



The Role of Science in Developing Enhanced Oil & Gas Resources, Being Environmentally Sound, Protecting Water Use and Future Economics

by

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ABSTRACT:
**The Role of Science in
Developing Enhanced Oil & Gas Resources,
Being Environmentally Sound,
and Protecting Water Use**

- **The world is going through a major transformation with fossil fuel being the primary source. Tight natural gas and oil is now being extracted at all time highs in the United States, particularly in selected states. Pipelines are being constructed as a record pace to supply refineries and terminal ports for export. This will have a pronounced effect on our GDP. There is profound interest in the extraction of natural gas and oil throughout the world, particularly in parts of the European Community, India, China, Brazil, Argentina, Chile, and Mexico as the proven reserves now are a fact.**

Contents

- **Drilling, Completion, Staging, Horizontal, Vertical, and Zipper Fracking**
- **Renewable Alternative Fuels**
- **Water, New and Used, Water Demands, Reuse, Flowback and Produced**
- **Basic Exploration and Production Economics, Debt, and Investing**
- **Conveyance**
- **Regulatory**
- **Global**
- **Summary**

Fossil Fuels

- **Natural Gas**
- **Petroleum Crude**
- **Coal**
- **Nuclear (different origin but from the earth and non-renewable)**

Alternative Fuels

- **Ethanol (corn based)**
- **Bio diesel (grasses, algae)**
- **Solar**
- **Wind Turbines**
- **Geothermal**
- **Others**

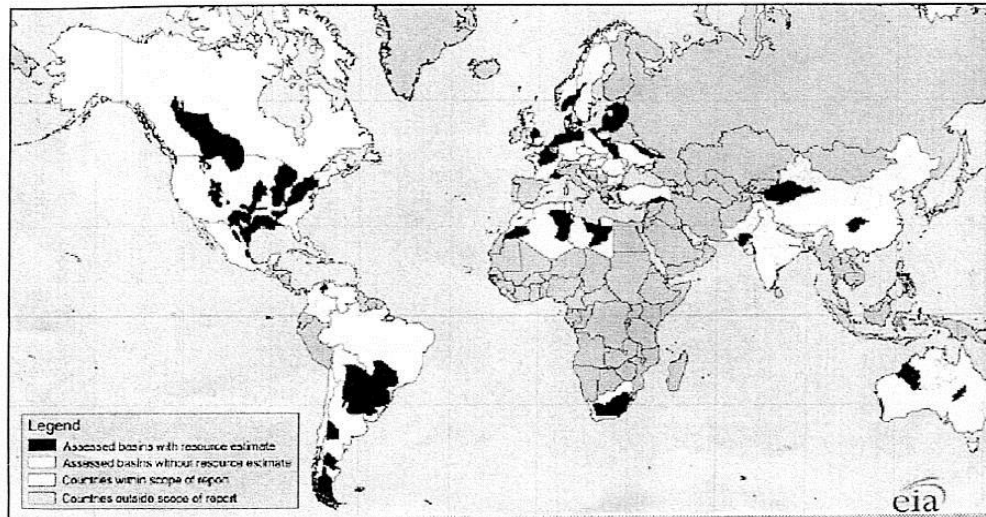
2014 Major Producers of Fossil Energy

- 1. United States***
- 2. Russia**
- 3. Saudi Arabia**

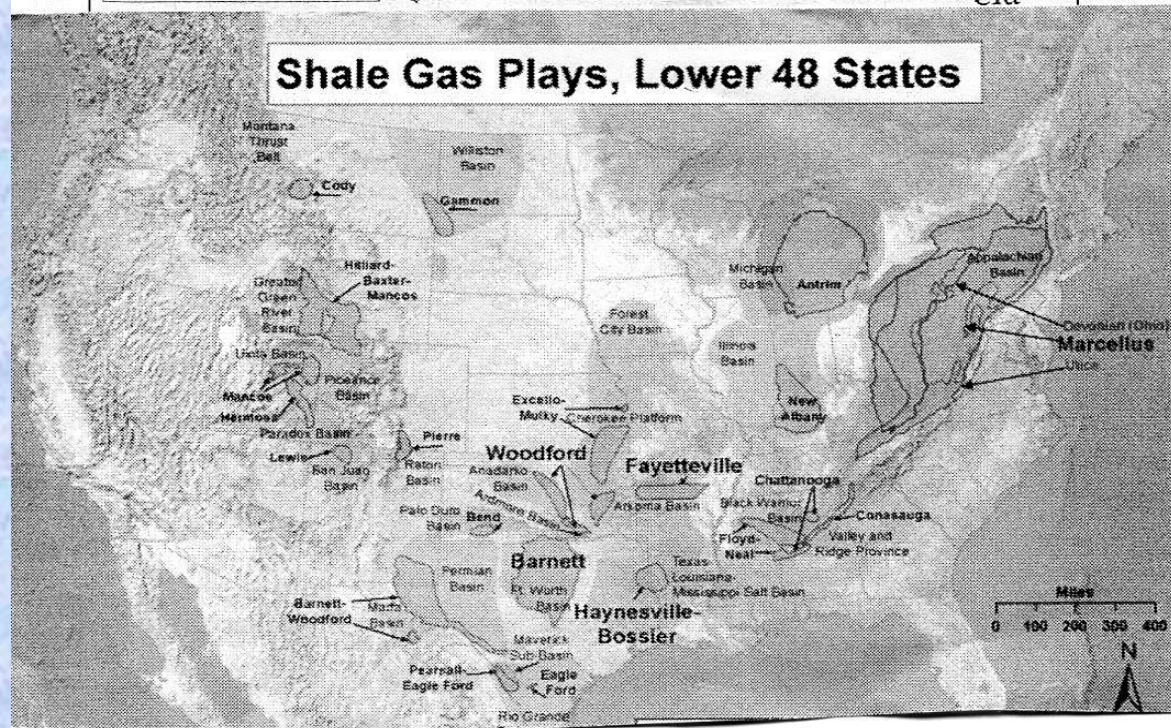
*** Recent, October, 2013 (WSJ)**

Most experts predict the United States will be a net exporter of oil & gas in the next 3 to 5 years.

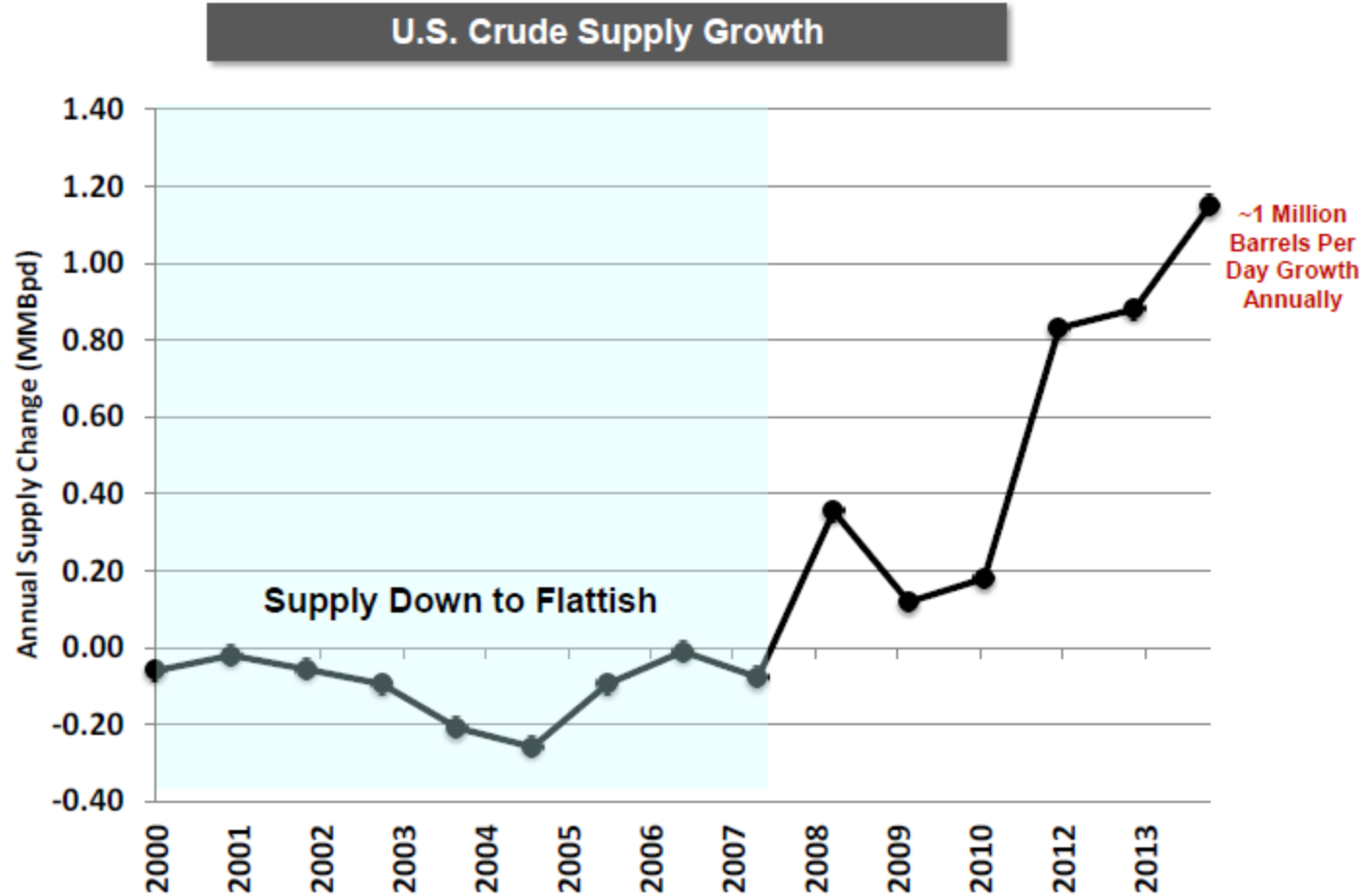
World Shale Gas Reserves

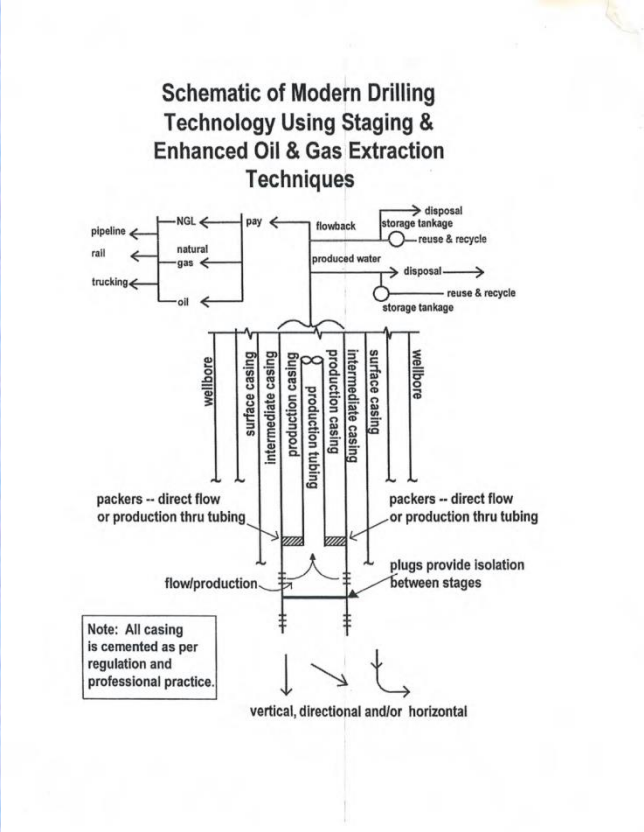


Shale Gas Plays, Lower 48 States

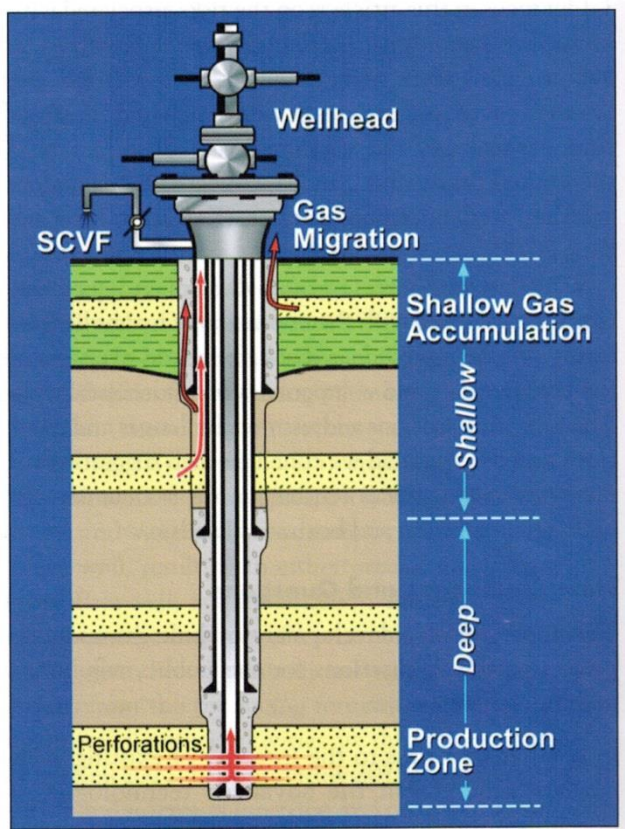


US Crude Supply Growth





Davis L. Ford (CWEI)



(NAE, 2014)

Remember:

GDP = Consumption

Investments

Government spending

Exports minus Imports

Conclusion:

When the U.S. becomes energy independent, the GDP goes up accordingly. This is a major national issue.

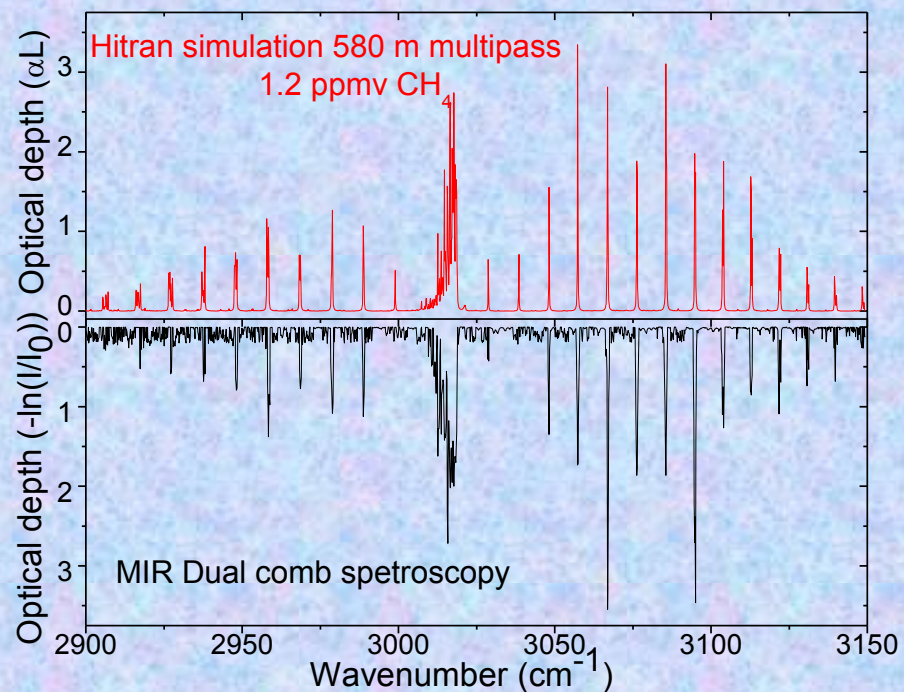
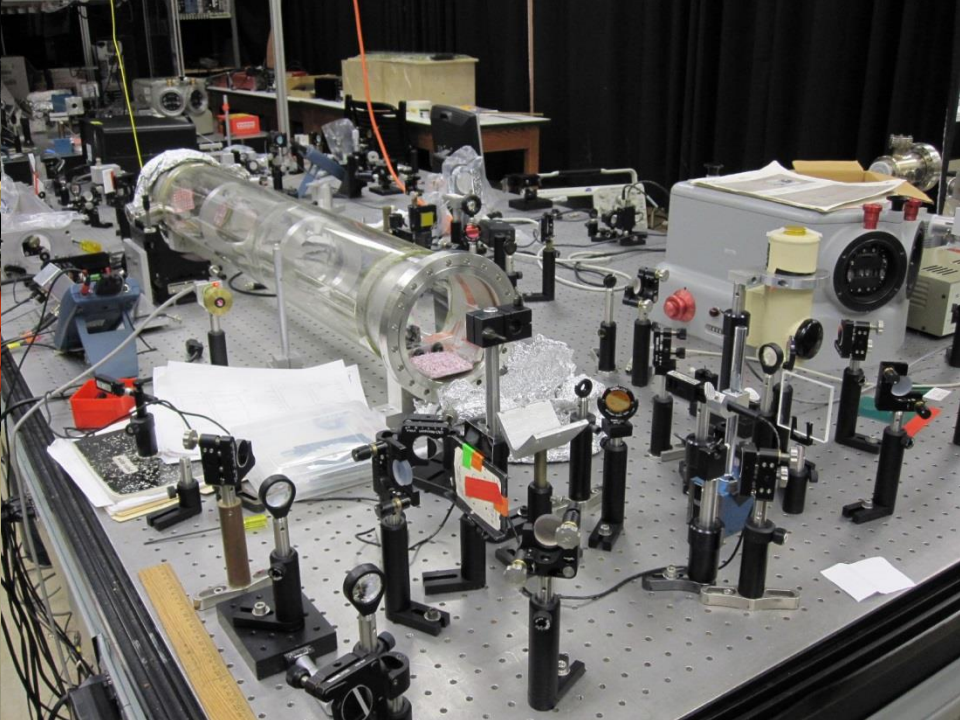
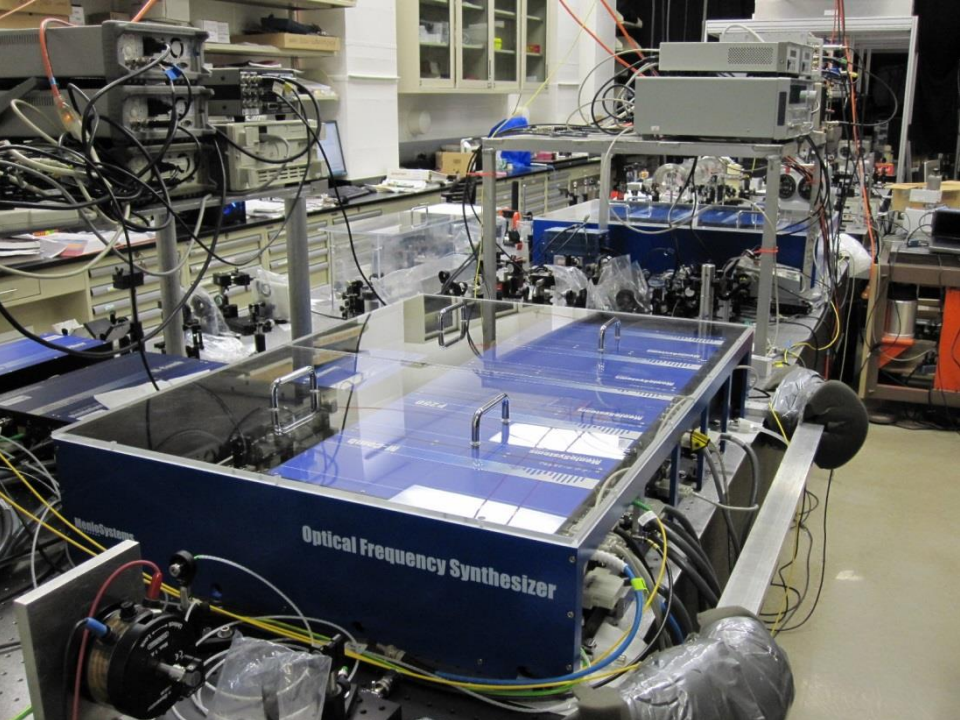
GLOBAL THINKING ON U.S. EXPORT POSITIONS OF NATURAL GAS

WITH THE BOOM OF FRACTURING RELATED OIL AND NATURAL GAS PRODUCTION IN THE U.S., EXPORTING NATURAL GAS (LNG) BECOMES A MAJOR ISSUE.

MANY IN THE EUROPEAN COMMUNITY, INCLUDING THE UKRAINE, POLAND, GERMANY, AND CONTIGUOUS COUNTRIES, ARE PLANNING ON GAS AS THE PRIMARY SUPPLIER OF ENERGY IN THE FUTURE. THIS OPENS UP A MAJOR OPPORTUNITY FOR OUR DOMESTIC PRODUCTION.

ARGENTINA HAS VAST AMOUNTS OF TIGHT NATURAL GAS, ALTHOUGH THE DEVELOPMENT THROUGH ENHANCED EXTRACTION IS JUST NOW BEGINNING TO OCCUR. BOTH ARGENTINA AND CHILE IMPORT MOST OF THEIR FOSSIL FUEL, PRIMARILY FROM EAST ASIA (INDONESIA, ETC)



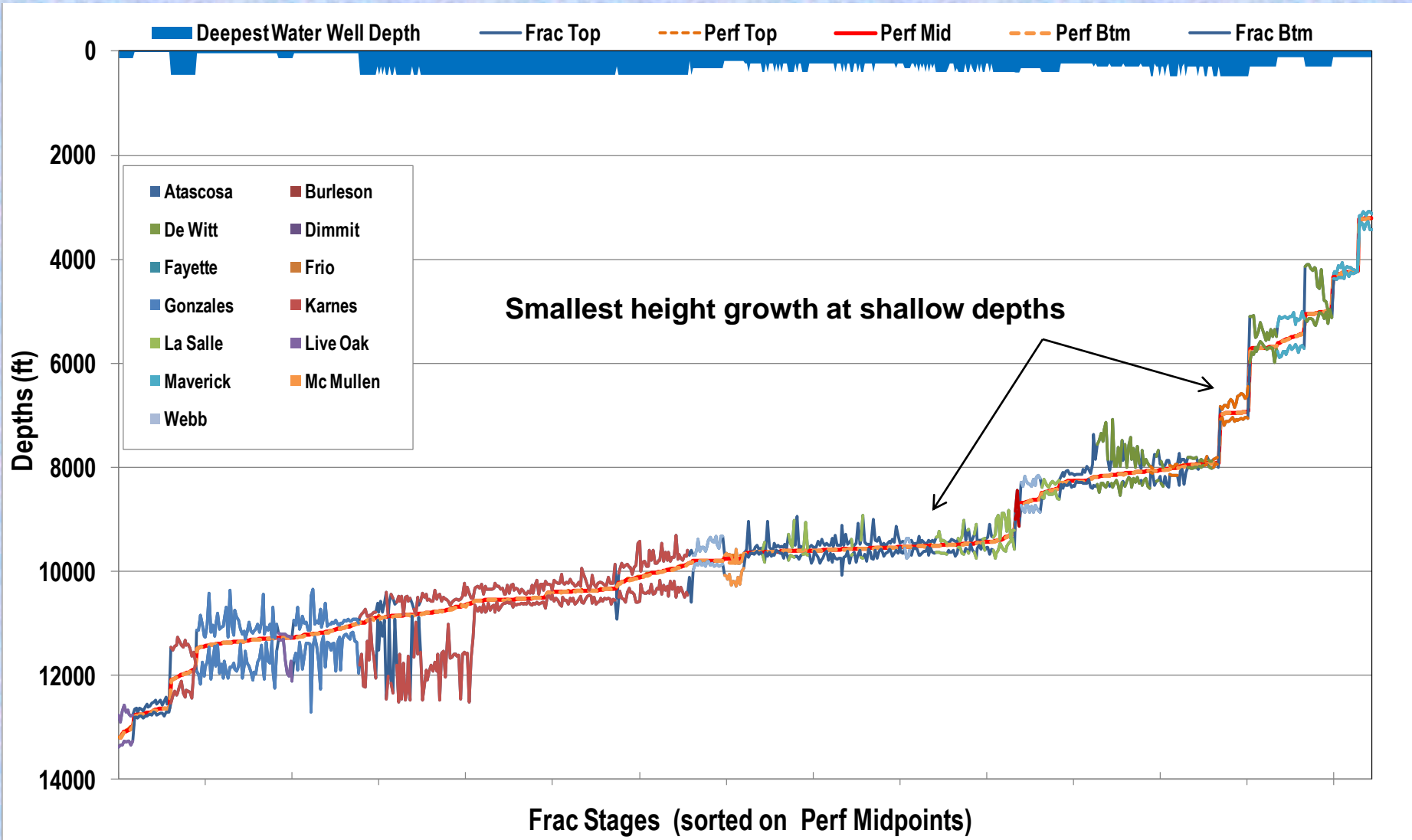


PHYSICS LABORATORY
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Mapped Microseismic Height for Eagle Ford Shale

Top: shallowest microseism; Bottom: deepest microseism

Aquifers: USGS deepest water wells by county



FEDERAL SUBSIDIES FOR ENERGY
(DOLLARS PER MEGAWATT HR)

(U.S. DEPARTMENT OF ENERGY, 2011)

OIL AND GAS	\$ 0.64
HYDRO	0.84
COAL	0.64
NUCLEAR	3.14
WIND	56.29
SOLAR	775.64

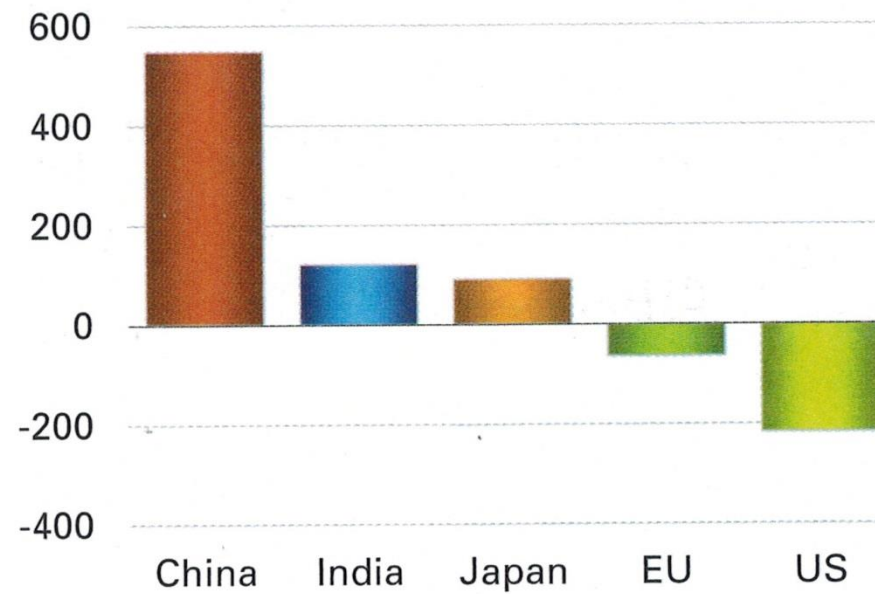
2015

<u>Energy Resource</u>	<u>Range of Gallons of Water Used per MMBTU of Energy Produced</u>	<u>Range of Power Generation Costs</u>	
		<u>Dollars (U.S.) mwh</u>	<u>Dollars (Europe) mwh</u>
Natural Gas		15-40	25-70
Conventional Oil	8-20	20	40-60
Synfuel-Coal Gasification	11-26	70	110-150
Oil Shale Petroleum	22-56	35-40	60-80
Tar Sands Petroleum	27-68	—	—
Synfuel-Fisher Tropsch (coal)	41-60	—	—
Fuel Ethanol (from irrigated corn)	2,510-29,100	—	—
Biodiesel (from irrigated soy)	13,000-75,000	—	—
Onshore Wind		70+	260+

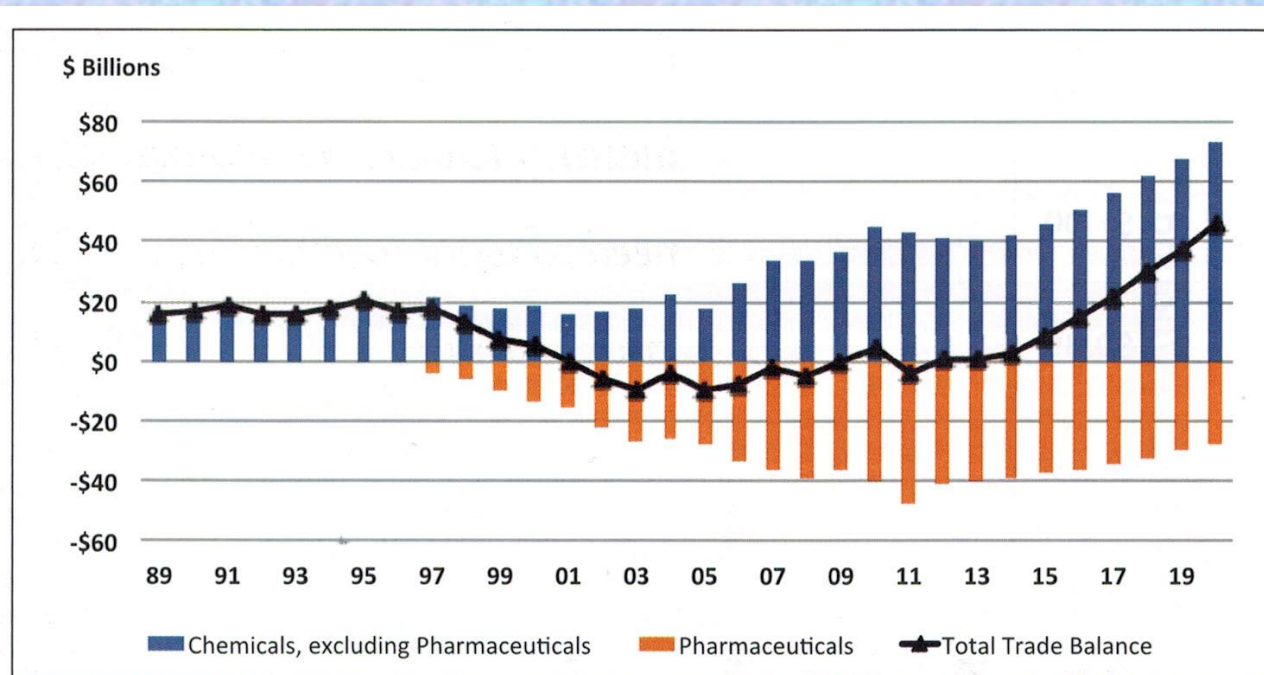
Note: These are approximate numbers depending on regional differences within the U.S. and European countries.

b) Largest emission changes in 2012

MtCO₂

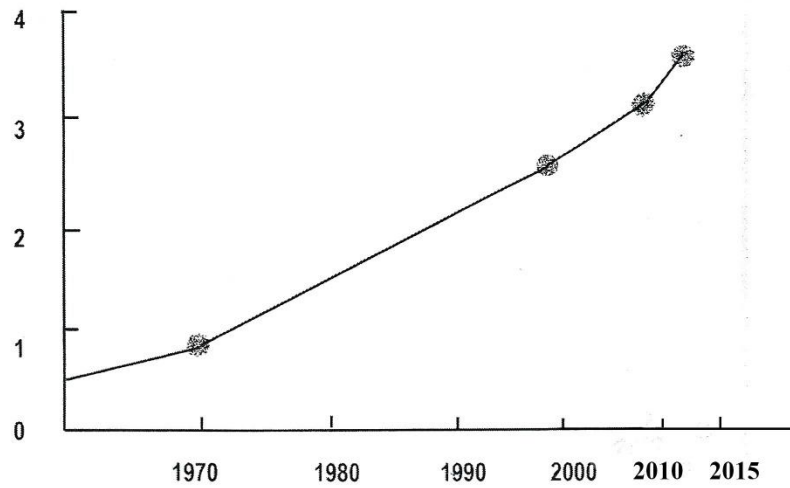


Downstream Industries Benefiting from Available Natural Gas Feedstock (Ethylene, HDPE, LDPE, VC, etc.)



Fossil Fuel Development and GDP Attributable to Enhanced Oil and Gas Development in the United States

Year	% of GNP
1972	0.9%
1980	1.6%
1990	2.5%
2000	2.6%
2015	3.7%



Source: U.S. Government

Estimated Relative Cost per Wet Ton Mile (Oil and Products)

Pipelines	0.5
Rail	10-15
Trucks	20-30

LEGAL SUMMARY

While there have been no U.S. court decisions to this date that have linked water well contamination directly attributed to hydraulic fracturing, the assault on this practice will not let up anytime soon.

The coming years will be vitally important for energy production and related industries.



Davis L. Ford & Associates

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Dr. Ford is a practicing environmental engineer with over fifty years of experience in the field. In addition, he serves on the faculty at The University of Texas at Austin as an adjunct professor and a Visiting Professor of Petroleum Engineering at Texas Tech University. He has published more than one hundred technical papers, has co-authored or contributed to ten textbooks, and written two biographies and co-authored one children's book. He has lectured extensively throughout the United States and in countries of Europe, South America, and Asia.

Ford received his bachelor's degree in civil engineering at Texas A&M University and his master and doctorate degrees in environmental engineering at The University of Texas at Austin. He is a Distinguished Engineering Graduate of both Texas A&M University and The University of Texas at Austin.

Ford was elected into the prestigious National Academy of Engineering (NAE, affiliated with the National Academy of Science and the National Academy of Medicine) in 1997. In 2005, he was inducted into the Academy of Medicine, Engineering, and Science of Texas. He is an Eagle Scout. He has served as president of the American Academy of Environmental Engineers and chairman of the Academy Ethics Committee. His honorary affiliations include Tau Beta Pi, Sigma Xi, and Chi Epsilon.

Ford lives in Austin, Texas, with his wife of more than 50 years, with his three daughters close by, and ten grandchildren---nine boys and one girl.

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