Feeding the People without Wasting the Planet

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RETHINKING METHANE

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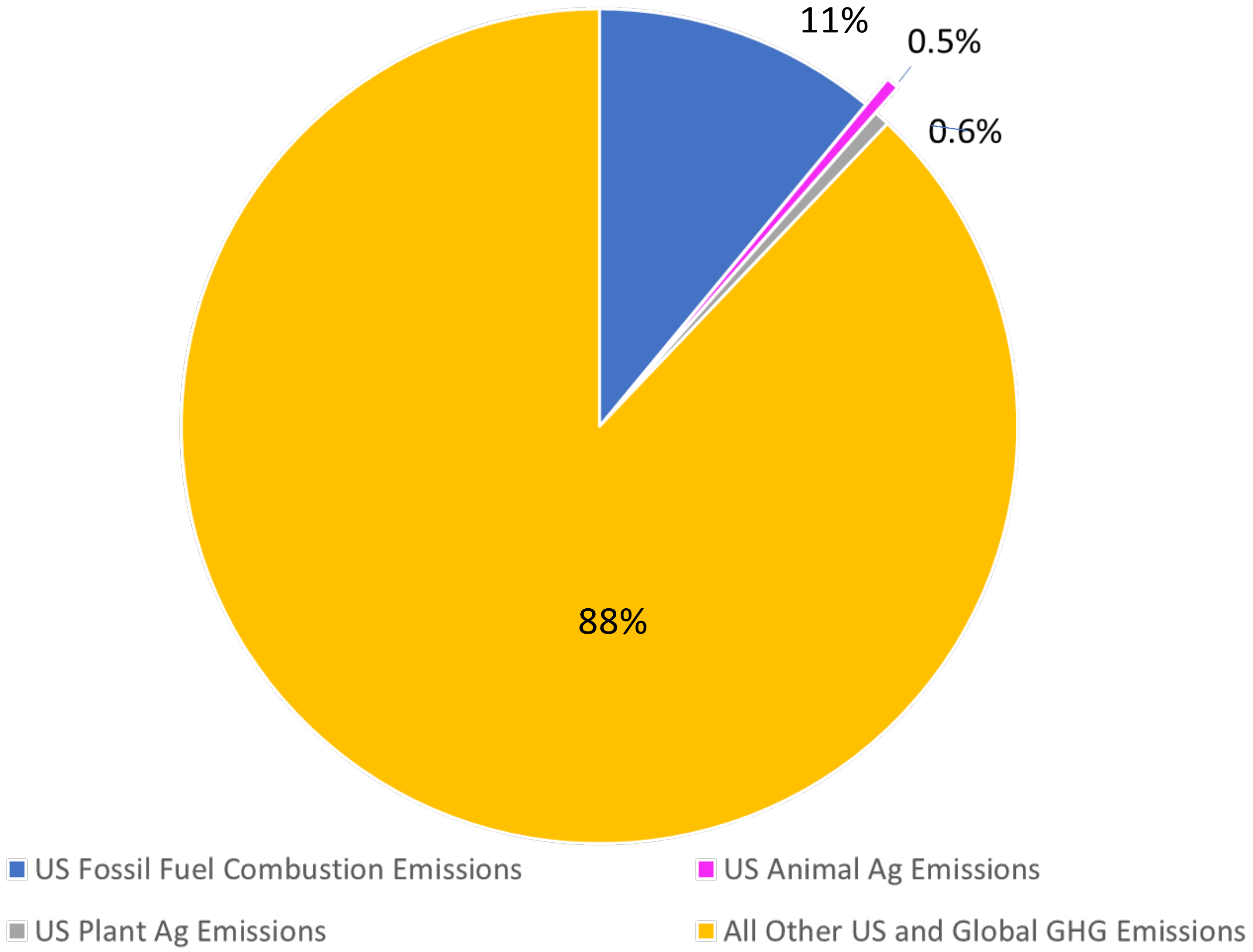
Global Greenhouse Gas Emissions in 2017
(Total Emissions were 49 Gt of CO2 Equivalents)



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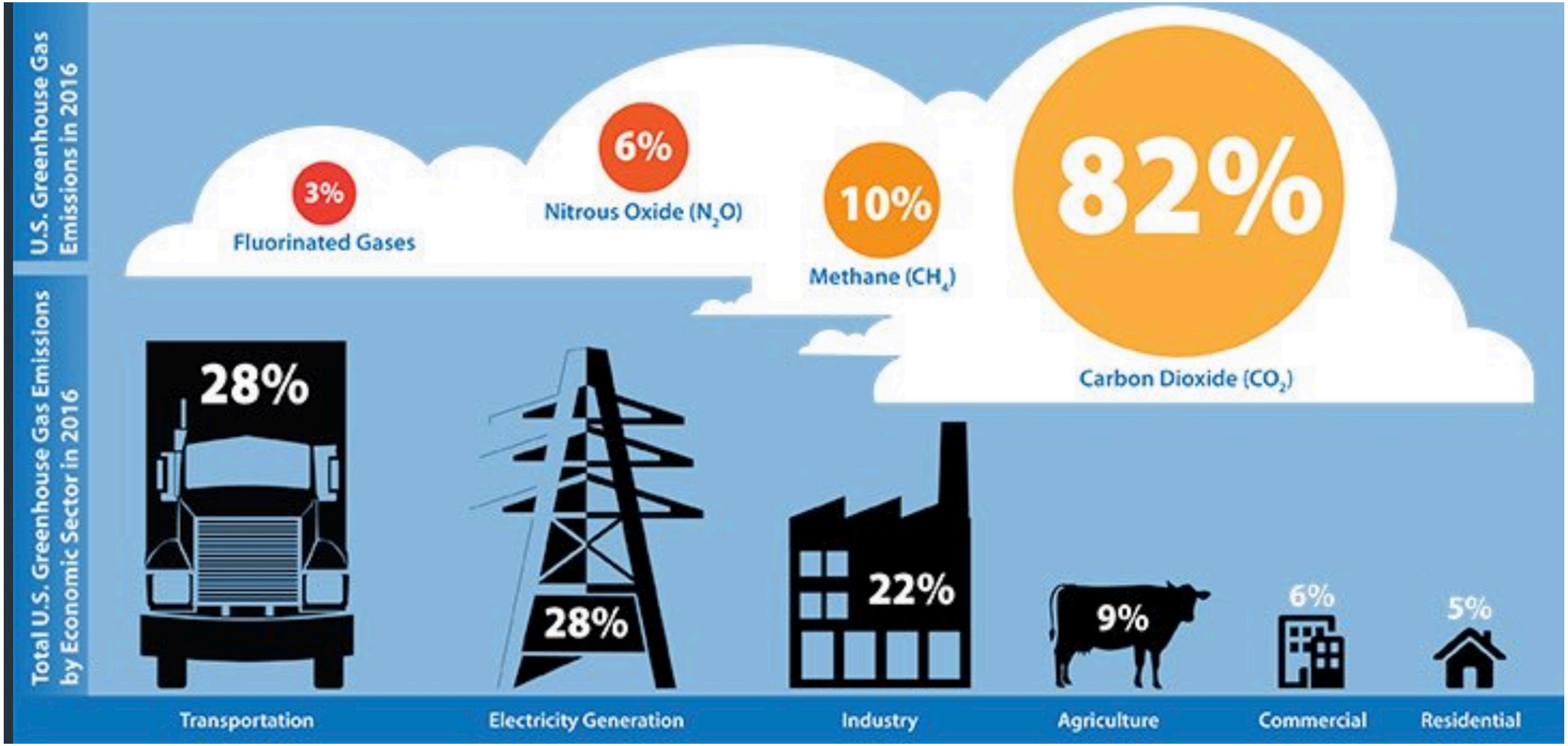
Source: US EPA Greenhouse Gas Emissions Inventory

National-Level U.S. GHG Inventory



Source: EPA (2017)

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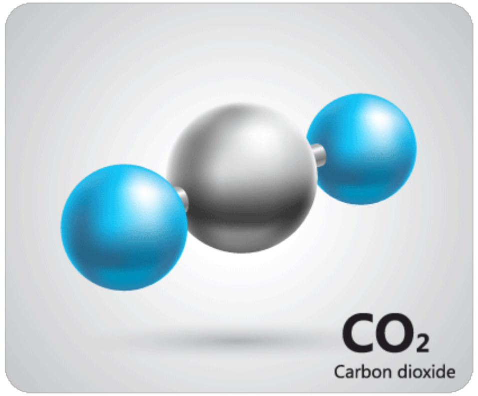
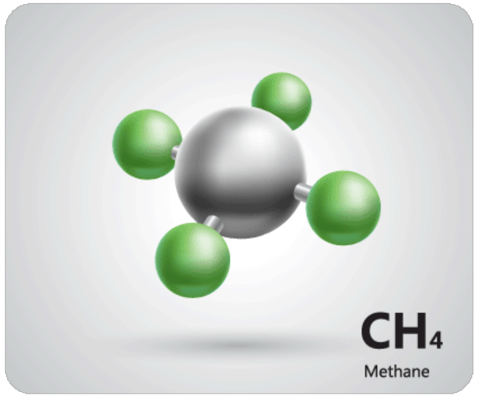
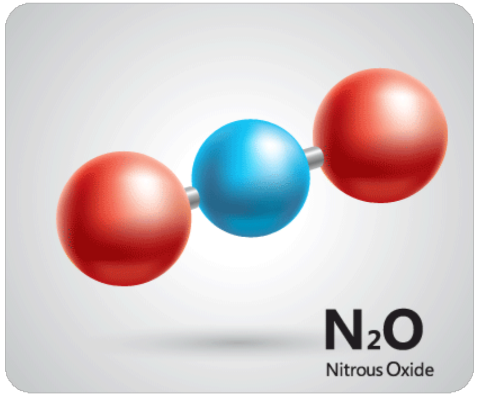
Global Warming Potential (GWP_{100}) of Main Greenhouse Gases







Carbon Dioxide (CO_2)	1
Methane (CH_4)	28
Nitrous Oxide (N_2O)	265

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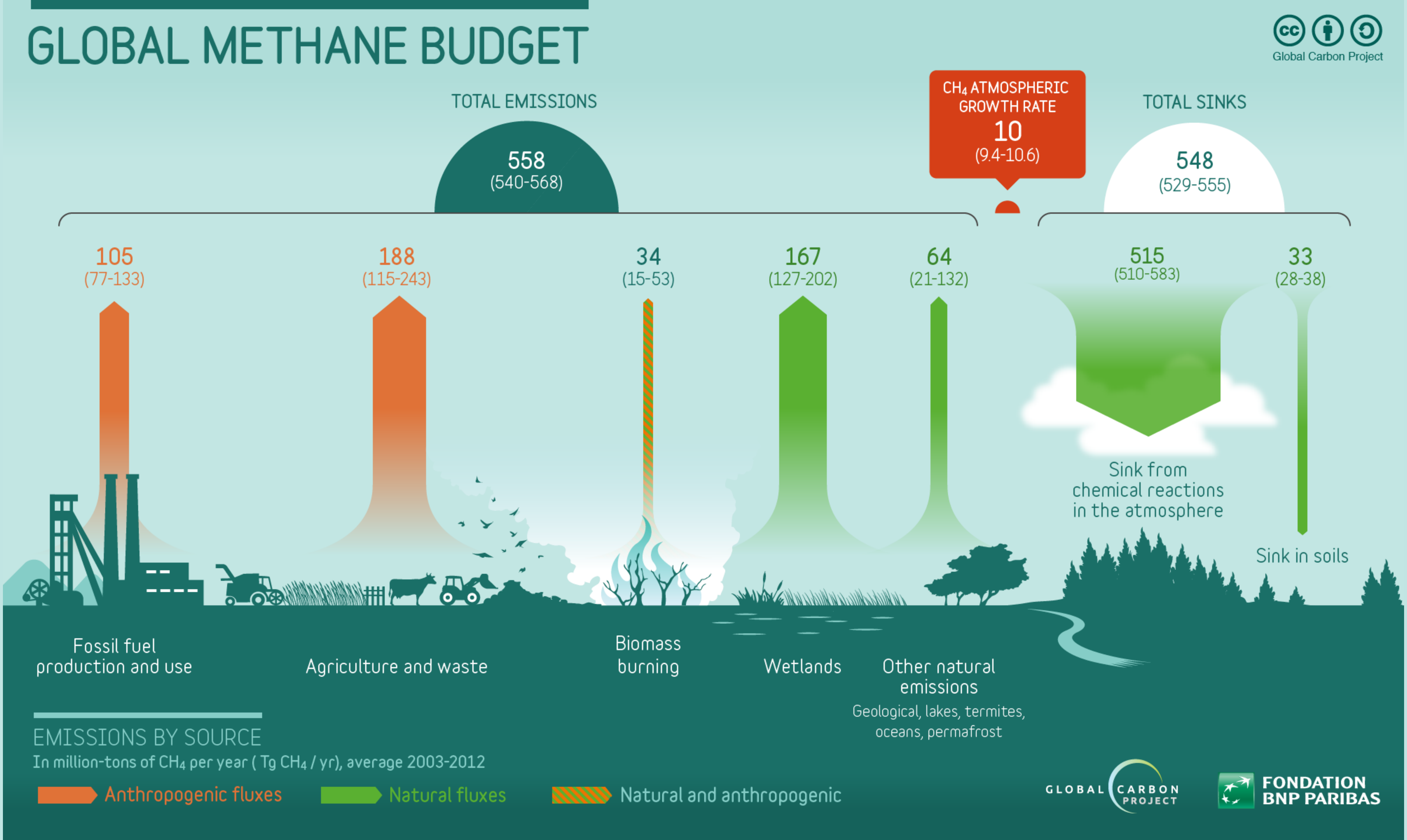
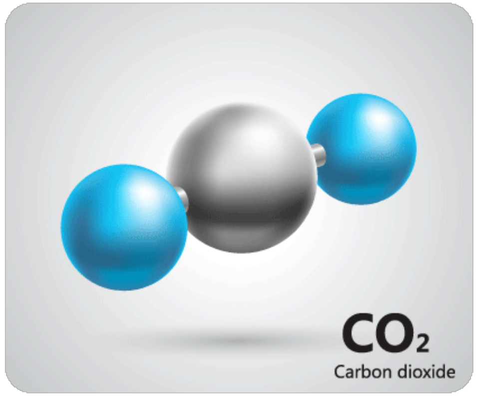
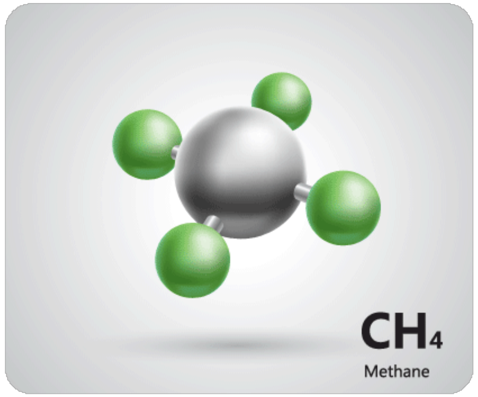
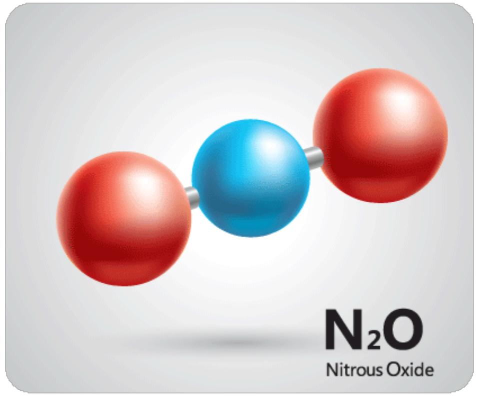

GLOBAL METHANE BUDGET
Global Carbon Project
TOTAL EMISSIONS
558
(540-568)
CH_4 ATMOSPHERIC GROWTH RATE
10
(9.4-10.6)
TOTAL SINKS
548
(529-555)
105
(77-133)
188
(115-243)
34
(15-53)
167
(127-202)
64
(21-132)
515
(510-583)
33
(28-38)
Sink from chemical reactions in the atmosphere
Sink in soils
Fossil fuel production and use
Agriculture and waste
Biomass burning
Wetlands
Other natural emissions
Geological, lakes, termites, oceans, permafrost
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

Half-Life of Main Greenhouse Gases in Years

Carbon Dioxide (CO_2)	1,000
Methane (CH_4)	10
Nitrous Oxide (N_2O)	110







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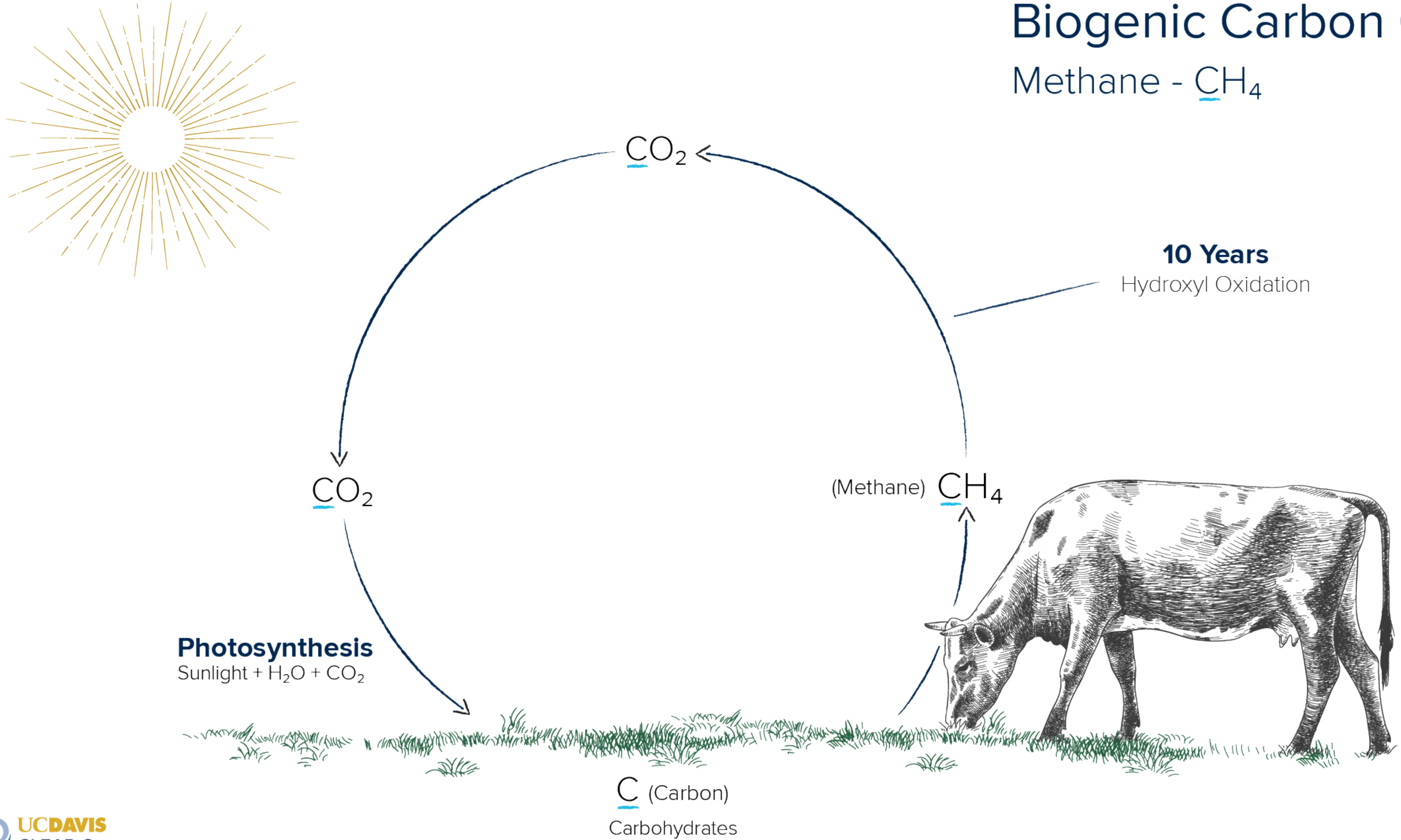
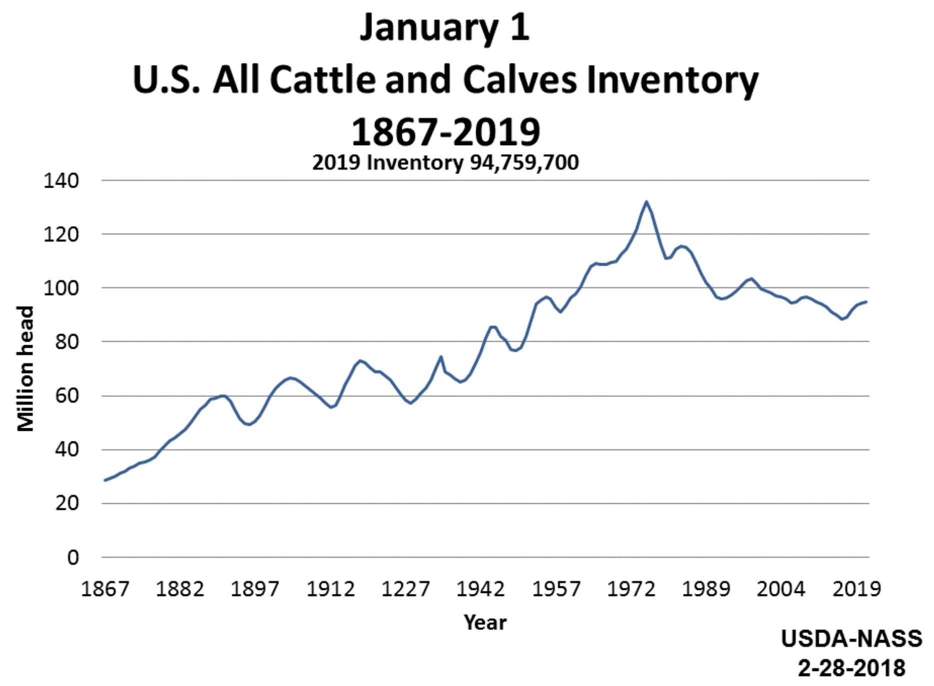
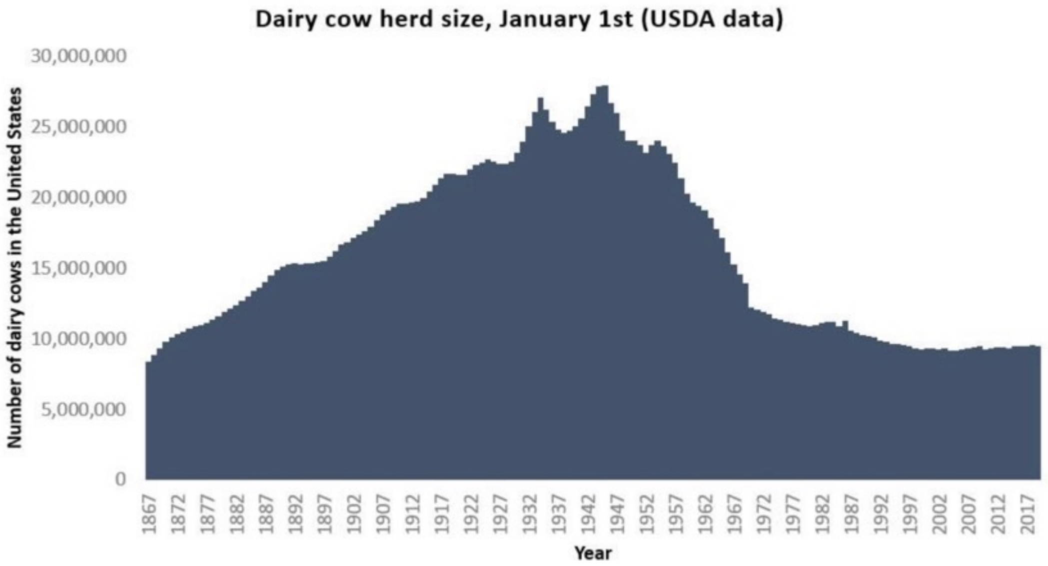
Biogenic Carbon Cycle

Methane - CH_4



If herd sizes do not increase for 10 years, then additional methane is not added to the atmosphere.





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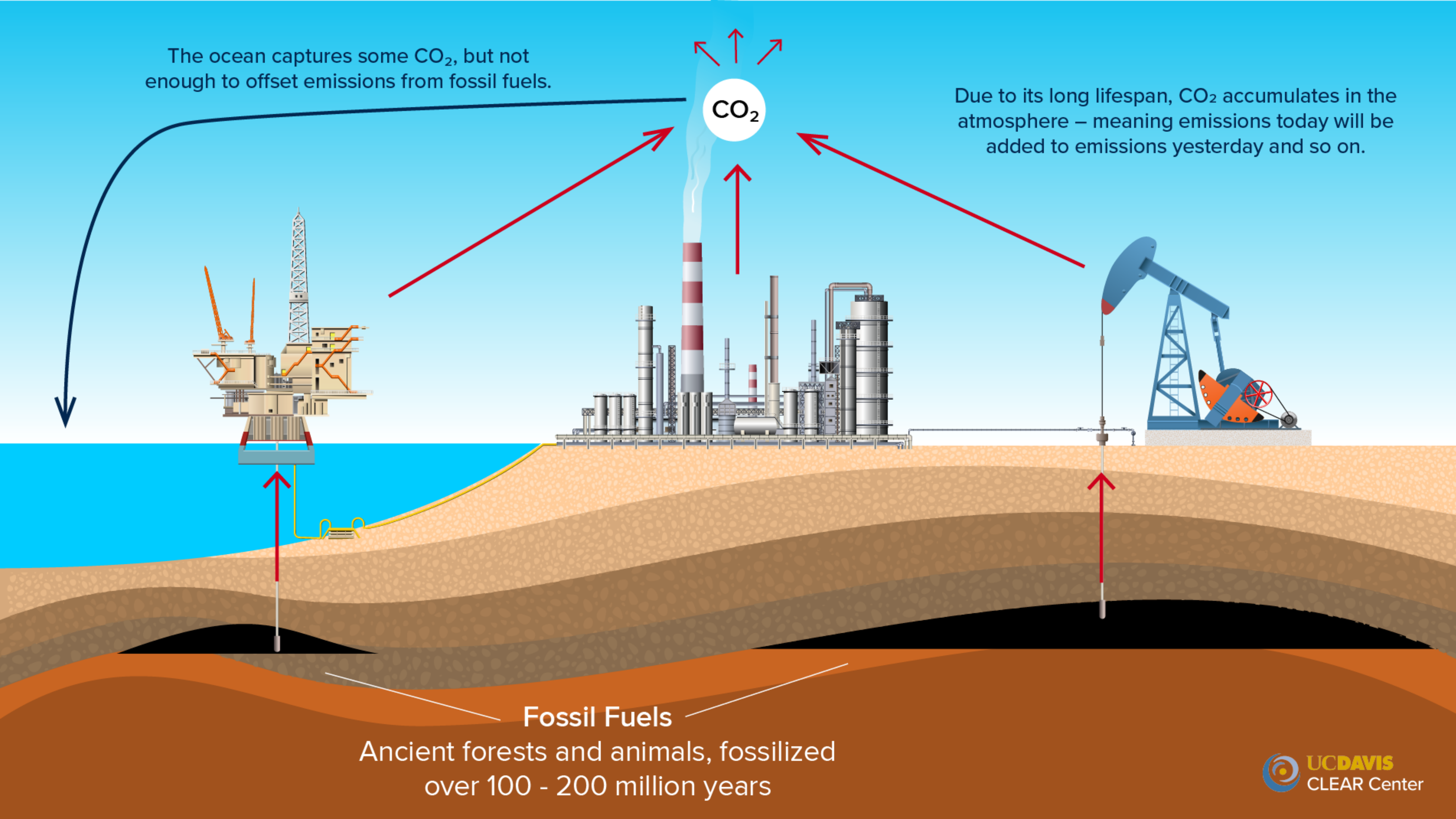
The ocean captures some CO_2, but not enough to offset emissions from fossil fuels.
CO_2
Due to its long lifespan, CO_2 accumulates in the atmosphere – meaning emissions today will be added to emissions yesterday and so on.
Fossil Fuels
Ancient forests and animals, fossilized over 100 - 200 million years
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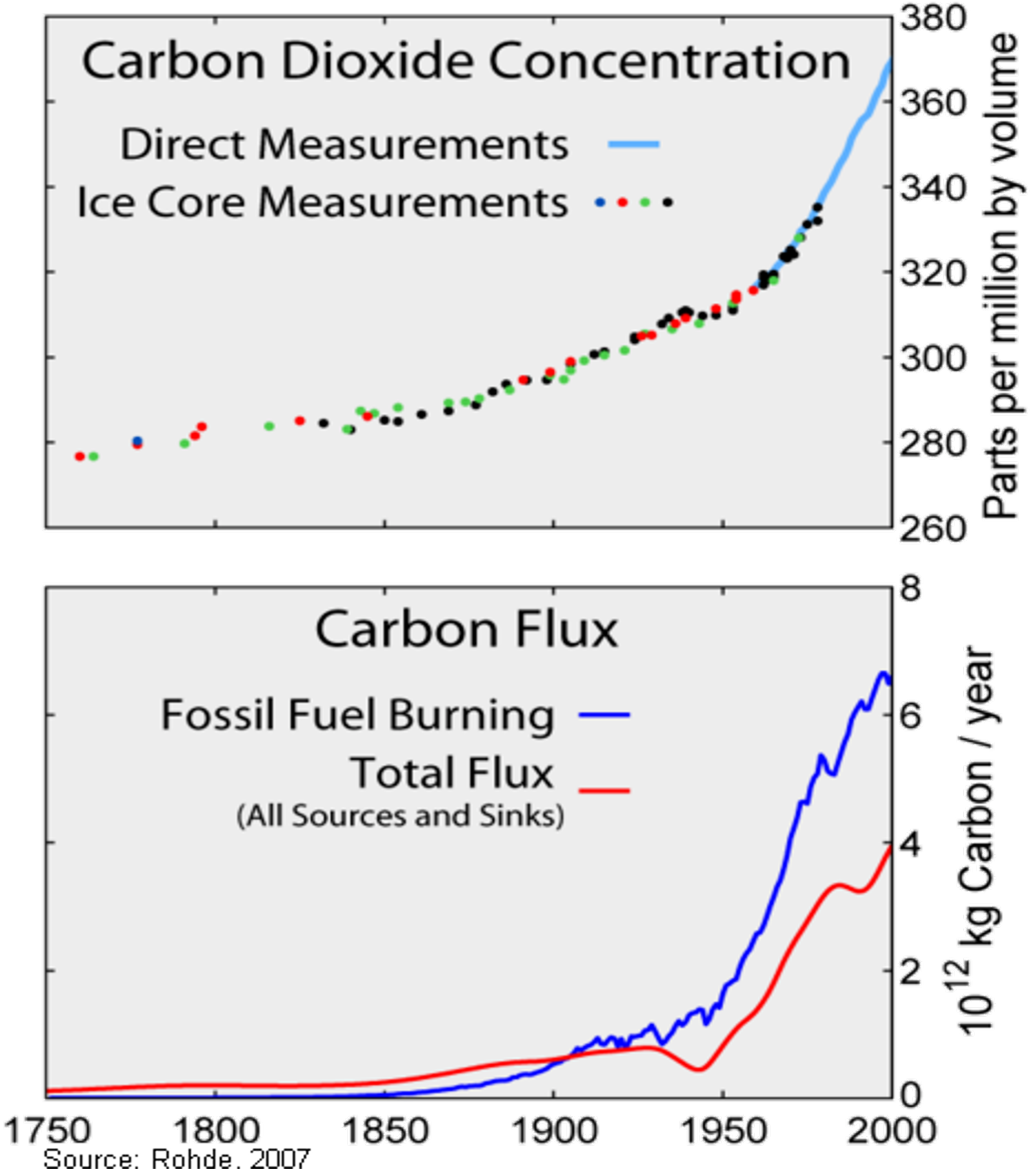
Carbon Dioxide and Carbon Flux



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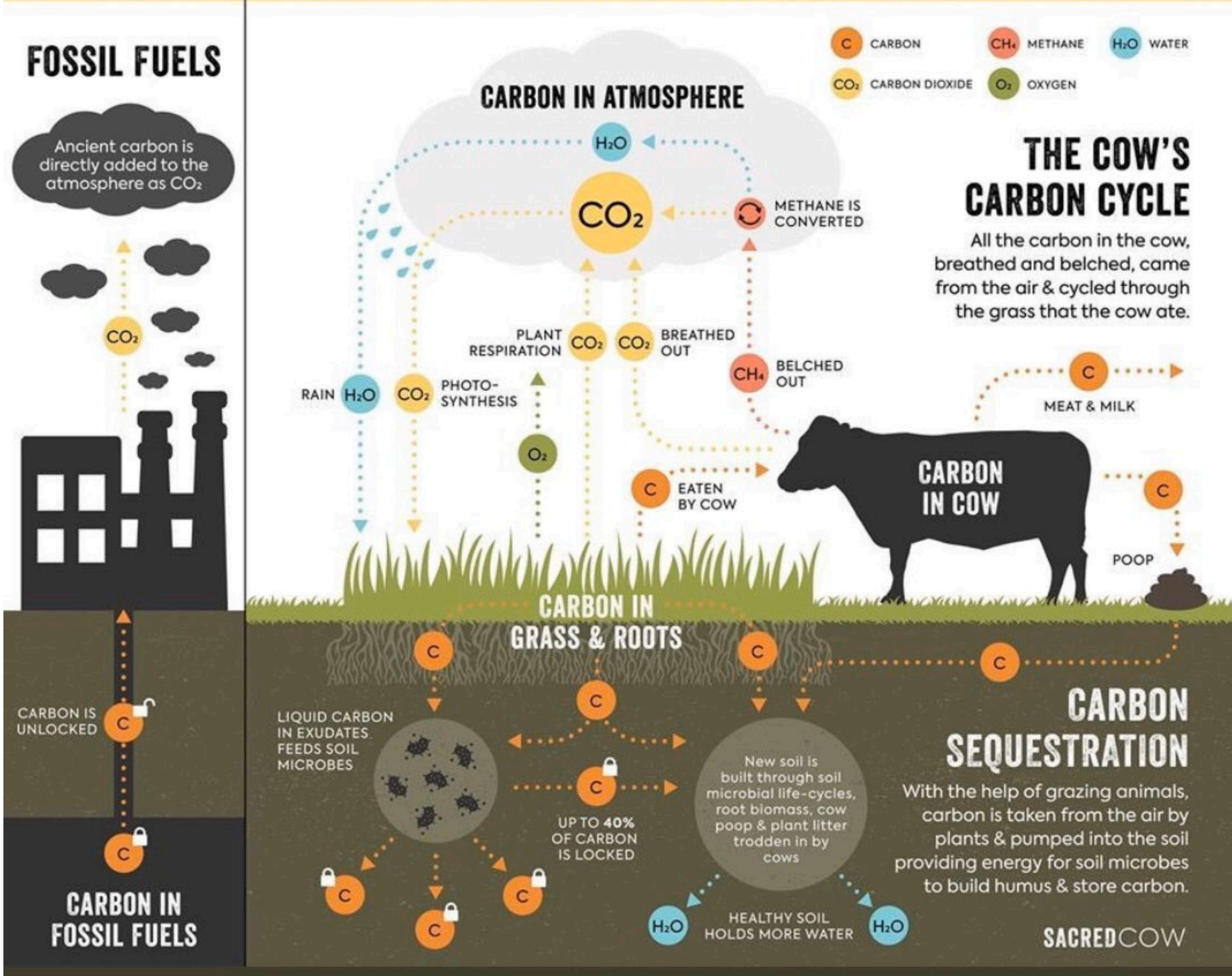
Fossil vs. Biogenic Carbon



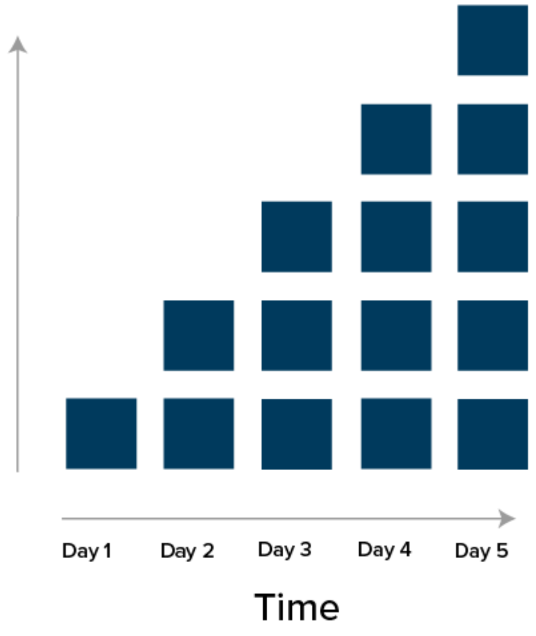
Via:
@sustainabledish
sacredcow.info

■ = Pulse of CO_2

Stock Gas

Carbon dioxide (CO_2)

Atmospheric Concentration



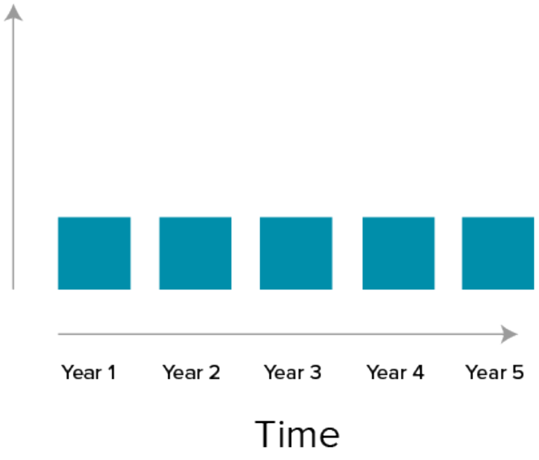
Stock gases will accumulate over time, because they stay in the environment.

■ = Pulse of CH_4

Flow Gas

Methane (CH_4)

Atmospheric Concentration



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

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Based on research by Myles R. Allen, Keith P. Shine, Jan S. Fuglestvedt, Richard J. Millar, Michelle Cain, David J. Frame & Adrian H. Macey.
Read more here: https://rdcu.be/b1t7S

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

June 12, 2018 12.59am EDT

Livestock is a significant source of methane, a potent but short-lived greenhouse gas. from www.shutterstock.com, CC BY-SA

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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 concentration 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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https://theconversation.com/why-methane-should-be-treated-differently-compared-to-long-lived-greenhouse-gases-97845

CarbonBrief
CLEAR ON CLIMATE

Cattle round-up before shipping on a West Texas ranch. Credit: Luc Novovitch / Alamy Stock Photo.

GUEST POSTS 7 June 2018 10:08

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

CB DR MICHELLE CAIN
06.07.18

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

npj | Climate and Atmospheric Science www.nature.com/npjclimatsci

ARTICLE OPEN

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

Michelle Cain[1,2], John Lynch[3], Myles R. Allen[1,3], Jan S. Fuglestvedt[4], David J. Frame[5] and Adrian H Macey[6,7]

Anthropogenic global warming at a given time is largely determined by the cumulative total emissions (or stock) of long-lived climate pollutants (LLCPs), predominantly carbon dioxide (CO_2), and the emission rates (or flow) of short-lived climate pollutants (SLCPs) immediately prior to that time. Under the United Nations Framework Convention on Climate Change (UNFCCC), reporting of greenhouse gas emissions has been standardised in terms of CO_2-equivalent (CO_2-e) emissions using Global Warming Potentials (GWP) over 100-years, but the conventional usage of GWP does not adequately capture the different behaviours of LLCPs and SLCPs, or their impact on global mean surface temperature. An alternative usage of GWP, denoted GWP*, overcomes this problem by equating an increase in the emission rate of an SLCP with a one-off "pulse" emission of CO_2. We show that this approach, while an improvement on the conventional usage, slightly underestimates the impact of recent increases in SLCP emissions on current rates of warming because the climate does not respond instantaneously to radiative forcing. We resolve this with a modification of the GWP* definition, which incorporates a term for each of the short-timescale and long-timescale climate responses to changes in radiative forcing. The amended version allows "CO_2-warming-equivalent" (CO_2-we) emissions to be calculated directly from reported emissions. Thus SLCPs can be incorporated directly into carbon budgets consistent with long-term temperature goals, because every unit of CO_2-we emitted generates approximately the same amount of warming, whether it is emitted as a SLCP or a LLCP. This is not the case for conventionally derived CO_2-e.

npj Climate and Atmospheric Science (2019)2:29 ; https://doi.org/10.1038/s41612-019-0086-4

INTRODUCTION

Comprehensive climate policies must appraise a range of greenhouse gases and aerosols, which can differ significantly in their radiative efficiencies and atmospheric lifespans, and hence the nature of their climate impacts.[1] To reflect this, different climate pollutants are often expressed using a common emission metric. Emissions reporting under the United Nations Framework Convention on Climate Change (UNFCCC) now requires the use of 100-year Global Warming Potential (GWP_{100}) to account for all gases as carbon dioxide equivalent (CO_2-e) quantities. Despite its prevalence in the UNFCCC and national climate policies, GWP has received criticism,[2–4] not least that it cannot be used to appraise temperature-related goals,[5] and other equivalence metrics have been proposed.[6–9] Indeed, Shine[3] notes that strong caveats were in place when GWP was introduced in the Intergovernmental Panel on Climate Change's First Assessment Report[10]: "It must be stressed that there is no universally accepted methodology for combining all the relevant factors into a single [metric]… A simple approach [i.e., the GWP] has been adopted here to illustrate the difficulties inherent in the concept." Working Group 1 of the Fifth Assessment Report, AR5, did not recommend any metric and emphasised that the choice of metric depends on the specific goal of the climate policy. In AR4, however, the GWPs were the recommended metric to compare the effects of long-lived greenhouse gases,[11] and AR5 values of GWP_{100} have now been adopted for emissions reporting (see the textual proposal from 12 December 2018 on the transparency framework for action and support referred to in Article 13 of the Paris Agreement: https://unfccc.int/process/bodies/subsidiary-bodies/ad-hoc-working-group-on-the-paris-agreement-apa/information-on-apa-agenda-item-5).

The temperature response to emissions is ambiguous under GWP[1,12,13] and this ambiguity is particularly relevant 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 well before the end of the century, neither the means by which this is to be achieved nor the metrics used to assess progress are explicitly stated.[14] Tanaka and O'Neill[15] demonstrate that net-zero aggregate CO_2-e emissions based on GWP_{100} (which is often assumed to be the definition of the balance of sources and sinks described in the Paris Agreement) are not essential to limit warming to 1.5 °C. Wigley[16] posits that the balance of sources and sinks in Article 4.1 of the Paris Agreement is scientifically inconsistent with the temperature goals in Article 2.1. These papers show how moving from the temperature goals articulated in the Paris Agreement to emissions targets and profiles is not something that is currently well-handled by conventional carbon accounting; they also show that the area

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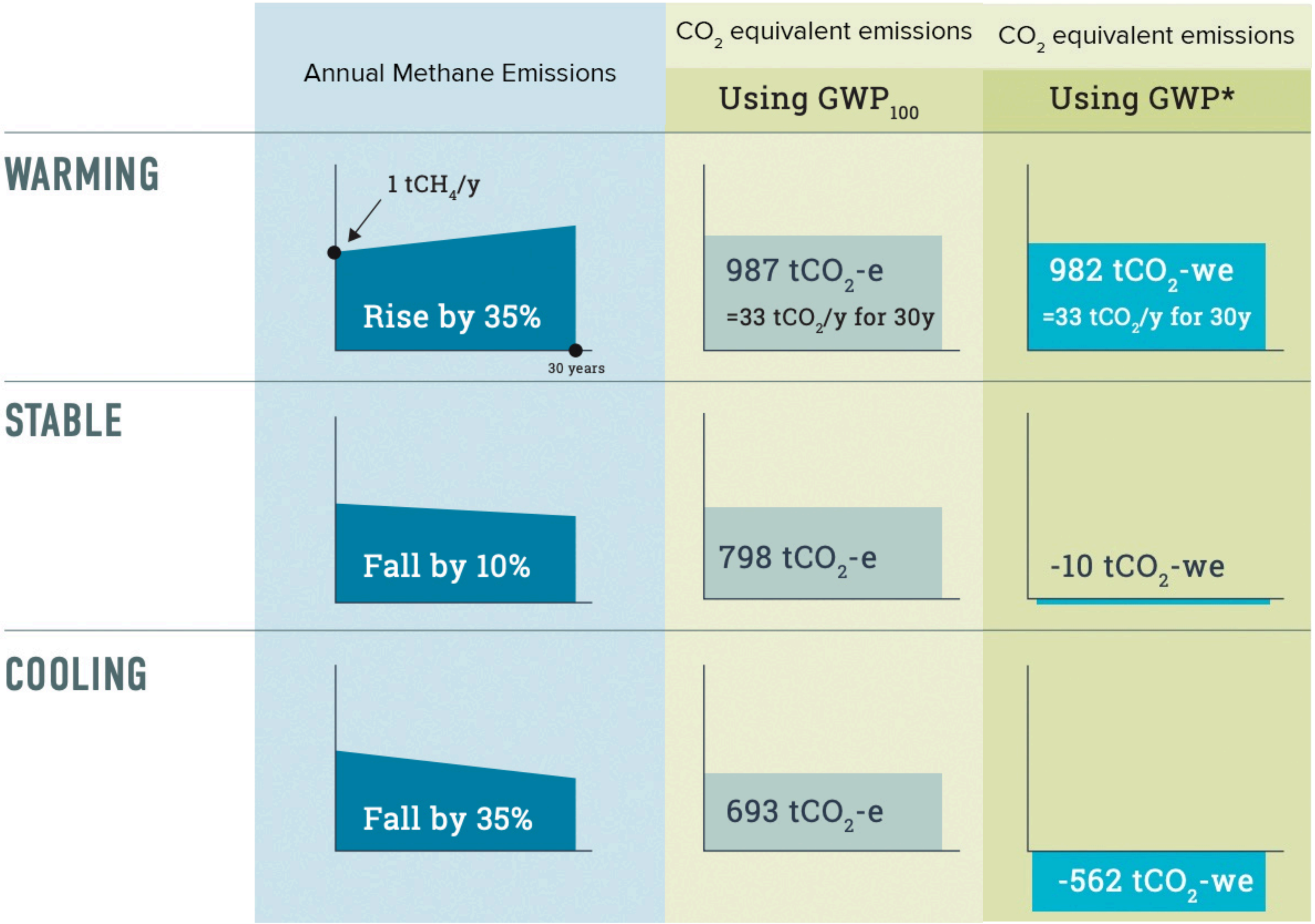

Cain, M., Allen, M. & Lynch, J. *Oxford Martin Programme on Climate Pollutants* (2019). Read more at: https://www.oxfordmartin.ox.ac.uk/downloads/academic/201908_ClimatePollutants.pdf.

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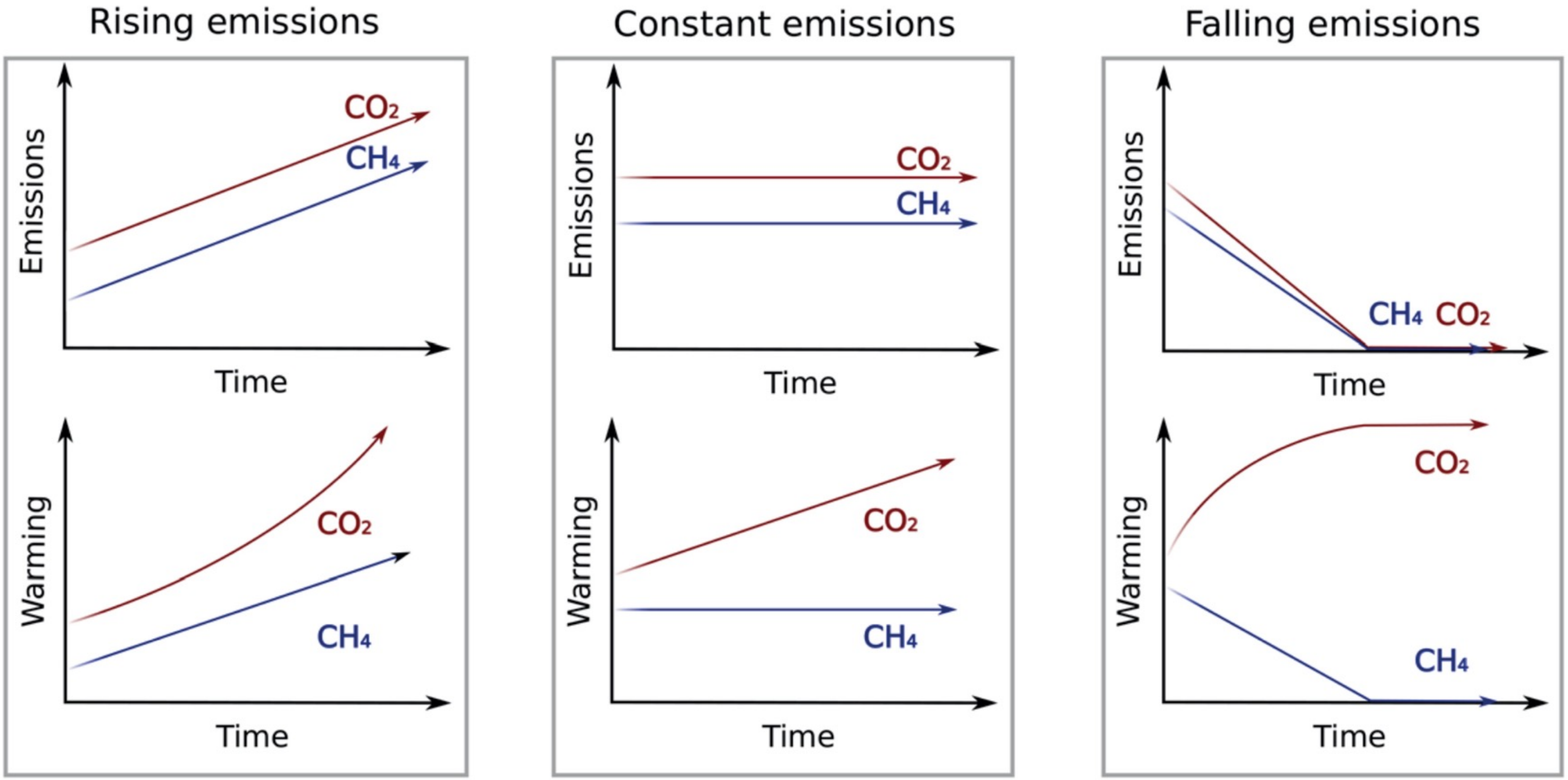

Oxford Martin, Climate Metrics for Ruminant Livestock, July 2018,
https://www.oxfordmartin.ox.ac.uk/downloads/reports/Climate-metrics-for-ruminant-livestock.pdf%C2%A0

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

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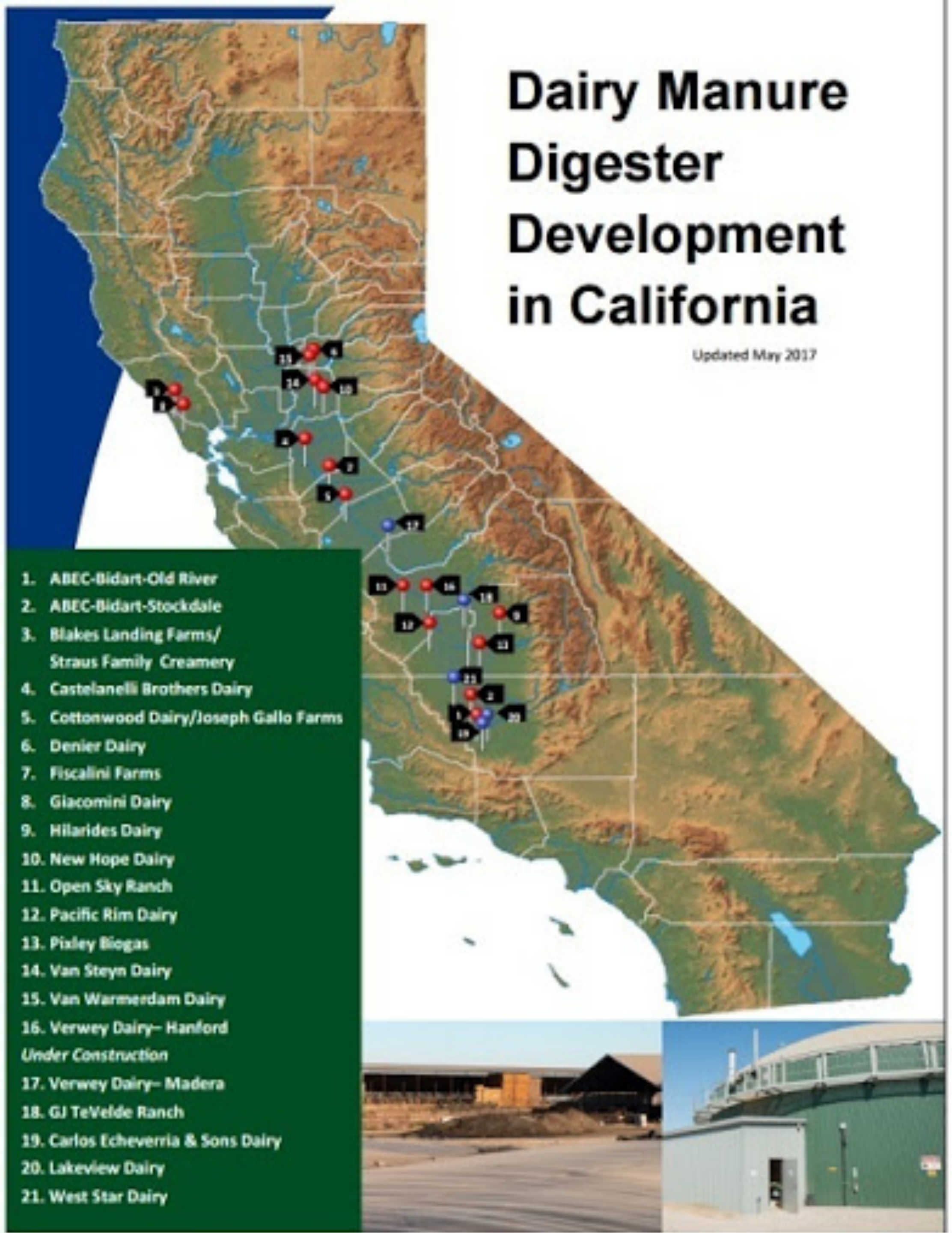

That’s a **25 percent** reduction in GHG emissions.

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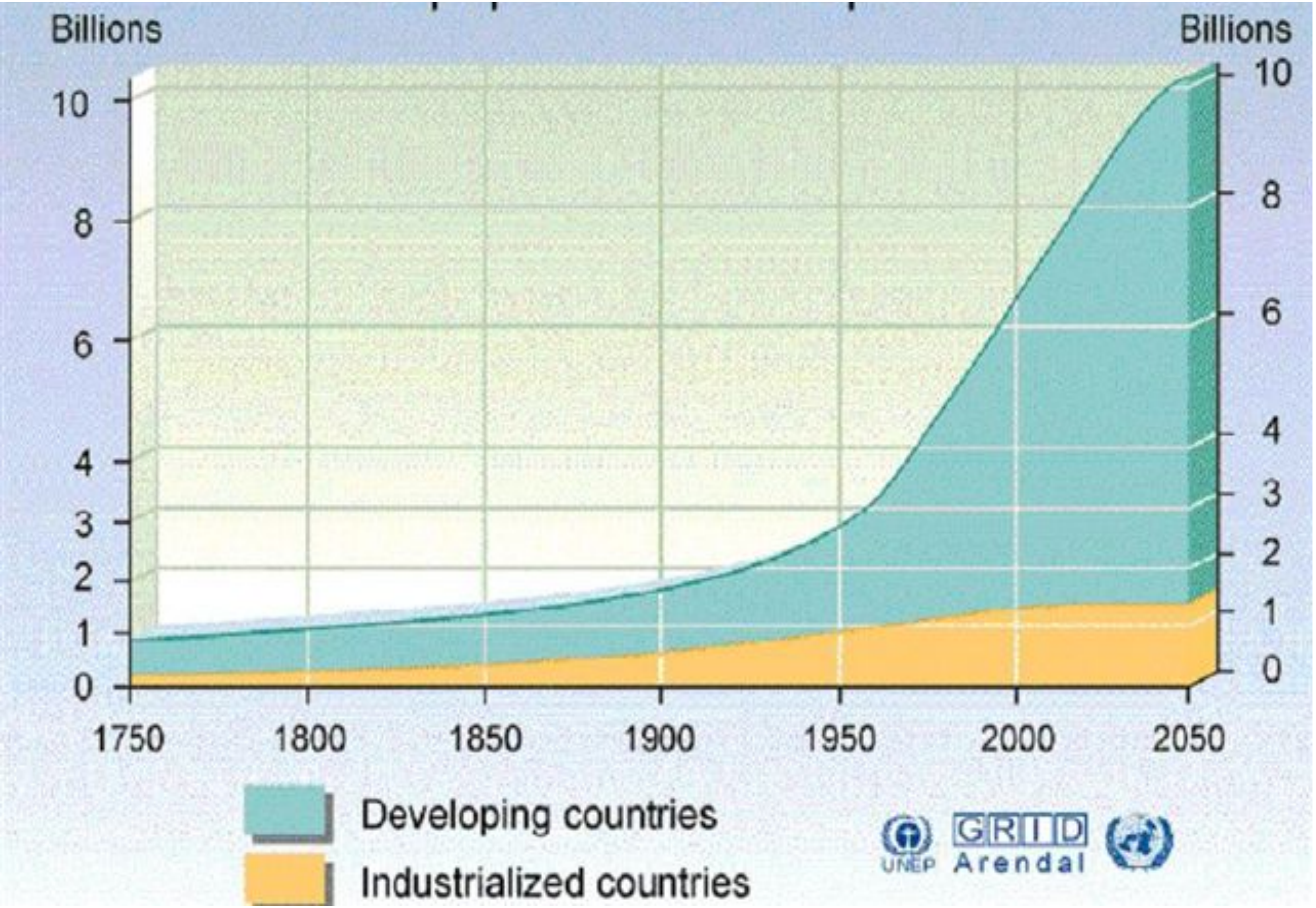

World Population Development

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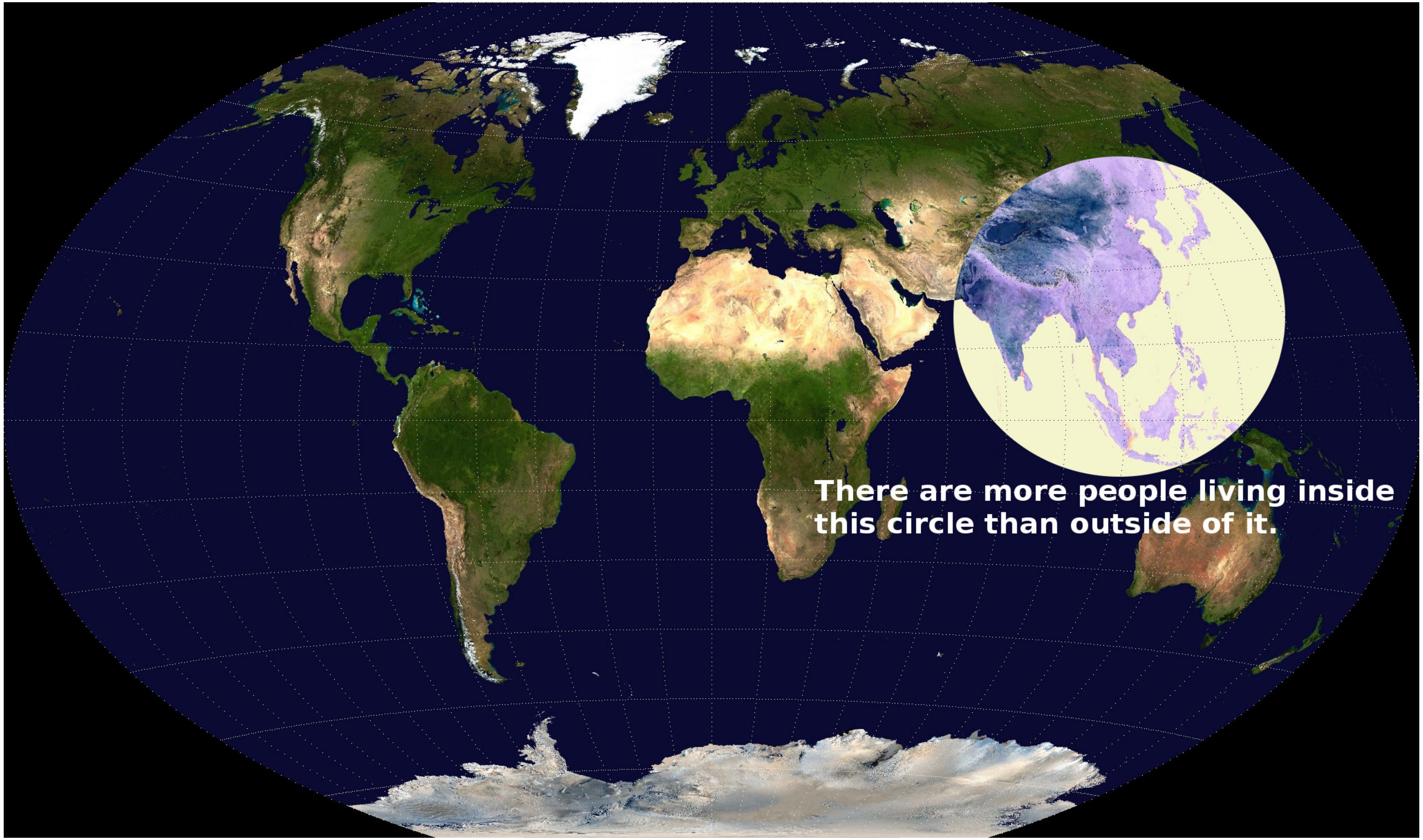

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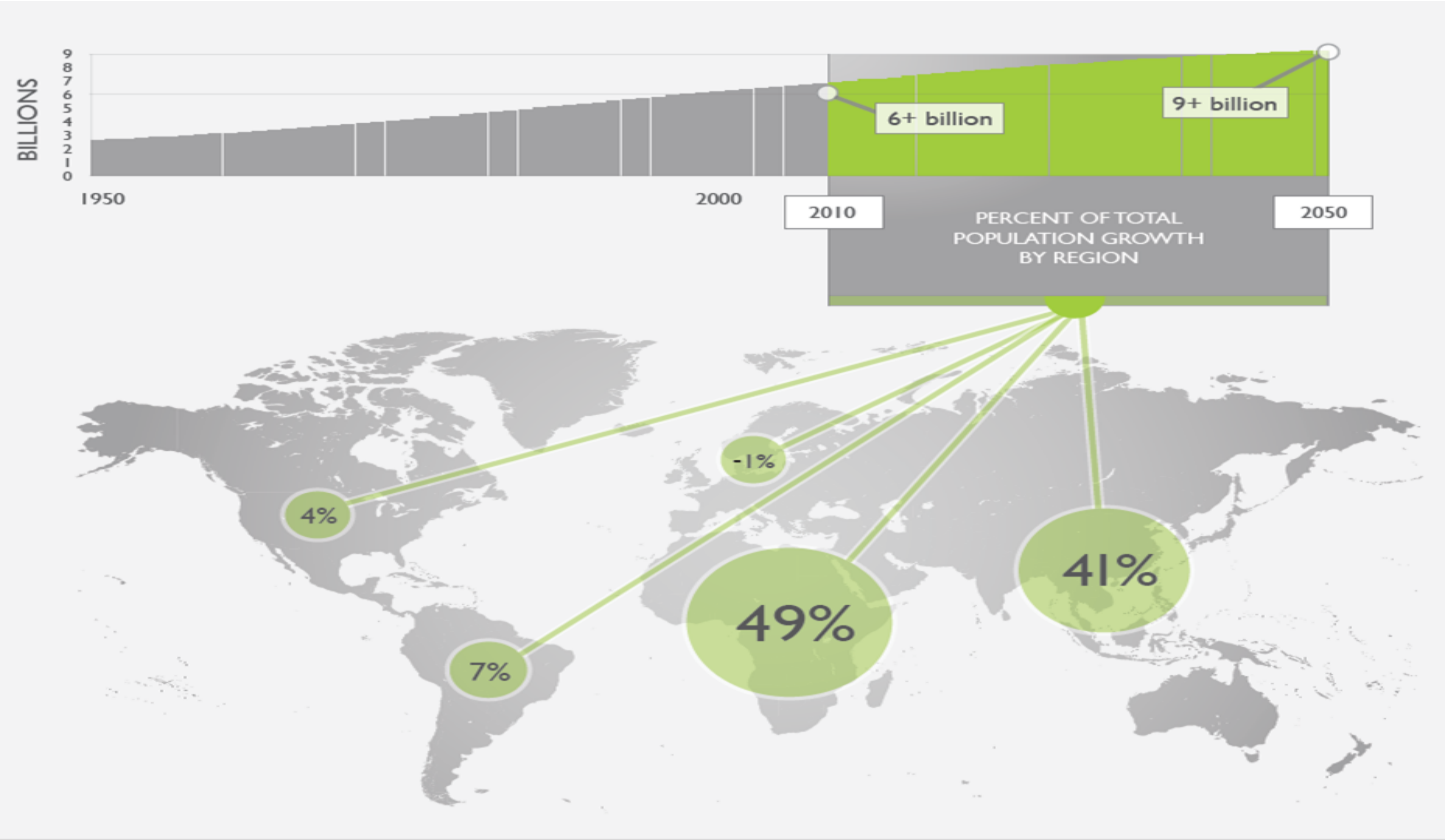

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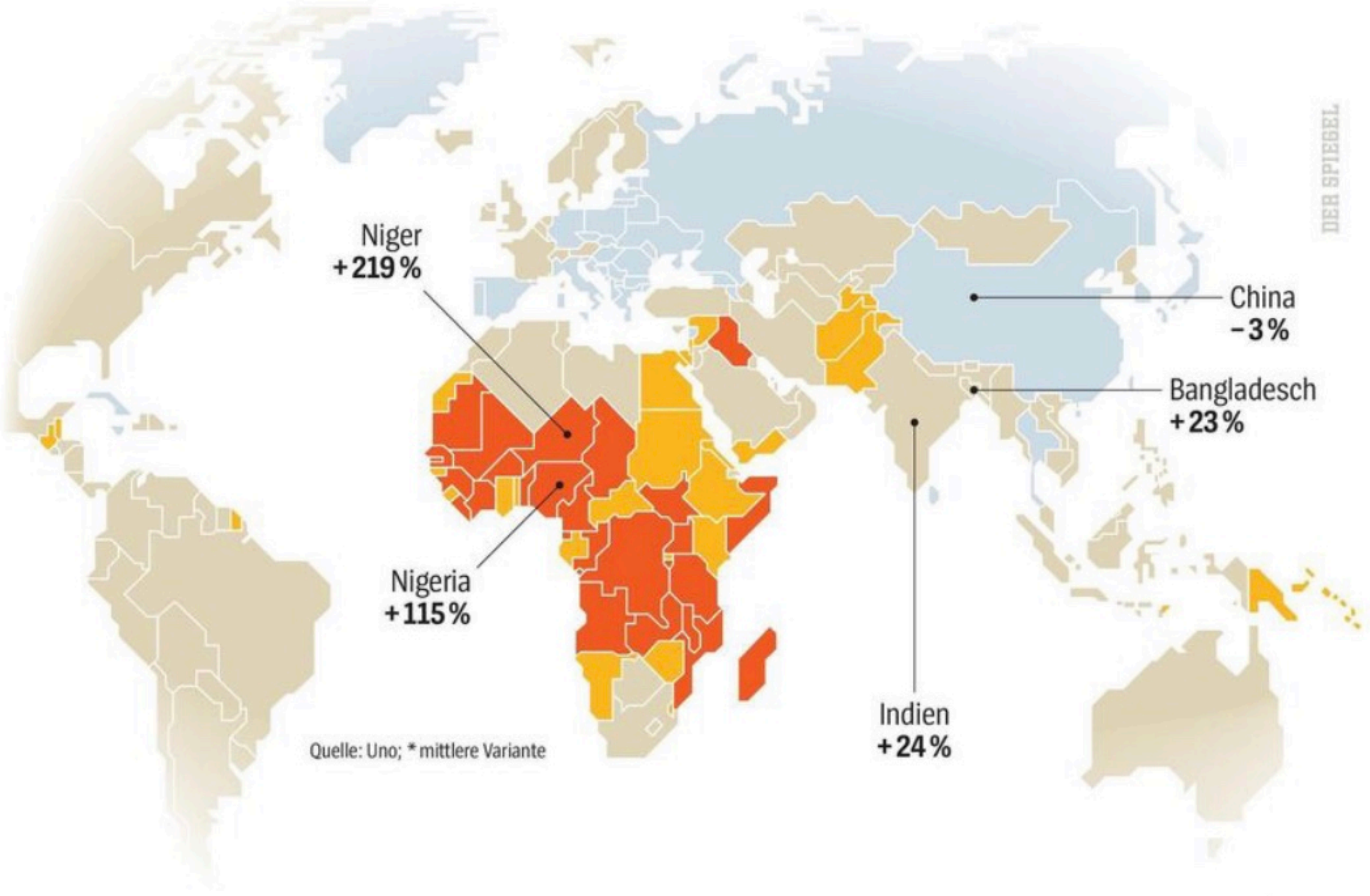

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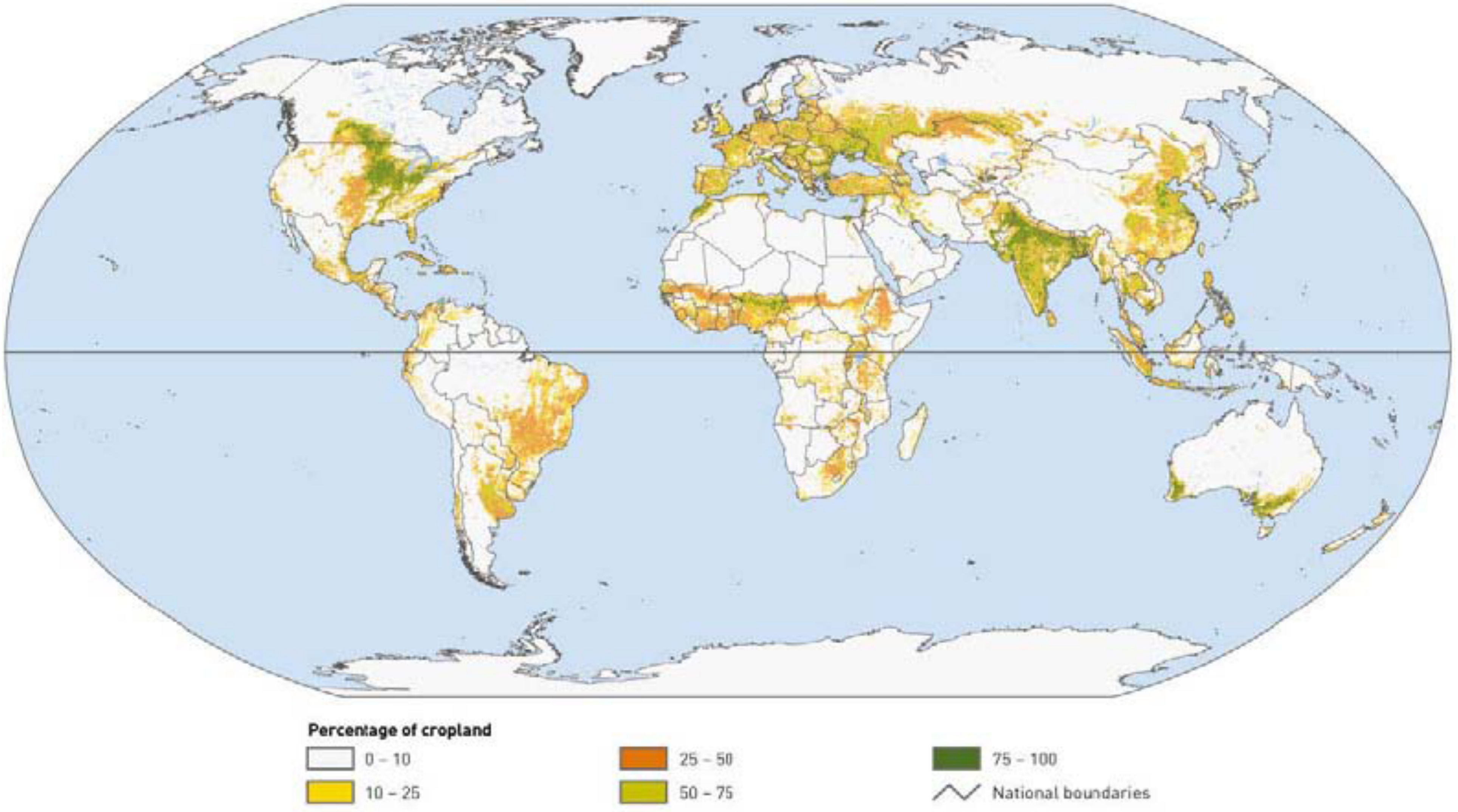
Distribution of cropland



Source: FAO, 2006f.

FAO (2006)

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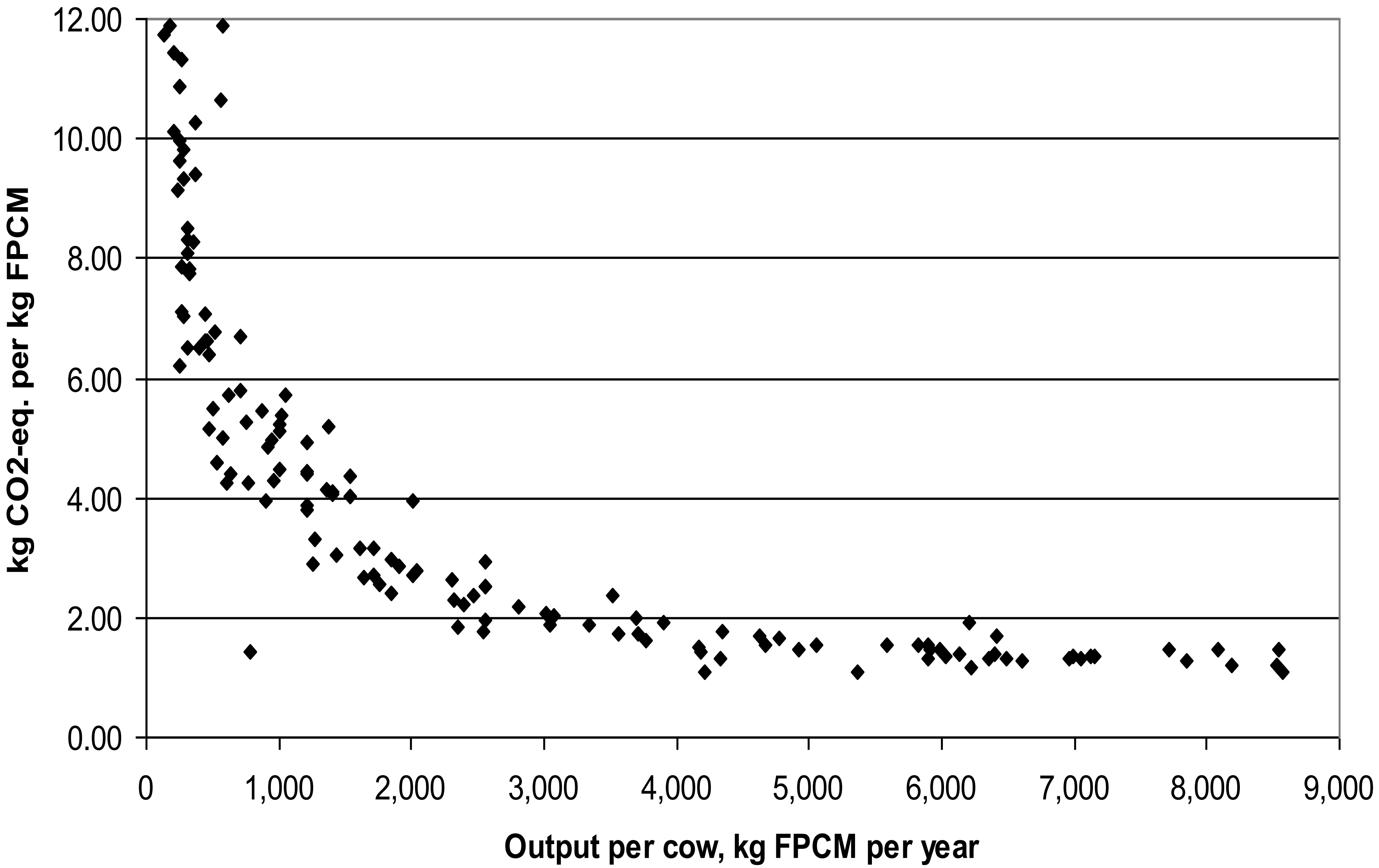
Relationship between total greenhouse gas emissions and milk output per cow



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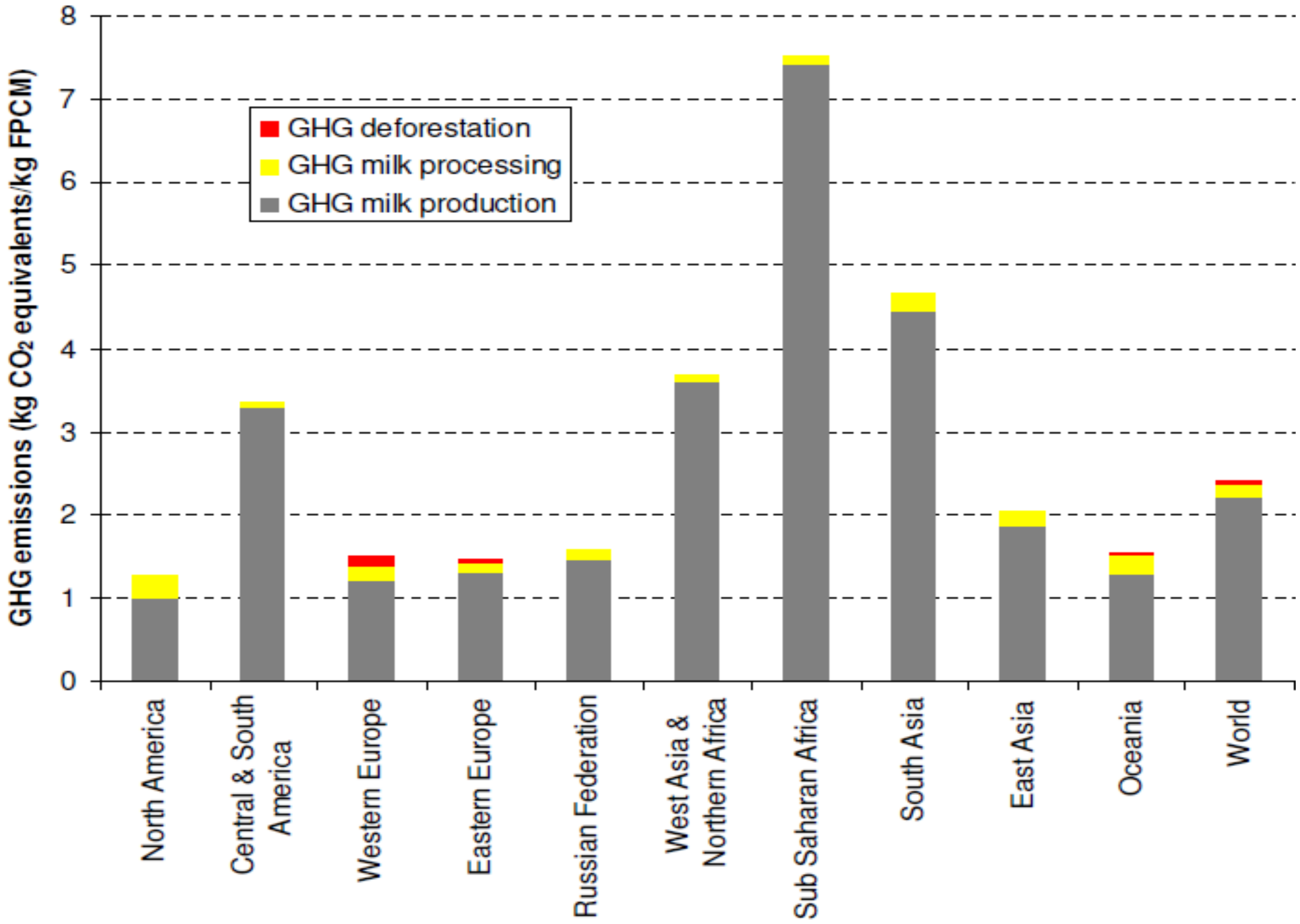
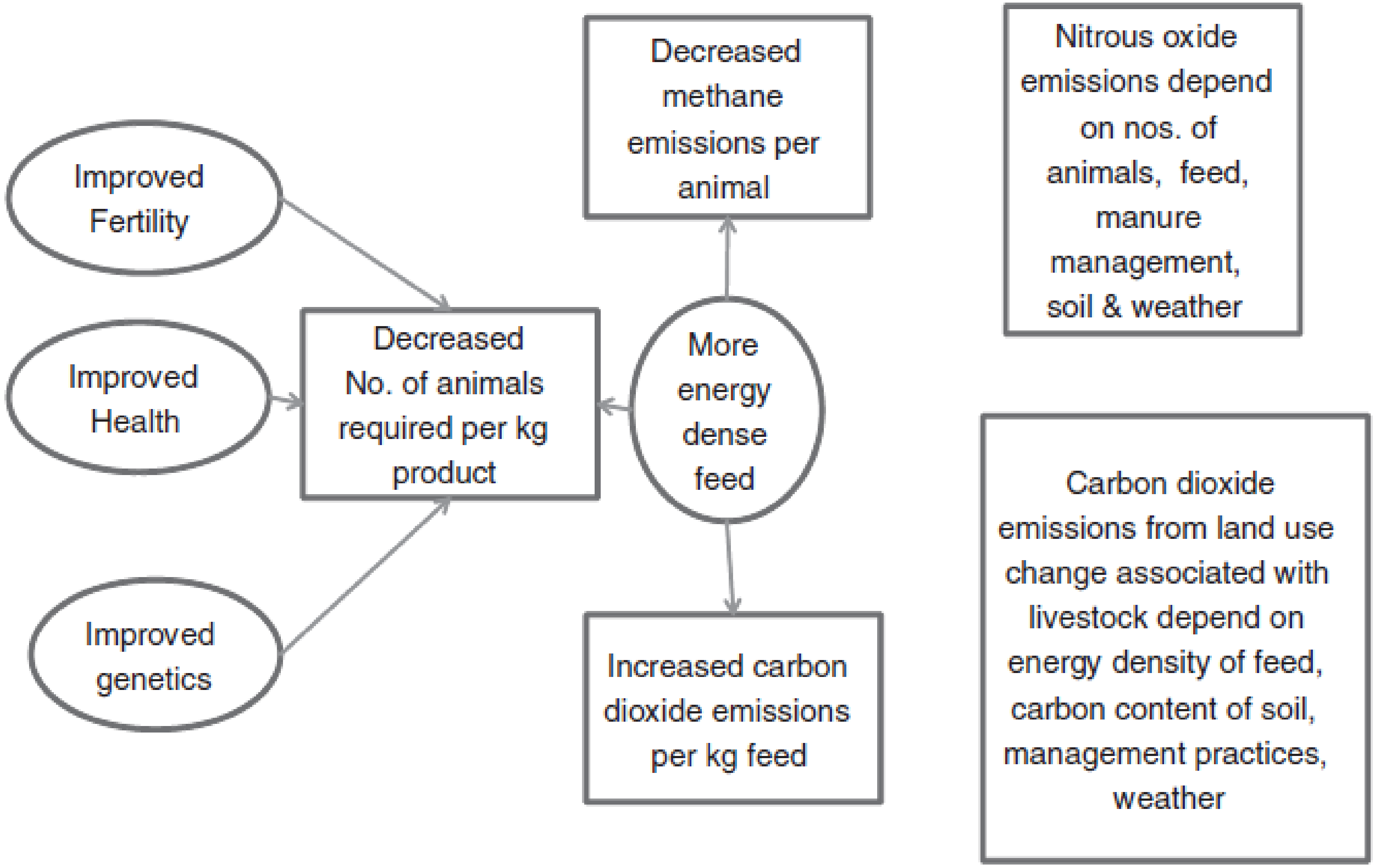
H. Steinfeld, 2015


GHG deforestation
GHG milk processing
GHG milk production
GHG emissions (kg CO_2 equivalents/kg FPCM)
0
1
2
3
4
5
6
7
8
North America
Central & South America
Western Europe
Eastern Europe
Russian Federation
West Asia & Northern Africa
Sub Saharan Africa
South Asia
East Asia
Oceania
World

FAO (2010)

Mitigation: interventions to improve productivity



Gill et al. (2010)

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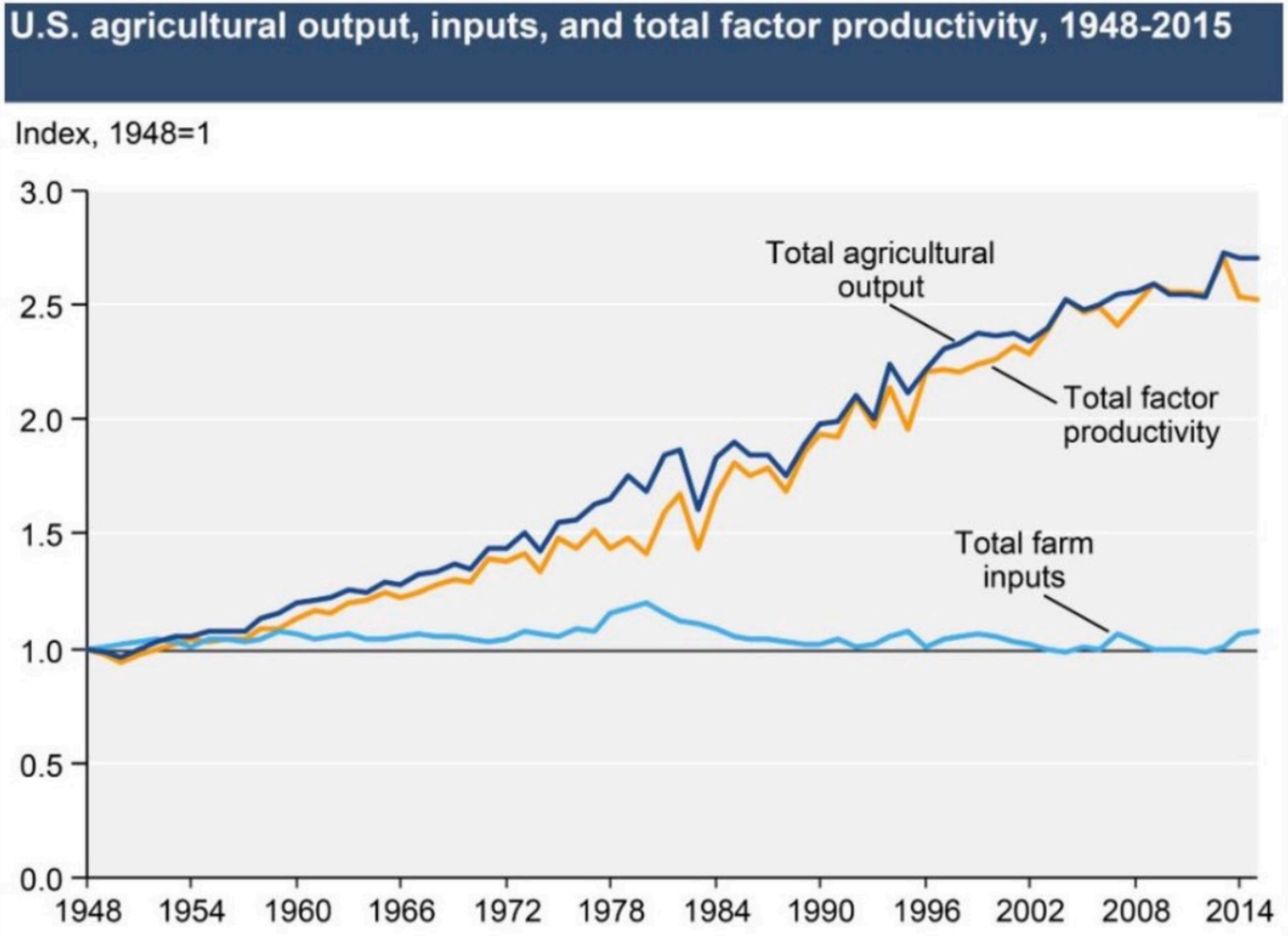

Source: USDA, Economic Research Service, *Agricultural Productivity in the U.S.* series; data as of October 2017.

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US Dairy trends

- In 1950, there were 25 million dairy cows in the US, vs 9 million today
- 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

China Swine Example

- China's five year plan focuses on making farms larger and more efficient
- Half of the world's pigs live in China
- 50 million sows w/ 20 piglets born alive
- Equals annual production of 1 Billion pigs
- Pre-weaning mortality causes 400 Million pigs to never make it to the market
- One more pig per sow would mean 1 Million tons of feed saved

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Summary

- Livestock in developing countries contribute to 70-80% of global enteric- and waste emissions
- Drastic emission reductions are necessary and feasible
- Technologies and regenerative practices hold the key to environmental mitigation
- Production intensity and emission intensity are inversely related

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Can we eat our way out of climate change?

- Omnivore to vegan (per yr) = 0.8 tons CO2e (Wynes & Nicholas, 2017)
- One trans-atlantic flight (per passenger) = 1.6 tons CO2e (Wynes & Nicholas, 2017)
- Meatless Monday (US) = 0.3% GHG reduction (Hall & White, 2017)
- Vegan US = 2.6% (Hall & White, 2017)

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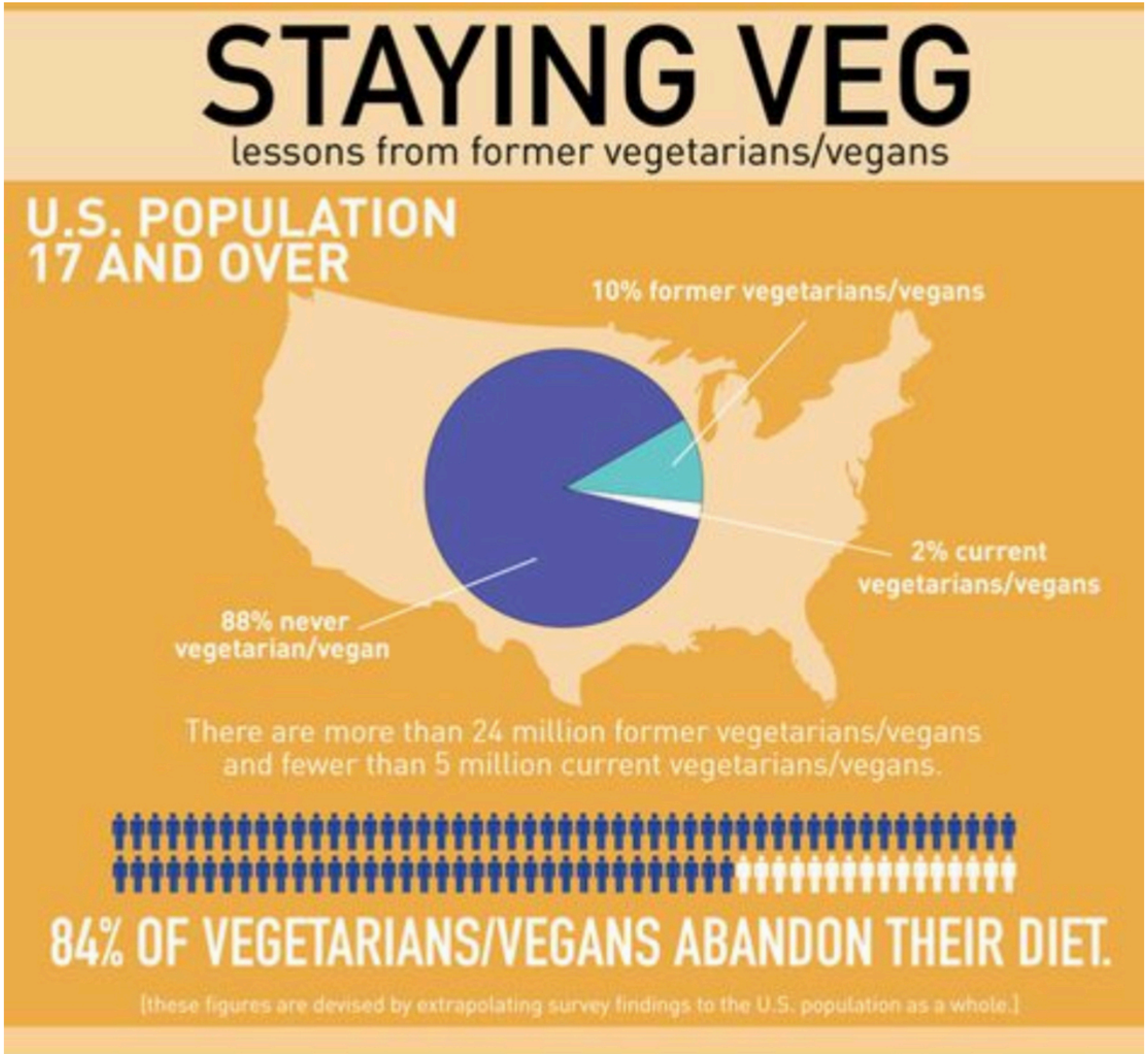

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