

# Cows Do What to the Planet?

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# Why are we talking about this?

- Livestock's Long Shadow
- Green New Deal
- Meatless Mondays
- EAT-Lancet diet
- Etc.

# EAT-Lancet Commission on Food, Planet, Health

- **The Planetary Health Diet**
- The EAT-Lancet Commission presents a global planetary health diet that is healthy for both people and planet.
- Discover the report's key takeaways and specific actions that we all can take to contribute to the Great Food Transformation.



# Current Efforts at The International Level

- The **EAT-Lancet diet** is an immediate challenge. This quasi-vegetarian diet is poised to be adopted by the United Nations at its Food Summit in September 2021.
- European Commission's plant-based initiative **Farm to Fork**.
- Both call for a dramatic worldwide reduction in animal foods with the ambition of bringing consumption of these foods down to zero by 2050.

# livestock's long shadow

environmental issues and options



The Food and Agriculture Organization of the United Nations is a specialized agency of the United Nations that leads international efforts to defeat hunger and improve nutrition and food security.

# Preface

The in-depth assessment presented in this document of the various significant impacts of the world's livestock sector on the environment is deliberately termed Livestock's long shadow so as to help raise the attention of both the technical and the general public to the very substantial contribution of animal agriculture to climate change and air pollution, to land, soil and water degradation and to the reduction of biodiversity.

# Preface

This is not done simply to blame the rapidly growing and intensifying global livestock sector for severely damaging the environment but to encourage decisive measures at the technical and political levels for mitigating such damage. The detailed assessment of the various environmental impacts of the sector is therefore associated with the outline of technical and policy-related action to address these impacts.



# Preface

This should assist and enhance decision-making on necessary action at all levels, from local to global, from private to public, from individual to corporate and from non-governmental to intergovernmental. Action is required: if, as predicted, the production of meat will double from now to 2050, we need to halve impacts per unit of output to achieve a mere status quo in overall impact

What Does the General Public  
Think About Cattle Production?

- **Land degradation**

- Extensive grazing still occupies and degrades vast areas of land; though there is an increasing trend towards intensification and industrialization.
- Expansion of livestock production is a key factor in deforestation, especially in Latin America where the greatest amount of deforestation is occurring – 70 percent of previous forested land in the Amazon is occupied by pastures, and feedcrops cover a large part of the remainder.
- About 20 percent of the world's pastures and rangelands, with 73 percent of rangelands in dry areas, have been degraded to some extent, mostly through overgrazing, compaction and erosion created by livestock action.

- **Atmosphere and climate**

- With rising temperatures, rising sea levels, melting icecaps and glaciers, shifting ocean currents and weather patterns, climate change is the most serious challenge facing the human race.
- The livestock sector is a major player, responsible for 18 percent of greenhouse gas emissions measured in CO<sub>2</sub> equivalent. This is a higher share than transport.

- **Water**

- The livestock sector is a key player in increasing water use, accounting for over 8 percent of global human water use, mostly for the irrigation of feedcrops.
- It is probably the largest sectoral source of water pollution, contributing to eutrophication, “dead” zones in coastal areas, degradation of coral reefs, human health problems, emergence of antibiotic resistance and many others.
- The major sources of pollution are from animal wastes, antibiotics and hormones, chemicals from tanneries, fertilizers and pesticides used for feedcrops, and sediments from eroded pastures.

- **Water**

- Global figures are not available but in the United States, with the world's fourth largest land area, livestock are responsible for an estimated 55 percent of erosion and sediment, 37 percent of pesticide use, 50 percent of antibiotic use, and a third of the loads of nitrogen and phosphorus into freshwater resources.
- Livestock also affect the replenishment of freshwater by compacting soil, reducing infiltration, degrading the banks of watercourses, drying up floodplains and lowering water tables. Livestock's contribution to deforestation also increases runoff and reduces dry season flows.

- **Biodiversity**

- We are in an era of unprecedented threats to biodiversity. The loss of species is estimated to be running 50 to 500 times higher than background rates found in the fossil record
- Fifteen out of 24 important ecosystem services are assessed to be in decline.

- **Biodiversity**

- Livestock now account for about 20 percent of the total terrestrial animal biomass, and the 30 percent of the earth's land surface that they now pre-empt was once habitat for wildlife.
- Indeed, the livestock sector may well be the leading player in the reduction of biodiversity, since it is the major driver of deforestation, as well as one of the leading drivers of land degradation, pollution, climate change, overfishing, sedimentation of coastal areas and facilitation of invasions by alien species.



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# Executive Summary

- This report aims to assess the full impact of the livestock sector on environmental problems, along with potential technical and policy approaches to mitigation.
- The assessment is based on the most recent and complete data available, taking into account direct impacts, along with the impacts of feed crop agriculture required for livestock production.

# Executive Summary

- The livestock sector emerges as one of the top two or three most significant contributors to the most serious environmental problems, at every scale from local to global
- The findings of this report suggest that it should be a major policy focus when dealing with problems of land degradation, climate change and air pollution, water shortage and water pollution and loss of biodiversity.

# Executive Summary

- Livestock's contribution to environmental problems is on a massive scale and its potential contribution to their solution is equally large.
- The impact is so significant that it needs to be addressed with urgency.
- Major reductions in impact could be achieved at reasonable cost

# Global importance of the sector

- Although economically not a major global player, the livestock sector is socially and politically very significant.
- It accounts for 40 percent of agricultural gross domestic product(GDP).
- It employs 1.3 billion people and creates livelihoods for one billion of the world's poor.
- Livestock products provide one-third of humanity's protein intake, and are a contributing cause of obesity and a potential remedy for undernourishment.

# Anthropogenic

an·thro·po·gen·ic

/,anTHrəpō'jenik/

*adjective*

adjective: **anthropogenic**

1.(chiefly of environmental pollution and pollutants) originating in human activity.

"anthropogenic emissions of sulfur dioxide"



# Atmosphere and climate

- With rising temperatures, rising sea levels, melting icecaps and glaciers, shifting ocean currents and weather patterns, climate change is the most serious challenge facing the human race.
- The livestock sector is a major player, responsible for 18 percent of greenhouse gas emissions measured in CO<sub>2</sub> equivalent. This is a higher share than transport.

U.S. Greenhouse Gas Emissions in 2016

Total U.S. Greenhouse Gas Emissions by Economic Sector in 2016

3%  
Fluorinated Gases

6%  
Nitrous Oxide (N<sub>2</sub>O)

10%  
Methane (CH<sub>4</sub>)

82%  
Carbon Dioxide (CO<sub>2</sub>)



Transportation



Electricity Generation



Industry



Agriculture



Commercial



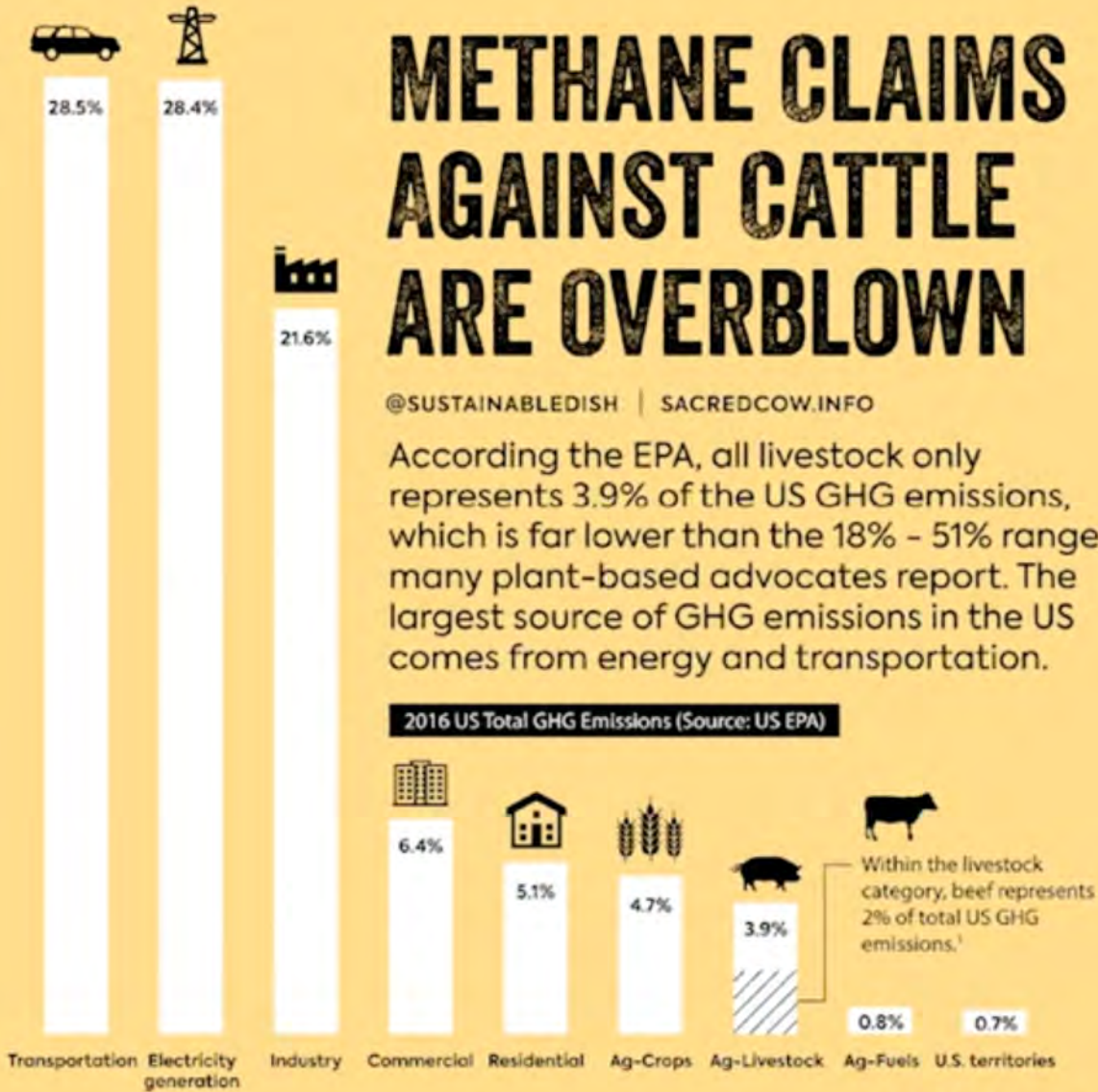
Residential

# METHANE CLAIMS AGAINST CATTLE ARE OVERBLOWN

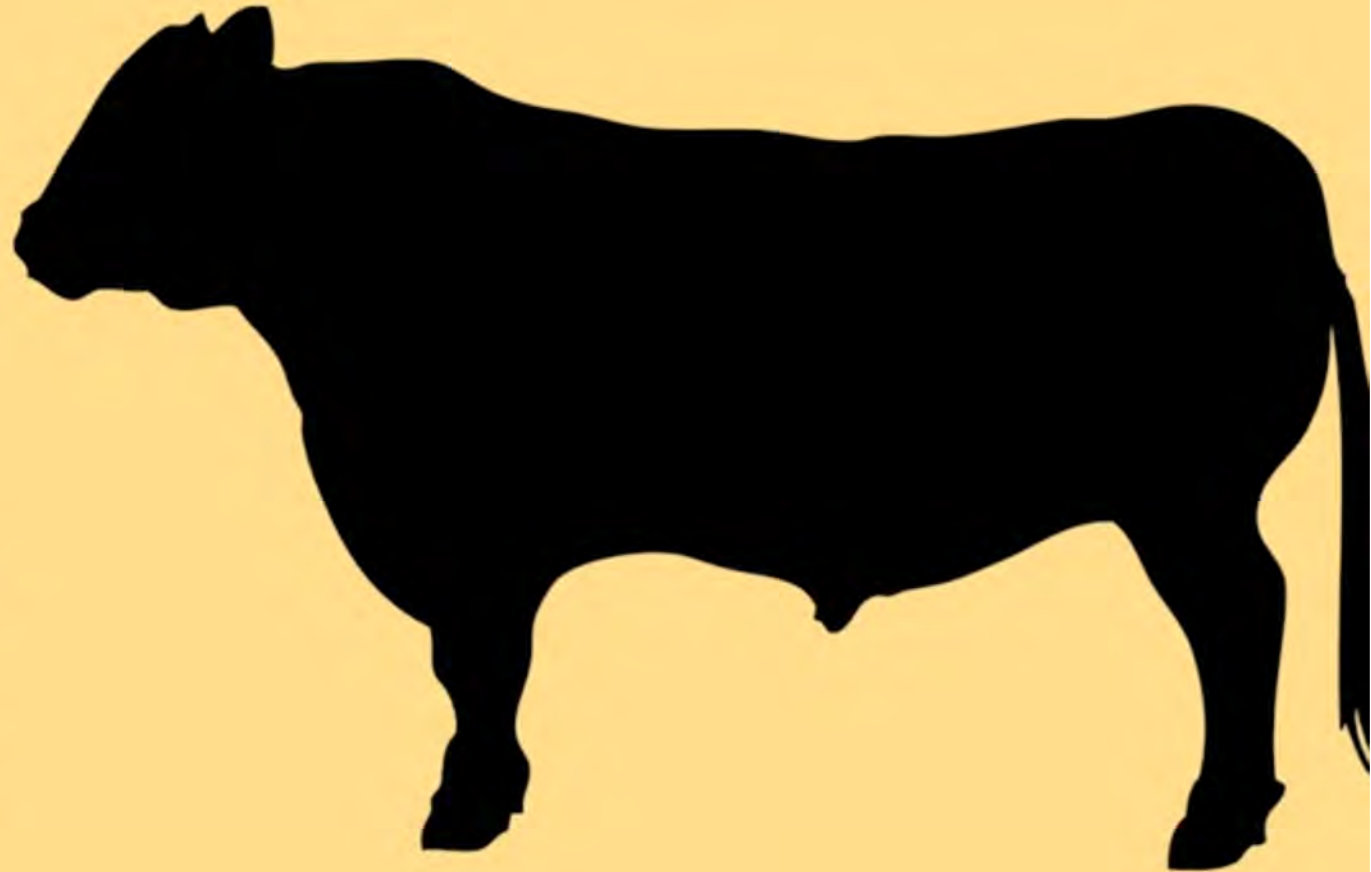
@SUSTAINABLEDISH | SACREDCOW.INFO

According to the EPA, all livestock only represents 3.9% of the US GHG emissions, which is far lower than the 18% - 51% range many plant-based advocates report. The largest source of GHG emissions in the US comes from energy and transportation.

2016 US Total GHG Emissions (Source: US EPA)



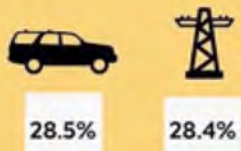
Beef represents only 2% of total U.S. greenhouse gas (GHG) EMISSIONS



Within the livestock category, beef represents 2% of total US GHG emissions.<sup>1</sup>

SACREDCOW

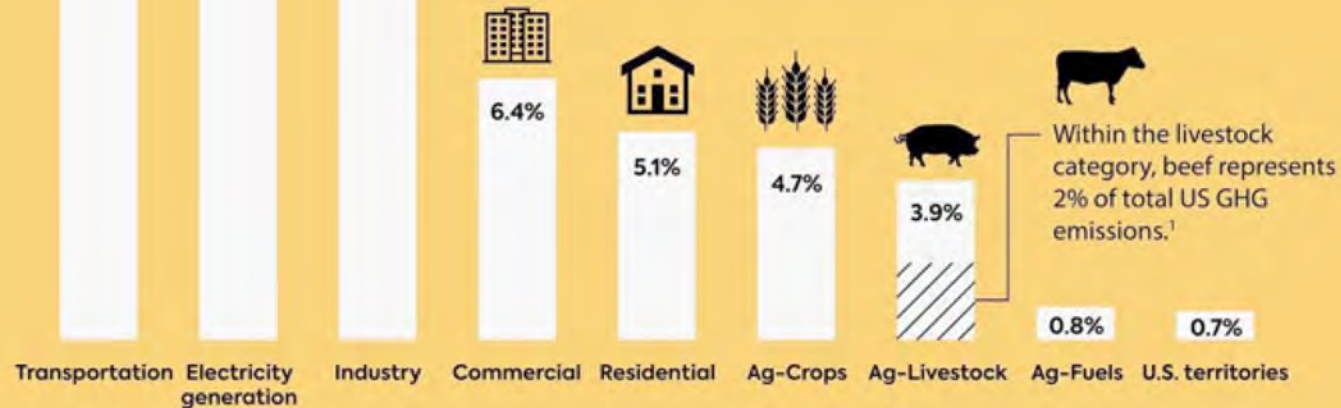
<sup>1</sup> <https://www.epa.gov/ghgemissions/sector-by-sector-greenhouse-gas-emissions#agriculture>



# METHANE CLAIMS AGAINST CATTLE ARE OVERBLOWN

According to the EPA, all livestock only represents 3.9% of the US GHG emissions, which is far lower than the 18% - 51% range many plant-based advocates report. The largest source of GHG emissions in the US comes from energy and transportation.

2016 US Total GHG Emissions (Source: US EPA)



1. <https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions#agriculture>

# Atmosphere and climate

- The livestock sector accounts for 9 percent of anthropogenic CO<sub>2</sub> emissions. The largest share of this derives from land-use changes – especially deforestation – caused by expansion of pastures and arable land for feedcrops.
- Livestock are responsible for much larger shares of some gases with far higher potential to warm the atmosphere.

# Atmosphere and climate

- The sector emits 37% of anthropogenic methane (with 23 times the global warming potential (GWP) of CO<sub>2</sub>) most of that from enteric fermentation by ruminants.
- It emits 65% of anthropogenic nitrous oxide (with 296 times the GWP of CO<sub>2</sub>), the great majority from manure.
- Livestock are also responsible for almost two-thirds (64%) of anthropogenic ammonia emissions, which contribute significantly to acid rain and acidification of ecosystems.

# Cross-cutting policy frameworks

- An important general lesson is that the livestock sector has such deep and wide-ranging environmental impacts that it should rank as one of the leading focuses for environmental policy: efforts here can produce large and multiple payoffs
- Indeed, as societies develop, it is likely that environmental considerations, along with human health issues, will become the dominant policy considerations for the sector.

## **1.1 Livestock as a major player in global environmental issues**

Livestock have a substantial impact on the world's water, land and biodiversity resources and contribute significantly to climate change.



# Rationale for government intervention

- Public policies need to protect and enhance public goods, including the environment. The rationale for public policy intervention is based on the concept of market failures.
- These arise because many local and global ecosystems are public goods or “commons,” and the negative environmental impacts that livestock have on them are “externalities” that arise because individual economic decisions usually consider only private individual costs and benefits.

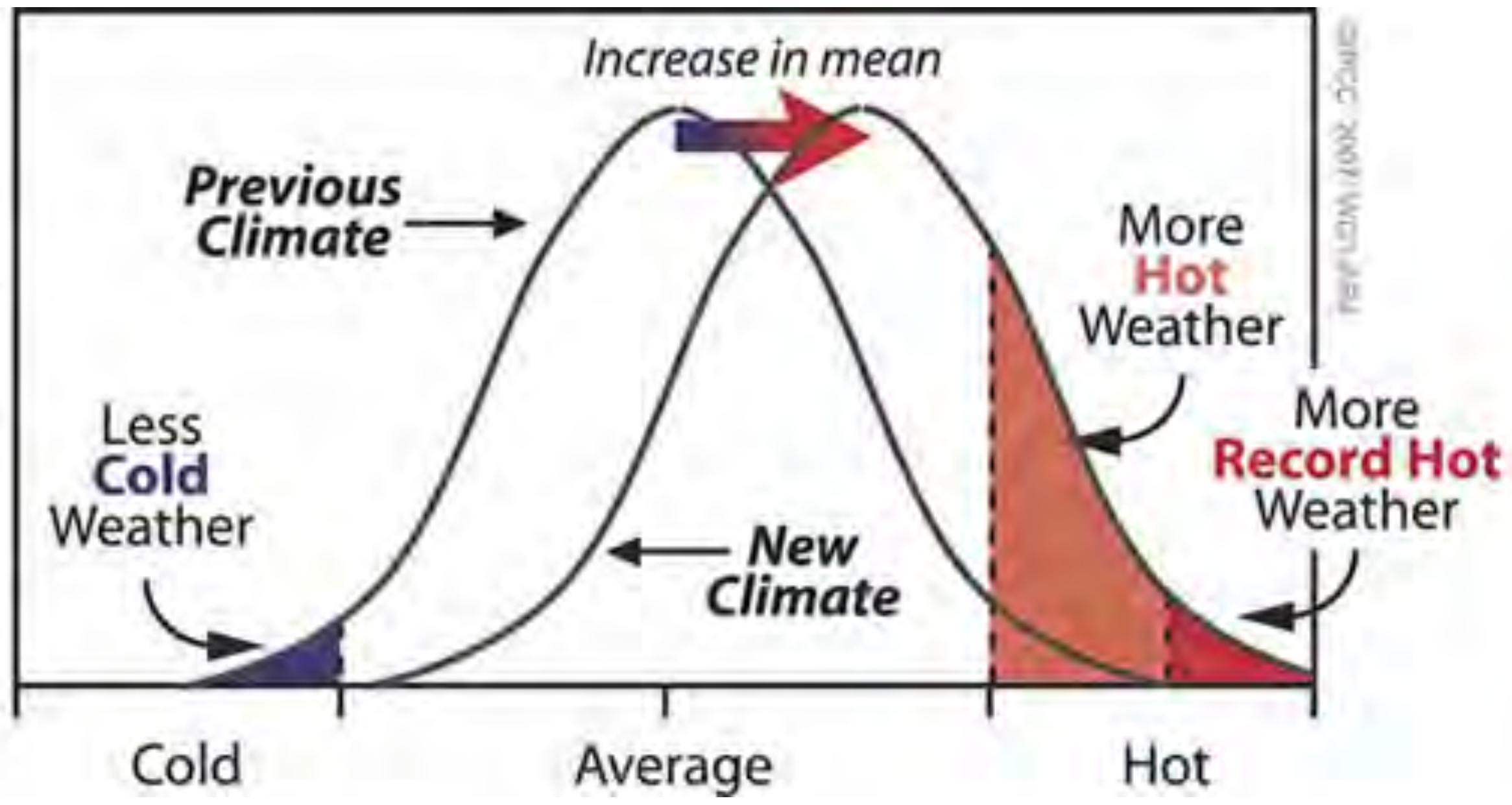
# Rationale for government intervention

- There are also consumption externalities through the negative health impact of excessive consumption of certain livestock products, particularly animal fats and red meat – however, these are beyond the scope of this study.
- Information failures also exist, for instance the inadequate understanding of highly complex phenomena such as bio-diversity or climate change.

# Rationale for government intervention

- As a consequence of externalities and information failures, the market fails to deliver a socially desirable level of environmental impact.
- Not only are there market and information failures, there are also policy failures, such as, for example, subsidies that sometimes constitute perverse incentives, promoting inefficient resource use or activities that damage the environment.

Probability of occurrence



Increase in mean

Previous Climate

More Hot Weather

Less Cold Weather

New Climate

More Record Hot Weather

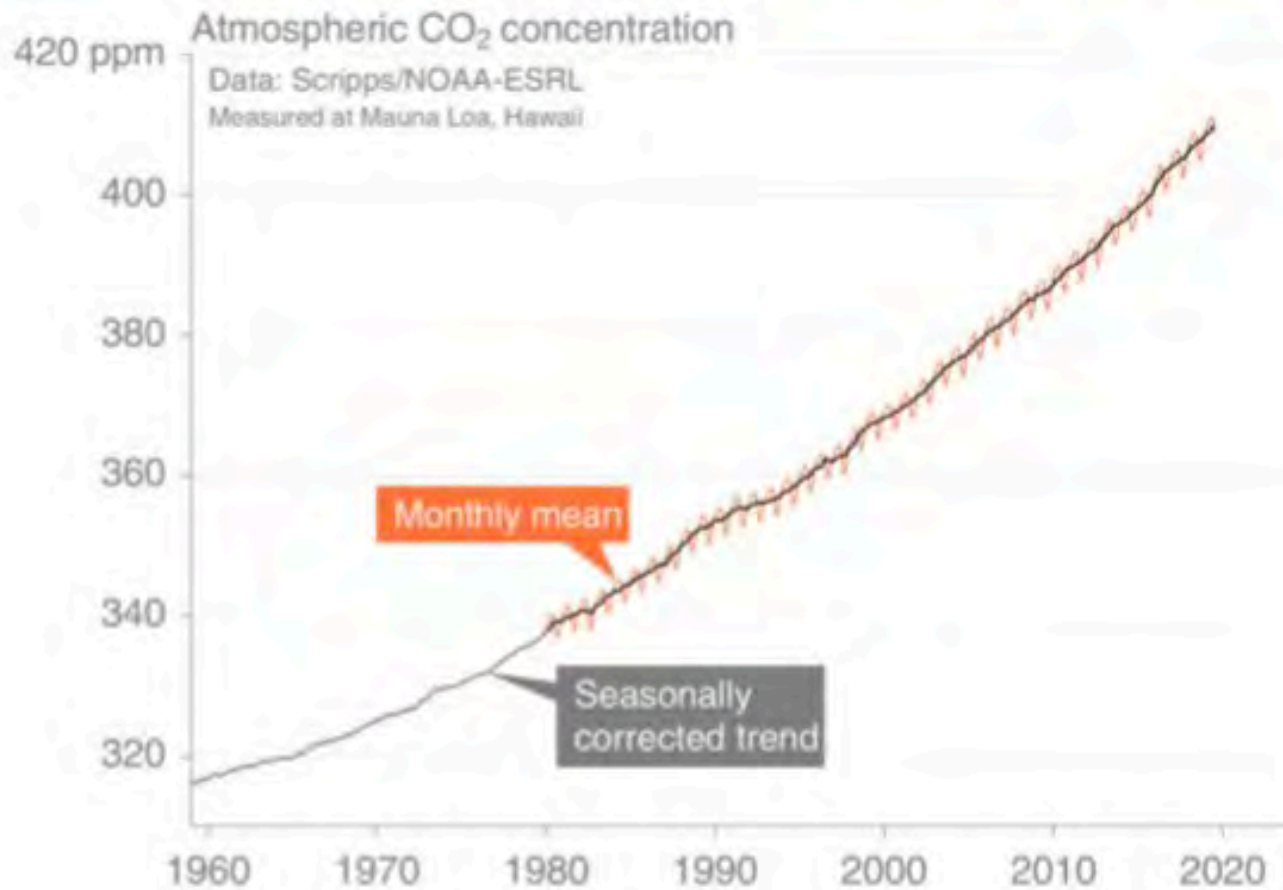
Cold

Average

Hot

## Atmospheric concentration

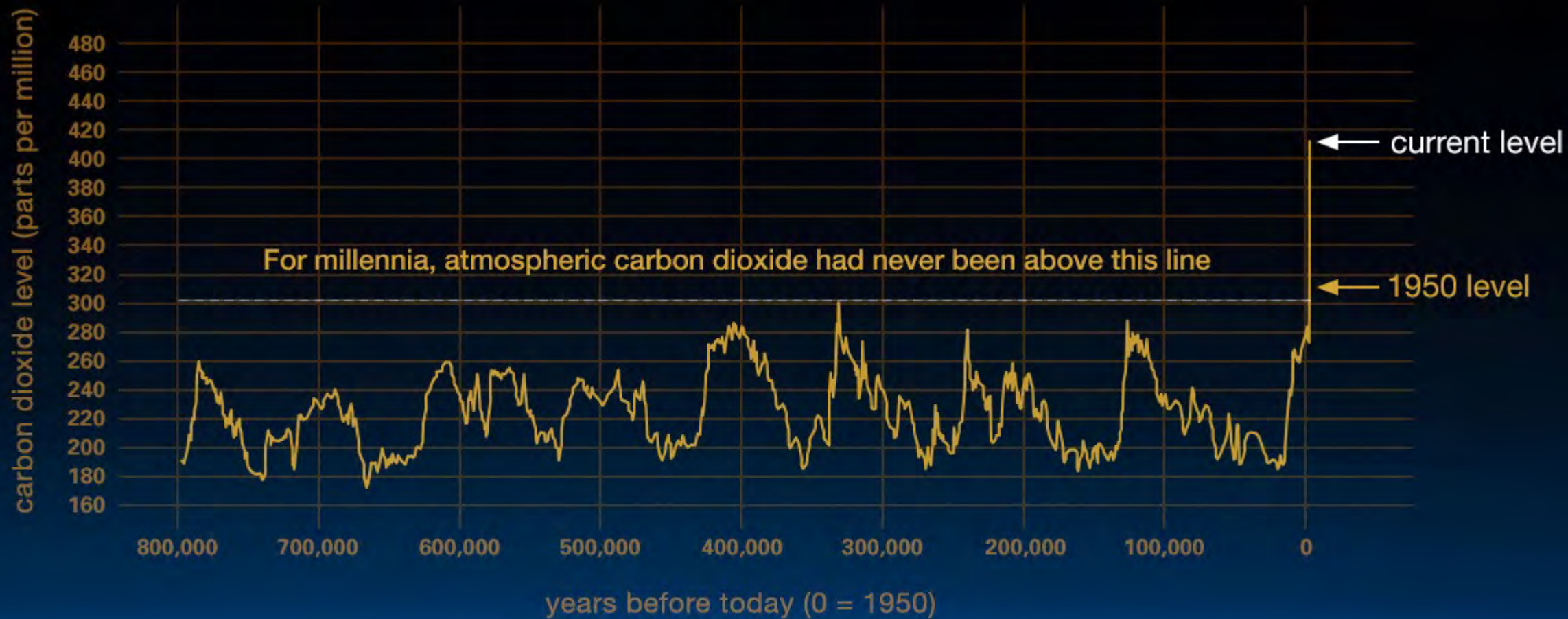
The global CO<sub>2</sub> concentration increased from ~277ppm in 1750 to 407ppm in 2018 (up 46%)  
2016 was the first full year with concentration above 400ppm



© Global Carbon Project

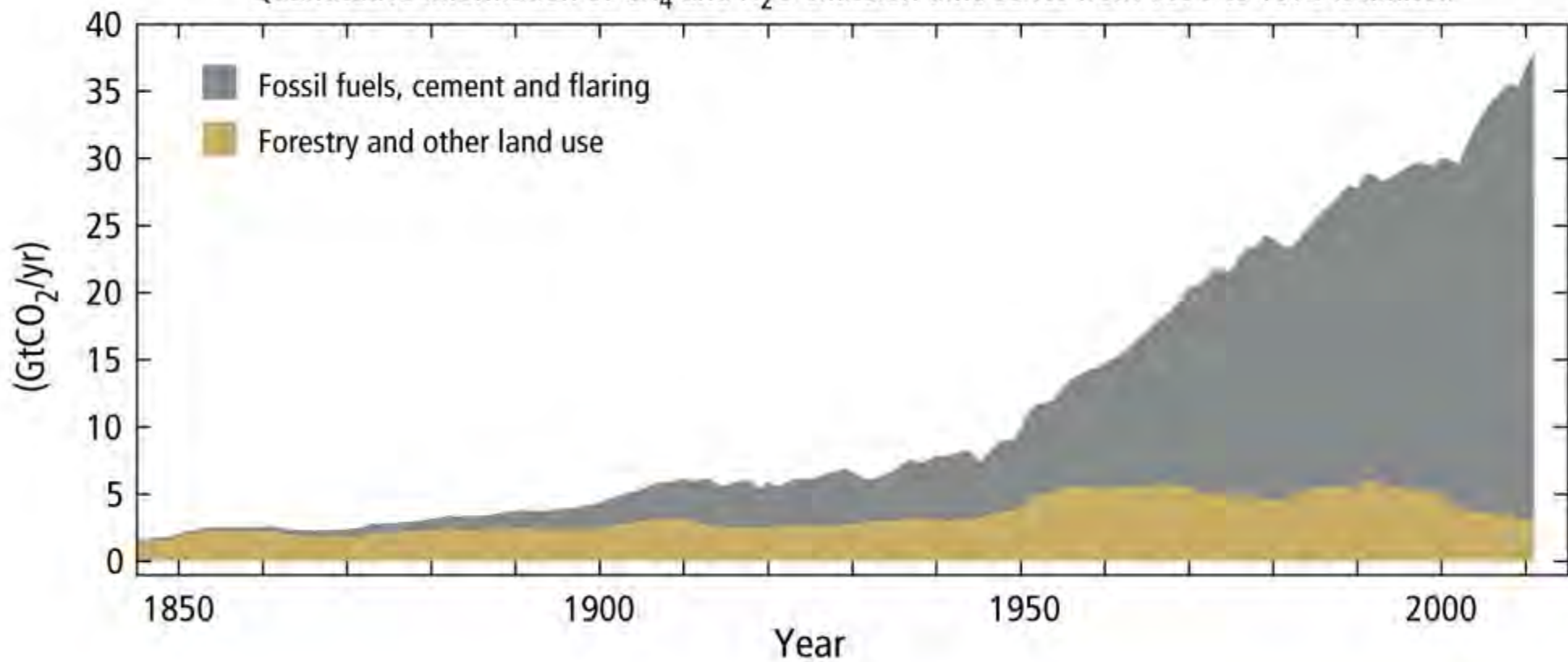
Globally averaged surface atmospheric CO<sub>2</sub> concentration. Data from: NOAA-ESRL after 1980;  
the Scripps Institution of Oceanography before 1980 (harmonised to recent data by adding 0.542ppm)

Source: [NOAA-ESRL](#); [Scripps Institution of Oceanography](#); [Friedlingstein et al 2019](#); [Global Carbon Budget 2019](#)

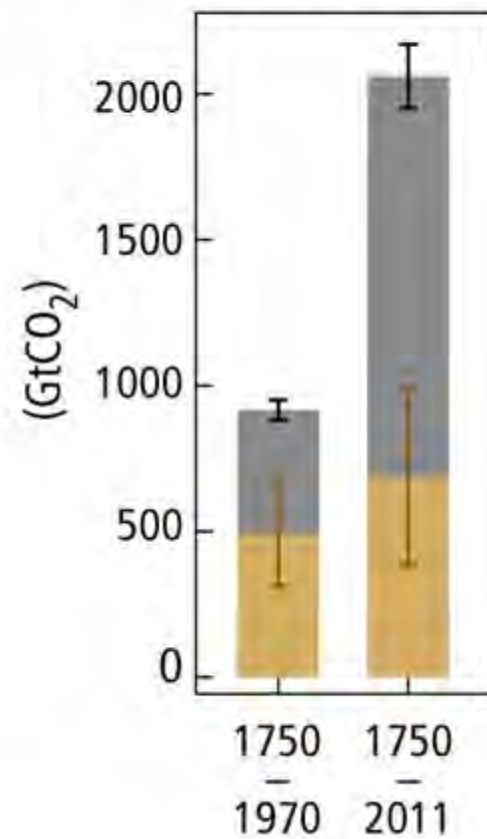


## Global anthropogenic CO<sub>2</sub> emissions

Quantitative information of CH<sub>4</sub> and N<sub>2</sub>O emission time series from 1850 to 1970 is limited

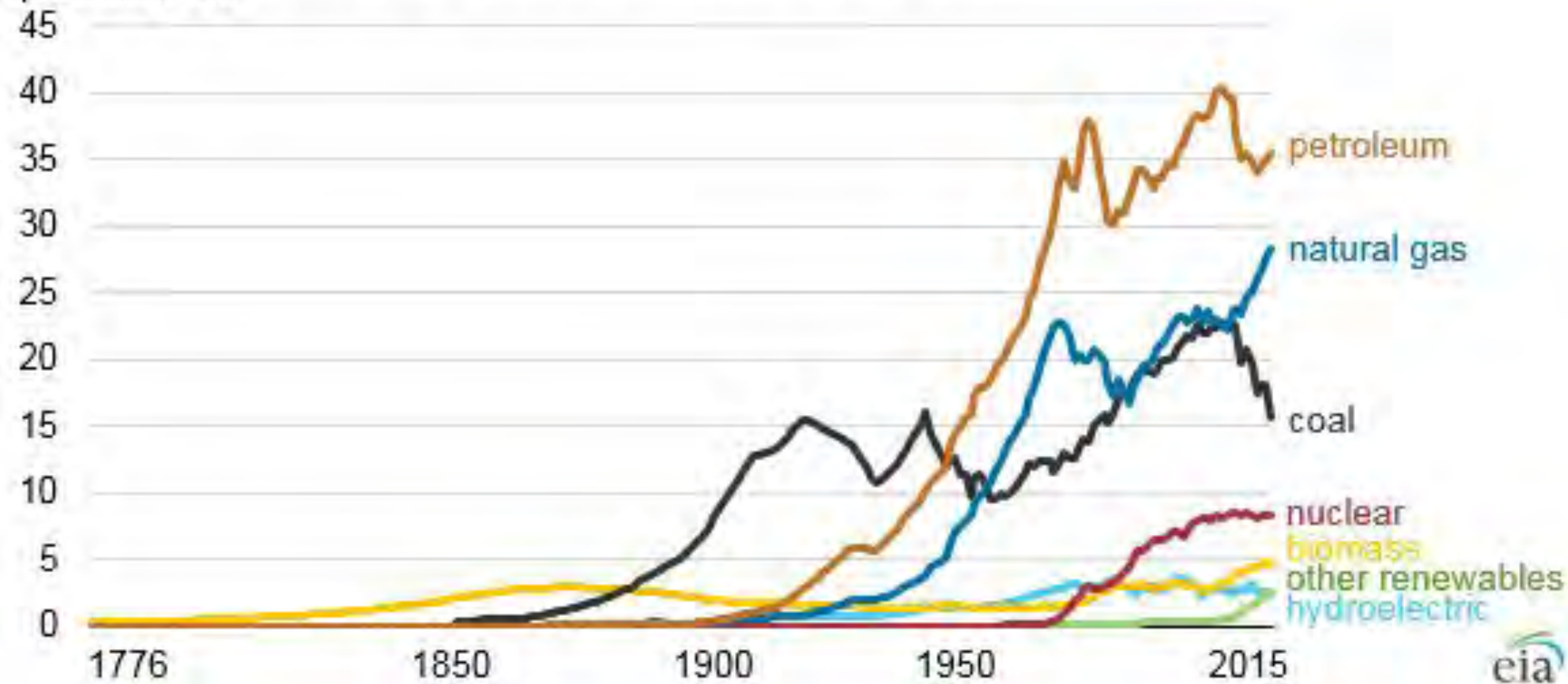


## Cumulative CO<sub>2</sub> emissions



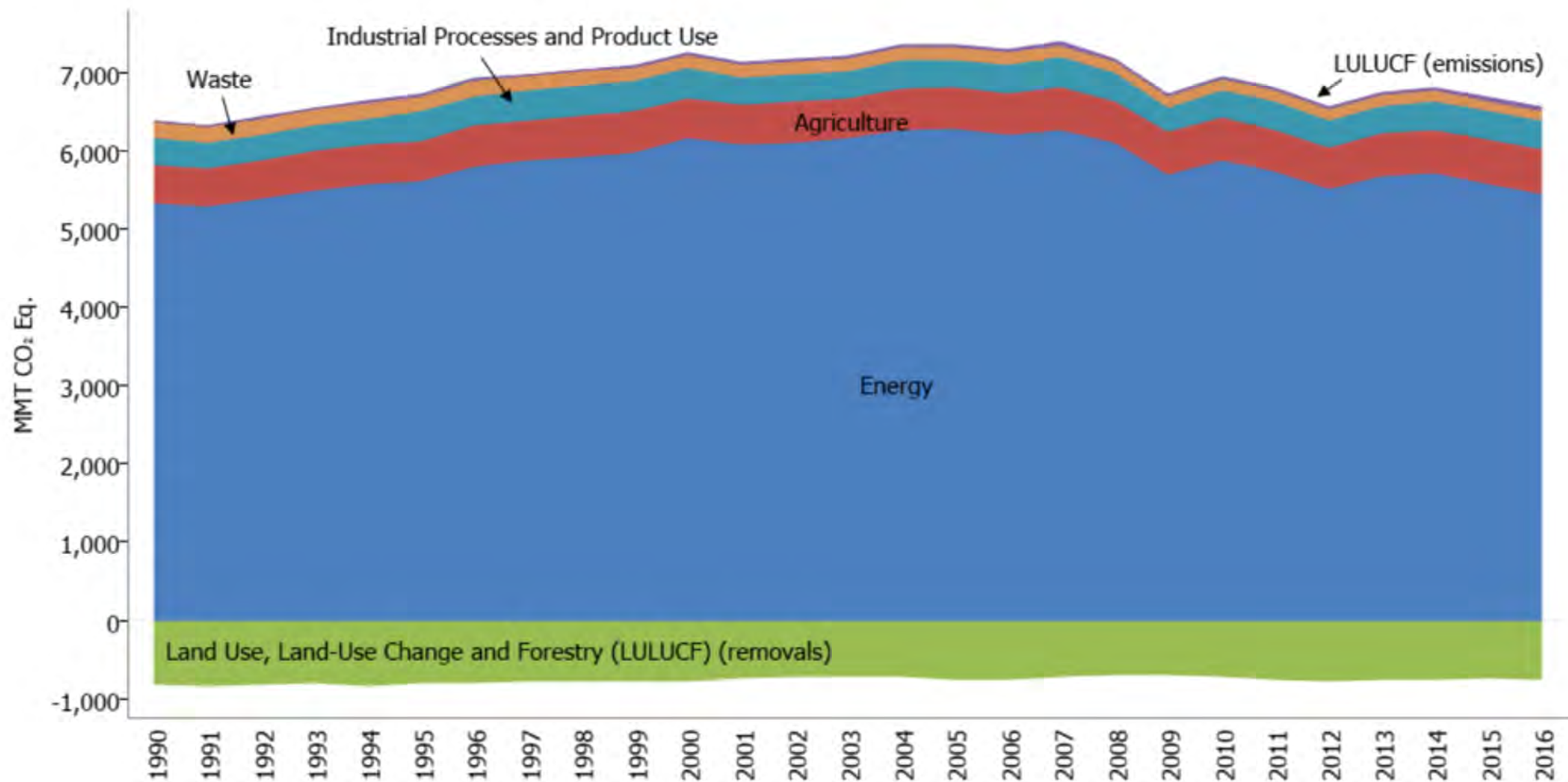
# Energy consumption in the United States (1776-2015)

quadrillion Btu



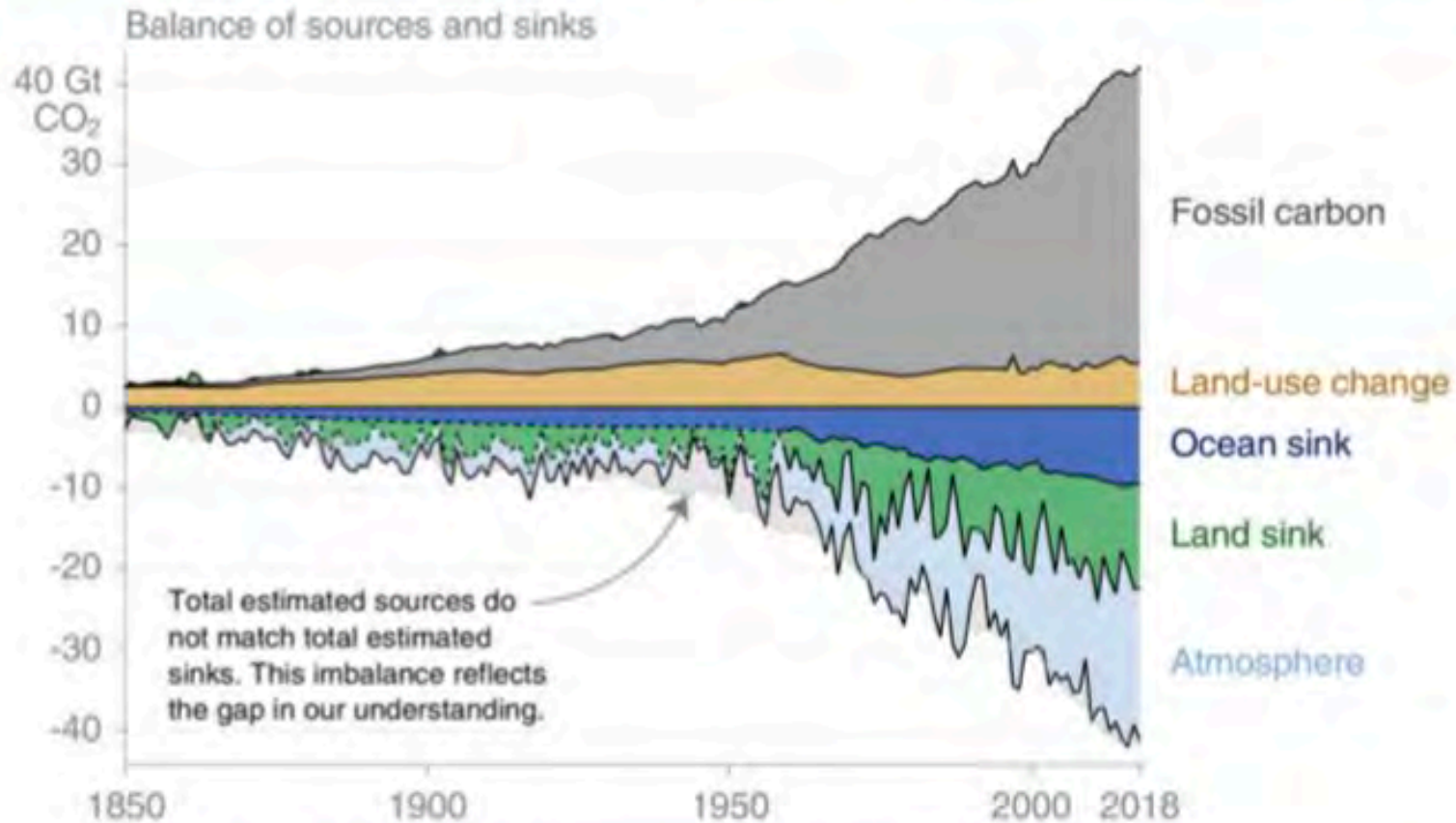


**Figure ES-12: U.S. Greenhouse Gas Emissions and Sinks by Chapter/IPCC Sector (MMT CO<sub>2</sub> Eq.)**



# Global carbon budget

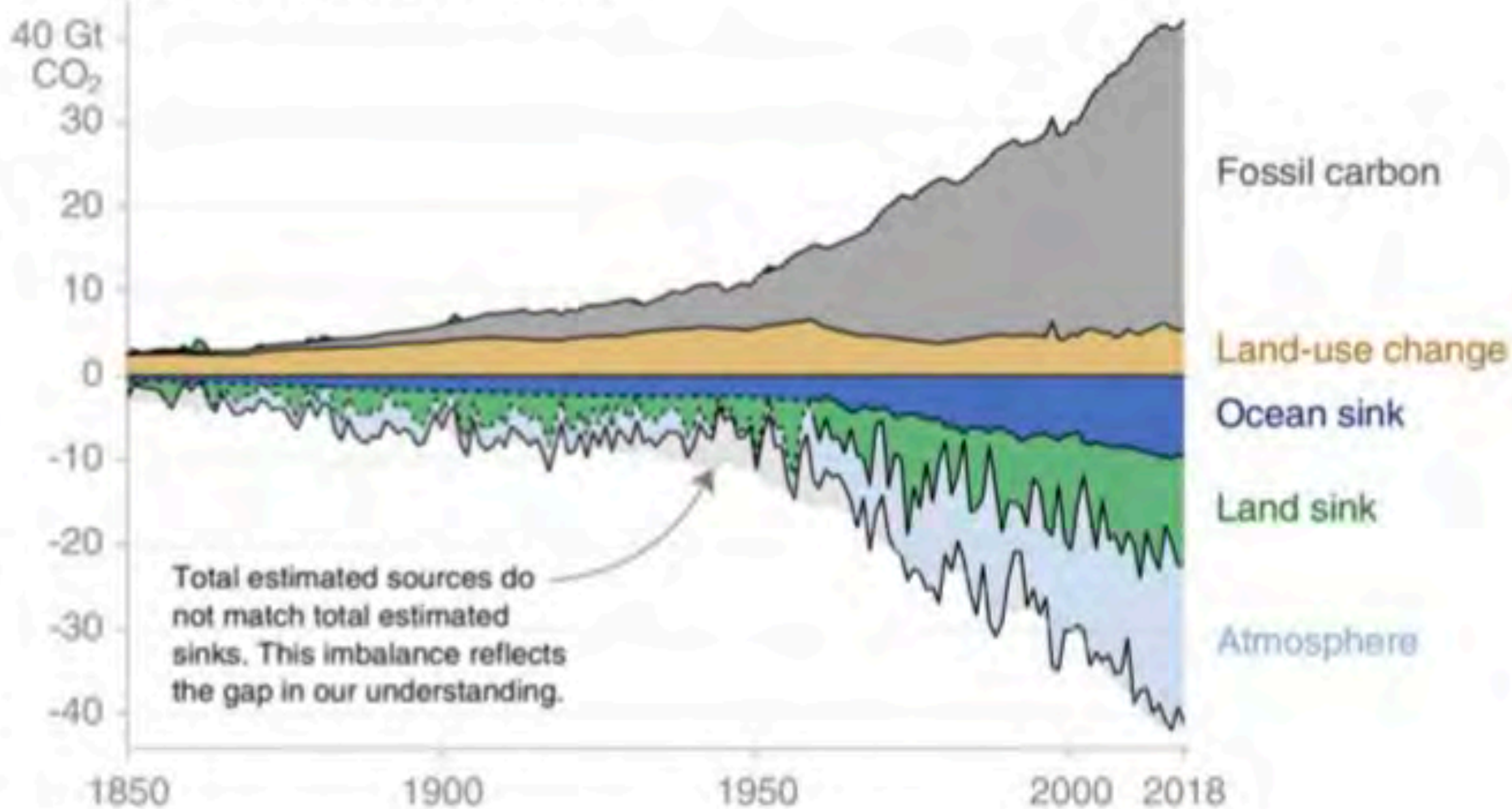
Carbon emissions are partitioned among the atmosphere and carbon sinks on land and in the ocean  
 The “imbalance” between total emissions and total sinks reflects the gap in our understanding



© Global Carbon Project • Data: CDIAC/NOAA-ESRL/UNFCCC/BRUSGS

Source: [CDIAC](#); [NOAA-ESRL](#); [Houghton and Nassikas 2017](#); [Hansis et al 2015](#); [Joos et al 2013](#); [Khatiwala et al. 2013](#); [DeVries 2014](#); [Friedlingstein et al 2019](#); [Global Carbon Budget 2019](#)

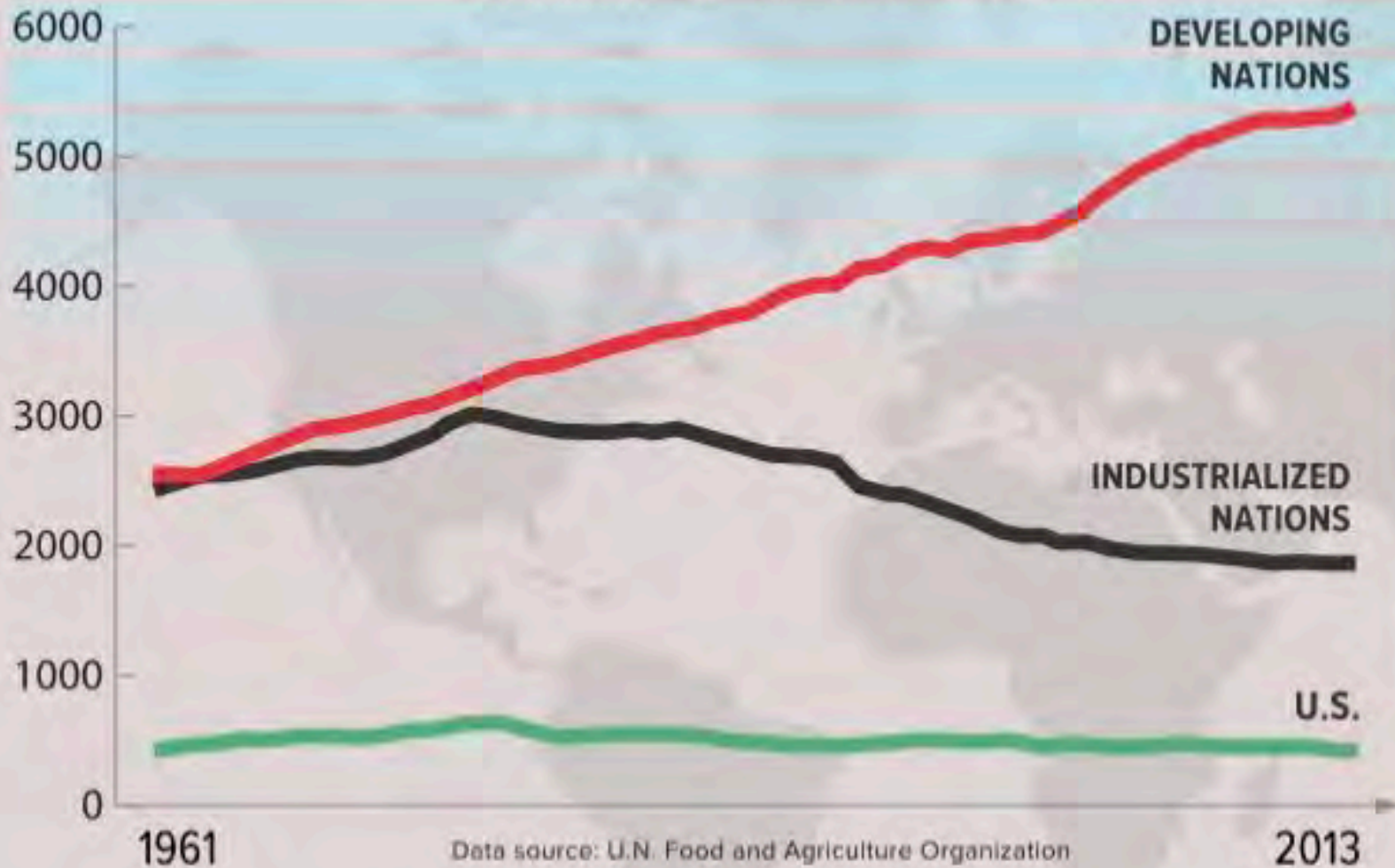
# Balance of sources and sinks



How have enteric methane emissions from beef cattle changed over time?

### CATTLE ENTERIC FERMENTATION PER YEAR

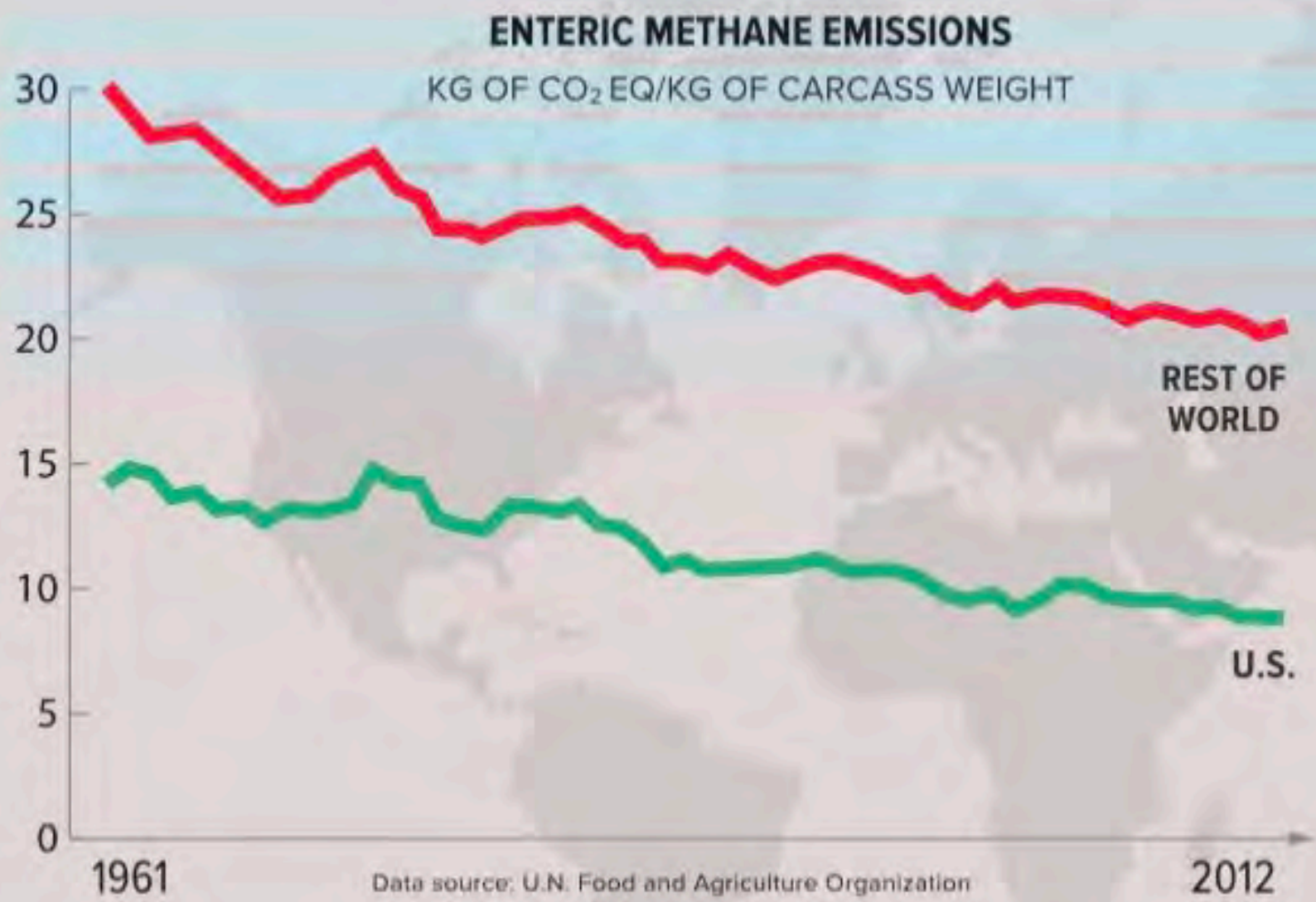
GIGAGRAMS OF METHANE EMISSIONS



Trends in total methane emissions from beef cattle also show that the U.S. and other industrialized nations have produced significantly **less methane emissions** over time, whereas developing nations have produced more.

Data source: U.N. Food and Agriculture Organization

# How have enteric methane emissions from beef cattle changed over time?



Trends in methane emissions per unit of carcass weight show that the U.S. has produced significantly **less methane emissions** than the rest of the world.

Data source: U.N. Food and Agriculture Organization

# Methane Emissions From Livestock

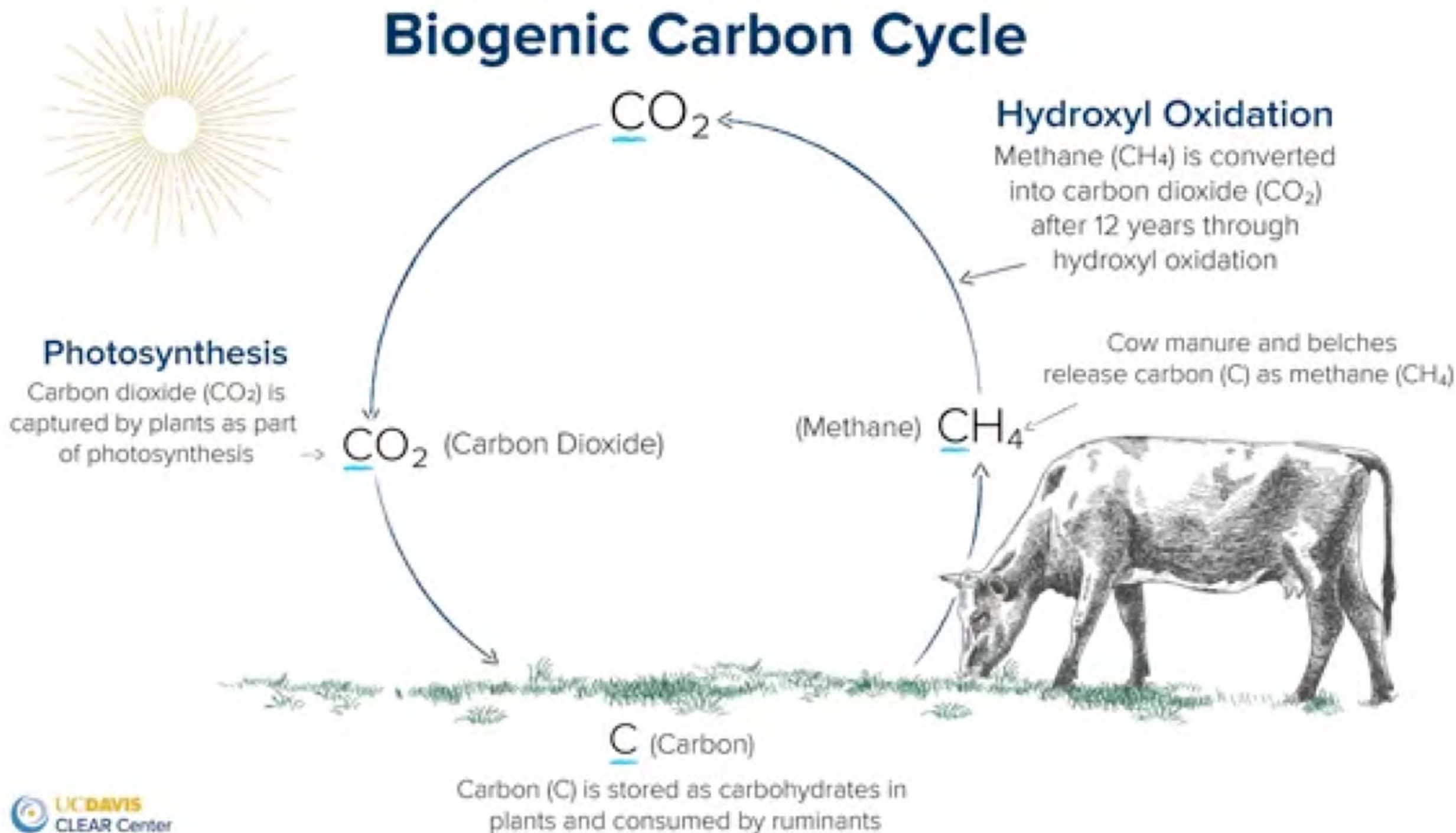
The total methane emissions from U.S. livestock—from digestive processes and manure management—have risen by nearly 20 percent from 1990 to 2016.

## U.S. METHANE EMISSIONS BY SOURCE

*In millions of metric tons of CO<sub>2</sub> equivalent*

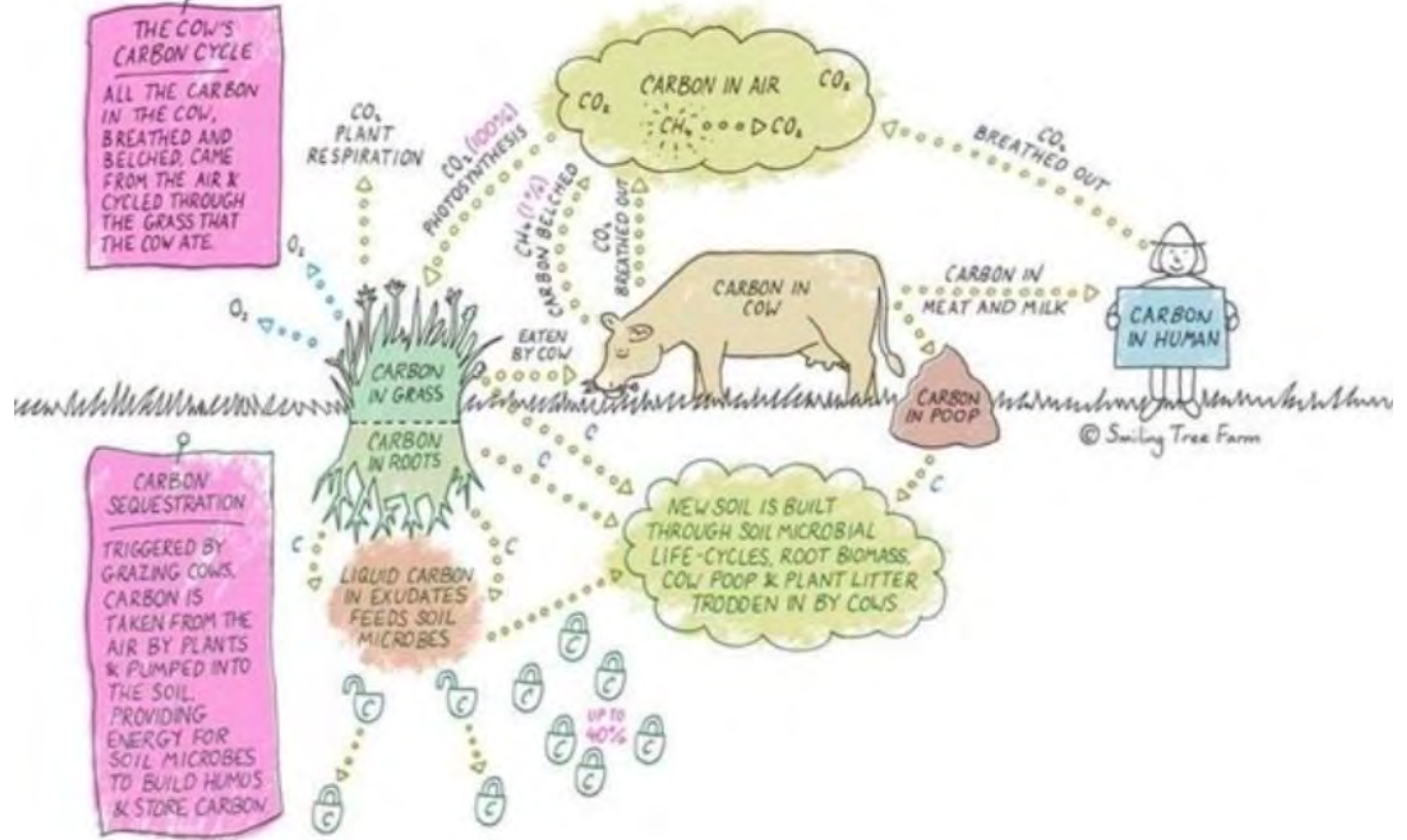


# Biogenic Carbon Cycle



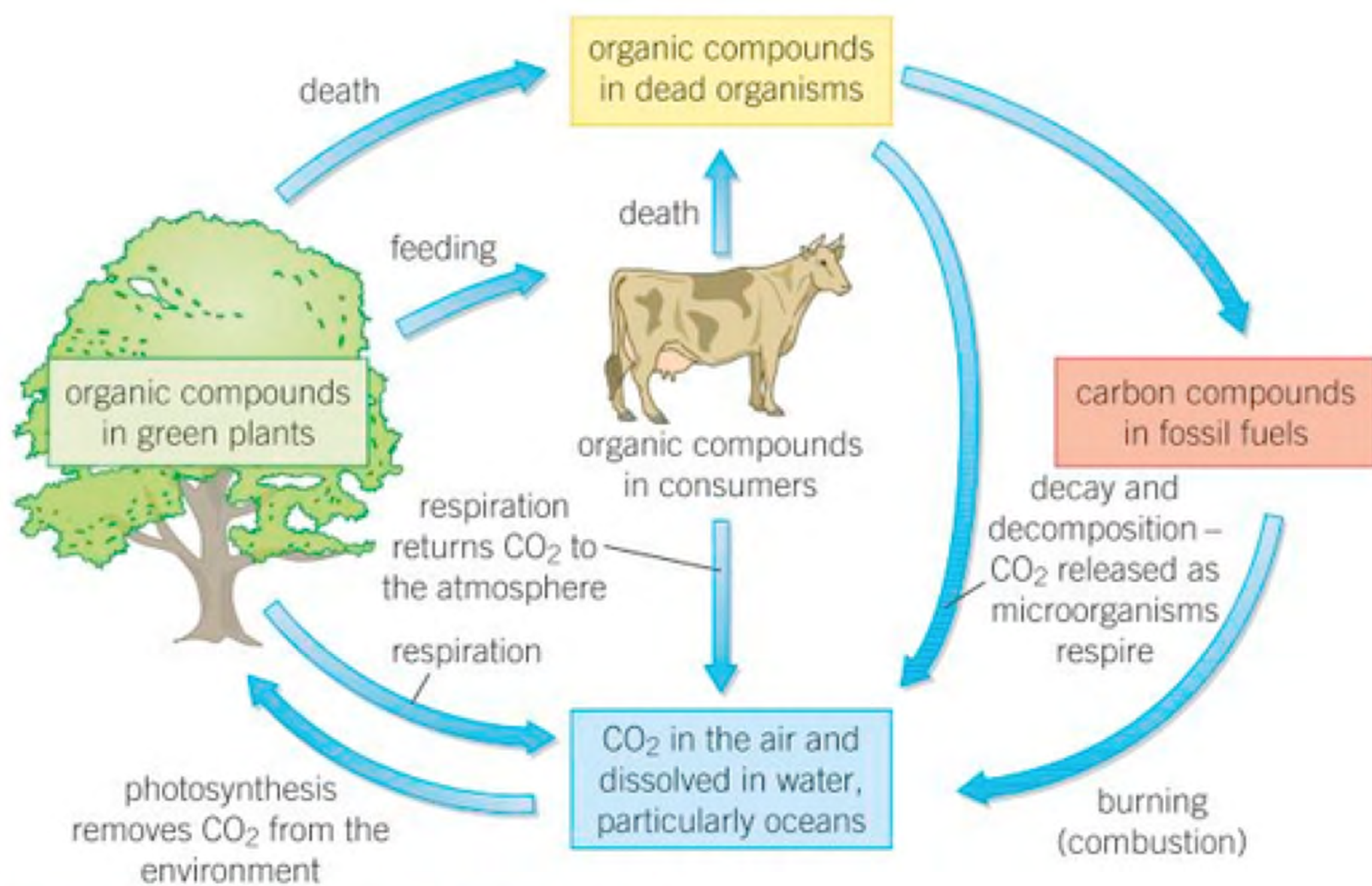
**THE COW'S CARBON CYCLE**  
 ALL THE CARBON IN THE COW, BREATHED AND BELCHED, CAME FROM THE AIR & CYCLED THROUGH THE GRASS THAT THE COW ATE.

**CARBON SEQUESTRATION**  
 TRIGGERED BY GRAZING COWS, CARBON IS TAKEN FROM THE AIR BY PLANTS & PUMPED INTO THE SOIL, PROVIDING ENERGY FOR SOIL MICROBES TO BUILD HUMUS & STORE CARBON

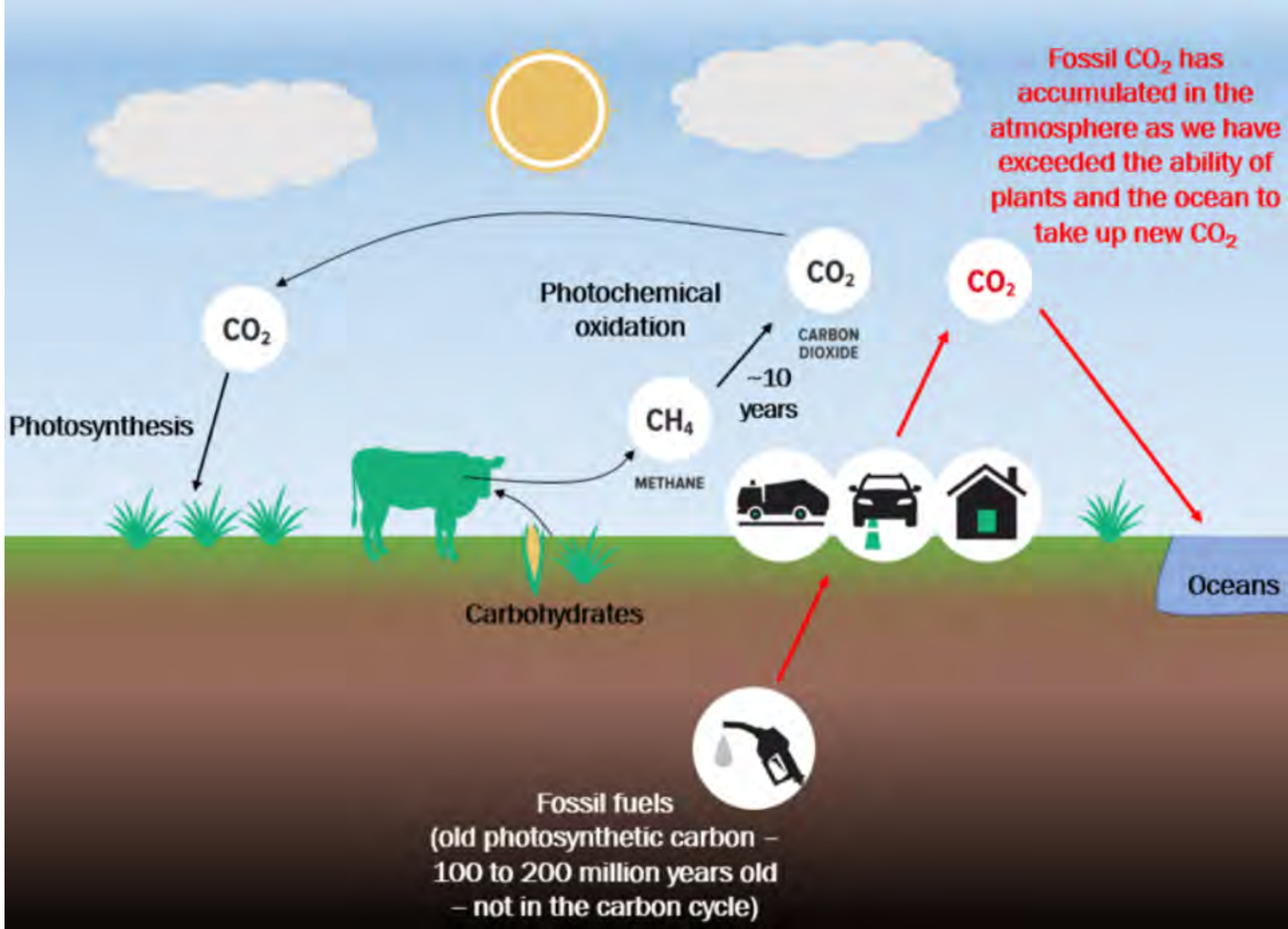


© Smiling Tree Farms





**Figure 2** *The carbon cycle in nature*





**We found methane-eating bacteria living in a common Australian tree. It could be a game changer for curbing greenhouse gases**

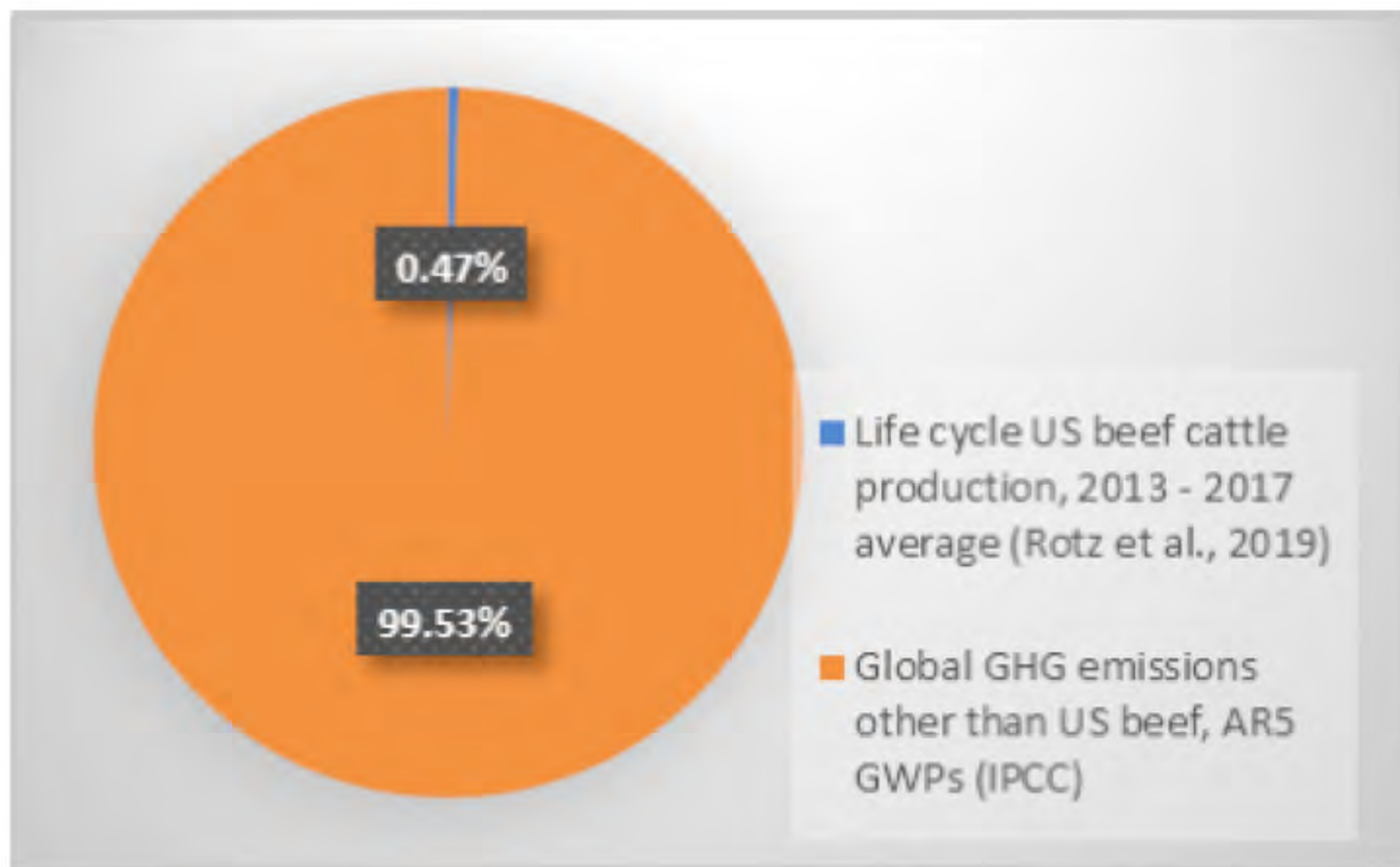
April 9, 2021 7.33am EDT

# Wait, trees emit methane?

- Yes, you read that right! Methane gas within cottonwood trees was [first reported in 1907](#), but has been largely overlooked for almost a century.
- In some cases, treethane emissions are significant. For example, the tropical Amazon basin is the world largest natural source of methane. Trees account for around [50% of its methane emissions](#).

# Wait, trees emit methane?

- Trees are the Earth's lungs – it's well understood they drawdown and lock up vast amounts of carbon dioxide from the atmosphere. But emerging research is showing trees can also emit methane, and it's currently unknown just how much.
- This could be a major problem, given methane is a greenhouse gas about 45 times more potent than carbon dioxide at [warming our planet](#).



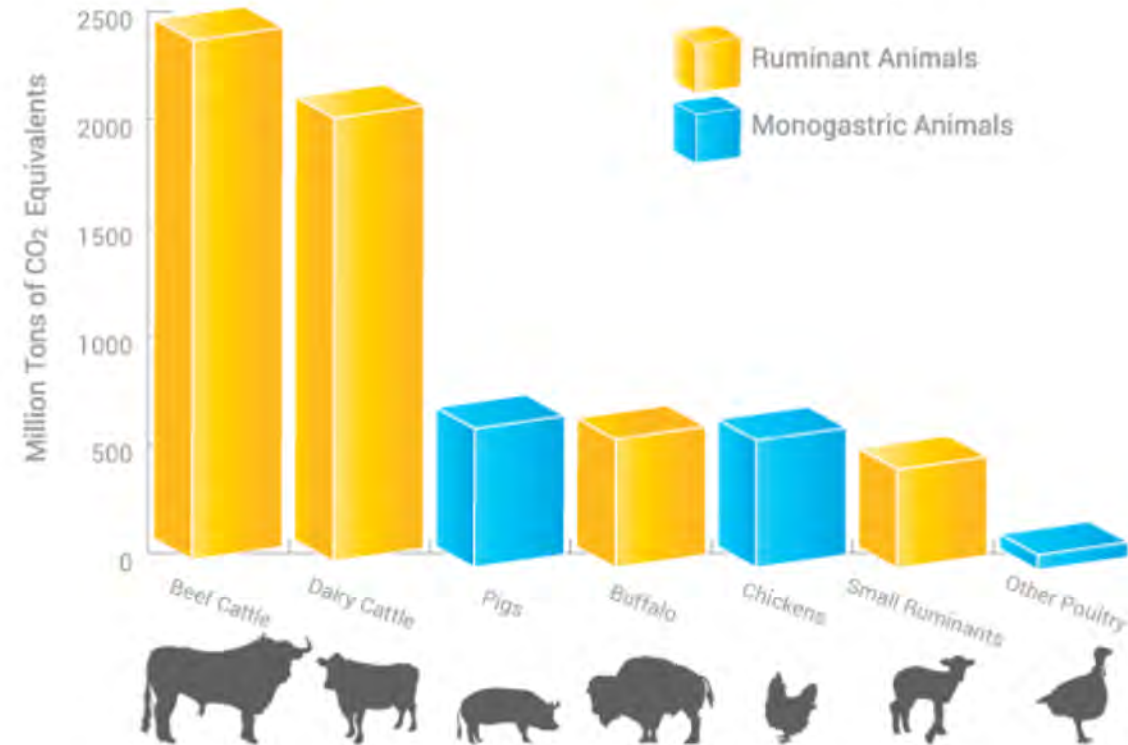
**Figure 1.** *U.S. beef cattle production emissions in the context of total global GHG emissions*

**FOR THE LOVE OF GOD**



**STOP BLAMING CATTLE FOR  
CLIMATE CHANGE**

# GREENHOUSE GAS EMISSIONS GLOBALLY BY LIVESTOCK SPECIES

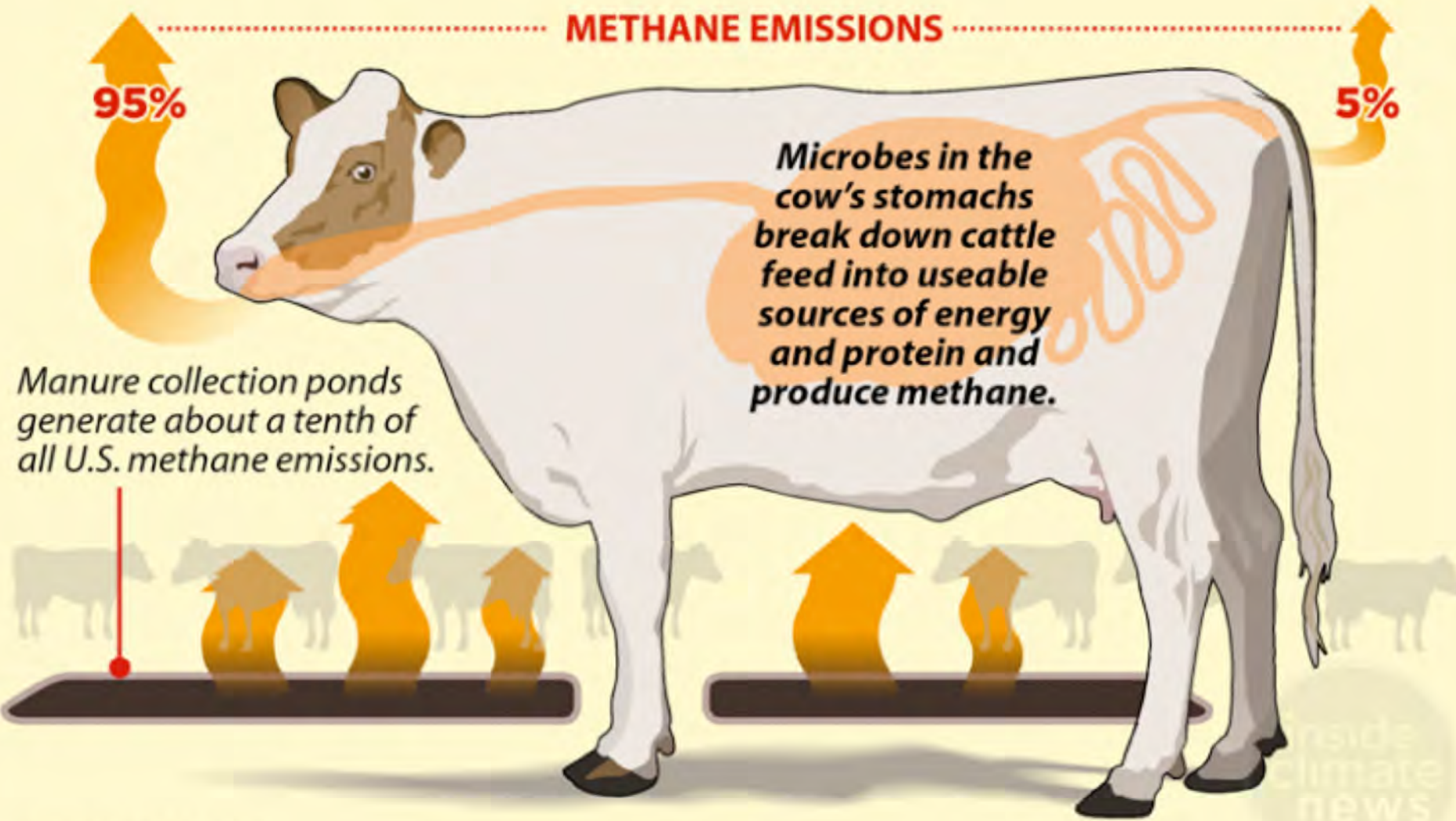


SOURCE: Gerber, P.J., Steinfeld, H., Henderson, B., Mottet, A., Opio, C., Dijkman, J., Faluccci, A. & Tempio, G. 2013. Tackling climate change through livestock – A global assessment of emissions and mitigation opportunities. Food and Agriculture Organization of the United Nations (FAO), Rome.



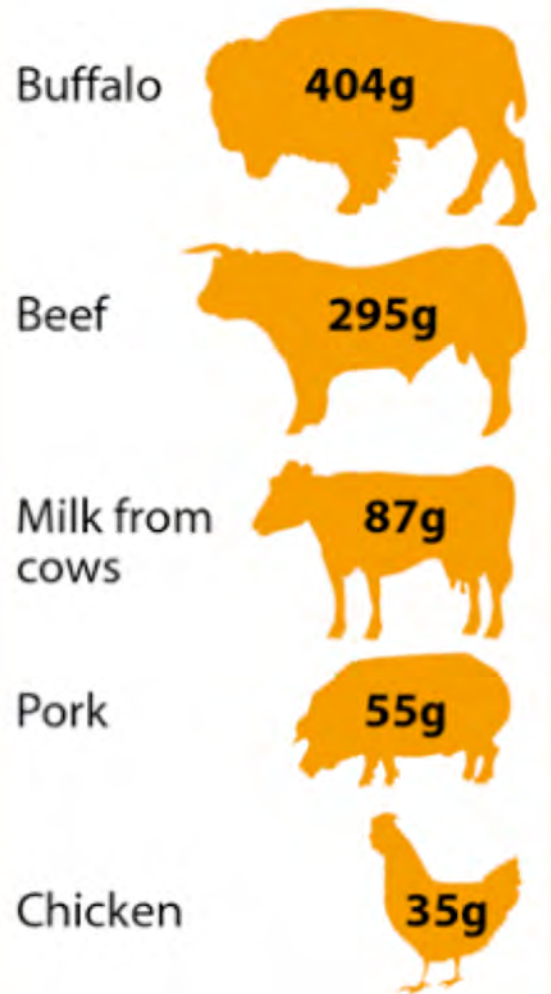
# Livestock-Based Methane Emissions

About a quarter of U.S. methane emissions come straight out of livestock, most of it from belching.

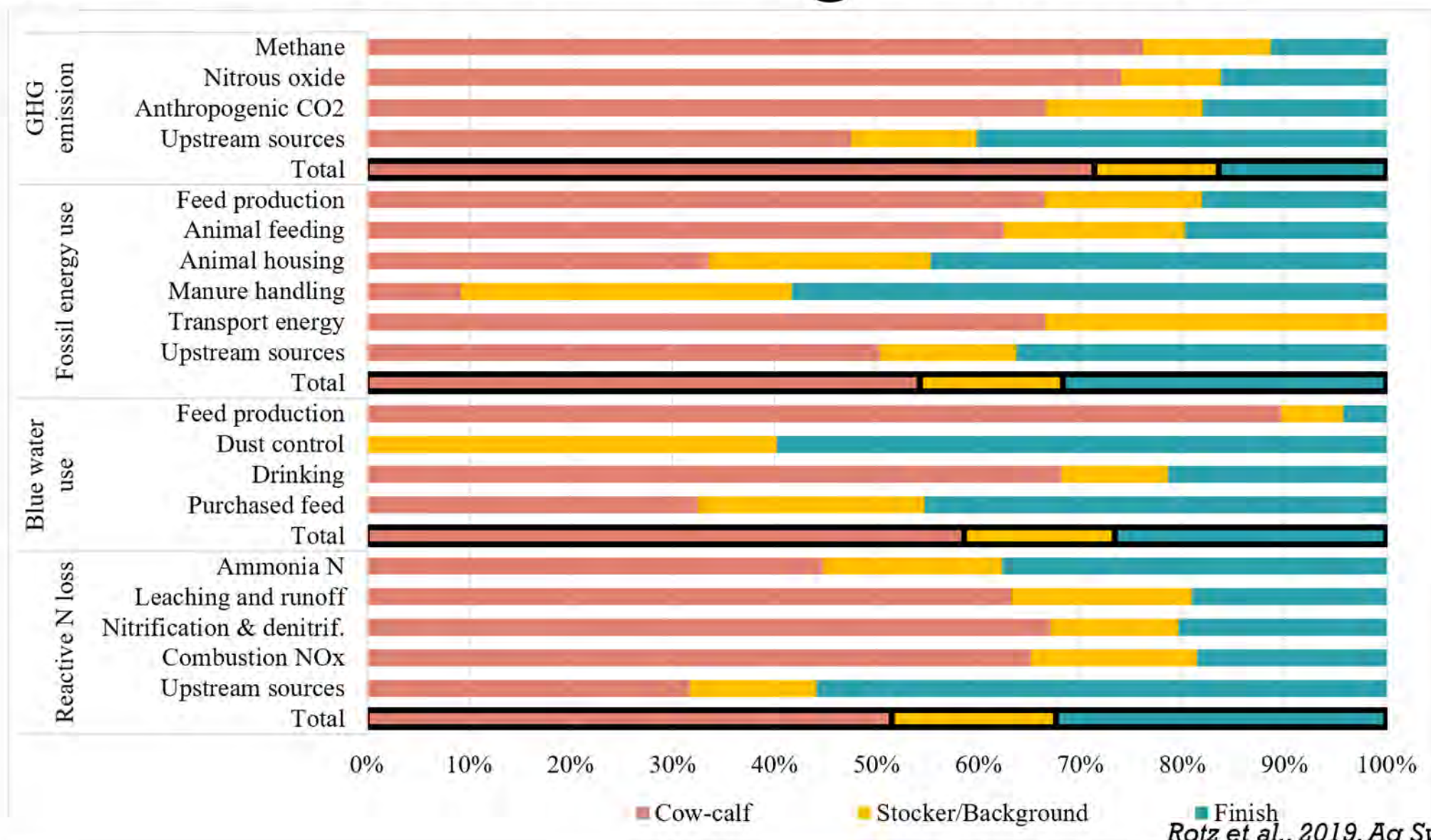


## METHANE EMISSIONS PER GRAM OF PROTEIN

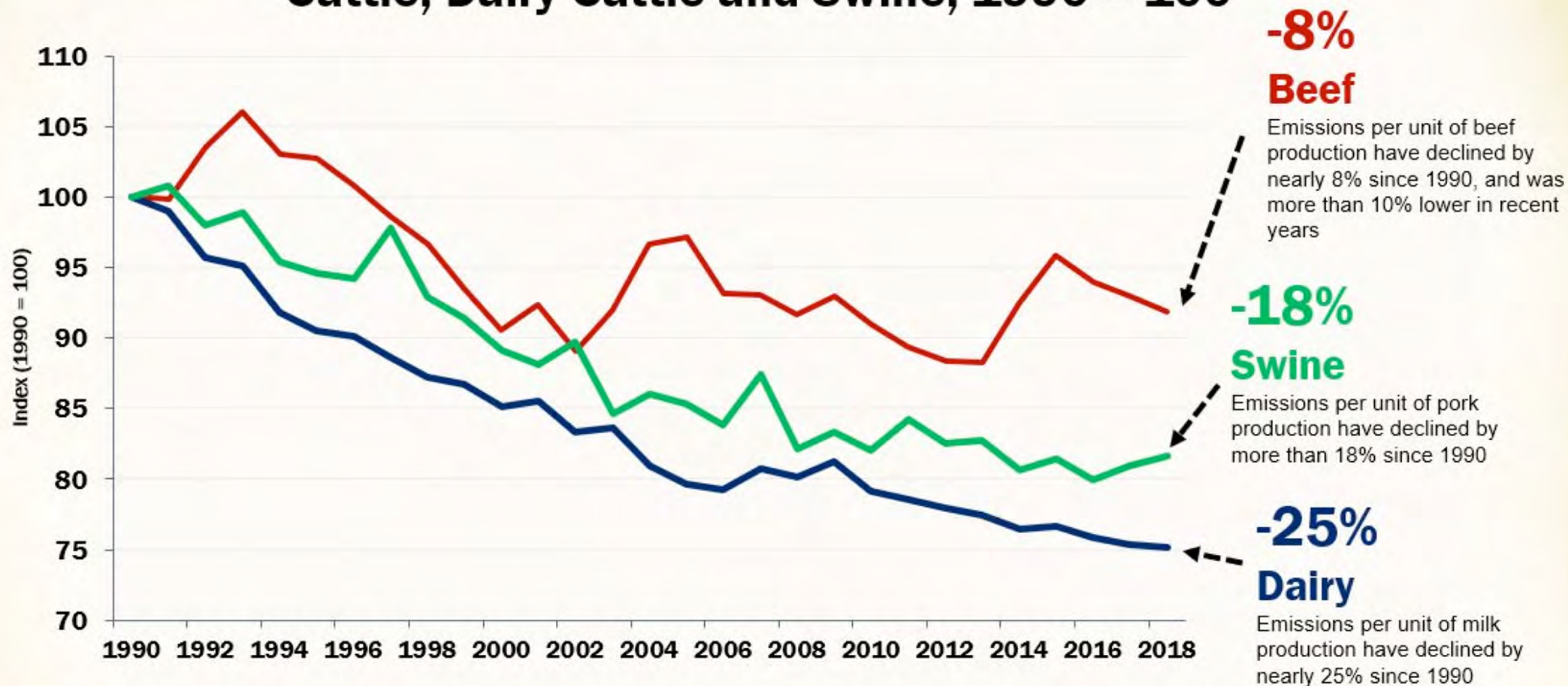
Global estimates in grams, CO<sub>2</sub>-equivalent



# Distribution among Phases

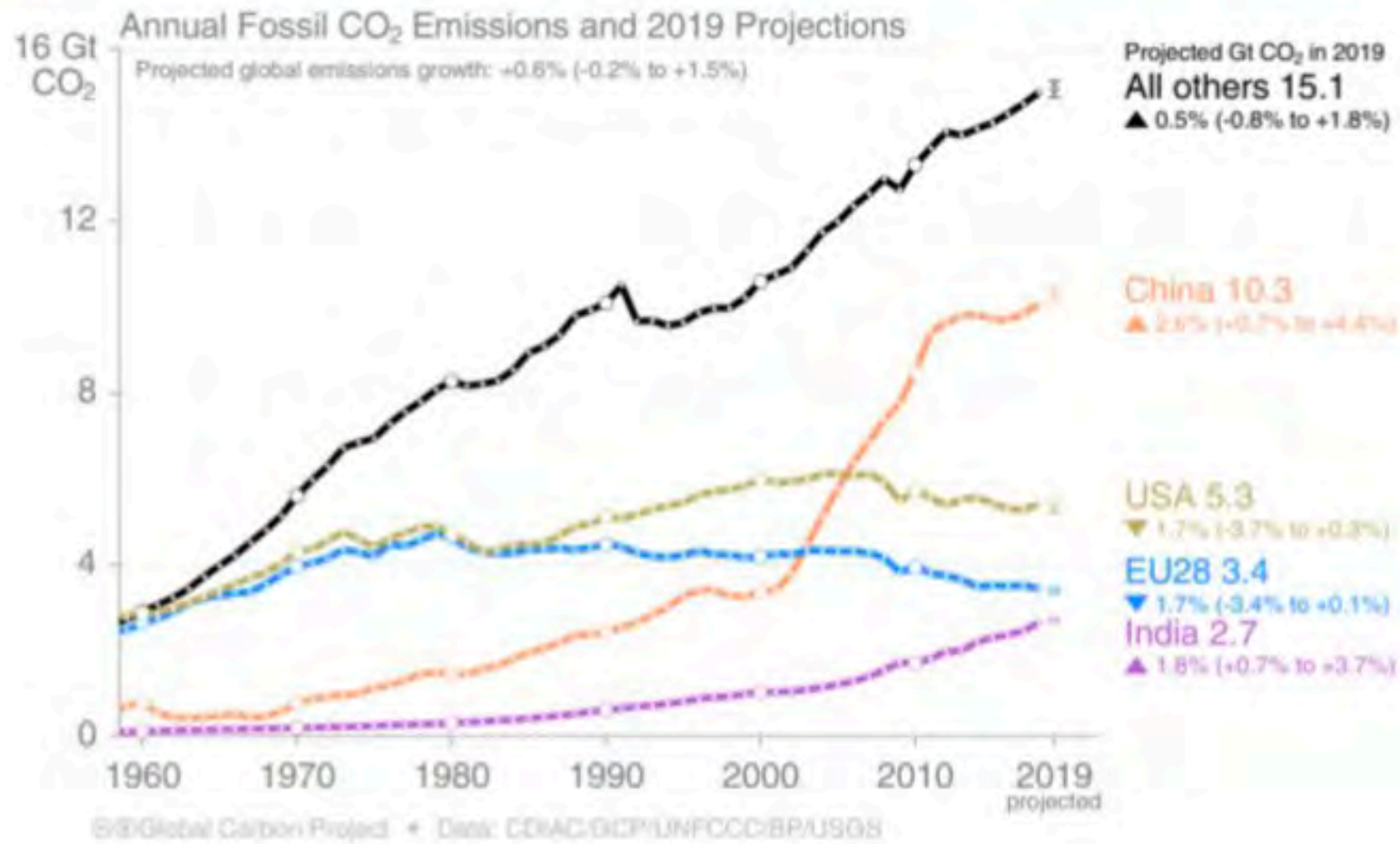


# Figure 4. Index of Methane Emissions Per Unit of Production for Beef Cattle, Dairy Cattle and Swine, 1990 = 100



# Emissions Projections for 2019

Global fossil CO<sub>2</sub> emissions are projected to rise by 0.6% in 2019 [range: -0.2% to +1.5%]  
 The global growth is driven by the underlying changes at the country level.



## Sources = Sinks



34.7 GtCO<sub>2</sub>/yr  
86%



14%  
5.5 GtCO<sub>2</sub>/yr

17.9 GtCO<sub>2</sub>/yr  
44%



29%  
11.5 GtCO<sub>2</sub>/yr



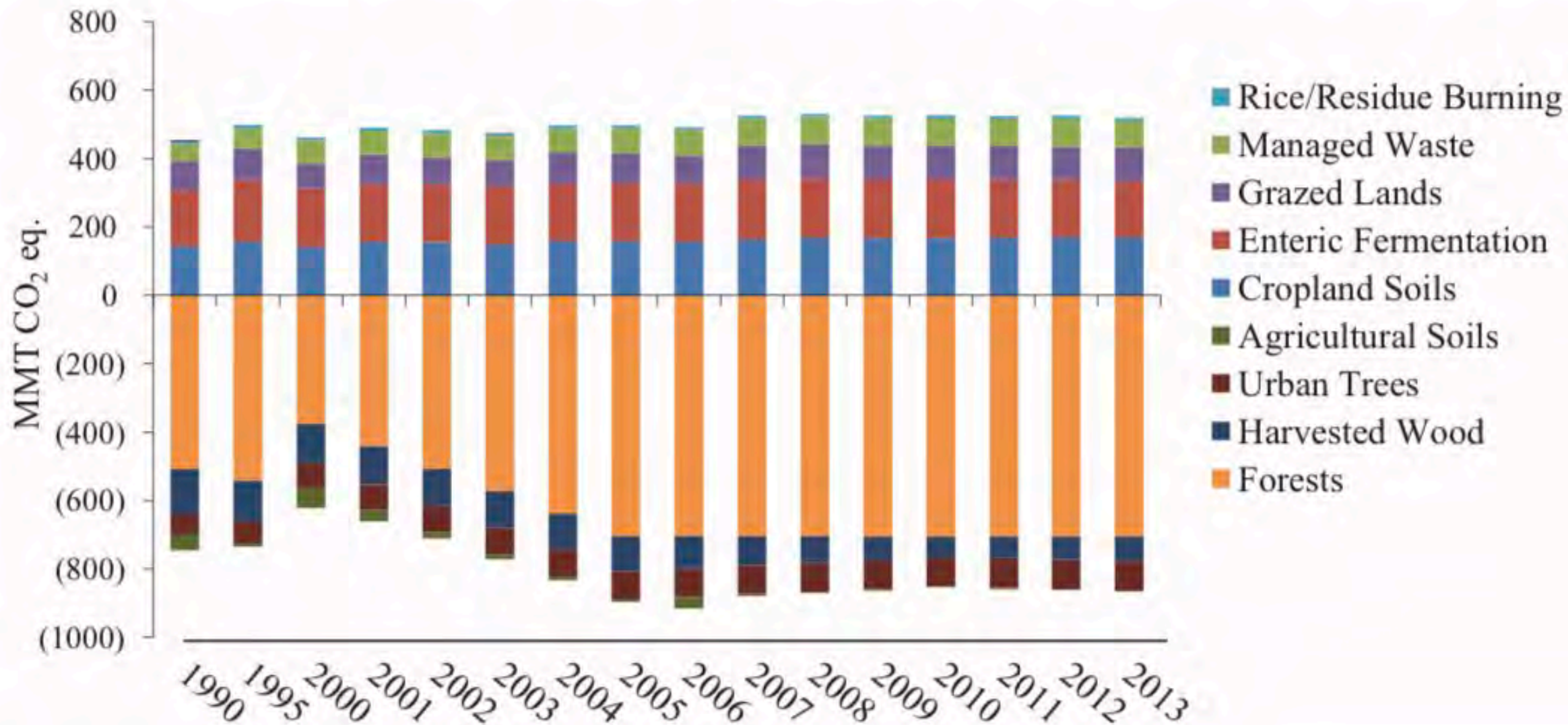
23%  
9.2 GtCO<sub>2</sub>/yr



**Budget Imbalance:**  
(the difference between estimated sources & sinks)

4%  
1.6 GtCO<sub>2</sub>/yr

# U.S. Agriculture and Forestry Greenhouse Gas Inventory: 1990-2013



**Figure 1-3 Agriculture and Forestry Emissions and Offsets for 1990, 1995, 2000-2013**  
 (MMT CO<sub>2</sub> eq. is million metric tons of carbon dioxide equivalent)

# Resources

- Dr. Frank Mitloehner – UC Davis, California
  - Twitter @GHGGuro
  - Clear Center – UC Davis, California
- <https://beef.tamu.edu>



**Frank Mitloehner**

12.8K Tweets



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UC Davis Professor & Air Quality CE Specialist, Dept Animal Science; Director, CLEAR Center; Opinions are mine, Blog: [clear.ucdavis.edu/blog](https://clear.ucdavis.edu/blog)



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# Rethinking Methane

New Paper on How California Dairy Can Achieve Climate Neutrality

<http://beef.tamu.edu>

<http://animalscience.tamu.edu/wp-content/uploads/sites/14/2016/01/Methane-and-Grassfed-Beef.pdf>

[rgill@tamu.edu](mailto:rgill@tamu.edu)