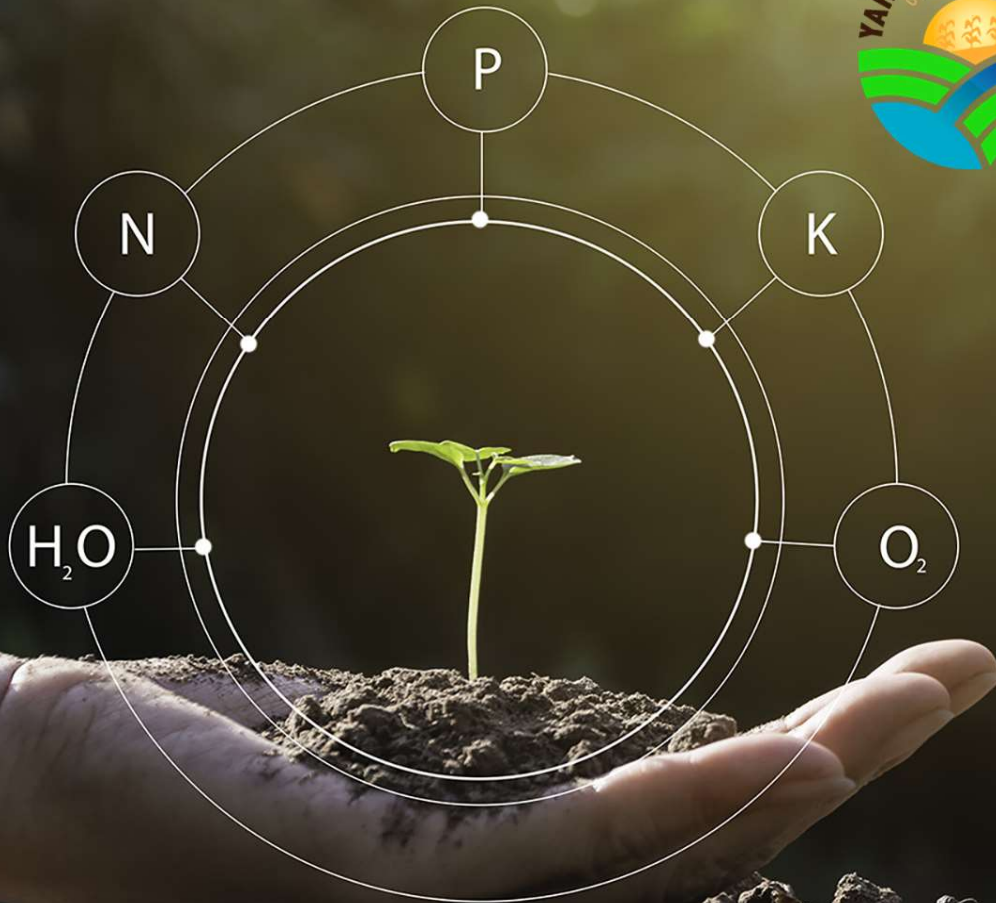




Yahara Pride Farms Watershed Wide Conference

March 5th, 2025

**Keynote Speaker:
Dr. Frank Mitloehner
UC-Davis**





SUSTAINABLE LIVESTOCK, SUSTAINABLE FUTURE

WHY WE NEED A TOOLKIT
OF SOLUTIONS TO
IMPROVE SUSTAINABILITY
IN ANIMAL AGRICULTURE

Frank Mitloehner, Professor, Air Quality Specialist, Director
fmnmitloehner@ucdavis.edu

 **UC DAVIS**
CLEAR Center

CLEAR Center at UC Davis

The Center leverages its two cores
– **research and science communication** – to help
animal agriculture become more sustainable.

clear.ucdavis.edu – a resource for you on animal agriculture and sustainability

Topical Explainers

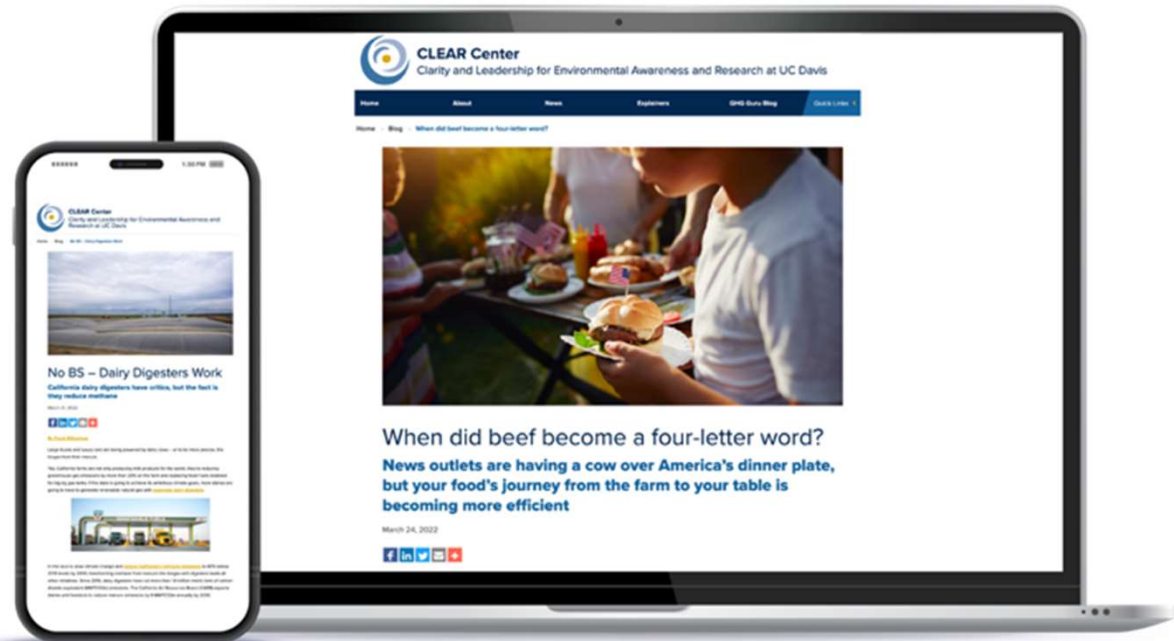
Articles that explain a topic or concept. For example, “What is a dairy digester?”

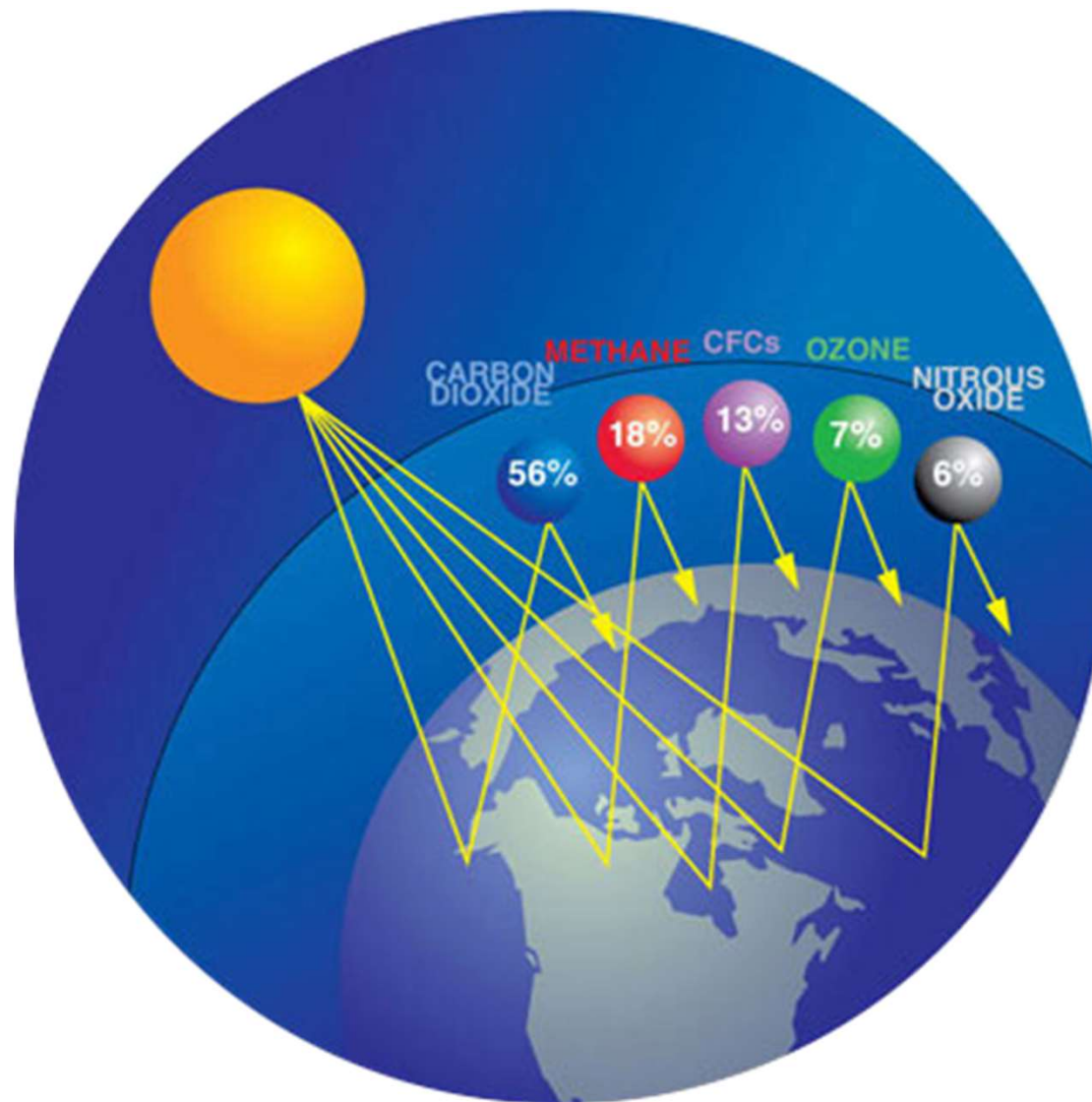
Blogs

Like op-eds, our blog offers perspective and context to topics around animal agriculture.

News Stories

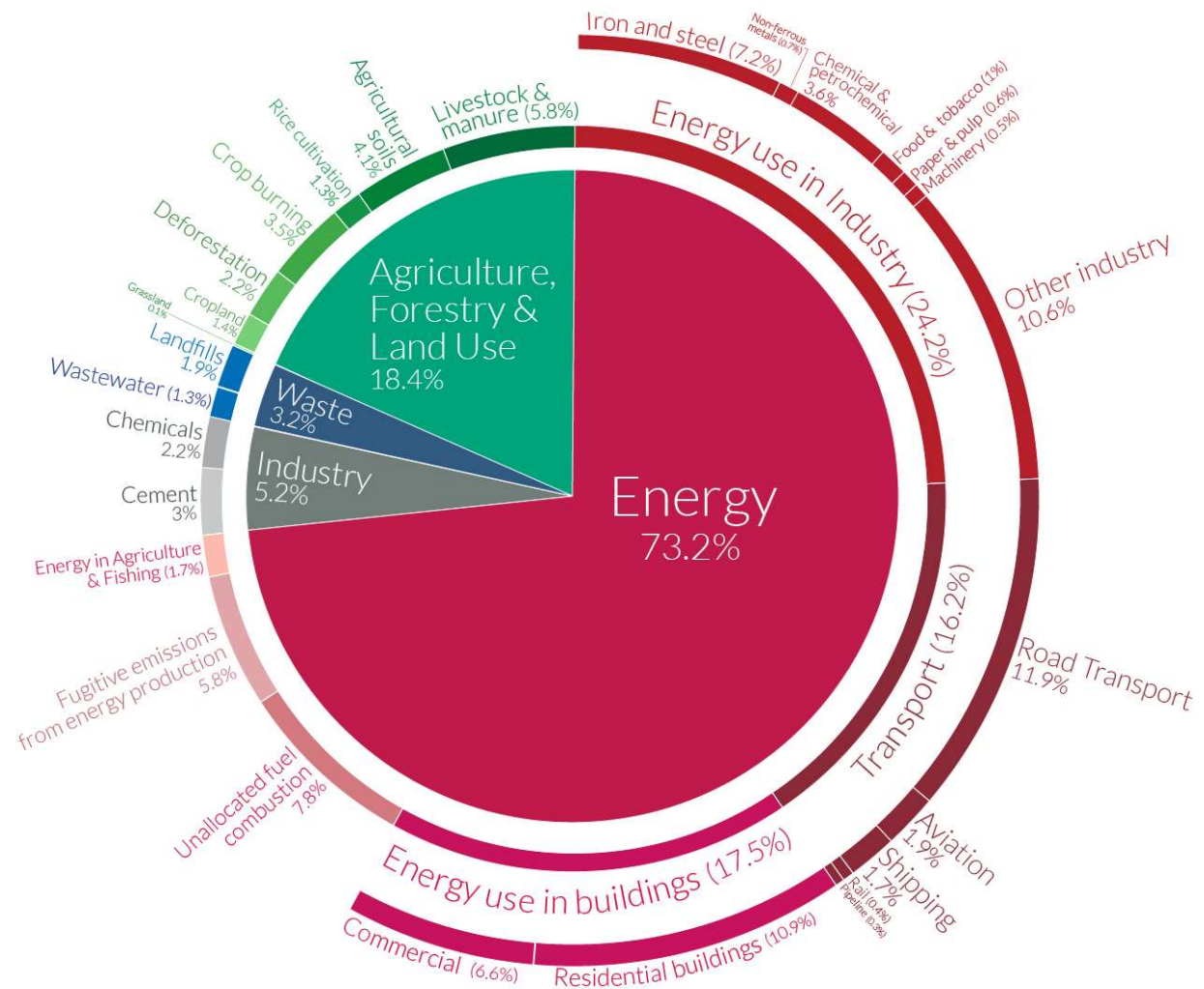
News-style articles that highlight research and CLEAR Center news.





Global Greenhouse Gas Emissions by Sector

Emissions from 2016, when global greenhouse gas emissions totaled 49.4 GT (billion tons) CO₂eq.

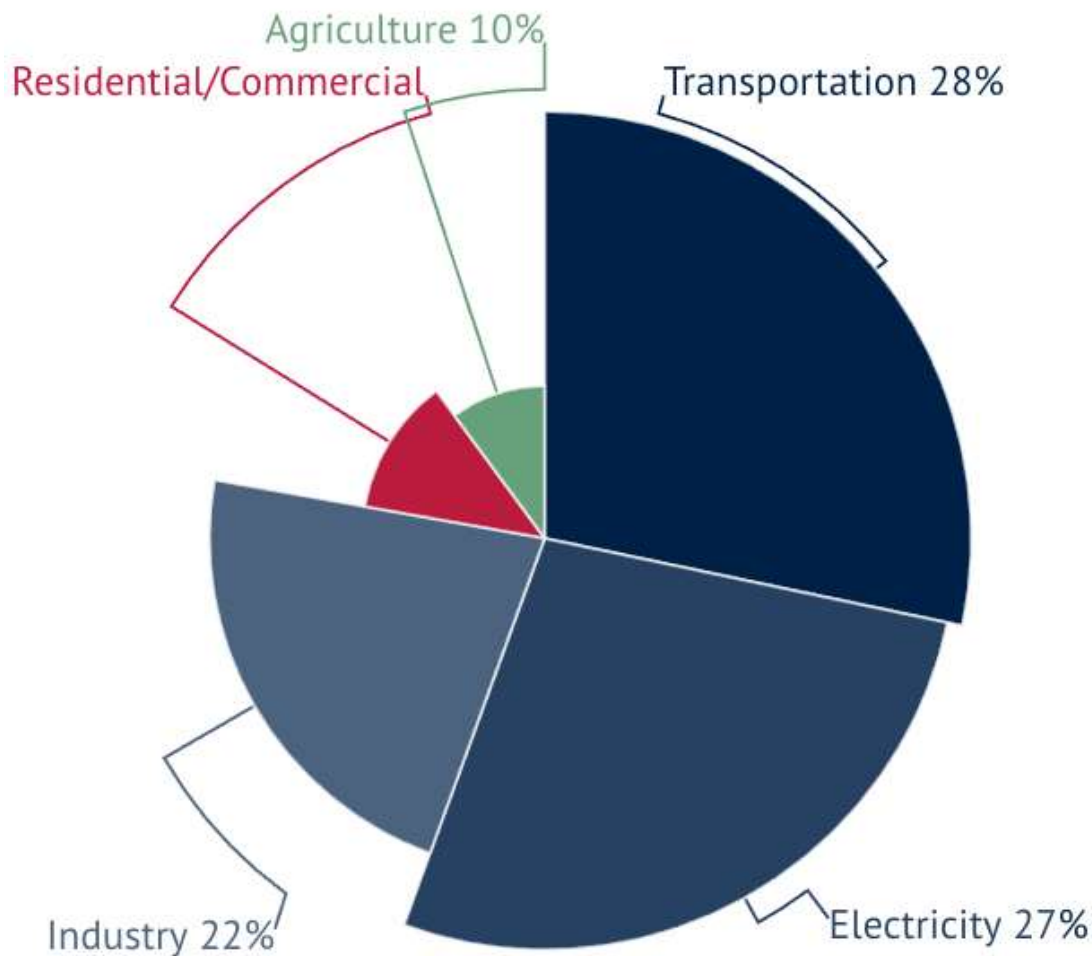


OurWorldinData.org – Research and data to make progress against the world's largest problems.

Source: Climate Watch, the World Resources Institute (2020).

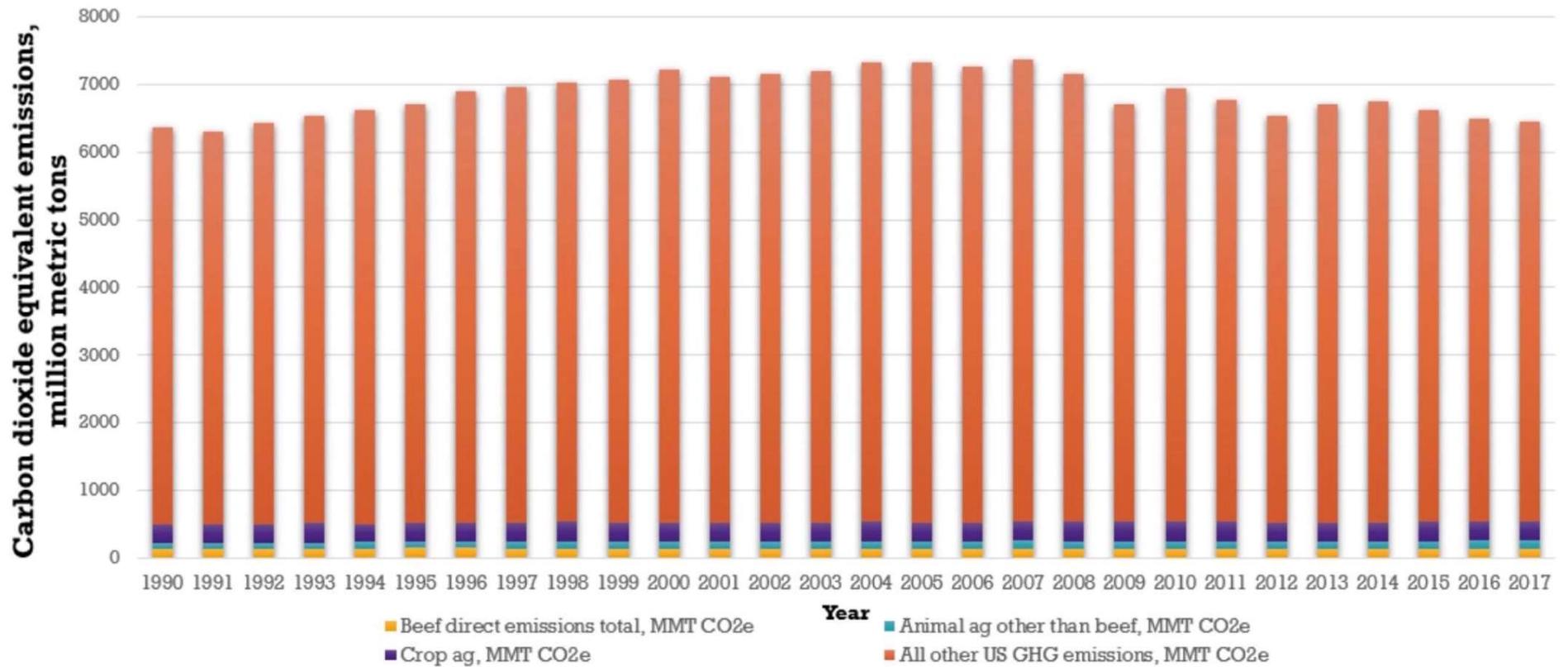
Licensed under CC-BY by the author Hannah Ritchie (2020).

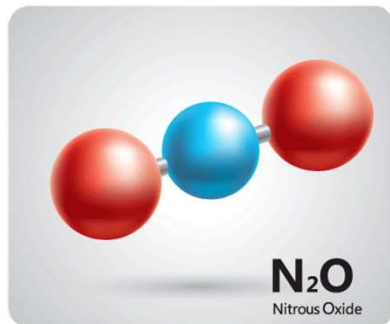
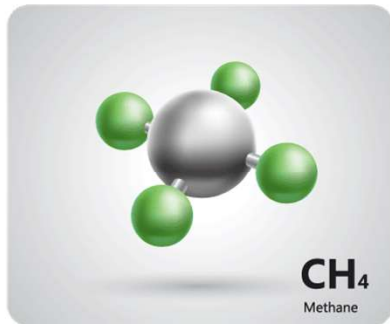
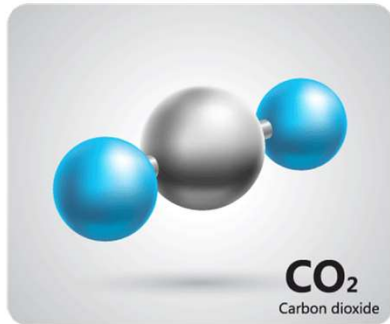
United States Greenhouse Gas Emissions by Sector



Total U,S, Emissions in 2018 =
6,677 [Million Metric Tons of CO₂ equivalent](https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions). Source: <https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions>

Trends in US Greenhouse Gas Emissions, 1990 - 2017 (source: EPA GHG Inventory)





Global Warming Potential (GWP₁₀₀) of Main Greenhouse Gases

Carbon Dioxide (CO₂) 1

Methane (CH₄) 28

Nitrous Oxide (N₂O) 265

GLOBAL METHANE BUDGET



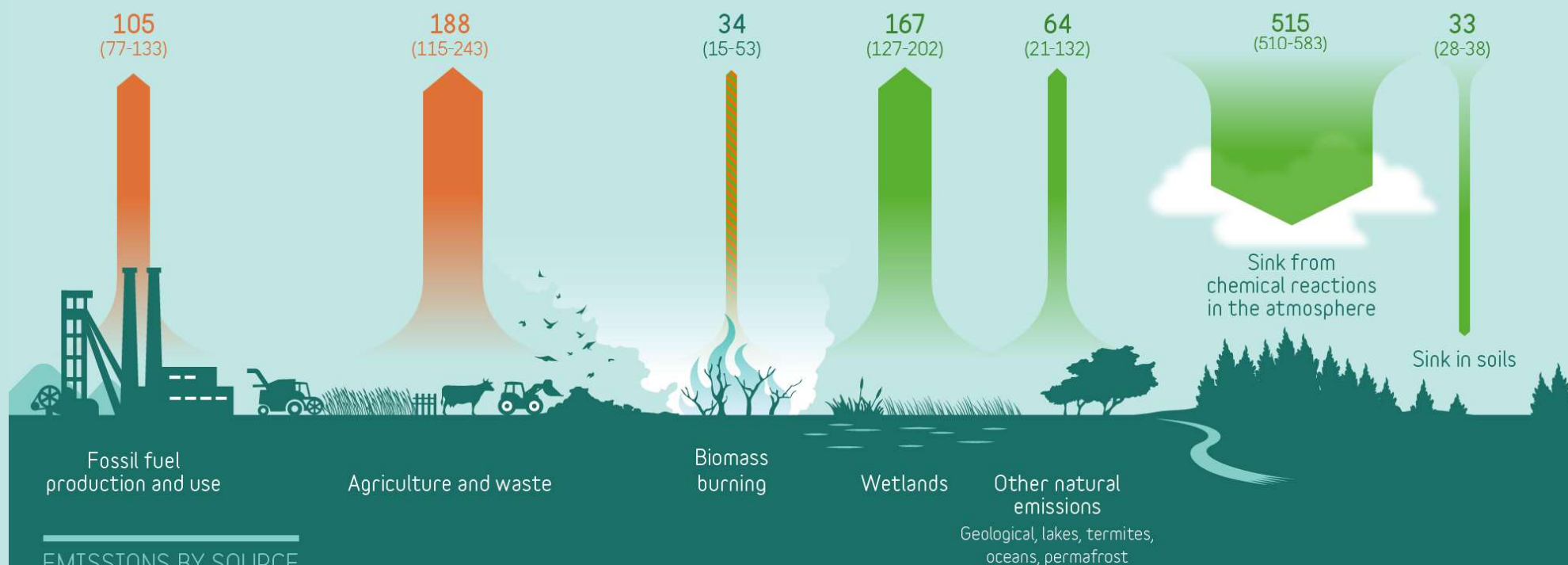
TOTAL EMISSIONS

558
(540-568)

CH₄ ATMOSPHERIC
GROWTH RATE
10
(9.4-10.6)

TOTAL SINKS

548
(529-555)

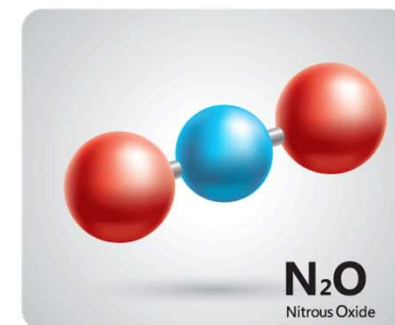
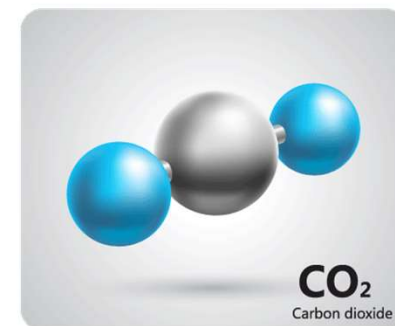


Half-Life of Main Greenhouse Gases in Years

Carbon Dioxide (CO₂) 1,000

Methane (CH₄) 12

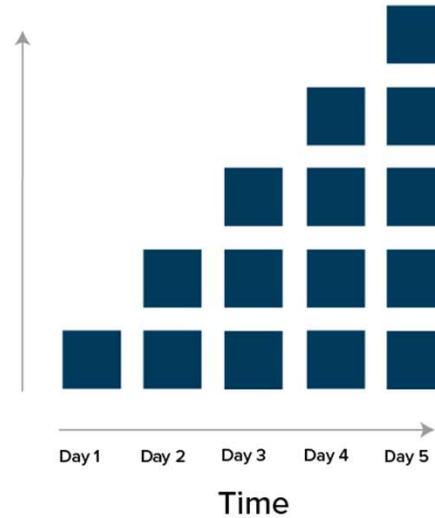
Nitrous Oxide (N₂O) 110



■ = Pulse of CO₂

Stock
Gas
Carbon dioxide
(CO₂)

Atmospheric
Concentration

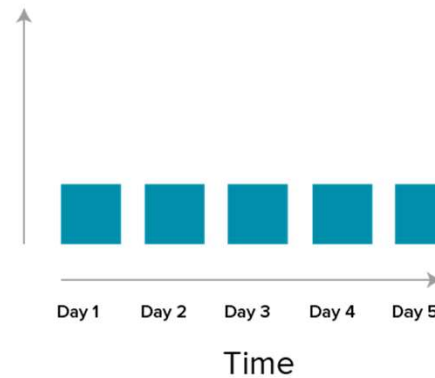


Stock gases will accumulate over time, because they stay in the environment.

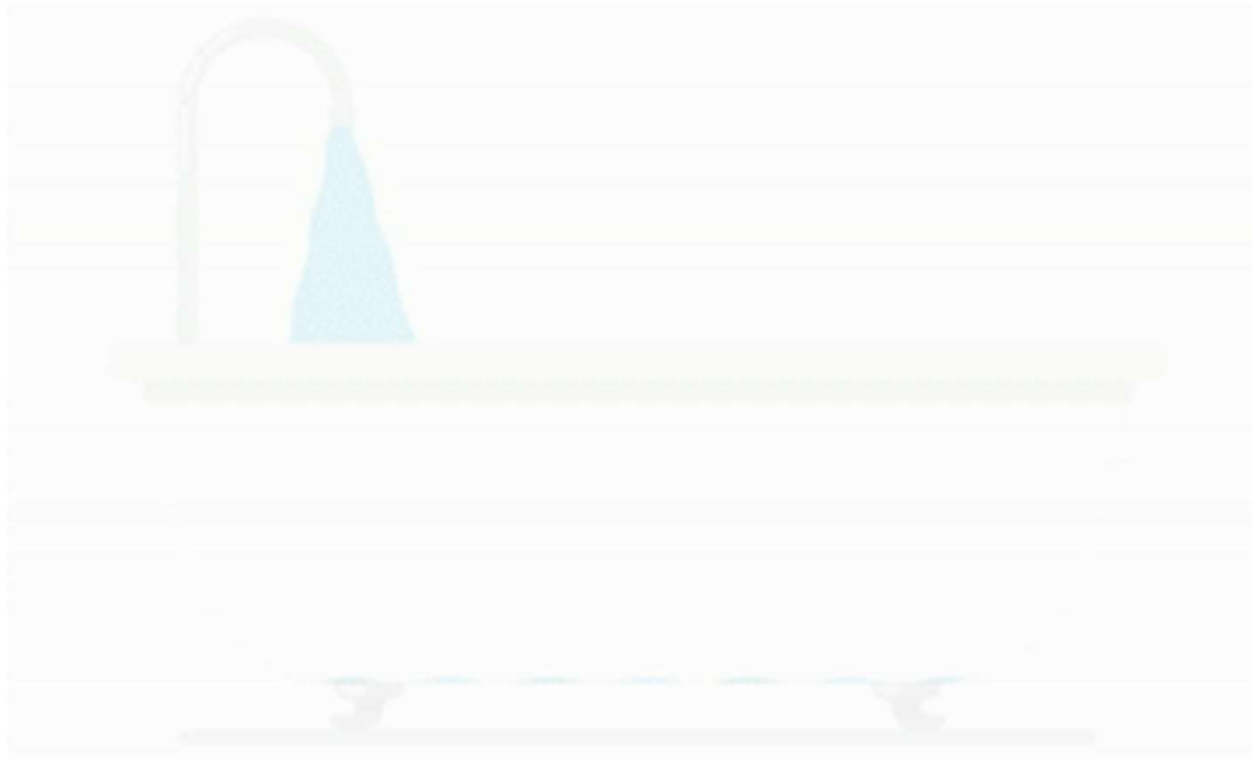
■ = Pulse of CH₄

Flow
Gas
Methane (CH₄)

Atmospheric
Concentration



Flow gases will stay stagnant, as they are destroyed at the same rate of emission.



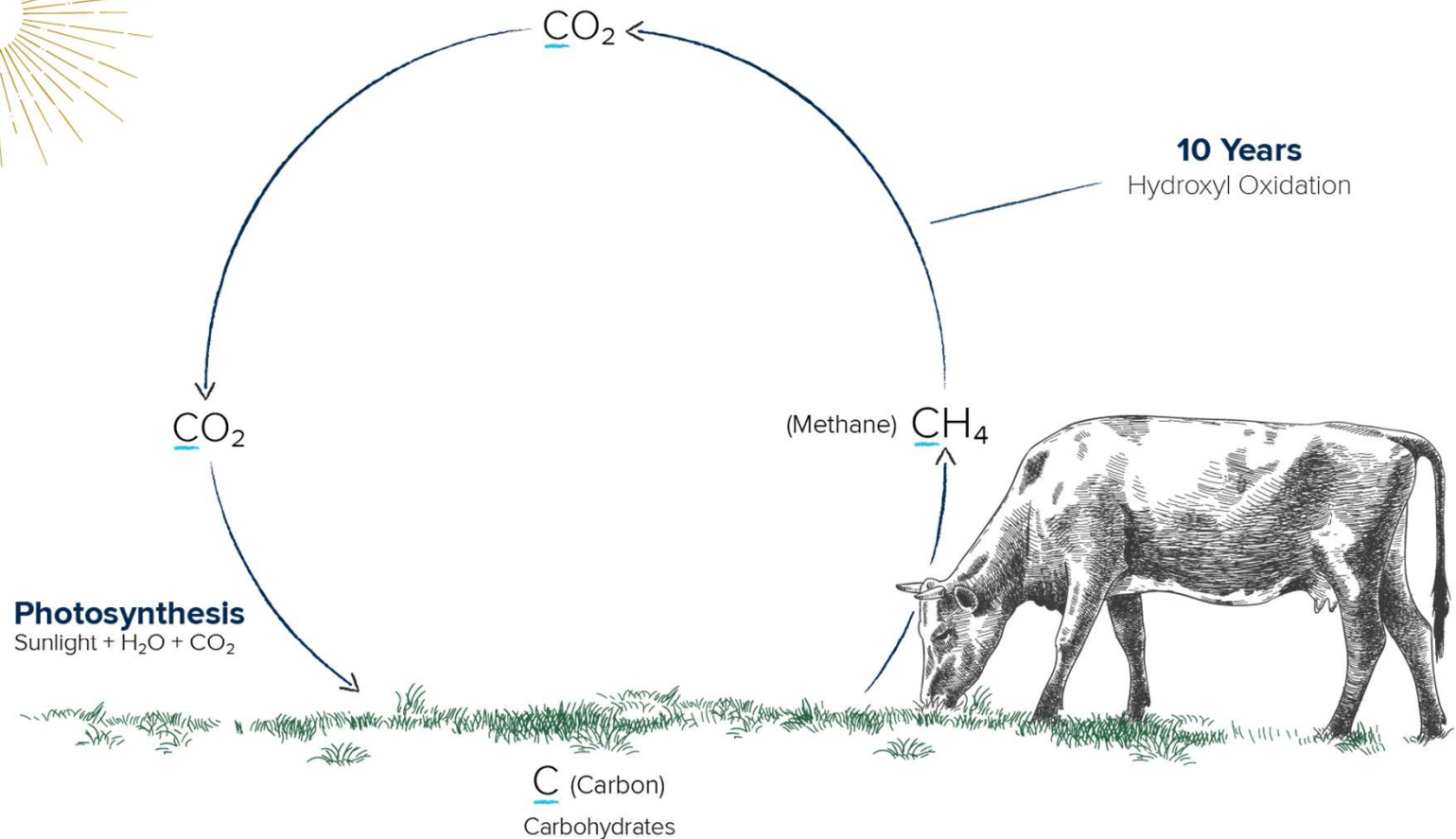
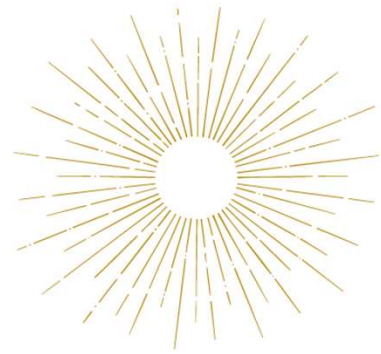
CO2



CH4

Biogenic Carbon Cycle

Methane - CH_4



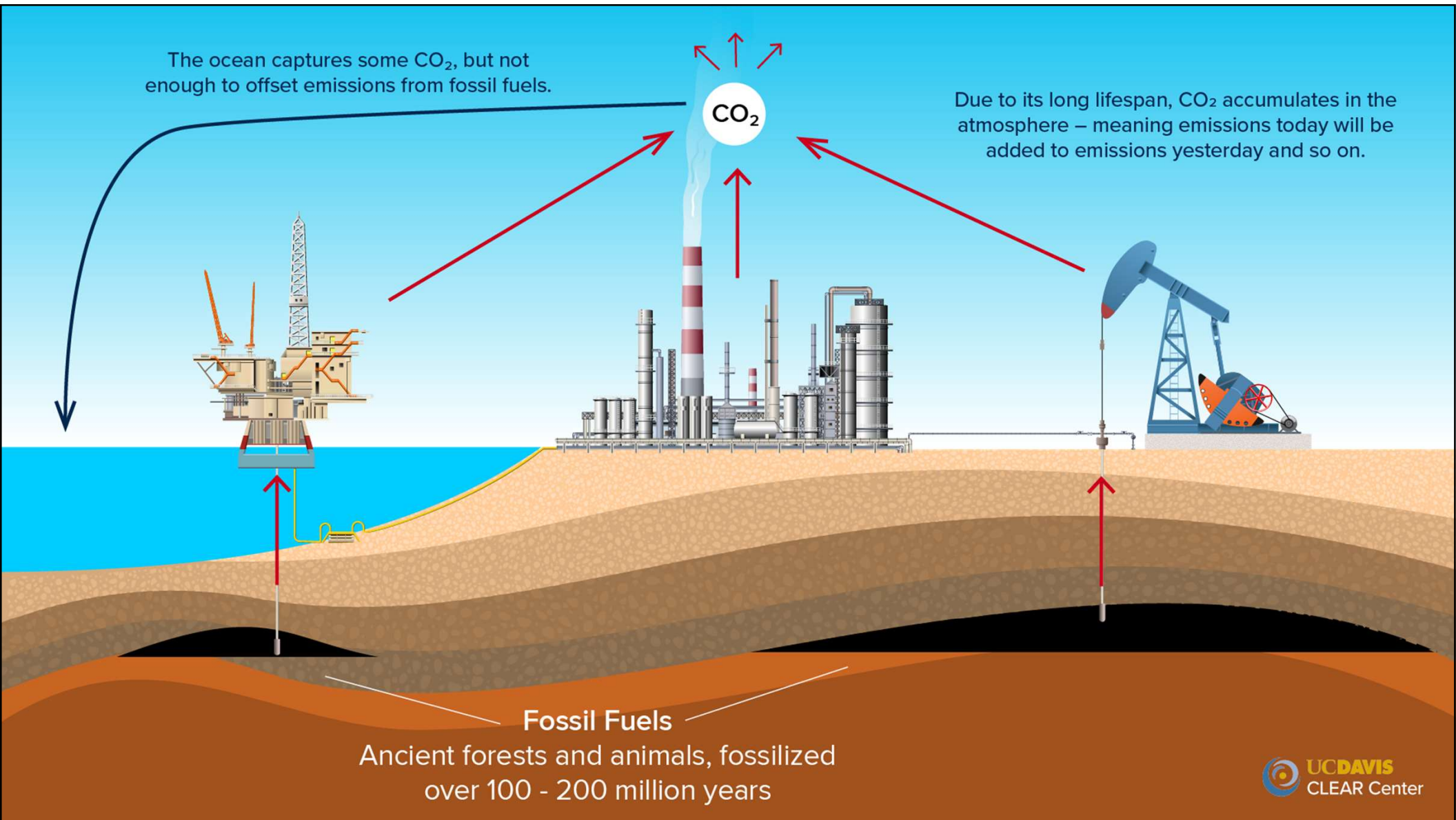
The ocean captures some CO₂, but not enough to offset emissions from fossil fuels.

Due to its long lifespan, CO₂ accumulates in the atmosphere – meaning emissions today will be added to emissions yesterday and so on.

CO₂

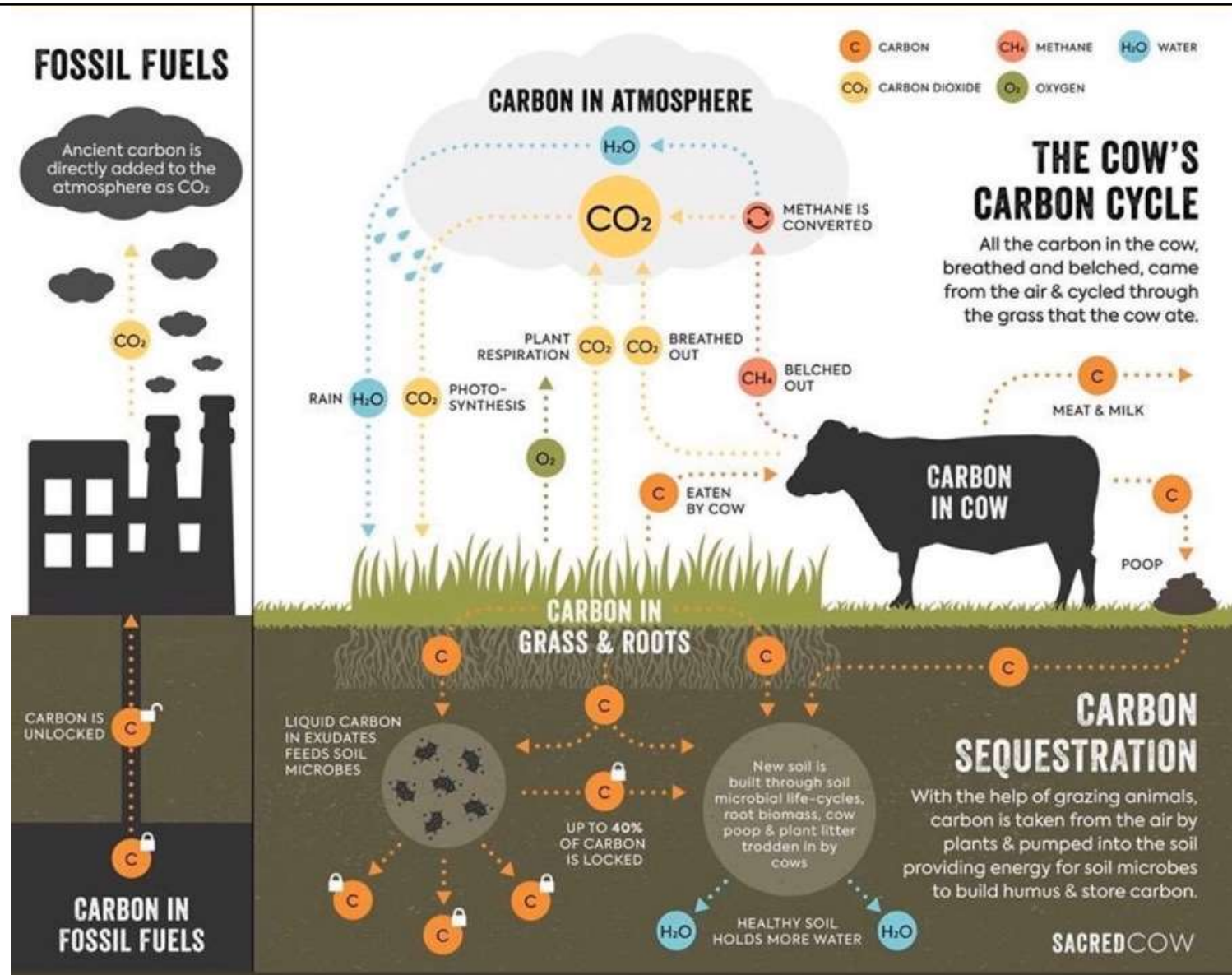
Fossil Fuels

Ancient forests and animals, fossilized
over 100 - 200 million years

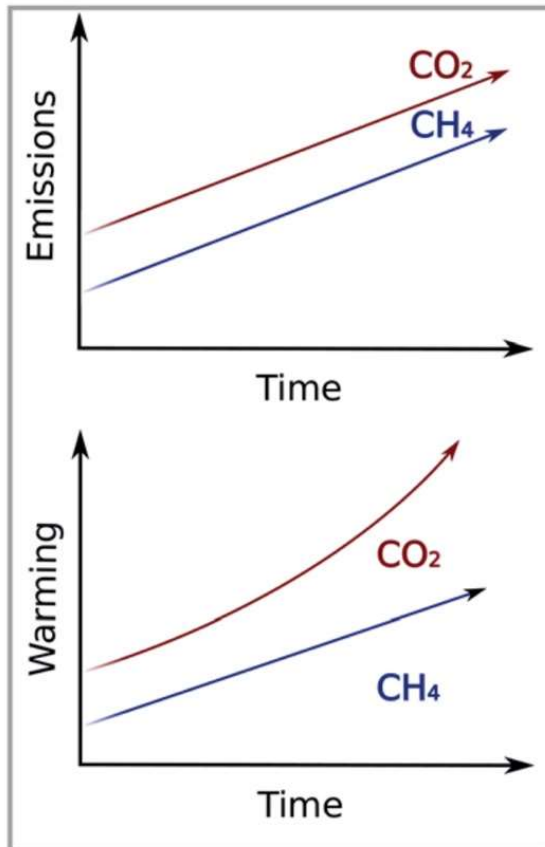


Fossil vs. Biogenic Carbon

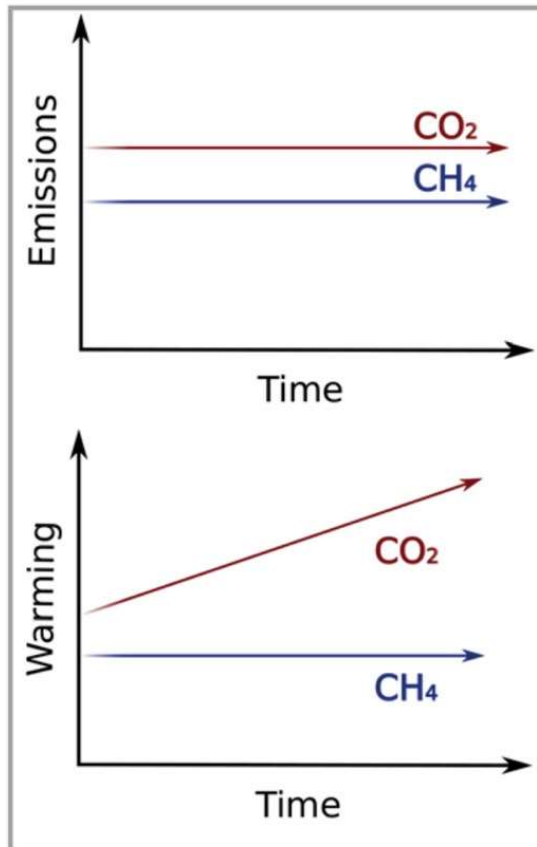
Via:
@sustainabledish
sacredcow.info



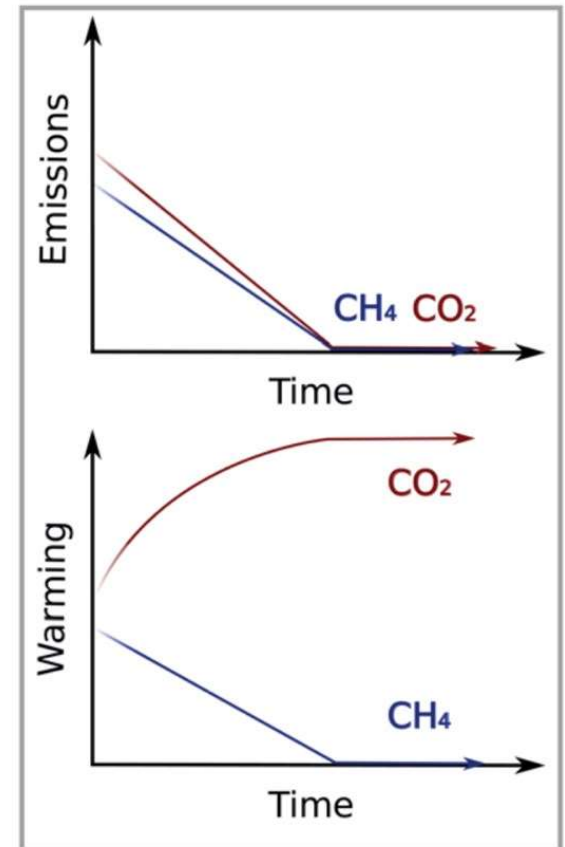
Rising emissions

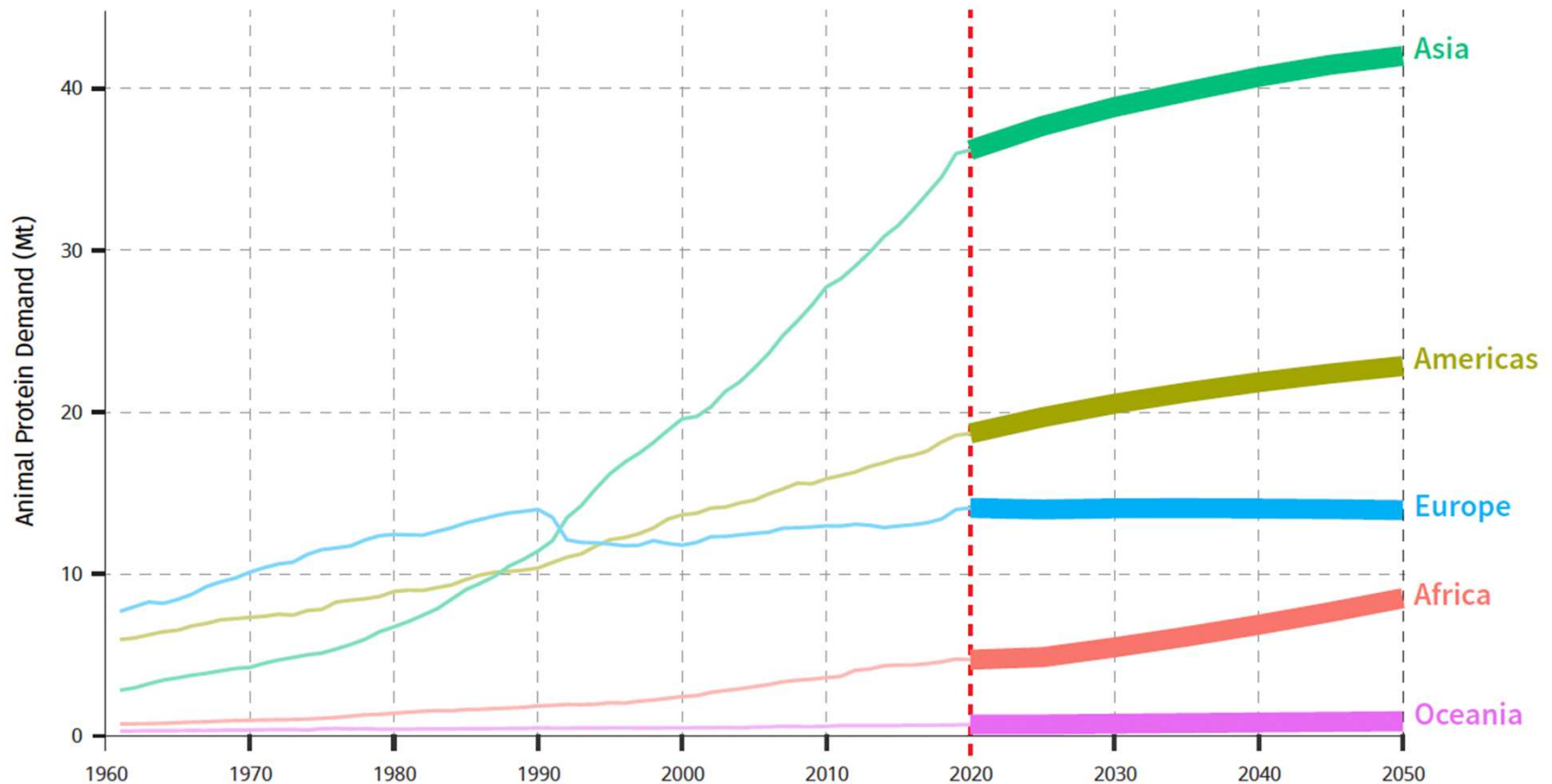


Constant emissions

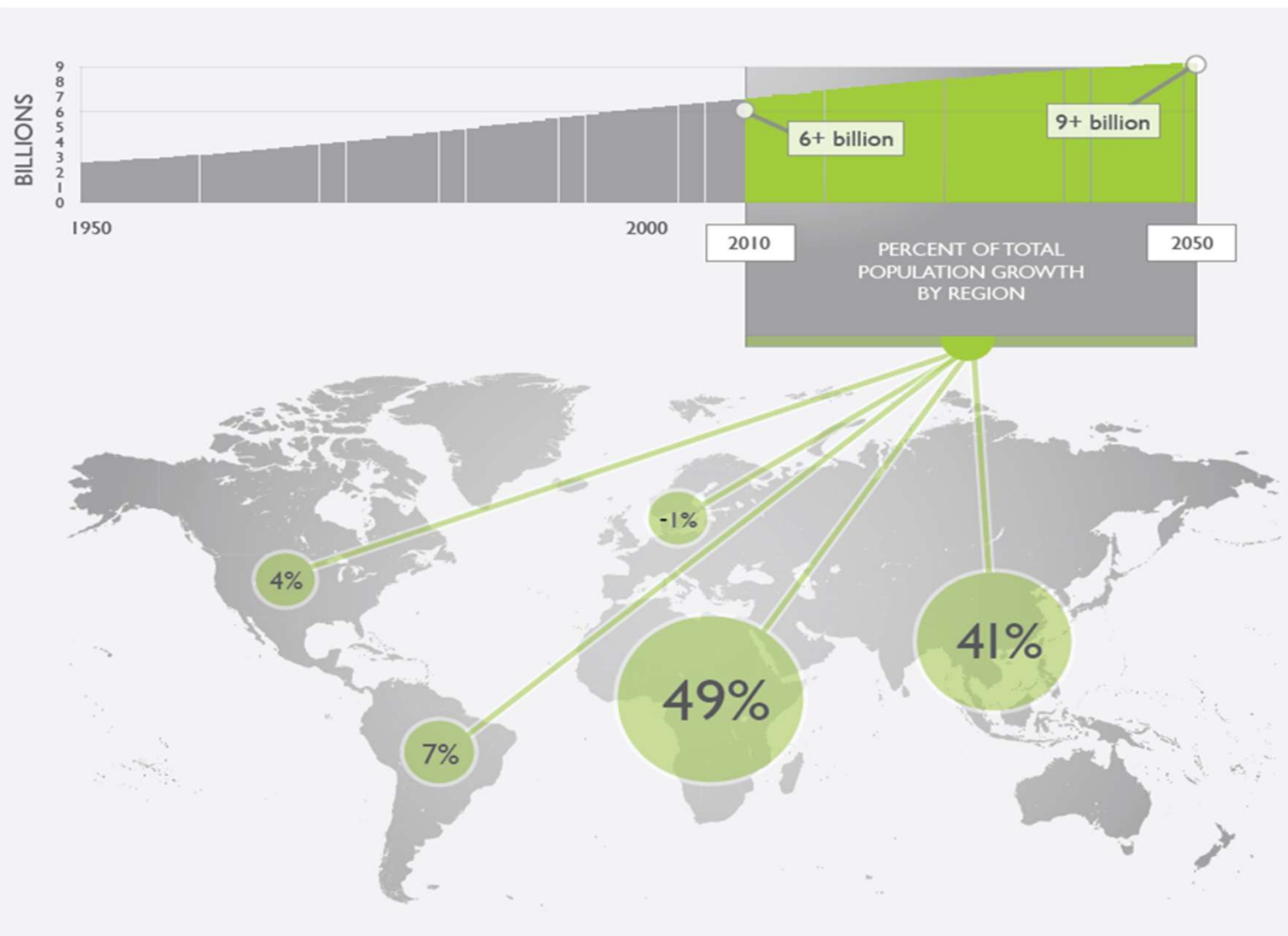


Falling emissions





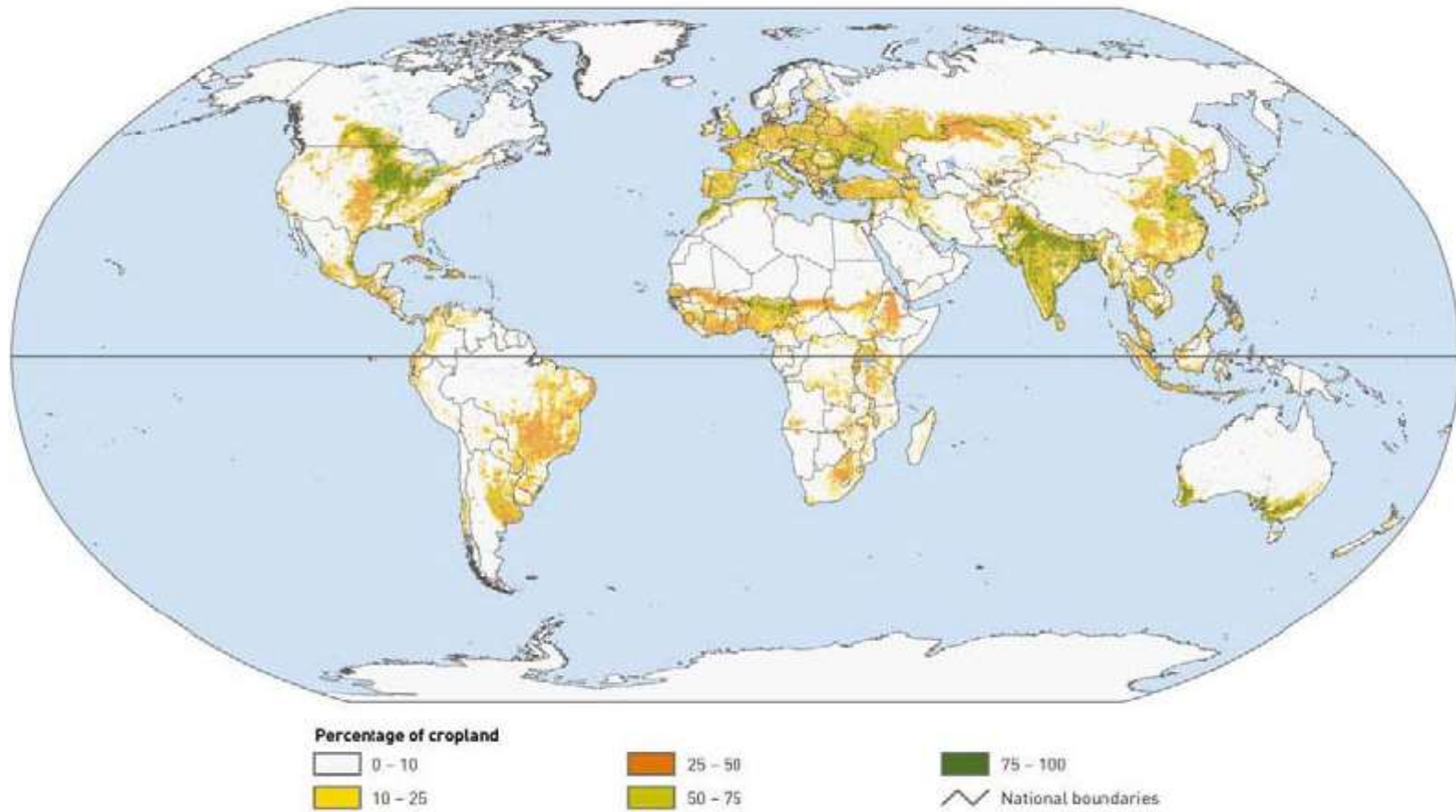
Historical and projected demand for animal products. Source: Based on FAOSTAT food balance sheets and the projected demand from FAO. 2018b. *The future of food and agriculture: Alternative pathways to 2050*. Rome. <https://www.fao.org/global-perspectivesstudies/resources/detail/en/c/1157074/>. **Pathways towards lower emissions – A global assessment of the greenhouse gas emissions and mitigation options from livestock agrifood systems.**





**There are more people living inside
this circle than outside of it.**

Distribution of cropland



FAO (2006)

**What are our
pathways to
reduce emissions
in animal
agriculture?**



It was celebrated
that the UN FAO
would tell the
world to eat less
meat at COP 28.



Green | Greener Living

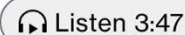
Eat Less Meat Is Message for Rich World in Food's First Net Zero Plan

- UN's FAO is set to publish plan for food's climate transition
- Food expected to take more focus at COP28 summit in Dubai



By [Agnieszka de Sousa](#)

November 25, 2023 at 5:00 PM PST



This article is for **subscribers only**.

The world's most-developed nations will be told to curb their excessive appetite for meat as part of the first comprehensive plan to bring the global agrifood industry into line with the Paris climate agreement.

They didn't.

Guardian

News | Opinion | Sport | Culture | Lifestyle

US | US politics | World | **Climate crisis** | Middle East | Ukraine | Oscars | Soccer | Business | Environment | Tech

Food

This article is more than 11 months old

'Bewildering' to omit meat-eating reduction from UN climate plan

Academic experts also criticise UN Food and Agriculture Organization for dismissing alternative proteins





Green | Greener Living

Eat Less Meat Is Message for Rich World in Food's First Net Zero Plan

- UN's FAO is set to publish plan for food's climate transition
- Food expected to take more focus at COP28 summit in Dubai



By [Agnieszka de Sousa](#)

November 25, 2023 at 5:00 PM PST

Save

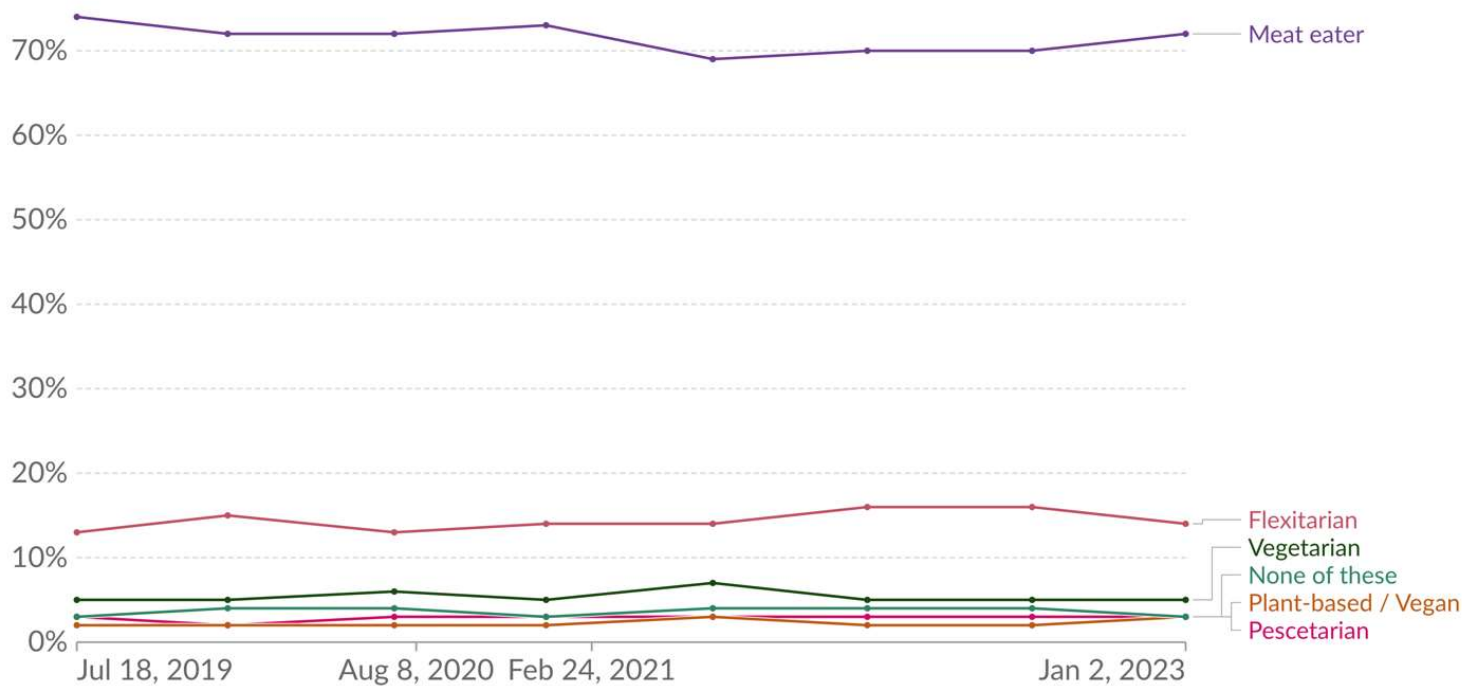
The world's most-developed nations will be told to curb their excessive appetite for meat as part of the first comprehensive plan to bring the global agrifood industry into line with the Paris climate agreement.

The global food systems' road map to 1.5C is expected to be published by the United Nations' Food & Agriculture Organization during the COP28 summit next month. Nations that over-consume meat will be advised to limit their intake, while developing countries – where under-consumption of meat adds to a prevalent nutrition challenge – will need to improve their livestock farming, according to the FAO.

Vegans, vegetarians and meat-eaters: self-reported dietary choices, United Kingdom, All adults, Jul 18, 2019 to Jan 2, 2023

Our World
in Data

- Flexitarian: mainly vegetarian, but occasionally eat meat or fish.
- Pescetarian: eat fish but do not eat meat or poultry.
- Vegetarian: do not eat any meat, poultry, game, fish, or shellfish.
- Plant-based / Vegan: do not eat dairy products, eggs, or any other animal product.



Diet choices
in the UK

Data source: YouGov (2023).

OurWorldInData.org/meat-production | CC BY

Note: Based on biannual survey data of adults aged 18 years and older. Around 2000 adults are included per survey.

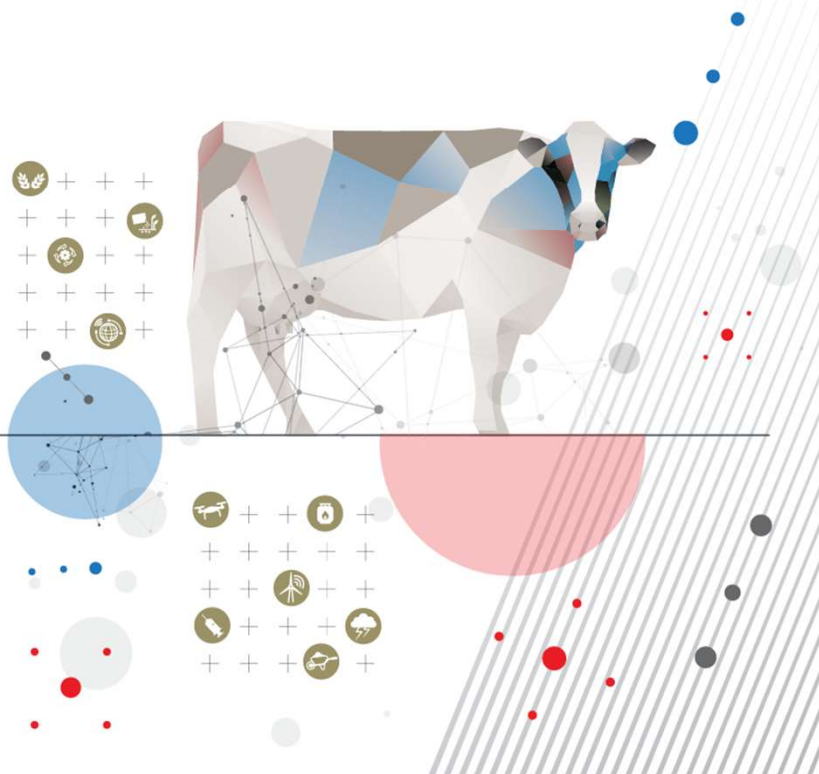
Edouard Mathieu and Hannah Ritchie (2022) - "What share of people say they are vegetarian, vegan, or flexitarian?" Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/vegetarian-vegan' [Online Resource]



Food and Agriculture
Organization of the
United Nations

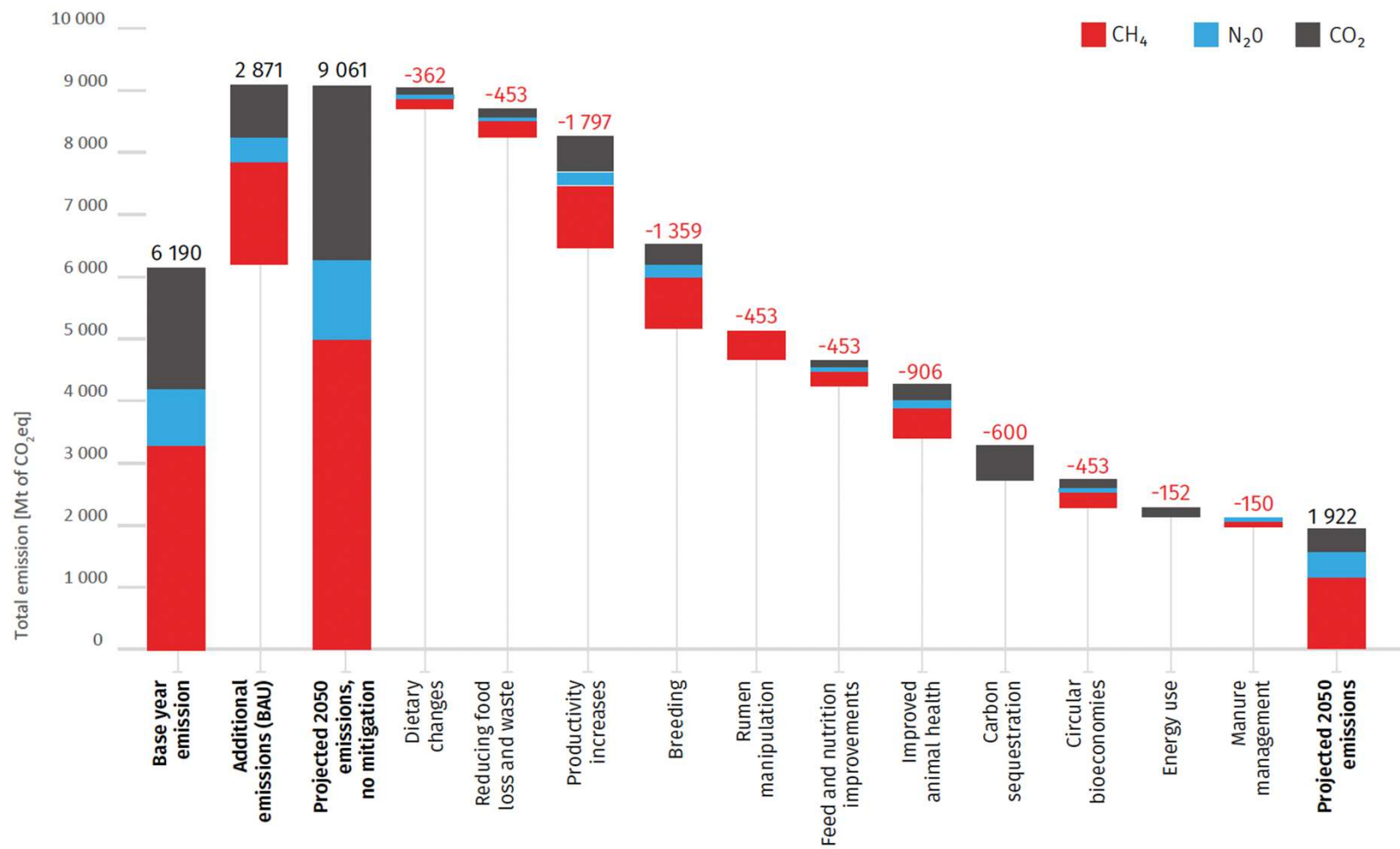
Pathways towards lower emissions

A global assessment of the greenhouse
gas emissions and mitigation options
from livestock agrifood systems



bitly

ucdavisclear.co/faopathways



Base year and projected emissions from livestock systems shown as a waterfall chart with a range of mitigation measures applied to 2050 with their technical potential. From: [Pathways towards lower emissions – A global assessment of the greenhouse gas emissions and mitigation options from livestock agrifood systems](#).



California Case Study

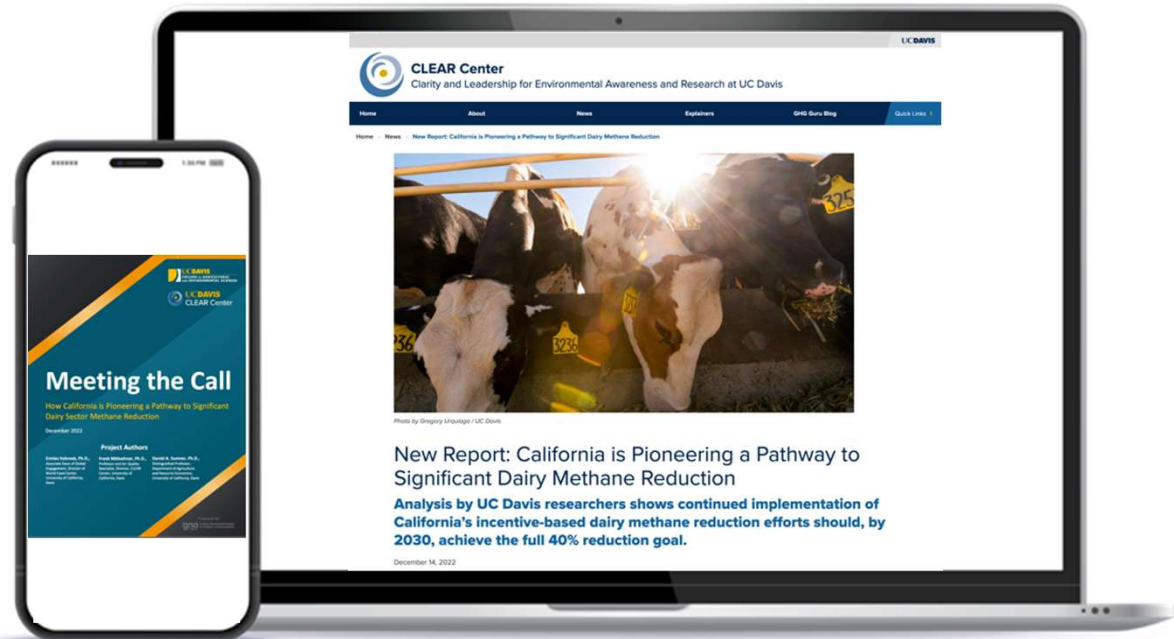
<https://bit.ly/pathwayclear>

Whitepaper highlighting benefits of incentive-based policies in GHG reductions



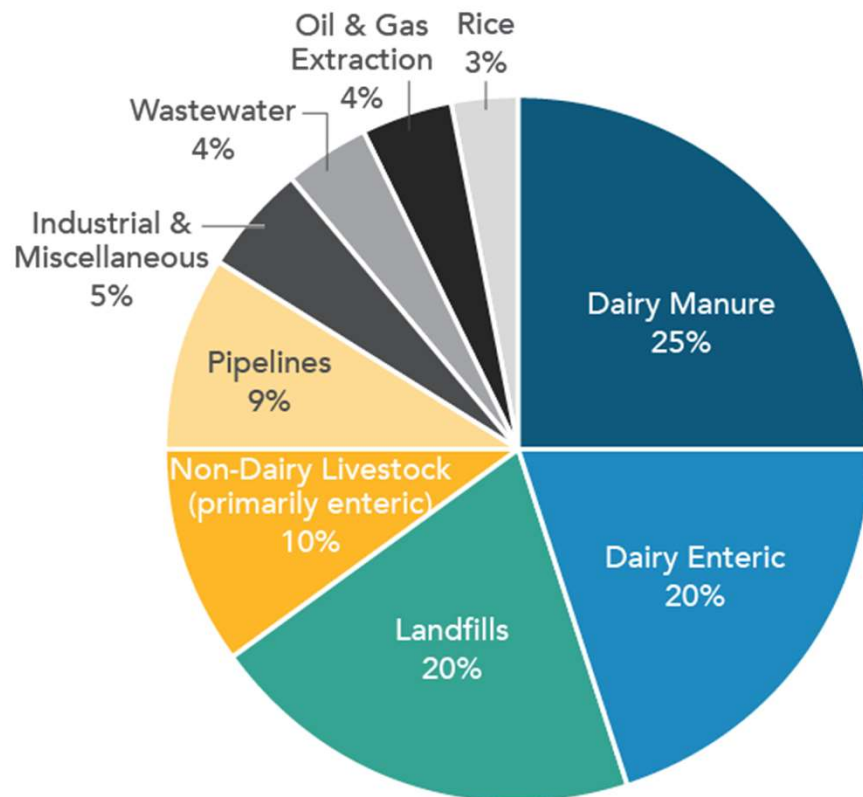
Use your cellphone camera to scan the QR code and take you to the article.

<https://bit.ly/pathwayclear>



Ambitious Goals in California

2013 Methane: 118 MMTCO₂e (20-yr GWP)

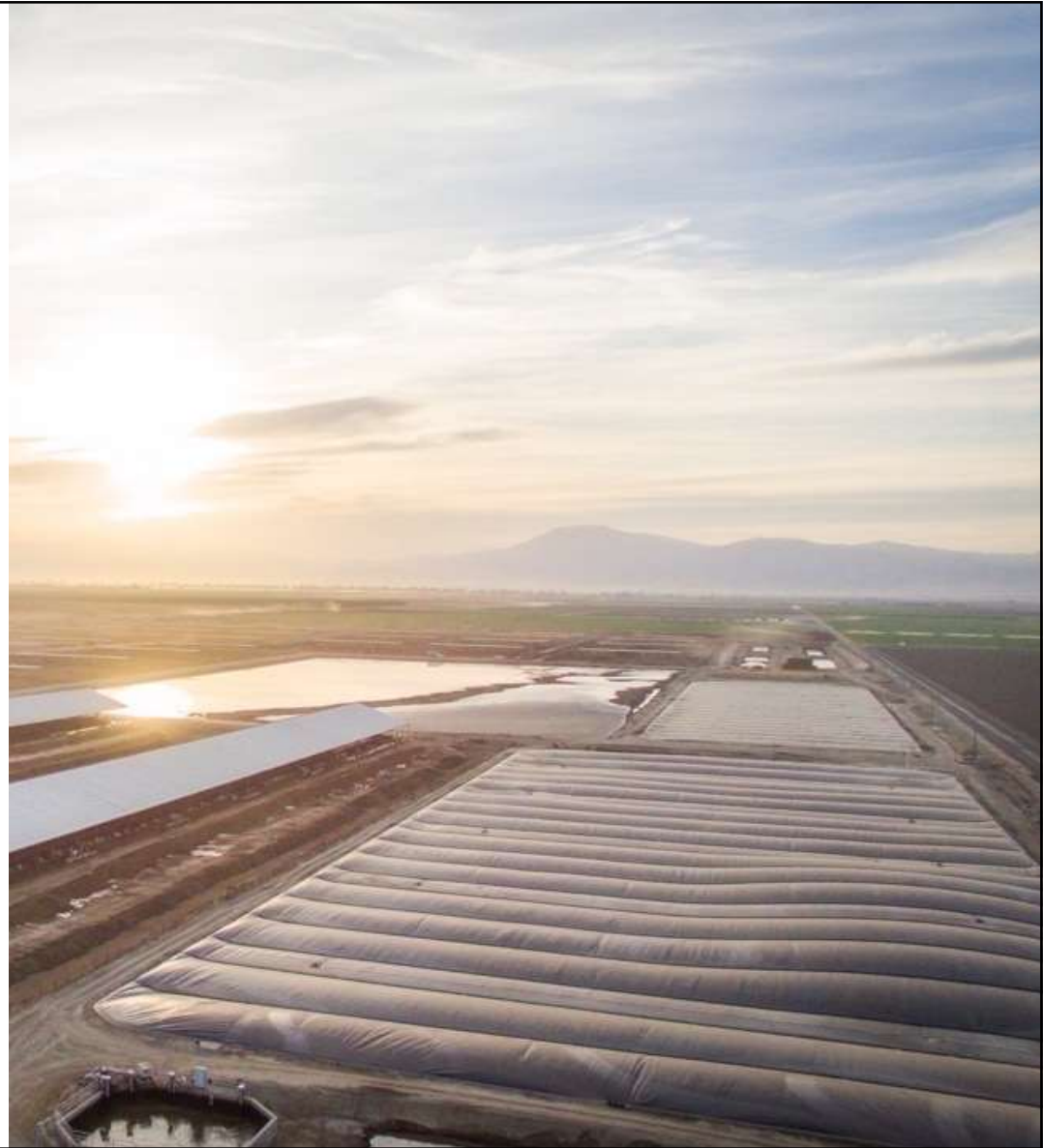


- California had set aggressive targets for reducing methane 40% below 2013 levels by 2030
- Dairy to reduce 7.2 MMTCO₂e
- 1.8 MMTCO₂e reductions coming from mostly beef cattle.

California dairy should exceed the full 40 percent reduction by 2030 = 7.61 – 10.59 MMT

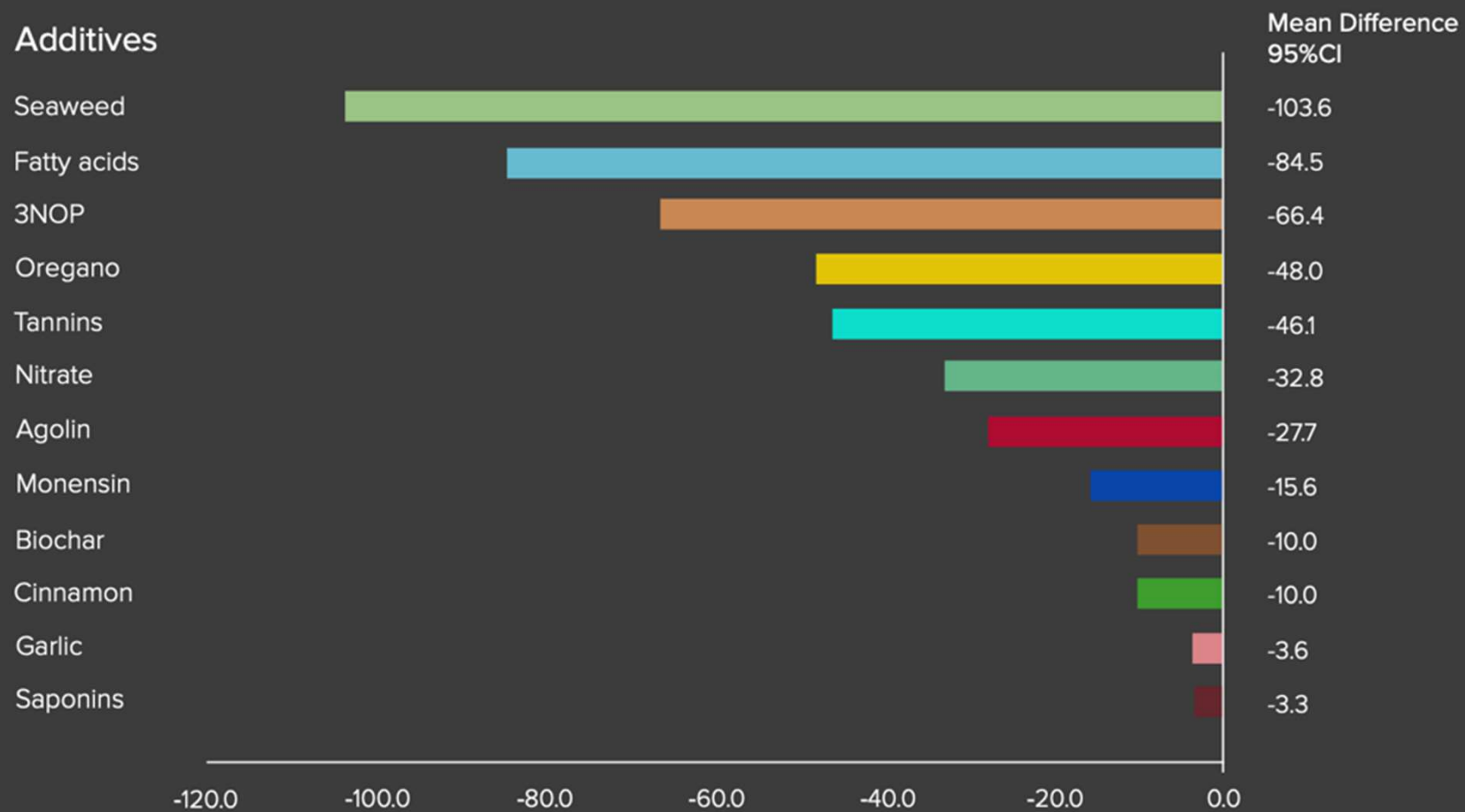
- Attrition - 2.6 to 3.3 MMTCO₂e/yr
- Alternative manure management - 0.6 and 1.1 MMTCO₂e/yr
- Dairy Digesters - 4 MMTCO₂e/yr
- Feed additives - 250,000 MTCO₂e - 2 MMTCO₂e/yr

California dairies
have reduced
greenhouse gases
by 4.4 MMTCO₂e
– more than half
of the sector's
methane
reduction goal.





Methane Reductions from Feed Additives





Created based on the work of Dr. Ermias Kebreab and Dr. Xiaoyu Feng,
University of California, Davis.
<https://ww2.arb.ca.gov/sites/default/files/2020-12/17RD018.pdf>



Review

Invited review: Current enteric methane mitigation options

Karen A. Beauchemin¹, Emilio M. Ungerfeld²  , Adibe L. Abdalla³,
Clementina Alvarez⁴, Claudia Arndt⁵, Philippe Becquet⁶,
Chaouki Benchaar⁷, Alexandre Berndt⁸, Rogério M. Mauricio⁹,
Tim A. McAllister¹, Walter Oyhantcábal¹⁰, Saheed A. Salami¹¹,
Laurence Shalloo¹², Yan Sun¹³, Juan Tricarico¹⁴, Aimable Uwizeye¹⁵,
Camillo De Camillis¹⁵, Martial Bernoux¹⁶, Timothy Robinson¹⁵,
Ermias Kebreab¹⁷

Show more 

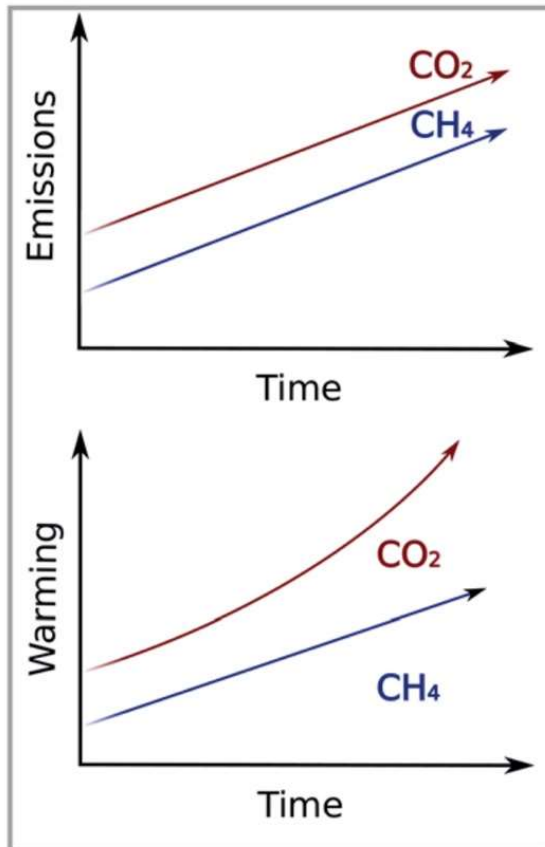
+ Add to Mendeley  Share  Cite

<https://doi.org/10.3168/jds.2022-22091> 

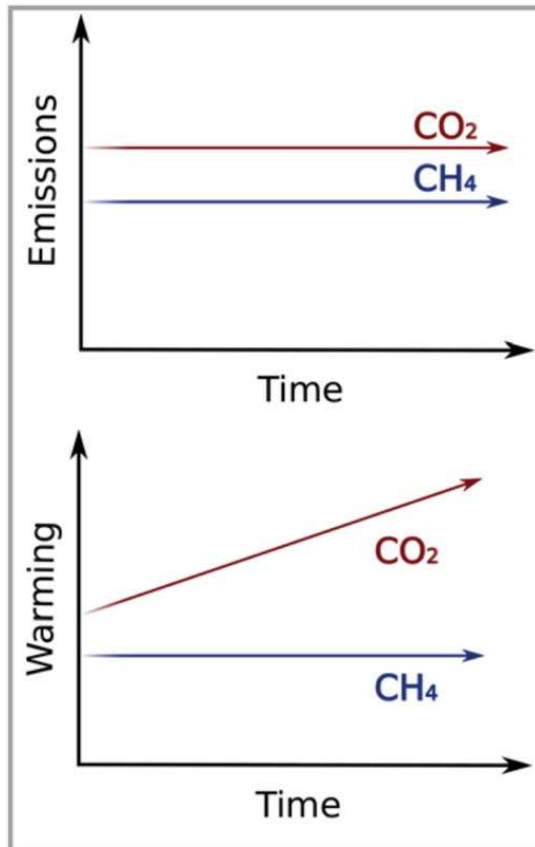
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- Increased Animal Productivity
- Selection of Low-Methane Animals
- Diet Reformulation
- Forages
- Action on Rumen Fermentation
- Early State Mitigation Strategies

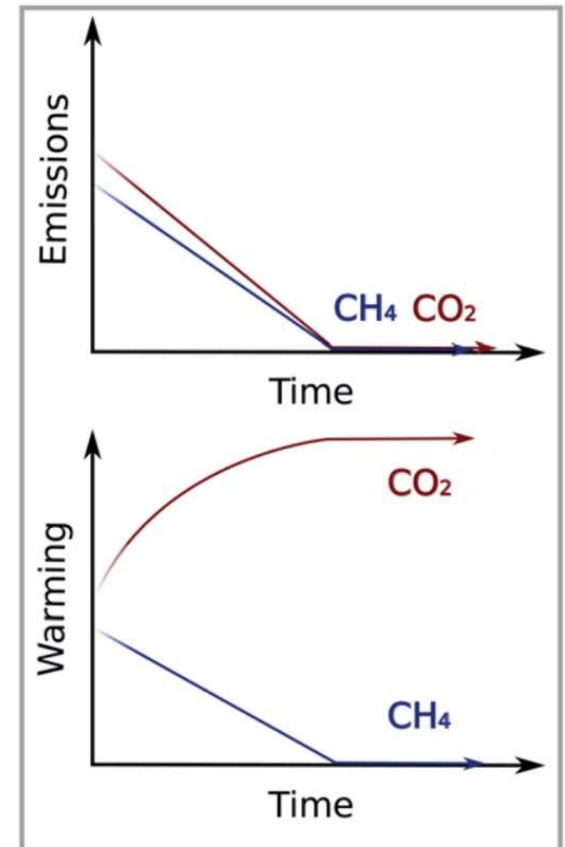
Rising emissions



Constant emissions



Falling emissions





Thank you
clear.ucdavis.edu

