Peak Oil: Crisis, what crisis?

PESGB

Conwy, 19 April 2012

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Outline

- What is peak oil, and does it matter ?
- Background: volumes, rates, investment
- Why might the peak happen now?
- Empirical evidence
- Crude oil alternatives
- The 5-year horizon
- Other opinions: the IEA, other agencies, the major oil companies

What is Peak Oil?

- Oil is a finite commodity in a finite world
- "Peak Oil" is when global conventional oil production reaches its maximum rate, and starts an irreversible decline.
- Commodity peaks are driven by either falling demand/falling cost or falling supply/rising cost.
- It may not be a sharp peak. It might be a "bumpy plateau"
- **We have probably been on that plateau since 2005, and may have peaked in 2008**

Why does it matter?

- Americans use **primary** energy equivalent to owning over 400 slaves
- Of this, the **oil** energy is equivalent to owning 180 slaves each. 80% is used for transport
- GDP is the conversion of natural resources into goods and services using energy, labour and capital

GDP : 0.25% produced by human energy

99.75% produced by primary energy

The Cheap Oil Peak

"The stone age didn't end because the world ran out of stones, and the oil age will not end because the world runs out of oil. It will end when something replaces it." (Attributed to Sheikh Ahmed Zaki Yahmani, among others)

Oil will never run out, but it will reach such a price that we cannot afford its current use.

This is about the peak of cheap, conventional crude oil and NGL – 97% of world oil production

Geology vs. economics

"Proven oil reserves worldwide continue to expand. It is thus a fact that the world is running into oil rather than out of it." (Peter Odell). Reserves still underpin the DECC view

We are discovering *what we expect to discover.* New discoveries are only book-keeping

<u>Geologists:</u> Finite resource, rate of oil production.

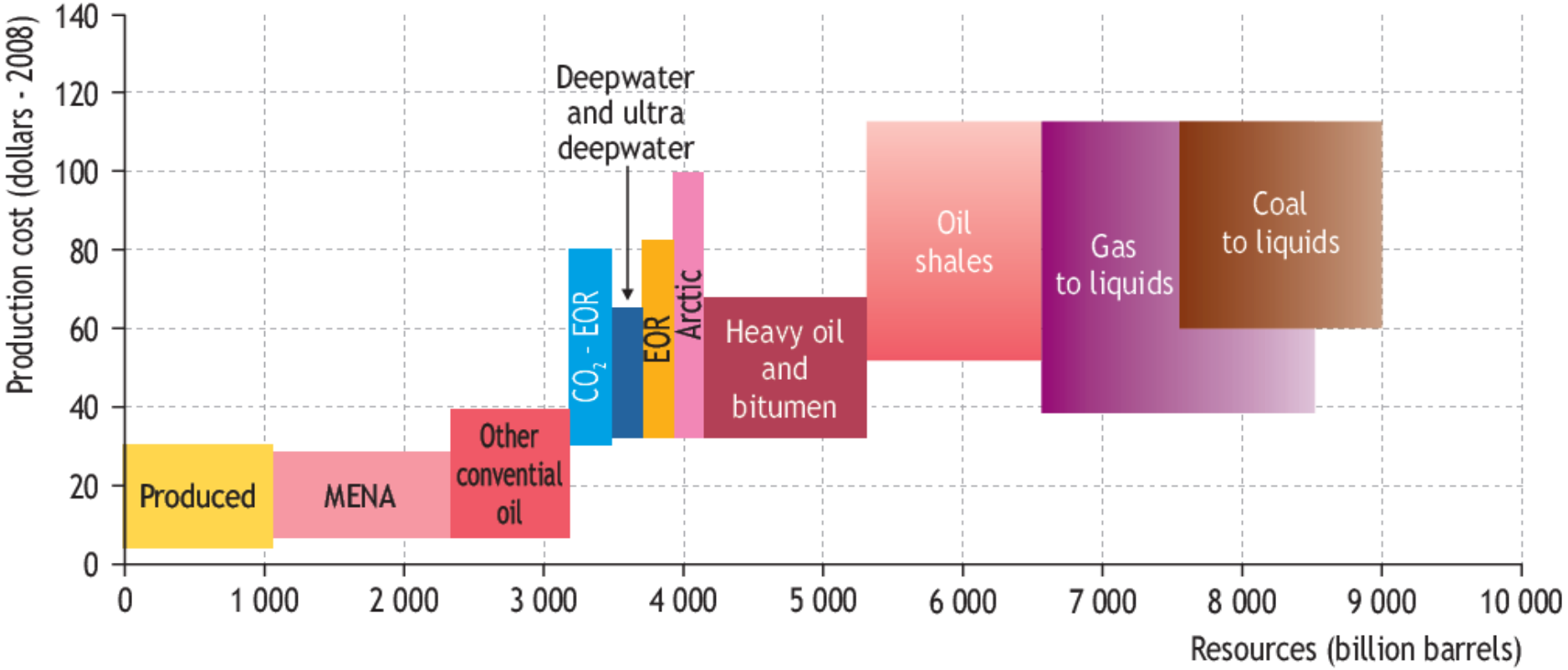
<u>Economists:</u> Market forces, investment, global reserves.

Economics does not create oil. We can only produce what exists.

Volume is plentiful and cheap…

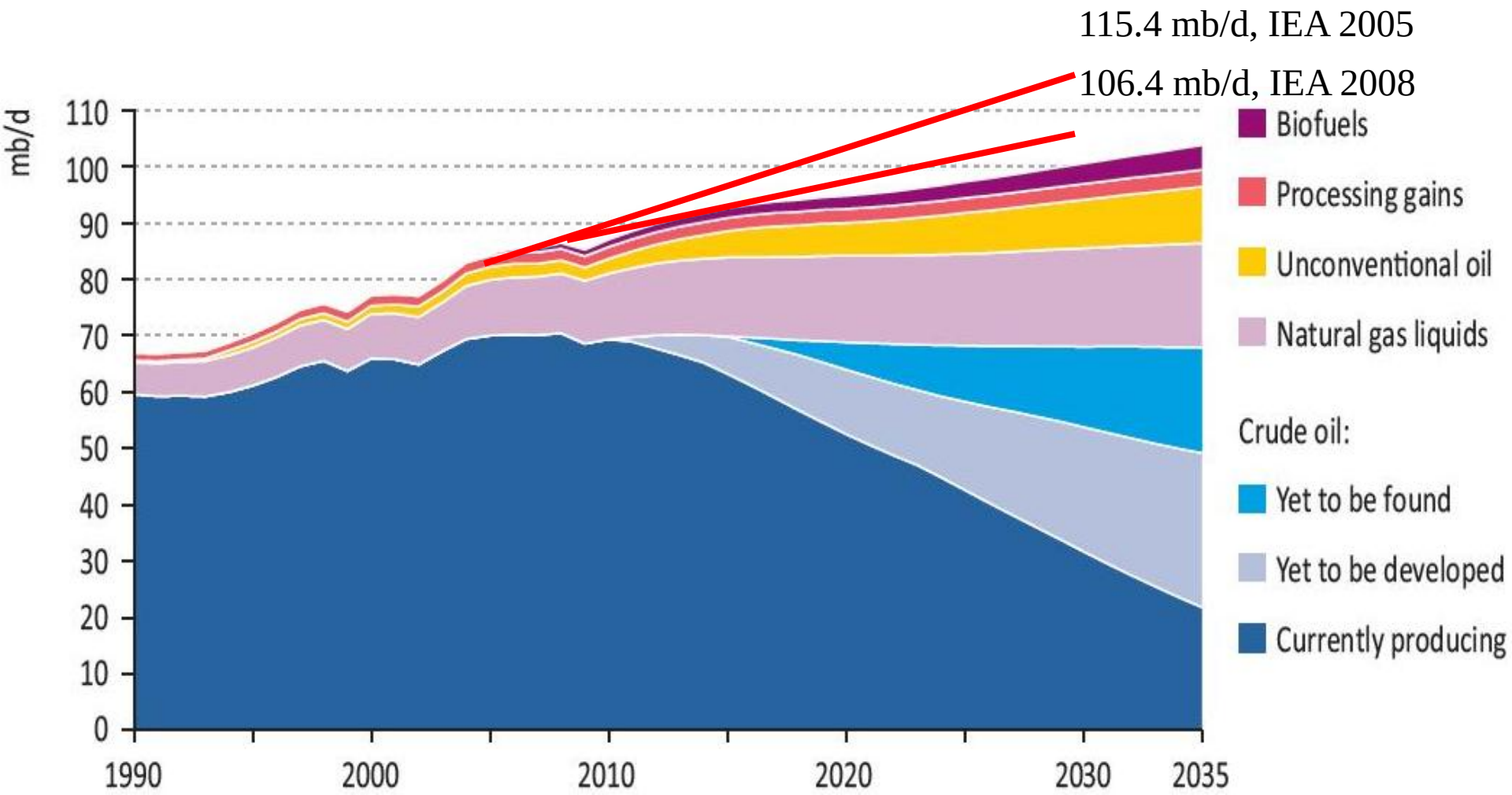
Official global proved reserves in 2010 were 1400 Gb (= billion barrels), or 46 years of today's supply *("Running into oil…")*.

IEA: Long-term oil supply cost curve (2008)



… but rates are hard to maintain

IEA 2011 forecast: 99.4 mb/d oil demand/supply in 2035

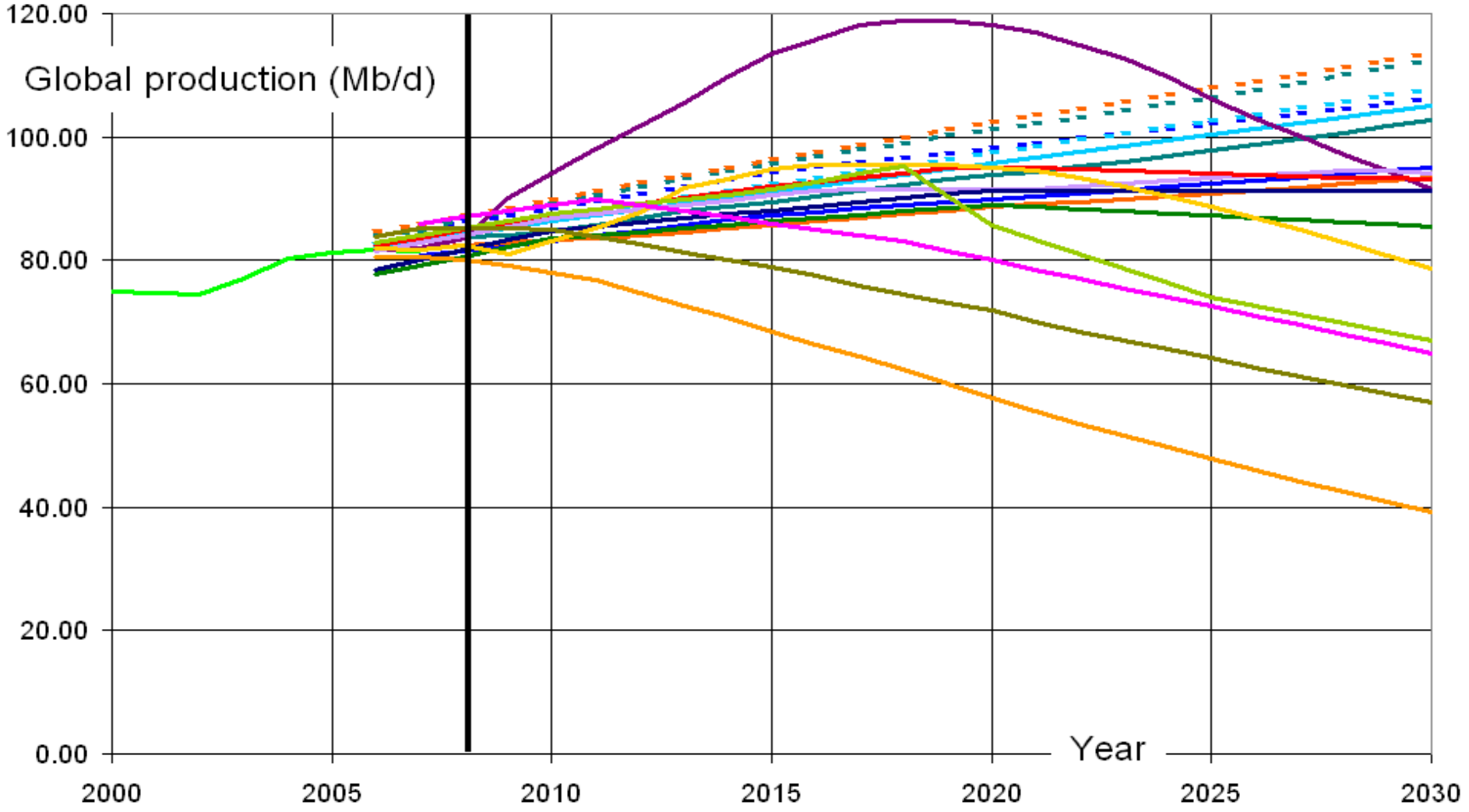


The battle towards 2035 – IEA's view (2011)

- Today's conventional crude fields drop from 69 million b/d to 22 million b/d. We lose 5 Saudi Arabias.
- New production: 28 mb/d from undeveloped fields, 19 mb/d from undiscovered fields
- These require double our best average production rates
- Price could reach $247/bbl. Investment requirements:
  - $10 trillion for oil (about 15% p.a. of current sales income)
  - $27.4 trillion for gas and electricity
- Unconventionals rise from 2.3 to 10.0 mb/d
- Biofuels rise from 1.1 to 4.4 mb/d

What might we get?

Some forecasts from agencies, universities, oil companies, analysts



Peak and Decline

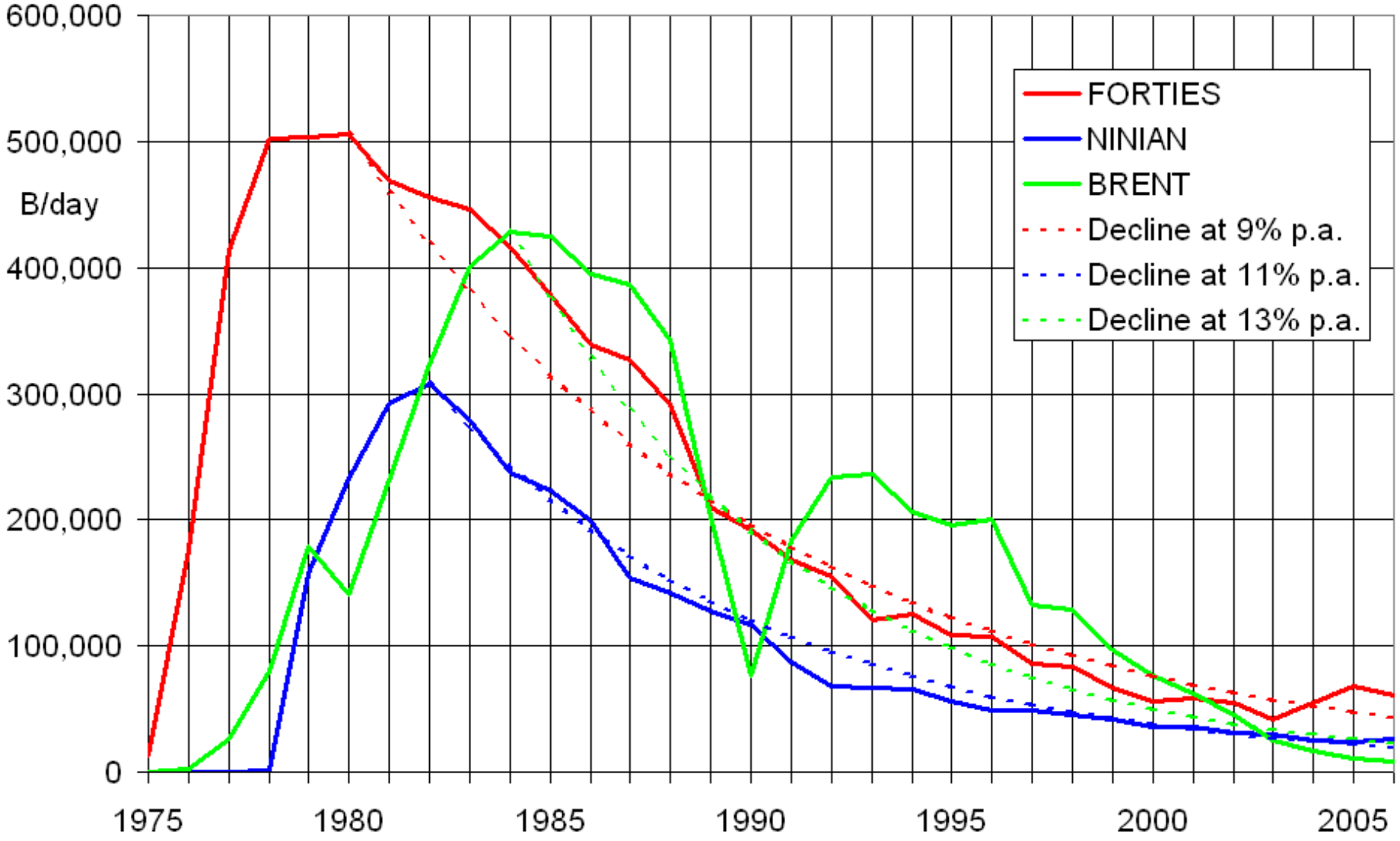
"Current reserves would last 46 years at current production rates, and we are still making new discoveries, so…"

- Why must peaking and decline happen now?
- Why can't we produce these reserves at any rate we want?
- Why can't we have lots of oil, cheaply, now?

Why Production Rates Decline

- When oil flows into a well, the pressure falls. Oil then flows more slowly, so the oil production rate drops
- Eventually, gas and/or water also enters the well (the “water cut”). Every barrel of water produced is a barrel of oil *not* produced
- All wells, and thus fields, soon experience declining rates of production
- On average, 35% of the oil is recoverable

How oil fields decline



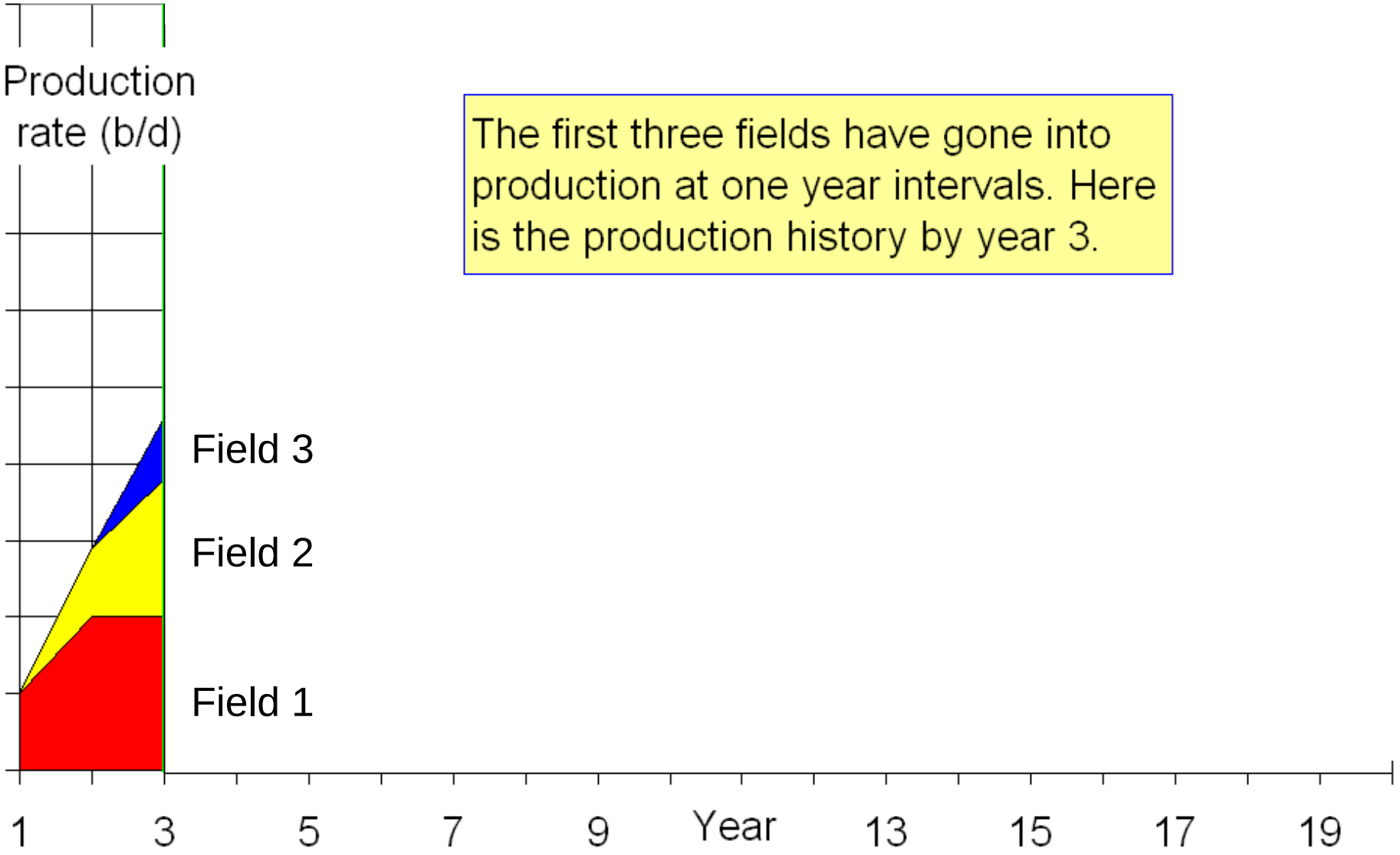
How regions decline

- A **basin** is the sum of its fields
- The largest fields in any basin are *usually* found first, and *usually* produced first.

In the following model, a new field is discovered and brought into production every year.

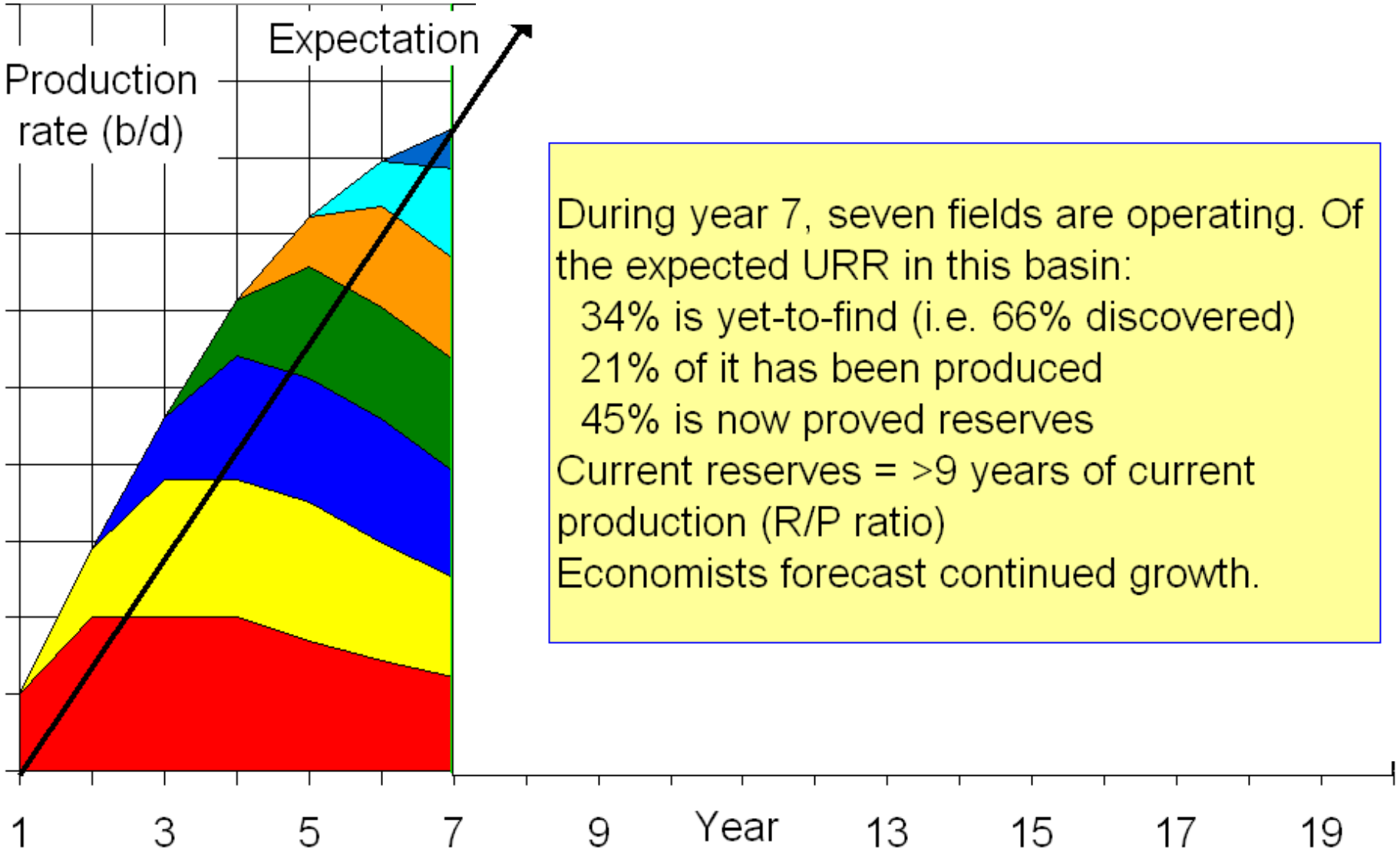
Each field discovered is 10% smaller than the previous discovery.

Oil basin decline: Year 3



The first three fields have gone into production at one year intervals. Here is the production history by year 3.

Oil basin decline: Year 7



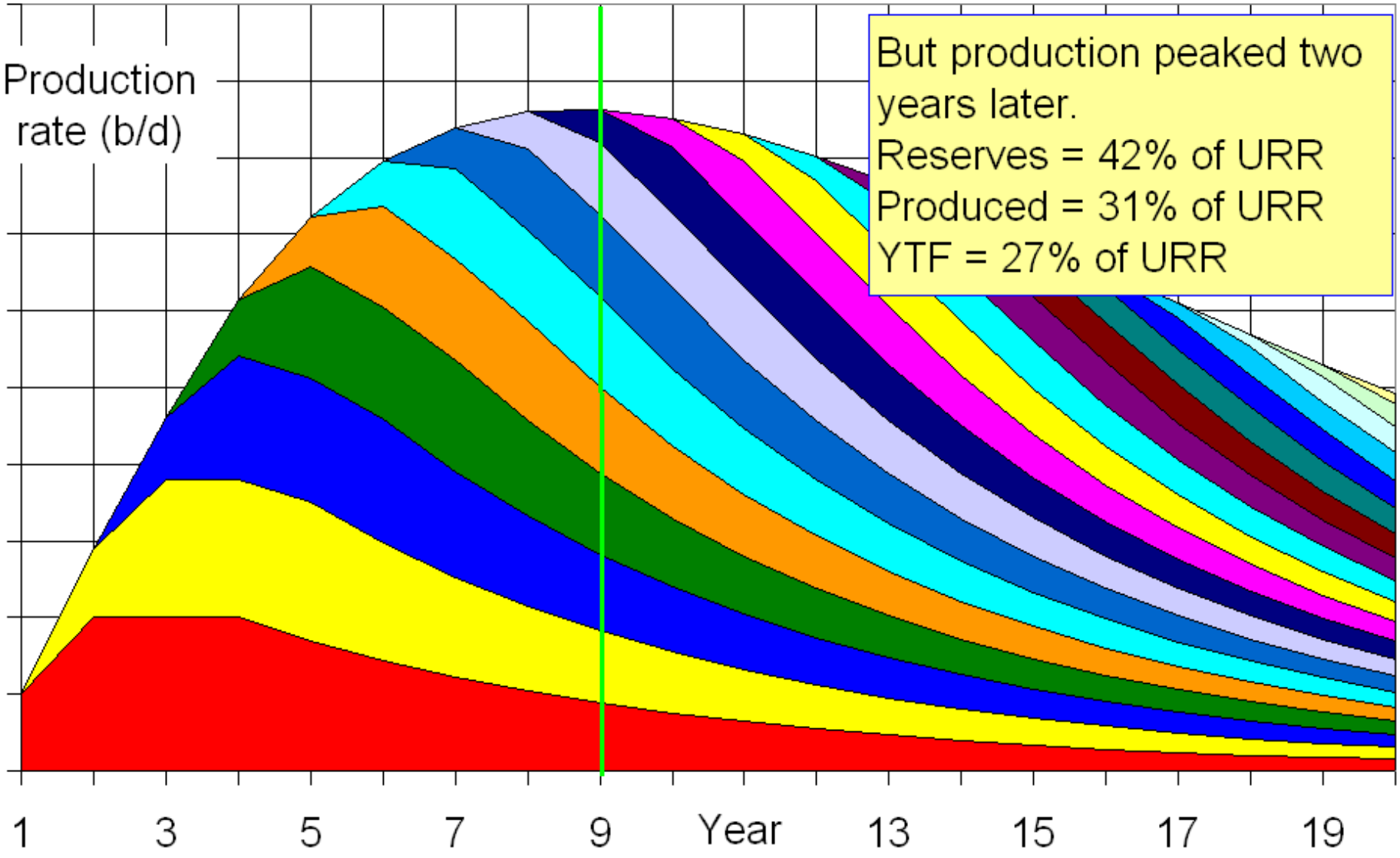
During year 7, seven fields are operating. Of the expected URR in this basin:

- 34% is yet-to-find (i.e. 66% discovered)
- 21% of it has been produced
- 45% is now proved reserves

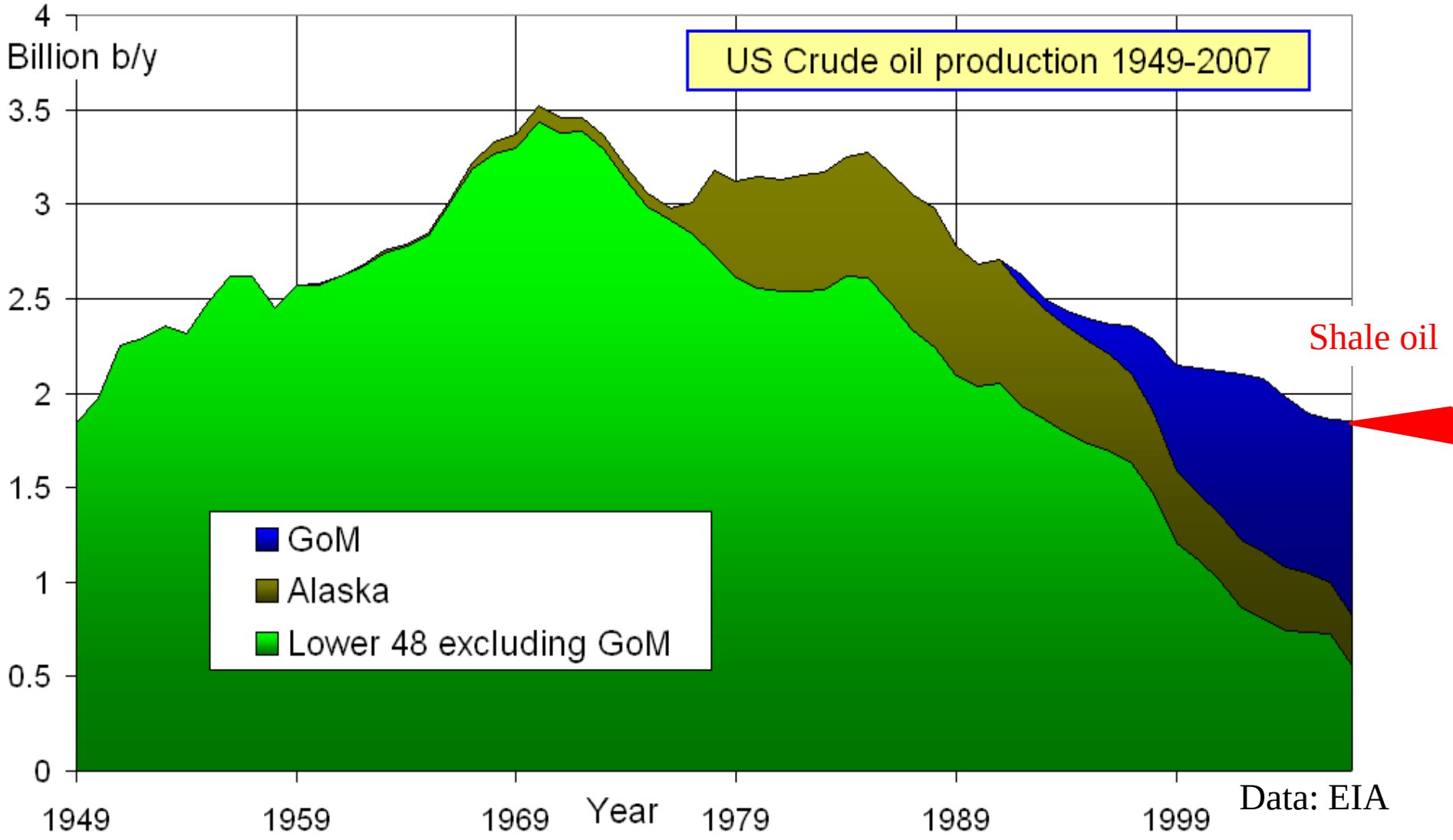
Current reserves = >9 years of current production (R/P ratio)

Economists forecast continued growth.

Oil basin decline: Year 9 and after



US: Post-peak decline



Global decline

- 70,000 oil fields in production
- 25% of all crude oil comes from 20 fields. 16 are in decline
- 37 countries are past peak, including US, UK, Norway and Mexico. Russia is probably at peak
- Global production decline is 4.1%, or 3.5 million b/d per year
- We need new production equal to a new Saudi Arabia every 3 to 4 years to maintain and grow supply

Date from UKERC, IEA

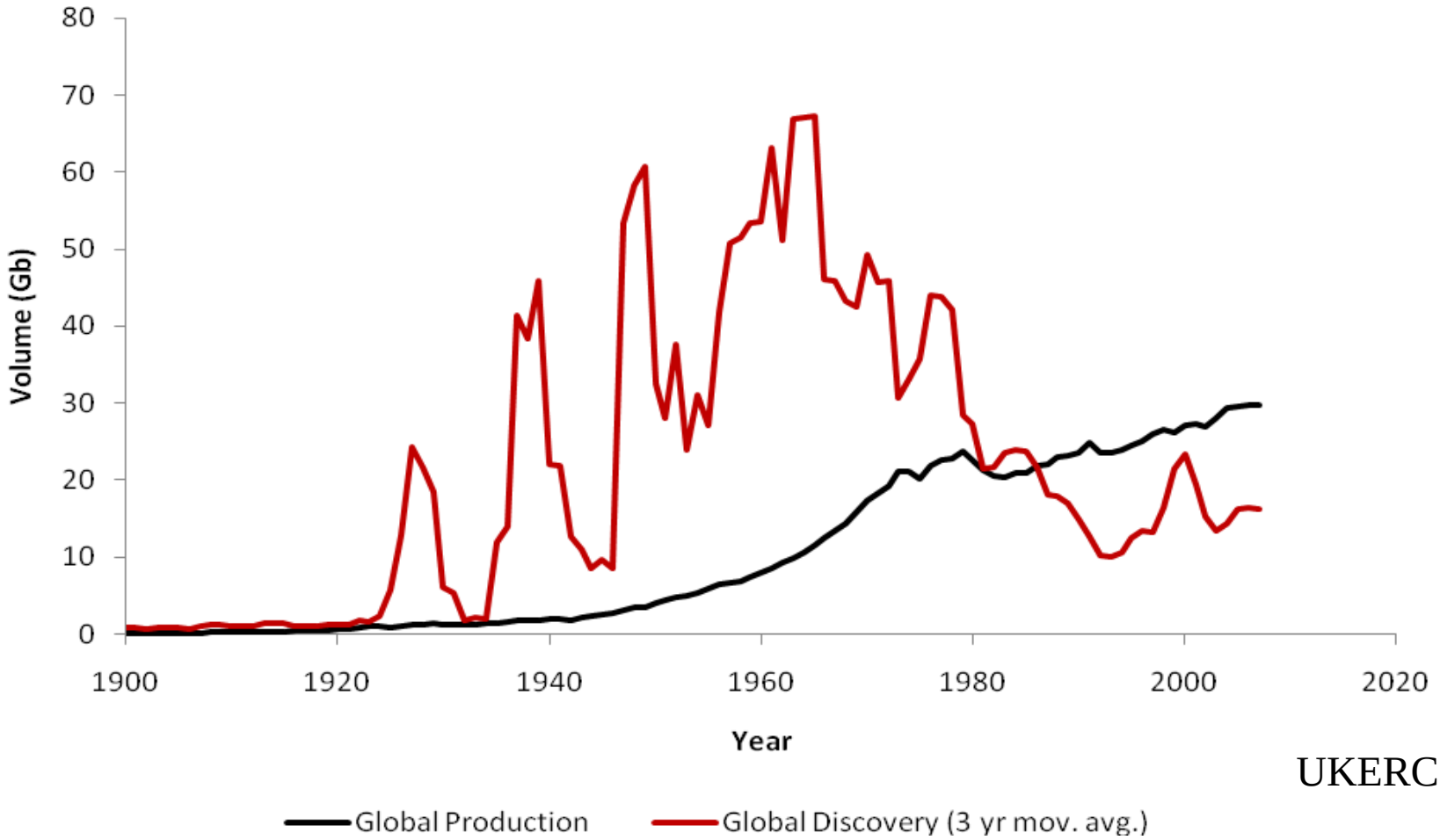
Are we at peak?

Probably on the plateau. We have not run out of oil, but it is expensive to raise the production rate

- Discovery has been less than production since 1985, although we can work old fields harder ("EOR")
- Conventional crude production peaked in 2006 or 2008 (IEA)
- Violent price change has not affected supply or discovery since 2005
- *Over* a third of the probable global crude URR has probably been produced – where we would fear peak

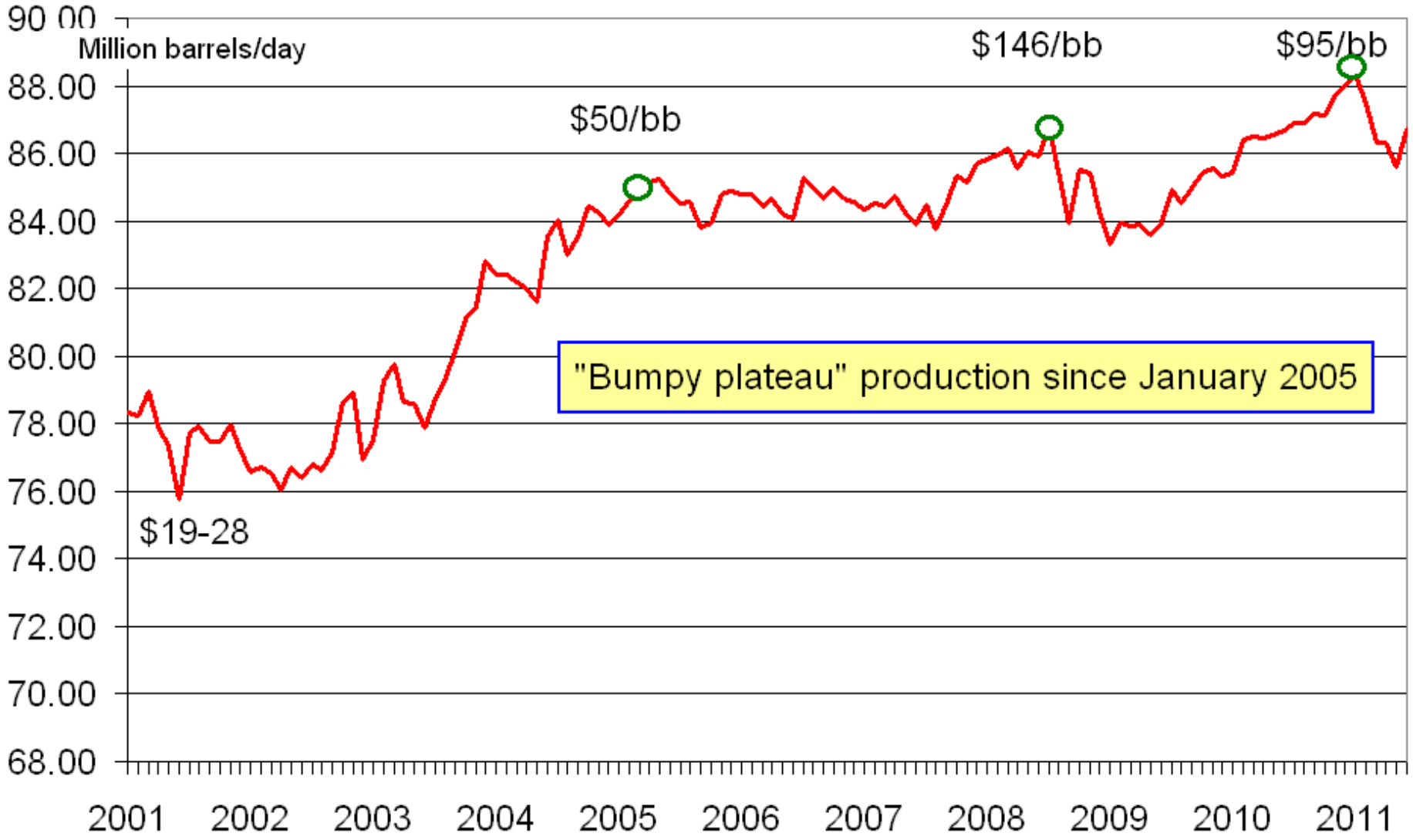
Global new crude oil discoveries

New discoveries have lagged production since the mid 1980s.
Reserves have grown by higher recovery rates and bad data.



UKERC 2009

Recent global (all) oil production



What might delay or prevent peaking?

Nothing. To maintain the rate of supply, we need new conventional fields.

Other analysts cite alternative solutions.

- Reserves growth – raising the 35% recovery rate with expensive technology
- Non-conventional oil
- Non-oil liquids – biofuels, synthetic fuels from gas or coal, hydrogen
- The global electric vehicle fleet
- New government policies world-wide

Non-conventional Oil and Biofuels

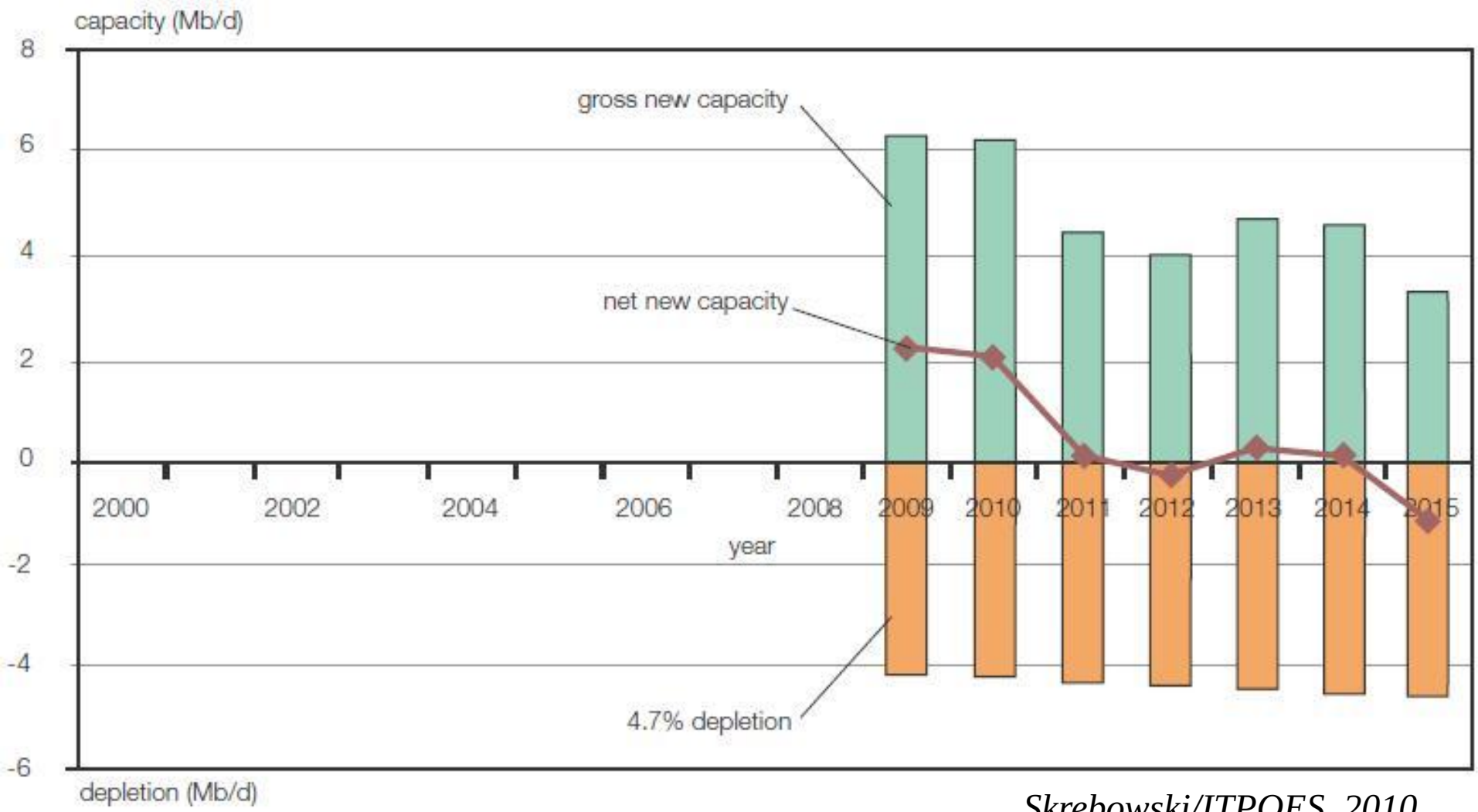
- "The market will find something better than oil".

Nothing is as cheap, convenient, plentiful and energy-dense, or we would already use it.

- Probably higher CO_2 emission per final barrel
- US shale oils: perhaps 0.9 million b/d in 2011
- Canadian tar sands *might* yield 6 million b/d by 2030, but the Canadians think about 4.5 million b/d
- Synfuels from gas and coal still insignificant by 2030
- Biofuels might make 4-5% of supply by 2035
- Total non-conventional liquids by 2035 might meet 10-12% of global liquids demand

IEA *WEO 2008, 2010; NEB March 2011*

Future capacity to 2015



Skrebowski/ITPOES, 2010

Cost of expected production gains to 2016

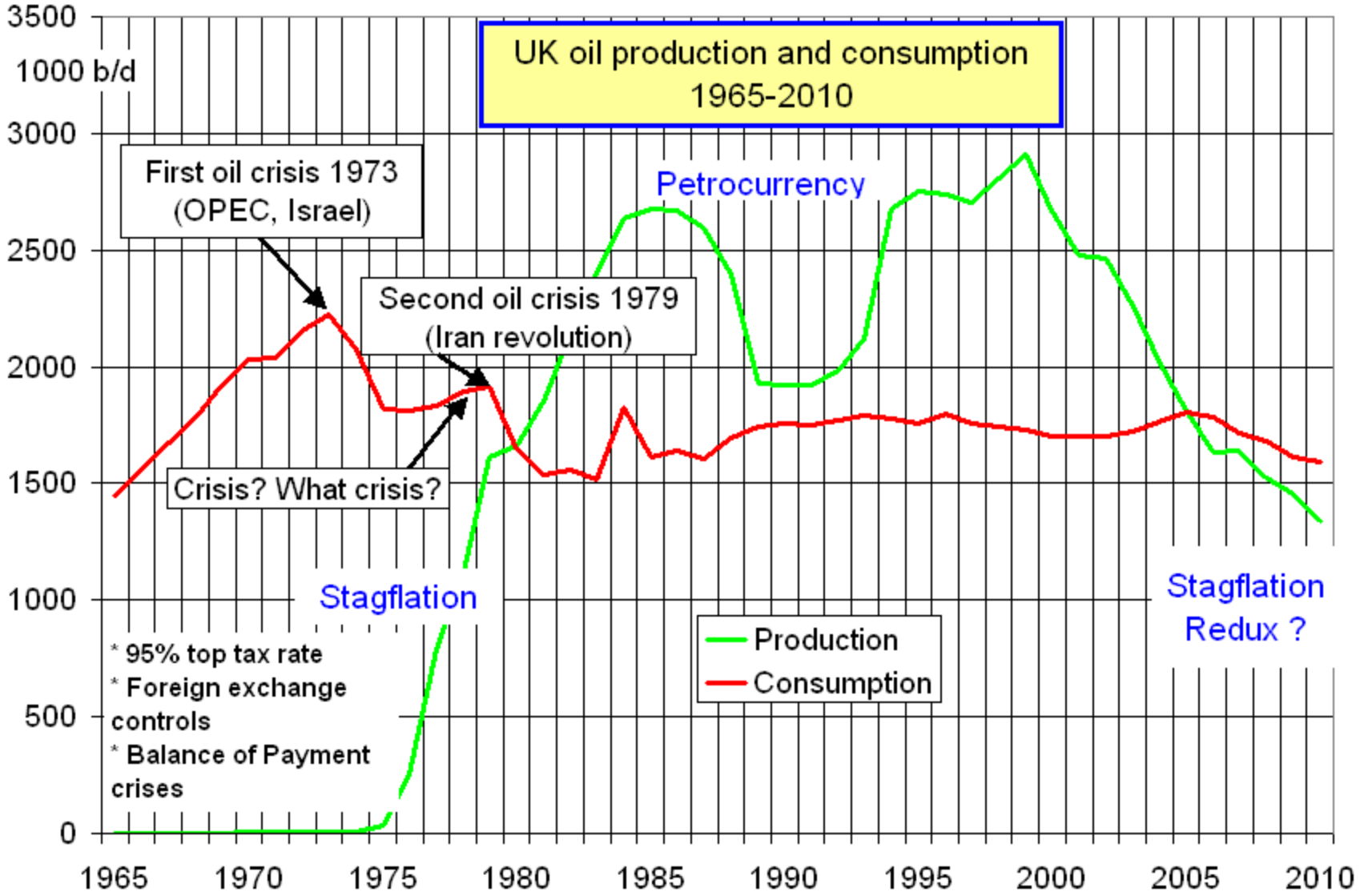
Country	Production gain (million b/d)	Incremental oil Cost ($/barrel)	Comment
Canada	1.0-1.2	70-90 (or $115 – NEB)	Tar sands
Brazil	0.9-1.1	60-80	Deep-water
US offshore	0.2-0.3	70-80	Gulf of Mexico
US shale oil	1.2-1.5	50-70	Bakken et al
Iraq	1.1-1.3	40-60	Security concerns
Angola	0.6-0.8	70-80	Deep-water
Abu Dhabi (UAE)	0.4-0.5	50-70	Redevelopments
Other Opec	0.5-1.0	40-80	Rises & declines

Skrebowski, 2011

Possible economic consequences

- $120/bbl has previously stopped European economies
- $80/bbl impacts the US economy
- Prices need to be > $90 -100/bbl to justify sanction
- China and India can afford higher prices than we can because of higher marginal utility value
- “Saw-tooth” economies until a crunch in 2015

The UK position



IEA view, 2010 - 2035

Bear in mind the IEA's remit to indicate *solutions*

- Emerging economies will drive demand
- Oil prices remain volatile
- Oil demand/supply rises from 84 mb/d in 2009 to 99 mb/d in 2035
- Supply can be maintained *with sufficient investment*
- **Crude production peaked in 2006 at 70 million b/d**. The difference is (1) gas liquids and (2) non-conventional oil
- "New Policies" scenario: no peak before 2035, prices rise
- "450 scenario" (extra reduction in fossil fuel consumption): demand falls by 2020, no resource constraint, prices drop
- Unconventional oil + biofuel reaches 10% of production by 2035
- Gas glut
- The keys are efficiency and investment

Some other views of trouble ahead

ITPOES – Virgin, SSE, Stagecoach, Arup, Solarcentury

US Army Corps of Engineers (2005). The DoD probably accounts for 2% of US oil consumption

UK Research Councils (UKERC report, 2009)

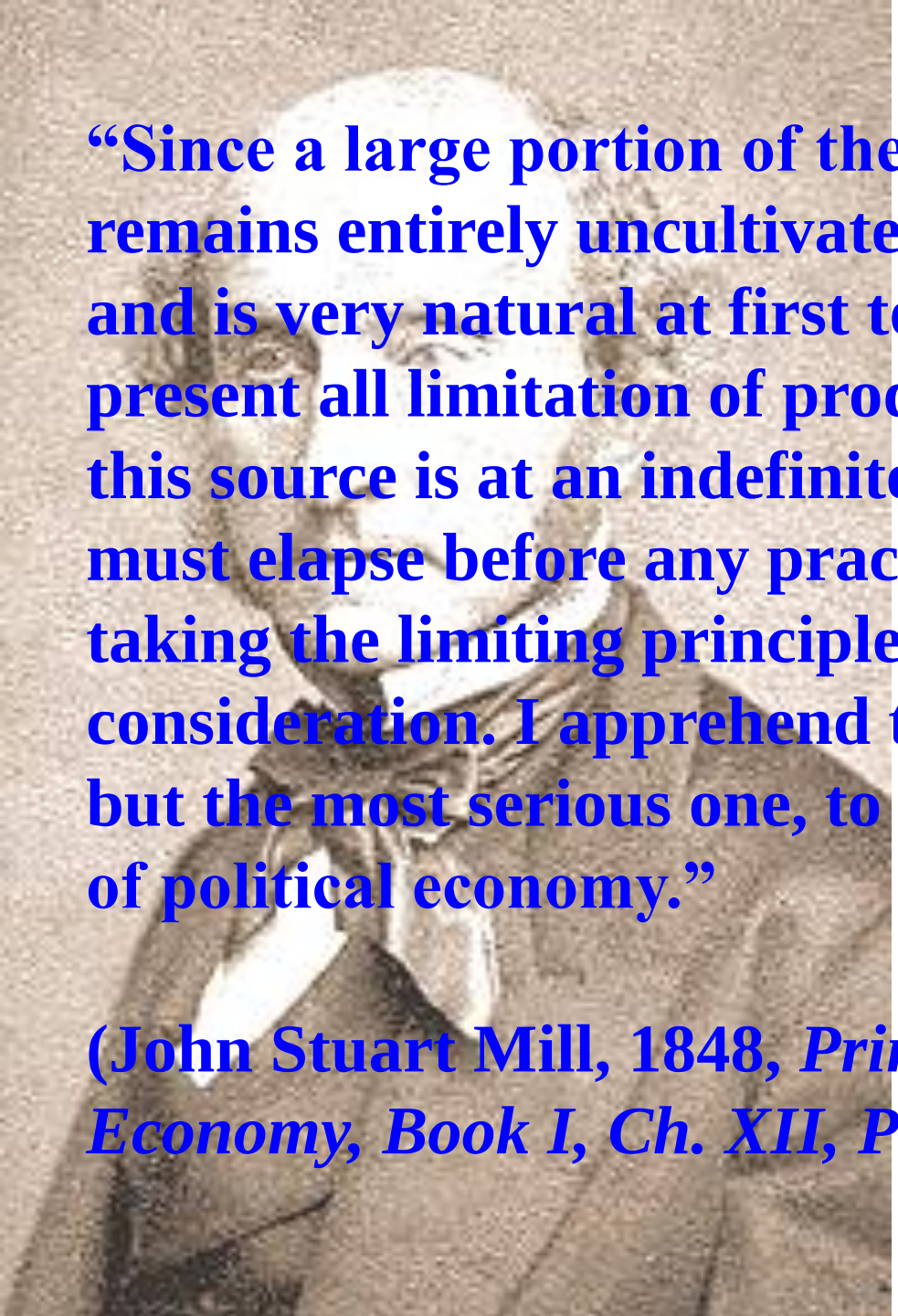
DECC – no trouble before 2020, but serious economic consequences and public disorder

Barclays - $100/bbl price floor

Deutsche Bank – peak in 2016 due to under-investment

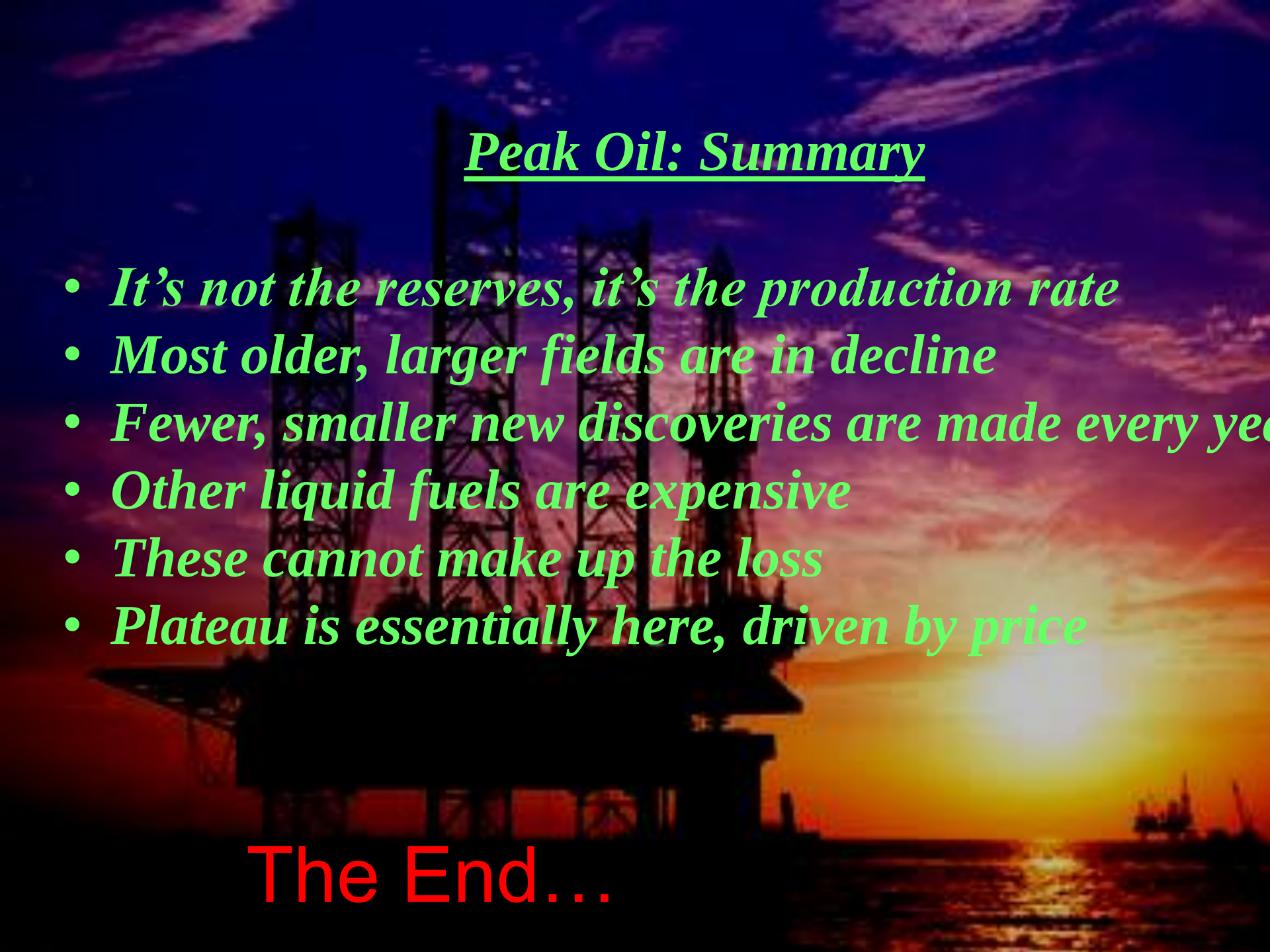
5 major IOCs

Company	Peak?	Into	Out of	Strategy	Comment
Shell (Peter Voser) 65% gas	2020 ("Scramble") 2030 ("Blueprints")	Gas, hydrogen, ethanol, oil sands, shales	Solar, nuclear, wind, coal	Gas, electric vehicles	Scenario models. New technology will make peak oil irrelevant
BP (Bob Dudley) 57% gas	Quiet - >40 years of reserves	Climate change 1971, oil-sands, wind, cellulosic biofuels	Solar? (declining interest)	Flip-flop on renewables	Hand may be forced by company crisis
Total (Christophe de Margerie) 43% gas	About now: already at maximum	Nuclear, solar	Excuses	Electric energy company	"We [oil company CEOs] all think the same"
Exxon Mobil (Rex Tillerson) 42% gas	Not in sight (> 2030)	Unconventional oil, minor biofuels (algal)	Climate change, peak oil	Last man standing	Thought to fund > 40 climate change denial groups
Chevron (John Watson) 35% gas	Tacitly expects price driven peak	Renewables: geothermal, solar, wind, all biofuels, fuel cells, hydrogen	Credibility, but I disagree	Renewable energy company	Possibly over-diversified



"Since a large portion of the earth's surface still remains entirely uncultivated; it is commonly thought, and is very natural at first to suppose, that for the present all limitation of production or population from this source is at an indefinite distance, and that ages must elapse before any practical necessity arises for taking the limiting principle into serious consideration. I apprehend this to be not only an error, but the most serious one, to be found in the whole field of political economy."

(John Stuart Mill, 1848, *Principles of Political Economy, Book I, Ch. XII, Pt. 2-3)*



Peak Oil: Summary

- *It's not the reserves, it's the production rate*
- *Most older, larger fields are in decline*
- *Fewer, smaller new discoveries are made every ye*
- *Other liquid fuels are expensive*
- *These cannot make up the loss*
- *Plateau is essentially here, driven by price*

The End…