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Enough Already with the Fallacy of Carbon Debt!

Even after years of explaining managed forest dynamics, the carbon debt misconception lives on.

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In May of 2011, more than ten years ago, FutureMetrics published a white paper titled "*How Manomet got it Backwards: Challenging the debt-then-dividend axiom*". The infamous Manomet study had several critical errors that were addressed in a series of four FutureMetrics white papers in 2011[1]. At the core of their flawed analysis is their assumption that there is a carbon debt after wood is harvested.

A number of FutureMetrics white papers since 2011 and numerous other publications have shown that there is no carbon debt if fundamental sustainability criteria form the basis for the management of the forest landscape.

Yet to this day, and sometimes by academics with PhD's after their names, the carbon debt fallacy is perpetuated. This white paper will try to explain why they get it wrong.

Dynamic Systems

At the core of the carbon debt story is a failure to grasp the dynamic nature of the growing working forests that are managed[2] to produce the raw materials needed for the production of a wide variety of commodity items such as building materials, paper, tissue, packaging, and biochemicals.

Understanding how a dynamical system[3] evolves over time requires sophisticated mathematics. But in simple terms, there are stocks, flows, and feedback loops. The relationships between them can lead to very complex systems.

An easy-to-understand dynamic model is a tub of water with a fill and a drain. If the fill and drain valves are open then the quantity of water in the tub is a dynamic system that, over time, changes. The quantity of water in the tub can be described with differential equations: $\text{Net Flow} = \frac{dI}{dt} - \frac{dO}{dt}$. Where I is the input flow and O is the output flow.

But no need to solve this system in order to conceptually understand the level of water over time. If the fill and drain rates are equal, then the quantity in the tub remains the same. Note that over time the water in

[1] The FutureMetrics white paper was in response to a study by the Manomet Center. The executive summary of the Manomet report is HERE. The FutureMetrics paper can still be downloaded from the FutureMetrics website. It is near the bottom of the long list of white papers.
[2] Working managed forests are tree farms in which the landowner's "crop" is being grown to be harvested.
[3] For a comprehensive description of dynamical systems see HERE.

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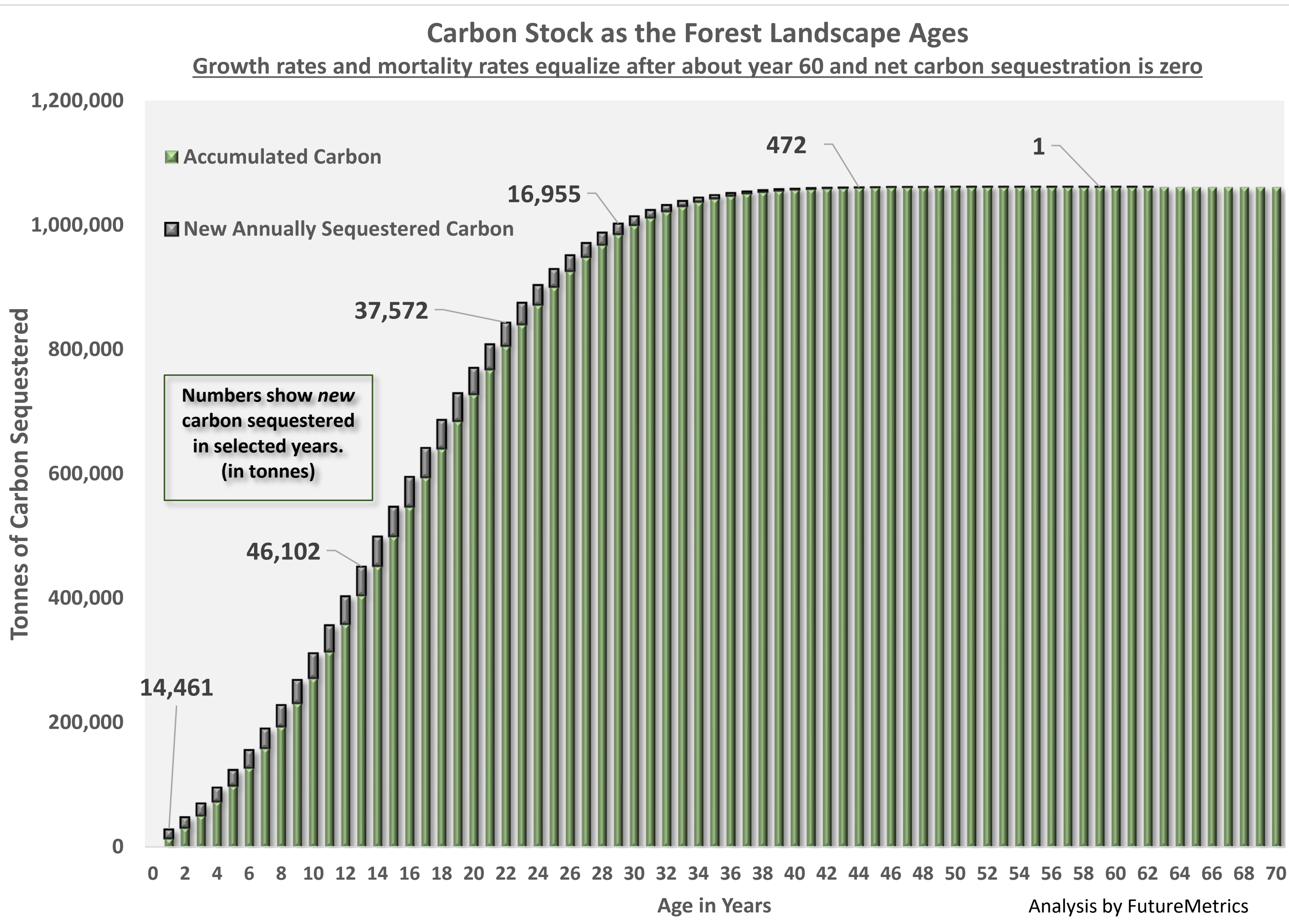
the tub is not the same water. In a simple stylized context, the new water is on top near the fill and the old water is at the bottom entering the drain.

Carbon Stocks in Forest Systems are Part of a Dynamic System

Now imagine a forest landscape that is managed for the production of trees that are being grown to become feedstock for a sawmill, a pulp and paper mill, and a pellet mill[4].

This forest is a dynamic system that, just like the water tub example above, experiences growth and drain. System dynamics and the limits to growth within a forest area means that over time forests reach an equilibrium in terms of the stock of wood in the landscape. A corollary to that is that the stock of carbon sequestered in the forest also reaches a limit.



[4] A single tree stem can have a portion suitable for lumber production, a portion for pulp chips, and a portion for the production of industrial wood pellets.

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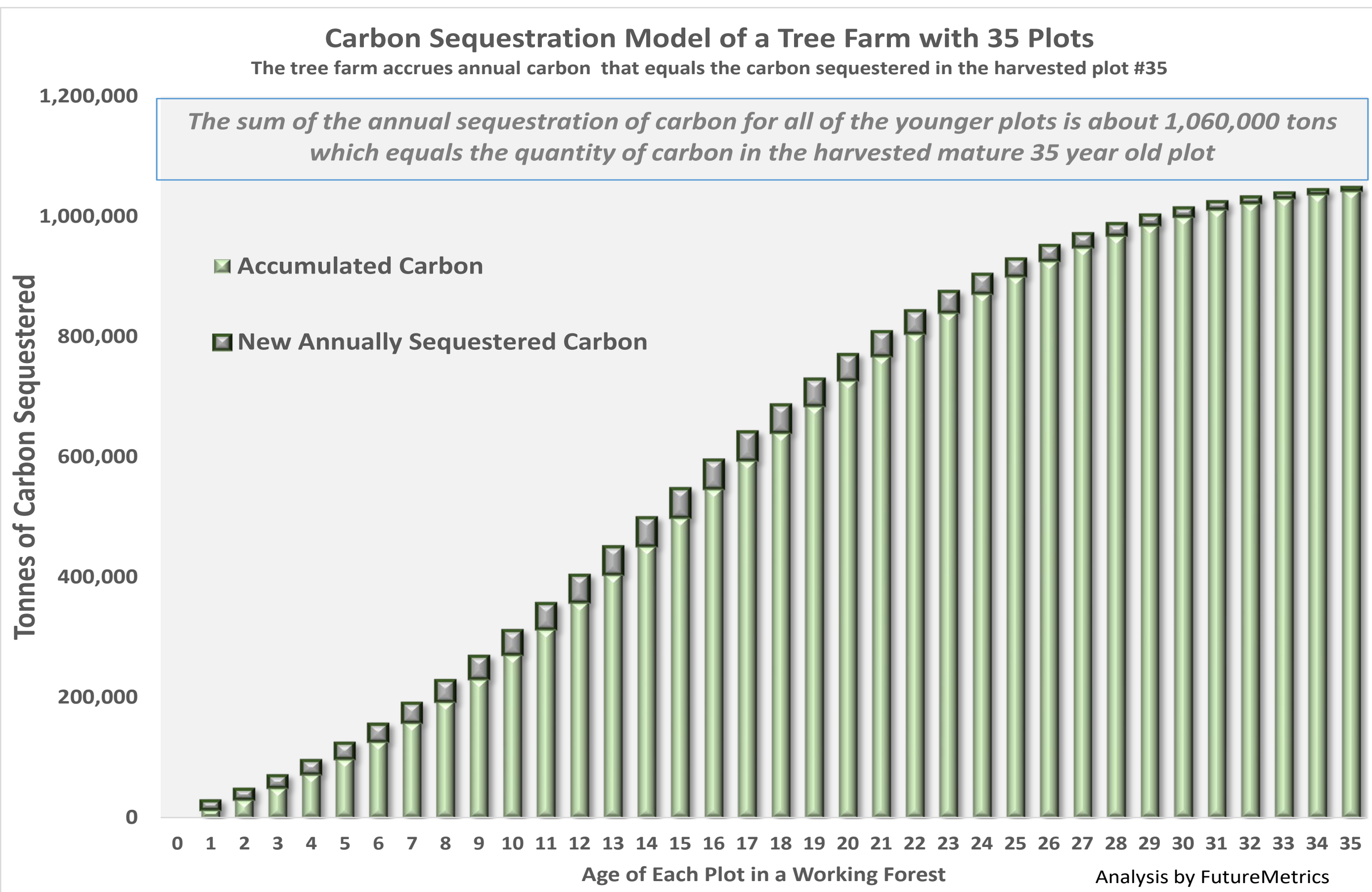
The chart shows the evolution of the sequestered carbon in a stylized forest landscape. Under the assumptions of the model, this forest no longer sequesters new carbon after about year 60. There are numerous reasons for slower growth; but eventually natural mortality equals growth. It is physically impossible for forests to grow larger forever. Once the stock of wood stops growing, the stock of carbon in the forest is thereafter constant because, just like the tub of water, the growth rate and the drain rate are equal. And just like how the water in the tub is constantly changing, in the forest there are new trees, there are growing trees, and there are dying trees. The amount of carbon held in the forest is constant, but the trees are constantly evolving though their life cycles.

Using the same model as in the chart above, the managed forest in the chart below has 35 separate plots at various stages of growth. The oldest plot has sequestered just over 1 million tonnes of carbon when it is ready for harvest. Some of that harvest becomes building materials, some becomes paper or packaging or tissue, and the residuals may become pellets[5]. The sum of the carbon sequestered in the other 34 plots is equal to the carbon held in the oldest mature 35th plot. In other words, growth equals drain and the net carbon stock across the forest landscape is not depleted.



[5] For a graphic interpretation, see the FutureMetrics dashboard HERE. The left panel of the dashboard shows the size of the forest needed for sustainably supplying a sawmill, a pulp mill, and a pellet mill (at user selected growth rates per hectare per year).

Failure to Grasp the Dynamics of a Forest Landscape is the Foundation of the Carbon Debt Fallacy

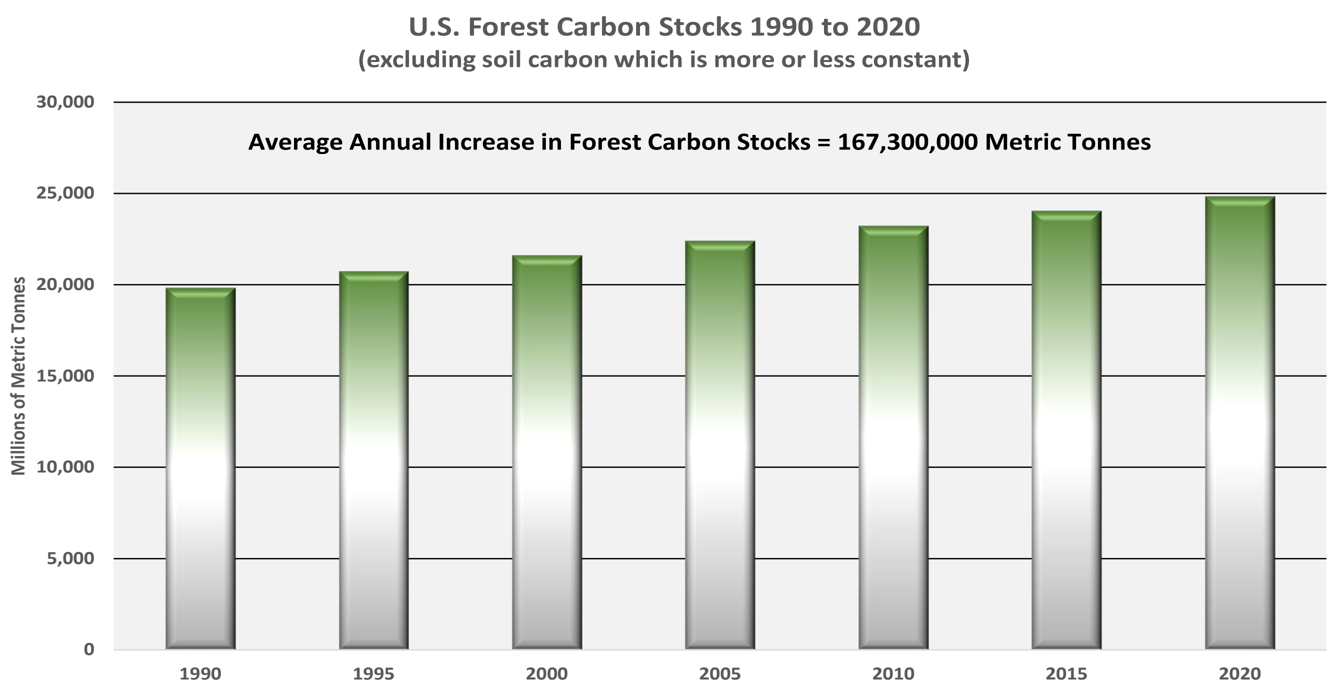
Carbon debt proponents essentially believe that a single tree represents the forest at large. That single tree's sequestered carbon is removed when it dies and rots or, in managed working forest, is harvested. It then takes decades for a new tree to replace that one. In the meantime, there is a carbon debt.

Carbon debt proponents believe that if part of the tree is used to produce heat and/or power, that the carbon dioxide released in combustion has to wait for the new tree to grow to cancel the debt.

This very narrow and non-dynamic view of forests does not allow the carbon debt proponents to acknowledge the fact that in aggregate, the forest's total stock of sequestered carbon is not depleted as long as the growth rate of the forest is greater than or equal to the drain rate.

Essentially, for the carbon debt story to be true, the implication is that the stock of sequestered carbon is being depleted faster than it is being refilled by new growth. If that were the case, then indeed there is a debt that can only be repaid by replenishing the carbon held in forests.

But that is not the case. The data in the chart below shows that, for US forests, carbon stocks in forested lands are increasing.



Sources: Data from EPA, Table 6-10 in Chapter 6, "Land Use, Land-Use Change, and Forestry," U.S. National Greenhouse Gas Inventory, April 2021. Analysis by FutureMetrics

Mistrust of the Industrial Wood Pellet Sector's Commitment to Sustainability

There is no logical escape from the facts: as long as the growth rate in the forest landscape is greater than the drain from mortality and harvest, there is no carbon debt.

The harvest of a single mature or high-graded[6] stand within a large managed forest may allow for an emotionally compelling and narrowly focused photo implying that the forest is being wantonly destroyed. But that viewpoint is not supported by basic business sense. And it is not supported by the rigorous independent auditing that is necessary if the industrial wood pellet producers what to sell their pellets into their markets.

From a business point of view, managed working forests' purpose is to supply the raw material for the production of building materials, paper, packaging, tissue, biochemicals, and many other products including wood pellets. From a business perspective, the major investment in a new sawmill or a pulp and paper mill or a pellet mill requires that it receive feedstock every day at a stable price for decades. This means that the mill's demand for feedstock cannot exceed the ability of the nearby managed forests to generate new wood at a rate that is equal to or greater than the needs of the mill.

For the industrial wood pellet exporters, there is an added layer of enforcement in the form of criteria that have to be met in order for the pellet fuel to qualify as highly carbon beneficial in the countries to which the pellet fuel is being exported. Compliance is rigorously assured with independent audits to prove that, among many other sustainability criteria, the stock of carbon in the forest is not being depleted.

Yet the carbon debt proponents focus only on the stand and not on the managed forest area at large to claim that there is nothing sustainable about the production of wood pellets. In effect, they do not believe that the pellet producers care about the health and long-term productivity of the managed forests that they, and other users, depend on.

That is highly illogical!

Which may be why some opponents to the use of wood pellets for replacing coal in power stations depend on stirring emotions rather than engaging with facts.

The Mistrust is Misplaced

Users of wood as feedstock require that the forest system be healthy and renewing at a rate that is equal to or greater than their demand. Forests are actively managed to achieve this.

For example, most of the industrial pellet fuel produced in western Canada is from wood that is grown on government land for the primary use as feedstock for sawmills. Most western Canadian pellet producers take the sawmill by-products and the portions of the harvest that are not suitable for the sawmills. The government's foresters set the "annual allowable cut" (AAC) based on careful scientific analysis of the net growth rate of the forest tenure that is allocated to the primary users. The purpose is to assure the optimal

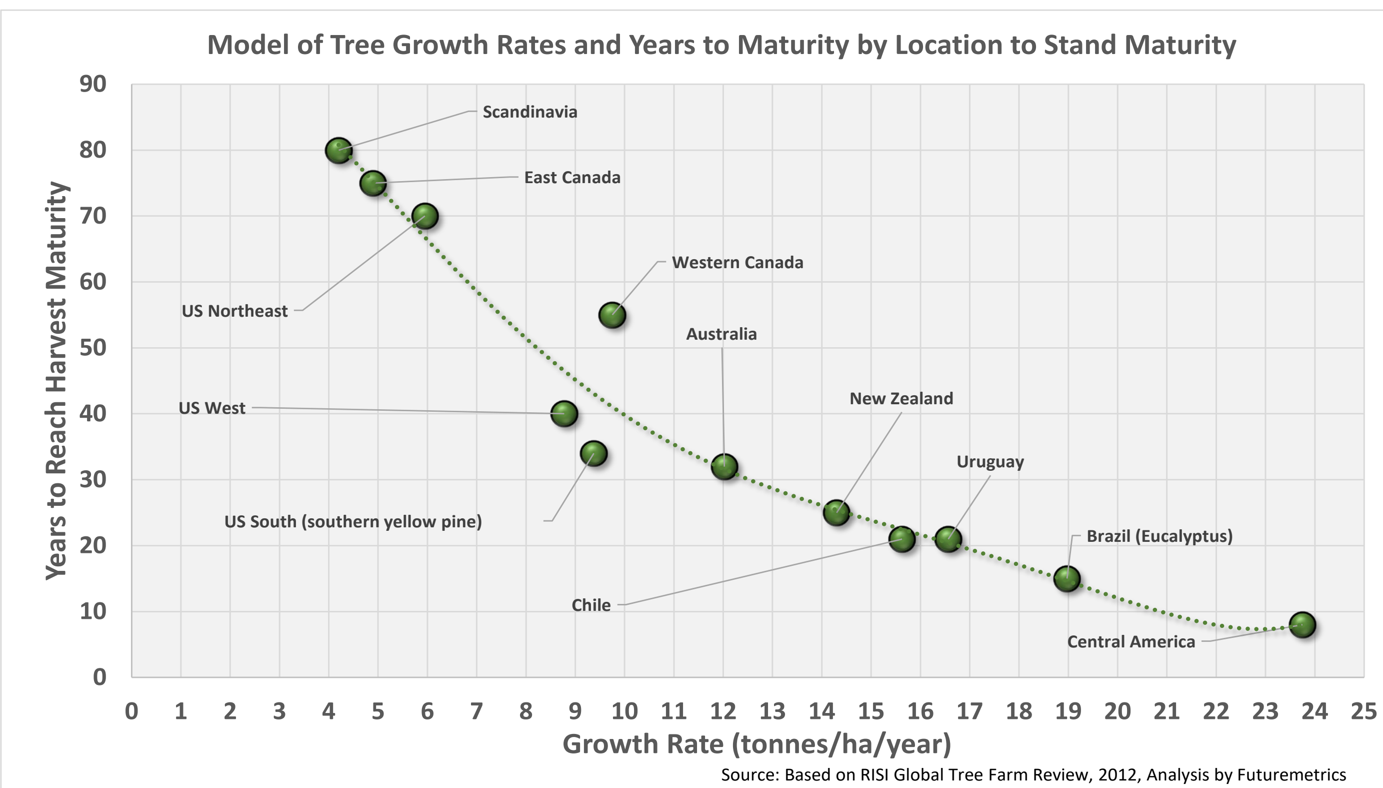
[6] See HERE for description of high-grading.

health, growth rates, and perpetual sustainability of the resource. A basic condition in determining the AAC is that the growth rate will be greater than or equal to the drain rate. Thus, the net carbon stocks in those forests are not depleted.

In contract to western Canada, most US industrial pellet fuel is derived from private forestland. There is no official AAC. But there is, as noted above, strict criteria imposed by the users on the producers to prove that the carbon stocks are not being depleted[7]. It is often said that the license to operate for the export markets begins with rigorous adherence to making sure that the forests are not depleted. Furthermore, as long as there are markets for the wood, landowners of all sizes want to have their land to continue to create value from healthy growing trees.

Of course, a plot that has been harvested will leave a space in the landscape without most of its trees. That space will regrow, resume the more rapid carbon sequestration rate that the older plot lost with age, and be part of the overall forest system's annual growth.

In very general terms, the limits to a regions ability to produce the raw materials needed for sawmills, paper mills, tissue mills, cardboard mills, panel board mills, and pellet mills is a function of the time it takes for a tree in a managed forest landscape to reach a merchantable size, and the density of the forested land around the mill. The chart below shows estimated growth rates and time to maturity for several regions around the world.



[7] The Sustainable Biomass Program is the leading independent certification system.

The only logical pathway to believing in a carbon debt is to not believe that the forest products industry cares about sustaining the forests they depend on. But the facts suggest that this mistrust is misplaced.

Conclusion

Carbon debt proponents imply that the pellet fuel used to replace coal for power generation is both detrimental to the net CO_2 concentrations in the atmosphere, and that the production of pellets is leaving vast empty spaces where there used to be forest. They believe that any tree removed from a forest is proof of a carbon debt; and thus that the atmosphere is experiencing an increase in CO_2 concentration until a new tree regrows in the same spot to the same size as the harvested tree.

Enough already with that narrow and biased view.

Facts, sometimes inconvenient and perhaps difficult to understand for some people unable to grasp the dynamics of a continuously growing managed forest, show that other than land use change from forested land to other uses[8], carbon stocks are increasing.

Furthermore, as the dashboard model referenced in footnote #4 shows, only a portion of the daily harvest makes its way to a pellet factory. The higher value portion of the tree goes to a sawmill and becomes lumber or furniture. That dashboard also illustrates how the production of pellet fuel can support a carbon negative solution to power generation. In fact, with bioenergy carbon capture and storage (BECCS), industrial wood pellets replacing coal are the only pathway to reducing CO_2 concentrations in the atmosphere and generating needed on-demand power.

With properly managed forests, there is no carbon debt. Quite the opposite with BECCS.

[8] Land use change is a function of the health of the markets for wood. If there is demand for wood and there are users willing to pay for it, landowners will grow trees to supply those markets. Remove those markets and some of the private managed forests will be cleared for other uses.