The Global Energy Road

• Fossil fuels are the bridge to an alternate energy future.
• Alternate energies will take time, technology, and money to scale up.
• The cost to reduce carbon is high; everyone must play and pay or we risk the global economy.
Main Entry: myth Pronunciation: ˈmɪθ Function: noun
Etymology: Greek mythos Date: 1830

1 a: a usually traditional story of ostensibly historical events that serves to unfold part of the world view of a people or explain a practice, belief, or natural phenomenon b: parable, allegory

2 a: a popular belief or tradition that has grown up around something or someone; especially: one embodying the ideals and institutions of a society or segment of society <seduced by the American myth of individualism — Orde Coombs>

2 b: an unfounded or false notion
Main Entry: par·a·dox Pronunciation: \ˈper-ə-ˈdäks, ˈpa-rə-
Function: noun Etymology: Latin paradoxum, from Greek paradoxon, from neuter of paradoxos contrary to expectation, from para- + dokein to think, seem — more at decent Date: 1540

1: a tenet contrary to received opinion

2 a: a statement that is seemingly contradictory or opposed to common sense and yet is perhaps true

2 b: a self-contradictory statement that at first seems true

2 c: an argument that apparently derives self-contradictory conclusions by valid deduction from acceptable premises
Ten Energy Myths

6. “Big Oil” controls the price of oil and gasoline and makes “obscene” profits.

7. Cutting oil imports will stabilize gasoline prices.

8. Global production of oil and natural gas are “peaking” and we are running out of fossil energy soon.

9. All coal is dirty.

10. The cost of energy increasing.
Ten Energy Myths

1. The US can be energy independent in the next 25 years.

2. “Renewable energy” can reduce dependence on fossil fuels significantly in the next 25 years.

3. The economy will adapt easily to a rapid, federally imposed energy transition.

4. Energy efficiency and savings (alone) will solve the problem.

5. There is plenty of low cost (conventional) oil ready to be found.
Energy Paradoxes

Crisis/Policy Paradox

Sound energy policy is necessary to prevent an energy crisis, yet crisis is seemingly necessary to cause policy to be considered.
Energy Paradoxes

Economy/Carbon Paradox

Emissions from the combustion of fossil fuels enhance global warming which harms the economy, yet a healthy economy relies on fossil energy today.

or

The road to an alternate (clean) energy future must be paved with fossil energy.
Energy Paradoxes

Government/Markets Paradox

Government policies are needed to enhance free market behavior.
Energy Paradoxes

Nationalization/Globalization Paradox

The US should be energy independent in order to remain a global leader in an interdependent world.
Myth 8

Global production of oil and natural gas are “peaking” and we are running out of fossil energy soon.
Global Energy

We depend upon fossil fuels today.

Energy Use (Quadrillion Btu)

Data: EIA, October 2007
We depend upon fossil fuels today.

### US Transportation Energy Demand (2006 Btu)

- **Light-Duty Vehicles**: 4892 Btu
- **Commercial Light Trucks 1**: 264 Btu
- **Buses**: 1333 Btu
- **Freight Trucks**: 611 Btu
- **Air 3**: 147 Btu
- **Water**: 592 Btu
- **Rail**: 688 Btu
- **Lubricants**: 618 Btu
- **Pipeline Fuel Natural Gas**: 16407 Btu
- **Military Use**: 2647 Btu

Data from EIA 2007
Global Reserves and Production

If China and India grow from 1 B/P/Y today to 5 B/P/Y by 2030, it will create 48 MMBD of new demand.
## Options to Conventional Oil

<table>
<thead>
<tr>
<th>Option</th>
<th>Time to Initiate (Yrs)</th>
<th>Impact (+10 Yrs) (MM bpd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhanced Oil Recovery</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Heavy Oils / Oil Sands</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Shale Oil</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Coal Liquids</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Gas-To-Liquids</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Biofuels</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

*after Hirsch et.al, 2005*
One More Option to Conventional Oil...

1 MMBOPD and 1.4 TCFY in 15 years

Access Restrictions

Note: TCF = Trillion Cubic Feet; B-BBL = Billion Barrels.

FIGURE ES-12. U.S. Oil and Natural Gas Resources Affected by Access Restrictions
Global Natural Gas Supply and Demand

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

Data: EIA, October 2007

Year

Natural Gas (Tcf)

Supply
Demand

R/P (yrs)

70

60
U.S. Natural Gas Production

Year

Annual Natural Gas Production (TCF)
0 1 2 3 4 5 6 7 8 9 10

U.S. Natural Gas Production

Total Natural Gas
Conventional Gas
Difference

US Dry Natural Gas Reserves

Technology and Ideas

Source: Energy Information Administration (EIA)
Myth 8 Realities

• Easy to produce (but hard to find!) conventional oil will plateau and then decline; i.e. the conventional oil “plateau”

• Global natural gas production is a few decades away from a plateau

• Easy to find (but hard to produce!) unconventional oil and natural gas are playing a growing role (function of environmental policy, economics and technology)

• Fossil fuel resources combined (oil, natural gas and coal) could provide over two hundred years at current consumption rates
Myth 2

“Renewable energy” can reduce dependence on fossil fuels significantly in the next 25 years.
Global Energy Consumption

H/C<1
(Wood, Coal)

H/C~2
(Oil)

H/C>4
(Natural Gas, Nuclear, All others)

Sound energy policy is necessary to prevent an energy crisis, yet crisis is seemingly necessary to cause (poor) policy to be considered.

and

The road to an alternate (clean) energy future must be paved with fossil energy.
Myth 2 Realities

• Energy is not “renewable”

• One of the great challenges of alternate energy is scale

• Energy transitions take time and are expensive

• Oil is beginning to plateau

• Disruptive breakthroughs in electricity storage and transmission are needed to facilitate alternate energy
Myth 1

The US can be energy independent in the next 25 years.
US Economy and Oil Price

GDP Growth (Percentage points at annual rates)
Crude Oil Domestic Wellhead Price ($2000)

Data: EIA February 2007 and US department of Commerce

Year
Electricity’s Role

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

Total Energy

Energy used to produce electricity

After Huber and Mills, 2005.
Electricity

- Transportation
- Heat
- Coal
- Hydro
- Uranium

Data from EIA 2007
Electricity Options

• 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*

• Renewables
  – Cleaner, less reliable and more expensive
  – *Challenge: Capacity impacts cost and reliability*

• Efficiency
  – Fuel, lighting, electronics, insulation
  – *Challenge: Rebound effect*
Global Carbon Emissions

Annual Anthropogenic CO2 (mmT)

- NA
- Europe
- Africa
- ME
- Eurasia
- Asia & Oceania
- Cent & SA

EIA, 2007
Emissions from the combustion of fossil fuels enhance global warming which harms the economy, yet a healthy economy relies on fossil energy today.

and

Government policies are needed to enhance free market behavior.
Myth 1 Realities

• The world is “flattening;” resource interdependence is becoming the norm

• Independence requires realistic, scalable alternatives, which take time and are very expensive ($ trillions)

• Concerns about climate and security have placed the public sights squarely on fossil energy, especially coal and oil

• Energy and economies are inextricably linked and mandated transitions don’t really work
Summary Thoughts

• The Three E Waltz (Energy, Economy, Environment) is a sensitive dance

• Oil and natural gas provide nearly 2/3 of the world’s energy

• We need to be realistic about a carbon constrained world
  – It is coming, it will take time, it won’t be cheap
  – Everyone needs to play and pay
  – Research funding and talent are vital
  – Government, private, academic partnerships