

Bio-fuels

Bio-fuel types

❑ Solid:

wood;
waste products from agriculture (crop residues) and forestry;
energy crops grown specifically for energy yield;
human and animal wastes - sewage and slurries;
domestic and industrial solid wastes.

❑ Liquid:

methanol (substitute for gasoline);
vegetable oils (substitute for diesel).

❑ Gaseous:

generally methane.

❑ Combustion produces CO_2 but the amount released equals the amount absorbed during growth, so the carbon cycle is closed (IF burned biomass is re-grown).

Biomass developing world

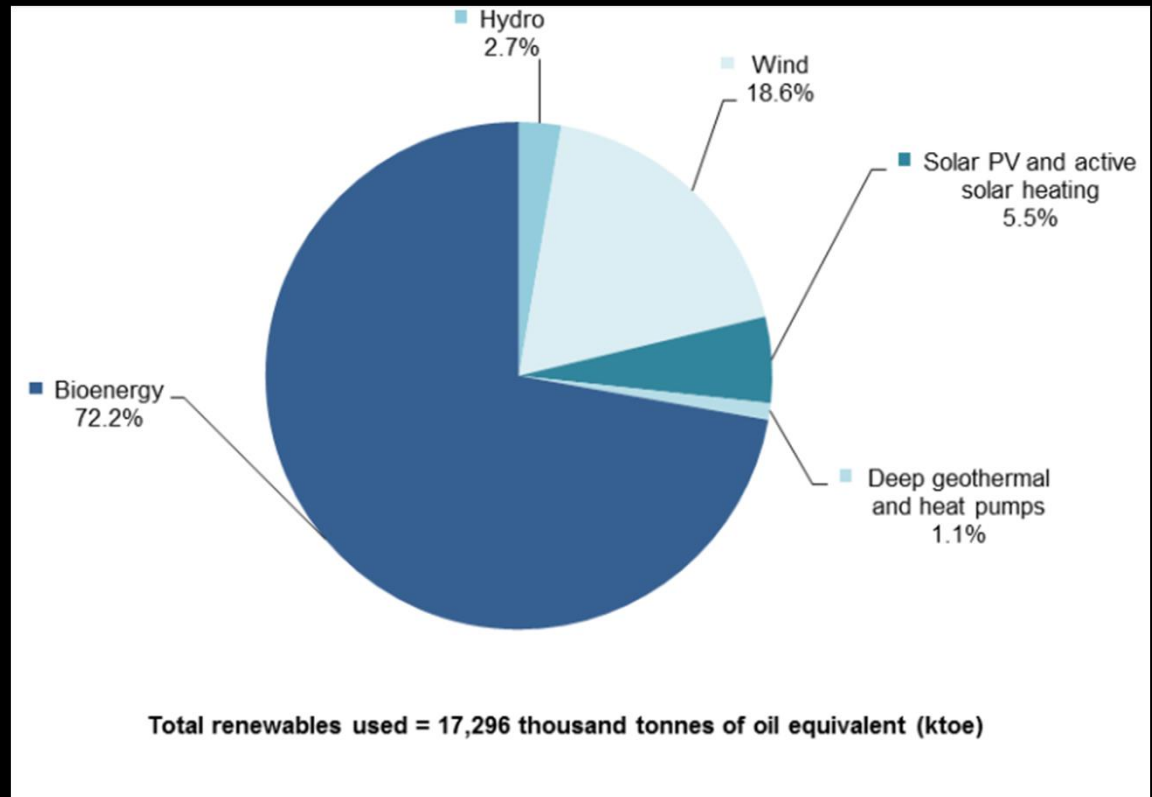
- ❑ Most biomass use is in the developing world
- ❑ Often NOT a sustainable fuel
 - Use is $>$ supply
 - Deforestation
 - Topsoil erosion

- ❑ 3 billion people worldwide cook on open fires or primitive stoves
- ❑ Cooking with biomass on open fires indoors results in very serious health problems
- ❑ Nearly 2 million people die prematurely from illness attributable to indoor air pollution from household solid fuel use. (source: WHO, 2011 factsheet 292)



UK renewable energy production in 2016

- ❑ Bioenergy dominates.
- ❑ Wind >> hydro.
- ❑ Increasing amount of solar
- ❑ Practical resource not vast relative to demand.
- ❑ High capture levels require:
 - increased transmission network capacity;
 - active distribution network management;
 - energy storage and/or standby capacity.



(c.f. the 1.5 billion tonnes of oil equivalent of fossil fuels consumed.)

UK biomass

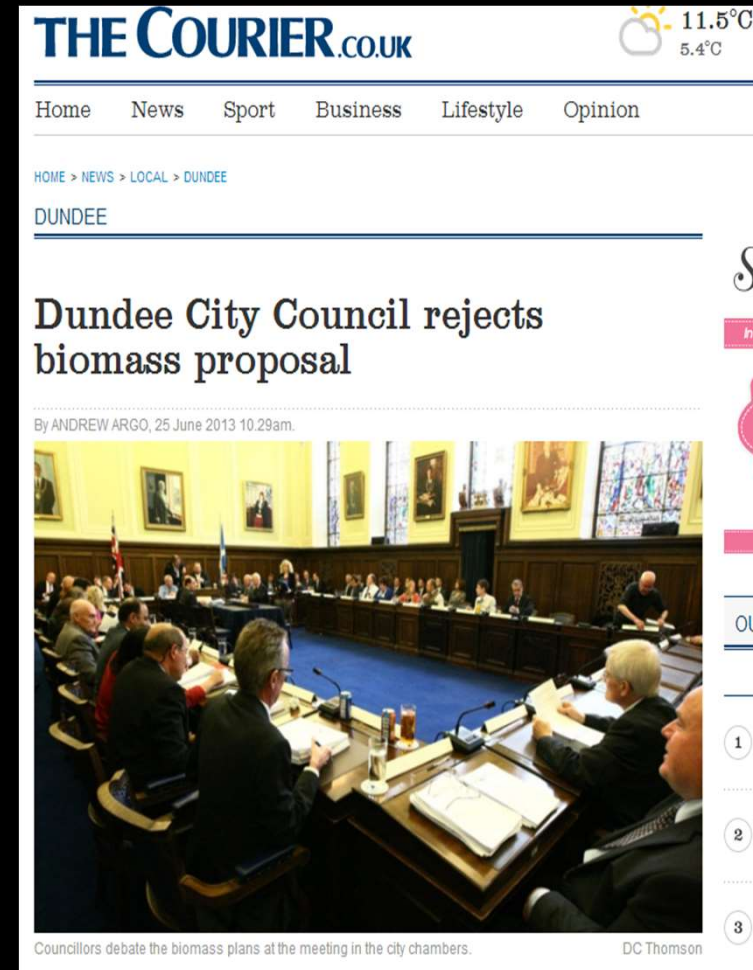
- ❑ Biomass and waste combustion account for the vast majority (>70%) of renewables output in the UK.
- ❑ Process is similar to fossil fuel combustion plant – Rankine cycle or combined cycle.
- ❑ Biomass encompasses a wide range of fuel types from chipped timber to sewage gas to waste.
- ❑ Photos from Lockerbie Biomass power station



UK biomass

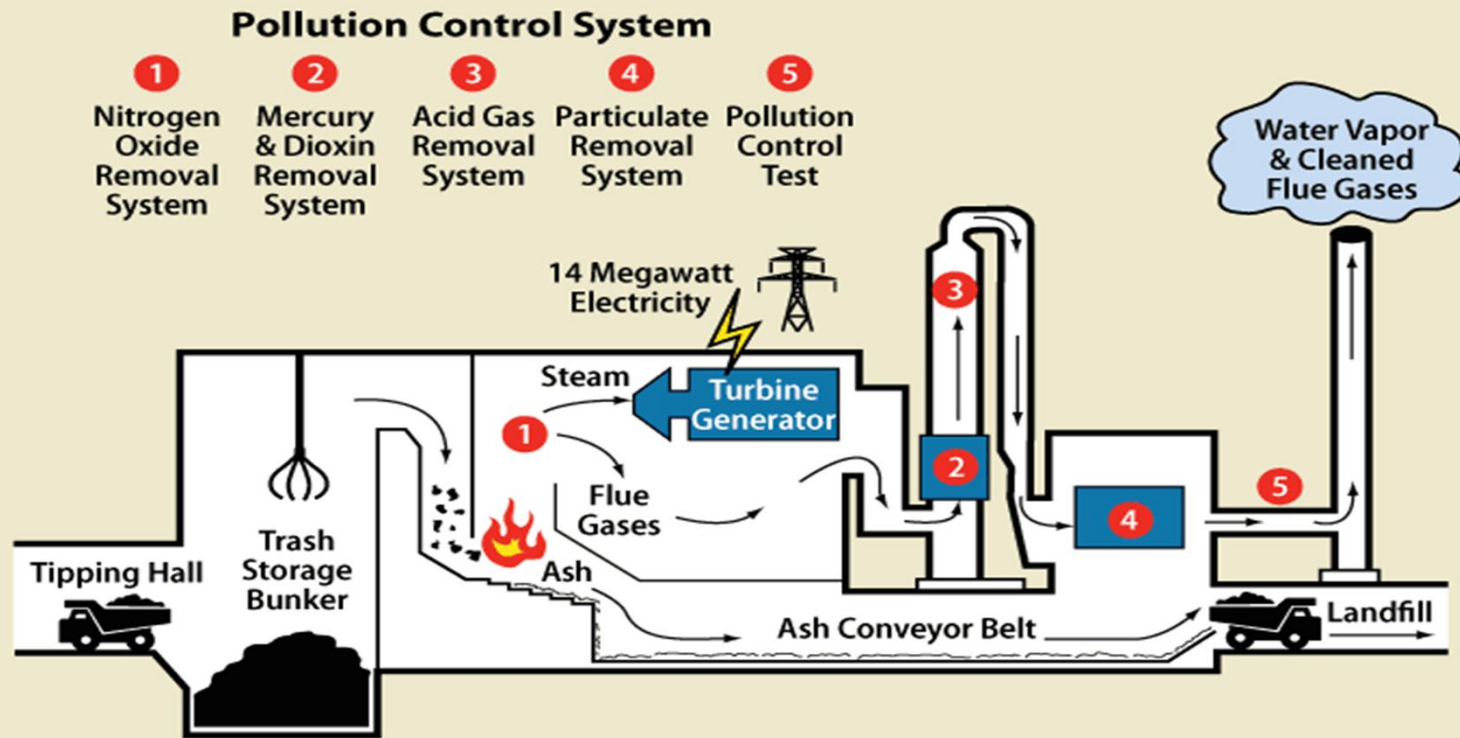
- ❑ June 2013: Forth Energy proposal for 120 MWe Biomass CHP plant costing £325m.
- ❑ Plants also proposed for Grangemouth, Rosyth.
- ❑ Biomass sourced from US.

- ❑ 70% of Drax power station output (2.8GW/4GW) from a variety of biomass fuels
- ❑ Mainly sourced from North America
- ❑ Proposal to convert remaining units to gas.



Waste-to-power plant

Waste to Energy Plant Diagram



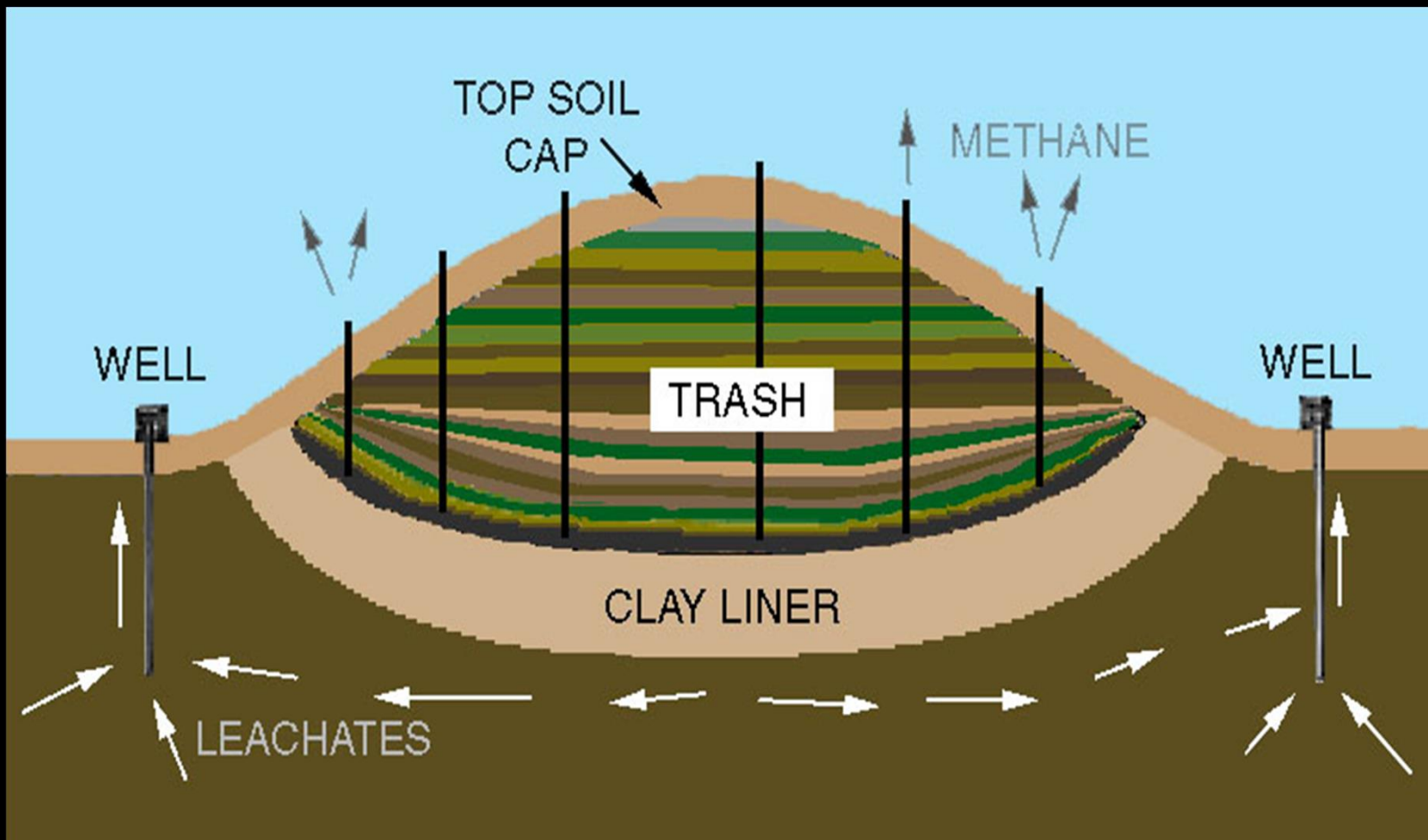
Source: ecomaine.

UK biogas

- ❑ Biogas from landfill accounts for 6% of UK renewables electricity output
- ❑ Equivalent to all hydro power output
- ❑ Double benefit as it burns methane (that would otherwise leak into the atmosphere) to produce CO₂
- ❑ Methane has 72 times the GWP₂₀ potential of CO₂
- ❑ Can be used in CHP schemes
- ❑ Example at Glasgow Summerston.



Landfill methane



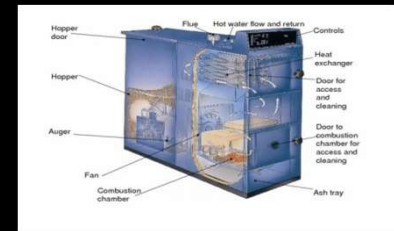
Biomass heating

- ❑ Boilers have high efficiency (~90%) and low emissions; output can be scheduled and matched to variable demand (microprocessor control of fuel and air supply).
- ❑ Issues are expense (up to £15,000 for a 25 kW automatic feed unit), pellet quality & availability, and monthly cleaning & ash removal. Safety also an issue in operation and pellet storage.
- ❑ Fuel prices are cheaper than electrical or oil heating in remoter areas of UK.
- ❑ Systems eligible under the Enhanced Capital Allowance scheme (tax relief to businesses investing in energy saving equipment).



Wood pellets

- ❑ Sweden, Finland and Austria have mature wood pellet markets (80% of new Austrian houses equipped with a wood pellet boiler).
- ❑ Efficiency of production ~80-85%.
- ❑ <http://www.nef.org.uk/logpile/index.htm> lists ~75 UK suppliers of wood pellets and ~50 suppliers of wood pellet boilers.
- ❑ Surveys show that adoption is a deliberate decision process starting with an evaluation of functional reliability and installation/running cost, mediated by attitudes and intentions.



Pellet market

Technology

- Pelletising properties of different biomass types.
- Torrefied pellets - advantages and challenges.
- Miscanthus pellets – experiences/opportunities.
- Making pellets from cork residues and shrubs.
- Development of low-dust biomass boilers.

Business issues

- How to set up a local wood pellet production.
- Financing and operating large pellet heating systems.
- Price indices for wood pellets.
- Wood pellet ESCOs.
- Operational results of pellet production plant.





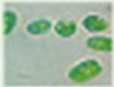
Policy

- The importance of standards to increase quality/output.
- Sustainability criteria for solid biomass production.
- European policies for biomass.
- European Pellet Standards.



Fuel	Energy density by mass (GJ/tonne)	Bulk density (kg/m ³)	Energy density by volume (MJ/m ³)
Wood chips (30% m.c.)	12.5	250	3,100
Log wood (20% m.c.)	14.7	350-500	5,200-7,400
Wood (oven dry)	19	400-600	7,600-11,400
Wood pellets	17-18	600-700	10,800-12,600
Miscanthus (25% m.c.)	13	140-180	1,800-2,300
House coal	27-31	850	25,500-25,400
Anthracite	33	1,100	36,300
Heating oil	42.5	845	36,000
Natural gas (NTP)	38.1	0.9	35.2
LPG	46.3	510	23,600

Bio-diesel: present yields and future prospects

Oil Source	Biomass (Mt/ha/yr)	Oil Content (% drymass)	Biodiesel (Mt/ha/yr)	Energy Content (boe/1000ha/day)
 Soya	1-2.5	20%	0.2-0.5	3-8
 Rapeseed	3	40%	1.2	22
 Palmoil	19	20%	3.7	63
 Jatropha	7.5-10	30-50%	2.2-5.3	40-100
 Microalgae	140-255	35-65%	50-100	1,150-2,000

mt = metric tons, ha = hectare, boe = barrel of oil equivalents

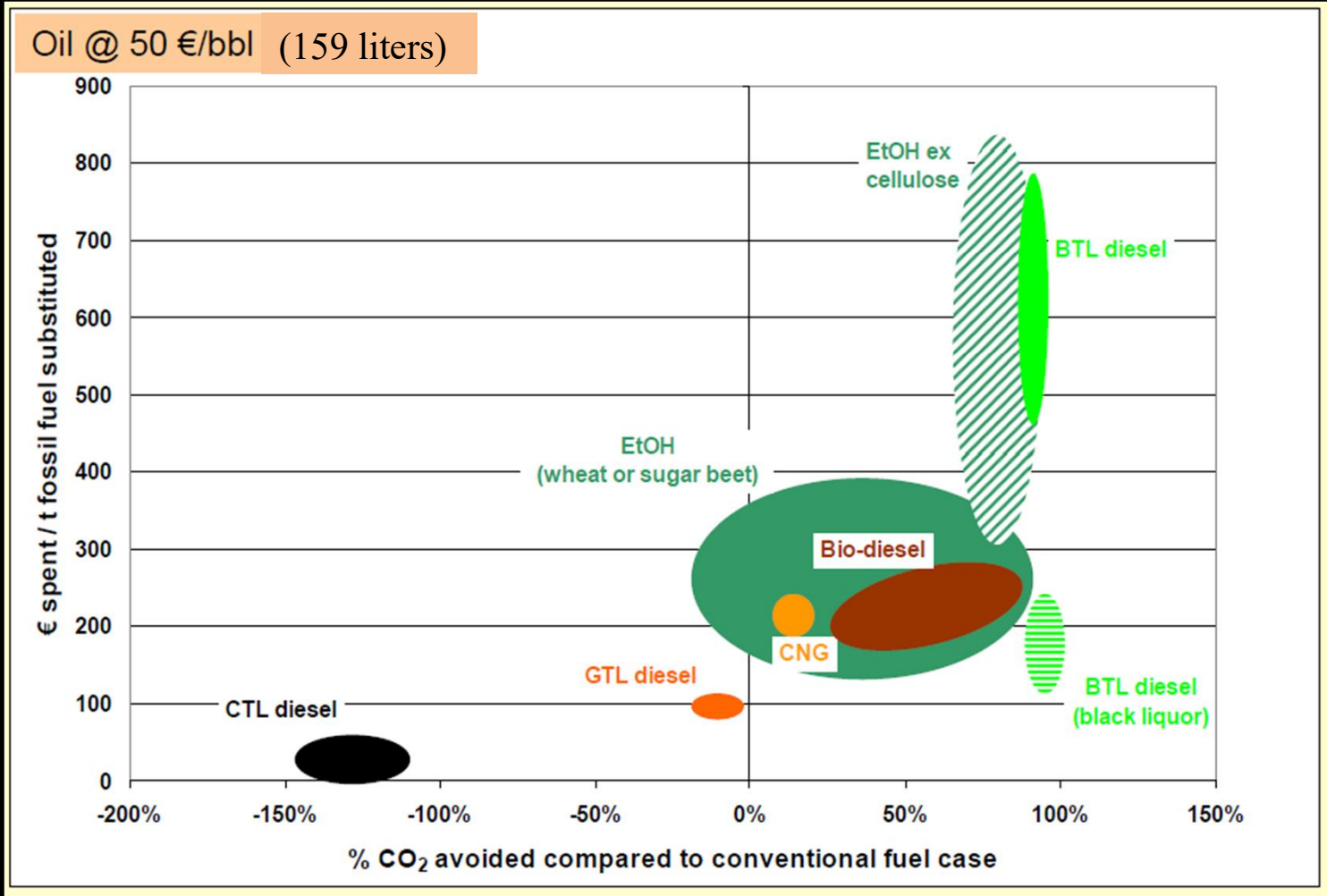
See the renewable transport fuel obligation: <https://www.gov.uk/renewable-transport-fuels-obligation>.

Biomass for transport: biodiesel

- ❑ Much of the diesel sold in the UK already contains a percentage of biodiesel.
- ❑ Demonstration schemes already in place (e.g. biobus – diesel from recycled cooking oil – Ayrshire).
- ❑ Equates to ~3% of total UK fuel use in 2017.

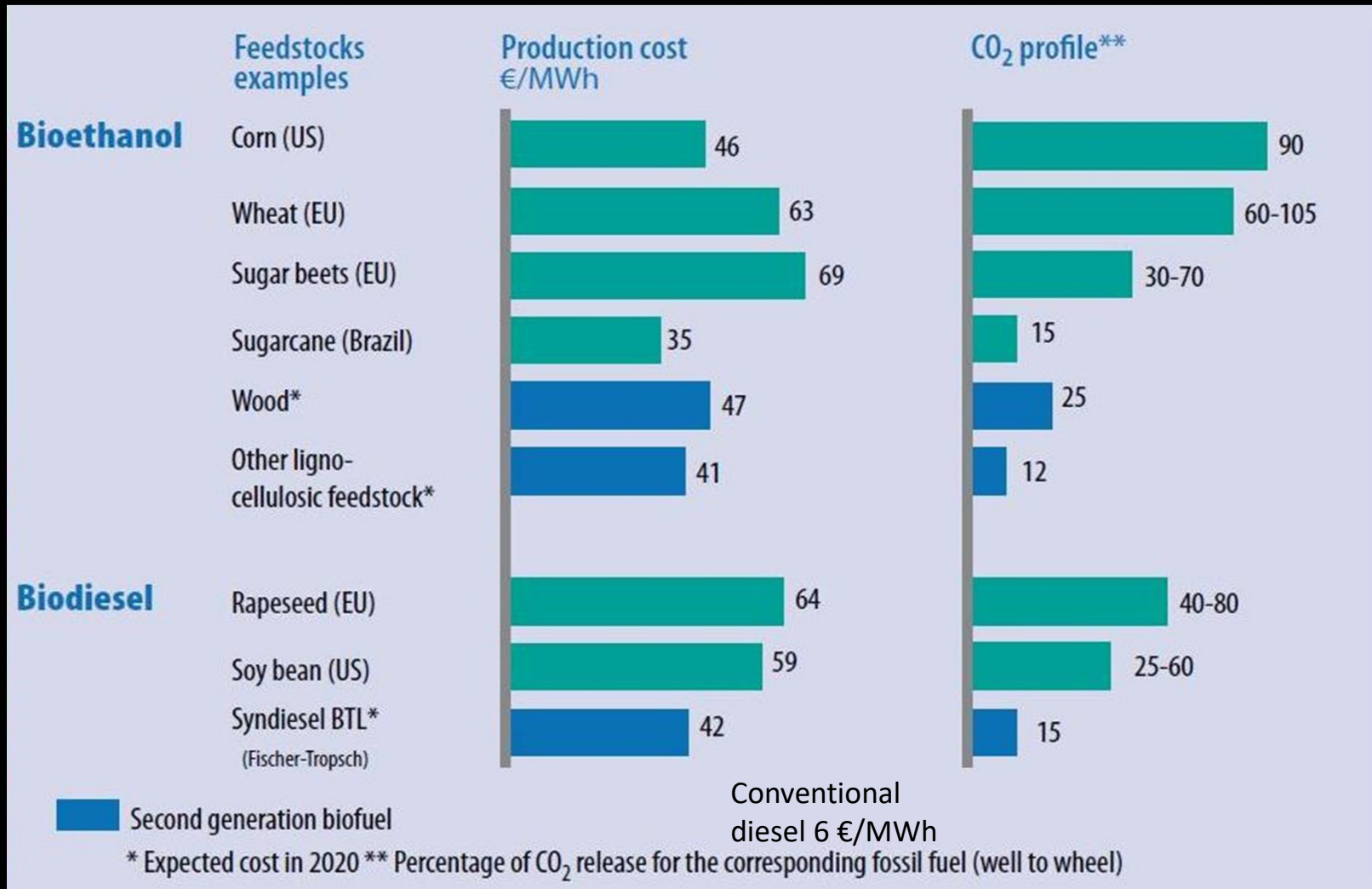


CO₂ avoided

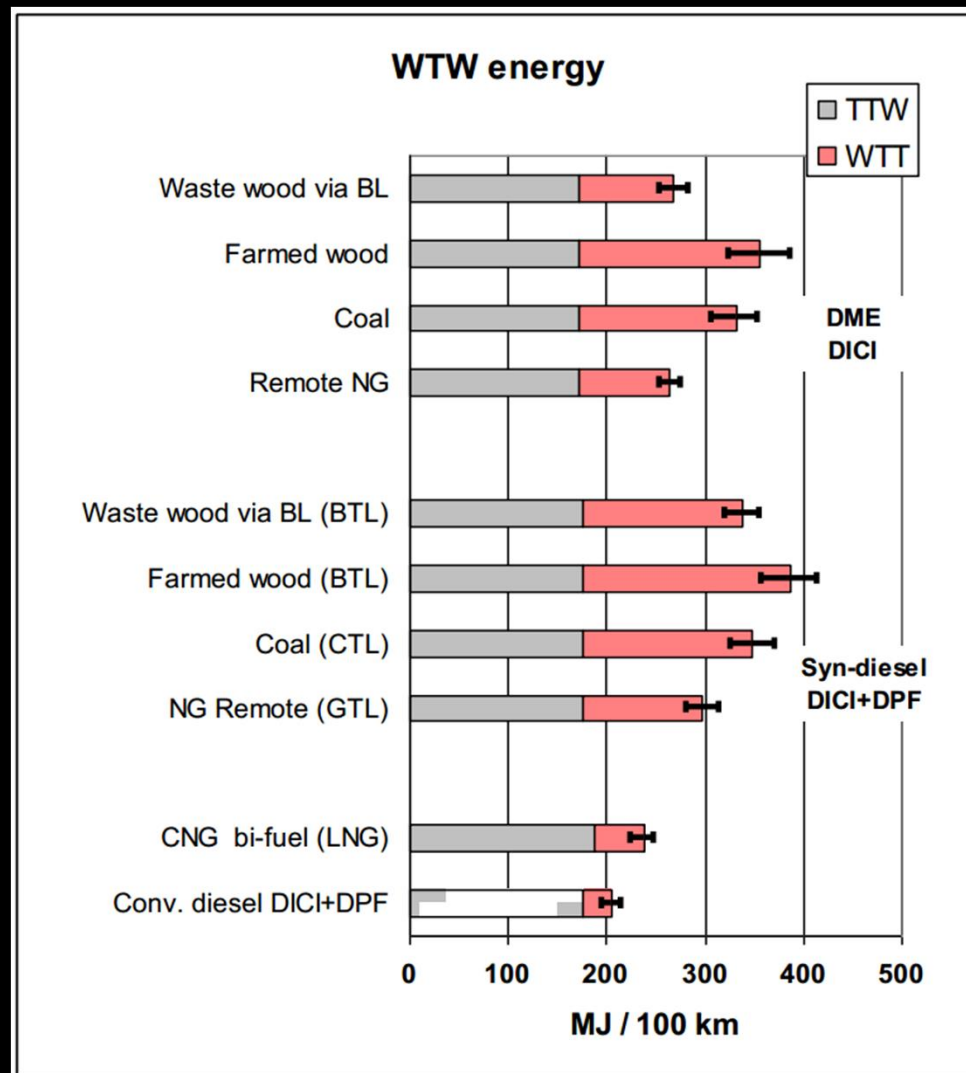


Source: CONCAWE/JRC/EUCAR

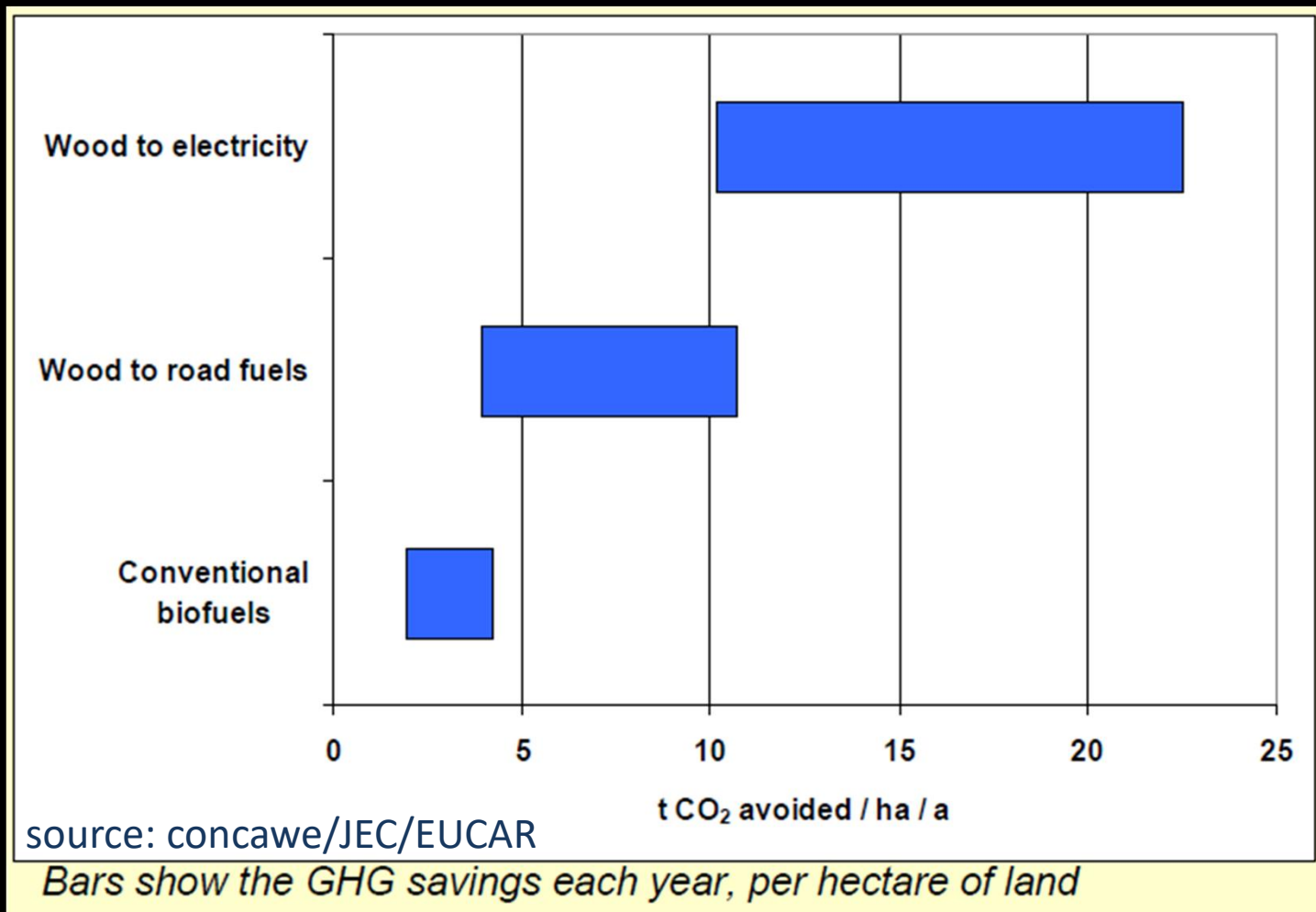
Bio-fuels for transport: emissions



Bio-diesel: energy efficiency



Bio-fuels for transport: land use efficacy



HOW BIOFUELS MEASURE UP

The case for biofuels isn't cut and dried. Their appetite for agricultural land and the modest savings on greenhouse gas emissions

Percentage of agricultural land needed to replace 10 per cent of transport fuel with biofuel

