

# All aboard the Titanic!!

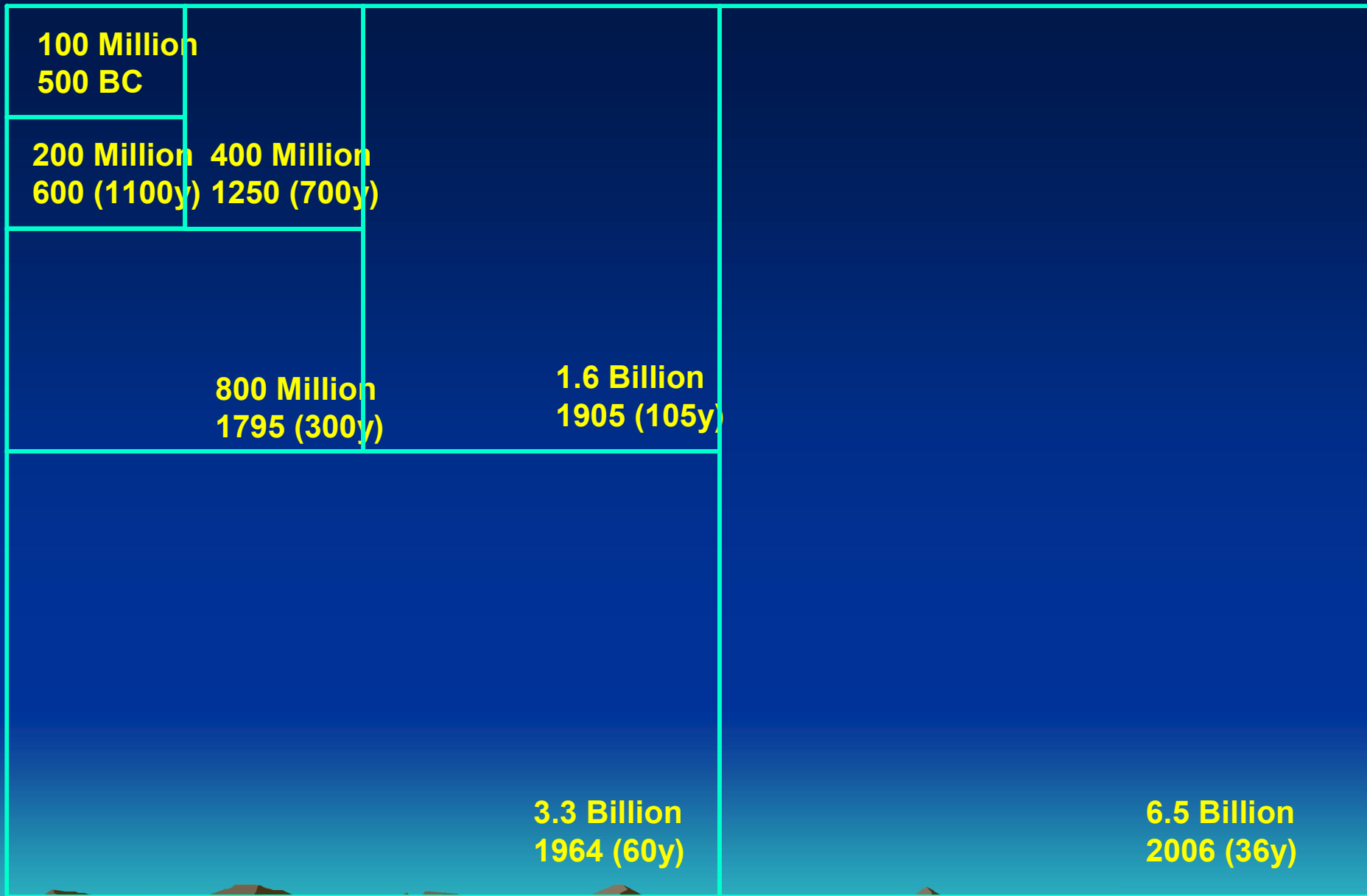
- “Woeee!! This is some ride! We are going fast!!”
- “Oooh what’s that big white thing?”
- “Hey? How fast can they turn this boat?!”
- “Dunno mate?!”
- “Where are the lifeboats..?!”



# Context: Exponential demand growth for a finite resource...

- Growth and competition has been the survival/economic imperative.
- This is out-growing the planet!
- FLAT EARTH ECONOMICS – growth can continue indefinitely
- The price signal will always produce more of what we need...





Global population has been accelerating... but for how much longer?

ppm

1 000

900

800

700

600

500

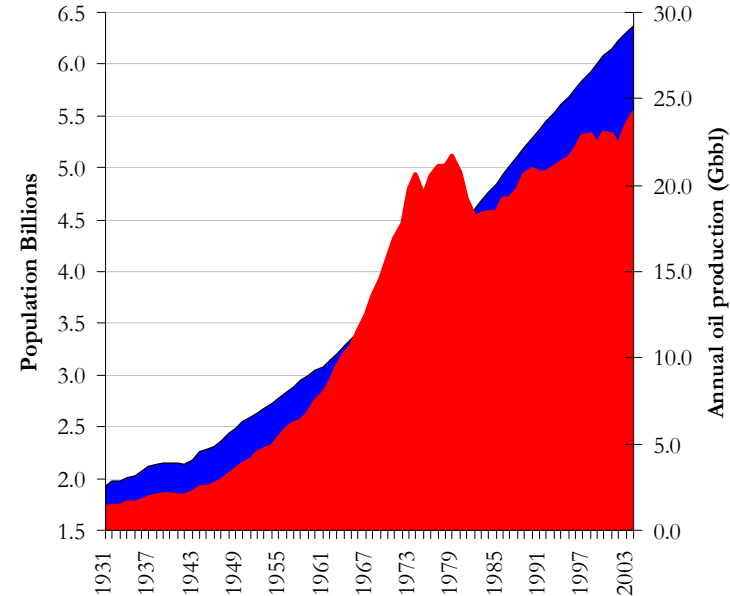
400

300

200

100

0



# World oil production 1930-2050 (ASPO)

CO<sub>2</sub>



Year

-300

0

Year

1,000

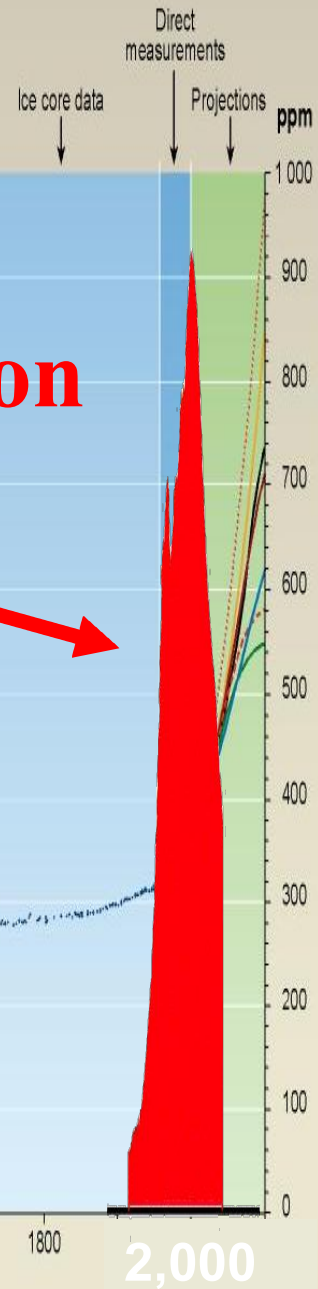
1200

1400

1600

1800

2,000



**Australia uses more than 45,000,000,000 litres of oil each year, a cube of about 360 metres size**



**=1.3  
EFT<sup>3</sup>**

Adelaide's Santos building is 99 m high

50  
45  
40  
35  
30  
25  
20  
15  
10  
5  
0

Chemical products, 1.3

Rail, 0.7

Misc., 2.5

Mining, 2.5

Agric., 2.5

Sea, 1.4

Air, 4.7

Petrol (others), 5.6

Diesel (road), 8.6

Petrol (cars), 13.9

Refining and Manufacturing, 2.2

All Road!! (61%)

All Transport (76%)

Collectively South Australians travel 60 Million km a day (=1400 times around the world!)

**Petrol driven passenger vehicles (cars) account for ONE THIRD of all oil use in Australia!**

# Million barrels per day 2004

Oil & Gas Journal July 5<sup>th</sup> 2004

Australia uses 0.8

China 6.3

US 20.5

World 81

**US 1 cubic km oil / year**

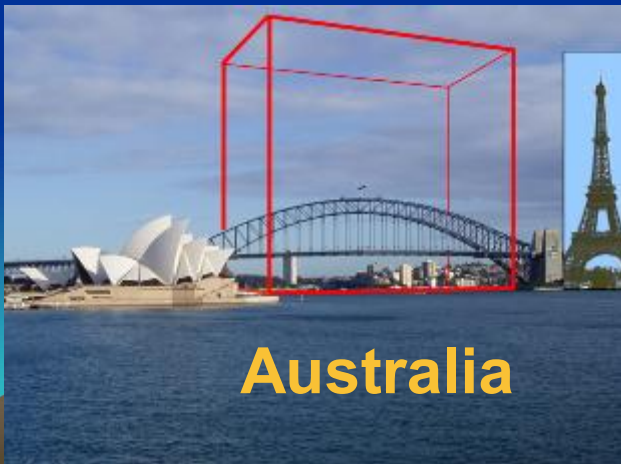
1 km

**United States**

Globally, oil burning  
accounts for 40%  
CO2 emissions!

US = 10% of CO2 from oil.  
And 25% of all  
CO2 emissions

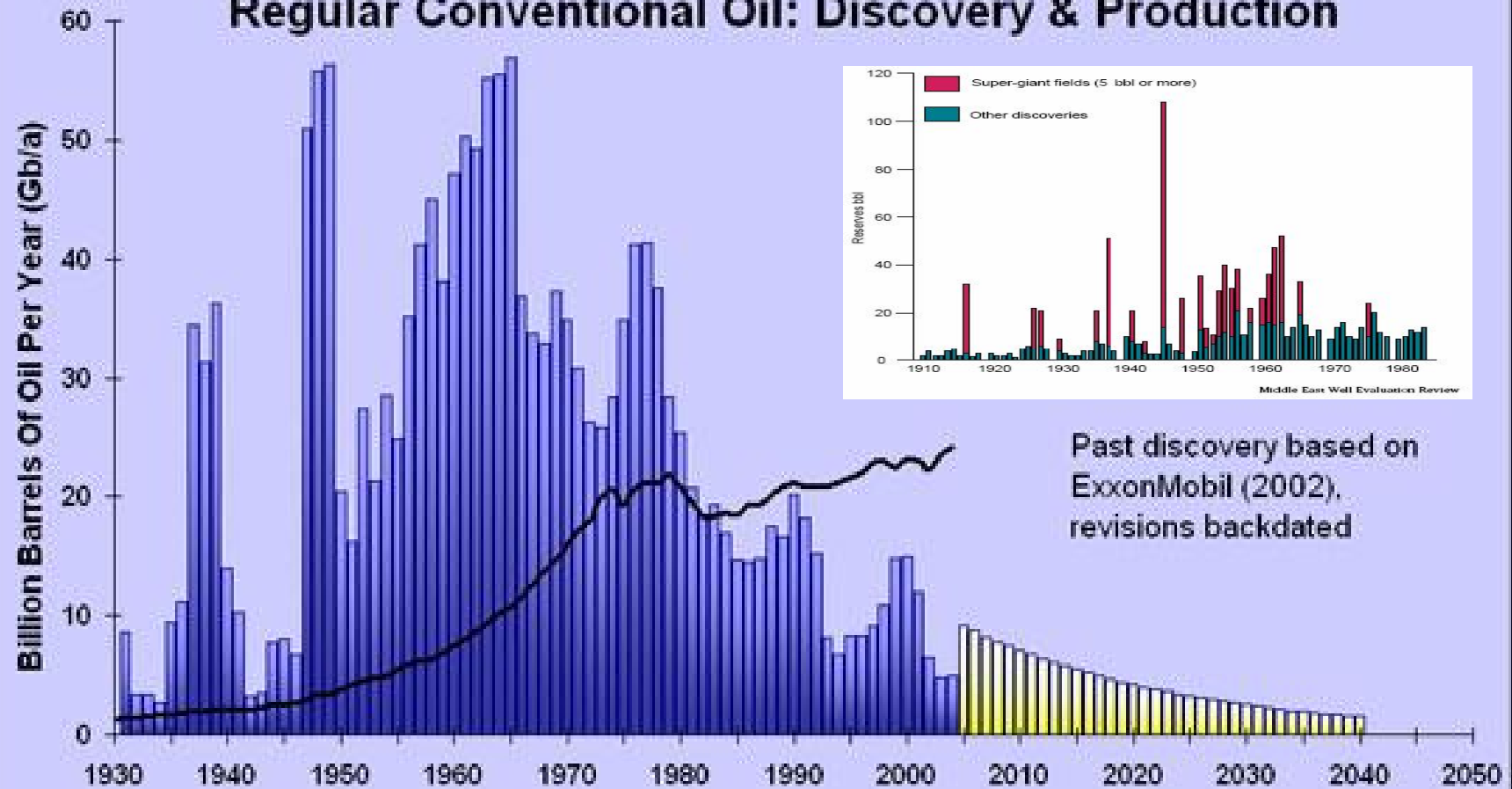
**China**



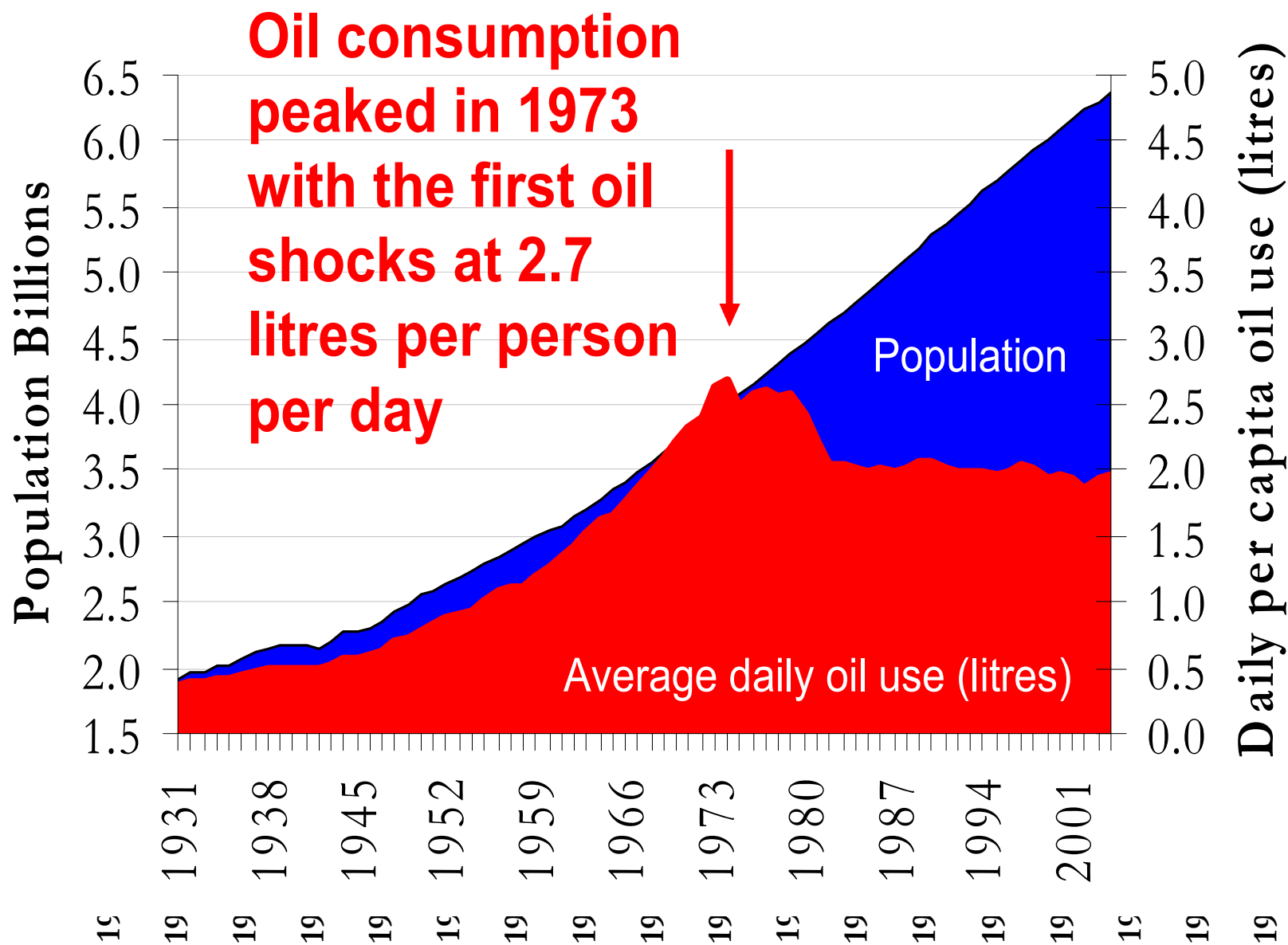
# Global Oil Discovery Peak: 1960s

## THE GROWING GAP

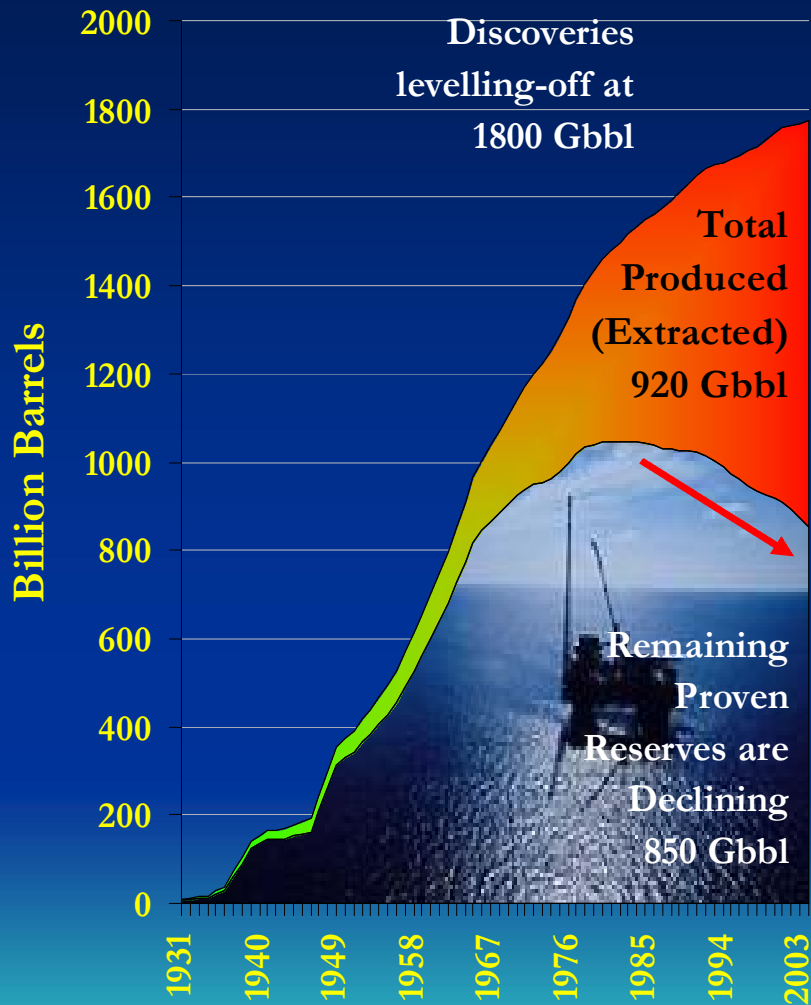
### Regular Conventional Oil: Discovery & Production



# Eating into our inheritance

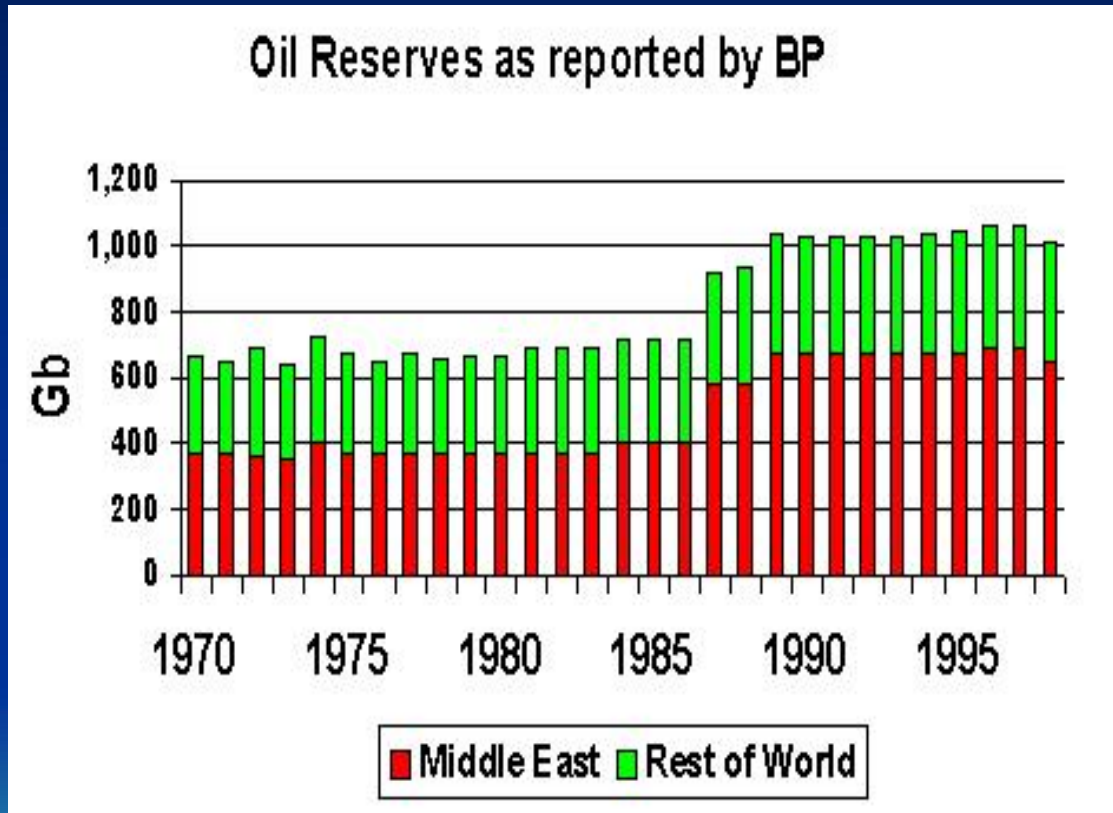


# What has been produced...



- Remaining reserves = total discoveries – production
- Discoveries have been small, so remaining reserves are falling
- We're around halfway through the “easy” oil

# 400 Billion OPEC Paper Barrels

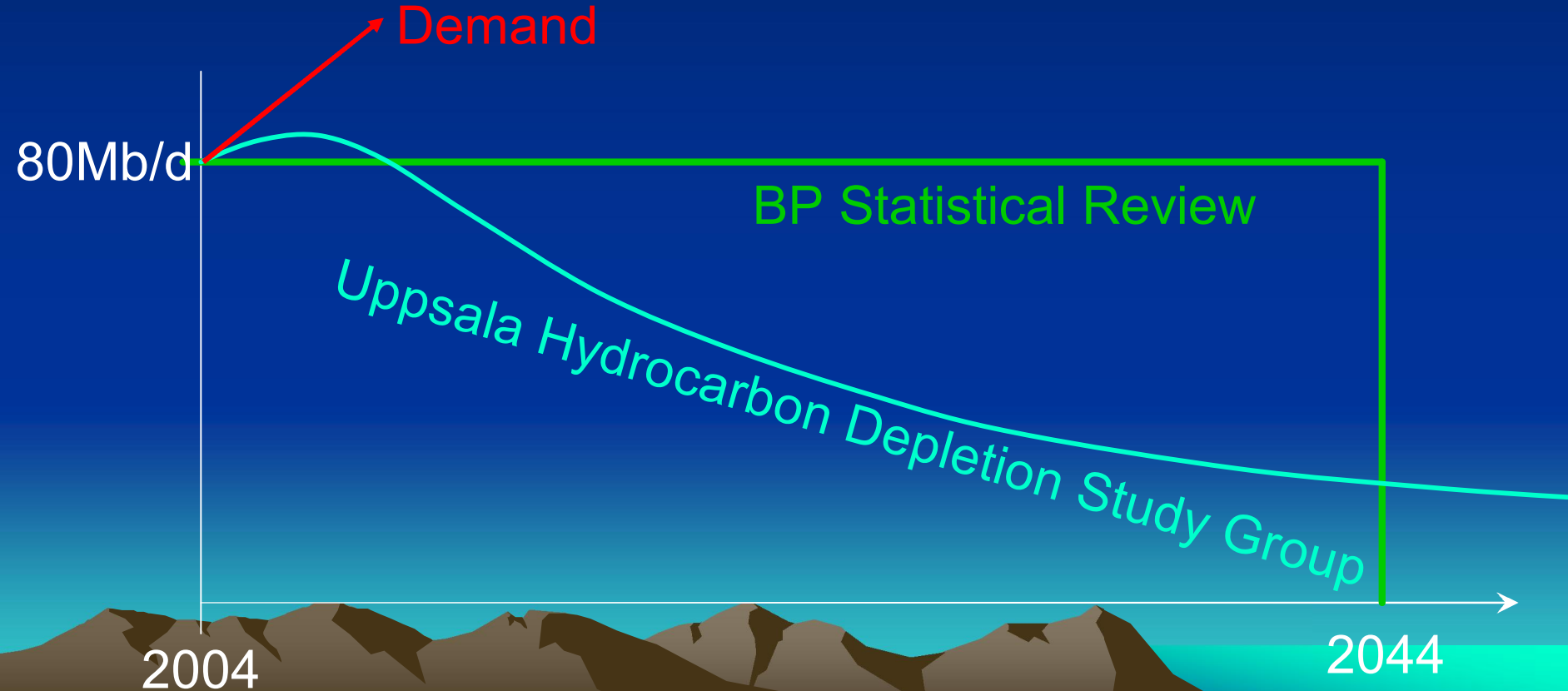


- Producers upped reserves to get bigger slice of market
- New finds were minimal
- Reported reserves high despite production!

400 Million barrels is about 13 years production (without growth in demand!) – i.e. peak could be much sooner than expected!!

ASPO Newsletter 42 comment on BP Statistical Review of World Energy of June 2004:

*“The most fatuous and misleading approach is to take the Reserve number and divide it by current production to say that the Reserves support current production for 41 years, ignoring the natural decline observed in all fields and countries.”*



# Look at it country by country:

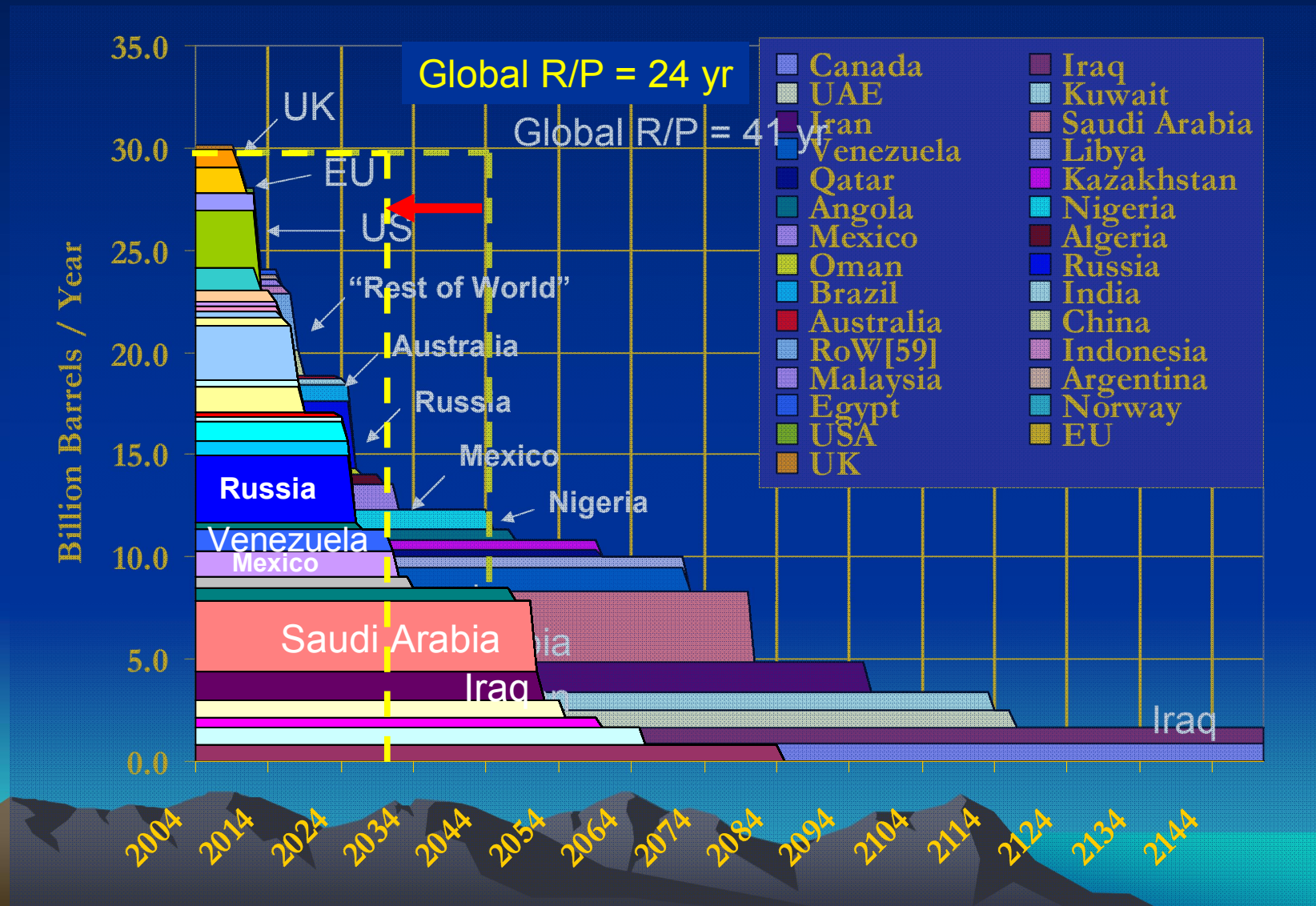
Calculate for  
each country!



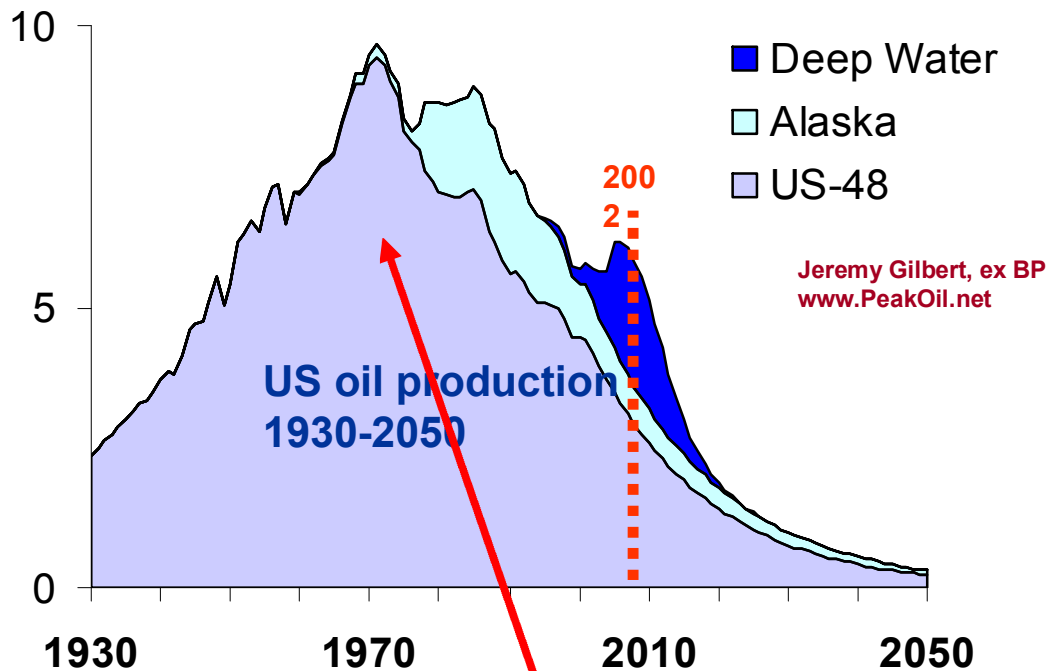
NATION	RESERVES (billion barrels)	PRODUCTION (billion barrels per year)	R / P (years left)
Saudi Arabia	262.7 (159)	3.46	76 (46)
Iran	133.3 (69)	1.45	92 (47)
Iraq	112.5 (61)	0.76	147 (80)
United Arab Emirates	97.8 (44)	0.87	112 (50)
Kuwait	96.5 (54)	0.88	109 (61)
Venezuela	75.6 (29)	1.12	67 (26)
Russia	69.0	3.34	21
Libya	40.0 (22)	0.60	67 (37)
Nigeria	36.0 (18)	0.89	40 (20)
Mexico	33.3	1.25	27
Kazakhstan	26.0	0.47	55
Angola	25.0	0.58	43
United States	22.5	2.78	8

Note: Figures in brackets – Reserves adjusted for Paper Barrels and Production

# How country R/Ps stack-up...



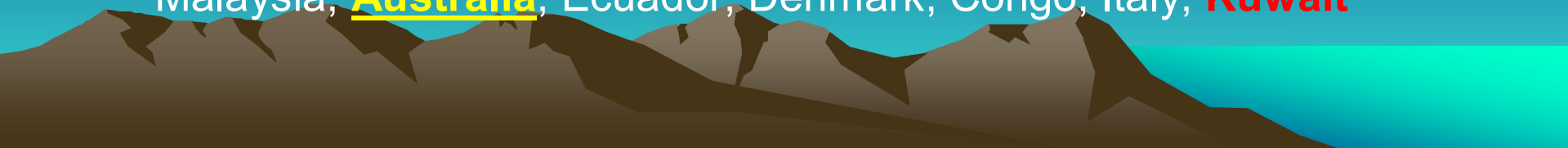
# How does it really work...



The US Lower 48: Peak  
1970

# 53 countries past their peak (in decline..)

- **Pre 1970** – Austria, Germany
- **1970s** – **Venezuela**, Bahrain, Ukraine, **Libya**, **USA**, Turkmenistan, **Canada**, **Iran**, Romania, Trinidad, Brunei, Algeria, **1980s** – Tunisia, Chile, Albania, Peru, Cameroon, Brazil, Hungary, **Russia**, France, Croatia, Netherlands
- **1990s** – Turkey, **UAE**, Pakistan, Papua, Syria, Egypt, Gabon, Argentina, Angola, Uzbekistan, **UK**, Colombia, Yemen, Indonesia
- **2000s** – Mexico, **Nigeria**, Norway, N. Zone, Oman, India, Qatar, Malaysia, **Australia**, Ecuador, Denmark, Congo, Italy, **Kuwait**



# Only OPEC and Russia left...

35 Million Barrels/day



The rest of the world has peaked...

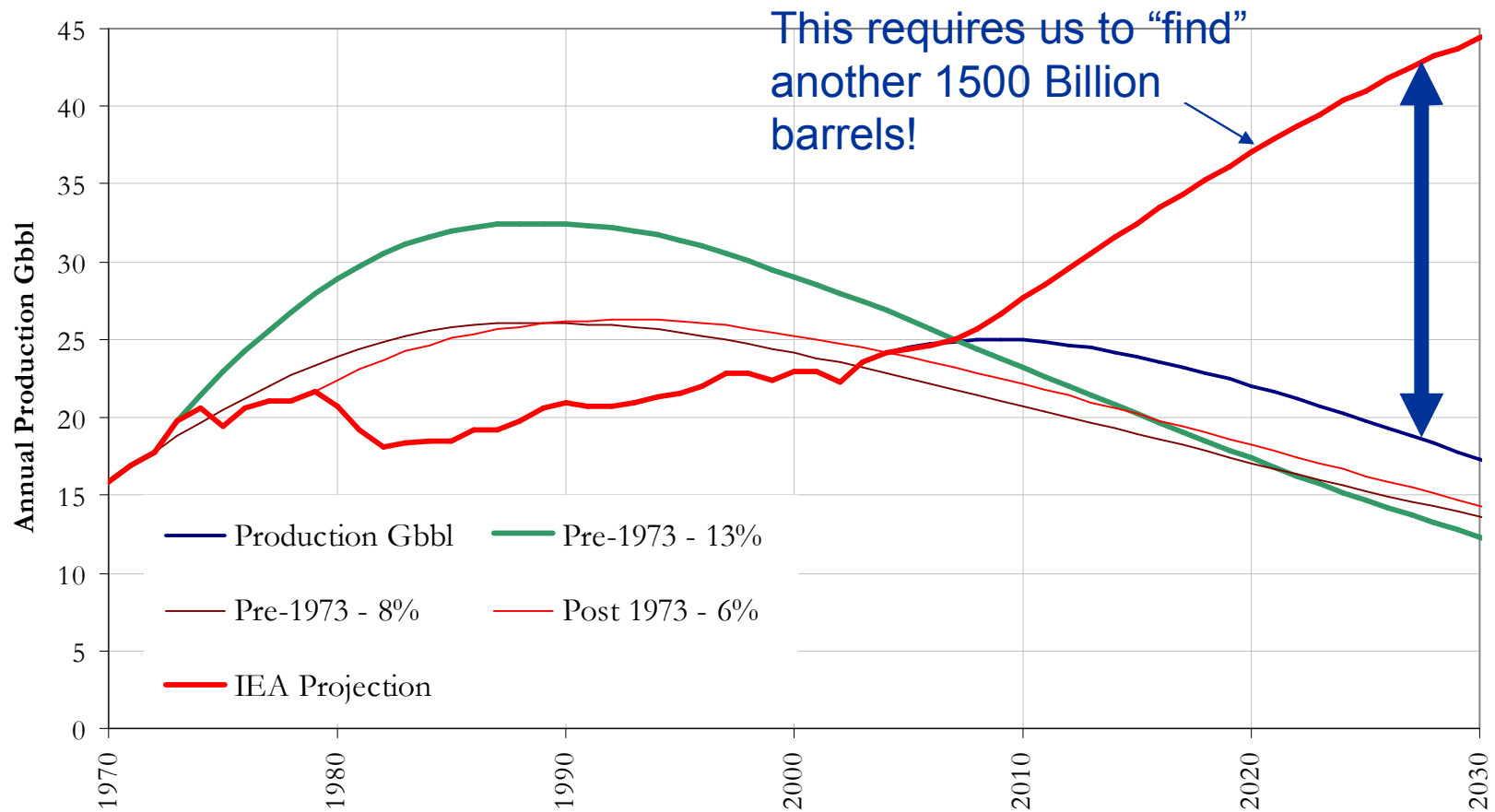
# Colin Campbell's ASPO base 2005 case for oil and gas

2006 – Peak  
for regular oil

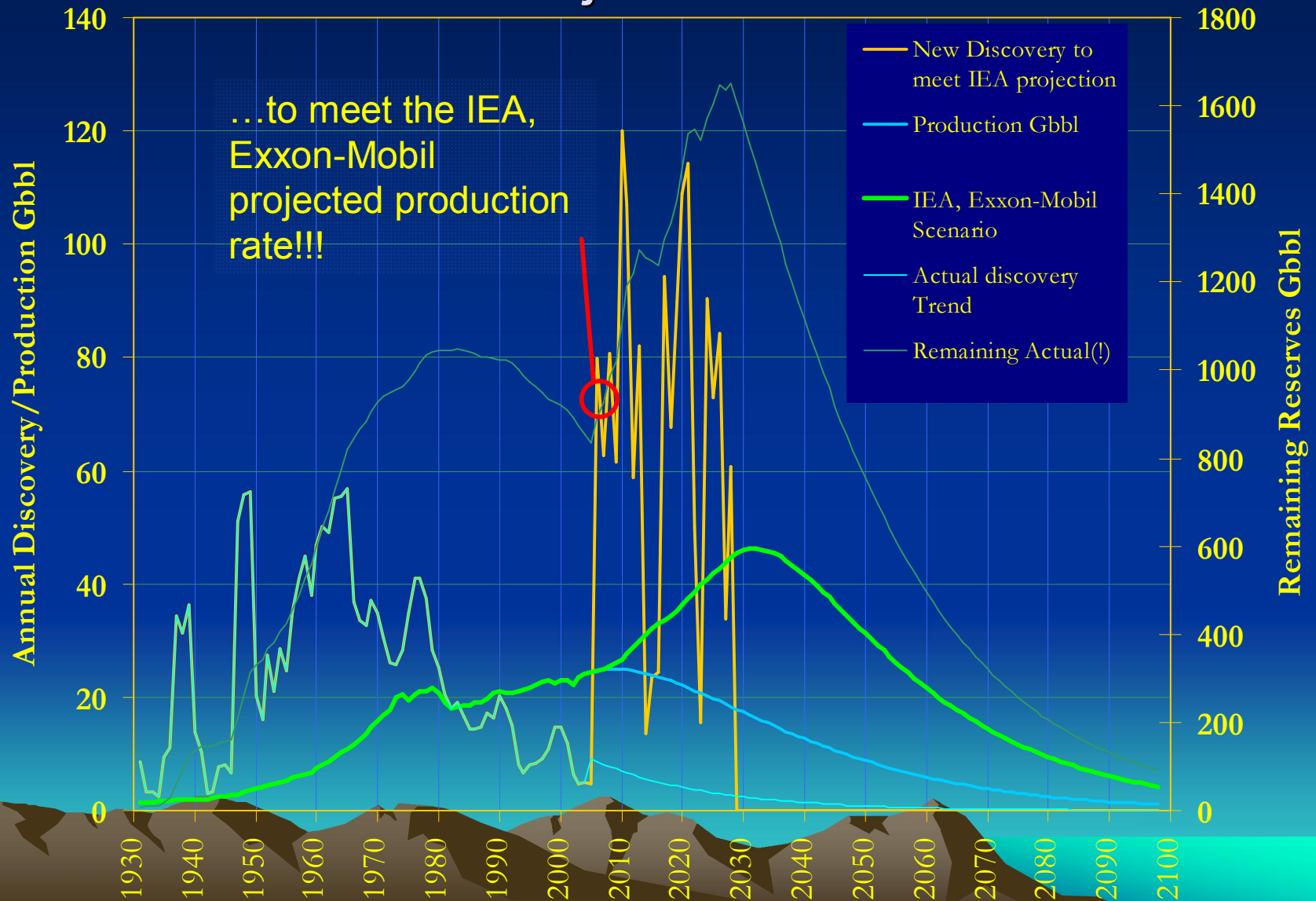
2011 – Peak  
for all gas  
and liquids



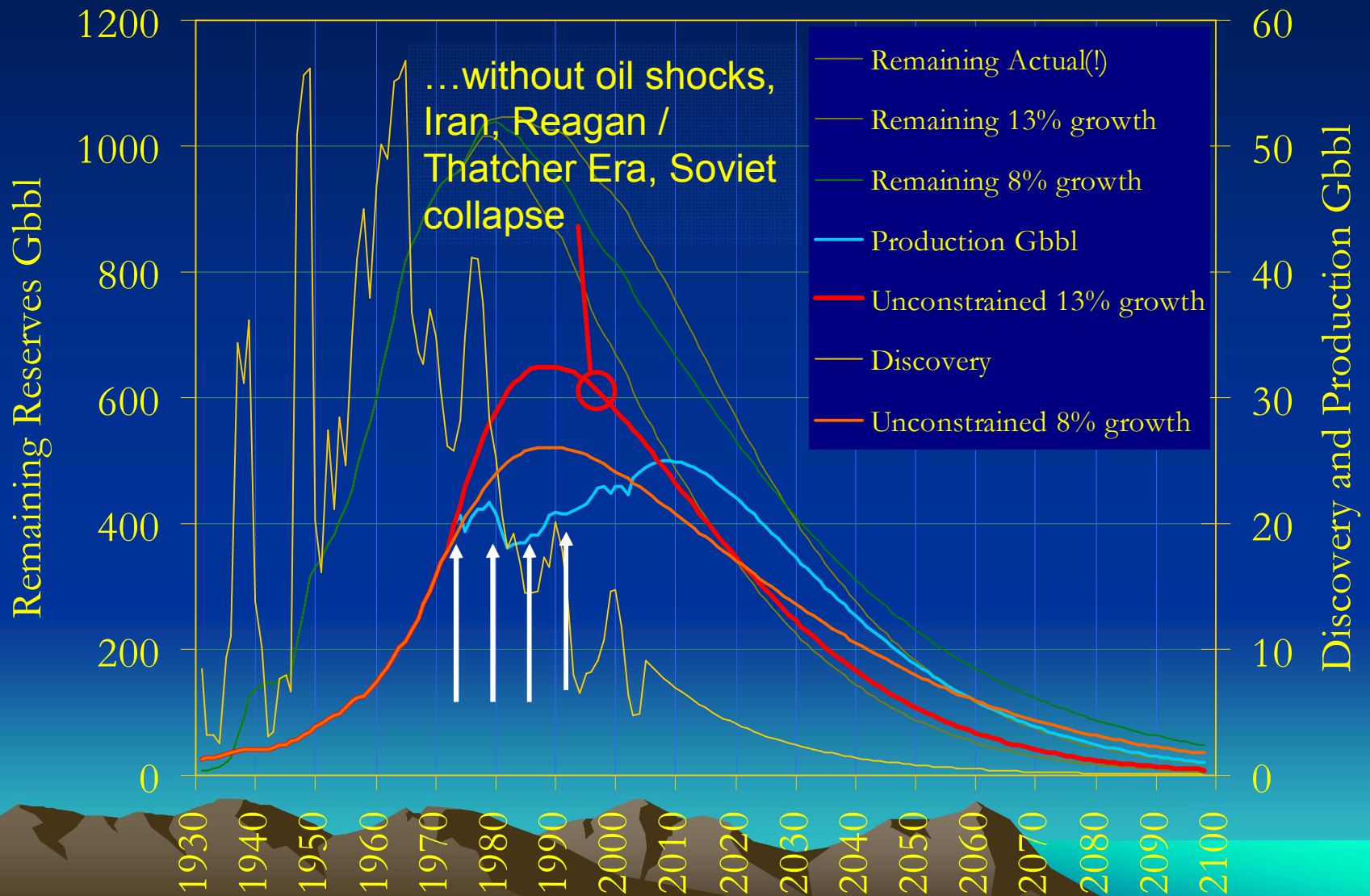
# The IEA, Exxon Mobil View



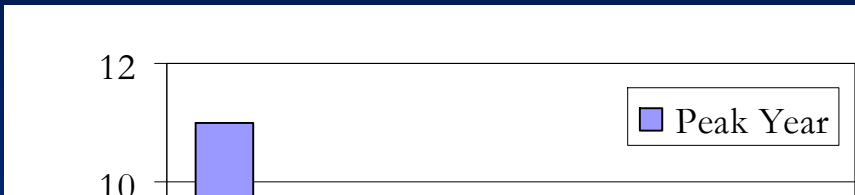
# Discovery required to meet the IEA/BP/ExxonMobil Projection...



# How it might have looked...



# It could peak anytime soon..

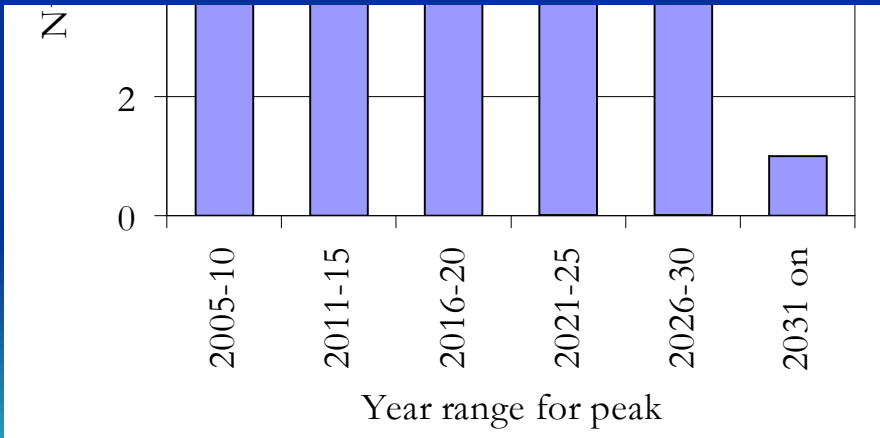


Peak Year	
Least optimistic	2007 5%ile
	2010 25%ile
	2015 Median

The optimistic projections are counting on the 400 Billion Paper Barrels.

The IEA/Exxon-Mobil are counting on finding and quickly developing another 1100 Billion barrels.

Who would you trust?



When you are at peak oil production, you have used more than half the NET ENERGY recoverable

Resource  
“easy” to  
extract.

Peak

Resource  
“difficult” to  
extract  
i.e. uses  
more  
energy

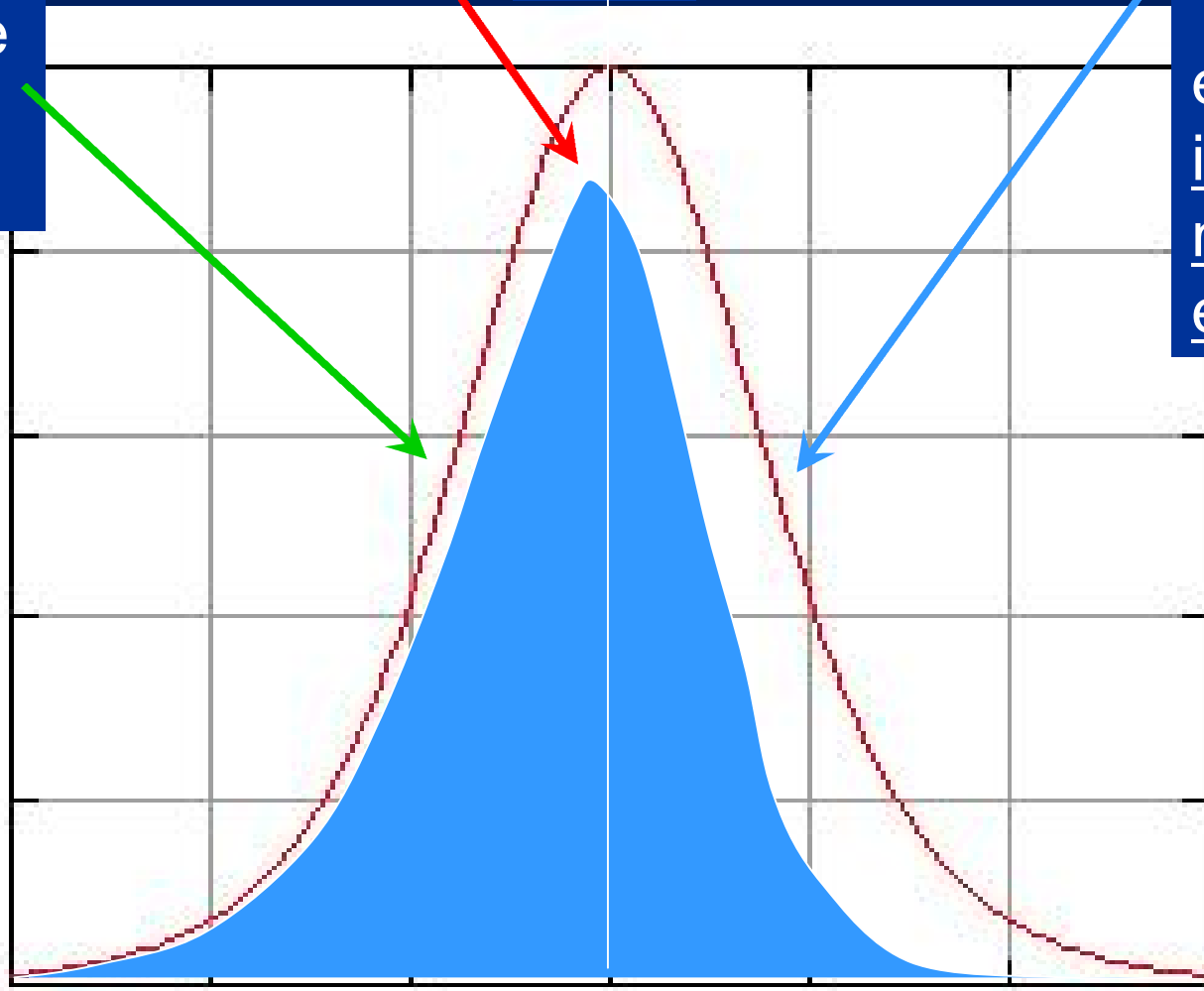
Production rate

0.2  
0.15  
0.1  
0.05  
0

-6 -4 -2 0 2 4 6

Time

NET ENERGY  
PRODUCTION



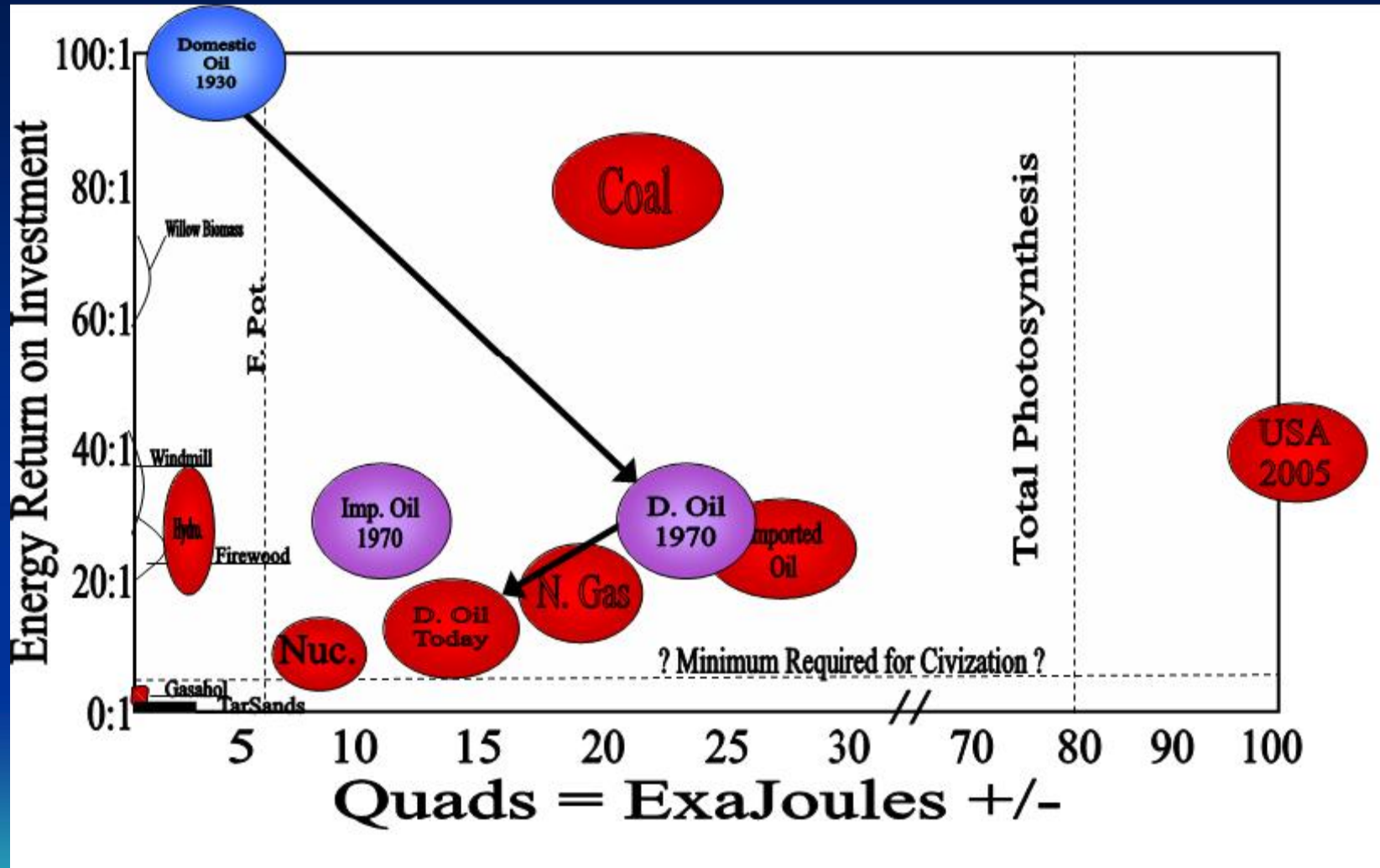
Like money, you need to invest energy to produce energy. However, for sustainable energy production it is simply NOT POSSIBLE to invest more energy than you can produce!

$$(\text{Energy produced}) - (\text{Energy invested}) = \text{NET ENERGY}$$

The most important thing is not how much oil there is but how much NET ENERGY it will yield. Net energy depends on the Energy Profit Ratio: EPR (also called “EROEI” – Energy Returned On Energy Invested or “payback”)

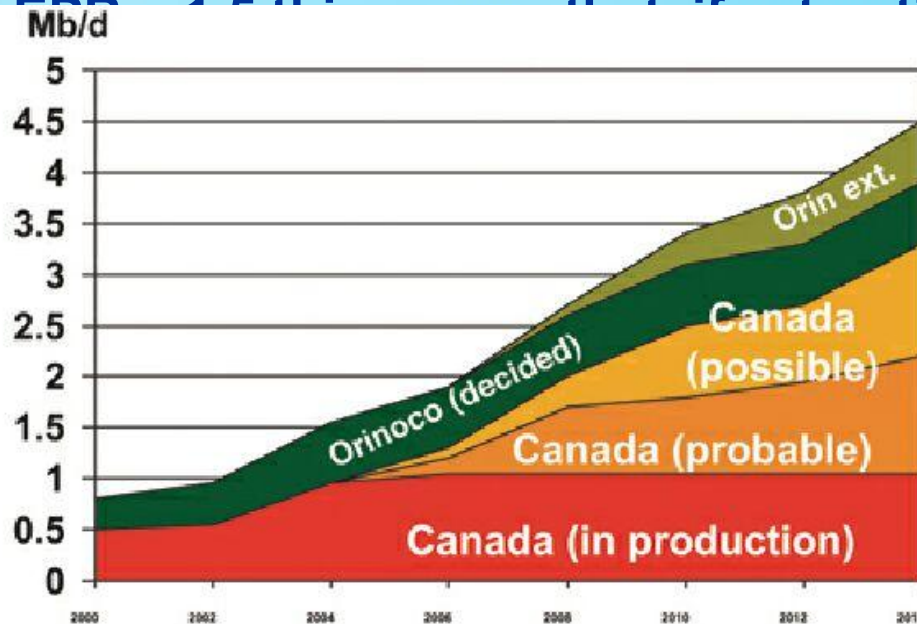
EPR MUST be  $>1$  or energy production CANNOT happen (without a subsidy)



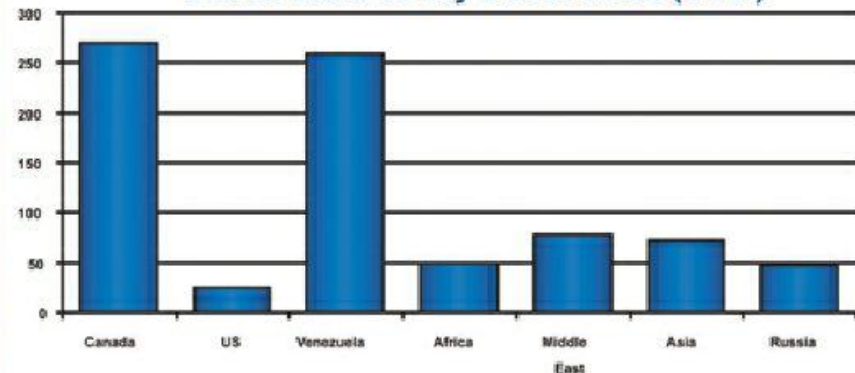


**Tar Sands:** The EPR of energy extraction from Canadian tar sands is estimated to be  $\leq 1.5$ . The total resource may be equivalent to one trillion barrels of oil with maybe 200 billion barrels accessible.

How  
with  
bar  
and  
rec  
use



World extra-heavy oil reserves (Bbbl)



Source: BP/USGS, Core USGS

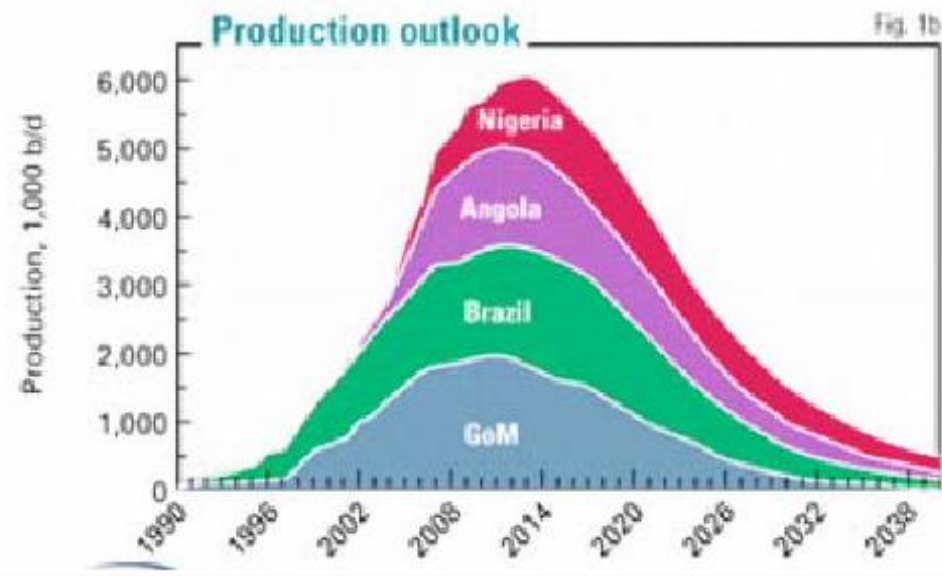
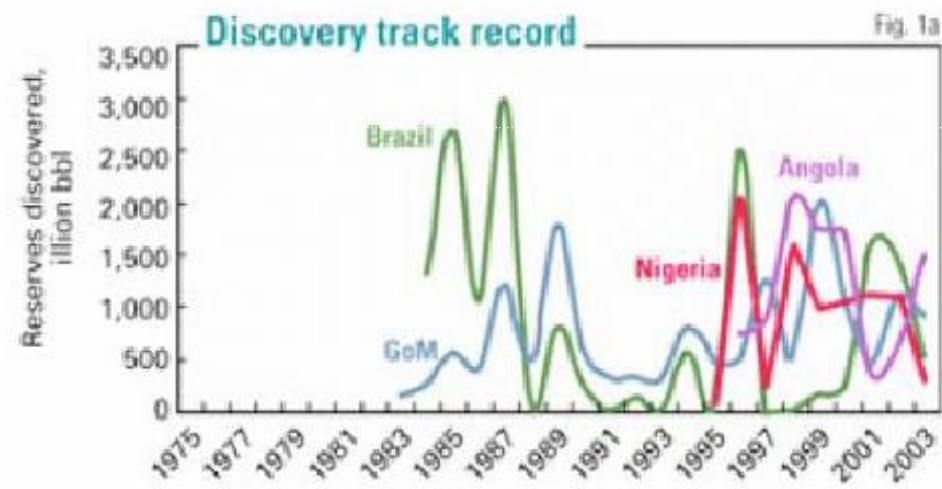


Gulf of Mexico, Dominion Exploration and Production

Deepwater discovery is in decline and production will probably peak at about 6 Mbd before 2014

# DEEPWATER BIG FOUR OIL E&P STATUS

Fig. 1

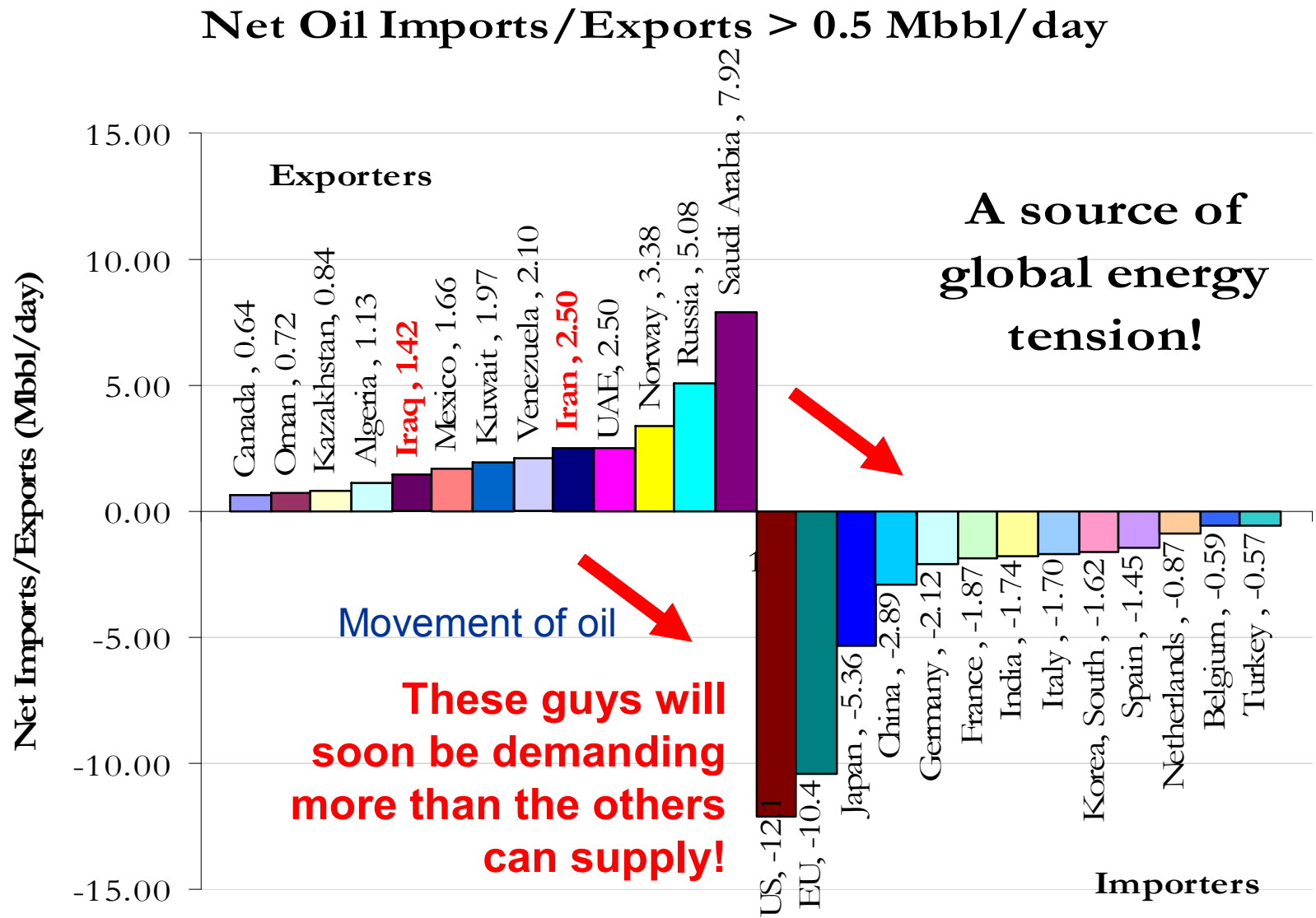


# What options?

- A new Saudi Arabia would provide 7 years oil consumption
- It takes 5 to 7 years to develop a new oil field
- New production cannot offset decline and demand growth..
- Price driven demand destruction balances the equation – poorer countries miss-out.



# Conflict – supply/demand tension



# Global “Peak” Oil

Views from the mountain top..

Dr Jeremy Wilkinson

4 August 2006



# Just a sample of books about Oil Depletion

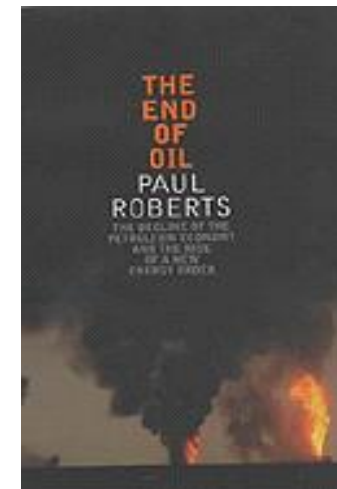
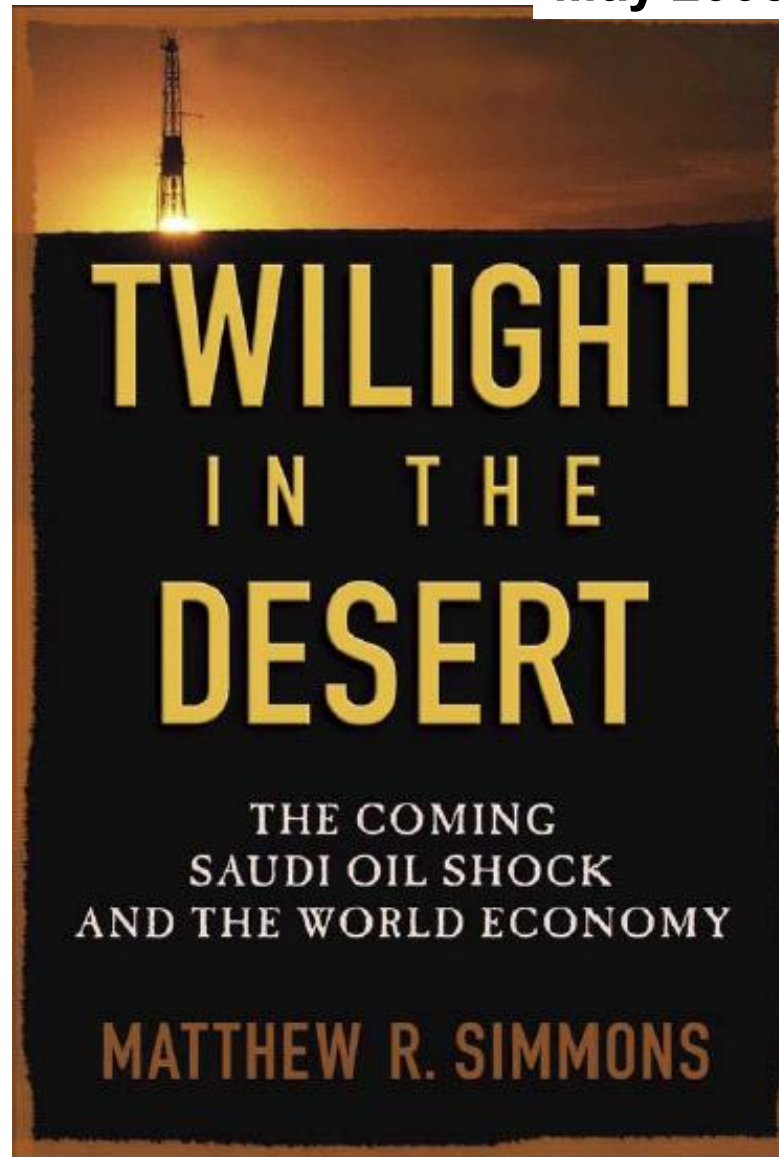
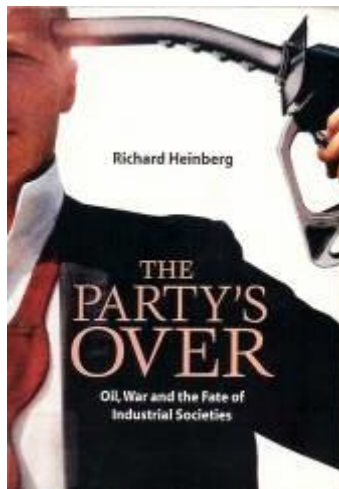
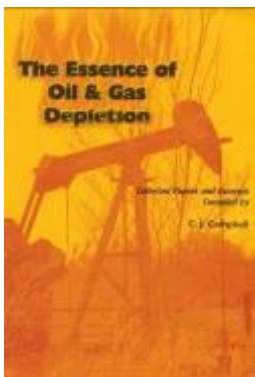
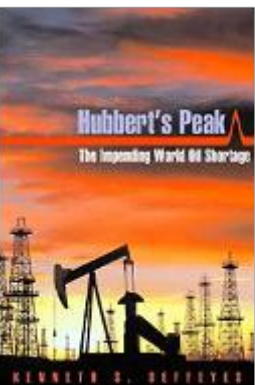
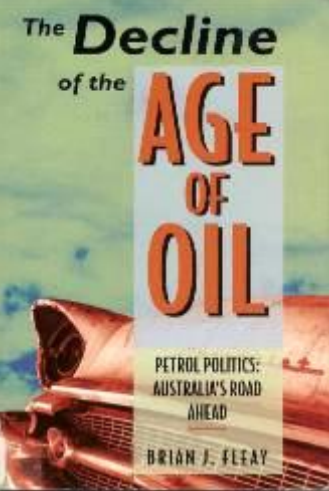
May 2005

Brian Fleay  
Perth  
1995

Deffeyes  
2001

Campbell &  
Laherrère  
March 1998

Roberts 2004<sub>10</sub>



Campbell 2003 Heinberg 2003

# What's Happening?

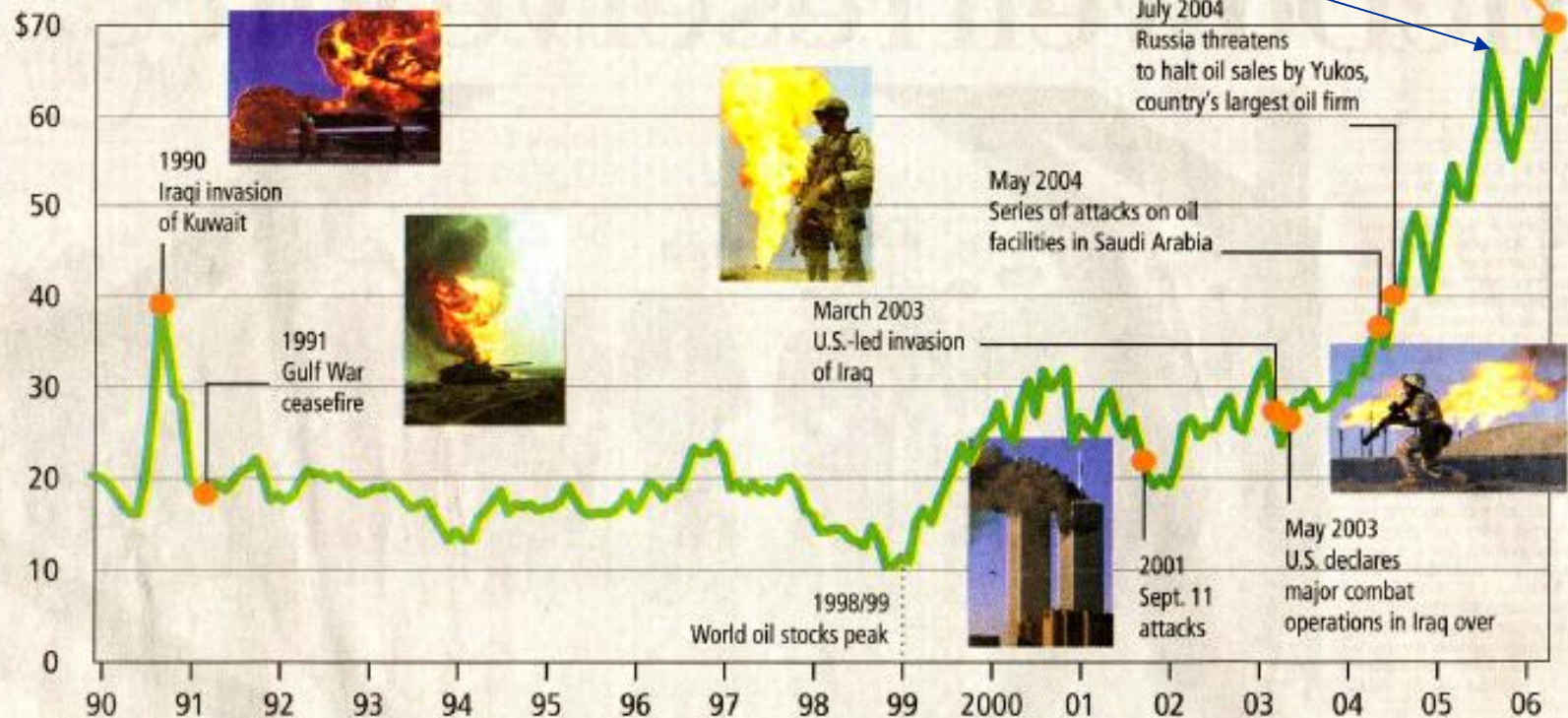
- Natural disasters – Katrina – 30% reduction in US oil supply
- Gulf Wars 1 and 2 – loss of Iraqi production
- Supply/Demand closely balanced – we use as much as can be pumped!
- Declining discovery since 1980s
- Declining output from ageing oil fields
- Uncertainty about remaining oil in place
- Rapid demand growth in China and India



# What's with Oil Prices!

## How world events hit the price of crude

BRENT CRUDE PRICES  
US\$ per barrel (monthly close)



\* Price at 1330GMT

Source: Irish Independent – April 21, 2006

Growth in  
Population, or  
Demand, or  
Consumption  
% per annum

Population, or  
Demand, or  
Consumption  
doubles every "y" years

0.1

693

0.5

139

1

69

1.5

46

2

35

3

23

5

14

7

10

10

7

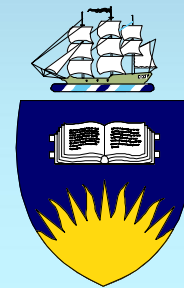
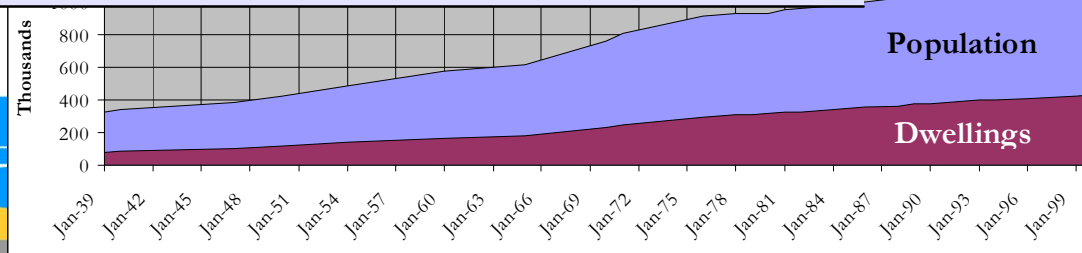
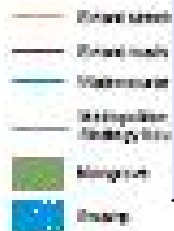
12

6

60

Note: The purpose  
is to indicate the  
metropolitan area  
specified (metropolitan  
and streets shown  
derived from the  
metropolitan and city  
roads that were at  
time.

Data From The  
South Australian  
by Michael Palmer



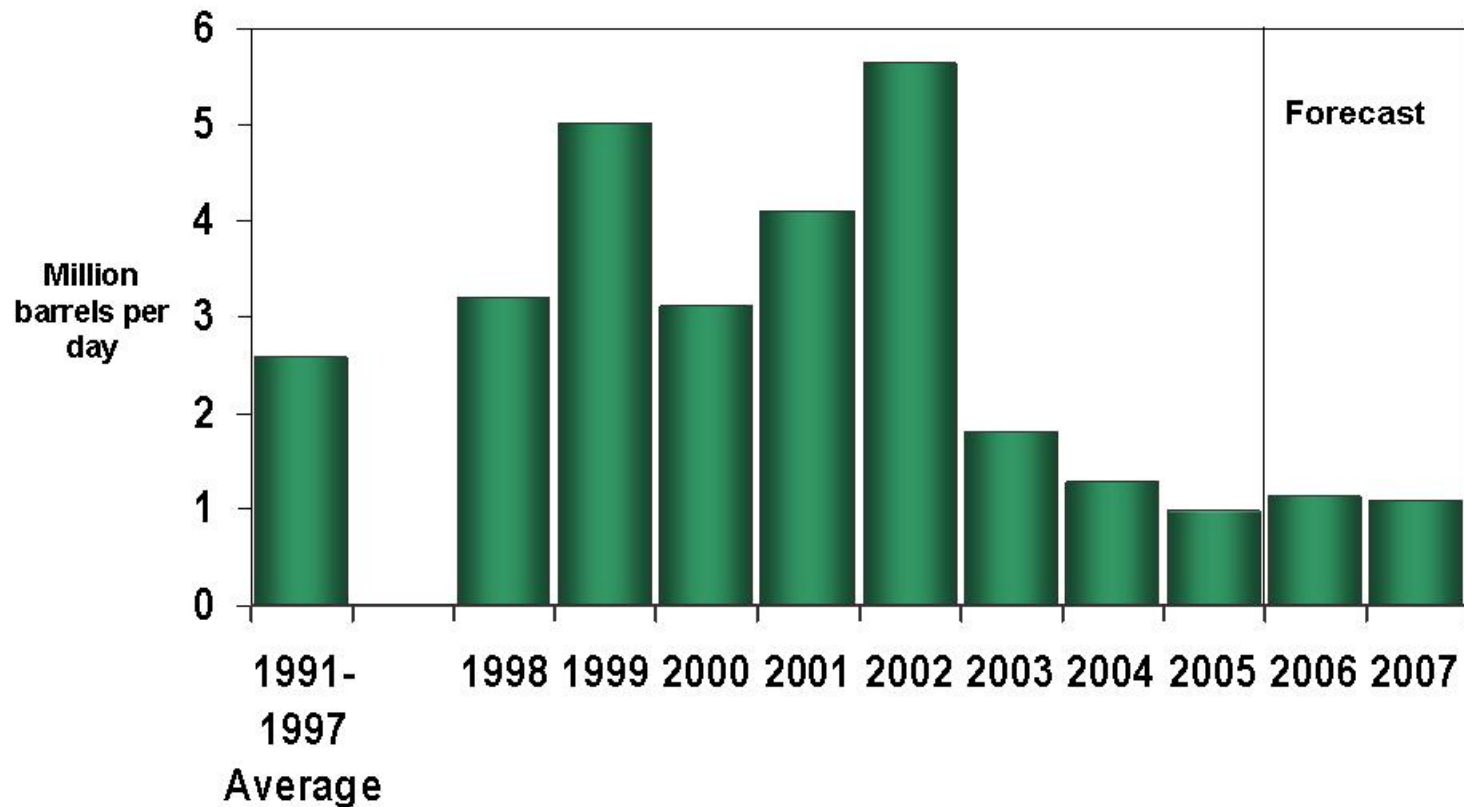
# Growth in Oil demand...

- Growing 3.5% a year - doubling every 20 years!
- India growing 7% - doubling every 10 years
- China 13% - doubles every 6 years!!
- They want cars and highways like us!
- AND they're building them – we have 600,000,000 cars globally



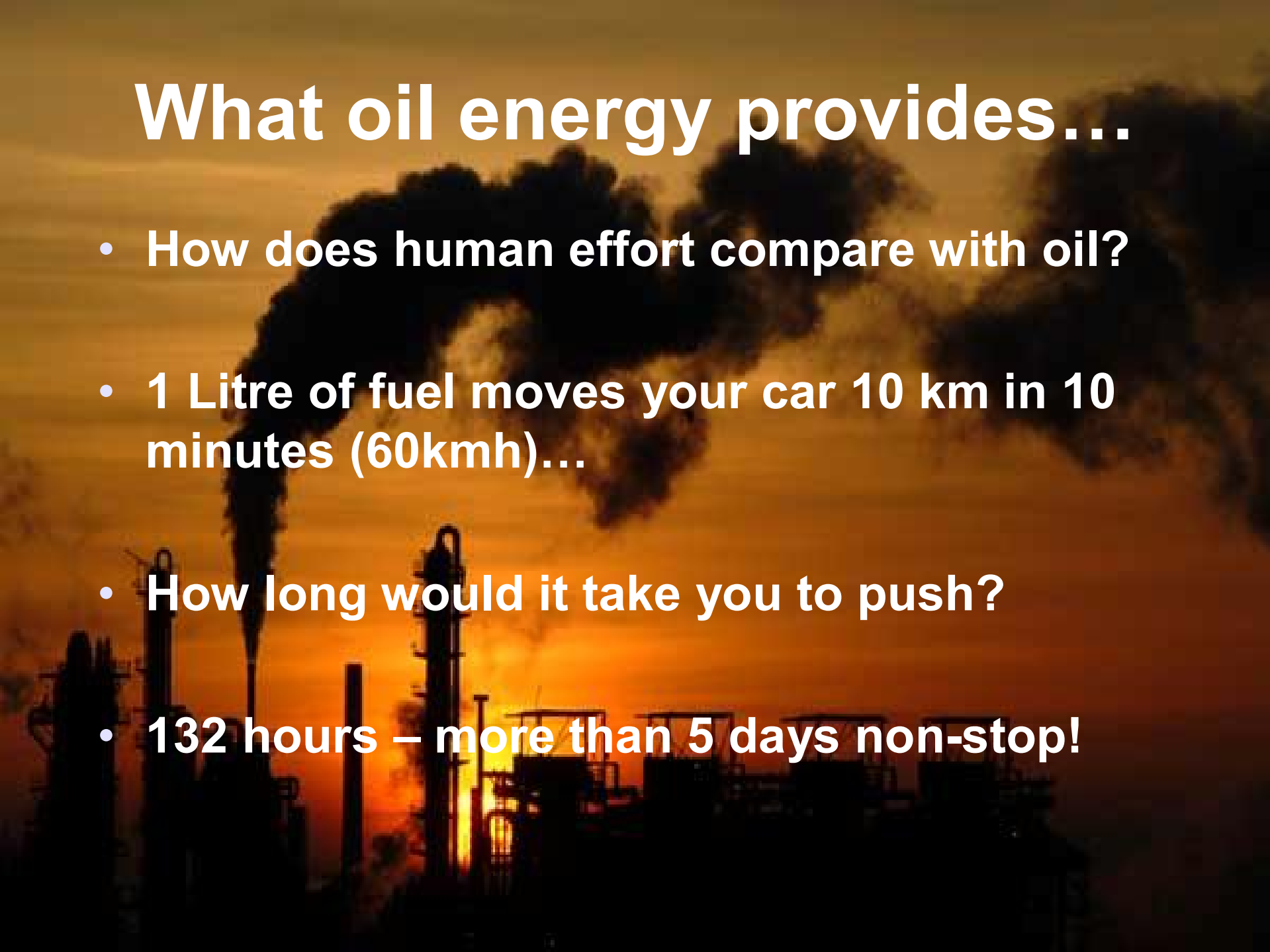
# What's the problem?

Figure 7. World Oil Surplus Production Capacity



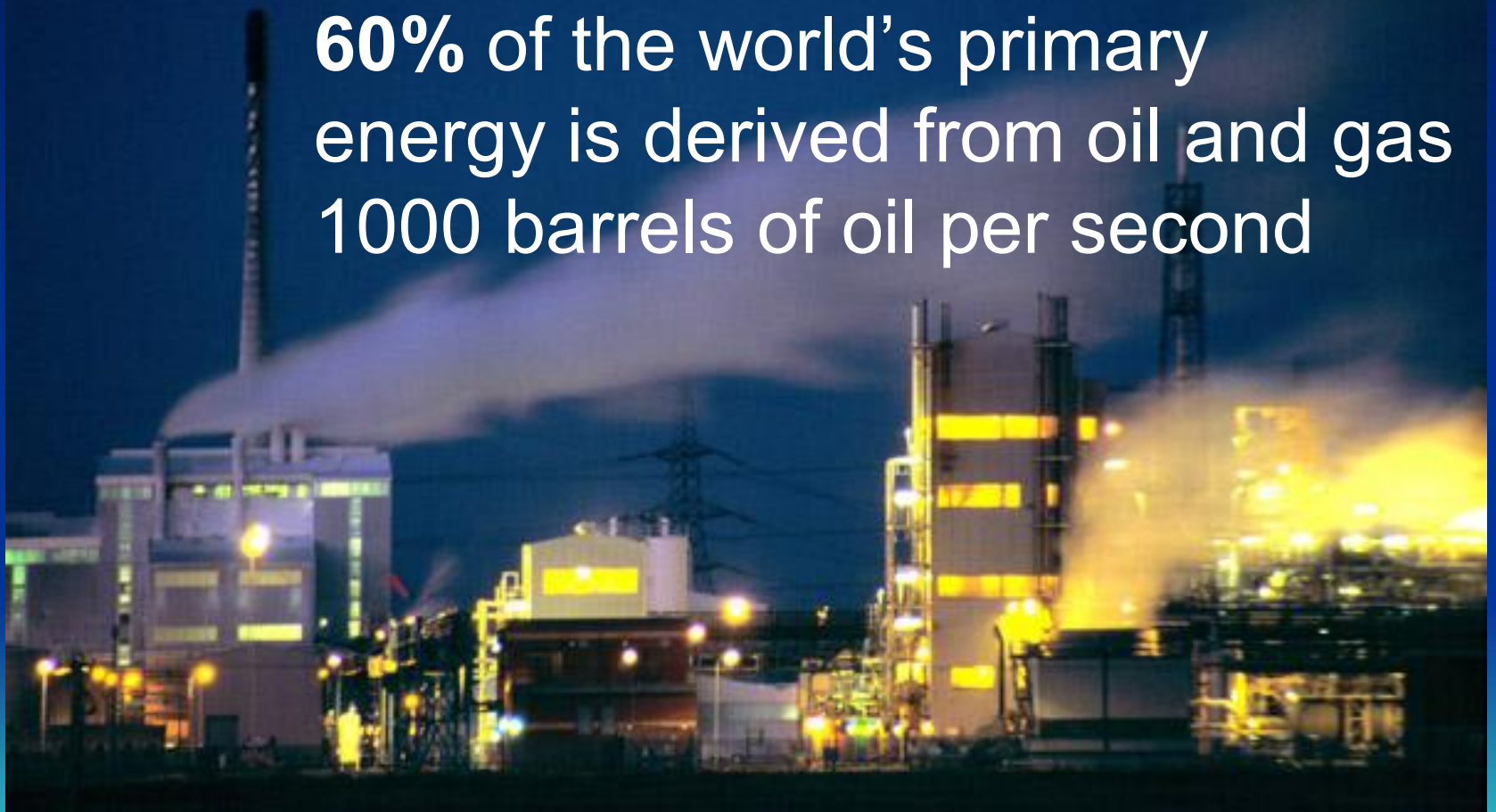
# What oil energy provides...

- How does human effort compare with oil?
- 1 Litre of fuel moves your car 10 km in 10 minutes (60kmh)...
- How long would it take you to push?
- 132 hours – more than 5 days non-stop!



A civilization based on hydrocarbon use

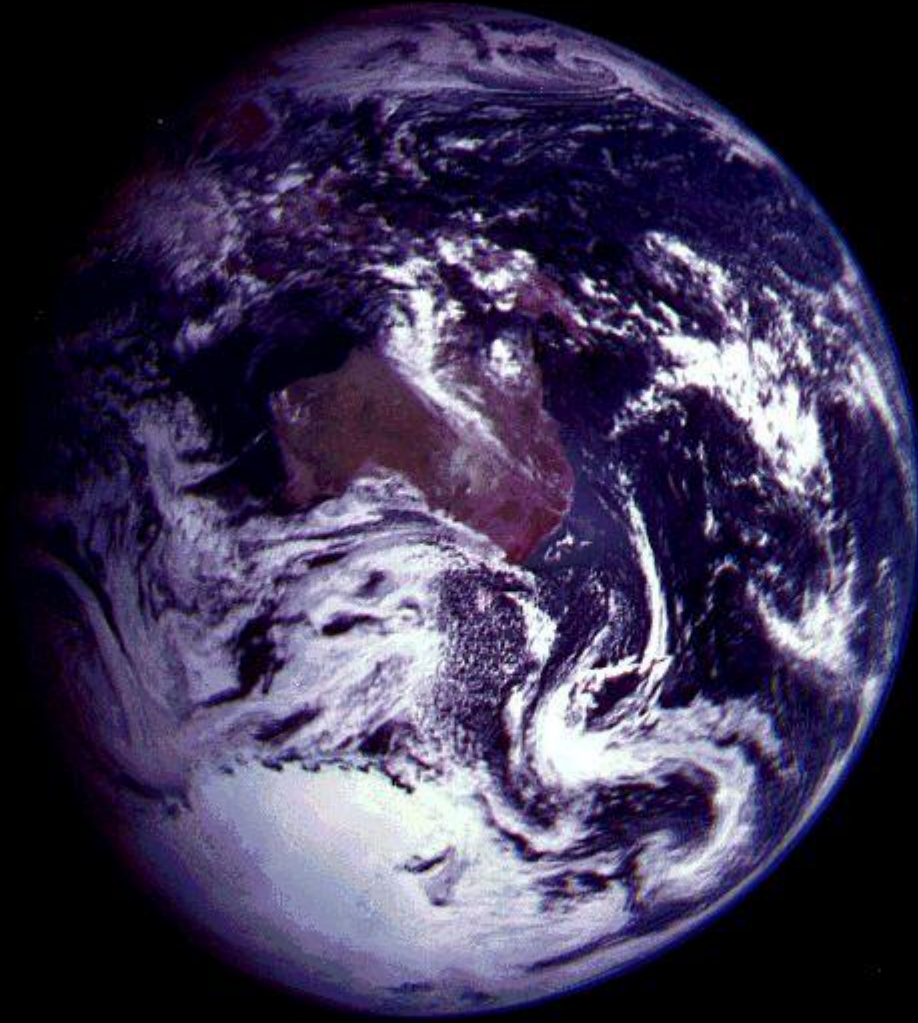
**60%** of the world's primary  
energy is derived from oil and gas  
1000 barrels of oil per second



> 90% of transport fuel comes from oil !



Globalisation is based on cheap transport



Cheap transport is based on cheap oil



1 kg of oil is  
needed to produce  
every kg of food !

“In the United States, 400  
gallons of oil equivalents  
[~ 9.5 barrels or 1,500 litres]  
are expended annually to  
feed each American (as of  
data provided in 1994).”

This is only the energy used  
**ON THE FARM!**

# Oil is the feedstock for most plastics and pharmaceuticals



Look around you – see how reliant we've become on oil and its products.....

# What about global reserves

- Estimates vary, but most credible analysts suggest between 1900 Billion and 2500 Billion barrels
- Discovery peaked in the 1960s



# What's left?

- We've produced around 1000 Billion barrels
- This leaves anywhere between 1000 and 1500 Billion barrels
- How long will it last?
- What BP tells us...

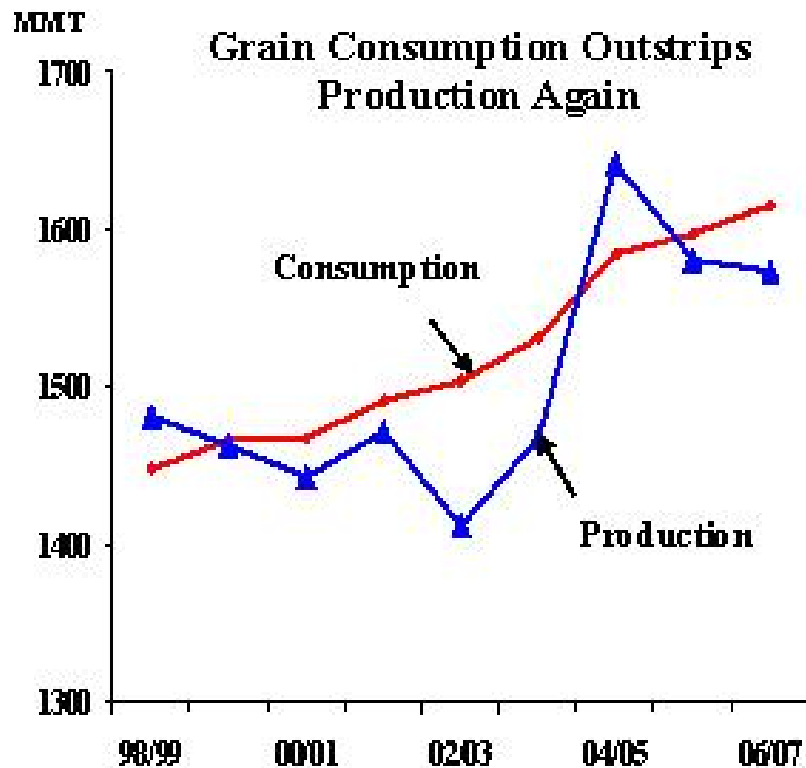


# The Future

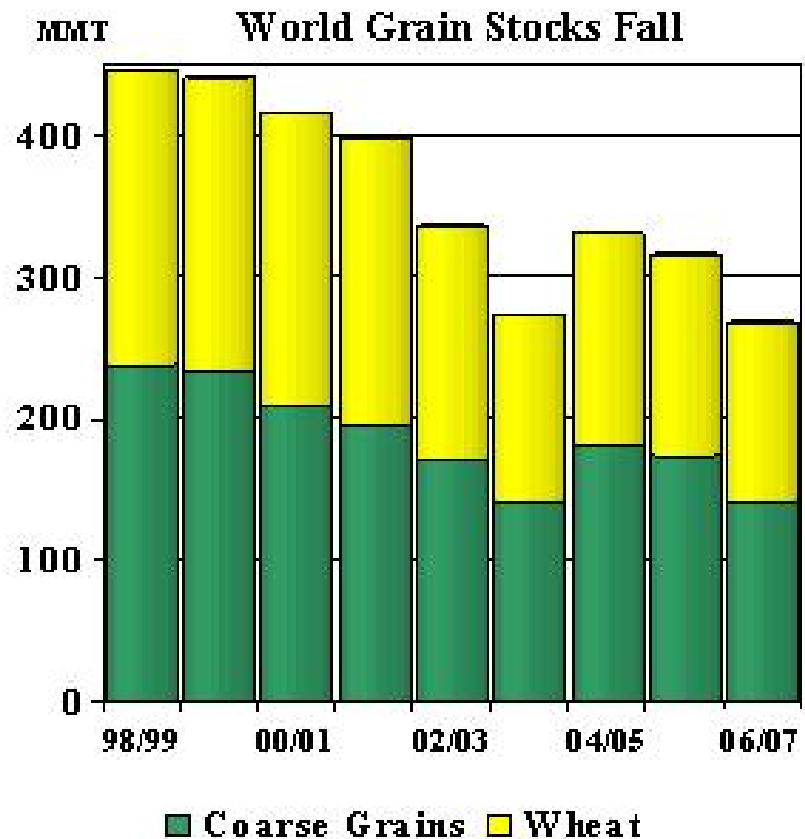
- Recovery efficiency falls past peak..
- What about alternatives?
- The supply/demand problem?
- Discovery to production lead time..
- Decline in existing production



# Growth, food production..



Note: Includes Coarse Grains and Wheat



# South Australia?

- “just in time” fuel supply (max. 17 days in reserve, average 10 days) that comes from Singapore!
- Early April 2006 down to 1 days diesel...

The solution ...

- Invest in local fuel storage facilities. Aim for a 3 month average reserve.
- Develop local liquid fuel emergency action plan – to maintain essential services...



# What if we don't act?

- We can expect some nasty surprises!
- Businesses may have to downsize rapidly
- Agriculture could suffer
- Powerful countries will demand “business as usual”, even if it means war....
- Iran – could lose 3% of global supply!
- Those climate-change impacts!!!



# What should we do??

- First – USE LESS!
- Second - USE Efficiently
- Third - Find substitutes

Message for the masses:-

If we all cut our use of oil the problem almost goes away!!

Pick the low hanging fruit – what gets the best return?





# ASPO Australia

Australian Association for the Study of Peak Oil and Gas



[www.aspo-australia.org.au](http://www.aspo-australia.org.au)

[www.adelaidepeakoil.com](http://www.adelaidepeakoil.com)

See also the following websites:

[abc.net.au/4corners/special\\_editions/20060710](http://abc.net.au/4corners/special_editions/20060710)

[www.drydipstick.com](http://www.drydipstick.com)

[www.energybulletin.net](http://www.energybulletin.net)

[www.peakoil.net](http://www.peakoil.net)

[www.peakoil.com](http://www.peakoil.com)

[www.odac-info.org/](http://www.odac-info.org/)

[www.hubbertpeak.com](http://www.hubbertpeak.com)

[www.globalpublicmedia.com](http://www.globalpublicmedia.com)

Don't believe a  
word that I have  
said.

Check it out for  
yourself!!!

Send an email to [michael.lardelli@adelaide.edu.au](mailto:michael.lardelli@adelaide.edu.au) if you wish to be sent the Beyond Oil Energy SA newsletter.

# Additional material



# Physical v Economic Reality...

- Quoting ex-Adelaide (Flinders) academic Bob Lloyd :  
*The problem is that the world economic picture, painted by economists on a background of free trade and globalisation, has failed to take into account the physical reality of energy in general and fossil fuel resources in particular; especially in terms of the state of the world's crude oil supplies. An examination of oil supplies will lead us to the conclusion that we have essentially been led up the garden path by a system of unrestricted marketing and growth dominated economics.*

*That there has been very little serious outcry or realisation of the situation, at least from the developed world, might be attributed to the fact that in general we are comfortable and have never had it so good. And that scientists have abdicated the operation of the global human situation to economists, due to the supposedly self evident success of this approach and the fact that contrary environmentalist meddling could be dismissed in the light of their obvious failures in the past.*



# World Events that Reduced Capacity

- The invasions of Iraq have damaged many wells and knocked-out 30% of capacity
- Katrina knocked-out 13% of US production capacity overnight
- There is no spare capacity to meet the short-fall – hence prices can double overnight



# Why can't we increase oil supply?

- The big oil fields are OLD!!
- 53 producers are declining
- No MAJOR finds since the 1970s
- The new prospects won't close the gap
  - Oil Sands
  - Deep water
  - Another “Saudi Arabia” would only supply us for 7 years!!

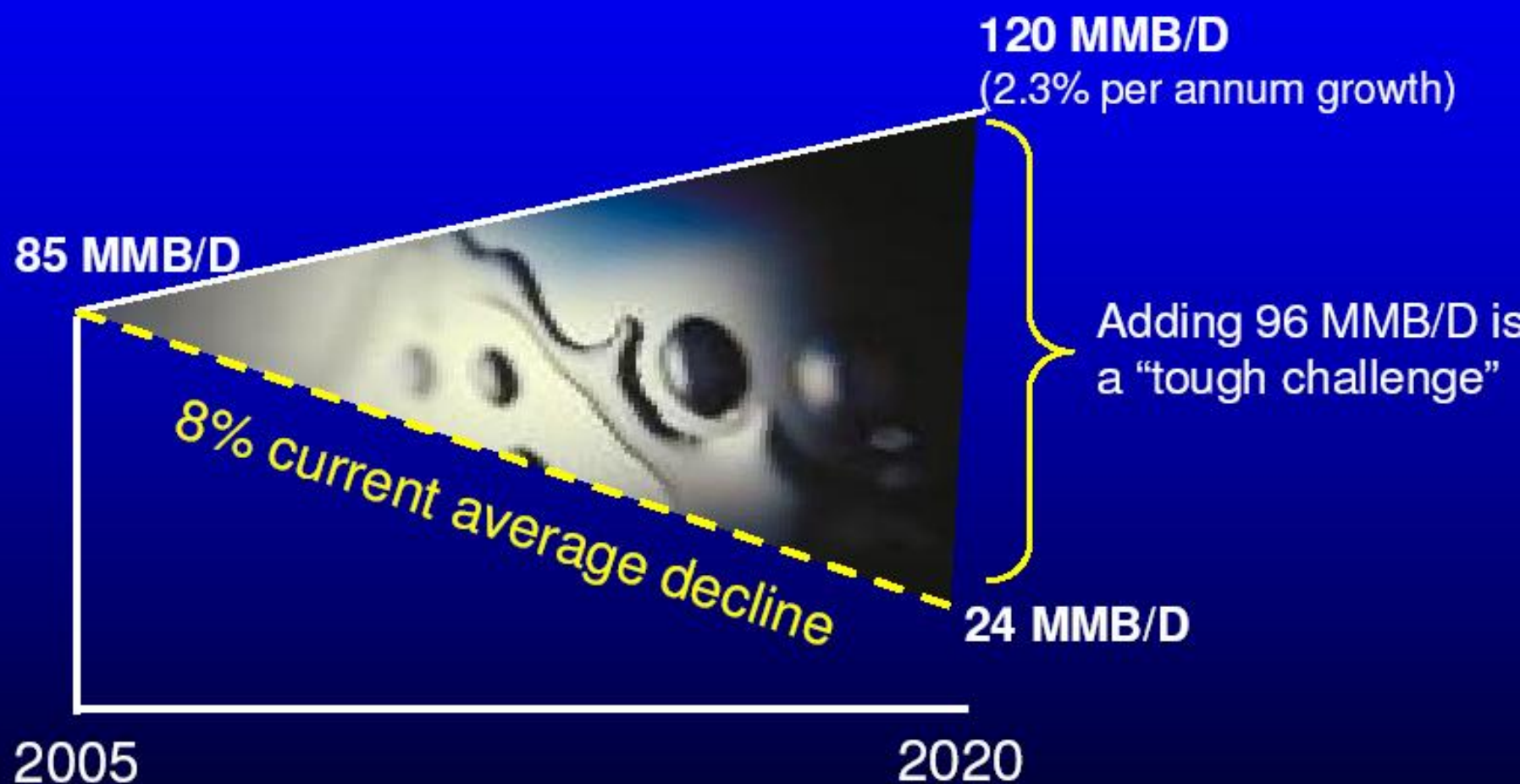


# The ASPO 2004 projection

! About Now!!

Oil and gas liquids scenario (updated from K. Aleklett and C.J. Campbell,  
Minerals & Energy, 2003; 18:5-20)

# Peak Oil Challenge



Old fields need water or gas to  
produce



# Hubbert's 1956 prediction for the US Lower 48



# So How Much Oil is There?

- Most estimates of global ultimate recovery of conventional oil lie within the range 1.8 to 2.2 trillion barrels.
- USGS estimated as much as 3 trillion barrels with > 700 Gbbl of discovery 1995-2025 (only 24 Gbbl/yr!!), this figure has been revised down on the basis of actual discoveries (only 8.5 Gbbl/yr)!



# How Quickly are we using-up our oil?

- Globally we use approximately 84 million barrels a day
- That's around 30 billion barrels a year
- We have used 1000 billion barrels
- That leaves around 800-1000 billion barrels



# How long will this last?

- If there were no growth in demand

AND

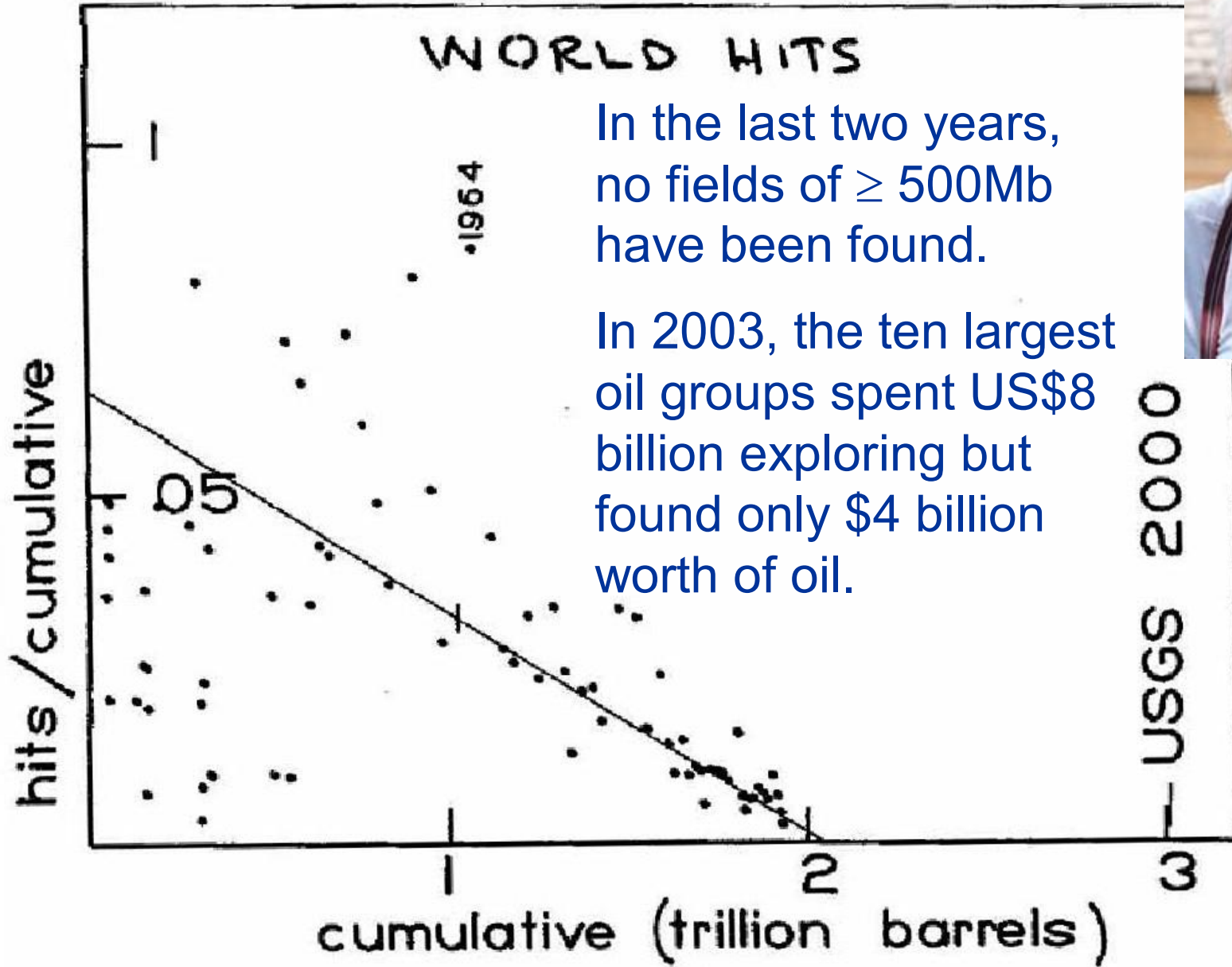
- We could access the oil as if it were in a tank [this is the BP R/P approach]:

$$1000 / 30 = 33 \text{ years}$$

- We have already seen that this is not a good representation of reality

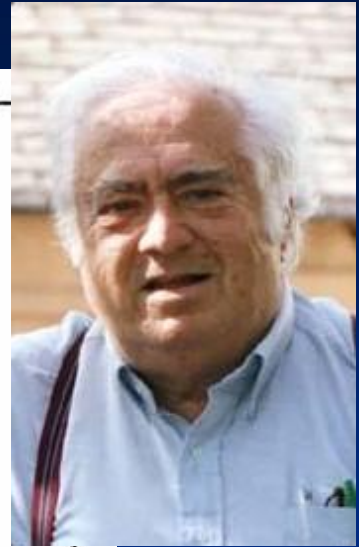


## WORLD HITS



In the last two years,  
no fields of  $\geq 500\text{Mb}$   
have been found.

In 2003, the ten largest  
oil groups spent US\$8  
billion exploring but  
found only \$4 billion  
worth of oil.



We need 6000 Billion Barrels to  
meet the IEA projection!!



# Global production peak – When??

- The independent petroleum geologists suggest peaking may be NOW or out to 2011
- The IEA, USEIA suggest 2030
- Energy investment banker Matt Simmons says without data reform we cannot be certain – but he asserts that the “crisis” is here now...



# When is “Peak Oil” expected



# Why the uncertainty in date?

- The remaining reserves estimates for OPEC producers are unreliable “paper barrels”
- Petroleum geology is an imprecise science
- Geological complexities can hamper recovery
- Depends on what reserve values used
- Depends on assumptions made



# Proven Reserves

- **The 3 Ps:**
- The ways reserves are estimated are also calculated differently in different countries. Roughly speaking there are the 3 Ps which include:
  - • Proved reserves (1P)
  - • Proved and Probable reserves (2P)
  - • Proved, Probable and Possible reserves (3P)
- Proved reserves are the official reserves and are generally considered to be reliable to within 95%. Probable reserves are assigned a probability of actually getting them out of the ground at around 50% and possible reserves are the ones that just might be there if exploration proceeds, with something like a 5 % chance of ever getting them to market.

# Nearly 400 Billion Paper Barrels

400 Million barrels is about 13 years production (without growth in demand!) – i.e. peak would be much sooner than expected!!



# Saudi Secrecy from 1978 on (and other OPEC producers)

Nor have Saudi reserve estimates fallen due to production...

# What about increasing supply?

- Saudi Aramco stated that they would increase output from 9.5 to 12.5 Mbbbl/day by 2010
- They have sub-sequently announced 8% decline in output per year and a mitigation plan for extensive additional drilling to maintain output



# Why is Saudi Arabia the key?

- Saudi Arabia provides 10% of global crude oil supply.
- Their oil fields are upto 60 years old and many of the super giant fields have peaked in production.
- Saudi Reserves estimates are very “elastic” – no-one knows for certain how much oil is left. Remember they “found”



# OPEC Oil Supplies Are Fragile Too

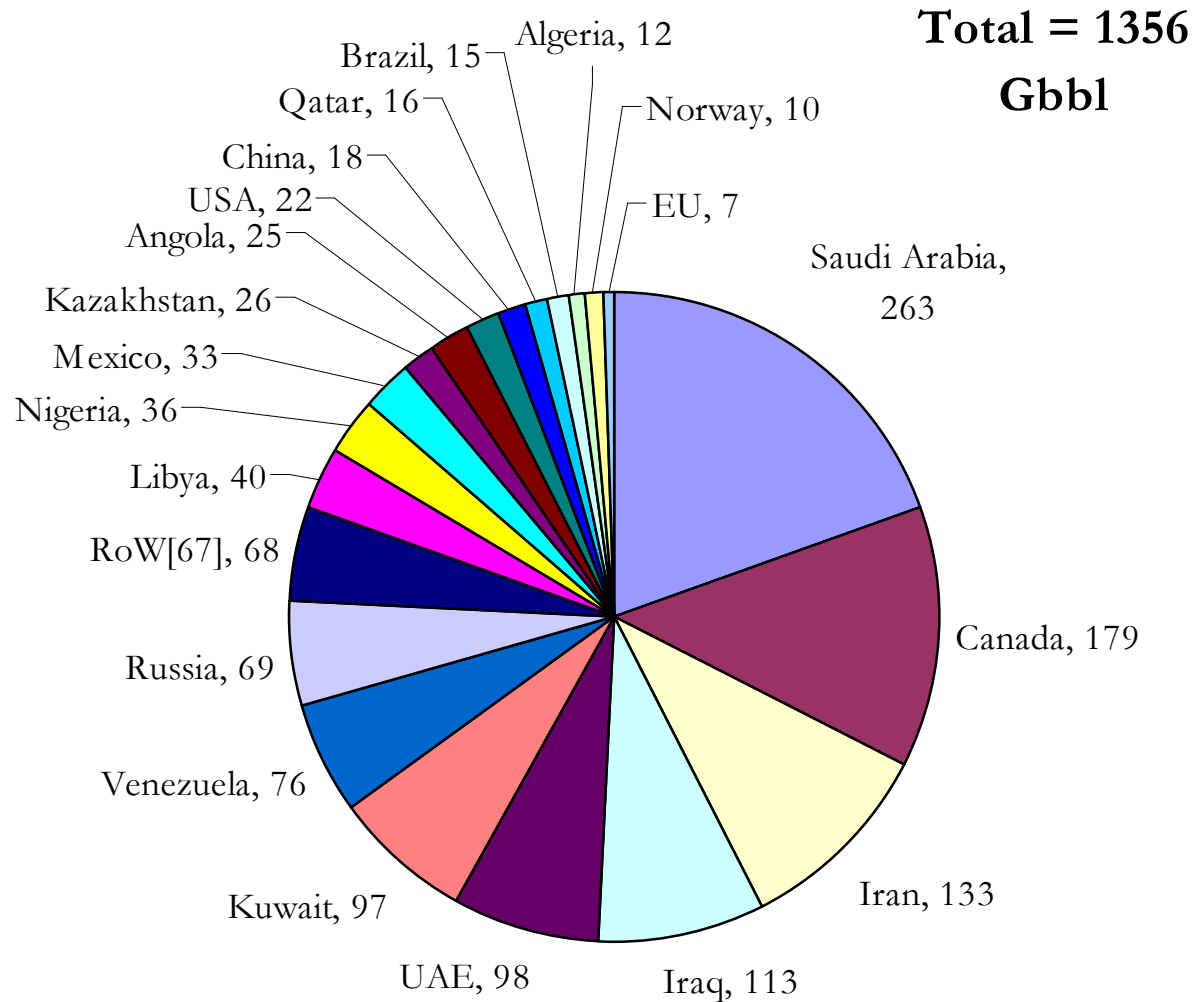
- No OPEC producer has inventory of new discoveries or shut-in supply “on the shelf.”
- Several key OPEC producers are past peak supply.

	MMB/D		
	<u>Peak Year</u>	<u>Peak Amount</u>	<u>Current</u>
Indonesia	1991	1.6	1.1
Iran	1974	6.0	3.5
Iraq	1979	3.4	2.0
Kuwait	1972	3.5	2.0
Libya	1970	3.3	1.4
Saudi Arabia	1981	10.0	8.0-9.0
Venezuela	1970	3.3	2.5

Source: EIA

**SIMMONS & COMPANY**  
**INTERNATIONAL**

# Major oil reserves



**Proven Reserves > 7 Billion bbl**

# Country Oil Production

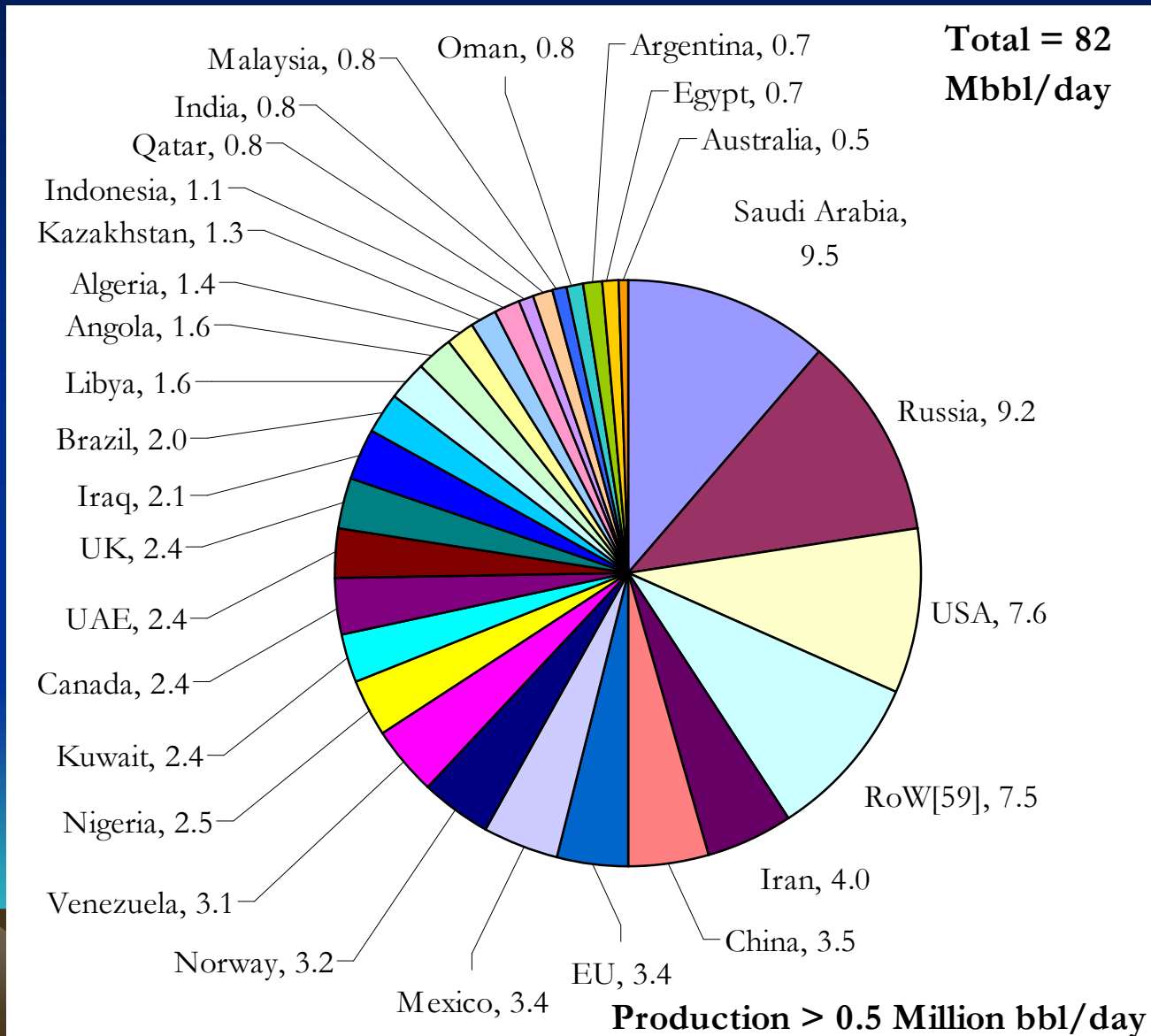
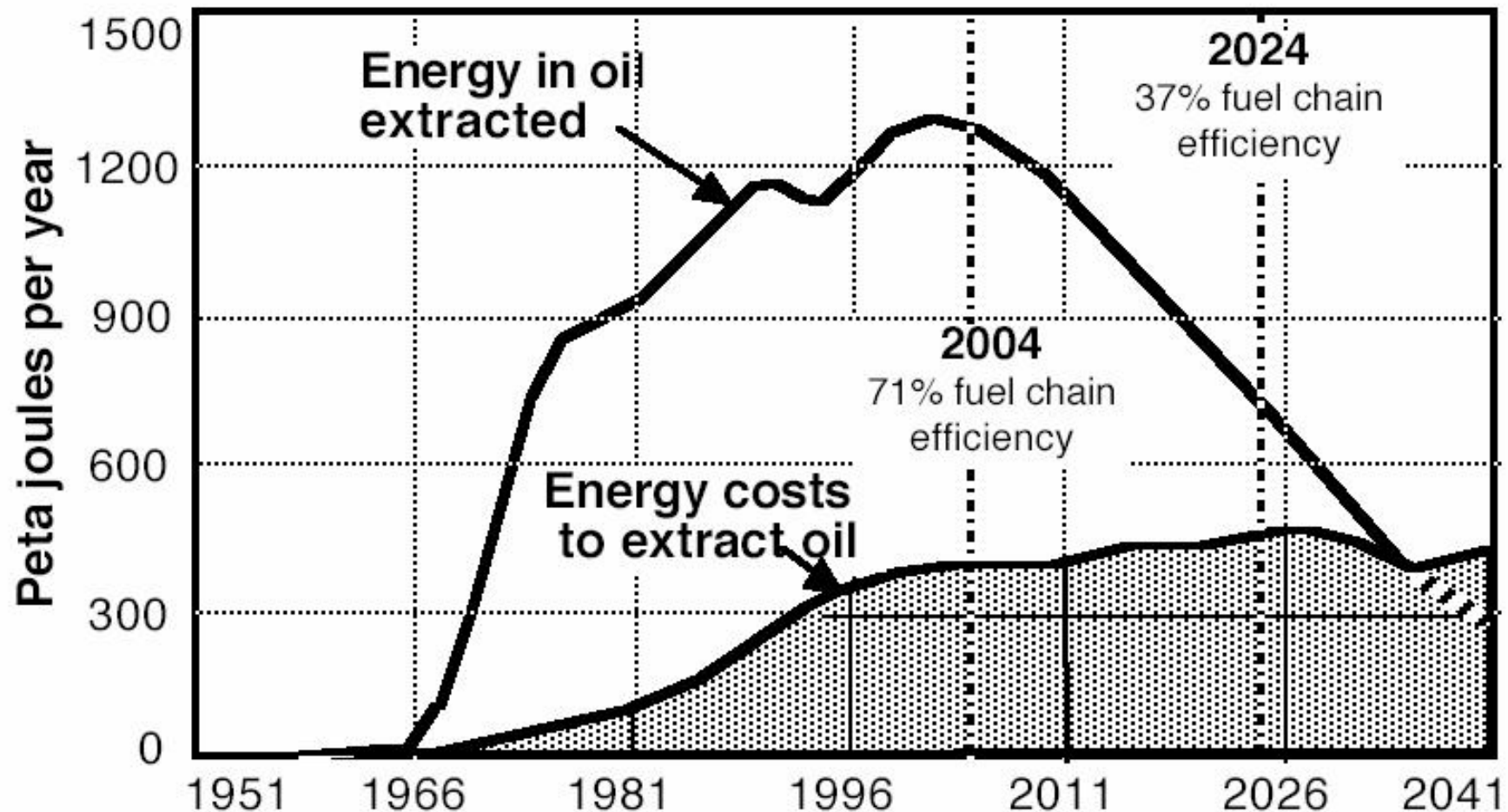


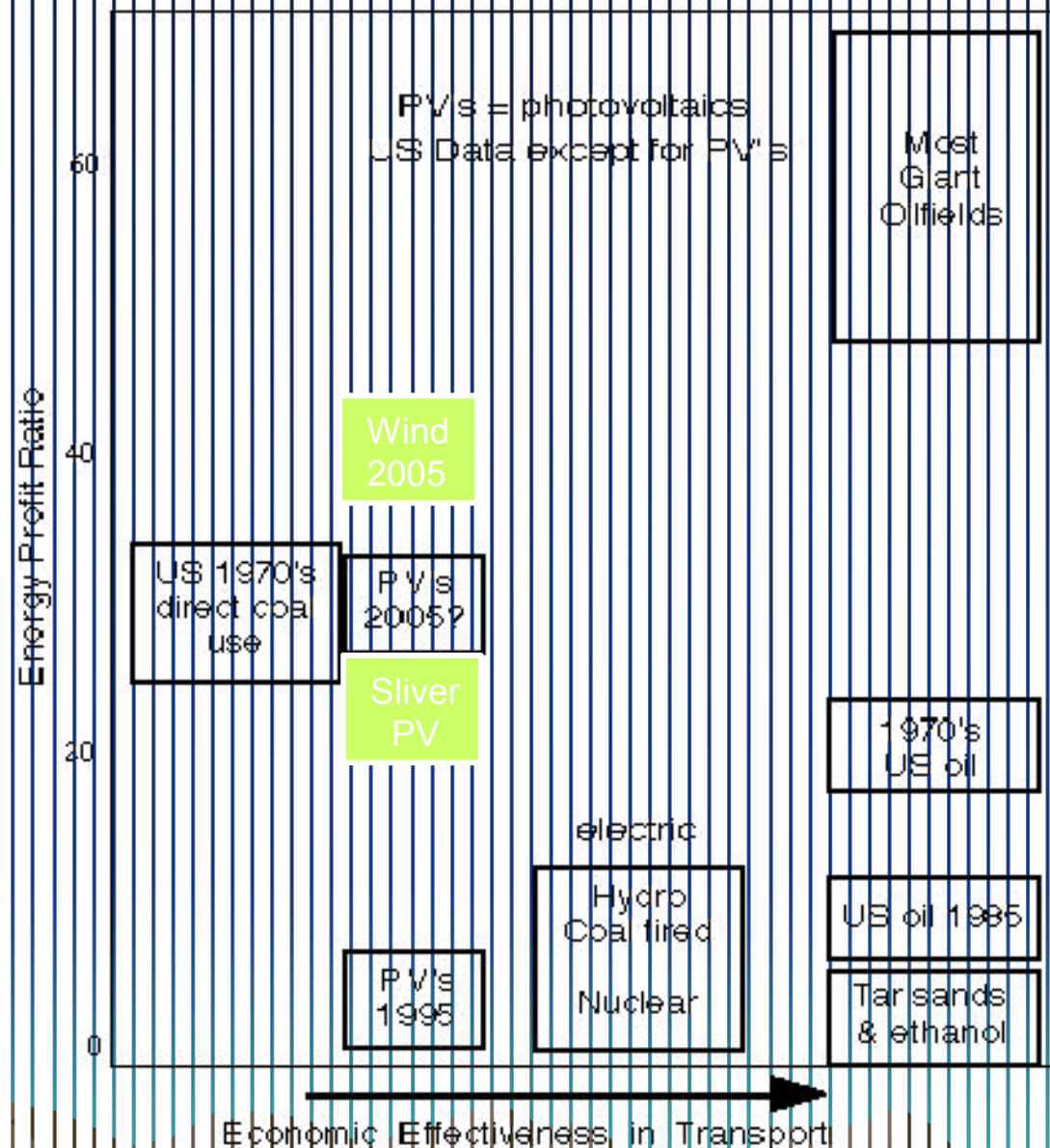
Figure 3 Energy costs and benefits of oil extraction 1951 to 2041



**Source:** Foran and Poldy (2002) Chapter 5 "The future of Energy" from "Future dilemmas: options to 2050 for Australia's population, technology, resources and the environment", by CSIRO Sustainable Ecosystems, Working paper series 02/01

# ENERGY PROFIT RATIOS FOR SEVERAL FUELS

“EPR”



Data from *Beyond Oil* 1991 p.70

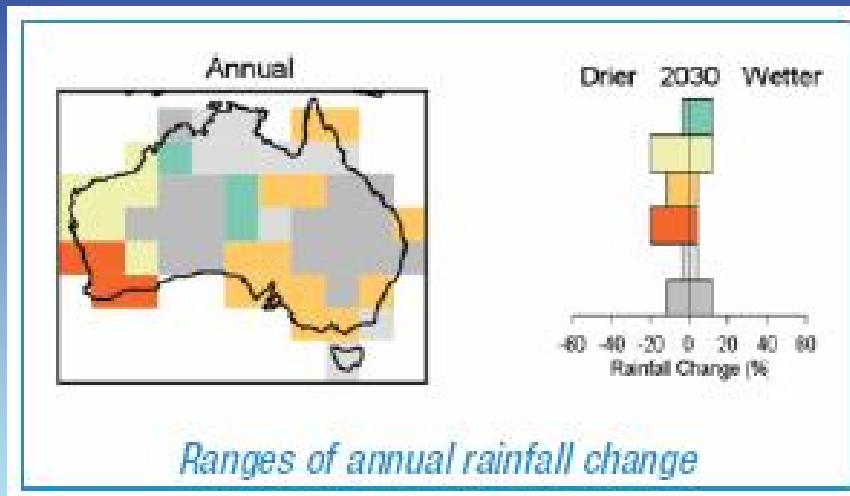
FIGURE 15

Fleay 1998



# Bigger Picture – Less Water

- Climate change  
By 2030, Australian Rainfall –



Each degree rise in temperature leads to a 10% decline in grain production

- Flinders research suggests that a 10% reduction in rainfall will reduce streamflows by 35%



Dr.  
Colin Campbell  
Petroleum  
geologist with BP,  
Texaco, Fina,  
Amoco and  
consultant to Shell  
and Esso.



Matt Simmons  
Chairman of  
Simmons and Co  
International  
Energy investment  
banker and advisor to  
President Bush on  
energy policy



Prof.  
Kjell Aleklett  
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Prof.  
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M.King Hubbert  
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Peak: The Impending  
World Oil shortage”



Prof. David  
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“Out of Gas”



Julian Darley  
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Natural Gas: The  
New Energy Crisis”



Richard  
Heinberg  
Author of “The  
Party’s Over: Oil,  
War and the Fate  
of Industrial  
Societies” and the  
“Powerdown”



Vice-President  
Dick Cheney  
Former chairman  
of Haliburton

# Bill Clinton:

During a July 7th interview with James Fallows of The Atlantic Monthly, Former President Bill Clinton cited peak oil as one of three major issues that “look different” to him now than when he was President. (The other two issues were AIDS and climate change.)

- Clinton said, as President, he had never received a security briefing which stated that by 2010 or so, “we’ll reach peak oil production globally.” Other related comments from that interview:
- The oil depletion issue “needs much more serious debate. It’s almost not discussed at all in the mainstream media and very few people know about it.”
- “There’s a good chance that these people who made a living all these years studying petroleum deposits know what they’re talking about, and we may not have as much oil as we think. So we need to get in gear.”



# Interesting Quotes 1:

- “The end-of-the-fossil-hydrocarbons scenario is ... a view of scarcity in the coming years and decades that must be taken seriously. Forward-looking politicians, company chiefs and economists should prepare for this in good time, to effect the necessary transition as smoothly as possible”  
- Deutsche Bank, Dec 2004
- "Peak oil is starting to become conventional wisdom."  
Edward Schreyer, Former Governor General of Canada, May 5, 2005
- "Peak oil is real and we are on the Peak now." Al Gore, Former US Vice President, June 5, 2005

# Interesting Quotes 2:

- *“So its very probable that the world is peaking in oil about now. .... The world in general, and the US in particular, has pretty much blown 25 years of time that we had, but no longer have, for preparation for the necessary transition.”* Roscoe Bartlett, Maryland Republican Representative, US Senate. May 4, 2005
- *“To me, a hope is that we are going to hit Peak Oil when oil resources begin to decline. ... And some geologists say we already hit it last year. The business community is now starting to take this very seriously. The impact of fossil fuel depletion is going to create enormous suffering, no doubt about it.”*  
David Suzuki, April 23, 2005

# Deputy Australian PM Quotes:

- "...I have to say it, the very real prospect that at some stage in the next few short years global production may very well peak and it may be hard to increase it further at a time when countries like China, of course, are looking for a lot more fuel and even in places like Australia our dependence on oil, on petrol and transportation continues to increase." ABC Insiders 16/5/2004
- "The reality is that it may not be as simple as that and you have to wonder whether over the next decade we won't start to get towards peak production and that could be a very interesting time and a very challenging time." ABC News Online 23/5/05