

OVERVIEW of COAL-TO-LIQUIDS (CTL)

Presented at the

2008 Gasification Technologies Conference

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by

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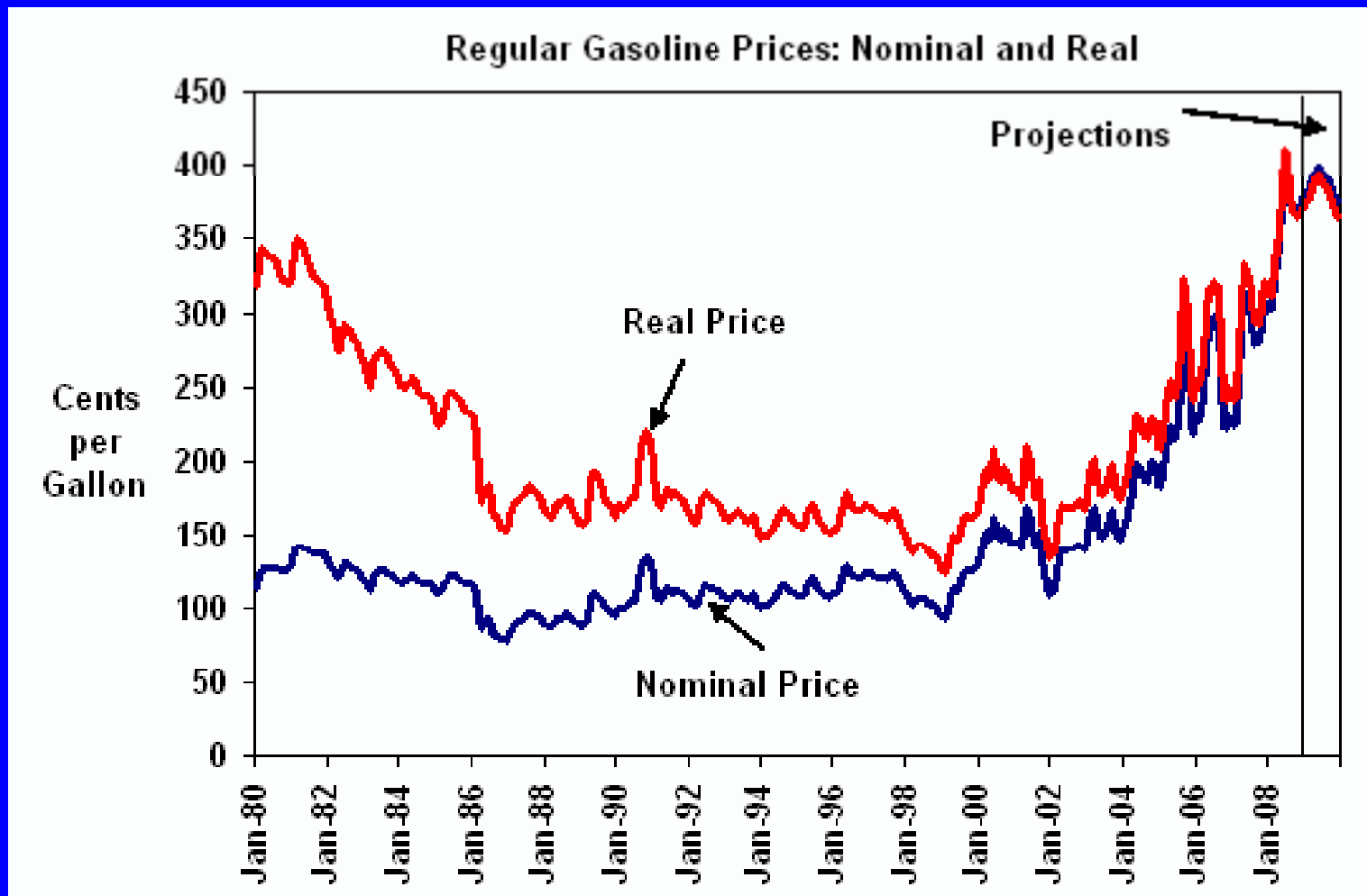
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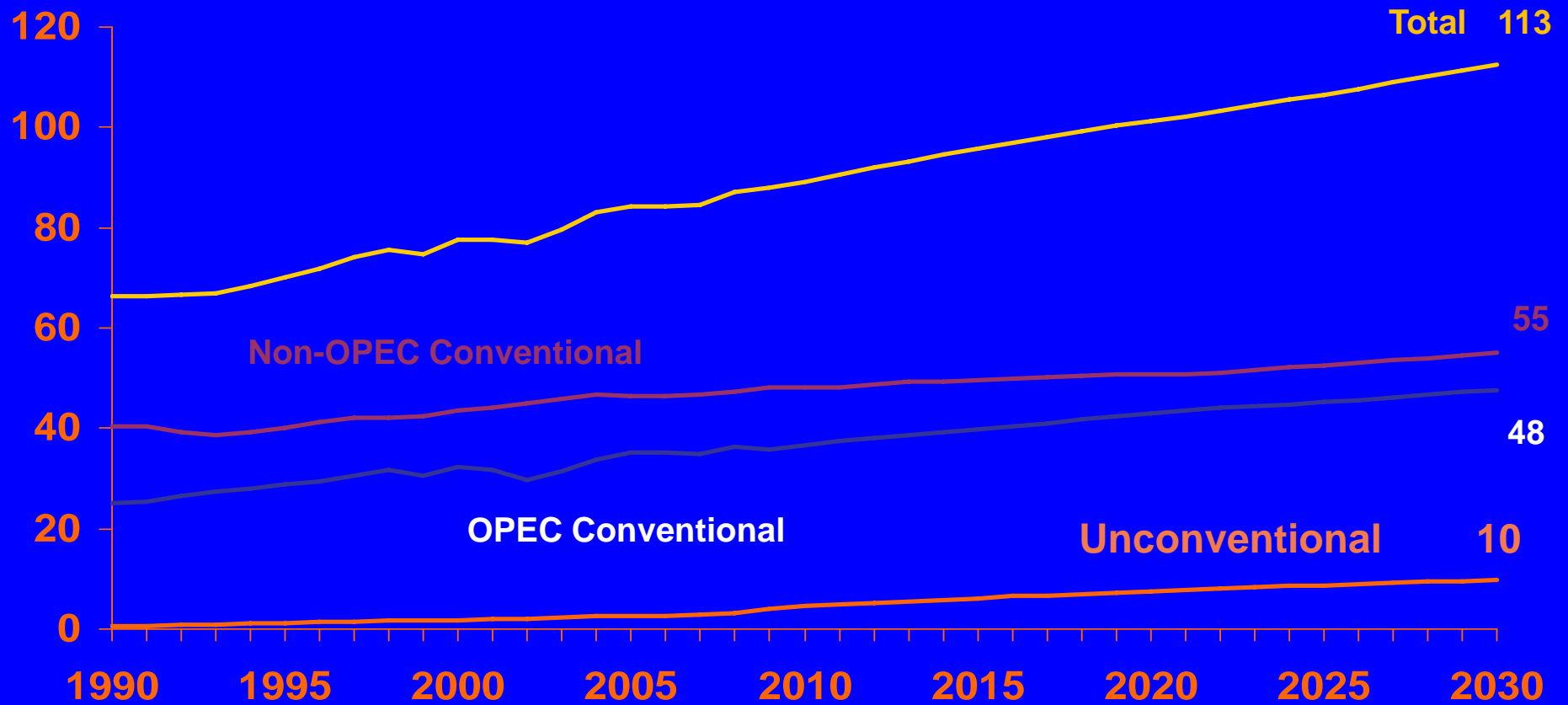
Liquid Fuels at Historic High Prices in 2008



Source: U.S. EIA *Short-Term Energy Outlook* June 2008

Unconventional Liquid Fuels (including CTL) Projected to Greatly Increase in the Future

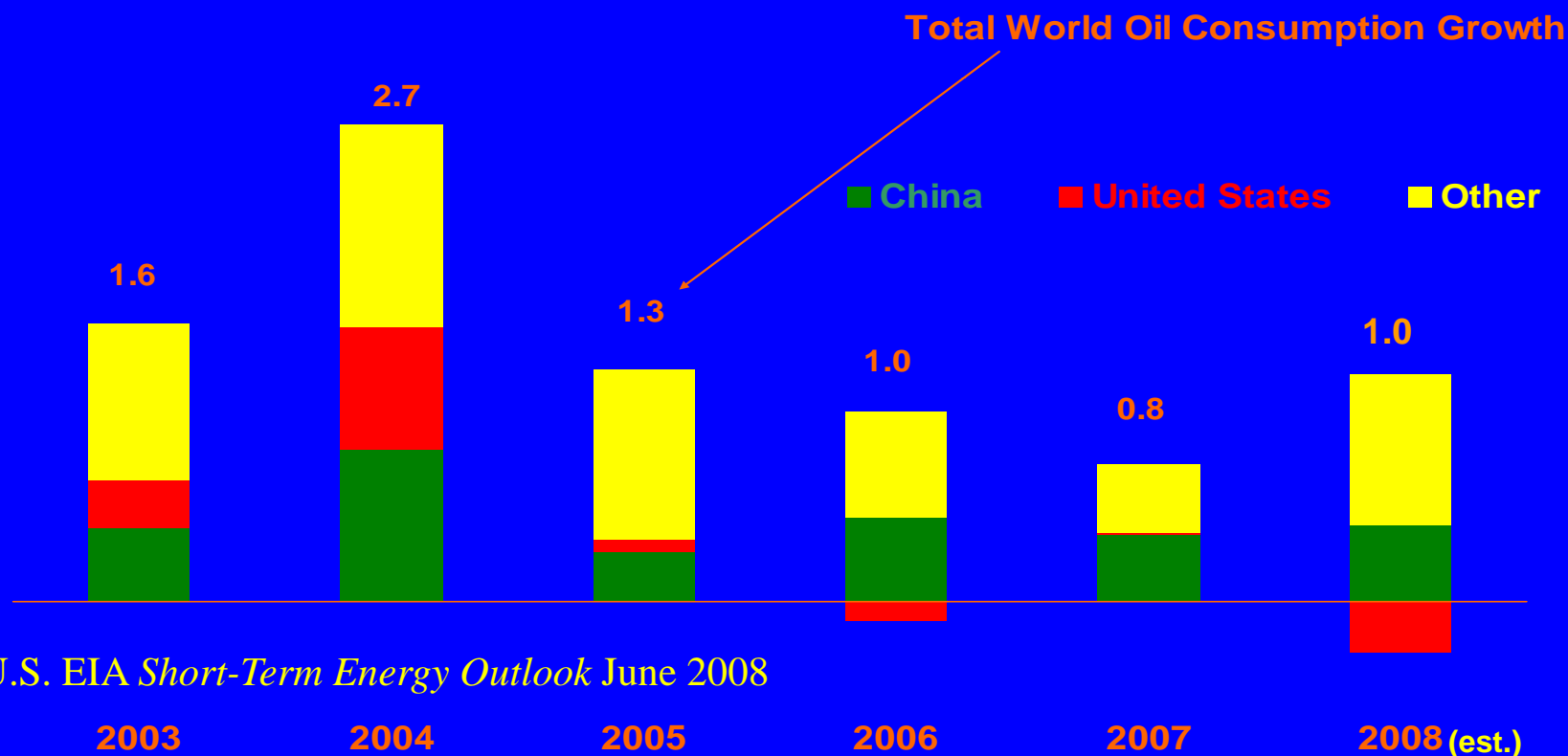
millions of barrels of oil equivalent per day



Source : U.S. EIA International *Energy Outlook 2008*

World Oil Consumption Increasing In Spite of Large Oil Rise to Historic High Prices in 2008

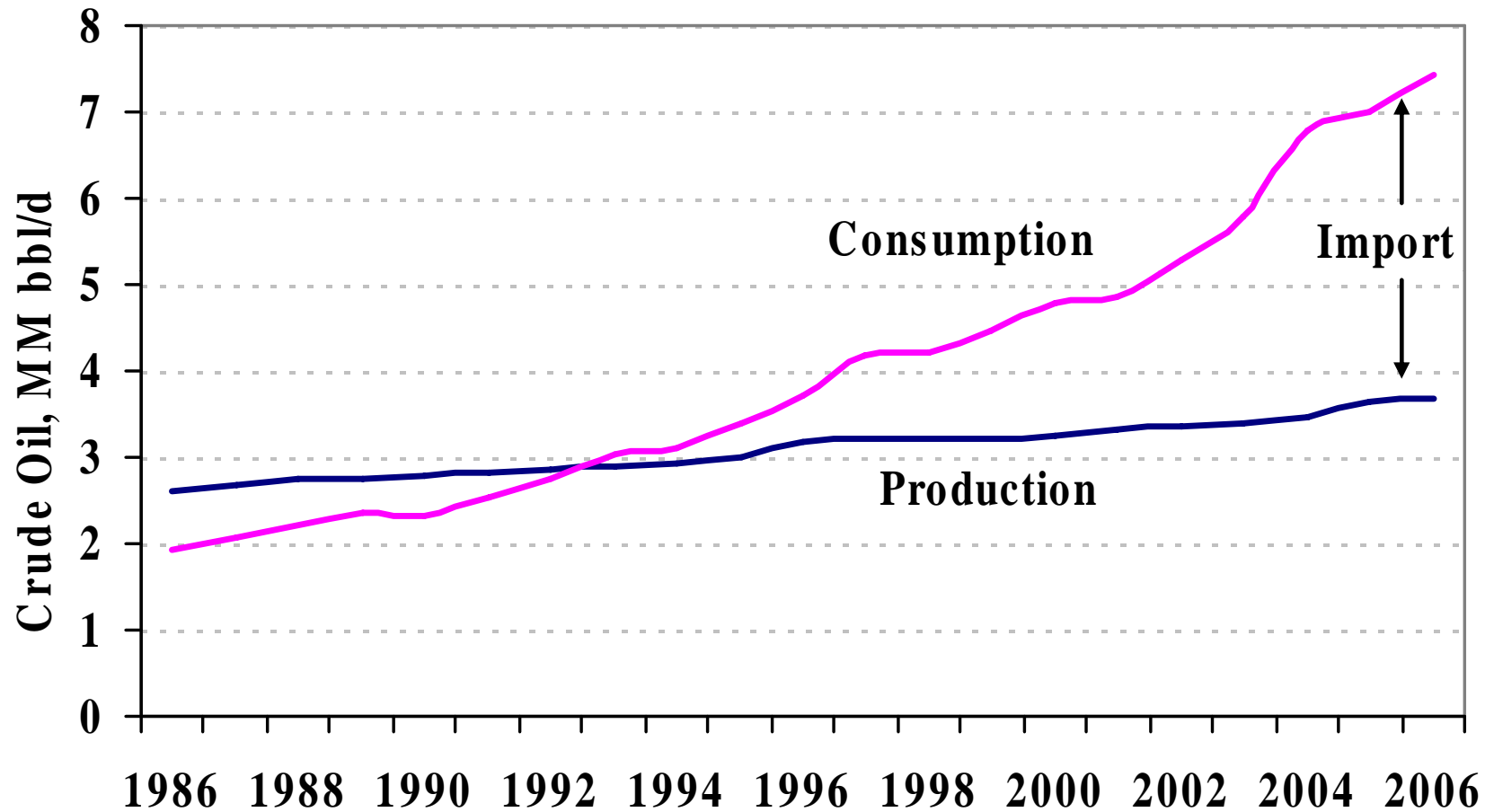
Growth from Prior Year in Million Barrels per day



Source: U.S. EIA *Short-Term Energy Outlook* June 2008

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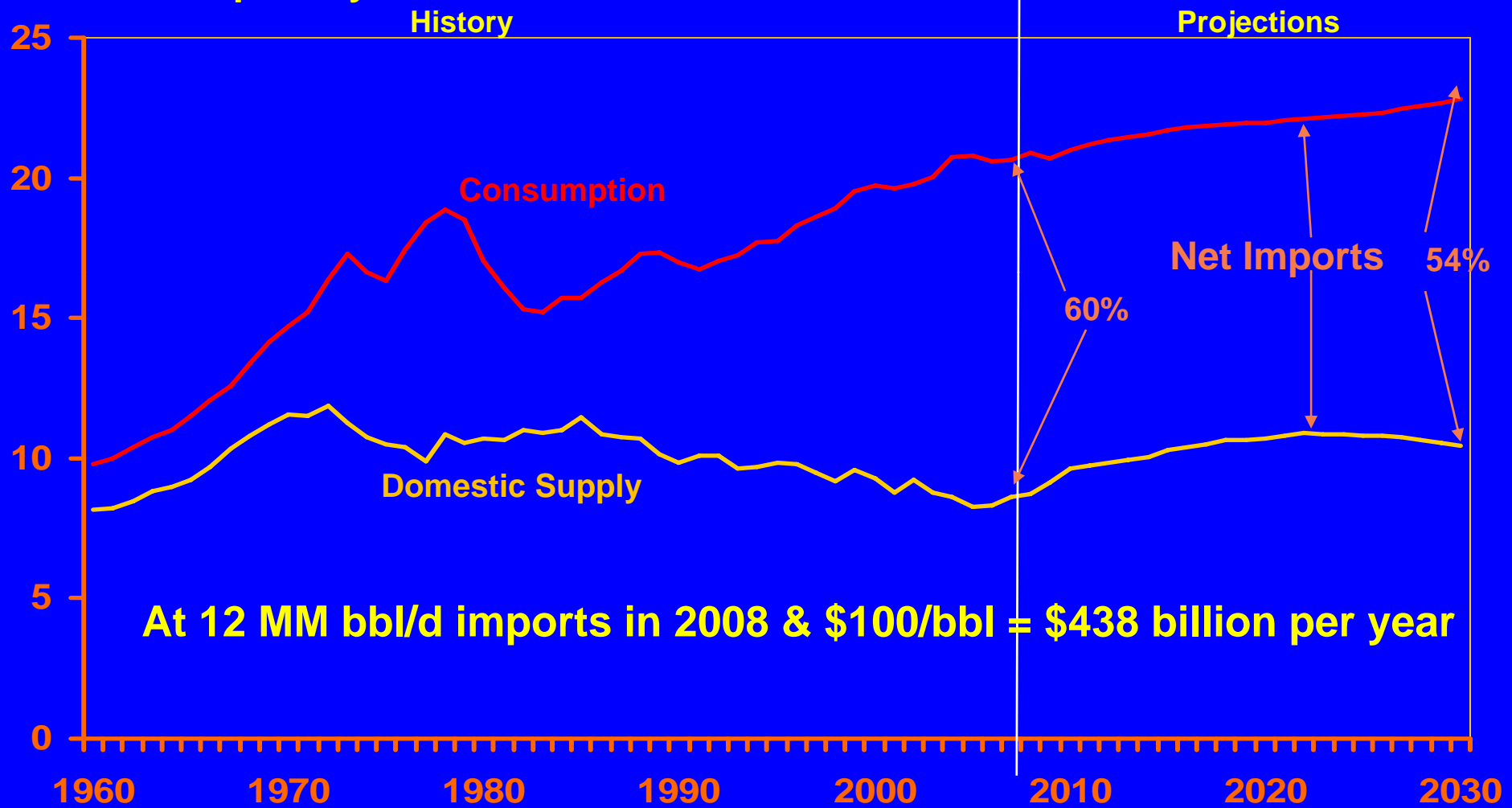
China's Oil Import



Source: Reference 5 of the SFA Second 2007 Quarterly Report - British Petroleum

United States Oil Imports

million barrels per day



Source: U.S. EIA Annual Energy Outlook 2008

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Various Coal-to-Liquid Options

Classic coal liquefaction review: my May 4, 1981 *Oil & Gas Journal* article

Direct coal liquefaction – severe hydrocracking of a coal/oil slurry at very high pressure to produce highly aromatic distillates requiring additional hydroprocessing to final liquid fuel products (total about 4,000 scf H₂/bbl)

- Massive H₂ from additional coal and/or liquefaction residue gasification

Indirect coal liquefaction – gasification to syngas for conversion to near zero S, N & aromatics cleaner fuel products with many additional options:

- **Any feedstock & blend from pet coke to coal to lignite to waste biomass**
- **F-T**: low or high temperature, fixed, fluid bed or slurry phase, iron or cobalt catalyst to mostly clean diesel or jet fuel + a low octane naphtha by-product
- **Methanol** for <10% gasoline blending to 100% methanol-to-gasoline (MTG)
- **Mixed alcohols** more like ethanol for >10% gasoline blending to 100% alcohol

Phantom coal liquids: coal-to-H₂ for crude oil residue to distillates

- Most cost effective but limited to oil refineries & crude oil residues

Coal-to-Liquids & Diesel Have Challenges

Many environmentalist adamantly appose CTL & F-T diesels

- Appears due to high CO₂ emission of CTL + lack of understanding CCS & efficiency advantages of new clean European diesels
 - Adding CO₂ capture & storage (CCS) and/or waste biomass co-processing can greatly reduce net CO₂ to even CO₂ neutral

U.S. market vehicle manufactures worry about dieselization

- Requires large new investments + challenges of meeting lower U.S. emissions standards requiring lower S, soot traps & on-board SCR

World oil refiners worry about dieselization beyond Europe

- European dieselization already forcing European refiners to trade excess gasoline yield for diesel from U.S. refineries

Biggest challenge is likely the high capital costs & adding CCS

- **However, once a CTL 2-4 billion dollar leap-of-faith is made, operating costs are low & total costs go way down as the capital is paid-off**