



## **Livestock and climate change - a focus on dairy**

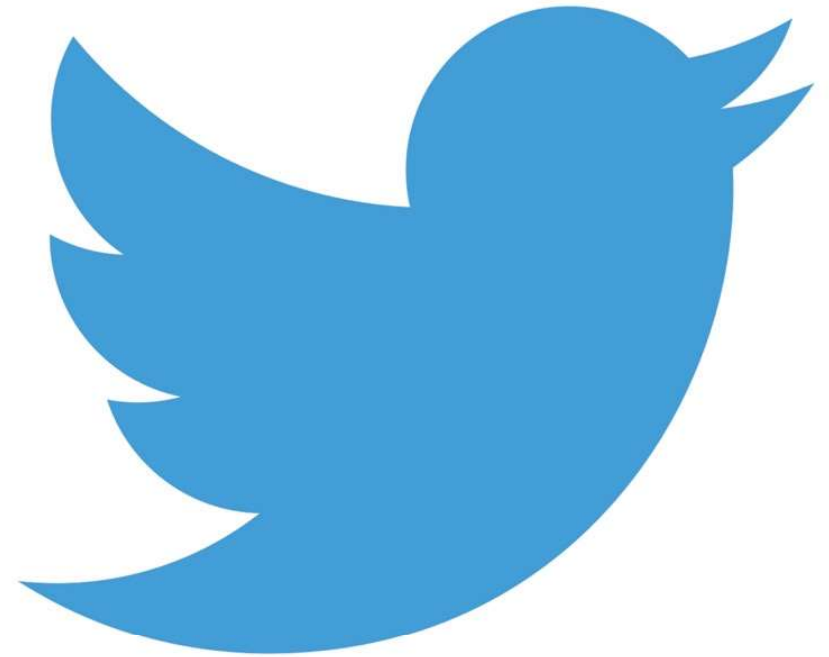
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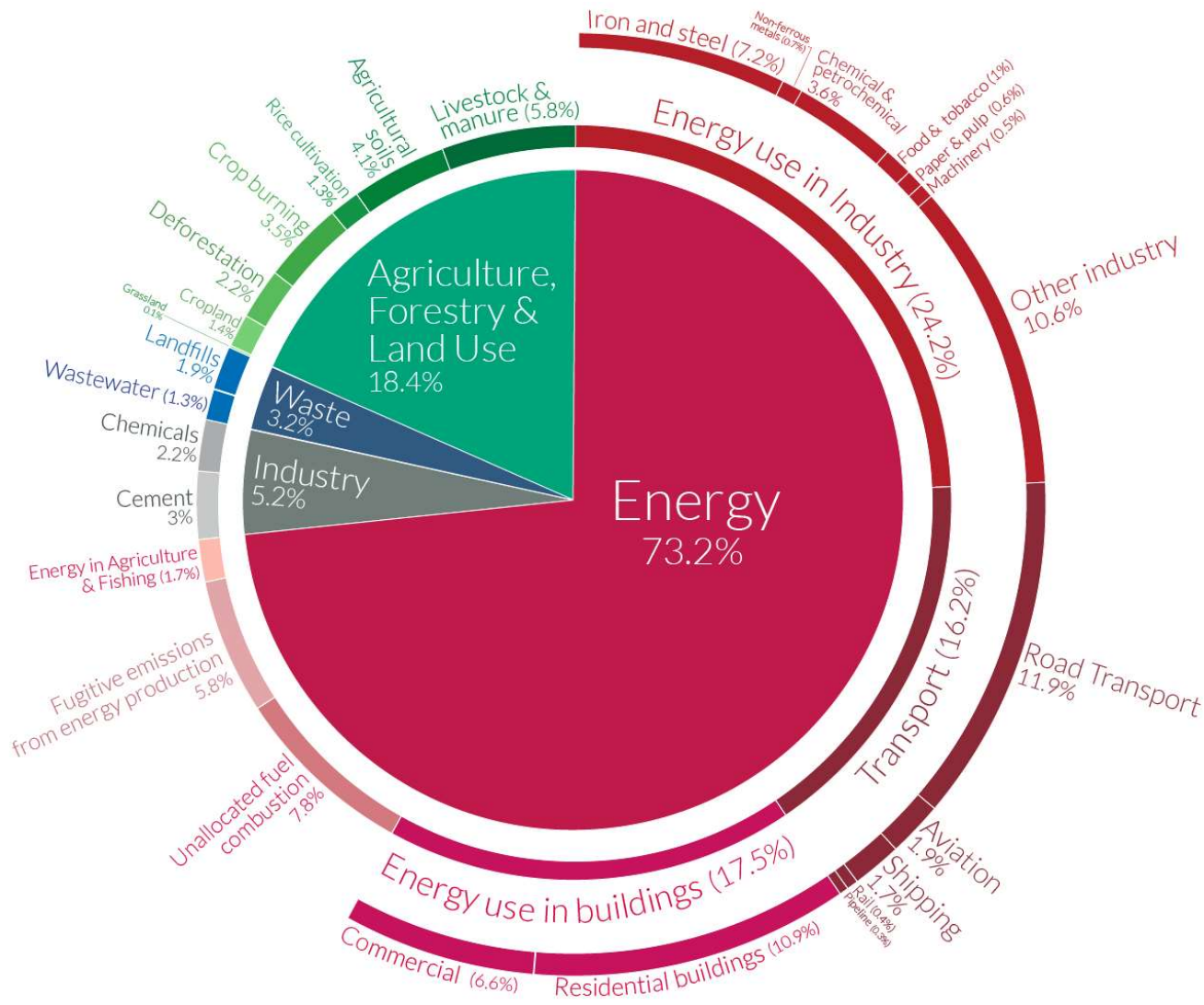
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# RETHINKING METHANE



# Global Greenhouse Gas Emissions by Sector

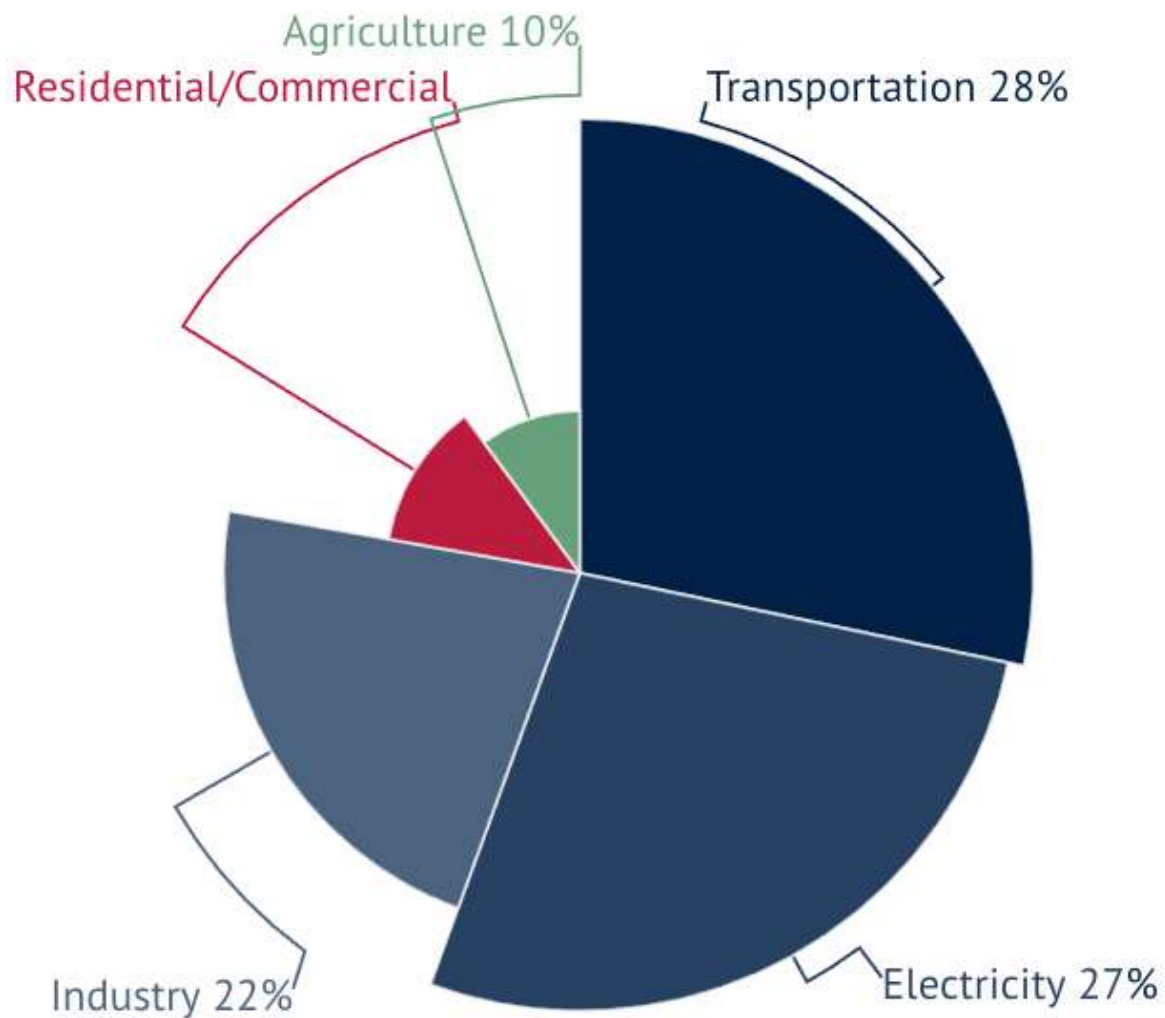


Emissions from 2016, when global greenhouse gas emissions totaled 49.4 GT (billion tons) CO<sub>2</sub>eq.

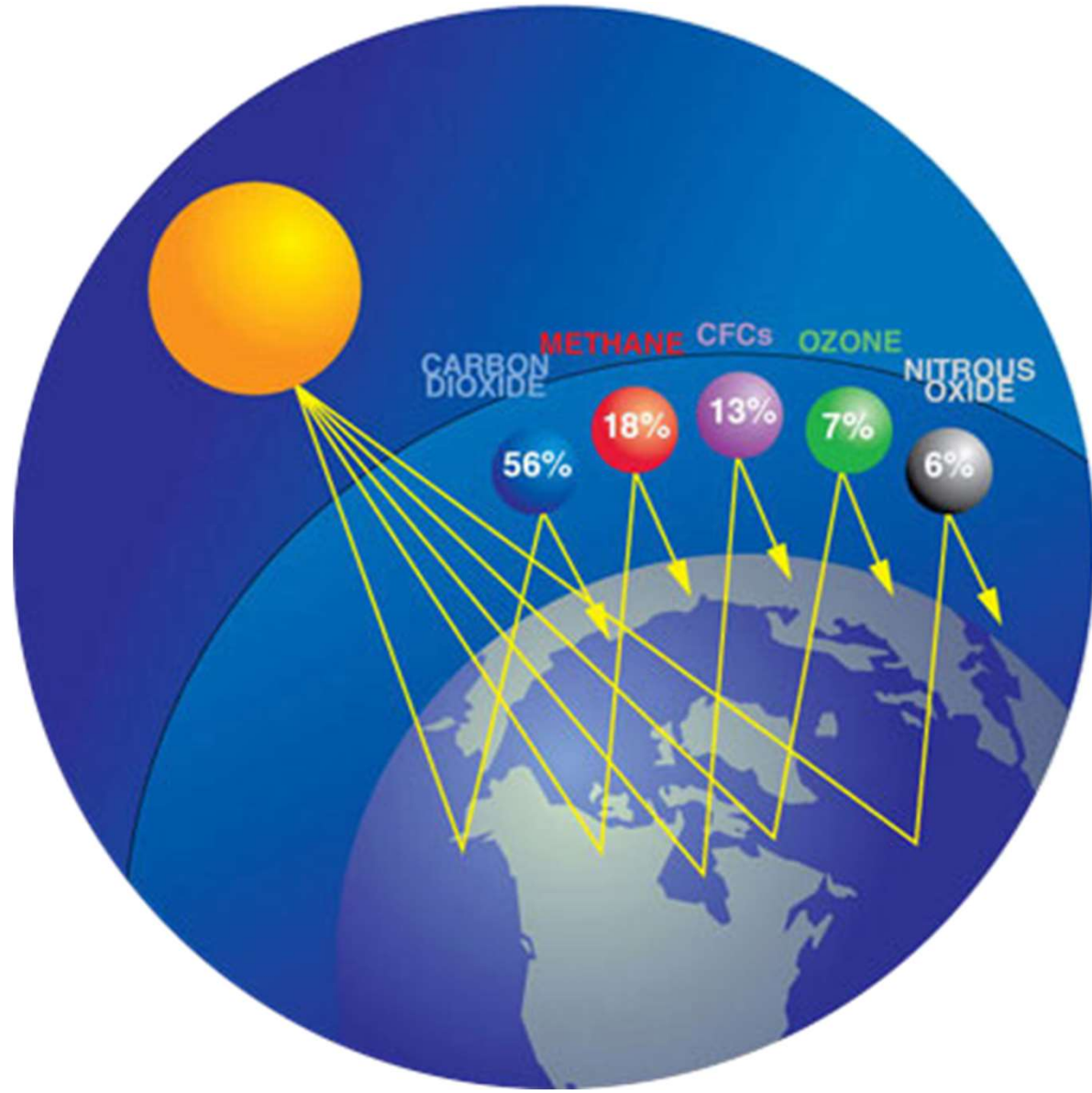


OurWorldinData.org – Research and data to make progress against the world’s largest problems. Source: Climate Watch, the World Resources Institute (2020). Licensed under CC-BY by the author Hannah Ritchie (2020).

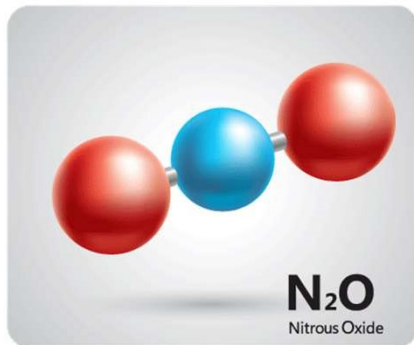
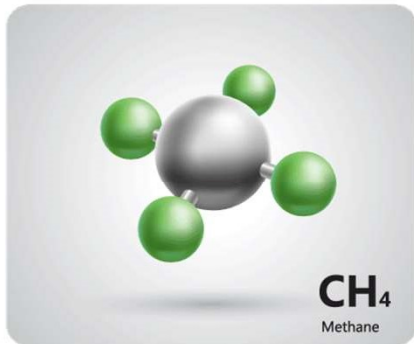
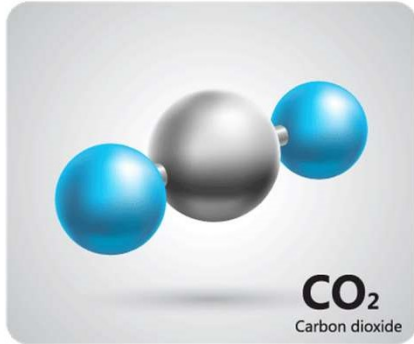
# United States Greenhouse Gas Emissions by Sector



Total U.S. Emissions in 2018 =  
6,677 [Million Metric Tons of CO<sub>2</sub> equivalent](https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions). Source: <https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions>



# Global Warming Potential (GWP<sub>100</sub>) of Main Greenhouse Gases



Carbon Dioxide (CO<sub>2</sub>) 1

Methane (CH<sub>4</sub>) 28

Nitrous Oxide (N<sub>2</sub>O) 265

# GLOBAL METHANE BUDGET

TOTAL EMISSIONS

558  
(540-568)

CH<sub>4</sub> ATMOSPHERIC GROWTH RATE  
10  
(9.4-10.6)

TOTAL SINKS

548  
(529-555)

105  
(77-133)

188  
(115-243)

34  
(15-53)

167  
(127-202)

64  
(21-132)

515  
(510-583)

33  
(28-38)



Fossil fuel production and use

Agriculture and waste

Biomass burning

Wetlands

Other natural emissions

Geological, lakes, termites, oceans, permafrost

Sink from chemical reactions in the atmosphere

Sink in soils

## EMISSIONS BY SOURCE

In million-tons of CH<sub>4</sub> per year ( Tg CH<sub>4</sub> / yr), average 2003-2012

▬ Anthropogenic fluxes    
 ▬ Natural fluxes    
 ▬ Natural and anthropogenic

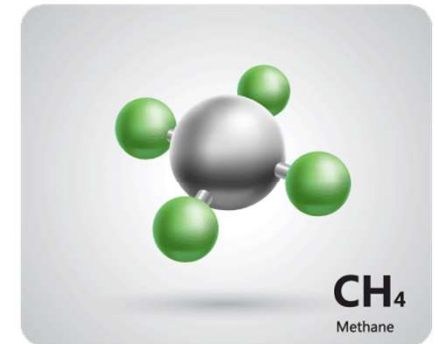
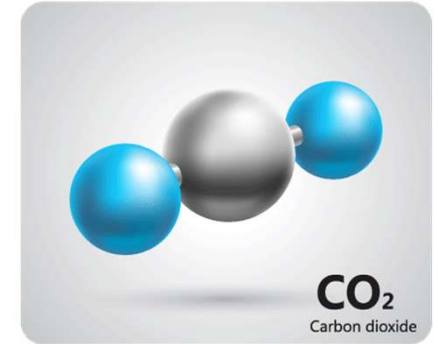


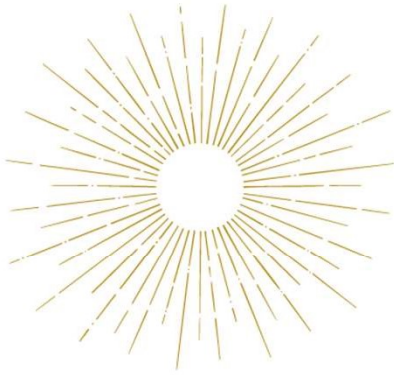
# Half-Life of Main Greenhouse Gases in Years

Carbon Dioxide (CO<sub>2</sub>) 1,000

Methane (CH<sub>4</sub>) 12

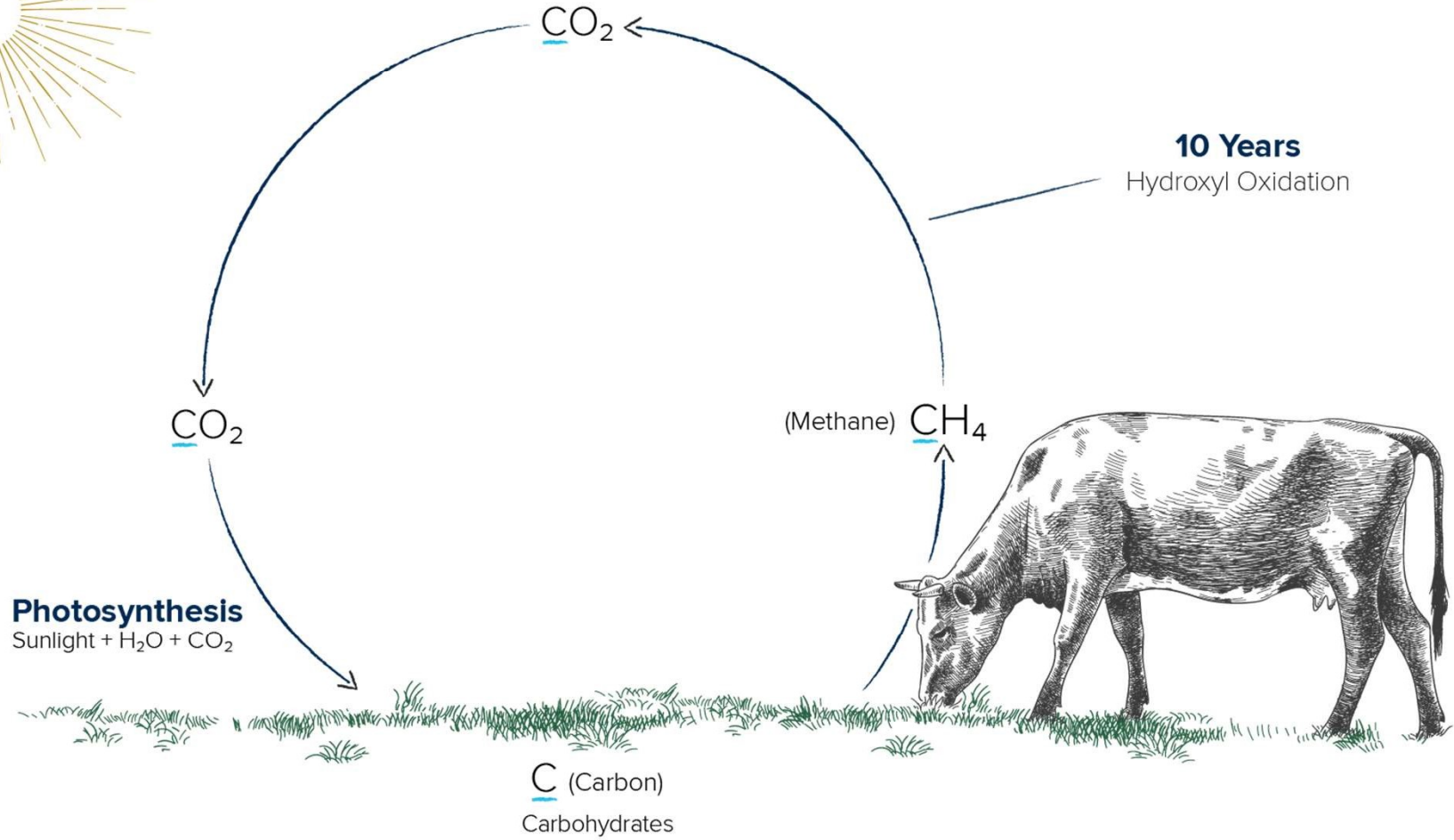
Nitrous Oxide (N<sub>2</sub>O) 110





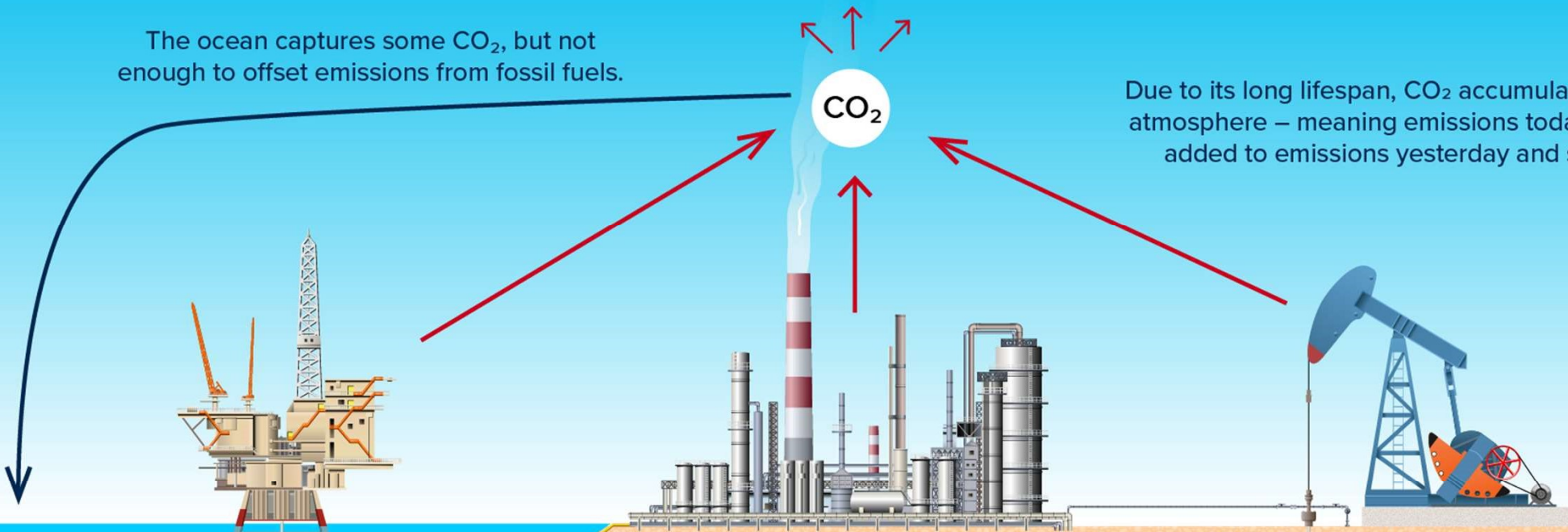
# Biogenic Carbon Cycle

## Methane - $\text{CH}_4$



The ocean captures some CO<sub>2</sub>, but not enough to offset emissions from fossil fuels.

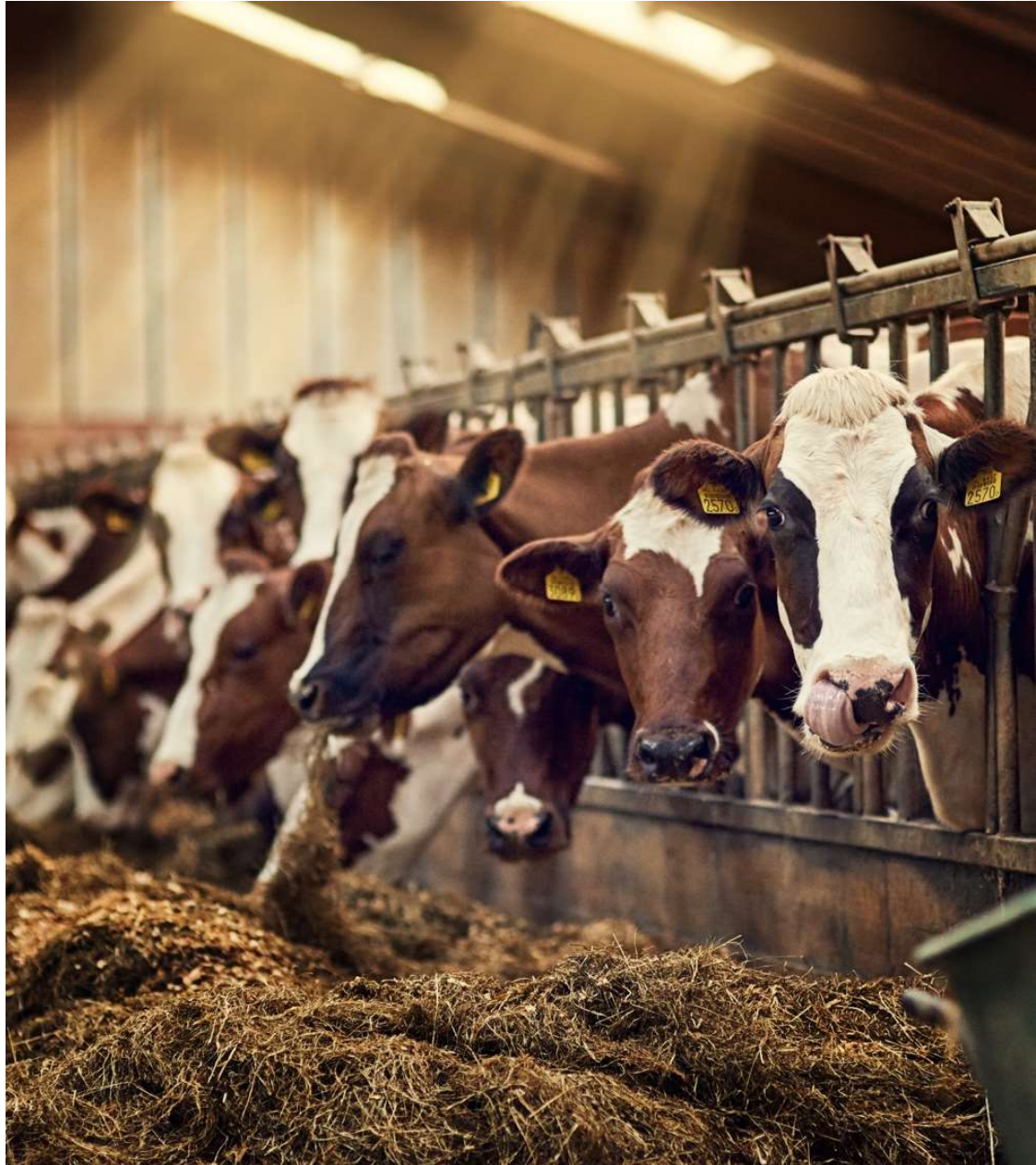
Due to its long lifespan, CO<sub>2</sub> accumulates in the atmosphere – meaning emissions today will be added to emissions yesterday and so on.



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

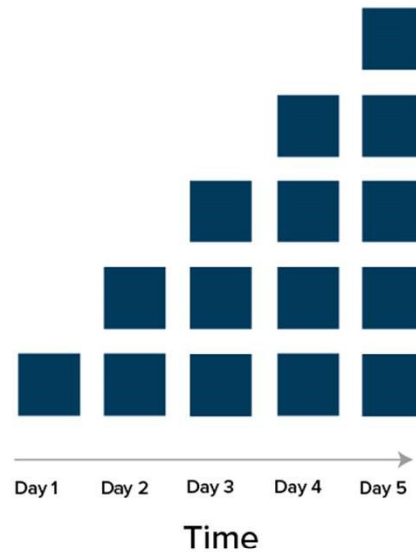
## GWP\* - A new way to characterize short-lived greenhouse gases

- GWP100 overestimates methane's warming impact of constant herds by a factor of 4, and overlooks its ability to induce cooling when CH<sub>4</sub> 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\* not only accounts for methane's short lifespan, but also its atmospheric removal.



■ = Pulse of CO<sub>2</sub>

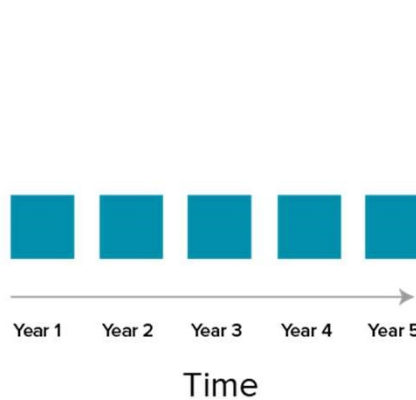
Stock Gas  
Carbon dioxide (CO<sub>2</sub>)  
Atmospheric Concentration



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

■ = Pulse of CH<sub>4</sub>

Flow Gas  
Methane (CH<sub>4</sub>)  
Atmospheric Concentration

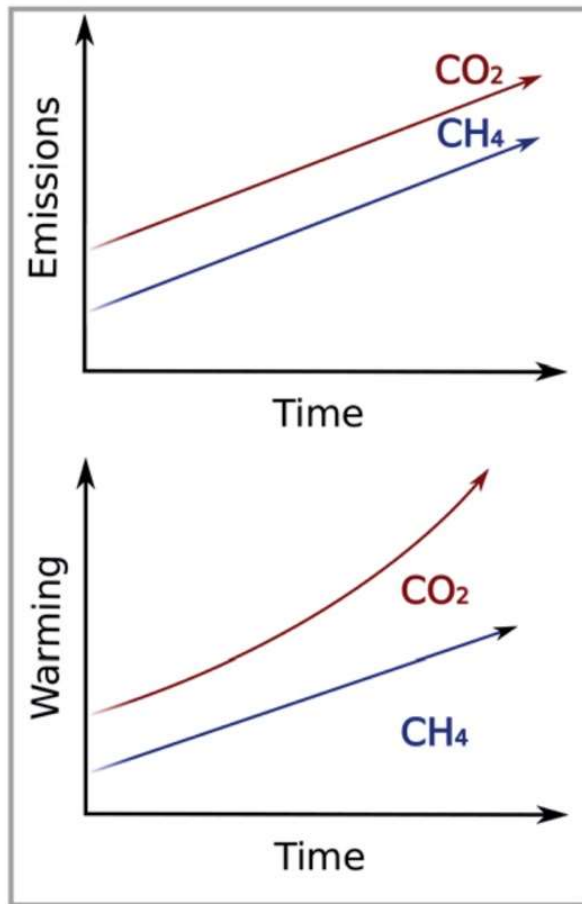


Flow gases will stay stagnant, as they are destroyed at the same rate of emission.

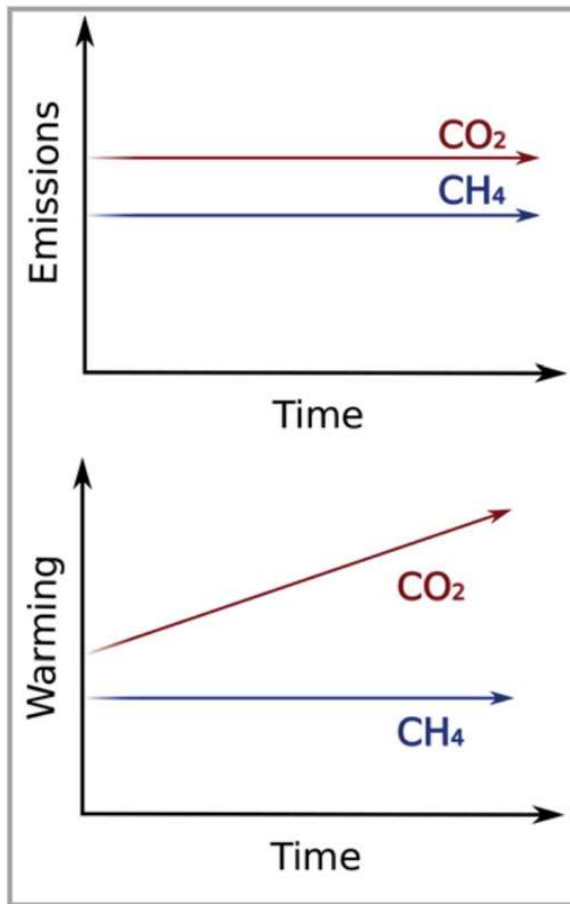
|                | Annual Methane Emissions                                | CO <sub>2</sub> equivalent emissions                           |   |
|----------------|---|--|---|
|                |   | Using GWP <sub>100</sub>                                       | Using GWP*  |
| <b>WARMING</b> | <p>1 tCH<sub>4</sub>/y<br/>Rise by 35%<br/>30 years</p> | <p>987 tCO<sub>2</sub>-e<br/>=33 tCO<sub>2</sub>/y for 30y</p> | <p>982 tCO<sub>2</sub>-we<br/>=33 tCO<sub>2</sub>/y for 30y</p> |
| <b>STABLE</b>  | <p>Fall by 10%</p>                                      | <p>798 tCO<sub>2</sub>-e</p>                                   | <p>-10 tCO<sub>2</sub>-we</p>                                   |
| <b>COOLING</b> | <p>Fall by 35%</p>                                      | <p>693 tCO<sub>2</sub>-e</p>                                   | <p>-562 tCO<sub>2</sub>-we</p>                                  |

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](https://www.oxfordmartin.ox.ac.uk/downloads/academic/201908_ClimatePollutants.pdf).

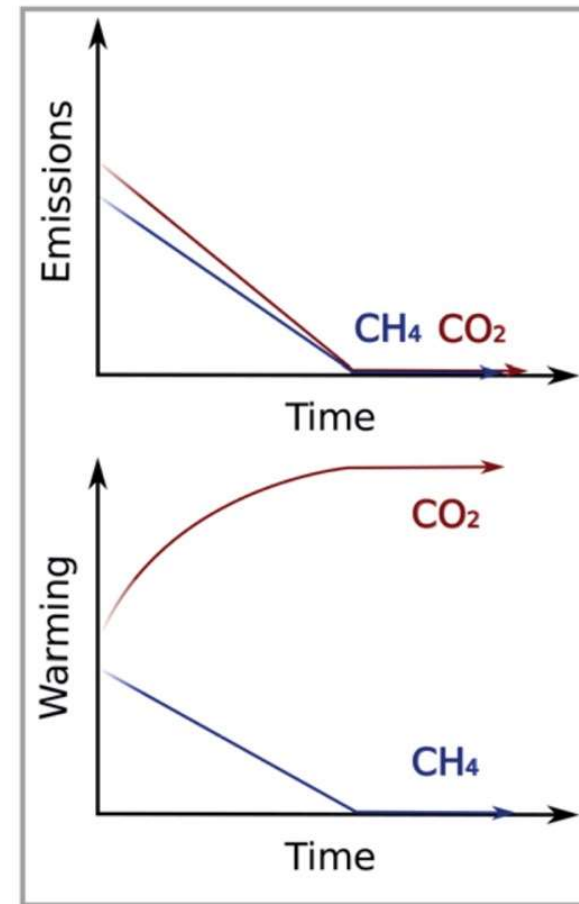
Rising emissions



Constant emissions



Falling emissions





# US Dairy Trends

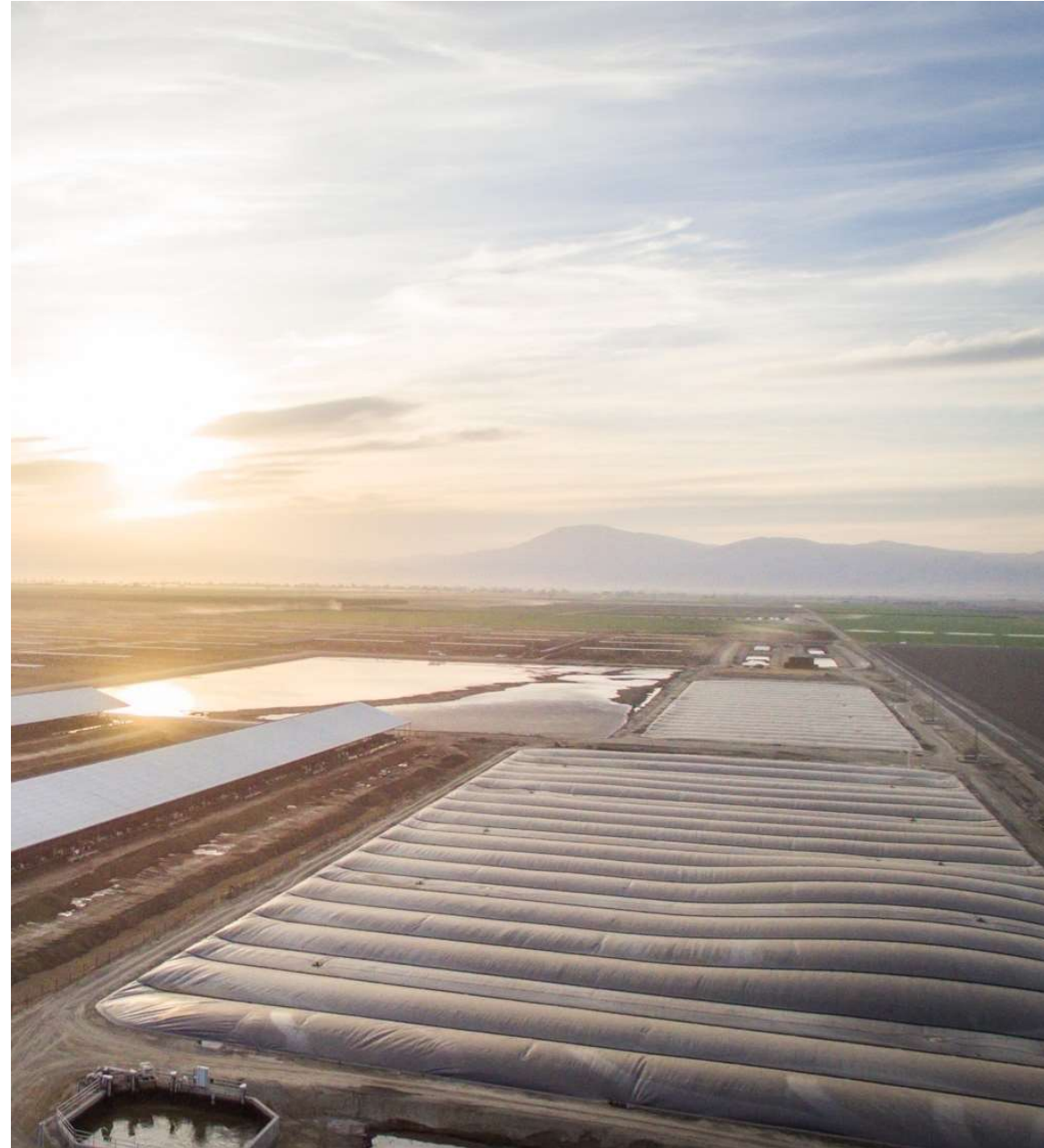
- In 1950, there were 25 million dairy cows in the U.S. Today there are 9 million.
- With 16 million fewer cows (1950 vs 2018), milk production nationally has increased 60 percent .
- The carbon footprint of a glass of milk is 2/3 smaller today than it was 70 years ago.



# California GHG trends

Since 2015 California dairies has reduced methane by

**2.2 million metric tons CO<sub>2</sub>e annually.**



# Dairy Manure Digester Development in California

Updated May 2017

1. ABEC-Bidart-Old River
2. ABEC-Bidart-Stockdale
3. Blakes Landing Farms/  
Straus Family Creamery
4. Castellanelli Brothers Dairy
5. Cottonwood Dairy/Joseph Gallo Farms
6. Denier Dairy
7. Fiscalini Farms
8. Giacomini Dairy
9. Hilarides Dairy
10. New Hope Dairy
11. Open Sky Ranch
12. Pacific Rim Dairy
13. Pixley Biogas
14. Van Steyn Dairy
15. Van Warmesdam Dairy
16. Verwey Dairy— Hanford  
Under Construction
17. Verwey Dairy— Madera
18. GJ TeVelde Ranch
19. Carlos Echeverria & Sons Dairy
20. Lakeview Dairy
21. West Star Dairy



That's a **25 percent** reduction in the dairy industry's methane emissions.

Read my blog  
[clear.ucdavis.edu/blog](http://clear.ucdavis.edu/blog)





Thank you  
**clear.ucdavis.edu**

