Bioenergy – a large but challenging potential

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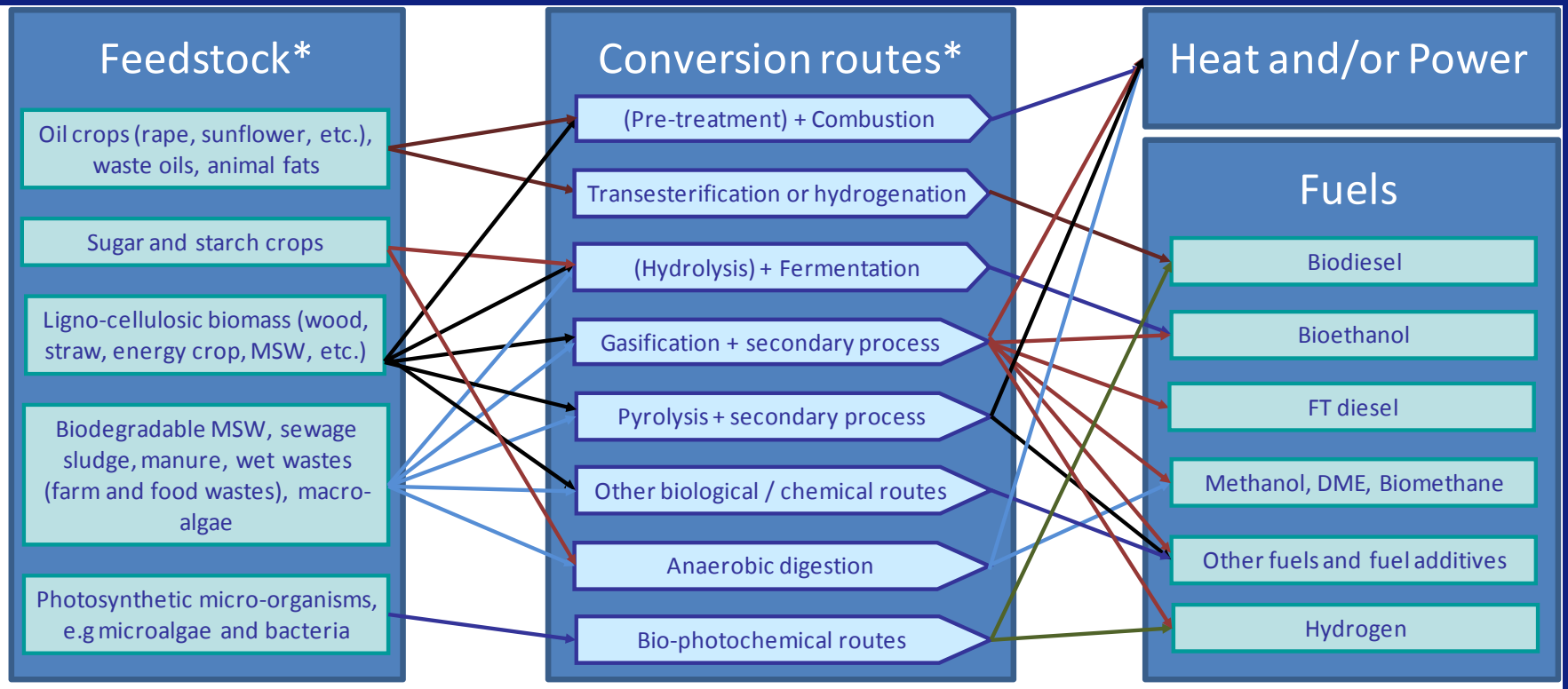
icept

Many options present and future

Many resources…

- Wastes and by-products from agriculture and forestry
  - straw, forest residues,…
- Wastes and by-products from industry and human activities
  - wood processing industry, MSW and wastewater treatment,…
- Biomass specifically grown for energy
  - conventional crops (wheat, corn, rapeseed, palm, …)
  - less conventional crops (jatropha, sorghum…)
  - wood and grass crops (willow, poplar, miscanthus,…)
  - aquatic species (macro and micro algae)

Many conversion processes and energy vectors…



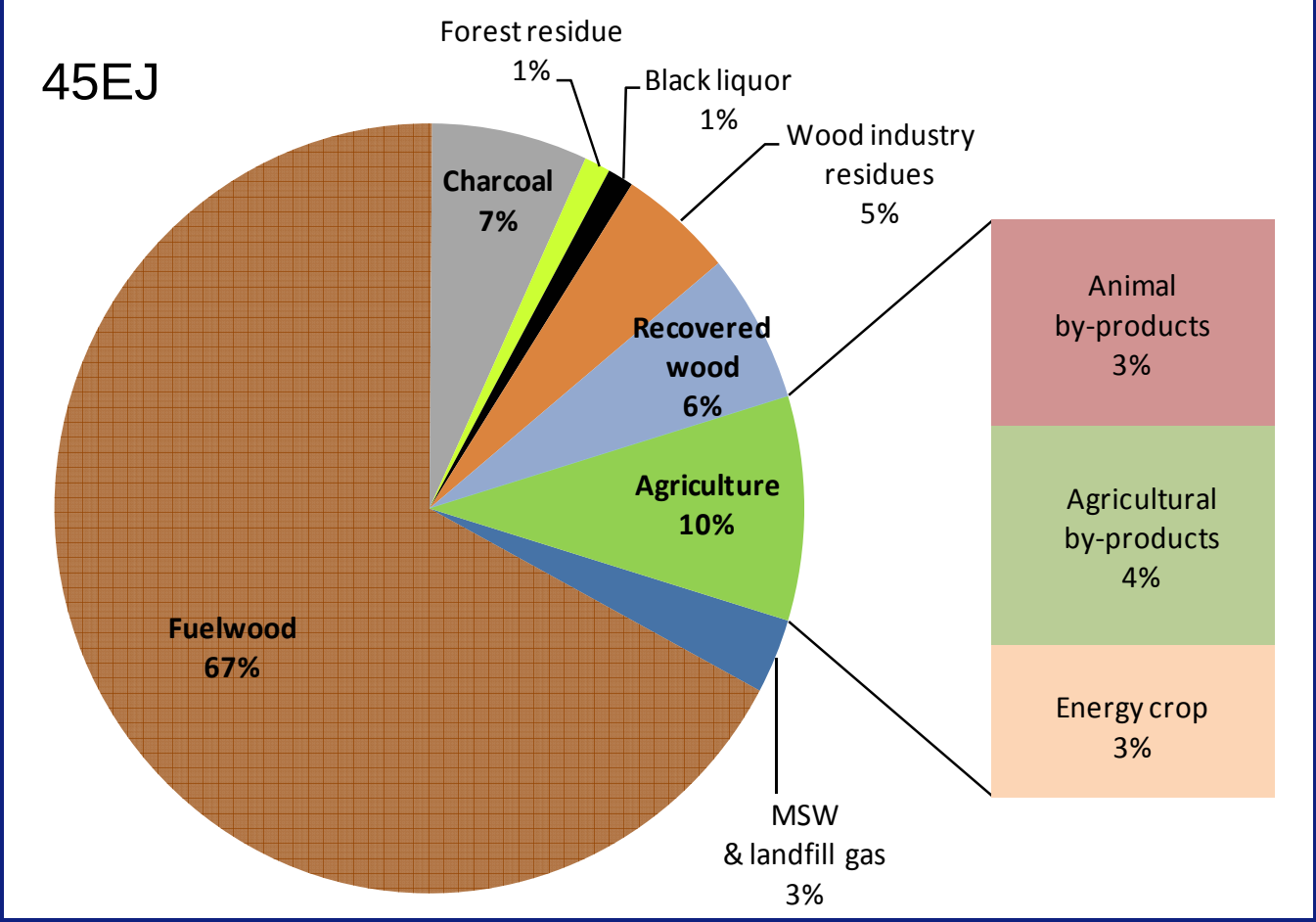
* Parts of each feedstock, e.g. crop residues could also be used in other routes

* Each route also gives co-products

A widely used resource and a large potential

Biomass contributes about 10% of global primary energy

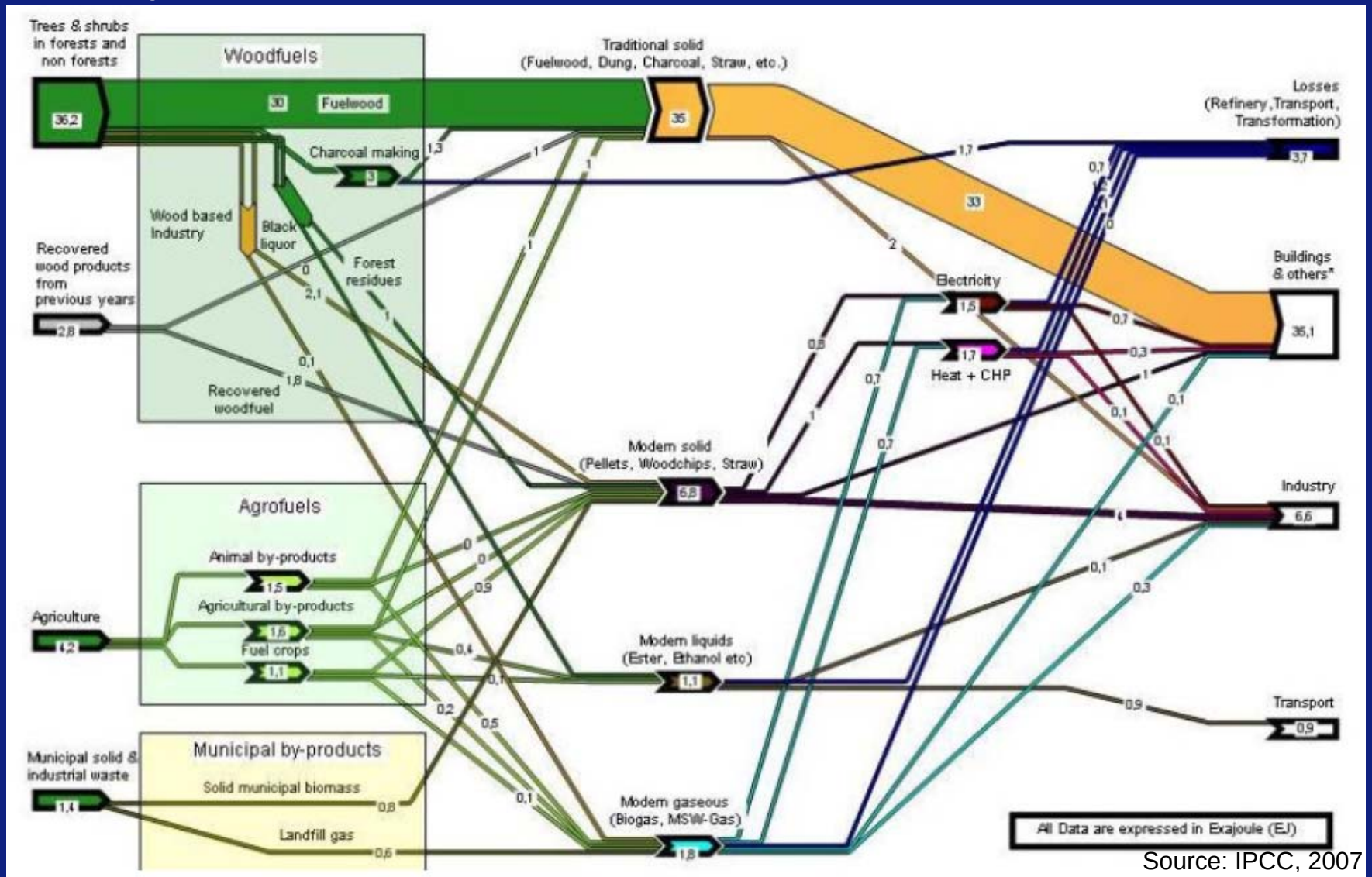
- 22% in non-OECD countries, 3.4% in OECD countries
- Mostly wood and wood derived products, followed by agricultural residues, and small contributions from energy crops and wastes



Source: IPCC, 2007

Much of which in traditional uses in developing countries

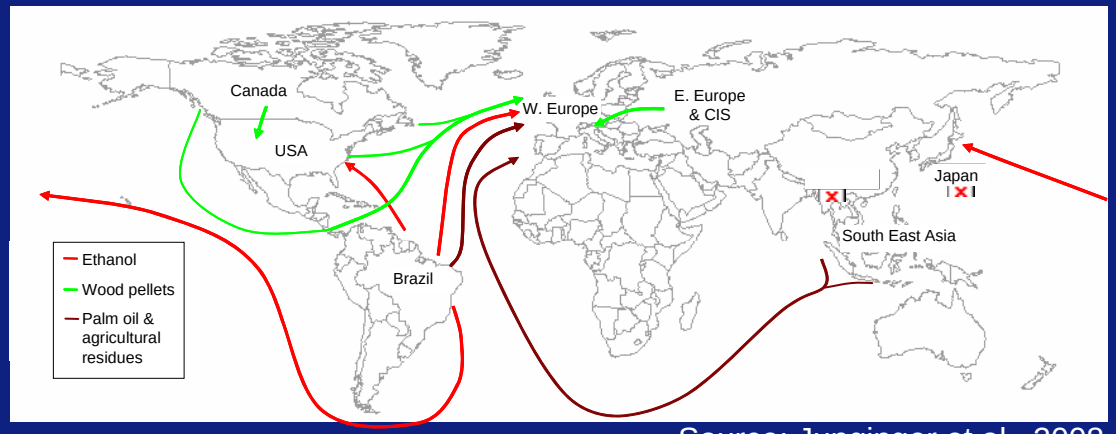
- About 75% traditional heating use and about 25% modern use for heat, electricity and fuels



Source: IPCC, 2007

An increasing amount of biomass is traded globally

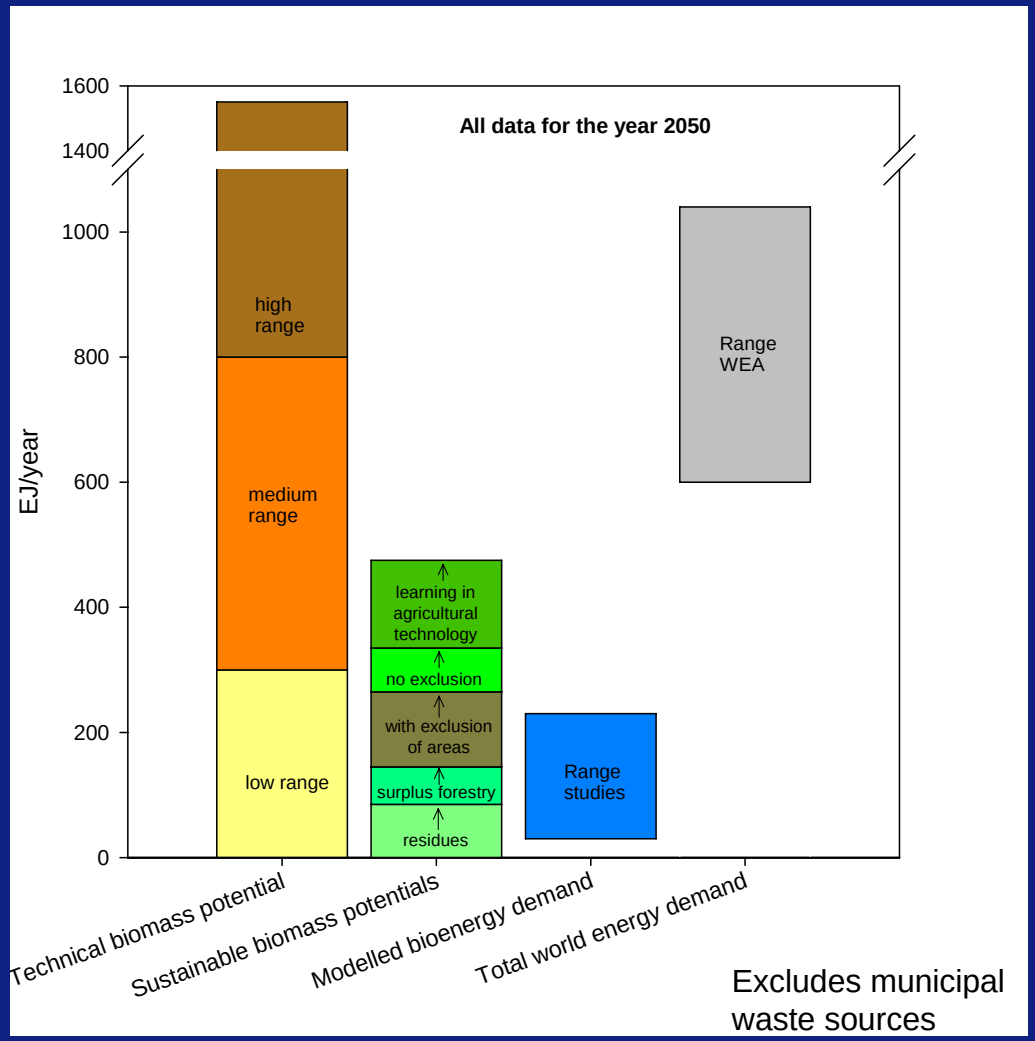
	PJ	Mtonne
Ethanol	160	6
Biodiesel	>90	>2.4
Fuel wood	40	3
Charcoal	20	0.9
Wood pellets	45	2.6
Palm oil	>60	>1.6
Direct trade:	>380	>16.7
Industrial round wood	480	50
Wood chips and particles	150	16
Indirect trade:	630	66
Total	> 1000	>83



Source: Junginger et al., 2008

A significant additional resource is potentially exploitable

- Agricultural and forest residues could provide a very significant resource
- But the big prize would rely on energy crops



Excludes municipal waste sources

Excludes biomass from non productive land i.e. algae

Source: Junginger, 2008

The UK potential is relatively significant too

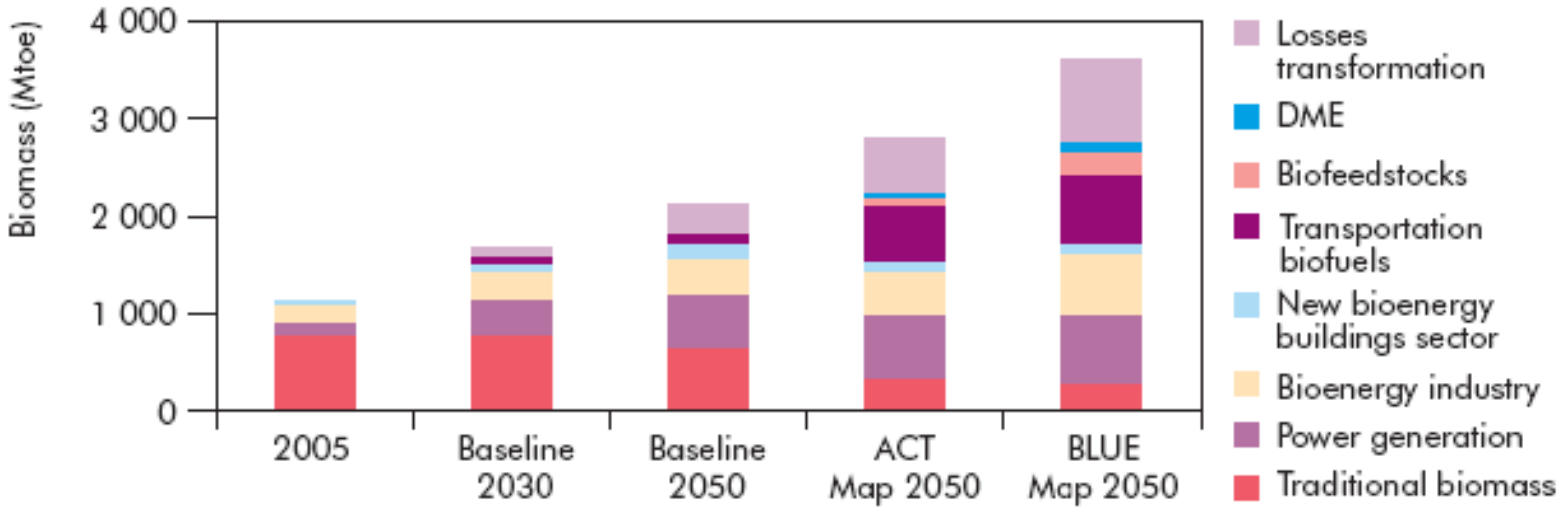
Resource type	UK potential (PJ)	Assumptions
Energy crops	324	Based on 1Mha of land and an average yield of 18 dry tonnes per ha in 2050 (up from the current average 12 dry tonnes per ha from field trials mentioned in the UK Biomass Strategy)
Agricultural residues	40	Cereal straw
Forest fuel and wood residues	42	Assumes only sawmill residues and forest residues. Includes an additional potential 1Mt of biomass from currently undermanaged forest.
Other wastes	134	Includes paper, garden/plant waste, waste wood, food waste and sewage sludge
Total	540	

Source: based on UK biomass strategy, 2007

Bioenergy use is projected to increase significantly

Significant global growth under different scenarios

- IEA WEO projects bioenergy to grow on average at 1.3% p.a. to 2030
- Different IEA scenarios indicate that bioenergy could contribute between 90 and 150EJ or up to about 23% of GPES by 2050

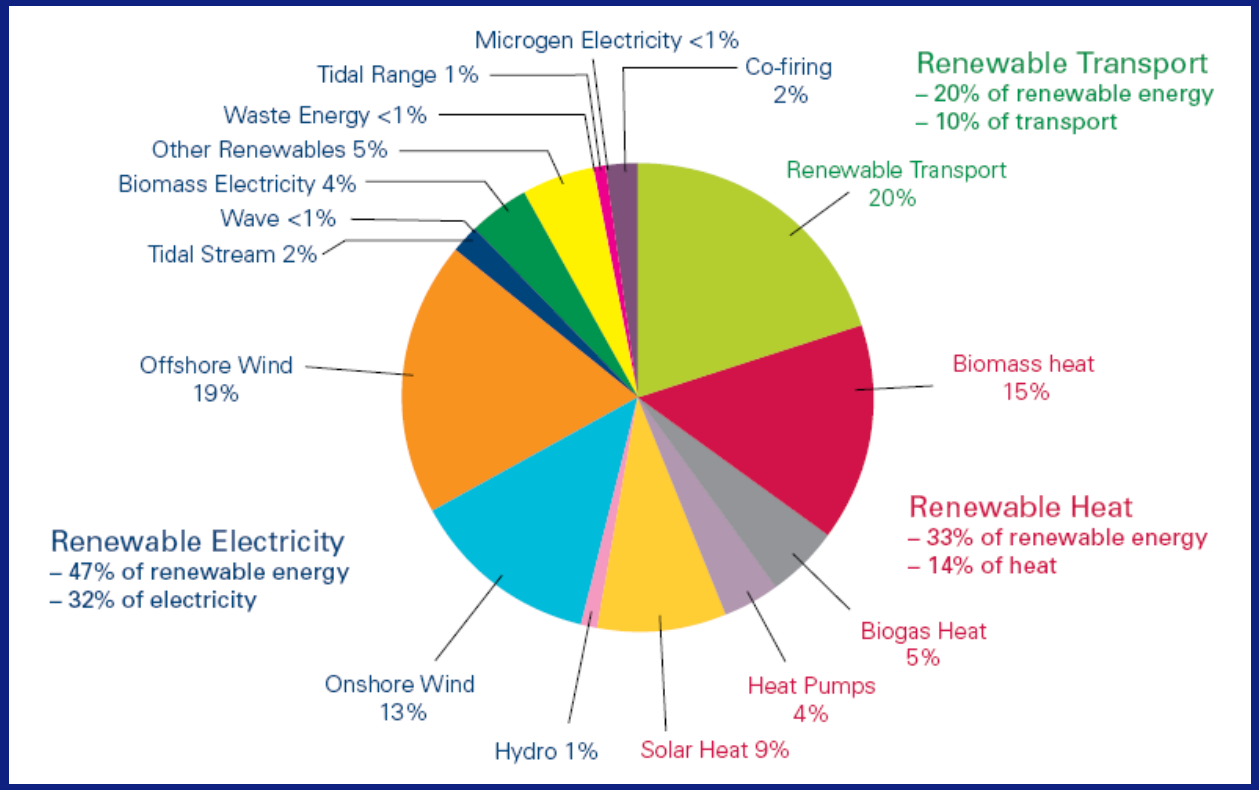


Note: Transformation losses in the production of liquid biofuels from solid biomass are indicated and accounted for in the energy balances.

Source: IEA, 2008

Significant growth expected in the UK too

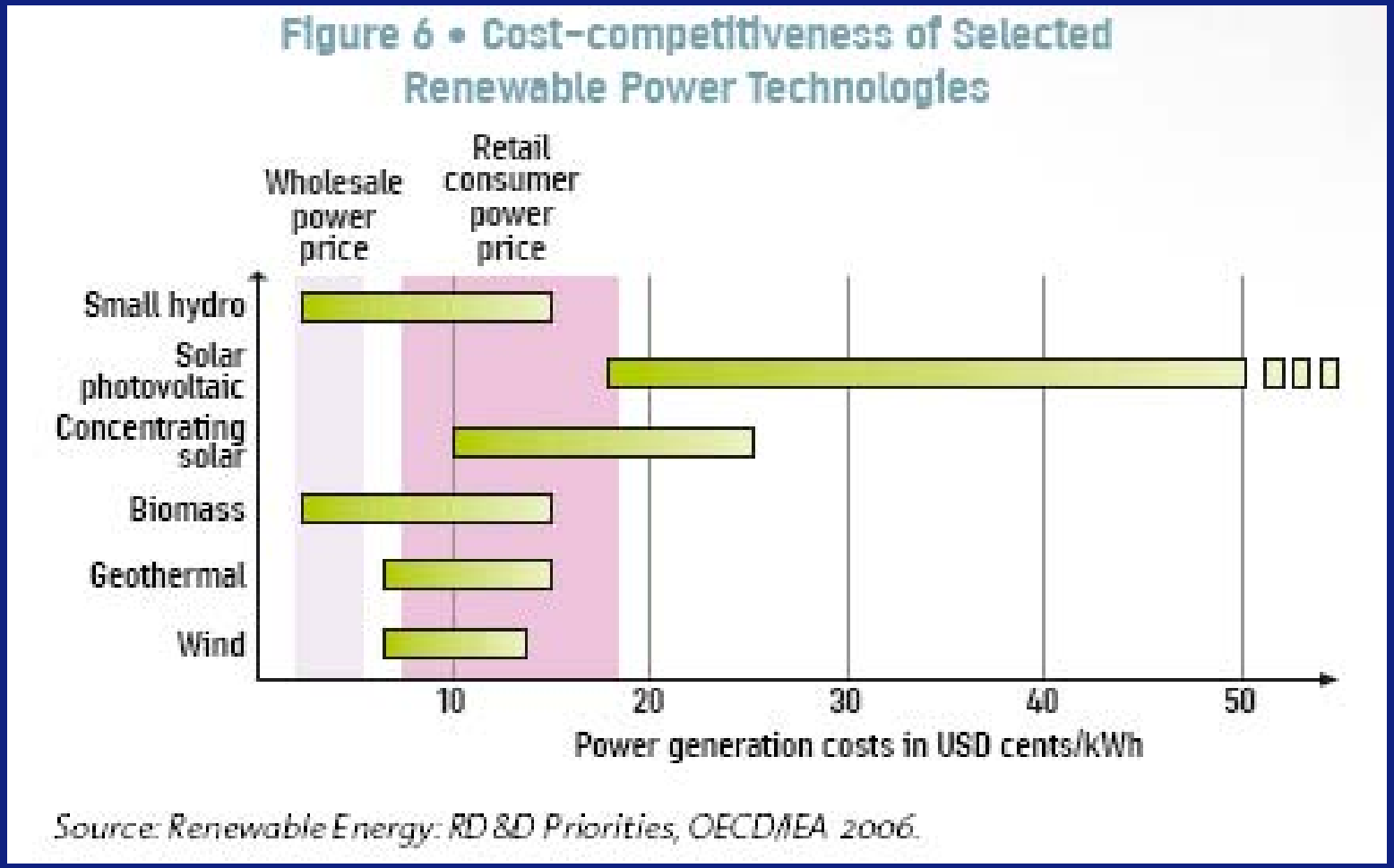
- Today: 2.3% of electricity, <1% of heat, 2% of transport fuel
- Illustrative RES scenario to 2020:
  - 30% of heat and electricity, 10% of transport fuel
  - 8% of renewable electricity, 60% of renewable heat
- Meeting heat and electricity target could require 360PJ of biomass



Source: BERR, 2008

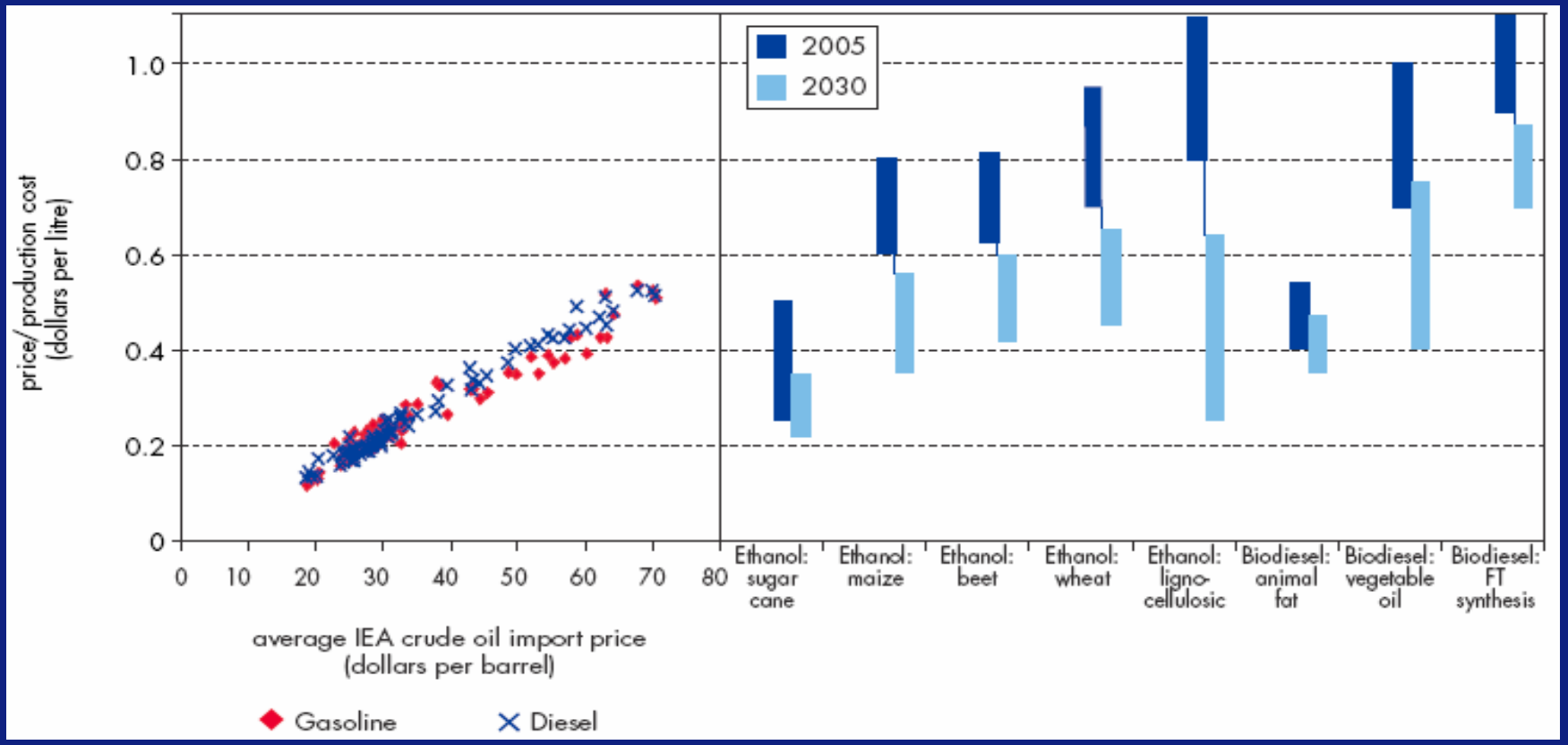
Costs vary but are potentially competitive with fossil and other renewable sources

Electricity from biomass costs



Biofuel costs

Biofuel production cost versus gasoline and diesel prices [Reference Scenario]

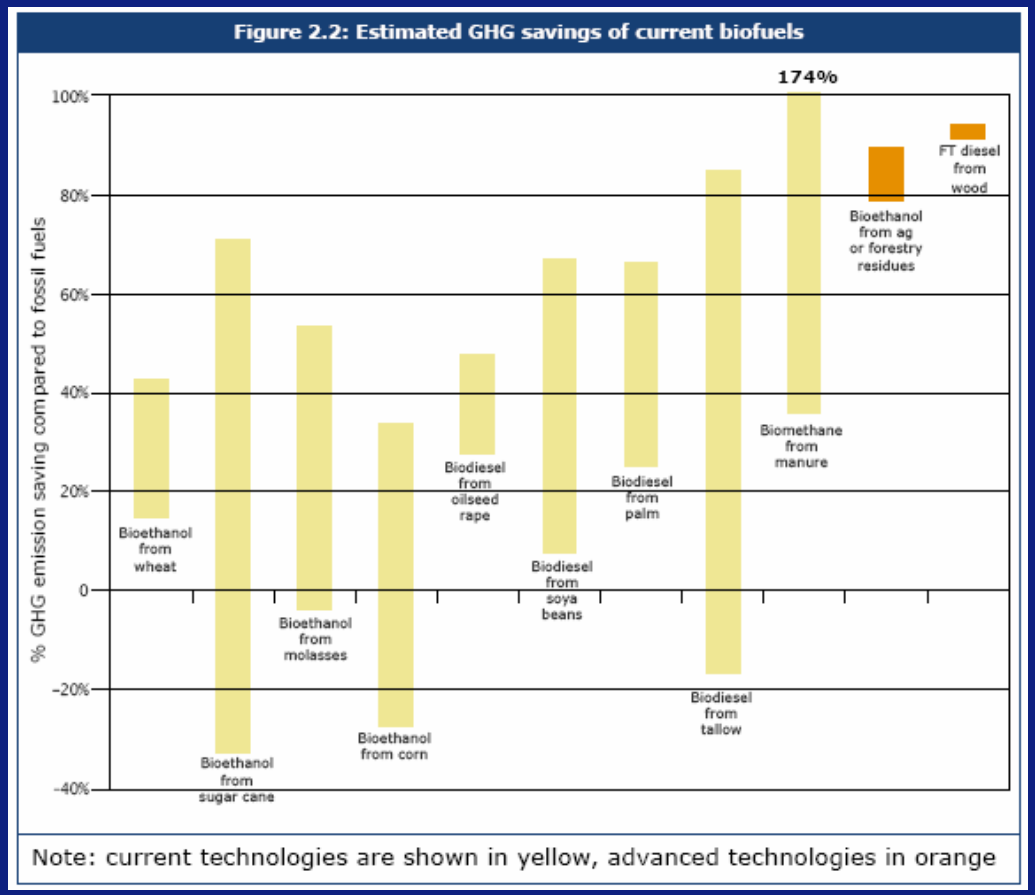


Source: IEA World Energy Outlook, 2006 Figure 14.7

Sustainability: a driver or a constraint?

GHG savings can vary widely

- Based on direct emissions and excluding land use change



Heat and electricity:
- Relative savings similar to biofuel chains
- Absolute savings generally greater per unit of biomass

Source: Gallagher Review

Carbon intensity varies by biofuel type depending on:
- Type of feedstock
- Way in which feedstock was produced
- Characteristics of conversion process

LUC could lead to long carbon payback times

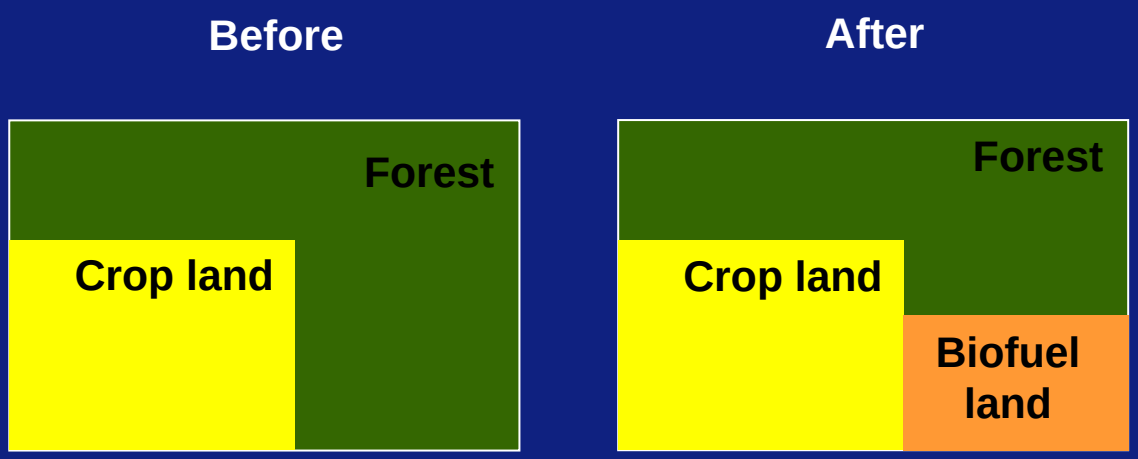


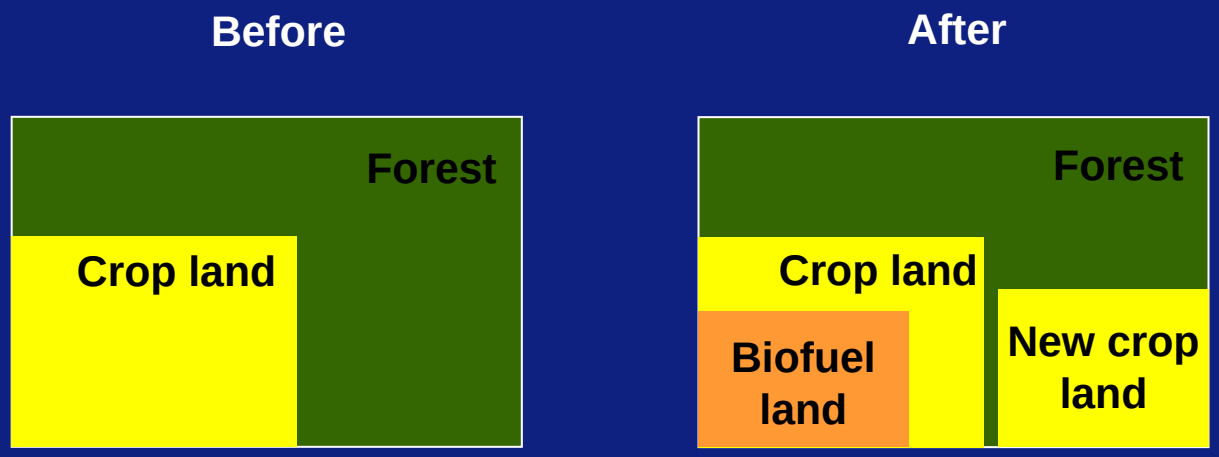
Table 2.1: Illustrative GHG savings and payback times for biofuel feedstock causing land change[13]

Fuel chain	Assumed country of origin	GHG saving excluding the impacts of land-use change	Carbon payback (years)	
		%	Grassland	Forest
Palm to biodiesel	Malaysia	46%	0 – 11	18 – 38
Soya to biodiesel	USA	33%	14 – 96	179 – 481
Sugarcane to bioethanol	Brazil	71%	3 – 10	15 – 39
Wheat to bioethanol	UK	28%	20 – 34	80 – 140

Source: Gallagher Review

Heat and electricity:
•Shorter carbon payback times, in particular for lignocellulosic crops (land change, planting practice, management)

Similarly indirect LUC could lead to long C payback



Similar effect for crops grown for fuels, heat and electricity – all depends on displaced crop and what happens to it

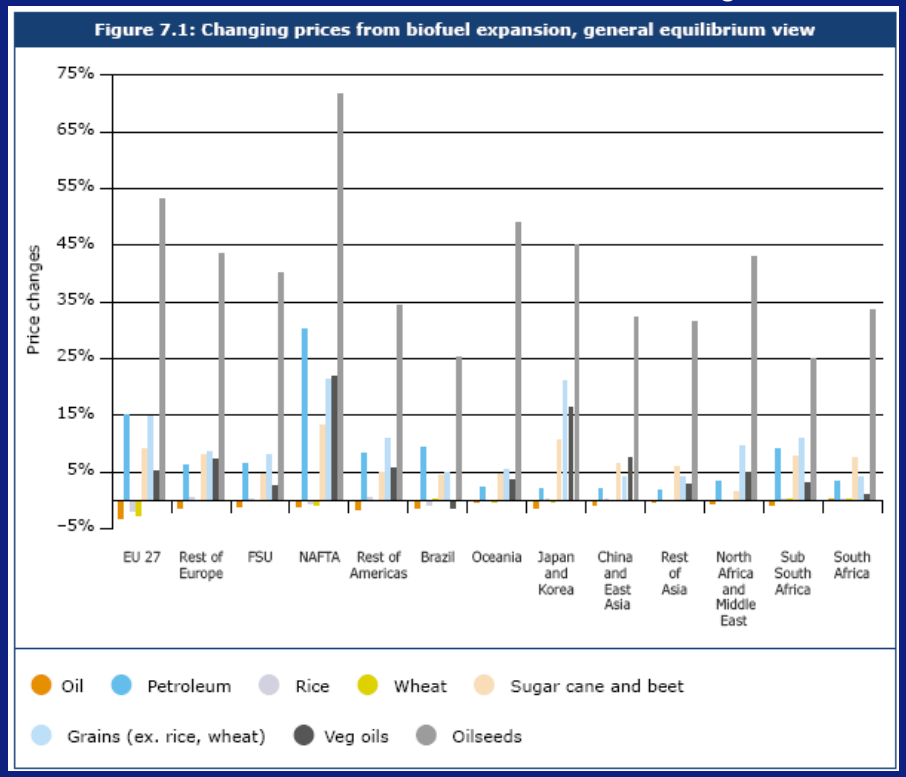
Broader environmental issues need to be managed

- Soil quality
  - Soil erosion from overexploitation and lack of preventive measures
    - nutrient depletion
    - reduced water-binding capacity
    - sediment buildup elsewhere
- Water quantity and quality
  - Aquifer depletion
  - Fertiliser and pesticide run-off
  - Increased soil salinity
- Biodiversity

Social issues are non trivial

- Social
  - Workers rights and working conditions
  - Land ownership issues
  - Effects on local communities
  - Macro-economic impacts e.g. food prices

Source: Gallagher Review



A significant potential…
but need to address sustainability concerns!

Biomass provides significant opportunity to supply different energy market segments

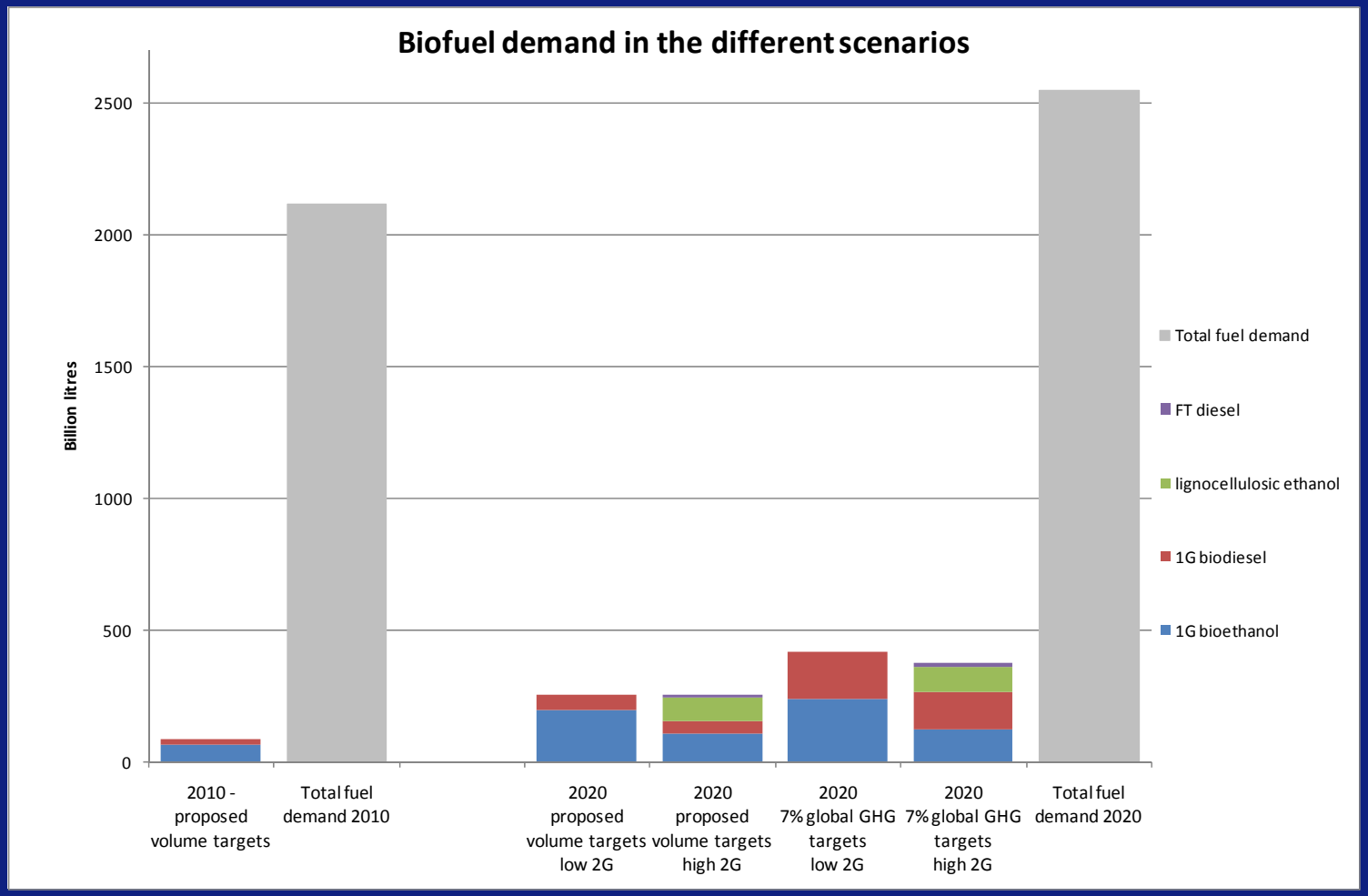
- A large potential resource
  - Plenty of wastes and residues
  - Land use for bioenergy
    - Agricultural intensification
    - Lands with low C and ecological value
    - Unproductive lands e.g. algae ponds

- High environmental and social standards
  - Significant GHG savings
    - Good practice and innovation in crops and technologies
  - Sustainability assurance schemes
    - UK has been a pioneer

Renewable Fuels Agency

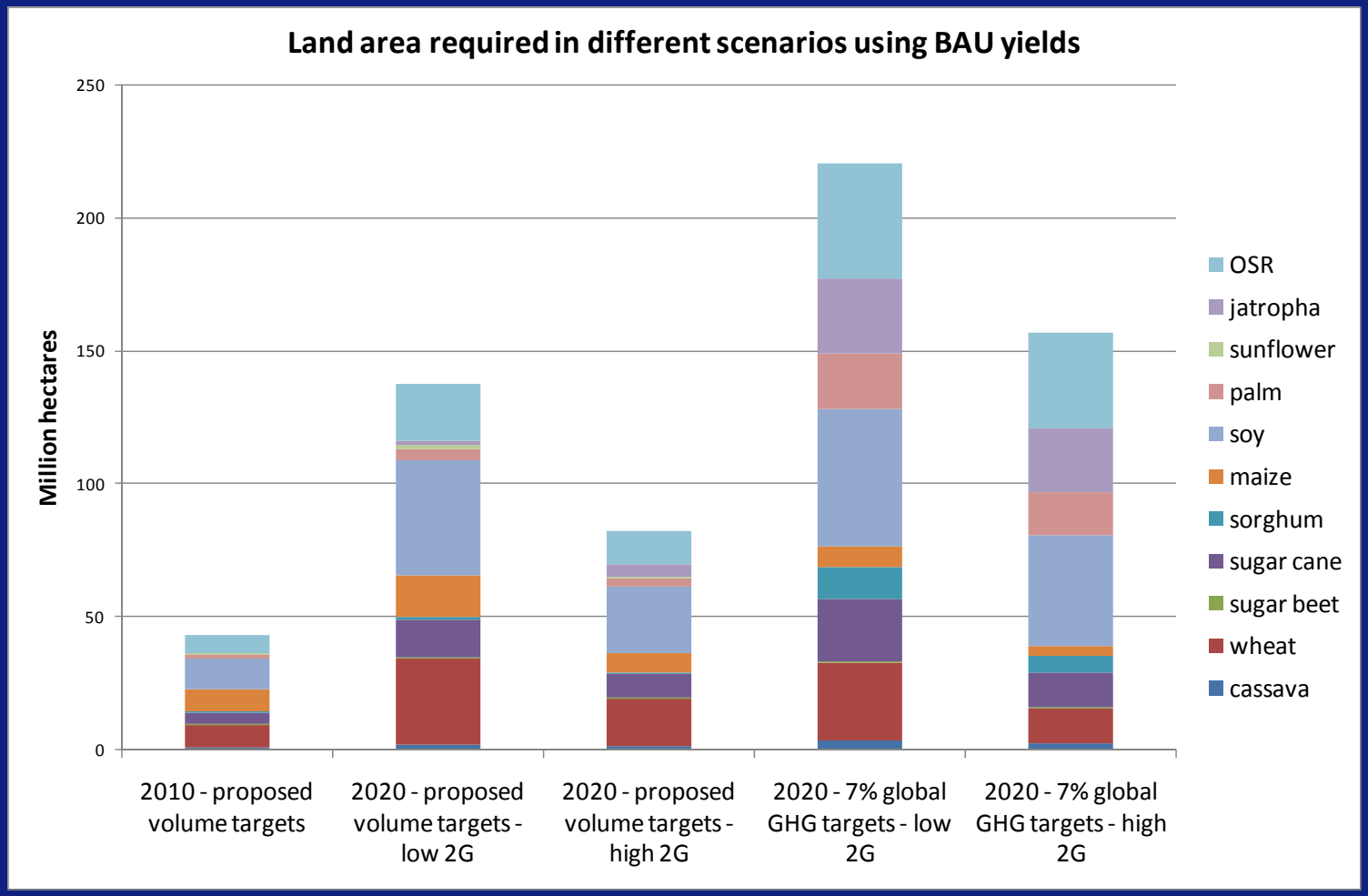
Additional slides

Biofuel scenarios



Source: Gallagher Review

Land use scenarios



Source: Gallagher Review