Response to the SAB Panel Peer Review Advisory

Introduction

In September 2011, EPA submitted the *Draft Accounting Framework for Biogenic CO_2 Emissions from Stationary Sources* to the Science Advisory Board (SAB) for peer review by the SAB's Biogenic Carbon Emissions Panel (SAB Panel). EPA charged SAB to review and comment on (1) EPA's characterization of the science and technical issues relevant to accounting for biogenic CO_2 emissions from stationary sources; (2) EPA's framework, overall approach, and methodological choices for accounting for these emissions; and (3) options for improving upon the framework for accounting for biogenic CO_2 emissions. After a year of review, during which the SAB Panel conducted an in-person meeting and four teleconference meetings, the SAB Panel submitted a letter and Peer Review Advisory report to Administrator Jackson on September 28, 2012.

In their Peer Review Advisory ('Advisory'), the SAB Panel highlighted a series of technical and practical issues and offered some recommendations to improve the draft framework. The EPA considered all the feedback the SAB Panel offered and made many changes to the framework report based on the SAB Panel's recommendations. This Response Document is intended to serve as: (1) a discussion of the major issues raised and recommendations made in the Advisory; and (2) an explanation of how EPA has addressed these issues in the revised framework, the *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources*. These issues include:

- Categorical Approaches and Carbon Neutrality
- Policy Context and Implementation
- Scope of Method
- Baselines
- Spatial Scale
- Temporal Scale
- Leakage
- Feedstock Categorization

Categorical Approaches and Carbon Neutrality

In its charge to the SAB, EPA requested that the SAB Panel evaluate the applicability of categorical approaches (both inclusion and exclusion) for quantifying the net atmospheric impact of biogenic feedstock utilization in the stationary source

context. Categorical approaches are those in which the net atmospheric biogenic CO_2 contribution of biogenic feedstocks used at stationary sources is determined by definition, based on general assumptions about the carbon cycle without technical analysis of the particular conditions relevant to feedstock production, processing, and use. EPA also requested that the SAB Panel evaluate whether categorical approaches are inadequate in the context of stationary sources, then a new accounting approach would be needed.

In its Advisory, the SAB Panel stated that (Executive Summary, p. 3; Advisory, p. 18):

> Carbon neutrality cannot be assumed for all biomass energy a priori. There are circumstances in which biomass is grown, harvested and combusted in a carbon neutral fashion but carbon neutrality is not an appropriate a priori assumption; it is a conclusion that should be reached only after considering a particular feedstock's production and consumption cycle. There is considerable heterogeneity in feedstock types, sources, production methods and leakage effects; thus net biogenic carbon emissions will vary considerably.

Based on this finding that carbon neutrality should be assessed and not assumed, the SAB Panel then stated disadvantages from using either a categorical exclusion or categorical inclusion approach: "Given that some biomass combustion could have positive net emissions, a categorical *exclusion* would remove any responsibility on the stationary source for CO_2 emissions from its use of biogenic material from the entire system (i.e., the global economy) and provide no incentive for the development and use of best management practices. Conversely, a categorical *inclusion* would provide no incentive for using biogenic sources that compare favorably to fossil energy in terms of greenhouse gas emissions" (Executive Summary, p.4; Advisory, p.18). The SAB Panel did endorse the overall goal of the draft framework, which is to provide the analytical foundation for making determinations about the estimated net atmospheric contribution of biogenic CO_2 emissions from the production, processing and use of biogenic feedstocks at stationary sources in lieu of categorical treatments.

Policy Context and Implementation

In the September 2011 draft framework, EPA explained that the framework was generally meant "for the policy context where it has been determined that a stationary source emitting biogenic CO_2 requires a means for "adjusting" its total onsite biogenic emissions estimate on the basis of information about growth of the feedstock and/or avoidance of biogenic emissions and more generally the carbon cycle" (Executive Summary, p. 4). The draft framework, in other words, was meant to provide an accounting approach that could be adapted for any number of policy-specific applications as appropriate. It went on to detail various decisions about

accounting – related to technical issues including, for example, selection of accounting boundaries, marginal versus average accounting, inclusion of different forest land activity types – that might depend on and be modified to accommodate any specific policy and implementation contexts in which it was used.

The SAB Panel concluded that the lack of implementation details in the draft framework itself hindered the ability of the Panel to fully evaluate the technical aspects of the draft framework. To remedy this deficiency, the SAB Panel suggested a complete description of the Clean Air Act motivation for the work, so that the technical aspects of the framework might be more clearly articulated, thus enabling a fuller evaluation of the technical details relative to the potential policy applications. To simplify implementation, the SAB Panel further suggested developing default accounting factors by region and feedstock "broadly categorized by type, region, prior land use and current management practices" (Advisory, p. 43), as a way of addressing the technical questions surrounding accounting in a policy-neutral fashion.

The revised framework maintains the policy agnostic approach from the first version and does not provide a detailed discussion of specific policy and implementation options. Ultimately, EPA found that the most appropriate course of action at this time is to be as flexible as possible: the revised framework outlines a policy-neutral approach to assess the extent to which there is a net atmospheric contribution of biogenic CO_2 emissions from the production, processing, and use of biogenic material at stationary sources. The framework also explains in detail particular elements of the framework equation where policy-relevant choices would need to be made for application to a specific policy or program. The framework is a technical document that does not set regulatory policy.

In terms of implementation, in response to the SAB Panel's specific recommendations, the revised framework does describe an approach that could be used to develop default assessment factors by feedstock and region. While it does not provide default assessment factors, the revised framework does present hypothetical case studies, based on observed data and/or modeled scenarios, and illustrative results to demonstrate the functionality of the revised framework and how such an approach by feedstock and region could work. These results can be found in Appendices I, L, and M. The revised framework also includes a discussion of some potential ways the biogenic assessment factor or elements of the biogenic assessment factor equation could potentially be applied. To conduct any policy-specific framework applications, the framework equation and its terms may need adjustments or modifications to accommodate the specific parameters needed for the particular application.

The SAB Panel also acknowledged that (Letter, p. 3):

> …practical considerations will weigh heavily in the agency's decision making. In fact, any method that might be adopted or considered, including methods

> proposed by the SAB, should be subject to an evaluation of the costs of compliance and the carbon emissions savings likely to be achieved as compared to both a categorical inclusion and a categorical exclusion. Uncertainties in the assessment of both the costs and the emissions savings should be analyzed and used to inform the choice of policy.

While not addressed specifically as a single technical issue in the revised framework, EPA has integrated practical considerations into the report through streamlining of the methodological approach, and identification of ways in which regional defaults could be developed. Additionally, in the policy application realm, EPA incorporates practical implementation considerations into any regulatory or policy action, and would continue this approach should the framework be used in the future.

Scope of Method

IPCC accounting

In its charge to the SAB Panel, EPA requested that the SAB Panel evaluate the applicability of the IPCC approach for national greenhouse gas (GHG) inventories to account for the net atmospheric biogenic CO_2 contribution from using biogenic feedstocks at stationary sources. The IPCC Guidelines were developed to provide a common international approach for countries to estimate anthropogenic GHG emissions and sinks within their borders. The IPCC approach attributes CO_2 emissions from biogenic feedstocks to a country's Land-Use, Land-Use Change and Forestry Sector, and not to the Energy sector (the sector in which stationary source emissions are accounted. The SAB Panel's Advisory explained the purpose of the IPCC inventory approach as well as limitations using it for other types of evaluation (Advisory, p. 17):

> IPCC develops guidelines for countries to report their anthropogenic greenhouse gas emissions. These emissions are reported as aggregate numbers by sectors, e.g., the Land-Use change and Forestry Sector, the Energy Sector, Industrial Processes and Product Use, etc. The IPCC's inventory of global greenhouse emissions (i.e., all emissions are counted) is comprehensive in quantifying all emissions sources and sinks, but does not describe linkages among supply chains. In other words, it is essentially a 'production-based inventory' or 'geographic inventory' rather than a 'consumption-based inventory' (Stanton et al. 2011). The IPCC inventory offers a static snapshot of emissions at any given time, but it does not expressly show changes in emissions over time.

The SAB Panel explained that the IPCC inventory approach would not "allow for a causal connection to be made between a stationary facility using a biogenic feedstock and the source of that feedstock," and it "would not capture the marginal effect of increased biomass harvesting for bioenergy on atmospheric carbon levels"

(Letter, p. 3). The SAB Panel concluded that the IPCC approach is thus inappropriate for the task at hand (Advisory, p. 17). A dissenting opinion from one Panelist disagreed with this conclusion, recommending that the agency could implement the IPCC approach by "abandon[ing] the framework altogether and instead choos[ing] to exempt biogenic CO_2 emissions from greenhouse gas regulation so long as aggregate measures of land-based carbon stocks are steady or increasing" (Advisory, page E-1). EPA notes that the dissenting view, in practice, could be considered as a national, as opposed to regional, scale implementation of the EPA's draft framework for all feedstocks at once, using EPA's greenhouse gas inventory as an historical reference point dataset, which is not the same thing as using the IPCC Guidelines approach (i.e., the dissenting approach is still conditional on an assessment of land-based carbon stocks, rather than a multisectoral analyses of net GHG emissions). The issues and recommendations related to scale of the framework are discussed later in this document.

As noted above, the success of the IPCC approach relies on the completeness of the accounting for all emissions sources and sinks across all sectors. The revised framework is intended to provide a more granular accounting method specifically for evaluating the net atmospheric contribution of biogenic CO_2 emissions associated with the production, processing and use of biogenic feedstocks at stationary sources, taking into account factors related to the biological carbon cycle. For this reason, the IPCC approach is not designed to address the specific needs and questions that this framework addresses.

Accounting boundaries and consistency with accounting for fossil fuel feedstocks

In the September 2011 draft framework, EPA included direct emissions occurring at the stationary source and offsite factors related to the biological carbon cycle in calculating the net atmospheric biogenic contributions from using a biogenic feedstock. These offsite factors include biogenic carbon sequestration and emissions occurring (or avoided) on the landscape that are associated with feedstock growth and harvest, as well as biogenic carbon-based fluxes (other than direct stack emissions from the stationary source) that occur as a result of storing, processing, and converting a biogenic feedstock at the stationary source, as well as alternative fates and leakage effects (discussed in detail later in this document). For that analysis, which specifically focused on biogenic carbon-based emissions, EPA excluded consideration of emissions from the consumption of fossil fuels associated with extraction, production, and transport of biogenic feedstocks.

As indicated in the Advisory and in the letter to the Administrator, the SAB Panel would have preferred a specific policy application to evaluate or a larger scope of analysis (e.g., cap and trade policy, downstream emissions, lifecycle analysis)(Letter, p.3; Executive Summary, p. 9; Advisory, p. 25). Nonetheless, the SAB Panel observed that the agency must work within boundaries of its regulatory authority under the Clean Air Act and, within that context, design a system that fits within its authority.

The SAB Panel also asserted that accounting for fossil fuels and biogenic feedstocks should be consistent. Specifically, the Panel stated (Executive Summary, p. 7), aside from the inherent carbon cycle differences, that "biogenic emissions accounting should be consistent with emissions accounting for fossil fuels for other emissions accounting categories—including losses, international leakage, and fossil fuel use during feedstock extraction, production and transport." Accordingly, the SAB Panel found that if EPA does not account for emissions associated with offsite factors (such as fossil fuel emissions generated during extraction and transportation) when fossil fuels are used in a stationary source, those emissions should not be accounted for when they are associated with biogenic feedstocks.

EPA agrees with the suggestion for consistency in accounting for fossil fuel and biogenic feedstocks, and has worked to maintain this consistency in the revised version of the framework, as much as possible. In particular, the scope of the revised framework is generally consistent with assessments of fossil fuel CO_2 emissions from stationary sources (which are based on direct emissions from the source, e.g., stack emissions from combustion of a fuel or from a process), with additional consideration of the biogenic carbon cycling effects associated with biogenic feedstock production. In the revised framework, EPA continues to focus its analysis on the unique aspects of biogenic feedstock production and consumption that are directly related to biogenic cycling and does not conduct a full lifecycle assessment.

Secondary use feedstocks

In the September 2011 draft framework, EPA considered biogenic CO_2 fluxes associated with biogenic feedstock production and processes at the initial stationary source, but did not address the implications of biogenic feedstock carbon (in products or other forms) passing through the initial stationary source possibly for use as energy downstream. These elements were considered outside the framework boundary. The SAB Panel critiqued this lack of discussion, finding that "EPA needs to make clear the implicit assumptions on how biogenic carbon will be treated upstream and downstream from the point source if this framework is used to regulate CO_2 emissions under the constraints imposed by the Clean Air Act for regulating stationary sources" (Advisory, p. 30). Although the overall scope of the revised framework has not changed, the revised framework includes a brief discussion (in the main report and Appendix D) acknowledging some different ways that these secondary use feedstocks – feedstocks that pass through and/or are created at one stationary source but used at another – could potentially be treated. One important consideration for any application of the revised framework would how to avoid possible instances of double-counting landscape and process attribute values as they relate to biogenic materials used or processed at the primary stationary source and transferred for use at a secondary stationary source. For example, counting total biogenic feedstock attributes values at both the primary and secondary stationary sources could result in double-counting these values.

Treatment of non-CO_2 gases

In the September 2011 draft framework, EPA generally discussed the role of CH_4 in the carbon cycle, particularly in the context of waste-derived feedstocks (such as landfill gas). Nitrous oxide (N_2O) and emissions of other gases from other external inputs to the feedstock production system were not included. The SAB Panel asserted that EPA should include CH_4, a key GHG emission for waste-derived feedstocks, and N_2O, because fertilizer is a key component of biomass feedstock production.

The revised framework provides an equation for assessing direct emissions of biogenic CO_2 occurring at stationary sources that combust or process biogenic material by considering carbon cycle fluxes associated with or avoided by the conversion of biogenic materials at stationary sources. For completeness, biogenic carbon and carbon-based gases – carbon dioxide and methane – are included within the framework as applied to forest-, agriculture- and waste-derived feedstocks and feedstock production. For example, the revised framework includes CH_4 in the assessment of waste-derived feedstocks (see Appendix N), because reducing or avoiding CH_4 emissions can provide an important GHG benefit of using waste feedstocks for energy at a stationary source instead of disposal, combustion without energy recovery, or other such alternative fates. EPA however, does not include N_2O emissions in the revised framework, as N_2O is not a carbon-based gas within the carbon cycle, and its emissions are the result of external inputs to the feedstock production system. In Appendix M of the revised framework, however, there is a discussion of the sensitivity of the assessment factor values to inclusion of N_2O emissions, in the event that a program or policy finds it appropriate to account for the N_2O emissions potentially associated with feedstock production.

Baselines

In the September 2011 draft framework, EPA described three different possible baseline applications (reference point, anticipated future baseline, and comparative baseline; p. 25).[1] The 2011 draft framework case studies applied only a retrospective reference point baseline approach, in which the net change in carbon stocks and related biogenic CO_2 fluxes between a specific historic point in time (or range of years) is compared with a fixed reference point in time to see how they have changed between the two points in time. This approach essentially answers the question, "Is there more or less carbon stored in the system (e.g., at the biogenic feedstock production site or region) at the end of an assessment period than there was at the beginning?"

[1] The Panel offered no explicit recommendations or findings on the comparative baseline approach (which compares biogenic feedstock production and consumption versus other fuels like fossil fuels or fossil fuel consumption displacement from biogenic feedstock use), though there are instances that they suggest evaluation of fossil fuel displacement with biomass- e.g., Executive Summary, p.2.

The SAB Panel noted, in response, that "the choice of a fixed reference point may be the simplest to execute, but it does not actually address the question of the extent to which forest stocks would have been growing/declining over time in the absence of a particular bioenergy facility" (Advisory, p. 29). In other words, the reference point baseline does not address the important question of additionality, or what would have been the trajectory of biogenic CO_2 stocks and fluxes in the absence of an activity or activities using biogenic feedstocks for energy. "Estimating additionality, i.e., the extent to which forest stocks would have been growing or declining over time in the absence of harvest for bioenergy, is essential, as it is the crux of the question at hand. To do so requires an anticipated baseline approach" (Letter, p. 2). The SAB Panel's recommendation for an anticipated baseline also included application to agricultural feedstocks as well: "For faster growing biomass like agricultural crops, the anticipated future baseline approach is still necessary to reflect changes in dynamic processes, e.g., soil carbon, 'anyway' emissions (those that would occur anyway without removal or diversion of non-growing feedstocks, for example, corn stover), and landscape changes" (Executive Summary, p. 4).

Per the SAB Panel's suggestion, the revised framework includes a more detailed consideration of the future anticipated baseline approach. This approach seeks to answer the question, "Is more or less carbon stored in the system over time compared to what could have been stored in the absence of changes in biogenic feedstock use?" As described by the SAB Panel, this approach "requires selecting a time period and determining what would have happened anyway without the harvesting and comparing that impact with the carbon trajectory associated with harvesting of biomass for bioenergy" (Executive Summary, p. 5). Specifically, the future anticipated baseline first establishes a business-as-usual (BAU) baseline scenario that serves as a reference level of projected or simulated future anticipated biogenic feedstock use and related environmental and socio-economic conditions and impacts along a specified time scale. The BAU baseline estimates are then compared with a future alternative scenario of changed (i.e., increased or decreased) biogenic feedstock demand. The resulting difference between these scenarios can indicate the possible effects of altered biogenic feedstock use.

The main body of the revised framework report includes more detailed consideration of the future anticipated baseline approach, and Appendices J, K, and L contain detailed discussions about what an anticipated baseline is and the quantitative methods and datasets used to develop baselines and illustrative assessment factors for forestry- and agriculture-derived feedstocks using this baseline approach. Similarly, Appendices H and I contain detailed discussion of developing illustrative assessment factors for forestry- and agriculture-derived feedstocks using the retrospective reference point baseline, and Appendix M places the two sets of illustrative assessment factors together to facilitate comparison.

The SAB Panel stated that for waste materials EPA should consider the alternative deposition of such materials or "what would have happened if not used for feedstocks using a counterfactual scenario approach" (Advisory, p. 5). The revised

framework considers waste-derived biogenic feedstocks to be sufficiently removed from the landscape production process[2] such that, rather than employing an approach to evaluate landscape-based effects, collection and use of these waste-derived feedstocks for energy are considered from the perspective of 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). This approach uses a counterfactual evaluation of how collection and use of waste-derived biogenic feedstocks for energy production at a stationary source compares to an alternate management fate for that feedstock. Appendix N provides further information on waste-derived biogenic feedstocks, as well as illustrative calculations and results.

Spatial Scale

Regional Accounting

In the September 2011 draft framework, EPA presented various spatial scales but suggested use of a regional approach for quantification of landscape-level carbon stocks as a balance between the strength of connection between a facility and the relevant land providing feedstock on one hand, and the availability of data and ease of implementation on the other. Specifically, EPA had proposed use of "a regional scale to reflect the important distinctions between regional drivers of changes in land-based carbon stocks and resource supply and demand that could be masked at the national level … The spatial scale of accounting must be large enough that accurate data are available, but small enough to capture important regional characteristics such as growth rates and variation in market demand for feedstocks" (EPA, 2011, p. 41). EPA did not define or recommend specific regions in its 2011 draft report. The SAB Panel noted the difficulty in assessing a regional approach generically, given that it "makes the estimate of the BAFs sensitive to the choice of the spatial region chosen for accounting purposes" (Advisory, p. 28).

In addition, the SAB Panel said that "to accurately capture the carbon outcome, an anticipated baseline approach and landscape level perspective are needed" (Executive Summary, p. 5). The Panel also concluded that "a landscape, versus stand or plot, perspective is important because land-management decisions are simultaneous, e.g., harvesting, planting, silvacultural treatments. Thus, there are concurrent carbon stock gains and losses that together define the net implications over time. A landscape level analysis, and BAF calculation, will capture these" (Executive Summary, p. 6). EPA understands this conclusion to mean that it is not advisable to select a scale that is too small, because it does not capture management decisions that affect multiple stands at once.

[2] The biologically based material in waste-derived feedstocks was removed from the land base for economic and production purposes outside of generating these feedstocks (e.g., newspaper, food, and construction materials) and represents material that has been discarded. Thus, the final disposition of the material must be managed in some fashion.

Though the SAB Panel did not explicitly define 'landscape level' anywhere in the Advisory package, the Panel did seem to use the term as synonymous to a regional spatial scale in some of the default BAF discussion text. The SAB Panel recommended that if the agency seeks to generate facility-specific BAFs utilizing an updated framework, the EPA could "develop a separate BAF equation for each feedstock category as broadly categorized by type, region, prior land use and current management practices" (Executive Summary, p 7; Advisory, p. 43), using specific baseline and other parameters for different feedstock categories (e.g., future anticipated future baseline for long-accumulation feedstocks like woody biomass and alternative fate analysis for waste-derived feedstocks). In its explicit recommendations for a default regional BAF approach, the SAB Panel describes this approach both as regional (as quoted above: Executive Summary, p. 7) and landscape level ("For long rotation woody biomass, sophisticated modeling is needed to capture the complex interaction between electricity generating facilities and forest markets and landscape level effects", Executive Summary, p. 7). For agricultural feedstocks or other feedstocks with short rotations, the Panel also found that "the *Framework* may, with some adjustments … and careful consideration of data and implementation, accurately represent direct carbon changes in a particular region" (Advisory, p.5).

The SAB Panel was particularly concerned with the choice of regional spatial scale in conjunction with the retrospective reference point baseline for specific framework equation terms. Specifically, they found that "the use of unspecified 'regions' in combination with a reference year baseline is a central weakness of the *Framework* with respect to forest-derived feedstocks" (Executive Summary, p. 2). Specifically for forestry-derived feedstocks, the SAB Panel stated that "the reference point estimate of region-wide net emissions or net sequestration does not indicate, or estimate, the difference in greenhouse gas emissions (the actual carbon gains and losses) over time that stem from biomass use" (Executive Summary, p. 6). The SAB Panel argued that "the agency's use of a fixed reference point baseline coupled with a division of the country into regions implies that forest biomass emissions could be granted an exemption simply because the location of a stationary facility is in an area where forest stocks are increasing" (Executive Summary, p. 6). The Panel thought of this combination of time and space as a means to avoid chain of custody accounting and evaluating changes in carbon stocks over time (Advisory, p. 28).

EPA recognizes both the importance of the choice of spatial scale, and the SAB Panel's concerns with the choice of very fine (e.g., stand-level) scales. EPA also appreciates the potential analytical concerns the SAB Panel identified with combining regional scales and retrospective reference point baselines for some feedstocks. The revised framework includes a more thorough discussion of spatial scale (in the main report as well as Appendix C), but also retains substantial flexibility in approach given the importance of the specific context of a particular policy or program. In response to SAB Panel's recommendation to consider a regional level default approach, EPA has prepared illustrative regional/landscape

level BAF calculations, using both the reference point and future anticipated baseline approaches. In the revised framework, EPA has identified and used specific regions (10 and 11 regions for forest and agricultural feedstocks, respectively) based on existing forest and agricultural inventory datasets to develop the illustrative case study assessment factor calculations.

However, although the revised framework employs a regional approach in the illustrative case studies analyzing forest-derived and agriculture-derived feedstocks, the illustrative analysis of waste-derived feedstocks within Appendix N to the framework does not depend on a choice of spatial scale. As mentioned above, waste-derived feedstocks are considered to be generated from other production and processes that would have taken place regardless of the waste-derived feedstock's use for energy. Therefore, the analysis of waste-derived feedstocks uses a counterfactual approach that considers waste-derived feedstock characteristics as consistent throughout the U.S.[3]

Temporal Scale

Overall, the SAB Panel found that "one fundamental deficiency in the EPA report is the lack of discussion of the different time scales inherent in the carbon cycle and the climate system that are critical for establishing an accounting system" (Advisory, p. 14). The SAB Panel also found that the September 2011 draft framework did not provide a thorough description of the role of temporal scales in the framework. The hypothetical case study results generated using the reference point baseline approach were based on inventory data on an average annual basis over a specified timeframe (from a window integrating 5-10 years' worth of measurements). This approach, in which estimates were averaged and presented at the regional scale to track regional-level carbon sequestration and emissions, did not require the choice of a specific future time frame in which to assess the trade-offs between long-term forest growth and short-term emissions.

The SAB Panel concluded that this type of assessment was limited because it did not link the emissions and sequestration outcomes with radiative forcing and climate change over time: "The *Framework* seeks to determine annual changes in emissions and sequestration rather than assessing the manner in which these changes will impact the climate over longer periods of time. In so doing, it does not consider the different ways in which use of bioenergy impacts the carbon cycle and global temperature over different time scales. Nor does it consider temporal differences of climate effects on the environment....The impacts of the temporal pattern on climate

[3] Waste-derived feedstock material characteristics are generally consistent nationally but may have some regional variability, including the composition of waste (which can vary from community to community within a region) and regional climate factors that affect methane (CH4) oxidation via cover soils at managed landfills (Bogner et al., 2007; EPA, 2009; Spokas and Bogner, 2011).

response depend on the metric used for measuring climate impacts and the time horizon being considered" (Executive Summary, p. 2).

Since, as the SAB Panel explains, research suggests that "the probability of limiting warming to or below 2°C in the twenty-first century is dependent upon cumulative emissions by 2050 (Meinshausen et al. 2009)" (Executive Summary, p. 2), if the framework is intended to capture the climate change impacts related to the use of biogenic feedstocks for energy, the SAB Panel found that the cumulative impact of a transition from fossil fuel to biomass should be considered. "If a carbon stock is cycling quickly on land and regrowth is sufficient to compensate for carbon losses from harvesting, it may have a beneficial impact when it displaces fossil fuel over successive cycles of growth and harvest (assuming this temporal displacement exceeds 100 years). If the carbon stock, or some part of it, turns over more slowly, if regrowth is not assured or if feedstocks are not being used to continuously displace fossil fuels, the impact on climate worsens" (Advisory, p. 14).

The SAB Panel also requested a more explicit discussion of temporal scale in the context of different feedstock categories (particularly between those with different turnover times), the decay rates of biomass that would otherwise not be used for bioenergy, soil carbon implications, and tradeoffs amongst policy choices related to the treatment of time. In the main body of the revised framework report and Appendix B, there are detailed discussions on the role of time when accounting for biogenic emissions, differences when treating time between different baseline applications, and the interplay between time and space.

In Appendix B in the revised framework, EPA has included a more explicit discussion of the intertemporal tradeoffs inherent in various options for treating emissions over time in the context of future anticipated baselines as well as inclusion of decay rates for feedstocks that would have otherwise decayed if not used for energy. Also, EPA has also added illustrative calculations using the future anticipated baseline, which estimates illustrative assessment factors using future simulations and thereby explicitly incorporates temporal patterns of different feedstocks (e.g., feedstock growth rates, decay rates) into the analysis (as seen in Appendix K and L). Although EPA does not recommend a specific timescale or timescales for framework applications, it does select specific time periods for assessing biogenic CO_2 emissions using the revised framework in the illustrative case study calculations, especially those for longer-rotation feedstocks, to provide insights into the potential implications of using different time frames.

EPA acknowledges that the potential long-term climate impacts related to the use of biogenic energy sources is an important topic for climate change mitigation policy and also recognizes the extensive work being conducted by the research community on this question. Evaluation of, for example, temperature change impacts, radiative forcing, and related social costs and benefits related to biogenic feedstock production, processing, and use for energy, could potentially be incorporated into a specific analysis using the revised framework. Nevertheless, EPA has continued with

its more targeted goal of developing tools to assess the extent to which there is a net atmospheric contribution of biogenic CO_2 fluxes from the production, processing, and use of biogenic feedstocks at stationary sources. This more narrowly defined assessment is a better fit for the types of program and policy applications in which this framework may potentially be applied.

Therefore, the report does not assess or propose methods for assessing radiative forcing, changes in total atmospheric concentrations of CO_2 and other GHGs, potential impacts of increasing levels of atmospheric CO_2 (changes in precipitation, temperature, etc.), or societal costs and benefits of mitigating GHGs.

Leakage

In the September 2011 draft framework, an equation term for leakage was included in the framework equation so that EPA could account for potential greenhouse gas emission increases or decreases taking place outside the accounting boundary due to changes in biogenic feedstock production activities. EPA did not provide specific methodologies for calculating leakage, and did not estimate the term as part of the illustrative case studies.

The SAB Panel acknowledged that leakage may be important when considering the overall net atmospheric biogenic CO_2 contributions associated with use of a biogenic feedstock, but also cautioned that leakage is difficult to quantify: "The assessment of the overall magnitude of leakage, associated with the use of bioenergy for fuel is highly uncertain and differs considerably across studies and within a study, depending on underlying assumptions. It will also differ by feedstock and location" (Executive Summary, p. 6). The SAB Panel stated that "while the existence of non-zero leakage is very plausible, the appropriateness of attributing emissions that are not directly caused by a stationary facility to that facility has been called into question (Zilberman et al. 2011)" (Advisory, p. 24). With that rationale, the SAB Panel suggested that EPA include, as part of an assessment, a more comprehensive discussion of the likely direction and magnitude of leakage estimates, so that leakage could be dealt with through supplemental polices rather than having specific values for leakage included in the BAF calculation (Executive Summary, p. 6):

> In dealing with leakage, we suggest measuring the magnitude of leakage to the extent possible or at least examining the directionality of net leakage – whether it is positive (leading to increased carbon emissions elsewhere) or negative (leading to carbon offsetting activities). In some cases even net directionality may be hard to establish. This information can be used to develop supplementary policies to control leakage before it occurs. We do not recommend incorporating a measure of leakage in the estimate of BAF

which would effectively hold a stationary facility responsible for emissions that are outside its control and occurring due to market effects.

In the revised framework, EPA has retained the equation term for leakage estimates in case they are needed for specific applications of the framework, including those that may not be able to implement the recommended supplemental policies, and those in which leakage may be quantifiable. While the revised framework can accommodate calculations of leakage effects when a specific policy or program context requires such a calculation, the revised framework does not choose or develop a specific methodology for identifying and evaluating these effects because the method chosen for such an analysis should reflect the needs or parameters of the specific policy or program context. Appendix E in the revised report contains a thorough discussion of leakage requested by the SAB Panel, including a review of literature that investigates the main drivers of leakage in the forestry and agriculture sectors, reviews estimates of leakage in various contexts, and examines how various policies and associated analyses address leakage in program applications.

Feedstock Categorization

The September 2011 draft framework organized biogenic feedstocks into three general categories (forest-derived woody biomass, agricultural biomass, and waste materials), with 16 subcategories. The categories were based broadly on similarities in market conditions, feedstock utilization, and biophysical conditions such as growth rates. The SAB Panel largely agreed with the EPA's general categorizations, and made some additional suggestions for how EPA might re-classify feedstocks.[4]

In the revised framework, EPA has slightly modified the feedstock organization in response to feedback from the SAB Panel. The three general categories remain the same, but now include 10 subcategories, as described in the main body of the framework and in Appendix D.

[4] The SAB Panel feedstock category recommendations, however, differ between the Executive Summary (p. 7: short rotation dedicated energy crops, crop residues, forest residues, municipal solid waste, trees/forests with short accumulation times, trees/forests with long accumulation times and agricultural residue, wood mill residue and pulping liquor) and the Advisory (p. 43: short rotation dedicated energy crops, crop residues, forest residues, perennial crops, municipal solid waste, long rotation trees and waste materials including wood mill residue and pulping liquor). Both were taken into consideration during development of the revised framework.