Comments of the Green Power Institute on the Nov. 2014

Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources

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Introduction

The Green Power Institute is the renewable energy program of the Pacific Institute for Studies in Development, Environment, and Security, a public-purpose (501(C)(3)), environmental-research institution located in Berkeley, CA. The GPI performs research into the environmental implications of renewable energy production, and advocates for public policies favorable to the development of renewable energy. We gratefully acknowledge that partial funding for the preparation of these comments was provided by the Biomass Power Association.

The Green Power Institute has reviewed and analyzed the November 2014, EPA *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources* (Framework). This document is significantly improved from the original, September 2011, version of the *Accounting Framework*. Nevertheless, we believe that additional significant improvements can be made, particularly in the areas of landscape effects and temporal effects, as discussed below.

As a preliminary matter, we note that the title of the new Framework document refers to assessing biogenic CO_2 emissions. In fact, one of the significant improvements in the new version of the framework is the inclusion of CH_4 as a key component of the biogenic carbon cycle. We ask that the title of the Framework document be clarified by substituting the word "carbon" for "CO_2" as follows: *Framework for Assessing Biogenic Carbon Emissions from Stationary Sources*.

Fuels Used for Bioenergy Production at Stationary Sources

The Framework is geared to assessing biogenic-carbon greenhouse-gas emissions associated with stationary sources, which can include a variety of conversion technologies, including engines, boilers, incinerators, and gasifiers, with or without power-generation capability. Our focus in these comments is on power generation from solid-fuel biomass, but the comments are generally applicable to other kinds of stationary sources using biofuels.

There are two inherent aspects of biomass power generation that set boundaries on the kinds of biomass that can be used as commercial fuels.

1. Energy is the lowest-valued use for biomass resources, well below its value when used for foods, fibers and chemicals.
2. Biomass power generation is expensive compared to other forms of power generation, and biomass fuel is a major contributor to the high cost.

Solid-biomass fuels can be derived from a wide range of sources, from the waste materials produced at sawmills, to crops harvested and/or cultivated for the express purpose of producing fuel. A great deal of the attention in the November 2014 Framework is devoted to fuels in the categories of crops, such as harvests of standing forests in order to produce fuel, and crops grown expressly to produce fuels. In fact, no fuels from the categories of crops are used for power generation by the U.S. biomass power industry, and the two inherent aspects of biomass power generation delineated above mitigate any such use in the foreseeable future. Biomass crops are grown and/or harvested to produce the highest-valued products possible (food and fiber), and biomass power generators simply cannot afford to pay the costs of producing crops for fuel. Biomass power production provides a beneficial-use outlet for the biomass residuals that remain after producing food and fiber products from biomass. The focus of the Framework should be on the kinds of biomass that are currently used for power production and likely to be used for power production in the future, in other words, biomass wastes and residues.

Landscape Attribute Terms

The term Landscape Attribute Terms, as used in the Framework (§2.4), includes a variety of types of effects, including:

- Net growth on the production landscape – GROW
- Avoided emissions – AVOIDEMIT
- Total net change in production site non-feedstock carbon pools – SITETNC
- Leakage associated with feedstock production – LEAK

Clear cutting a standing forest for purposes of fuel production would make the energy enterprise responsible for all of the landscape carbon fluxes, including loss of sequestered carbon in the biomass on the landscape, and loss of carbon in the soil due to harvesting. On the other hand, if the standing forest is clear cut for purposes of building a housing project, and the biomass residuals produced in the clear cut are used as fuel for power generation, then the energy enterprise should not be held responsible for the losses of sequestered carbon in the standing biomass or in the soils. The energy enterprise should only be held responsible for the difference between conventional handling and disposal of the residuals, and use of the residuals as fuel. As discussed in the previous section, all of the fuels used by the biomass power industry are in the category of residuals and wastes, not crops.

The presence of a market for biomass fuels can decrease the cost of residuals handling and disposal for activities that produce biomass residuals, even if the processing and delivery of fuels made from biomass residuals costs more than the fuel is worth. This is often the case. Take, for example, the case of forest-thinning operations that produce fuel-usable residues. The value of the fuel is less than the cost of thinning the forest and processing and transporting the residues, but the net cost of thinning with fuel production from the residues is less than the cost of thinning without fuel production. It has been argued that the ability to use residuals as fuels can make an otherwise uncommercial project viable (e.g, a fuel-reduction treatment on overgrown forested land), and that therefore in the absence of the energy application for the residuals the project would not have been carried out. In such cases, some have suggested that at least some of the landscape attributes associated with crops ought to be attributed to the energy component. This is a tricky principle to put into practice, due in large part to the difficulty of identifying which non-biomass energy projects fall into the category of being enabled by the presence of a market for biomass fuels, and which projects do not. We note that in cases where the biomass-fuels market enables a thinning operation to be carried out, and the thinning leads to a higher long-term biomass stocking on the landscape due to its greater resiliency to fire loss, then the same logic suggests that the energy enterprise should be given credit for the enhanced long-term carbon sequestration on the landscape resulting from the thinning operation it allowed to be conducted.

Periodic major-loss events

A major deficiency that the Green Power Institute originally identified in the 2011 Accounting Framework document that appears to be carried over into the November 2014 Framework is the lack of any discussion or consideration of periodic major-loss events, like fires, insect attacks, and disease outbreaks. Many of the forest treatments that produce forest-residue fuels in today's energy marketplace are aimed squarely at reducing the severity of these risks, among other objectives. The failure to include these events in the modeling and analysis of the carbon cycle implications of forest-fuel use ignores one of the major benefits of biomass energy production with respect to its implications for long-term stocking (sequestration) of carbon on landscapes that are candidates for treatment.

For example, the Framework document recognizes that a forest treatment operation (thinning) providing fuel to a biomass energy operation initially removes carbon from the forest, and adds it to the atmosphere in the form of CO_2. Subsequently, the net growth rate on the treated landscape is increased, resulting in a net-sequestration enhancement that eventually brings the stocking on the treated forestland back up to the level that it would have been had the forest not been treated. However, the Framework does not address the fact that the forest is constantly subject to risks of major-loss events, which, for modeling purposes, can be handled on a probabilistic basis. If a loss event follows a treatment operation, then the extent and intensity of the loss event will be reduced compared to what it would have been had the forest treatment not been performed. In fact, in many cases the post-loss-event landscape will hold more sequestered carbon than the untreated landscape, even though immediately before the event the opposite was true, that is, the untreated forest held more carbon than the treated forest. With the analysis that is provided in the Framework this possibility is completely missed, even though it may be the primary motivation for performing the treatment operation in the first place.

The long-term greenhouse-gas implications of forest treatments or harvests of any kind that produce fuel for power generation can only be understood when periodic major-loss events are included in the modeling and analysis.

Methane vs CO_2

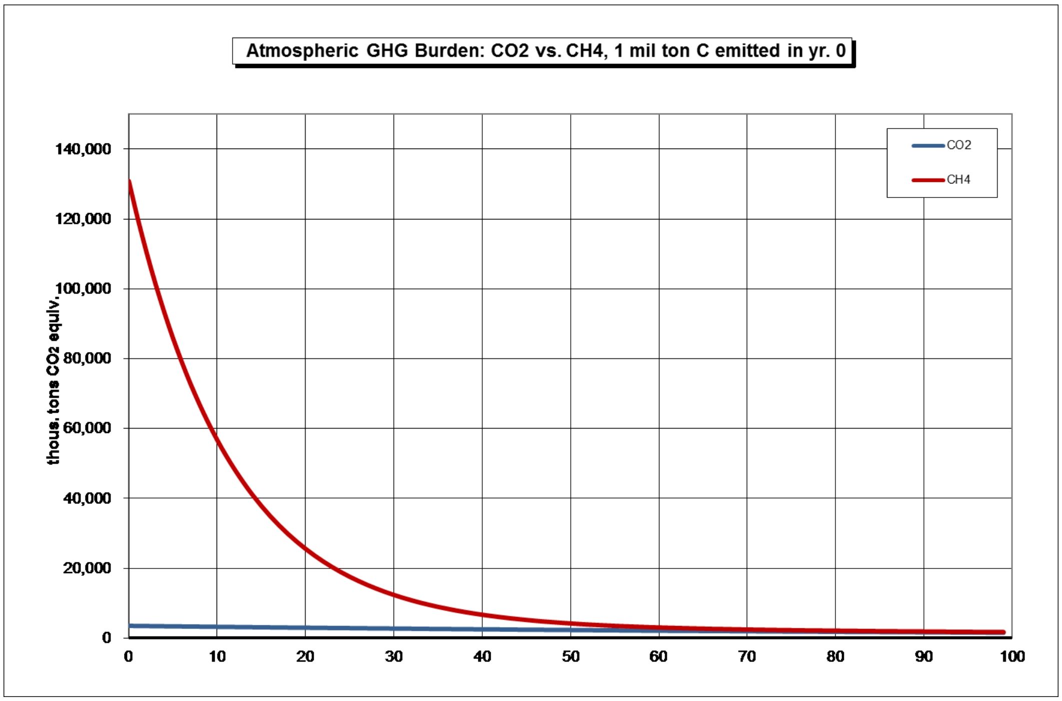
The most active part of the global carbon cycle involves the exchange of carbon between the atmosphere and the earth's biota. Carbon from CO_2 in the atmosphere is fixed into growing biomass, while fixed carbon in biomass is returned to the atmosphere in the forms of CO_2 and CH_4. The CH_4 in the atmosphere is cleared via oxidation to CO_2, in which form it is available for fixation into biomass. Methane is a much more potent greenhouse gas than CO_2, but its atmospheric residence time is much shorter, 12 years for CH_4 versus 50-200 years for CO_2.

The production of energy from biomass can have greenhouse-gas implications in two different ways. First, if the energy enterprise contributes to a net shifting of carbon between the atmospheric stock, and the landscape stock, the result can be either more atmospheric CO_2 (loss of carbon from the landscape), or less atmospheric CO_2 (enhanced carbon stocking on the landscape). Second, during the part of the carbon cycle in which carbon is cycled from the biota to the atmosphere, the carbon can be emitted in either the form of CO_2 or CH_4. If the energy enterprise shifts emissions that would have been in the form of CH_4 to CO_2, then the resulting greenhouse-warming potential of the emissions is reduced. The Framework is focused on greenhouse-gas implications of the first type (shifts in stocks), but our work demonstrates that implications of the second type (shifts in mix of CO_2 and CH_4 emissions) can also be significant.

Biomass power plants emit virtually all of the biogenic carbon in their fuel into the atmosphere in the form of CO_2. In the absence of using these biomass wastes and residues for fuel, the materials would experience an alternative fate, such as open burning, landfilling, or accumulation in the forest as overgrowth biomass. In all cases the biomass carbon is eventually recycled, and some or all of it is emitted to the atmosphere as a mixture of CO_2 and CH_4. Because all of the non-energy alternatives (alternative fates) for biomass wastes and residues entail greater emissions of CH_4 than energy production, the biogenic greenhouse-gas implications of alternative disposal have the potential to be greater than the implications of energy production.

Figure 1 illustrates the difference in global-warming activity between emitting one million tons of carbon in the form of either CO_2 or CH_4. At time zero, emitting the carbon in the form of CH_4 produces a greenhouse-warming potential that is nearly 40 times greater than emitting the same amount of carbon in the form of CO_2. Over time the CH_4 converts to CO_2 with a half-life of 8.5 years, with the result that by the end of approximately 50 years the residual global-warming potential of the two gases is virtually the same (very little CH_4 is left). In other words, to the extent that diversion of biomass from an alternative fate to energy production substitutes CO_2 emissions for what would have been CH_4 emissions, the resulting reduction in greenhouse warming potential is dramatic at the time of the substitution, and the residual benefit persists for some fifty years. The 2013 IPCC update reports that the global warming potential for methane is 34 on a 100-year timeframe, and 86 for a 20-year time frame.

Figure 1



In discussing the significance of methane emissions, the Framework minimizes their importance with respect to bioenergy systems with the following argument:

> In the context of agriculture- and forest-derived feedstocks, the framework can take into consideration landscape CH_4 emissions that are avoided when biogenic feedstock materials such as residues are collected and used for energy, instead of being open-burned or left to decay on the production landscape. However, in the United States, CH_4 is not a significant contributor to landscape carbon-based emissions related to the growth and harvest of biogenic feedstocks because most forest- and agriculture-derived feedstocks are produced in upland areas rather than in areas with higher moisture content, such as rice paddies or wetlands. These areas do not typically generate CH_4 emissions (Anderson et al., 2010) or, in some cases, have a small negative net CH_4 fluxes (EPA, 2013b). [Framework, pg. 10.]

We do not understand the purpose of this argument within the context of the Framework document. The point is not whether the forests or other landscapes that are the source of biomass fuels are major contributors to the national inventory of CH_4 emissions. The point is what happens to the carbon in the biomass that can either be used for energy production, or left to an alternative fate.

Temporal Scale

The SAB criticized the 2011 Accounting Framework for its deficient treatment of the issue of the long-term implications of the biogenic greenhouse-gas emissions associated with biomass energy production. For example, some of the Landscape Attribute Terms associated with energy crops, which are a major focus of the Framework, can only be understood over a long-term timeframe, on the order of 100 years. The November 2014 Framework includes an enhanced treatment of temporal-scale issues, but it still chooses to rely on a methodology based on static-analytical techniques, rather than adopting a dynamic-analytical approach. The problem with employing a static analysis is that if a short-term timeframe is used, long-term effects become masked, while if a long-term timeframe is used, short-term effects become masked. As the figure above illustrates, if a 100-year timeframe is employed for the analysis, then the dramatic upfront benefits of substituting CO_2 emission for CH_4 emissions will not be appreciated.

While biomass energy systems can shift what otherwise would be CH_4 emissions to CO_2 emission, a complicating factor is that sometimes the timing, as well as the mix of the emissions can be altered. For example for biomass that is disposed of in a landfill, the material breaks down at a slow rate, and the emissions to the atmosphere occur over a period of decades, with some of the carbon remaining buried permanently. If the biomass is sent to a biomass power plant rather than disposed of in the landfill, all of the CH_4 emissions will be eliminated, but on the other hand all of the carbon in the biomass will be promptly emitted in the form of CO_2. Thus the tradeoff is between immediate emission of all of the biomass carbon in the form of CO_2 vs. delayed emissions of a portion of the biomass carbon as a mixture of CO_2 and CH_4 (the composition of the mixture depends on whether the landfill has gas collection and flaring). In the opinion of the Green Power Institute, the only way to account for the various flows over a long period of time that does not mask the shorter-term effects is to employ the techniques of dynamic analysis, which we believe may be referred to in the Framework as year-to-year carryover analysis.

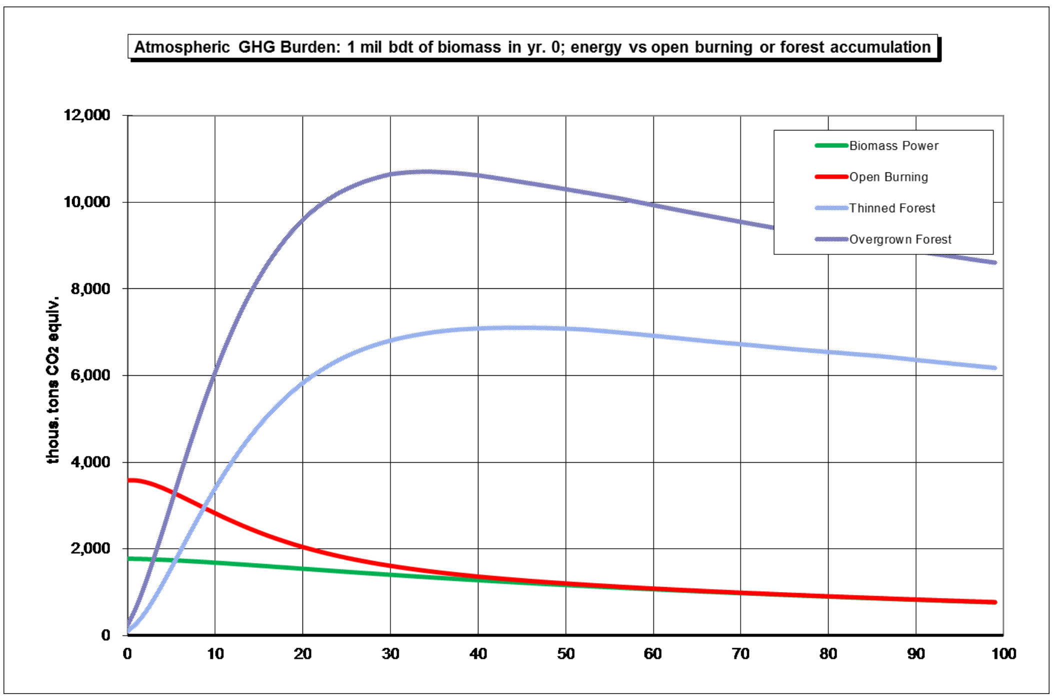
In the Green Power Institute's own modeling work on biogenic carbon emissions from biomass energy production,[1] which we have previously supplied to the EPA staff and the SAB docket, we perform a dynamic analysis over a 100-year timeframe for the carbon emissions associated with biomass energy production and alternative fates for the biomass, in order to explicitly study the long-term fate of the biogenic carbon, whether the biomass is used for energy production, or left to an alternative fate.

In Figure 2 we illustrate the dynamic profiles for the fate of biogenic-carbon greenhouse-gas emissions from biomass energy production vs. biomass disposal via open burning, or

[1] Morris, G., *Bioenergy and Greenhouse Gases*, Report of the Pacific Institute, May 15, 2008, http://www.pacinst.org/reports/Bioenergy_and_Greenhouse_Gases/Bioenergy_and_Greenhouse_Gases.pdf

via accumulation as overgrowth material in the forest (not-thinned forest in need of thinning). All four of the profiles in the figure are based on one-million bdt of biomass that is either used for energy production, or left to its alternative fate (open burning or forest accumulation). In the case of biomass energy (the green curve in the figure), virtually all of the carbon in the biomass is released immediately to the atmosphere in the form of CO_2, resulting in an atmospheric burden in year 0 of approximately 1.8 million tons. The CO_2 then slowly decays, falling to 0.8 million tons atmospheric burden 100 years after the biomass was converted into energy.

Figure 2



If, instead of energy production, the one-million bdt of biomass had been disposed of by open burning (the red curve in the figure), virtually all of the biogenic carbon in the biomass would likewise have been emitted to the atmosphere in year 0. However, with open burning combustion is inefficient, and enough of the carbon is emitted in reduced form,[2] for example from pyrolysis at the edges of the fires whose gases do not combust, that the greenhouse-gas potency of the mixture is nearly twice as great as the potency of the power plant's CO_2 alone in the year that the material is combusted. Over the early years the decay curve of the gas mixture emitted during open burning is faster than the decay curve of the CO_2 emitted during energy production, with the result that by about 40 years following combustion the residual atmospheric greenhouse-gas burden of the two options, energy production and open burning, is indistinguishable. The net benefit for

[2] Carbon in reduced forms, whether in the form of CH_4 or non-methane HCs, has approximately the same global warming potential per carbon as CH_4.

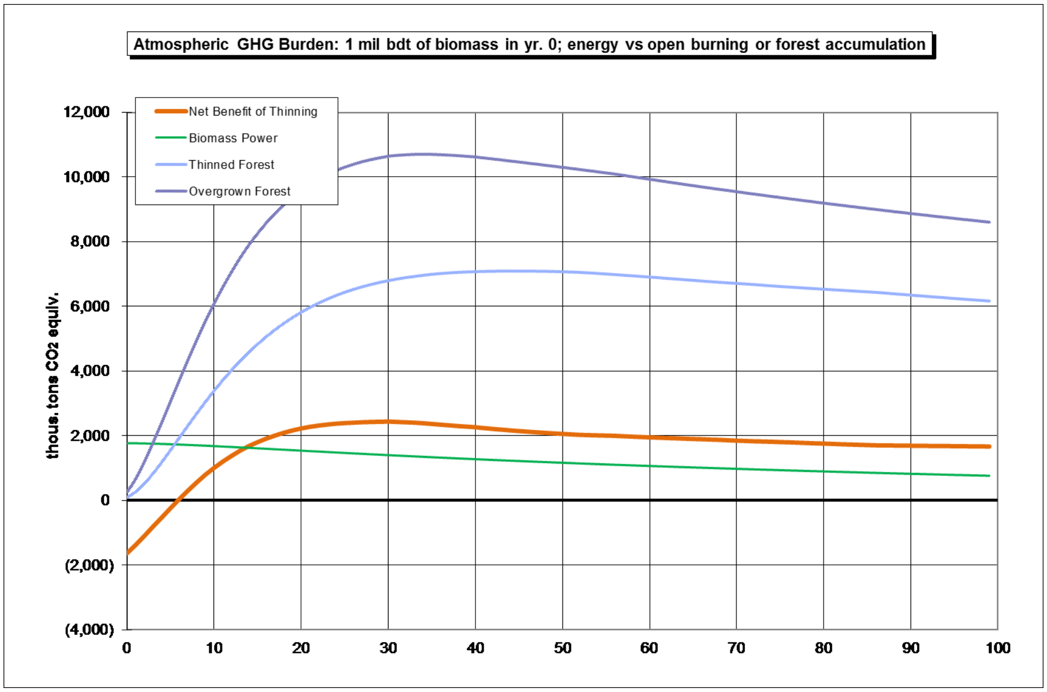
avoiding open burning is the difference between the green curve (energy production) and the red curve (open burning in piles).

For biomass that is either left in the forest as overgrowth material, or removed in a thinning operation and used as fuel, two profiles are necessary to characterize the greenhouse gas implications arising from the forest landscape (the profile for using the biomass as fuel is the green curve in the figure), one curve for the emissions associated with the overgrown-forest landscape (dark blue curve in the figure), and one curve for the emissions associated with the thinned-forest landscape (dark blue curve in the figure). Two profiles are necessary because the greenhouse-gas implications of performing the thinning operation extend well beyond the wood that would be removed from the forest in the thinning to the entire forest. There are no immediate emissions associated with the landscape regardless of whether or not a thinning is performed. Over time the forest landscape sequesters carbon due to its growth on a net basis, but supplies carbon emissions to the atmosphere during major loss events (fires, insect and disease outbreaks). The profiles in the figure are based on California forest-growth curves and wildfire events, which are handled in the model on a probabilistic basis. Compared to the untreated, overgrown landscape, the thinned landscape has a faster net growth rate (net rate of carbon sequestration), and lower probabilities of both the occurrence of fires, and the severity of fires.

The profiles for both landscape alternatives (thinned or untreated) start out as net producers of greenhouse gases, as the losses due to fire exceed the net growth rate on a probabilistic basis. Over time, as increasing fractions of the landscape have experienced fire, that portion of the landscape has a net growth rate that exceeds the risk of fire loss, and so the curves for the total landscapes peak at around 35 – 40 years, and slowly decline thereafter. The profile for the overgrown landscape peaks earlier because the probability and severity of fire are higher, resulting in more of the landscape landing in the post-fire, net-carbon-uptake category earlier. The net benefit for fuels derived from forest thinning is the green curve (energy production from thinning residues) plus the lighter blue curve (thinned landscape) less the darker blue curve (overgrown landscape).

The orange curve in Figure 3 (green curve + lighter blue curve – darker blue curve) illustrates the net benefit associated with thinning operations. Based on the profiles in the figure, the thinned-landscape-with-energy-production-from-the-residuals scenario starts out as a negative, or a net greenhouse-gas burden on the atmosphere, as biomass has been removed from the landscape and burned. However, by approximately seven years after the thinning, on a probabilistic basis, the thinned landscape / energy alternative reaches parity with the untreated landscape with respect to the associated greenhouse-gas burden, and thereafter provides a significant benefit with respect to reducing the greenhouse-gas burden of biogenic greenhouse gases.

Figure 3



We believe that the best approach to understanding the time-dependent aspects of the greenhouse-gas effects of biomass energy systems requires dynamic, rather than static modeling of biogenic carbon.

Conclusion

In order to be a more useful document, the Framework needs to be focused on the kinds of real-world waste and residue fuels that are used for biomass energy production at stationary sources. The Framework needs to acknowledge and include the role of CH_4 in the biogenic carbon cycle, and its implications for greenhouse-gas emissions. The Framework also needs to adopt a more robust dynamic approach to carbon modeling.

All of the fuels that are actually used by the U.S. biomass energy industry, and likely to be used, show an improved biogenic greenhouse-gas profile when the biomass is used for energy production in lieu of its alternative fate. This means that all biomass fuels used for power generation in the U.S. would have negative BAFs. Not only should these fuels be given a categorical determination of carbon neutrality or better for purposes of compliance with the tailoring rule, they should be candidates for the creation of greenhouse-gas offsets if and when there is a market for greenhouse-gas allowances.

We are grateful for the opportunity to be able to provide these comments for the EPA's and the SAB's consideration. The greenhouse-gas implications of biomass energy use are complex and difficult to fully elucidate, but they are not beyond our ability to understand and act on.