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Energy and Climate Change

Dr Geoff O'Brien

Geographical Association, 7 March 2017



Access to energy services defines our
Standard of Living!

In rural sub-Saharan Africa many
women carry 20Kgs of fuel-wood
up to 5km per day. The health impacts
of cooking with fuel-wood in a confined
area are clear.

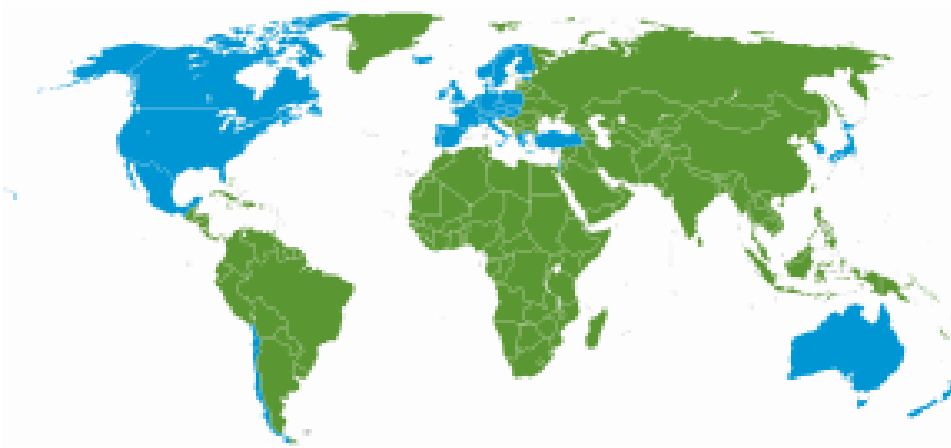
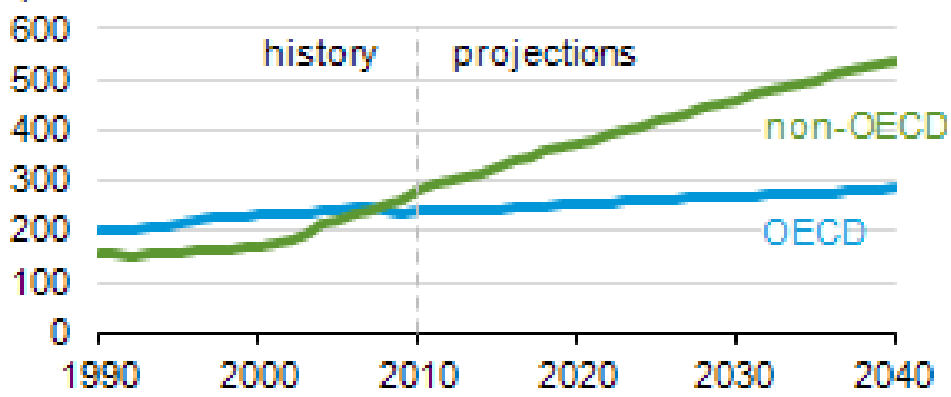
We just flick a switch or turn a knob!

Or get a Take-Away delivered!



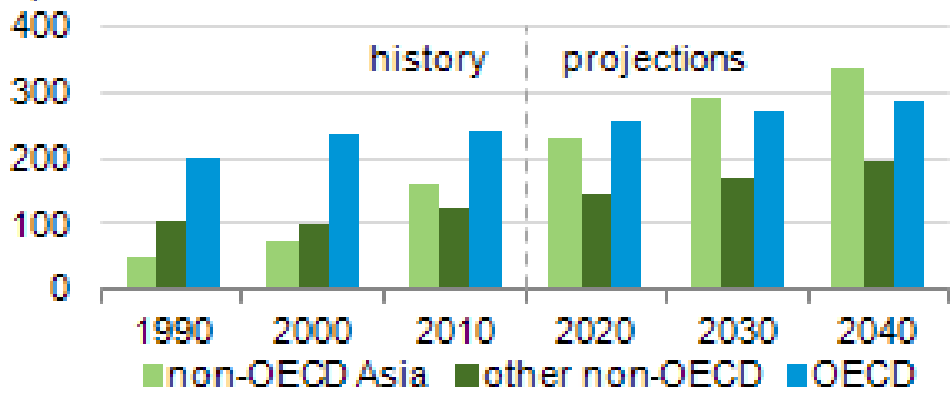
World energy consumption

quadrillion Btu



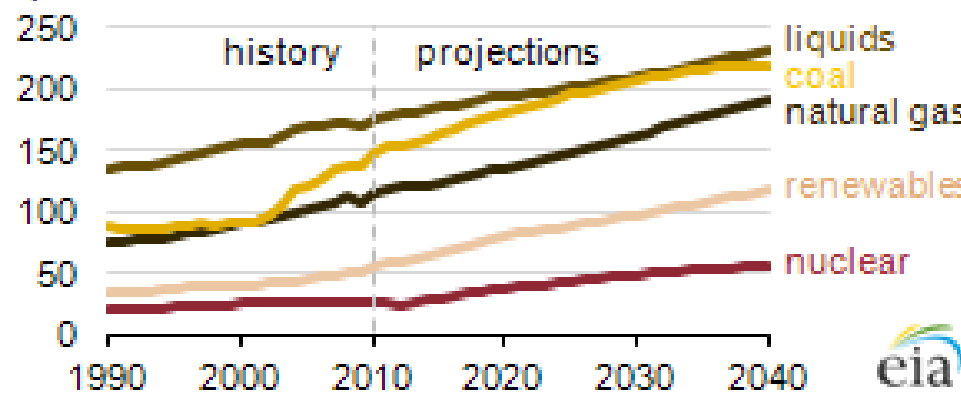
World energy consumption

quadrillion Btu

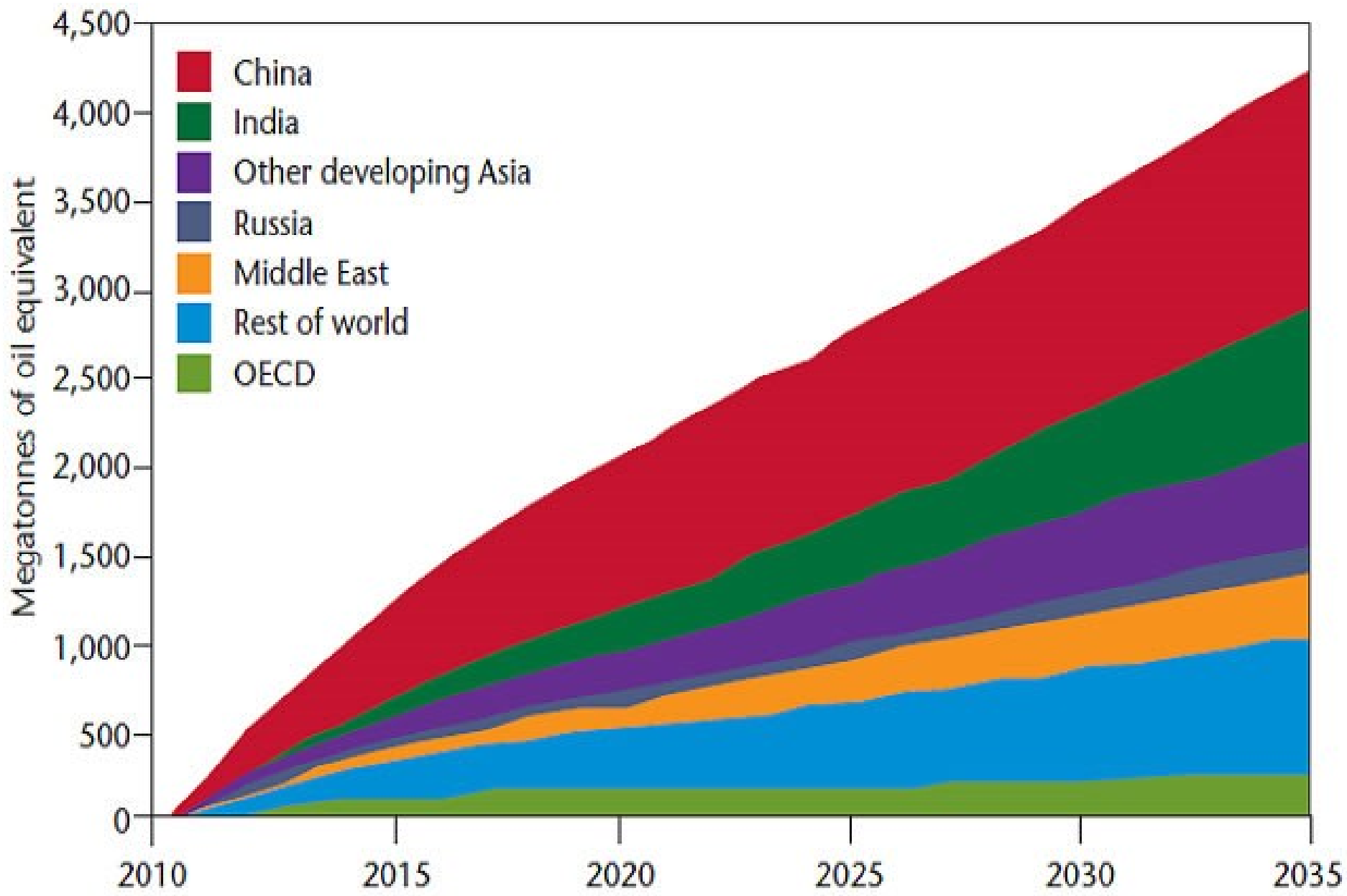


World energy consumption by fuel

quadrillion Btu



Energy usage is driven by population growth – some 10bn by 2050



So where does our energy come from?

Apart from nuclear power energy is generated by the Sun!

Fossil fuels (coal, oil and gas) are formed by the interaction of our environment and the Sun.

Trees need sunlight to grow - as they die they are buried and turn to coal.

Oil is made from the bodies of tiny sea-creatures.

Gas is formed from decaying biomass – grass, moss etc.

We have other forms of energy:-

Wind

PV

Sunlight

Wave

Hydro

Tide

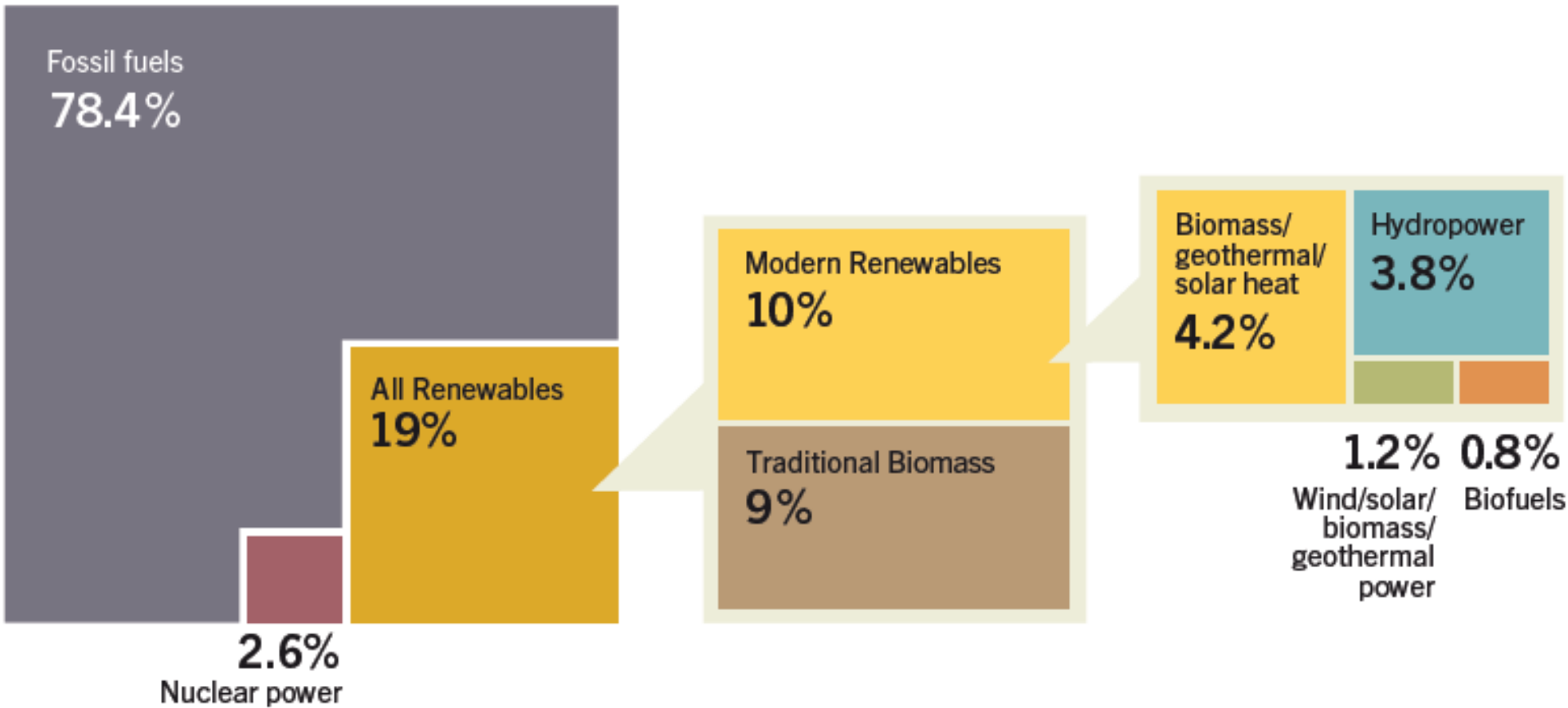
Biomass

Geothermal Power

These are known as renewables – more about this later!!

The Problem? Our dependence of fossil fuels

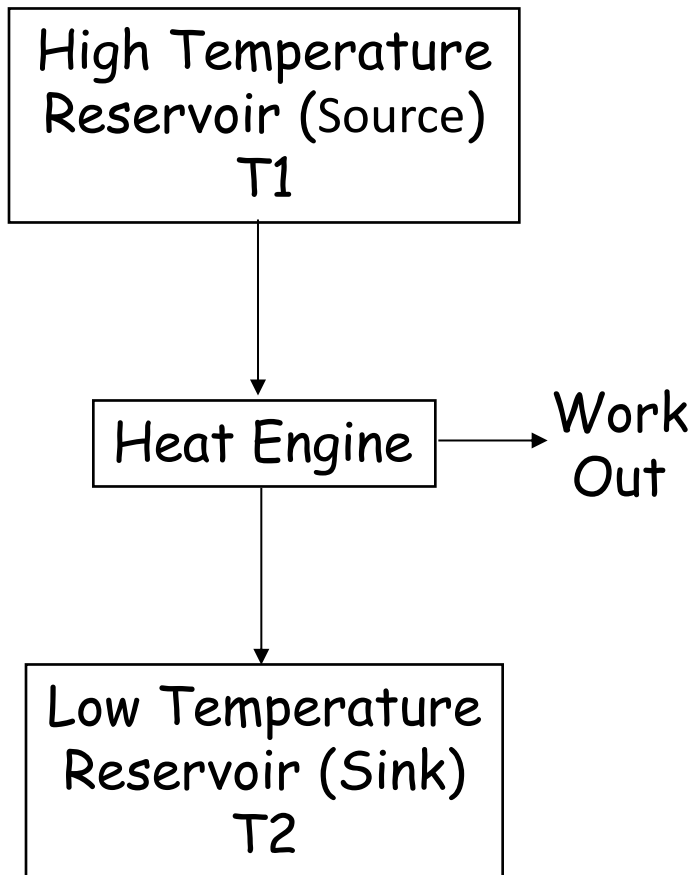
Figure 1. Estimated Renewable Energy Share of Global Final Energy Consumption, 2012



Source: REN 21 – Renewables Global Status Report 2014

Laws of Thermodynamics govern most of our energy technologies

The Heat Engine



$$\text{Efficiency (\%)} = (1 - T_2/T_1) \times 100\%$$

Assume T1 is 300 C (superheated steam) and T2 is 100 C (condensed steam) then efficiency is about 66%.

This ignores the efficiency of process to convert water to steam and pressurise, mechanical losses, etc.

Thermal process are inefficient – power stations (40%), internal combustion engines (25%), etc

Why is Efficiency Important?

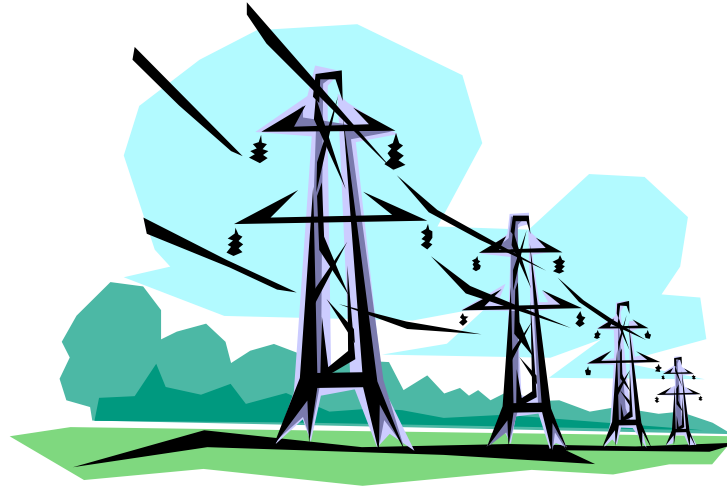
The lower the efficiency the greater the losses

Power Generation



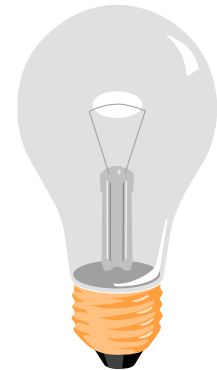
40% efficient

Transmission



Losses of 2-3%
can be 15% in developing
countries

Service



1.5- 2.5% efficiency for
incandescent bulbs
-7-10% for CFL
-rest is lot as heat
and non-visible part
of spectrum

About 3 - 6% of energy input to power station is
converted to useful light depending on the bulb!!!

So where are we in terms of energy?

We use a lot of fossil fuels

Fossil fuel use is not very efficient

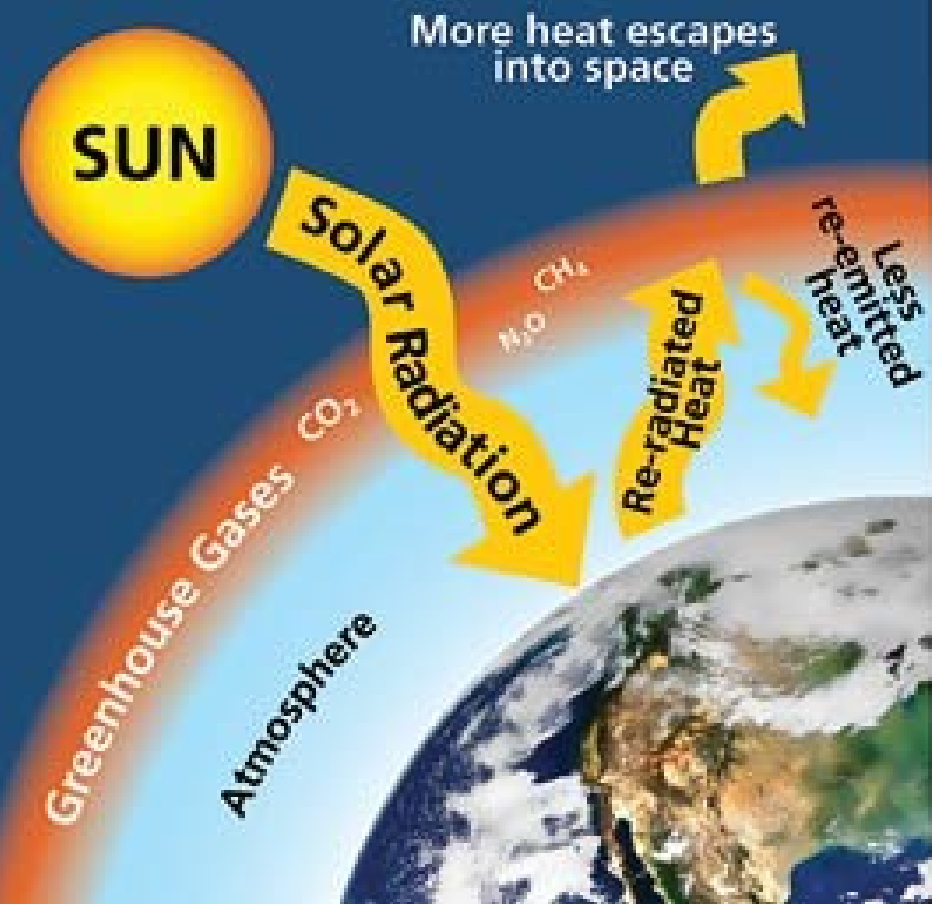
Burning fossil fuels produces Green House Gases (GHGs) and Pollution

GHGs cause global warming

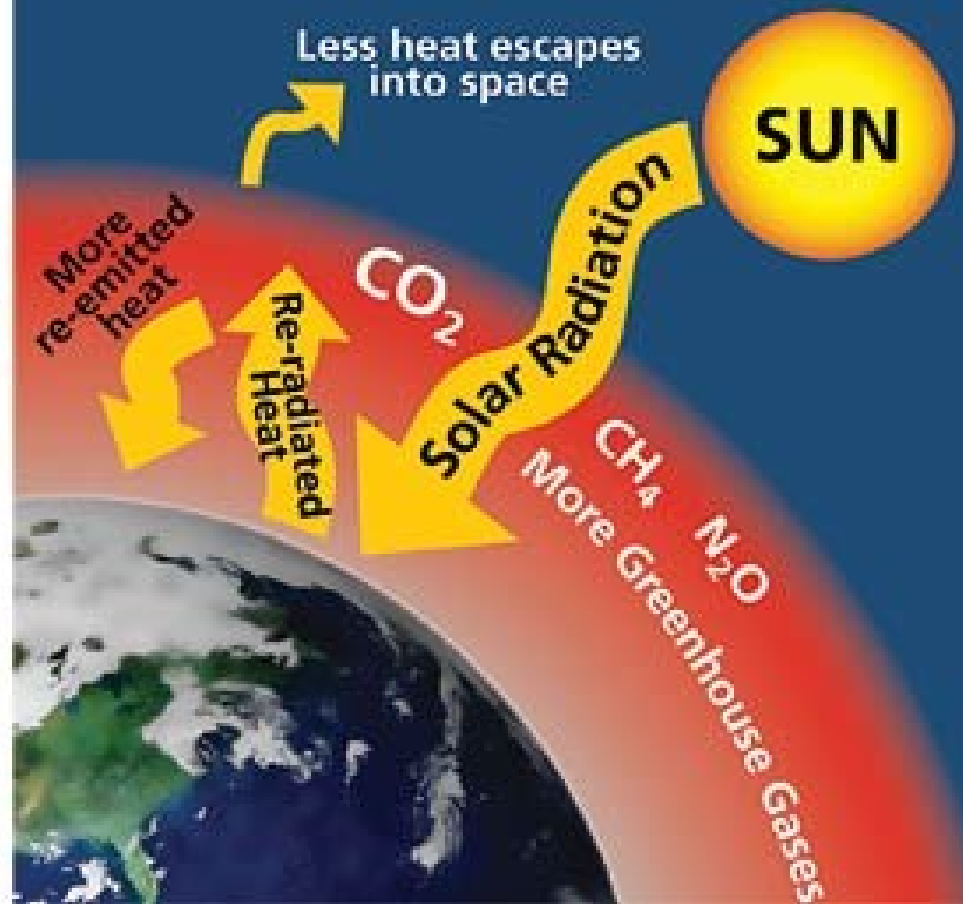
Pollution impacts the environment and human health

So is global warming a bad thing?

Natural Greenhouse Effect

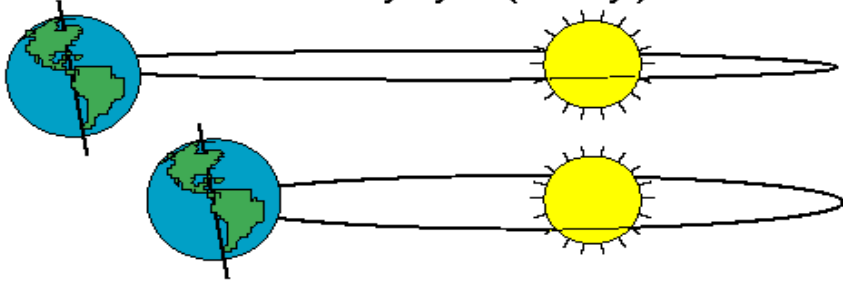


Human Enhanced Greenhouse Effect



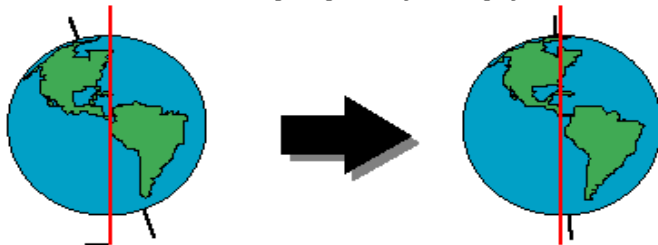
Relationships are really important – we live on small rotating rocky planet (but large enough to have sufficient gravity to retain the atmosphere) in the middle of nowhere that travels around the Sun and fortunately has a metal core that produces a magnetic field that protects us from solar storms.

Eccentricity Cycle (100 k.y.)



Orbit changes from circular to elliptical

Obliquity Cycle (41 k.y.)

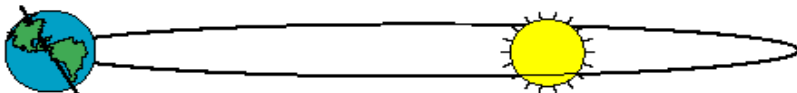


Wobbles like a top but the Moon acts as stabiliser

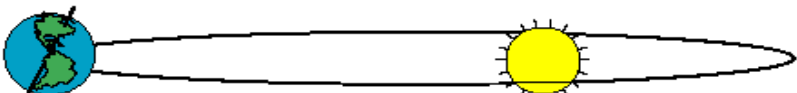
Normal to Ecliptic

©Scott Rutherford (1997)

Precession of the Equinoxes (19 and 23 k.y.)



Northern Hemisphere tilted away from the sun at aphelion.



Northern hemisphere tilted toward the sun at aphelion.

Reason for the seasons – imagine what it would be like with no seasons!

Milankovitch Cycles

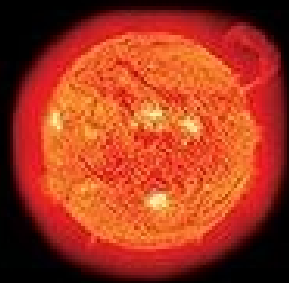
Precession



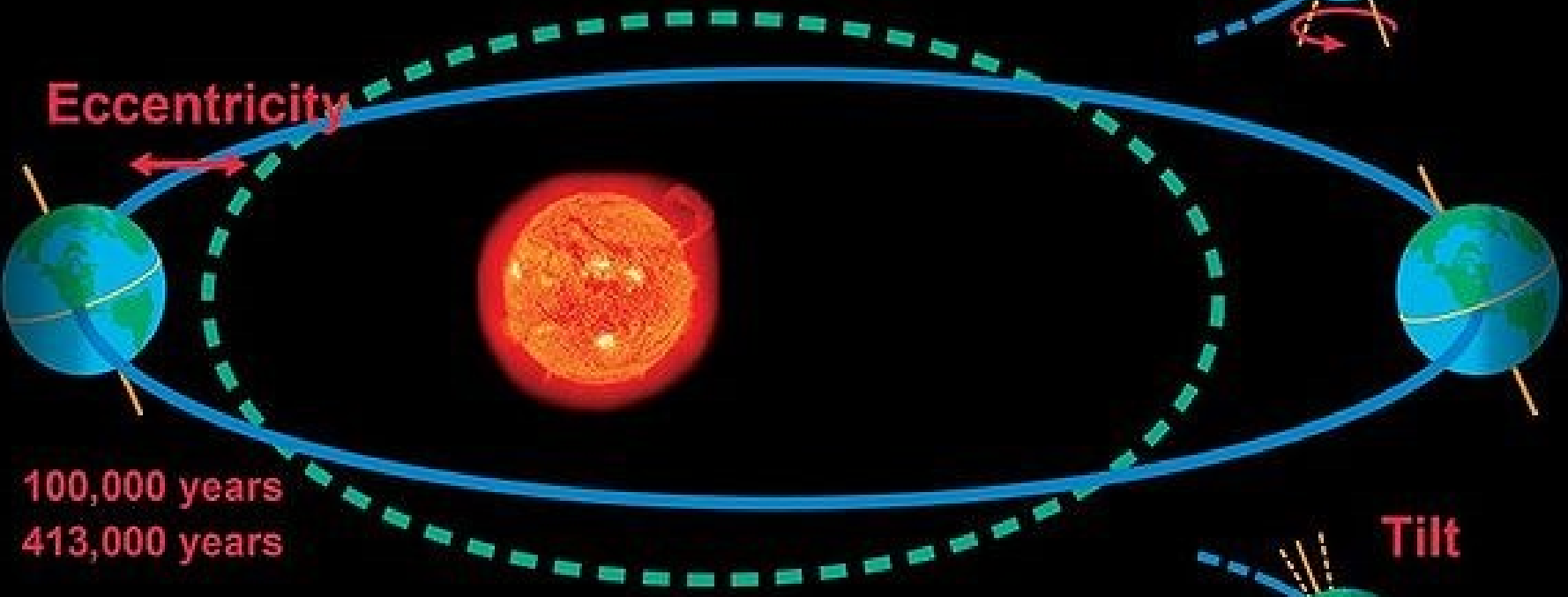
19-24,000 years



Eccentricity



100,000 years
413,000 years

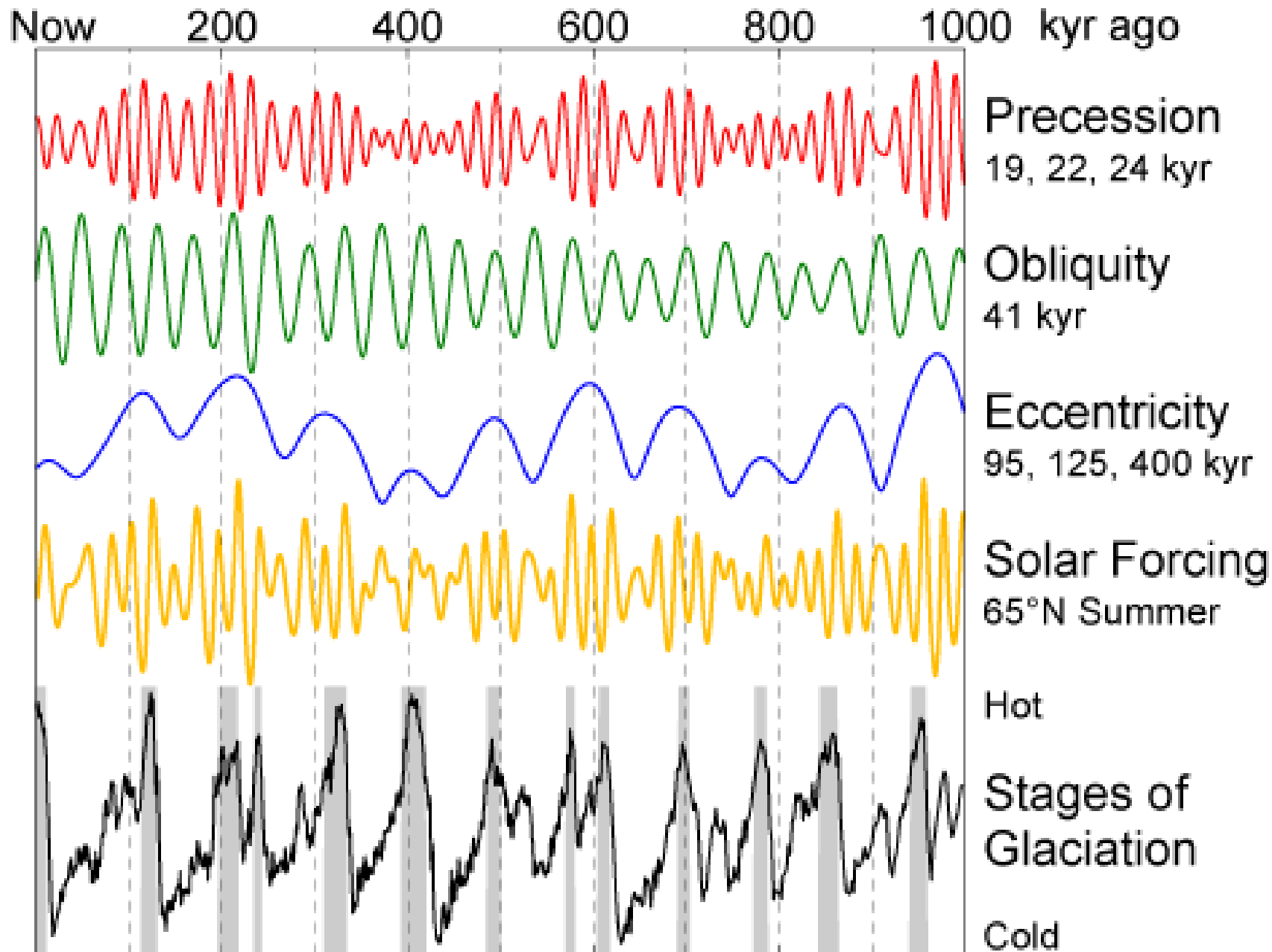


Tilt

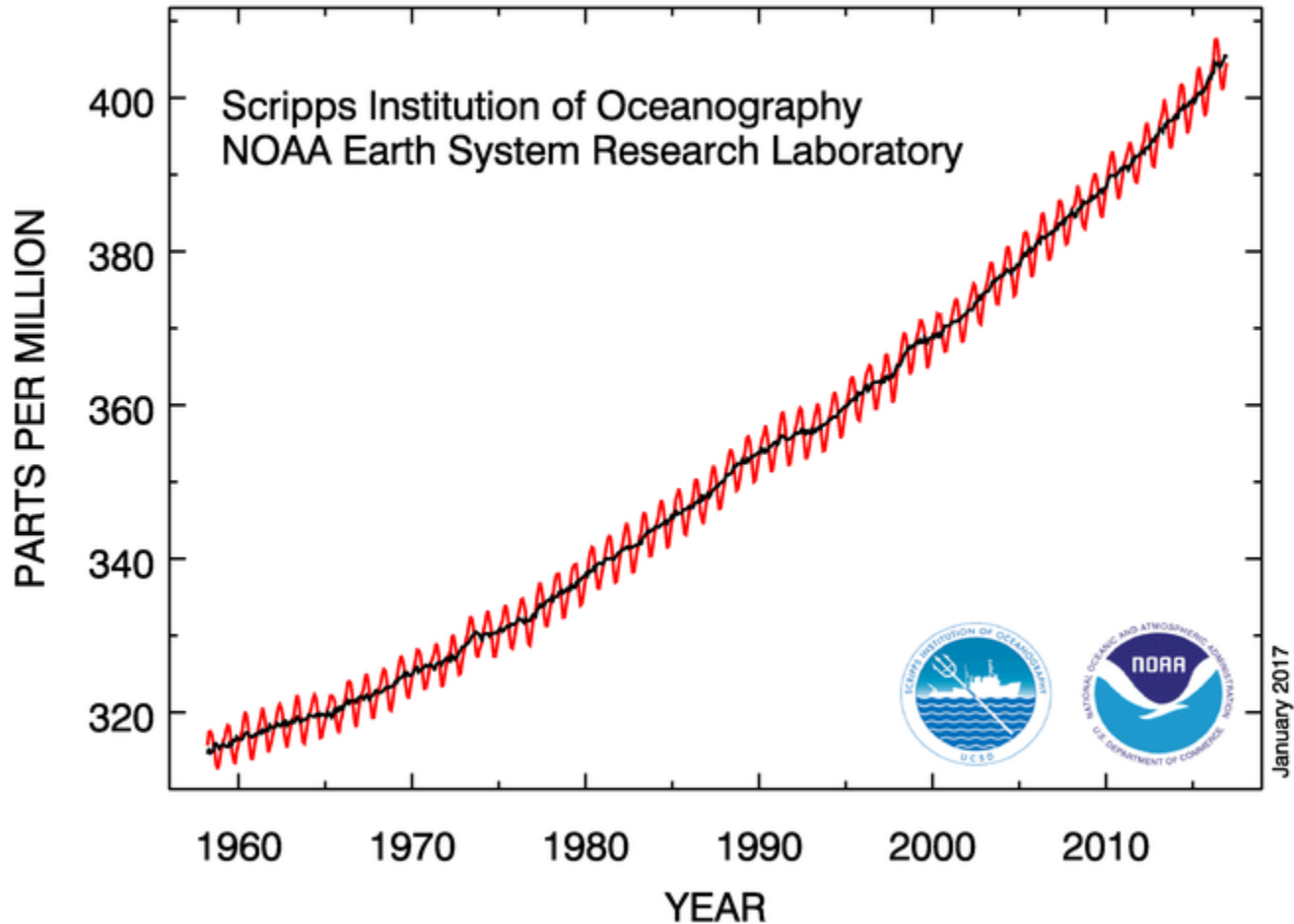
41,000 years



21.5°-24.5°
Currently 23.5°



Atmospheric CO₂ at Mauna Loa Observatory



We emit 2ppm per year – we have 25 years to sort out problem before we get to 450ppm and dangerous climate change

What are the impacts of Climate Change?

Short term:-

Storms

Floods

Heat Waves

Precipitation

Long term:-

Sea Level Rise

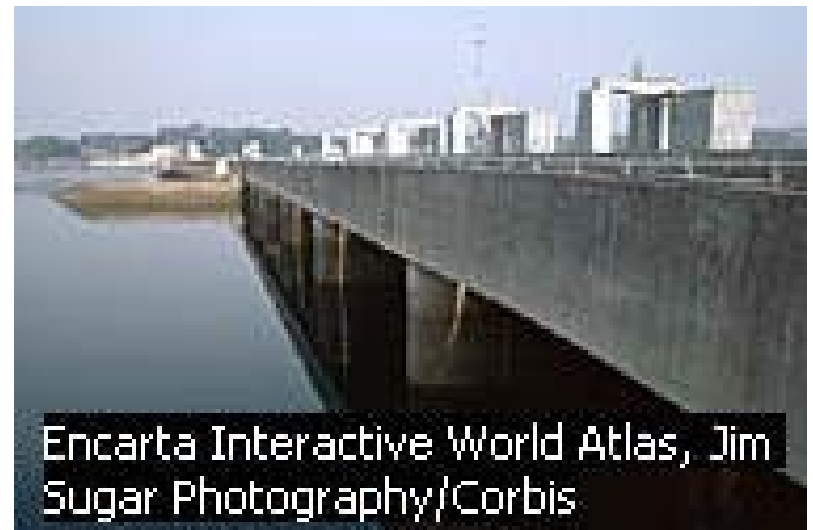
Drought

Impact on biodiversity

Population shifts

Loss of glacier (rivers)

What's the answer to CC? Easy use renewables and improve efficiency



Why don't we? We do – but not enough - the problem is greed

Despite Shell recognising in 1991 the climate problem:

<https://www.theguardian.com/environment/2017/feb/28/shell-film-warning-climate-change-rate-faster-than-end-ice-age>

The fossil fuel industry receives subsidies of \$548bn pa
(renewables \$121bn pa) – about \$10m per minute.

The oil countries and companies are rich, greedy and corrupt.

They have immense sway over our political leaders (UK fracking v cutting support
for renewables)

Despite the need to keep global temperature rise below 2 degrees (currently up
by 1.1.degrees) oil companies are still exploring even though they know we cannot
use any of our reserves (climate scientists (Bill McKibben) argue that we should only use the
fossil fuels we are currently exploiting – in short all known reserves should be left in the ground.

This means the majority of assets of energy countries and companies would be worthless.

But what is happening?

Slowly but surely we are recognising that the era of fossil fuels is drawing to an end!

EVS and renewables will become the norm . Authors such as Tony Seba believe it will happen before 2030!

That may not happen – but it is clear the future will be different.

You will have to cope with climate change that we have already built into the system.

Good luck with that

Thank You

Any Questions?

