

# Does “fracking” change the energy world?

Prospects & Impacts of Unconventional  
Gas in the U.S. & Globally

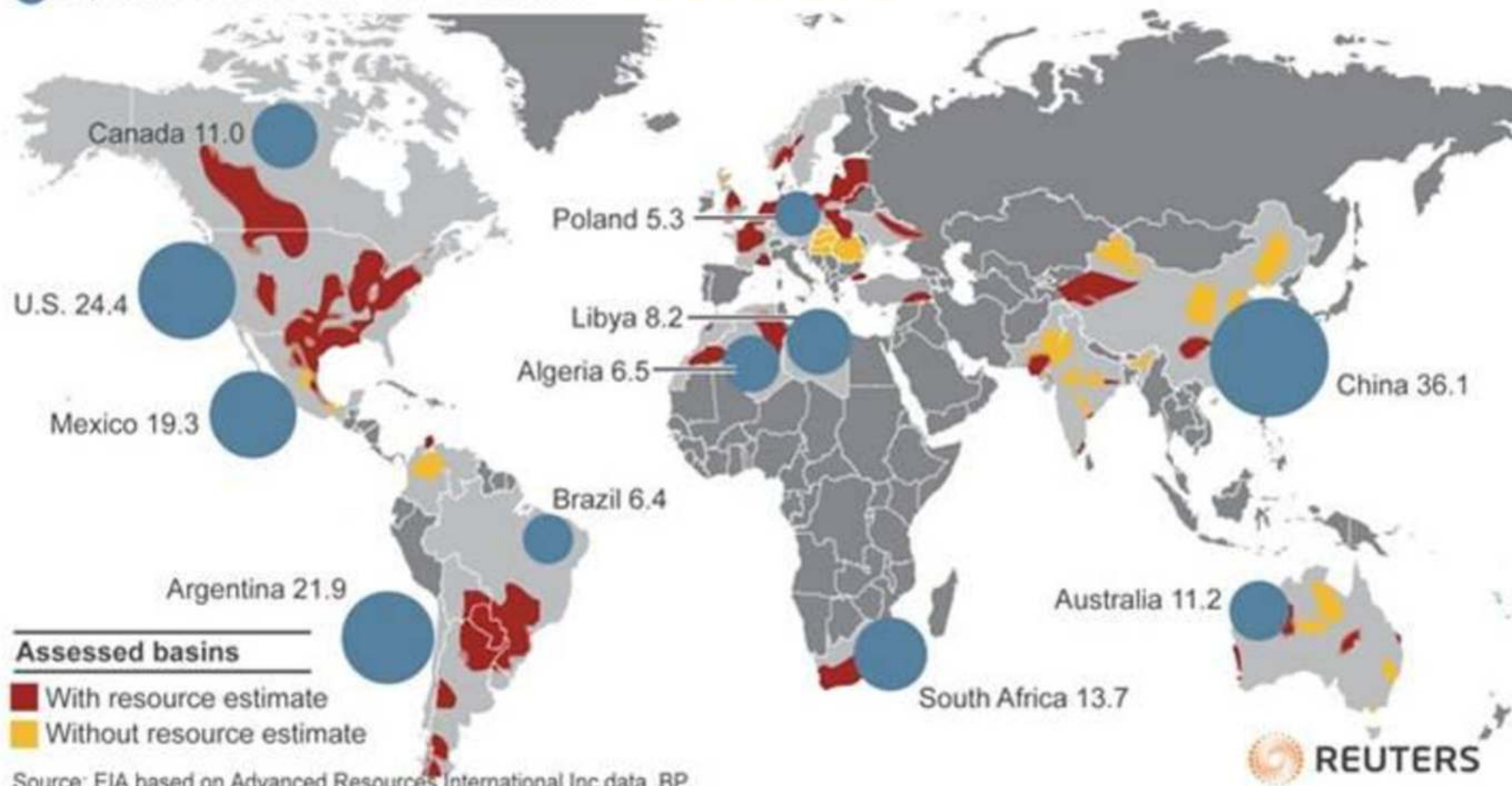
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August 20, 2013

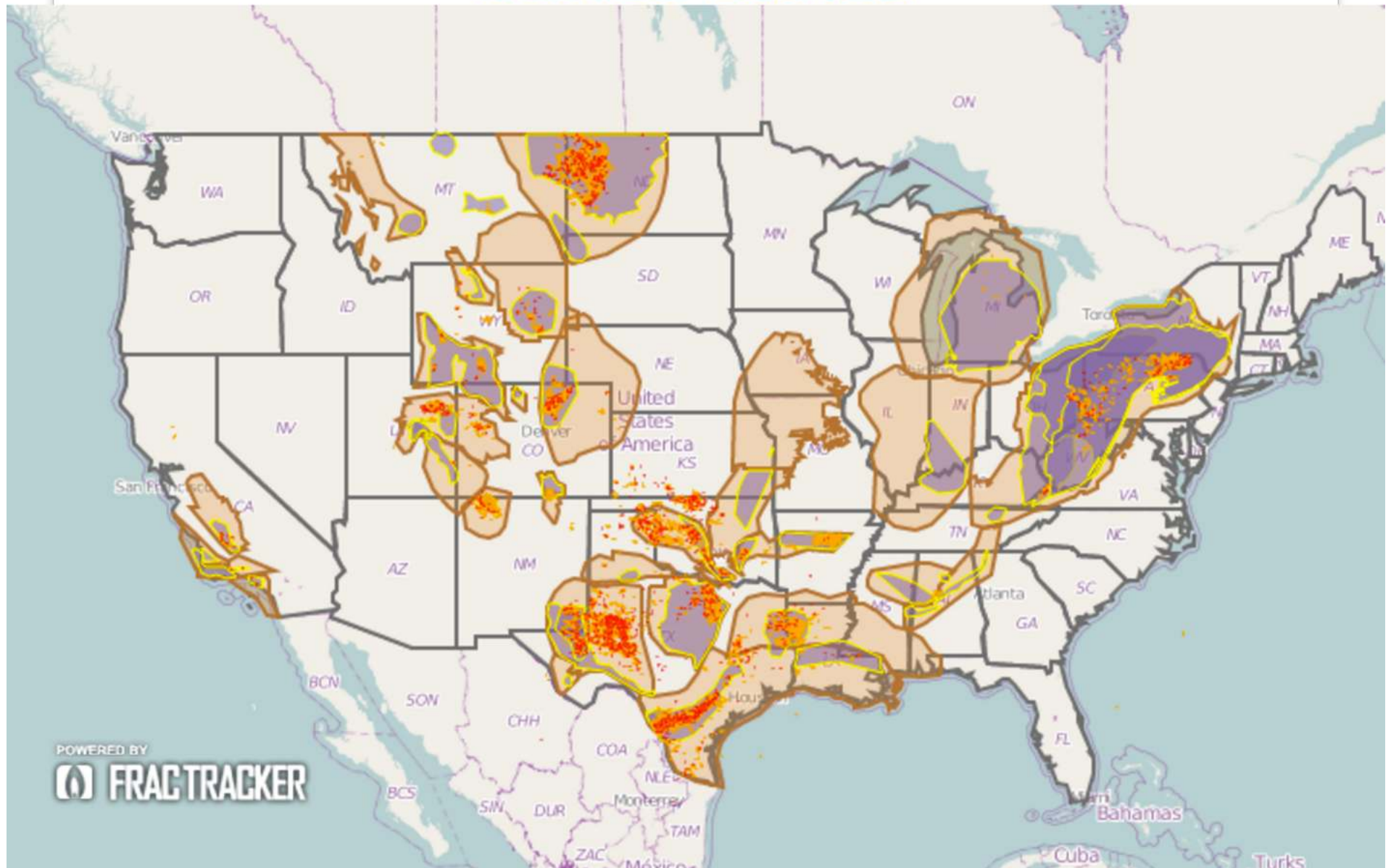
# Global Shale Gas Basins, Top Reserve Holders

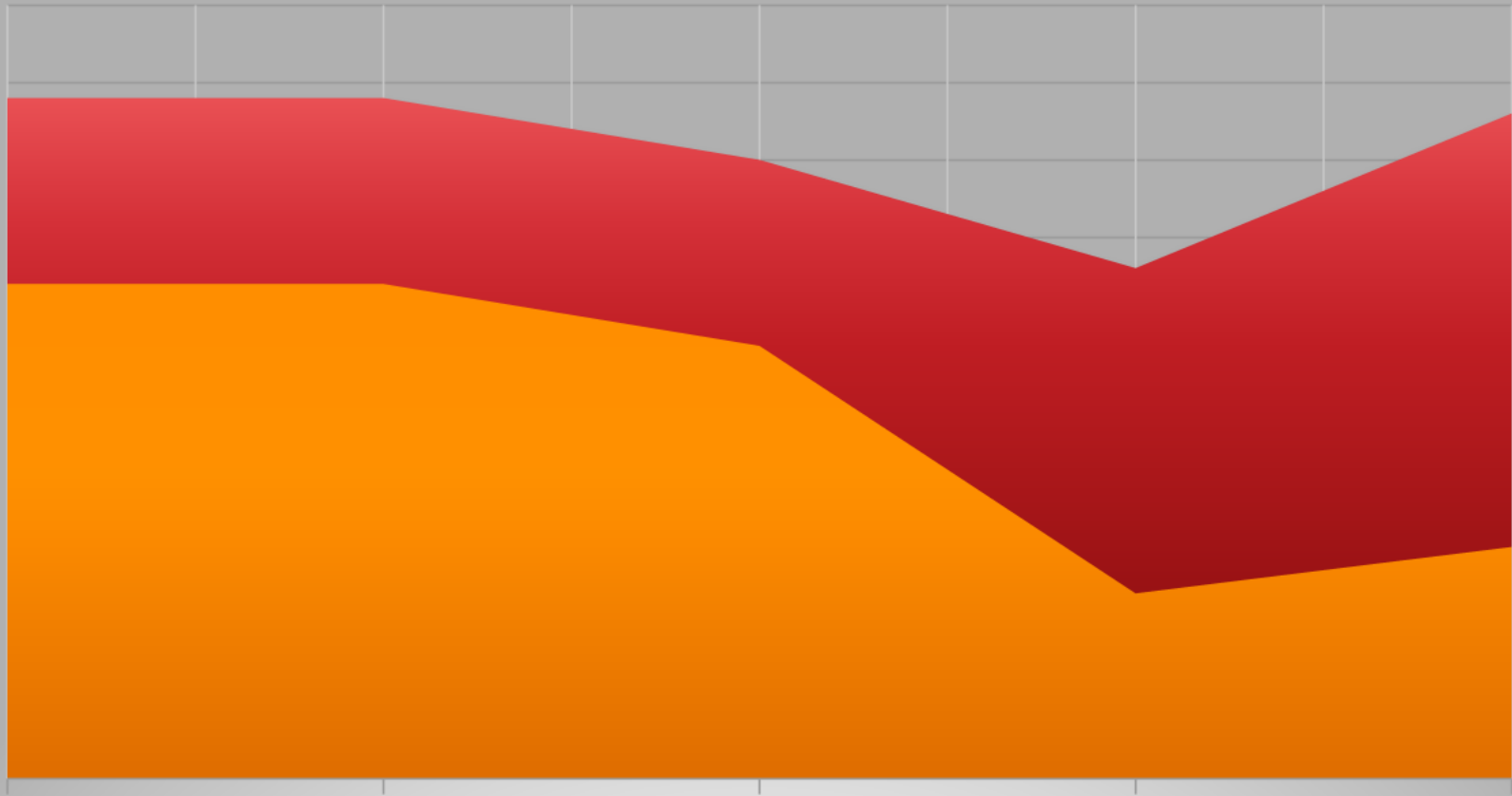
● Top reserve holders 200 - Trln cubic metres



Reuters graphic/Catherine Trevethan

# Shale Gas Plays in the Continental United States





# Energy Trends

How U.S. gas extraction affects the global energy market



**Table 1. Technically recoverable shale oil and shale gas unproved resources in the context of total world resources**

	Crude oil (billion barrels)	Wet natural gas (trillion cubic feet)
<b>Outside the United States</b>		
Shale oil and shale gas unproved resources	287	6,634
Other proved reserves 1	1,617	6,521
Other unproved resources 2	1,230	7,296
<b>Total</b>	<b>3,134</b>	<b>20,451</b>
<b>Increase in total resources due to inclusion of shale oil and shale gas</b>	<b>10%</b>	<b>48%</b>
<b>Shale as a percent of total</b>	<b>9%</b>	<b>32%</b>
<b>United States</b>		
EIA shale / tight oil and shale gas proved reserves 3, 4	n/a	97
EIA shale / tight oil and shale gas unproved resources <sup>5</sup>	58	567
EIA other proved reserves <sup>6</sup>	25	220
EIA other unproved resources <sup>5</sup>	139	1,546
<b>Total</b>	<b>223</b>	<b>2,431</b>
<b>Increase in total resources due to inclusion of shale oil and shale gas</b>	<b>35%</b>	<b>38%</b>
<b>Shale as a percent of total</b>	<b>26%</b>	<b>27%</b>
<b>Total World</b>		
Shale / tight oil and shale gas proved reserves	n/a	97
Shale / tight oil and shale gas unproved resources	345	7,201
Other proved reserves	1,642	6,741
Other unproved resources	1,370	8,842
<b>Total</b>	<b>3,357</b>	<b>22,882</b>
<b>Increase in total resources due to inclusion of shale oil and shale gas</b>	<b>11%</b>	<b>47%</b>
<b>Shale as a percent of total</b>	<b>10%</b>	<b>32%</b>

Source: Data compiled by the U.S. Energy Information Administration

**Table 2. Wet natural gas production and resources (trillion cubic feet) Via EIA**

Region totals and selected countries <sup>(1)</sup>	2011 natural gas production <sup>(2)</sup>	January 1, 2013 estimated proved natural gas reserves <sup>(3)</sup>	2013 EIA/ARI unproved wet shale gas technically recoverable resources (TRR)	2012 USGS conventional unproved wet natural gas TRR, including reserve growth <sup>(4)</sup>	Total technically recoverable wet natural gas resources
<b>Europe</b>	<b>10</b>	<b>145</b>	<b>470</b>	<b>184</b>	<b>799</b>
Bulgaria	0	0	17		
Denmark	0	2	32		
France	0	0	137		
Germany	0	4	17		
Netherlands	3	43	26		
Norway	4	73	0		
Poland	0	3	148		
Romania	0	4	51		
Spain	0	0	8		
Sweden	-	-	10		
United Kingdom	2	9	26		
<b>Former Soviet Union</b>	<b>30</b>	<b>2,178</b>	<b>415</b>	<b>2,145</b>	<b>4,738</b>
Lithuania	-	-	0		
Russia <sup>5</sup>	24	1,688	287		
Ukraine	1	39	128		
<b>North America</b>	<b>32</b>	<b>403</b>	<b>1,685</b>	<b>2,223</b>	<b>4,312</b>
Canada	6	68	573		
Mexico	2	17	545		
United States <sup>6</sup>	24	318	567	1,546	2,431
<b>Asia and Pacific</b>	<b>13</b>	<b>418</b>	<b>1,607</b>	<b>858</b>	<b>2,883</b>
Australia	2	43	437		
China	4	124	1,115		
Indonesia	3	108	46		
Mongolia	-	-	4		
Thailand	1	10	5		

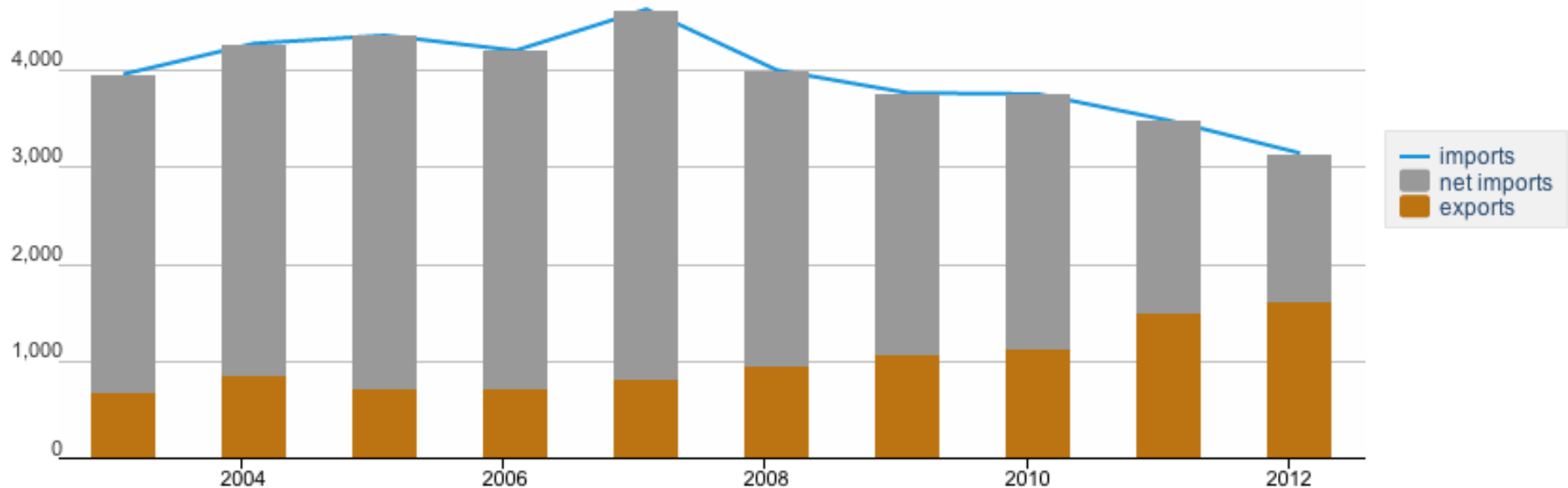
**Table 2 Continued...**

<b>South Asia</b>	<b>4</b>	<b>86</b>	<b>201</b>	<b>183</b>	<b>470</b>
India	2	44	96		
Pakistan	1	24	105		
<b>Middle East and North Africa</b>	<b>26</b>	<b>3,117</b>	<b>1,003</b>	<b>1,651</b>	<b>5,772</b>
Algeria	3	159	707		
Egypt	2	77	100		
Jordan	0	0	7		
Libya	0	55	122		
Morocco	0	0	12		
Tunisia	0	2	23		
Turkey	0	0	24		
Western Sahara	-	-	8		
<b>Sub-Saharan Africa</b>	<b>2</b>	<b>222</b>	<b>390</b>	<b>831</b>	<b>1,443</b>
Mauritania	-	1	0		
South Africa	0	-	390		
<b>South America &amp; Caribbean</b>	<b>6</b>	<b>269</b>	<b>1,430</b>	<b>766</b>	<b>2,465</b>
Argentina	2	12	802		
Bolivia	1	10	36		
Brazil	1	14	245		
Chile	0	3	48		
Colombia	0	6	55		
Paraguay	-	-	75		
Uruguay	-	-	2		
Venezuela	1	195	167		
<b>Subtotal of above countries<sup>7</sup></b>	<b>89</b>	<b>3,157</b>	<b>7,201</b>	<b>NA</b>	<b>NA</b>
<b>Subtotal, excluding the United States<sup>7</sup></b>	<b>65</b>	<b>2,840</b>	<b>6,634</b>	<b>NA</b>	<b>NA</b>
<b>Total World<sup>7, 8</sup></b>	<b>124</b>	<b>6,839</b>	<b>7,201</b>	<b>8,842</b>	<b>22,882</b>

## Increase in U.S. export of gas:

**Chart 1. U.S. net imports of natural gas (all types), 2003-12**  
**Via EIA**

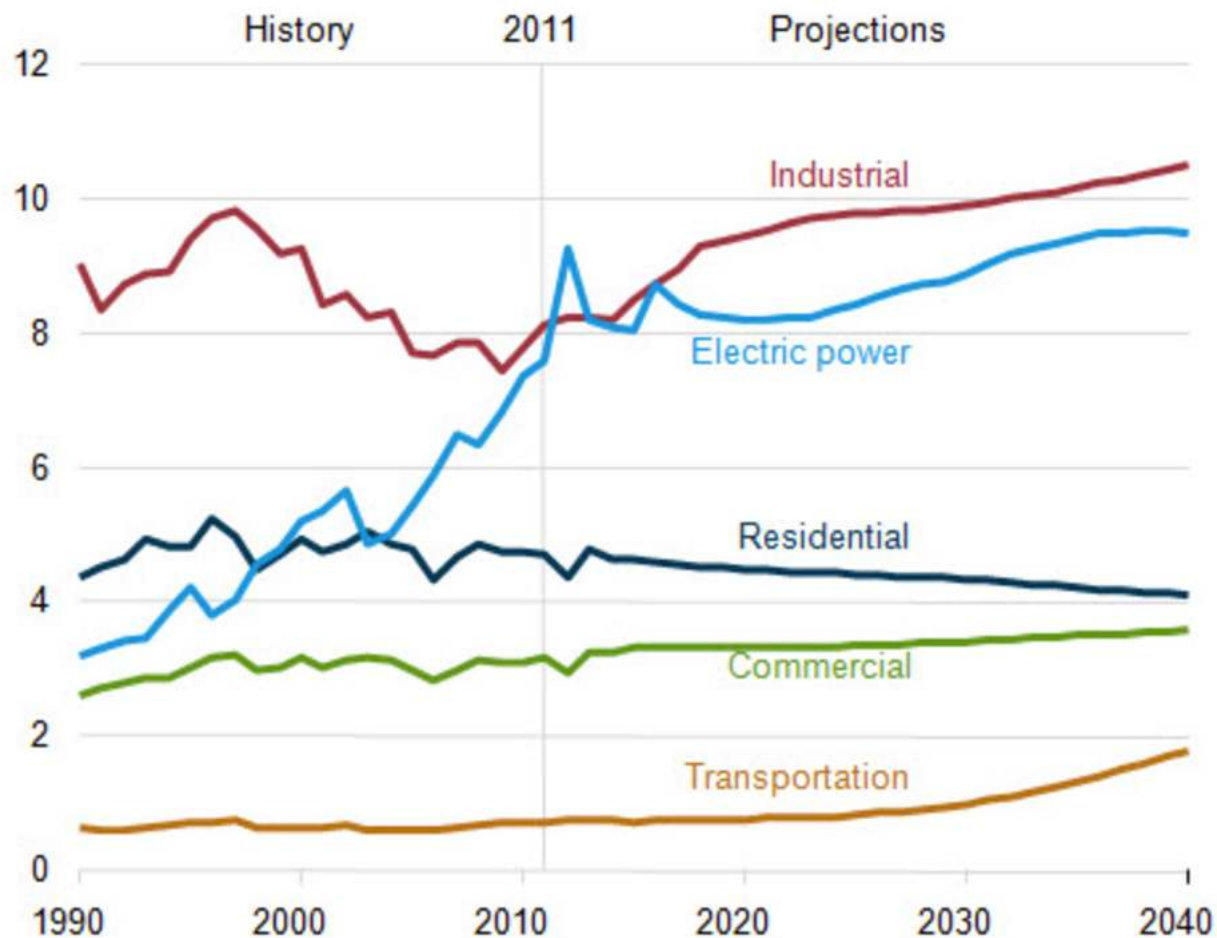
billion cubic feet (Bcf)





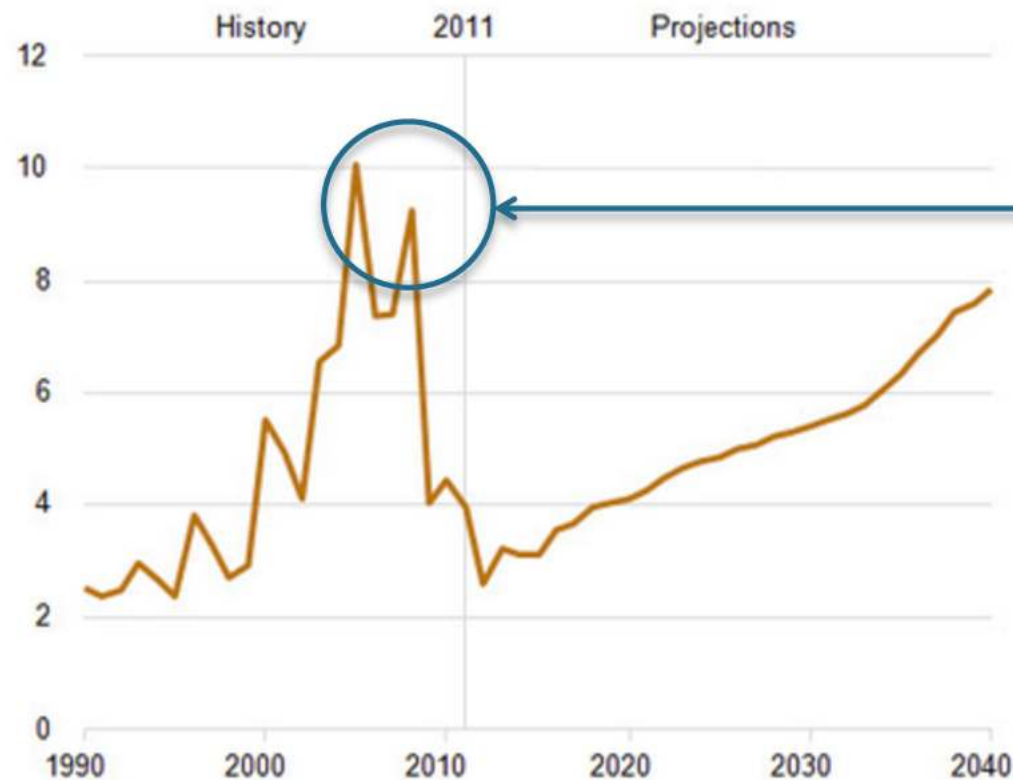
## Chart 2. Natural gas consumption by sector in U.S., 1990-2040

trillion cubic feet (Tcf)



Residential is only sector expected to decrease in consumption (due to improved efficiency and population shifts to warmer regions)

**Chart 3. Annual average Henry Hub spot natural gas prices in U.S., 1990-2040 (2011 dollars per million Btu)**



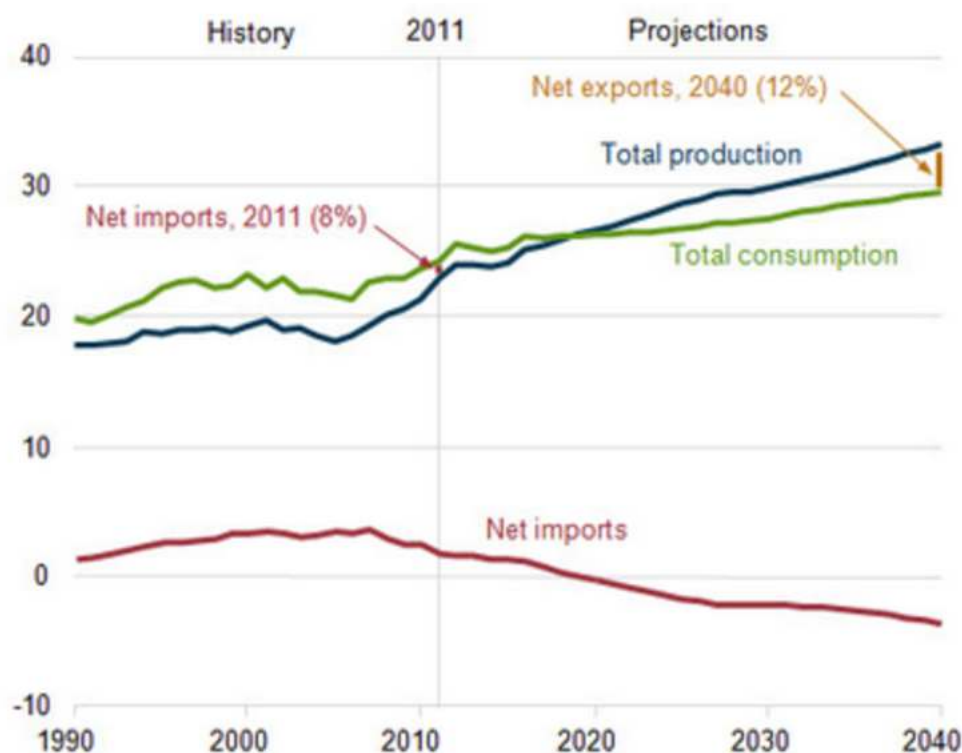
2007-08: When shale gas began hitting market, but also when U.S. stock market crashed. Hard to tease effects apart.

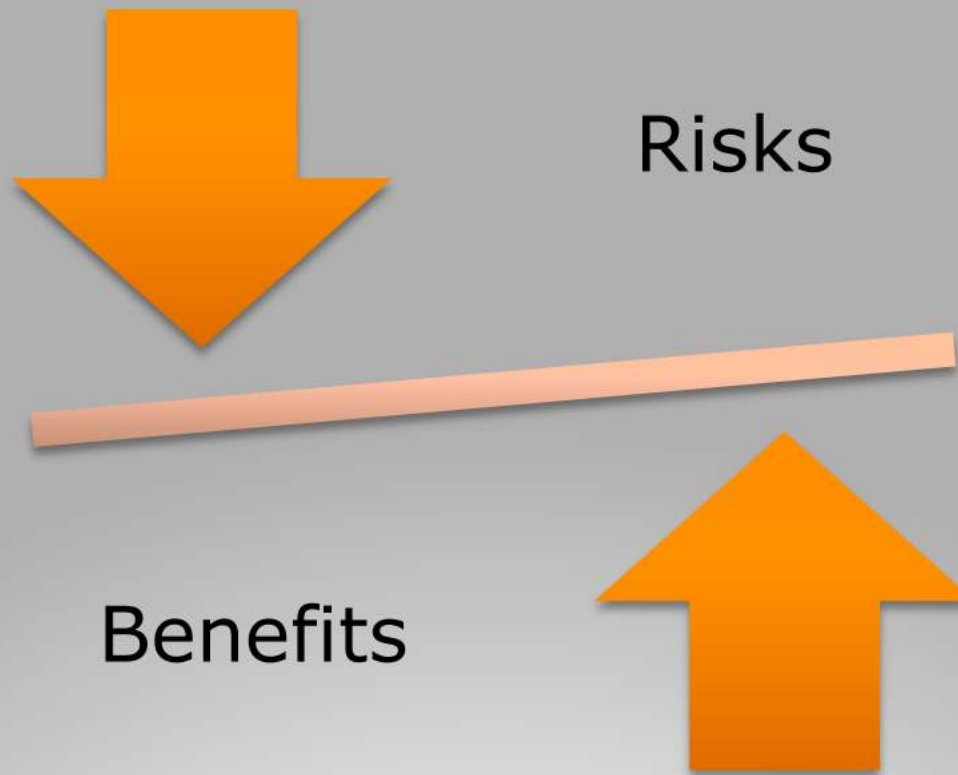


Energy from natural gas will remain less expensive than energy from oil in U.S. through 2040, although difference will narrow over time.

**With production outpacing consumption, U.S. exports of natural gas will likely exceed imports over time:**

**Chart 4. Total U.S. natural gas production, consumption, and net imports, 1990-2040**  
trillion cubic feet (Tcf)





## Shortfalls Experienced in the U.S.

Learning from our mistakes



# Problem 1: Data Transparency



Knowledge

Presentation

Information

Data

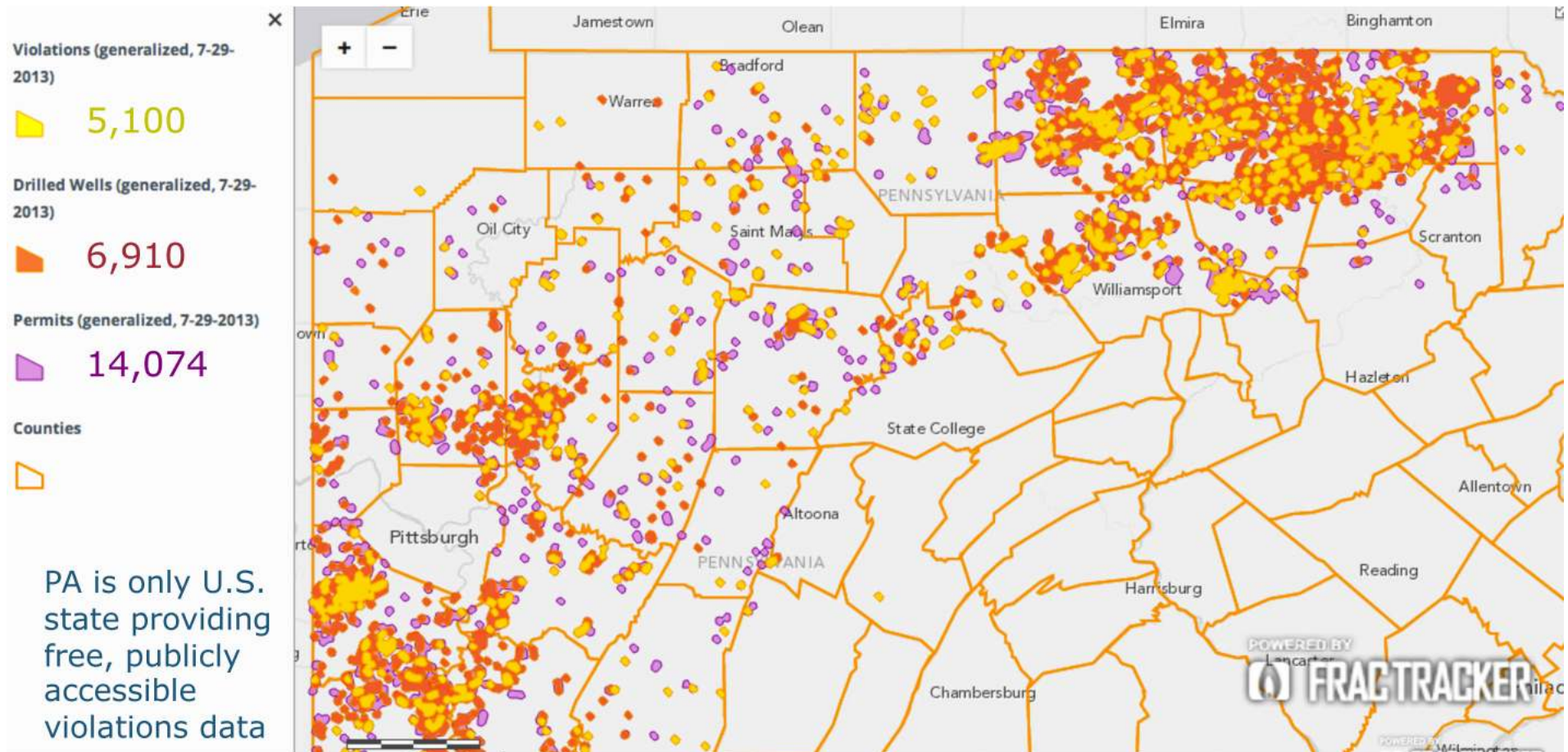
- “Publicly available data” should be in electronic format and shared online
- The lack thereof hinders regulatory trust and transparency
- Shale gas extraction is a controversial subject, so data transparency needed improvement
- Drove the development of FracTracker.org and FracTracker Alliance

## **What FracTracker Alliance does with data (all types):**

- Collect
- Analyze
- Manipulate, where necessary
- Map or chart, and then
- Share it

# Example of heavy unconventional drilling activity

## Pennsylvania, U.S. (2005 – July 2013)





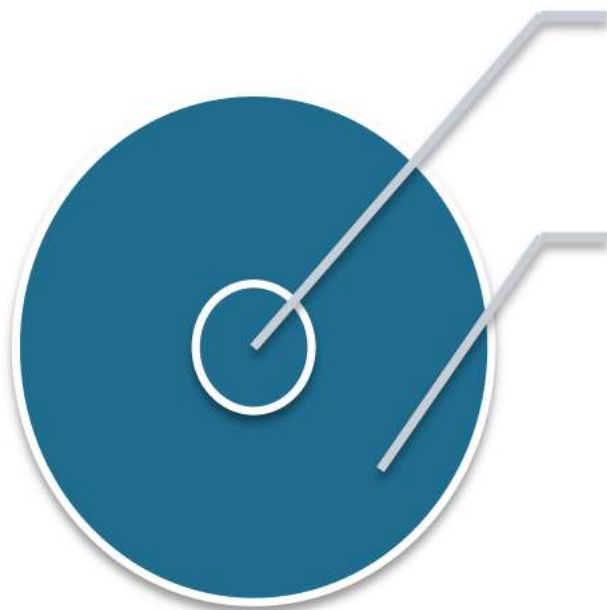
**Problem 2:  
Drilling is  
occurring close  
to residences.  
Public concern &  
safety need to  
be prioritized.**



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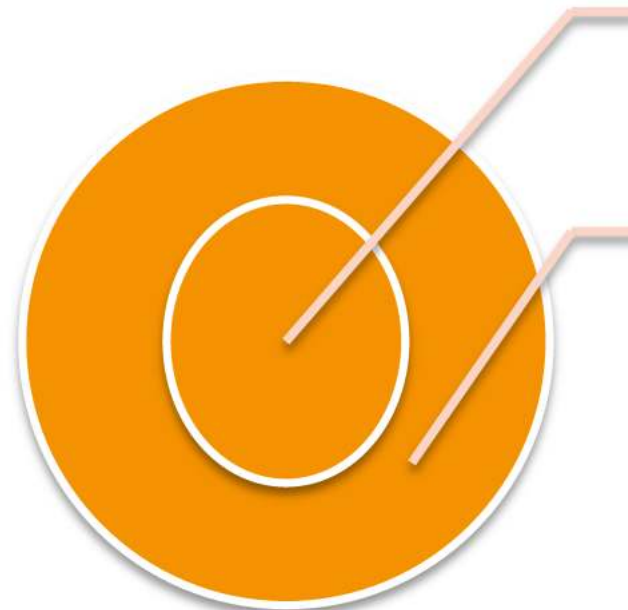
## US



Population  
= 314  
million

Area =  
9.83  
million  
km<sup>2</sup>

## Europe



Population  
= 739  
million

Area =  
10.82  
million  
km<sup>2</sup>

## ... and accidents happen



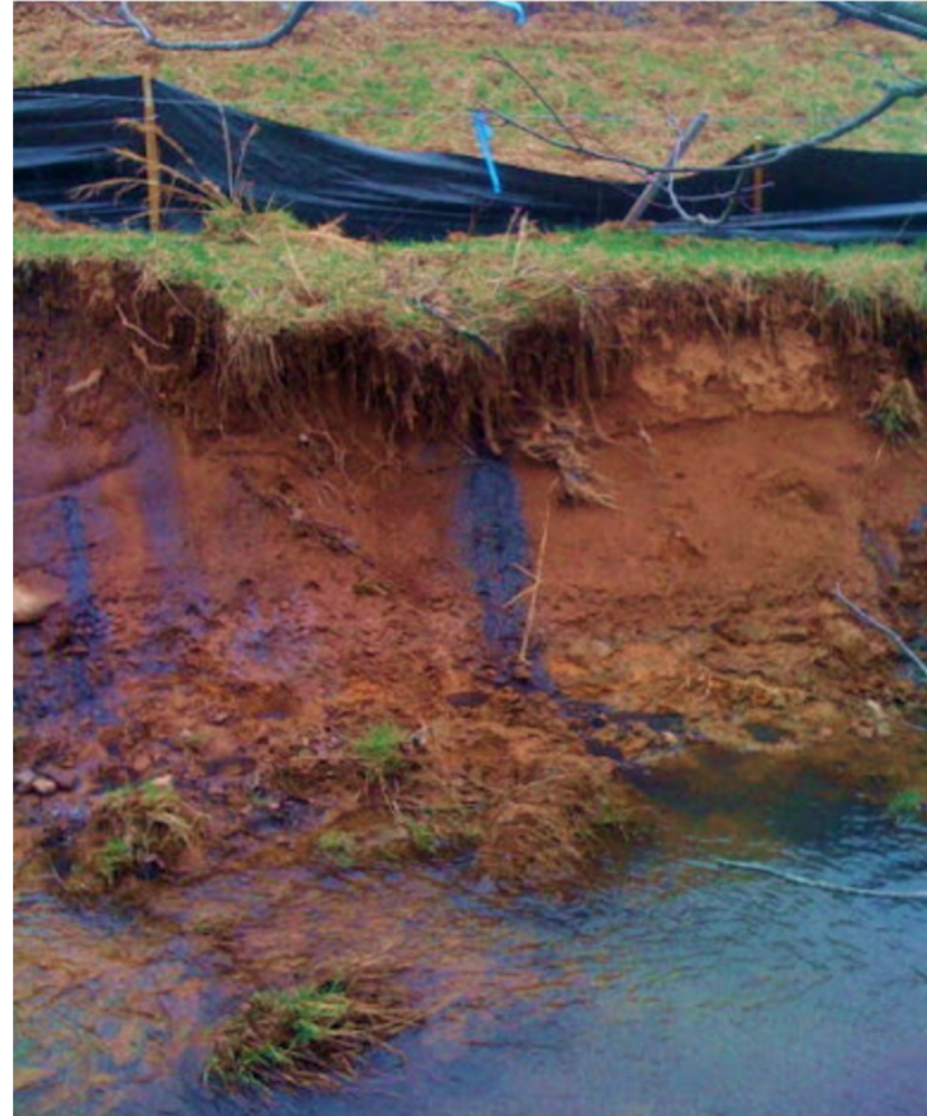
Fire on McDowell B well site near Wetzel County, WV. Burned for 9 days.  
Photo Credit: Wetzel Co. Action Group, Ed Wade, Jr. (Sept. 2010)



## Water Pollution Events

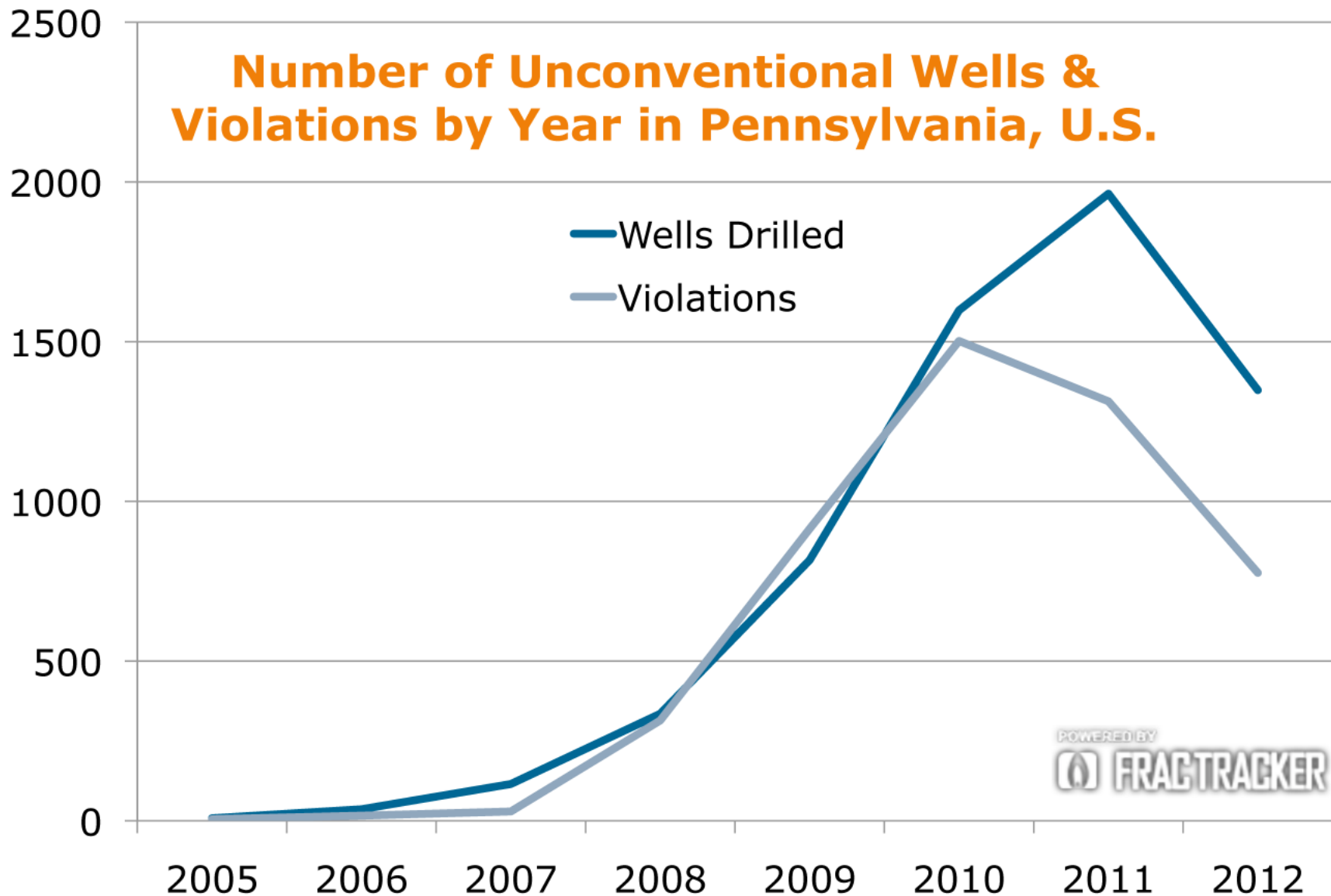


Buckeye Creek spill, Sept. 2009  
Both photos courtesy of WV Host Farms Program  
([www.wvhostfarms.org](http://www.wvhostfarms.org))



Drill site, Harrison County, WV. Landowner reported seeing oily substance bubbling up from ground and into stream. Driller later cited for putting a well pad on top of a wetland area.

## Number of Unconventional Wells & Violations by Year in Pennsylvania, U.S.



POWERED BY  
 FRACTRACKER

"Environmental" violations peaked in 2011. "Administrative" violations peaked in 2010.  
Distinctions between categories not reliable.



## Problem 3: Global Climate Change Implications

### **Benefits:**

- Natural gas burns more cleanly than traditional fossil fuels like coal and oil
- Less pervasive in atmosphere
- High energy density (when pressurized into liquid form)
- Sulfur is not released during combustion of natural gas

## Continued...

### Drawbacks:

- Methane often released during extraction and distribution
  - 2009: Methane emitted during oil and gas activities = 328 million metric tons of CO<sub>2</sub> equivalent. (~78 coal-fired power plants)
- Methane is a more potent (yet less pervasive) greenhouse gas than CO<sub>2</sub>
- ~ 40% of gas vented or flared in onshore drilling could be captured w/available control technologies
- Some CO<sub>2</sub> is also released during the gas extraction lifecycle
- Natural gas – like other fossil fuels – not quickly renewable

## Positive

- Amount of methane emitted from shale gas operations may be lower than first thought (EPA 2013).
- Shale gas lower life cycle GHG emissions vs. coal by 20-50% (Mohan et al 2011)

## Negative

- Vs. Conventional oil/gas: Footprint for shale gas greater, especially over 20-year time span.
- Vs. Coal: Footprint for shale 20% greater, especially 20-year horizon. Comparable over 100 years (Howarth *et al.* 2011).

**Climate Change Research Findings**

## Problem 4: Health Concerns

### Not discussed in detail here



- Air pollution (PM, Ozone, CO, NO<sub>x</sub>, VOCs, BTEX, NORMs...)
- Water pollution (primarily surface waters)
- Light, noise, and smell pollution
- Exposure to frac fluid/chemicals
- Earthquakes (due to injection of waste)
- Traffic incidents
- Occupational risks (well pad incidents, H<sub>2</sub>S, silica sand)
- Local community/social impacts and stress.
- Read Korfmacher *et al.* 2012 to learn more



## In Summary

### Does Fracking Change the Energy World?

- Yes, but *how* is being determined
- Uncertainty of future reserves, production, and gas prices exist
- Shale gas has many benefits if extracted and distributed properly
- Need to focus on limiting impacts and emissions
- Data transparency and quality need improvement
- Check out [FracTracker.org](http://FracTracker.org) to learn more

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Maps courtesy of [FracTracker.org](http://FracTracker.org)

Many thanks to my colleagues at FracTracker for their support in the development of this presentation and data.

# Questions?

## Select References

Howarth RW, Santoro R, and Ingraffea A (2011). Climatic Change Letters, doi:10.1007/s10584-011-0061-5

Korfmacher KS, Jones WA, Malone SL, Vinci LF. (2013). Public Health and High Volume Hydraulic Fracturing. NEW SOLUTIONS: A Journal of Environmental and Occupational Health Policy 23(1), pp. 13 – 31.

Mohan Jiang et al. (2011). Life cycle greenhouse gas emissions of Marcellus shale gas. Environmental Research Letters, doi: 10.1088/1748-

US EPA (2013). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2011. Accessed online.