## MAJOR OIL EXPORTING NATIONS

<table>
<thead>
<tr>
<th>Country</th>
<th>1990</th>
<th>2000</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saudi Arabia</td>
<td>6.1</td>
<td>7.8</td>
<td>28%</td>
</tr>
<tr>
<td>Russia</td>
<td>3.2</td>
<td>4</td>
<td>25%</td>
</tr>
<tr>
<td>Iran</td>
<td>2.2</td>
<td>2.6</td>
<td>18%</td>
</tr>
<tr>
<td>UAE</td>
<td>2.2</td>
<td>2.2</td>
<td>—</td>
</tr>
<tr>
<td>Venezuela</td>
<td>2</td>
<td>2.7</td>
<td>35%</td>
</tr>
<tr>
<td>Iraq</td>
<td>1.7</td>
<td>2.6</td>
<td>53%</td>
</tr>
<tr>
<td>Norway</td>
<td>1.5</td>
<td>3.2</td>
<td>113%</td>
</tr>
<tr>
<td>Libya</td>
<td>1.3</td>
<td>1.5</td>
<td>15%</td>
</tr>
<tr>
<td>Mexico</td>
<td>1.3</td>
<td>1.7</td>
<td>31%</td>
</tr>
<tr>
<td>Nigeria</td>
<td>1.2</td>
<td>2</td>
<td>67%</td>
</tr>
<tr>
<td>Kuwait</td>
<td>1.2</td>
<td>2</td>
<td>67%</td>
</tr>
<tr>
<td>Algeria</td>
<td>1</td>
<td>1.4</td>
<td>40%</td>
</tr>
</tbody>
</table>
## Major Oil Consuming Nations

<table>
<thead>
<tr>
<th>Country</th>
<th>1990</th>
<th>2000</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>16.9</td>
<td>18.7</td>
<td>11%</td>
</tr>
<tr>
<td>Japan</td>
<td>5.3</td>
<td>5.5</td>
<td>4%</td>
</tr>
<tr>
<td>Russia</td>
<td>5</td>
<td>2.5</td>
<td>-50%</td>
</tr>
<tr>
<td>Germany</td>
<td>2.4</td>
<td>2.8</td>
<td>17%</td>
</tr>
<tr>
<td>China</td>
<td>2.3</td>
<td>4.8</td>
<td>109%</td>
</tr>
<tr>
<td>France</td>
<td>1.8</td>
<td>2</td>
<td>11%</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>1.8</td>
<td>1.7</td>
<td>-6%</td>
</tr>
<tr>
<td>Canada</td>
<td>1.7</td>
<td>1.8</td>
<td>4%</td>
</tr>
<tr>
<td>India</td>
<td>1.2</td>
<td>2.1</td>
<td>75%</td>
</tr>
<tr>
<td>South Korea</td>
<td>1</td>
<td>2.2</td>
<td>120%</td>
</tr>
</tbody>
</table>
Energy Consumption as an Indicator of the Wealth of Nations

The world’s 15 largest economies

Per capita income vs. Per capita oil consumption (bbl/yr)
China vs US Consumption

• In the last decade China’s oil consumption increased by 2.5 million barrels per day, the largest in the world by far. (The US consumption increased by 1.8 million barrels per day)

• If China were to use the same per capita consumption, as the US, it would require 80 million barrels per day (more than the entire world use.)
Energy Consumption per Dollar of GDP

Energy use per unit of gross domestic product (Mbtu/$)


UK  Industrial Revolution  Cars for the Masses  End of WWI

US  End of WWII

Japan  Arab Oil Embargo

Developing World

Source: DOE/EIA, 2000, Skov, 2000, DOC/BEA 2001, National Academy of Engineering, 1990
Economides and Oligney “Twist” Forecast of World Energy Consumption
Hydrogen a Historical Imperative

Source: Robert Hefner
The New Energy Economy

Increasingly:
- Clean
- Energy intensive
- Technologically sophisticated
- Distributed

Carbon content:
- High
- Medium
- Low
- (Zero)

The emerging “hydrogen economy” better characterized as a “fuel cell economy” that will run on natural gas--i.e. a “natural gas economy”
LNG/CNG

• Market “regionality”
• Entry point is key
• Many options for supply chain
LNG transport

• 130 LNG tankers worldwide (March 2002)
• Standard ship size 138,000 cubic meters, up from 87,000 cubic meters used in Kenai
• Two 145,000 cubic meter tankers under construction
• Two major containment systems:
  – Moss spherical tanks
  – Membrane tanks
  – Each has skirt welded around tank and insulation
LNG tanker underway

Photo Courtesy of BP
Stranded Gas Worldwide

World stranded natural gas reserves amount to approximately 2,842 Tcf. The Former Soviet Union and Middle East account for 46 and 37 percent of the stranded gas reserves.
CNG vs. LNG

- renewed interest
- major advantage in terms of market entry
- much less capital deployed in country
- up to 2 Bcf on a ship
- ideal for limited supply, limited consuming markets
- preferential to LNG for short hauls (cost of CNG transport is all in the boats)
CNG Tanker
The Color of Oil is “Red”
The Color of Oil is (still) “Red”
The Color of Oil is (a mitigated) “Red”
Most threatening oil crisis brewing in Venezuela

By LUIGI SAPUTELLI

Oil experts in Houston and elsewhere are worried about the possible impact of an oil disruption from the Middle East. But there is an emerging crisis in the Venezuelan oil industry that could have a far more dire and lasting impact on the U.S. petroleum supply than any Mideast oil embargo.

The United States imports 1 million barrels of crude oil plus an additional million barrels of refined products each day. The impact on my country of Venezuela is likely to be far worse. As of Tuesday, the entire country was shut down.

Last week, the public affairs director of Petróleos de Venezuela, or PDVSA, and another executive were fired “for cause.” Monday, five more senior executives were fired and 12 others were forced into early retirement. Some refineries have been shut down completely and crude oil production will most certainly be affected. At issue is the blatant and very simplistic politicization of the company, a venerable institution in Venezuela and the source of much of the country’s income and economic activity.

PDVSA has long been a beacon of hope for the country, a progressive enclave of professional people where meritocracy ruled. The best and the brightest of my Chavez people.

Mandini did not last long. Seven months later, he was unceremoniously canned and replaced by a highly unqualified ideologue, Hector Ciavaldini, who started a process of “purification.” Ciavaldini, a relatively low-level ex-PDVSA employee, had no discernible status among PDVSA professionals or managers. His only qualification was his allegiance to the government (and his animosity toward the old management). New appointments, not just to key positions, but also to run-of-the-mill, routine jobs were, firstly, ideologically based. Merit was only as an afterthought. Government loyalist vigilantes were installed in the board of directors.

Both Ciavaldini’s management, but especially his moves, brought about a quick reaction among PDVSA professionals and a large public outcry. What was happening was a stark departure from decades of practices. Continued unrest brought another swift change. Ciavaldini was replaced by an army general who had no previous connection with PDVSA. Gen. Guicaipuro Lameda took over as PDVSA president in October 2000 with some obvious apprehension by the staff. Yet, his tenure was probably not what the government had expected. From the beginning, one of his stated tasks was to depoliticize the company. He ran the company as a progressive entity that responds to internationally recognized business practices and not...
CHINA ENERGY
An Analysis

• Energy consumption about 40 Quads per year (10% of the World total)
• Third largest oil consumer, approaching 5 million barrels per day
• China will surpass Japan, perhaps by 2010
• In 2020 our estimates suggest 11 million barrels of oil per day.
• Major geopolitical player in energy
• Offshore oil production will certainly need beefing up. Bohai Sea looks interesting but not yet spectacular. Maximum daily production cannot exceed 1 million barrels per day. Ultra-deep water activity has yet to begin
• Onshore production, accounting for over 90% of domestic production will likely decline fast.
• We are estimating that Daqing, China’s largest field will begin declining within 2 to 3 years
• Both Daqing and Liaohe will require considerable re-engineering and technology and operational optimization
The Bohai Sea Petroleum Developments
South China Sea and the Disputed Offshore Areas
CHINA ENERGY

- Foreign ventures will bring substantial benefits but the Chinese companies still need considerable improvement in the international theaters, especially in oil trade.
- CNPC stake in Kazakhstan’s Aktobemunaigaz will depend on the mechanism of exploiting the oil. Pipeline from Kazakhstan to China? Reserves may not be there to justify line.
CHINA ENERGY

• Pipeline from Siberia makes a lot of sense. Yukos is capable of delivering more than 500,000 barrels per day in Tomsk region.

• Transneft pipeline to Nakhodka on the Pacific Coast of Siberia, or a variant, will be built for at least 1 million barrels per day. China would receive most of this oil.
Selected Gas Export Pipeline Proposals from Eastern Russia

CHINA ENERGY

• In my view, natural gas, accounting for less than 1 Quad (3% of Chinese energy demand) is the major future energy source of the country.
• Reserves stand at 48 Tcf, which may be less than 5% of the actual potential.
• Xinjiang will become an “energy superpower” inside China. The recently awarded to Shell and others West-to-East pipeline must be considered as the beginning of a pipeline corridor.
• Siberian gas from Irkutsk is also possible in the near future.
Potential Natural Gas Supply Routes for China
What a market-driven pipeline corridor looks like.
China Long-Term

• Energy will be China’s choke point
• Expect a very assertive, if not belligerent, posture. This would be the normal expectation
  – Geopolitically, seeking the same energy sources as the US
  – Domestically, embarking on massive nuclear development (with all its other ramifications)
China Long-Term

• Major opening for the US to “join them instead of fighting them”
  – Provide technological solutions instead of global competition and a new Cold War
  – China maybe the first to massively use hydrogen as mobile energy with nuclear as stationary energy. It would require “disruptive” technological leap...US would be essential