# CIBO Annual Meeting
# Fort Lauderdale, Florida
# October 13, 2011


**David M. Sweet**
**Executive Director**
**World Alliance for Decentralized Energy**
**President, Natural Gas Roundtable**


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# WADE Mission

- WADE Research activities
  - Reports, market surveys and studies
  - WADE Economic Model
- WADE Advocacy activities
  - Policy advise for governments
  - Participation in legislative and regulatory proceedings
  - Cooperation with International Organisations, Institutions and NGOs
- WADE Promotion activities
  - WADE Conferences and events
  - WADE Newsletters

# What is Decentralized Energy (DE)?

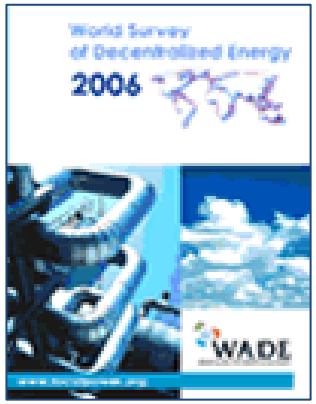
Electricity production *at the point of use*, irrespective of size, fuel or technology – on-grid or off-grid:

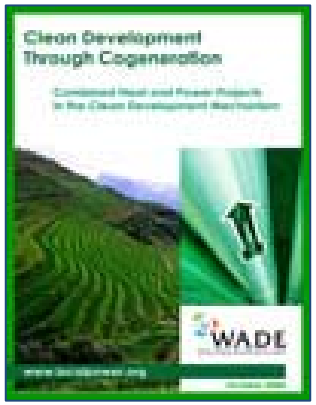
- High efficiency cogeneration (CHP)
- On-site renewable energy
- Industrial energy recycling and On-site power

- Otherwise known as:
  - CCHP (Combined Cooling Heat and Power), Distributed Generation, Captive Power, Embedded Generation, Microgeneration, CHP, Trigeneration, Recycling Energy, etc.

# The Move to Decentralized Technology

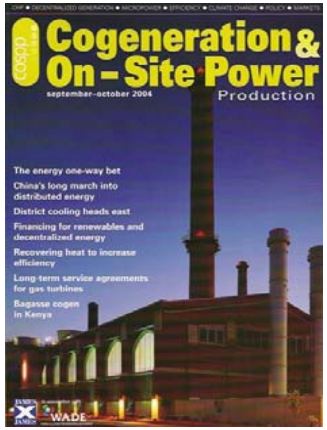
# WADE Communications



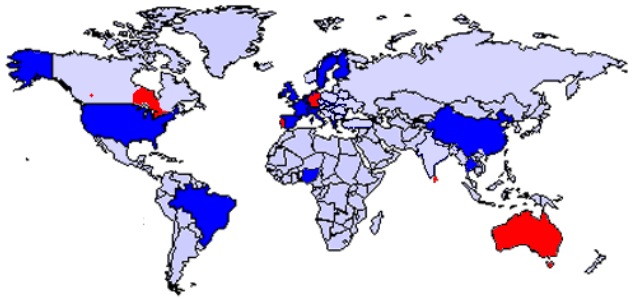






# Applications of the WADE Economic

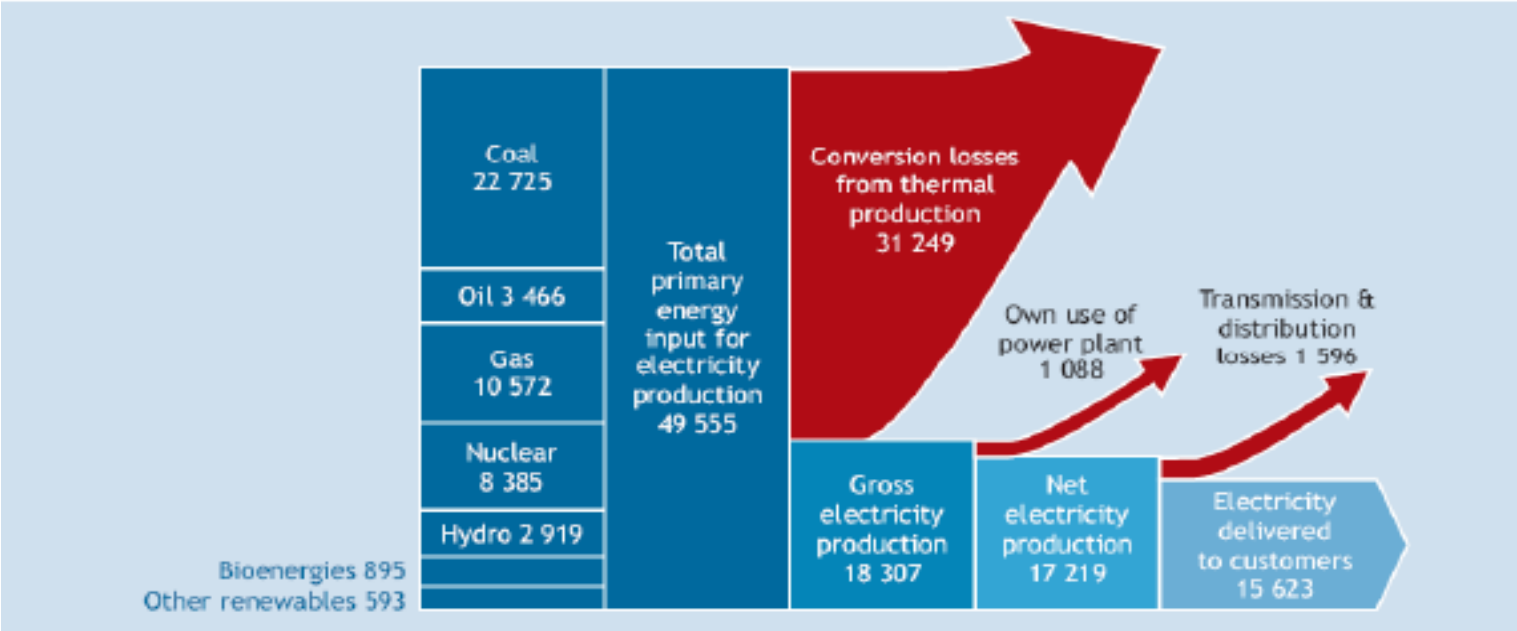
**WADE would like to see model work replicated, at a municipal level, in the world's major cities.**



- **Australia -** Commonwealth Scientific and Industrial Research Organization
- **Canada** - Federal Government of Canada (Natural Resources Canada)
- **China** - UK Government (Foreign Office), for China
- **EU** - European Commission – DG-FER programme
- **Ireland** - Government of Ireland (Sustainable Energy Ireland)
- **Sri Lanka -** European Commission
- **Germany -** IZES for the Ministry of Environment
- **UK -** Greenpeace UK
- **UK –** Department of Trade and Industry
- **USA -** Primary Energy Inc.
- **City of Calgary-** Federal Government of Canada
- **Province of Ontario-** Federal Government of Canada
- **Scotland-** Greenpeace Scotland
- **Iran –** Greenpeace International
- **G8+5** – IEA
- **Turkey** - REC

# Wasted energy is a huge opportunity

## Energy Flows in the Global Electricity System




**2/3 of the fuel we use to produce power is wasted**

**CHP can more than double this efficiency**

IEA/OECD, 2008

# Why is DE better?

Benefits of DE compared to centralised generation

- DE is more efficient
- DE is cheaper
- DE is cleaner
- DE is more reliable
- DE is more secure
- DE provides access to electricity in remote areas
- DE can be sited quicker and with less opposition

# Doomsday Scenario

"The world will soon start to run out of conventionally produced oil. If we manage somehow to overcome that shock by shifting the burden to coal and natural gas, the two other primary fossil fuels, life may go on more or less as it has been – until we start to run out of all fossil fuels by the end of this century… Even if human life does go on, civilization as we know it will not survive, unless we can find a way to live without fossil fuels."

Out of Gas, by David Goodstein

# A Contrarian Voice

- **“The raw fuels are not running out. The faster we extract and burn them, the faster we find still more.”**
- **“The cost of energy as we use it has less and less to do with the cost of fuel.”**
- “The more efficient our technology, the more energy we consume.”
- “The competitive advantage in manufacturing is now swinging decisively back toward the United States.”

# A Contrarian Viewpoint

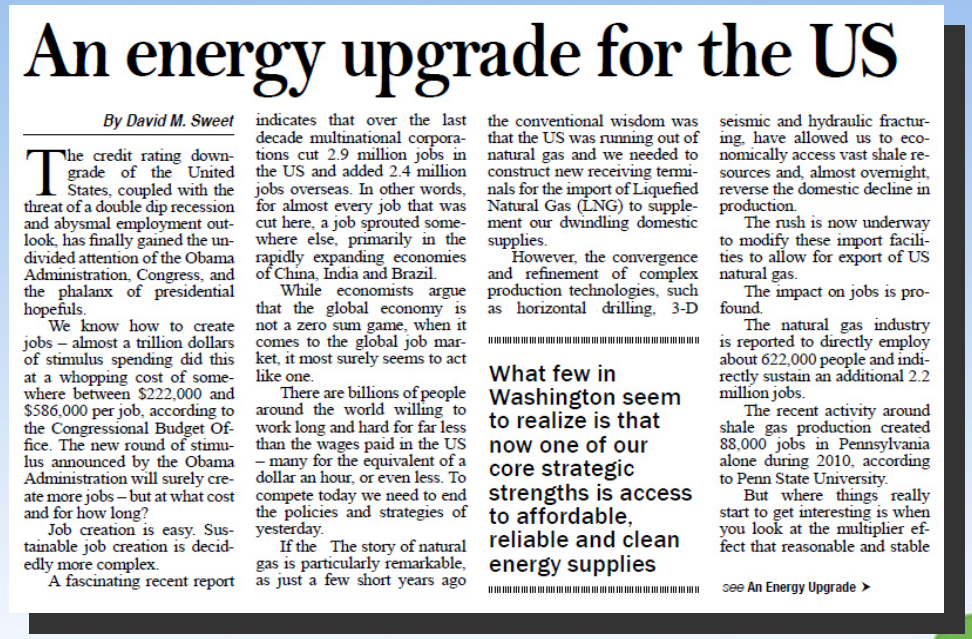
- **"The raw fuels are not running out.** The faster we extract and burn them, the faster we find still more."
- **"The cost of energy as we use it has less and less to do with the cost of fuel."**
- "The more efficient our technology, the more energy we consume."

The Bottomless Well, by Peter Huber and Mark Mills

# An Energy Upgrade for the US

**By: David M. Sweet**

**Sep 28, 2011, The Washington Times**



## An energy upgrade for the US

*By David M. Sweet*

The credit rating downgrade of the United States, coupled with the threat of a double dip recession and abysmal employment outlook, has finally gained the undivided attention of the Obama Administration, Congress, and the phalanx of presidential hopefuls.

We know how to create jobs – almost a trillion dollars of stimulus spending did this at a whopping cost of somewhere between $222,000 and $586,000 per job, according to the Congressional Budget Office. The new round of stimulus announced by the Obama Administration will surely create more jobs – but at what cost and for how long?

Job creation is easy. Sustainable job creation is decidedly more complex.

A fascinating recent report indicates that over the last decade multinational corporations cut 2.9 million jobs in the US and added 2.4 million jobs overseas. In other words, for almost every job that was cut here, a job sprouted somewhere else, primarily in the rapidly expanding economies of China, India and Brazil.

While economists argue that the global economy is not a zero sum game, when it comes to the global job market, it most surely seems to act like one.

There are billions of people around the world willing to work long and hard for far less than the wages paid in the US – many for the equivalent of a dollar an hour, or even less. To compete today we need to end the policies and strategies of yesterday.

If the The story of natural gas is particularly remarkable, as just a few short years ago the conventional wisdom was that the US was running out of natural gas and we needed to construct new receiving terminals for the import of Liquefied Natural Gas (LNG) to supplement our dwindling domestic supplies.

However, the convergence and refinement of complex production technologies, such as horizontal drilling, 3-D seismic and hydraulic fracturing, have allowed us to economically access vast shale resources and, almost overnight, reverse the domestic decline in production.

**What few in Washington seem to realize is that now one of our core strategic strengths is access to affordable, reliable and clean energy supplies**

The rush is now underway to modify these import facilities to allow for export of US natural gas.

The impact on jobs is profound.

The natural gas industry is reported to directly employ about 622,000 people and indirectly sustain an additional 2.2 million jobs.

The recent activity around shale gas production created 88,000 jobs in Pennsylvania alone during 2010, according to Penn State University.

But where things really start to get interesting is when you look at the multiplier effect that reasonable and stable

see An Energy Upgrade ➤

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# Why Natural Gas? Why Now?

- **Why Natural Gas? Proven contributor to economy, environment and energy security**
  - Jobs and economic growth
    - Creates nearly 3 million jobs – direct and indirect – resulting in $180 billion in labor income between 2005 - 2010
    - Contributes to economy – over $3.5 billion per year average in government revenues between 2005 and 2010
    - Contributes to global competitiveness
  - Environmental benefits
    - Low emissions
    - Small land footprint
    - Sustainable
    - Essential to complement renewable energy sources
  - Domestic energy security
    - More than a 100-year supply and growing
- **Why Now? Abundant, secure and domestic**
  - Huge untapped shale gas resource newly unleashed by innovation and technology

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# 2001 to 2011 - A Decade Makes a Difference

| Then | Now |
| --- | --- |
| ➢ 60-year supply and falling | ➢ 100+ years supply and growing |
| ➢ Shale known but uneconomic to develop | ➢ Flourishing production, vast shale resources now accessible |
| ➢ Underground gas storage primarily traditional reservoir, operationally not very flexible | ➢ Storage boom with more flexible salt-cavern facilities and additional market area storage |
| ➢ Pipeline capacity growing incrementally | ➢ 16,000+ miles of interstate pipeline added since 2000 |
| ➢ Rising prices with several spikes | ➢ Plentiful supplies moderate prices and provide supply diversity |

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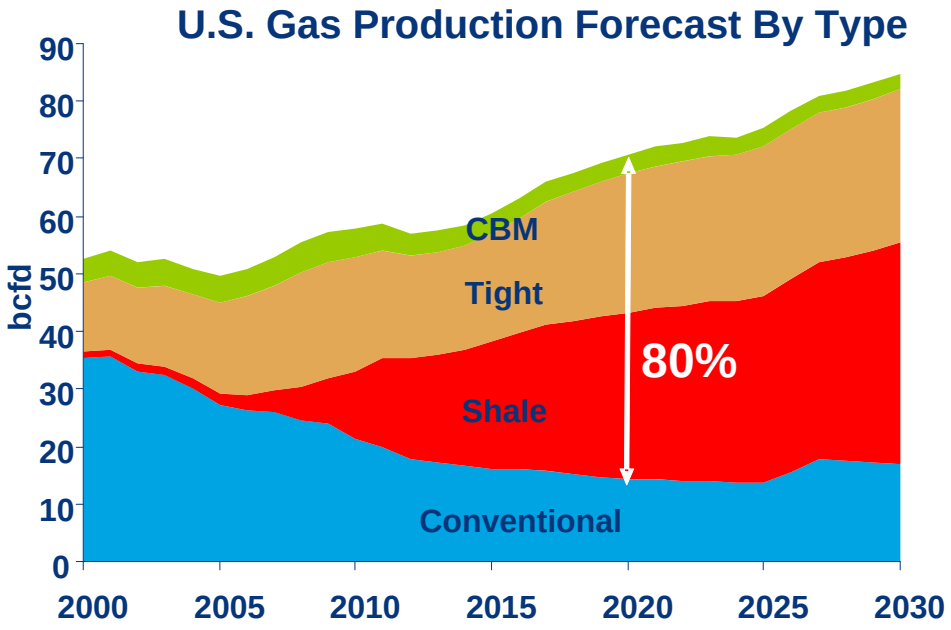
# How The Game Has Changed

- Improvements in technology brought down costs and greatly increased the scope of resource development
- Shale gas production quadrupled between 2006 – 2010 and is poised to comprise more than 40% of U.S. gas production in 2020
- Shale and other “unconventional’ gases could account for over 80% of U.S. gas production by 2020, compared to 66% today
- Diversity of supply complements strong and growing pipeline system, reduces vulnerability to hurricanes, brings natural gas closer to consumers



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# Typical Shale Well: Horizontal Drilling and Hydraulic Fracturing Provide Long, Stable Production Life

**Initial Production from Typical Shale Well**
**2 to 15 million cubic feet per day***




* Based on one company's experience of typical production from the Haynesville shale wells

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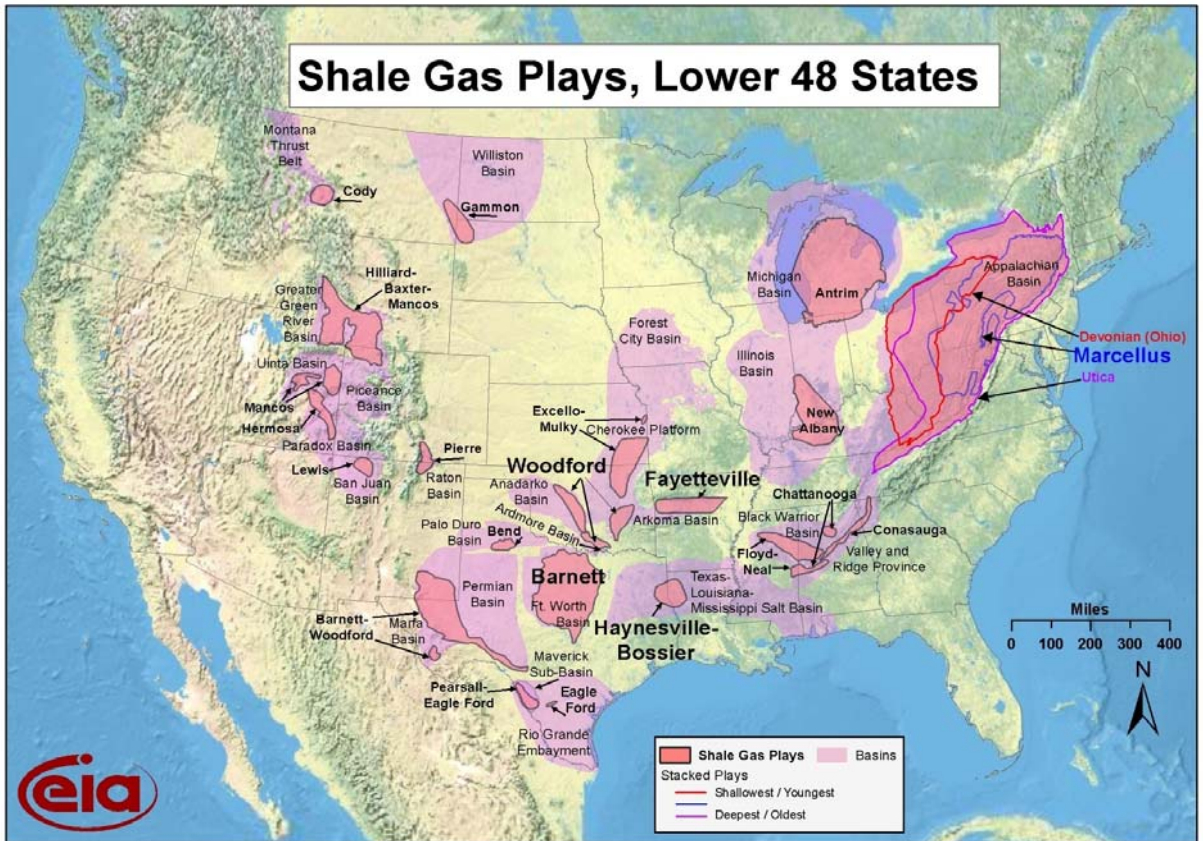
# Abundant Unconventional Gas Widespread Across U.S.

**U.S. Gas Reserves Increased 22% between 2006 – 2009 Primarily Due to Shale Development**




**Updated: June 6, 2010**

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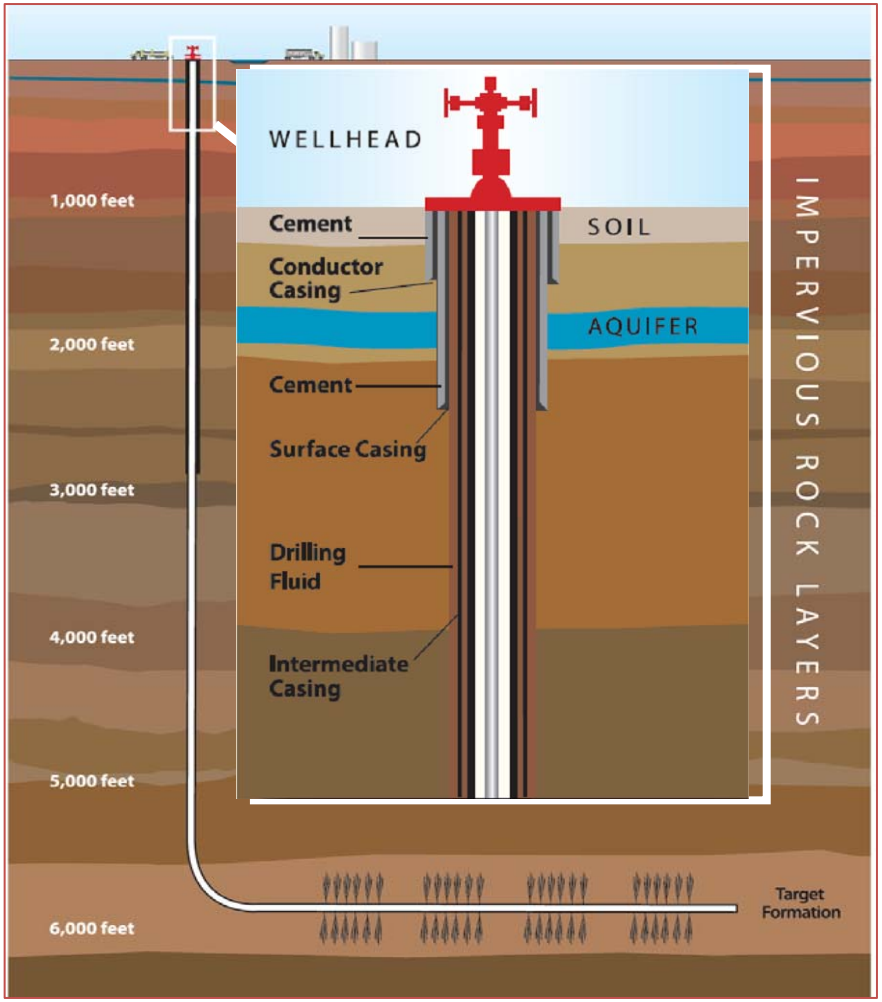
# Technology Makes It All Work

- Drilling technology improvements and efficiencies in shale have emerged
  - Longer horizontal laterals
  - Multiple-stage hydraulic fractures per lateral
- Small surface footprint for multiple, extended wells
- Horizontal drilling and hydraulic fracturing result in gas wells with long stable production lives
- Ground water is separated by thousands of feet and tons of impermeable rock and protected by state and federal regulation
- Significant amount of water is recycled
- "Micro-seismic" technology evolving and enabling even greater precision in fracturing wells



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# Government Oversight of Natural Gas Production

## Regulated by states and under the following federal laws:

- Clean Water Act – surface water discharge, storm water runoff
- Clean Air Act – air emissions associated with processing equipment and engines
- Safe Drinking Water Act – underground injection disposal/reuse of produced water and flowback fluids
- Federal Land Policy and Management Act – permitting for federal onshore resources
- Outer Continental Shelf Lands Act – permitting for federal offshore resources
- National Environmental Policy Act – permits and environmental impact statements
- Occupational Safety and Health Act – requires information about chemicals used at every site
- Emergency Planning and Community Right-to-Know Act – annual reporting to emergency responders of chemicals stored and used above certain quantities
- Extensive State Oversight – implement federal laws and regulate drilling fluids and produced water management
    - Detailed state regulatory information available at www.STRONGERInc.org

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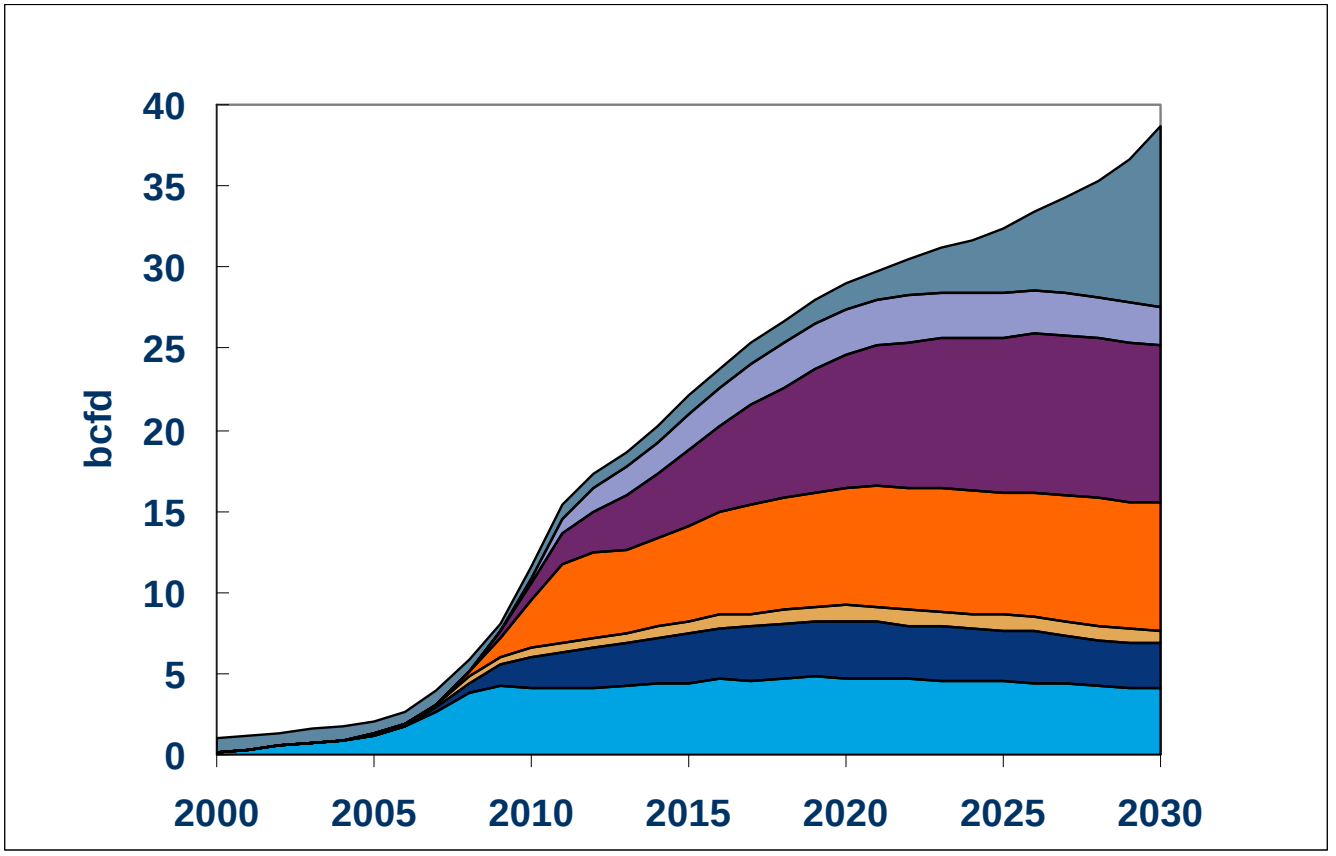
# Shale Production Grows to Over 30 bcfd by 2025

**By 2020, shale gas to comprise more than 40% of production, compared to 20% today**




Source: Wood Mackenzie 2010

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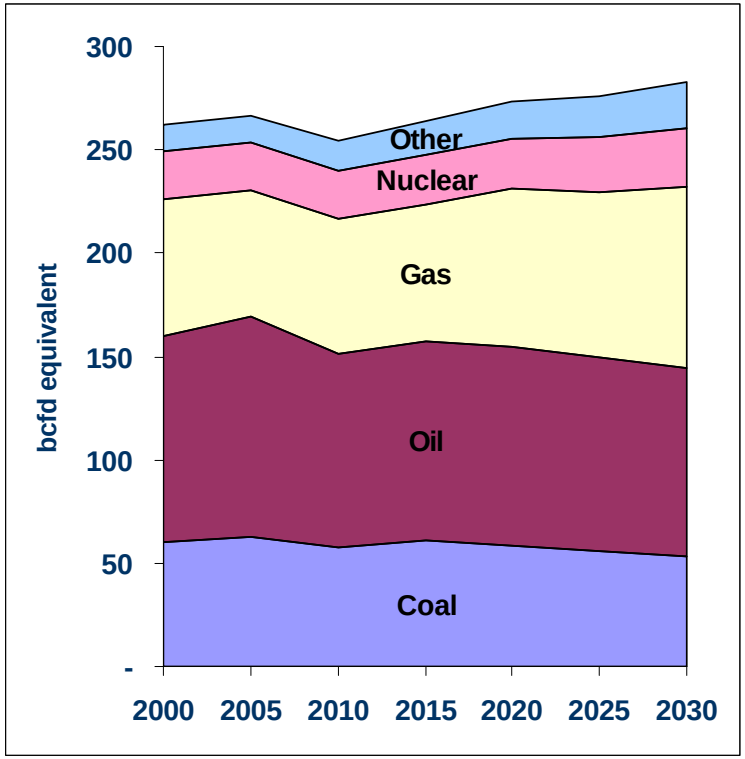
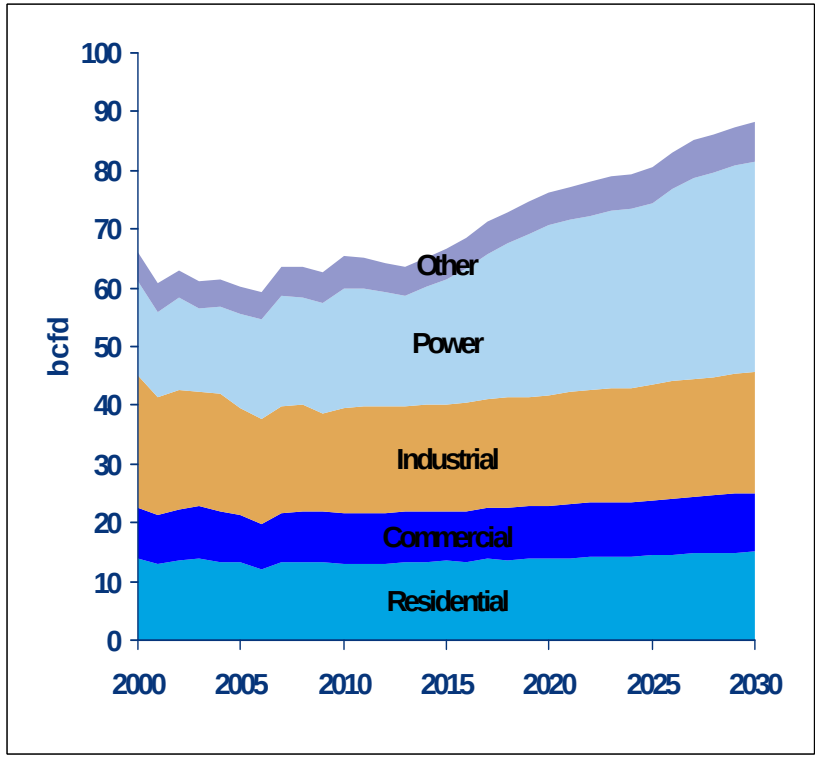
# United States Total Energy and Natural Gas Demand

## Total U.S. Primary Energy By Type




## U.S. Natural Gas Demand By Sector




Source: Wood Mackenzie

# Consumer Savings – Navigant Consulting

**September 2011**

- Consumers in 2010 paid $44 billion less for natural gas (annual basis) than they would have without the emergence of domestic natural gas abundance (compared to 2007-2009 gas costs).

- In essence, the recent growth in gas supply has injected $44 billion in energy cost savings into a struggling U.S. economy.

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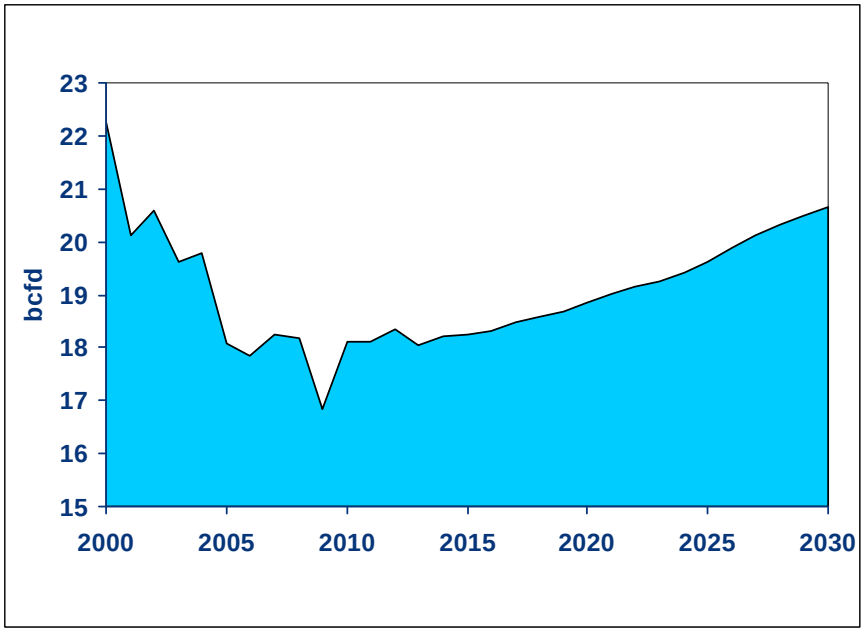
# Adequate Natural Gas Supply at Competitive Prices Helps Grow the U.S. Economy

- Lower gas prices have helped U.S. industry
- Chemical and fertilizer facilities are seeing increased utilization with lower gas prices
- Energy-intensive industry can be more competitive in the global market
- Additional potential demand from natural gas vehicles

## U.S. Industrial Demand for Natural Gas




Source: Wood Mackenzie

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# Natural Gas' Impact on the U.S. Economy and Employment

- Natural gas companies contributed over $4.4 billion per year on average in gas royalty payments alone to the federal government between 2005 and 2010
- Overall contribution to the economy even greater:
  - $385 billion to the domestic economy in 2008
  - $180 billion in labor income alone
- **Nearly 3 million American jobs**
- **Over 600,000 Americans are directly employed by natural gas development**

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# As Supply Increases, Price Forecasts Have Dropped, With Henry Hub Now Forecast Under $6.00 to Mid - 2020s

## *Annual Energy Outlook 2011*
## Reference Case

The Paul H. Nitze School of Advanced International Studies
December 16, 2010
Washington, DC

Richard Newell, Administrator

U.S. Energy Information Administration

Source: EIA, Annual Energy Outlook 2011

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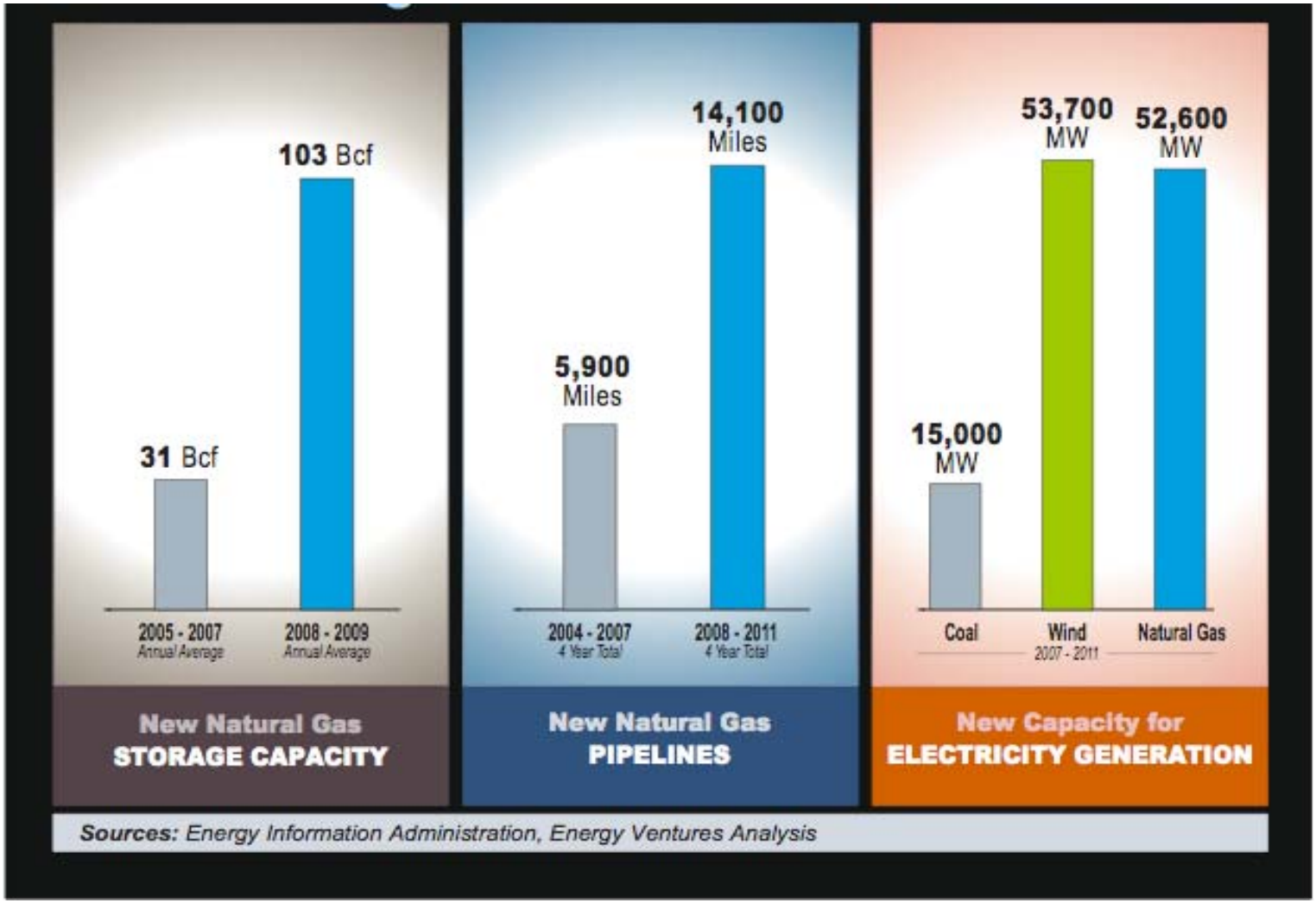
# Industry Already Recognizing Importance of Natural Gas by Investing in Storage, Pipelines, and Gas Generation



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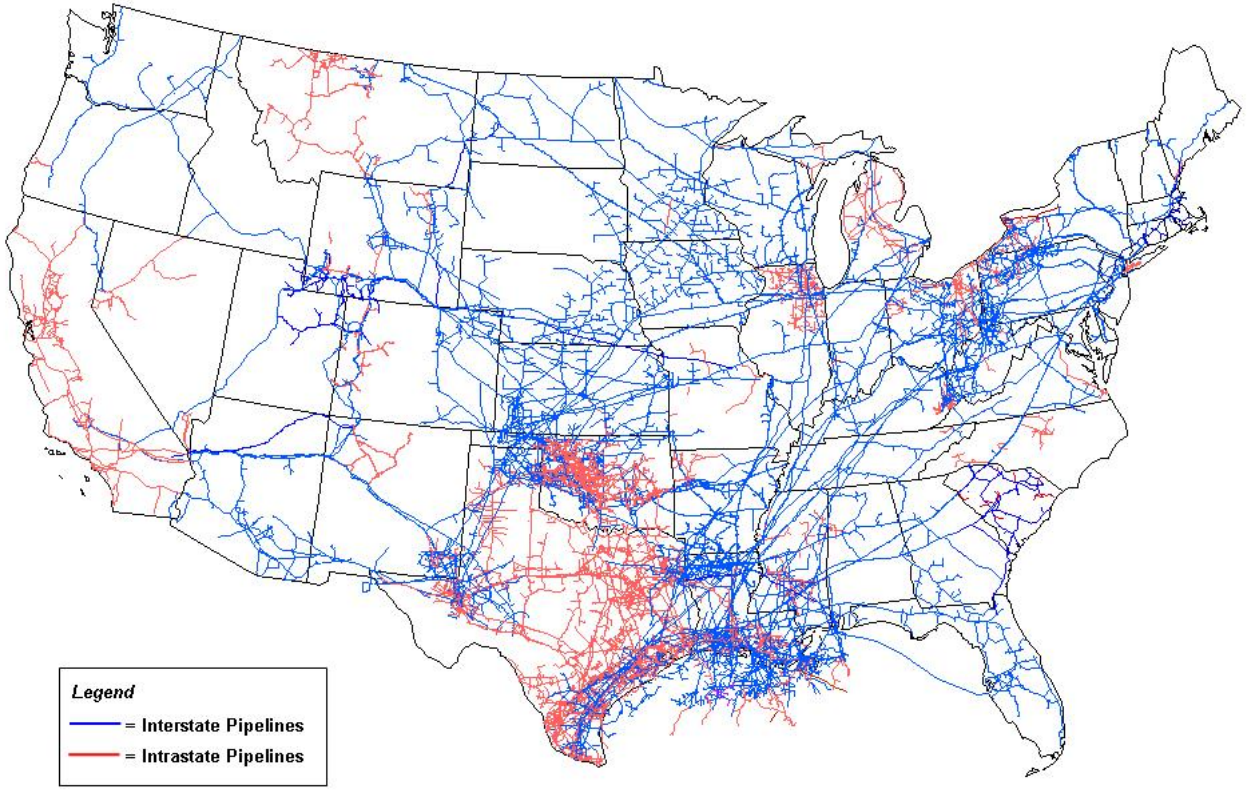
# Pipeline System Extensive and Expanding at Record Pace

- **Between 2000 and 2010, FERC approved more than 16,000 miles of new interstate pipeline, with capacity to move an additional 113 bcf per day**
- **Pipeline system connects U.S. with Canada and Mexico**
- **Storage capacity grew 22% from 2006 - 2010**
- **Half of new storage is flexible high-turnover salt dome and is closer to customers**




Source: Energy Information Administration, Office of Oil & Gas, Natural Gas Division, Gas Transportation Information System

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# Natural Gas and Power Generation

- Low capital and operating costs relative to other technologies
- Clean burning – low carbon, GHGs, mercury, particulates, SOx, NOx
- Low water use compared to other technology
- Small land footprint
- Easier to permit, finance and build
- Natural gas key to making intermittent resources viable

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# Order No 1000

- Planning Requirements
- Cost Allocation Requirements
- Nonincumbent Developer Requirements
- Compliance

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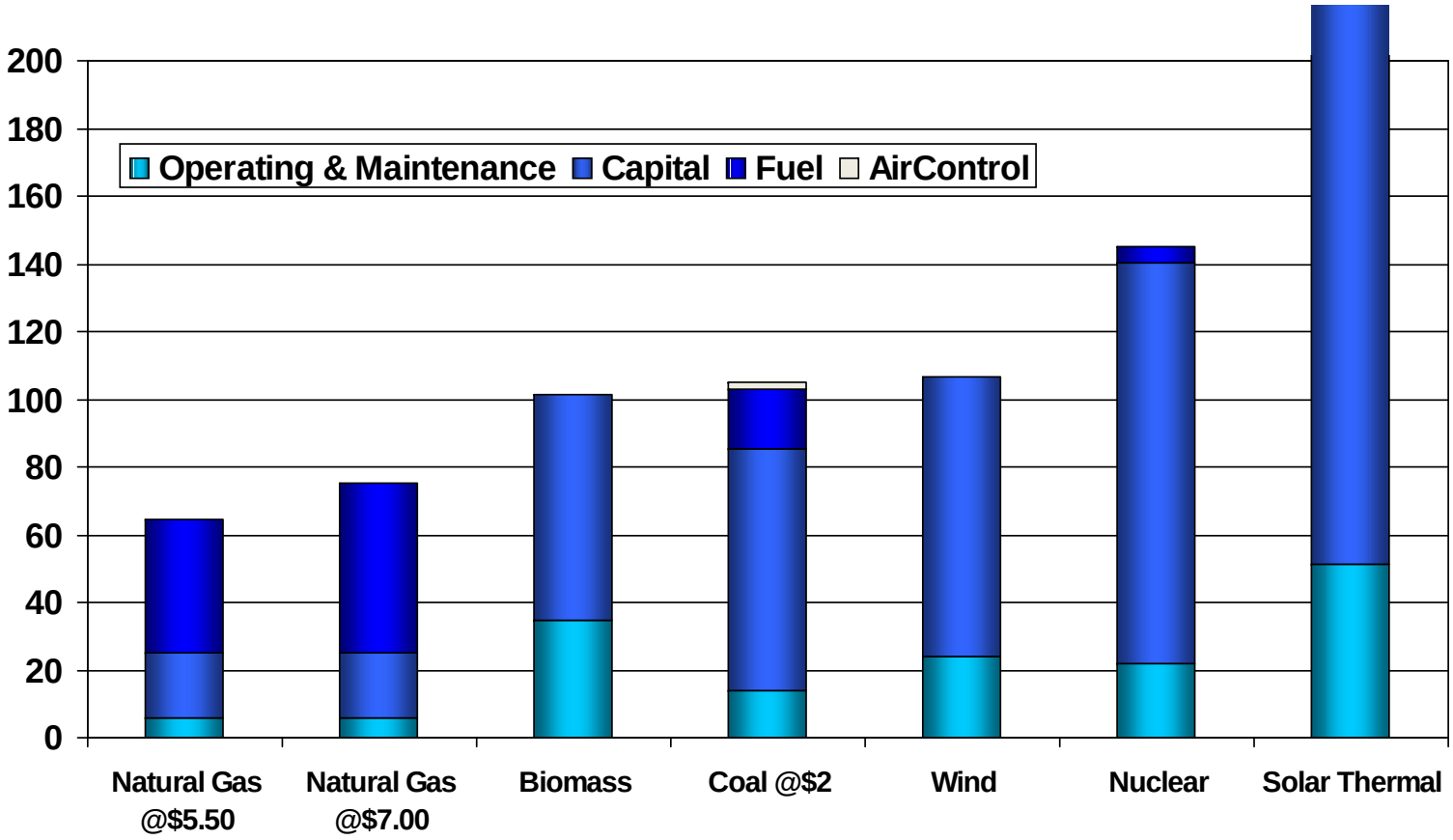
# Capital and Operating Costs Make Gas a Preferred Choice for Power Generation




**A combined-cycle gas turbine (CCGT) natural gas facility is the least expensive, full-cycle generation alternative.**

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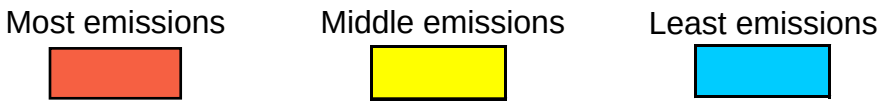
# Natural Gas Is Among the Cleanest Electric Generation Alternatives

| Tons per year per thousand households | Biomass (Wood) | Coal | Natural Gas | Nuclear & Renewables |
|---|---|---|---|---|
| **Carbon Monoxide (CO)** | **51** | **5.8** | **1.5** | **0.0** |
| **Carbon Dioxide (CO2)** | **Low** | **9,362** | **3,558** | **0.0** |
| **Nitrogen Oxides (NOx)** | **28** | **3.4** | **0.3** | **0.0** |
| **Particulate Matter** | **2.7** | **0.9** | **0.0** | **0.0** |
| **Volatile Organic Compounds (VOC)** | **5.6** | **0.2** | **0.0** | **0.0** |
| **Sulfur Dioxide (SO2)** | **2.8** | **5.0** | **0.2** | **0.0** |
| **Mercury** | **0.0** | **0.0001** | **0.0** | **0.0** |

**Natural gas is clean burning**




Sources: R.W. Beck data and, EPA *"Mercury in Petroleum and Natural Gas Report"*

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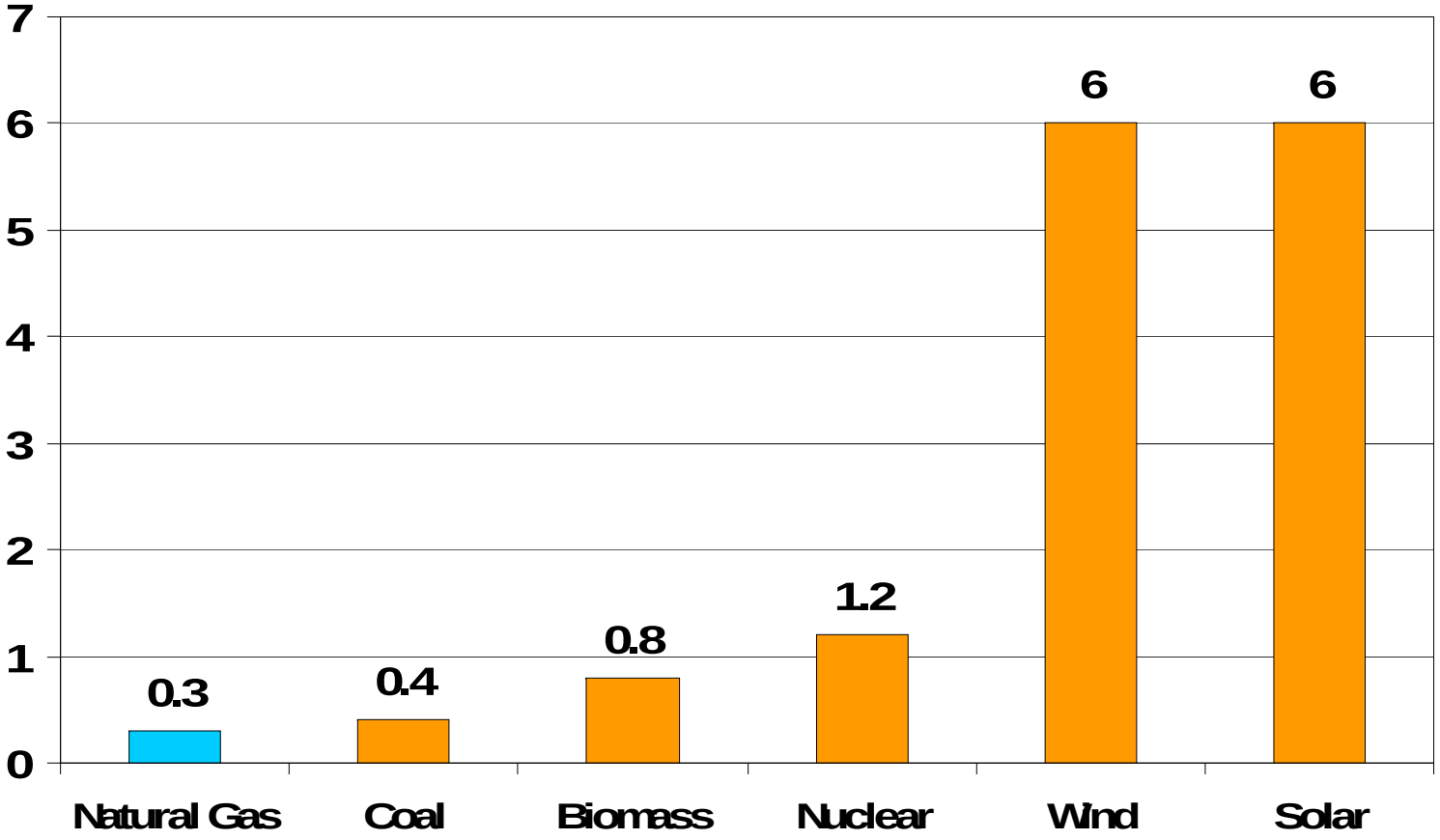
# Land Usage Also Makes Gas a Preferred Choice for Power Generation

**Acres of land needed to produce the fuel and generate enough electricity to serve 1,000 households for one year**




Source: R.W. Beck and Black and Veatch for NGSA

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# To Make It All Happen, Industry Is Committed to Good Stewardship

- Listening to and addressing community concerns
- Use of stringent industry and government standards on land reclamation, well construction, water management and pipeline safety
- Responsible hydraulic fracturing practices
- Minimizing surface effects on land and infrastructure
- Offshore safety and spill containment

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# … And Government Must Do Its Part As Well

- Fair access to onshore and offshore resources
- Continued strong and effective state regulation of hydraulic fracturing
- Level playing field: avoid picking winners and losers through mandates
- Tax policy must be fair, not burdensome, and compatible with resource development and job creation
- Financial regulations must not create “economic drain” on investment
- Current regulatory model for pipelines ensures safe, reliable operations and infrastructure investment

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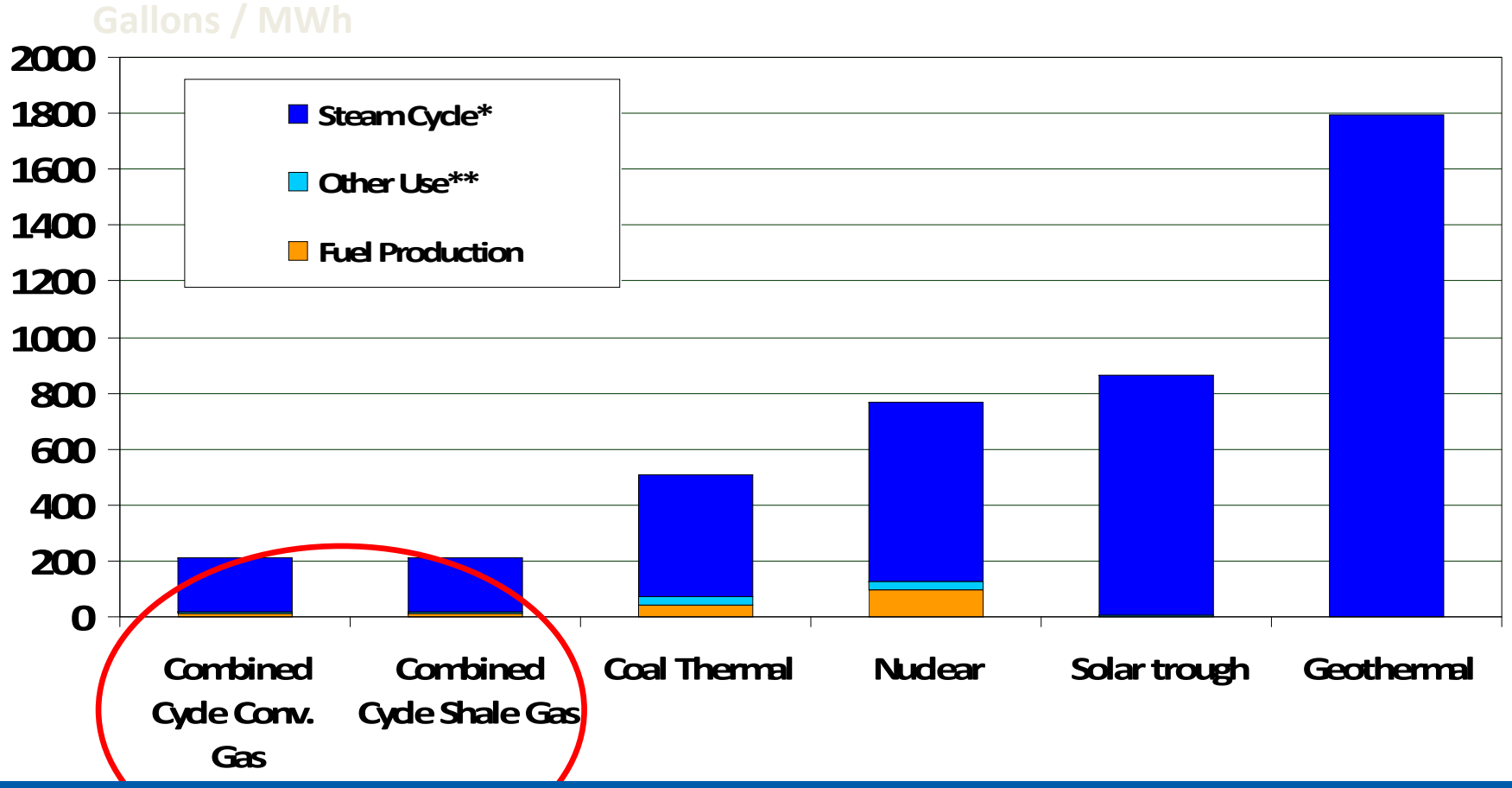
# Water Intensity for Various Power Generation Technologies




**Gas-fired combined cycle power plants use much less water than thermal power plants with only a small contribution from gas production**

Sources: U.S. Department of Energy, "Energy Demands on Water Resources", December 2006; NREL, "A Review of Operational Water Consumption and Withdrawal Factors for Electricity Generating Technologies," March 2011; Chesapeake for shale gas water use
* Assumes closed loop cooling tower
**Other use includes water for other process uses such as emissions treatment, facilities

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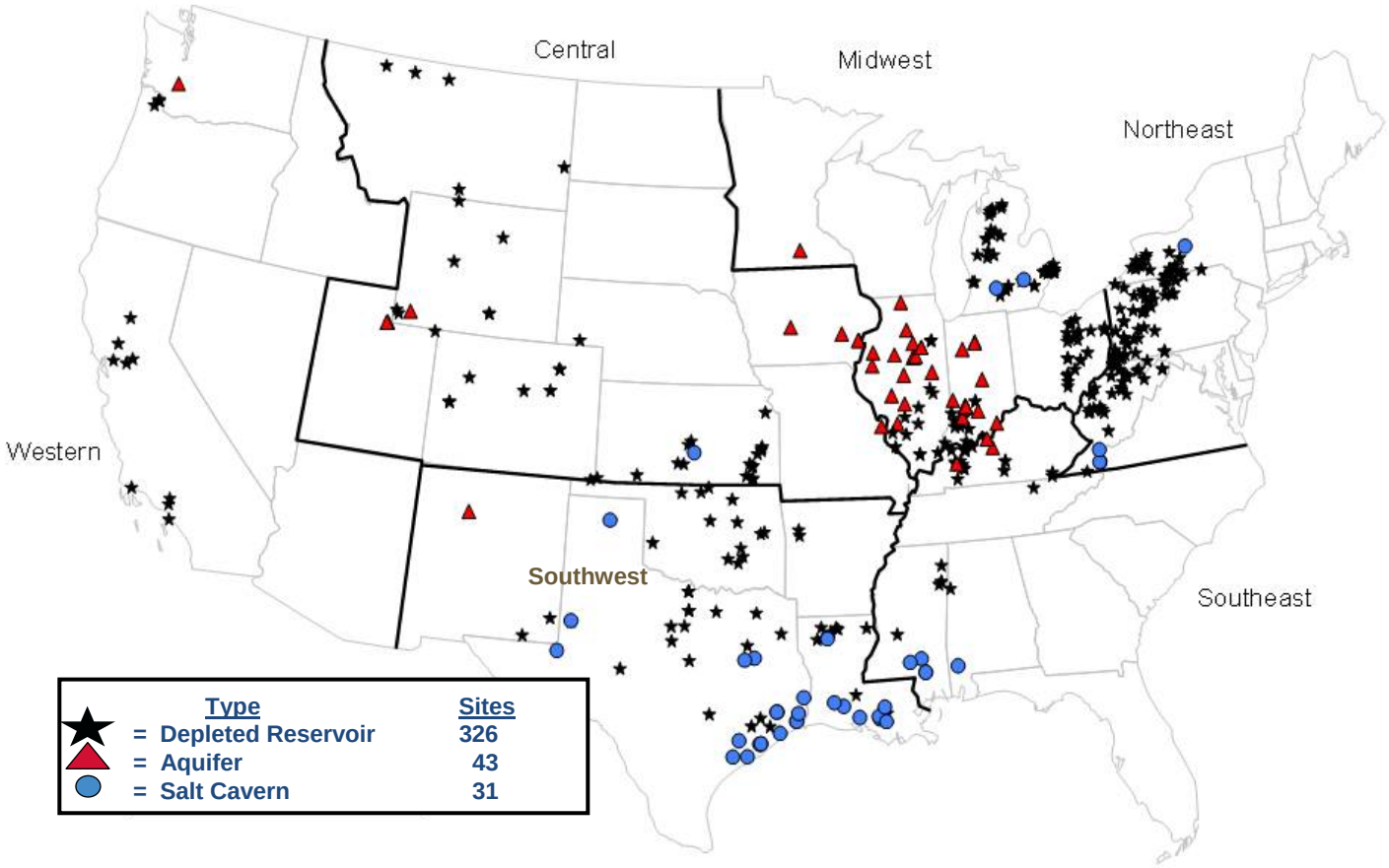
# Storage Allows Flexibility and Reliability in Delivery

- Natural gas storage capacity grew 22% between 2006 and 2010 to over 4.3 Tcf working capacity
- Much of the new storage capacity has been high delivery, flexible salt storage
- The new storage provides additional reliability to the pipeline system, as well as allowing quick response to peaking electric generation requirements




Source: Energy Information Administration, Office of Oil & Gas, Natural Gas Division Gas, Gas Transportation Information System, December 2008.

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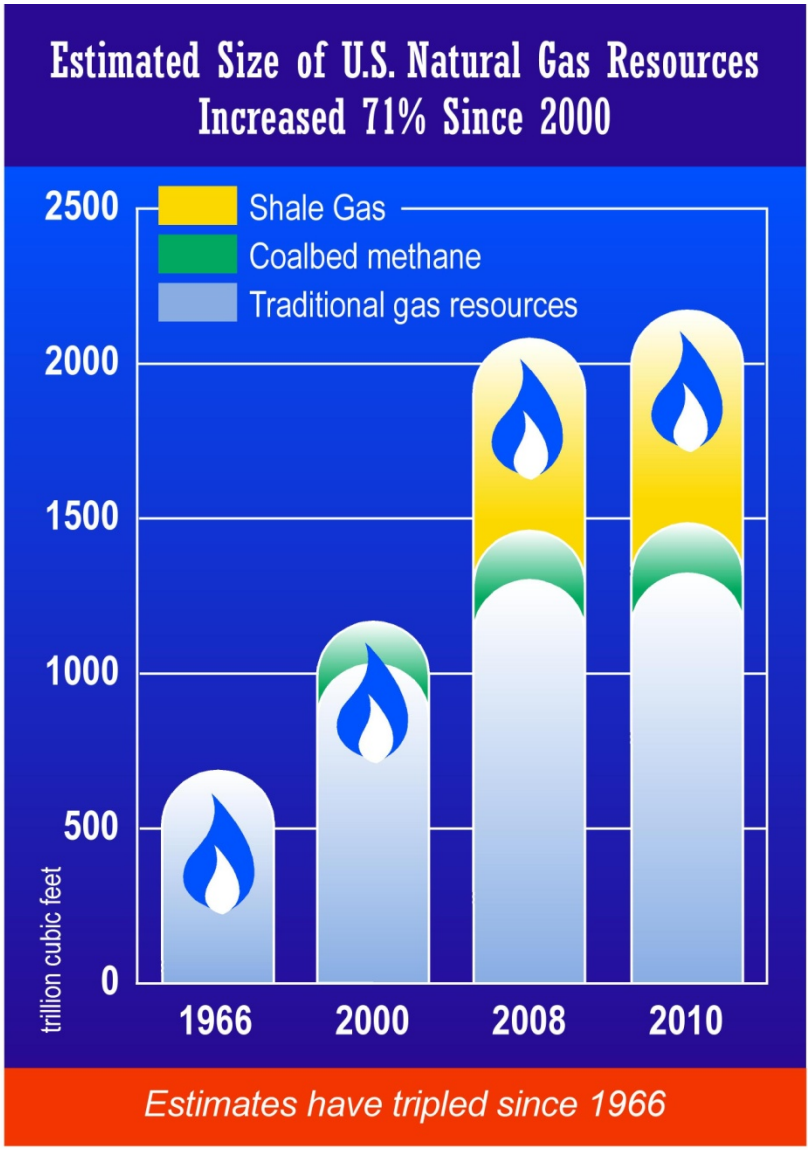
# Revitalized Supply Picture

- Shale gas increased the size of the natural gas resource base by 71% from 2000 to 2010
- Improvements in technology brought down costs to develop
- Diversity of supply complements strong and growing pipeline system, reduces vulnerability to hurricanes, brings natural gas closer to consumers
- Resource size has increased with each successive PGC report -- even though more than 200 trillion cubic feet drawn down in last decade alone

Source: U.S. Potential Gas Committee Biennial Report, 2009




Source: Potential Gas Committee, 2011.

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# What's in Hydraulic Fracturing Fluid

**Public State-based Registry of Hydraulic Fracturing Fluids**
**Launches April 11, 2011**

- Fluid is 99% water and sand, less than 1% chemical additives
- Registry created and managed by state regulators – the Ground Water Protection Council and the Interstate Oil & Gas Compact Commission
- Endorsed by America's Natural Gas Alliance, American Exploration & Production Council, American Gas Association, American Petroleum Institute, Independent Petroleum Association of America, Interstate Natural Gas Association of America, Natural Gas Supply Association
- Searchable public database with well-by-well information and glossary of chemicals

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# Water Management

Recycling wastewater reduces environmental footprint, transportation costs and reliance on groundwater or municipal sources of water

- •Drilling companies in the Marcellus recycled more than 66 % of water June 2008-May 2010
- •Re-used 44 million gallons of water & disposed of 21 million gallons (*Source: Penn State University Hydrologist David Yoxtheimer*)

Producer goal: Recycle 100% of produced water in Pennsylvania

State wide test results show recycled water meets all federal radium standards

- •Quote: *"…all samples tested … showed levels at or below the normal naturally occurring background levels of radioactivity." (Pennsylvania Department of Environmental Protection, March 7, 2011)*

State and local testing of water to continue on regular basis, with strong support from natural gas companies

**How Much Is 5 Million Gallons?**

*The 5 million gallons of water needed to drill and fracture a typical deep shale gas well is equivalent to the amount of water consumed by:*

- **New York City** in approximately **seven minutes**
- A 1,000 megawatt coal-fired **power plant** in **12 hours**
- A **golf course** in **25 days**
- **10 acres of cotton** in a season

While these represent continuing consumption, the water used for a gas well is a one-time use.

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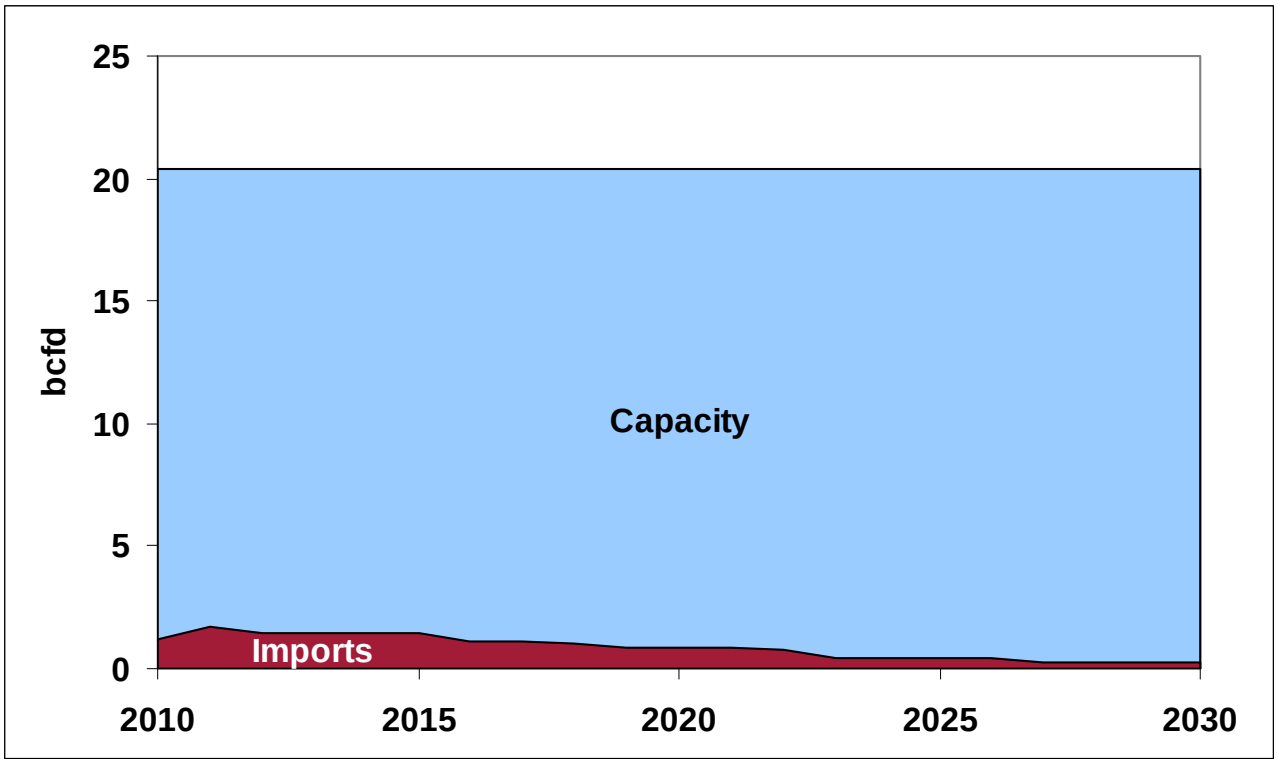
# U.S. Import and Receiving Terminal Capacity Provides Significant Opportunity for Supply Flexibility




- LNG import facilities have over 20 bcfd delivery capability into U.S.*
- Shale gas has minimized the current need for much of the capacity
- Excess capacity can be used to supplement U.S. production if ever needed

* Includes Canaport, Costa Azul, and 3 floating buoy systems

Source: Wood Mackenzie 2010

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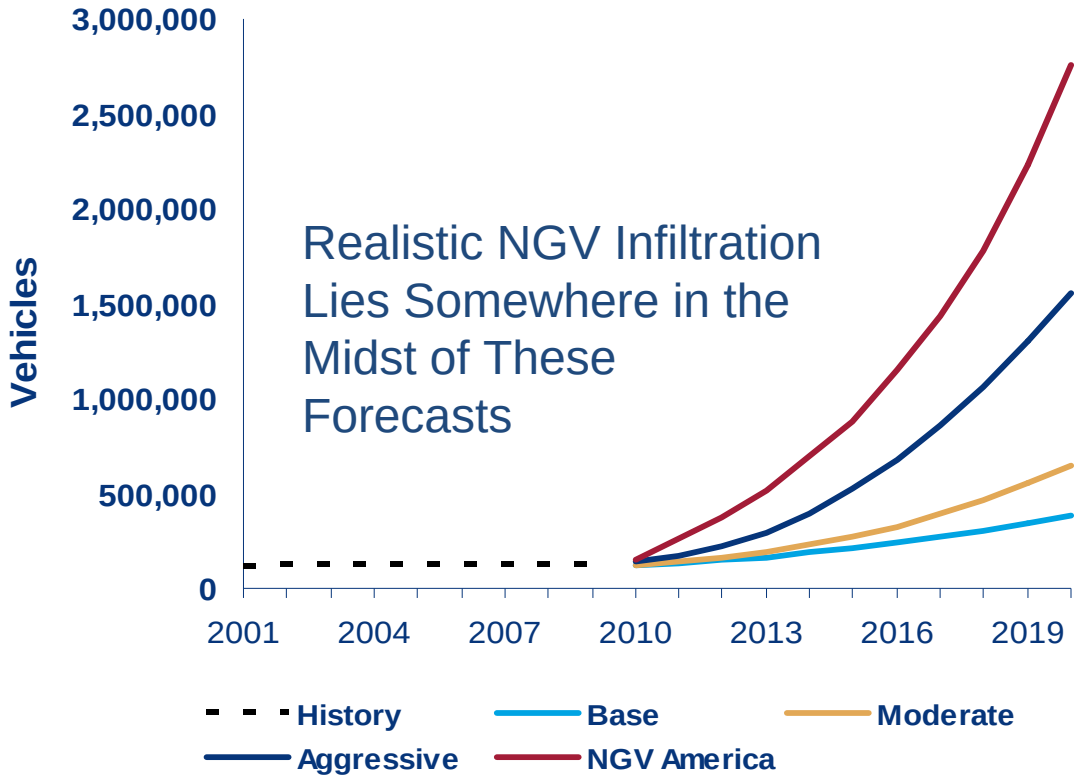
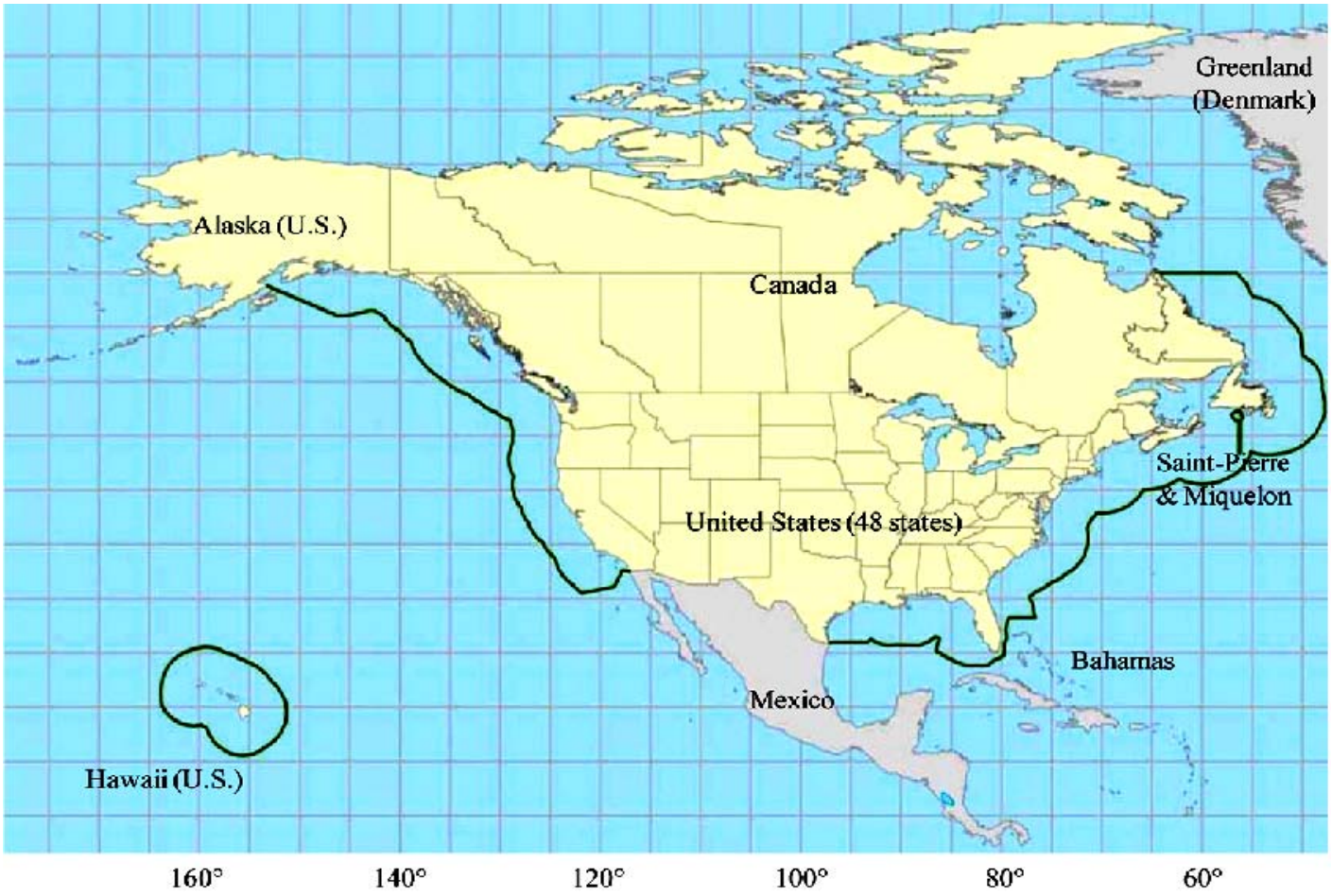
# Natural Gas for Transportation Can Make Sense in Heavy-Duty Fleet Vehicles

- Long term success of passenger NGVs linked to consumer confidence, not government subsidies
- Heavy-duty truck conversions to natural gas can provide very healthy returns, but will be most successful in fleets
- Reduces oil imports and improves energy security




Sources: Wood Mackenzie/NGV America

# US / Canada Emission Control Area “ ECA ”




Source:http://www.google.com/imgres?imgurl=http://www.canadiansailings.ca/canadiansailings/portals/0/April_13/emissions_area_map.jpg&imgrefurl=http://

**EPA tightens emissions requirements within Exclusive Economic Zone “EEZ” 200 miles off coasts effective August 2012**

# Macro Perspective

**“The world's 90,000 vessels burn approximately 370 million tons of fuel per year”**

Source: http://www.gizmag.com/shipping-pollution/11526/

**Significant global commercial marine annual energy demand…**
**370 million tons heavy fuel or 14.9 Tcf equivalent gas.**

# US Marine Segments

| | | Work rate | engine consumption | gas heat rate | Billion Cubic Feet / yr |
|---|---|---|---|---|---|
| | Number US / yr | million kw hr / yr | kj / kw hr | kj / ft.3 | Bcf/ yr |
| Inland Vessels | 5300 | 27583 | 8370 | 1084.5 | 212.9 |
| Cruise Ship Dockside | 4300 | 515.81424 | 8370 | 1084.5 | 4.0 |
| Ocean Vessels Dockside Power | 60578 | 3796.05979 | 8370 | 1084.5 | 29.3 |
| Ocean Vessels Transit ECA Coast | 60578 | 3873.5304 | 8370 | 1084.5 | 29.9 |
| | | | | Total | 246.2 |

**Realistic target 246 Bcf gas ( Ultimate Pool 580 Bcf) …**

**= 64 Electric Power Plants of 200 Megawatts … 100K Trucks**

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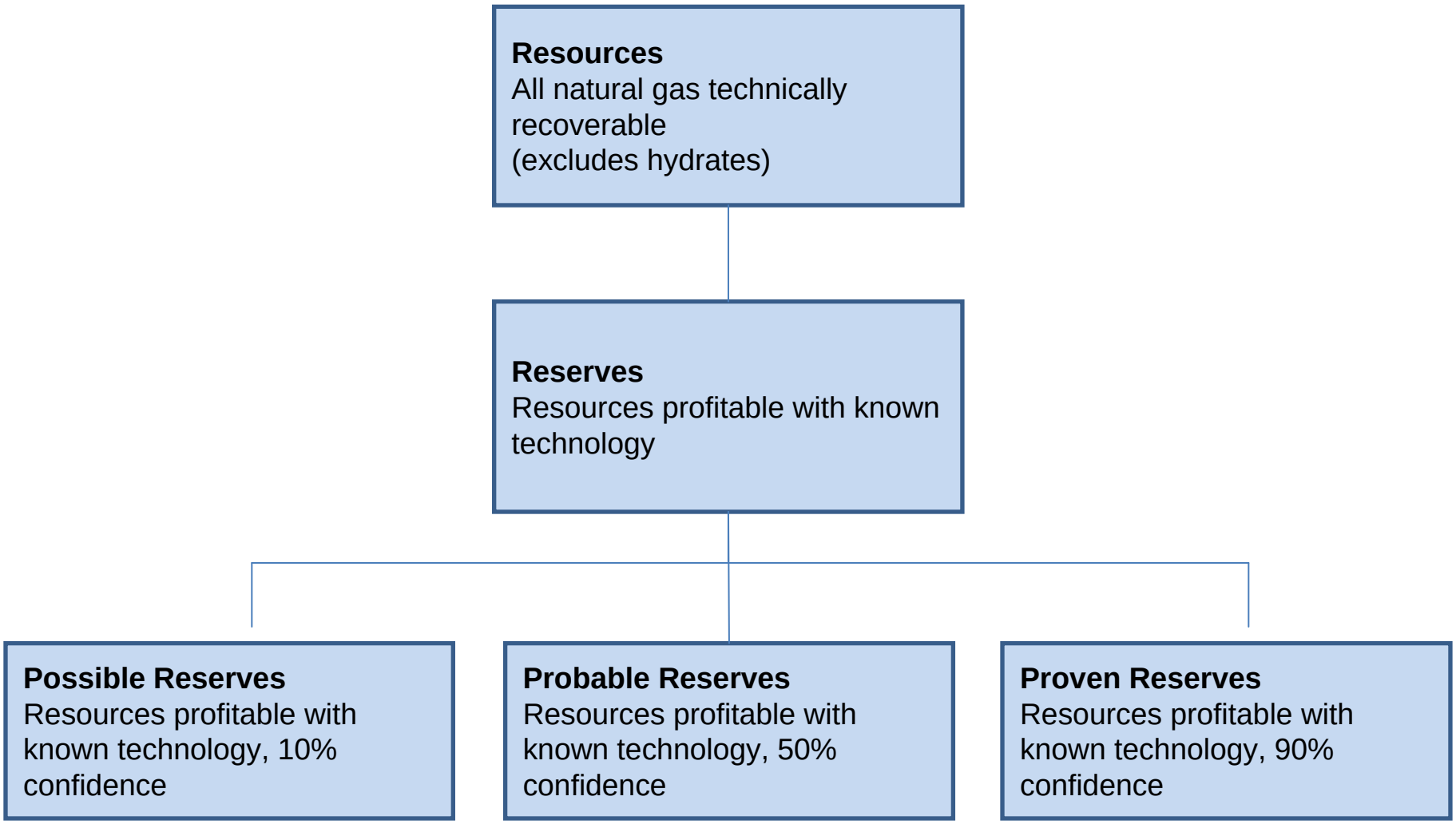
# Natural Gas Supply Terminology



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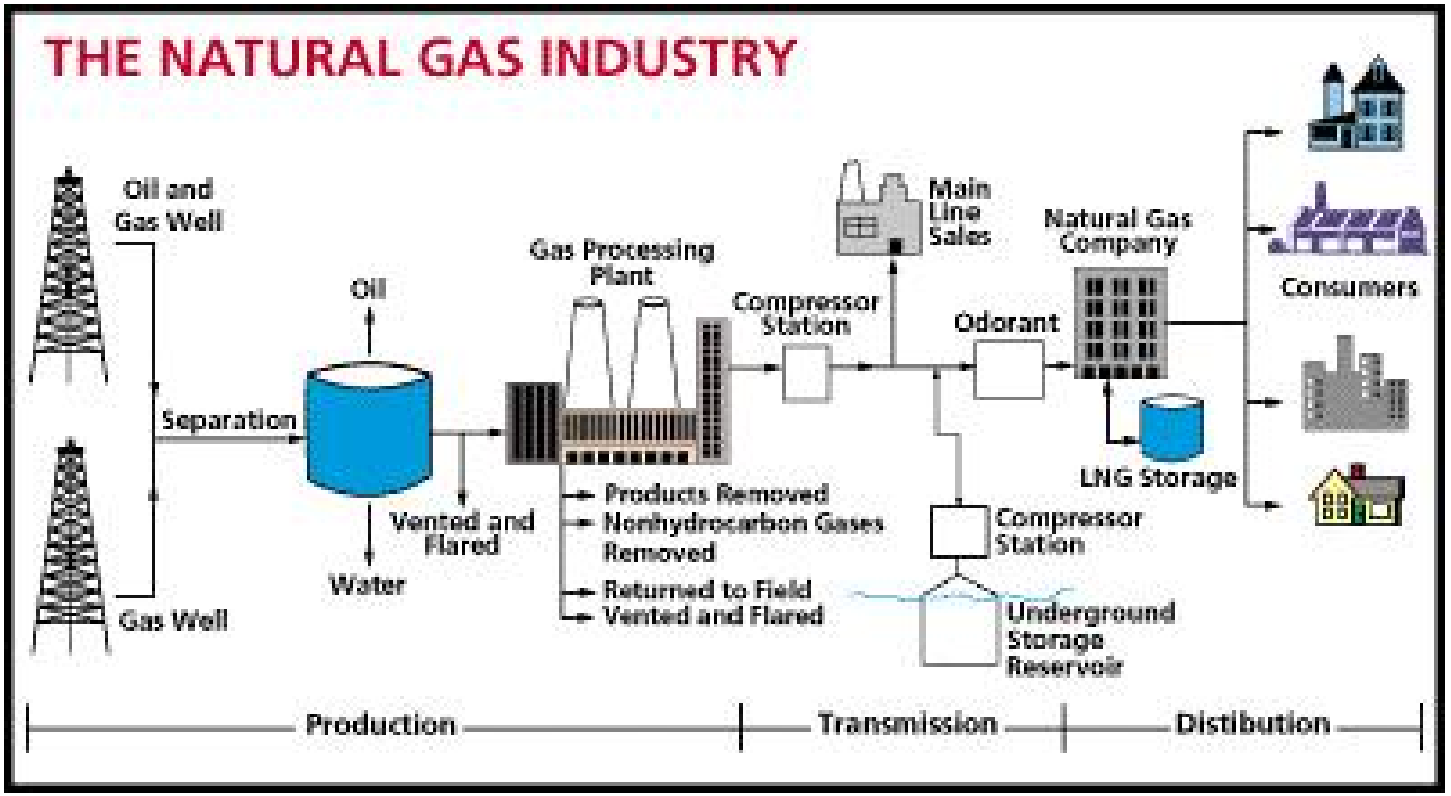
# Industry Structure in the U.S. Physical Flow of Gas




Source: EIA

# Conclusions:

- DE is a win-win form of power generation;
- DE has great potential to reduce emissions and reduce overall costs of supplying power;
- The renaissance in natural gas production will be a key driver for the US economy
- Clean, affordable and reliable supplies of natural will bring about major shifts in US power generation and transportation

# THANK YOU

QUESTIONS??

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