



2012 JOINT CONFERENCE OF HARBOR SAFETY COMMITTEES AND AREA MARITIME SECURITY COMMITTEES

LET'S PUT PENNSYLVANIA BACK TO WORK.



MARCELLUS
SHALE COALITION

WWW.MARCELLUSCOALITION.ORG

JAMES R. DALEY, PMP

**DIRECTOR OF NATURAL GAS &
ENERGY PROGRAMS**

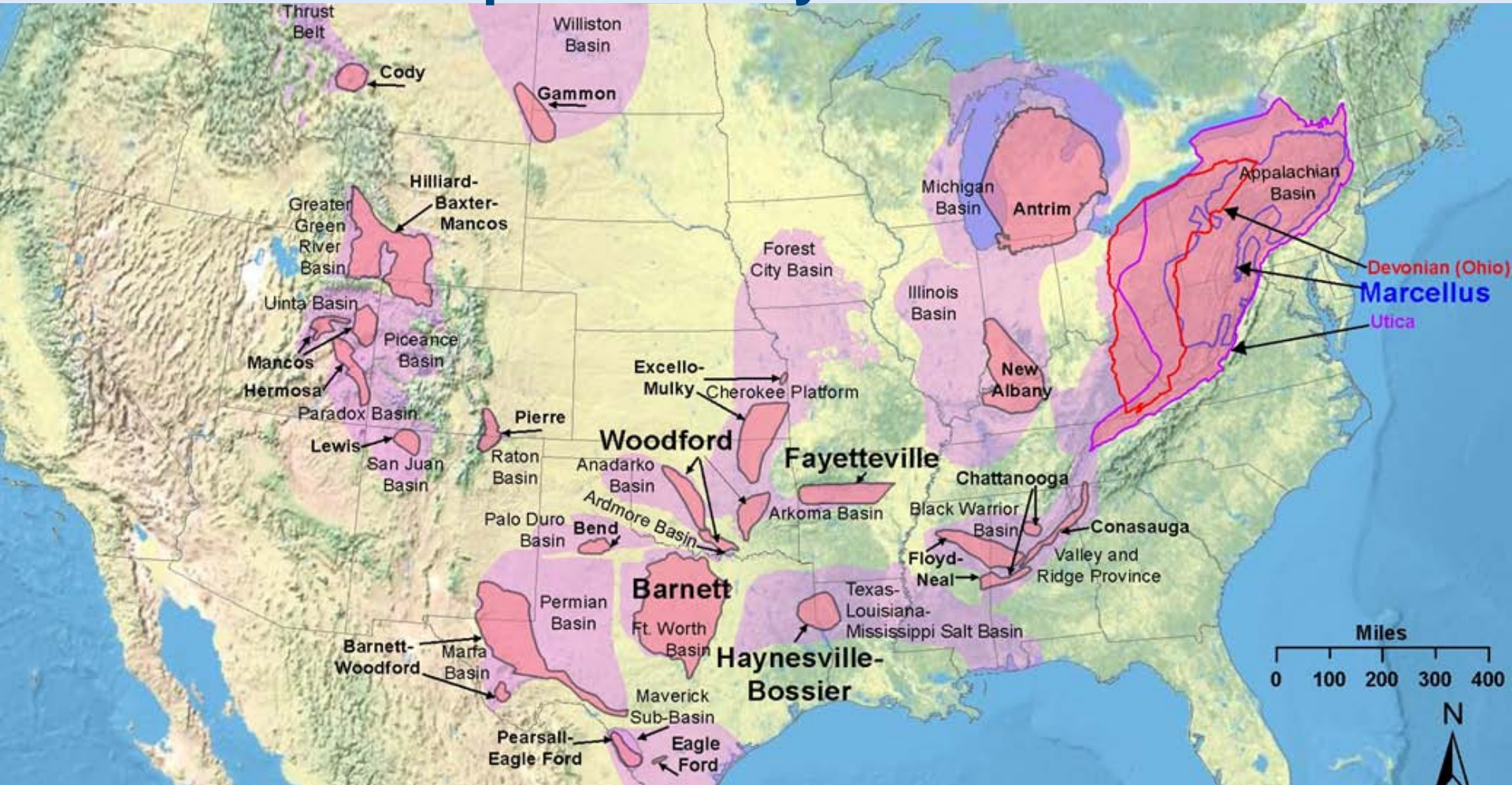


**Greenhorne & O'Mara, Inc.
Associate Member - MSC**

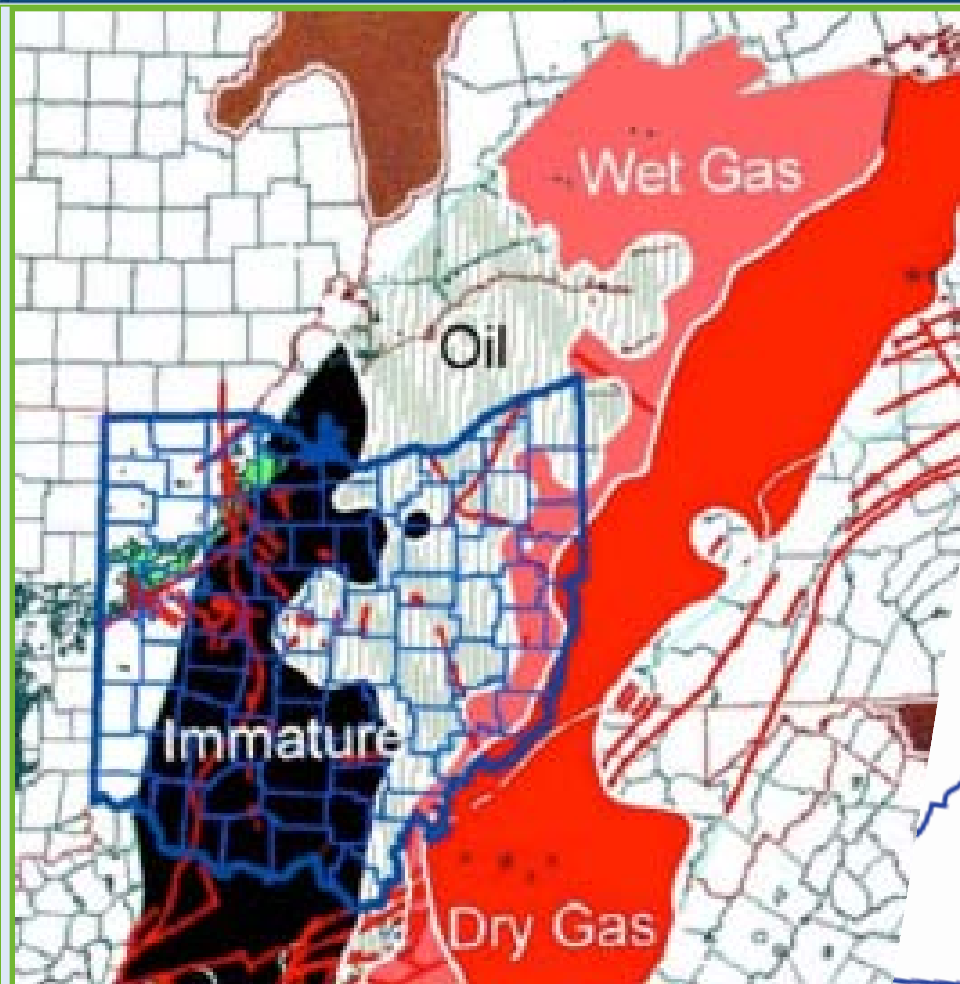
- Where are the U.S. shale plays?
- How did they get here?
- How do we harness these resources?
- What materials are consumed and produced in shale plays?
- Current and projected water transport – inland waterways and exports.

Session Title/Presentation Topic

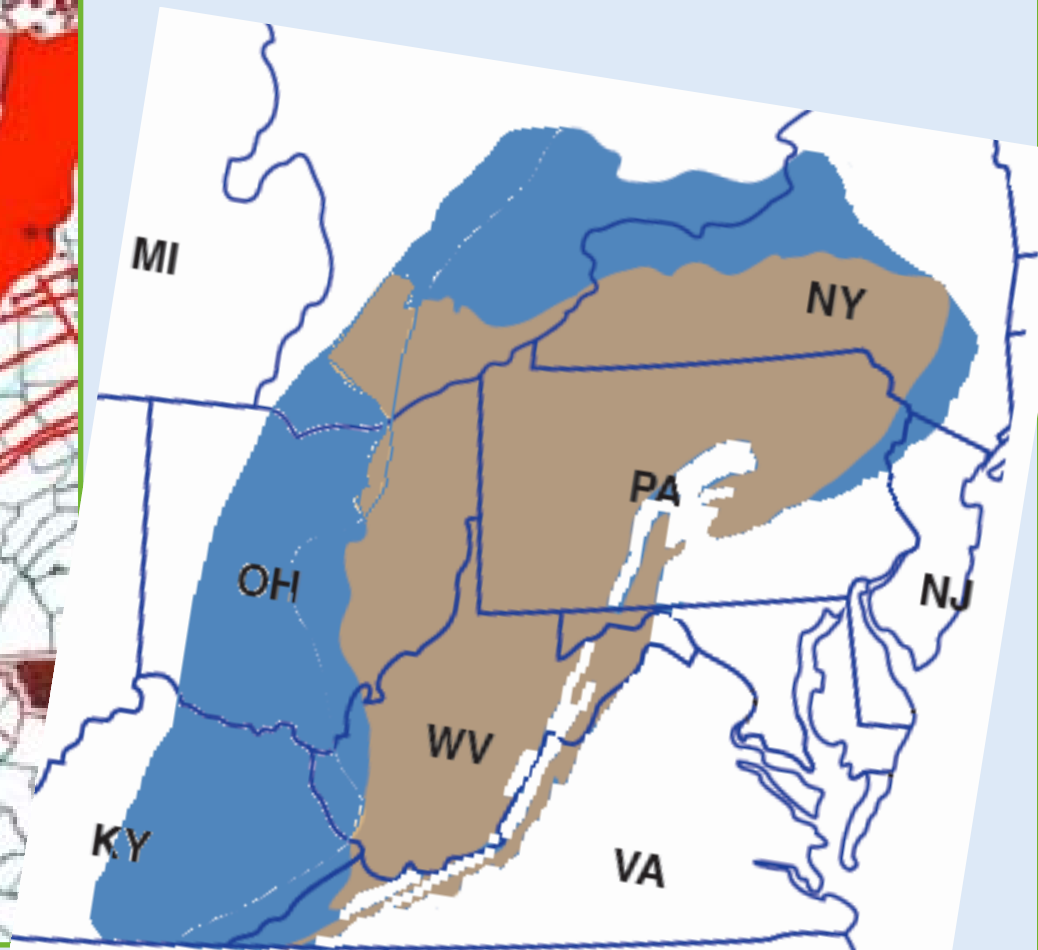
Shale Gas, Inland to Coast: Export and Wastewater Issues



Shale gas overview & Appalachian basin focus

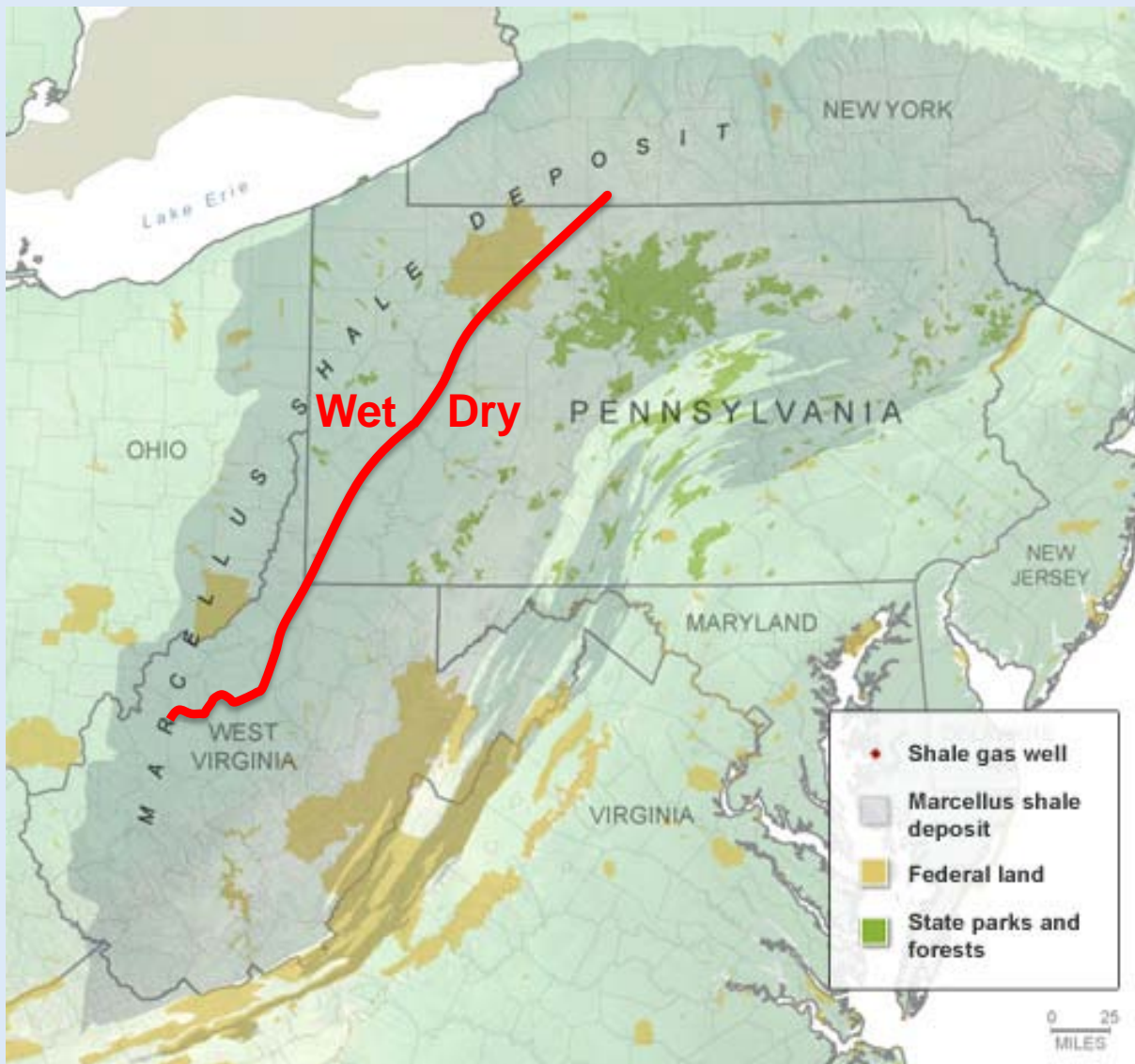


Utica/Pt. Pleasant Formation



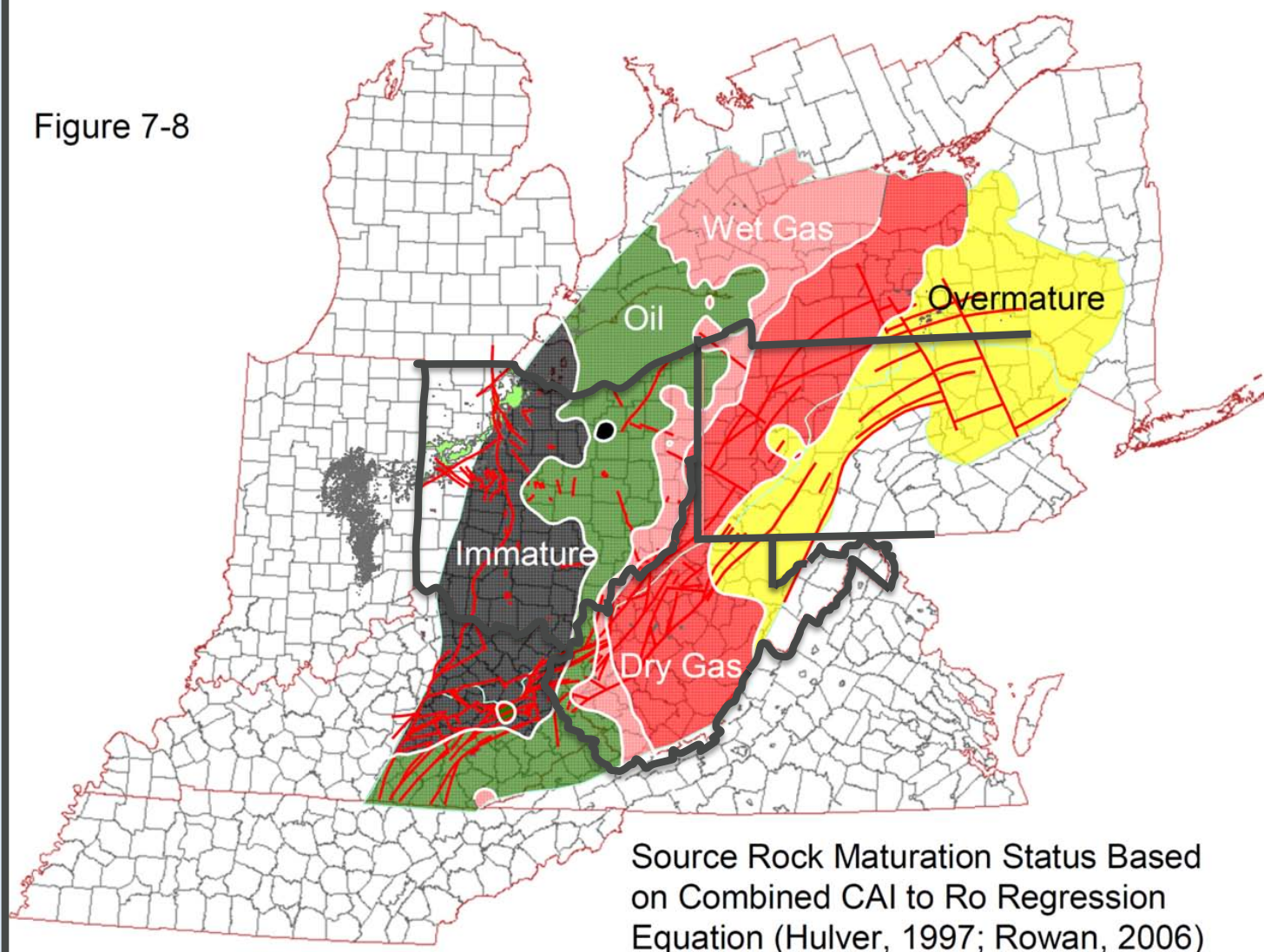
Utica & Marcellus Formations

Where is the Marcellus Shale?



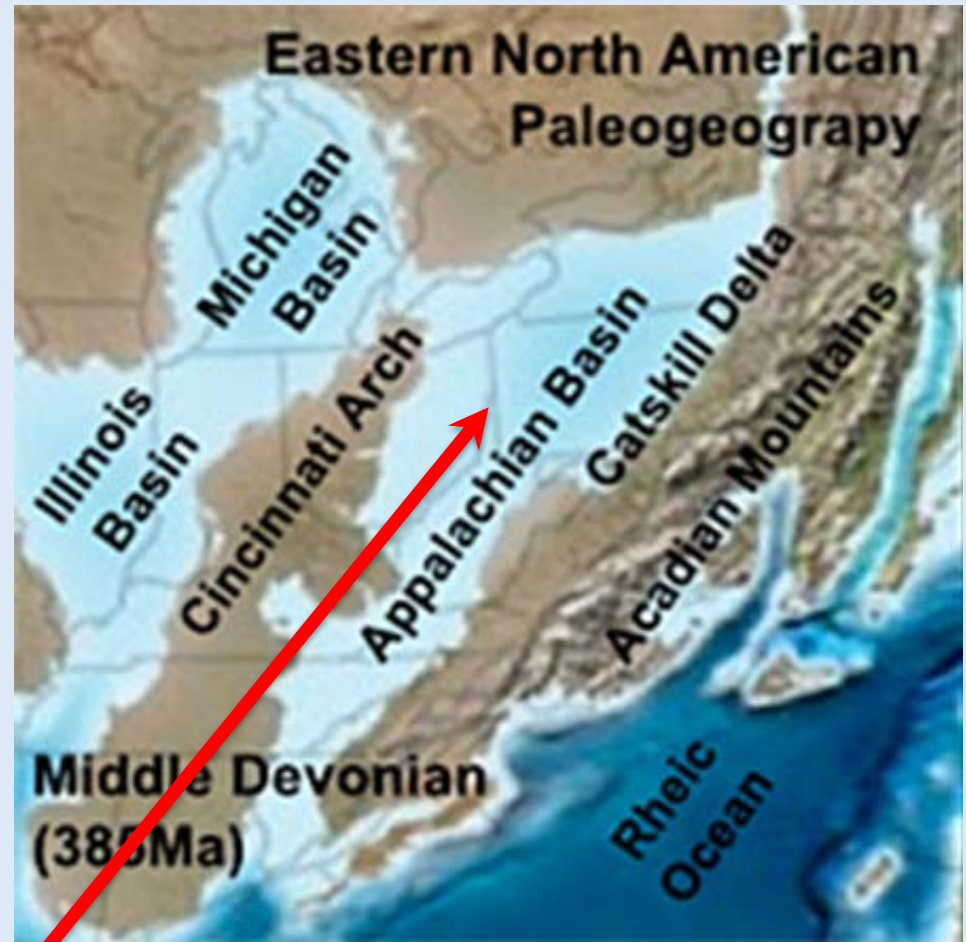
Where is the Utica Shale?

Figure 7-8



How did they get here?

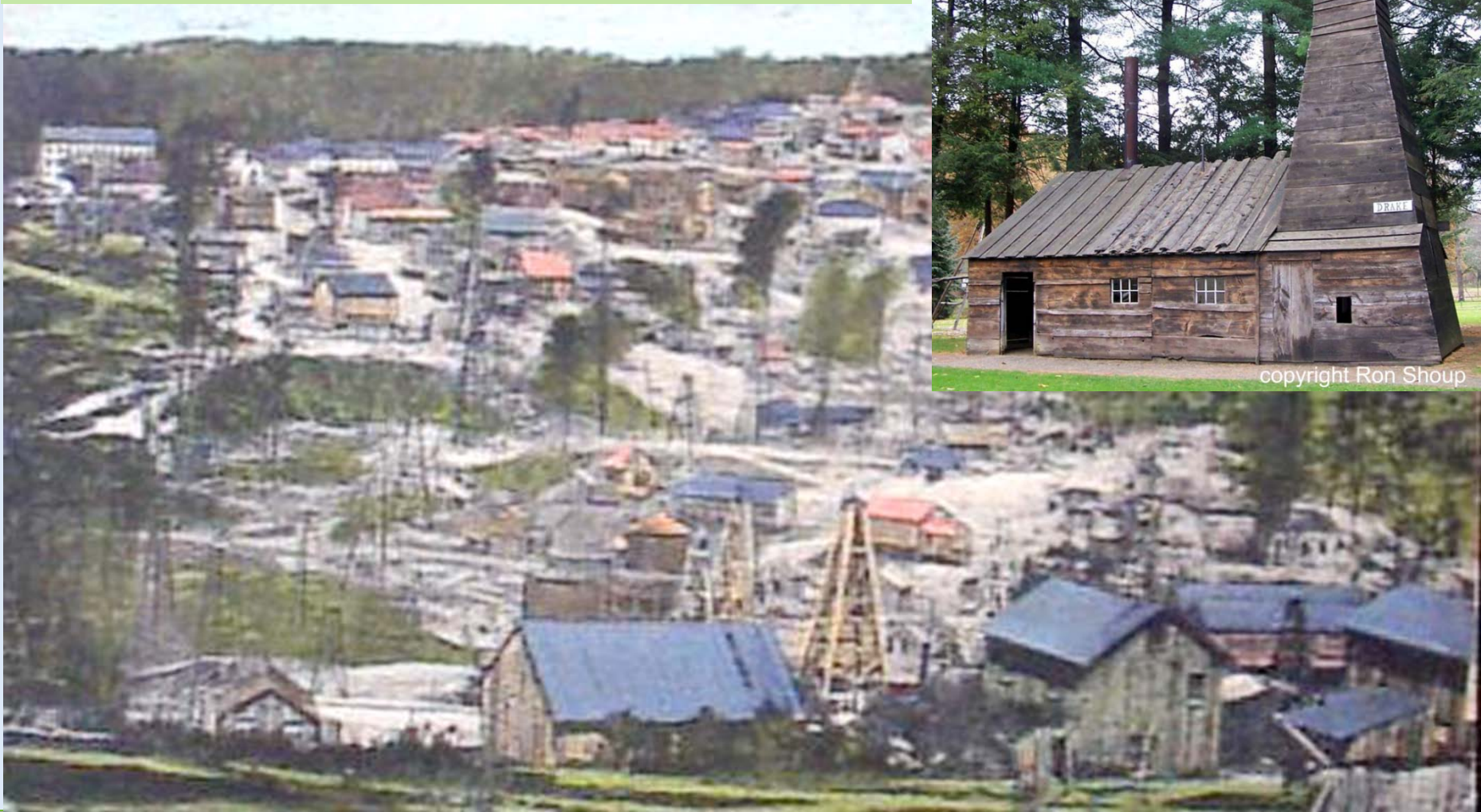
- Appalachian Basin was a sea
- Organic carbon from plankton in muds 390 million years ago
- Underwent deep burial, formed shale under great pressure and “cooked the carbon”
- Uplifting after deep burial



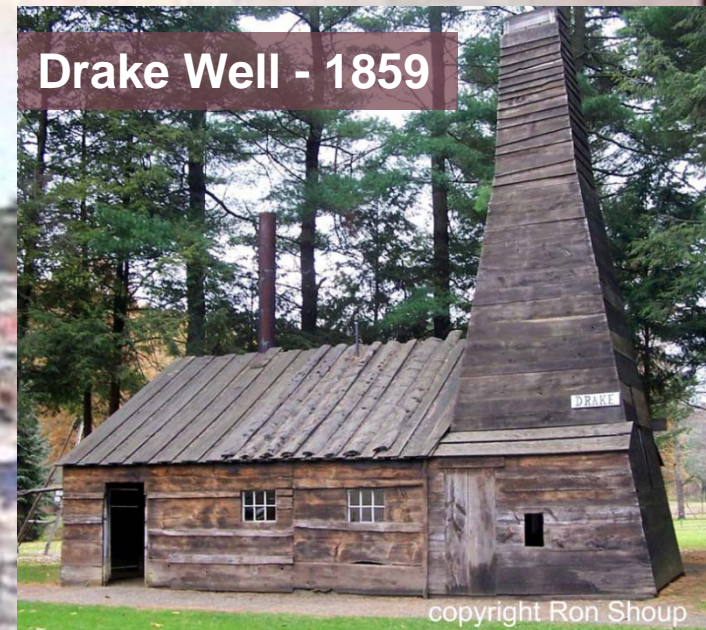
Appalachia Basin was a sea

How were these resources tapped in the past?

Pithole City – 1865 (photo from Titusville Morning Herald, 8/4/1865, appears at www3.gendisasters.com)



Drake Well - 1859



copyright Ron Shoup

How do we harness these resources today?



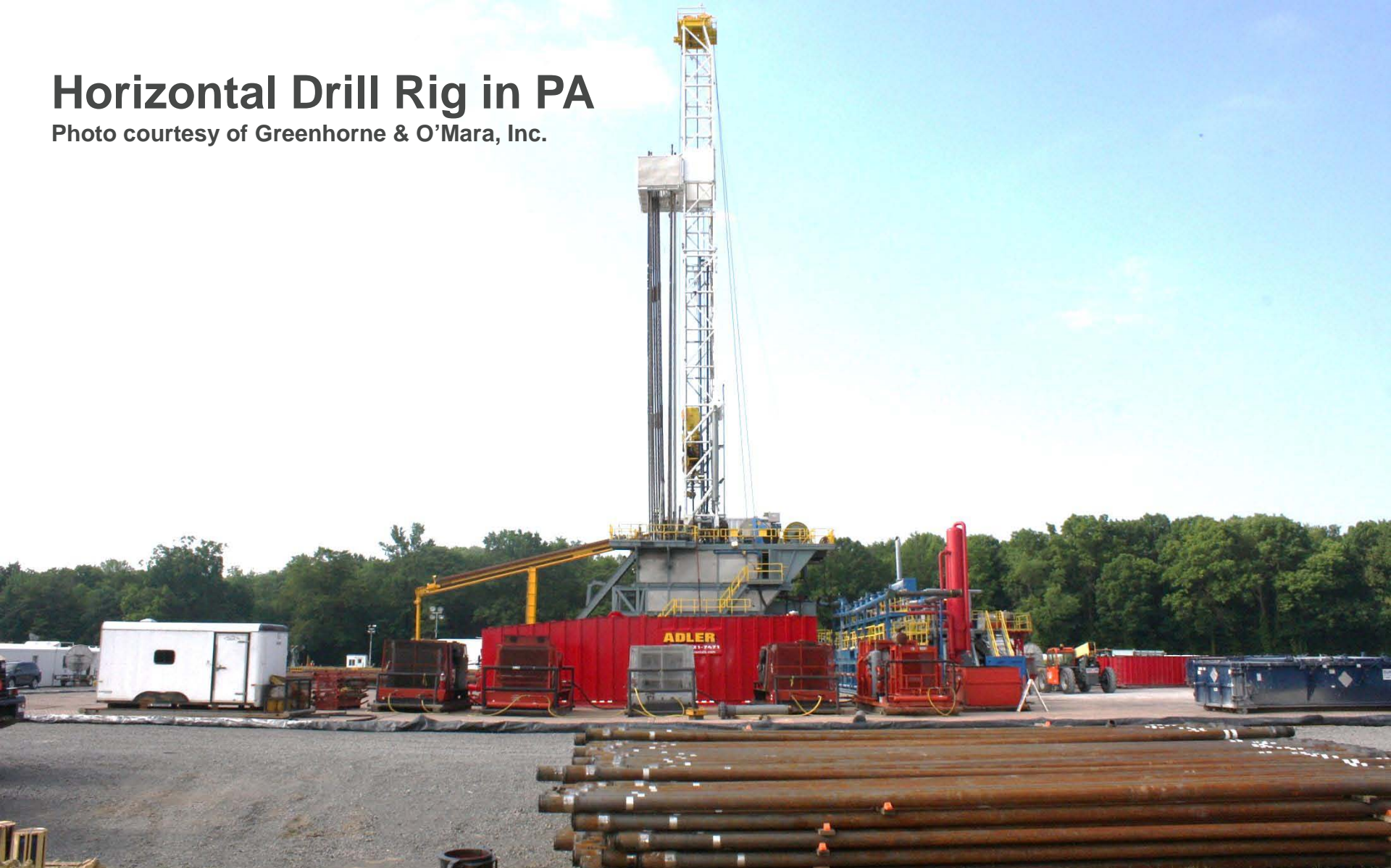
How do we harness these resources?



How do we harness these resources?

Horizontal Drill Rig in PA

Photo courtesy of Greenhorne & O'Mara, Inc.



How do we harness these resources?

Hydraulic Fracturing to Create Pathways in the Formation



Source:
Mike
Arthur
(Penn
State)
Webinar –
Plumbing
the
Depths in
PA

How do we harness these resources?

Chesapeake Rock Cave Marcellus Shale Well, West Virginia



How do we harness these resources?



Additives used in hydraulic fracturing

Additive Purpose	Primary Compound(s)	Other Common Uses
Corrosion control & scale inhibitors	<ul style="list-style-type: none"> - Acids (hydrochloric, muriatic) - Ammonium bisulfate - N, n-Dimethyl formamide - Ethylene glycol 	<ul style="list-style-type: none"> - Swimming pool cleaning, concrete etching - Cosmetics, food and beverage processing - Pharmaceuticals, acrylic fibers, plastics - Auto anti-freeze, household cleaners, aircraft deicing
Biocide	<ul style="list-style-type: none"> - Glutaraldehyde 	<ul style="list-style-type: none"> - Disinfectant, medical equip. sterilization
Friction reducer	<ul style="list-style-type: none"> - Polyacrylamide - Petroleum distillates 	<ul style="list-style-type: none"> - Water treatment, soil conditioning - Make-up remover, laxatives, candy
Viscosity improvement/maintenance	<ul style="list-style-type: none"> - Borate salts - Isopropanol 	<ul style="list-style-type: none"> - Laundry detergents, hand soaps, cosmetics - Glass cleaner, antiperspirant, hair color
Prolong gel state	<ul style="list-style-type: none"> - Sodium chloride 	<ul style="list-style-type: none"> - Table salt
Thickener to suspend sand	<ul style="list-style-type: none"> - Guar gum 	<ul style="list-style-type: none"> - Thickener in baked goods, ice cream, toothpaste and salad dressings
Metal oxides control	<ul style="list-style-type: none"> - Citric acid 	<ul style="list-style-type: none"> - Lemon juice, citrus drinks, food and beverage additive
Prop open fissures after stimulation	<ul style="list-style-type: none"> - Sand or manufactured proppant 	<ul style="list-style-type: none"> - Play sand, water filtration

Flowback water characteristics

Comparison of FB Water with Conventional Produced Water

Source: Gas Technology Institute

Note: FB is Flowback and PW is Produced Water

Location A Location B Conv. PW

Parameter	14-d FB	14-d FB	Ranges ^F
pH	5.5	6.5	5 - 8
Alkalinity *	52	93	NA
TDS **	112,000	105,000	20,000 - 100,000
Tot Susp Solids **	17	197	0-250
Tot Org Carbon **	34	39	NA
Biochemical Oxygen Demand ‡	149	2.8	NA
Oil & Grease **	31	< 5 mg/l	3 – 100

* mg/l as CaCO₃

‡ mg/l as O₂

† NA = Not Available

** mg/l

‡ ND = Nondetect

^F IPEC, 2004; GRI, '94

Flowback water characteristics

Constituent	Low (mg/L)	Medium (mg/L)	High (mg/L)
Ba	2,300	3,310	4,700
Ca	5,140	14,100	31,300
Fe	11	52	134
Mg	438	938	1,630
Mn	2	5	7
Sr	1,390	2,100	6,830
Hardness (as CaCO ₃)	17,900	49,400	90,337
Radioactivity	ND	ND	ND
TDS	69,400	175,600	248,000

Source: Slide presentation – “ Sustainable Water Management for Marcellus Shale Development”
Radisav Vidic, PhD, P.E.,
University of Pittsburgh,
Dept. of Civil & Environmental Engineering

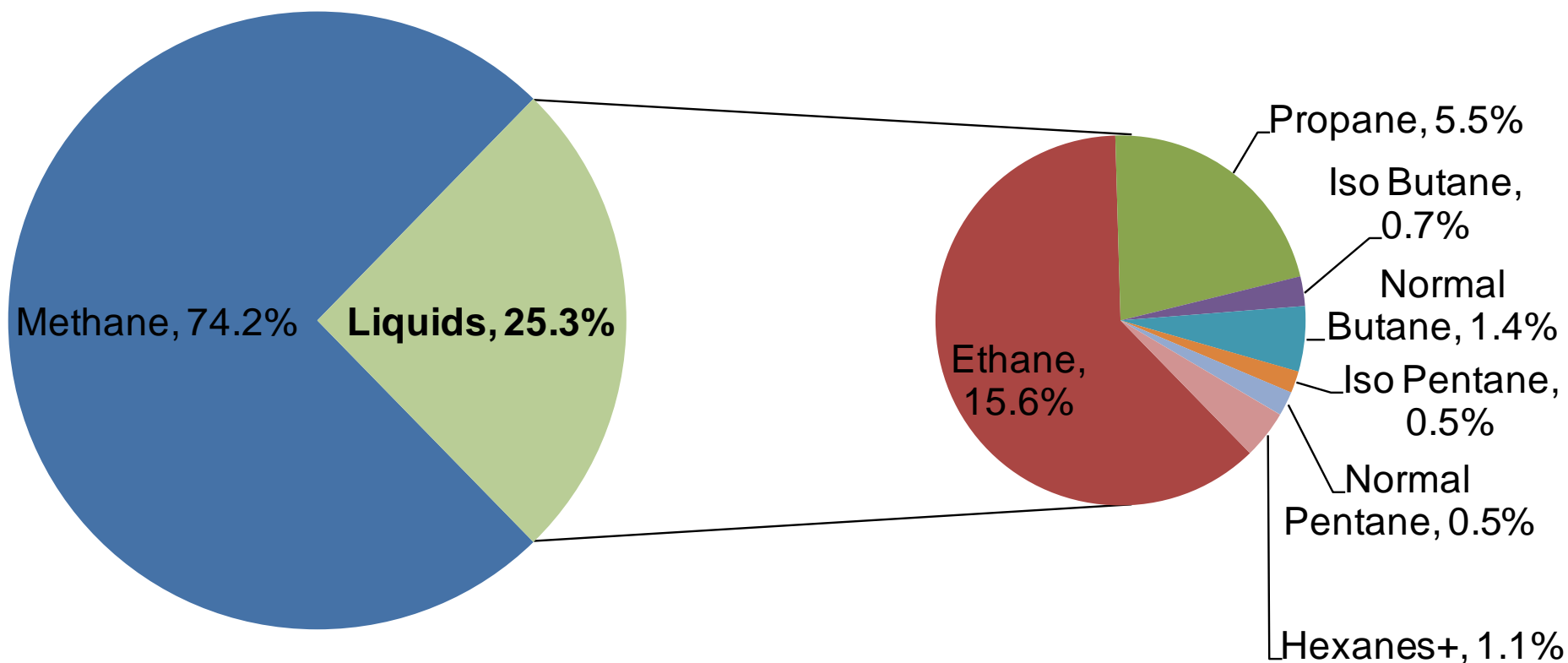
What are Natural Gas Liquids?

Natural Gas. We burn primarily methane in our homes – the simplest hydrocarbon.

- CH_4
- Net Heating Value = 910 Btu/Ft³ (75% min)

Natural Gas Liquids. Those hydrocarbons in natural gas that are separated from the gas as liquids through the process of absorption, condensation, adsorption, or other methods in gas processing or cycling plants. (from EIA)

What are Natural Gas Liquids?

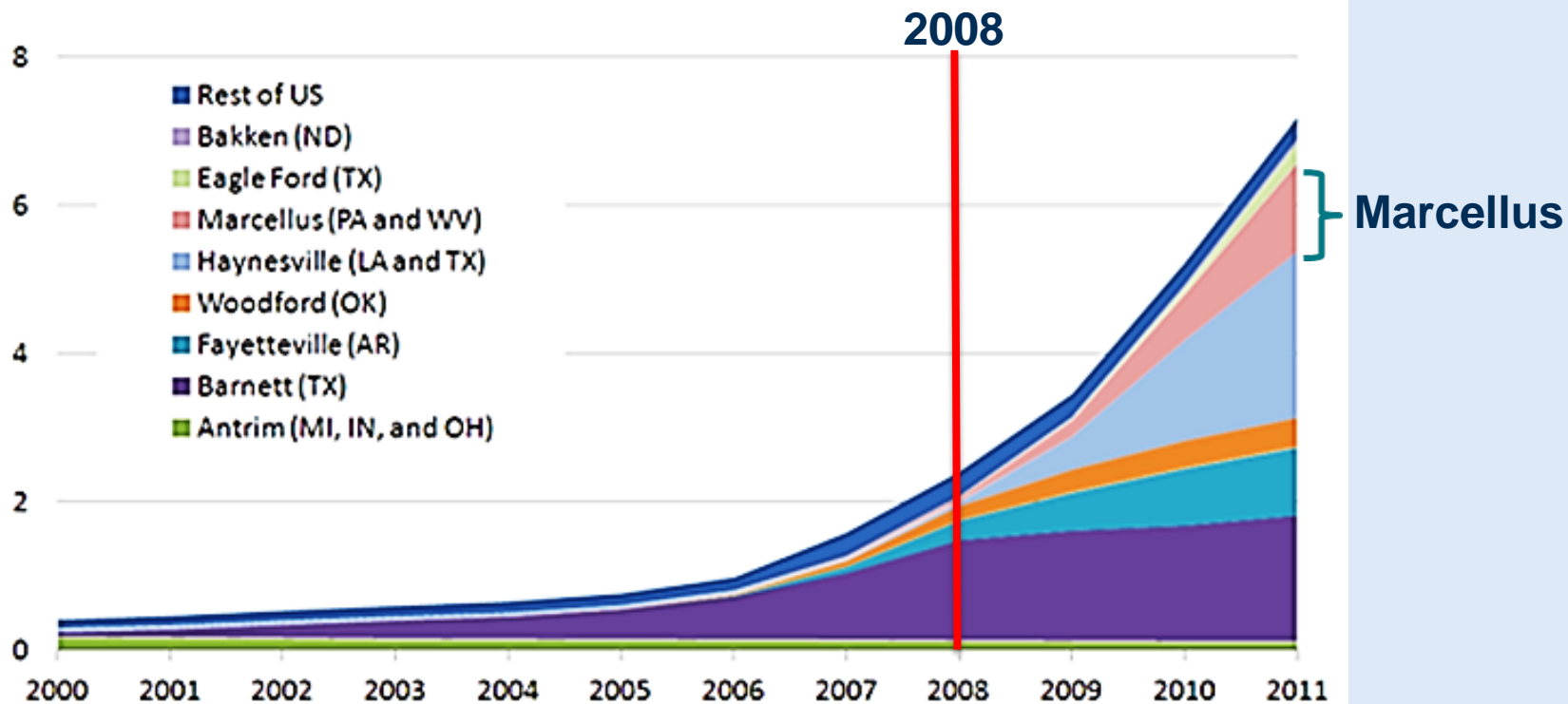


- C_2H_6 Ethane 1,630 Btu/Ft³ (10% max)
- C_3H_8 Propane 2,371 Btu/Ft³ (5% max)
- C_4H_{10} Butane 2,977 Btu/Ft³ (2% max)
- C_5H_{12} Pentane 3,679 Btu/Ft³ (0.5% max)

Shale gas has changed the energy outlook

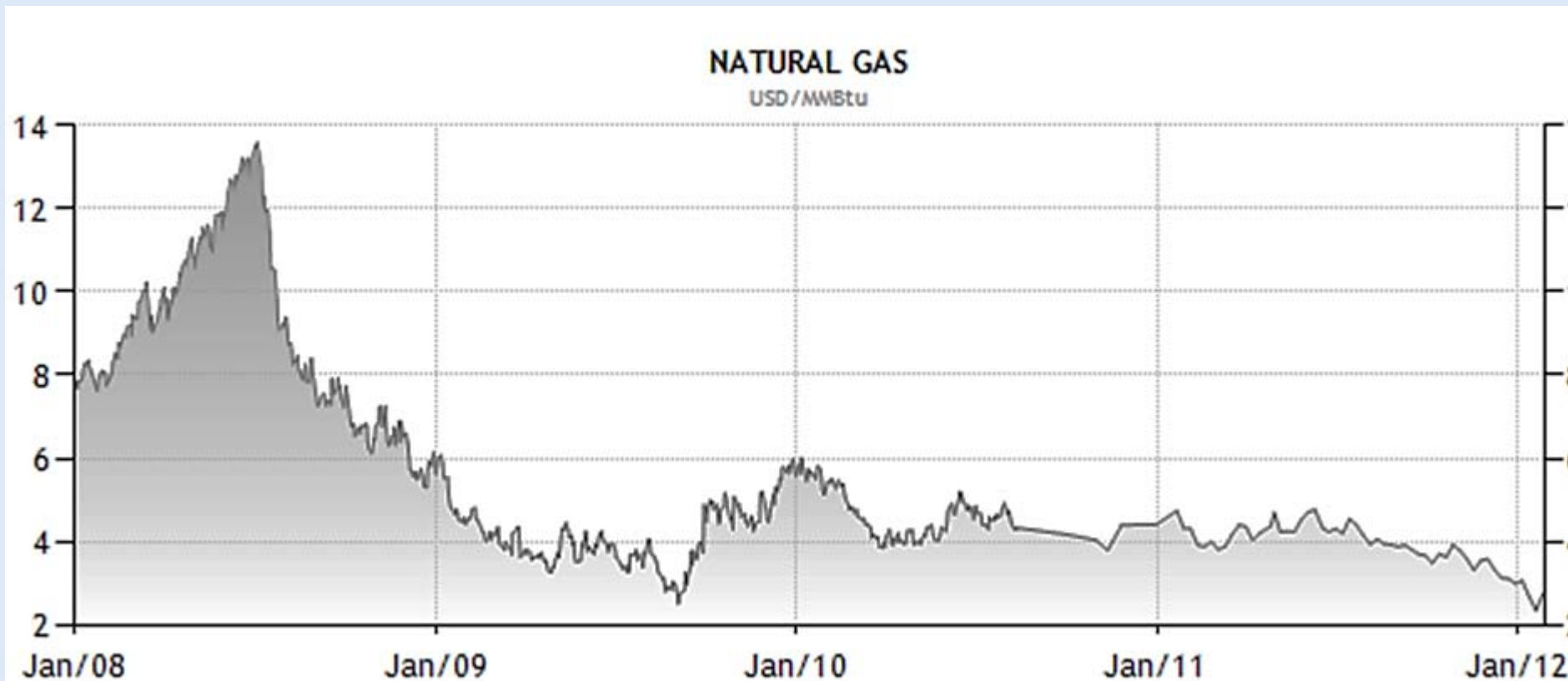
Since 2000, U.S. shale gas production has increased 17-fold and now comprises about 30 percent of total U.S. dry production

annual shale gas production (dry)
trillion cubic feet



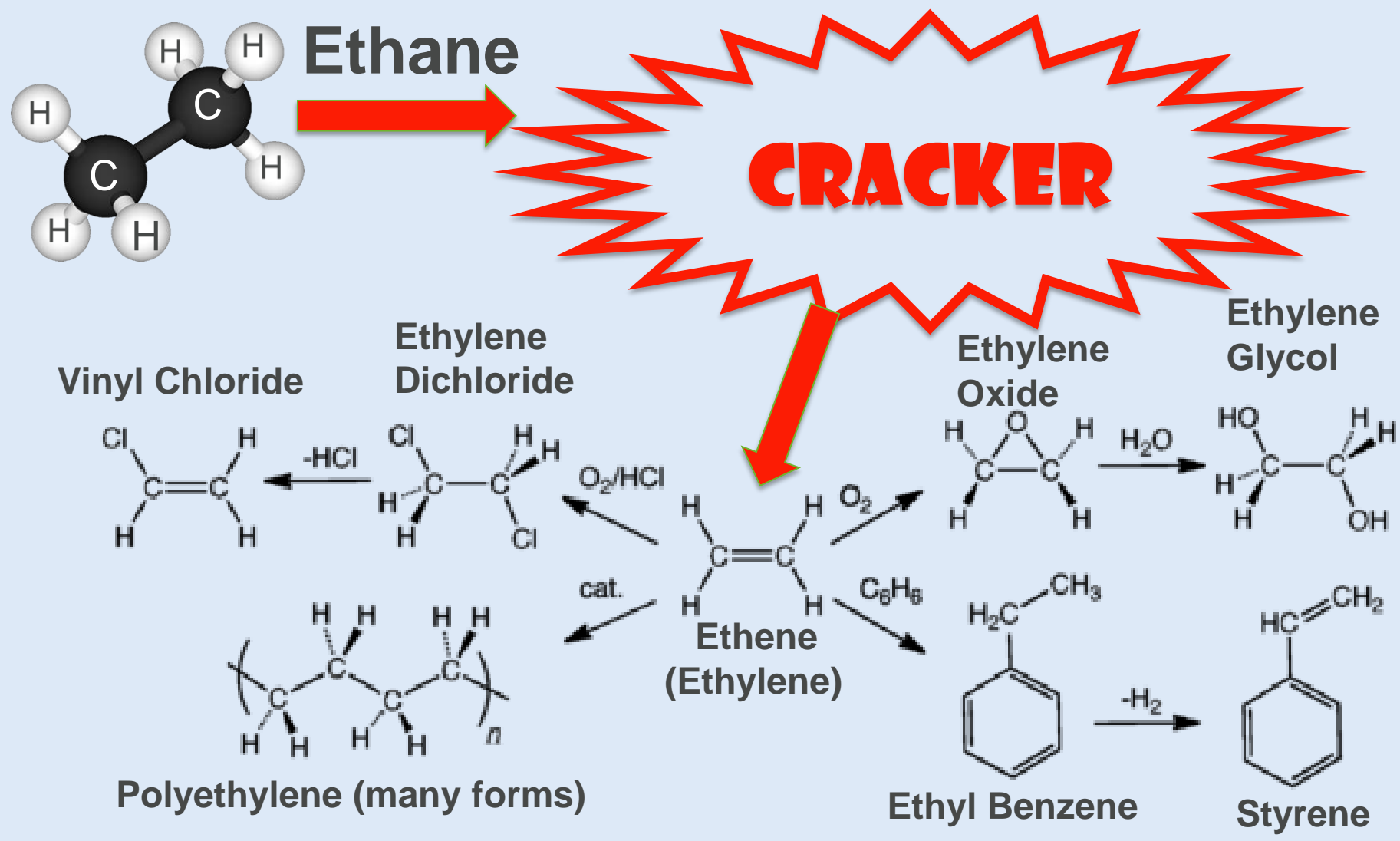
Source: Lippman Consulting, Inc. gross withdrawal estimates as of November 2011 and converted to dry production estimates with EIA-calculated average gross-to-dry shrinkage factors by state and/or shale play. Note: Data as of December 2011.

Abundant gas cuts prices, drives a NGL market



Source: www.tradingeconomics.com | NYMEX

Abundant gas will drive petrochemicals



Water transport gaining importance



Gas Processing & Cracker Siting – Pipelines in and truck/rail/**barge** out:

- Shell Cracker Prospective Site: Monaca, PA (Ohio River)
- Dominion Processing/Fractionation Facility: Natrium, WV (Ohio River)
- Caiman Energy Ft. Beeler Processing Plant: Marshall Co. WV (Monongahela River)
- Caiman Energy Fractionation Plant: Moundsville, WV (Ohio River)
- Private Investors Cracker Facility: Montgomery WV (Kanawha River)
- Aither Chemicals Proposed Cracker in Region: Barge transport is siting criterion

Map from NationalAtlas.gov

What is being transported to well sites?



Activity	# of Truckloads
Drill Pad & Access Road Construction	10 to 45
Drill Rig	30
Drilling Fluids (Muds) & Materials	25 to 50
Drilling Equip/Casing/Drill Pipe	25 to 50
Completion Rig	15
Completion Fluids & Materials	10 to 20
Completion Equipment/Piping/Wellhead	5
Fracture Stimulation Fluids	100 to 1,000*
Fracture Stimulation Equip – Pump Trucks & Tanks	100 to 150
Total Per Well	320 to 1,365
Total @ 2,000 Wells/Year	Up to 2.73 Million

*Note – Many operators migrating to piping and centralized water storage

What is being hauled by barge locally?



Sand as Proppant: Likely three local terminals.

- Considerations: Spurred by large quantity needed and rail car shortage. Must keep grain sizes separated and sand clean.(covered storage at terminals). Higher grades of sand (including ceramic proppant) moved in super sacs by rail (expensive and fragile).

Drill Pipe & Casings: Some comes via imports, moved up the Mississippi.

- Considerations - Pipe, particularly coated pipe, is fragile for barging.

Condensate, Crude Oil, NGL Products, Petrochemicals: Limited now in Appalachia, but more will be moved by barge as the Utica is developed.

Hydraulic Fracturing Flowback & Produced Water: Limited in Appalachia, but could grow if additional disposal is needed.

Other Commodities: For example, pre-ground barite used in drilling mud

Large Equipment: Potential movement of entire drill rigs by barge between the various shale plays. Also large equipment like compressors.

What is being transported: sand/proppants

**Frac Sand Silos for
Railcar Load out,
Valley, Wisconsin**



TRANSLOADING.ORG

Marcellus Shale Fracking – Transloading Bulk Materials for Marcellus Shale Drilling

Serving the Natural Gas Fracking Industry

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What is being transported: sand/proppants

Frac Sand Transfer from Rail to Truck at Newberry Yard in Williamsport, PA

<http://www.clintoncountypa.com/resources/CCNGTF/pdfs/articles/12.30.10%20-%20Railroads%20and%20the%20Marcellus%20Shale.pdf>



What is being transported: steel pipe/casing

BUSINESS March 26, 2012, 10:48 p.m. ET

Steel Finds Sweet Spot in the Shale

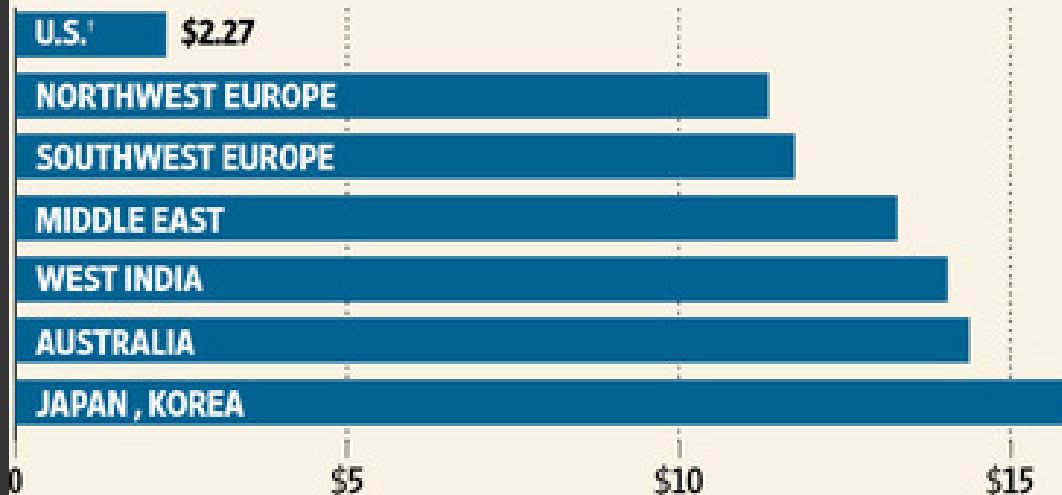
Natural-Gas Boom Begets Low Prices for Fuel, Strong Demand for Piping—a Double Boon for Mills



Steely Effects

The natural-gas boom has helped U.S. steel production by reducing energy costs for making steel and improving demand for steel pipes used for gas drilling.

Natural-gas-futures price, per million BTUs*

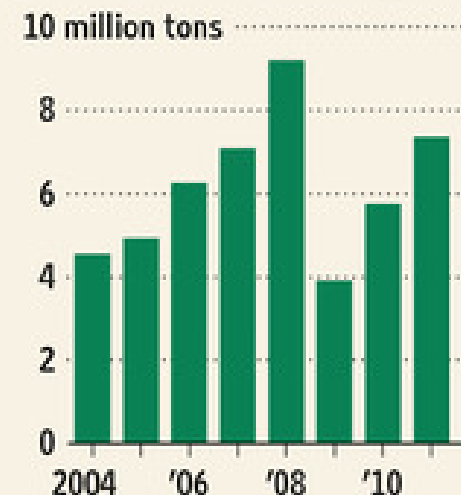


*As of March 22 †Henry Hub, La., benchmark contracts traded on the New York Mercantile Exchange

Sources: Platts (futures); American Iron and Steel Institute (shipments)

Close

Shipments of pipes and other gas- and oil-related steel goods



The Wall Street Journal



Bottom Dollar - Export coal, petrochemicals and crude drive strong inland market. By Pamela Glass - 3/20/2012

American Commercial Lines (ACL), Jeffersonville, Ind., saw its year-end revenues rise 18 percent from 2010 to 2011 to \$852.9 million. The surge in business came mostly in the company's petroleum and chemical business and export coal, according to Mark Knoy, president and CEO. **Demand on the liquid side should remain strong into 2012**, as domestic crude oil production and historically low natural gas prices are expected to continue. **The additional refining of crude will require barges to move gasoline, distillates and other crude oil derivatives.**

Peter H. Stephaich, chairman of **Campbell Transportation Inc.**, a barge operator on the Upper Ohio River based in Houston, Pa., near Pittsburgh. The future for some barge lines could very well lie in the emerging energy markets for shale gas production. Stephaich said. **Barges are already moving pipes and fracking sands.** Shell will announce soon where it will locate a shale natural gas processing plant. **"The gas will come by pipeline, but the [refined] products will go out by barge,"**



GreenHunter President and COO Jonathan D. Hoopes from a corporate press release:

*“We are pleased to report that operations at our Ohio River bulk water storage facility began last week. We **began accepting both production water and frac flowback water and we expect to receive up to 4,000 barrels per day** from a single new customer for the next ten weeks as we begin to ramp up operations. By leveraging proprietary innovations, advanced infrastructure design and the experience we have gained from operating our existing salt water disposal operations, we have the ability to offload up to nine trucks simultaneously while emptying entire loads from trucks in less than 10 minutes time. The addition of 70,000 barrels (2,940,000 gallons) of bulk storage increases our storage capacity in the region by a significant magnitude. With these assets in operation, we expect to realize an improvement in the economic utilization and overall profitability of our existing Class II salt water disposal wells in the area as we **continue working on bringing the barge operations on line in the near future.**”*

Source: Informa Economics, Inc. - A Special Industry Study "Opportunities in Tank Barges Related to Crude Oil Production and Movement"

"From September 2008 until October 2011, US crude oil production has increased from 3.9 million barrels per day to 5.8 million or an increase of 49%, which is now creating transportation opportunities."

Barge locking information queried from the Army Corps Lock Performance data indicated a **dramatic increase in crude petroleum barge loadings**. All indications point to the **increases in crude oil production from the natural gas and oil site extraction continuing in areas tributary to the river system**, and an important question has emerged such as "what adjustments will be required by the inland barge industry in the short and long term to handle this extra volume?"

Source: Bain & Company, Bain Brief, Dec. 5, 2011

In North America, abundant shale gas has caused several dramatic effects. Given current consumption levels, the United States will require neither LNG nor Canadian imports until the next century. **Focus in the US has shifted from importing gas to exporting it.** As of November 2011, the Federal Energy Regulatory Commission (FERC) reported that two facility operators have proposed gas exports and another three have identified the potential to export.

http://www.bain.com/offices/london/en_us/publications/are-we-on-the-edge-of-a-truly-global-gas-market.aspx

Projected water transport – LNG exports

Source: flickr – Ken Hodge (user: kenhodge13, I.D. 40132991 @NO7
LNG Tanker



Projected water transport – LNG exports



Dominion Cove Point LNG Facility. Photo courtesy of Greenhorne & O'Mara, Inc



Thank you!

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www.MarcellusCoalition.org

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[Facebook.com/marcelluscoalition](https://facebook.com/marcelluscoalition)

