Midterm Review

Assignments

Brightspace discussion question:

“How concerned are you about the impacts of climate change in your lifetime?”

Due this Friday by 5pm.

Third programming assignment on identifying crops in remote sensing data

Due Friday the 3rd by midnight.

Midterm - March 9th

Syllabus update

Mar 7: Project plans/instructions
Project proposal assignment given
Mar 9: Midterm
SPRING BREAK
Mar 21: Influencing people/policy
Mar 23: Financing in a net-zero economy
Mar 28: Project Plan Presentations
Mar 30: Career Day
Apr 4: Disaster Response
Apr 6: Health Impacts
Fourth assignment given
Apr11: Guest lecture on NYU's M2Lines project
Apr 13: Predicting extreme weather events
Apr 18: Predicting food shortages
Apr 20: Automated Farming
Apr 25: Climate Migration
Apr 27: Project work day
May 2: Project Presentations
May 4: Project Presentations

Climate change in the news

Climate change in the news

CLIMATE

An activist group is spreading misinformation to stop solar projects in rural America

February 18, 2023 · 8:41 PM ET

MIRANDA GREEN | MICHAEL COPLEY

RYAN KELLMAN

FROM floodlight

An energy company offered to lease Houser's property in rural Page County to build a solar plant that could power about 25,000 homes. It was a good offer, Houser says. More money than he could make growing hay and selling cattle.

"The idea of being able to keep the land as one parcel and not have it split up was very attractive," Houser says. "To have some passive income for retirement was good. And then the main thing was the electricity it would generate and the good it would do made it feel good all the way around."

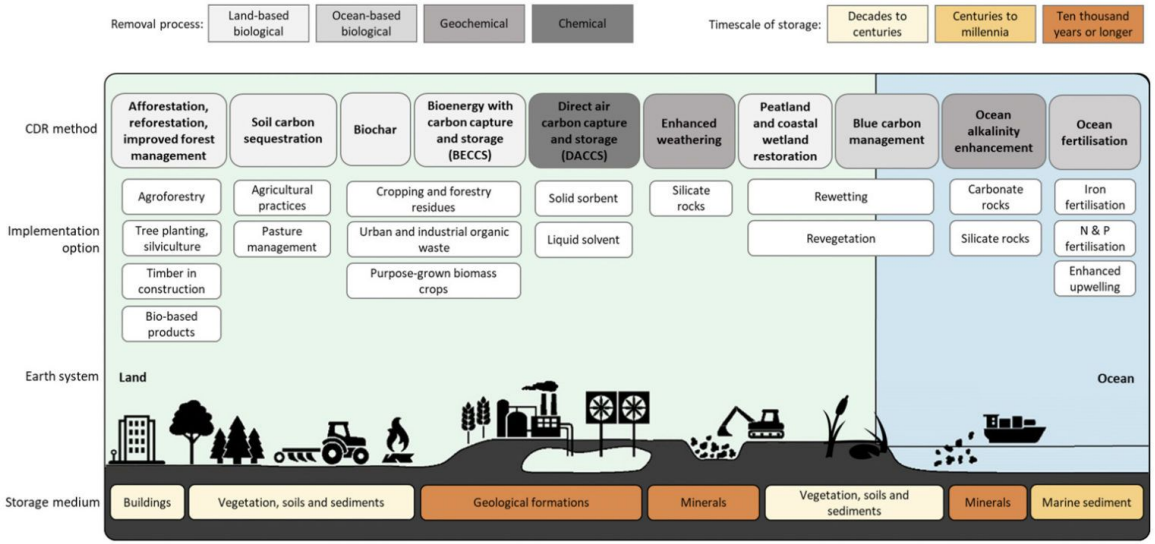
But soon after he got the offer, organized opposition began a four-year battle against solar development in the county. A group of locals eventually joined forces with a nonprofit called Citizens for Responsible Solar to stop the project on Houser's land and pass restrictions effectively banning big solar plants from being built in the area.

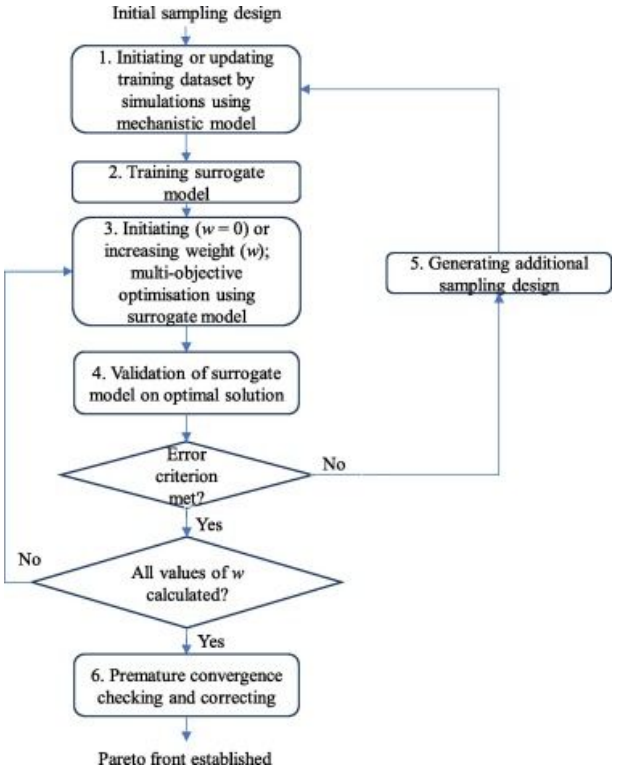
Citizens for Responsible Solar was founded in an exurb of Washington, D.C., by a longtime political operative named Susan Ralston who worked in the White House under President George W. Bush and still has deep ties to power players in conservative politics.

Ralston said in an email to NPR and Floodlight that Citizens for Responsible Solar is a grassroots organization that helps other activists on a volunteer basis. The group isn't opposed to solar, Ralston said, just projects built on farmland and timberland. Solar panels belong on "industrial-zoned land, marginal or contaminated land, along highways, and on commercial and residential rooftops," she said.

But her group's rhetoric points to a broader agenda of undermining public support for solar. Analysts who follow the industry say Citizens for Responsible Solar stokes opposition to solar projects by spreading misinformation online about health and environmental risks. The group's website says solar requires too much land for "unreliable energy," ignoring data showing power grids can run dependably on lots of renewables. And it claims large solar projects in rural areas wreck the land and contribute to climate change, despite evidence to the contrary.

Recap


Removal process:
Land-based biological
Ocean-based biological
Geochemical
Chemical
Timescale of storage:
Decades to centuries
Centuries to millennia
Ten thousand years or longer
CDR method
Afforestation, reforestation, improved forest management
Soil carbon sequestration
Biochar
Bioenergy with carbon capture and storage (BECCS)
Direct air carbon capture and storage (DACCS)
Enhanced weathering
Peatland and coastal wetland restoration
Blue carbon management
Ocean alkalinity enhancement
Ocean fertilisation
Implementation option
Agroforestry
Tree planting, silviculture
Timber in construction
Bio-based products
Agricultural practices
Pasture management
Cropping and forestry residues
Urban and industrial organic waste
Purpose-grown biomass crops
Solid sorbent
Liquid solvent
Silicate rocks
Rewetting
Revegetation
Carbonate rocks
Silicate rocks
Iron fertilisation
N & P fertilisation
Enhanced upwelling
Earth system
Land
Ocean
Storage medium
Buildings
Vegetation, soils and sediments
Geological formations
Minerals
Vegetation, soils and sediments
Minerals
Marine sediment


Initial sampling design
1. Initiating or updating training dataset by simulations using mechanistic model
2. Training surrogate model
3. Initiating ($w = 0$) or increasing weight (w); multi-objective optimisation using surrogate model
4. Validation of surrogate model on optimal solution
Error criterion met?
No
Yes
All values of w calculated?
No
Yes
5. Generating additional sampling design
6. Premature convergence checking and correcting
Pareto front established

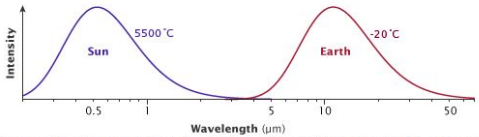
Midterm

March 9th, normal time and place

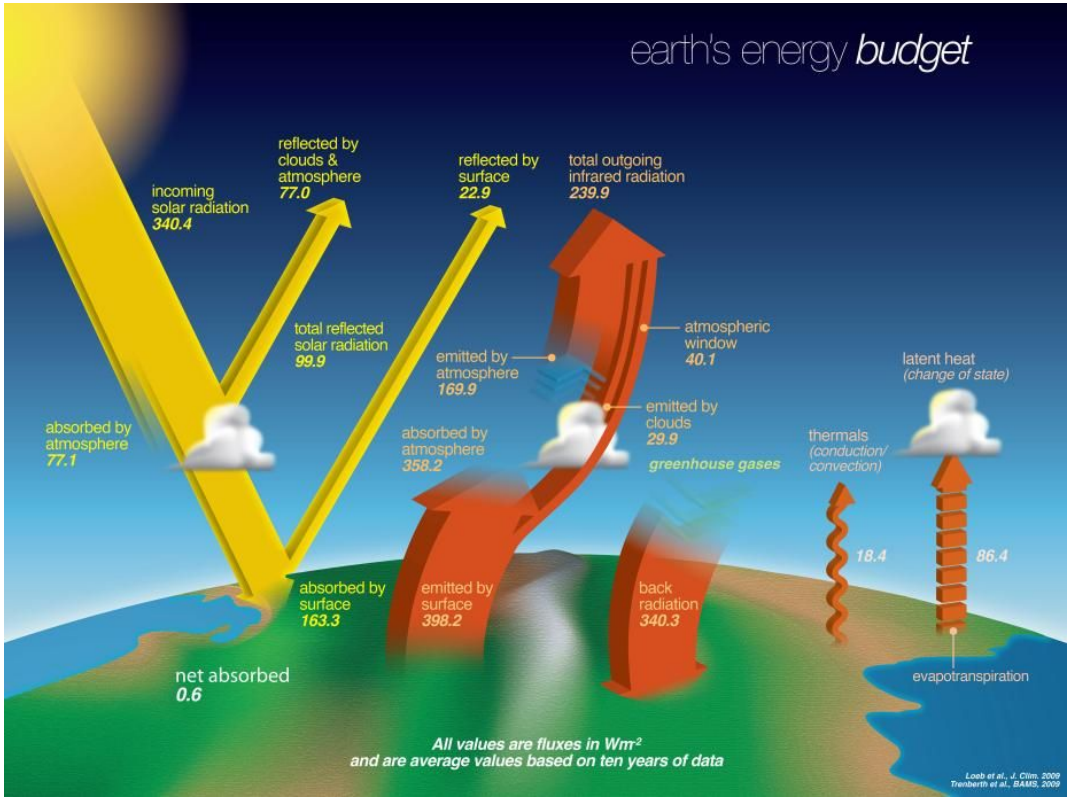
Written exam: mix of multiple choice and short answer

Covering climate content, machine learning concepts, and specific papers

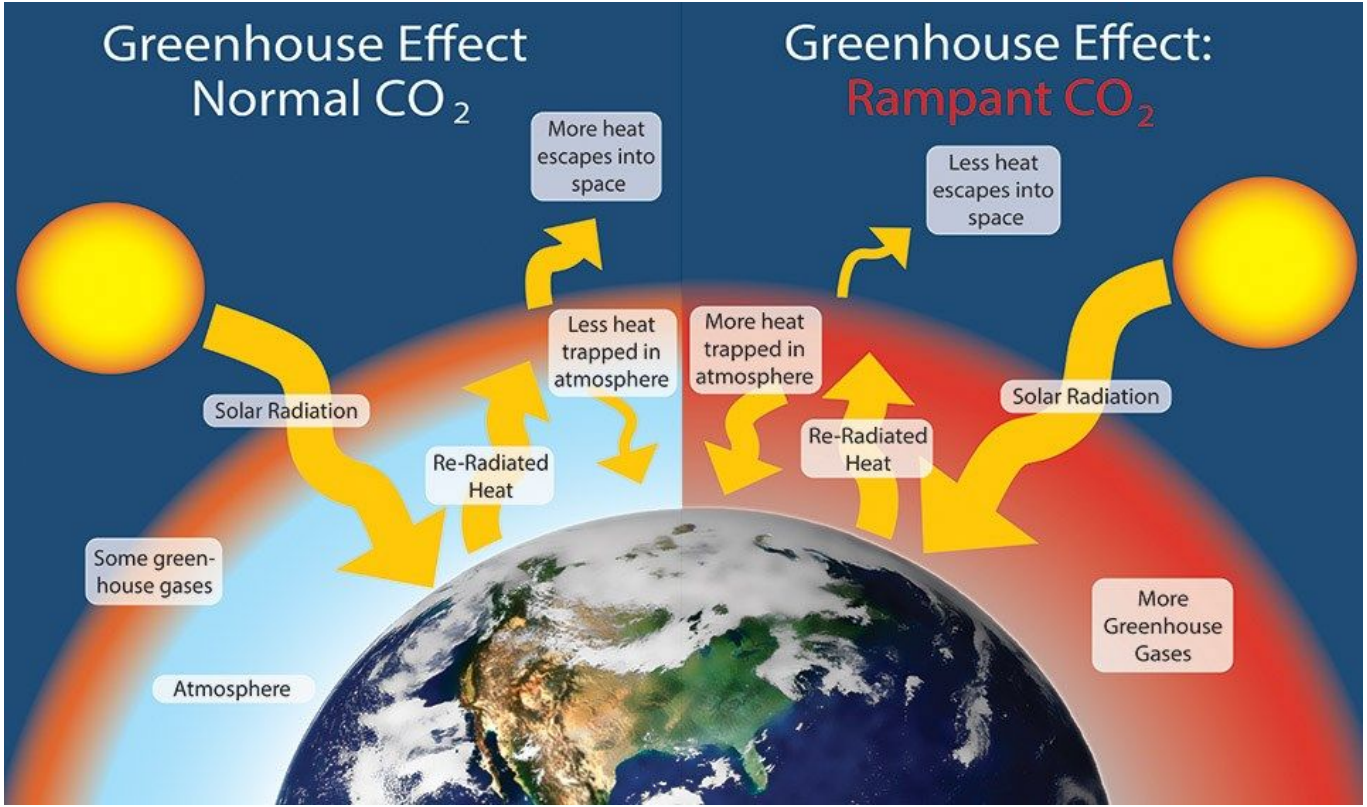
Earth’s energy budget and the greenhouse effect



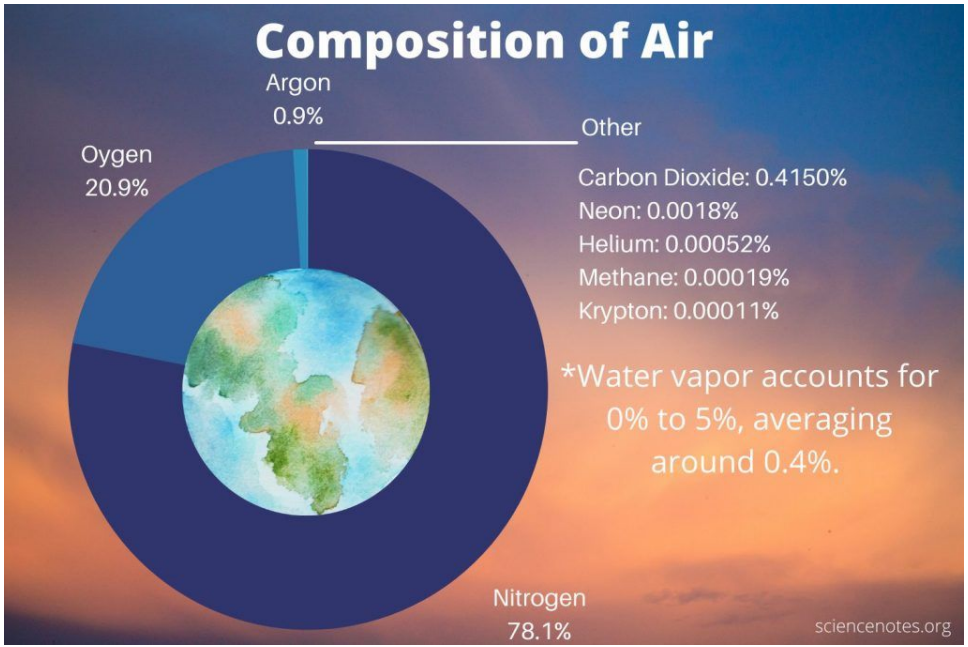
The Sun’s surface temperature is 5,500° C, and its peak radiation is in visible wavelengths of light. Earth’s effective temperature—the temperature it appears when viewed from space—is -20° C, and it radiates energy that peaks in thermal infrared wavelengths. (Illustration adapted from Robert Rohde.)

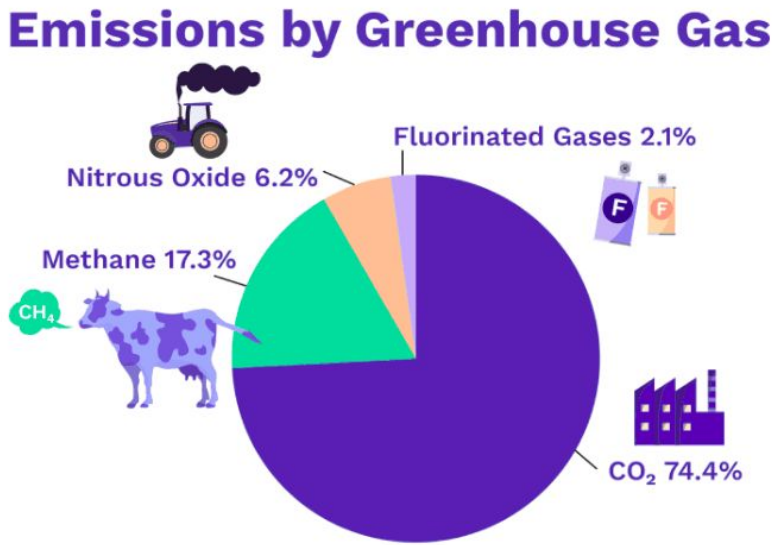


Earth's energy budget and the greenhouse effect



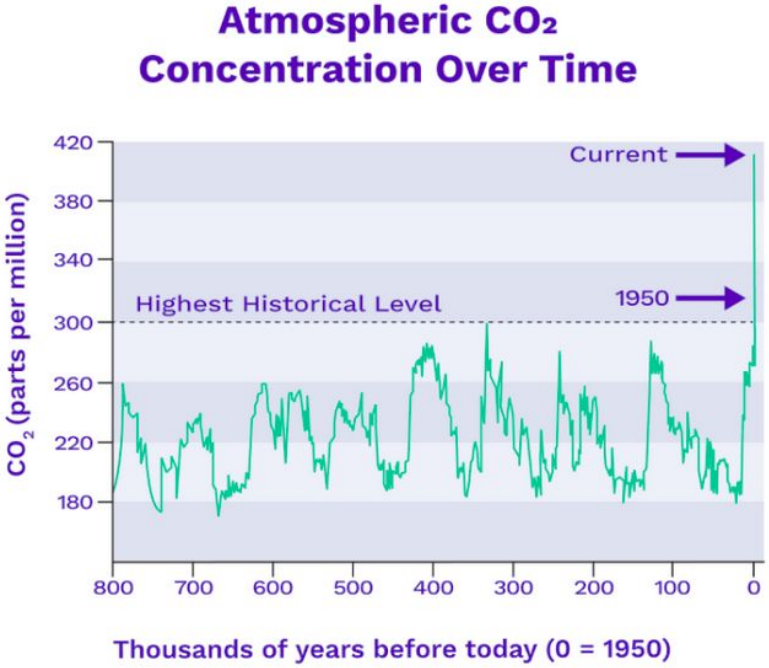
Greenhouse gases



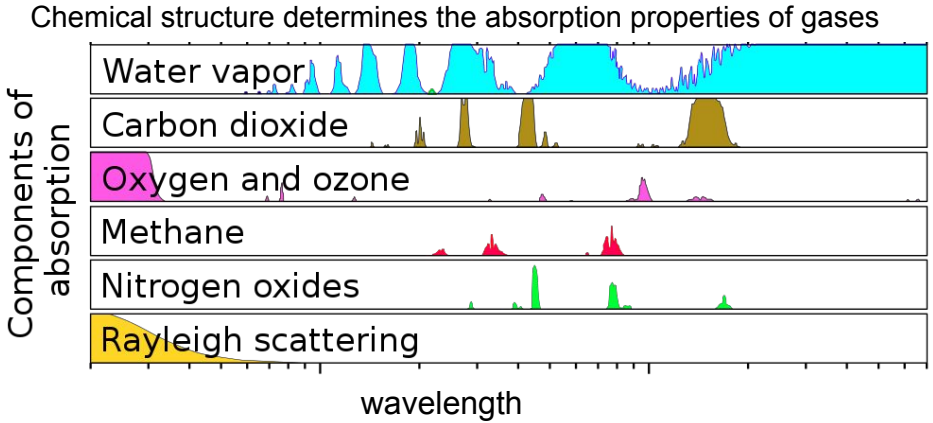


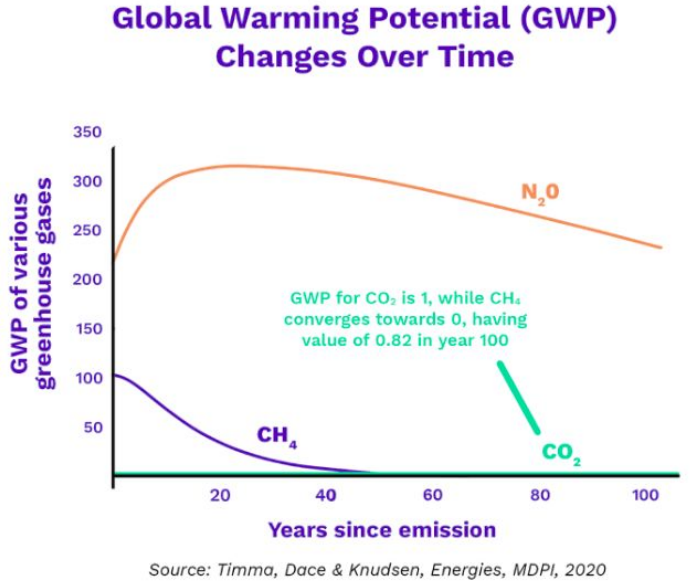
Source: World Resource Institute- [World Greenhouse Gas Emissions: 2016].

Greenhouse gases



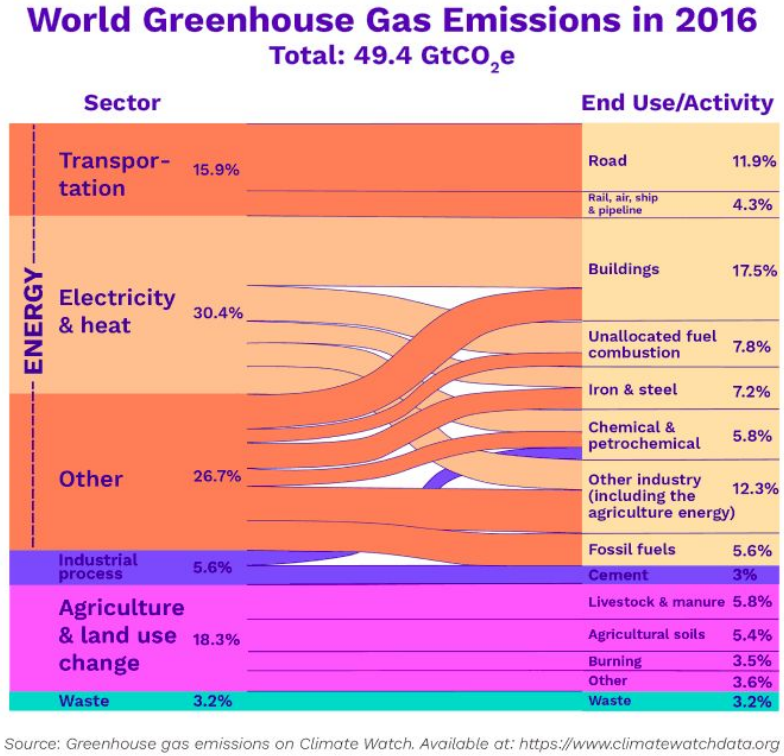
Source: NASACO2, https //climate.nasa.gov/vital-signs/carbon-dioxide



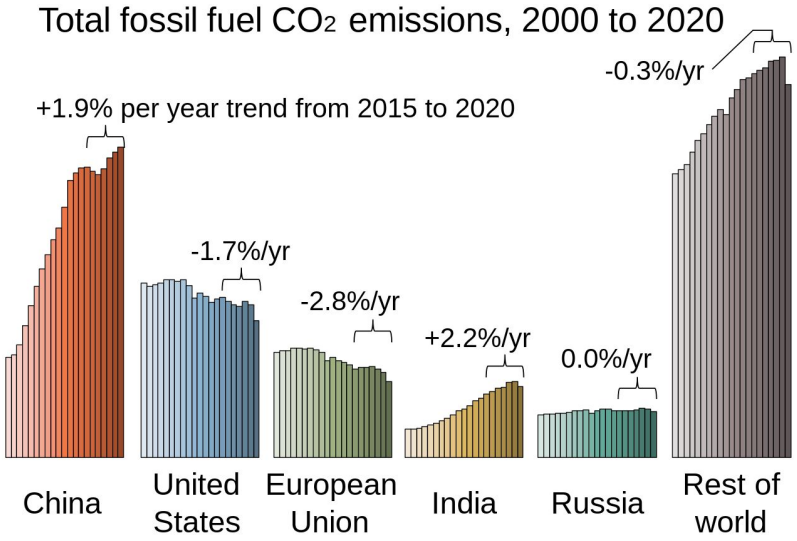


Source: Timma, Dace & Knudsen, Energies, MDPI, 2020

Emissions



Source: Greenhouse gas emissions on Climate Watch. Available at: https://www.climatewatchdata.org



The Intergovernmental Panel on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science related to climate change.

Reports

The IPCC prepares comprehensive Assessment Reports about the state of scientific, technical and socio-economic knowledge on climate change, its impacts and future risks, and options for reducing the rate at which climate change is taking place. It also produces Special Reports on topics agreed to by its member governments, as well as Methodology Reports that provide guidelines for the preparation of greenhouse gas inventories. The IPCC is working on the Sixth Assessment Report which consists of three Working Group contributions and a Synthesis Report. The Working Group I contribution was finalized in August 2021, the Working Group II contribution in February 2022 and the Working Group III contribution in April 2022.

Working Group 1
The Physical Science Basis

This report focuses on how and why the world's climate has changed in the past, and how it is projected to change in the future.

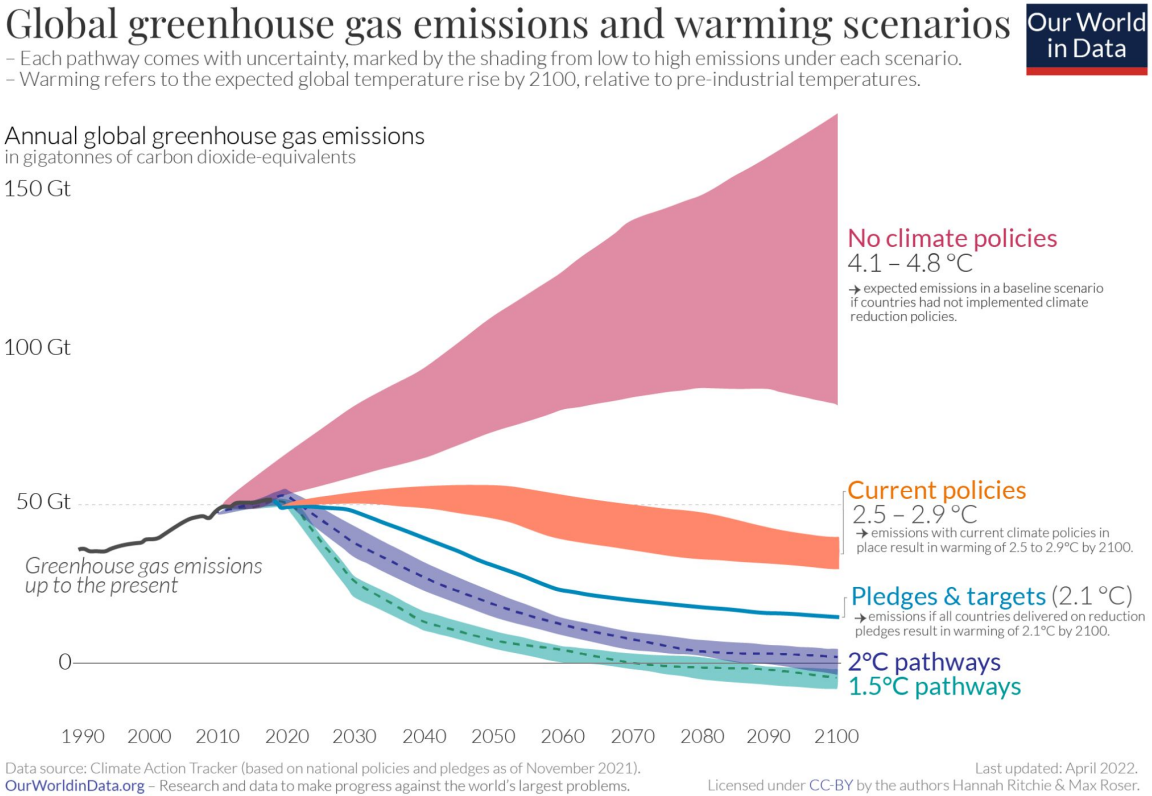
Working Group 2
Impacts, Adaptation, and Vulnerability

This report focuses on how climate change affects people, our built systems, and the natural world. It also addresses how we can adapt and become more resilient to climate change.

Working Group 3
Mitigation of Climate Change

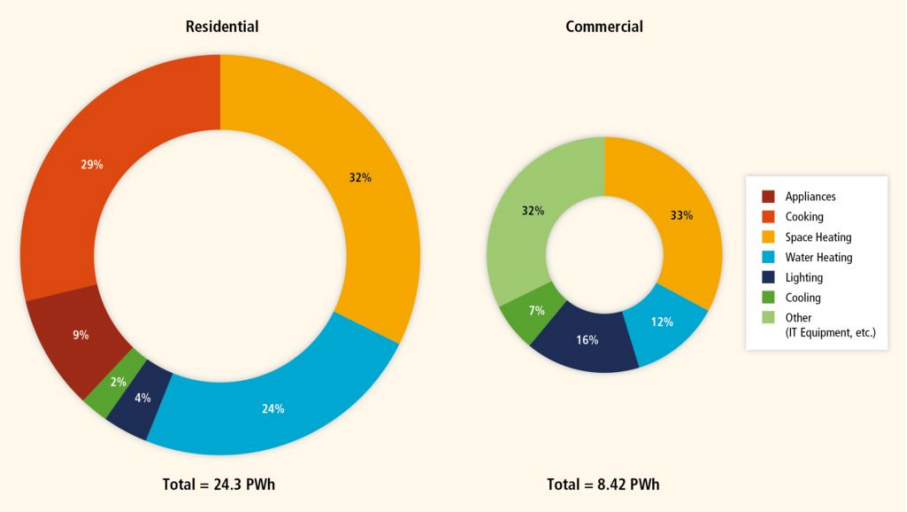
This report focuses on the actions we can take to reduce future climate change and prevent it from becoming too extreme.

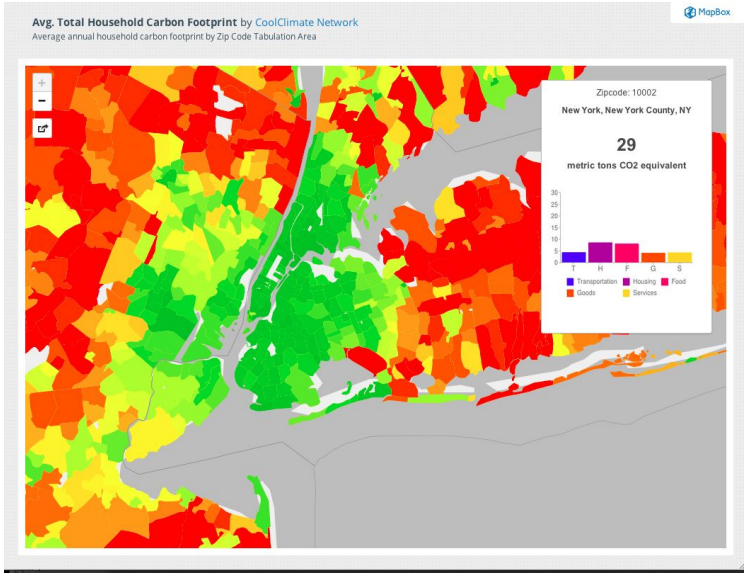
Different warming scenarios



Discussions of temperature increases are usually in degrees celsius relative to pre-industrial averages. We are currently at +1.2C

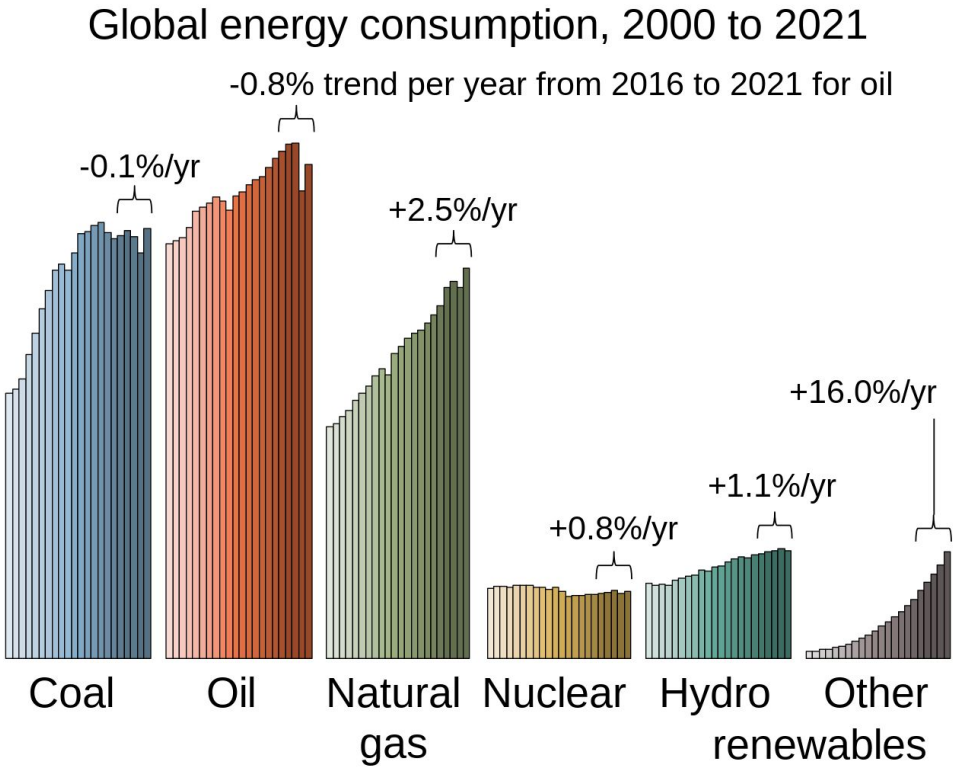
Building energy

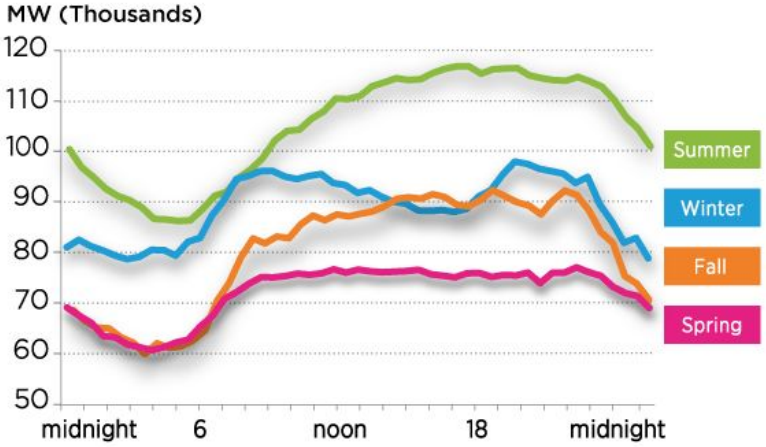


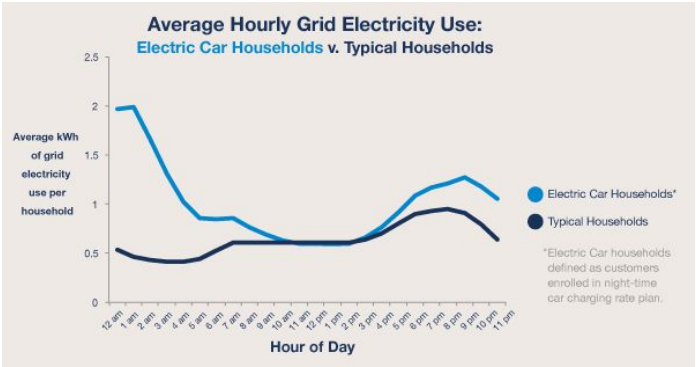


With shared resources, shared walls and generally smaller square footage, households in buildings with five or more units consume only 38 percent of the energy of households in single-family homes (Brown et al., 2005).

Energy supply and demand







Calculating emissions

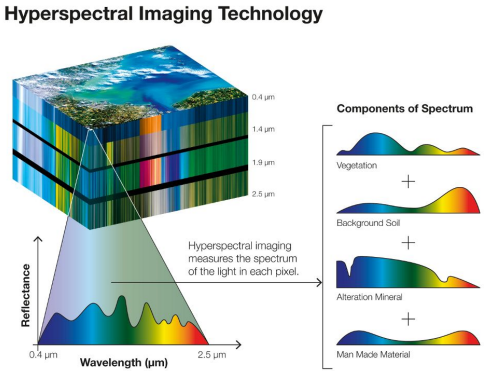
Most emissions are calculated “bottom-up”

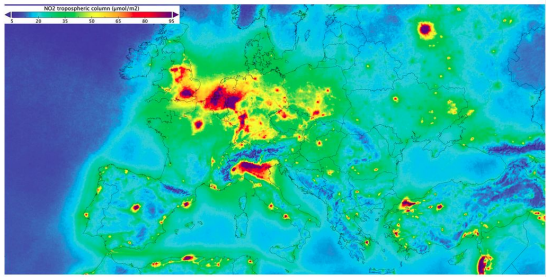
Amount of certain activity done or material produced

multiplied by

Average amount of emissions expected from that activity/production

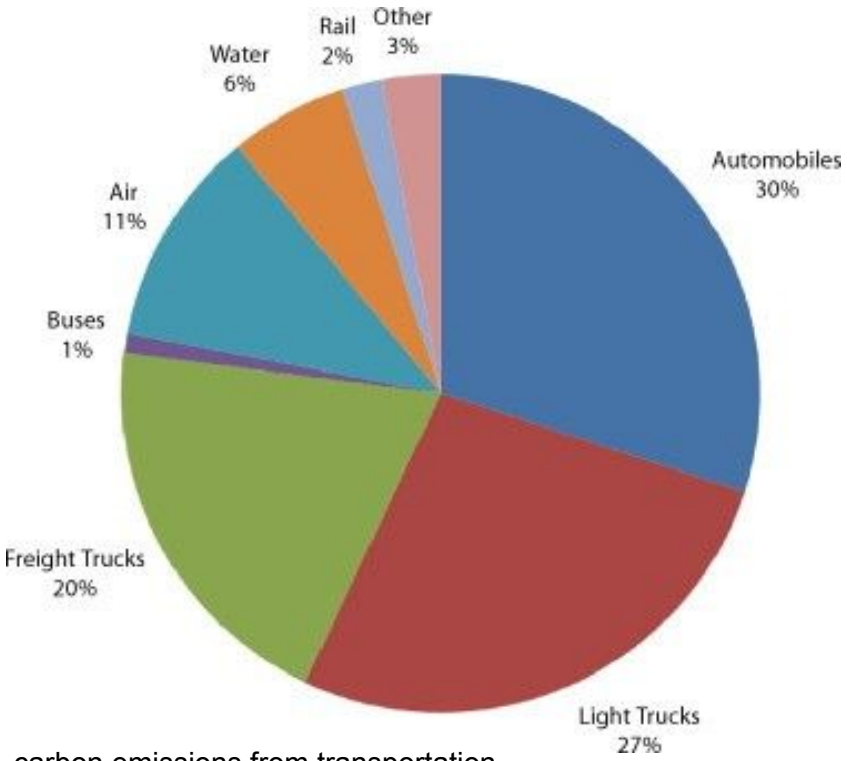
Remote sensing can be used for “top-down” estimates





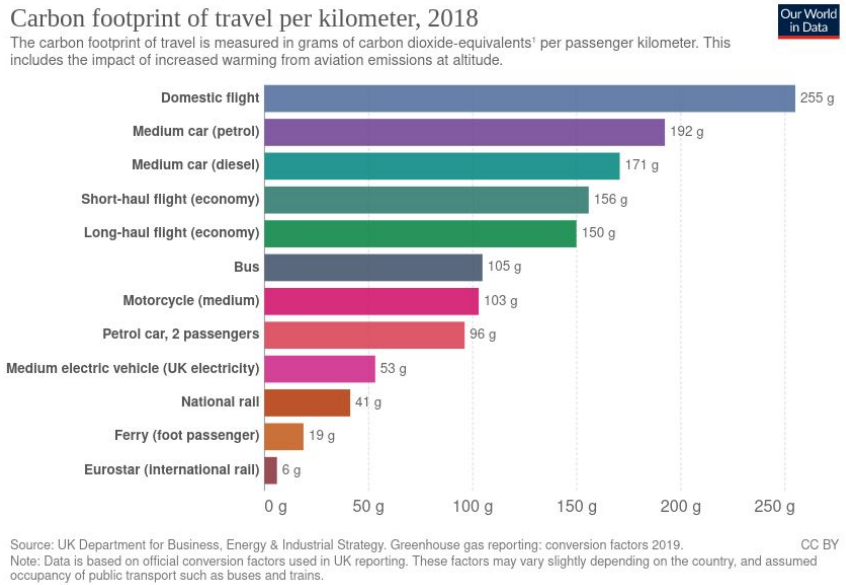
According to the Air Quality in Europe report published in 2018 by the European Environment Agency (EEA), 19 EU Member States recorded nitrogen dioxide concentration above the annual permissible limit. Imagery from Sentinel-5P

Transport emissions



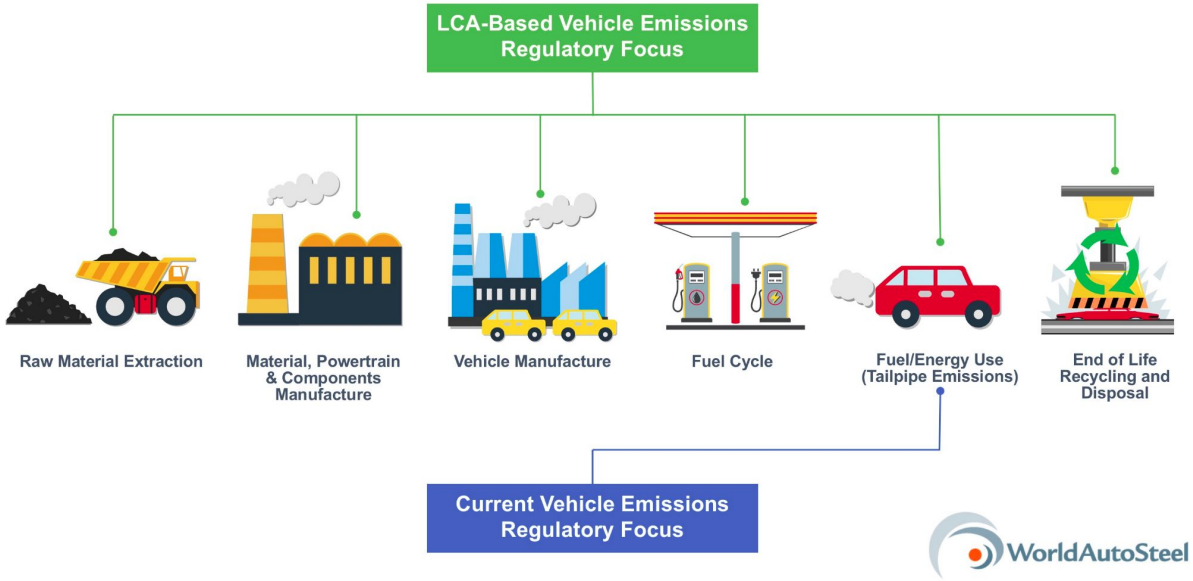
U.S. carbon emissions from transportation, 2005 (*Source*: EIA, 2007b).

The largest sector contributing to transportation emissions is personal car use. Aviation is the worst per distance emitter.



Life Cycle Analysis (LCA)

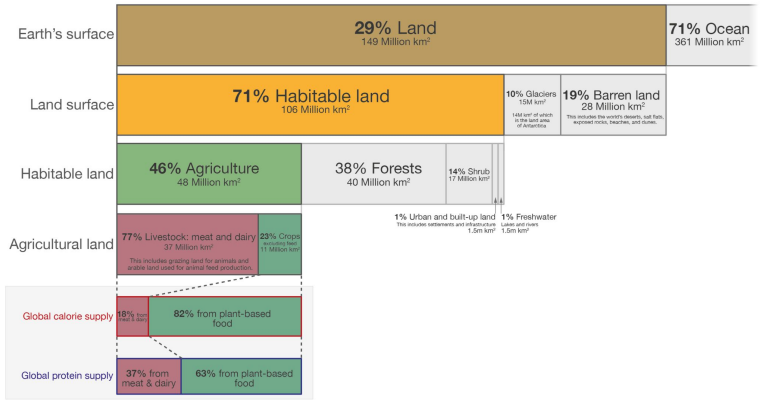
Life Cycle Analysis refers to the process calculating emissions for a product based on the full supply, production, and disposal chain.



Agriculture has a large impact on the planet

Global land use for food production

Our World in Data

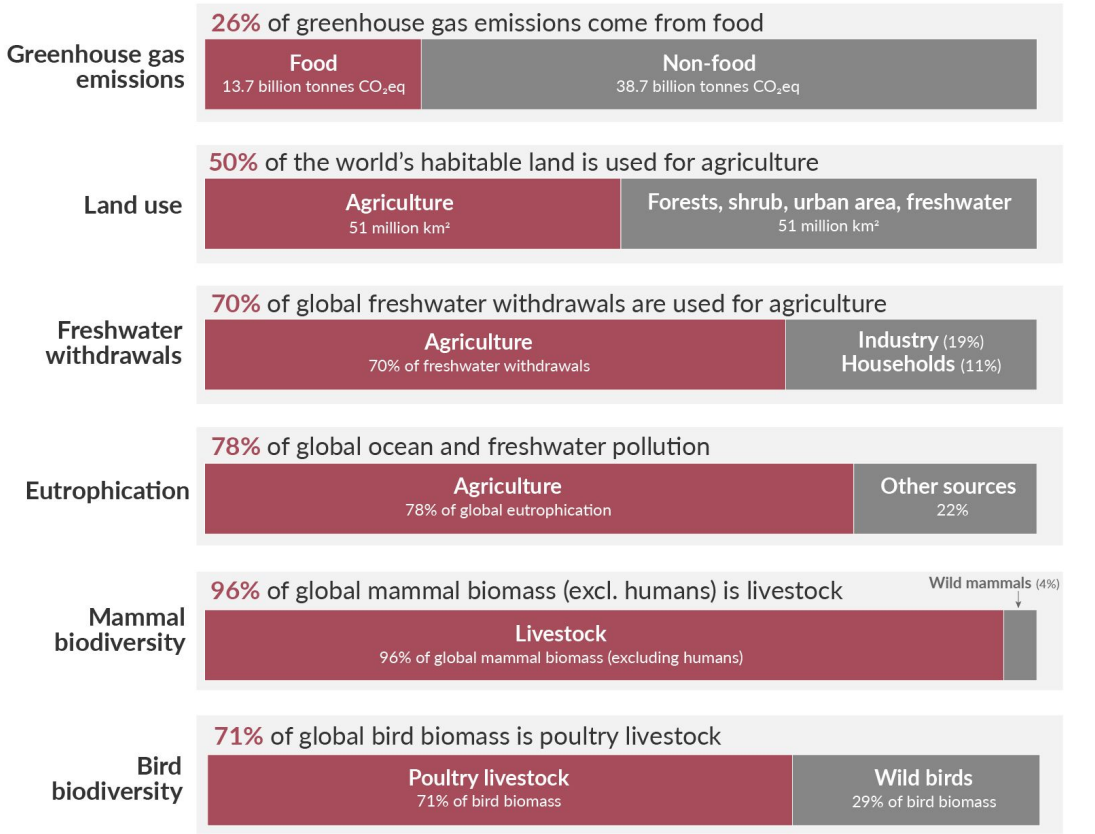


Data source: UN Food and Agriculture Organization (FAO)
OurWorldinData.org – Research and data to make progress against the world's largest problems.

Licensed under CC-BY by the authors Hannah Ritchie and Max Roser.
Date published: November 2019.

The environmental impacts of food and agriculture

Our World in Data



Data sources: Poore & Nemecek (2018); UN FAO; UN AQUASTAT; Bar-On et al. (2018).
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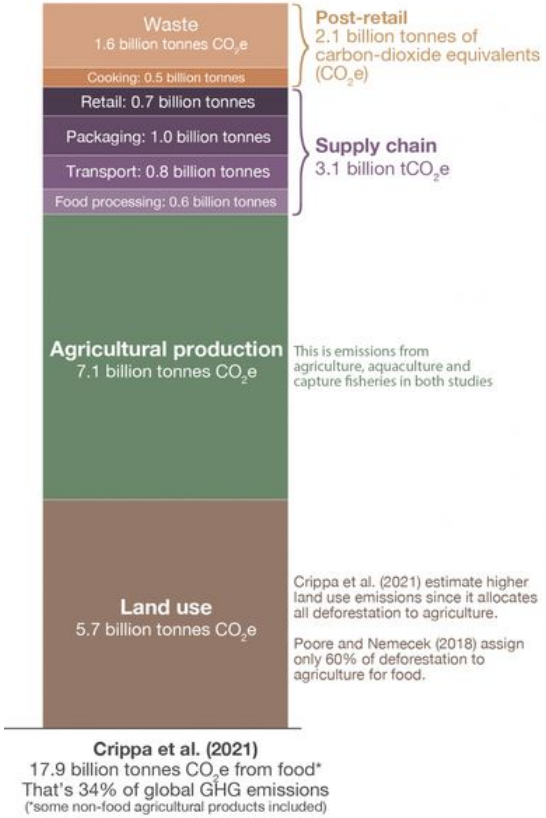
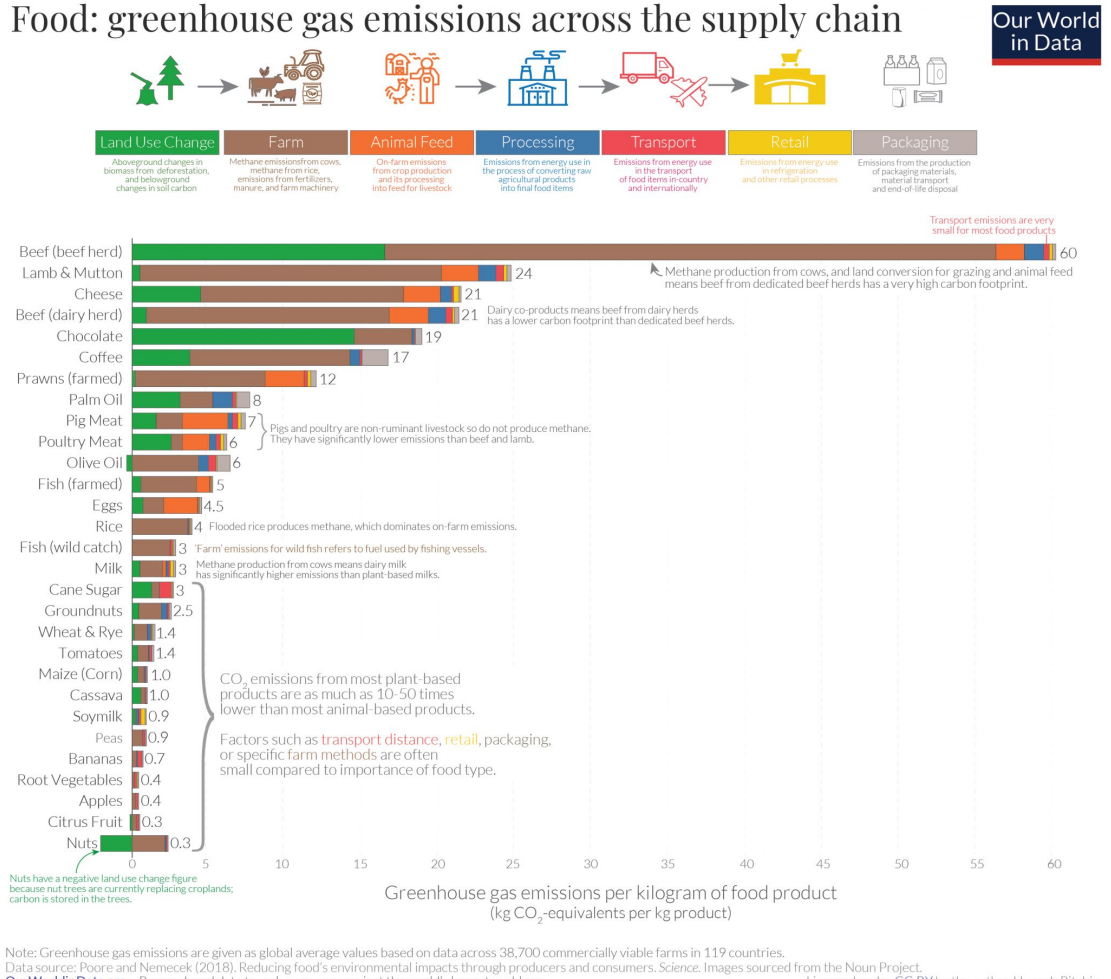
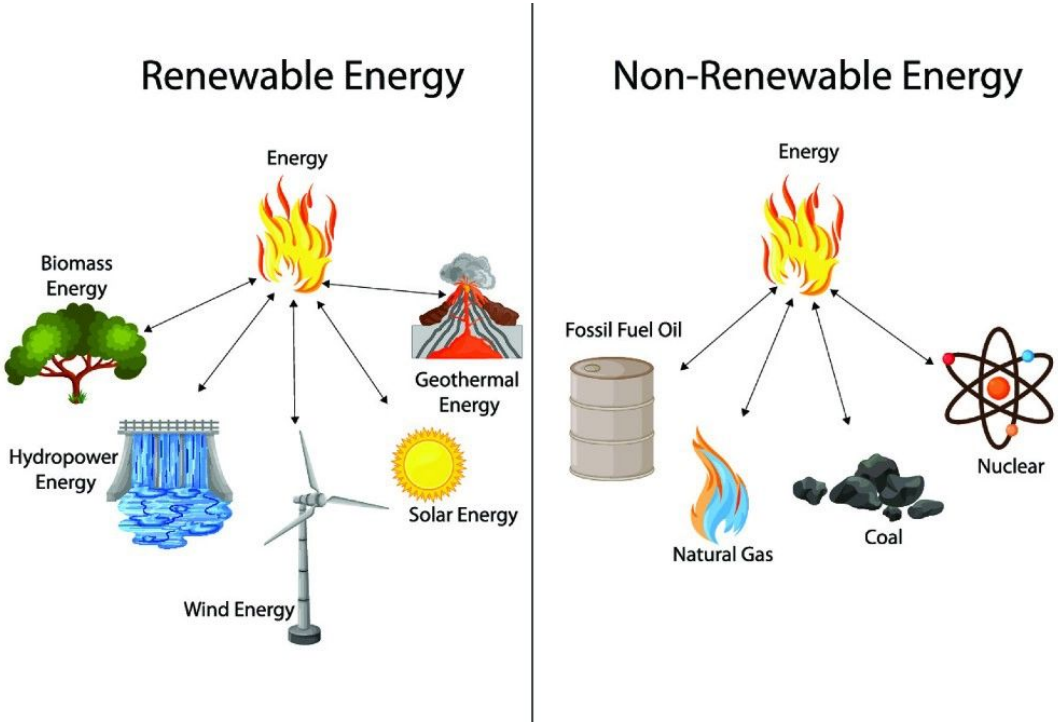
Food emissions

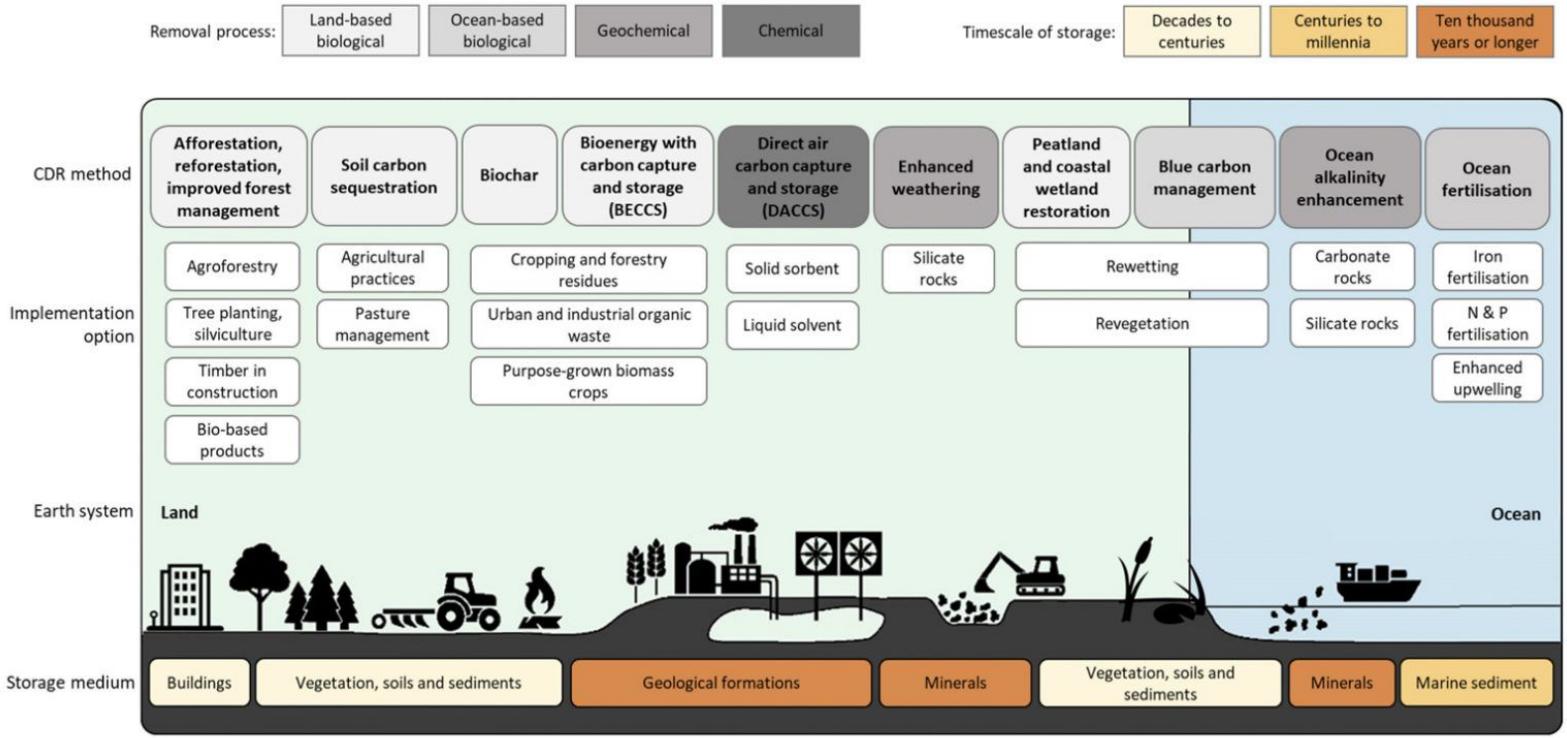




Energy sources



How can GHGs be removed from the atmosphere?



IPCC

When evaluating removal methods, need to consider process (including energy) and permanence.

Machine learning concepts

Regression, classification, optimization

Cross-validation / training vs test data

Evaluation methods: precision, recall, r^2, root mean squared error, percentage-based error

Basics of: regression methods, artificial neural networks, genetic algorithms

Themes from papers

The midterm will include questions about specific deep dive papers, centered on some re-occuring themes. You should review the paper deep dives in light of these themes.

Themes from papers

Restricting data features to those that are commonly available

Towards Indirect Top-Down Road Transport Emissions Estimation

Ryan Mukherjee Derek Rollend Gordon Christie Armin Hadzic
Sally Matson Anshu Saksena Marisa Hughes
Johns Hopkins University Applied Physics Laboratory
{firstname}.{lastname}@jhuapl.edu

Applied Energy
Volume 208, 15 December 2017, Pages 889-904

Machine learning approaches for estimating commercial building energy consumption

Caleb Robinson [a], Bistra Dilkina [a], Jeffrey Hubbs [c], Wenwen Zhang [b], Subhrajit Guhathakurta [b], Marilyn A. Brown [c], Ram M. Pendyala [d]

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https://doi.org/10.1016/j.apenergy.2017.09.060

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Themes from papers

Surrogate models/data to replace physical simulations

Machine Learning for AC Optimal Power Flow

Neel Guha [1] Zhecheng Wang [2] Matt Wytock [3] Arun Majumdar [2]

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

Improvement in fresh fruit and vegetable logistics quality: berry logistics field studies

M. Cecilia do Nascimento Nunes, Mike Nicometo, Jean Pierre Emond, Ricardo Badia Melis and Ismail Uysal

Phil. Trans. R. Soc. A 2014 **372**, 20130307, published 5 May 2014

Chemical Engineering Journal
Volume 461, 1 April 2023, 141804

Surrogate modelling-assisted comparison of reactor schemes for carbon dioxide removal by enhanced weathering of minerals using seawater

Jinyuan Zhang [a], Aidong Yang [a], Richard Darton [a], Lei Xing [b], Adam Vaughan [a]

Show more

Detecting Methane Plumes using PRISMA: Deep Learning Model and Data Augmentation

Themes from papers

Real-time computing constraints

Machine Learning for AC Optimal Power Flow

Neel Guha [1] Zhecheng Wang [2] Matt Wytock [3] Arun Majumdar [2]

ELSEVIER

Applied Energy

Volume 200, 15 August 2017, Pages 155-169

Image-based deep neural network prediction of the heat output of a step-grate biomass boiler

Pál Tóth [a b], Attila Garami [a], Bernadett Csordás [a]

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Themes from papers

Determining feature importance

ELSEVIER

Applied Energy

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Machine learning approaches for estimating commercial building energy consumption

Caleb Robinson [a], Bistra Dilkina [a], Jeffrey Hubbs [c], Wenwen Zhang [b], Subhrajit Guhathakurta [b], Marilyn A. Brown [c], Ram M. Pendyala [d]

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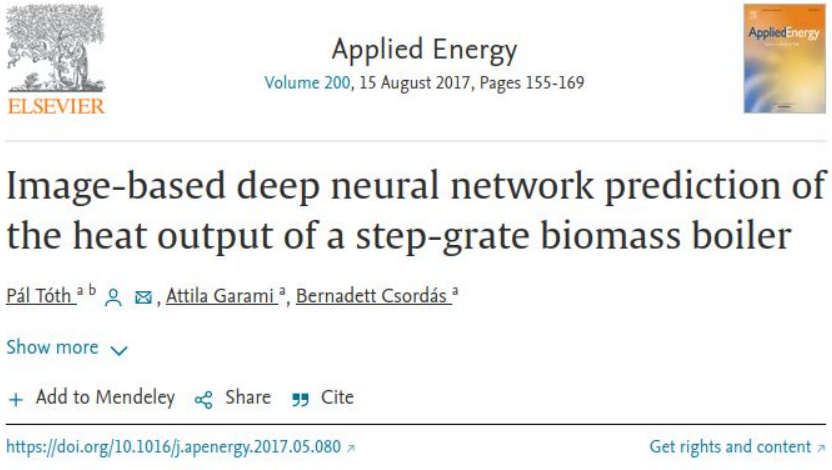
Open Access Article

Predicting and Mapping of Soil Organic Carbon Using Machine Learning Algorithms in Northern Iran

by Mostafa Emadi [1], Ruhollah Taghizadeh-Mehrjardi [2,3], Ali Cherati [4], Majid Danesh [1], Amir Mosavi [5,6,7,*] and Thomas Scholten [2,8,9]



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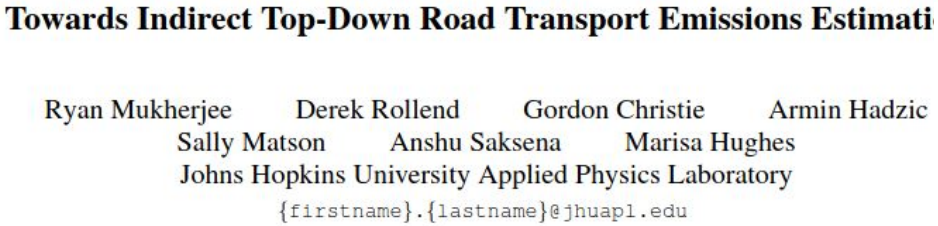
Themes from papers

Resolution mismatch issues



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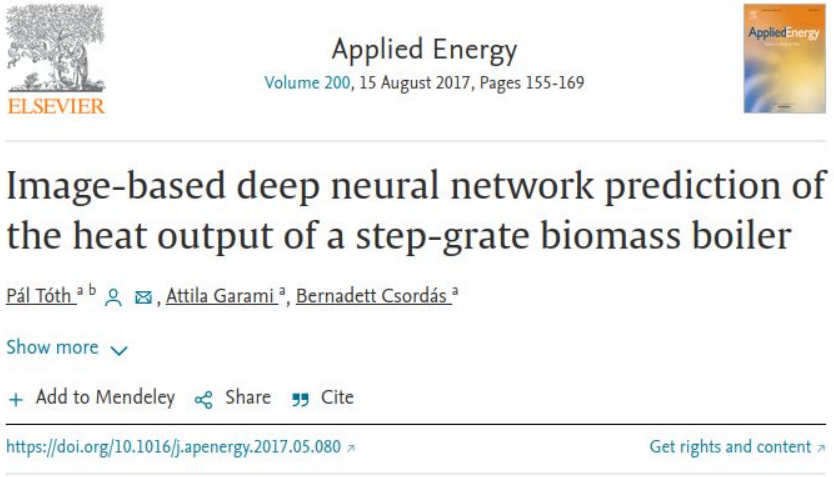

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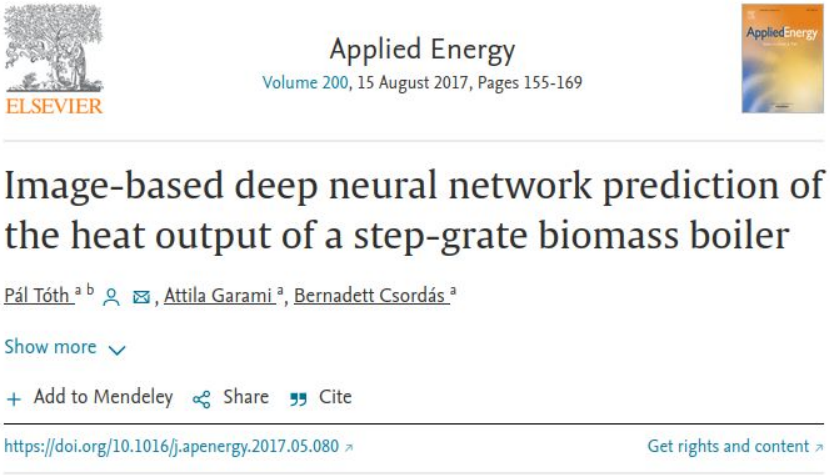
Themes from papers

Model generalizability/transfer



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Questions?