Hydraulic Fracturing and Other Trends in Oil and Gas Production

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Mission Statement: *The Indiana Division of Oil and Gas is committed to encouraging the responsible development of Indiana's oil and gas resources in a manner that will: prevent waste, encourage the greatest economic recovery of oil and gas, protect the correlative rights of owners, protect human health and safety, and protect the environment.*

Based upon information reported in Well Completion Reports filed with the Division of Oil and Gas 2005 through 2011

History of Well Fracturing

- 1860's – Fracturing can be traced to the 1860's when **nitroglycerin** was first used to stimulate shallow wells in Pennsylvania, New York, Kentucky, and West Virginia.
- 1930's - The use of acid injected under pressure was found to be effective in increasing well production.
- 1947 - Stanolind Oil performed the first experimental treatment to "Hydrafrac" a well in Grant County, Kansas.
- 1949 – A patent was issued and an exclusive license was granted to Halliburton Oil Well Cementing Company to pump the new Hydrafrac process.
- Early fracturing operations used approx. 750 gallons of fluid (gelled crude oil or kerosene)and 400 lbs of sand.
- Early fracturing employed only 10 to 15 hydraulic horsepower.
- 1950's – water increasingly became the primary fluid used.
- Modern fracturing operations utilize >1,500 hydraulic horsepower and more than 6,000,000 gallons of water with pump rates more than 100 bbl/minute.
- Specialized additives have been developed to improve the effectiveness of the hydraulic fracturing operation.

What is Hydraulic Fracturing and Why is it Used?

- It increases the production of oil and gas from a well. Hydraulic fracturing has increased U.S. recoverable reserves of oil by at least 30% and of gas by 90%.
- Creates numerous "pathways" or "conduits" through the producing formation to enhance the flow of oil or gas into the wellbore.
- Usually performed initially when the well is completed and equipped for initial production.
- May also be used on other well types to increase fluid flow into the formation (i.e. Class II wells).

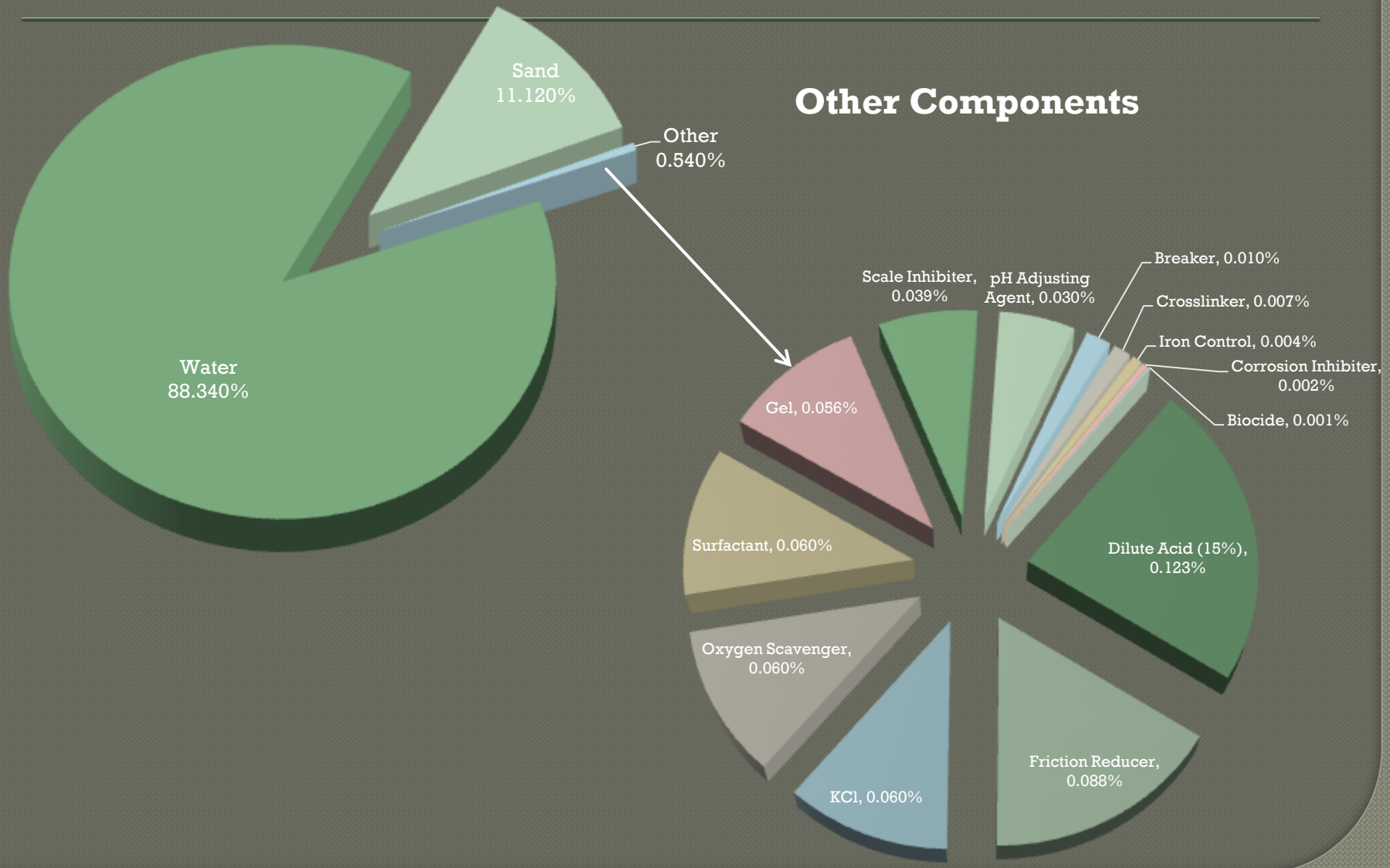
How Is Hydraulic Fracturing Regulated?

- **State Oil and Gas Conservation Laws have always regulated hydraulic fracturing.**
- **Most laws became effective in 1940's.**
- **Hydraulic fracturing developed in the late 1940's and gained popularity in 1950's.**
- **Specific requirements can vary by state but all require detailed reporting of hydraulic fracturing operations such as volumes and types of fluids used and the nature and amounts of proppants.**
- **States are updating their requirements in response to the use of high-volume multi-stage fracing.**
- **Information is reported on the Well Completion Report and made a part of the permanent well record.**
- **Not regulated under Safe Drinking Water Act (UIC Program) or any other federal regulatory program.***

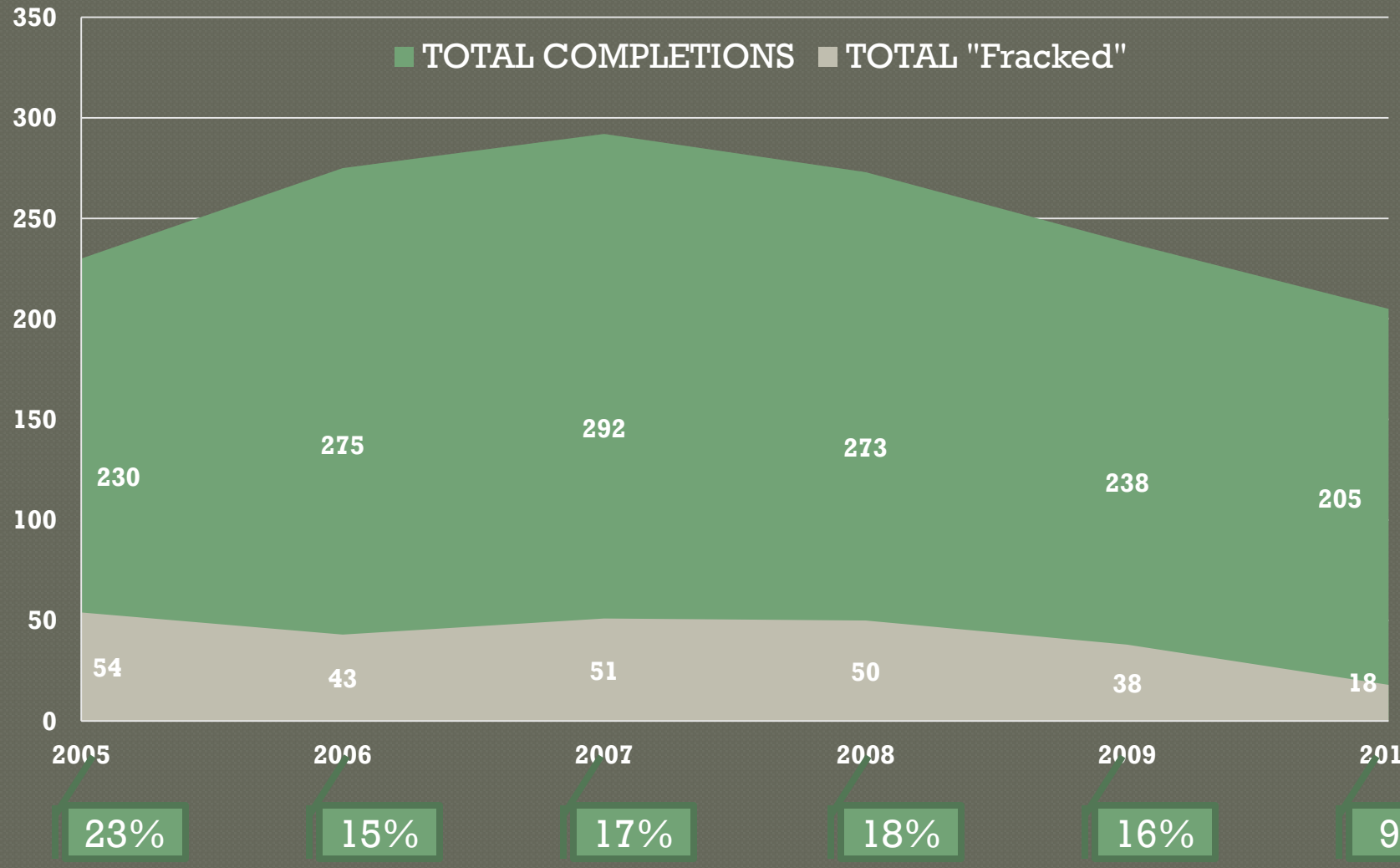
Typical Frac Additives

Additive Type	Description of Purpose	Examples of Chemicals[26]
Proppant	"Props" open fractures and allows gas / fluids to flow more freely to the well bore.	Sand [Sintered bauxite; zirconium oxide; ceramic beads]
Acid	Cleans up perforation intervals of cement and drilling mud prior to fracturing fluid injection, and provides accessible path to formation.	Hydrochloric acid (HCl, 3% to 28%)
Breaker	Reduces the viscosity of the fluid in order to release proppant into fractures and enhance the recovery of the fracturing fluid.	Peroxydisulfates
Bactericide / Biocide	Inhibits growth of organisms that could produce gases (particularly hydrogen sulfide) that could contaminate methane gas. Also prevents the growth of bacteria which can reduce the ability of the fluid to carry proppant into the fractures.	Gluteraldehyde; 2-Bromo-2-nitro-1,2-propanediol
Clay Stabilizer / Control	Prevents swelling and migration of formation clays which could block pore spaces thereby reducing permeability.	Salts (e.g., tetramethyl ammonium chloride) [Potassium chloride (KCl)]
Corrosion Inhibitor	Reduces rust formation on steel tubing, well casings, tools, and tanks (used only in fracturing fluids that contain acid).	Methanol
Crosslinker	The fluid viscosity is increased using phosphate esters combined with metals. The metals are referred to as crosslinking agents. The increased fracturing fluid viscosity allows	Potassium hydroxide
	the fluid to carry more proppant into the fractures.	
Friction Reducer	Allows fracture fluids to be injected at optimum rates and pressures by minimizing friction.	Sodium acrylate-acrylamide copolymer; polyacrylamide (PAM)
Gelling Agent	Increases fracturing fluid viscosity, allowing the fluid to carry more proppant into the fractures.	Guar gum
Iron Control	Prevents the precipitation of metal oxides which could plug off the formation.	Citric acid; thioglycolic acid
Scale Inhibitor	Prevents the precipitation of carbonates and sulfates (calcium carbonate, calcium sulfate, barium sulfate) which could plug off the formation.	Ammonium chloride; ethylene glycol; polyacrylate
Surfactant	Reduces fracturing fluid surface tension thereby aiding fluid recovery.	Methanol; isopropanol

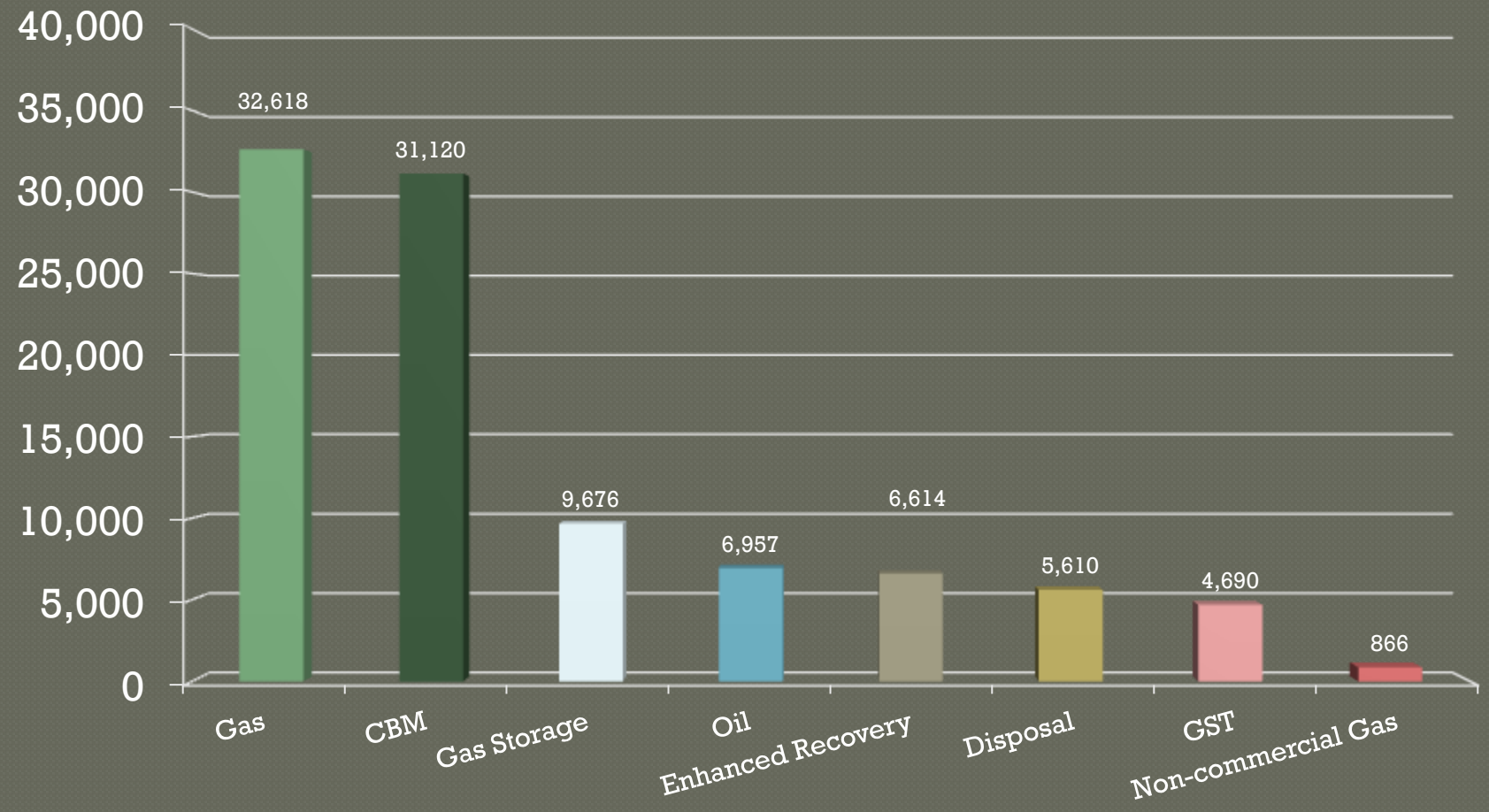
Composition of Hydraulic Fracturing Fluid



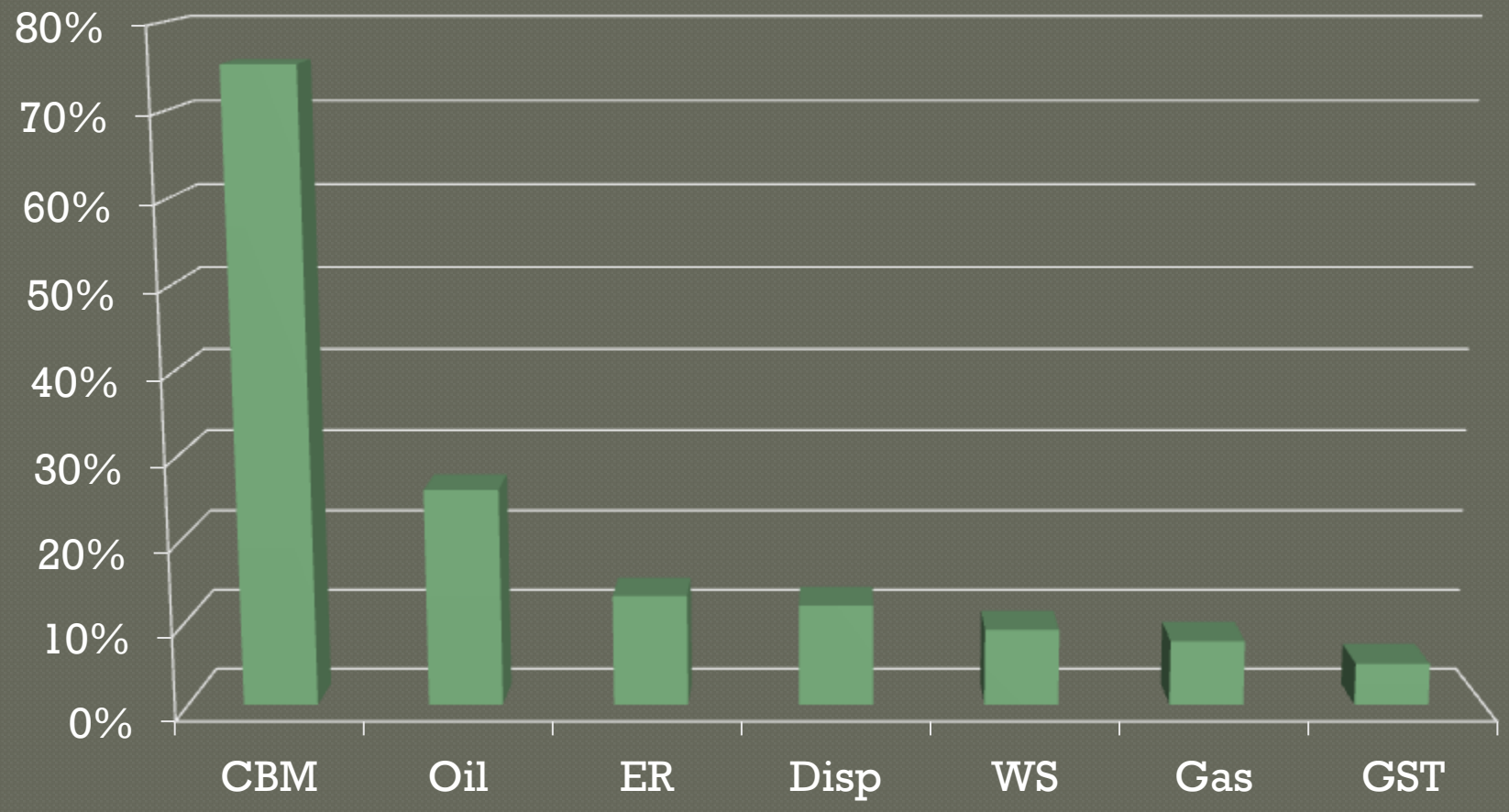
Annual Indiana Well Completions and Hydraulic Fracturing



Average Frac Volume By Well Type (gal.)



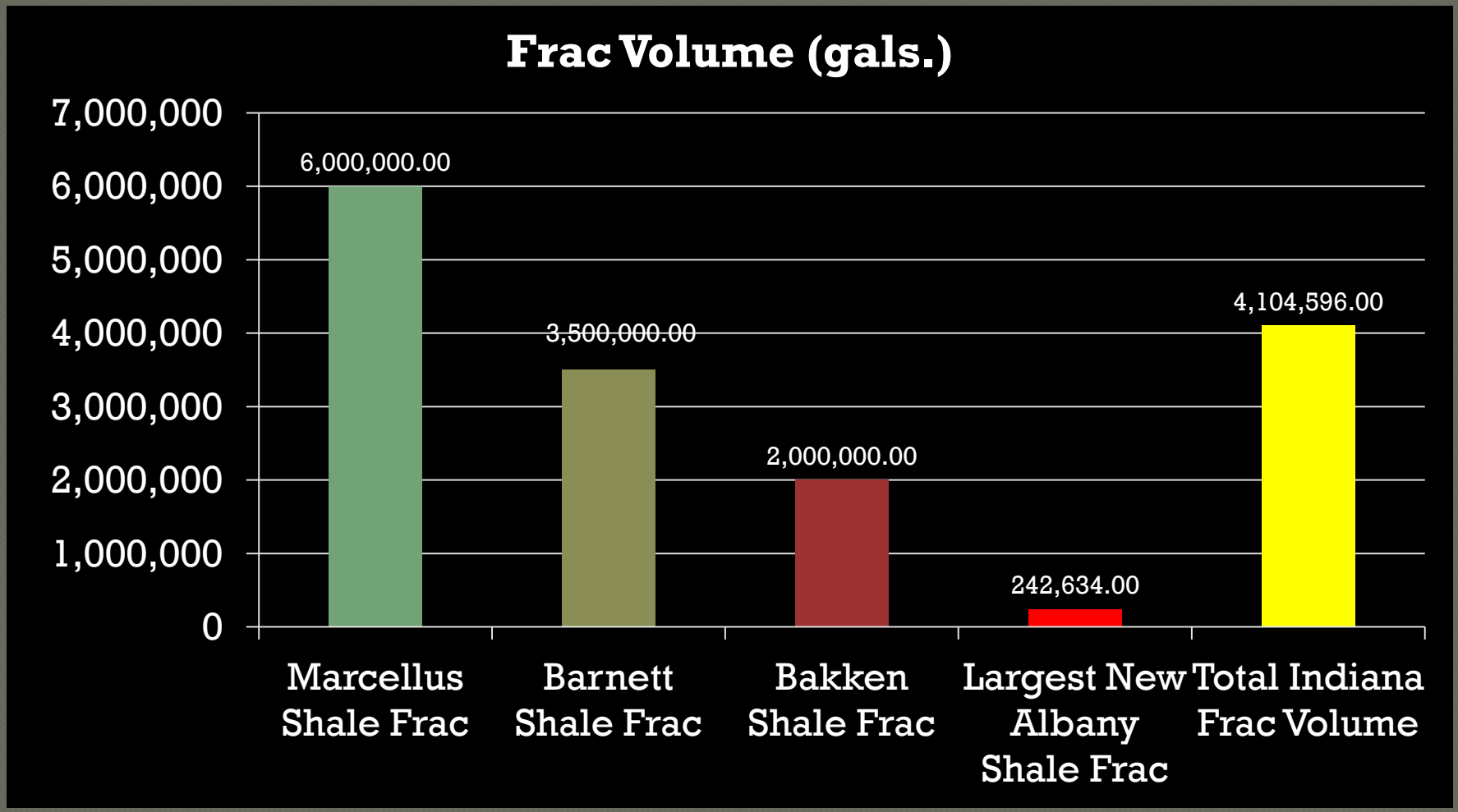
Percent of Wells Fraced by Well Type



Indiana Hydraulic Fracturing Compared to Other High Profile Basins

- Hydraulic fracturing operations in Indiana are not reflective of some wells in other basins, such as horizontal Marcellus Shale gas wells widely publicized in the Appalachian Basin.
- The cumulative volume of all reported hydraulic fracturing fluid used in all wells in Indiana during the period 2005 to 2011 represents only 68.4% of the total fluid that might be used in a single Marcellus Shale well.
- The largest reported volume of fluid used to hydraulically fracture a single well in Indiana during the period 2005 to 2011 represents only 4.0% of the total fluid that might be used in a single Marcellus Shale well.

Comparison of Hydraulic Fracturing Fluid Volumes 2005 to 2011
Indiana Wells vs. Other Shale Wells



What's On The Horizon?

- Continuation of the growth in exploitation of shale gas "plays" domestically and globally.
- Continuation of the use of large volume multi-stage fracs (12 million gallons of water or more), but not in Indiana (yet!).
- Increased development of cost-effective technology to allow for greater reuse or recycling of flow back fluids.
- Continuation of the debate over the affects which hydraulic fracturing is or may be having on the environment.
- EPA is currently conducting a broad study of these impacts. Initial results are expected by the end of 2012 with the goal of a final report in 2014.
- Increased transparency and reporting of chemicals used in hydraulic fracturing.
- Wyoming and Arkansas among the first states to implement new requirements requiring the reporting of frac chemicals. Other states are rapidly following, including Indiana.
- In Indiana, SB 71 (2011) requires detailed hydraulic fracturing plans and disclosure of frac chemical additives for CBM wells. HB 1107 (2012) expanded additive reporting requirements to all well types.

The path forward

- The debate should continue in order to inform those who are interested in a better understanding of the issues and to shape reasonable policy on the use of hydraulic fracturing.
- Focus on:
  - Sharing of reliable and accurate information and involve greater transparency.
  - Remember that drilling is drilling, well construction is well construction, surface spills are surface spills, producing is producing, and fracing is fracing, each with their own unique characteristics and risks.
  - Identifying the most effective means of guarding against adverse impacts to public health and safety and to the environment and whether those should be at local, state, or federal level.
  - Ensuring the protection and preservation of private property rights.
  - Promoting the responsible development of oil and natural gas.
- One-size-fits-all approach is not appropriate - outcomes can and should vary by state and region and should reflect those issues that are relevant considering state and local issues.
- States are in the best position to address the majority of issues surrounding the actual practice of hydraulic fracturing and its related processes given their role (and responsibility) as primary regulators of oil and gas drilling and production and their familiarity of the geology and hydrology within their state.
- Remain flexible and adapt to evolving technologies and management practices.

For More Information

- Division of Oil and Gas:
  - http://www.in.gov/dnr/dnroil/
- Groundwater Protection Council (GWPC):
  - http://www.gwpc.org/e-library/documents/general/Shale%20Gas%20Primer%202009.pdf
- EPA's Website on HF:
  - http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/index.cfm
- Fracfocus (GWPC/IOGCC) HF Chemical Registry Database:
  - http://fracfocus.org/