Outline

- What is Peak Oil?
- What is the Problem?
- The Era of Easy Oil is Over
- The Current Global Oil Picture
- Biomass to the Rescue?
- Delusions over Brazil
  - Why Brazil can’t be a model for the world
  - Brazil versus U.S. energy statistics
- Rise of the Snake Oil Salesmen
  - The TDP Story: A cautionary tale
- Energy Policy Mistakes
  - Solutions that would make a difference
Peak Oil

- Peak oil is the point at which oil production rates begin an irreversible decline
- Peak oil is NOT a theory
- Peak oil does not mean we are running out of oil
- Peak oil dates for various countries
  - Germany – 1966
  - USA – 1970 (peaked at 9.6 million bpd; currently at 5)
  - UK - 1999
  - Norway – 2000
  - Mexico – 2004

- The global peak?
  - Maybe last year, maybe in 5 years, but without a doubt a problem that the world must soon contend with
The Threat from Peak Oil

- Oil is presently the lifeblood of the global economy
- The global transportation system – and thus global trade – is utterly dependent upon cheap oil
- Industrial agriculture is enabled by cheap fossil fuels
- Modern militaries can’t function without oil
- Modern society that has been arisen over the past 100 years has done so on the back of cheap oil
- Societies deprived of cheap oil will struggle – North Korea, Japan, Cuba
- *Globalization makes it impossible for societies to collapse in isolation* – Jared Diamond
Notable Viewpoints

- Domestic demand in Saudi Arabia is forecast to rise by 250% by 2030 - Khalid A. Al-Falih, Saudi Aramco President and CEO
- By 2012, surplus oil production capacity could entirely disappear, and as early as 2015, the shortfall in output could reach nearly 10 million barrels per day - US Joint Forces Command
- Non-OPEC production peaked in 2006; global production to peak in 2014 - Department of Petroleum Engineering, Kuwait University
The Easy Oil is Gone

Conventional Oil: Discoveries vs. Production

Graphic Source: Colin Campbell
Global Oil Picture

- Global oil production – 85.4 million bpd*
  - On a plateau since 2005
  - Some spare capacity, but...
    - Projects are being delayed – setting up price surges
    - The “incident” in the Gulf of Mexico will hasten the decline

- The good news
  - U.S. oil demand down 1.2 million bpd from 2004-2008

- The bad news
  - Largely induced by crippling prices and recession
  - Demand from China and India up by 1.9 million bpd
  - Oil at $70-$80/bbl the new norm

- How does the recession end if oil prices remain at recession-inducing levels?
Biomass
Biomass as a Solution?

- Replacing current consumption of fossil fuels with biomass IS NOT POSSIBLE
  - Photosynthetic efficiency is too low
  - Each year we burn >400 years of ancient biomass*
  - That biomass was processed with heat and pressure courtesy of Mother Nature in fossil fuels

- “Renewable” energy is often heavily dependent on fossil fuels

- Two examples of presently energy intensive processes in the renewable energy world
  - Cellulosic ethanol
  - Algal biofuel

*Burning Buried Sunshine: Human Consumption of Ancient Solar Energy
Pseudo-Renewable Energy

- Is the renewable fuel renewable?
- The energy balance matters
  - How many units of fossil fuel to produce a unit of renewable energy?
  - How many BTUs to transport renewable energy (1/3rd of the energy density of oil)
- If production costs are high because energy inputs are high, you have a receding horizon problem
  - Cost position may worsen as oil prices increase
- The problem of receding horizons
  - "Oil Shale Development Imminent" – headline circa 1900
  - When oil was $20/bbl, oil shale needed $40/bbl
  - At $80/bbl, oil shale still not economical
While the U.S. has been successful at rapidly ramping up corn ethanol, it barely registers on the scale of our petroleum demand.
Brazil
Can the World Emulate Brazil?

- "As a result [of ethanol], Brazil has virtually stopped importing expensive foreign oil." – Dan Rather in *The Ethanol Solution*

- "If Brazil can do it, so can we." – Bill Clinton, promoting California’s Prop 87

- "As Brazil's 'energy independence miracle' proves, an aggressive strategy of investing in petroleum substitutes like ethanol can end dependence on imported oil." – Vinod Khosla and Tom Daschle in *Miles per Cob* (a New York Times editorial)

- "I'm driving a Chevrolet in the middle of Brazil on ethanol, pure ethanol, not a drop of oil, imported oil in this tank. And here is the stuff grown all around us that is the fuel. So I'm thinking, why can't I do this in America? Why aren't we doing it?" – Frank Sesno in CNN’s *We Were Warned*
Energy Policy in Brazil

- Sugarcane ethanol has long been a cornerstone of Brazil’s energy policy.
- Can be produced from byproduct molasses – food and fuel.
- The key to the process is bagasse:
  - A readily available energy source for fueling boilers.
  - Minimal fossil fuel inputs relative to corn ethanol.
Reality Check

- Annual ethanol usage in Brazil: 0.33 barrels* per person
- Annual oil usage in Brazil: 4.4 barrels per person
- Oil still supplies more than 90% of Brazil’s transportation needs
- Brazil celebrated energy independence in 2006
  - Brazilian President Luiz da Silva made the announcement on the P-50 oil rig in the Albacora Leste field in the Atlantic Ocean

* Barrels of oil equivalent (BOE)
Reality Check – It Gets Worse

- Annual oil usage in US: 23.4 bbl/person*
- Annual oil usage in Brazil: 4.4 bbl/person
- Annual oil production in US: 8.1 bbl/person
- Annual oil production in Brazil: 3.5 bbl/person
- U.S. supply imbalance: 15.3 bbl/person
- Brazil’s supply imbalance: 0.9 bbl/person

Consumption and production are:
- Grossly unbalanced in the US
- Fairly balanced in Brazil

So, how can the US emulate Brazil?
- By cutting oil consumption by 2/3rds
- Or by tripling oil production

* Consumption and production figures are from 2008
Rise of the Pretenders
Anything into Oil: The TDP Story

“Technological savvy could turn 600 million tons of turkey guts and other waste into 4 billion barrels of light Texas crude each year” – Discover Magazine, May 2003

The thermal depolymerization process can convert a wide range of waste materials into oil and other useful by-products, in proportions that vary according to the specific type of feedstock run through the works:

<table>
<thead>
<tr>
<th>100 POUNDS OF:</th>
<th>PLASTIC BOTTLES: 70 pounds oil, 16 pounds gas, 6 pounds carbon solids, 8 pounds water</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLASTIC BOTTLES: Clear (polyethylene terephthalate) and translucent (high-density polyethylene)</td>
<td>MUNICIPAL LIQUID WASTE: 26 pounds oil, 9 pounds gas, 8 pounds carbon and mineral solids, 37 pounds water</td>
</tr>
<tr>
<td>MUNICIPAL LIQUID WASTE: 75 percent sewage sludge, 25 percent grease trap refuse</td>
<td>Tires: 44 pounds oil, 19 pounds gas, 42 pounds carbon and metal solids, 4 pounds water</td>
</tr>
<tr>
<td>TIRES: All kinds, including standard rubber and steel-belted radials</td>
<td>HEAVY OIL: 74 pounds oil, 17 pounds gas, 9 pounds carbon solids</td>
</tr>
<tr>
<td>HEAVY OIL: Refinery residues, heavy crude oil, and tar sands</td>
<td>MEDICAL WASTE: 65 pounds oil, 10 pounds gas, 5 pounds carbon and metal solids, 20 pounds water</td>
</tr>
<tr>
<td>MEDICAL WASTE: Transfusion bags, needles and razor blades, and wet human waste</td>
<td></td>
</tr>
</tbody>
</table>
Everything’s Coming Up Roses

- From May 2003 Discover Magazine
- The price is right
  - “We will be able to make oil for $8 to $12 a barrel”
- The technology sounds futuristic
  - “thermal depolymerization process”
- The cast is interesting
  - “a tall, affable entrepreneur”
  - “a team of scientists, former government leaders, and deep-pocketed investors”
- The awards and accolades rained down...
The Bloom Comes Off

- Discover Update, April 2006
  - “We were too aggressive in our earlier projections”
  - “Production costs turned out to be $80 per barrel” (as crude oil was trading at $40/bbl)
  - “Construction problems”
  - “Odor problems”

- Complete failure to deliver
- Company now bankrupt
Lessons Learned (or not)

- It is easy to fool people with ‘new technology’
- The potential problems of scaling up a process tend to be underestimated
- Small problems in the lab are big problems at scale
- Technical vetting and critical analyses are often lacking
- Failure to understand the idea that:

Killing cancer cells in the lab is not the same as curing cancer
So What to Do?
Solutions

- Cease the delusions of ‘cheap gas for everyone’
  - Cheap gas encourages fossil fuel consumption
- Trade off fossil fuel taxes for income taxes
  - Rebate income taxes to make it revenue neutral
  - Encourages energy conservation
  - Encourages alternatives
  - Encourages mass transit
- Encourage behaviors that reduce energy consumption
  - Rebates for solar water heaters, fuel efficient cars
Key Questions for Alternatives

- Is the process enabled by fossil fuels?
- Does the process impact food supplies?
- Can the process operate without straining water supplies?
- Does the process lower the soil quality?
- Does the process impact local biodiversity?
- What are the emissions from the process?
Conclusions

- The world is collectively asleep at the wheel
- The future will arrive regardless of whether you plan for it
- None of us expect our houses to burn down
  - But if it does, the consequences are great
  - Thus, we carry insurance
- The consequences of peak oil are far greater, yet we have no insurance policy
- The good news is that there is enough solar energy falling on the earth to sustain a good quality of life – if we ever resolve the technical challenges of efficiently storing and later using the energy
Recommended Reading

- Crude World by Peter Maass – to help put into perspective the price of our oil dependency
- The Long Emergency by Jim Kunstler – to scare you into action
- The Hirsch Report by Robert Hirsch – to convince you that delaying action will be far more problematic than facing the problem now
- The Oil Depletion Protocol by Richard Heinberg – to see one possible course of action
Thank You