



Rethinking Methane

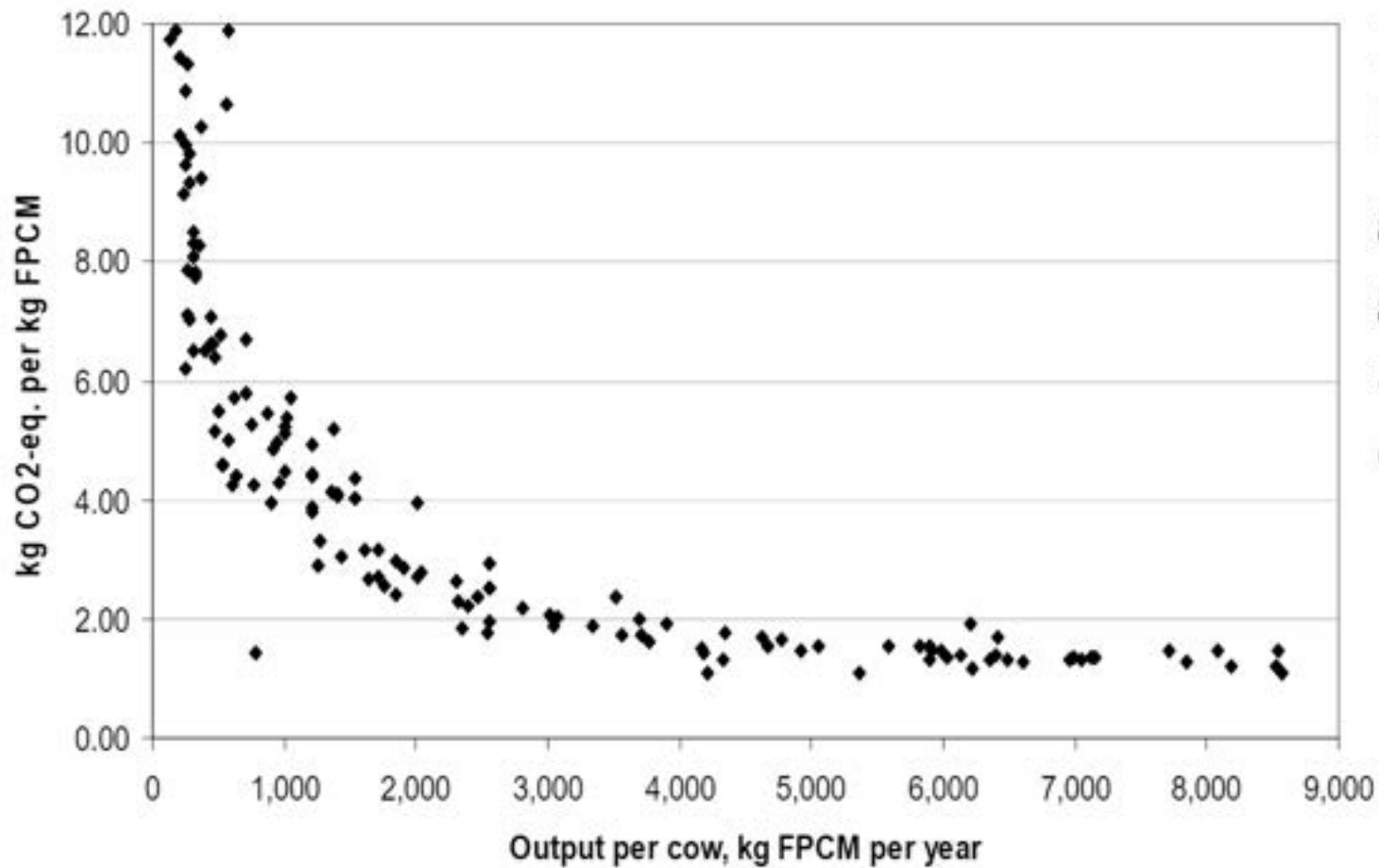
The Path to Climate Neutrality

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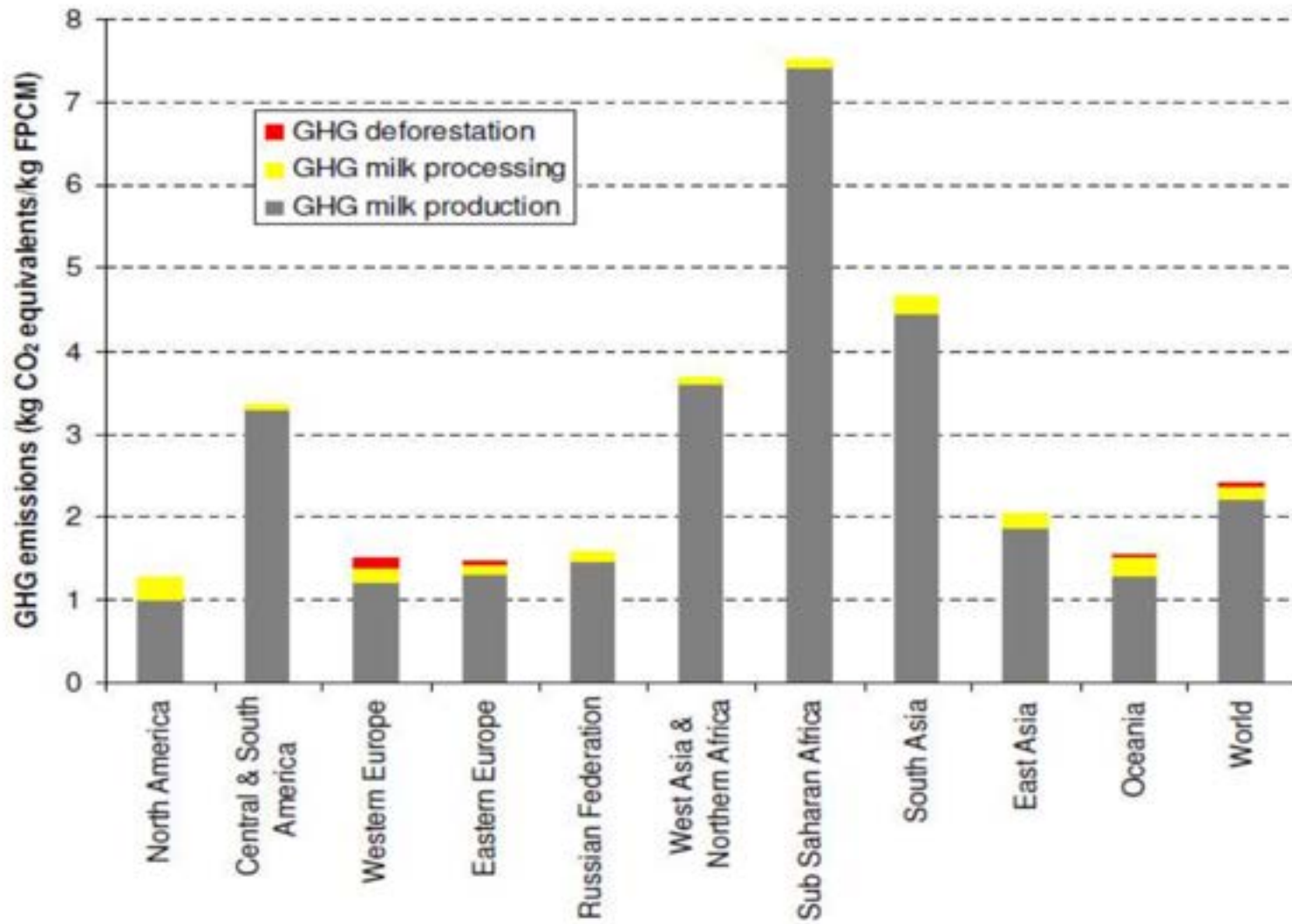
RETHINKING METHANE



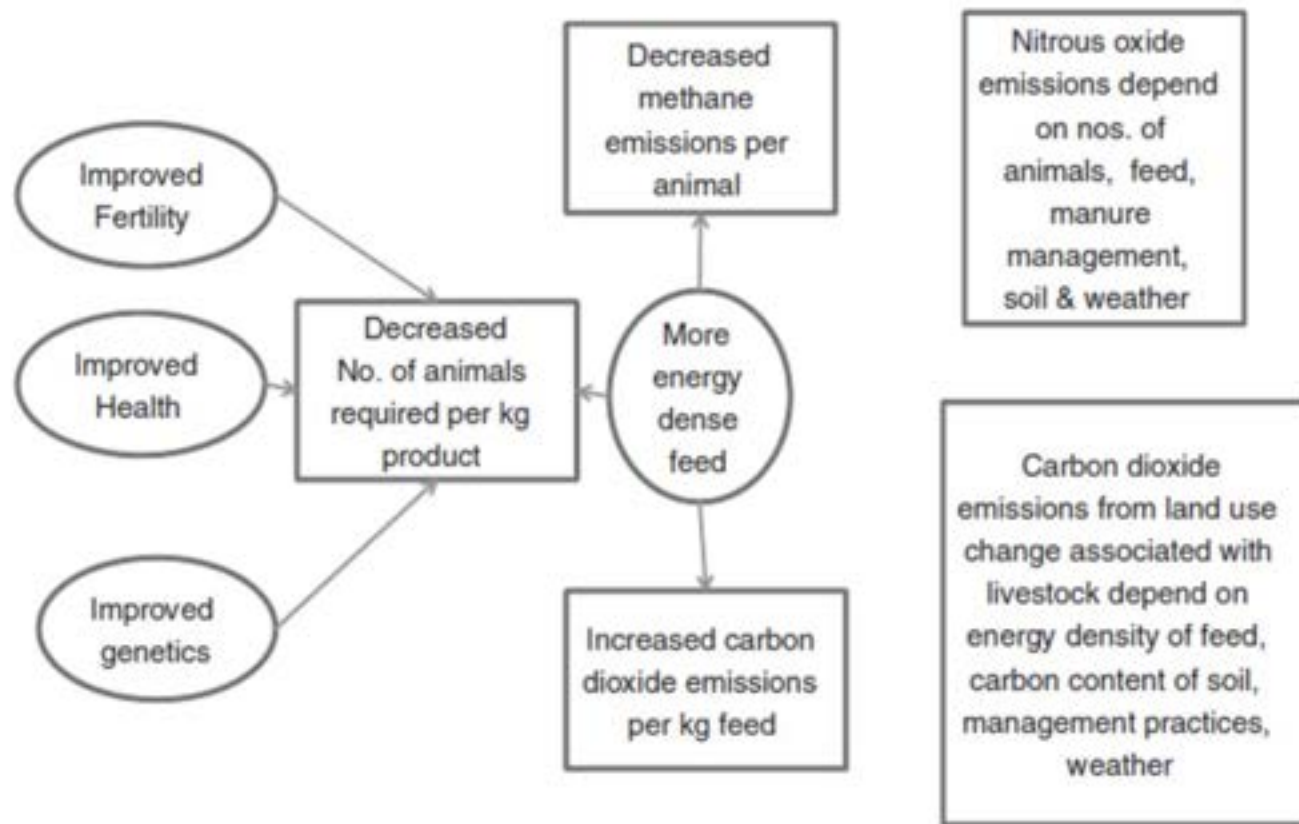


Relationship
between total
greenhouse
gas emissions
and milk
output per cow





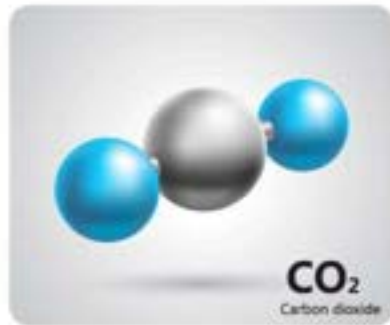
FAO (2010)



Nitrous oxide emissions depend on nos. of animals, feed, manure management, soil & weather

Carbon dioxide emissions from land use change associated with livestock depend on energy density of feed, carbon content of soil, management practices, weather

Mitigation: interventions to improve productivity



Global Warming Potential (GWP₁₀₀) of Main Greenhouse Gases

Carbon Dioxide (CO₂) 1

Methane (CH₄) 28

Nitrous Oxide (N₂O) 265

GLOBAL METHANE BUDGET



Global Carbon Project

TOTAL EMISSIONS

558
(540-568)

CH₄ 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 CH₄ per year (Tg CH₄ / yr), average 2003-2012

Anthropogenic fluxes

Natural fluxes

Natural and anthropogenic



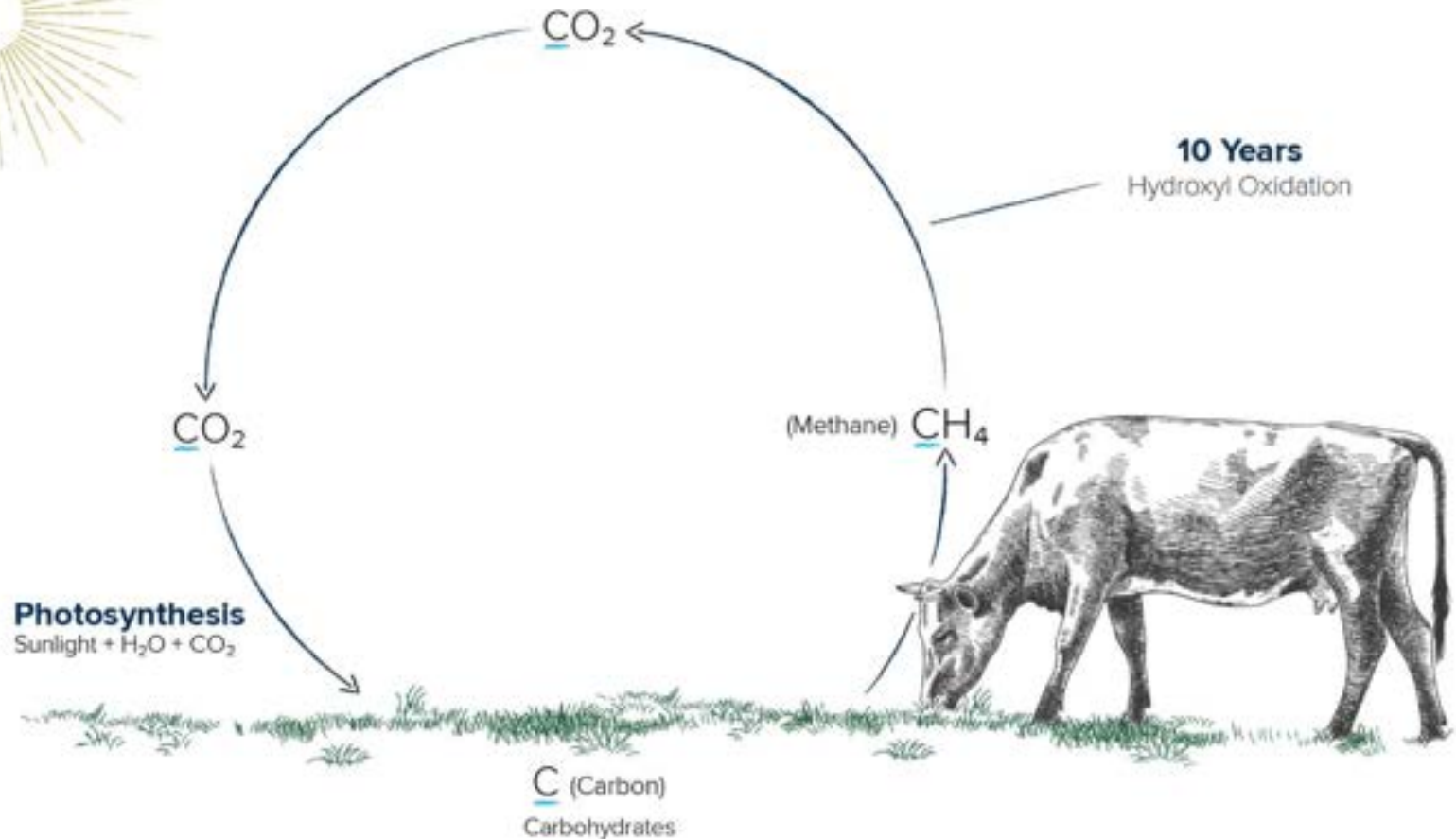
Half-Life of Main Greenhouse Gases in Years

Carbon Dioxide (CO ₂)	1,000
Methane (CH ₄)	10
Nitrous Oxide (N ₂ O)	110



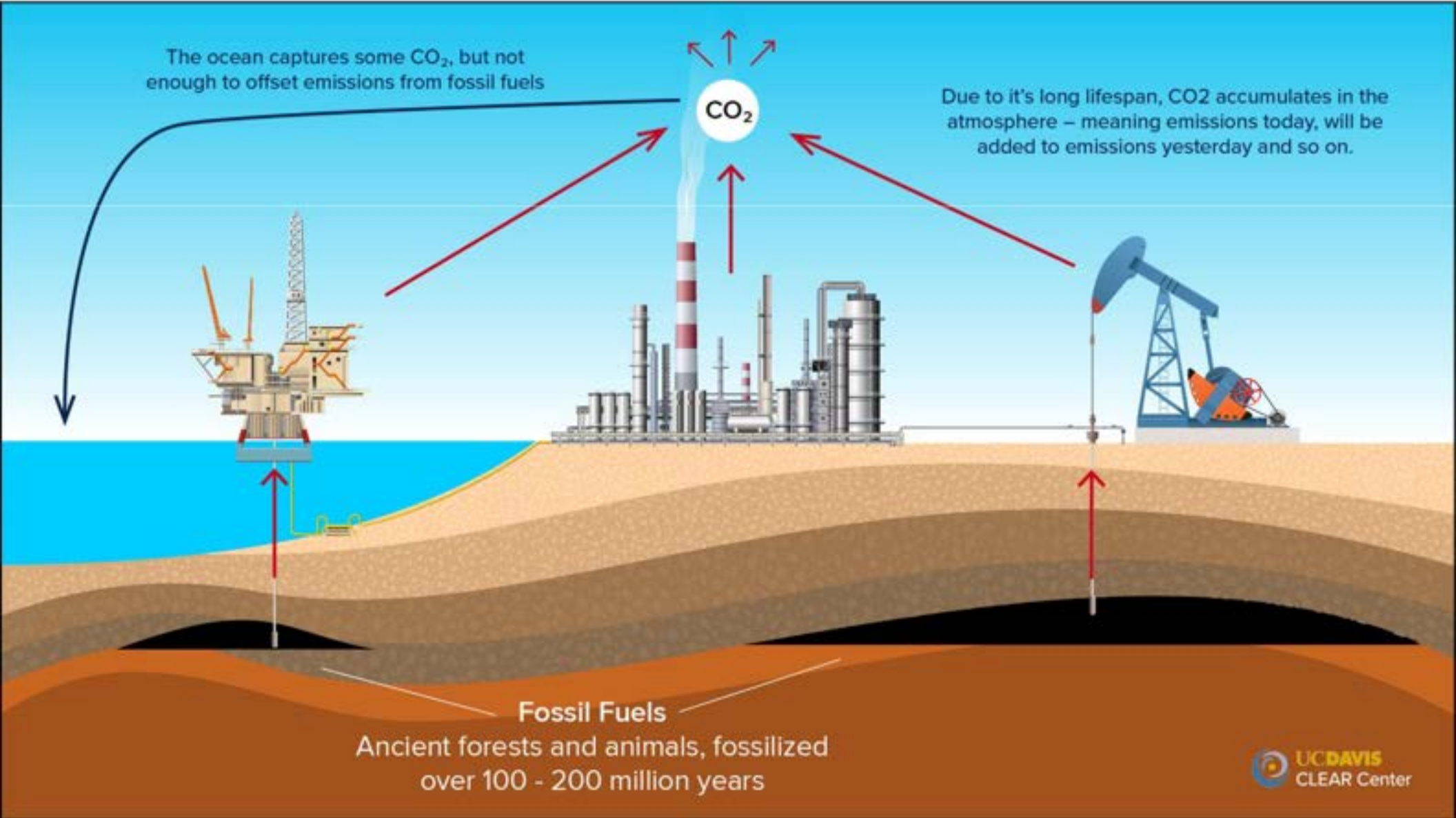
Biogenic Carbon Cycle

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.



■ = Pulse of CO₂

Stock Gas
Carbon dioxide
(CO₂)

Atmospheric
Concentration



Day 1 Day 2 Day 3 Day 4 Day 5

Time

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

■ = Pulse of CH₄

Flow Gas
Methane (CH₄)

Atmospheric
Concentration



Day 1 Day 2 Day 3 Day 4 Day 5

Time

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



Why methane should be treated differently compared to long-lived greenhouse gases

Livestock is a significant source of methane, a potent but short-lived greenhouse gas.

New research provides a way out of a longstanding quandary in climate policy: how best to account for the warming effects of greenhouse gases that have different atmospheric lifetimes.

Carbon dioxide is a long-lived greenhouse gas, whereas methane is comparatively short-lived. Long-lived "stock pollutants" remain in the atmosphere for centuries, increasing in concentration as long as their emissions continue and causing more and more warming. Short-lived "flow pollutants" disappear much more rapidly. As long as their emissions remain constant, their concentrations and warming effect remain roughly constant as well.

Our research demonstrates a better way to reflect how different greenhouse gases affect global temperatures over time.

Cost of pollution

The difference between stock and flow pollutants is shown in the figure below. Flow pollutant emissions, for example of methane, do not persist. Emissions in period one, and the same emissions in period two, lead to a constant (or roughly constant) amount of the pollutant in the atmosphere (or river, lake, or sea).

With stock pollutants, such as carbon dioxide, concentrations of the pollutant accumulate as emissions continue.

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GUEST POSTS 7 June 2018 10:00

Guest post: A new way to assess global warming potential of short-lived pollutants

DR MICHELLE CAIN

GUEST POSTS Guest post: A new way to assess global warming potential of short-lived pollutants

Dr Michelle Cain in a science and policy research associate on the Oxford Martin School's

<https://www.carbonbrief.org/guest-post-a-new-way-to-assess-global-warming-potential-of-short-lived-pollutants>

Improved calculation of warming-equivalent emissions for short-lived climate pollutants

Michelle Cain^{1,2}, Ashley Havelly Mawzy^{1,2}, Mylen A. Allen^{1,3}, Ian S. Ferguson^{1,2}, David L. Frame¹ and Ashin H. Chow^{1*}

Anthropogenic global warming at a given time is largely determined by the cumulative total emissions (or stocks) of long-lived climate pollutants (CO₂, greenhouse gases, methane (CH₄), and the aerosols sets for PM_{2.5} and black carbon (BC)). The aerosols sets for PM_{2.5} and BC are not included in the Paris Agreement, but the aerosols sets for CH₄ and CO₂ are. This paper reports on a new method for calculating the warming equivalent emissions (WEE) of short-lived climate pollutants (SLCPs) in their impact on global mean surface temperature. An alternative set of WEE, denoted WEE', accounts for the impact of SLCPs on the aerosols sets for CH₄ and CO₂. We show that this approach, while an improvement on the conventional usage, slightly underestimates the impact of future increases in SLCP emissions on current rates of warming because the climate does not respond instantaneously to methane forcing. We resolve this with a modification of the WEE' definition, which incorporates a term for each of the short-lived and long-lived climate pollutants to changes in methane forcing. This modified version allows WEE' warming equivalent CO₂ to be necessary for calculating SLCPs from reported emissions. These WEE' can be compared directly to carbon budgets committed with long-term temperature goals, because every unit of CO₂ or methane generates approximately the same amount of warming whether it is emitted as a SLCP or a CO₂. This is not the case for conventional WEE.

INTRODUCTION
Comprehensive climate policy must consider a range of greenhouse gases and aerosols, which can differ significantly in their relative efficiencies and atmospheric lifetimes, and hence the nature of their climate impacts. To reflect this, different climate pollutants are often expressed using a common emission metric, emissions reported under the United Nations Framework Convention on Climate Change (UNFCCC) have included the use of "global warming potential (GWP)" to account for all gases in carbon dioxide equivalent (CO₂e) emissions. Similar to emissions in the UNFCCC and national climate policies, GWP has remained constant^{1,2} – not least that it cannot be used to compare methane-related goals³ and other emissions metrics have been proposed^{4,5}. Indeed, Stone⁶ notes that strong reasons exist to show when GWP was introduced in the Intergovernmental Panel on Climate Change's first assessment report⁷ – "to make an incorrect but there is no universally accepted methodology for combining all the relevant factors into a single metric" – a simple approach is, the GWP has been retained here to facilitate the difficult task of "the concept" Working Group 1 of the Fifth Assessment Report, AR5, did not recommend any units, and concluded that the choice of metric depends on the specific goal of the climate policy in 2010. However, the GWP metric has remained largely in common use, despite the efforts of long-lived greenhouse gases⁸ and SLCPs of GWP₁₀₀ have been used.

The temperature response to emissions is analogous under GWP₁₀₀ and the uncertainty is particularly evident in the context of the Paris Agreement given its stated aim of holding the increase in the global average temperature well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C. Beyond the reference to a balance of emissions by sources and removals by sinks, such factors that aid of the climate, neither the means by which this is to be achieved nor the metrics used to assess progress are explicitly stated. "Science and Technology" demonstrates that methane equivalent CO₂e emissions based on GWP₁₀₀ which is often suggested to be the definition of the balance of sources and sinks described in the Paris Agreement are not consistent to limit warming to 2°C. Working Group 1 of the Paris Agreement is accordingly inconsistent with the temperature goal in Article 2.1. These papers show how moving from the temperature goal articulated in the Paris Agreement to emissions targets and profiles is not something that is currently well founded by conventional values accounting they also show that the use

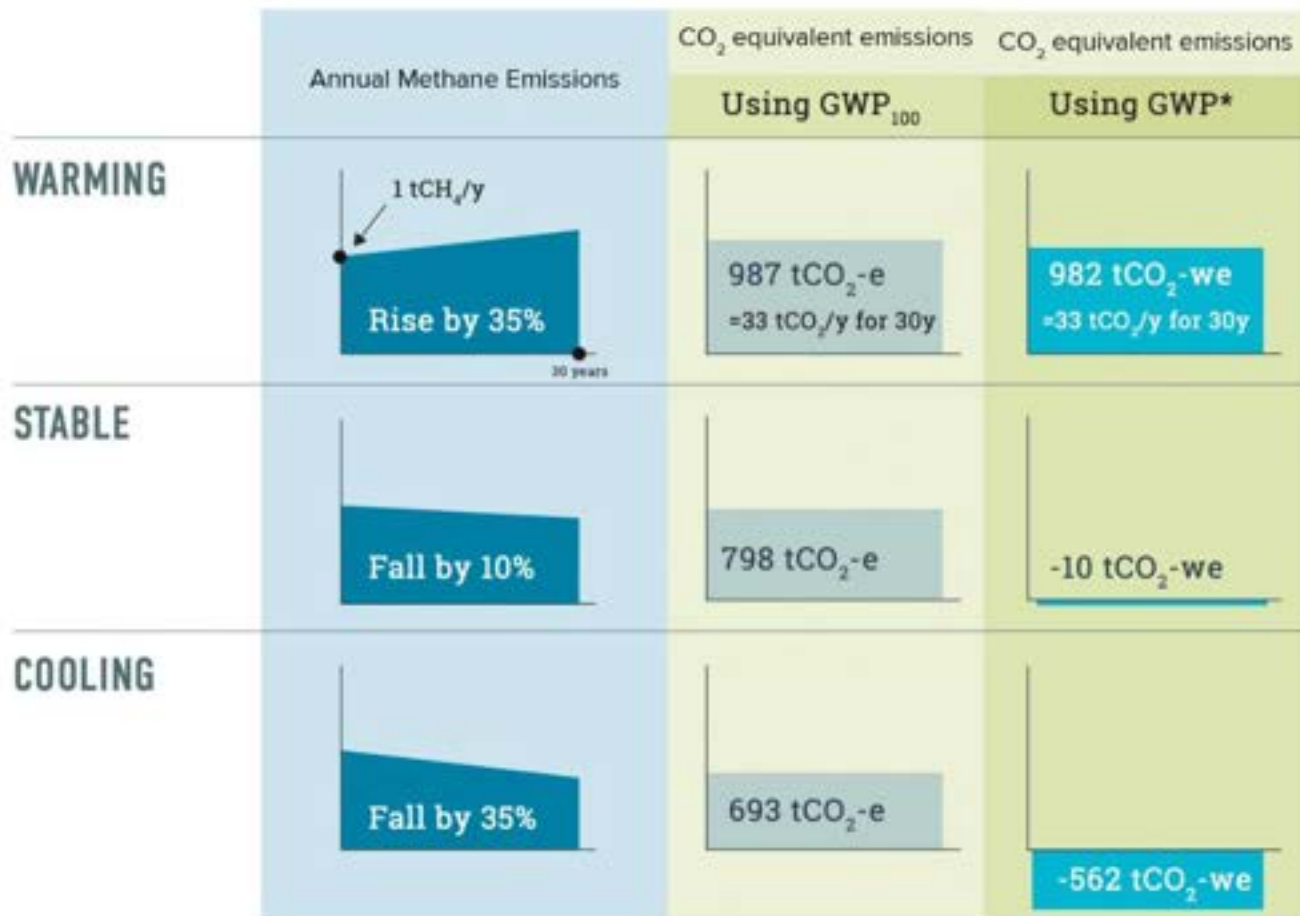
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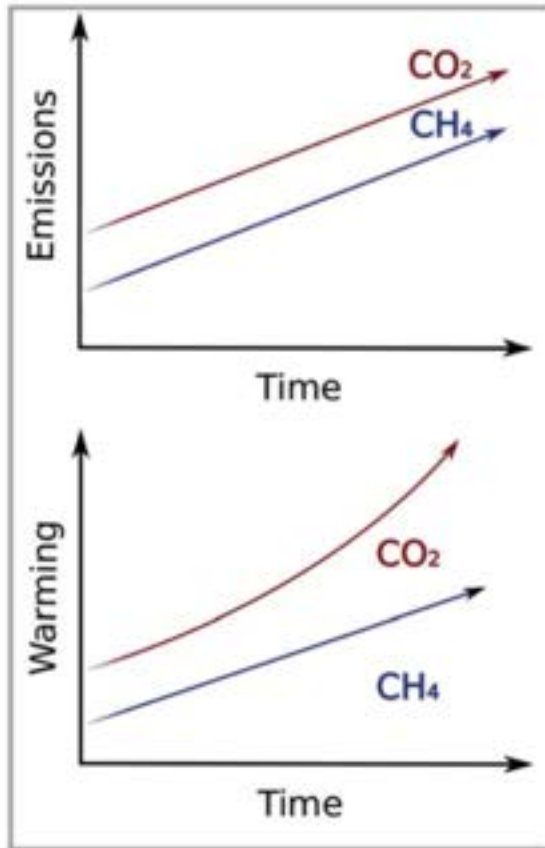
<https://www.nature.com/articles/s41612-019-0086-4.pdf>



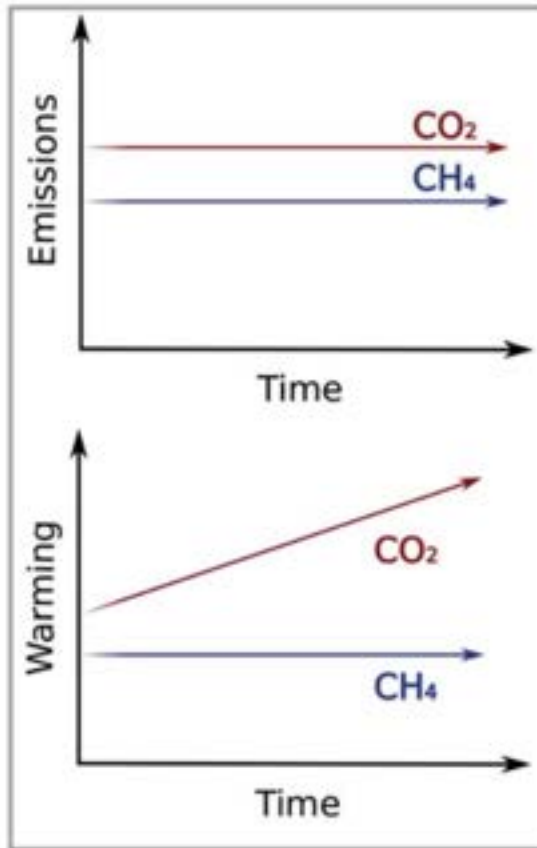


Cain, M., Allen, M. & Lynch, J. *Oxford Martin Programme on Climate Pollutants* (2019). Read more at: https://www.oxfordmartin.ox.ac.uk/downloads/academic/201908_ClimatePollutants.pdf.

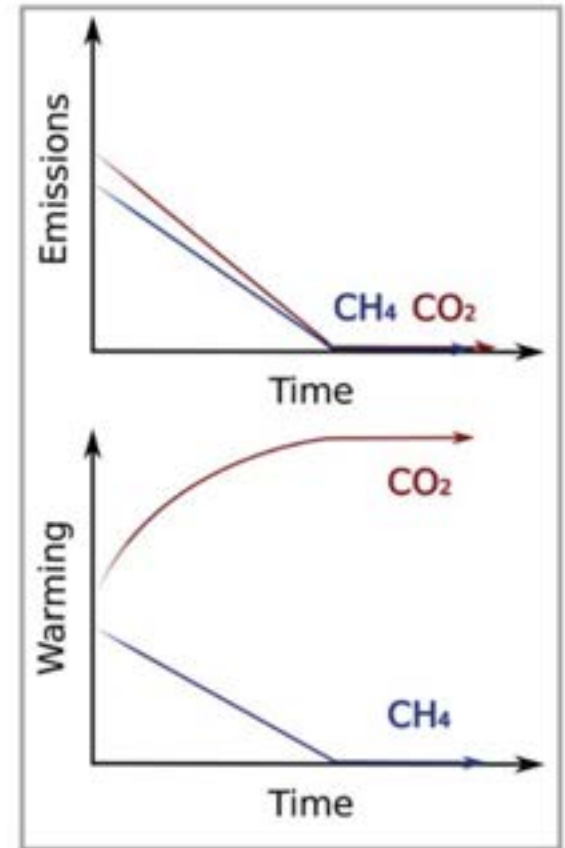
Rising emissions



Constant emissions



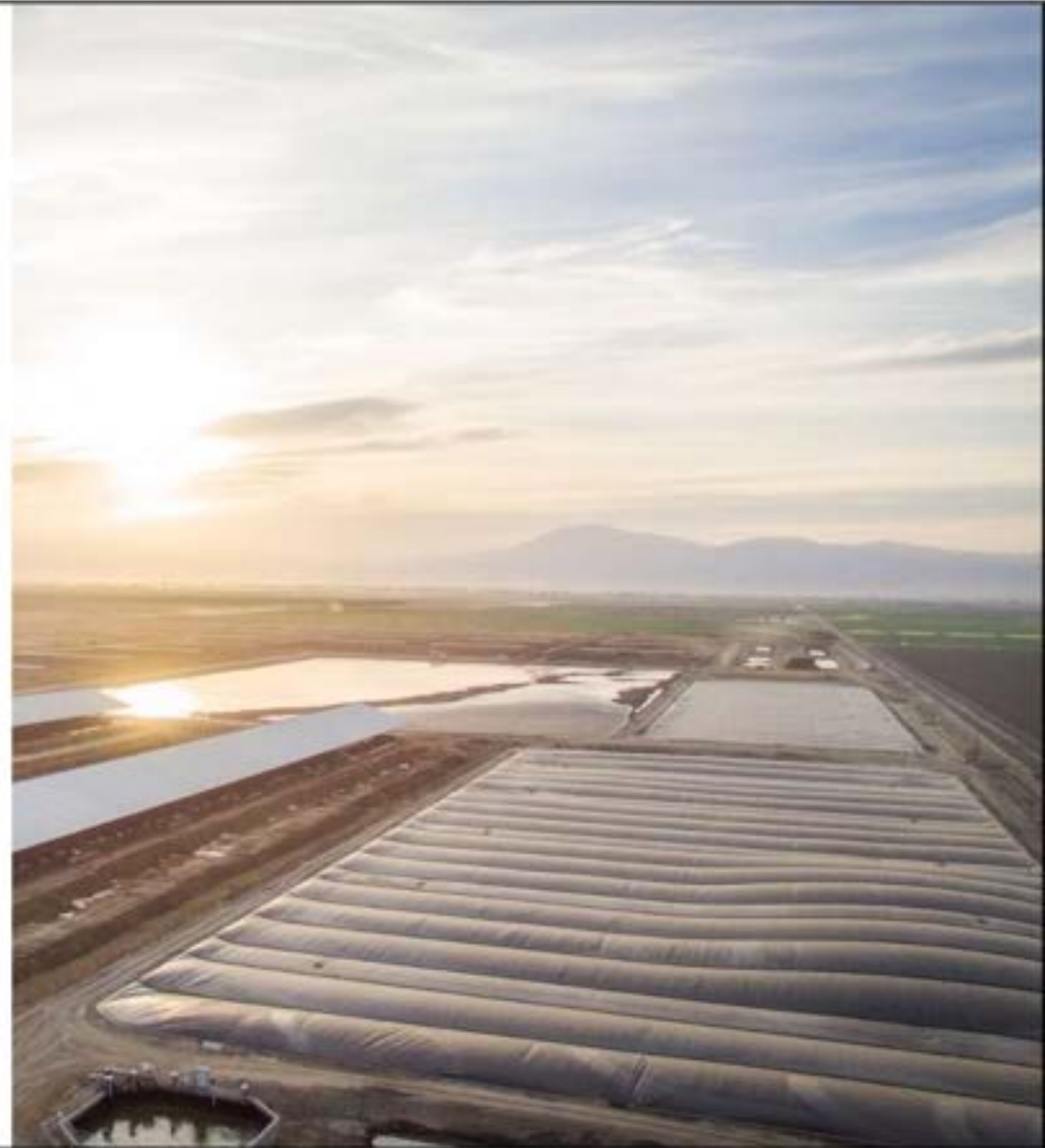
Falling emissions





How do
we do it?

Since 2015
California dairies
have reduced
**2.2 million
metric tons**
of greenhouse
gases



Dairy Manure Digester Development in California

Updated May 2017



1. ABEC-Bilant-Old River
2. ABEC-Bilant-Stockdale
3. Blakes Landing Farms/
Straus Family Creamery
4. Castellani 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. Poley Bingas
14. Van Steyn Dairy
15. Van Warmendam Dairy
16. Verwey Dairy- Hanford
Under Construction
17. Verwey Dairy- Madera
18. GJ TeVelle Ranch
19. Carlos Echeverria & Sons Dairy
20. Lakeview Dairy
21. West Star Dairy

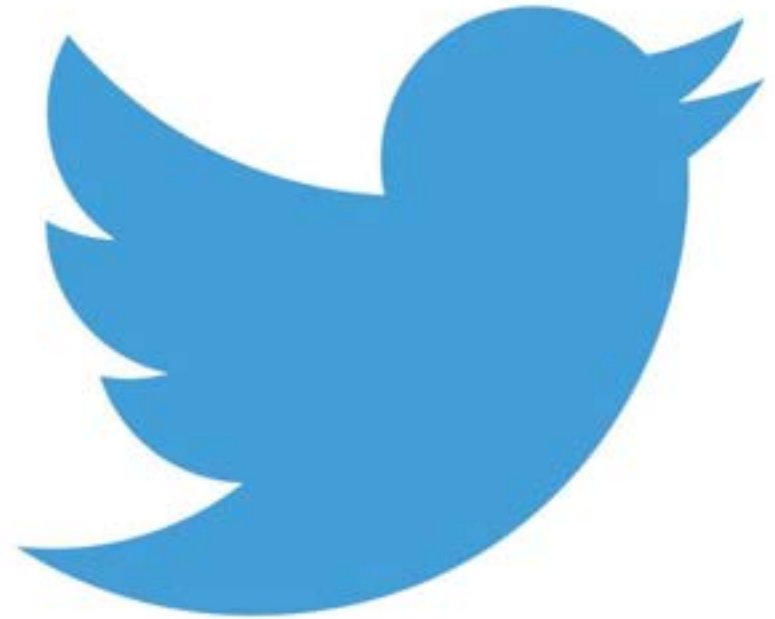


That's a **25 percent** reduction in manure methane emissions.

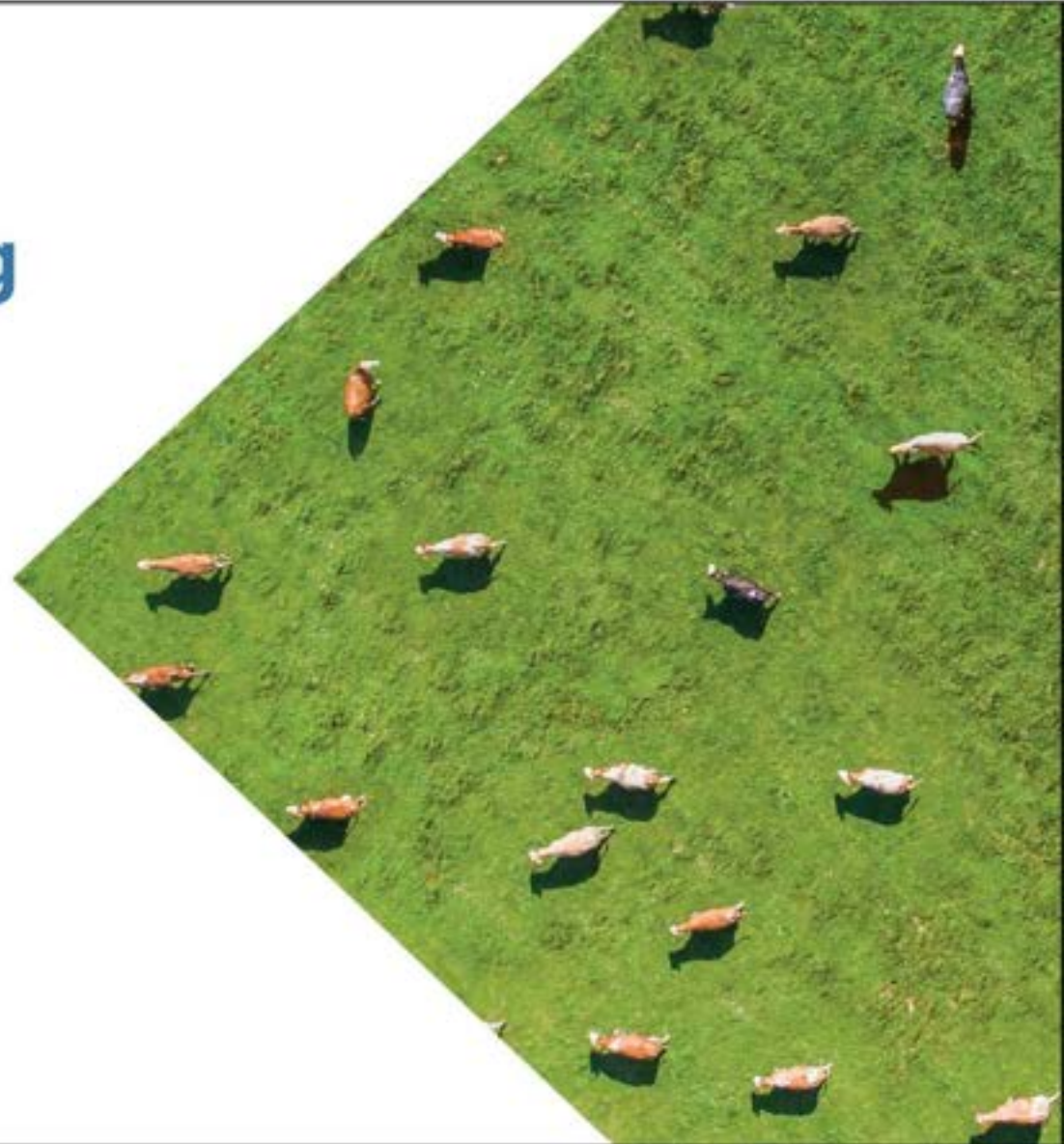
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