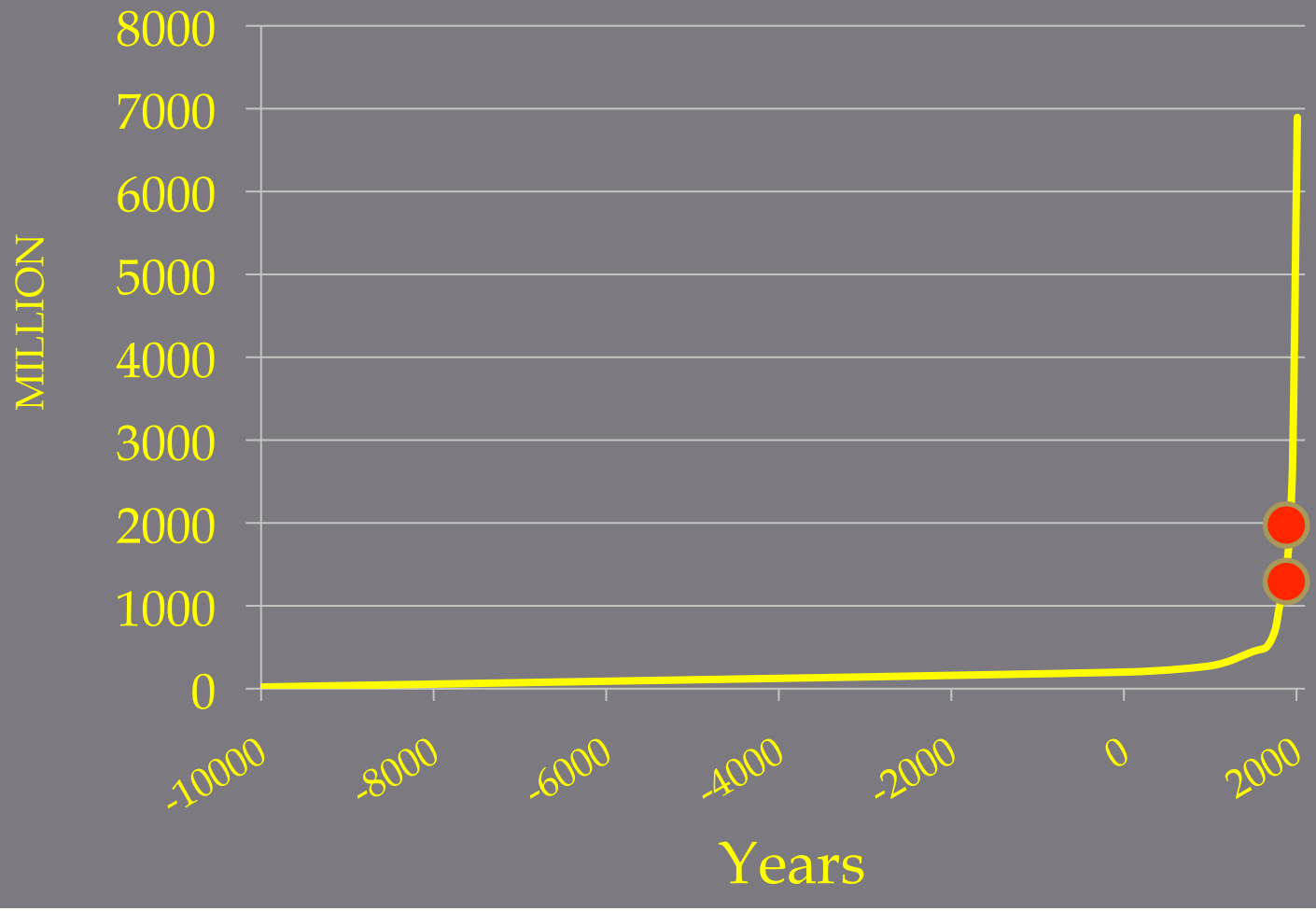
ENERGY TRENDS IN THE 21ST CENTURY

Ron Oxburgh

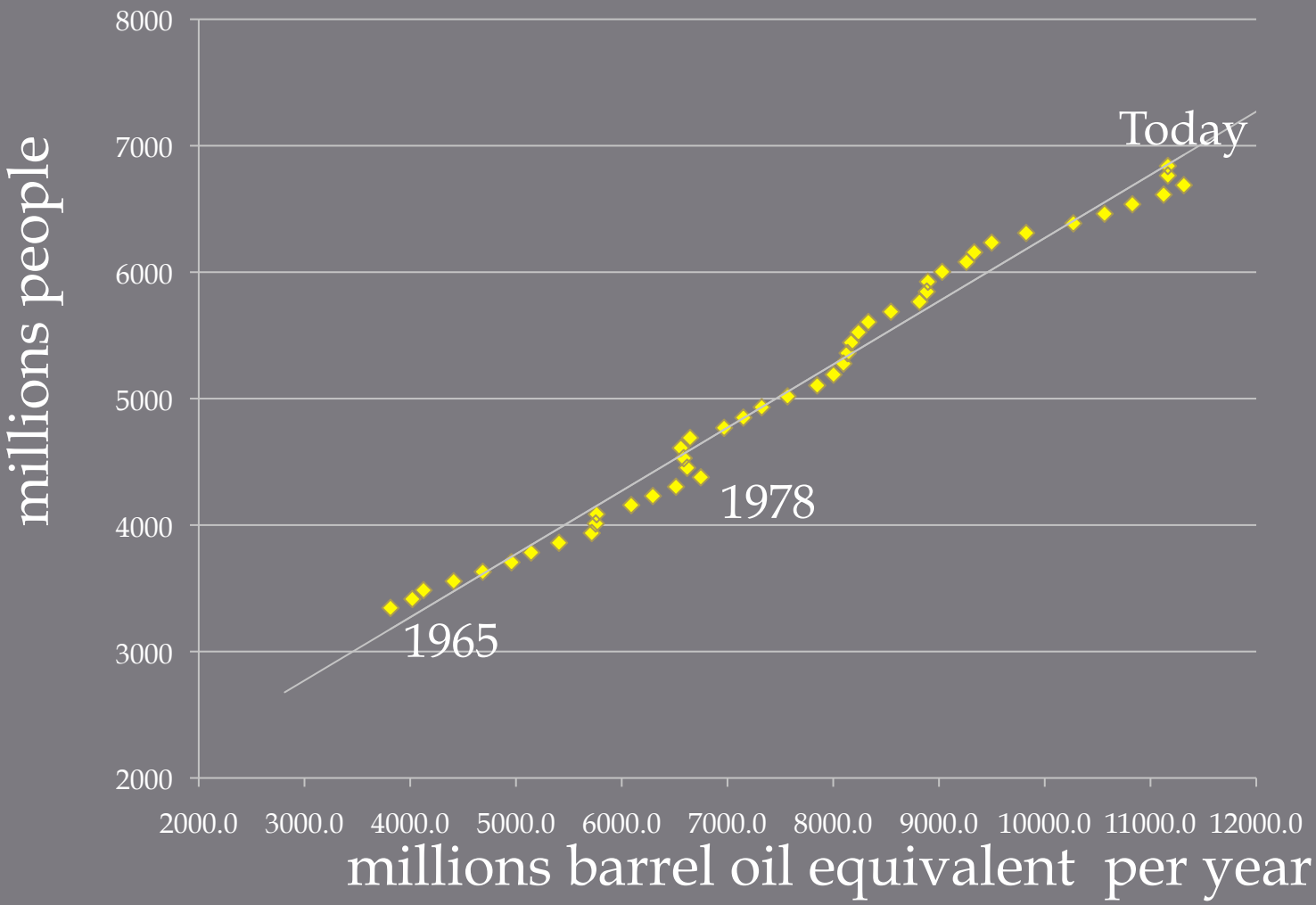
Oil Centenary Conference 2013

Imperial College, 23 September

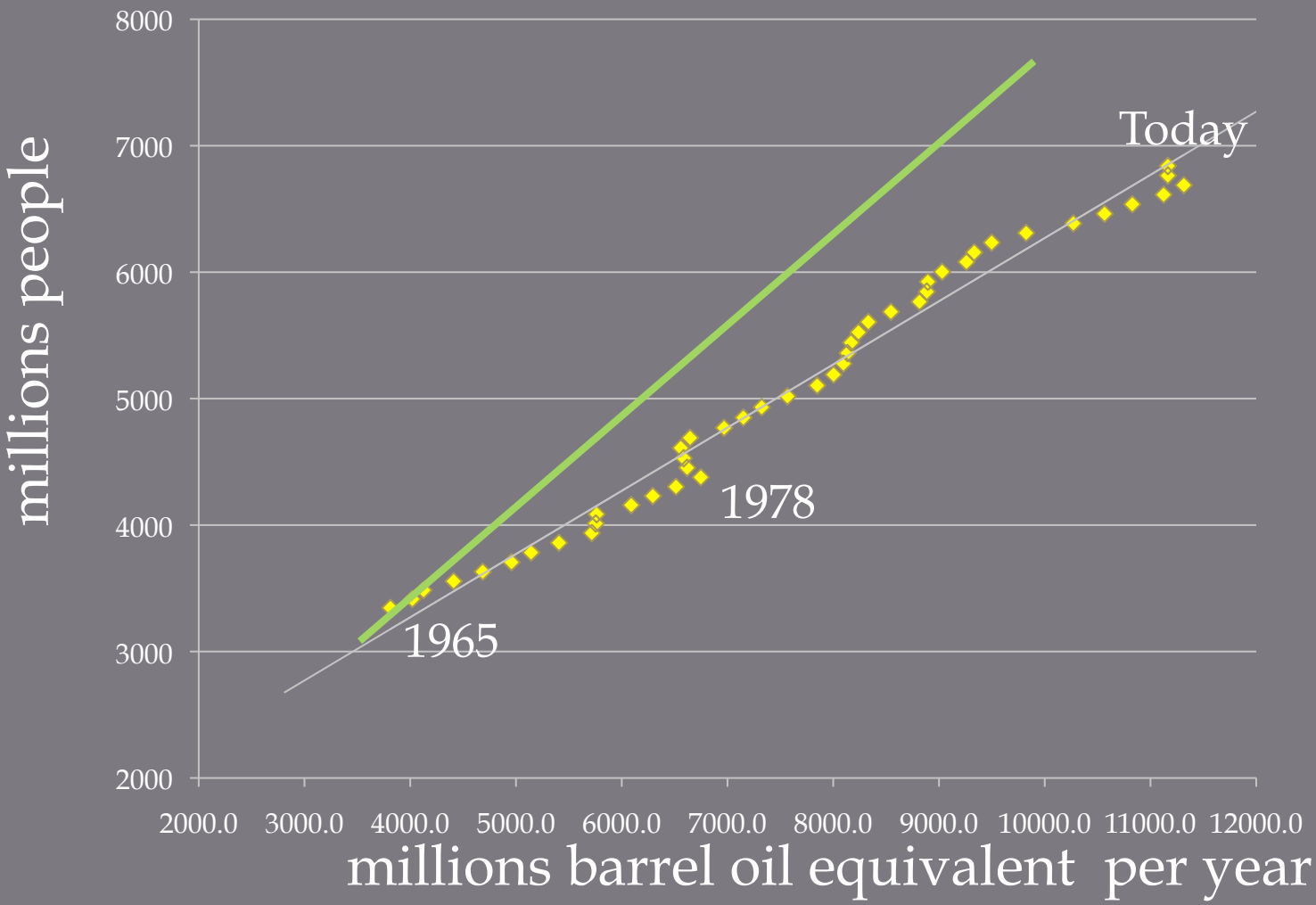
World Population – last 12,000 years



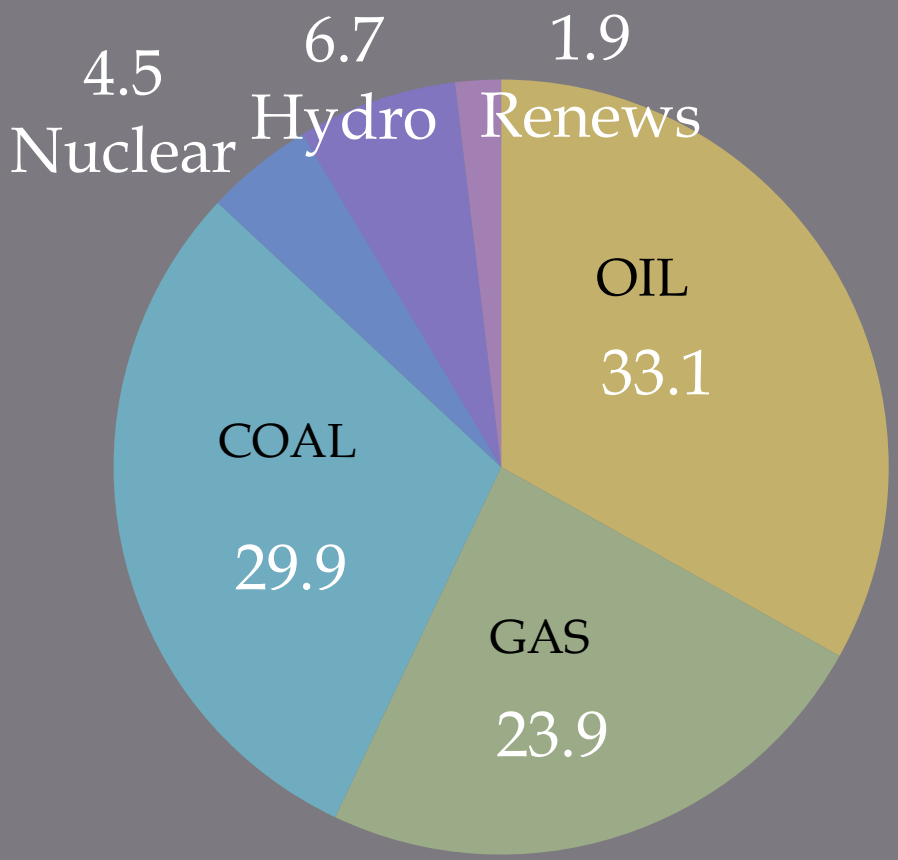
Energy & People



Energy & People



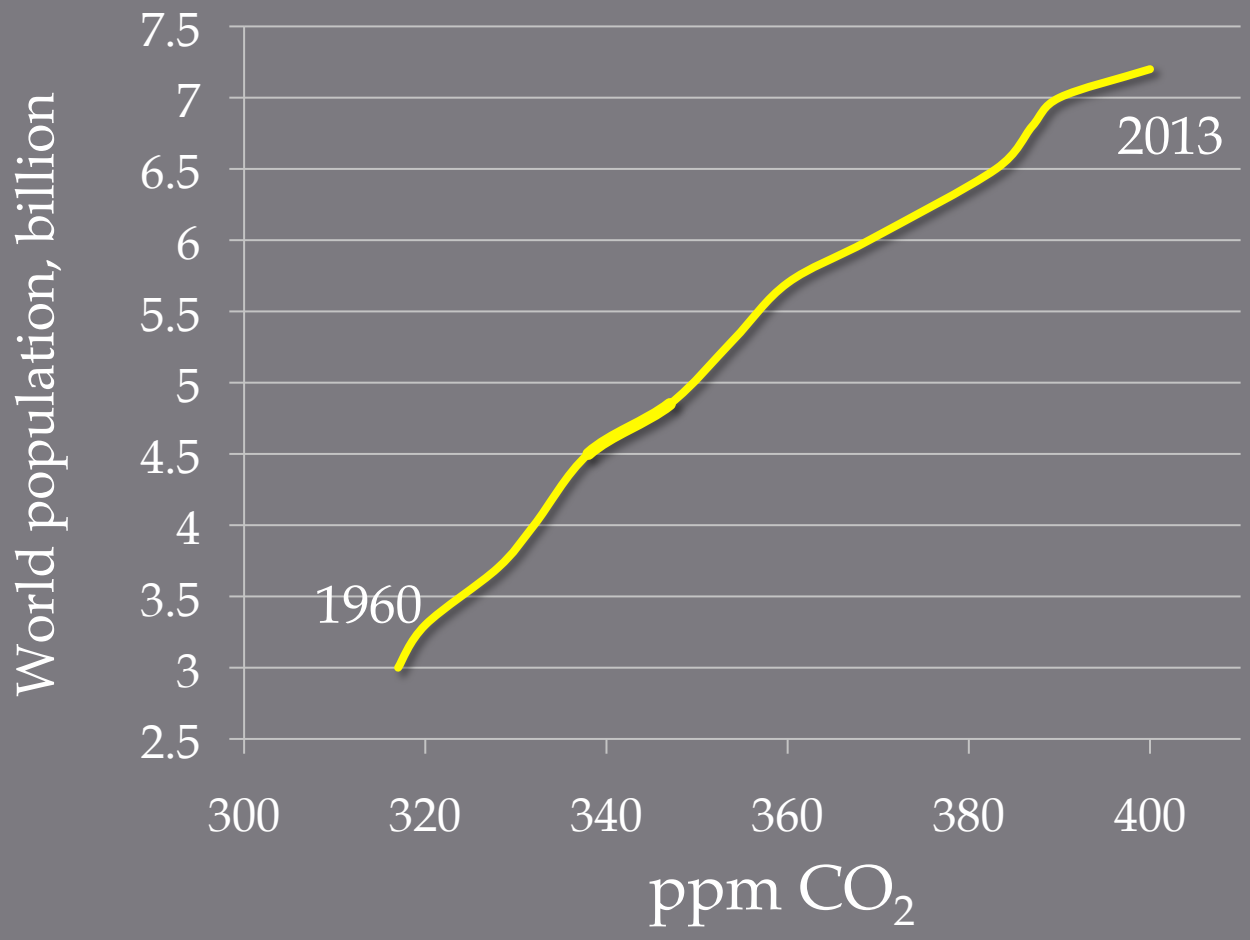
World Primary Energy 2012

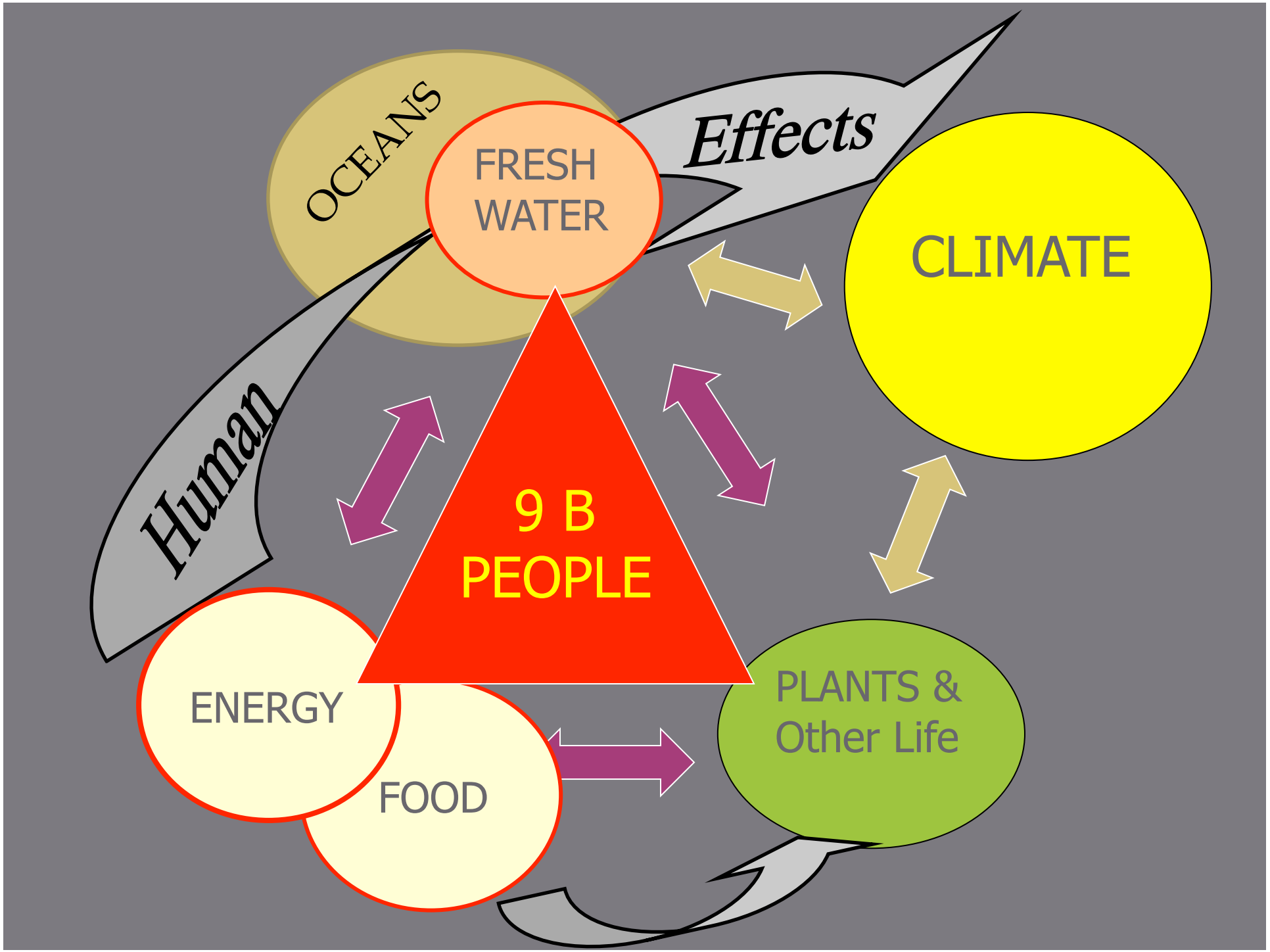


% of total
12,477 mtoe

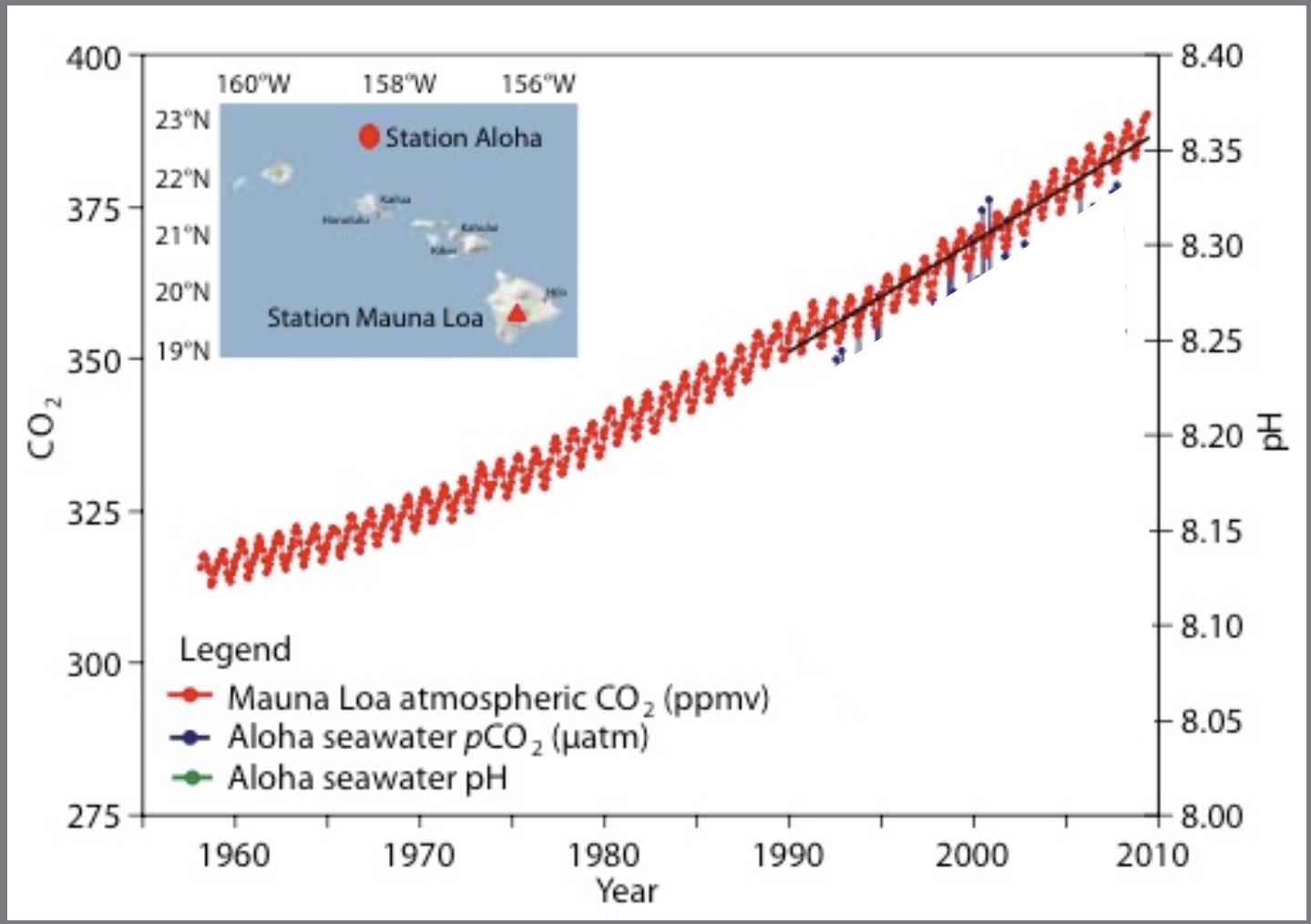
BP Stat. Rev. 2013

Greenhouse Gases & People




OCEANS
FRESH WATER
Effects
CLIMATE
Human
9 B PEOPLE
ENERGY
FOOD
PLANTS & Other Life

CO_2 in Atmosphere & Ocean



Ocean Acidification: A Critical Emerging Problem for the Ocean Sciences By S.C. Doney, W.M. Balch, V.J. Fabry, and R.A. Feely

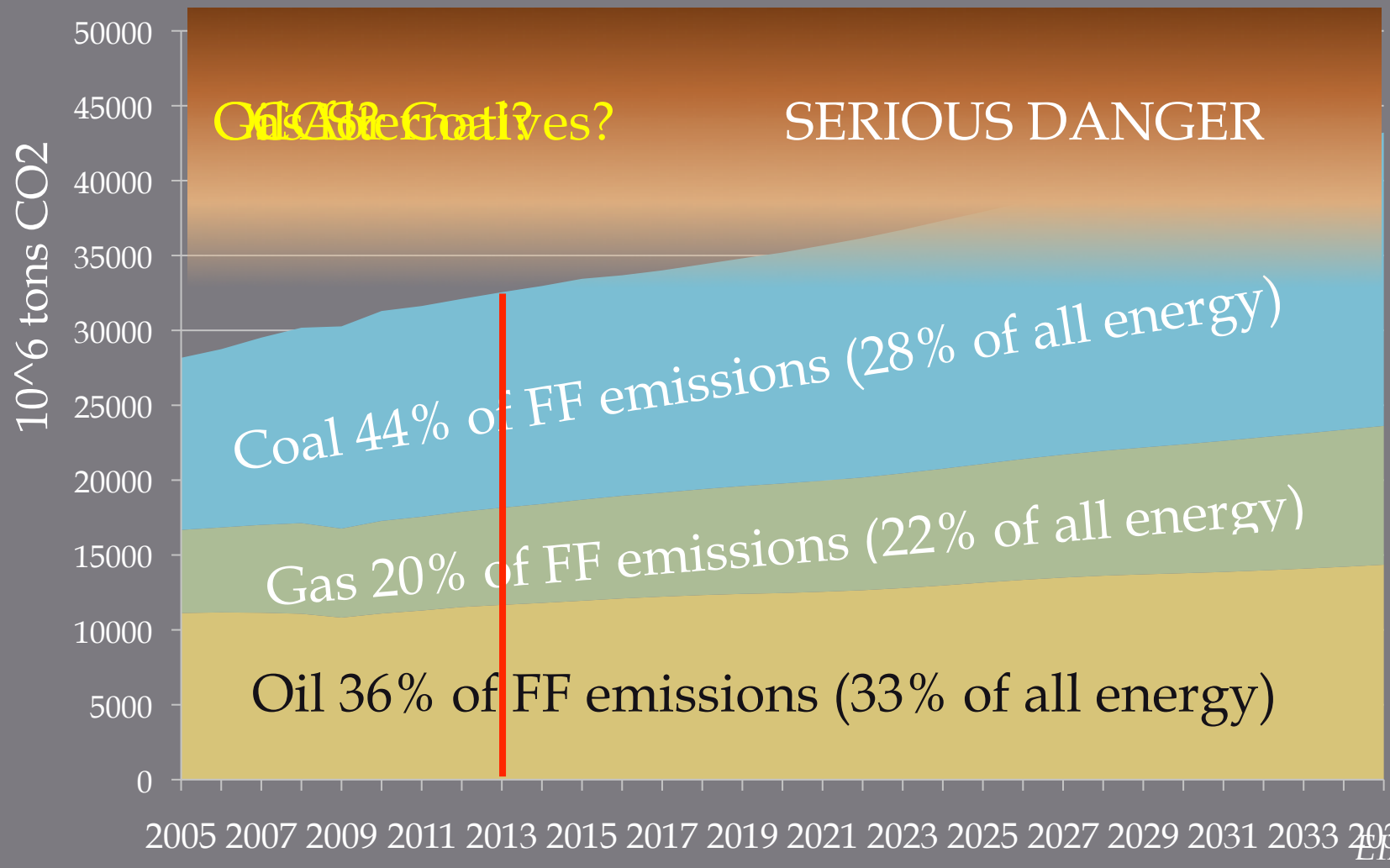
What are the Choices?

- BAU – incremental market driven change from the present - if allowed

OR

- A low-C path: energy conservation, efficiency, changed energy sources

World CO_2 Emissions by Fuel

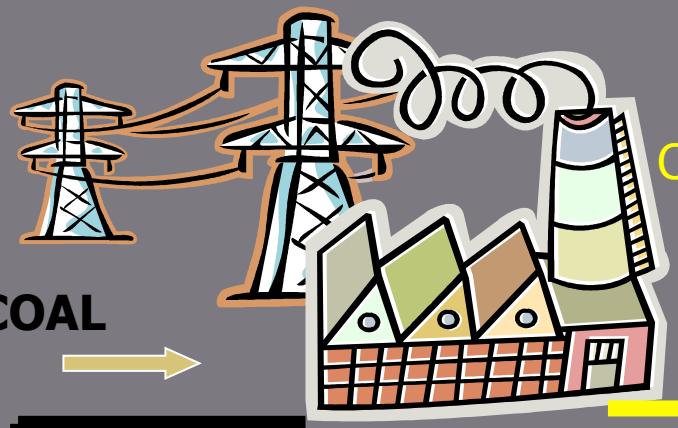


EIA, 2012

The LOW-C path

- Transitional measures
  - Substitute gas for coal
  - CCS on both coal and gas
- Where practicable substitution of renewables for fossil fuel generation; BUT
  - Intermittency
  - Geographical limitations
  - System dispatchability
  - Storage technology
- Flexible nuclear
- Sustainable high energy-density liquids

Carbon Capture and Storage



70% cost
Capture

10%
Transport

COAL

CO_2

20%
Storage

CO2

COAL
MINE

- Present technology would increase electricity cost by 30-50%
- Same as off-shore wind?
- Water requirement increased by around 30%

The CCS Dilemma

- CCS essential as a 30 – 40 year bridging technology – carbon reduction targets not achievable without
- But to be effective:
  - CCS needs to be deployed globally
  - Currently too expensive for developing countries

CCS – the Future

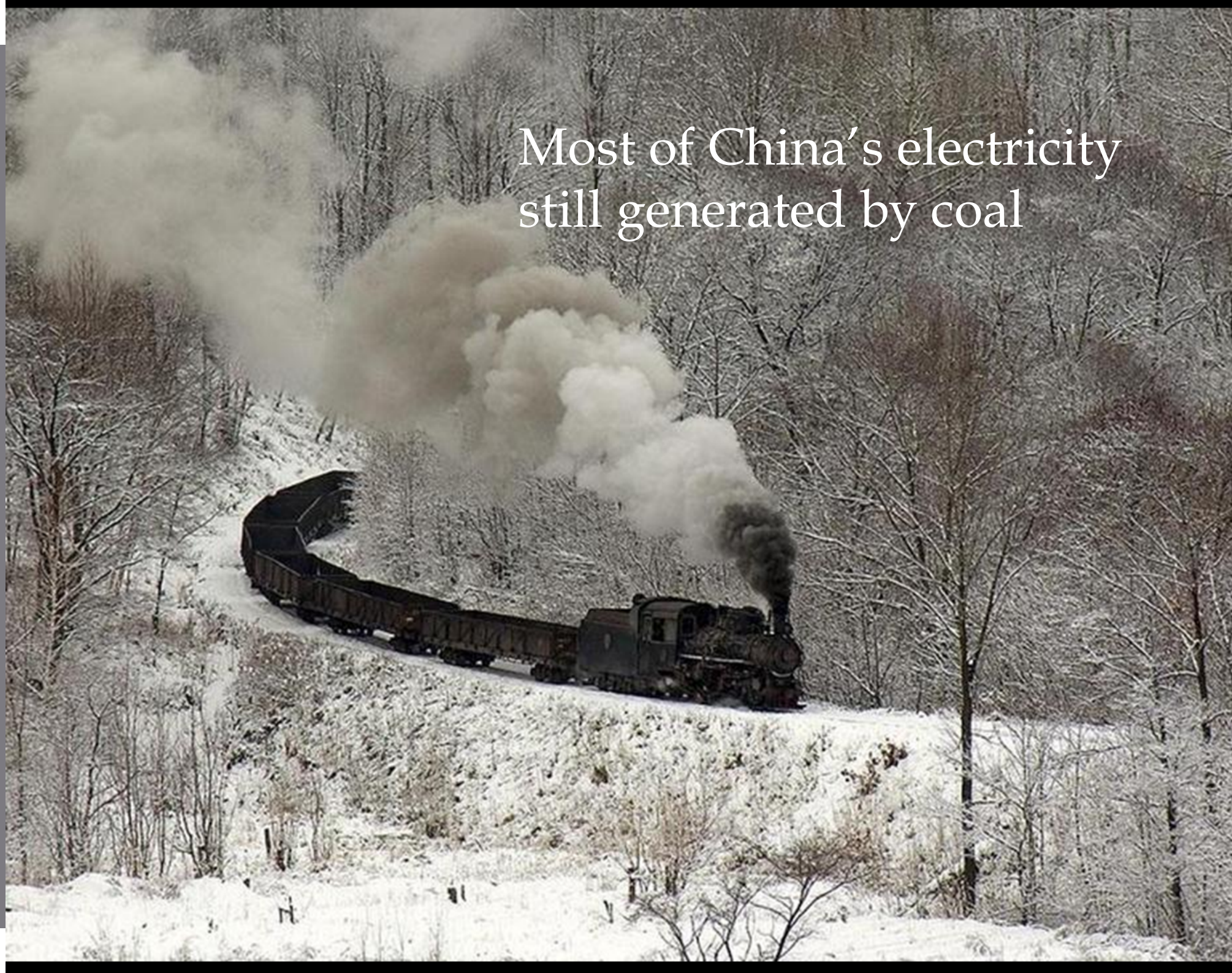
- Cost reduction task force - £100/kWh target
  - still not low enough for global deployment
- Industry hesitant – high costs; investment justified? Best use of capital?
- Use EOR to gain experience and reduce costs
- Capture costs:
  - Currently a major capital and efficiency penalty – physical rather than solvent capture technology?
- Storage –
  - in useful solids rather than underground?

Decarbonisation Needs New Technologies

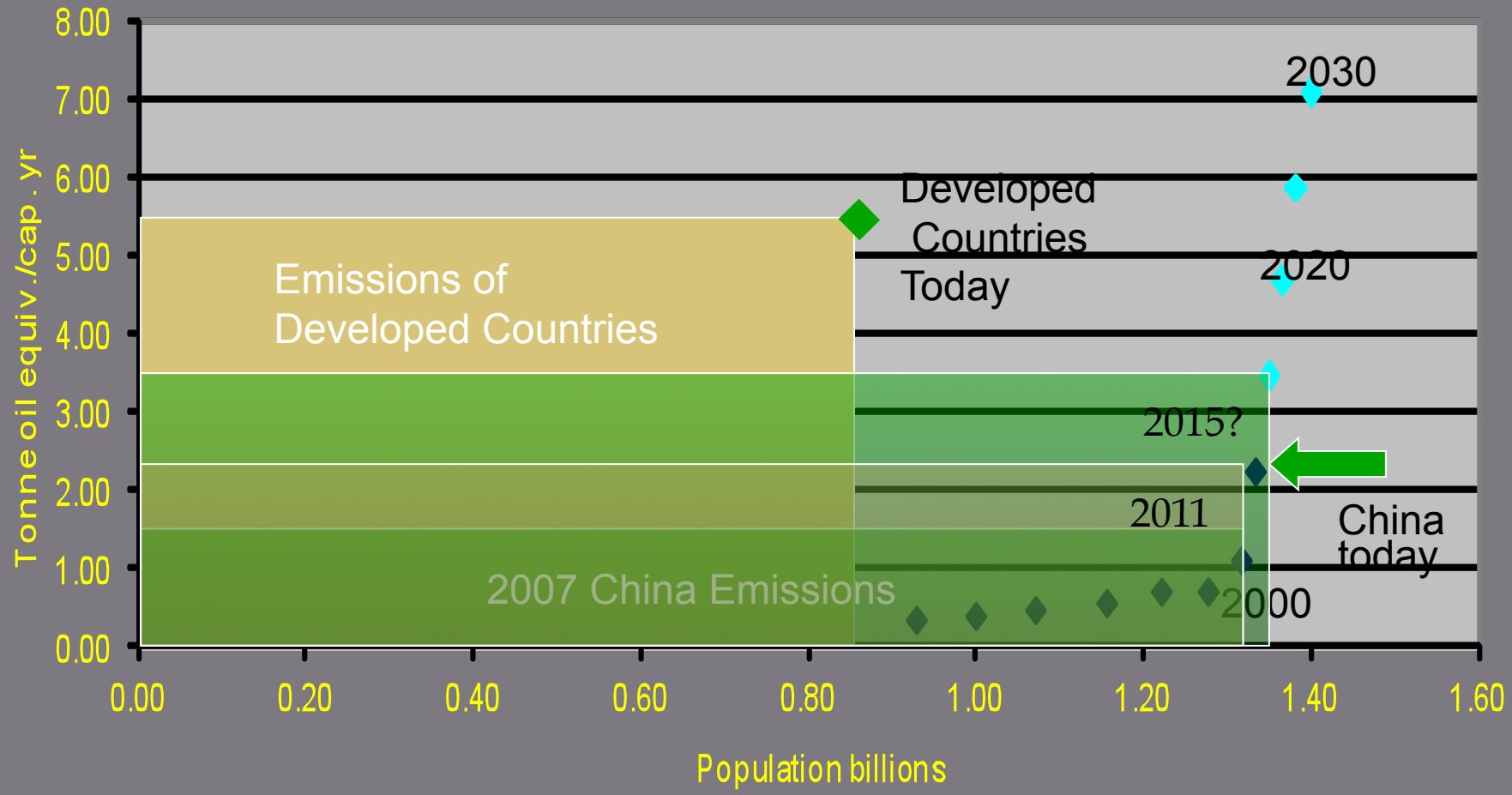
- Immense natural resources of wind, wave, tides sun, and low-grade heat; future depends on:
  - Energy storage – the grand challenge
  - Use of low grade heat
- Flexible fail-safe nuclear
- Sustainable high energy bio-liquids for ICE
  - Organic by-products and wastes
  - Biotechnology on plant cells
- Affordable C-capture
- BUT we are in a time of unprecedented rate of technological change

Questions for Energy Investors

- Will governments/electorates develop climate change fatigue? A worry for low-C investors
- If not, are fossil fuel companies overvalued – value based on reserves of unburnable C?
- Future oil demand – will demand peak before production?
- Water limitations for thermal generation?


Most of China's electricity
still generated by coal

Energy & Emissions Developed Countries and China



Role of China

- Has the most techno-literate government in the world
- Recognises the CC threat to China's future
- China today responsible for nearly half of world emissions; intends to reduce after current rise
- A third of the 2012 five-year plan objectives relate to renewables, energy efficiency etc.
- As China's economic influence grows, sanctions on perceived free riders?

Finally

- World energy demand will continue to rise with population
- It is urgent to control the GH gases that acidify the oceans and over-energise the climate
- The low-C path comprises nuclear, renewables, energy storage, synthetic low-C liquids and fossil fuels with CCS
- Industrial confidence essential for the necessary investment
- China has a central role; if she remains committed to low-C the world will have to follow
- But still 37 years to 2050 – surprises, technological and otherwise?