LESS IS MORE?

Energy After Oil

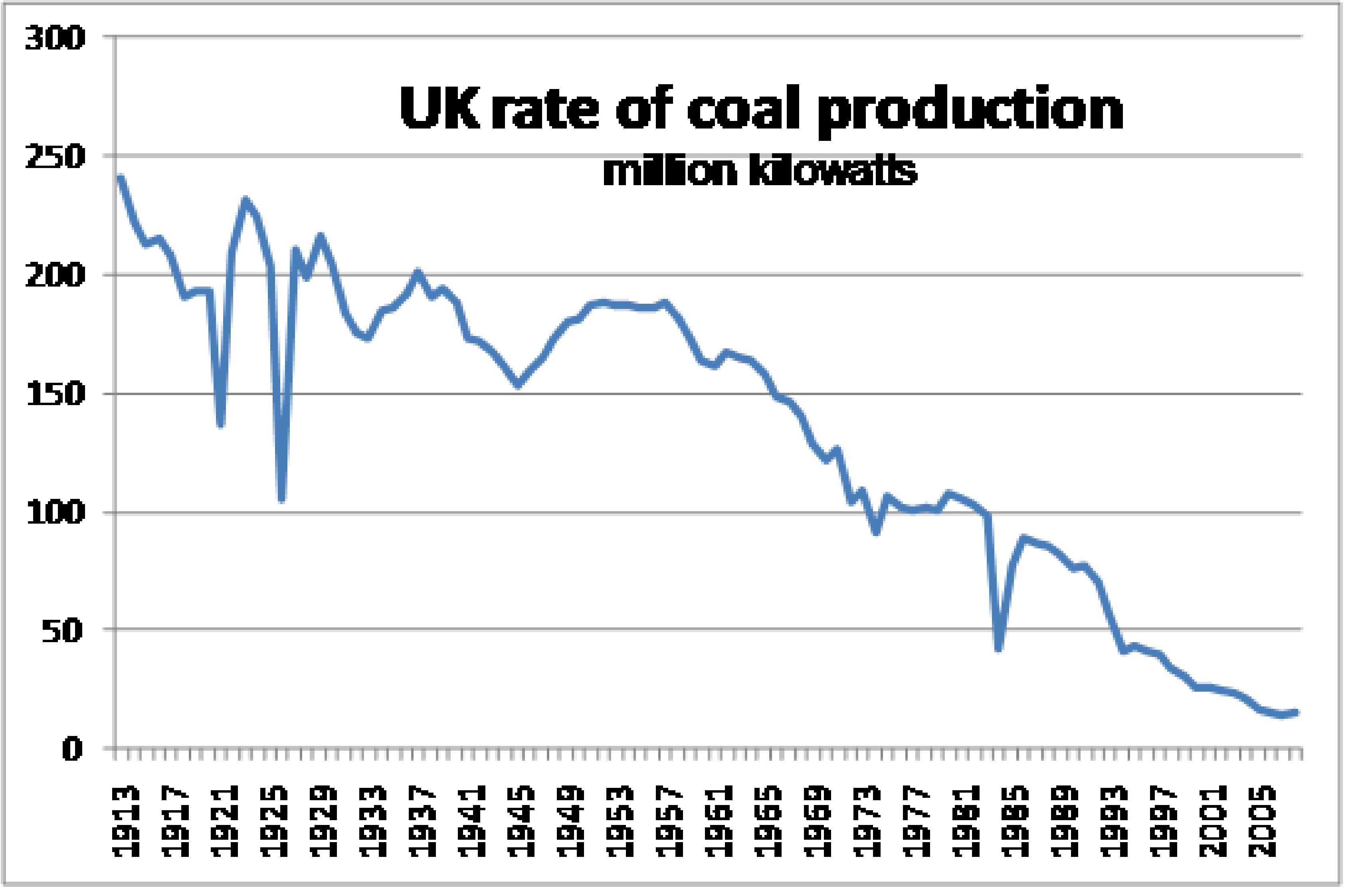
David Olivier

Less Is More?

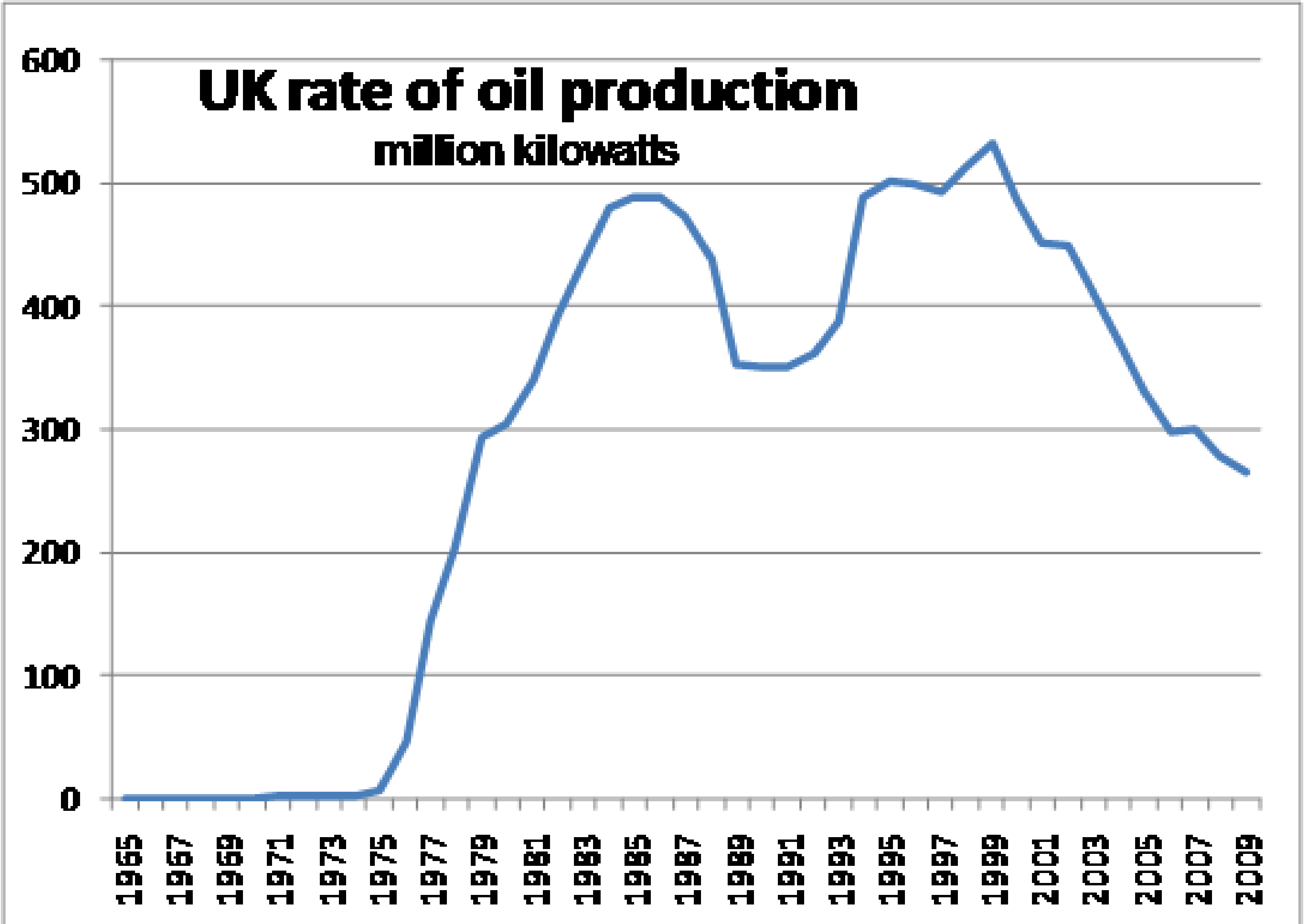
AECB report - in preparation

- A sustainable energy future after oil - using less energy, more productively.
- Climate change policy. What must we do to return atmospheric CO_2 levels to 350 ppm and safeguard world climate?
- The UK has had its peak coal, oil and gas. What next?
- How do the costs of different future energy systems, including energy efficiency, compare to fossil fuels?
- The coming age of scarcity; why we must arguably plan for an absolute decline in energy availability.
- Increased energy productivity; what has the UK achieved, what must it achieve? Thermodynamic realities.
- Changes needed to UK energy policy to deliver a sustainable *and affordable* energy system.

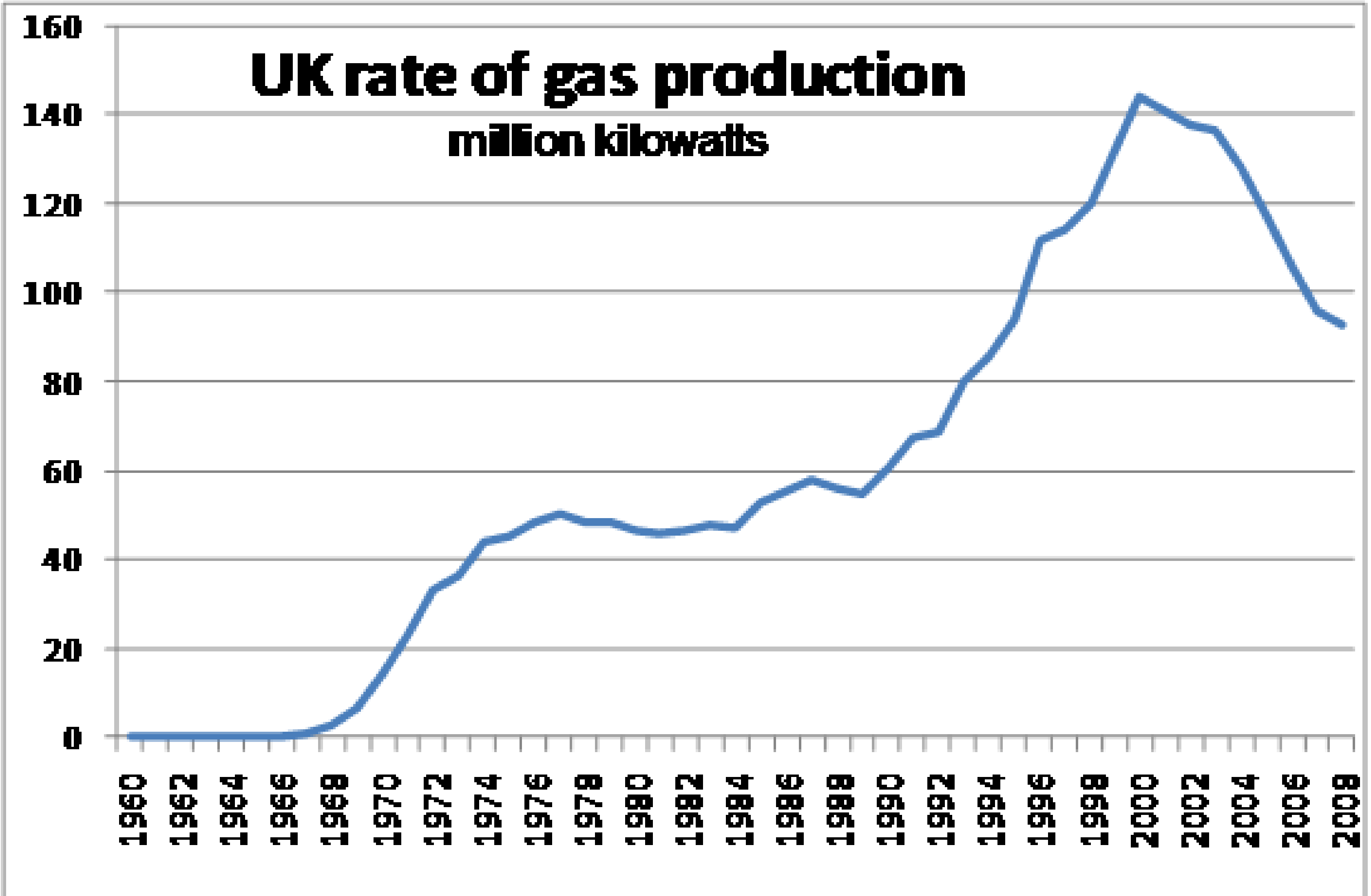
UK Peak Coal Was in 1913



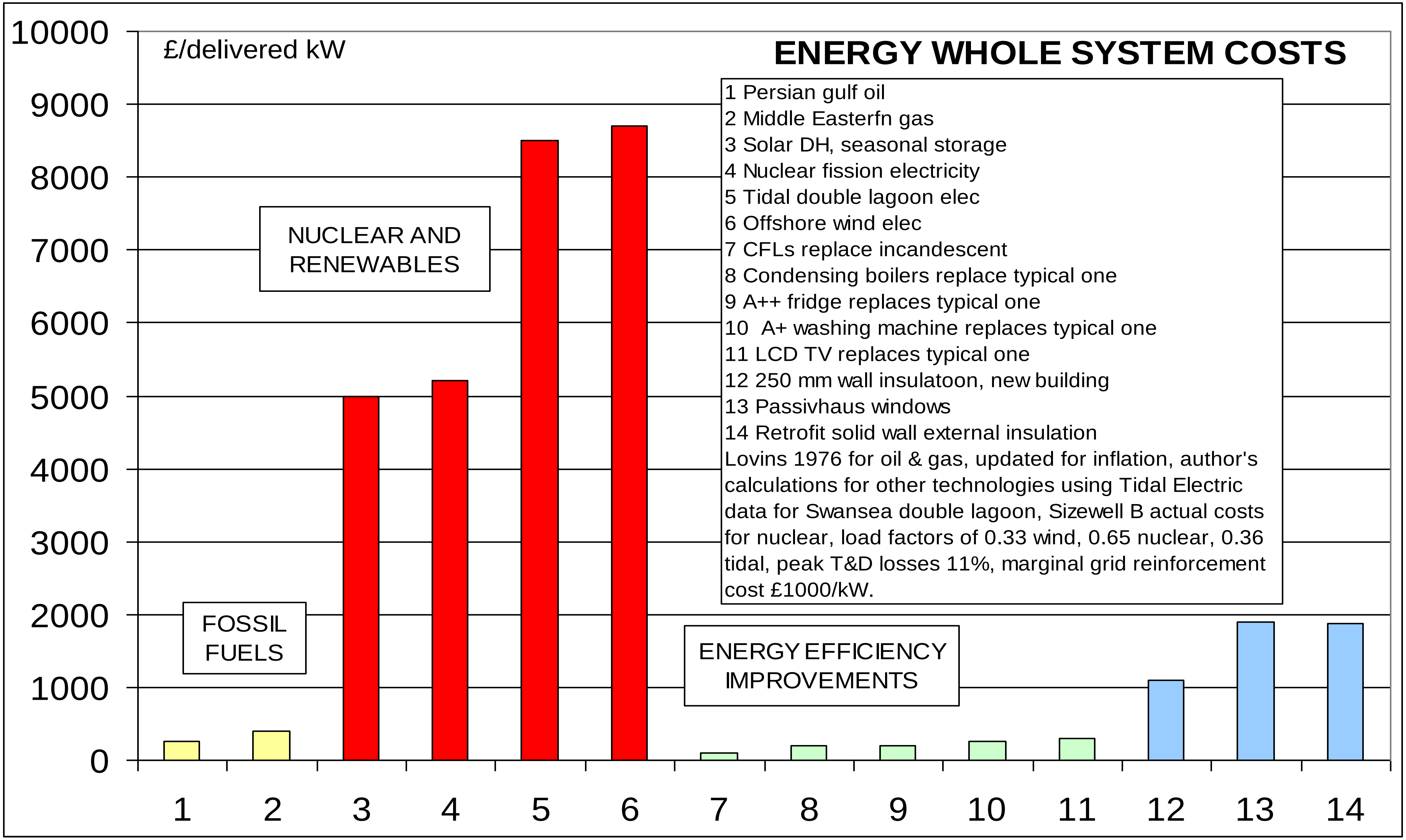
UK Peak Oil Was in 1999



UK Peak Gas Was in 2000



Energy Economics:
The High Costs of Future Energy Supply



Worked Example

- External solid wall insulation is utilised to save heat in a well-heated low-rise detached house in the Birmingham area; i.e., a fairly typical UK climate.
- Done *en masse*, in a mass market, work is assumed to cost £50 per m^2 of wall area. 75 mm phenolic foam reduces the U-value of a plastered solid 215 mm brick wall from 2.1 to 0.24 W/m^2K.
- Calculations with PHPP show that, if done "in order", this measure saves 230 $kWh/yr.m^2$ wall area.
- Cost to "deliver" an average kilowatt of heat to final consumers
  = £ 50x8766/230 = £1,900/delivered kilowatt.
- Illustrative only; not a definitive study.

The Problem

- Future energy sources are more resource-intensive and costly than fossil fuels. (Note that the world market price of oil and natural gas is weakly-related to the cost of extracting and transporting the fuels).

- Electricity supply systems used at low load factor; e.g. for heat, have particularly high costs, expressed in £ per delivered kilowatt or pence per kWh of delivered energy.

- With the rising cost of new energy supply systems, energy supply costs per unit GDP could rise by an order of magnitude, with adverse economic consequences.

Potential Ways Forward

- Unlike new supply, many energy efficiency measures studied to date compete with the resource cost of oil, let alone the market price of oil.

- Lavish, but selective, investment in energy efficiency could keep annual costs at acceptable levels, despite the rise in energy supply costs per kWh.

- We need to give energy efficiency priority over more costly options, otherwise we shall face great economic difficulties.

Improving the Existing Building Stock

1960s cavity-walled, solid ground-floored terraced housing in London, before and after proposed retrofit. Gas-heated.

CO_2 potentially down 82%, without many renewables. Modelled with PHPP. Most measures cost <£40/tonne now, others projected to be <£40 in mass market.

NOTE: Funding request declined in late 2009. Seeking support from other sources.

The Starting Point

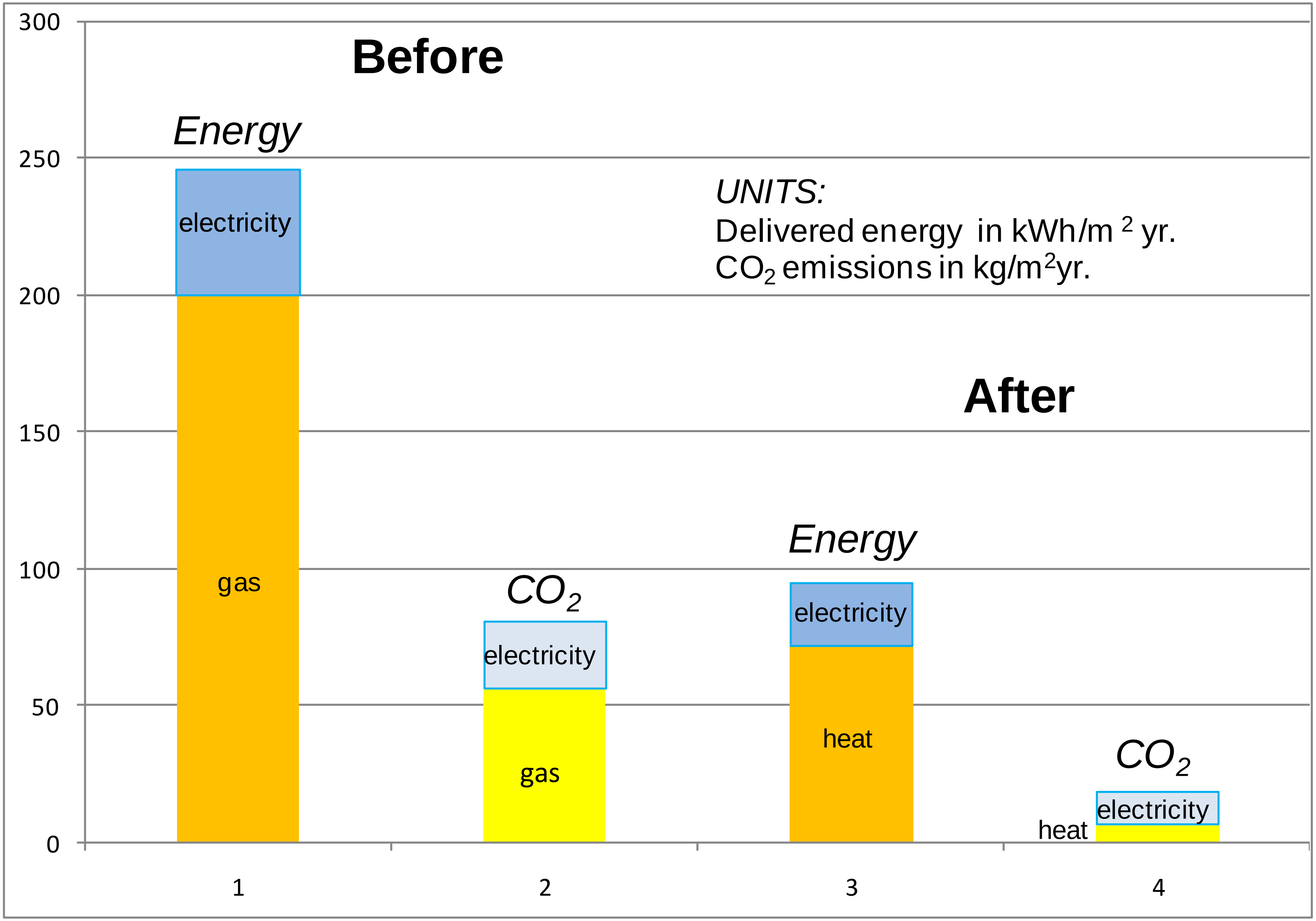
TARGETS:

Space heat down from 200 to 72 kWh/m^2yr

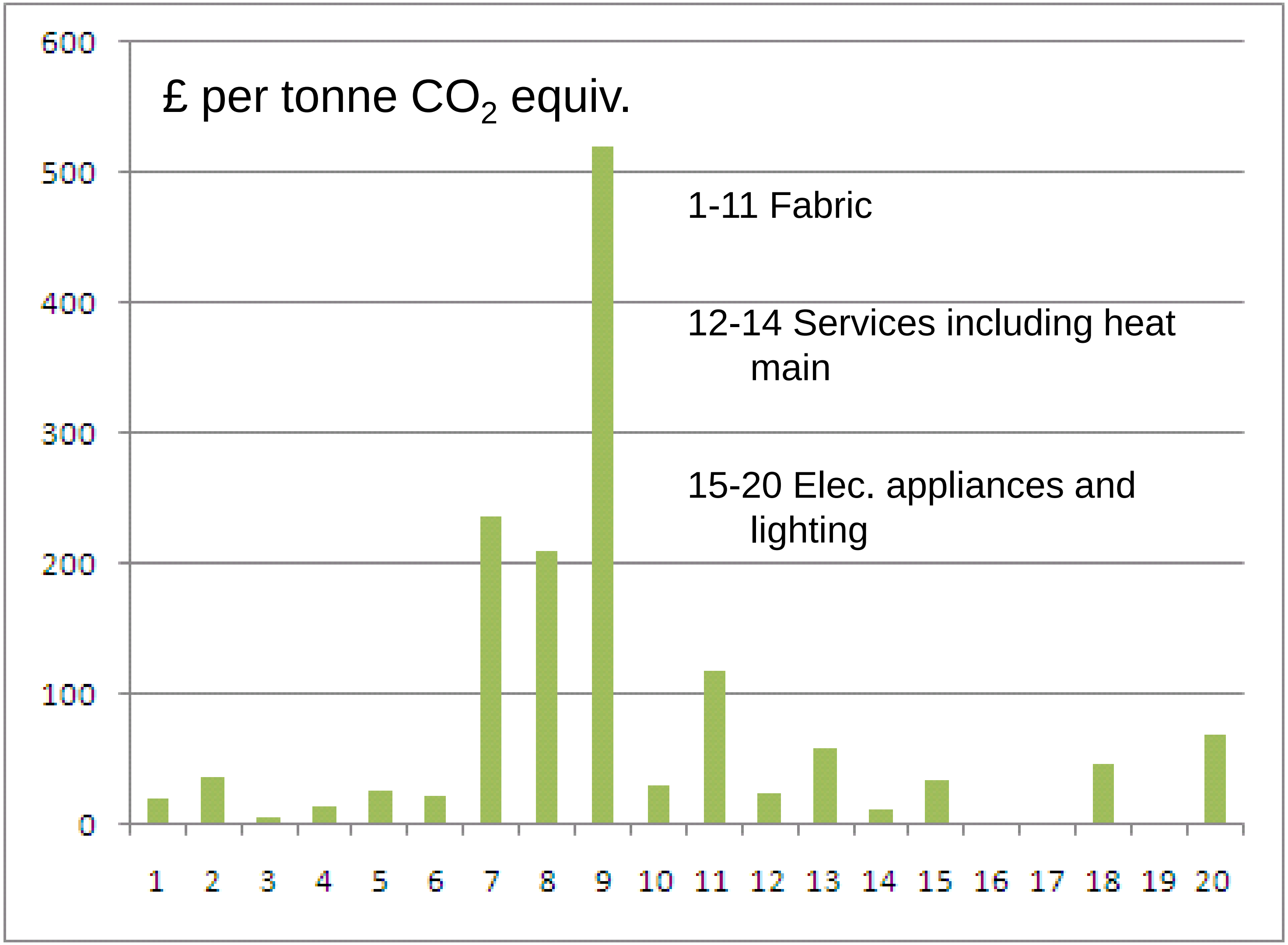
CO_2 emissions per unit of heat down from 0.28 to 0.09 kg per kWh

Electricity for lights and appliances down by 50%.

Delivered Energy and CO_2 Emissions



Cost of Some Measures Analysed



CHP and Elec. Heat Pumps

Pictures courtesy www.logstor.com, www.pipesystems.com www.isoplus.de and John Cantor Heat Pumps Ltd.

Bottom left - Danish heat transmission line

Centre - PEX twin pipe, low-cost technology permitting DH in low rise housing areas

Top right - Italian geothermal DH

Bottom right - Welsh heat pump, see evaporator coil in ground.

Solar Collectors, Denmark

1996/2002 - 18,000 m^2 of ground-mounted solar collectors and heat storage helps to heat the small coastal town of Marstal. Distribution temperatures were dropped to 70/40ºC to raise the solar fraction.

Large collectors produce heat at *one-fifth* the cost of heat from collectors on house roofs and are being widely connected to Danish district heating systems.

Pictures courtesy Leon Miller.

More Solar Collectors, Denmark

Top - 8,000 m^2 of ground-mounted solar collectors help to heat the small town of Strandby, Jutland.

Bottom right - solar collector field being craned into place.

Pictures courtesy http://www.solarthermalworld.org/node/766

Biomethane CHP, Germany

The picture shows a gas production and storage system, not the CHP plant

Picture courtesy

http://www.farmworldonline.com/general/meggiegermanyblog.asp

Energy-Efficient ‘Cold’ Appliances

Below left - energy-efficient 259 litre larder refrigerator, USA, 76 kWh/yr. Plus optional external condenser. **Old UK models about 500 kWh/yr. Saves 85%.** *Below right* - A++ 195 litre chest freezer, Europe, 113 kWh/yr. **Old UK models about 700 kWh/yr. Saves 84%.**

Typical cost of saved electricity to go from so-called “good practice” to above levels = 2 p per kWh.

Results of US test at 32ºC and 21ºC are interpolated linearly to calculate consumption in a CEN test at 25ºC.

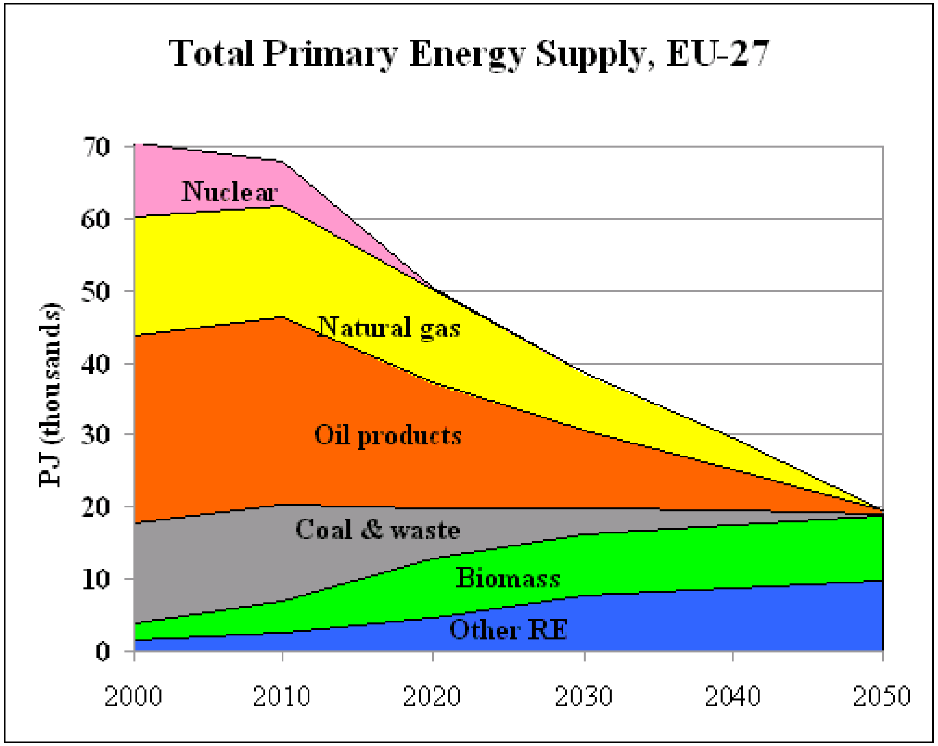
Pictures courtesy www.liebherr.com and www.sunfrost.com

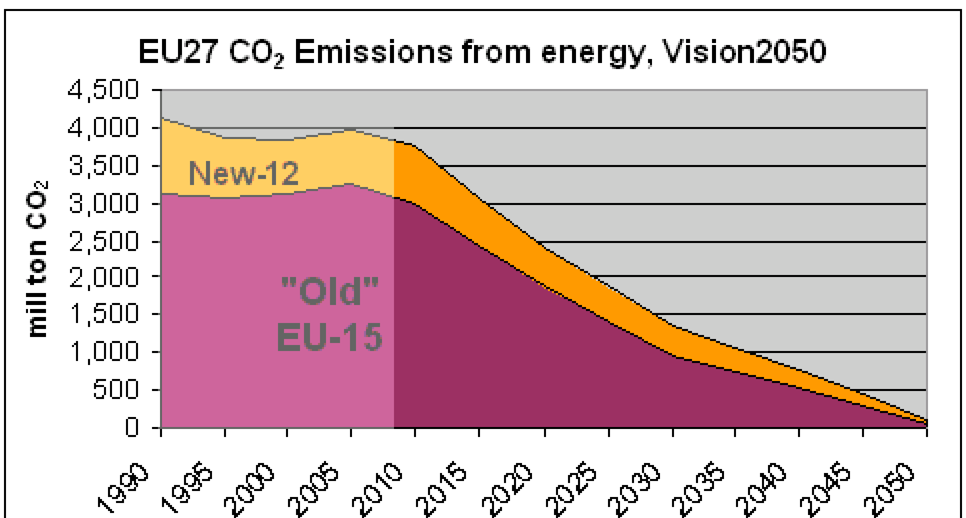
Energy Scenarios for the EU-27

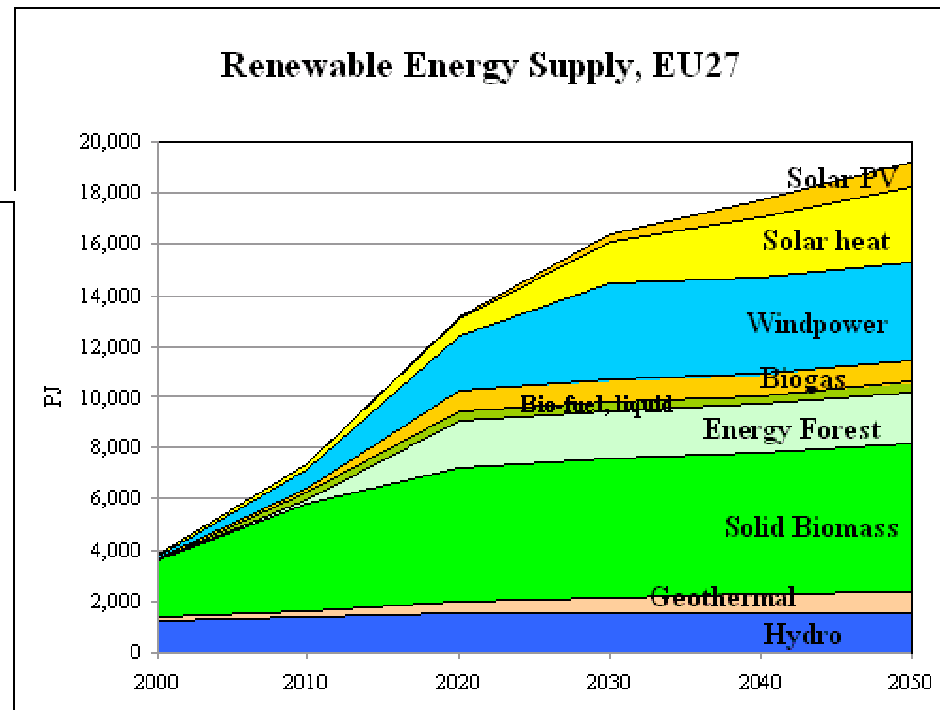
"Vision 2050"

Reproduced by courtesy of

http://www.inforse.org







Denmark's Vision 2050 *Summary*

- Consumer electrical and electronic equipment - best available technology of 2008 is in universal use.
- Existing buildings - space heating useful energy is reduced from an EU-wide average of 150 to 60 kWh/m^{2}yr. *No* reduction in internal temperature because that would conflict with social policy.
- New buildings - in Denmark, space heating useful energy falls to 36 kWh/m^{2}yr by 2010, 27 kWh/m^{2}yr by 2015, etc, as per their Building Regulations. (Total heat = ~20 kWh/m^{2}yr more than space heat).
- Extensive use of very large and therefore efficient heat pumps in the heat distribution networks which supply 60-65% - soon 75% - of Denmark's space and water heating. Enables the electric grid to be kept stable while accepting more windpower than today's 209%.
- With its well-developed sustainable construction and energy sectors, Denmark could phase out fossil fuels by 2030, not 2050.

www.ove.org; http://www.inforse.org/europe/pdfs/Vision_DK_2009.pdf

David Olivier, BSc MASHRAE

Principal

ENERGY ADVISORY ASSOCIATES

1 Moores Cottages, Bircher, Leominster,
Herefordshire, England, HR6 0AX

T: (01568) 780868.

E: d.olivier@energyadvisoryassociates.co.uk

W: www.energyadvisoryassociates.co.uk