The Honorable Scott Pruitt
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460

Subject: SAB review of *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources* (2014)

Dear Administrator Pruitt:

The EPA Science Advisory Board (SAB) was asked by the EPA Office of Air and Radiation to review and comment on its *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources* (2014) ("2014 Framework"). The 2014 Framework considers the scientific and technical issues associated with accounting for emissions of carbon dioxide (CO_2) from biogenic feedstocks used at stationary sources.

The purpose of the 2014 Framework is to develop a method for calculating the adjustment, or Biogenic Assessment Factor (BAF), for carbon emissions associated with the combustion of biogenic feedstocks taking into account the biological carbon cycle effects associated with their growth, harvest, and processing. This mathematical adjustment to stack emissions is needed because of the unique ability of biogenic material to sequester CO_2 from the atmosphere, in biomass and soil, over years or decades through the process of photosynthesis. The BAF is an accounting term developed in the Framework to denote the offset to total emissions (mathematical adjustment) that reflects a biogenic feedstock's net carbon emissions after taking into account subsequent sequestration of carbon in biomass or soil that results from regrowth of biomass, or emissions that might have occurred with an alternate fate had the biogenic material not been used for fuel.

The 2014 Framework is a revision of the 2011 Framework, which the SAB previously reviewed. We are pleased that the 2014 Framework incorporated some of the SAB's prior advice and advanced the analytical foundation for making determinations about the net contribution of biogenic feedstocks to the CO_2 in the atmosphere. Specifically, the 2014 Framework has incorporated the SAB's prior advice as follows:

- It has adopted an alternate fate approach (i.e., a counterfactual evaluation of what the net biogenic atmospheric contribution might have been if the feedstocks were not used for energy) to the collection and use of waste-derived feedstocks, including avoided methane (CH_4) emissions when GHGs beyond CO_2 are considered.
- It includes a discussion of the trade-offs inherent in the selection of a temporal scale for considering net emissions.
- It has developed representative BAFs by feedstock and region in view of the data demands of a facility-specific BAF calculation.
- It includes a review of existing approaches to addressing leakage, the phenomenon by which efforts to reduce emissions in one place affect market prices that shift emissions to another location.

- It offers an approach to construct an anticipated baseline that allows assessment of the additional CO_2 emissions to or uptake from the atmosphere that can be attributed to biogenic feedstocks as a result of changes in biomass feedstock demand.

The 2014 Framework does not, however, provide a policy context, specific BAF calculations for that context, or the implementation details the SAB previously requested. In fact, the lack of information in both Frameworks on how the EPA may use potential BAFs made it difficult to fully evaluate these frameworks. A policy context would have provided information relevant to the assessment of BAFs, such as the scale of demand for biogenic feedstocks and the anticipated time frame for that demand and eligible feedstocks to meet it. As we stated in our 2012 report and we reiterate here: this SAB review would have been enhanced if the Agency offered a specific regulatory application that, among other things, provided explicit proposed BAF calculations, and defined its legal boundaries regarding upstream and downstream emissions in the feedstock life cycles. The 2014 Framework is written in a way that is too flexible, with too many possibilities. The equivocality of 2014 Framework precludes the SAB from answering some of the presented charge questions in a concrete manner. Rather than offering a lengthy menu of calculation options, the EPA needs to make some decisions and offer justification for those choices, as a basis for BAF assessment.

In the absence of a policy construct, concern about many potential impacts of biogenic feedstocks were raised by commenters, including effects on forest conservation, biodiversity and ecosystem services. The SAB considers these out of scope for the Framework and thus for this review because the SAB was charged narrowly with reviewing the scientific appropriateness of the Framework for quantifying the adjustment to smokestack carbon emissions from stationary facilities using biogenic feedstocks. The SAB recommends EPA make the boundaries of the assessment more clear in the Framework by specifying a policy context, providing example BAF calculations, and clearly defining boundaries for EPA's regulatory authority.

Despite the significant limitation of assessing the Framework in the absence of a policy construct, we have some overarching suggestions for continued development of a framework for assessing the BAFs of biogenic feedstocks. In addition to our specific responses to EPA's charge questions, we provide general guidance regarding the calculation of BAFs. For example, EPA's equations were based on emissions (fluxes) with some adjustment terms to account for carbon mass escaping the system between the point of assessment and the point of emissions. In the enclosed report, we offer an alternative formulation based on changes in terrestrial (non-atmospheric) carbon stocks (or pools) that explicitly incorporates the principle of conservation of mass. While the carbon stock based accounting system results in a similar formula for BAF as the EPA's emissions based approach, it offers multiple advantages: carbon stocks are typically inventoried and modeled in the scientific community; they can be aggregated and rearranged as needed or further subdivided; and these stocks will follow rules related to the conservation of mass. Even with this alternative formulation, there is still the need to select appropriate temporal and spatial boundaries, consider variability among classes of feedstocks, account for non-CO_2 greenhouse gases such as nitrous oxide and methane, and quantify stocks and fluxes that are difficult to measure or estimate.

As mentioned above, the 2014 Framework offers an option to estimate representative BAFs by feedstock and region but without the concreteness needed for proper evaluation (policy context, and specific recommendations). A facility-specific BAF was deemed impractical due to the conceptual and

practical challenges of identifying spatial boundaries for feedstock supply to a facility and the potential for market-induced spillover (indirect) effects on land use, biomass production and diversion from non-energy uses and carbon stocks across space. We have also concluded since the increased demand for biomass feedstocks can affect terrestrial carbon stocks into the future (positively or negatively), a BAF metric based on cumulative changes in carbon stocks over time is scientifically appropriate.

Using a carbon stock formulation in the attached report, we show how the estimate of cumulative BAF of a feedstock can be obtained from the estimate of net biogenic emissions (NBE), defined as the difference in stocks of carbon between the reference (baseline) scenario and the increased biomass feedstock demand scenario. We show how the NBE for a feedstock varies with the time horizon and can be positive or negative at a point in time, as can the BAF.

There was extended discussion between the SAB and the Biogenic Carbon Emissions Panel over the significance of the time horizon used to calculate BAFs. The Panel recommended that the general principle for determining the time horizon for BAF calculations should be to select a time horizon that fully accounts for the temporal dynamics of NBE changes for all feedstocks. This is the time horizon (a) over which carbon stock changes due to increased demand for biogenic feedstocks by stationary facilities stabilizes, and (b) that is long enough to account for nearly all (e.g., >95%) of the positive and negative changes in terrestrial carbon stocks between the increased biomass feedstock demand scenario (with increased demand for all types of bioenergy) and a reference scenario (without increased demand for bioenergy. The use of a shorter time horizon than that which accounts for all future effects would truncate these effects on carbon stocks and could lead to a feedstock-specific BAF that either under or over-estimates the total net carbon stock effects; the Panel did not find a compelling scientific rationale for selecting this shorter time horizon. The Panel also regarded BAFs as scientific calculations (of expected carbon changes), and distinct from policy objectives, which define regulatory stringency.

On the other hand, some members of the SAB made the point that for some types of policy initiatives that consider shorter time horizons it may be inappropriate to use a BAF calculated to incorporate nearly all carbon stock effects over time. These SAB members would favor selecting the time horizon for calculating the BAF to comport with the policy time horizon under consideration. To accommodate such cases, the presented methods enable a BAF to be calculated for any selected time horizon. The selection of a time horizon for calculating the BAF is an issue for which it was not possible to reach full consensus between the Panel and some members of the chartered SAB. The Panel recognizes that policy-makers may choose a different time horizon than the one recommended by the Panel. If so, that would imply leaving out expected future carbon stock changes relevant to climate change. In such a case, the carbon accounting implications should be calculated and clearly communicated.

It is also important to point out that BAF calculations are focused on carbon emissions only. In considering the use of biomass for electricity generation, we only consider the carbon stock implications relevant to climate in accordance with our charge from the EPA, and EPAs need for emissions accounting. We did not evaluate other concerns like forest conservation, biodiversity and ecosystem services. If, for example, biomass pellets were sourced from old growth forests, that would pose unique risks that would not be reflected in a BAF calculated for carbon impacts. This is, however, no different than emissions accounting for other energy options (fossil fuel, renewable, nuclear), which also have non-carbon environmental and social dimensions. We offer this caveat about BAFs, and the boundaries of our review, with a recognition that non-carbon effects are valid concerns worthy of separate analyses.

We recommend consideration of two alternative approaches for calculating a cumulative BAF, both based on carbon stock changes under an increased biomass feedstock demand scenario (with increased demand for bioenergy) relative to a reference scenario (without increased demand for bioenergy). The first approach is EPA's cumulative BAF metric from the 2014 Framework, which computes the difference in carbon stocks at the end of the time horizon. The second approach was developed by members of the Biogenic Carbon Emissions Panel, which accounts for the time path and residence time of the additional emissions in the atmosphere. This second BAF approach accumulates the annual differences in carbon stocks on the land over time as a proxy for the presence of carbon in the atmosphere each year. Both cumulative BAFs are biophysical estimates that attempt to adjust biogenic emissions for future sequestration and alternate fates. The choice of appropriate cumulative BAF metric should be informed by a scientific assessment of the dynamics of additions to atmospheric carbon stocks and mechanisms by which changes in atmospheric carbon stocks affect the climate. EPA's cumulative BAF captures cumulative changes in carbon stocks, while the second cumulative BAF alternative reflects transitional changes in carbon stocks. The atmospheric carbon stock and climate affects should be assessed for both.

BAF calculations will require integrated economic-biophysical modeling to estimate expected changes in carbon stocks over time from increasing biomass demand for energy. As such, it will be important to develop a model based on the best science, with periodic evaluation of the model using well-defined scientific criteria. EPA did not ask us for feedback on its modeling approach, but given that different approaches can yield different results, we think this was an oversight. An integrated modeling approach that captures economic and biophysical dynamics and interactions is necessary to implement the anticipated future baseline approach and to estimate the additional effect of increased bioenergy demand on CO_2 emissions. While the 2014 Framework employed such an integrated model for some of its alternative BAF calculations, EPA did not offer explicit justification for its modeling choices derived from articulated criteria. In addition, sensitivity of BAF responses to underlying features of the model was not examined. Thus, we conclude EPA should identify criteria for choosing a model and evaluating its modeling choice, as well as examine the sensitivity of BAF estimates to key modeling features.

The SAB appreciates the opportunity to provide advice on the 2014 Framework and looks forward to your response.

Sincerely,

Dr. Peter S. Thorne, Chair
Science Advisory Board

Dr. Madhu Khanna, Chair
SAB Biogenic Carbon Emissions Panel

Enclosure