

Fracking Forum

Risks and Rewards

A Pro-Business, Pro-Innovation
and Pro-Human Outlook

By:
John Harpole



Mercator Energy_____

October 6, 2014

2008 Conventional Wisdom

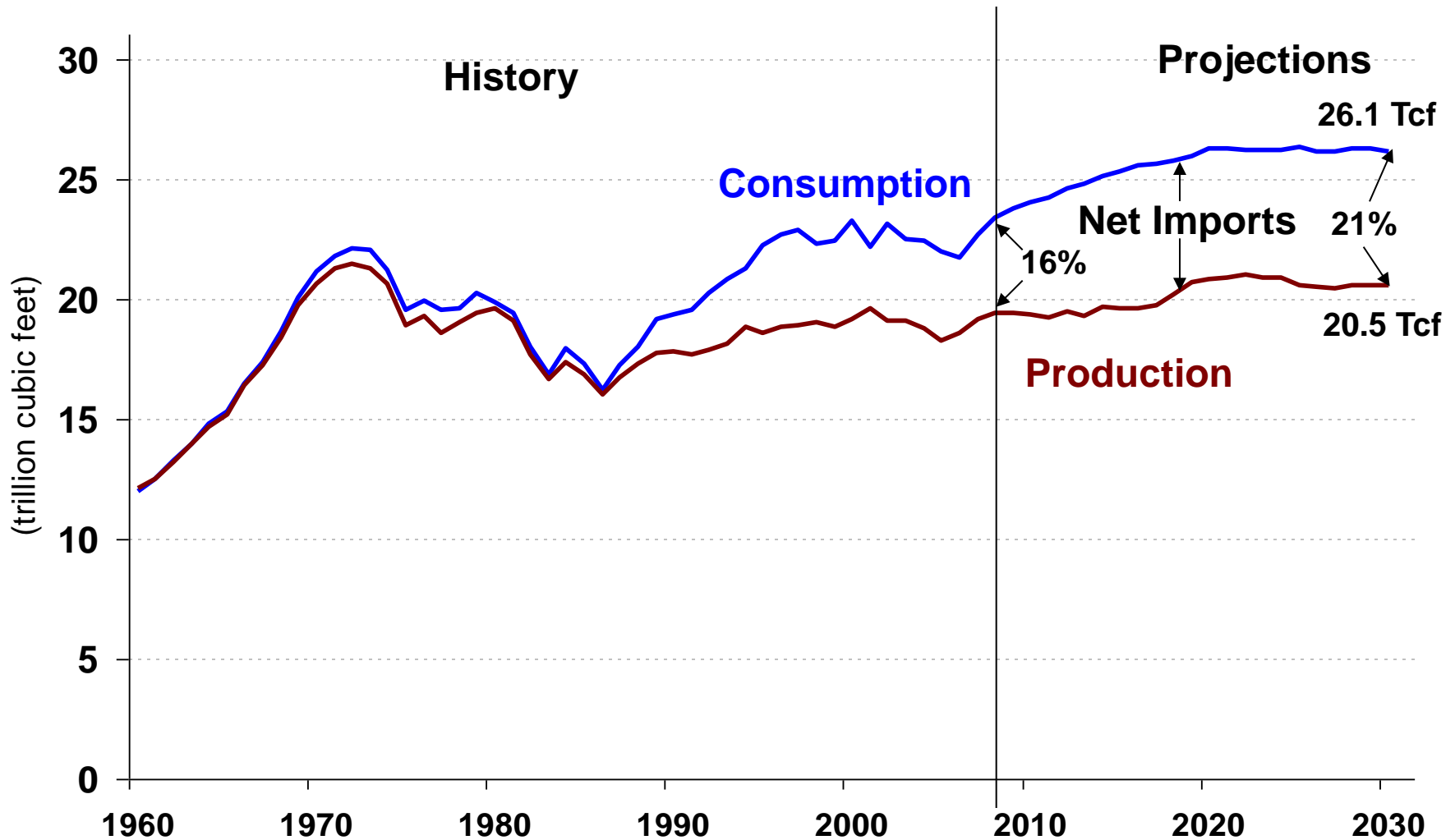
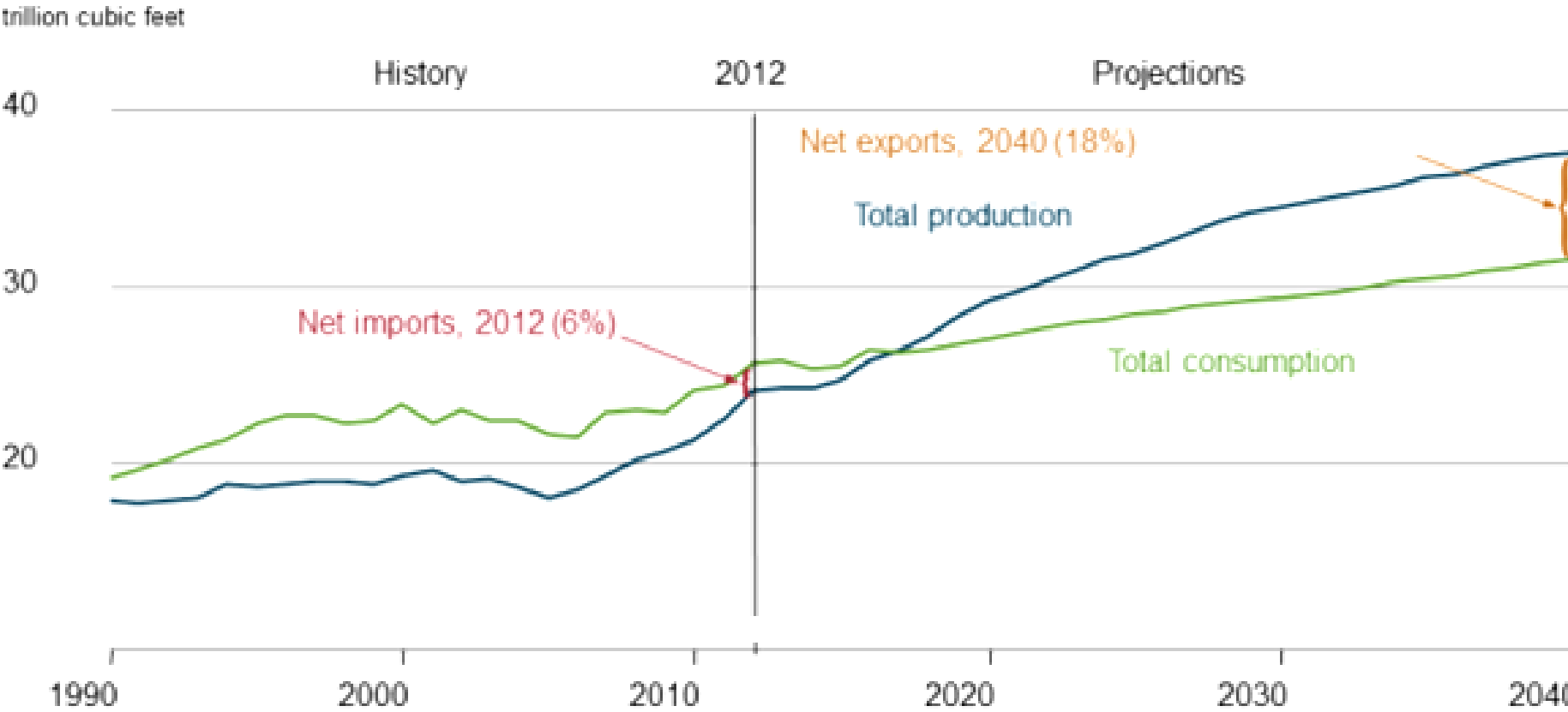


Figure MT-42. Total natural gas production, consumption, and imports in the Reference case, 1990-2040

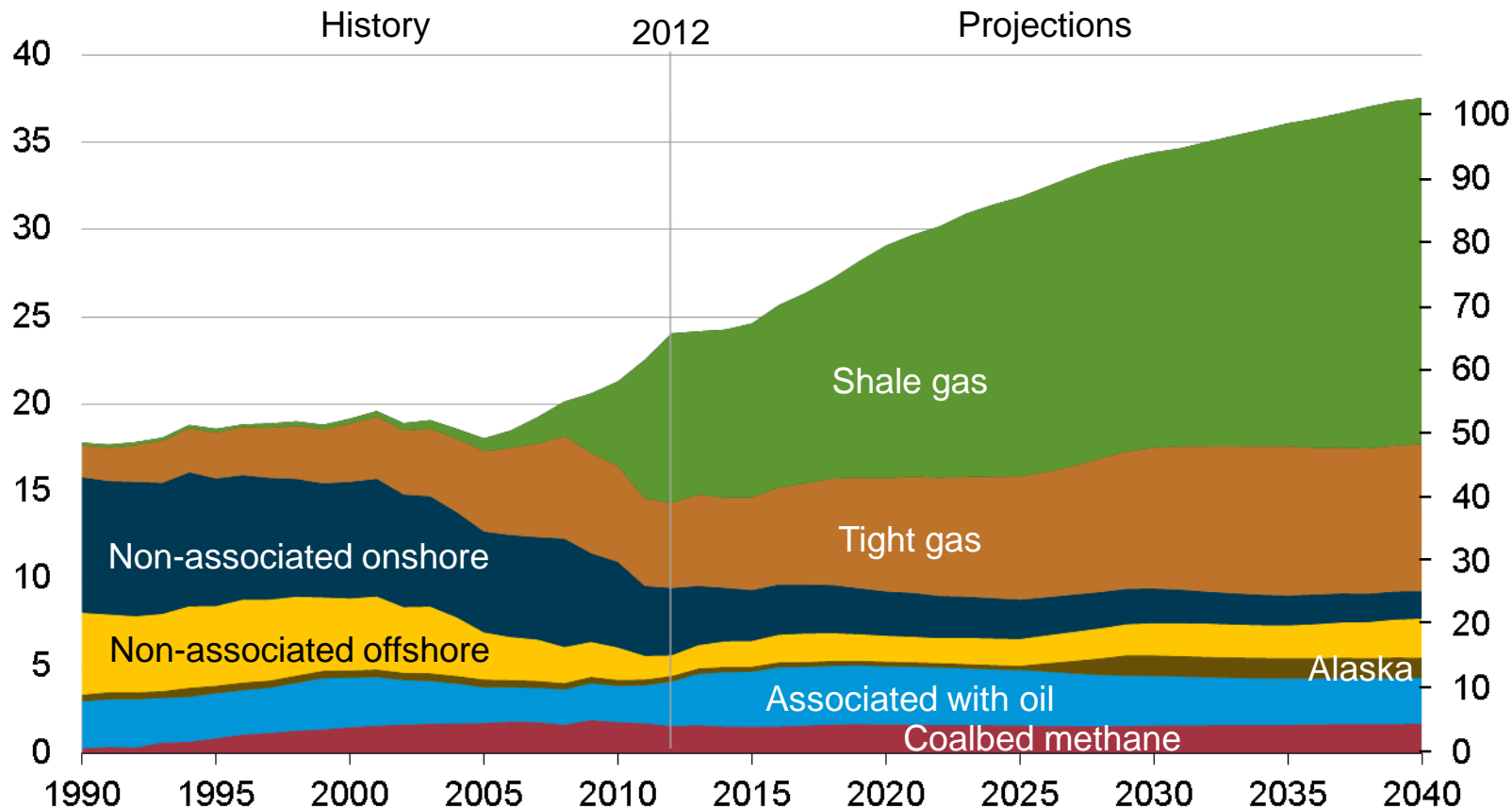


U.S. shale gas leads growth in total gas production through 2040 to reach half of U.S. output

U.S. dry natural gas production

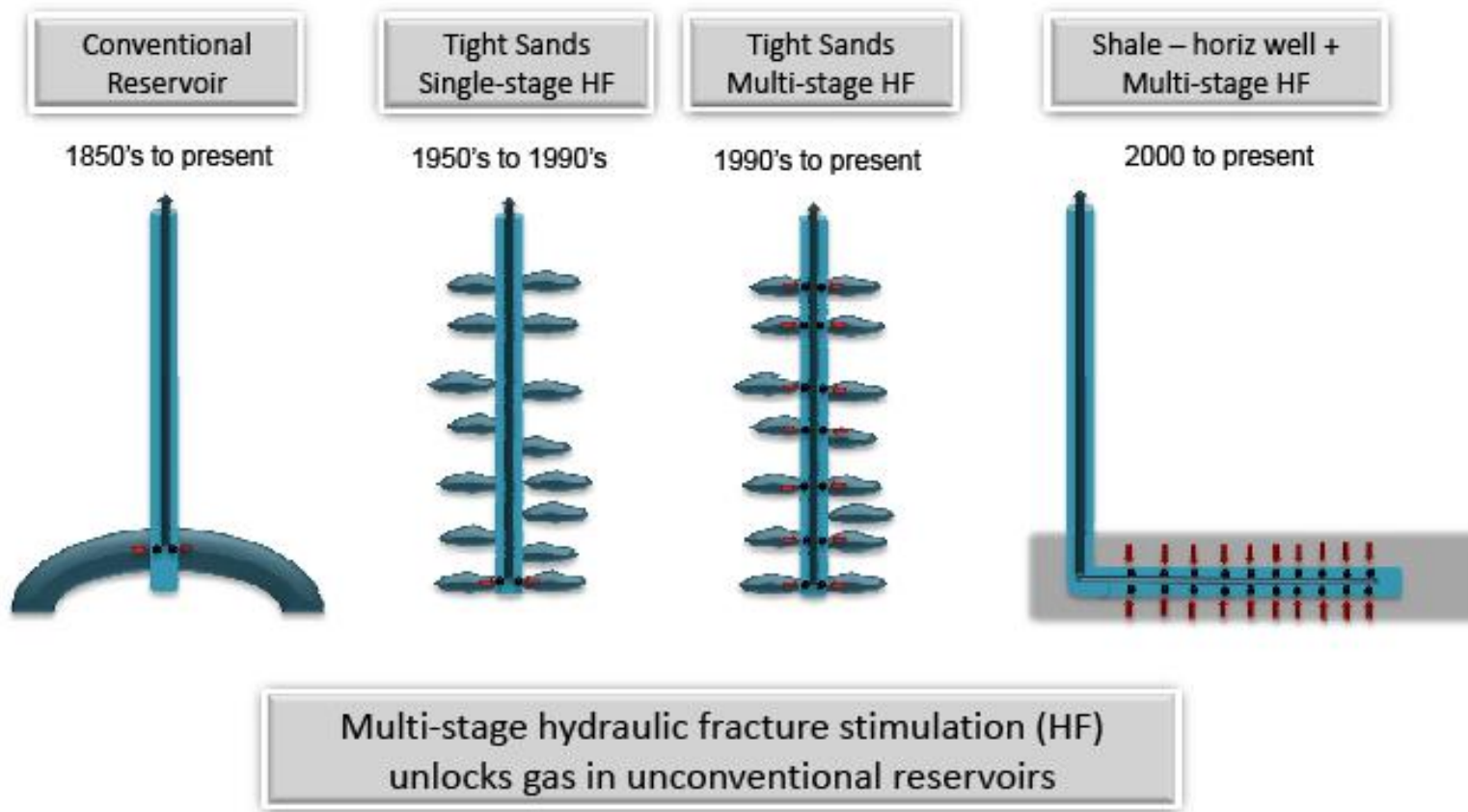
trillion cubic feet

billion cubic feet per day



Source: EIA, Annual Energy Outlook 2014 Early Release

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



U.S.: Envy of the Energy World

- The Shale Revolution has added some \$473 billion per year to the U.S. economy.
- Consulting firm, IHS, recently estimated that more than 2.1 million U.S. jobs are now supported by shale related oil and gas activity.
- In Colorado, the oil and gas industry generates \$29.6 billion per year. That's 11% of Colorado's GDP or \$80.8 million per day.

Source: Colorado Oil and Gas Association (COGA)

Mom and Dad – Before and After







May 13th, 1966



Harpole-Bud



This U.S. energy breakthrough has positive implications for the poor.

Mom and the utility bills



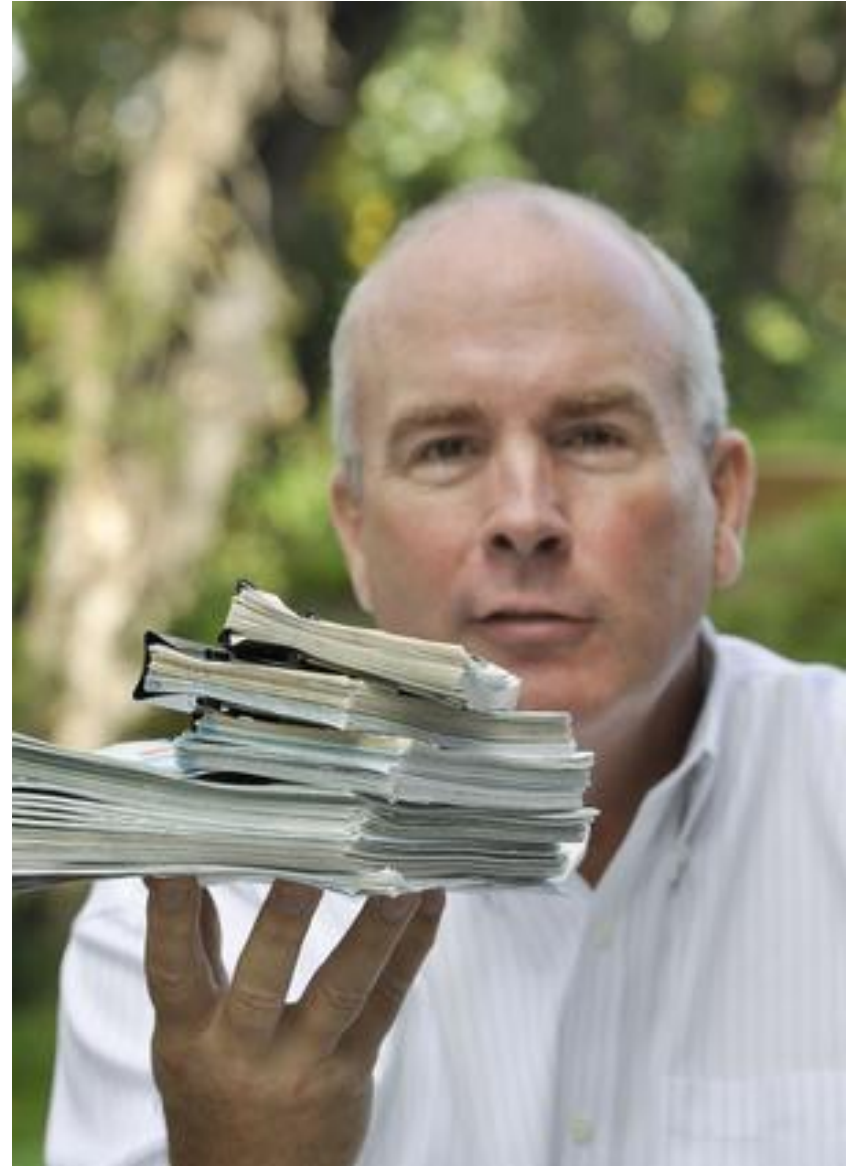
35 Years of Energy Bills



“The test of our progress is not whether we add to the abundance of those who have much. It is whether we provide enough to those who have little.”

- Franklin D. Roosevelt

What Fracking Means to Low Income Households



Wall Street Journal Editorial

September 6, 2013

- Poor households spend four times more of their income on home energy (10.4%) than do non-poor households (2.6%)
- LIHEAP provided roughly \$3.5 billion to about nine million low income households in 2012
- New drilling technologies saved poor households almost 3 times more
- Low gas prices benefit nearly all poor households while LIHEAP helps fewer than one in four

What Fracking Means to Low Income 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

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 \times **.36**

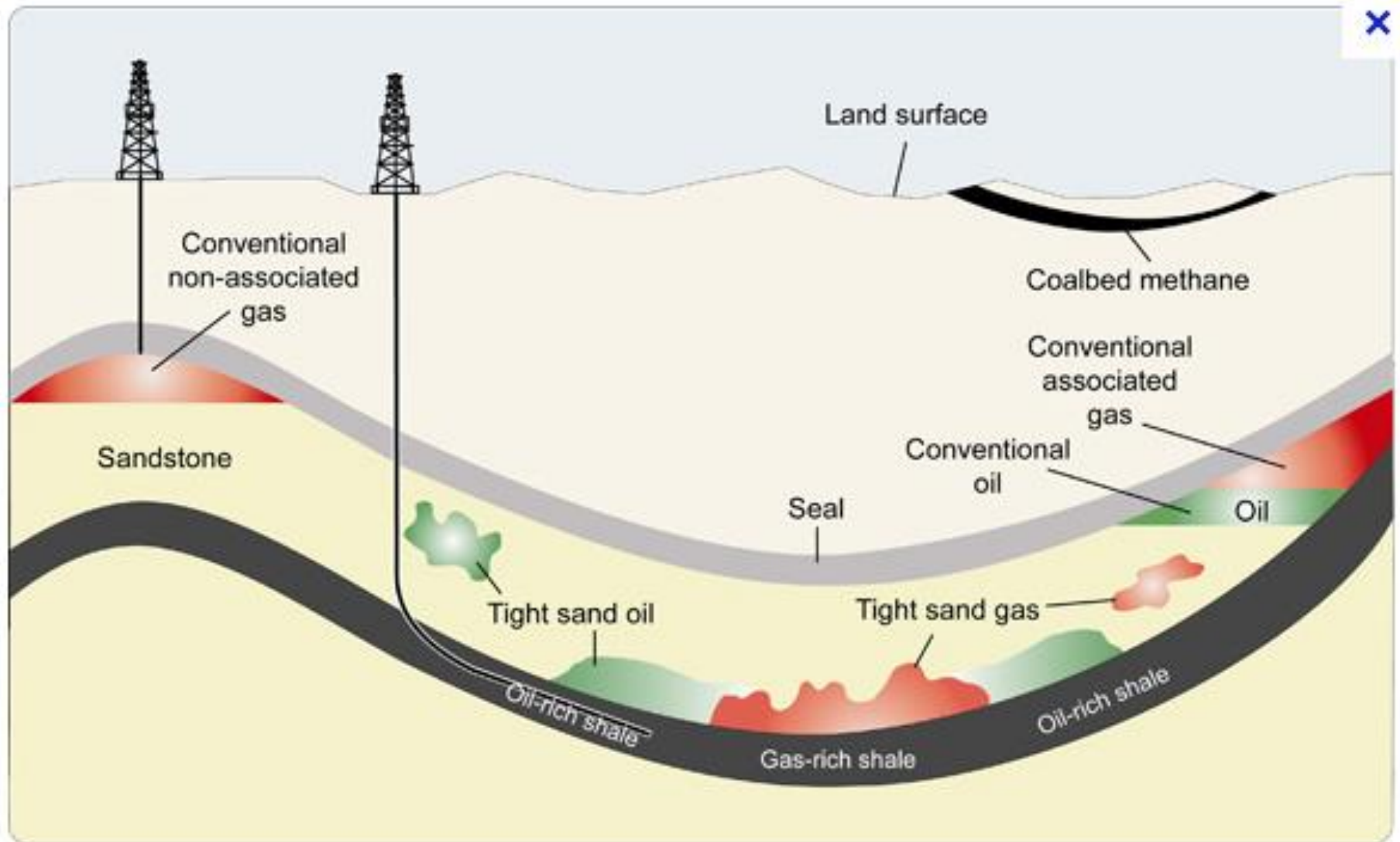
2012 LIHEAP Eligible Cash Savings = **\$11,748,240,000**

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

Conventional vs Unconventional Reservoirs



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

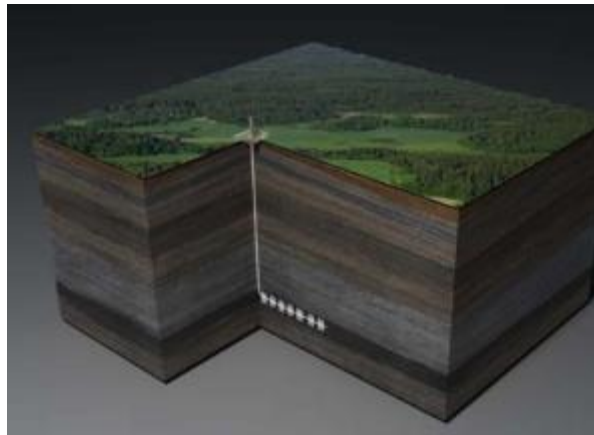
Fracture Treatment in 1949



12 Miles East of Duncan, OK

Definition

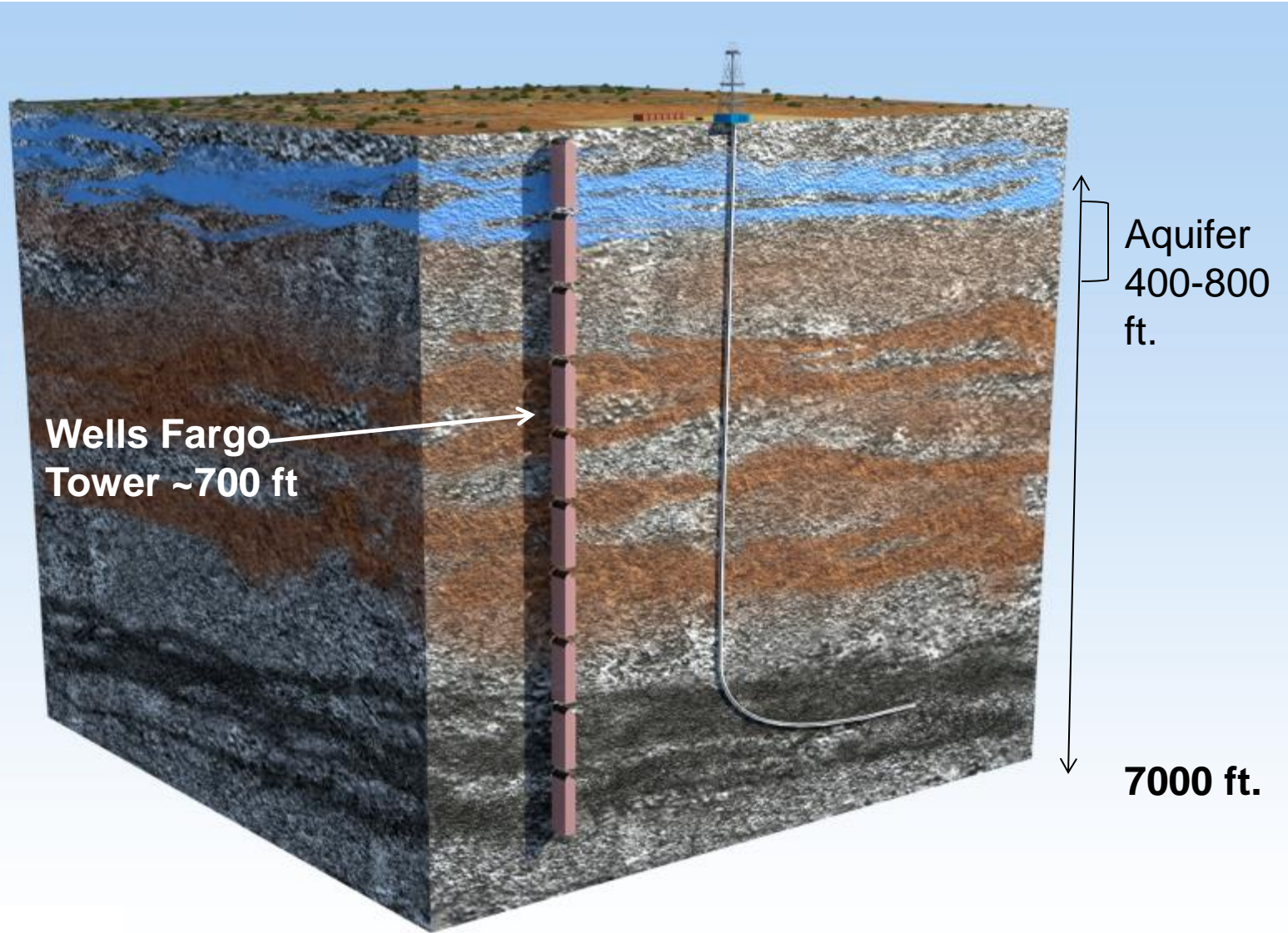
- The use of fluids to create a crack by hydraulic pressure
- The continued injection of fluids into the created crack fracture to make it grow larger
- The placement of small granular solids into the crack to ensure the crack remains open after the hydraulic pressure is no longer applied



Why HF a Well?

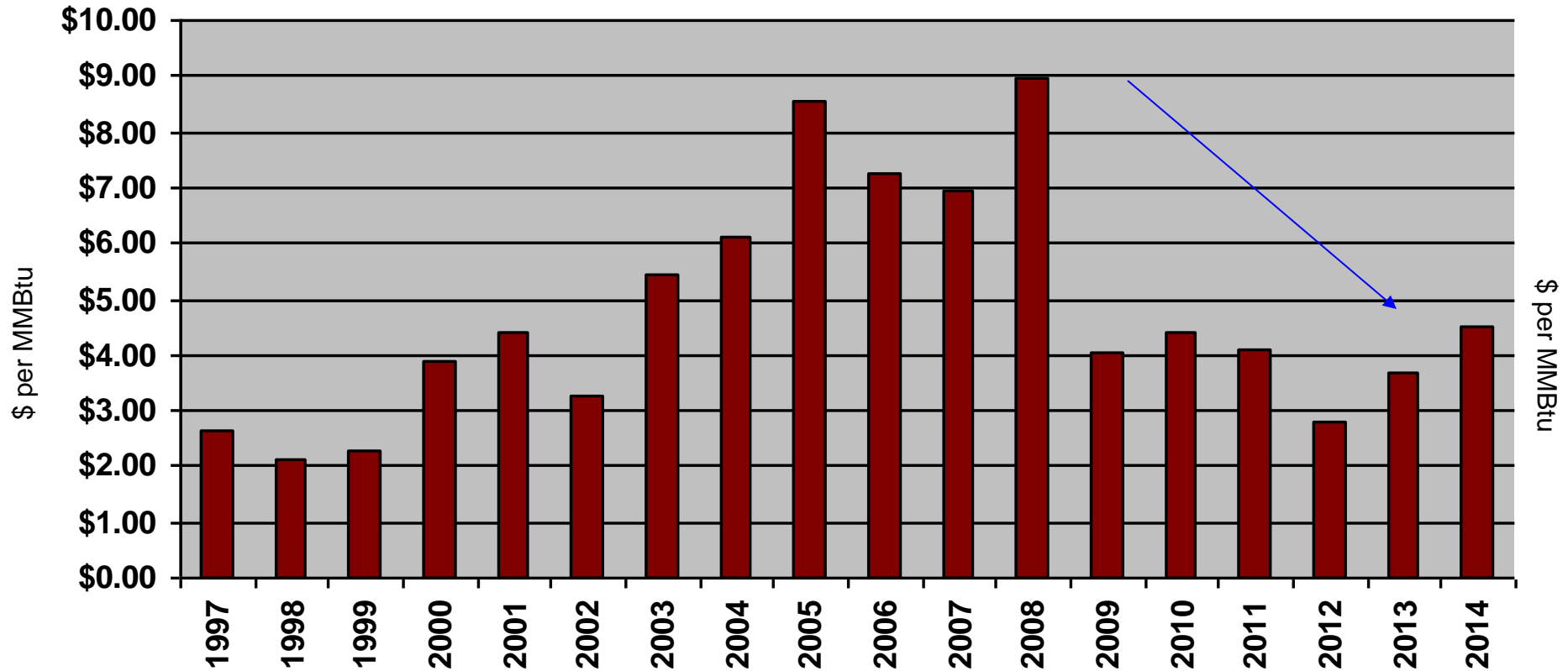
- Increase the **Rate** at which the well is capable of producing oil or gas
- Most unconventional formations **Require** hydraulic fracturing to be economic
- Does not increase total **Reserves**

Drilling Distance



NYMEX Henry Hub Natural Gas Price*

1996 - 2014 Actual



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

World LNG Estimated September 2014 Landed Prices



This U.S. energy breakthrough has
positive implications for national
security.

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

NATO Chief: Putin Behind Anti-Fracking Campaign

June 19, 2014



Putin Behind Anti-Fracking Campaign

Anders Fogh Rasmussen, secretary of the North Atlantic Treaty Organization (NATO) said, “I have met allies who can report that Russia, as part of their sophisticated information and disinformation operations, engaged actively with so-called non-governmental organizations – environmental organizations working against shale gas – to maintain European dependence on imported Russian gas.”

Source: *Russia 'secretly working with environmentalists to oppose fracking'* The Guardian, Fiona Harvey, June 19, 2014

Gazprom's Current Near-Monopoly Supply Position

% of Supply from Gazprom/Russia

Slovakia	100%
Macedonia	100%
Finland	99%
Bulgaria	97%
Serbia & Montenegro	87%
Lithuania	84%
Hungary	80%
Czech Republic	79%
Greece	76%

Source: "Domestic Consumption" EIA International Energy Annual, 2007; "Exports 2006 and 2007" Gazexport as cited by Energy Intelligence, March 2008

Gazprom's Current Near-Monopoly Supply Position (cont'd)

% of Supply from Gazprom/Russia

Austria	74%
Slovenia	64%
Poland	62%
Ukraine	66%
Turkey	60%
Germany	40%
Croatia	37%
Italy	30%
France	25%

Source: "Domestic Consumption" EIA International Energy Annual, 2007; "Exports 2006 and 2007" Gazexport as cited by Energy Intelligence, March 2008

This U.S. energy breakthrough has positive implications for addressing air pollution world-wide.

Harpoles In China: 2010 & 2012







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





ENVIRONMENTAL IMPACTS OF COAL



For Educational Purposes Only - Copyrighted

Kyoto Protocol

U.S. Energy Information Agency reports that America's greenhouse gas emissions have **fallen 7 percent to 1992 levels.**

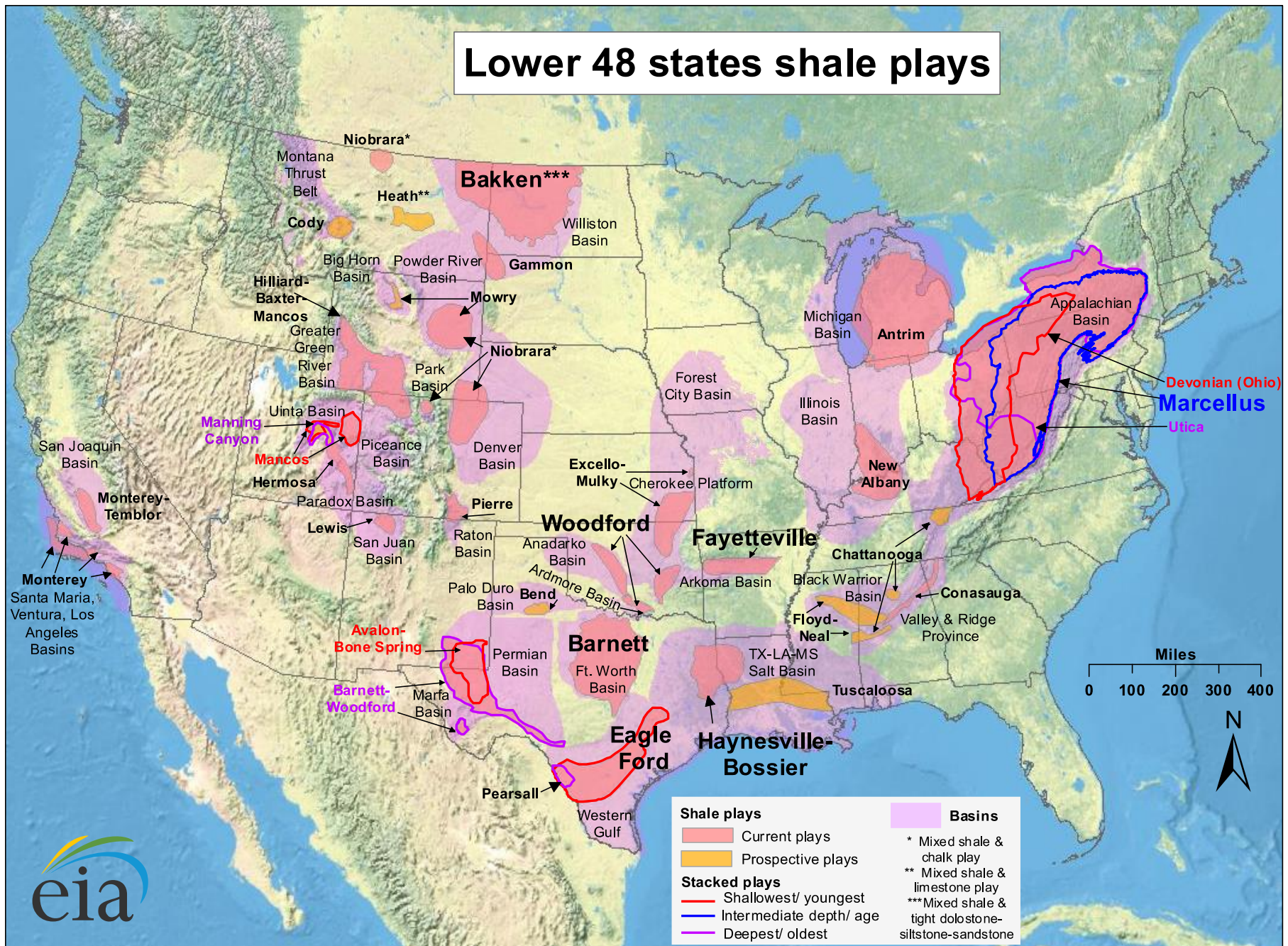
US, a non participant in Kyoto Protocol Treaty, is the only nation to meet 1999 forecasted reduction

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

Lower 48 states shale plays



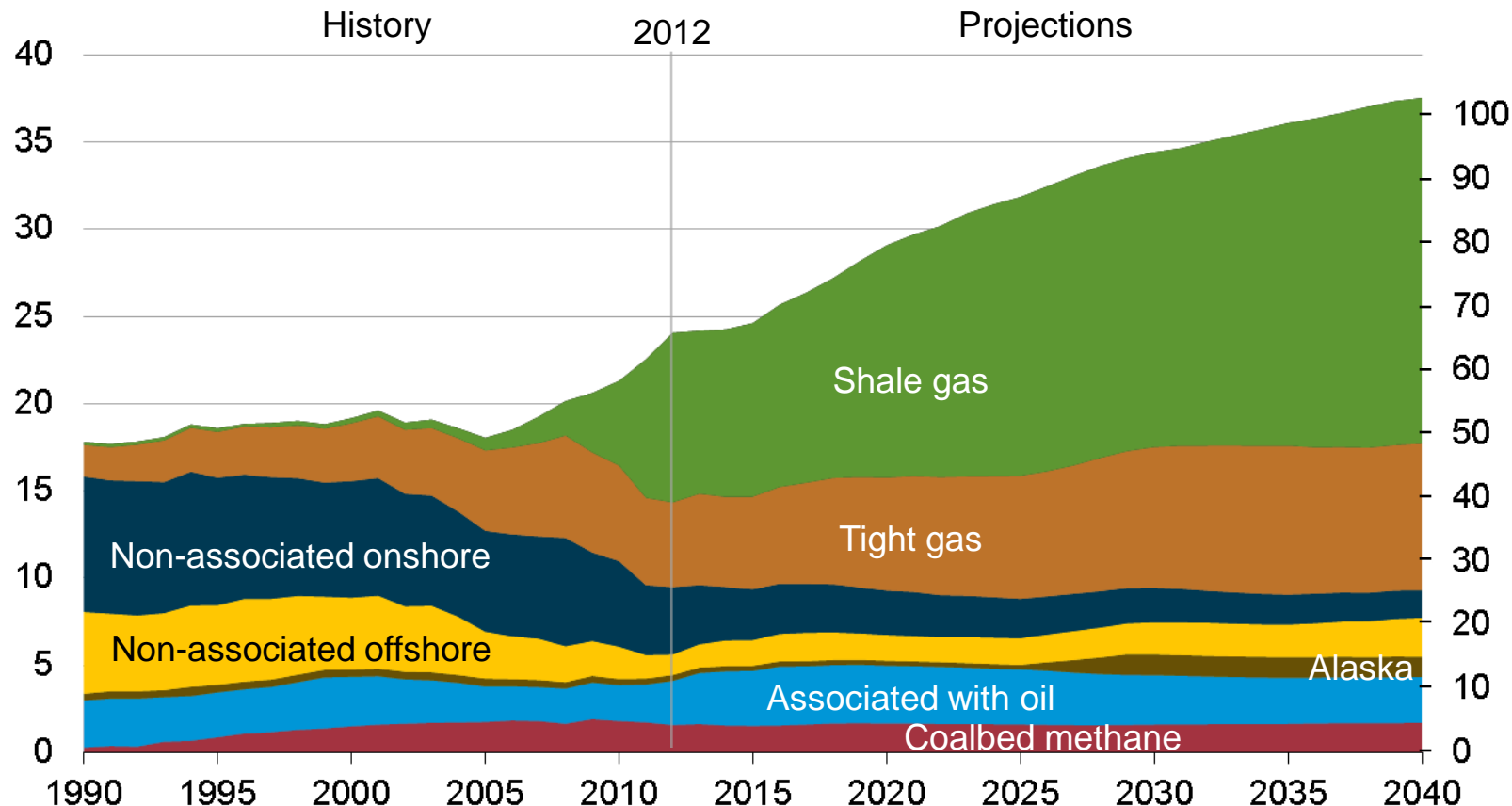
Source: Energy Information Administration based on data from various published studies.
Updated: May 9, 2011

U.S. shale gas leads growth in total gas production through 2040 to reach half of U.S. output

U.S. dry natural gas production

trillion cubic feet

billion cubic feet per day



Source: EIA, Annual Energy Outlook 2014 Early Release

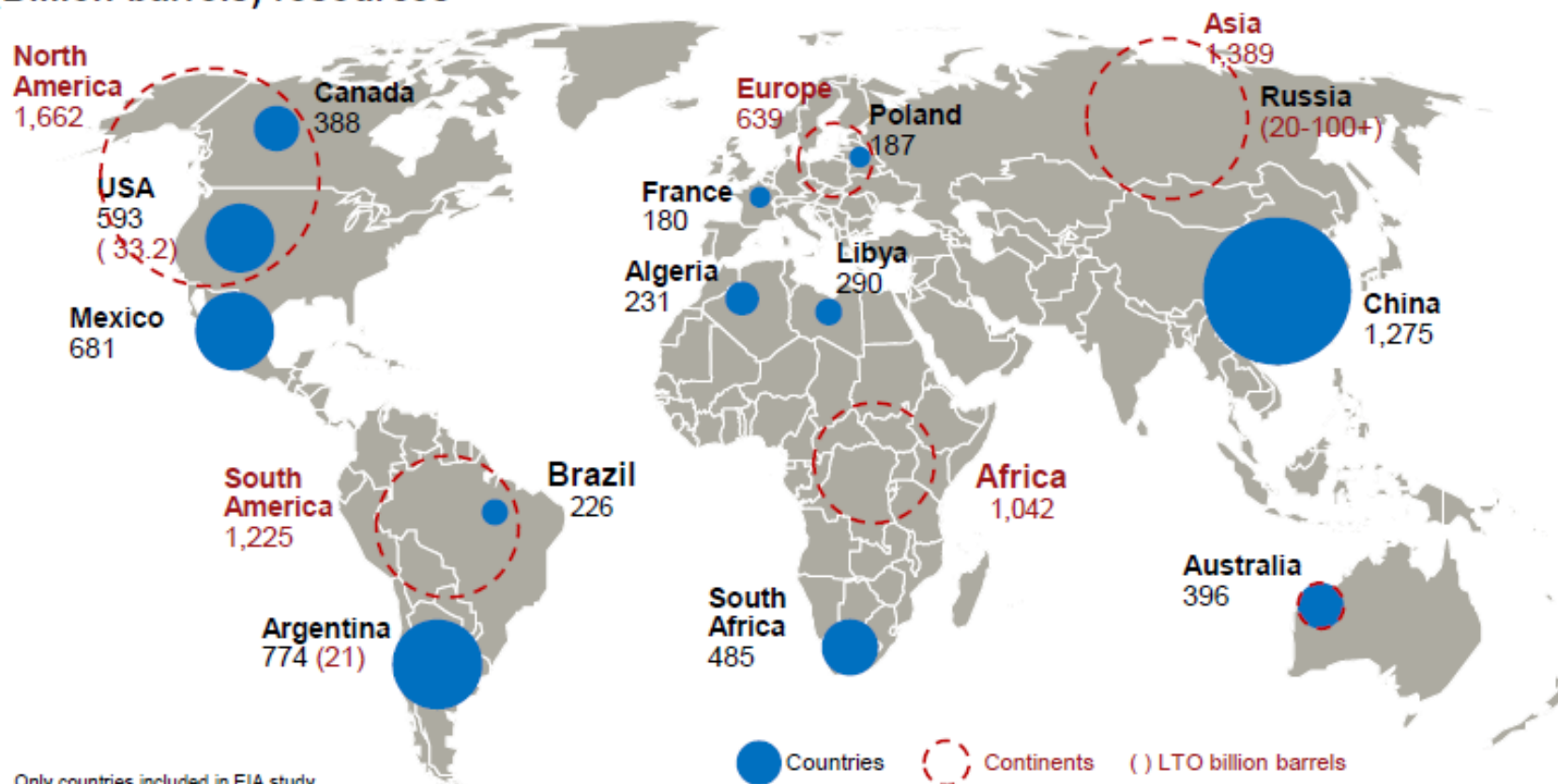
World Gas Reserves 2003 vs. 2013

2003 Rank	Country	Proved Reserves, Trillion Cubic Feet (2003)	Proved Reserves Trillion Cubic, Feet (2013)	2013 Rank
1	Qatar	910.1	890	3
2	Iran	970.8	1187	2
3	United Arab Emirates	213.9	215.025	7
4	Saudi Arabia	238.4	287.844	5
5	Russia	1694.4	1688	1
6	Algeria	160.4	159.05	10
7	Turkmenistan	102.4	265	6
14	United States	186.9	308.436	4
15	Canada	56.6	68.166	18

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

Major global shale gas and LTO opportunities¹

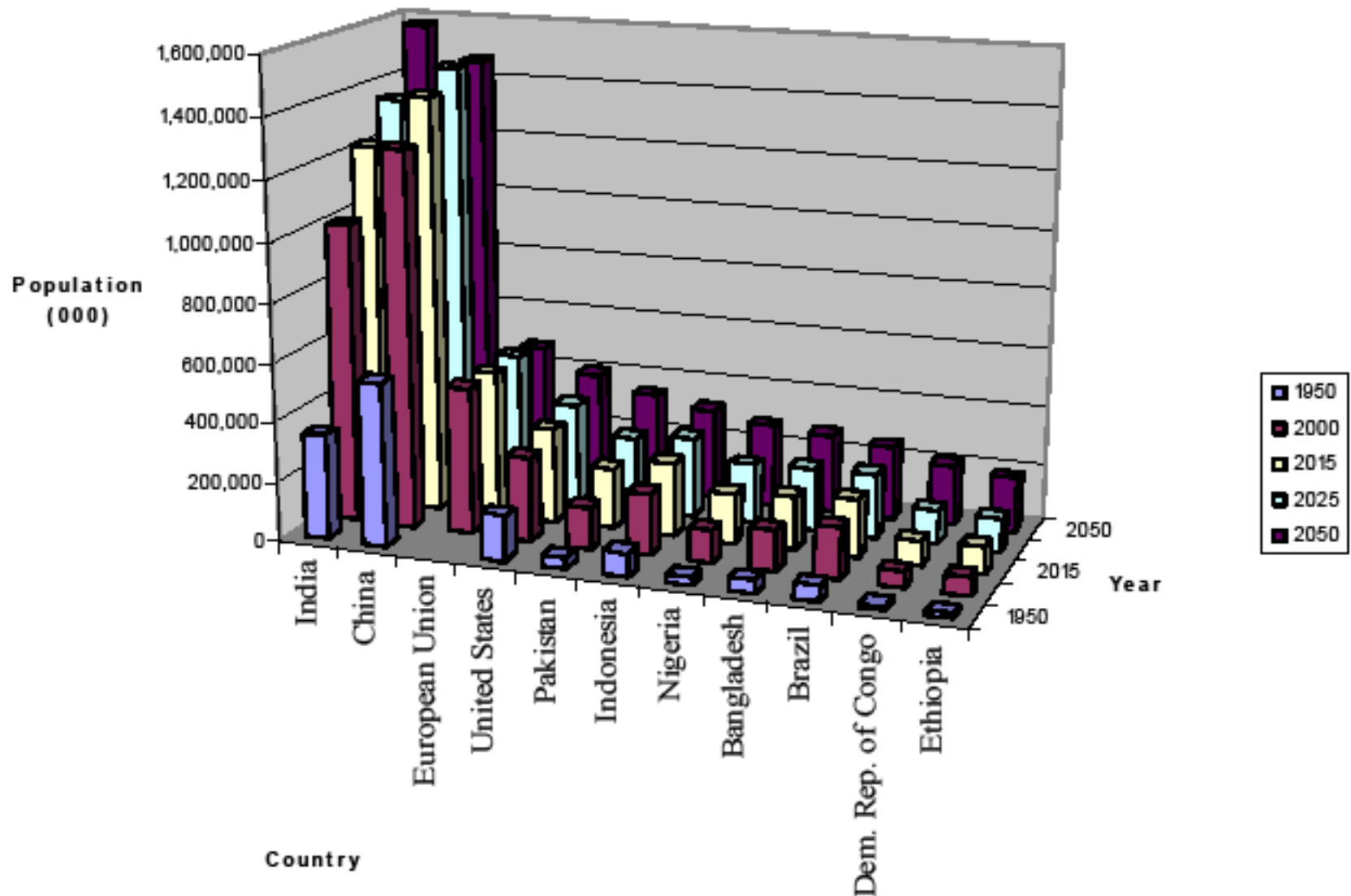
Technically recoverable shale gas (trillion cubic feet) and LTO (Billion barrels) resources



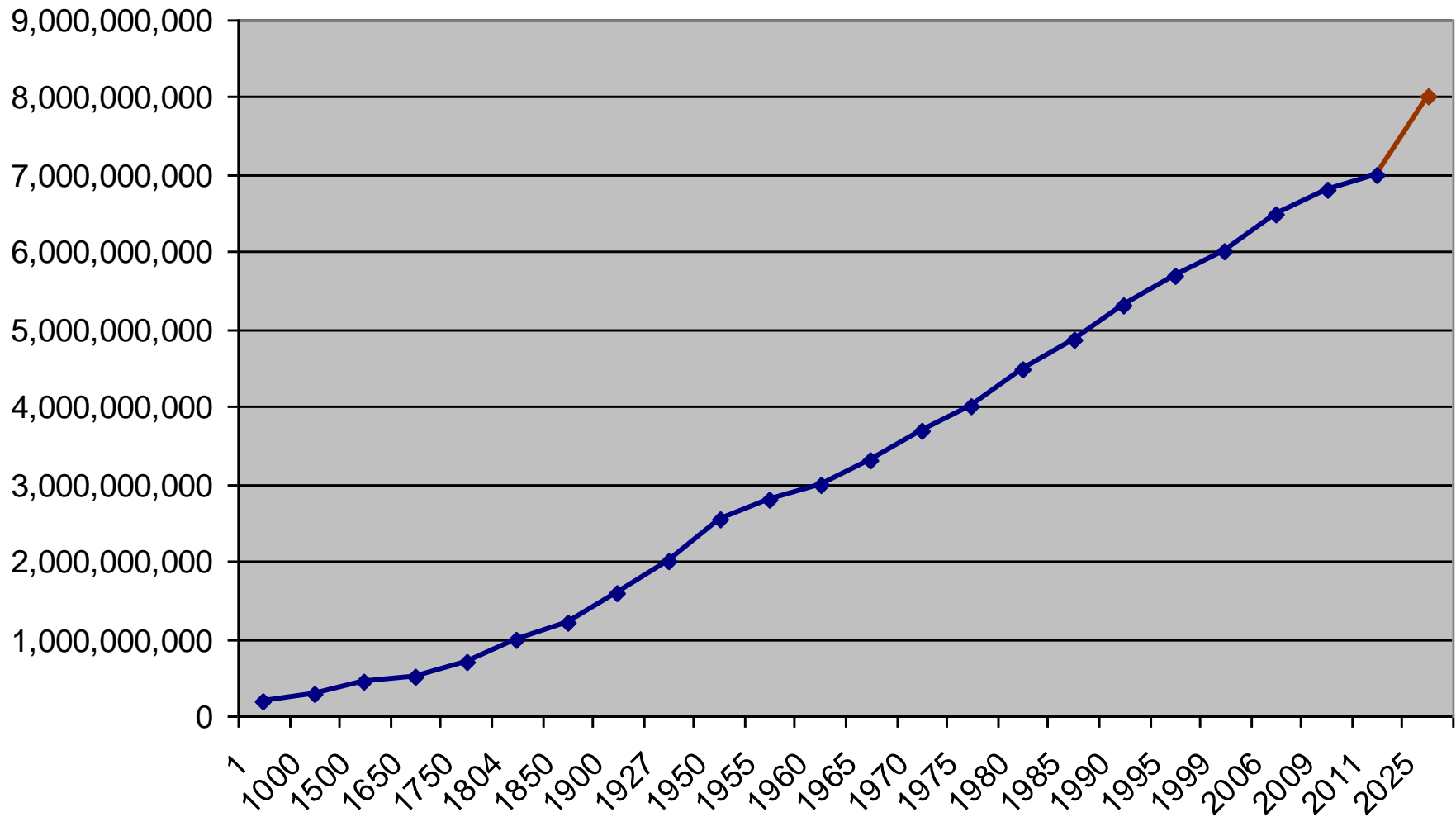
1. Only countries included in EIA study
 Source: EIA, Forbes, <http://www.shale-gas-tight-oil-argentina-ii.com/>

This U.S. energy breakthrough has positive implications quality of life.

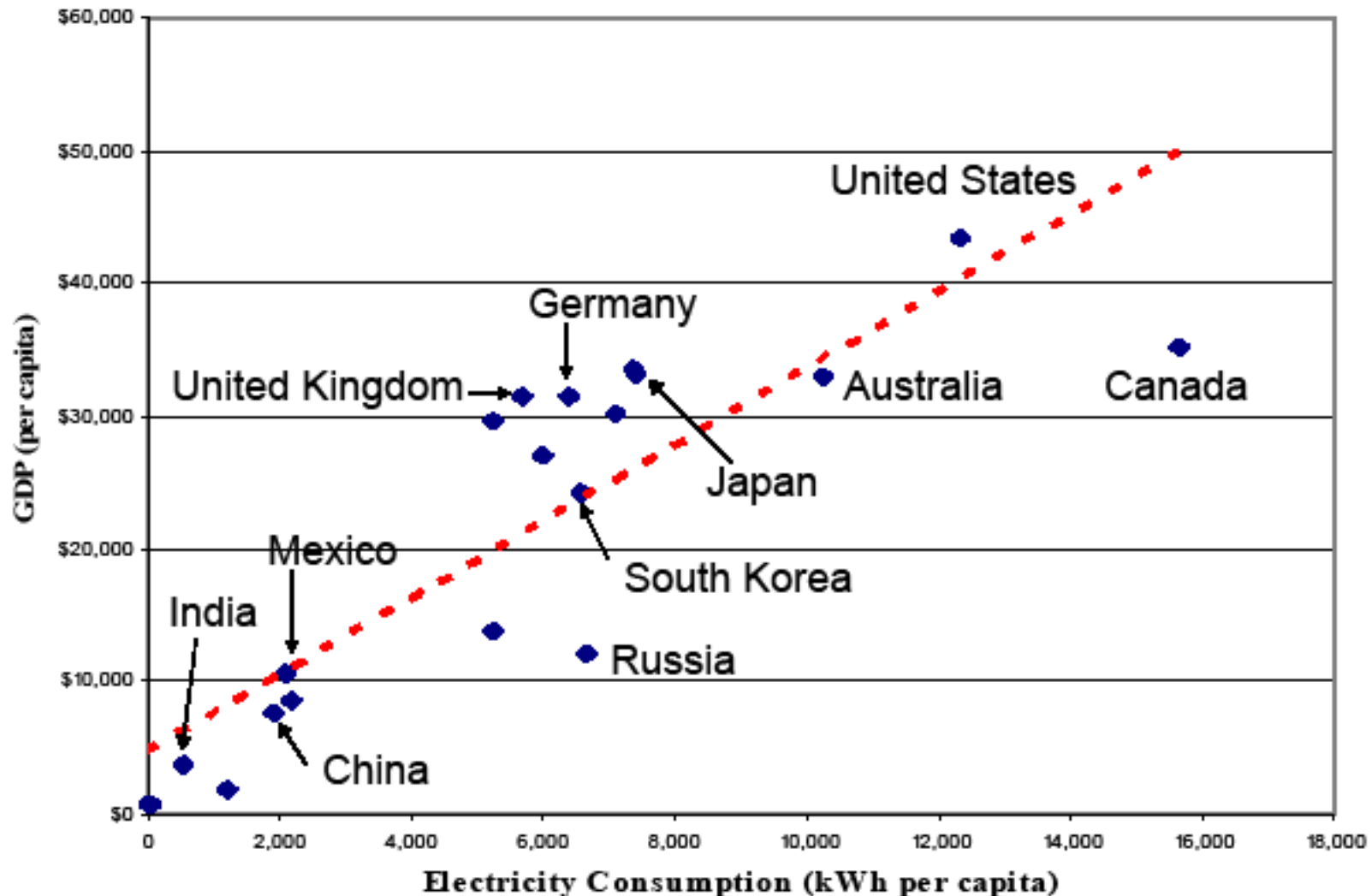
Population Growth from 1950-2050



World Population Growth

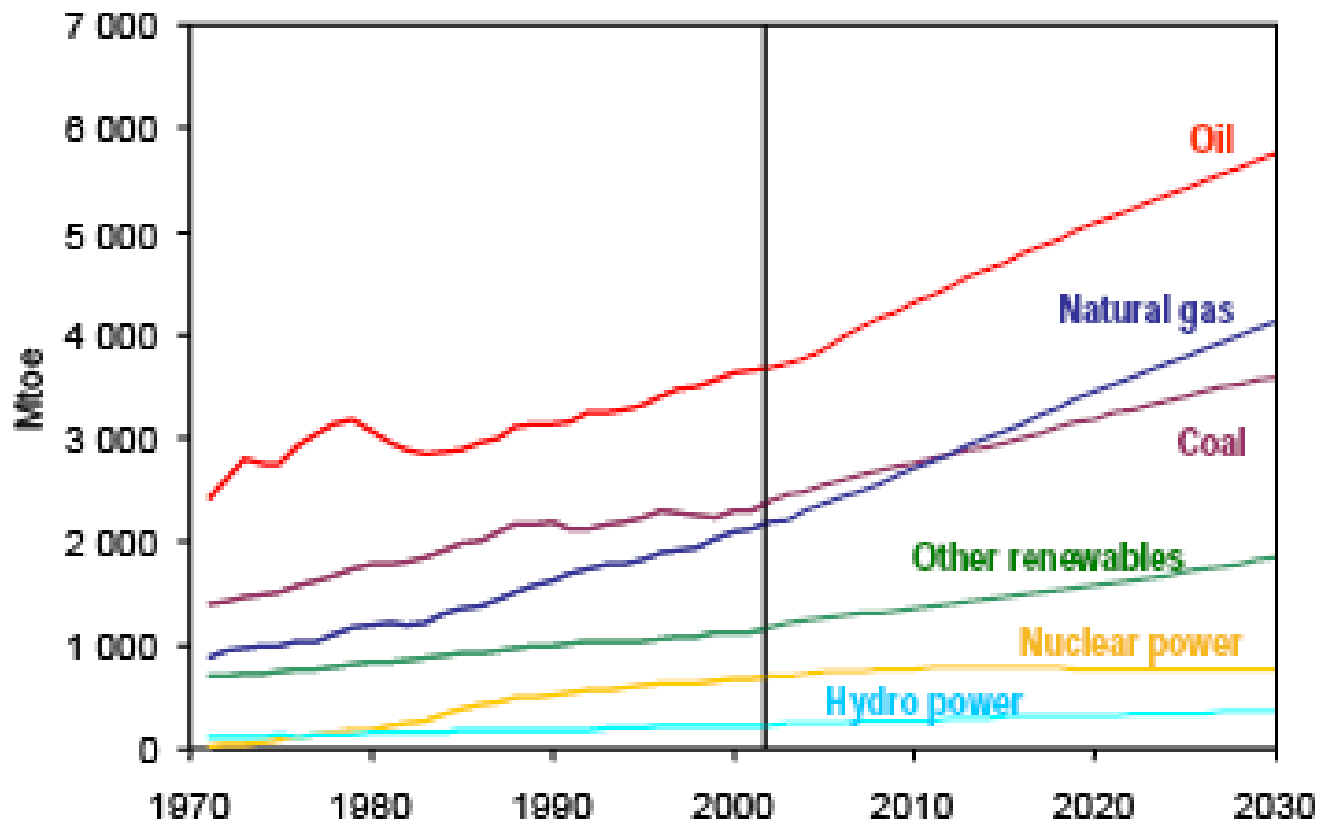


Quality of Life is Strongly Correlated with Electricity Consumption



Source: CIA World Factbook, 2007

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



The essentiality of electricity to modernity

Over 1.2 billion people – 20% of the world's population – are still without access to electricity worldwide, almost all of whom live in developing countries. This includes about 550 million in Africa, and over 400 million in India.



Scale on Electricity

- The entire continent of Africa uses the same amount of electricity as Canada.
- The average Chinese uses about five times as much electricity as the average Indian, while the average American uses about 20 times more.

Source: *When 600 Million People Lost Power*, Robert Bryce, August 5, 2012

Indoor air pollution

About 2.8 billion people use solid fuels – wood, charcoal, coal and dung – for cooking and heating. Every year fumes and smoke from open cooking fires kill approximately 1.5 million people mostly women and children, from emphysema and other respiratory diseases.



This U.S. energy breakthrough
has positive implications for the
cost of food.

Natural gas – fertilizer – food

“If we all ate simple vegetarian diets and farmed every acre of arable land as wisely as possible using the best techniques of the late 1800s, the earth could support a population of around 4 billion people. In theory, the other 2 billion-plus inhabitants should be starving, the natural result of population out-stripping food supply, as doomsayers from Thomas Malthus to Paul Ehrlich have long predicted.”

- Thomas Hager

Nihilistic Ecotheology

“...apocalyptic fears of ecological collapse, disenchanting notions of living in a fallen world, and the growing conviction that some kind of collective sacrifice is needed to avoid the end of the world”

Source: Breakthrough Institute, Ted Nordhaus and Michael Shellenberger, September 2011

Example – Bill McKibben

- “perhaps the nation’s most effective grass-roots environmental advocate” (New York Times)
- ...“our systems and economies have gotten too large...we need to start building them back down. What we need is a new trajectory, toward the smaller and more local.” (Bill McKibben)

Sierra Club and Scale

- “Sierra Club, Greenpeace, and many other groups want to pave the world with low-density wind turbines.”*
- The world currently get 50 times as much energy (from coal, oil, natural gas, nuclear and hydropower) as we do from wind, solar geothermal and biomass.

*Source: *Smaller, Faster, Lighter, Denser, Cheaper*, Robert Bryce, May 2014

A Question of Scale

- 32% growth in CO2 emissions since 2002 (8.4 billion ton increase) nearly all of this in the developing world
- To replace the U.S. 300 billion watts of coal fired capacity would require placing wind turbines over 116,000 square miles...a footprint roughly the size of Italy
- Last year's increase in U.S. oil production is roughly equal to twice the energy equivalent of every solar energy installation on the planet.

Proponents of Fracking



“We produce more natural gas than ever before...and nearly everyone’s energy bill is lower because of it...[T]he natural gas boom has led to cleaner power and greater energy independence.”

- President Barack Obama

“We should strengthen our position as the top natural gas producer...[I]t not only can provide safe, cheap power, but it can also help reduce our carbon emissions.”

- President Barack Obama

“There’s nothing inherently dangerous in fracking that sound engineering practices can’t accomplish.”

- Gina McCarthy, Current EPA Administrator



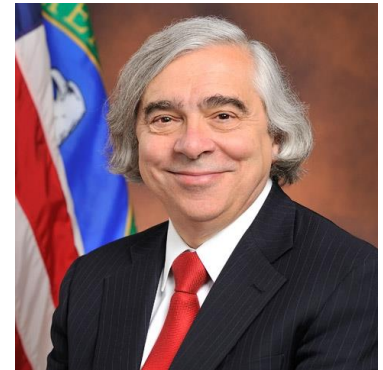


“I’m not aware of any proven case where the fracking process itself has affected water.”

- Lisa Jackson, Former EPA Administrator

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

- Ernest Moniz, Secretary of Energy



“This [hydraulic fracturing] is something you can do in a safe way.”

- Steven Chu, Former Secretary of Energy



“Fracking has been done safely for decades.”

- Sally Jewell, Secretary of Interior



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

- Ken Salazar, Former Secretary of Interior



“I know and you know that fracking is not a threat to our communities when it is done safely and responsibly.”

- Mark Udall, Senator of Colorado



“We believe oil and gas development can thrive while also meeting our high standards for protection of health, water and the environment.”

- John Hickenlooper, Governor of Colorado

Conclusions

- Inexpensive energy translates to:
 - Jobs
 - Affordable heat
 - Affordable light
 - Affordable food
- All of those conditions can significantly contribute to an environment conducive to a far better world.
- The U.S. must export its success in product, technology and nation security.

Conclusions

- By arguing against fracking and natural gas, one op-ed writer has characterized this as a battle of “Greens v. the poor: It’s a movement of the ‘haves.’”*
- The Sierra Club seems to espouse anti-human life environmentalism: Pitting people against the planet, embracing radical depopulation as a key to saving the planet.

*Source: New York Post, Naomi Schaefer Riley, September 17, 2014

Contact Information

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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:

Energy Information Administration (EIA)
Bentek Energy, Jack Weixel
American Petroleum Institute (API)
Ponderosa Advisors LLC
The Washington Post
Office of Energy Projects
Potential Gas Committee (PGC)
Office of Fossil Energy
Fox News
Bloomberg
Office of Oil Gas Global Security Supply
U.S. Department of Energy
Raymond James and Associates, Inc.
U.S. Federal Energy Regulatory Commission (FERC)
Institute for Energy Research (IER)
Bernstein Research
Western Energy Alliance
Platts Gas Daily Report, A McGraw Hill Publication
Colorado Oil and Gas Association
America's Natural Gas Alliance
Colorado Oil and Gas Association (COGA)
Coloradans for Responsible Energy Development (CRED)
Robert Bryce
The Wall Street Journal
Waterborne Energy, Inc.
The World Bank

Question

Question –

Keeping poor people poor and hungry?

- The breakthrough on hydraulic fracturing and horizontal drilling has created a super-abundant energy commodity (natural gas) that will improve the quality of life as it is disseminated throughout the world.
- This U.S. energy breakthrough has positive implications for the cost of food.
- How would you plan to feed the world's population without manmade nitrogen whose sole feedstock is natural gas?
- At least 2.5 billion people would starve to death if the world moved toward organic farming.

Responses

The Stanford Model

- Mark Jacobson's "roadmap to renewables" assumes perfect electricity storage
- With electricity you are either producing it, transmitting it or consuming it. The ability to store it on a utility scale has been the Holy Grail pursued by geniuses like Alessandro Volta (1745-1827) and Thomas Edison (1847-1931).
- It is misleading to presume a solution will occur in time to make Jacobson's prediction a reality.

Alessandro Volta

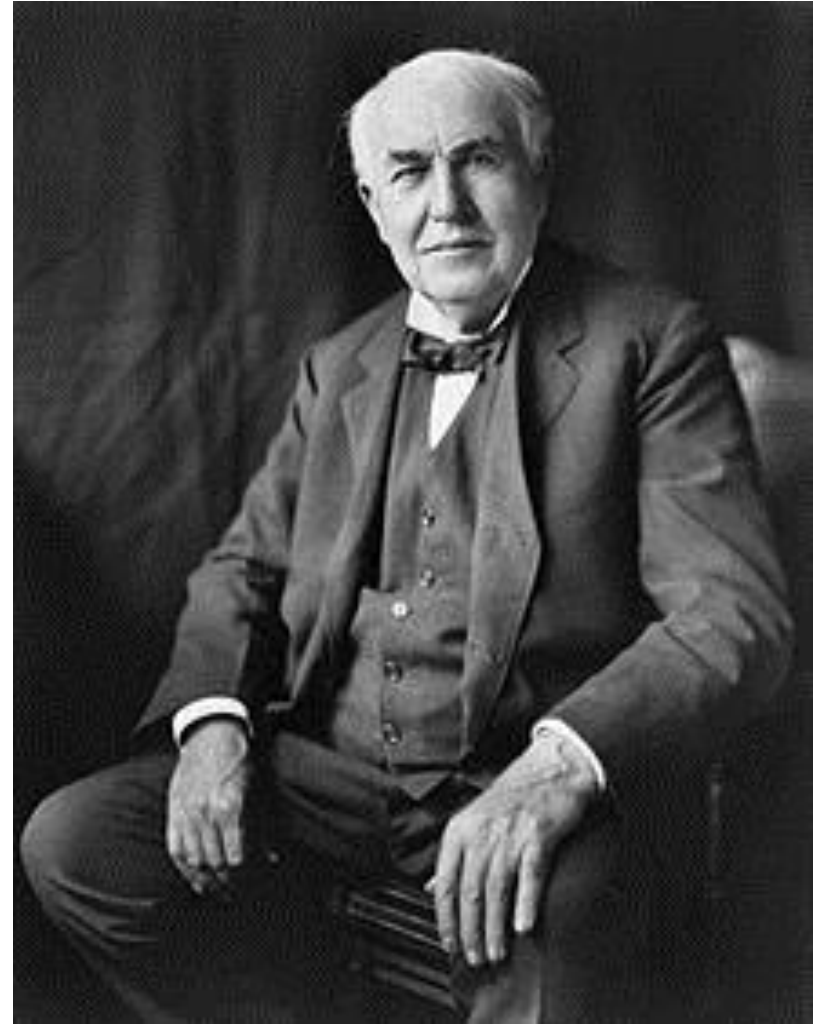


Physicist, chemist and a pioneer of electrical science

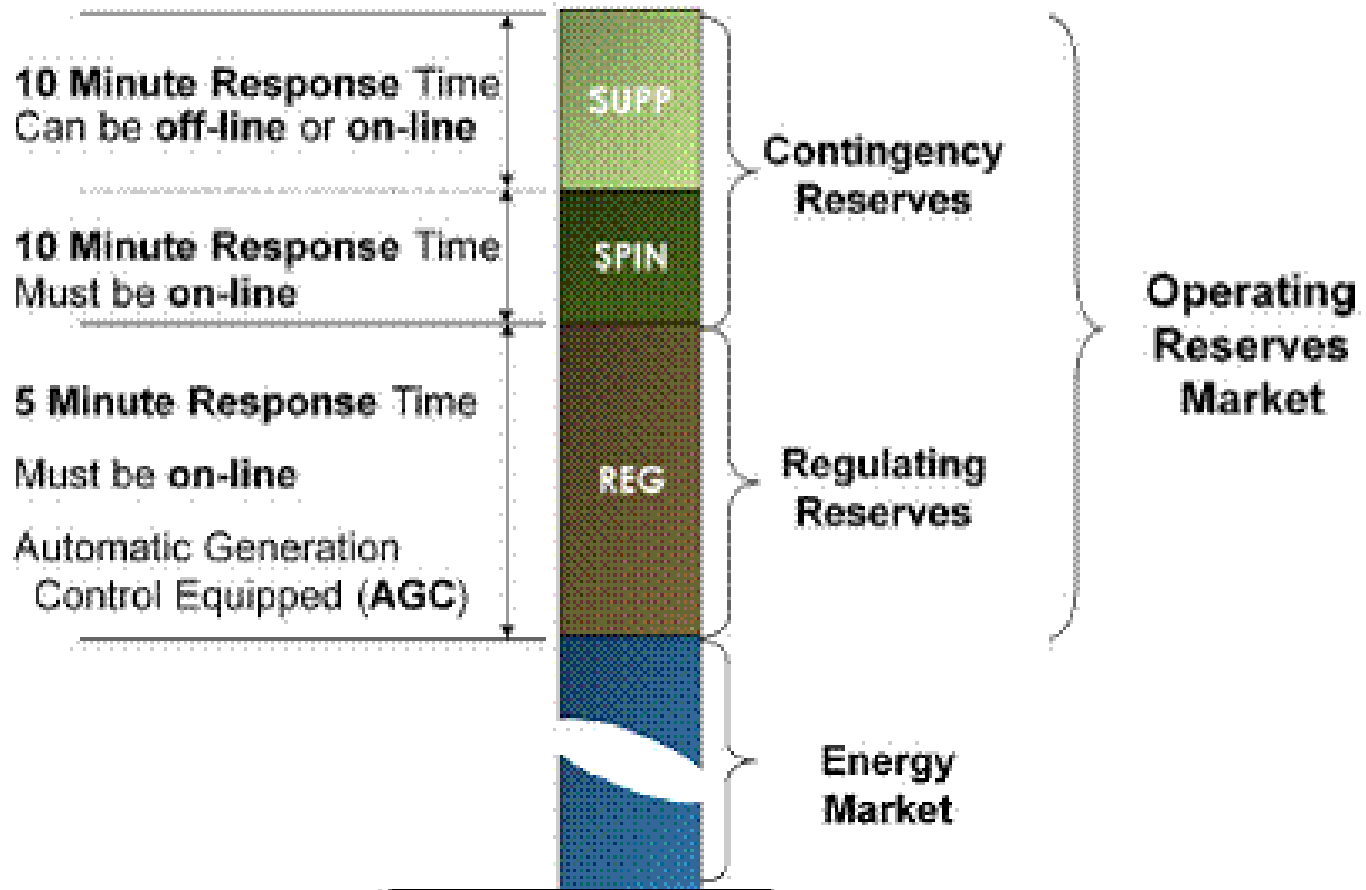
Thomas Edison

1847 – 1931

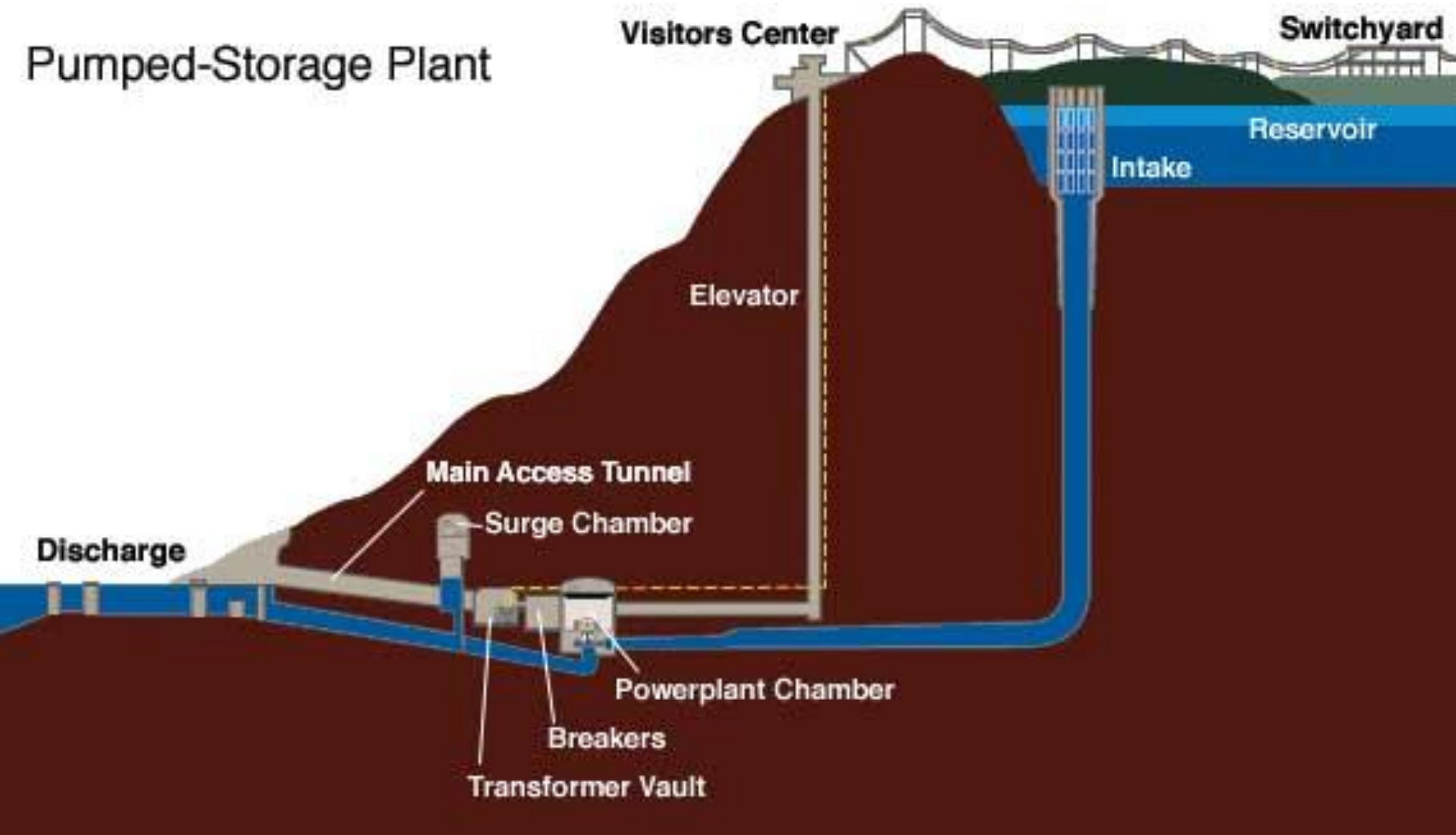
“Genius is one percent inspiration, ninety-nine percent perspiration.”



MISO's Day-Ahead and Real-Time Markets Include Four Products...



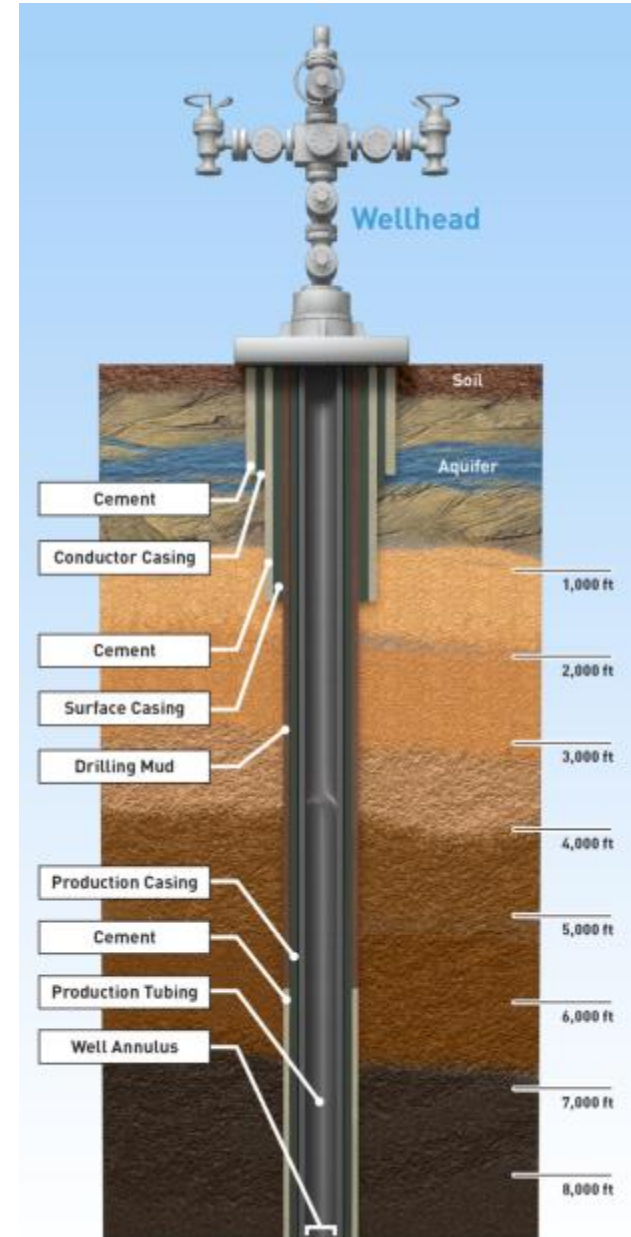
Pumped-Storage Plant



Source: Wikipedia, Diagram of the TVA pumped storage facility at Raccoon Mountain Pumped-Storage Plant

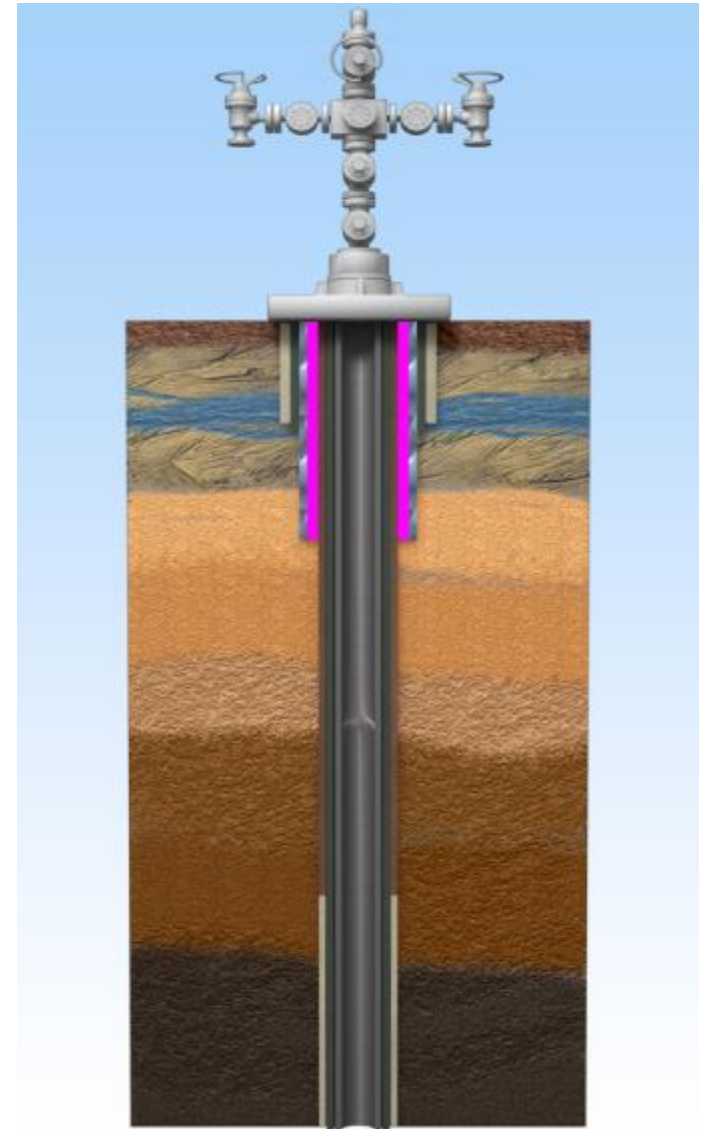
Casing

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



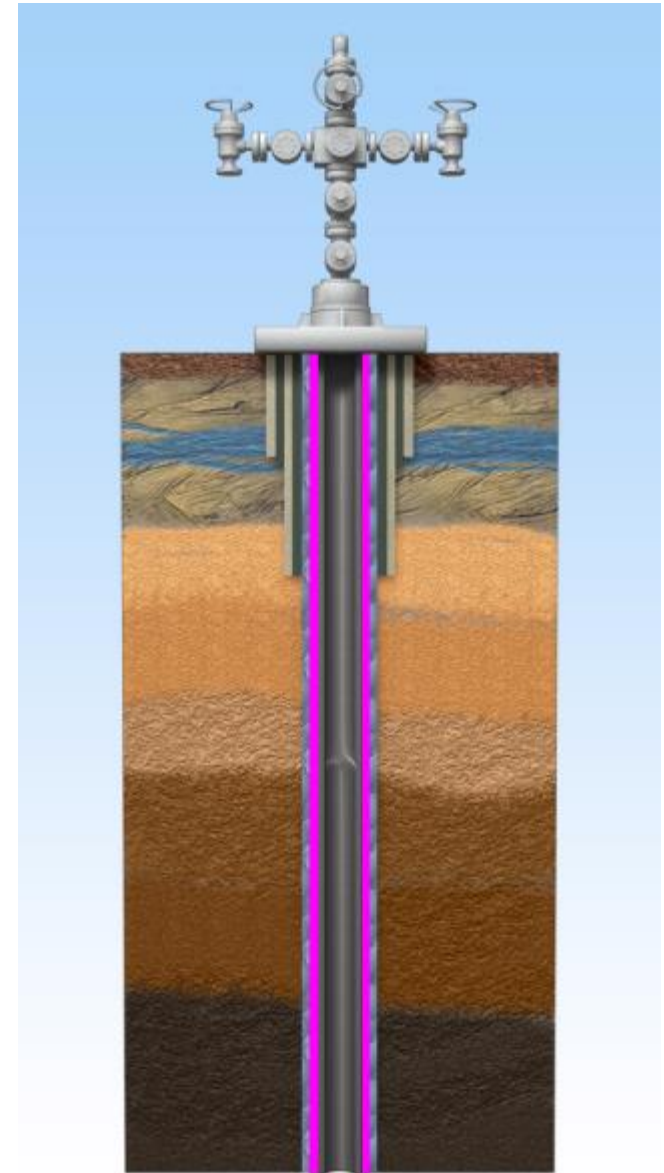
Surface Casing

- 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

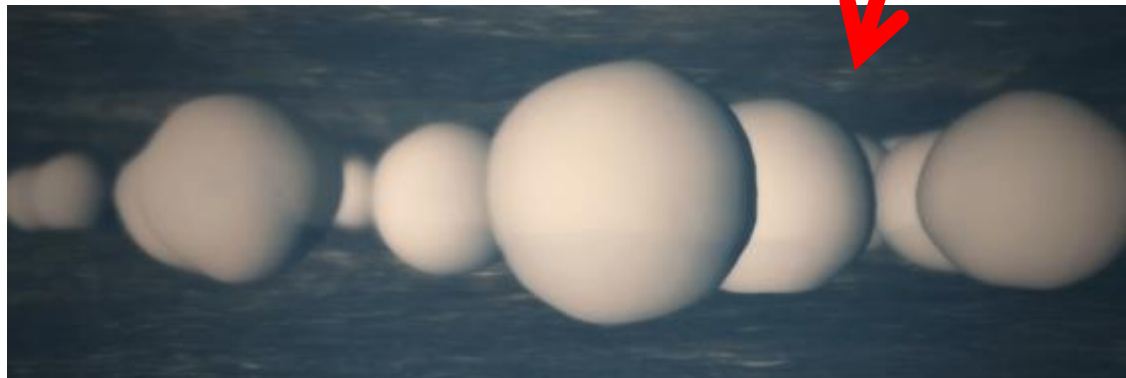


Production Casing

- 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



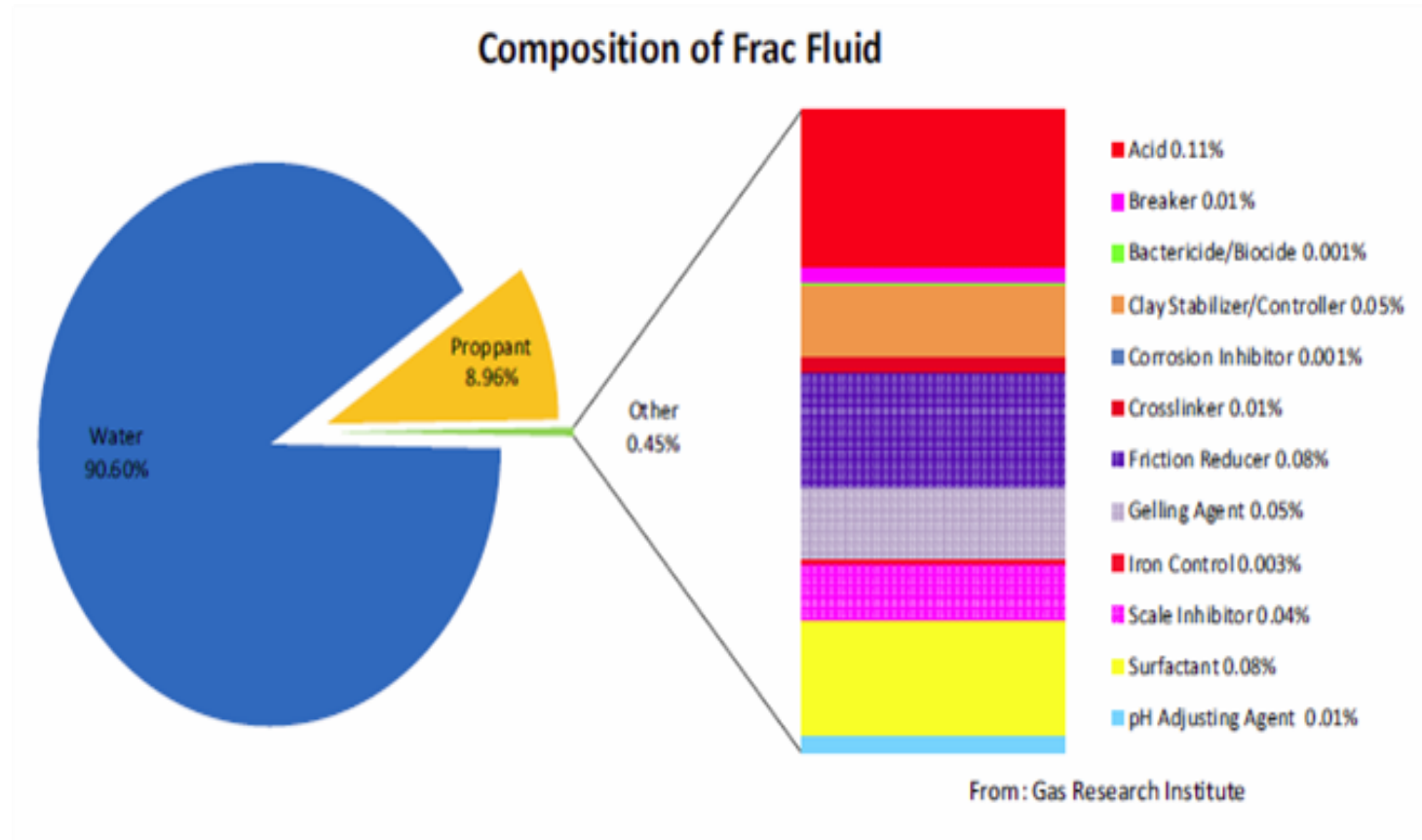
Fractures and Proppant



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



HF Fluids

Additive	Main Compound	Common Use
Diluted Acid	Hydrochloricor, 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

Water Requirements for Various Energy Resources*

Energy Resource¹	Range of Gallons of Water Used per MMBtu of Energy Produced
Barnett Shale Natural Gas	1.47²
Coal (no slurry transport)	2 – 8
Coal (with slurry transport)	13 – 32
Nuclear (uranium ready to use in a power plant)	8 – 14
Conventional Oil	8 – 20
Synfuel – Coal Gasification	11 – 26
Oil Shale	22 – 56
Tar Sands	27 – 68
Synfuel – Fisher Tropsch (from coal)	41 – 60
Enhanced Oil Recovery (EOR)	21 – 2,500
Concentrated Solar / Solar Parabolic Trough Plant	234³
Biofuels (Irrigated Corn Ethanol, Irrigated Soy Biodiesel)	> 2,500

*Source: “Water Use in Barnett Deep Shale Gas Exploration: Fact Sheet”, Chesapeake Energy, May 2011

¹Source: “Deep Shale Natural Gas: Abundant, Affordable, and Still Water Efficient”, GWPC, 2010

²The transport of natural gas can add between zero and two gallons per MMBtu

³Calculated using information from the World Energy Outlook 2011 Special Report Annex A, General Conversion Factors for Energy (3412 Mbtu (1,000 Btu) = 1 GWh) & The Arizona Water Resource, September – October 2008 Volume 17, Number 1 referencing a 2006 report Energy Demands on Water Resources, Report to Congress on the Interdependency of Energy and Water prepared by the U.S. Department of Energy stating a solar parabolic trough plant uses 760-920 gallons/MWh

Colorado Water Use

	Total (Million gallons/Day)	Total (Billion gallons/Year)
Irrigation (crop)	12,322	4497
Irrigation (golf course)	41	14
Public-supply	864	315
Domestic	34	12
Industrial	142	52
Livestock	33	12
Mining	21	8
Thermo-electric	123	45
Total withdrawals	13,581	4957

Source: USGS 2005 *Estimated Withdrawals and Use of Water in Colorado, 2005*

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

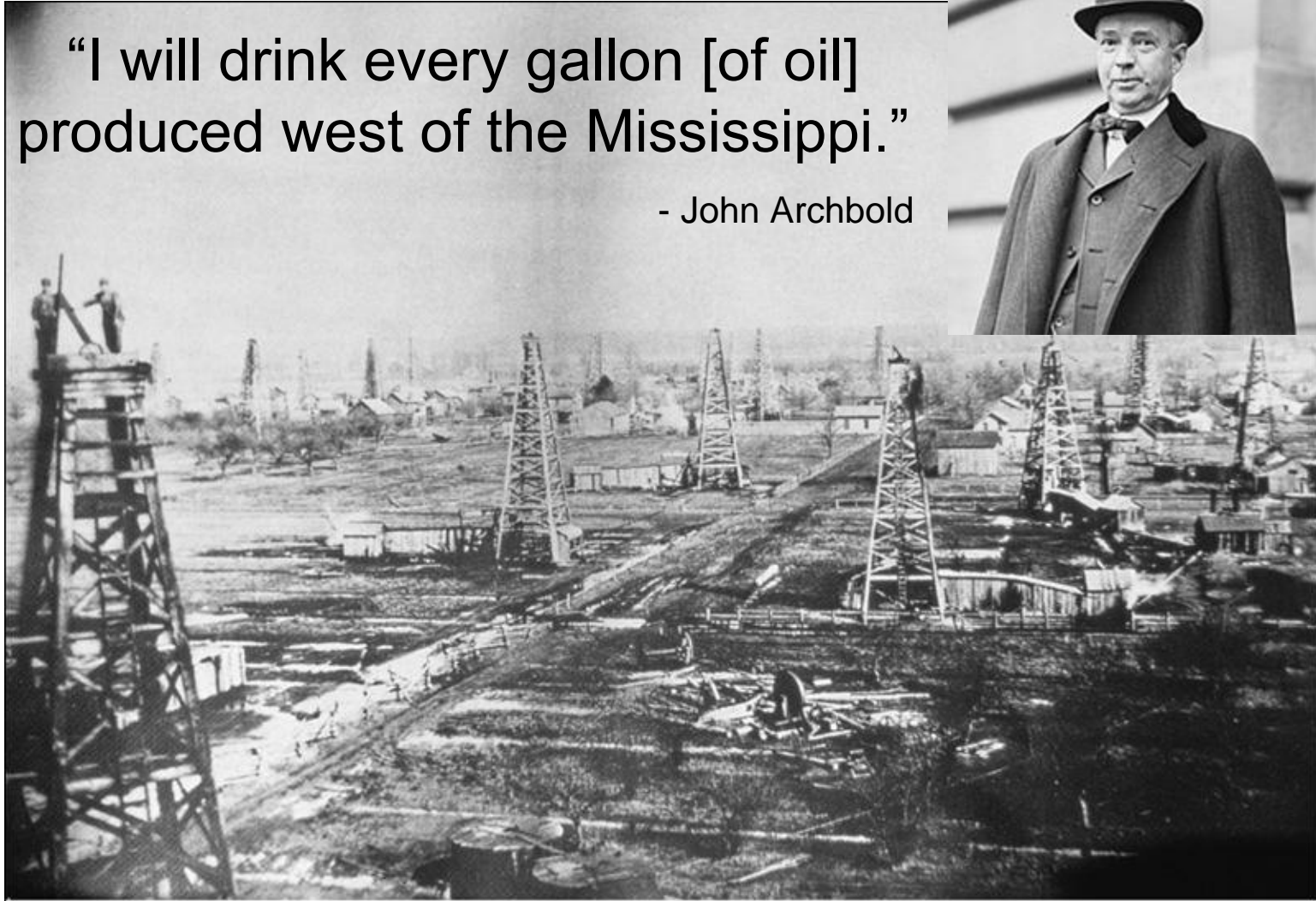
Source: COGCC

Notable past predictions of peak oil that didn't turn out

1885

“I will drink every gallon [of oil]
produced west of the Mississippi.”

- John Archbold



Notable past predictions of peak oil that didn't turn out

“Within the next two to five years, the oil fields of this country will reach their maximum production, and from that time on we will face an ever-increasing decline.”

- Van H. Manning, director of the U.S. Bureau of Mines

1919



Notable past predictions of peak oil that didn't turn out

1956

“U.S. oil production will likely peak between 1965 and 1970 and decline thereafter.”

- M. King Hubbert,
a geologist for Shell Oil



Notable past predictions of peak oil that didn't turn out

“We are living in the twilight of the petroleum age.”

-Glenn Seaborg, former chairman of the Atomic Energy Commission

1978



Notable past predictions of peak oil that didn't turn out 2005



“Global oil [production] is 84 million barrels [per day]. I don't believe you can get it any more than 84 million barrels. I don't care what Abdullah, Putin or anybody else says about oil reserves or production. I think they are on decline in the biggest oil fields in the world today.”

-T. Boone Pickens



Falling U.S. Oil Imports

Thanks to horizontal drilling and fracking in the shale plays: The share of total U.S. petroleum and other liquids consumption met by imports fell from 60% in 2005, to 32% in 2013. EIA, the statistical arm of the U.S. Department of Energy (DOE), expects the net import share to fall even more, to 21% in 2015, which would be the lowest level since 1968.

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**



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 voluntarily 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?

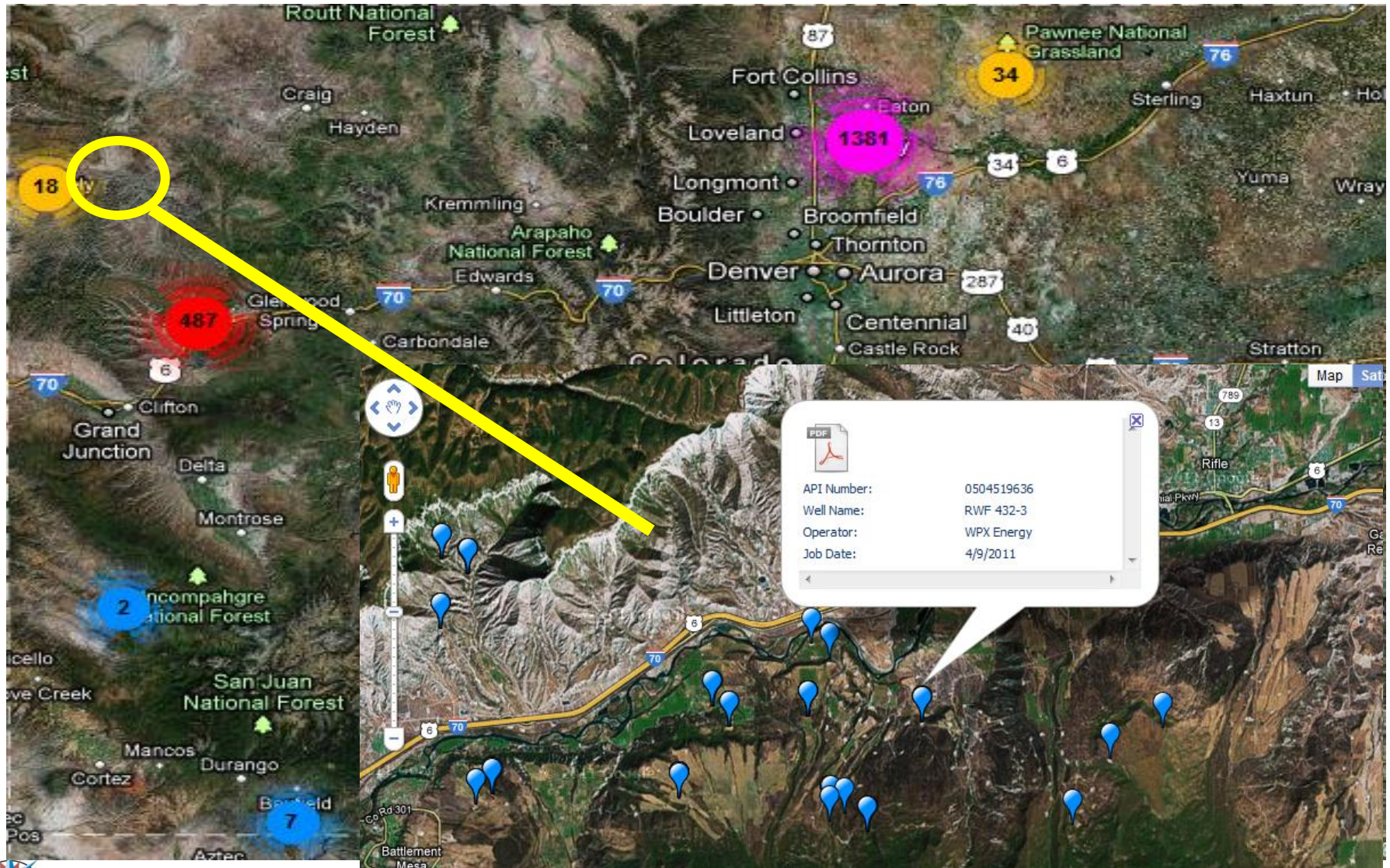
A. Although the source of water for fracturing can come from surface water, ground water or both, the volumes of water needed for fracturing horizontal shale gas wells necessitate that, with some notable exceptions like the Barnett shale in Texas, surface water provide the bulk of the water used in most 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.

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 (gal)*:	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

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

- 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

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

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

Fig. 1: Russian gas export to Europe: On-border sales and transit arms (1)



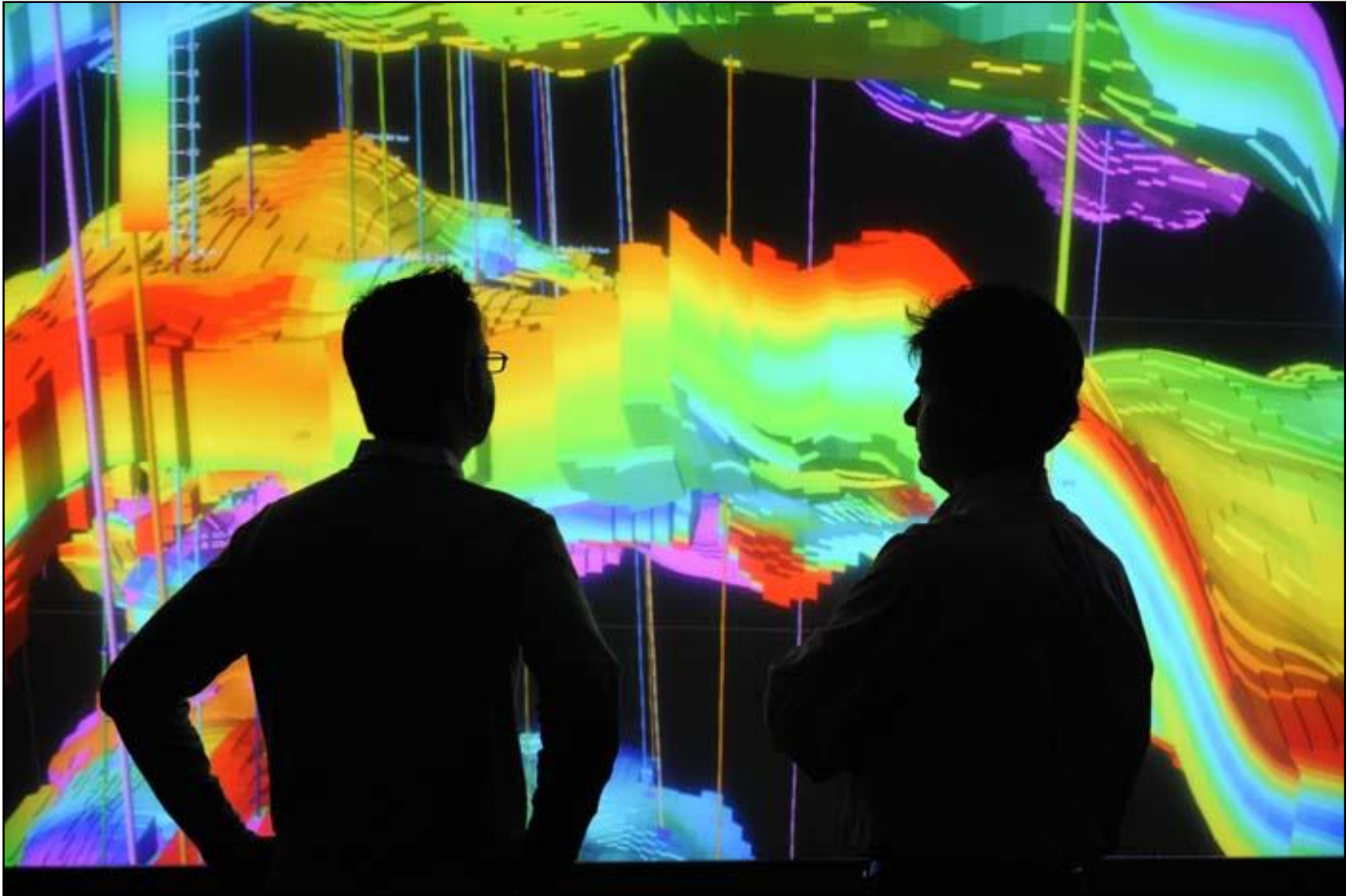


Noble in Israel and the Eastern Mediterranean

- ▶ Noa discovered 1999
- ▶ Mari-B discovered 2000
 - 28 BCM
 - Created Israel's natural gas industry
 - First gas sales 2004
- ▶ Tamar and Dalit discoveries in 2009
 - 280 BCM - 25 years supply
 - First gas sales in 2013
- ▶ Leviathan discovery in 2010
 - 535 BCM – export project
 - Potential to be online in 2016
- ▶ Cyprus A, Dolphin discoveries in 2011, Tanin in 2012



Noble Energy 3-D Visualization Center



Source: Noble Energy presentation, July 23, 2013

Tamar Platform
950ft, 290 m



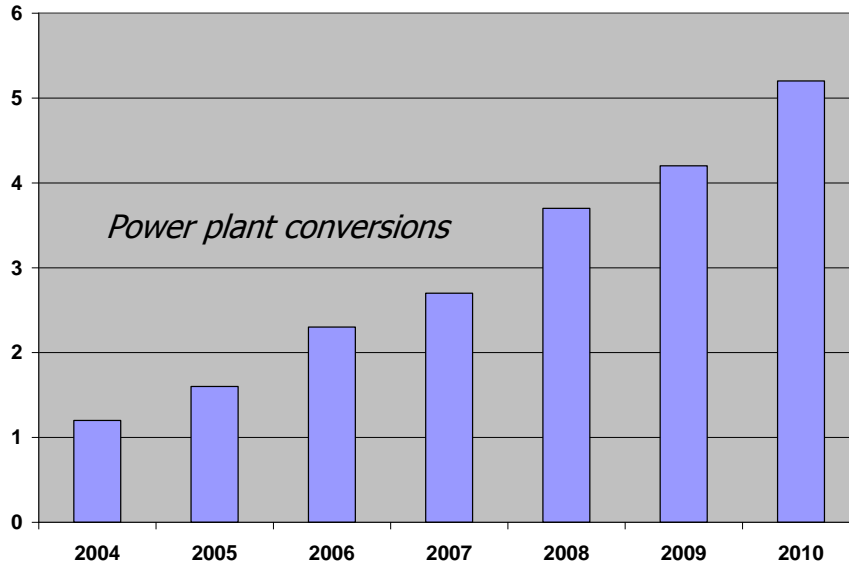
Moshe Aviv Tower
801ft, 244m



Source: Noble Energy presentation, July 23, 2013

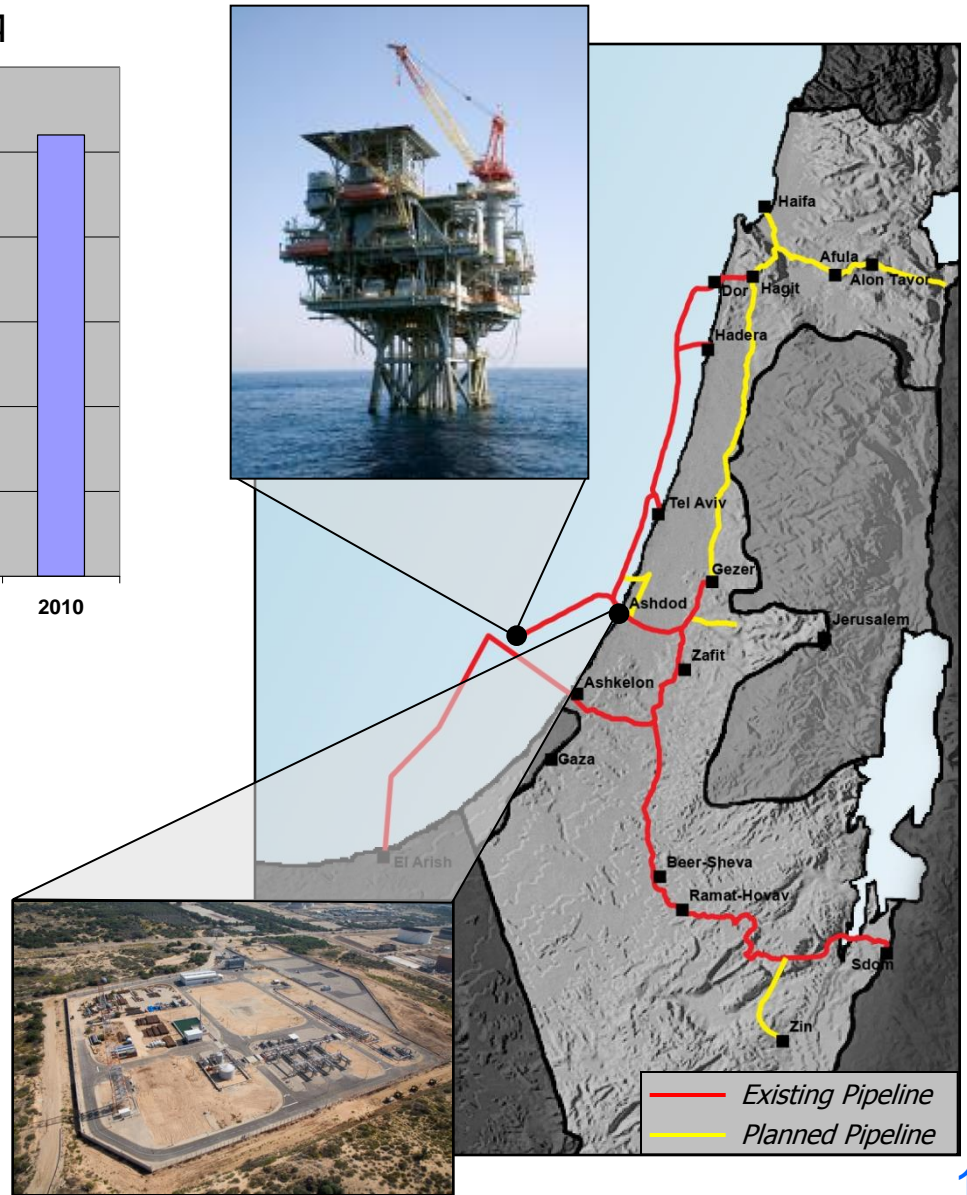
Mari-B Field

IEC Natural Gas Consumption, BCMA



- Supplies fuel for one-third of Israel's electricity generation
 - Over NIS 26 Billion in total savings since 2004
 - Saved 17 million metric tons of CO2 emissions to date

Source: Noble Energy presentation, July 23, 2013



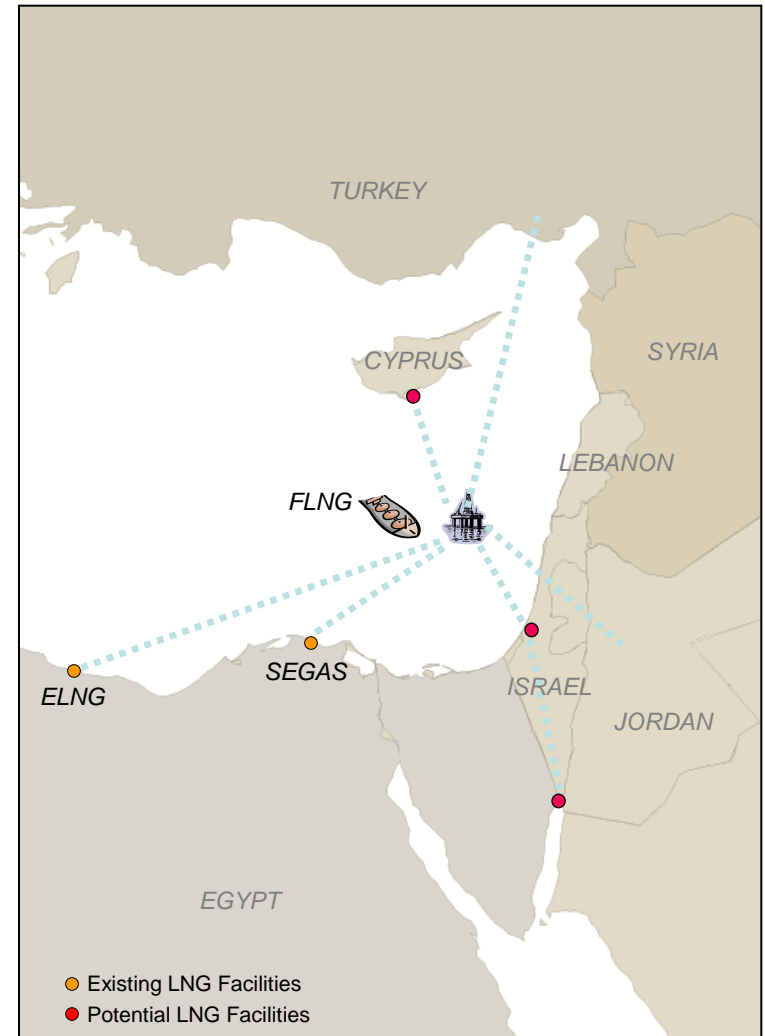
Tamar Reservoir Size



Source: Noble Energy presentation, July 23, 2013

Leviathan Export

- ▶ Drivers for natural gas exports
 - Accelerates Leviathan sanction
 - Encourages exploration
 - Value generation
- ▶ LNG options
 - Onshore Pre-FEED studies underway for multiple sites
 - FLNG nearing FEED stage
- ▶ Pipeline options
 - Jordan
 - Turkey
 - Egypt



Benefits to State of Israel

- ▶ Over the next 30 years government revenues from Tamar and Leviathan exceed \$100 billion
- ▶ Price of domestically produced natural gas is 1/3 that of alternative fuels (HFO and Diesel, and imported LNG)
- ▶ One-year delay of Tamar cost IEC approximately 12 billion NIS
- ▶ Economic analysis indicates that adoption of the Zemach recommendations on Leviathan increases the net present value (NPV) of the government's interest ~\$10 billion
- ▶ Government can realize benefit ahead of actual gas sales based on project capital and timeline commitments

Game Changer for Israel and the Middle East Region

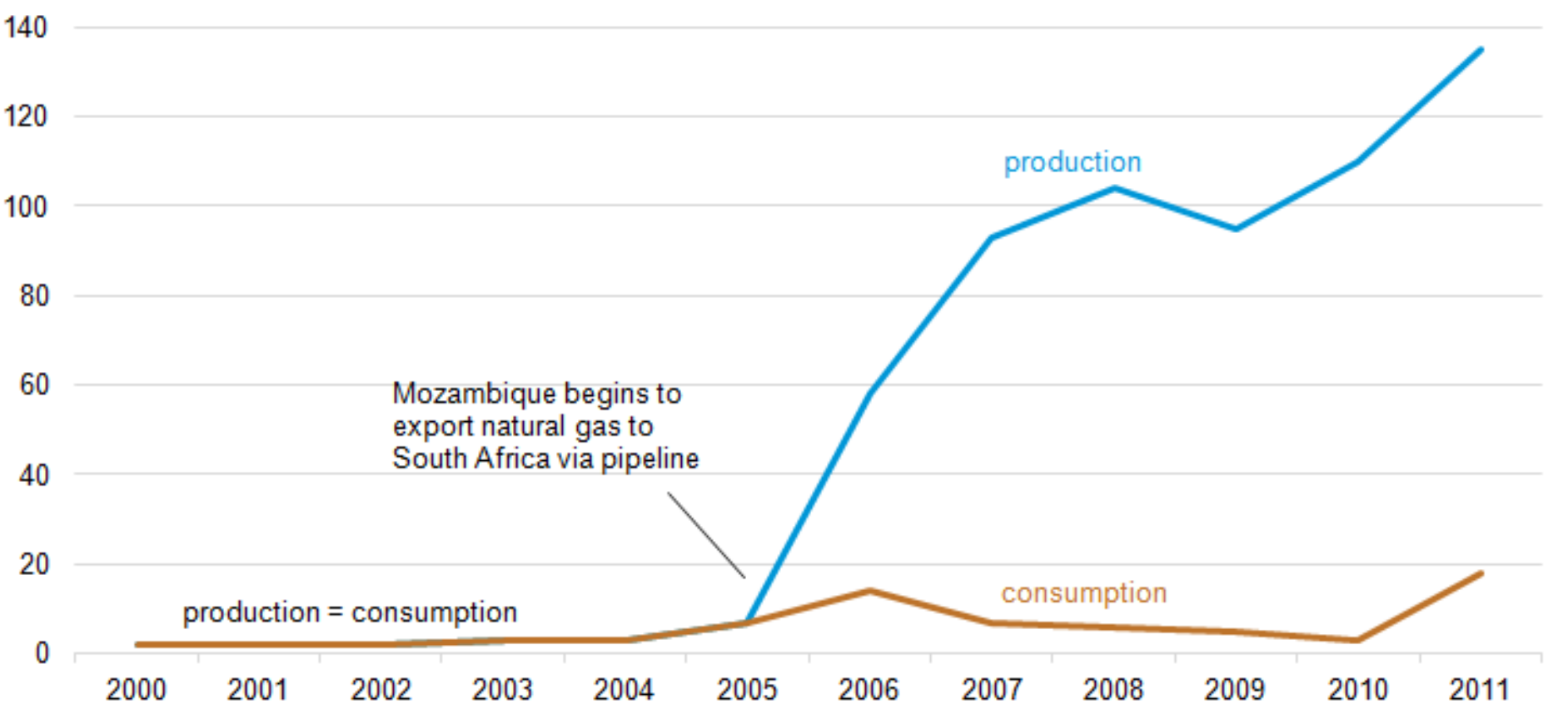
- Noble supplies 100% of Israel's gas requirements
- Noble has entered into gas sales agreements with the Palestinian Authority and a company in Jordan.
- Noble is looking at further exports to Egypt and Turkey and additional volumes to Jordan

Africa – The Dark Continent

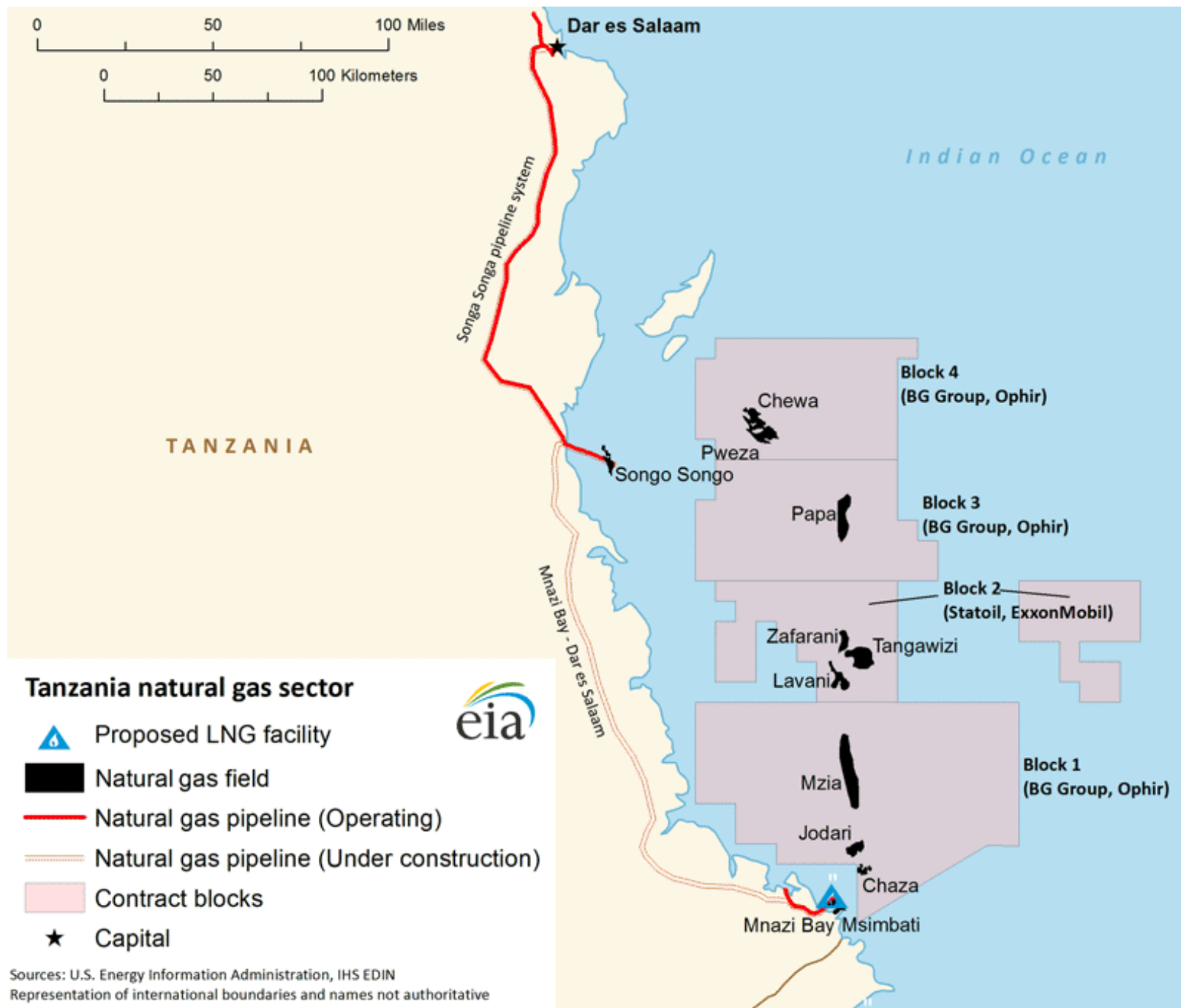


Mozambique natural gas production and consumption, 2000-2011

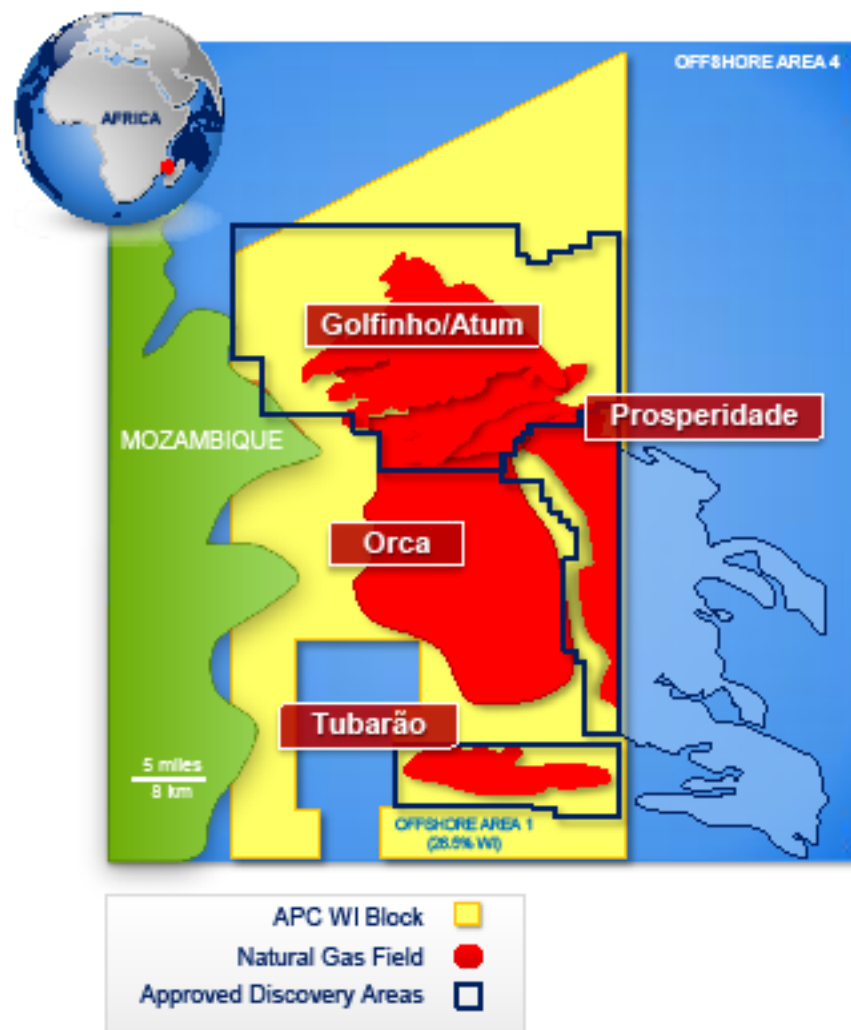
billion cubic feet



Source: U.S. Energy Information Administration



Mozambique: Premier Global LNG Supply



Massive Resource

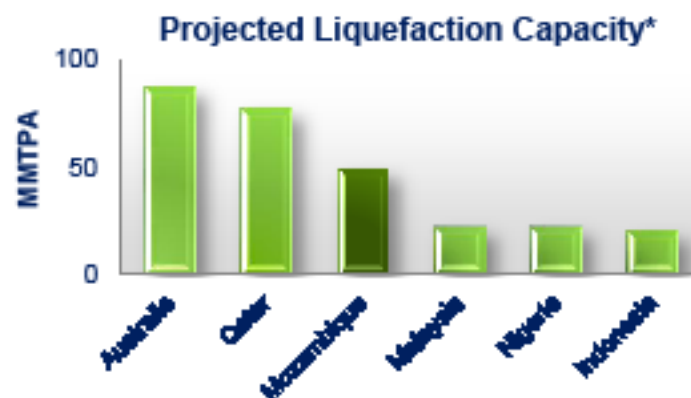
- 45 - 70+ Tcf Recoverable Natural Gas in Area 1
- Resource Size Supports 50 MMTPA

Extensive Appraisal Drilling

Obtained Reserves Certification

Global Endorsement

- \$9.6 Billion Pre-Transaction Market Valuation
- 3.3 MMTPA Non-Binding HOAs with Multiple Asian Customers

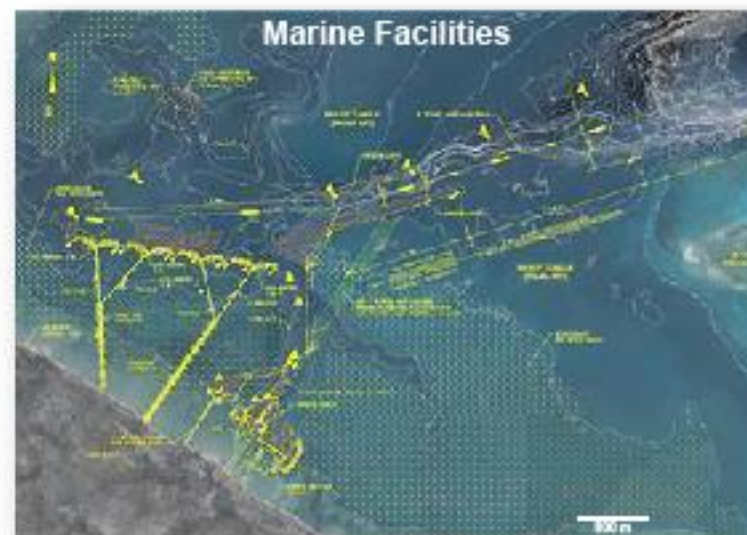


* Wood Mackenzie



Location & Cost Advantages Enhance Value

- **High-Quality Reservoirs**
 - High Deliverability
 - Established Reservoir Continuity
- **Proximity to Shore 5 - 25 Miles**
 - Initial Subsea-to-Shore Development
- **Natural Harbor**
- **Scalable Onshore Development**
 - 17,000+ Acre Site
 - Future Expansion Capability to 50 MMTPA
- **Proximity to Asian Markets**



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 \$0.97
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 0.010000 \$0.78
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 **\$10.90/MMBtu**, the total residential bill would have been:

\$71.78

**90%
Increase**

- With the gas cost in **China** of **\$15.25/MMBtu**, the total residential bill would have been:

\$91.94

**144%
Increase**

- With the gas cost in **Japan** of **\$15.65/MMBtu**, the total residential bill would have been:

\$93.80

**148%
Increase**

UK Shale Development Incentives

In a taster of what the government probably needs to do to encourage local support for shale development in the UK, Ineos has pledged to give 6% of any future UK shale gas output revenues to landowners and local communities, way above the Government's 1% and £100k of benefits.



UK Shale Development Incentives

Ineos, with some extremely bullish production expectations, expects to pay-out ~\$4B over the life of its business; landowners within 100 sq.km can expect to receive around £375mm over the lifetime of the project. Landowners and Homeowners directly above the well can expect 4% gross revs (£250mm) and communities affected will receive 2% (£125mm).

