EMERGING UNCONVENTIONAL LIQUID PETROLEUM OPTIONS

Presented at the annual

EIA Energy Outlook and Modeling Conference

March 27, 2006

Washington, D.C.

by

Dale Simbeck

SFA Pacific, Inc.

444 Castro Street, Suite 720
Mountain View, California 94041
web home page: www.sfapacific.com

phone: 1-650-969-8876
fax: 1-650-969-1317
e-mail: info@sfapacific.com

SFA Pacific, Inc.

Presentation Overview

Background

- SFA Pacific
- When will the oil age peak
- Impacts of higher oil prices
- What happens if we really move into a carbon constrained world

Unconventional oil supply options

- CO_2 enhanced oil recovery (EOR)
- Oil sands & ultra heavy oil
- Oil shale
- Oil substitution - clean alternative liquid fuels via syngas-to-liquids (STL) from natural gas, coal & biomass plus ethanol & biodiesel

Outlook and Summary

SFA Pacific, Inc.

SFA Pacific Background

Founded in 1980

Performs technical, economic & market assessments for the major international energy & engineering companies

- Over 40% of our work is consistently outside the United States

Principal work involves heavy oil upgrading, syngas (H_2 & CO), electric power generation & emissions control

Niche is objective outside opinion & comparative analysis before companies make major decisions or investments

Unique perspective with no vested interest in engineering, resources, technologies, R&D or project development

SFA Pacific, Inc.

Famous Hubbert Curve Peak Oil Analysis

In 1956 M. King Hubbert, a Shell Oil geologist, predicted USA domestic oil production would peak in the early 1970s

- In spite of much ridicule from his peers, he was correct for the USA
- This famous paper was focused on promoting nuclear energy and also predicted that USA NG would peak in 1973 & world oil would peak in 2000 at 33 million bbl/d, both quite wrong
- Hubbert curve analysis continues today by mostly oil peak "doomsayers" who are usually predicting the oil peak is only few (2-5) years away for the last 26 years (since the 1980 oil price price run-up)

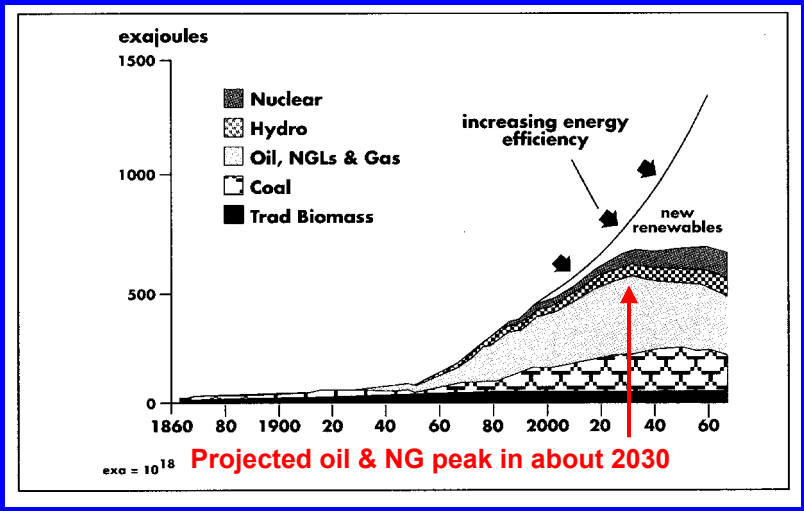
Hubbert peak curve analysis is based on a bell curve analysis with the key input being a fixed recoverable resource

- Fixing the recoverable resource is questionable due to our poor ability to predict future technology improvements & impact of oil prices

SFA Pacific, Inc.

Shell's Famous 1996 World Energy Supply/Demand Projection

Shows the long-term importance of increasing efficiency & new renewables

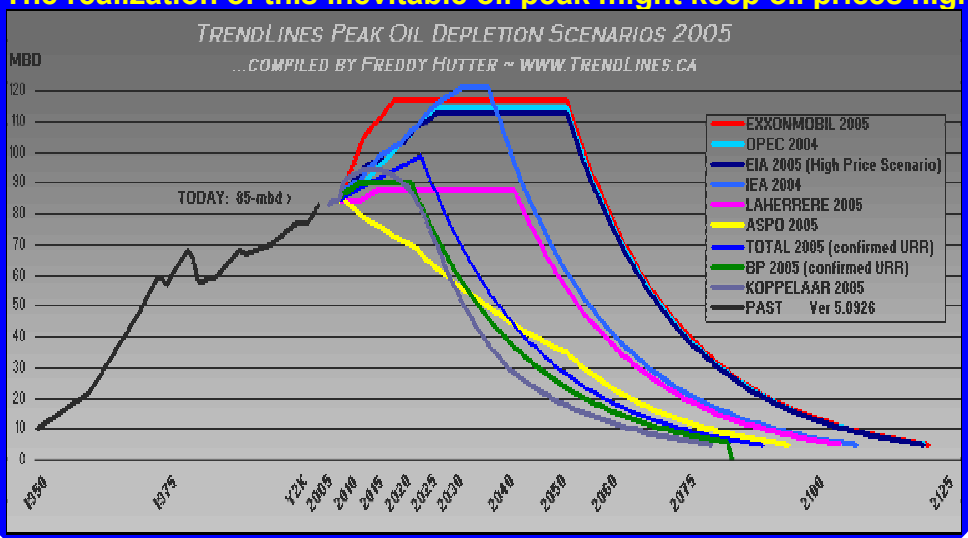


Source: Paper by C.A. Herkstroter (managing director of Royal Dutch Shell), "A Continuing Contribution--Oil and Gas in the 21st Century", presented at Nymphenburg Talk, Munich, June 19, 1996

SFA Pacific, Inc.

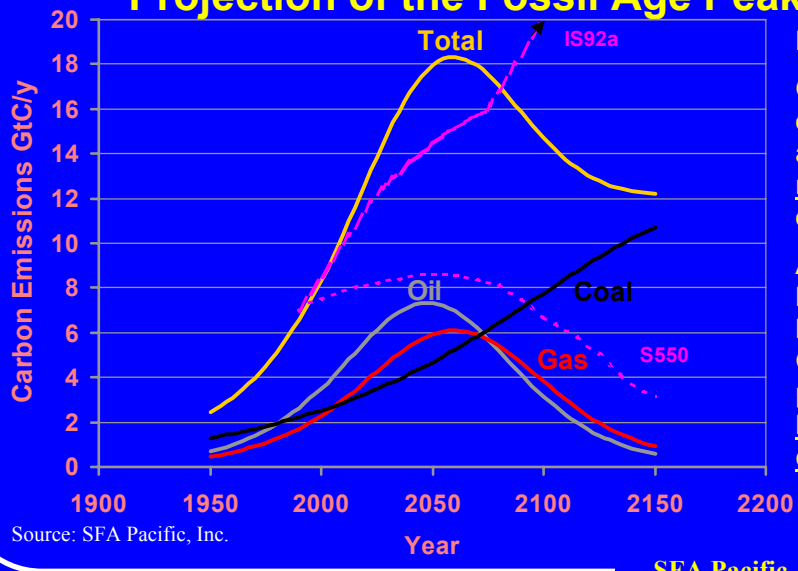
Big Range In Current Oil Peak Projections

The realization of this inevitable oil peak might keep oil prices high



SFA Pacific, Inc.

SFA Pacific's Worst (Latest) Case Projection of the Fossil Age Peak



Source: SFA Pacific, Inc.

Note:

CO_2 emissions as carbon not units of energy

Also the IPCC IS92a beyond 2050 Gt/y carbon projection is highly questionable

SFA Pacific, Inc.

Hubbert Curve Oil Peak Doomsayers Commonly Ignore Several Basic Issues:

How consistently wrong everyone's past projections have been, being too negative or conservative on future oil supplies

Typical remaining oil in place (ROIP) is still 60-70% of the original oil in place (OOIP) when defined as unrecoverable

- Long-term it is likely reasonable to expect doubling of total production to ROIP down to only 30-35% of OOIP
- Increasing oil recovery via improving technologies & higher oil prices

Unconventional oil options, the focus of this presentation

The inevitable oil peak will be when oil supplies vs. demand makes oil prices high enough that other options become more economical - we are only running out of cheap oil

SFA Pacific, Inc.

High Oil Prices Generates More Conservation Plus Increased Oil Supplies & Oil Substitution

Oil conservation driven by higher fuel prices (oil price & taxes)

- Large potential in just replacing current 15 mpg SUVs with 30 mpg clean diesels & hybrid SUVs
- Large potential by also reducing vehicle weight - smaller & lighter SUVs & autos, regardless of power source - 15 mpg SUV vs. 60 mpg compact

Increased oil supplies from unconventional oil such as: CO_2 EOR, heavy oil, oil sands & shale oil - driven by high oil prices

Oil substitution via syngas-to-liquids (STL) from remote natural gas (GTL) & coal (CTL) - become economical at high oil prices

However, 5-10 years lag time due to the long life of energy use equipment & high capital cost of energy investments

SFA Pacific, Inc.

What If We "Really" Moved Into a "Carbon Constrained World"

Conservation & energy efficiency significantly increase as energy prices rise to reflect increasing realization that oil & NG could peak in 10-40 yr.

Natural gas demand/prices go up while coal & oil residue demand/prices go down as CO_2 avoidance & emission cost gains "real" market values

Nuclear will eventually make a big comeback, however, not for 20-30 years, until life-extensions & upgrades + eventual decommissioning of current fleet + we honestly assess why nuclear power failed the 1st time

Renewables become increasingly important but have limitations

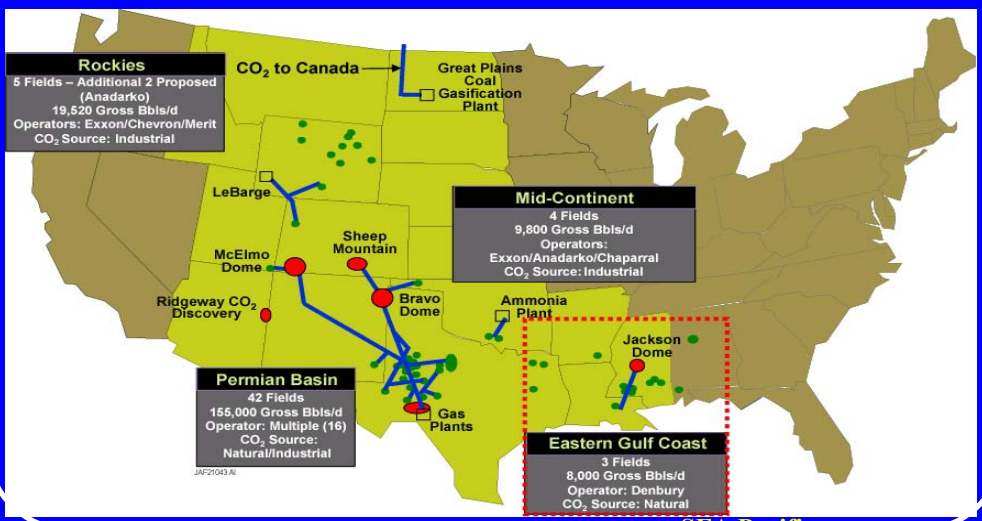
- Intermittent solar PV & wind turbines cannot replace baseload coal power
- Beyond waste biomass, bioenergy requires cheap land & ultra-cheap labor

CO_2 capture & storage (CCS) of fossil fuels becomes strategic for technical, economic, energy resource & overall reduction perspectives

- Once big coal CCS units can co-process biomass for "double reductions"

SFA Pacific, Inc.

Over 25 Years of Experience - Currently 35 Million t/y CO_2 Storage (with 30% from Anthropogenic CO_2 Sources) producing 250,000 bbl/d of Enhanced Oil Recovery (EOR)



SFA Pacific, Inc.

CO_2 EOR CCS Using Anthropogenic CO_2

State/ Province	Plant Type	CO_2 Million t/yr	EOR Fields	Operator
Texas	Gas Processing	1.6	Sharon, Ridge, etc.	ExxonMobil
Colorado	Gas Processing	1.3	Rangely	ChevronTexaco
Oklahoma	Fertilizer	0.7	Purdy, Sho-Ven-Tum	Anadarko/ Chaparell
Wyoming	Gas Processing	3.6	Lost Soldier, Salt Creek	ExxonMobil
Alberta	Ethylene Plant	0.5	Joffre Viking	Numac Energy
Saskatchewan & North Dakota	Coal Gasification	2.0	Weyburn	EnCana
		------		
North American Total		9.7 million tons per year CO_2		

This is almost 30% of the total North American EOR of about 35 million t/y

For comparison North Sea Sleipner Aquifer CO_2 injects only 1.0 million t/y

SFA Pacific, Inc.

Large CO_2 EOR Opportunity While Also Reducing CO_2

Currently 0.25 million bbl/d EOR while storing 35 million t/y CO_2 with total USA domestic oil production at only 5 million bbl/d and total USA proven reserves of only 21.9 billion bbl

Feb. 2006 DOE Report by ARI estimate of USA EOR potential:

- 582 billion barrels OOIP & 389 billion barrels ROIP (67% of original IP)
- 47 billion barrels (*economic potential, current technology*)
- 89 billion barrels (*technical potential, current technology*)
- 129 billion barrels (*technical potential, advanced technology*)
- Exploitable U.S. CO_2-EOR potential up to 3 million bbl/d by 2020
  - CO_2 requirements - about 0.5 billion t/yr CO_2 or 9% of U.S. total

EOR is currently limited by CO_2 supplies - must develop cost effective man-made CO_2 supplies as this is a big "win-win"

SFA Pacific, Inc.

Large CO_2 EOR Potential Gaining Support

North Sea: BP announced NG to H_2 for power with CO_2 capture for EOR
Statoil & Shell - NG to power & MeOH with CO_2 capture for EOR

California: BP announced refinery coke gasification for H_2 to power with CO_2 for local EOR

East Texas: Strong Texas State government supporting refinery coke or coal gasification to refineries H_2 & power with CO_2 capture for EOR

Western Canada: Considering CO_2 pipeline for Fort McMurray oil sands upgrading sources of CO_2 for EOR amenable oil fields near Edmonton

Alaska North Slope: Considering CO_2 from clean-up of NG for the planned North Slope NG pipeline with CO_2 capture for EOR

Expanding existing CO_2 EOR systems + additional potential in other North American oil fields (including Midwest & Mexico)

SFA Pacific, Inc.

Oil Sands and Ultra-Heavy Oil

Alberta, Canada - Heavy oil and mostly "oil sands"

- Recoverable resource estimated at >180 billion bbl - big increase due to the development of Steam Assisted Gravity Drainage - SAGD
- Oil sands production already 1 million bbl/d & conservatively estimated to grow to 3 million bbl/d by 2020 - $70 billion being invested
- Total resource about 1,600 billion bbl

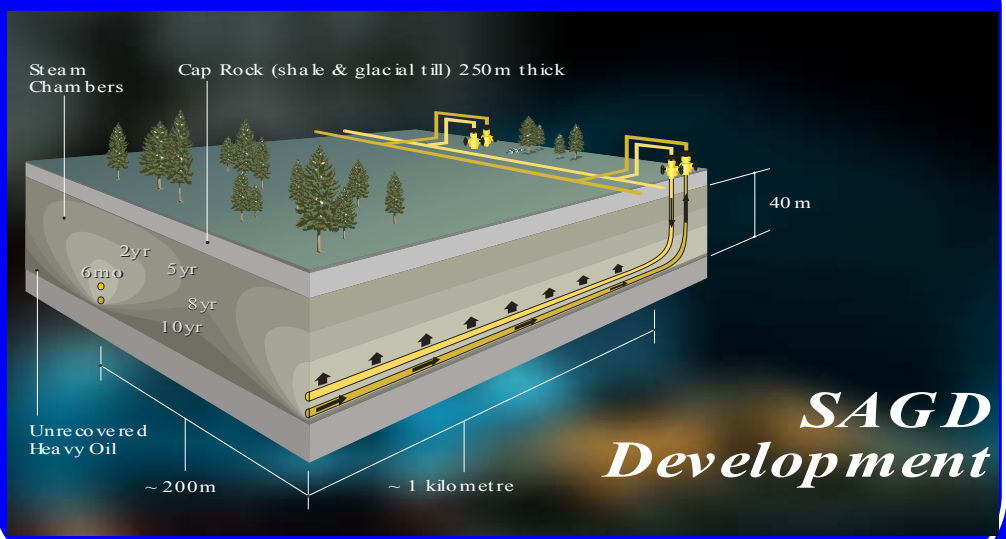
Venezuela - mostly Orinoco "extra heavy crude"

- Recoverable resource estimated at 272 billion bbl
- Current production total approaching 3.5 million bbl/d with 0.5 million bbl/d from Orinoco but political instability hurting growth
- Total resource about 1,900 billion bbl

Other steam stimulated heavy oil EORs in USA & Mexico

SFA Pacific, Inc.

Steam Assisted Gravity Drainage



Source: Suncor

SFA Pacific, Inc.

Oil Shale

Perhaps the most technically & economically challenging unconventional oil resource

- Due to the low energy (oil) content per ton of oil shale "rock"
- However, massive resource (over 1,500 billion bbl in just the USA) thus the size of the recoverable "reward" warrants high risk R&D efforts
- Innovative R&D efforts underway by several major energy companies

Will likely require innovative new in-situ process to:

- Reduce massive solids handling, thermal processing & water use
- Avoid massive CO_2 emissions of carbonate rock calcinatiion

Oil shale is an important domestic oil resource, however impacts likely minor for the next 25 years

- Nevertheless, expect some innovative demonstrations in the future

SFA Pacific, Inc.

Oil Substitution at High Oil Prices via Syngas (H_2 & CO)-to-liquids (STL)

Growing F-T diesel + some methanol, ethanol, mixed alcohol, dimethyleither & even H_2 (for FCV) as transportation fuels

- Syngas-to-liquids via remote natural gas GTL: already 50,000 b/d with >1 million b/d F-T & MeOH under development in Qatar, Nigeria & Iran
  - Higher capital & lower efficiency than LNG but GTL gives better net-back value & market flexibility to the remote NG resource owner
- Syngas-to-liquids via coal CTL: already 150,000 b/d F-T operating in South Africa with >400,00 b/d being proposed in Australia, China & U.S.
  - Very high capital & low efficiency requires cheap coal & high oil prices
- Coal gasification for syngas-to-liquids or H_2 has nice co-benefits
  - Can easily co-feed what ever waste fuels are available, like waste biomass
  - Large pure CO_2 vent - thus cost effective large source of CO_2 for EOR

SFA Pacific, Inc.

National Academies Recent 2003 *Hydrogen Economy Report* - Major Finding

- Could have a major impact in the next 50 years - conducting RD&D to determine whether a hydrogen economy might be realized is important
- H_2 must be economic, safe & appealing, & offer energy security & environmental advantages - four fundamental RD&D challenges
  - Economic, durable, safe & environmentally acceptable FC & H_2 storage
  - Infrastructure to provide H_2 for FCV
  - Sharply reduce costs of H_2 production from renewables
  - If policies for CO_2 reduction develop, capture & storage of CO_2 from coal gasification H_2 production may become an important technology
- Transition period is likely to be lengthy
- H_2 FCV can reduce imported energy via use of domestic coal, nuclear & renewables - however impacts likely minor for the next 25 years

SFA Pacific, Inc.

Oil Substitution at High Oil Prices via Renewable Energy Alternative

Ethanol & biodiesel - discussed by others at this conference

- Key issues: size of required subsidies, unsustainable use of aquifer water & low liquid fuel yield per year per acre (or hectare) of land use
- Most of subsidies paid to the big distillers with few benefit to farmers

Waste biomass for substitute liquid fuels is likely better

- Could be cellulosic ethanol, aggressively promoted in North America
- Europe appears to favor waste biomass to syngas-to-liquids due to twice the liquid fuel yield year per unit of land use vs. ethanol
- However more likely co-processing any waste biomass in large coal based syngas-to-liquids units is more cost effective, even with CCS
  - Essential economy-of-scale for gasification to make the syngas & avoids massive seasonal biomass storage or low annual load factors

SFA Pacific, Inc.

Outlook

Potential for worldwide unconventional oil by 2025 in millions of bbl/d crude oil equivalents if oil prices stay above $45/bbl

Options	MM bbl//d COE	Key location
CO_2 EOR	3-6	USA
Oil sands	4-5	Canada
Ultra heavy oils	4-5	Venezuela
Syngas-to-liquids from remote NG	2-3	Middle East
Syngas-to-liquids from coal/biomass	1-2	China & USA
Ethanol without subsidies	<0.5	Brazil
Ethanol & biodiesel via big subsidies	<0.5	USA
Oil shale	only demos	USA
Total	**15-22 million bbl/d**	

SFA Pacific, Inc.

Summary

We are only running out of cheap oil

- Nevertheless, the Hubbert curve "doomsayers" will likely keep public attention on the peak in the oil age, which helps keep oil prices high

High oil prices generates more conservation plus increased oil supplies (like unconventional oil) & oil substitution (like STL)

- However, 5-10 years lag time due to equipment life & big investments

Large potential for unconventional oil in just North American

- Impressive Canadian oil sands growth shows what can be done
- CO_2 EOR is the biggest "win-win" for the USA - limited by CO_2 supplies
  - Potentially 3-5 million bbl/d EOR production while storing 0.5-1.0 billion t/yr CO_2 if we can develop cost effective big man-made CO_2 supplies
- Syngas-to-liquids via coal + waste fuel gasification is an effective USA source of clean alternative liquid fuels plus big CO_2 supplies for EOR

SFA Pacific, Inc.