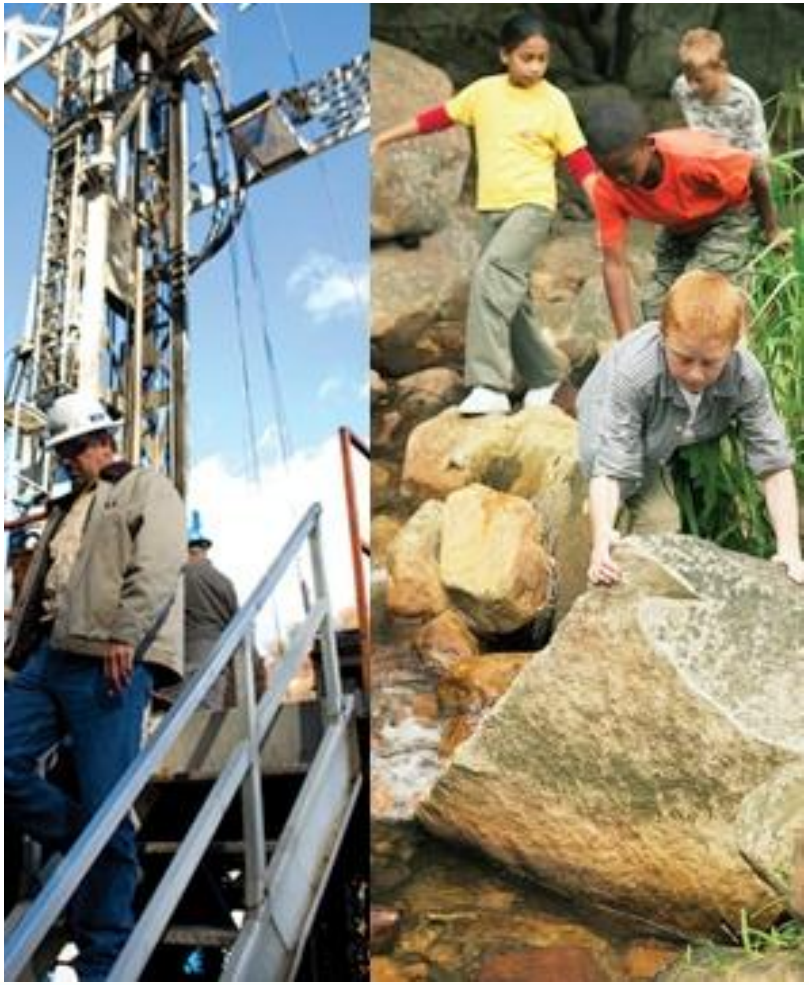
MARCELLUS SHALE COALITION

Master Presentation

www.MarcellusCoalition.org

Twitter.com/marcellusgas

Facebook.com/marcelluscoalition



February 20, 2013

Shale Gas 101

Marcellus Shale: Introduction

Marcellus Shale bank along Route 174 just south of Slate Hill Road in Marcellus, NY

What is the Marcellus Shale?

- Geological formation formed by accumulation of sediment into a sea almost 400 million years ago

- Compressed to produce an organic-rich black shale.

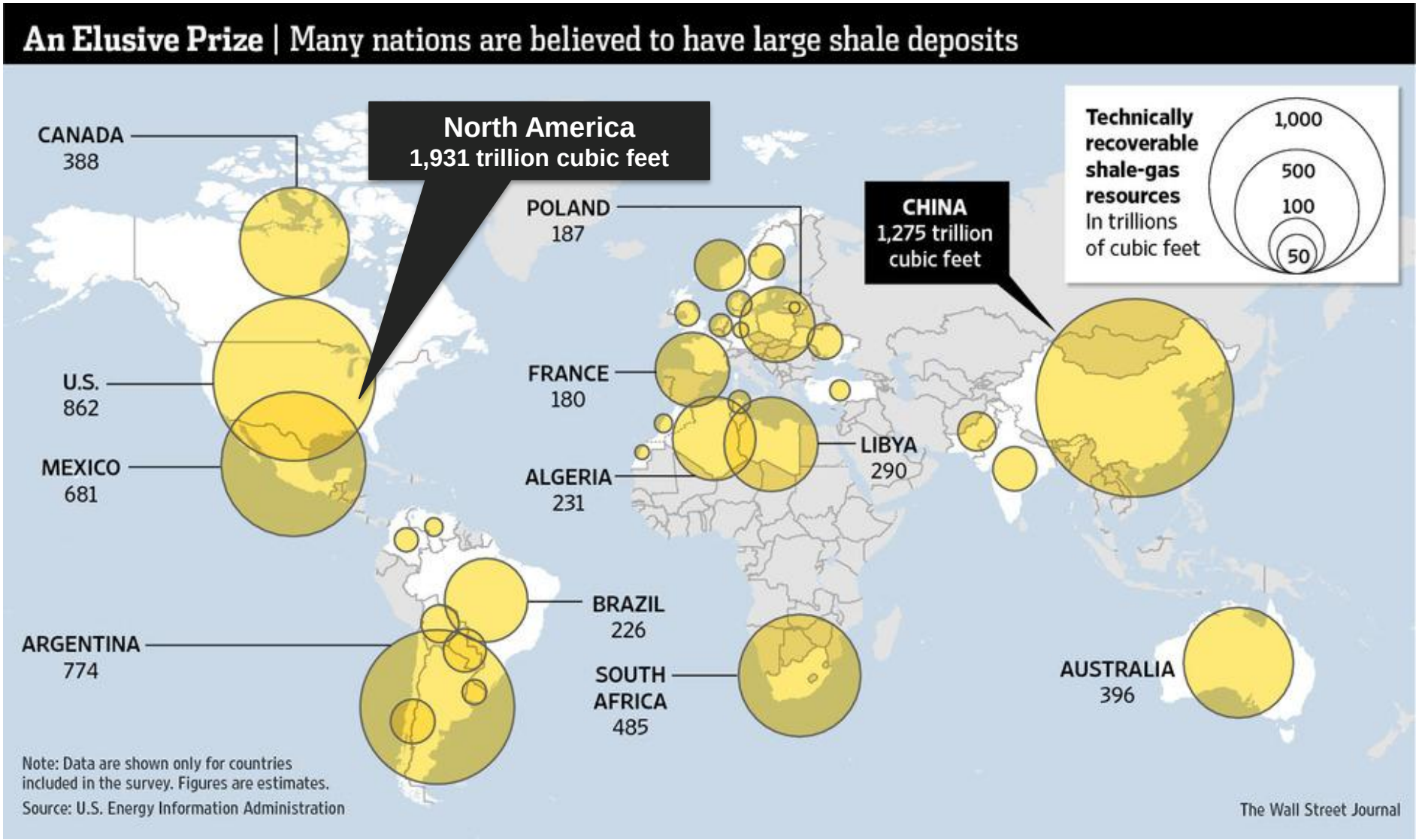
- Starts at NY, Catskills, stretches across toward Marcellus, New York then southwest to PA, West Virginia, Kentucky, and Ohio.

Why Now?

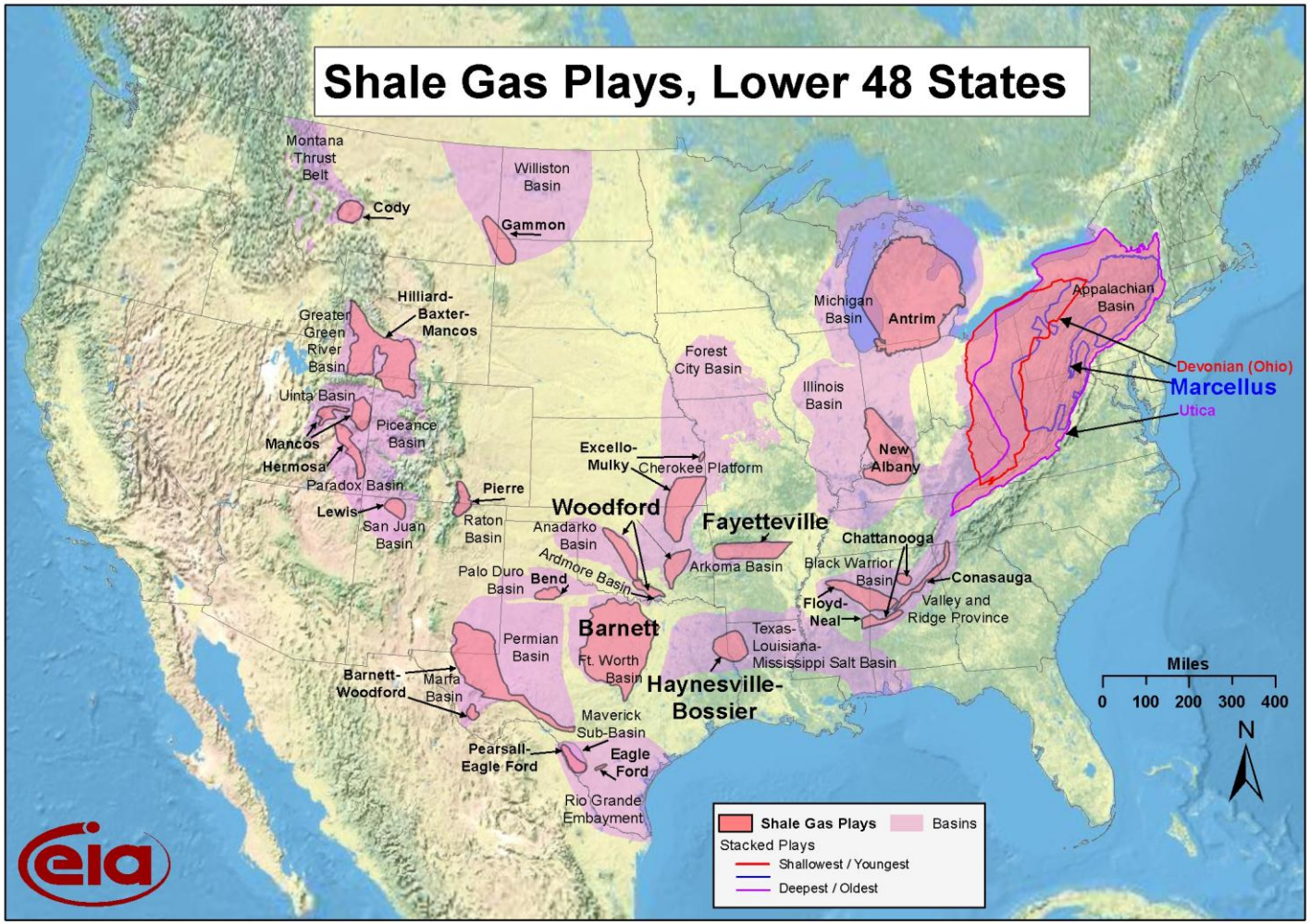
- Success of other shale plays has allowed companies to transfer horizontal drilling and technology to other areas.

- Proximity to high-demand markets along the East Coast make it an attractive target for energy development.

Shale Gas – Global Opportunity



Shale Gas Revolution Across the U.S.



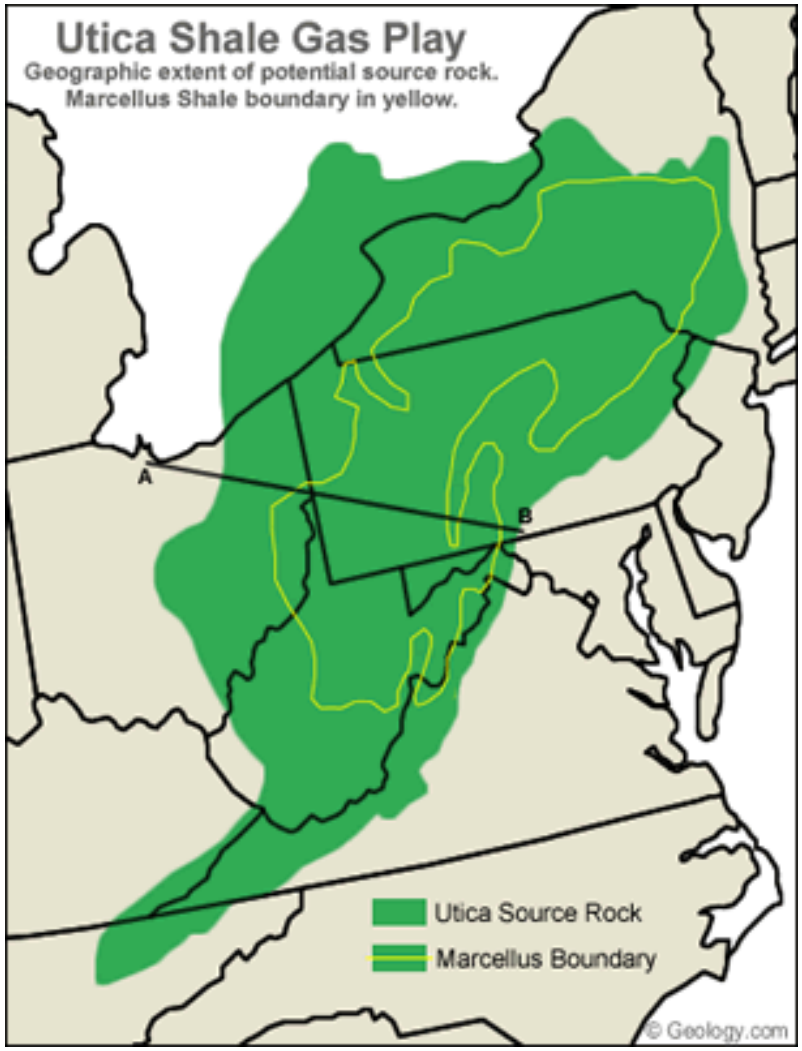
Source: Energy Information Administration

Marcellus Shale: Geographic Footprint

Potentially The Second Largest Reserve In The World

Utica Shale

- Below the Marcellus
- Bigger, deeper, denser
- One of the latest U.S. unconventional energy fields
- Particularly attractive in OH
- Success in the Marcellus has led to success in the Utica



Industry Segments

UPSTREAM

Exploration and Production

- Gas Field Exploration
- Well Drilling and Hydraulic Fracturing
- Gas Recovery and Production

MIDSTREAM

Gathering and Gas Processing

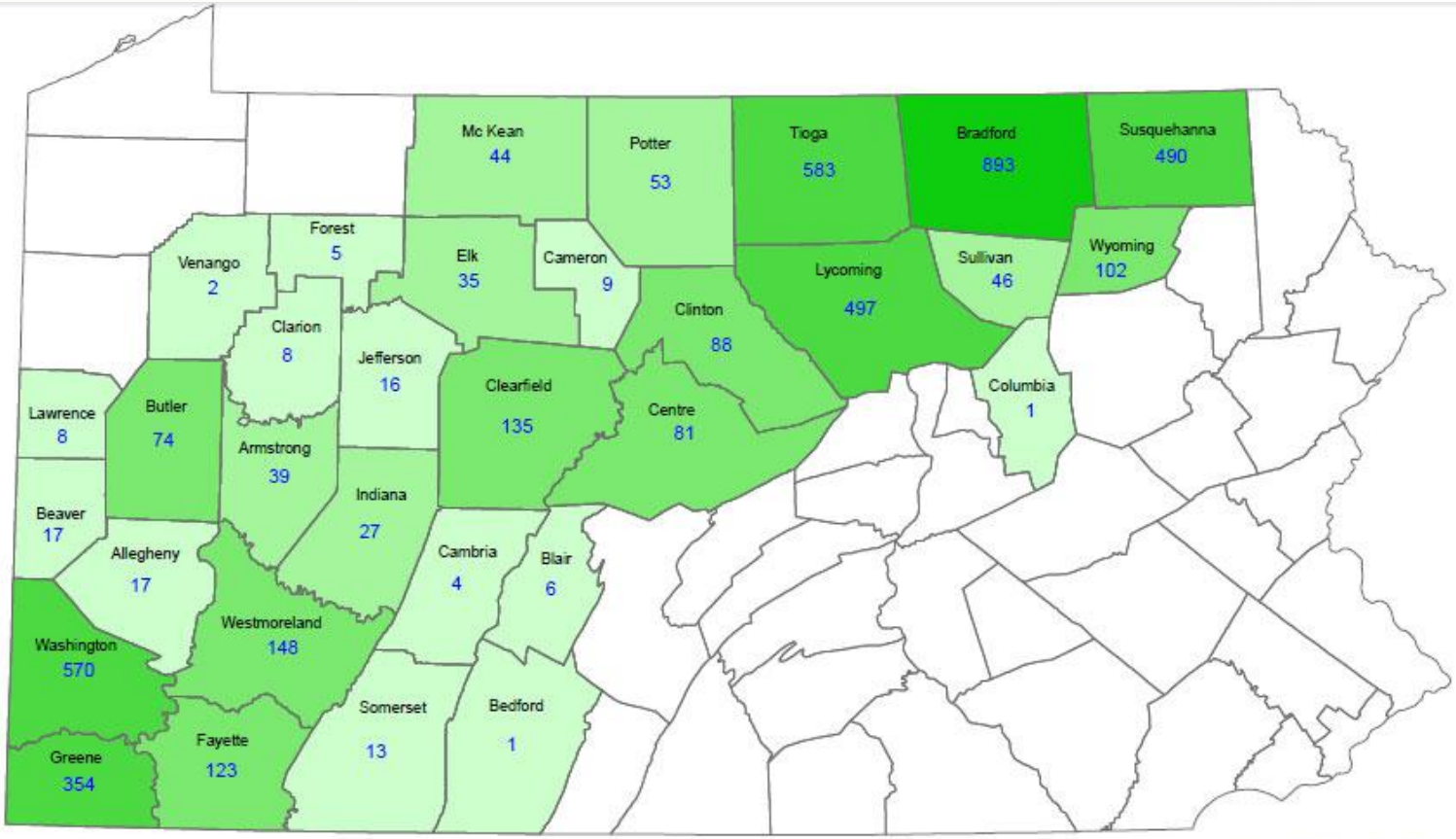
- Gas Collection and Transportation Systems (Gathering Pipelines)
- Gas Processing (Dehy, Separation, Fractionation)
- Compression (Well Head, Gathering)

DOWNSTREAM

Selling and Distribution

- Interstate and LDC Transportation Systems (Transmission and Distribution Pipelines
- Compression (Transmission)
- Regulation
- Metering

Pennsylvania Wells By County



Horizontal, Unconventional Wells - 4,489

Legend

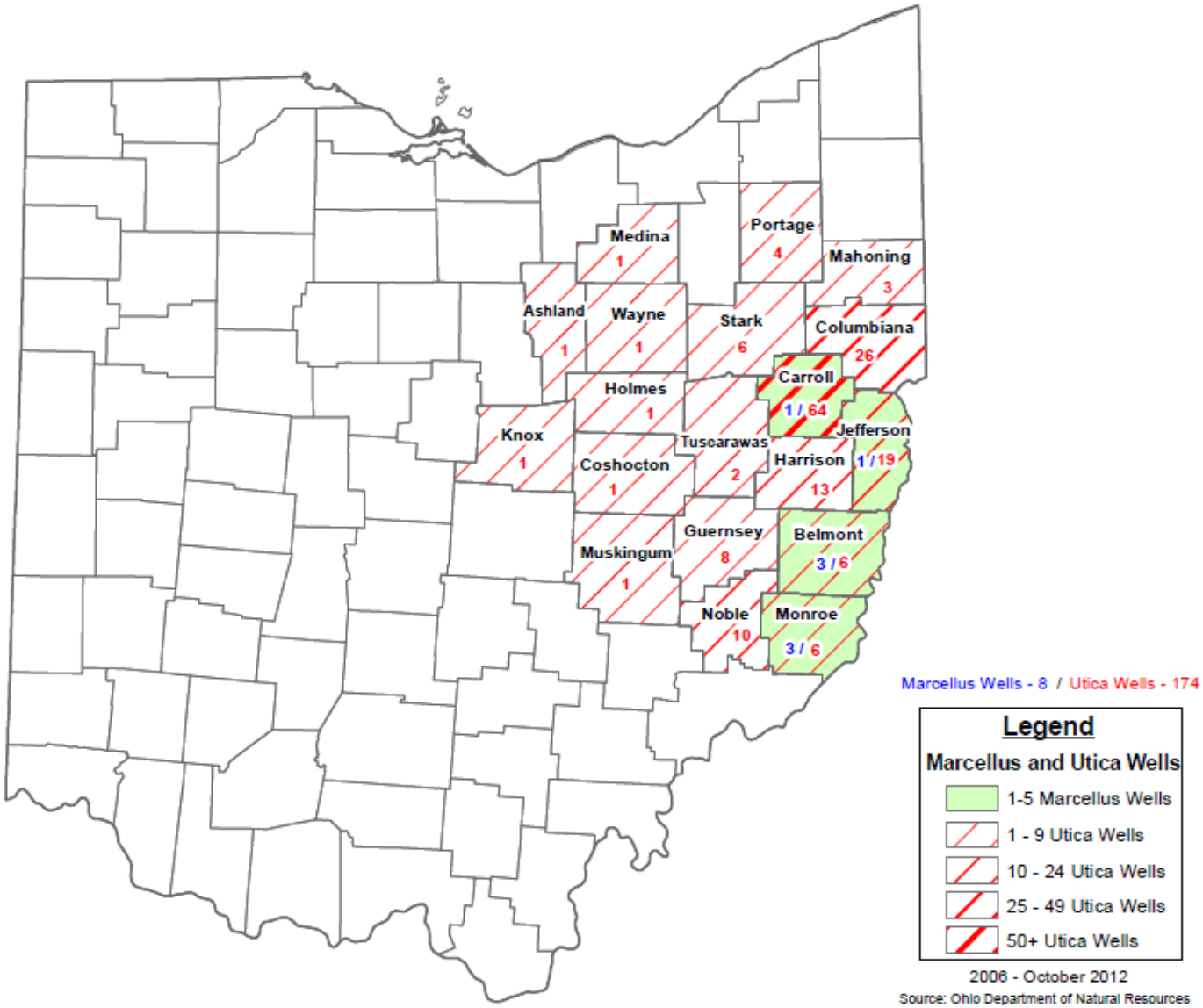
Unconventional Wells

1 - 19	150 - 599
20 - 54	600+
55 - 149	

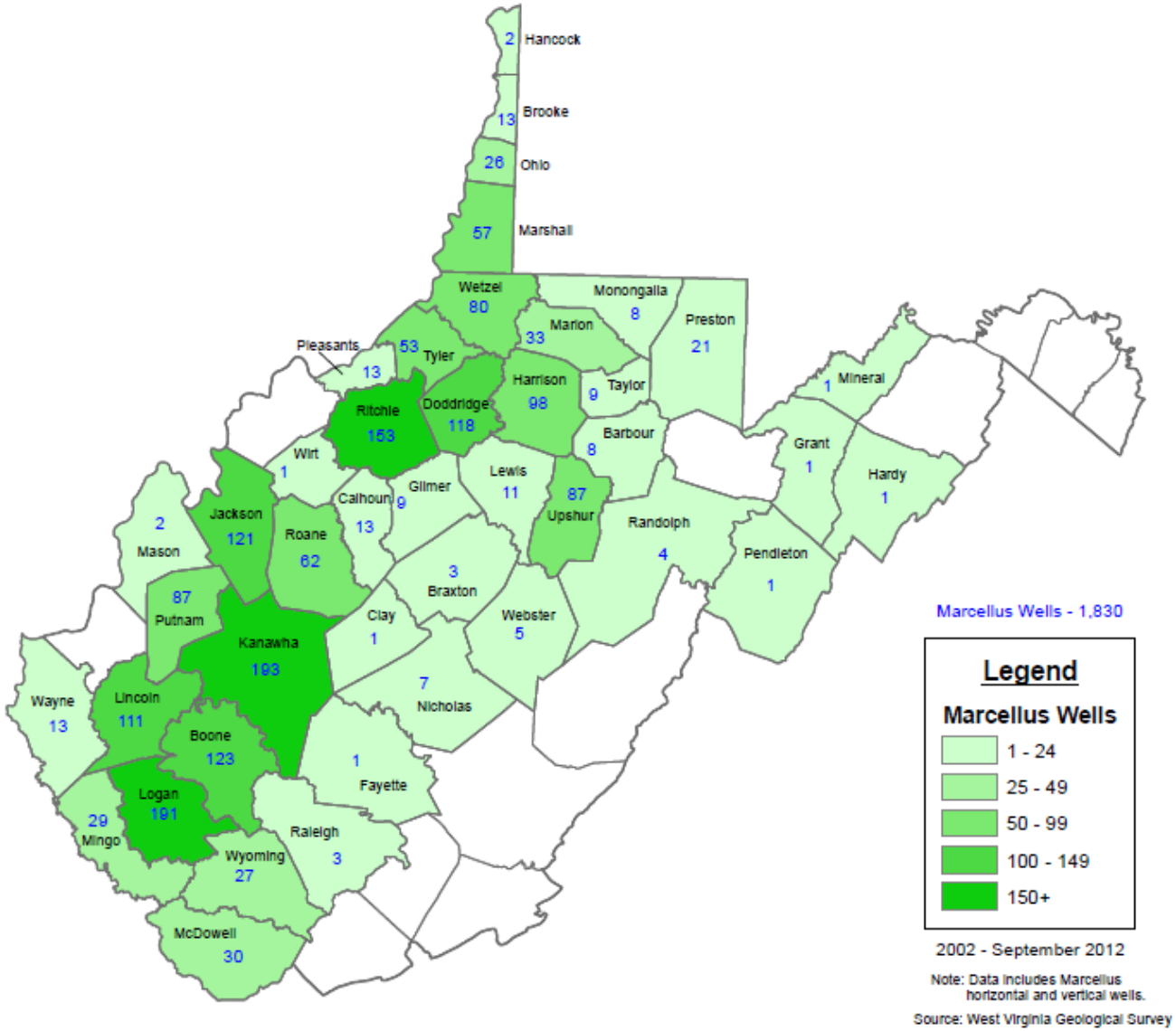
2004 - June 2012

Source: Department of Enviromental Protection and Pennsylvania Bureau of Oil and Gas

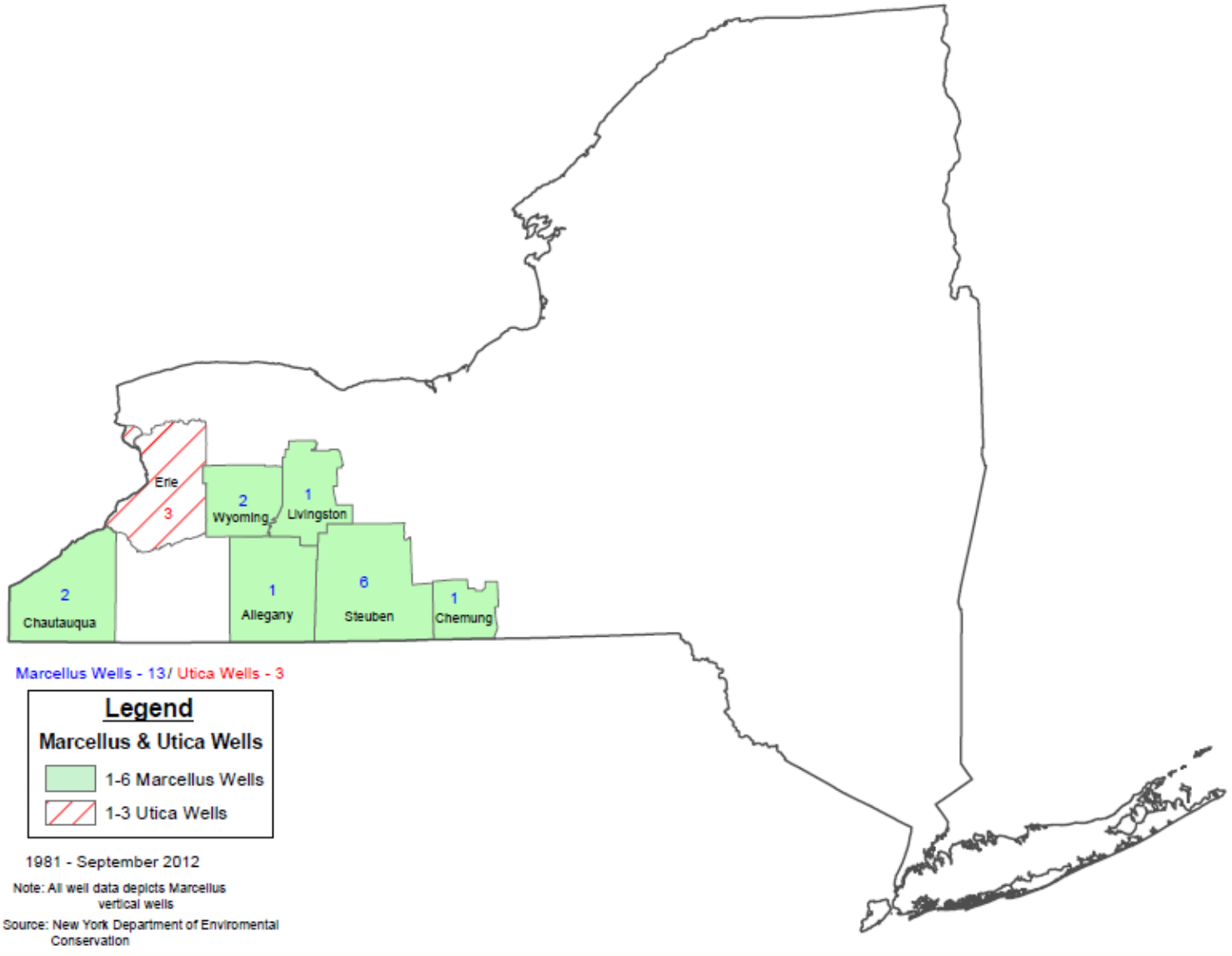
Ohio Wells By County



West Virginia Wells By County



New York Wells By County



Exploration/Production, Midstream, and Downstream 101

Shale Gas: Steps in Drilling

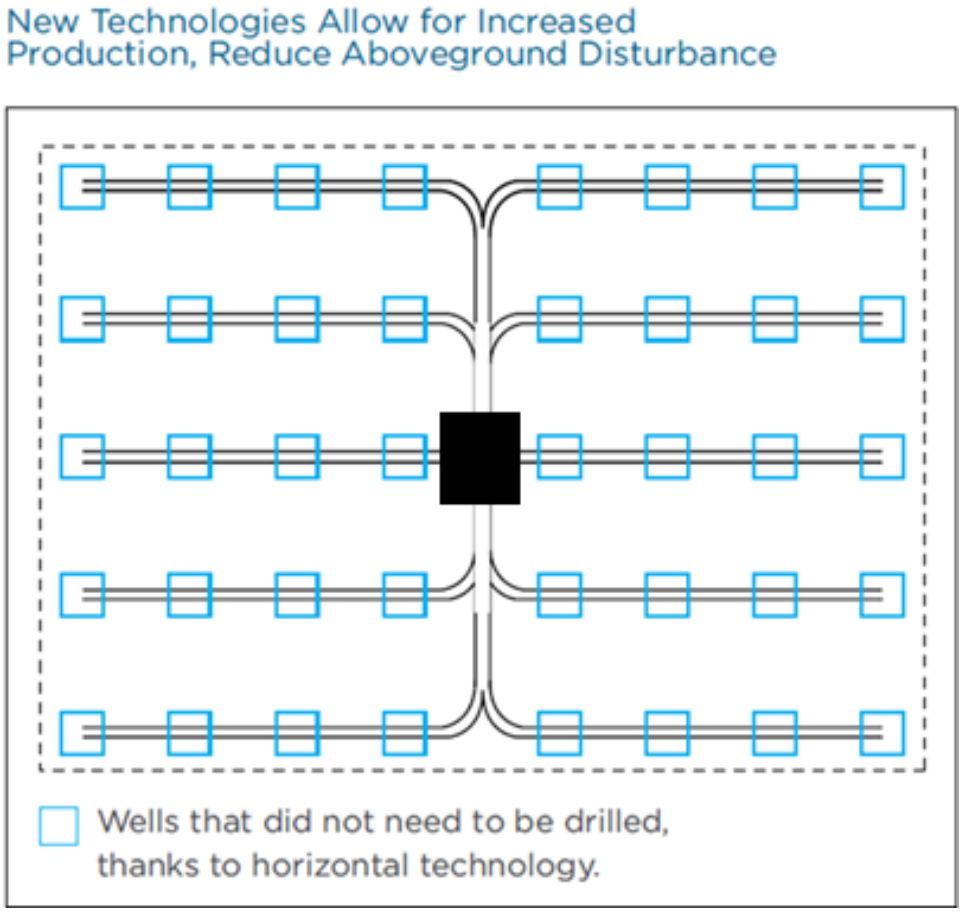
Land Acquisition/Site Preparation

- Obtain rights from landowner.
- Educated landowner is an ideal partner.
- “Production unit” - contiguous parcels of land combined for development.
- Production unit incorporated into a company’s drilling program.
- Site is prepared for drilling activity.

Shale Gas: Steps in Drilling

Horizontal Drilling

- More efficient production, smaller footprint.
- Conductor, surface casing protect drinking water source.
- Well is drilled vertically and horizontally as much as 5,000 feet.
- Wellbore is approximately 20 inches in diameter at its widest.
- 5 ac vs. 24 ac = 1 acre when done



Shale Gas: Environmental Protection in Wells

MARCELLUS SHALE COALITION

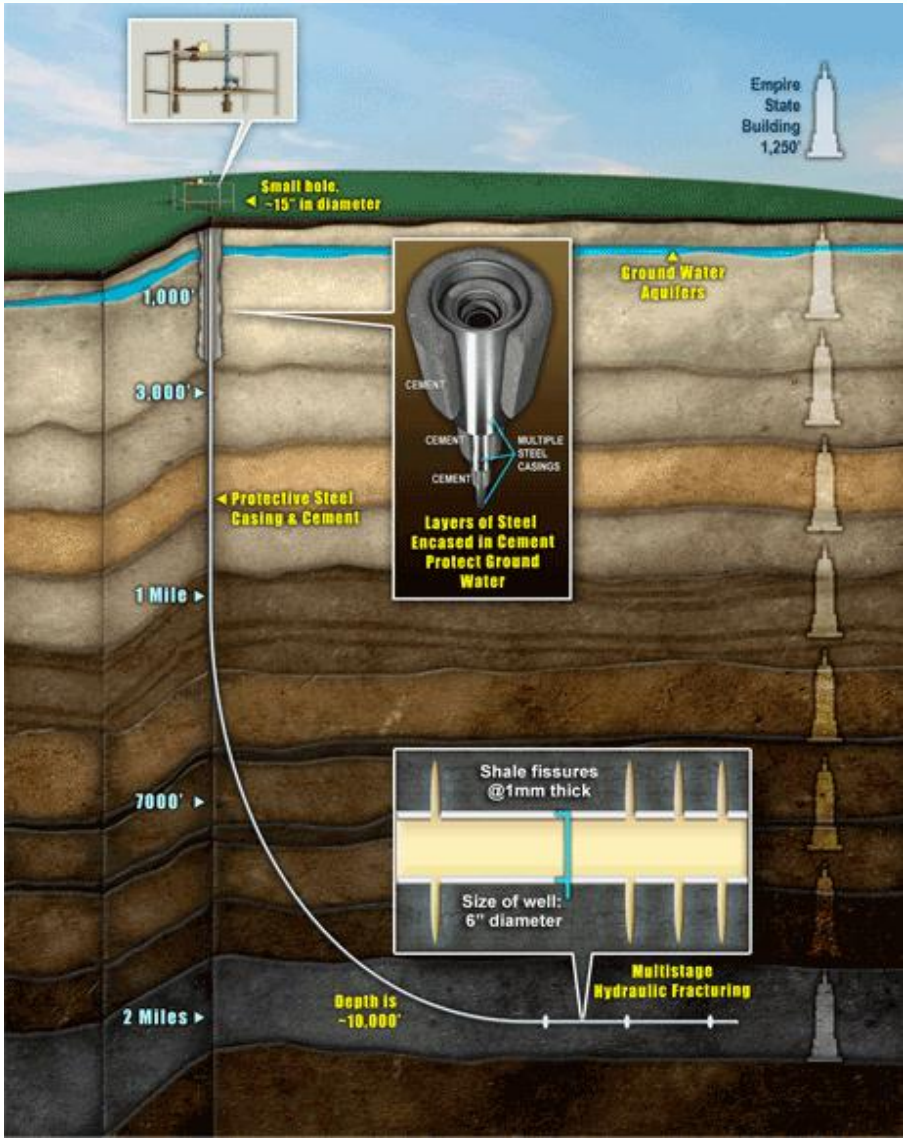
Well Casing

- Multiple layers of steel and cement to ensure redundant protection
  - 1 – through fresh water aquifer
  - 2 – to depths of ~1,500 feet
  - 3 – to final depths
- Cementing to surface at each layer provides stability and protection, preventing the crossflow of hydrocarbons
- 25 PA Code, Chapter 78 rules have further strengthened standards

Shale Gas: Steps in Completion

Hydraulic Fracturing

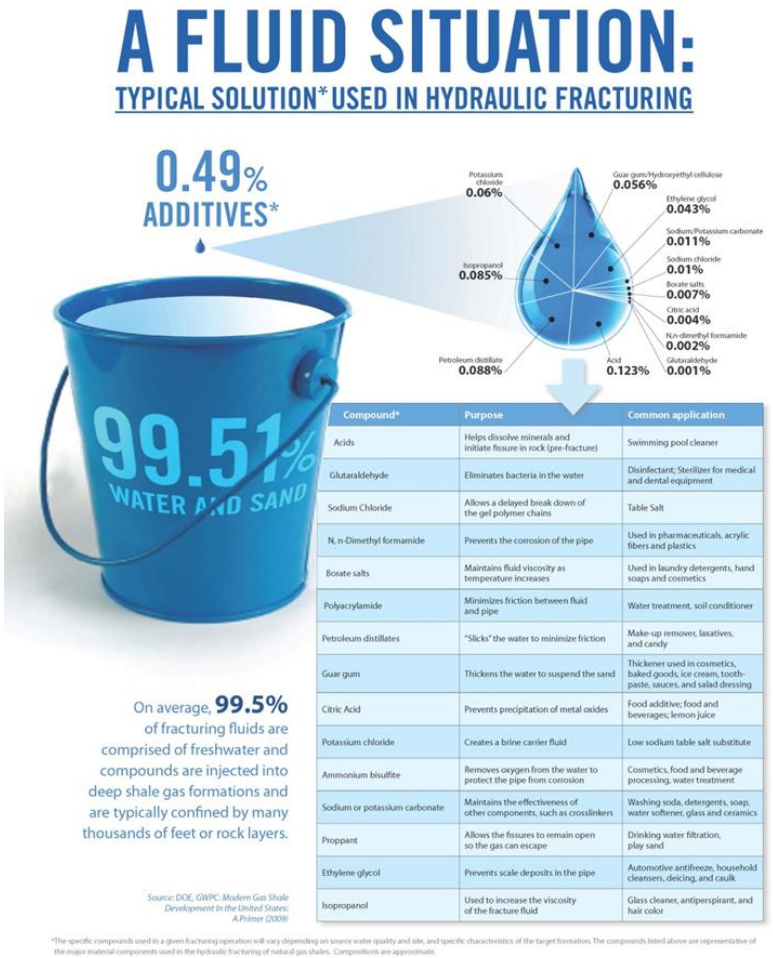
- Permits from state regulatory agencies for water withdrawal.
- New technologies allow producers to recycle most water
- 30 State and federal agencies monitor hydraulic fracturing
- Industrial process; properly encased well, along with proper containment at the surface is critical.



Shale Gas: Steps in Completion

Hydraulic Fracturing (HF)

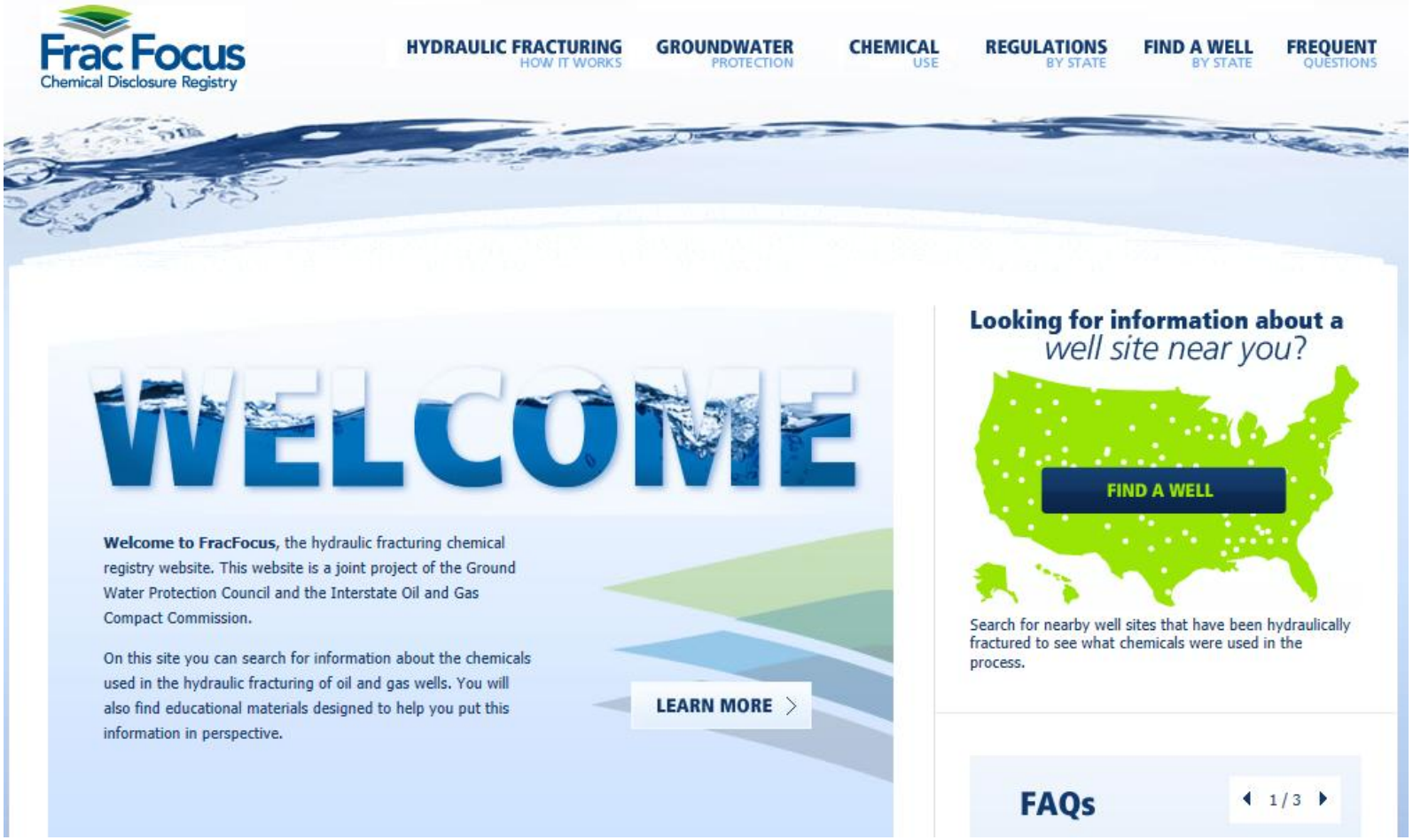
- > 60 years: more than 1 million wells in 27 states
- 90 percent of oil and gas wells use HF technology
- 99.5 percent water/sand mix
- 3 to 5 million gallons of water fractures the shale.
- Well casing protects water supply
- PA Chapter 78 upgrades reflect best practices in well casing



Compound*	Purpose	Common application
Acids	Helps dissolve minerals and initiate fissure in rock (pre-fracture)	Swimming pool cleaner
Glutaraldehyde	Eliminates bacteria in the water	Disinfectant; Sterilizer for medical and dental equipment
Sodium Chloride	Allows a delayed break down of the gel polymer chains	Table Salt
N, n-Dimethyl formamide	Prevents the corrosion of the pipe	Used in pharmaceuticals, acrylic fibers and plastics
Borate salts	Maintains fluid viscosity as temperature increases	Used in laundry detergents, hand soaps and cosmetics
Polyacrylamide	Minimizes friction between fluid and pipe	Water treatment, soil conditioner
Petroleum distillates	"Slicks" the water to minimize friction	Make-up remover, laxatives, and candy
Guar gum	Thickens the water to suspend the sand	Thickener used in cosmetics, baked goods, ice cream, toothpaste, sauces, and salad dressing
Citric Acid	Prevents precipitation of metal oxides	Food additive; food and beverages; lemon juice
Potassium chloride	Creates a brine carrier fluid	Low sodium table salt substitute
Ammonium bisulfite	Removes oxygen from the water to protect the pipe from corrosion	Cosmetics, food and beverage processing, water treatment
Sodium or potassium carbonate	Maintains the effectiveness of other components, such as crosslinkers	Washing soda, detergents, soap, water softener, glass and ceramics
Proppant	Allows the fissures to remain open so the gas can escape	Drinking water filtration, play sand
Ethylene glycol	Prevents scale deposits in the pipe	Automotive antifreeze, household cleansers, deicing, and caulk
Isopropanol	Used to increase the viscosity of the fracture fluid	Glass cleaner, antiperspirant, and hair color

Shale Gas: Transparency in Completion

MSC Commitment to FracFocus.org Bolsters PA Requirements



FracFocus.org is a Project of the Groundwater Protection Council and the Interstate Oil & Gas Compact Commission

Environmental Protection

Center for Rural PA Study

- Comprehensive research over two years, published in 2011
- Suggested private water well standards are needed
- Pre-drill testing by natural gas companies – a public service
- Regulations require testing of all water supplies within 2,500’ of proposed gas well.
- >40% of 1.2 million private water wells do not meet safe drinking water standard
- Another 20% percent of wells contained pre-existing methane

Shale Gas: Steps in Production

Site Restoration

- Involves landscaping and contouring the property as closely as possible to pre-drilling conditions.
- Property owners generally see:
  - Small wellheads on a level pad
  - Small amount of equipment
  - Two to three water storage tanks
  - Metering system to monitor gas production

Courtesy: Range Resources

Focus on Pennsylvania Roads

Before

After

Courtesy: Chesapeake Energy, NE Pa.

Pipeline Systems

Gathering and Transmission Pipelines

- Critical link between production and consumers
- Pipelines can transport gas before or after processing
- Designed and constructed to the latest pipeline safety standards
- Utilize new construction methods to minimize the environmental impact
- New coating technologies mean pipelines will last even longer
- Geographic Information Systems allow for efficient layout and accurate tracking of pipeline systems
- Subject to regulatory inspection (PAPUC, DOT PHMSA)

Focus on Land Reclamation

Gathering Line Construction – Spring/Summer/Fall 2010 Asylum Township, Bradford Co.

Courtesy: Chesapeake Energy, NE Pa.

Compression Systems

Compressor Stations

- State of the art sound attenuation
- Built to the highest welding, fabrication, and material standards
- 24/7 monitoring and control
- Automatic safety systems
- Annual inspections by regulating entities

Compressor Packages

- High tech integrated control systems (engine and compressor)
- 24/7 monitoring and control
- Produced and packaged in the USA
- Operated and maintained by local workers

Environmental Protection

Highly regulated. Highly sophisticated.

- Transparency in permitting
- Staffing, permit fee increases
- Advances in water recycling and reuse
- Protective well casing standards
- Focus on best practices
- FracFocus.org

Regulatory Framework

Site Construction

12 PA Regulations

Reclaimed/Completed Site

10 PA Regulations

Drilling Phase

18 PA Regulations

Hydraulic Fracturing

18 PA Regulations

Midstream

11 PA Regulations

Environmental Protection

Less Reliance on Water Resources

	Gallons per million BTU	
	Range	Mid-point
Deep shale natural gas	0.60 – 5.80	3
Nuclear	8 – 14	11
Conventional oil	8 – 20	14
Coal	13 – 32	23
Fuel ethanol from corn	2,510 – 29,100	15,800
Biodiesel from soy	14,000 – 75,000	44,500

Source: Ground Water Protection Council, U.S. Department of Energy

Environmental Protection

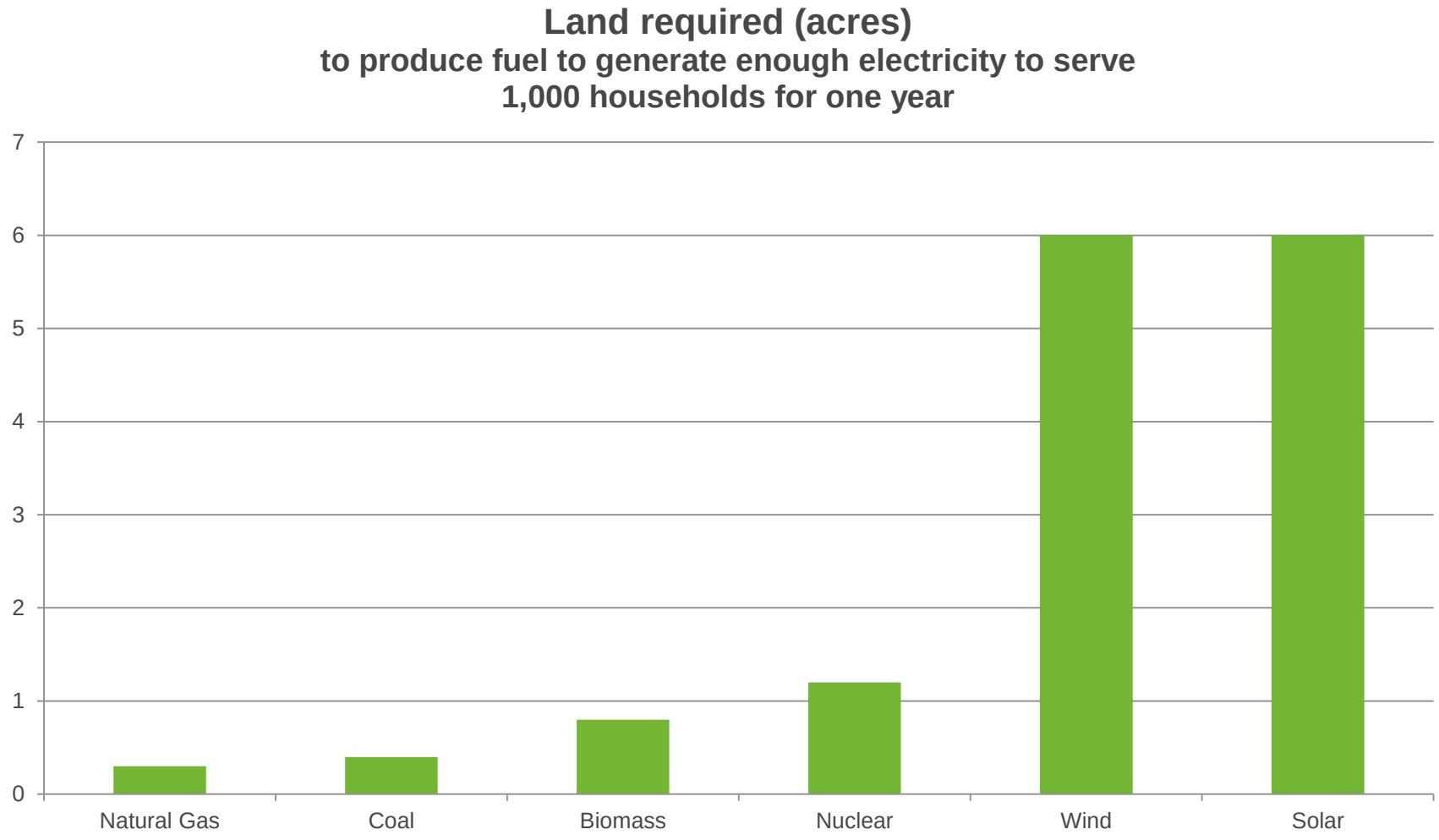
Water Use: In Perspective

The 5 million gallons of water needed to drill and complete a typical deep shale gas well is equivalent to the amount of water consumed by:

- New York City in approximately four minutes
- A 1,000 megawatt coal-fired power plant in 12 hours
- A golf course in 25 days
- While these represent continuing consumption, the water used for a gas well is a one-time use.

Source: CONSOL Energy, September 22, 2011

Environmental Protection

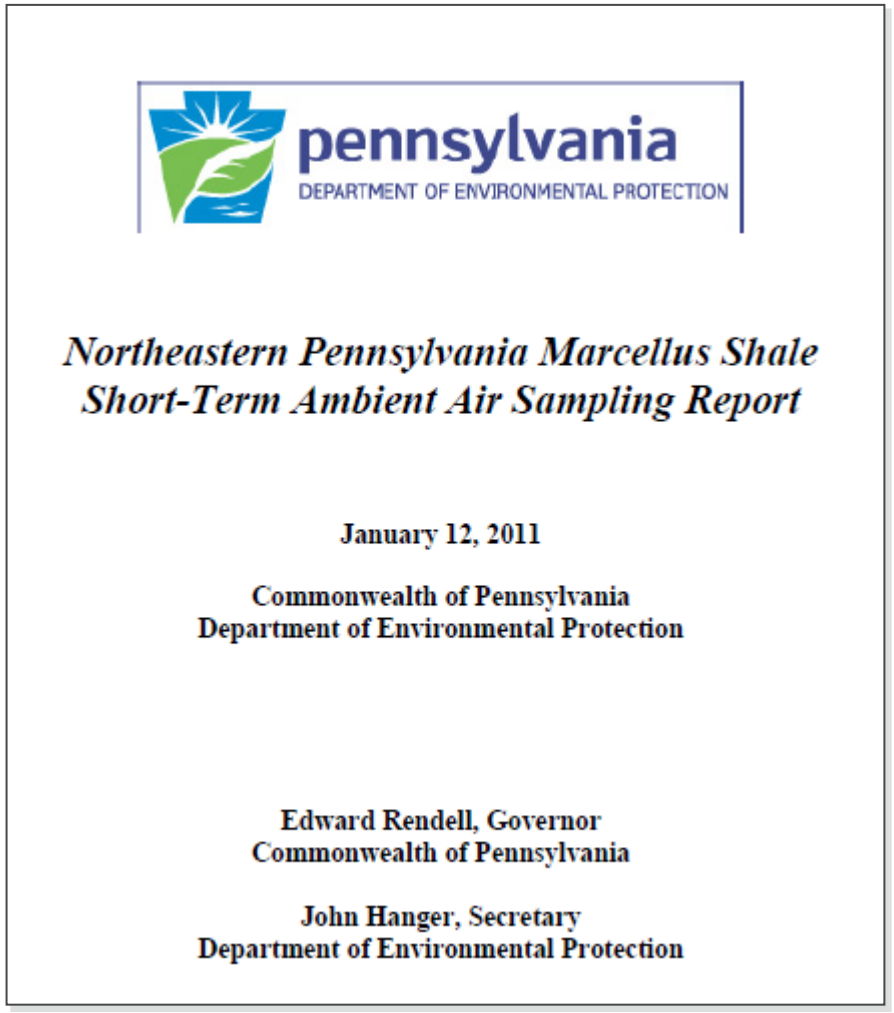


Source: CONSOL Energy

Environmental Protection

Air Quality Standards

- Short-term monitoring in Northeastern, Southwestern, and North Central PA:
  - **"[D]id not identify concentrations of any compound that would likely trigger air-related health issues associated with Marcellus Shale drilling activities."**
- Air quality standards tightly-regulated:
  - Gas Processing Plants: Plan approval/air permit
  - Compressors: Covered by GP-5
- Companies exploring "bifuel" rigs to reduce use of diesel



pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Northeastern Pennsylvania Marcellus Shale Short-Term Ambient Air Sampling Report

January 12, 2011

Commonwealth of Pennsylvania
Department of Environmental Protection

Edward Rendell, Governor
Commonwealth of Pennsylvania

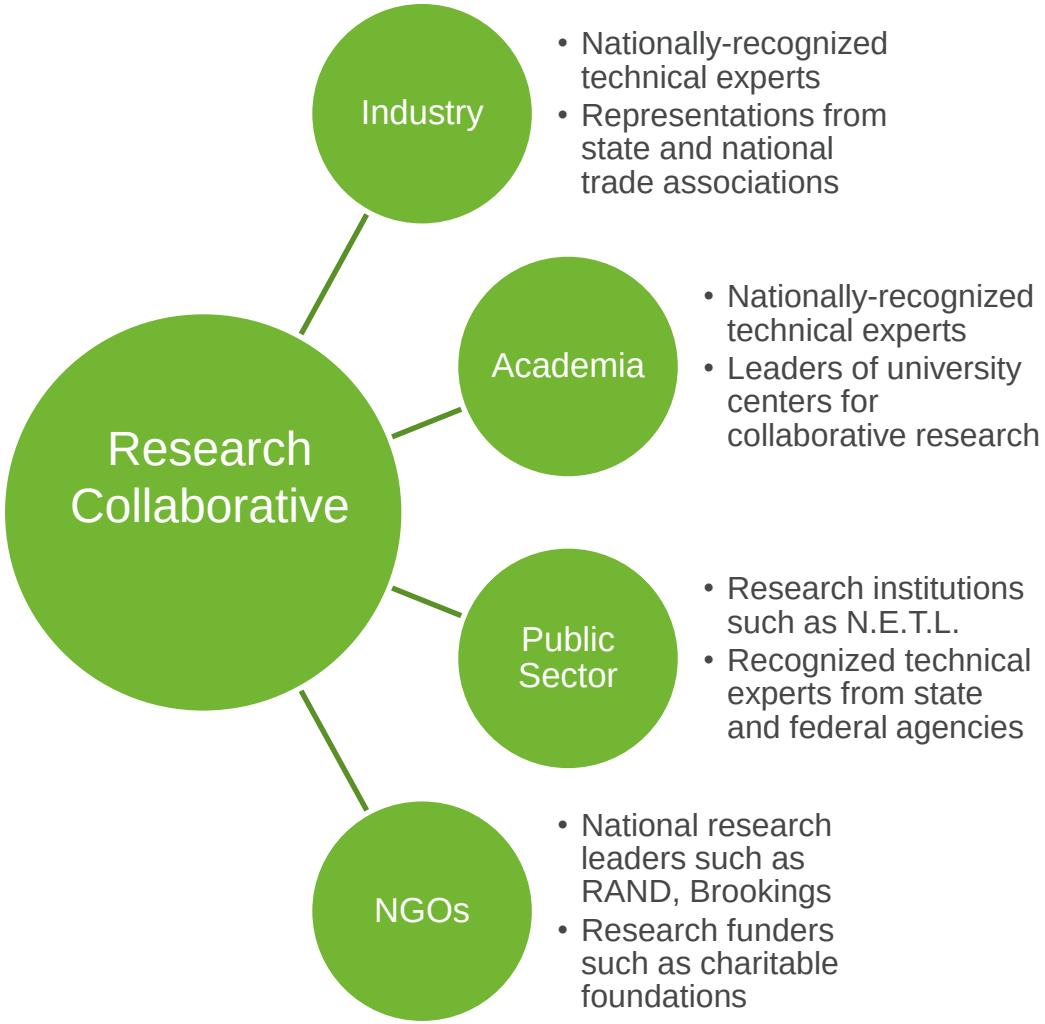
John Hanger, Secretary
Department of Environmental Protection

Environmental Protection

Environmental, Public Health Benefits of Natural Gas

- When used to generate electricity, natural gas emits just over half of the CO_2 per megawatt-hour (MWh) of a traditional power plant.
- Natural gas combined-cycle turbines emit 60 percent less CO_2 per MWh than a typical coal plant.
- Natural gas vehicles emit 25% less CO_2 than vehicles that run on traditional fuels.
- According to the Congressional Research Service, if U.S. doubled the utilization of combined cycle natural gas capacity to 85%, we could displace approximately 636 million metric tons of CO_2. This amounts to an 8.8% reduction of all CO_2 emissions in the U.S.

Research Collaborative



Know the Fundamentals

Three Industry Segments

Upstream: bringing natural gas to the surface (drilling)

Midstream: storing and transporting natural gas (pipelines, etc.)

Downstream: selling and distributing natural gas (your supplier)

Types of Natural Gas

Dry Gas: Home, business heating and fueling

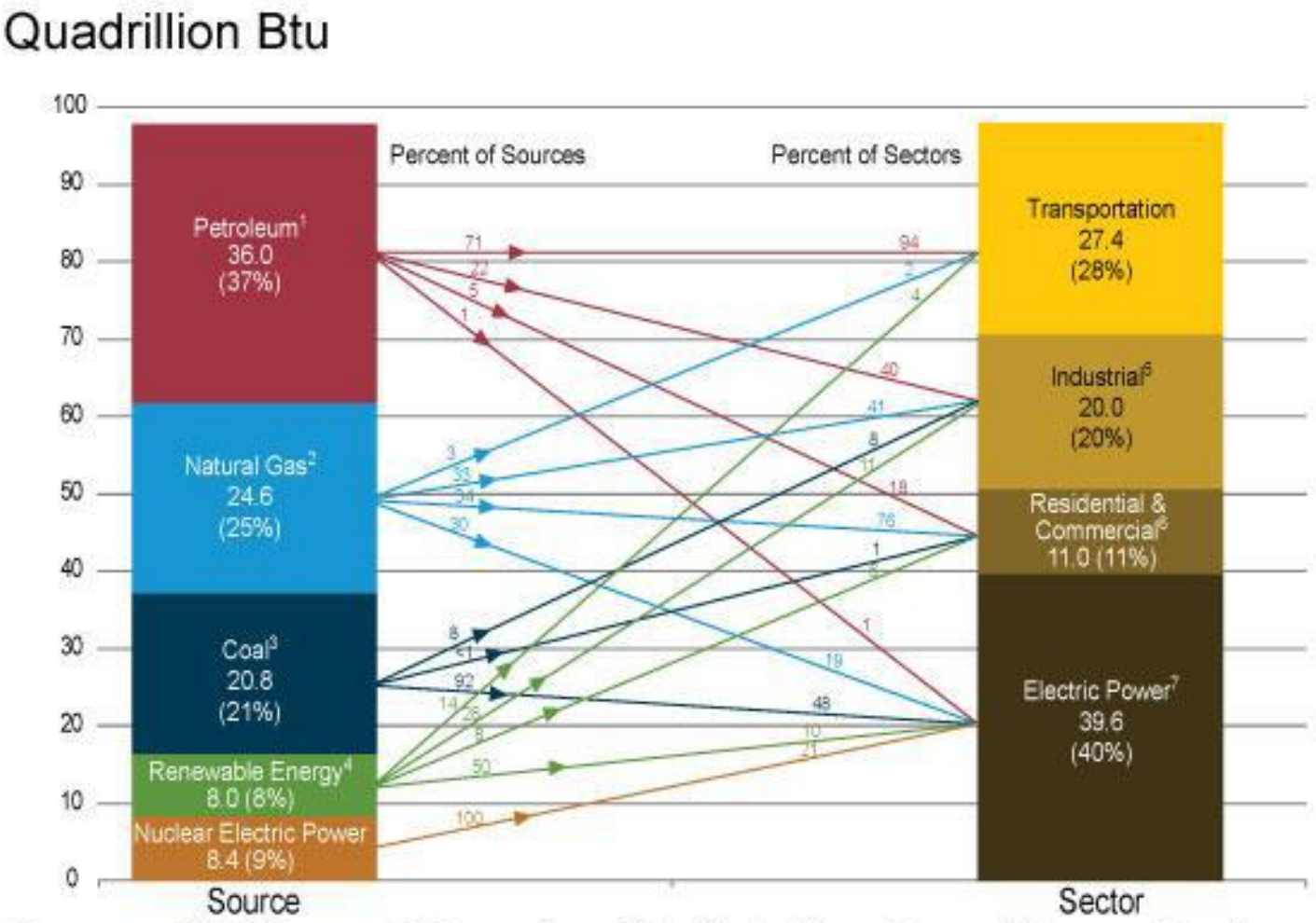
Wet Gas: Contains Natural Gas Liquids, or NGLs; Raw material for other products (polymers, paints, plastics, fertilizers, etc.)

The Economics of Shale Gas

Clean, Abundant, and Versatile Resource

1. Electricity generation, heating
2. Combined heat and power applications
3. Light and heavy duty transportation applications
4. Feedstock for industries and other liquids use

Energy Consumption Overview

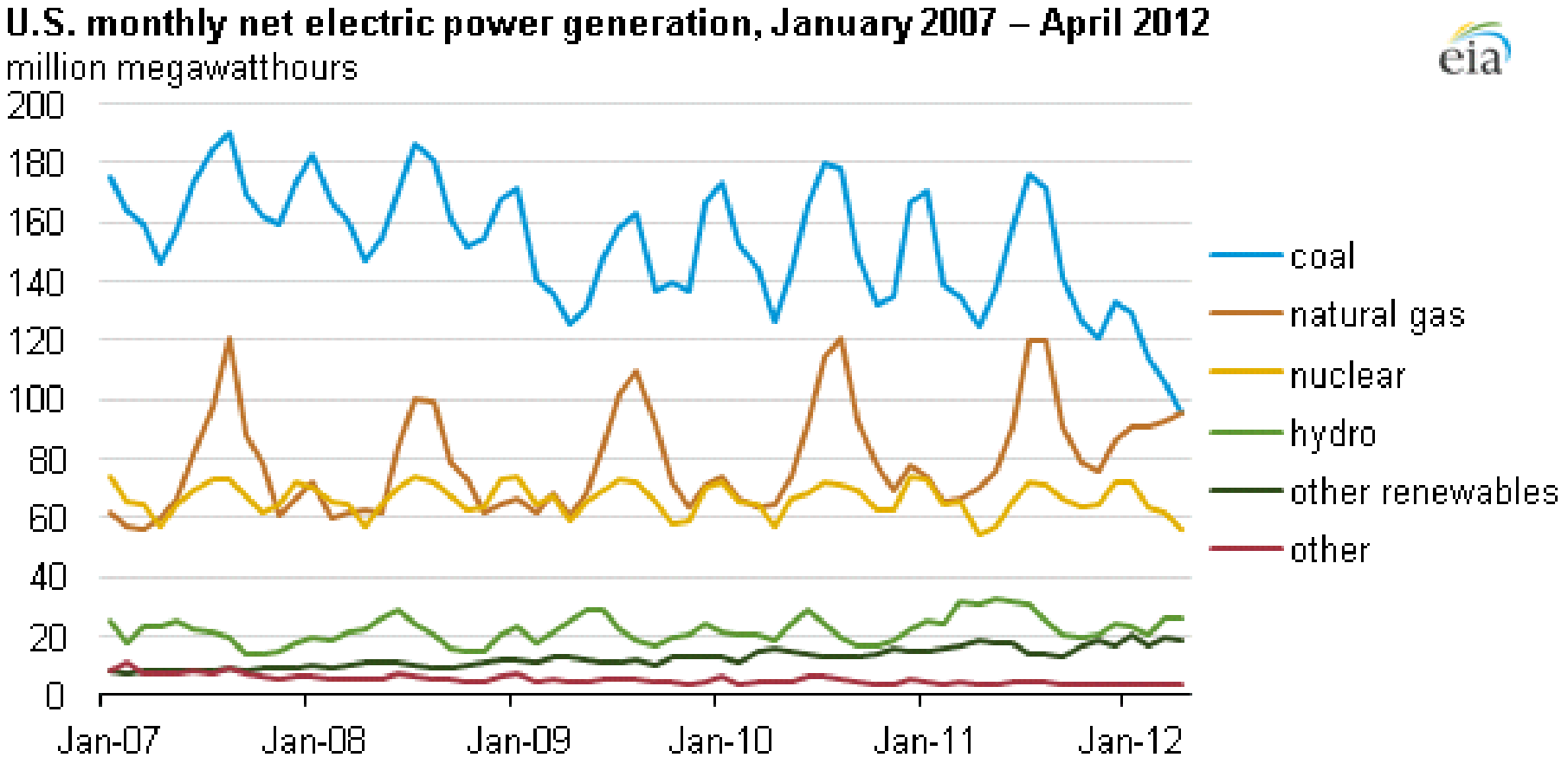


Sources: U.S. Energy Information Administration, *Annual Energy Review 2010*, Tables 1.3, 2.1b-2.1f , 10.3, and 10.4 (October 2011).

Clean, Abundant, and Versatile Resource

1. **Electricity generation, heating**
2. Combined heat and power applications
3. Light and heavy duty transportation applications
4. Feedstock for industries and other liquids use

U.S. Power Generation



Monthly coal- and natural gas-fired generation equal for first time in April 2012

Clean, Abundant, and Versatile Resource

1. Electricity generation, heating
2. **Combined heat and power applications**
3. Light and heavy duty transportation applications
4. Feedstock for industries and liquids use

CHP Attracting Public Sector Attention

Combined heat and power (CHP) plant: A plant designed to produce both heat and electricity from a single heat source. The term is being used in place of the term "cogenerator". CHP better describes the facilities because some of the plants included do not produce heat and power in a sequential fashion and, as a result, do not meet the legal definition of cogeneration specified in the Public Utility Regulatory Policies Act (PURPA).

U.S. Department of Energy
Mid-Atlantic Clean Energy Application Center
Promoting CHP, District Energy, and Waste Heat Recovery

Commonwealth Recycled Energy Economic Development Alliance Promoting Marcellus Shale Gas-Fired Combined Heat & Power (CHP)

Pennsylvania CHP Summary

Source	Sites	Capacity (kW)
Total	135	3,276,430
Boiler/Steam Turbine	54	1,929,075
Combined Cycle	5	1,156,400
Combustion Turbine	10	97,715
Fuel Cell	3	580
Microturbine	14	4,290
Other	1	231
Reciprocating Engine	47	85,139
Waste Heat Recovery	1	3,000

Source: ICF International, 2011

Clean, Abundant, and Versatile Resource

1. Electricity generation, heating
2. Combined heat and power applications
3. **Light and heavy duty transportation applications**
4. Feedstock for industries and other liquids use

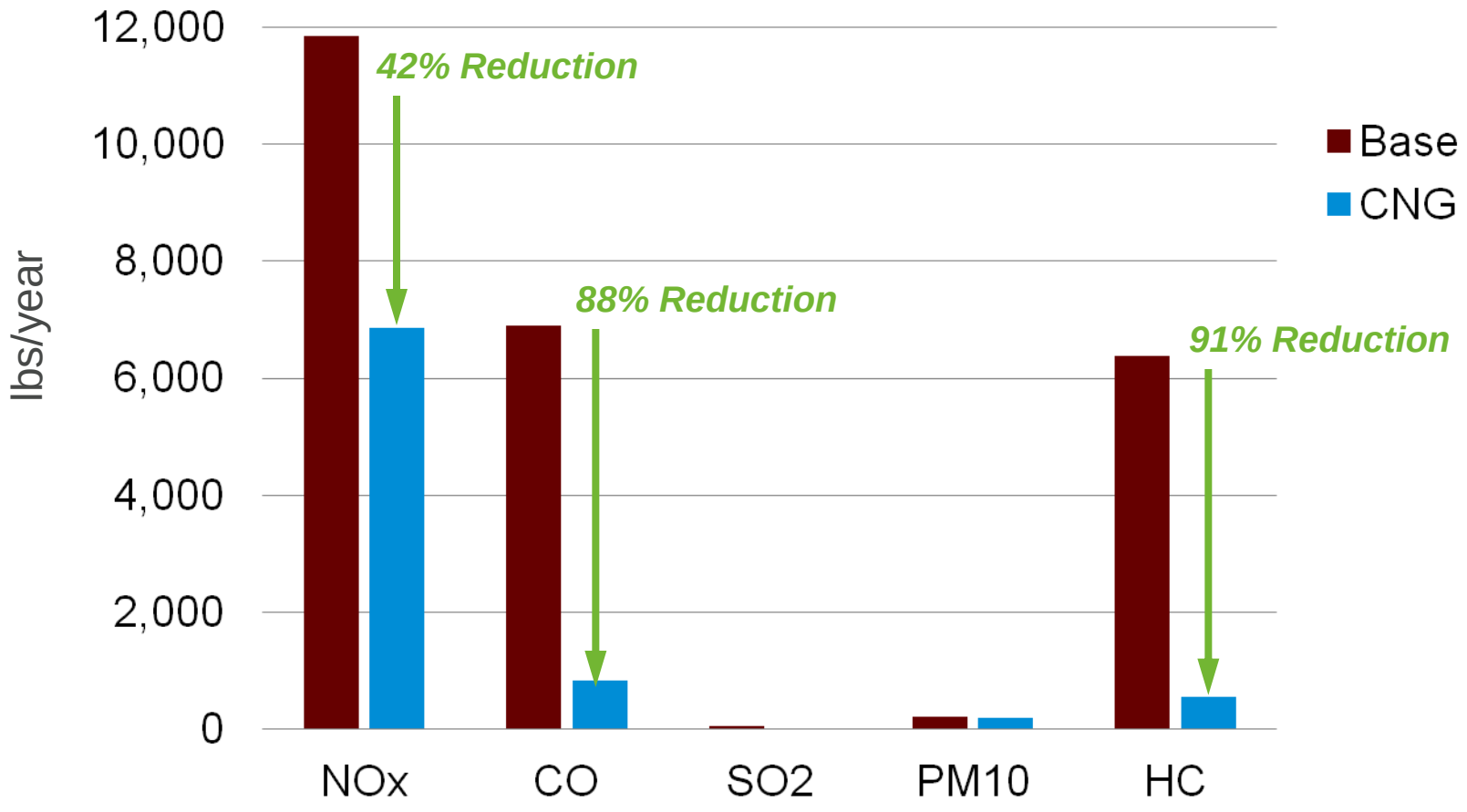
NGV Market Penetration

Vehicle Type	U.S NGV Population		U.S Market Penetration (by vehicle count)		U.S Annual NGV Fuel Use (thousand DGE)		U.S. Market Penetration (by fuel use)	
	Low	High	Low	High	Low	High	Low	High
Transit Buses	8,500[b]	12,200[e]	12.82%	17.43%	146,616[a]	153,400[e]	22.79%	23.59%
Refuse Trucks	1,300[c]	1,500[b]	0.95%	1.09%	12,856[c]	14,833[c]	1.05%	1.21%
School Buses	1,360[d]	2,300[b]	0.27%	0.46%	1,635[d,g]	2,765[d,g]	0.30%	0.51%
Medium-Duty Trucks/Vans	10,000[b]	22,000[a]	0.35%	0.76%	13,042[a]		0.15%	
Other Heavy-Duty Trucks	1,600[a]	3,651[a]	0.02%	0.04%	3,253[a]	7,424[a]	0.01%	0.02%
Light Trucks/Vans	41,000[a]	71,500[f]	0.05%	0.09%	15,261[a]		0.02%	
Passenger Cars	31,000[a]		0.02%		10,107[a]		0.01%	
Total	**94,760**	**144,151**	**0.04%**	**0.06%**	**202,770**	**216,832**	**0.11%**	**0.12%**

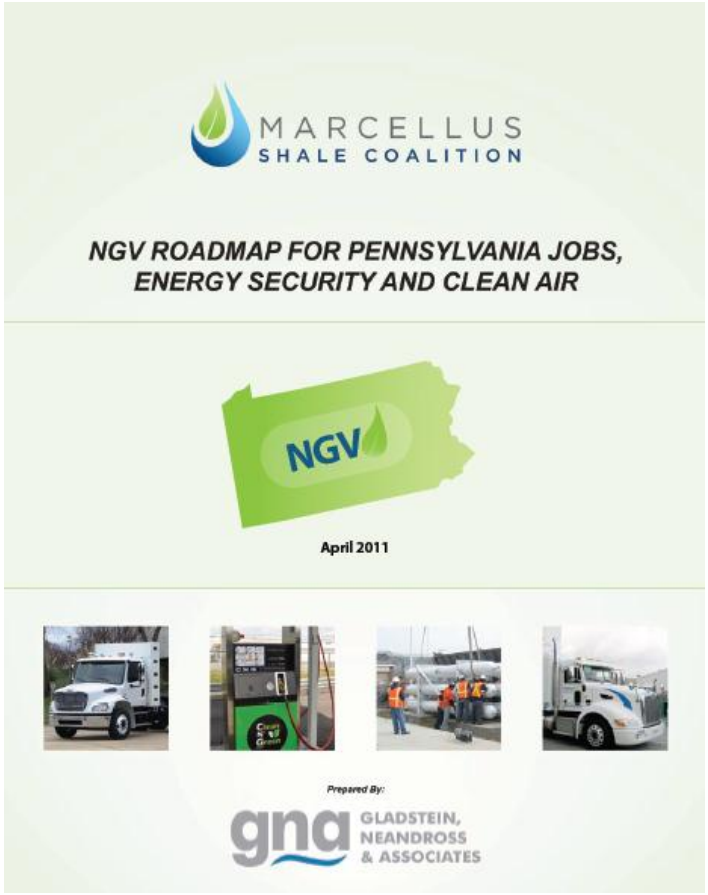
[a]Energy Information Agency, *Alternatives to Traditional Transportation Fuels 2008*, 2010
[b]Yborra, S., *Growth of the NGV Market: Lessons Learned Roadmap for Infrastructure Development*, 2008
[c]Cannon, J., *Greening Garbage Trucks: Trends in Alternative Fuel Use*, 2006
[d]Monahan, P., *School Bus Pollution Report Card 2006*, 2006
[e]American Public Transportation Association, *2010 Public Transportation Fact Book*, 2010
[f]U.S. Census Bureau, *Vehicle In Use Survey*, 2002
[g]U.S. Department of Energy, Energy Efficiency and Renewable Energy, "Transportation Energy Data Book, Edition 28," 2009.

Neighborhood Air Emissions

Neighborhood Air Emissions
Base Case (Diesel) vs. CNG Case



Dialogue & Education



MSC *Pennsylvania Roadmap* Study

- MSC's contribution to nationwide NGV conversation
- Only 150,000 NGVs in U.S. with millions worldwide
- 17 new fueling stations for fleets
- Begin with fleet conversions and urban infrastructure focus to achieve better air quality, lower noise, lower cost
- $5 million reduction in annual fuel costs for PA fleet operators
- A direct impact on nearly 1,300 PA jobs
- A reduction of NOx emissions, particulate matter emissions, and greenhouse gas emissions

Clean, Abundant, and Versatile Resource

1. Electricity generation, heating
2. Combined heat and power applications
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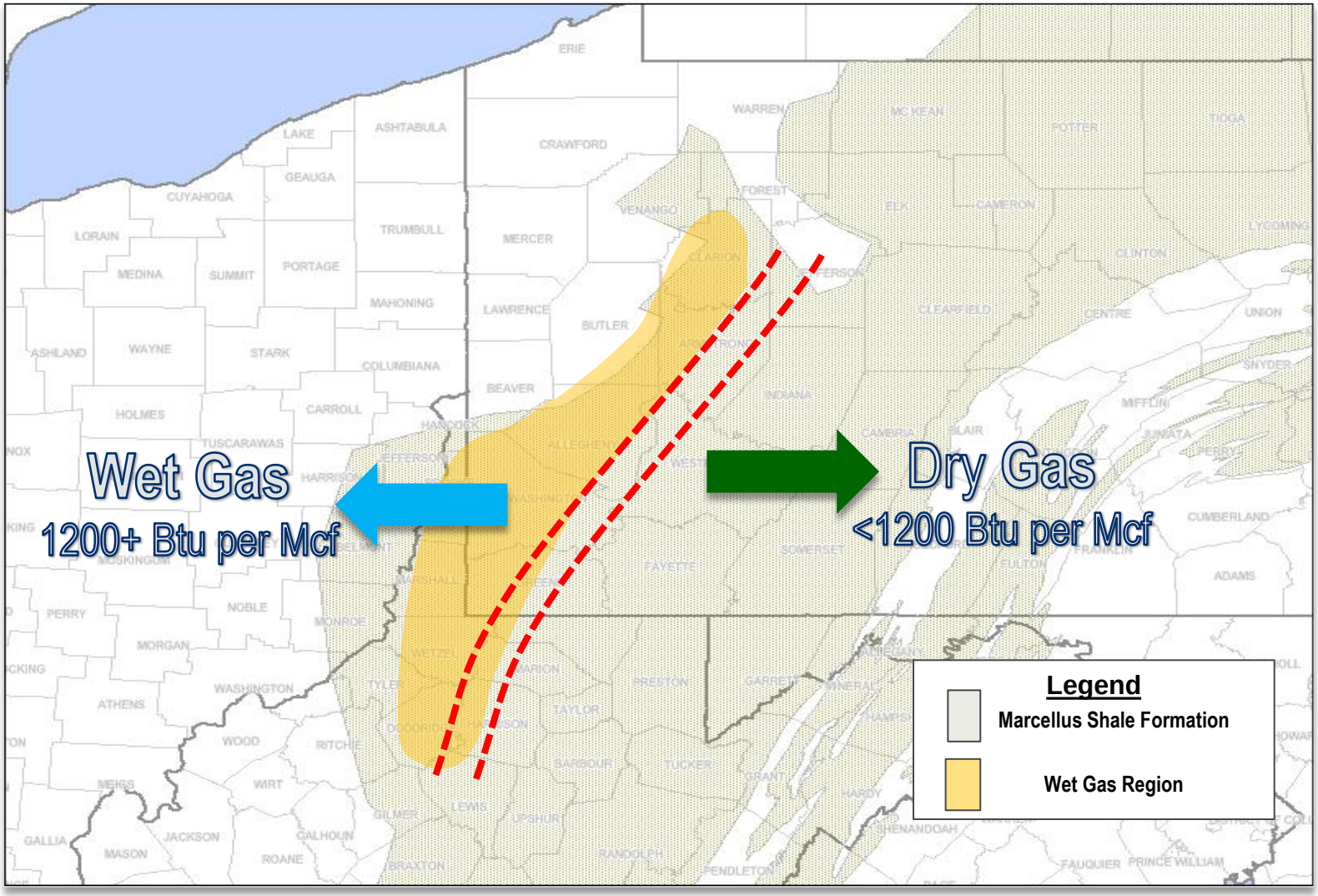
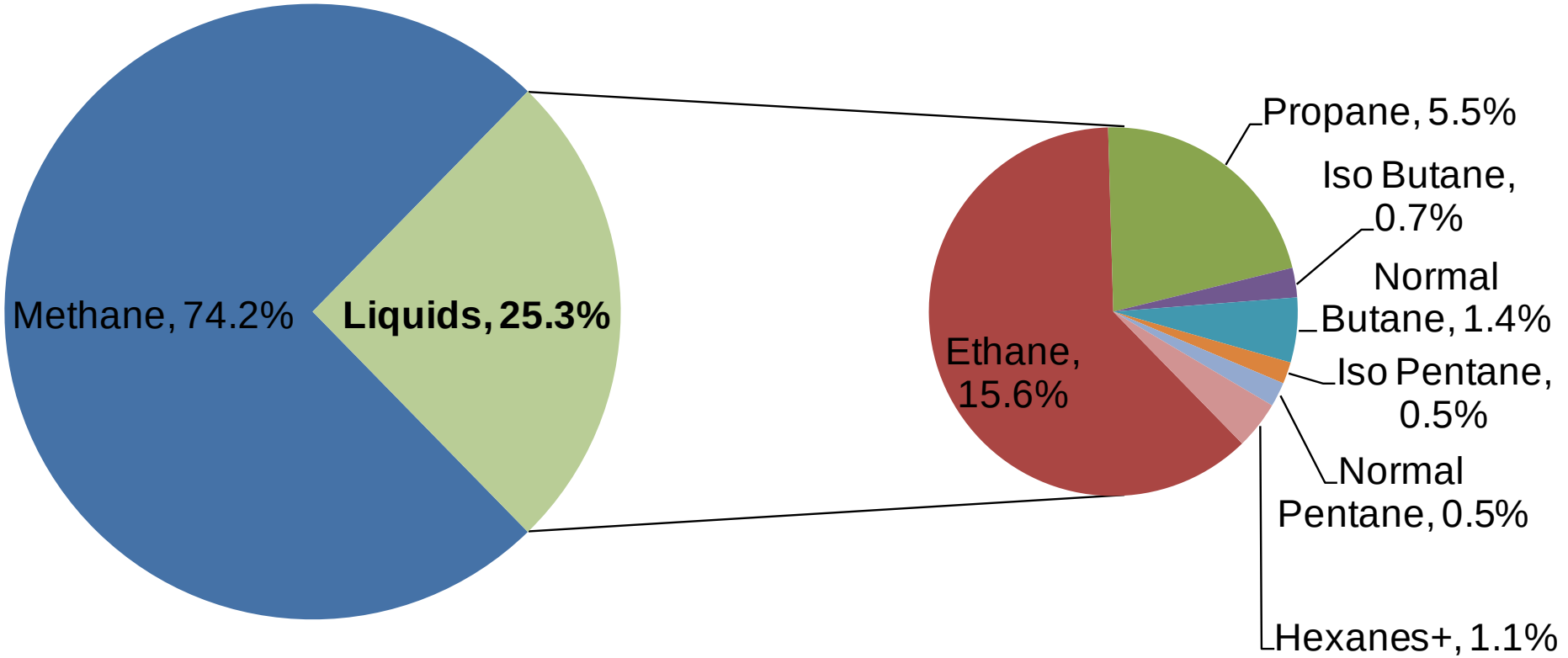
4. **Feedstock for industries and other liquids use**

“Wet Gas” Region of Marcellus Shale



Sources: Pace Global; Equitable Resources, MarkWest, Atlas Energy, Range Resources, and Caiman Energy.

Average Composition in Wet Gas Region



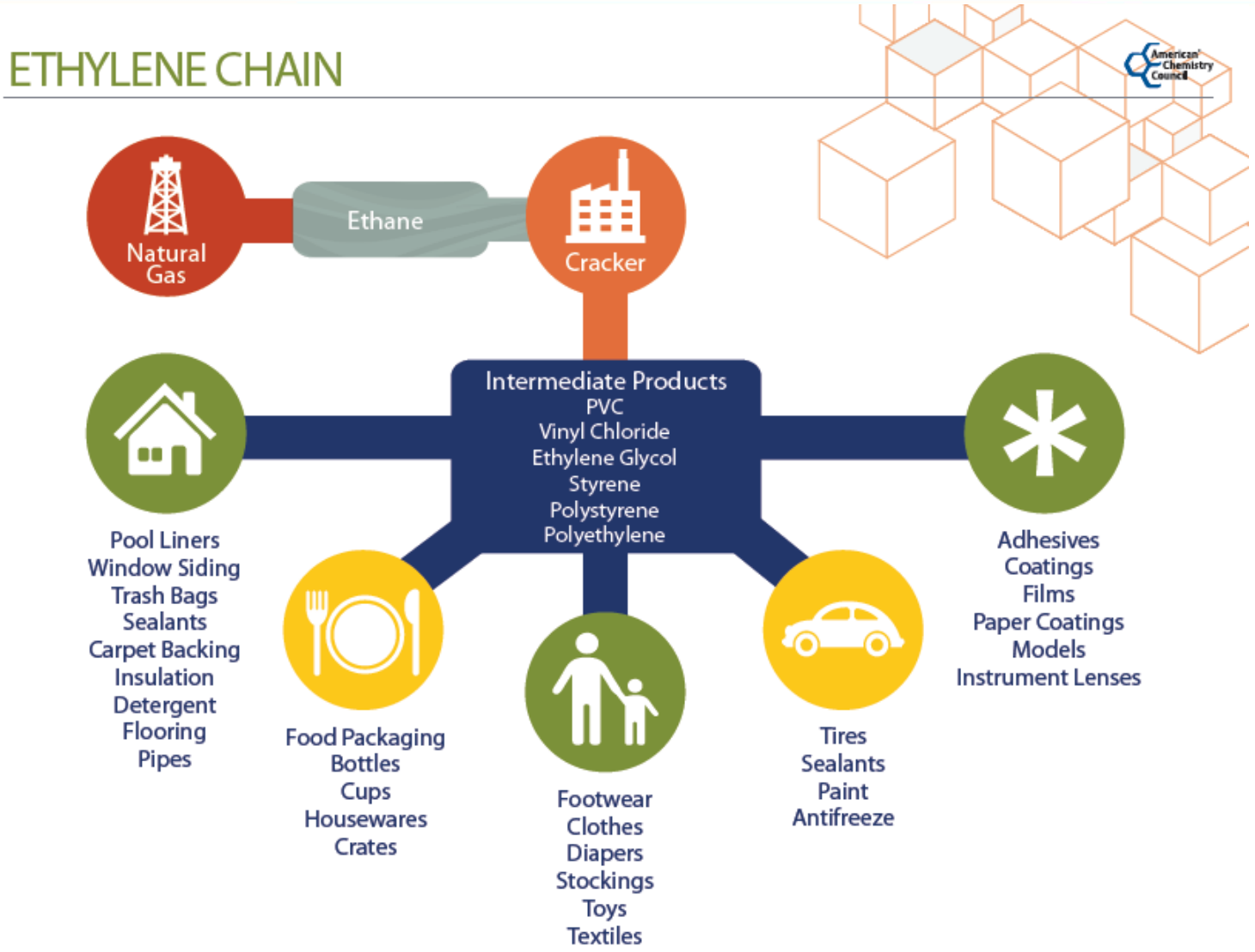
Source: Pace Global; NiSource Gas Transmission and Storage Presentation to WVONGA Spring Meeting May 6, 2010 p.5

Gas Processing

Gas Dehydration, Separation and Fractionation

- Northeast Marcellus is “dry” Southwest is “wet” (contains more Natural Gas Liquids)
- Gas processing is required to condition production gas to proper “pipeline quality” for end users
- Dehydration removes saturated water entrained in production gas (typically to below 7 lbs/MMcf)
- Cryogenic processing separates the NGLs from the production gas lowering the BTUs to proper levels (980 – 1100 BTU/cf)
- Fractionation separates the NGLs into individual marketable products (ethane, propane, natural gasoline)

The Ethane Factor



Shale and manufacturing

- About 1/3 of all of the energy used in the USA consumed by manufacturing
- Lower feedstock and energy costs could reduce energy costs by $11.6 billion **annually** through 2025

Price Waterhouse Coopers (Dec. 2011) "Shale Gas: A renaissance in US manufacturing?"

Companies returning to USA:

1. Dow Chemical
2. Formosa Plastics
3. Chevron Phillips Chemical Co
4. Bayer Corp
5. Westlake Chemical
6. Shell Oil; CF Industries
7. Santana Textiles

Shale Gas Revolution

Thank you!

Marcellus Shale Coalition

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