U.S. Natural Gas: Why, Where, How

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U.S. Natural Gas

- **WHY**
  is natural gas important to the future of the United States?

- **WHERE**
  do we explore for and produce natural gas?

- **HOW**
  do we utilize this abundant resource within our borders?
U.S. Energy Portfolio: Natural Gas Facts

- **ABUNDANT**: A 70-100 year supply and growing
- **CLEAN**: Lower combustion emissions than coal and oil
- **DOMESTIC**: Produced in 32 states, used nationwide
- **VERSATILE**: Electricity generation, home, business and transportation
- **SECURE**: Does not require importation, distribution systems in place
- **VALUABLE**: Oil & Natural Gas industry supports 9.2 million U.S. jobs
- **BRIDGE FUEL**: Natural gas is today’s fuel that can power us to tomorrow
**Natural Gas Advantages: Abundant**

*Assumes an annual consumption rate of 23.1 Tcf and no growth for the United States*

- Current industry and government estimates of natural gas reserves range from 70-100 years of supply at current consumption

Source: 1, 2, 3
# Natural Gas Advantages: Clean

<table>
<thead>
<tr>
<th></th>
<th>Combustion Emissions (Pounds/ Billion BTU of Energy Input)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Natural Gas</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>117,000</td>
</tr>
<tr>
<td>Carbon Monoxide</td>
<td>40</td>
</tr>
<tr>
<td>Nitrogen Oxides</td>
<td>92</td>
</tr>
<tr>
<td>Sulfur Dioxides</td>
<td>.6</td>
</tr>
<tr>
<td>Particulates</td>
<td>7</td>
</tr>
</tbody>
</table>

Natural Gas Combustion Produces:
- 29% less CO2 than oil
- 44% less CO2 than coal
- No solid waste
- Extremely low particulates

“The US will need to develop affordable natural gas supplies in the immediate future” – Sierra Club

“Greenhouse Gas emissions from natural gas are 23% lower than diesel, and 30% lower than gasoline” – California Energy Commission

Source: 4,5
Natural Gas Advantages: Versatile

- Natural Gas is used in most sectors of the economy

A small but growing fuel for transportation

The clean way to generate electricity that is also used as a backup source for wind/solar generation

Heats/cools over 50% of US homes, over 65 million residential customers

Clean fuel to power industry, manufacture fertilizer for food, and many other specialty uses and products

Source: 2
Natural Gas Advantages: Domestic

The Oil and Natural Gas Industry
• Employs 9.2 million Americans
• Employs 4% or more of total employment in 15 states
• Supports 7.5% of U.S. GDP

Source: 6,7,22
Natural Gas Advantages: Secure Infrastructure

Shale Basins indicated in green

Source: 8
Role of Renewables

- All renewable energy currently provides only 6% of our total primary energy consumption

- Even with a significant increase in wind and solar energy, natural gas will still be critical to supplying our energy needs

Source: 2
Electricity Generation

2009 Electricity Generation by Source

- Hydroelectric: 7%
- Renewables: 3%
- Nuclear: 20%
- Natural Gas: 24%
- Coal: 44%
- Petroleum Liquids: 1%

• Electricity generation is responsible for 30% of all U.S. greenhouse gas emissions

• The EIA expects 53% of new electric generations built by 2025 will be natural gas combined cycle or combustion turbine generation

Source: 2
Electricity Generation: Cost vs Energy Efficiency

Source: 9,10,11,12

Note: Efficiency = BTU input vs BTU output
## Natural Gas for Transportation

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>2007 US Registered Vehicles</th>
<th>25% NGV Market Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger Car</td>
<td>135,933,000</td>
<td>33,983,000</td>
</tr>
<tr>
<td>Other 2 Axle, 4 Tire</td>
<td>101,470,000</td>
<td>25,367,000</td>
</tr>
<tr>
<td>Trucks 2 Axle, 6 Tire or More</td>
<td>6,807,000</td>
<td>1,702,000</td>
</tr>
<tr>
<td>Truck Combination</td>
<td>2,221,000</td>
<td>555,000</td>
</tr>
<tr>
<td>Bus</td>
<td>834,000</td>
<td>209,000</td>
</tr>
<tr>
<td>Total</td>
<td>247,265,000</td>
<td>61,816,000</td>
</tr>
<tr>
<td>Annual Consumption (Tcf)</td>
<td></td>
<td>10</td>
</tr>
</tbody>
</table>

What can 10 Tcf of Natural Gas Displace?

- 23 billion gallons of diesel = 548 million barrels = 16.5% of 2009 U.S. imported Crude Oil
- Could reduce imports from OPEC Nations by over 30%
- Based on a $75/barrel crude price, that is $41 Billion per year not spent on imports

Source: 13,14,15,16
# Water Consumption: By Energy Source

<table>
<thead>
<tr>
<th>Energy Resource</th>
<th>Range of Gallons of Water Used per MMBtu of Energy Produced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep Shale Natural Gas</td>
<td>*0.60-5.8</td>
</tr>
<tr>
<td>Nuclear (uranium ready to use in a power plant)</td>
<td>8-14</td>
</tr>
<tr>
<td>Conventional Oil</td>
<td>8-20</td>
</tr>
<tr>
<td>Synfuel- Coal Gasification</td>
<td>11-26</td>
</tr>
<tr>
<td>Coal (ready to use in a power plant)</td>
<td>13-32</td>
</tr>
<tr>
<td>Oil Shale</td>
<td>22-56</td>
</tr>
<tr>
<td>Tar Sands</td>
<td>27-68</td>
</tr>
<tr>
<td>Synfuel- Fisher Tropsch (from coal)</td>
<td>41-60</td>
</tr>
<tr>
<td>Enhanced Oil Recovery (EOR)</td>
<td>21-2,500</td>
</tr>
<tr>
<td>Fuel Ethanol (from corn)</td>
<td>2,510-29,100</td>
</tr>
<tr>
<td>Biodiesel (from soy)</td>
<td>14,000-75,000</td>
</tr>
</tbody>
</table>

Source: 17,18,19,20
Unconventional Reservoirs

Shale Gas, Tight Sands, and Coal Bed Methane

Unconventional production currently accounts for 46% of total U.S. production

Source: 17
Unconventional Reservoirs

Since 2004, unconventional reservoirs are the primary source of natural gas production.

Extraction requires the proper application of:
- Horizontal drilling
- Stimulation techniques

Unconventional reservoirs:
- Low Permeability
- Low Porosity

Source: 2
Shale Gas Development

Vertical vs Horizontal Wells

Old: Numerous well sites per square mile (Vertical Wells)

New: Minimal well sites per square mile (Horizontal Wells)

Horizontal wells are established technologies with a track record dating back to the 1930s

Source: 17
Shale Gas Development

Horizontal Wells and Hydraulic Fracturing

• Fracturing creates the pathways that allow trapped gas to flow from previously unproducible rock

• Frac Fluid mixture utilized is 99.5% water and sand
• Critical to the economic viability of shale gas production

Approx. 1-1.5 miles below groundwater aquifer

Source: 17, 18, 21
Shale Gas Development

Protecting Groundwater

Groundwater aquifers, which occur at shallow depths, are protected by multiple strings of cemented metal casing and are regulated by local states and municipalities.

EPA testimony of 12/8/2009 confirmed no documented cases of hydraulic fracturing contaminating any groundwater supplies.

Source: 17, 18
Shale Gas Development

Natural Gas Well Lifecycle

Drilling (30 days)
Drilling Pad site-4 acres

Stimulating (Hydraulic Fracturing) (1-3 Days)

Producing (Years)
Production Pad Site-1 acre

Community concerns during drilling and stimulation include: traffic volume, road damage, dust, noise

Source: 17
Final Thoughts...

• Natural Gas is a clean, domestic, abundant and secure energy that is the energy bridge to the future

• Natural Gas is available today and in the future to meet the increasing demand for electrical generation

• The supply of Natural Gas is rapidly growing with the proven technologies currently in place

• Technologies exist that can increase the use of Natural Gas as a cleaner burning transportation fuel

• Domestic Natural Gas used for transportation could displace a significant amount of the crude oil the U.S. currently imports

• In order to develop and produce our abundant Natural Gas reserves, regulatory policy must encourage the drilling for more Natural Gas
References

2) Energy Information Administration (EIA) Annual Energy Outlook 2009
3) Potential Gas Committee (PGC): June 2009
5) Sierra Club: Testimony before the House Committee on Appropriations (April 3, 2009)
6) EIA “Annual Energy Review 2007”
7) The Contributions of the Natural Gas Industry to the U.S. Nation and State Economies (Sep 2009)
12) EIA: “Electricity Market Module” (Mar 2009)
14) Clean Energy: “Natural Gas for Transportation: The Secret is Out” (April 2009)
15) Natural Gas Vehicles for America: “Natural Gas Vehicles 2009 Year in Review”
16) Center for Energy Policy and the Environment: “Kill Oil with Natural Gas and Electricity” (Report No. 4 Sept 2009)