Open University

Energy and Environment Research Unit

Sustainable energy systems: Linking the local to the global

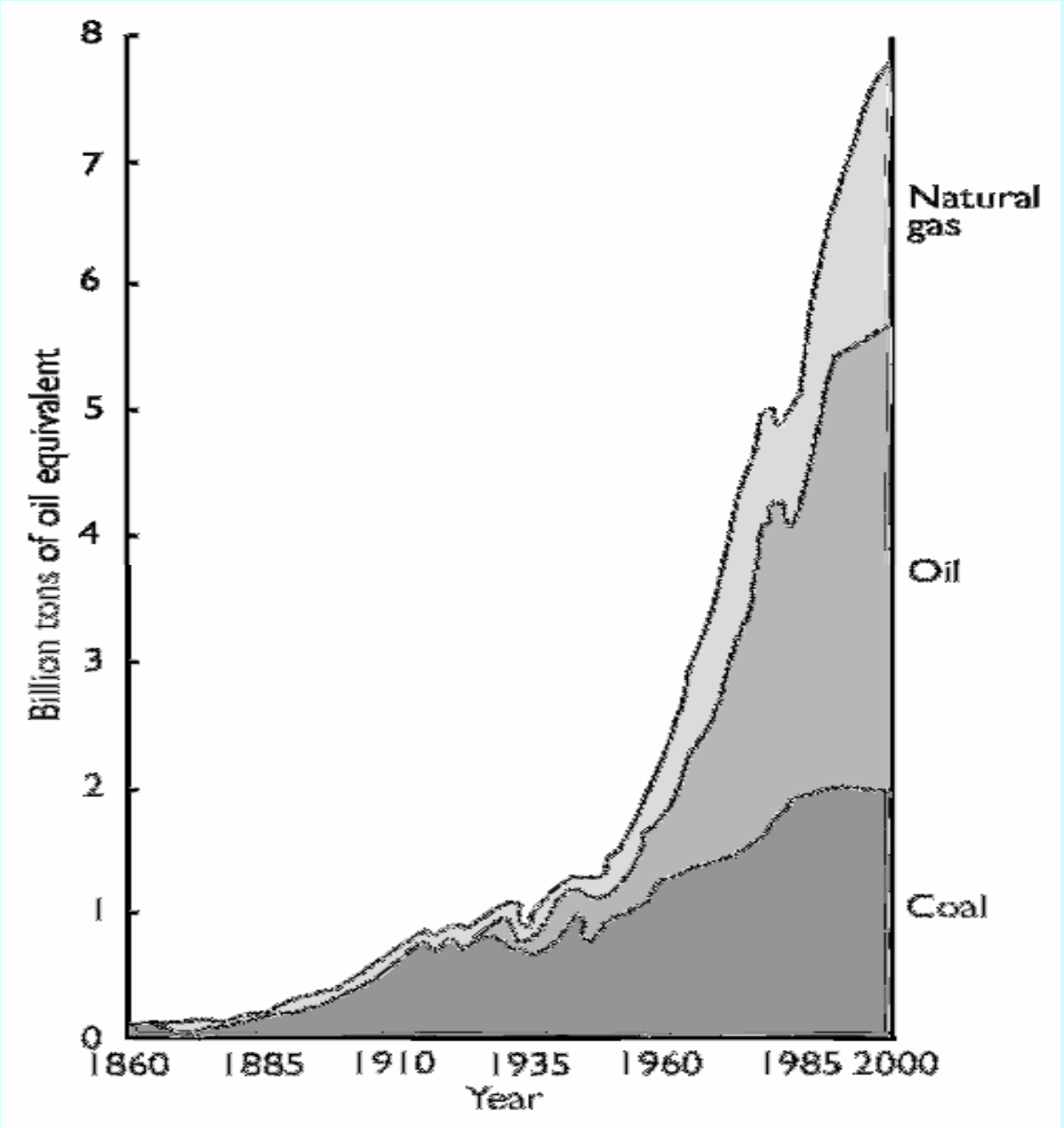
Prof. David Elliott

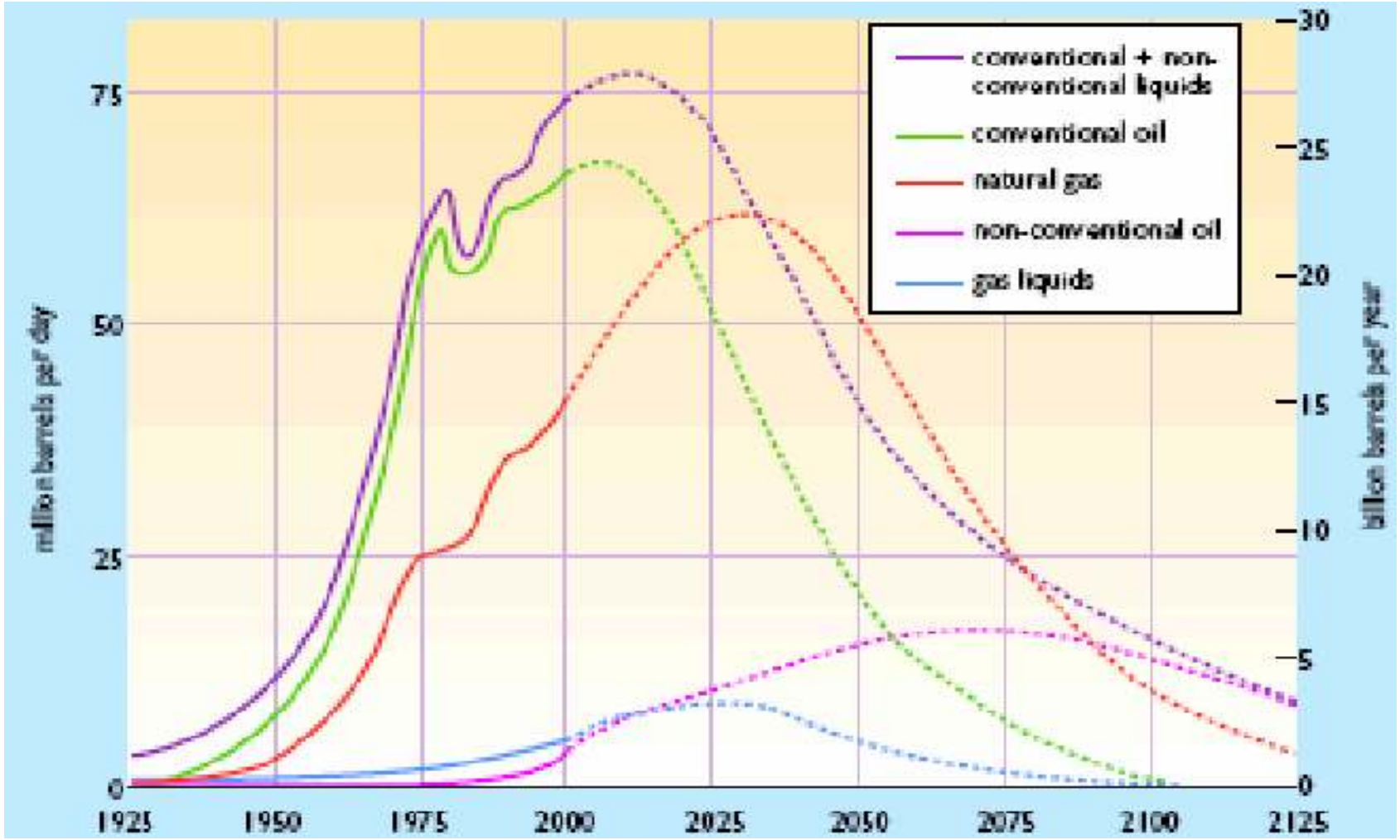
Agenda

- Energy - Climate and other eco-impacts
- Decarbonisation options

1. What scale- local or global?
2. Potentials and Progress
3. How to integrate / link up
4. Supergrids- across continents
5. Global solutions- technical & social policy issues

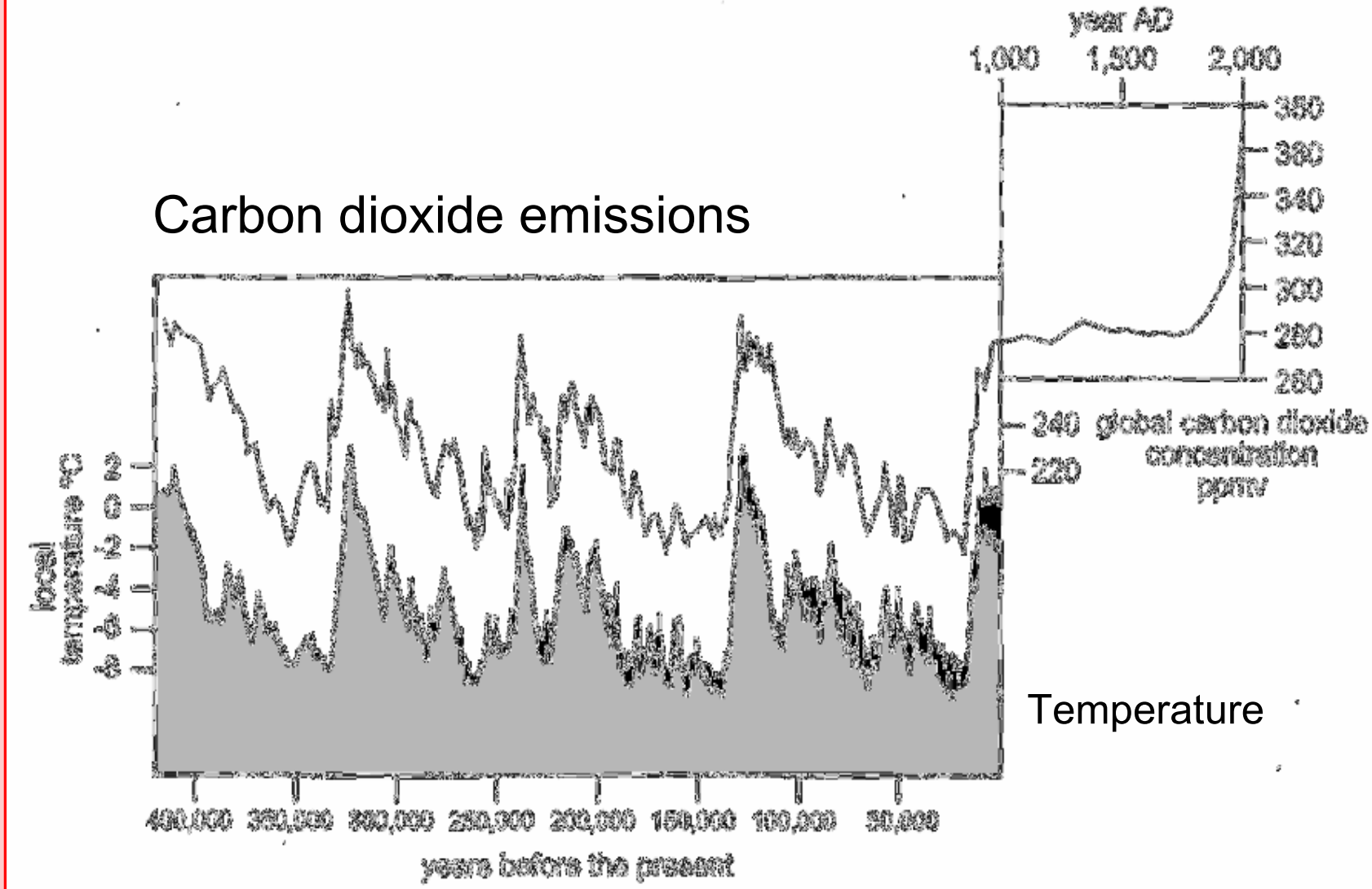
World Fossil Fuel Use



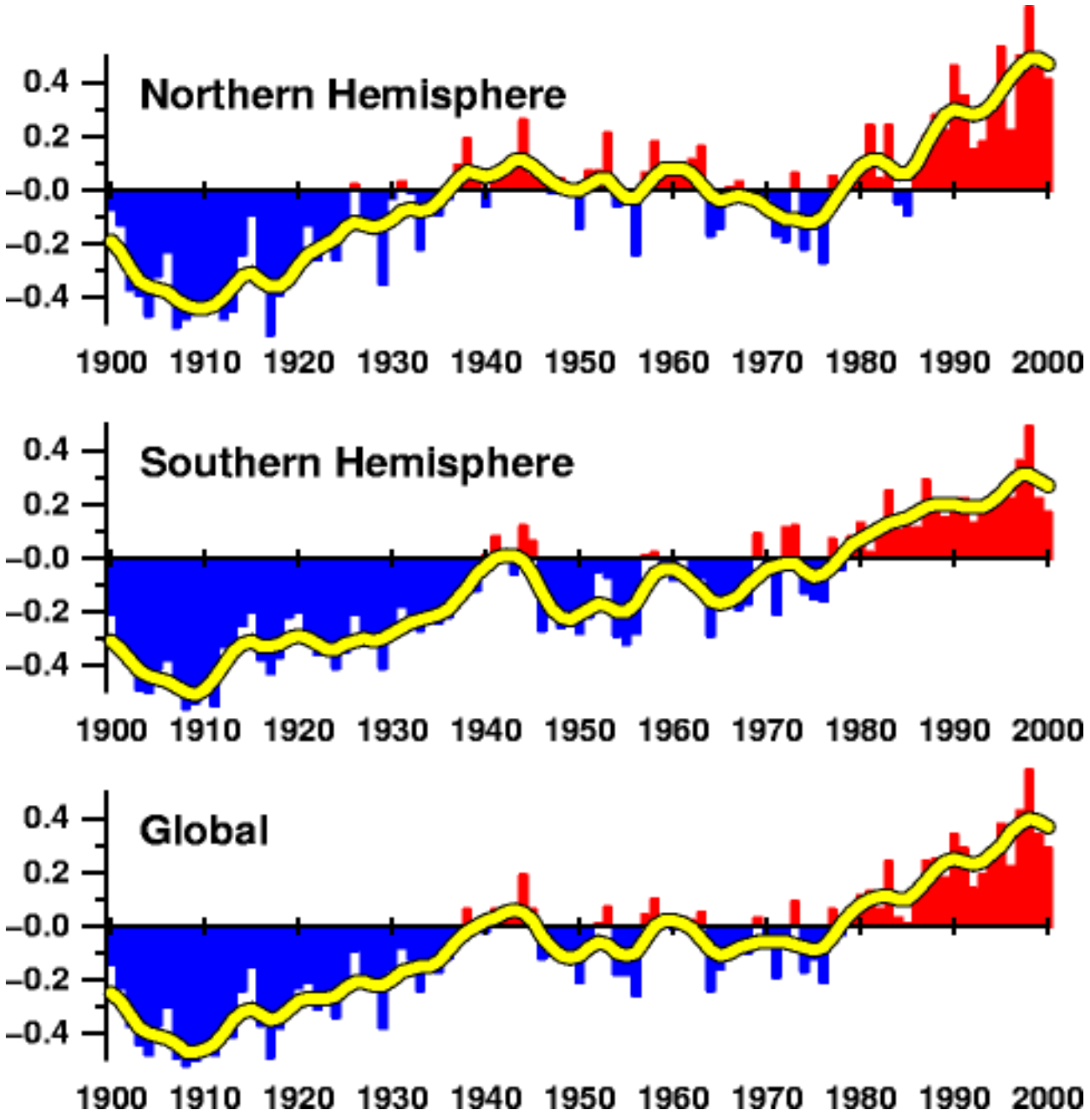


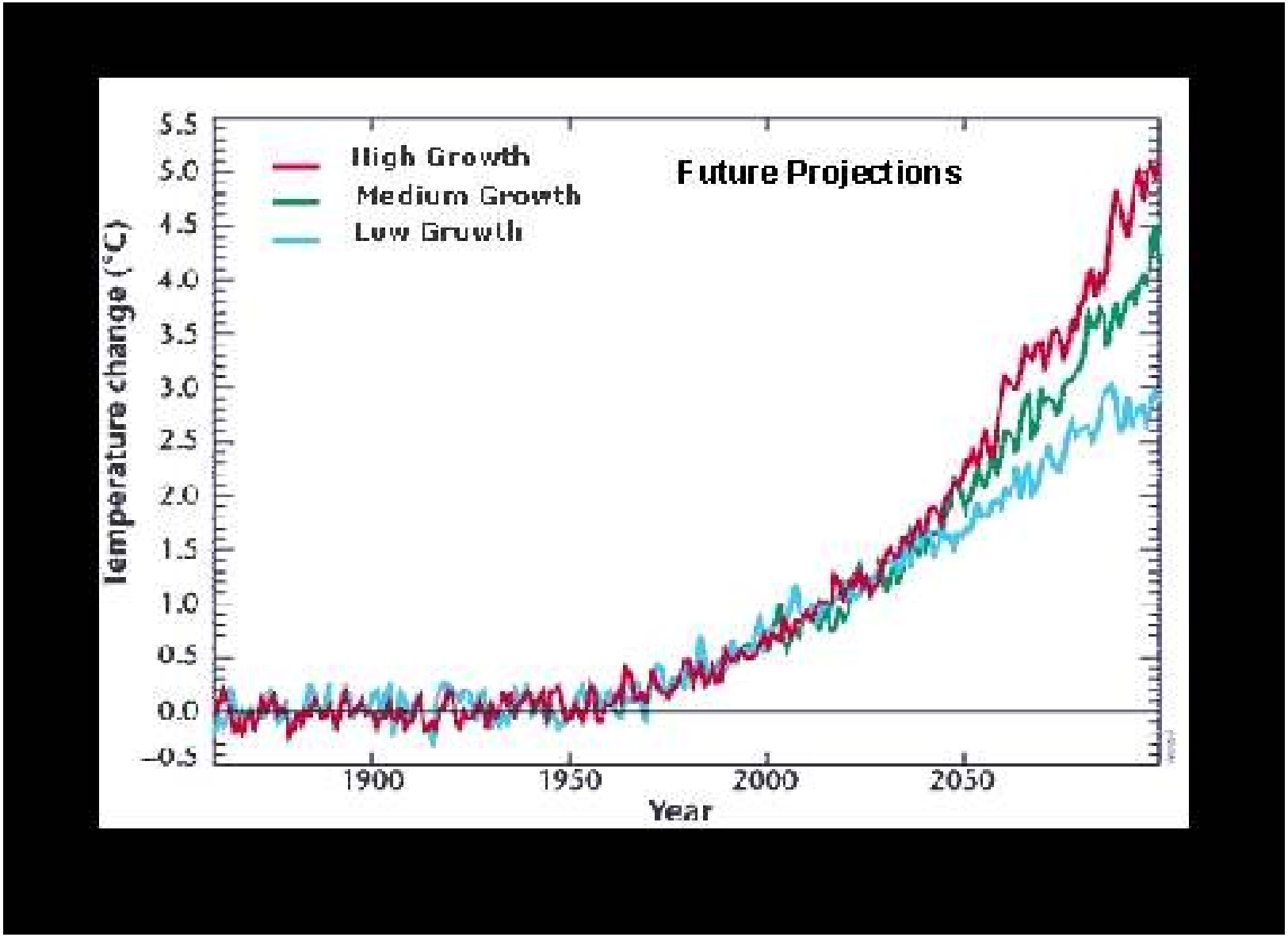
Possible Oil and gas peaks

Laherrere, J.H
OPEC Seminar
2001



Royal Commission on Environmental Pollution (2000) 'Energy – The Changing Climate', 22nd Report, Cmnd 4749


Northern Hemisphere
Southern Hemisphere
Global
0.4
0.2
−0.0
−0.2
−0.4
1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000



Summary of IPCC TAR projections

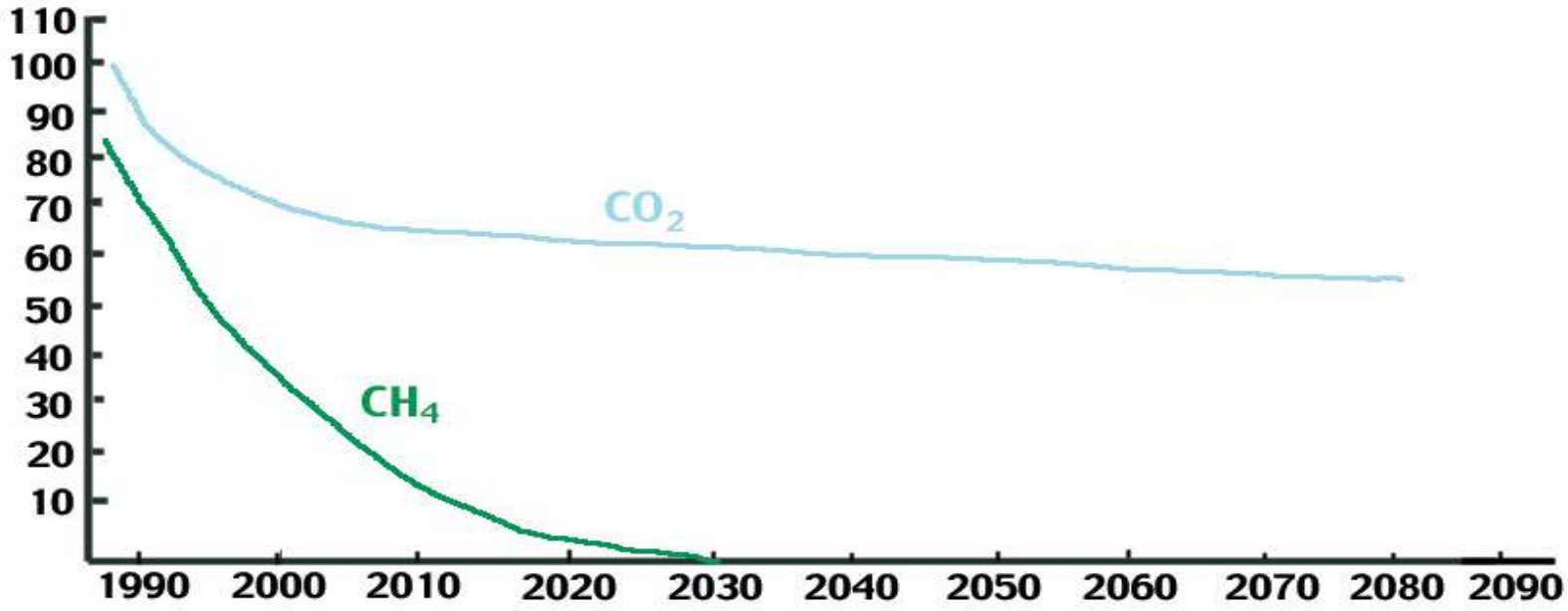
Does it matter?

Climate change

The Stern report in 2008 estimated that the control/mitigation costs were equivalent to around 1-2% of UK Gross National Product, whereas the long term damage costs might be up to 20% of GNP

Why the rush?

Because it takes a long time for greenhouse gases to disperse/be absorbed



Residence time in upper atmosphere- for emissions in ~1990

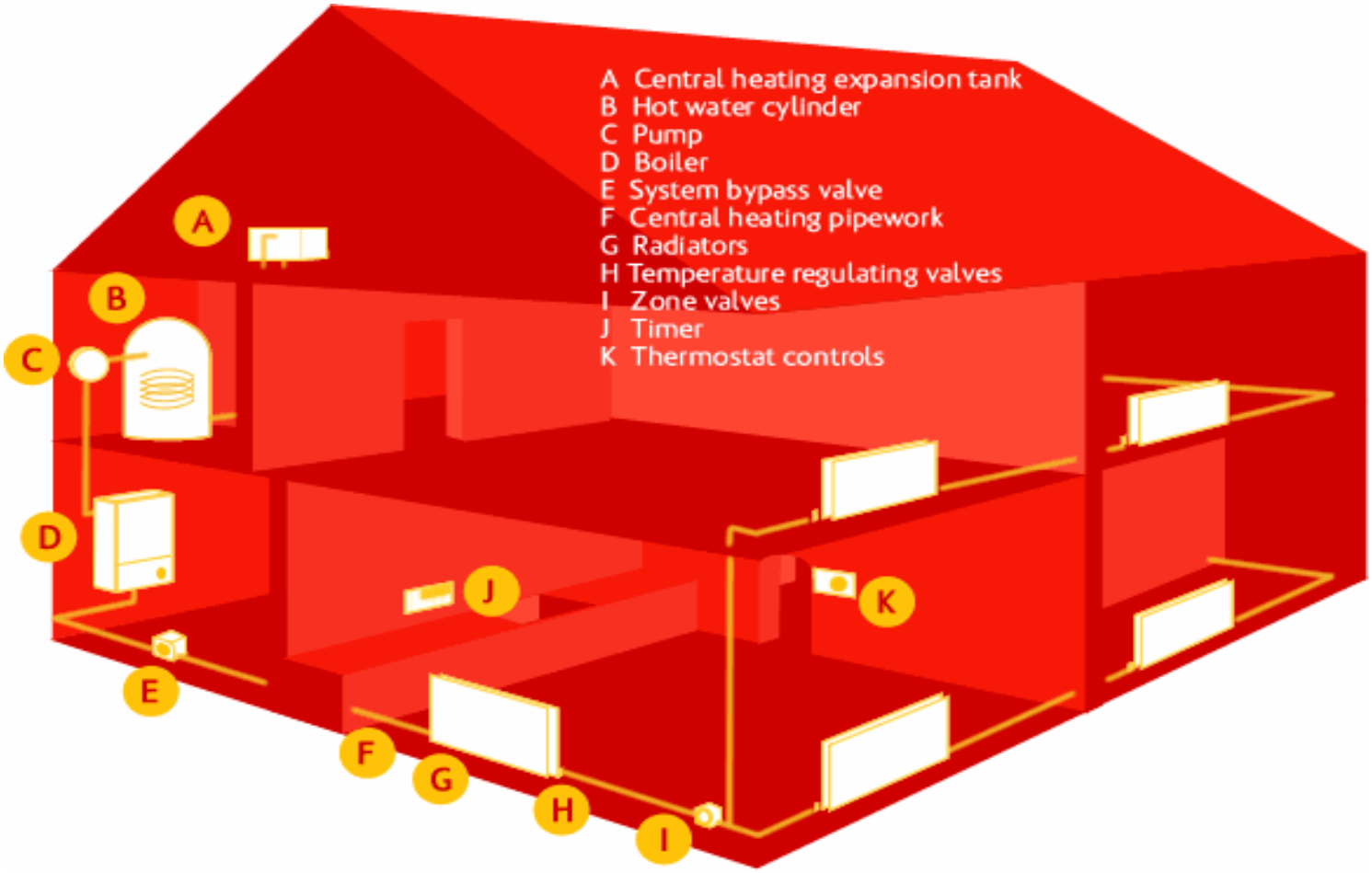
Source: IPCC TAR

Electricity Supply- a major source of CO_2

Conventional coal fired power plant- carbon dioxide gas released up chimney stack

Waste heat pumped out as steam from cooling towers

Also a large source-
Gas fired central heating



C02 produced directly in your house!

Vehicle fuels

Road traffic currently produces about 20% of UK greenhouse gas emissions

On present trends, by 2030 emissions from aviation could rise from 6% as at present to 20% of UK greenhouse gas emissions

Mitigation of climate change

Decarbonisation -Technological Solutions

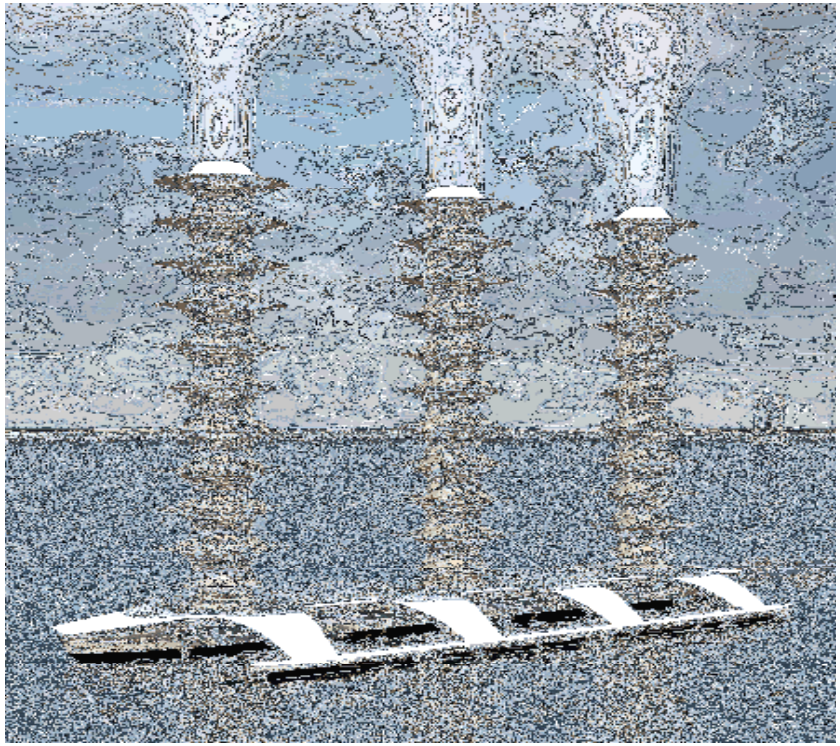
1. Sequestration - capture and store CO2
2. Use lower carbon fuels- switch to gas
3. Generate energy more efficiently -CHP
4. Use fuels more efficiently- more from less
5. Use non-fossil fuels - nuclear and/or renewables

Social solutions - use less/change lifestyle

Adaptation to climate change- social and technical adjustments to cope with it

Trees absorb carbon dioxide as they grow, but release it again when they rot or burn

Geotechnical fixes



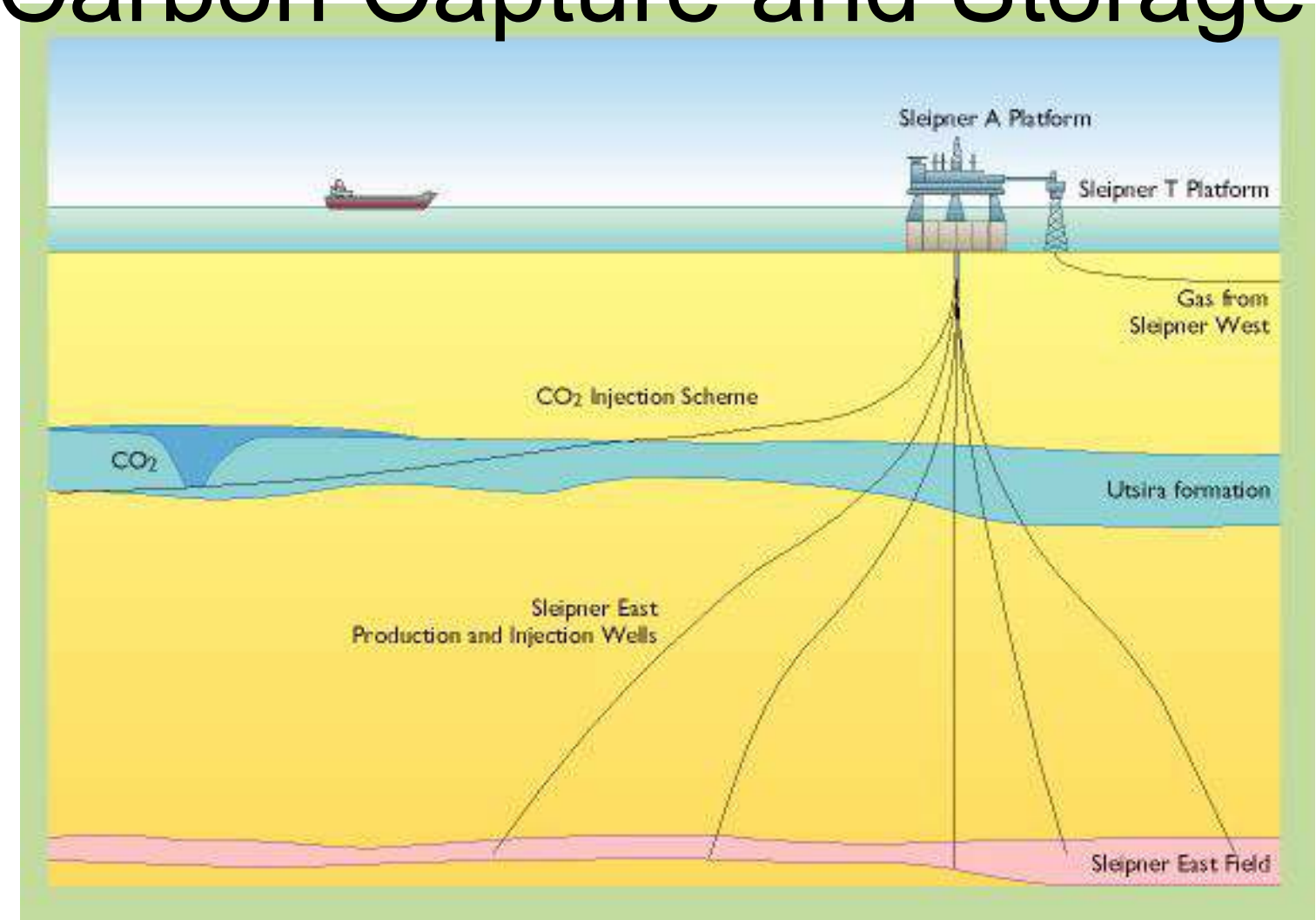
• Spray water droplets into atmosphere- makes cloud cover whiter so reflecting more sunlight. Salter has proposed fleets of remote controlled spray vessels using Flettner rotors and the Magnus effect.

•Seed the seas with ferric compounds to increase algal growth to absorb more carbon dioxide

•Put micro-particles in space orbit or aerosol particles in the atmosphere to reflect sunlight

Unknown eco- impacts

Carbon Capture and Storage



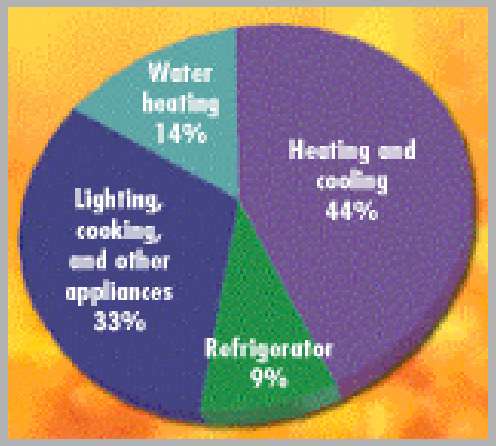
Carbon dioxide storage:

Norwegian **Statoil's Sleipner** field project. Gas from this field has a very high CO2 content.
Excess CO2 is pumped into a saline aquifer, the Utsira formation, about 800 m below the sea bed.
A million tonnes per year of CO2 are 'sequestered' in this way

energy saving trust

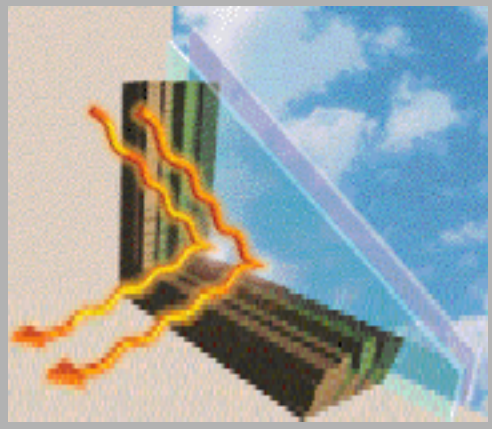
Cavity wall filling

Loft Insulation



Domestic Energy Efficiency

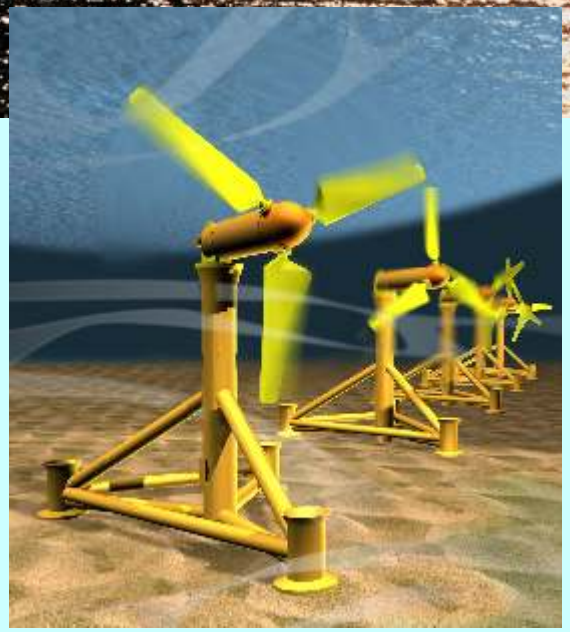
Compact Fluorescent Lamps



High efficiency Windows

There is 120GW of wind capacity installed so far globally- mostly on land

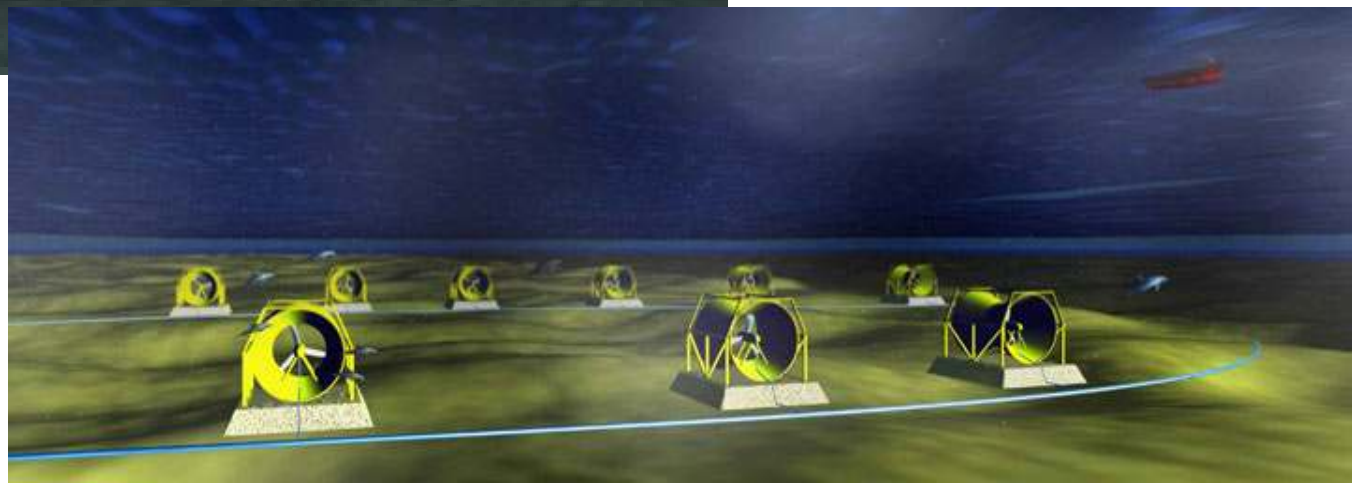
Next-
Offshore
wind,
tidal,
wave



SeaFlow Marine Current Turbine farm

Building offshore renewables at Burntisland Fabrications in Scotland

Lunar Energy Tidal farm



We can also use solar energy

for **heating** - 120GW(Thermal) globally so far
and for **electricity** generation - 10GW (e) so far globally

Connecting: solar installation at Perivale

..and
biomass
energy crops

The UK is very well placed- we have enviable renewable energy sources

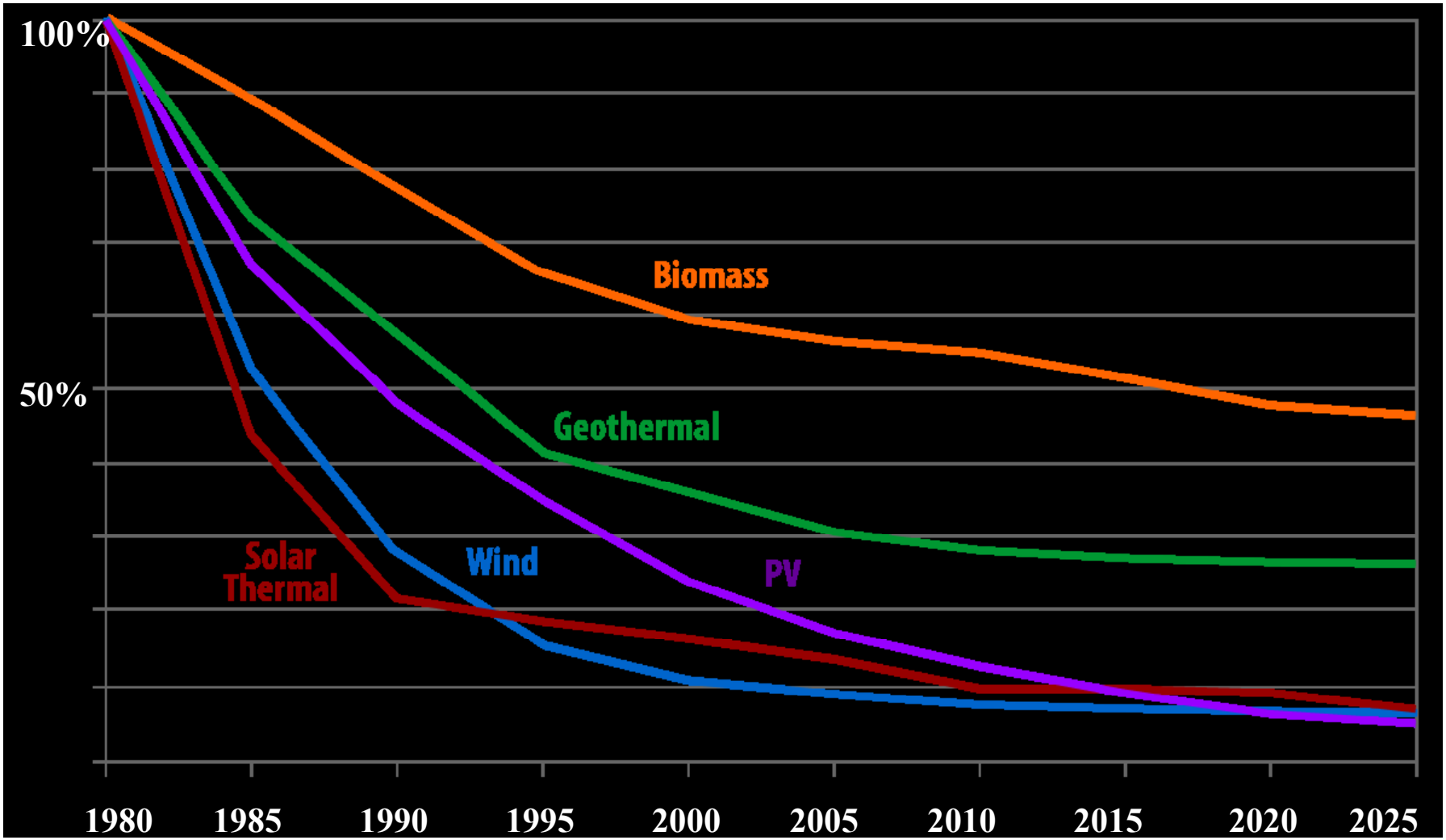
Potential % of overall UK electricity supply in 2050

Onshore wind	8-11%
Offshore wind	18-23%
Wave/Tidal	12-14%
Biomass	9-11%
PV solar	6-8%
TOTAL	53-67%

Based on overall likely level of supply of 400-500 TWh in 2050

Source: DTI/Carbon Trust 'Renewables Innovation Review' 2004

Past and Expected reductions from 1980 prices



Source: 'U.S. Program in Renewable Energy- Effectiveness and Progress', Stanley R. Bull, NREL, paper to WREC X 2008

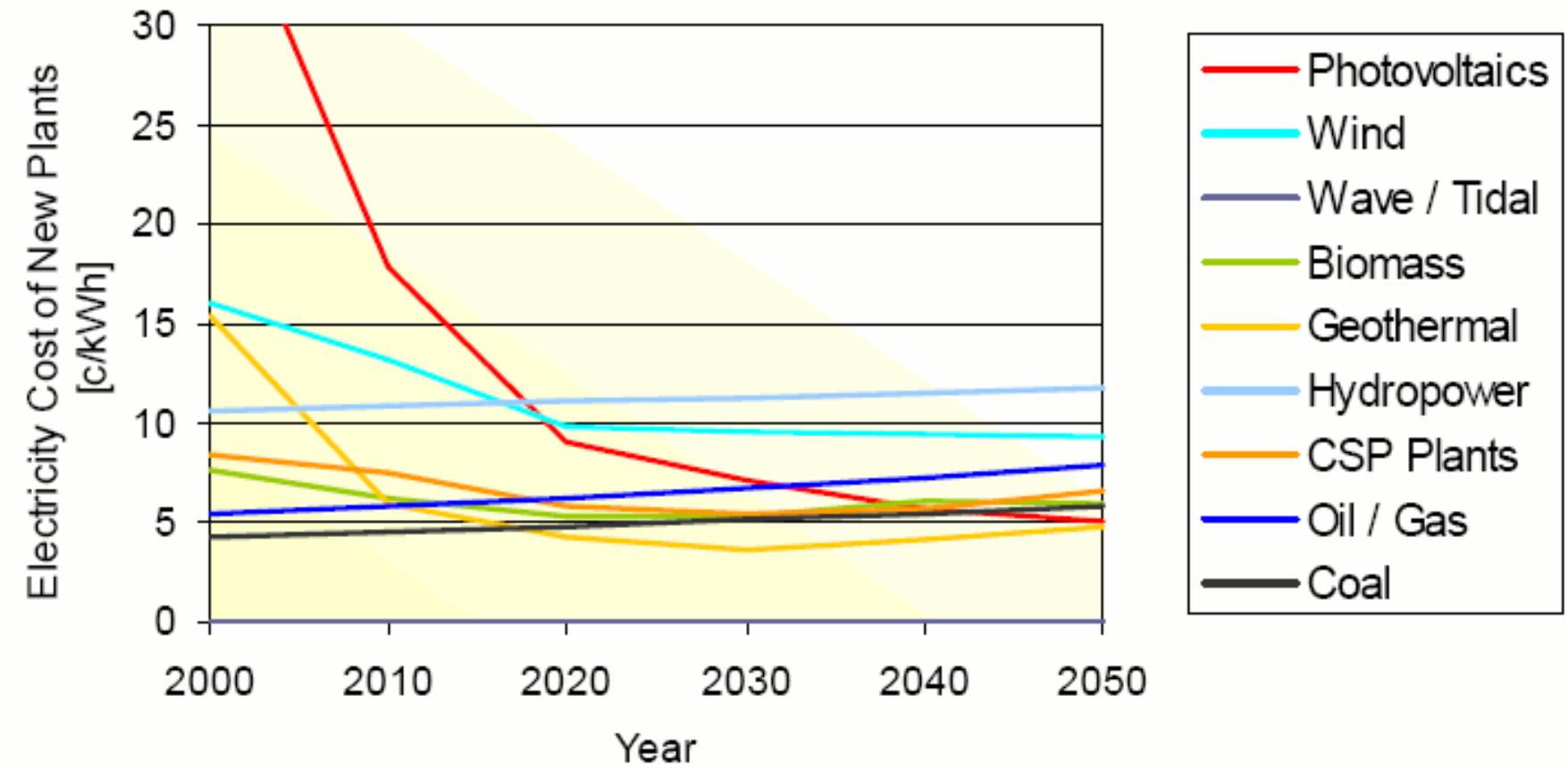
Costs of electricity by 2020

	pence/kWh
On Land wind	1.5 - 2.5
Offshore wind	2 - 3
Energy crops	2.5- 4
Wave and tidal power	3 - 6
PV Solar	10 - 16
Gas CCGT	2 - 2.3
Large CHP/cogeneration	under 2p
Micro CHP	2.3 - 3.5
Coal (IGCC)	3 – 3.5
Nuclear	3 - 4

Source: PIU Energy Review

UK Cabinet Office PIU study 2003

Long term cost trends



Source: SUNA Iran,
paper to WREC X 2008