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MEMORANDUM

To: **Holly Stallworth, Designated Federal Official**
Science Advisory Board Staff Office

From: **Paul Gunning, Director**
Climate Change Division

Subject: **Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources and Charge Questions for SAB peer review**

The purpose of this memorandum is to transmit the revised *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources,* related documentation and charge questions for consideration by the Science Advisory Board (SAB) during your upcoming peer review.

In January 2011, the U.S. Environmental Protection Agency (EPA) announced a series of steps it would take to address biogenic CO_2 emissions from stationary sources. EPA committed to conduct a detailed examination of the science and technical issues related to assessing biogenic CO_2 emissions from stationary sources and to develop a framework for evaluating those emissions. The draft study was released in September 2011 and subsequently peer reviewed by the SAB Ad-Hoc Panel on Biogenic Carbon Emissions (SAB Panel). The final peer review report was published September 2012.

To continue advancing the agency's technical understanding of the role that biomass use can play in reducing overall greenhouse gas emissions, the EPA released a second draft of the technical report, *Framework for Assessing Biogenic Carbon Dioxide for Stationary Sources*, in November 2014. This revised report presents a methodological framework for assessing the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO_2 emissions. The revised report takes into account the SAB Panel's peer review recommendations on the draft 2011 Framework as well as the latest information and input from the scientific community and other stakeholders.

The revised framework addressed many of the SAB Panel's key concerns and recommendations by incorporating: an anticipated baseline approach analysis, including an alternative fate approach for waste-derived feedstocks and certain industrial processing products and byproducts; an evaluation of tradeoffs from using different temporal scales; an improved representation of the framework equation; and illustrative case studies demonstrating how the framework equation can be applied, using region-feedstock combinations to generate regional defaults per different baseline approaches and temporal scales.

We ask the SAB to review and offer recommendations on specific technical elements of the revised framework for assessing the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic

CO_2 emissions, as identified in the charge accompanying this memo. We look forward to the SAB's review.

Please contact me if you have any questions about the attached study and charge.

Attachments:

1) *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources*
2) Technical Appendices
3) Response to the 2011 SAB Panel Peer Review Advisory

Peer Review Charge on the Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources

To improve the quality, utility, and scientific integrity of the Framework, EPA is providing this study, *Framework for Assessing Biogenic CO_2 Emissions from Stationary Sources* (November 2014) and related materials to the Science Advisory Board (SAB). The revised report takes into account the SAB Biogenic Carbon Emissions Panel's ("SAB Panel") peer review recommendations[1] on the draft 2011 Framework[2] as well as the latest information and input from the scientific community and other stakeholders. The "Response to SAB" document included in the materials provided for this review discusses and responds to the SAB Panel key points and recommendations, serving as a guide to how the revised framework incorporates their recommendations. This charge narrowly focuses on a few specific remaining questions that were not explicitly addressed in the initial SAB Panel peer review report.

The revised 2014 framework report identifies key scientific and technical factors associated with assessing biogenic CO_2 emissions from stationary sources using biogenic feedstocks, taking into account information about the carbon cycle. It also presents a methodological framework for assessing the extent to which the production, processing, and use of biogenic material at stationary sources for energy production results in a net atmospheric contribution of biogenic CO_2 emissions.

The revised framework and the technical appendices address many of the SAB Panel's key concerns and recommendations by incorporating: an anticipated baseline approach analysis (Appendices J-L), an alternative fate approach for waste-derived feedstocks (Appendix N) and certain industrial processing products and byproducts (Appendix D Addendum); an evaluation of tradeoffs from using different temporal scales (Appendix B); an improved representation of the framework equation (Appendix F); and illustrative case studies demonstrating how the framework equation can be applied, using region-feedstock combinations to generate regional defaults per different baseline approaches and temporal scales (Appendices H-N).

As explained in the revised framework introduction and accompanying SAB response document, the revised framework maintains the policy neutral approach from the 2011 draft Framework. It is a technical document that does not set regulatory policy nor does it provide a detailed discussion of specific policy and implementation options. Ultimately, the framework provides a methodological approach for considering, and a technical tool (the framework equation) for assessing, 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 revised framework details technical elements that should be considered as appropriate per specific policy applications or biogenic carbon-

[1] The final peer review report from the SAB Panel on the draft 2011 framework was published on September 28, 2012 (Swackhamer and Khanna, 2011). Information about the SAB peer review process for the September 2011 draft framework is available at http://yosemite.epa.gov/sab/sabproduct.nsf/0/2F9B572C712AC52E8525783100704886.
[2] The 2011 *Draft Accounting Framework for Biogenic CO_2 Emissions from Stationary Sources* is available at www.epa.gov/climatechange/ghgemissions/biogenic-emissions.html.

based feedstock assessments. Therefore, this charge excludes policy and regulatory recommendations or legal interpretation of the Clean Air Act's provisions related to stationary sources.

The revised report does not provide any final values or determinations: it offers indications of different biogenic feedstock production effects per research and analyses conducted, including illustrative example results per specific case study parameters. As discussed by the previous SAB Panel, this report also finds that biophysical and market differences between feedstocks may necessitate different technical approaches. Even using a future anticipated baseline approach, forest- and agriculture-derived feedstock characteristics, and thus analyses and results, may vary per region and per feedstock, and may be influenced by land use change effects. Illustrative analyses conducted for specific waste-derived feedstock case studies using a counterfactual anticipated baseline, as recommended by the SAB Panel, yielded minimal or negative net emissions effects.

This charge focuses on questions that remain regarding whether there are more definitive technical determinations appropriate for parameterizing key elements of the revised framework, regardless of application to a specific policy or program. Specifically, we ask that the SAB Panel examine and offer recommendations on future anticipated baseline specification issues in the context of assessing the extent to which the production, processing, and use of forest- and agriculture-derived biogenic material at stationary sources for energy production results in a net atmospheric contribution of biogenic CO_2 emissions – such as appropriate temporal scales and the scale of biogenic feedstock usage (model perturbations or 'shocks') for analyzing future potential bioenergy production changes.

Technical approaches, merits and challenges with applying a future anticipated baseline

Establishing a baseline creates a point of comparison necessary for evaluating changes to a system.[3] Baseline specification can vary in terms of what entity or groups of entities are being analyzed (e.g., industries, economic sectors), temporal and spatial scales, geographic resolution, and, depending on context, environmental issues/attributes (EPA, 2010).[4] The choice of baseline approach can also depend on the question being asked and the goal of the analysis at hand. For example, some GHG analysis may require a baseline against which historic changes of landscape carbon stocks can be measured. Other applications may necessitate a baseline against which the estimated GHG emissions and sequestration associated with potential future changes in related commodity markets and policy arenas. Analyses of the estimated GHG emissions and sequestration effects from changes in biomass use have used different baseline approaches, as well as a wide range of different temporal scales and alternative scenario parameters (Sohngen and Sedjo, 2000; Fargione, 2008; UNFCCC, 2009; Walker et al., 2010;

[3] Definitions for baseline vary, including "the reference for measurable quantities from which an alternative outcome can be measured" (IPCC AR4 WGIII, 2007) or "the baseline (or reference) is the state against which change is measured. It might be a 'current baseline,' in which case it represents observable, present-day conditions. It might also be a 'future baseline,' which is a projected future set of conditions excluding the driving factor of interest. Alternative interpretations of the reference conditions can give rise to multiple baselines" (IPCC AR4 WGII, 2007).
[4] Guidelines for Preparing Economics Analyses (NCEE), Chapter 5: http://yosemite.epa.gov/ee/epa/eerm.nsf/vwAN/EE-0568-05.pdf/$file/EE-0568-05.pdf

Cherubini et al, 2011; Galik and Abt, 2012; Latta et al., 2013; Walker et al., 2013; AEO, 2014; U.S. EPA, 2014; Miner et al., 2014).

The draft 2011 framework had discussed three different potential baseline approaches – reference point, future anticipated and comparative – and used the reference point baseline in its hypothetical case study applications of the Framework. The SAB Panel in its review stated 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" (SAB Advisory, p. 29). The SAB Panel expressed concern that 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, especially in the context of forest-derived feedstocks.[5] "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" (SAB Letter, p. 2).

Through public comments to the SAB Panel during the 2011-2012 SAB peer review process, various stakeholders expressed divergent perspectives on the appropriate baseline for the draft 2011 framework report.[6] The revised 2014 framework retains the reference point baseline and adds the anticipated baseline in order to retain adaptability for potential applications, and discusses both approaches at length in the revised report and several technical appendices. However, as the SAB Panel was clear in its previous review of the reference point baseline, EPA has no outstanding technical questions for the SAB Panel on that baseline approach. This charge focuses specifically on remaining technical questions that EPA has on the future anticipated baseline approach.

Part 1 – Future anticipated baseline approach and temporal scale

It is important to consider possible treatments of time and the implications of these treatments in developing strategies for long-term and short-term emissions assessment, because the choice of treatment may have significant impacts on the outcome of an assessment framework application. For

[5] The difference in net atmospheric CO_2 emissions contributions with and without changes in biogenic feedstock use is known as additionality (Murray et al., 2007). Additionality can be determined by assessing the difference in potential net atmospheric CO_2 emissions of a specific level of biogenic feedstock use over a certain period of time (in many cases the business-as-usual [BAU] baseline) versus the net atmospheric CO_2 emissions contributions that would have occurred over the same time period with a different level of biogenic feedstock use (counterfactual scenario), holding other factors and assumptions consistent between scenarios.

[6] The American Forest and Paper Association (AF&PA) supported the reference point baseline (e.g., comments submitted October 2011, March 2012) applied historically (January 2012, March 2012). The National Alliance of Forest Owners (NAFO) stated if certain feedstocks weren't categorically excluded, then the historical reference point baseline should be used (e.g., March 2012, August 2012). The U.S. Department of Agriculture stated preference for a historic baseline approach (May 2012). The Environmental Defense Fund (EDF) (January 2012, May 2012) and NCASI (October 2011, March 2012) both supported the retrospective reference point approach, though also both offered recommendations if an anticipated baseline approach was included (EDF for future anticipated and NCASI for counterfactual). Others, such as Green Power Institute (March 2012), the National Resource Defense Council (NRDC, August 2012), Becker et al. (August 2012), Biomass Energy Resource Center et al. (February 2012), and a group scientists letter to EPA (June 2014) all support some form of the anticipated baseline approach (future anticipated and/or counterfactual).

the intended use of the revised Framework – assessing the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO_2 emissions – there are different elements of time to consider when using a future anticipated baseline approach. These elements can include:

- Emissions horizons, assessment or policy horizons, and reporting periods (i.e., fluxes related to feedstock production may occur over many years to decades, whereas reporting may be the current year and policies may cover only a few years or decades), and
- Differences in temporal characteristics of different feedstocks (i.e., annual crops, short rotation energy crops, and longer rotation forestry systems).
- Changes in biophysical and economic conditions over time may affect or differ from those in future anticipated baseline and scenario estimates.

The SAB Panel in its previous peer review noted that "this is a complicated subject because there are many different time scales that are important for the issues associated with biogenic carbon emissions" (Advisory, page 13). They discussed multiple temporal scales associated with mixing of carbon throughout the different reservoirs on the Earth's surface at the global scale (Advisory, page 13) and climate responses to CO_2 and other greenhouse gases (Advisory, page 15), implications of temporal scales greater and shorter than 100 years, and those related to the growth cycles of different feedstock types (Advisory, page 15). The SAB Panel specifically highlighted considerations for using a 100-year or longer temporal scale for evaluating climate impacts and radiative forcing[7] as well as decay rates and carbon storage in forest ecosystems in the main text as well as in Appendices B-D. However, in its recommendations, including those for developing default biogenic assessment factors per region, the SAB Panel did not offer recommendations per what temporal scale to use in the specific context of the Framework for its intended use and scope. Instead, the SAB Panel stated that "there is no scientifically correct answer when choosing a time horizon, although the *Framework* should be clear about what time horizon it uses, and what that choice means in terms of valuing long term versus shorter term climate impacts (Advisory, page 15) and recommended that a revised framework "incorporate various time scales and consider the tradeoffs in choosing between different time scales" (Advisory, page 43).

Multiple stakeholders have also weighed in on temporal scales, some with specific recommendations on what temporal scale should/could be used for framework assessments, others with no specific recommendations but emphasizing the importance of time. In various comments submitted during the 2011-2012 SAB process, NAFO supported a 100-year timeframe (March 2012). The National Council for Air and Stream Improvement (NCASI) in October 2011 comments suggested "the need for considerable flexibility in setting the temporal scales for determining the stability of forest carbon stocks. There are a

[7] EPA acknowledges that the long-term climate impacts of shifting from fossil fuel to biogenic energy sources is an important topic for climate change mitigation policy and also recognizes the extensive work being conducted by EPA and throughout the research community on this question. However, EPA's focus here is on a narrower, more targeted goal of developing tools 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 feedstocks at stationary sources. This more narrowly defined assessment is anticipated to be a better fit for the types of program and policy applications in which this framework may potentially be applied.

range of circumstances that can cause transient trends in carbon stocks that can obscure the more relevant long-term picture."

Other groups, such as The Wilderness Society (TWS), NRDC, EDF and others, submitted comments supporting consideration of shorter temporal scales. In its comments and example calculations, TWS (in October 2011 comments) implied support for shorter temporal scales, and stated in later comments that the SAB "text appears biased toward ignoring effects that occur within a 100-year period" (May 2012). NRDC (August 2014) implied support for shorter temporal scales: "even if near-term carbon emissions increases are eventually 'made up' by regrowth over the very long term, the carbon emission from these types of biomass actually exceed those from fossil fuels for decades. This puts use of these types of biomass fuels in conflict with the urgent need for near-term carbon emissions reductions. The time profile of the carbon emission from biogenic fuel sources matters because it is critical to limit near-term global GHG emissions." This perspective was similar to that shared by Becker et al. in their August 2012 comments. EDF (January 2012) suggested a very short temporal scale (in the context of supporting a retrospective reference baseline). Others, such as the Biotechnology Industry Organization (October 2011) simply asked for "clarification on the methodology used to identify the time scale of carbon cycles."

Per the various recommendations above, the revised framework report and the technical appendices include a more detailed discussion of intertemporal tradeoffs inherent in various options for treating emissions over time in the context of assessing biogenic CO_2 emissions from stationary sources. Specifically, the revised report has: a section on key temporal scale considerations (pages 33-38); an appendix dedicated to temporal scale issues (Appendix B), which includes further discussion of temporal scales in the context of future anticipated baselines and decay rates for feedstocks that would have otherwise decayed if not used for energy, and; an appendix describing the background of and modeling considerations for constructing an anticipated baseline approach (Appendix J). Also, illustrative calculations using the future anticipated baseline estimates use future simulations and thereby explicitly incorporate temporal patterns of different feedstocks (e.g., feedstock growth rates, decay rates) into the analysis and shows how results can vary per temporal scale used (as seen in Appendices K and L). The revised framework does not recommend specific temporal scales for framework applications, but rather identifies different elements of and considerations concerning time to provide insights into the potential implications of using different temporal scales.

EPA seeks guidance on the following issues regarding appropriate temporal scales for assessing biogenic CO_2 emissions using a future anticipated baseline, using the above referenced components of the revised framework report as the starting point for the SAB Panel's discussion. As the previous SAB Panel recommended developing default assessment factors by feedstock category and region that may need to be developed outside of a specific policy context, and as the framework could be also be used in specific policy contexts, the questions below relate to the choice of temporal scale both within and outside of a specific policy context.

1. What criteria could be used when considering different temporal scales and the tradeoffs in choosing between them in the context of assessing the net atmospheric contribution of biogenic CO_2 emissions from the production, processing, and use of biogenic material at stationary sources using a future anticipated baseline?*
   a. Should the temporal scale for computing biogenic assessment factors vary by policy (e.g., near-term policies with a 10-15 year policy horizon[8] vs mid-term policies or goals with a 30-50 year policy horizon vs long-term climate goals with a 100+ year time horizon), feedstocks (e.g., long rotation vs annual/short-rotation feedstocks), landscape conditions, and/or other metrics? It is important to acknowledge that if temporal scales vary by policy, feedstock or landscape conditions, or other factors, it may restrict the ability to compare estimates/results across different policies or different feedstock types, or to evaluate the effects across all feedstock groups simultaneously.
      i. If temporal scales for computing biogenic assessment factors vary by policy, how should emissions that are covered by multiple policies be treated (e.g., emissions may be covered both by a short-term policy, and a long-term national emissions goal)? What goals/criteria might support choices between shorter and longer temporal scales?
      ii. Similarly, if temporal scales vary by feedstock or landscape conditions, what goals/criteria might support choices between shorter and longer temporal scales for these metrics?
      iii. Would the criteria for considering different temporal scales and the related tradeoffs differ when generating policy neutral default biogenic assessment factors versus crafting policy specific biogenic assessment factors?
   b. Should the consideration of the effects of a policy with a certain end date (policy horizon) only include emissions that occur within that specific temporal scale or should it consider emissions that occur due to changes that were made during the policy horizon but continue on past that end date (emissions horizon)?[9] The production, processing, and use of biogenic feedstocks at stationary sources can, in some circumstances, have terrestrial emissions effects extending into the future and there are different methods and perspectives about how to assess future emissions trajectories. Assessing for these emissions appropriately in different policy contexts and policy temporal scales may necessitate various decisions that reflect the goals, parameters and

* Though discussion of temporal scale issues appears through the revised framework, targeted discussions on temporal scales can be found in the following framework components: revised report Section 4.2 (pages 33-38); an appendix dedicated to temporal scale issues (Appendix B); an appendix describing the background of and modeling considerations for constructing an anticipated baseline approach has a section on temporal dynamics (Appendix J, Section 3.1.2), and the appendices that construct baselines and alternative scenarios for illustrative future anticipated baseline approach case studies (Appendices K and L).

[8] In some cases, it may be useful to distinguish between the emissions horizon and the policy horizon. The emissions horizon is the period of time during which the carbon fluxes resulting from actions taking place today actually occur, which may span a year to several decades, depending on the feedstock and production site conditions. The policy horizon is the established or expected period of time for policy implementation and analysis of related estimated effects. In effect, these time horizons can differ significantly.

[9] See footnote 8 above for more detail on these terms.

temporal scale of the policy. In some cases, the emissions horizon and the policy horizon can differ significantly. In some cases, emissions are considered under/affected by multiple policies (e.g., state, U.S. national, those impacted by policies in other nations) or commitments (e.g., emissions may be covered by multiple EPA regulations with different policy horizons, or an EPA regulation may have a policy horizon that differs from U.S. nationally determined contributions to the UNFCCC process).

c. Should calculation of the biogenic assessment factor include all future fluxes into one number applied at time of combustion (cumulative – or apply an emission factor only once), or should there be a default biogenic assessment schedule of emissions to be accounted for in the period in which they occur (marginal – apply emission factor each year reflecting current and past biomass usage)? [10]
d. What considerations could be useful when evaluating the performance of a future anticipated baseline application on a retrospective basis (e.g., looking at the future anticipated baseline emissions estimates versus actual emissions *ex post*), particularly if evaluating potential implications for/revisions of the future anticipated baseline and alternative scenarios going forward?

Part 2 – Scales of biomass use when applying future anticipated baseline approach

When using a future anticipated baseline approach, there are different ways to simulate potential future economic and biophysical conditions associated with changes in biogenic feedstock demand and supply (Sohngen and Sedjo, 2000; Fargione, 2008; Walker et al., 2010; Cherubini et al, 2011; Galik and Abt, 2012; Latta et al., 2013; Walker et al., 2013; AEO, 2014). In general, future anticipated baseline approach modeling typically starts with an identified initial equilibrium condition (e.g., market clearing) in the baseline. After establishing the baseline, analysts employ different 'shocks' or changes to one or more coefficients or variables within the model. The shock perturbs the initial equilibrium condition, simulating different market, policy or biophysical conditions, and a new equilibrium is reached. This technique is used often to test sensitivity of the results to specific variables and different expectations of future market or other conditions. In the context of this charge, the shock refers to changing the scale of biomass demand or usage to simulate related biogenic feedstock production market and land use effects, including the biogenic carbon-based emissions profile.

According to the previous SAB Panel, one of the key questions surrounding the use of biogenic feedstocks as fuel is "whether the harvesting of biomass for bioenergy facilities is having a negative impact on the carbon cycle relative to emissions that would have occurred in the absence of biomass usage. This requires determining what would have happened anyway without the harvesting and comparing the impact with the increased harvesting of biomass for bioenergy in order to isolate the

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[10] As discussed in the framework report and various appendices, data, models, tools and assumptions (e.g., historic or potential future biological data like growth rates/yields, anticipated future economic parameters) used to create baselines and alternative scenarios could be updated as new data, models, or methods are released, if appropriate within specific policy applications of the framework. Such updates, if appropriate, could be used to reflect improved future trajectories of estimated emissions fluxes related to biogenic feedstock production and use if initial estimated trajectories differ from actual emissions flux trajectories.

incremental or additional impact of the bioenergy facility" (Advisory, page 28). Though the SAB Panel encouraged the use of an anticipated baseline approach throughout the Advisory (e.g., pages 4-8, 26-28, 32-35) and discussed different elements that future anticipated modeling efforts and scenarios should include[11], the SAB Panel did not identify any specific recommendations on how to establish the scale of biomass use in the baseline or the shock or modeled change in the scale of biomass demand from the anticipated baseline in its recommendations. Numerous stakeholders also supported the anticipated baseline (both the future anticipated baseline and counterfactuals, as discussed in previous sections), but offered no specific recommendations.

The case studies using the future anticipated baseline approach in Appendices K and L of the revised framework illustrate how the future anticipated baseline approach could be applied in practice to assess landscape-level emissions effects related to changes in demand for individual feedstocks. The intertemporal optimization approach used to construct baseline scenarios in Appendix K and alternative future scenarios in Appendix L capture land use investment behavior and management activities under anticipated changes in feedstock demand (i.e., the increased scale of biogenic feedstock demand in the model) over the long term and provide estimates of related landscape-level biogenic CO_2 emissions fluxes. The case studies presented do not apply the future anticipated baseline approach to any specific policy or program, but instead uses a hypothetical biogenic feedstock demand increase for its deviation from the baseline scenario. Each feedstock scenario is evaluated relative to the three alternative baseline scenarios, and the biogenic feedstock demand shock applied to these baselines consists of regional biomass consumption trajectory estimates from the Annual Energy Outlook (AEO) 2012 Reference baseline with an additional 1 million short dry tons of specific biogenic feedstock consumption in the region under consideration.[12]

[11] "An anticipated baseline approach must incorporate market effects even when direct effects of the use of biogenic feedstocks on carbon emissions are being estimated. The projected baseline level of forest carbon stocks will need to be compared with the level in the case when there is demand for roundwood for bioenergy to assess the change in forest stocks due to the demand for bioenergy. The case with demand for bioenergy should consider the possibility that investment in long-lived trees could be driven by expectations about wood product prices and biomass prices, leading landowners to expand or retain land in forests, plant trees, shift species composition, change management intensity and adjust the timing of harvests. The role of demand and price expectations/anticipation is well developed in the economics literature (e.g., see Muth 1992) and also in the forest modeling literature (Sedjo and Lyon 1990; Adams et al. 1996; Sohngen and Sedjo 1998), which includes anticipatory behavior in response to future forest carbon prices and markets (Sohngen and Sedjo 2006; Rose and Sohngen 2011). The U.S. Energy Information Administration (EIA) has projected rising energy demands for biogenic feedstock based on market and policy assumptions, which could be met from a variety of sources, including energy crops and residues, but also short rotation woody biomass and roundwood (EIA 2012; Sedjo 2010; Sedjo and Sohngen 2012)…. To capture both the market, landscape and biological responses to increased biomass demand, a bioeconomic modeling approach is needed with sufficient biological detail to capture inventory dynamics of regional species and management differences as well as market resolution that captures economic response at both the intensive (e.g., changing harvest patterns, utilization or management intensity) and extensive margins (e.g., land use changes)" (Advisory, page 34).

[12] Results from the illustrative case studies show aggregate emissions estimates on a specific regional scale per case study. Results can be interpreted as the projected emissions intensity of specific biogenic feedstocks consumed at existing or anticipated stationary sources across multiple baseline projections of biogenic feedstock consumption. However, results do not reflect the net emissions *contribution* of a particular feedstock within a particular region but rather illustrate potential net biogenic emissions effects *associated with increased consumption* of a specific feedstock in a specific region under specific conditions. To maintain consistency with the reference point approach, region- and feedstock-specific simulation scenarios were developed to isolate the landscape-level carbon-based emissions fluxes related to a demand shift for an individual feedstock relative to the AEO Reference baseline. (see Appendix L for details)

EPA seeks guidance on technical considerations concerning how to select model perturbations ('shocks') for future anticipated baseline simulations estimating the net atmospheric contribution of biogenic CO_2 emissions from the production, processing, and use of biogenic material at stationary sources, using the above referenced components of the revised framework report as the starting point for the SAB Panel's discussion. As the SAB Panel recommended developing default assessment factors by feedstock category and region that may need to be developed outside of a specific policy context, and as the framework could be also be used in specific policy contexts, the questions below relate to the choice of model shocks both within and outside of a specific policy context.

2. What is/are the appropriate scale(s) of biogenic feedstock demand changes for evaluation of the extent to which the production, processing, and use of biogenic material at stationary sources results in a net atmospheric contribution of biogenic CO_2 emissions using a future anticipated baseline approach? In the absence of a specific policy to model/emulate, are there general recommendations for what a representative scale of demand shock could be?**
    a. Should the shock reflect a small incremental increase in use of the feedstock to reflect the marginal impact, or a large increase to reflect the average effect of all users?
    b. What should the general increment of the shock be? Should it be specified in tons, or as a percentage increase?
    c. Should the shock be from a business as usual baseline, or from a baseline that includes increased usage of the feedstock (i.e., for a marginal shock, should it be the marginal impact of the first ton, or the marginal impact of something approximating the last ton)?
    d. Should shocks for different feedstocks be implemented in isolation (separate model runs), in aggregate (e.g., across the board increase in biomass usage endogenously allocated by the model across feedstocks), or something in between (e.g., separately model agriculture-derived and forest-derived feedstocks, but endogenously allocate within each category)?
    e. For feedstocks that are produced as part of a joint production function, how should the shocks be implemented? (e.g., a general increase in all jointly produced products; or, a change in the relative prices of the jointly produced products leading to increased use of the feedstock, and decreased production of some other jointly produced products, but not necessarily an overall increase in production).
    f. How should scale of the policy be considered, particularly for default factors? (e.g., can a single set of default factors be applied to policies that lead to substantially different increases in feedstock usage)?
    g. Would the answers to any of the above questions differ when generating policy neutral default factors, versus generating factors directly tied to a specific policy?
    h. What considerations could be useful when evaluating the performance of the demand shock choice *ex post*, particularly if evaluating potential implications for/revisions of the future anticipated baseline and alternative scenarios going forward?

****** Specific revised framework components that discuss model perturbations in the context of illustrative future anticipated baseline and alternative scenario simulations using the framework equation are Appendices K and L.

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