Energy Supply/Demand Trends and Forecasts: *Implications for a Sustainable Energy Future in Canada and the World*

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COMMISSION GÉOLOGIQUE DU CANADA
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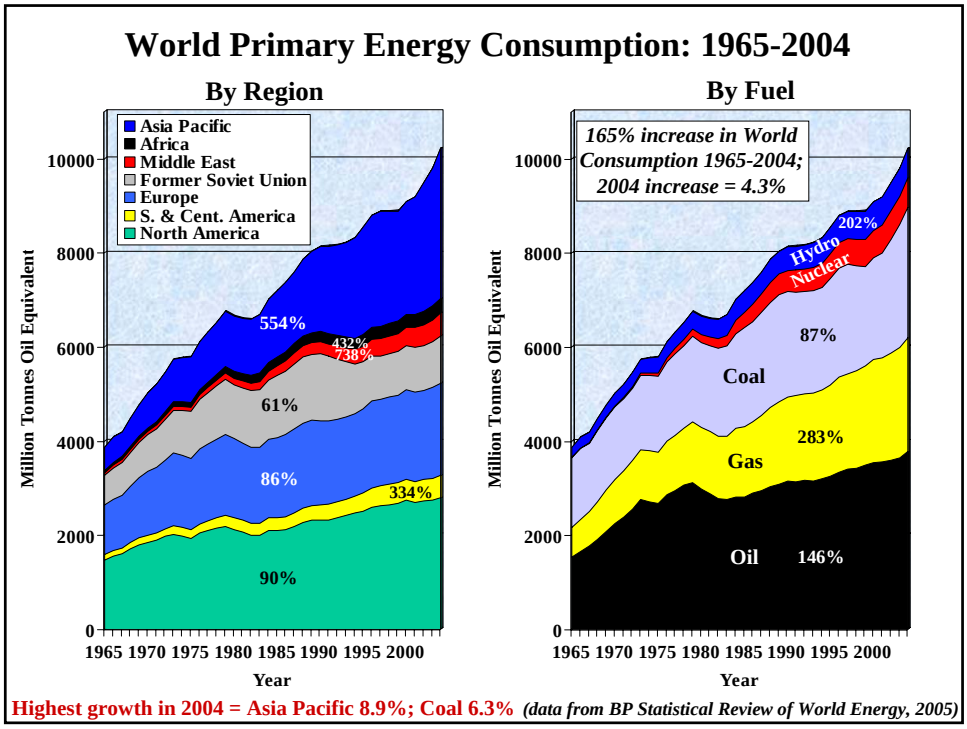
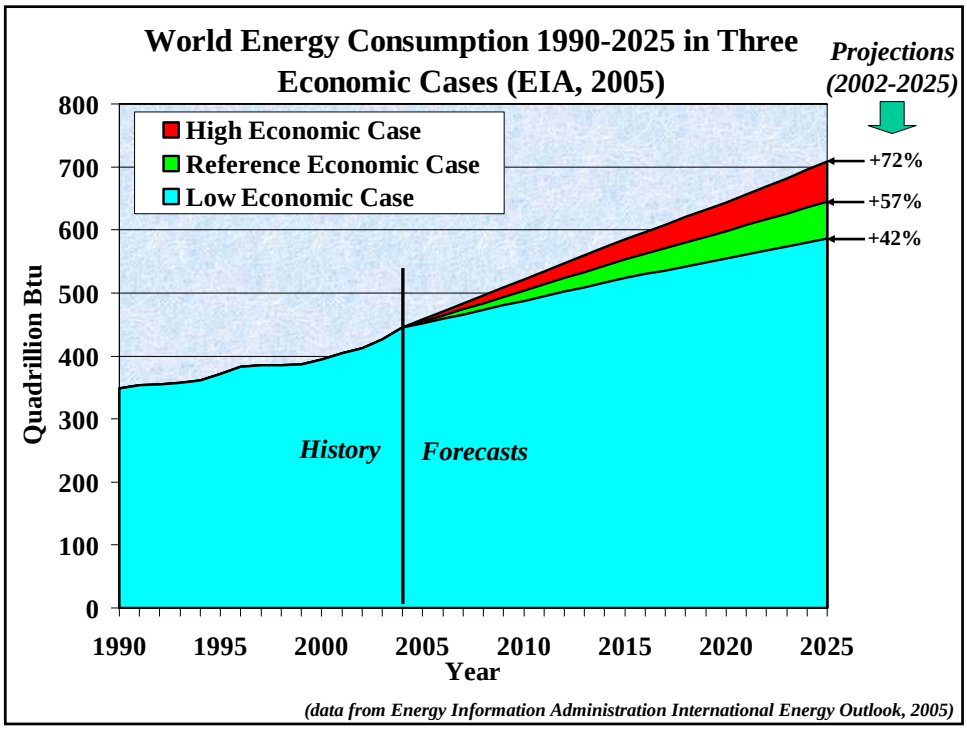
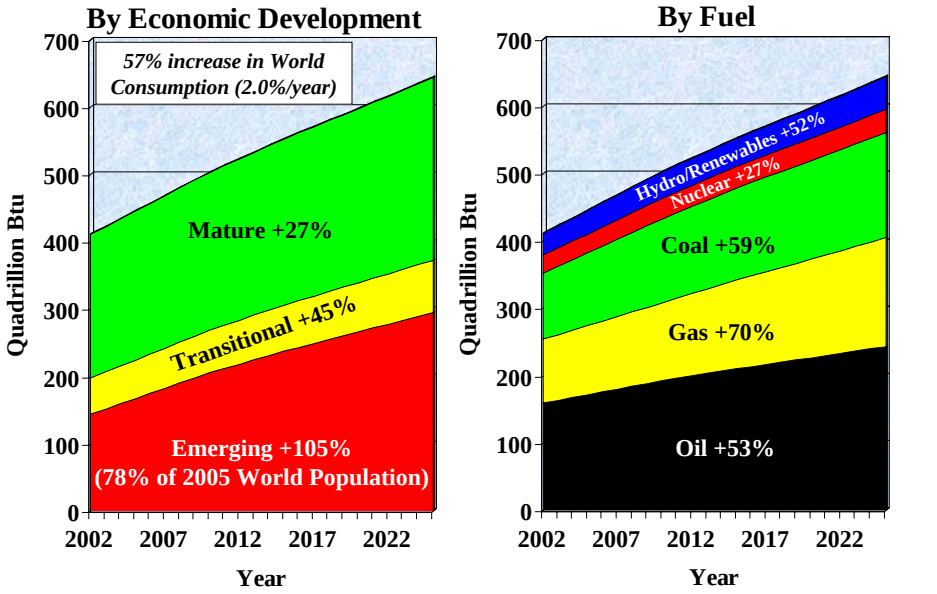
Points to be covered:

- **Patterns of Energy Consumption and Production:**
  - ***History*** *- what actually happened "Hindsight"*
  - ***Forecasts*** *- always arguable and debatable:*
    - *-"economists vs. geologists"*
    - *-"geologists vs. geologists"*
    - *-"optimists vs. pessimists"*
- **Magnitude and Distribution of Remaining Energy Reserves and Resources:**
  - *Implications for security of energy supply*
- **Where does Canada Stand in All This?**
- **Some thoughts on the way forward:** ***Challenges and Changes for a Sustainable Energy Future***


World Primary Energy Consumption: 1965-2004
By Region
By Fuel
Asia Pacific
Africa
Middle East
Former Soviet Union
Europe
S. & Cent. America
North America
554%
432%
738%
61%
86%
334%
90%
165% increase in World Consumption 1965-2004; 2004 increase = 4.3%
202%
Hydro
Nuclear
87%
Coal
283%
Gas
Oil
146%
Million Tonnes Oil Equivalent
0
2000
4000
6000
8000
10000
1965 1970 1975 1980 1985 1990 1995 2000
Year
Highest growth in 2004 = Asia Pacific 8.9%; Coal 6.3%
(data from BP Statistical Review of World Energy, 2005)


World Energy Consumption 1990-2025 in Three Economic Cases (EIA, 2005)
Projections (2002-2025)
High Economic Case
Reference Economic Case
Low Economic Case
+72%
+57%
+42%
History
Forecasts
Quadrillion Btu
0
100
200
300
400
500
600
700
800
1990
1995
2000
2005
2010
2015
2020
2025
Year
(data from Energy Information Administration International Energy Outlook, 2005)

Forecast Growth In World Energy Consumption, 2002-2025 (EIA, 2005, Reference Economic Case)



(data from Energy Information Administration International Energy Outlook, July, 2005)

Summary

- Hydrocarbons provided 87% of the world's primary energy in 2004

- Forecasts suggest that 87% of a greatly expanded energy demand will continue to be provided by hydrocarbons in 2025

- Most of the balance of energy supply will be provided by large hydro and nuclear – sources with their own environmental problems

- The Question is: *IS THIS SUSTAINABLE?*

…… Lets look in more detail at oil, gas and coal

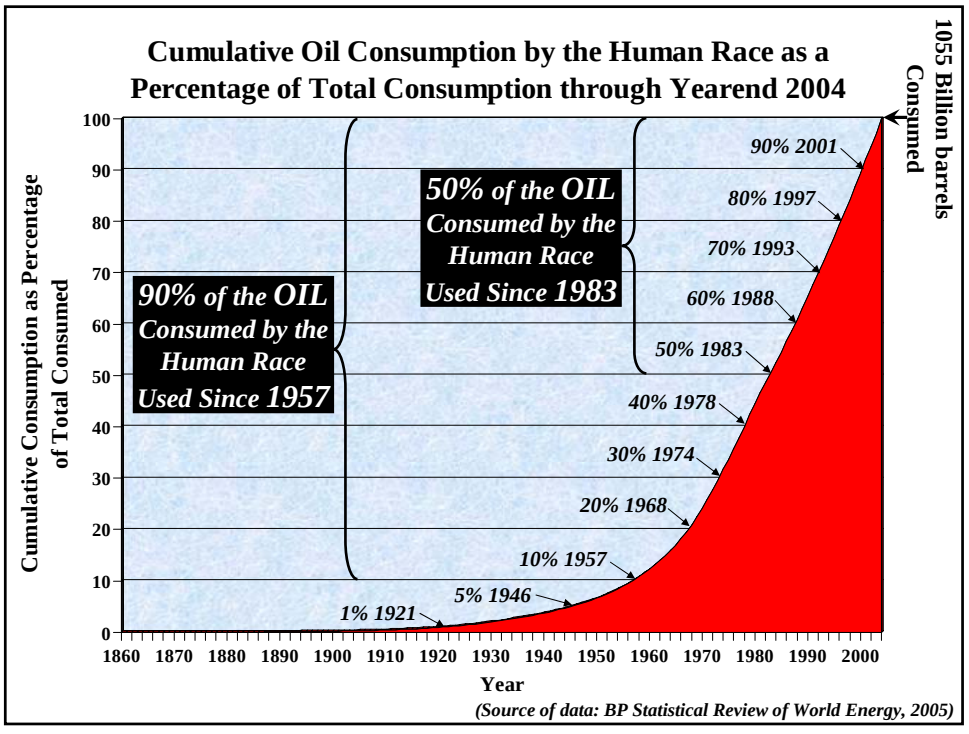
OIL

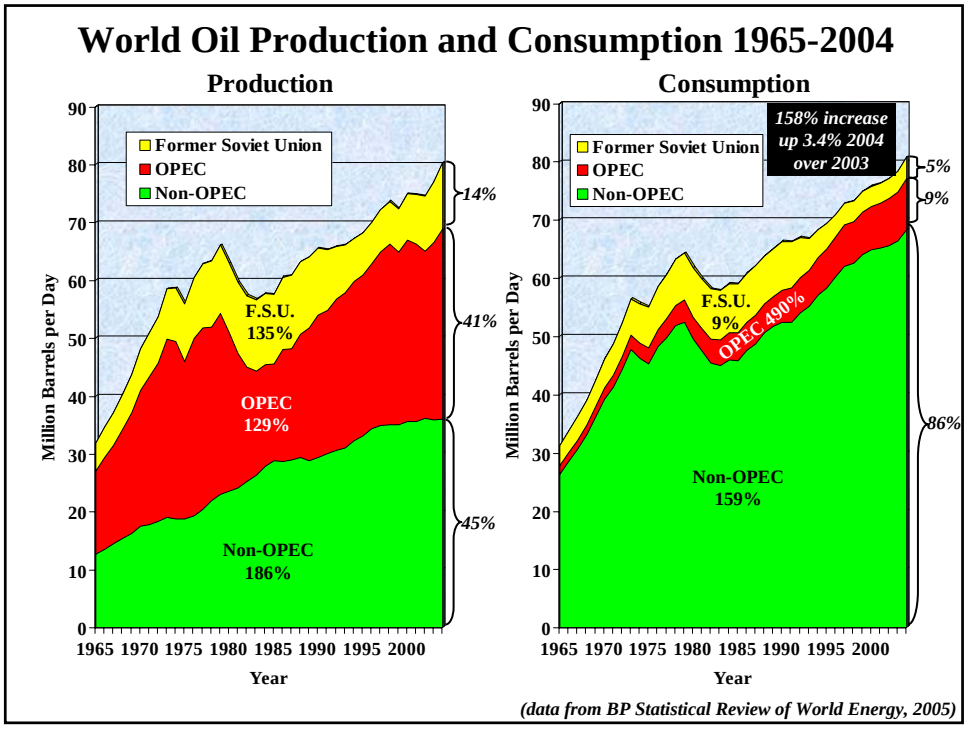
- The largest source of energy in the world *(36.8% of primary energy consumption in 2004)*

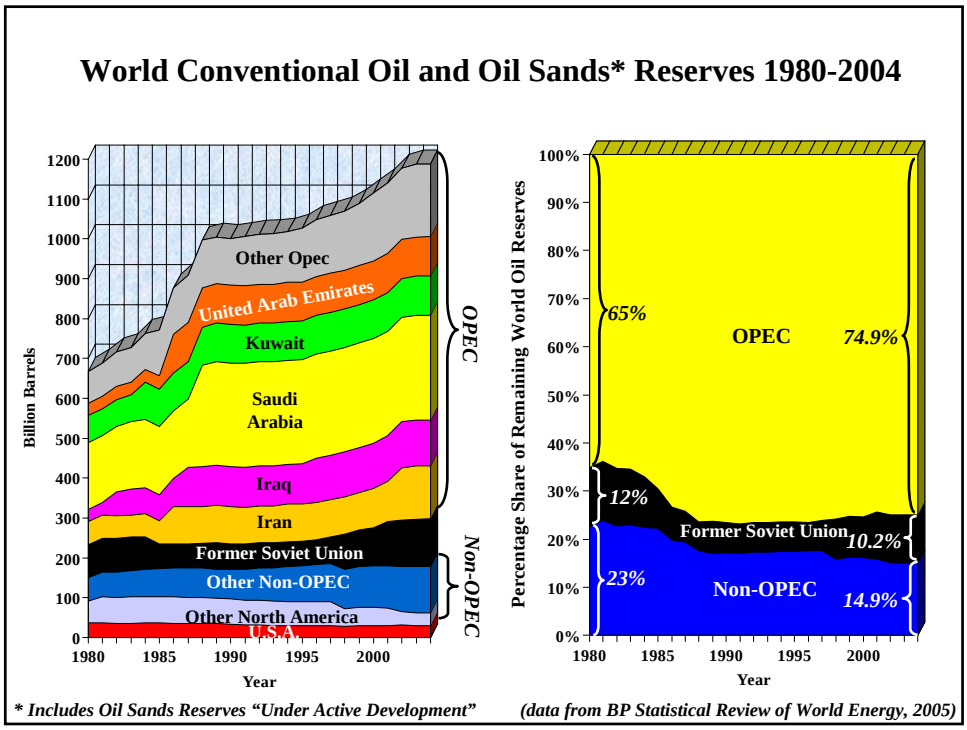
- The ultimate fuel for international trade – *easily moved by tanker and pipeline*

- Highly subject to Geopolitics – *the OPEC cartel has three quarters of remaining reserves and the only remaining spare production capacity – terrorism or natural disasters like Hurricanes Katrina and Rita can cause extreme price volatility*

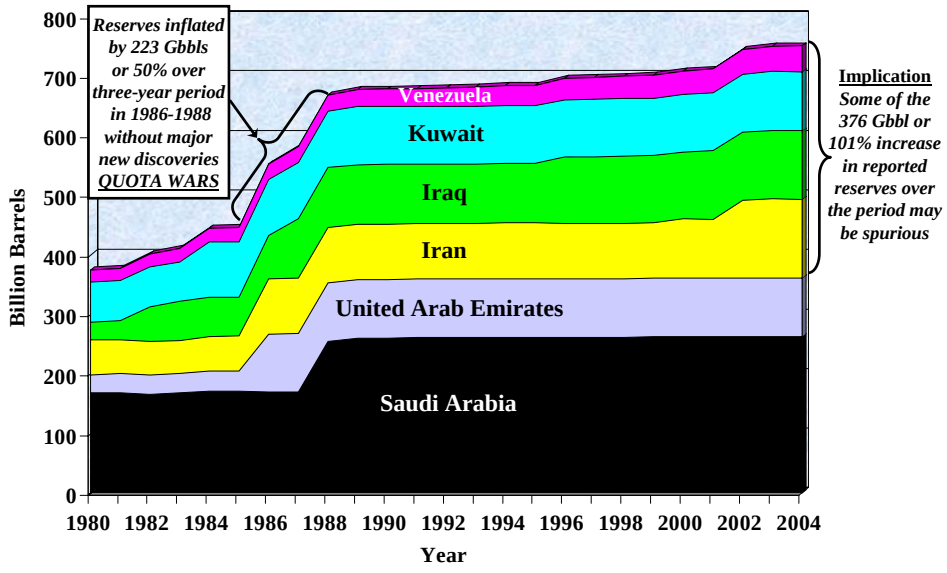
- Alternatives to oil have seen similar price spikes over the past several years *(natural gas, coal and uranium)*




World Oil Production and Consumption 1965-2004
Production
Consumption
Former Soviet Union
OPEC
Non-OPEC
Million Barrels per Day
F.S.U.
135%
OPEC
129%
Non-OPEC
186%
14%
41%
45%
158% increase
up 3.4% 2004
over 2003
F.S.U.
9%
OPEC 490%
Non-OPEC
159%
5%
9%
86%
Year
(data from BP Statistical Review of World Energy, 2005)


World Conventional Oil and Oil Sands* Reserves 1980-2004
Billion Barrels
Other Opec
United Arab Emirates
Kuwait
Saudi
Arabia
Iraq
Iran
Former Soviet Union
Other Non-OPEC
Other North America
U.S.A.
OPEC
Non-OPEC
Year
Percentage Share of Remaining World Oil Reserves
65%
OPEC
74.9%
12%
Former Soviet Union
10.2%
23%
Non-OPEC
14.9%
* Includes Oil Sands Reserves "Under Active Development"
(data from BP Statistical Review of World Energy, 2005)

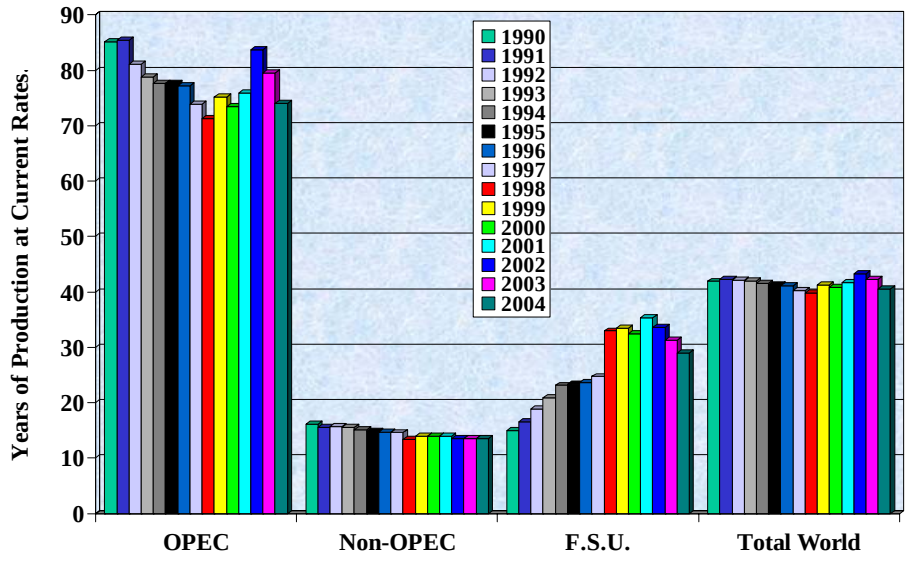
Oil Reserve Reporting in Selected OPEC Countries, 1980-2004, Representing 84.3% of 2004 OPEC Reserves and 63% of World Reserves



These Countries also Produced 172.3 Billion Barrels over the Period

(data from BP Statistical Review of World Energy, 2005)

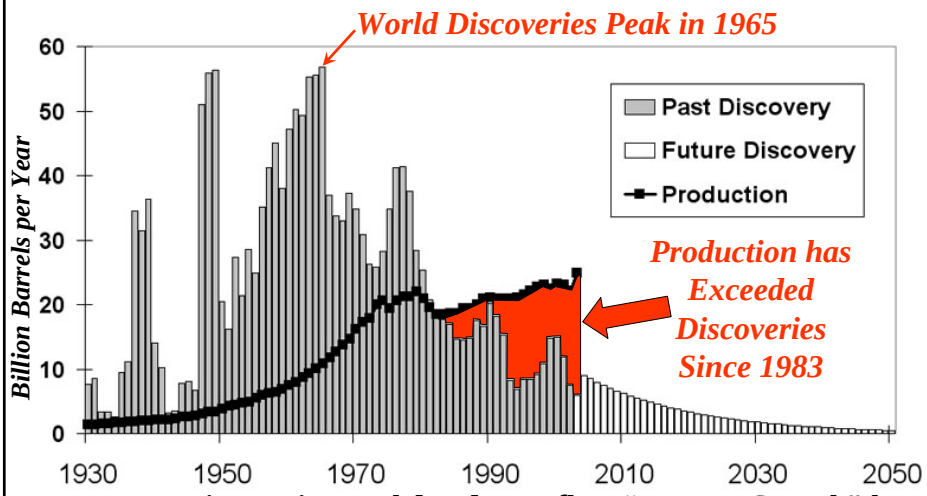
World Oil Reserve to Production Ratio in Years Including Oil Sands* and Possibly Spurious post-1986 OPEC Reserves



** Includes Oil Sands Reserves "Under Active Development"*

(data from BP Statistical Review of World Energy, 2005)

The Growing Gap between World Oil Discoveries and Annual Consumption with Forecasts to 2050



Note: Past Discoveries Backdated to Reflect "Reserve Growth" based On ExxonMobil (2002) Revisions

(from Campbell, 2004)

World Oil Production Peak

WHEN?

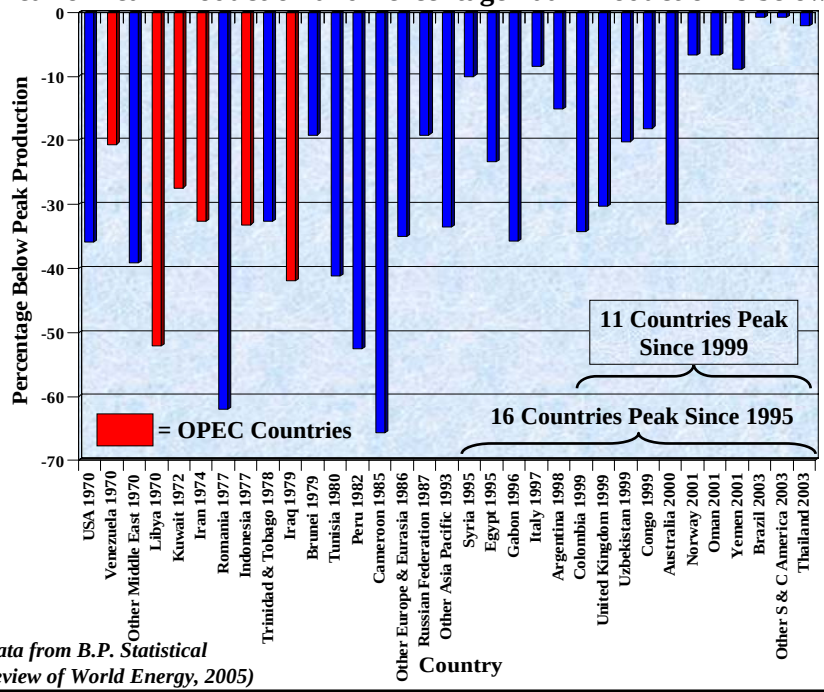
- Debatable, because of the variables, ***BUT IT IS HIGHLY LIKELY TO HAPPEN***

DEPENDS ON:

- **ULTIMATE RECOVERABLE RESERVES** *- a function of:*
  - **Mother Nature's Endowment** *(total discovered and undiscovered resources)*
  - **Technology and Price** *(determines economics)*
  - **Reserve Appreciation (Growth) in known pools** *(through more drilling, better technology and higher prices)*

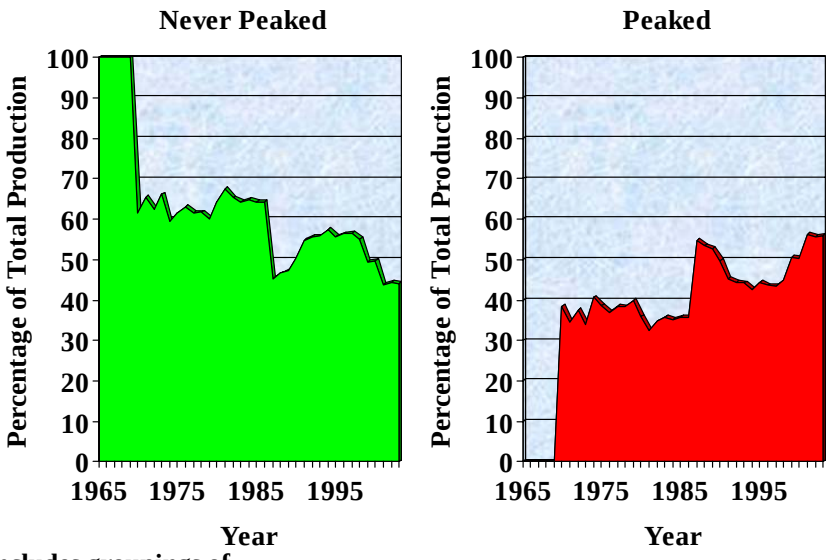
- **RATE OF CONSUMPTION** *- a function of:*
  - **Price** *(controls economic growth and encourages/discourages conservation)*
  - **Infrastructure** *for production*
  - **Depletion rates** *of producing pools*

Year of Peak Production and Percentage 2004 Production is below Peak



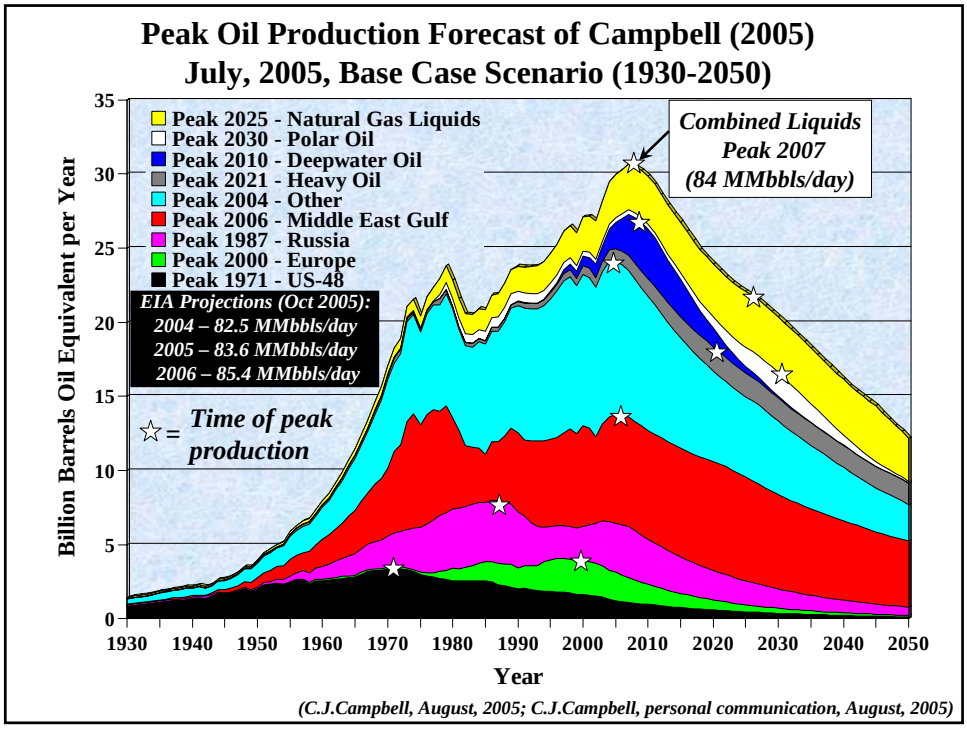
(data from B.P. Statistical Review of World Energy, 2005)

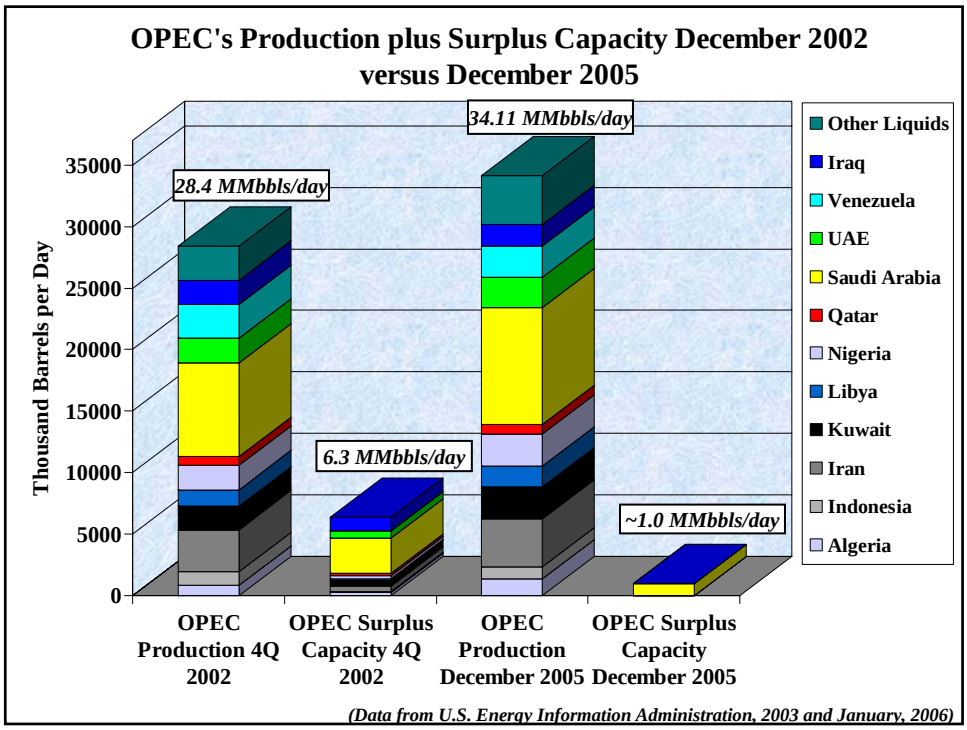
Percentage of World Oil Produced from Countries* that Have and Have Not Experienced a Peak in Oil Production, 1965-2004

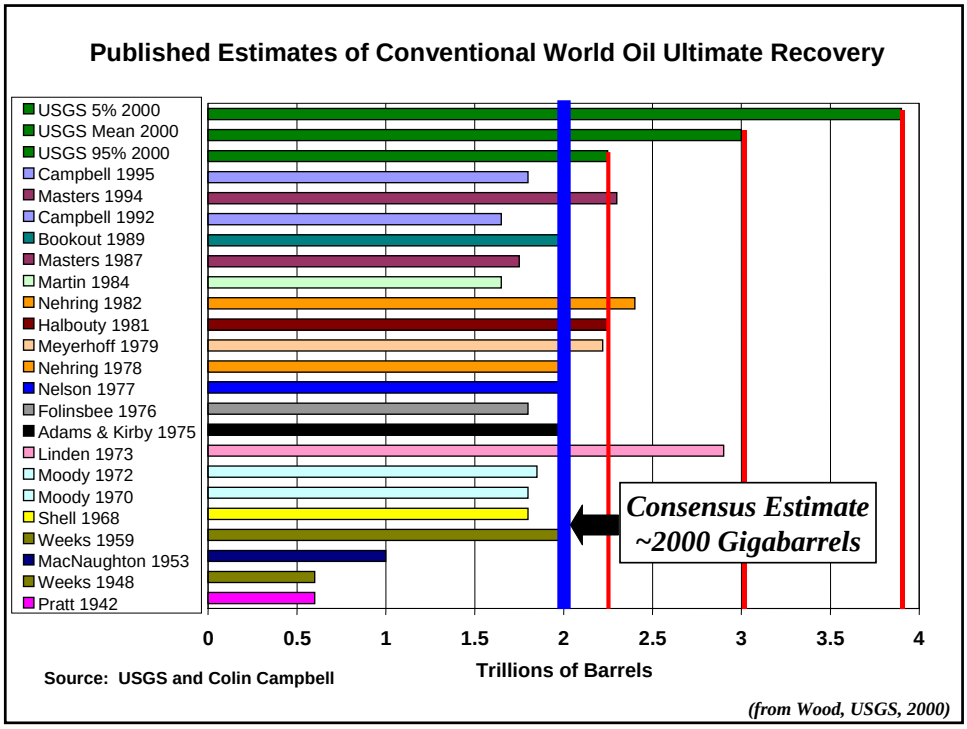


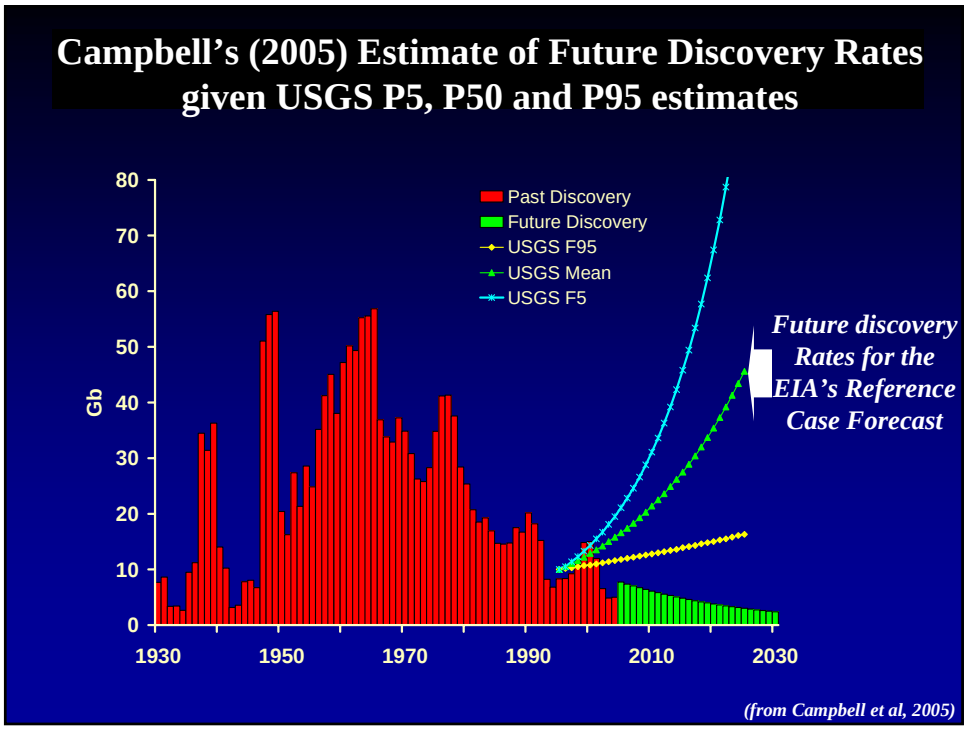
*Includes groupings of smaller producing countries by BP

(data from B.P. Statistical Review of World Energy, 2005)

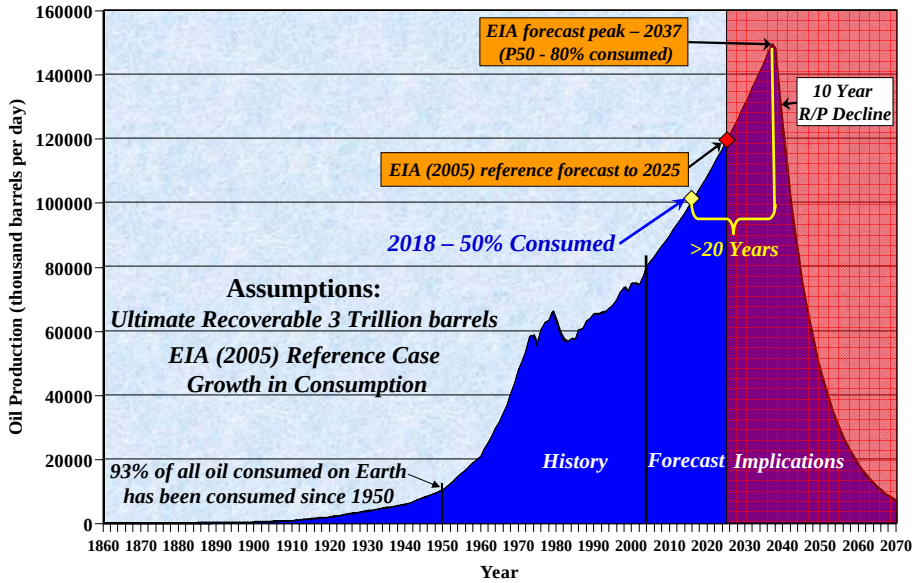

Peak Oil Production Forecast of Campbell (2005)
July, 2005, Base Case Scenario (1930-2050)
Billion Barrels Oil Equivalent per Year
Year
Peak 2025 - Natural Gas Liquids
Peak 2030 - Polar Oil
Peak 2010 - Deepwater Oil
Peak 2021 - Heavy Oil
Peak 2004 - Other
Peak 2006 - Middle East Gulf
Peak 1987 - Russia
Peak 2000 - Europe
Peak 1971 - US-48
EIA Projections (Oct 2005):
2004 – 82.5 MMbbls/day
2005 – 83.6 MMbbls/day
2006 – 85.4 MMbbls/day
Combined Liquids
Peak 2007
(84 MMbbls/day)
☆ = Time of peak production
0
5
10
15
20
25
30
35
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
(C.J.Campbell, August, 2005; C.J.Campbell, personal communication, August, 2005)


OPEC's Production plus Surplus Capacity December 2002
versus December 2005
Thousand Barrels per Day
0
5000
10000
15000
20000
25000
30000
35000
28.4 MMbbls/day
6.3 MMbbls/day
34.11 MMbbls/day
~1.0 MMbbls/day
OPEC Production 4Q 2002
OPEC Surplus Capacity 4Q 2002
OPEC Production December 2005
OPEC Surplus Capacity December 2005
Other Liquids
Iraq
Venezuela
UAE
Saudi Arabia
Qatar
Nigeria
Libya
Kuwait
Iran
Indonesia
Algeria
(Data from U.S. Energy Information Administration, 2003 and January, 2006)


Published Estimates of Conventional World Oil Ultimate Recovery
USGS 5% 2000
USGS Mean 2000
USGS 95% 2000
Campbell 1995
Masters 1994
Campbell 1992
Bookout 1989
Masters 1987
Martin 1984
Nehring 1982
Halbouty 1981
Meyerhoff 1979
Nehring 1978
Nelson 1977
Folinsbee 1976
Adams & Kirby 1975
Linden 1973
Moody 1972
Moody 1970
Shell 1968
Weeks 1959
MacNaughton 1953
Weeks 1948
Pratt 1942
Consensus Estimate ~2000 Gigabarrels
0
0.5
1
1.5
2
2.5
3
3.5
4
Trillions of Barrels
Source: USGS and Colin Campbell
(from Wood, USGS, 2000)

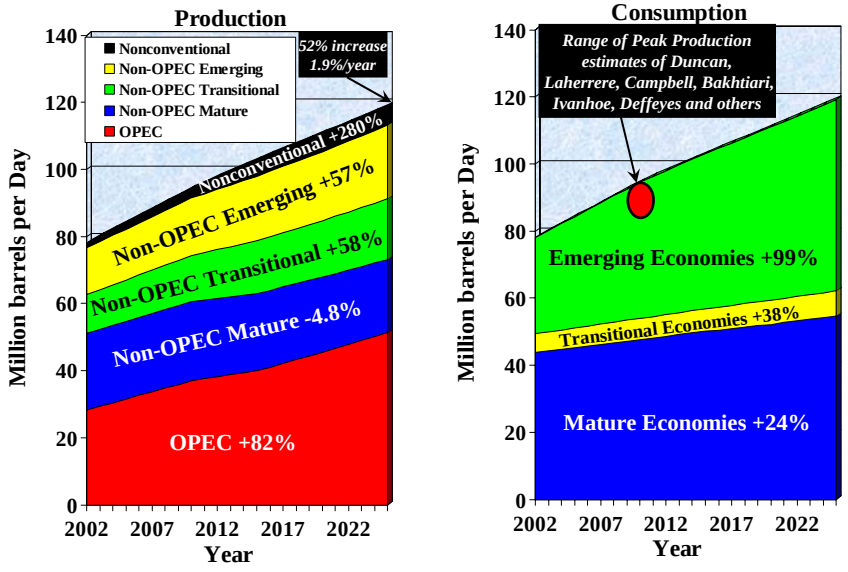

Campbell's (2005) Estimate of Future Discovery Rates given USGS P5, P50 and P95 estimates
Past Discovery
Future Discovery
USGS F95
USGS Mean
USGS F5
Gb
80
70
60
50
40
30
20
10
0
1930
1950
1970
1990
2010
2030
Future discovery Rates for the EIA's Reference Case Forecast
(from Campbell et al, 2005)

Forecast of World Peak Oil Production Using EIA Methodology Assuming USGS (2000) P50 Ultimate Recoverable of 3003 Billion Barrels and 1.9% yearly growth



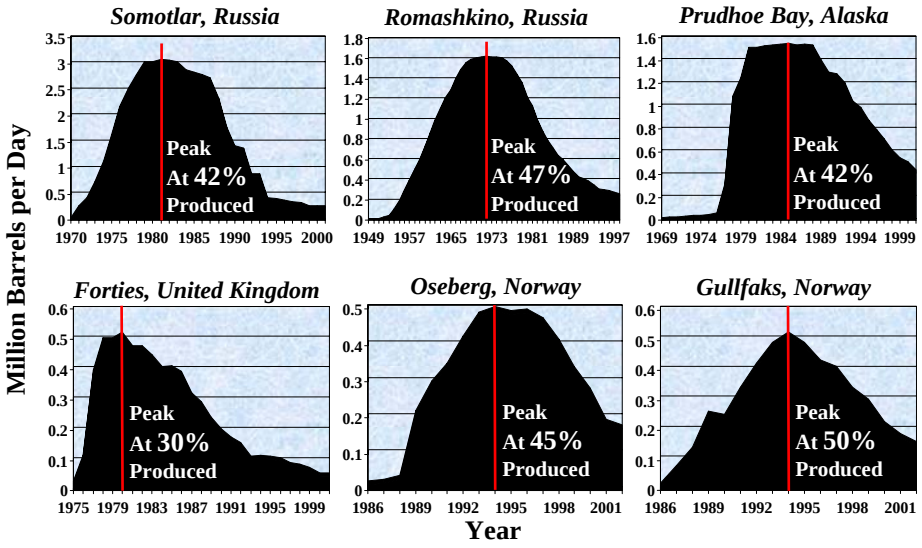
(Source of data: BP Statistical Review of World Energy, 2005; Wood, USGS, 2000; EIA IEO, 2005)

EIA World Oil Production and Consumption Forecast 2002-2025 (Reference Economic Case)



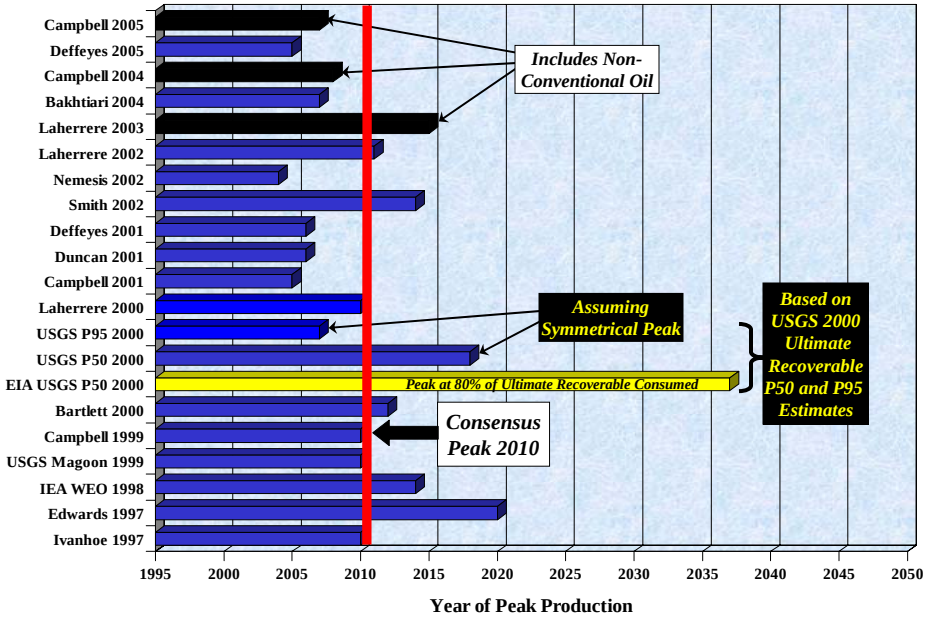
(data from USDOE Energy Information Administration International Energy Outlook, July, 2005)

Peaking Profiles of Giant and Super Giant Fields at 30-50% of Total Production Suggests Peaking of World Production at 80% of Ultimate Recoverable Consumed is Wishful Thinking



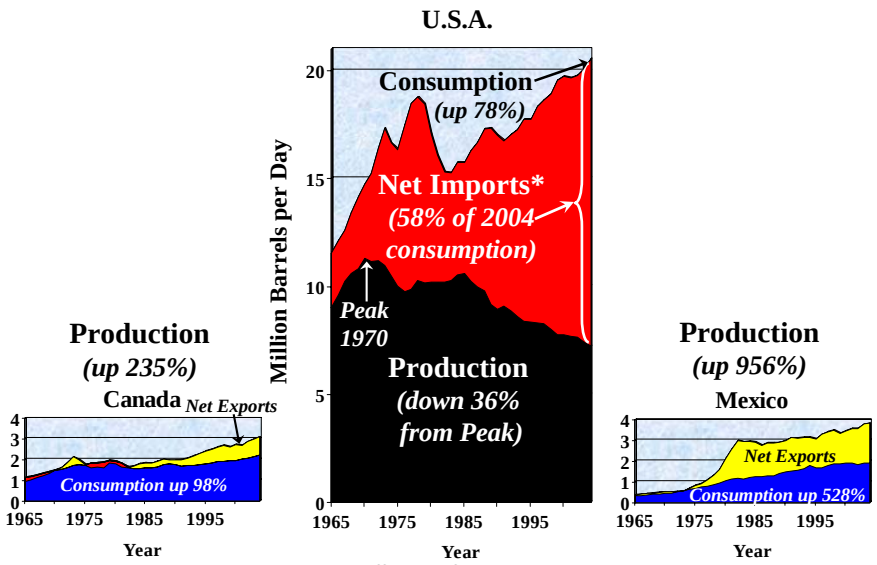
(data from Simmons, "The Saudi Arabia Oil Miracle", February, 2004)

Post 1997 Estimates of the Time of Peak World Oil Production



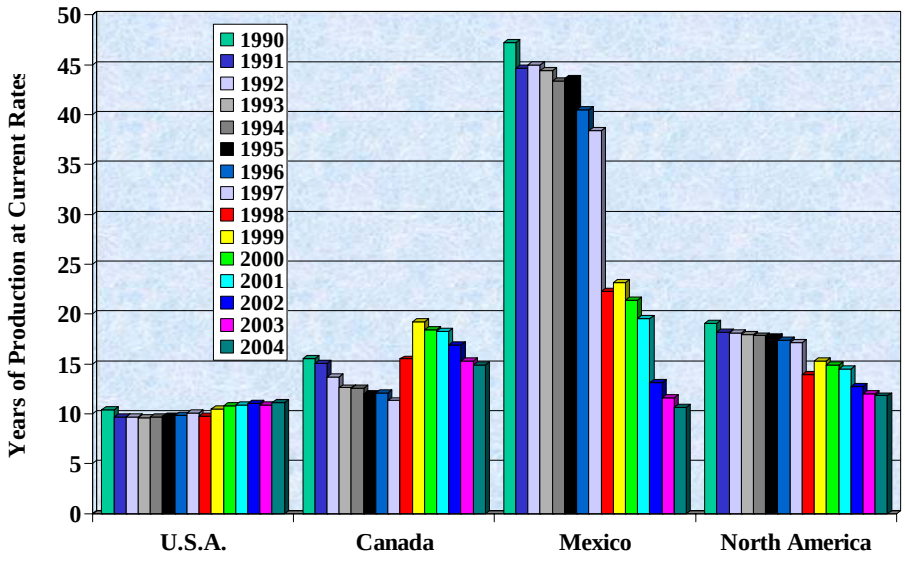
(Source Bentley, 2002; Wood, USGS, 2000; EIA IEO, 2005; Oil and Gas Journal, 2004; and others)

North American Oil Consumption and Movements: 1965-2004



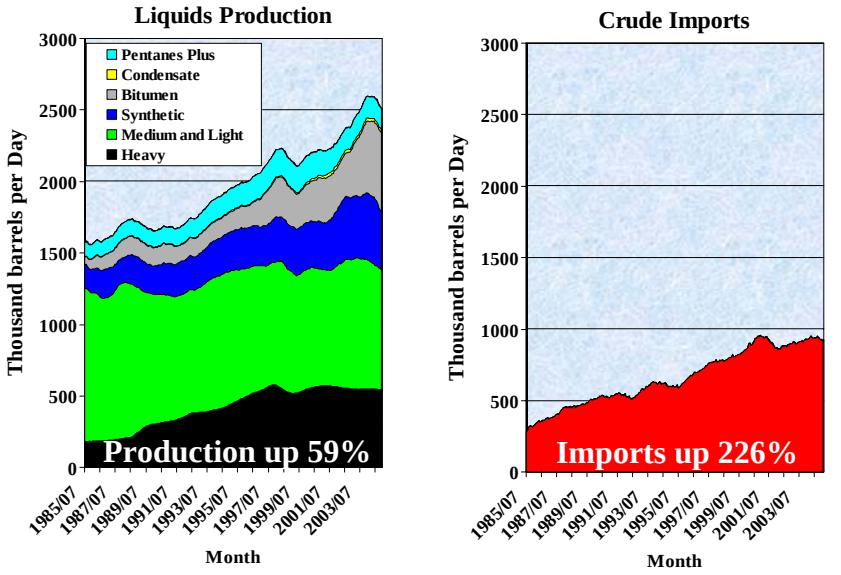
The total consumption-production gap is 65%, the difference of which is made up from withdrawls from storage and other non-import sources (data from BP Statistical Review of World Energy, 2005)

North America Reserve to Production Ratio in Years Including Oil Sands*



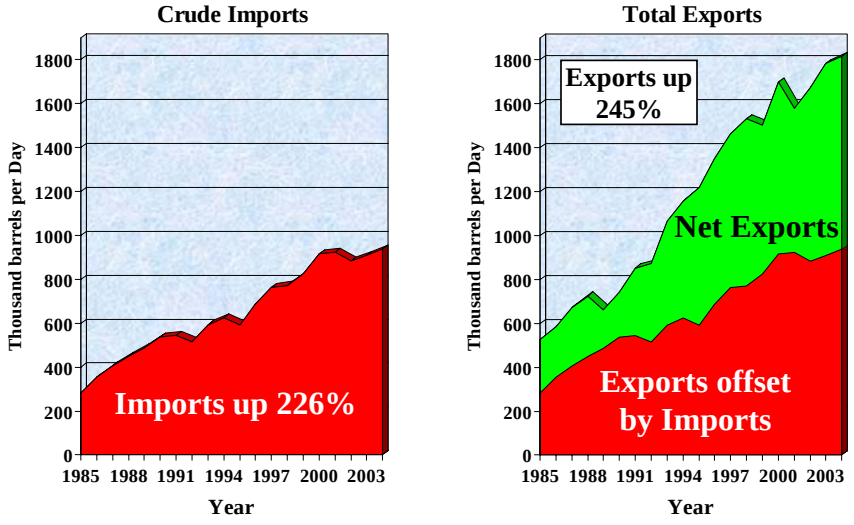
** Includes Oil Sands Reserves "Under Active Development"* *(data from BP Statistical Review of World Energy, 2005)*

Canadian Oil Production and Imports 1985-2005
(12 month centered moving average)



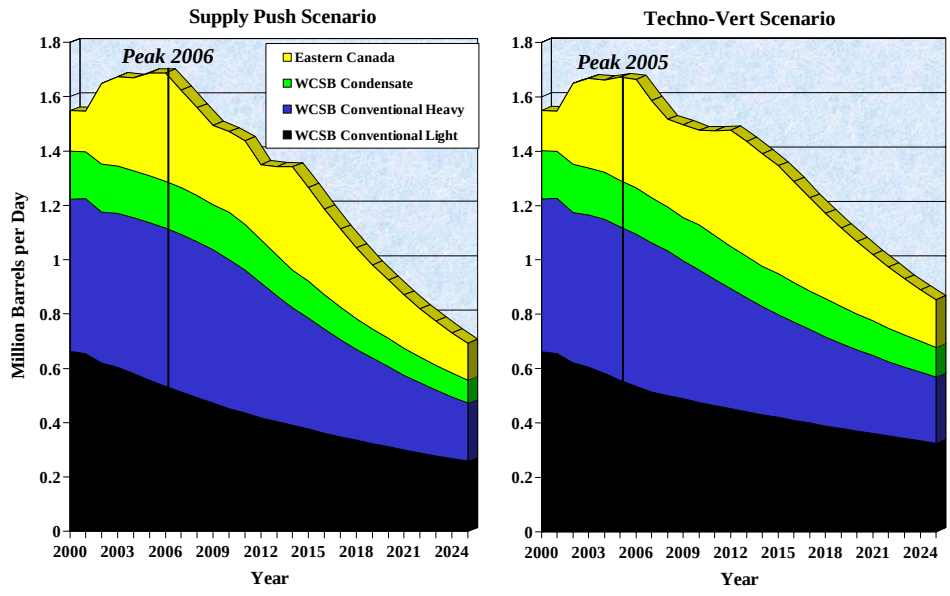
(data from Statistics Canada, October, 2005)

Canadian Oil Imports and Exports 1985-2004



(data from Statistics Canada, October, 2005, and BP Statistical Review of World Energy, 2005)

Canada Scenarios of Oil Production Excluding Oil Sands (NEB, 2003)



(data from National Energy Board, July, 2003)

Yes, But We've Got the
OIL SANDS – More Oil than Saudi Arabia!

- The Oil Sands cannot significantly offset declines in world production because of the lead times and capital investment required. Massive expansions in the Oil Sands and Venezuelan Orinoco extra-heavy oil belt could increase combined production from 1.74 million barrels per day at present to as much as six million barrels per day by 2025, which is only 5% of EIA forecast World Demand in 2025.

- Oil from the oil sands is very energy intensive – Forecast four- to five-fold growth to 2025 will require between 1.6 and 2.3 bcf/day of natural gas, which is approximately equivalent to the planned maximum capacity of the MacKenzie Valley pipeline of 1.9 bcf/day, or about one-fifth of forecast Canadian domestic consumption.

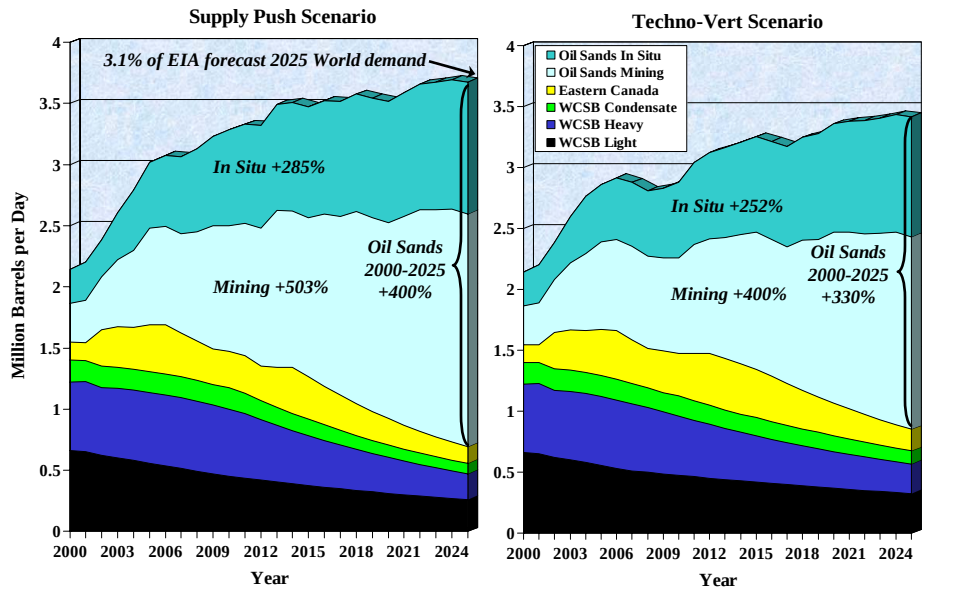
- Expansion of capacity is limited by natural gas supply and natural gas price, which could destroy economics if there are shortfalls in supply, **barring widespread application of non-thermal processes, or switching to alternative fuels.**

- Expansion of capacity is limited by water supply ([1]need average of 1-2 barrels of make-up water for every barrel of oil, depending on recovery method and technology), let alone future expansion **unless technologies to reduce water consumption and/or further recycle water can be employed.**

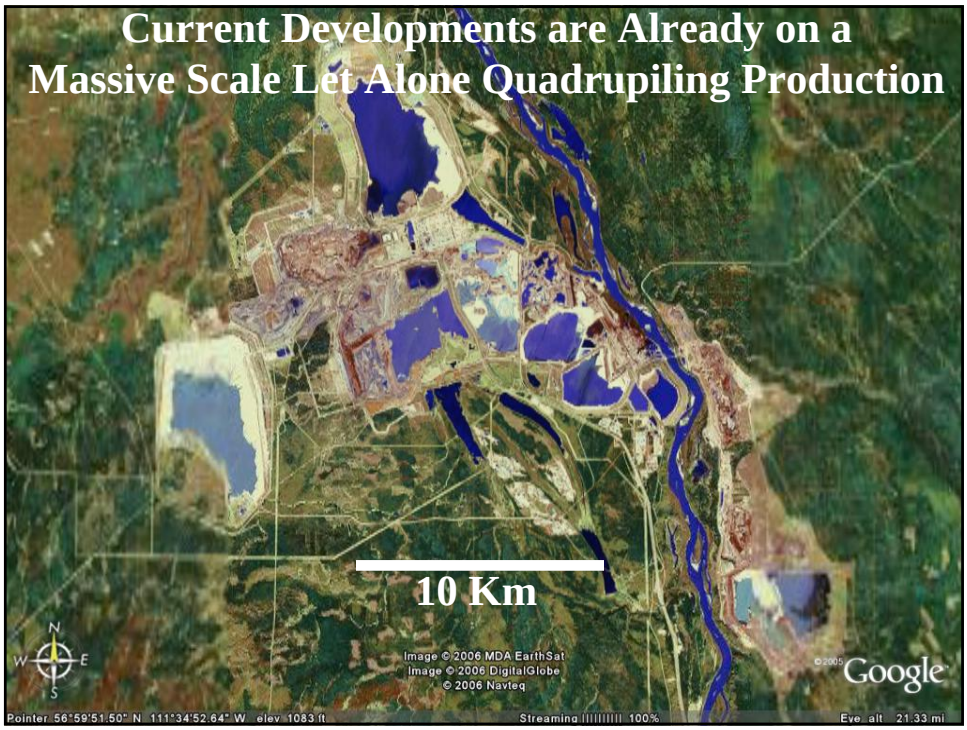
- Expansion of bitumen export capacity may also be limited by projected shortfalls of condensate/light crude diluent for blending which are forecast to occur in the 2004-2006 timeframe (National Energy Board, 2003), requiring other alternatives such as synthetic crude or conventional light oil**.**

([1]CERI report 2003)

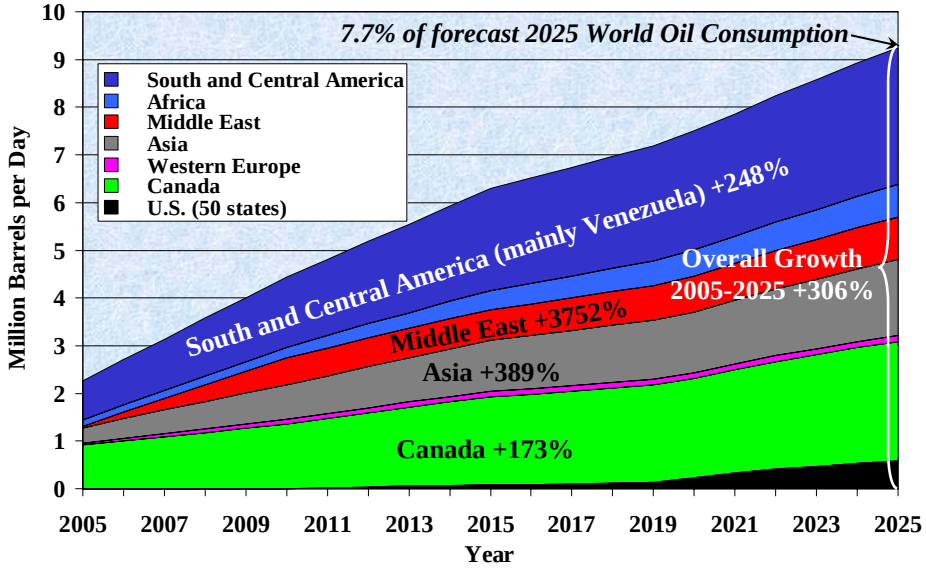
Canada Scenarios of Oil Production Including Oil Sands (NEB, 2003)



(data from National Energy Board, July, 2003)

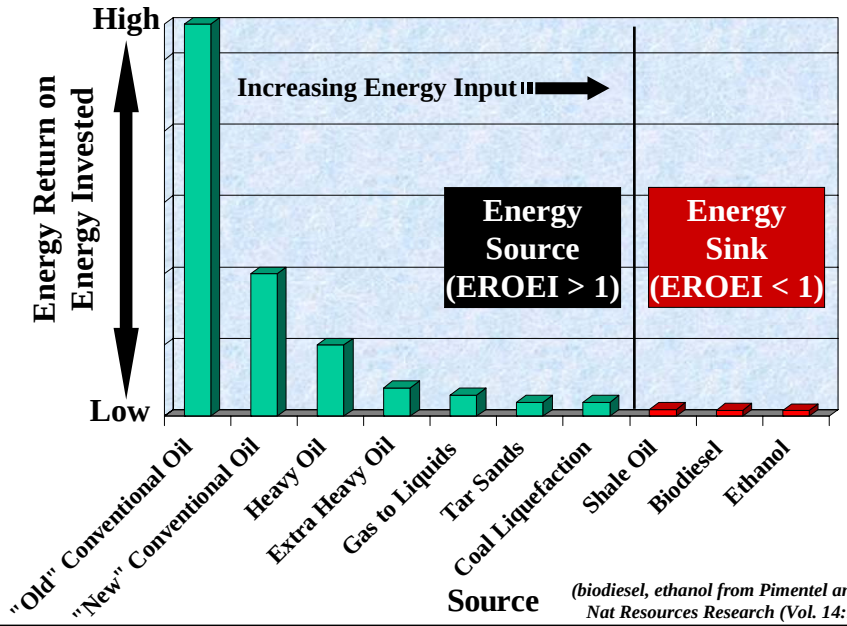


EIA World Non-Conventional Oil Production Forecast 2005-2025 (Reference Economic Case, 2006) – includes Biodiesel, Ethanol, Coal-to-liquids, Gas-to-liquids, Oil sands, Extra Heavy Oil and Oil shale



(data from Energy Information Administration, Annual Energy Outlook, 2006)

Energy Profit Ratio for Liquid Hydrocarbons



(biodiesel, ethanol from Pimentel and Patzek Nat Resources Research (Vol. 14:1, 65-76))

GAS

- **The third largest source of energy in the world** *after oil and coal (23.7% of primary energy consumption in 2004)*

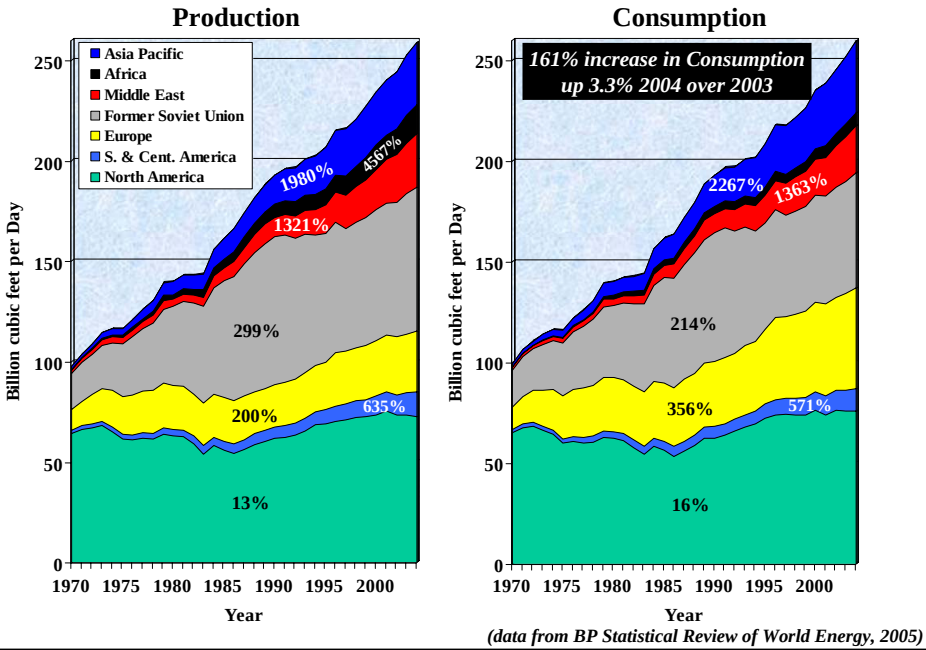
- **Largely landlocked when it comes to international trade,** *unlike oil and coal – 6% of World consumption was moved by Liquefied Natural Gas (LNG) in 2004*

- **Natural Gas is difficult to store by comparison to Oil and Coal** *(approximately 3.2 Tcf of "working" storage in the U.S. or 50 days of U.S. Supply) - North America is a Continental gas market- about 2.8% of North American (ie. U.S.A.) consumption was moved as LNG in 2004*

- **LNG entails an energy loss of between 15 and 30% for liquefaction, transportation and regasification,** *as LNG must be cooled to –165 degrees Celsius for movement by ship*

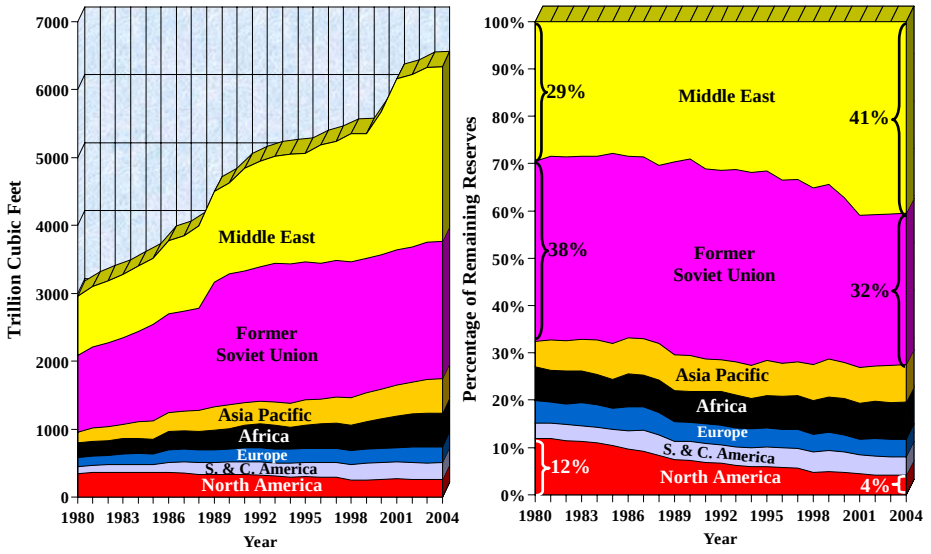
- **LNG is subject to Geopolitics** *as three-quarters of remaining natural gas reserves are located in the Former Soviet Union and the Middle East,* ***as well as the NIMBY syndrome in locating new receiving terminals in North America*** *because of perceived dangers by the general public*

World Gas Production and Consumption: 1970-2004



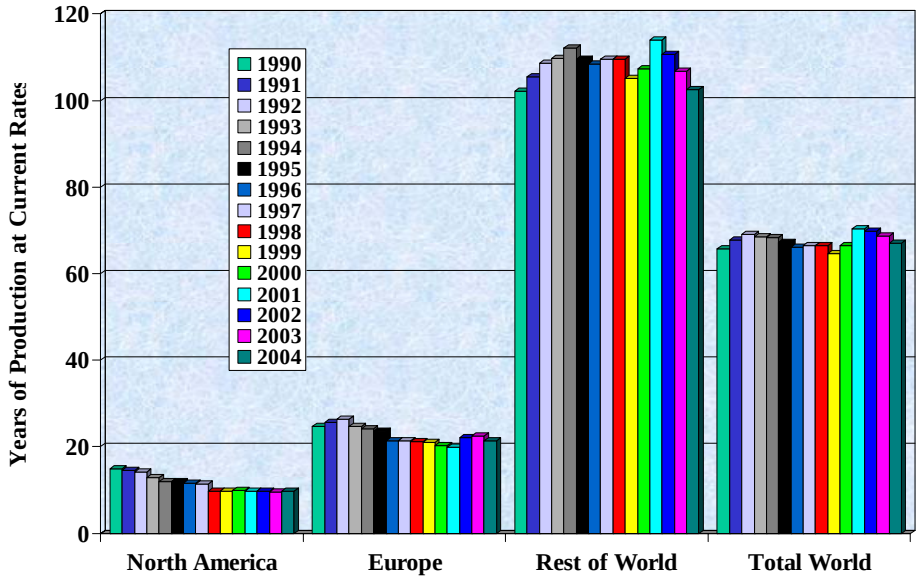
(data from BP Statistical Review of World Energy, 2005)

World Gas Reserves: 1980-2004

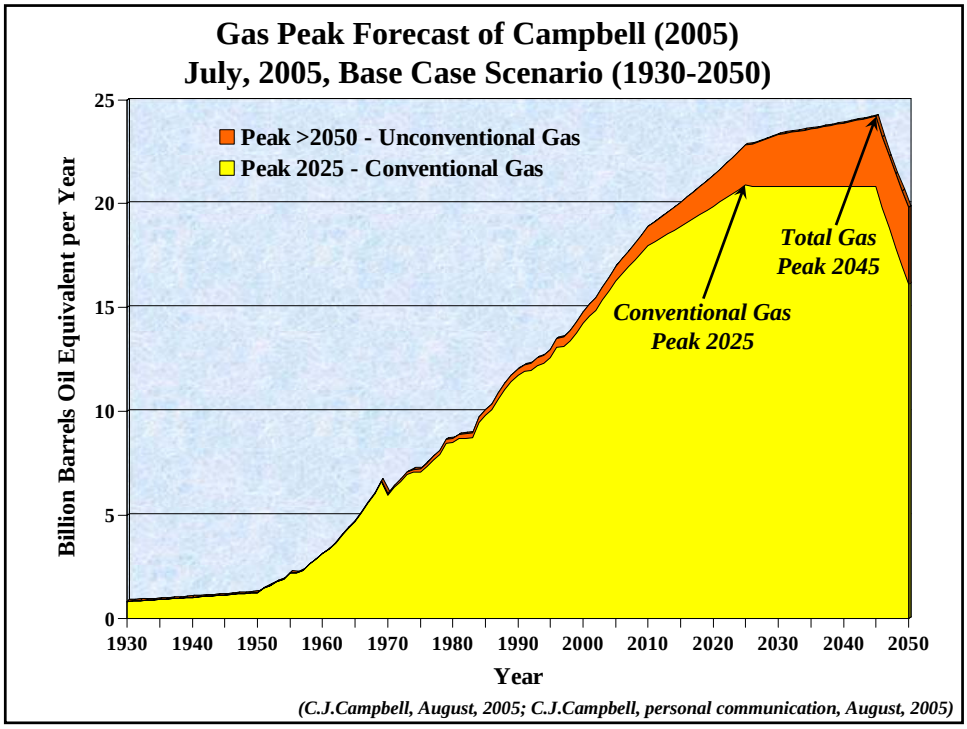


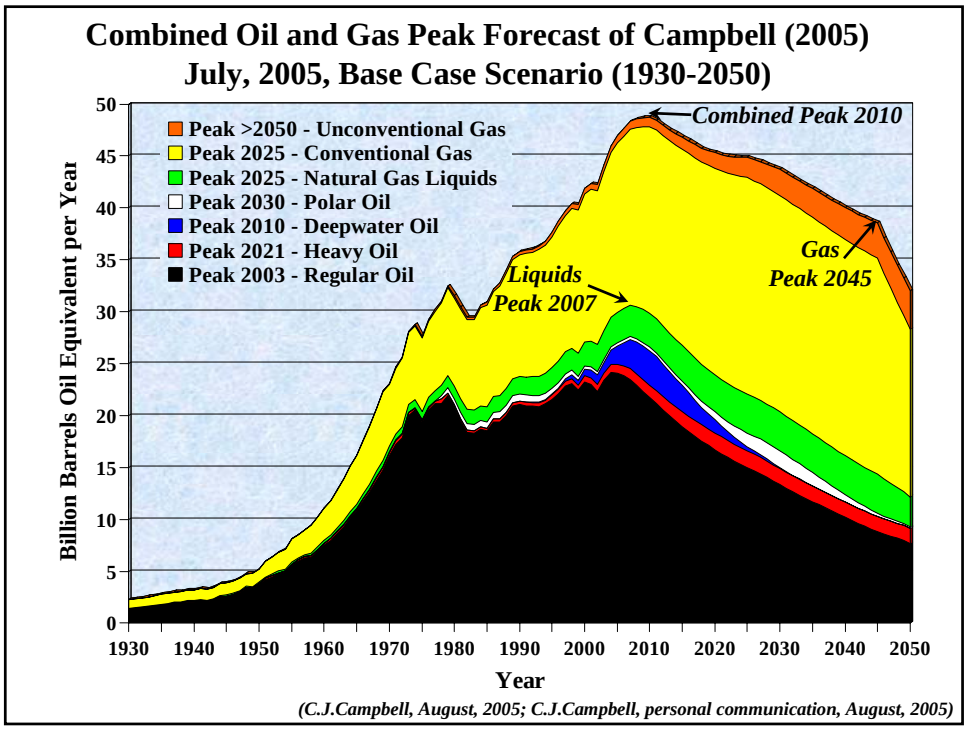
(data from BP Statistical Review of World Energy, 2005)

World Natural Gas Reserve to Production Ratio in Years 1990-2004

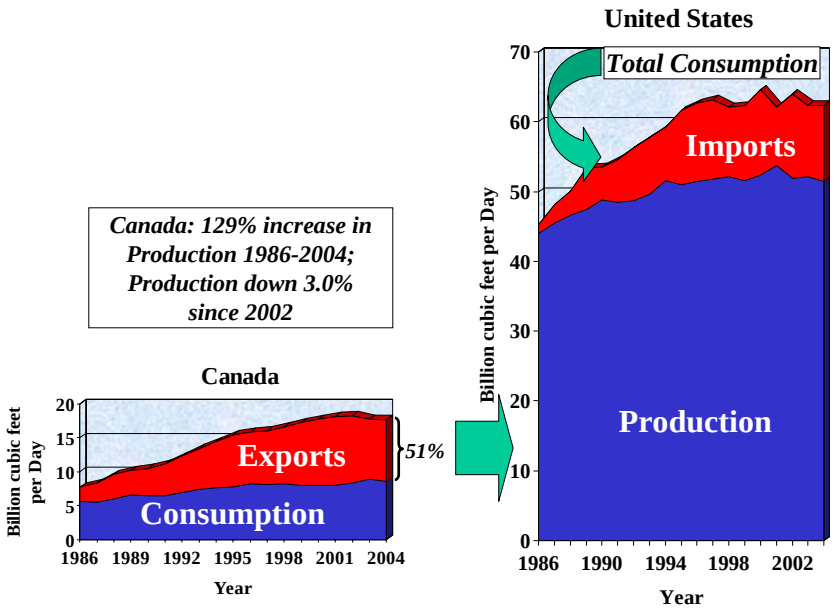


(data from BP Statistical Review of World Energy, 2005)


Gas Peak Forecast of Campbell (2005)
July, 2005, Base Case Scenario (1930-2050)
Billion Barrels Oil Equivalent per Year
Year
Peak >2050 - Unconventional Gas
Peak 2025 - Conventional Gas
Total Gas
Peak 2045
Conventional Gas
Peak 2025
0
5
10
15
20
25
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
(C.J.Campbell, August, 2005; C.J.Campbell, personal communication, August, 2005)

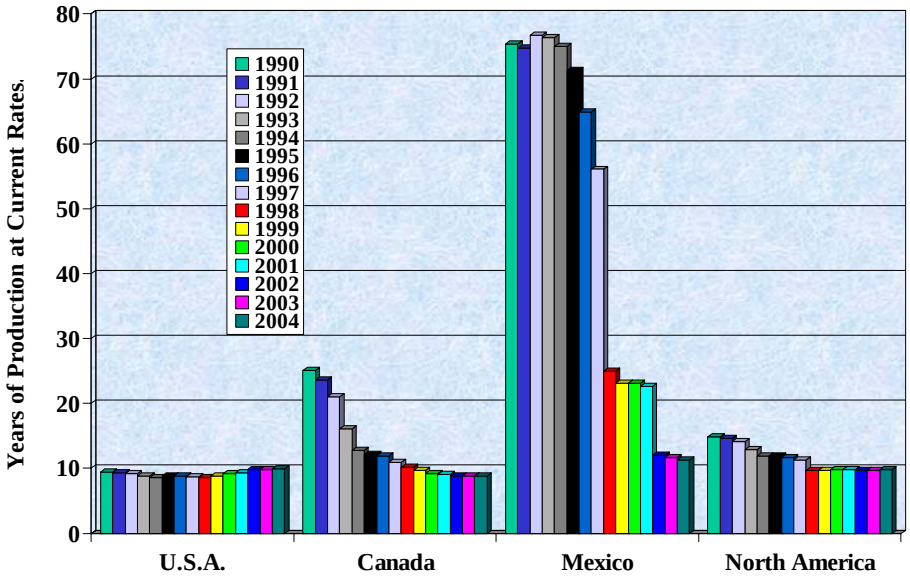

Combined Oil and Gas Peak Forecast of Campbell (2005)
July, 2005, Base Case Scenario (1930-2050)
Billion Barrels Oil Equivalent per Year
Year
Peak >2050 - Unconventional Gas
Peak 2025 - Conventional Gas
Peak 2025 - Natural Gas Liquids
Peak 2030 - Polar Oil
Peak 2010 - Deepwater Oil
Peak 2021 - Heavy Oil
Peak 2003 - Regular Oil
Combined Peak 2010
Gas
Peak 2045
Liquids
Peak 2007
0
5
10
15
20
25
30
35
40
45
50
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
(C.J.Campbell, August, 2005; C.J.Campbell, personal communication, August, 2005)

North American Gas Production and Movements: 1986-2004



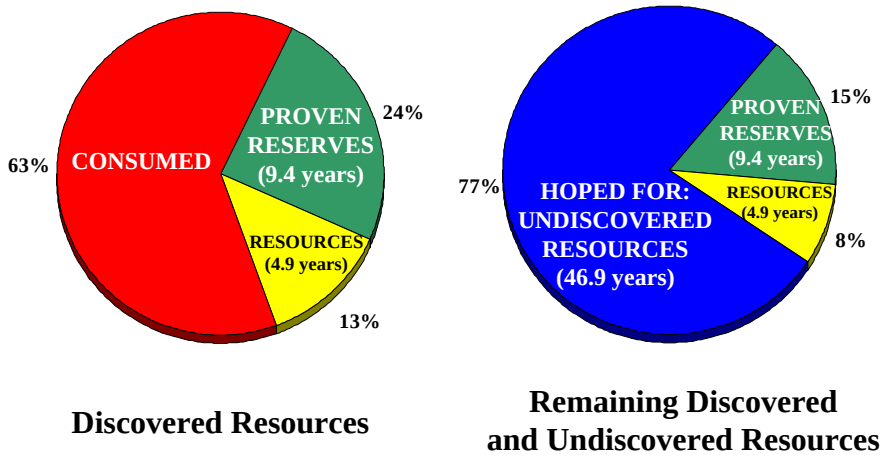
(data from BP Statistical Review of World Energy, 2005)

North America Natural Gas Reserve to Production Ratio in Years 1990-2004



(data from BP Statistical Review of World Energy, 2005)

Canada's Remaining Discovered and Undiscovered Conventional Marketable Natural Gas Resources According to NEB (2006) Estimates including Lifetime assuming 2005 Production Rates

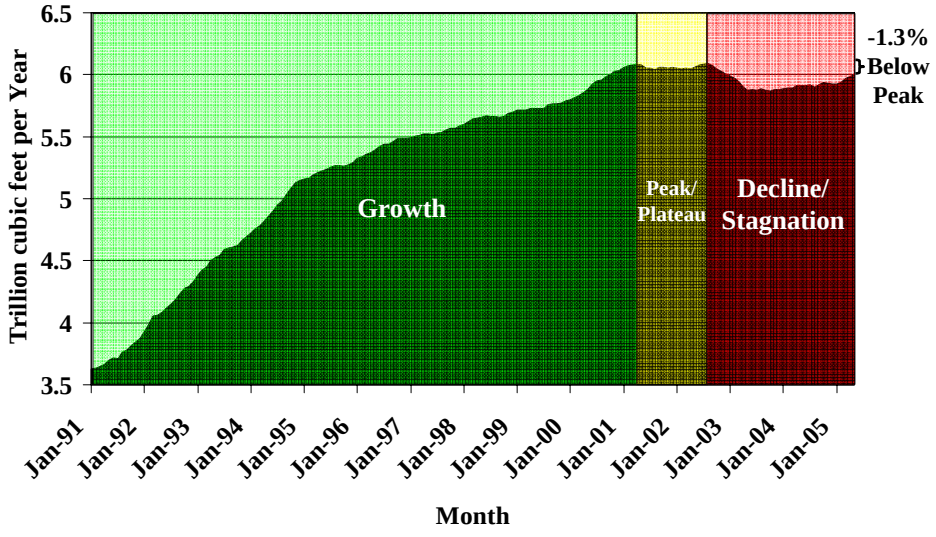


Discovered Resources

Remaining Discovered and Undiscovered Resources

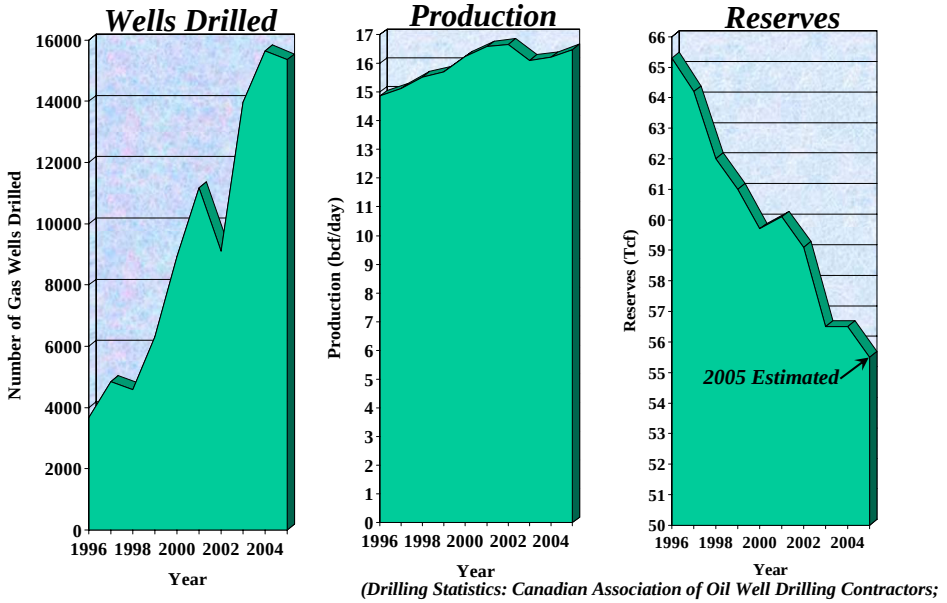
(Resource estimates from National Energy Board, March, 2006, Report 2006-A, as at December 31, 2004; 2004 Proven Reserves from CAPP, 2006; 2005 Production from Statistics Canada, 2006)

Annual Canadian Marketable Natural Gas Production by Month January 1991 - January 2006 (12 month centered moving average)



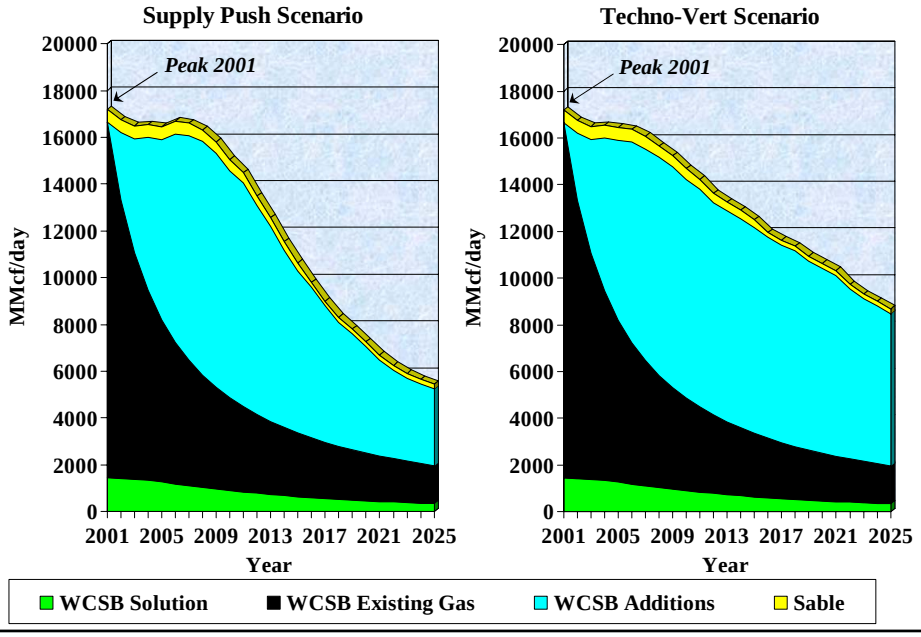
(Source of data Statistics Canada, April, 2006)

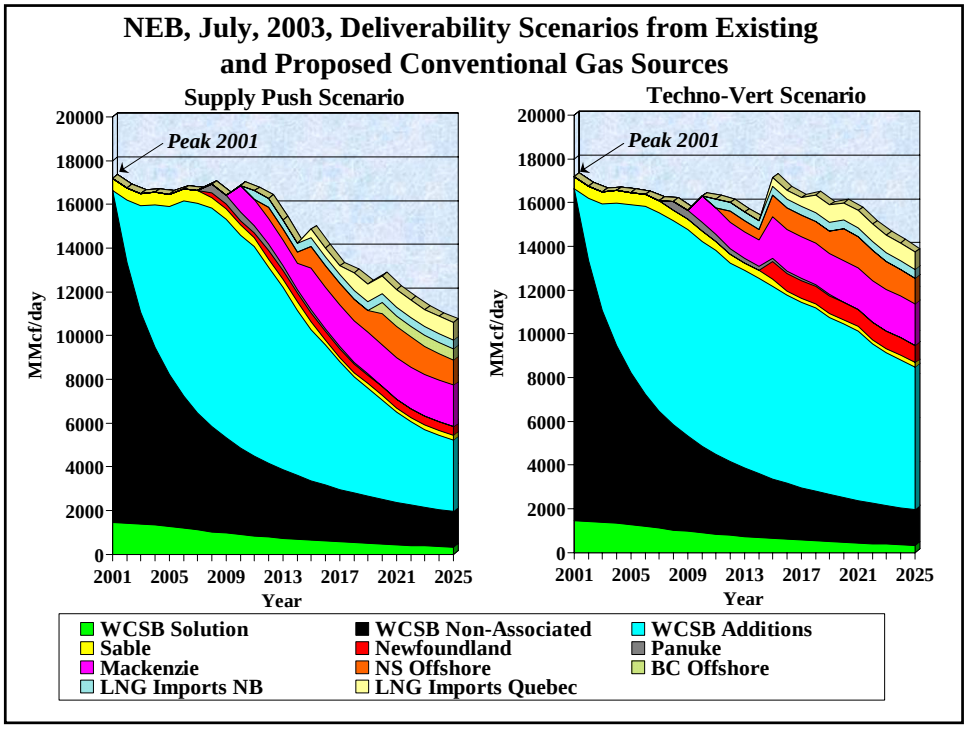
Canada's Exploration Treadmill – more and more drilling to find less and less gas

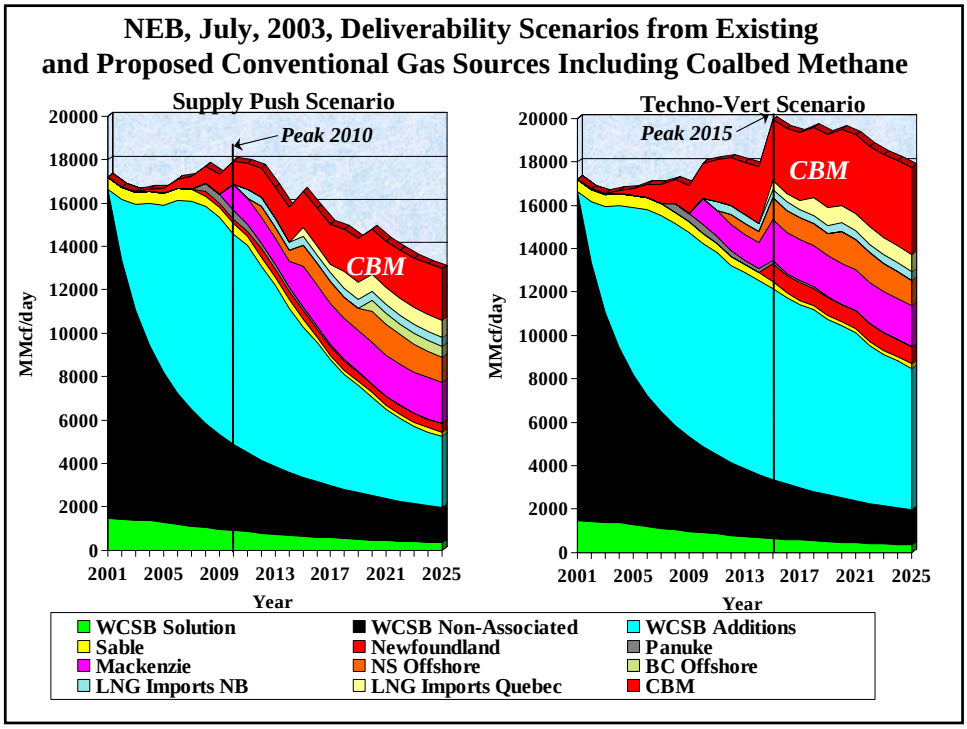


(Drilling Statistics: Canadian Association of Oil Well Drilling Contractors; Marketable Production: Statistics Canada; Remaining Reserves: Canadian Association of Petroleum Producers)

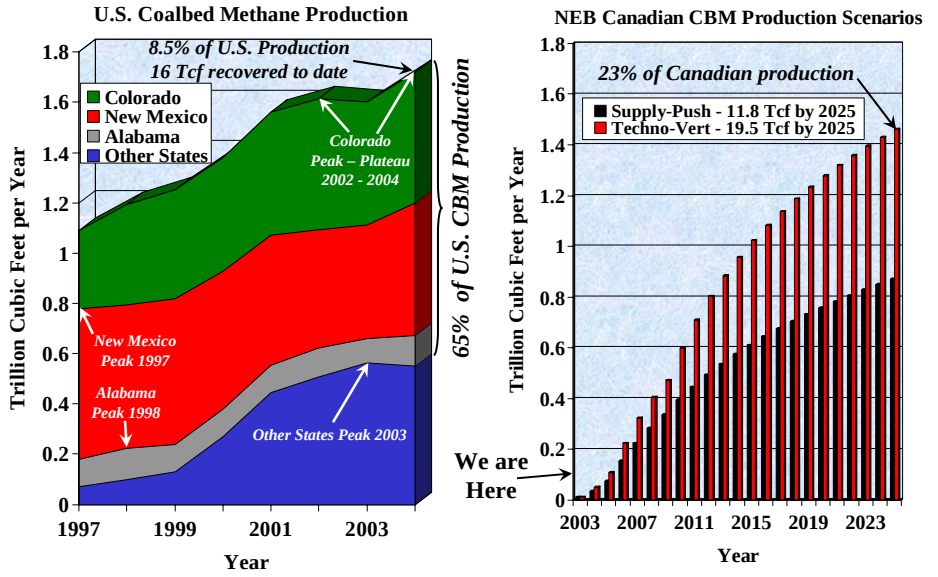
NEB, July, 2003, Deliverability Scenarios from Existing Gas Sources




NEB, July, 2003, Deliverability Scenarios from Existing and Proposed Conventional Gas Sources
Supply Push Scenario
Techno-Vert Scenario
Peak 2001
Peak 2001
MMcf/day
Year
WCSB Solution
WCSB Non-Associated
WCSB Additions
Sable
Newfoundland
Panuke
Mackenzie
NS Offshore
BC Offshore
LNG Imports NB
LNG Imports Quebec

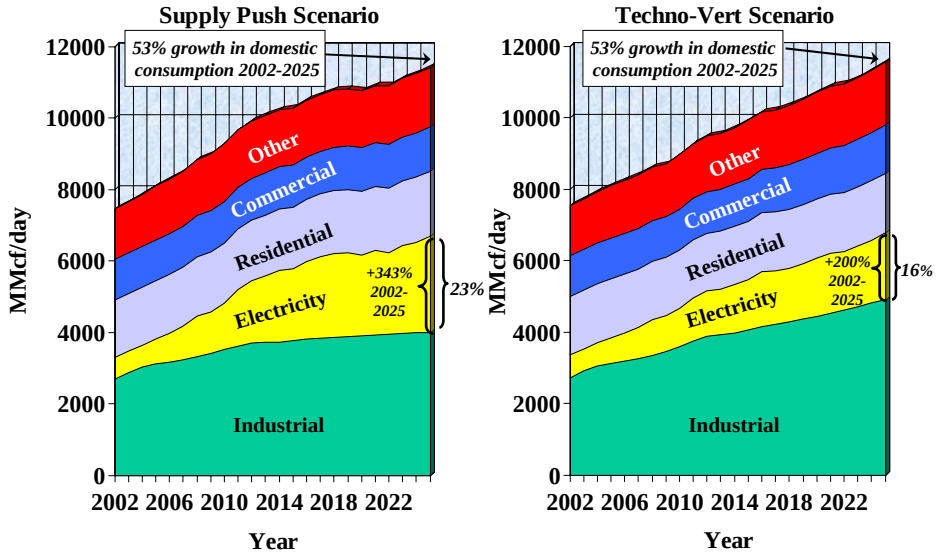

NEB, July, 2003, Deliverability Scenarios from Existing and Proposed Conventional Gas Sources Including Coalbed Methane
Supply Push Scenario
Techno-Vert Scenario
Peak 2010
Peak 2015
CBM
CBM
MMcf/day
Year
WCSB Solution
WCSB Non-Associated
WCSB Additions
Sable
Newfoundland
Panuke
Mackenzie
NS Offshore
BC Offshore
LNG Imports NB
LNG Imports Quebec
CBM

Actual Coalbed Methane Production in the U.S. 1997-2004 Compared to NEB Coalbed Methane Production Scenarios 2003-2025

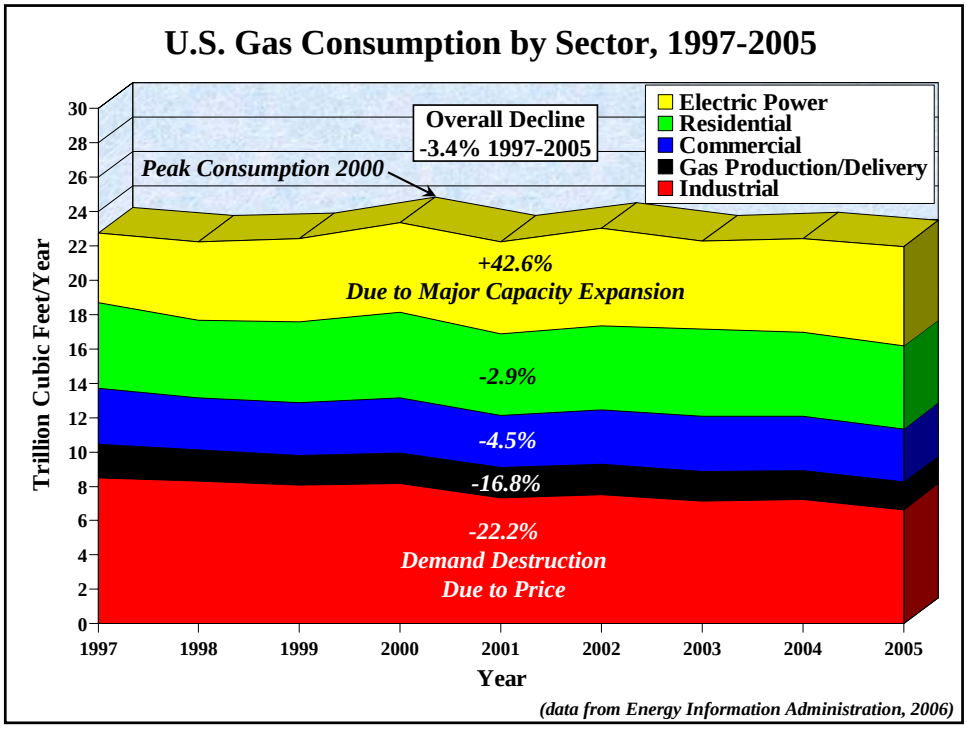


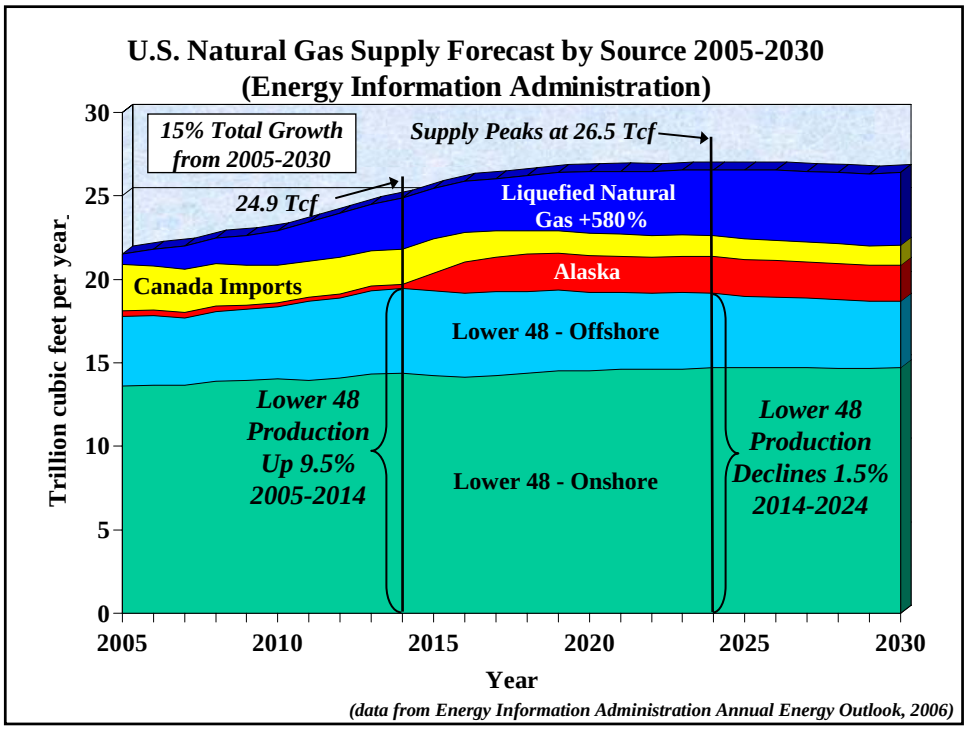
(Source of data Energy Information Administration, 2006; National Energy Board, July, 2003)

NEB, 2003, Canadian Domestic Natural Gas Demand Scenarios by Sector, 2002-2025

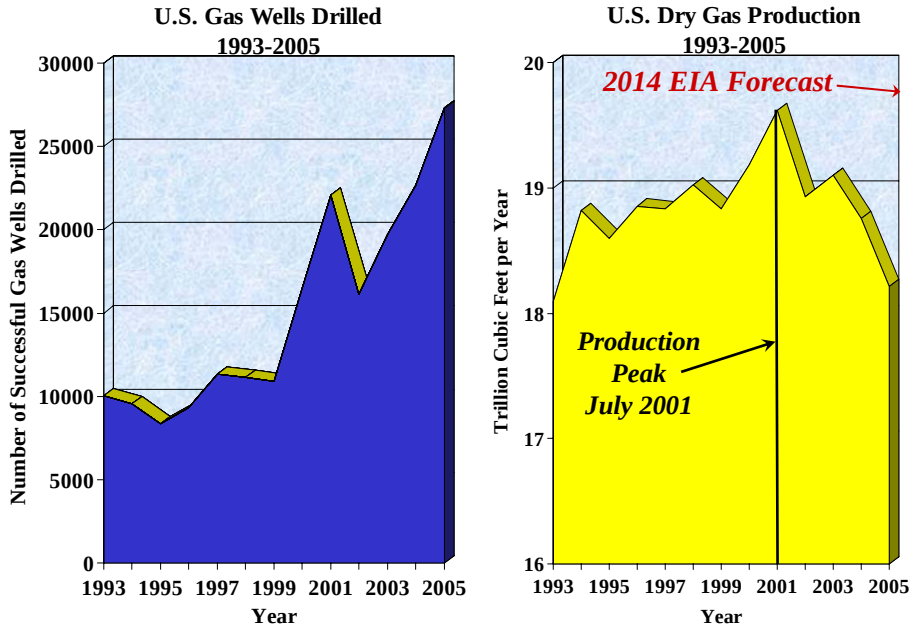


(data from National Energy Board, July, 2003)


U.S. Gas Consumption by Sector, 1997-2005
Electric Power
Residential
Commercial
Gas Production/Delivery
Industrial
Overall Decline
-3.4% 1997-2005
Peak Consumption 2000
+42.6%
Due to Major Capacity Expansion
-2.9%
-4.5%
-16.8%
-22.2%
Demand Destruction
Due to Price
Trillion Cubic Feet/Year
Year
(data from Energy Information Administration, 2006)

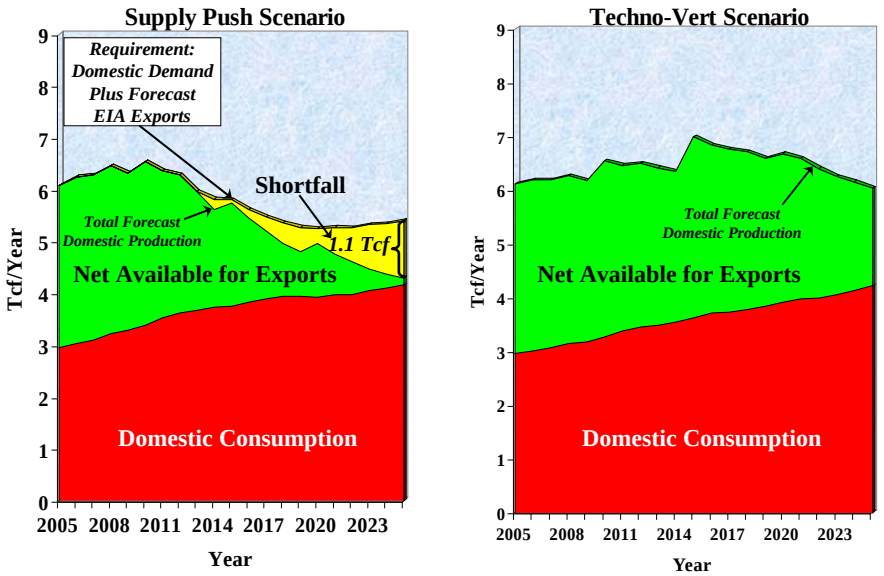

U.S. Natural Gas Supply Forecast by Source 2005-2030
(Energy Information Administration)
15% Total Growth
from 2005-2030
Supply Peaks at 26.5 Tcf
24.9 Tcf
Liquefied Natural
Gas +580%
Alaska
Canada Imports
Lower 48 - Offshore
Lower 48 - Onshore
Lower 48
Production
Up 9.5%
2005-2014
Lower 48
Production
Declines 1.5%
2014-2024
Trillion cubic feet per year
Year
(data from Energy Information Administration Annual Energy Outlook, 2006)

The U.S. Gas Exploration Treadmill



(data from U.S. Energy Information Administration, April, 2006)

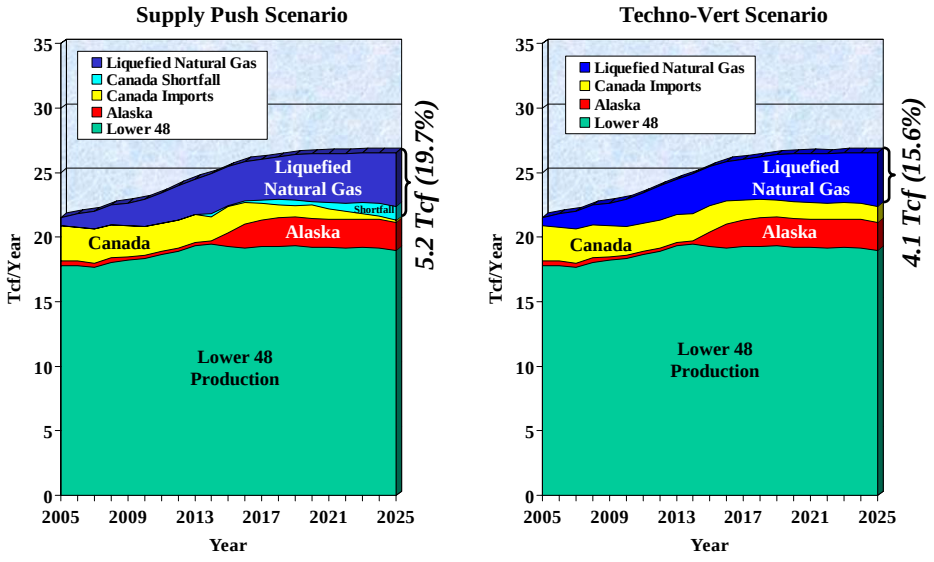
Canadian Shortfalls in Gas Supply Given Domestic Production Scenarios and Forecast EIA (AEO 2006) Reference U.S. Import Requirements



Note: Forecast Canadian LNG Imports are Excluded from Domestic Production

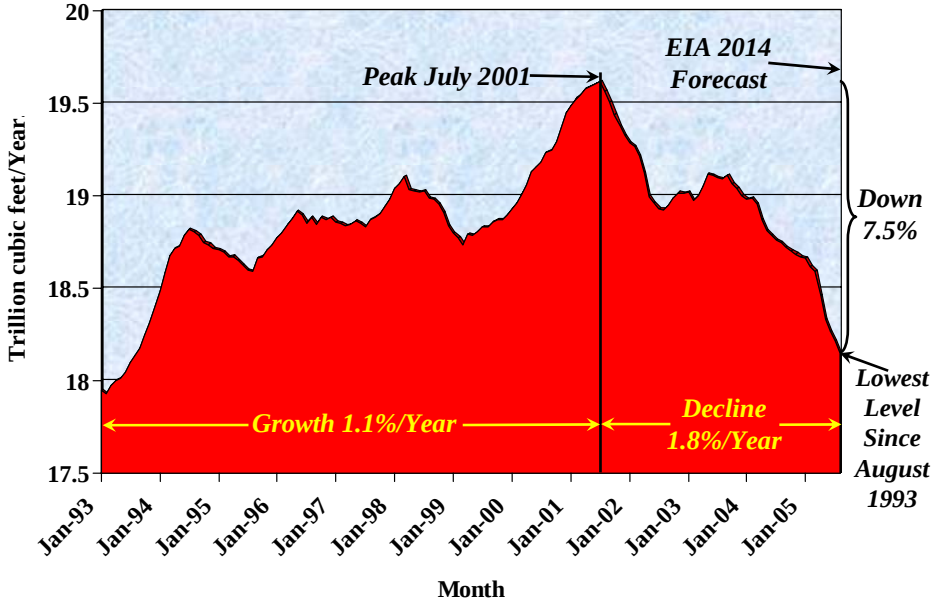
(data from National Energy Board, July, 2003, and EIA Annual Energy Outlook, 2006)

U.S. Supply with Canadian Imports and Shortfalls Given NEB, 2003, Supply Scenarios and EIA (2006) Reference Case Supply Scenario



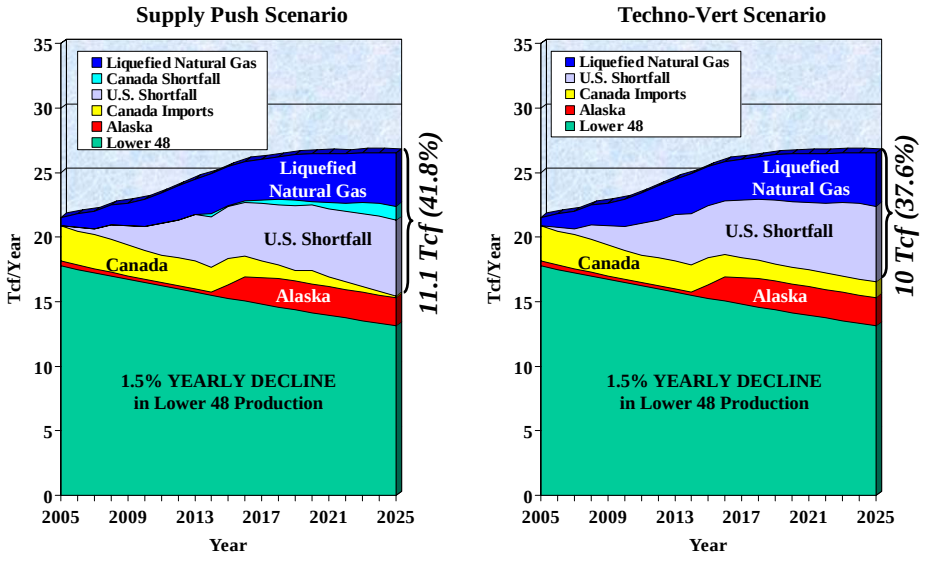
(data from Energy Information Administration Annual Energy Outlook, 2006, and National Energy Board, July, 2003)

U.S. Annual Dry Gas Production Rate by Month January 1993 - January 2006 (centered 12 month moving average)



(Data from Energy Information Administration, April, 2006; Forecast from EIA Annual Energy Outlook, 2006)

U.S. Supply with Canadian Imports and Shortfalls Given NEB, 2003, Supply Scenarios and EIA Reference Case Supply Scenario with 1.5% Yearly Decline in Lower 48 Production



(data from Energy Information Administration Annual Energy Outlook, 2006, and National Energy Board, July, 2003)

FUTURE OUTLOOK:

- *IMPLICATIONS* – If supply and demand forecasts are to be believed, there appear to be serious supply shortfalls in Continental natural gas coming – *Canada is unlikely to be able to fill the supply gap*

- *SOLUTIONS* - probably involve a portfolio of options:

- **Conservation and Efficiency**
- **LNG – *already factored into existing forecasts; GEOPOLITICAL + NIMBY IMPLICATIONS***
- **Unconventional Gas - *already factored into existing forecasts in a big way***
- **Fuel Switching – *to oil or coal – capacity quite limited without new capital investment***
- **Destroy Demand – *move gas intensive industries offshore (fertilizer and petrochemical plants) - this is already happening; GEOPOLITICAL IMPLICATIONS***

LNG Logistics

OPERATING COSTS (FREEPORT, TEXAS[1]):

- Production = $US .50-$1.00/mcf
- Liquefaction = $US .80-$1.00/mcf

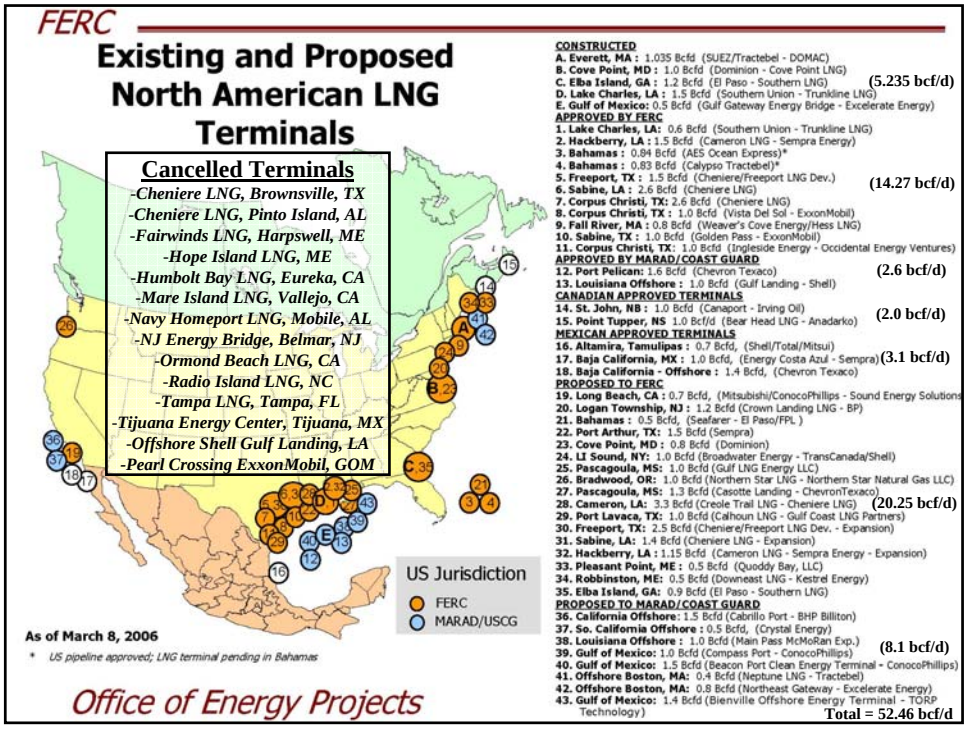
- Shipping = $US .50-$1.45/mcf
- Receiving = $US .24-$.40/mcf
- TOTAL = $US 2.04-$3.85/mcf
(U.S. 2005 Imports priced at $US 5.72-$7.44/mcf)

([1]Reimer, Freeport LNG, 2003; EIA November, 2005)

LNG Logistics

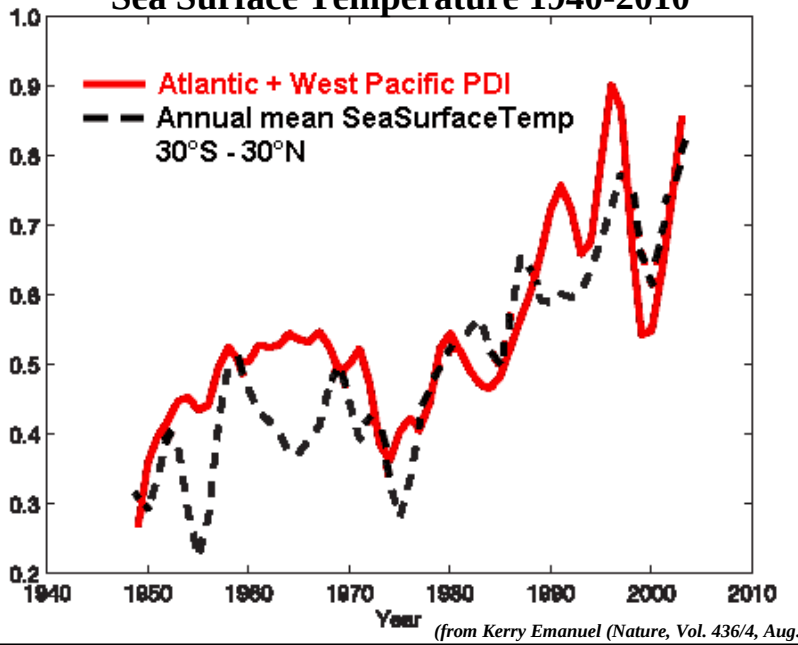
COVERING PROJECTED U.S. SHORTFALLS OF 4-11 TCF/YEAR WITH LNG WOULD REQUIRE NEARLY DOUBLING TO TRIPLING THE WORLD'S PRESENT LNG CAPACITY (the U.S. will also be in competition with many other countries for LNG supplies). EXPANSION OF NORTH AMERICAN LNG CAPACITY TO 11 TCF/YEAR WOULD REQUIRE ON THE ORDER OF:

- 200 New 3bcf capacity LNG Tankers
- 30 New 1bcf/day North America-based receiving terminals
- 56 New Foreign-based 200 bcf/year liquefaction trains
- Capital investment in the order of $US100+ Billion
- Time to Build Total Capacity = 10-20+ Years
- OVERCOMING THE NIMBY SYNDROME IN LOCATING NEW TERMINALS
- ACCEPTING THE GEOPOLITICAL IMPLICATIONS OF DEPENDENCY ON OFFSHORE SUPPLY SOURCES


FERC
Existing and Proposed North American LNG Terminals
Cancelled Terminals
-Cheniere LNG, Brownsville, TX
-Cheniere LNG, Pinto Island, AL
-Fairwinds LNG, Harpswell, ME
-Hope Island LNG, ME
-Humbolt Bay LNG, Eureka, CA
-Mare Island LNG, Vallejo, CA
-Navy Homeport LNG, Mobile, AL
-NJ Energy Bridge, Belmar, NJ
-Ormond Beach LNG, CA
-Radio Island LNG, NC
-Tampa LNG, Tampa, FL
-Tijuana Energy Center, Tijuana, MX
-Offshore Shell Gulf Landing, LA
-Pearl Crossing ExxonMobil, GOM
US Jurisdiction
FERC
MARAD/USCG
As of March 8, 2006
* US pipeline approved; LNG terminal pending in Bahamas
Office of Energy Projects
CONSTRUCTED
A. Everett, MA : 1.035 Bcfd (SUEZ/Tractebel - DOMAC)
B. Cove Point, MD : 1.0 Bcfd (Dominion - Cove Point LNG)
C. Elba Island, GA : 1.2 Bcfd (El Paso - Southern LNG)
D. Lake Charles, LA : 1.5 Bcfd (Southern Union - Trunkline LNG)
E. Gulf of Mexico: 0.5 Bcfd (Gulf Gateway Energy Bridge - Excelerate Energy)
(5.235 bcf/d)
APPROVED BY FERC
1. Lake Charles, LA: 0.6 Bcfd (Southern Union - Trunkline LNG)
2. Hackberry, LA : 1.5 Bcfd (Cameron LNG - Sempra Energy)
3. Bahamas : 0.84 Bcfd (AES Ocean Express)*
4. Bahamas : 0.83 Bcfd (Calypso Tractebel)*
5. Freeport, TX : 1.5 Bcfd (Cheniere/Freeport LNG Dev.)
6. Sabine, LA : 2.6 Bcfd (Cheniere LNG)
7. Corpus Christi, TX: 2.6 Bcfd (Cheniere LNG)
8. Corpus Christi, TX : 1.0 Bcfd (Vista Del Sol - ExxonMobil)
9. Fall River, MA : 0.8 Bcfd (Weaver's Cove Energy/Hess LNG)
10. Sabine, TX : 1.0 Bcfd (Golden Pass - ExxonMobil)
11. Corpus Christi, TX: 1.0 Bcfd (Ingleside Energy - Occidental Energy Ventures)
(14.27 bcf/d)
APPROVED BY MARAD/COAST GUARD
12. Port Pelican: 1.6 Bcfd (Chevron Texaco)
13. Louisiana Offshore : 1.0 Bcfd (Gulf Landing - Shell)
(2.6 bcf/d)
CANADIAN APPROVED TERMINALS
14. St. John, NB : 1.0 Bcfd (Canaport - Irving Oil)
15. Point Tupper, NS 1.0 Bcf/d (Bear Head LNG - Anadarko)
(2.0 bcf/d)
MEXICAN APPROVED TERMINALS
16. Altamira, Tamulipas : 0.7 Bcfd, (Shell/Total/Mitsui)
17. Baja California, MX : 1.0 Bcfd, (Energy Costa Azul - Sempra)
18. Baja California - Offshore : 1.4 Bcfd, (Chevron Texaco)
(3.1 bcf/d)
PROPOSED TO FERC
19. Long Beach, CA : 0.7 Bcfd, (Mitsubishi/ConocoPhillips - Sound Energy Solutions
20. Logan Township, NJ : 1.2 Bcfd (Crown Landing LNG - BP)
21. Bahamas : 0.5 Bcfd, (Seafarer - El Paso/FPL)
22. Port Arthur, TX: 1.5 Bcfd (Sempra)
23. Cove Point, MD : 0.8 Bcfd (Dominion)
24. LI Sound, NY: 1.0 Bcfd (Broadwater Energy - TransCanada/Shell)
25. Pascagoula, MS: 1.0 Bcfd (Gulf LNG Energy LLC)
26. Bradwood, OR: 1.0 Bcfd (Northern Star LNG - Northern Star Natural Gas LLC)
27. Pascagoula, MS: 1.3 Bcfd (Casotte Landing - ChevronTexaco)
28. Cameron, LA: 3.3 Bcfd (Creole Trail LNG - Cheniere LNG)
29. Port Lavaca, TX: 1.0 Bcfd (Calhoun LNG - Gulf Coast LNG Partners)
30. Freeport, TX: 2.5 Bcfd (Cheniere/Freeport LNG Dev. - Expansion)
31. Sabine, LA: 1.4 Bcfd (Cheniere LNG - Expansion)
32. Hackberry, LA : 1.15 Bcfd (Cameron LNG - Sempra Energy - Expansion)
33. Pleasant Point, ME : 0.5 Bcfd (Quoddy Bay, LLC)
34. Robbinston, ME: 0.5 Bcfd (Downeast LNG - Kestrel Energy)
35. Elba Island, GA: 0.9 Bcfd (El Paso - Southern LNG)
(20.25 bcf/d)
PROPOSED TO MARAD/COAST GUARD
36. California Offshore: 1.5 Bcfd (Cabrillo Port - BHP Billiton)
37. So. California Offshore : 0.5 Bcfd, (Crystal Energy)
38. Louisiana Offshore : 1.0 Bcfd (Main Pass McMoRan Exp.)
39. Gulf of Mexico: 1.0 Bcfd (Compass Port - ConocoPhillips)
40. Gulf of Mexico: 1.5 Bcfd (Beacon Port Clean Energy Terminal - ConocoPhillips)
41. Offshore Boston, MA: 0.4 Bcfd (Neptune LNG - Tractebel)
42. Offshore Boston, MA: 0.8 Bcfd (Northeast Gateway - Excelerate Energy)
43. Gulf of Mexico: 1.4 Bcfd (Bienville Offshore Energy Terminal - TORP Technology)
(8.1 bcf/d)
Total = 52.46 bcf/d

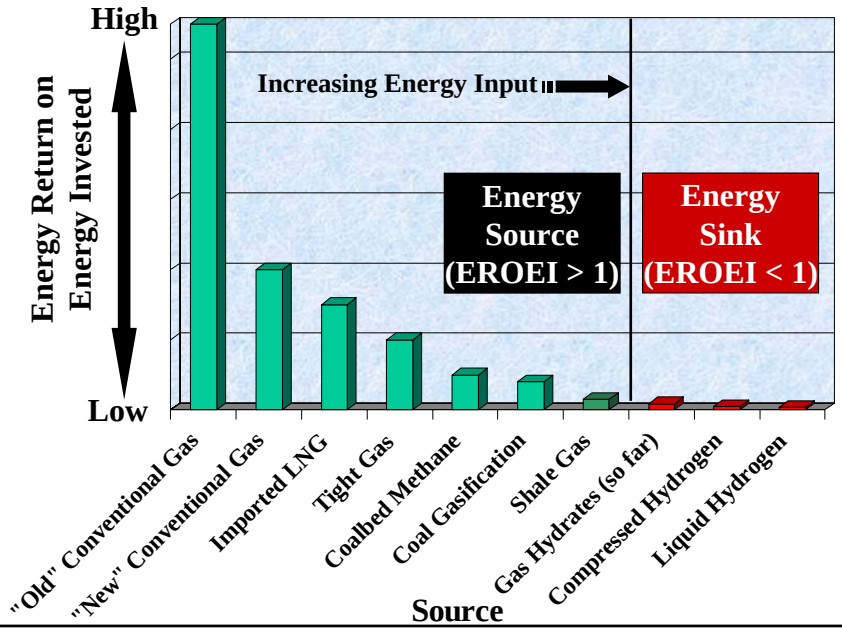

Category 4 and 5 Hurricanes in the Gulf of Mexico are becoming an increasing Risk for Oil and Gas Production and Delivery Systems
(Few platforms can withstand Category 4 Hurricanes)

Power Dissipation Index of Hurricanes versus Sea Surface Temperature 1940-2010



(from Kerry Emanuel (Nature, Vol. 436/4, Aug. 2005)

Energy Profit Ratio for Natural Gas and Alternatives



COAL

- Two-thirds of the world's remaining hydrocarbon energy

- 27.2% of the world's primary energy consumption in 2004 – second only to *OIL*

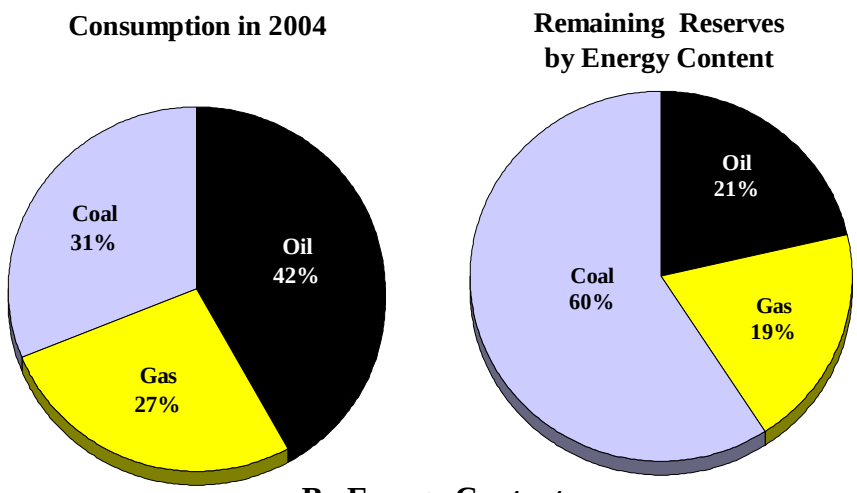
- Used for electricity generation (more so than any other fuel), primary heat and in the steel industry

- Lowest cost heat source: $0.84-$3.00US/gigajoule versus $9.52US/gigajoule for gas and $9.69US/gigajoule for oil

- Double the carbon footprint of gas using conventional technology – with advanced "clean coal" technologies the carbon footprint can be reduced almost to that of gas (but costs $$$)

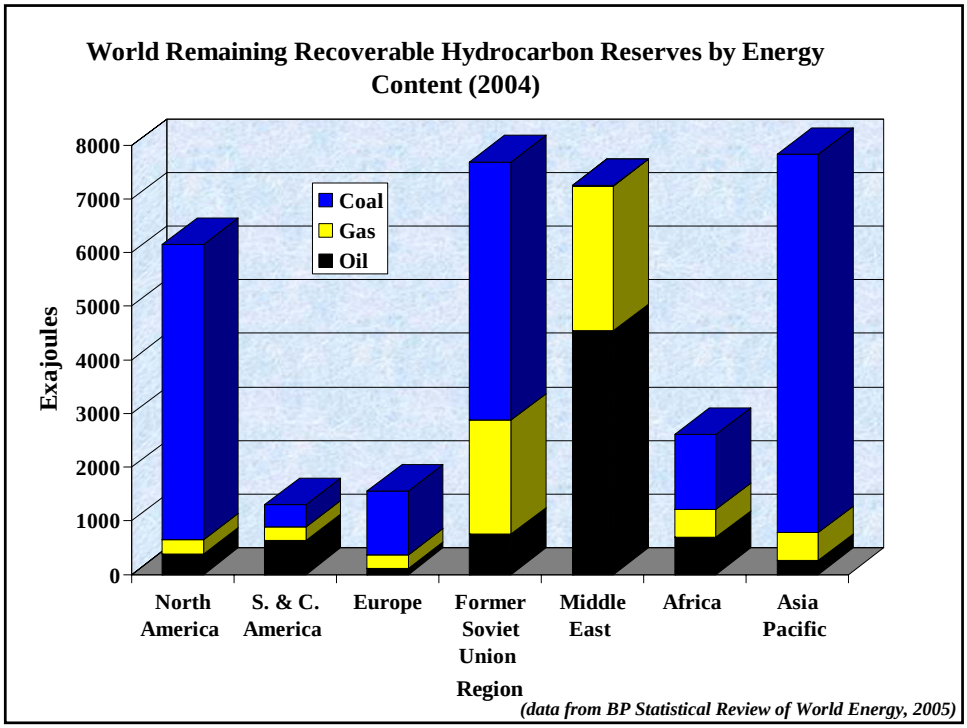
- Fastest growing hydrocarbon fuel source: consumption has grown 25% since yearend 2001 (6.3% in 2004)

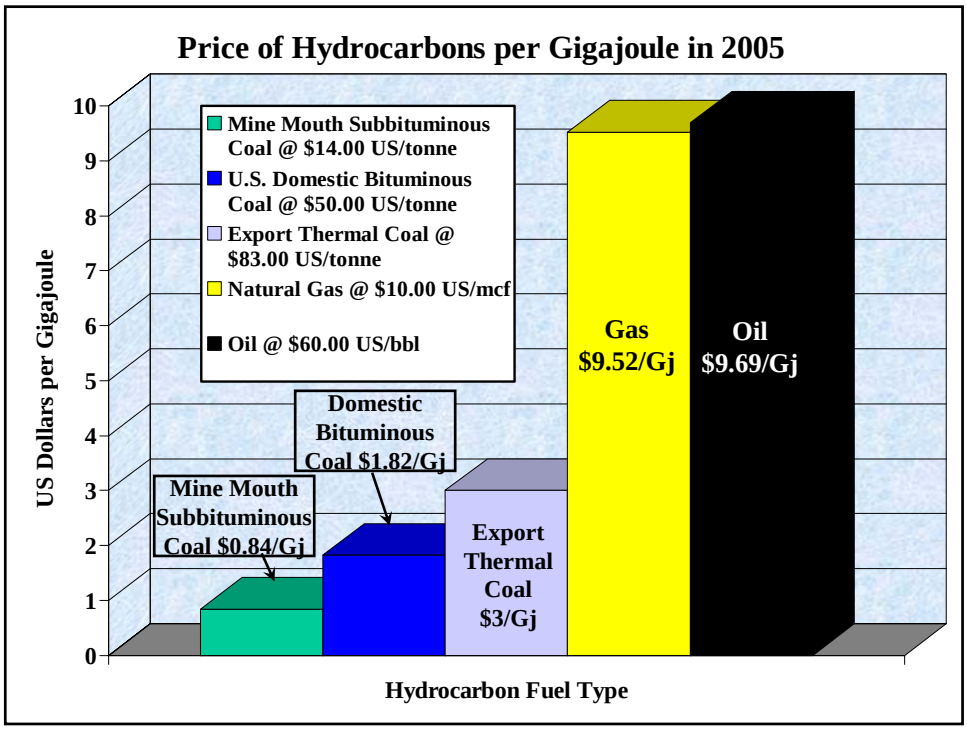
World Hydrocarbon Consumption in 2004 Versus Remaining Hydrocarbon Energy Reserves



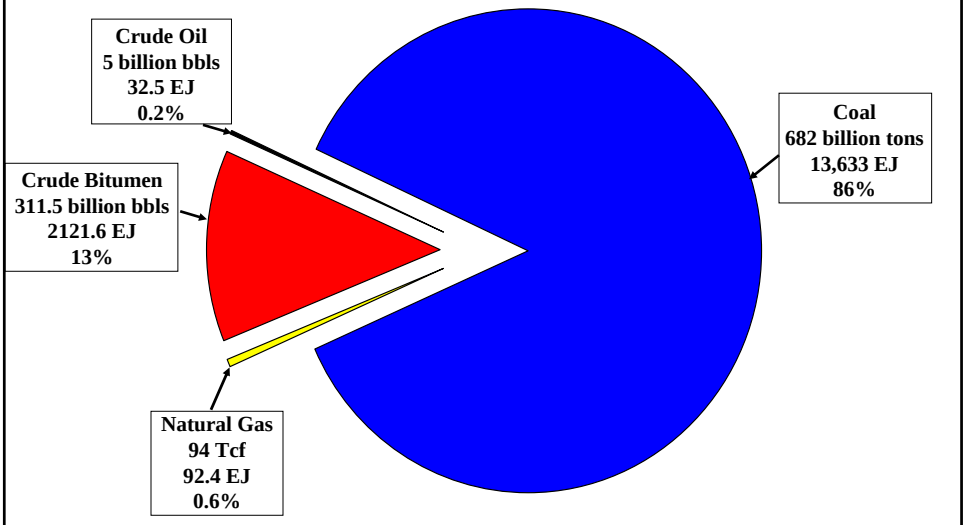
By Energy Content

(data from BP Statistical Review of World Energy, 2005)


World Remaining Recoverable Hydrocarbon Reserves by Energy Content (2004)
Exajoules
8000
7000
6000
5000
4000
3000
2000
1000
0
Coal
Gas
Oil
North America
S. & C. America
Europe
Former Soviet Union
Middle East
Africa
Asia Pacific
Region
(data from BP Statistical Review of World Energy, 2005)


Price of Hydrocarbons per Gigajoule in 2005
US Dollars per Gigajoule
10
9
8
7
6
5
4
3
2
1
0
Mine Mouth Subbituminous Coal @ $14.00 US/tonne
U.S. Domestic Bituminous Coal @ $50.00 US/tonne
Export Thermal Coal @ $83.00 US/tonne
Natural Gas @ $10.00 US/mcf
Oil @ $60.00 US/bbl
Domestic Bituminous Coal $1.82/Gj
Mine Mouth Subbituminous Coal $0.84/Gj
Export Thermal Coal $3/Gj
Gas $9.52/Gj
Oil $9.69/Gj
Hydrocarbon Fuel Type

Energy Content in Recoverable Remaining Ultimate Potential of Hydrocarbons in Alberta (in exajoules)



(data from Alberta Energy and Utilities Board, 2003)

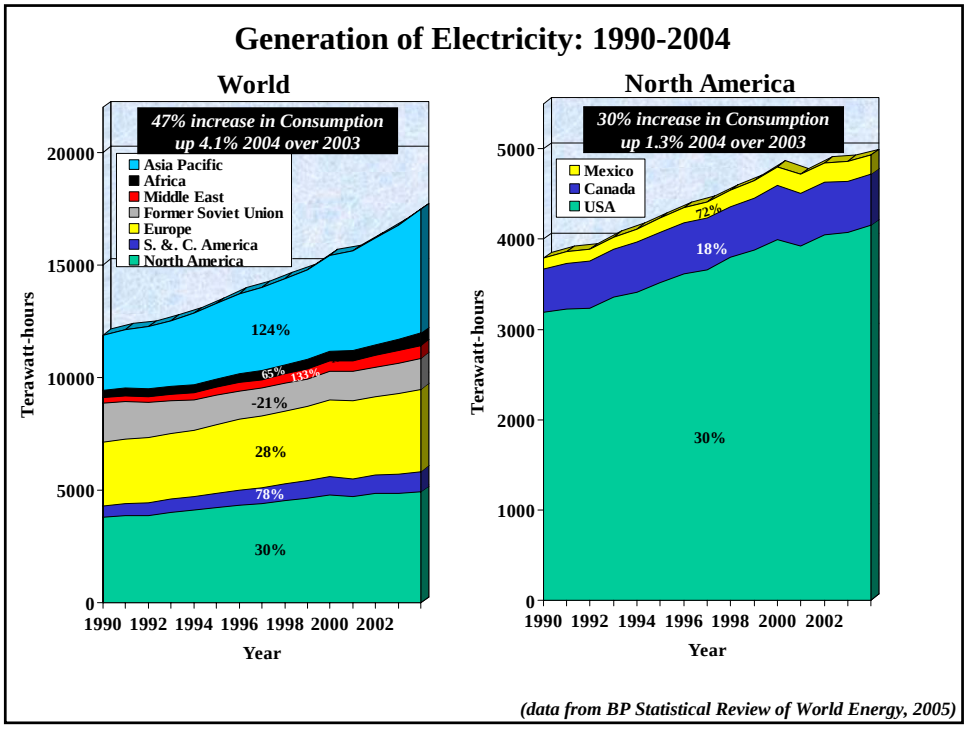
ELECTRICITY

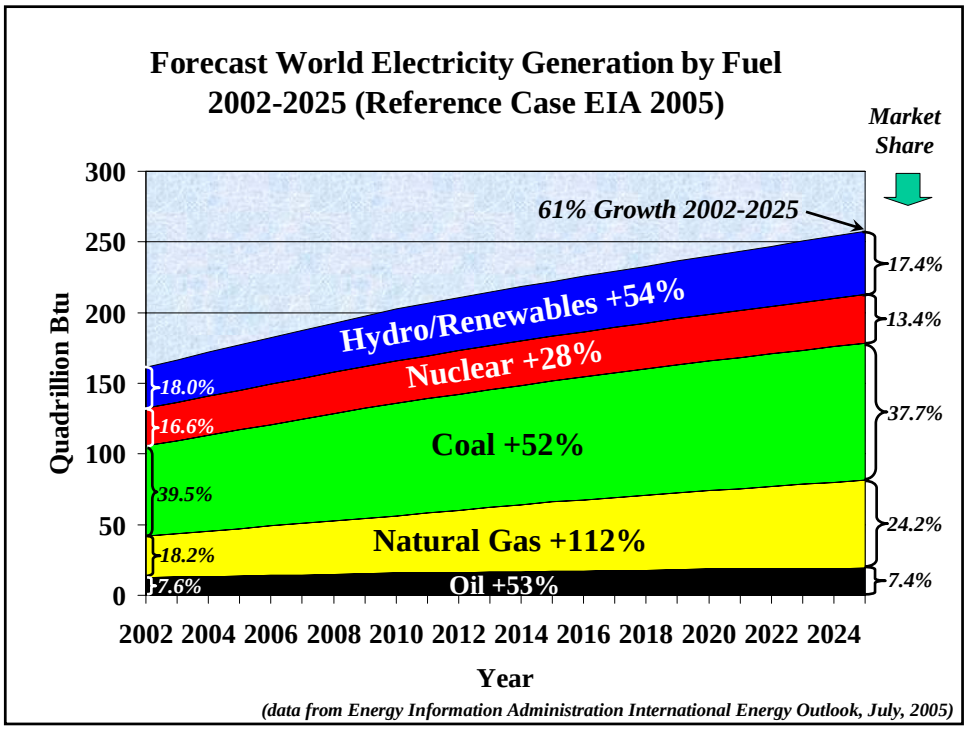
- Availability of reliable electricity defines our modern civilization

- Electricity in essence cannot be stored in bulk – it must be generated on demand

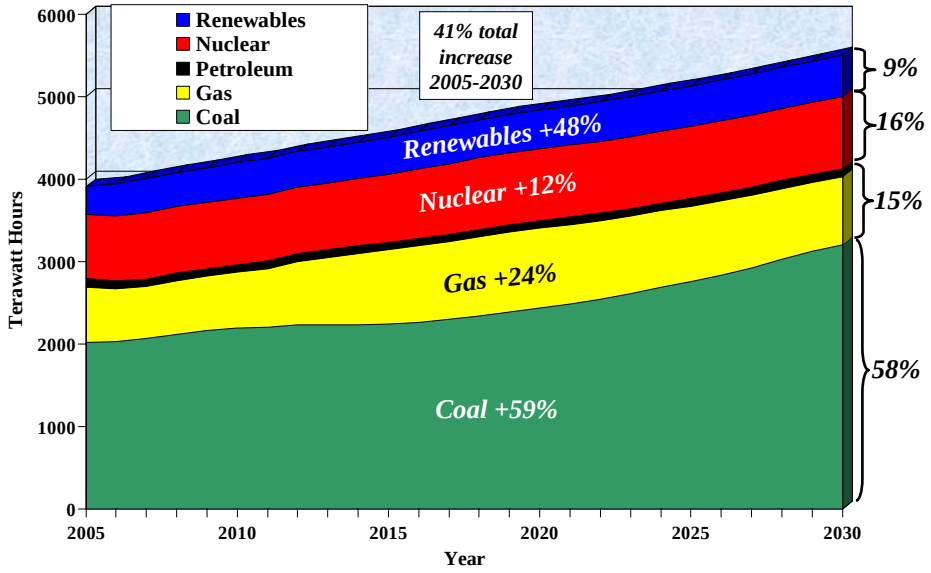
- We convert hydrocarbons to electricity at an energy penalty of from 30 to 70%

- Electricity is transmitted to points of use with losses depending on transmission distance – *IT IS NOT A WORLD TRADABLE COMMODITY*


Generation of Electricity: 1990-2004
World
47% increase in Consumption
up 4.1% 2004 over 2003
Asia Pacific
Africa
Middle East
Former Soviet Union
Europe
S. &. C. America
North America
Terawatt-hours
20000
15000
10000
5000
0
124%
65%
133%
-21%
28%
78%
30%
1990 1992 1994 1996 1998 2000 2002
Year
North America
30% increase in Consumption
up 1.3% 2004 over 2003
Mexico
Canada
USA
Terawatt-hours
5000
4000
3000
2000
1000
0
72%
18%
30%
1990 1992 1994 1996 1998 2000 2002
Year
(data from BP Statistical Review of World Energy, 2005)

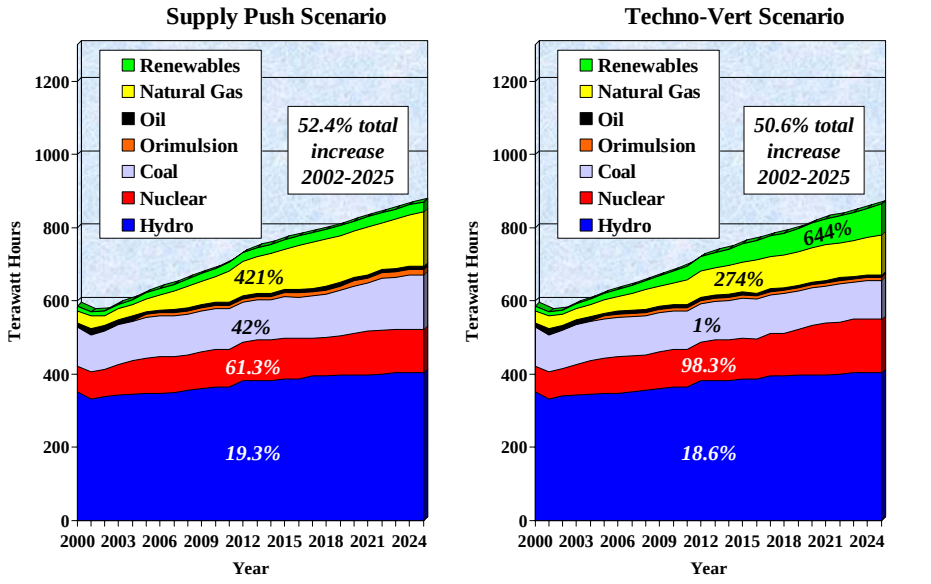

Forecast World Electricity Generation by Fuel
2002-2025 (Reference Case EIA 2005)
Market
Share
Quadrillion Btu
300
250
200
150
100
50
0
61% Growth 2002-2025
Hydro/Renewables +54%
Nuclear +28%
Coal +52%
Natural Gas +112%
Oil +53%
18.0%
16.6%
39.5%
18.2%
7.6%
17.4%
13.4%
37.7%
24.2%
7.4%
2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022 2024
Year
(data from Energy Information Administration International Energy Outlook, July, 2005)

Forecast U.S. Electricity Generation by Fuel Type 2005-2030
(EIA Annual Energy Outlook, 2006, Reference Economic Case)



(data from Energy Information Administration Annual Energy Outlook, 2006)

Canadian Electricity Generation Scenarios by Fuel, 2000-2025



(data from National Energy Board, July, 2003)

Implementation Times and Other Considerations For New Electricity Infrastructure

FACTOR	*GAS*	*COAL*	*NUCLEAR*	*HYDRO*
Capital Cost	LOW-MOD	MOD-HIGH	HIGH - VERY HIGH	VERY HIGH
Fuel Cost	VERY HIGH	LOW	VERY LOW	VERY LOW
Environmental Footprint	LOW	MOD(now) LOW(future)	VERY LOW[1]	VERY LOW[2]
Time to startup (years)	**1-2+**	**5-7+**	**5-12+**	**6-10+**

[1] If the as yet unsolved problem of waste disposal is not considered
[2] If the environmental costs of flooding river valleys, siltation and ecosystem impacts are not considered

Implications for Sustainability - *OIL*

THERE IS A DISCONNECT BETWEEN WORLD OIL RESERVES AND FORECAST OIL CONSUMPTION:

- World Oil Production could peak in the 2008-2012 timeframe (consensus) – even the Optimist's Reference Case says 2018 if peak symmetrical or 2037 if peak at 80% of Ultimate Recoverable Conventional Oil consumed.

- OPEC has most of what's left and could become the dominant oil supplier before the end of the decade, but will need to rapidly expand its production capacity which could be problematic.

- Industrialized countries will be in competition with rapidly growing consumers in the Developing World over a finite supply, with attendant impacts on economic growth due to oil price (which will shape the world oil production profile at peak).

- Even with a four- or five-fold expansion of production from the Oil Sands, Canada will be a small player in World Oil Supply (about 3% of forecast 2025 World Demand with net export capacity of about 1% of forecast 2025 World Demand).

- Supply from Unconventional Oil is unlikely to compensate for the decline in Conventional Oil Production. Unconventional liquids production including biodiesel, ethanol, coal-to-liquids, gas-to-liquids, oil sands and oil shale is forecast to meet less than 8% of 2025 World demand.

Implications for Sustainability - *GAS*

THERE IS A DISCONNECT BETWEEN NORTH AMERICAN GAS DELIVERABILITY AND FORECAST CONSUMPTION:

- Several existing producing areas in North America are in or near decline.

- Higher cost frontier and offshore conventional production and non-conventional production from coalbed methane, tight gas and shale gas likely cannot forestall the declines in conventional production for long and cannot provide for forecast aggressive domestic demand and export growth, unless as-yet-unproven windfalls result from hydrates, coalbed methane, shale gas etc.

- The United States will require between 16 and 42% of projected demand to be met by offshore sources by 2025, depending on the success of the development of non-conventional gas in the U.S. and Canada, the pace of new conventional development in Canada, the realization (or lack thereof) of optimistic supply additions in the U.S., and the development of LNG import capacity in the U.S. and Canada.

- Solutions include conservation/efficiency, LNG imports, (which would mean large investments in new infrastructure), ***demand destruction,*** (move intensive fertilizer/petrochemical industries offshore), ***additional non-conventional gas and fuel switching.***

Implications for Sustainability - *ELECTRICITY*

- The North America Electric Reliability Council (NERC, September, 2005) indicates 206 gigawatts of new gas-fired generation was completed in 1998-2004 and forecasts new gas-fired supply growth of 58.5 gigawatts through 2011 (25% NA grid expansion 1998-2011)

- Electricity generation accounted for 24.3% of U.S. gas consumption in 2005 *(EIA, 2006) and is expected to account for 28% in 2020 (EIA, 2006)*

- Forecast shortfalls in supply of natural gas could jeopardize future availability of a secure electricity supply unless new supplies can be secured

- Renewable energy - biomass, wind and photovoltaics must be emphasized but will realistically only provide a relatively small incremental supply (eg. Wind represents about 0.5% of Canada's generating capacity at present).

- Nuclear is limited by capital cost, public perceptions and environmental impact (Waste storage at Yucca Mtn. will cost $US50billion+ to build and will be completely filled with U.S. wastes since the beginning of the Atomic Age). The EIA (2005) forecasts only modest growth in world electricity generation from nuclear through 2025 (28%) with declines thereafter. The EIA AEO 2006 reference economic case indicates only 12% growth in U.S. nuclear capacity through 2025.

- Large Hydro is limited by lack of available sites and environmental costs

Implications for Sustainability - *COAL*

- Two-thirds of World's remaining hydrocarbon energy (90% of North America's)

- Lowest cost hydrocarbon energy - cost is 9% to 32% that of gas and oil at $US10/mcf and $US60/bbl, ***but double the carbon footprint of gas with old technologies***

- New more efficient utilization technologies, with reduced GHG emissions, are the key to expanded coal use:

- ***Higher Efficiency Generation*** new existing technologies can raise thermal efficiency from 32% to 45% with a corresponding reduction in GHG emissions of 30%, but they are expensive (SCPC, IGCC) – ***expected future improvements in efficiency to 50% (2010) and 60% (2020) (Vision 21 USDOE).***
  ITS HAPPENING – eg. NIEDERAUSSEM 3900 MWATT GERMAN PLANT @ 43.2% EFFICIENCY; VATTENFALL OXYFUEL PILOT IN GERMANY

- ***Petrochemicals from Coal (POLYGENERATION) – gasification, liquefaction, in situ gasification for deep coal utilization***

- ***Hydrogen from coal*** (competes with H_2 from natural gas @ $4.00US/mcf – China produces 5 Mt of H_2/year from coal for fertilizers) or in conjunction with electricity generation (IGCC, ZECA - higher cost)

- ***"Zero Emission" utilization through CO_2 sequestration*** in coal seams, depleted oil and gas reservoirs and saline aquifers

HYDROGEN
The Silver Bullet?

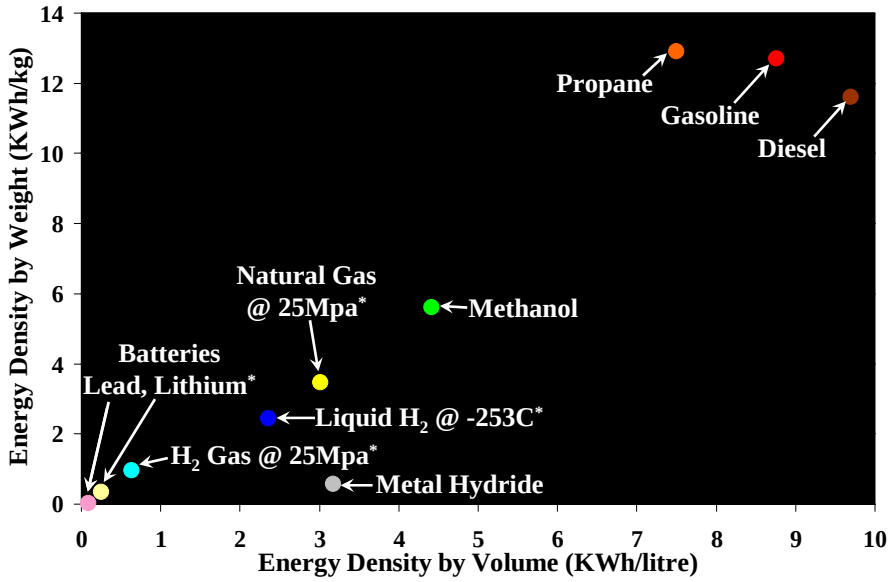
- Hydrogen is an *ENERGY CARRIER* not an *ENERGY SOURCE*

- Hydrogen is largely created from hydrocarbons or electrolysis, each of which can be used directly without the energy conversion losses to hydrogen

- Because of energy losses in production of hydrogen from hydrocarbons or electrolysis, a "Hydrogen Economy" could actually exacerbate the greenhouse gas emission and Global Warming Problem, if hydrogen cannot be generated exclusively from renewable sources (conversion from gas loses 30% and from electolysis 28% (not including the losses from hydrocarbons to electricity – a further 30-70%))

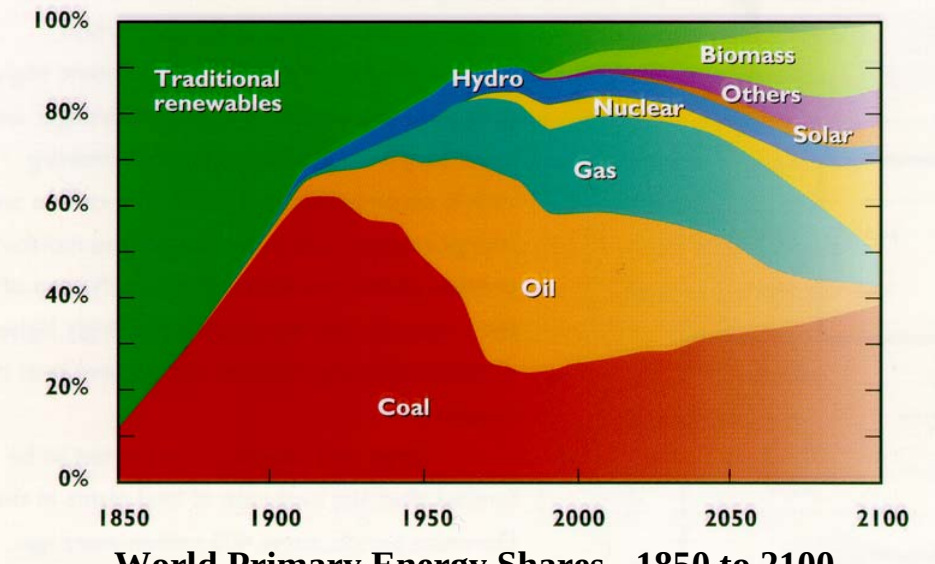
- The stock brokers have already figured it out - witness "Hydrogen's non-future" published in the Financial Post of April 3, 2004, based on BMO Nesbitt Burns analysis of the Hydrogen Economy

Energy Density of Hydrogen in Comparison With Other Energy Carriers



*Includes Weight of Containment Vessel

(data from Dr. Werner Zittel et al, 1996)



World Primary Energy Shares - 1850 to 2100 Given Oil and Gas Supply Limitations

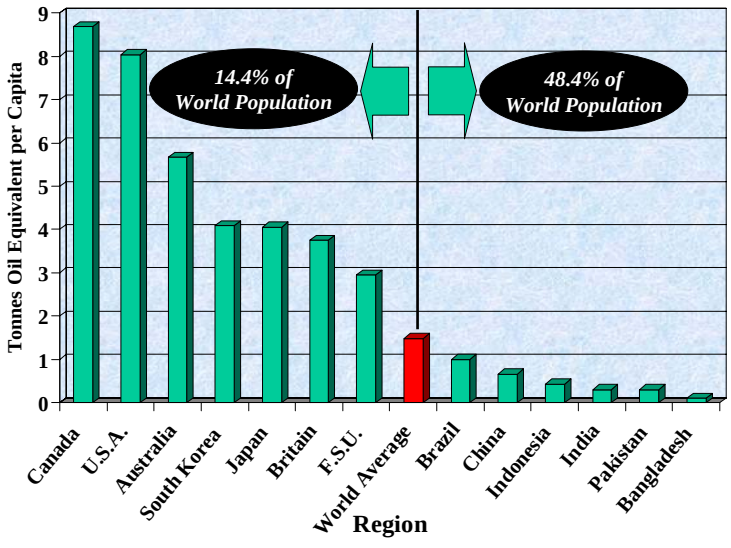
Source - World Coal Institute

The Last Piece of the Energy Sustainability Puzzle:

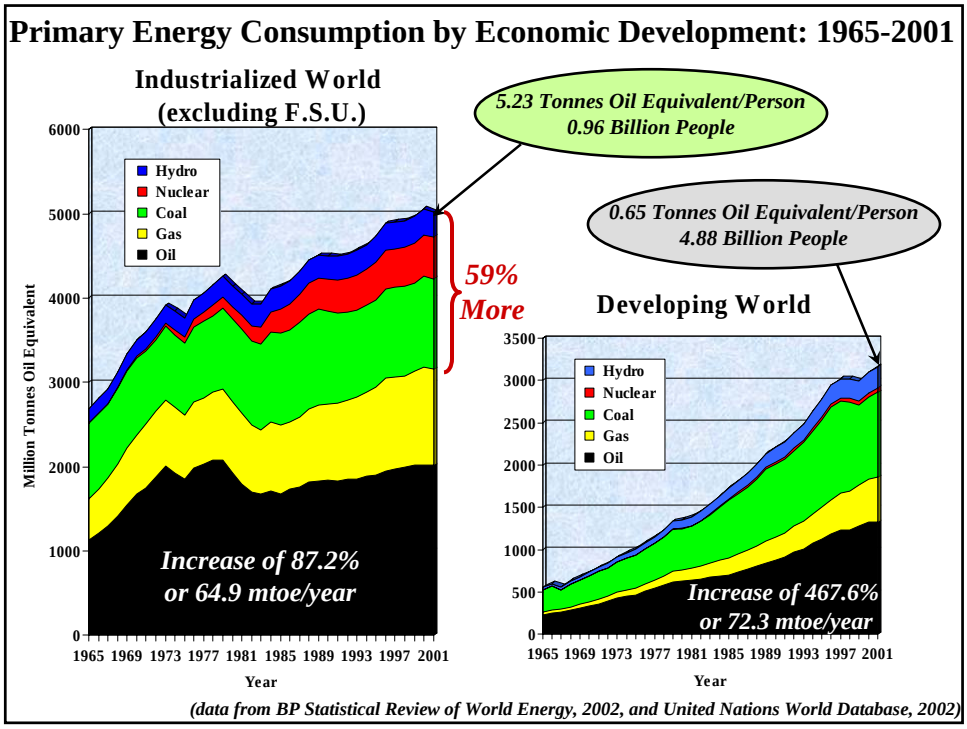
POPULATION GROWTH and ASPIRATIONS OF GROWTH IN ENERGY CONSUMPTION IN THE DEVELOPING WORLD

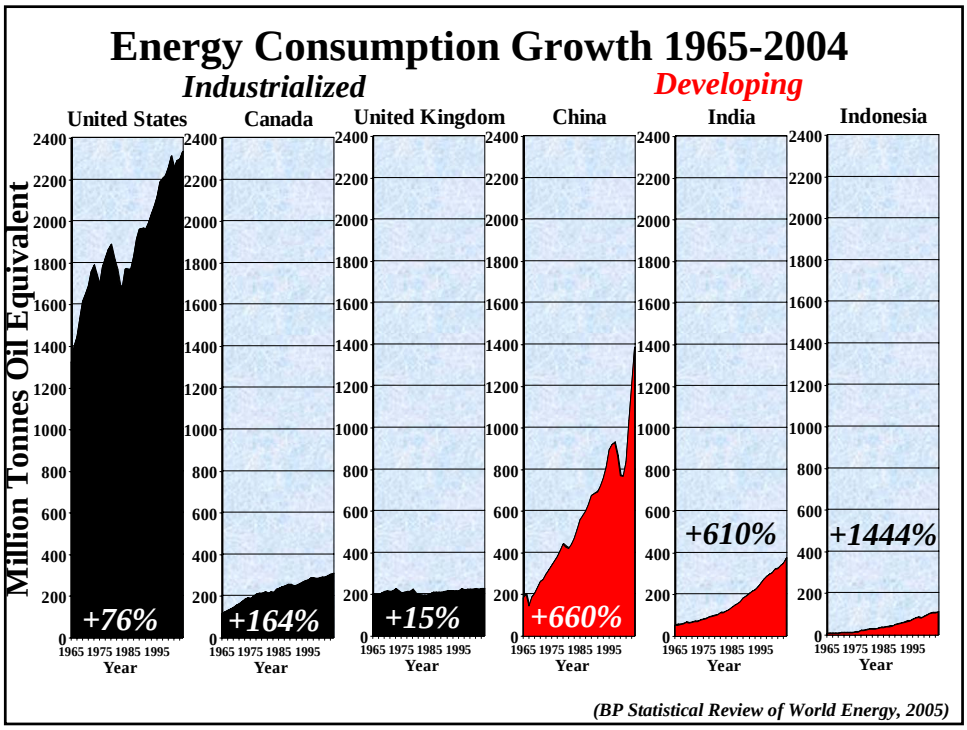
There is a Great Inequity in Energy Consumption Worldwide

Primary Per Capita Energy Consumption of Selected Countries in 2001

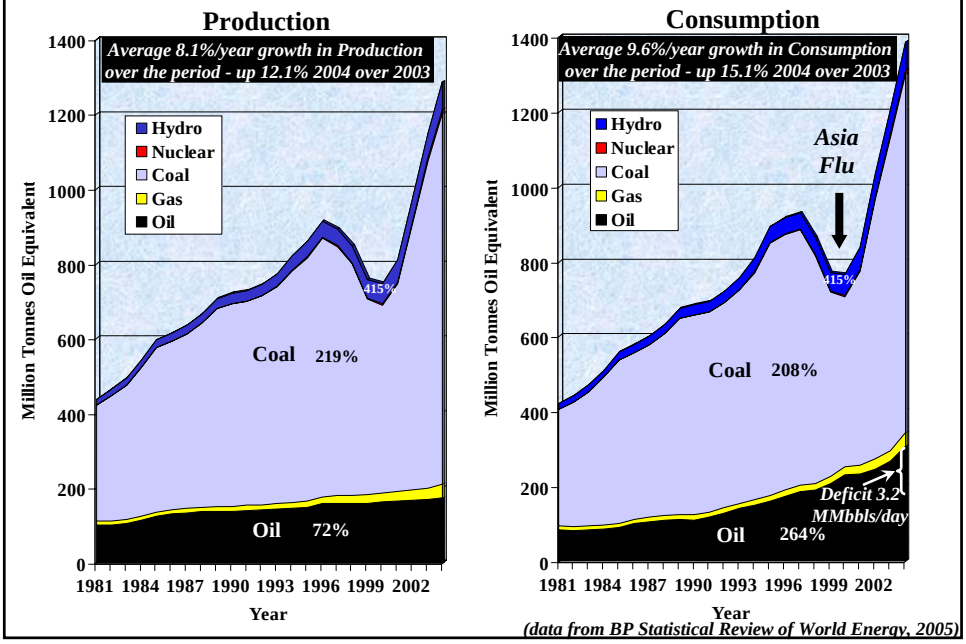


(data from BP Statistical Review of World Energy, 2002, and United Nations World Database, 2002)


Primary Energy Consumption by Economic Development: 1965-2001
Industrialized World
(excluding F.S.U.)
5.23 Tonnes Oil Equivalent/Person
0.96 Billion People
0.65 Tonnes Oil Equivalent/Person
4.88 Billion People
59%
More
Developing World
Hydro
Nuclear
Coal
Gas
Oil
Million Tonnes Oil Equivalent
Increase of 87.2%
or 64.9 mtoe/year
Increase of 467.6%
or 72.3 mtoe/year
1965 1969 1973 1977 1981 1985 1989 1993 1997 2001
Year
(data from BP Statistical Review of World Energy, 2002, and United Nations World Database, 2002)

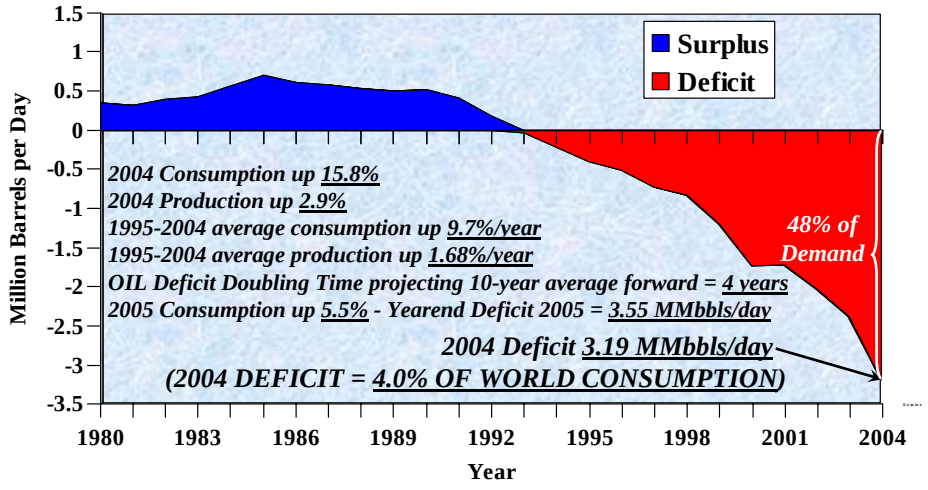

Energy Consumption Growth 1965-2004
Industrialized
Developing
United States
Canada
United Kingdom
China
India
Indonesia
Million Tonnes Oil Equivalent
+76%
+164%
+15%
+660%
+610%
+1444%
1965 1975 1985 1995
Year
(BP Statistical Review of World Energy, 2005)

CHINA: The World's Number 2 Consumer of Energy
Primary Energy Production and Consumption by Fuel: 1981-2004



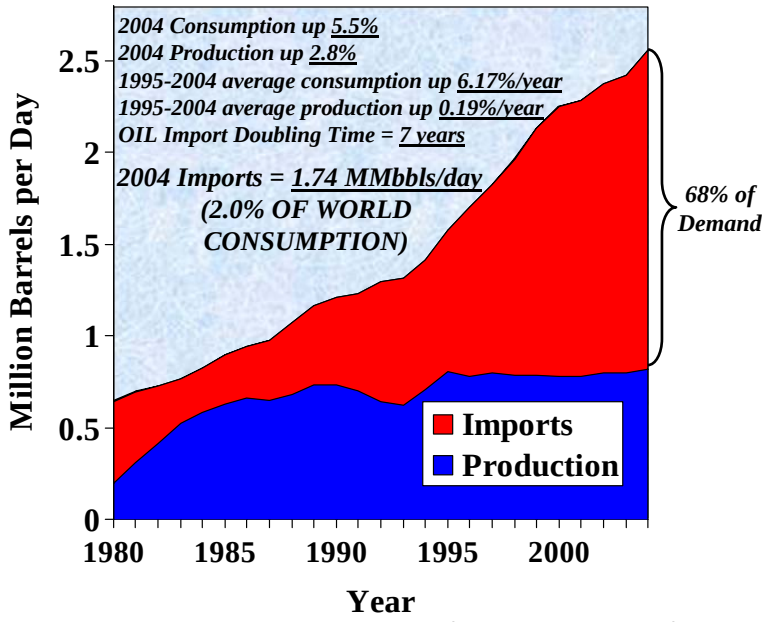
(data from BP Statistical Review of World Energy, 2005)

CHINA's Oil Production Surplus and Deficit 1980-2004



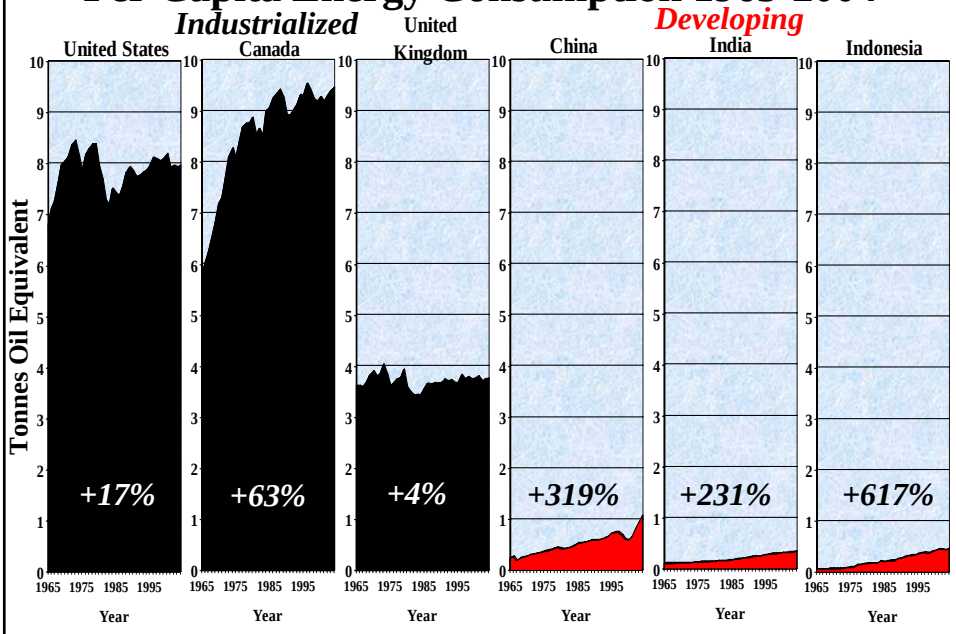
(data from BP Statistical Review of World Energy, 2005; International Energy Agency OMR, July, 2005)

INDIA's Oil Production and Imports 1980-2004



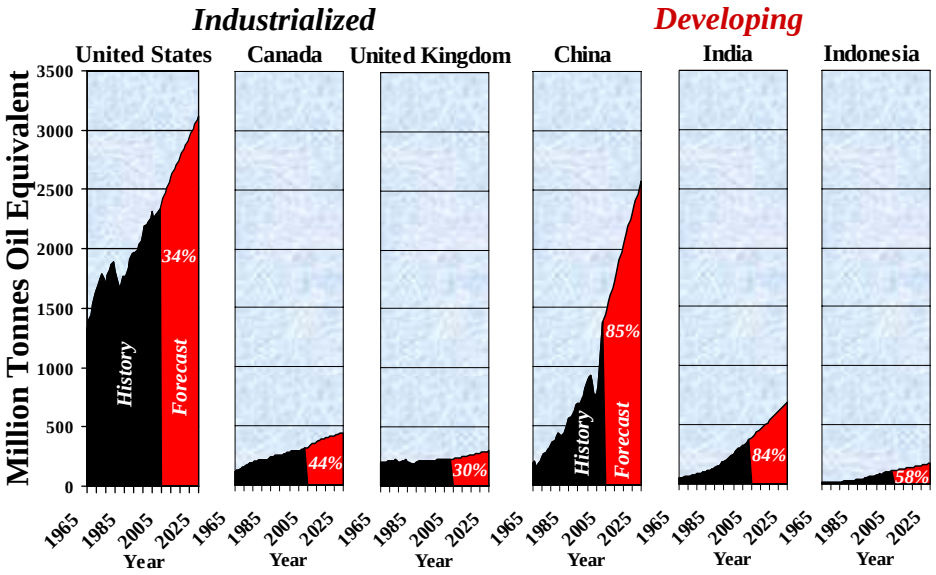
(data from BP Statistical Review of World Energy, 2005)

Per Capita Energy Consumption 1965-2004



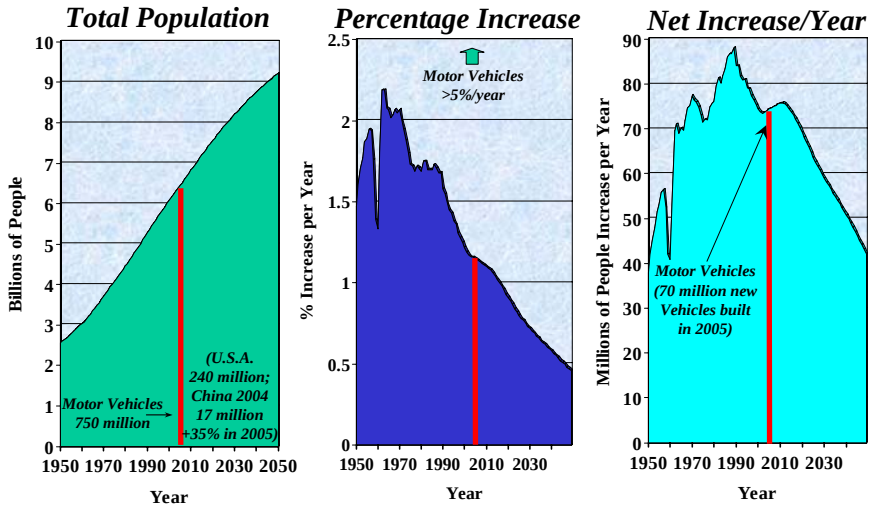
(BP Statistical Review of World Energy, 2005; United States Bureau of Census, 2005)

Energy Consumption and Growth Forecast 1965-2025
(EIA Reference Case Forecast to 2025)



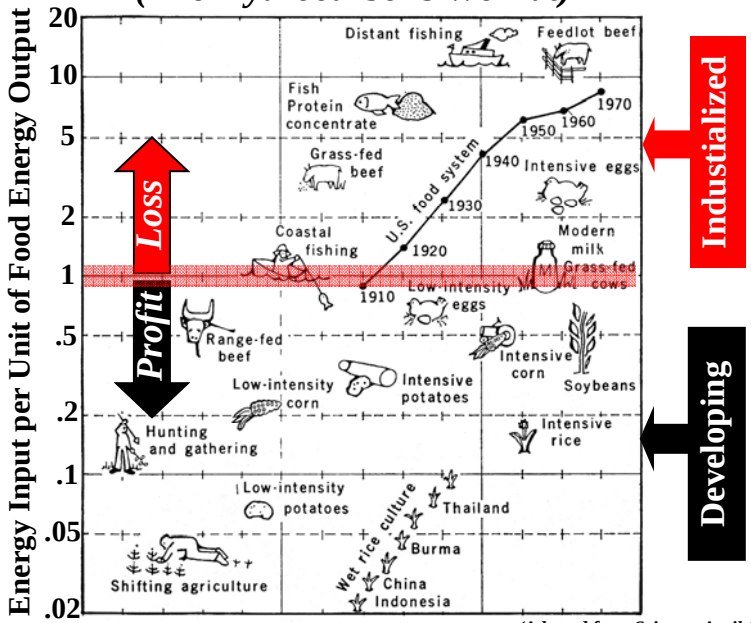
(BP Statistical Review of World Energy, 2005; EIA International Energy Outlook, 2005)

World Population Increase 1950-2050



(U.S. Bureau of Census, 2005; Hirsch, 2005; Globe and Mail February 17, 2006)

Trends in Energy Investment for Food Production (The Hydrocarbons We Eat)



(Adapted from Science, April 19, 1974)

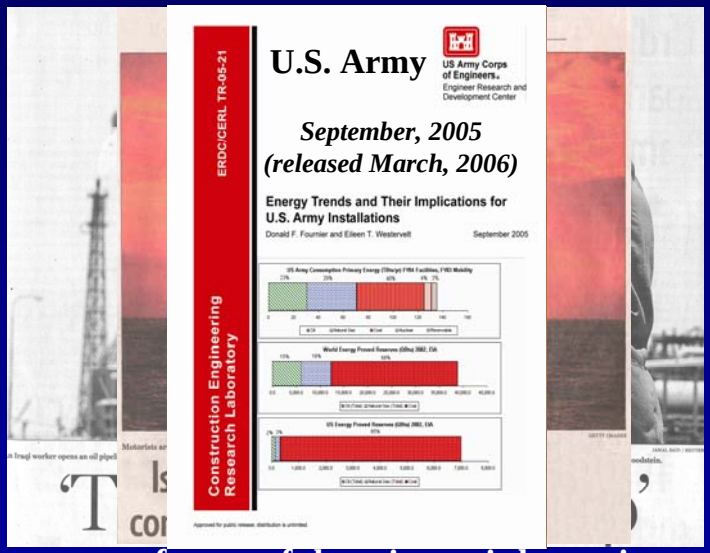
The Way Forward

- **Business as usual is not a sustainable option** – the ultimate resource potential of oil and gas is arguable but we are definitely dealing with a finite resource - the implication of this is that we are running out of the *CHEAP OIL* that fueled the rapid growth in per capita consumption and lifestyle of the last century. Production from crude bitumen resources is not scalable to offset declines in conventional production.
- ***GAS* availability in North America is highly correlated with electricity reliability and cost** - replacement of declining low-cost conventional gas and meeting future demand growth with higher cost conventional and non-conventional supplies represents an *EXTREME CHALLENGE* and, even if it is doable, likely means much higher-cost electricity and higher costs for all other gas uses. LNG imports face infrastructure limitations, siting and Geopolitical obstacles which will likely limit LNG's ability to fill the supply gap. Banking on windfalls from as-yet-unproven hydrates, CBM, shale gas etc. could prove dangerous if the required production levels are not realized.

The Way Forward

- **The first step is to recognize the problem, and begin making the changes and creating the infrastructure that will be required for transit to a more sustainable energy future**
- **The most cost-effective approach is energy conservation - reduce consumption on all levels**
- **A longer term vision is required than the lifespan of a typical government – *THERE IS NO SILVER BULLET* – all options must be objectively assessed and deployed as incremental contributions to a solution**
- **A sustainable energy future is not out of reach – but we have to be thinking in the 10-20+ year timeframe to develop the infrastructure for alternatives as well as technologies and incentives to reduce consumption**

Public Awareness Is Crucial as it Empowers Governments to Take the Long-Term View Required to Implement Solutions



Media coverage of some of these issues is becoming an almost daily occurrence, but there is still much denial

Awareness is Rising

U.S. Army Corps of Engineers (March 14, 2006)

"The Army operates in a domestic and world energy situation that is highly uncertain"

"Future availability of customary energy sources is problematic-world petroleum production is nearing its peak"

"The earth's endowment of natural resources are depleting at an alarming rate-exponentially faster than the biosphere's ability to replenish them"

"Current energy policies and consumption practices are not sustainable. They clearly limit and potentially eliminate options for future generations"

"As the Earth's population swells-competition for finite resources will increase…conservation is '...the best path to follow'"

"…disproportionate [U.S.] consumption of energy relative to global consumption causes loss of the world's good will and provides a context for potential military conflicts…"

Awareness is Rising

Jim Buckee, CEO of Talisman Energy (May 4, 2005):

Conservation and energy efficiency are the "most important" ways to reduce oil demand

Questioned whether the world will ever be able to produce 90 million barrels a day

IEA World Energy Outlook 2005 (November 7, 2005):

"… projected [energy consumption] trends have important implications and lead to a future that is not sustainable"

"We must…get the planet onto a sustainable energy path"

Awareness is Rising

Peter Tertzakian, Chief Economist ARC Financial Corp
Author "A THOUSAND BARRELS A SECOND"
(February 13, 2006):

"…the World is on the verge of a break point that could come before the end of the decade…"

"…there is no quick technology fix to save us from the inevitable, at least in the next five to ten years…"

"…only Government has the power and the tools to push us to a new energy path…Free market forces are not strong enough to catalyze rapid change in energy because it takes so much capital"

"What the World needs is rapid change. There has to be a push from Nations"

Some of the Smartest Comments on Energy Sustainability I've Heard Lately

- **Senior Executive, Dow Chemical, New Orleans, March 17, 2005:**
  Letter to George Bush signed by many concerned industrial representatives included two top priorities on energy security:
  - Conservation and Efficiency (in *ALL* Sectors)
  - Fuel Diversity: Clean Coal, Coal Gasification, Renewables, Nuclear
- **Senior Energy Executive on using Gas to Produce and Refine the Oil Sands:**
  Using gas to produce and refine the oil sands is akin "… to turning gold into lead…"
- **Dow Canada CEO on gas use for electricity/oil sands:**
  Utilizing Gas for low value uses like electricity generation and oil sands as opposed to high value uses such as petrochemicals is like "…lighting candles with one hundred dollar bills…"

Some of the Other Comments on Energy Sustainability I've Heard Lately

- U.S. Vice President Dick Cheney on Conservation:
  "Conservation may be a sign of personal virtue, but it is not a sufficient basis for a sound, comprehensive energy policy"

- U.S. Energy Bill:
  - Tax break of $3,150 for buying a hybrid vehicle.
  - Tax break of $25,000 for buying a Hummer or SUV greater than 3 tons, as long as it is used for business, with write off of all remaining costs over 6 years.
  - Business owners of vehicles weighing less than 3 tons can only write off a maximum of $15,535 over six years irregardless of cost.

- Oregon State Government "We're losing revenue on gas taxes because of people buying hybrid vehicles"
  "We'll put a GPS system on all vehicles and tax people on how many miles they drive, not how much gas they consume"

Is This the Shape of Things to Come?

Gas Station Lineup, South China, August 17, 2005

Can Energy Supply Meet Forecast World Demand?

- *MOST PROBABLY NOT* – Present Global Energy Demand Forecasts are likely to prove to be Unsustainable unless they are revised sharply downward

- The Energy Sustainability Issue will certainly affect us and will profoundly impact our Children and Grand Children, unless Global proactive actions are taken *(SOON)*

- The Energy Sustainability Issue may Trump the Global Warming /Environmental Degradation Issue with respect to short term Socio-Economic impact, although both are on the radar in the near term

- Solutions to both Issues have common components (eg. Conservation, Efficiency, Technology, Alternatives), hence mitigating one issue can help mitigate the other

THE PROBLEM

Aggressive demand growth in the past and forecast in the future

Built mainly on non-renewable energy sources

CONSUMING THE EARTH'S CAPITAL AND ITS INTEREST

THE SOLUTION

Radically Reduced Demand – how to do it?

Supplied mainly by renewable energy sources

But also by alternative higher value uses of non-renewables

LIVING ON THE EARTH'S INTEREST AND PUTTING SOMETHING IN THE BANK FOR PAST TRANSGRESSIONS

SOLUTIONS

- *RENEWABLE ENERGY SOURCES* such as wind, photovoltaics, run of stream hydro, tidal power, solar thermal and biomass are *EXTREMELY UNLIKELY* to fill the hydrocarbon gap if we insist on maintaining our current levels of consumption (let alone increasing them).

- The *ABSOLUTE FIRST PRIORITY* is to reduce energy consumption as much as possible. This requires a crash program through:

- *MORE EFFICIENT AND SUSTAINABLE COMMUNITIES*:

- **Radically enhanced building codes – R2000+++**
- **Mass Transit as a viable option**
- **Incentives for efficient appliances and heating**
- **Increased densities**
- **Design for local access to consumer requirements**
- **Enabling pedestrian, biking and car pool transport**

SOLUTIONS

- IMPLEMENT LOW COST OR REVENUE NEUTRAL READJUSTMENTS THAT ENCOURAGE A REDUCTION IN ENERGY CONSUMPTION:

- **STOP building and widening roads to accommodate ever more traffic – instead reinvest these funds to improve public transit**
- **Implement user fees for car travel in downtown areas that are served by public transit (this has worked well in many places in Europe, where per capita energy consumption is half of that in the U.S. and Canada)**
- **Reintroduce lower speed limits – this worked in the 1970's**
- **Mandate much higher average mileage requirements for the vehicle fleet**

SOLUTIONS

***- LIVING LOCALLY*:**

- The *INTERNET* represents an absolutely unprecedented opportunity to reduce commuting as well as to access World Markets. *BROADBAND INTERNET* expanded to all rural communities can ensure the viability of dispersed, more sustainable communities.

- Encourage and nurture the development of *LOCALLY GROWN FOOD* and *LOCAL MANUFACTURE* of required commodities in order to minimize long distance transport.

SOLUTIONS

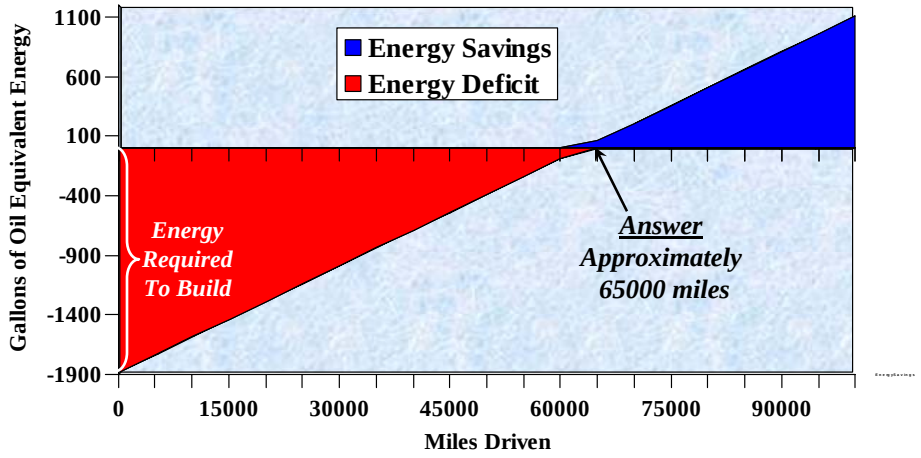
***-MORE EFFICIENT VEHICLES*:**

- *<u>BOTTOM LINE:</u>* Replacing half of the U.S. ground vehicle fleet would cost $3.8 Trillion and consume 5.6 billion barrels of oil equivalent energy to build. *Even with a crash program implementation it would take 8-10 Years.* Yearly savings of 25% of current fuel use would be 3.3 billion barrels.

(vehicle numbers, proportion of fuel consumption and average lifespan from Hirsch, 2005)

How far must a Hybrid Car be Driven before it Saves More Energy than it took to Build It?

Comparison of Hybrid at 50 mpg with existing Vehicle at 20 mpg



(energy for vehicle construction from Savinar/Ruppert, September, 2005)

SOLUTIONS

-*MORE EFFICIENT VEHICLES* (continued):

MESSAGE:

- Reducing transportation requirements is likely to have a much more immediate impact than replacing the vehicle fleet with hybrids and maintaining existing transportation habits.

- The existing vehicle fleet represents a tremendous amount of embodied energy in its construction that would require a similar expenditure of energy to replace.

- *IDEALLY* we need to do both: replace vehicles at the end of their practical lifespan with the most efficient vehicles available *AND* reduce transportation requirements as much as possible.

SOLUTIONS

***- BULK COMMODITY TRANSPORT*:**

-TRAINS instead of TRUCKS
– trains are 3.4 times as efficient in moving goods than trucks

- SHIPS instead of TRUCKS
– ships are 8.7 times as efficient in moving goods than trucks

- SHIPS, TRAINS and TRUCKS instead of PLANES
– ships, trains and trucks are much more efficient in moving goods than planes

(data from U.S. Dept. of Transportation and Canadian Shipowners Association, 2006)

SOLUTIONS

-Implement *RENEWABLES* such as *WIND, BIOMASS* and *PHOTOVOLTAICS* to the maximum extent possible:

- *WIND*, unfortunately, cannot exceed about 20% of the grid as it is intermittent and must therefore be backed up by a (usually) nonrenewable energy supply (wind is 0.5% of Canada's capacity at present). Also requires proximity of high quality sites to load centres.

- *BIOMASS* can be used in a highly efficient manner given present technology but realistically represents only a small incremental contribution to current consumption levels (The Energy Profit Ratio of Biomass MUST also be considered – what is the net energy returned after all energy inputs are accounted for?).

SOLUTIONS

-Implement *RENEWABLES* (continued):

- *PHOTOVOLTAICS* are also limited by the intermittent nature of the sun and the storage problems if batteries are used. They are optimally suited to residential applications because of their low power intensity but they are expensive. *TRUE NET METERING* with *TIME OF USE PRICING* in grid intertie applications *CAN RADICALLY IMPROVE THE ECONOMICS OF PV* and has been implemented in several States. Generators of PV electricity can "run the meter backwards" obtaining the retail price at the time of the sale (typically during peak load when the price is highest). This not only improves the economics of PV, it reduces peak load and therefore the need to build new large scale fossil fueled generation by utilities.

SOLUTIONS

- *NONRENEWABLES ALTERNATIVE USE*: Remaining fuels should be used for their highest value contribution to society:

- *CONSERVE NATURAL GAS* used for electricity generation and as a low grade heat source through substitution by renewables, distributed generation with CHP, clean coal technologies, coal gasification, coal-to-liquids, and, if economical, nuclear – for example, ethane extracted from raw natural gas and turned into polyethylene increases its value by a factor of 12, into packaging products by 20, and by upgrading to building materials by a factor of 58 *(Dr. Ramachandran, President DOW Canada, June, 2005)* .

- Implement expansion of alternative oil and gas substitutes including *COAL-TO-LIQUIDS* (commercially viable at $30-$35/bbl), *COAL GASIFICATION, GAS-TO-LIQUIDS* and *LNG* technology (but, as with oil sands, takes many years and $$$ for infrastructure).

SOLUTIONS

- Continued expansion of the *OIL SANDS* is inevitable but must employ technologies that utilize alternatives to natural gas for energy input and minimize environmental impacts including water consumption (but, as noted, takes many years and $$$ for infrastructure and therefore will be a small part of the solution).

- Expansion of the *VENEZUELA ORINOCO EXTRA HEAVY OIL BELT* is also inevitable but must be done with maximum efforts to minimize energy inputs and environmental impacts.

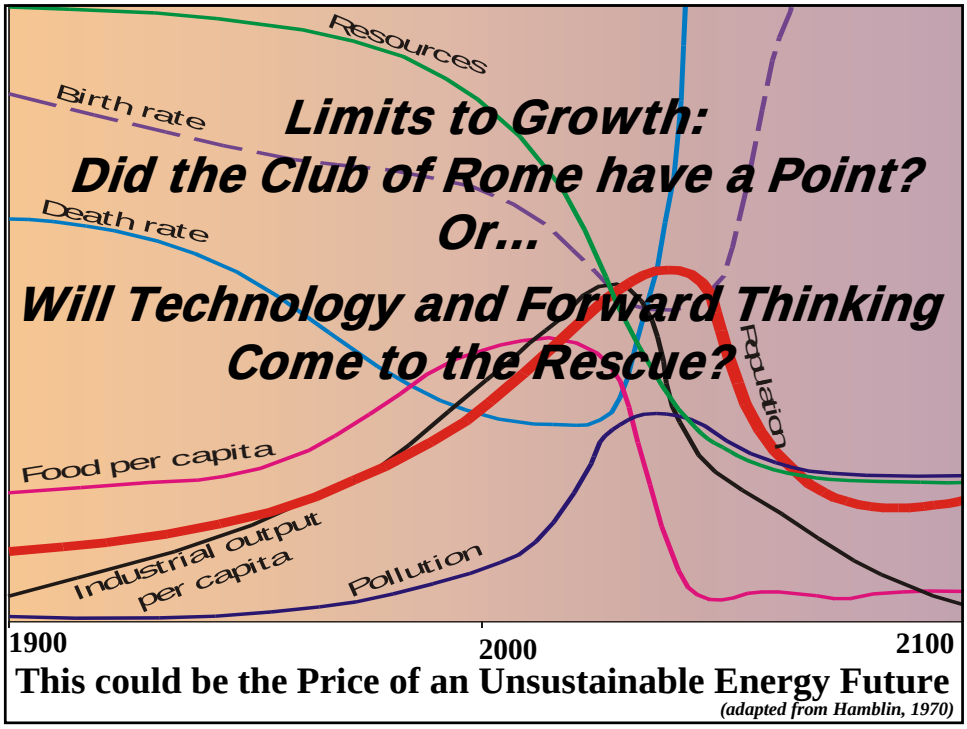
- *FORGET HYDROGEN* as a major contributor to transportation and distributed generation unless there are major improvements in fuel cell technology (10-20x in cost; 5x in lifetime; 2x in efficiency) as well as in storage technology, and the ability to generate hydrogen from renewable sources.

IMPLEMENTING MANY OF THESE SOLUTIONS (ESPECIALLY CONSERVATION AND EFFICIENCY) GOING FORWARD IS NOT OPTIONAL

ENERGY CONSUMPTION CANNOT EXCEED ENERGY SUPPLY

MOTHER NATURE WILL TAKE CARE OF THE PROBLEM

BUT UNLESS WE ARE PROACTIVE WE MAY NOT LIKE THE SOLUTION



This could be the Price of an Unsustainable Energy Future

(adapted from Hamblin, 1970)