Global Energy
Build Bridges, Not Walls

100 Years of Scientific Impact

Dr. Scott W. Tinker
Director

Bureau of Economic Geology
Jackson School of Geosciences
The University of Texas at Austin
Concepts

I. Energy is the engine of modern economies

II. Energy transitions take time

III. Electricity provides the opportunity to deal with carbon

IV. Build bridges for energy security
Global Energy Use

Energy Use (Quadrillion Btu)

- Asia & Oceania
- United States
- Europe
- Eurasia
- Central & South America
- Middle East
- Canada & Mexico
- Africa

87% Fossil Fuels

1 Quad ~ 1 Exajoule ~ 1 Tcf ~ 170 mmbo

Data: EIA, October 2007
Energy End Use

- Conventional Oil
- Natural Gas
- Coal
- Biomass
- Hydro
- Uranium

*U.S. Data*

Data: EIA 2007
Energy Underpins Economies

1980-2004

High Energy Path

Low Energy Path

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

After: Koonin, 2008
US Economy and Oil Price

GDP Growth (% change on 2000 chained 2000 dollars)

Year

Oil Price

- $ of the day
- $ 2007

Data: EIA February 2007 and US Department of Commerce

Nixon | Ford | Carter | Reagan | Bush | Clinton | W Bush

I. Energy is the Engine of Modern Economies
Concepts

I. Energy is the engine of modern economies

II. Energy transitions take time

III. Electricity provides the opportunity to deal with carbon

IV. Build bridges for energy security
Global Oil Reserves & Production

Global Oil Reserves & Production

Primary Energy Demand Forecast

1.25% annual demand growth

Historical Data: EIA October 2007

Global Energy Consumption (quads)

Tinker Forecast

~255Q  ~415Q  ~495Q

1.25% annual demand growth

Global Energy Consumption (quads)

20% Non Fossil

Historical Data: EIA October 2007
Oil Forecast

Source: National Petroleum Council, 2007
U.S. Oil and Natural Gas Drilling Activity

"Windfall Profits" Tax ('80-'88)

- U.S. Crude Oil, Natural Gas, and Dry Developmental Wells Drilled (Count)
- U.S. Crude Oil, Natural Gas, and Dry Exploratory Wells Drilled (Count)
U.S. Oil and Natural Gas Drilling Activity

“Windfall Profits” Tax (‘80–’88)

Proposed Tax Policy

Crude ($2007)
**Natural Gas Forecast**

*Supply = world natural gas production & Demand = world natural gas consumption.*

Data: EIA, October 2007

Source: SPE Paper 68755, National Petroleum Council, 2007
32,560 TcF resources

~ 200 years resources at 150 TcF year

<table>
<thead>
<tr>
<th>Region</th>
<th>Coalbed Methane</th>
<th>Shale Gas</th>
<th>Gas in Tight Sands</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>3,017</td>
<td>3,840</td>
<td>1,371</td>
<td>8,228</td>
</tr>
<tr>
<td>Latin America</td>
<td>39</td>
<td>2,116</td>
<td>1,283</td>
<td>3,448</td>
</tr>
<tr>
<td>Western Europe</td>
<td>157</td>
<td>509</td>
<td>353</td>
<td>1,019</td>
</tr>
<tr>
<td>Central and Eastern Europe</td>
<td>118</td>
<td>39</td>
<td>78</td>
<td>235</td>
</tr>
<tr>
<td>Former Soviet Union</td>
<td>3,957</td>
<td>627</td>
<td>901</td>
<td>5,485</td>
</tr>
<tr>
<td>Middle East and North Africa</td>
<td>0</td>
<td>2,547</td>
<td>823</td>
<td>3,370</td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>39</td>
<td>274</td>
<td>784</td>
<td>1,097</td>
</tr>
<tr>
<td>Centrally Planned Asia and China</td>
<td>1,215</td>
<td>3,526</td>
<td>353</td>
<td>5,094</td>
</tr>
<tr>
<td>Pacific</td>
<td>470</td>
<td>2,312</td>
<td>705</td>
<td>3,487</td>
</tr>
<tr>
<td>Other Asia Pacific</td>
<td>0</td>
<td>313</td>
<td>549</td>
<td>862</td>
</tr>
<tr>
<td>South Asia</td>
<td>39</td>
<td>0</td>
<td>196</td>
<td>235</td>
</tr>
<tr>
<td>World</td>
<td>9,051</td>
<td>16,103</td>
<td>7,406</td>
<td>32,560</td>
</tr>
</tbody>
</table>

Source: SPE Paper 68755, National Petroleum Council, 2007
U.S. Natural Gas Production

- **Total Natural Gas**
- **Conventional Gas**
- **Difference**

Tinker, 2009

U.S. Natural Gas Production

Orange dots are 50 nm in diameter

Areas of higher carbon content

SEM of ion-cut surface

Human Hair

50 µm

SEM from Reed and Loucks

Blakely Well, 7,111′
Coal Forecast

Global Energy Consumption (quads)

Source: National Petroleum Council, 2007

One Large Coal Power Plant

San Gorgonio Pass Wind Farm, California
619 MW Nameplate ~ 216 MW Generation

Horse Hollow Wind Energy Center, Texas
291 1.5 MW and 130 2.3 MW turbines
47,000 acres (190 km²)
735.5 MW nameplate ~ 258 MW Generation

One Large Coal Plant ~ Four Horse Hollows
47,000 * 4 = 188,000 acres = 294 sq mi
Chicago = 228 square miles
With Current Technology

~25,000 Offshore 4 MW Turbines
~100,800 MW Nameplate
35% Capacity Factor
~35,000 MW Actual

~1 Quad
(~170,000,000 BOE)

2008 U.S. Wind Capacity
~22,000 MW Nameplate
Renewables Forecast

42 Q!

~ 7% of 2030 Global Energy Demand
~ 17% of 2030 Electricity Demand

II. Energy Transitions
Take Time
I. Energy is the engine of modern economies

II. Energy transitions take time

III. Electricity provides the opportunity to deal with carbon

IV. Build bridges for energy security
Electricity’s Role

Electricity will play an ever greater role in the energy end use mix.

After Huber and Mills, 2005.
**CO₂ Emissions**

Historical Data: EIA October 2007

![Graph showing CO₂ emissions from 1980 to 2030, with a line indicating extrapolation of current trend. The graph includes bars representing actual emissions and calculated CO₂, with colors indicating CO₂ from oil, gas, and coal.](image-url)

- **Actual Emissions**
- **Calculated CO₂**

Based on Tinker Forecast

**Extrapolation of current trend**

**Global Energy Consumption (quads)**

- 1980: 60.00
- 1985: 80.00
- 1990: 100.00
- 1995: 120.00
- 2000: 140.00
- 2005: 160.00
- 2010: 180.00
- 2015: 200.00
- 2020: 220.00
- 2025: 240.00
- 2030: 260.00

**CO₂ Oil (million metric tons)**
- Actual: [Chart data]
- Calculated: [Chart data]

**CO₂ Gas (million metric tons)**
- Actual: [Chart data]
- Calculated: [Chart data]

**CO₂ Coal (million metric tons)**
- Actual: [Chart data]
- Calculated: [Chart data]
BEG’s Gulf Coast Carbon Center

“Stacked Sinks”

CCS

EOR

CMMVA

+$

-$
Electricity Options

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

- Natural Gas
  - Abundant, reliable, price volatility, and cleaner
  - *Challenges: Global deliverability (LNG) and Access*

- Coal
  - Abundant, reliable, cheap and dirty
  - *Challenge: Sequestration (IGCC w/ CCS), financing, public perception*

- Nuclear
  - Abundant, reliable, moderate price and cleaner
  - *Challenges: Waste disposal, security, public perception*

- Alternatives
  - Cleaner, less reliable and more expensive
  - *Challenge: Capacity impacts cost and reliability*
Electricity Options

III. Electricity Provides the Opportunity to Deal with Carbon

A Grand Challenge: Electricity Storage and Transmission
Concepts

I. Energy is the engine of modern economies

II. Energy transitions take time

III. Electricity provides the opportunity to deal with carbon

IV. Build bridges for energy security
Parameters for Energy Security

- Available
- Affordable
- Reliable
- Clean
Policy for Energy Security

- **Increased Efficiency**
- **Diversify** the global energy portfolio
- **Improved energy Infrastructure**
- **Carbon Price** that is transparent, economy-wide, global, not wasteful. Cap and Trade is none of these.
- **Strengthen global Energy Trade**
- **Dialog** between Developed and Developing Nations
- **Balance global Workforce Demographics**
- **Global Policy** that engages Energy, Economy and Environment
Key Global Bridges for Energy Security

- Energy, Economy, Environment
- Industry, Government, Academe
- Developed and Developing Nations
Summary Concepts

I. Energy is the engine of modern economies
   - fossil fuels provide 87% of today’s energy

II. Energy transitions take time
   - fossil fuels are the stable bridge to an alternate energy future
   - pace of change is limited by scale

III. Electricity use is growing
   - Provides the opportunity to deal with carbon

IV. Build bridges for energy security
Respect those who seek the truth, but be wary of those who claim to have found it…

Mark Twain