Hydraulic Fracturing:
Technological Advances and Florida's Energy

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www.EnergyTomorrow.org

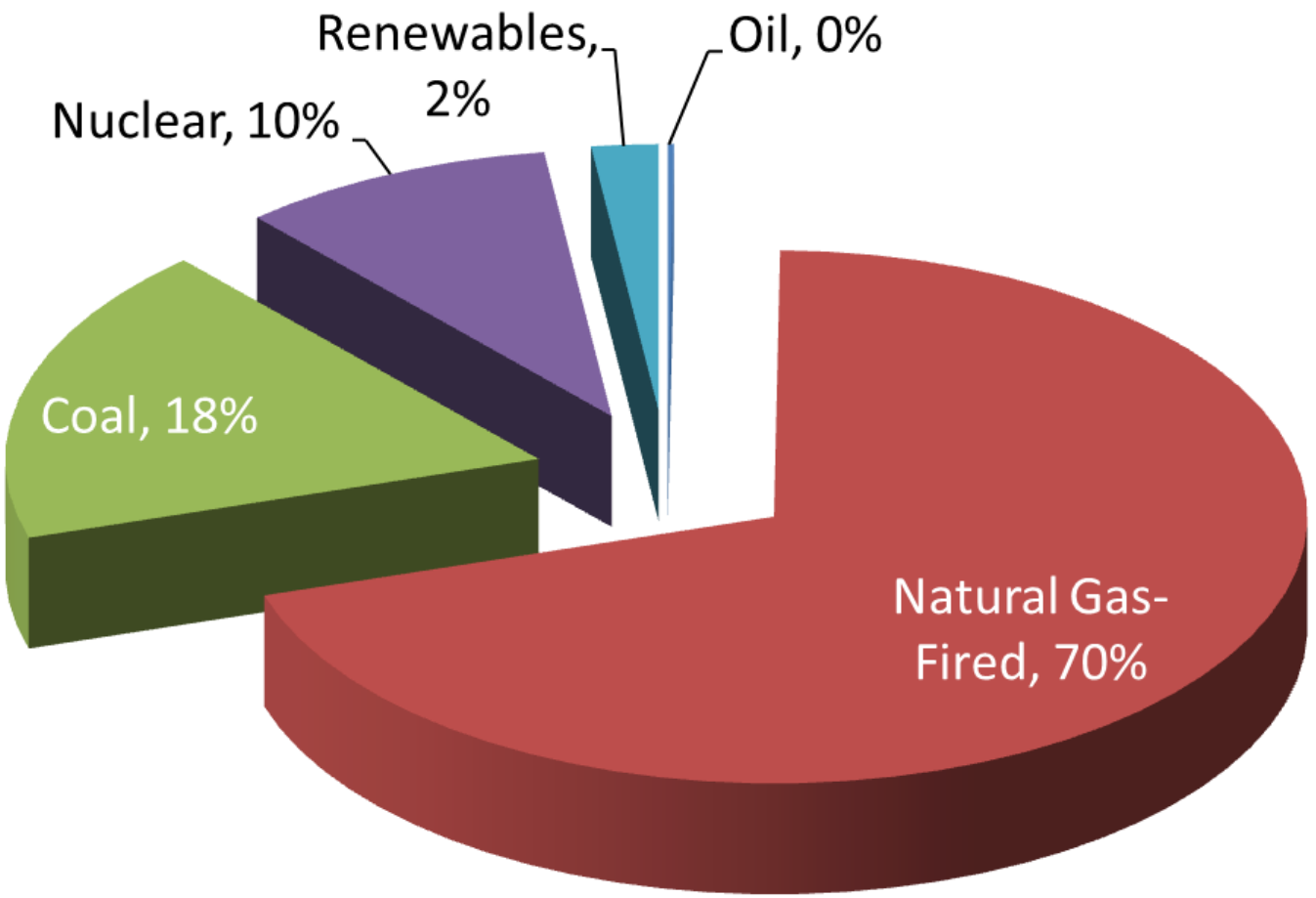
Florida Petroleum Council

- Division of the American Petroleum Institute
- Represent All Segments of the Petroleum Industry
  - ✓ Exploration
  - ✓ Production
  - ✓ Refining
  - ✓ Transportation
  - ✓ Retailing

Florida Energy Perspective

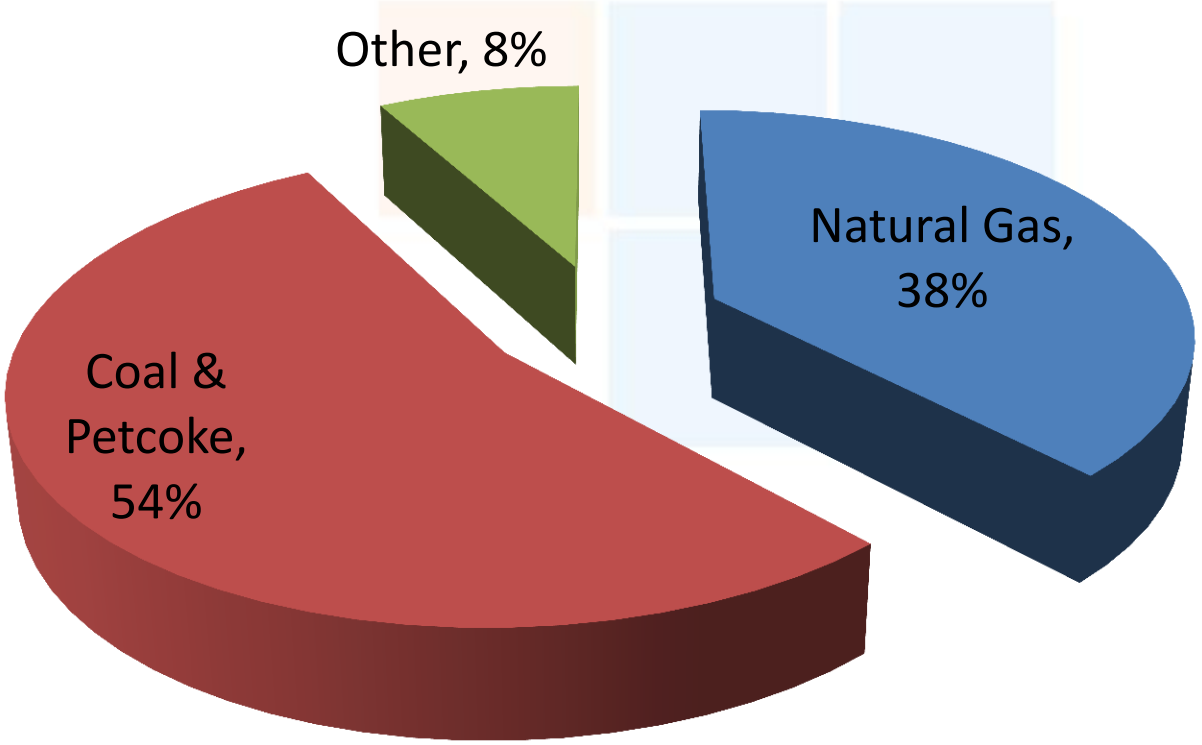
- 3rd in Population and growing
- Over 105 million tourists / year
- 3rd in Gasoline/Diesel Consumption
- Over 10 billion gallons of gasoline and diesel sold annually
- ~27 million gallons of gasoline and diesel per day

Florida Net Electricity Generation October 2015



Source: U.S. Energy Information Agency

Jacksonville Electric Authority Utility Mix



Jacksonville Electric Authority

Brandy Branch Generating Station

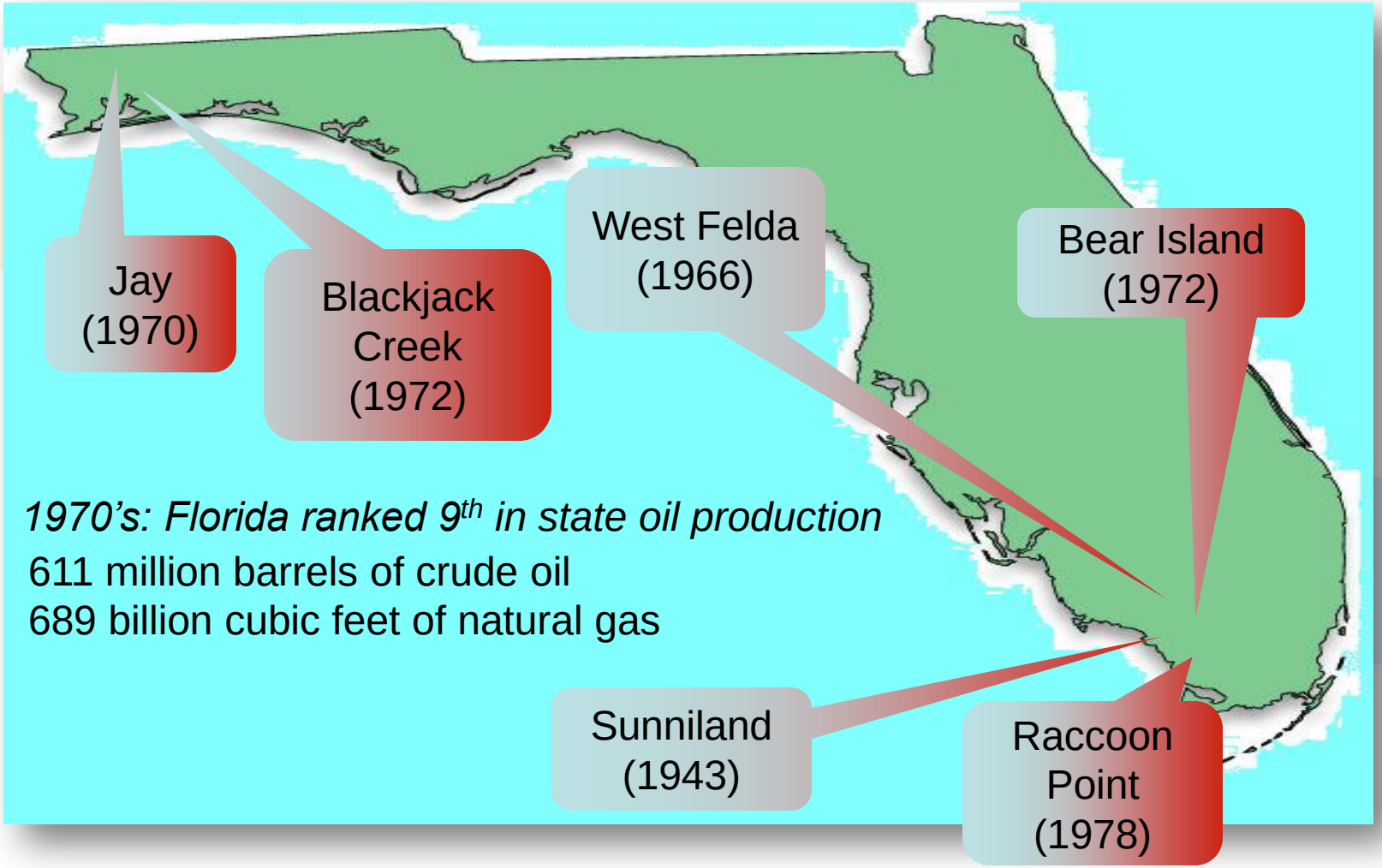
Northside Generating Station

Kennedy Generating Station

Greenland Energy Center


SUNNILAND OIL FIELD

Long History of Florida Oil and Gas Production



1970's: Florida ranked 9th in state oil production

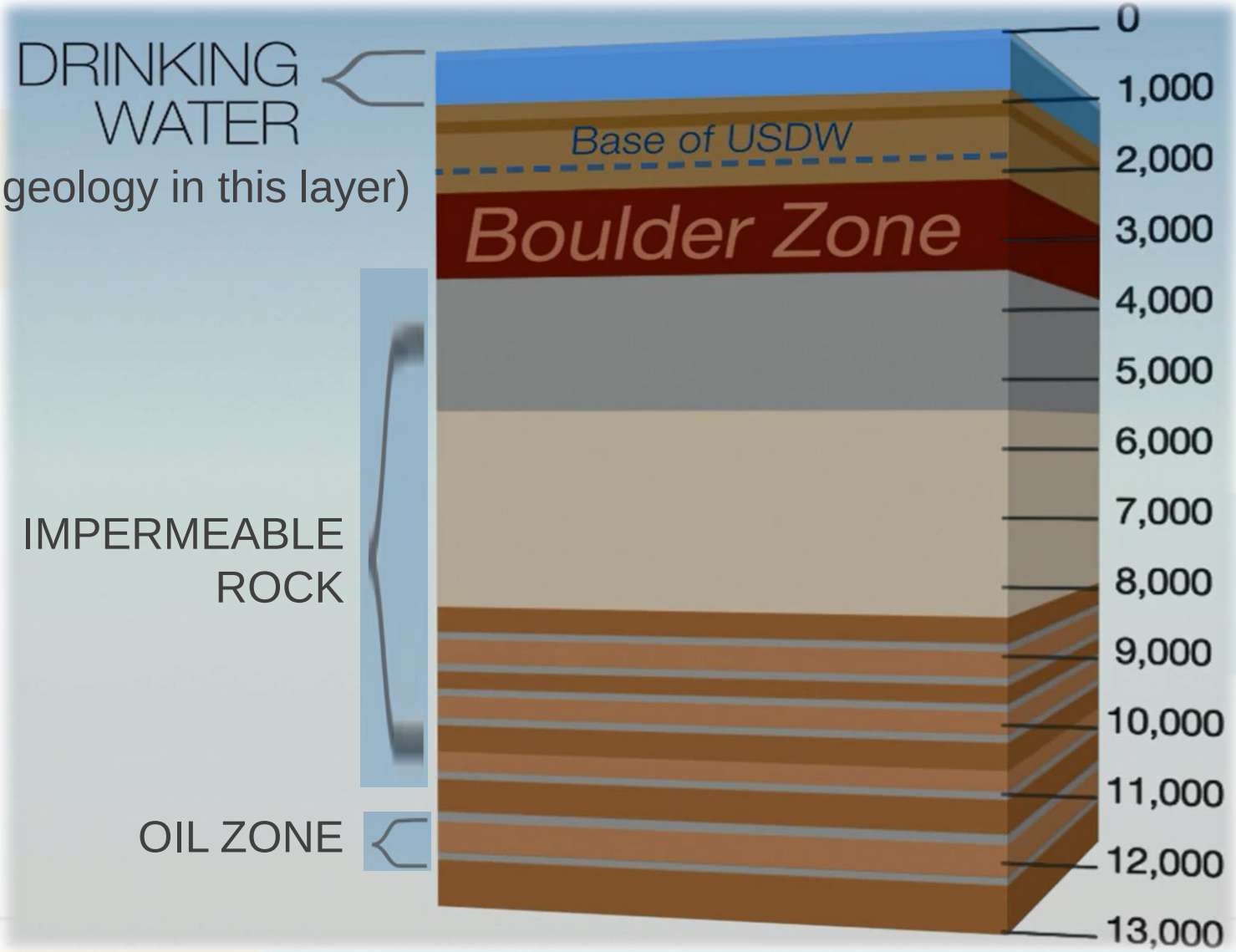
611 million barrels of crude oil

689 billion cubic feet of natural gas

Hydraulic Fracturing – Established Technology

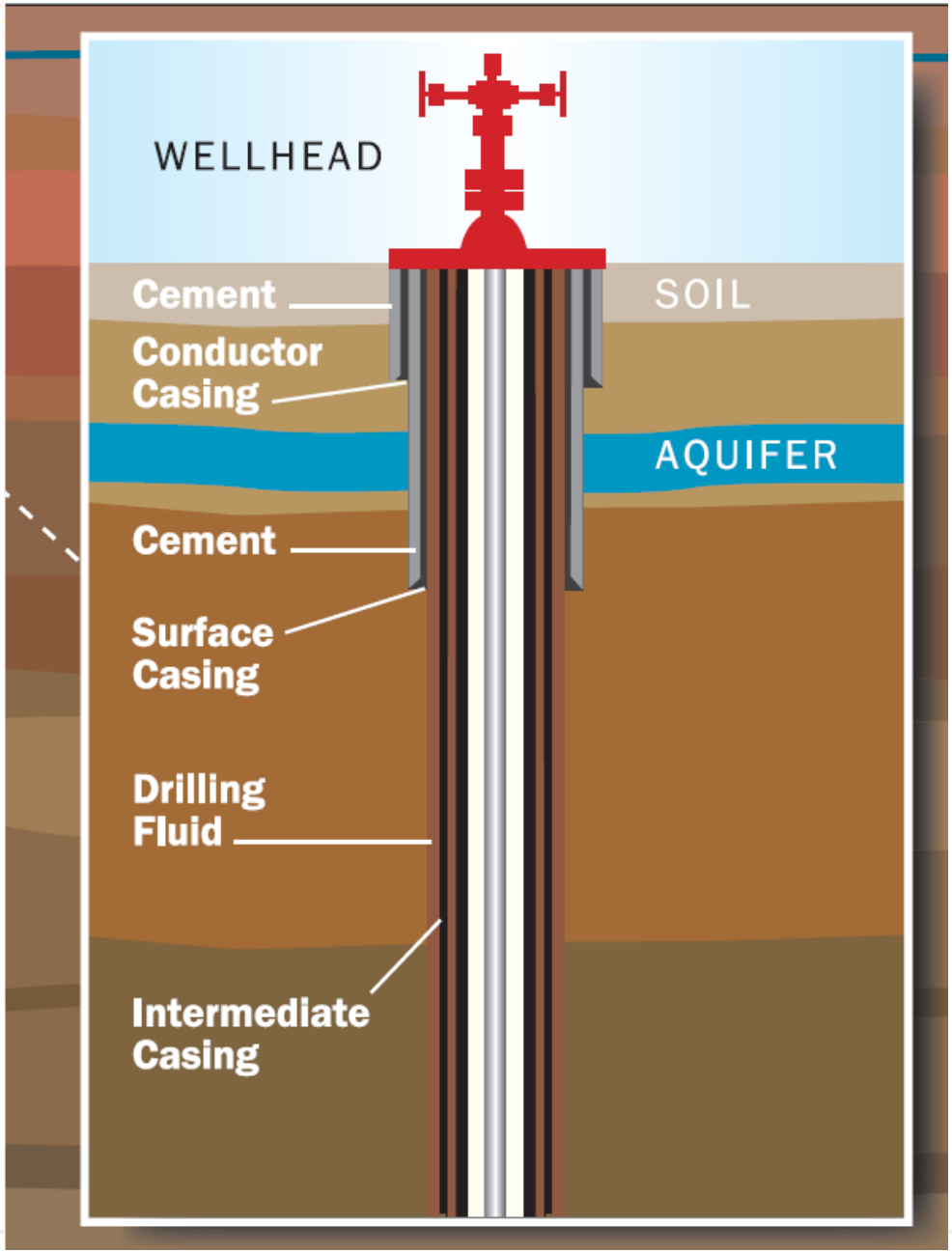
- Technology established in 1940's
- Established to extract shale oil and natural gas
- Over 2 million wells drilled
- Over 7 billion barrels of oil produced
- Over 600 trillion cubic feet of natural gas
- Technology blossomed in early 2000's

Florida Geology

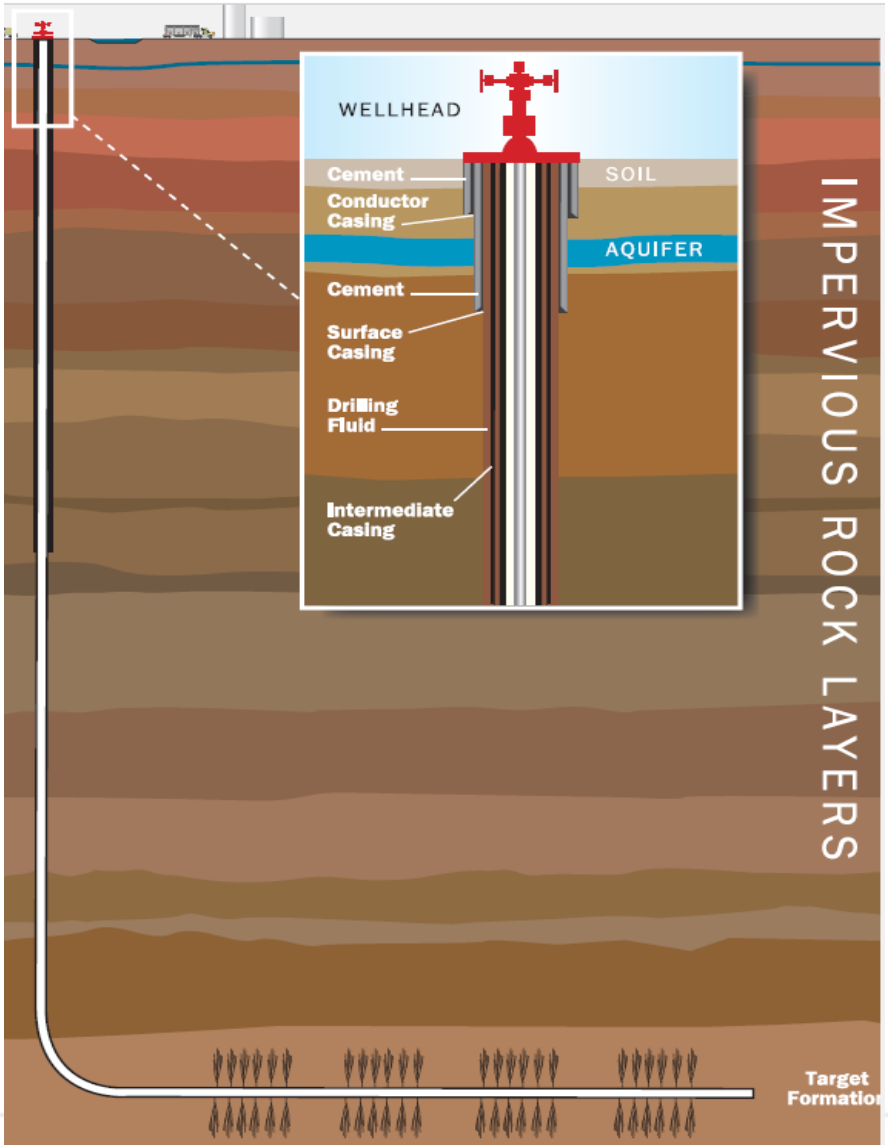


Stages of Oil and Natural Gas Production

- **Well Construction (Drilling)**
  - ✓ Approximately 30 – 90 days
  - ✓ Note – Hydraulic fracturing is not a drilling process.
- **Well Stimulation**
  - ✓ Approximately 2 – 5 days
  - ✓ Optimizing the well for Production
  - ✓ Acidation, Matrix Acidation, Hydraulic Fracturing
- **Production**
  - ✓ Extracting the Natural Gas and/or Oil
  - ✓ Approximately 20 – 40 years

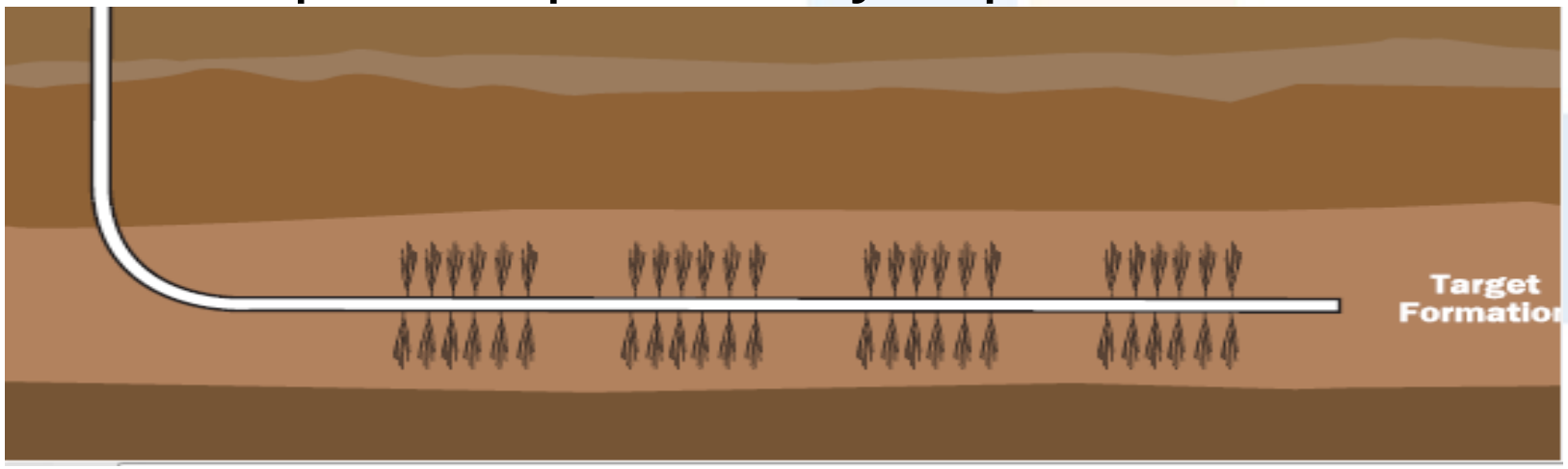

WELLHEAD
Cement
SOIL
Conductor Casing
AQUIFER
Cement
Surface Casing
Drilling Fluid
Intermediate Casing

Well Construction



Well Stimulation – Hydraulic Fracturing

Note: the Natural Gas Zone is two miles below the aquifer separated by impermeable rock



Note: the fractures remain in the Natural Gas Zone

Well Stimulation – Hydraulic Fracturing

- Water is injected at sufficient pressures to create fissures in the oil zone rock to release more oil and/or natural gas
- Sand, included in the water, is used as a proppent to keep the fissures open
- Other ingredients are added to facilitate the fracturing and extraction process

Hydraulic Fracturing Fluid

The fracturing mixture consists primarily of fresh water mixed with some sand and a small proportion of common chemicals.

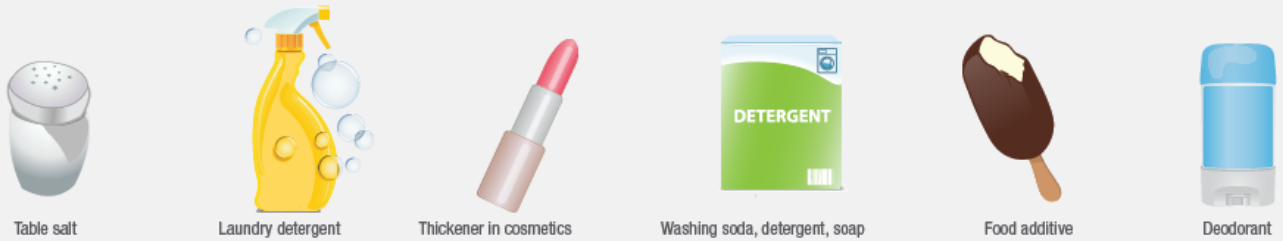


Table salt | Laundry detergent | Thickener in cosmetics | Washing soda, detergent, soap | Food additive | Deodorant

Compound	Purpose	Common Application
Acids	Helps dissolve minerals and initiate fissure in rock (pre-fracture)	Swimming pool cleaner
Sodium Chloride	Allows a delayed breakdown of the gel polymer chains	Table salt
Polyacrylamide	Minimizes the friction between fluid and pipe	Water treatment, soil conditioner
Ethylene Glycol	Prevents scale deposits in the pipe	Automotive anti-freeze, deicing agent, household cleaners
Borate Salts	Maintains fluid viscosity as temperature increases	Laundry detergent, hand soap, cosmetics
Sodium/Potassium Carbonate	Maintains effectiveness of other components, such as crosslinkers	Washing soda, detergent, soap, water softener, glass, ceramics
Glutaraldehyde	Eliminates bacteria in the water	Disinfectant, sterilization of medical and dental equipment
Guar Gum	Thickens the water to suspend the sand	Thickener in cosmetics, baked goods, ice cream, toothpaste, sauces
Citric Acid	Prevents precipitation of metal oxides	Additive in food and beverages
Isopropanol	Used to increase the viscosity of the fracture fluid	Glass cleaner, antiperspirant, hair coloring

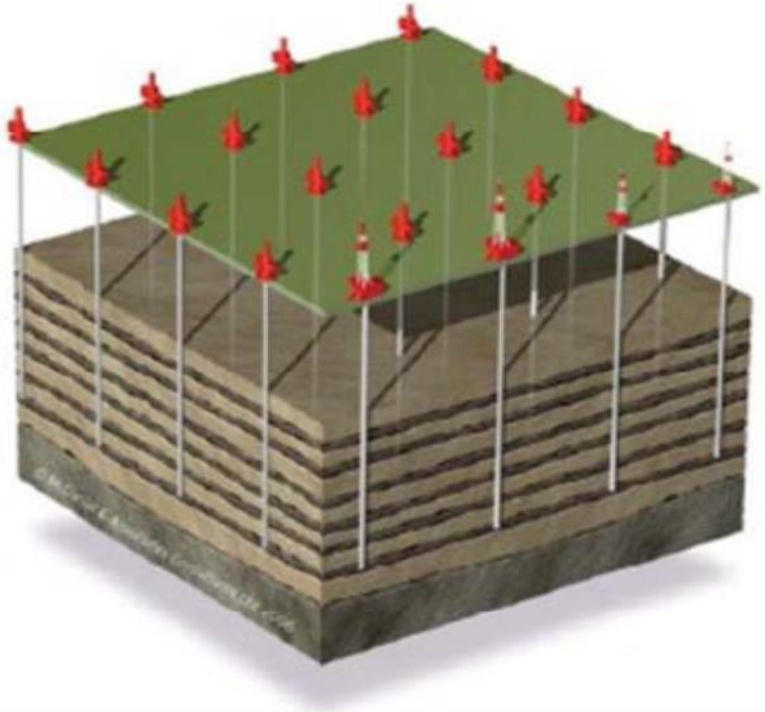
Other Stimulation Techniques: Acidation

- Used to clean up well scale and clear bore hole
- Dilute acid – hydrochloric or citric acid
- Reacts with calcium carbonate (holding the oil)
- Totally neutralized to salt, water, and carbon dioxide
- Used for decades in Florida

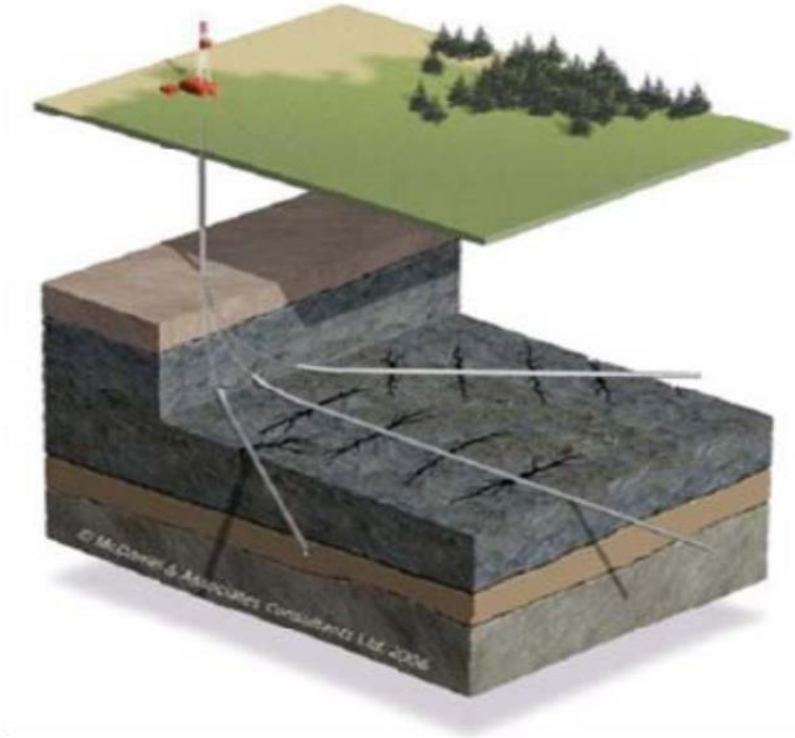
Other Stimulation Techniques: Matrix Acidation

- Used to slightly expand bore hole
- Injected with slight pressure (below fracturing pressures)
- Dilute acid – hydrochloric or citric acid
- Reacts with calcium carbonate (holding the oil)
- Totally neutralized to salt, water, and carbon dioxide
- Used for decades in Florida

Benefits: Smaller Footprint for Access to Oil and Gas

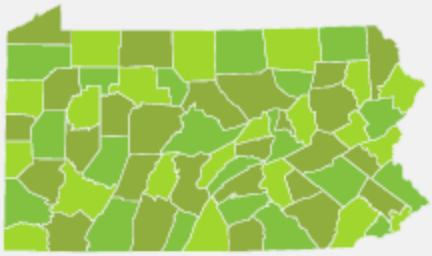


Traditional Wells



Horizontal Drilling

Pennsylvania HF Water Usage / Day: 1.9 million gallons



PENNSYLVANIA

Annual Water Usage Example

1.42 BILLION GALLONS PER DAY
PUBLIC WATER SUPPLY

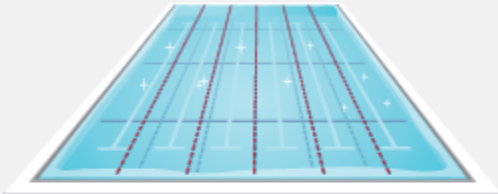
6.43 BILLION GALLONS PER DAY
THERMOELECTRIC POWER

61.8 MILLION GALLONS PER DAY
LIVESTOCK

24.3 MILLION GALLONS PER DAY
IRRIGATION

SITE LEVEL

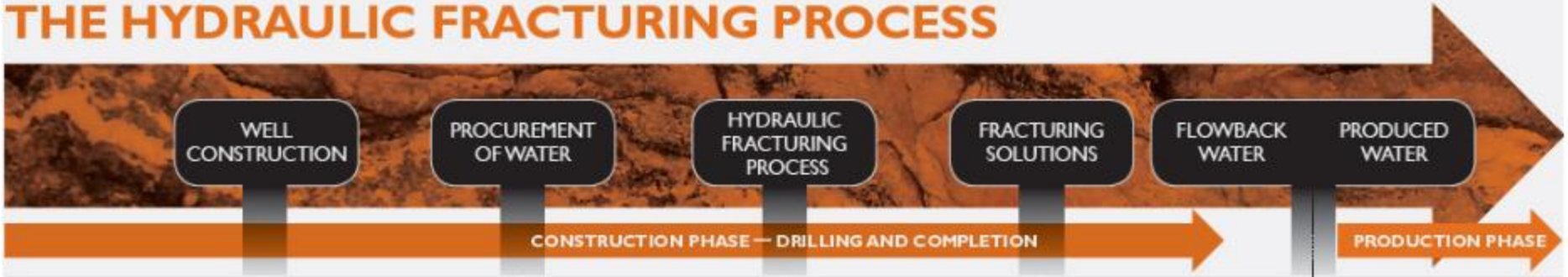
The amount of water used during hydraulic fracturing for one well is typically the equivalent of the volume of three to six Olympic sized swimming pools



EACH AMERICAN GOLF COURSE USES MORE THAN
4 MILLION
GALLONS OF WATER
PER SUMMER MONTH

Sources: U.S. Geological Survey Circular 1344. 52p. and Marcellus Shale Development Water Use: June 1, 2008 - May 21, 2010; Energy In Depth, October 8, 2012; Aboutnaturalgas.com

FEDERAL STATUTES REGULATE EVERY STEP OF THE HYDRAULIC FRACTURING PROCESS



CWA
- Water Resource Protection
- Inspection and Enforcement Authority

OSHA
- Worker Safety and Operations
- Inspection and Enforcement Authority

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OSHA
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OSHA
- Worker Safety and Operations
- Chemical Disclosure
- Inspection and Enforcement Authority

SUPERFUND
- Spill Reporting
- Clean Up
- Inspection and Enforcement Authority

EPRCA
- Hazardous Substance Reporting
- Inspection and Enforcement Authority

CWA
- Spill Prevention Control and Countermeasures
- Management Requirements
- Inspection and Enforcement Authority

CWA
- Water Resource Protection and Discharge Requirements
- Reporting
- Inspection and Enforcement Authority

SDWA
- Water Injection Requirements
- Inspection and Enforcement Authority

CWA: Clean Water Act • OSHA: Occupational Safety and Health Administration • SDWA: Safe Drinking Water Act • EPRCA: Community "Right to Know" Act

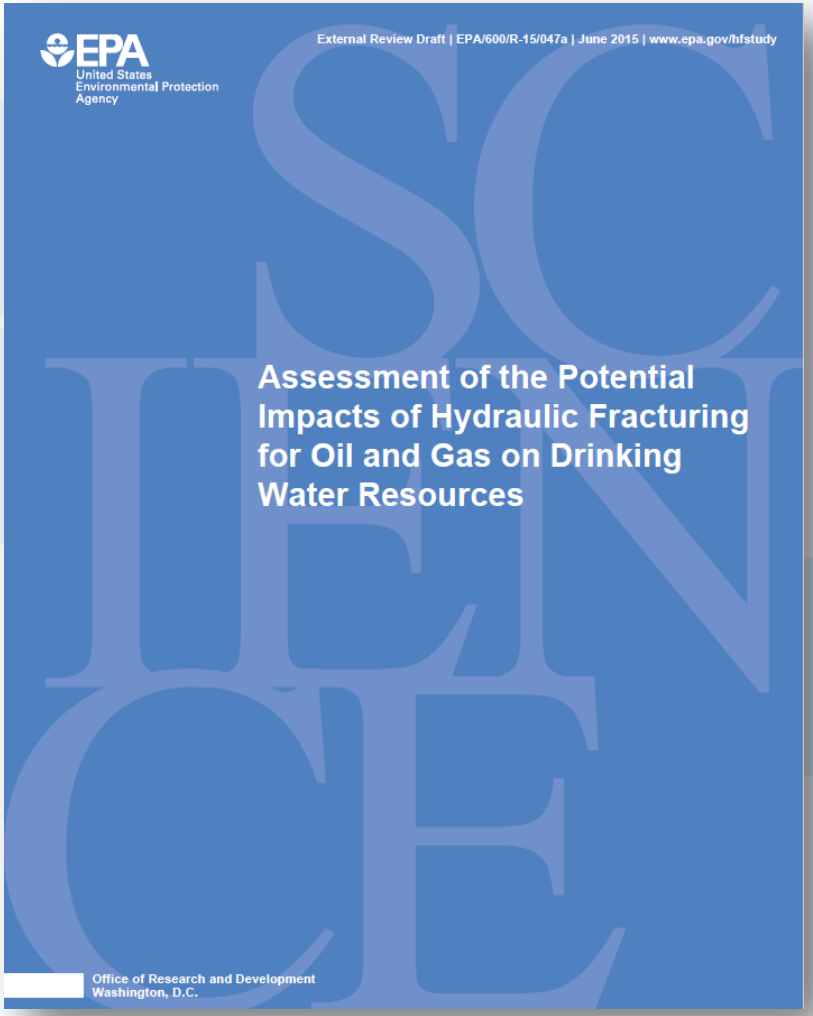
Source http://energyindepth.org/wp-content/uploads/2009/03/Federal-Hydraulic-Fracturing-Process.pdf

Hydraulic Fracturing Success

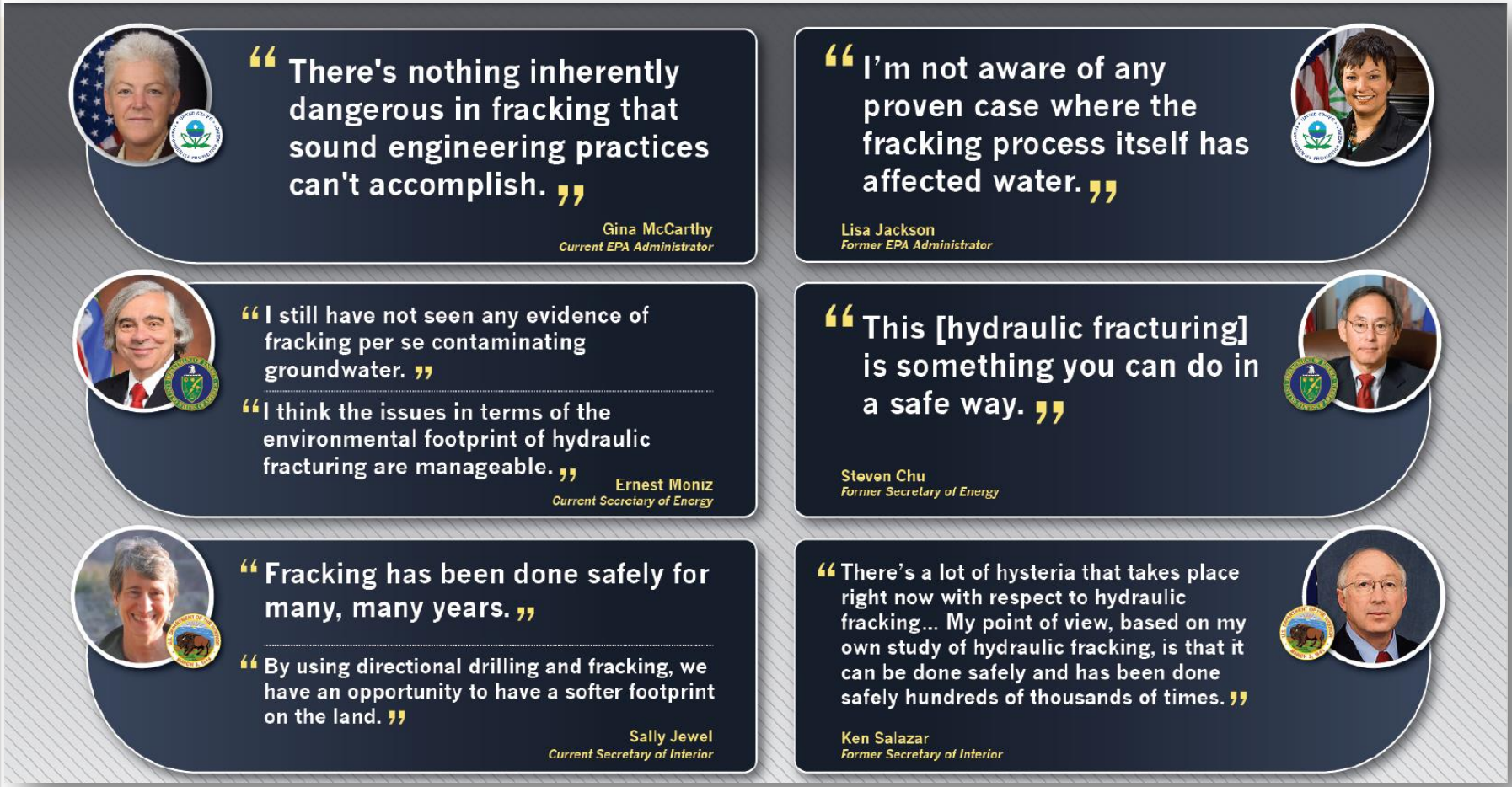
- U.S. is now the largest energy producer in the world - U.S has vaulted past Russia to become the world's largest natural gas producer
- U.S. oil production has increased from 5 million to 9 million barrels per day
- 50% of domestic oil production from HF wells
- Production from the Utica and Marcellus shale plays are averaging over 22 billion cubic feet per day
- The U.S. is expected to become a net natural gas exporter within the next decade
- Supports 9.8 million jobs

EPA Report Finds Fracking Safe

- EPA produced data revealing *"no evidence that fracking has any systemic groundwater impacts"*
- 6,800 sources of drinking water for public water systems located within one mile of at least one hydraulically fractured well
- Those water well sources served more than 8.6 million people
- Peer reviewed

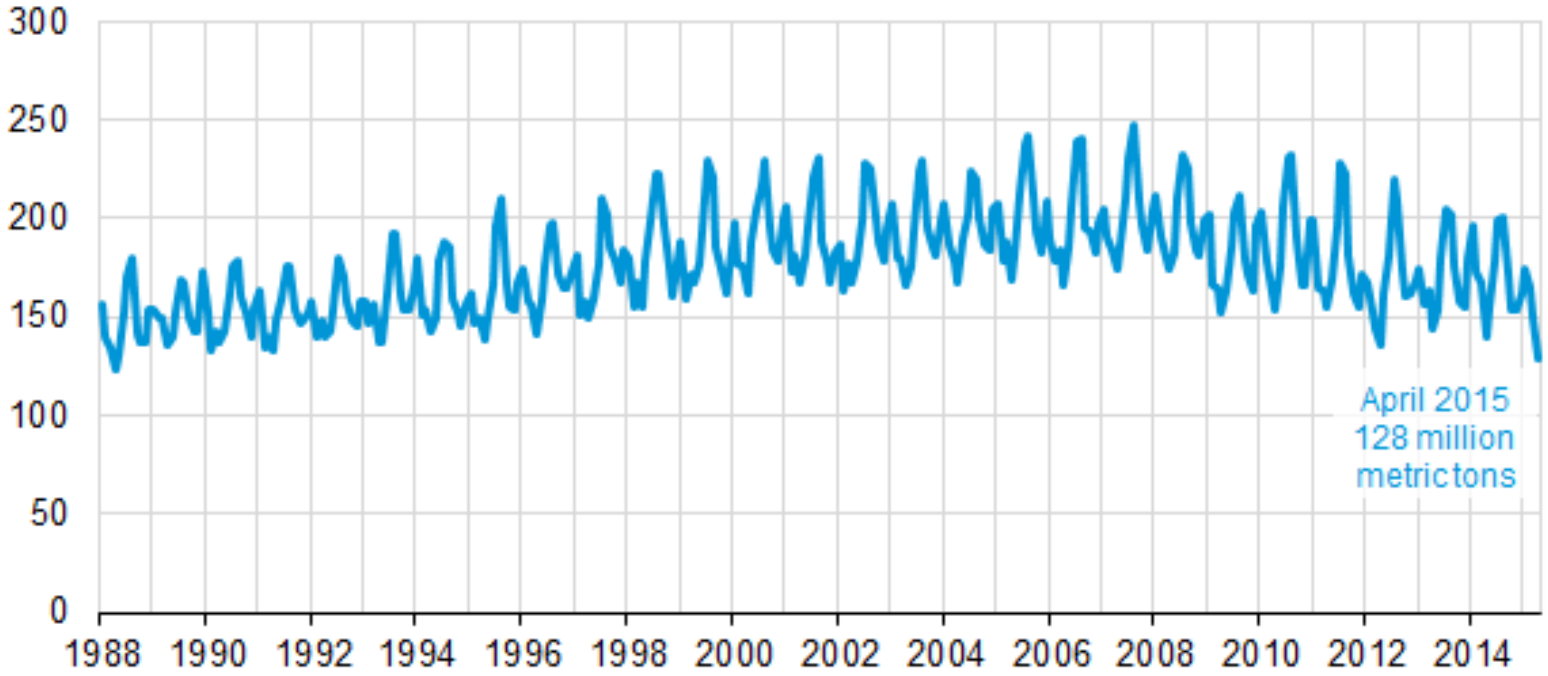


What do federal regulators say…

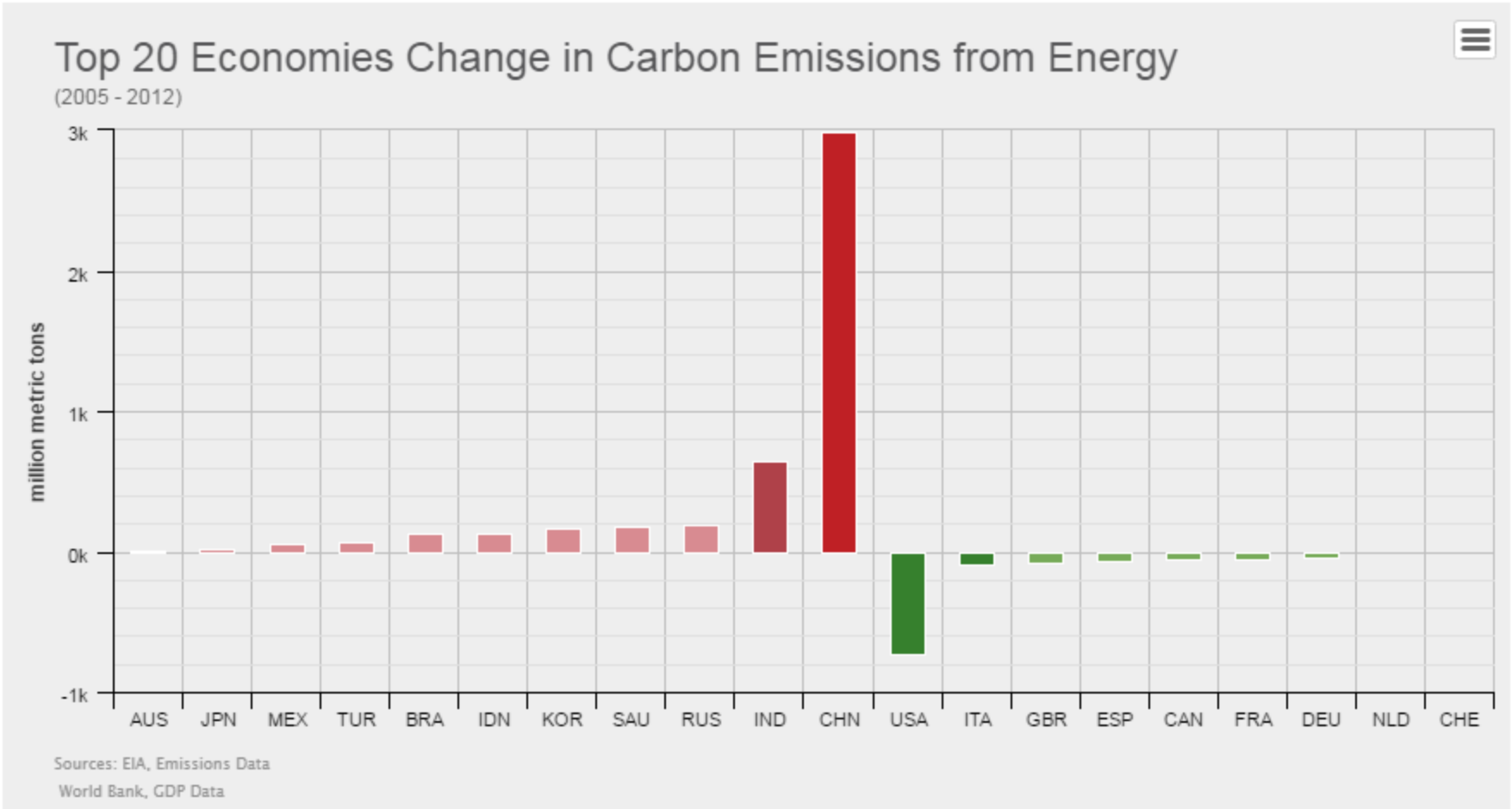


Monthly power sector carbon dioxide emissions reach 27-year low in April

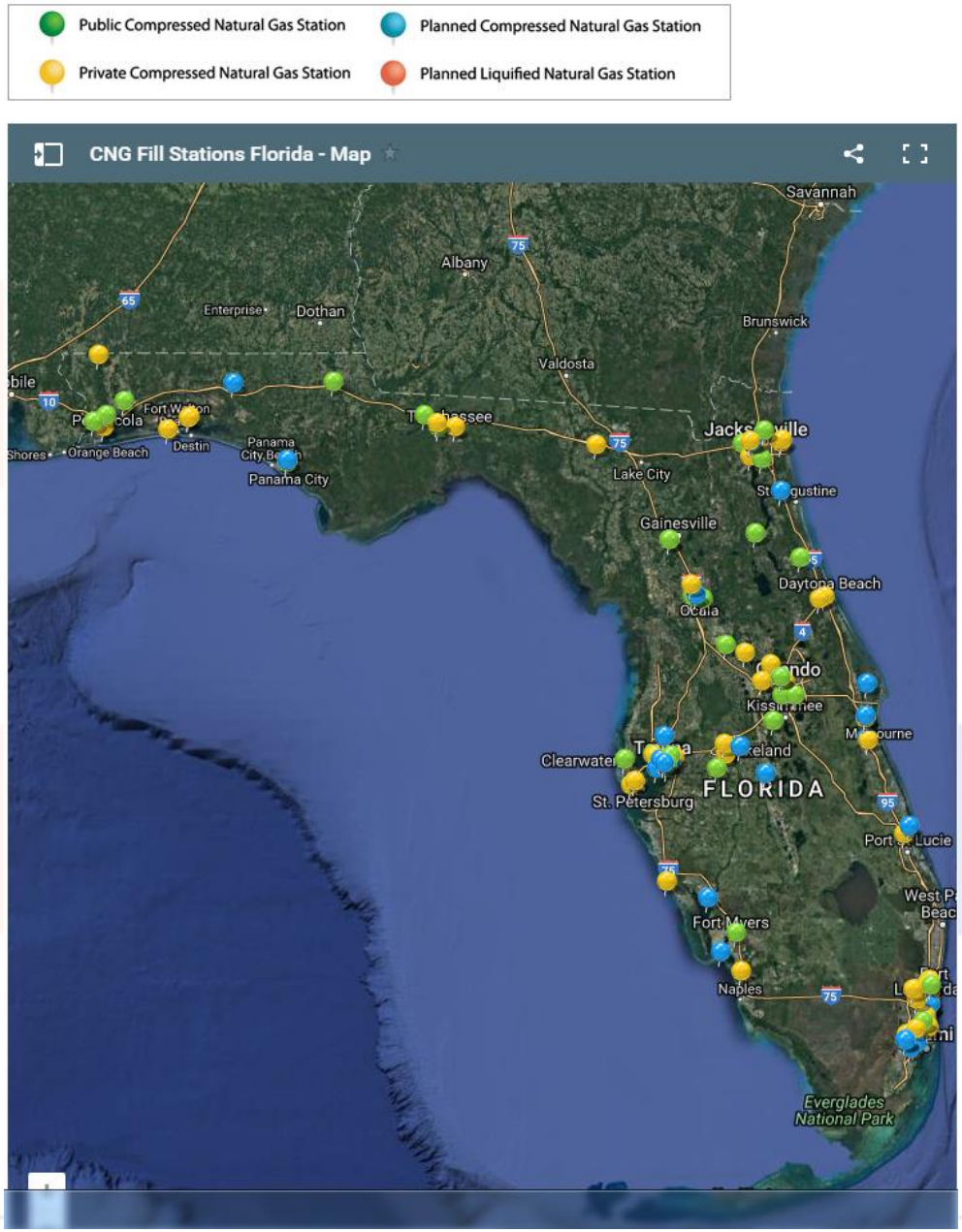
U.S. carbon dioxide emissions from the electric power sector (Jan 1988-Apr 2015)
million metric tons



Source: U.S. Energy Information Administration, *Monthly Energy Review*
Note: Data exclude emissions from biomass energy consumption.


Top 20 Economies Change in Carbon Emissions from Energy
(2005 - 2012)
million metric tons
3k
2k
1k
0k
-1k
AUS
JPN
MEX
TUR
BRA
IDN
KOR
SAU
RUS
IND
CHN
USA
ITA
GBR
ESP
CAN
FRA
DEU
NLD
CHE
Sources: EIA, Emissions Data
World Bank, GDP Data

Natural Gas as Transportation Fuel

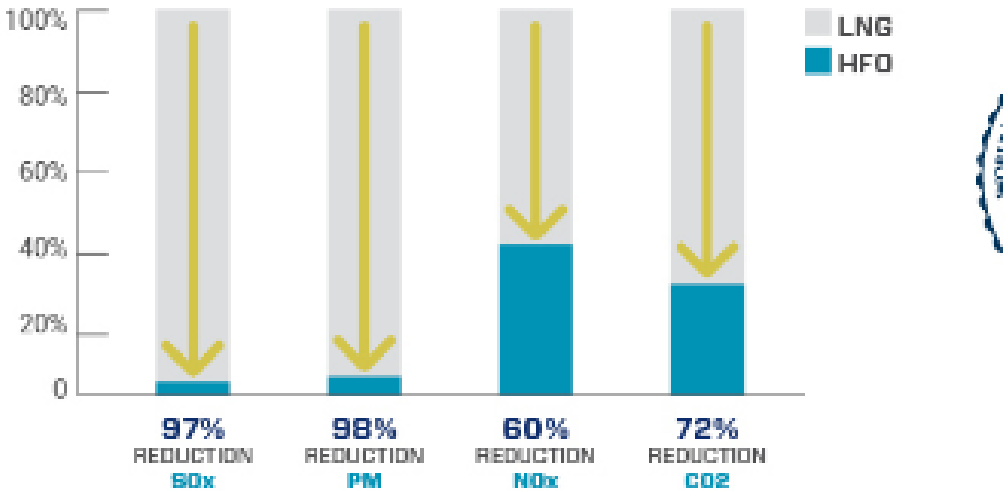


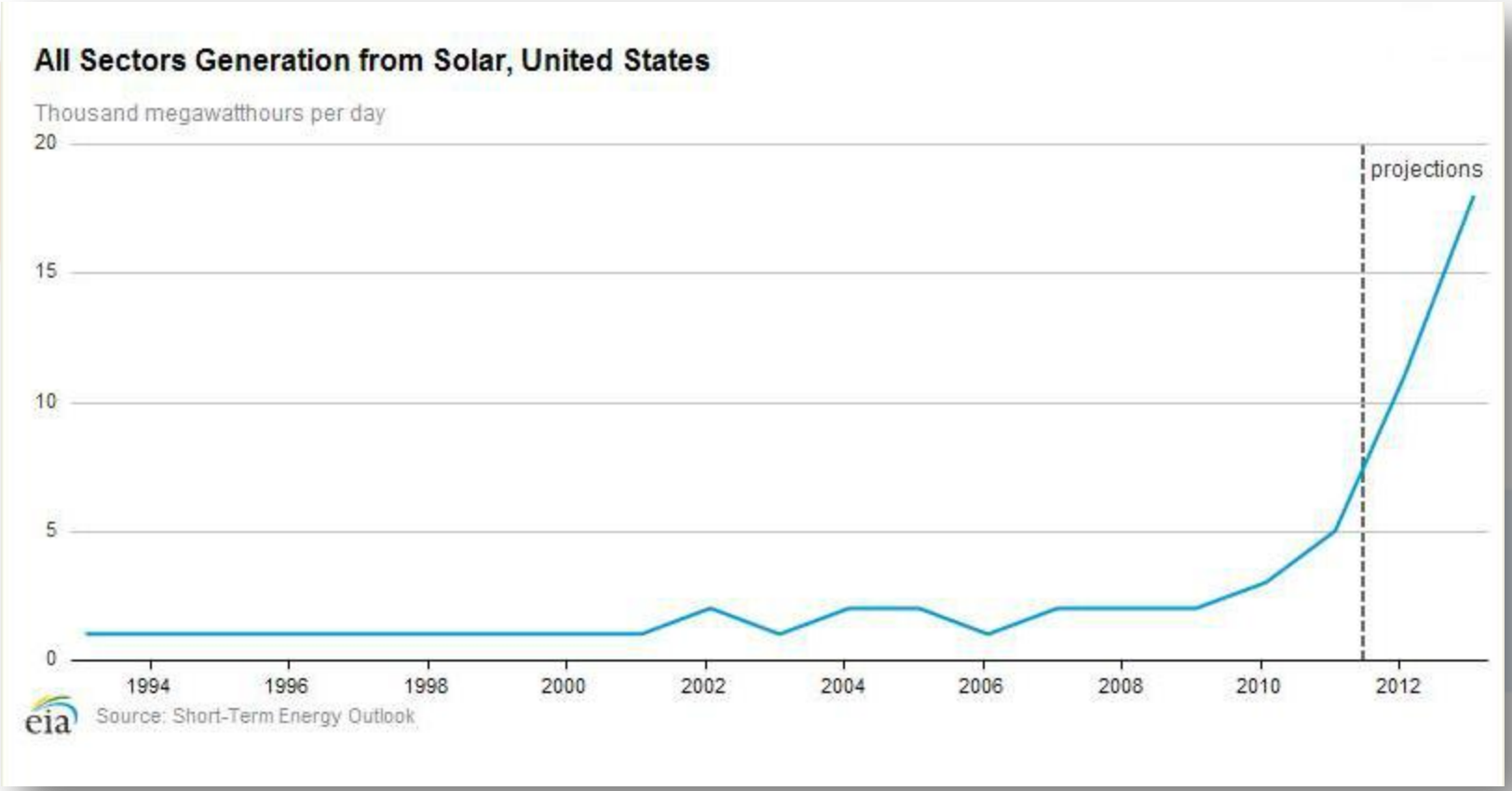
Jax Port Natural Gas Leadership

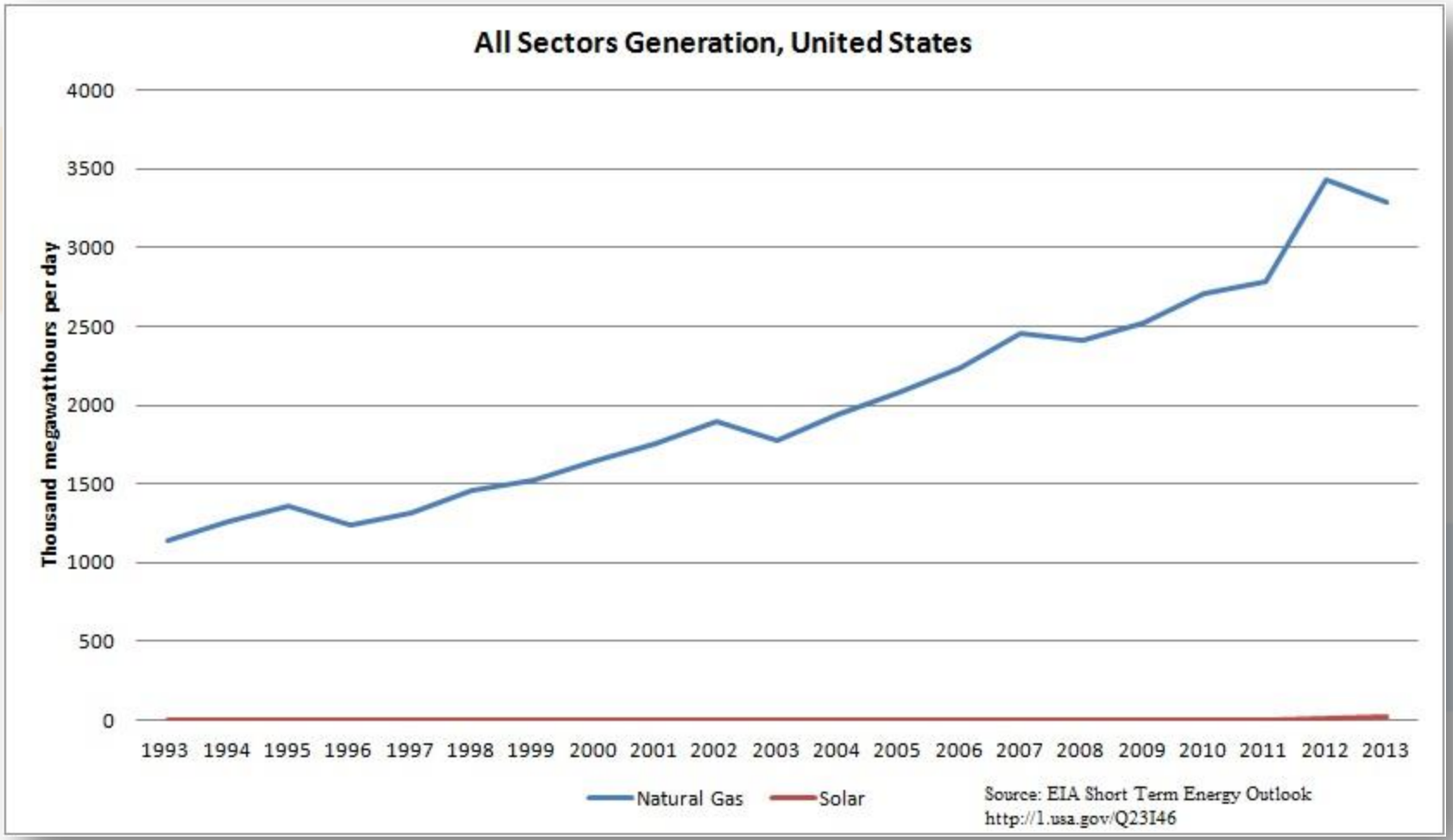
Marlin Class Vessels - Puerto Rico

Isla Bella

Puerto Rico Marlin Class Vessels Emissions (KM/ANNUAL KFEU-NM)

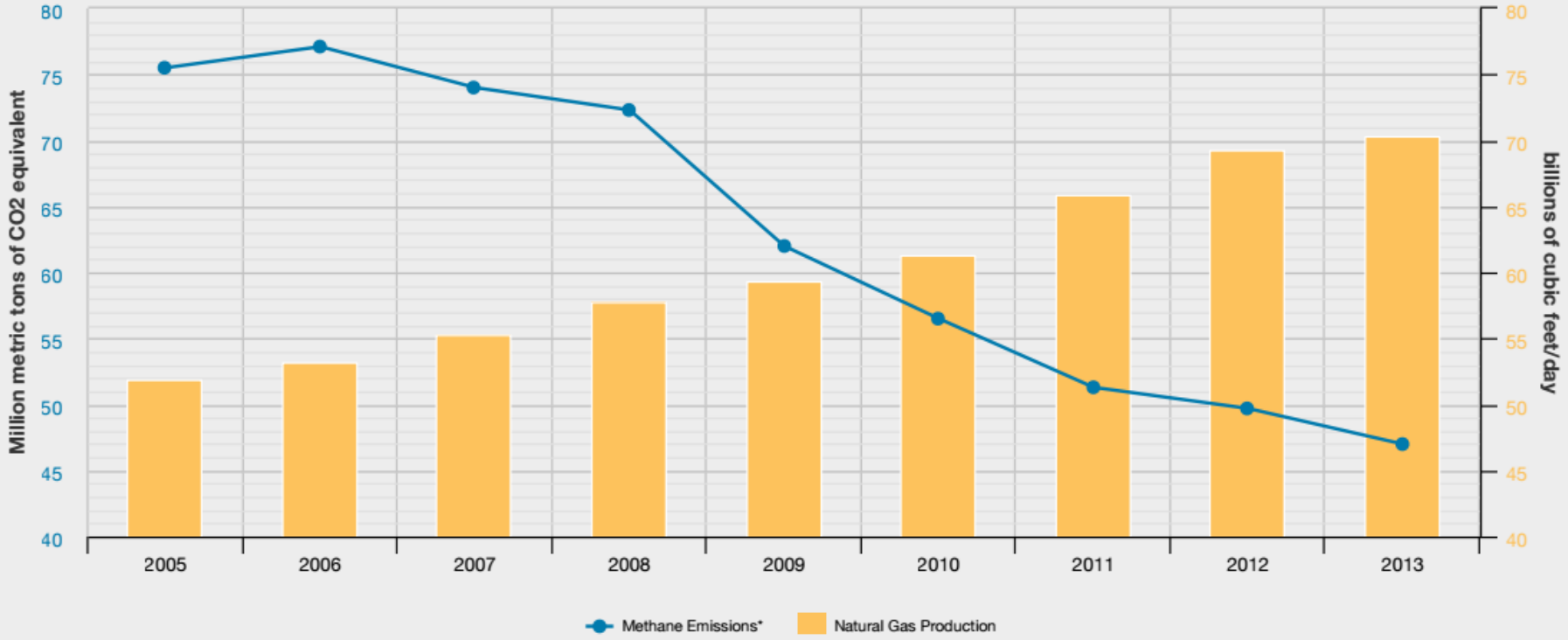



All Sectors Generation from Solar, United States
Thousand megawatthours per day
20
15
10
5
0
projections
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
eia
Source: Short-Term Energy Outlook


All Sectors Generation, United States
Thousand megawatthours per day
4000
3500
3000
2500
2000
1500
1000
500
0
1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
Natural Gas
Solar
Source: EIA Short Term Energy Outlook
http://1.usa.gov/Q23I46

Questions

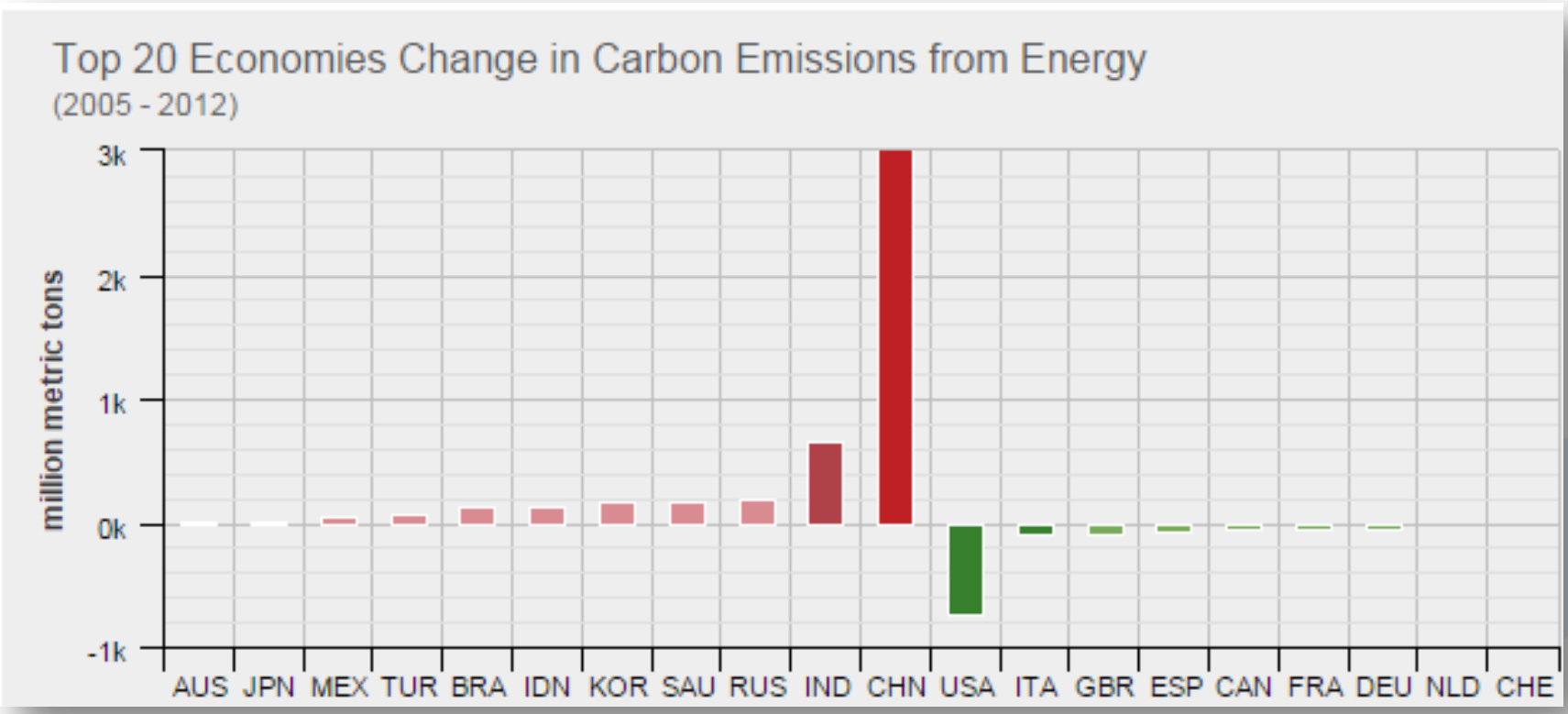
Natural Gas Production and Methane Emissions from Production



*U.S. CH4 net emissions from natural gas systems field production

Source: EPA, Inventory of GHG and Sinks: 1990–2013, Table 3-45; and EIA, Marketed Natural Gas Production.

U.S. Leads the World in CO_2 Reductions



Hydraulic Fracturing Delivers Real Climate Benefits

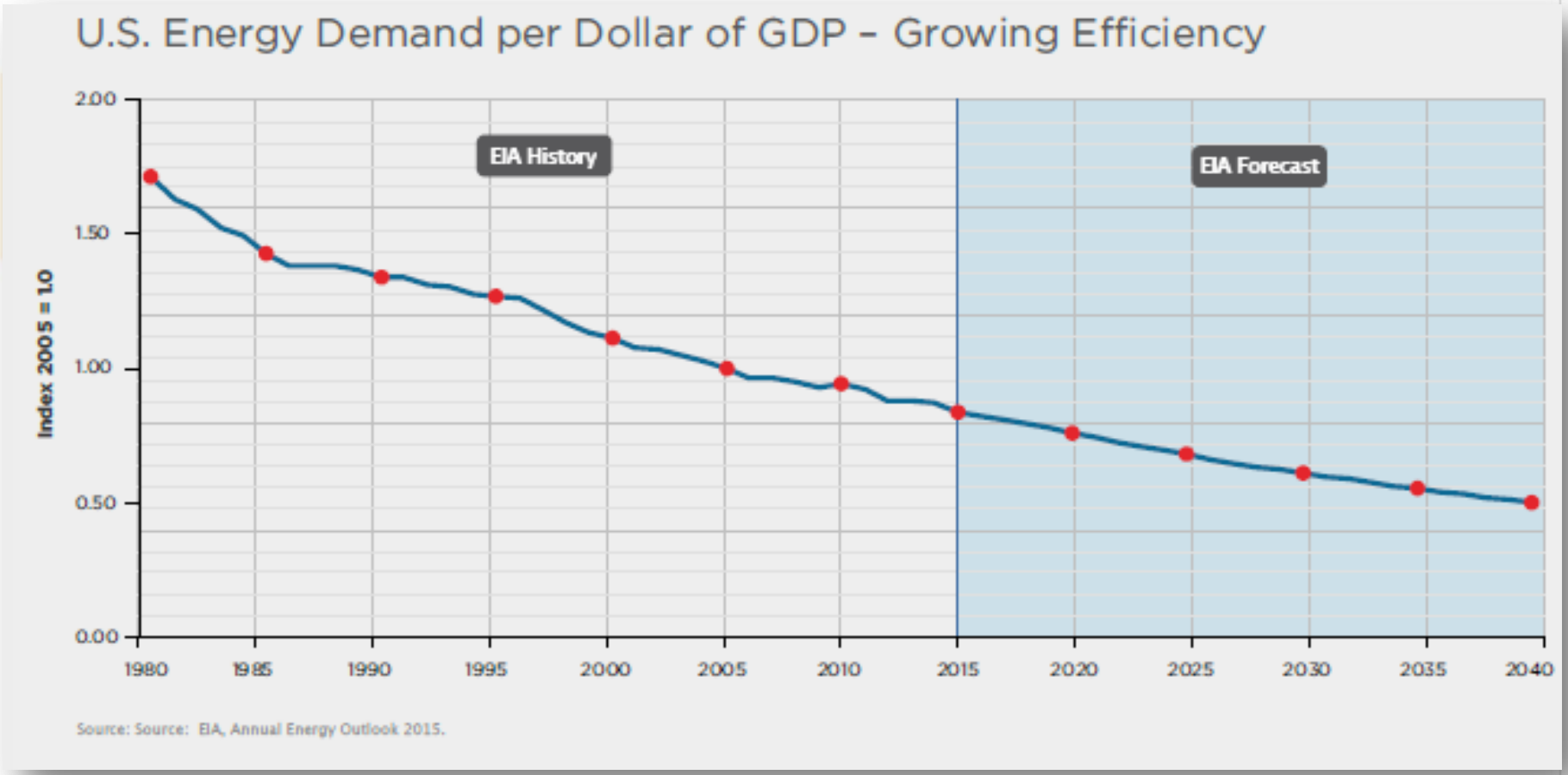
Intergovernmental Panel on Climate Change (IPCC) Climate Assessment

In its latest "Climate Change 2014: Mitigation of Climate Change":

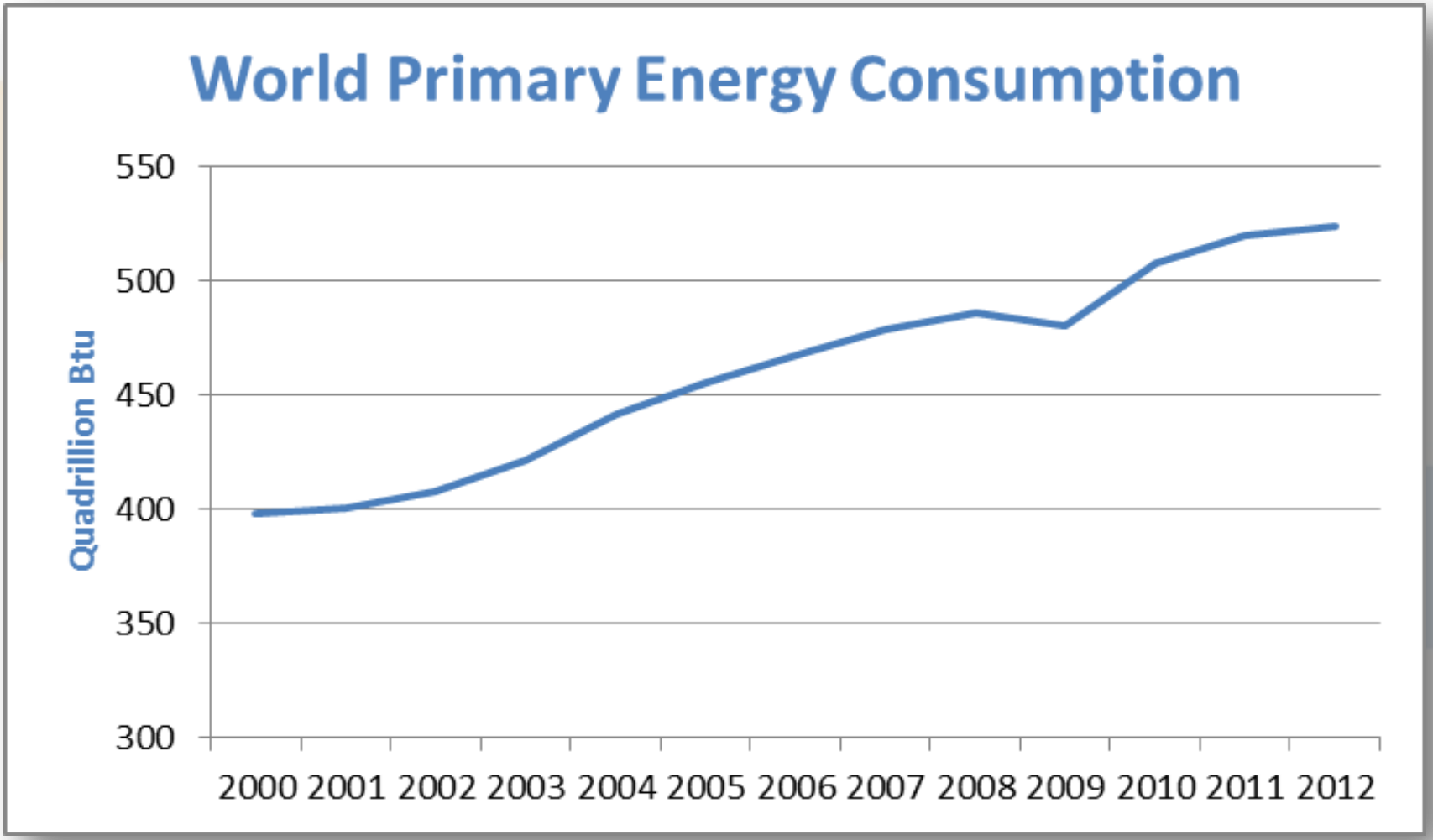
"A key development since AR4 (2007) is the rapid deployment of hydraulic fracturing and horizontal drilling technologies, which has increased and diversified the gas supply…is an important reason for a reduction of GHG emissions in the United States."

(Ch. 7, p. 527)

Efficiency Improves…Driven by Competition



Energy Consumption Grows with Economies/Populations



Source: Energy Information Agency