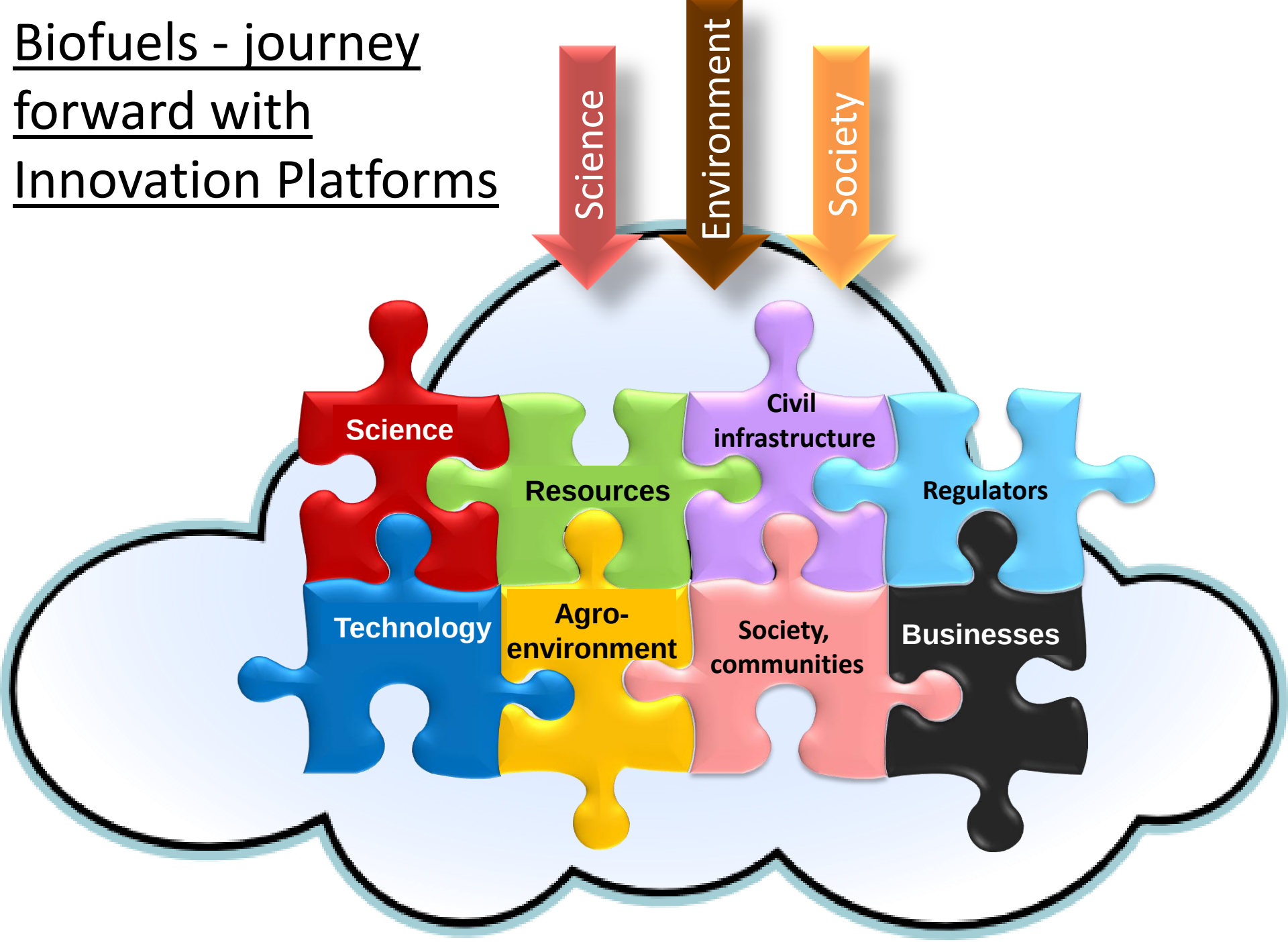
Biofuels - journey forward with Innovation Platforms



The arguments

1. Society aspirations are built on energy
2. Biofuels fit a gap –rather too well
3. We can make more biofuel (if)....
   - ✓ we have resources
   - ✓ we have the technologies
4. The ‘haves’ and ‘have-nots’ will need to negotiate
5. New approaches will be needed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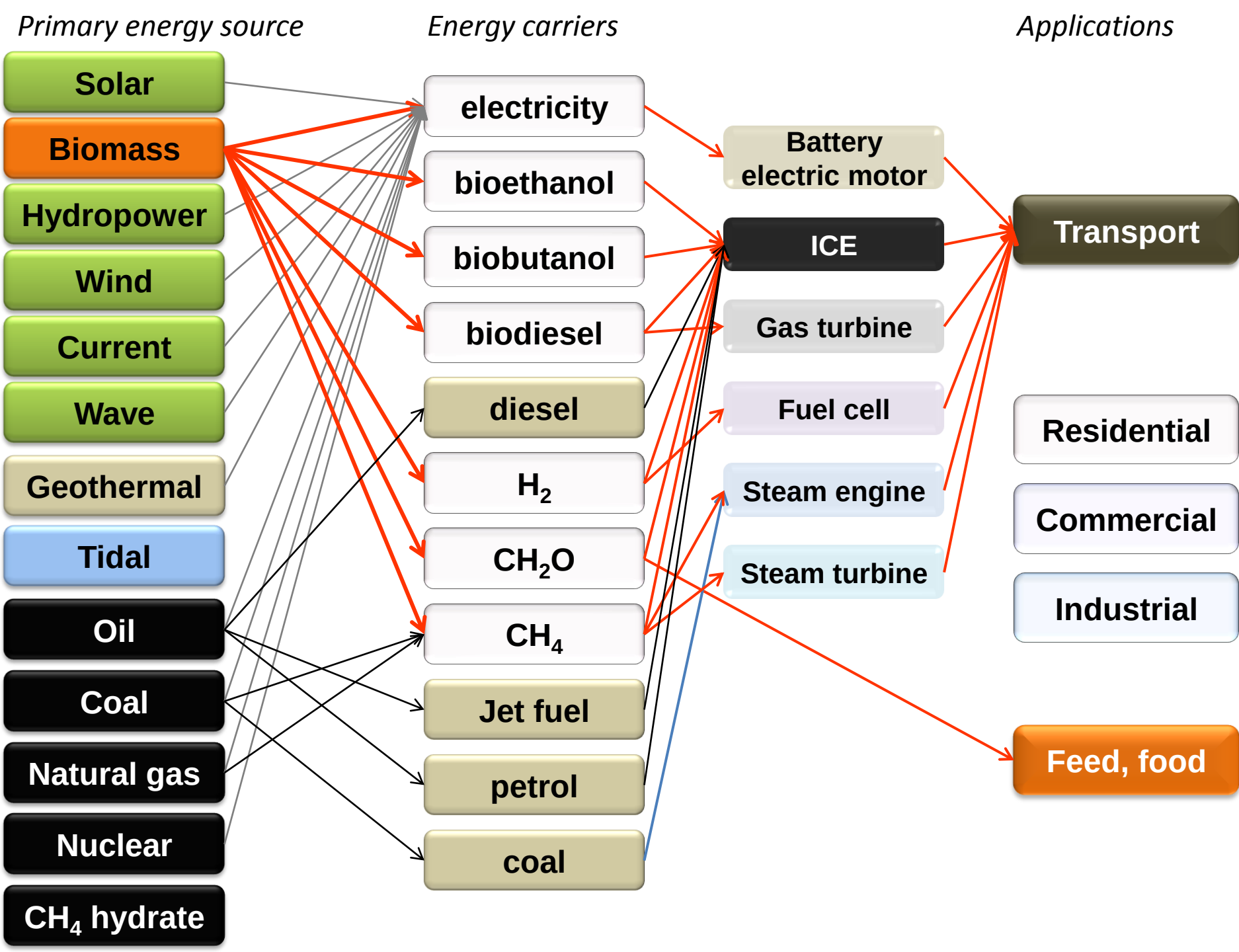
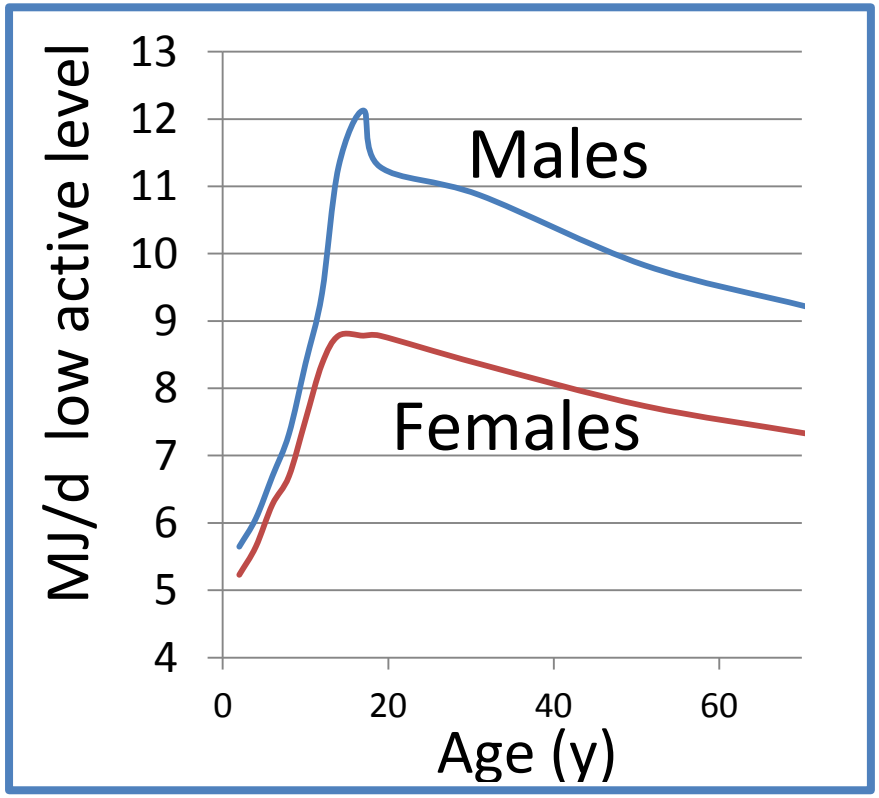

Primary energy source
Energy carriers
Applications
Solar
Biomass
Hydropower
Wind
Current
Wave
Geothermal
Tidal
Oil
Coal
Natural gas
Nuclear
CH4 hydrate
electricity
bioethanol
biobutanol
biodiesel
diesel
H2
CH2O
CH4
Jet fuel
petrol
coal
Battery electric motor
ICE
Gas turbine
Fuel cell
Steam engine
Steam turbine
Transport
Residential
Commercial
Industrial
Feed, food

How much energy?

Living cells must continuously take in energy



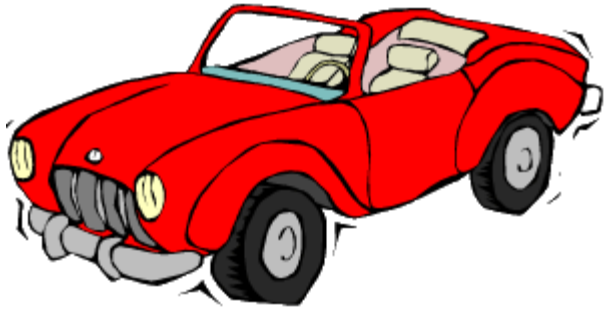
http://www.hc-sc.gc.ca/fn-an/food-guide-aliment/basics-base/1_1_1-eng.php

Energy consumption in the UK (2009) – excluding air transport *(DECC, UK census)*

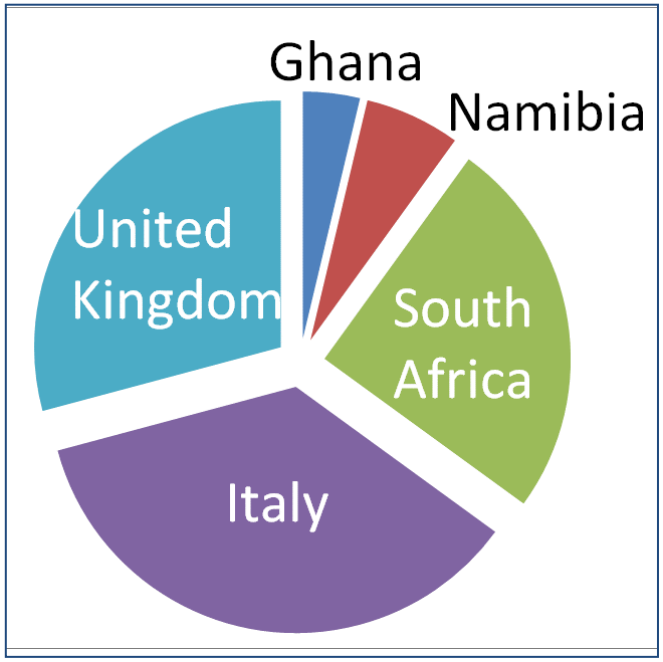
Sector(UK)	MJ/d/person
Transport	679
Domestic	819
Industry & Commerce	91366

What do we (think) want in the UK?

Heating (gas)	**45%**
Hot water (gas)	**16%**
lighting (elec)	**1%**
TV (elec)	**0.5%**
Cooking (elec)	**3%**
Dishwasher (elec)	**2%**
Fridge/freezer (elec)	**2%**
Washer/drier (elec)	**0.5%**
Car (petrol)	**30%**

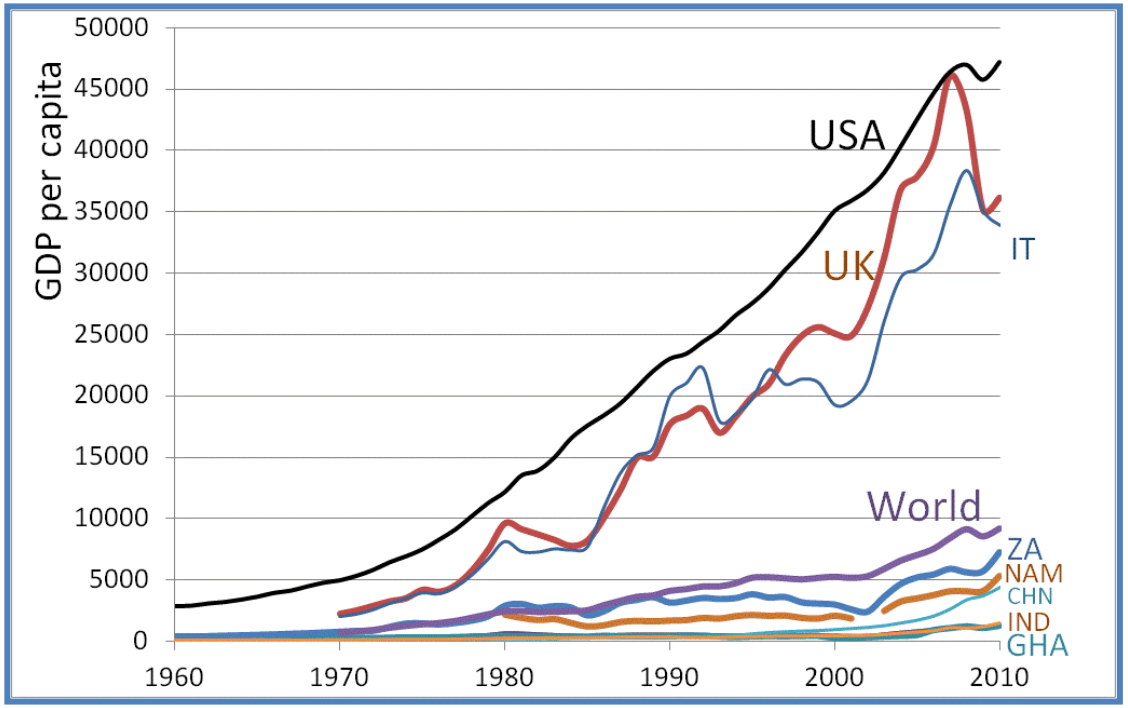


% Energy consumption per capita (2005)

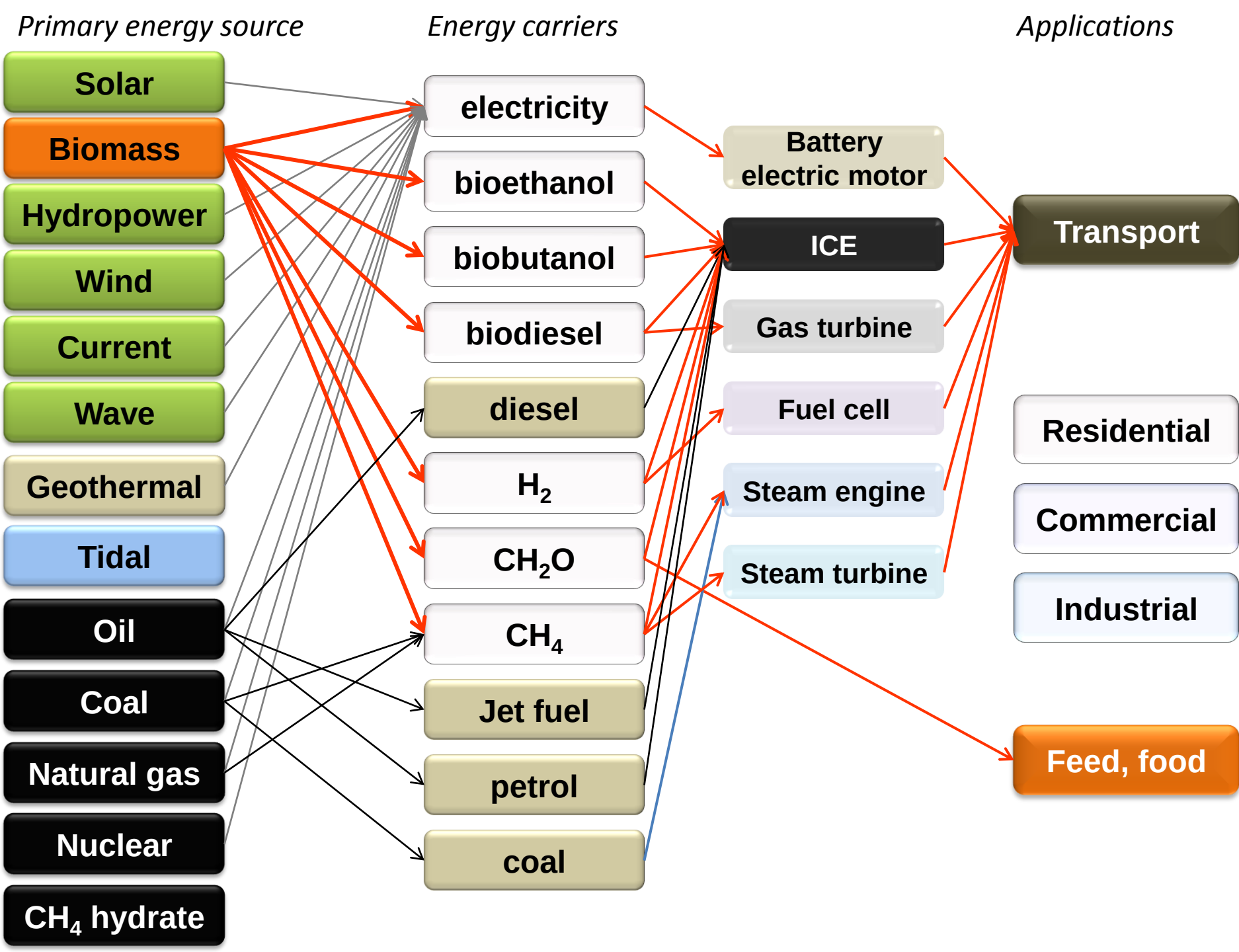


http://earthtrends.wri.org/searchable_db/index.

GDP per capita



http://data.worldbank.org/indicator/NY.GDP.PCAP.CD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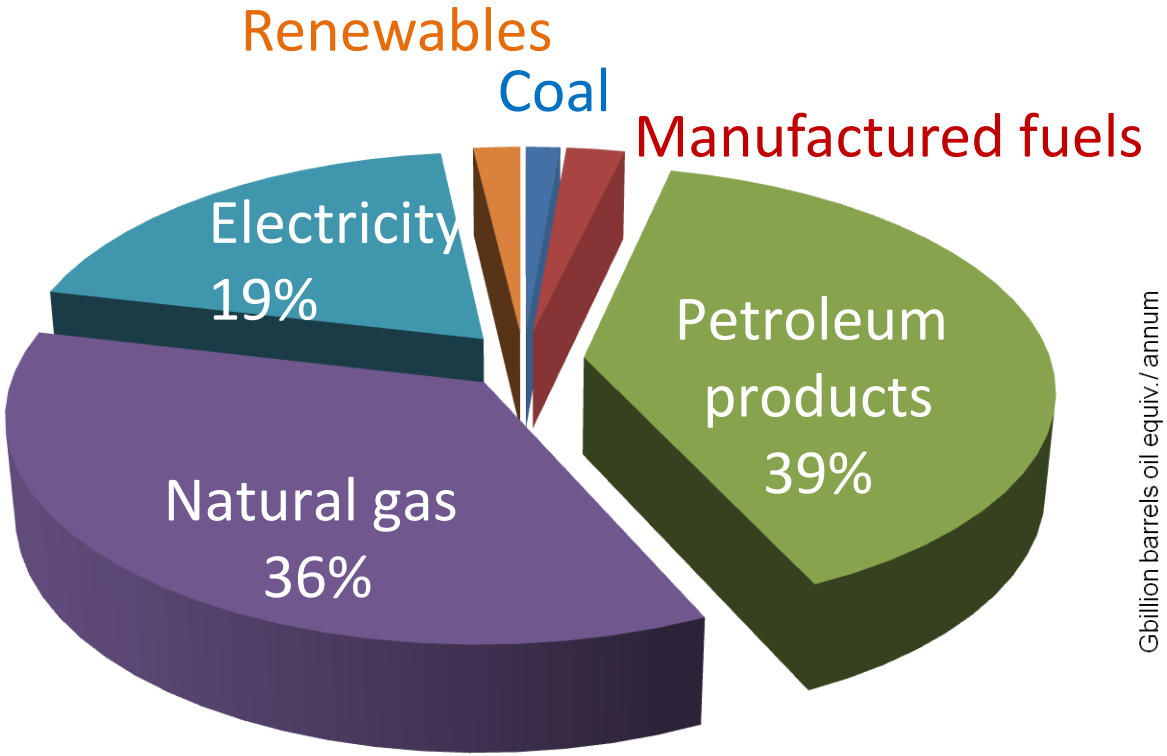
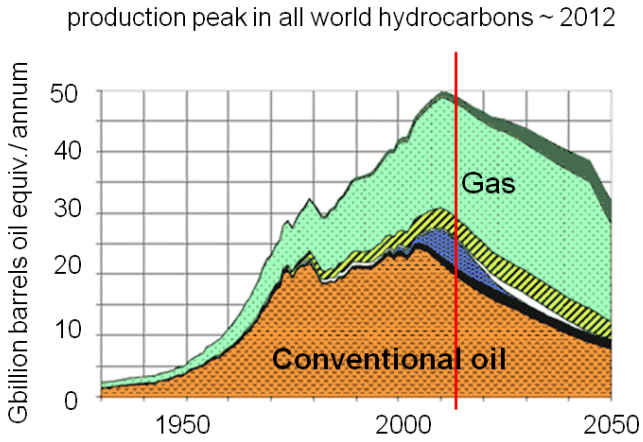
Oil
Coal
Natural gas
Nuclear
CH4 hydrate
electricity
bioethanol
biobutanol
biodiesel
diesel
H2
CH2O
CH4
Jet fuel
petrol
coal
Battery electric motor
ICE
Gas turbine
Fuel cell
Steam engine
Steam turbine
Transport
Residential
Commercial
Industrial
Feed, food

UK Energy Consumption 2009





2157962 TJ Petroleum products of which 69% is for road transport.

1st generation feed-stocks


Peanut oil


Soy bean


Sunflower


Rapeseed


Palm

Oil - biodiesel

Starch, sugars - bioethanol


Sugar beet

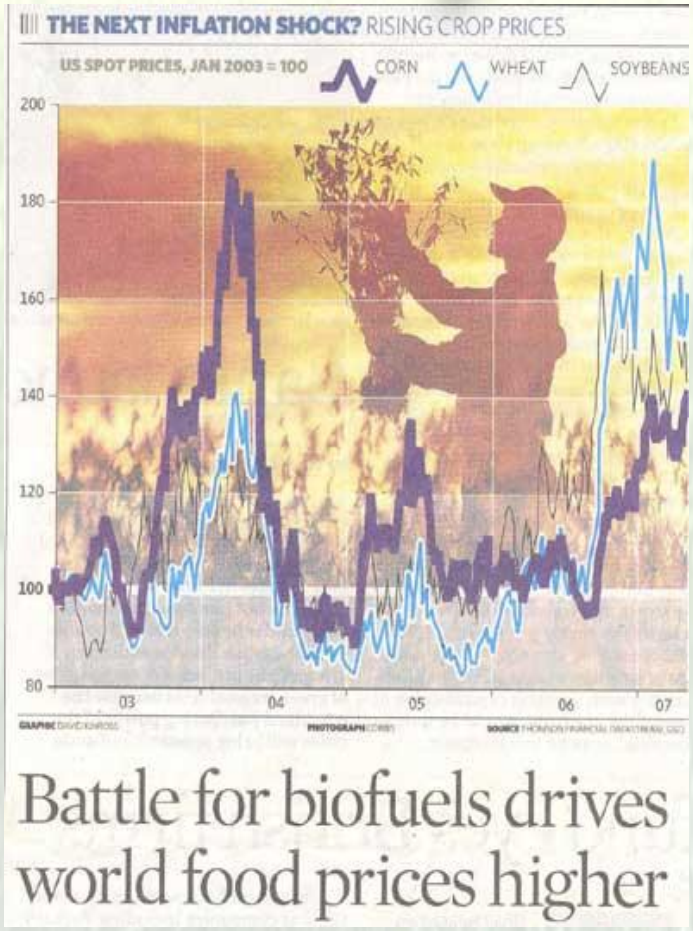

Sugar cane


Corn -maize


Wheat

Biofuels fill a gap – rather too well

Society

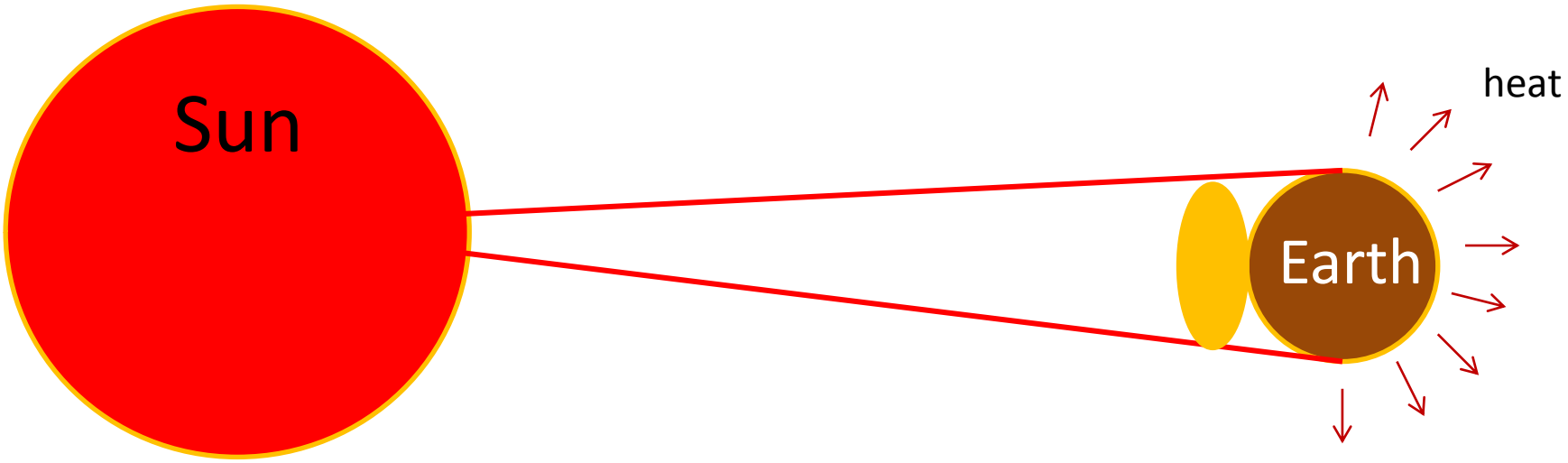

THE NEXT INFLATION SHOCK? RISING CROP PRICES
US SPOT PRICES, JAN 2003 = 100
CORN
WHEAT
SOYBEANS
200
180
160
140
120
100
80
03
04
05
06
07
Battle for biofuels drives world food prices higher


TELL THE GOVERNMENT
TO CHOOSE THE RIGHT
BIOFUEL
OR THE
ORANG-UTAN
GETS IT

Can we grow more biofuel?

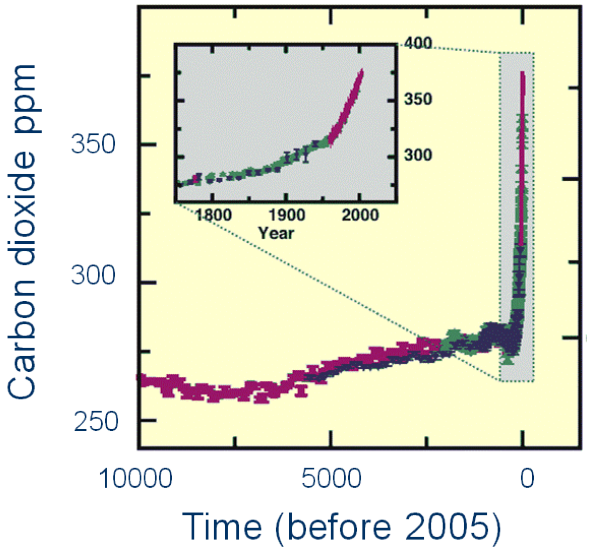
Solar energy considerations

- 5.2×10^{21} kJ y^{-1} solar energy received
- 3.0×10^{21} kJ y^{-1} usable in photosynthesis
- Only 3.8×10^{18} kJ y^{-1} captured in organic molecules



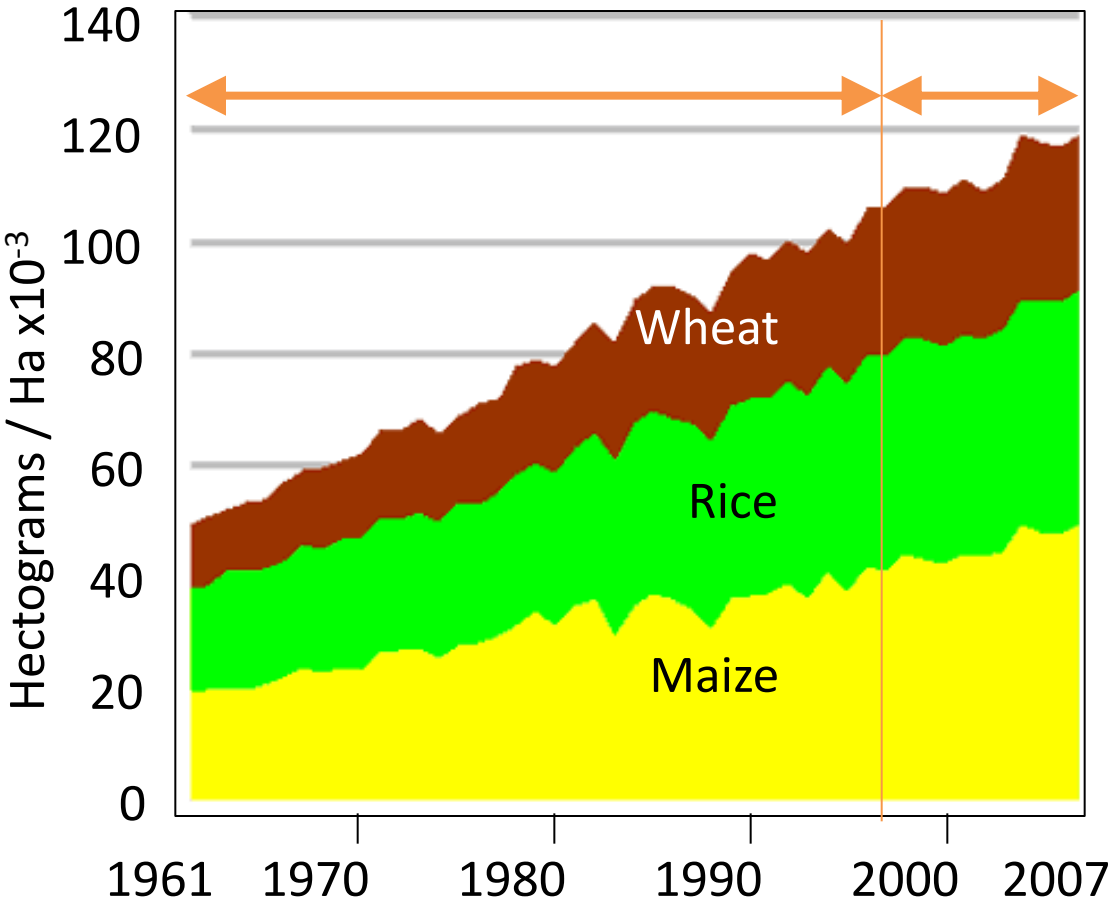
CO_2 (and other) considerations

- C4 plants – concentrate CO_2
- CAM plants – hot dry adaptation
- Lignification could be an issue



Yields of rice, wheat and maize

Source: FAOStat May2008



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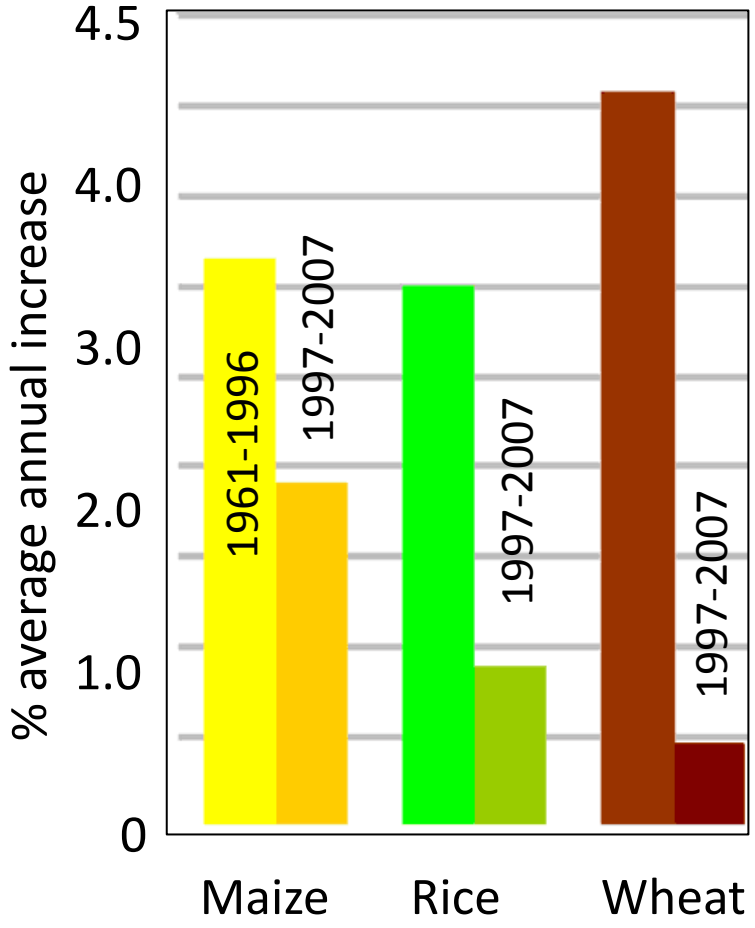
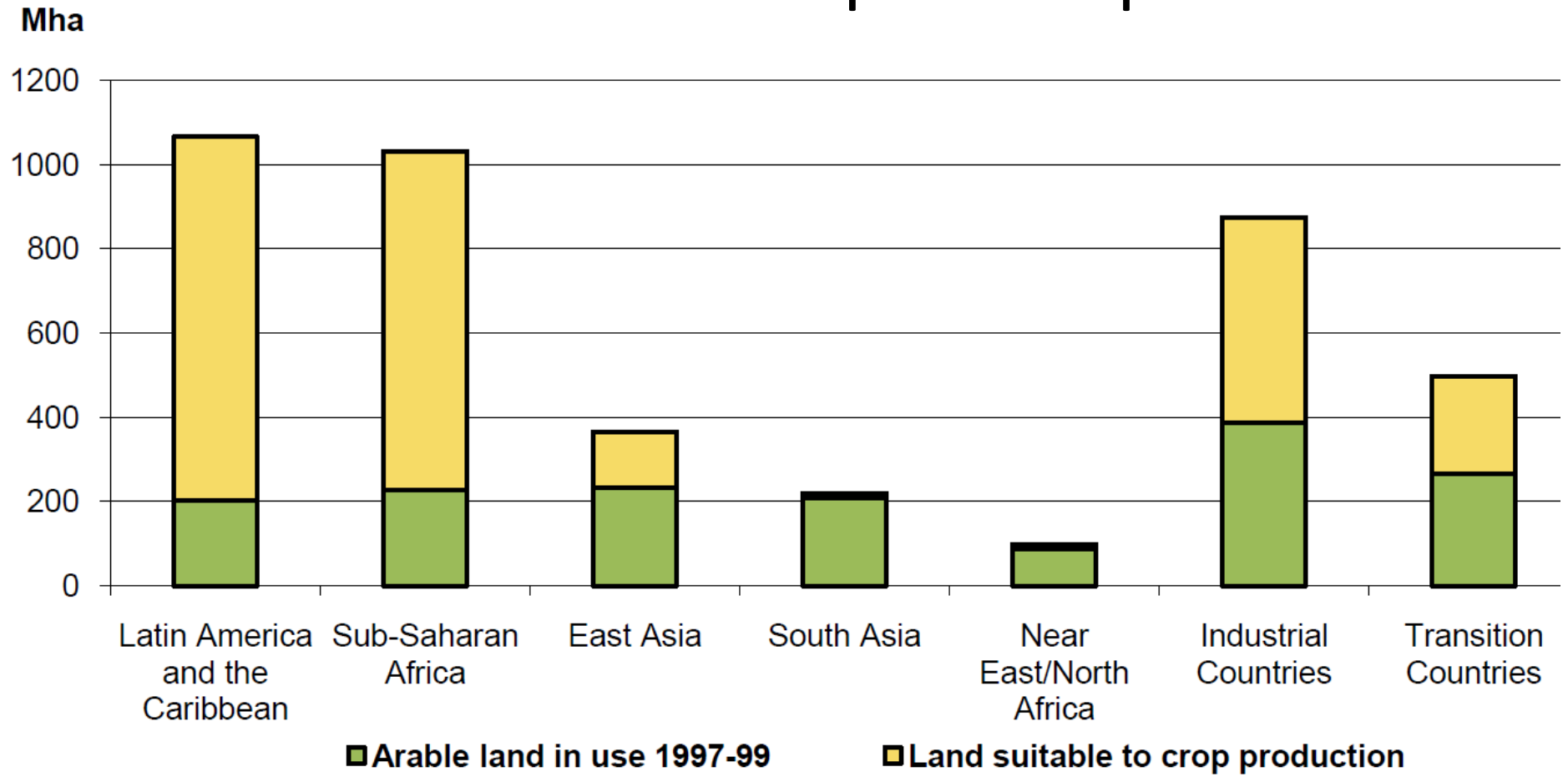


- Breeding
- Introduce no-till farming to improve soil, drought resistance and yields

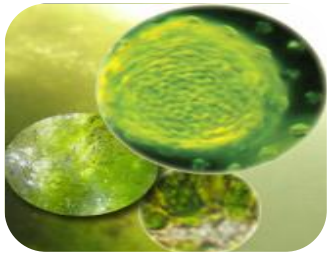
Potential area for cropland expansion



Source: FAO, 2003

Developing countries have land

2nd generation feed-stocks



Microalgae

Jatropha

Non-food oil

Straw

Miscanthus

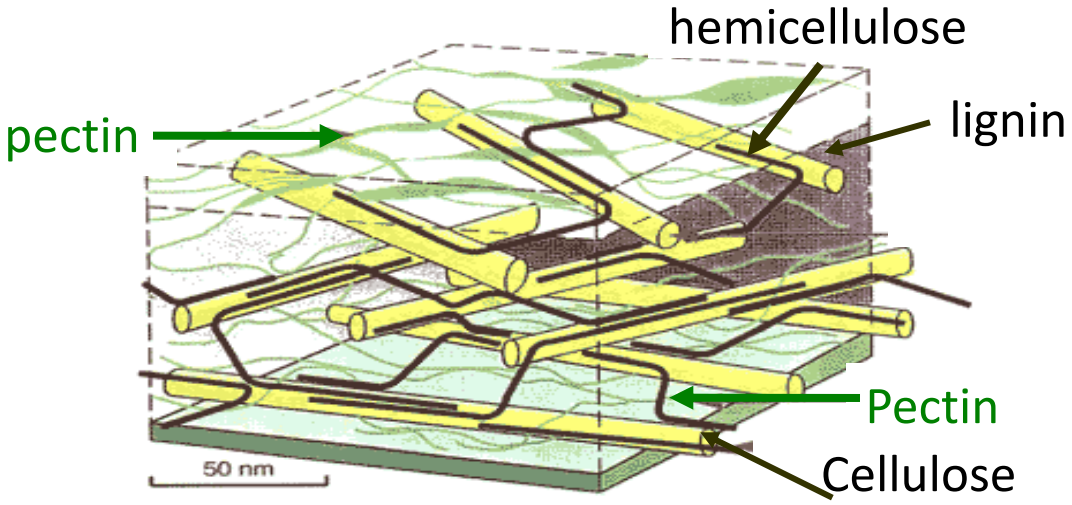
Willow

Wood

Lignocellulosics

Food waste

Extraction of cellulose from lignocellulose for ethanol is not trivial



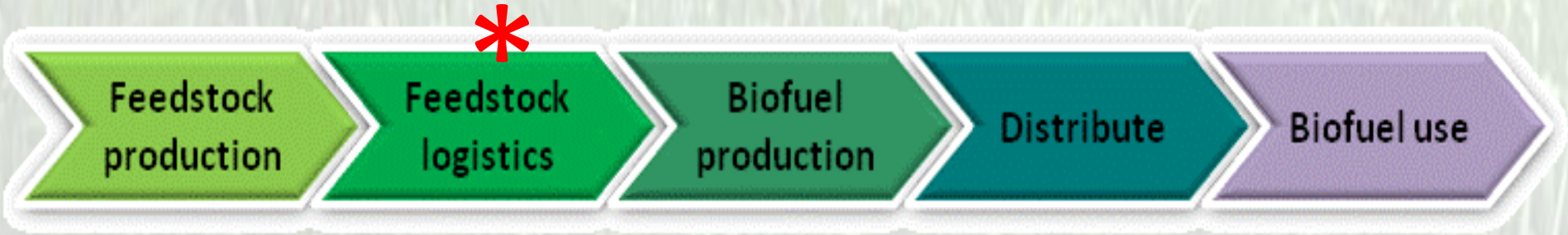
Developed countries (will have) technologies

Biofuel feedstocks are bulky, wet and dispersed

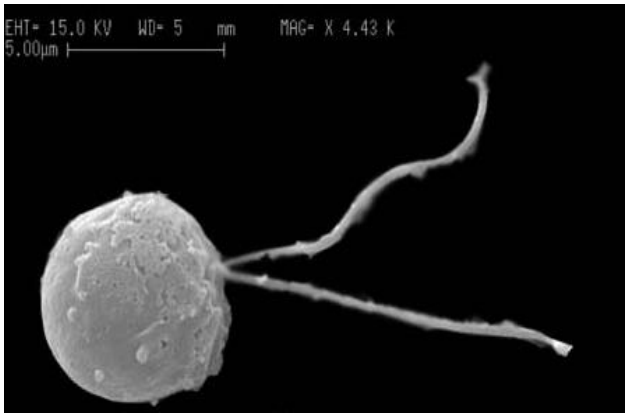
Sugar cane bagasse

- 50% fibre
- 48% water
- 2% sugar

Transport is expensive



Algae: also wet (= bulky), dispersed



50-75% water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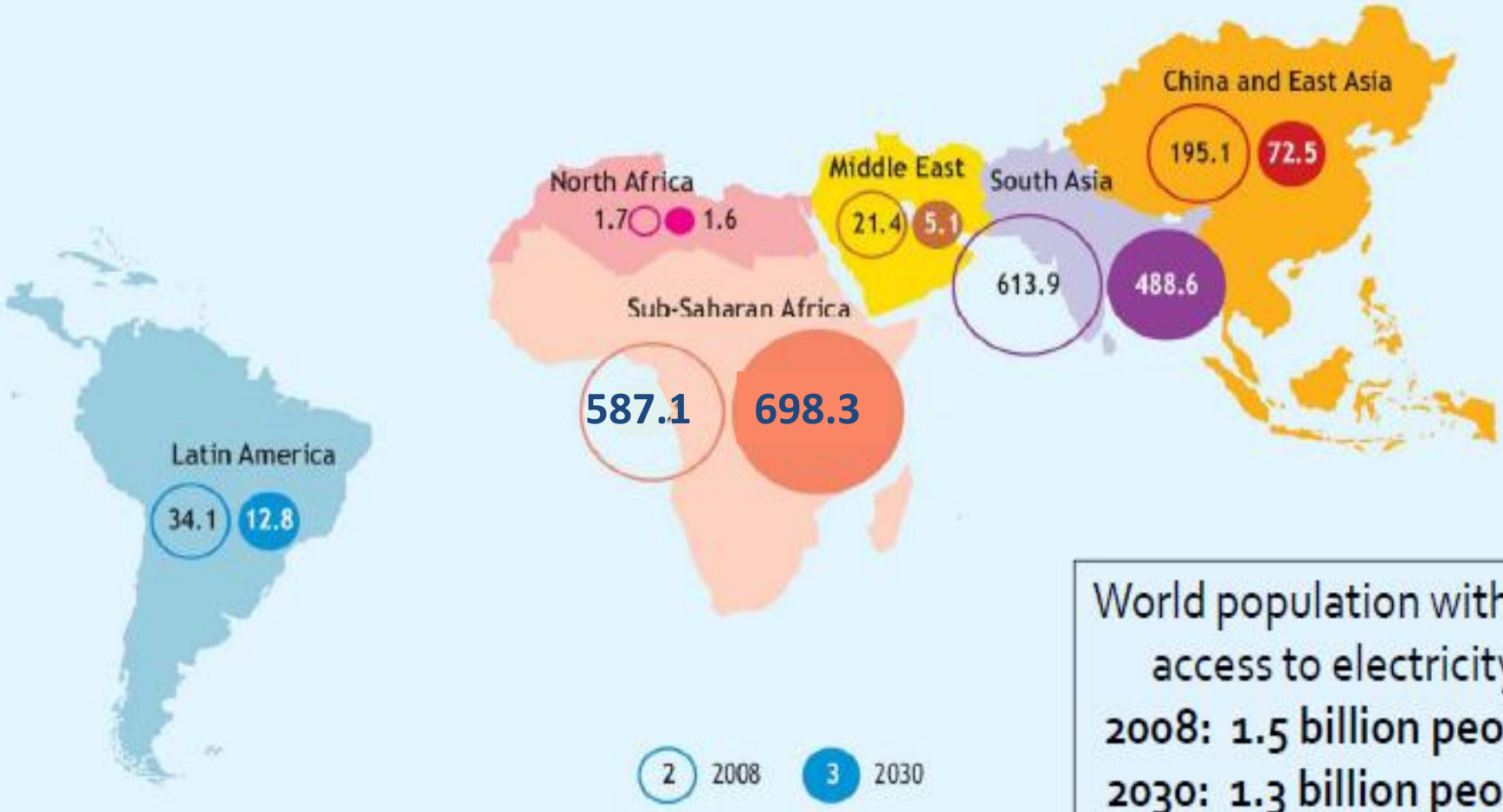
Number of people without access to electricity in the Reference Scenario (millions)



World population without access to electricity

2008: 1.5 billion people

2030: 1.3 billion people

Strategies to raise adaptive capacity, reduced vulnerability and risk?

1. Technological solutions

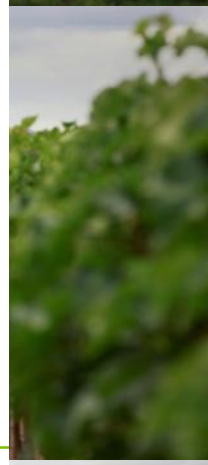
SUN BIOFUELS
SUSTAINABLE CLEAN ENERGY

Environment › Biofuels

UK firm's failed biofuel dream wrecks lives of Tanzania villagers

The collapse of Sun Biofuels has left hundreds of Tanzanians landless, jobless, and in despair for the future

Damian Carrington in Tanzania
The Observer, Sunday 30 October 2011



Strategies to raise adaptive capacity, reduced vulnerability and risk?

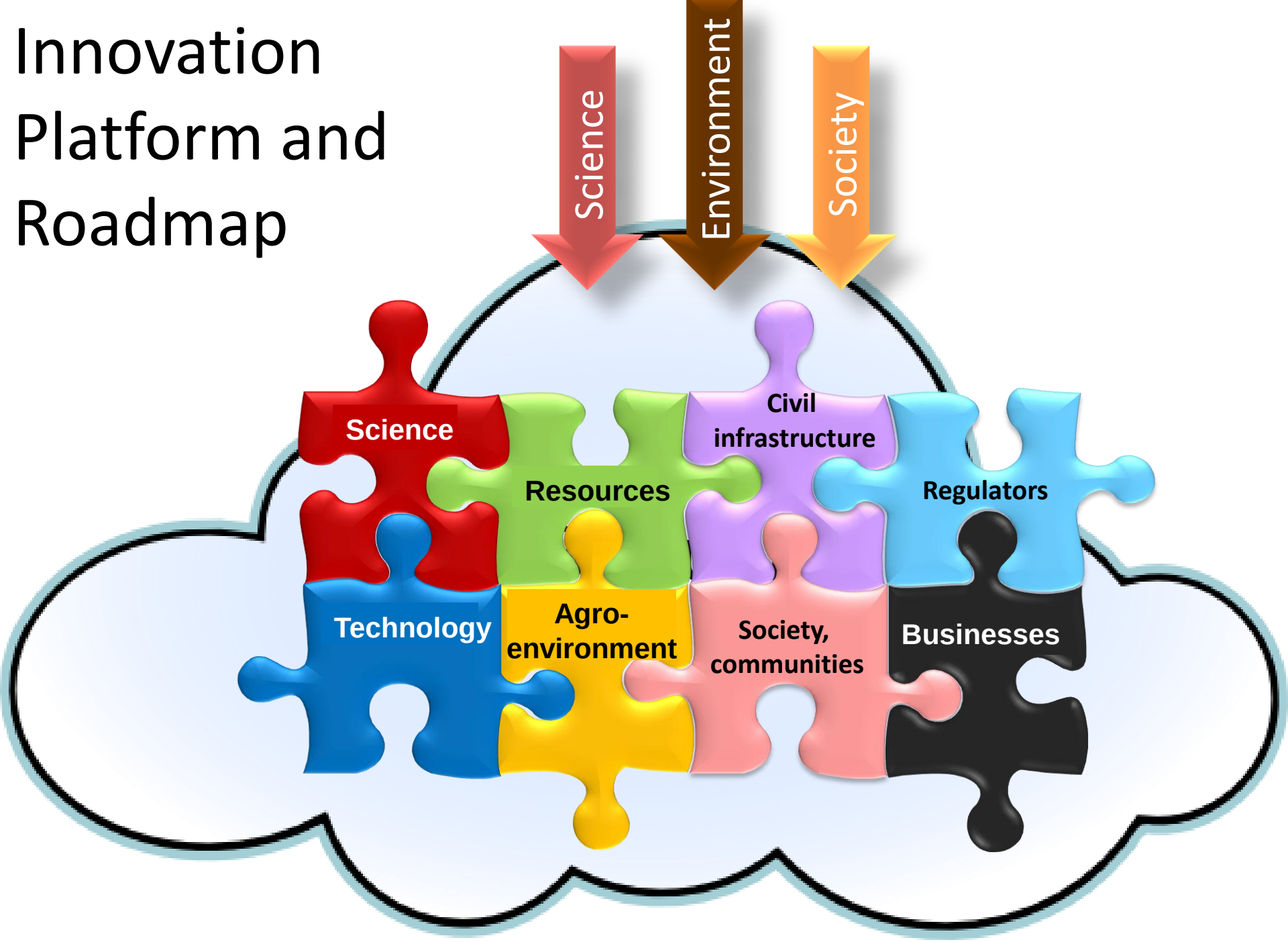
1. Technological solutions
2. Self-empowerment and community action

GORE'S CARBON FOOTPRINT

Strategies to raise adaptive capacity, reduced vulnerability and risk?

1. Technological solutions
2. Self-empowerment and community action
3. Innovation platforms and a road map

Innovation Platform and Roadmap



"The power of population is so superior to the power of the earth to produce subsistence for man, that premature death must in some shape or other visit the human race.

The vices of mankind are active and able ministers of depopulation.

They are the precursors in the great army of destruction, and often finish the dreadful work themselves.

But should they fail in this war of extermination, sickly seasons, epidemics, pestilence, and plague advance in terrific array, and sweep off their thousands and tens of thousands.

Should success be still incomplete, gigantic inevitable famine stalks in the rear, and with one mighty blow levels the population with the food of the world".

—Malthus T.R. 1798. *An essay on the principle of population*.

Case Studies and Analysis

- Life Cycle Analysis
- Innovation systems analysis: Change motors
  - How has the system evolved (variation, selection)?
  - What human controversies?

	Proto-stage 2005 Section 5.1	2006-2007 Section 5.2	Early 2008 Section 5.3	Late 2008 – 2009 Section 5.4
Landscape				
Regime				
Jatropha niche development 1.networking 2.learning 3.expectations				
Change motors 1. Evolutionary variation & selection (in terms of technology and business organisation) 2. Contestation & conflict between stakeholders				

Fig. 1. Structure of empirical analysis in Section 5.