AVAILABILITY AND PRICE OUTLOOK
OF HYDROCARBON FUELS FOR SUPersonic AIRCRAFT

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The outlook for jet fuels in the year 2000 and beyond has been strongly influenced by changing consumption patterns for energy and oil. Worldwide economic growth through 2000 is now expected to average 3%/year, while energy consumption will grow only 2%/year and oil consumption less than 1%. The relatively slower growth of oil consumption will provide the time needed to develop a wide range of new sources of oil.

The total hydrocarbon resource base is enormous. Proven reserves are 688 billion barrels, roughly 525 billion barrels of conventional reserves remain to be discovered or developed, and the enhanced oil recovery (EOR) target is at least 800 billion barrels. After that, there are even larger resources of extra heavy oil, bitumens and oil shale. After OPEC's inexpensive reserves begin to be depleted, around the turn of the century, the cost of finding and producing the next increment of world reserves will be higher. Most undiscovered non-OPEC conventional oil is likely to be found in small fields with complex geology or in remote regions with hostile environments.

The next economic increment of oil will be produced using EOR methods to recover a portion of the two-thirds of the oil that remains in the ground after conventional production. Improved EOR technology is expected to make significant amounts of oil available at prices in the $25 to $40 a barrel range.

After EOR, the next more costly large deposits are in the form of extra heavy oil, oil sands and bitumen. These resources represent potential future sources of hydrocarbons that can be converted to usable liquid fuels, but not until the price reaches approximately twice that of today's conventional oil ($35 to $50 a barrel).

The time when these resources will be developed will depend on the rate of world oil consumption. Examination of possible consumption/production profiles suggests that these resources can be developed sequentially rather than simultaneously with each one peaking as the previous one declines. As a result, the rate of real price growth - about 1%/a year - is considerably lower than was generally expected in recent years.

Jet fuel demand is expected to grow faster than any other major oil product despite the fact that the efficiency of air transportation is continuing to improve. Jet fuel will claim a growing share of the middle of the crude oil barrel, but declining use of traditional kerosene, particularly in Asian households, will help prevent any major availability problems.

In summary, conventional type hydrocarbon fuels are likely to be available long into the next century at real prices that will not be higher than those experienced in the last decade. If a special quality fuel is required for supersonic aircraft, it could probably be provided, but at a price that would reflect the special handling required.

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Energy Consumption
World Excluding CPE

Million Barrels Per Day Oil Equivalent

- OIL
- GAS
- COAL
- HYDRO/MISC
- NUCLEAR
- SOLAR/BIOMASS

[Graph showing energy consumption trends from 1970 to 2000]
World Proved Crude Oil Reserves

- Canada: 4.8 Billion Bbls.
- United States: 27.3 Billion Bbls.
- Mexico: 26.5 Billion Bbls.
- South America: 64.7 Billion Bbls.
- Western Europe: 18.9 Billion Bbls.
- Africa: 57.0 Billion Bbls.
- Middle East: 387.1 Billion Bbls.
- Centrally Planned Economies: 81.3 Billion Bbls.
- Asia/Pacific: 21.1 Billion Bbls.

Non-OPEC: 199.1 Billion Bbls.
OPEC: 489.6 Billion Bbls.
OPEC Crude Oil Production

Million Barrels Per Day

Crude Price Outlook

1987 Dollars Per Barrel

Arabian Light

U.S. Average Wellhead Price

OPEC Control

1900 1925 1950 1975 2000 2025 2050 2075 2100
Estimated Resource Base
Trillion Barrels Recoverable

- Produced
- Proved Reserves
- Undiscovered
- EOR to 50%
- EOR to 60%
- Extra Heavy & Bitumen
- Shale Oil

0 1 2 3 4 5 6 7 8 9 10
World Crude Oil Supply
High Demand
Million Barrels Per Day

Total Consumption

Extra Heavy & Bitumen

Undiscovered

EOR

Shale Oil

1900 1925 1950 1975 2000 2025 2050 2075 2100

0 10 20 30 40 50 60 70 80
World Crude Oil Supply
Truncated Demand
Million Barrels Per Day

Total Consumption
Extra Heavy & Bitumen
EOR
Undiscovered
Shale Oil

1900 1925 1950 1975 2000 2025 2050 2075 2100
Crude Price Outlook

1987 Dollars Per Barrel

Arabian Light

Domestic Average Wellhead Price

Extra Heavy Oil

EOR

OPEC Control

Shale Oil

1900 1925 1950 1975 2000 2025 2050 2075 2100
Light Product Consumption
World Excluding CPE

Percent of Total Oil Consumption

- GASOLINE
- DISTILLATE
- KEROSENE
- JET

Middle Distillate Consumption
World Excluding CPE

Percent of Total Oil Consumption

- DISTILLATE
- KEROSENE
- JET

Jet Fuel Consumption

Percent of Total Oil Consumption

- UNITED STATES
- WORLD EX. CPE
- WESTERN EUROPE
- ASIA

Kerosene and Jet Fuel Consumption
Percent of Total Oil Consumption


ASIA
UNITED STATES
WORLD EX. CPE
WESTERN EUROPE