Hydraulic Fracturing, Shale Gas, and Water

The Water Council

September 10, 2013

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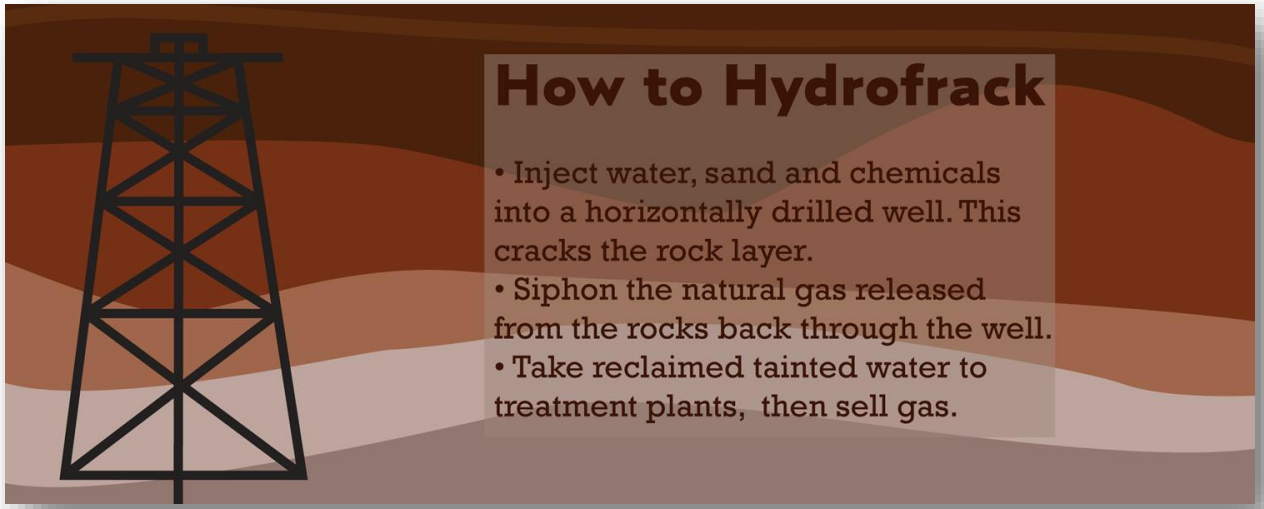
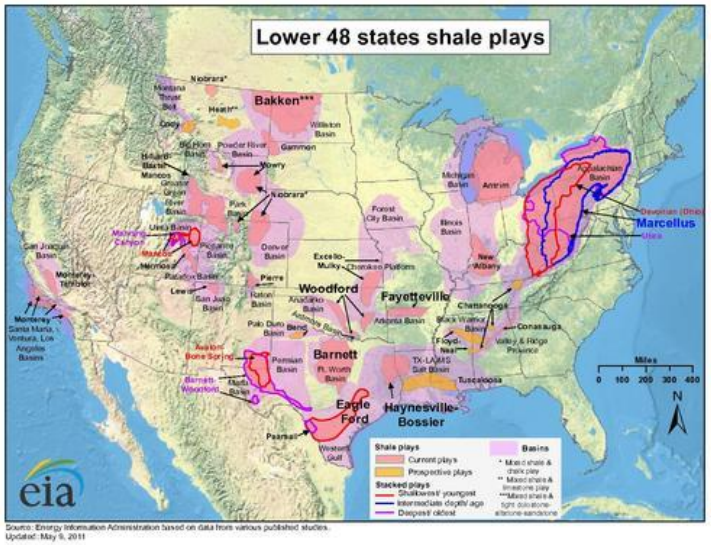
Shale Gas and Fracking

- Shale gas is an unconventional source of natural gas that until recently was "locked up" in shale rock formations
- New technology has allowed access shale gas reserves
  - Horizontal drilling – multiple wells drilled from one surface location
  - Hydraulic Fracturing ("Fracking")



U.S. Shale Gas Reserves



- Recoverable Shale Gas Reserves:
  - 2003: National Petroleum Council estimate: 38 trillion cubic feet
  - Current estimates: 1,080 trillion cubic feet, equivalent to 47 years of natural gas supply at current rates of consumption!

- The U.S. has become the "Saudi Arabia" of natural gas
  - Prices significantly lower than in other energy intensive economies, including China, India, Brazil, Germany, Russia, and Japan
  - The U.S. is the leading global producer of natural gas and a net exporter of natural gas liquids (NGLs)

Shale Gas Means Low Cost Ethylene Value Chain

- Shale gas is "wet", and generally has high "NGL" (Natural Gas Liquids), which are high in Ethane and other hydrocarbons.
- Cracking ethane is the most efficient method of producing ethylene, the world's most widely produced petrochemical. Ethane is the "Willy Wonka Golden Ticket" for U.S. manufacturing
  - Ethane derived from natural gas via steam cracking yields a mixture rich in ethylene, which increases supply (lowers prices) across the entire ethylene value chain (e.g. HDPE, LLDPE, vinyl acetate, styrene, vinyl chloride, etc.) Conversely, ethylene derived from petroleum based naptha is significantly more expensive.

Follow the Money (Part 1)

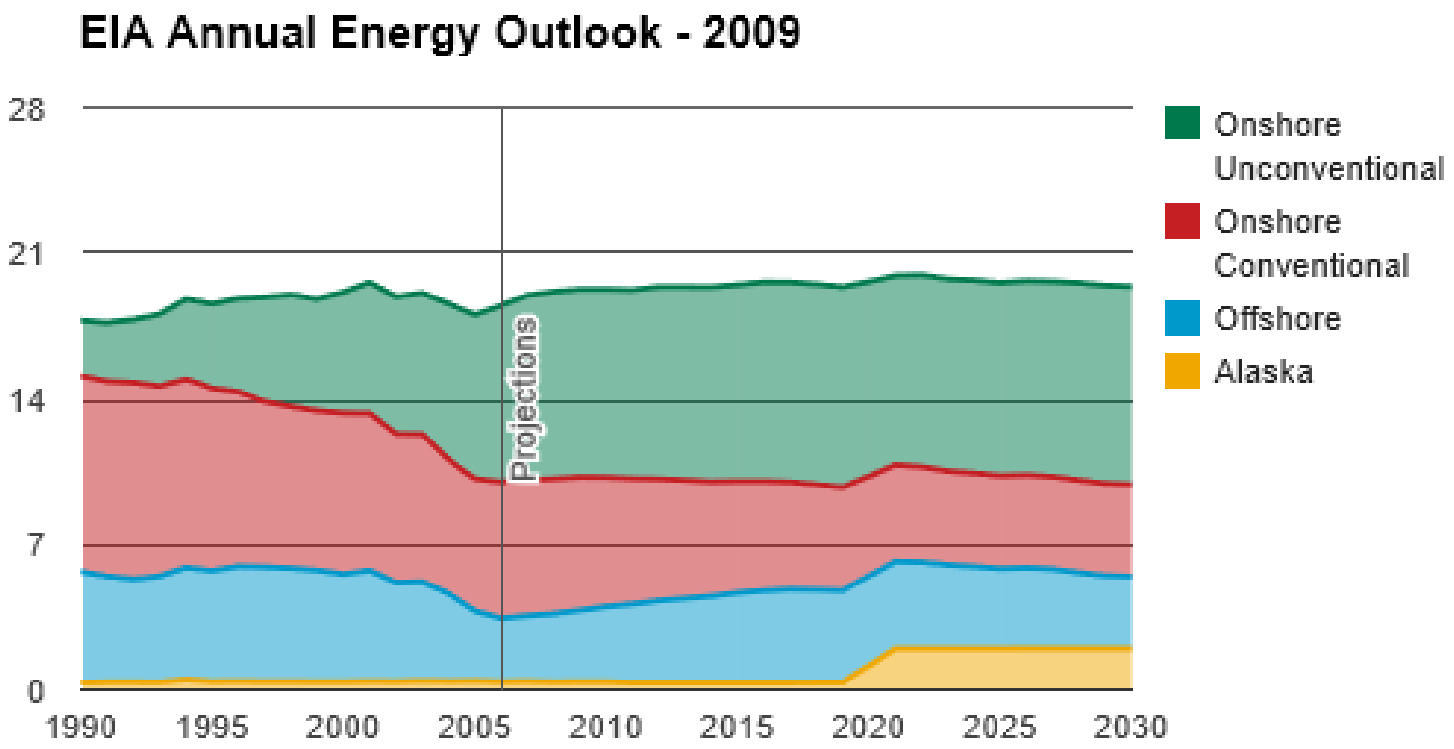
- U.S. Chemical Industry reaps double benefits of low-cost natural gas
  - Low-cost energy plus low-cost feedstocks →→ revival in U.S. manufacturing (for chemical production, as well as general manufacturing)
  - Largely because of shale gas, U.S. chemical firms will invest over ***$71.7 billion*** in new capacity by 2020 (based on projects announced through March 2013 – American Chemistry Council)
- New crackers announced or coming on line:
  - Chevron Phillips, Dow Chemical, Formosa Plastics, Williams, BASF, Mitsui, Kosan Co., ExxonMobil Chemical, Sasol, Shell Chemicals and Occidental Chemical/Mexichem

Follow the Money (Part 2)

A spokesperson with DDA Public Relations, which runs PR for Participant Media, the company that developed the film fund backing "Promised Land", confirmed that AD Media is a financier. ***The company is wholly owned by the government of the United Arab Emirates***

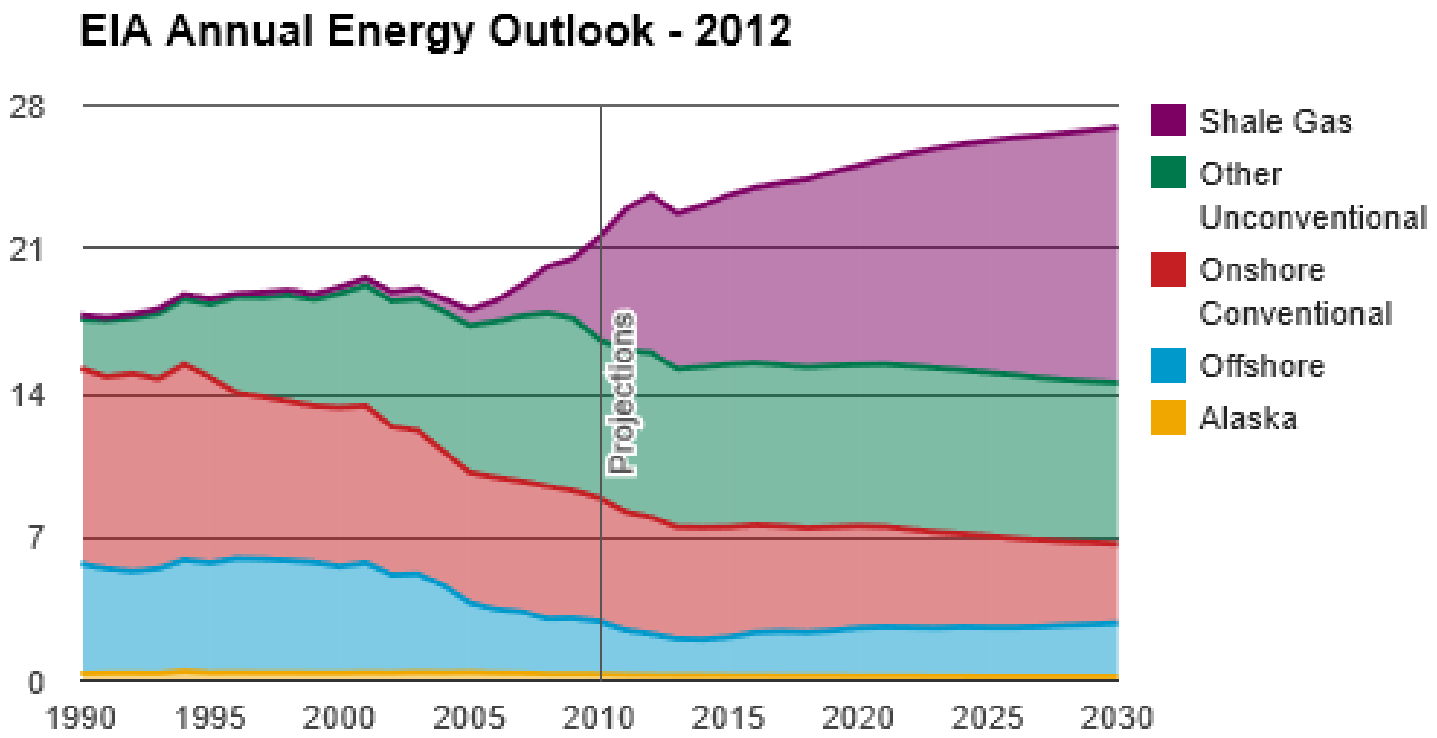
Source: Investor's Business Daily

2009 Forecast – Natural Gas



US Natural Gas Output, Trillion Cubic Feet

2012 Forecast – Natural Gas



US Natural Gas Output, Trillion Cubic Feet

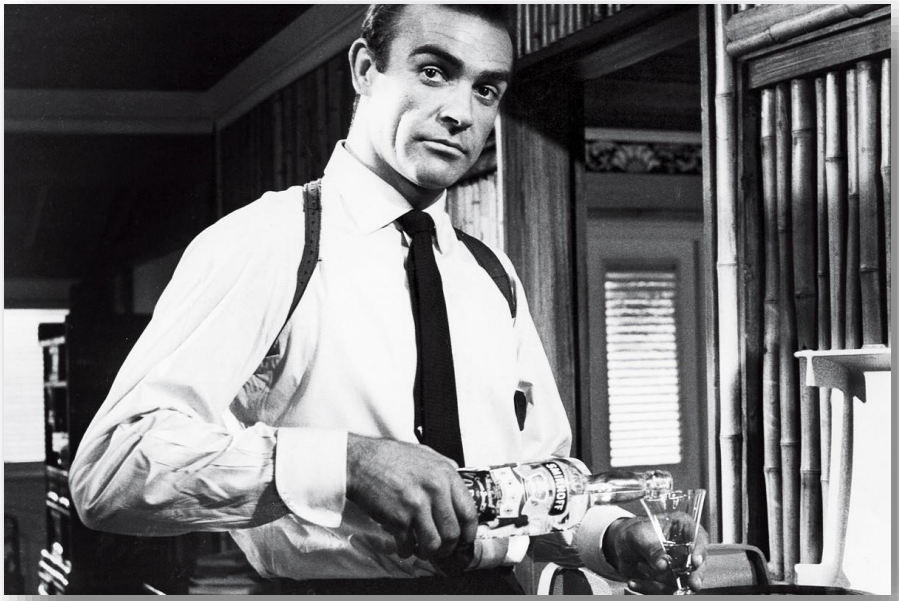
Oil and Gas Chemical Categories

- ***Drilling fluids***
  - *Chemical systems are used to lubricate the drill bit, to control formation pressure and to remove formation cuttings.*
- ***Cementing and stimulation***
  - *Chemicals are used to cement steel pipes or casing to the sides of the borehole and to encourage the flow of crude oil to the well (stimulation).*
- ***Oil production chemicals***
  - *Products are used at all stages, from oil production at the well bore to the delivery of crude to the refinery. Products include corrosion and scale inhibitors, biocides and demulsifiers.*

"HexaMethyl Pixie Dust – HELP!"

- Imidazolines and Amido Amines
- Phosphonates and phosphonate salts
- Quaternary amines ("Quats")
- Phosphate Esters
- Bauxite, Silica, resin coated silica
- Guar gum, Organometallic Crosslinked Guars
- Methanol, Isopropanol, Ethylene Glycol, 2-Butoxyethanol, Citric Acid, Hydrochloric Acid, Sodium Choride, Glutaraldehyde, Polyacrylamides

Shaken, Not Stirred….



- Each well requires a unique "cocktail" of additives engineered to maximize production for the specific geology and and chemistry of the site.
- This suggests that a one size fits all approach to water treatment is also unlikely

Serious Science Plus Black Magic

- Service bureau business model – each site is different
  - Engineered problem solving approach, versus traditional: "How many drums would you like today?"
- Defensible positions in fracking water treatment will likely be driven by knowledge of specific wells, geologic formations, chemistries, and regulation.
- Who has this knowledge?
  - Oilfield services companies / "retailers"*
  - Petroleum Engineering firms
  - Some (but not all) well owners / operators

**Retailers is an industry term for regional and local suppliers*

Convergence

- Oil and gas extraction and water treatment are fundamentally the same business:
  - In each, you are extracting, treating, and transporting complex fluids which are unique to the site and heavily regulated.
  - Institutional technical expertise configured locally
  - The synergies of convergence are enormous.
    - I.P., local know how, regulatory compliance, historical / institutional knowledge, less reinvention of the wheel

"BASF merges water, oilfield and mining businesses"

BASF Press Release, 3/27/2013

Fuzzy, Macro Opinion

- North America regains position as manufacturing powerhouse
  - **Low cost energy** (shale gas)
  - **Low cost chemicals and plastic** products
  - Continued **technology leadership** (required in current configuration as high cost producer)
  - High **labor costs**
  - Difficult **tax** and **regulatory** climate
- Net of **GOOD** and **BAD** is probably still pretty good

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