

Food, climate, land use biodiversity and health

What is the science ? What might we might change personally and communally

Martin Stevens
Halesworth u3a
March 2025

Some audience assumptions

- That we take as read the overwhelming scientific conclusion that climate change is real, man made and caused primarily by an increase in 'green house gases' (GHGs).
- That biodiversity around the globe is decreasing and is impacted by climate change, other human activities such as agriculture and other land uses.
- That the food we produce and eat impacts both our individual health and the wider environment.
- That it can be often be difficult to disentangle the science from anecdotal observation, fashion and sometimes 'political' leanings' of researchers and authors.

So included

- Food production and GHGs
- Organic food production – climate change and health – with a local diversion
- Vegan //plant based diets – health and planet
- Rewilding — biodiversity and GHGs
- Agrovoltatics – food production and electricity
- Fish
- What can we do here ? —Discussion

Background —agriculture and climate change

The IPCC's Special Report on Climate Change and Land (2019) estimated that, globally, agriculture is directly responsible for up to **8.5% of all greenhouse gas emissions**

- — with a further **14.5% coming from land use change** (mainly deforestation in the developing world to clear land for food production).
- So towards a $\frac{1}{4}$ of all GHGs — second only to energy production

What does food have to do with climate change? (UN 2021)

What we eat, and how that food is produced, affects our health but also the environment.

- Food needs to be grown and processed, transported, distributed, prepared, consumed, and sometimes disposed of.
- Each of these steps creates greenhouse gases that trap the sun's heat and contribute to climate change. **About a third of all human-caused greenhouse gas emissions is linked to food.**

The largest part of food-related greenhouse gases comes from agriculture and land use. This includes :--

- methane from cattle's digestive process,
- nitrous oxide from fertilizers used for crop production,
- carbon dioxide released from cutting down forests for the expansion of farmland,
- other agricultural emissions from manure management, rice cultivation, burning of crop residues, and the use of fuel on farms.

Continued : A **much smaller** share of the green house gas emissions of food are caused by:

- refrigeration and transport of food,
- industrial processes such as the production of paper and aluminum for packaging,
- the management of food waste.

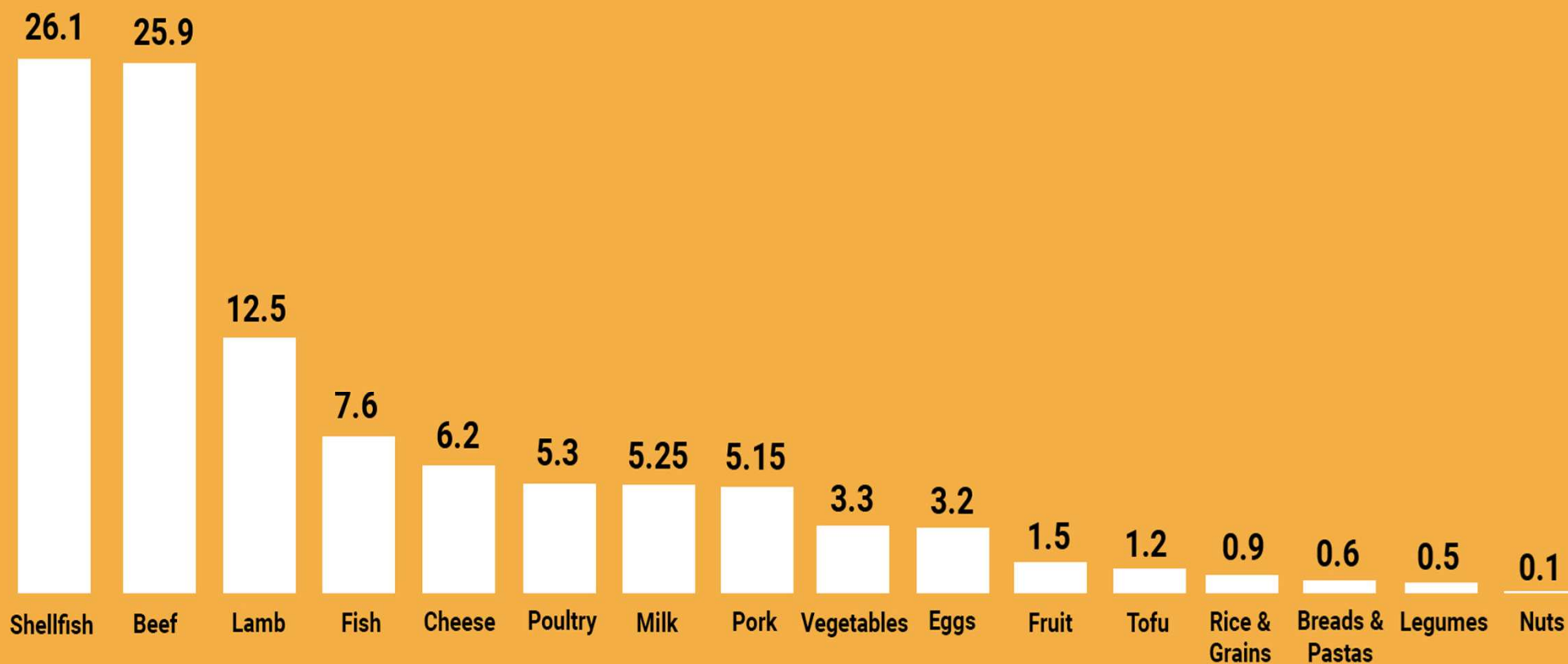
And in the UK –from HMG

In 2022, agriculture in the UK **was responsible for about 12%** of UK greenhouse gas (GHG) emissions. Includes emissions from livestock, soils, machinery, and stationary combustion sources.

Main emissions

- **Nitrous oxide:** Agriculture is responsible for about 70% of nitrous oxide emissions in the UK.
- **Methane:** Agriculture is responsible for about 49% of methane emissions in the UK.
- **Ammonia:** Agriculture is responsible for about 87% of ammonia emissions in the UK.
- **They do NOT seem to count imported food in this budget (nearly half!)**

Kilograms of greenhouse gas emissions per 1000 kilocalories



What does organic food mean?

‘Organic’, refers to how the food is **grown, processed and stored**. The standards vary from country to country but, in general, organic food and drink must be grown without:

- pesticides (limited, natural pesticides only)
- genetically modified ingredients
- routine use of antibiotics
- growth stimulants like hormones
- artificial colours or preservatives
- caging animals (only free-range)

Organics

In the UK , organic farming accounts for about 3% of the total farmed area. This proportion has decreased since peak in 2008,

In USA also about 3% of land BUT this includes meat production ... some parts of India are overwhelmingly organic .. Austria was aiming at 20%

Health : The evidence on whether organic food is healthier than conventional food is largely **observational**.

Zoe concluded little evidence it makes much difference – but suggests that eating organic oats (porridge) has some benefit due to non organic has high toxic uptake

Background — GHGs: is organic production a (partial) solution ?

Many studies which indicate that organic and 'conventional' foods, on the whole, performed comparably to one another regarding GHGs by unit of production.

On average, fruits, pulses and oil produced **less GHGs** when farmed organically,

— while vegetables, cereals and animal products produced **more**.^{18 Jun 2024} — **but all with lower yields per acre**

Effects of going organic on GHGs / Climate

- Organic farming is often promoted as the way forward, as it is aiming for more sustainable farming practices.
- However, organic farming also presents dilemmas. The most significant drawback is the **low productivity level, and consequently that it requires more land.**
- This poses a risk to the food system globally . Organic farming alone cannot feed the world population. Crop-land expansion leads to more greenhouse gas emissions per ton of food produced and is also more harmful to biodiversity.

A Systematic Review of Organic Versus Conventional Food Consumption: Is There a Measurable Benefit on Human Health? National Institutes of Health. USA 2019

- **Health:** Consumption of organic food is often tied to overall healthier dietary practices and lower levels of overweight and obesity, which are likely to be influential in the results of observational research.
- **Biodiversity effect:** Organic farming widely considered to be a far more **sustainable** alternative when it comes to food production. The lack of pesticides and wider variety of plants enhances biodiversity and results in better soil quality and reduced pollution from fertilizer or pesticide run-off.

Organics sustainable ? — well it's complicated

- Locally organic farming is widely considered to be a far more sustainable alternative when it comes to food production.
- BUT — lower yields here may mean additional acreage often overseas is brought into production from virgin forest/ marginal, but diverse / indigenous often grass land.

Organics continued

- Studies consistently find that it is far more environmentally sustainable to eat organic chicken instead of beef that was produced conventionally.
- Consuming large portions of organically produced meat will still have a bigger environmental/climate impact than eating conventionally produced crops and fruits.
- While the organic versus conventional farming debate continues, there is one clear way to significantly lower the environmental impact of your food, **by reducing the amount of meat (particularly red) in our diet.**

A local diversion– History of soil science

The Haughley Experiment

In 1939, Lady Eve Balfour launched the Haughley experiment (Suffolk) with Alice Debenham.

They wanted to know whether there was any difference between organic and intensive farming.



The Haughley Experiment

In 1939, Lady Eve Balfour launched the Haughley experiment with Alice Debenham - ran until 1980. To discover— **if there is any difference between organic and intensive farming?** To test this, they created **one organic plot, one mixed plot, and one intensive plot** side by side. It concluded.

- Organic fields can become self-supporting. This happens because of increased biological strength.
- Organic crops put more energy into establishing a healthy and expansive root system.
- Livestock in the organic section required less food for a higher yield of produce such as milk, meat or eggs.

Eve Balfour – ended her days in Theberton. Near to the Red Lion – became the founder of the Soil Association

Vegan Diet – how healthy – Science is mixed

Vegans generally have lower lower cholesterol and blood pressure but also lack some essential nutrients. Good for heart and brain.

Have 2x incidence of broken hips – especially an issue for older vegans. Vegetarians have 25% increased risk compared to omnivores

Low levels of vitamin D and B12 and other micronutrients are often found –even with supplements some find getting ‘healthy’ levels an issue. Bad for nerves and brain.

Fatigue caused by lack of B12 is a reason some give up their vegan diet... varies. genetic?

Most of the Science — is observational — vegans tend to report being more health aware than general omnivore population— and are thinner.

- I now eat organic oats – after listening to the Zoe podcast !

Rewilding –defining –meaning UK

Rewilding takes a big picture, holistic approach to helping nature recover and flourish.

‘ At Rewilding Britain’ they define rewilding as the **large-scale restoration of ecosystems to the point where nature is allowed to take care of itself.**

‘Rewilding seeks to reinstate natural processes and, where appropriate, missing species – allowing them to shape the landscape and the habitats within’.

Rewilding – biodiversity/climate change

‘Rewilding, as a nature based solution (NbS), can address both biodiversity and climate issues , including through improved land complexity and resilience’.

The (carbon) sequestration provided will deliver the critical emissions reductions and carbon removal required for the UK to meet net zero, along with nature benefits, **even though the bulk of reductions will come from decarbonising the wider economy.** However evidence gaps mean that the current and future potential contribution that rewilding can make to meeting (UK) net zero is subject to a high level of uncertainty, hence the strong need to address these gaps effectively and quickly.



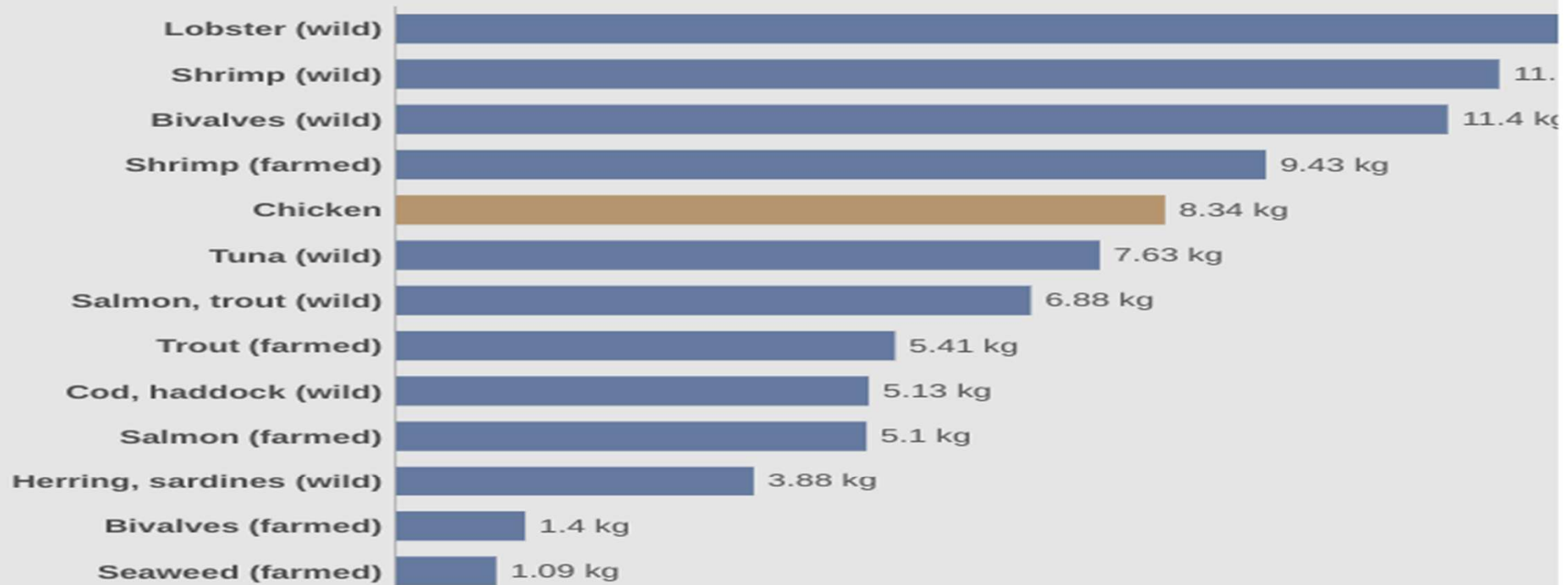
So what about seafood -

- Seafood **can be** a low carbon (and more healthy) option
- Choosing seafood over land based animal products can be one way to lower your carbon footprint.
- On average, seafood generates less carbon per unit of protein than beef and pork, and has a carbon footprint similar to poultry.
- **But not all seafood is the same.**

Greenhouse gas emissions per kilogram of

Based on a meta-analysis of data from 1690 fish farms and 1000 unique fishery records, this chart shows the greenhouse gas emissions in kilograms of carbon dioxide-equivalents per kilogram of edible weight.

Table Chart

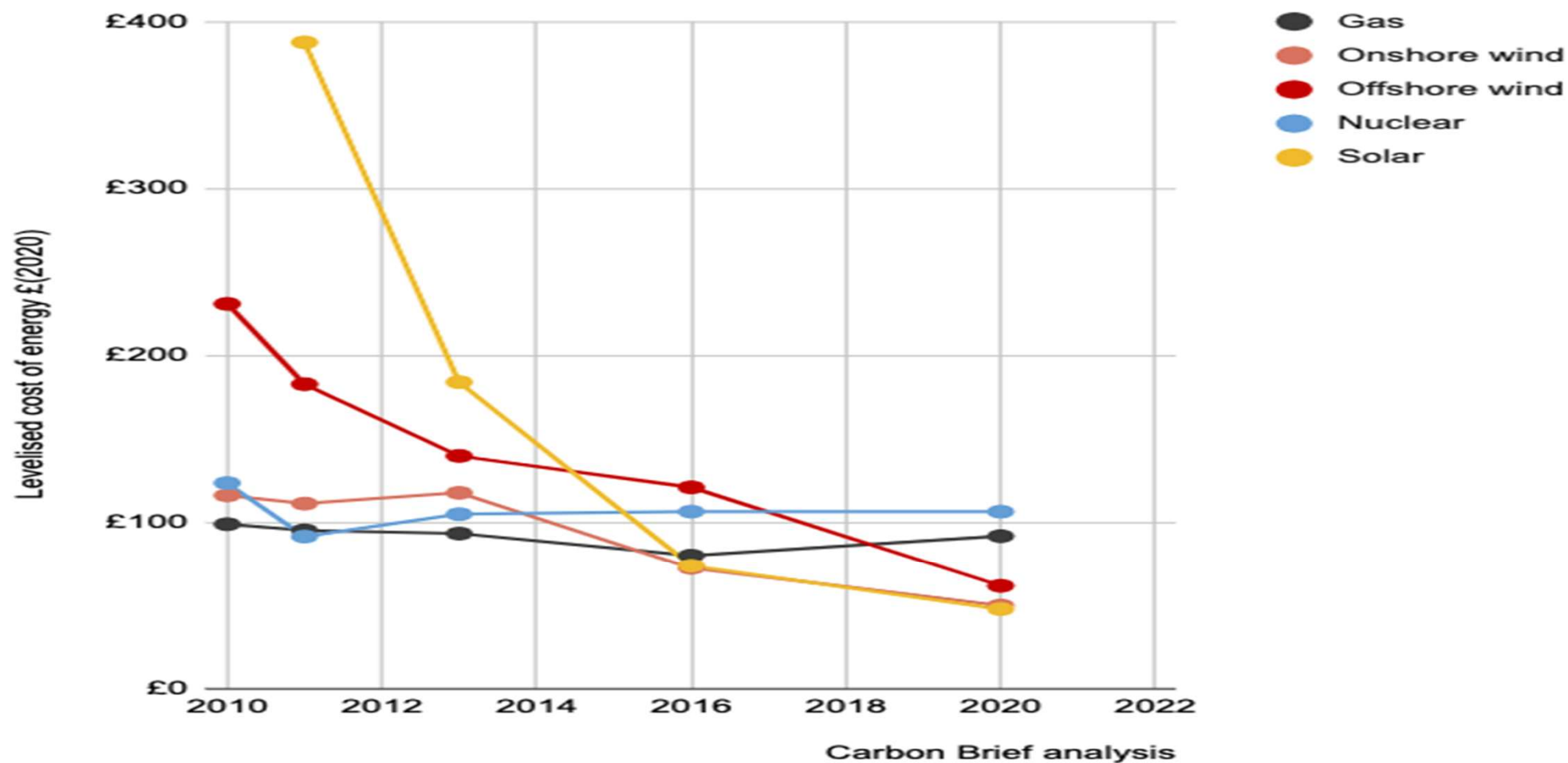


Data source: Gephart et al. (2021). – [Learn more about this data](#)

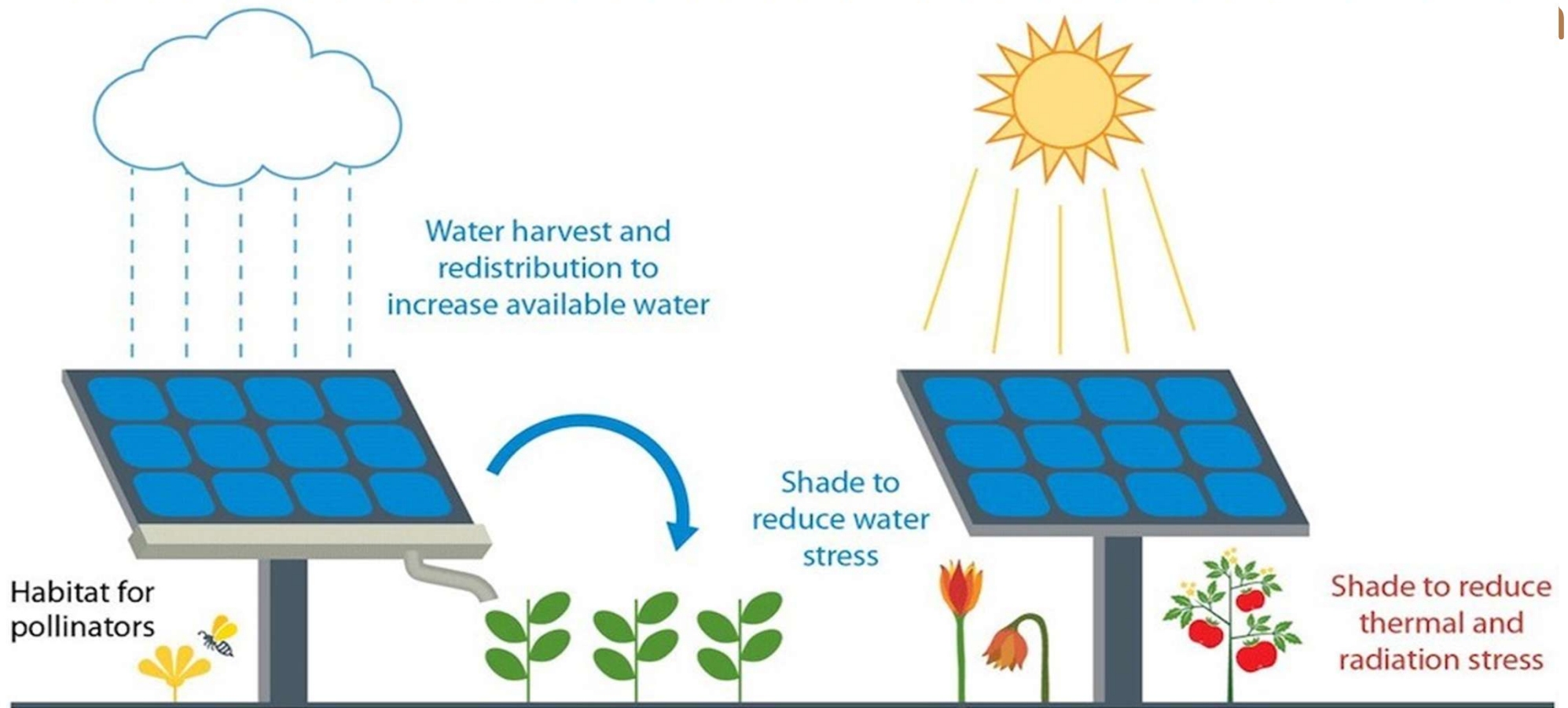
Note: Includes on-farm and off-farm, but does not include post-farmgate emissions. This means it does not include transport to retail, packaging, processing or cooking.

Solar is now 88% cheaper than thought a decade ago, UK govt says – and half its estimate for gas power

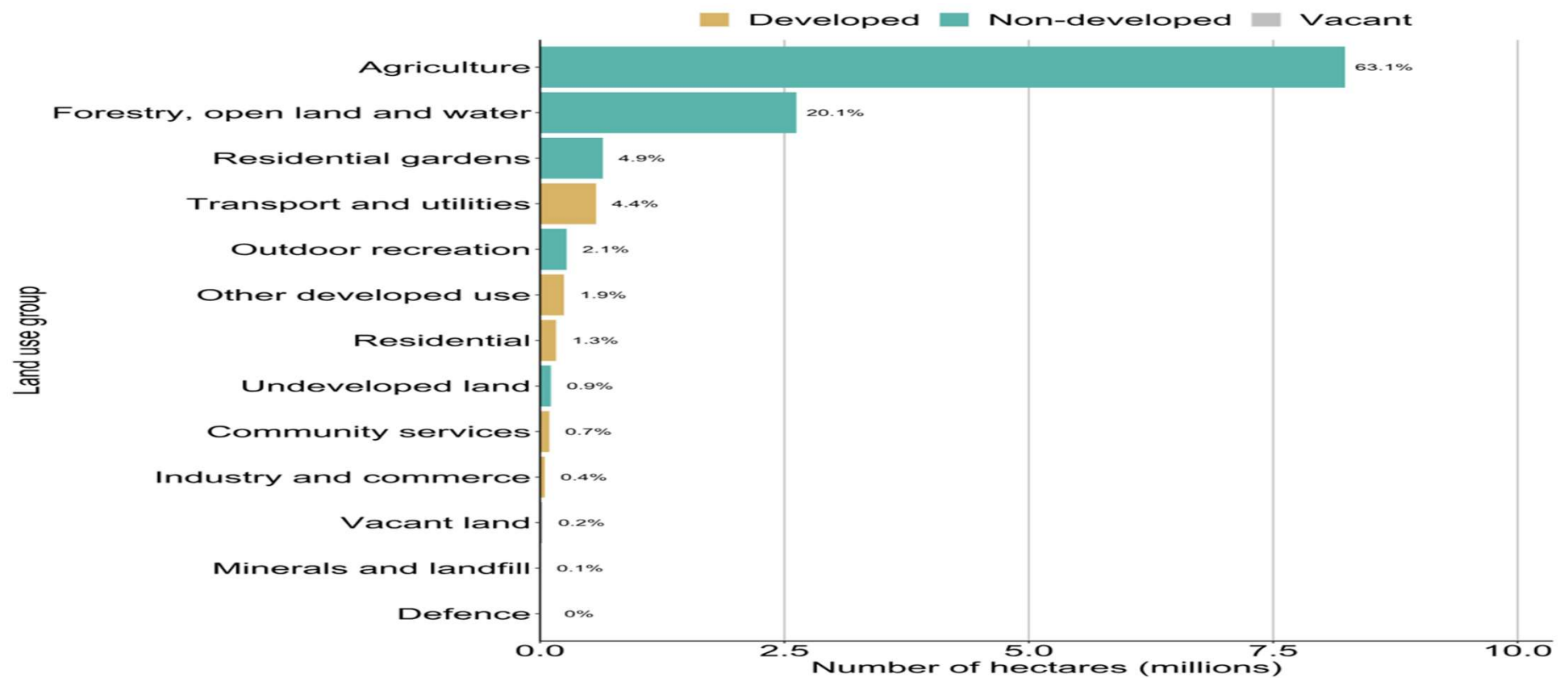
Levelised cost estimates are down 57% for onshore and 73% for offshore wind



Agrovoltaics..

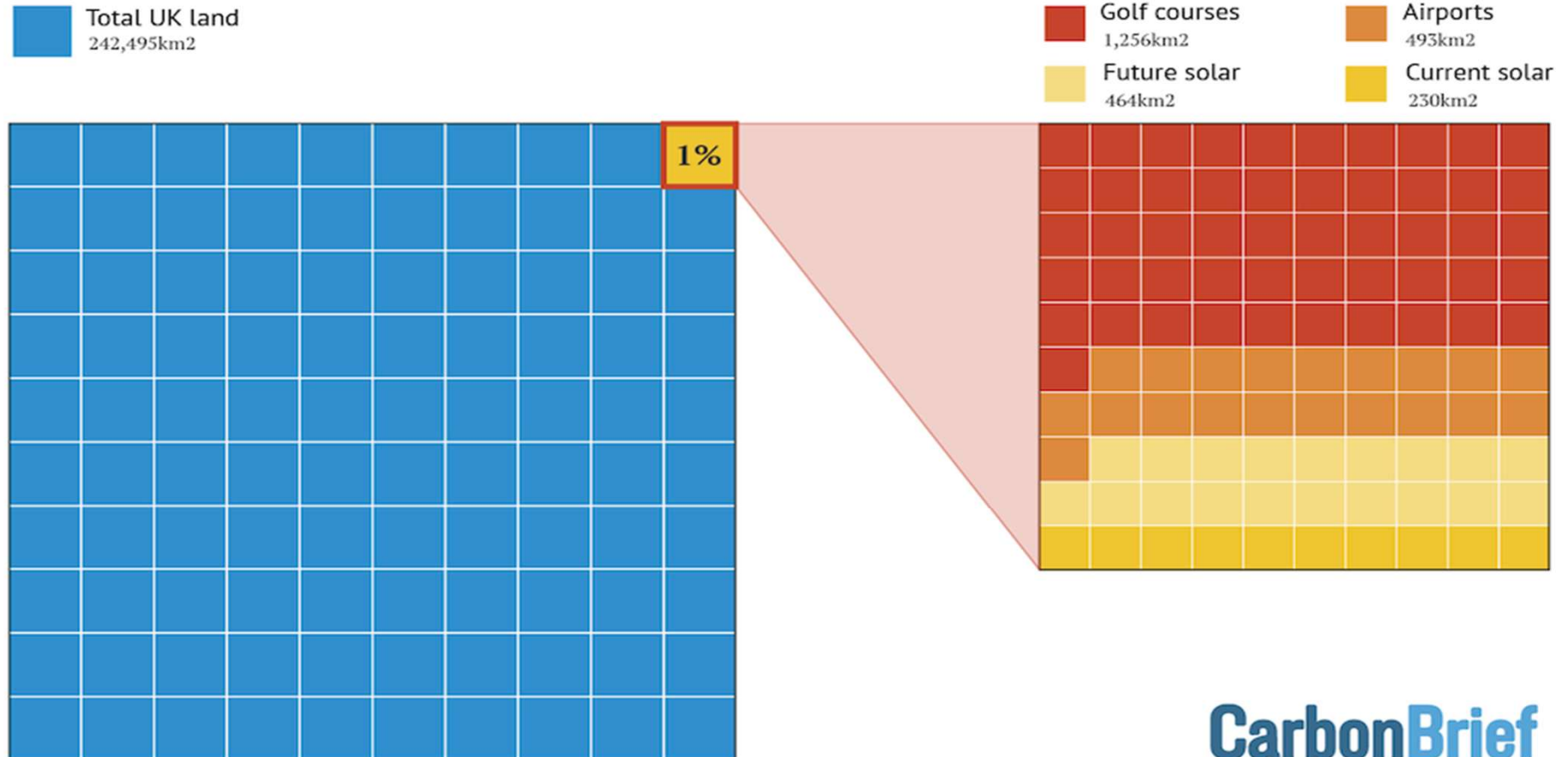


HMG -Land use in England in 2022



Golf courses take up more space than solar power in the UK

Current and future solar power land use compared to other uses



Traditional utility-scale configurations

Crop Production



Crops grown in between rows

Animal Husbandry



Grazing in between and underneath panels

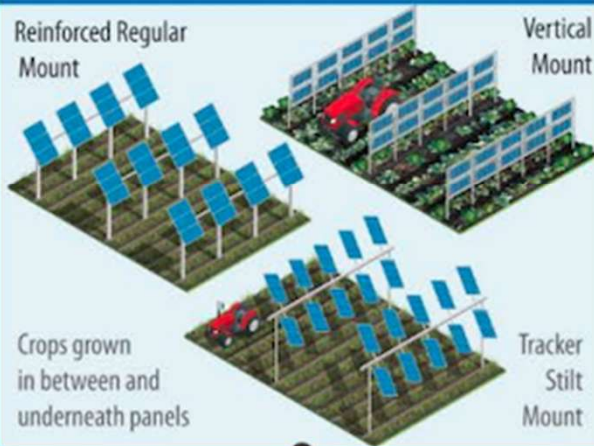
Ecosystem Services

Vegetation grown in between and underneath panels



Reinforced Regular Mount

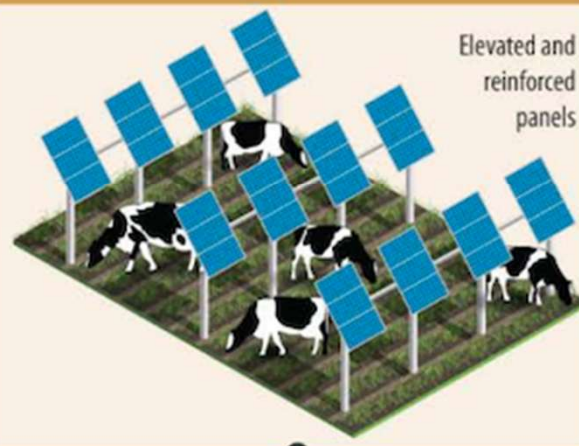
Vertical Mount



Crops grown in between and underneath panels

Tracker Stilt Mount

Elevated and reinforced panels



Greenhouse Solar

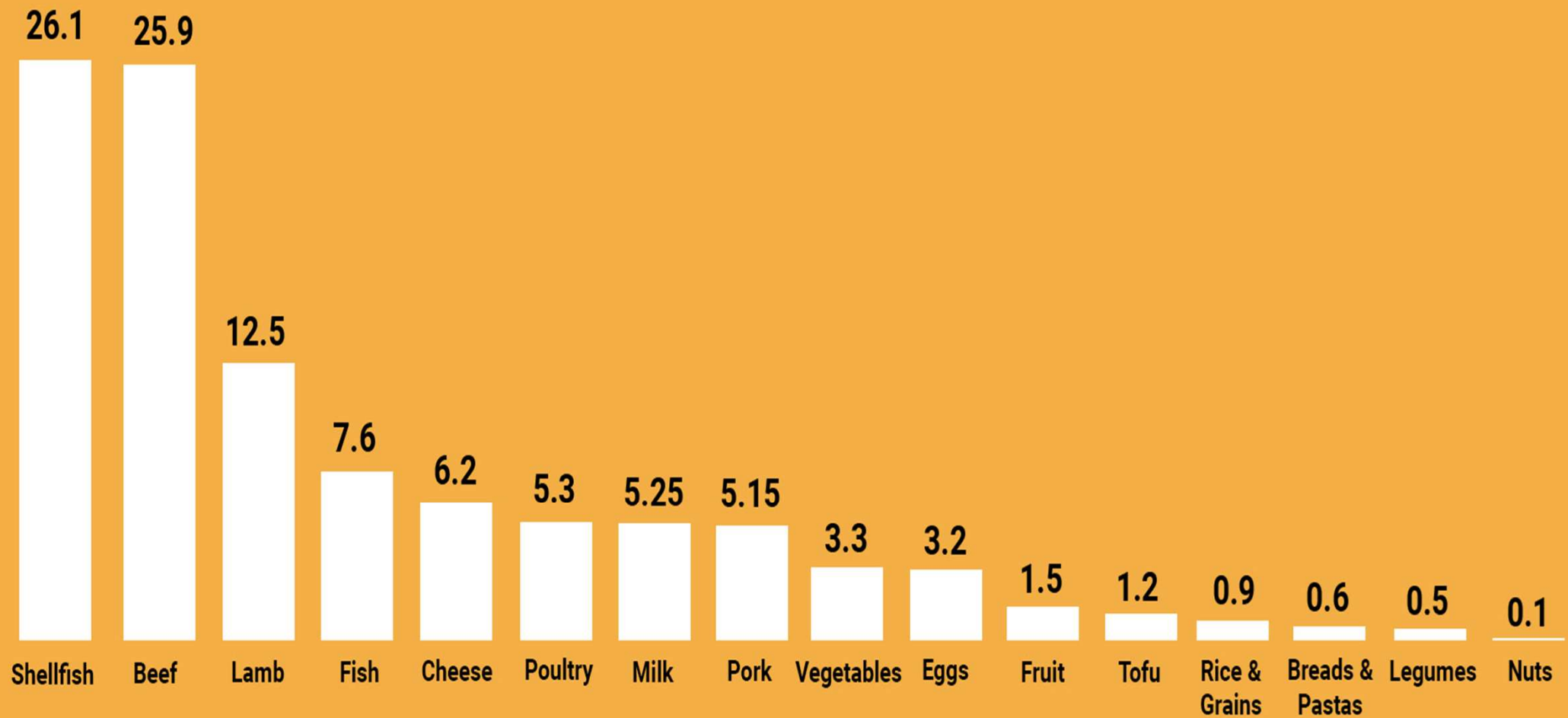


Alternative configurations

Solar versus bio fuels - best bang for an acre?

- **Crops grown for biofuel production take up 77 times more land than used for solar panels.**
- **1 acre of solar panels delivers 48 to 112 times more driving distance, when used to charge an electric vehicle, than that land could growing biofuels.**

Kilograms of greenhouse gas emissions per 1000 kilocalories



ENVIRONMENT

Carbon emissions 'fall to 1872 levels'

Greenhouse gas emissions in the UK fell last year to their lowest level since 1872, researchers say.

Analysis based on preliminary Government energy data found that the country's planet-warming emissions fell by 3.6 per cent to 371 million tonnes of carbon dioxide equivalent (Mtco₂e) in 2024.

This is the lowest since 1872 and on a par with 1926, when a general strike closed polluting factories.

The fall was largely driven by coal use dropping to its lowest since 1666, the Carbon Brief website said. The last coal-fired power station, at Ratcliffe-on-Soar, Nottinghamshire, shut in September.

Stop Press – HMG Committee for Climate Change (CCC) Feb 2025 - Tyndall Centre UEA

If the UK is to achieve net zero emissions by 2050, over one-third of its sheep and cows will have to go, with their fields being replaced by huge new areas of woodland.

The UK has almost halved its greenhouse gas emissions since 1990, but that was the easy half. Most dirty industries are long gone, for instance, and coal power plants have been replaced with gas and renewable energy.

Currently, agriculture makes up about 11% of UK emissions, **but this proportion will rise considerably over the next 15 years as other sectors decarbonise further.**

Continued

Cattle and sheep contribute most of these emissions, and the latest UK carbon budget indicates their numbers will have to be reduced by **22% by 2035 and by over 38% by 2050.**

This is **principally to release land to plant tens of thousands of hectares of new woodland each year (60,000 hectares a year by 2040)**

— **and to grow energy crops (38,000 hectares a year by 2040).** It will also mean **fewer emissions from the animals themselves and from growing animal feed.**

Tyndall Centre UEA : Faced with the basic maths, a marked reduction looks unavoidable. The sooner the conversation can shift from whether change is needed to how it might best be fairly and equitably pursued, the better.

So where does the science / data lead us?

- Reducing GHG emissions / slowing climate change is a global issue – many countries are making limited progress – some are not.
- Food especially red meat accounts for a significant and increasing proportion of GHGs – worldwide
- Biodiversity is impacted by loss of habitat due to food production to produce beef and dairy – often grassland
- Looks like growing more trees is part of a solution – cutting down forests for food production is to say the least ‘unhelpful’
- In UK we can self deceive and ‘export’ our production of GHGs .Then a need to import even more food due to loss of land to solar/rewilding/development/organics – as meat/ dairy, or food to feed cattle etc.
- We need to change our food driven carbon footprint individually – especially significantly modify what we eat — this should also improve health and biodiversity