Remarks to the EPA Science Advisory Board Panel on Bioenergy Accounting

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March 25, 2015

Thank you for the opportunity to present to you today. I'd like to offer four basic remarks.

1. SCOPE OF THE POTENTIAL BIOMASS DEMANDS:

My first observation is that the potential quantities of biomass, from forests or otherwise, that may be demanded for bioenergy if it is treated as favorable from a carbon standpoint are very large. They also come on top of very large increases in demand for biomass for other human needs.

- In general, demand for food crops, milk and meat from pasture, and commercial timber is likely to grow 70% or more by 2050. These growth rates mean that there is no free land, and that yield growth potential is already in heavy demand if the goal is simultaneously to preserve terrestrial carbon and the forest carbon sink.
- If all existing timber harvest in the U.S. were diverted to energy use, and even if it could be used with the same efficiency as fossil fuels, the maximum contribution to US energy supply would be roughly 3.5%. On a global basis, the figure would be 6.5%. (See table in appendix.) Accounting even for some modest reduced conversion efficiencies compared to fossil fuels, the figures are probably more like 2.5% and 5%.
- An Energy Information Administration analysis projects that at moderate carbon prices, biomass used for electricity will grow by 4% by 2035 if it is viewed as carbon neutral. That would require an amount of biomass roughly equal to 70% of present US timber harvest. The International Energy Agency estimates that treating biomass as carbon free, as part of a reasonably aggressive climate program (450 ppm), would lead to an increase in electricity consumption from biomass of 6%. That would require an amount of biomass equivalent to 140% of all commercial tree harvest today.
- Global targets articulated by some, including sometimes the IPCC, of 20% of global energy by 2050 would require an amount of biomass roughly equal to 100% of human harvests today of crops, crop residues, grasses for livestock and wood.

How the US treats biomass is likely to affect how other countries treat biomass, and we should act from the presumption that other countries will do roughly the same. There are therefore a few implications of these figures:

- The scope of the potential impacts on the world's forests and landscapes is almost unprecedented.
- Even without additional biomass demand, there will be a huge stimulative effect on production in all its forms from increased demand. The effects on yields of crops, pasture or timber production of additional demand – assuming there is some – is likely to be at points of diminishing response due to basic economic principles of diminishing returns. Even if we had well-derived economic factors for estimating supply and demand responses, the potential and in fact likely market effects of treating biomass as carbon-free or low carbon fuels, are likely to lie well outside of the range of any changes used for prior estimates.

2. THE WORLD ALREADY HAS AN AGREED METHOD FOR COUNTING THE CARBON EFFECTS OF BIOMASS, WHICH REQUIRE IMMEDIATELY COUNTING CHANGES IN TERRESTRIAL CARBON.

Listening to the debate about biomass, one of the strange claims is that treating biomass as anything other than carbon-free contradicts IPCC guidance on national greenhouse gas reporting. The truth is the opposite.

Under consistent IPCC guidance, including the 2006 AFOLU guidance, if a tree is harvested for bioenergy, the carbon emitted from combustion is not counted but the loss of the entire tree's carbon stock is supposed to be immediately counted. The result will be that in the year counted, harvest of trees for biomass will result in increased emissions because the avoided fossil fuel emissions will be far less than the lost carbon stocks due to a variety of efficiency losses. (Those losses include substantial tree carbon that is killed but not removed, reduced combustion efficiency, and higher carbon content of biomass per unit of energy.) Thus, in the U.S., if we harvest more trees for biomass, we will report net increases in emissions in the years harvested.

In addition, even if the US responds to biomass by diverting its existing pulpwood and then importing more pulp, the country that produces that additional pulp elsewhere through additional tree harvest is required to report the carbon loss from that harvest. The IPCC guidance was not concerned with apportioning responsibility for emissions but merely for accurately counting them on a global basis.

It is true that if additional tree harvest leads eventually to additional tree growth as young trees regrow, that growth will count as a carbon gain. But the time counting is annual. By 2030, for example, reports from US and the rest of the world would result in accurate reporting of cumulative changes in net emissions based only on what has happened to the landscape by then. Thus, when the world judges whether the US has met its pledges, this approach will be used to count it.

What this means is that when governments translate national reporting guidance into regulations that apply only to the energy sector – if they choose to ignore the very real carbon emitted from smokestacks -- they therefore have to account for the changes in forest (and other terrestrial) carbon stocks if their accounting is to be consistent with IPCC guidance.

Put simply, the IPCC guidance says: Count bioenergy impacts by looking at changes in terrestrial carbon. Unless that is done, national regulations will be inconsistent with national reporting.

Moreover, unless we wish to claim unfair credit for bioenergy that results from importing more biomass, we also need to account for international impacts on forest carbon. That is not because of "international leakage." The real emissions from the use of biomass occur in the US when we burn it – and when we also use pulp products in other ways. The question is whether the US can ignore these emissions based on claiming credit for increased carbon uptake abroad. If the US therefore chooses to ignore these emissions from combusting biomass, the IPCC guidance says it can only do so with scientific validity if it counts the changes in terrestrial carbon where they occur.

3. INSUFFICIENT ECONOMIC EVIDENCE IS AVAILABLE TO SUPPORT USE OF ECONOMIC MODELS TO CLAIM THAT BIOENERGY RESULTS IN INCREASED RATES OF FOREST CARBON ACCUMULATION ON A GLOBAL BASIS.

One of the two main questions in the proposed framework I wish to focus on is whether, and if so, under what conditions, it would be appropriate to use economic models to project that increased use of biomass will result in increased forest carbon accumulation due to economic forces. According to some models, more forest product demand might result in additional regional or even global tree planting, or on a regional basis, might lead forest owners to forego tree harvest in anticipation of higher returns later.

This kind of analysis is critical to the framework EPA has put out with some extraordinary results. According to at least one of its major scenarios, every ton of carbon removed from a southern forest for bioenergy will result in an increase in forest carbon by 0.4 tons. In other words, even without bioenergy, additional wood demand increases forest carbon. Put another way, so long as the wood is paid for, buying large quantities of wood for bioenergy and burning it in an open bonfire would lead to increased forest carbon.

If this result is true, then the tens of millions of Americans who participate in paper recycling programs are doing serious environmental harm by depressing demand for pulpwood. Those policies are motivated by the broad understanding that globally, wood harvest has had enormous impacts on forests and continue to have these effects. If you examine Global Forest Watch, you can track the loss of global forest cover, a large fraction of which is due to wood harvest. Before the EPA is prepared to accept that kind of result, it should have a very strong evidentiary basis.

With all due respect to the economists on the SAB panel, I would argue the following:

- There is insufficient evidentiary basis for believing that increased demand has led to additional forest carbon growth globally.
- Any legitimate analysis would have to account for changes in all land uses on a global basis, including agricultural land uses.
- The tools and quality economic evidence are not available to make these kinds of economic projections for bioenergy
- It should not be enough just to have a policy that says use some kind of model. Models differ dramatically in results. The SAB should ask EPA for descriptions of the ten most important elasticities and supply or demand functions in its FASOM modeling, as well as the underlying empirical studies on which they are derived and assess whether they provide reasonable confidence of these projections.

A. ***Historic experience in the U.S*:**

Over the last 50 years, the US has had increasing forest removals, roughly stable forest area, and increasing carbon stocks. This pattern has led some to claim that increasing demand for wood is the cause of these increases in carbon stocks.

What this argument ignores is the power of exogenous factors, and I mention here only two.

- First, there has been a large decline in agricultural area. That is in part due to a decline in bioenergy in the form of draught animals. As late as the early 1930's, according to USDA data, the U.S. still had tens of millions of acres devoted to small grains for draught animals, and some unknown number of additional acres devoting to grazing land for them. There has probably been well more than a 50 million acre decline in such land uses – the decline in land used for oats and rye alone are roughly that much area. What that means is that there has been a huge increase in availability of land for forests. Any estimate that increased wood demand has led to additional area planted in forests must somehow factor out these huge exogenous changes. I have not seen any analysis that has credibly done so.

- Second, climate change and rising carbon dioxide have themselves had large effects on forest carbon accumulation rates. If you use USFS data for 1997 and 1952, southern forests were growing at 114 more cubic meters per year and removals were higher by 127 cubic meters, implying a net growth in accumulation rates absent removals of 231 cubic meters or around 115 dry tons. US Forest Service, US Forest Facts and Historical Trends (2000). Over an area of roughly 90 million hectares, that implies a growth rate of around 1.3 tons per year or around 2.6 tons of wet weight. (I am deliberately using rounded numbers because conversion numbers are not known with precision.) But one well-regarded paper from the Smithsonian Environmental Research Center estimated that forests in its long-term trend studies unaffected by changes in management were growing at an additional rate of roughly 4 tons of wet weight per hectare per year over an average of age classes (S. McMahon et al., 2010. Evidence for a recent increase in forest growth, *PNAS* 107:3611-3615). There is a large uncertainty about those numbers over the broader landscape, but these exogenous factors are undoubtedly very important, and could possibly even explain the entire increased rate of forest stock accumulation.

Moreover, the impact of demand must be judged globally. It seems likely that the growth of planation forests has somewhat increased forest stock accumulation rates in the U.S. But the U.S. has also increased its net imports of wood products. It is likely that overall forest products are harvested less efficiently globally than on managed forests in the U.S., implying larger losses of carbon for each cubic meter of wood ultimately supplied. Many forests, once harvested, never regrow because road building and related factors leads to some form of agricultural conversion. An analysis would have to account for these impacts globally.

B. **Need for global analysis of all land uses**

The EPA draft analysis achieves its results in part because it provides a purely regional analysis and ignores what others would call “leakage,” and what should really be thought of as true “additionality.” According to the model, forests gain carbon in part because forest owners reduce their immediate harvests in anticipation of higher future returns. They also plant some more land. Assuming the first response is valid, that will generally require that pulp be supplied elsewhere, quite likely from abroad. An analysis that ignores the impacts of that replacement wood is in effect assuming that wood now used for other pulp purposes is carbon free and therefore its diversion is “additional.” Global impacts must be analyzed to determine whether there really is additional carbon.

Additional tree planting also has to be done on some land, presumably land in agricultural use. With such large expected increases in crop and pasture demand, these products need to be replaced elsewhere. Again, without a truly proper analysis, there is no reason to believe that leads to net carbon gains.

Even theoretically, therefore, the modeling is inadequate and in effect assumes that existing pulp supplies and agricultural land are carbon free resources. They are not. I question whether any model can legitimately do this global analysis in a credible way, but ignoring the carbon "opportunity costs" of these resources cannot be valid.

C. The economic evidence needed for credible modeling?

The number of economic parameters and functions (and even biophysical parameters) necessary for doing this kind of modeling is very large. I will mention just a few.

- *Relative elasticities of supply from more intensive management, additional area expansion, and harvesting existing forests*. Models that project additional forest accumulation are based on projections that the additional plantings and growth rates from management in effect dominate over just harvesting existing forests more. What is the actual evidence for that? Because of carbon dioxide and nitrogen fertilization and climate change, forests are accumulating carbon worldwide by large amounts. (That does not mean harvesting them more has no biodiversity effects because they are harvested in one place even if higher growth occurs across all forests.) Moreover, in a proper global analysis, these elasticities and functions must be understood (a) in all substantial wood supply markets, and (b) in the relationships between these markets. How valid are these estimates?

- *How would these elasticities be affected by the large increases in demand?* Even if we knew these parameters and functions in the past, what will they be like in the future? Supply functions are constantly changing with development. Every time a developing country builds a new road near forests, it makes it more likely that forest will be a source of global supply rather than more intensive management. Many Asian countries are planting forests in large part for erosion control. And the size of the potential demand for bioenergy is likely to make the demand shock far larger than any shock used to estimate prior responses.

- *How much carbon is lost for each ton of wood produced in different forests globally*? A critical factor in evaluating bioenergy is how much carbon is lost relative to each ton of wood produced. Doing this analysis globally requires this figure. Although we should generally believe that loss rates are much higher in less managed forests, much is not known.

- *Will the demand be persistent?* The basis for the EPA modeling projection of increased forest growth is not the immediate demand but the projection of likely growth in future demand. Without that future demand, forest owners will just cut more trees. How likely is that future demand to occur and will landowners really bank on that growth? Solar energy is dramatically more efficient per acre than bioenergy, and its storage technologies are rapidly improving. EIA projections largely estimate that electricity will rely on biomass for co-firing, not for stand-alone electricity production, so as larger greenhouse gas reductions are required, bioenergy may no longer be economically viable. (Even so, the likely impacts for a few decades on forest carbon could be quite large.) This critical assumption is basically just that, an assumption.

- *SAB analysis*: Models differ enormously in their results. While the EPA, using FASOM, is now projecting more forest carbon, Roger Sedjo, a member of this panel, put out a projection from his model that the primary source of biomass for ethanol would come from diverting the great majority of U.S. wood pulp to bioenergy. Previously, Dr. Sedjo had put out a paper projecting more plantings. Relatively small changes in parameters and functions can have large effects. I personally believe Dr. Sedjo's new analysis is more credible for the simple reason that U.S. pulp is cheap, and that pulp can be replaced by relatively cheap international supplies. But the likely carbon effects globally are harsher than if the U.S. simply increased its own harvest of managed forests for pulp because we can anticipate that foreign suppliers on average will overall manage their forests or harvest their timber less efficiently than we do.

Proper economic analysis is extremely hard. It requires instrumented analysis to truly separate exogenous from endogenous effects, to segregate supply and demand feedback effects, and to filter out the effects of unexplained variables. I have seen very little forest economic literature using these modern approaches.

For this reason, I encourage the SAB to ask the EPA to provide at least the major elasticities and functions used in its modeling as well as to describe in detail the empirical studies on which they are based.

4. ACCOUNTING FOR TIME

The accounting for time in the SAB proposal is grossly inadequate. I believe the issue is actually simpler than people think and I address it in two ways.

First, the question EPA is facing is not the relative value of greenhouse gas mitigation today versus in the future (or the relative harm of emissions at different times). This decision has in effect already been made. Based on its analysis, President Obama has pledged the U.S. to reduce emissions by a certain level beginning roughly today and achieving certain reductions in 2030. As a result, utilities are obligated (in part through state action) to achieve certain levels of reductions starting right away. The first question is whether actions that actually increase emissions during these time periods should be treated as reducing emissions based in effect on a kind of promissory note. I do not believe so. They will not be counted this way in our international reporting, and I do not believe countries will credit the US with these claimed "reductions."

But even if that approach might be acceptable, the second question is how regulations should distinguish between actions that cause immediate reductions as required by regulations and actions that actually increase emissions for many years but promise to reduce emissions in the long run. This question is no different for bioenergy than for any other mitigation strategy.

In effect, those who would shift to bioenergy and increase emissions for many years are asking to be treated as providing precisely the same value of emissions reductions as utilities that immediately reduce emissions. And if that is the case, then all utilities, whatever their compliance pathway, should be entitled to claim compliance by actually increasing emissions so long as they promise to compensate (without any discounting) by reducing emissions eventually.

For basic economic reasons that cannot be valid because every regulated entity would wait if only because that entity can use capital for alternative purposes in the meantime while also allowing for technological change to provide more mitigation options.

Think of this as an emissions trading system. Any utility required to reduce emissions in year one could alternatively increase emissions and reduce them down the line, but it would have to buy emissions credits. It would then have to pay interest on the money used to buy those credits. Moreover, it would probably demand a premium on this investment because of various uncertainties. If you discount with any reasonable discount rate, the economic value of actions that increase emissions in the short-term quickly falls to zero with even modest payback periods. For example, if bioenergy doubled emissions in year one, and then mitigated those emissions at 5% per year so that it reached parity after 20 years, the mitigation value (assuming constant credit value) would just pay off the interest on the initial investment at 5% per year without ever paying off the capital, which means the "mitigation" would have no economic value even if continued indefinitely.

There is no reason to distinguish bioenergy from any other form of mitigation. If EPA allows utilities to mitigate based on long claimed payback periods for bioenergy with no discounting, it logically should allow the same deal for any other mitigation strategy.

Second, even if this question were focused on the relative value of mitigation, there is an established literature on this, almost all of which is ignored. The U.S., for example, has used this literature to establish a social cost of carbon, which also establishes a value of mitigation in different years. If you use these modeling approaches to estimate the value of a bioenergy choice that increases emissions in year one and then pays it back over time, you will find that the value of the mitigation goes to zero over a few decades depending on the size of the initial increase. There are many possible parameters that could be used, but with initial emissions of double those of fossil fuels in year one and reasonable regrowth rates, the value is likely to be zero according to these models.

I am not particularly sanguine about these economic models of climate change because they tend to underestimate the impact of uncertainty and downside risks and therefore also the flexibility provided by the value of immediate reductions. However, even if the EPA were to use these standard approaches to measuring the economic value of mitigation, it would have to evaluate bioenergy using short time periods.

Wood Production and Potential Energy Supply Using FAOSTAT Data by Country or Region				
	Canada	European Union	United States of America	World
Item				
Roundwood (cubic meters)	135,655,250	412,879,661	340,363,718	3,403,189,709
Roundwood (Coniferous) (cubic meters)	111,106,615	281,991,856	207,664,423	1,134,700,239
Roundwood (NonConiferous) (cubic meters)	24,548,636	130,887,805	132,699,296	2,268,489,470
Wood Residues (cubic meters)	8,774,000	44,200,075	13,875,000	130,170,948
Oven-dry Roundwood in tonnes[1]	58,503,755	184,352,975	154,751,809	1,652,781,791
Exajoules of Roundwood	1.17	3.69	3.10	33.06
Primary Energy Consumption in Exajoules	13.8	70.8	95.0	513.9
Percent Roundwood is of Primary Energy	8.5%	5.2%	3.3%	6.4%
Oven-dry Wood Residuals (FAO definition of residues)	3,783,945	19,735,570	6,308,491	63,218,389
Exajoules of residual wood[2]	0.1	0.4	0.1	1.3
Percent Wood Residuals is of Primary Energy	0.5%	0.6%	0.1%	0.2%
Percent Total Wood (roundwood plus residuals) of Primary Energy Consumption	9.0%	5.8%	3.4%	6.7%
Electricity Consumption KWH	549,500,000,000	3,037,000,000,000	3,741,000,000,000	19,010,000,000,000
Total Electricity Consumption in Exajoules[3]	2.0	10.9	13.5	68.4
Percent of Electricity Consumption 100% of Wood Harvest Could Supply[4]	15.7%	9.3%	6.0%	12.5%

Sources: Roundwood and Wood Residue volumes are 2008-2011 FAOStat Forestry Production data; Primary energy consumption is BP Statistical Review of World Energy June 2012 bp.com/statisticalreview; Electricity consumption is CIA World Factbook https://www.cia.gov/library/publications/the-world-factbook/rankorder/2042rank.html#top

[1]Conversion of wood volumes to oven-dry equivalents is .411 tonnes oven-dry per cubic meter for coniferous and .523 tonnes oven-dry to cubic meters for hardwood, Table 5, USDA, Specific Gravity and Other properties of Wood and Bark for 156 Tree Species Found in North America (2009)

[2]Conversion of wood tonnage to energy is 20 GJ per tonne and 1,000,000,000 gigajoules per exajoule.

[3]Conversion of kWh is 1 kilowatt hour = 3.6 × 10^-12 exajoules

[4]Conversion of Wood to electricity is at 25% efficiency