Reducing the Footprint through Alternative Diets

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Overview

- Why consider diets as a means to reduce environmental impacts?
- Average U.S. diet compared to:
  - *Dietary Guidelines* recommended food patterns
    - Omnivorous, Vegetarian, Vegan
- Individual, self-selected U.S. diets

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Production-side improvements will be insufficient to meet 2°C climate targets

- Seen in repeated projection studies:
  - Hedenus et al., 2014, *Climate Change*
  - Bajzelj et al., 2014, *Nature Climate Change*
  - Bryngelsson et al., 2016, *Food Policy*
  - Bennetzen et al., 2016, *Global Change Biology*

- Demand-side reductions are also necessary!
  - Reduced meat and dairy consumption
  - Reduced food waste

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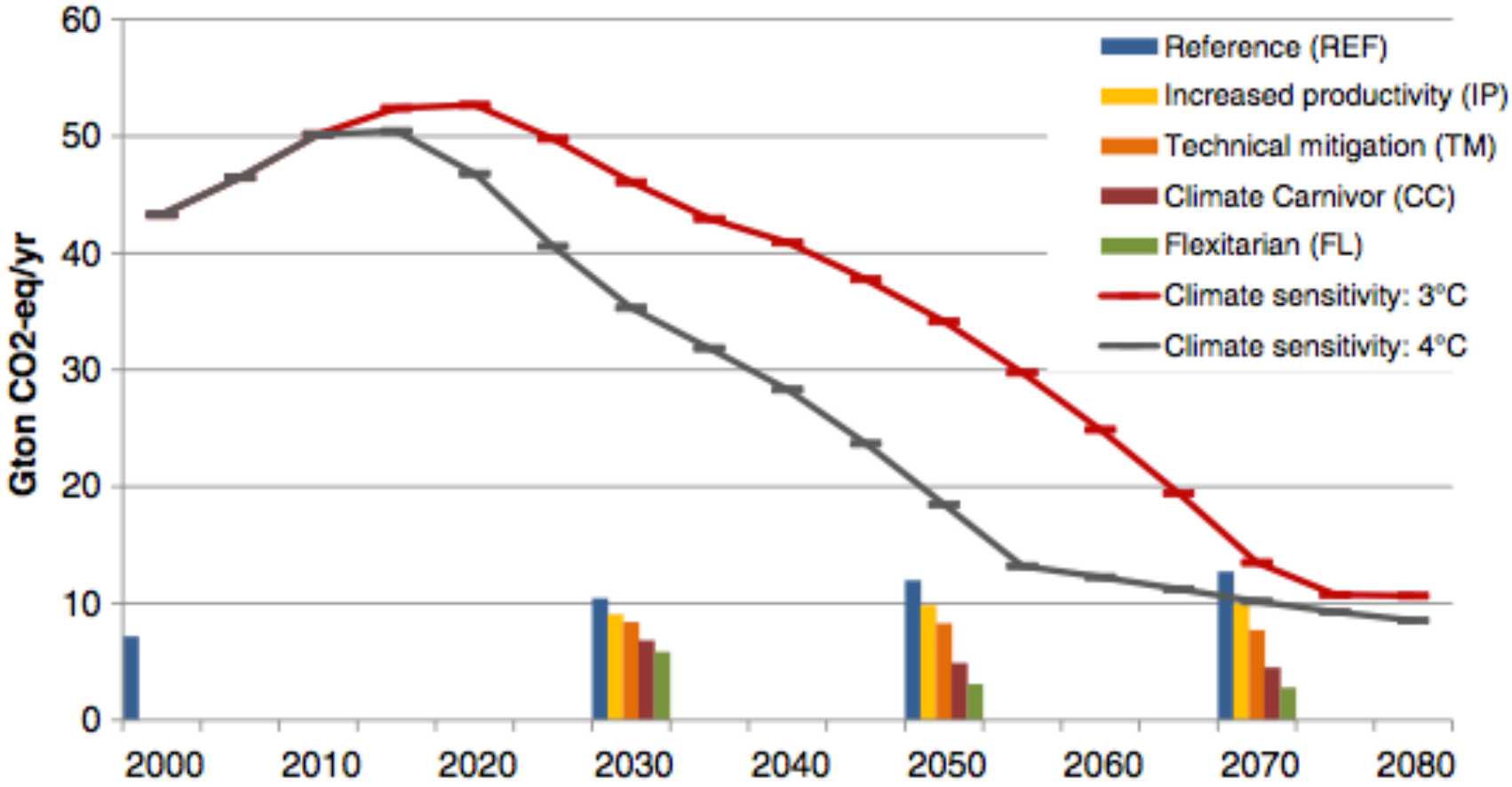
Production-side improvements will be insufficient to meet 2°C climate targets



Source: Hedenus et al., 2014, *Climate Change*

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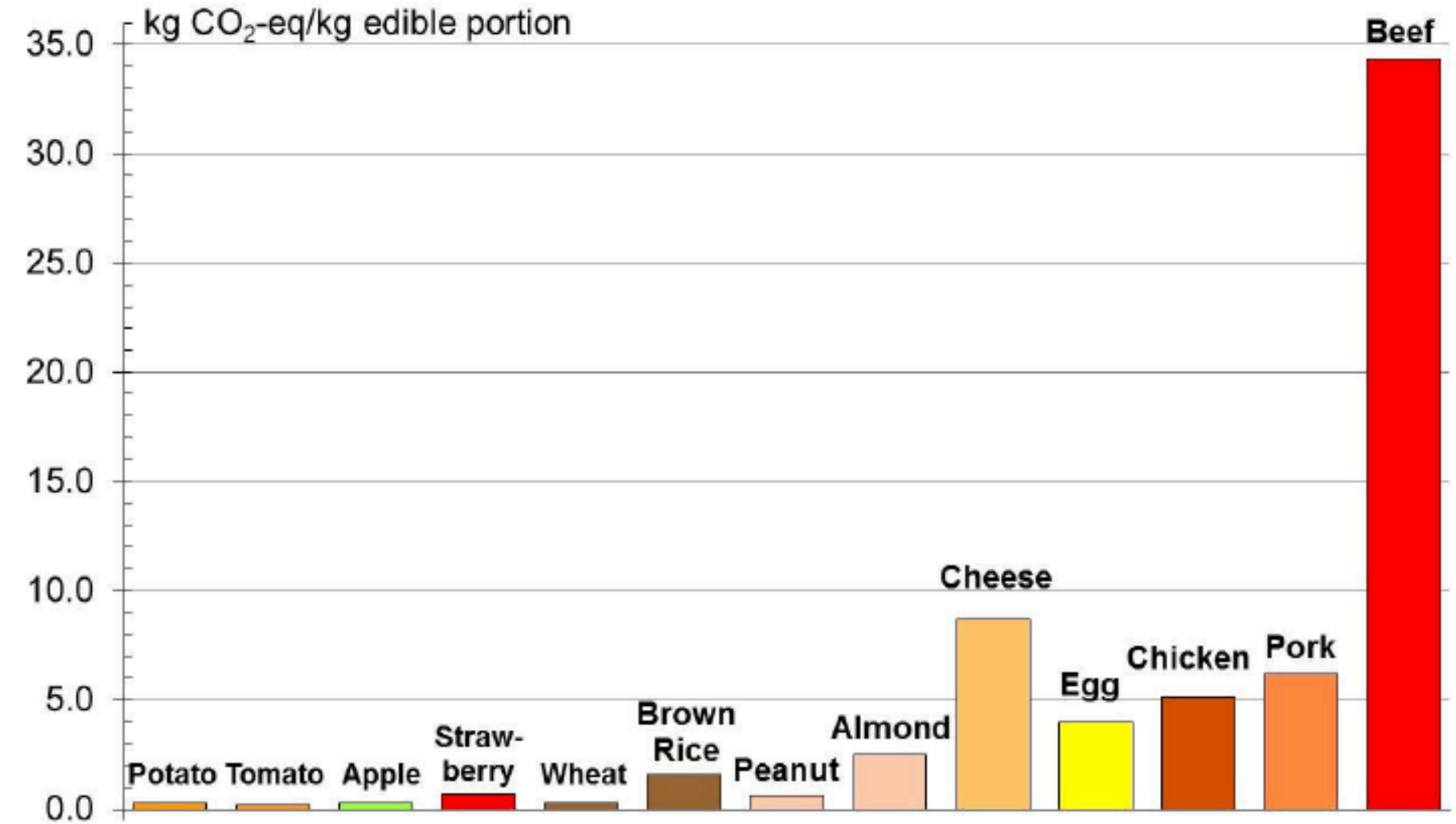
Greenhouse gas emissions (GHGE) from the production of foods varies by food type



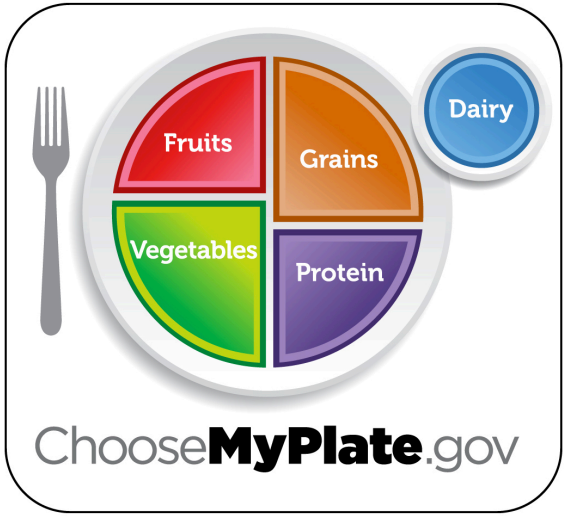
Source: Rose, Heller, Roberto, *J Nutr Educ Behavior*, in press

What would happen if U.S. shifted to recommended diet?

- Heller, M. C.; Keoleian, G. A., (2015) “Greenhouse Gas Emission Estimates of U.S. Dietary Choices and Food Loss”. *Journal of Industrial Ecology*

- Used USDA’s Loss Adjusted Food Availability dataset (2010) as proxy for current diet;
  - average per capita caloric intake = 2534 Calories

- Compared against *2010 Dietary Guidelines for Americans* food patterns at 2534 and 2000 Calories



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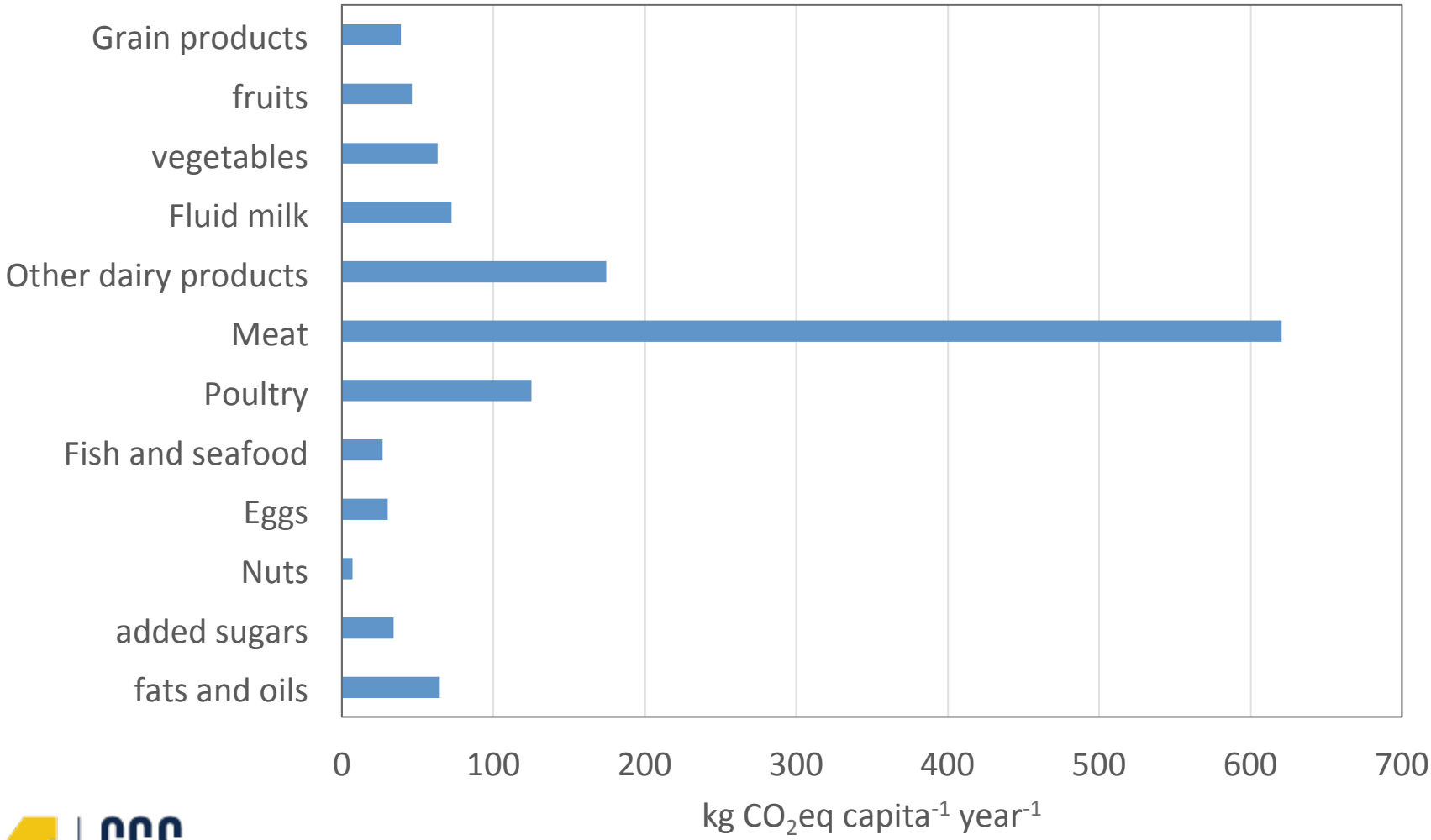
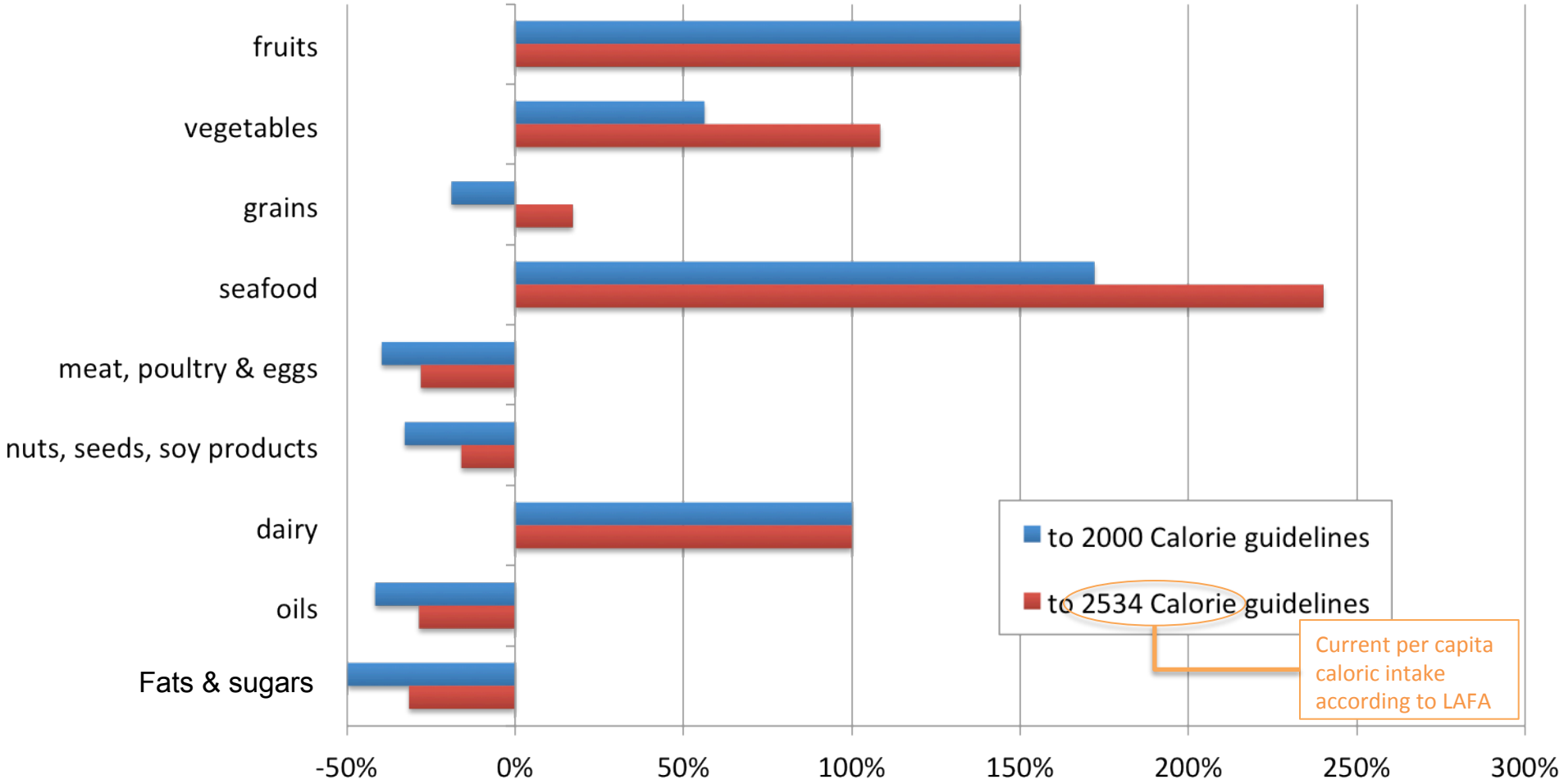
GHGE of "average US diet"
according to Loss Adjusted Food Availability



Source: Heller & Keoleian (2015) *J Ind Ecol*

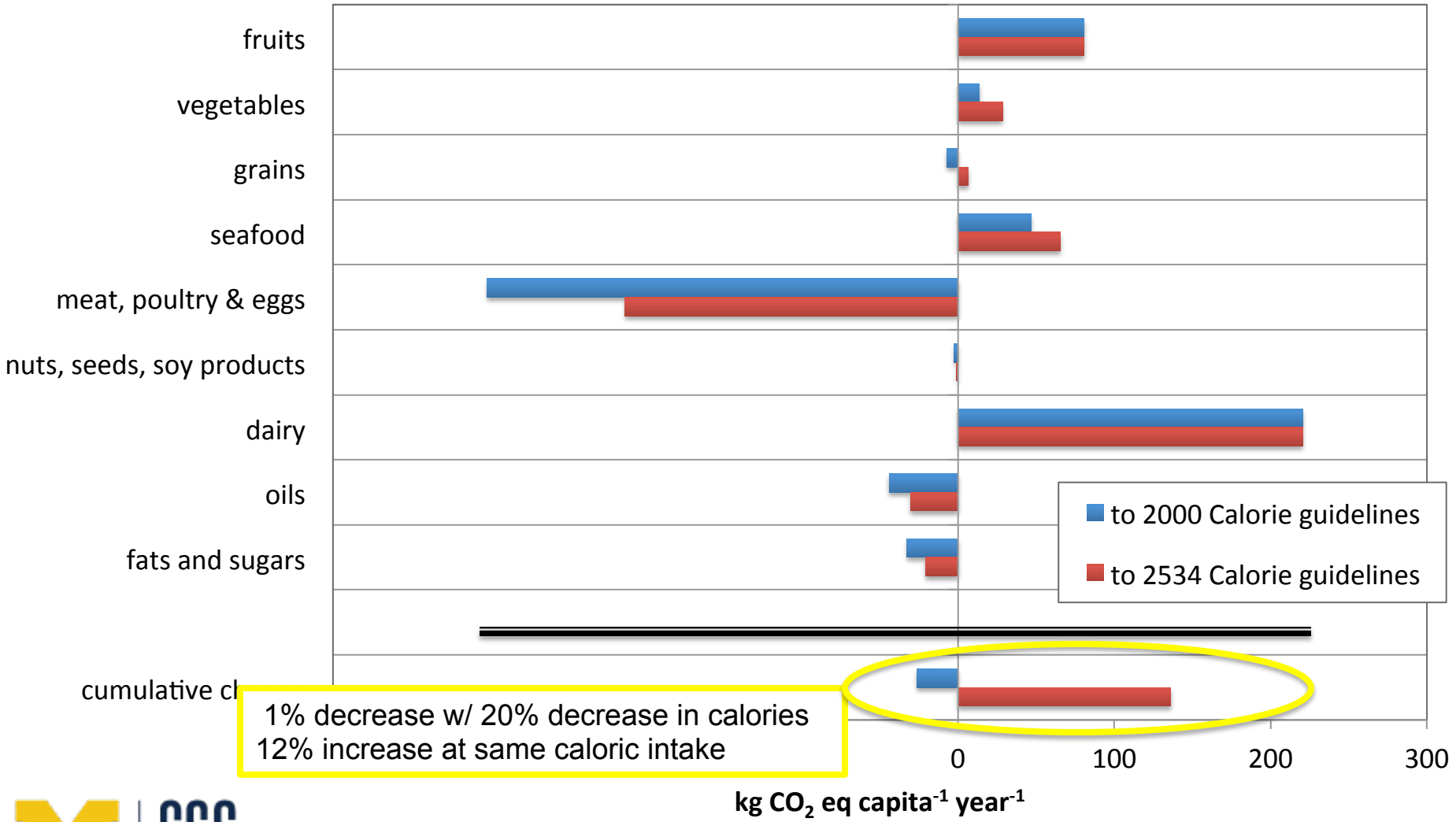
Changes from current diet necessary to meet 2010 Guidelines



←decreased consumption Increased consumption→

Source: Heller & Keoleian (2015) *J Ind Ecol*

Changes in annual GHGE when shifting from current diet to Guidelines



Source: Heller & Keoleian (2015) *J Ind Ecol*

Dietary guidelines (@2000 Calorie intake): omnivore, vegetarian, vegan, Harvard's Healthy Eating Plate

	kg CO_2eq capita^{-1} day^{-1}	**Reduction from current average diet**
2010 Dietary Guidelines Omnivorous	3.6	1%
Lacto-ovo vegetarian	2.4	33%
Vegan	1.7	53%
Harvard's Healthy Eating Plate*	2.4	33%

*relative to omnivorous DGA:

more:
whole grains
fish, poultry, beans and nuts
poly unsaturated fatty acids

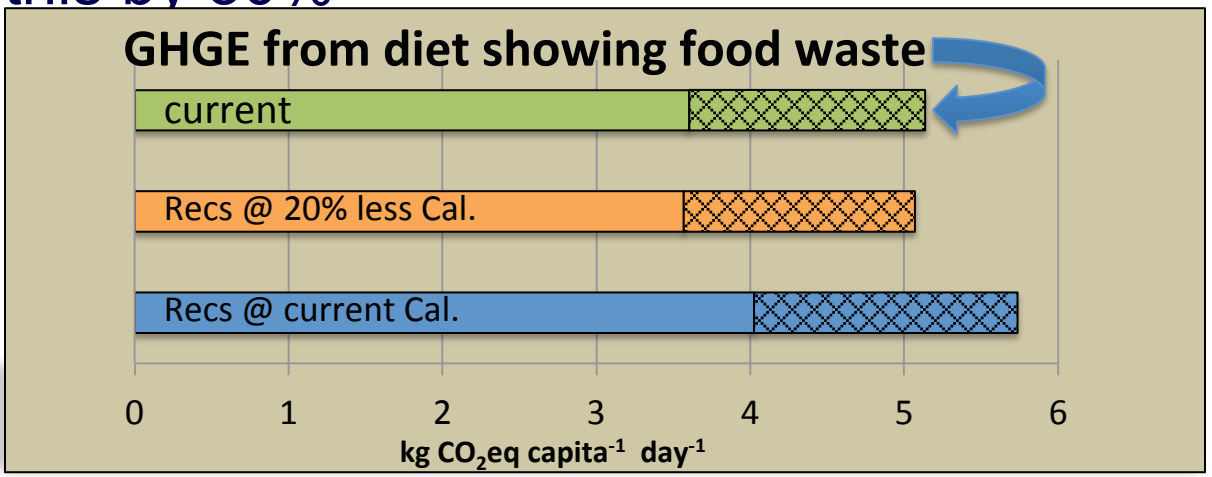
less:
refined grains
red meat and processed meat
sugar-sweetened beverages
dairy

Source: Heller & Keoleian (2015) *J Ind Ecol*
Heller & Keoleian LCAFood 2014 conf.

GHG impacts of food waste

- 1/3 of total U.S. diet-related emissions are from producing food wasted at retail and by consumers
- Equivalent to annual tailpipe emissions from 33 million average passenger vehicles

  (US EPA GHG equivalencies calculator)
- Adding GHGE associated with landfilling all food losses increases this by 30%



Source: Heller & Keoleian (2015)

Energy use and blue water footprint for current and recommended U.S. diets

- Different approach to estimating current caloric intake
- Also consider fossil energy use and (irrigation) water use
- A shift to a recommended food mix and caloric intake would increase:
  - GHGE by 6%,
  - Energy use by 38%
  - Water use by 10%

(Tom et al. 2016 *Environment Systems & Decisions*)

Carrying capacity of U.S. agricultural land under varying diet scenarios

- Carrying capacity = number of persons that can be fed with U.S. agricultural lands
- Current consumption (baseline) = USDA Loss Adjusted Food Availability.
- Combines average crop yields and livestock rations to determine land requirements
- Current carrying capacity = 130% of 2010 population

Shift to average diet based on 2010 Dietary Guidelines:	carrying capacity (% of 2010 pop.)
100% omnivorous	136%
80% omnivorous, 20% lacto-ovo veg.	178%
20% omnivorous, 80% lacto-ovo veg.	249%
100% lacto-ovo vegetarian (no meat)	255%
100% lacto-vegetarian (no eggs)	261%
100% vegan (no animal products)	238%

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(Peters et al. 2016, *Elementa*)

Greenhouse gas emissions and energy use associated with production of individual self-selected US diets

- Individual-level data allows for:
  - Linkage with demographics within a population
  - Better understanding of relationship between environmental impact and health outcomes
  - More nuanced modeling of dietary change policies

Heller, Willits-Smith, Meyer, Keoleian and Rose (2018) *Environ. Res. Lett.* 13 044004

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Approach

NHANES
(National Health and Nutrition Examination Survey)

2005-2010

16,800 individuals
(18+ years of age)
>7000 as-consumed food items

Food Environmental Impact DB
Populated with literature-based emission factors

Primarily food commodity basis

Approach

NHANES
(National Health and Nutrition Examination Survey)
2005-2010

16,800 individuals
(18+ years of age)
>7000 as-consumed food items

FCID
(Food Commodities Intake Database)

332 food commodities

Food Environmental Impact DB
Populated with literature-based emission factors

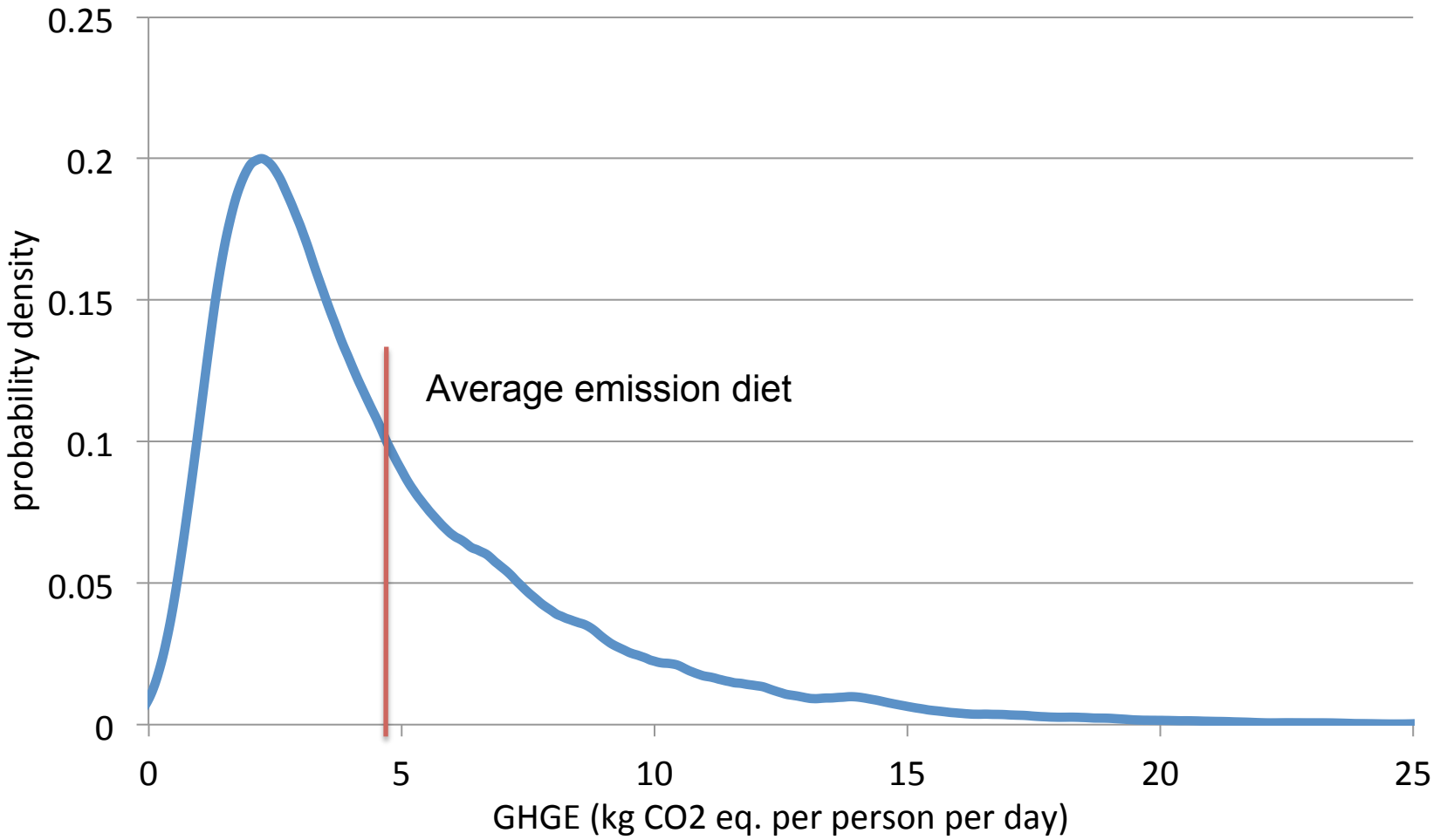
dataFIELD = **data**base of **F**ood **I**mpacts on the **E**nvironment for **L**inking to **D**iets

Results at the mean of population

		Consumed		Food loss contributions		Consumed + all losses	
		Mean	SE	Retail losses	Consumer losses	Mean	SE
GHGE (kg CO_2 eq. per capita)	per day	3.6	0.04	0.3	0.9	4.7	0.05
	per 1000 kcal	1. 7	0.01	0.1	0.4	2.2	0.02
Energy Demand (MJ per capita)	per day	18.9	0.2	1.4	4. 9	25.2	0.3
	per 1000 kcal	8.9	0.07	0.7	2.4	12.0	0.1

Source: Heller, Willits-Smith, Meyer, Keoleian and Rose (2018) *Environ. Res. Lett.* 13 044004

Distribution of GHGE from production of nationally representative 1-day diets



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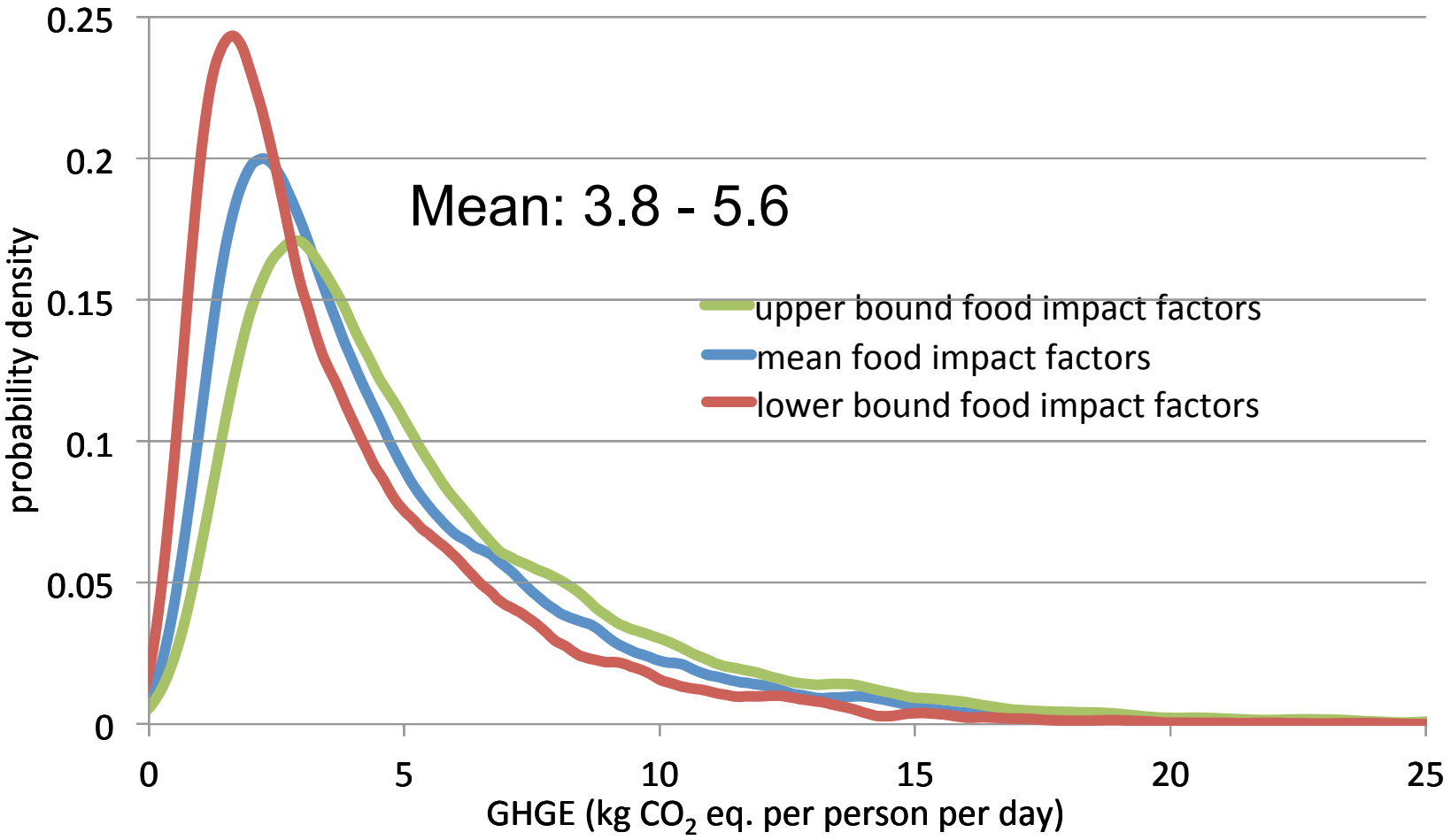
Distribution, showing food impact factor variability



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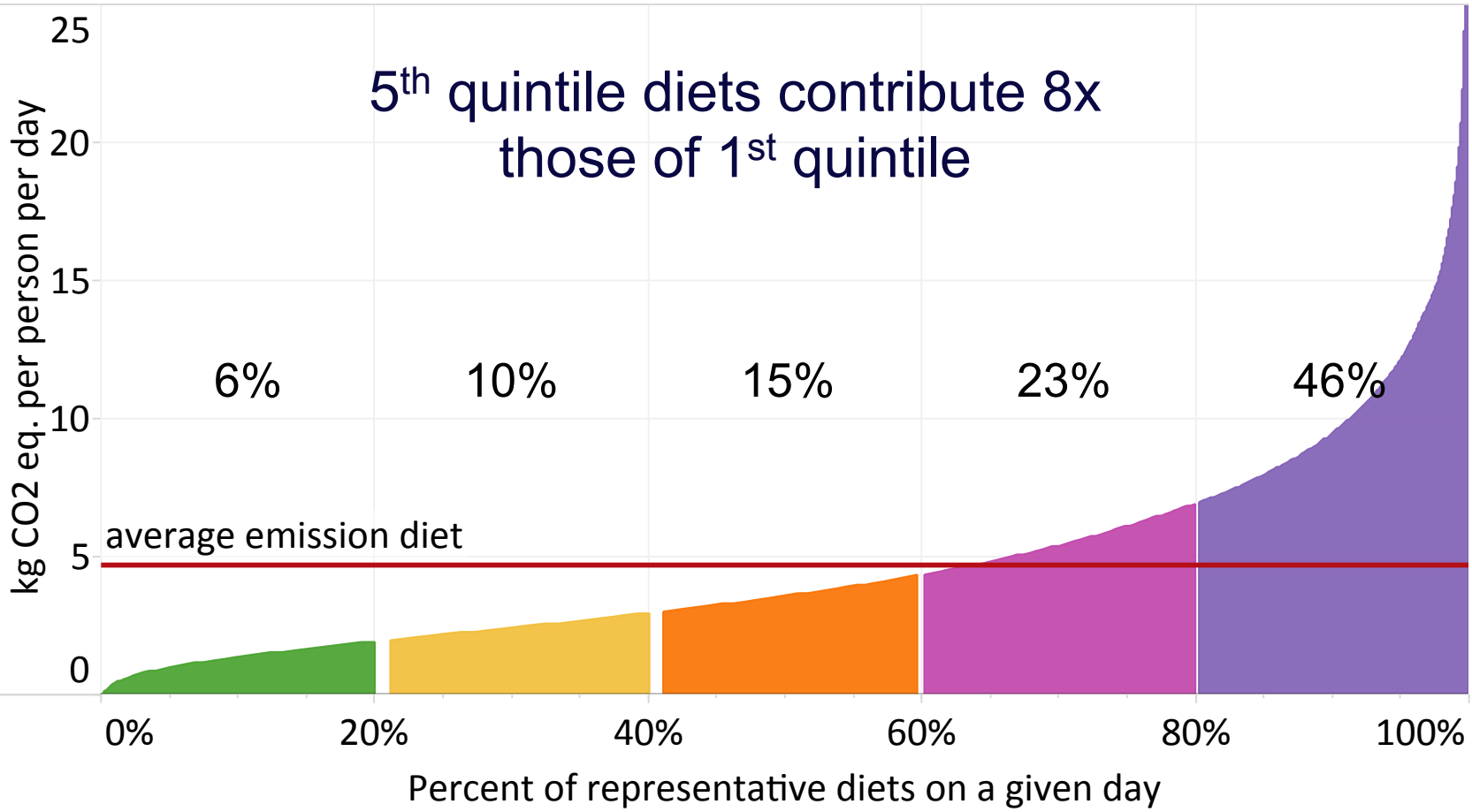
Cumulative emission intensity of U.S. one-day diets, divided into quintiles



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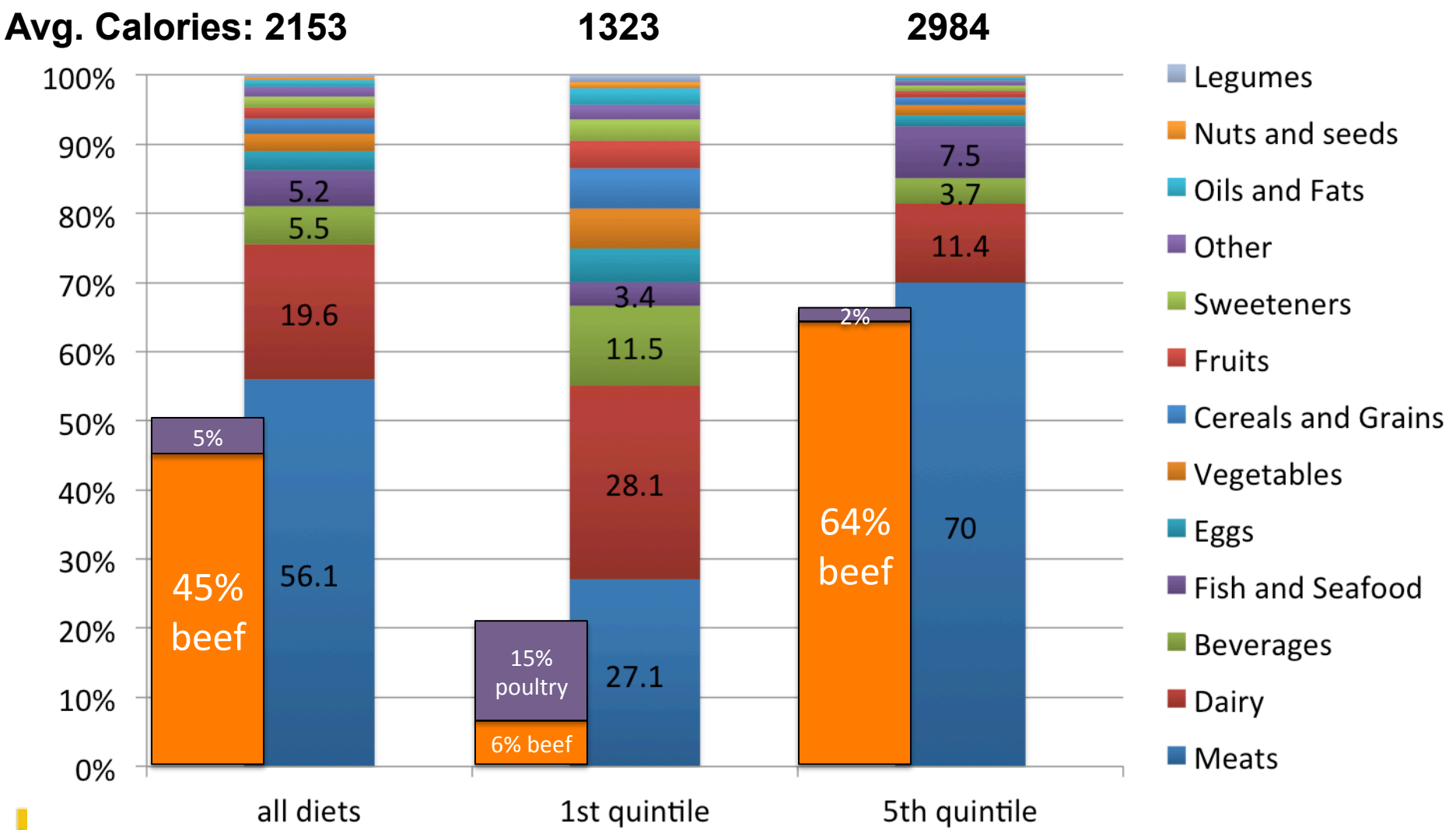
Percent contributions from food groups to total GHGE



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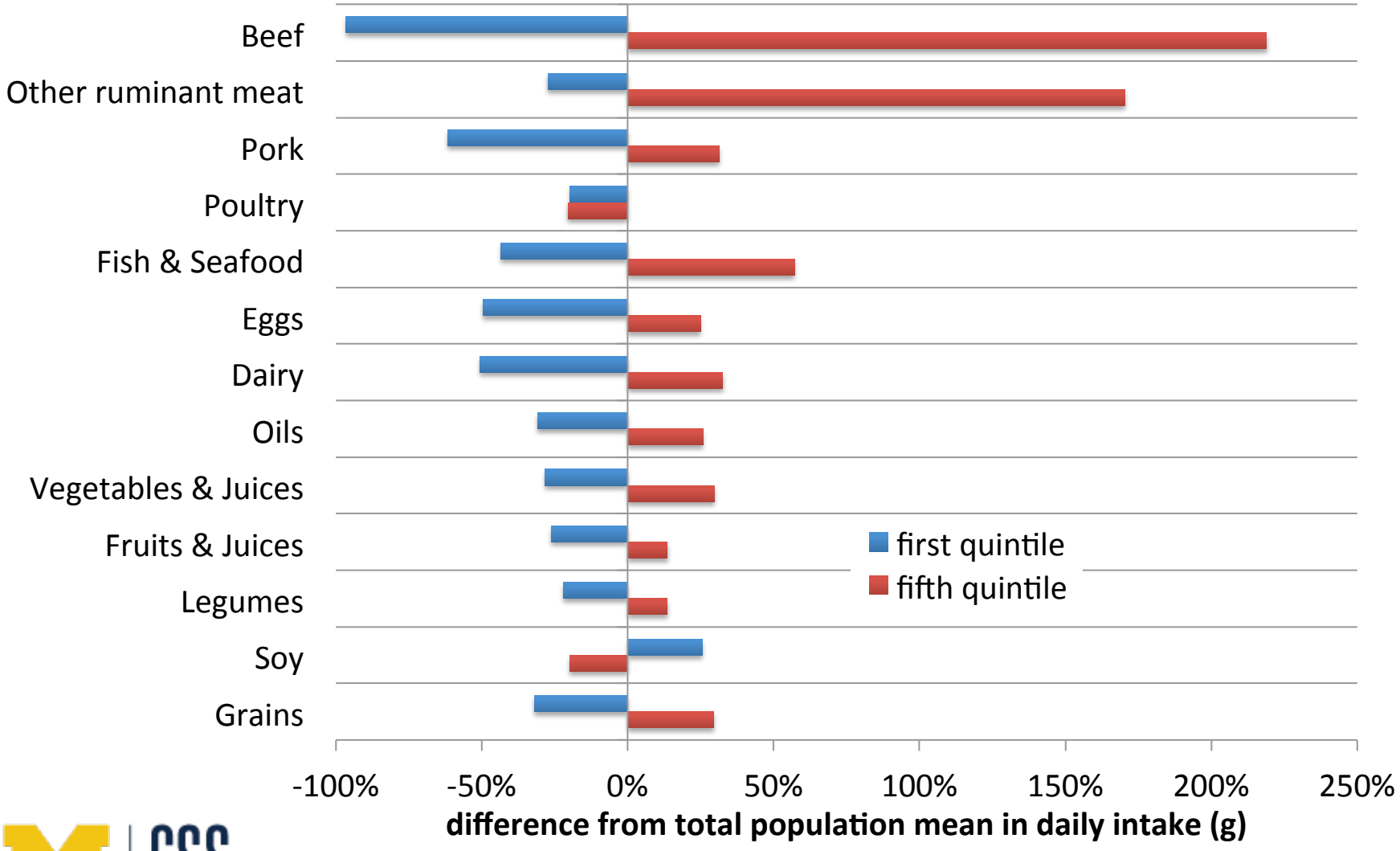
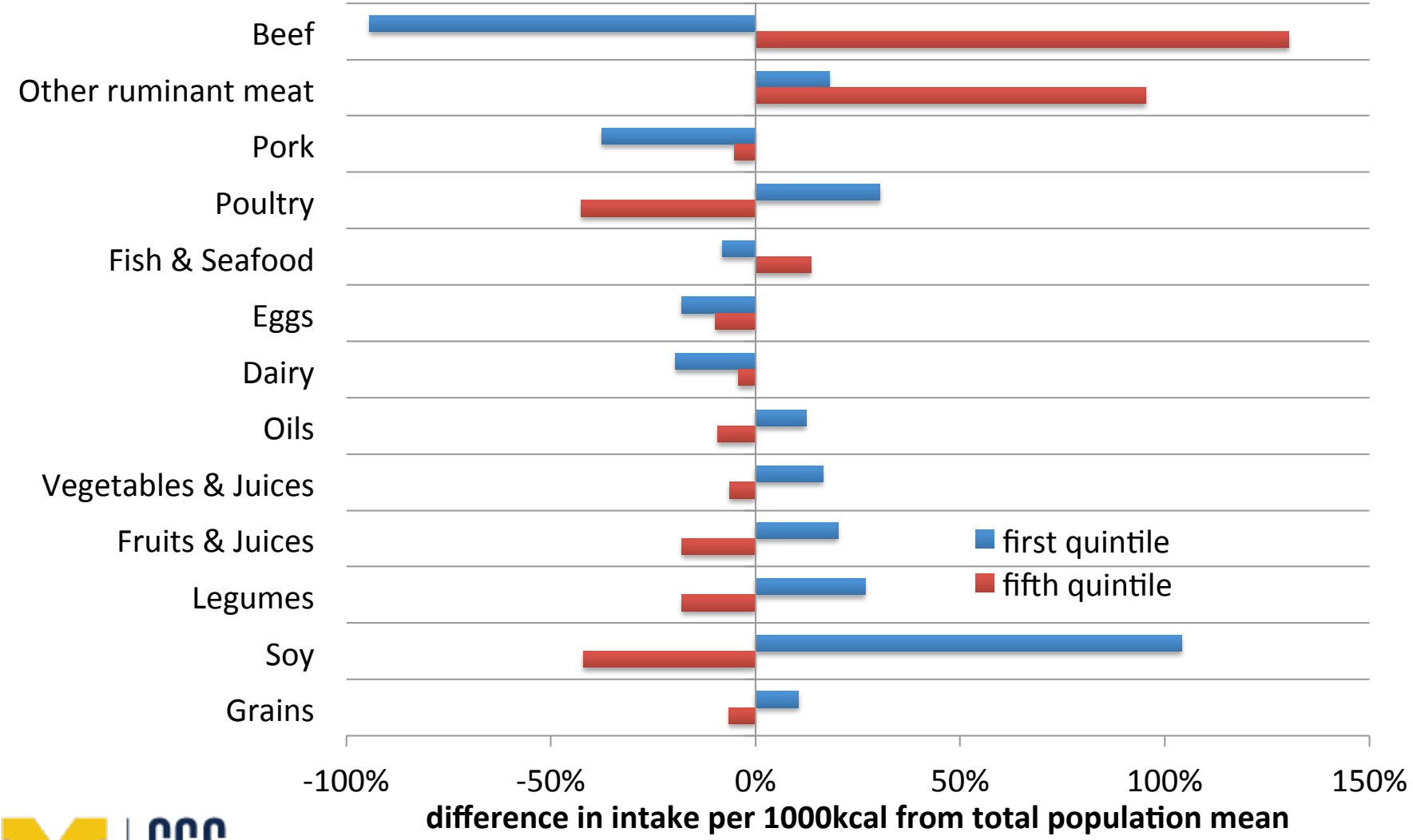
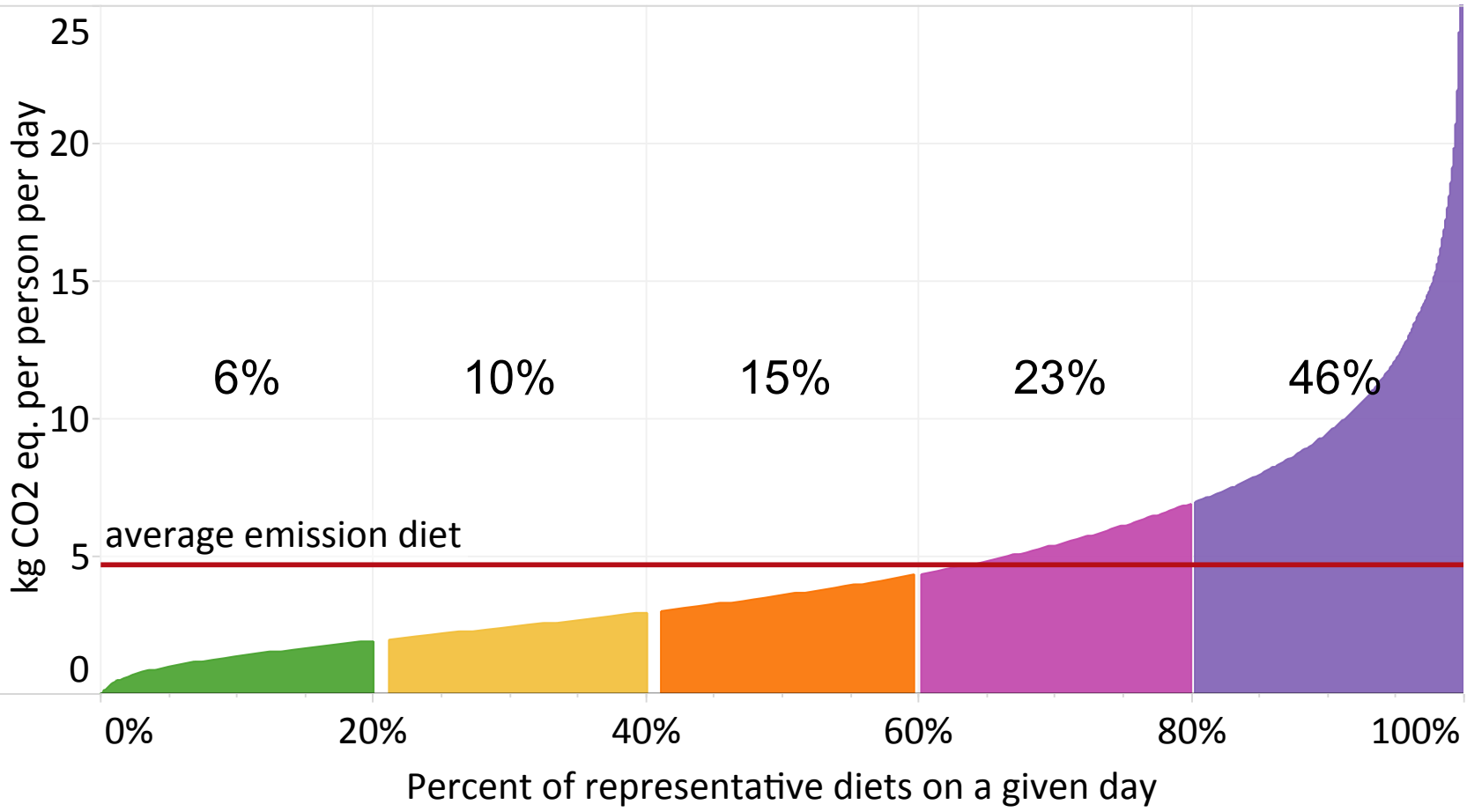
Food intake of “Low” and “High” emission diets relative to average intake



Food intakes per 1000 kcal of “low” and “high” emission diets



Hypothetical diet shift:



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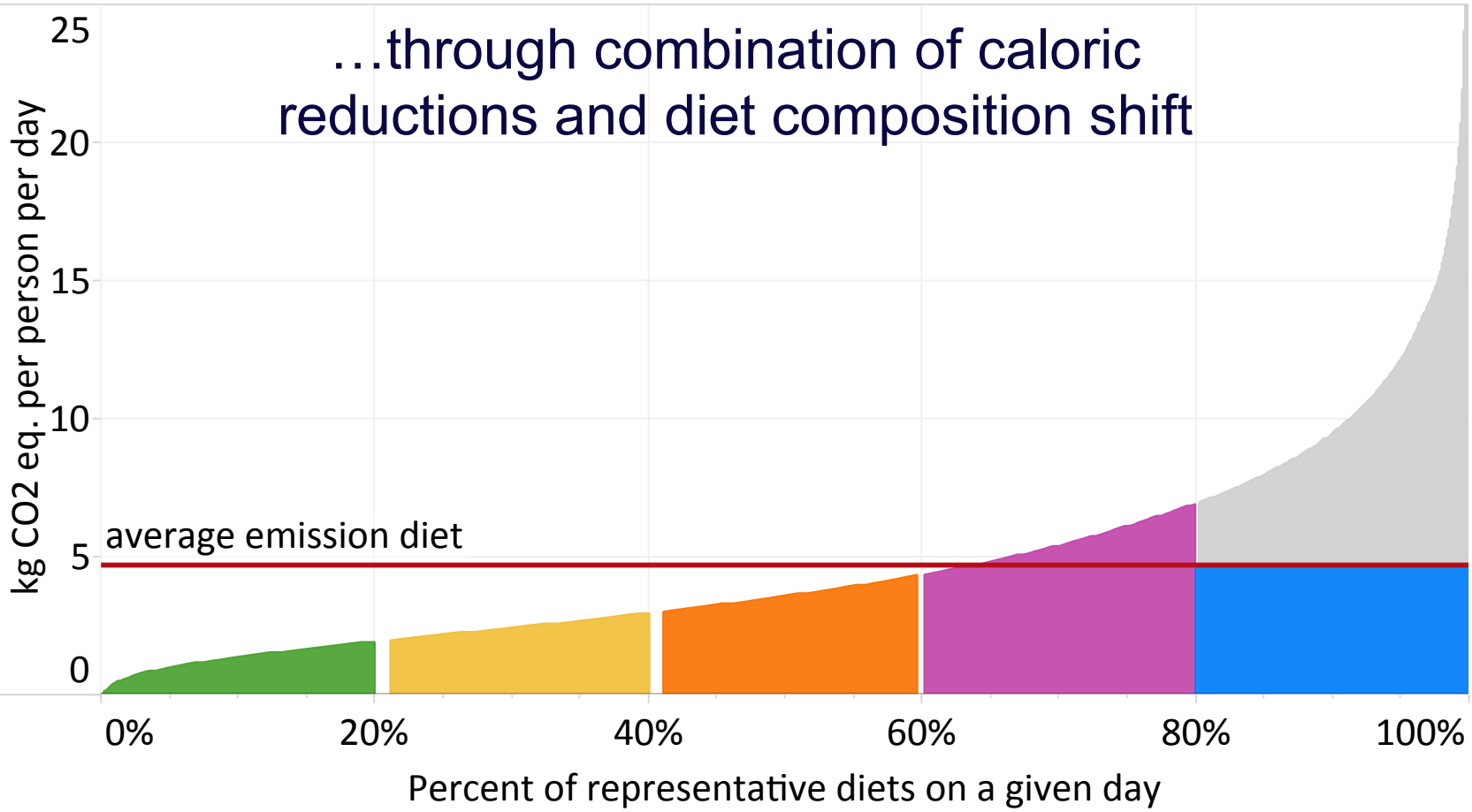
Hypothetical diet shift: top quintile to "average emission diet"



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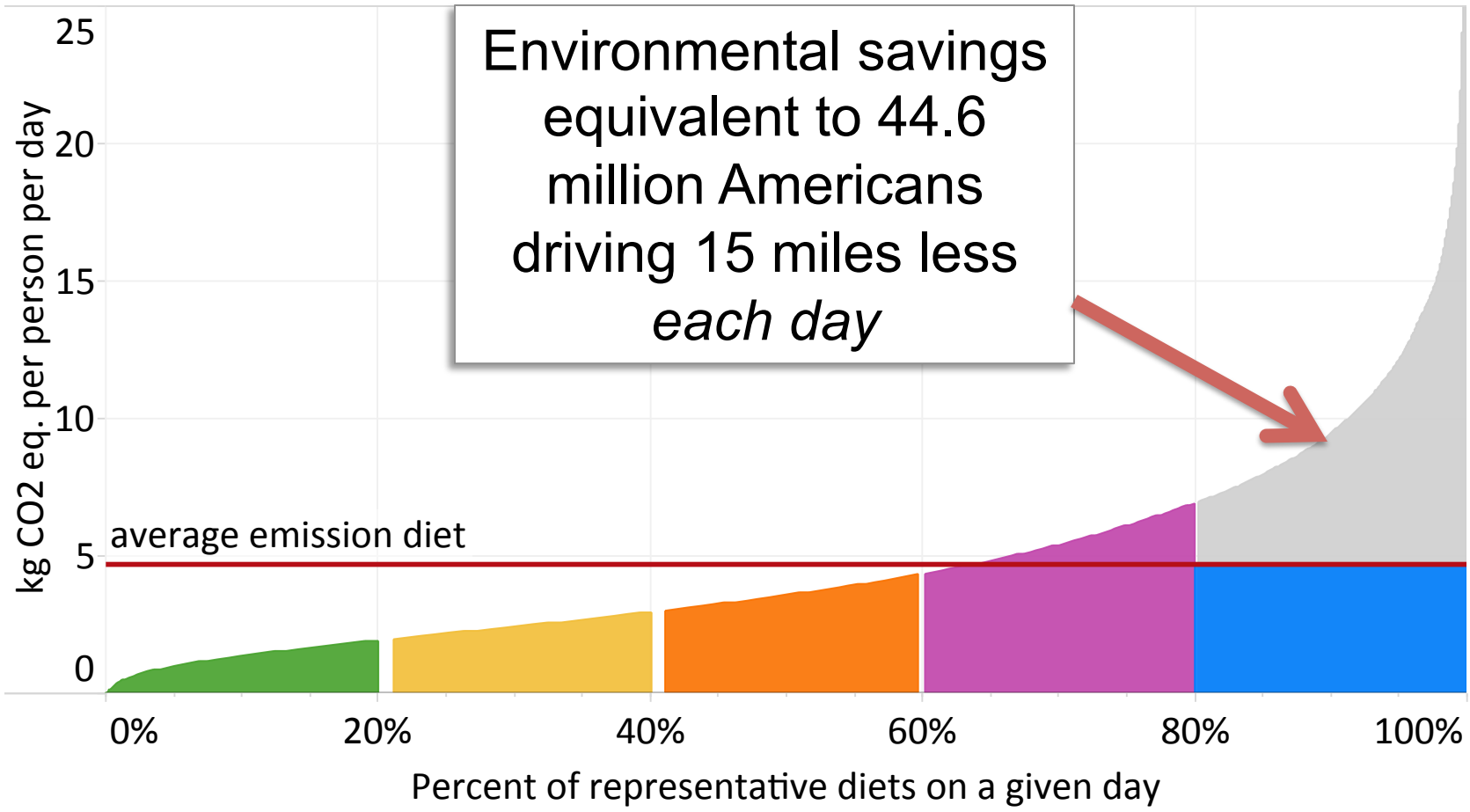

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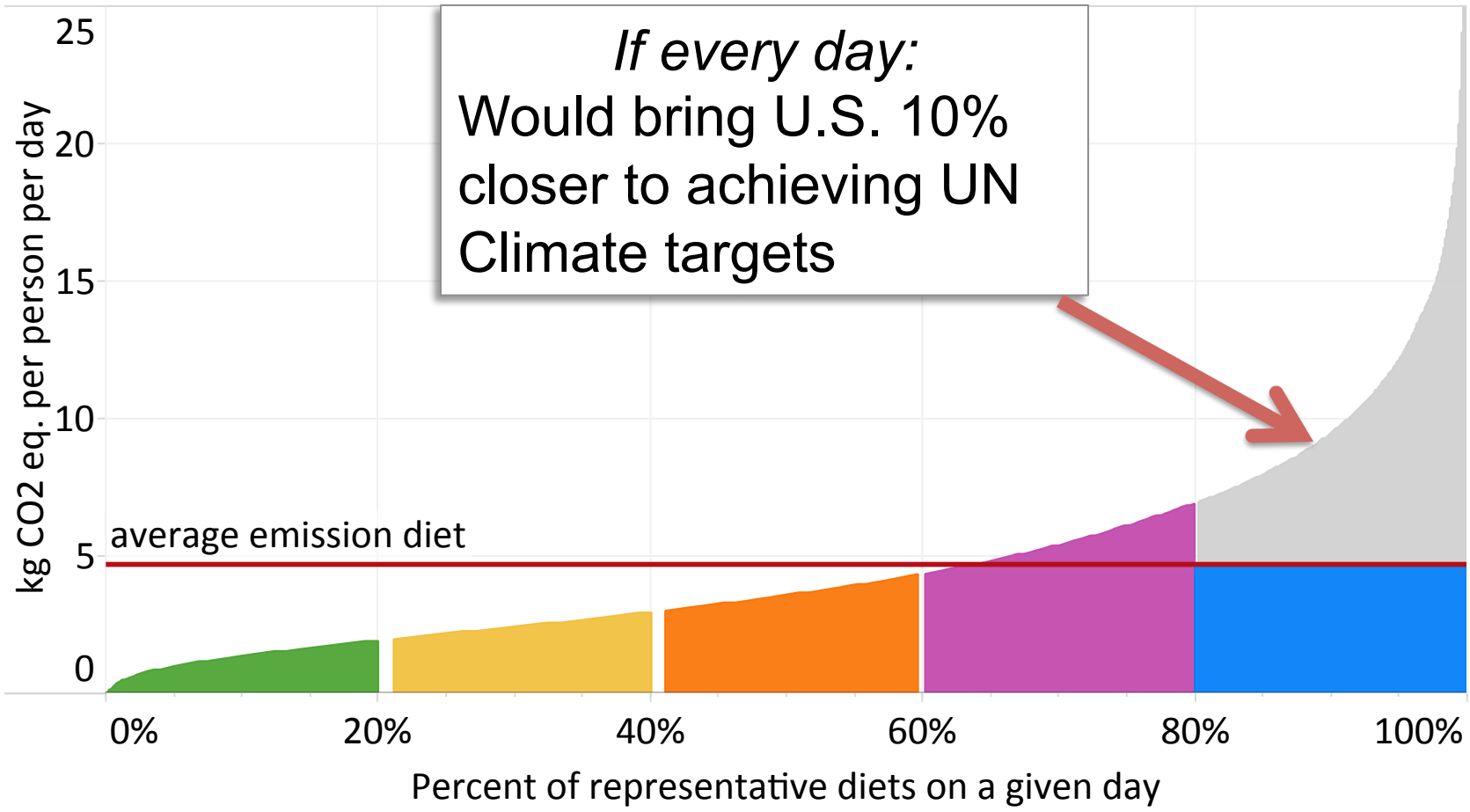

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Concluding Remarks

- Demand-side changes are likely needed to meet emission reduction targets.
- Significant reductions in environmental impact are possible through shifts in U.S. dietary patterns and consumer behaviors
  - reduced food waste
  - Less meat (doesn't have to mean no meat)
  - Underlying assumption: production follows U.S. demand…
- Modeling based on individual self-selected diets:
  - points to wide discrepancies in diet-related impact across the population
  - Offers opportunity for nuanced diet shift and policy scenario modeling
- Synergies and trade-offs with other indicators should be evaluated
  - Water and land use impacts, nutritional health, cost

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