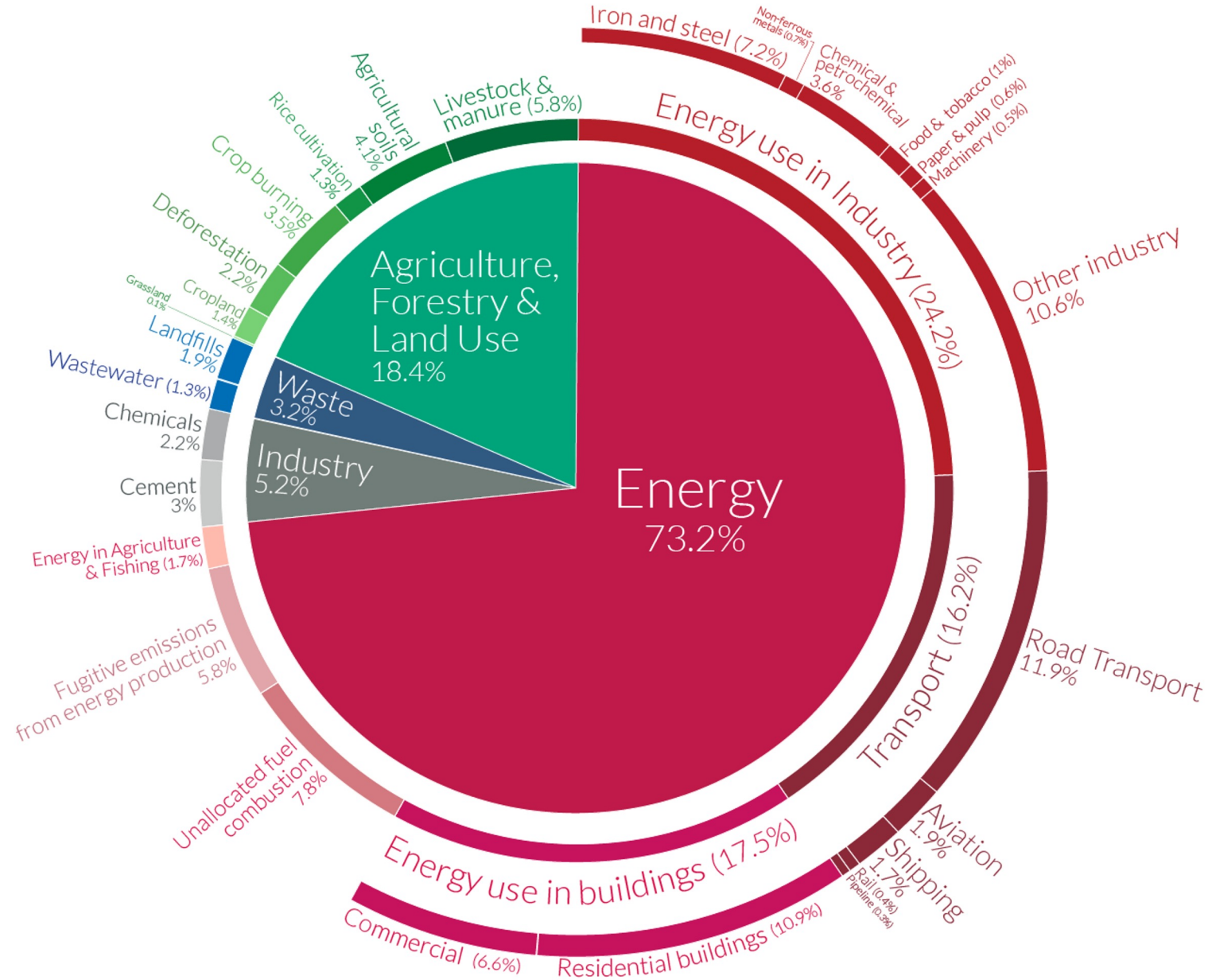# Emissions from food.
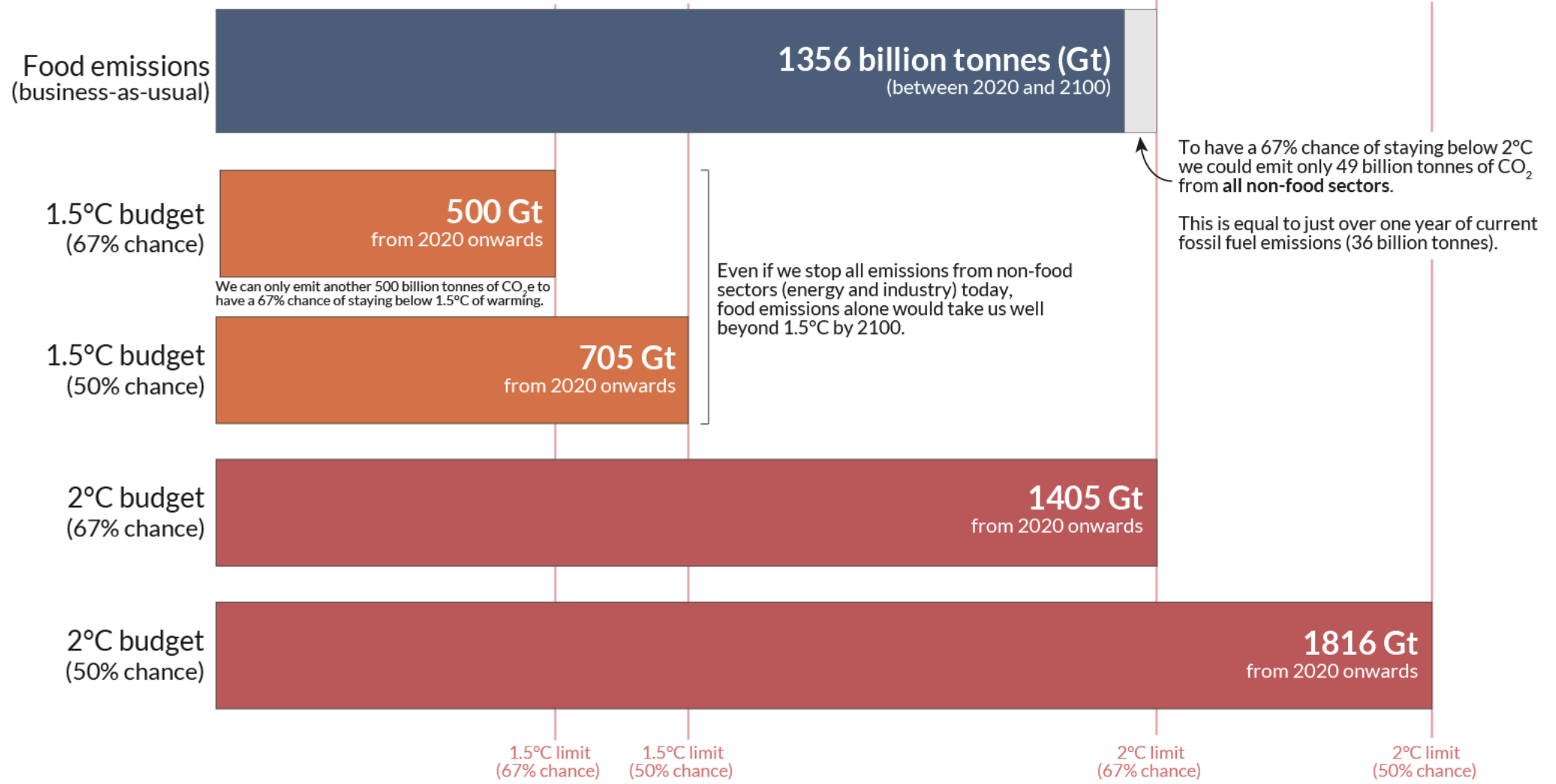
Ex-lightning talk

Oscar Mitcham

Global greenhouse gas emissions by sector

This is shown for the year 2016 – global greenhouse gas emissions were 49.4 billion tonnes CO_2eq.

Energy 73.2%

- Energy use in Industry (24.2%)
  - Iron and steel (7.2%)
  - Non-ferrous metals (0.7%)
  - Chemical & petrochemical 3.6%
  - Food & tobacco (1%)
  - Paper & pulp (0.6%)
  - Machinery (0.5%)
  - Other industry 10.6%
- Transport (16.2%)
  - Road Transport 11.9%
  - Aviation 1.9%
  - Shipping 1.7%
  - Rail (0.4%)
  - Pipeline (0.3%)
- Energy use in buildings (17.5%)
  - Commercial (6.6%)
  - Residential buildings (10.9%)
- Unallocated fuel combustion 7.8%
- Fugitive emissions from energy production 5.8%
- Energy in Agriculture & Fishing (1.7%)

Agriculture, Forestry & Land Use 18.4%

- Livestock & manure (5.8%)
- Agricultural soils 4.1%
- Rice cultivation 1.3%
- Crop burning 3.5%
- Deforestation 2.2%
- Cropland 1.4%
- Grassland 0.1%

Industry 5.2%

- Cement 3%
- Chemicals 2.2%

Waste 3.2%

- Wastewater (1.3%)
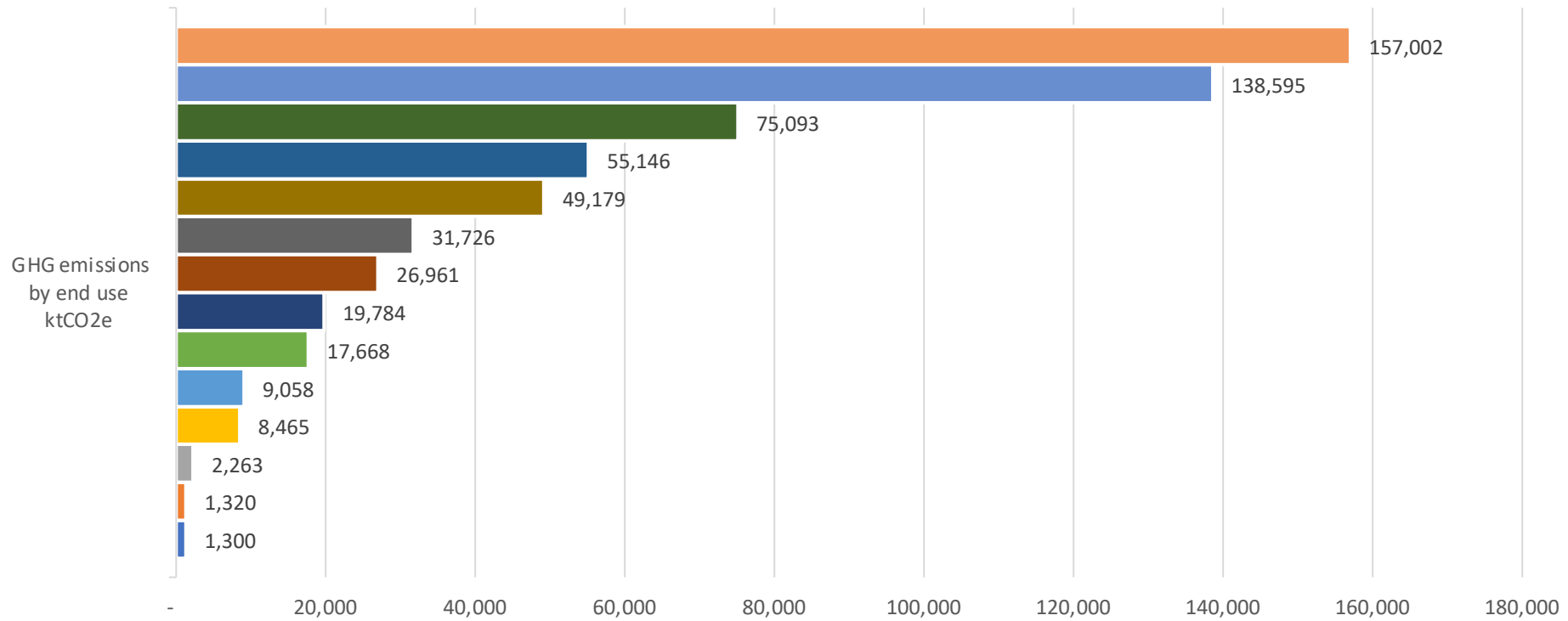- Landfills 1.9%

Food emissions could consume most of our 1.5°C or 2°C carbon budget

Shown are estimates of cumulative greenhouse gas emissions from food production from 2020 to 2100 based on population, dietary and agricultural trends in a business-as-usual scenario. This is shown relative to total cumulative emissions to keep global average temperature rise below 1.5°C or 2°C by 2100.
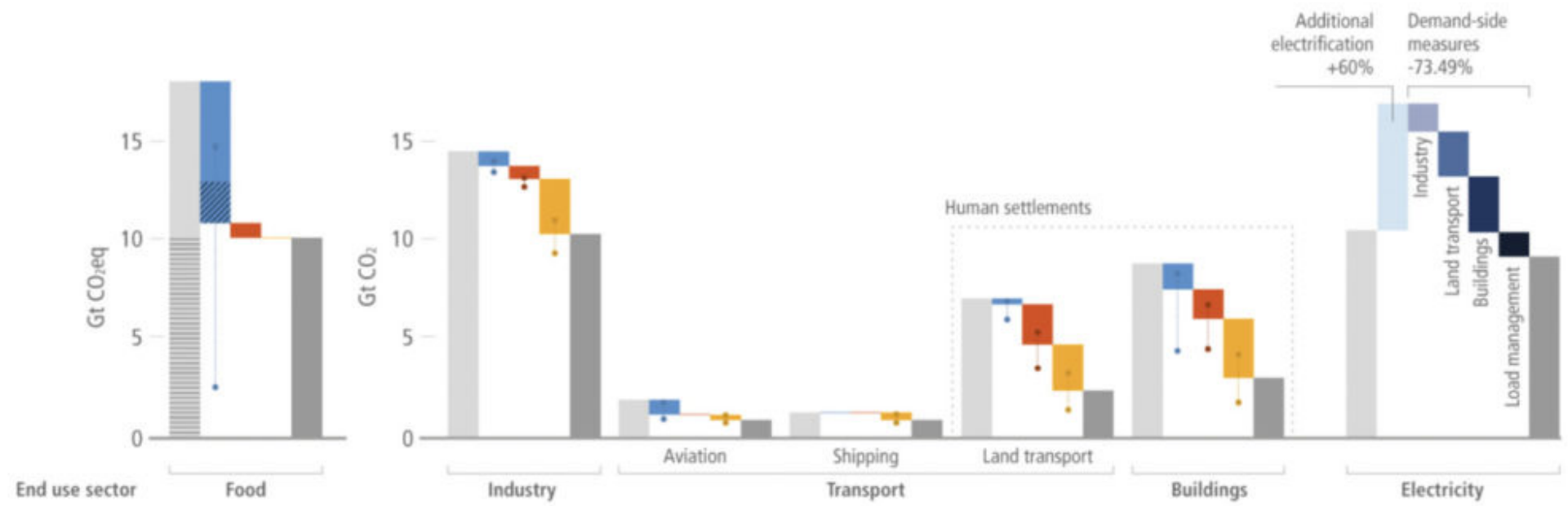
Food emissions (business-as-usual)

1356 billion tonnes (Gt)
(between 2020 and 2100)

To have a 67% chance of staying below 2°C we could emit only 49 billion tonnes of CO_2 from **all non-food sectors**.

This is equal to just over one year of current fossil fuel emissions (36 billion tonnes).

1.5°C budget (67% chance)

500 Gt
from 2020 onwards

We can only emit another 500 billion tonnes of CO_2e to have a 67% chance of staying below 1.5°C of warming.

Even if we stop all emissions from non-food sectors (energy and industry) today, food emissions alone would take us well beyond 1.5°C by 2100.

1.5°C budget (50% chance)

705 Gt
from 2020 onwards

2°C budget (67% chance)

1405 Gt
from 2020 onwards

2°C budget (50% chance)

1816 Gt
from 2020 onwards

1.5°C limit (67% chance)

1.5°C limit (50% chance)

2°C limit (67% chance)

2°C limit (50% chance)

Note: This is measured in global warming potential (GWP*) CO_2 warming-equivalents (CO_2-we).
Source: Michael Clark et al. (2020). Global food system emissions could preclude achieving the 1.5° and 2°C climate change targets. *Science*.
OurWorldinData.org – Research and data to make progress against the world's largest problems.

GHG emissions by end use ktCO2e

Category	Value
Transportation	157,002
Housing & power	138,595
Gross Fixed Capital Formation	75,093
Food & beverages	55,146
Government	49,179
Recreation & communication	31,726
Hotels & restaurants	26,961
Furnishing, appliances	19,784
Other consumption	17,668
Clothing & footwear	9,058
Other	8,465
Education	2,263
Health	1,320
Alcohol & tobacco	1,300

Legend:
- Transportation
- Housing & power
- Gross Fixed Capital Formation
- Food & beverages
- Government
- Recreation & communication
- Hotels & restaurants
- Furnishing, appliances
- Other consumption
- Clothing & footwear
- Other
- Education
- Health
- Alcohol & tobacco

Demand for service	Nutrition	Manufactured products	Mobility	Mobility	Mobility	Shelter
Socio-cultural factors	Shift in dietary choice with reduced animal protein; avoid food waste; avoid over-consumption	Avoid short life span products	Avoid long haul flights; shift to trains wherever possible	Currently not applicable	Teleworking or telecommuting; active mobility such as walking and cycling	Social practices in energy saving; and lifestyle and behavioural changes
Infrastructure use	Enhance the role of choice architectures & information; financial incentives; waste management; recycling infrastructure	Reuse and recycling	Currently not applicable	Currently not applicable	Public transport; shared mobility; compact city; spatial planning	Compact cities; built environment; living floor space rationalisation; architectural design; feedback control systems
Technology adoption	Currently not applicable	Access to materials-efficient services; access to energy-efficient and CO$_2$-neutral materials	Adoption of energy-efficient technologies; technologies with improved aerodynamics	Adoption of energy-efficient technology/systems	Electric vehicles; efficiency technologies	Adopting energy-efficient solutions; shift to renewables

Legend:
- Total emissions 2050
- Socio-cultural factors
- Infrastructure use
- Technology adoption
- Emissions that cannot be avoided or reduced through demand side options
- Deforestation and land-use change
- Economic potential without considering LUC

Percentage change in average number of weekly units of meat, fish or poultry purchased per buyer by age group.

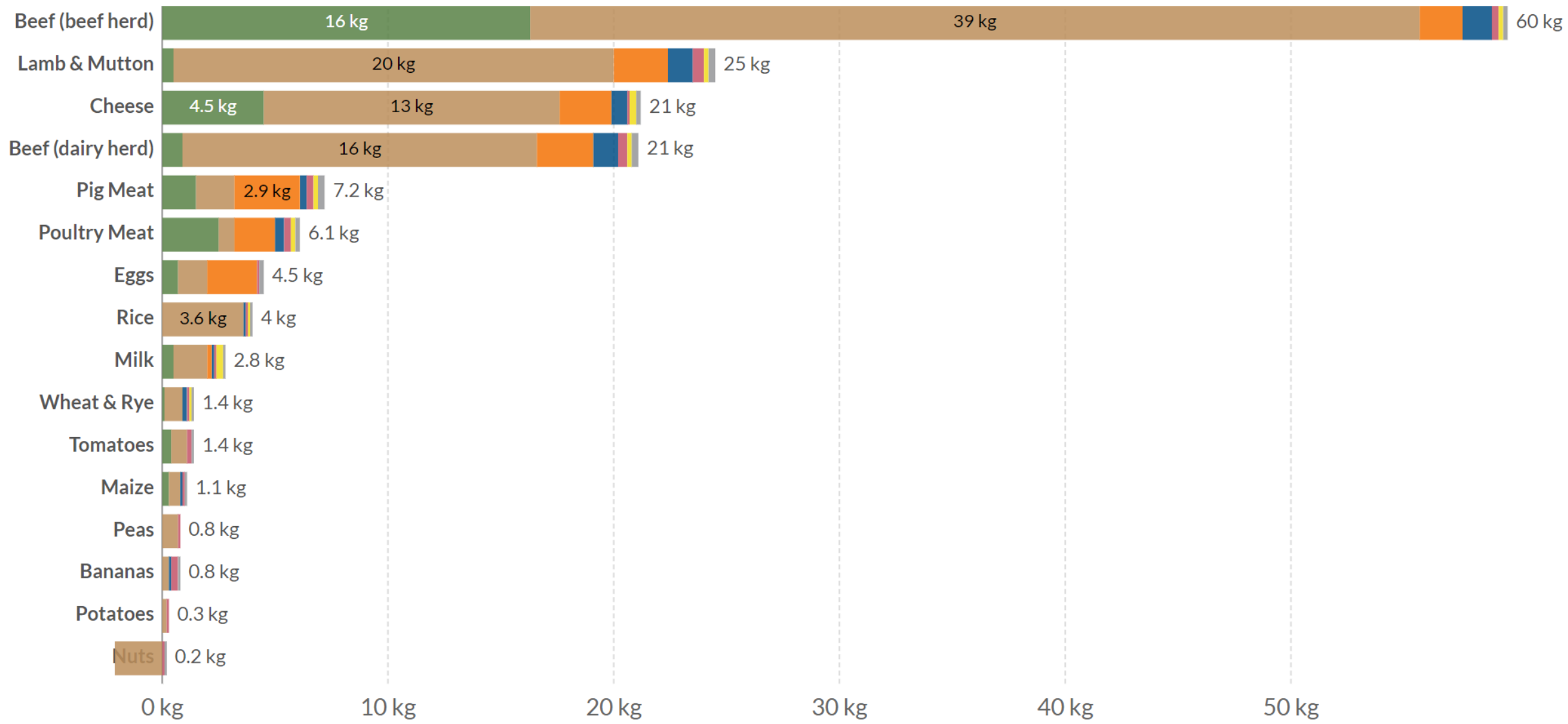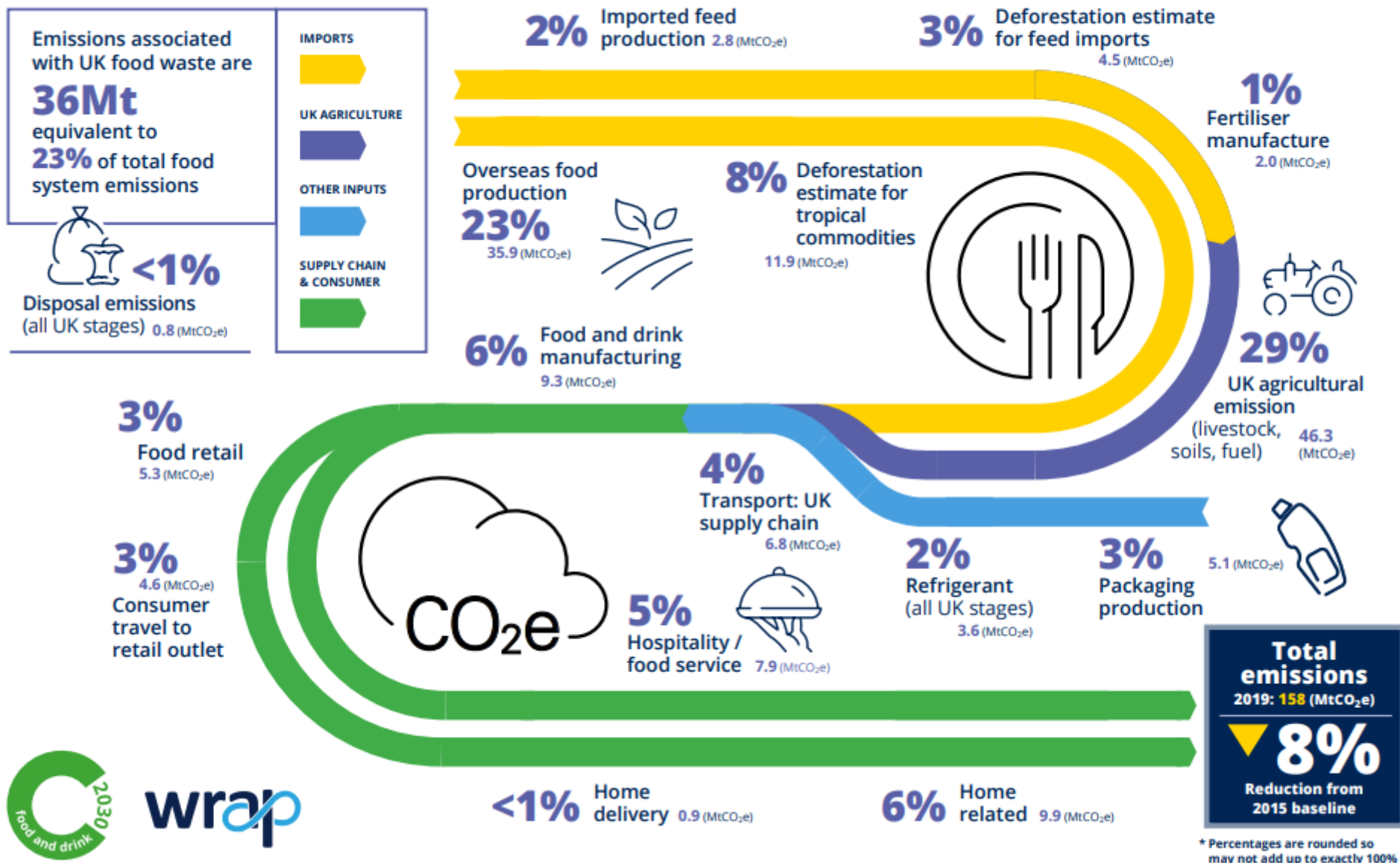Sainsbury's shoppers, 2017-2020.

Change in MFP (meat/fish/poultry) units per customer from 2017/18 to 2019/20
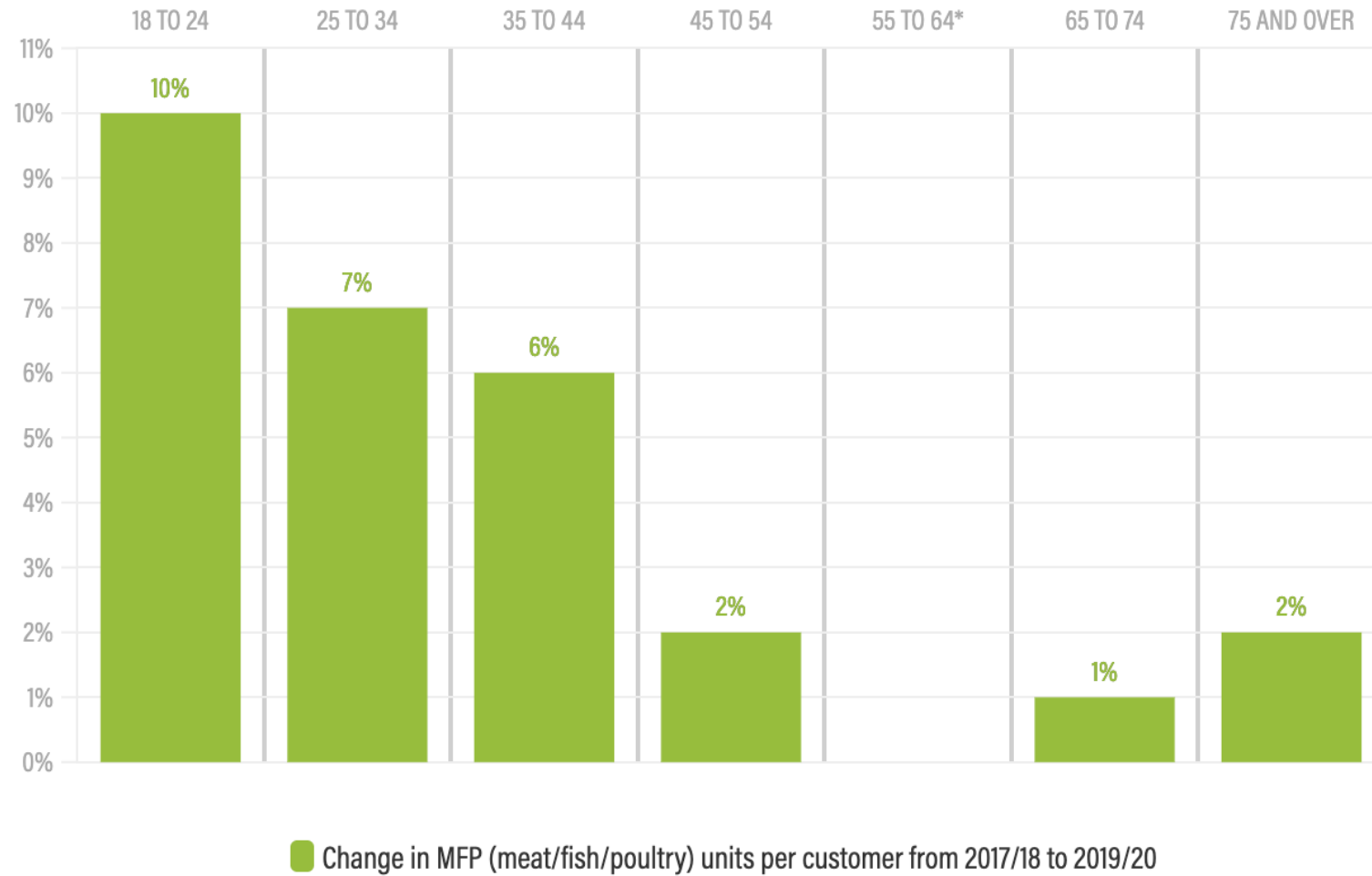
Source: Sainsbury's, 2017-2020
* Note: 55 to 64 is 0%

WORLD RESOURCES INSTITUTE

Legend: Land use change · Farm · Animal feed · Processing · Transport · Retail · Packaging

Food	Land use change	Farm	Total
Beef (beef herd)	16 kg	39 kg	60 kg
Lamb & Mutton		20 kg	25 kg
Cheese	4.5 kg	13 kg	21 kg
Beef (dairy herd)		16 kg	21 kg
Pig Meat		2.9 kg	7.2 kg
Poultry Meat			6.1 kg
Eggs			4.5 kg
Rice		3.6 kg	4 kg
Milk			2.8 kg
Wheat & Rye			1.4 kg
Tomatoes			1.4 kg
Maize			1.1 kg
Peas			0.8 kg
Bananas			0.8 kg
Potatoes			0.3 kg
Nuts			0.2 kg

UK FOOD SYSTEM EMISSIONS FLOWS 2019

Emissions associated with UK food waste are **36Mt** equivalent to **23%** of total food system emissions

IMPORTS

UK AGRICULTURE

OTHER INPUTS

SUPPLY CHAIN & CONSUMER

<1% Disposal emissions (all UK stages) 0.8 (MtCO₂e)

2% Imported feed production 2.8 (MtCO₂e)

3% Deforestation estimate for feed imports 4.5 (MtCO₂e)

1% Fertiliser manufacture 2.0 (MtCO₂e)

Overseas food production **23%** 35.9 (MtCO₂e)

8% Deforestation estimate for tropical commodities 11.9 (MtCO₂e)

29% UK agricultural emission (livestock, soils, fuel) 46.3 (MtCO₂e)

6% Food and drink manufacturing 9.3 (MtCO₂e)

3% Food retail 5.3 (MtCO₂e)

4% Transport: UK supply chain 6.8 (MtCO₂e)

5.1 (MtCO₂e)

3% 4.6 (MtCO₂e) Consumer travel to retail outlet

CO₂e

5% Hospitality / food service 7.9 (MtCO₂e)

2% Refrigerant (all UK stages) 3.6 (MtCO₂e)

3% Packaging production

2030 food and drink

wrap

<1% Home delivery 0.9 (MtCO₂e)

6% Home related 9.9 (MtCO₂e)

Total emissions 2019: **158** (MtCO₂e) ▼ **8%** Reduction from 2015 baseline

* Percentages are rounded so may not add up to exactly 100%
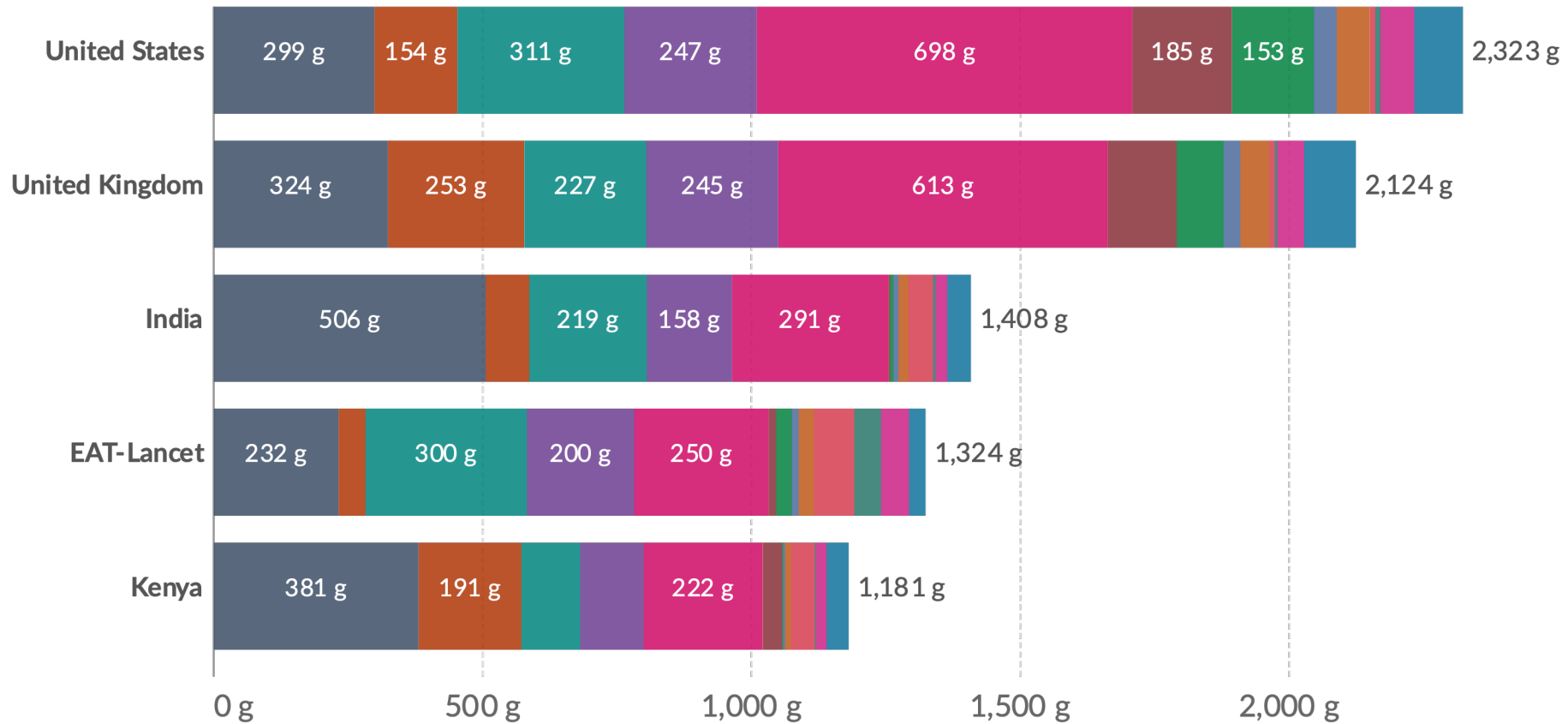
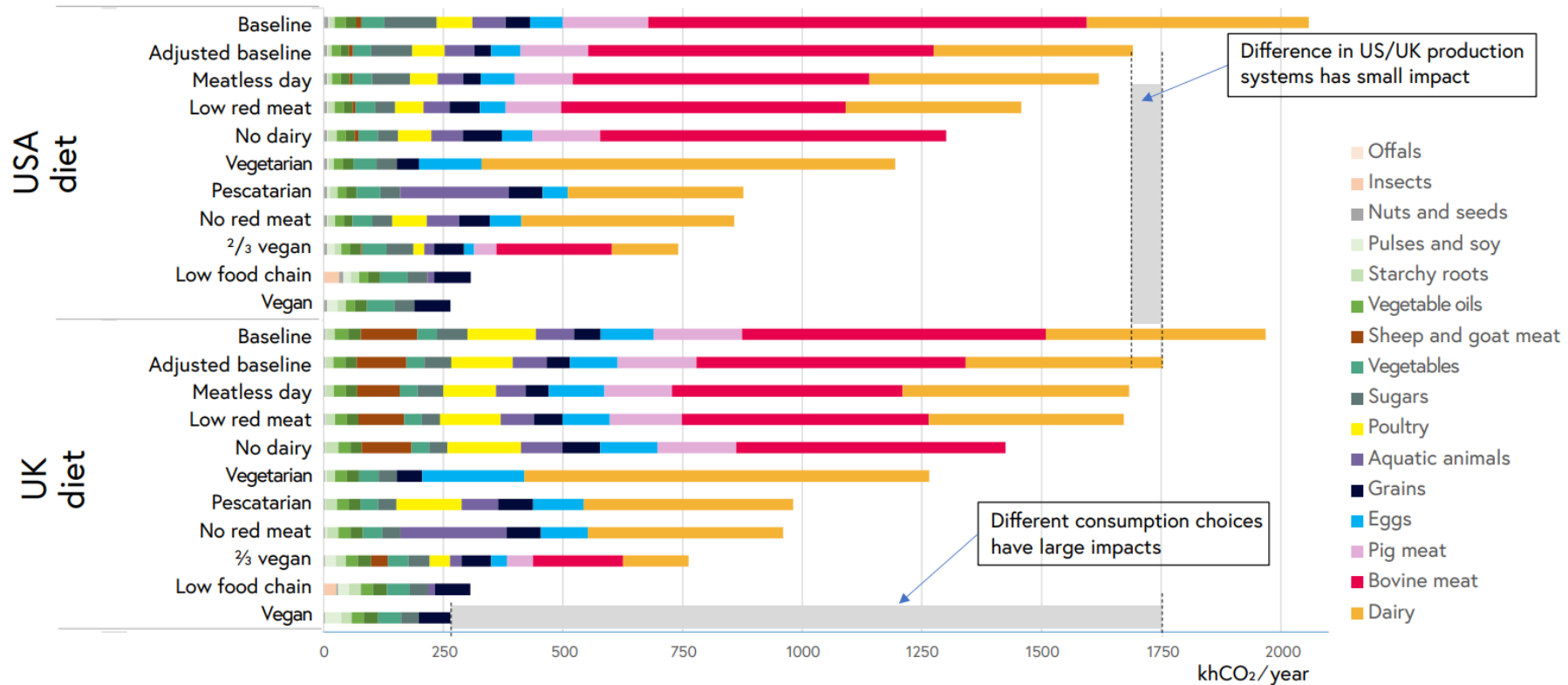# How do actual diets compare to the EAT–Lancet diet?

Diets are shown as average daily per capita supply of different food groups, compared to the EAT-Lancet diet. The EAT-Lancet diet is a diet recommended to balance the goals of healthy nutrition and environmental sustainability for a global population.
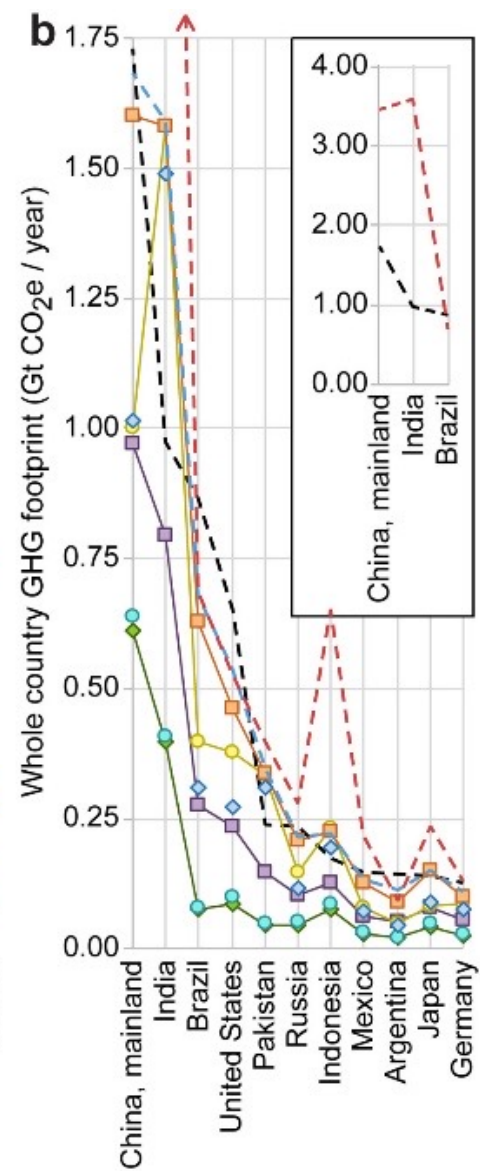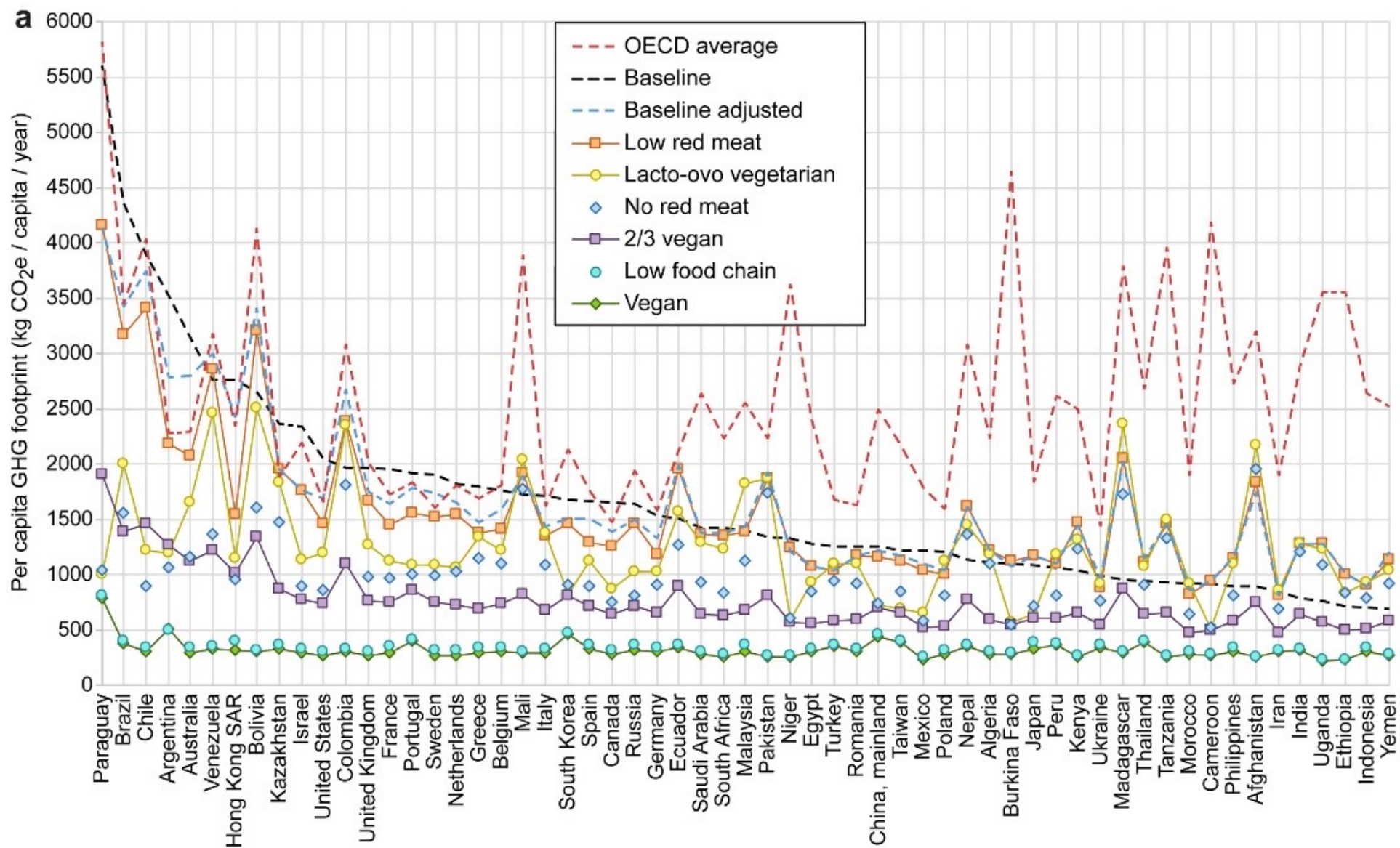
Legend:
- Cereals
- Roots and tubers
- Vegetables
- Fruits
- Dairy (milk equivalents)
- Red meat
- Chicken
- Eggs
- Fish
- Legumes
- Nuts
- Oils (added fats)
- Sugar

Country	Cereals	Roots and tubers	Vegetables	Fruits	Dairy	Red meat	Chicken	Total
United States	299 g	154 g	311 g	247 g	698 g	185 g	153 g	2,323 g
United Kingdom	324 g	253 g	227 g	245 g	613 g			2,124 g
India	506 g		219 g	158 g	291 g			1,408 g
EAT-Lancet	232 g		300 g	200 g	250 g			1,324 g
Kenya	381 g	191 g		222 g				1,181 g

Axis: 0 g — 500 g — 1,000 g — 1,500 g — 2,000 g

Source: Food and Agriculture Organization of the United Nations; EAT-Lancet Commission   OurWorldInData.org/diet-compositions • CC BY
Note: Diets by country are given as food supply – this is higher than actual intakes because it does not correct for consumer waste.

# It's what we farm, more than how we farm, that causes the environmental impact of our diet

Difference in US/UK production systems has small impact

Different consumption choices have large impacts

Legend:
- Offals
- Insects
- Nuts and seeds
- Pulses and soy
- Starchy roots
- Vegetable oils
- Sheep and goat meat
- Vegetables
- Sugars
- Poultry
- Aquatic animals
- Grains
- Eggs
- Pig meat
- Bovine meat
- Dairy

USA diet categories: Baseline, Adjusted baseline, Meatless day, Low red meat, No dairy, Vegetarian, Pescatarian, No red meat, ²/₃ vegan, Low food chain, Vegan

UK diet categories: Baseline, Adjusted baseline, Meatless day, Low red meat, No dairy, Vegetarian, Pescatarian, No red meat, ²/₃ vegan, Low food chain, Vegan

x-axis: 0, 250, 500, 750, 1000, 1250, 1500, 1750, 2000 — $khCO_2$/year

SOURCE: Kim,B.F. Santo, R.E. Scatterday, A.P. Et al. (2020). Country-specific dietary shifts to mitigate climate and water crises, Global Environmental Change, Volume 62

a

Per capita GHG footprint (kg CO₂e / capita / year)

Legend:
- OECD average
- Baseline
- Baseline adjusted
- Low red meat
- Lacto-ovo vegetarian
- No red meat
- 2/3 vegan
- Low food chain
- Vegan

Countries (x-axis): Paraguay, Brazil, Chile, Argentina, Australia, Venezuela, Hong Kong SAR, Bolivia, Kazakhstan, Israel, United States, Colombia, United Kingdom, France, Portugal, Sweden, Netherlands, Greece, Belgium, Mali, Italy, South Korea, Spain, Canada, Russia, Germany, Ecuador, Saudi Arabia, South Africa, Malaysia, Pakistan, Niger, Egypt, Turkey, Romania, China, mainland, Taiwan, Mexico, Poland, Nepal, Algeria, Burkina Faso, Japan, Peru, Kenya, Ukraine, Madagascar, Thailand, Tanzania, Morocco, Cameroon, Philippines, Afghanistan, Iran, India, Uganda, Ethiopia, Indonesia, Yemen

b

Whole country GHG footprint (Gt CO₂e / year)

Countries (x-axis): China, mainland, India, Brazil, United States, Pakistan, Russia, Indonesia, Mexico, Argentina, Japan, Germany

Inset: China, mainland; India; Brazil

For context, the College's total estimated scope 1 and 2 emissions were 2631 tCO_2e in 2018. These are harder to abate emissions that typically will require capital investment. The College's full scope 1-3 emissions profile has not been completed but typically scope 1 and 2 constitutes around 5-15% of comparable businesses. Food is likely around 1750-2250 tCO_2e per annum.
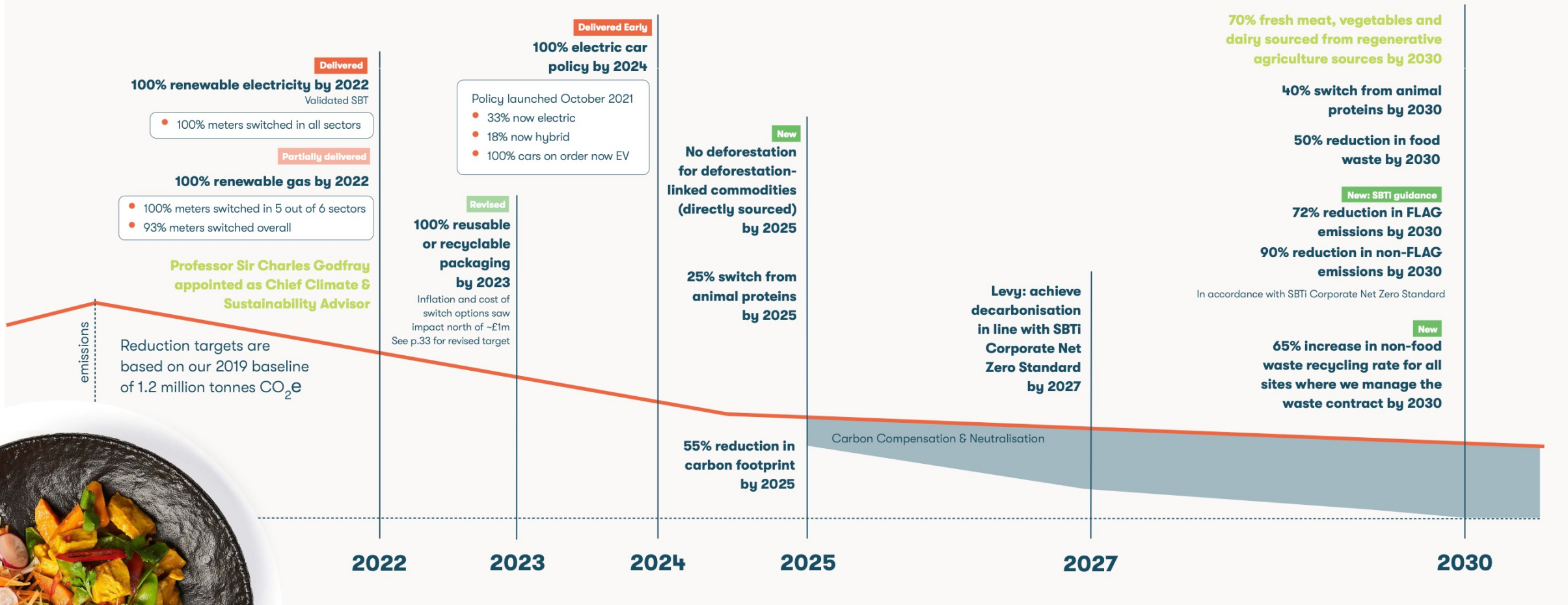
PROPORTION CO2

BEEF	71%
POULTRY	9%
LAMB	5%
PORK	15%

KG BOUGHT

BEEF	353
POULTRY	445
LAMB	63
PORK	626
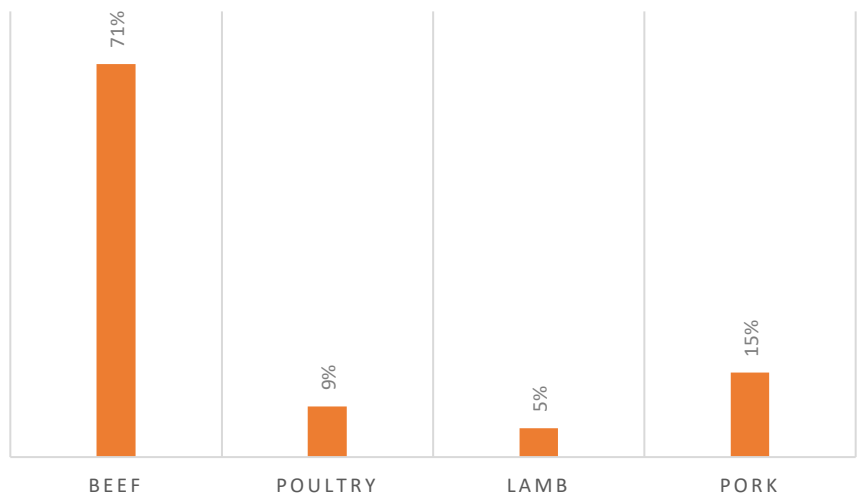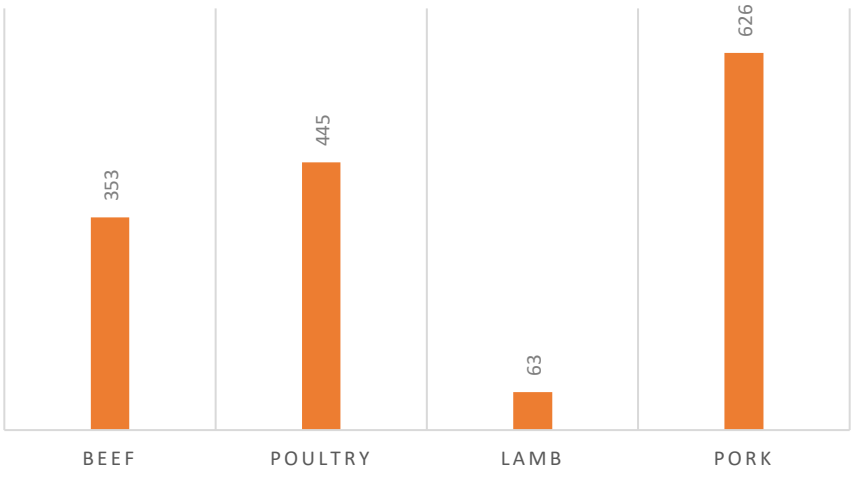
Our Roadmap

First launched in May 2021, this Roadmap is reshared here to show milestones met, target progress, and wider sustainability commitments in support of a just transition to Climate Net Zero by 2030.

Delivered

100% renewable electricity by 2022
Validated SBT

- 100% meters switched in all sectors

Partially delivered

100% renewable gas by 2022

- 100% meters switched in 5 out of 6 sectors
- 93% meters switched overall

Professor Sir Charles Godfray appointed as Chief Climate & Sustainability Advisor

emissions

Reduction targets are based on our 2019 baseline of 1.2 million tonnes CO_2e

Revised

100% reusable or recyclable packaging by 2023
Inflation and cost of switch options saw impact north of ~£1m
See p.33 for revised target

Delivered Early

100% electric car policy by 2024

Policy launched October 2021
- 33% now electric
- 18% now hybrid
- 100% cars on order now EV

New

No deforestation for deforestation-linked commodities (directly sourced) by 2025

25% switch from animal proteins by 2025

55% reduction in carbon footprint by 2025

Carbon Compensation & Neutralisation

Levy: achieve decarbonisation in line with SBTi Corporate Net Zero Standard by 2027

70% fresh meat, vegetables and dairy sourced from regenerative agriculture sources by 2030

40% switch from animal proteins by 2030

50% reduction in food waste by 2030

New: SBTi guidance

72% reduction in FLAG emissions by 2030

90% reduction in non-FLAG emissions by 2030
In accordance with SBTi Corporate Net Zero Standard

New

65% increase in non-food waste recycling rate for all sites where we manage the waste contract by 2030

2022   **2023**   **2024**   **2025**   **2027**   **2030**

Other sustainability commitments

2
3

Table TS.6 Assessment of food system policies targeting (post-farm gate) food chain actors and consumers

	Level	Transformative potential	Environ. effective.	Feasibility	Distributional effects	Cost	Co-benefits[a] and adverse side-effect	Implications for coordination, coherence and consistency in policy package[b]
Integrated food policy packages	**NL**				**can be controlled**	**Cost efficient**	**+ balanced, addresses multiple sustainability goals**	Reduces cost of uncoordinated interventions; increases acceptance across stakeholders and civil society *(high confidence)*.
Taxes on food products	GN				regressive	low[#1]	- unintended substitution effects	High enforcing effect on other food policies; higher acceptance if compensation or hypothecated taxes *(medium evidence, high agreement)*.
GHG taxes on food	GN				regressive	low[#2]	-unintended substitution effects +high spillover effect	Supportive, enabling effect on other food policies, agricultural/fishery policies; requires changes in power distribution and trade agreements *(medium confidence)*.
Trade policies	G				impacts global distribution	complex effects	+ counters leakage effects +/- effects on market structure and jobs	Requires changes in existing trade agreements *(medium evidence, high agreement)*.
Investment into research & innovation	GN				none	medium	+ high spillover effect + converging with digital society	Can fill targeted gaps for coordinated policy packages (e.g. monitoring methods) *(high confidence)*.
Food and marketing regulations	N					low		Can be supportive; might be supportive to realise innovation; voluntary standards might be less effective *(medium confidence)*.
Organisational level procurement policies	NL					low	+ can address multiple sustainability goals	Enabling effect on other food policies; reaches large share of population *(medium evidence, high agreement)*.
Sustainable food-based dietary guidelines	GNL				none	low	+ can address multiple sustainability goals	Little attention so far on environmental aspects; can serve as benchmark for other policies (labels, food formulation standards, etc.) *(medium confidence)*.
Food labels/ information	GNL				education level relevant	low	+ empowers citizens + increases awareness + multiple objectives	Effective mainly as part of a policy package; incorporation of other objectives (e.g., animal welfare, fair trade...); higher effect if mandatory *(medium confidence)*.
Nudges	NL				none	low	+ possibly counteracting information deficits in population subgroups	High enabling effect on other food policies *(medium evidence, high agreement)*.

4
5 **Color code**: **Effect of measures:** negative ▮, none/unclear ▮, slightly positive ▮, positive ▮; **Level**: G: global/multinational, N: national, L: local; **#1** Minimum level
6 to be effective 20% price increase; **#2** Minimum level to be effective 50-80 USD tCO_2-eq^{-1}.
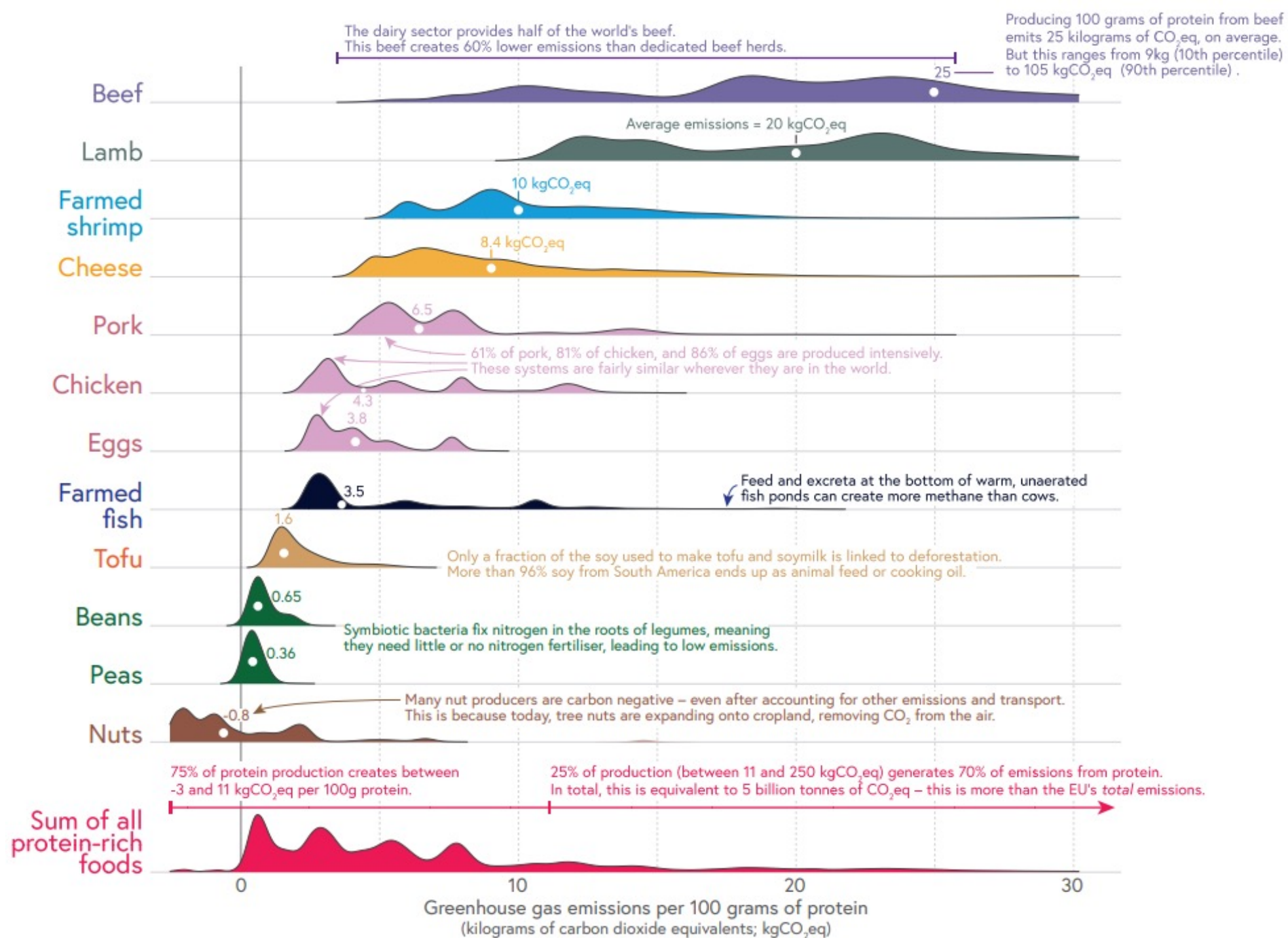7 **a.** In addition, all interventions are assumed to address health and climate change mitigation.
8 **b.** Requires coordination between policy areas, participation of stakeholders, transparent methods and indicators to manage trade-offs and prioritisation between possibly
9 conflicting objectives; and suitable indicators for monitoring and evaluation against objectives. {Table 12.9}
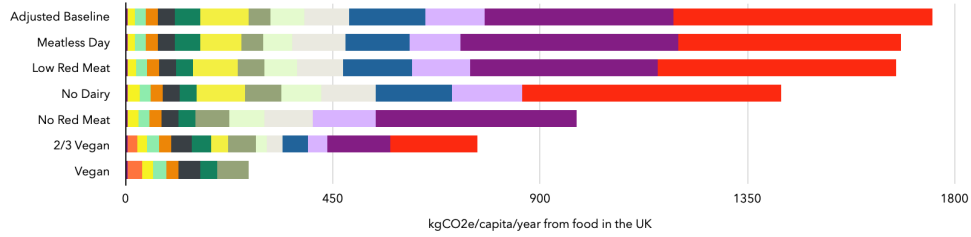
The dairy sector provides half of the world's beef.
This beef creates 60% lower emissions than dedicated beef herds.

Producing 100 grams of protein from beef emits 25 kilograms of CO_2eq, on average. But this ranges from 9kg (10th percentile) to 105 kgCO_2eq (90th percentile).

Beef
25

Lamb
Average emissions = 20 kgCO_2eq

Farmed shrimp
10 kgCO_2eq

Cheese
8.4 kgCO_2eq

Pork
6.5

61% of pork, 81% of chicken, and 86% of eggs are produced intensively.
These systems are fairly similar wherever they are in the world.

Chicken
4.3

Eggs
3.8

Farmed fish
3.5

Feed and excreta at the bottom of warm, unaerated fish ponds can create more methane than cows.

Tofu
1.6

Only a fraction of the soy used to make tofu and soymilk is linked to deforestation. More than 96% soy from South America ends up as animal feed or cooking oil.

Beans
0.65

Symbiotic bacteria fix nitrogen in the roots of legumes, meaning they need little or no nitrogen fertiliser, leading to low emissions.

Peas
0.36

Many nut producers are carbon negative – even after accounting for other emissions and transport. This is because today, tree nuts are expanding onto cropland, removing CO_2 from the air.

Nuts
-0.8

75% of protein production creates between -3 and 11 kgCO_2eq per 100g protein.

25% of production (between 11 and 250 kgCO_2eq) generates 70% of emissions from protein. In total, this is equivalent to 5 billion tonnes of CO_2eq – this is more than the EU's *total* emissions.

Sum of all protein-rich foods

0   10   20   30

Greenhouse gas emissions per 100 grams of protein
(kilograms of carbon dioxide equivalents; kgCO_2eq)

HOW TO CHANGE YOUR DIET

Adjusted Baseline
Meatless Day
Low Red Meat
No Dairy
No Red Meat
2/3 Vegan
Vegan

0   450   900   1350   1800

kgCO2e/capita/year from food in the UK

WHY?

Changing how you eat is one of the biggest things you can do for the Climate and your health. Here's why:

- It's big: **21-37% of global emissions** are caused by the food system.

- It's healthy: **eating processed meat caused 130,000 additional deaths** in 2017.

- It's impactful: just by changing your diet, **you could reduce your emissions from food by 84%**.

- School have made it easy to change your diet at WinColl.

At WinColl, **our diets emit up to 210% of the national average**, and the UK is already 13th worst in the world in terms of per capita food emissions. We should be among the first to transition.

SOURCES

21-37% of global emissions: IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems.
Processed meats (anything salted, cured, fermented, smoked, etc.): *GBD (Global Burden of Disease) 2017 Risk Factor Collaborators.*
Graph & …from food by 84%: *Kim et al. (2019)*

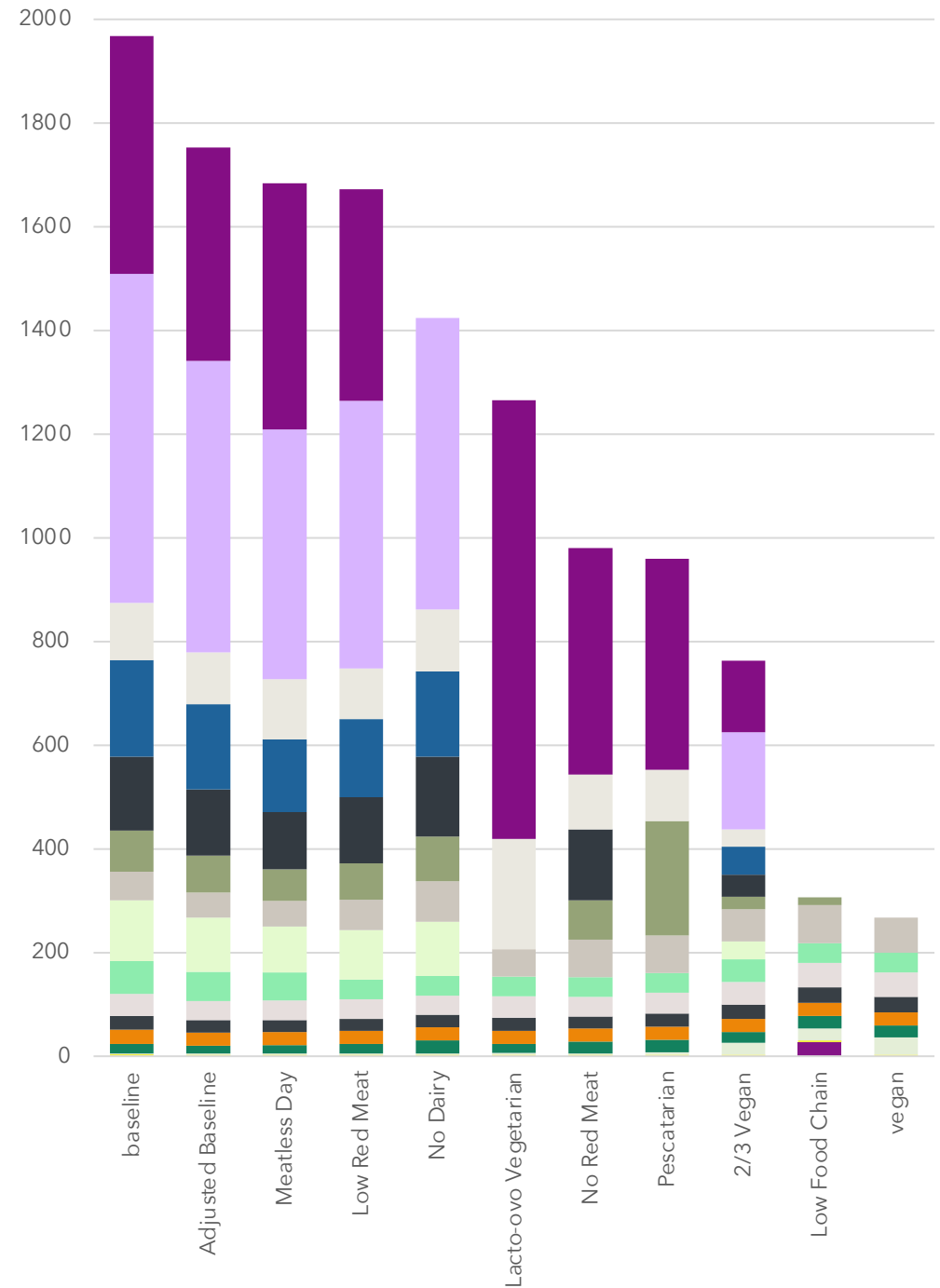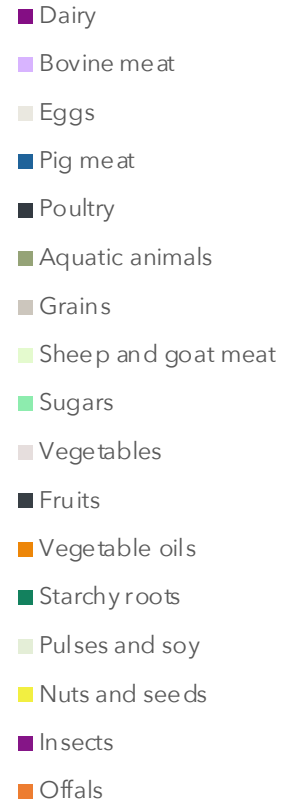For full sources, see *climatesoup.co.uk/20230423-foodposter/* .

HOW?

Here are the options we've had confirmation from Chartwells and Mr Leicester-Thackara (COO) are possible:

1. **Going completely vegetarian/ vegan.**

2. **Switching just lunches/dinners to veggie/vegan.**
   This allows people to reduce meat consumption without making a completely binary choice.

3. **Switching red meat for white meat.**
   You can ask not to have red meat and get white meat (instead of veggie food). For such a small change, this is really impactful.

4. **No meat at breakfast.**
   No one really eats this much meat for breakfast at home right?

Any of your housemaster, matron, or head chef should be able to help you if you ask. Your parents may be asked to confirm the change.

If you have any concerns or would like help, email sgs2@Wincoll.ac.uk, AIC@wincoll.ac.uk, or O_Mitcham@wincoll.ac.uk.

Key: bovine meat, dairy, poultry, pig meat, eggs, aquatic animals, grains, sheep and goat meat, sugars, vegetables, vegetable oils, fruits, starchy roots, pulses and soy, nuts and seeds (right to left).

Legend:
- Dairy
- Bovine meat
- Eggs
- Pig meat
- Poultry
- Aquatic animals
- Grains
- Sheep and goat meat
- Sugars
- Vegetables
- Fruits
- Vegetable oils
- Starchy roots
- Pulses and soy
- Nuts and seeds
- Insects
- Offals

baseline, Adjusted Baseline, Meatless Day, Low Red Meat, No Dairy, Lacto-ovo Vegetarian, No Red Meat, Pescatarian, 2/3 Vegan, Low Food Chain, vegan

Key points

- Read our report in the Sust soc OneNote or a summary here: climatesoup.co.uk/food/review/2022/03/27/food-comic.html
- Food is hard to decarbonise supply-side, and has a lot of potential for demand-side changes.
- Wincoll is especially carbon intensive within the UK, and the UK is especially carbon intensive within the world.
- It is possible to obtain necessary nutrition on veggie or vegan diet, although of course it requires some effort.
- Eating less meat has other knock on effects, e.g. in improving biodiversity and restoring habitats.