How Manomet got it Backwards:
Challenging the “debt-then-dividend” axiom

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The so-called Manomet Study[1] has generated a great deal of interest and controversy about the greenhouse gas impact of using woody biomass for energy. In response to some of the controversy, the Manomet Center for Conservation Sciences released a two page clarification[2] in June of 2010 acknowledging the need for a rational reading of the study: “Manomet has also issued a statement to aid in the interpretation of some of the misleading press coverage that followed the release of the report”.

However, the two page statement continues to advance the assumption that there is a carbon debt that is incurred before there can be a dividend. This is embodied in the statement on page one of the clarification: “While burning wood does emit more GHGs initially than fossil fuels, these emissions are removed from the atmosphere as harvested forests re-grow.”

This short paper challenges the assumption that there is always a carbon debt incurred and then a carbon dividend later (debt-then-dividend) when using woody biomass for energy.

The Manomet authors have that assumption so deeply ingrained into their logic that it is presented as axiomatic. In complex systems theory one of the points of study is the concept that “selection is information”. By presenting the debt-then-dividend assumption as an axiom, the Manomet authors have limited the scope of their view of the world and thereby have removed information from the system. Their model allows no conclusion other than those that accrue from their debt-then-dividend framework.

The following pages begin with some of the already published criticisms of the Manomet study. This brief paper however focuses on the self-evident (axiomatic) presupposition of the study’s authors’ assumptions regarding carbon sequestration and release.

[1] http://www.manomet.org/sites/manomet.org/files/Manomet_Biomass_Report_Full_LoRez.pdf
[2] http://www.manomet.org/sites/manomet.org/files/Manomet%20Statement%20062110b.pdf

The Fallacy that Underpins the Manomet Argument

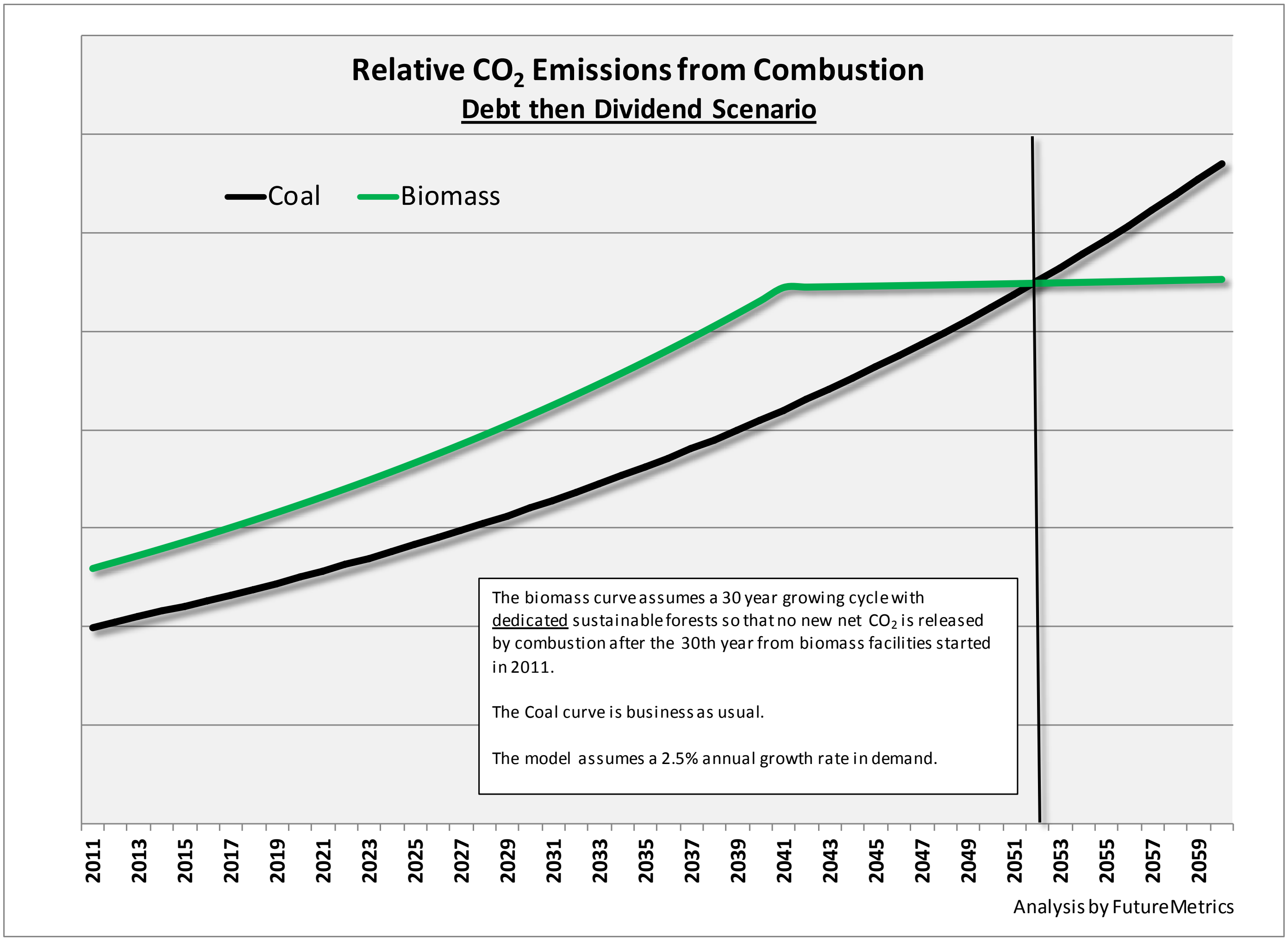
As some critiques[3] have noted, the Manomet Study has a simplistic view of forestry that has been characterized as a "stand versus landscape" argument:

> "Manomet's model of greenhouse gas emissions focuses only on stands of trees that are harvested in any given year and ignores stands that are not disturbed by harvesting. As a result, the model creates the false impression that forest carbon stocks are always depleted by harvesting; that biogenic CO_2 emissions from biomass energy systems are equivalent to carbon stock depletion due to biomass feedstock removals from harvested stands and that carbon stock depletion is reversed only gradually over a period of years by regrowth of the harvested stands."[4]

Manomet's reply to that critique[5] includes a statement in the early paragraphs ("This initial carbon debt…") that embodies this paper's thesis that Manomet's authors have subtly postulated that there is only one view of how forests work. The foundation of the Manomet argument is that there is a debt when the CO_2 is released from combustion and over a growth cycle, the debt is repaid as the trees grow and gather carbon from the atmosphere.

Taken to the logical extreme, the Manomet study's logic is essentially beginning with a full grown tree, then they are watching that tree get harvested and used for energy and having its stored carbon released as CO_2 (the debt) and then they continue to watch the empty spot where there tree was for 30 to 50 years while a new tree grows in its place. Only after that regrowth is the carbon debt repaid (the dividend). Using this debt-then-dividend model the chart below shows the pattern of net CO_2 from combustion[6].

[3] http://www.nxtbook.com/nxtbooks/saf/forestrysource_201009/#/4
[4] Ibid.
[5] http://www.nxtbook.com/nxtbooks/saf/forestrysource_201011/index.php#/4
[6] Note that we ignore the life cycle carbon accumulation. For both fossil fuels and woody biomass fuels, the values should be considered. But this analysis is strictly about combustion.



The chart above is similar to those in the Manomet Study. Note that the model compares biomass and coal with the assumption that all capacity could be biomass beginning this year. It also assumes a 30 year growth cycle[7]. The assumed energy conversion efficiencies for both coal and biomass (both only making electricity) are 30%[8]. In this comparison scenario, the "dividend" from biomass derived energy is defined as that point in time when the net CO_2 from combustion of biomass becomes less than the net from coal for the same energy demand. In this case, the "dividend" from biomass generation versus business as usual coal generation does not materialize until 2052. The Manomet Study does show that there will be a dividend at some point in the future as long as trees grow to replace those used for energy.

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[7] The actual growth time to maturity will vary and is typically longer than 30 years but for this exercise the time assumption only affects the proportion of the total forest stock that can be sustainably harvested each year. This exercise does not try to quantify the level of sustainable harvest; but there is some level of sustainable harvest that will allow a significant proportion of fossil fuel use to be displaced. See for example http://www.biomassthermal.org/resource/2025vision.asp

[8] As noted in a footnote later in this paper, straight electricity generation from biomass may not be the best use of this limited sustainable resource.

The "stand versus landscape" critique suggests that the Manomet error is to ignore the fact that the forest is a system. The Manomet logic would suggest that some stand of trees is picked and every tree is harvested. In actual forest systems, assuming sustainable forestry practices[9], the carbon released by combustion from selective harvesting is offset by carbon accumulation from the rest of the system's continued growth.

Describing this in simple terms, if there is a forest system with 1,000,000 tons of biomass on January 1 of a given year and that system has 1,010,000 tons of biomass on December 31 of that same year then the forest has increased its carbon stock over the year and it is embodied in the extra 10,000 tons of biomass. If 10,000 tons are harvested from the system on December 31, then the system begins the next year with the stock of biomass and carbon at the same level that it was at the beginning of the previous year.

Implicit in the Manomet "debt-then-dividend" logic is that the timeline for the carbon accounting starts the moment the tree is harvested.

Suppose we dismiss their axiomatic assumption and we start the carbon accounting at a point in the past.

In our 1,000,000 ton system, if we start our accounting on January 1, we accrue our dividend first before we harvest the benefits. There is never a debt. Let's call this a "dividend-then-benefit" logic.

We do not even have to assume a forest system as long as we have a history of sustainable forestry practices. We can look just a small group of trees. Those trees have been gathering carbon (some of which is from the combustion of fossil fuels) for the same 30 years that was assumed for the debt-then-dividend chart above. We have accrued a dividend. We can then derive a benefit from that dividend by using those trees for energy[10].

The chart below shows this scenario. The model assumes that the carbon accounting for this "stand" begins 30 years ago. It also assumes that as the demand for power generation increases at the assumed rate of 2.5% per year, the sustainable biomass necessary to meet this demand also increases due to improved silviculture[11].

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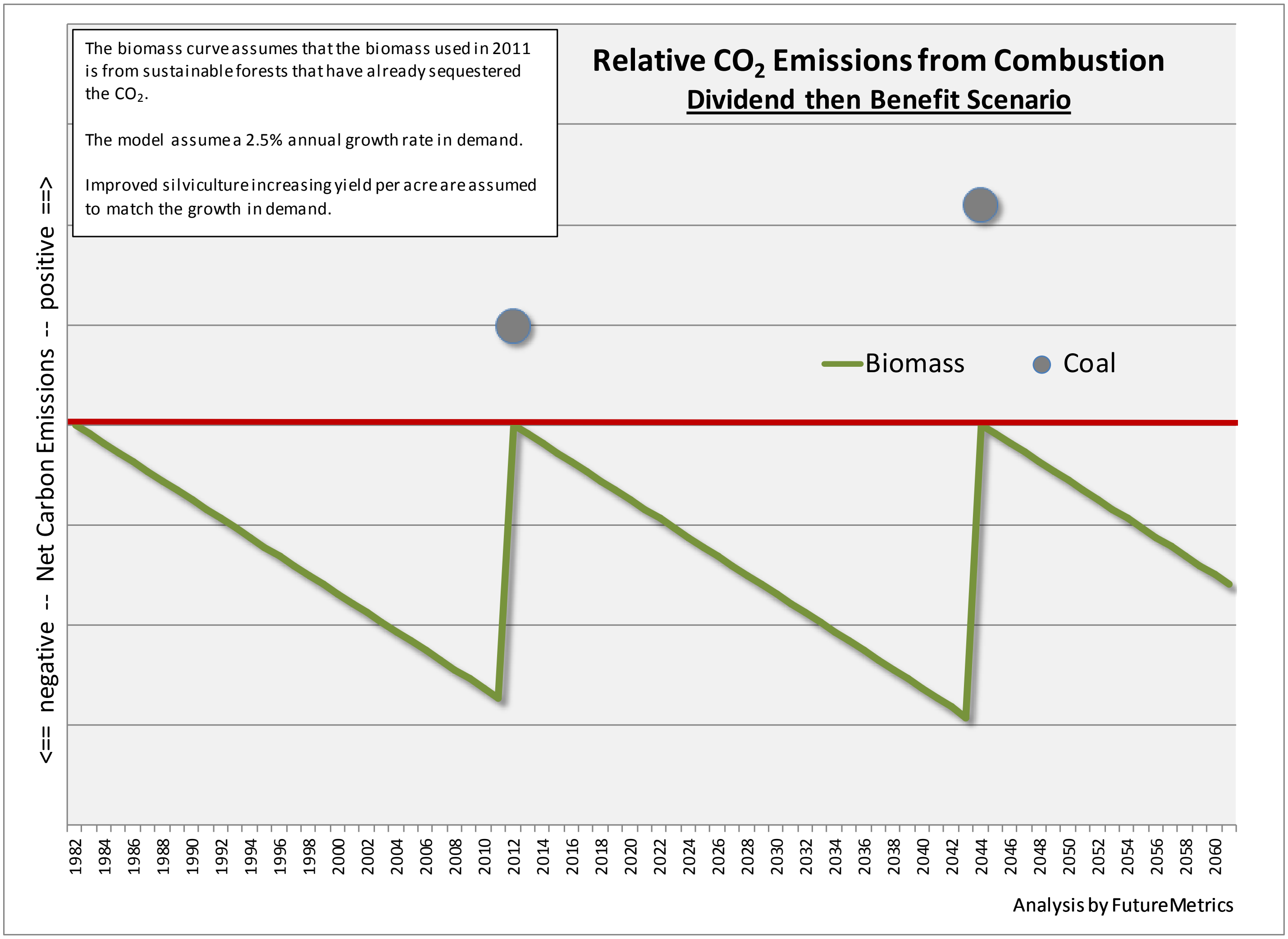
[9] In the simplest of terms (ignoring all the other ecological sustainability criteria) here we mean that the net stock of the forest systems resource is never depleted. That is, the growth to harvest ratio is equal to or greater than one.

[10] As with any limited sustainable resource, the method of use matters. Using the fuel in high efficiency and clean systems is *our* axiomatic assumption. That would mean a very high proportion of the energy would be used for thermal needs either for heating or for thermal process needs that are currently provided by fossil fuels. Home heating with pellets, heating larger buildings with chips, or combined heat and power for industry would be our recommended uses.

[11] See http://www.maine.gov/doc/mfs/pubs/pdf/biomass_memo_071708.pdf for a report on the sustainable supply of biomass and the expected improved yields from improved silviculture in Maine.



In this scenario, the accounting starts in 1982. The red line is the zero net carbon level (again, this accounting is not including any other carbon other than that from combustion and it does not consider the carbon in the stumps and other un-harvested components of the "stand"). The stand captures carbon for 30 years. The down sloping green line shows the net carbon dividend accruing as carbon is sequestered. In 2011, we compare the net CO_2 from the stand being used for energy and for a quantity of coal being used that yields the same amount of energy. The stand gives up its dividend and the coal releases its net new carbon (the grey ball). The stand regrows over the next 30 years (it is larger this time due to improved silviculture) and has enough energy to match the necessary coal needed for the increased demand[12].

Clearly this scenario has a number of simplifying assumptions that may change the shape and magnitude of the points on the chart. But the underlying conclusion is also clear: if biomass is harvested from existing forests that will be sustainably managed in the future, there is no debt.

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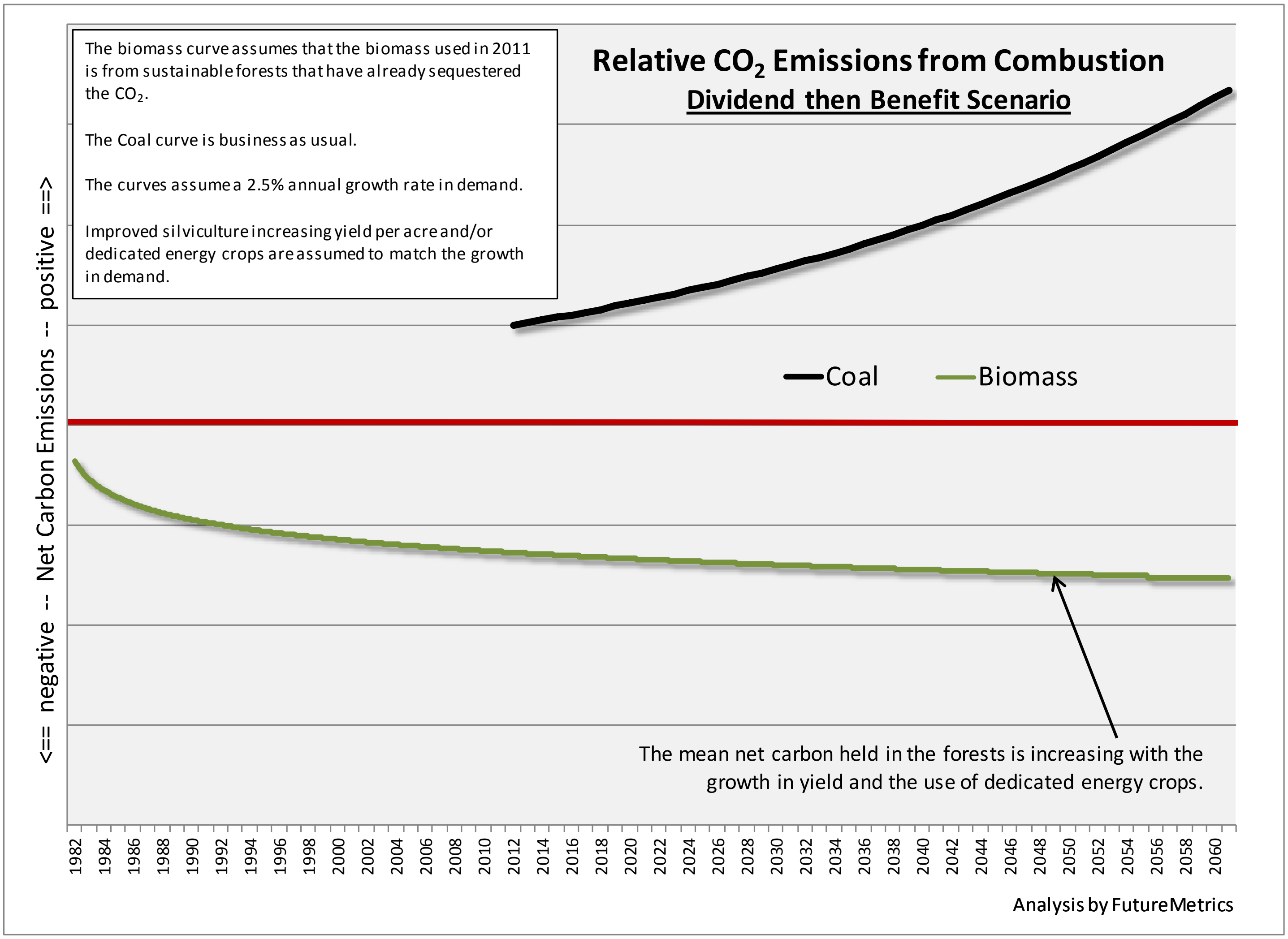
[12] The assumption that the net forest biomass per acre increases is not necessary for this logic. This exercise is based on data that shows that yields in the northern forests could be significantly improved (as they are already in European managed forests). If yields do not improve, then the grey balls would be at the same level and the net carbon dividend over each growth cycle would be the same.

Looking at the same "dividend-then-benefit" story from a system perspective rather than just a single set of trees, the benefits of using sustainably managed forests for energy versus business as usual become even clearer. The assumption is that those trees harvested every year starting in 2011 have completed their dividend gathering in the preceding growth cycle which, in this model, began for the first trees in 1982. Also, we can broaden the scope for increased yield to include not only better forest management practices but also dedicated energy crops.



Sustainable use of the Accrued Carbon Dividend

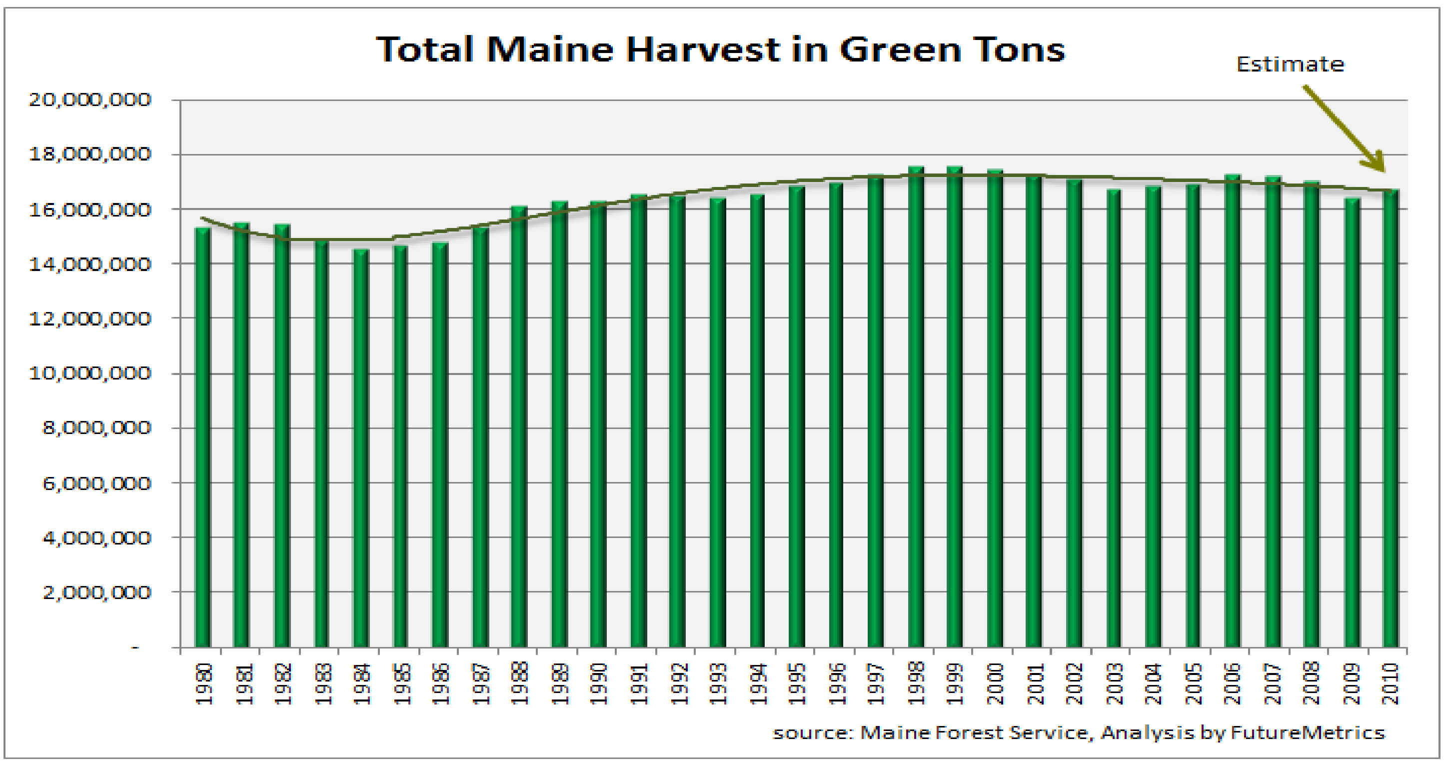
Of course this analysis depends upon the assumptions that the stock of biomass (and therefore sequestered carbon) has been more or less constant for a growth cycle and that the yield per acre would be expected to improve in the future.

This remaining analysis will focus on Maine's forests and will prove that, for Maine, those assumptions are true. Maine is the focus of this last section because Maine has very detailed and current data and because FutureMetrics has provided analysis on Maine forest characteristics as they relate to wood-to-energy for more than 5 years[13]. However, we expect that most if not all of the states in the northeast have systems of forest resources with accrued carbon stocks that can be applied sustainably to use for energy.

The Manomet authors have made it clear that their study's scope was limited to Massachusetts[14]. It is possible that Massachusetts cannot support any further growth in the use of wood for energy without depleting the stock of trees (and therefore creating a net loss of sequestered carbon over time). But the shortcomings of Massachusetts in terms of forested land versus potential demand on the forest resource, first, should not be assumed to be generalizable to other states; and second, do not change the Manomet study's fallacy of not accounting for the already accrued carbon dividend from those working forest systems that do have a history of sustainable management whether they are located in Massachusetts or elsewhere.

As it shown in the following pages, the characteristics of Maine's forests clearly support the premise that Maine has an accrued carbon dividend and that the net carbon stock in Maine's forests can not only remain constant, but can grow larger over time.

The total harvest in Maine has been relatively stable for the last 30+ years as the chart below shows.



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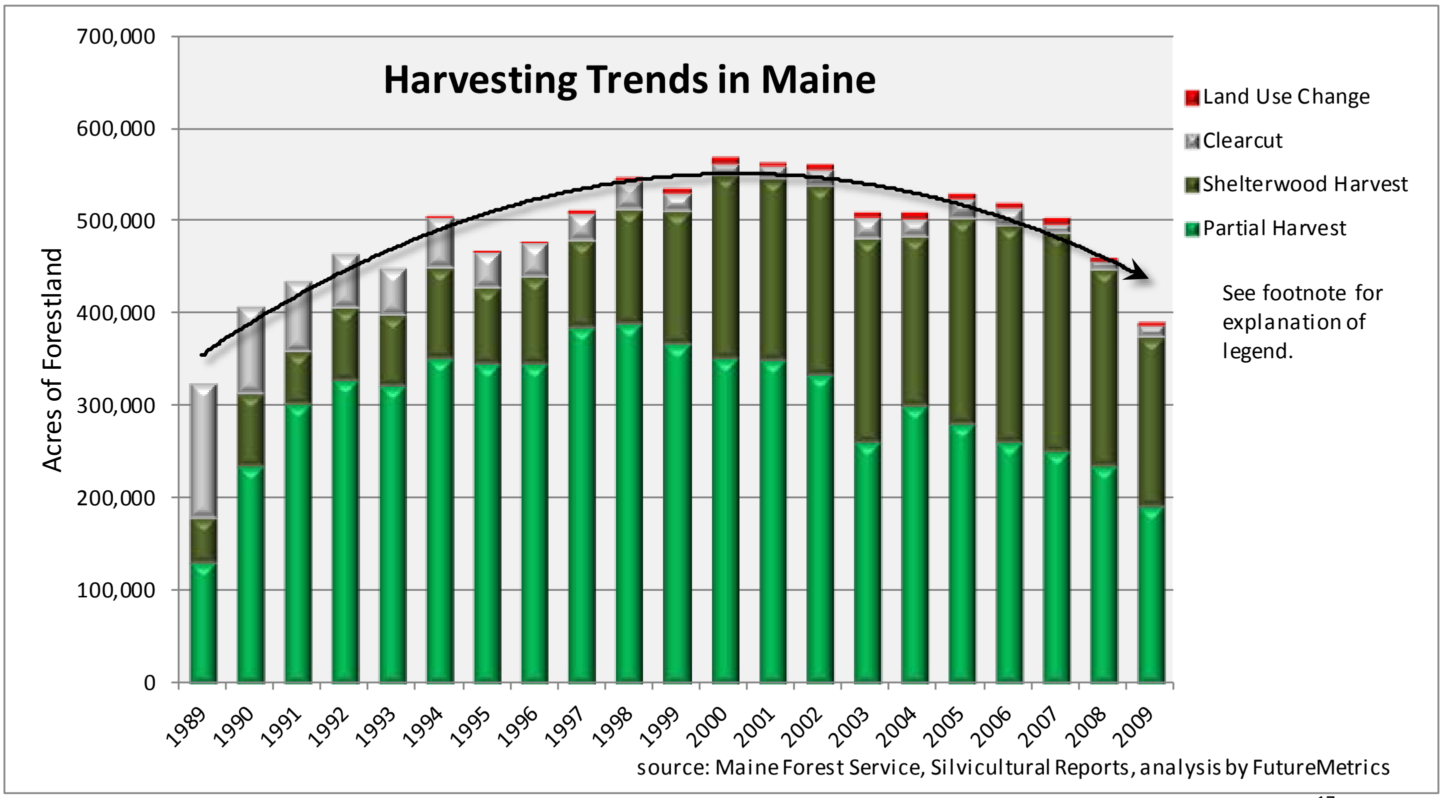
[13] Dr. William Strauss was asked to and did serve as the chief economist on the Maine Governor's Wood-to-Energy Task Force in 2008.

[14] That caveat is often overlooked by the media, by opponents of the use of wood for energy, by policymakers in states other than Massachusetts, and even by several of the Manomet study authors in some presentations that have been observed by the author of this paper.

The fluctuations in total tonnage between 15 and 17 million tons per year have also resulted in fluctuations in the number of acres harvested each year in Maine (see chart below). Of the 17.7 million acres of forestland in Maine, between 400,000 and 500,000 acres per year were actively engaged in the harvesting of sawlogs, pulpwood, biomass, and firewood between 1991 and 2009. That is between 2.5% and 2.8% of the total forested land in Maine. The total forested land in Massachusetts is 3.2 million acres[15] which obviously can support a far lower annual sustainable rate of harvest. The fact that Massachusetts has a much smaller forest resource and that the forest products industry is relatively insignificant compared to Maine (and other northeastern states) [16] may be a contributing factor to the Manomet study's misunderstanding of forest growth cycle dynamics.

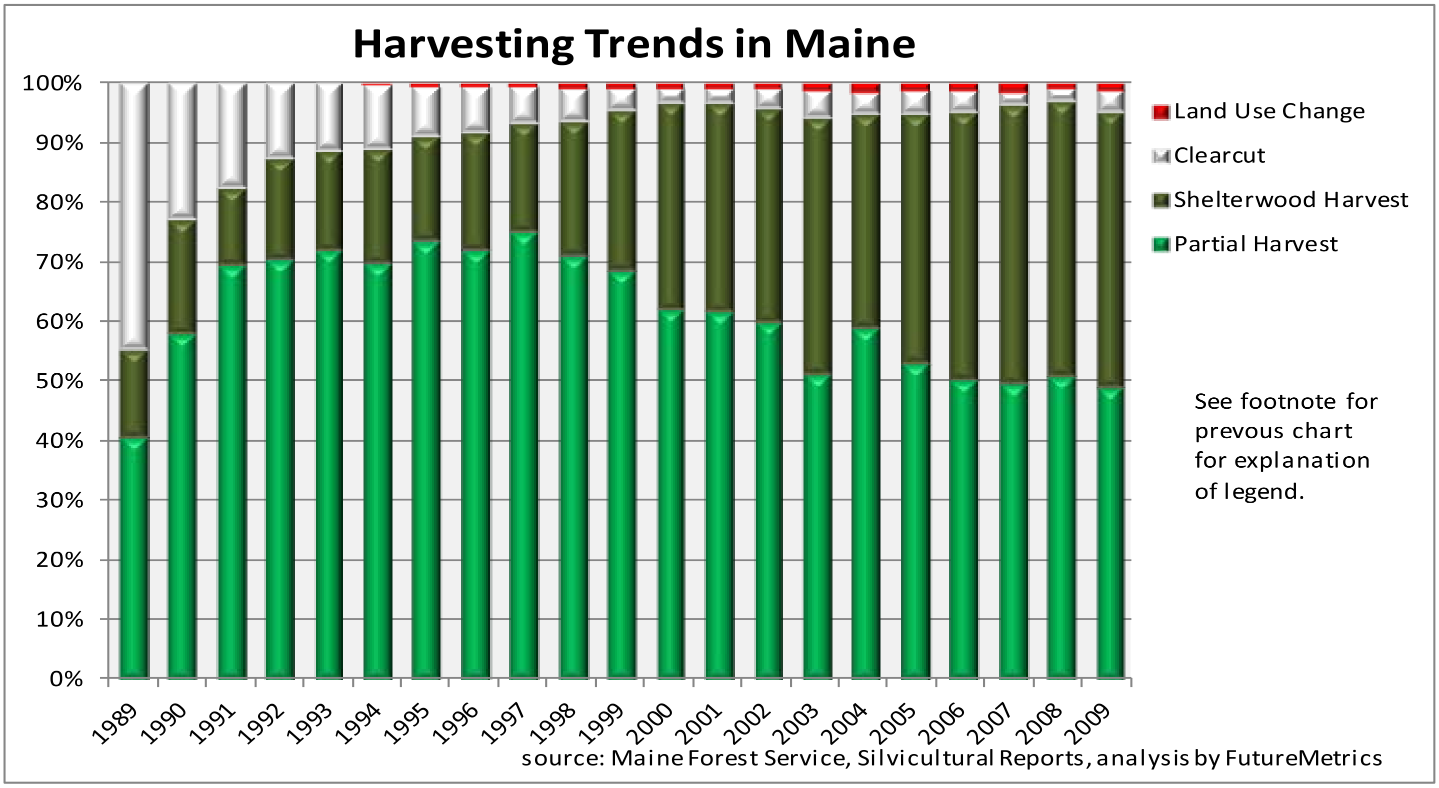


[17]

The trend in how many acres are harvested in Maine in the chart above tells several stories.

[15] Forested acreage from "Forest Resource Fact Sheets," USDA, 2011.
[16] Forestry alone accounts for 1.48% of gross state product in Maine compared to 0.24% in Massachusetts (US Census, table 571, GDP by industry and state). Forest based manufacturing provided a high proportion of gross state product. It provided 31% of the manufacturing gross state product in Maine in 2005 ("The Economic Importance and Wood Flows from Maine Forest, 2007" by the North East State Foresters Association).
[17] Partial Harvest: Harvest where trees are removed individually or in small (<5 acre) patches.
Shelterwood: Harvest of mature trees from a forest site in two or more stages. The first stage removes a portion of the trees to allow establishment of regeneration before the remaining trees are removed in subsequent harvest.
Clearcut: Harvest on a site larger than 5 acres that results in a residual basal areas of acceptable growing stock trees >4.5" DBH of less than 30 square feet per acre.
Land Use Change: Harvest conducted to convert forestland ton another use such as house lots, farm pasture, etc.

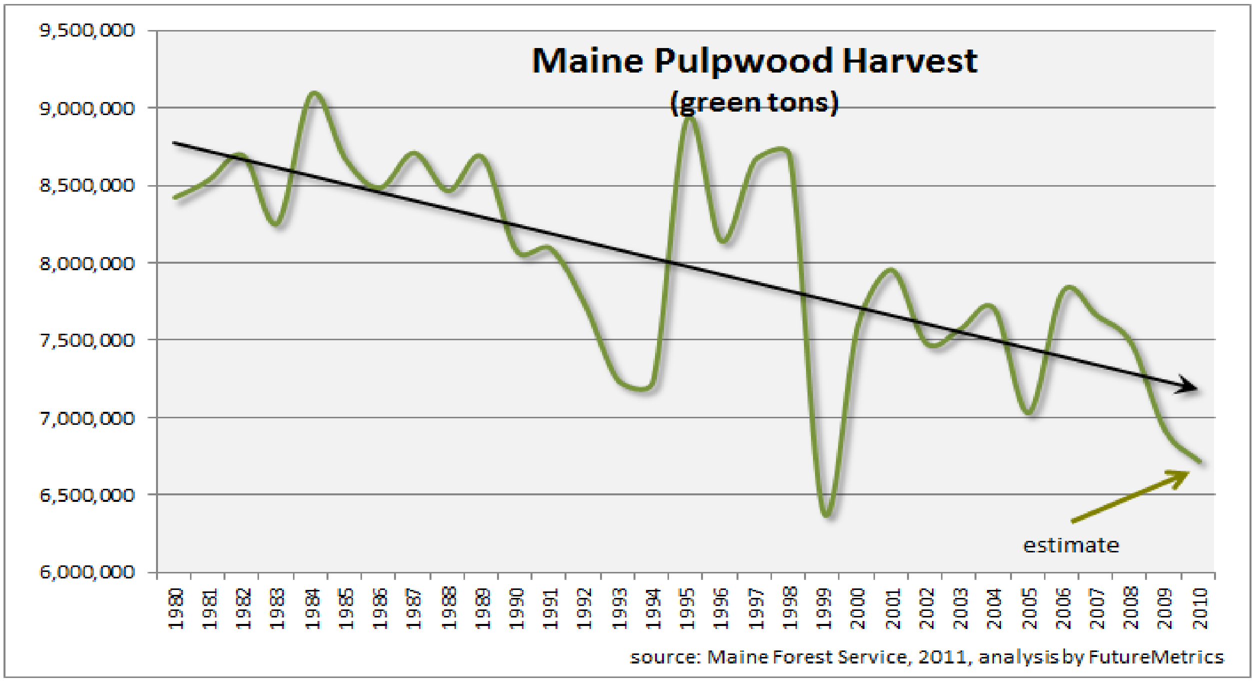
The chart below shows that clearcuts have steadily declined from more than nearly 133,000 acres in 1989 (44% of the total harvest) to less than 15,000 acres in 2009 (3.8% of the total harvest) as better and more sustainable forest management methods are embraced by the landowners.

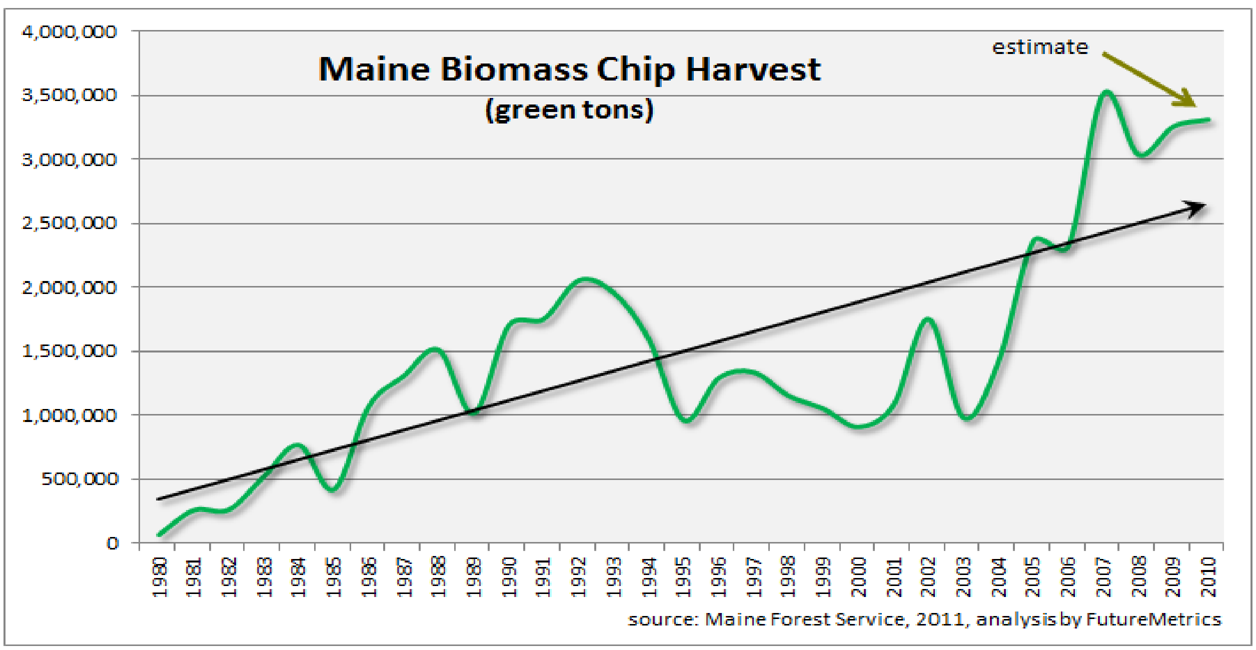


The chart above also shows the increased uses of "shelterwood" harvests and the decline of clearcuts. These improvements in silvicultural practices are gradually increasing the health of the forests and the yield per acre.

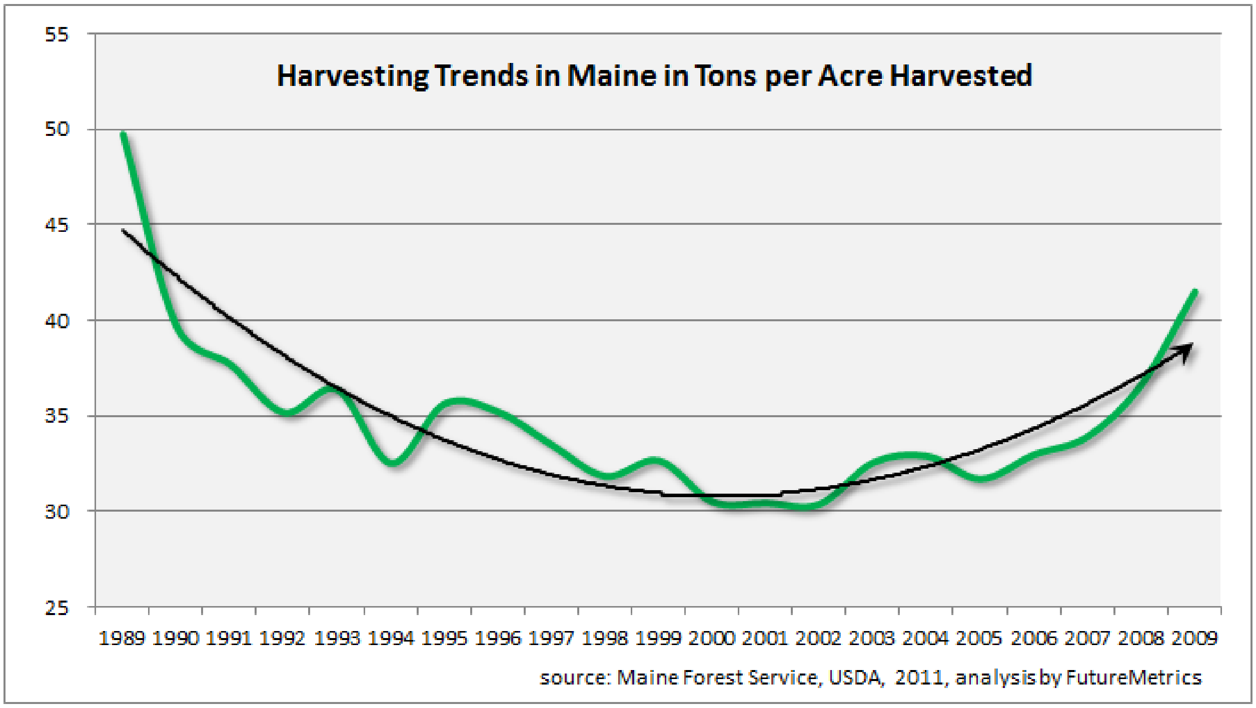
Another reason for the change in yields per acre is that the components of the total harvest have changed. In recent years the demand for pulpwood and therefore the harvest of pulpwood has declined. Concurrently, the demand for biomass chips has increased as wood-to-energy demand has increased. Biomass chips can be created from some parts of the trees that do not otherwise have commercial value. More of what was once considered waste is now being brought out of the woods. This has effectively increased the yield per acre[18]. The charts below show these trends.

[18] Maine Forest Service guidelines and sustainability certifications such as SFI and FSC require that parts of the harvest be left on the forest floor to maintain balanced forest ecology. Most of the larger industrial parcels (87% in 2005 as reported by the Maine Forest Service) are SFI or FCS (or both) certified.





The “dividends” of the investment in improved silviculture in Maine in previous decades, and of a broadening support of the working forests by the growth of the biomass to energy sector are contributing to an improvement in forest productivity. The shift away from the unsustainable practices of the last century left more trees per acre in the forest systems and required more acres per year to be harvested to yield the same output in tons. This “investment” (and the decline of clear cutting) caused the yield per acre to decline from 1989 to a low point in 2002. As the chart below shows, the dividends from that investment along with the increased harvest of biomass chips have made Maine’s forests more productive.



These conclusions complement those of the Maine Forest Service who wrote:

> An analysis of highly reliable existing information on Maine's forest resources indicates that, **with improvements in forest utilization and silviculture, Maine's forests are capable of producing substantially more wood than they do currently,** while at the same time retaining the number of den trees, snags, large dead logs, and limbs and tops needed to maintain or improve site fertility, wildlife populations, and biodiversity[19].

Conclusion

The Manomet study has an embedded axiomatic assumption regarding carbon accounting. The foundation of the study is a "debt-then-dividend" flow for carbon accounting. This paper has shown that this so-called axiom is a flawed basis for a proper understanding of the carbon benefits that wood-to-energy can provide. In fact, Manomet gets it backwards. There is no debt if the forest system has been in growth-to-harvest equilibrium or has a growth-to-harvest ratio greater than one and the forest is managed sustainably so that the net stock of biomass does not deplete. This is true in aggregate for Maine and it is true in other locations.

Wood-to-energy from sustainably managed forests, as this paper has shown and as all of Europe has codified in its carbon accounting rules, can provide net zero carbon emission or even positive carbon sequestration[20] if the woody biomass stock is not depleted or grows over time.

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[19] From "Maine Forest Service Assessment of Sustainable Biomass Availability," July, 2008.

[20] This is based on the combustion of the fuel only. A complete life cycle analysis will, as long a fossil fuel is used in harvesting and transportation, always have some positive carbon emission components.