

Hydro-fracking

Heaven-sent
or
Too Good To Be True?

The Earth at Night: a bird's eye view on energy use

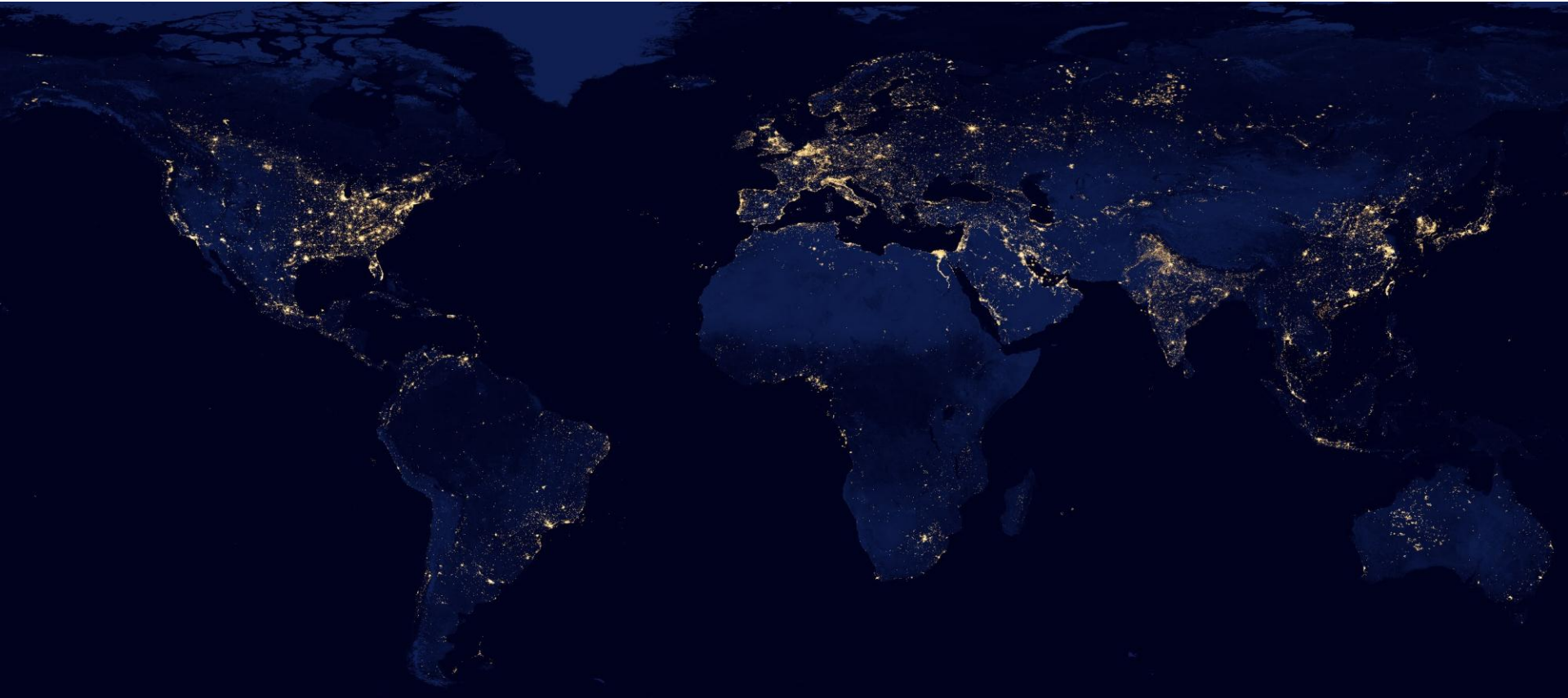
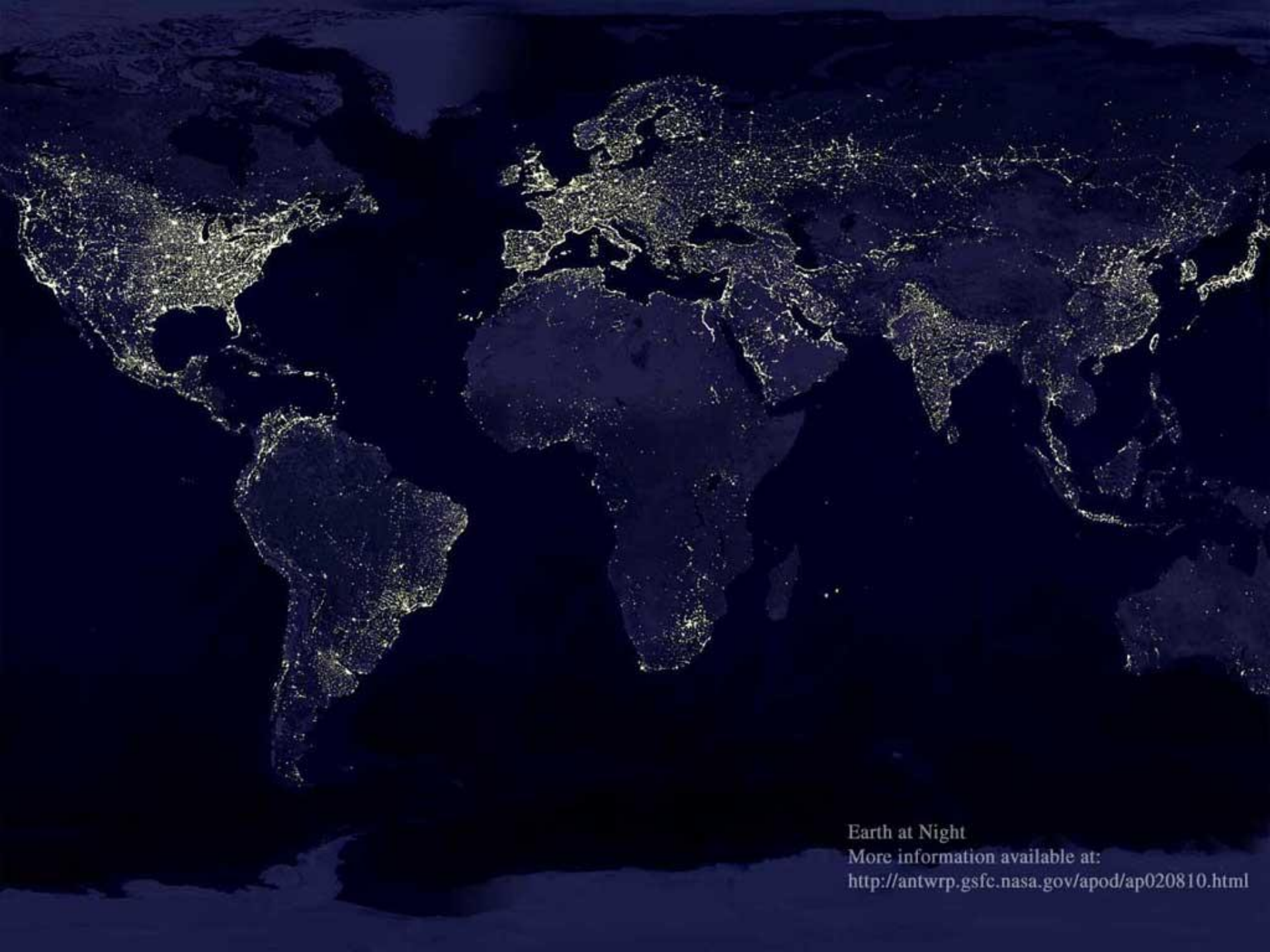


image from NASA: http://www.nasa.gov/mission_pages/NPP/news/earth-at-night.html







Earth at Night

More information available at:

<http://antwrp.gsfc.nasa.gov/apod/ap020810.html>

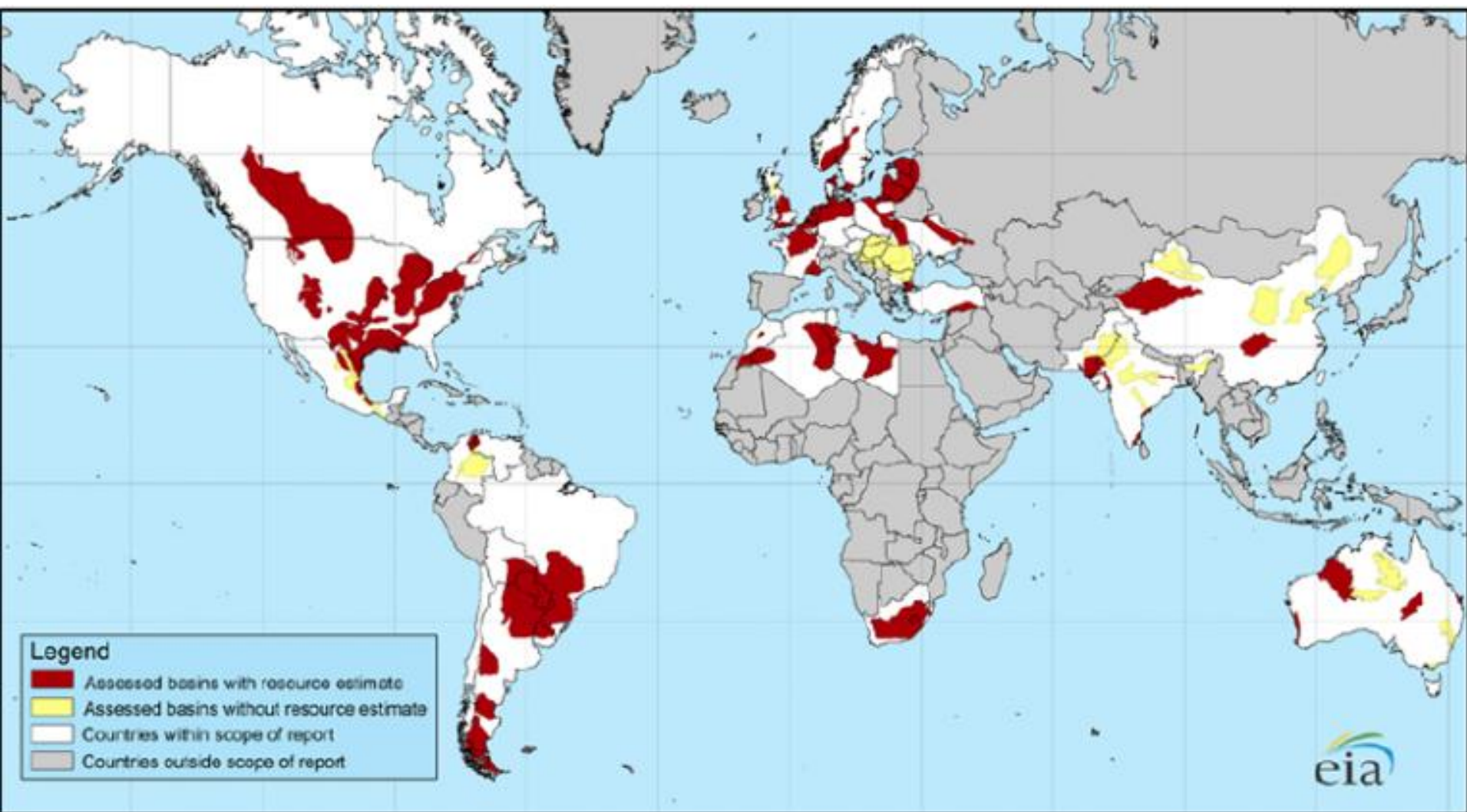
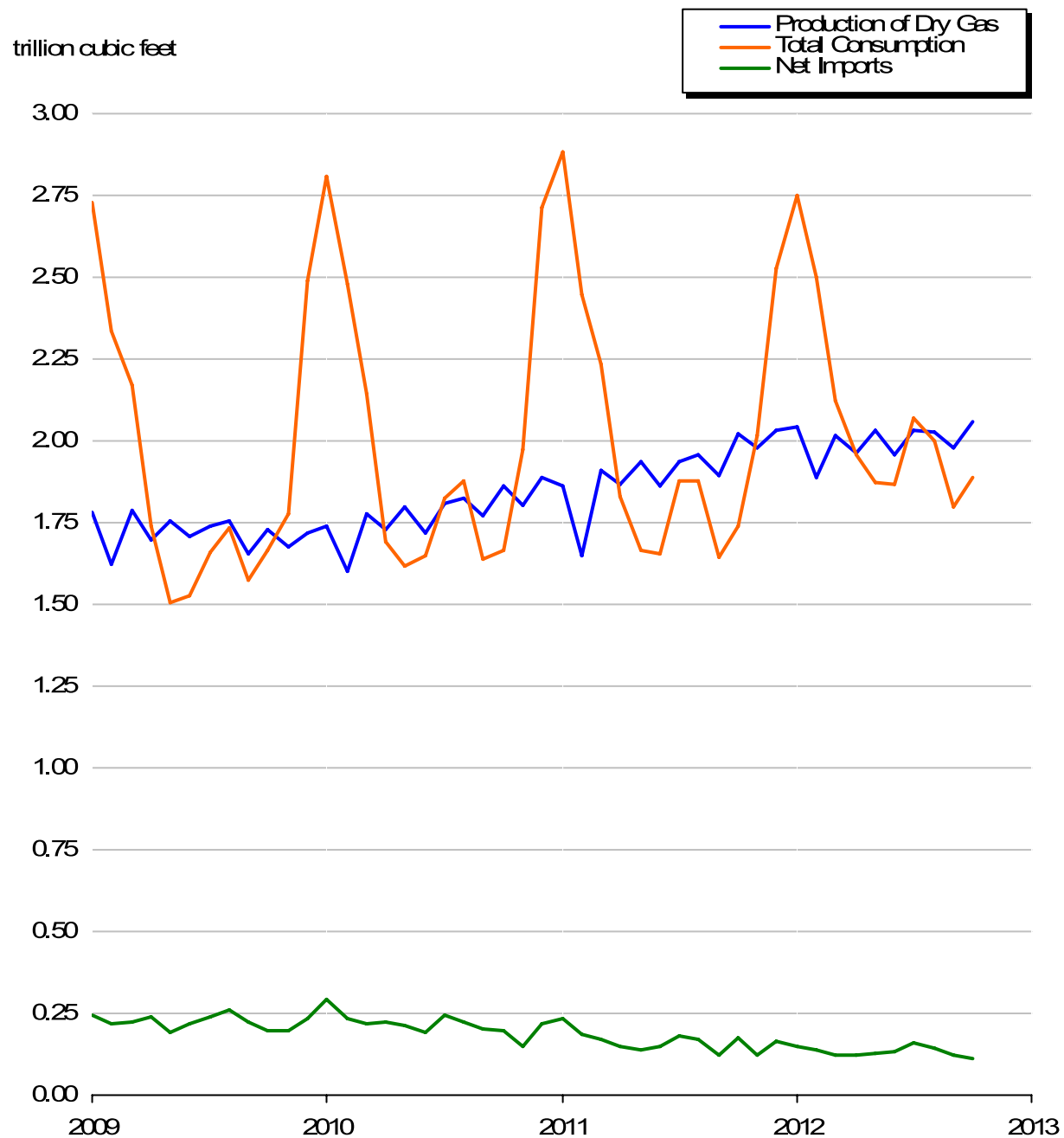
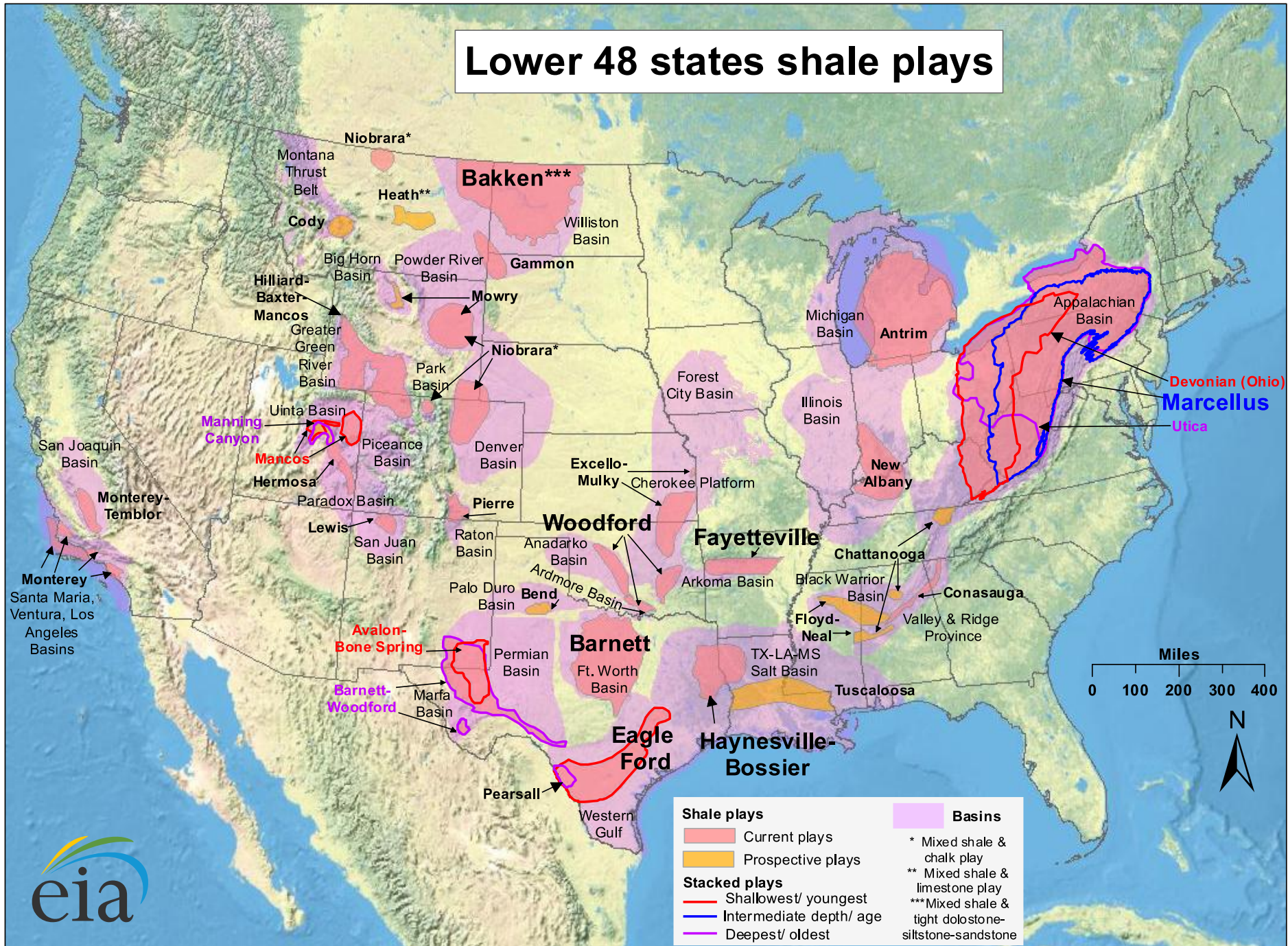
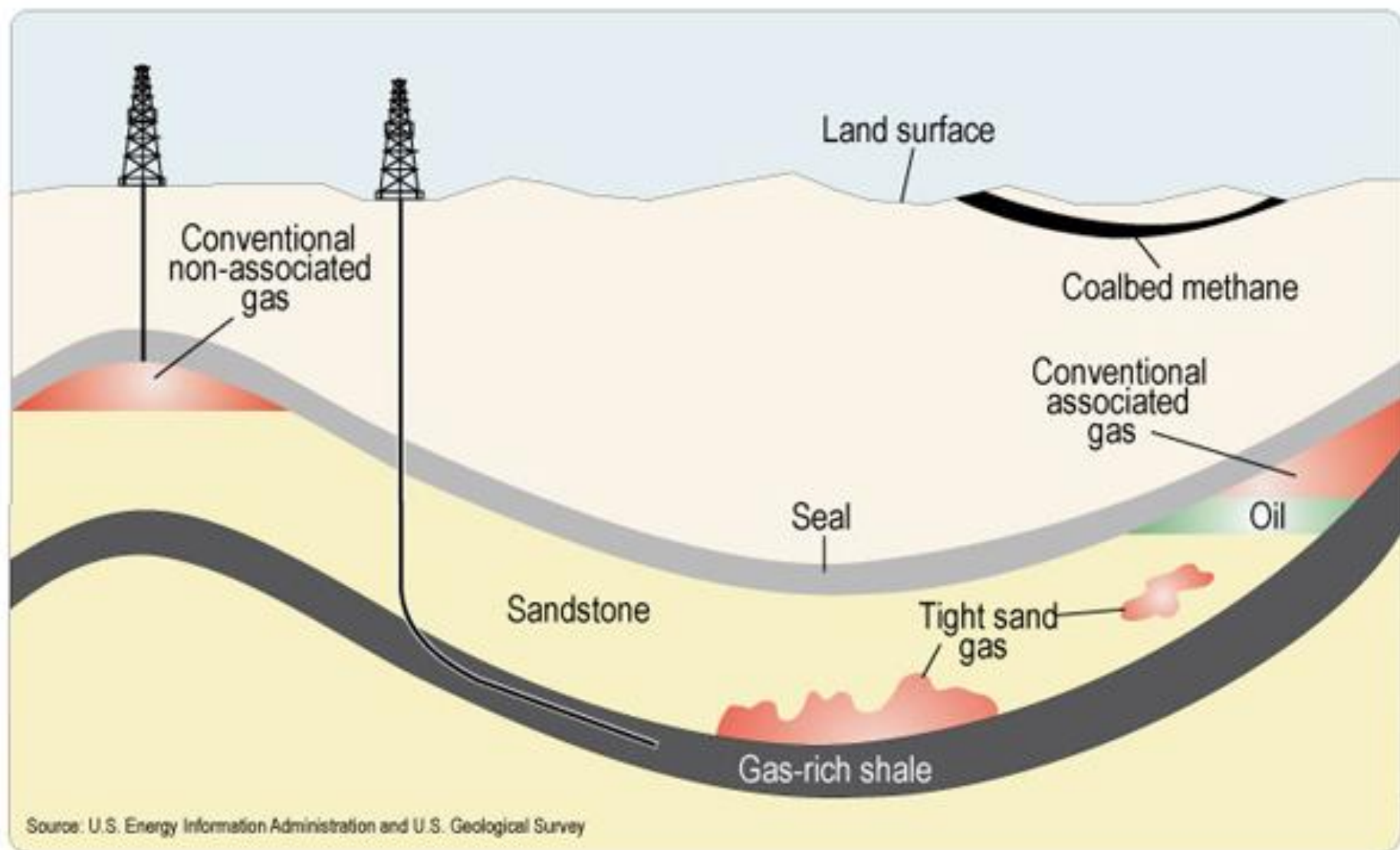


Figure 1. Production, consumption, and net imports of natural gas in the United States, 2009-2012

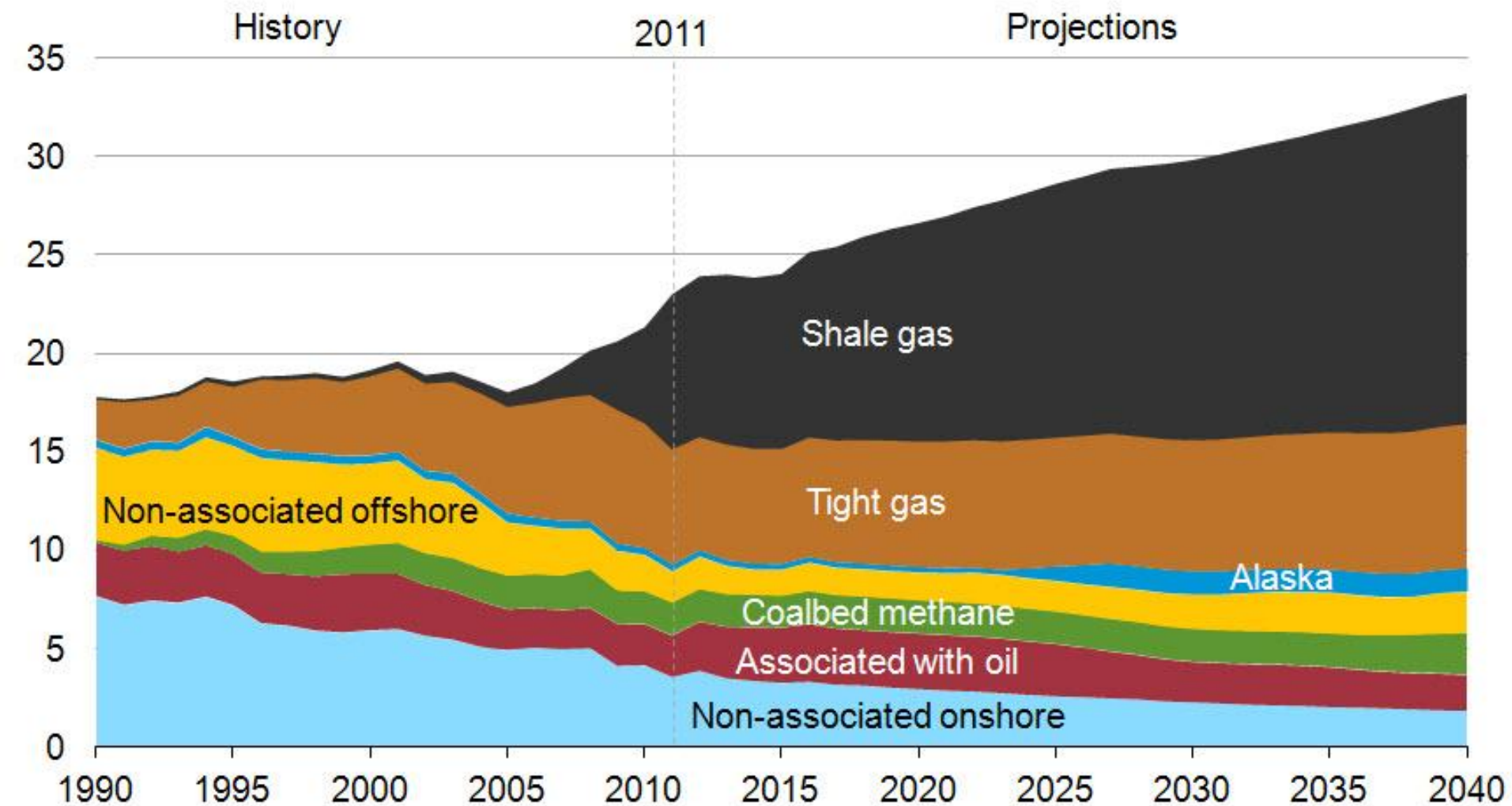


Lower 48 states shale plays



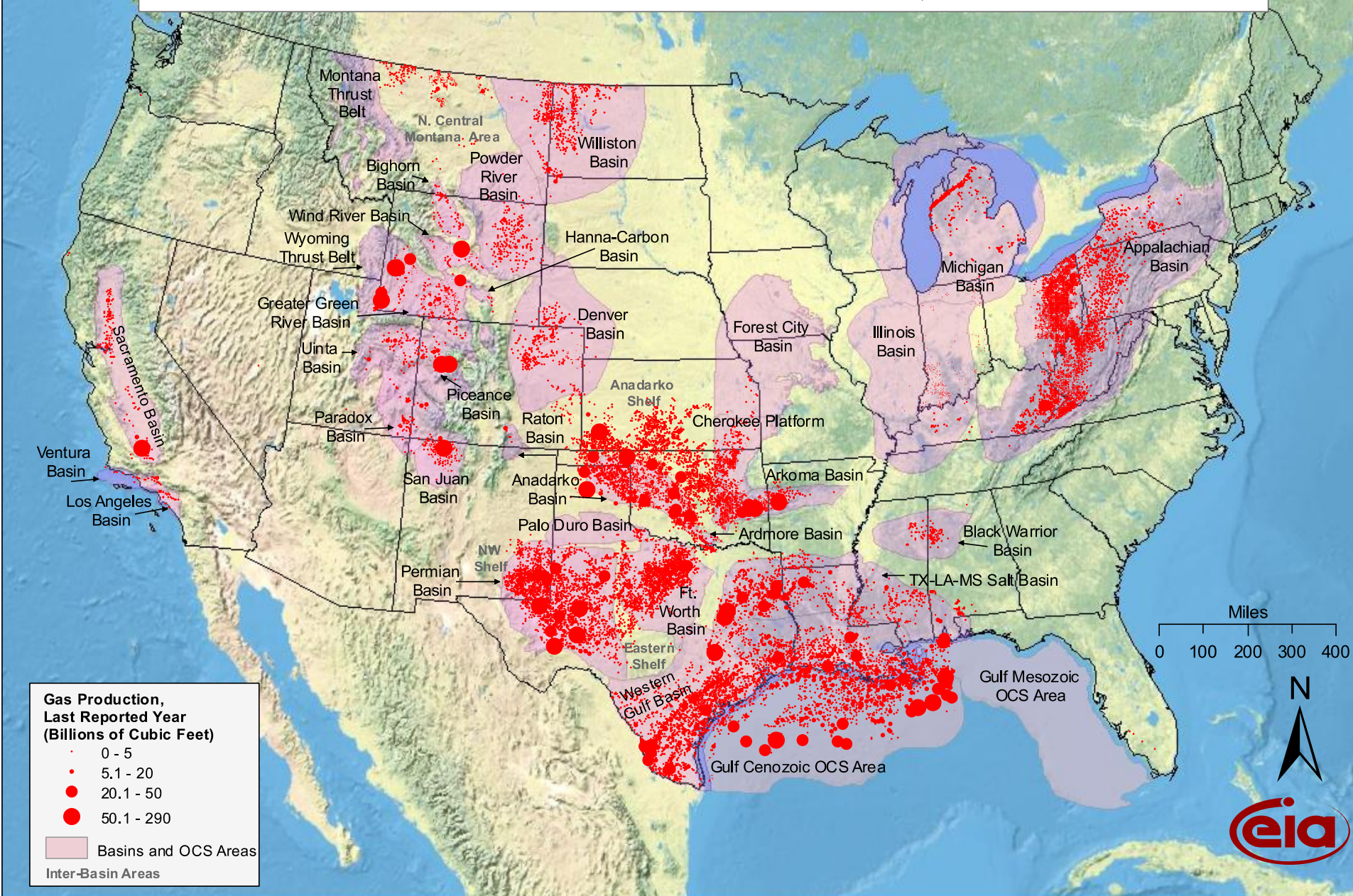


U.S. dry natural gas production trillion cubic feet

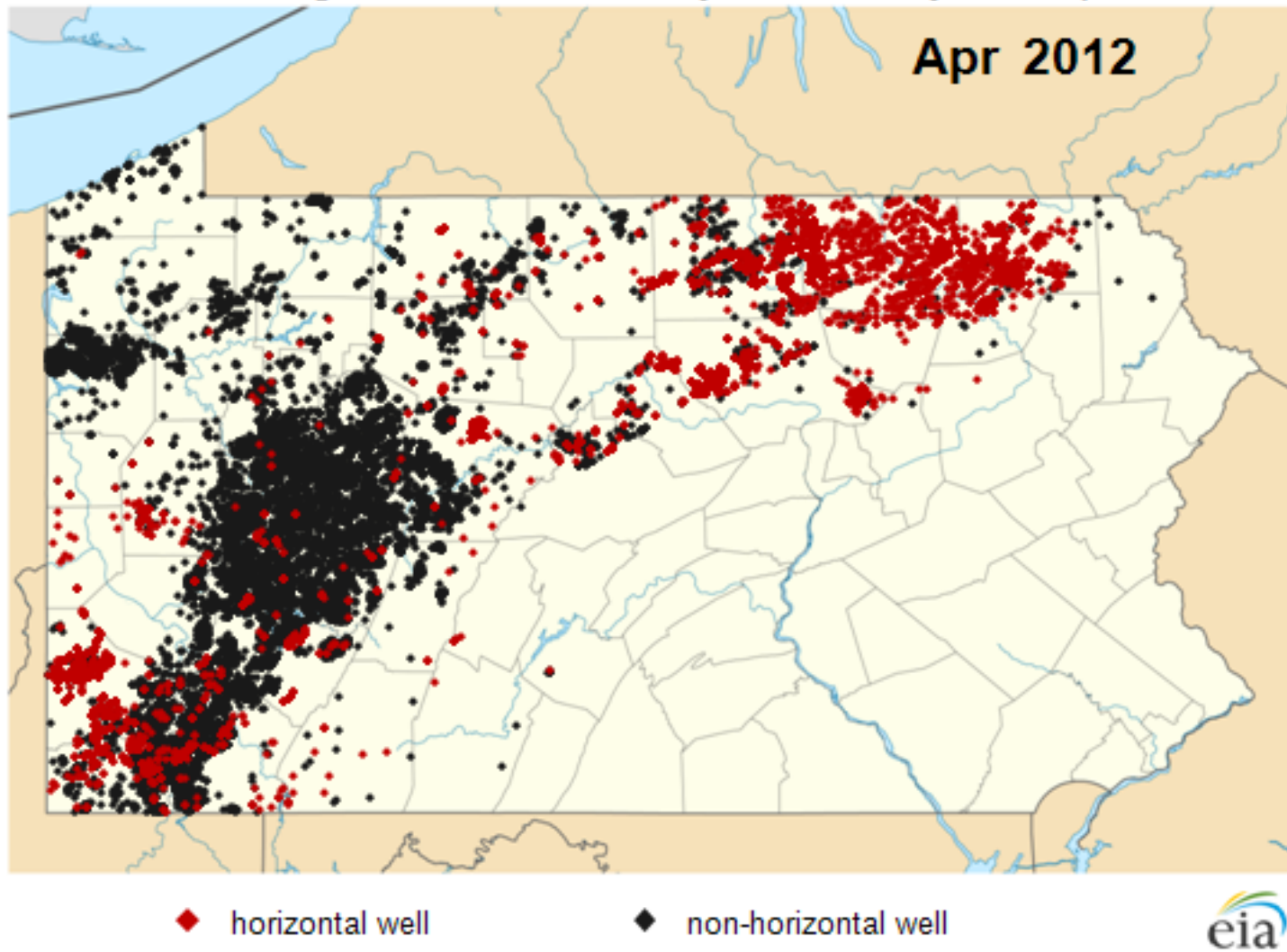


Source: U.S. Energy Information Administration, *Annual Energy Outlook 2013 Early Release*

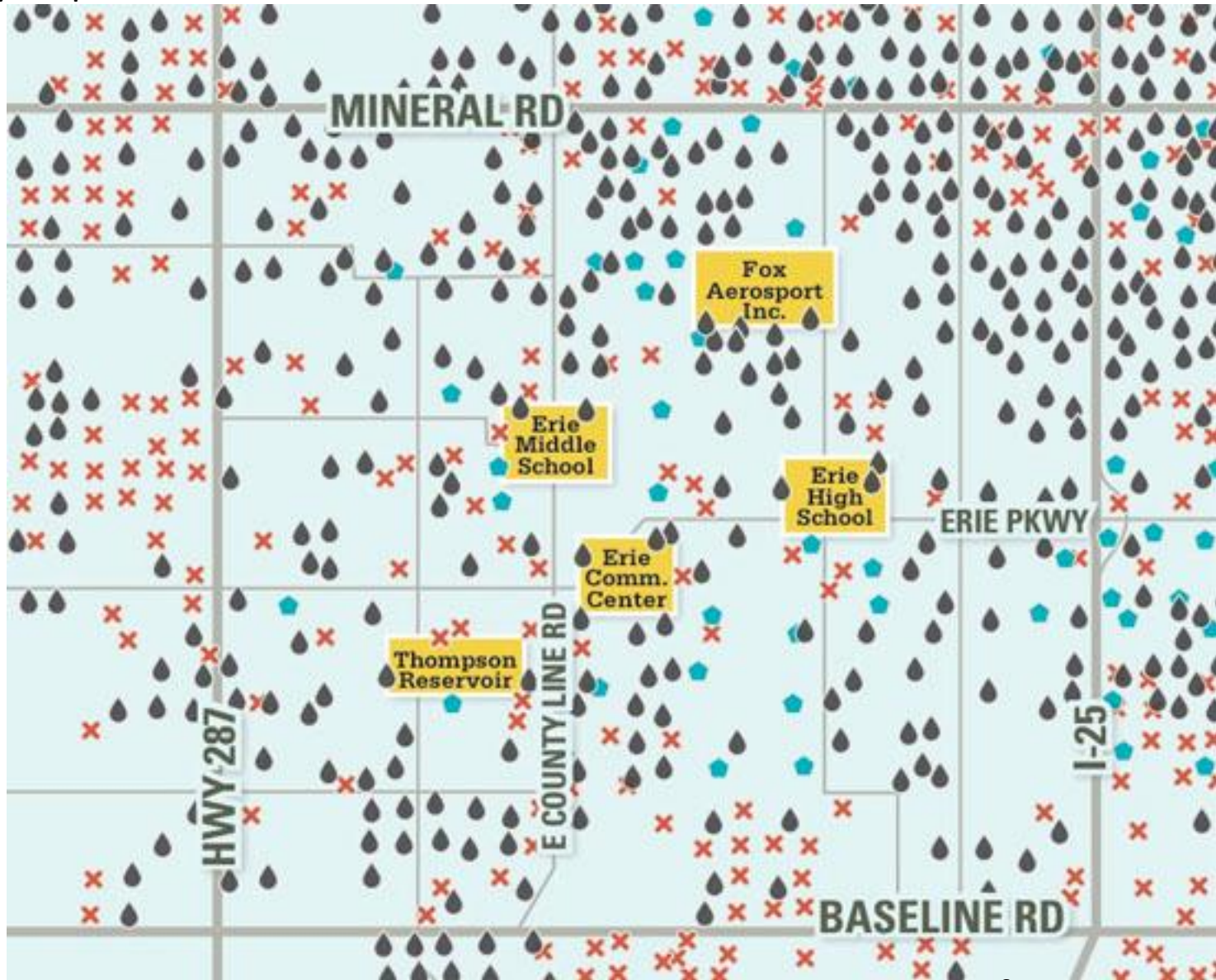
Gas Production in Conventional Fields, Lower 48 States



Cumulative natural gas wells drilled in Pennsylvania, January 2005 - April 2012



City map in Colorado



from eser.org

7/7/2011

2885 ft

WTFrack.org 2012
Colorado

© 2012 Google

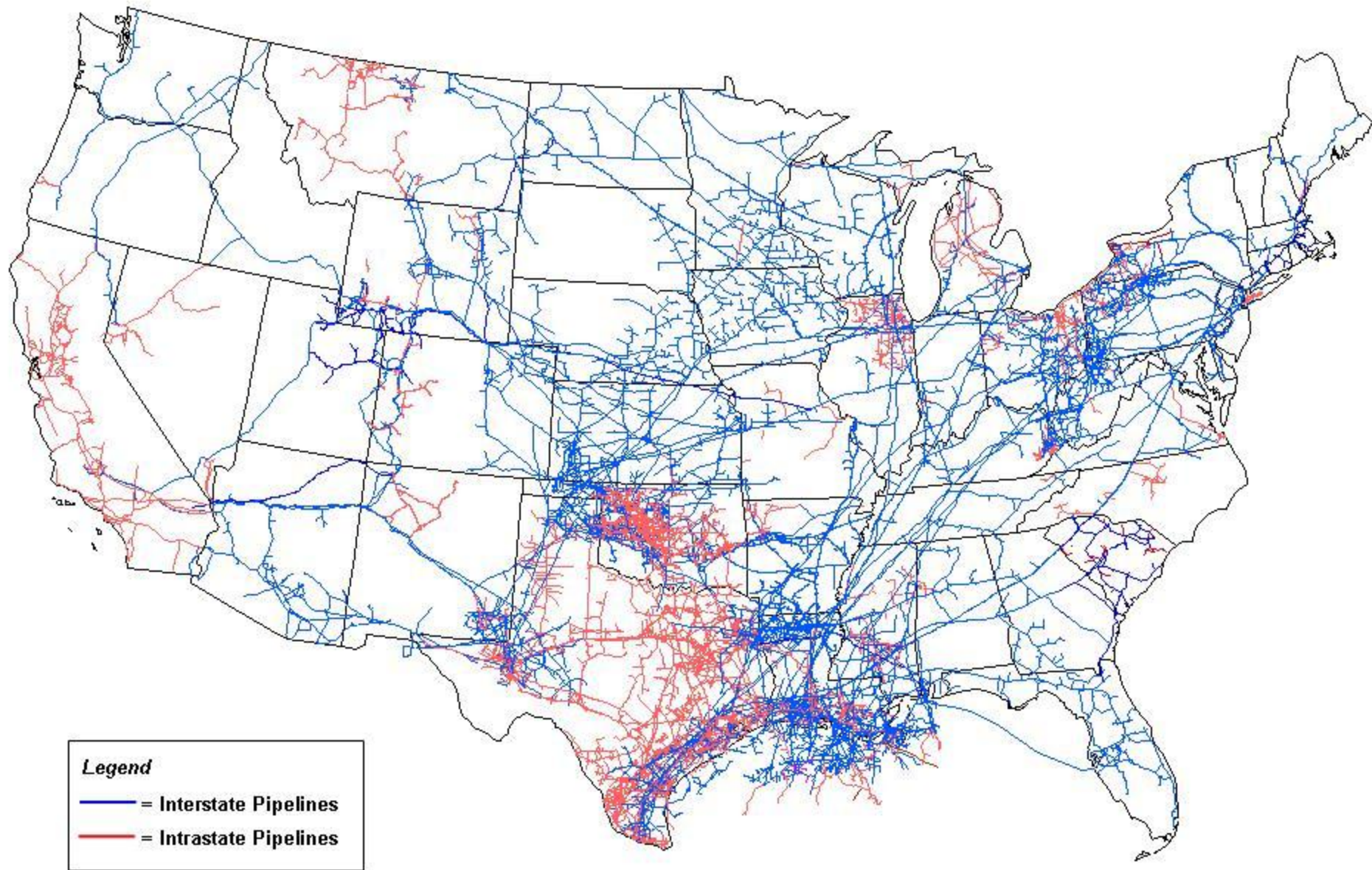
Image © 2012 DigitalGlobe

Imagery Date: 7/7/2011



1999

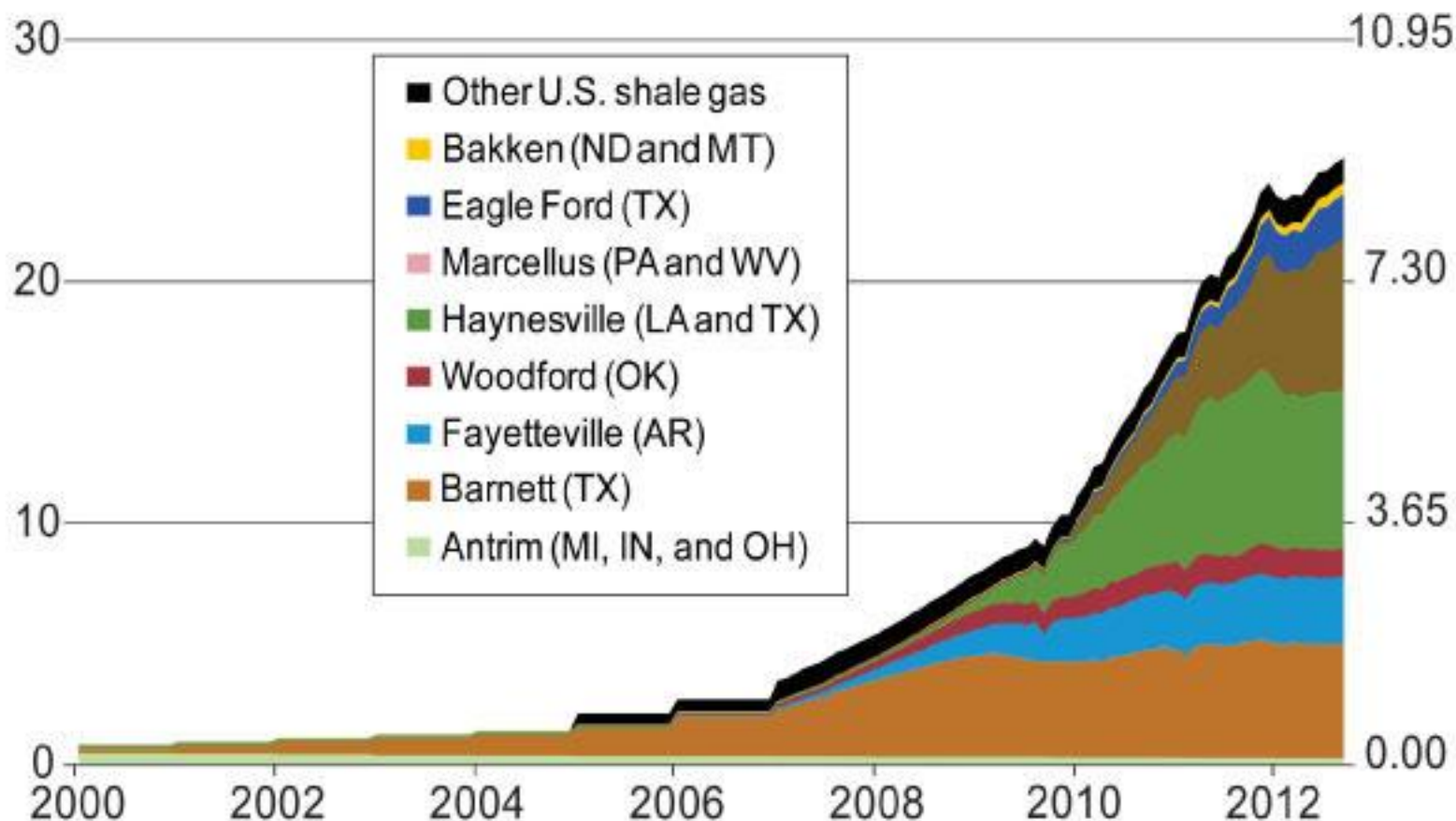
40°14'25.63" N 104°33'22.73" W elev 4731 ft



Source: Energy Information Administration, Office of Oil & Gas, Natural Gas Division, Gas Transportation Information System

Shale gas production (dry)
billion cubic feet per day

Shale gas production (dry)
trillion cubic feet



Sources: LCI Energy Insight gross withdrawal estimates as of September 2012 that are converted to dry production estimates with EIA-calculated average gross-to-dry shrinkage factors by state and/or shale play.

Roughly 200 tanker trucks deliver water for the fracturing process.

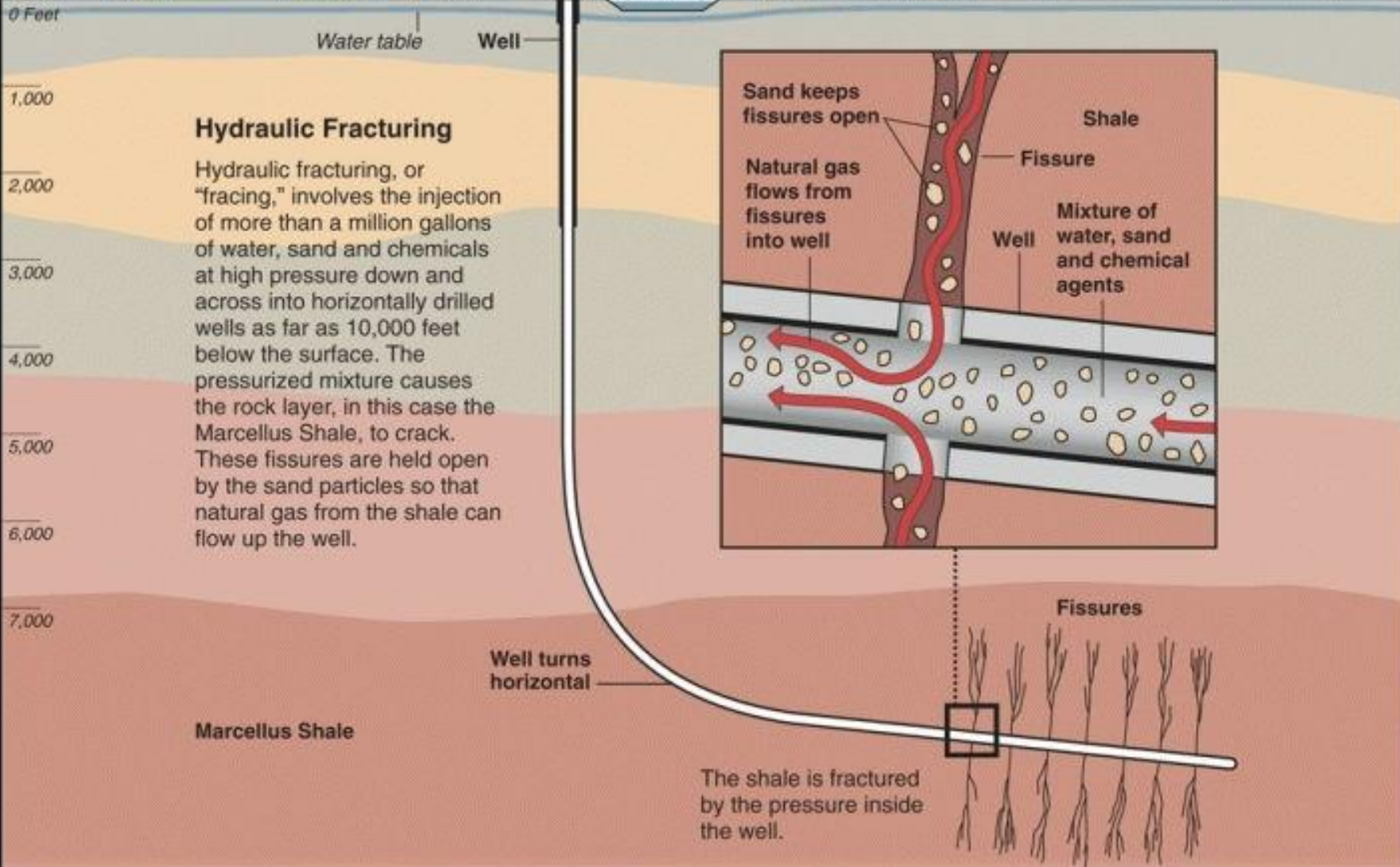
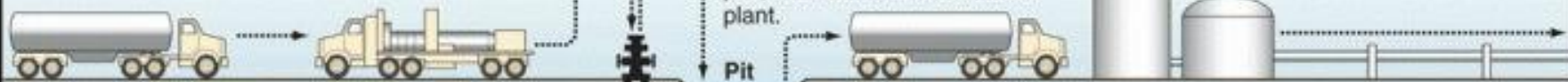
A pumper truck injects a mix of sand, water and chemicals into the well.

Natural gas flows out of well.

Recovered water is stored in open pits, then taken to a treatment plant.

Storage tanks

Natural gas is piped to market.



Hydraulic fracturing fluids: Water, sand and additives are pumped at extremely high pressure – over 100 bar, about $1,050\text{kg/m}^2$ – down wellbore

Continual pumping: Increases pressure of frac fluids in well, breaking rocks apart. Fracking continues until rocks are cracked to desired length, about 200-300m

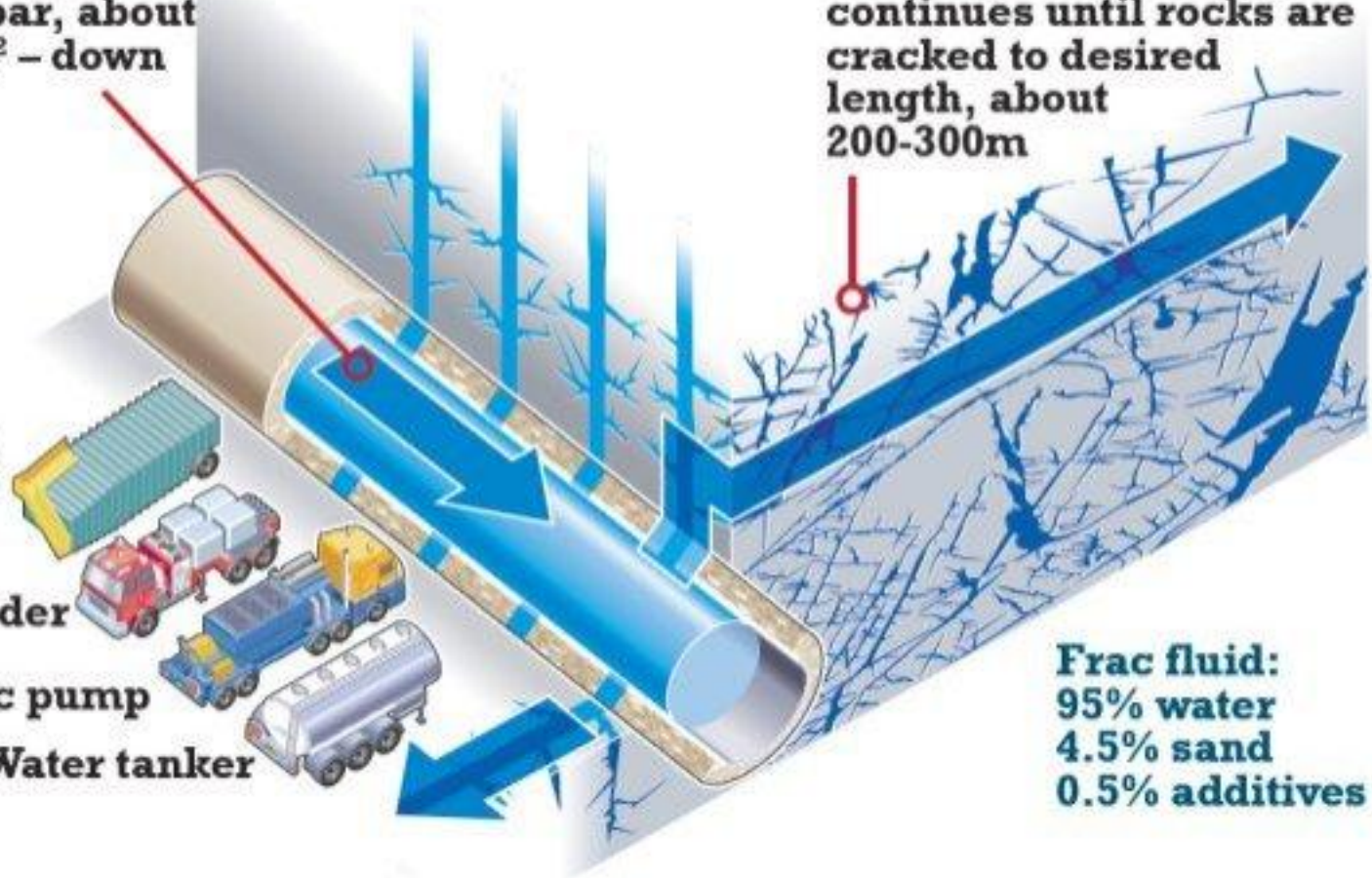
Sand truck

Blender

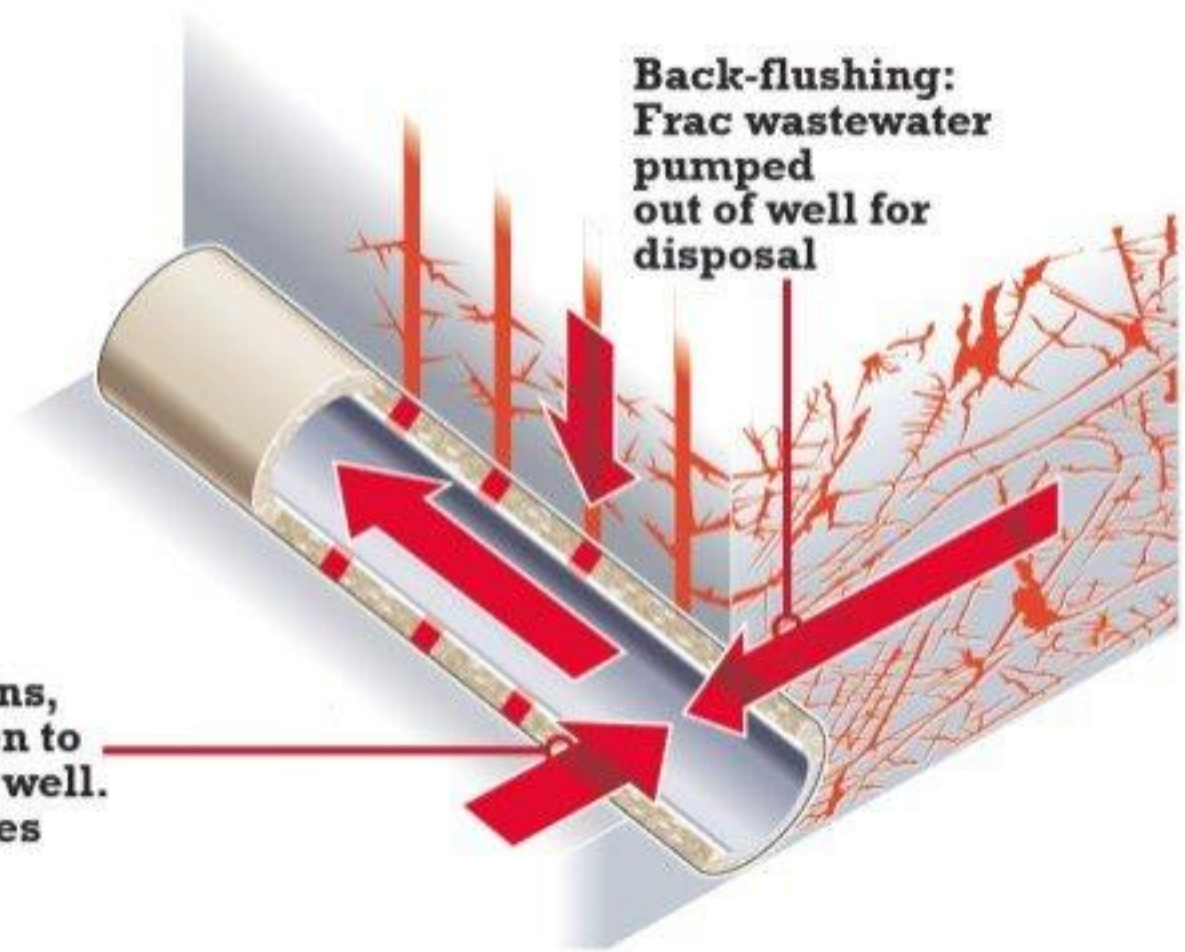
Frac pump

Water tanker

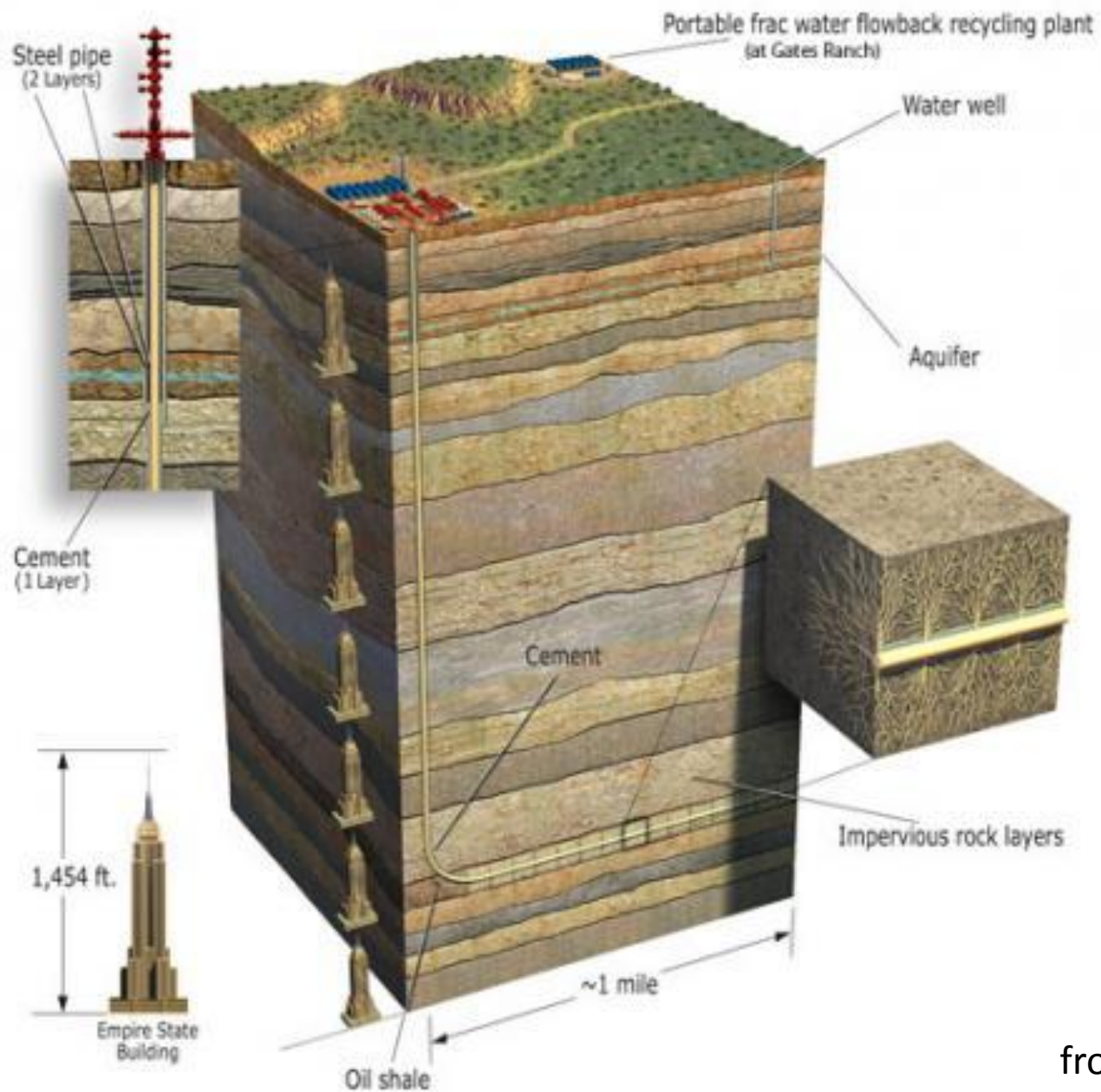
Frac fluid:
95% water
4.5% sand
0.5% additives



Gas flow: Sand remains, holding fractures open to allow gas to flow into well. Fracking process takes up to 10 days



**Back-flushing:
Frac wastewater
pumped
out of well for
disposal**



from FracFocus.org



[National Geographic](#)

Understanding

Typical Additives Used in Fracturing Fluid and COMMON HOUSEHOLD ITEMS

The fluid from the hydraulic fracturing process is nearly
**99.5%
WATER
& SAND.**

**9.5%
SAND**

**0.5%
CHEMICAL
ADDITIVES**

**90%
WATER**



SODIUM CHLORIDE
used in table salt



ETHYLENE GLYCOL
used in household cleaners



BORATE SALTS
used in cosmetics



**SODIUM/POTASSIUM
CARBONATE**
used in detergent



GUAR GUM
used in ice cream



ISOPROPANOL
used in deodorant

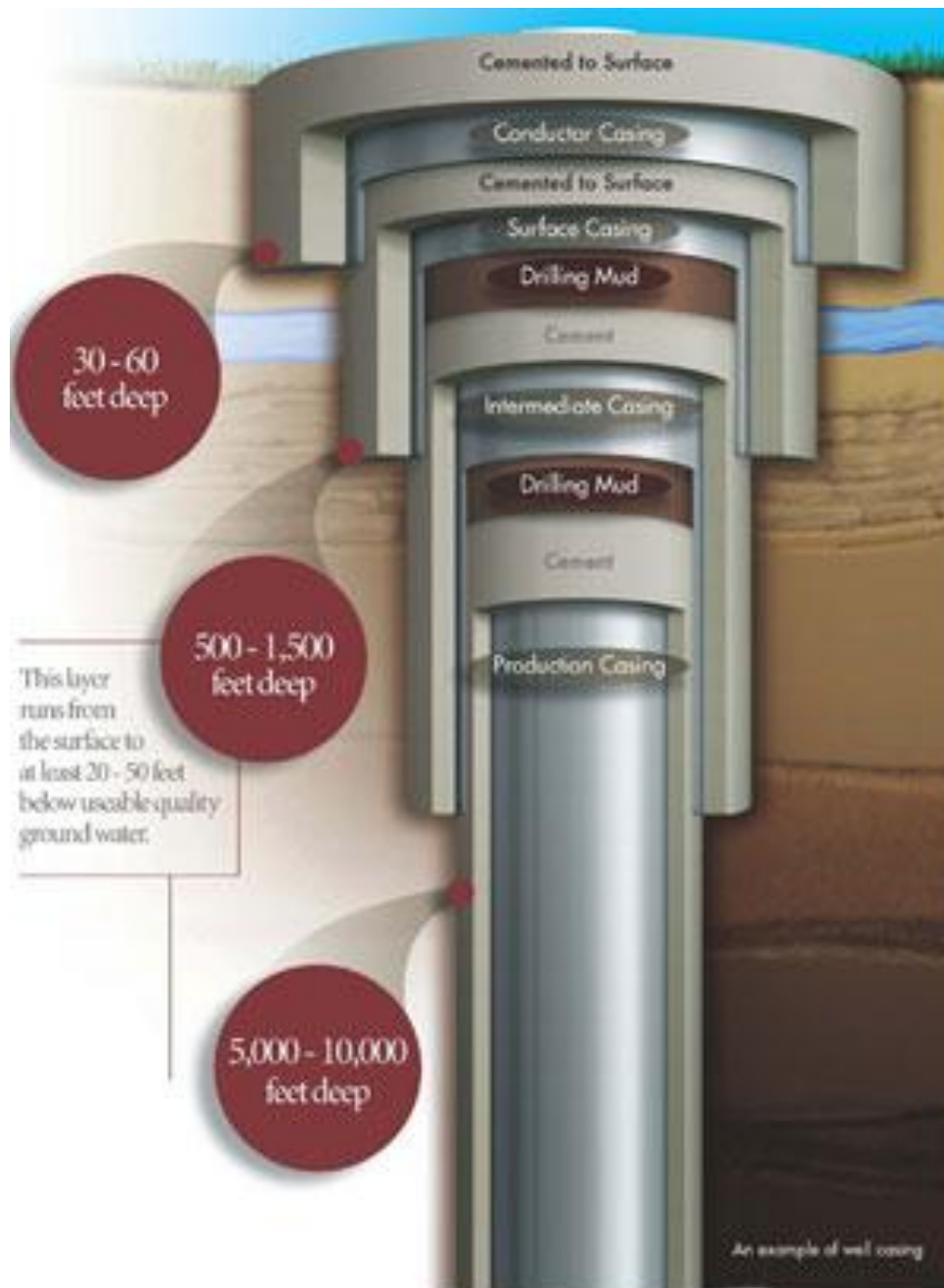
To create productive natural gas wells, companies force fluid thousands of feet below the surface at high pressure to crack shale rock and release trapped natural gas. This extraction technique is called hydraulic fracturing. The fluid used in the process is made up almost entirely of water and sand. However, it also includes a very small percentage of chemical additives that help make the process work.

from EnergyAnswered.org

[List](#) of chemicals commonly
used from FracFocus.org

Images are everything....





Graphic Courtesy of Texas Oil and Gas Association

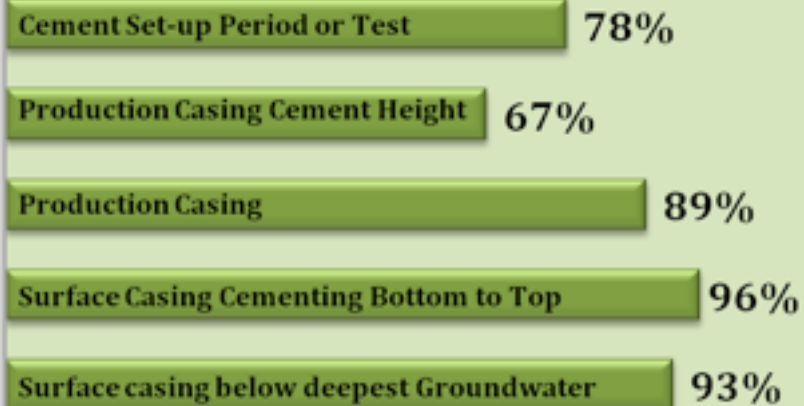
Casing schematic

Note: casing regulations are state-controlled

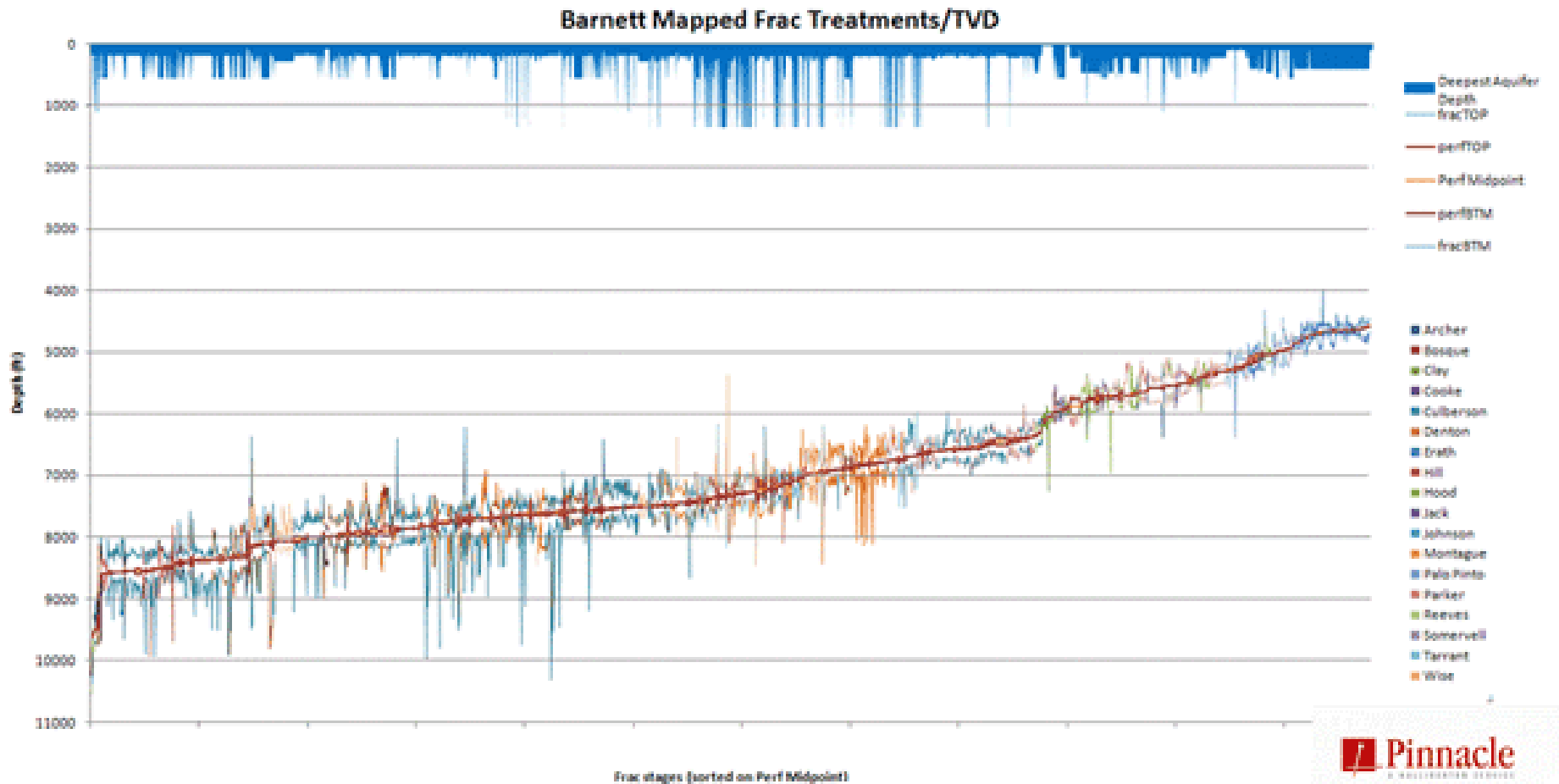
no federal regulation

(pros and cons?)

% of states w/ casing regulation:

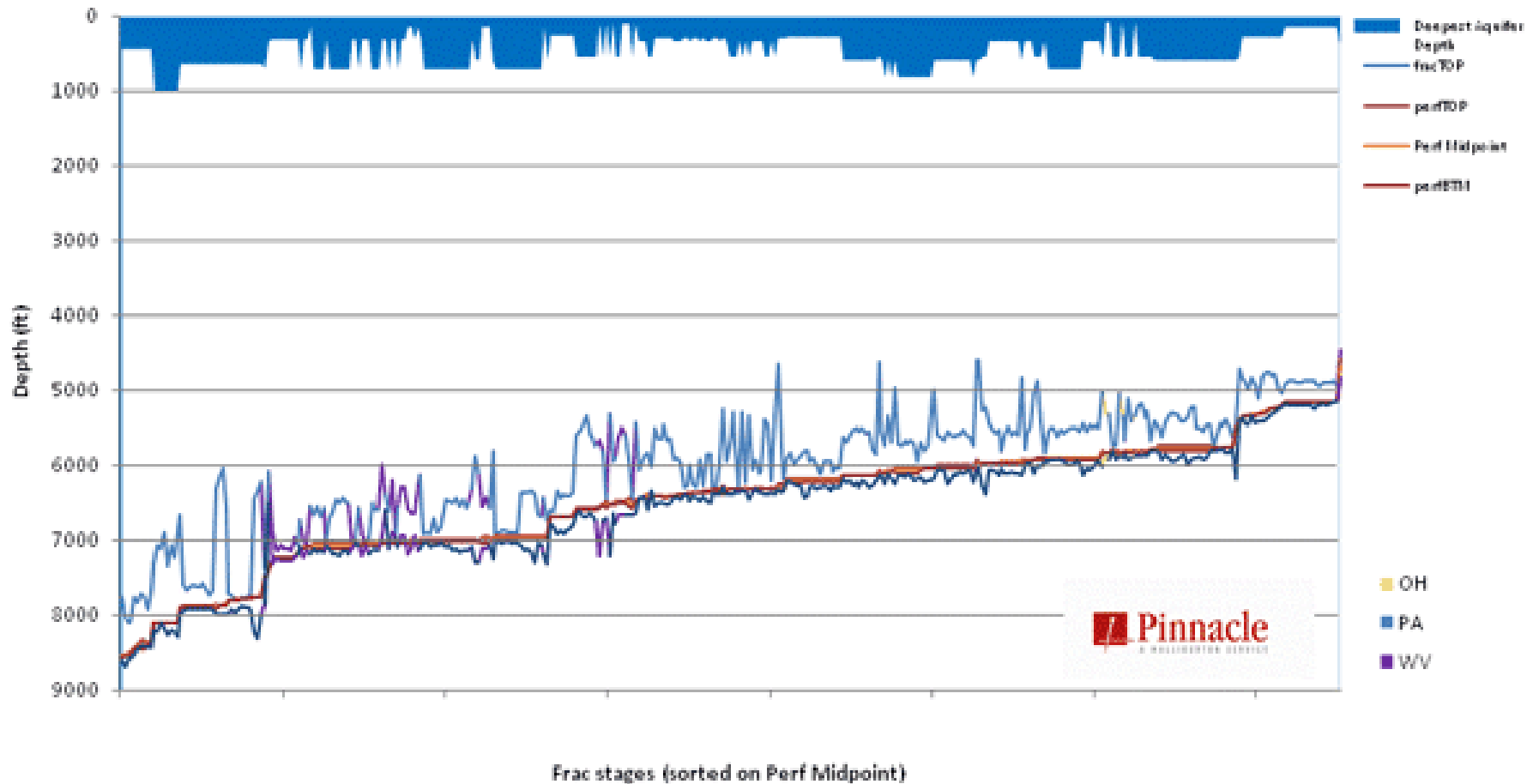


Depth of fracking vs depth of deepest aquifers: Texas



Depth of fracking vs depth of deepest aquifers: OH, PA, and WV

Marcellus Mapped Frac Treatments/TVD



Video links for discussion:

<http://nyti.ms/NWkLsH>

<http://watch.bnn.ca/commodities/january-2013/commodities-january-18-2013/#clip846701>

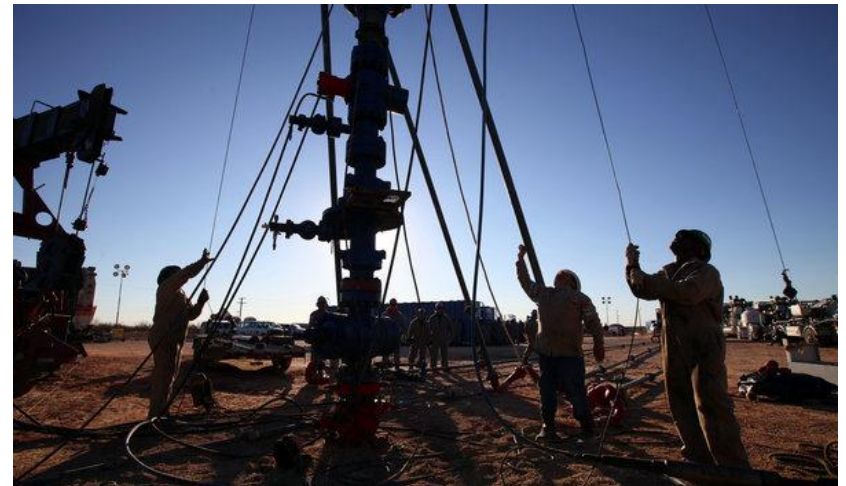
Fracking FAQ: The science and technology behind the natural gas boom

By Josie Garthwaite



THE ENERGY RUSH

U.S. Inches Toward Goal of Energy Independence



Jim Wilson/The New York Times

An Apache Corporation well near Hobbs, N.M. Apache is drilling in the Permian Basin, an oil field once thought played out.
[More Photos »](#)

By CLIFFORD KRAUSS and ERIC LIPTON

Published: March 22, 2012 | 499 Comments

Issues for discussion:

- 1) potential for groundwater contamination? well integrity? regulation?
- 2) really better for climate? rate of methane escape?
- 3) economic imperative?
- 4) energy independence?
- 5) land use/remediation?
- 6) impacts on renewables?