Forest Bioenergy and Climate Goals

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The Climate Has Already Changed From Adding Heat Trapping Gases to the Atmosphere
Climate Goals

- 1992 – UN Framework Convention on Climate Change
  - “The goal of this convention ... is to achieve ... a concentration of greenhouse gases in the atmosphere that will avoid dangerous anthropogenic interference in the climate system.”

- Paris Climate Agreement 2015
  - “This Agreement ... aims to strengthen the global response to the threat of climate change ... by holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels.” - Article 2
  - “Parties should take action to conserve and enhance, as appropriate, sinks and reservoirs of greenhouse gases ... including forests.” Article 5

- 2018 Intergovernmental Panel on Climate Change 1.5°C Report
Test for Whether Forest Bioenergy is Helping or Hurting Climate Change

- The important metric is the amount of CO₂ and other greenhouse gases in the atmosphere.
- How rapidly we achieve a safe concentration of greenhouse gases in the atmosphere is important.
- If we do not act sufficiently rapidly, amplifying feedback loops will make it impossible to “avoid dangerous interference with the climate system!”
IPCC Special Report Global Warming of 1.5°C (2.7°F) October 8, 2018

To keep temperatures from rising excessively
“… global net anthropogenic carbon dioxide emissions (must) decline by about 45% from 2005 levels by 2030 … reaching net zero around 2050 …”

Must simultaneously reduce CO₂ emissions and increase its removal from the atmosphere
What is Zero Carbon, Net Zero Carbon, Negative Carbon and Carbon Neutrality

- **Zero Carbon** means that no CO\(_2\) is emitted from producing energy or a product.

- **Net Zero Carbon** means the difference between CO\(_2\) emitted and removed is zero.
  - Sustainable forest management is Net Zero Carbon if accomplished each year.

- **Carbon Neutral** is sometimes interchangeable with Zero Net Carbon, but increasingly means there is an offset somewhere else.

- **Carbon Negative** is removing more Carbon than is being emitted.
5 scenarios
IPCC AR6 2021

Carbon dioxide (GtCO₂/yr)

SSP5-8.5
SSP3-7.0
SSP2-4.5
SSP1-2.6
SSP1-1.9

Absolute Negative Emissions
Anthropogenic perturbation of the global carbon cycle

Perturbation of the global carbon cycle caused by anthropogenic activities, global annual average for the decade 2011–2020 (GtCO$_2$/yr)

The budget imbalance is the difference between the estimated emissions and sinks.

Source: NOAA-ESRL; Friedlingstein et al 2021; Canadell et al 2021 (IPCC AR6 WG1 Chapter 5); Global Carbon Project 2021
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Terrestrial Biosphere and oceans remove ~60% of annual emissions

Source: NOAA-ESRL; Friedlingstein et al 2021; Canadell et al 2021 (IPCC AR6 WG1 Chapter 5); Global Carbon Project 2021
Reducing fossil fuel emissions with greater energy efficiency and zero carbon alternatives
84% less energy for heat and hot water than code
Grid connected - Net electricity exported
Annual net zero energy met by solar panels
Import from zero carbon sources

Electric Vehicle and
More solar panels added later
charging 7000 miles/year

Total negative CO₂ emissions

2022 = year 15
Global Scale Forest Bioenergy
UK replacing coal with wood pellets

2,600 MW biomass-fueled power plant uses 7+ million tons of wood pellets annually and 1,300 MW 2.5 tons coal

All wood is imported
Subsidized at $1.1 billion per year
Claims by Drax the world’s largest single user of forest bioenergy

- “Our industry is a critical part of maintaining healthy forests.”
- “The world’s leading authority on climate science is the United Nations Intergovernmental Panel on Climate Change, or IPCC. The IPCC explicitly recognizes bioenergy as a renewable energy source that is critical to our low-carbon future.” – Drax
Here is what IPCC states about GHG emission estimates AR5 2013 WG 3 section 11.13.4

- “The neutrality perception is linked to a misunderstanding of the guidelines for GHG inventories,”
- “IPCC — Land Use, Land-Use Change and Forestry (2000) states “Biomass fuels are included in the national energy and carbon dioxide emissions accounts for informational purposes only.”
- “Within the energy module biomass consumption is assumed to equal its regrowth. Any departures from this hypothesis are counted within the Land Use Change and Forestry Model.”
- Interpretation:
  - Fossil fuel emissions are counted in Energy Sector
  - Bioenergy emissions are counted as forest loss in Land Use Sector and noted, but not counted in Energy Sector
Drax removed from green company market index

“Drax has been booted from an investment index of clean energy companies as doubts over the sustainability of its wood-burning power plant begin to mount within the financial sector.”

“We argue that bioenergy production is not carbon neutral, in almost all instances. This casts doubt on whether bioenergy with carbon capture and storage (BECCS) is a net-negative emissions technology. The widespread deployment of BECCS looks challenging,” – Jefferies Financial LLC

The Guardian 10/19/21
CLAIM 1 - To address climate change, it is necessary to replace fossil fuels with renewable energy

COUNTER CLAIM - The goal is to eliminate emissions of carbon dioxide and other heat trapping gases

- Wood is more carbon intensive than coal, oil or gas and electricity conversion is less efficient

- **Natural gas**: 117.8 lb CO₂/mmbtu
- **Bituminous coal**: 205.3 lb CO₂/mmbtu
- **Wood**: 213 lb CO₂/mmbtu (bone dry)

- Utility-scale biomass boiler: 24%
- Average efficiency US coal fleet: 33%
- Average gas plant: 43%

EPA applications – M. Booth
CLAIM 2 - Wood bioenergy is renewable energy

Counterclaim - Burning wood is instantaneous: Growing it back is a slowly renewable process
European Union Commitment is to renewables rather than CO₂ reduction

- “Well, that’s the prime objective, to go to full renewables. But simply looking at how fast we need to do that, we just can’t reach the levels of renewables we would need to have to stop burning fossil fuels and meet E.U. energy needs to completely exclude biomass.”

  - Frans Timmermans Vice President European Commission, COP 26
Assumptions for Claim that burning wood is net zero and renewable

Assumption

- We must eliminate coal and other fossil fuels
- Trees are renewable and Grow Back
- So let’s burn wood to replace coal!

CLAIM 3- Wood bioenergy is carbon neutral. Carbon that is emitted now and reabsorbed later has no impact on the climate

COUNTER CLAIM - Emissions from burning wood are comparable to burning coal. Burning it now and removing the CO$_2$ later causes changes that are not reversed when trees grow back.

Added CO$_2$ from burning wood traps additional heat throughout regrowth period melting glaciers and sea ice, raising sea level, releasing additional methane from permafrost.

These are not restored to their previous condition when trees grow back.

EVENTUAL CARBON NEUTRALITY IS NOT CLIMATE NEUTRALITY!
US law defines sustainably managed forest bioenergy as carbon neutral.

“... the carbon neutrality of biomass harvested from sustainably managed forests has been recognized repeatedly by numerous studies, agencies, institutions, and rules around the world ... .” Senator Collins on the amendment to Energy Policy Modernization Act, S. 2102 in 2016.

Harmon and Franklin 1990 * Extra atmospheric carbon
CLAIM 4 - Young trees grow faster than older trees. We should harvest older trees for bioenergy, and replace them with faster growing younger trees

COUNTER CLAIM -

- The goal is to accumulate the most carbon out of the atmosphere by any given date in the future.
- Young trees hold very little carbon
- They can never accumulate more carbon than older trees until after those older trees die
- We do not have time to wait for regrowth
CARBON ROCK STARS: LARGE, OLDER TREES AND FORESTS

How many oak trees does it take to store 8 tons of carbon?

Robert Leverett 2021

1 Mature Canopy Tree
100’ tall x 54” dia

35 Young Canopy Trees
50’ tall x 12” dia

151 Typical Street Trees
40’ tall x 6” dia

465 New Large Landscape Trees
25’ tall x 4” dia
CLAIM 5 - Wood bioenergy is carbon neutral if only waste wood is burned and this waste would simply rot and release carbon dioxide anyway

COUNTER CLAIM - Waste wood emits just as much CO₂ per pound as does burning whole trees

- Whole trees are a significant portion of forest biofuel
- Logging waste (tops & branches) decays slowly releasing some CO₂, and some wood becomes soil carbon
Wood harvest for bioenergy SE USA

Harvest emissions are counted here in US land sector and not in Europe where the pellets are burned.
CLAIM 6 - As long as there is more carbon removed by forests than is emitted from them, burning wood is immediately carbon neutral

COUNTER CLAIM -

- Forests in aggregate, remove about 25% of human CO₂ emissions from all sources including bioenergy.
- Growing forests do not absorb 100% of the emissions only from wood burning
Keeping trees in the ground where they are already growing is an effective low-tech way to slow climate change.
Increasing carbon accumulation by forests to meet climate goals

- “...the largest one percent of trees in mature and older forests comprised 50 percent of forest biomass worldwide”  Lutz et al 2018
- Altering forest management to let more trees grow would allow global forests to accumulate twice as much carbon  Erb et al 2018
- The potential for growing forests to accumulate carbon by natural regrowth is better than active management and has been underestimated by 32%  Cook-Patton et al 2020
Proforestation Management

growing forests to reach their ecological potential for biodiversity and carbon accumulation in trees and soils

Larger trees in older and growing forests accumulate the most atmospheric carbon over time, and store it in the wood of their trunk and limbs and in soils.
Atmospheric carbon removal

Technology Direct Air Capture 2000 t CO$_2$/y

Nature’s Solution 11x10$^9$ tCO$_2$/y

Profrontation
- An approach to forest management based on understanding and working with natural ecological and evolutionary processes
- Degraded forests are restored, and secondary forests enabled to recover
- The management goal is emergence of a primary forest ecosystem
Harvest and Regrowth carbon in a one acre stand of white pine in Northeast United States 150 years. If burned, average addition CO$_2$ to atmosphere is somewhere between 0 and 22 tons.
Accumulated carbon in a one acre stand of white pine in Northeast United States

![Graph showing cumulative carbon in tonnes at different ages (50, 100, 150 years).]
Accumulated carbon stocks in mature and old forests is the most effective forest-related climate mitigation strategy

Where is the carbon from harvested forests?

US forest harvesting (162 MMtC/y) exceeds US emissions from commercial and residential building sectors (149 MMtC/y) Harris 2016 (USFS)

Washington, Oregon, California

TOTAL HARVESTED forest carbon since 1900

- Long lived wood products carbon
- Landfilled wood carbon
- Atmospheric wood carbon

Hudiburga et al 2019
Strategies for closing the carbon gap and preventing catastrophic feedback heating

- Prevent deforestation, the draining of wetlands and soil loss
- **Proforestation** management for some forests is far more effective than “planting a trillion trees”
- **Proforestation** management is among the least costly options for removing and storing additional carbon dioxide out of the atmosphere
- Create Strategic Climate and Biodiversity Reserves (Law et al 2022)
Establish two types of forests:

- Strategic Climate and Biodiversity Reserves
- Industrial production forests
Urgent need for collaboration among forestry scientists and forest ecosystem and climate scientists

- The Climate Emergency is unfolding extremely rapidly because of amplifying feedbacks from natural systems (13,500 scientists – Ripple et al 2019)
  - Forest, soils and wetland respiration
  - Methane from wetlands and permafrost thaw
  - Increased water vapor from warmer oceans
  - Loss of albedo from ice, snow and declining sea ice cover in Arctic

- There is just a 2 in 3 probability that meeting Net Zero carbon by 2050 scenario will limit global temperature to 1.5°C (2.7°F)
To reach Net Zero Carbon by 2050, we need to slow additions by removing more atmospheric CO₂ today than we are adding.

- **We do not have enough time** for newly planted trees to remove sufficient carbon between now and 2030 or 2050.

- Forest off-sets simply **transfer credit**, but do not alter atmospheric concentrations.

- Replacing fossil fuels with zero emitting solar and wind and **letting some forests continue growing** reduces additions to the atmosphere the most rapidly.

- A better economic and climate use for forest residues is to use fibers to make building insulation to reduce atmospheric additions (Maine).
Forest carbon density in N.E. United States

USFS COLE MAP

Note that carbon density is 3x greater in western New England than in Maine.
State of protected Areas in New England

Moomaw et al 2019

Less than 5 percent have any regulatory or Statute protection
Protecting and interconnecting at least half of the planet’s land and water is necessary to sustain the health, function, and diversity of all life.

E.O. Wilson co-founder of biodiversity science
10 June 1929 - 26 December 2021
That means the other half can provide the resources for the economy if sustainably managed

- Halting climate change meets that criterion!
- Does burning forests for bioenergy help meet that goal?
Thank you