Our Green Down Payment: Fight Climate Change by Turning Buildings into Carbon Sinks with Timber Bamboo

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Summary

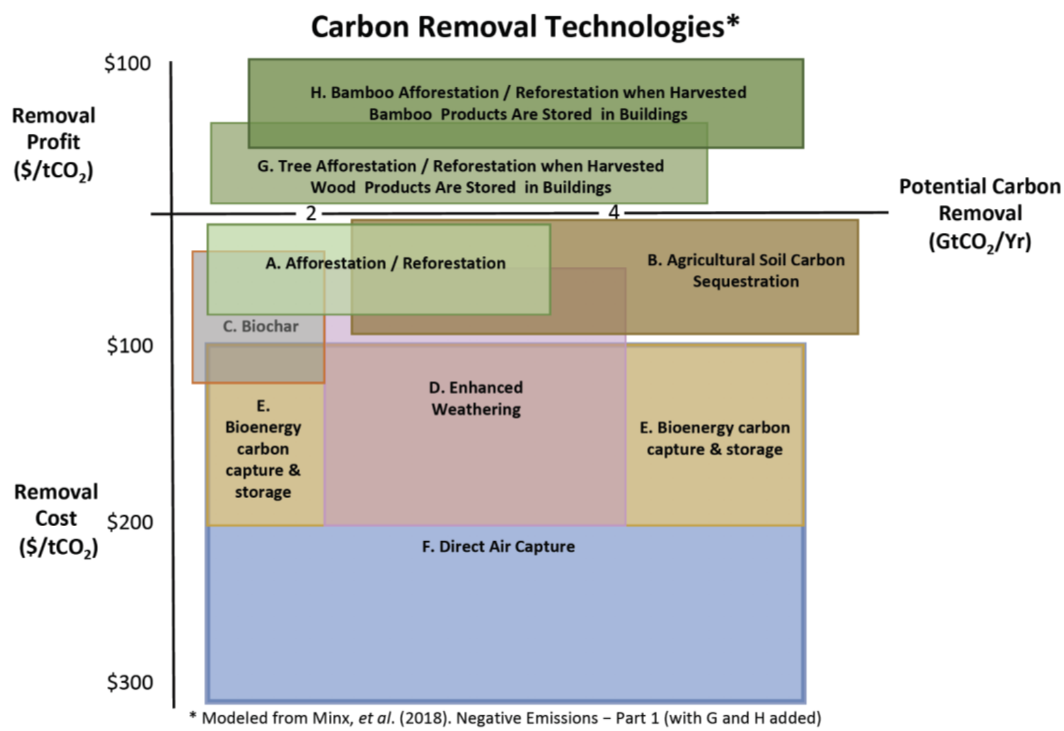
Humankind faces a climate precipice unless it can significantly slow the course of climate change through both emission reductions and removal of existing atmospheric carbon. Decisive action must be taken in the current decade. Yet, relative to carbon removal, the options are limited, mostly unproven and costly to operate. Growing wood forests are an option for carbon removal but they are also needed for durable products like buildings. Trees take many decades to accumulate their carbon removal, but when harvested less than 50% of the carbon ends up being storable in a building. Timber bamboo can also be incorporated into buildings. But critically, timber bamboo can be harvested annually starting around year seven and then annually thereafter, making it five to six times more carbon productive than comparable wood. Moreover, timber bamboo is at least four times more efficient in total fiber production for the same planted land area. If we accelerate our adoption of timber bamboo into the built environment, we can turn buildings into carbon sinks and make a crucial "green down payment" on the carbon removal needed in the current decisive decade.

Code Red for Humanity.

No one can escape the ominous evidence of accelerating climate change seen in the increasing frequency and devastation of extreme weather events. July 2021 was the hottest month globally ever recorded. Only a few years back, the scientific and policy climate communities were focused on 2050 and 2100 as the key horizons. Now, President Biden and many others are calling the remaining eight and a fraction of years until 2030 "the decisive decade for climate action," and the UN Secretary General just issued a "code red for humanity" warning. The scientific opinion is unanimous: we must both reduce greenhouse gas (GHG) emissions *and* remove existing GHG from the atmosphere (also called negative emissions). This sudden push to urgency is necessary because the earth's climate system is comprised of multiple powerful tipping points, which once tipped can't be righted again and once tipped accelerate further climate change.

We Have Limited Options to Remove Carbon from the Atmosphere.

Most of us know a wide range of ways we can *reduce* emissions. But few of us know how we will *remove* the emissions already in the atmosphere. Conceptually, we have maybe six broad options. The chart below from a 2018 article by a global group of nineteen independent scientists summarizes six major carbon removal options (A to F). Each option is assumed to have reached its maximum scaling.[1] The cost (or profit) to remove a ton of carbon dioxide is shown on the vertical axis and the theoretical amount of carbon dioxide removed (in gigatons/year) is shown on the horizontal axis.



Notice that all six options A to F fall below the cost-profit breakeven line, meaning they will cost money to remove GHGs. The upper three of the six options, afforestation, and reforestation (A), agricultural soil carbon sequestration (B), and biochar (C), are "natural climate solutions."[2] They are all mature approaches and can be implemented today, but as shown still cost cash to capture carbon. Of these, forestation and agriculture cost the least to pursue and are the most scalable. The lower three options, enhanced weathering (D), bioenergy with carbon capture and sequestration (E), and direct air capture with sequestration (F), are "geoengineering solutions" *and require a place to store the captured carbon,* if not permanently then at least long term. The geotechnical solutions are far more speculative, less immediately scalable, and are expected to cost multiples more per ton when and if they can begin to scale than the natural climate options.

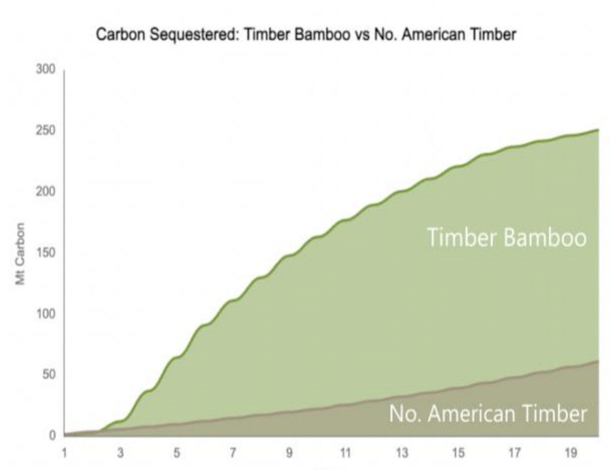
We placed an additional removal option (G) above the cost-profit line, meaning *forestation can be profitable to remove carbon* from the atmosphere. Most scientific projections and policy reviews of forestation approaches assume we spend money to plant trees to grow and capture carbon and leave the trees standing. But that misses our many millennial relationships with trees. We also harvest them (hopefully sustainably) to make durable harvested wood products that can store the captured carbon in buildings and keep it out of the atmosphere for many generations. When you add the harvested wood products to the equation, you can pay for the cost of forestation with the profits. This multiplies the amount of carbon removal forestation we can afford to do because it is profit-making in the ordinary course of human economic activity.

Planting a Lot of Trees to Remove the Carbon Can't Do It

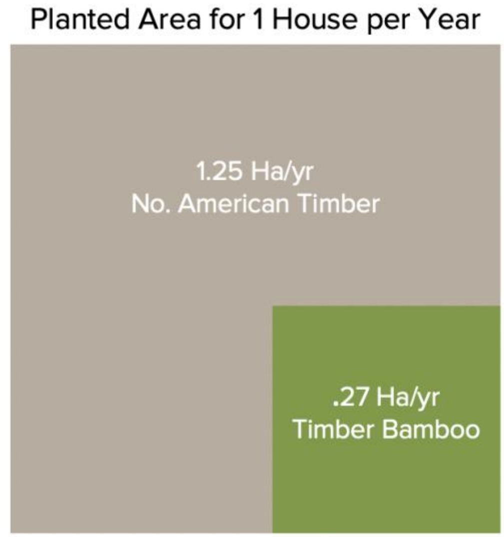
Realistically, wood forestation, even with harvested wood products, can't remove sufficient atmospheric carbon. There are five reasons. First, *trees just don't grow fast enough to help slow climate change in the critical short term*. Trees accumulate their carbon over many decades. Tree growth in the early years is relatively small compared to growth after the first two decades for most species (though there are a couple of exceptions). We already recognize the forestation opportunity. At least five multinational afforestation/reforestation agreements have been forged with target timelines (REDD+, Bonn Commitment, Initiative 20x20, New York Declaration on Forests, and AFR100). But the progress across all of them has been slow, due in large part to lack of funding to subsidize the cost. The time window for humankind to rely principally on forestation to help address our decisive decade is closing fast or it has already closed. Realistically, we either have to develop a whole new generation of super fast-growing trees (and some are working on this) or we must turn to grass.

Timber bamboo is a giant grass that grows to its full height in its first year. Final height can range from 60 to over 100 feet when growing from a mature stand, which happens four to seven years after the initial planting. Fortunately, like trees, timber bamboo can also be harvested and turned into durable building products that store the captured carbon (option H added to the above chart). But, as a grass, timber bamboo grows new culms (stalks) from the underground root system that can be *harvested annually* by intercutting (never clear-cutting). This annual regeneration cycle allows timber bamboo to constantly capture carbon and produce durable harvested wood products every year, starting around year seven. Timber bamboo grows prolifically in the tropical and subtropical areas of the Americas', Asia and Africa. Globally, timber bamboo covers about 1% of the land area that tree forests cover.

Second, as valuable as trees and wood are to us in capturing carbon and providing buildings, the process of recovering the usable fiber from wood that can go into buildings is notably inefficient. Harvesting trees in North America (even if not clear-cutting) results in only a 60-70% recovery of the carbon in the tree. Then at the mill, the material recovery ranges from only 40% to 80%.[3] When these recoveries are combined, the carbon fiber stored in a wood building is at best 24% to 56% of the carbon captured by trees. Turning bamboo into harvested bamboo building products is less well studied than wood. Still, our estimates of overall carbon recovery from the bamboo culm are well above the wood numbers, both in the forest and at the mill. We studied the overall carbon flux of timber bamboo compared to commonly used North American framing timber using the United States Forestry Services data. The results were surprising. As the chart below illustrates, in the crucial first 20 years, timber bamboo captured carbon over 400% better than wood. When studied for a more extended 75-year period, timber bamboo and its resultant harvested building products outperform wood by 500% to 600%, depending on assumptions used.[4]

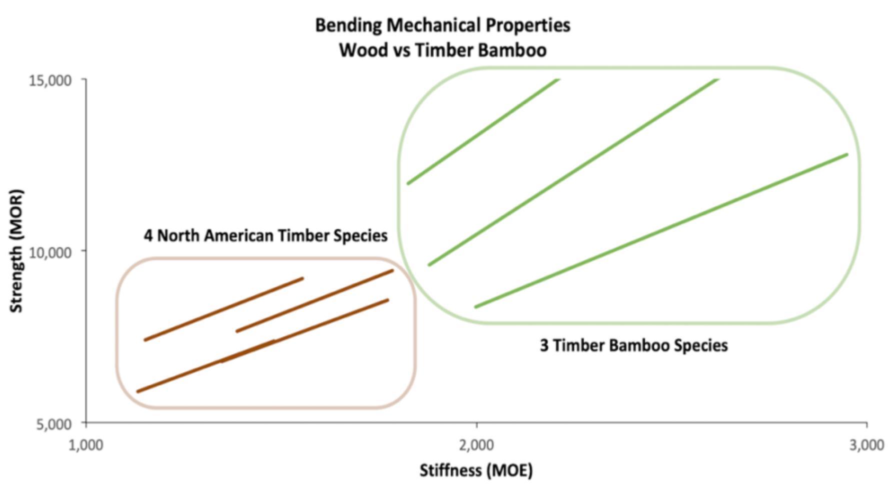


Third, to reach scale, wood forestation will require vast areas of land which puts it in competition with our needs for expanding cities, growing food, biodiversity preservation and even land needed for to-be-developed geoengineering climate solutions like bioenergy with carbon capture and storage. Fortunately, in terms of land-use intensity, timber bamboo is about five times more efficient than trees. This is because of bamboo's faster growth and annual harvesting cycle compared to wood's slower growth and 25-75 year harvesting cycle. The following diagram adapted from an LCA study by Quantis-International illustrates bamboo's land-use efficiency. To produce the vertical framing timber for a single prototype house each year requires 1.25 hectares of wood versus .27 hectares of timber bamboo.[v]



Fourth, structurally, while wood is optimally effective in the low-rise building sector, it can't quickly displace high carbon footprint concrete and steel dominating the mid and high-rise markets, which is where significant growth will occur in the next three decades throughout the developing world. We must reduce the use of concrete and steel in our buildings because they generate more that 10% of global GHG emission. And despite many efforts to lower the energy intensity of concrete and steel, there are high theoretical limitations to the likely improvements to the carbon footprint of concrete and steel.[6] Fortunately, timber bamboo mechanical properties typically exceed wood by 25% to 100% for the same volume or density as illustrated in the chart below. Incorporating timber bamboo, in conjunction with wood, is a vital tool to help decarbonize mid and high-rise buildings.

Fifth, we have conflicting goals relative to wood forestation. We want it to capture and store carbon and to provide structural products for buildings (and for paper, pulp, mulch, etc.). We include it in carbon offset programs. But we



also harvest wood for sheltering and other needs and in doing such produce a massive emission event within several years of the harvest, resulting in less than half the removed carbon being stored long term in a building. If we don't harvest forests commercially, where will we get the fiber for durable goods and buildings? Since timber bamboo can be intercut annually, there is never this harvest emission event releasing the decades of stored carbon. The rest of the bamboo clump just keeps growing and putting up new shoots. Effectively, we can use timber bamboo to farm carbon perennially and store the carbon in buildings.

Timber Bamboo Can Make an Immediate "Green Down Payment" to Decarbonize Buildings in the Decisive Decade

Given the speed of growth, profit opportunity, land-use efficiency, and strength advantages, timber bamboo is uniquely positioned to help humanity make a vital "green down payment" on our need to remove carbon from the atmosphere in the immediate future. We accept that all the options in the carbon removal portfolio are important to explore in the long run. But we can't get to the long run unless we can navigate around the climate tipping points. This means our focus must not be just on the tantalizing high-technology, geoengineering solutions until after we know we can navigate around the tipping points.

So, why isn't more being done to advance forestation with harvested wood products, especially with timber bamboo? Relative to the adoption of timber bamboo carbon removal, we do not believe the limitation should be available land since it is five times more efficient than trees. (Neither should be the carbon footprint of oceanic transport of bamboo HWP, which is relatively small compared to the benefit.) Globally, the area of deforested or already disturbed land is estimated to range from 350 to 1780 million hectares.[8] More specifically, 500 million hectares of this degraded land are in the tropics and subtropics, a prime growing area for timber bamboo.[7] In the theoretical case that just the degraded tropical areas are planted with timber bamboo, our estimate of *total carbon removal is over 130 gigatons in 20 years*, which is about the amount of 3 years of total global emissions Even a fraction of this would be a crucial green down payment as we explore and develop the less-proven carbon removal options.

Afforestation and reforestation are often categories for carbon credit programs that subsidize the forest's carbon offset. Bamboo afforestation is almost always ignored as a possible source of carbon credits. But we need the structural fiber and it's more efficient to fight climate change with timber bamboo fiber than wood. If forestation carbon credit programs were re-structured to include timber bamboo and the captured carbon that is ultimately sequestered in buildings, then **timber bamboo could drive a powerful, useful, and profitable way to farm carbon efficiently while also making an immediate "green down payment" on carbon removal.**

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