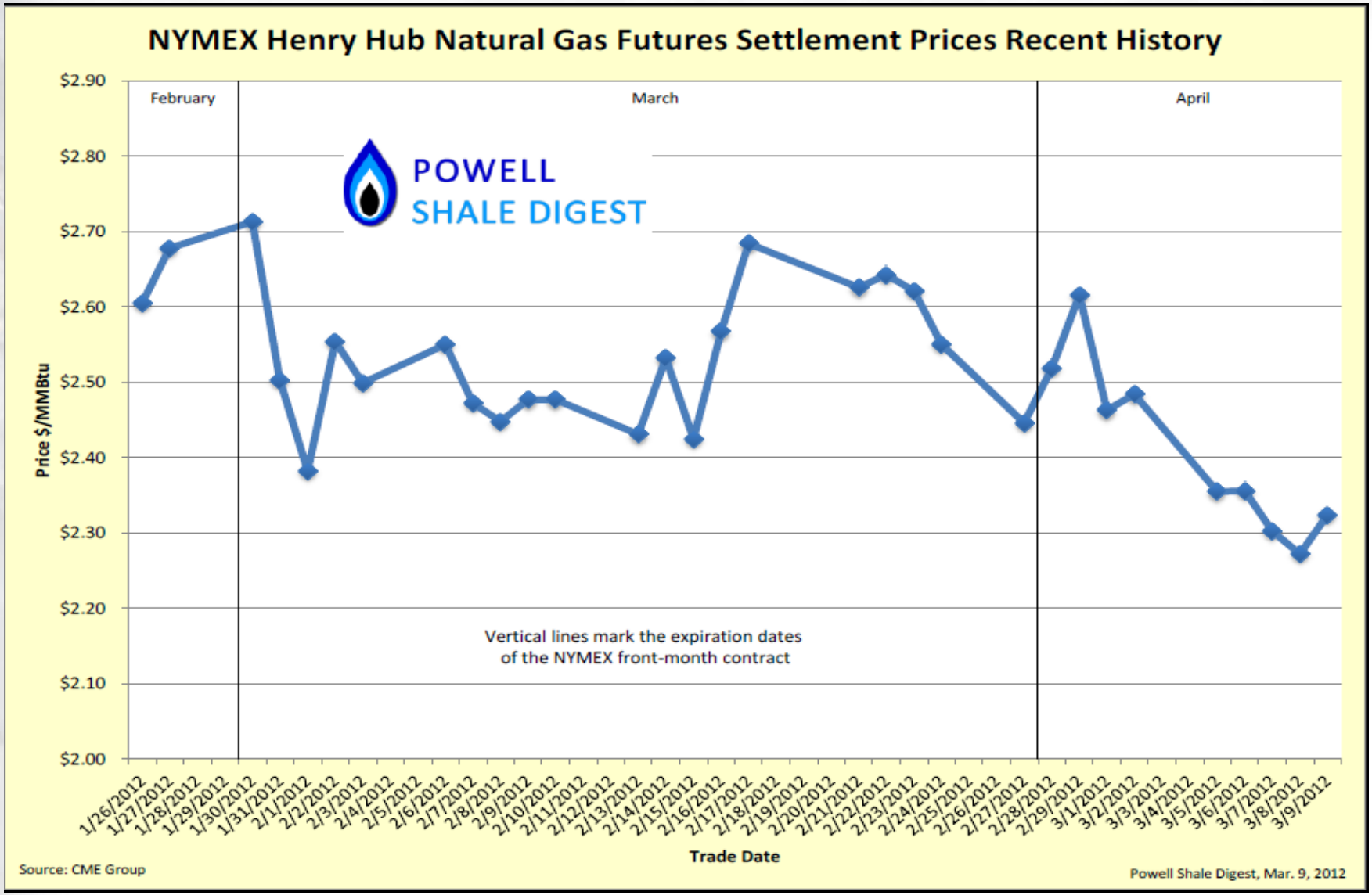
U.S. Natural Gas Prices



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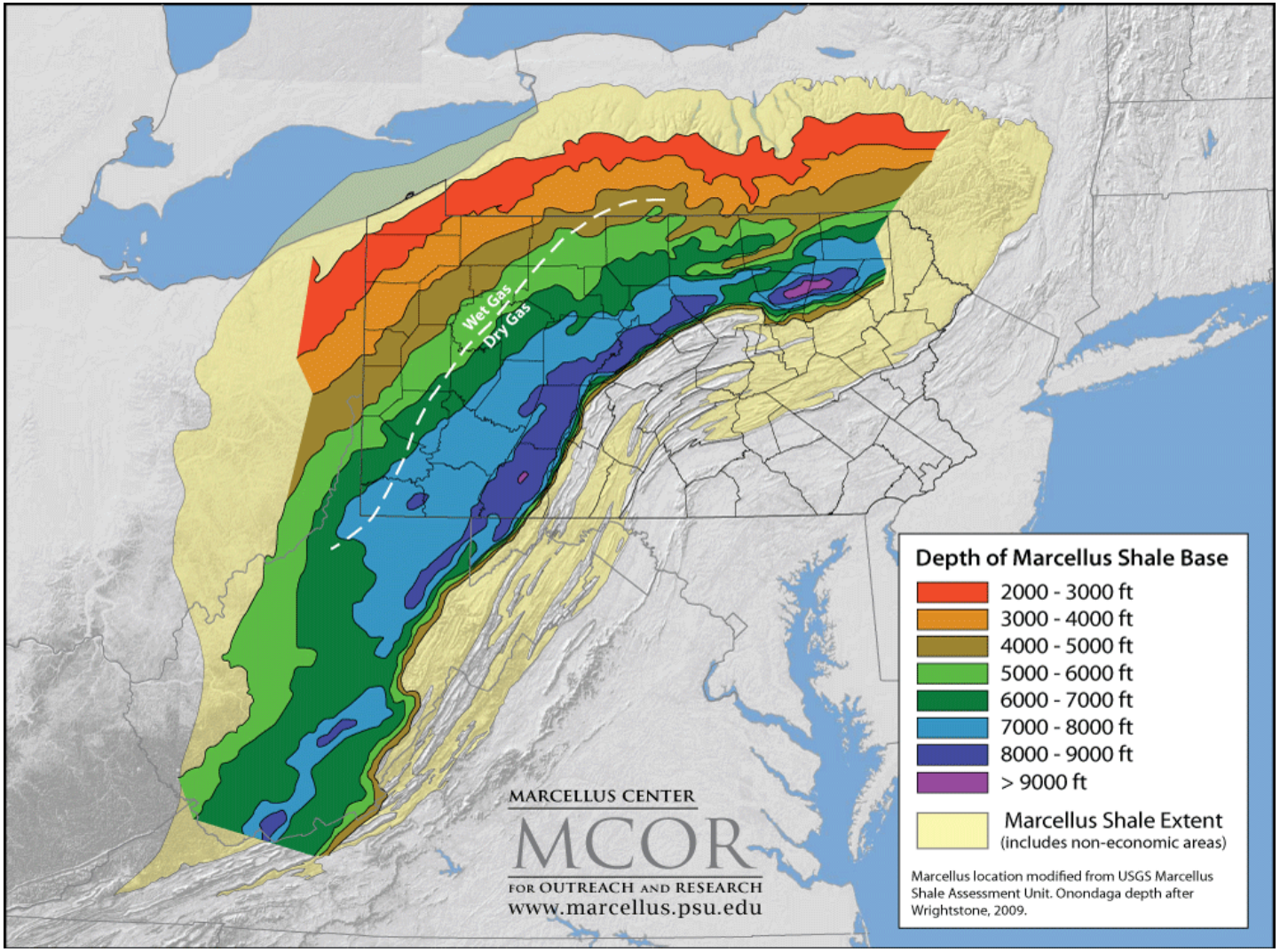
Producing Wells

- 95 drill rigs running in PA
  - 116 last year at this time
  - 19 currently in OH

- As of June ’11
  - ~3200 drilled in PA
  - 1697 reported producing
  - 52% producing in PA

  - Estimated to be 2250 on 1/1/12

Natural Gas Liquids (NGLs)



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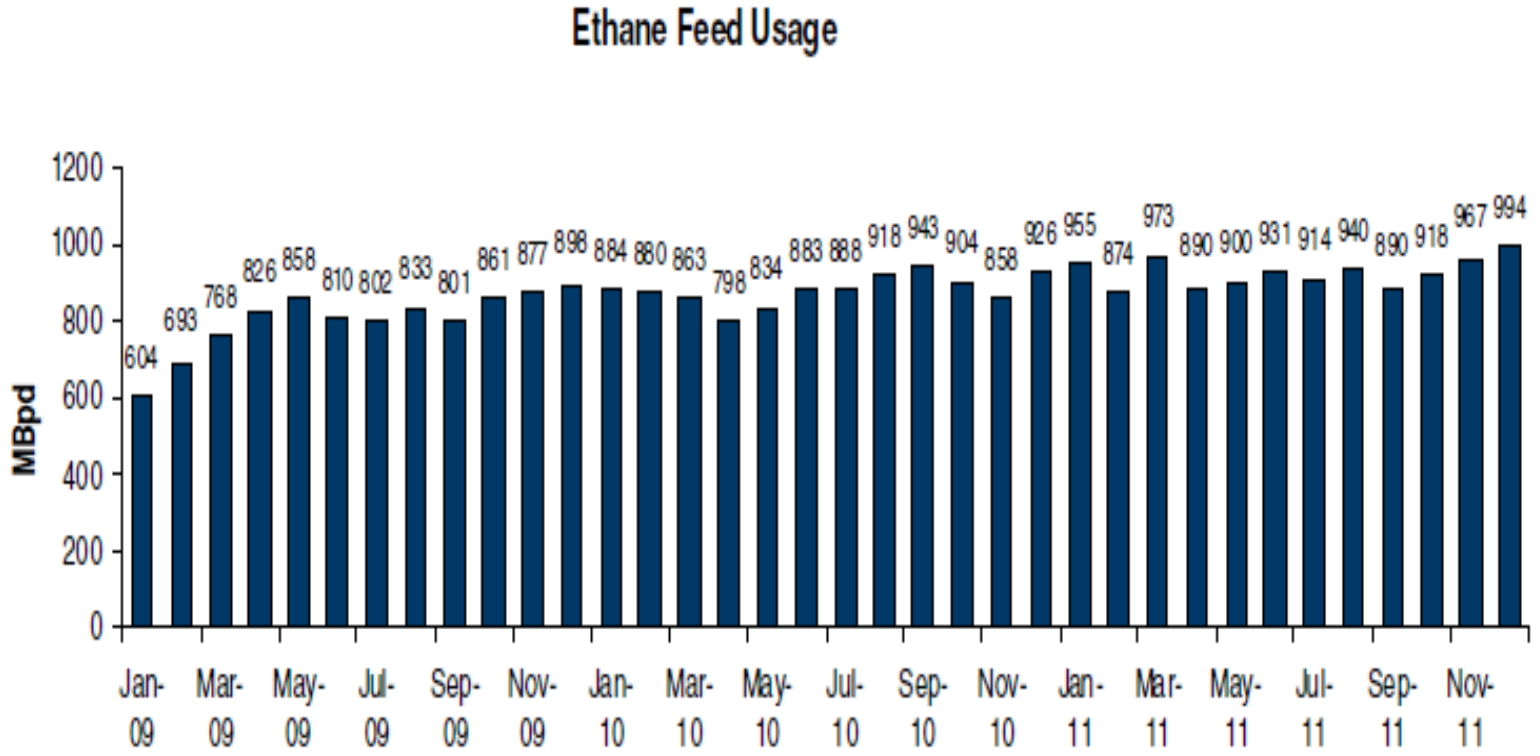
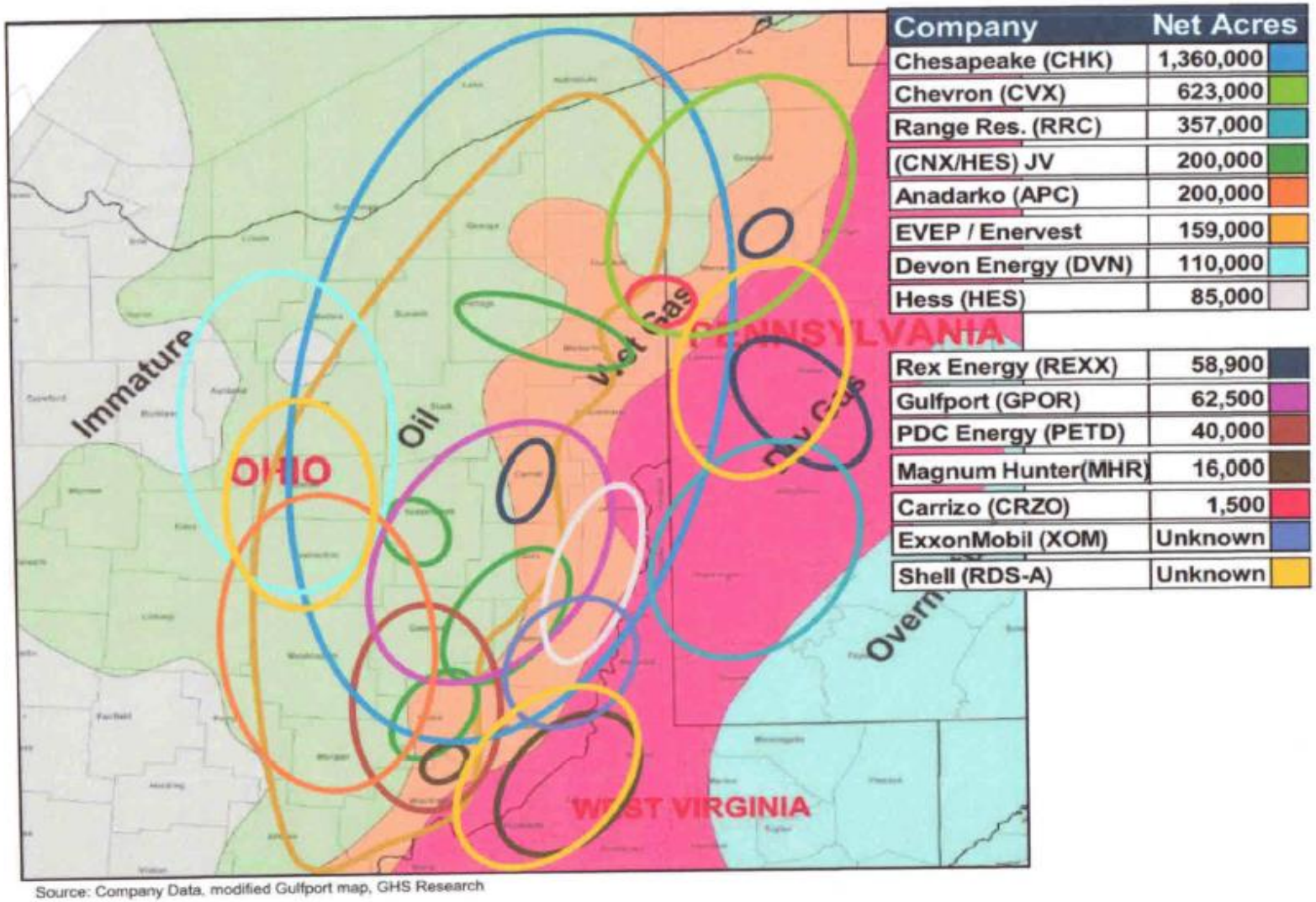
Demand for NGL's Rising

Exhibit 7: **Ethane Feed Usage from NGLs**



Source: Hodson Reports, Credit Suisse

Utica Development



Company	Net Acres
Chesapeake (CHK)	1,360,000
Chevron (CVX)	623,000
Range Res. (RRC)	357,000
(CNX/HES) JV	200,000
Anadarko (APC)	200,000
EVEP / Enervest	159,000
Devon Energy (DVN)	110,000
Hess (HES)	85,000
Rex Energy (REXX)	58,900
Gulfport (GPOR)	62,500
PDC Energy (PETD)	40,000
Magnum Hunter(MHR)	16,000
Carrizo (CRZO)	1,500
ExxonMobil (XOM)	Unknown
Shell (RDS-A)	Unknown

Source: Company Data, modified Gulfport map, GHS Research

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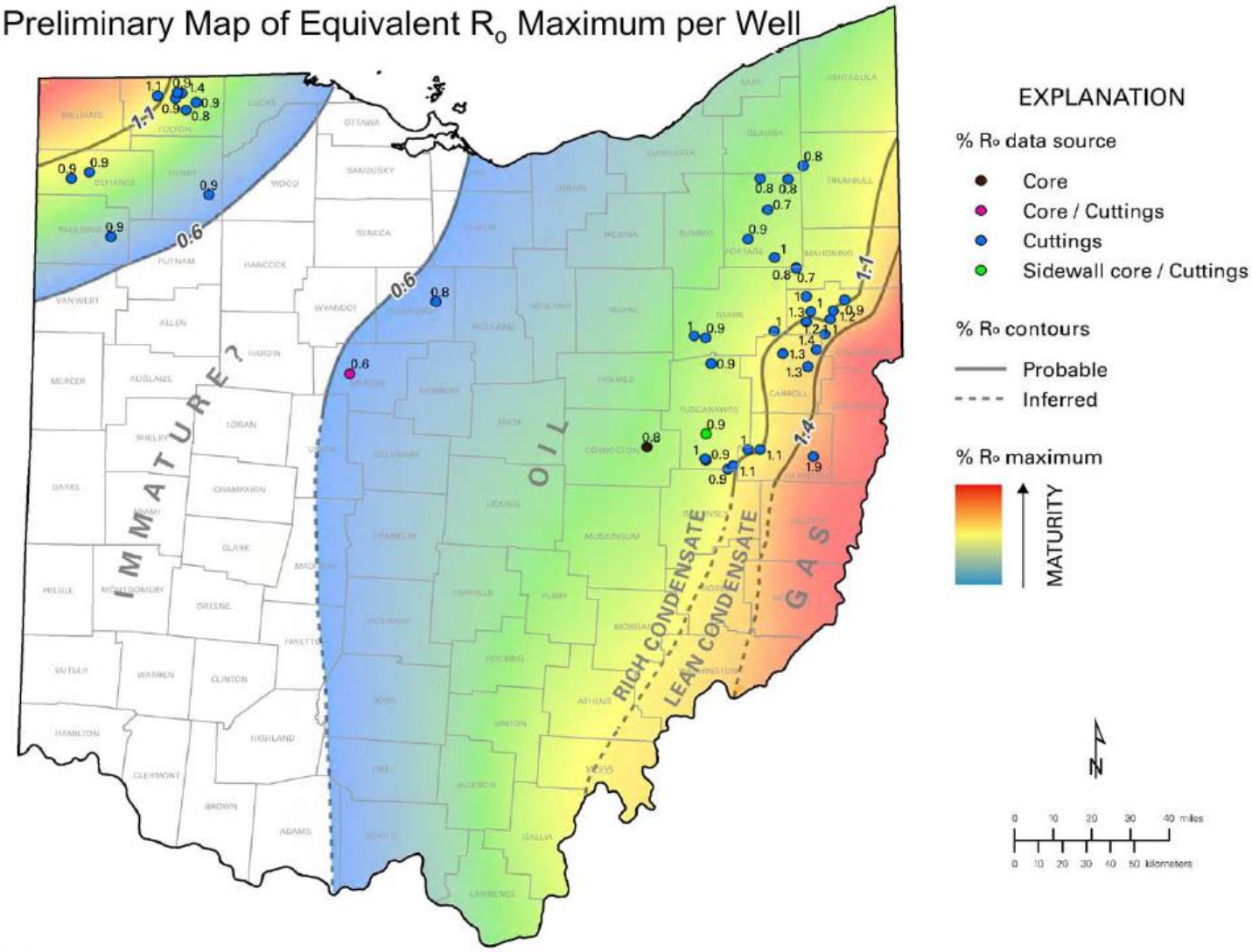
Preliminary Map of Equivalent R_o Maximum per Well



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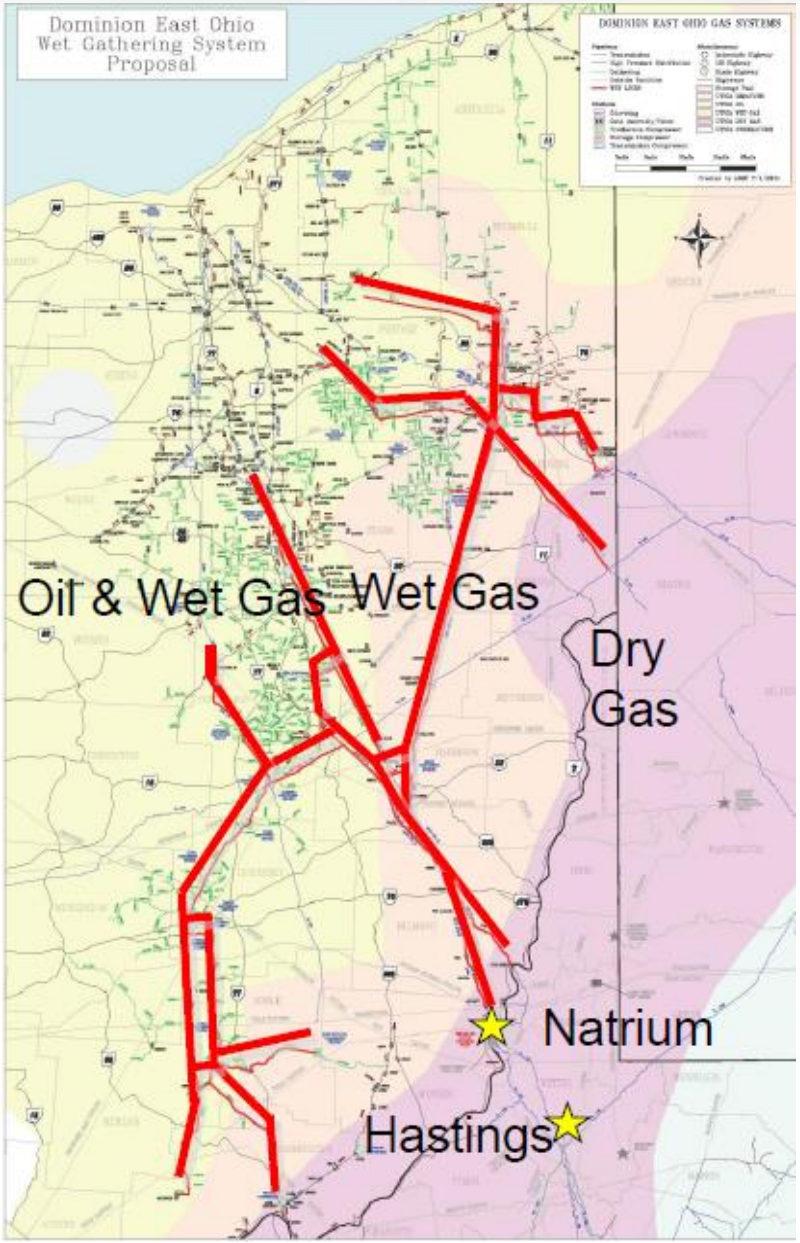
Utica Midstream Buildout



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ETHYLENE CHAIN

American Chemistry Council

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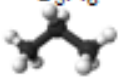
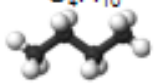
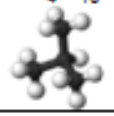
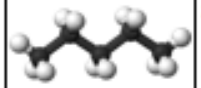
NGL Attribute Summary

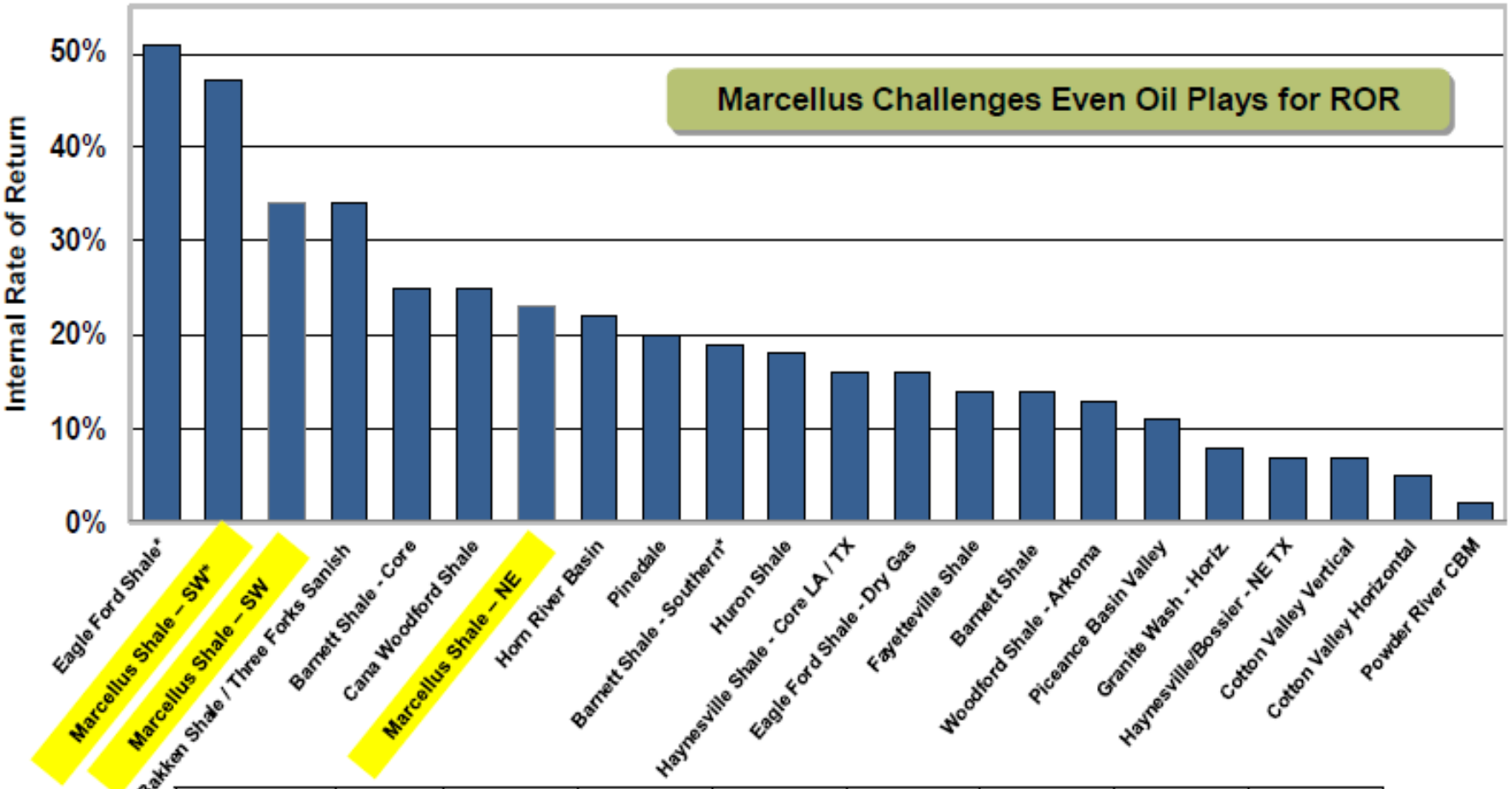
Natural Gas Liquid	Chemical Formula	Applications	End Use Products	Primary Sectors
Ethane	C_2H_6 	Ethylene for plastics production; petrochemical feedstock	Plastic bags; plastics; anti-freeze; detergent	Industrial
Propane	C_3H_8 	Residential and commercial heating; cooking fuel; petrochemical feedstock	Home heating; small stoves and barbeques; LPG	Industrial, Residential, Commercial
Butane	C_4H_{10} 	Petrochemical feedstock; blending with propane or gasoline	Synthetic rubber for tires; LPG; lighter fuel	Industrial, Transportation
Isobutane	C_4H_{10} 	Refinery feedstock; petrochemical feedstock	Alkylate for gasoline; aerosols; refrigerant	Industrial
Pentane	C_5H_{12} 	Natural gasoline; blowing agent for polystyrene foam	Gasoline; polystyrene; solvent	Transportation
Pentanes Plus*	Mix of C_5H_{12} and heavier	Blending with vehicle fuel; exported for bitumen production in oil sands	Gasoline; ethanol blends; oil sands production	Transportation

C indicates carbon, H indicates hydrogen; Ethane contains two carbon atoms and six hydrogen atoms

*Pentanes plus is also known as "natural gasoline." Contains pentane and heavier hydrocarbons.

Source: EIA, Bentek Energy LLC

Relative Profitability of Shale Plays



Year:	1	2	3	4	5	6	7	8+
WTI Oil:	$93.18	$87.55	$88.76	$89.20	$89.81	$90.57	$90.57	$90.57
NYMEX Gas:	$4.09	$4.15	$4.69	$5.00	$5.22	$5.47	$5.47	$5.47

Source: Credit Suisse Research Report – October 18, 2011

*Liquids Rich

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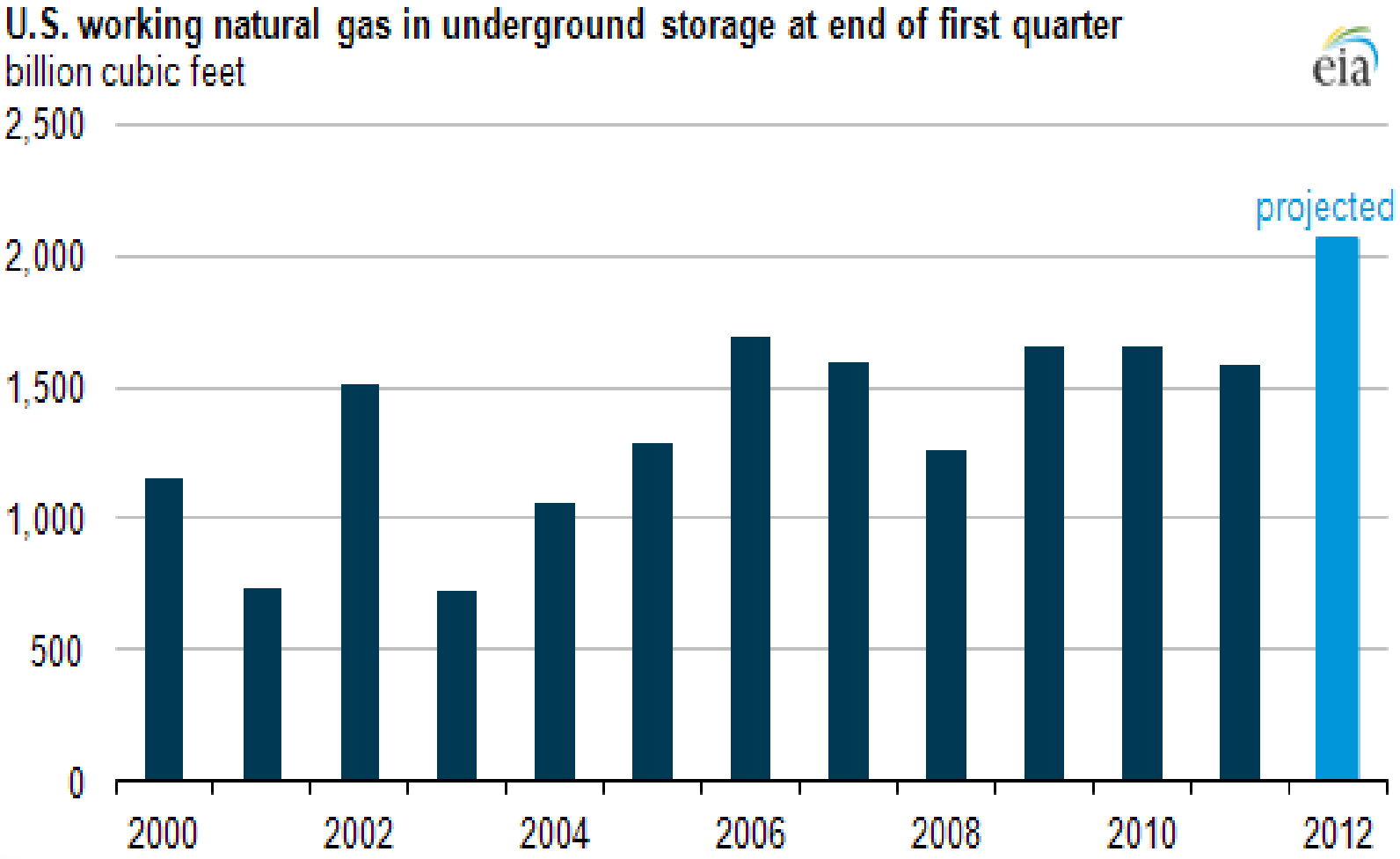
Gas Storage



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New Energy Picture?

- Story is changing from production to utilization
- Adding value to the commodity
- Large energy consumers
  - Industrial
  - Power
  - Domestic/Cross-border
  - Transportation
- New workforce dynamics
- In-state manufacturing of key components
- New industrial renaissance?
- Reduces likelihood of “boom/bust”?

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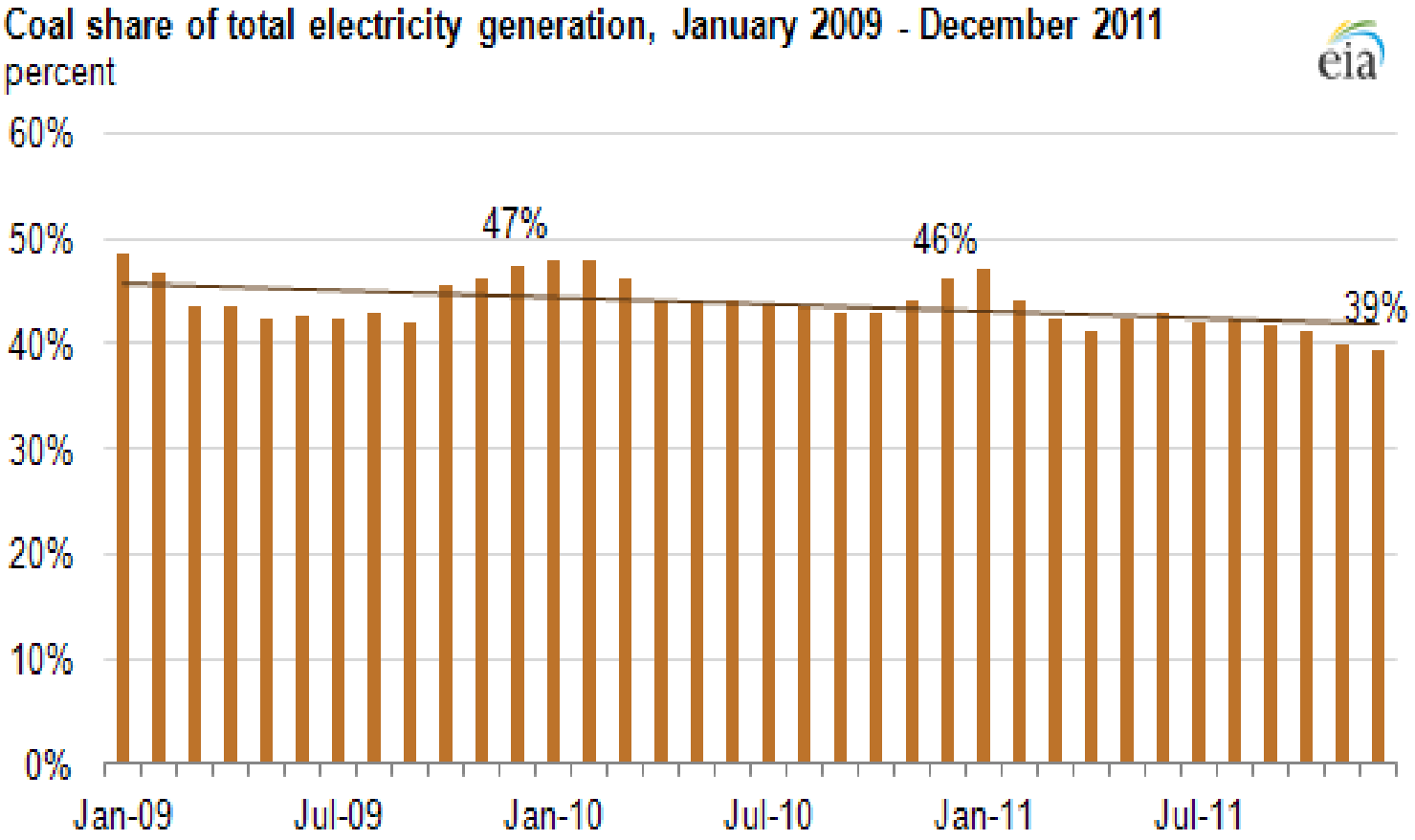
U.S. Electricity Production from Coal

(lowest since '78)



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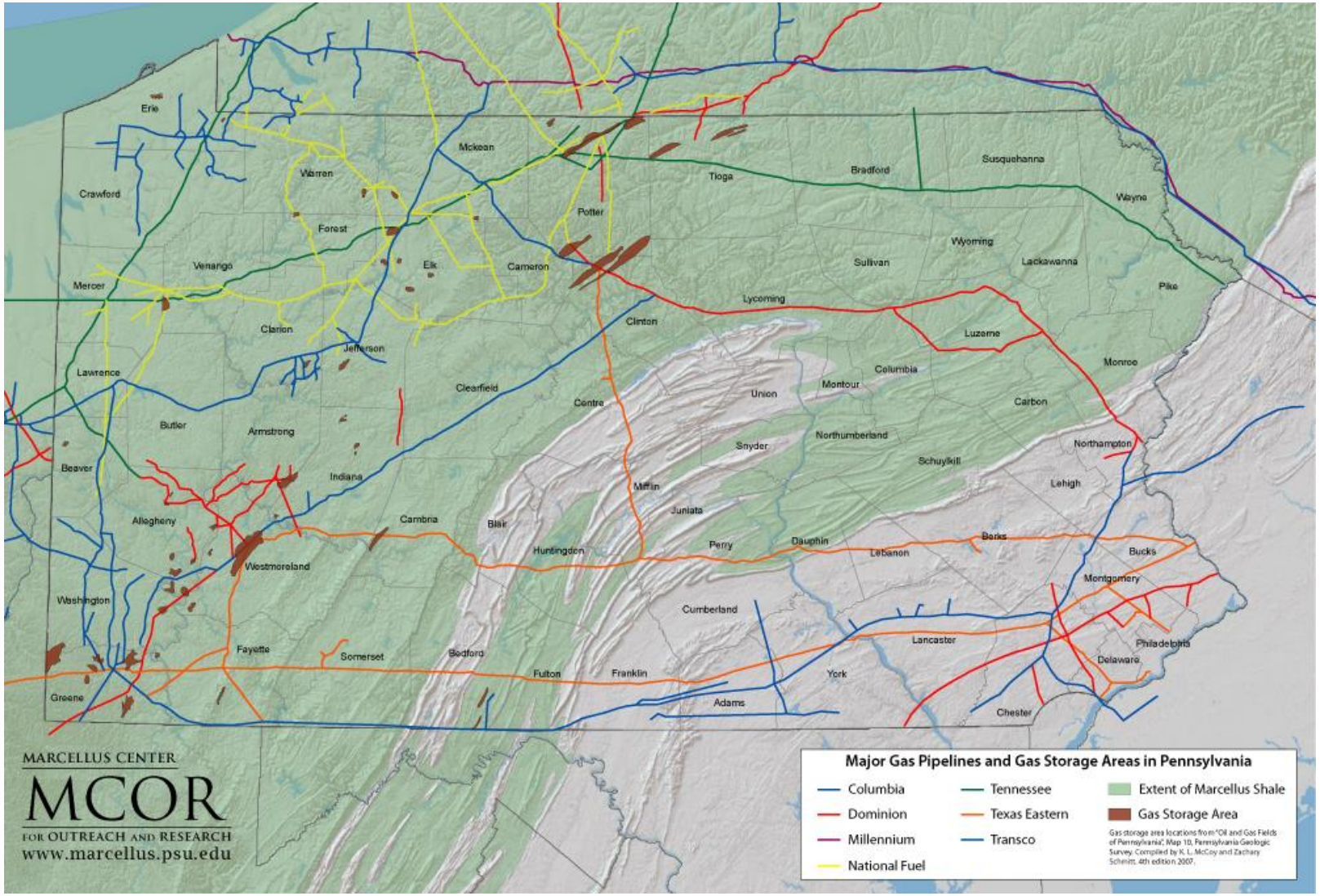
Interstate Pipeline and Storage



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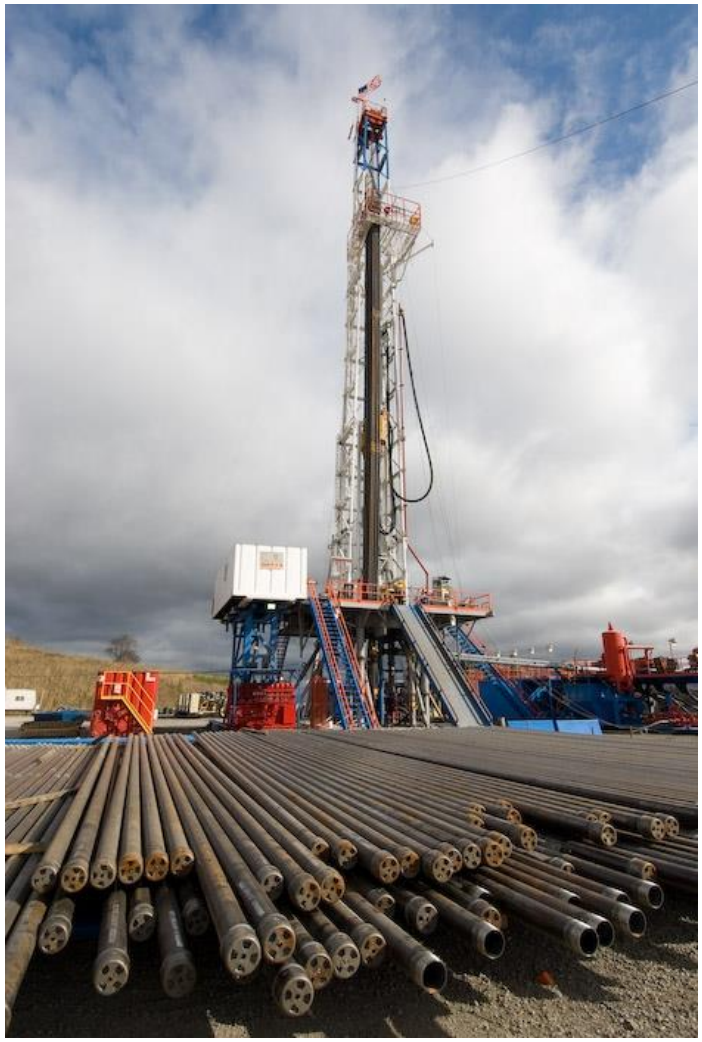
LNG Export

- Is there capacity to export the commodity?
  - Permit issued from the Gulf Coast
  - Alaska
  - Western Canada
  - Cove Point
- Are the economics favorable?
  - Long term contracts vs. spot pricing
  - Competitive environment - Africa, Australia, Qatar
- Is there political will to do so?
- Where would it go?
  - Asia
  - Europe



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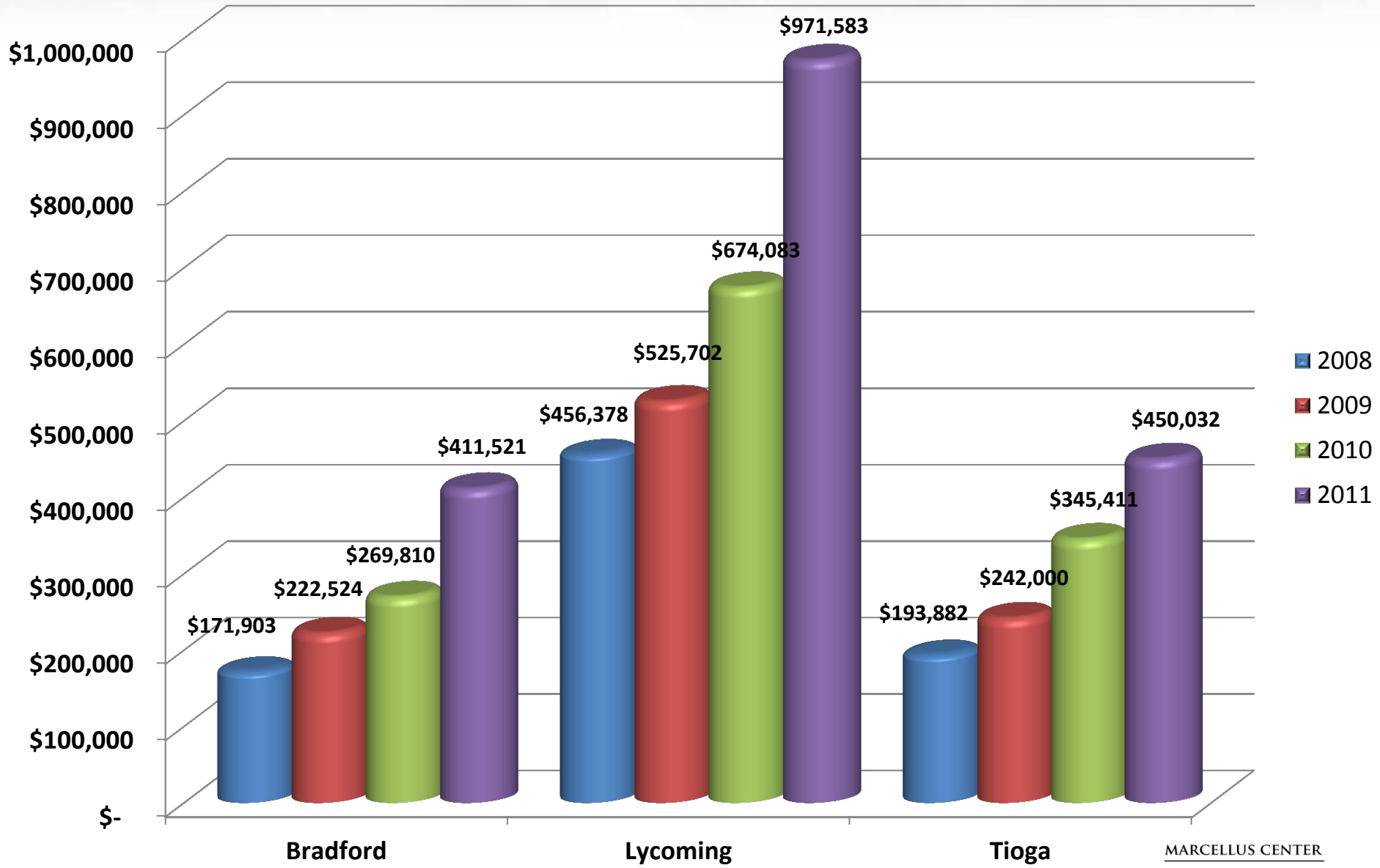
Land Use Changes

- Pipeline
  - 50K miles for gathering lines
- Agricultural use
  - workforce
- “Industrialization”
- Community wide planning
  - Sullivan
  - Westmoreland
- State Forest
  - Wild lands
  - Wildlife habitat
  - Timber resource
    - Certification
- Terminal use of property
- Aesthetics
  - Impact to tourism
- Traffic
  - Mitigation??

Business Impacts Hotel Tax



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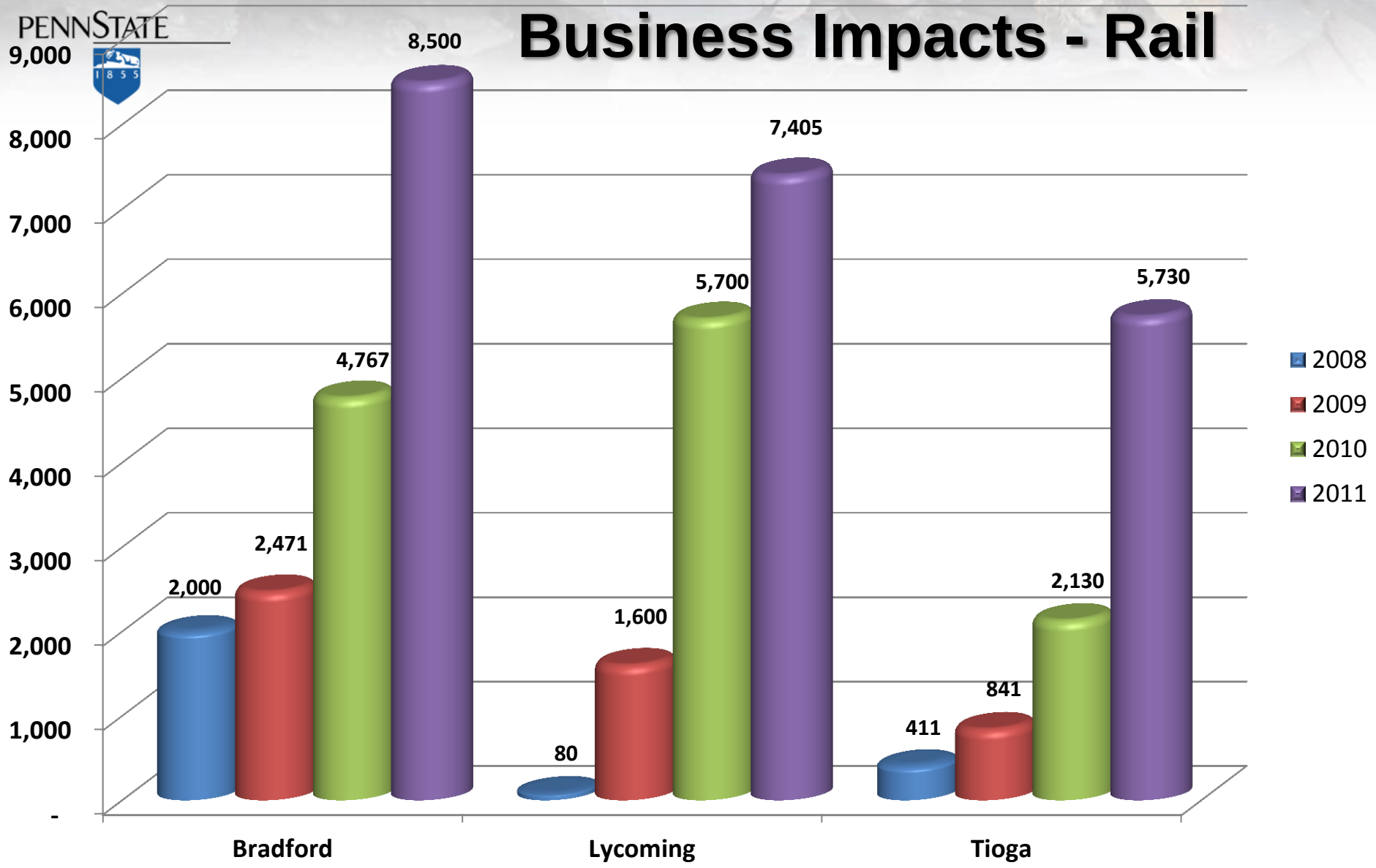
Business Impacts - Rail



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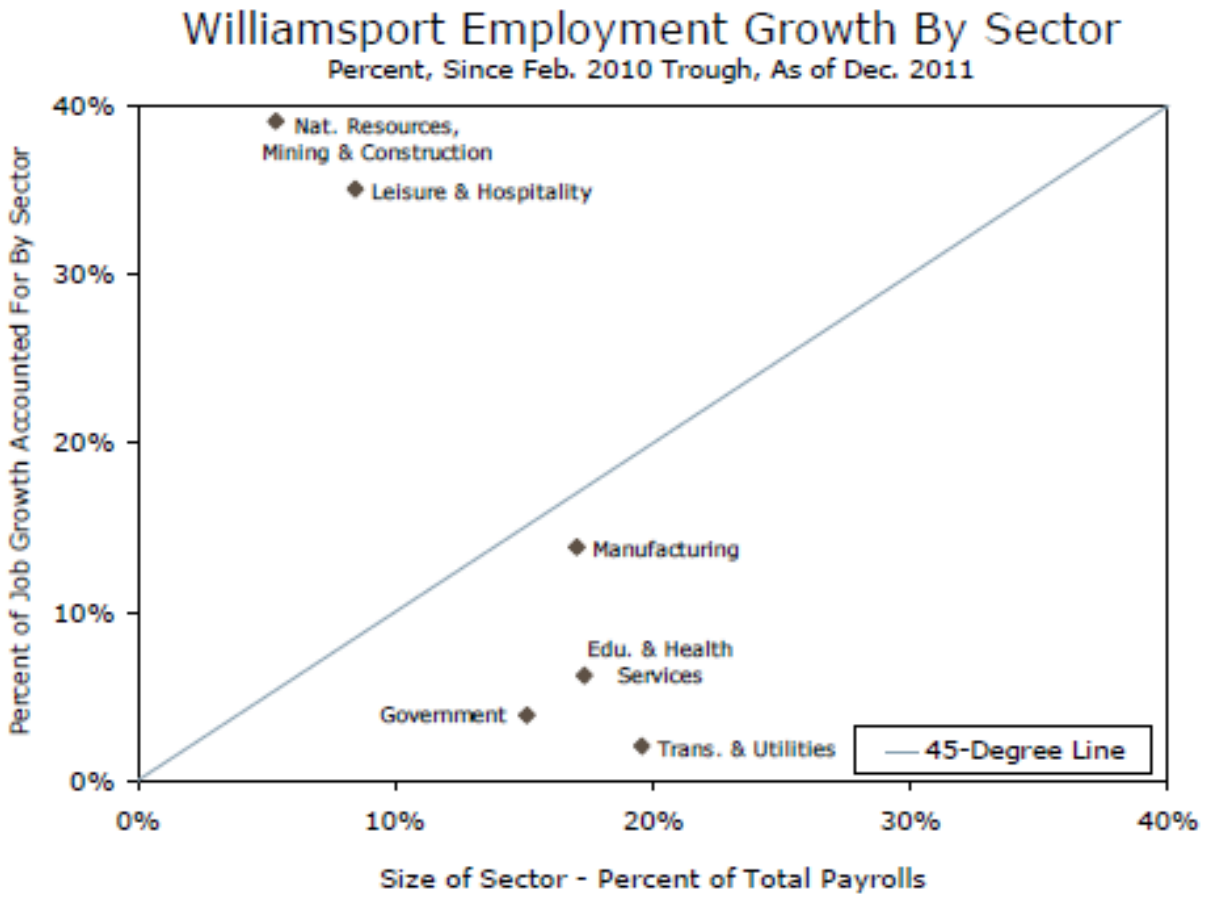

Source: Wells Fargo Economic Advisory 3/12

- **Web Resources:**

- www.marcellus.psu.edu
- www.msetc.org
- www.naturalgas.psu.edu

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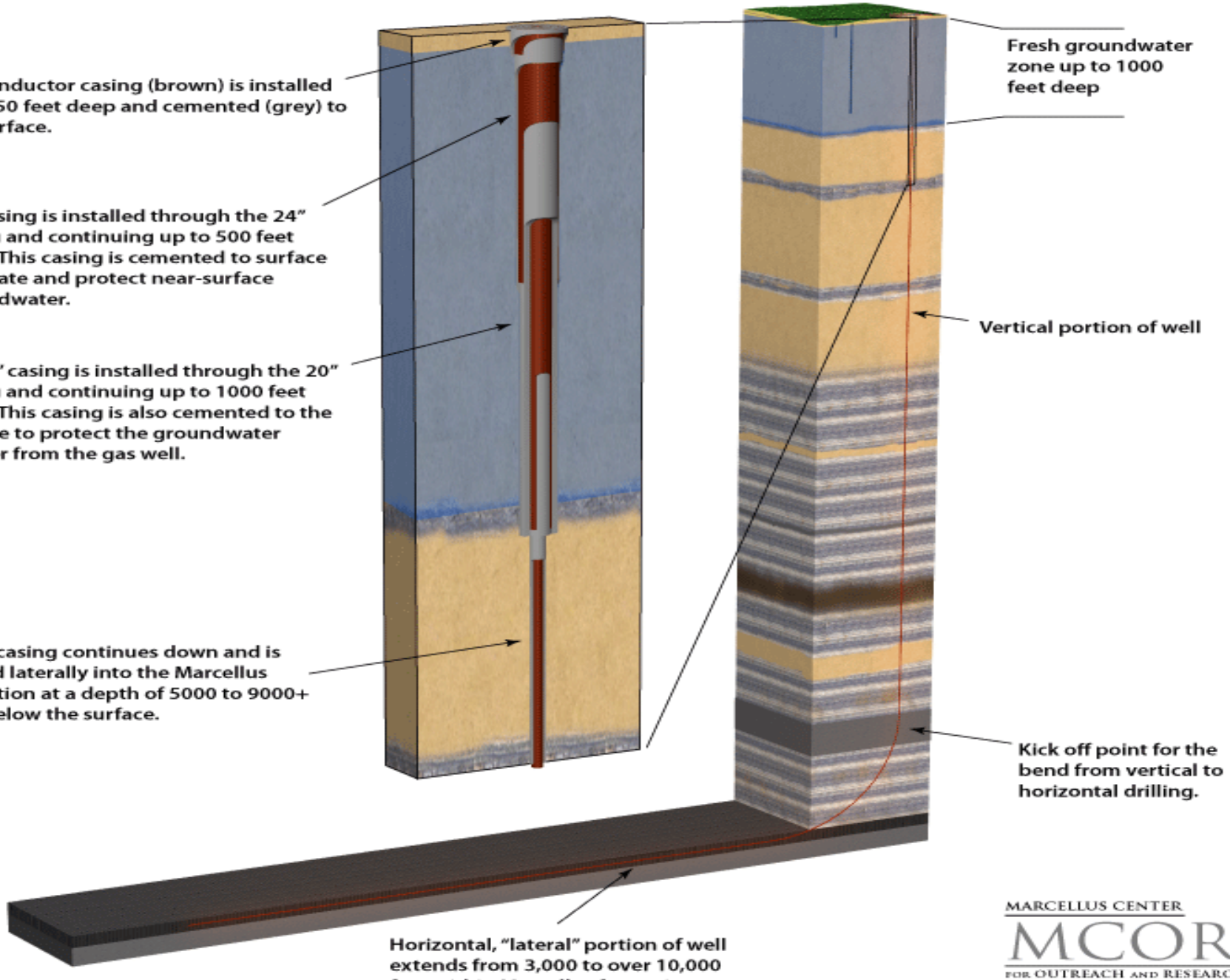
Cross-Section of Typical Horizontal Marcellus Well



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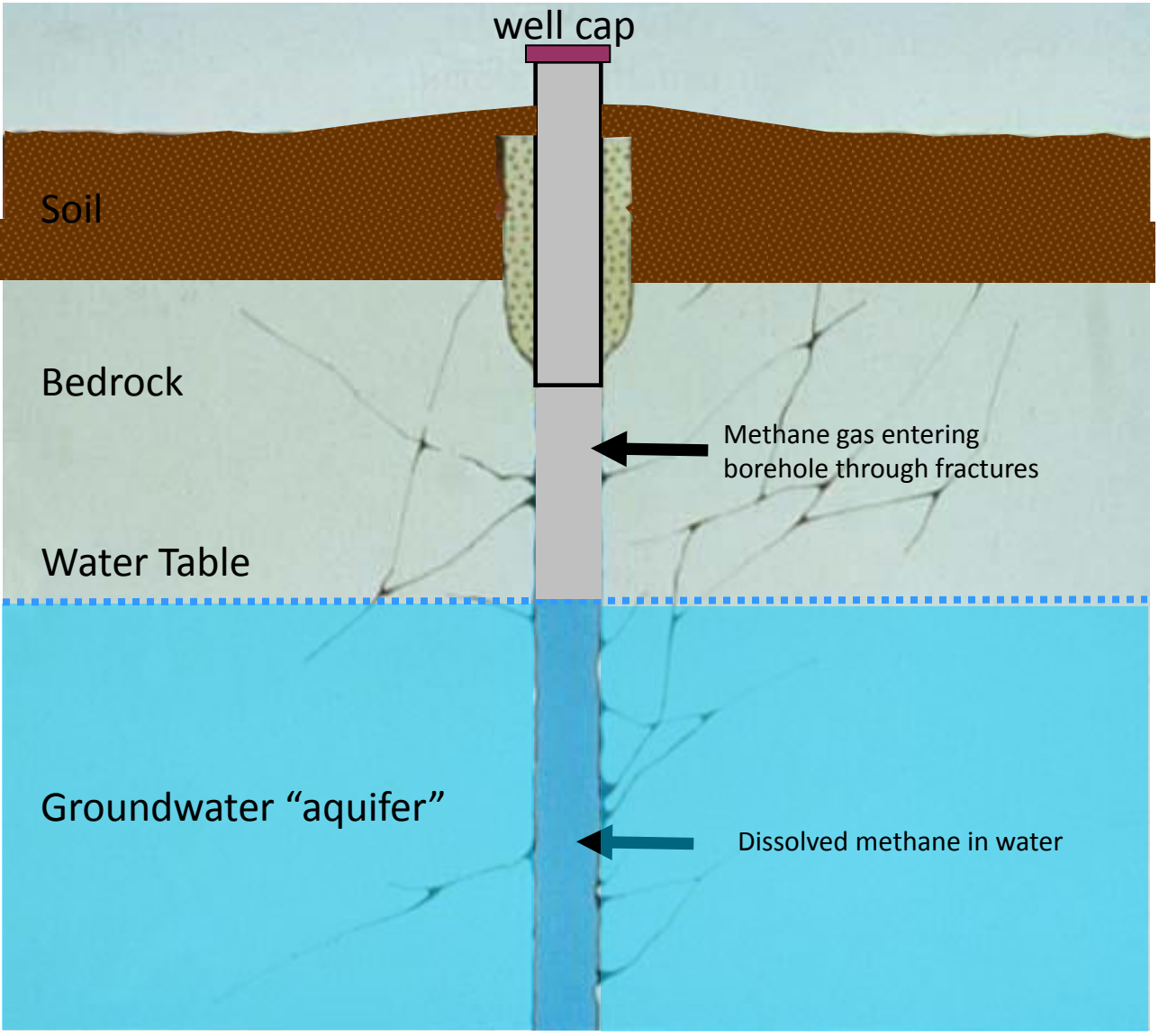
www.marcellus.psu.edu

Methane in Water Wells



- Can be naturally occurring or from gas drilling
- Pumping water can release dissolved methane by lowering pressure
- No drinking water standard or uniform testing method. Levels above 28 mg/L of great concern.
- Pre-existing detectable methane may occur in ~20% of water wells but most are below 1 mg/L.

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Groundwater Protection

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Groundwater/Pad Protections

Later Stages of Site Work

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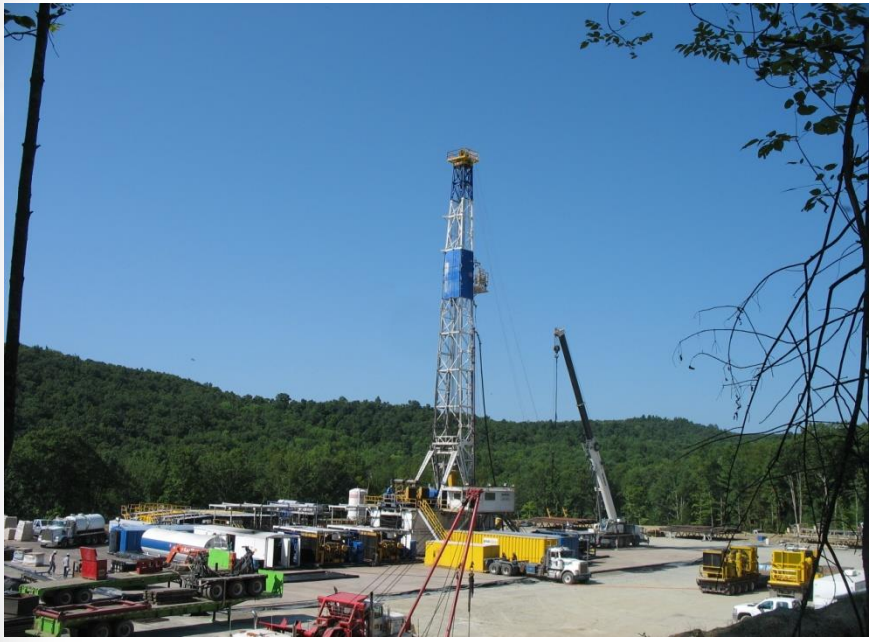
Start of Drilling



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Well Site in Operation

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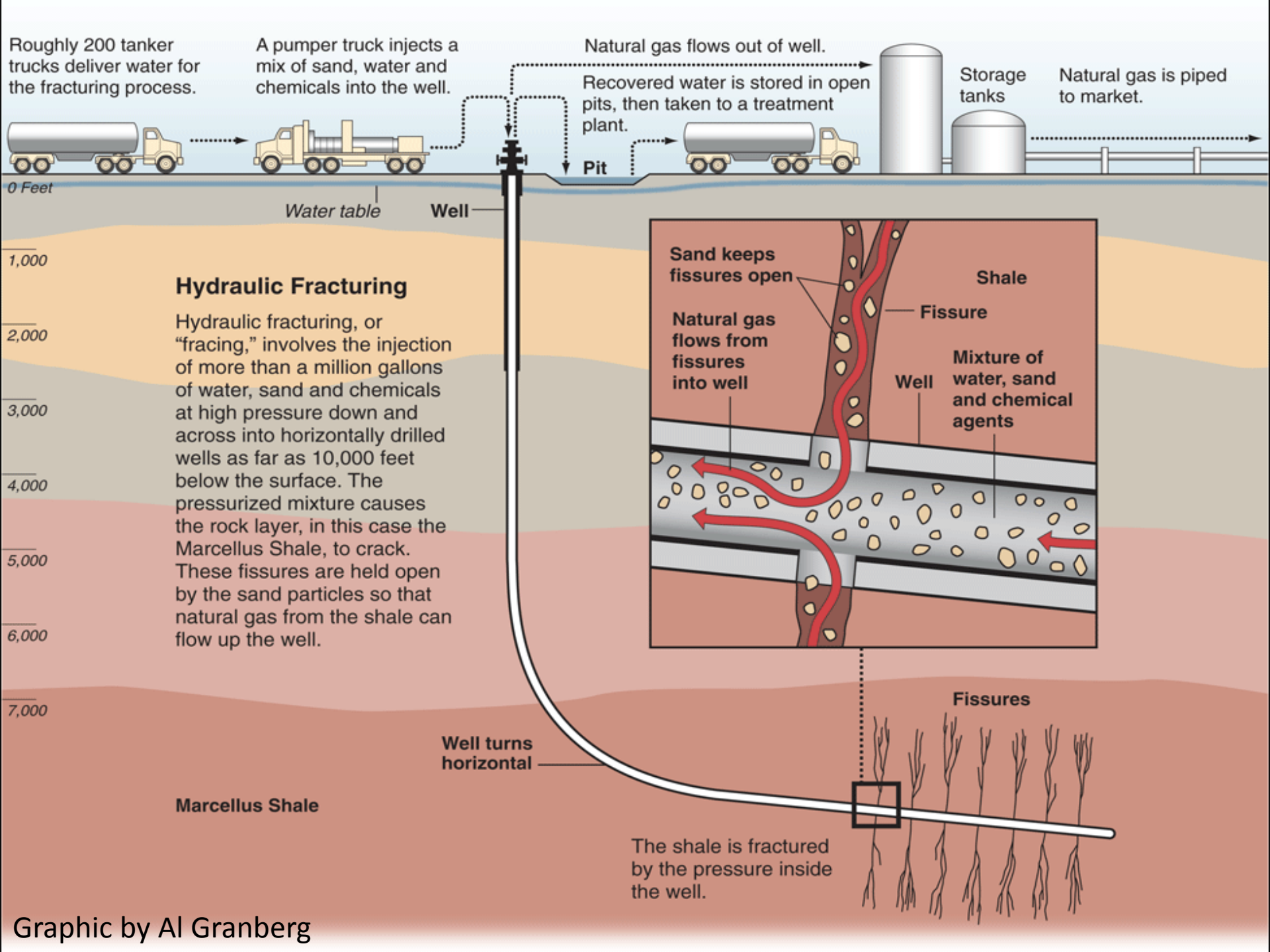

Graphic by Al Granberg

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Hydraulic Fracturing Process

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Infrastructure Completion

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Gathering Line Connection

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Site Renovation

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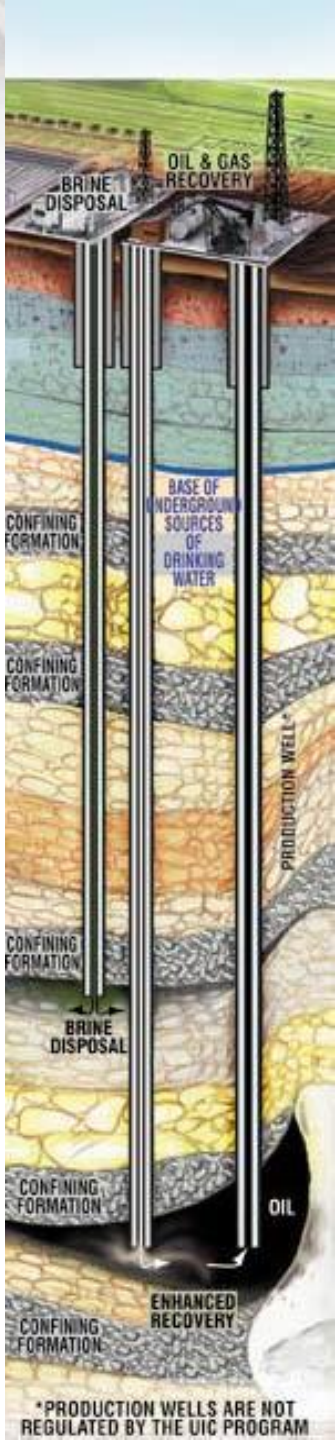
Wastewater Options

- 5 million gallons per well, 10% return
- Conventional treatment
  - Low cost, salt remains, limited in PA
- Deep injection wells (mostly OH and WV)
  - Limited by geology and orphan wells
- Advanced treatment (crystallization, membrane filtration, etc)
  - $$ but produces very clean water for re-use or discharge
- Reuse / recycling
  - Direct re-use of early flowback water
  - Re-use with dilution
  - Re-use with minimal treatment and dilution
  - Direct re-use after advance treatment



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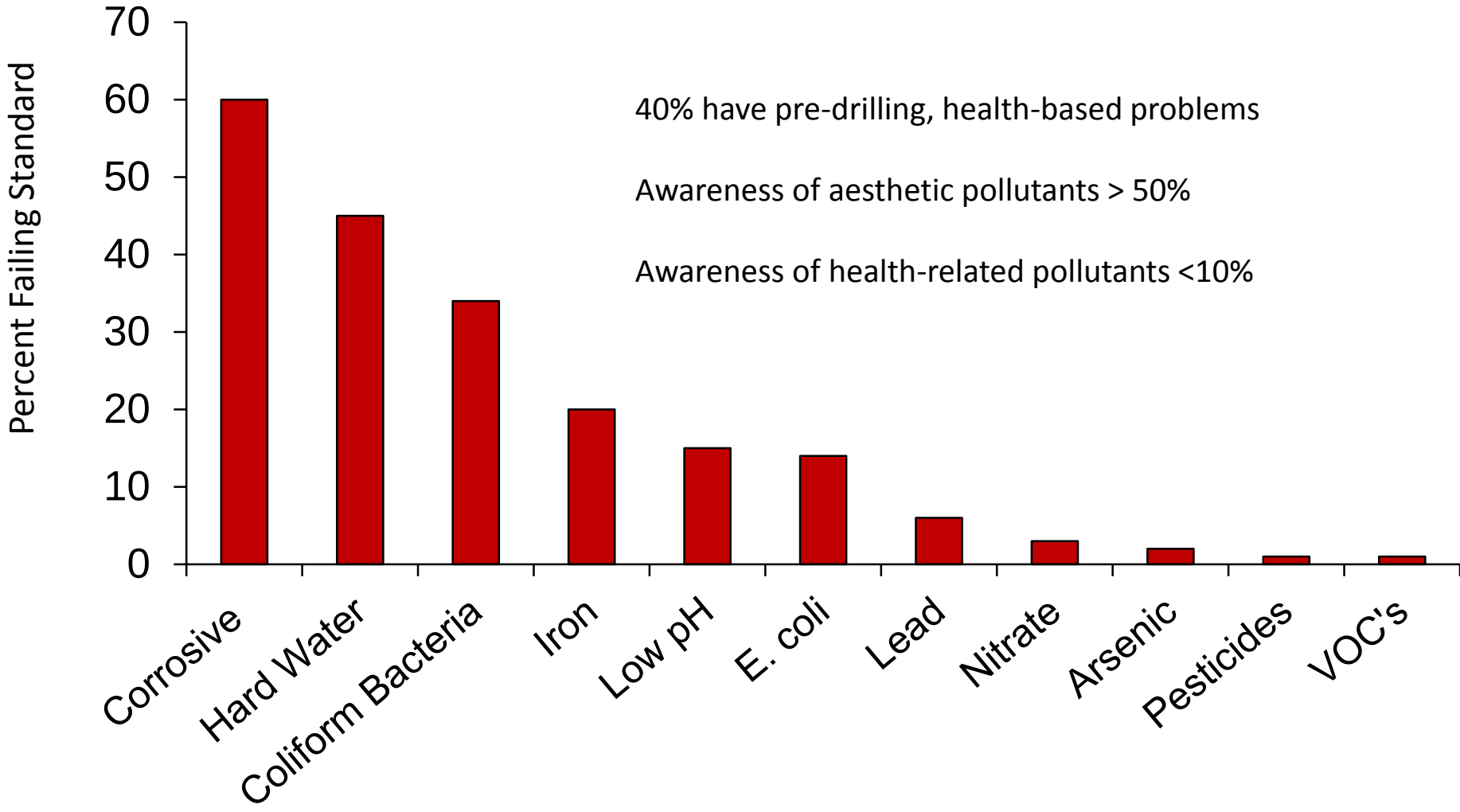
Pre-Drilling Problems are Common

(2006-07 survey of 701 water wells)



Impact of Marcellus Gas Drilling on Rural Drinking Water Supplies

- Five Penn State project coordinators

- Funded by the Center for Rural Pennsylvania (a legislative agency of the Pennsylvania General Assembly) and the Pennsylvania Water Resources Research Center at Penn State University

Objectives:

- Provide an unbiased and large scale study of water quality in private water wells both before and after the drilling of Marcellus gas wells nearby.

- Document both the enforcement of existing regulations and the utilization of voluntary measures by homeowners to protect water supplies.

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