

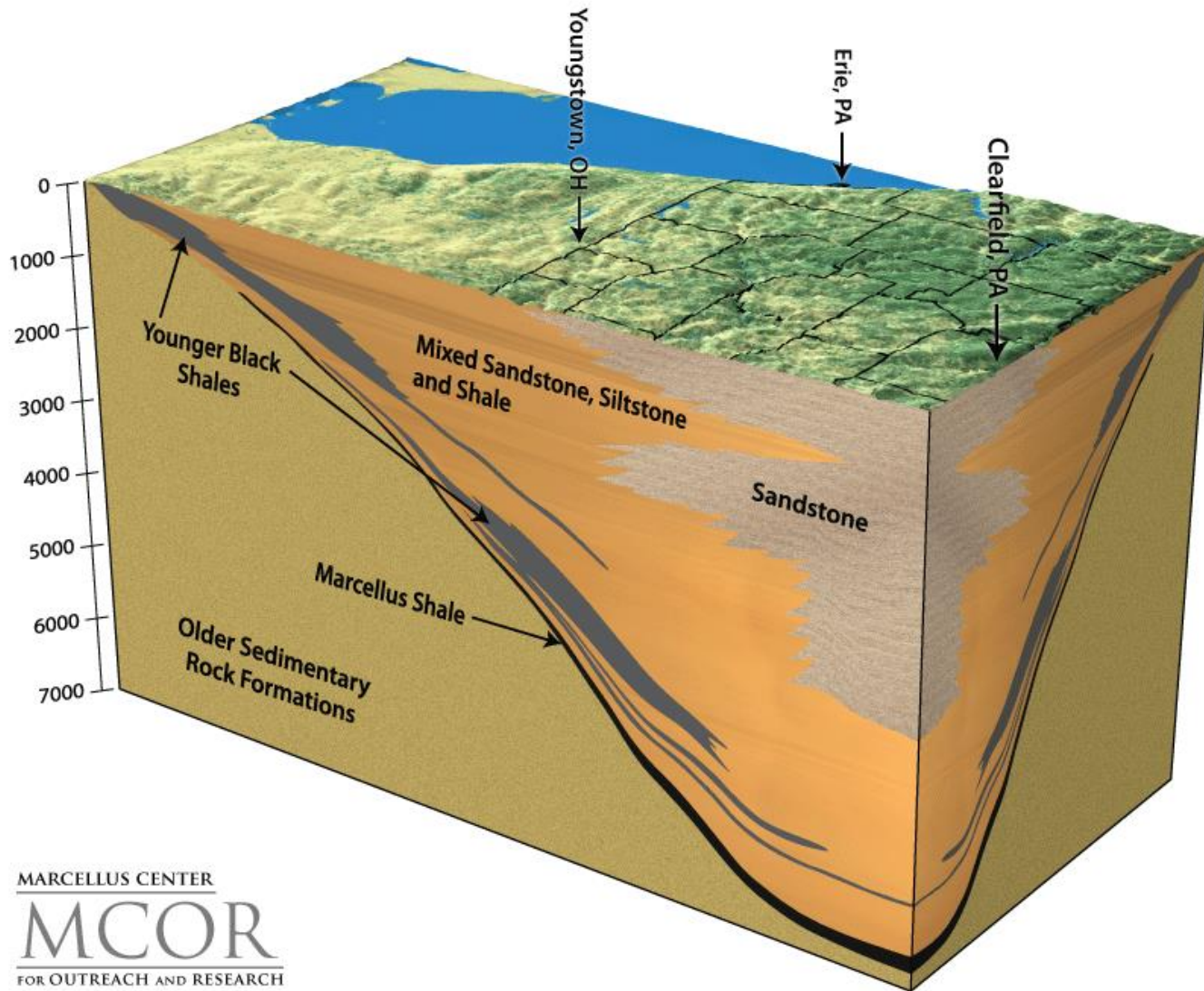


“Shale Gas”

Well Pad thru Transmission to Distribution Networks

Mark T. Taylor, P.E.
October 15, 2015

Generalized Geologic Cross Section Showing Marcellus Shale in Western Pennsylvania



MARCELLUS CENTER

MCOR

FOR OUTREACH AND RESEARCH

Shale Gas

► History

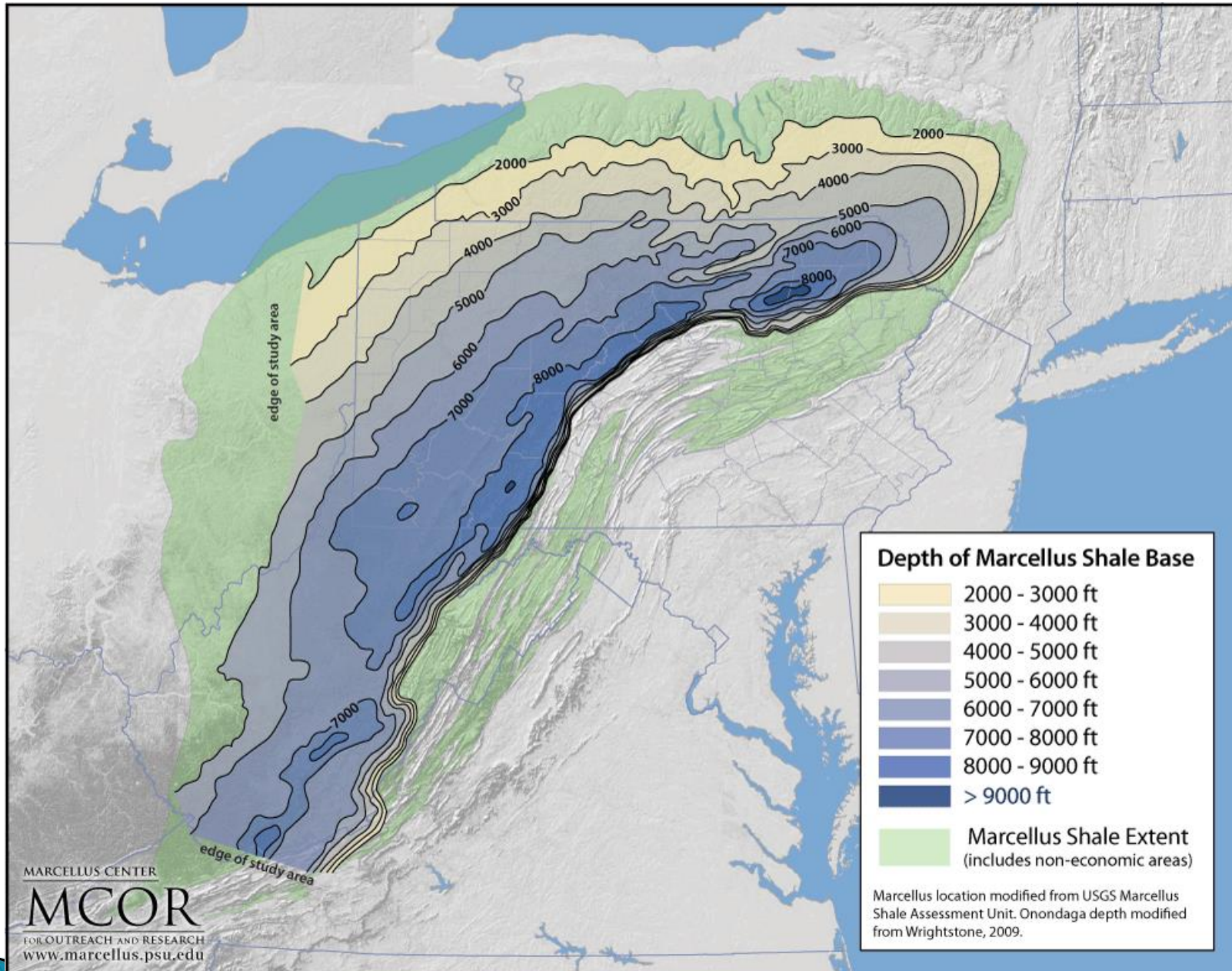
- Ontario County, NY (NYDEC)
 - Natural seeps shown to French Explorers in 1669 by Native Americans.
- Fredonia, NY 1821 (NYDEC)
 - 27' Deep hand dug well to top of slate rock formation.
 - Drilled an additional 70' deep
 - Piped with hollow logs and tared rags.
- Fredonia Gas Light Company, established 1858

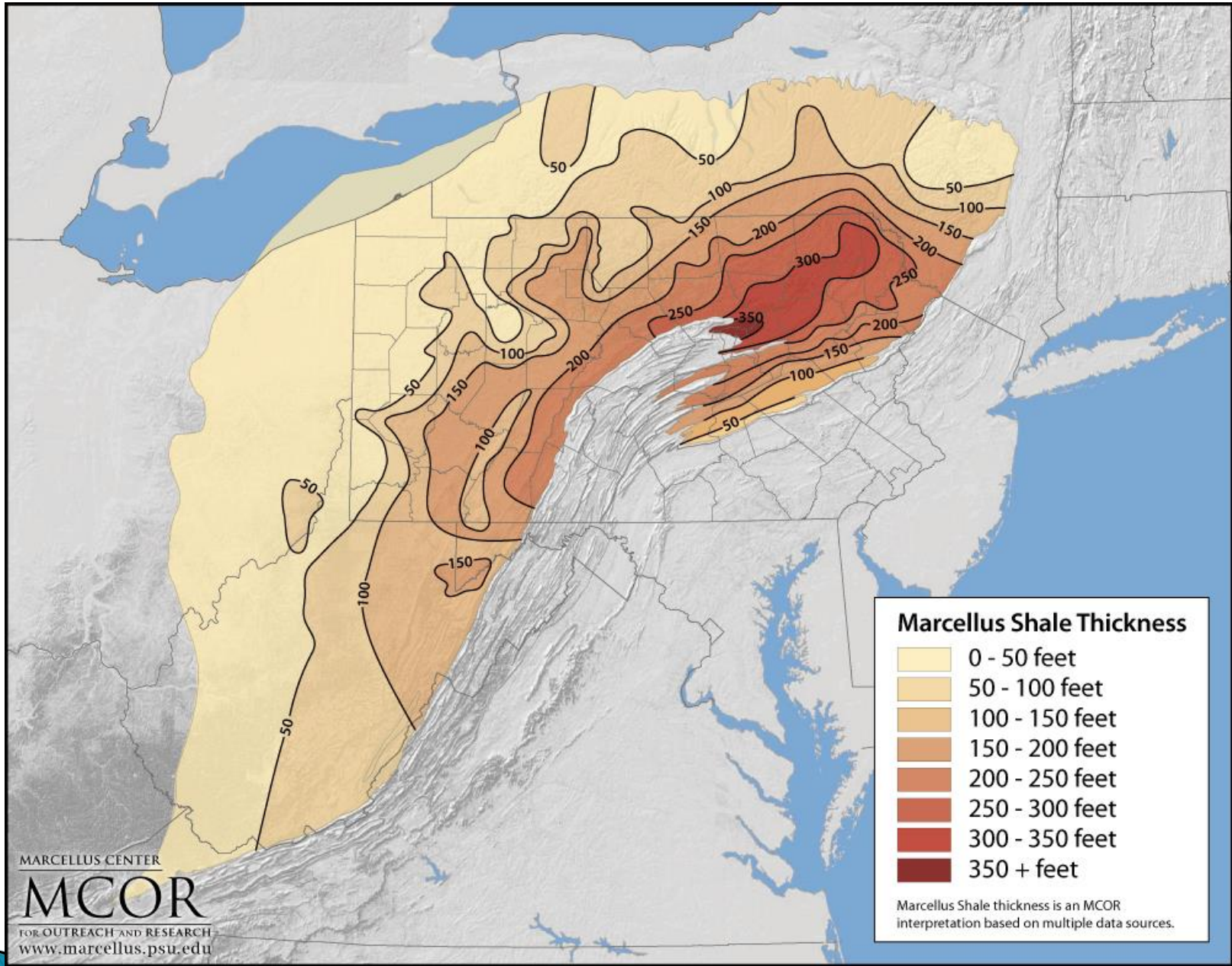
Shale in the Lower 48

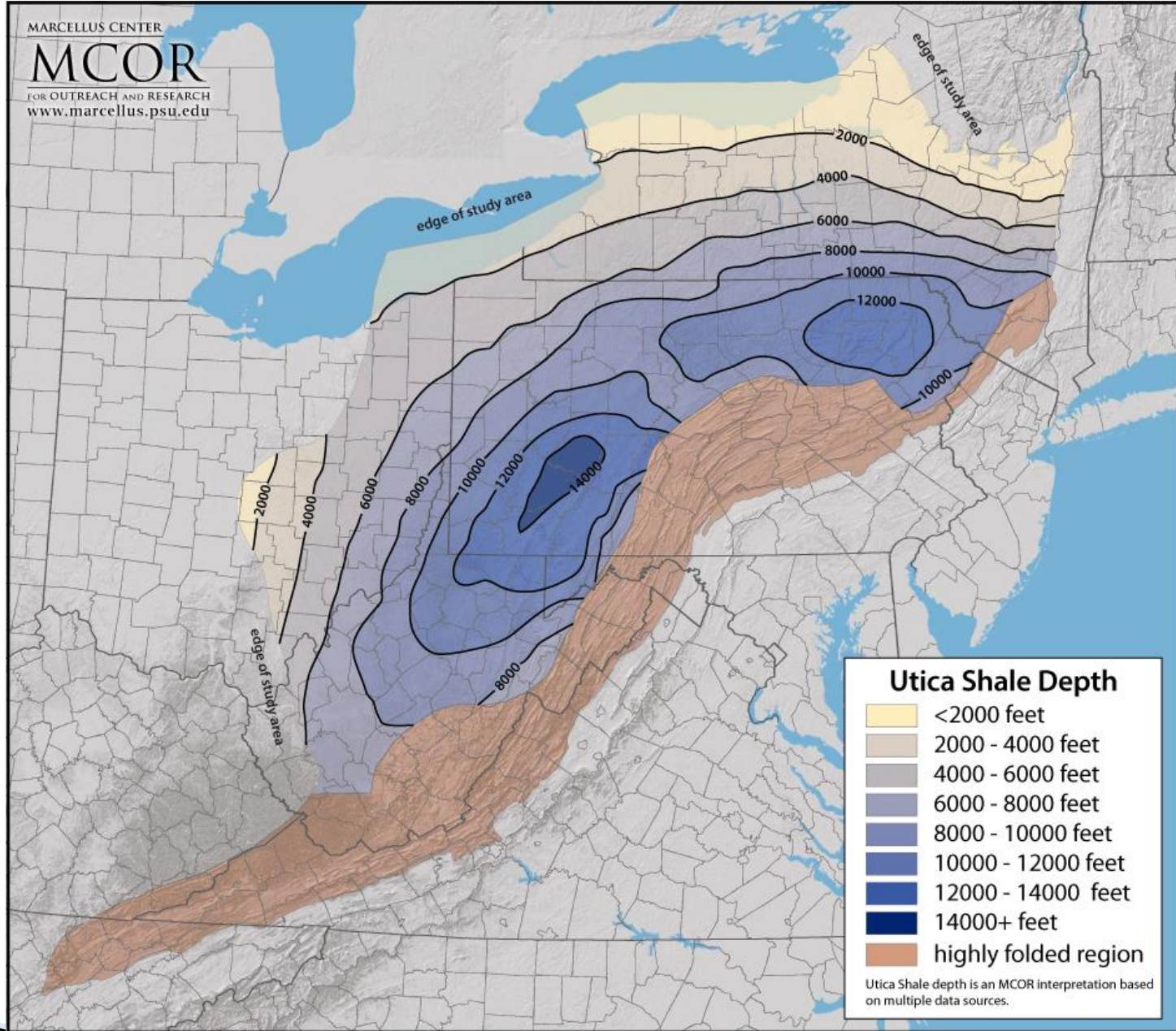
-  Shale Plays
-  Shale Basins

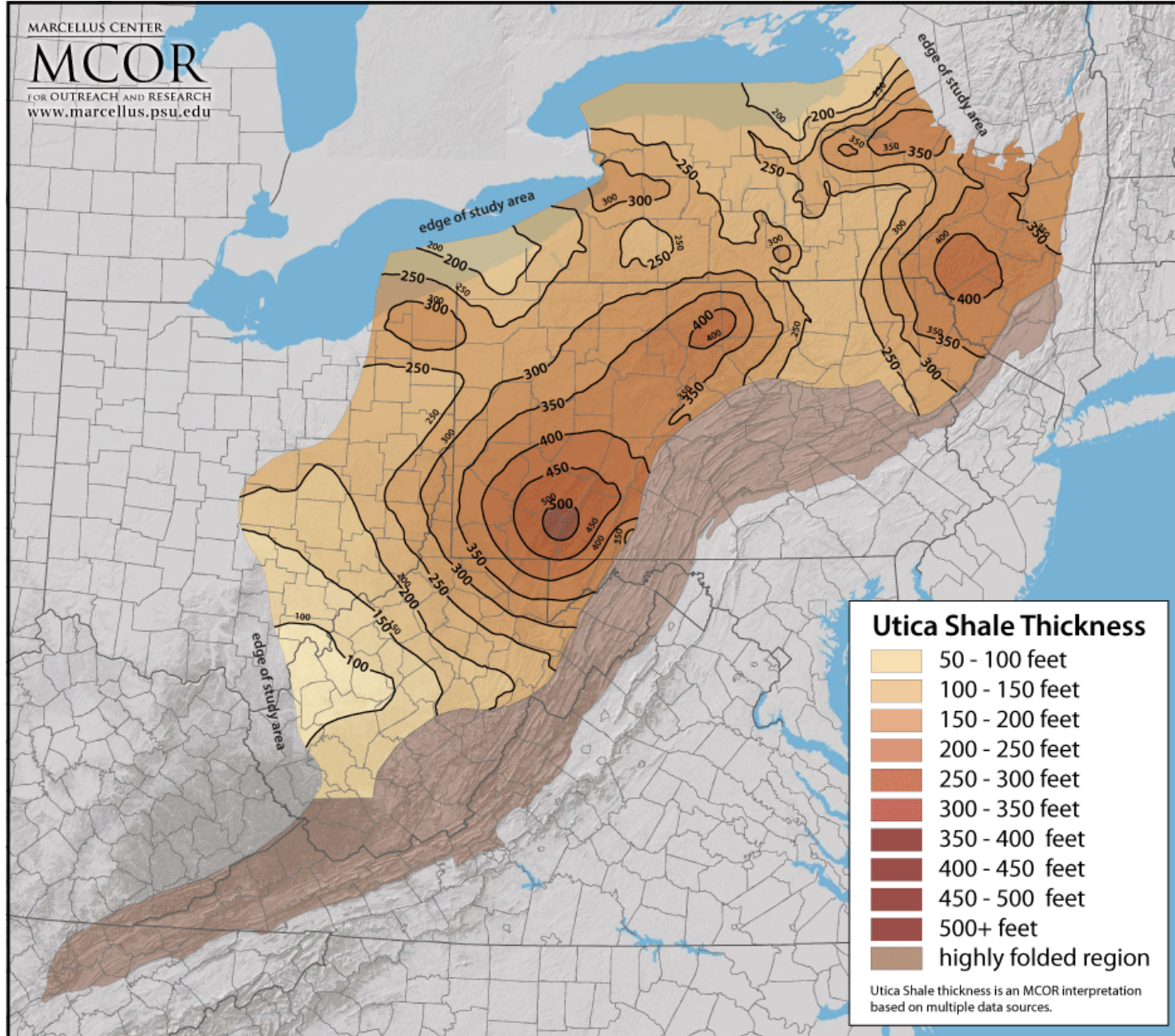
Data Courtesy U.S. Energy Information Administration, May 2011





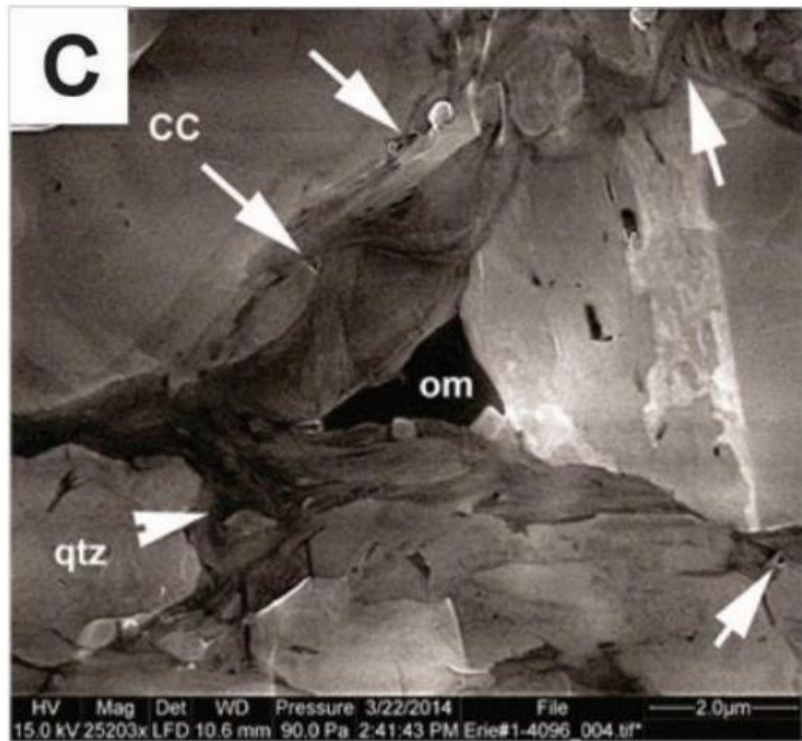
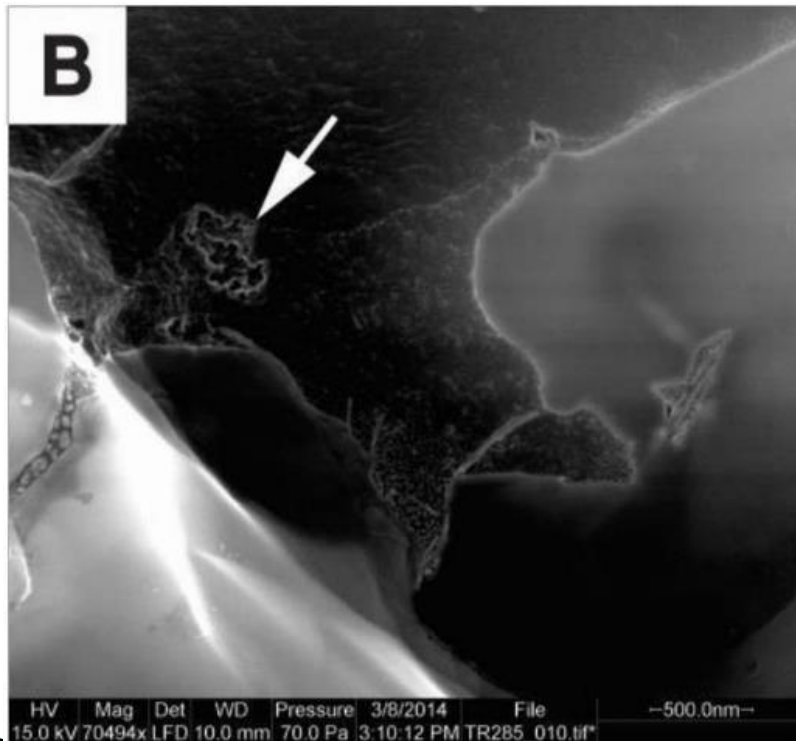






Shale Gas

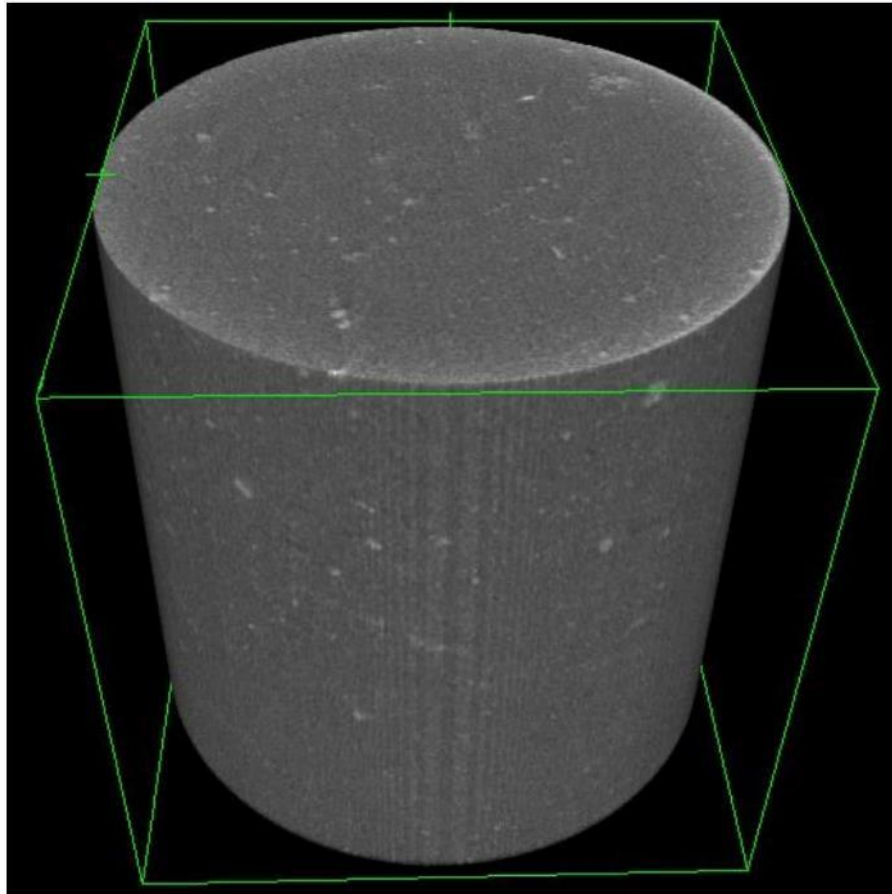
- ▶ Natural gas from shale formations.
- ▶ The fine voids in the shale contain gas.



Carter, Kristin M., & Soeder, Daniel J., 2015

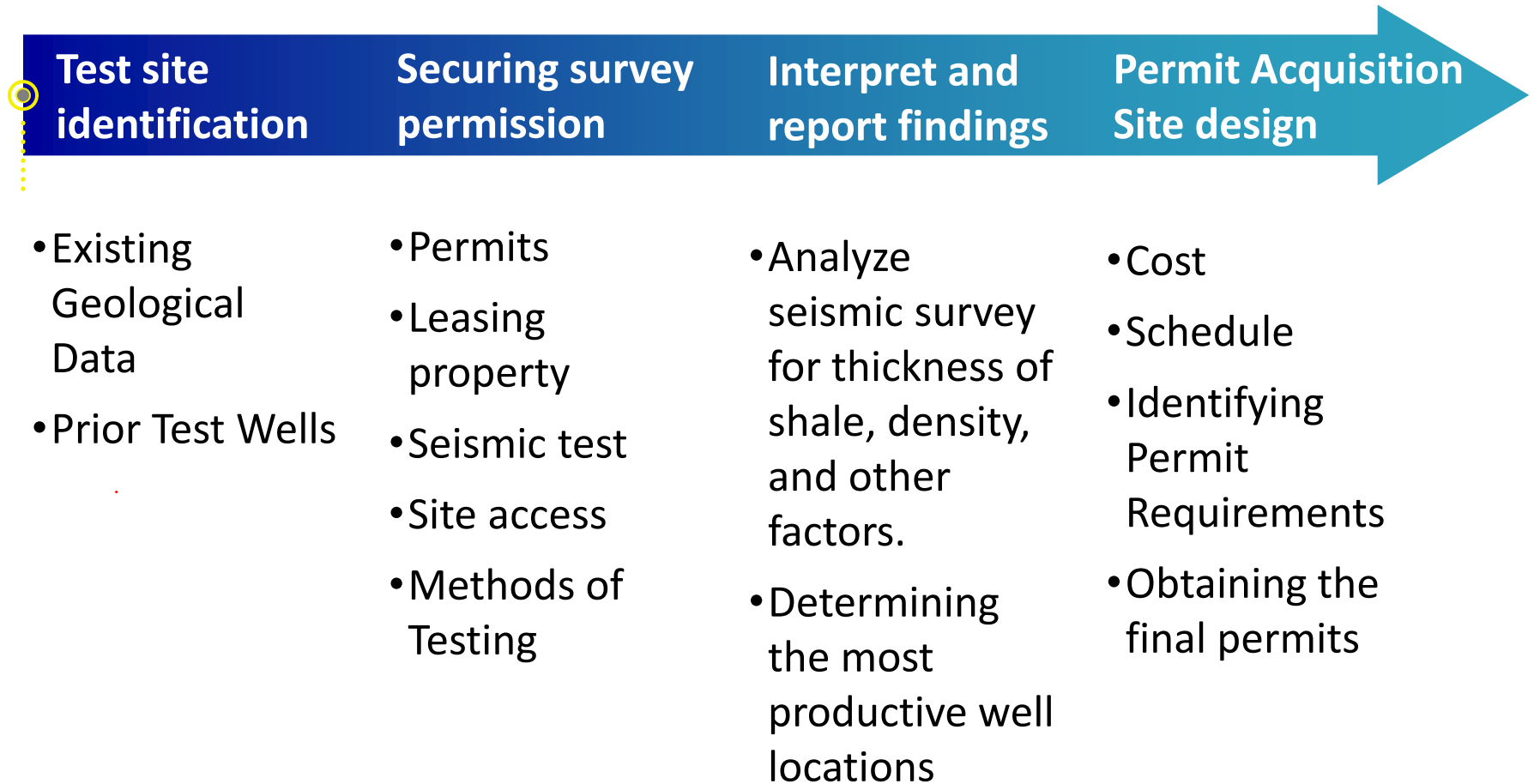
Shale Gas

Re-Constructed CT Scan of Marcellus Shale



Carter, Kristin M., & Soeder, Daniel J., 2015

Determining Well Pad Location

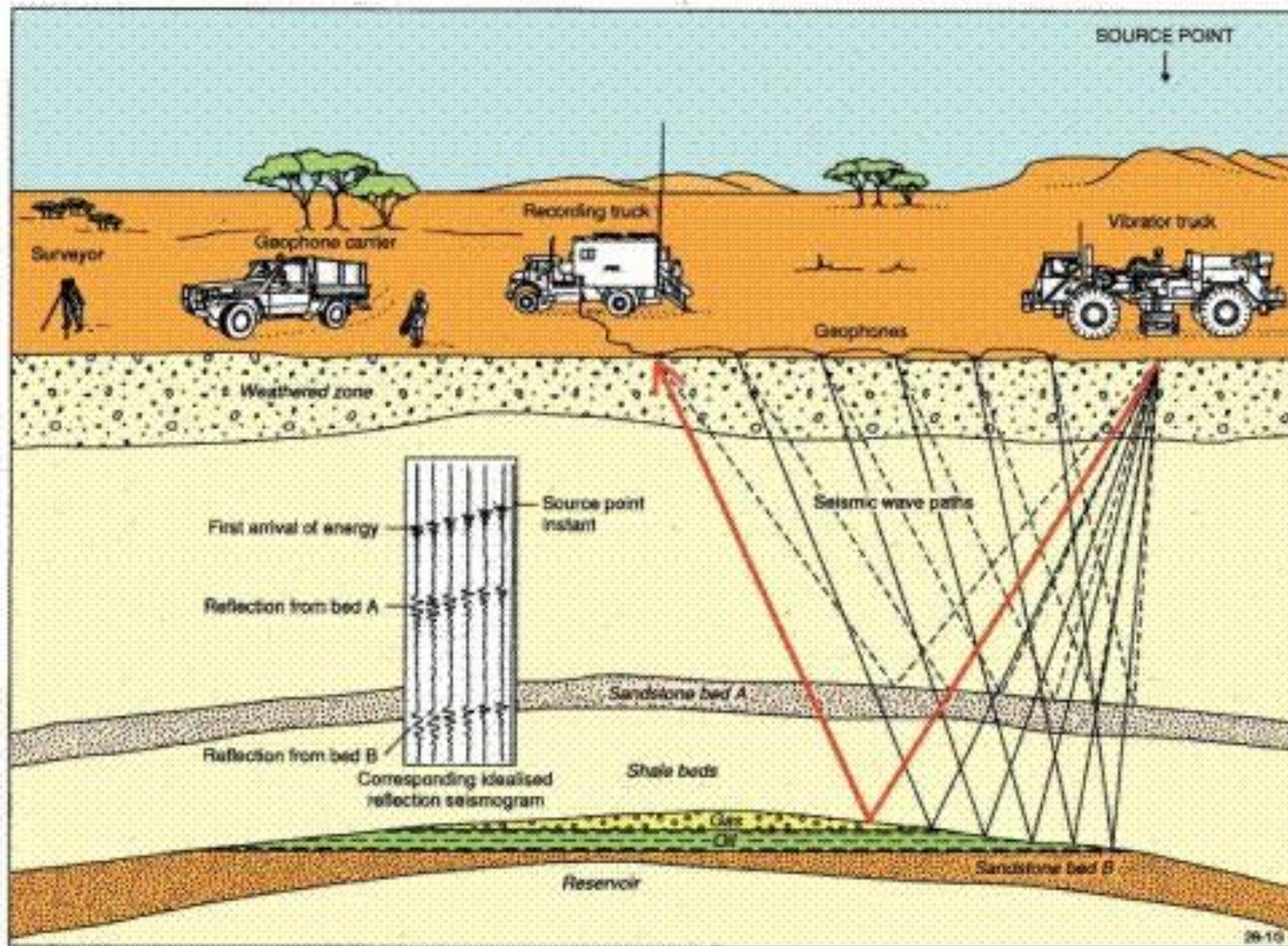


Determining Well Pad Location

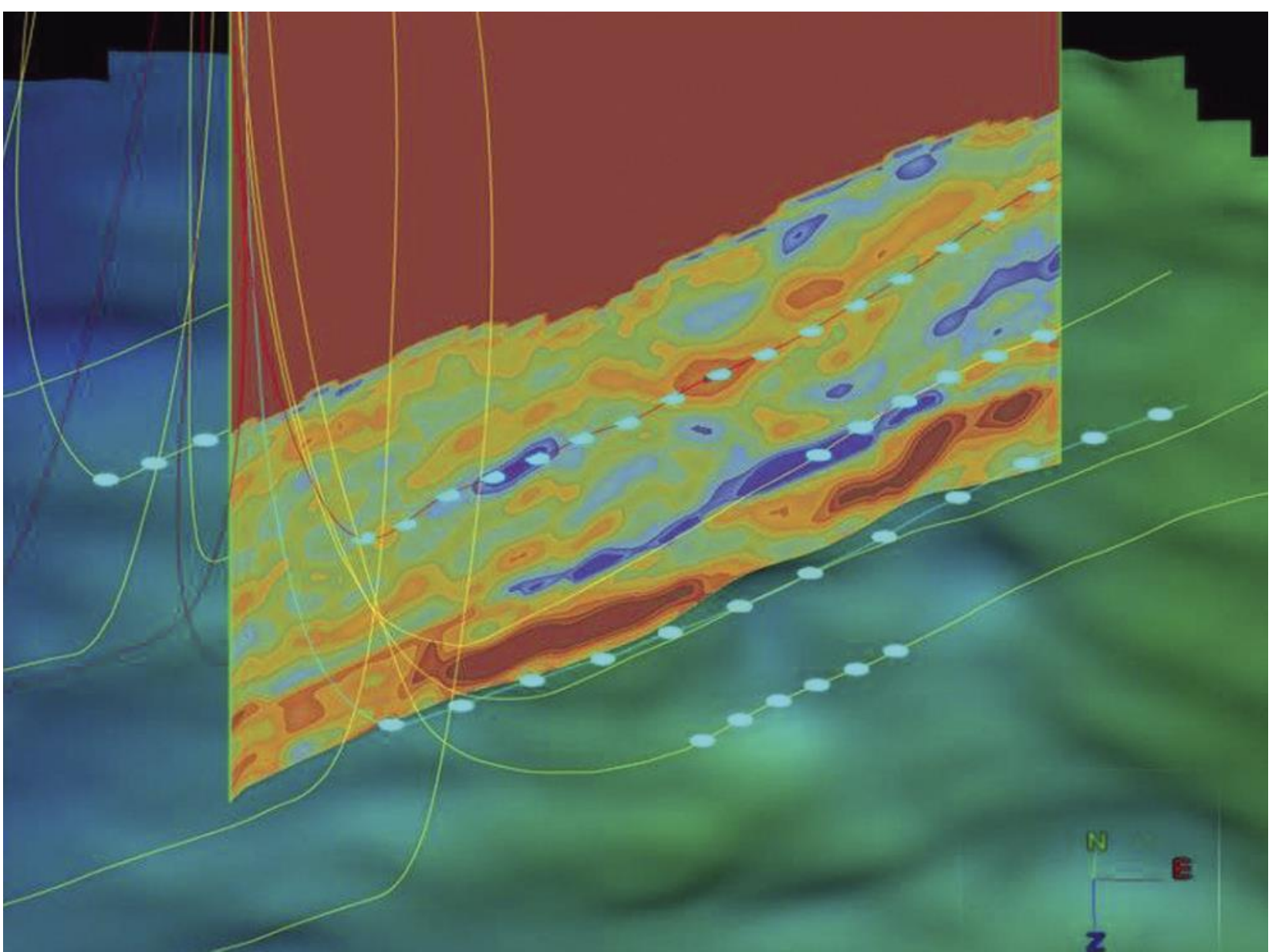
- ▶ Secure Survey Permission
 - Seismic Survey



Energyindustryphotos.com



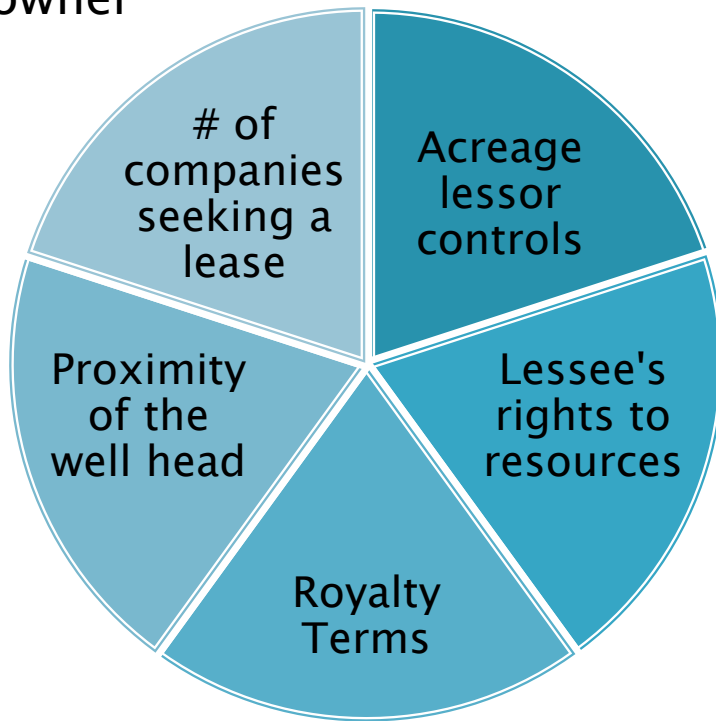
29-10



Monk, Close, Perez, Goodway, 2011

Securing the Well Pad Location

Factors influencing the negotiating power of the mineral owner



► Secure Oil & Gas Lease

◦ Lease

• Primary Term

- Standard \$25/acre (PA) (Harper & Kostelnik, pg. 38)
- Boom increased to \$6,000/acre (PA) (Harper & Kostelnik, pg. 38)

• Secondary Term

◦ Damage Payments

◦ Royalty Payments

- Standard 12.5% (Harper & Kostelnik, pg. 38)
- Boom increased to 25% (Harper & Kostelnik, pg. 38)

◦ Pooling

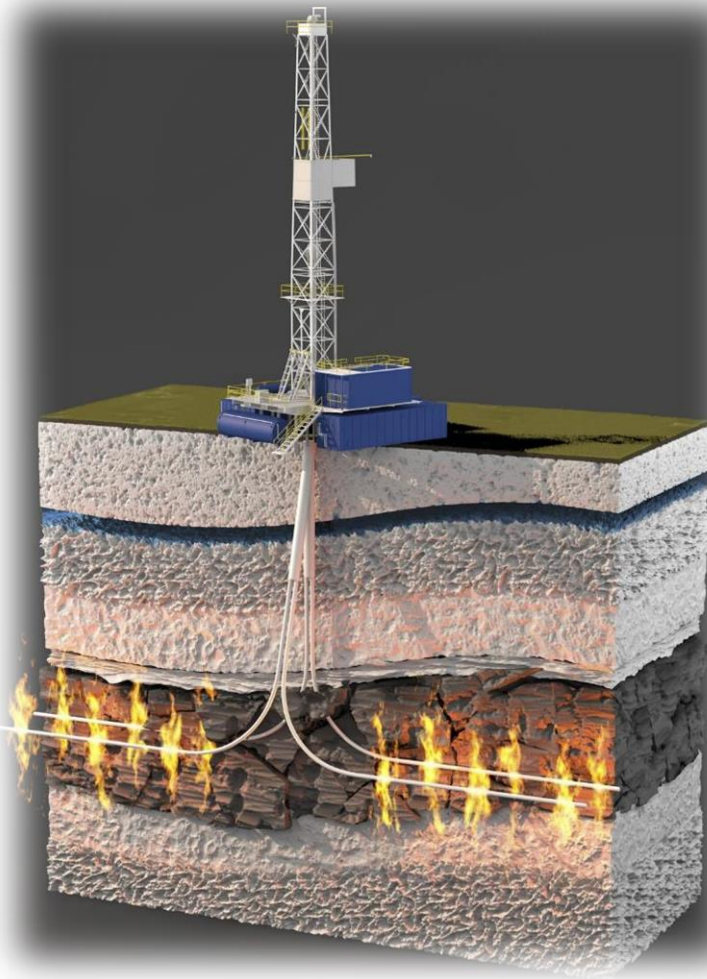
Well Pad Construction



Well Drilling



Developing a Gas Well



- ▶ Resources and Logistics
 - Approximately 400 truck trips per well site
 - Water
 - 2MM to 4MM Gallons per well
(<http://extension.psu.edu/natural-resources/natural-gas>)
 - Sand
 - 4.57 MM Pounds
(<http://extension.psu.edu/natural-resources/natural-gas>)
 - Human Resources
 - Material
 - Fuel

Hydraulic Fracturing



Building a Gathering System

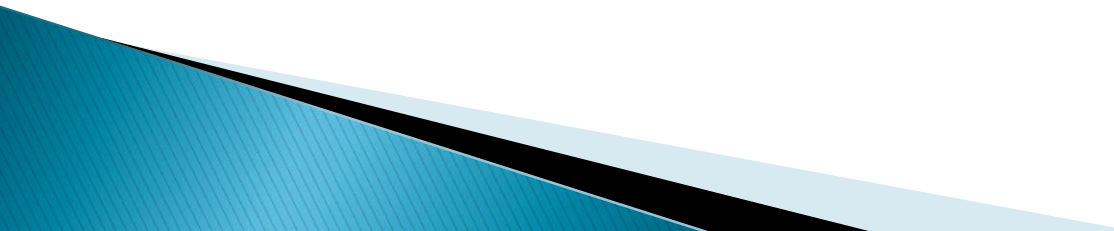
- ▶ Pipeline R-O-W Acquisition
- ▶ Permitting
- ▶ Design
- ▶ Material Procurement
- ▶ Construction
- ▶ Restoration





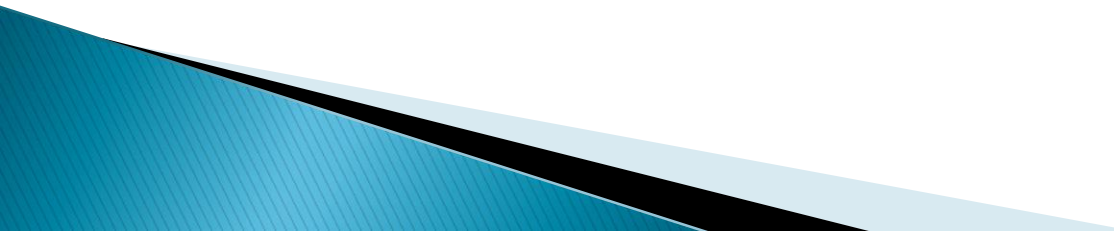


Compression and Treatment

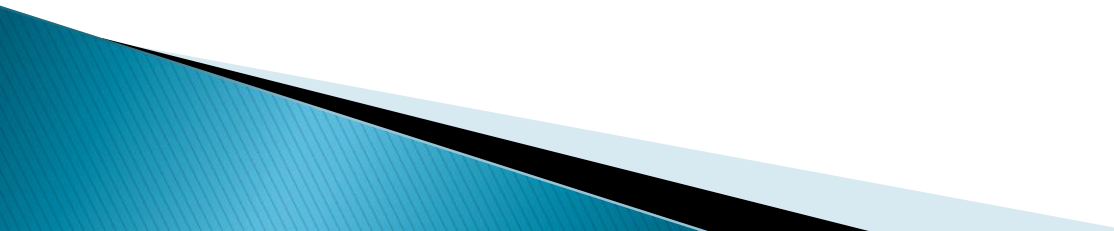
- ▶ Compressor Station Site Acquisition
 - ▶ Permitting
 - ▶ Design
 - ▶ Material Procurement
 - ▶ Construction
 - ▶ Operation
- 



Transmission Interconnect

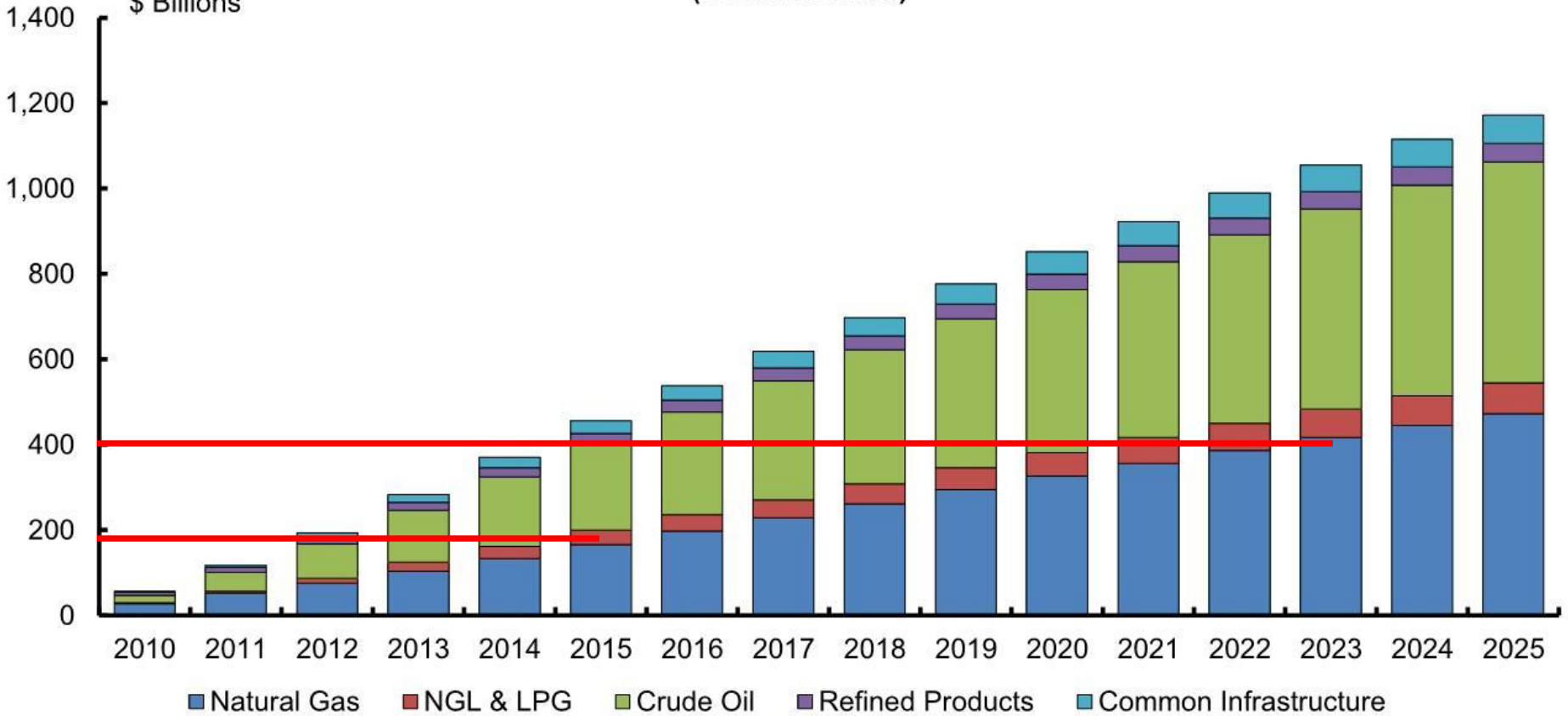
- ▶ Site R-O-W Acquisition
 - ▶ Permitting
 - ▶ Design
 - ▶ Material Procurement
 - ▶ Construction
 - ▶ Operation
 - Filtration
 - Metering
 - Odorization
- 

Transmission Pipeline & Storage

- ▶ Currently at or near capacity
 - ▶ Major projects underway for Looping
 - ▶ Several major projects for new pipelines
 - ▶ Regulatory Agencies
- 

**Base Case Direct Capital Investments Cumulative
(in 2012 Dollars)**

\$ Billions

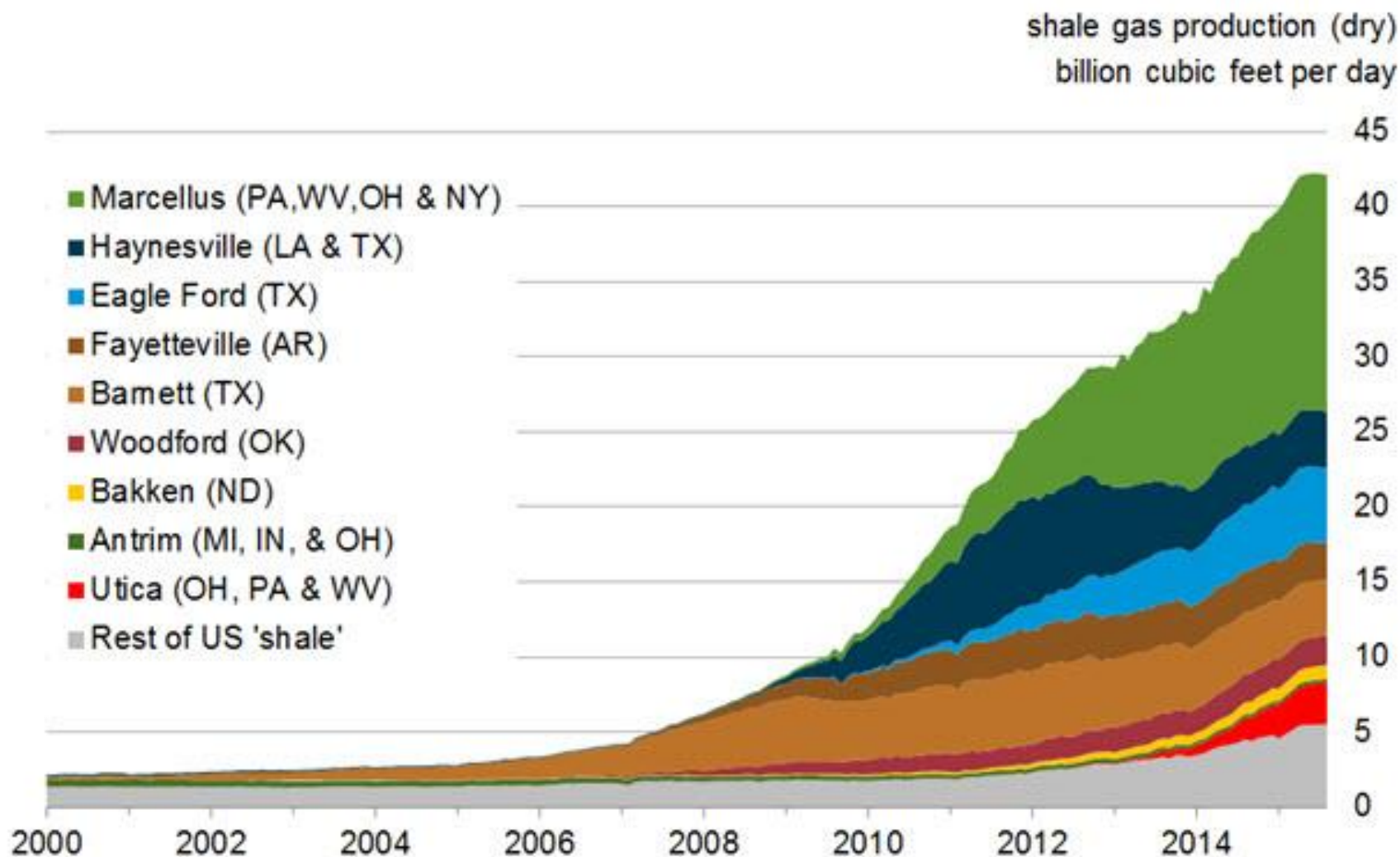


API-Infrastructure-Investment-Study

Local Distribution

- ▶ New Service Demands
- ▶ Aging Infrastructure
- ▶ Commercial Demands
- ▶ Expectations
 - Clean Reliable Product

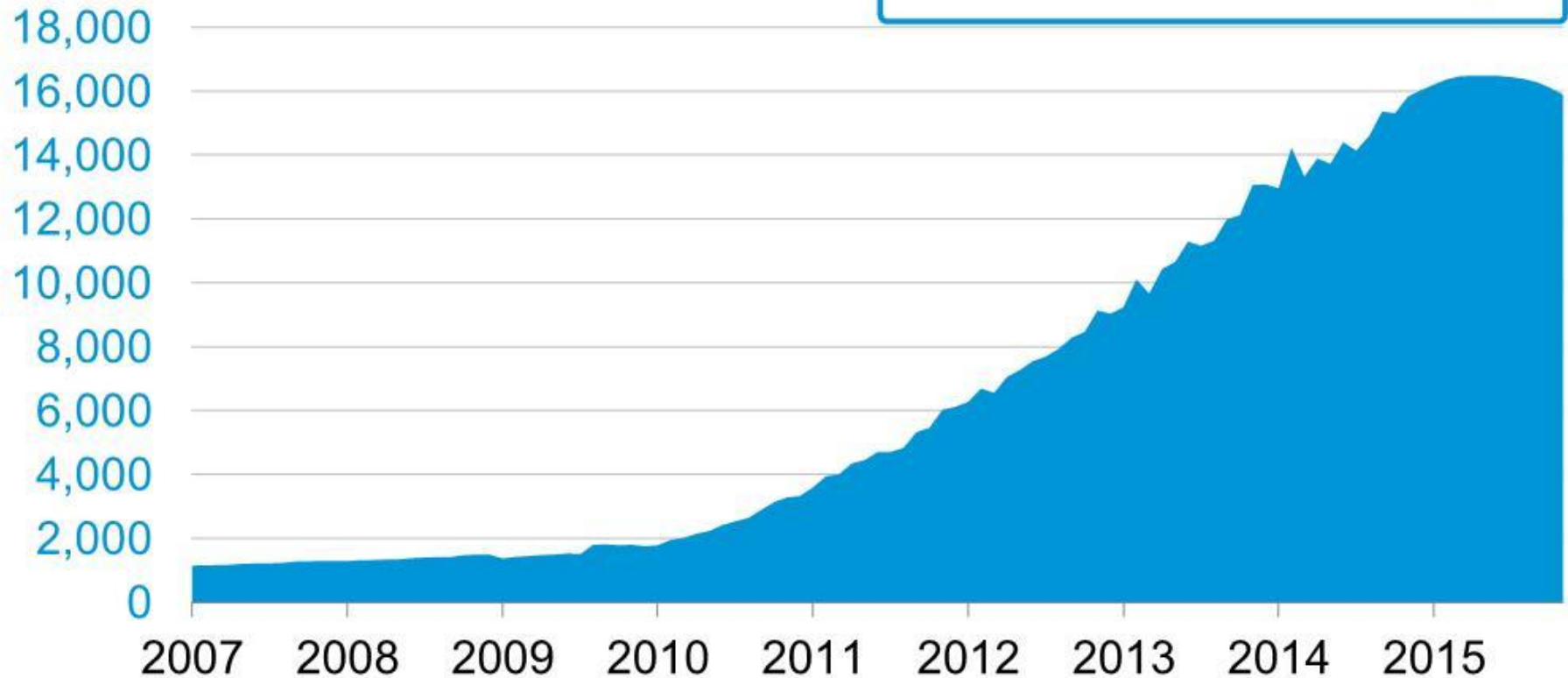
U.S. dry shale gas production



Sources: EIA derived from state administrative data collected by DrillingInfo Inc. Data are through August 2015 and represent EIA's official shale gas estimates, but are not survey data. State abbreviations indicate primary state(s).

Marcellus Region Natural gas production

million cubic feet/day



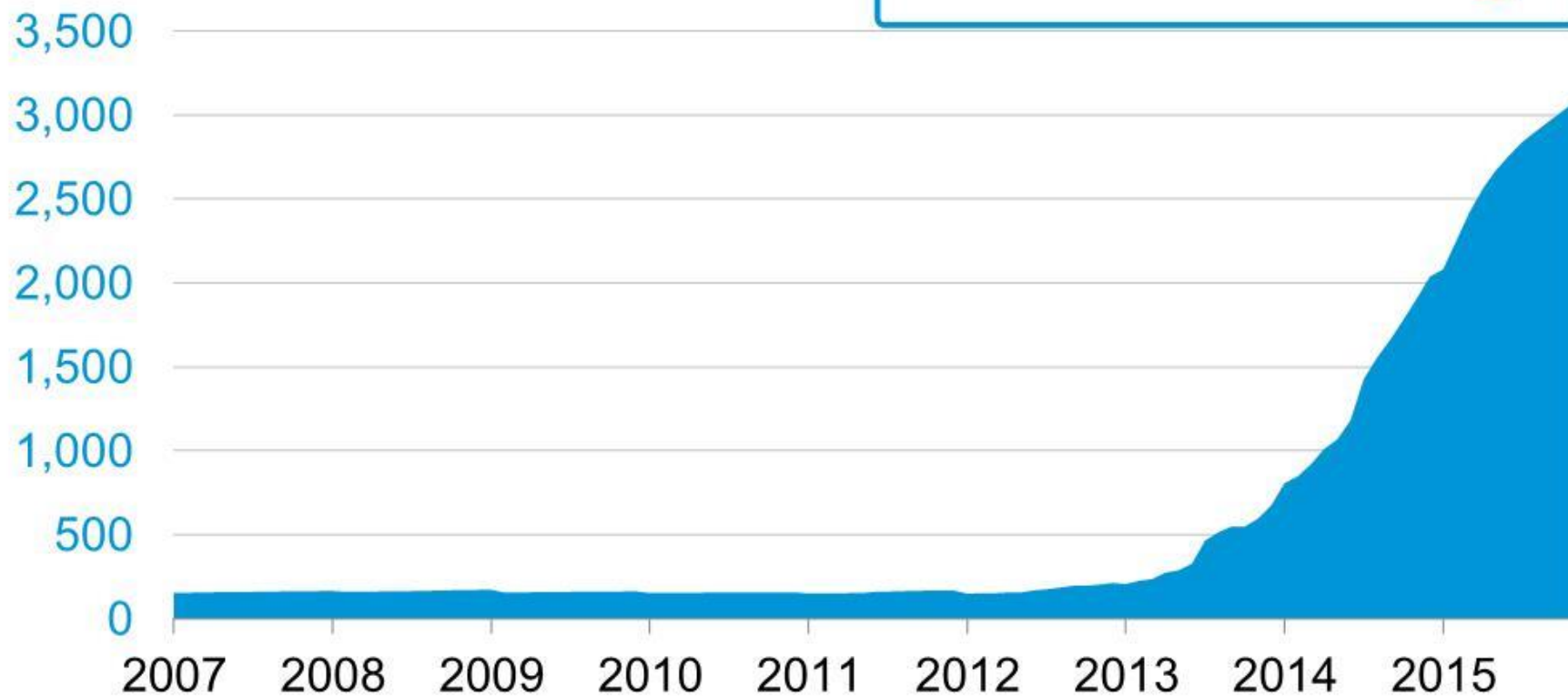
Gas -215
million cubic feet/day
month over month



U.S. Energy Information Administration, Oct. 2015

Utica Region Natural gas production

million cubic feet/day



Gas +57
million cubic feet/day
month over month

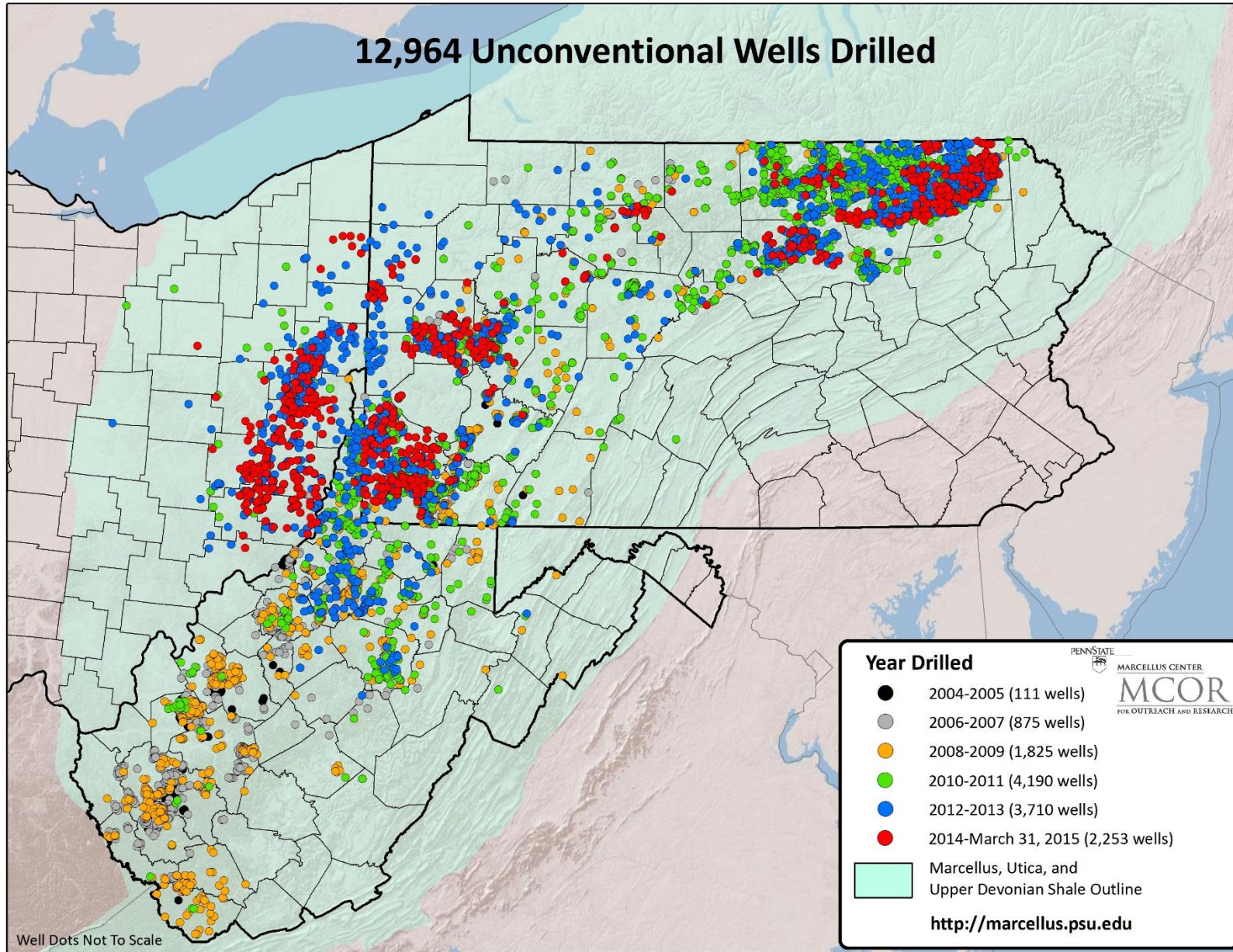


U.S. Energy Information Administration, Oct. 2015

Economic Impact

- ▶ Royalties
 - ▶ Tariffs
 - ▶ Taxes
 - ▶ Employment
 - ▶ Sustained Energy
- 

12,964 Unconventional Wells Drilled



Top Producing Well Pads: Susquehanna County

Well-Pad Name		Production Values	
1	KOROMLAN S SUS (6 active wells))	27,856,756	Mcf
	Susquehanna County Auburn Township	\$ 93,320,132.60	ATW dollars
	Gas company: CHESAPEAKE	\$ 11,665,016.58	Est. Royalties
2	R HINKLEY (4 active wells))	26,296,781	Mcf
	Susquehanna County Springville Township	\$ 88,094,216.35	ATW dollars
	Gas company: CABOT	\$ 11,011,777.04	Est. Royalties
3	J BLAISURE (6 active wells))	25,029,945	Mcf
	Susquehanna County Dimock Township	\$ 83,850,315.75	ATW dollars
	Gas company: CABOT	\$ 10,481,289.47	Est. Royalties
4	BRAY B (10 active wells))	24,955,112	Mcf
	Susquehanna County Auburn Township	\$ 83,599,625.20	ATW dollars
	Gas company: CABOT	\$ 10,449,953.15	Est. Royalties
5	J ZICK (5 active wells))	24,942,195	Mcf
	Susquehanna County Lenox Township	\$ 83,556,353.25	ATW dollars
	Gas company: CABOT	\$ 10,444,544.16	Est. Royalties
6	CLAUDE SUS (3 active wells))	23,110,294	Mcf
	Susquehanna County Auburn Township	\$ 77,419,484.90	ATW dollars
	Gas company: CHESAPEAKE	\$ 9,677,435.61	Est. Royalties
7	B RUSSO (5 active wells))	23,044,933	Mcf
	Susquehanna County Springville Township	\$ 77,200,525.55	ATW dollars
	Gas company: CABOT	\$ 9,650,065.69	Est. Royalties
8	EMPET D (4 active wells))	22,768,641	Mcf
	Susquehanna County Harford Township	\$ 76,274,947.35	ATW dollars
	Gas company: CABOT	\$ 9,534,368.42	Est. Royalties

Well Name: T FLOWER 2 [Show Wellsite on Map](#)

MGOrg ID: 13453 (DEP permit number: 115-20861)

County: Susquehanna

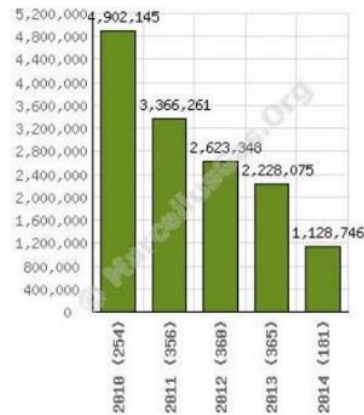
Municipality: Springville

Well Development Started:  PA PUC start date: Aug 11th, 2012
PA PUC well status: Active

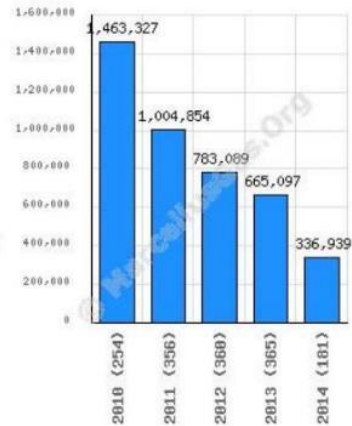
Well Production Values:  [Show/Hide Production Report](#) 

Production reports are available for Full Members Only. [Become a Full Member](#)
Sample Production Report below:

Production/ATW dollars



Production/Mcf



NOTE: 2012 values are partial, from Jan-to-June

Mcf = one thousand cubic feet © MarcellusGas.Org

2,923,969 Mcf: Production total for this well

\$ 41,608,078.87: Residential value @ \$14.23 Mcf

\$ 7,426,881.26: Wellhead value @ \$2.54 Mcf

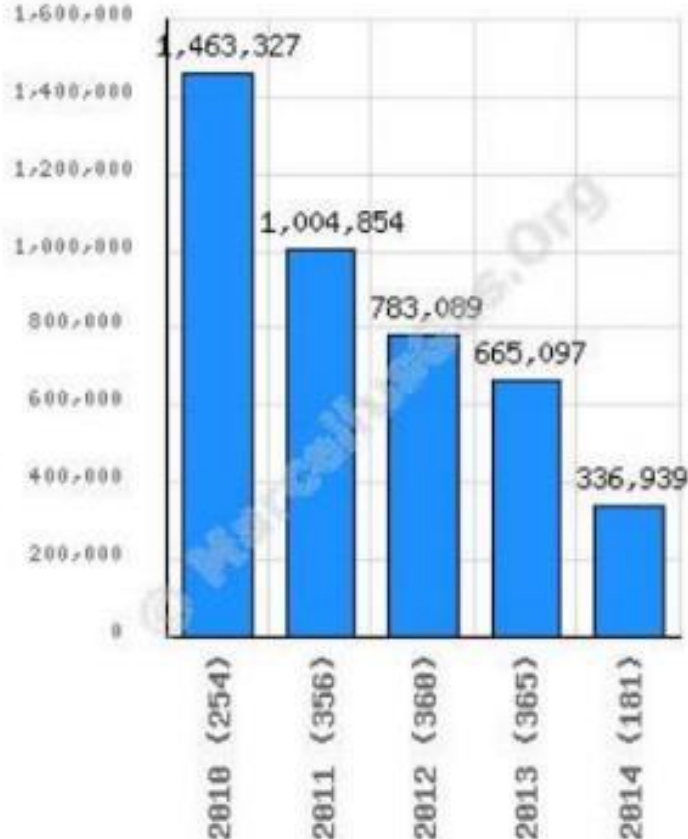
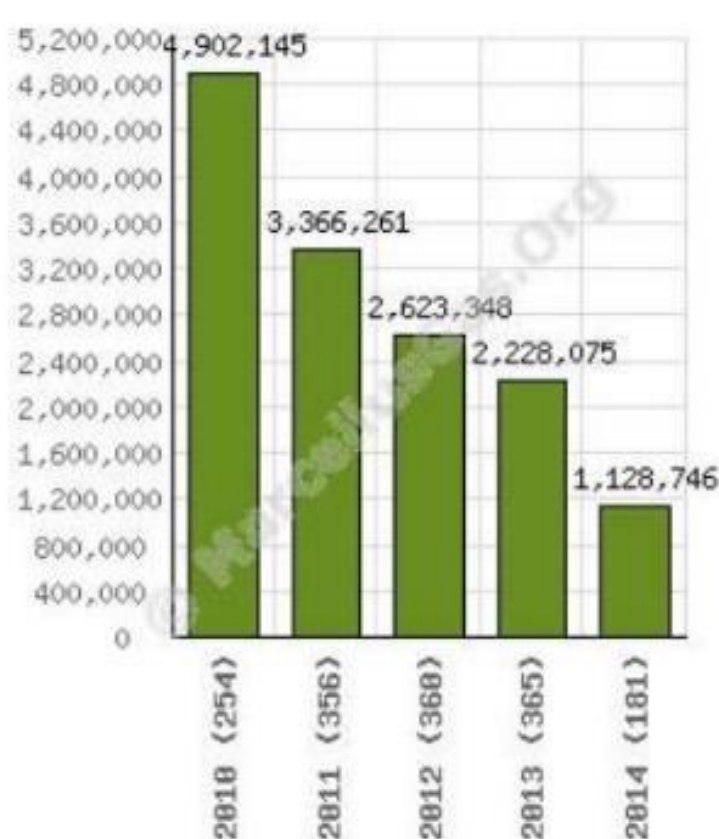
\$ 928,360.16: Estimated royalties (12.5% wellhead value)

26,825: Number of homes this would heat for one year

Accumulative data used to generate values above:

© MarcellusGas.Org

Operating Period: Jul 2009 - Jun 2010



NOTE: 2012 values are partial, from Jan-to-June

Mcf = one thousand cubic feet © MarcellusGas.Org

2,923,969 Mcf: Production total for this well

\$ 41,608,078.87: Residential value @ \$14.23 Mcf

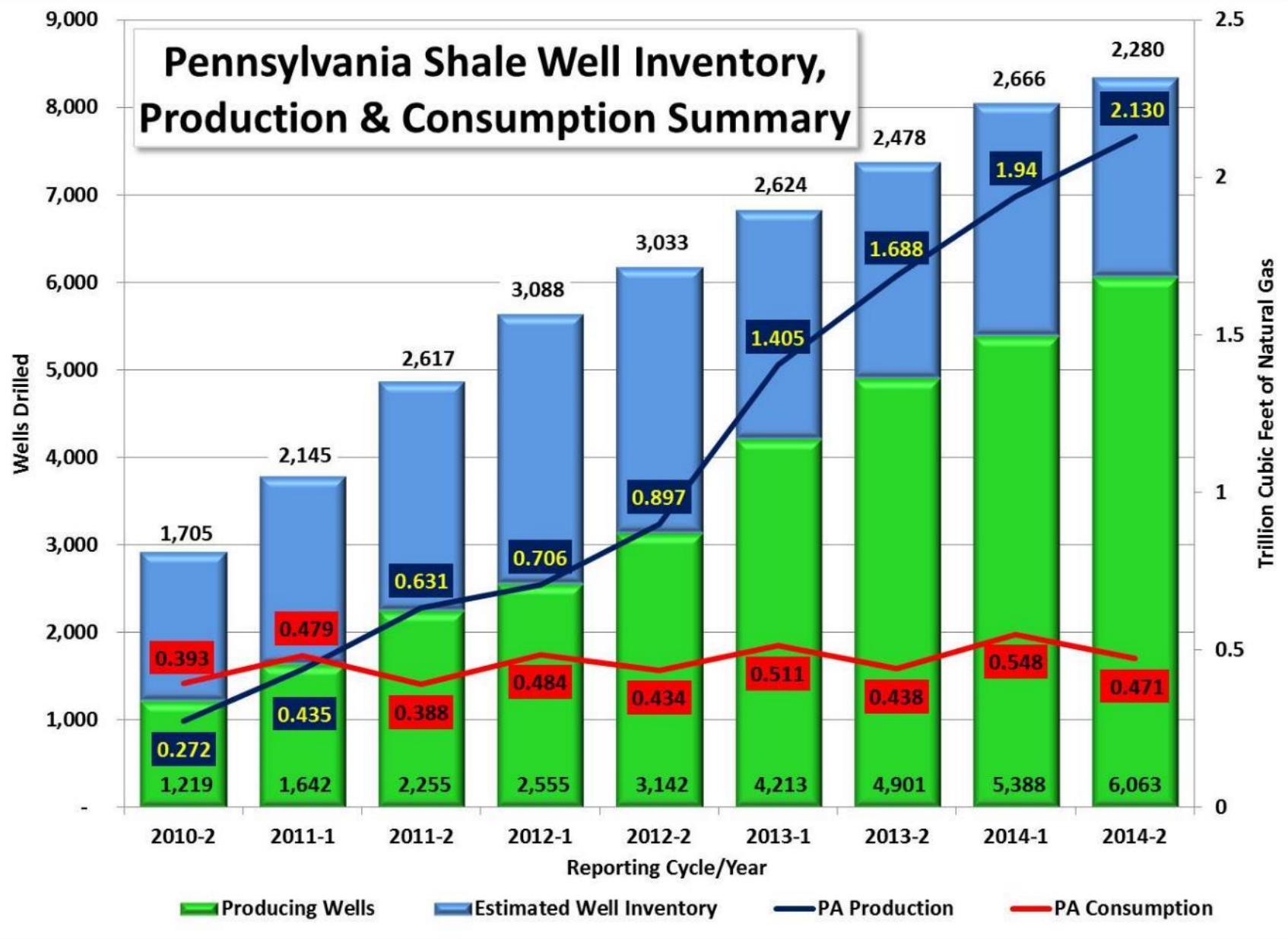
\$ 7,426,881.26: Wellhead value @ \$2.54 Mcf

\$ 928,360.16: Estimated royalties (12.5% wellhead value)

26,825: Number of homes this would heat for one year

Accumulative data used to generate values above:

© MarcellusGas.Org



[http:// www.marcellus.psu.edu](http://www.marcellus.psu.edu)



References

- ▶ Carl T. Montgomery and Michael B. Smoth, NSI Technologies, Hydraulic Fracturing, History of an Enduring Technology, JPT, December 2010
- ▶ Carter, Kristin M., and Soeder, Daniel J., 2015, Reservoir porosity and permeability, in Patchen, D.G. and Carter, K.M., eds., A geologic play book for Utica Shale Appalachian basin exploration, Final report of the Utica Shale Appalachian basin exploration consortium, p. 141–159, Available from: <http://www.wvgs.wvnet.edu/utica>.
- ▶ Daniel R. Cahoy, Joel Gehman, & Zhen Lei, Fracking Patents: The Emergence of Patents as Information–Containment Tools in Shale Drilling, 19 Mich. Telecomm. & Tech. L. Rev 279 (2013), available at <http://www.mttl.org/volnineteen/cahoy.pdf>
- ▶ Dave Monk, David Close, Marco Perez, and Bill Goodway, Shale Gas and Geological Developments, CSG Recorder, January 2011
- ▶ Development of the Natural Gas Resources in the Marcellus Shale, New York, Pennsylvania, Virginia, West Virginia, Ohio, Tennessee, and Maryland, National Park Service, U.S. Department of the Interior, November 2009.
- ▶ Drilling Productivity Report, U.S. Energy Information Administration, October 2015
- ▶ Eagle Ford, Oil and Natural Gas Fact Book, Marathon Oil
- ▶ <http://extension.psu.edu/natural-resources/natural-gas>
- ▶ <http://http://www.marcellus-shale.us/>
- ▶ <http://marcellusgas.org>
- ▶ <http://naturalgas.org>
- ▶ <http://www.energyindustryphotos.com>

References

- ▶ James Ladlee, Associate Direct, Penn State Marcellus Center, Pennsylvania Production, Consumption and Well Inventory, August 31, 2014
- ▶ John A. Harper & Jaime Kostelnik, The Marcellus Shale Play in PA
- ▶ Karen Boman and Rigzone Staff, Study: Utica Shale Larger Than Previous Estimates, Thursday, July 16, 2015– See more at:
http://www.rigzone.com/news/oil_gas/a/139667/Study_Utica_Shale_Larger_Than_Previous_Estimates#sthash.KtT8GBpj.dpuf
- ▶ NYDEC, New York's Oil & Natural Gas History – A Long Story, but not the Final Chapter,
http://www.dec.ny.gov/docs/materials_minerals_pdf/nyserda2.pdf
- ▶ Oil & Natural Gas Transportation & Storage Infrastructure: Status, Trends, & Economic Benefits
<http://www.api.org/~media/Files/Policy/SOAE-2014/API-Infrastructure-Investment-Study.pdf>
- ▶ Recommended Practices: Site Planning, Development and Restoration, Marcellus Shale Coalition, MSC RP 2012–1 April 26, 2012
- ▶ Review of Emerging Resources: U.S. Shale Gas and Shale Oil Plays, U.S. Energy Information Administration, July 2011
- ▶ Richard Fullenbaum, James Fallon, & Bob Flanagan, Oil & Natural Gas Transportation & Storage Infrastructure: Status, Trends, & Economic Benefits, American Petroleum Institute, submitted by HIS Global Inc., December 2013
- ▶ The Life of a Natural Gas Well, Part 1 of 2, Cabot Oil & Gas
- ▶ Trisha A. Smrecak and the PRI Marcellus Shale Team, Understanding Drilling Technology, Marcellus Shale, Issue #6, January 2012
- ▶ Understanding Well construction and Surface Equipment., Canadian Society for Unconventional Resources,
http://www.csur.com/sites/default/files/Understanding_Well_Construction_final.pdf