

CARBON FOOTPRINTS - AN INTRODUCTION

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Carbon Footprints : Outline of the Lecture

- Introduction
- Some Definitions
- Direct and Indirect Emissions
- Carbon Risk
- A Postscript

Carbon Footprints : Objectives of the Lecture

- ❑ To explain the term 'carbon footprint'
- ❑ To outline the relationship between 'carbon footprint' and other terms such as 'embodied energy'
- ❑ To highlight some of the potential liabilities companies face if they fail to assess carbon risk
- ❑ To raise awareness and perhaps ..
- ❑ Enlist your help !!

A carbon footprint is a measure of the amount of carbon dioxide emitted by the combustion of fossil fuels

- a) during the manufacture and supply of a product, or
- b) the manufacture, supply and operation of a process

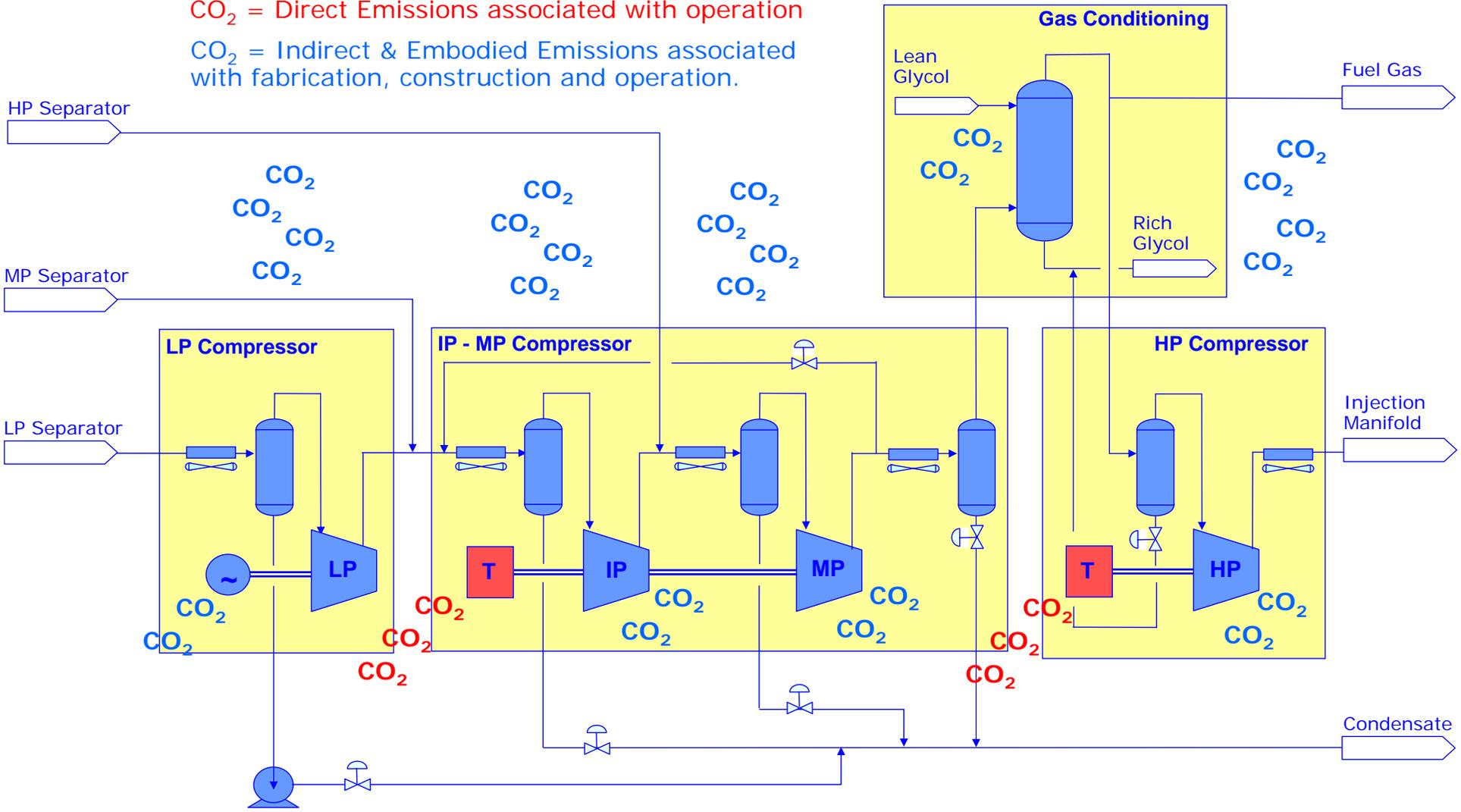
Carbon dioxide emissions can be classified as:

- ❑ Direct - typically associated with the operation of a process and relatively easy to determine.
- ❑ Indirect - typically associated with the manufacture and supply of a product or process. These are more difficult to calculate, but can be determined from the embodied energy content of materials and services.

Carbon Footprints : Direct & Indirect Emissions

CO₂ = Direct Emissions associated with operation

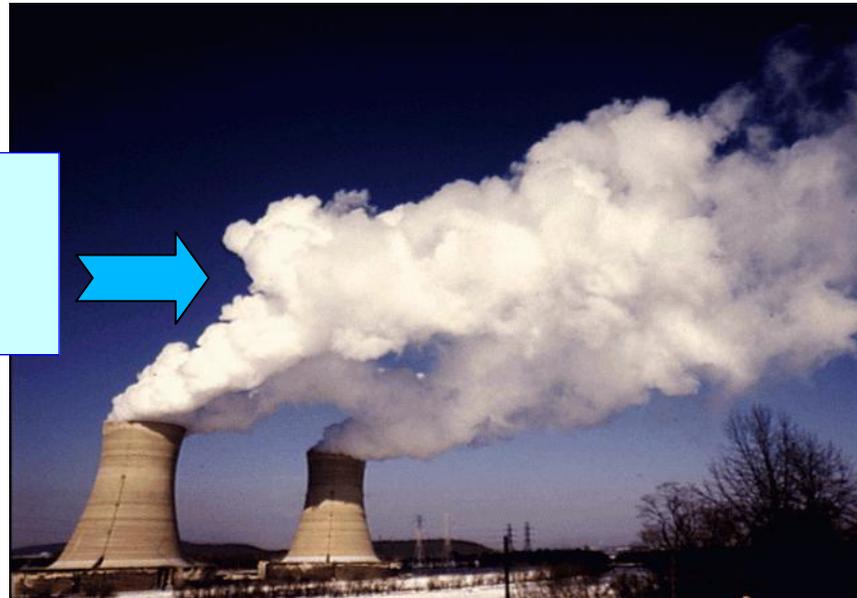
CO₂ = Indirect & Embodied Emissions associated with fabrication, construction and operation.



Carbon Footprints : A Popular Misconception

- ❑ These are cooling towers. The emissions you can see are plumes of warm, moisture laden air condensing.

This is not
carbon
dioxide !!



- ❑ However, the emissions do have a carbon footprint. These are indirect ones and represent the waste heat/embodied energy consumed by the (power) plant.

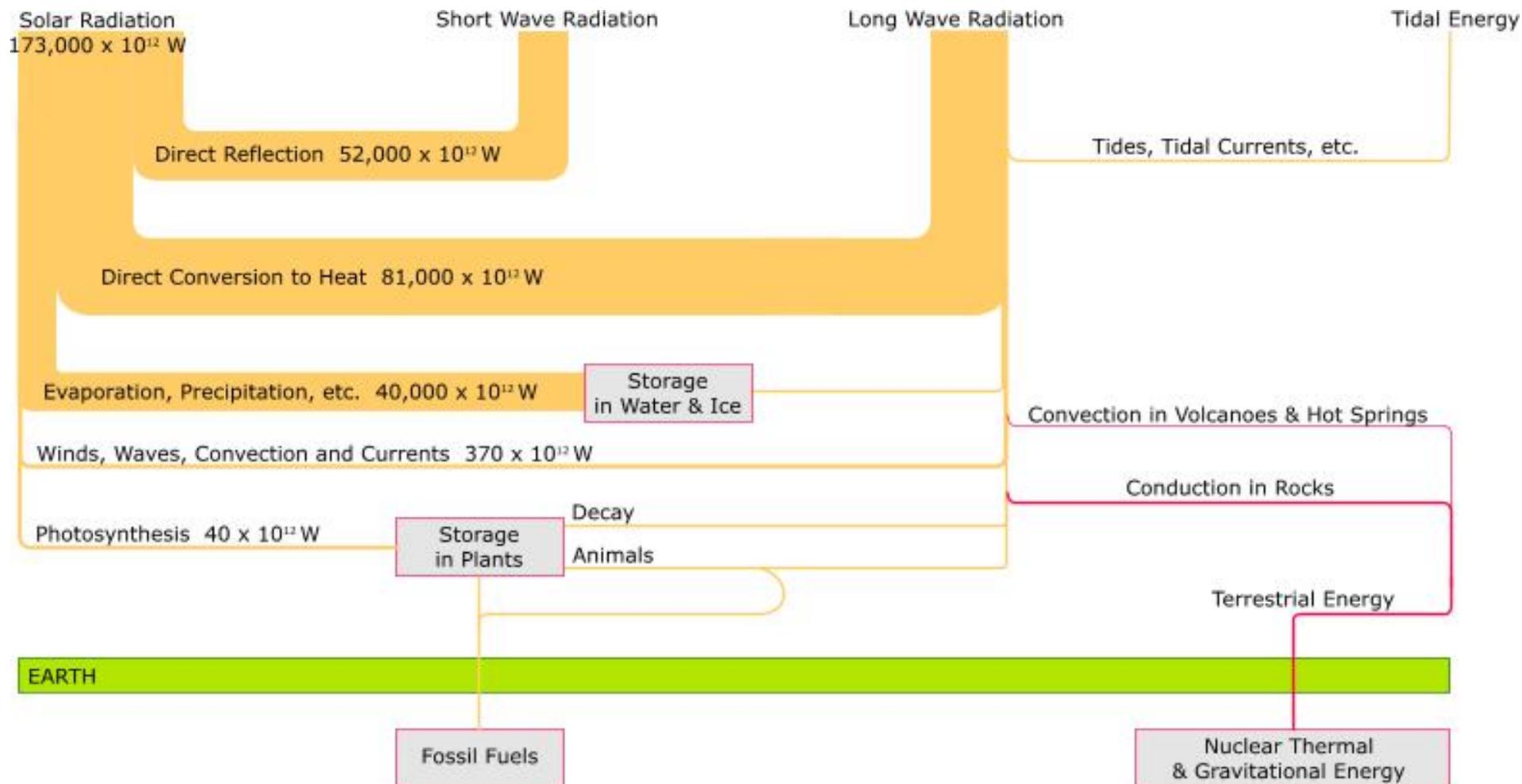
Embodied energy is the total amount of energy required to produce a product or supply a service

This includes:

- ❑ Extraction of raw materials.
- ❑ Manufacture, assembly and installation
- ❑ Transport

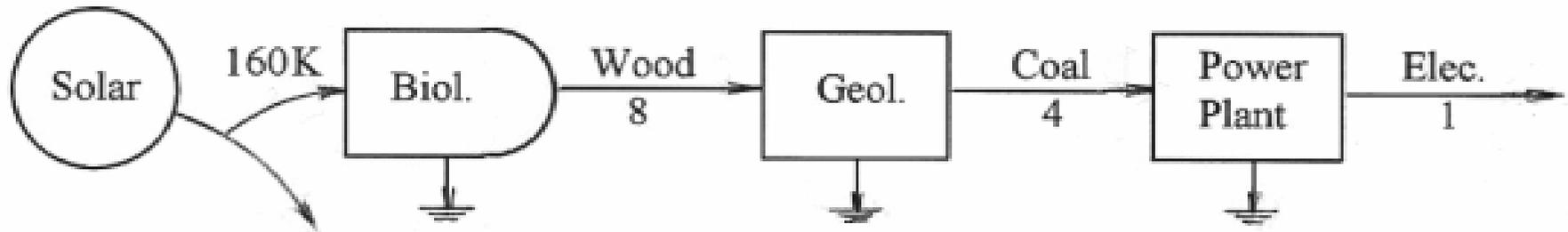
Values have been developed for building materials. A number of organisations are sponsoring the development of globally accepted values and a methodology for the manufacture of finished goods and services.

Carbon Footprints : Embodied Energy



After M. King Hubbert. [The Energy Resources of the Earth](#), 1971

Carbon Footprints : Embodied Energy

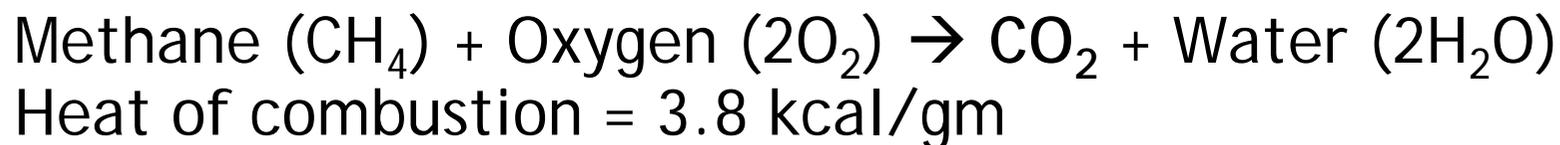


Transformation of Energy (after H.T. Odum)

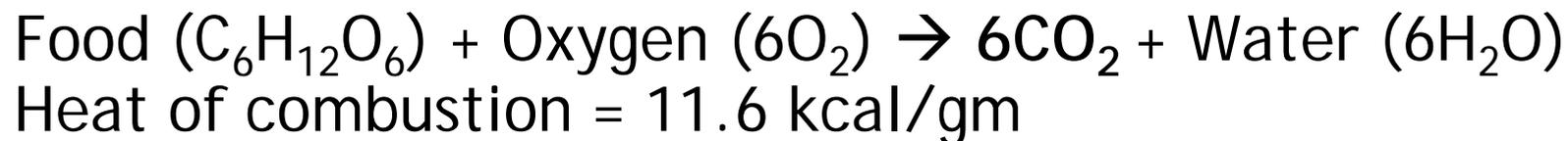
- ❑ Equivalency: On average 0.098 tonnes of carbon dioxide are produced per gigajoule of embodied energy. Source: [CSIRO](#) MMT Brochures.
- ❑ Typical values, UK supply (MJ/kg): Aluminium = 154, Steel = 24, Cement = 5. Source: Inventory of Carbon & Energy (ICE), University of Bath 2006.

Carbon Footprints : The Chemistry

- ❑ The chemical formula for carbon dioxide is CO_2
- ❑ It is a product of a combustion process that also generates heat, e.g:



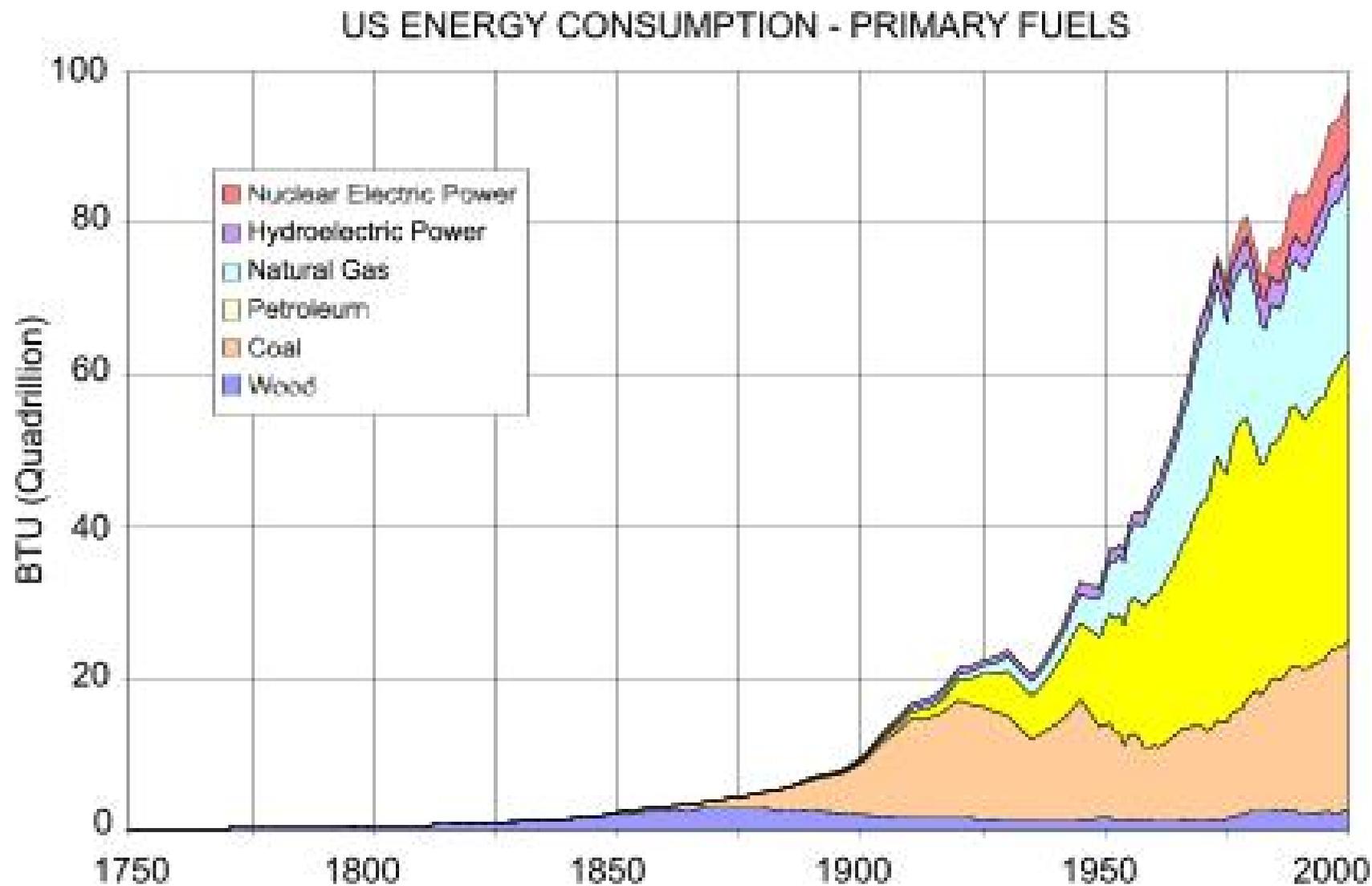
- ❑ **NB:** our bodies use essentially the same process when we eat (burn) food, e.g :



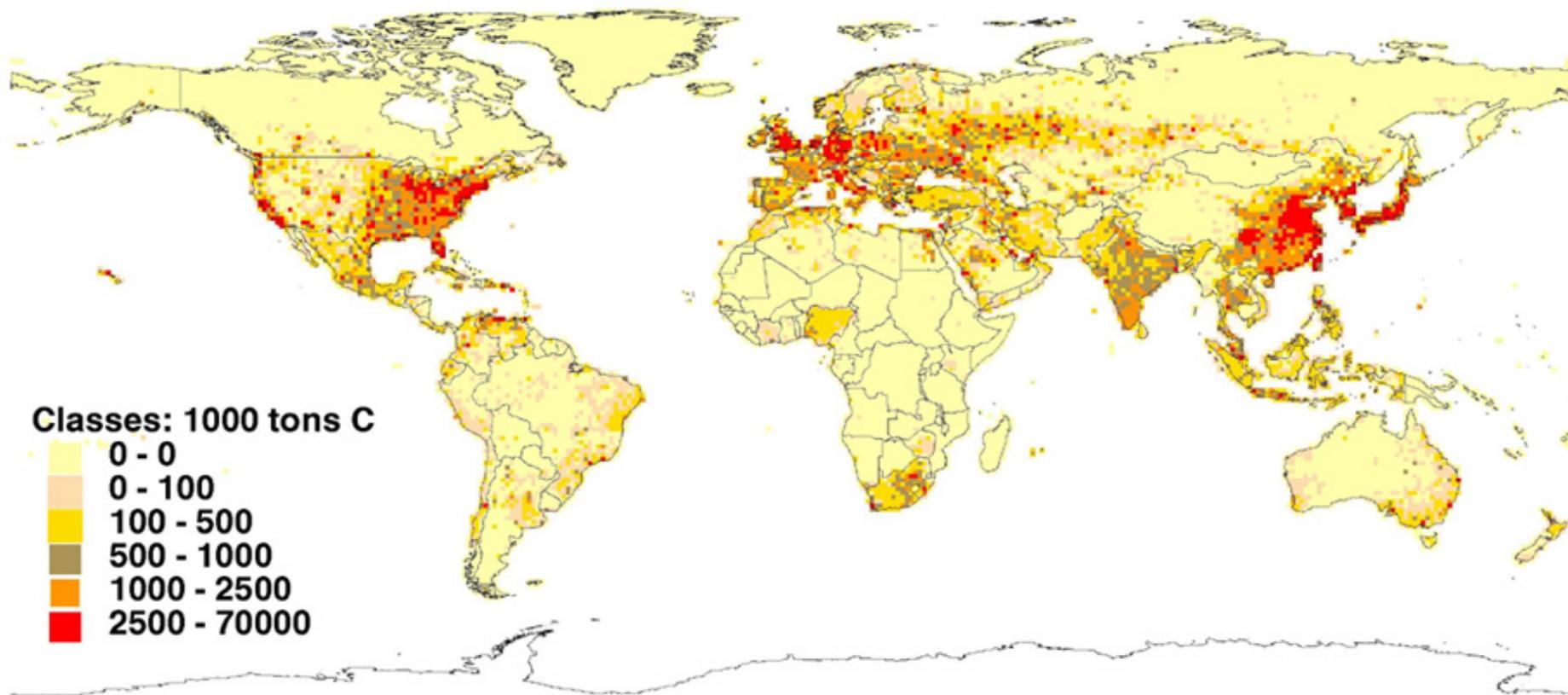
Carbon Footprints : The Consumption of Fuels

- ❑ We use the heat generated by combustion to power the processes that sustain our economies.
- ❑ Although the World's primary source of energy is the sun, our economies rely most on the combustion of fossil fuels because their embodied energy content is so great.
- ❑ This includes coal, crude oil and natural gas ...

Carbon Footprints : The Consumption of Fuels

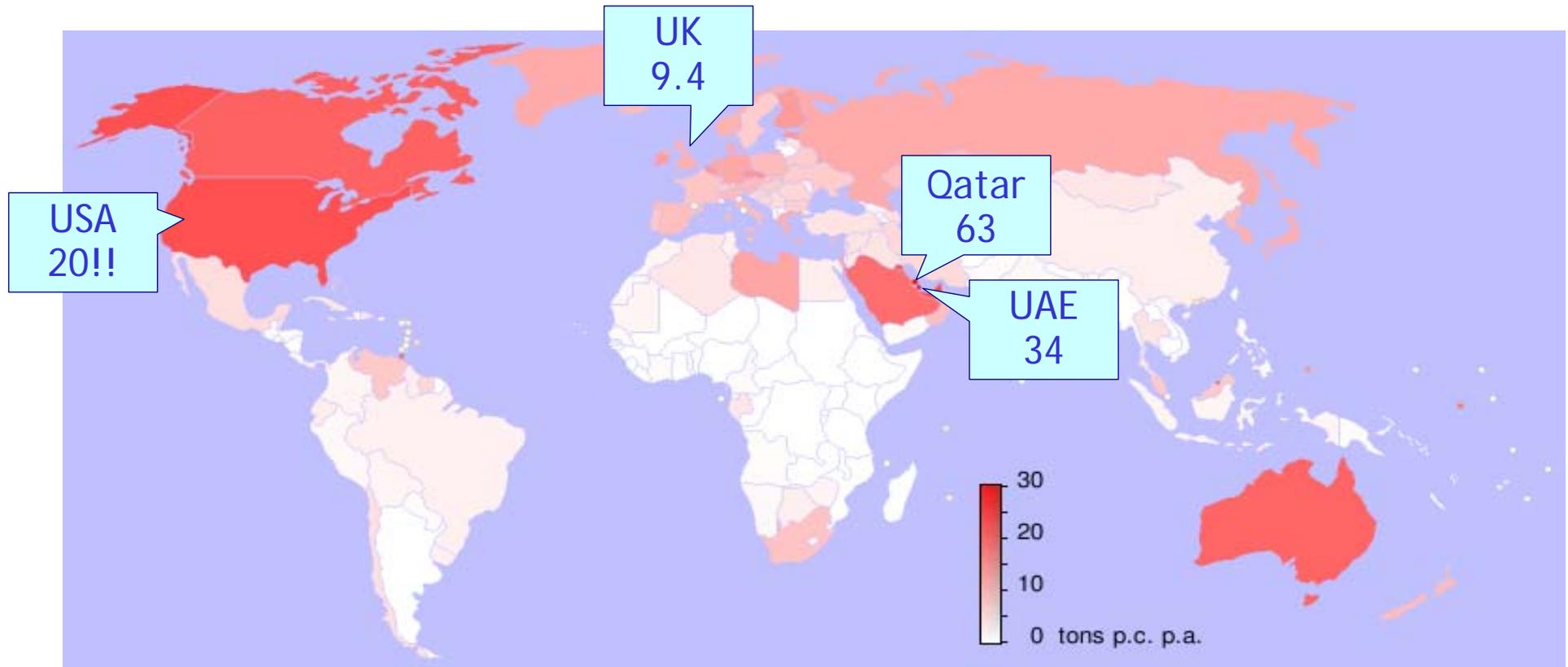


Carbon Footprints : CO₂ Emissions



Source : Emissions from Burning Fossil Fuel, Producing Cement and Flaring, [Brenkett, et al.](#) Oak Ridge National Laboratory, 1998

Carbon Footprints : CO₂ Emission per Capita



CO₂ emissions : tons per capita per year per country (2003)

Source : [Wikipedia/List of Countries by CO₂ Emissions](https://en.wikipedia.org/wiki/List_of_Countries_by_CO2_Emissions)

Carbon Footprints : The Link to Climate Change

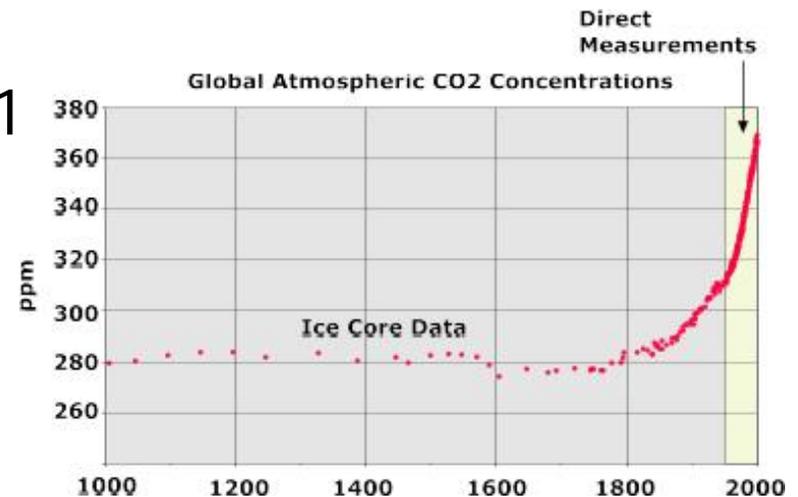
There is a growing awareness that the emissions of green house gases (GHG) primarily associated with the combustion of fossil fuels, is linked to climate change.

The primary greenhouse gases are:

- ❑ Carbon Dioxide (IPCC 2001: CO₂e = 1)
- ❑ Methane (CO₂e = 23)
- ❑ Nitrous oxide (CO₂e = 296)
- ❑ HFCs (CO₂e = 1,100 → 12,000)

Non-methane VOCs should also be considered

CO₂e = Carbon dioxide equivalent global warming potential

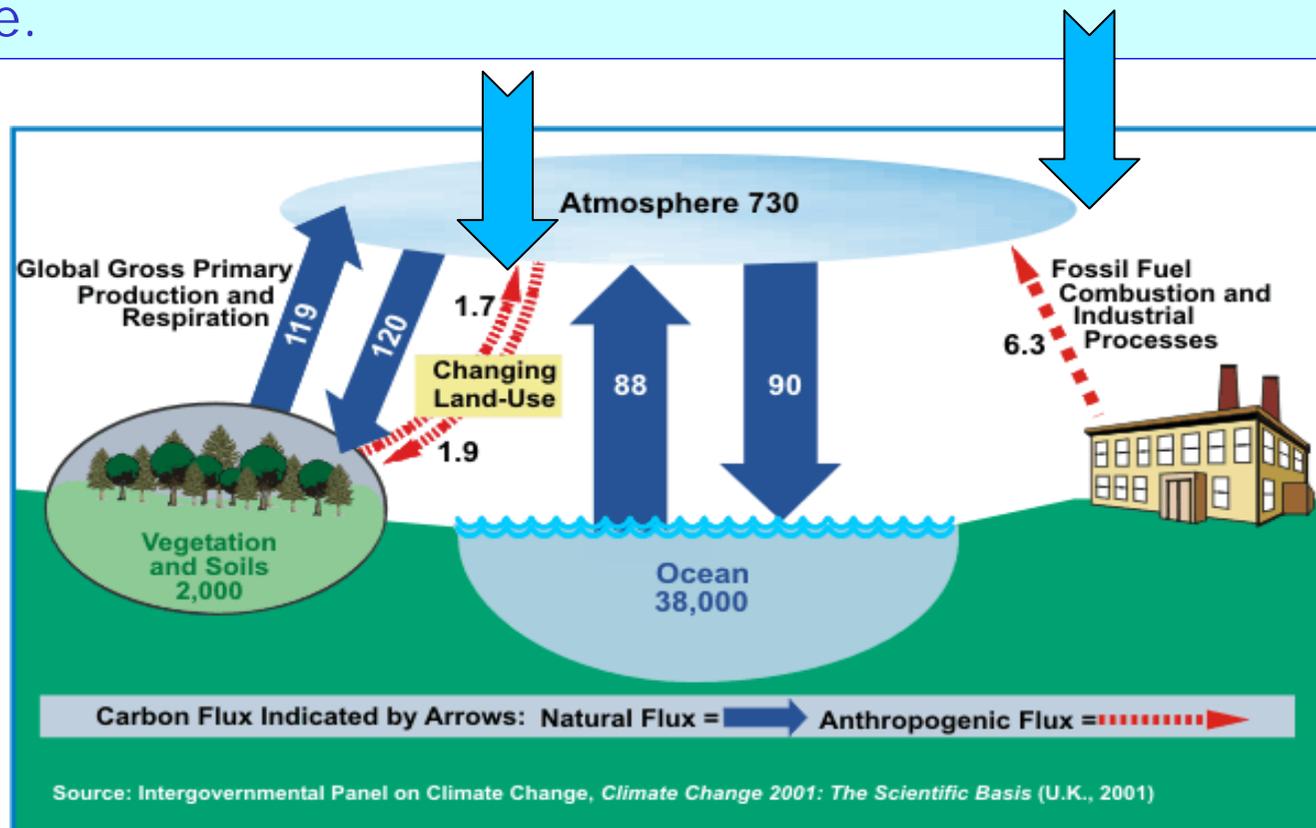


Carbon Footprints : The Link to Climate Change

- ❑ CO_2 emissions = direct + indirect + multiplier
- ❑ The multiplier represents the impact that the release of carbon dioxide into the atmosphere is having on global temperatures (the greenhouse effect).
- ❑ Rising temperatures have the potential to disturb carbon sinks and release yet more carbon dioxide into the atmosphere. These sinks include the soil and the oceans.
- ❑ We must await the results of further scientific research before a value can be assigned to the multiplier.

Carbon Footprints : The Global Carbon Cycle

The concern is that the increase of atmospheric carbon dioxide levels due to the burning of fossil fuels and change of land use is affecting the natural carbon cycle.



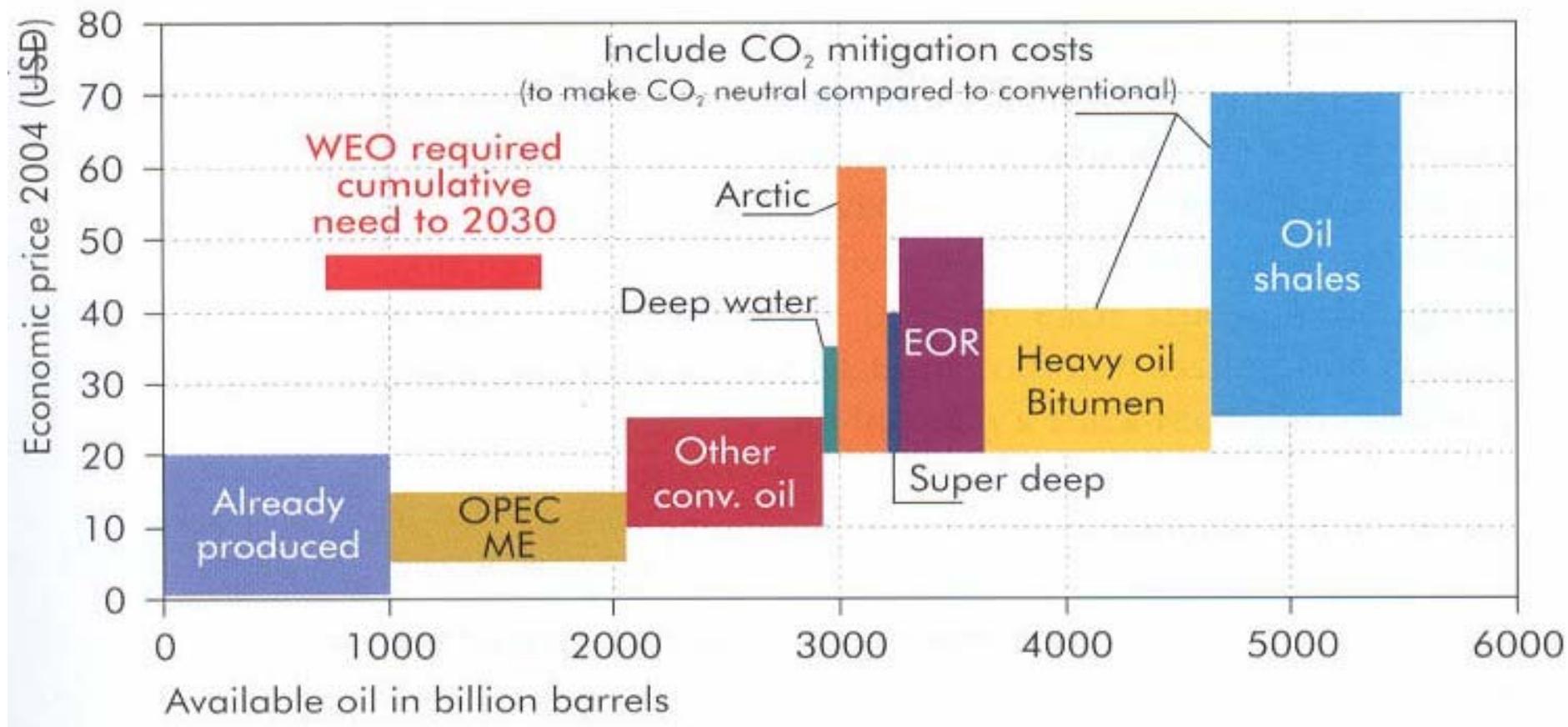
Flows in billions of metric tonnes per annum. Source : [Carbon Cycle Information](#), US NOAA Research, Earth System Research Laboratory

- ❑ Governments are moving to a point where a new agreement to control the emissions of green house gases will be negotiated to replace the [Kyoto Protocol](#). This expires in 2012.
- ❑ It seems likely that such an agreement will seek to reduce the consumption of hydrocarbons (either by cap and trade, taxation or a mix of both). By inference, this will seek to curtail production from oil and gas facilities.
- ❑ There will still be a demand for fossil fuel, but production may well be circumscribed in favour of those processes that can demonstrate a low carbon footprint.

Carbon Footprints : The Future for Our Industry

- ❑ The hydrocarbon industry needs to develop methods to help quantify its CO₂ emissions and to demonstrate that it has selected and operates processes with a low carbon footprint.
- ❑ Projects with high carbon footprints are likely to include:
 - ❑ Oil sands
 - ❑ Stranded gas developments, such as gas-to-liquid (GTL) and liquified natural gas (LNG) processes
 - ❑ Enhanced oil recovery (though what about CO₂ flood?!)
 - ❑ Those with a high acid and/or sour gas content
 - ❑ Deep water, offshore platforms !!

Carbon Footprints : The Future for Our Industry

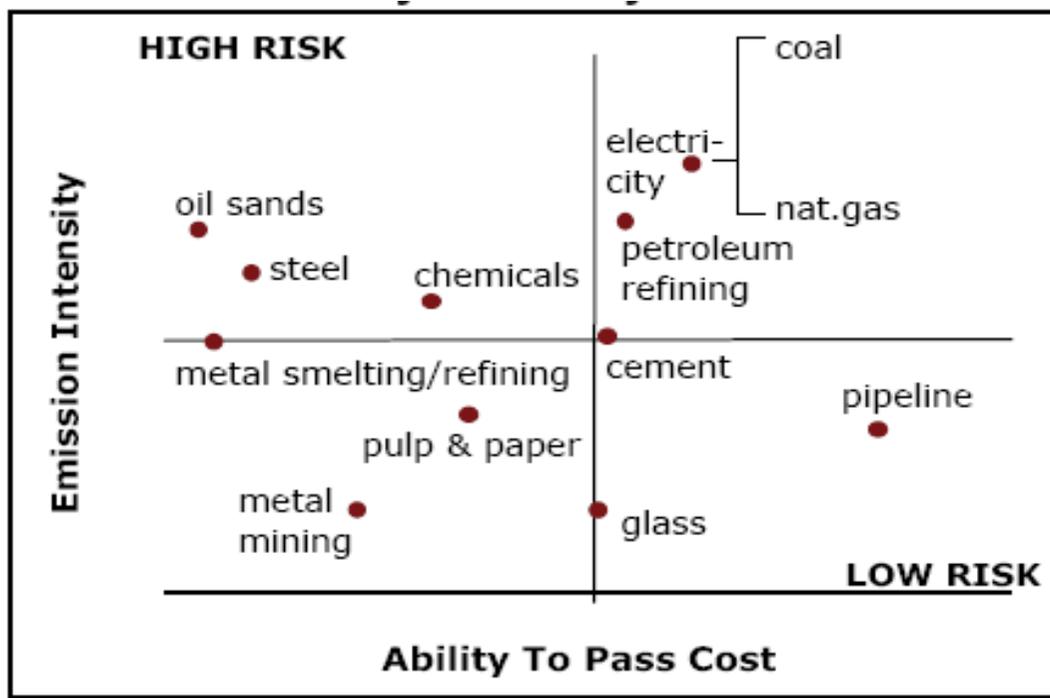


Source : International Energy Authority, [Resources to Reserves](#), 2005

Carbon Footprints : Evaluating Carbon Risk

Where would you place these on the graph ?

gas-to-liquids LNG sour gas EOR deepwater platform FPSO



Emission Intensity: kilotonnes CO2 per \$ of output

Carbon Risk in the Canadian Economy : Emission Intensity vs Ability to Pass Cost
Source : [CIBC World Markets](http://www.cibc.com/worldmarkets), Monthly Indicators, 12th February 2007

- ❑ Corporate owners of oil and gas production facilities need to identify the potential impact carbon liabilities will have on their balance sheet.
- ❑ Similar considerations may apply to owners wishing to externalise their carbon risks by contracting operating rights to duty holders.
- ❑ The risk premium associated with the financing of new oil and gas projects will rise as banks and other institutions become more aware of carbon footprints.
- ❑ The oil and gas industry and its agents may be increasingly exposed to legal / tort action by groups campaigning against the effects of global warming.

Carbon Footprints : A Post Script

You will shortly be able to purchase products that will tell you how much carbon dioxide has been emitted in producing and delivering them to your retail outlet !

First products:
Walkers Crisps,
Innocent Smoothies
and the Botanics range
from Boots



Carbon Trust : [Carbon-Label](#) Initiative

FOR THE SECOND PART OF THIS PRESENTATION, CONSULT:
CARBON FOOTPRINTS - A PROPOSED METHODOLOGY