

Peak Oil in NZ – Are we ready for it ?



- **Bob Lloyd Otago University, Physics Dept**
- **September 2010**

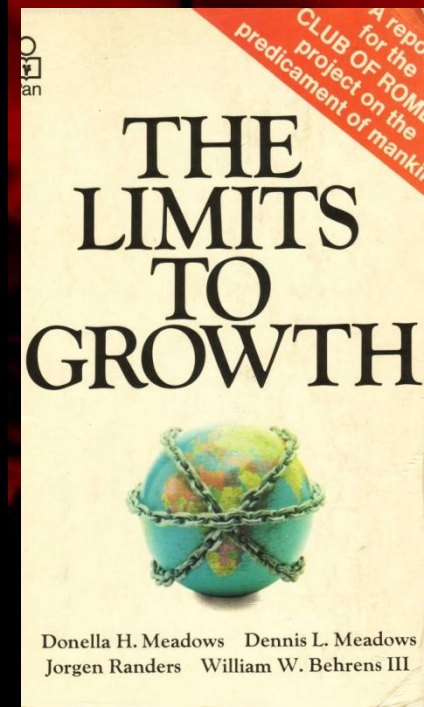
The contention

- **The contention of this presentation is that Peak Oil and Climate Change are but symptoms of the general urge of society to promote growth - at all cost**
- **In addition an increasing oil/energy supply is necessary for economic growth**
- **Finally it is likely that our economic system cannot function without economic growth**

Hubbert on growth



- King Hubbert realised in 1949 that we needed to move from fossil fuels to renewable resources if mankind was to keep its high energy use intact and the population and our consumption etc
- It was perfectly evident then
- More so in the 1970s when “The Limits to growth” came out



SCIENCE

FEBRUARY 4, 1949.

ENERGY FROM FOSSIL FUELS

M. KING HUBBERT

MICROCOMPOSITION OF BIOLOGICAL
TISSUE ANALYZED BY INDUCED
RADIOACTIVITY

CORNELIUS A. TOBIAS AND RAYBURN W. DUNN

TECHNICAL PAPERS

COMMENTS & COMMUNICATIONS

BOOK REVIEWS

ASSOCIATION AFFAIRS

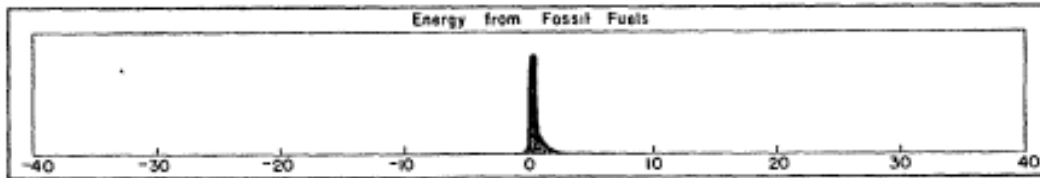
NEWS AND NOTES



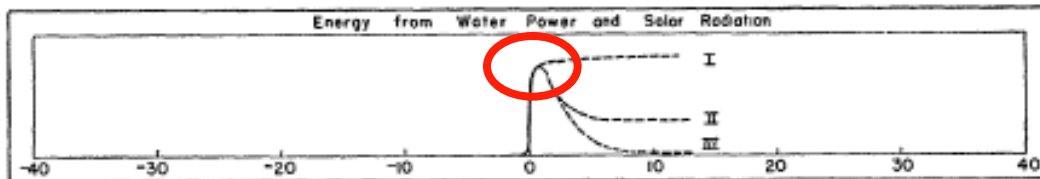
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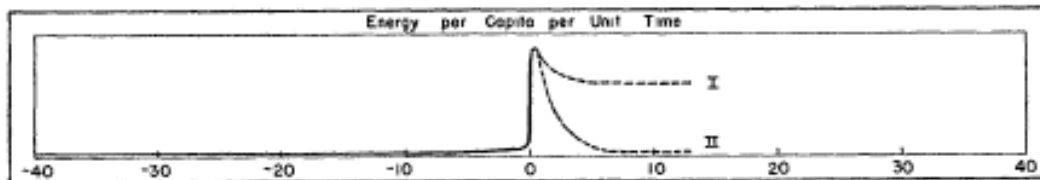
AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE



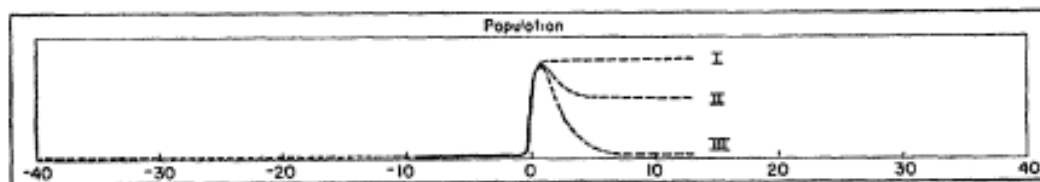
Fossil fuels



Renewable energy



Energy Conservation



Population

TIME (Thousands of Years)

FIG. 8. Human affairs in time perspective.

Hubbert on economics

- **"The world's present industrial civilization is handicapped by the coexistence of two universal, overlapping, and incompatible intellectual systems:**
 - **the accumulated knowledge of the last four centuries of the properties and interrelationships of matter and energy; and**
 - **the associated monetary culture which has evolved from folkways of prehistoric origin".**

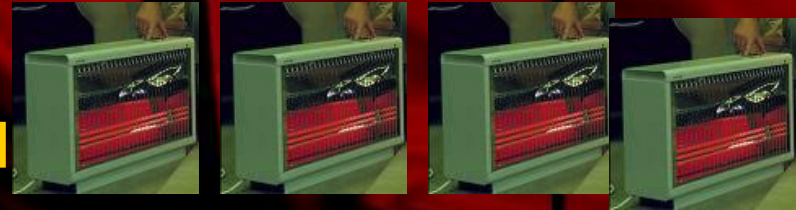
Energy and Civilisation

Every one agrees that energy is essential for civilisation

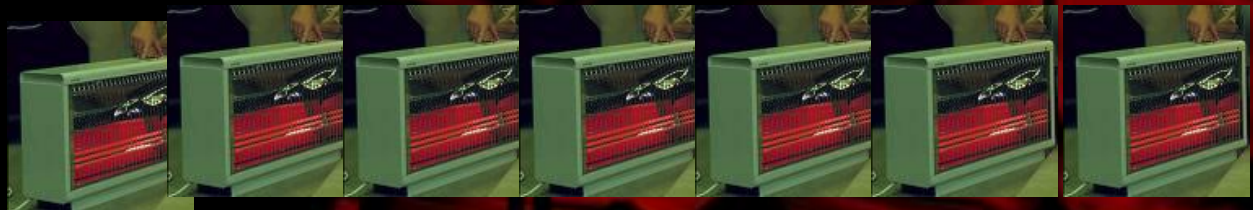
Pre industrial society used energy at around 500 Watts per capita



NZ now uses energy at around 8 kW per capita



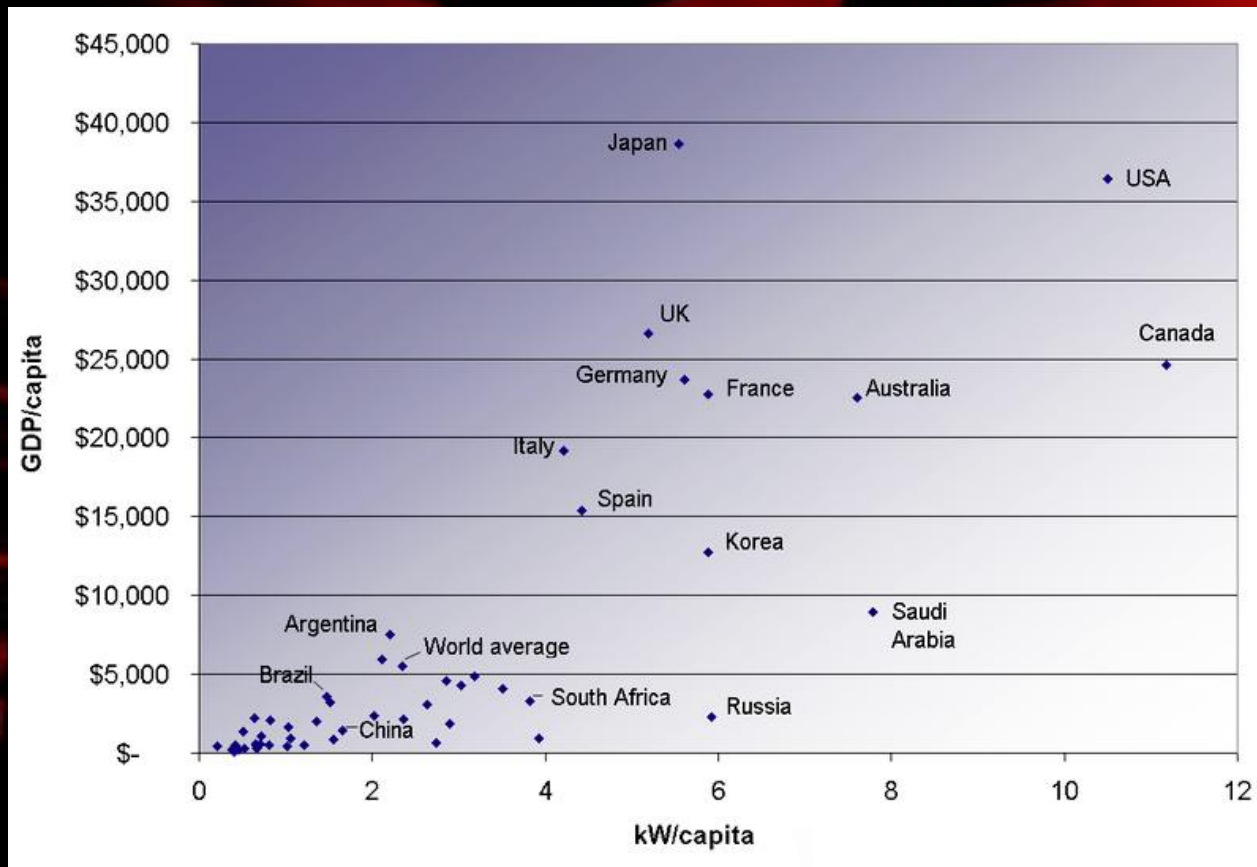
USA at around 14 kW per capita



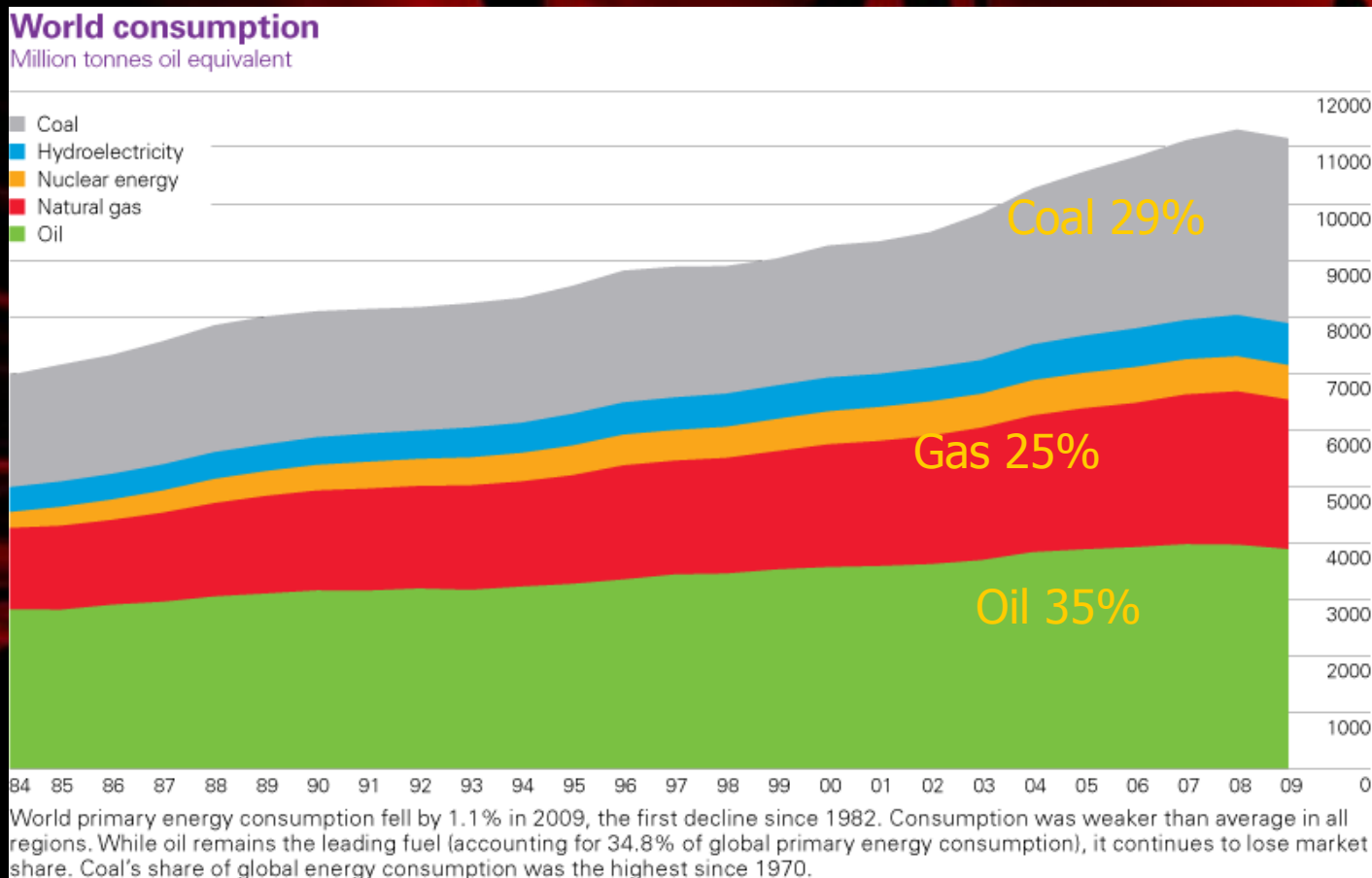
The world average is around 2.4 kW per capita



High energy use means high GDP



This energy is mostly (89%) supplied by fossil fuels



Peak Oil a short history

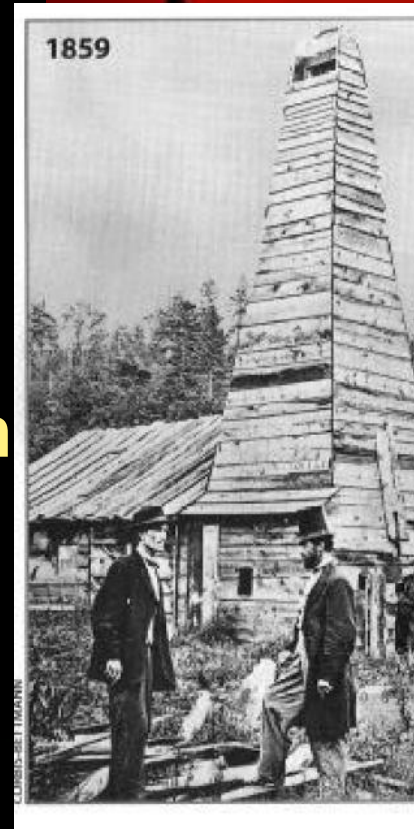
Oil discovered in US 1859

Hubbert 1956 predicted peak oil in the US (1970) and the world (2000)

World ignored Hubbert

Oil Crisis in 1970s everyone wanted to get into the act: Carter puts PV on white house roof.

Oil price collapses in the 1980s everyone forgets peak oil: Reagan takes panels off roof, promotes oil companies



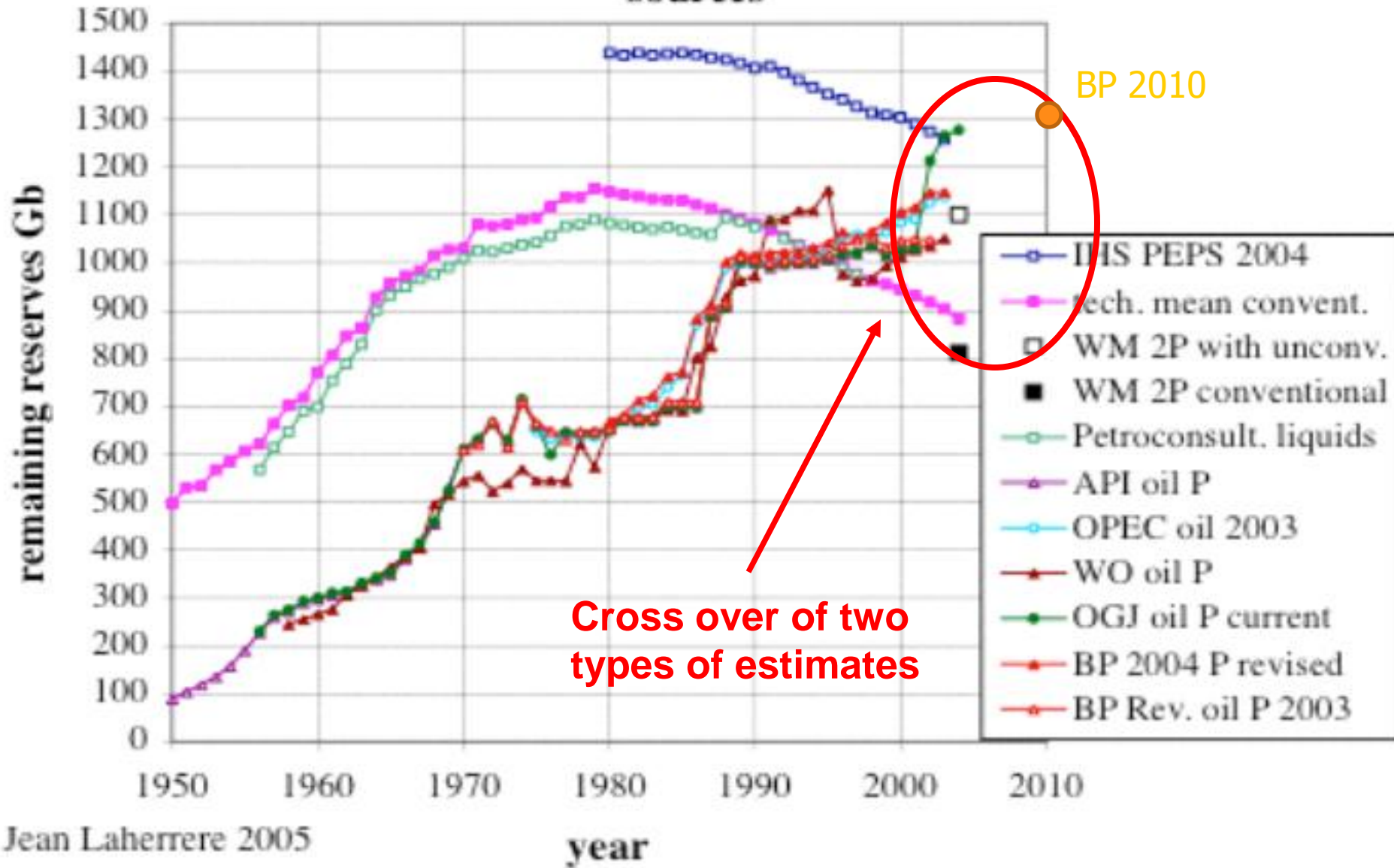
- **1998 Campbell and Laherrere Peak oil paper in Scientific American “The end of cheap oil”**
- **2000 The Association for the study of peak oil (ASPO) formed in Europe by Colin Campbell and Kjell Aleklett**
- **Establishment snubs peak oil as theorists, 2004 IEA report copies USGS to put peak oil > 2037 Governments follow suit including NZ**
- **2008 Governments and agencies start to acknowledge peak oil IEA Fatif Birol suggests “we must leave oil before oil leaves us”.**

The evidence

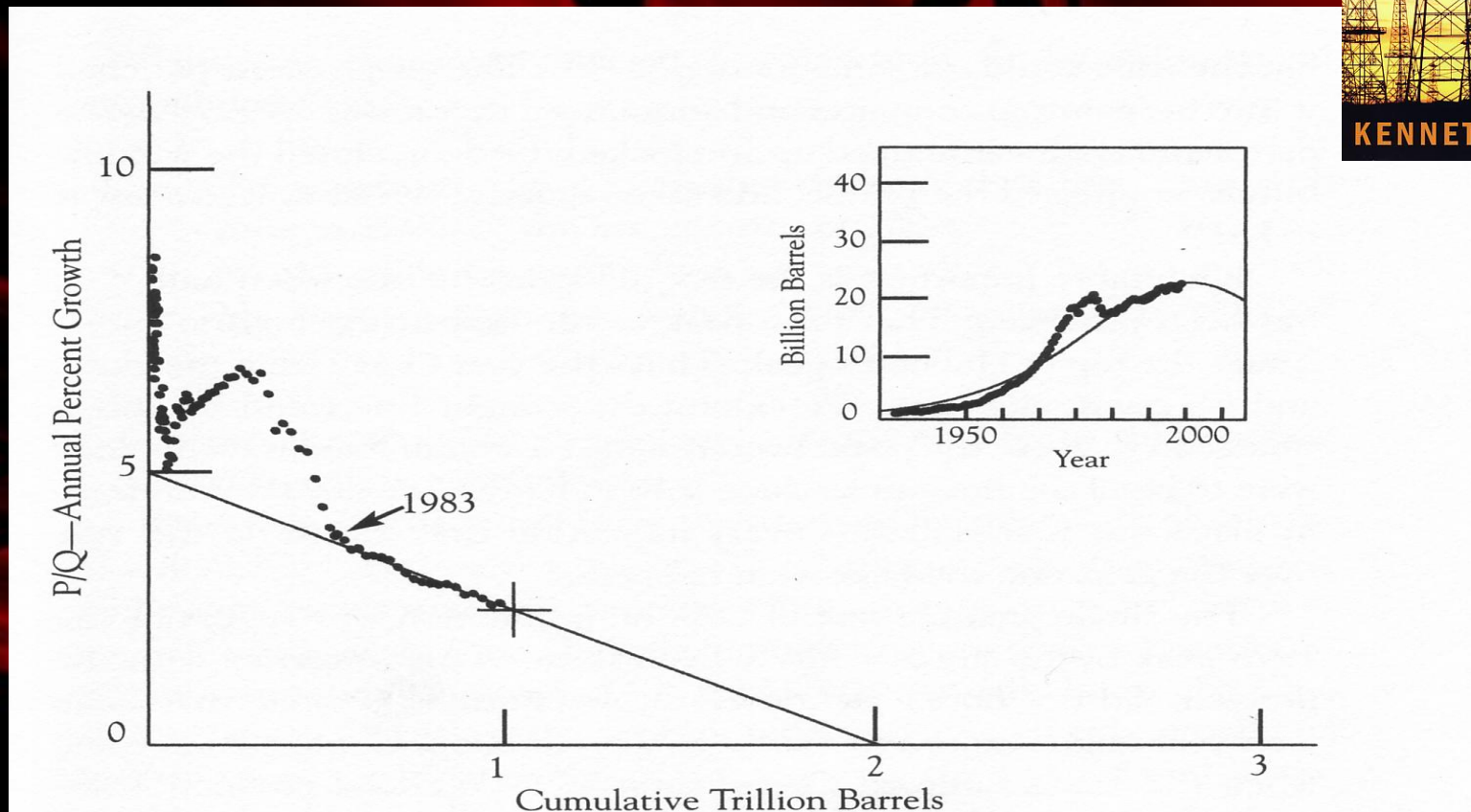
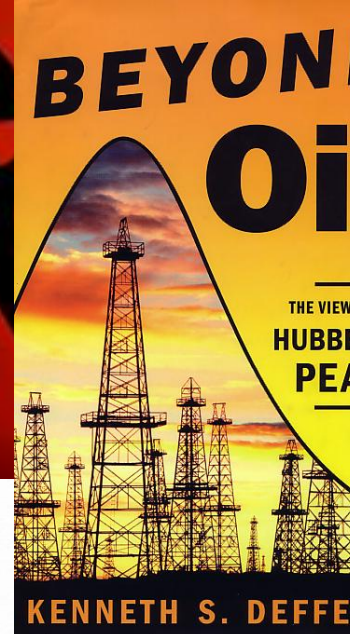


- **Geological surveys**
- **Hubbert's linearisation**
- **Creaming curves**
- **Delays between discovery and production**
- **Industry information**
- **Econometric models**

World remaining oil reserves from political and technical sources



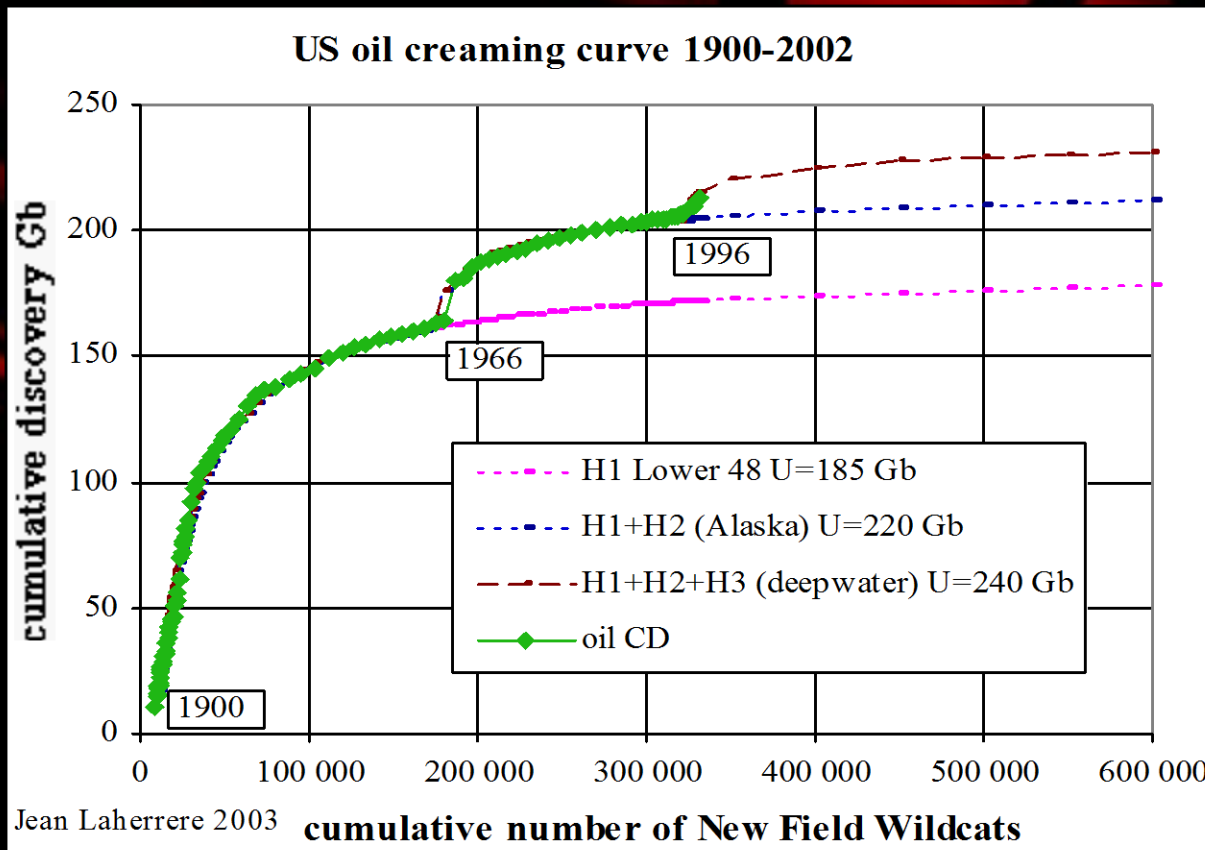
Hubbert Linearization this gives a EUR of: 2 trillion barrels



From "Beyond Oil" by Kenneth Deffeyes

Creaming curve

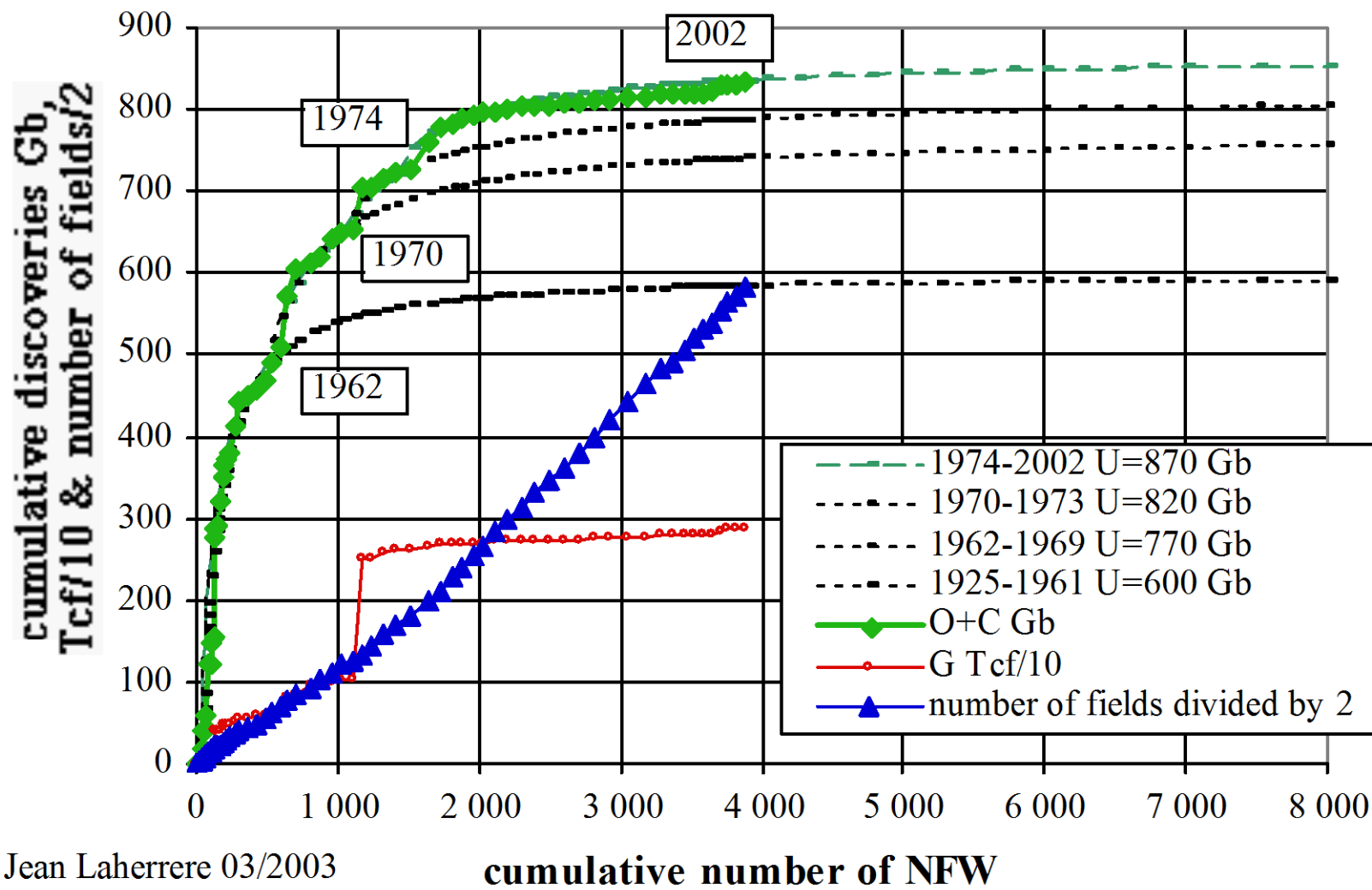
Another way of trying to estimate the EUR from proved reserves is to use the creaming curve: This is a plot of the cumulative discovery against the cumulative # of new field wildcats



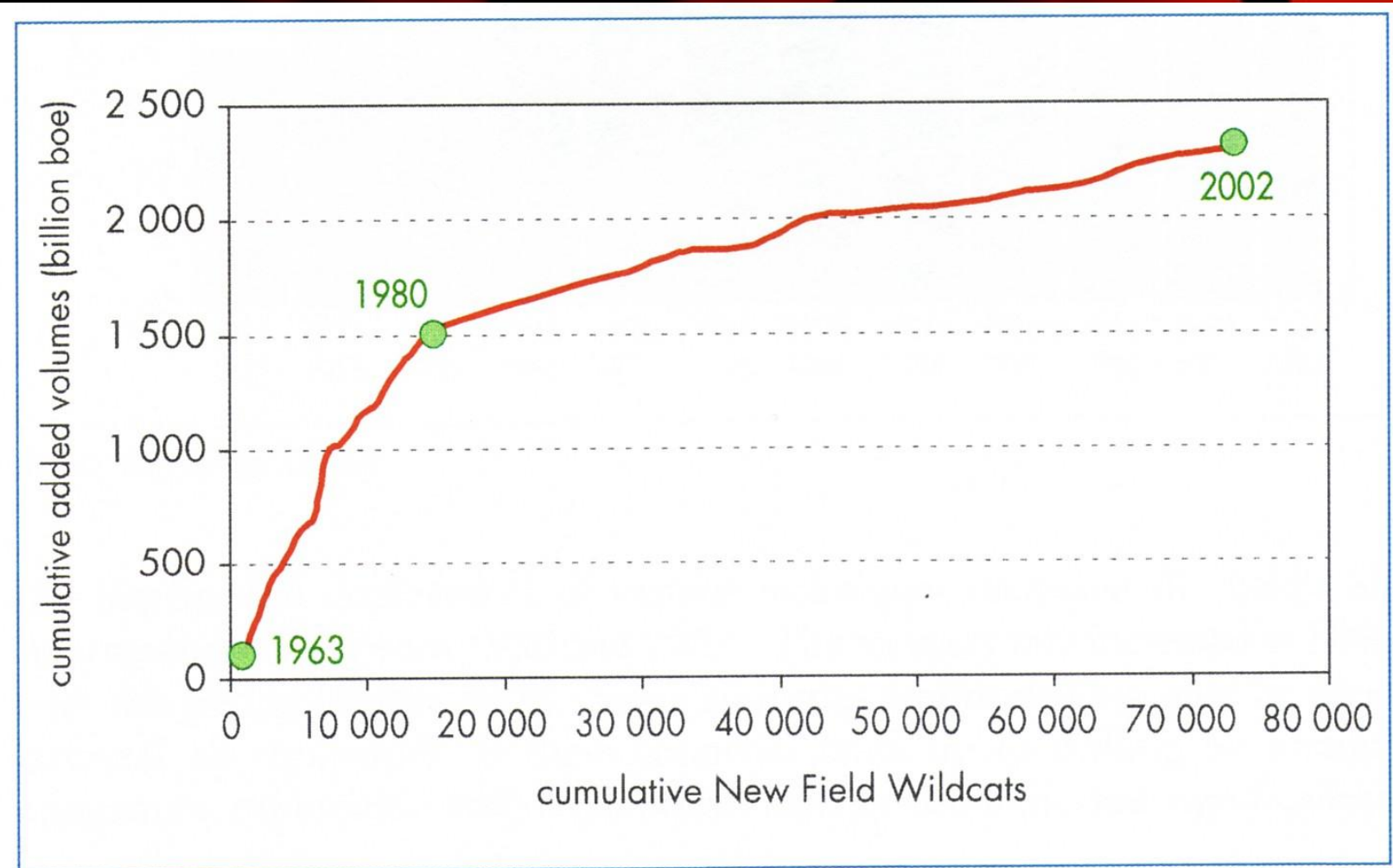
From Laherrere 2003

Middle East

Middle East oil & gas creaming curve 1905-2002

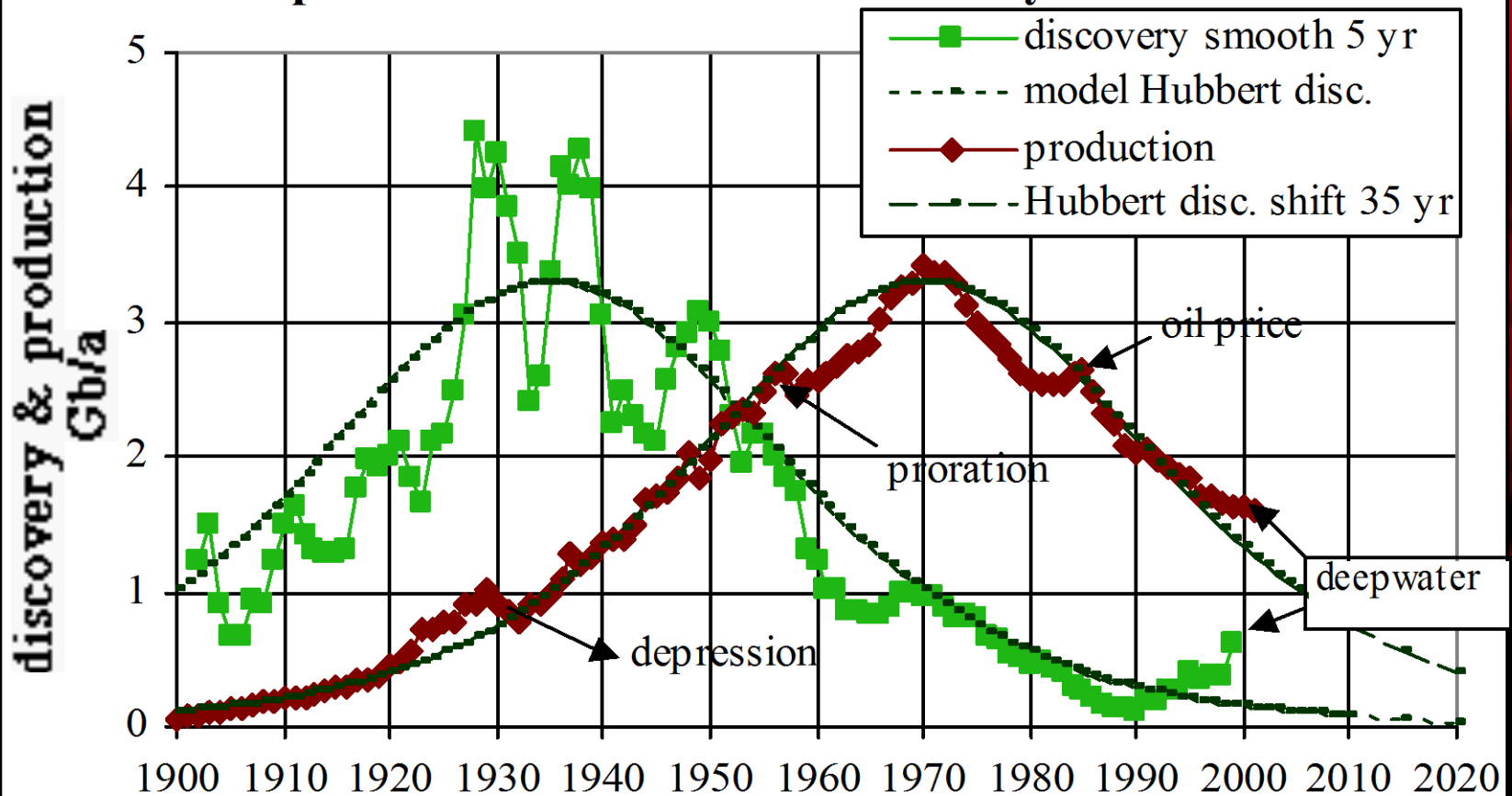


World “creaming curve” for oil and gas taken from WEO 2004 (IEA)

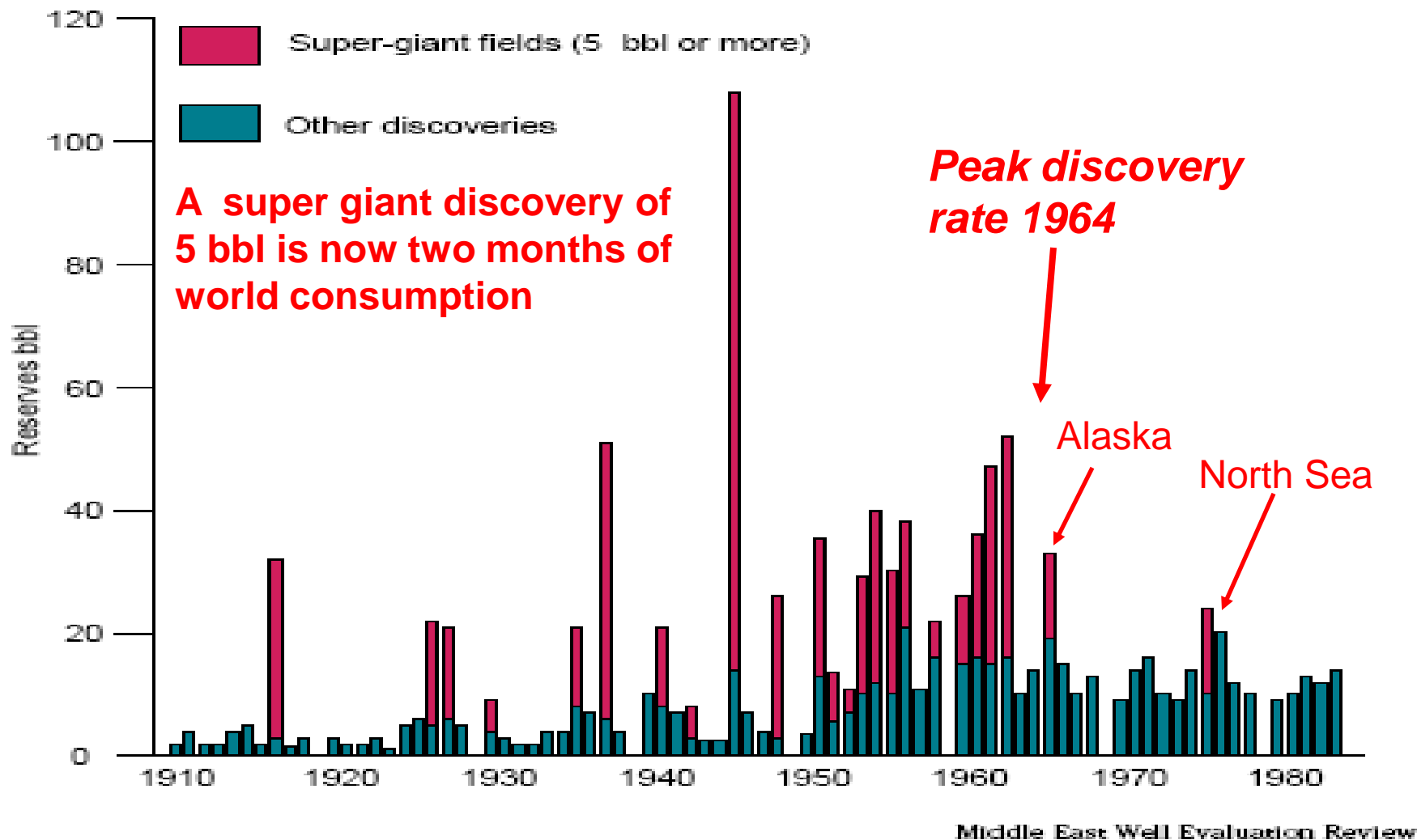


DELAY: US as modeled by Laherrere

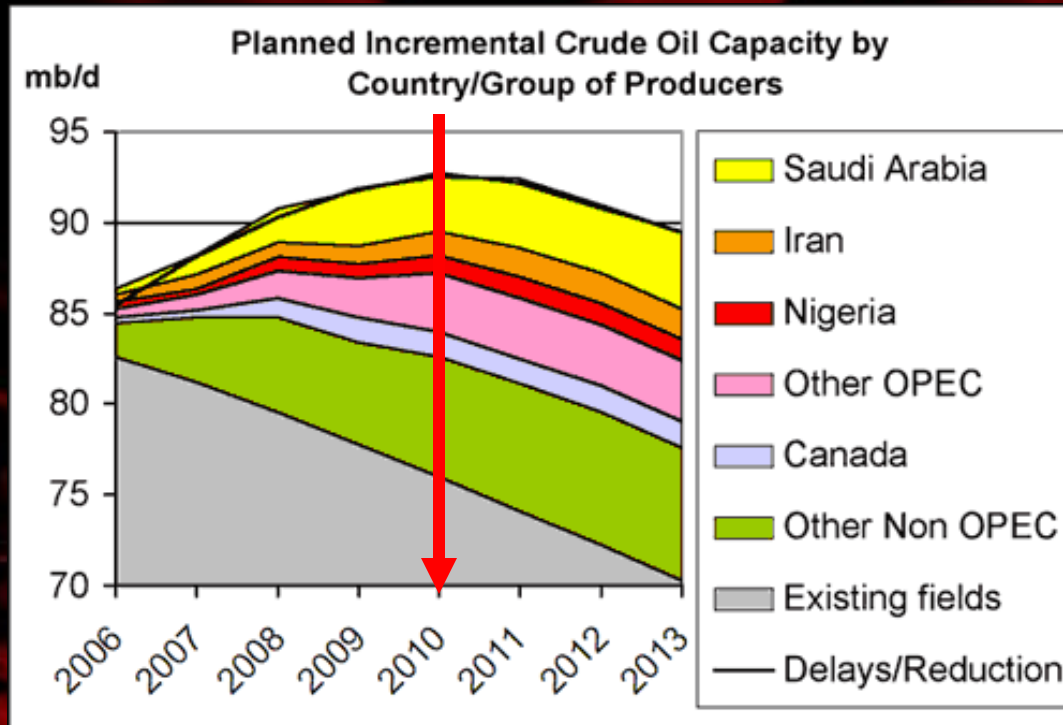
US Lower 48: annual oil "mean" discovery & production with Hubbert discovery model



World Oil reserves - discovery rate

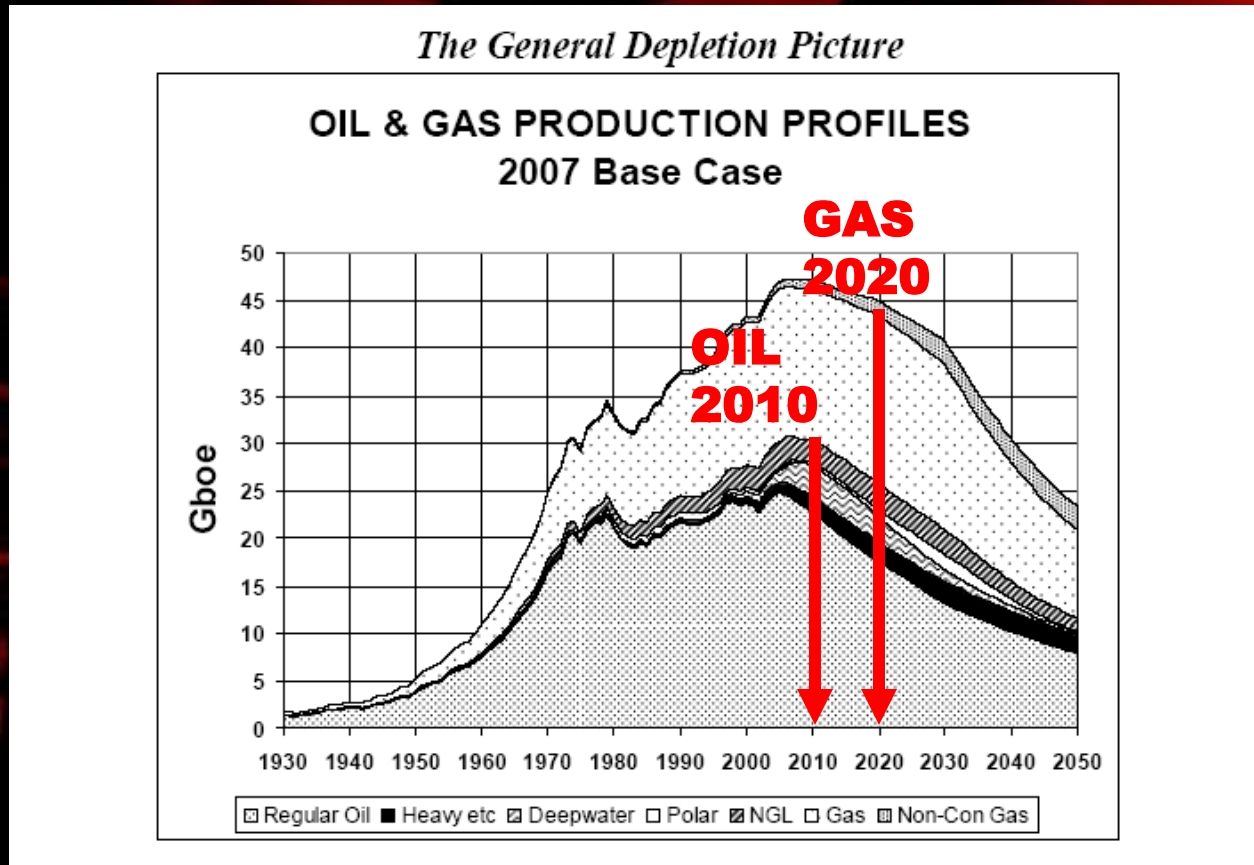


Petroleum Review April 2008 includes mega projects in the pipeline



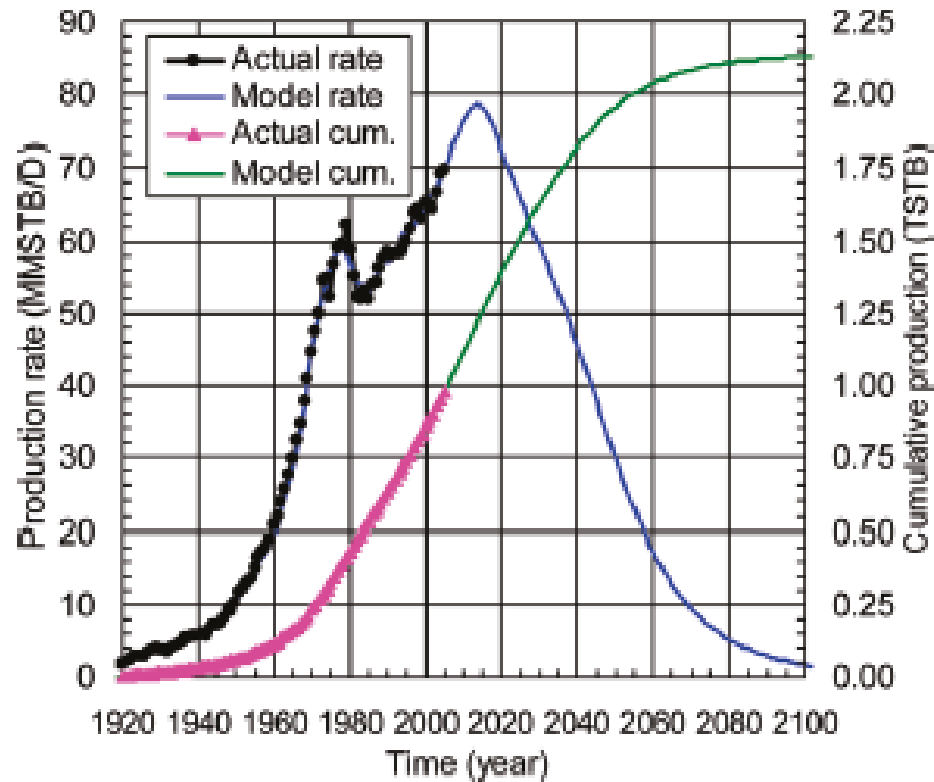
At the 2008 ASPO Chris Skrebowsky's updated model shows a peak in mid 2010 - much as in the chart- It is important to note that this is flow data and not based on EURs

OIL - Colin Campbell's latest scenario puts peak oil (all liquids) at 2010: GAS a decade later in 2020



Colin's EUR for conventional oil = 1.9T bbls All liquids 2.5T bbls

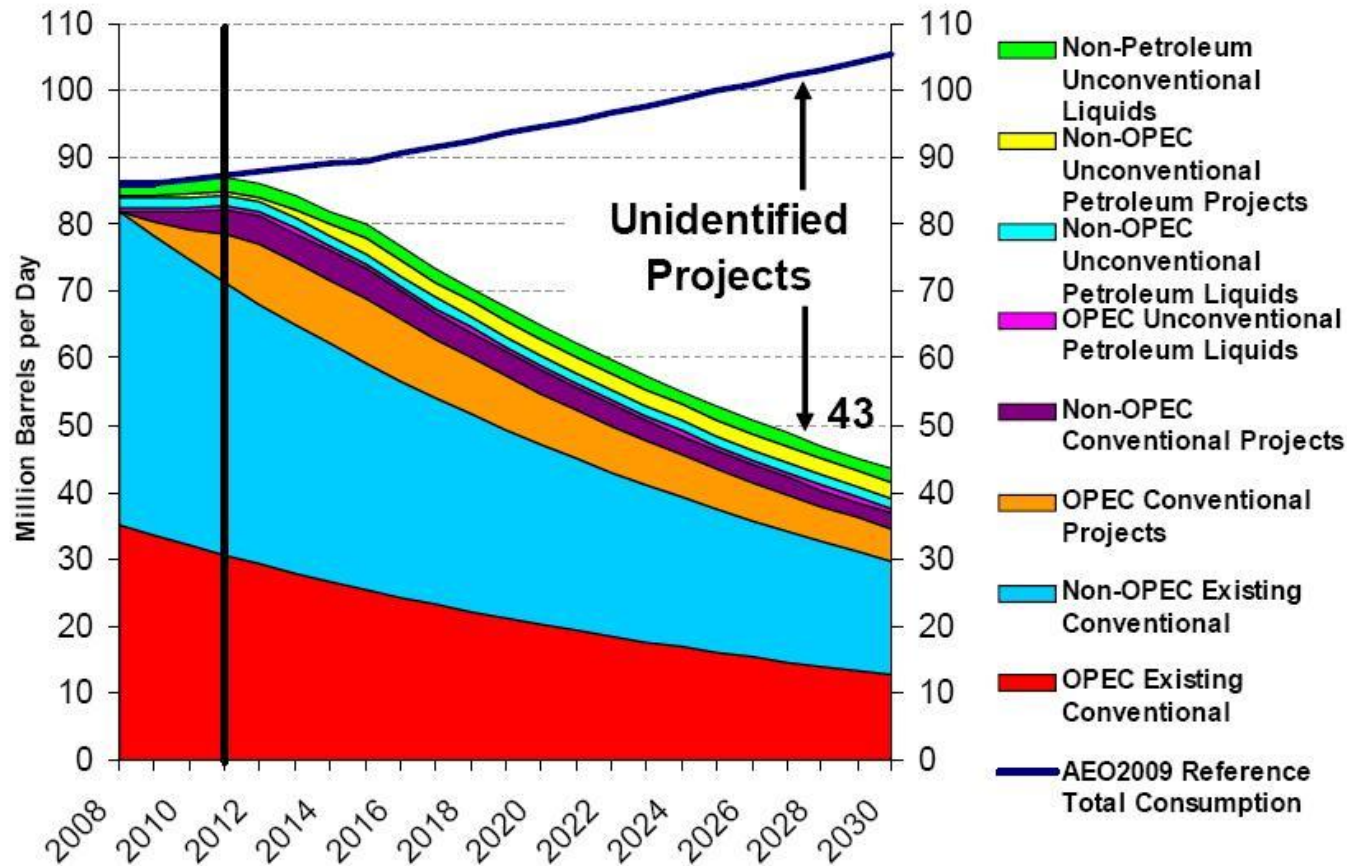
Dec 2009 Kuwait study - 2014



Latest from EIA -March 2010

Oil supplies could decline from 2012

World's Liquid Fuels Supply

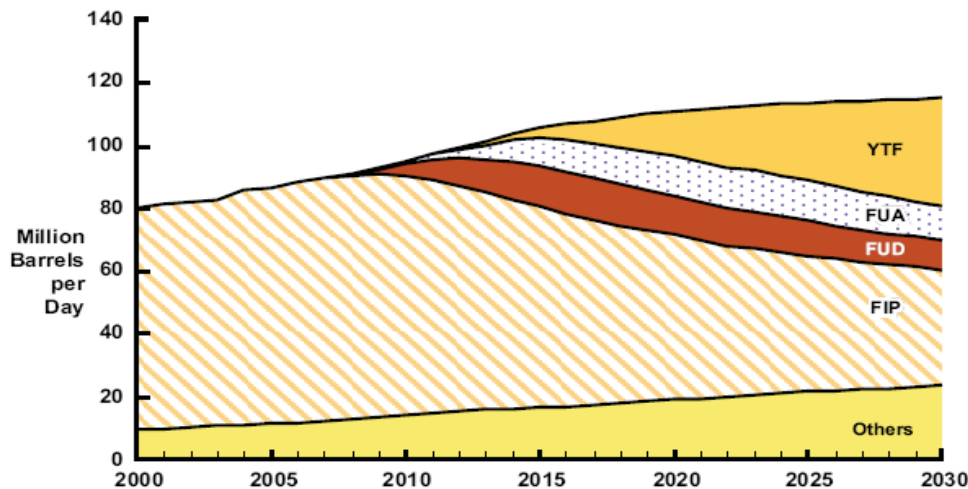


Source: EIA, AEO2009

Cambridge Energy Research Associates CERA

Figure 1

Global Liquids Productive Capacity Outlook



Source: IHS Cambridge Energy Research Associates.
90509-3

- fields in production (FIP)
- fields under development (FUD)
- fields under appraisal (FUA)
- yet-to-find (YTF) resources

Recent major oil reports

- **In February 2010 the UK Government produced a report on peak oil “*The Oil Crunch: A wake-up call for the UK economy*”**
- **Also in February 2010 the US Department of Defence produced a report on the “Joint Operating Environment” investigating strategic issues facing the US defence forces.**

- 
- **In March 2010 the French newspaper Le Monde reported an interview with Glen Sweetnam, director of the International, Economic and Greenhouse Gas division of EIA**
 - **Then in June 2010 Lloyd's Insurance UK and Chatham House released a white paper on energy issues "Sustainable Energy Security: Strategic risks and opportunities for business".**

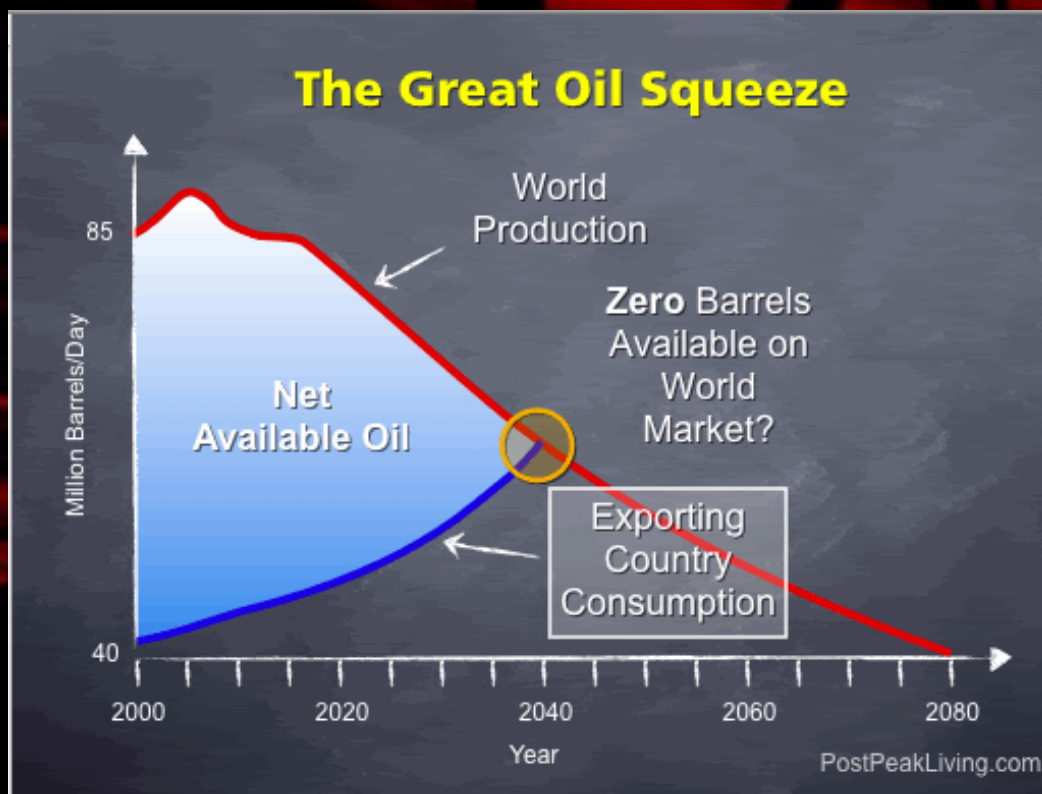
**The evidence is pretty conclusive
Peak Oil will likely occur this decade**

**The next question to answer is what
decline rates are we likely to see?**

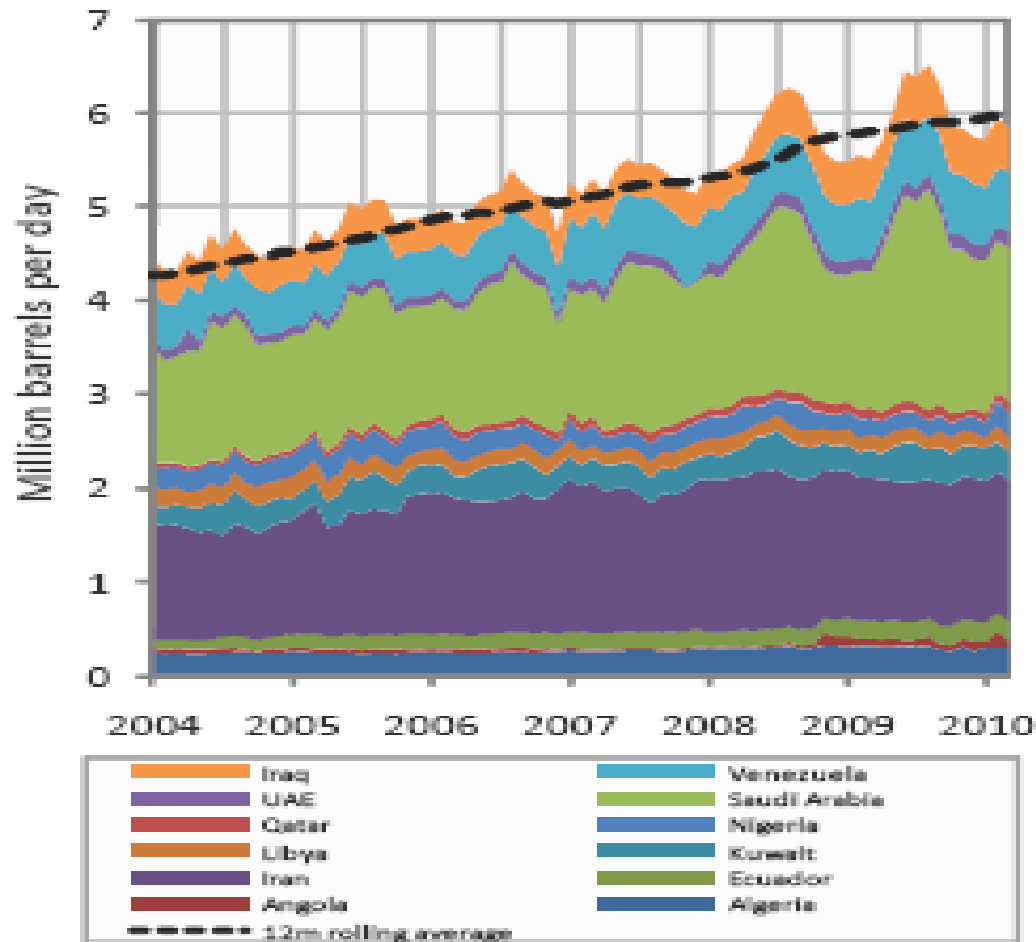
**The answer will depend on whether
you are an oil exporter or importer**

**For an oil importer the situation will be
much worse because:**

Many exporters have very high national growth rates and so internal consumption is rapidly increasing



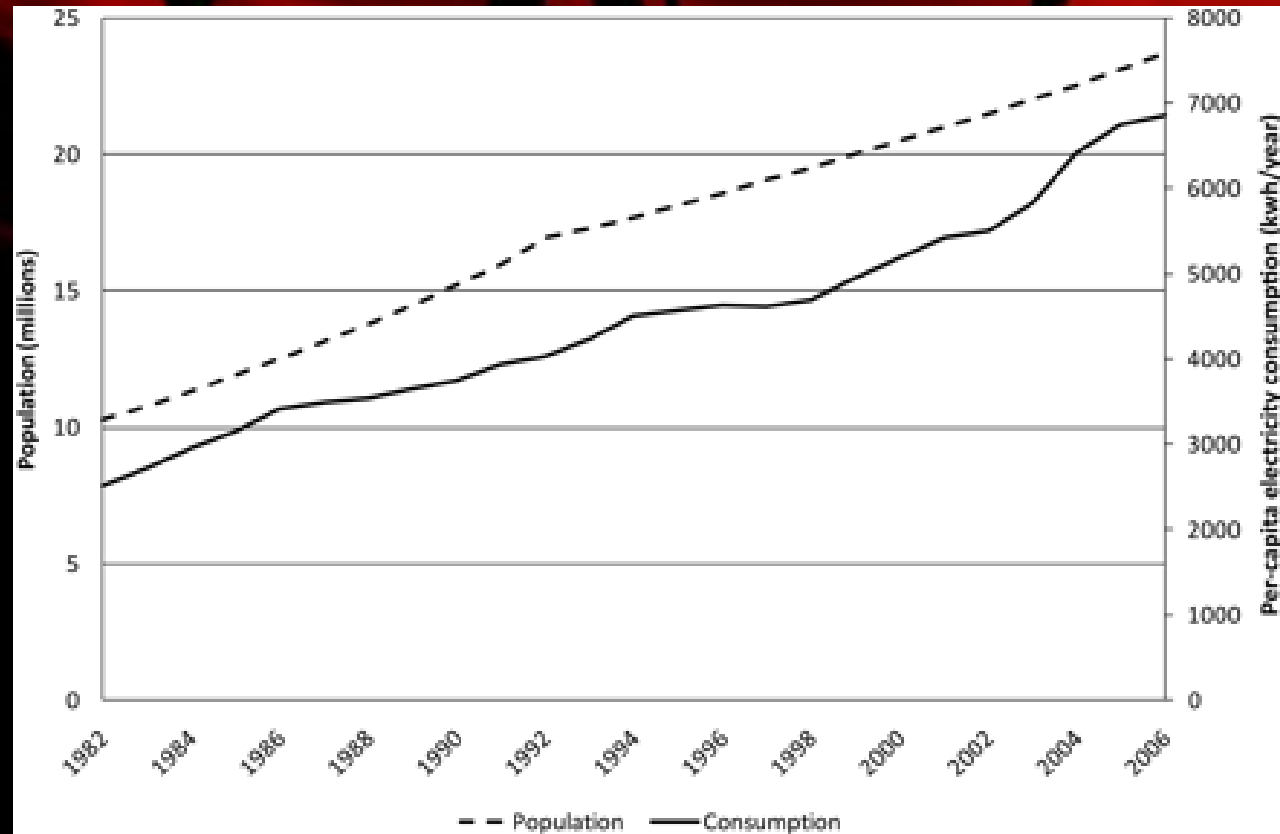
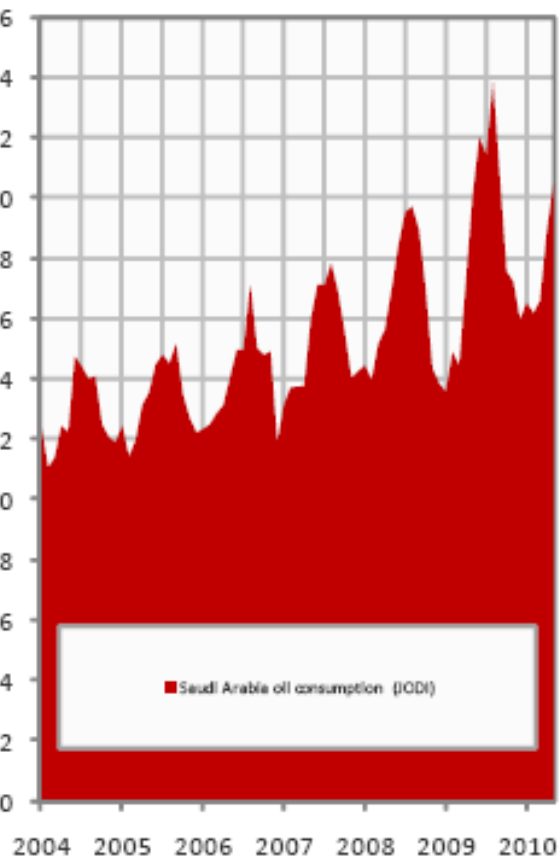
OPEC oil consumption



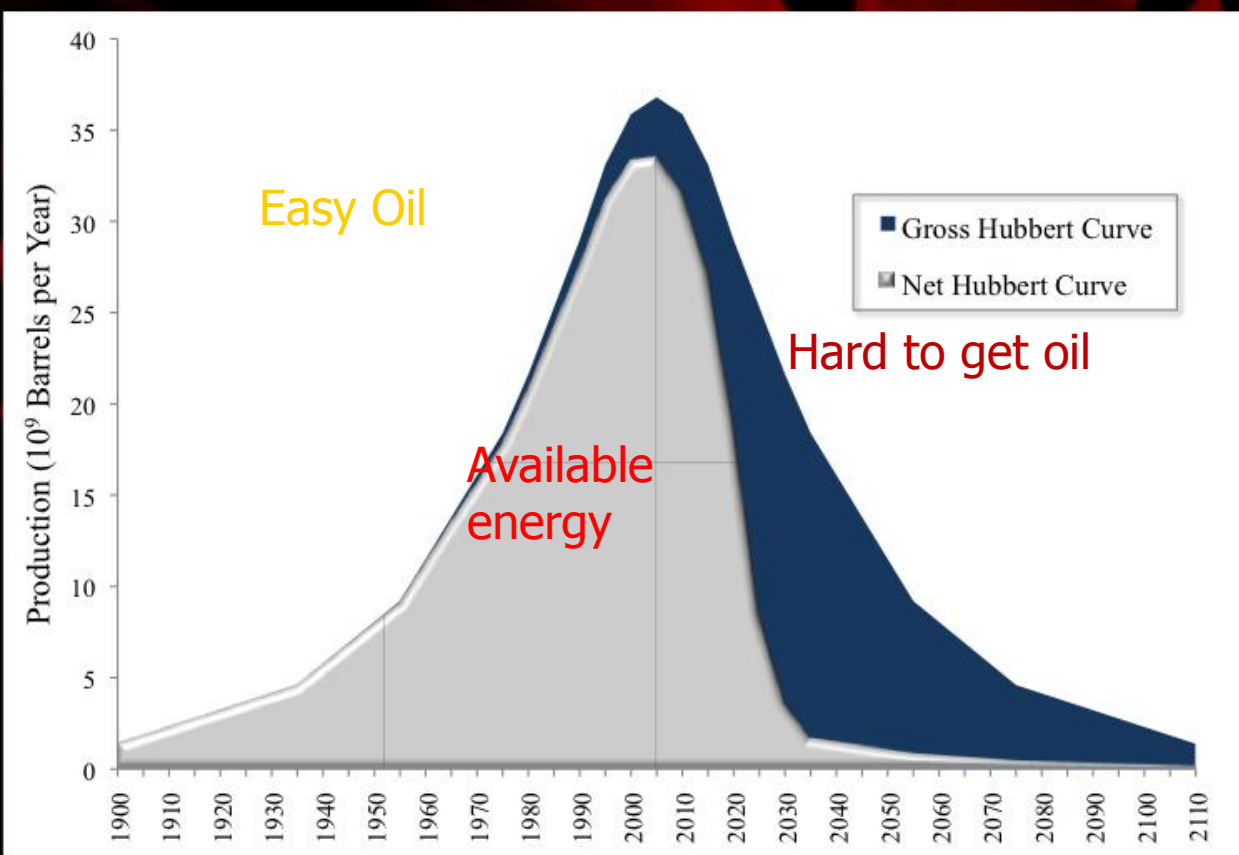
Source: Joint Oil Data Initiative

Saudi Arabia oil consumption increasing at 6.7% pa, Population increasing at 2.5% pa

9: Saudi Arabia Oil Consumption Jan. 2004 - May 2010



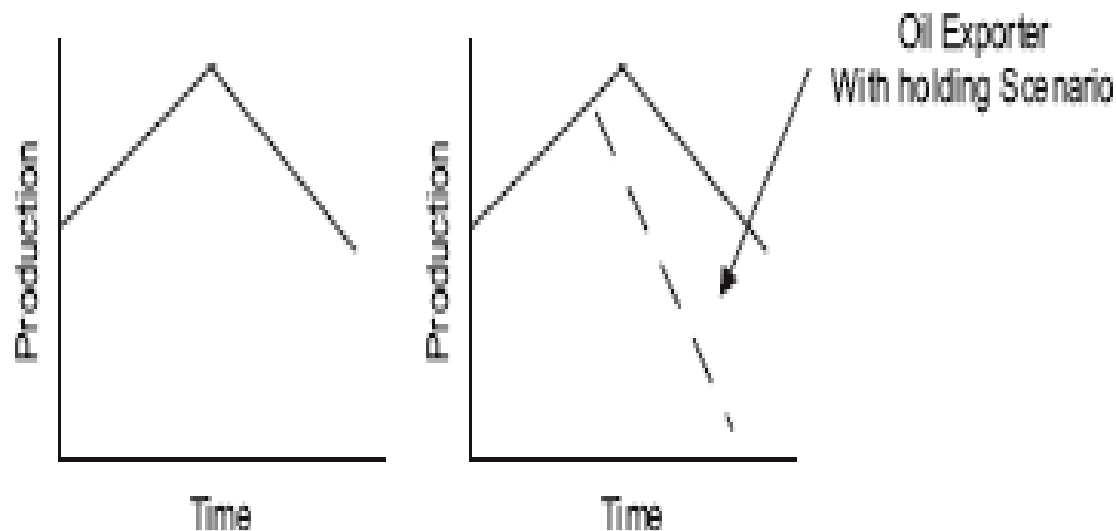
In addition EROEI for oil is declining rapidly 100:1 in 1930 11:1 today (USA) tomorrow ???



Hirsch paper 2008

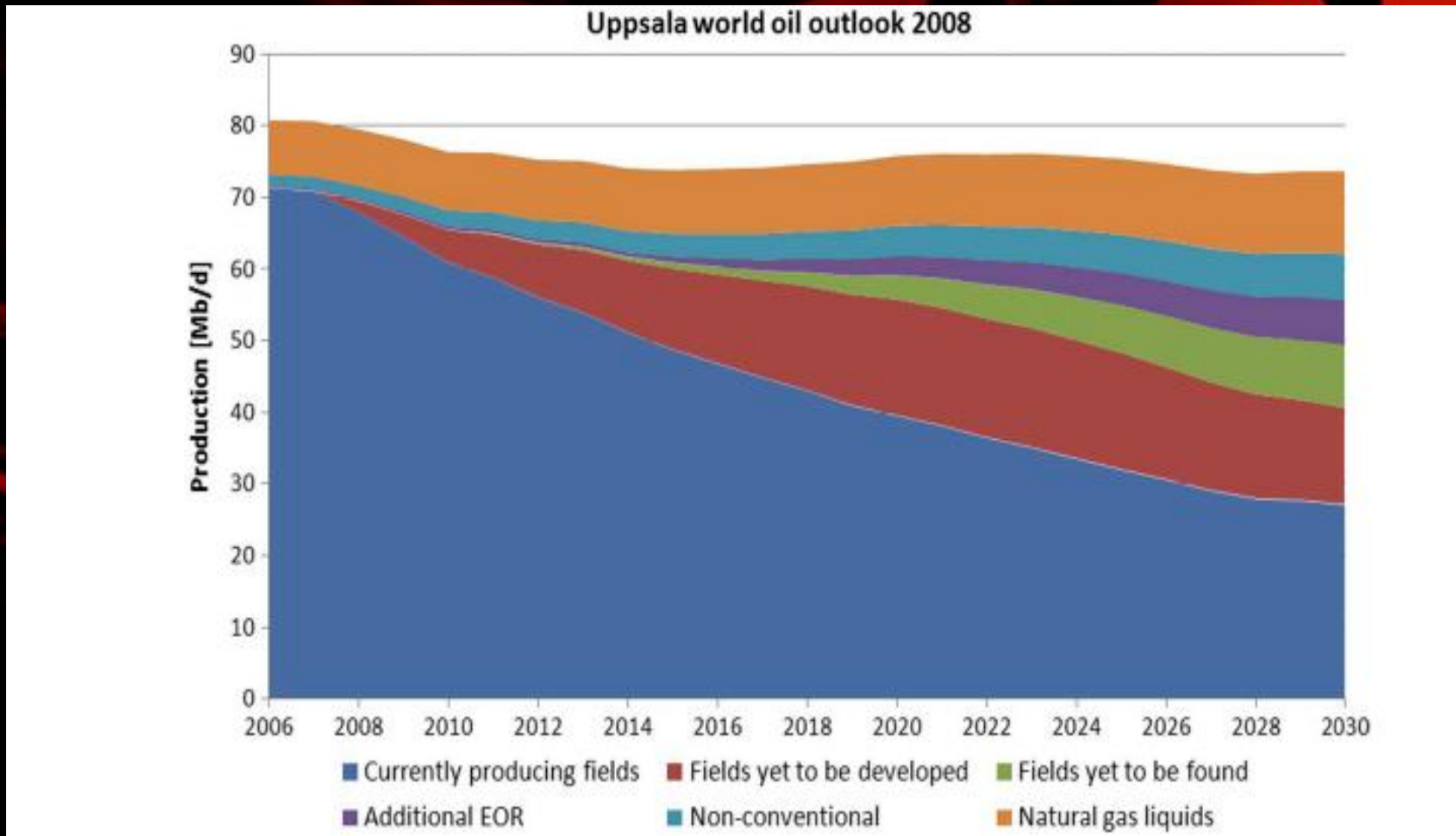
- Gives peak date somewhere between 2010 and 2018
- Suggested oil decline rates of between 2% and 5% pa

R.L. Hirsch / Energy Policy 36 (2008) 881–889



Alleklett et al 2008

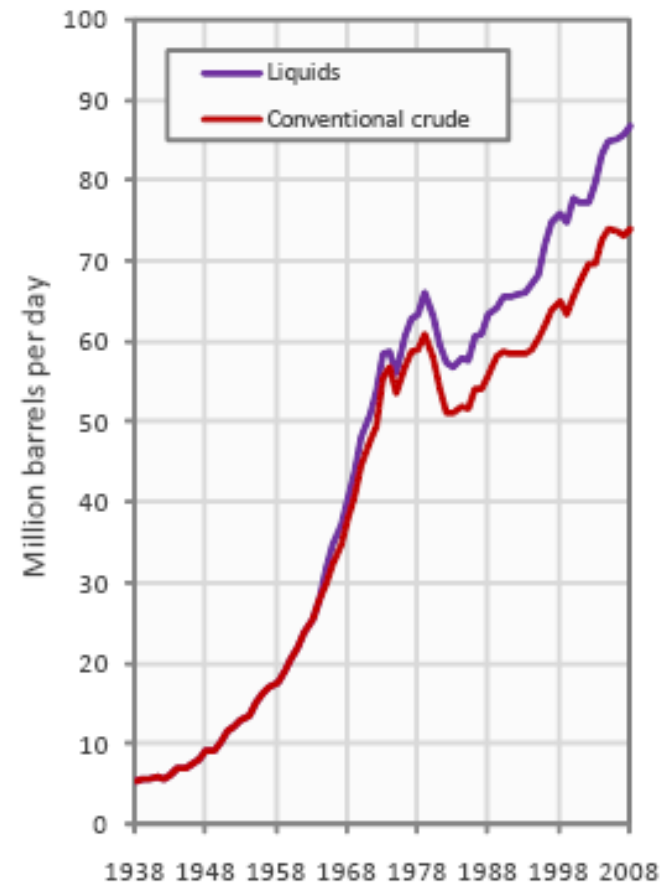
More gentle declines of around 0.6% pa until 2030



Must be careful what one is talking about

- **Conventional Crude**
- **All crude including heavy deep water etc**
- **All fossil fuel liquids ie including NGL**
- **All liquids ie including biofuels**

Chart 8: World Crude and Liquids production 1938 - 2008



Source: International Energy Agency & Energy Information Administration

Chart 9: Unconventional Oil Production 1938 - 2008

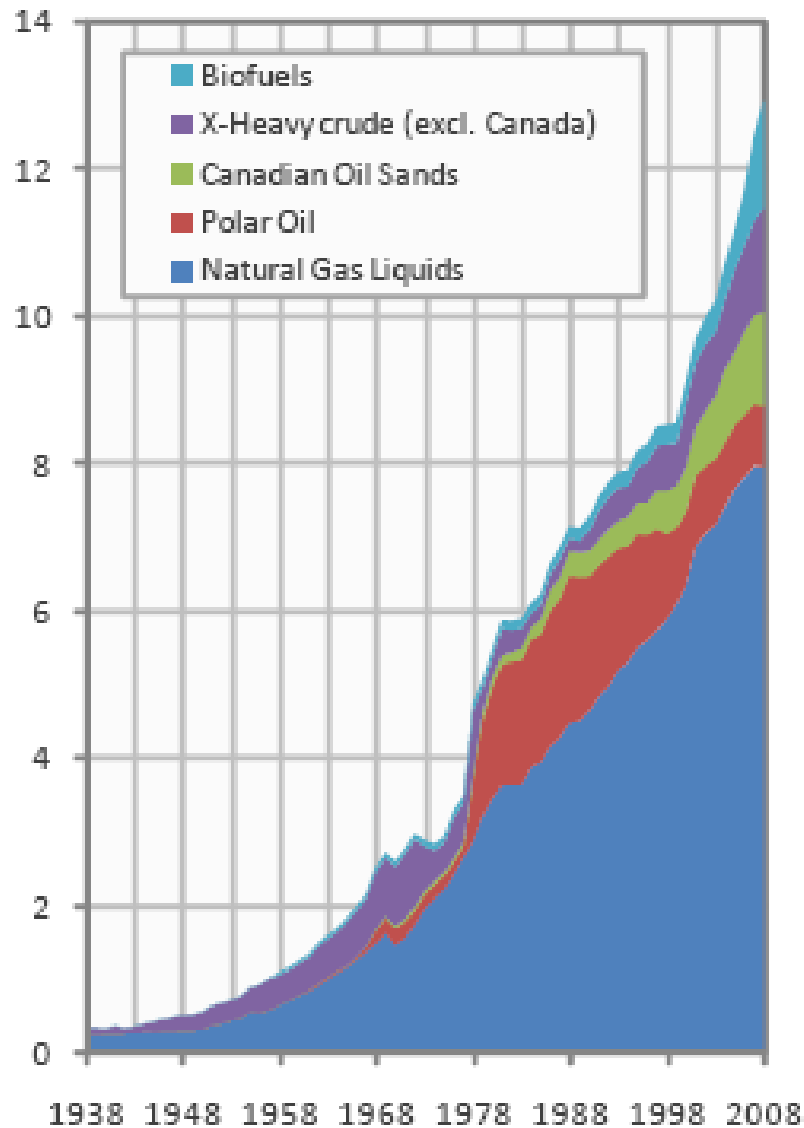
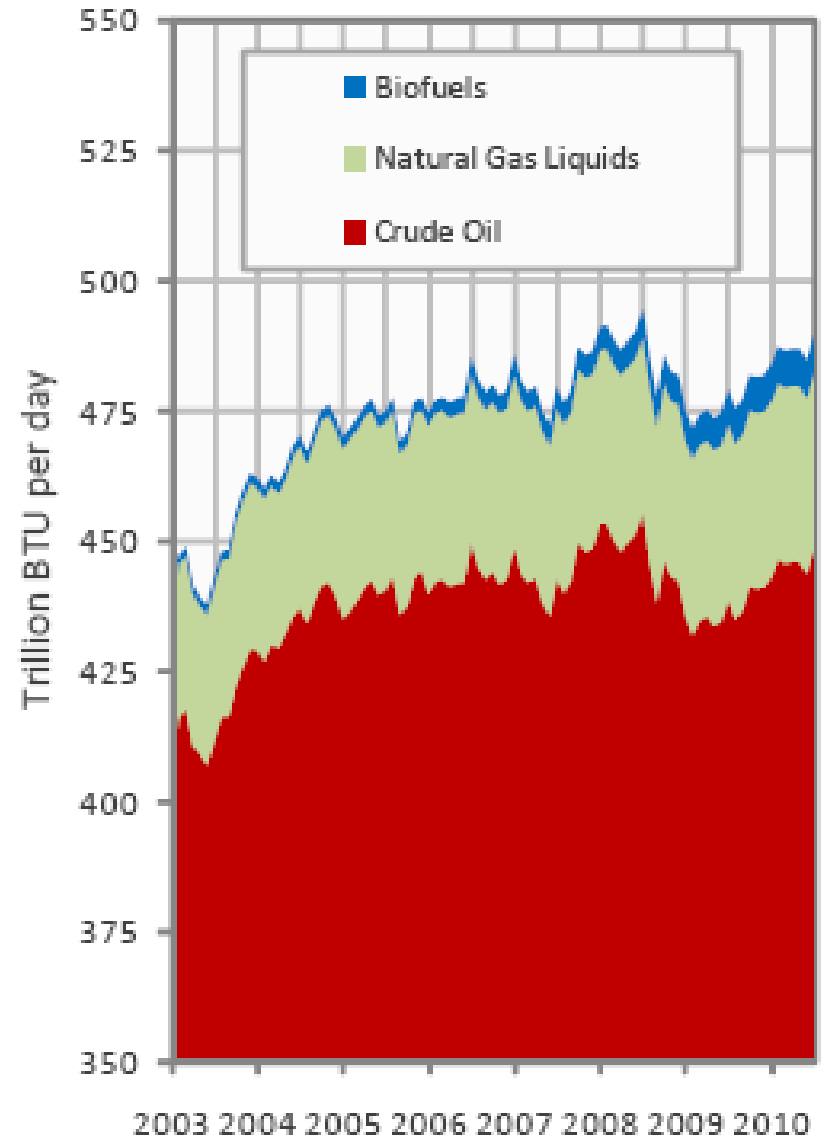


Chart 10: World Production in BTU January 2003 - July 2010



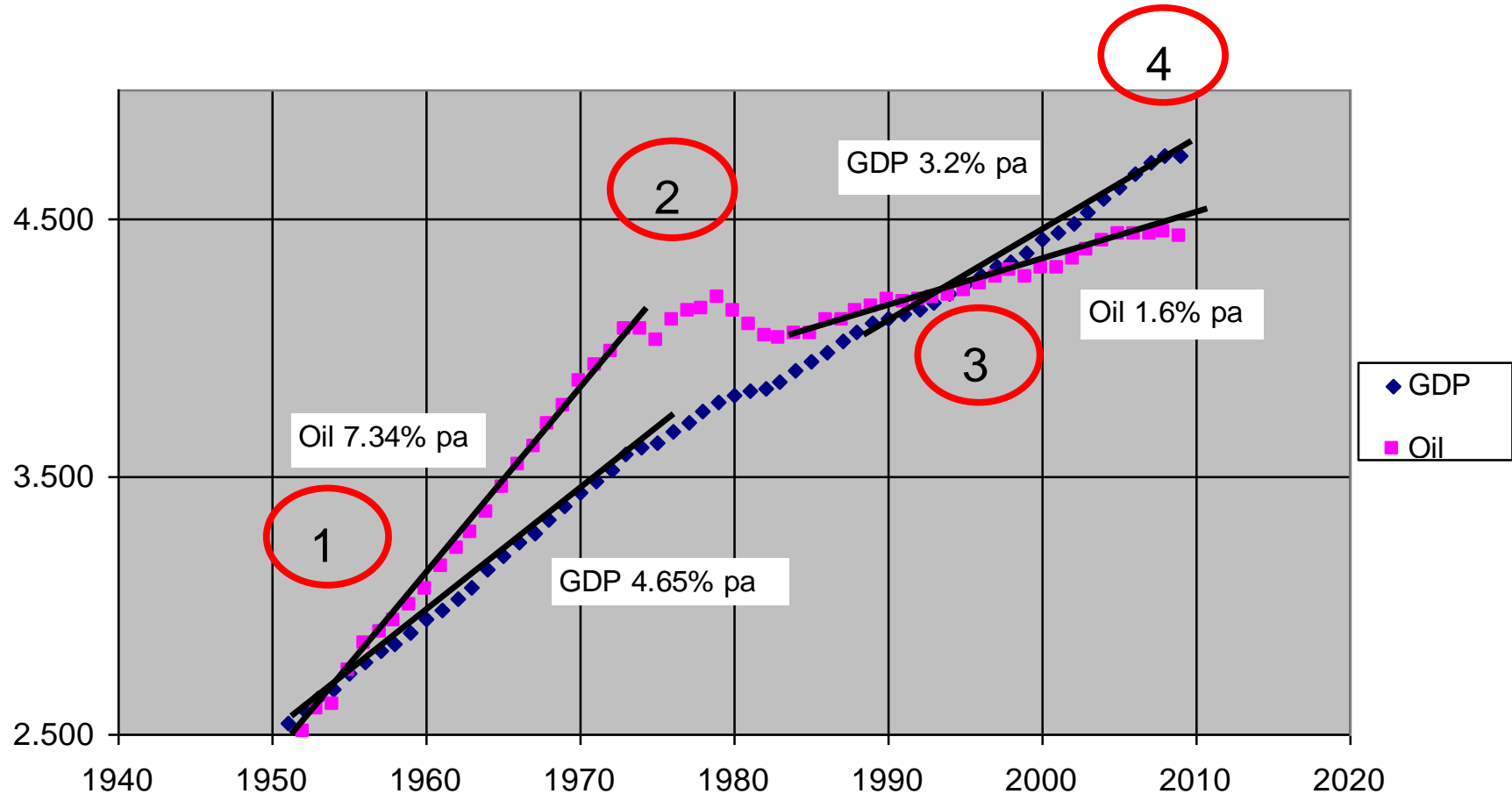
Oil and money

Is oil money ?



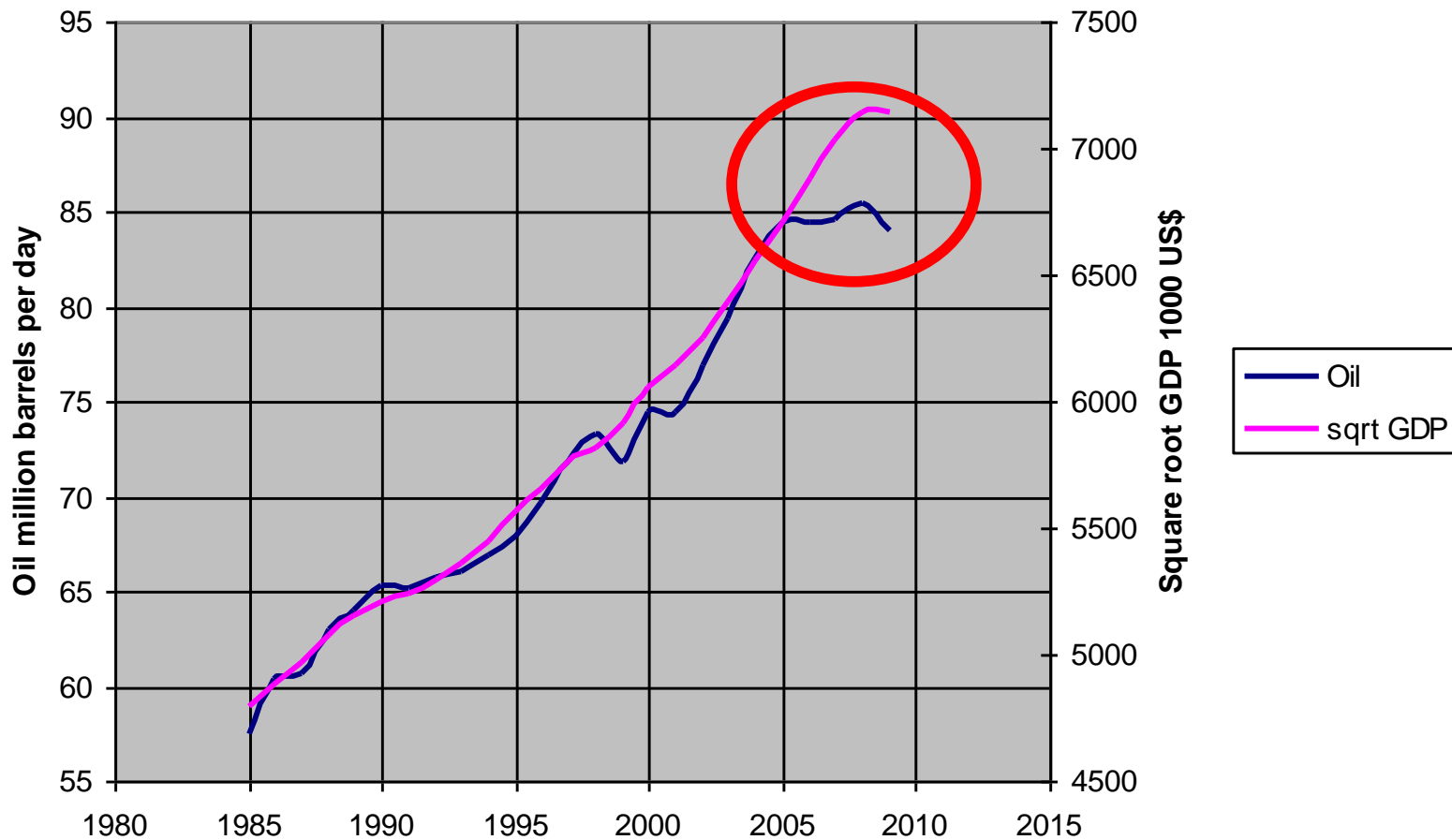
History of oil and world GDP

Ln world GDP and Ln world oil consumption



GDP Data from Angus Maddison in constant US \$

Oil consumption is closely linked to world GDP

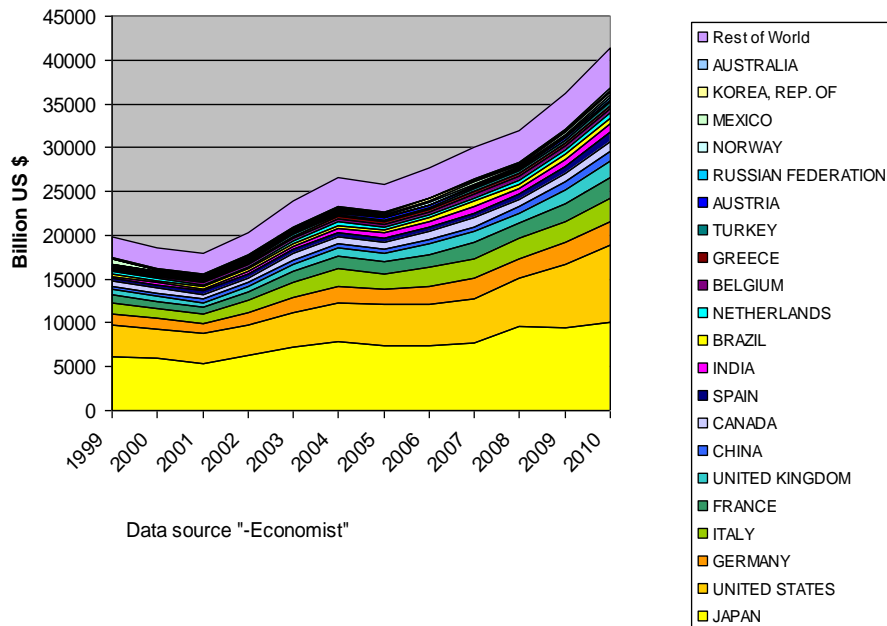




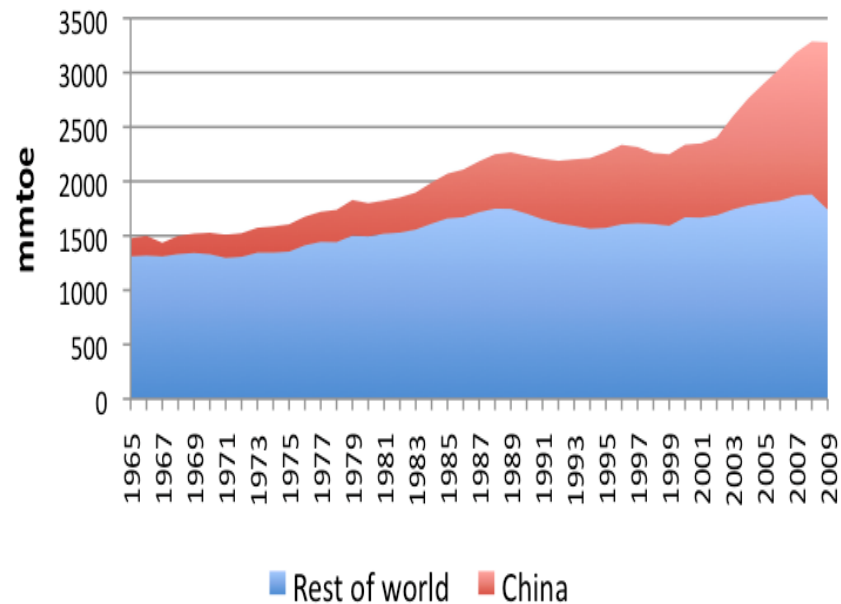
**Does this mean a
decoupling of GDP from
Oil consumption ??**

World Debt and Coal consumption increasing

World Public Debt



China coal consumption



Gail the Actuary on Debt

Economic decline ->
Lots of Debt Defaults

Repaying loans is easy in a growing economy



Repaying loans is much more difficult in a
shrinking – or flat - economy



See Gail Tvberg

<http://www.theoil drum.com/node/6191>

Highly non linear effects

- **Originate because the world financial system is predicated on growth**
- **Including our fractional reserve banking system**
- **Debt and interest**
- **Are all essentially a Ponzi scheme**
- **Once growth falters then the system is liable to non linear contraction**

Linear v highly non linear effects of peak oil

- **Linear: Hirsh - oil declines at 1% pa transport declines at 1% pa. world GDP declines at 1% pa.**
- **Economists like linear interactions as they are more tractable**
- **Highly Non linear: oil declines at 1% pa world economy collapses as financial system cannot work with negative growth (Knightian, Taleb: Black Swans)**
- **Highly Non linear interactions needs systems dynamics modelling**

Future oil prices:



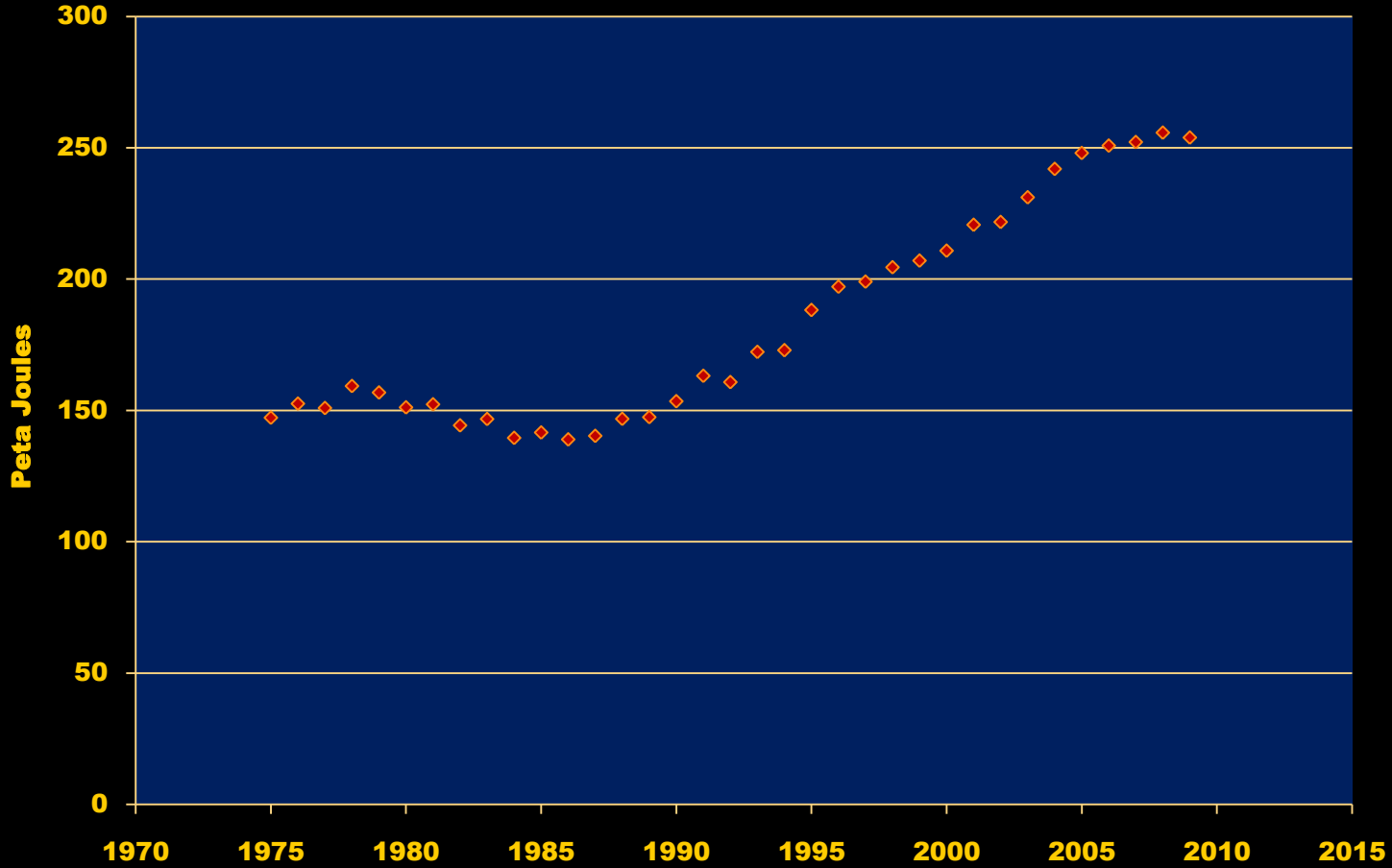
- **Sadad Al Husseini ASPO 2009 Denver** *“there is a ceiling to what the global economy can afford for energy. Roughly speaking, once you get to five to six percent of the global GDP being spent on oil, that’s about the ceiling”*
- **Implications oil price cannot go much above US\$120 / barrel**

Back to NZ

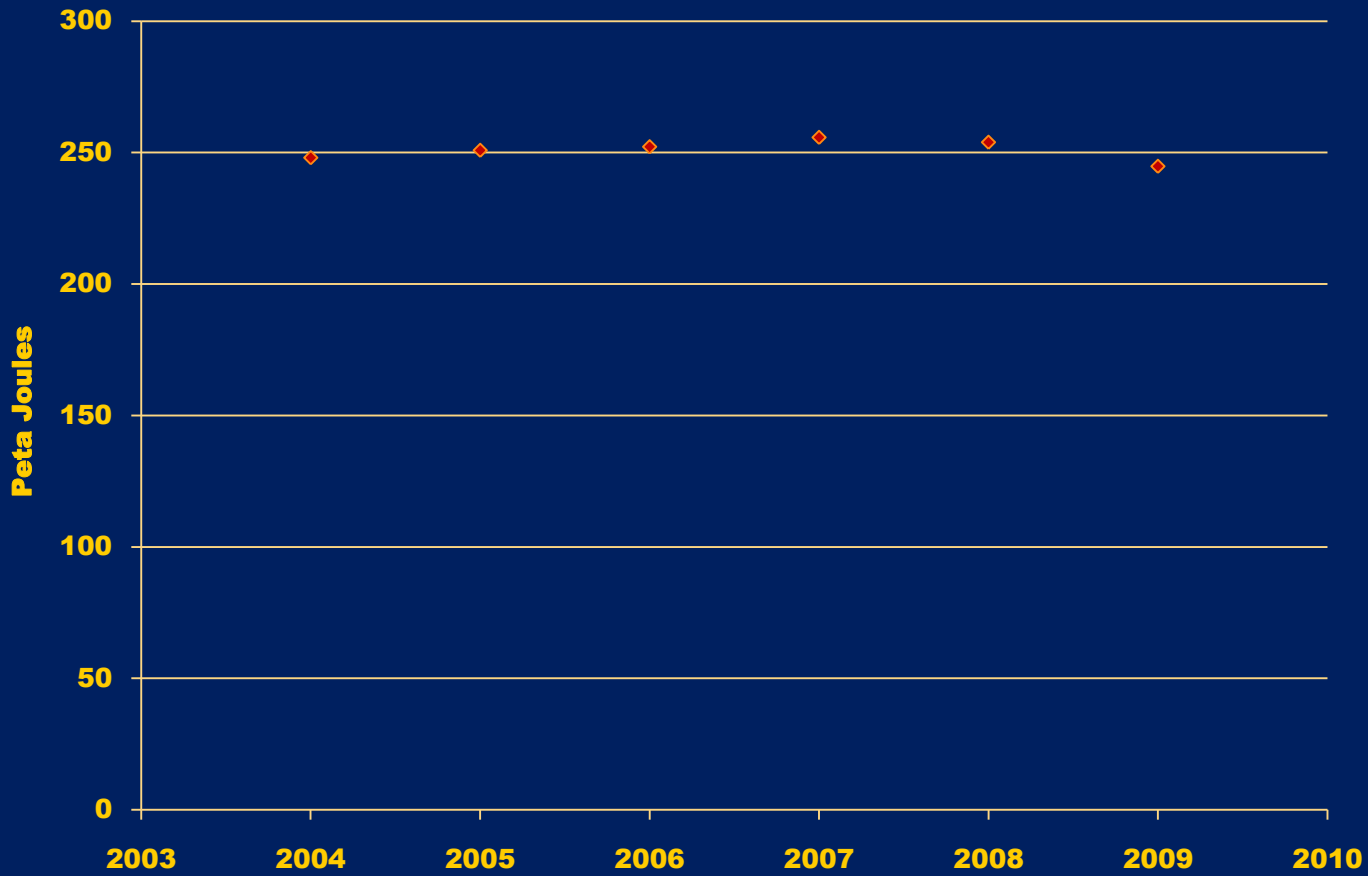
- **Is NZ ready for Peak Oil ?**
- **It will depend on whether the predominant outcomes are linear or non linear and on the rates of decline of oil production**



NZ Oil Consumption



Recent NZ Oil Consumption



Risk analysis: 4 scenarios

- **Optimistic: oil decline rate 0.6% pa until 2030**
- **Pessimistic: oil decline rate 4% pa**
- **World economy reaction: linear**
- **World economy reaction: non linear**

Linear 0.6% decrease pa



- **Efficiency gains and transport reorganization could mitigate crude oil declines with little adverse effects until around 2030 by which time either climate change difficulties or gas declines and coal peaking are likely to have triggered non linear responses.**

Linear, 4% decrease pa

- **Efficiency gains could mitigate crude oil declines until around 2015 - 2020 depending on when the declines start. China and developing economies will be stressed by lack of petroleum supplies to fund further growth and the collapse of the world factory, among other problems, including climate change, are likely to trigger non linear responses elsewhere.**

Highly Non linear, 0.6% decrease

- **Oil supply decline will trigger a slowdown in world economies and the world will move to period of stagnating recession alternating with periods of recovery.**
- **Evidence for this scenario has already appeared.**
- **What follows is likely to be a series of peaks and downturns in the world economy as the non linear interaction unfolds and the world adjust to a declining oil supply.**

Highly Non linear 4% decrease



- **A 4% oil supply decline per annum will trigger a run on the world stock markets triggering a substantial world depression necessitating a revision of the world monetary system.**

A transition is possible to RE but there are Barriers

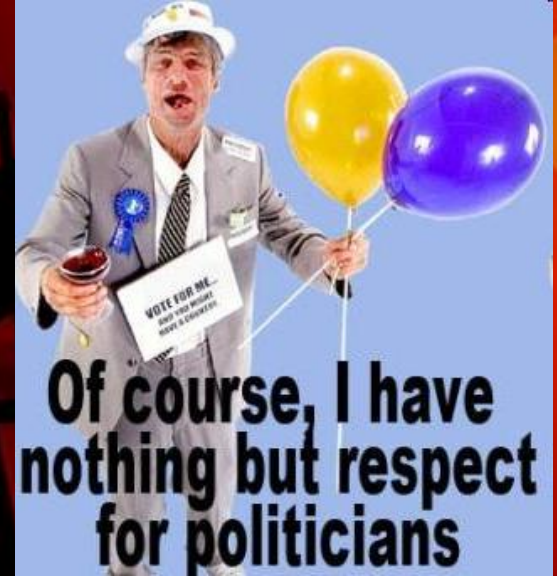
- **Growth as an axiom**
- **Vested interests**
- **Politics**
- **Inertia**

Fossil fuels are profitable



- **The 800 billion tonnes of coal in the ground is worth around US\$ 40 trillion at US\$ 50/tonne**
- **The remaining 800 billion barrels of oil is worth around US\$ 64 trillion at US\$80 per barrel.**

The political barrier .



- **Politicians if they want to get re-elected can never promise their electorate a reduction in living standards -which is interpreted as necessary if a reduction in consumption is required**

Social Inertia



- **Anti wind movement in NZ**
- **Consumer society**
- **Marketing industry**
- **Third world needs growth**
- **Others**

Questions

MAJOR CRACKS ARE APPEARING IN EVERYTHING



Thanks to Leunig

- **NZ Oil?**
- **Coal to liquids**

