



Welcome to this week's presentation and conversation  
hosted by the  
**Canadian Association for the Club of Rome,**

Sharing creative ideas that moderate the rate and depth of changing Earth systems.

## Darrin Qualman - Climate, farms, food, emissions, and solutions

Our speaker today is Darrin Qualman, National Farmers Union Director of Climate Crisis Policy & Action. He will explain the sources of greenhouse gas emission from our farms and food system. He will also explore on-farm and government policy solutions to reduce those emissions. Going beyond the present he will take a long-term, big-picture view of how humans turn sun, rain, seeds, labour, tools, and other inputs into food, and examine the basic flows and geometry of our civilization to reveal new insights into why food systems—like all systems—are increasingly sources of damaging outflows and unintended consequences. He will explain why tweaking won't work and why a fundamental restructuring is needed.

Darrin Qualman's presentation will be followed by a conversation, questions, and observations from the participants.

2022 March 30

# **GHG Emissions from Agriculture, Material Flows in Civilizations, and the True Meaning of Sustainability**

**March 30, 2022**

**Canadian Association for the Club of Rome**

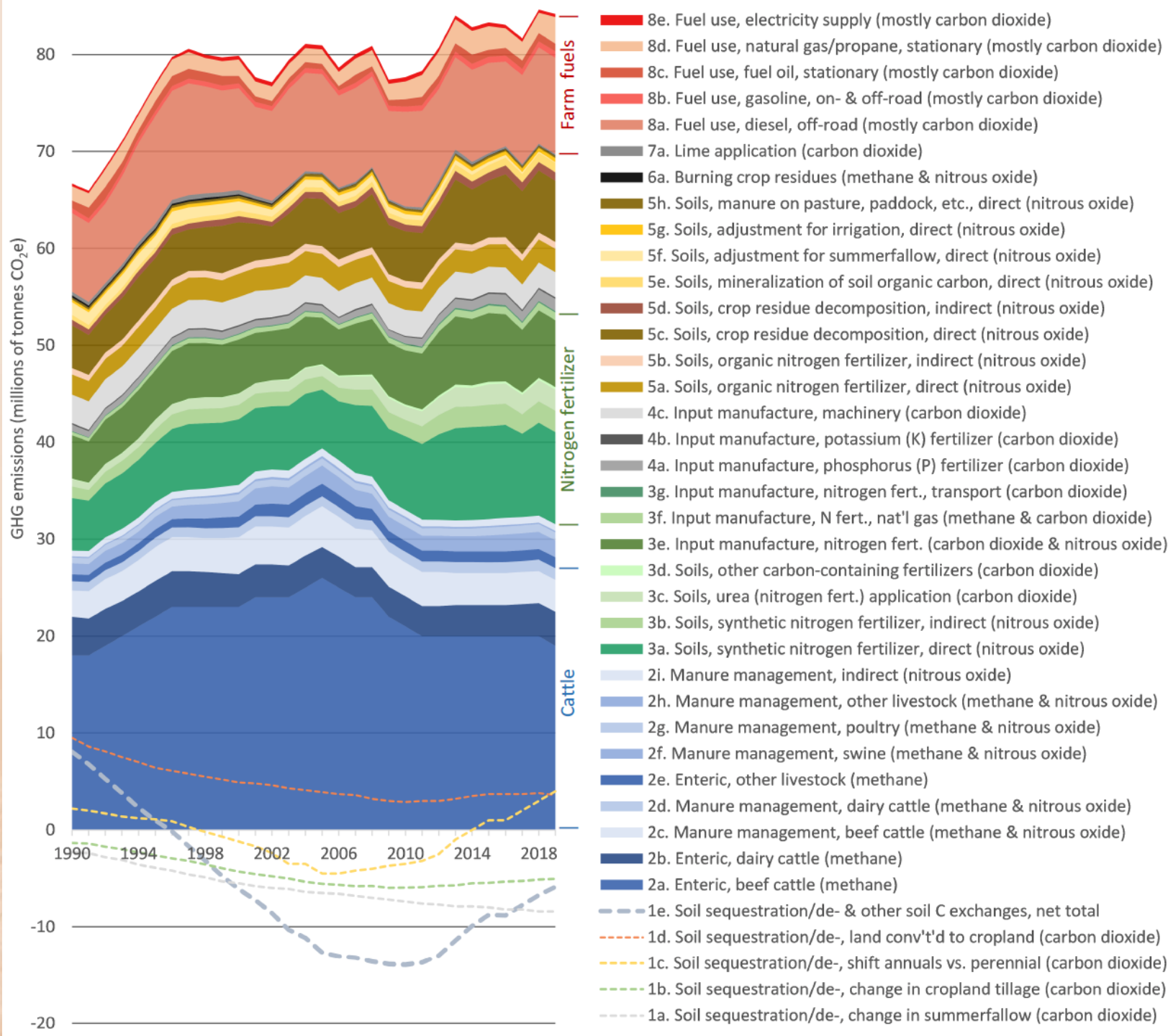
**Darrin Qualman  
National Farmers Union**



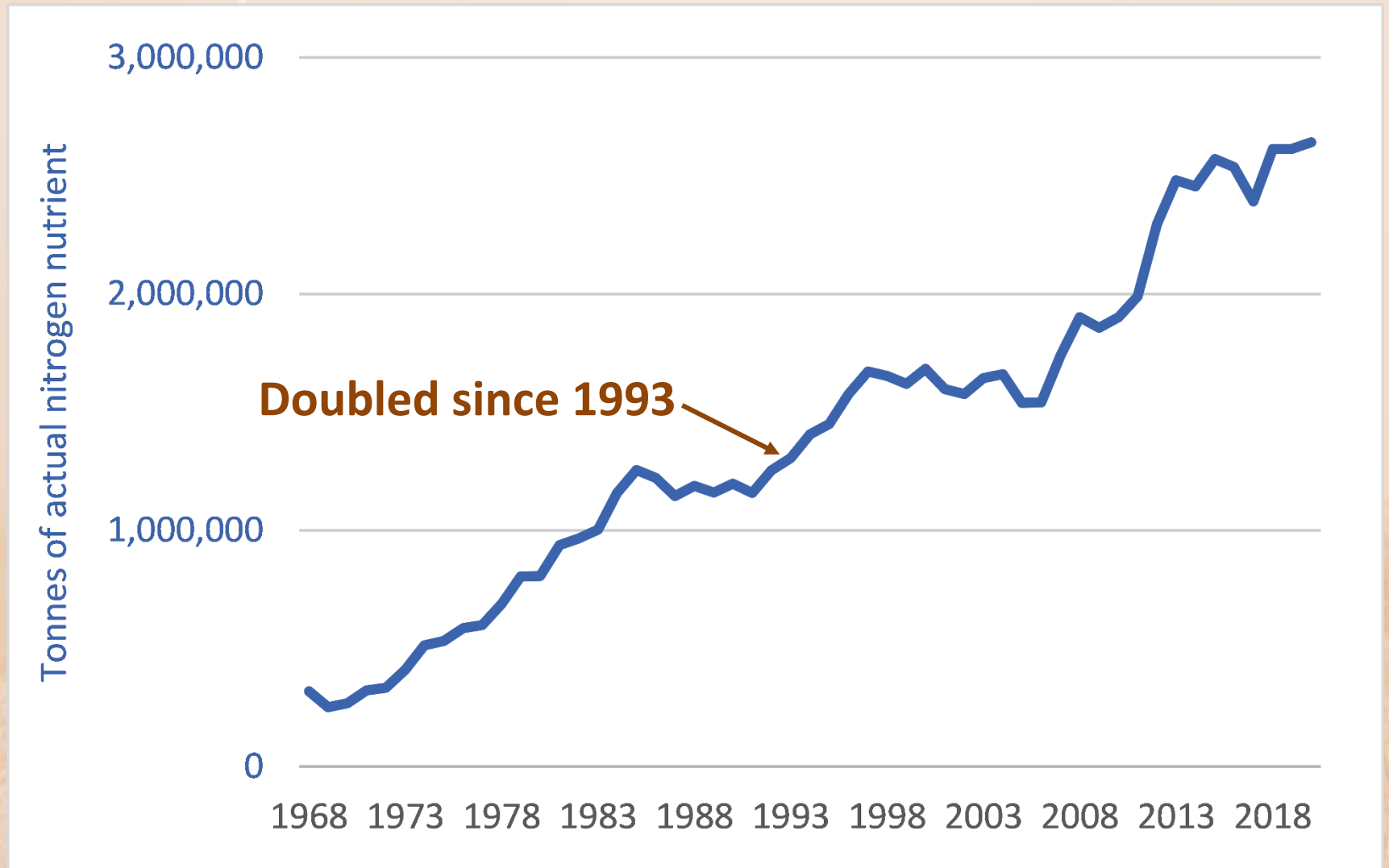
# Part 1 of 5

## Agricultural emissions

*“In which we see that GHG emissions from farms and food systems are high and rising”*



# Canadian nitrogen fertilizer use





# Energy use in agriculture

Nitrogen is a fossil fuel product—made from natural gas.

The energy in 1 tonne of nitrogen fert. is equal to 2 tonnes of gasoline.

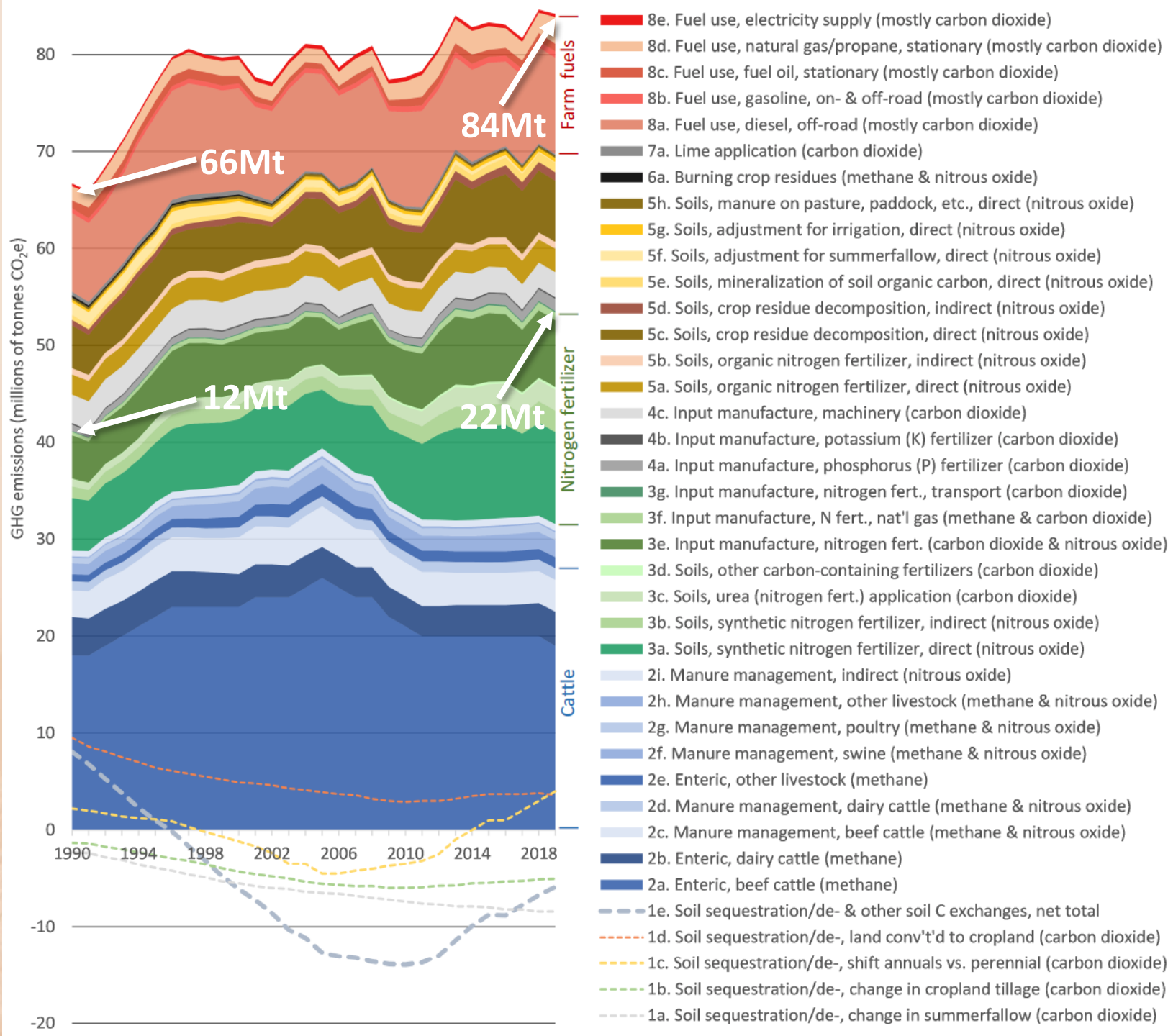




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## Part 2 of 5

Why are there agricultural emissions?

*“In which we see that what goes in  
must come out”*



**Why are there agricultural emissions?**

**Because agriculture has been made into a linear system.**

**We're pushing inputs in one end of these linear systems and emissions are coming out the other**

**The tonnage of GHG emissions coming out of agriculture is a direct function of the tonnage of inputs going in.**



**Agriculture does not produce GHG emissions; Agricultural inputs produce GHG emissions.**

**Humans have been farming for 10,000 years and we haven't affected the atmosphere or climate, until recently.**

**Any low-emission food system will be low-input food system.**



**Again....**

**Agriculture does not produce GHG emissions; Agricultural inputs produce GHG emissions.**

**Humans have been farming for 10,000 years and we haven't affected the climate, until recently.**

**Low emission food systems will be low-input systems.**





# Part 3 of 5

## Breaking loops and the linearization of agriculture

*“In which, our our farms, we see loops  
replaced by lines”*



# Breaking loops in agriculture

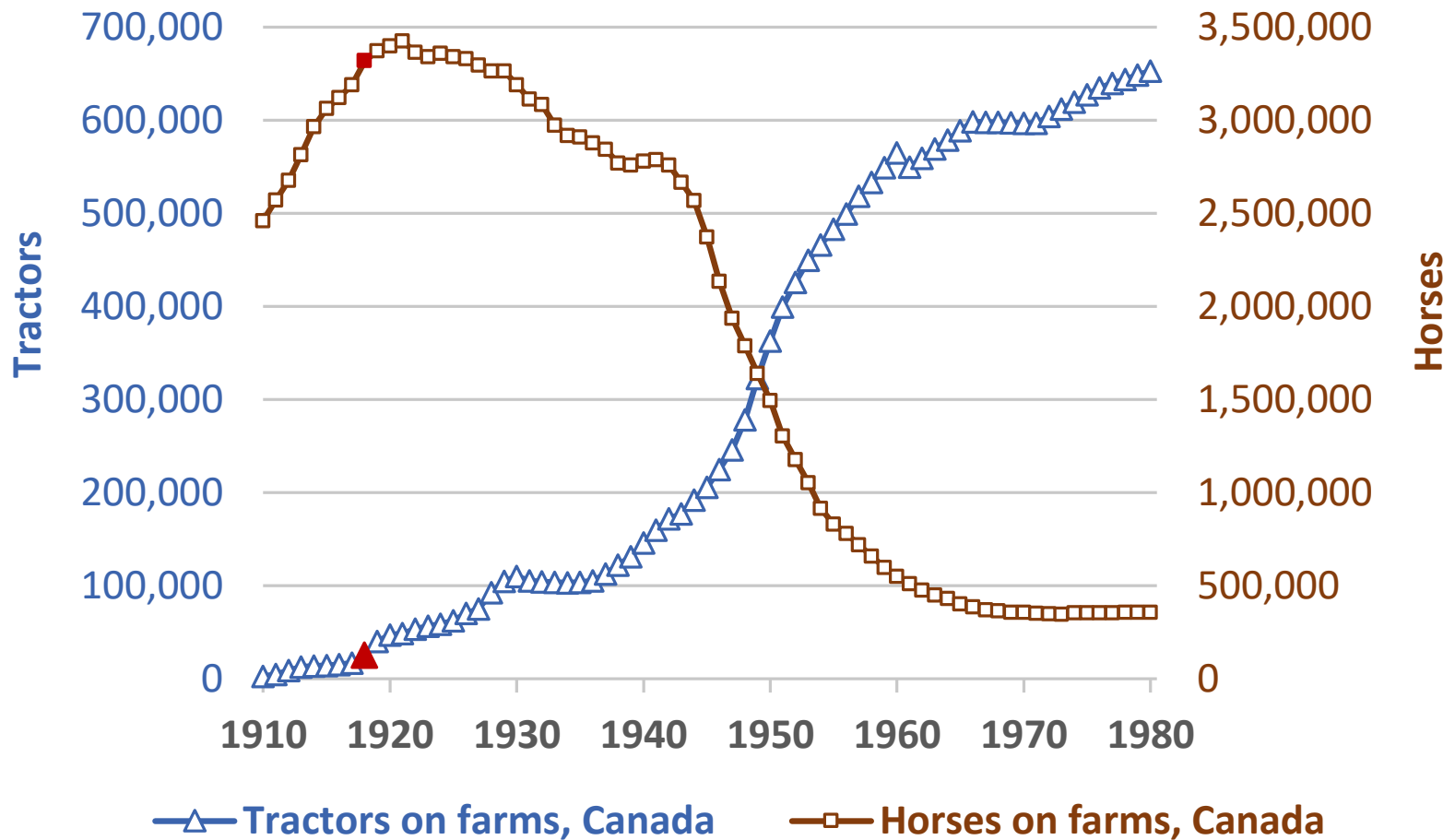




# Breaking loops in agriculture

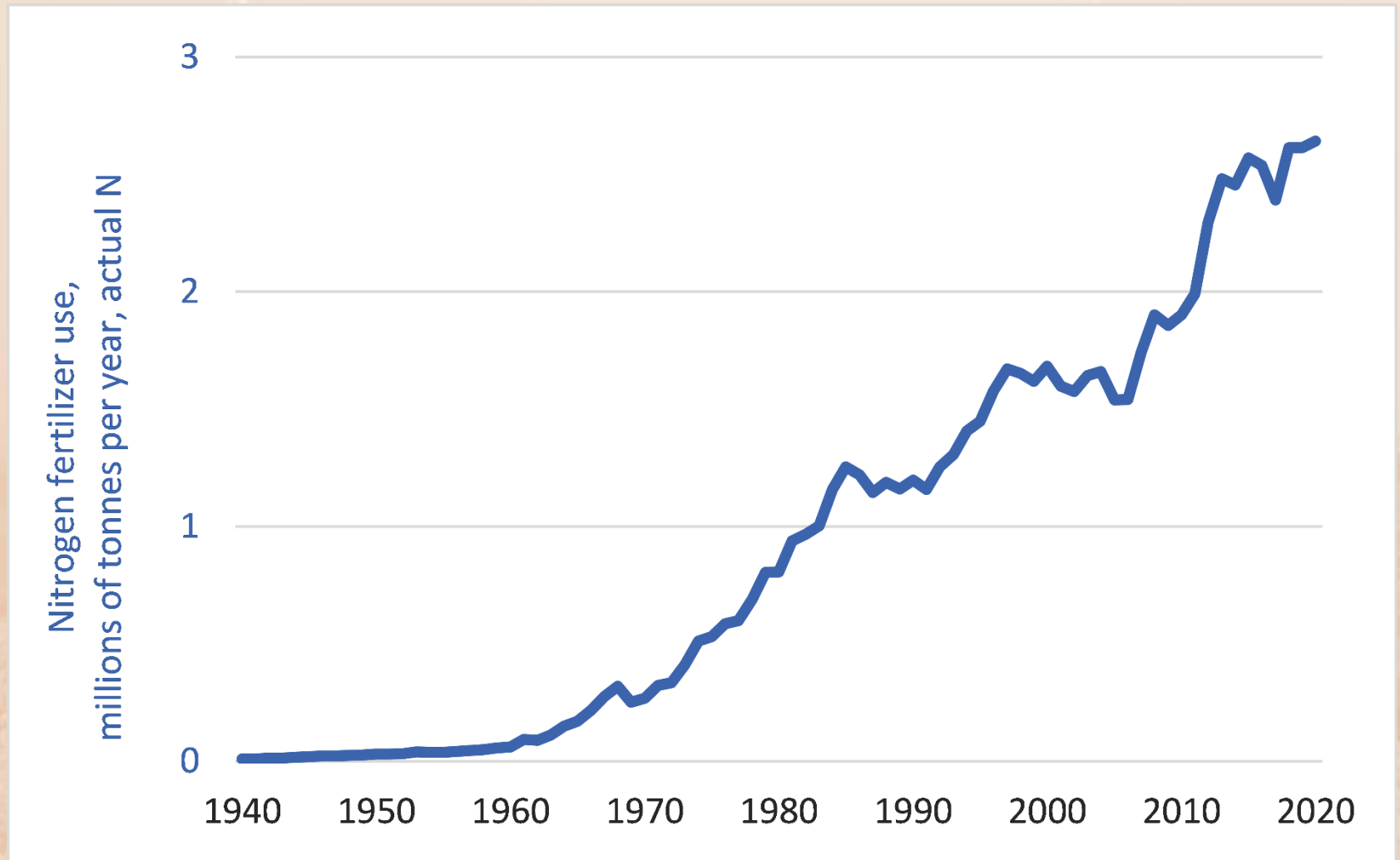


# Breaking loops: energy for farm labour and traction power





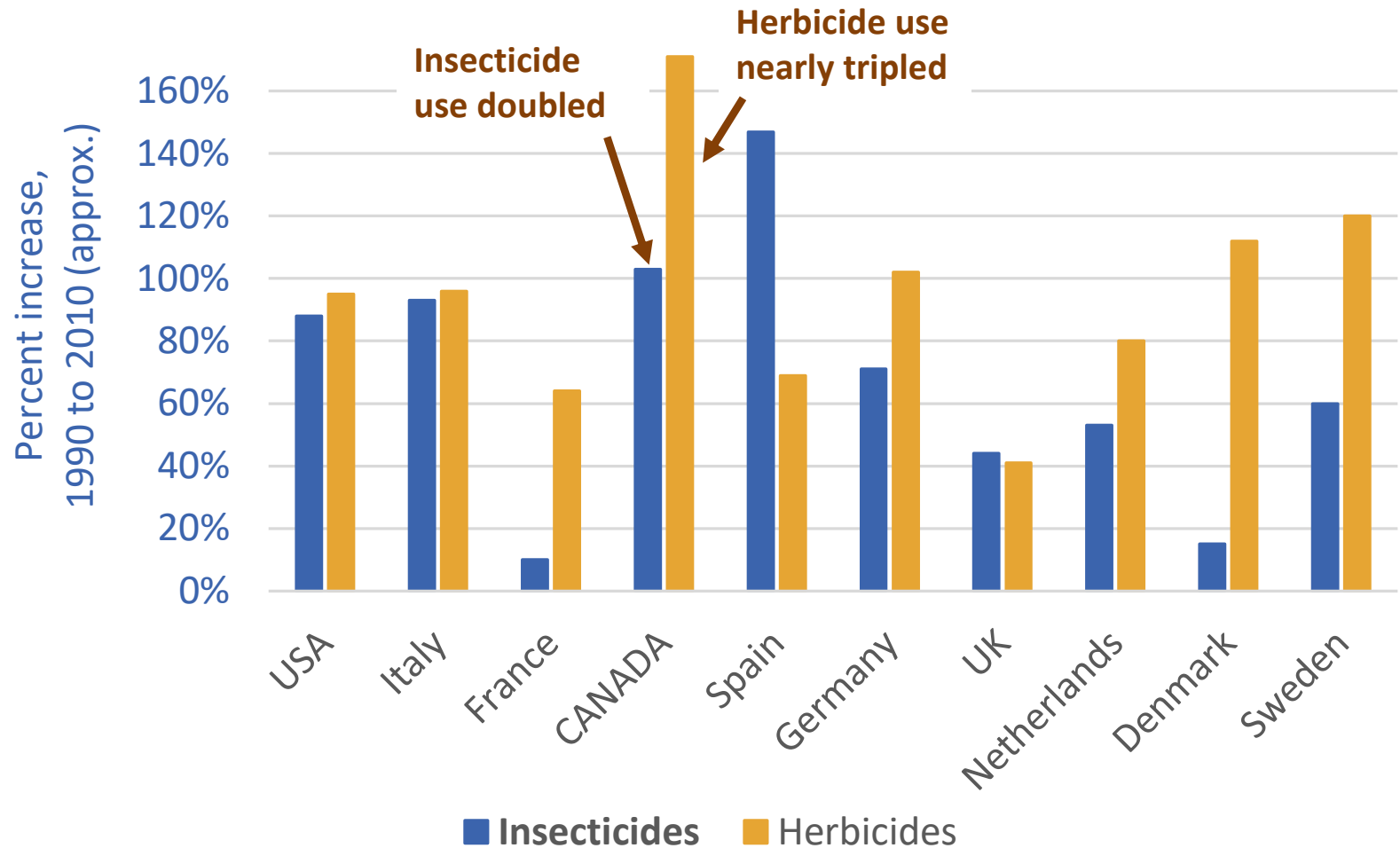
# Breaking loops: fertility (Canada)



# Breaking loops: Seeds & knowledge



# Herbicide and insecticide





## Part 3 of 5

**What goes in  
must come out**

***“In which we see loops replaced by lines  
in every one of our civilizational systems”***



## Key insight #1

The material flows in 19<sup>th</sup>, 20<sup>th</sup>, and 21<sup>st</sup> century petro-industrial capitalism are linear flows.

This is new. Before about 1850, the material flows in nature and in human systems were circular.



## **Key insight #2**

**Atoms are indestructible.**

**Many molecules persist.**

**Everything ends up somewhere.**

**Whatever you push into one end  
of our linear petro-industrial  
systems comes out the other end**

## **Key insight #1 plus #2**

**If we push billions of tonnes of indestructible atoms and persistent molecules into one end of our linear systems, they will come out the other end.**



The linear-flow structure of our entire civilization is causing a wide range of related problems, including:

- Climate change
- Ocean dead zones
- Algae-clogged lakes
- Oceans full of plastics
- Accumulating toxicity
- Resource depletion
- Deforestation
- Etc.



# A 30-second chemistry review.

Atoms are indestructible.



**Carbon atoms**



**Nitrogen atoms**



**Phosphorus atoms**



**All the atoms we push into our linear production systems come out the other end.**

**Carbon in fossil fuels in goes in....**

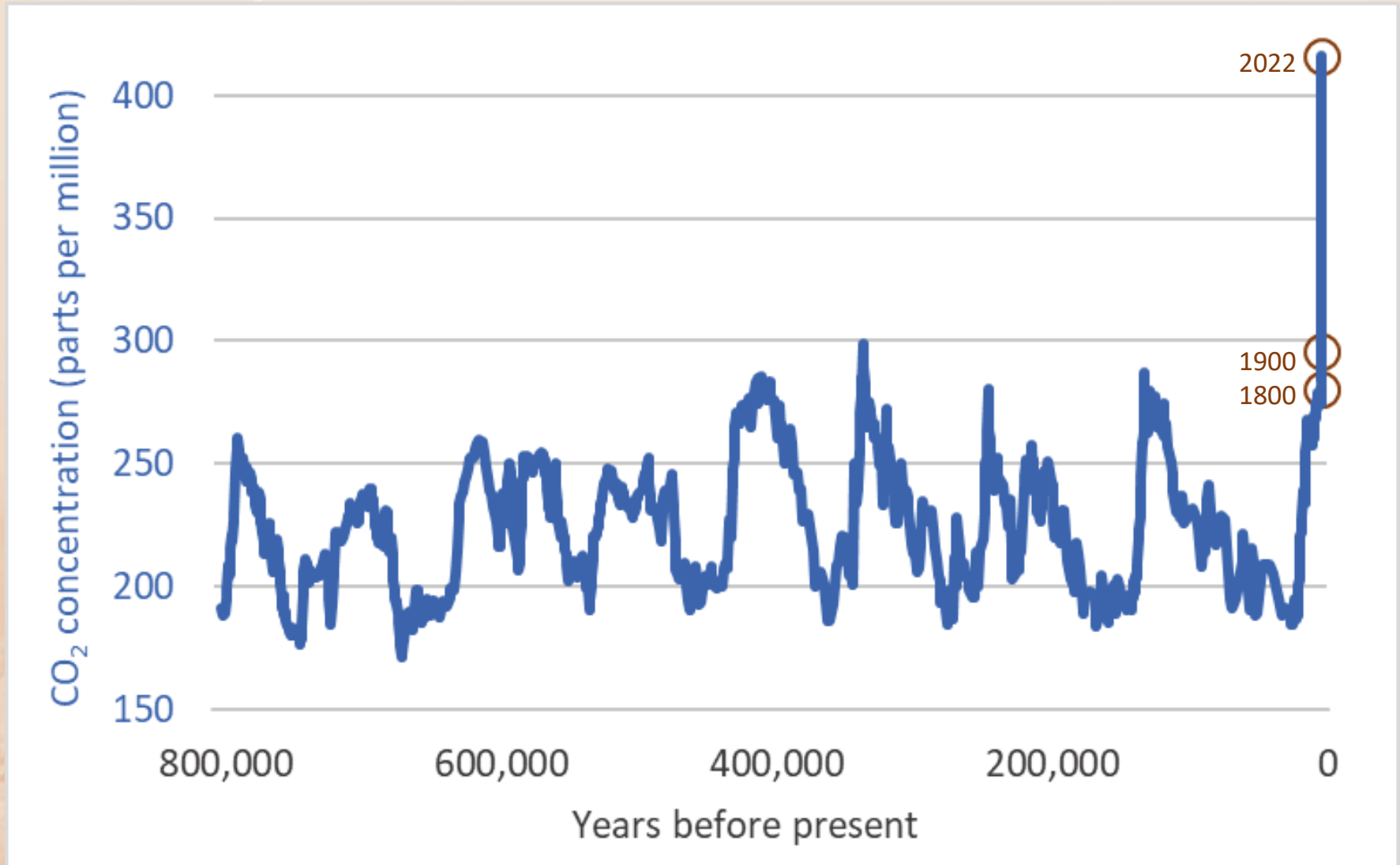
**Carbon as CO<sub>2</sub> comes out**

**→ climate change; and  
ocean acidification**





# Carbon dioxide concentrations



**Everything we push in comes out.**

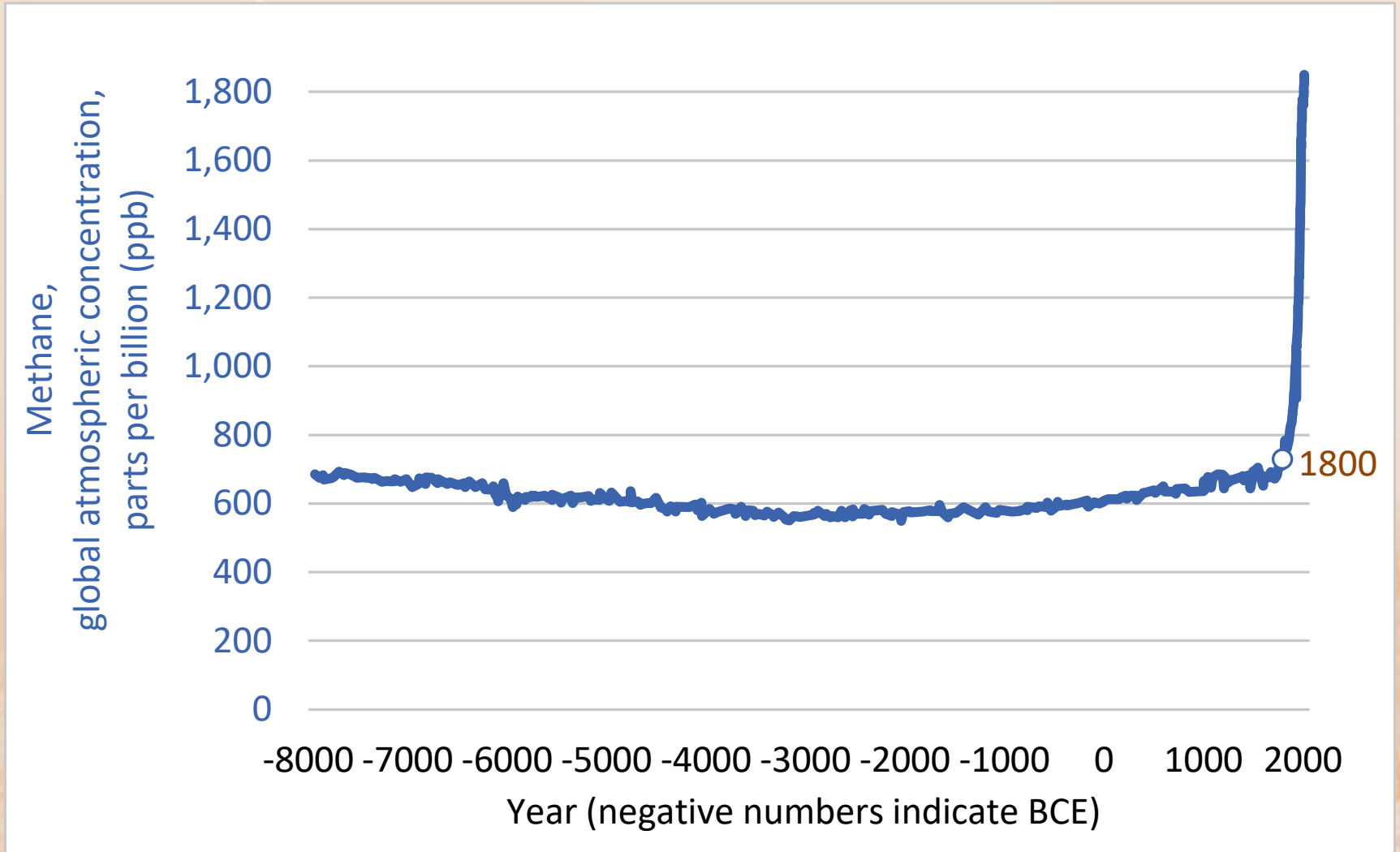
**Carbon in fossil fuels and from other sources goes in....**

**Carbon as methane (CH<sub>4</sub>) comes out**

**➔ climate change**



# Methane





**Moving from carbon to nitrogen....**

**Nitrogen atoms go in (fertilizer)...**

**Nitrogen as nitrous oxide ( $N_2O$ ) and various N compounds comes out**

**➔ climate change;  
ocean dead zones; and  
terrestrial ecosystem damage**



## FEATURE

## A safe operating space for humanity

Identifying and quantifying planetary boundaries that must not be transgressed could help prevent human activities from causing unacceptable environmental change, argue **Johan Rockström** and colleagues.

Although Earth has undergone many periods of significant environmental change, the planet's environment has been unusually stable for the past 10,000 years<sup>1-3</sup>. This period of stability — known to geologists as the Holocene — has seen human civilizations arise, develop and thrive. Such stability may now be under threat. Since the Industrial Revolution, a new era has arisen, the Anthropocene<sup>4</sup>, in which human actions have become the main driver of global environmental change<sup>5</sup>. This could see human activities push the Earth system outside the stable environmental state of the Holocene, with consequences that are detrimental or even catastrophic for large parts of the world.

During the Holocene, environmental change occurred naturally and Earth's regulatory capacity maintained the conditions that enabled human development. Regular temperatures, freshwater availability and biogeochemical flows all stayed within a relatively narrow range. Now, largely because of a rapidly growing reliance on fossil fuels and



## SUMMARY

- New approach proposed for defining preconditions for human development
- Crossing certain biophysical thresholds could have disastrous consequences for humanity
- Three of nine interlinked planetary boundaries have already been overstepped

industrialized forms of agriculture, human activities have reached a level that could damage the systems that keep Earth in the desirable Holocene state. The result could be irreversible and, in some cases, abrupt environmental change, leading to a state less conducive to human development<sup>6</sup>. Without pressure from humans, the Holocene is expected to continue for at least several thousands of years<sup>7</sup>.

## Planetary boundaries

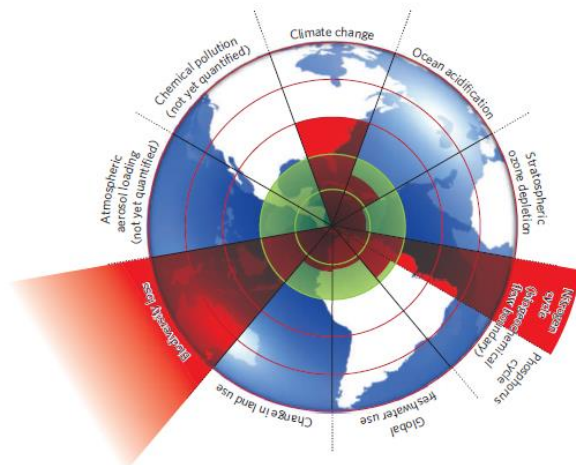
To meet the challenge of maintaining the Holocene state, we propose a framework based on 'planetary boundaries'. These

boundaries define the safe operating space for humanity with respect to the Earth system and are associated with the planet's biophysical subsystems or processes. Although Earth's complex systems sometimes respond smoothly to changing pressures, it seems that this will prove to be the exception rather than the rule. Many subsystems of Earth react in a nonlinear, often abrupt, way, and are particularly sensitive around threshold levels of certain key variables. If these thresholds are crossed, then important subsystems, such as a monsoon system, could shift into a new state, often with deleterious or potentially even disastrous consequences for humans<sup>8,9</sup>.

Most of these thresholds can be defined by a critical value for one or more control variables, such as carbon dioxide concentration. Not all processes or subsystems on Earth have well-defined thresholds, although human actions that undermine the resilience of such processes or subsystems — for example, land and water degradation — can increase the risk that thresholds will also be crossed in other processes, such as the climate system.

We have tried to identify the Earth-system processes and associated thresholds which, if crossed, could generate unacceptable environmental change. We have found nine such processes for which we believe it is necessary to define planetary boundaries: climate change; rate of biodiversity loss (terrestrial and marine); interference with the nitrogen and phosphorus cycles; stratospheric ozone depletion; ocean acidification; global freshwater use; change in land use; chemical pollution; and atmospheric aerosol loading (see Fig. 1 and Table).

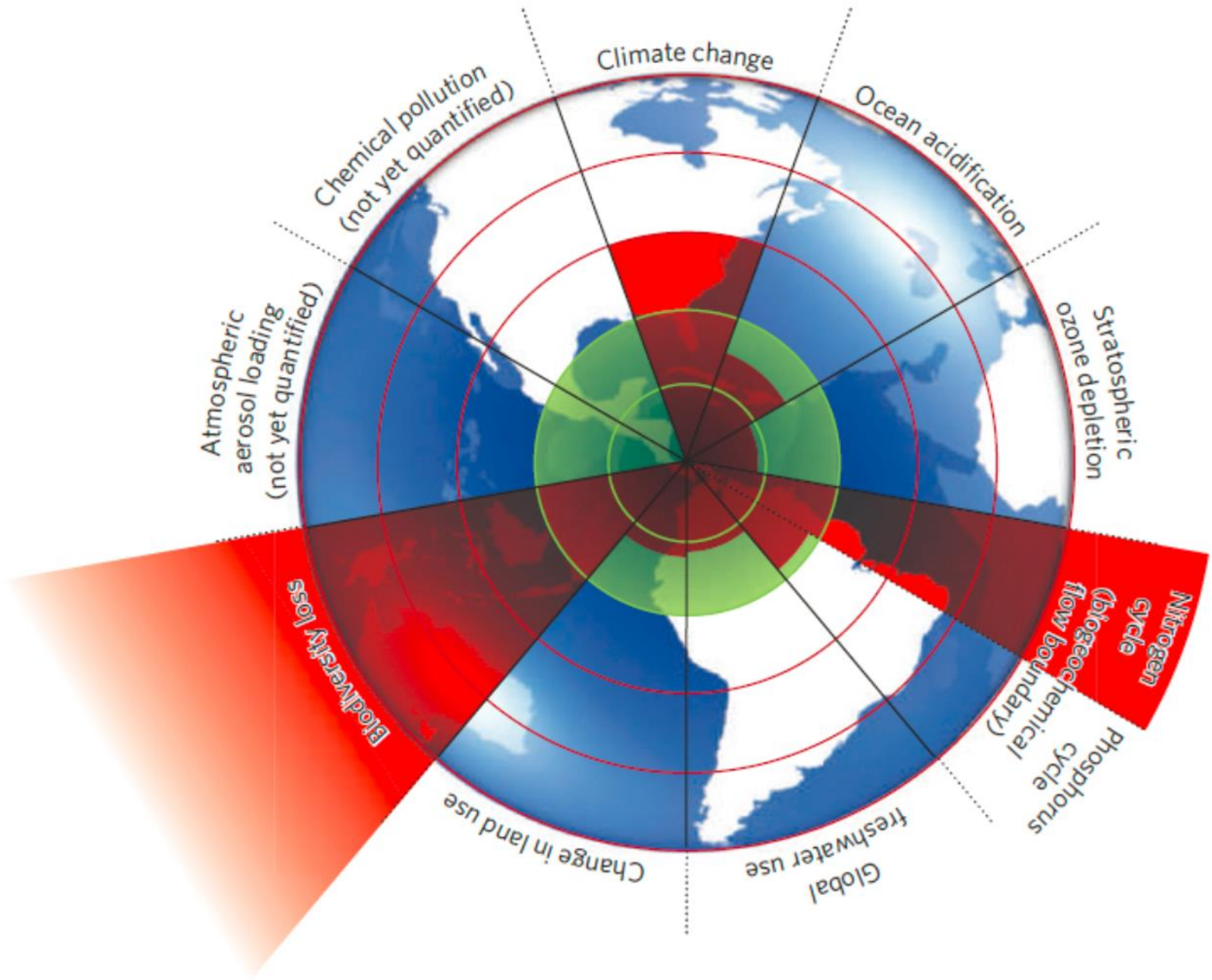
In general, planetary boundaries are values for control variables that are either at a 'safe' distance from thresholds — for processes with evidence of threshold behaviour — or at dangerous levels — for processes without



**Figure 1 | Beyond the boundary.** The inner green shading represents the proposed safe operating space for nine planetary systems. The red wedges represent an estimate of the current position for each variable. The boundaries in three systems (rate of biodiversity loss, climate change and human interference with the nitrogen cycle), have already been exceeded.

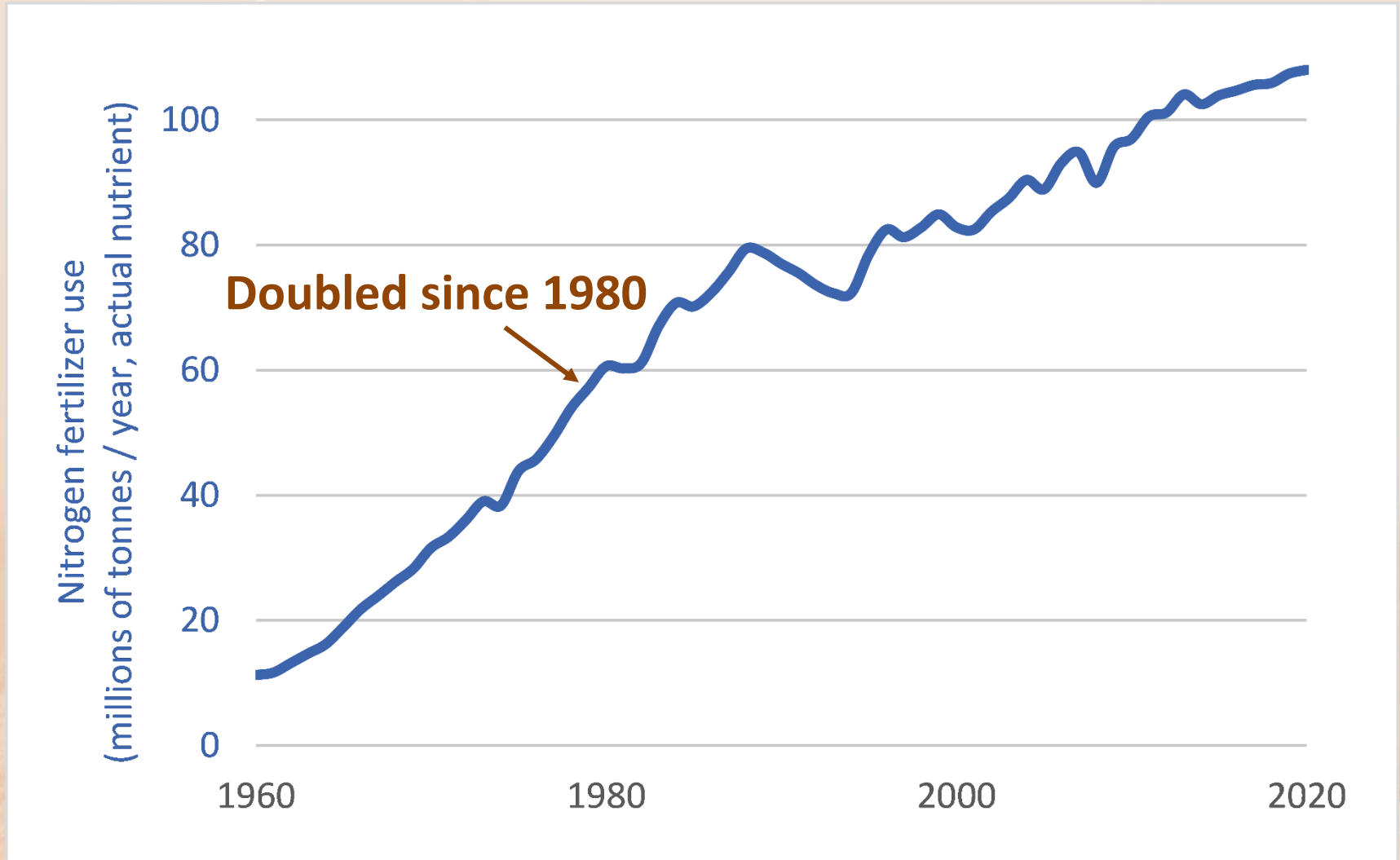


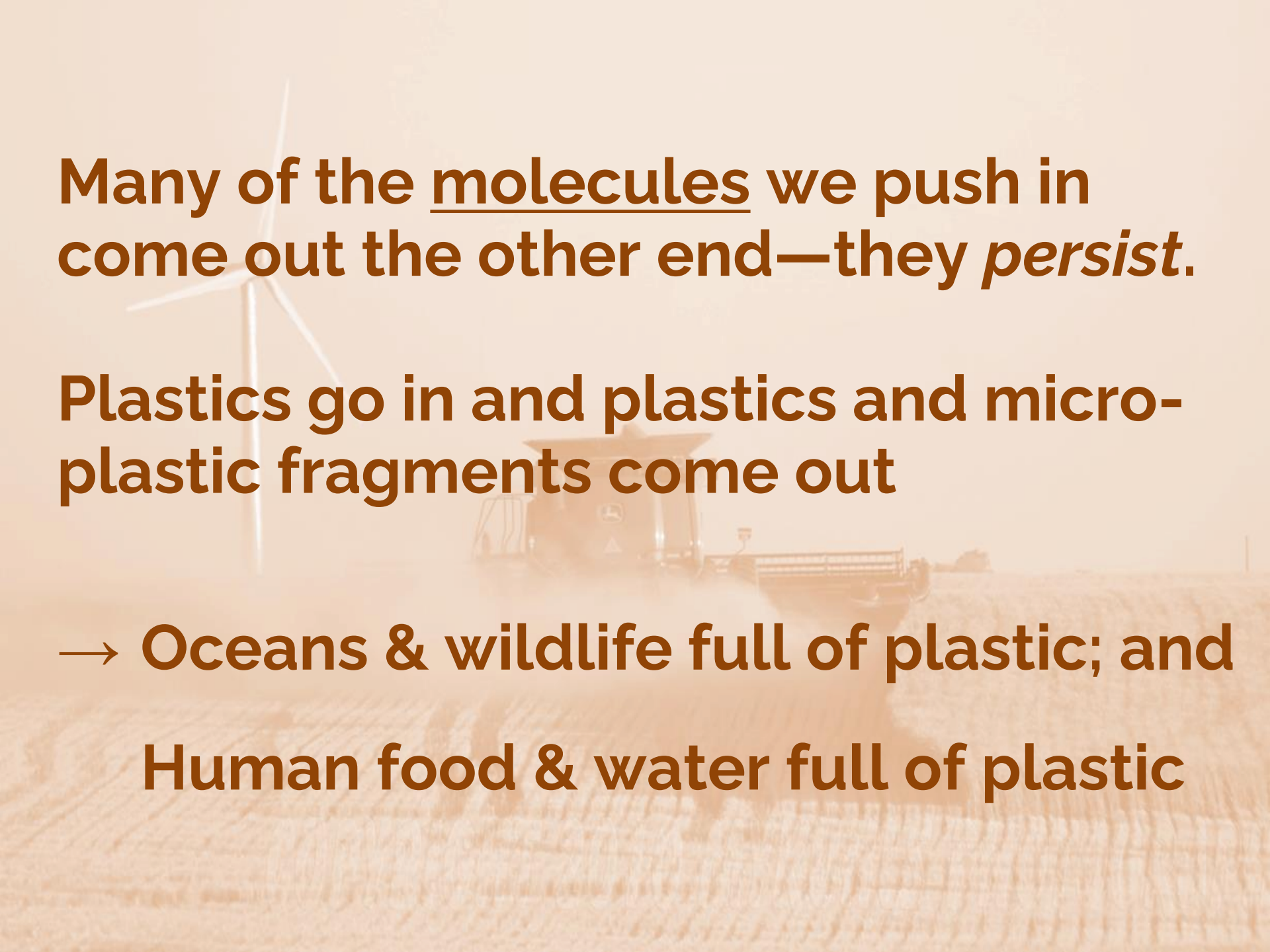






# Breaking loops: fertilizer (Global)



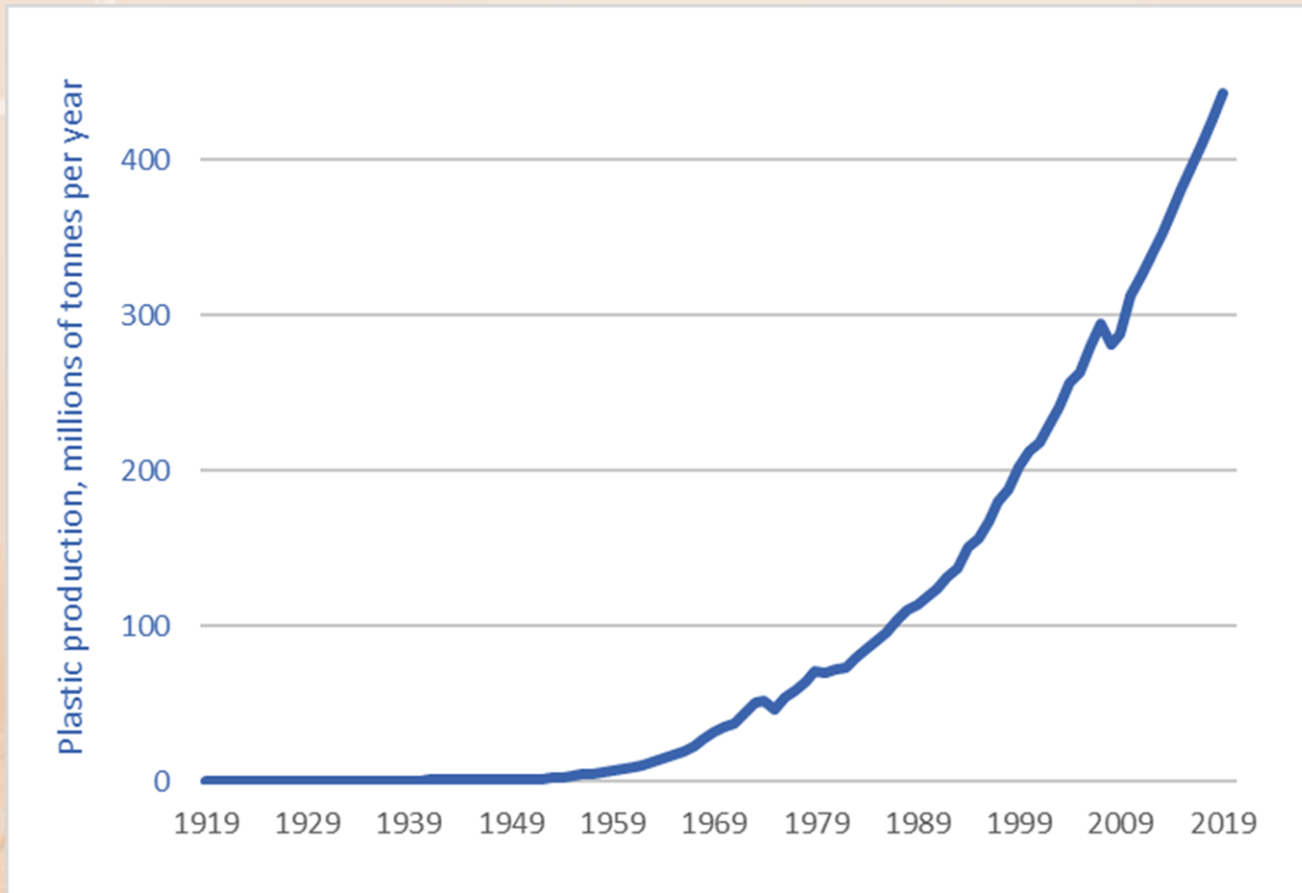


Many of the molecules we push in  
come out the other end—they *persist*.

Plastics go in and plastics and micro-  
plastic fragments come out

→ Oceans & wildlife full of plastic; and  
Human food & water full of plastic

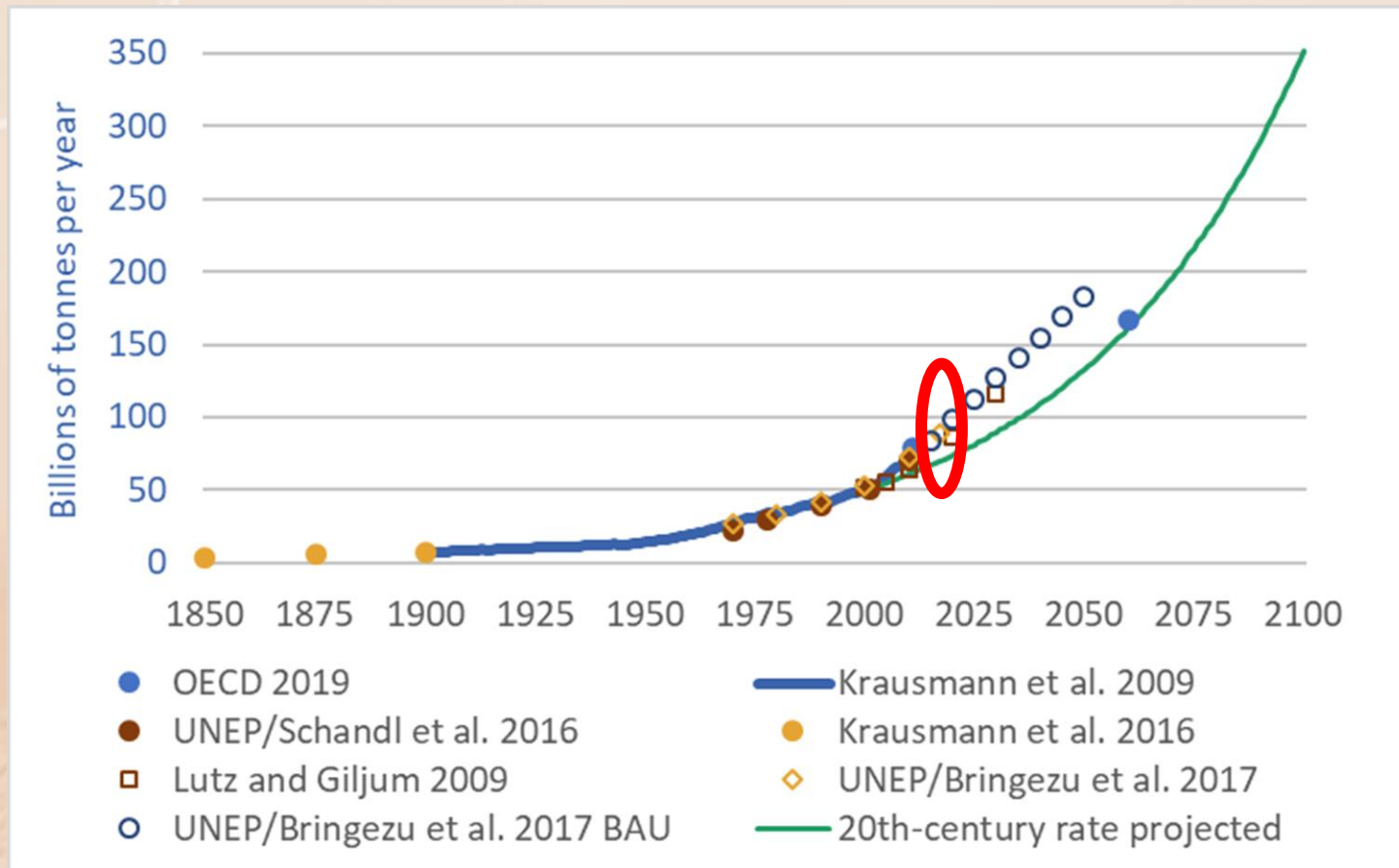
# Plastic







# Materials overall



## Part 4 of 5

**Energy must be immaterial**

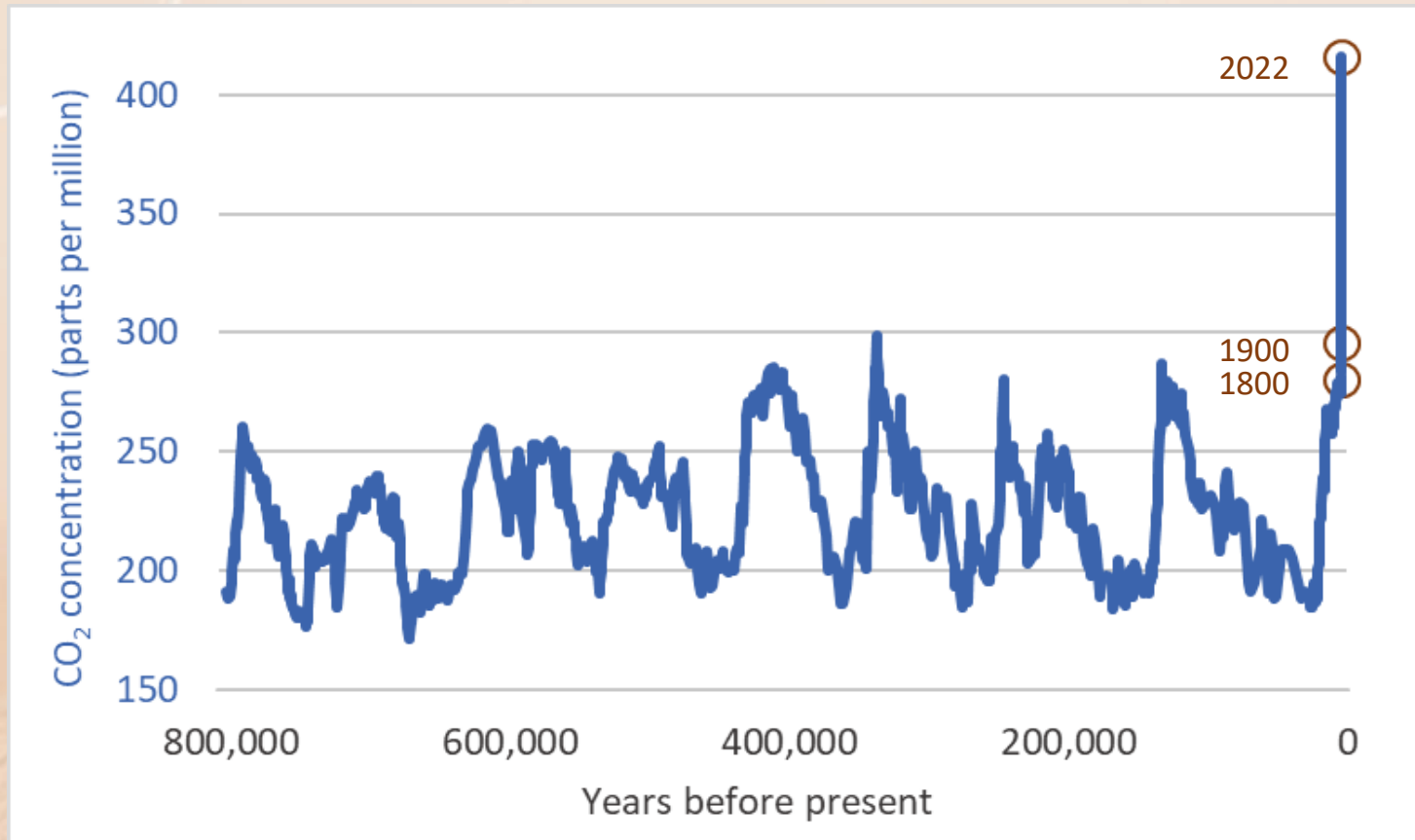
*“In which we see that any energy source that has a material carrier will be trouble”*

**Until the 18<sup>th</sup> century, all energy systems on Earth relied on solar power.**





# Carbon dioxide (CO<sub>2</sub>)



## Energy sources with material carriers:

- oil
- coal
- natural gas
- nuclear
- biomass

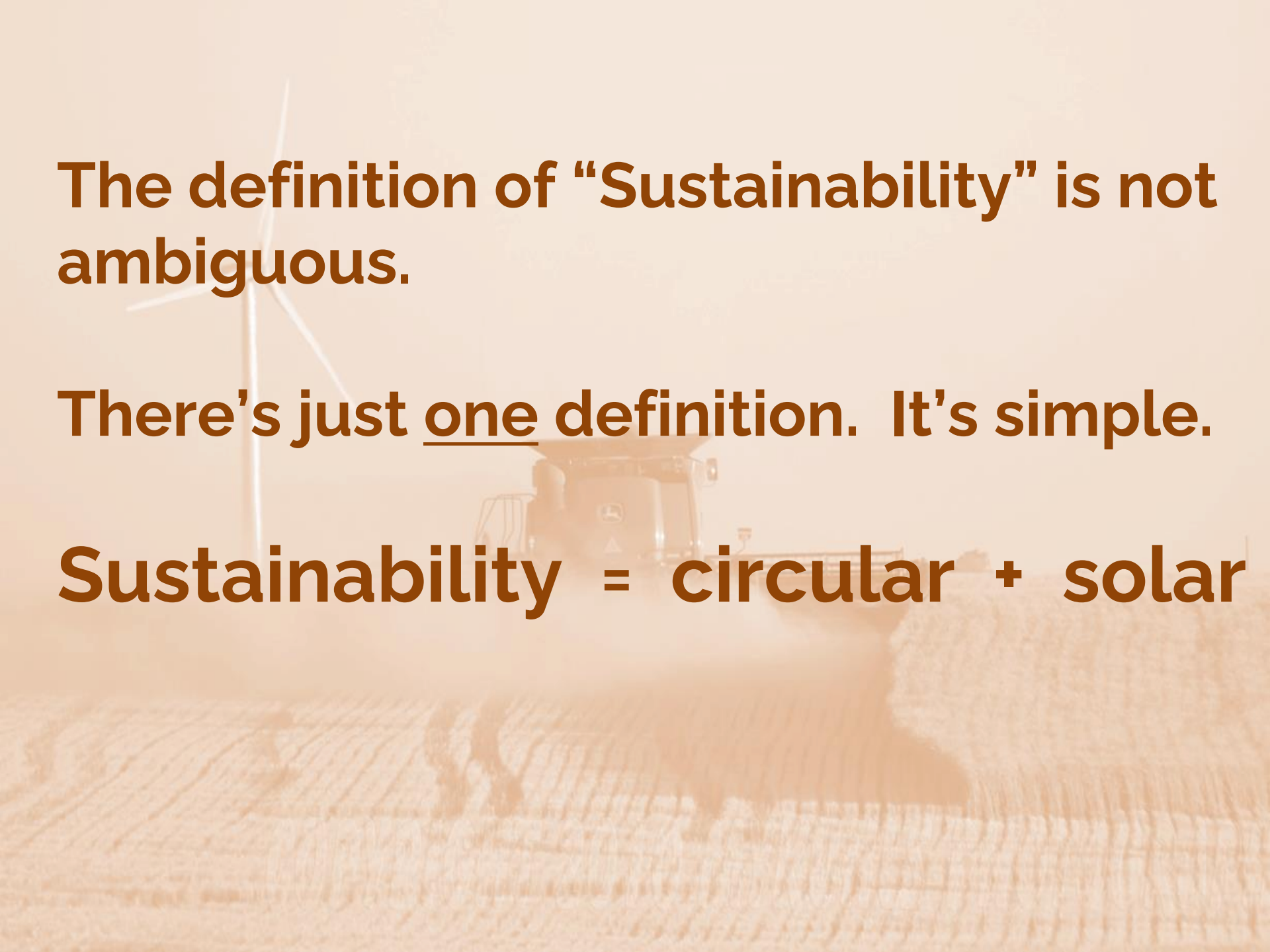
## Energy sources without material carriers:

- solar
- wind
- hydro

# Part 5 of 5

## Sustainability

*In which we see that there is nothing more clear than the definition of “sustainability”*

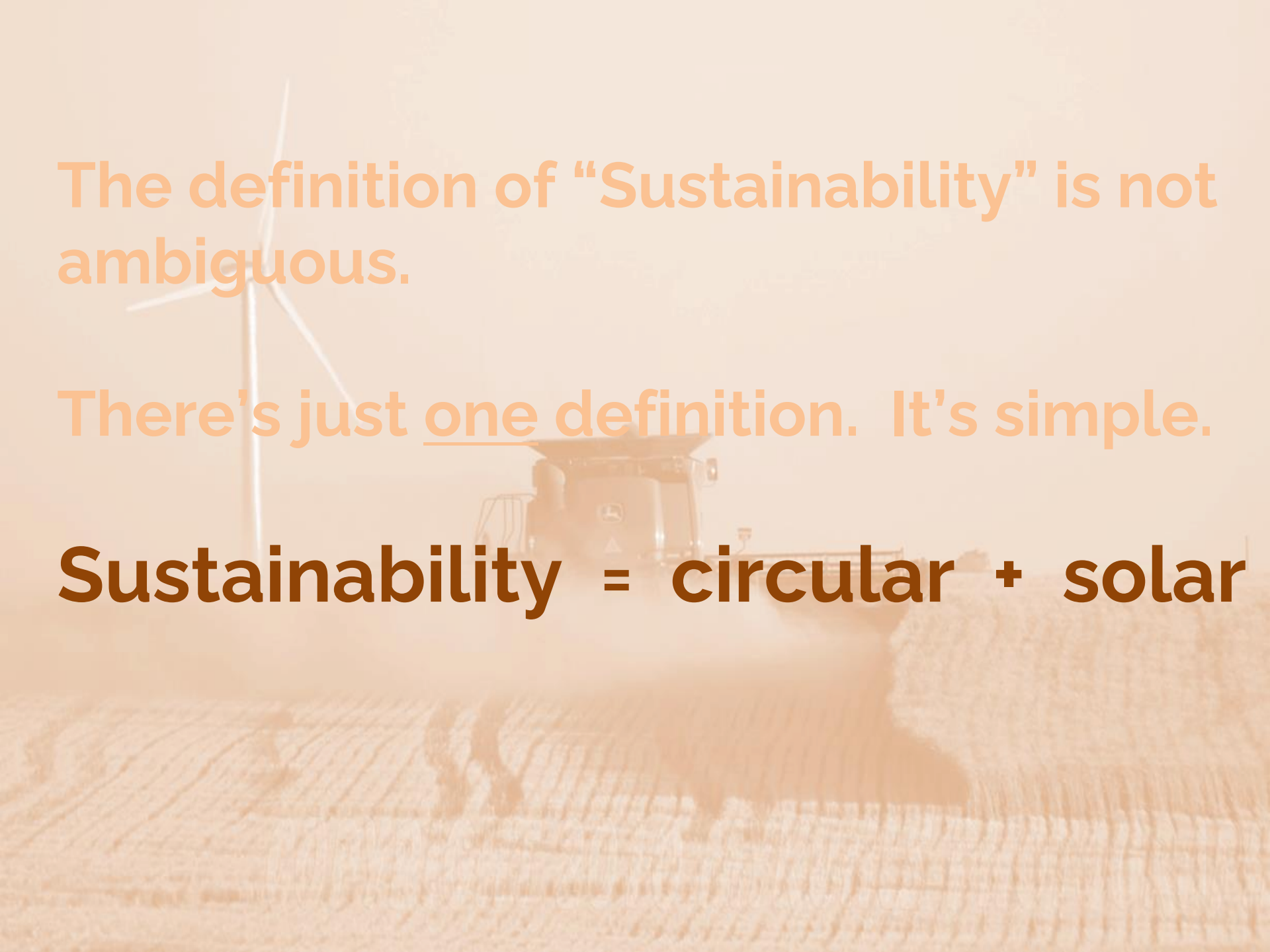


**The definition of “Sustainability” is not ambiguous.**

**There’s just one definition. It’s simple.**

**Sustainability = circular + solar**





The definition of “Sustainability” is not ambiguous.

There’s just one definition. It’s simple.

**Sustainability = circular + solar**

**What sustainability isn't**

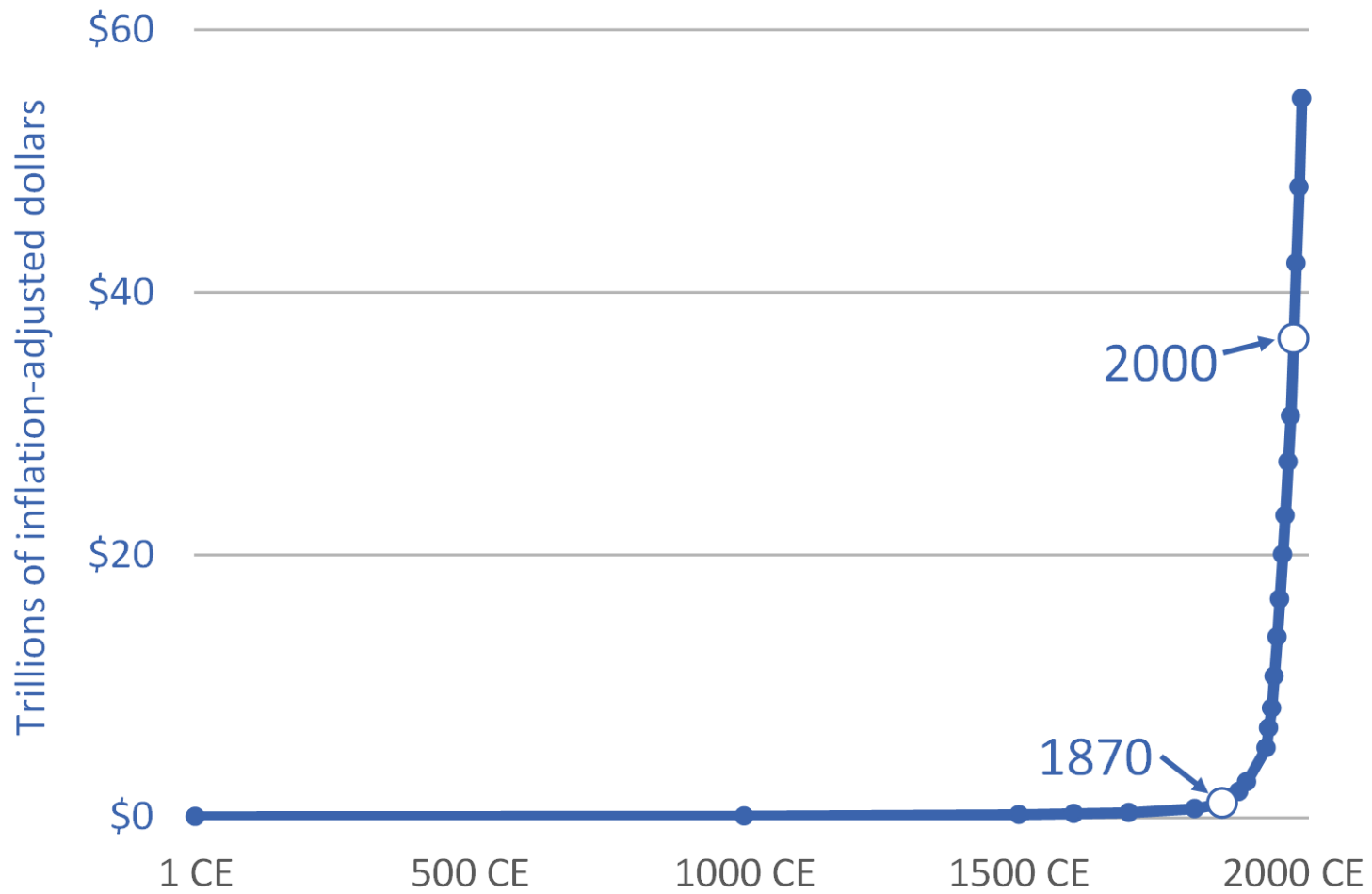


# Picture sustainability

- **Stability**
- **Constancy**
- **Horizontal trendlines**









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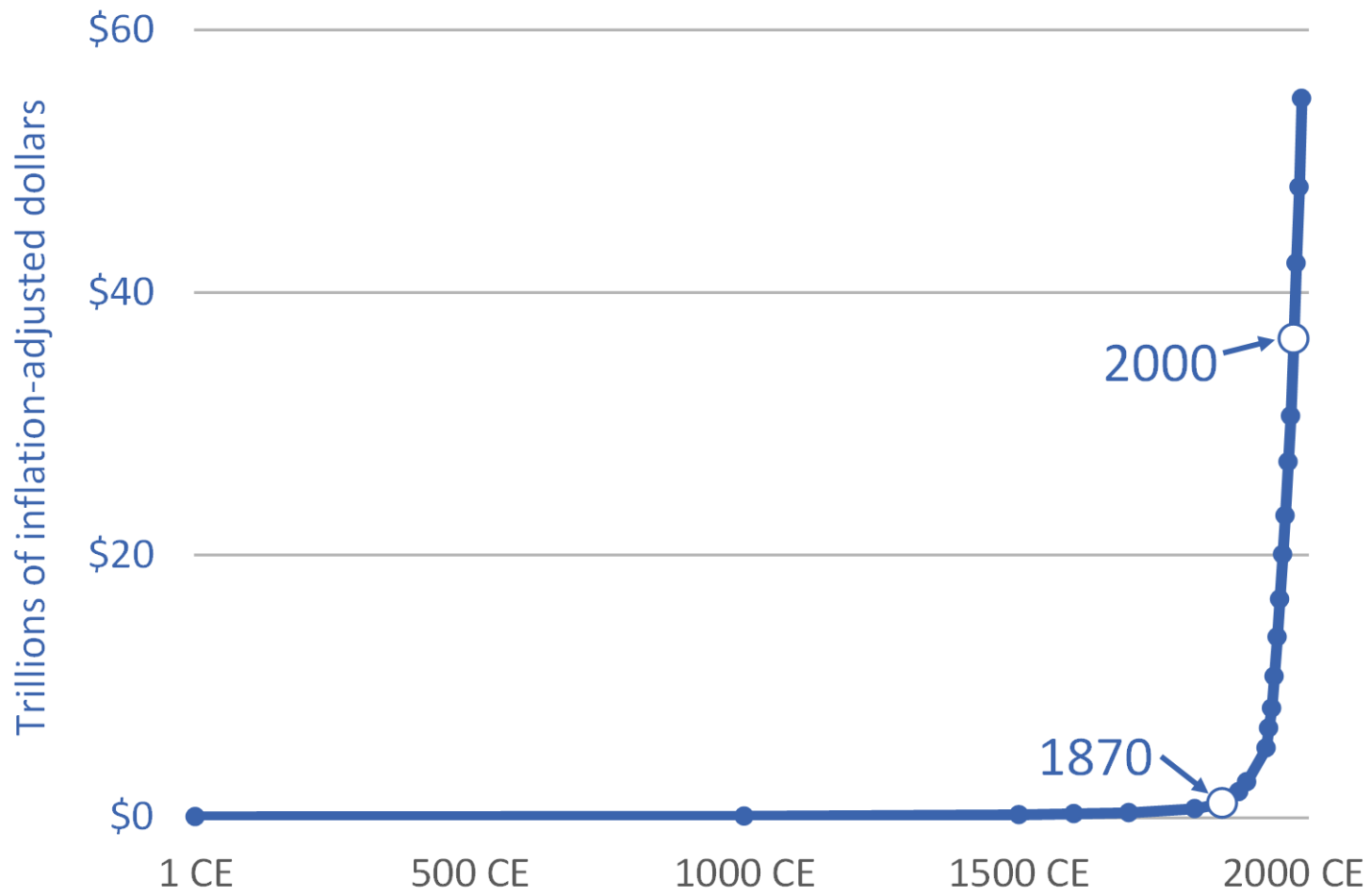
Opinion

World

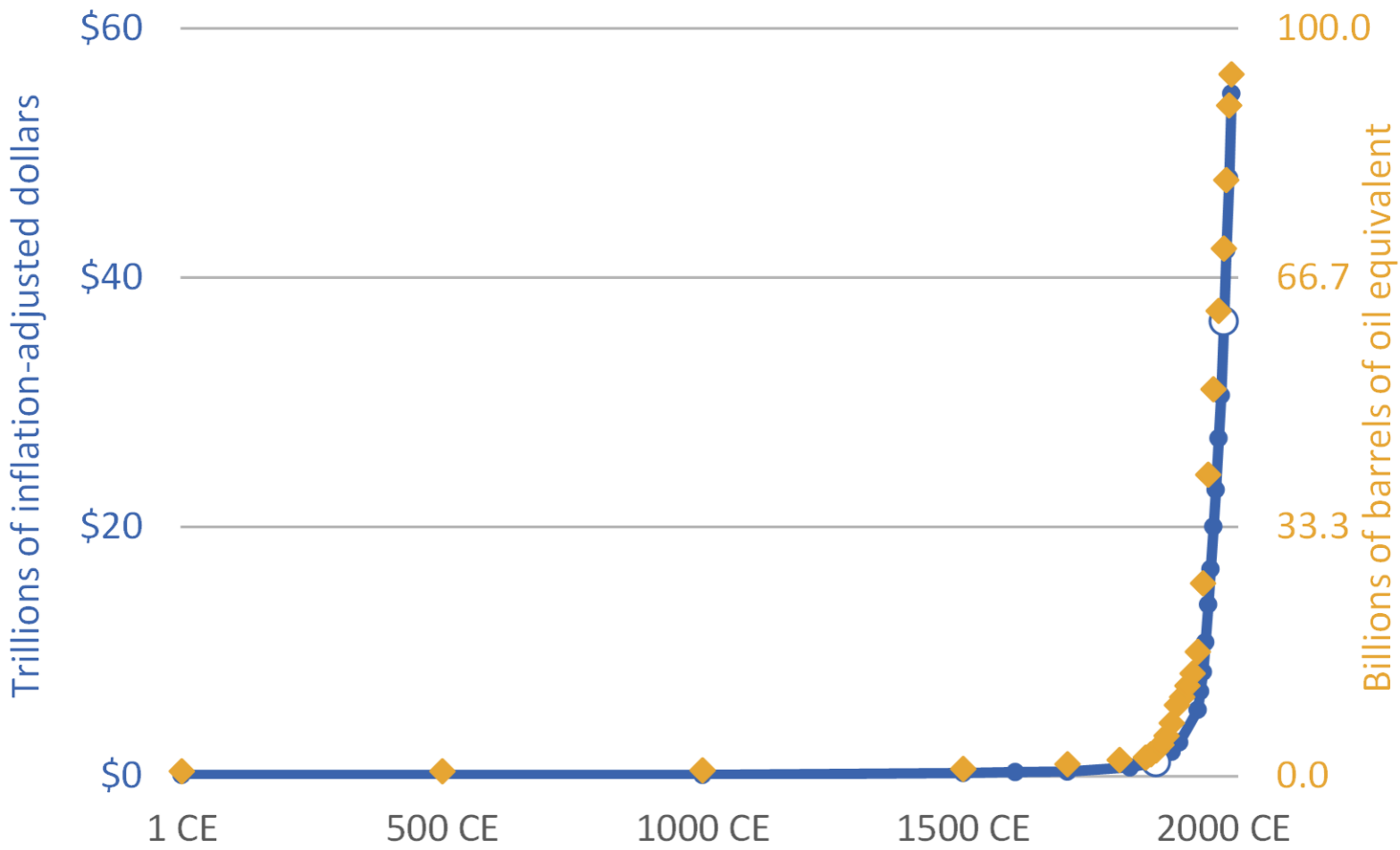
Canada

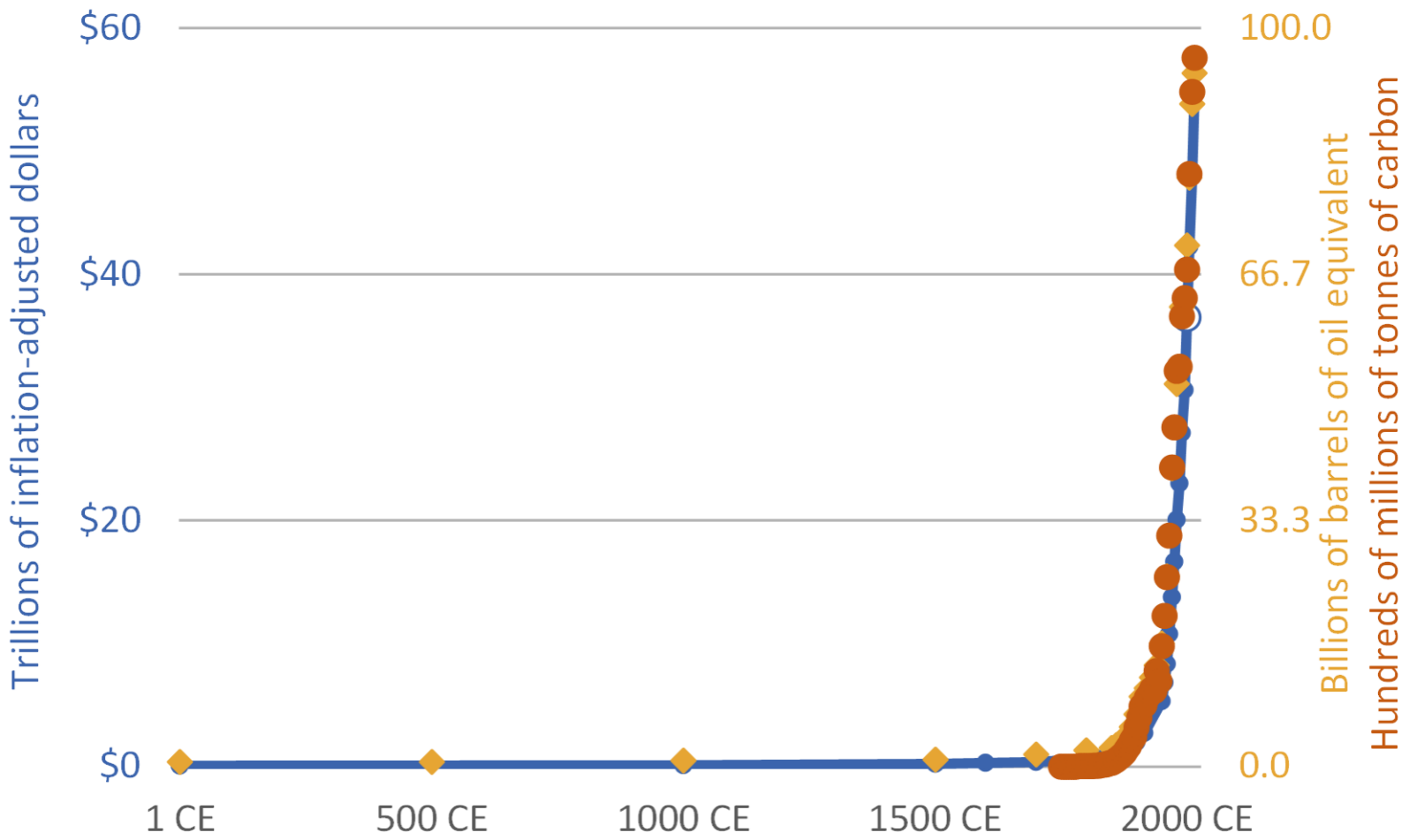
Business

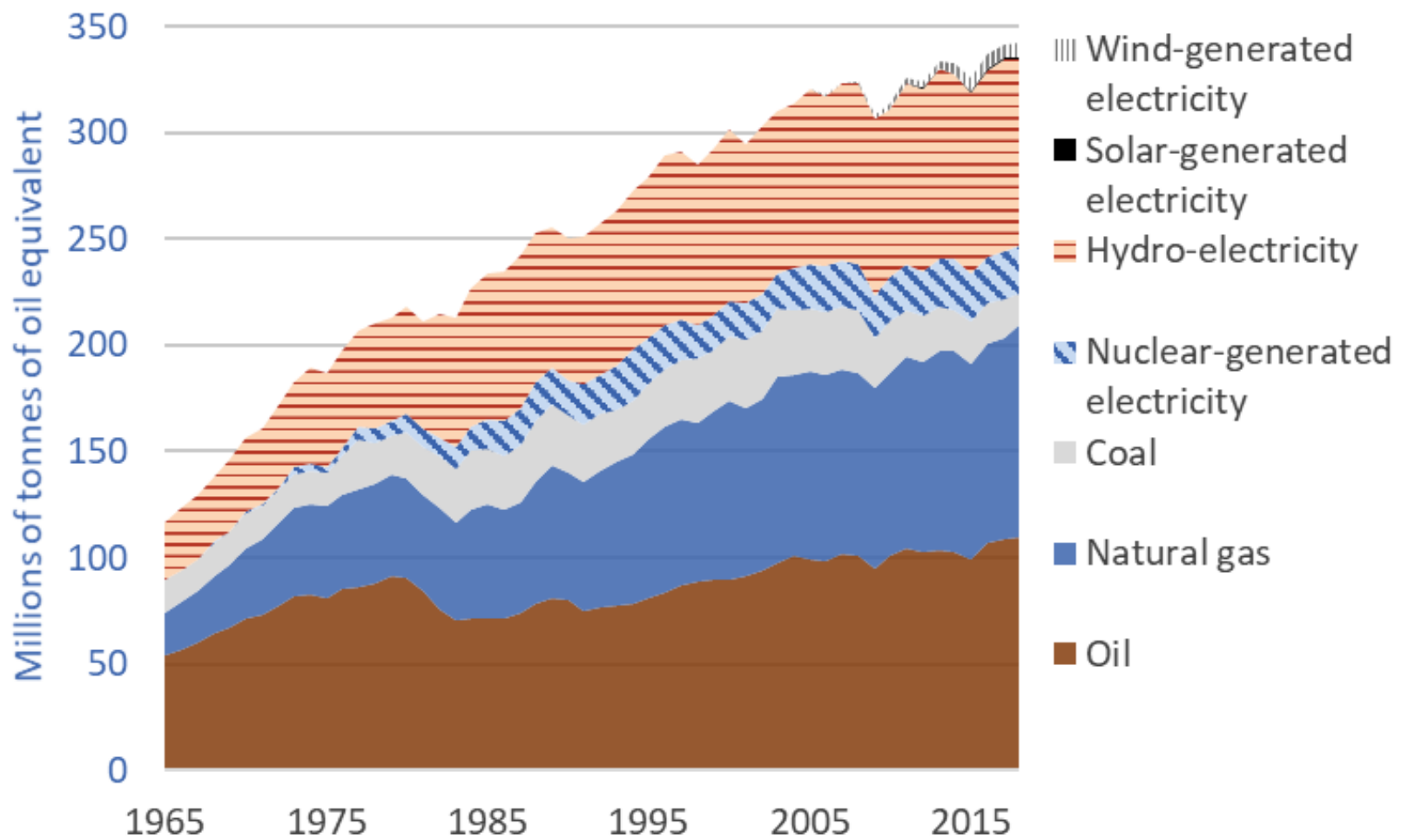
# Canadian economy grew at 2.9% pace in 2nd quarter, lower than expected

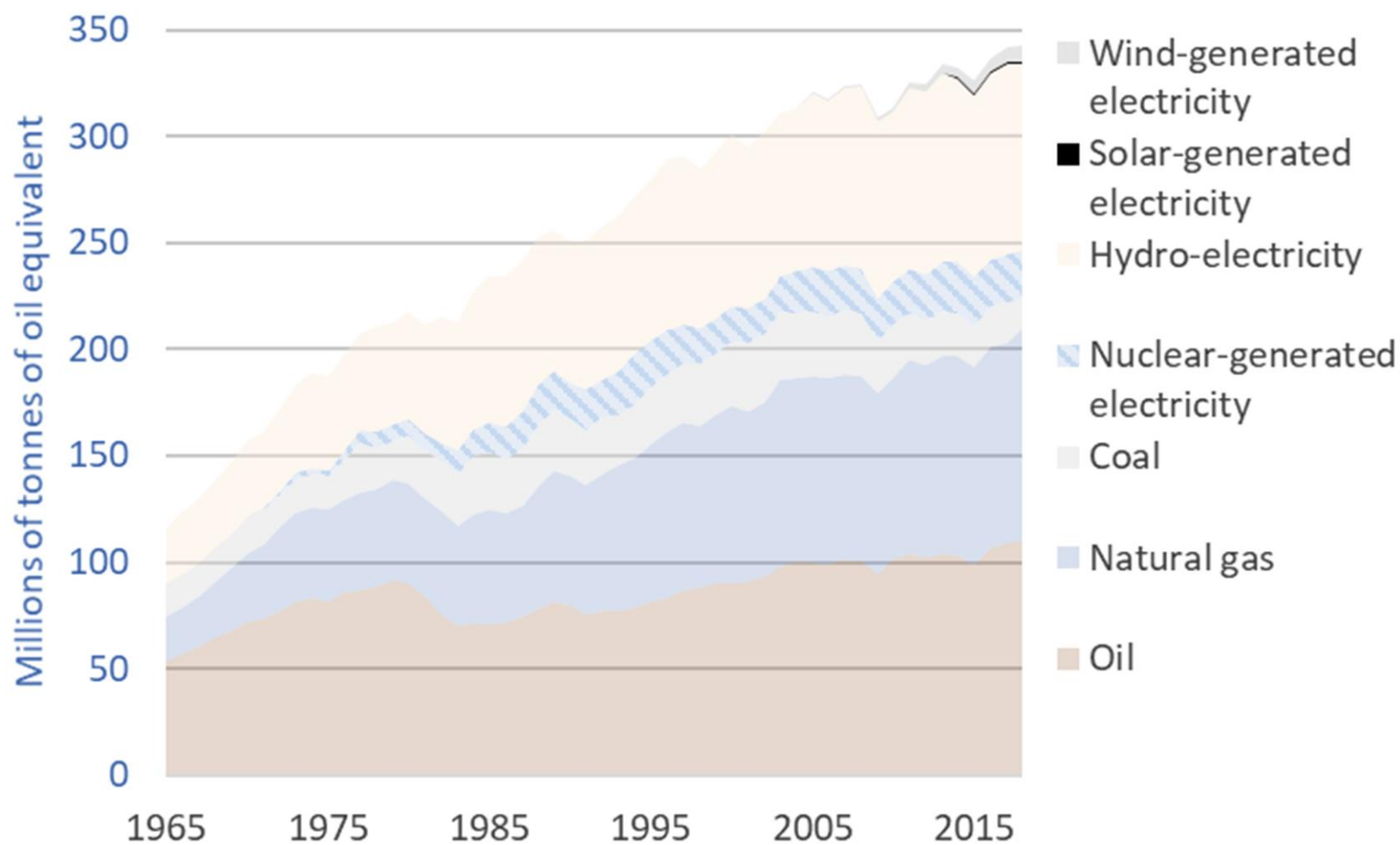














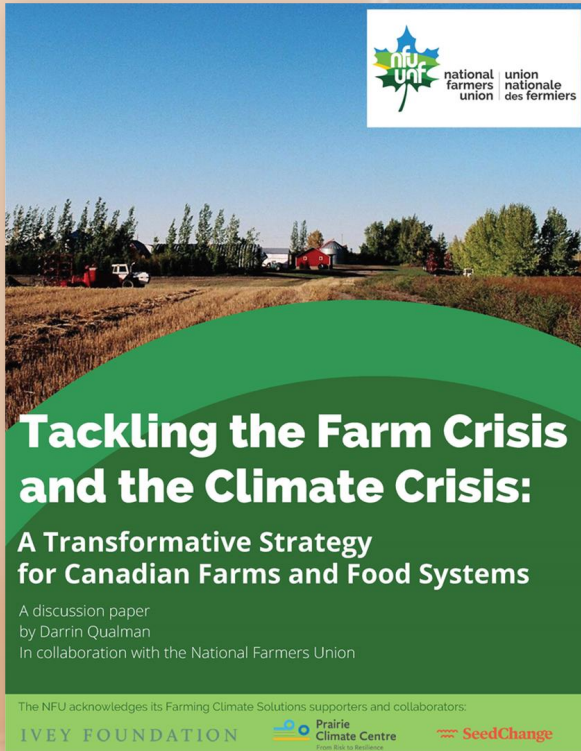
**What we have to do is not unclear.**


**The definition of “Sustainability” is not ambiguous.**

**There’s just one definition. It is simple.**

**Sustainability = circular + solar**

# For more information






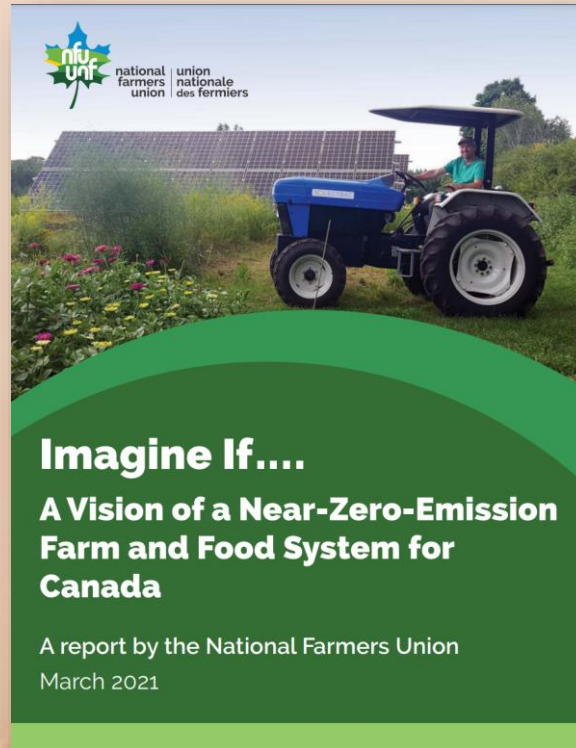
 national farmers union / union nationale des fermiers


## Tackling the Farm Crisis and the Climate Crisis: A Transformative Strategy for Canadian Farms and Food Systems

A discussion paper  
by Darrin Qualman  
In collaboration with the National Farmers Union

The NFU acknowledges its Farming Climate Solutions supporters and collaborators:

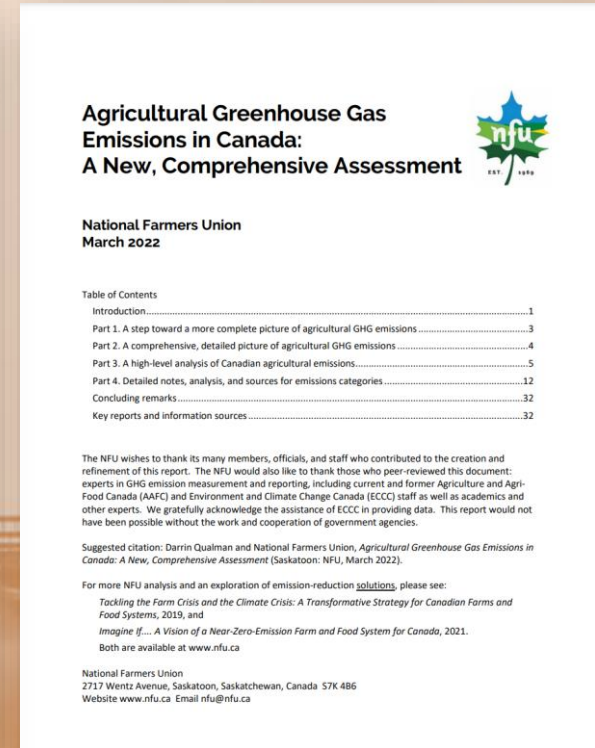
 IVEY FOUNDATION  Prairie Climate Centre  SeedChange




 national farmers union / union nationale des fermiers

## Imagine If.... A Vision of a Near-Zero-Emission Farm and Food System for Canada

A report by the National Farmers Union  
March 2021



 national farmers union / union nationale des fermiers

## Agricultural Greenhouse Gas Emissions in Canada: A New, Comprehensive Assessment

National Farmers Union  
March 2022

Table of Contents

Introduction.....	1
Part 1. A step toward a more complete picture of agricultural GHG emissions.....	3
Part 2. A comprehensive, detailed picture of agricultural GHG emissions.....	4
Part 3. A high-level analysis of Canadian agricultural emissions.....	5
Part 4. Detailed notes, analysis, and sources for emissions categories.....	12
Concluding remarks.....	32
Key reports and information sources.....	32

The NFU wishes to thank its many members, officials, and staff who contributed to the creation and refinement of this report. The NFU would also like to thank those who peer-reviewed this document: experts in GHG emission measurement and reporting, including current and former Agriculture and Agri-Food Canada (AAFC) and Environment and Climate Change Canada (ECCC) staff as well as academics and other experts. We gratefully acknowledge the assistance of ECCC in providing data. This report would not have been possible without the work and cooperation of government agencies.

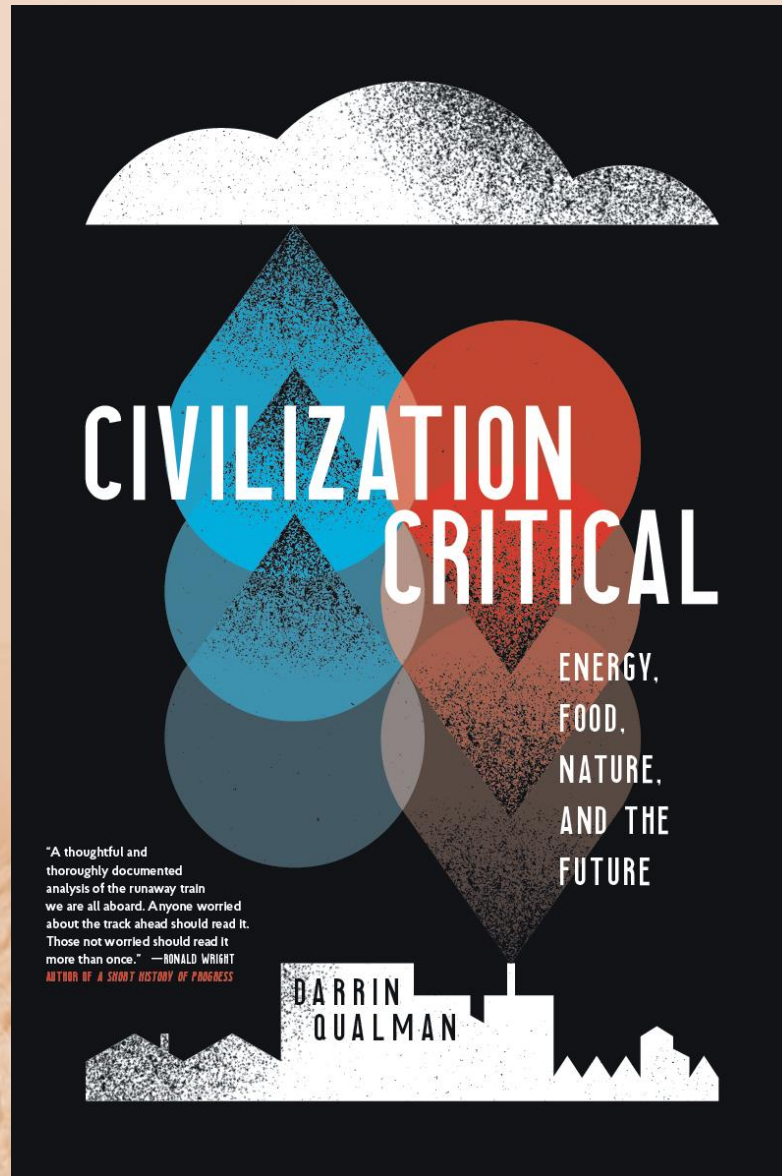
Suggested citation: Darrin Qualman and National Farmers Union, *Agricultural Greenhouse Gas Emissions in Canada: A New, Comprehensive Assessment* (Saskatoon: NFU, March 2022).

For more NFU analysis and an exploration of emission-reduction [solutions](#), please see:  
*Tackling the Farm Crisis and the Climate Crisis: A Transformative Strategy for Canadian Farms and Food Systems*, 2019, and  
*Imagine If.... A Vision of a Near-Zero-Emission Farm and Food System for Canada*, 2021.  
Both are available at [www.nfu.ca](http://www.nfu.ca)

National Farmers Union  
2717 Wentz Avenue, Saskatoon, Saskatchewan, Canada S7K 4B6  
Website [www.nfu.ca](http://www.nfu.ca) Email [nfu@nfu.ca](mailto:nfu@nfu.ca)



# For more information





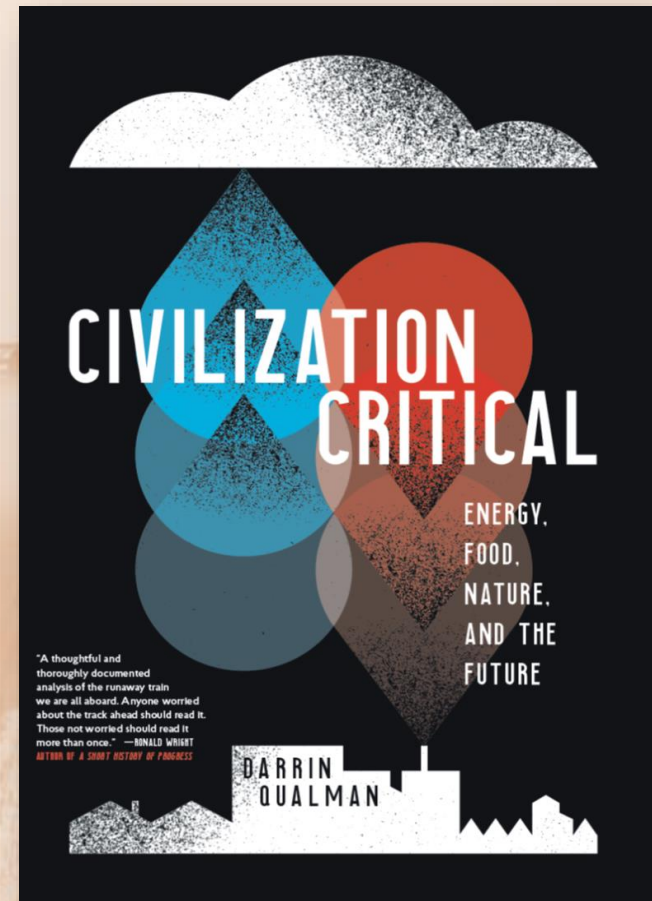
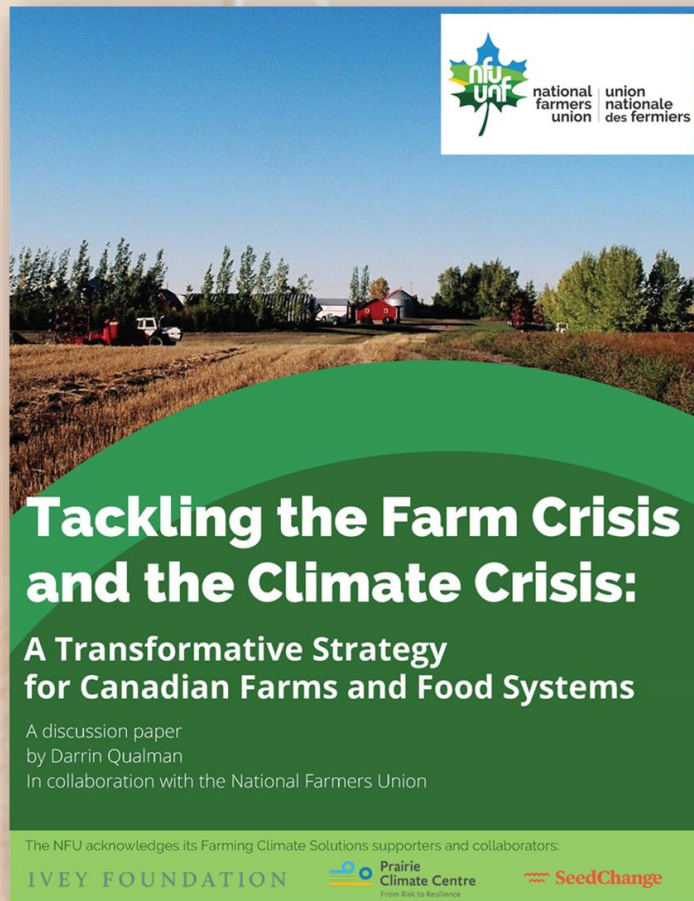
# Thank you

## Darrin Qualman

## qualman@nfu.ca

## National Farmers Union

## www.nfu.ca





# Thank you

## Darrin Qualman

[qualman@nfu.ca](mailto:qualman@nfu.ca)

## National Farmers Union

[www.nfu.ca](http://www.nfu.ca)

