Oil Depletion and the Future of Globalization

Think Global – Act Local

ACEEE Summer Study, 2007

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What is Peak Oil?

- Peak Oil will occur when the global production of oil peaks and begins an inevitable decline.
- The real energy crisis begins not when the world runs out of oil, but when global production begins an inexorable decline.
What is Peak Oil? (cont.)

- In 1956, M. King Hubbert, a Shell Oil geologist, predicted that Peak Oil for the US would occur in the 70’s, and it did, in 1970. US discoveries had peaked in the 30’s.

- Both discoveries and production were plotted as Bell Curves, with the production curve lagging by about 35 years.
What is Peak Oil? (cont.)

- Global discovery of oil peaked in 1964.

- When will Peak Oil arrive?
  - T Boone Pickens (Texas oilman), “The peak is now”.
  - Kenneth Deffeyes, (Petroleum geologist and Princeton professor) – Thanksgiving 2005
  - Uppsala Hydrocarbon Depletion Study Group - 2008
  - US Energy Information Agency - 2037
When will the peak in natural gas production occur?

- 2019  Oil & Gas Journal (8/16/04)
- 2030  Jean Laherrere, ASPO Berlin (5/25/04)
  Association for the Study of Peak Oil & Gas
  (www.peakoil.net)
- 2010  Projected peak of oil and gas combined
  (and conventional oil peaked in 2004)
  Association for the Study of Peak Oil & Gas
What is Peak Oil? (cont.)

- Natural gas production has exceeded discovery since 1990.
- Non-OPEC gas production will peak before 2015.
Oil and Gas Combined Peak

ASPO: OIL & GAS PRODUCTION PROFILES
2005 Base Case

Gboe


Regular Oil ■ Heavy etc □ Deepwater □ Polar ■ NGL ■ Gas ■ Non-Con Gas
Global Discovery and Production of Conventional Oil

THE GROWING GAP

Past discovery based on ExxonMobil (2002). Revisions backdated.
What is Peak Oil? (cont.)

- Recent Discovery Trends for Major Oil/Gas Fields (over 500 million boe)
  - 16 in 2000
  - 8 in 2001
  - 3 in 2002
  - 1 in 2003
  - 0 in 2004
  - 1 in 2005

(Source: Petroleum Review, January 2004, and Oil Depletion and Analysis Centre, January 2006)
What is Peak Oil? (cont.)

- Current Production Trends (Mega projects with 500 million boe and 100,000 b/d)
  - 2005: 7 projects (<1 million b/d)
  - 2006: 9 projects (~2 million b/d)
  - 2007: 9 projects (~1 million b/d)
  - 2008: 9 projects (~2 million b/d)
  - 2009: 1 project (~1 million b/d)
  - 2010: 2 projects (<1 million b/d)

(Source: Petroleum Review, October 2005)
Why the Range in Forecasts?

**Technical Assumptions:**
- Reserve Base (1,800 - 3,900 Billion bbls)
  How much remains in the Middle East?
- Demand Growth (1 – 3%/yr)
- Reserves to Production Ratio after the Peak (R/P = 10)

**Political Considerations:**
- OPEC Production Quotas
- Domestic Implications of Peak Oil
- Supply derived from projected growth rates
Alternative Forecasts of Peak Oil: EIA

Figure 2. Annual Production Scenarios with 2 Percent Growth Rates and Different Resource Levels (Decline R/P=10)

<table>
<thead>
<tr>
<th>Probability</th>
<th>USGS Estimates of Ultimate Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (95%)</td>
<td>2,248 BBls</td>
</tr>
<tr>
<td>Mean (expected value)</td>
<td>3,003 BBls</td>
</tr>
<tr>
<td>High (5%)</td>
<td>3,896 BBls</td>
</tr>
</tbody>
</table>

Source: Energy Information Administration
Note: U.S. volumes were added to the USGS foreign volumes to obtain world totals.
Alternative Forecasts of Peak Oil: EIA

Figure 3. 12 EIA World Conventional Oil Production Scenarios

- USGS Estimates of Ultimate Recovery
- Ultimate Recovery BBls
- Probability
  - Low (95 %): 2,248
  - Mean (expected value): 3,003
  - High (5 %): 3,896

- Peak Range 46 yrs or 91 yrs
- 3 % Growth
- 2 % Growth
- 1 % Growth
- Decline R/P = 10
- 900 Billion Bbls Moves Peak 10 Years From 2037 - 2047

Source: Energy Information Administration
Note: U.S. volumes were added to the USGS foreign volumes to obtain world totals.
Global demand is currently 85 million bbl/day (International Energy Agency, 2005) and rising, especially in China, India, the US, Russia and OPEC.

- 3.4% growth in 2004. 2.7% in 2005
- Demand in developing world may accelerate.
What is Peak Oil? (cont.)

- The stress on global production capacity has caused the recent volatility in world oil prices, and OPEC target price range has jumped from 22 - 28 $/bbl to 60 - 70 $/bbl.
- OPEC at full production in early 2006. Cuts in late 2006 to protect price range.
- Geopolitical instability (the curse of oil).
- In 2006, up to 54 of 65 largest producing countries have passed their peak.
- When Non-OPEC production peaks ~2010, what can OPEC (Saudi Arabia) do?
What is Peak Oil? (cont.)

What are the implications of Peak Oil?

- National Security:
  Most future oil and gas is in the volatile Middle East.¹

- Economic:
  Stagflation and $100/bbl for oil (if you can get it!).²

- International Relations:
  Resource wars (the winner gets it!).³

1. PFC Energy, September 2004
   “Crude Awakening” by Michael T. Klare
Recent Oil Price Trends
# The Future Price of Oil

## Near Term Peak Oil Scenario (Before 2020)
- Supply surplus declines from 1.5 million bbl/day (MBD) to 0 MBD
- OPEC hoarding for domestic markets and/or higher profits
- Demand growth remains high (above 2%)
- Recent discovery and production trends continue (mega projects)
- Geologic limits
- New production primarily from Saudi Arabia/Middle East

Price Impact: $(>\$100/\text{bbl})$
Exception: Recessions or worse

## Long Term Peak Oil Scenario (After 2020)
- Supply surplus grows from 1.5 MBD to 6 or 7 MBD by 2010
- OPEC strives to maintain supply surplus
- Demand growth declines (below 2%)
- New technology and much higher investment finds and produces more oil
- New production primarily from Saudi Arabia/Middle East

Price Impact: $(\leq \$40/\text{bbl})$ until supply surplus is gone
Exceptions: Demand or Geopolitics
Hedberg Research Conference: Understanding World Oil Resources (November 2006)
Hedberg Research Conference (Cont.)

Key Findings

- Peak Oil not imminent (after 2020)
- The “peak” will be a high plateau
- Peak production ~ 90-100 million b/d
- 10-20% higher than 2005
- Achieving this production will require massive sustained industry effort
- Achieving this production will require an accommodating political environment
“Peak Oil Theory is Garbage!”

Figure 2
United States Production, Hubbert versus Actual

Source: Cambridge Energy Research Associates.
©1019-1
What will the Peak look like?

- An analysis by Robert Hirsch of SAIC, published in World Oil magazine (October 2005)
  - In all cases studied, it was not obvious that production was about to peak one year prior to the event
  - The peaks were sharp, not gently varying bell curves and not flat topped
  - Post-peak production declines were much greater than the assumed 2%
Other Recent Peak Oil Studies

- **US Army Corps of Engineers (September 2005)**
  - **Energy Trends and Their Implications for U.S. Army Installations**
    - “The US economy uses 50% more energy per unit of GDP than the other developed nations of the world (EIA 2004). The fossil fuel-based, automobile-centered, throw-away economy is not a viable model for the United States or the rest of the world over the long term. It is not sustainable. (p.53)”
    - “This disproportionate [US] consumption of energy relative to global consumption causes loss of the world’s good will….A more equitable distribution of resources is in our best interest for a peaceful future. (p. iv)”
Conventional Oil Peaked in 2004

- From now on, depletion will outweigh new supply of conventional oil
- 3% annual depletion
- Unconventional oil must meet global demand growth and net depletion
- Unconventional oil will be primarily deepwater oil (now) and tar sands (after 2009)
- Future capital costs and oil prices will continue upward trend of last five years

(CIBC World Markets, December 2006)
When will all Liquid Fuels Peak?

Chris Skrebowski, Editor, Petroleum Review

- Supply will remain tight and prices high barring a major economic setback
- Oil supply will peak in 2010/2011 at around 92-94 million b/d
- Oil supply in international trade may peak earlier than oil production peak
- Collectively we are still in denial
Has Liquid Fuel Peaked in 2006?
(Crude, NGL, Other Liquids, Biofuels)
When to Prepare for Peak Oil

- Mitigation efforts will take decades

  - It takes 12 to 15 years for major technological transformations to go from 10-90% adoption\(^1\)

  - “Prudent risk management requires the planning and implementation of mitigation well before peaking. Early mitigation will almost certainly be less expensive and less damaging to the world’s economies than delayed mitigation”\(^2\)

1. RMI, *Winning the Oil Endgame*, 2004
2. DOE, *Peaking of World Oil Production: Impacts, Mitigation, & Risk Management*, 2005
Some Big Peak Oil Mitigation Questions

- How do we motivate mitigation actions before depletion leads to (very high) oil price signals?
- How will much higher energy prices impact the global economy?
- How do we currently use petroleum products and natural gas?
- What are the potential targets and strategies for reducing oil and natural gas dependencies?
How Do We Motivate Mitigation Actions?

- Both regulation and price signals, **BUT**
- Energy taxes or carbon taxes?
- Issue: Outsourcing of energy consumption and CO$_2$ emissions
- Embodied emissions (and energy) in imported goods are significant and growing proportion of total GHG emissions.
- Tax imports or ignore GHG (and energy) outsourcing?
How Do We Motivate Mitigation Actions (cont.)?

<table>
<thead>
<tr>
<th>U.S. Embodied Emissions</th>
<th>1997</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO₂ emissions from imports (%)</td>
<td>9-14</td>
<td>13-30</td>
</tr>
<tr>
<td>CO₂ emissions from imports (gigatons)</td>
<td>0.5-0.8</td>
<td>0.8-1.8</td>
</tr>
<tr>
<td>SO₂ emissions from imports (10⁶ Tons)</td>
<td>2.4-5.0</td>
<td>3.8-11.9</td>
</tr>
<tr>
<td>NOₓ emissions from imports (10⁶ Tons)</td>
<td>1.9-2.9</td>
<td>2.6-5.9</td>
</tr>
</tbody>
</table>

(Weber and Matthews, July 2007)
Impacts of Peak Oil on the Global Economy

Six recurring themes:

- Business travel and shipping will decline and efficiency of both will improve
- All fuel prices will increase significantly
- Renewed emphasis on energy productivity
- Electrification, fuel switching and dual fuel capability will increase
- Natural gas curtailment for industry will increase
- Interest in renewable energy will increase greatly.
The Largest Opportunities for Business to Reduce Oil and Gas

- Transportation
- Space heating
- Process heating
- Water heating (boilers)
- Electric loads
Structural Changes to Economy from Peak Oil

- Economic contraction will reduce certain global markets
  - Transportation equipment
  - Construction equipment
  - Process industries (Chemicals, Paper, Metals, Glass, Plastics)
  - Consumer products/durable goods
  - Traditional agriculture (field crops and meat production)

- Service industries will contract with decline in consumer spending
  - Air travel
  - Restaurants
  - Entertainment
  - Tourism (foreign and long distance)
Structural Changes to Economy from Peak Oil (cont.)

- Some manufacturing industries will grow
  - Electric utilities and their equipment suppliers
  - Alternative energy industries
  - Advanced materials suppliers for transportation sector
  - Relocalized manufacturing sectors:
    - Food processing
    - Agriculture
    - Greenhouse production agriculture
    - Recycling and remanufacturing industries
    - Low cost commodities with relatively high transport costs
Structural Changes to Economy from Peak Oil (cont.)

- New economic trends will expand certain service industries
  - Energy efficiency services industry
  - Alternative energy services industry
  - Local tourism and recreation
  - Home based entertainment and recreation
How Can The World Prepare for Peak Oil?

- Understand new economic trends resulting from Peak Oil (very high energy prices).
- Adopt a global Oil Depletion Protocol.
- Develop national/local initiatives to limit future oil and gas demand
  - Implications of land use development patterns for building and transportation energy demand
  - Regionalization of building practices, manufacturing and food production.
Three Principles of Industrial Relocalization

- Meet essential needs (food, shelter and others) as locally as possible, taking into account bio-regional strengths and weaknesses.
- Minimize transport of higher volume, lower-cost goods and commodities.
- Focus global trade on low-volume, high-cost specialist technology that facilitates local production of essential high-volume, low-cost goods and commodities.

(“Think Globally, Manufacture Locally” Josh Floyd. July, 2007)
Benefits of Industrial Relocalization

- Domestic socioeconomic benefit of diversified, localized economy more resilient to energy supply and cost challenges of peak oil.
- Reduction of imports will reduce growth in national debt.
- Reduction of carbon emissions.
- Potential for humanitarian benefits for workers in poor countries (Fair Trade vs. Free Trade).

(Josh Floyd, July 2007)
Conclusions

- Peak Oil will bring considerable change to the global economy.
- New growth industries can help mitigate job losses brought on by structural shifts.
- Mitigation efforts should begin at least 15 years before the onset of Peak Oil.
- Most projections of Peak Oil are before 2020.
- As is often true in life, denial will only make things worse.
Related Web Links

- www.postcarbon.org
- www.oildepletionprotocol.net
- www.energybulletin.net
- www.energypreparedness.net
- www.museletter.com
- www.willitseconomiclocalization.org
- www.peakoilnyc.org