The Carbon Debt Fallacy

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At Enviva, our purpose is to improve the environment by displacing coal and growing more trees. We are proud of the fact that we have been a measurable part of the renewable energy transition in the UK and in Europe. Intermittency is a real and costly problem for utilities seeking to move to a more renewable future: you simply can’t run a grid on wind and solar alone, because wind and solar don’t produce energy when the wind isn’t blowing and the sun isn’t shining. Biomass-fired generation provides renewable, dispatchable energy to the grid, in the process displacing fossil fuels and reducing the lifecycle GHG impact of energy generation.

Critics of forest biomass often argue that bioenergy is contributing incrementally to additional GHG emissions in the short term because, they claim, the carbon emissions from combusting forest feedstocks remain in the atmosphere and contribute to global warming until trees grow back to sequester an equivalent amount of carbon. This is known as a “carbon debt” argument. While seemingly intuitive, the carbon debt approach is deeply flawed. [1]

Regulatory policy in countries around the world is premised upon the conclusion that the stack emissions from using biomass in a stationary source facility can be treated as having zero carbon if the biomass is sourced from forests whose carbon stocks are stable or net growing. [2] In such a case, the stack emissions are offset effectively and completely by the growth in that forest that occurred despite (or even because of) a managed economic harvest of forest products, including biomass for energy. Carbon debt supporters dispute this: they argue that the stack emissions should be counted as something else. I’ll explain technically why this argument is specious when applied to the managed working forests of the Southeastern United States.

The “carbon debt” argument is misleading, whether it is applied at the stand scale or at the landscape level. Let’s take each one in turn.

Stand-level carbon debt thinking ignores the landscape context

When one considers carbon debt at the forest tract level, typically it’s via a modeling analysis that “cuts” a theoretical forest tract, assumes instantaneous emissions from the harvest, and then “regrows” the theoretical forest in a computer model to find the point in time when the emissions from harvest are thought to have been reabsorbed by the growing forest. The conclusion is often that the debt, or payback time, is longer or shorter depending on many factors including the rotation age of the particular forest stand in question. [3]

First logical error: Treating forest stands independently

This stand-level carbon debt approach makes two key assumptions that are not supported by practice. First, this approach commits a logical error with respect to spatial scale by treating each
forest stand individually, when in fact forests are managed at the landscape scale. Every year in the U.S. Southeast, 2% of the forest is harvested while the remaining 98% is in various stages of regrowth – thus every year there is simultaneous harvest and regrowth, the net result of which is that every year there is more carbon in the forest than there was the year before. Sedjo and Tian (2012) explain this landscape-scale market-mediated phenomenon for forest products:

“forest management involves more than simply harvesting mature stands and replanting them without consideration of adjacent stands. Rather, forest management responding to markets involves the simultaneous management of many multiaged stands and an anticipation of future market conditions. Indeed, the market coordinates wood use and forest management across many stands and ownerships. Thus, at the scale of a timbershed for a forest products conversion facility, the regulated forest need not be managed by a single individual but rather multiple managers whose forest management decisions are directed by market signals.” [5]

Thus, the appropriate spatial scale for accounting for the atmospheric impact of bioenergy is at the landscape scale, not the level of individual stands. Prisley et al. (2018) put this into context directly for the carbon accounting case:

“Carbon debt is an artifact of the arbitrary choice of the temporal starting point and spatial area that is used for carbon accounting. In forested landscapes, multiple individual landowners are making decisions whether to maintain or regenerate forests in anticipation of eventual commercial harvests and in response to demand for wood. A landscape perspective enables consideration of the well-documented effects of active wood markets.” [6]

**Second logical error: Setting the starting point for accounting at the end of the forest growth cycle rather than the beginning**

The second assumption that proponents of carbon debt at the stand level often make is that accounting must begin at the moment of harvest, rather than the moment of regeneration. Following this approach, we account for only the loss of forest carbon when a harvest occurs, effectively negating all of the carbon that was built up in the forest as it grew, before it was harvested.

This assumption about the starting point for accounting is not supported by historical practice, as forests in the U.S. Southeast have been managed sustainably over time to produce a steady stream of wood products into the economy. Instead, we know that: “multiple harvest-regrowth cycles provide ongoing benefits;” [7] these harvest-regrowth cycles occur at the scale of individual stands, arranged like a mosaic within the larger forest landscape; and there is no sound scientific basis for choosing one starting point over another, as forests in the U.S. Southeast have been continuously managed for centuries.
Landscape-scale carbon debt thinking ignores forest growth as a response to robust forest products markets as well as the important safeguard offered by existing bioenergy policies

Critics sometimes also discuss carbon debt using a landscape scale argument. This second argument assumes a rapid change in policy or practice that could lead to increased demand for forest biomass at an aggregate level across a region. Under this scenario, if we implement a new policy this year, then next year there could be a dramatic increase in forest harvest specifically for biomass, which would result in a measurable increase in emissions when that biomass is used.

This approach is misleading because it ignores the broader trends in forest carbon sequestration - that are actually caused by harvest itself -- as well as the conditions in the broader macroeconomy that lead to fluctuations in market demand for all forest products. In order for biomass to cause an incremental increase in emissions, there would have to be measurable and incremental harvest associated with biomass that causes a decline in forest carbon stocks. The forest bioenergy policies mentioned above have an automatic “escape valve” to ensure that this net negative climate outcome will not occur. The EU, for example, under its RED2 policy, makes clear that biomass from the US will qualify as an appropriate, sustainable, and climate-friendly feedstock only if it comes from a supply region with stable or increasing carbon stocks.

Historical data on year-to-year fluctuation in harvest rates show that harvest for all products across the U.S. Southeast is responsive to macroeconomic forces and structural change across the forest products industry. Overall harvest of forest products in the U.S Southeast has increased by about half since recordkeeping began in 1953, with some fluctuations depending on macroeconomic conditions. [8] Over the same time period, forest inventory has more than doubled, even after harvests are accounted for. In fact, there is a positive and direct relationship between forest harvest and forest area, forest inventory, and forest growth, proving empirically what forest economists have been telling us for years: robust markets for forest products cause landowners to invest in forests, leading to investments in more and healthier forests. It’s difficult to see how there might have been incremental emissions from bioenergy, because when carbon stocks are stable or growing there are no incremental emissions from harvest at all.

Sourcing data from Enviva’s regions: putting pellets into perspective

Let’s dig into this a little more, using data from Enviva’s sourcing regions (map in Figure 1). Figure 2 shows the trends in overall harvest in Enviva’s combined supply regions from 2000 to
the present. Note the “total removals” line is the total of all the tons removed from the forest in each year, and is the sum of sawtimber, pulpwood, and pellet removals. These are the dashed lines. The solid lines are the total standing growing stock inventory in the forest in each of the years.

We can draw several conclusions from this time series dataset. First, inventory and carbon storage continue to grow. Every year there is more carbon in the forest than there was the year before, because the robust forest products market in the regions where we operate provides an incentive for landowners to continue to invest in their forestland. Second, in Enviva’s sourcing regions, pellets were responsible for only about 10% of the total removals in 2018. And finally, while total removals for all products dipped around the time of the Great Recession, a phenomenon tied closely to the reduction in housing starts over this period, they have recovered and are now about the same as they were in 2000. The demand for forest products overall has been reasonably constant and thus there is no incremental demand for wood as a result of the biomass market.

Figure 1. Map of Enviva’s combined supply regions. Counties shown in tan are areas from which Enviva has purchased material.
These data show that forests in Enviva’s sourcing regions are robust, and are actually storing more carbon year over year. As a result, we know that there are no incremental short-term emissions from biomass harvested from these regions and thus there is no carbon debt. **Going forward, when the EU RED2 policy becomes effective, that will impose an additional regulatory safeguard, such that it will not be possible for additional future biomass demand to cause incremental increase in harvest.**

Biomass sourced from the U.S. Southeast has helped fuel Europe’s transition from fossil fuels, taking coal off the grid while contributing to the growth in these forests. We think that’s a win-win.
We couldn’t agree more with the importance of reducing emissions immediately. In fact, in its October 2018 report describing the urgency of addressing the climate crisis, the Intergovernmental Panel on Climate Change (IPCC) laid out scenarios for how the world can limit an increase in global temperatures to 1.5 degrees Celsius, including meaningful contributions from biomass to meeting emissions reduction targets from now through 2050. In the IPCC’s median scenarios, biomass makes up approximately 14% of global primary energy supply in 2030 and 25% in 2050 (around 3% of global electricity generation in 2030 and 8% in 2050).[9]

This is why biomass advocates are so certain that our work to replace coal is absolutely crucial to the future of our planet. We are reducing emissions, right now, by enabling our customers to displace coal with biomass. We are doing this while also creating market conditions that result in demonstrably healthier, more robust forests without causing additional short-term emissions. And we are doing this today.

**Notes**


[4] We use US Forest Service data to inform our analysis of the status and trends in the forest landscapes where we operate. You can find their data at https://www.fia.fs.fed.us/tools-data/index.php -- the data we cite are a ratio between the area affected by forest harvest and total forest area.


[7] Ibid.
