March 23, 2016

Dr. Peter Thorne, Chair
Chartered Science Advisory Board

Dr. Holly Stallworth, EPA Designated Federal Officer
Biogenic Carbon Emissions Panel

Dr. Thomas Carpenter, EPA Designated Federal Officer
Chartered Science Advisory Board

Dear Dr. Thorne, Dr. Stallworth, and Dr. Carpenter,

The following comments on the report by the SAB Panel on biogenic carbon accounting focus on two issues of concern in the report: the Panel's endorsement of a particular economic modeling approach for assessing emissions from biomass, and the timeframe for assessment of net emissions. Our comments focus mostly on the problems with the report's approach as applied to forest-derived biomass.

All page numbers provided in these comments refer to the page of the whole pdf of the Panel's report, not the page numbering system used in the document.

Context

The Biogenic Carbon Panel was assembled to critique EPA's framework for assessing biogenic emissions, an approach originally conceived to count smokestack emissions of CO_2 from power plants burning biomass. Rather than simply summing the tons of CO_2 coming out the smokestack, as would occur for a fossil-fired plant, EPA wanted a way to adjust biogenic emissions to account for their hypothetical future offsetting by new plant growth.

EPA initially proposed a framework that, in one configuration, would simply treat smokestack emissions from power plants burning wood as zero, as long as regional land carbon stocks either didn't change, or increased, in the period over which the facility was operating.

The panel ultimately rejected this approach and instead proposed a modeling approach that compares future land carbon stocks under a bioenergy scenario to stocks under a counterfactual scenario. This approach was subsequently refined to enable the model to sum yearly differences between the two scenarios. With a counterfactual approach (calculating the net CO_2 emitted under a bioenergy scenario, compared to a business as usual scenario, as the converse of the carbon stored on land) one must devise a scenario of emissions if biomass weren't burned for energy, and instead underwent an alternate fate – for instance, trees continuing to grow, or, being harvested for pulp feedstock, instead of fuel.

A land-based carbon framework allows all the carbon emissions associated with biomass use to be accounted for, rather than just the CO_2 coming out the stack. This provides a more realistic assessment of the amount of carbon "embedded" in woody biomass fuels, including the soil carbon that is lost from disturbance during forest harvesting, the belowground biomass that is killed and left in place to decompose when aboveground biomass is harvested; and ideally, the fossil fuel (and biomass) that is burned during biomass harvest, processing (particularly for wood pellets) and transport. None of this carbon is emitted during biomass fuel collection, processing, and transport is associated with electricity generation, thus counting it increases the amount of carbon emitted per unit energy.

Beyond the carbon directly associated with biomass collection, processing, and transport, the foregone carbon sequestration of trees that are harvested for bioenergy significantly increases the carbon impact of burning forest biomass, because removing a sink for carbon has the same effect as increasing a source. Counterfactual modeling can account for this foregone sequestration, by simulating forest growth and carbon stocks under various harvesting scenarios.

However, counterfactual modeling can be complicated. We don't know the future, and the longer into the future we try to model, the more difficult prediction becomes. That difficulty increases exponentially when modeling is conducted using an economic model like FASOM, as EPA did when it ran scenarios of biomass use and included them in the framework. The Panel is not responsible for the terrible tangle that is FASOM – but the Panel has, unfortunately, endorsed the use of massive economic models as important for assessing biogenic emissions, a conclusion that is probably inevitable given the presence of several economic modelers on the Panel.

The report remarks on the modeling approach, and admits it is still full of uncertainties:

p. 17

EPA did not ask for feedback on its modeling approach but, given that alternative approaches can yield alternative results, the choice of model is an important issue. For the task at hand, estimating BAFs, we believe that an integrated modeling approach that captures economic and biophysical dynamics and interactions is appropriate to simulate the "with "and "without" demand scenarios to estimate the additional effect of bioenergy demand on CO_2 emissions. Additionally, given the temporal scale of these impacts, the potentially wide choice of crop-based and forest feedstocks and the spatial heterogeneity in their production conditions, the dynamic model would need to include both the agricultural and the forestry sectors, competition between land using activities, investment decisions that consider potential future returns (especially for slower growing, long rotation feedstocks), and a large number of spatially distinct regions (while keeping the model tractable).

The FASOM model used by EPA for its illustrative BAF estimates in the 2014 Framework has the above ***features however there is a need for more model validation, evaluation, justification, and sensitivity analysis****.*

Economic models like FASOM often contain certain elements that predispose them to find a carbon "benefit" from burning biomass. Important among these is an "anticipatory planting" effect, whereby landowners are modeled as planting trees in anticipation of a bioenergy market emerging. Carbon sequestered by these trees is then credited by the model as "offsetting" emissions from actually burning biomass.

The Panel acknowledges there may be difficulties with this approach:

p. 17

*For example, a feature of intertemporal optimization models like FASOM, that could have implications for BAF estimates, is that l****andowners are assumed to make investment decisions based on expected current and future economic returns and engage in anticipatory planting*** *and management if economical to do so given expected future biomass demand. This assumption could imply that an increase (decrease) in demand for biomass feedstocks translates into increased (decreased) investments in feedstock production that satisfy expected demand in the future.* ***Accordingly, an increase in demand for a long-rotation feedstock may lead to a low BAF with the analytic assumption of long planning horizons. This assumption, along with other model features listed above, should be evaluated*** *when justifying alternative modeling approaches; thus* ***assessing the actual planning horizon of landowners is important****.*

PFPI submitted the following comments critiquing EPA's use of FASOM in March 2015. Page numbers and references in the following section refer to technical support documents that were provided with the version of the Framework published in November 2014. Those appendices are downloadable at https://www3.epa.gov/climatechange/downloads/Framework-for-Assessing-Biogenic-CO2-Emissions-Technical-Appendices.zip.

Anticipatory planting is a major driver in FASOM; essentially, the model allows effects to precede causes. Appendix L explains:

"The intertemporal optimization approach used in these illustrative case studies captures ***investment behavior under anticipated changes in feedstock demand; thus, land management responds in advance of an anticipated change.*** *This approach allows for a depiction of land use investment/management over the long term, which provides an improved projection of landscape-level biogenic CO2 emissions under anticipated changes in biogenic feedstock consumption than static (one-time) models or recursive dynamic models that do not react to future expectations."*[1]

The carbon sequestration associated with anticipatory planting, combined with the underestimation of bioenergy emissions due to the subtraction of avoided coal emissions, means that some of EPA's modeling runs show a significant reduction in carbon emissions with use of bioenergy. This is a highly counterintuitive result given that burning biomass for energy emits more CO_2 than fossil fuels, and that facility-specific modeling such as that conducted using the U.S. Forest Service Forest Vegetation Simulator finds that offsetting these excess emissions takes years to decades, depending on the feedstock.

The effects described for FASOM strain credulity. For instance, describing one of the scenarios where emissions are essentially offset immediately, Appendix L states:

"Initially, emissions intensity is negative and relatively large in magnitude, reflecting a net increase in carbon sequestration on the landscape driven by land-owner investment decisions (anticipatory planting) and harvest timing decisions in response to the anticipated long-term demand shift for roundwood-derived biomass. That is, landowners plant new trees and delay harvests in an effort to meet this long-term increase in demand."[2]

In fact, it seems just as likely (if not more likely) that landowners will shorten their harvest intervals in response to increased demand and rising prices!

There are other examples of unrealistic assumptions about forest management incorporated into the FASOM runs. The scenario examining use of logging residues for fuel in the Pacific Northwest is especially strange and deserving of comment. The narrative for the scenario states

"*Early in the simulation horizon, the model projects that the additional biomass requirement leads to increased forest harvest emissions. An increase in logging residue demand leads to a net increase in roundwood harvests for other products* ***in order to meet the additional residue demand****. Then, afforestation and forest management responses to the feedstock requirement lead to an increase in biogenic carbon sequestration (hence, large negative values for GROW), resulting in negative landscape*

[1] Page L-3.
[2] Page L-11.

factors from 2020–2040. Over the long term, however, this effect flips as harvest emissions outweigh growth in landscape-level biogenic carbon sequestration."[3]

In fact, harvesting for wood products is generally *not* driven by a need to generate tops and limbs for biomass fuel, but the model acts as if it is, while ignoring another, more plausible scenario – that if residues are insufficient to meet emerging demand for biomass, whole-tree harvesting might be increased in response. The assumption that "afforestation" is likely to occur in the Pacific Northwest to meet emerging demand for bioenergy is the final unrealistic piece of this scenario.
Other examples also produce odd results. For instance, as summarized in Appendix L, the model finds that cutting roundwood and residues in the Southeast ultimately drives greater carbon sequestration, meaning that net emissions are close to zero or even negative; yet burning corn stover causes net emissions, because burning stover ultimately causes more wood to be burned, which degrades forest carbon stocks.

FASOM, and models like it, can produce results that are directly in opposition to what we observe in real experience. Depending on them is risky.

Further, calculating the BAF by averaging over the whole time period modeled, as the Panel proposes to do, gives credit for carbon sequestration occurring over very long timeframes where outcomes become less and less certain. We address the issue of long timeframes for modeling in more detail below, but it is important here to note that combining complex modeling approaches, where whole sectors of the economy undergo changes in "black box" manner in response to hypothetical biomass demand shocks, with very long timeframes in excess of 100 years, is a recipe for diluting carbon impacts and muddying conclusions about atmospheric impacts of burning biomass. It's feasible to model over short periods of 5 to 15 years, because one can have a fairly high degree of confidence what the management and fate of any particular forest would be over that timeframe. However, the difficulty of predicting land-use fates increases dramatically when one is trying to prognosticate several decades to more than a century into the future.

Timeframe

The issue of the timeframe over which to evaluate emissions has been particularly controversial. EPA asked the Panel whether the timeframe for computing a biogenic accounting factor (BAF) for biomass should vary by policy, or be fixed. The panel's stance is that the timeframe is determined by finding that point at which the modeled carbon stocks of the reference and bioenergy scenarios are no longer changing relative to each other.

p. 31

To fully account for all positive and negative terrestrial effects over time, we recommend using the "emissions horizon" as described by the 2014 Framework. As defined by the EPA, this "emissions horizon" is the period of time during which the carbon fluxes resulting from actions taking place today actually occur …" (U.S. EPA 2014). In the context of an anticipated baseline approach, this emissions horizon would be the ***length of time it would take for the effect of increased demand for a feedstock on the carbon cycle to reach a state in which the difference in carbon stocks between the policy case and the reference case is no longer changing*** *or when the difference is approaching an asymptote. Defining the emissions horizon to be long enough to achieve a state where the difference in carbon stocks between the policy case and the reference case stabilizes or approaches stabilization will ensure that all positive and negative changes in carbon stocks attributable to increased use of a bioenergy feedstock have been*

[3] Page L-15.

accounted for, to the extent tractable. The time horizon could be standardized by selecting the longest time period among the various feedstock horizons and applying it to all feedstocks.

Critically, the Panel appears to think that a single timeframe – determined by the feedstock with the longest perturbation cycle – should be applied to *all* feedstocks.

However, this approach seems designed to ensure that all BAF's are minimized. The longer one runs out the clock, the smaller the BAF becomes, by definition, because it is a ratio. The numerator – the difference between the modeled biomass and BAU scenarios – keeps shrinking as carbon emissions are offset by new trees growing back; meanwhile the denominator (gross emissions) keeps getting bigger. Thus, the longer the period that is modeled, the smaller the BAF that is computed.

As the whole point of the BAF is to determine the carbon impact of different fuels through time, insisting that every fuel be evaluated over the same very long timeframe obviates the purpose. The BAF is *not* a single number – by definition, it's a dynamic curve that changes through time as feedstocks (theoretically) regrow and offset emissions from burning biomass. Taking a simple example, cutting down a tree and burning it has a large carbon impact initially; as a replacement tree grows, those emissions are mitigated by carbon uptake. The net contribution of burning that tree is large at the beginning and diminishes through time. In contrast, emissions from burning an annual grass can be offset in a shorter period of time. It is only by comparing these dynamic offsetting curves for different feedstocks that we can determine the carbon impacts of different biomass fuels. Tying calculation of the BAF to a single year in the distant future, as the Panel advocates, collapses the BAF down to a single number, eliminating the dynamic nature of the BAF and the information it contains.

The Panel acknowledges that the impact of emissions on the climate has engendered discussion, but disavows that this is the Panel's problem to address:

p. 29

The SAB's comments on time scale for determining a BAF for a feedstock focus on accounting for all direct and indirect contributions of harvesting that feedstock for bioenergy on the atmosphere. ***Our comments are not based on the impact of those emissions on the climate system****. Nonetheless, the value of emissions mitigation over time is relevant to the discussion of time scale and climate policy generally. Thus we wish to address the concerns of some public commenters who generally favored short-run emissions mitigation over long-run mitigation.*

The report then goes on to affirm what in our opinion is the erroneous conclusion that timing of emissions doesn't actually matter, and that only *cumulative* emissions matter:

p. 29

A number of existing studies (Allen et al. 2009; Matthews et al. 2009) find that the relationship between carbon emissions and their impact on the climate is not linear or immediate. These studies conclude that it is ***cumulative emissions over roughly a 100-year period that lead to a climate response and that different scenarios of emissions pathways over the next several decades that have equivalent cumulative emissions over the next 100 years are likely to lead to a similar global temperature response****. Similarly, Kirschbaum (2006) finds virtually no climate benefit for sinks established in the near term (next several decades).*

We believe this conclusion is wrong because it is based on two false suppositions, as we explain below.

First: The timing of emissions does matter

It's common sense that the trajectories for warming will differ depending on when emissions occur. Compare the following two trajectories for emissions over a 25 year period. They have identical cumulative emissions, but the amount of CO_2 in the atmosphere over the time period is vastly different. In scenario 1, emissions are front-loaded, so atmospheric CO2 increases and can force warming for the whole period. In the second example, CO2 increases abruptly at the end of the period. There are much more likely to be feedbacks and tipping points reached in the first scenario. This is an extreme example, but, according the approach endorsed by the Panel's report, the effects of these two scenarios wouldn't differ.

Scenario 1: 100 tons emitted in Year 1			Scenario 2: 100 tons emitted in Year 25		
Year	How much CO2 emitted	How much CO2 in atmosphere	Year	Emissions (tons)	How much CO2 in atmosphere
1	100	100	1	1	1
2	1	101	2	1	2
3	1	102	3	1	3
4	1	103	4	1	4
5	1	104	5	1	5
6	1	105	6	1	6
7	1	106	7	1	7
8	1	107	8	1	8
9	1	108	9	1	9
10	1	109	10	1	10
11	1	110	11	1	11
12	1	111	12	1	12
13	1	112	13	1	13
14	1	113	14	1	14
15	1	114	15	1	15
16	1	115	16	1	16
17	1	116	17	1	17
18	1	117	18	1	18
19	1	118	19	1	19
20	1	119	20	1	20
21	1	120	21	1	21
22	1	121	22	1	22
23	1	122	23	1	23
24	1	123	24	1	24
25	1	124	25	100	124
	Cumulative Emissions			Cumulative Emissions	
	124			124	

We believe focusing only on long-term temperature is a fundamental flaw in the panel's report. A given amount of emissions in the next year (or decade) leads to long-term impacts, including increased loss of sea-ice, forest die-off/fires, permafrost thawing - positive feedbacks that cannot be compensated for with equal mitigation in the future (and indeed, many of the impacts will be irreversible). It is also notable that the report does not mention of the importance of rising CO_2 for ocean acidification.

The following statement does not adequately address the near-term concerns:

"These studies conclude that it is cumulative emissions over roughly a 100-year period that lead to a climate response and that different scenarios of emissions pathways over the next several decades that have

equivalent cumulative emissions over the next 100 years are likely to lead to a similar global temperature response."

However, temperature is not the only concern in the near-term; it's the consequences of the warming on feedbacks and other immediate impacts that cannot be undone in human timescales. Allowing emissions to increase in the near-term increases the burden of reducing emissions later. If you delay taking a ton of CO2, or methane, or other climate pollutant out of the system till 2030, you have to take more out at that future date, because, for example, greenhouse gases emitted today melt arctic sea ice by a quantifiable amount, and that melting will increase solar absorption by a certain amount. This triggers 15 years more of additional sea level rise, coastal damage, enhanced storminess, enhanced air pollution, etc, that won't necessarily be recovered significantly upon a decrease of an equal number of tons in 2030 depending on the trajectory of all other emissions.

The near-term emissions matter profoundly; indeed, they are the key to making sure we don't lose the first big battle of climate change. If we let near-term emissions set off feedbacks that we can't undo, climate will re-stablize at a temperature that will make it much more difficult to return to safety.

Second: The report implies emissions would be equivalent under different scenarios, but they're not.

The panel's conclusion that the timeframe of emissions does not matter depends on comparing scenarios where the cumulative emissions are equivalent. The report states,

p.29

"These studies conclude that it is cumulative emissions over roughly a 100-year period that lead to a climate response and that different scenarios of emissions pathways over the next several decades ***that have equivalent cumulative emissions*** *over the next 100 years are likely to lead to a similar global temperature response."*

…

What this means is that an intervention in forests or farming that results in either an increase or decrease in storage of carbon or emissions reductions must endure significantly longer than 100 years to have an influence on the peak climate response ***as long as cumulative emissions from all sources are constant****.*

For a comparison between a bioenergy and a no-bioenergy scenario, however, which forms the basis of the counterfactual approach for determining net bioenergy emissions, emissions would *not* be equivalent. Per unit energy, at the stack, wood burning power plants emit about 1.5 times as much CO_2 as coal plants, and 2.5 – 3.5 times as much CO_2 as natural gas plants.

CO_2 Emission Rates From Modern Power Plants	Lb CO_2/MMBtu	Facility efficiency	MMBtu /MWh	Lb CO_2/MWh	Biomass v. Tech
New gas combined cycle[a]	117	51%	6.7	**786**	385%
New subcritical coal steam turbine[b]	210	39%	8.7	**1,839**	165%
U.S. coal fleet avg, 2013[c]	210	33%	10.5	**2,198**	138%
New biomass steam turbine[d]	213	24%	14.2	**3,028**	

References:

CO_2 per MMBtu

a, b, c : from EIA at http://www.eia.gov/environment/emissions/co2_vol_mass.cfm. Value for coal is for "all types." Different types of coal emit slightly more or less.

d: Assumes HHV of 8,600 MMBtu/lb for bone dry wood (Biomass Energy Data Book v. 4; Oak Ridge National Laboratory, 2011. http://cta.ornl.gov/bedb.) and that wood is 50% carbon.

Efficiency

a: DOE National Energy Technology Laboratory: Natural Gas Combined Cycle Plant F-Class (http://www.netl.doe.gov/KMD/cds/disk50/NGCC%20Plant%20Case_FClass_051607.pdf)

b: International Energy Agency. Power Generation from Coal: Measuring and Reporting Efficiency Performance and CO_2 Emissions. https://www.iea.org/ciab/papers/power_generation_from_coal.pdf

c. EIA data show the averaged efficiency for the U.S. coal fleet in 2013 was 32.6% (http://www.eia.gov/electricity/annual/html/epa_08_01.html)

d: ORNL's Biomass Energy Data Book (http://cta.ornl.gov/bedb; page 83) states that actual efficiencies for biomass steam turbines are "in the low 20's"; PFPI's review of a number of air permits for recently proposed biopower plants reveals a common assumption of 24% efficiency.

Bioenergy emissions may be offset with forest regrowth, but, it is not justified to assume that emissions are equivalent between a bioenergy and a no-bioenergy scenario, given the much larger emissions per unit energy at wood-burning plants than fossil-fueled plants. Since presumably our energy demand isn't going to decrease, meeting any given amount of energy demand by switching to biomass *increases* emissions. Thus, it is incorrect to assume that cumulative emissions would be equivalent under a biomass and no-biomass scenario.

The Panel's BAF approach is a significant improvement over EPA's approach

The report concedes that the timing question is important enough that it needs to be acknowledged, and in that respect, the panel's approach is better than the one originally proposed by EPA:

p. 30:

Nonetheless, in recognition of the temporal issues associated with biogenic feedstocks in the context of the EPA's regulatory authority over stationary sources, the SAB offers an alternative (in section 4.1) BAF formulation ***that places more emphasis on transitional or short-run effects*** *(BAF∑T) while also acknowledging the validity of a metric that captures cumulative emissions at some point in the future (BAFT).*

The cover letter to the report at page 3 states that whereas EPA's original approach accounts for difference in carbon stocks at end of time period, the panel's new approach accumulates annual differences in carbon stocks over time to account for the presence of carbon in the atmosphere each year. This approach sums all the differences in each year over a time period (to get net biogenic emissions, NBE), and sums all the potential gross emissions (PGE) in each year, then divides NBE by PGE to derive the BAF.

However, evaluating emissions from a single facility was the original intent of the framework. While in theory, the approach advocated by the report could be "scale and process invariant as it could be used for a stand, plot, fuel shed, or region" (p. 19), the Panel's advocacy for sprawling economic models is difficult to reconcile with the idea of using the approach to assess emissions at an individual facility. The economic model considers large "regions" with ripple effects where economic activity in all kinds of spheres is affected by changes in biomass demand. In contrast, a single facility built on its own might not have much of an effect, regionally. The Panel points out how much work is left to be done, essentially highlighting the current unworkability of the economic modeling approach, when it recommends to EPA that:

p. 25
Recommendation
• For proper scientific evaluation of a biogenic carbon accounting approach, the EPA should specify a policy context, propose specific BAF calculations and values, and specify its legal authorities over upstream and downstream emissions ***as well as the spatial boundaries for assessing emissions associated with a stationary facility****. The Framework should be explicit about underlying expectations about other prevailing land use management, renewable energy and carbon policies that could impact the choice of feedstocks and their production methods and thus the estimates of their BAF.*

We believe that the use of long timeframes for assessment of net biogenic emissions, combined with endorsement of complex, unverifiable economic models, is almost certain to underestimate the actual climate forcing impacts of bioenergy on atmospheric CO_2. We urge the SAB to require that the report more fully acknowledge the physical reality that burning wood for electricity emits more carbon than burning fossil fuels, and endorse an accounting approach that is capable of distinguishing what types of bioenergy can "pay off" carbon debts at scales relevant to operation of individual facilities, in timeframes relevant to current climate policies.

Thank you for the opportunity to comment.

Mary Booth, President,
Partnership for Policy Integrity

Durwood Zaelke, President,
Institute for Governance and Sustainable Development