( or How Not to Transition to the Fuels of the Future)

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“The New Basics”

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What Do Policy Makers Believe?

Petroleum import dependence is a good measure of vulnerability

Petroleum likely to be in short supply – need directed and crash program to transition to the fuels of the future (peak oil).

Alternative fuels/technologies yield high environmental benefits, improve energy security, are cost-effective---and generate lots of jobs.

....but a look at the numbers does not support the belief structure and policies supporting these assumptions are increasing the financial risk to the industry.

THIS IS YOUR TAKE AWAY!!!!!!!!!!!!!!
Conventional Wisdom -- Just 5 Short Years Ago

World to Face Large Scale Shortages in Refining Capacity

No Major Large Scale Additions Likely in Petroleum Reserves (peak oil) – prices will rise to well over $100/bbl.

U.S. to Face Natural Gas Shortages – Massive Commitment to Domestic LNG Receiving Facilities

Developing World (particularly China, India) – Liquids Demand to Double in 10 years

Latin America has been Fully Explored
The Peak Oil Problem: How Serious?

"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

Global Production, million b/d

Positive Expectations

- Oil development in Iraq delayed
- Iraq invasion: outlook positive for new oil field rehabilitation
- Outlook positive for expanded output from Nigeria, Mexico, Venez., Russia, North Slope

Expectations Shift

- Yukos -- Kremlin taking control of Russian oil development
- Russia takes over Sakhalin II, Chavez Nationalizes Projects
- Congress continues ban on ANWR and offshore development
- OPEC Excess Capacity remains limited

Negative Expectations

- Continuing civil strife in Sudan, Nigeria
- Oil development in Iraq delayed
- Congress continues ban on ANWR and offshore development
- OPEC Excess Capacity remains limited
- Congress continues ban on ANWR and offshore development

World Oil Production (EIA)
Expected Production (EIA 2001 Predictions)
OPEC Excess Capacity (EIA)
Crude Oil Price

2001 2002 2003 2004 2005 2006 2007 2008e

Global Production, million b/d

Crude Oil Price per barrel ($/bbl)
## Permian Basin

**Testing Hubbard-Method Predictions for Reserves and Production**

*(Billions of Barrels)*

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

Source: EPRINC, October 2006. *Does the Hubbard Method Provide a Reliable Means for Predicting Future Oil Production*, Richard Nehring, October 2006,
IRAQ

A Series of Fortunate Events Leading to New Expectations?
"We did a private evaluation of Iraq’s oil resources for the government...We believe they are probably greater than Saudi Arabia’s."

—an executive of one of the original Aramco partners, and an Aramco Board member, in a private conversation in 1987
Expected Iraqi Production Growth Excluding Auctioned Projects

- **Kirkuk (Incremental)**
- **Other Northern fields**
- **Kurdistan (foreign companies)**
- **Ahdab**
- **Nassirya**
- **Burzurgan**
Iraqi Production Growth Under Several Scenarios

- **Contracted Volumes - First Scenario**: 75% of Targets in 2017 and 100% in 2020
- **Contracted Volumes - Second Scenario**: 50% of Targets in 2017 and 75% in 2020
- **Expected Growth Excluding Auctioned Fields**
- **Base Production**

Graph showing production growth from 2010 to 2020 in thousand barrels per day.
What Happened to the Natural Gas Shortage?

January 28, 2010
Davos, Switzerland

Unconventional gas will transform the entire energy production landscape in the United States and alters the U.S. energy outlook for probably a hundred years*

Tony Hayward
Chief Executive Officer
BP plc

*In 2009 the United States became the world’s largest producer of natural gas
U.S. Proven Gas Reserves Since 1980

~50% increase in 8 years – nearly all from shale gas
U.S. Shale Supply Cost Curve

Source: Wood Makenzie, EPRINC calculations
World LNG and Unconventional Gas Production

- 10% of global gas production (most of it in the US)
- 44% of US gas production
- Australia, India, Indonesia, and other places
- Europe now receiving attention

Source: SH
A Quick Look at America’s Most Successful Alternative Fuels Program

.......ethanol
EISA ’07 Renewable Fuels Standard

Source: DOE, EIA Data and June 2009 STEO. Blend wall assumes projected 2009 gasoline consumption found in the June 2009 EIA STEO.
Approaching the Blend Wall

- **U.S. Product Supplied of Finished Motor Gasoline (Thousand Barrels per Day)**
- **Ethanol Component of Gasoline Supply**
- **Theoretical Blend Wall (10% of National Gasoline Pool)**

The chart shows the trend of U.S. product supplied of finished motor gasoline, the ethanol component of gasoline supply, and the theoretical blend wall over the years from January 2000 to December 2009.
The Blend Wall and the Value of Ethanol

Ethanol has a high value as an oxygenate, but...

It must then compete with gasoline on a BTU basis

The cost of corn feedstock is more valuable than the ethanol it produces when ethanol is discounted to RBOB on a BTU basis

- Ethanol Futures Price
- RBOB Futures Price
- Corn Feedstock Costs Per Gallon of Ethanol (at $5/bushell, 2.8 gallons per bushell [USDA Estimate])
- Ethanol Blend VALUE Relative to RBOB (On a BTU Basis)
FFVs and E85 Usage

Source: EIA Data, DOE Data, EPRINC Calculations
Figure 1. Net Lifecycle Greenhouse Gas Emissions By Lifecycle Component With 100 Year Time Horizon And 2% Discount Rate.
What Were They Thinking?

• 15 billion gallon mandate easily achievable with growing gasoline demand -- blend wall would not exceed 10% (2007 forecast environment).
• Gasoline prices would rise – making ethanol cost competitive – an antidote to high gasoline prices.
• Mandates were needed to overcome resistance from the petroleum industry.
• Rural renaissance.
• And besides – it would deliver substantial benefits in lower emissions of GHGs.
What did they miss?

- Gasoline demand did not grow, prices fell.
- RFS mandates were volumetric – driving fuel sector to the blend wall in next year or two.
- Ethanol not cost competitive under most scenarios.
- Ethanol substitutes for gasoline -- not crude oil -- leading to refinery output inefficiencies.
- Food versus fuel problem.
- Carbon benefits under attack from ILUC.
OK That’s Not So Great...

But What About Electric Cars, Cash for Clunkers, and LCFS
**2030/2035 Technology Comparison**

**Plug-in hybrid and conventional hybrid offer same GHG on U.S. average grid**

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**2006 Baseline:**
- 8.85 L/100 km
- 252 g CO₂/km
## Cost and Effectiveness of Cash for Guzzlers Program

**Baseline=18 mpg, 12,000 VMT**

<table>
<thead>
<tr>
<th>Voucher Value</th>
<th>Program Cost for One Million Vehicles</th>
<th>Gallons Saved Per Vehicle, Annually</th>
<th>Total Fuel Savings for One Million Vehicles Over Eight Years, Gallons</th>
<th>Cost Per Gallon Saved Over Eight Years</th>
<th>Fleet Fuel Consumption Reduction Compared to 2008 Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Car, +4 MPG</td>
<td>$3,500</td>
<td>$3,500,000,000</td>
<td>121.2</td>
<td>969,600,000</td>
<td>$3.61</td>
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<tr>
<td>New Car, +10 MPG</td>
<td>$4,500</td>
<td>$4,500,000,000</td>
<td>238.1</td>
<td>1,904,800,000</td>
<td>$2.36</td>
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<tr>
<td>New Light Truck/SUV, +2 MPG</td>
<td>$3,500</td>
<td>$3,500,000,000</td>
<td>66.7</td>
<td>533,600,000</td>
<td>$6.56</td>
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<tr>
<td>New Light Truck/SUV, +5 MPG</td>
<td>$4,500</td>
<td>$4,500,000,000</td>
<td>144.9</td>
<td>1,159,200,000</td>
<td>$3.88</td>
</tr>
</tbody>
</table>

Sources: EIA Data, EPA Data, EPRINC Calculations
Note: US LCFS limits leads to significant reductions in emissions attributed to the LCFS, but these reductions are largely offset by increased emissions in the rest of the world: Canadian oil sands go elsewhere & most increased biofuel use is at the expense of biofuel use elsewhere.

Source: Unpublished research from US DOE.
Policy Implications

Energy Security – more closely linked to volatility instead of dependence.

Oil Shortages and Peak Oil—backstop price for petroleum likely to be well below $100/bbl. Iraq, and abundance of natural gas likely to drive down and/or limit large increase in backstop price.

Expensive and state directed strategies (e.g., US commitment to electric cars, ethanol, bio-diesel) pose severe and difficult to manage financial risks----potential for paradigm shifts and failure modes remain high.

America’s largest renewable fuels program (ethanol) is broken, expensive, and facing growing fiscal fatigue.

Market developments (in the real world) will force a much slower and lower cost transition to the fuels of the future. Proceed with Caution!!