World Petroleum Markets
What the Past Tells Us About the Future

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Senate Staff Briefing
Capitol Hill
Washington, DC

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Washington, DC
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Introduction

Energy Policy Research Foundation Inc. (EPRINC), formerly the Petroleum Industry Research Foundation Inc. (PIRINC)

Founded in NY in 1944

- Moved to Washington from NYC in Feb 2007
- EPRINC brings policy analysis and industry economics to bear on current energy issues

*Note: All data in this presentation are from EIA unless otherwise noted. Summary conclusions, comments, etc, are the sole responsibility of EPRINC.*
Topics for Today

• EPRINC’s Perspective on Structure and Pricing in the Upstream Crude Market (some history is useful)

• Why Are Crude Prices So High Today?

• What Does History and the Structure of the Crude Oil Market Tell Us About Policy Choices (and what is the problem we are trying to fix?)

• Assessments of Trends in US and World Petroleum Product Markets
1973-74 Arab Oil Embargo

NOT AN EMBARGO, but instead a

• Structural Shift in Ownership and Control of the Resources of the Middle East

• Fundamental Change in Expectations on Production from Middle East Producers

As an Embargo it was a failure, market was integrated (lesson not yet learned by Chavez)
1979 Price “Shock”

OIL MARKET WAS NOT FRAGILE, but instead there was a shift in:

- Expectations regarding regional risk; i.e. more risky

- Prospects for future output from Iran and Iraq were reduced substantially, i.e., access to those reserves would now be delayed
1986 Price Collapse

- Saudi Arabia abandons role as swing producer at low levels of net demand for SA crude

- Shift in expectations on Saudi decision making within OPEC and as regulator of world oil market

- Sustained reduction in oil use as a percentage of GNP in major Western countries
1998 Price Collapse: Six Central Issues

Asian economic crisis brings a collapse in net demand

- OPEC misreads the oil market
- Warm 1997-98 summers in N. America, Europe, Asia
- Increase in Russian oil exports as Ruble collapses
- Chinese authorities decrease imports in Q4 of 1998
- UN authorizes increase in Iraqi exportation in 1998
- Asian economic crisis brings a collapse in net demand
The Peak Oil Problem:
New Supplies Will Be More Expensive,
but We Are Not Running Out of Oil

"One thing is clear: the era of easy oil is over. What we all do next will determine how well we meet the energy needs of the entire world in this century and beyond."
- David J O'Reilly, Chairman & CEO, Chevron Corporation, July 2005
A Series of Unfortunate Events Leading to New Expectations

Positive Expectations

- Oil development in Iraq delayed
- Yukos -- Kremlin taking control of Russian oil development
- OPEC Excess Capacity remains limited
- Outlook positive for expanded output from Nigeria, Mexico, Venezuela, Russia, North Slope

Expectations Shift

- Continuing civil strife in Sudan, Nigeria
- Congress continues ban on ANWR and offshore development
- Nigeria rebels hurt output

Negative Expectations

- Russia takes over Sakhalin II, Chavez Nationalizes Projects
- Korea takes over Russian oil development
- Oil development in Iraq delayed
- Continuing civil strife in Sudan, Nigeria
- Congress continues ban on ANWR and offshore development
- Nigeria rebels hurt output

World Oil Production (EIA)
Expected Production (EIA 2001 Predictions)
Crude Oil Price

Graphs showing changes in oil production and price over time.
## San Joaquin Valley

Testing Hubbert-Method Predictions for Reserves and Production

(Billions of Barrels)

<table>
<thead>
<tr>
<th>Year</th>
<th>Cumulative Discoveries</th>
<th>Percent Attributable to 1915</th>
<th>Cumulative production as of</th>
<th>Year 2000 production projected in: (mb/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1964</td>
<td>7.7</td>
<td>49%</td>
<td>8.0-9.5</td>
<td>44-112</td>
</tr>
<tr>
<td>1982</td>
<td>11.8</td>
<td>69%</td>
<td>11.9-12.1</td>
<td>189</td>
</tr>
<tr>
<td>2000</td>
<td>16.1</td>
<td>76%</td>
<td>16.1-16.2</td>
<td>597 (actual)</td>
</tr>
</tbody>
</table>

Source: EPRINC, October 2006. *Does the Hubbert Method Provide a Reliable Means for Predicting Future Oil Production*, Richard Nehring, October 2006,
## Permian Basin
Testing Hubbert-Method Predictions for Reserves and Production  
(Billions of Barrels)

<table>
<thead>
<tr>
<th>Year</th>
<th>Cumulative Discoveries</th>
<th>Percent Attributable to 1950</th>
<th>Cumulative production as of</th>
<th>Year 2000 production projected in: (mb/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1964</td>
<td>17.6</td>
<td>85%</td>
<td>19-27.5</td>
<td>162-479</td>
</tr>
<tr>
<td>1982</td>
<td>27.9</td>
<td>86%</td>
<td>28.5-30.5</td>
<td>326-479</td>
</tr>
<tr>
<td>2000</td>
<td>35.2</td>
<td>84%</td>
<td>35.8-37.5</td>
<td>910(actual)</td>
</tr>
</tbody>
</table>

Source: EPRINC, October 2006. *Does the Hubbert Method Provide a Reliable Means for Predicting Future Oil Production*, Richard Nehring, October 2006,
What Does the Permian and San Joaquin Tell Us About the Hubbert Predictions?

- Knowledge and technology grow over time
- Big payoff to long term access to both existing and new oil provinces
- More importantly Hubbert Method does not reveal...........
  - The Backstop Price
  - Total Recovery
What Does This Analysis Tell Us About the Energy Security Problem?

• Current Market Price Probably Tied to a “Perfect Storm” of Unfortunate Events – More Than Declining Reserves (Peak Oil)

• Longer Term Energy Security Problem Remains “A Concentration of Low Cost Reserves Among Relatively Few Players.”

• This Concentration of Low Cost Reserves Poses Risks to the US (wealth transfers, price spikes)

• Focus on Import Dependence Not Likely to Fundamentally Address Energy Security Problem and Can Be Costly. Policy Focus Should be On Reducing Vulnerability.

• What Would be the Elements of an Effective Strategy Given This Analysis?
# Gulf of Mexico Deepwater Frontier Exploration and Production Timeline

## Individual Prospect: 5,000' Water Depth, 30,000' Drilling Depth

<table>
<thead>
<tr>
<th>Cost (millions)</th>
<th>Cumulative Cost (millions)</th>
<th>Activity</th>
<th>Lease Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1-5</td>
<td>$1-5</td>
<td>Acquire 2D and 3D seismic and evaluate geological, geophysical and engineering data to identify leads/drilling ideas.</td>
<td>-3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prepare bids for lease sale.</td>
<td>-3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13</td>
</tr>
<tr>
<td>$10-200</td>
<td>$11-205</td>
<td>Lease sale - sealed competitive bidding process.</td>
<td>-3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13</td>
</tr>
<tr>
<td>$1-2</td>
<td>$12-207</td>
<td>High bid lease awarded (10 year term). Cumulative annual lease rentals.</td>
<td>-3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13</td>
</tr>
<tr>
<td>$5-10</td>
<td>$17-217</td>
<td>Acquire and interpret 3D and other data to turn ideas into drilable prospects.</td>
<td>-3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Find partners to share costs to drill exploratory well.</td>
<td>-3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Perform shallow hazard, archeological and other regulatory permitting requirements to obtain Federal approval to drill.</td>
<td>-3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Contract a rig to drill.</td>
<td>-3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13</td>
</tr>
<tr>
<td>$100-150</td>
<td>$117-367</td>
<td>Drill exploration well.</td>
<td>-3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13</td>
</tr>
<tr>
<td>$40-60</td>
<td>$157-427</td>
<td>Drill sidetrack to exploration well.</td>
<td>-3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Evaluate results.</td>
<td>-3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13</td>
</tr>
<tr>
<td>$100-300</td>
<td>$257-727</td>
<td>If encouraging, drill appraisal/delineation well(s) and sidetrack(s).</td>
<td>-3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Evaluate well results, formulate plan of development for discovery.</td>
<td>-3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prepare and file permits for development, wait for approvals.</td>
<td>-3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13</td>
</tr>
<tr>
<td>$1,000-5,000</td>
<td>$1,300-5,700</td>
<td>Sanction commerciality, build and install facility, drill and complete producing wells to achieve production.</td>
<td>-3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13</td>
</tr>
</tbody>
</table>

**Legend:**
- Pre-lease evaluation
- Lease Term
- Exploration Phase
- Development Phase

**Discovery:** If exploration well unsuccessful, start process over.

**1st Production:**
Some Questions on Expanding Domestic Leasing

• What is the nature of the E&P Process?
• Should we provide more leasing opportunities when so much land is already under lease?
• What are the environmental risks?
• Can production in the future effect prices today?
• How does more domestic oil fit in with efforts to transition to the fuels of the future?
Refined Oil Products, etc.

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World Oil Production and Consumption, 2001-2008

Source: U.S. Energy Information Agency
World Petroleum Consumption and Refining

* Global excess capacity until early 1990s - investment climate?

* 2003: Demand catches up with capacity - China?

* 2007: Demand exceeds capacity?

Declining Dollar Value Relative to Foreign Currency Basket


Source: U.S. Federal Reserve
$135 today would be $93 if the $ value didn't change

Source: EPRINC calculations : U.S. Energy Information Agency,
U.S. Federal Reserve
What’s a Refinery?

- **gases**
  - Isomerization
  - Catalytic Reforming
  - Alkylation
  - Fuel Gas
  - Propane
  - Gasoline Blendstocks
  - Jet Fuel
  - Diesel Fuels and Heating Oils
  - Gasoline and Distillate Blendstocks
  - Lubricating Oils
  - Coke
  - Asphalt

- **naphthas**
  - Hydrotreating
  - Fluid Catalytic Cracking
  - Hydrocracking
  - Lubricants
  - Atmospheric Distillation

- **distillates**
  - Atmospheric Distillation

- **gas oils**
  - Vacuum Distillation

- **residue**
  - Coking
  - Deasphalting
  - Vacuum Distillation
U.S. Oil Refineries History: 1970 - Present

* Many sub-economic, small refineries -- some couldn't make unleaded mogas

* Geographic population shift; local crude supply ran out

* Large scale called for; water access for supply-product distribution; major pipeline access
U.S. Oil Refineries History: 1970 - Present

- 1970s: The Small Refiner Bias in the 1973 price control program encouraged the building of excess small refineries.
- 1979: Price controls end.
  - Closure of small, uneconomic units - adversely impacted by population and crude supply shifts.
  - Capacity at existing, better-located facilities expanded.
    - Remaining refinery campuses become bigger, more efficient.
- Mid-1990s: Capacity grows; demand grows faster.
- 2000s: More investment needed to expand existing refineries.
  - Regulatory issues
  - Capital requirements and investment decisions

What happened to “Refining’s Golden Age?”
Modular Investment in Refinery Upgrades

Need to:

1. Make high specification products
2. Make cleaner gasoline
3. Make gasoline for ethanol blending
4. Make ultra-low sulfur diesel (ULSD)
5. Make across-the-board sulfur reduction
6. Adjust to declining crude quality
7. Reduce refinery site emissions
U.S. Retail Prices: Gasoline vs. Diesel
2006 - 2008

Diesel is $0.70 /gal above gasoline
Gasoline and Distillate Prices: NYH vs. Rotterdam - 2006 - 2008

• 2006/7: Gaso & distillate prices track. NYH gaso has summer spike.

• 2007/8: World distillate prices exceed gasoline.

Source: U.S. Energy Information Agency

Note tight refiner margin.
Recent refiner margin compression

Source: U.S. Energy Information Agency
Gasoline Imports as Percentage of Consumption: 2005 - 2008

Note recent decline in gaso imports

Source: U.S. Energy Information Agency

Note expanded refiner margin.

Source: U.S. Energy Information Agency

Distillate Imports as % of Consumption

Source: U.S. Energy Information Agency
US Ethanol Consumption: 2006 - Present

Mandate requirement assumes 750 million gallons per month for 12 months to reach the 9 billion gallon mandate for 2008.

Source: Renewable Fuels Association
US Ethanol Consumption: 2006 - Present

• Quick ramp-up made it look easy—but really was displacement of MTBE
• Ethanol does not displace much foreign oil. 6 bil gallons per year of ethanol saves approx 100 million bbls of oil.
• Corn prices have risen from $1.60 to $7.00. How much attributable to ethanol driven demand? $1.00? $2.00?
• At $1.00/bu, oil saved cost $130/bbl; at $2.00/bu, the figure is $230 per bbl.
• Current Ethanol Economics Looks Dicey—With high corn prices, low fuel ethanol prices, existing plants earn losses.
• Existing plants have 7 bil gal capacity; mandate calls for 2 bil more
• Plants under construction and planned may not be completed/brought on line
• If corn prices remain stable at current levels, ethanol prices must rise by at least $0.50 per gallon in order for ethanol to be sufficiently profitable to attract investment.
• More capacity needed to meet 9 bil gal mandate for 2008
CBOT Ethanol Futures versus CBOT Corn Futures

Corn and Ethanol prices go **wrong** way

![Graph showing the correlation between Corn and Ethanol Futures prices](image)

Correlation -- 0.1088
# Ethanol Production Cost

## Ethanol Production Cost ($/gal.)

<table>
<thead>
<tr>
<th>Cost</th>
<th>Wet Mill</th>
<th>Dry Mill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>0.30</td>
<td>0.30</td>
</tr>
<tr>
<td>Miscellaneous Inputs</td>
<td>0.56</td>
<td>0.52</td>
</tr>
<tr>
<td>Corn ($6/bu)</td>
<td>2.31</td>
<td>2.14</td>
</tr>
<tr>
<td>Co-product credit</td>
<td>-1.03</td>
<td>-0.41</td>
</tr>
<tr>
<td>Subtotal</td>
<td>2.14</td>
<td>2.55</td>
</tr>
<tr>
<td>Remaining To Cover Fixed Costs/Profit</td>
<td>0.36</td>
<td>-0.05</td>
</tr>
</tbody>
</table>

Sources: Simmons & Company International; EPRINC Calculations