Aqua lacta Est:
How Much Water is Really Used in Hydraulic Fracturing

International Petroleum Environmental Conference
Hydraulic Fracturing: Technological Realities & Public Perceptions
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Motivation

St. Sebastian after the the Mauretanian archers were finished in 286.

Actually it doesn’t turn out that badly for Sebastian

St. Sebastian is healed by Irene of Rome

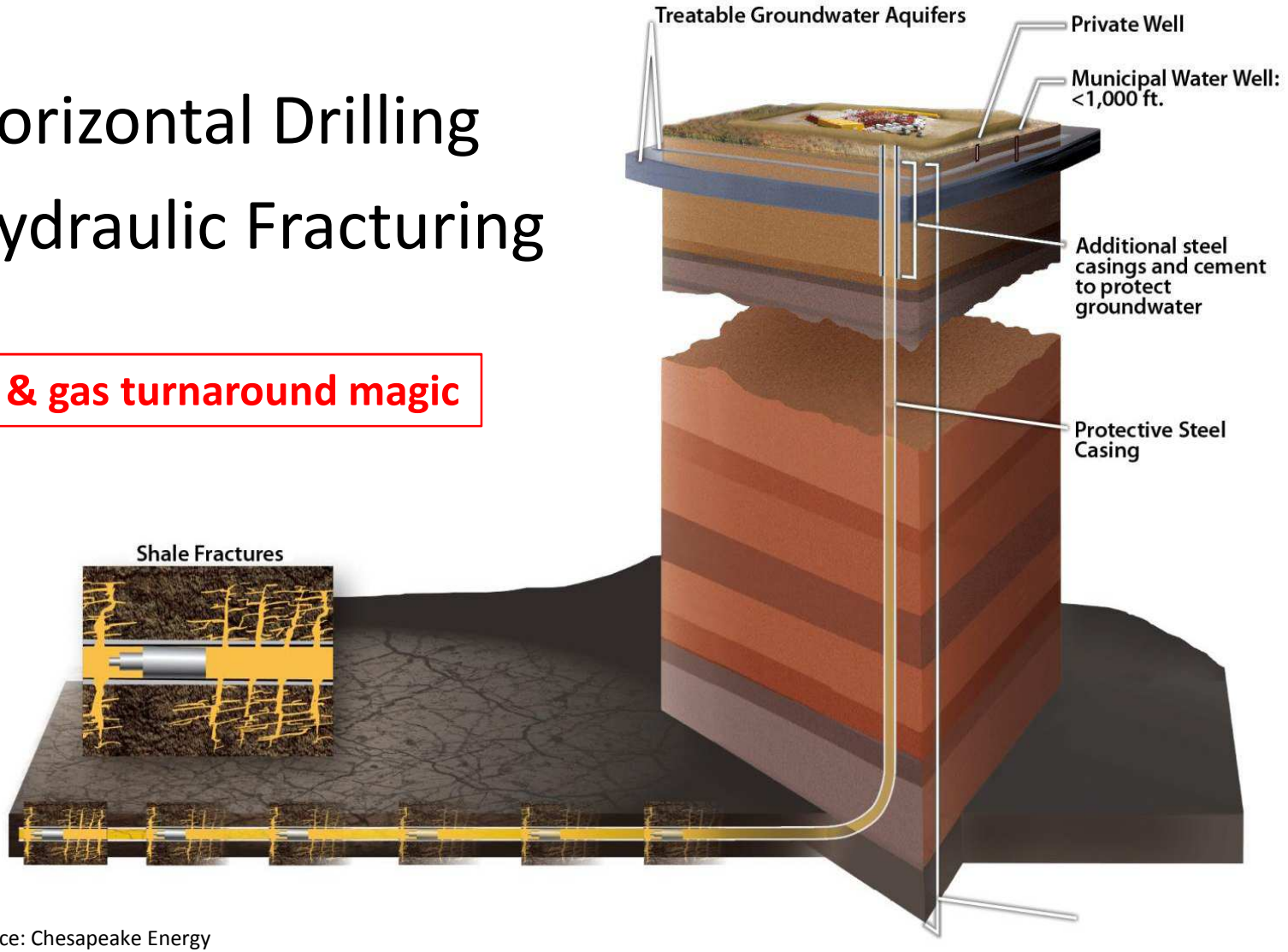
Freshwater -- Essential to Oil and Gas Development

- Drilling
  - Water-based mud
  - Rig wash down
  - Domestic use
- Completion
  - Hydraulic fracturing

Key Technologies

- Horizontal Drilling
- Hydraulic Fracturing

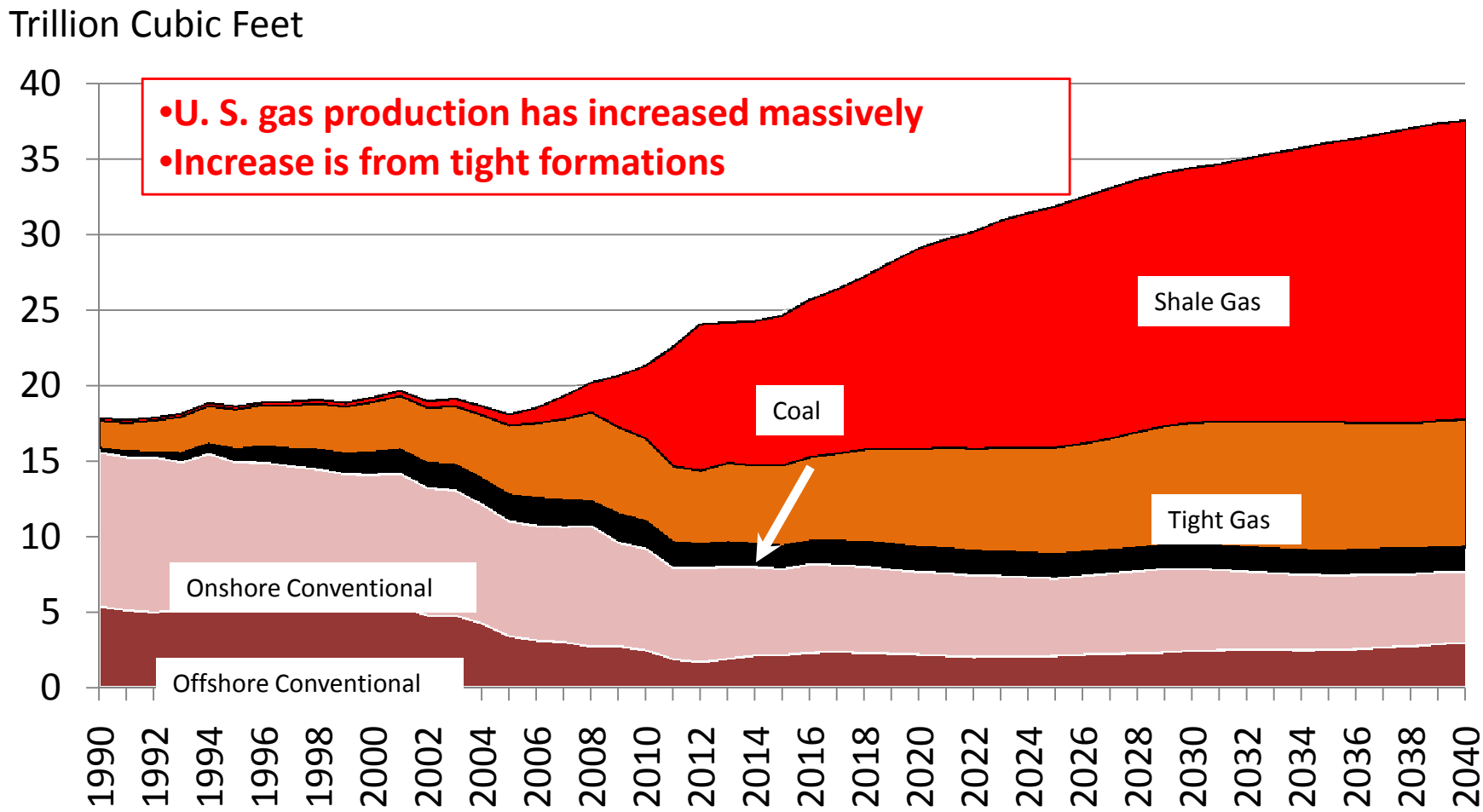
Oil & gas turnaround magic



Source: Chesapeake Energy

Source: U. S. Energy Information Administration

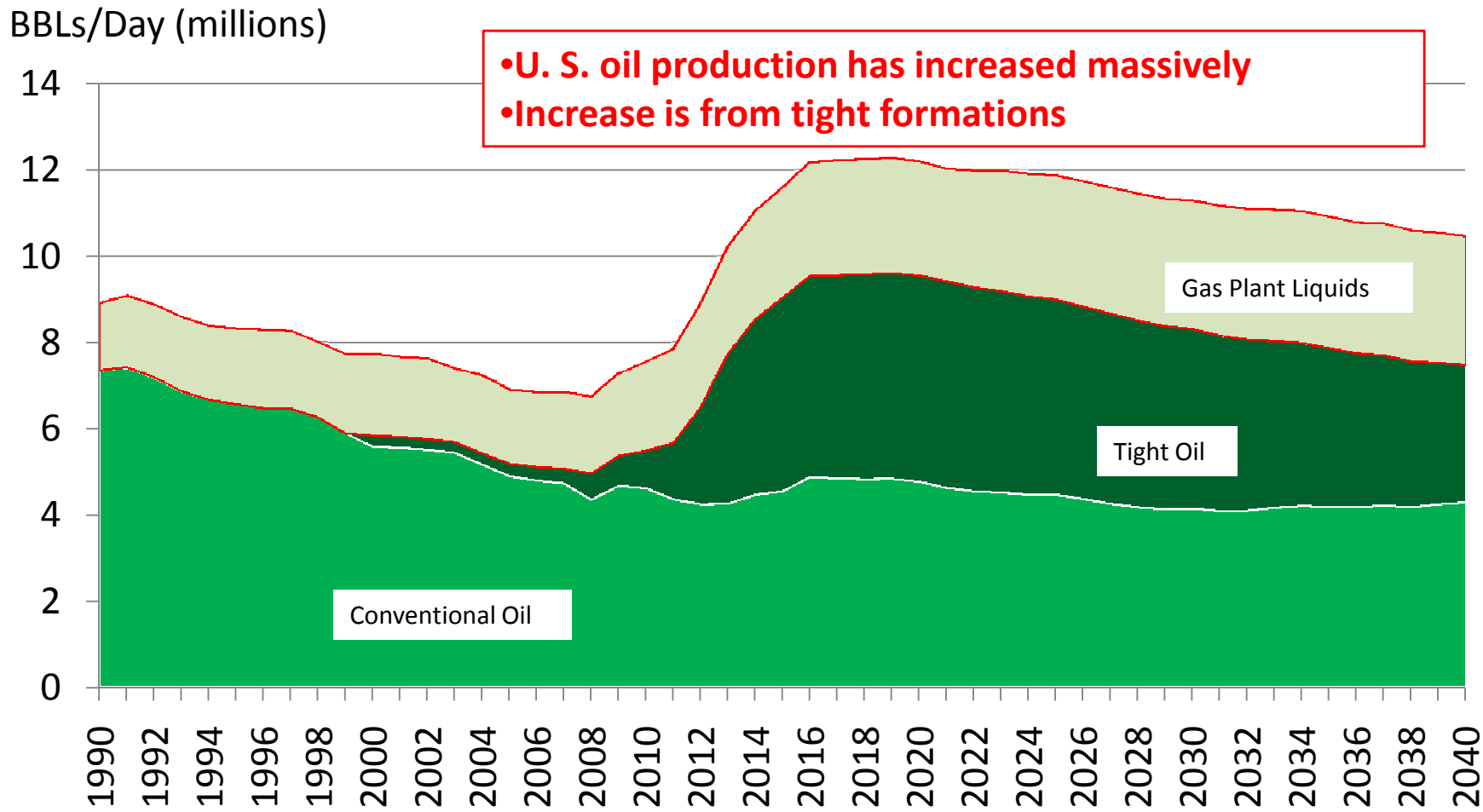
U. S. natural gas production by source (Reference Case, 1990-2040)



Source: U.S. EIA Annual Energy Outlook 2014, available at http://www.eia.gov/forecasts/aeo/MT_naturalgas.cfm#natgas_prices?src=Natural-b1

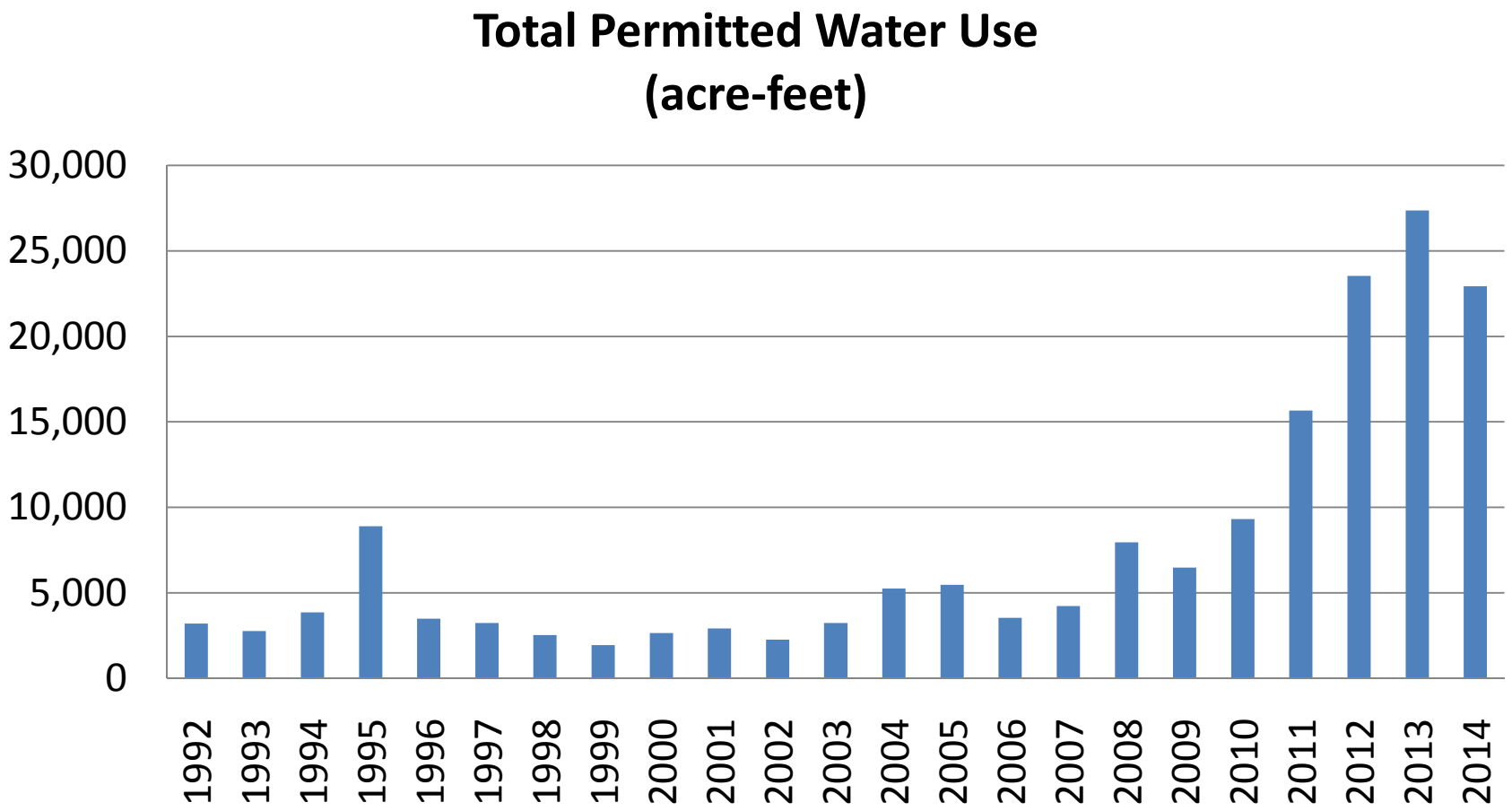
Source: U. S. Energy Information Administration

U. S. Crude Oil and NGL Production by Source (1990-2040)

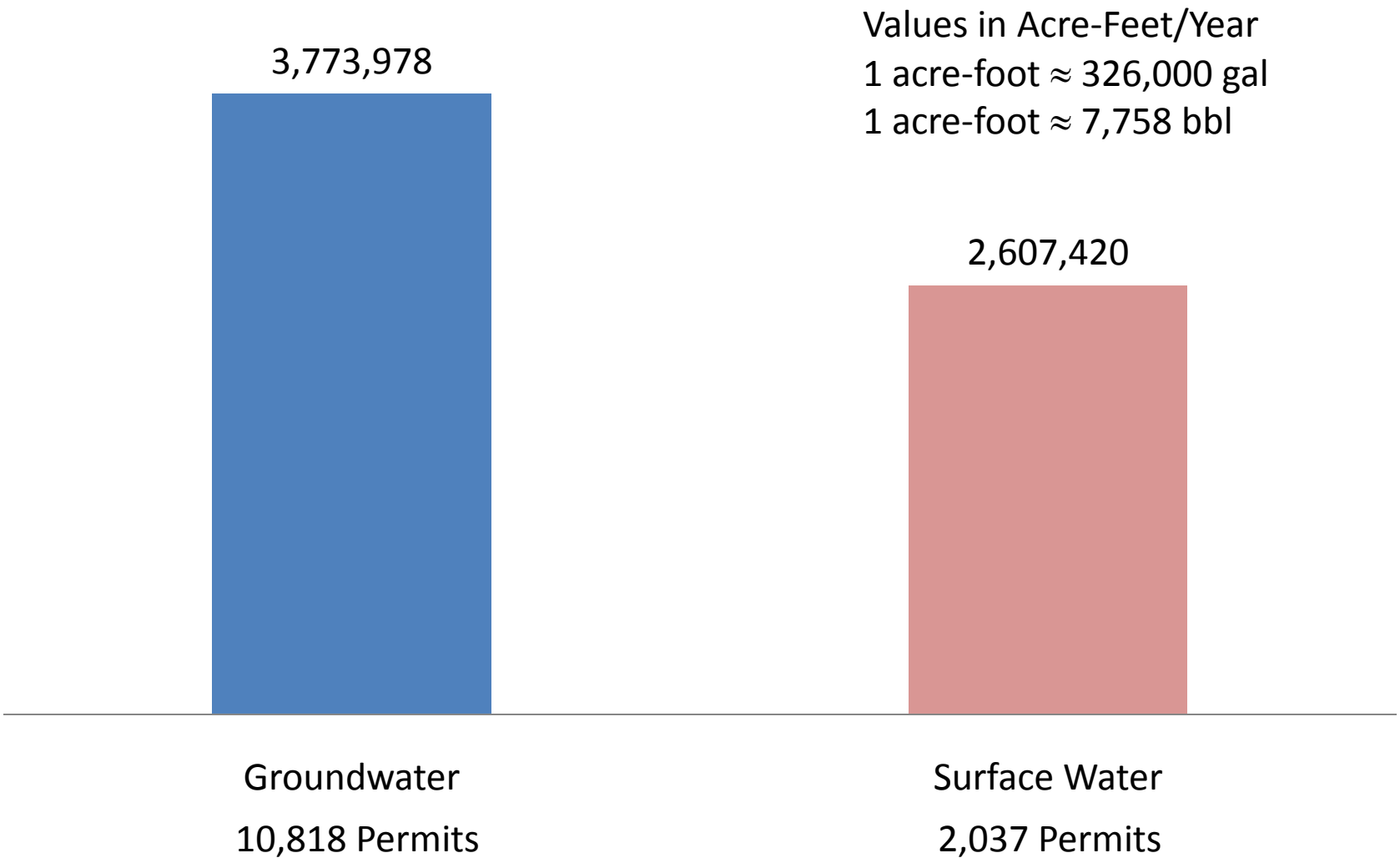


Source: U.S. EIA Annual Energy Outlook 2014, available at http://www.eia.gov/forecasts/aeo/MT_naturalgas.cfm#natgas_prices?src=Natural-b1

90-Day Provisional-Temporary Permits
Oil, Gas & Mining Use (1992-2014)



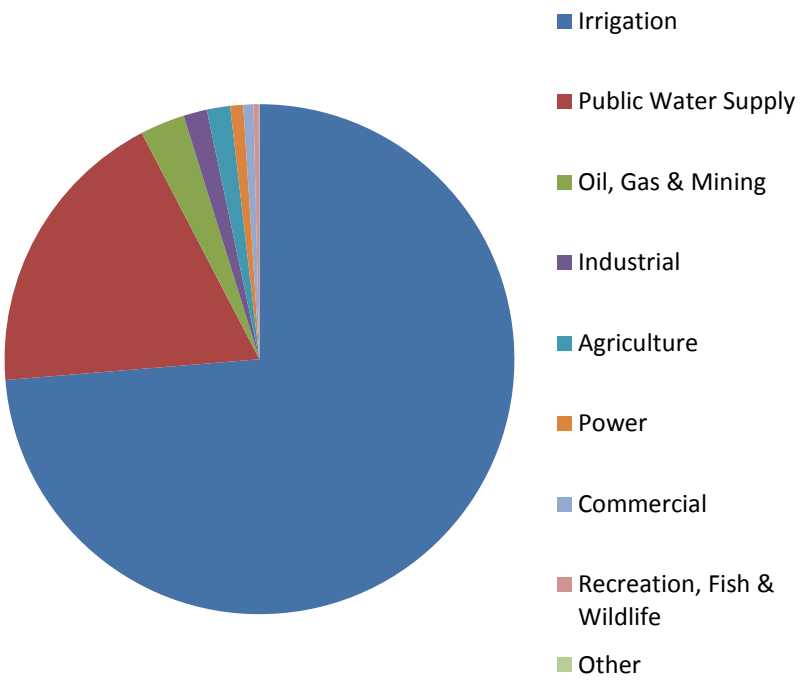
Oklahoma Water Permits by Source



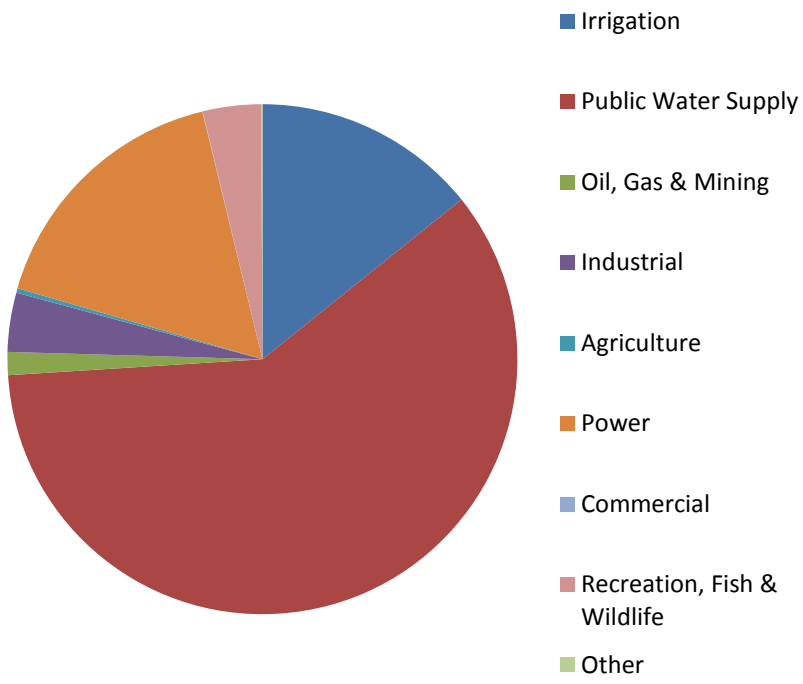
Current Active Groundwater and Surface Water Permits (OWRB Data; 10/02/2014)

Oklahoma Water Permits by Prupose

Groundwater

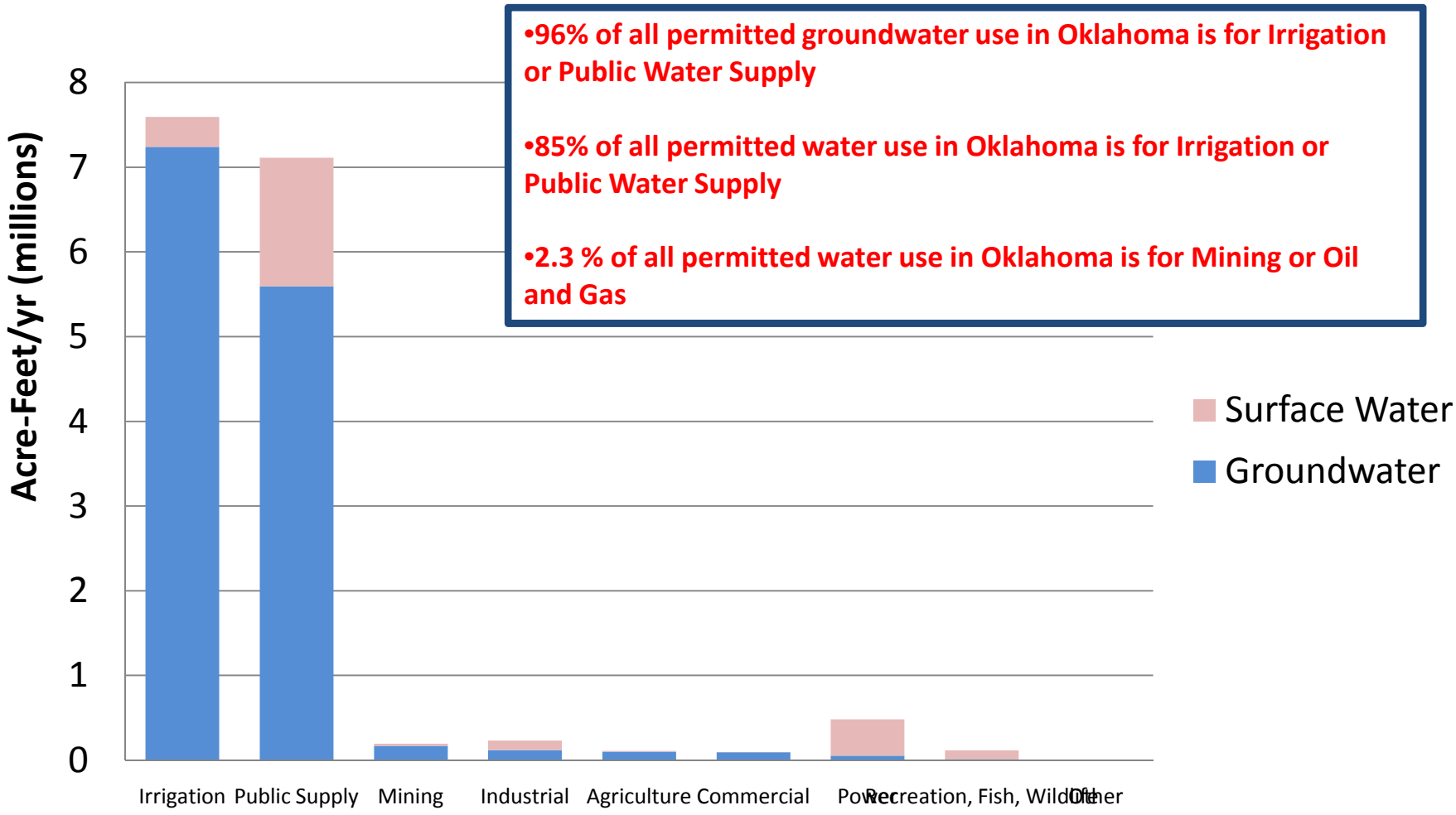


Surface Water



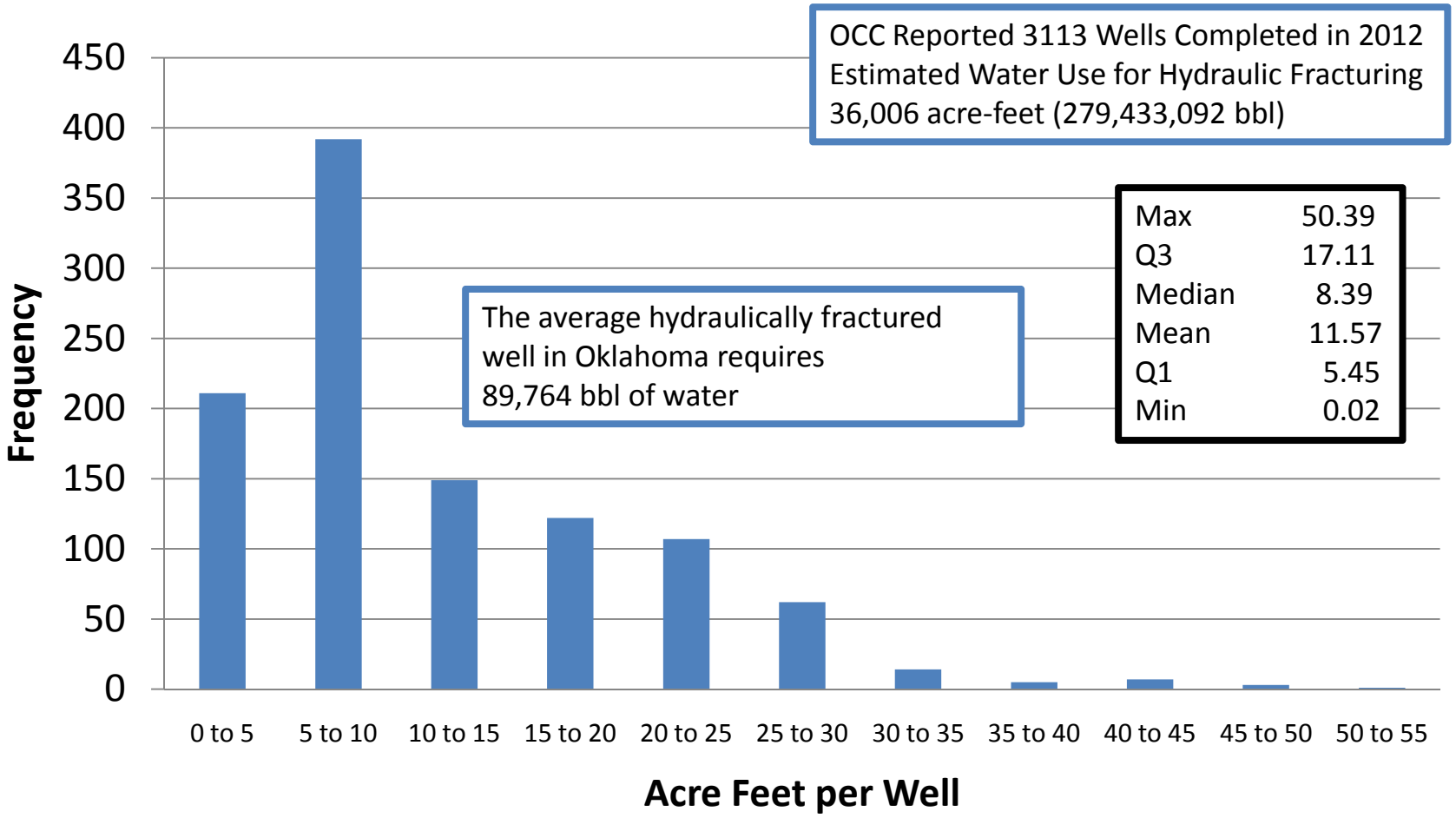
Current Active Groundwater and Surface Water Permits (OWRB Data; 10/02/2014)

Permitted Water Use in Oklahoma



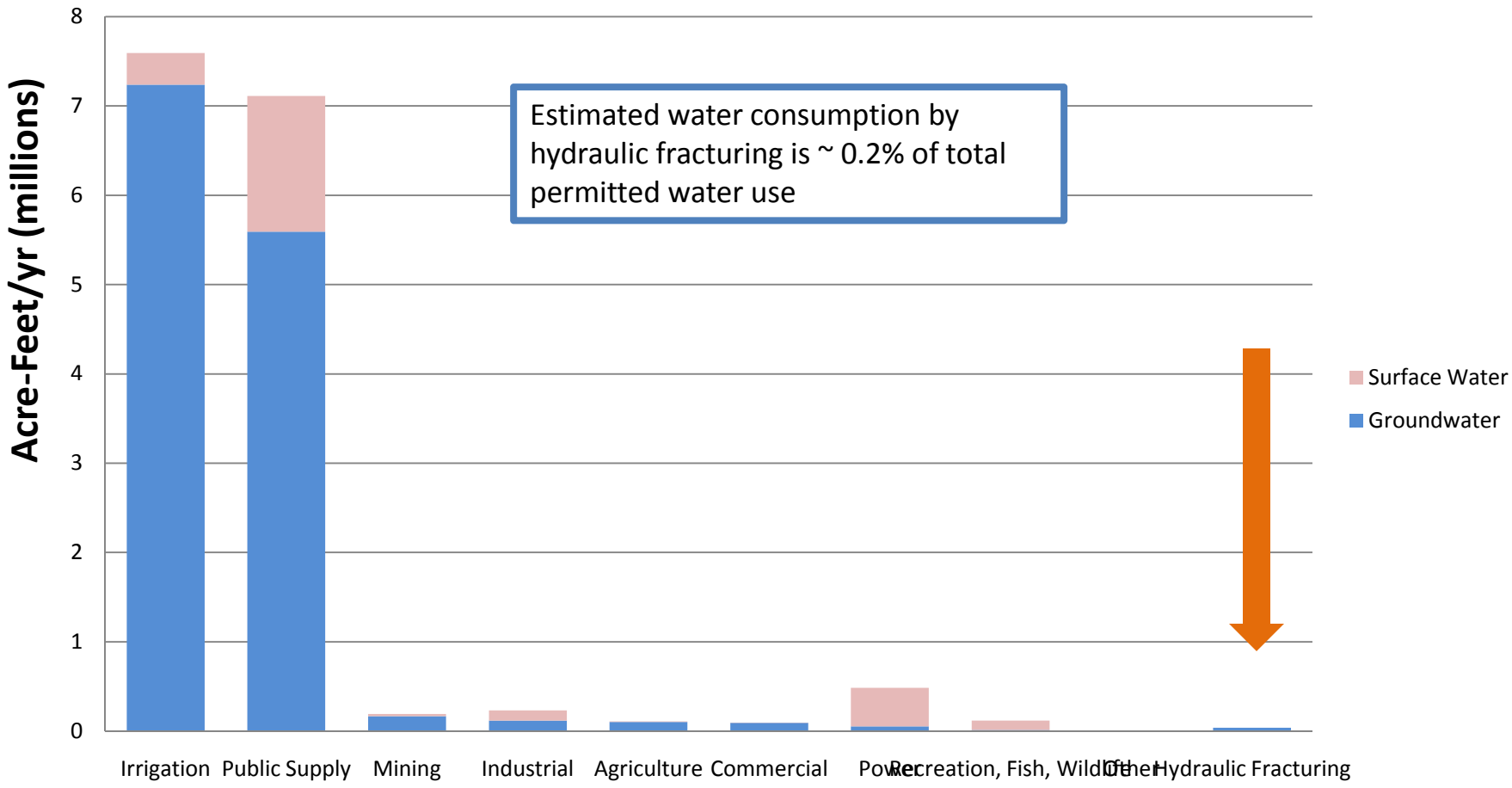
Current Active Groundwater and Surface Water Permits (OWRB Data; 10/02/2014)

Oklahoma Hydraulic Fracturing Water Use 2011-2013 (FracFocus)



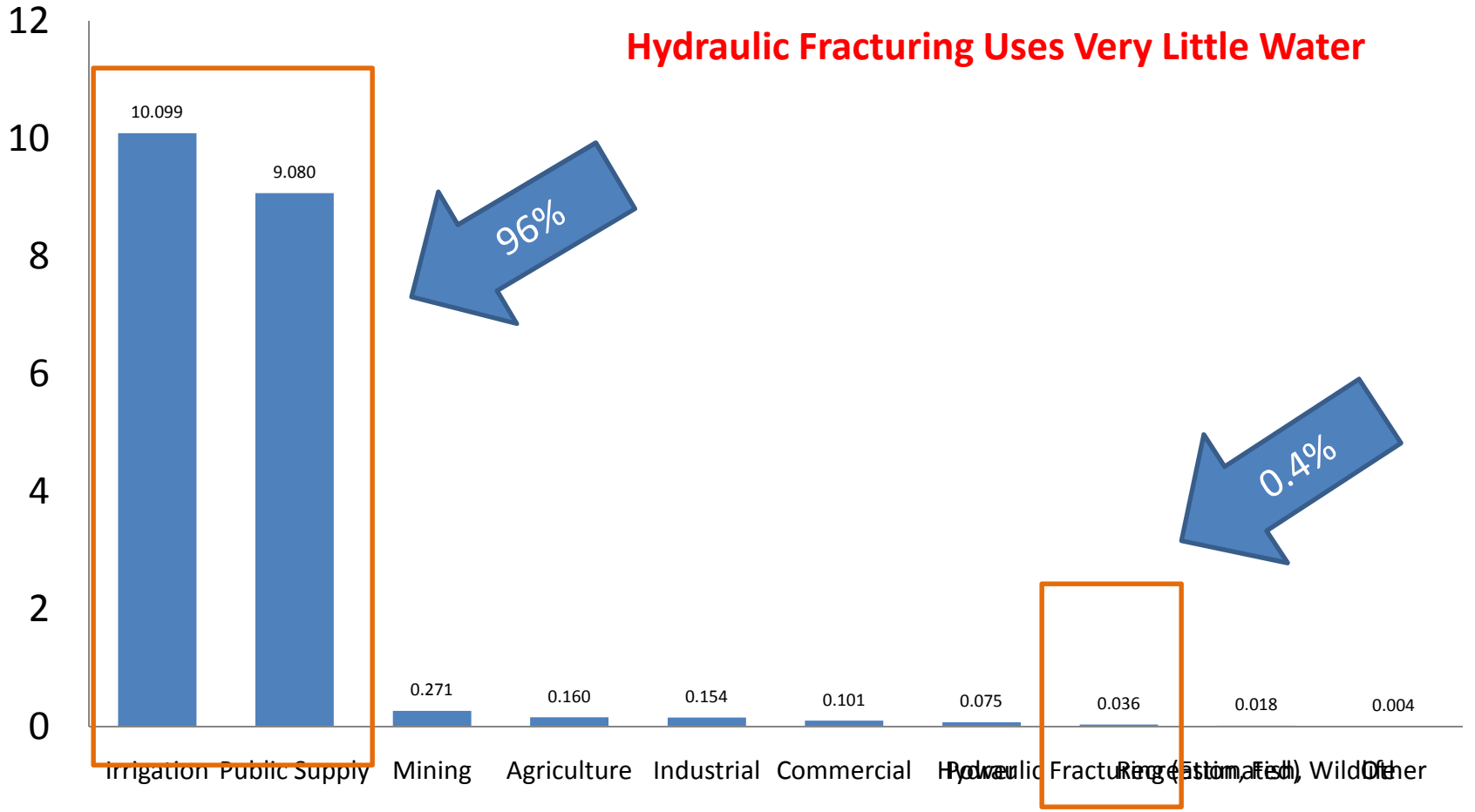
FracFocus Data 2011-2013; Wells Reported = 1,073

Permitted Water Use in Oklahoma



Current Active Groundwater and Surface Water Permits (OWRB Data; 10/02/2014)

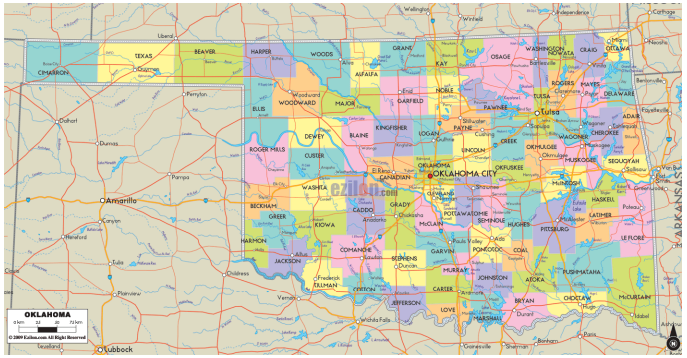
Groundwater Use in Oklahoma



Current Active Groundwater Permits (OWRB Data); Estimated Water Volume Used for Hydraulic Fracturing (FracFocus and OCC Data)

Water Used in Hydraulic Fracturing

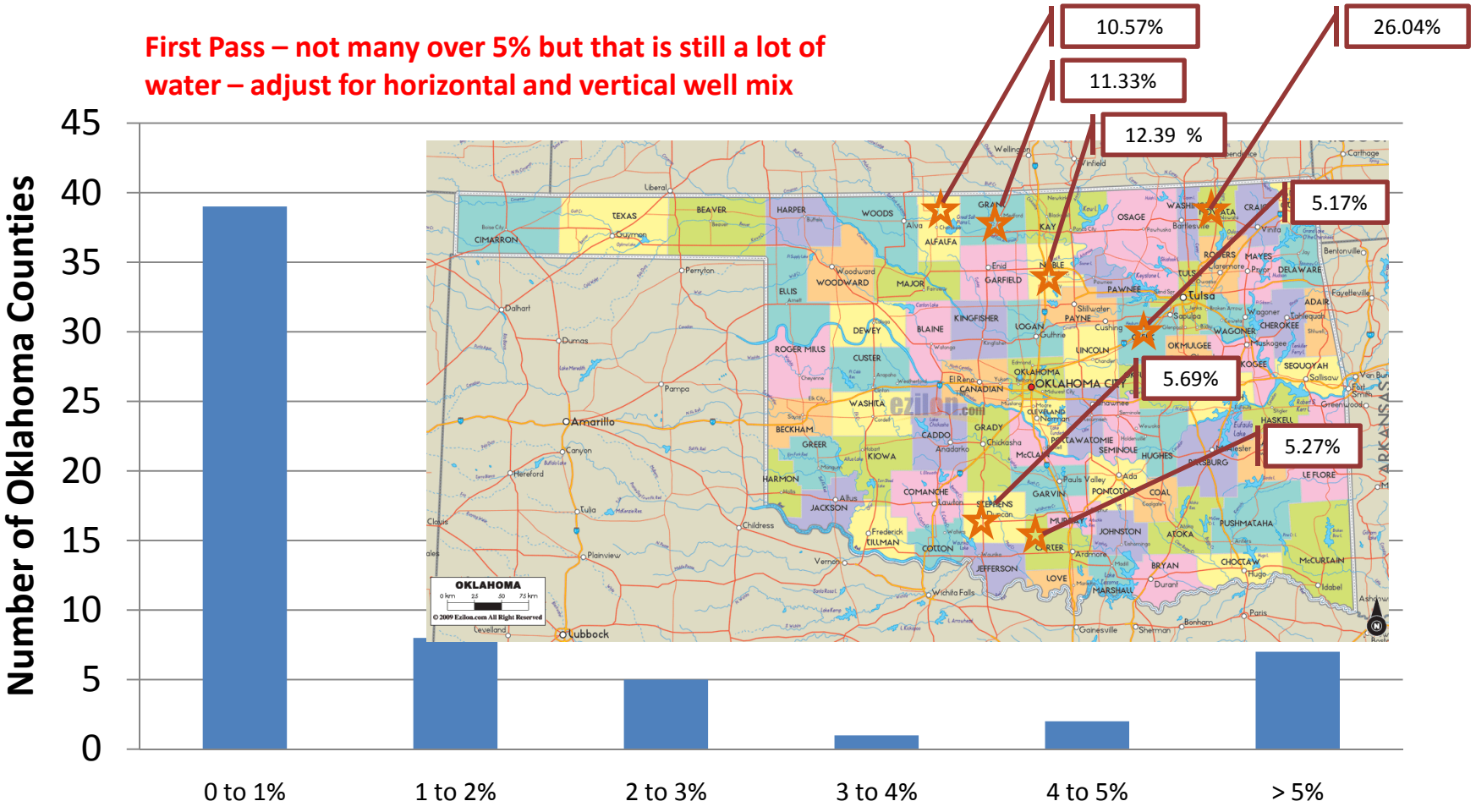
- In 2012 – 62 counties with completed wells
- Total water permits for these counties
  - 5,243,801 acre-feet
- Estimated water used in hydraulic fracturing in these counties
  - 36,006 acre-feet



0.69% to total permitted water

Oklahoma Hydraulic Fracturing Water Use For Individual Oklahoma Counties

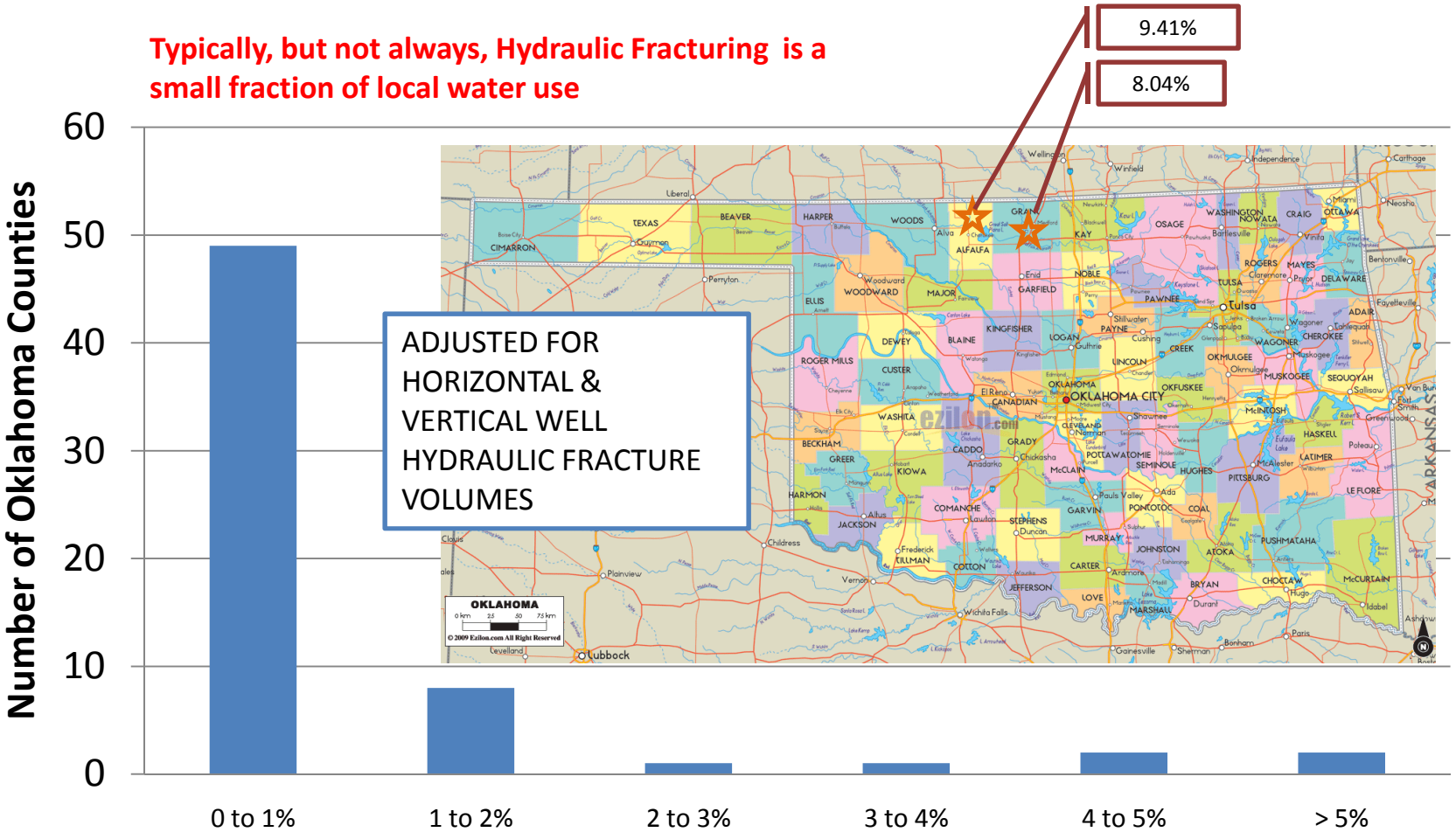
First Pass – not many over 5% but that is still a lot of water – adjust for horizontal and vertical well mix



Average volume of water used in hydraulic fracturing 11.57 acre-feet/well: FracFocus Data 2011-2013; Wells Reported = 1,073; OCC reported 3113 wells completed in 2012; estimated water use for hydraulic fracturing 36,006 acre-feet (279,433,092 bbl)

Oklahoma Hydraulic Fracturing Water Use For Individual Oklahoma Counties

Typically, but not always, Hydraulic Fracturing is a small fraction of local water use



Average volume of water used in hydraulic fracturing 11.57 acre-feet/well: FracFocus Data 2011-2013 (assume horizontal wells); Wells Reported = 1,073; Estimated hydraulic fracturing water use for vertical wells 0.1 acre-feet (review of completion reports for 2012); OCC Reported 1783 horizontal wells and 1330 vertical wells completed in 2012; Estimated water use for hydraulic fracturing 20,763 acre-feet (161,086,981 bbl)

Summary

- Hydraulic fracturing
  - Essential to U.S. energy development
  - Overall uses very little water
  - Can be a locally significant water user