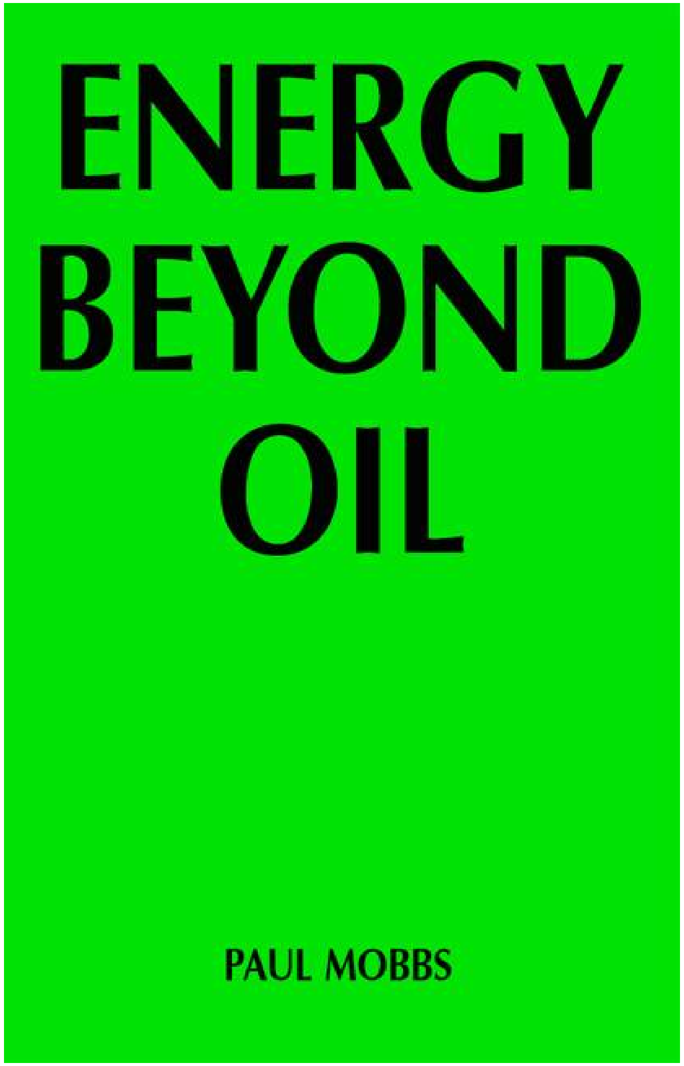
Energy Beyond Oil



UK Peak Energy Tour
March 2007

http://www.fraw.org.uk/tour/

An illustration of the problem...

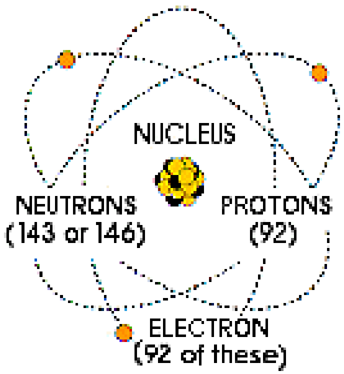
Source:
NASA

An illustration of the problem...

Source: NASA

Fundamental Forces

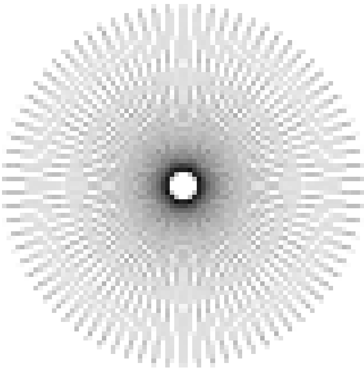
All forms of energy are based upon one of four "fundamental forces"



Strong nuclear

Weak nuclear

Electro-magnetic

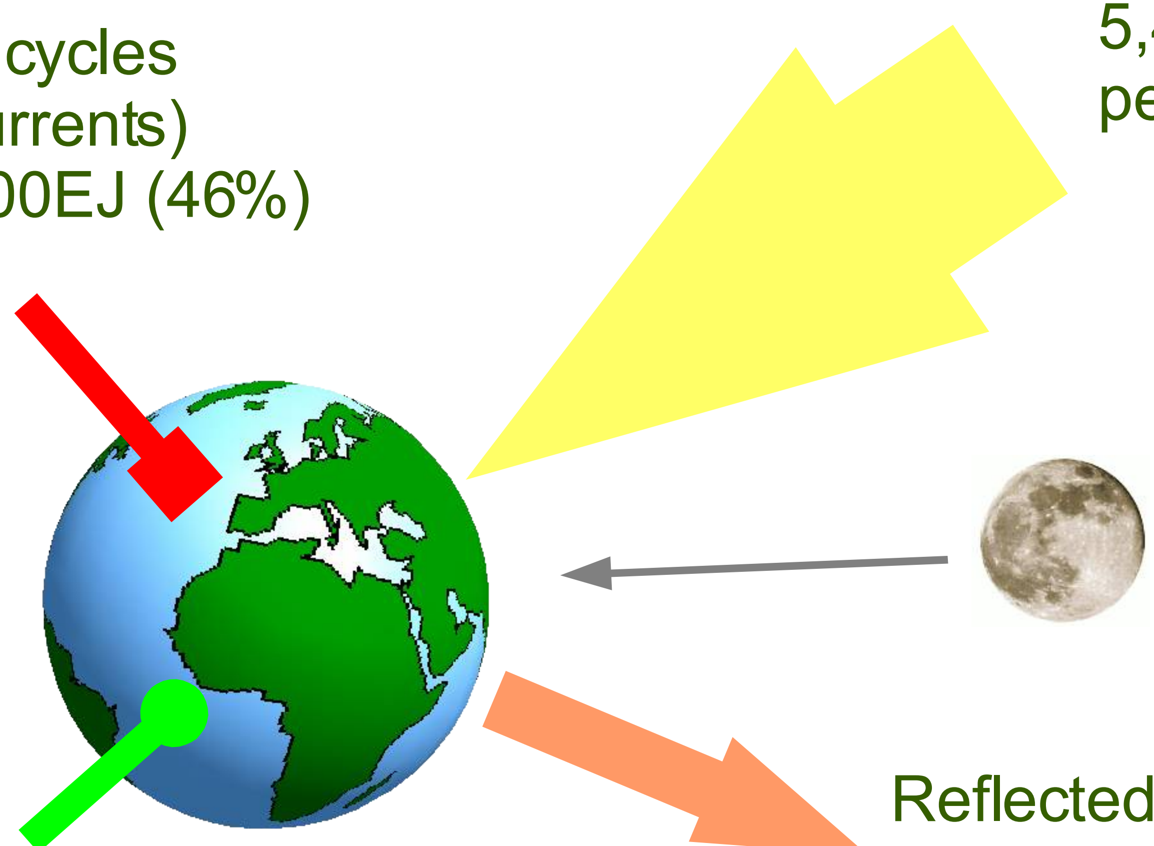


Gravity

The rules:

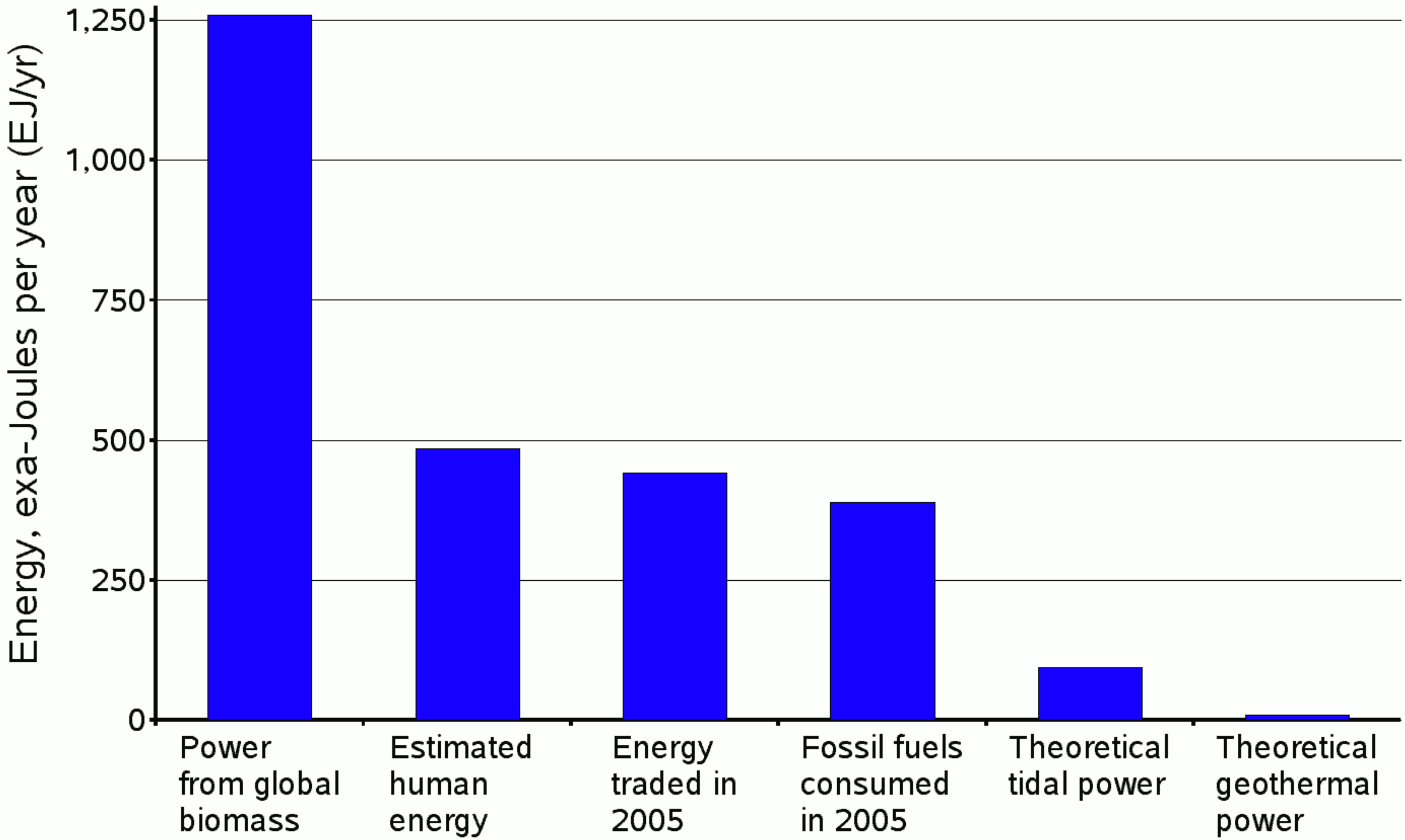
- ► Energy and matter are constant (*Law of Conservation*)
- ► The activity within any system is proportional to the energy flowing through it (*First Law of Thermodynamics*)
- ► Energy only flows "downhill" – once utilised it takes more energy to restore its "quality" to its original state (*Second Law of Th.*)

Global Energy Inputs



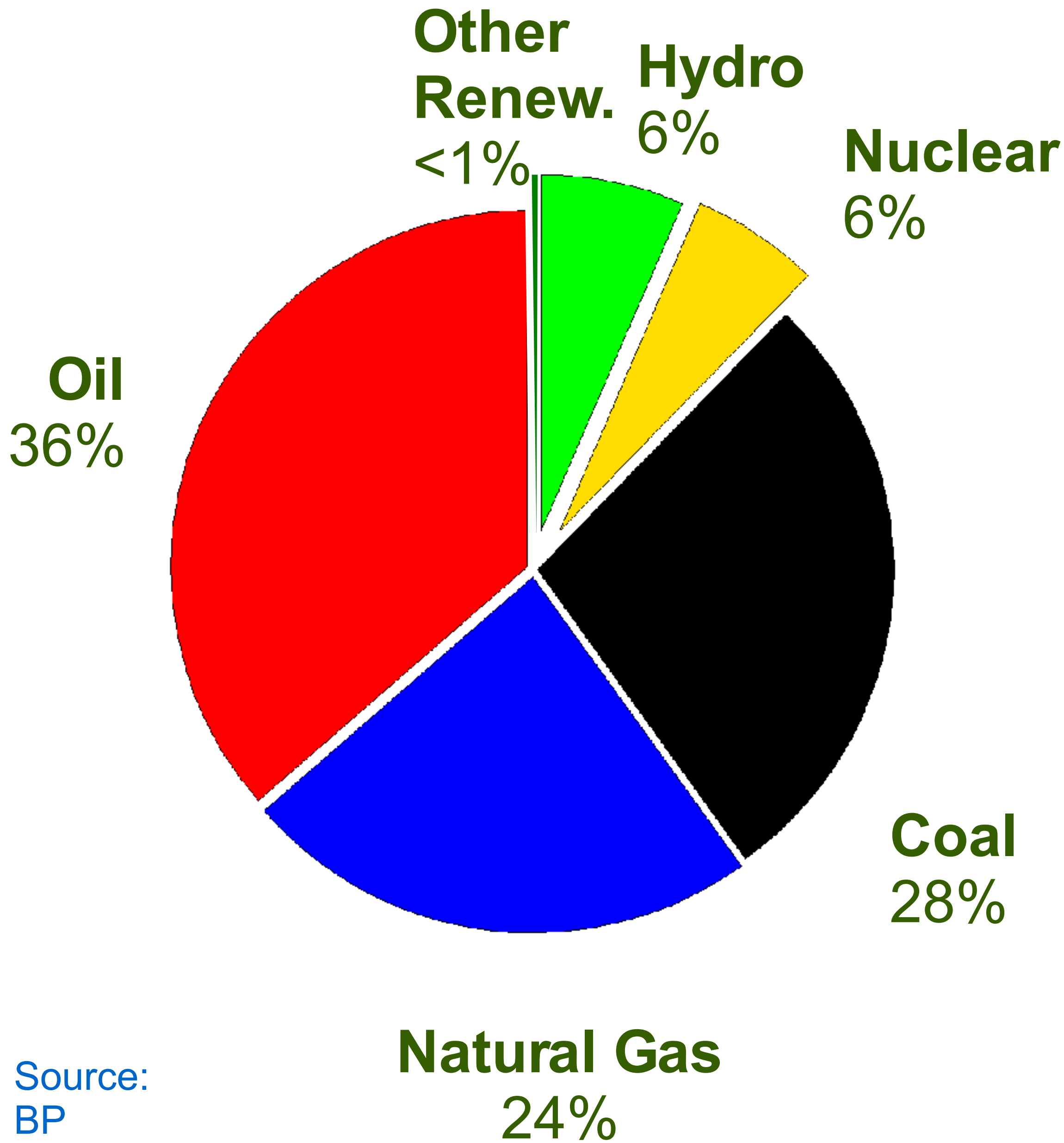
Source:
Open University

The Scale of Human Energy Use



Source:
BP/Open University

Globally Traded Energy, 2005

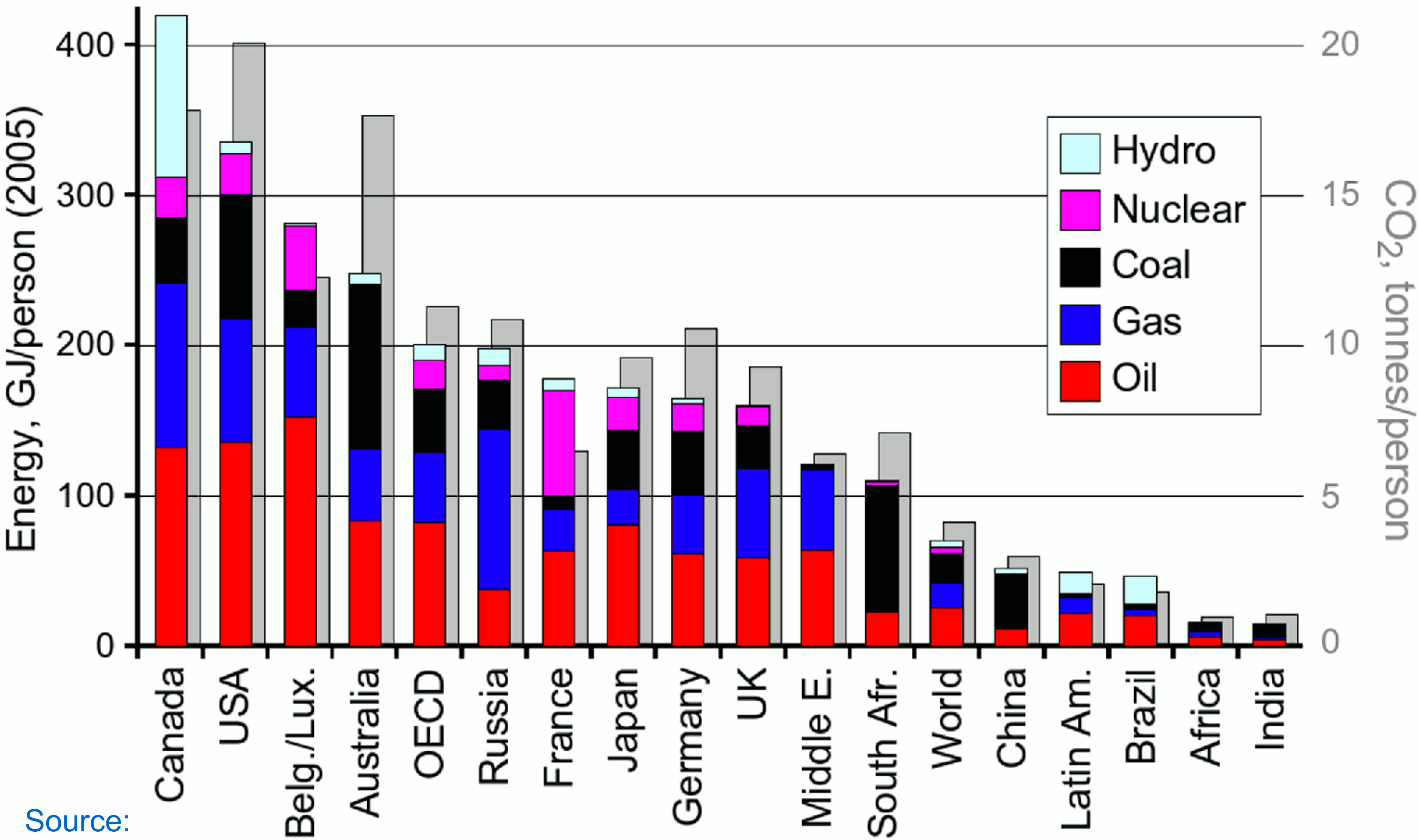


Consumption:	EJ
Oil	161
Natural Gas	104
Coal	123
Nuclear	26
Hydro	28
Total	**442**

88% fossil fuels!

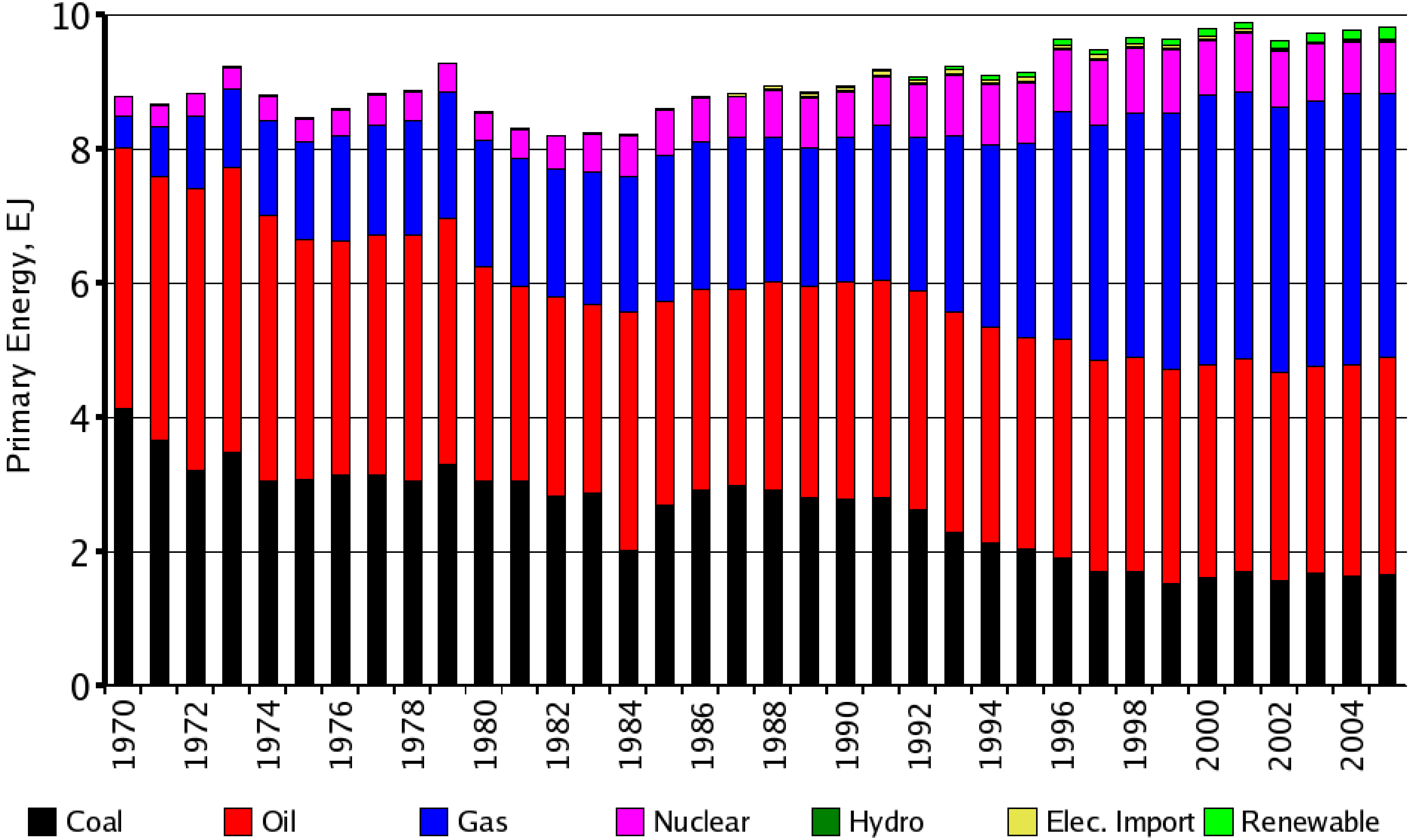
Source:
BP

Energy and Inequality, 2005



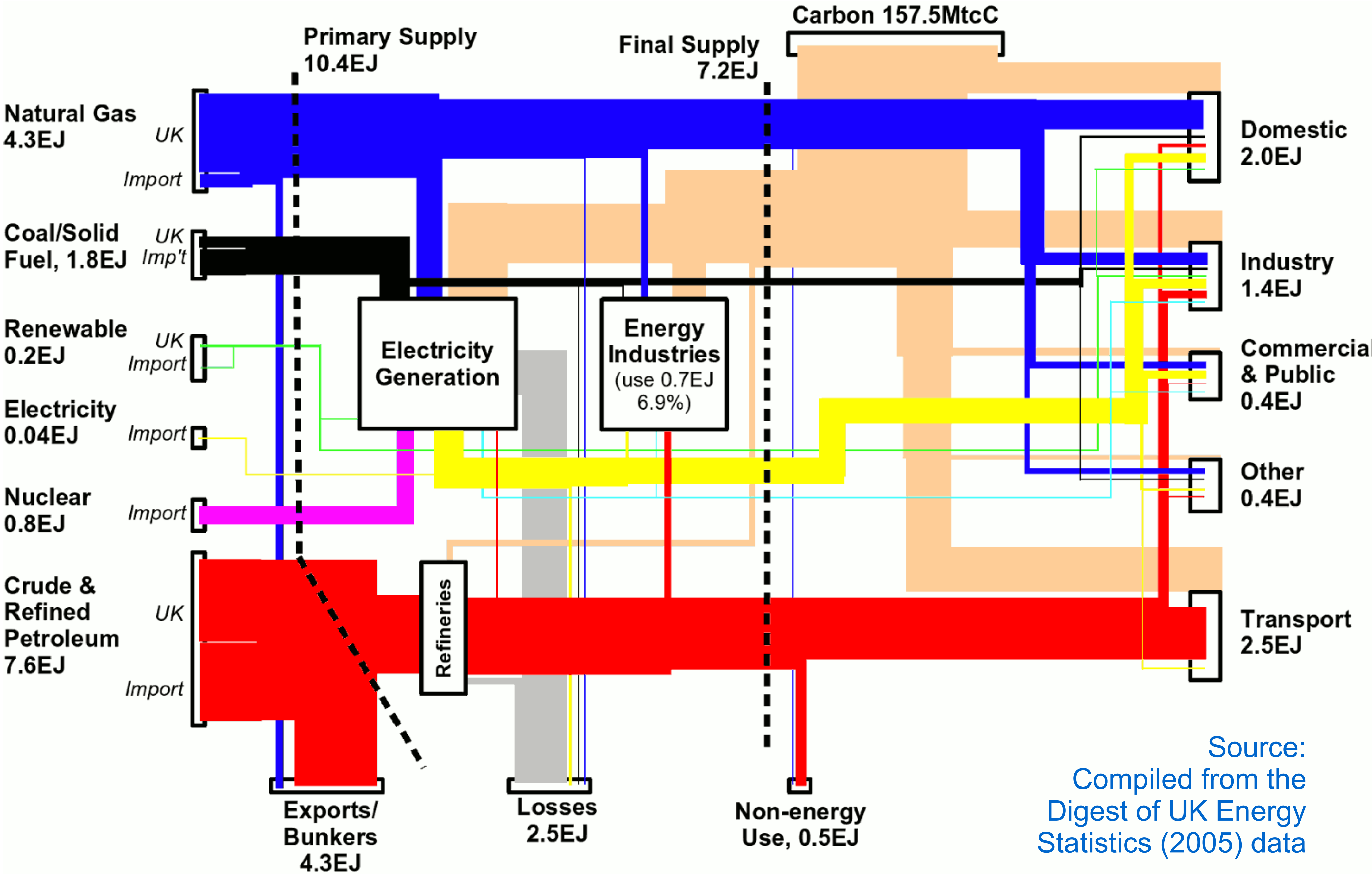
Source:
BP/IEA

UK Primary Energy Supply, 1970-2005



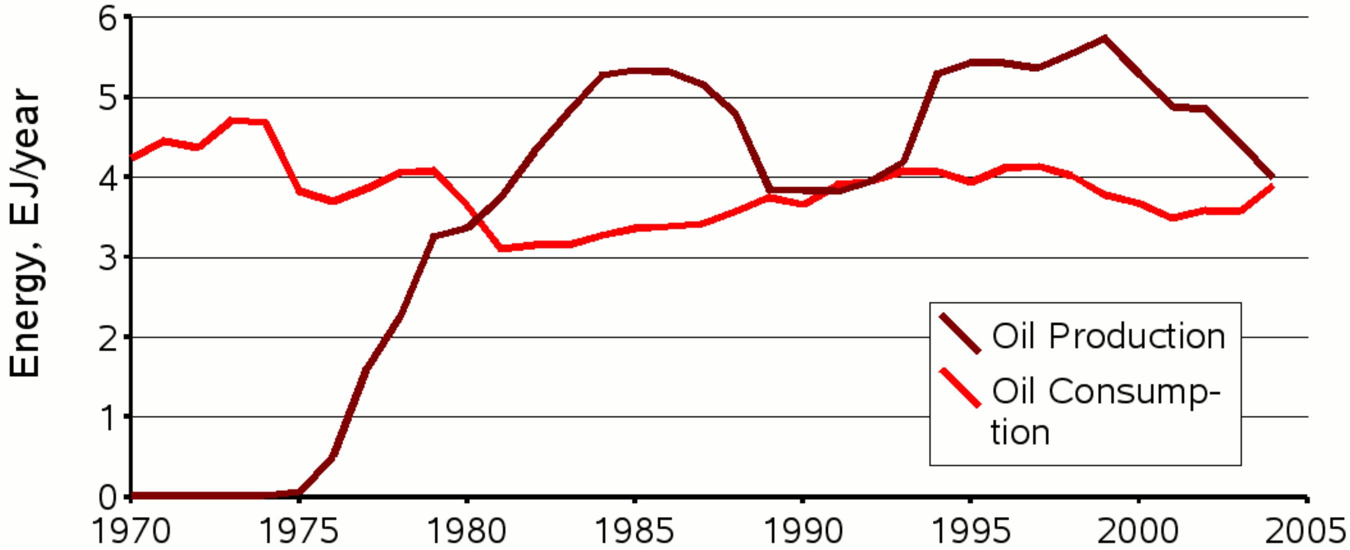
Source:
Digest of UK Energy Statistics 2006, DTI

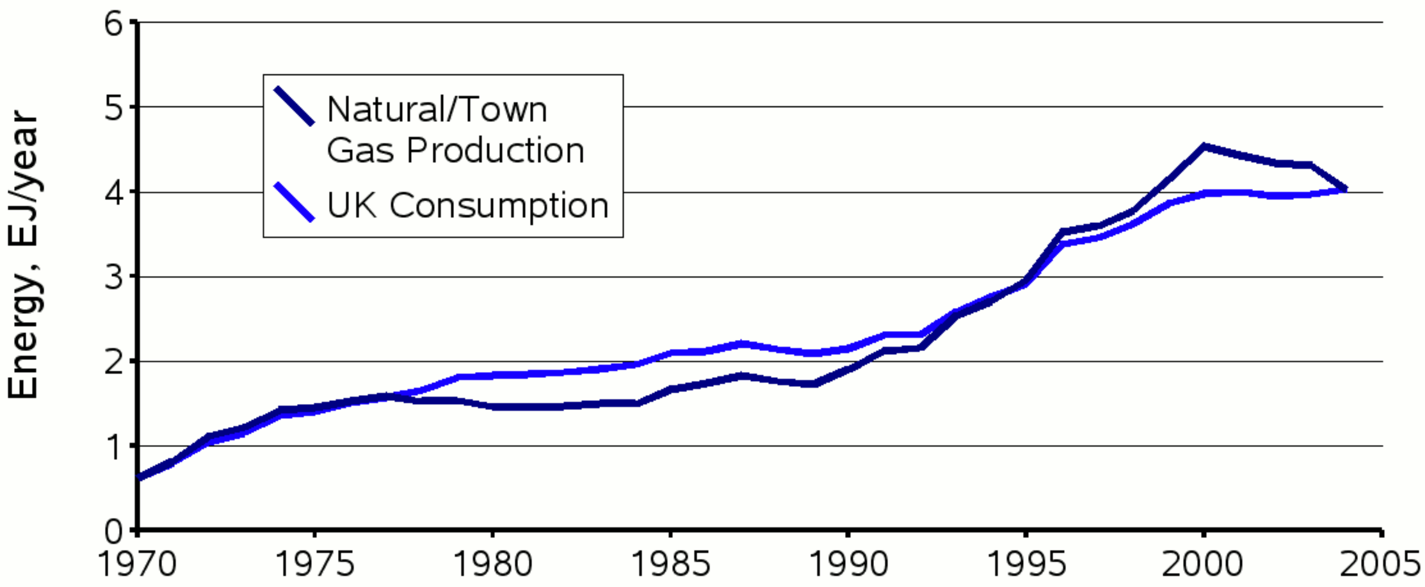
UK Energy and Carbon Flowchart, 2005



Source:
Compiled from the Digest of UK Energy Statistics (2005) data

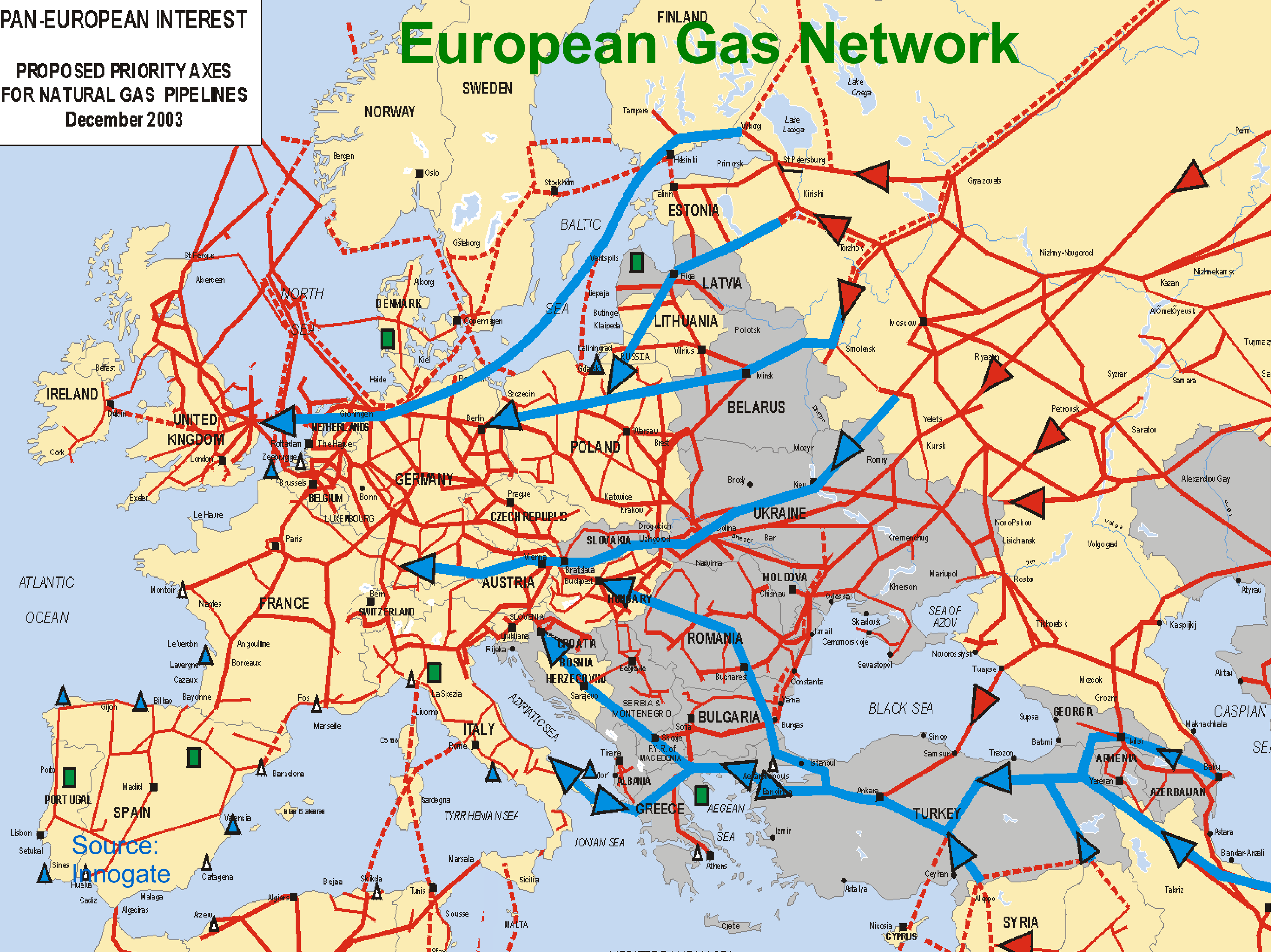
UK Oil and Gas Production





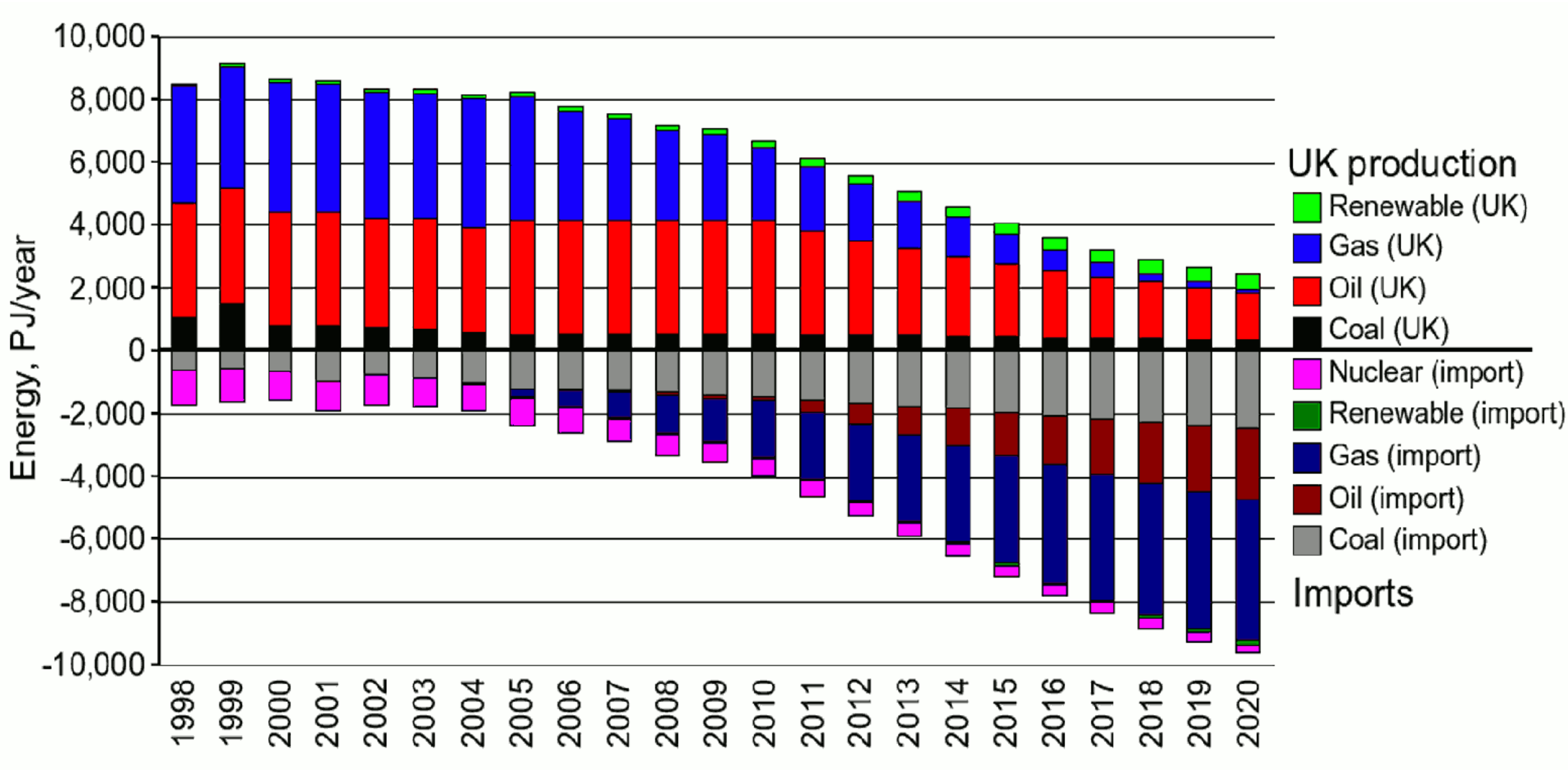
Source:
Digest of UK Energy Statistics 2005, DTI

European Gas Network



Source: Inogate

Change in Imports



Source:
UK Joint Energy Security of Supply (JESS) Committee

What's Renewable?

Wind

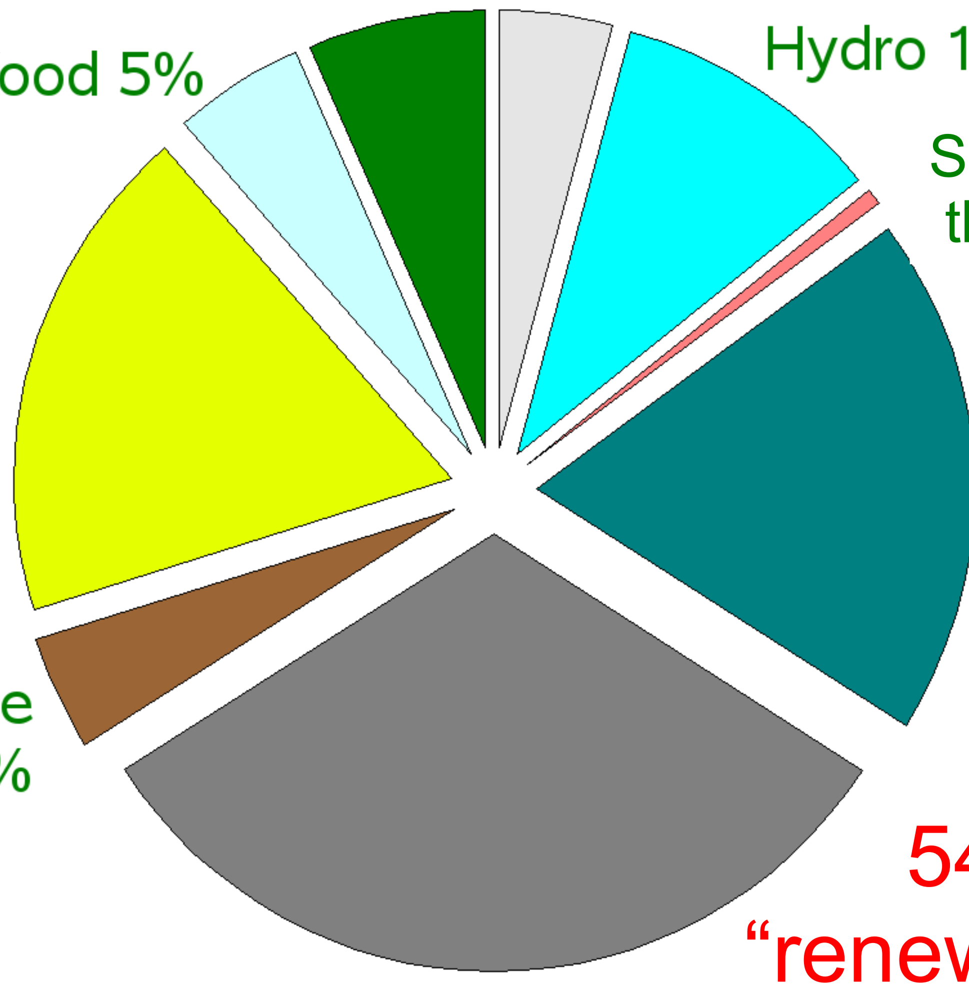
Wave

Hydro

Solar PV

Thermal solar

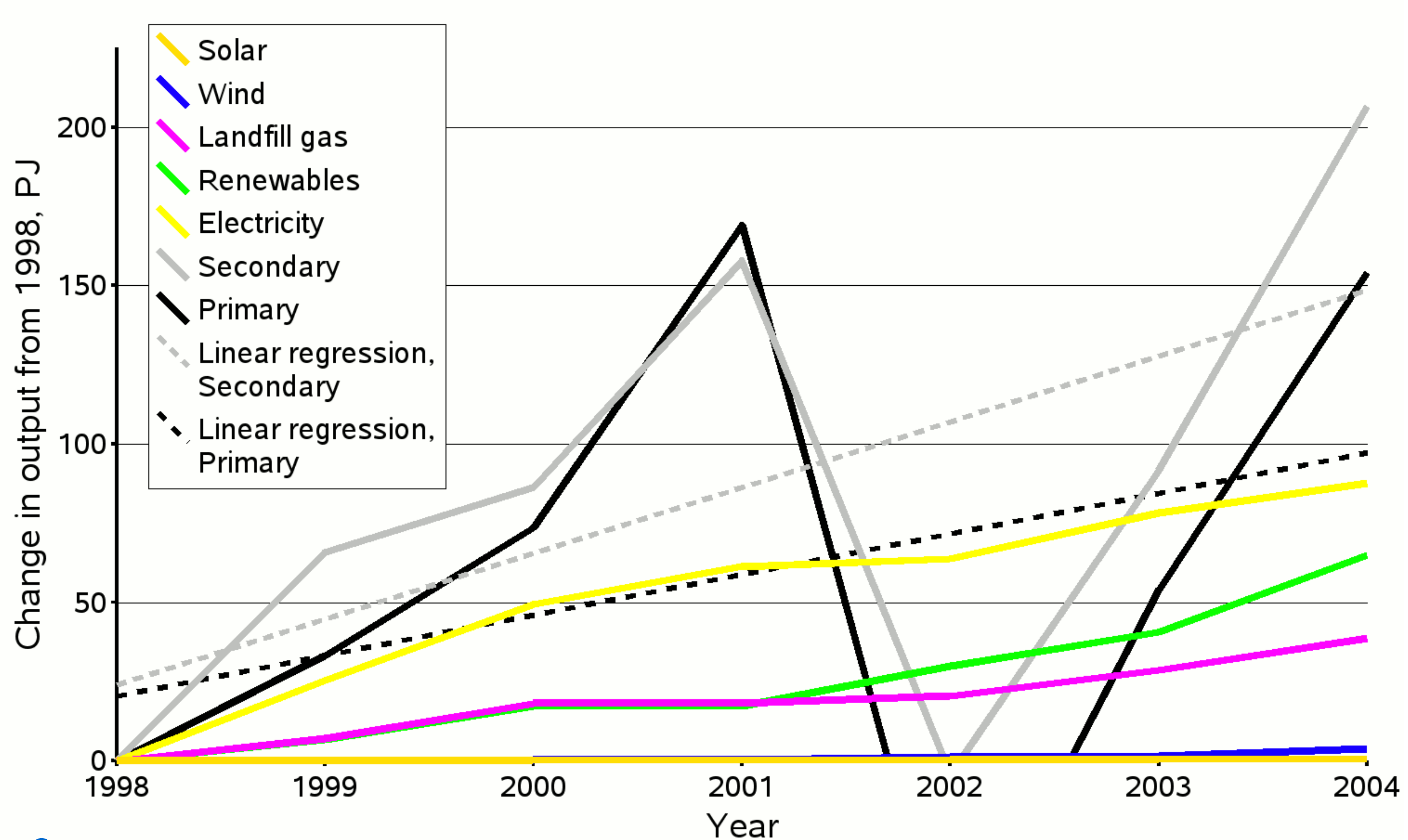
UK "Renewable" Energy, 2005



54% of our "renewable" energy is pure rubbish!

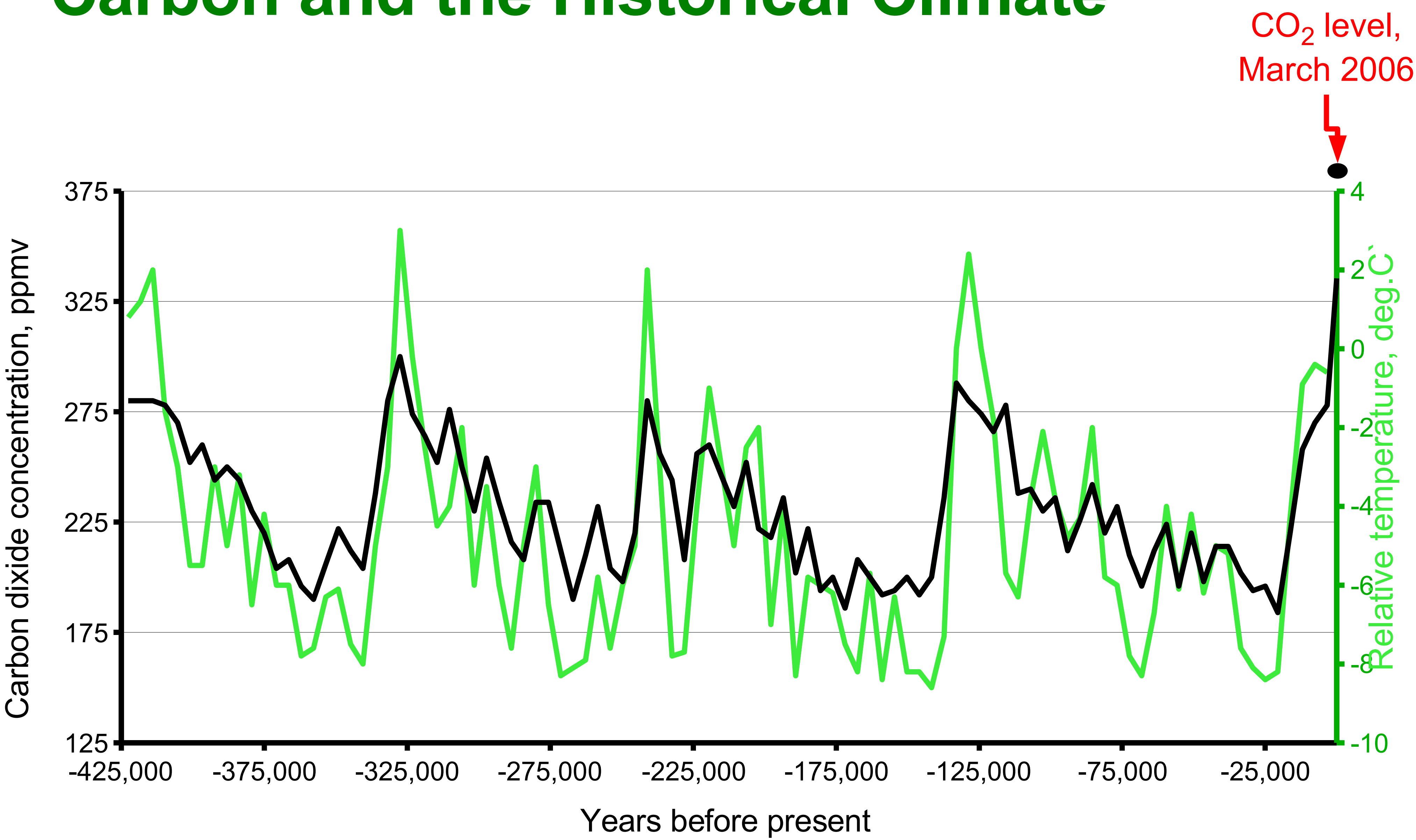
Source:
Digest of UK Energy Statistics 2006, DTI

Does Renewable Energy Matter?



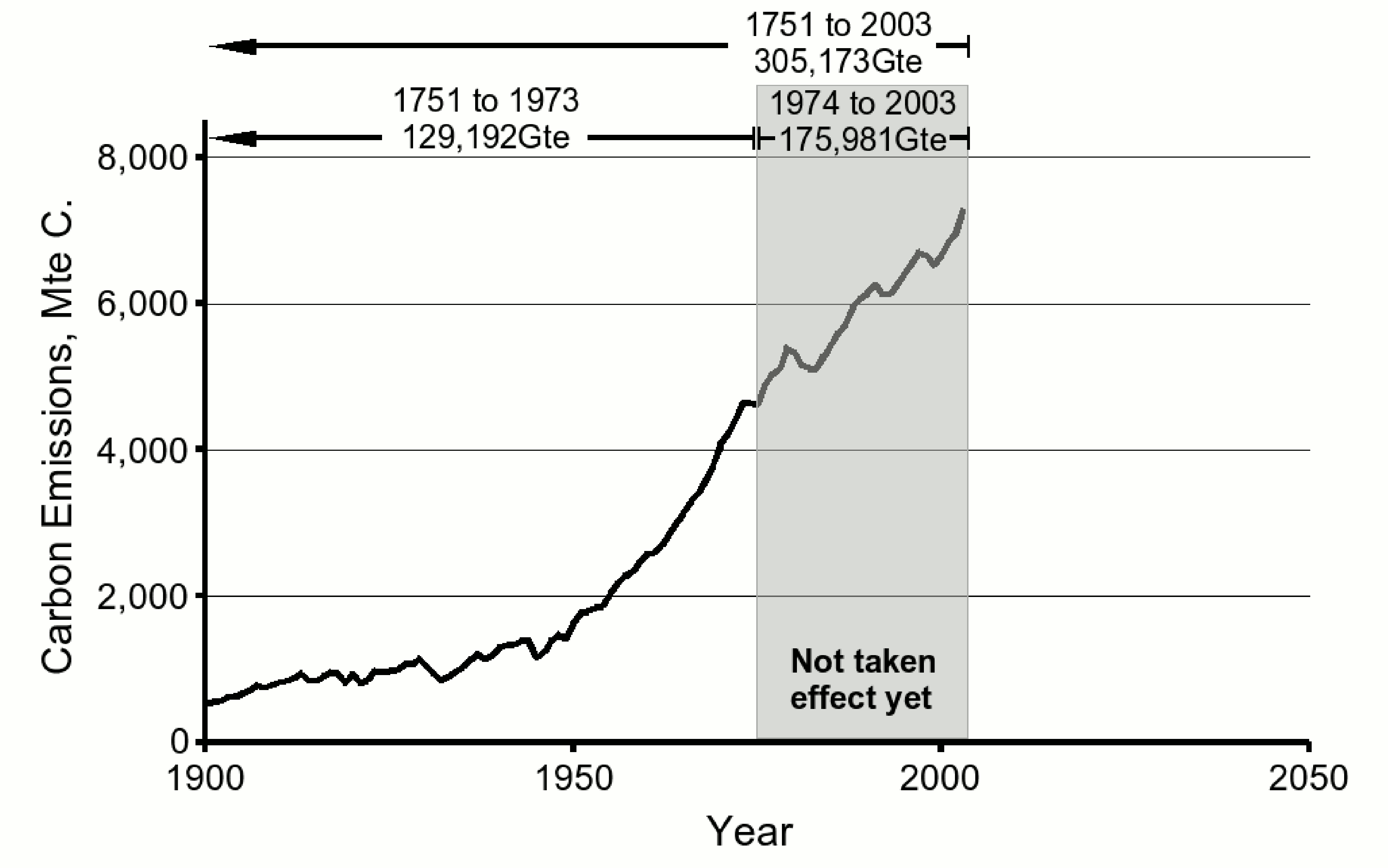
Source:
Digest of UK Energy Statistics 2005, DTI

Carbon and the Historical Climate

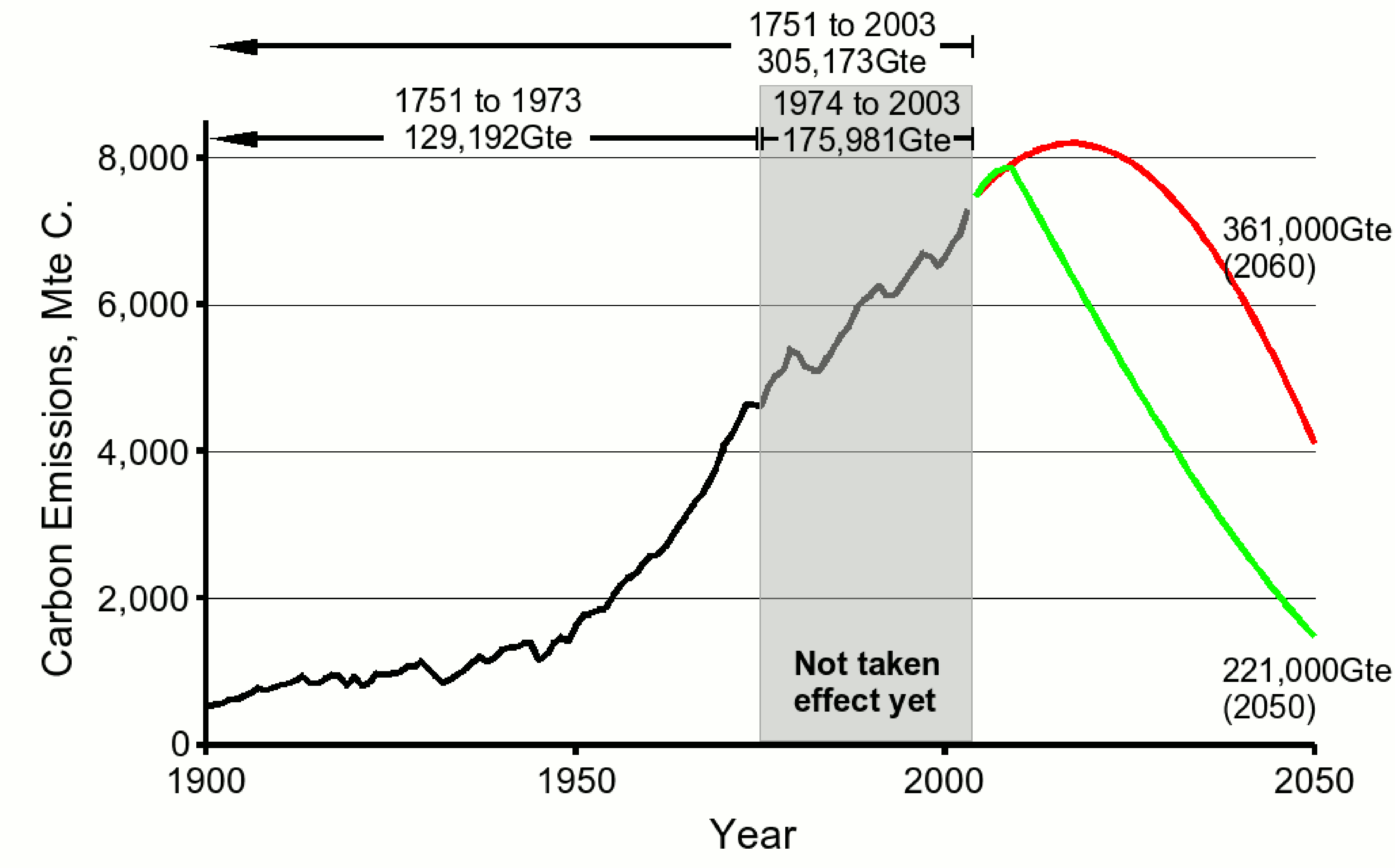


Source:
RCEP/Hadley Centre

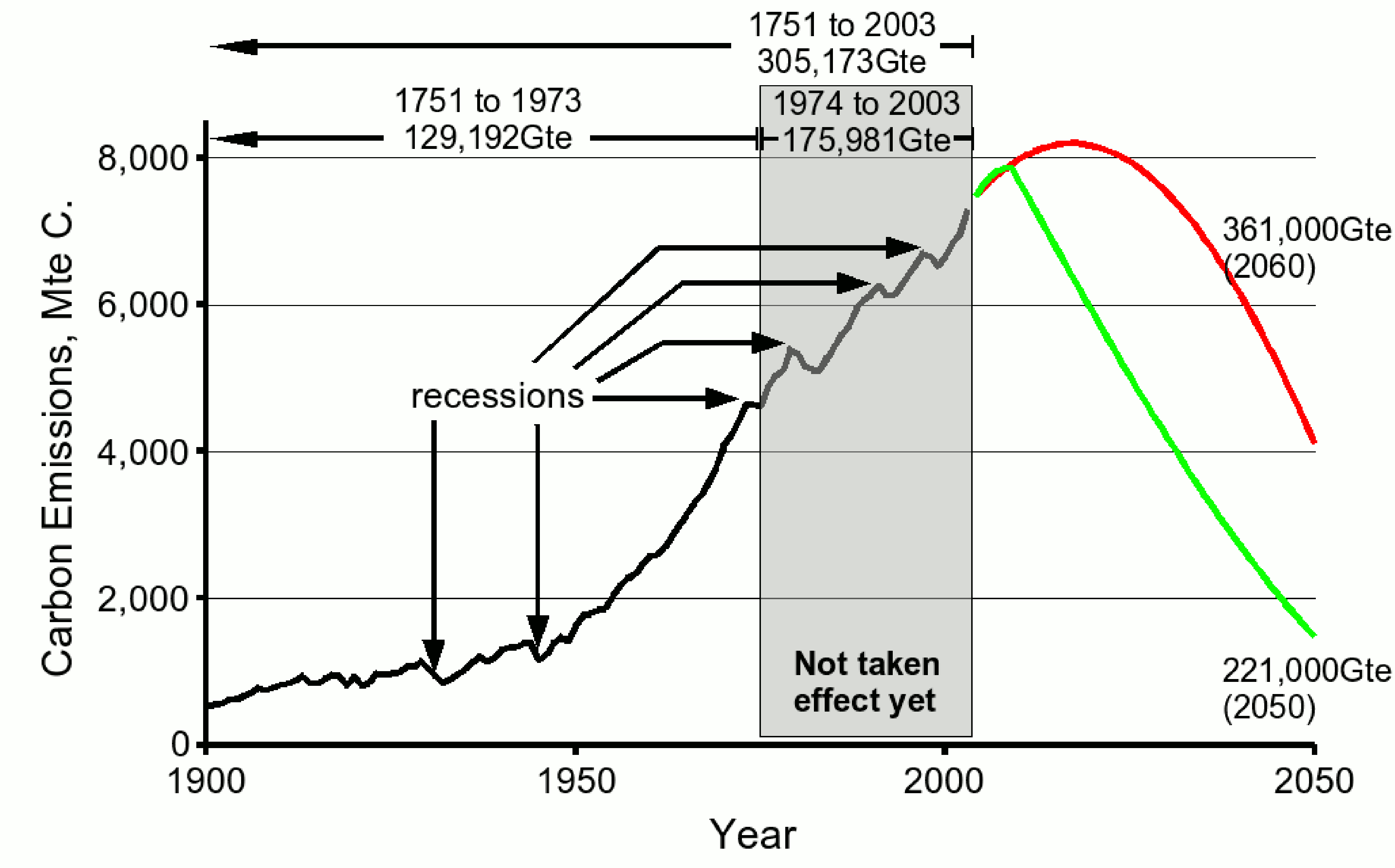
How Much Carbon?



How Much Carbon?



How Much Carbon?



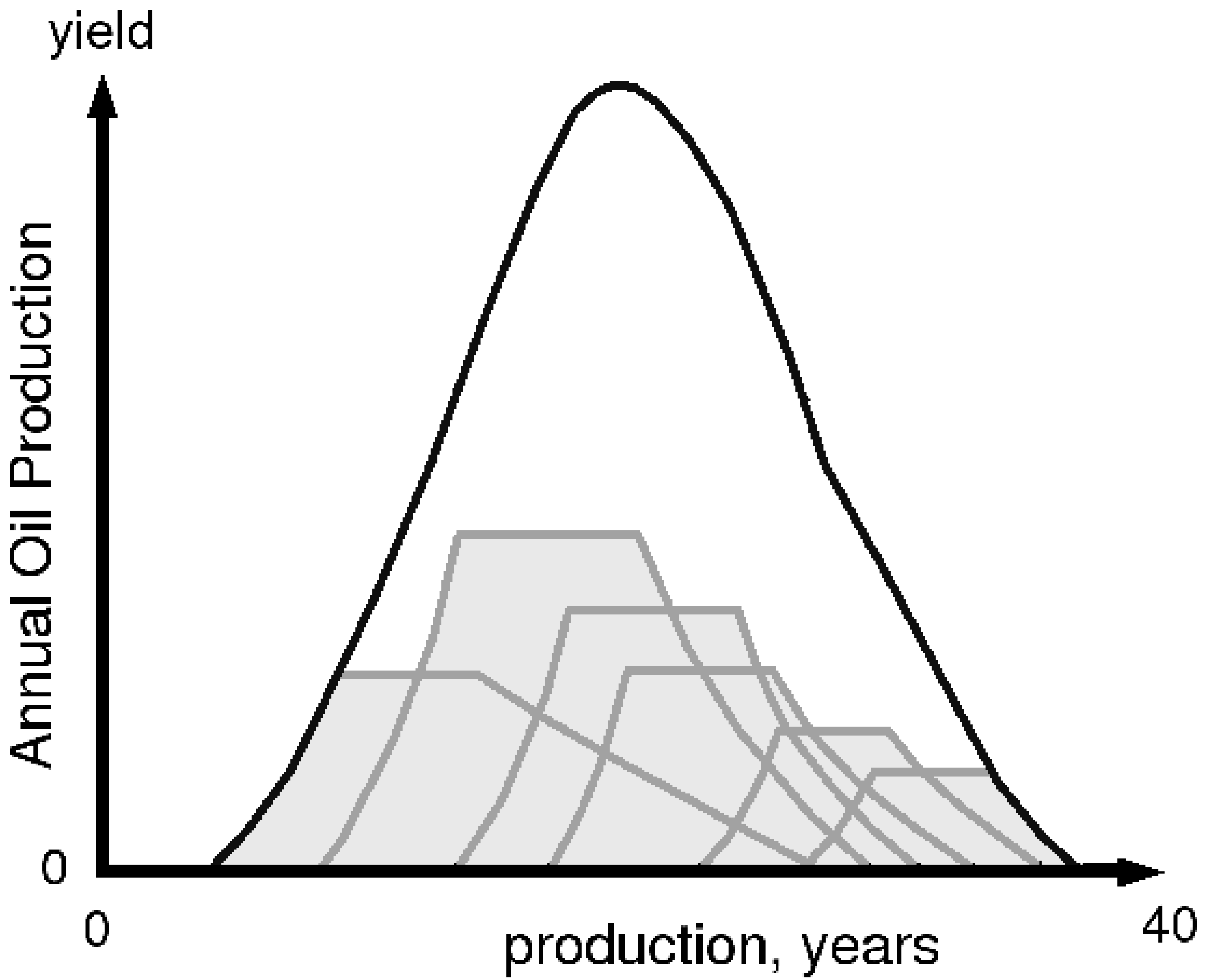
The Real Problem...

"In 2004, carbon dioxide emissions were 4 per cent below their 1990 level and latest projections show that carbon emissions will be 14 per cent below 1990 levels by 2010. Carbon emissions per unit of UK output fell 31 per cent between 1990 and 2004, but this improvement was largely offset by a 39 per cent increase in the size of the economy.

Energy – Its Impact on the Environment and Society 2005
Department of Trade and Industry 2005

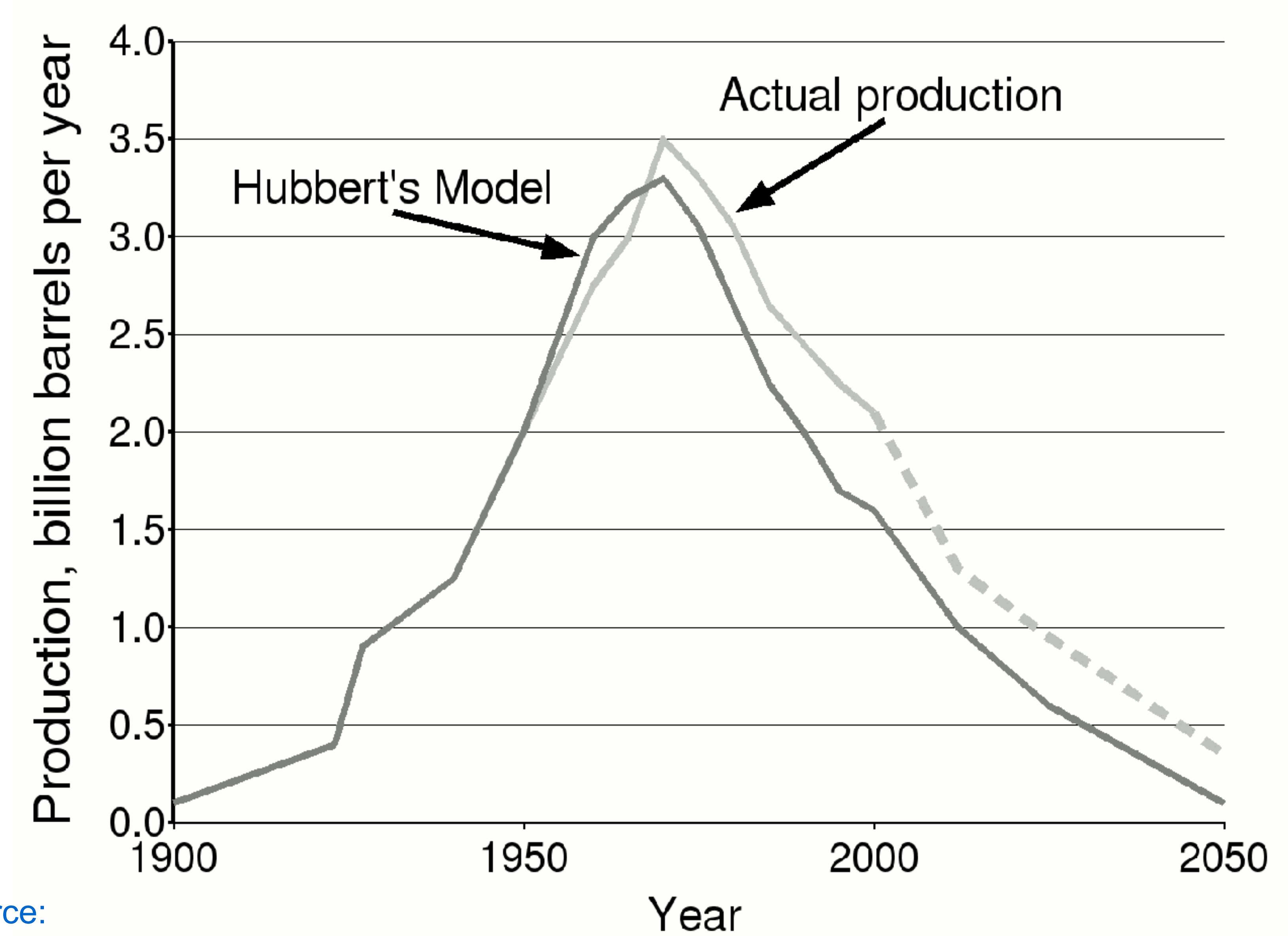
In short,
<u>the problem is the growth in consumption, not carbon</u>

Conventional Oil Production



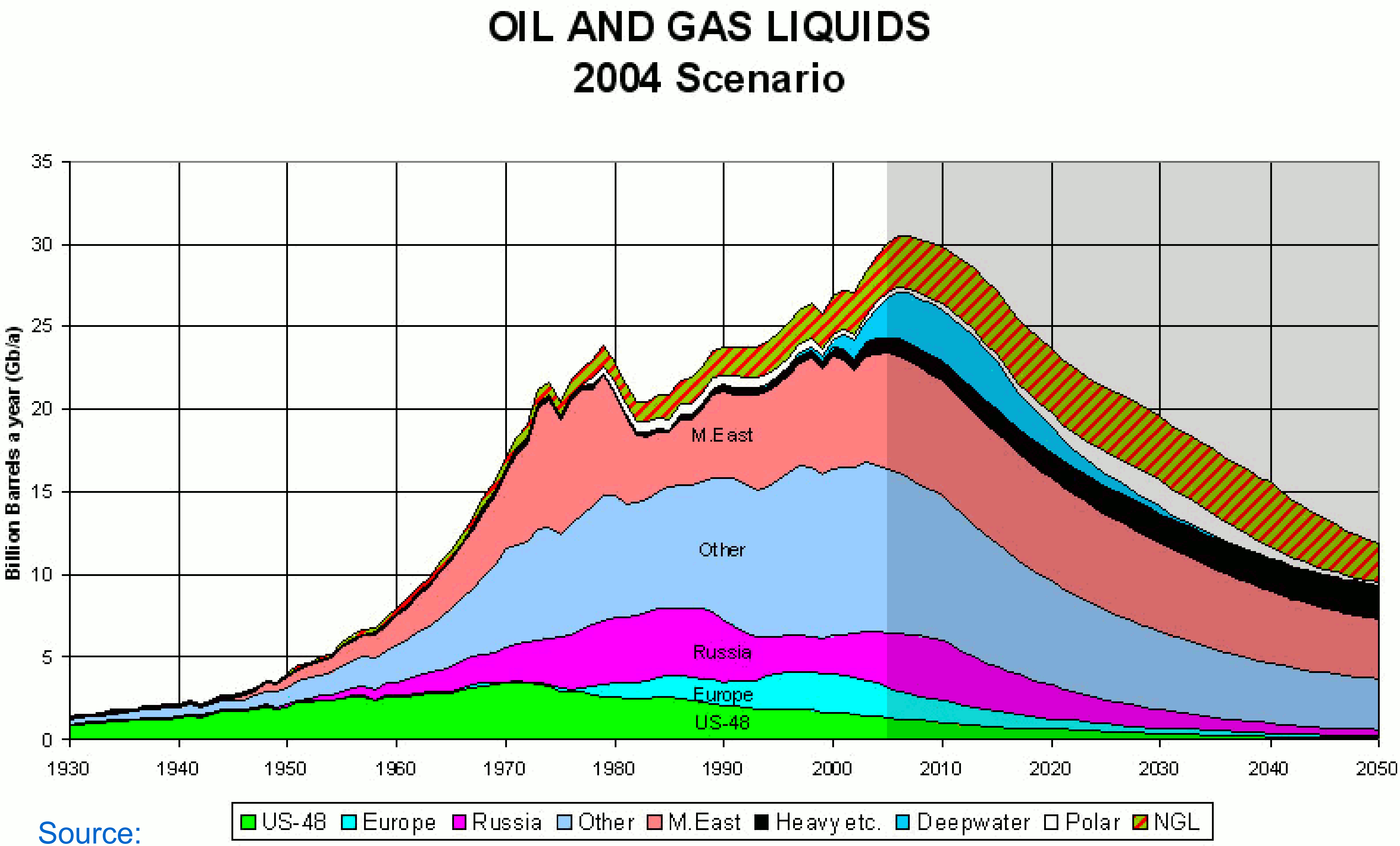
Source:
Campbell & Laherrere 1998

Hubbert's Peak



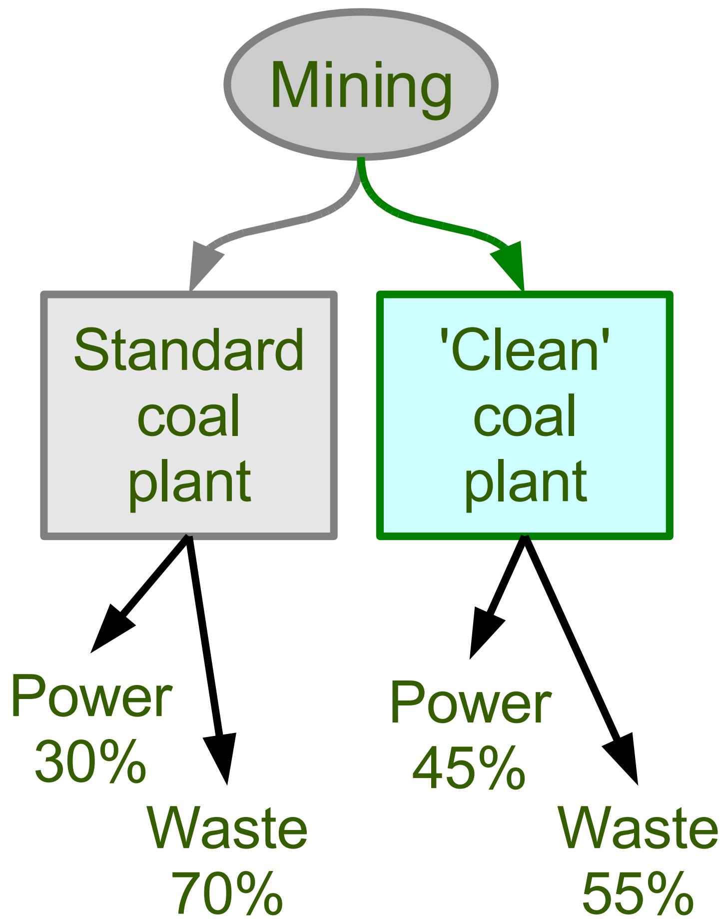
Source:
Open University

The Global Peak



Source:
ASPO

What About Coal?



A. UK 'economic' coal reserves ≡ 1,500 million tonnes

B. UK coal consumption ≡ 58 million tonnes/year

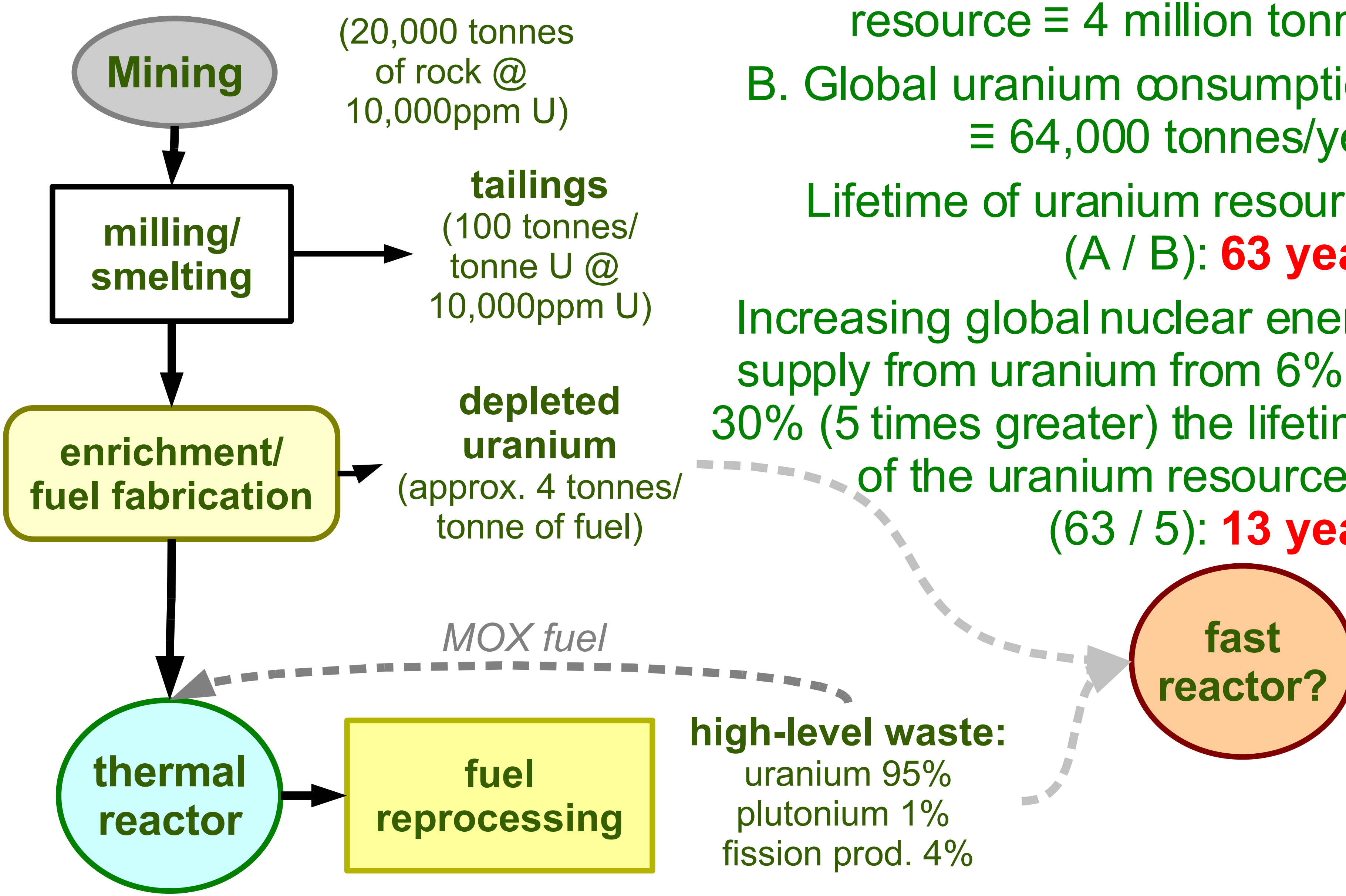
Lifetime of reserves at current consumption (A / B): **26 years**

C. Coal required to provide 30% of the primary energy supply (ignoring inefficiency of conversion) ≡ 111 million tonnes/year

Lifetime of UK reserves at @ 30% of primary supply (A/C): **13.5 years**

Sources: OU/BP Statistical Review of Energy

What About Uranium?



A. Global 'proven' uranium resource ≡ 4 million tonnes

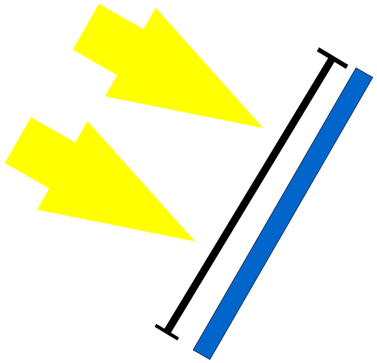
B. Global uranium consumption ≡ 64,000 tonnes/year

Lifetime of uranium resource (A / B): **63 years**

Increasing global nuclear energy supply from uranium from 6% to 30% (5 times greater) the lifetime of the uranium resource is (63 / 5): **13 years**

Source: IEA/OECD-NEA/WNA

Flux: The Limitation on Energy

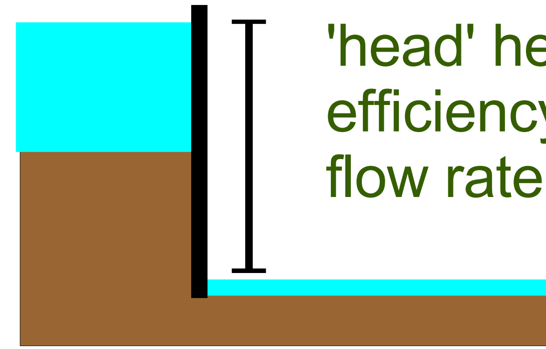


surface area x
efficiency x
insolation

solar thermal/

solar PV

flux = sunlight

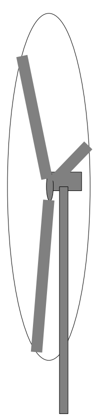


'head' height x
efficiency x
flow rate

hydro/

tidal impounds

flux = water flow

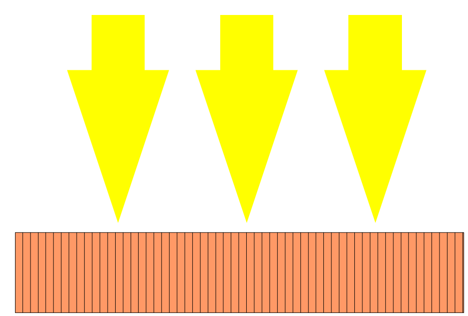


swept area x
efficiency x
flow rate x
density

wind/

tidal stream

flux = wind/water flow



crop yield
x
efficiency
x
area/year

biomass

flux = crop yield/area

Biomass

Solar radiation,
36,000GJ/ha/year 100%

↓

Absorbed by plant,
1,836GJ/ha/year 5%

↓

Biomass produced,
230GJ/ha/year 0.6%

↓ *combustion-based power generation*

Power output,
70GJ/ha/year 0.2%

Source: OU

A. Net energy produced from one hectare (2.5 acres) of intensively produced short rotation coppice, less power generation losses ≡ 5MWh/year

B. UK power generation in 2003 ≡ 400,000,000MWh

C. UK land area ≡ 24,290,000 hectares

Number of UK's required to provide just the UK's electrical power (one-fifth of total energy consumption) from biomass ([B / A] / C): **3.3**

Biofuels

Solar radiation, 36,000GJ/ha/year — 100%

↓

Absorbed by crop, 1,836GJ/ha/year — 5%

↓

Biodiesel produced, 41GJ/ha/year — 0.1%

↓

10,500 miles travelled/year

A. Amount of land, producing intensively grown oilseeds for rapeseed methyl ester, required to fuel one average (9,000 miles per year) car for one year ≡ 0.85 hectares.

B. Number of cars on the UK's roads ≡ 30,000,000

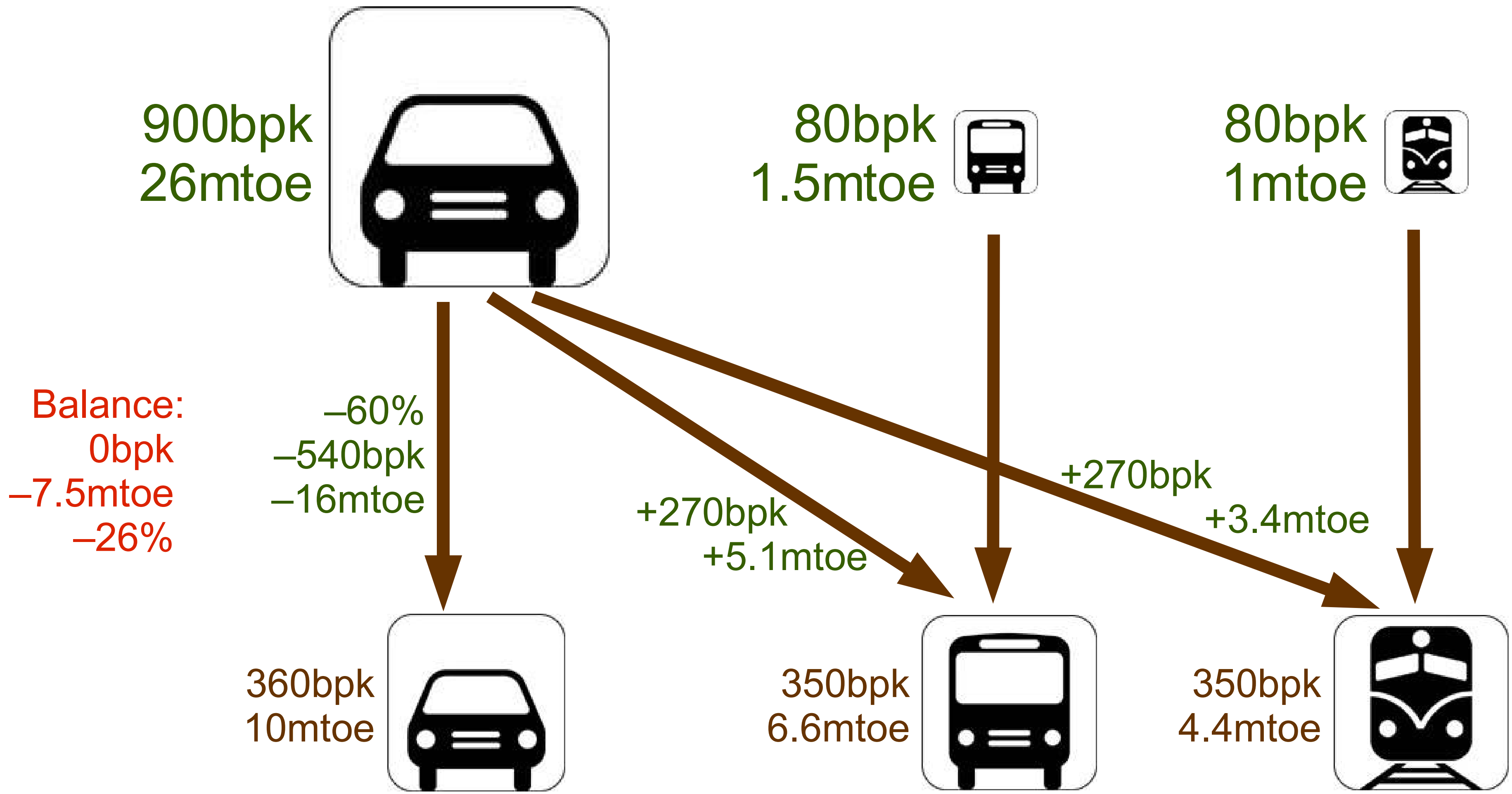
C. UK land area ≡ 24,290,000 hectares

Number of UK's required to provide biodiesel for the car fleet ([A x B] / C): **1.0**

Source: DEFRA

Energy and Transport

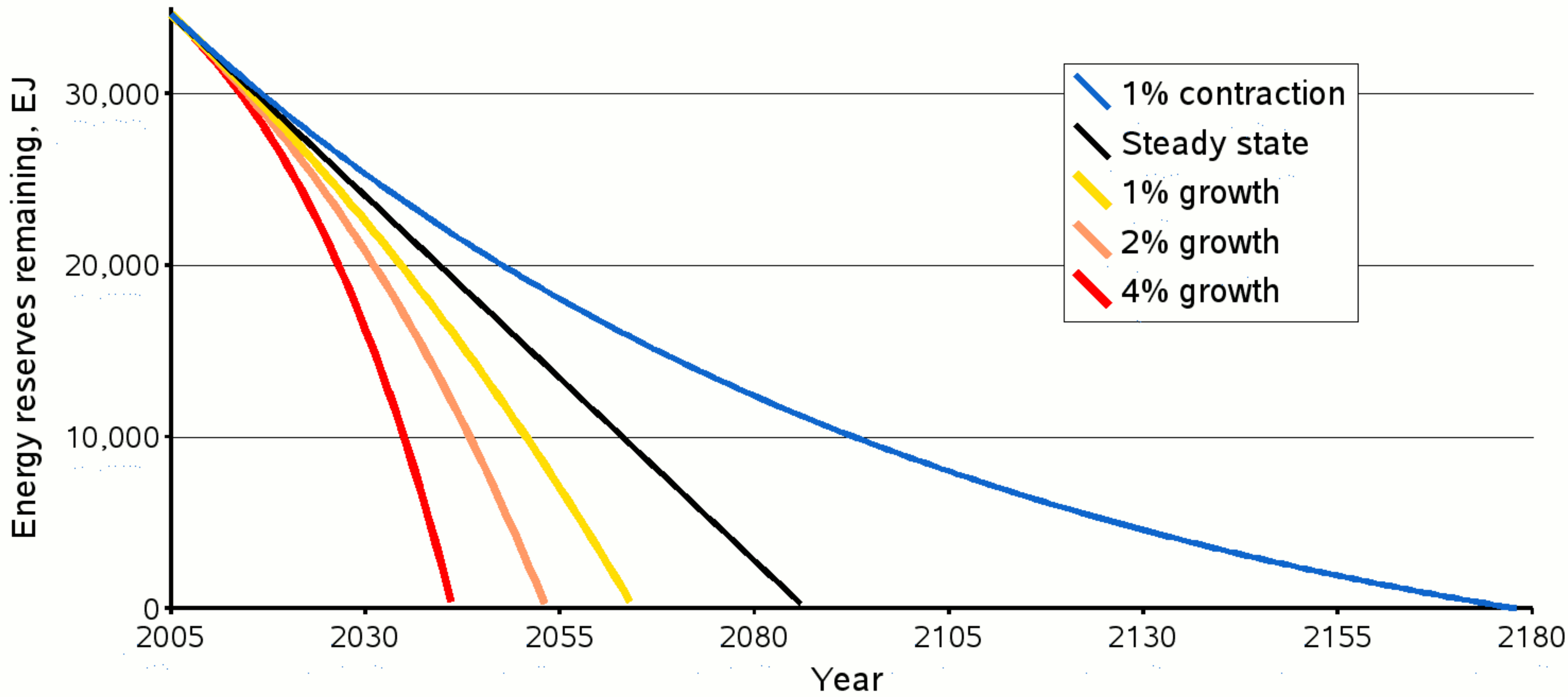
Cutting the use of cars by 60% and moving demand to buses/trains
only cuts the energy consumption in road passenger transport by 26%



Source: BP/IEA

How Long Will It All Last?

Resource	"Proven/ probable" resource	Annual consumption	Equivalent value of resource	Consumption EJ/year (2005)	R/P ratio, years
Oil (conventional)	1,201	30 billion barrels	6,856	172	40
Natural gas	179,850	2,750 billion cu. m.	6,777	104	65
Coal	909,100	5,853 million tonnes	19,370	123	158
Nuclear (uranium)	4,000	64 kilo-tonnes	1,632	26	63
Total (all resources)			34,634	424	82



The Simple Solution...

Why n☺t just

HAVE LESS?

The Likely Future

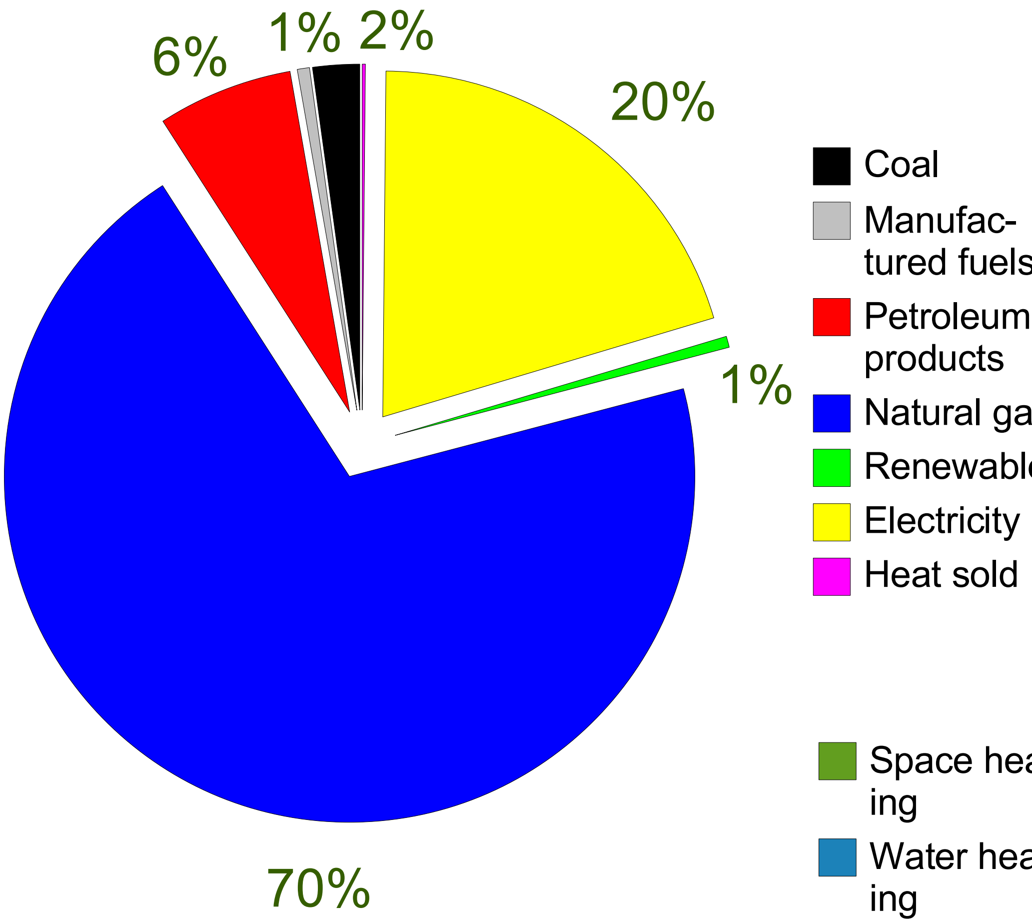
We don't need to produce more energy, we need to use less!

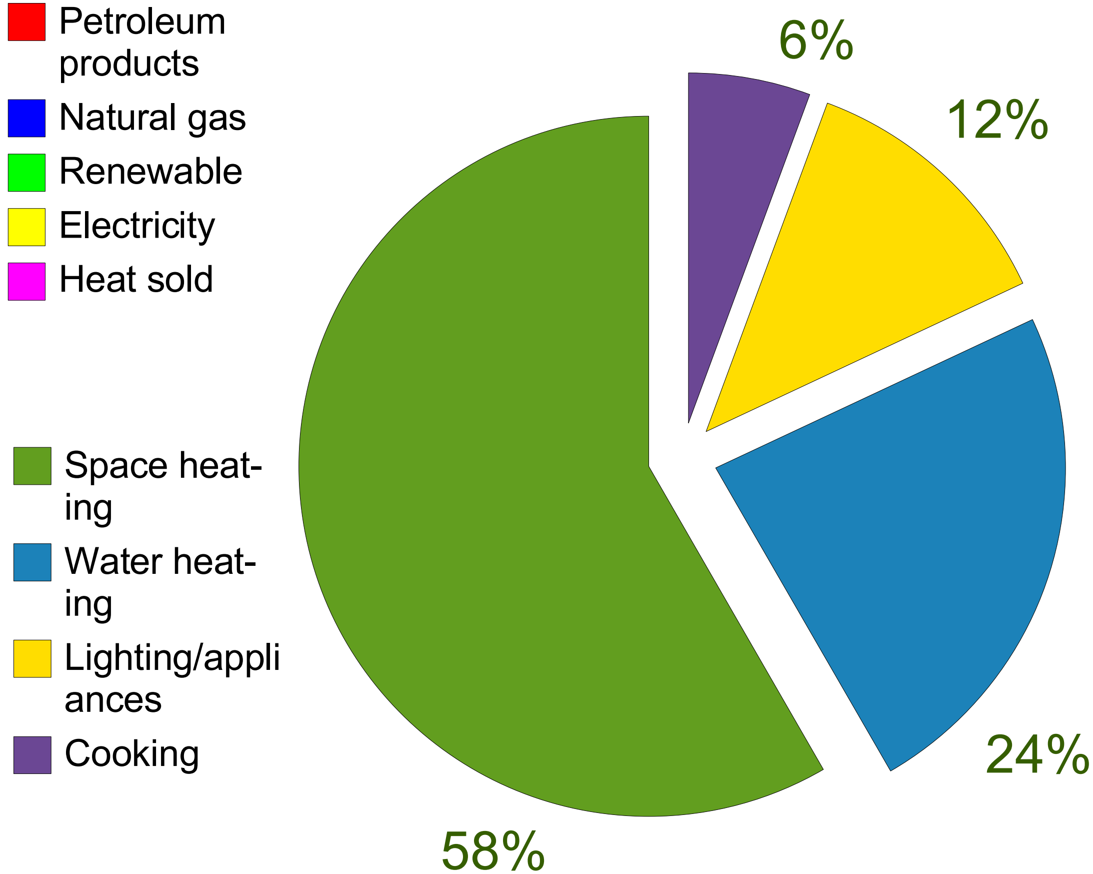
- Petroleum will become very expensive within 10 years and will be in short supply within 20.
- Gas will become expensive. Just as more people are switching to gas, this too will begin to run short around 2030.
- Coal creates problems because of climate change, and nuclear has problems because the uranium won't last long.
- Renewables can't fill the gap – wind needs back-up/storage, biomass needs massive land area that it would affect agriculture, and other options have a low power density.

In short, renewables might supply 30% to 40% of the UK's current energy use. That means cutting use by 60% to 70% over 60 to 70 years.

Domestic Energy Use

So, if standby devices use 10% of your lighting/ appliance consumption, that's 10% of 12% = 1.2%! (not a lot compared to the space heating load)



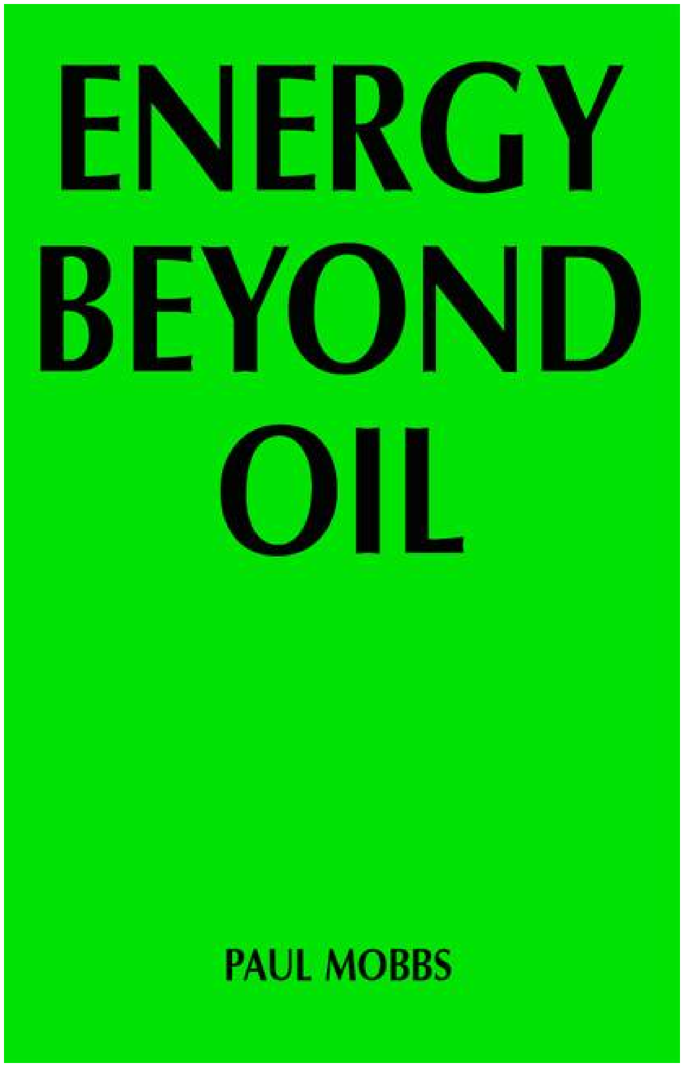


Source:
DTI

Some Quick Ideas...

- **Get out of debt!**
- Cutting energy use – 50% of domestic consumption is space heating, and 25% water heating (low energy light bulbs won't solve the problem – *only saves about 4.5%!*).
- Energy reduction becomes more difficult to achieve the more you cut, so it's actually easier to look at on-site energy production (micro-generation) to offset consumption.
- Solar systems can reduce hot water demand by 50%, but for larger savings you'll need to do some major engineering on the house and install a solar roof and heat store – note that a thermal system is more productive (and cheaper) than PV
- You need to tackle your use of commodities – the easiest way of doing this is gardening to produce food, and developing local networks to supply other goods from within the area.
- You need to set yourself up to travel less within 10 to 15 years.

Finally, read the book!



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