

Hydraulic Fracturing: What Informs Me

Broomfield Presentation

By:
John Harpole



October 8, 2013

Two Things I Think of When I Hear of a Fracking Ban...

- Mom's utility bills
- Pollution in China

Wall Street Journal Editorial Page 9/7/2013

Fracking and the Poor

By now even the Obama Administration has recognized that the natural gas drilling boom has led to more high-wage jobs, more secure energy supplies and lower manufacturing costs. But one of the biggest benefits from fracking and other new drilling technologies is often overlooked: the windfall to American consumers, especially the poor.

A new study by the Colorado-based energy broker Mercator Energy quantifies the multi-billion-dollar annual savings to American households through lower utility bills from the fall in natural gas prices.

From 2003-08, shortly before the fracking revolution took hold, the price of natural gas averaged about \$7.20 per million BTUs. By 2012 after new drilling operations exploded across the U.S.—from West Texas to Pennsylvania to North Dakota—the increase in natural gas production had slashed the price to \$2.80 per million BTUs.

Mercator examined Department of Energy data on natural gas usage to find out how this 61% price decline translated into lower home-heating and electricity bills. According to the federal Energy Information Administration, American households use about 7.4 billion MMBTUs for home heating and residential electricity each year.

Thanks to the lower price for natural gas, families saved roughly \$32.5 billion in 2012. (That's 7.4 billion MMBTUs of residential use of natural gas times the \$4.40 reduction in price.) The windfall to all U.S. natural gas consumers—industrial and residential—was closer to \$110 billion. This is greater than the annual income of all of the residents in 14 states in 2011.

Mercator's most notable finding is that the income group helped the most by this bonanza is the poor because energy is a big component

of their family budgets. Data from the annual report of the federal Low Income Home Energy Assistance Program (Liheap) show that poor

The natural gas boom may be America's best antipoverty program.

households spend four times more of their income on home energy (10.4%) than do non-poor households (2.6%). That same report says that roughly 40 million households, or 36% of U.S. households, are eligible for Liheap. Though the poor on average spend less overall on heating and electricity, lower natural gas prices have still shaved about \$10 billion a year from the utility bills of poor families.

To put it another way, fracking is a much more effective antipoverty program than is Liheap. In 2012, Liheap provided roughly \$3.5 billion to about nine million low-income households to subsidize their home-heating costs. New drilling technologies saved poor households almost three times more. Low gas prices benefit nearly all poor households, while Liheap helps fewer than one in four.

These energy savings are especially impressive compared to what residents of other industrialized nations are paying. The natural gas price this summer increased to about \$3.70 per million BTUs, but that compares to the roughly \$10 that consumers pay in Spain or \$13 in China. According to the Mercator analysis, if natural gas prices were that high in the U.S., average home heating bills for millions of Americans would be almost 75% higher.

You'd think that good liberal egalitarians would welcome these financial savings to poor households. Yet most green groups, in particular the Sierra Club, continue to oppose fracking and are using lawsuits and political lobbying to stop it. Rich Hollywood types like Matt Damon propagandize against it. No one is doing more to increase income inequality in America than the affluent environmentalists who oppose natural gas drilling.

Fox News Coverage One Month Ago

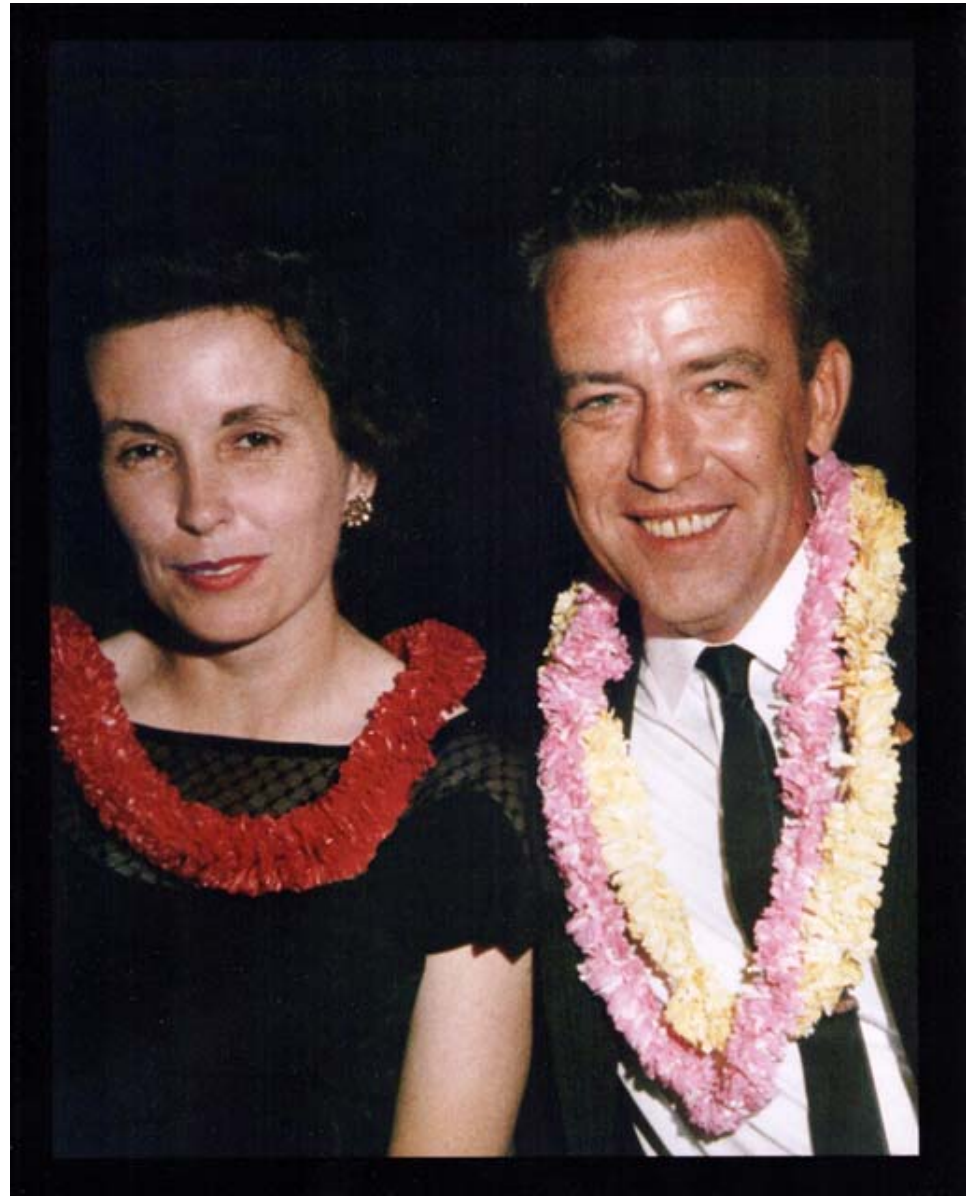


Michael Harpole, the Intern



Who I Am

- 33 years in the Oil & Gas Industry
- Appointed by Gov. Owens to **Low Income Energy Commission** in 1998
- **Energy Outreach Colorado Board Member** since 2006
- Author of **RIK-LIHEAP 2005 Energy Policy Act**
- Son of Phil & Mary





May 13th, 1966





35 Years of Energy Bills



The Cougar's Cubs in Action





Rocky Mountain News

A Scripps-Howard Newspaper

Reg. U.S. Pat. Off.

Colorado's First Newspaper—Founded in 1859

113TH YEAR, NO. 85

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FORECAST:
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10c
128 PAGES

Trip before May at Chou En-lai's invitation

President to visit mainland China



LOS ANGELES (UPI)—In a stunning surprise, President Nixon announced Thursday night he had accepted an invitation from Premier Chou En-lai to visit the Peoples Republic of China sometime before next May.

He said the trip was arranged during a secret visit of his national security adviser, Dr. Henry A. Kissinger, to Peking July 9 to July 11 while Kissinger was on an around the world trip.

"I have taken this action because of my profound conviction that all nations will gain from a reduction of tensions and a better relationship between the United States and the People's Republic of China," the President said in a five minute nationwide radio and television statement.

He would be the first U.S. President to visit the People's Republic of China, the world's largest Communist nation, which the United States has never formally recognized.

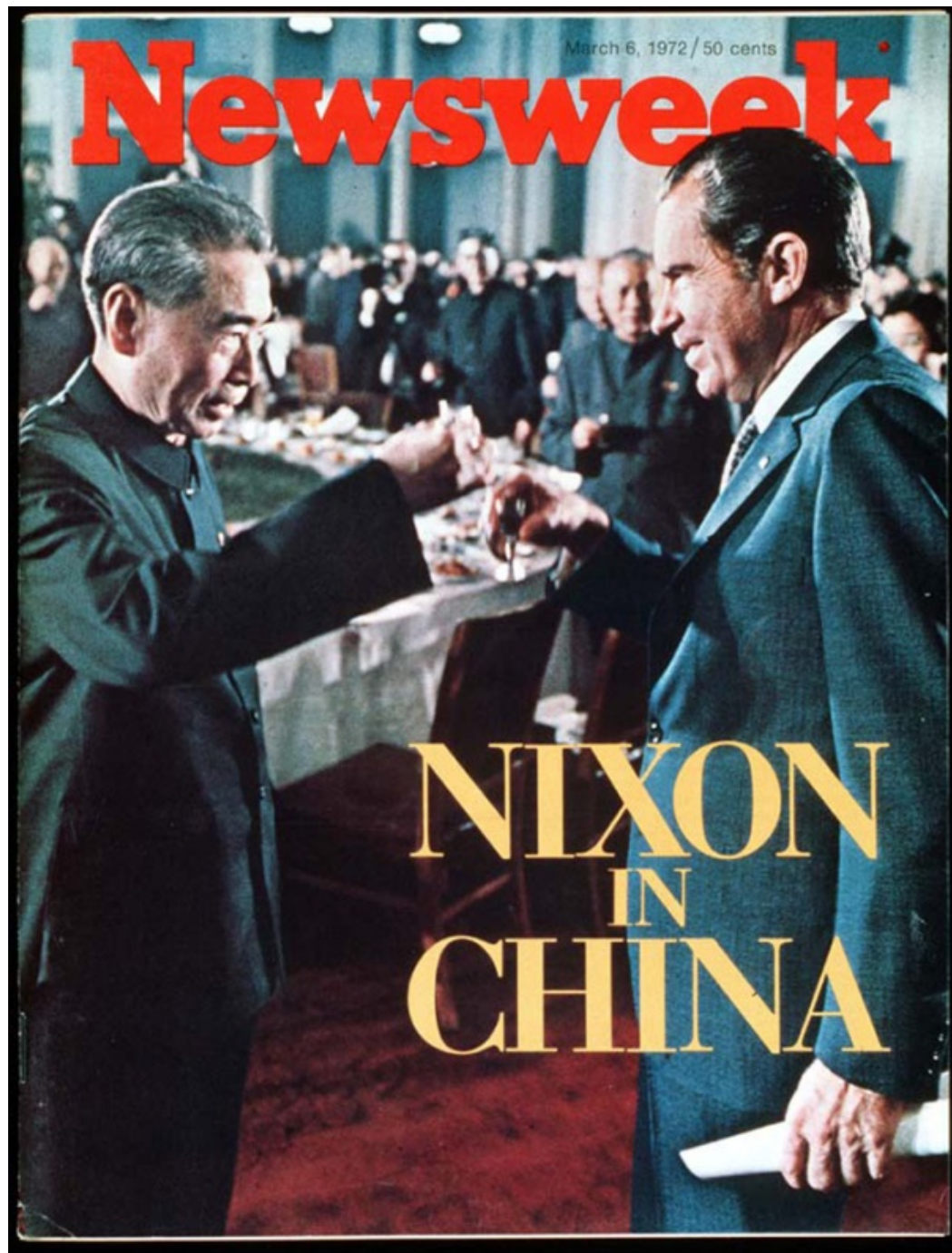
The announcement, made simultaneously here and in Peking, signaled a major departure in the policy which the United States has followed since the Communists took over mainland China at the end of World War II.

"As I have pointed out on a number of occasions over the past three years, there can be no stable and enduring peace without the participation of the Peoples Republic of China and its 750 million people," the President said.

In anticipation of the protest that appeared sure to be heard from the government of the Republic of China in Taiwan, the President said his action in seeking a new relationship with mainland China "will not be at the expense of our old friends."

"It is not directed against any other nation. We seek friendly relations with all nations. Any nation can be our friend without being any other nation's enemy."

The announcement came on the heels of several initiatives toward normalizing relations with the Communist Chinese government. The President recently relaxed trade and travel restrictions to mainland China and indicated that the United States might drop



Harpoles In China: 2010 & 2012











China is Looking to Us



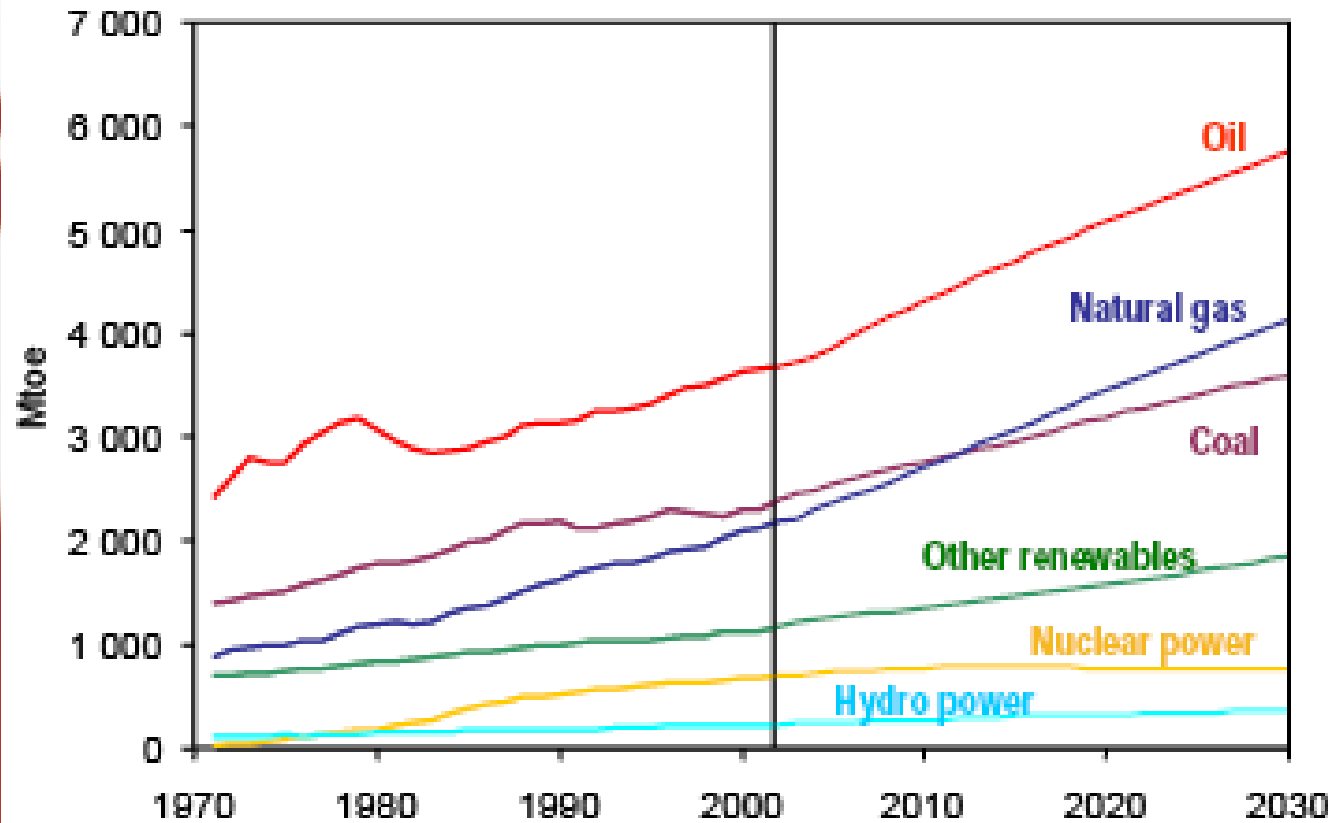








World Primary Energy Demand



Fossil fuels account for almost 90% of the growth in energy demand between now and 2030

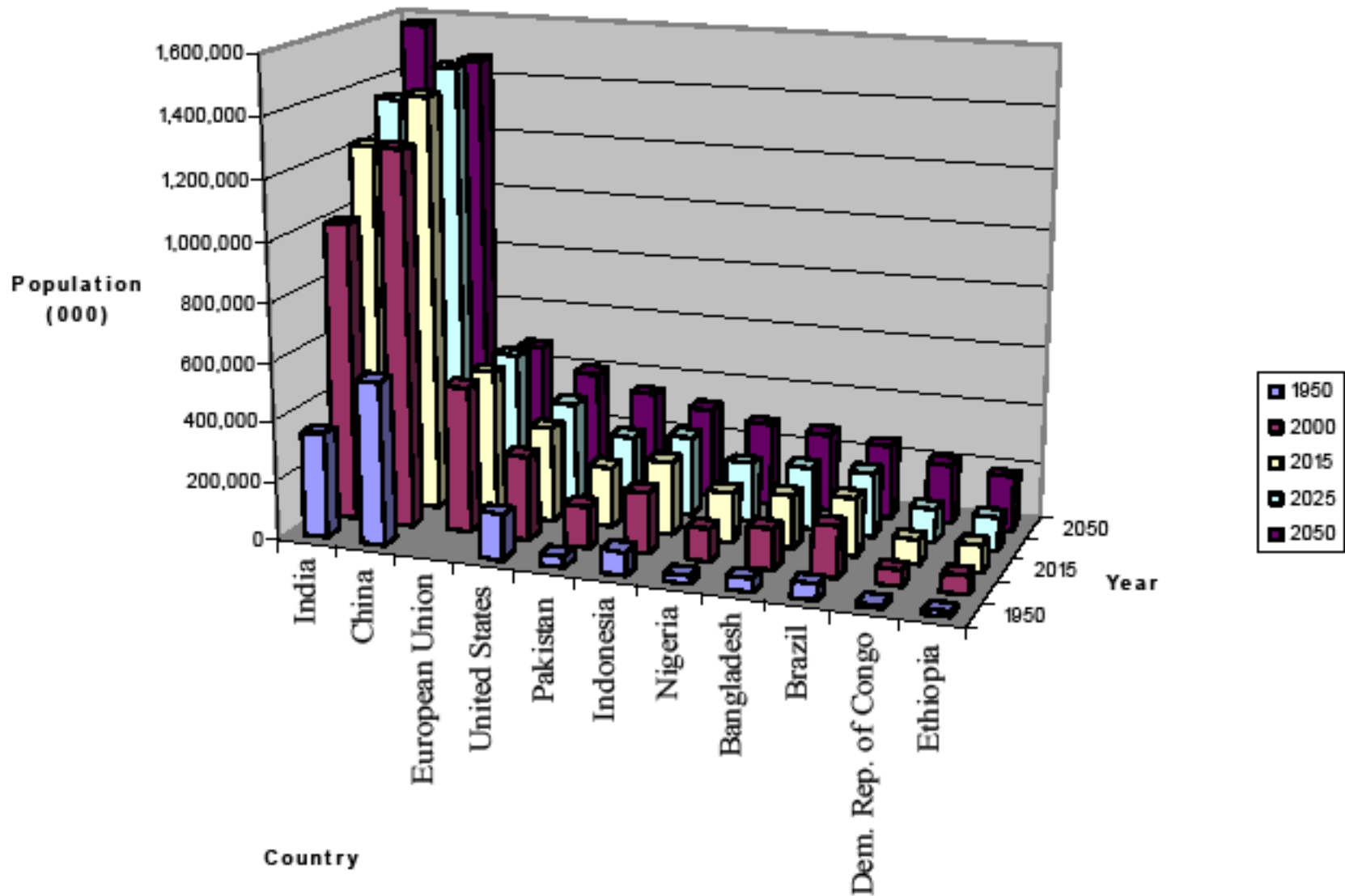
WORLD
ENERGY
OUTLOOK

INTERNATIONAL
ENERGY AGENCY

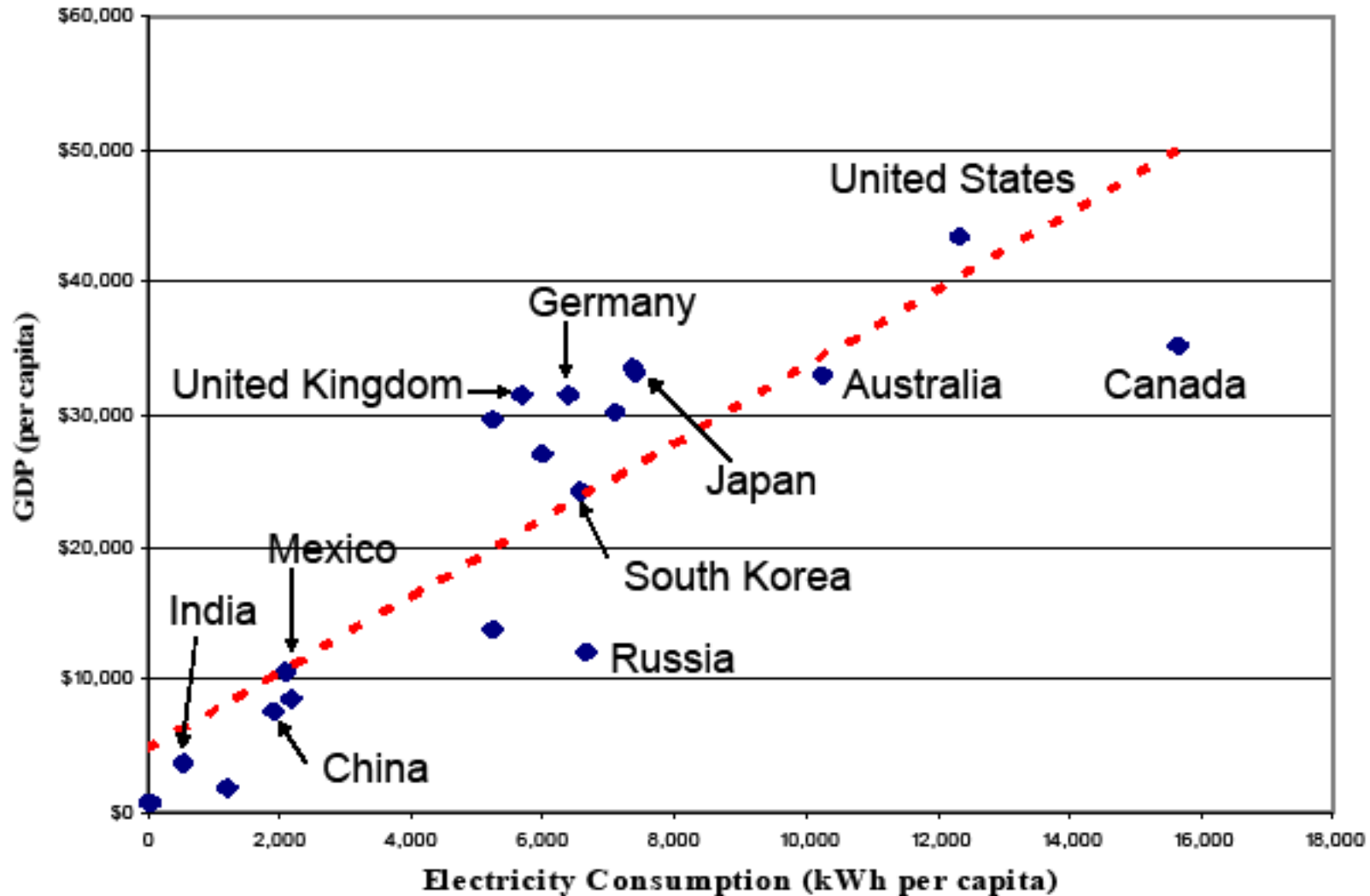


Mercator Energy

Population Growth from 1950-2050

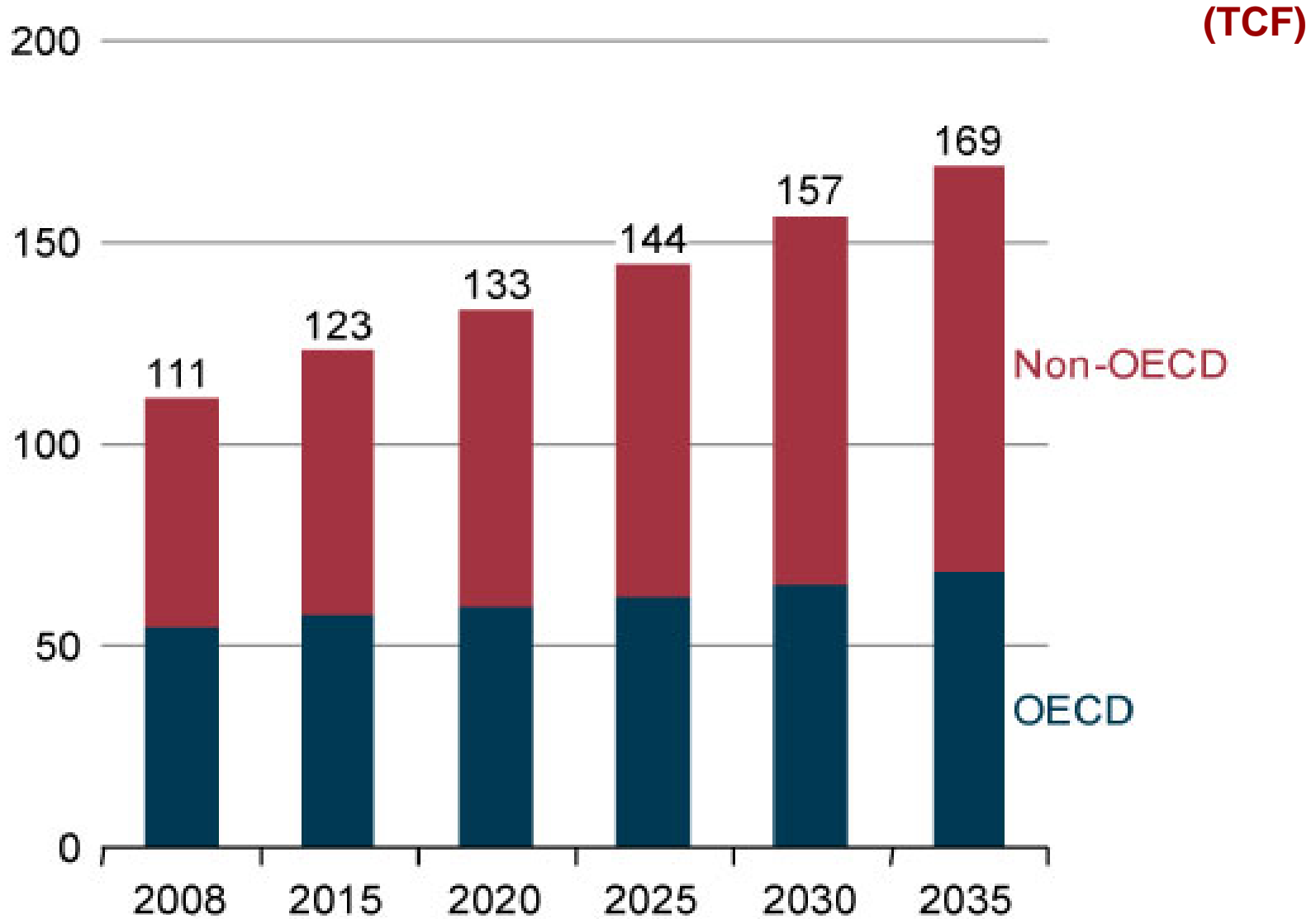


Quality of Life is Strongly Correlated with Electricity Consumption



Source: CIA World Factbook, 2007

World Natural Gas Consumption, 1990-2035



Russia, Iran and Qatar Form Natural Gas Cartel

10/21/2008 in Tehran, Iran

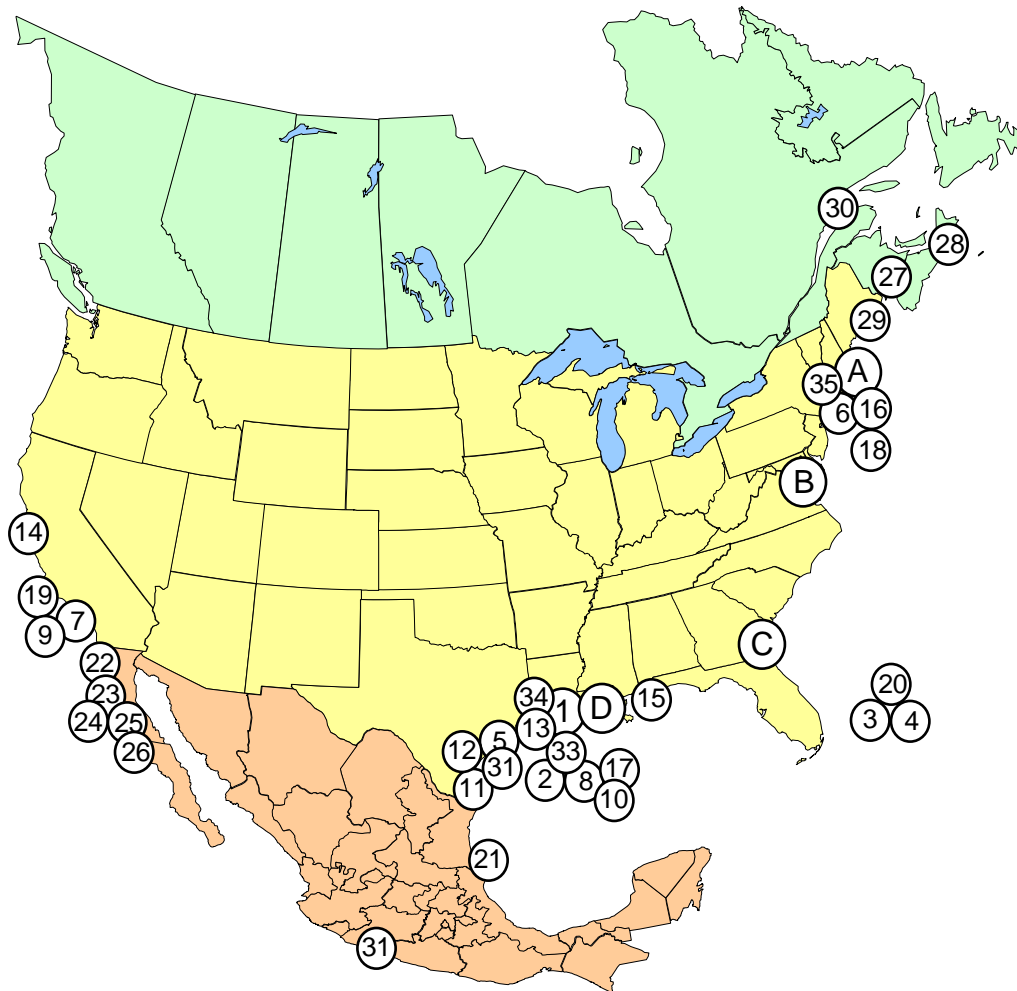


Qatar's Deputy Premier and
Minister of Energy and Industry,
Abdullah bin Hamad Al-Attiya

Iranian Oil Minister,
Gholam Hossein Nozari

Alexei Miller, Chief of
Russia's state gas
monopoly - Gazprom

Existing and Proposed Lower-48 LNG Terminals



December 2003

Source: Pat Wood, Federal Energy Regulatory Commission, LNG Ministerial Conference Presentation

Existing Terminals with Expansions

- A. Everett, MA : 1.035 Bcfd (Tractebel)
- B. Cove Point, MD : 1.0 Bcfd (Dominion)
- C. Elba Island, GA : 1.2 Bcfd (El Paso)
- D. Lake Charles, LA : 1.2 Bcfd (Southern Union)

Approved Terminals

- 1. Hackberry, LA : 1.5 Bcfd, (Sempra Energy)
- 2. Port Pelican: 1.0 Bcfd, (Chevron Texaco)

Proposed Terminals – FERC

- 3. Bahamas : 0.84 Bcfd, (AES Ocean Express)
- 4. Bahamas : 0.83 Bcfd, (Calypso Tractebel)
- 5. Freeport, TX : 1.5 Bcfd, (Cheniere / Freeport LNG Dev.)
- 6. Fall River, MA : 0.4 Bcfd, (Weaver's Cove Energy)
- 7. Long Beach, CA : 0.7 Bcfd, (SES/Mitsubishi)

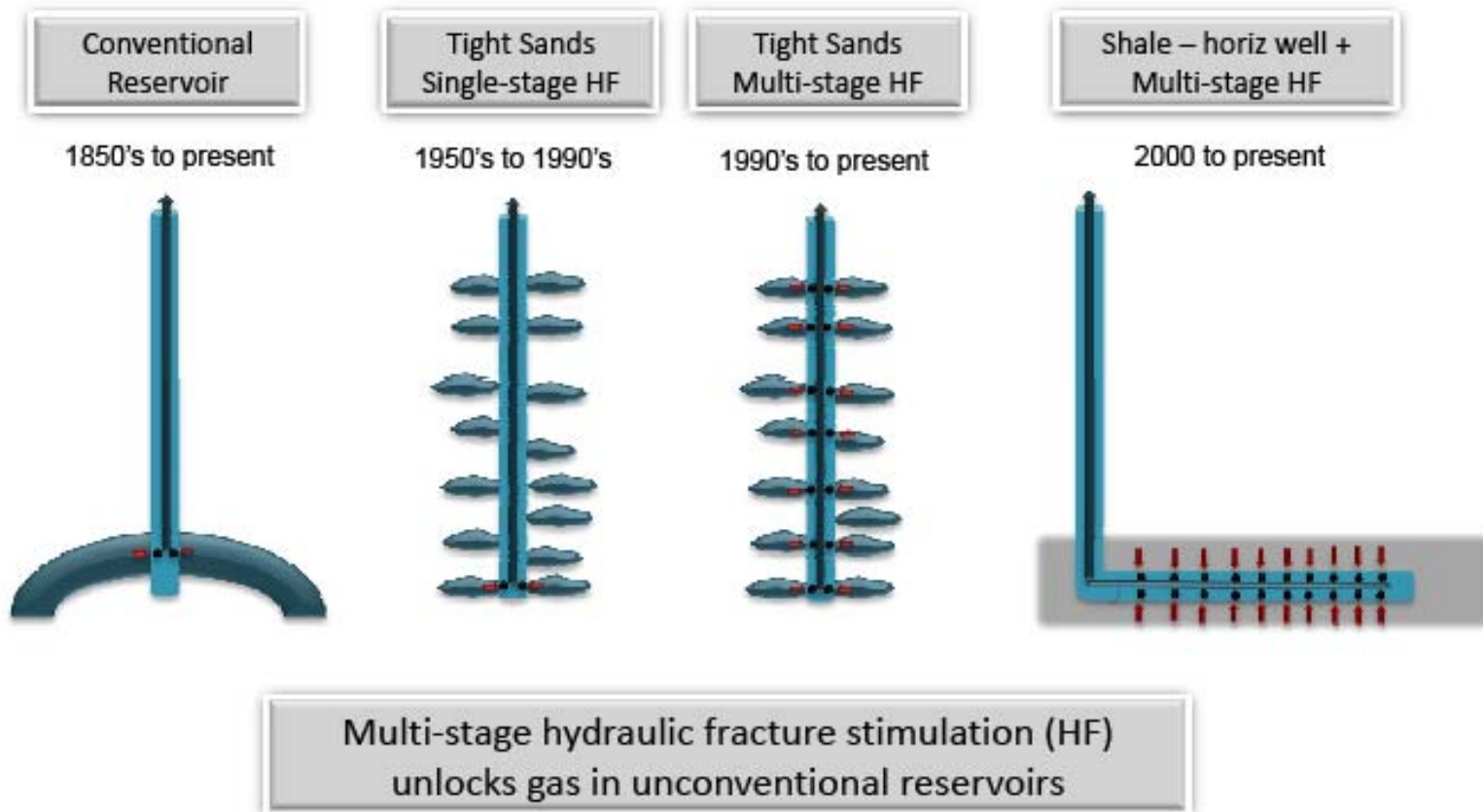
Proposed Terminals – Coast Guard

- 8. Gulf of Mexico: 0.5 Bcfd, (El Paso Global)
- 9. California Offshore: 1.5 Bcfd, (BHP Billiton)
- 10. Louisiana Offshore : 1.0 Bcfd (Gulf Landing – Shell)

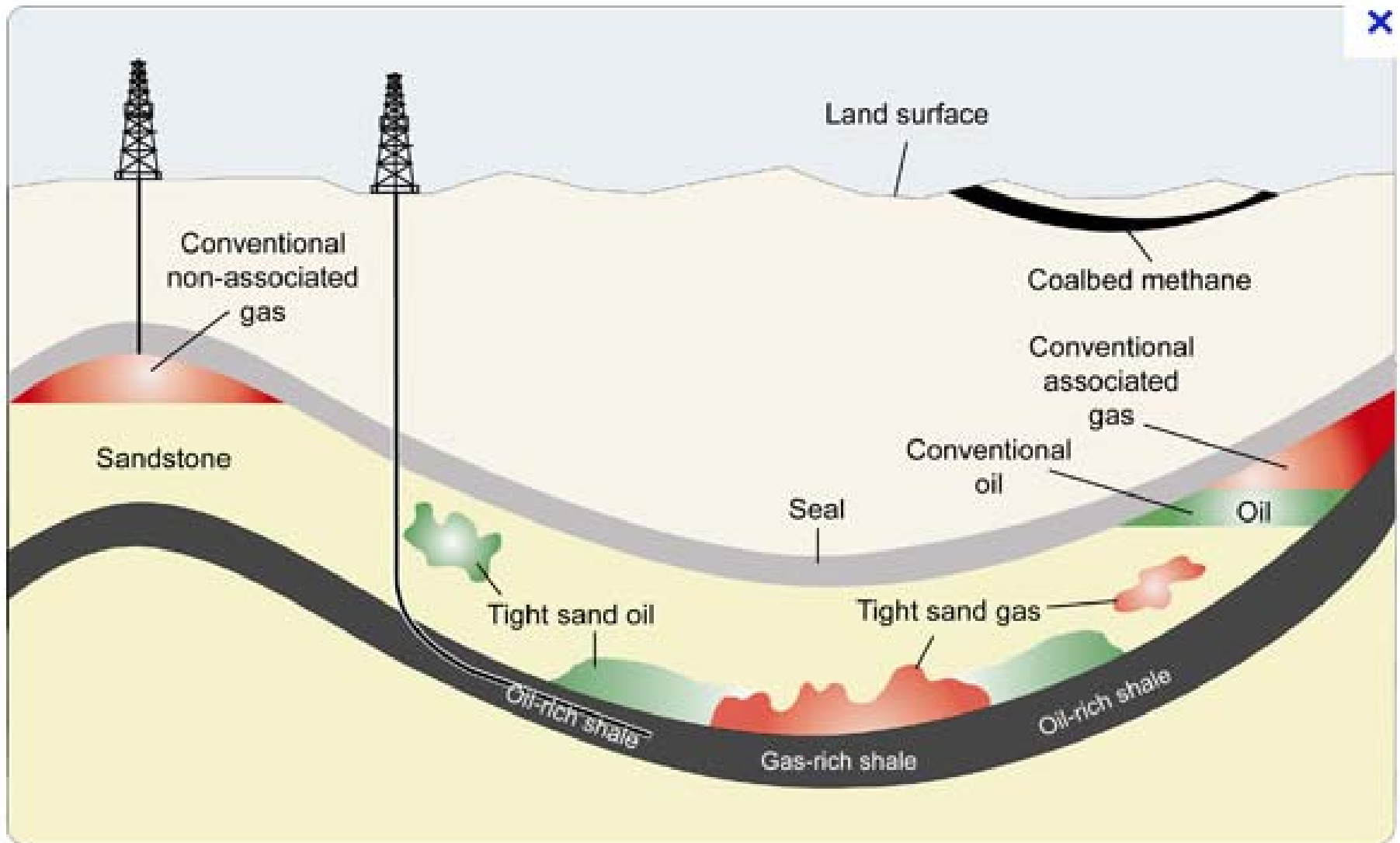
Planned Terminals

- 11. Brownsville, TX : n/a, (Cheniere LNG Partners)
- 12. Corpus Christi, TX : 2.7 Bcfd, (Cheniere LNG Partners)
- 13. Sabine, LA : 2.7 Bcfd (Cheniere LNG)
- 14. Humboldt Bay, CA : 0.5 Bcfd, (Calpine)
- 15. Mobile Bay, AL: 1.0 Bcfd, (ExxonMobil)
- 16. Somerset, MA : 0.65 Bcfd (Somerset LNG)
- 17. Louisiana Offshore : 1.0 Bcfd (McMoRan Exp.)
- 18. Belmar, NJ Offshore : n/a (El Paso Global)
- 19. So. California Offshore : 0.5 Bcfd, (Crystal Energy)
- 20. Bahamas : 0.5 Bcfd, (El Paso Sea Fare)
- 21. Altamira, Tamulipas : 1.12 Bcfd, (Shell)
- 22. Baja California, MX : 1.3 Bcfd, (Sempra)
- 23. Baja California : 0.6 Bcfd (Conoco-Phillips)
- 24. Baja California - Offshore : 1.4 Bcfd, (Chevron Texaco)
- 25. Baja California : 0.85 Bcfd, (Marathon)
- 26. Baja California : 1.3 Bcfd, (Shell)
- 27. St. John, NB : 0.75 Bcfd, (Irving Oil & Chevron Canada)
- 28. Point Tupper, NS : 0.75 Bcfd (Access Northeast Energy)
- 29. Harpswell, ME : 0.5 Bcfd (Fairwinds LNG – CP & TCPL)
- 30. St. Lawrence, QC : n/a (TCPL and/or Gaz Met)
- 31. Lázaro Cárdenas, MX : 0.5 Bcfd (Tractebel)
- 32. Corpus Christi, TX : 1.0 Bcfd (ExxonMobil)
- 33. Gulf of Mexico : 1.0 Bcfd (ExxonMobil)
- 34. Sabine, LA : 1.0 Bcfd (ExxonMobil)
- 35. Providence, RI ; 0.5 Bcfd (Keyspan & BG LNG)

EVOLUTION IN GAS WELL COMPLETION TECHNOLOGY - THE KEY TO TODAY'S NATURAL GAS REVOLUTION

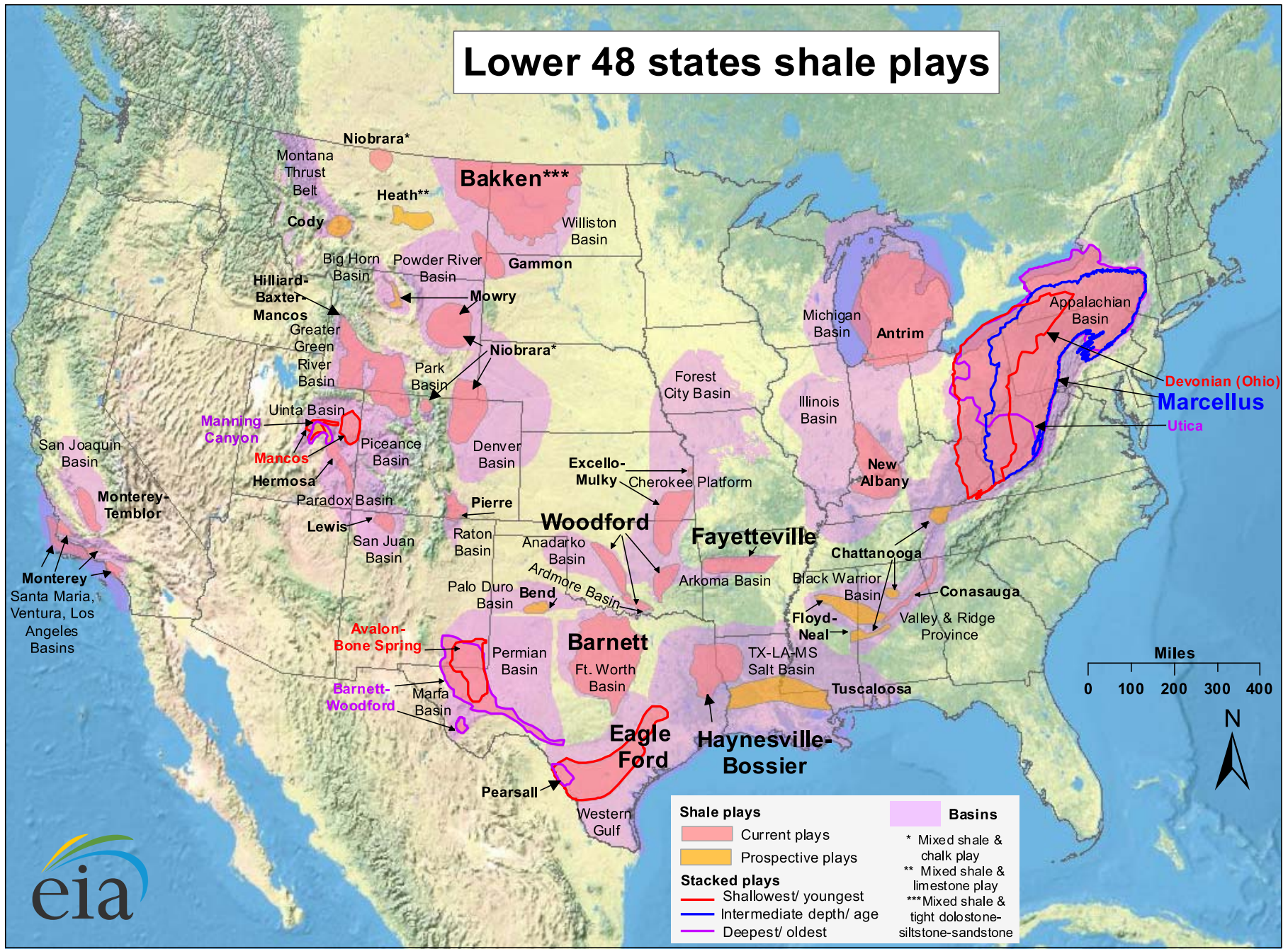


Conventional vs Unconventional Reservoirs



Source: Chris Wright, Liberty Resources Tuesday Lunch Club Presentation, 3/5/13

Lower 48 states shale plays



Source: Energy Information Administration based on data from various published studies. Updated: May 9, 2011

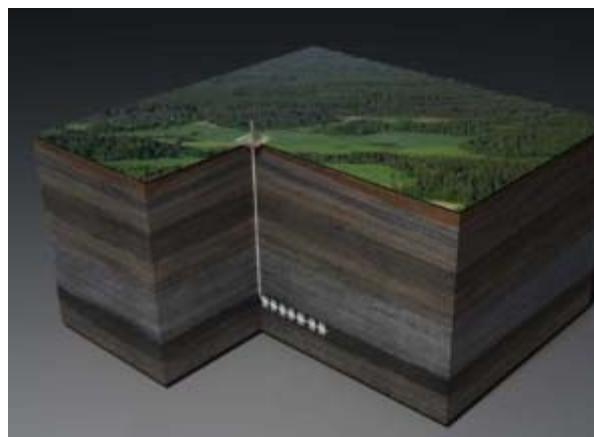
Fracture Treatment in 1949



12 Miles East of Duncan, OK

Definition

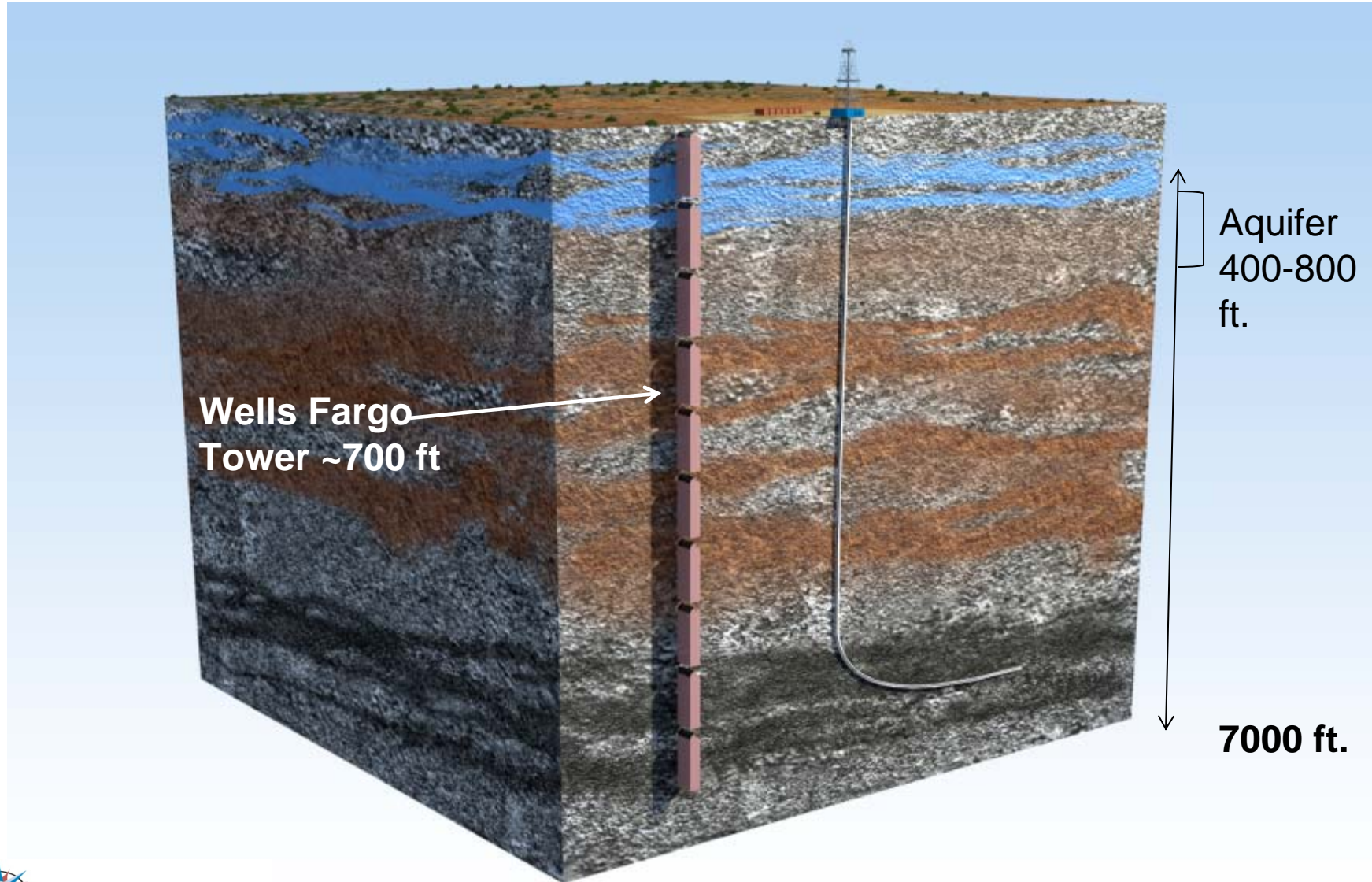
- The use of fluids to create a crack by hydraulic pressure
- The continued injection of fluids into the created crack fracture to make it grow larger
- The placement of small granular solids into the crack to ensure the crack remains open after the hydraulic pressure is no longer applied



Why HF a Well?

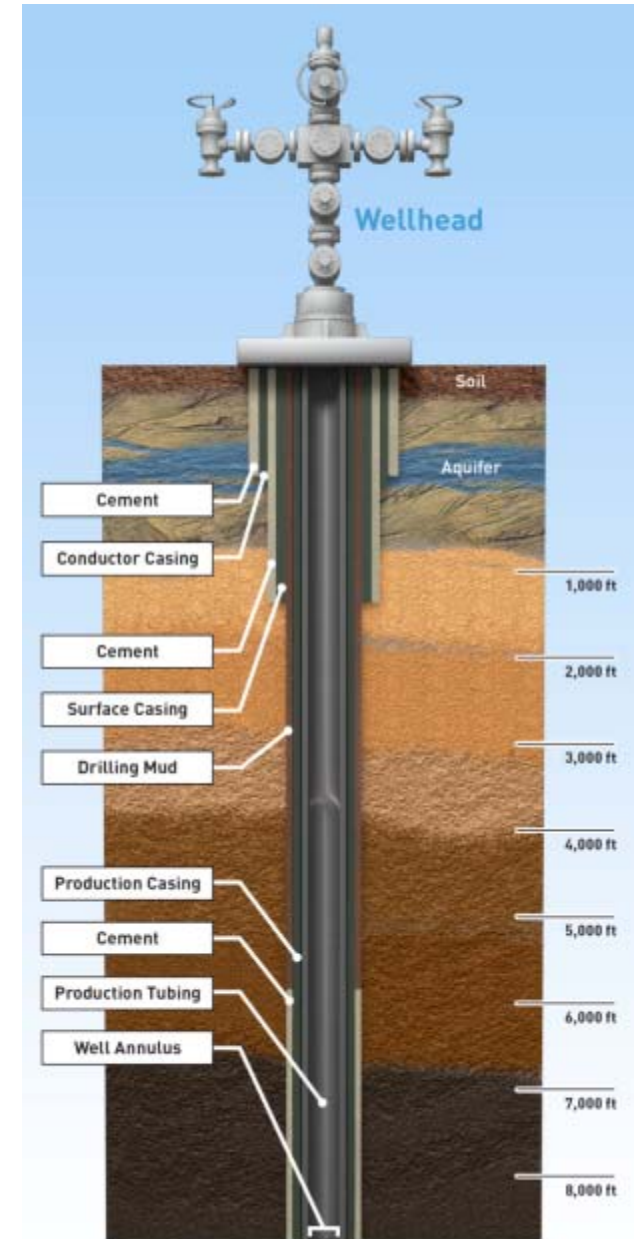
- Increase the **Rate** at which the well is capable of producing oil or gas
- Most unconventional formations **Require** hydraulic fracturing to be economic
- Does not increase total **Reserves**

Drilling Distance



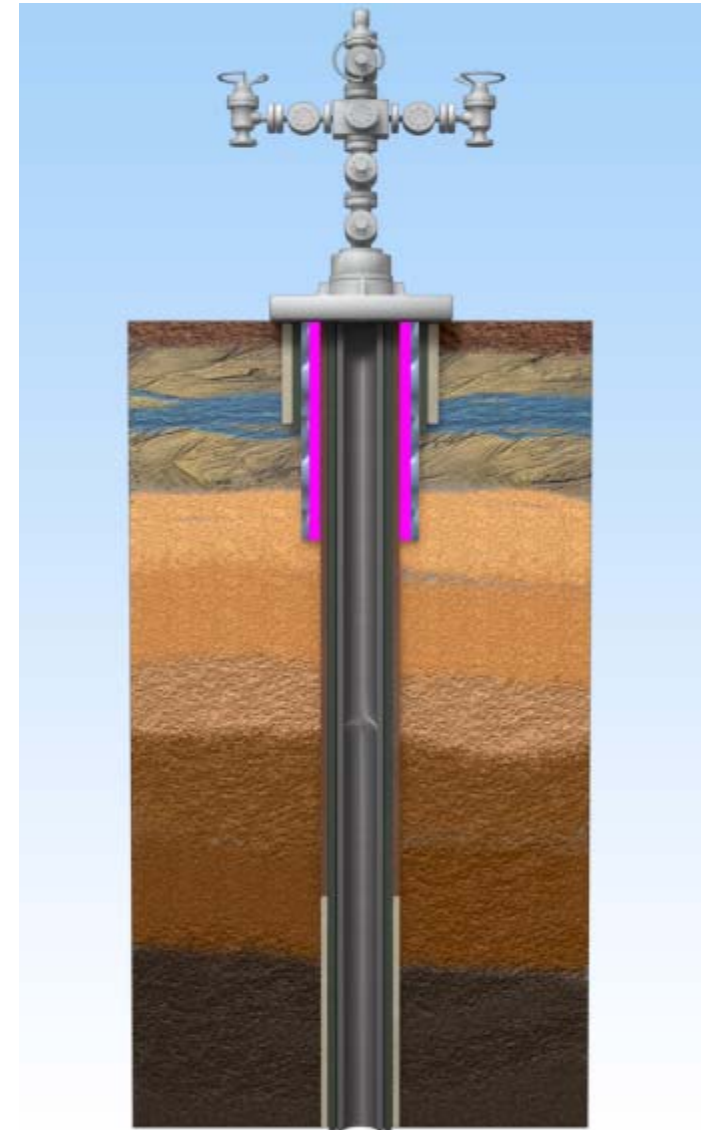
Casing

- Multiple layers surrounding the aquifer
 - Cement
 - Conductor Casing
 - Cement
 - Surface Casing
 - Drilling Mud
 - Production Casing
 - Cement
 - Production Tubing
 - Well Annulus



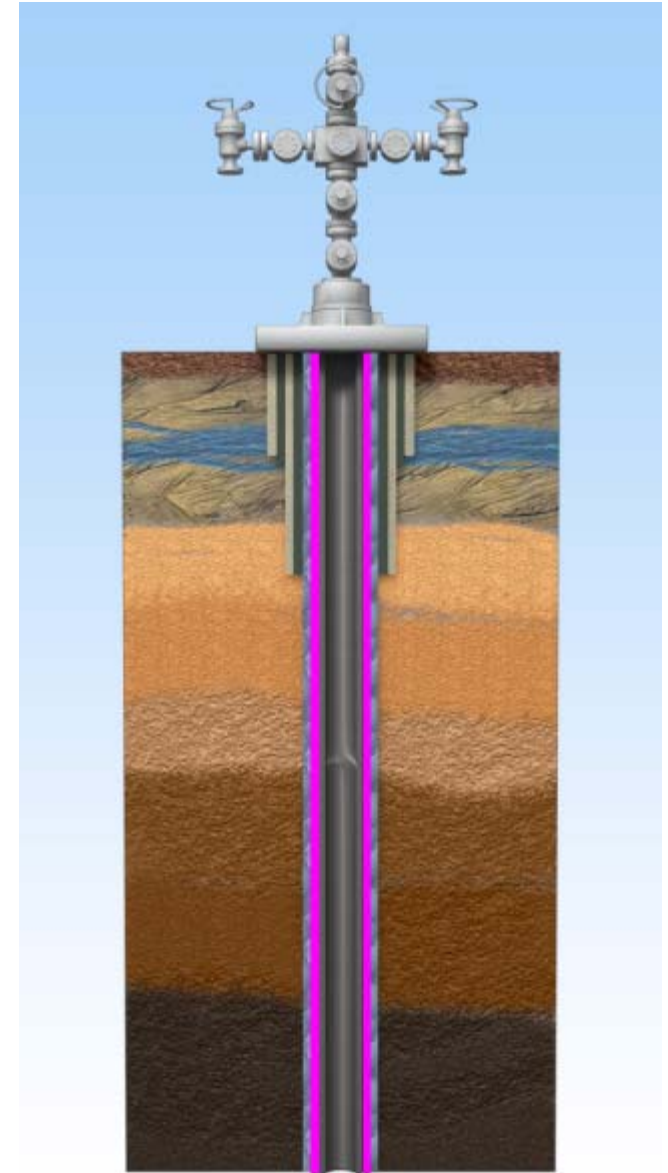
Surface Casing

- Purpose
 - Protect ground water
 - Provide stable wellbore during drilling operation
 - Provide well control during drilling
- Depth Requirements
 - Set by State and BLM regulations
 - Extends below the aquifer
- Cement Helps
 - Protect casing from corrosion
 - Provide zonal isolation
 - Support casing in wellbore



Production Casing

- Purpose
 - Provide zonal isolation
 - Provide well control
 - Well path to productive intervals
- Cement Requirements
 - Set by State regulations
 - Set by BLM regulations
 - Operator requirements
- Cement Helps
 - Protect casing from corrosion
 - Support casing in wellbore



HF Fluids

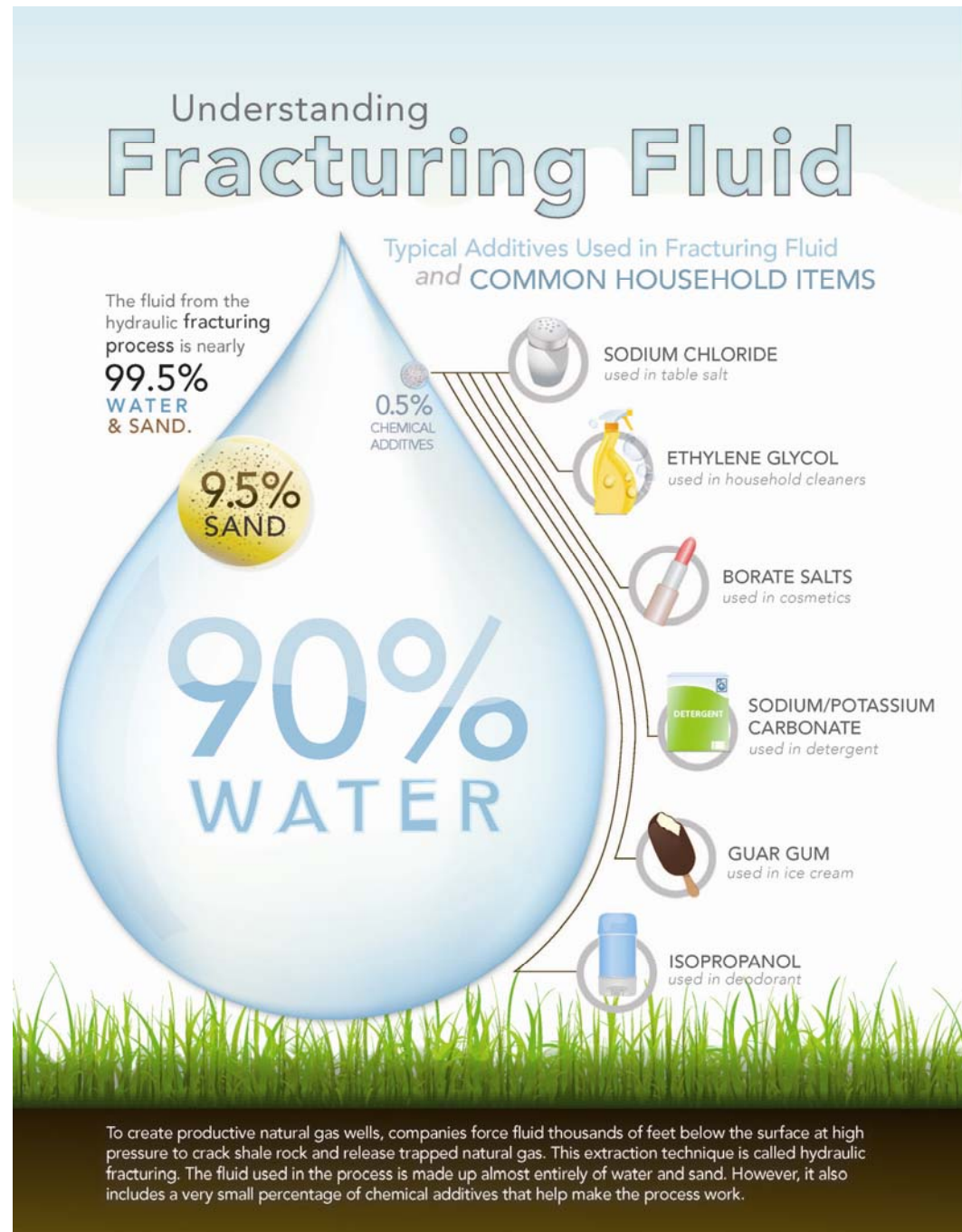
- Depending on the fluid system being pumped various additives are used:
 - Polymers
 - Crosslinkers
 - pH Control
 - Gel Breakers
 - Surfactants
 - Clay Control
 - Bacteria Control
 - Fluid Loss Additives
- Additives are transported in concentrated form
- Typically injected at less than 3 gallons per 1,000 gal of water (0.3%)
- All additive injection rates are controlled.
- The purpose of any additive is to help improve the overall process

HF Fluids

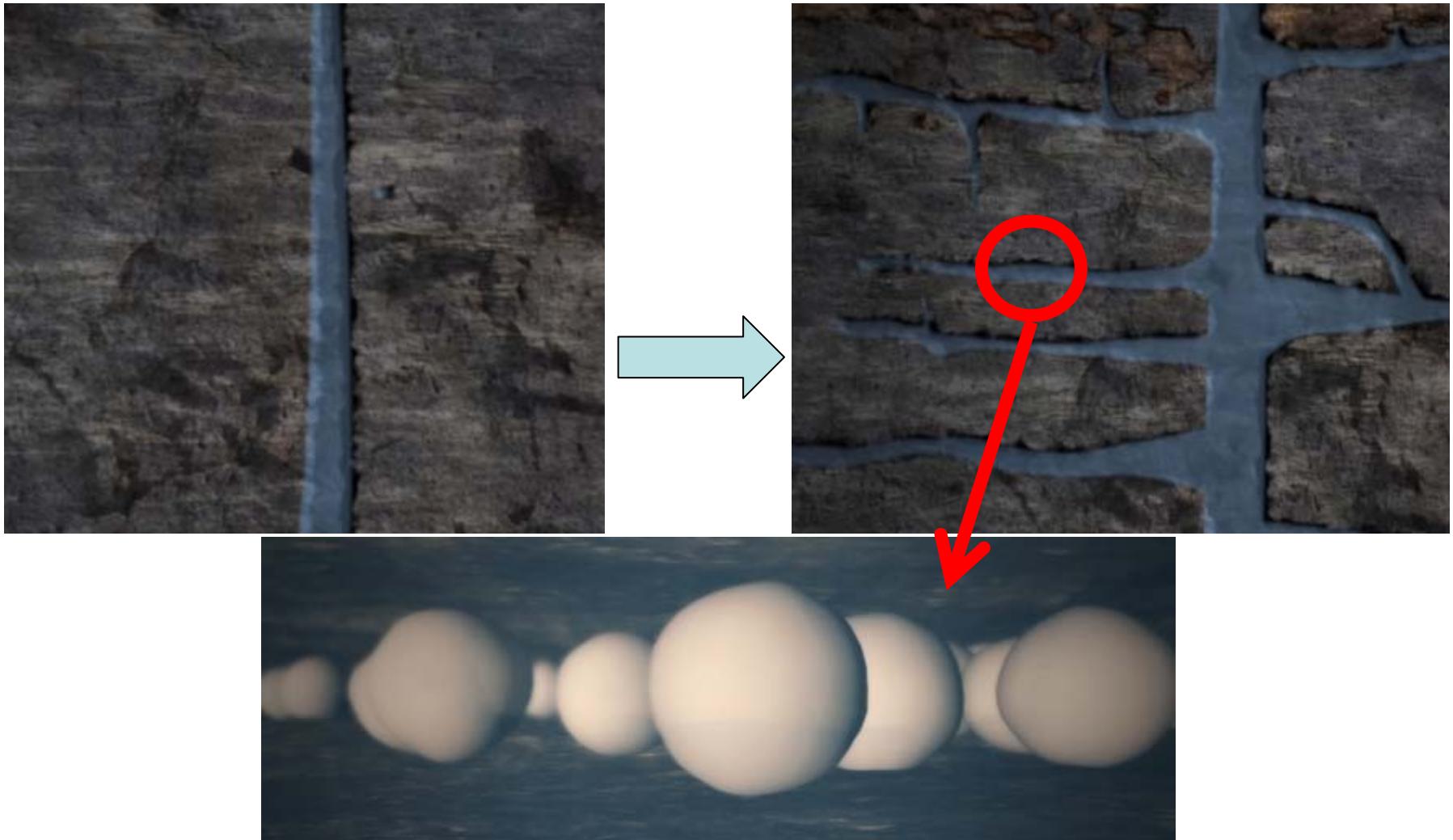
Additive	Main Compound	Common Use
Diluted Acid	Hydrochloric, Muriatic Acid	Swimming Pools
Biocide	Glutaraldehyde	Dental Disinfectant
Breaker	Ammonium Persulfate	Bleaching Hair
Crosslinker	Borate Salts	Laundry Detergents
Iron Control	Citric Acid	Food Additive
Gelling Agent	Guar Gum	Biscuits
Scale Inhibitor	Ethylene Glycol	Antifreeze
Surfactant	Isopropanol	Glass Cleaner
Friction Reducer	Polyacrylamide	Water and Soil Treatment

More than 85% of the natural gas consumed in the U.S. last year was produced from a hydraulically fractured formation.

Source: Energy From Shale, *Fracking Fluids*

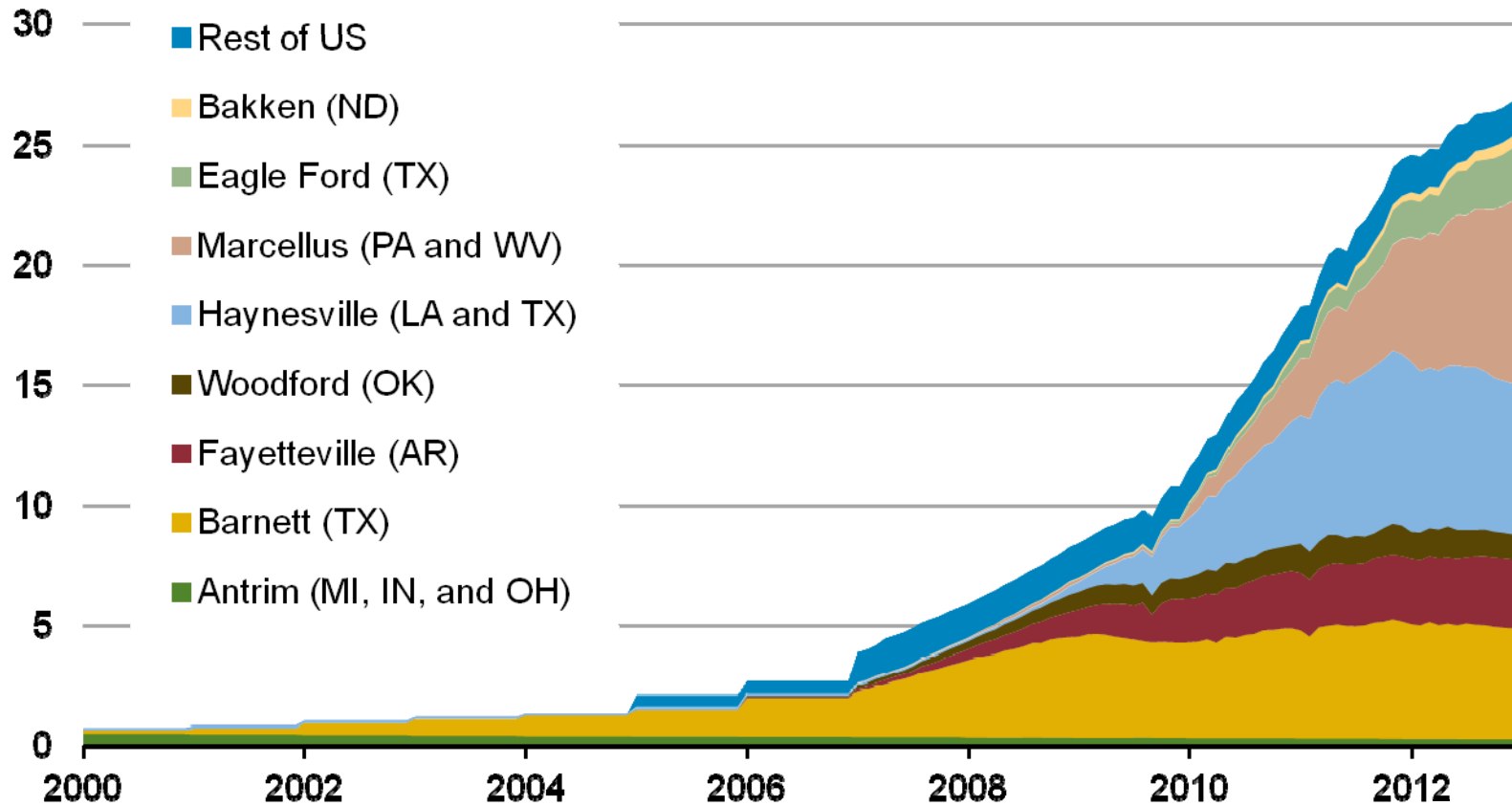


Fractures and Proppant



Domestic production of shale gas has grown dramatically over the past few years

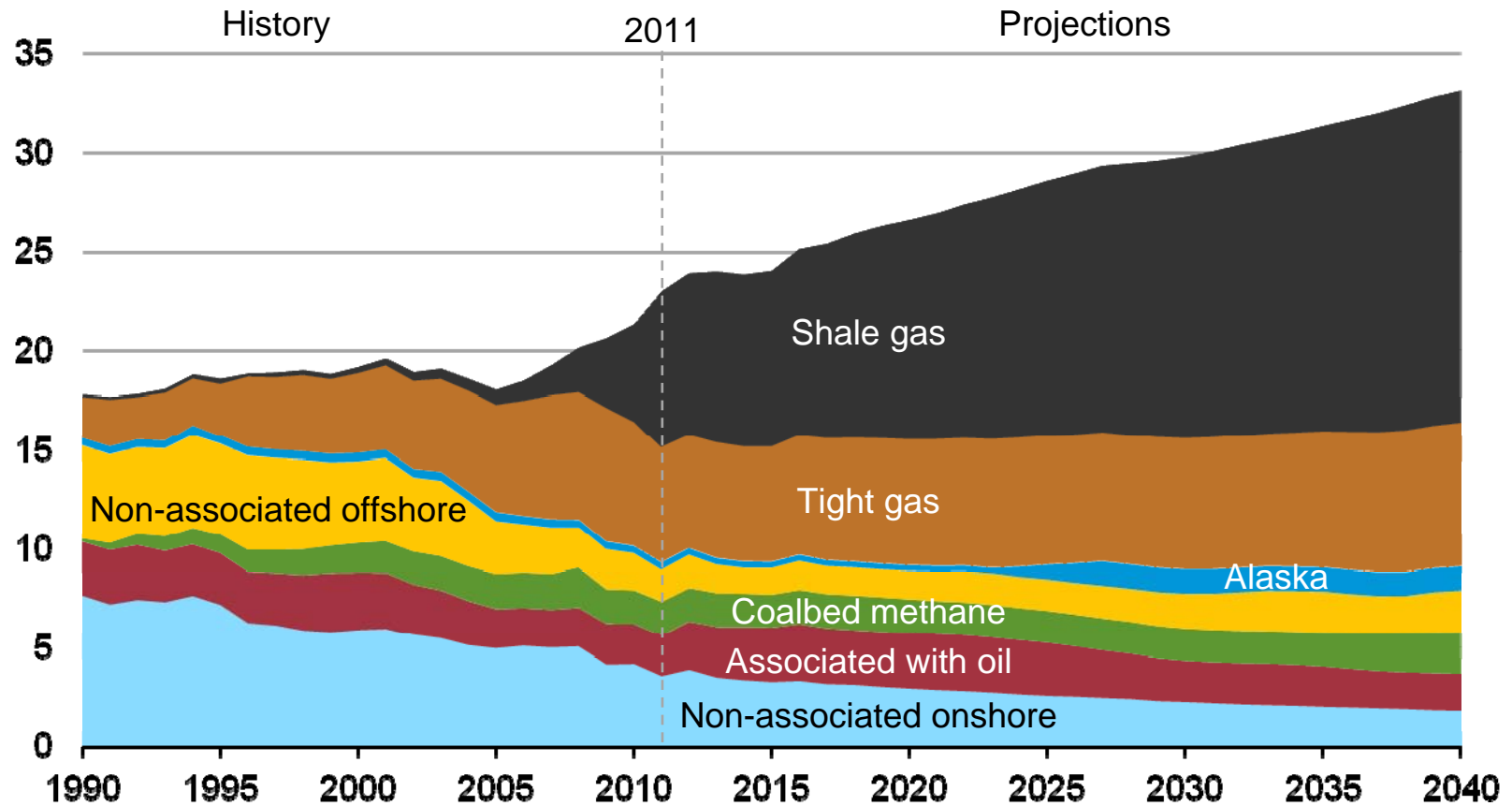
shale gas production (dry)
billion cubic feet per day



Sources: LCI Energy Insight gross withdrawal estimates as of January 2013 and converted to dry production estimates with EIA-calculated average gross-to-dry shrinkage factors by state and/or shale play.

Shale gas leads growth in total gas production through 2040

U.S. dry natural gas production
trillion cubic feet



Source: EIA, Annual Energy Outlook 2013 Early Release

Forecasts for Shale Gas Resource?

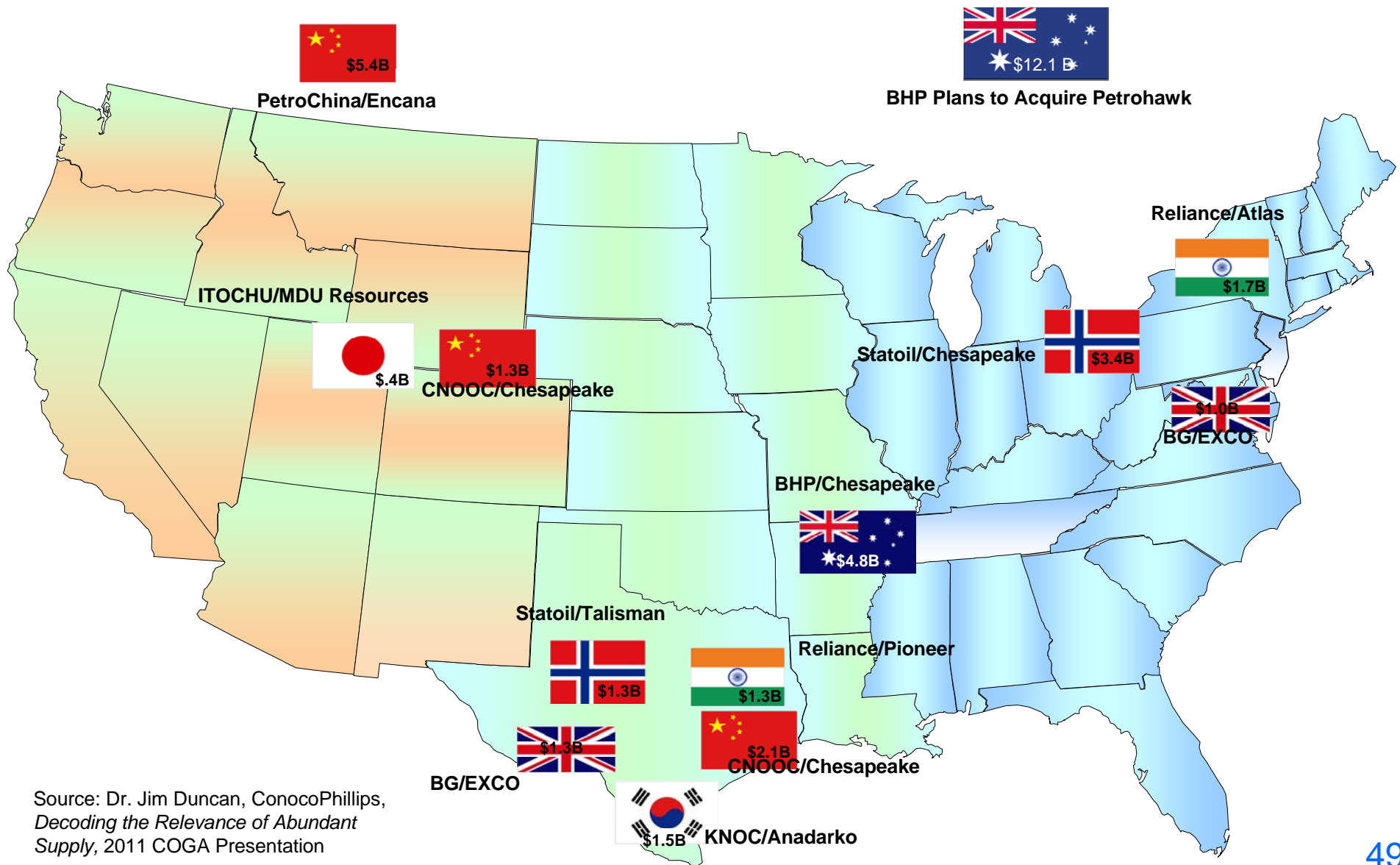
- 2008 - **347 TCF** - Energy Information Administration (EIA)
- 2008 - **840 TCF** - Navigant for Clean Skies Foundation
- 2009 - **616 TCF** - Potential Gas Committee (PGC)
- 2011 - **827 TCF** - Energy Information Administration (EIA)
- 2013 – **1,073 TCF** - Potential Gas Committee (PGC)

Source: Various resource estimates

THE SUPPLY CURVE HAS MOVED

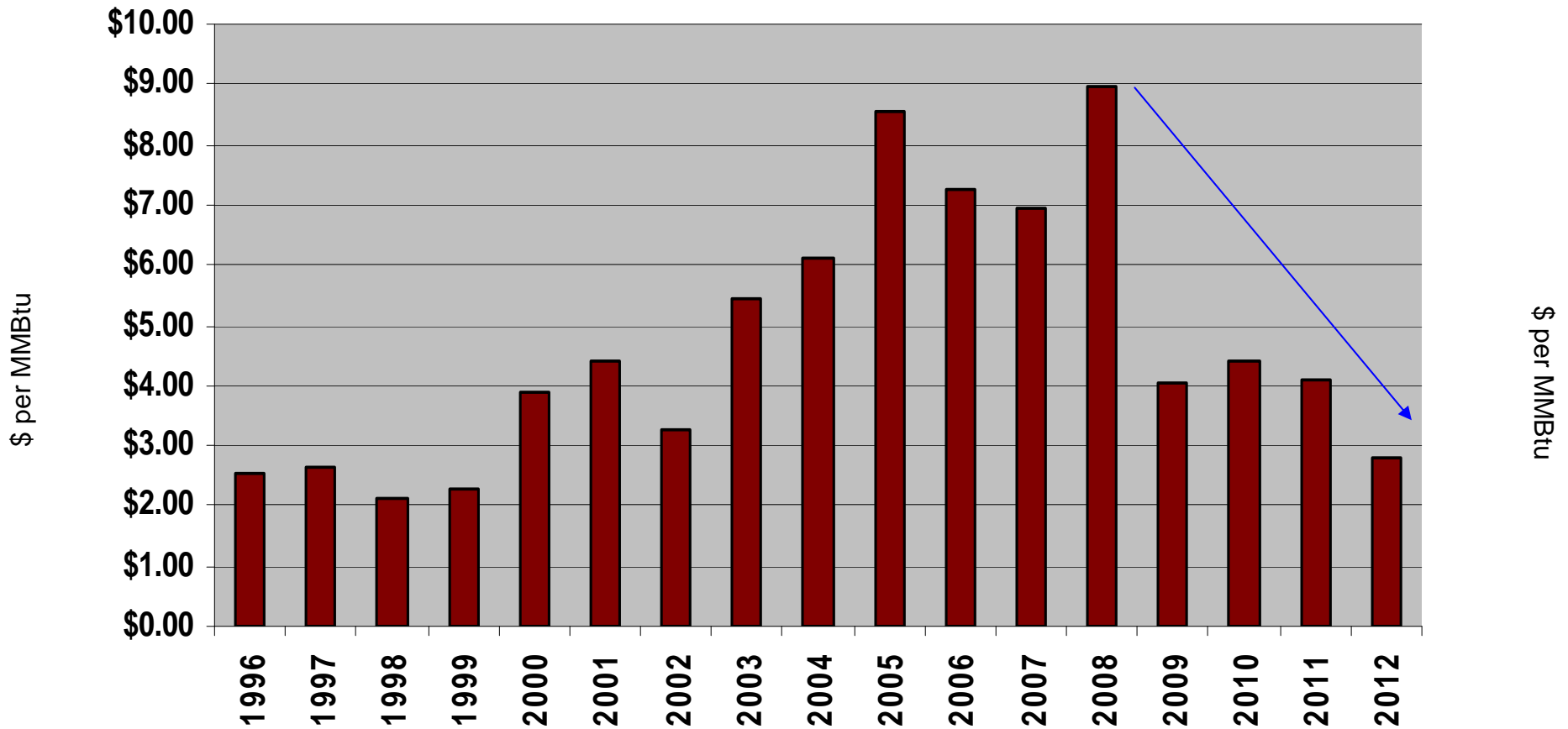
According to the Potential Gas Committee, during the last two years, the future gas supply estimate for the US rose nearly 25% to a 48-year record of **2,688 TCF**.

Foreign Investment in U.S. Shale



Source: Dr. Jim Duncan, ConocoPhillips, *Decoding the Relevance of Abundant Supply*, 2011 COGA Presentation

NYMEX Henry Hub Natural Gas Price* 1996 - 2012 Actual



Source: *Average of last three days of trading as published in the Platts Gas Daily Report

World LNG Estimated June 2013 Landed Prices



Source: Waterborne Energy, Inc. Data in \$US/MMBtu

Updated May/23, 2013 2188

Perspective: Residential Gas Usage



In a single year, the average US home uses 84 MCF of natural gas.

Source: Natural Gas Supply Association

The Effect of Fracking on Residential Gas Cost



PUBLIC SERVICE COMPANY OF COLORADO *
 P O BOX 840
 DENVER, CO. 80201
 (800) 895-4999 Español: (800) 687-8778

Page 1 of 1

Customer Name	Service Address	Account No.	Date Due	Amount Due
[REDACTED]	[REDACTED]	[REDACTED]	Dec 26, 2012	\$37.75

Account Activity			
Date of Bill	Dec 5, 2012	Previous Balance	\$29.26
Number of Payments Received	1	Total Payments	(\$29.26)
Number of Days in Billing Period	34	Balance Forward	\$0.00
Statement Number	349691134	+ Current Bill	\$37.75
Premise Number	300801460	Current Balance	\$37.75

Gas Service - Account Summary			
Invoice Number	0227514926	Residential	
Meter No.	00000R471013	Usage Charge	45 therms x 0.090444 \$4.07
Rate	RG Residential	Interstate Pipeline	45 therms x 0.000020 \$0.90
Days in Bill Period	34	Natural Gas 4 Qtr	45 therms x 0.355870 \$16.01
Current Reading	7720 Actual 12/05/2012	Pipe Sys Int Adj	45 therms x 0.016660 \$0.75
Previous Reading	7668 Actual 11/01/2012	Service & Facility	\$11.94
Measured Usage	52	Subtotal	\$36.65
Therm Multiplier	0.8606	Franchise Fee	3.00% \$1.10
Therms Used	45.0	Sales Tax	\$0.00
		Total Amount	\$37.75



The Effect of Fracking on Residential Gas Cost

- With the gas cost in **Spain** of **\$10.05/MMBtu**, the total residential bill would have been:

\$67.84

**80%
Increase**

- With the gas cost in **China** of **\$13.70/MMBtu**, the total residential bill would have been:

\$82.29

**118%
Increase**

What Fracking Means to Households

2003-2008 NYMEX ¹ Avg. Price ² /MMBtu	\$7.21	61% Drop
2012 NYMEX ¹ Avg. Price/MMBtu	\$2.80	

Price Differential/MMBtu	\$4.41
	x
Residential Home Heating and Electricity Usage ³ /MMBtu	7,400,000,000

Residential Cash Savings = \$32,634,000,000

1 NYMEX – Average last 3 days of close of Natural Gas Contract as reported in Platts Gas Daily Report

2 See Addendum A for supporting documentation

3 Residential Gas Usage – Energy Information Administration

Wall Street Journal Editorial September 6, 2013

- Families saved roughly \$32.6 billion in 2012
- Windfall to U.S. natural gas consumers (industrial and residential) was closer to \$110 billion
- That is greater than the annual income of all of the residents in 14 states in 2011

Fracking and the Poor, Steve Moore ,Wall Street Journal Editorial, September 6, 2013

What Fracking Means to Low Income Households

- Roughly 40 million U.S. residential households (36% of 114 million total⁴) are estimated to qualify for LIHEAP assistance⁵

2012 Residential Cash Savings = **\$32,634,000,000**

Percent of households LIHEAP eligible × **.36**

2012 LIHEAP Eligible Cash Savings = **\$11,748,240,000**

2012 LIHEAP Total Cash Assistance = **\$3,500,000,000**

⁴ US Census Bureau State and County Quickfacts

⁵ LIHEAP Home Energy Notebook for FY 2009: Appendix B: Income Eligibility Household Estimates; See Addendum A

Reducing Greenhouse Gas Emissions

	Natural Gas	Coal
Carbon Dioxide	117,000	208,000
Carbon Monoxide	40	208
Nitrogen Oxide	92	457
Sulfur Dioxide	0.6	2,591
Particulates	7	2,744
Formaldehyde	0.750	0.221
Mercury	0.000	0.016

Source: EIA – Natural Gas Issues and Trends

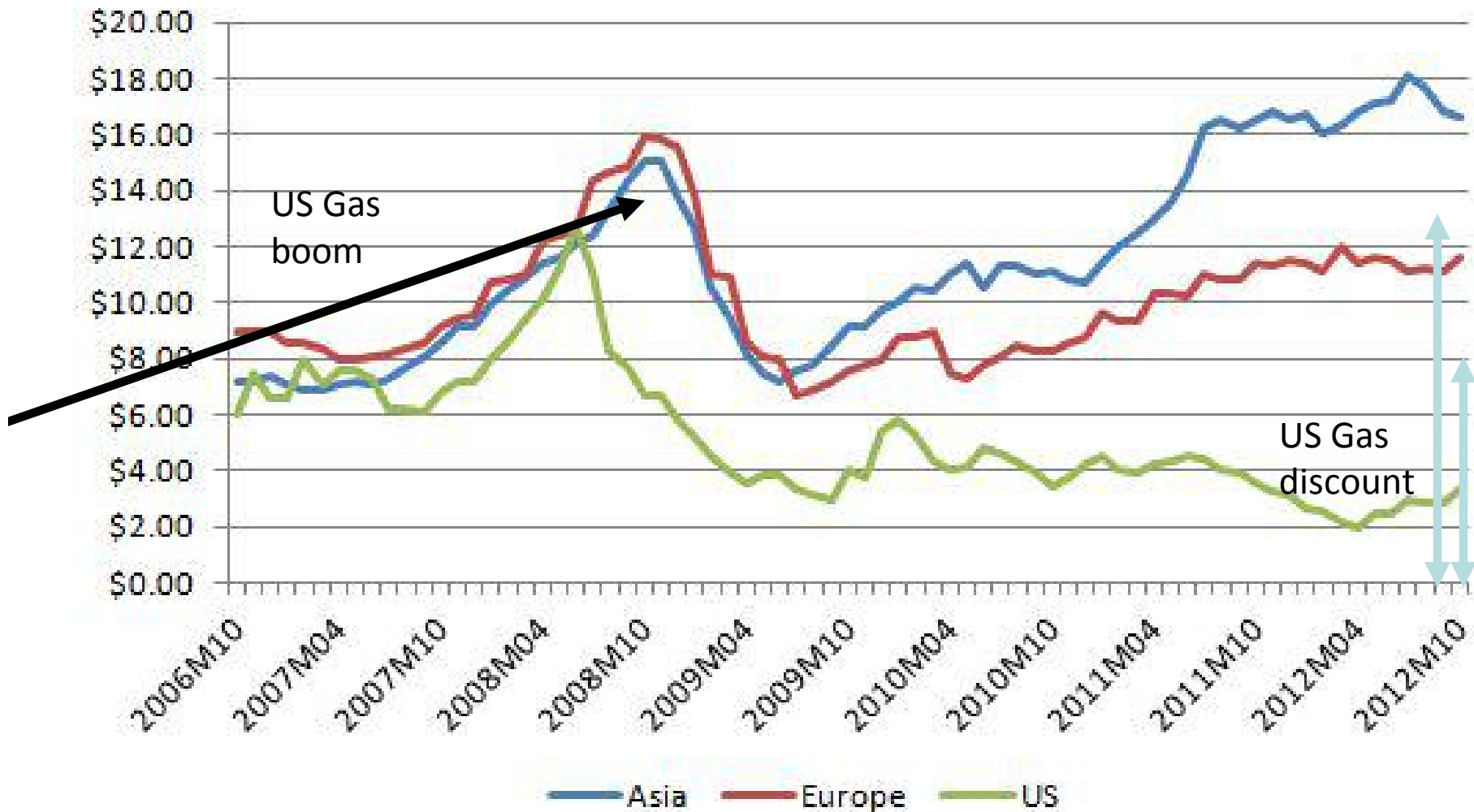
Pounds of air pollutants produced per billion Btu energy

Kyoto Protocol

US Energy Information Agency reports that America's greenhouse gas emissions have **fallen 7 percent to 1992 levels**. US, a non participant in Kyoto Protocol Treaty, is the only nation to meet 1999 forecasted reduction

Gas Prices by Region

Natural Gas Price (\$/mmbtu)



Source: Chris Wright, Liberty Resources Tuesday Lunch Club Presentation, 3/5/13

**Applications Received by DOE/FE to Export Domestically Produced LNG
from the Lower-48 States (as of April 2, 2013)**

All Changes Since March 7, 2013 Update Are In Red

Company	Quantity ^(d)	FTA Applications ^(d) (Docket Number)	Non-FTA Applications ^(d) (Docket Number)
Sabine Pass Liquefaction, LLC	2.2 billion cubic feet per day (Bcf/d) ^(d)	Approved (10-85-LNG)	Approved (10-111-LNG)
Freeport LNG Expansion, L.P. and FLNG Liquefaction, LLC	1.4 Bcf/d ^(d)	Approved (10-160-LNG)	Under DOE Review (10-161-LNG)
Lake Charles Exports, LLC	2.0 Bcf/d ^{(d)**}	Approved (11-59-LNG)	Under DOE Review (11-59-LNG)
Carib Energy (USA) LLC	0.03 Bcf/d: FTA 0.01 Bcf/d: non-FTA ^(d)	Approved (11-71-LNG)	Under DOE Review (11-141-LNG)
Dominion Cove Point LNG, LP	1.0 Bcf/d ^(d)	Approved (11-115-LNG)	Under DOE Review (11-128-LNG)
Jordan Cove Energy Project, L.P.	1.2 Bcf/d: FTA 0.8 Bcf/d: non-FTA ^(d)	Approved (11-127-LNG)	Under DOE Review (12-32-LNG)
Cameron LNG, LLC	1.7 Bcf/d ^(d)	Approved (11-145-LNG)	Under DOE Review (11-162-LNG)
Freeport LNG Expansion, L.P. and FLNG Liquefaction, LLC ^(d)	1.4 Bcf/d ^(d)	Approved (12-06-LNG)	Under DOE Review (11-161-LNG)
Gulf Coast LNG Export, LLC ^(d)	2.8 Bcf/d ^(d)	Approved (12-05-LNG)	Under DOE Review (12-05-LNG)
Gulf LNG Liquefaction Company, LLC	1.5 Bcf/d ^(d)	Approved (12-47-LNG)	Under DOE Review (12-101-LNG)
LNG Development Company, LLC (d/b/a Oregon LNG)	1.25 Bcf/d ^(d)	Approved (12-48-LNG)	Under DOE Review (12-77-LNG)
SB Power Solutions Inc.	0.07 Bcf/d	Approved (12-50-LNG)	n/a
Southern LNG Company, L.L.C.	0.5 Bcf/d ^(d)	Approved (12-54-LNG)	Under DOE Review (12-100-LNG)
Excelerate Liquefaction Solutions I, LLC	1.38 Bcf/d ^(d)	Approved (12-61-LNG)	Under DOE Review (12-146-LNG)
Golden Pass Products LLC	2.6 Bcf/d ^(d)	Approved (12-88-LNG)	Under DOE Review (12-156-LNG)
Cheniere Marketing, LLC	2.1 Bcf/d ^(d)	Approved (12-99-LNG)	Under DOE Review (12-97-LNG)
Main Pass Energy Hub, LLC	3.22 Bcf/d ^{(d)***}	Approved (12-114-LNG)	n/a
CE FLNG, LLC	1.07 Bcf/d ^(d)	Approved (12-123-LNG)	Under DOE Review (12-123-LNG)
Waller LNG Services, LLC	0.16 Bcf/d	Approved (12-152-LNG)	n/a
Pangea LNG (North America) Holdings, LLC	1.09 Bcf/d ^(d)	Approved (12-174-LNG)	Under DOE Review (12-184-LNG)
Magnolia LNG, LLC	0.54 Bcf/d	Approved (12-183-LNG)	n/a

**Applications Received by DOE/FE to Export Domestically Produced LNG
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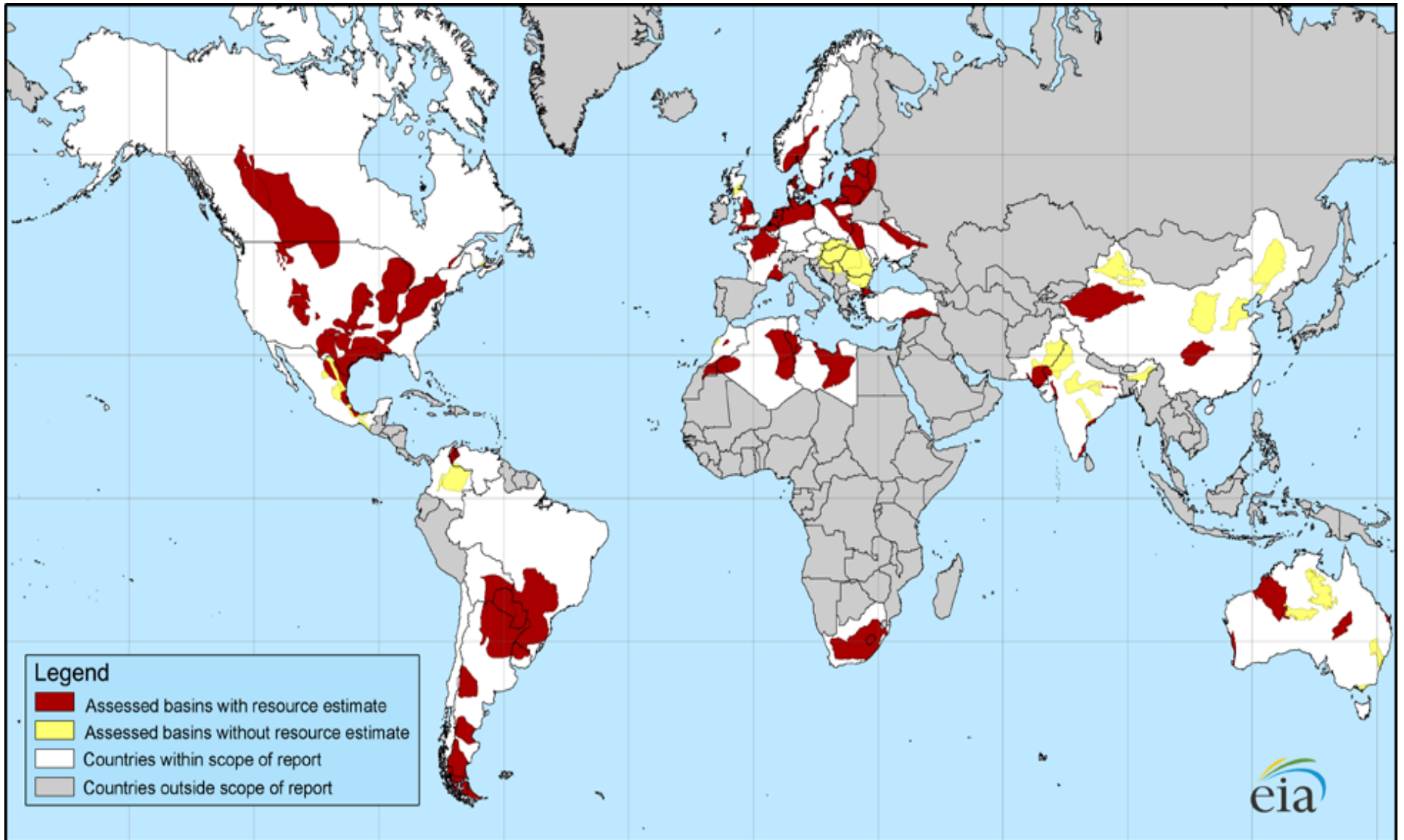
All Changes Since March 7, 2013 Update Are In Red

Company	Quantity ^(a)	FTA Applications ^(b) (Docket Number)	Non-FTA Applications ^(c) (Docket Number)
Trunkline LNG Export, LLC	2.0 Bcf/d**	Approved (13-04-LNG)	Under DOE Review (13-04-LNG)
Gasfin Development USA, LLC	0.2 Bcf/d	Approved (13-06-LNG)	n/a
Freeport-McMoRan Energy LLC	3.22 Bcf/d***	Pending Approval (13-26-LNG)	Under DOE Review (13-26-LNG)
Sabine Pass Liquefaction, LLC	0.28 Bcf/d ^(d)	Pending Approval (13-30-LNG)	Under DOE Review (13-30-LNG)
Sabine Pass Liquefaction, LLC	0.24 Bcf/d^(d)	Pending Approval (13-42-LNG)	Under DOE Review (13-42-LNG)
Total of all Applications Received		29.93 Bcf/d(**) (***)	28.54 Bcf/d

** Lake Charles Exports, LLC (LCE) and Trunkline LNG Export, LLC (TLNG), the owner of the Lake Charles Terminal, have both filed an application to export up to 2.0 Bcf/d of LNG from the Lake Charles Terminal. The total quantity of combined exports requested between LCE and TLNG does not exceed 2.0 Bcf/d (i.e., both requests are not additive and only 2 Bcf/d is included in the bottom-line total of applications received).

*** Main Pass Energy Hub, LLC (MPEH) and Freeport McMoRan Energy LLC (FME), have both filed an application to export up to 3.22 Bcf/d of LNG from the Main Pass Energy Hub. (The existing Main Pass Energy Hub structures are owned by FME). The total quantity of combined FTA exports requested between MPEH and FME does not exceed 3.22 Bcf/d (i.e., both requests are not additive and only 3.22 Bcf/d is included in the bottom-line total of FTA applications received). FME's application includes exports of 3.22 Bcf/d to non-FTA countries and is included in the bottom line total of non-FTA applications received, while MPEH has not submitted an application to export LNG to non-FTA countries.

Global Shale Reserves

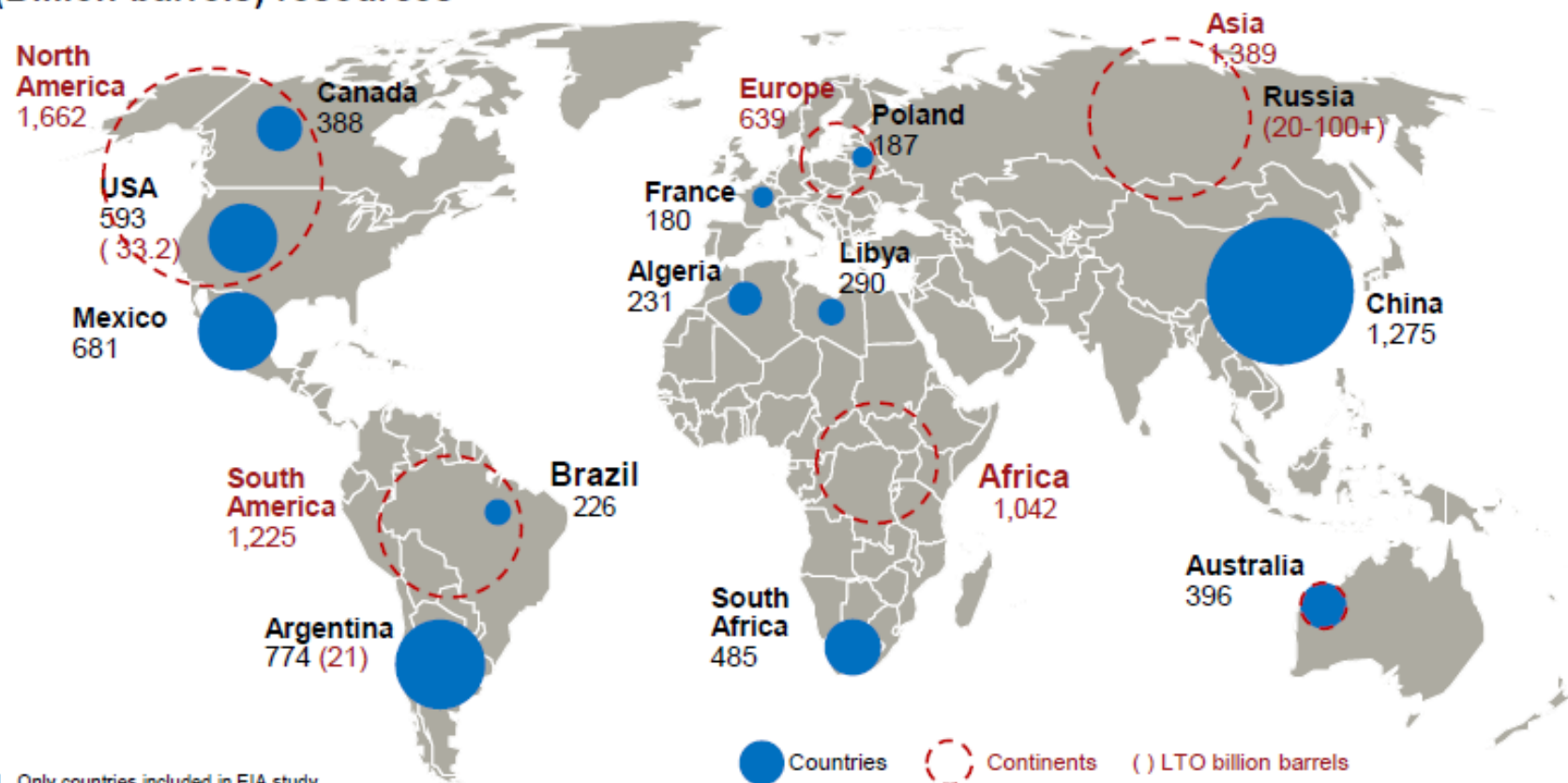


Source: EIA; Dr. Jim Duncan, ConocoPhillips, *Decoding the Relevance of Abundant Supply*, 2011 COGA Presentation

Resource potential in North America is massive – with the Rockies accounting for a significant fraction

Major global shale gas and LTO opportunities¹

Technically recoverable shale gas (trillion cubic feet) and LTO (Billion barrels) resources



1. Only countries included in EIA study
Source: EIA, Forbes, <http://www.shale-gas-tight-oil-argentina-ii.com/>

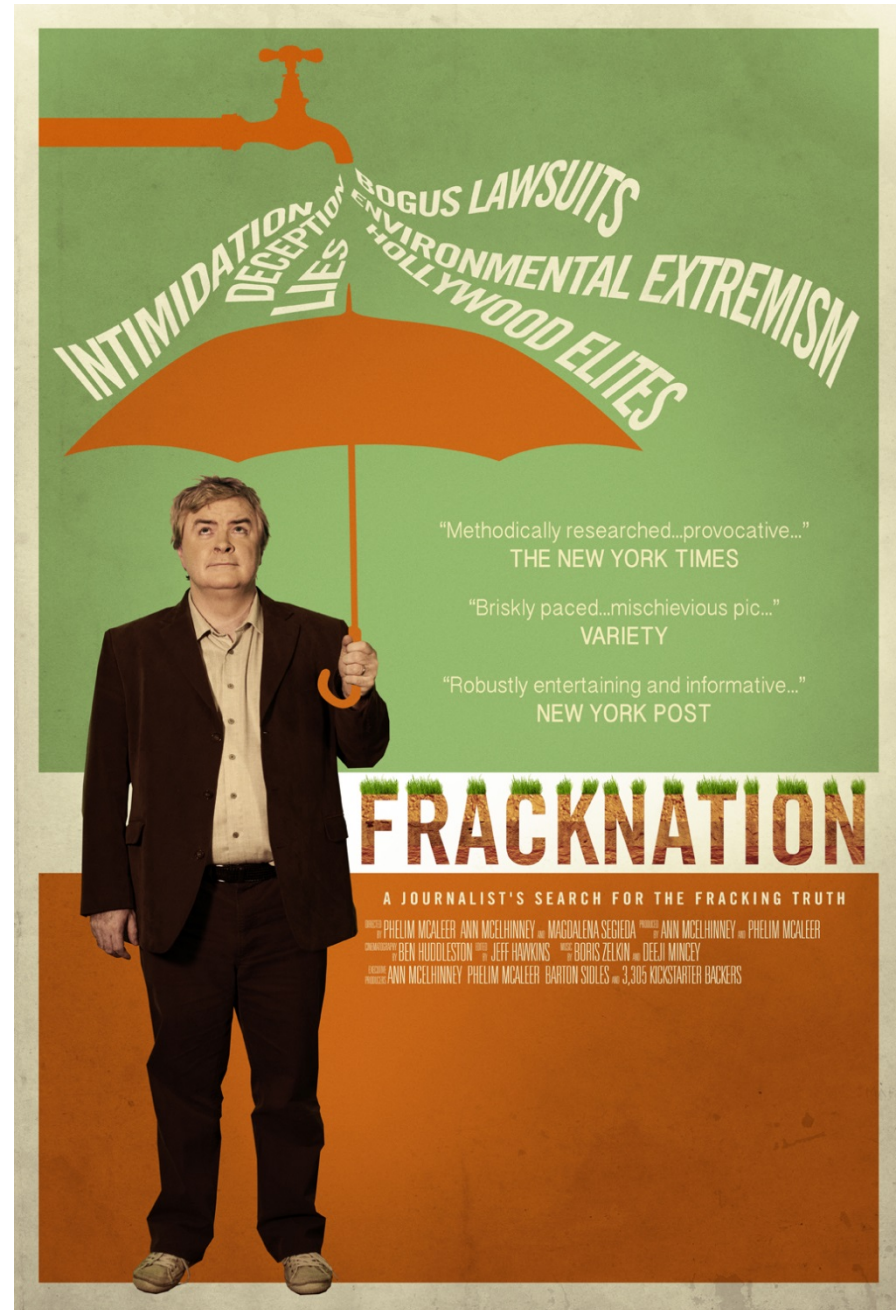
Job Creation

- America's Oil & Natural Gas Industry supports **9.2 million** men and women across the US in a wide range of highly skilled, well-paying professions

Revenue Creation

- The US Oil and Natural Gas industry contributes **\$86 million a day** in taxes, royalties and other fees – about **\$31 billion a year**

The Rest of the Story



Conclusions

- Since 1949, over 1,200,000 **wells** have been hydraulically fractured in the US...No one has ever been able to demonstrate that it is harmful to human health
- Low natural gas prices will **significantly** advance the general public health and welfare
 - Conversion coal to gas, reduced air emissions
 - Energy security, job creation & lower energy costs for low income households

Conclusions

- Increased industry activity in urbanized areas and environmentally sensitive areas should be addressed in a collaborative manner without **demonizing** oil and gas development
- What is more important to environmental groups, **creating an ideological enemy** (oil & gas development) with an artificial bogeyman (hydraulic fracturing) or advancing society?

For More Information

- www.COGA.org
- www.anga.us
- www.api.org
- www.energyindepth.org
- www.cogcc.state.co.us
- www.ipaa.org
- www.fracfocus.org

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Citations for Report

All of the information utilized for this report is a compilation of information pulled from the following data sources:

Ponderosa Advisors LLC

Blue, Johnson Associates, Inc.

Chris Wright, Liberty Resources

Office of Fossil Energy

Office of Oil Gas Global Security Supply

U.S. Department of Energy

Raymond James and Associates, Inc.

Charif Souki, Cheniere Energy Inc.; Cheniere Research

U.S. Federal Energy Regulatory Commission

Institute for Energy Research (IER)

Energy Information Administration (EIA)

Bernstein Research

Western Energy Alliance

Sutherland LNG Blog

Platts Gas Daily Report, A McGraw Hill Publication

Colorado Oil and Gas Association

Frequently Asked Questions

Highly Regulated

- Colorado has some of the highest standards of regulations concerning oil and gas development including, but not limited to, the 2008 rulemaking process, and the three rule makings in the past two years regarding:
 - Additive disclosure
 - Groundwater testing
 - Setbacks

Highly Regulated

GENERAL RULES

(200 Series)

- 201. Effective Scope of Rules and Regulations
- 201A. Effective Date of Amendments
- 202. Office and Duties of Director
- 203. Office and Duties of Secretary
- 204. General Functions of Director
- 205. Access to Records
- 206. Reports
- 207. Tests and Surveys
- 208. Corrective Action
- 209. Protection of Coal Seams and Water-Bearing Formations
- 210. Signs and Markers
- 211. Naming of Fields
- 212. Safety
- 213. Forms Upon Request
- 214. Local Governmental Designee
- 215. Global Positioning Systems
- 216. Comprehensive Drilling Plans

E&P WASTE MANAGEMENT

(900 Series)

- 901. Introduction
- 902. Pits - General and Special Rules
- 903. Pit Permitting/Reporting Requirements
- 904. Pit Lining Requirements and Specifications
- 905. Closure of Pits, and Buried or Partially Buried Produced Water Vessels
- 906. Spills and Releases
- 907. Management of E&P Waste
- 907A. Management of Non-E&P Waste
- 908. Centralized E&P Waste Management Facilities
- 909. Site Investigation, Remediation and Closure
- 910. Concentrations and Sampling for Soil and Ground Water
- 911. Pit, Buried or Partially Buried Produced Water Vessel, Blowdown Pit, and Basic Sediment/Tank Bottom Pit Management Requirements Prior to December 30, 1997
- 912. Venting or Flaring Natural Gas

- 323. Open Pit Storage of Oil or Hydrocarbon Substances
- 324A. Pollution
- 324B. Exempt Aquifers
- 324C. Quality Assurance for Chemical Analysis
- 324D. Criteria to Establish Points of Compliance
- 325. Underground Disposal of Water
- 326. Mechanical Integrity Testing
- 327. Loss of Well Control
- 328. Measurement of Oil
- 329. Measurement of Gas
- 330. Measurement of Produced and Injected Water
- 331. Vacuum Pumps on Wells
- 332. Use of Gas for Artificial Gas Lifting
- 333. Seismic Operations
- 334. Public Highways and Roads
- 335. OGCC Form 15. Pit Construction Report/Permit
- 336. OGCC Form 18. Complaint Form
- 337. OGCC Form 19. Spill/Release Report
- 338. OGCC Form 24. Soil Analysis Report
- 339. OGCC Form 25. Water Analysis Report
- 340. OGCC Form 27. Site Investigation and Remediation Workplan
- 341. Bradenhead Monitoring During Well Stimulation Operations

SAFETY REGULATIONS

- 601. Introduction
- 602. General
- 603. Drilling and Well Servicing Operations and High Density Area Rules
- 604. Oil and Gas Facilities
- 605. RESERVED
- 606A. Fire Prevention and Protection
- 606B. Air and Gas Drilling
- 607. Hydrogen Sulfide Gas
- 608. Coalbed Methane Wells

DRILLING, DEVELOPMENT, PRODUCTION AND ABANDONMENT

(300 Series)

- 301. Records, Reports, Notices - General
- 302. OGCC Form 1. Registration for Oil and Gas Operations
- 303. OGCC Form 2. Requirements for Form 2, Application for Permit-to-Drill, Deepen, Re-enter, or Recomplete and Operate; Form 2A, Oil and Gas Location Assessment
- 304. Financial Assurance Requirements
- 305. Notice, Comment, Approval
- 306. Consultation
- 307. OGCC Form 4. Sundry Notices and Reports on Wells
- 308A. OGCC Form 5. Drilling Completion Report
- 308B. OGCC Form 5A. Completed Interval Report
- 308C. Confidentiality
- 309. OGCC Form 7. Operator's Monthly Production Report
- 310. OGCC Form 8. Mill Levy
- 311. OGCC Form 6. Well Abandonment Report
- 312. OGCC Form 10. Certificate of Clearance and/or Change of Operator
- 313. OGCC Form 11. Monthly Report of Gasoline or Other Extraction Plants
- 314. OGCC Form 17. Bradenhead Test Report
- 315. Report of Reservoir Pressure Test
- 316A. OGCC Form 14. Monthly Report of Fluids Injected
- 316B. OGCC Form 21. Mechanical Integrity Test
- 317. General Drilling Rules
- 317A. Special Drilling Rules - D-J Basin Fox Hills Protection Area
- 317B. Public Water System Protection
- 318. Location of Wells
- 318A. Greater Wattenberg Area Special Well Location, Spacing and Unit Designation Rule
- 318B. Yuma/Philips County Special Well Location Rule
- 319. Abandonment
- 320. Liability
- 321. Directional Drilling
- 322. Commingling

(600 Series)

UNIT OPERATIONS, ENHANCED RECOVERY PROJECTS, AND STORAGE OF LIQUID HYDROCARBONS

(400 Series)

- 401. Authorization
- 402. Notice and Date of Hearing
- 403. Additional Notice
- 404. Casing and Cementing of Injection Wells
- 405. Notice of Commencement and Discontinuance of Injection Operations



COGCC

- Rule 205 – Disclosure of Chemicals
- Rule 317 – General Drilling Rules
- Rule 317B – Drinking Water Protection
- Rule 318A – Greater Wattenberg Area
- Rule 341 – Bradenhead Monitoring
- Rule 608 – CBM Baseline Sampling
- Rules 903, 904, and 905 - Updated Pit Rules
- Rule 906 - Spill Notification
- Rule 907 – Management of Waste
- Rule 325 – Underground Disposal of Water
- Rule 908 – Waste Management Facilities

COGCC

- Rule 317B – Drinking Water Protection
 - Near surface waters and tributaries that are sources of public drinking water
 - Mandatory setbacks
 - Enhanced environmental precautions
- Rule 318A - Greater Wattenberg Area
 - DJ Basin
 - Sample water wells before drilling

COGCC

- Rule 341 – Bradenhead Monitoring
 - Objective: confine stimulation fluids to the objective formations
 - During stimulation, bradenhead annulus pressure continuously monitored
 - If pressure increases above 200 psig, verbal notification and reporting requirements
 - All well stimulation record kept for at least 5 years

COGCC

- Rule 608 – CBM Baseline Sampling
 - Coalbed methane operators
 - Pressure test wells
 - Sample nearby water wells before, during, and after operations
- Rules 903, 904, and 905 - Updated Pit Rules
 - Enhanced requirements for pit permitting, lining, monitoring and containment

COGCC

- Rule 906 - Spill Notification
 - Promptly report any spills that threaten waters
 - Commission, Environmental Release/Incident Report Hotline, and landowner



COLORADO
OIL & GAS
ASSOCIATION

HF Disclosure Registry



New HF Rule

- Requires public disclosure of HF chemicals using FracFocus.org
 - Well-by-well Basis
- Include MSDS Information
- Trade Secret Protection
 - File with COGCC
 - Justify Trade Secret Status

New HF Rule

- 48 hour advance notice from Operator to the Commission is required of intention to hydraulically fracture a well.
- Stakeholder Rulemaking Process Late 2011
- Most Stringent in Nation

HF Disclosure Registry

- Initiated by the Ground Water Protection Council (GWPC) and Interstate Oil & Gas Compact Commission (IOGCC)
- Website Development Committee: Industry, State, & GWPC
- Industry has unanimously supported the Registry
 - ANGA (American Natural Gas Alliance)
 - AXPC (American Exploration & Production Companies)
 - API (American Petroleum Institute)
 - IPAA (Independent Petroleum Association of America)
 - NGSA (Natural Gas Supply Association)
 - INGAA (Interstate Natural Gas Association of America)

Concept of the Registry

- Web interface where operators register HF chemicals
 - Timely, consistent data
 - Centralized upload area for operators
 - Secure information
- Web interface where public finds more information on the HF process
- Well site search tool
 - Allow public to search for individual HF wells
 - Query by state, county, API number, production type, lease name or well number
 - From 2011 forward

FracFocus Website

Welcome / Publications / News & Updates / Projects & Partnerships / Links

Frac Focus
Chemical Disclosure Registry

HYDRAULIC FRACTURING HOW IT WORKS | **GROUNDWATER** PROTECTION | **FIND A WELL** BY STATE | **REGULATIONS** BY STATE | **CHEMICALS** GLOSSARY | **FREQUENT** QUESTIONS

WELCOME

Welcome to **FracFocus**, the hydraulic fracturing chemical registry website. This website is a joint project of the Ground Water Protection Council and the Interstate Oil and Gas Compact Commission.

On this site you can search for information about the chemicals used in the hydraulic fracturing of oil and gas wells. You will also find educational materials designed to help you put this information in perspective.

[LEARN MORE >](#)

Looking for information about a well site near you?

FIND A WELL

Search for nearby well sites that have been hydraulically fractured to see what chemicals were used in the process.

FAQs

◀ 1/3 ▶

Q. Where does the water for hydraulic fracturing come from?

A. Although the source of water for fracturing can come from surface water, ground water or both, the volumes of water needed for fracturing horizontal shale gas wells necessitate that, with some notable exceptions like the Barnett shale in Texas, surface water provide the bulk of the water used in most areas of the country. Water can be taken from streams, ponds or artificial impoundments, or can be purchased from water providers such as a municipality. In some cases recycled water from prior hydraulic fracturing

Is groundwater protected?

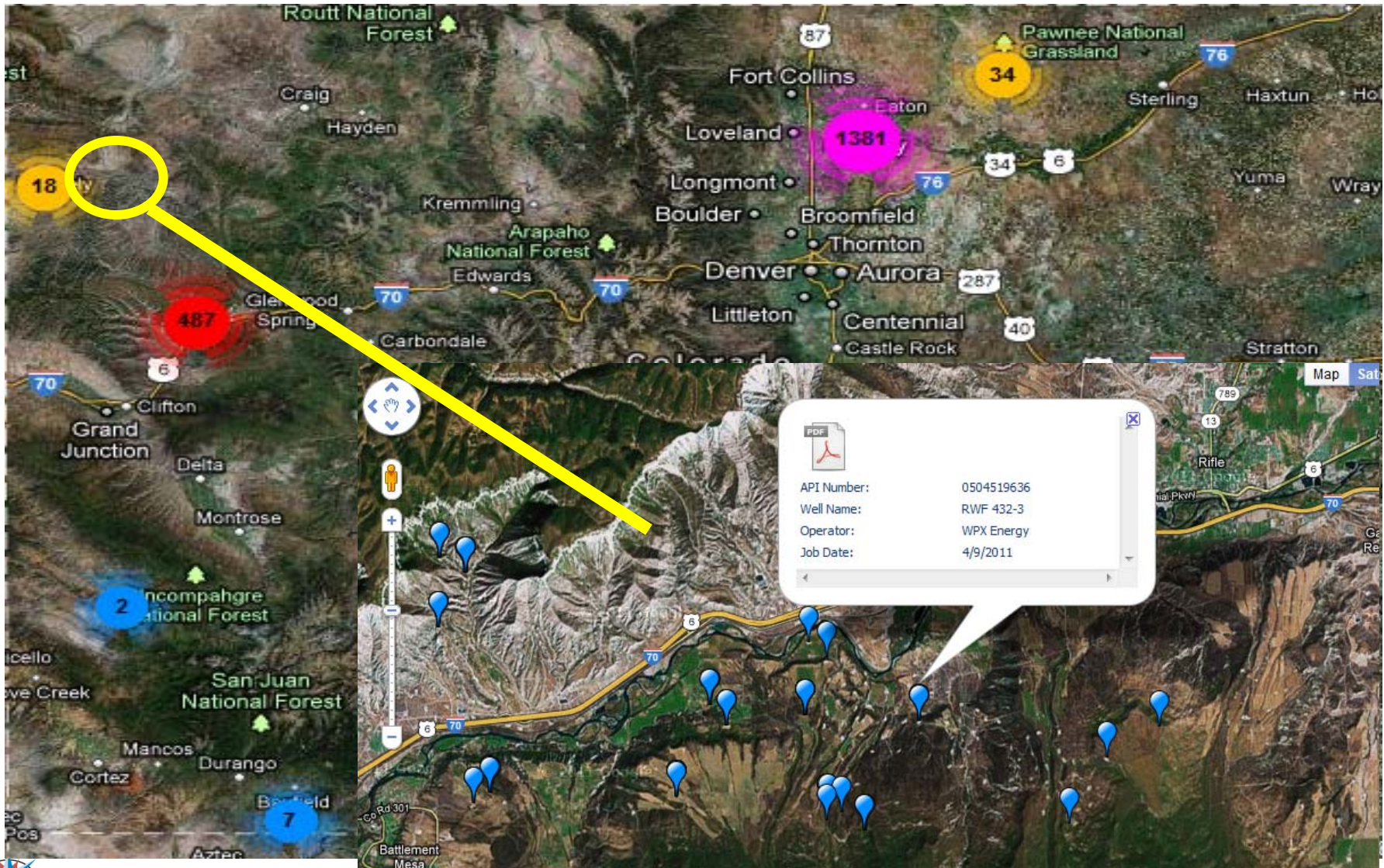
Groundwater Protection: Priority Number One

Oil and natural gas producers have stringent requirements for how wells must be completed. The genesis of these requirements is water safety.

Crimes in the first line of defense used to protect freshwater supplies

◀ Welcome | Hydraulic Fracturing | Protective Casing | State Regulations | Chemical Glossary ▶

Improved Search



HF Disclosure Example

Hydraulic Fracturing Fluid Product Component Information Disclosure

Fracture Date:	2/17/2011
State:	OKLAHOMA
County:	ROGER MILLS
API Number:	3512923458
Operator Name:	CHESAPEAKE
Well Name and Number:	THOMAS 1-16H
Longitude:	-99.948713
Latitude:	35.510162
Long/Lat Projection:	NAD27
Production Type:	Gas
True Vertical Depth (TVD):	10,607
Total Water Volume (gall):	3,977,442

Hydraulic Fracturing Fluid Composition:

Trade Name	Supplier	Purpose	Ingredients	Chemical Abstract Service Number (CAS #)	Maximum Ingredient Concentration in Additive (% by Mass)**	Maximum Ingredient Concentration in HF Fluid (% by Mass)**	Comments
Fresh Water		Carrier/Base Fluid				88.72029%	
Sand (Proppant)		Proppant				10.26952%	
15 hcl	TRICAN WELL SERVICE LP	Acid	Hydrochloric Acid	007647-01-0	15.00%	0.01336%	
MC B 8650 WS	MULTI-CHEM GROUP LLC	Bactericide	Glutaraldehyde (Pentanediol)	000111-30-8	50.00%	0.01787%	
			Water	007732-18-5	50.00%	0.01787%	
			Methanol (Methyl Alcohol)	000067-56-1	0.50%	0.00018%	
CC-1 (Clay Control)	TRICAN WELL SERVICE LP	Clay Stabilizer	Choline Chloride	000067-48-1	70.00%	0.11937%	
LFR-30	TRICAN WELL SERVICE LP	Friction Reducer	Anionic Polyacrylamide Copolymer	N/A	100.00%	0.08923%	
			Petroleum Distillate	N/A	100.00%	0.08923%	
			Ammonium Chloride	N/A	2.00%	0.00178%	
WG-111L	TRICAN WELL SERVICE LP	Gelling Agent	Petroleum Distillate Blend	N/A	60.00%	0.08827%	
			Polysaccharide blend	N/A	60.00%	0.08827%	
LBK-30 EP	TRICAN WELL SERVICE LP	Breaker	Ammonium Persulfate	007727-54-0	100.00%	0.00315%	
LNE-20	TRICAN WELL SERVICE LP	Surfactant	Alcohol Alkoxylate	N/A	20.00%	0.00783%	
			Methanol (Methyl Alcohol)	000067-56-1	20.00%	0.00783%	

** may include fresh water, produced water, and/or recycled water



Oil & Gas Development Near Cultural Development







Nothing New

- Dallas
- Los Angeles
- Pittsburgh
- Oklahoma City
- Bakersfield
- Greeley
- Evans
- Broomfield has had over 150 wells drilled within the city limits

Nothing New

- Weld County has the largest oil field in the U.S. directly below the 5th largest agricultural producing county in the U.S.
- They have co-existed for over a century.

Nothing New

- The Weld County Health Department will test any water well for free.
- 140 water wells have been tested, not one instance of contamination has been found

Economic Impacts

Economic Impact

- In 2012, the oil and gas industry pumped \$29.6 billion into the Colorado economy, supporting over 110,000 high paying jobs

Source: University of Colorado Economic Study 2012

Economic Impact

- “Direct employment totaled more than 51,200 jobs, with average wages over \$74,800, which are 49% higher than the state average for all industries”

Source: University of Colorado Economic Study 2012

Economic Impact

- “Collectively, this industry contributed nearly \$3.8 billion in employee income to Colorado households in 2012...”

Source: University of Colorado Economic Study 2012

Economic Impact

- “Employment due to the oil and gas industry increased 17 per cent from 2010 to 2012, adding over 7,600 jobs”

Source: University of Colorado Economic Study 2012

Economic Impact

- “Oil and gas tax revenue streams provide significant funding for road repairs, fire districts, school districts, parks, and many more services that support our way of life.

Economic Impact

- “In 2012 alone, \$1.6 billion went to state coffers from our industry with an estimated \$500 million going directly to education.”

Economic Impact

- By placing a ban on hydraulic fracturing 111,000 working men and women and their families are being put at risk and it sends the message that Colorado is not open for business.

Economic Impacts

“Colorado sits on top of vast fossil fuel resources with estimates running as high as 2 billion barrels of oil, according to the U.S. Energy Information Administration.”

Water

- There are more than 1.2 million wells fractured in the United States and there has been no evidence of water contamination from the process despite numerous studies.

Water

- Results of water sampling conducted September 26 by the CDPHE show no evidence of pollutants from oil and gas spills in rivers and streams affected by flooding
- CDPHE collected samples at 29 sites in eight different rivers

Water

- Colorado has evidence in over 2,000 groundwater samples in the San Juan Basin (southwest Colorado) that hydraulic fracturing doesn't contaminate groundwater.

Colorado Water Use

Sector	2010 Use (Acre-Feet/Yr) ⁴	Percent of State Total
Total	16,359,700	
Agriculture	13,981,100	85.5%
Municipal and Industrial	1,218,600	7.4%
Total All Others	1,160,000	7.1%
Breakdown of "All Others"		
Total All Others	1,160,000	
Recreation	923,100	5.64%
Large Industry	136,000	0.83%
Thermoelectric Power Generation	76,600	0.47%
Hydraulic Fracturing	13,900	0.08%
Snowmaking	5,300	0.03%
Coal, Natural Gas, Uranium, and Solar Development	5,100	0.03%
Oil Shale Development	0	0.00%

Estimated Water Use

Projection of Annual Demand for Hydraulic Fracturing (Acre-Feet ²) ³					
2010	2011	2012	2013	2014	2015
13,900	14,900	16,100	16,900	17,800	18,700

- 2015: 0.10% of total water use

One Acre Foot is Approximately 326,000 Gallons

Source: COGCC

Are “frack fluids” dangerous?

- Colorado requires disclosure of all “frack fluids” on www.fracfocus.org including the additive name, use and concentration of proven proprietary ingredients, many of which are common household and industrial products

But if you don't believe me...

Former EPA Administrator:

There is no “proven case where the fracking process itself has affected water.”

- Lisa Jackson

EPA Administrator:

“I am not aware of any definitive determinations that would contradict those statements [by Lisa Jackson, referenced above].”

- Gina McCarthy

Former BLM Director:

BLM “has never seen any evidence of impacts to groundwater from the use of fracking technology on wells that have been approved by [BLM]...we believe, based upon the track record so far, that it is safe.”

- Bob Abbey

Former Secretary of the Interior:

“[Hydraulic fracturing] is creating an energy revolution in the United States alone...I would say to everybody that hydraulic fracking is safe”

- Ken Salazar

Acting BLM Director:

“I don’t think we are aware of any clear approving cases.”

- Neil Kornze

Secretary of the Interior:

“I’m not aware of any documented cases.”

- Sally Jewell

EPA Head Advisor for the Office of Water:

“No, I am not [aware of documented cases].”

- Ken Kopocis

Secretary of Energy:

“To my knowledge, I still have not seen any evidence of fracking, per se, contaminating groundwater.”

- Ernest Moniz

Former US Secretary of Energy:

“Drilling for shale gas can be done safely, and at least one prominent study about the risks is not credible...This is something you can do in a safe way.”

- Steven Chu

Secretary of the Pennsylvania Dept of Environmental Protection

“It’s our experience in Pennsylvania that we have not had one case in which the fluids used to break off the gas from 5,000 to 8,000 feet (1,500-2,400m) underground have returned to contaminate ground water.”

- John Hanger

Seismic?

“In one comprehensive study that monitored several thousand shale fracture treatments in various North American shale basins, the largest microseism recorded had a measured magnitude of about 0.8. This is approximately 2,000 times less energy than a magnitude 3.0 earthquake, which is commonly used to delineate deep earthquakes that can be felt at the surface of the earth, and much less than one that could cause surface damage.”

Seismic?

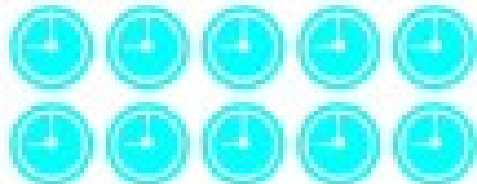
“The energy released by one of these tiny microseismic events is equivalent to the energy of a gallon of milk hitting the floor after falling off a kitchen counter.”

- Mark Zoback, Professor of Geophysics,
Stanford School of Earth Sciences**

A FEW WEEKS WORK... DECADES OF ENERGY

The drilling and hydraulic fracturing techniques used to access oil and natural gas trapped in shale rock only account for a tiny fraction of the lifespan of a typical well.

 = 5 days



DRILLING & WELL CONSTRUCTION 50-100 DAYS

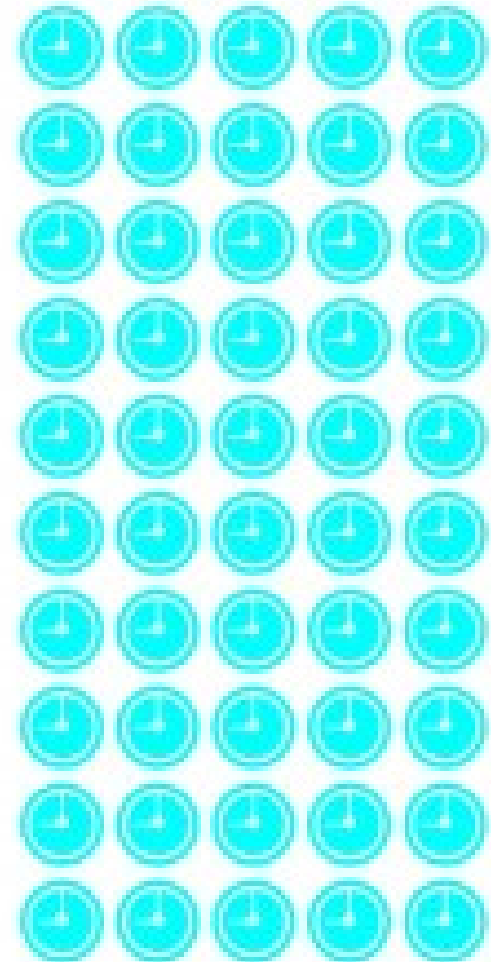
Oil and gas wells in shale formations are drilled to reach far below the earth's surface. These wells are built with redundant layers of steel casing that are cemented into place.



HYDRAULIC FRACTURING 2-5 DAYS

Operators pump a mixture of water, sand and chemicals down the well at high pressure to create paper-thin cracks in dense shale rock, freeing oil and natural gas trapped inside. This process is called hydraulic fracturing, or fracking for short.

29 x



ENERGY PRODUCTION 20-40 YEARS

When a well is complete, reclamation efforts reduce the work area to about the size of a two-car garage. The well will supply energy to consumers for decades.

Figure 1: Class II Injection Wells Across the Country

