IOGCC
2009

The Current and Future Role of Unconventional Gas in U.S. Energy

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100 Years of Scientific Impact
1909-2009

Outline

I. Global Energy

II. Natural Gas

III. Alternatives to Natural Gas

IV. Future Energy Trends

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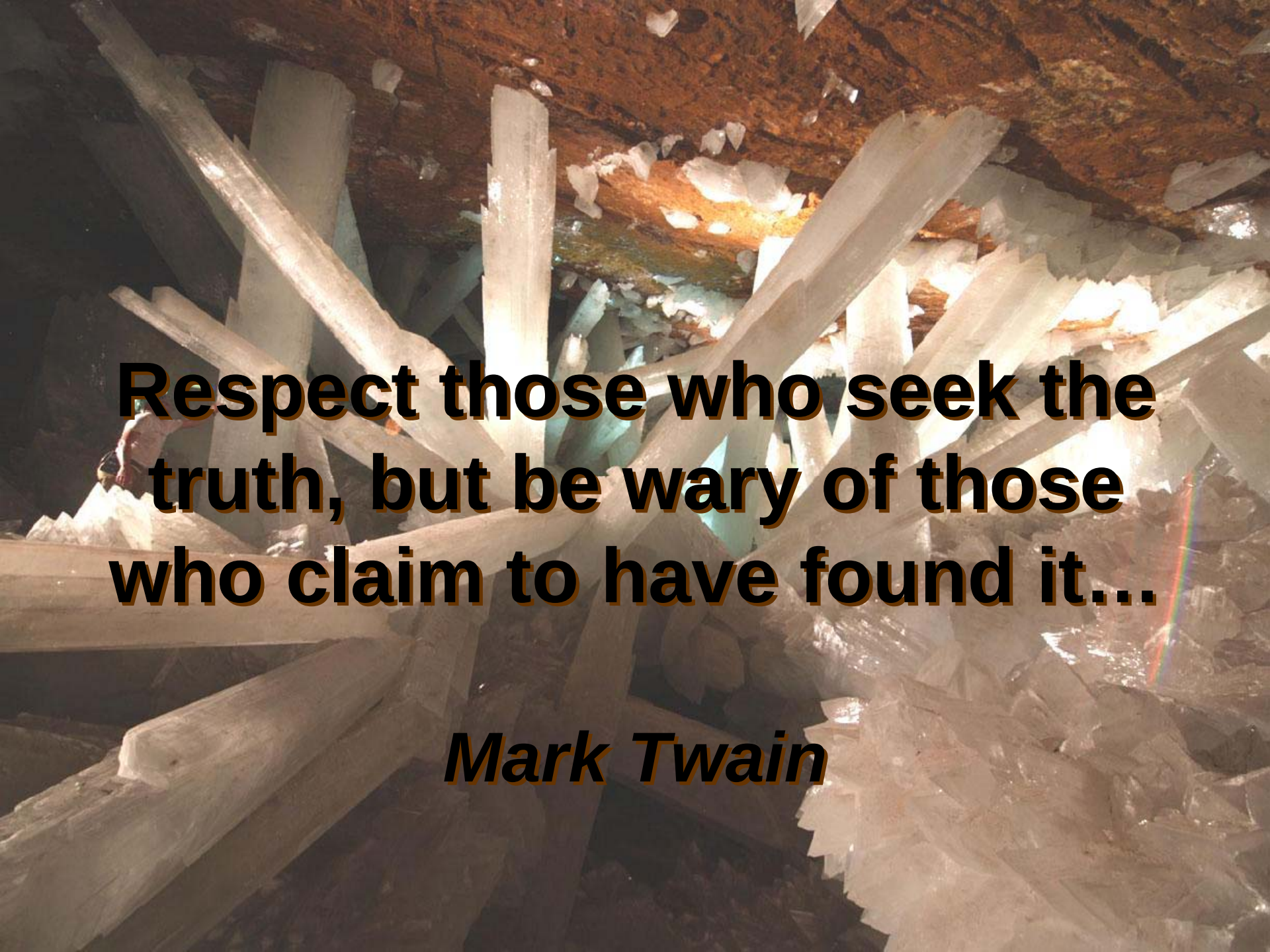
Take Aways

I. Energy underpins modern economies

II. Natural gas is globally abundant, thanks to unconventional gas

III. Most alternate energy fuels produce electricity

IV. Energy transitions take time


Respect those who seek the truth, but be wary of those who claim to have found it…
Mark Twain

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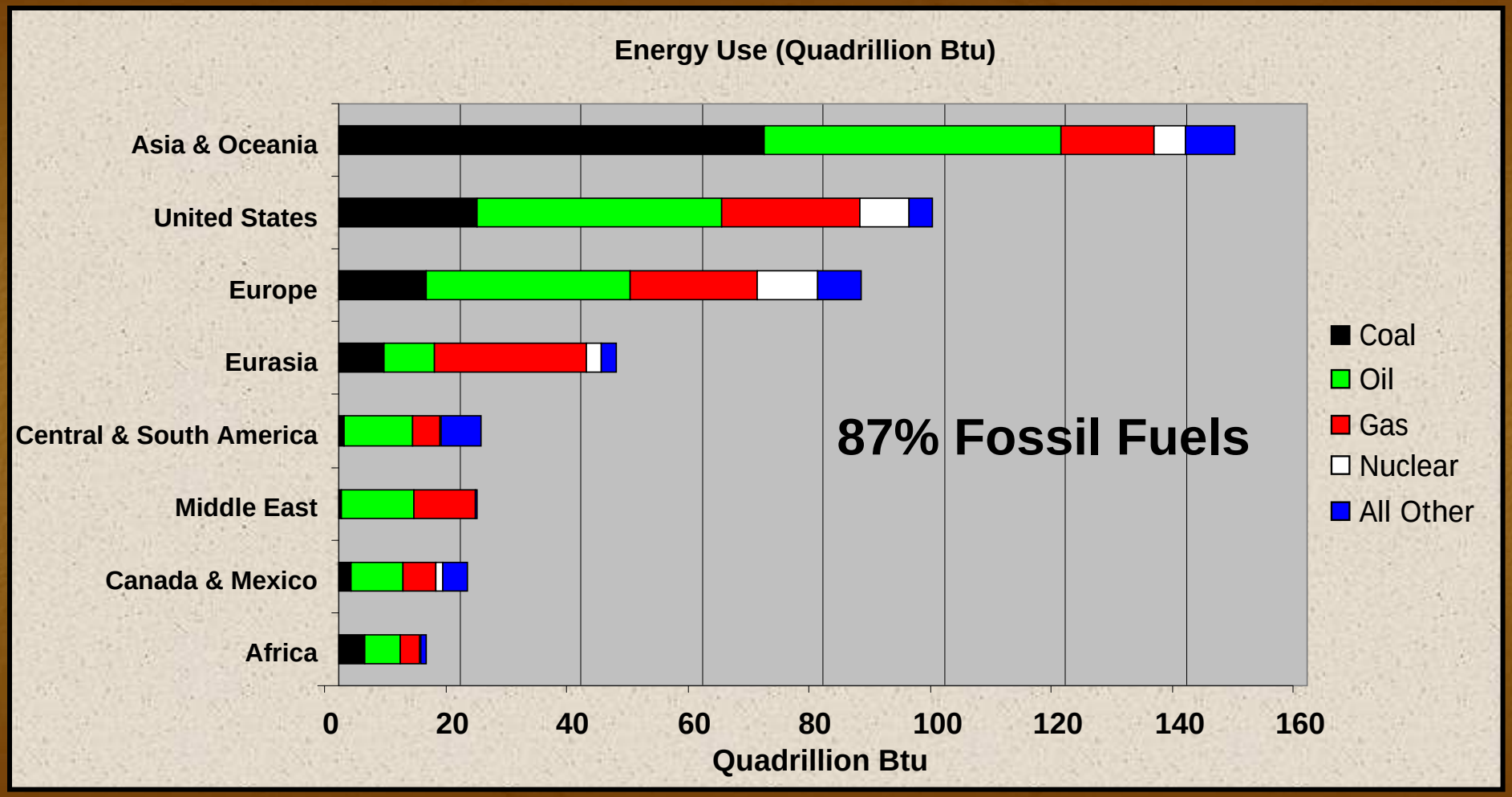
Global Energy Use



1 Quad ~ 1 Exajoule ~ 1 Tcf ~ 170 mmbo (~ 33 GWY)

Data: EIA, October 2007

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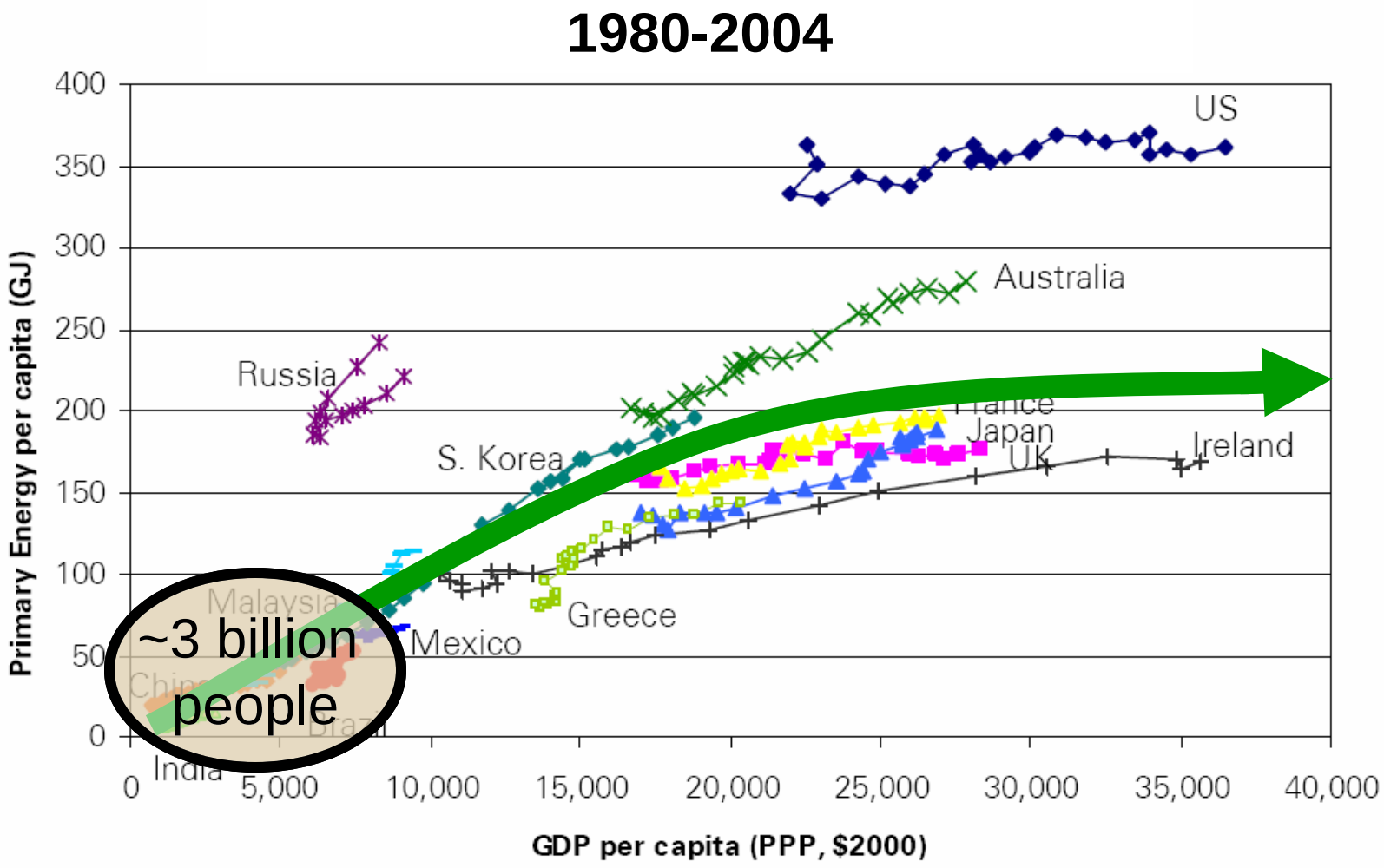
Energy and GDP



Source: UN and DOE EIA
Russia data 1992-2004 only

After: Koonin, 2008

Take Away I

Energy Underpins Modern Economies

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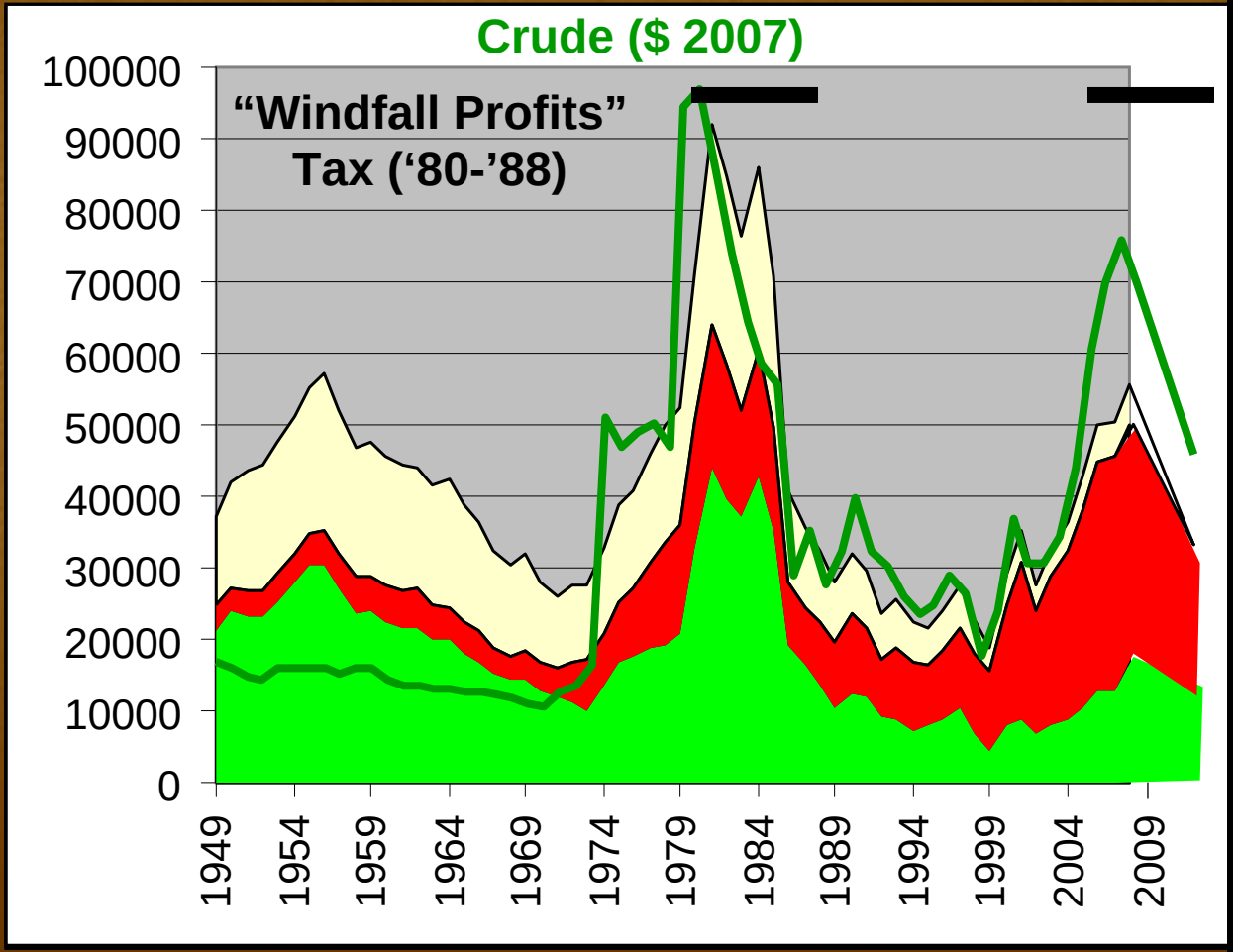
U.S. Oil and Natural Gas *Drilling Activity*



2010
Proposed O & G Tax Policies

- Repeal Expensing of Intangible Drilling Costs
- Repeal Percentage Depletion
- Repeal Marginal Well Tax Credit
- Repeal Enhanced Oil Recovery Credit
- Repeal Manufacturing Tax Deduction
- Increase G and G Amortization Cost
- Excise Tax on Gulf of Mexico Production
- Fee ($4/acre) on "non-producing" GOM leases
- Carbon Tax (or Cap and Trade scheme)

Data: EIA, 2007

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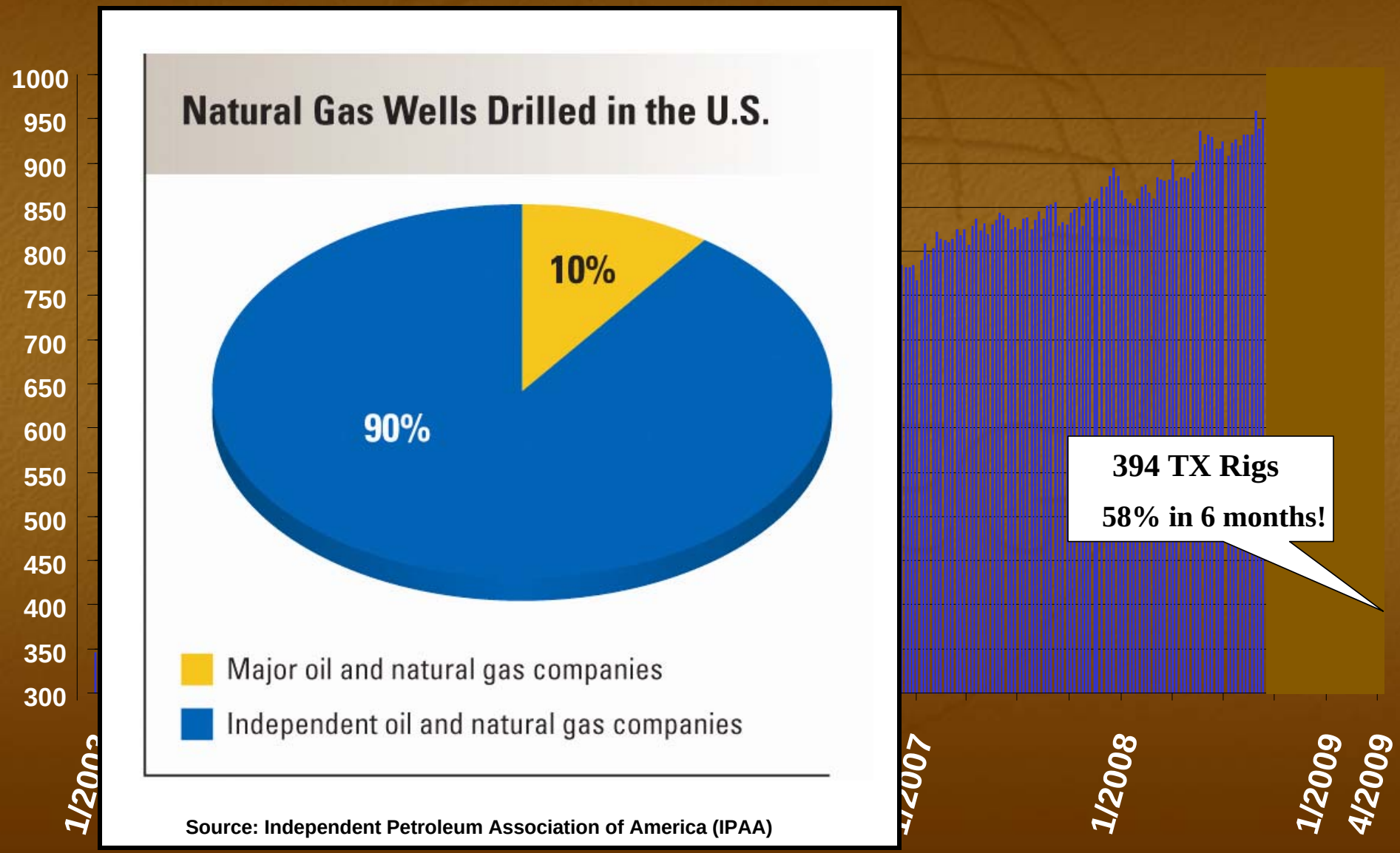
Texas Active Rig Count

(Source: Baker Hughes)



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Oil vs. Natural Gas Price (btu)

After Steve Harvey, EIA

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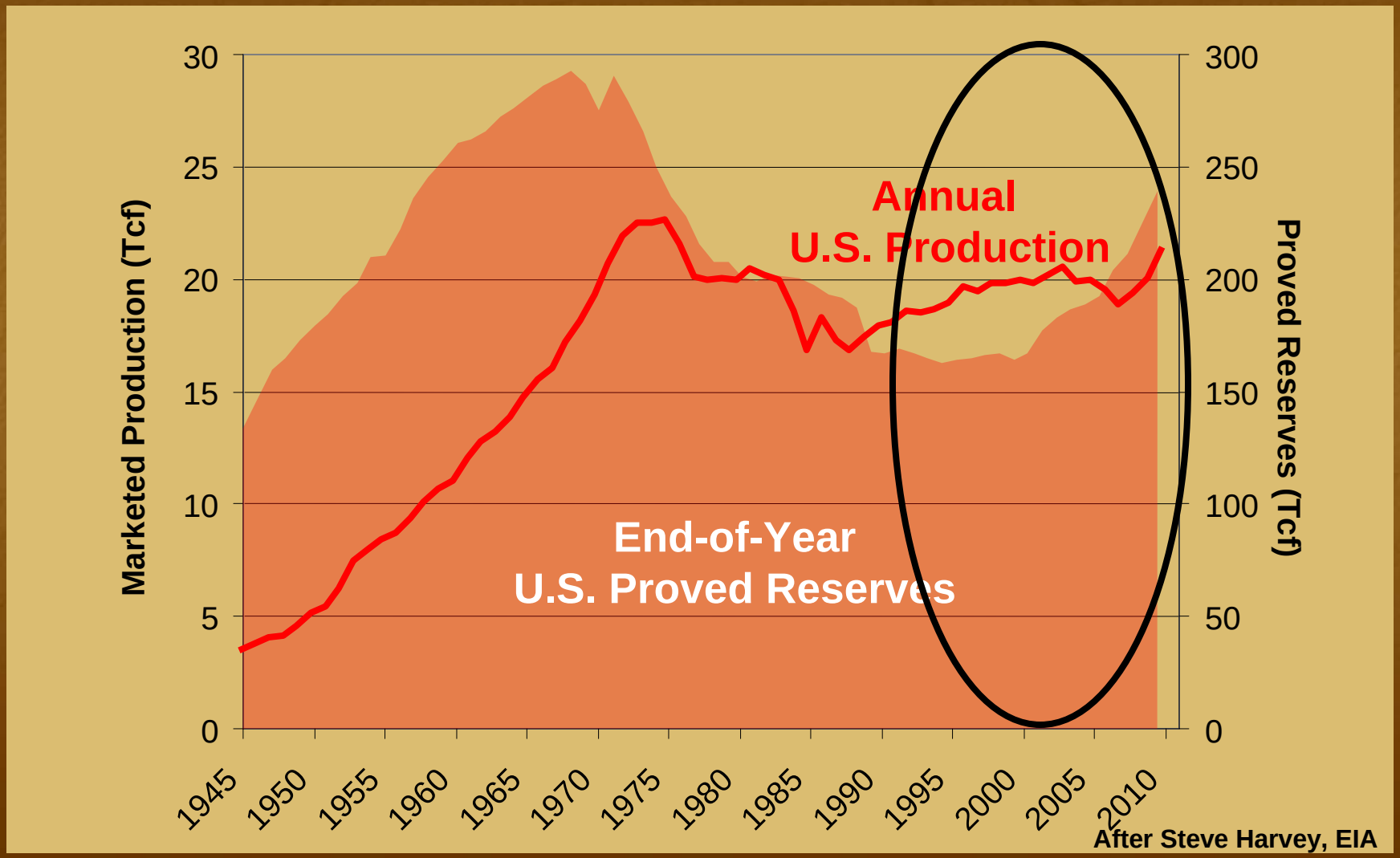
U.S. Natural Gas Production and Reserves



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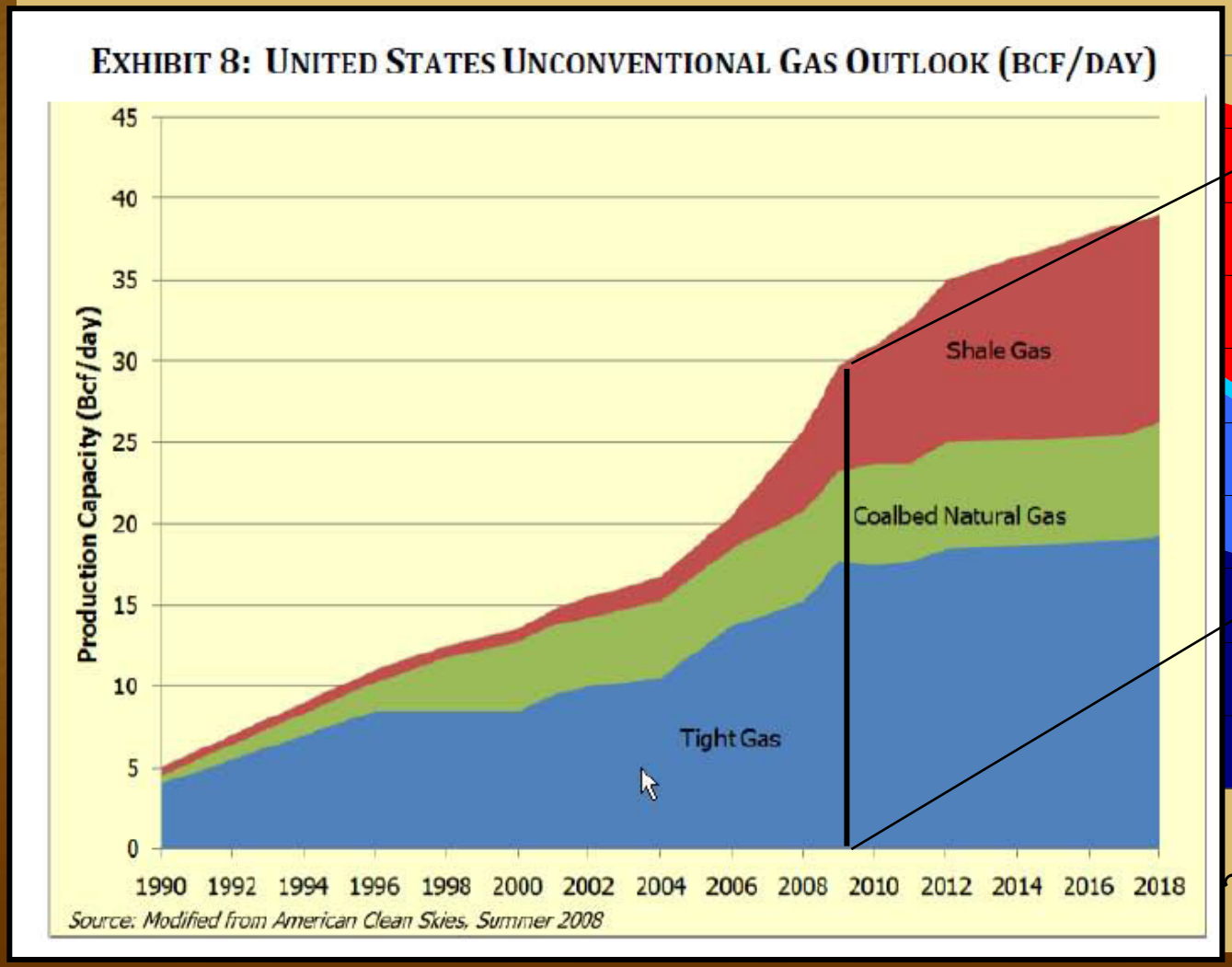
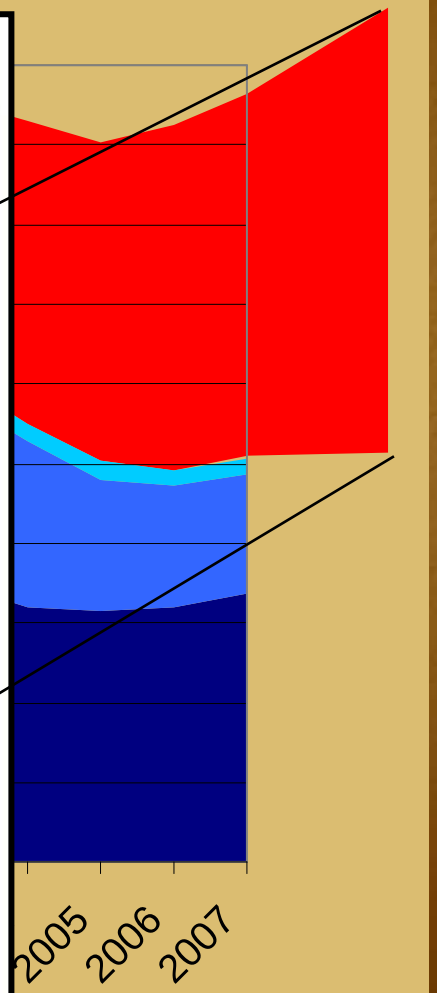
U.S. Natural Gas Production





After Steve Harvey, EIA

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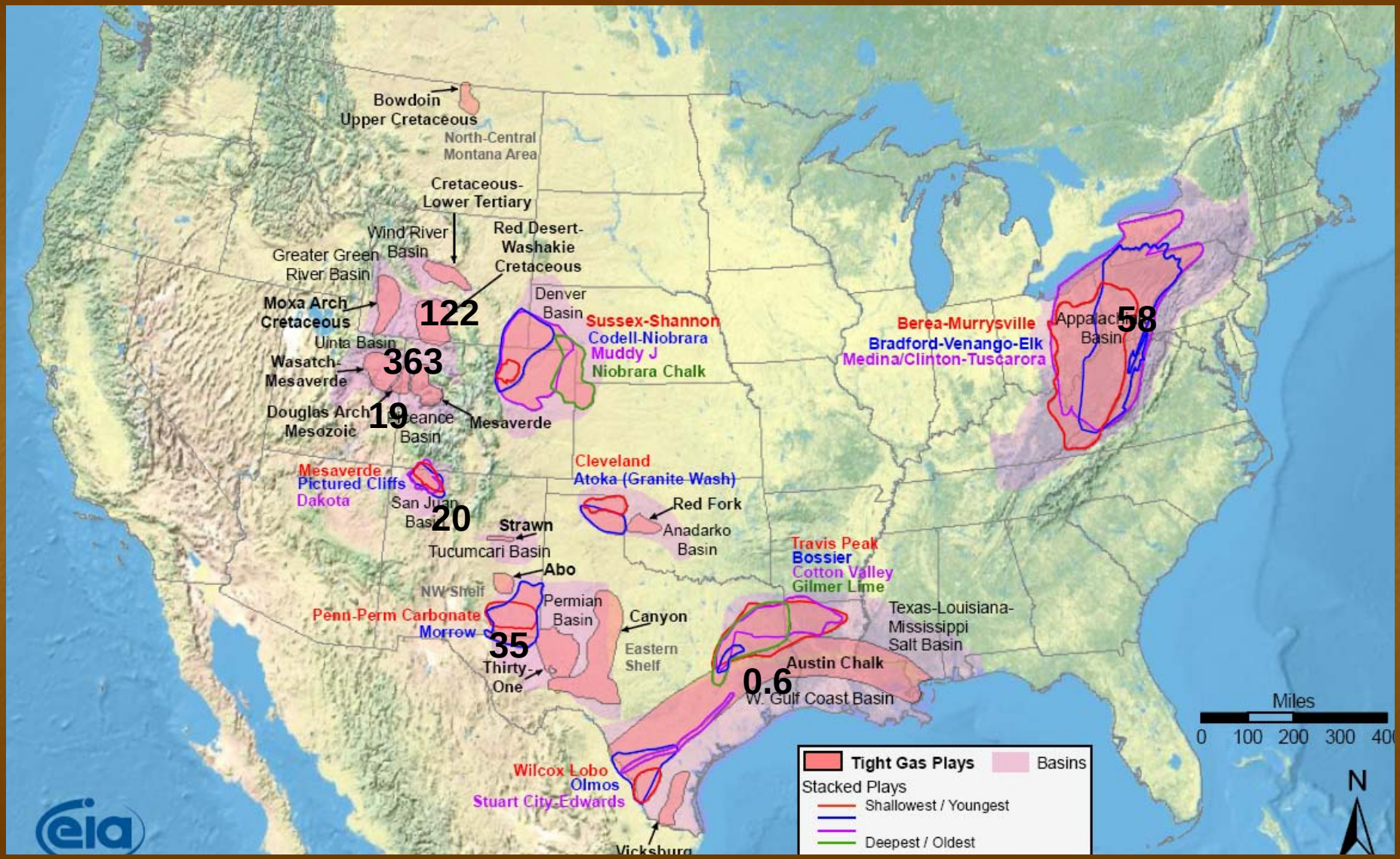
Tight Sand Plays



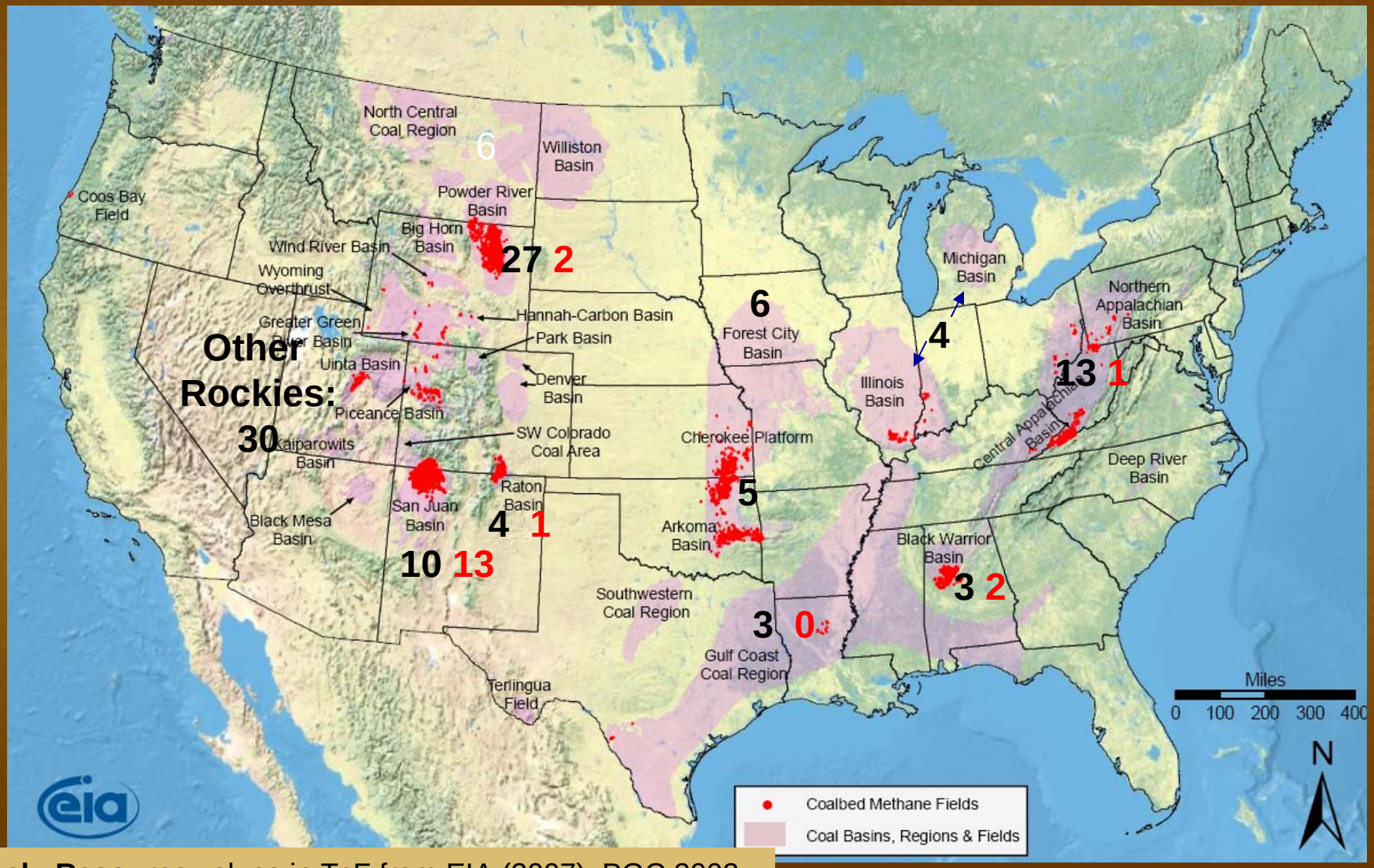
Resource, Mean undiscovered values in Tcf from USGS, 1995 and later

EIA, 2009

Tinker, 2009

Coalbed Methane Plays

Alaska: 57 0



Black: Resource values in TcF from EIA (2007), PGC 2002
Red: Production, TcF, from EIA 2007

Map: EIA, 2009

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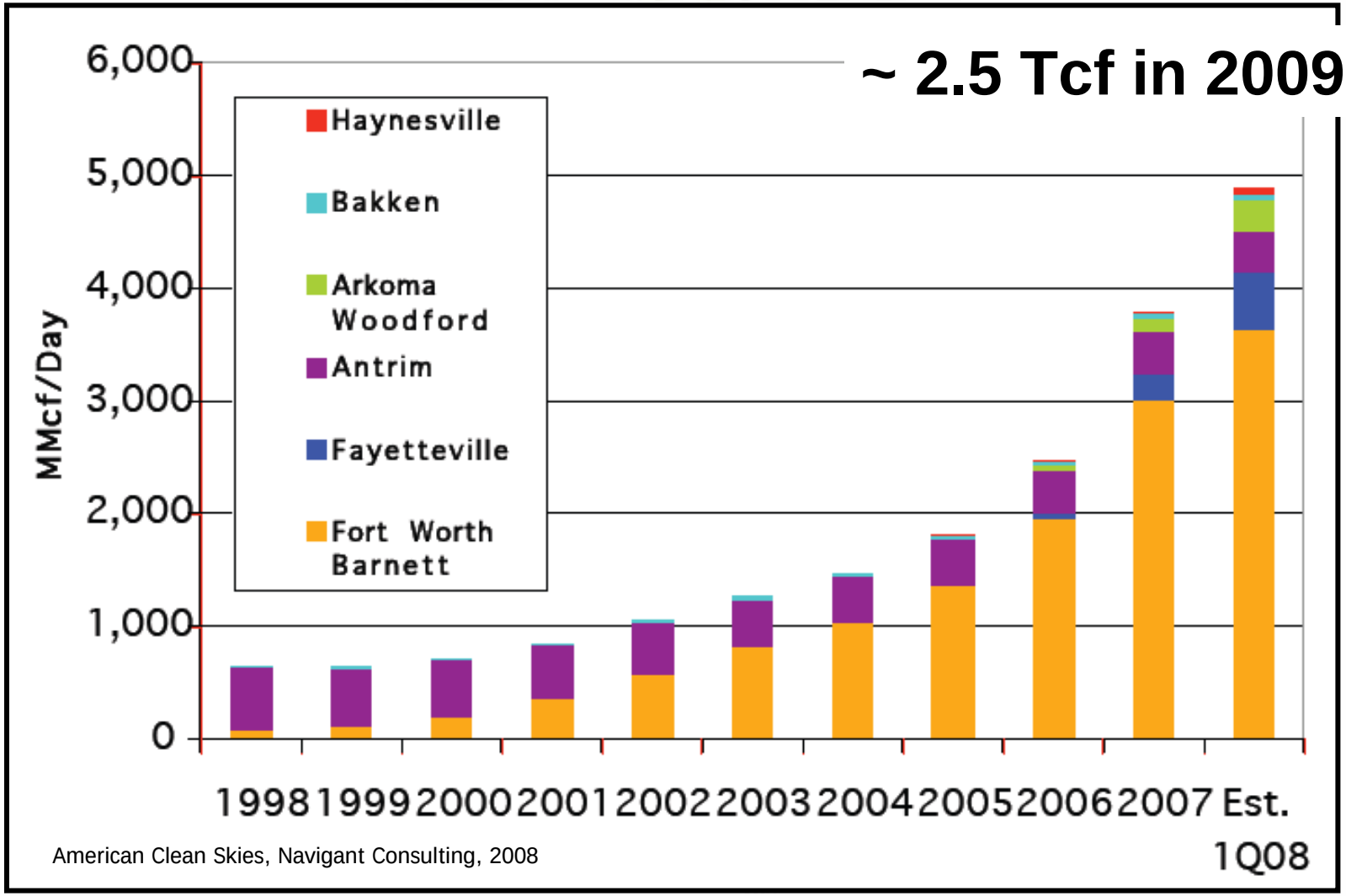
US Shale Gas Plays



Map: DOE Shale Gas Primer, 2009

Black = Resource values in Tcf, DOE Shale Gas Primer (Rockies PGC); Clean Skies, 2008
Red = cumulative production, Texas RRC, Curtis 2009, Ark Geol Surv 2007, Andrews 2007

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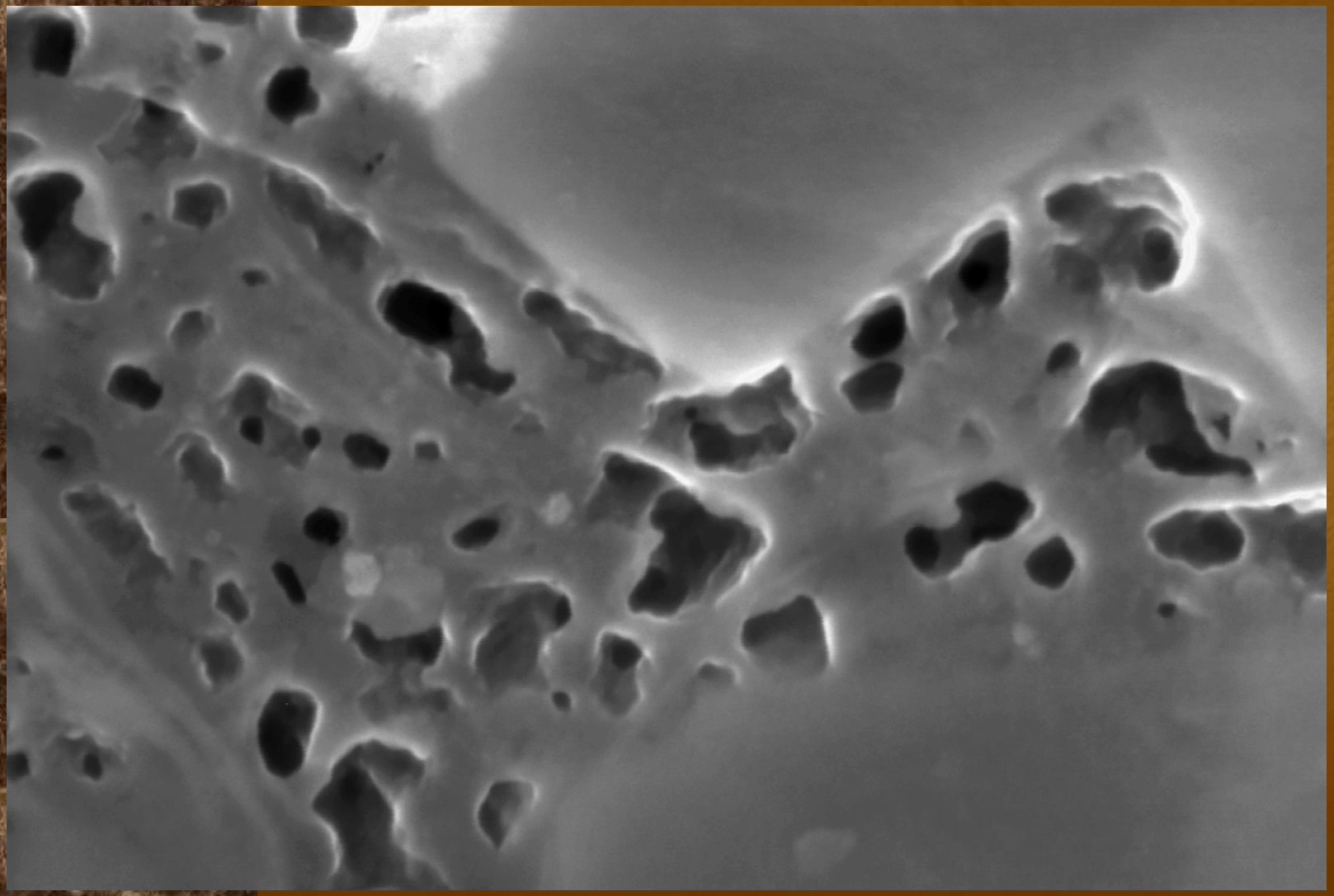
Nanopores in Barnett Organics



After Reed, BEG

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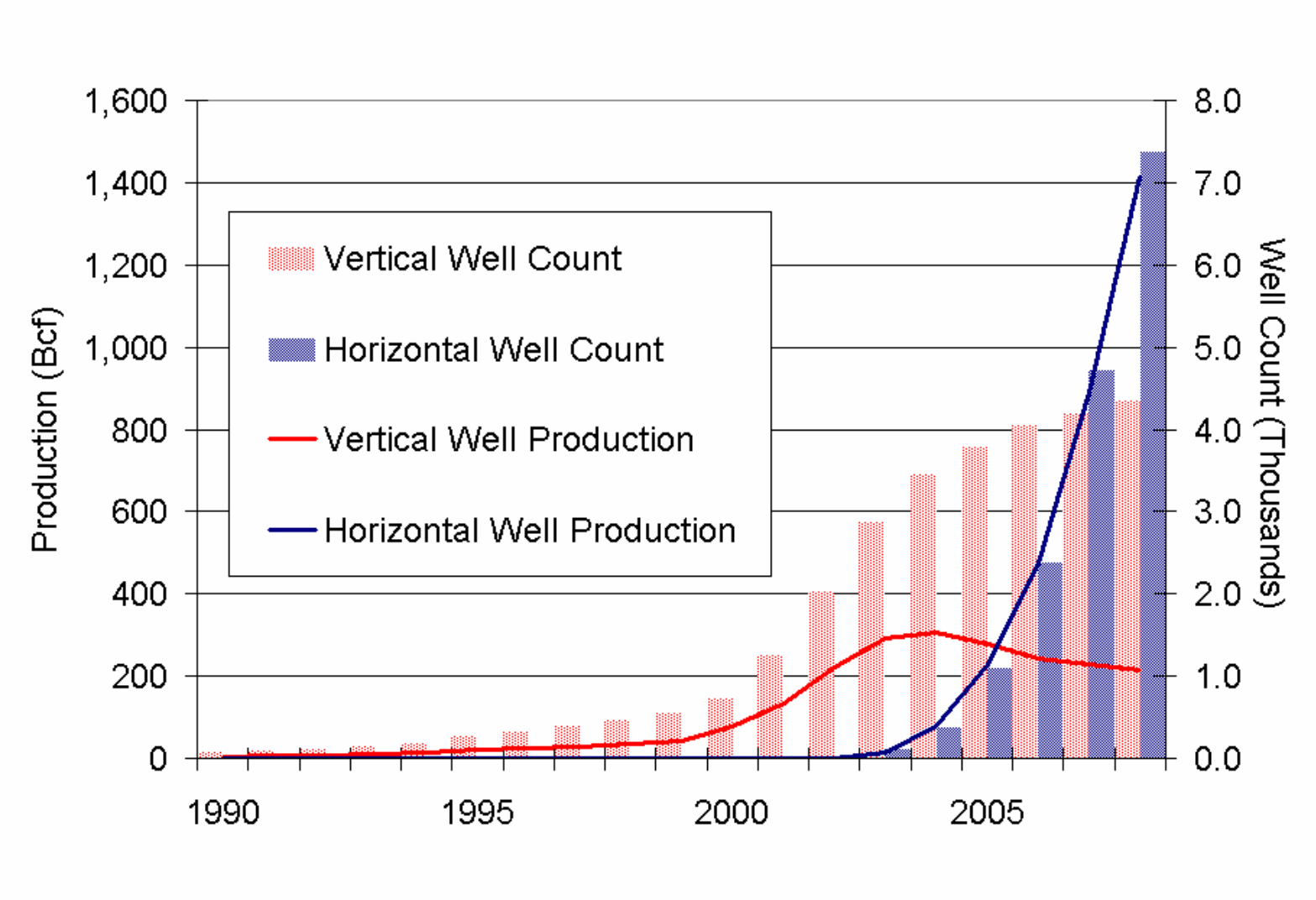
Barnett Shale Technology



After Steve Harvey, EIA

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Implications of U.S. Shale Development

- Environmental
  - Traffic (-)
  - Noise/light (-)
  - Water (-)
  - Land Use (-)
  - Carbon (+/-)
- Energy Security (+)
- Fuel Diversity (+)

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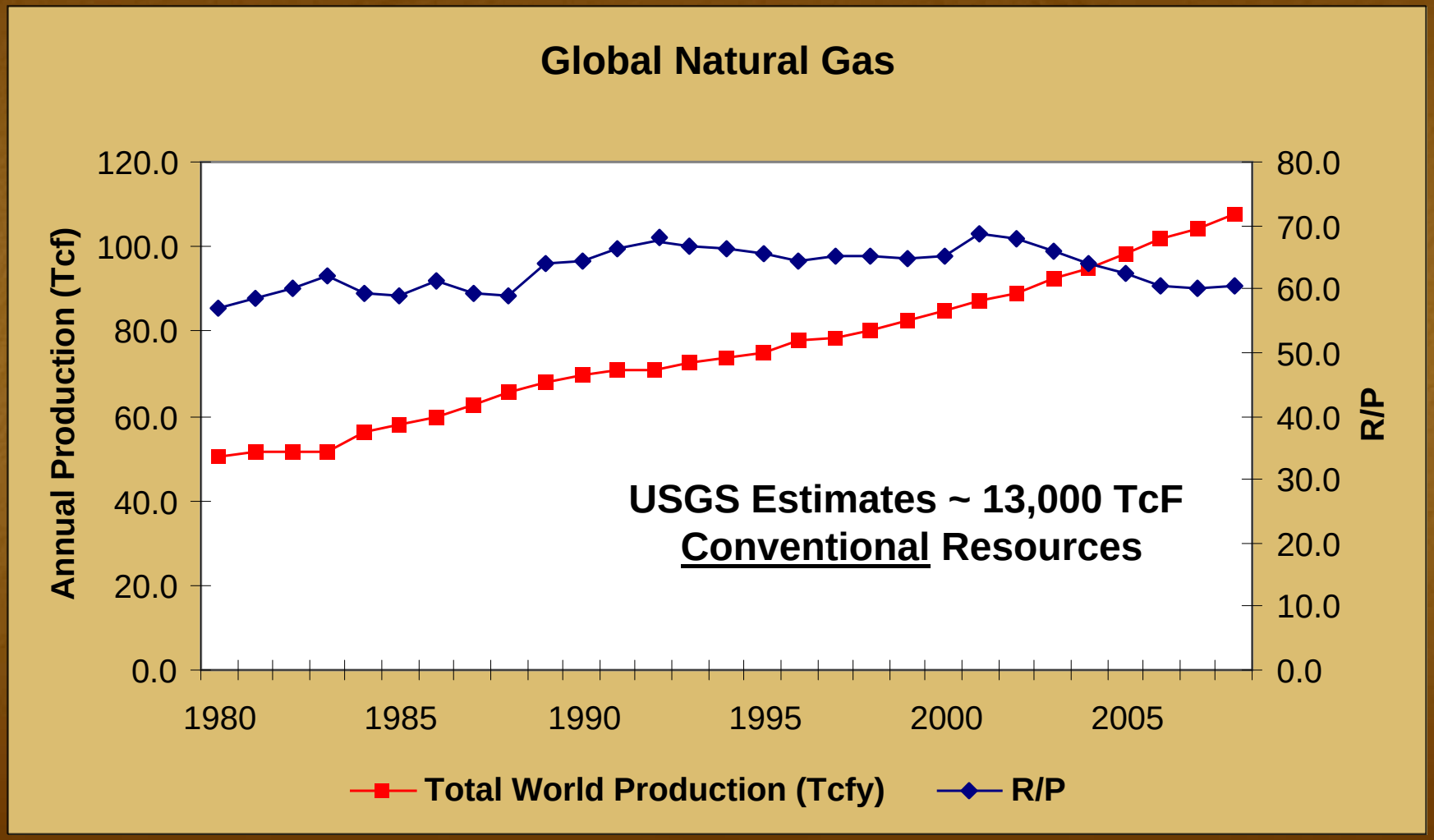
Global Natural Gas



Data: BP, 2009

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Global Unconventional Gas Resource Estimates

Region	Coalbed Methane	Shale Gas	Gas in Tight Sands	Total
North America	3,017	3,840	1,371	8,228
Latin				8
Western Europe	157	509	353	1,019
Central and Eastern Europe	118	39	78	235
Former Soviet Union	3,957	627	901	5,485
Middle East and North Africa	0	2,547	823	3,370
Sub-Saharan Africa	39	274	784	1,097
Centrally Planned Asia and China	1,215	3,526	353	5,094
Pacific	470	2,312	705	3,487
Other Asia Pacific	0	313	549	862
South Asia	39	0	196	235
World	9,051	16,103	7,406	32,560

North America: @ ~30% recovery; 25 TcF/yr for ~100 yrs

Source: SPE Paper 68755

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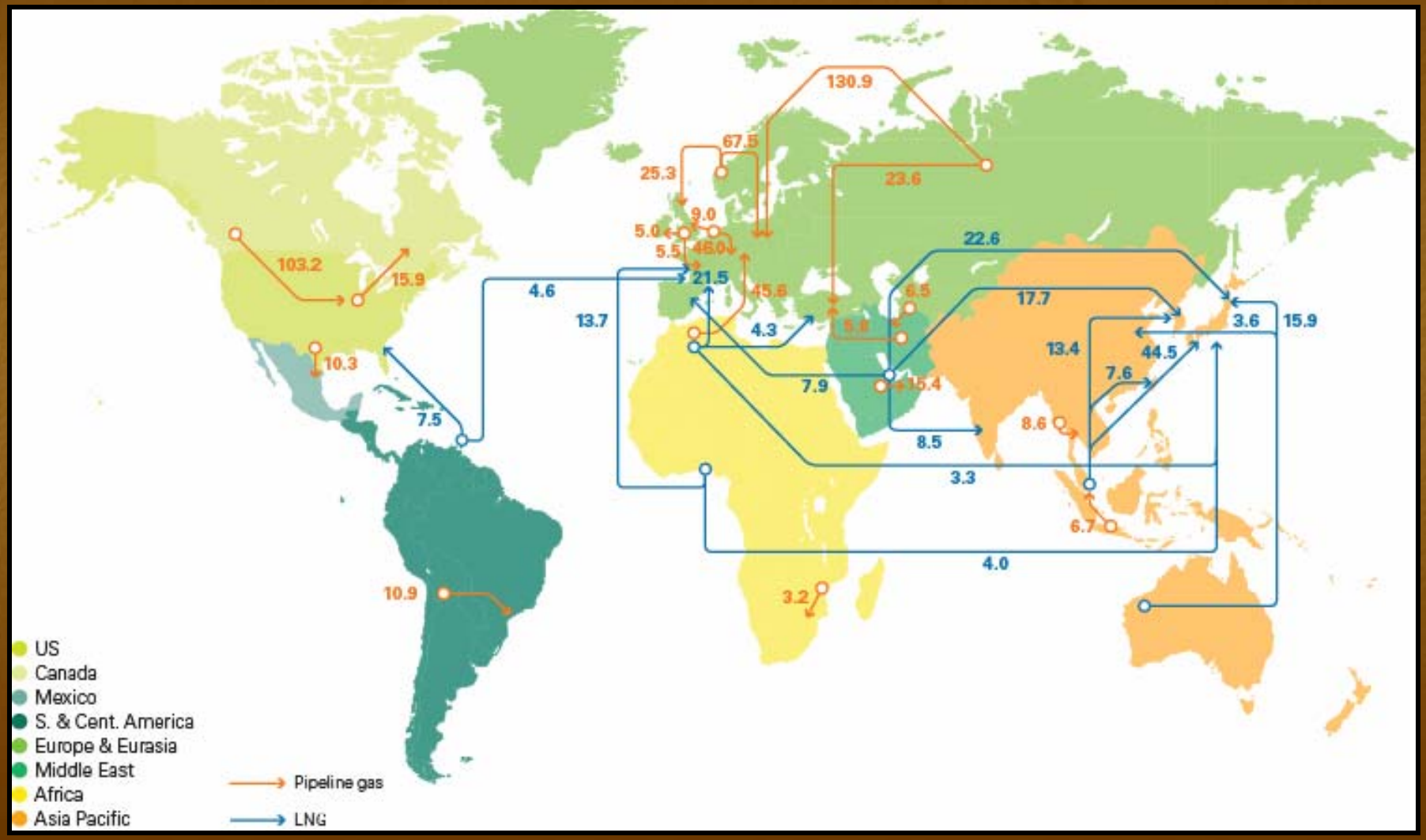
Major Trade Movements



Data: BP, 2008

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LNG

Take Away II

Natural Gas is Globally Abundant, Thanks to Unconventional Gas

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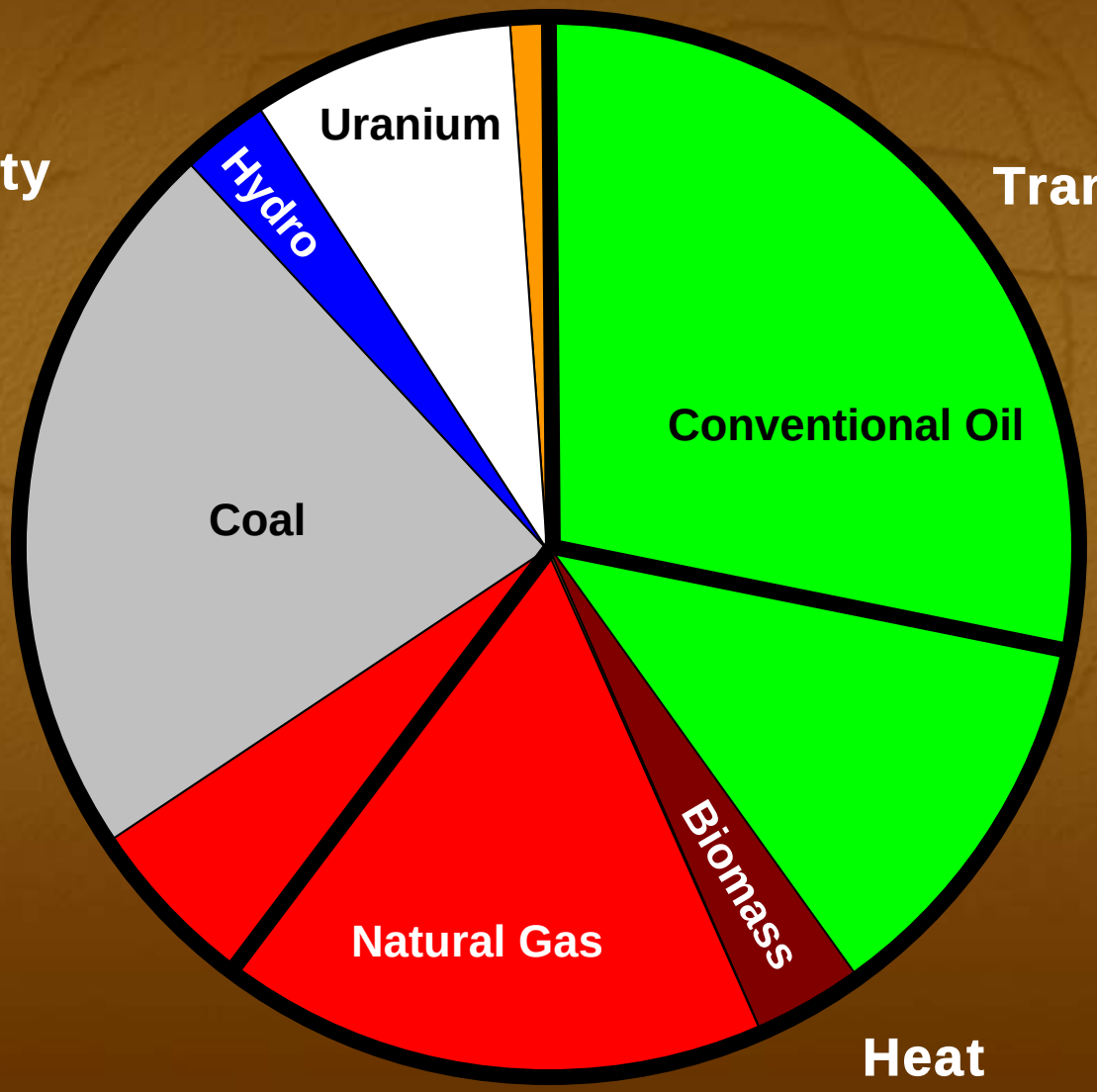
Energy End Use



U.S. Data

Data: EIA 2007

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Biofuels

Carbohydrates to Hydrocarbons

Perennial Cellulosic

- **Sorghum**
- **Switch Grass**
- **Miscanthus**
- **Shrub Willow**

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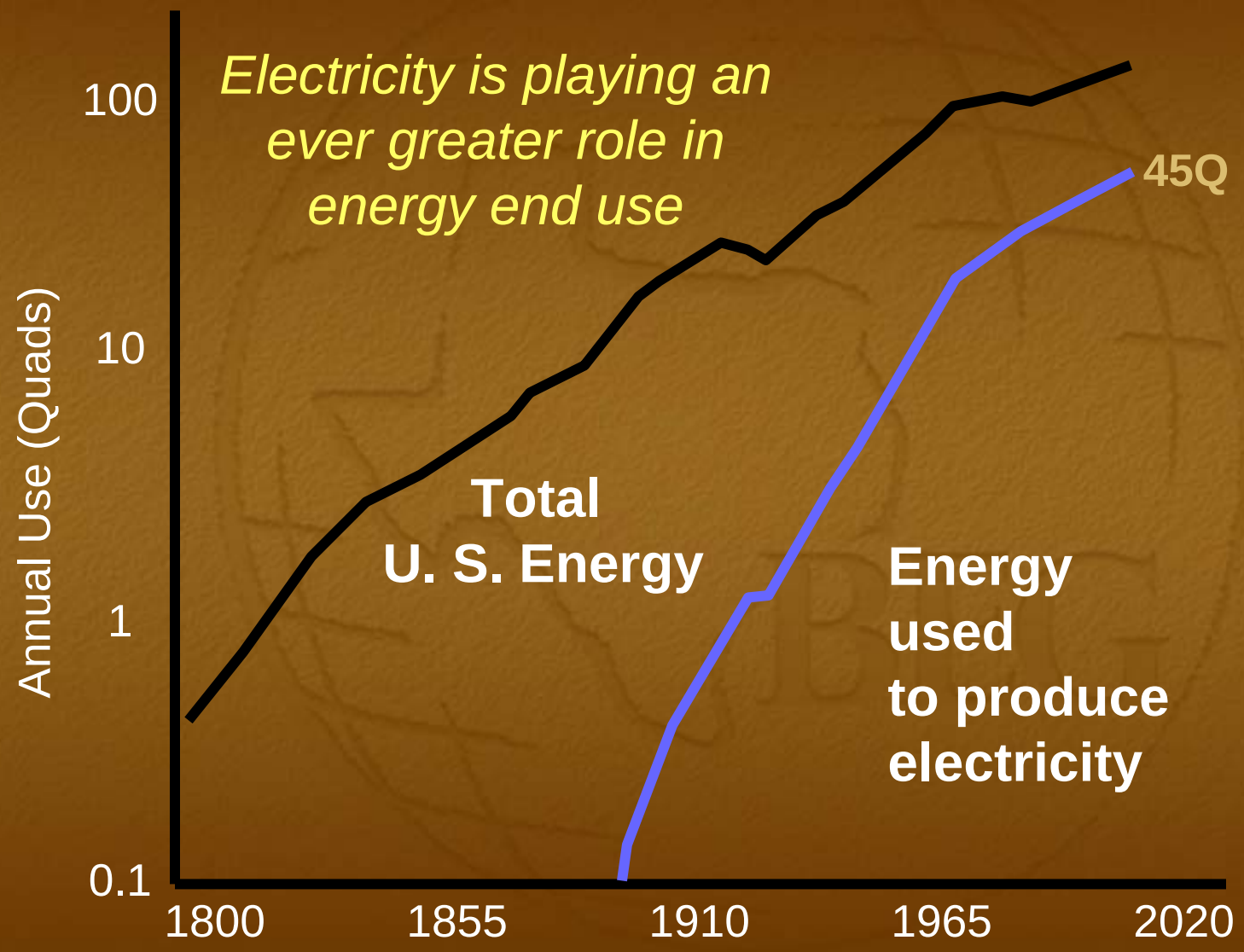
Electricity's Role



After Huber and Mills, 2005.

Data: EIA, Annual Review, 2003. US Census Bureau, Historical Statistics of the US Colonial Ties to 1970

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Electricity Options

- **Efficiency**
  - **Fuel, lighting, electronics, insulation**
  - ***Challenge: Rebound effect***
- **N**
- **C**
- **N**

tion

A Grand Challenge: Improved Electricity Storage and Transmission

- **Alternatives (hydro, wind, solar, geothermal, tides, waves…)**
  - **Cleaner, less reliable, can be more expensive**
  - ***Challenge: Intermittency, scale, cost***

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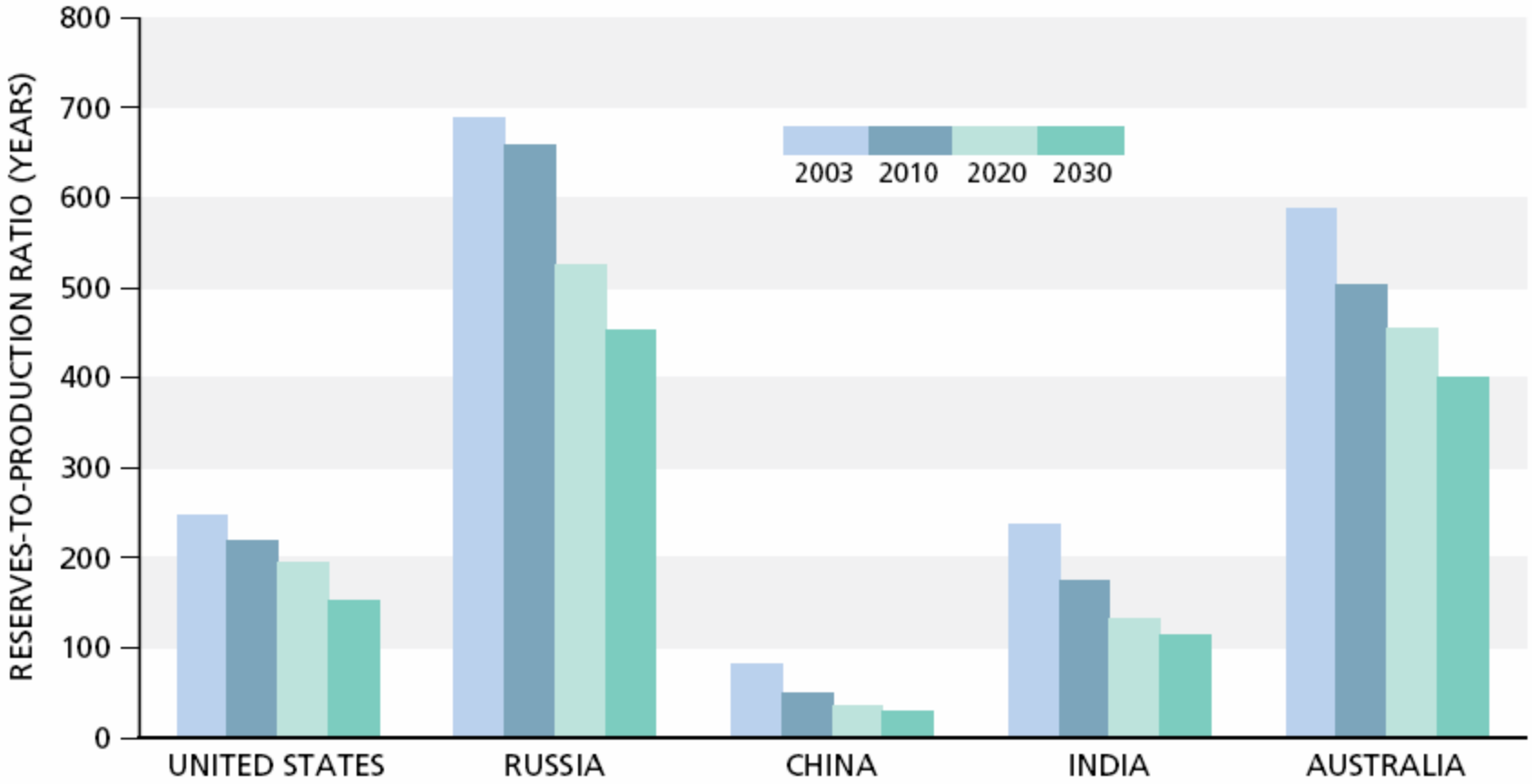
Coal



Sources: World Energy Council 2006; and Energy Information Administration, *International Energy Outlook 2006.*

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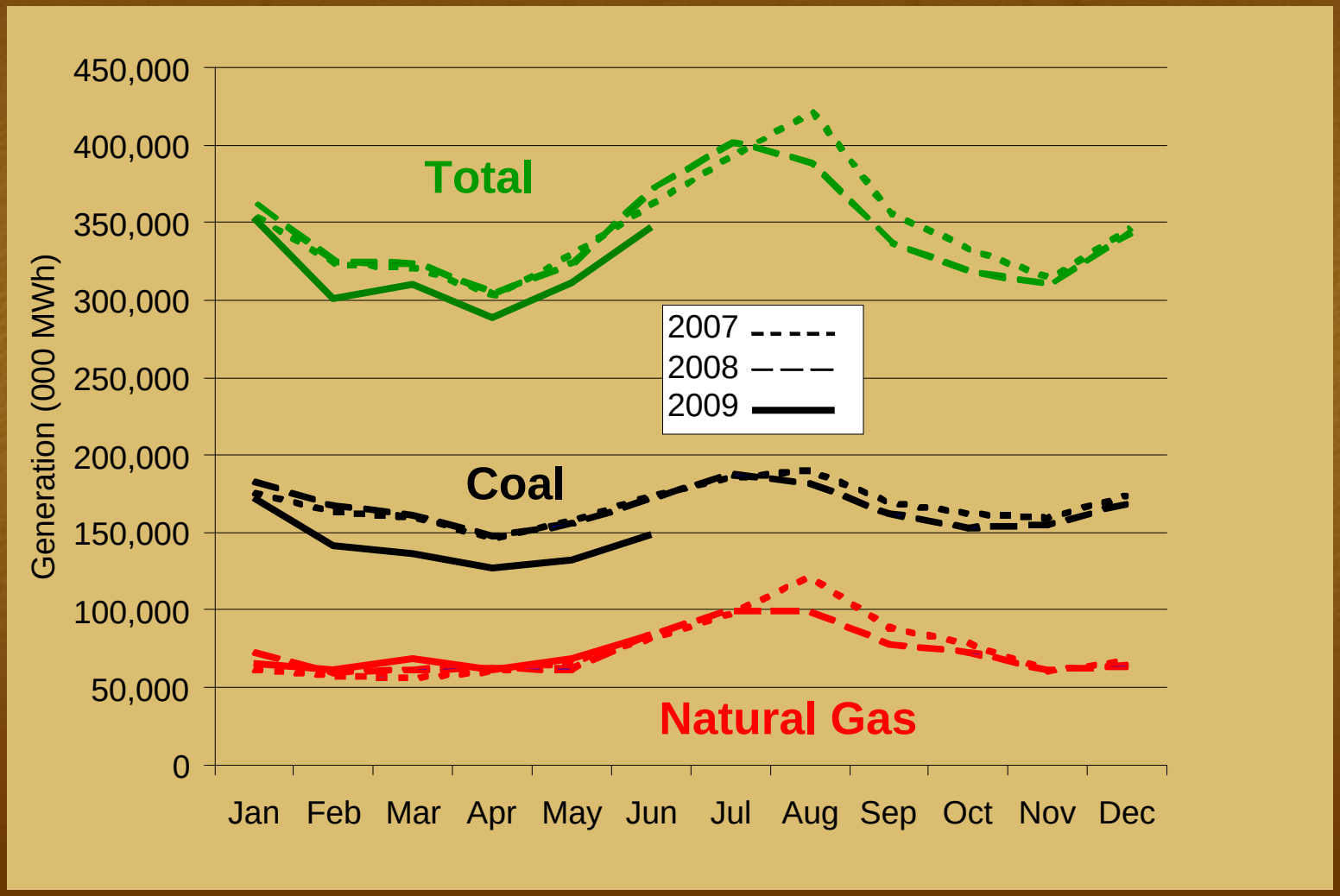
U.S. Electric Generation



After Steve Harvey, EIA

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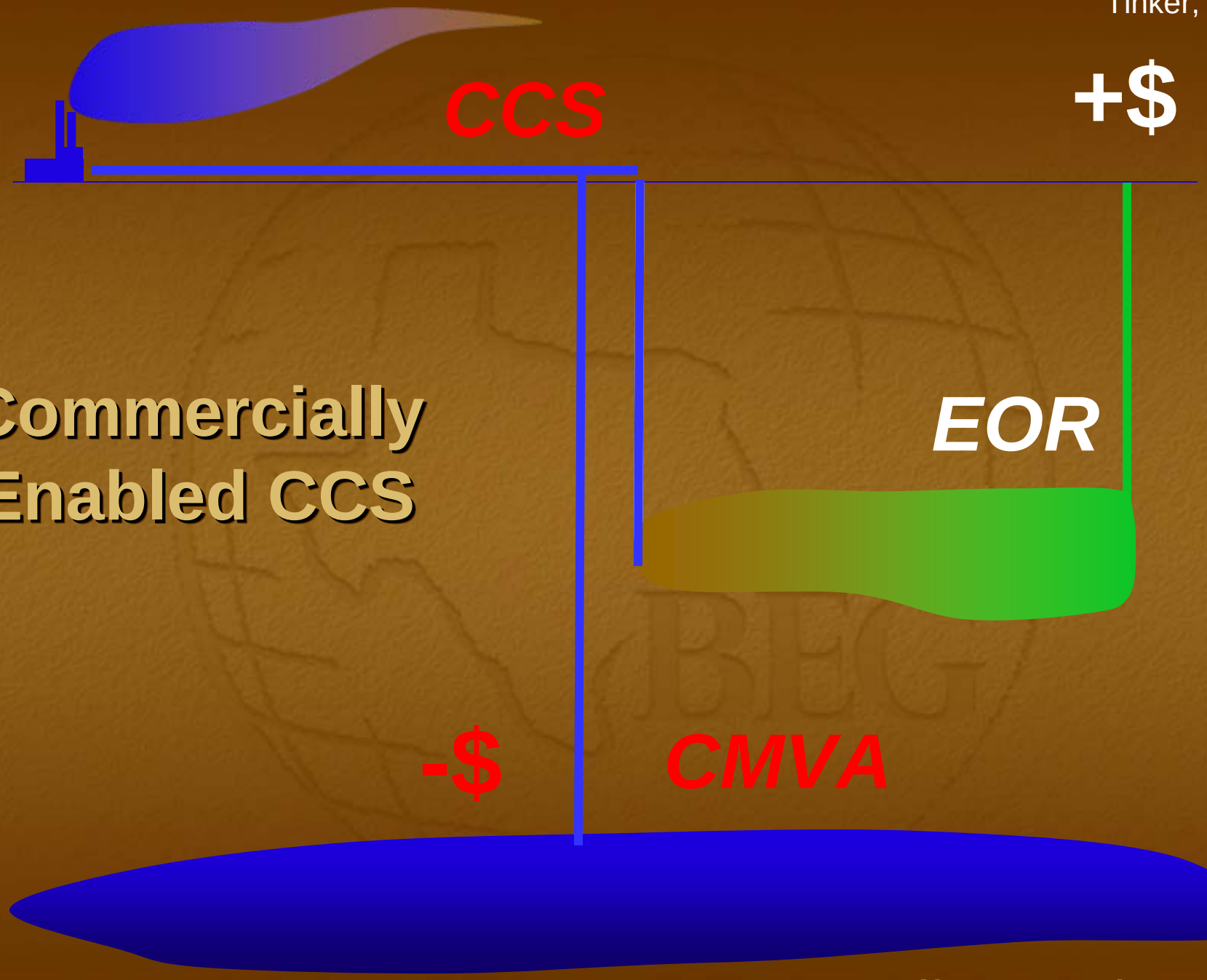

Commercially Enabled CCS

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Nuclear

Le Hague Waste Recycling

Normandy, France

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Wind

San Gorgonio Pass Wind Farm, California (619 MW Nameplate)

Copenhagen, Denmark

40 MW Nameplate

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Solar

Spain

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Hydro

Norway

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Geothermal

Iceland

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Alternate Energy

- Wind
- Solar
- Hydroelectric
- Geothermal
- Mass
- Waves

- *"Renewable"*
- *Cleaner*
- *Intermittent*
- *Lower Energy Density*
- *More Expensive*

Take Away III

Most Alternate Energy Fuels Produce Electricity

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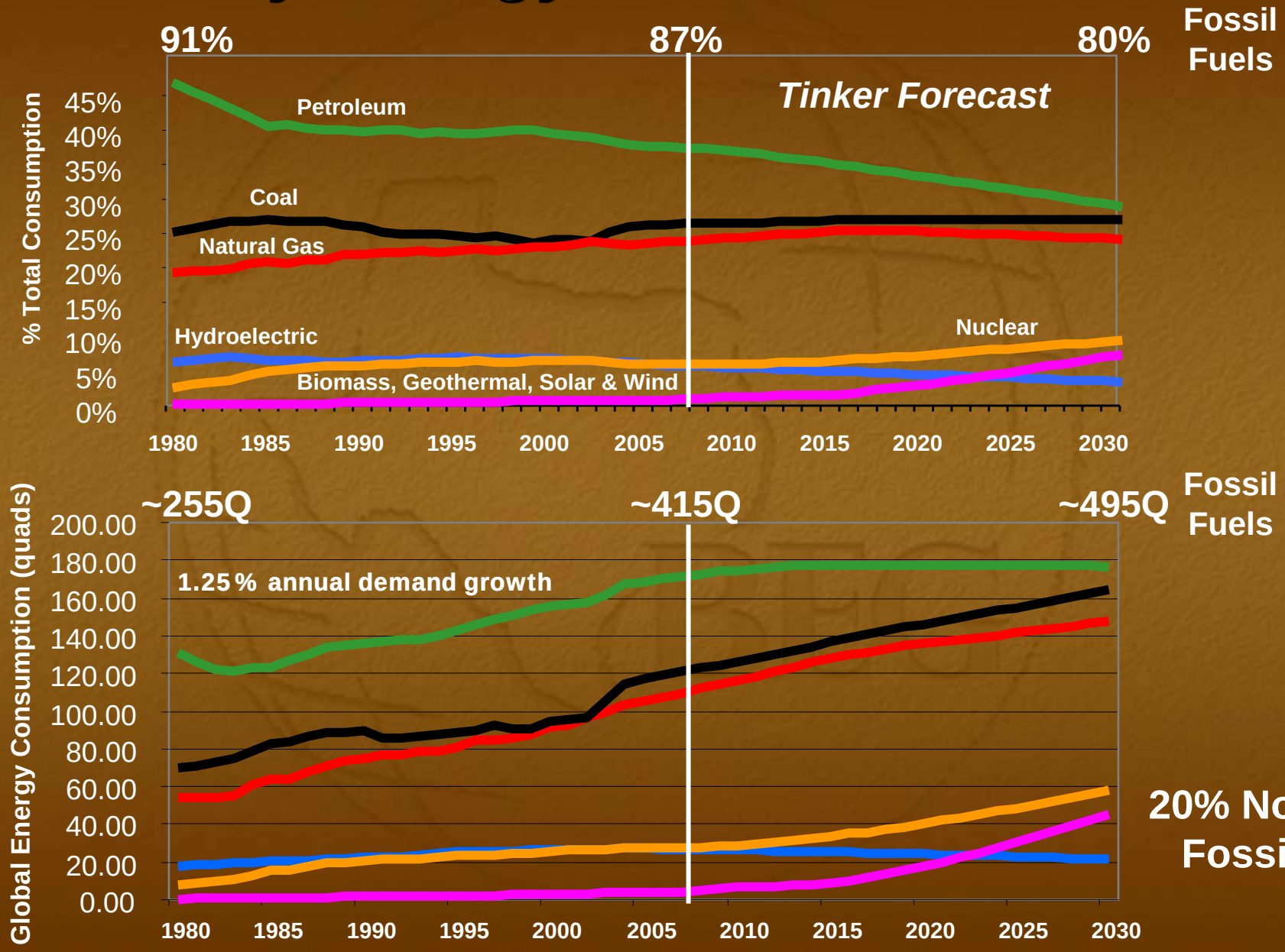
Primary Energy Demand Forecast



Historical Data: EIA October 2007

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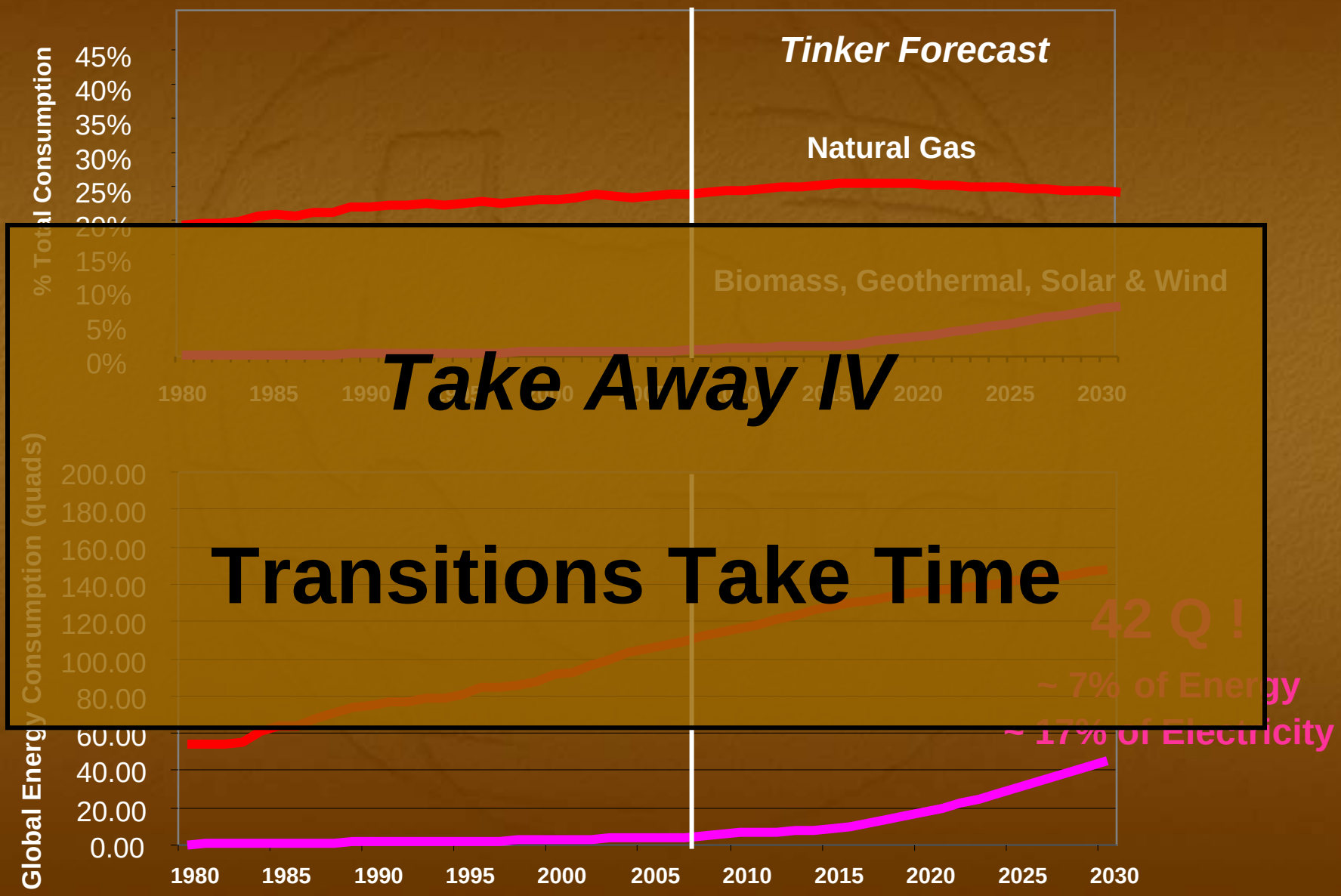
Primary Energy Demand Forecast



Take Away IV

Transitions Take Time

Historical Data: EIA October 2007

Take Aways

I. Energy underpins modern economies

II. Natural gas is globally abundant

III. Most alternate energy fuels produce electricity

IV. Transitions take time

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A Note on Energy Security and Policy

- Available
- Affordable
- Reliable
- Clean

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Policy for Energy Security

- Increased global **Efficiency**
- **Diversify** the global energy portfolio
- Improved global energy **Infrastructure**
- **Carbon Price** that is transparent, economy-wide, global, not wasteful. Cap and Trade struggles
- Strengthen global **Energy Trade**
- **Dialog** between Developed and Developing Nations
- Global **Policy** that engages Energy, Economy and Environment

Let's be thoughtful as we move into the future.

The global complexities are too great to risk a careless leap!