Forest Carbon Accounting Considerations for U.S. Bioenergy Policy

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Key Points

- As long as wood-producing land remains in forest, **forest bioenergy reduces** fossil fuel use and **long-term carbon emission impacts.**

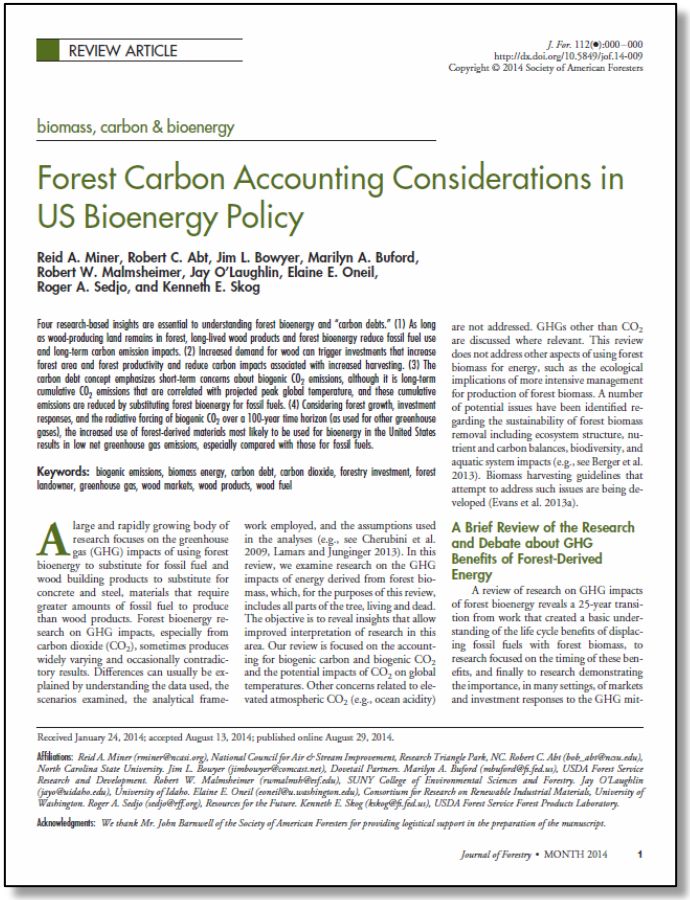
- **Increased demand** for wood **can** trigger investments that **increase forest area and forest productivity, <u>and</u> reduce carbon impacts** associated with increased harvesting.

- According to the IPCC, **long-term cumulative CO_2 emissions** are correlated with projected **peak global temperature**. Forest bioenergy **reduces** long-term cumulative emissions.

- Considering forest growth, investment responses, and the radiative forcing of biogenic CO_2 over a 100-year time horizon, the **increased use of forest biomass** most likely to be used for bioenergy **results in low net GHG emissions** compared to fossil fuels.

Literature Review: Four Key Insights

- The current debate about biomass energy often narrows the discussion to *short-term and direct effects of increased use of forest biomass.*
- This *causes:*
  - *Confusion*, and
  - *Misunderstanding of the impacts* of using sustainably produced forest-based products and fuels.
- Extensive literature review reveals *four key insights* important to correctly understanding the impacts of using forest biomass.



REVIEW ARTICLE

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Four research-based insights are essential to understanding forest bioenergy and "carbon debts." (1) As long as wood-producing land remains in forest, long-lived wood products and forest bioenergy reduce fossil fuel use and long-term carbon emission impacts. (2) Increased demand for wood can trigger investments that increase forest area and forest productivity and reduce carbon impacts associated with increased harvesting. (3) The carbon debt concept emphasizes short-term concerns about biogenic CO_2 emissions, although it is long-term cumulative CO_2 emissions that are correlated with projected peak global temperature, and these cumulative emissions are reduced by substituting forest bioenergy for fossil fuels. (4) Considering forest growth, investment responses, and the radiative forcing of biogenic CO_2 over a 100-year time horizon (as used for other greenhouse gases), the increased use of forest-derived materials most likely to be used for bioenergy in the United States results in low net greenhouse gas emissions, especially compared with those for fossil fuels.

Keywords: biogenic emissions, biomass energy, carbon debt, carbon dioxide, forestry investment, forest landowner, greenhouse gas, wood markets, wood products, wood fuel

A large and rapidly growing body of research focuses on the greenhouse gas (GHG) impacts of using forest bioenergy to substitute for fossil fuel and wood building products to substitute for concrete and steel, materials that require greater amounts of fossil fuel to produce than wood products. Forest bioenergy research on GHG impacts, especially from carbon dioxide (CO_2), sometimes produces widely varying and occasionally contradictory results. Differences can usually be explained by understanding the data used, the scenarios examined, the analytical framework employed, and the assumptions used in the analyses (e.g., see Cherubini et al. 2009, Lamarc and Junginger 2013). In this review, we examine research on the GHG impacts of energy derived from forest biomass, which, for the purposes of this review, includes all parts of the tree, living and dead. The objective is to reveal insights that allow improved interpretation of research in this area. Our review is focused on the accounting for biogenic carbon and biogenic CO_2 and the potential impacts of CO_2 on global temperatures. Other concerns related to elevated atmospheric CO_2 (e.g., ocean acidity) are not addressed. GHGs other than CO_2 are discussed where relevant. This review does not address other aspects of using forest biomass for energy, such as the ecological implications of more intensive management for production of forest biomass. A number of potential issues have been identified regarding the sustainability of forest biomass removal including ecosystem structure, nutrient and carbon balances, biodiversity, and aquatic system impacts (e.g., see Berger et al. 2013). Biomass harvesting guidelines that attempt to address such issues are being developed (Evans et al. 2013a).

A Brief Review of the Research and Debate about GHG Benefits of Forest-Derived Energy

A review of research on GHG impacts of forest bioenergy reveals a 25-year transition from work that created a basic understanding of the life cycle benefits of displacing fossil fuels with forest biomass, to research focused on the timing of these benefits, and finally to research demonstrating the importance, in many settings, of markets and investment responses to the GHG mit-

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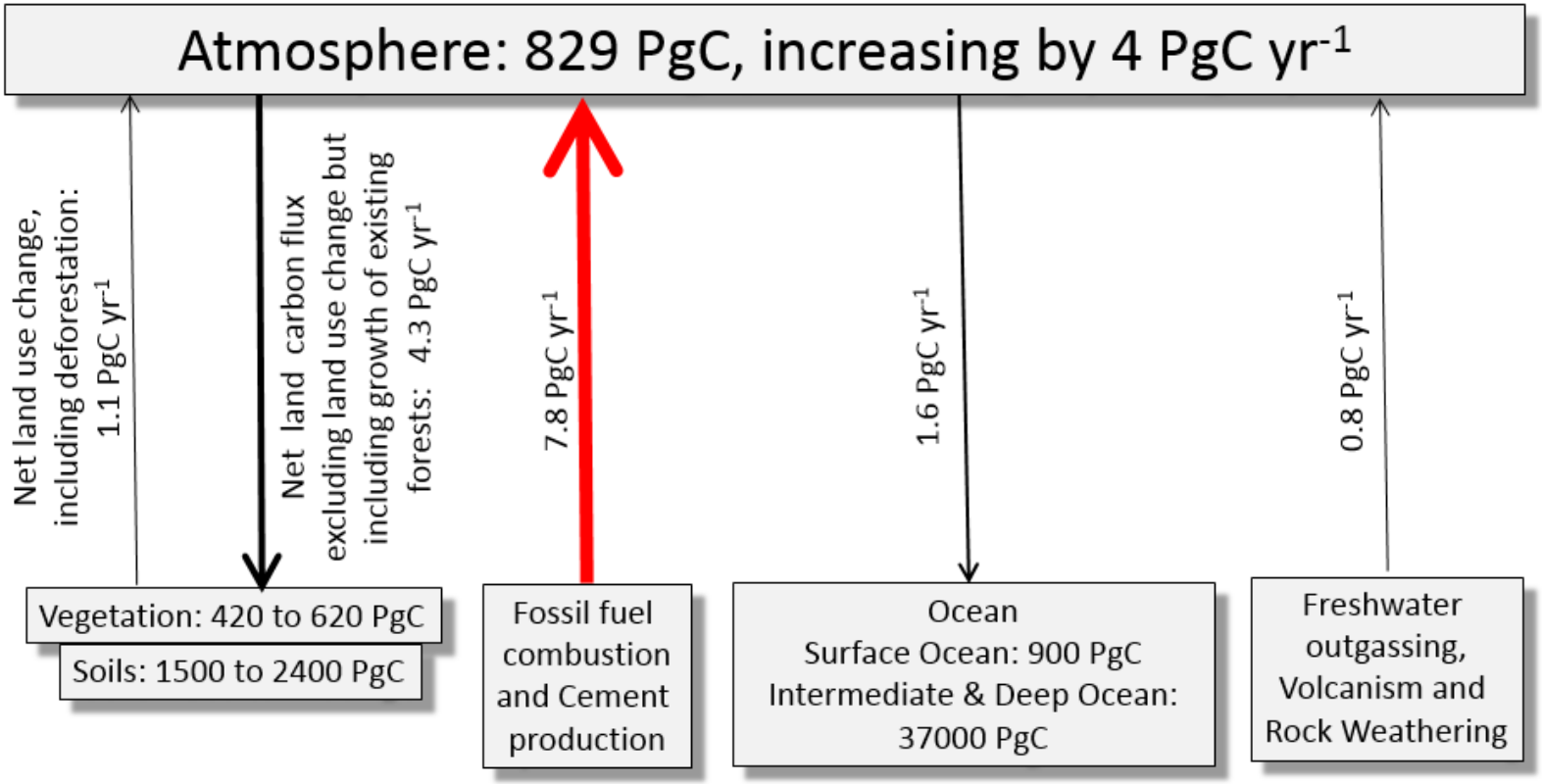
Miner et al. 2014. *Journal of Forestry* 112(6):590-605.

The Basics: The Carbon Cycle

"Emissions of CO_2 from fossil fuel combustion, with contributions from cement manufacture, are responsible for more than 75% of the increase in atmospheric CO_2 concentration since pre-industrial times." (IPCC Fourth Assessment Report)



Source: IPCC Fifth Assessment Report, WGI report – Figure 6.1.
Line widths proportional to amount of flow

Fossil Fuel-Related CO_2 Emissions are Increasing While Land Use Change Emissions (Primarily Deforestation in the Tropics) Are Slowing.

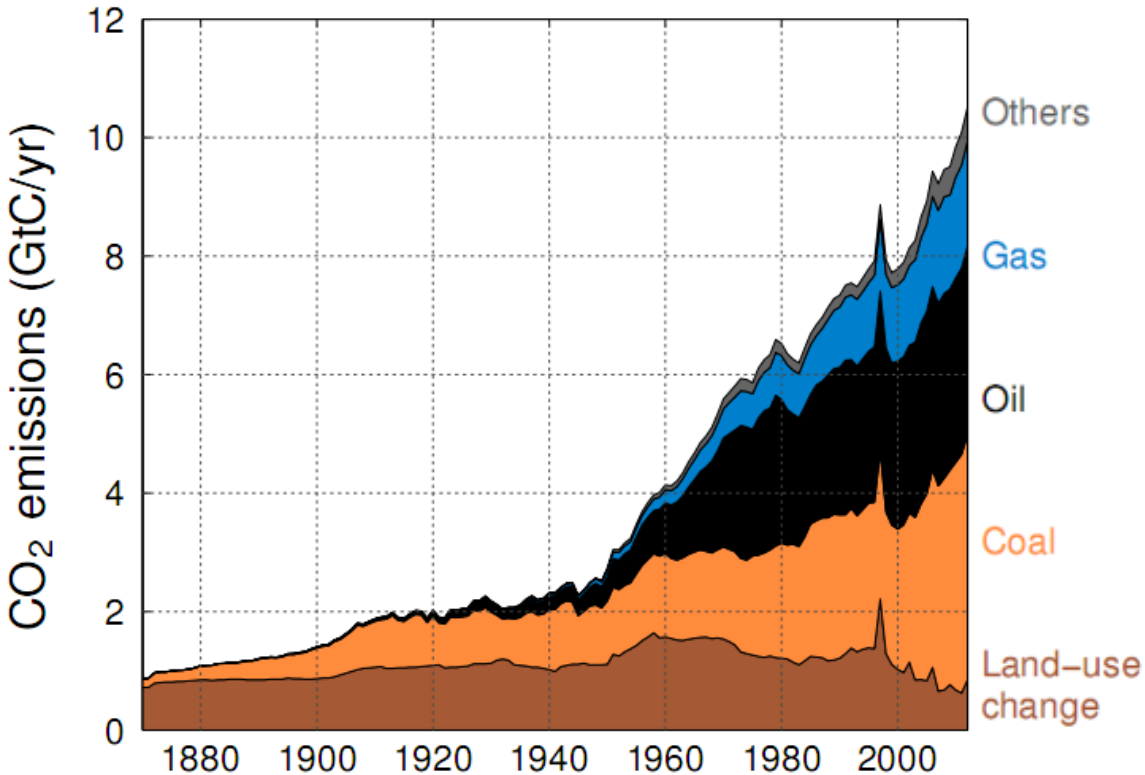


Figure from Carbon budget and trends 2013.
[www.globalcarbonproject.org/carbonbudget] released on 19 November 2013

Insight 1: Ultimate Benefits

As long as wood-producing land remains in forest, long-lived wood products and **forest bioenergy reduce** fossil fuel use and **long-term carbon emission impacts.**

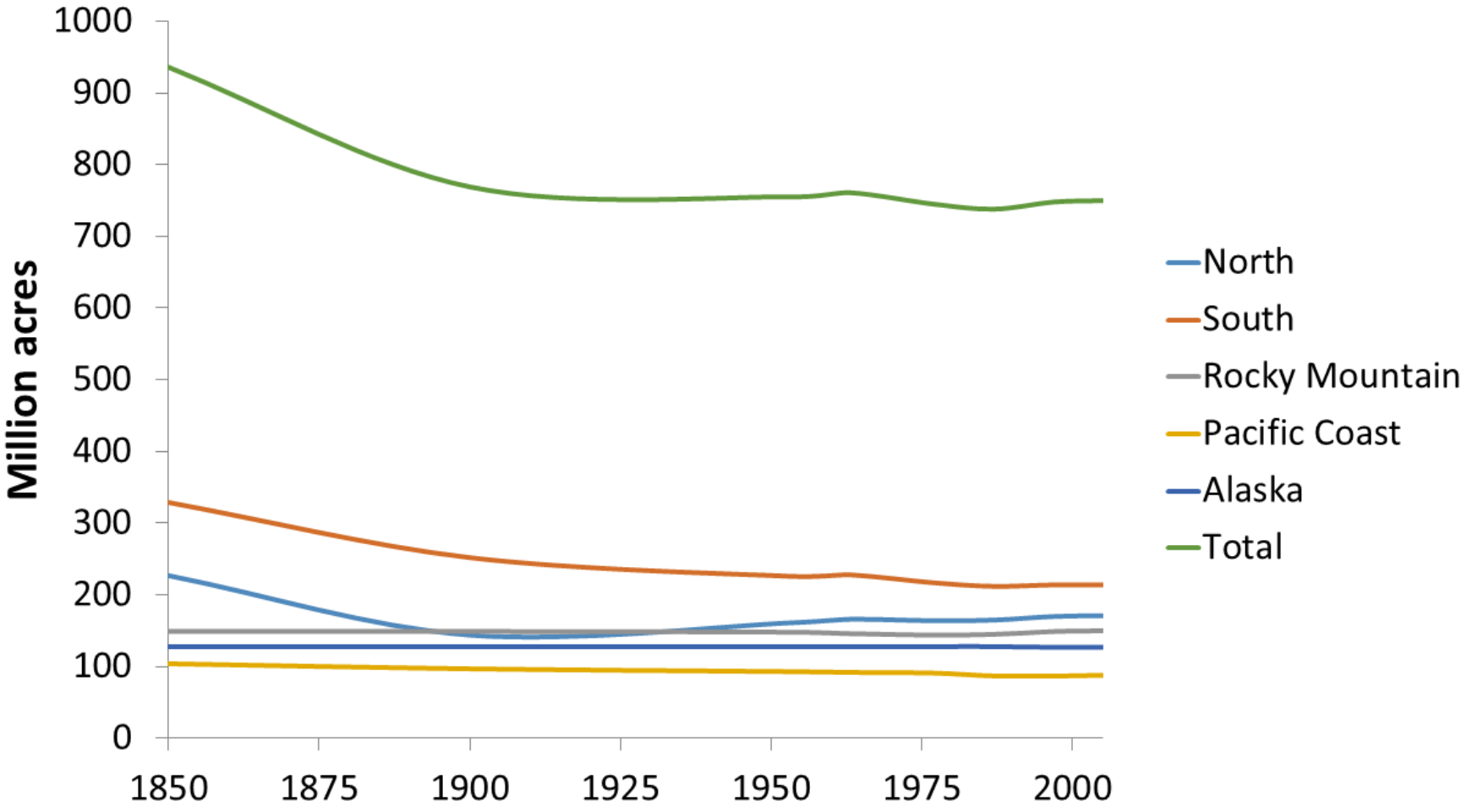
- Near term emissions are sometimes higher but long-term cumulative emissions are almost always reduced
- This “carbon debt” concept has been known for 25 years.
- The current debate regards the timing of benefits.

Insight 2: The Carbon Impacts of Market Responses to Increased Demand

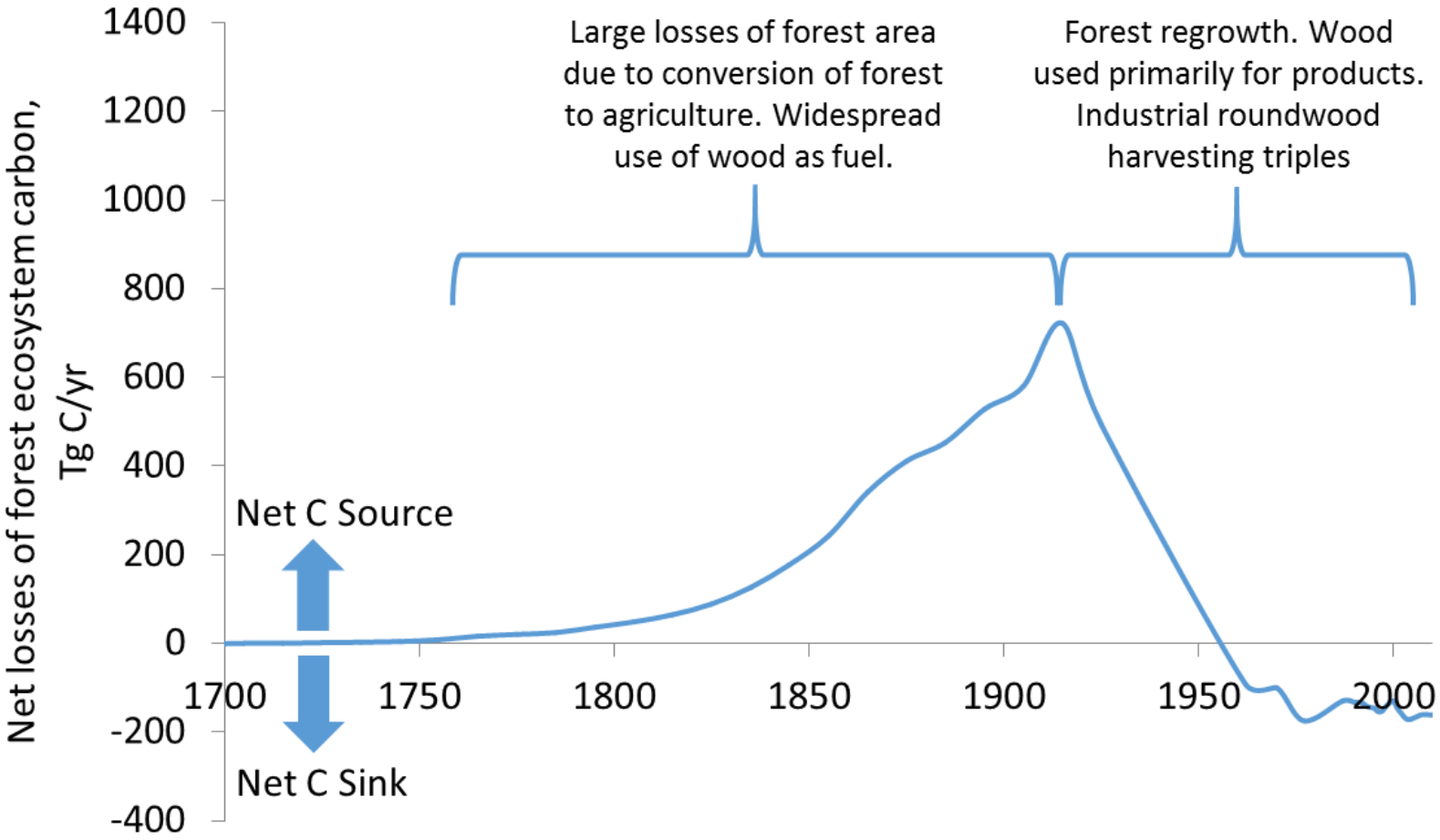
Increased demand for wood **can** trigger investments that **increase forest area and forest productivity <u>and</u> reduce carbon impacts** associated with increased harvesting.

- The evidence for this includes (1) general observations over time, (2) empirical studies and (3) modeling.

U.S. Forest Area is Stable



Carbon stocks Recovered While Industrial Harvesting Increased Dramatically



Insight 3: Cumulative CO_2 Emissions

The carbon debt concept emphasizes near-term concerns about biogenic CO_2 emissions, although it is **long-term cumulative CO_2 emissions** that, according to IPCC, are **correlated with projected peak global temperature**.

Forest bioenergy **reduces** long-term cumulative emissions.

The Implications for Forest-based Systems

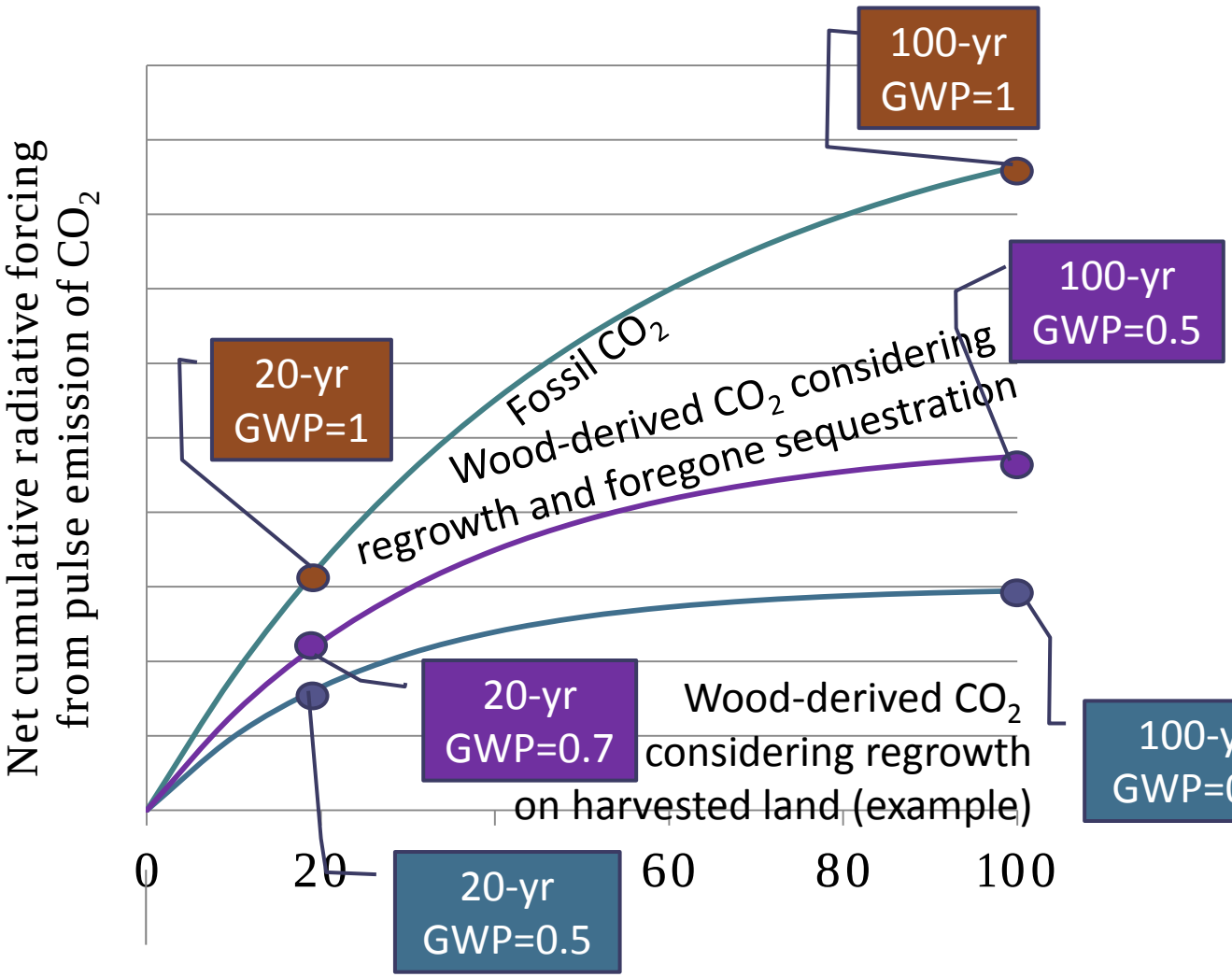
The emphasis on near term action is primarily driven by concerns about "lock-in" of technologies that increase long-term cumulative CO2 emissions.

- The mitigation benefits of forest-based mitigation activities are sometimes *delayed*, but any near term increases in emissions are *reversible and temporary* <u>and</u> are incurred in the interest of *limiting cumulative CO2 emissions*.
- Short-term increases in CO2 attributable to forest-based systems should be viewed differently than increases from systems that lock-in further increases in cumulative emissions in the long term.

Insight 4: Characterizing Net GHG Emissions from Increased Use of Forest Biomass

Considering (1) forest growth, (2) investment responses, and (3) the radiative forcing of biogenic CO_2 over a 100-year time horizon (as used for other greenhouse gases), the **increased use of forest-derived materials** most likely to be used for bioenergy in the U.S. **results in low net GHG emissions**, especially compared to fossil fuels.

Proper Characterization of the Impacts of Biogenic CO_2 from the Use of Forest Biomass



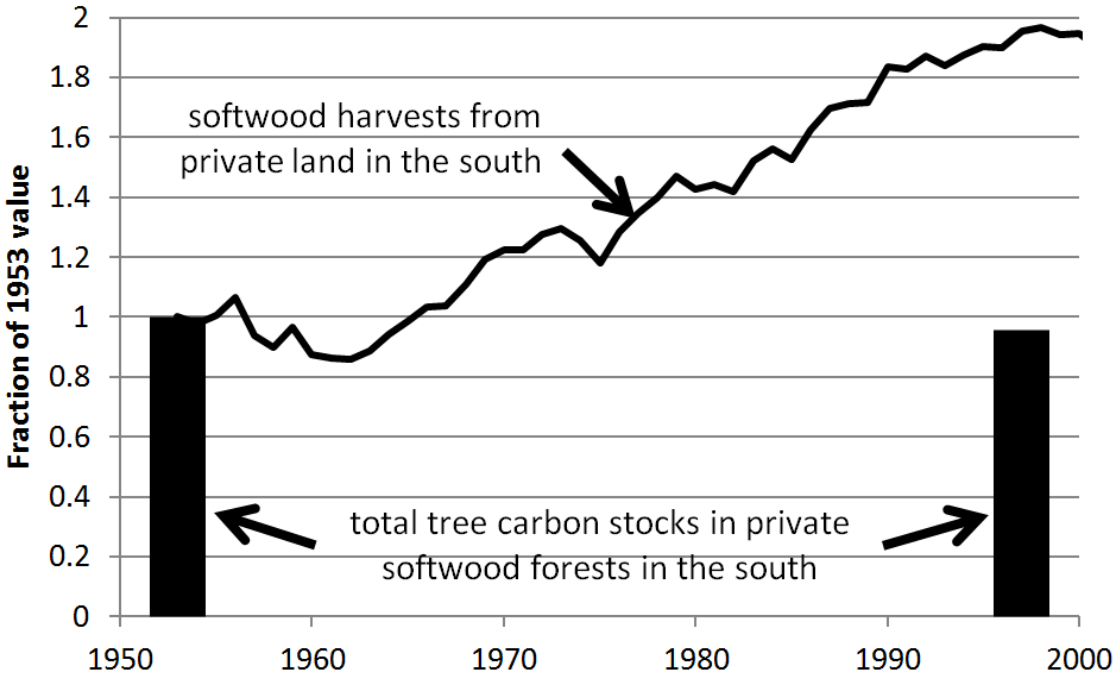
Example: Methane
20-year GWP = 72
100-year GWP = 28

Using a time horizon of less than 100 years for judging net radiative forcing impacts from biogenic CO_2 associated with use of forest biomass is **fundamentally inconsistent** with 100-year Global Warming Potentials (GWPs).

Market Induced Investments

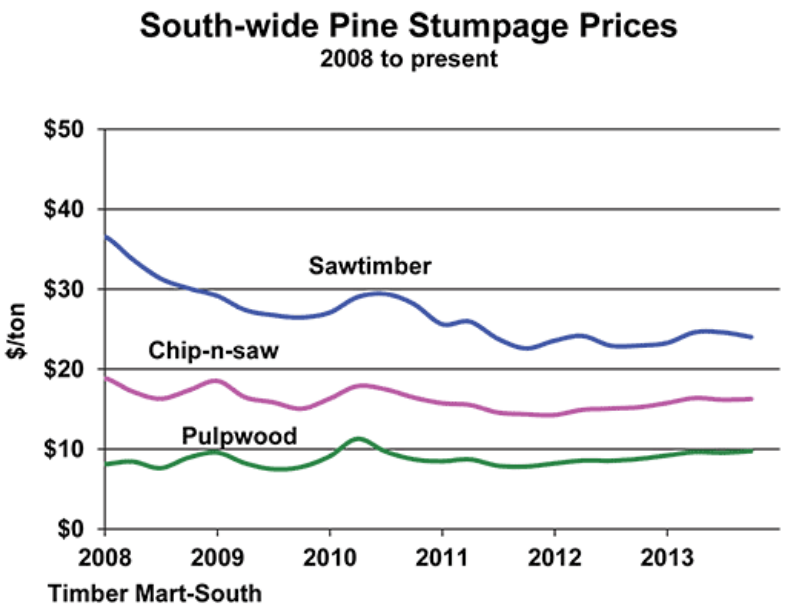
In calculating the impacts from increased use of forest biomass for energy, one must consider indirect market-related impacts, especially timely investments in forestry, that tend to offset potential delays in seeing net benefits.

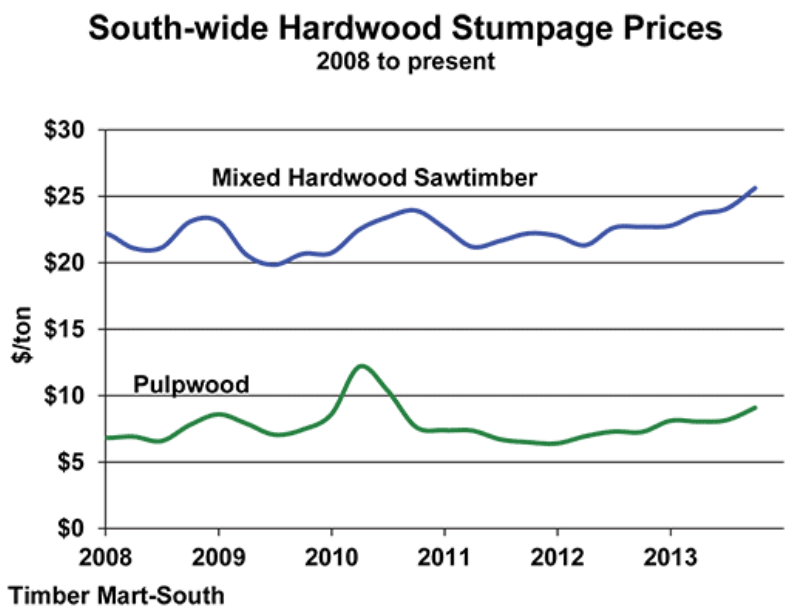
Example: Softwood harvests from private land in the Southern U.S.



Forest Biomass Likely to Be Used for Bioenergy

The types of forest biomass likely to show the longest times to obtain net benefits (e.g. large trees) are unlikely to be used for energy where they can be sold into a higher value market (e.g. sawtimber).





Large logs suitable for use as sawtimber sell for several times the price of small logs. As a result, where a market for sawtimber exists, it is *unlikely* that large logs will be used for energy (Figures from TimberMart-South).

Conclusion: Some Generalizations on Increased Use of Forest Biomass

- **Manufacturing residuals** (e.g. bark, sawdust)
  - Will normally show net benefits in *very short periods*, often immediately.
- **Harvest residuals**
  - Will show benefits *immediately* if the alternative is pile burning.
  - If the alternative is decay in the forest, benefits are normally observed in *less than a decade or two*, although longer times can be associated with conditions where decay rates are slow.
- **Roundwood**
  - Considering the growth rates and investment responses associated with the types of roundwood most likely to be used for energy in the US, benefits are *likely in less than a decade or two.*
  - Much *longer* times, however, can be associated with situations *where growth rates are slow, the investment response is lacking, or large trees are used* (which is unlikely where sawtimber market exists).