How managing methane can help livestock be part of a climate solution

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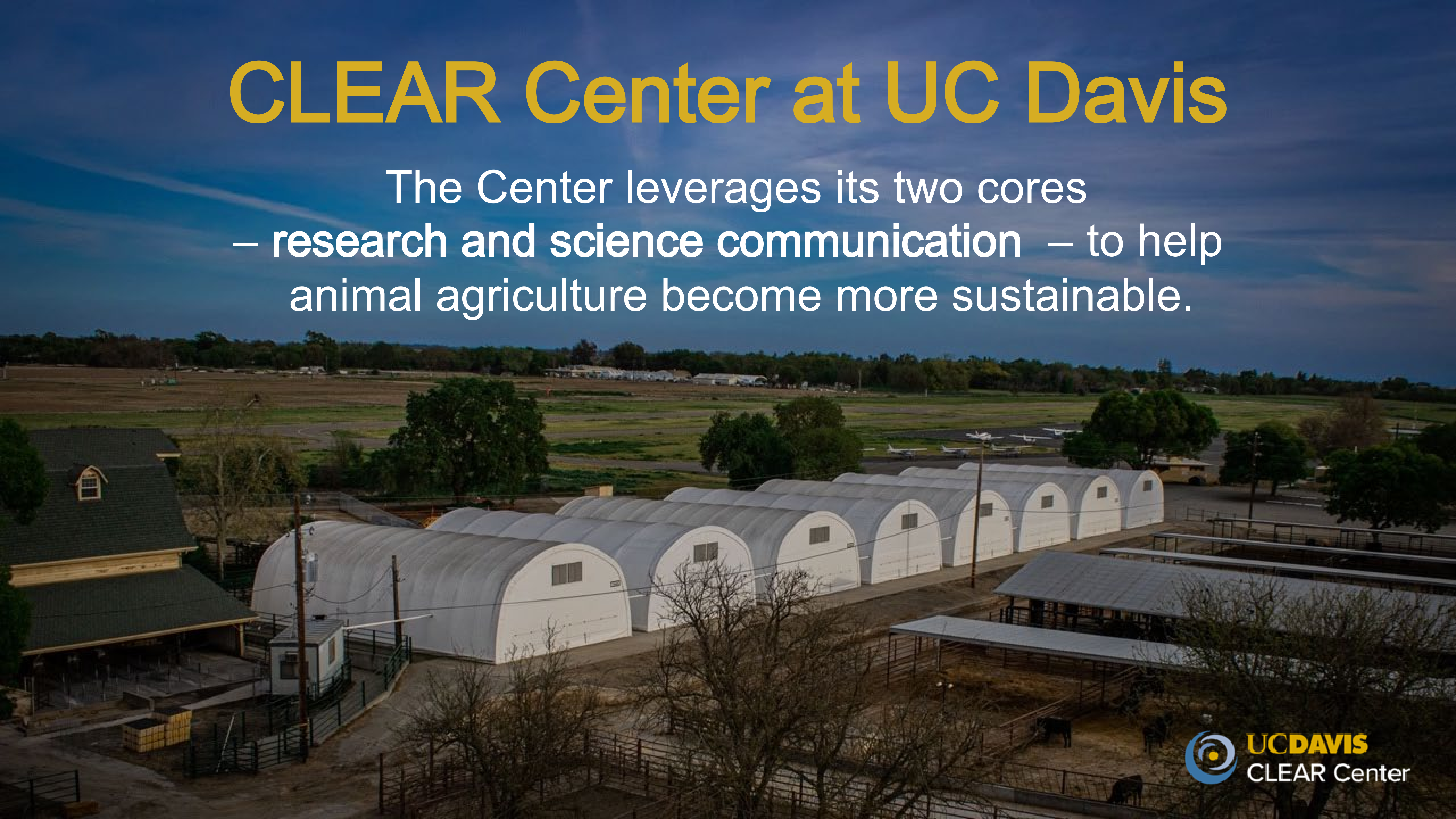
The Center leverages its two cores – **research and science communication** – to help animal agriculture become more sustainable.



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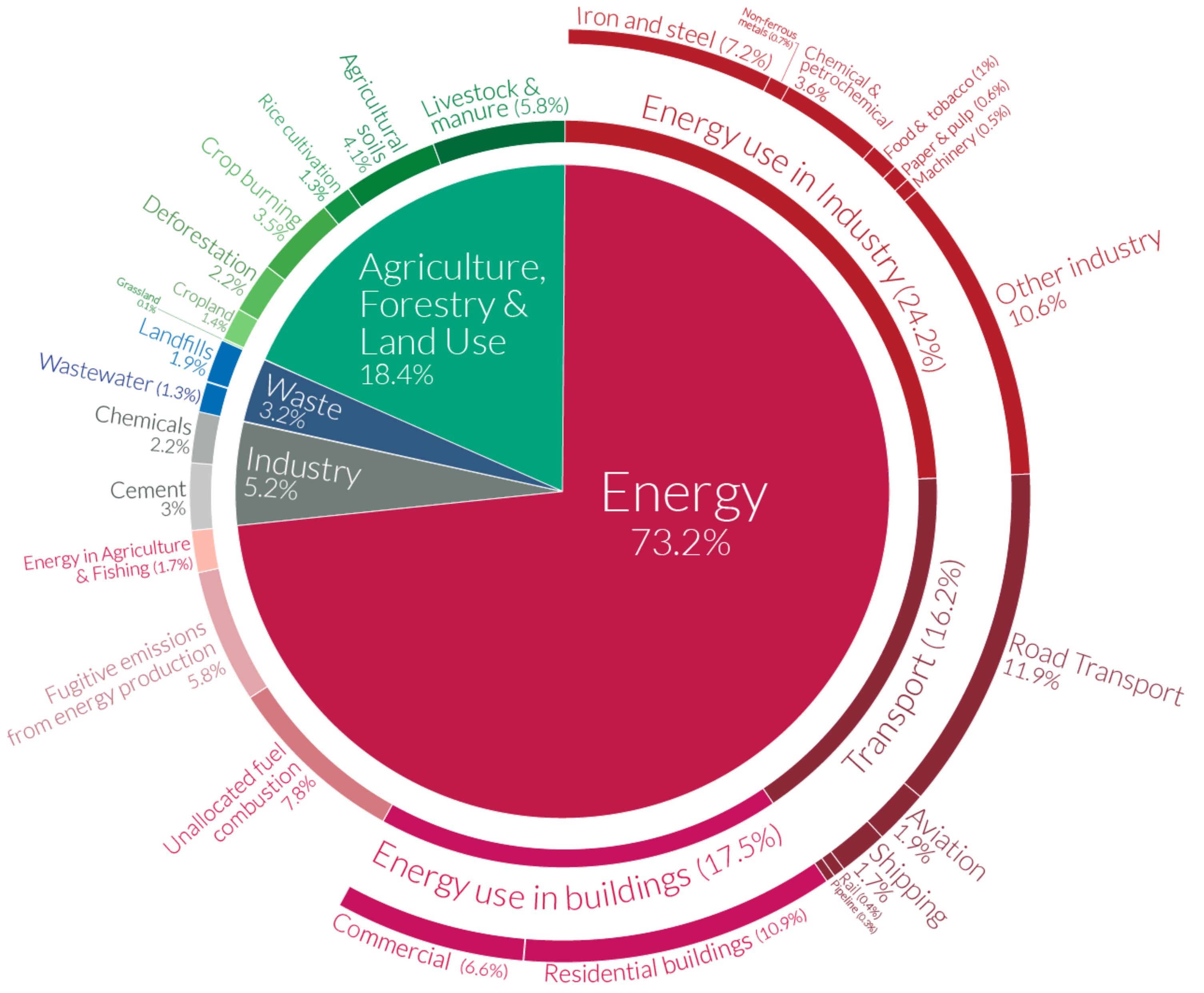
Global Greenhouse Gas Emissions by Sector



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

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

Emissions from 2016, when global greenhouse gas emissions totaled 49.4 GT (billion tons) CO_2eq.

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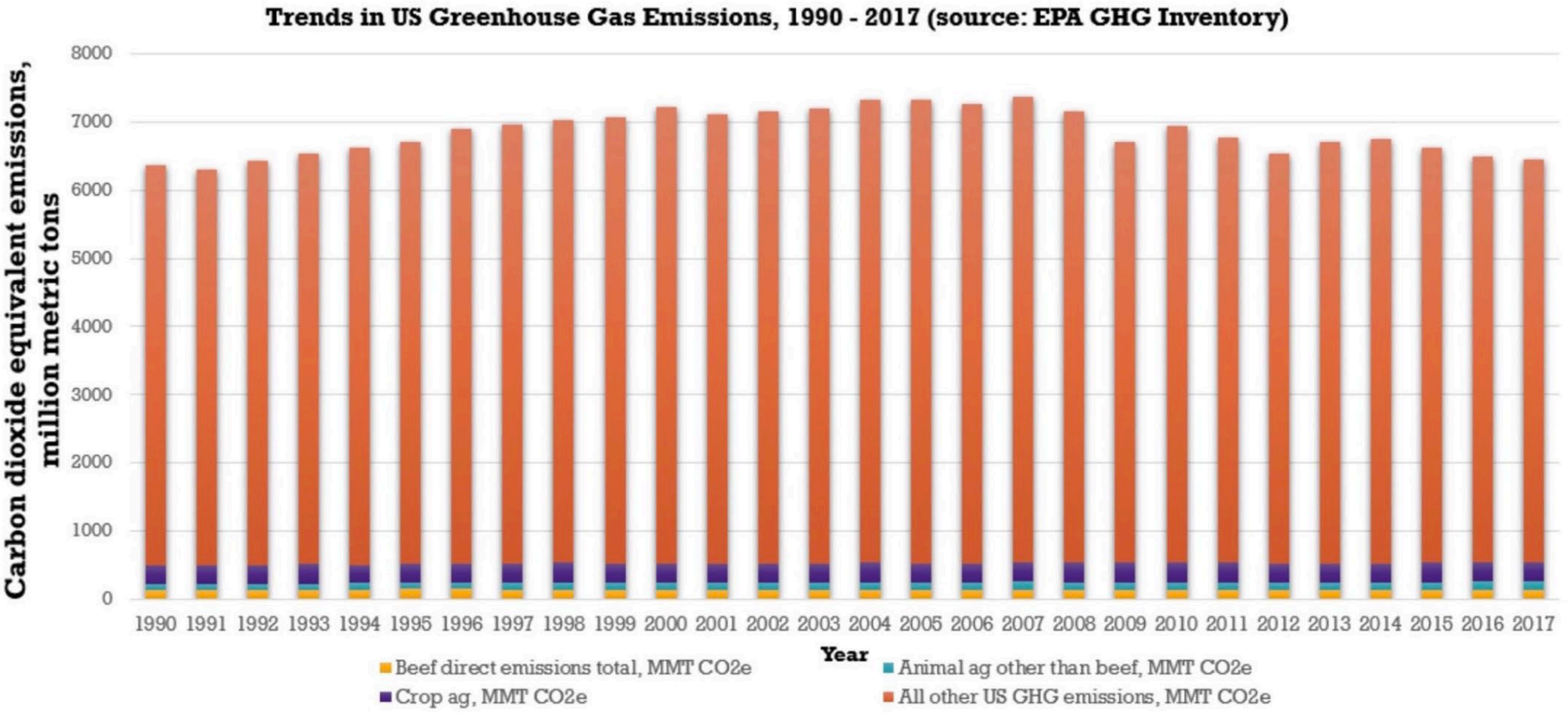
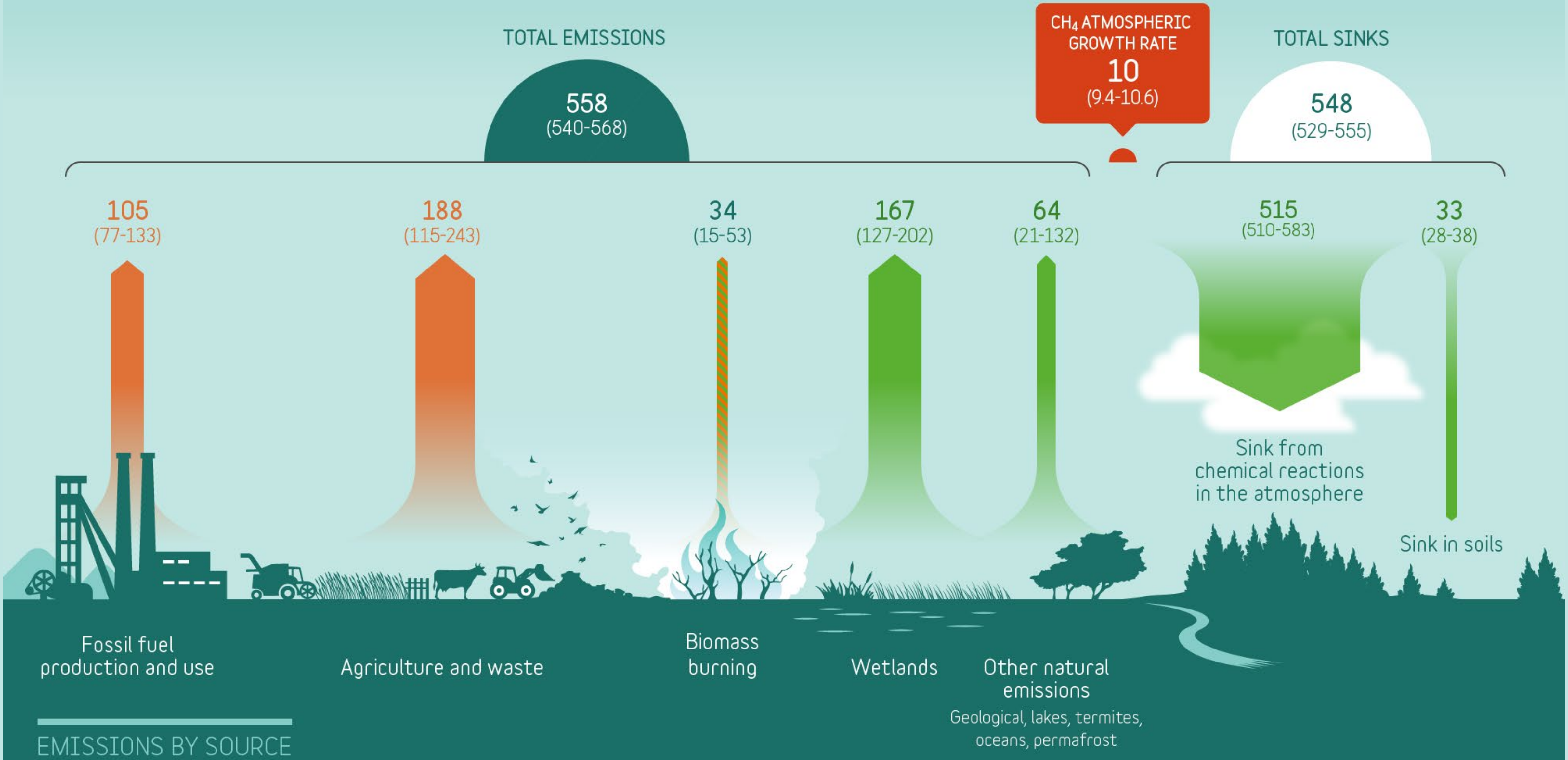


Trends in US Greenhouse Gas Emissions, 1990 - 2017 (source: EPA GHG Inventory)

GLOBAL METHANE BUDGET



TOTAL EMISSIONS

558
(540-568)

CH_4 ATMOSPHERIC GROWTH RATE
10
(9.4-10.6)

TOTAL SINKS

548
(529-555)

105
(77-133)
Fossil fuel production and use

188
(115-243)
Agriculture and waste

34
(15-53)
Biomass burning

167
(127-202)
Wetlands

64
(21-132)
Other natural emissions
Geological, lakes, termites, oceans, permafrost

515
(510-583)
Sink from chemical reactions in the atmosphere

33
(28-38)
Sink in soils

EMISSIONS BY SOURCE

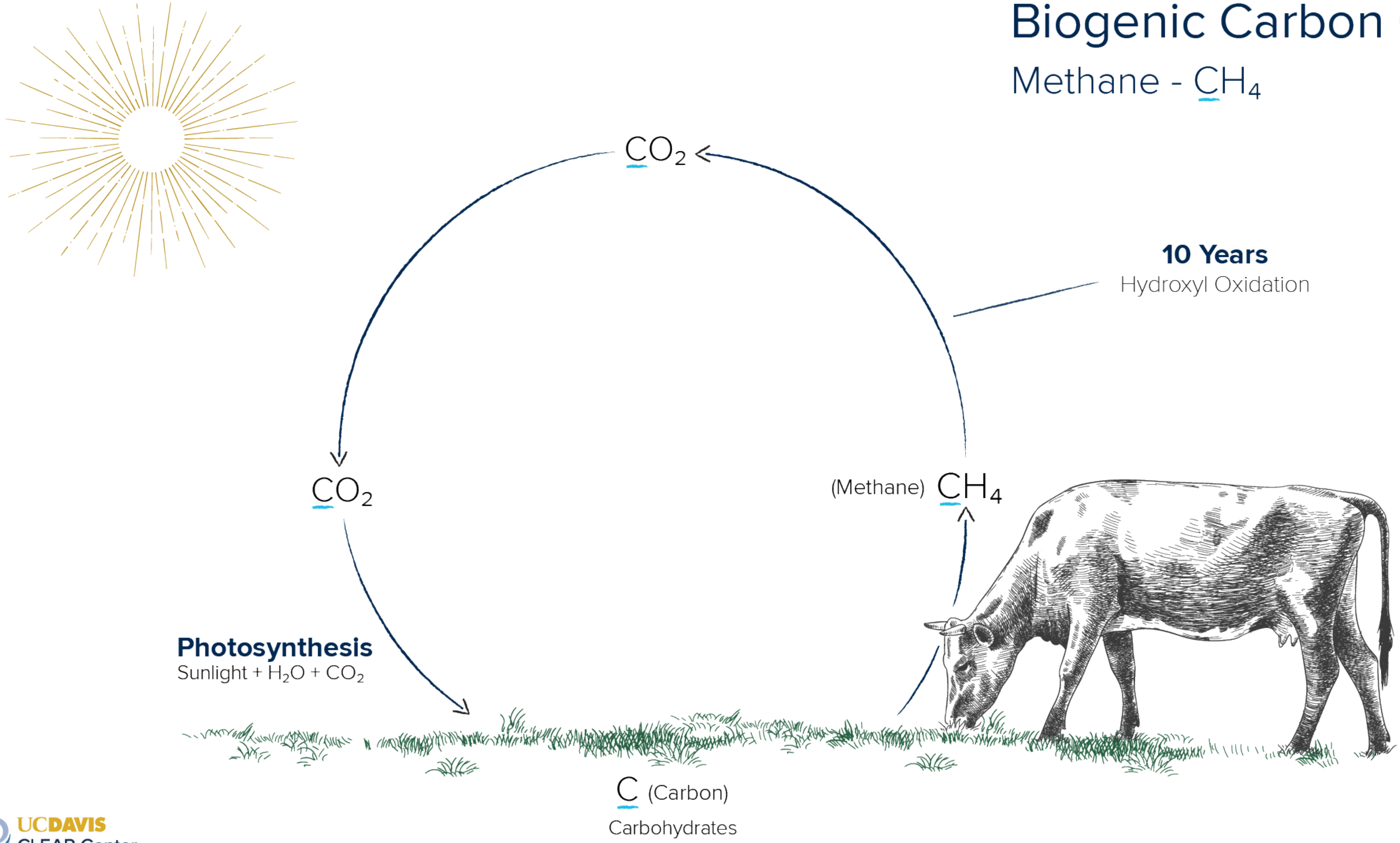
In million-tons of CH_4 per year (Tg CH_4 / yr), average 2003-2012

🟧 Anthropogenic fluxes 🟩 Natural fluxes ▨ Natural and anthropogenic

GLOBAL CARBON PROJECT
FONDATION BNP PARIBAS

Biogenic Carbon Cycle

Methane - CH_4



CO_2

10 Years
Hydroxyl Oxidation

CO_2

(Methane) CH_4

Photosynthesis
Sunlight + H_2O + CO_2

C (Carbon)
Carbohydrates

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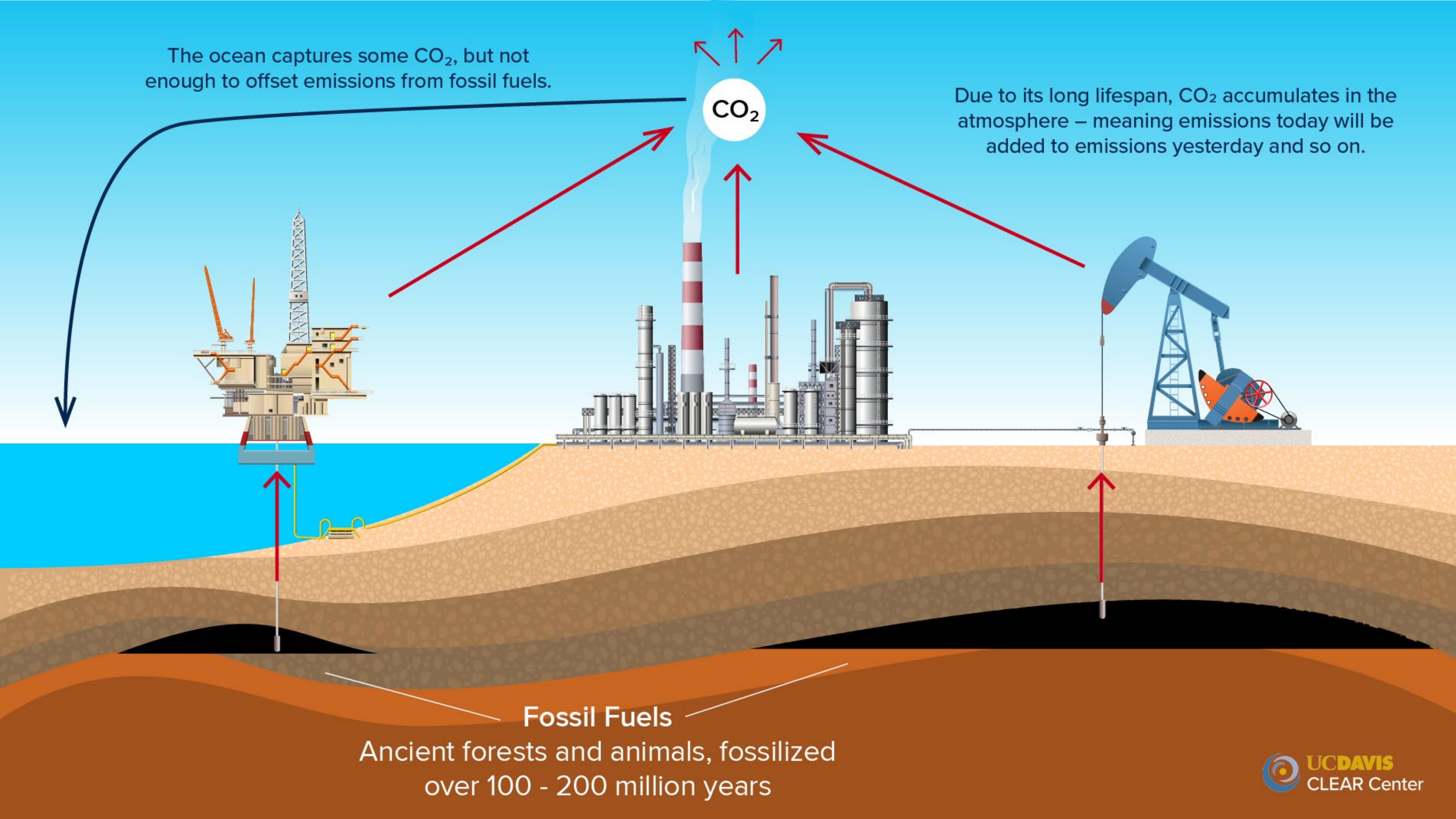

The ocean captures some CO_2, but not enough to offset emissions from fossil fuels.

Due to its long lifespan, CO_2 accumulates in the atmosphere – meaning emissions today will be added to emissions yesterday and so on.

Fossil Fuels

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

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GWP*- A new way to characterize short-lived greenhouse gases

- GWP100 overestimates methane’s warming impact of constant herds by a factor of 4 and overlooks its ability to induce cooling when CH_4 emissions are reduced.

- GWP* is a new metric out of the University of Oxford that assesses how an emission of a short-lived greenhouse gas affects temperature.

- GWP* accounts for methane’s short lifespan, including its atmospheric removal.

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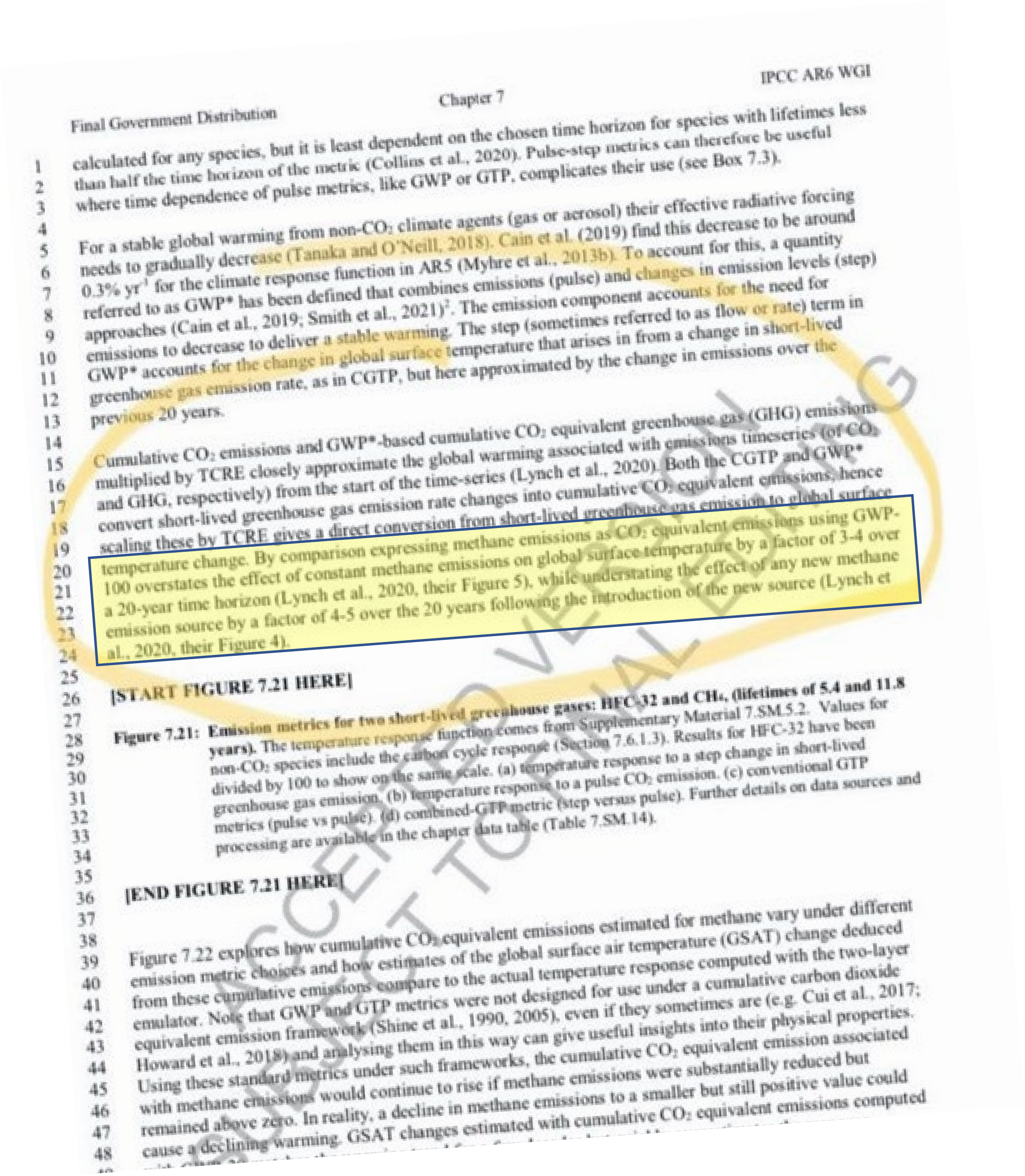


calculated for any species, but it is least dependent on the chosen time horizon for species with lifetimes less than half the time horizon of the metric (Collins et al., 2020). Pulse-step metrics can therefore be useful where time dependence of pulse metrics, like GWP or GTP, complicates their use (see Box 7.3).

For a stable global warming from non-CO_2 climate agents (gas or aerosol) their effective radiative forcing needs to gradually decrease (Tanaka and O'Neill, 2018). Cain et al. (2019) find this decrease to be around 0.3% yr^{-1} for the climate response function in AR5 (Myhre et al., 2013b). To account for this, a quantity referred to as GWP* has been defined that combines emissions (pulse) and changes in emission levels (step) approaches (Cain et al., 2019; Smith et al., 2021)[2]. The emission component accounts for the need for emissions to decrease to deliver a stable warming. The step (sometimes referred to as flow or rate) term in GWP* accounts for the change in global surface temperature that arises in from a change in short-lived greenhouse gas emission rate, as in CGTP, but here approximated by the change in emissions over the previous 20 years.

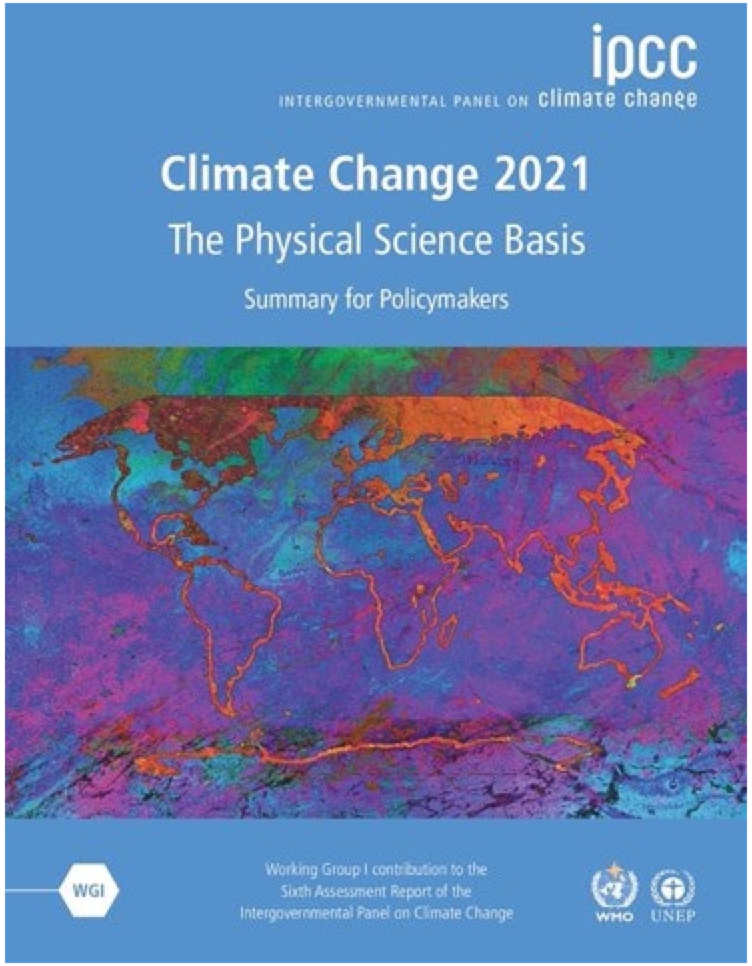
Cumulative CO_2 emissions and GWP*-based cumulative CO_2 equivalent greenhouse gas (GHG) emissions multiplied by TCRE closely approximate the global warming associated with emissions timeseries (of CO_2 and GHG, respectively) from the start of the time-series (Lynch et al., 2020). Both the CGTP and GWP* convert short-lived greenhouse gas emission rate changes into cumulative CO_2 equivalent emissions, hence scaling these by TCRE gives a direct conversion from short-lived greenhouse gas emission to global surface temperature change. By comparison expressing methane emissions as CO_2 equivalent emissions using GWP-100 overstates the effect of constant methane emissions on global surface temperature by a factor of 3-4 over a 20-year time horizon (Lynch et al., 2020, their Figure 5), while understating the effect of any new methane emission source by a factor of 4-5 over the 20 years following the introduction of the new source (Lynch et al., 2020, their Figure 4).

[START FIGURE 7.21 HERE]

Figure 7.21: Emission metrics for two short-lived greenhouse gases: HFC-32 and CH_4, (lifetimes of 5.4 and 11.8 years). The temperature response function comes from Supplementary Material 7.SM.5.2. Values for non-CO_2 species include the carbon cycle response (Section 7.6.1.3). Results for HFC-32 have been divided by 100 to show on the same scale. (a) temperature response to a step change in short-lived greenhouse gas emission. (b) temperature response to a pulse CO_2 emission. (c) conventional GTP metrics (pulse vs pulse). (d) combined-GTP metric (step versus pulse). Further details on data sources and processing are available in the chapter data table (Table 7.SM.14).

[END FIGURE 7.21 HERE]

Figure 7.22 explores how cumulative CO_2 equivalent emissions estimated for methane vary under different emission metric choices and how estimates of the global surface air temperature (GSAT) change deduced from these cumulative emissions compare to the actual temperature response computed with the two-layer emulator. Note that GWP and GTP metrics were not designed for use under a cumulative carbon dioxide equivalent emission framework (Shine et al., 1990, 2005), even if they sometimes are (e.g. Cui et al., 2017; Howard et al., 2018) and analysing them in this way can give useful insights into their physical properties. Using these standard metrics under such frameworks, the cumulative CO_2 equivalent emission associated with methane emissions would continue to rise if methane emissions were substantially reduced but remained above zero. In reality, a decline in methane emissions to a smaller but still positive value could cause a declining warming. GSAT changes estimated with cumulative CO_2 equivalent emissions computed



ipcc
INTERGOVERNMENTAL PANEL ON climate change

Climate Change 2021
The Physical Science Basis
Summary for Policymakers

WGI

Working Group I contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

Read the page here:bit.ly/ipcc_ch7

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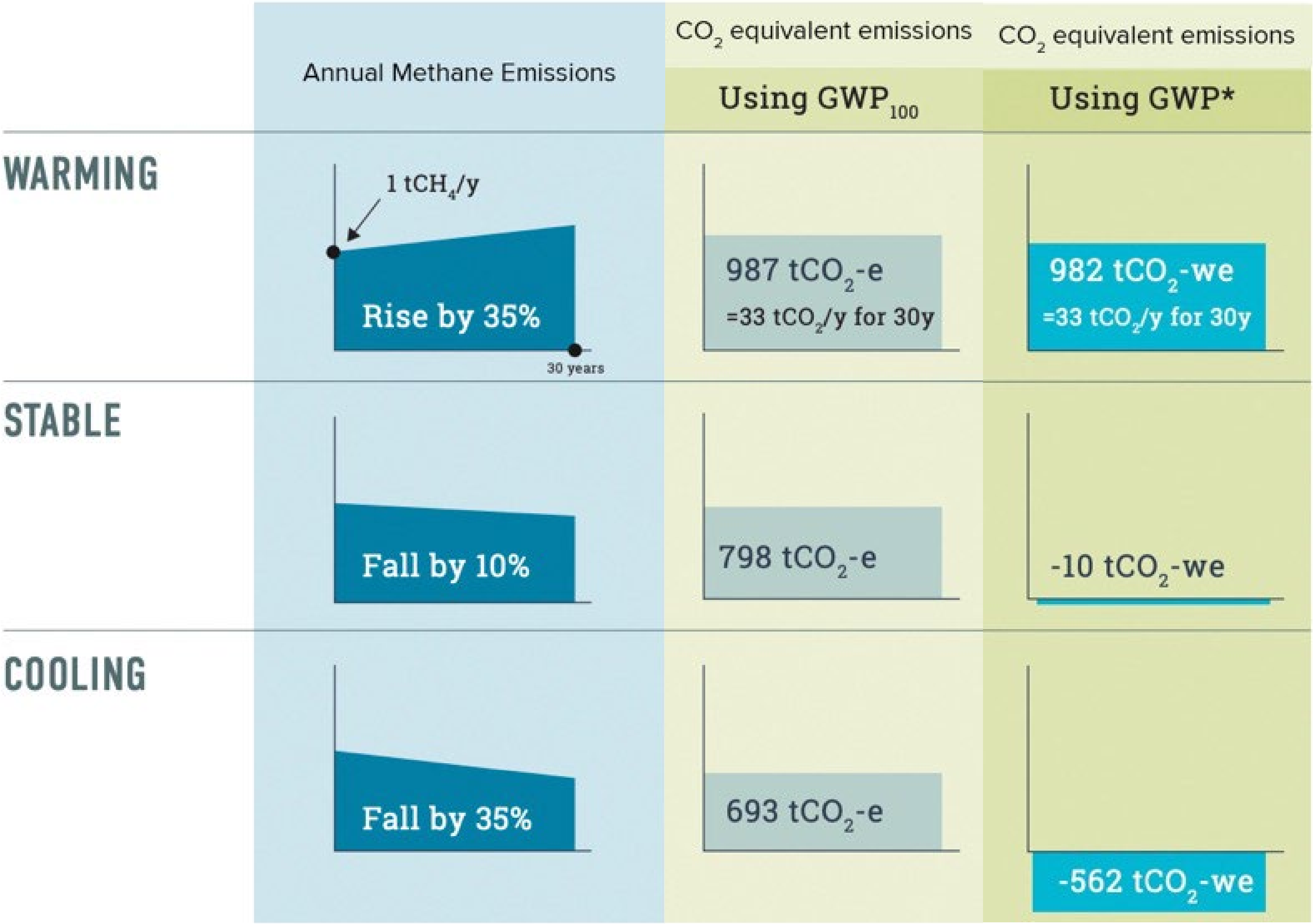

	Annual Methane Emissions	CO_2 equivalent emissions Using GWP_{100}	CO_2 equivalent emissions Using GWP*
WARMING	Rise by 35%	987 tCO_2-e =33 tCO_2/y for 30y	982 tCO_2-we =33 tCO_2/y for 30y
STABLE	Fall by 10%	798 tCO_2-e	-10 tCO_2-we
COOLING	Fall by 35%	693 tCO_2-e	-562 tCO_2-we

Cain, M., Allen, M. & Lynch, J. *Oxford Martin Programme on Climate Pollutants* (2019). Read more at: https://www.oxfordmartin.ox.ac.uk/downloads/academic/201908_ClimatePollutants.pdf.

California dairies have reduced greenhouse gases by 2.5MMTCO2e – **30% of the sector's methane reduction goal.**

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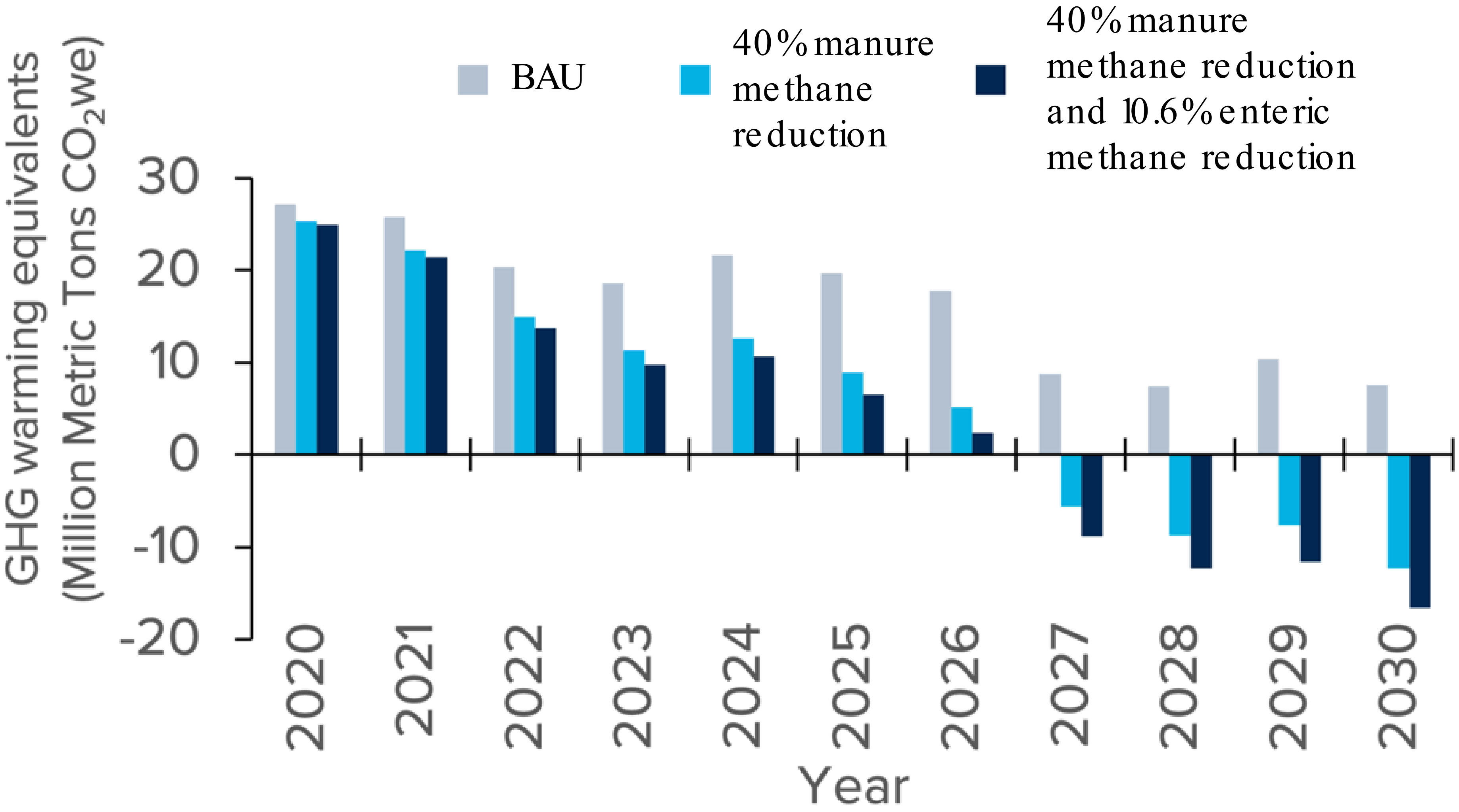
Potential pathways to climate neutrality for California dairy



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California Case Study: 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

Meeting the Call

How California is Pioneering a Pathway to Significant Dairy Sector Methane Reduction

December 2022

Project Authors

Ermias Kebreab, Ph.D., Frank Mitloehner, Ph.D., Daniel A. Sumner, Ph.D.,

CLEAR Center

Clarity and Leadership for Environmental Awareness and Research at UC Davis

Photo by Gregory Urquiaga / UC Davis

New Report: California is Pioneering a Pathway to Significant Dairy Methane Reduction

Analysis by UC Davis researchers shows continued implementation of California's incentive-based dairy methane reduction efforts should, by 2030, achieve the full 40% reduction goal.

December 14, 2022

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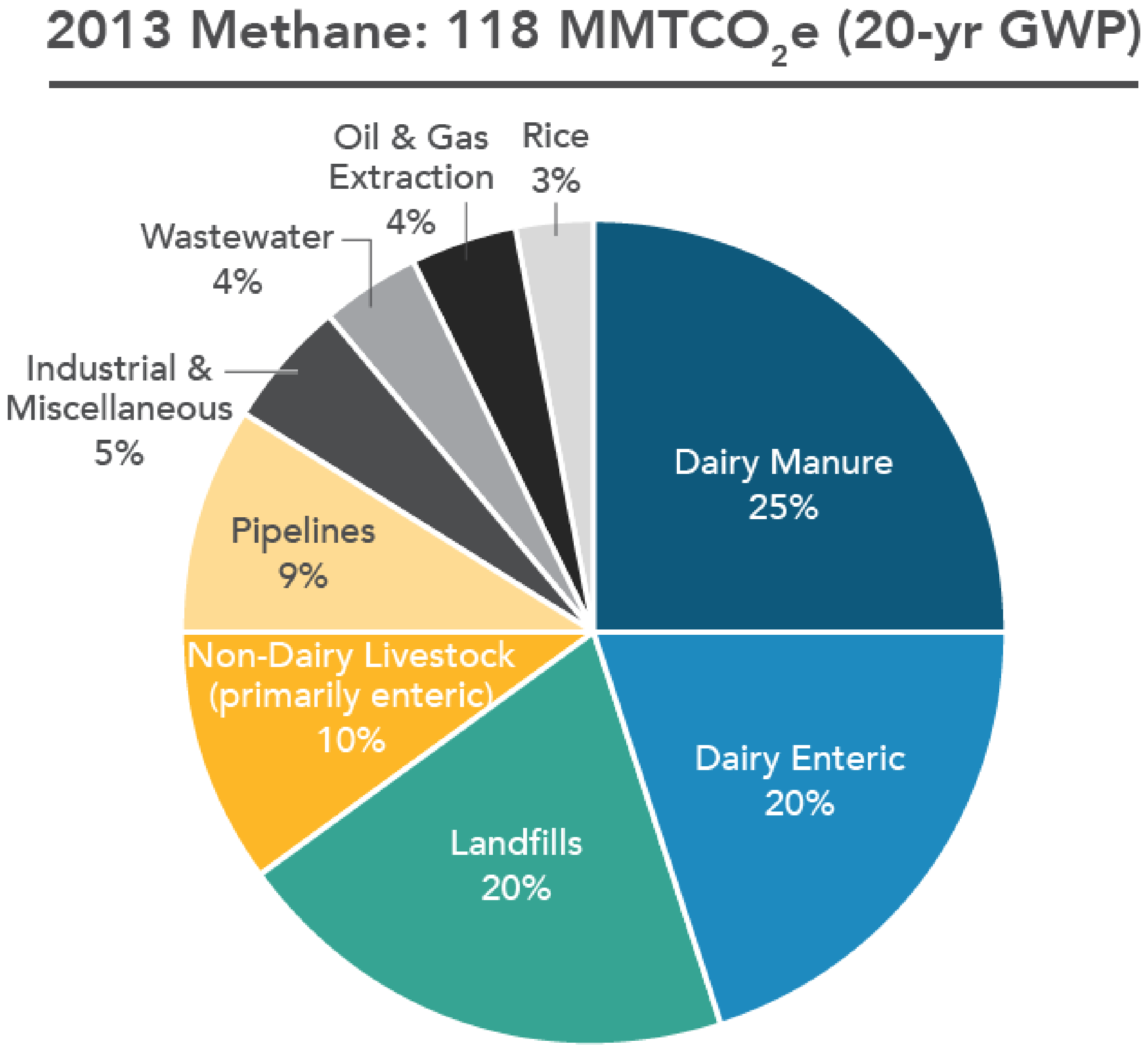
Ambitious Goals in California



- 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.

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California dairy should meet the full 40 percent reduction by 2030 = 7.2MMTCO2e

- 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

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Feed additives offer the greatest potential for sector-wide methane reductions and could be feasibly implemented at existing operations.

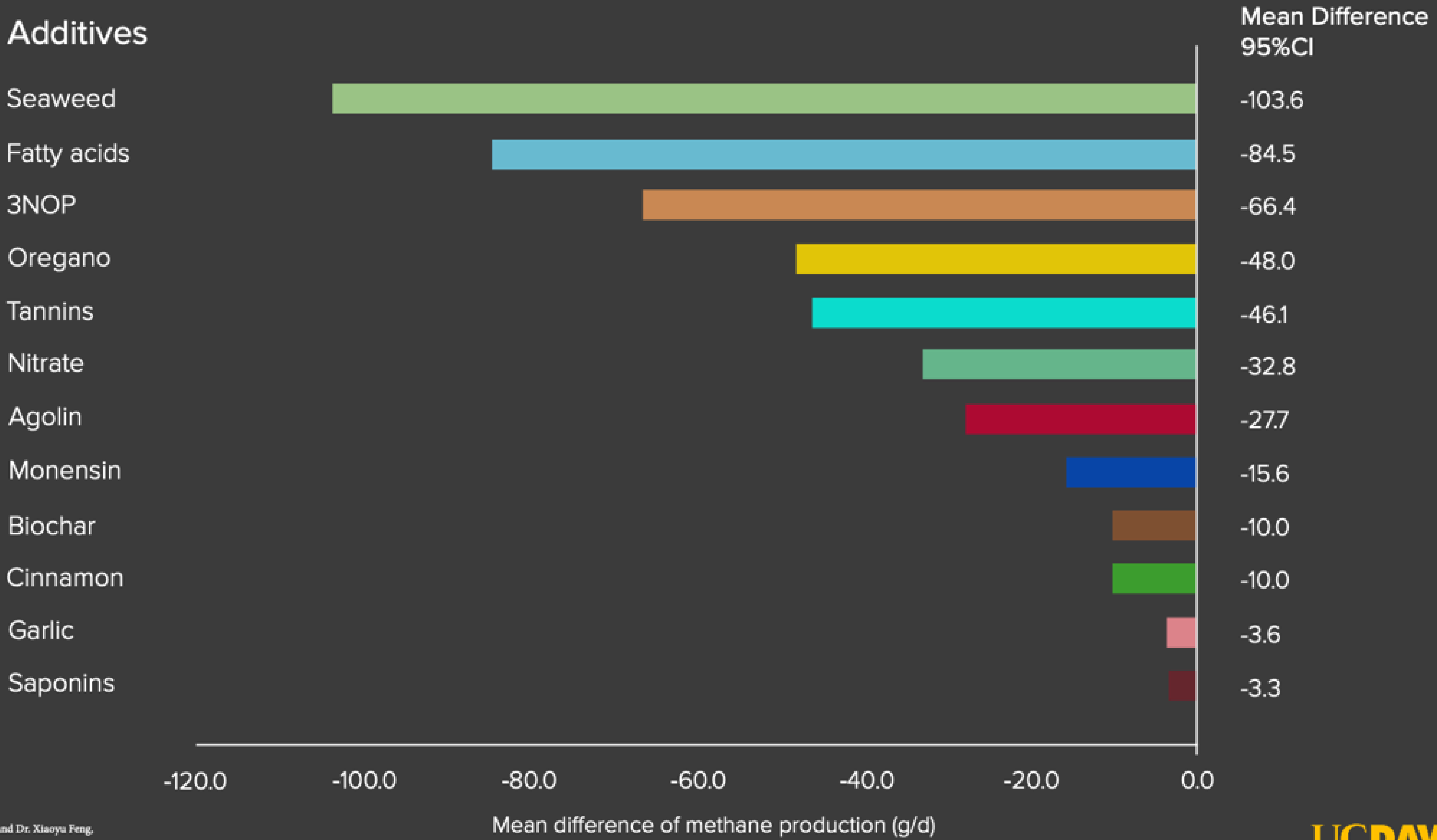
Dairy Herd Penetration

Projections of Enteric Methane Emission Reduction Strategies at Various Dairy Sector Penetration Scenarios (in MTCO2e/yr.)

Reduction Effectiveness of Feed Additives	Herd Penetration			
	50%	60%	70%	80%
10%	255,000	306,000	357,000	408,000
20%	510,000	612,000	714,000	816,000
30%	765,000	918,000	1,071,000	1,224,000
40%	1,020,000	1,224,000	1,428,000	1,672,000
50%	1,275,000	1,530,000	1,785,000	2,040,000

Reductions range from 255,000 MTCO2e/yr. methane emissions assuming a feed additive with 10 percent reduction effectiveness and 50 percent herd penetration to 2,040,000 MTCO2e/yr. reductions with 50 percent reduction effectiveness and 80 percent herd penetration.

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

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Thank you

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