Petrochemistry and Chemical Engineering

The Role of Enhanced Shale Oil & Gas Recovery in the US & Development & Pricing of Significant Potential Shale Production in Other Countries Such as South America, Canada, & Europe/Asia

2018/2019

Dr. Davis L. Ford, PhD, PE, NAE
Key Points

- Fossil fuels are here to stay for at least the next 50 years
- The impact on GDP changes people’s lives
- Increase in GDP makes for a better world
Current Oil and Gas Extraction Status

- Major producers of oil and gas extraction: United States, Russia and Saudi Arabia
- Price of Brent Crude in the Range of $60-70 dollars per BBL (2018)
- With increase in proven yet undeveloped reserves, prices may temporarily decline
- Proven reserves in the world plan to develop production, such as Chile and Argentina, China, Canada, Mexico and Norway (off shore)
- Countries with a sound GDP will be importing oil and gas as the most cost effective way from competitive countries in the International Market
Abstract

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

- Global transformation with fossil fuel as primary source which have an effect on GDP, export/import changes, and global effects on pricing
- History of evolution of oil and gas production in the United States
- Global development: European Community, India, China, Brazil, Chile, Argentina and Mexico all have proven reserves
- All time high extraction of tight natural gas and oil being environmentally sound and protecting domestic water supplies
- Hydraulic fracking below potable water supplies
- Drilling Diagrams – Vertical and Horizontal, Proper Casing
  - Record pace of pipeline construction to supply refineries & terminal ports
  - Pronounced effect on GDP
- Natural gas treatment, delivery, from source to energy deficient countries exported as LNG
- Cost subsidies and economic pricing of oil and gas extraction, hydro power, coal, nuclear, wind, and solar. Cost of power by region
- There are no “Dry Holes” and more attributes of highly advanced geological technology
US Moving Toward Net Exports
Note: aggressive increase in natural gas (light blue) and petroleum (dk blue)
Sources of U.S. Energy Production

Note: fossil fuels make up majority of Btu Production

U.S. primary energy production by major sources, 2016

Note: Natural gas is dry gas, NGPL is natural gas plant liquids, other is geothermal, solar, and wind, and hydro is conventional hydroelectric.

Shale Gas Plays, U.S
We Are Experiencing An Energy Renaissance
Global Perspective on U.S. Export Positions of Natural Gas

- Boom of fracture related oil and natural gas production and U.S. exporting
- Many in European Community are planning on natural gas as the primary supply of energy in the future
  - Ukraine, Poland, Germany, and contiguous countries
  - Major opportunity for domestic (U.S.) production
World Shale Gas Reserves

US to Asia
US to Europe
Russia

Legend
- Assessed basins with resource estimate
- Assessed basins without resource estimate
- Countries within scope of report
- Countries outside scope of report
Argentina

- Enhanced extraction just beginning to occur
- Vast amounts of natural gas
- Current major importer of fossil fuel
- Key difference is in US, citizens own most mineral rights
- Government ownership makes it more complex
Fuel Consumption by Region
Note: Asia in yellow is 73% of coal consumption, with the USA at 11%
Overall World Fuel Consumption
Note: coal in grey, oil in green, natural gas in red

- Coal
- Renewables
- Natural Gas
- Oil

World primary energy consumption grew by 1.0% in 2016, well below the 10-year average of 1.8% and the third consecutive year at or below 1%. As was the case in 2015, growth was below average in all regions except Europe & Eurasia. All fuels except oil and nuclear power grew at below-average rates. Oil provided the largest increment to energy consumption at 77 million tonnes of oil equivalent (mtoe), followed by natural gas (57 mtoe) and renewable power (53 mtoe).
US Fuel Supply Growth
Tight Oil and Gas Growth - TECH Driven

Figure 1. U.S. petroleum and other liquid fuels supply by source, 1970-2040

(millions barrels per day)

History

2012

Projections

Net petroleum and biofuel imports

32%

Other

12%

Natural gas plant liquids

16%

Tight oil production

17%

Crude oil production (excluding tight oil

23%
U.S Natural Gas Production
Growth of Shale and Tight Gas is TECH driven

Figure MT-44. U.S. natural gas production by source in the Reference case, 1990-2040
Microseismic Barnett Shale
Fracking is No Threat to Fresh Water Resources

Mapped microseismic height for Barnett shale

- Top: shallowest microseism
- Bottom: deepest microseism
- Aquifers: USGS

Smallest height growth at shallow depths

Large spikes are likely fault interactions
Drilling Diagram
Redundant Casing and Cement

Davis L. Ford (CWEI)  (NAE, 2014)
Production Diagram
Natural Gas Treatment
# Federal Subsidies for Energy

Dollars per Megawatt Hour (US Dpt of Energy)

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Subsidy ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil and Gas</td>
<td>$0.00</td>
</tr>
<tr>
<td>Hydro</td>
<td>$0.84</td>
</tr>
<tr>
<td>Coal</td>
<td>$0.64</td>
</tr>
<tr>
<td>Nuclear</td>
<td>$3.14</td>
</tr>
<tr>
<td>Wind</td>
<td>$56.29</td>
</tr>
<tr>
<td>Solar</td>
<td>$775.64</td>
</tr>
</tbody>
</table>
Global Industrial Electricity Prices

Note: the US is one of the lowest in the world with one of the smallest tax components
Largest Emissions Changes
Decrease in US Without Carbon Tax, or Gov’t Intervention

Thousand Metric Tons CO2
GDP Impact

• GDP
  • Consumption
  • Investments
  • Government spending
  • Exports minus imports

• Conclusion
  • When US becomes energy independent the GDP increases accordingly. This is a major national issue.
Fossil Fuel Development and GDP USA

The graph shows the trend of fossil fuel development and GDP in the USA from 1972 to 2017. The percentage on the y-axis ranges from 0.00% to 6.00%, and the years are marked at intervals of 10 years, starting from 1972 and ending in 2017.
Quick Riches From a Rescue
Ares is in line to triple its money and reap more than $1 billion in profit.

Clayton Williams Energy share price

March 8
Ares agrees to loan Clayton Williams $350 million and buy warrants.

March 31 - June 3
Ares buys $16.6 million of Clayton Williams stock.

July 25
Ares agrees to buy $150 million of shares from the company.

Jan. 16
Noble Energy says it will buy Clayton Williams for $2.7 billion.
Noble Sets $2.7 Billion Deal
Energy Powers Stocks to New High
Producers Gear Up For Oil’s Recovery

Exxon Joins Land Rush in Southwest

Old Style Oil Wells Get New Life

New West Texas-to-Corpus pipeline set

The pipeline will carry 440,000 barrels of oil a day over its 730 miles.

By Rya Drizin
San Antonio Express News

The “EPIC” pipeline—which stands for Eagle Ford, Permian, Ingleside and Corpus—would transport upwards of 440,000 barrels per day of crude oil and condensate out of the Permian Basin Shale field to the Corpus Christi region when it comes online in the first quarter of 2019. Additionally, Eagle Ford connections could add 130,000 barrels or more of capacity, bringing the total to 590,000 barrels a day.

“The Permian production is growing at an incredible rate with lots of money being spent on acquiring acreage, and the rig counts continue to grow,” said Jeff Dorrrow, vice president of business development for San Antonio-based Fertitta Midstream Logistics, the lead company on the project.

The pipeline to the port in Corpus Christi is necessary because the refineries in the Houston market all are full, Dorrrow said.

The port has become increasingly important as U.S. oil production takes off. Almost $1.5 billion in oil was exported out of Corpus Christi last year, according to the website U.S. Trade Numbers.

The port’s website says more than 29.7 million tons of crude oil was outbound from the port in 2015, which would equal more than 217 million barrels for the year or 600,000 barrels of oil a day.

With Texas drilling more oil than it can handle, “the next barrel that’s going to be produced is...
Key Points

• Fossil fuels are here to stay for at least the next 50 years
• The impact on GDP changes people’s lives
• Increase in GDP makes for a better world
Dr. Davis L. Ford

Davis L. Ford, PhD, PE, NAE

Davis 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 hundreds of technical papers, has co-authored or contributed to ten textbooks, written several biographies, and also co-authored a children’s book. Dr. Ford lectures extensively throughout the United States, Europe, South America, and Asia. Dr. Ford received his bachelor’s degree in Civil Engineering at Texas A&M University and his master's and doctorate degrees in Environmental Engineering from The University of Texas at Austin. He is a Distinguished Engineering Graduate of both Texas A&M University and The University of Texas as well as a Distinguished Alumnus of Texas A&M. Dr. Ford was elected to The National Academy of Engineers (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 at Texas. He is an Eagle Scout. He resides in Austin, Texas, with his wife of more than fifty years, his three daughters close by, and ten grandchildren - nine boys and one girl.

To learn more about Dr. Ford please visit his website: www.davislfordphd.com
If you wish to contact him directly please email dfordphd@aol.com