Unconventional Gas Production in the United States

The State of the Industry
Marcellus and Utica Shale in the Appalachian Basin

October 21, 2014
Contents

• Overview of the Marcellus Shale in Pennsylvania
• Economic Impacts to Pennsylvania
• Economic Impacts to the U.S.
• US Energy Supply – the need for Hydraulic Fracturing
• Utica Shale in Northeast PA
• Future Transportation Needs
ACCORDING TO EIA, U.S. OIL AND GAS INDUSTRY HAS MEANS TO PRODUCE OVER 2,400 TCF OF GAS USING CURRENT TECHNOLOGY, WITH SHALE GAS PLAYS (MARCELLUS AND UTICA) AS THE FOUNDATION. AT 25 TCF PER YEAR IN GAS CONSUMPTION, THIS REPRESENTS ABOUT A 100 YEAR SUPPLY OF NATURAL GAS FOR THE U.S.
Figure 1. U.S. oil and natural gas proved reserves, 1982-2012

MARCELLUS INDUSTRY EVOLUTION

TWO CORE AREAS

Unconventional Wells
10,019 Wells Drilled Through November 19, 2013

Year Drilled
- 2012-2013 (3,186 wells 11.19.13)
- 2010-2011 (4,285 wells)
- 2008-2009 (1,997 wells)
- 2006-2007 (500 wells)
- 2004-2005 (15 wells)

Marcellus, Upper Devonian, and/or Utica Outline
http://marcellus.psu.edu
MARCELLUS INDUSTRY EVOLUTION

CURRENT PRODUCTION AT 14 BCFED, POTENTIAL TO EXCEED 20 BCFED, CURRENT US DEMAND IS 75 BCFED

SHALE GAS PROVIDES EVER INCREASING PORTION OF U.S. RESERVE BASE, WITH MARCELLUS ESTIMATED AT 500 TCFE MINIMUM

Source: Bentek Energy
**PENNSYLVANIA ECONOMIC IMPACT**

Royalty Values - Typical Marcellus Well
Assumes 8.0 BCF Well, 15% Royalty Rate, $4.00 per MCF Gas
Per 80 - 100 Acres of OGM Ownership

<table>
<thead>
<tr>
<th>YEAR</th>
<th>Well MCF's</th>
<th>Royalty Revenue</th>
<th>Cumulative Royalty</th>
<th>% of Total</th>
<th>Cumulative %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1,662,644</td>
<td>$1,122,285</td>
<td>$1,122,285</td>
<td>20.78%</td>
<td>20.78%</td>
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<tr>
<td>2</td>
<td>775,145</td>
<td>$523,223</td>
<td>$1,645,507</td>
<td>9.69%</td>
<td>30.46%</td>
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<tr>
<td>3</td>
<td>558,361</td>
<td>$376,894</td>
<td>$2,022,401</td>
<td>6.98%</td>
<td>37.44%</td>
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<tr>
<td>4</td>
<td>449,375</td>
<td>$303,328</td>
<td>$2,325,730</td>
<td>5.62%</td>
<td>43.06%</td>
</tr>
<tr>
<td>5</td>
<td>381,760</td>
<td>$257,688</td>
<td>$2,583,418</td>
<td>4.77%</td>
<td>47.83%</td>
</tr>
<tr>
<td>6</td>
<td>334,974</td>
<td>$226,108</td>
<td>$2,809,525</td>
<td>4.19%</td>
<td>52.01%</td>
</tr>
<tr>
<td>7</td>
<td>300,329</td>
<td>$202,722</td>
<td>$3,012,248</td>
<td>3.75%</td>
<td>55.76%</td>
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<tr>
<td>8</td>
<td>273,454</td>
<td>$184,582</td>
<td>$3,196,829</td>
<td>3.42%</td>
<td>59.18%</td>
</tr>
<tr>
<td>9</td>
<td>251,889</td>
<td>$170,025</td>
<td>$3,366,854</td>
<td>3.15%</td>
<td>62.33%</td>
</tr>
<tr>
<td>10</td>
<td>234,130</td>
<td>$158,038</td>
<td>$3,524,892</td>
<td>2.93%</td>
<td>65.25%</td>
</tr>
<tr>
<td>11-15</td>
<td>982,898</td>
<td>$663,456</td>
<td>$4,188,348</td>
<td>12.28%</td>
<td>77.54%</td>
</tr>
<tr>
<td>16-20</td>
<td>757,674</td>
<td>$511,430</td>
<td>$4,699,778</td>
<td>9.47%</td>
<td>87.01%</td>
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<tr>
<td>21-25</td>
<td>586,274</td>
<td>$395,735</td>
<td>$5,095,513</td>
<td>7.33%</td>
<td>94.33%</td>
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<tr>
<td>26-30</td>
<td>453,647</td>
<td>$306,212</td>
<td>$5,401,725</td>
<td>5.67%</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

Total 8,002,555 $5,401,725 100.00%
PA Marcellus Oil and Gas Production and Royalty Value by County
Estimated Total Paid Through June, 2014 - $5.09 Billion (Private Lands Only)

- MCFs of Gas Produced
- Estimated Royalty Value
- Bbls of Oil Produced

- ALLEGHENY
- ARMSTRONG
- BEAVER
- BLAIR
- BRADFORD
- BUTLER
- CAMBRIA
- CAMERON
- CENTRE
- CLARION
- CLINTON
- CLINTON
- CRAWFORD
- ELK
- ERIE
- ERIE
- FOREST
- GENE
- GREENE
- HUNTINGDON
- INDIANA
- JEFFERSON
- LAWRENCE
- LEOMING
- MCKEAN
- MERCHER
- POTTER
- SOMERSET
- SULLIVAN
- SUSQUEHANNA
- Tioga
- VENANGO
- WARREN
- WESTMORELAND
- WASHINGTON
- WYOMING

Estimated Total Paid Through June, 2014 - $5.09 Billion (Private Lands Only)
ASSUMPTIONS
- LEASE BONUSES WILL DIMINISH FROM 2012 VALUE TO ZERO BY 2030
- PA MARCELLUS GAS PRODUCTION WILL INCREASE FROM 12.0 BCFED IN 2014 TO 18.3 BCFED IN 2020, REMAIN FLAT UNTIL 2030
- OIL AND GAS PRICES WILL AVERAGE $86 PER BARREL, $4.50 PER MCF THROUGH 2030
- AVERAGE ROYALTY RATE OF 15%

ESTIMATED REVENUES TO PRIVATE LANDOWNERS (IN $ MILLIONS)

<table>
<thead>
<tr>
<th></th>
<th>LEASE BONUS</th>
<th>ROYALTIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>THROUGH 6-2014</td>
<td>$ 6,852.9</td>
<td>$ 5,088.3</td>
</tr>
<tr>
<td>2014 – 2030</td>
<td>$ 4,334.4</td>
<td>$ 72,230.7</td>
</tr>
<tr>
<td>TOTALS</td>
<td>$ 11,187.3</td>
<td>$ 77,319.0</td>
</tr>
</tbody>
</table>

Assumed production through 2030 approximately 100 TCFE, or 20% of estimated reserves of 500 TCFE (Marcellus)
PA Marcellus Oil and Gas per Capita Royalty Value by County
Estimated Total Paid Through December, 2030 - $77.3 Billion (Private Lands Only)
<table>
<thead>
<tr>
<th>Description</th>
<th>$ MM</th>
</tr>
</thead>
<tbody>
<tr>
<td>DCNR BONUS, ROYALTIES</td>
<td>$413.0</td>
</tr>
<tr>
<td>IMPACT AND PERMIT FEES</td>
<td>$225.0</td>
</tr>
<tr>
<td>STATE AND LOCAL TAX TOTAL</td>
<td>$2,003.0</td>
</tr>
<tr>
<td>TOTAL REVENUES</td>
<td>$2,641.0</td>
</tr>
<tr>
<td>2013 PA STATE GENERAL FUND REVENUES</td>
<td>$27,060.0</td>
</tr>
<tr>
<td>(EXCLUDING FEDERAL PROGRAMS)</td>
<td></td>
</tr>
</tbody>
</table>

9.8%

Sources – PADCNR, PADEP, PSU (Consadine)-2011
PENNSYLVANIA ECONOMIC IMPACT

UNQUANTIFIED ECONOMIC BENEFITS

3/15/12 – WSJ – “SHELL PICKS PITTSBURGH FOR NEW PETROCHEMICAL PLANT” – NEW $2 BILLION ETHANE CRACKER WILL SUPPLY 10,000 CONSTRUCTION JOBS, 400 PERMANENT JOBS

3/27/13 – PTR – “SHALE BOOM PUSHING PIPELINE GROWTH - $1.1 BILLION OR MORE THAN ONE-HALF THE AMOUNT SPENT IN THE US IN 2012 ON PIPELINE PROJECTS SPENT IN PENNSYLVANIA

3/1/13 – PTR - “MORE IN THAN OUT” – SHALE, HEALTH CARE FUEL REVERSAL IN MIGRATION

10/11/12 – PTR – NEW NATURAL GAS POWER PLANTS ANNOUNCED IN BRADFORD AND LAWRENCE COUNTIES, CREATING 500 NEW JOBS AT EACH FACILITY

2/15/13 – MONEYMORNING.COM – “CHEAP NATURAL GAS PRICES GIVE HOPE TO US STEEL INDUSTRY – DIRECT-REDUCED-IRON TECHNOLOGY THE FUTURE OF MAKING STEEL, POSSIBLE NOW WITH CHEAP NATURAL GAS

2/15/13 – WALL STREET JOURNAL – CHEMICAL AND FERTILIZER PLANTS (DOW CHEMICAL AND CHEVRON) ANNOUNCE PLANS TO BUILD MULTI-BILLION DOLLAR PLANTS IN TEXAS, LOUISIANA CITING LOWER NATURAL GAS PRICES MAKING THE US A MORE COMPETITIVE MANUFACTURING LOCATION

3/5/13 – PTR – “DRILLING SPURS GROWTH” – PENNSYLVANIA RANKS 3RD FOR NEW OR EXPANDED CORPORATE FACILITIES (430) IN 2012
PENNSYLVANIA ECONOMIC IMPACT

UNQUANTIFIED ECONOMIC BENEFITS

PARTIAL LIST OF NEW COMPANIES OPERATING IN PENNSYLVANIA DUE TO INVOLVEMENT IN MARCELLUS

TALISMAN ENERGY USA
ANADARKO E&P COMPANY LP
SWEPI LP (SHELL OIL)
SOUTHWESTERN ENERGY
CHEVRON APPALACHIA LLC
CHIEF OIL AND GAS COMPANY
CARRIZO MARCELLUS LLC
SM ENERGY COMPANY
XTO ENERGY INC (EXXON-MOBIL)
ULTRA RESOURCES
ANTERO RESOURCES APPALACHIAN

STONE ENERGY
ENCANA OIL AND GAS US
HESS CORP
NEWFIELD EXPLORATION
NOBLE ENERGY INC
HILCORP ENERGY COMPANY
WILLIAMS PIPELINE CORP
MARKWEST HYDROCARBON
CAIMAN ENERGY
JW OPERATING COMPANY
SAMPSON RESOURCES

THIS PARTIAL LIST REPRESENTS COMPANIES WITH A COMBINED MARKET CAP OF OVER $1.0 TRILLION NOW DOING BUSINESS IN PENNSYLVANIA
US ECONOMIC IMPACTS

US OIL AND NATURAL AND NATURAL GAS PRICES

- Oil Price, $/bbl
- Gas Price, $/mcf
- Gas Price, Russia, $/Mcf

Year

Oil Price, $/bbl

Gas Price $/mcf

Gas Price $/Mcf

## PENNSYLVANIA AND US ECONOMIC IMPACT

### NATURAL GAS CONSUMPTION, AVERAGE, 2008 - 2013 *

<table>
<thead>
<tr>
<th></th>
<th>2013 ANNUAL BCF</th>
<th>2008 DELIVERED PRICE PER MCF</th>
<th>2008 TOTAL COST, SMM</th>
<th>2013 DELIVERED PRICE PER MCF</th>
<th>2013 TOTAL COST, SMM</th>
<th>ANNUAL DIFFERENCE (SAVINGS)</th>
<th>% DIFFERENCE</th>
<th>TOTAL SAVINGS, 2014 - 2030</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RESIDENTIAL</strong></td>
<td>232</td>
<td>$13.89</td>
<td>$3,222.48</td>
<td>$10.33</td>
<td>$2,396.56</td>
<td>$(825.92)</td>
<td>-25.6%</td>
<td>$(14,040.64)</td>
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<tr>
<td><strong>COMMERCIAL</strong></td>
<td>146</td>
<td>$12.23</td>
<td>$1,785.58</td>
<td>$8.13</td>
<td>$1,186.98</td>
<td>$(598.60)</td>
<td>-33.5%</td>
<td>$(10,176.20)</td>
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<tr>
<td><strong>INDUSTRIAL</strong></td>
<td>211</td>
<td>$9.65</td>
<td>$2,036.15</td>
<td>$4.66</td>
<td>$983.26</td>
<td>$(1,052.89)</td>
<td>-51.7%</td>
<td>$(17,899.13)</td>
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<tr>
<td><strong>VEHICLE</strong></td>
<td>0</td>
<td>$11.75</td>
<td>$0.00</td>
<td>$5.67</td>
<td>$0.00</td>
<td>$(5.67)</td>
<td>-100%</td>
<td>$(5.67)</td>
</tr>
<tr>
<td><strong>ELECTRIC</strong></td>
<td>359</td>
<td>$9.26</td>
<td>$3,324.34</td>
<td>$4.49</td>
<td>$1,611.91</td>
<td>$(1,712.43)</td>
<td>-51.5%</td>
<td>$(29,111.31)</td>
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<tr>
<td><strong>PA TOTAL</strong></td>
<td>948</td>
<td></td>
<td>$10,368.55</td>
<td></td>
<td>$6,178.71</td>
<td>$(4,189.84)</td>
<td>-40.4%</td>
<td>$(71,227.28)</td>
</tr>
<tr>
<td><strong>NEW YORK</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>RESIDENTIAL</strong></td>
<td>358</td>
<td>$13.89</td>
<td>$4,972.62</td>
<td>$10.33</td>
<td>$3,698.14</td>
<td>$(1,274.48)</td>
<td>-25.6%</td>
<td>$(21,666.16)</td>
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<tr>
<td><strong>COMMERCIAL</strong></td>
<td>270</td>
<td>$12.23</td>
<td>$3,302.10</td>
<td>$8.13</td>
<td>$2,195.10</td>
<td>$(1,107.00)</td>
<td>-33.5%</td>
<td>$(18,819.00)</td>
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<td><strong>INDUSTRIAL</strong></td>
<td>74</td>
<td>$9.65</td>
<td>$714.10</td>
<td>$4.66</td>
<td>$344.84</td>
<td>$(369.26)</td>
<td>-51.7%</td>
<td>$(6,277.42)</td>
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<tr>
<td><strong>VEHICLE</strong></td>
<td>4</td>
<td>$11.75</td>
<td>$47.00</td>
<td>$5.67</td>
<td>$22.68</td>
<td>$(24.32)</td>
<td>-51.7%</td>
<td>$(413.44)</td>
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<tr>
<td><strong>ELECTRIC</strong></td>
<td>499</td>
<td>$9.26</td>
<td>$4,620.74</td>
<td>$4.49</td>
<td>$2,240.51</td>
<td>$(2,380.23)</td>
<td>-51.5%</td>
<td>$(40,463.91)</td>
</tr>
<tr>
<td><strong>NY TOTAL</strong></td>
<td></td>
<td></td>
<td>$13,656.56</td>
<td></td>
<td>$8,501.27</td>
<td>$(5,155.29)</td>
<td>-37.7%</td>
<td>$(87,639.93)</td>
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<td><strong>U.S.</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>RESIDENTIAL</strong></td>
<td>4,941</td>
<td>$13.89</td>
<td>$68,630.49</td>
<td>$10.33</td>
<td>$51,040.53</td>
<td>$(17,589.96)</td>
<td>-25.6%</td>
<td>$(299,029.32)</td>
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<tr>
<td><strong>COMMERCIAL</strong></td>
<td>3,293</td>
<td>$12.23</td>
<td>$40,273.39</td>
<td>$8.13</td>
<td>$26,772.09</td>
<td>$(13,501.30)</td>
<td>-33.5%</td>
<td>$(229,522.10)</td>
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<td><strong>INDUSTRIAL</strong></td>
<td>7,461</td>
<td>$9.65</td>
<td>$71,998.65</td>
<td>$4.66</td>
<td>$34,768.26</td>
<td>$(37,230.39)</td>
<td>-51.7%</td>
<td>$(632,916.63)</td>
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<tr>
<td><strong>VEHICLE</strong></td>
<td>33</td>
<td>$11.75</td>
<td>$387.75</td>
<td>$5.67</td>
<td>$187.11</td>
<td>$(200.64)</td>
<td>-51.7%</td>
<td>$(3,410.88)</td>
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<tr>
<td><strong>ELECTRIC</strong></td>
<td>8,153</td>
<td>$9.26</td>
<td>$75,496.78</td>
<td>$4.49</td>
<td>$36,606.97</td>
<td>$(38,889.81)</td>
<td>-51.5%</td>
<td>$(661,126.77)</td>
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<tr>
<td><strong>US TOTAL</strong></td>
<td>23,881</td>
<td>$12.23</td>
<td>$256,787.06</td>
<td>$8.13</td>
<td>$149,374.96</td>
<td>$(107,412.10)</td>
<td>-41.8%</td>
<td>$(1,826,005.70)</td>
</tr>
</tbody>
</table>

*Source - EIA, Excludes Plant and PL Fuel*
Figure 8. U.S. primary energy consumption by fuel, 1980-2040
US ENERGY SUPPLY - HYDRAULIC FRACTURING

US Onshore Drilling History with Wells Hydraulically Fractured

- Total US Wells Drilled
- Total US Wells Fraced

Years: 1949-2009

Wells Drilled

U.S. Dry Gas Production by Source
(trillion cubic feet per year)

Source data EIA

Shale Gas
Tight Gas
Offshore Non-Associated
Alaska
Coalbed Methane
Associated with Oil
Non-Associated Onshore
POTENTIAL US ECONOMIC IMPACT 2014-2030

ESTIMATED ADDITIONS TO US TRADE DEFICIT WITHOUT HYDRAULIC FRACTURING

CHANGE IN US OIL IMPORTS  22.0 BILLION BBL
CHANGE IN US NAT GAS IMPORTS  101.8 TRILLION CF

ESTIMATED VALUE *  $ 4.049 TRILLION

ESTIMATED ANNUAL VALUE  $ 224.9 BILLION

NUMBER OF JOBS LOST  2,025,000
(ACCORDING TO THE ECONOMIC POLICY INSTITUTE)

* BASED ON BRENT OIL PRICE $110 / BBL, INTERNATIONAL LNG PRICE (JAPAN) $16.00 / MCF (MARCH, 2013)
Figure 10. Total energy production and consumption, 1980-2040

(Quadrillion Btu)

- Consumption
- Production
- Net imports

- History
- 2012
- Projections
- 2035

UTICA SHALE - NEXT FRONTIER

- Below the Marcellus
- Bigger, deeper, denser
- One of the last big U.S. unconventional energy fields
- Success in the Marcellus has lead to success in the Utica
- Primary Development in Ohio, recent large discoveries in Northeast PA
- Production, Reserves of 1.5X Marcellus in NEPA
- Production Peak at 25 – 30 BCFD
- Reserves of +300.0 TCFE
Northeast US Natural Gas Supply / Demand (Marcellus Only)
MARCELLUS AND UTICA SUPPLIES

MAJOR PIPELINES WILL BE UPGRADED AND CAPACITY WILL EXPAND
MARCELLUS AND UTICA SUPPLIES

- Pipeline expansion must take place with routes east, west, south and north into Canada
- New Pipeline routes alone will not be sufficient to provide necessary capacity for estimated 40 BCFD of ultimate capacity from NEPA Marcellus and Utica fields
- Exports via LNG carriers necessary to move supplies
- Existing LNG Terminal in Maryland and Georgia
NATIONAL ENERGY POLICY?

- JOHNSON – OIL $3/BBL, GAS $0.50/MCF – LOW STABLE PRICES, 1972: 1 OUT OF 5 BARRELS OF OIL USED IN U.S. IMPORTED
- 1973 - YOM KIPPUR WAR 1st ARAB OIL EMBARGO - ENERGY CRISIS
- NIXON – PROJECT INDEPENDENCE, ACHIEVE ENERGY INDEPENDENCE BY 1980, ”GAS WON’T GO OVER $1/GALLON”
- FORD – EXTENDS OIL PRICE CONTROLS, STRATEGIC PETROLEUM RESERVE CREATED, ”ENERGY POLICY AND CONSERVATION ACT”
- CARTER-”OIL IMPORTS WILL GO DOWN” (IN A SWEATER) DOE 1977
- REGAN-OIL PRICE CONTROLS ELIMINATED, $37/BBL TO $14/BBL
- BUSH (1)-”REDUCE OUR DEPENDENCE ON FOREIGN OIL”
- CLINTON – SOLAR, WIND AND BIOMASS INITIATIVES
- BUSH (2) “PROMOTE ENERGY INDEPENDENCE FOR OUR COUNTRY”
- OBAMA- RENEWABLE AND CLEAN ENERGY INITIATIVES
GAS SHORTAGE!
Sales Limited to
10 GALS. OF GAS.
PER CUSTOMER

NO GAS
U.S. Petroleum Consumption by Sector

Figure 3.7 Petroleum Consumption by Sector

By Sector, 1949–2013

Million Barrels per Day

Transportation

Industrial*

Electric Power

Residential and Commercial*

By Sector, June 2014
Figure 4.1 Natural Gas (Trillion Cubic Feet)

Overview, 1949–2013
U.S. Electric Power Generation by Source
SUMMARY

• THE SUCCESSFUL DEVELOPMENT OF THE MARCELLUS SHALE COINCIDED WITH THE END OF THE U.S. ENERGY CRISIS THAT BEGAN IN 1973 –

• COMBINING HYDRAULIC FRACTURING AND LONG HORIZONTAL WELLS IS KEY TO ECONOMIC EXTRACTION OF HYDROCABONS FROM VERY LOW PERMEABILITY ROCKS SUCH AS SHALES

• LIMITING OR BANNING HYDRAULIC FRACTURING WILL HAVE CATESTROPHIC ECONOMIC CONSEQUENCES FOR THE U.S.

• THE U.S. CAN TRULY BECOME ENERGY INDEPENDENT WITHIN THE NEXT DECADE – JOBS, REVENUES, TRADE DEFICIT REDUCTION, ENERGY SECURITY AND POLITICAL INFLUENCE
OIL PRICES HIT $200 PER BARREL
NATURAL GAS OVER $20/MCF!
OIL PRICES HIT $200 PER BARREL
NATURAL GAS ONLY $6/MCF!
A higher standard of living requires more energy.
• Energy is an enabler of progress.

• Affordable reliable energy supports rising living standards and job creation and contributes to opportunities for better health, education and social welfare.

• Energy is the foundation supporting our high standard of living.
Much of the world depends on biomass for fuel.
Projected World Energy Supplies

World Energy Demand

- Crude Oil
- Natural Gas
- Coal
- Nuclear Electric
- Solar Wind
- Geothermal
- Hydroelectric
- Unconventional Shale Gas & Oil

Billion Barrels of Oil Equivalent per Year (GBOE)

1900 1920 1940 1960 1980 2000 2020 2040 2060 2080 2100

after Edwards, AAPG