Comments by

Clean Air Task Force, Conservation Law Foundation, Natural Resources Council of Maine, Natural Resources Defense Council, Sierra Club, Southern Environmental Law Center

on the

Environmental Protection Agency's Call for Information: Information on Greenhouse Gas Emissions Associated with Bioenergy and Other Biogenic Sources

75 Fed. Reg. 41,173 (July 15, 2010)

EPA–HQ–OAR–2010–0560

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Introduction and Overview

Please accept these comments on behalf of the Clean Air Task Force, Conservation Law Foundation, Natural Resources Council of Maine, Natural Resources Defense Council, Sierra Club, and Southern Environmental Law Center on the "Call for Information: Information on Greenhouse Gas Emissions Associated with Bioenergy and Other Biogenic Sources," 75 Fed. Reg. 41,173 (July 15, 2010) ("Call for Information"). In the Call for Information, EPA writes that it "did not take action on a request from commenters to exclude CO_2 emissions from biogenic fuels" in the final Tailoring Rule (75 Fed. Reg. 31,514 (June 3, 2010)). Instead,

> EPA explained that the legal basis for the Rule, reflecting specifically the overwhelming permitting burdens that would be created under the statutory emissions thresholds, does not itself provide a rationale for excluding all emissions of CO_2 from combustion of a particular fuel, even a biogenic one. The fact that the Tailoring Rule did not take final action one way or another concerning such an exclusion does not mean that EPA has decided there is no basis for treating biomass CO_2 emissions differently from fossil fuel CO_2 emissions under the Clean Air Act's [Prevention of Significant Deterioration] and Title V Programs. Further, in finalizing the Tailoring Rule, the Agency did not have sufficient information to address the issue of the carbon neutrality of biogenic energy in any event.

75 Fed. Reg. at 41,174.

First and foremost, we fully agree with EPA that the legal underpinnings of the Tailoring Rule do not provide a basis for excluding biogenic CO_2 emissions from the permitting requirements of the Clean Air Act ("CAA" or the "Act"). There is no evidence demonstrating that the burdens of calculating those emissions would be onerous enough to trigger the doctrine of "administrative necessity." Moreover, as explained below, the purpose of the Prevention of Significant Deterioration ("PSD program") and Title V operating permits is to limit harmful air pollutants at the point of emission. As EPA has defined CO_2 and other GHGs as an air pollutant subject to regulation under the CAA – and has confirmed the harmful effects on public health and welfare from these emissions – there is no reason to believe that application of the CAA's permitting requirements would trigger the "absurd results" doctrine.

Second, we applaud EPA's effort here to solicit comment on the most current scientific assessments of CO_2 emissions associated with bioenergy projects and accurate accounting procedures to calculate those emissions. We agree with EPA that accounting for greenhouse gas ("GHG") emissions associated with bioenergy[1] is "complex"[2] and thus merits additional attention by EPA regulating GHG emissions from stationary sources under the Prevention of Significant Deterioration ("PSD") program and Title V of the CAA. Only when polices and regulations are based upon the most current and accurate scientific analyses can they ensure biomass energy projects will not only have a neutral or positive climate benefit, but also that use of these feedstocks will not have a negative climate impact, based on direct emissions, lost sequestration capacity, etc.

The purpose of these comments is to aid EPA in the development of such scientifically accurate and effective climate policies with respect to bioenergy projects. In Section I we explain why biogenic CO_2 emissions[3] must be regulated in accordance with the requirements of the Clean Air Act, in particular with the requirement that emitters apply the "best available control technology" ("BACT"). Biomass combustion emits as much, if not more, CO_2 per unit of energy than the combustion of fossil fuels. We recognize, however, that biomass-based energy production differs from fossil fuel-based energy generation. While biomass energy production results in an initial pulse of CO_2 emissions from activities such as land clearing and combustion, in ideal circumstances it can also spur additional cultivation of biomass and result in the re-sequestration of that CO_2 over time. Therefore, we indicate that EPA should explore the possibility of developing a methodology whereby certain kinds of biomass feedstocks may constitute a "clean fuel" and thus comply with the BACT requirement. In the event EPA determines it has authority under the CAA to develop a lifecycle analysis through the "clean fuel" provision, we list several key principles to guide that process.

Section II of these comments begins with an in-depth review of many of the pertinent analyses done to-date on the net GHG impact of biomass power applications. Three key points are drawn from the literature: first, many bioenergy systems achieve carbon neutrality only after years or decades; second, carbon neutrality is a highly subjective designation, dependent on the system boundaries and accounting methods employed; and third, carbon neutrality does not imply climate neutrality, since biogenic CO_2 contributes to climate change between combustion and uptake in new biomass.

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[1] Throughout these comments, the term "bioenergy" collectively refers to all plant-based and waste-derived energy sources, unless otherwise noted.

[2] 75 Fed. Reg. at 41,174.

[3] For purposes of these comments, "biogenic CO_2" refers to the definition contained in the Mandatory GHG Reporting Rule. *See* 74 Fed. Reg. 56260, 56384 (40 C.F.R. § 98.6) (Oct. 30, 2009) (defining "biogenic CO_2" as CO_2 emitted from the combustion of biomass). Similarly, for purposes of these comments "biomass" means non-fossilized and biodegradable organic material originating from plants, animals or micro-organisms, including products, by-products, residues and waste from agriculture, forestry and related industries as well as the non-fossilized and biodegradable organic fractions of industrial and municipal wastes, including gases and liquids recovered from the decomposition of nonfossilized and biodegradable organic material. *Id.* at 56,384 (40 C.F.R. § 98.6) (defining biomass as the same).

Next, we explain that the accounting approach set forth in guidelines by the Intergovernmental Panel on Climate Change is incompatible with EPA's regulatory obligations under the Clean Air Act. The IPCC guidelines were designed to avoid double counting within national emissions inventories; using the approach for the very different purpose of regulating biogenic emissions from stationary sources in the United States would result in emissions associated with bioenergy never being counted at all.

Section III responds directly to EPA's request for quantitative data and qualitative information about the kinds of energy facilities that produce biogenic emissions, the feedstocks they use, and their emissions. The numbers depict an industry with a rapidly growing appetite for standing trees. Annual demand by bioenergy facilities for green wood is projected to nearly triple over the next five years on a tonnage basis, during which time the availability of forest residues and dedicated energy crops will be limited. As consequence, it is overwhelmingly likely that whole-tree harvesting will provide the vast majority of fuel. As demonstrated by the recent study conducted by the Manomet Center for Conservation Sciences, carbon payback times for biomass energy are unacceptably long relative to fossil fuels when whole trees are used as fuel.

I. Review of Statutory and Regulatory Applicability of PSD Requirements to Biogenic Emissions

This section responds to EPA's request for comment on the following:

- What criteria might be used to consider biomass fuels differently with regard to the BACT review process under PSD?; and
- How could the process of determining BACT under the PSD program allow for adequate consideration of the impacts and benefits of using biomass fuels?[4]

First, this section explains that biogenic CO_2 emissions trigger the permitting requirements of the PSD program and Title V – including the BACT requirement – and therefore EPA may not exclude those emissions from the Act's permitting requirements. Second, we consider EPA's and state permitting authorities' potential authority to determine on a case-by-case basis, based on a lifecycle analysis of the CO_2 emissions associated with full fuel lifecycle, that some forms of bioenergy constitute a "clean fuel" and therefore comply with the BACT requirement.

As discussed below, the presumption under the Clean Air Act is that the actual emissions from biomass-burning facilities is subject to regulation. In order to engage in a more comprehensive analysis of the facilities' impact on climate, EPA and the regulated biomass energy industry will have to take the following steps:

1. Before it can consider the lifecycle emissions associated with biomass-based power generation, EPA must identify legal authority for doing so within the context of the Clean Air Act's BACT analysis framework.[5] If the Act confers such authority – and it is not evident to the commenters that it does – that authority may exist in the BACT "clean fuel" provision.
2. If EPA identifies the legal authority to utilize lifecycle analysis in the BACT context to examine the net GHG emissions associated with biomass, it must assess those emissions using a methodology that rationally accounts for the substantial uncertainty involved in measuring and modeling the impact of biomass energy on climate.
3. Using that methodology, biomass energy producers will have to demonstrate on a case-by-case basis that their facilities utilize the "best available control technology."

[4] 75 Fed. Reg. at 41,175.

[5] We recognize the possibility that such a lifecycle analysis of CO2 emissions associated with biomass may be permissible under the 'alternatives' provision contained in 42 U.S.C. § 7475(a)(2) of the Clean Air Act.

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A. Exclusion of Biogenic CO_2 Emissions from the BACT and Other Permitting Requirements of the CAA Would Be Unlawful

Under the CAA and EPA's regulatory framework to date, biogenic CO_2 emissions are subject to the permitting requirements of the PSD program and Title V.[6] In the Final Endangerment Finding, EPA has defined the "air pollutant" that will be subject to regulation for purposes of the PSD Program as the basket of the six well-mixed GHGs, including CO_2.[7] This definition is unqualified with regard to the type of material or process resulting in the emission of the air pollutant, and is independent of any lifecycle GHG emissions analysis, and thus must be read as including biogenic CO_2 emissions. A categorical exemption of biogenic CO_2 emissions would therefore contradict the plain language of the CAA and EPA's own regulations.[8] As explained below, exempting CO2 emissions from biomass on the basis of a lifecycle analysis of biogenic CO_2 emissions would also contravene the traditional approach to the BACT analysis.

The purpose of the permitting requirements of the PSD program and Title V – in particular the BACT requirement – is to reduce emissions of dangerous air pollutants – in this case, GHGs including CO_2 – directly from major emitting facilities. Accordingly, the CAA makes clear that the only emissions relevant for purposes of the BACT applicability determination are the "end of the stack emissions": "the proposed facility is subject to the best available control technology for each pollutant subject to regulation under this chapter *emitted from, or which results from, such facility.*"[9] Therefore, to determine whether BACT obligations are triggered by a given emission of a regulated air pollutant, only two questions need to be answered[10]: 1) Is the substance in question an air pollutant subject to regulation? 2) If so, is it being emitted from or does it result from the facility in question?

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[6] The fact that biogenic emissions are not calculated in determining whether a facility meets the reporting thresholds in the Mandatory GHG Reporting Rule is irrelevant, as well as scientifically dubious. EPA promulgated the stationary source GHG reporting requirements pursuant to its authority under Section 114 of the CAA, which provides the Administrator great discretion in establishing monitoring and reporting programs. *See* 42 U.S.C. § 7414(a)(1). In contrast, the PSD program contains specific statutory mandates that EPA has no discretion to ignore. *See, e.g.*, 42 U.S.C. §7475(a)(4) (requiring application of BACT to the emission of each air pollutant subject to regulation).

[7] 74 Fed. Reg. 66,496, 66,536-37 (Dec. 15, 2009).

[8] *Id*. Indeed, if EPA were to determine that biogenic CO_2 emissions are categorically exempt from the permitting requirements of the CAA on the basis of inherent carbon neutrality, EPA would arguably have to amend the definition of air pollutant in the Endangerment Finding pursuant to notice and comment procedures. In addition, EPA would have to show that such a determination was not arbitrary and capricious or contrary to law, a showing which we believe EPA would not be able to make based on the scientific evidence to date and the plain language and precautionary nature of the Act.

[9] 42 U.S.C. §7475(a)(4) (emphasis added).

[10] Provided that established thresholds are met.

In the case of biogenic CO_2 released from major emitting facilities, the answer to both questions is unequivocally "yes".

Because the purpose of the BACT requirement is to reduce emissions directly from major emitting facilities, the applicability analysis has not traditionally included a lifecycle assessment of a fuel's environmental impacts. In the case of CO_2, there is no reason or authority to deviate from this approach. In fact, exclusion of biogenic CO_2 emissions could have disastrous consequences, including significant net increases in the release of CO_2 as a result of both direct and indirect land use changes. Given this potential, a blanket exclusion of biogenic CO_2 emissions would fly in the face of the precautionary nature of the CAA.[11] Indeed, EPA in the Final Endangerment Finding stressed that the "air pollution" that is anticipated to endanger human health and welfare is the *currently* elevated and unprecedented atmospheric levels of the six well-mixed GHGs, which in turn are causing the current observed effects of climate change.[12] Therefore, EPA's focus should be on reducing these already elevated air pollution levels. As both a matter of law and policy, biogenic CO_2 emissions must be treated the same as any other "air pollutant" for purposes of whether BACT applies.

In section II.B., we explain why the accounting procedures provided for in the framework established in the UNFCCC according to the IPCC, which do not require reporting biogenic CO_2 emissions as part of a country's net GHG emissions, are inaccurate and do not fully account for the climate impacts associated with biomass. We emphasize here, however, that contrary to EPA's suggestion,[13] the conventions of international accounting procedures are *irrelevant* to EPA's execution of its regulatory duties under the CAA. Most importantly, because EPA has defined "the air pollutant subject to regulation" as including CO_2 without qualification, biogenic CO_2 emissions should be treated on par with other CO_2 emissions.[14] The fact that the IPCC guidelines have influenced subsequent reporting systems or have provided "a foundational methodology for accounting for GHG emissions" is of little consequence. EPA is bound by the requirements of the CAA when regulating GHGs from stationary sources. This is doubly true where the reporting systems and accounting methodologies in question were developed for a very different context and do not work for national-scale stationary source regulations, as is the case with the IPCC guidelines.

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[11] *See, Lead Indus. Ass'n v. EPA*, 674 F.2d 1130, 1152 (D.C. Cir. 1980); *Am. Lung Ass'n v. EPA*, 134 F.3d 388, 389 (D.C. Cir. 1998); *Ethyl Corp. v. EPA*, 541 F.2d 1, 13 (D.C. Cir 1976).

[12] 74 Fed. Reg. at 66,517 ("The latest assessment of the USGCRP, as summarized in EPA's TSD, confirms the evidence presented in the Proposed Findings that current atmospheric greenhouse gas concentrations are now at elevated and essentially unprecedented levels as a result of both historic and current anthropogenic emissions."); *see also id*. ("Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level.")

[13] 75 Fed. Reg. at 41,175.

[14] In addition, although not directly relevant here, the reporting requirements of the UNFCCC have no relevance to national reporting obligations as those must be governed by the provisions Mandatory GHG Reporting Rule and any other requirements of the CAA.

B. EPA Should Consider Establishing a Methodology for Determining, on a Case-By-Case Basis, Whether a Biomass Feedstock May Qualify as a "Clean Fuel"

As noted above, the BACT and other permitting requirements apply to emissions of regulated air pollutants directly emitted by any major source, regardless of the feedstock from which those emissions are derived. For these reasons, EPA has not historically conducted a lifecycle emissions analysis with respect to fuel feedstocks (generally, coal and natural gas).

However, as explained in more detail below, lifecycle analysis may be the only method by which EPA can accurately assess the GHG emissions associated with the full fuel lifecycle of biomass. Although it is not at all clear that EPA has the legal authority to incorporate such an analysis in evaluating and regulating emissions from biomass to energy projects,[15] EPA may want to explore circumstances under which biomass could be considered a "clean fuel"[16] with respect to carbon dioxide emissions, as compared to fossil fuels. We first give a brief history of the treatment of "clean fuels" and describe why this historical treatment is not readily applicable to biomass for CO_2 purposes.[17] We then describe the factors that EPA should consider in developing regulations or policy guidance on when biomass may constitute a clean fuel based on such a lifecycle analysis, if permitted by the Clean Air Act and EPA's own regulations.

The term "clean fuels" was added to the definition of BACT in the 1990 Amendments to the CAA. EPA policy "has for a long time required that the permit writer examine the inherent cleanliness of the fuel" in the BACT analysis.[18] Administrator Jackson recently confirmed that clean fuels must be considered and that applicants proposing to rely on other fuels must show why the use of "clean fuels" would not be appropriate at their facility.[19] There is little EPA guidance or case law defining what constitutes a "clean fuel". Generally, the focus has been on whether the chemical composition of the fuel itself renders it "inherently" "clean" or "cleaner," thus reducing emissions at the stack in comparison with other fuels.[20] Common examples are coal with a naturally lower sulfur

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[15] In particular, we would foresee difficultly in incorporating such a lifecycle analysis for bioenergy and failing to provide for the same type of accounting procedures for fossil fuels used at stationary sources.

[16] 42 U.S.C. § 7479(3) (BACT includes "clean fuels"). Importantly, unlike biomass feedstocks, there is no potential future reuptake of carbon dioxide emissions associated with fossil fuels, an important distinguishing factor.

[17] The assumption that biomass should not readily qualify as a "clean fuel" is based in part on the fact that CO2 emissions from bioenergy tend to be higher, not lower, than those from fossil fuels per unit of energy generated.

[18] *In re. Inter-power of New York*, 5 E.A.D. 130, 134 & n.7 (1994) ("*In re. Inter-power*").

[19] *In re. Cash Creek Generation, LLC*, Order Responding to Issues Raised in January 31, 2008 and February 13, 2008 Petitions, and Denying In Part and Granting In Part Requests for Objection to Permit, Permit No. Title V/PSD #V-07-017, 7-9 (Dec. 15, 2009) ("*Cash Creek Order*").

[20] *See* Letter from William G. Rosenberg, Assistant Administrator for Air and Radiation, EPA to Henry A. Waxman, Chairman, Subcommittee on Health and Environment, House Committee on

content[21] and natural gas[22]. For these reasons, the determination of whether a fuel is "clean" has not traditionally involved a lifecycle assessment of air emissions associated with the fuel.

Biomass, however, is not "inherently cleaner" than fossil fuels with regard to CO_2 in this sense because biomass facilities tend to emit at least as much CO_2 per unit of energy generated as fossil-fueled facilities.[23] Nonetheless, biomass combustion is different from the combustion of fossil fuels because it has the potential to spur reuptake of the CO_2 through additional plant growth (albeit slowly). Therefore, if EPA wants to develop a BACT process to account for any potential GHG benefits associated with biomass use, it must do so within the context of the "clean fuel" provision.

Importantly, such regulations or guidance determining whether a biomass feedstock constitutes a "clean fuel" must be done on a case-by-case basis for each facility subject to the CAA's permitting requirements. The permitting requirements of the PSD program make clear that any BACT determination must be made on "a case-by-case basis"[24] and that the issuance of such permit must be subject to notice and comment.[25] As several environmental organizations, including CATF, stated in comments on the proposed Tailoring Rule, the proposals by EPA to establish presumptive BACT and general permits for certain types of sources sharply deviate from these statutory requirements, and therefore may be used only – if at all – in the most limited circumstances as the result of administrative impossibility.[26] Therefore, unless EPA can otherwise legally justify such a sharp deviation from the statute's requirement, EPA may not provide that certain types of

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Energy and Commerce (Oct. 17, 1990) (reproduced in full at 136 Cong. Rec. S16,895, S16,916-17 (daily ed. Oct. 27, 1990)).

[21] *Id.*; *see also In re. Inter-power*, 5 E.A.D. at 137; 136 Cong. Rec. S3,814, S3,820 (Apr. 3, 1990) (statement of Sen. Simpson (sponsor of the amendment)) ("The addition of the term 'clean fuels' indicates to the EPA Administrator that he may consider the use of very clean fuels in meeting the BACT requirement. . . . The amendment was meant to apply to a very narrow range of circumstances where very clean coals could result in the same emission rate as the use of technology. This amendment would not result in any increase in emissions in the west or any other part of the United States. It was my sole intention to allow the use of clean fuels only where the emissions rate would approximate that which would be required under a technology requirement.").

[22] *See Cash Creek Order* at 7-9. The other definitions of BACT confirm that determination of whether a fuel is "clean" is generally measured at the level of the emissions unit in comparison with emissions from other fuels or the fuel without treatment. 42 U.S.C. § 7479(3) (BACT also includes "fuel cleaning" or "treatment" or "innovative combustion techniques").

[23] *See* U.S. Energy Information Administration, *Voluntary Reporting of Greenhouse Gases Program: Fuel and Energy Source Codes and Emissions Coefficients* (compare bituminous coal with wood and waste).

[24] 42 U.S.C. § 7479(3).

[25] *Id.* § 7475(a)(2).

[26] Comments of Alliance for Climate Change, Clean Air Task Force, Climate Solutions, Environment America, Natural Resources Defense Council, Citizens for Pennsylvania's Future (PENN FUTURE), and Sierra Club on the Proposed Tailoring Rule, 28 & 31-33 (Dec. 28, 2009) (Exhibit 1).

biomass (including certain types of technologies used in conjunction with biomass) presumptively constitute a "clean fuel." In addition, the case-by-case determination arguably requires that for each such BACT analysis, EPA employ the most up-to-date and scientifically accurate GHG accounting methodology.

C. Key Regulatory Principles

Should EPA identify authority within the BACT framework to provide guidance or regulations delineating the limited circumstances in which biomass would constitute a "clean fuel," it must consider several factors in developing an accurate lifecycle GHG emissions analysis. In general, however, EPA policy should emphasize the following principles:

- *Timeframe Issues*: The timeframe over which net GHG emissions are calculated is of critical importance in determining whether and when climate benefits, if any, from biomass occur.[27] As described in the 2009 comments to EPA submitted by CATF and others on the Proposed Renewable Fuel Standard, numerous studies suggest that we cannot afford to trade near-term increases in GHG emissions for long-term reductions because doing so heightens the risk that we will trigger potentially irreversible system responses like accelerated melting of ice sheets – after which, the long-term reductions in net emissions theoretically associated with biofuels will be substantially less helpful.[28]

  An important recent study published by the National Academy of Science ("NAS") offers an additional basis for concern about biofuels' front-loaded emissions. The NAS report, "Climate Stabilization Targets: Emissions, Concentrations, and Impacts over Decades to Millenia" (2010), emphasizes that global mean temperature increases are strongly linked to cumulative emissions of CO2, which affect carbon loading in the ocean as well as atmospheric concentrations. The authors of the study find that higher cumulative emissions will correspond to warming that peaks higher and lasts longer. They estimate that cumulative emissions of 1150 GtC will lock in long-term warming of 2 degrees C.[29]

  Humans have already emitted enough CO_2 during the industrial period to account for about half of that cumulative level, and we are on track to accumulate the other half within a few decades. Front-loaded emissions from biofuels and other forms of

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[27] 74 Fed. Reg. 24,904, 25,033-37 (May 26, 2009); *see also* J. Melillo et al., *Indirect Emissions from Biofuels: How Important?* J. Melillo et al., *Indirect Emissions from Biofuels: How Important?* 326 SCIENCE 1,397, 1,397-98 (2009)(analyzing one case study showing a negative climate impact through 2050 but a climate benefit by 2100).

[28] CATF 2009 Cmts at 29-33, *available at* http://www.regulations.gov (Docket ID No. EPA-HQ-OAR-2005-0161).

[29] National Research Council Committee on Stabilization Targets, *Climate Stabilization Targets: Emissions, Concentrations, and Impacts over Decades to Millenia* (2010) (www.nap.edu/catalog/12877.html).

crop-based bioenergy accelerate that process and increase the likelihood that we will reach the 1150 GtC level before any additional plant growth resulting from energy crop production can fully re-sequester the CO_2 emissions associated with bioenergy.

EPA has correctly recognized that "one advantage of using a shorter time period is that it is more 'conservative' from a climate policy perspective" and that it involves less uncertainty.[30] Environmental organizations [31] have recommended that EPA use a timeframe of not longer than 20 to 30 years when implementing EISA 2007. Shorter timeframes (of as little as one year) have been suggested as a means to reduce uncertainty and to account for the potential substantial short term penalties resulting from the use of biomass.[32]

- *Account for the Warming Associated with Bioenergy, Not Just the Emissions*: Similarly, because time must pass before a bioenergy system can achieve arithmetic "neutrality," carbon neutral is not the same thing as climate neutral. Although plant regrowth can eventually remove the additional CO_2 (as compared to fossil energy systems) that is released when biomass is combusted, that additional CO_2 contributes to climate change during its residence in the atmosphere. EPA must account for the interim warming.

- *Limit Direct Land Use Changes*: EPA policy should provide that any biofeedstock from recently converted forests, grasslands, or other ecologically productive lands does not qualify as a clean fuel, particularly from high-carbon density terrestrial sinks such as tropical forests.[33] The definition of "renewable biomass" in EISA 2007 goes a long way to achieving this goal.[34] However, where the biomass production

[30] 74 Fed. Reg. at 25,035.

[31] These comments were submitted on behalf of the following ten environmental organizations: CATF, Environment America, Environmental Working Group, Friends of the Earth, National Wildlife Federation, Natural Resources Defense Council, Sierra Club, Union of Concerned Scientists, The Wilderness Society, World Resources Institute. They are available at http://www.regulations.gov/ (Docket ID. No. EPA-HQ-OAR-2005-0161).

[32] J. Melillo et al., *Indirect Emissions from Biofuels: How Important?* 326 SCIENCE at 1,399 (analyzing one case study showing a climate negative impact through 2050 but a climate benefit by 2100); J. Fargione et al., *Land Clearing and the Biofuel Carbon Debt*, SCIENCEXPRESS, 10.1126/science.1152747, 1 (2008)("*Biofuel Carbon Debt*")("We call the amount of CO2 released during the first 50 years of this process the 'carbon debt' of land conversion. Over time, biofuels from converted land can repay this carbon debt if their production and combustion has net GHG emissions that are less than the life-cycle emissions of the fossil fuels they displace.")

[33] *See* H. Gibbs et al., *Carbon Payback Times for Crop-based Biofuel Expansion in the Tropics: The Effects of Changing Yield and Technology*, 3 ENVIRON. RES. LETT. 1, 4 &8 (2008) ("*Carbon Payback Times*") *available at* http://www.iop.org/EJ/article/1748-9326/3/3/034001/erl8_3_034001.pdf?request-id=b65d5b16-97d2-4937-adf6-37581f529d28 ("*Carbon Payback Times*")..

[34] *See* 42 U.S.C. § 211(o)(1)(I).

has resulted in net carbon uptake on poorly managed or otherwise degraded land, this could point in favor of the biomass constituting a "clean fuel".[35]

- *Consider encouraging utilization of clean organic waste, residue, and materials at the end of their useful life*: Energy use of manure or crop and timber residues may have increased climate benefits, and EPA policy should encourage sustainable use of these materials.[36] In addition, EPA should encourage the conversion of biowastes destined for landfills to biogas to avoid their decomposition and release of methane.[37] Finally, studies have shown that converting biofeedstocks to a useful material (such as plastic) and subsequently using that material for energy production at the end of its useful life may have significantly greater CO_2 reduction benefits than burning of biomass alone.[38]

- *"Sustainably Harvested" Should Not Be Used as a Proxy for "Climate Beneficial"*: EPA cannot escape the constraints of the Clean Air Act's BACT framework (*e.g.*, the lack of an unambiguous grant of authority allowing EPA to regulate the areas from which biomass is harvested) merely by stipulating that biomass, particularly forest biomass, be harvested "sustainably." An inescapable conclusion of the Manomet study is that even "sustainably harvested" wood – that is, wood harvested at levels that can be regrown within normal harvesting cycles – is not "carbon neutral" or even "low carbon" when burned for fuel. In fact, Manomet concluded that "sustainably harvested" wood has net emissions that exceed those from fossil fuels, even after four decades, when used in utility-scale facilities to generate electricity.

- *Discourage Indirect Land Use Change (ILUC) Emissions*: In general, EPA should discourage ILUC by accounting for the emissions associated with the conversion of cropland used for food and other types of land as a result of bioenergy demand. As with direct land use change, EPA should consider the type of land being converted and may wish to acknowledge that cultivation of unproductive or degraded land may have climate benefits.

- *Discourage significant emissions from transportation:* The transportation emissions associated with a given biofeedstock should be taken into account, and EPA should encourage feedstocks with the lowest such emissions.

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[35] D. Tilman et al., *Beneficial Biofuels –The Food, Energy, and Environmental Trilemma*, 325 SCIENCE 270, 270 (2009) ("*Beneficial Biofuels*"); J. Fargione et al., *The Biofuel Carbon Debt*, SCIENCEXPRESS, at 2; H. Gibbs et al., *Carbon Payback Times*, 3 ENVIRON. RES. LETT. at 4. We note, however, that it is not necessarily the case that use of such feedstocks will either result in climate benefits or are available in quantities to make these a viable feedstock source. This is discussed further in sections II and III.
[36] *See* D. Tilman et al., *Beneficial Biofuels*, 325 SCIENCE at 270.
[37] UN-Energy, *Sustainable Bioenergy: A Framework for Decisionmakers*, 49 (Apr. 2007) ("*Sustainable Bioenergy*"), *available at* http://esa.un.org/un-energy/pdf/susdev.Biofuels.FAO.pdf..
[38] *Id*.

- *Encourage Combined Heat and Power ("CHP")*: Studies suggest that use of biomass in CHP projects can substantially reduce GHG emissions in the near future.[39] Therefore, EPA and permitting authorities should consider encouraging development of these projects.

In the alternative,[40] EPA should develop a regulatory approach to biogenic emissions that incorporates the critical point in Searchinger (2010) – *i.e.*, that bioenergy systems "do not reduce total emissions from energy combustion but at best only offset them."

> By definition, an offset means an increase in carbon sinks (even if temporary) or a reduction in other kinds of emissions. In basic concept, using land to grow plants for biofuels to offset energy emissions is no different from using land to offset those emissions by growing forests. Biofuels use the carbon taken up by the plants, the sink, to displace fossil fuels and thereby leave more carbon underground. Forest projects use the carbon uptake to increase sequestered carbon aboveground. Either way, a forest or any other plant cannot provide an offset if it already exists or would grow anyway; only additional plant growth provides an offset.[41]

Under a regulatory system that focuses primarily on determining whether a bioenergy system is resulting in "additional" biological sequestration, EPA's net emissions calculation would credit biomass systems with carbon reductions only when the biomass used for energy production would not have otherwise been used for food, animal feed or wood products, or sequestered in trees, plants, or soils. If the case of dedicated energy crops, carbon stored in the energy crops would be credited within the net emissions calculation only to the extent the growth of those crops results in additional absorption of carbon from the atmosphere – that is, beyond what would be absorbed by the land if it were not dedicated to energy crops.

Under this approach, EPA would count biogenic emissions unless it can be reasonably demonstrated by the owner or operator of the emitting facility that the emissions are offset by "additional" plant growth. As preliminary matter, EPA would need to remain vigilant for abuses where materials are inappropriately defined as residues. The supply of forest residues and mill residues is well quantified in Forest Service data, and does not change greatly from year to year. EPA is capable of itself assessing, or requiring other entities to assess, whether the supply of forestry, mill and agricultural "residues", as well as energy crops, is sufficient to fuel the amount of biomass power capacity operating and proposed in any given area. Many existing biomass facilities would likely thus escape regulation, to the extent that they *truly* use wood residues. However, where such materials

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[39] *Id*.
[40] The question of whether EPA has authority under the Clean Air Act to develop offset-based approach to biogenic emissions is not addressed in these comments.
[41] Searchinger, T. (2010). "Biofuels and the need for additional carbon." Environ. Res. Lett. 5 (2010) 024007: 2.

are already committed to existing uses, and where forest residues are limited or inaccessible for any reason, it is a reasonable assumption that trees will be cut for fuel that would not otherwise be cut, or will displace some other use of harvested wood, potentially causing leakage as that industry expands its procurement activities. Whatever EPA does to assess biogenic emissions, the Agency must guard against creating a system that incentivizes such activities.

More fundamentally, EPA would have to confront the significant uncertainty inherent in any comparison between something that happened (*e.g*., cultivating biomass from a plot of land for bioenergy production) and something that did not (*e.g.*, not cultivating biomass from that land, and instead making it available for other use). EPA can accommodate this uncertainty in two ways. It can optimistically assume that most biomass will be additional, and therefore protect against the likelihood that net carbon reductions associated with biomass use are not credited (and thus risk over-counting reductions). Or it can adopt a precautionary approach, assume that most biomass is not actually additional, and ensure that every credited carbon reduction represents an actual reduction (and thus risk under-counting reductions). Given the precautionary nature of the Clean Air Act, and the substantial mistakes made in the past about our ability to assess the net climate impact of bioenergy,[42] we urge EPA to proceed with caution.

[42] *See, e.g.,* the wholesale failure of state and federal biofuel policies enacted prior to 2007 to account for the substantial indirect land use change associated with biofuel feedstock production.

II. Accounting for Biogenic Emissions: Principles and Methodologies

This section responds to EPA's request for comments on technical information regarding accounting approaches for biogenic CO_2 emissions. First, we provide an overview of the key analyses done to-date on the net GHG impact of biomass power applications. Second, we explain why the accounting system provided for in the Intergovernmental Panel on Climate Change (IPCC) guidelines is incompatible with EPA's statutory duties to regulate harmful air pollutants as required by the Clean Air Act. Third, in the event EPA identifies legal authority to conduct lifecycle analyses within the BACT/"clean fuel" framework, we provide a detailed description of what we believe would be a rational analytic approach to accounting for these emissions, given the high level of uncertainty involved in performing a case-by-case lifecycle analysis for GHG emissions associated with biomass.

A. Bioenergy Accounting: Review of Relevant Research[43]

1. Introduction

This section reviews some of the literature on carbon accounting that is relevant to the EPA's Call for Information[44] on biogenic CO_2 accounting in support of the "Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule" (75 Fed. Reg. 31514).

The Call for Information notes that under existing IPCC guidelines, CO_2 emissions from bioenergy are not counted toward national emission targets: since net reductions in terrestrial biomass *would be* counted under those guidelines, counting combustion emissions would double-count the carbon removed from ecosystems. However, as it stands, the IPCC approach is itself considered inadequate and an inappropriate model for national GHG regulation (Marland and Schlamadinger 1995; Schlamadinger, Bird et al. 2007; Searchinger, Hamburg et al. 2009). In a recent analysis, 35 international experts on land use and forestry wrote (Schlamadinger, Bird et al. 2007):

> The current framework for implementation, which was finally accepted at COP7 in Marrakech in 2001, is a negotiated solution produced by an evolving political process that had to deal with considerable scientific uncertainty. It has the great advantage of having been agreed to, thus allowing the negotiations to turn to other pressing issues. Nevertheless, there are deficiencies with the current framework: monitoring and reporting are complex and expensive; and the main source of LULUCF emissions, deforestation in developing countries, is not covered.

To close the gaps in the IPCC accounting system, all carbon sources and sinks in the land-use, land-use change, and forestry (LULUCF) sector must be counted, in all countries.

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[43] The review of bioenergy accounting literature was conducted by Richard Plevin, Ph.D.
[44] Federal Register/Vol. 75, No. 135/Thursday, July 15, 2010/Notices, *available at* http://regulations.gov as EPA-HQ-OAR-2010-0560-0021.pdf.

Otherwise the exclusion of biogenic carbon from accounting in the energy sector is creates incentives for the unsustainable use of bioenergy (Searchinger, Hamburg et al. 2009). Similarly, in a regulatory system that limits CO_2 emissions, ignoring biogenic carbon emissions would be appropriate only if all corresponding reductions in ecosystem carbon were accounted for as well.

2. Different Accounting Systems Capture Different Effects

There is no universal GHG accounting system that is applicable for all purposes. Broadly speaking, the main alternatives are to account for (i) direct (e.g., smokestack) emissions or (ii) life cycle emissions, i.e., those occurring throughout the supply chain as well as (in some cases) emissions induced outside the supply chain.

A key question in carbon accounting is whether the accounting system is used to penalize emitters or to promote projects that provide net emission reductions. To achieve the latter requires attention to leakage, i.e. addressing any increases in emissions beyond the regulatory jurisdiction in response to actions taken within the jurisdiction.

i. Direct GHG Emissions

Regulating direct emissions is the simplest approach, since it involves largely measurable quantities that are clearly attributable to a particular party. Direct regulations are appropriate when the primary goal is to assign responsibility for emissions to a particular source.

Regulating direct emissions is effective when regulatory coverage of emissions sources is broad enough to prevent significant leakage. Otherwise, in the worst case, regulation can simply push the regulated activity outside the regulated jurisdiction, reducing or completely undermining actual emission reductions.

ii. Life Cycle GHG Emissions

Life cycle approaches recognize that emissions occur throughout the life cycle of a product, from raw material extraction to disposal. Accounting for life cycle emissions offers the possibility of incorporating leakage effects by counting emissions resulting from unregulated activities both inside and outside the regulatory jurisdiction.

Life cycle assessment (LCA) includes two distinct approaches: *attributional* LCA accounts for the emissions in a static production system, attributing these emissions to different products within the system. Attributional LCA focuses on the product supply chain and includes the average effects of the processes involved. In contrast, *consequential* LCA examines the effect of a change in production, relying on the marginal effects of processes involved. Consequential LCA can also include responses of the economic system, including price and income effects that result in changes in emissions.

If comprehensive, global GHG regulations were in force, life cycle GHG accounting would be redundant. However, lacking such complete GHG regulation, LCA-based regulations attempt to avoid unintended consequences that would result from promoting an activity that offers ostensible direct benefits while causing disbenefits when its full life cycle is considered—or the reverse.

iii. Carbon Accounting in LCA

Life cycle assessments often give special treatment to biogenic carbon, counting neither the sequestration in biomass nor the emissions of CO_2 upon combustion. However, there have been several calls in the LCA literature toward explicit accounting for biogenic carbon (Rabl, Benoist et al. 2007; Luo, van der Voet et al. 2009; van der Voet, Lifset et al. 2010). The need to account explicitly for sources and sinks of CO_2 emissions from bioenergy is more apparent in consequential LCA, since market-mediated effects such as indirect land use change can significantly alter the carbon balance (Searchinger, Heimlich et al. 2008; Hertel, Golub et al. 2010), and differences in the timing of emissions between scenarios with and without a bioenergy system affects estimates of climate benefits (O'Hare, Plevin et al. 2009; Anderson-Teixeira and Delucia 2010; Levasseur, Lesage et al. 2010).

3. Literature Review

Carbon accounting has long been discussed in the academic literature, mainly in the context of the Kyoto Protocol and project-based accounting systems such as the Clean Development Mechanism (CDM) and Joint Implementation (JI) projects. This section reviews some of that literature.

A bibliography of key research is appended to these comments (see Appendix 1).

i. Project Based Accounting

In a series of papers starting in the mid-nineties, Bernhard Schlamadinger and various co-authors (frequently Gregg Marland) examined issues in carbon accounting for forestry projects, developing the GORCAM (Graz/Oak Ridge Carbon Accounting Model) to explore numerous bioenergy scenarios.

Marland and Schlamadinger (1995) recognized that full fuel cycle analysis must account for co-products and variability, and the opportunity cost of managing the land to produce biomass. Some of the challenges to understanding biomass / climate interaction involve treatment of standing carbon in forests and possibility of both credits and debits for GHG sequestration or emission. The authors apply the standard engineering (non-economic) approach of assuming 100% MJ-for-MJ displacement of fossil resources by biomass resources. They note the possibly long payback periods for initial carbon debt, and that durable wood products provide a temporary sink while potentially displacing higher-GHG products. They assume long-lived wood products have a mean lifetime of 60 years, and substitute for concrete and steel and that short-lived products have a 15-year mean lifetime, with similar energy and emissions displacement effects. They show that under some circumstances, the opportunity cost (i.e., the carbon sequestration benefits of afforesting) is greater than the benefits of fossil fuel displacement, unless long timeframes (i.e., 100 years) are considered for payback. Importantly, they take an essentially consequential (change-oriented) approach here, comparing the use of residues for bioenergy with a scenario that does not use the residues. Harvesting and combusting the residues puts CO_2 in to the air more quickly than it would otherwise oxidize (they assume a mean lifetime 15 years, noting that this varies with climate.)

This paper noted the problem of potential double-counting that was addressed by IPCC by recommending that CO_2 emissions from biomass combustion be reported as zero in the energy sector, with these emissions counted instead in the LUC sector. But they say this doesn't really work when there is trade in biomass or JI projects offer credits elsewhere:

> In the case of CO_2, emissions from biomass energy systems, the IPCC methodology suggests that emissions be calculated but reported as zero in the energy sector. The presumption for CO_2 is that, if net emissions are not zero, the difference from zero will eventually be captured in the loss of accumulation of C in the biosphere and be reported under "changes in land use". Reporting in the energy sector would result in double counting. This seems to us to be an entirely appropriate procedure for calculating the inventory of national greenhouse-gas emissions, especially when little biomass fuel moves across national borders; that is, changes in land use and combustion of biomass fuels occur within the same political jurisdiction. It is not so clear that the procedure is equally appropriate when forest is harvested in one jurisdiction and the fuelwood used in another, or when we start to contemplate joint-implementation projects, i.e. projects where one country claims credits for actions taken in another country.

This is particularly a problem when the party receiving the fuel wood is subject to emission reduction requirements that treat net emissions of bioenergy as zero while the party producing the fuelwood is not subject to carbon regulation (effectively likewise treating the release of stored carbon and the loss of sequestration capacity as zero). Clearly, this creates the possibility that uncounted, unsustainable harvests are inappropriately treated as producing no additional CO_2.

They describe three brief scenarios with transfer of biomass from a producer to a consumer, showing the challenges of assigning debits and credits. Key questions are whether carbon debit occurs when a tree is cut or when it is combusted, and whether carbon credit occurs when a tree is grown or when it is used for long-term wood products. (Although it may be difficult to implement, one answer would be to count the debit when the combustion is *committed*, i.e. when the biomass is clearly destined for combustion or left on the ground to decay.)

Schlamadinger and Marland (1996) describes the GORCAM model. The authors use it to look at 16 scenarios to understand when bioenergy projects yield net benefits (e.g., relative to baseline afforestation or leaving forest intact). The primary conclusion of this study is that bioenergy projects can result in increases or decreases in CO_2 emissions, depending on a wide range of factors, including growth rate, harvest rate and yield, energy conversion efficiency, the type of fossil energy displaced, and the timeframe of the assessment. The implication is that incentivizing all forms of bioenergy by excluding biogenic CO_2 from regulation regardless of the actual climate benefits of the project would result in perverse incentives in at least some cases.

Schlamadinger, Apps et al. (1997) describe a standard methodology for bioenergy GHG balances. They note (as in prior papers) that bioenergy systems generally have lower efficiency than fossil fuel processes, so bioenergy is more CO_2-intensive per unit energy delivered, a situation that is even more problematic when biomass is unsustainably harvested. They note positive and negative rebound (price) effects as well, characterizing these as *leakage*. (However, they argue (somewhat weakly) that bioenergy substitutes almost 100% for the fossil equivalent. Notably, this is based on the assumption that biomass fuel fills a demand that "would eventually have been met with fossil fuel". This is not an economic argument, but an assumption that is likely incorrect at least for liquid fuel markets (Stoft 2010).)

The objective of the proposed standard is "to calculate the net reduction of GHG emissions to the atmosphere for various bioenergy projects, using traditional fossil fuel systems as the reference." They set boundaries between the atmosphere on one side, and all other spheres (technosphere, biosphere, geosphere) on the other. The approach focuses on the actual effect on atmospheric GHG concentration resulting from bioenergy projects.

One important aspect of net carbon accounting is that forest litter and soils reach a new equilibrium (under a steady harvest regime) while fossil fuel displacement continues. Clearing of dense, young stands prior to commercial tree farming can increase average carbon storage, as can afforestation. Under certain conditions, removing "fuel" from the forest floor can reduce the incidence of wildfires, leading to a higher equilibrium carbon storage rate. Projects that are sinks might be reduced sinks compared to the reference case, meaning that despite being sinks, they are responsible for a net reduction in C storage compared to business-as-usual.

This standard seems to approach consequential thinking in many ways, but it remains focused on the supply chain, i.e., ignoring market-mediated effects. They note that results will vary with the analytic horizon: longer payback periods can produce a net climate benefit whereas short horizons may fail to do so. Also important is when the snapshot of net carbon flows is taken: before or after harvest? If an average is used, what is the averaging period? Large areas can be useful for averaging over age classes, but even the average age class can vary over time due to changes in disturbance regime (whether anthropogenic or natural). They write:

> In reality the issue of which temporal approach is appropriate is not entirely a scientific issue. Rather it depends on management and policy strategies and, more specifically, whether the selection of energy systems is made to meet long-term or short-term GHG objectives.

Two types of reference cases are considered. First, how would energy demand be met in the absence of the bioenergy project? The second compares against a "zero alternative", which essentially compares the bioenergy system to no system. A third, not considered here, asks how the world looks with and without the bioenergy system, which is subtly different, since it allows demand to change as well.

They describe four different approaches to allocating emissions in a combined heat and power ("CHP") facility, none of which takes a truly consequential approach (i.e., examining what would happen in the absence of the plant.) They do, however, describe expanding the "reference entity" (system expansion, in other words) and recommend comparing the simpler allocation-based methods to this. One of their methods is essentially the displacement method. The difference between system expansion and displacement is clarified with an example, showing that displacement uses a functional unit related to the main product, taking credit for whatever amount of co-product displacement occurs. System expansion differs in that the functional unit includes all useful co-products: the system that produces less must have some amount of additional function added to it. (In which case, the choice of additional processes is critical to the outcome.)

Notably, they raise the point that when producing liquid biofuel, increasing the production of by-product heat or electricity (e.g., from lignin) benefits the GHG rating of the biofuel: "Processes resulting in less by-product may thus appear less attractive in terms of GHG emissions even though the goal was to produce the more valuable transportation fuel."

They note that when comparing combustion of biomass residues to burning coal, the reference case of leaving the residues on the forest floor must be considered. The benefits of displacing coal burning accrue over time as the residue would have been oxidizing in the reference case. (Though they don't consider atmospheric residence time and decay. (See Anderson-Teixeira and Delucia (2010) for more on that.))

The authors compare a bioenergy system to a reference case, but their *ceteris paribus* assumption (which is standard in attributional LCA) ignores economics. The net effect on the atmosphere depends on what would have happened in the absence of the bioenergy system, inclusive of induced economic and ecological effects.

Regarding the long-term storage of C in landfills, they write:

> The sum of the greenhouse impact of the emissions (CO_2 and CH_4) and this carbon sink determines the total greenhouse impact of the landfill option. In practice it is difficult to present any reliable and general calculation principles for landfill emissions, mainly because of the heterogeneity of different landfill sites. The final

greenhouse impact of the waste wood or biomass waste used for energy purposes is obtained by subtracting the net emissions of waste decay (the reference scenario) from the net emissions of burning waste for energy.

Interestingly, this paper recognized the ILUC issue back in 1997:

The question that has to be answered in the case of dedicated crops is: "Instead of what?", i.e., what would happen with the land if it were not dedicated for biomass production. As an example, if corn is used for the production of ethanol to displace the use of gasoline, then an alternative land use might be afforestation (with considerable uptake of carbon from the atmosphere), or it might be fallow land (with some uptake of carbon, mainly in soils). It could also be that the corn that was produced for feed prior to the ethanol project is now produced elsewhere, perhaps even resulting in the clearing of forests for agricultural land.

They suggest using afforestation on the same land as a reference case, noting that "there is often a 'carbon opportunity cost' associated with using land for biomass production. They also recommend calculating "the net reduction of C emissions to the atmosphere due to the decision to produce bioenergy." This, of course, is the definition of a consequential LCA, though they fail to capture the economics. They really were quite close, though.

In many ways, this paper was ahead of its time, and many LCAs conducted since then have failed to address these key points.

The authors helpfully conclude: "Estimating the impact of bioenergy systems on net greenhouse gas emissions (full fuel cycle analysis; this paper) is not the same as accounting for bioenergy-related emissions credits and debits between countries."

Marland and Schlamadinger (1997) compare when forest storage outperforms bioenergy production, concluding:

When sustainably-produced forest products are used inefficiently to displace fossil fuels, the greater C benefit is achieved through reforestation and protection of standing forests, and increasing the rate of stand growth yields little gain. However, when forest products are used efficiently to displace fossil fuels, sustainable harvest produces the greater net C benefits, and the benefit increases rapidly with increasing productivity.

This paper again uses the GORCAM model, showing that analysis needs to be site-specific and that GHG benefits are a function of land management practices.

They consider the use of unused or degraded land under (i) afforestation (and non-use) and (ii) development of a short-rotation energy crop (tree or other perennial) to displace fossil fuels. The two key parameters are the growth rate of the crop (Mg C ha^{-1} y^{-1}) and efficiency of displacing fossil fuel C (Mg C avoided per Mg C in biomass.) They assume that 20% of the harvested biomass is lost during harvest and hauling and oxidizes in the harvest year. They account for five litter pools and 1 soil pool. Base case: 1 kg C in harvested wood displaces 0.6 kg C in coal, owing to efficiency and C density differences. This (non-economic) CO_2 displacement factor would be lower for a natural gas baseline, or higher for CHP or improved conversion efficiency for biomass. A critical factor is when the afforestation saturates in C accumulation (though more recent evidence indicates continued sequestration.) They recognize that if bioenergy induces additional consumption, the displacement factor might drop to near zero, and can reach 1.5 if displacing separate inefficient sources of heat and power. They assume a constant harvest of 50 Mg C ha^{-1}, so doubling growth rate halves rotation period.

This paper highlights many important issues, but misses (i) the atmospheric residence time of CO_2, consideration of which would weaken the case for bioenergy (O'Hare, Plevin et al. 2009; Anderson-Teixeira and Delucia 2010; Levasseur, Lesage et al. 2010); (ii) recent evidence (Luyssaert, Schulze et al. 2008) that trees keep on growing; and (iii) lack of serious consideration of rebound effects. Notably, in all cases, inclusion of these factors weakens the case for bioenergy relative to afforestation. However, the model also fails to consider disturbances which weakens the case for afforestation (Anderson-Teixeira and Delucia 2010), especially in zones prone to wildfire.

The authors conclude:

> The success of any mitigation project relying on the use of biomass as a fuel will be strongly dependent on site-specific parameters and on the technical factors of energy substitution. Considering that land resources are limited, these parameters play a key role in determining whether fossil fuel substitution should be preferred to on-site C sequestration strategies.

Schlamadinger and Marland (1999) is largely a reprise of the 1997 "sensitivity analysis" paper. Important conclusions of this paper include:

> Any intent to use forest harvesting to help mitigate the buildup of carbon dioxide in the earth's atmosphere should be able to demonstrate that the forest regrowth and product use can compensate for the loss of carbon from the forest as a result of the initial harvest.
>
> ….
>
> Only with growth rates greater than 1.5 to 3 Mg C ha^{-1} yr^{-1} (depending on the time consideration) is it possible to sequester more C with forest harvest than with forest protection within a time frame of 20 to 70 years.

While acknowledging that their simple model treats all C emissions the same regardless of when they occur, they still fail to recognize atmospheric residence time, instead discussing discounting of flows (while recognizing that costs and benefits should be discounted instead) and using a net present value (NPV) approach for comparison. They recognize that discounting results in no gain for harvest scenarios since payback is discounted, noting also that "It may also be appropriate to discount future C flows because of their uncertainty, uncertainty that arises, for example, from possible climatic changes and their impact on forests, and from changes in political or socio-economic circumstances." They also note that including natural disturbances in their model "would tend to reduce the 'carbon-pay-back-period' of clear-cut harvest."

Gustavsson, Karjalainen et al. (2000) examine project-based GHG accounting, focusing on baselines and additionality. They identify four basic principles—accuracy, comprehensiveness, conservativeness, and practicability—that should be used to construct baselines. They define a baseline as "a path through time that an accounting variable would have followed in the absence of a specific greenhouse-gas mitigation activity." They note the impossible task this presents suggesting that describing the "most probable" path is adequate. (Arguably, that this is no better known than the actual path.) They define accuracy essentially as having a complete inventory, even if the levels are not precise, noting that a precise and incomplete inventory is less useful than a complete and imprecise one.

The ultimate question is essentially that of consequential LCA: "Had not a project been implemented, what would have been the net emissions of greenhouse gases?" They suggest re-evaluating the baseline, giving a case in which better options become available making continuation of the project a relative source of GHGs relative to stopping it. However, for practical reasons, they note that continuous updating is not desirable either.

They also address spatial and temporal leakage beyond system boundaries. Spatial leakage includes relocating emissions from Annex I to non-Annex-I countries. Temporal leakage includes reversal of carbon storage, e.g., from forest fires. Understanding the post-project fate of carbon is essential.

The paper is one of the few that discusses rebound effects. In addition to the usual price effects, they consider income effects in countries receiving project funds, in which additional economic activity results in increased GHG emissions.

The authors recommend making conservative estimates of emission reduction benefits since both sellers and buyers share the incentive to overstate mitigation benefits by establishing artificially high baselines. Also, uncertainty in some parameters can be exploited to create a high baseline or high reductions. They conclude that GHG credits "should not be overestimated due to uncertainties."

Schlamadinger, Bird et al. (2007) describe the treatment of land use, land-use change and forestry (LULUCF) under the Marrakech Accords, accepted into the UNFCCC framework at COP7 in 2001. The accords were a negotiated solution that had to deal with considerable scientific uncertainty, and it is more complex than some would like. That the inclusion of LULUCF was agreed to after the establishment of Kyoto targets resulted in LULUCF being treated as an offset mechanism. To do otherwise would have triggered a renegotiation of emission targets.

Three unique characteristics of the LULUCF sector are *saturation* (limits to biological sequestration potential), *non-permanence*, and the *degree of human control*. Saturation means that sinks eventually reach a steady state in which, on average, NPP equals the rate of heterotrophic respiration. Non-permanence means that sequestration of carbon in the biosphere is reversible, whether by management changes or natural causes such as disease and fires caused by lightning. Whereas actual reductions in (fossil) CO_2 emissions are permanent, offsets via storage in the biosphere is not. The Kyoto protocol deals with non-permanence through annual accounting of carbon fluxes in GHG inventories. However, non-permanence is an issue for project-based accounting, especially in countries that don't have emission reduction commitments. The *degree of human control* refers to the natural factors beyond human control (e.g., drought, disease, fire, changes in precipitation, CO_2 concentration, and atmospheric nitrogen deposition) that can undermine (or, occasionally, enhance) carbon sequestration activities. Whereas humans have great control over fossil CO_2 emissions, we have much less control over CO_2 sequestration in the biosphere.

Bioenergy is not included in land-use activity under the Kyoto Protocol. Rather, any reduction in fossil fuel use is accounted for in the energy sector. Notably, this inherently includes rebound effects within national (accounting) boundaries, but ignores those outside the country. (Note that unsustainable use of biomass is *not* counted in CDM projects, since baselines are required to account only for energy, industrial processes, solvent and other product use, non-CO_2 gases in agriculture, and waste.)

ii. Life Cycle Assessment Literature

Though not an LCA paper, Jacobson (2004) is instructive on one key point pertaining to biomass carbon accounting which is closely related to life cycle GHG accounting: which GHGs are included in the accounting, and how exactly one accounts for the more uncertain climate effects of aerosols, can strongly affect the assessment of net climate benefits. This important issue has been frequently discussed in a more fuel cycle accounting context by Mark Delucchi (e.g., Delucchi 2010). In this paper, Jacobson looks at biomass burning using a simulation model, showing that burning and regrowth always result in net warming. However, his work indicates a net cooling in the near-term from biomass burning, owing to albedo effects of emissions of organic carbon, but a long-term warming effect from emissions of CO_2.

Bergsma, Vroonhof et al. (2007) produced guidelines and a software tool for bioenergy GHG accounting for The Netherlands' Cramer Commission. They review some other accounting schemes, including IPCC and several national bioenergy accounting tools. They note that the reference (prior) use of biomass must be included in the analysis since the replacement of the prior use will have GHG consequences. (This is structurally identical to the case of ILUC.) They write that "As research from the University of Utrecht and CE Delft has shown, factoring in a reference residue use can lead to a 50% decrease in GHG reduction in the case of bio-electricity generation."

Rabl, Benoist et al. (2007), in a one-page editorial in the International Journal of LCA, make the case for the explicit accounting of all CO_2 fluxes rather than relying on the assumption of carbon neutrality. They argue that only by accounting explicitly for sequestration and emission of biogenic carbon can we address the time dimension: photosynthetic CO_2 sequestration occurs over years or decades for some species, whereas emission can be effectively immediate, e.g., in the case of forest fire. Under explicit carbon accounting, the emission of biogenic C in waste treatment (e.g., waste-to-energy systems) is not treated as carbon neutral, since the system boundary extends only as far as the generation of the waste: upstream emissions *and sequestration* should be excluded. "Thus, the CO_2 emitted during incineration has to be counted fully." Finally, explicit accounting follows the 'polluter pays' principle and Kyoto rules, which allocate GHG fluxes to the causing agent. The authors argue that "under a system of greenhouse gas taxation, the CO_2 from using wood for space heating should be taxed the same way as CO_2 from oil heating, and a credit for CO_2 removal should be paid only when and where the wood is replaced by new growth."

Christensen, Gentil et al. (2009) examine a range of approaches to carbon accounting for waste management systems, showing that (a) many approaches fail to properly account for carbon fluxes experienced by the atmosphere, and (b) biogenic C can be treated as "neutral" or counted, so long as the treatment is consistent. Specifically, if biogenic C is treated as "neutral", sequestration of that carbon in landfills must be counted as saving CO_2 emissions. Alternatively, emissions of biogenic C can be counted, but sequestration of the same carbon should not be counted.

Gentil, Christensen et al. (2009) compare carbon accounting for waste management systems under national GHG inventories, GHG accounting for corporations or other organizations, LCA, and trading schemes such as the CDM, showing how the different accounting scopes affect the results of the analysis.

When viewed on a project basis, some waste-to-energy systems are net GHG emitters. Just as with forest energy systems, the net benefit of waste-to-energy (WTE) systems depends on (i) the alternative fate of the waste, and (ii) the type and quantity of energy displaced by project. Treating all WTE systems as carbon neutral ignores these factors and provides equal incentives whether the WTE system mitigates or exacerbates climate change. Moreover, if EPA treats WTE systems as carbon neutral, it should count for the long-term sequestration of biogenic carbon in landfills as a sink—one that decreases over time as waste is diverted instead to WTE systems.

Guinée, Heijungs et al. (2009) discuss the challenges of estimating the GHG savings from bioenergy systems, focusing on the handling of biogenic carbon and of co-products and recycling. They note that

> Common practice in energy LCAs is that no explicit biogenic carbon balances are made, but that CO_2 fixation during crop growth for bioenergy is set to zero, and the CO_2 emission of incineration or digestion of the biofuel is also set to zero.

Searchinger, Hamburg et al. (2009) point out that treating bioenergy as carbon-neutral is inappropriate when the sustainability of the production of the biomass is unverified. This "accounting error" could stimulate deforestation while treating the harvested biomass as though it doesn't contribute to climate change. They write that when "biomass is counted as carbon neutral, economics favor large-scale land conversion for bioenergy regardless of the actual net emissions."

Courchesne, Bécaert et al. 2010 (2010) – Examine three biofuel pathways using the "Lashof method", which compares the cumulative radiative forcing of emissions from different systems as measured at a fixed point in time. This approach is closely related to ideas previously proposed in by O'Hare, Plevin et al. (2009) and Levasseur, Lesage et al. (2010). The fundamental point made by these three papers is that the specific time profile of GHG emissions determines the total warming effect of those emissions. Standard LCA practices simply add together emissions without regard to timing. For projects that cause sizable up-front emissions, standard LCA therefore underestimates the relative warming effect relative to any fixed date in the future.

Walker, Cardellichio et al. (2010) – the Manomet study – examines the role of bioenergy in climate change mitigation, from the perspective of Massachusetts. Chapter 6 of this detailed report is dedicated to life cycle carbon accounting; that chapter is reviewed here. One key point in the Manomet study is that bioenergy is more carbon intensive than fossil fuel, so the use of bioenergy causes greater direct CO_2 emissions per unit of energy delivered. In terms of direct emissions, therefore, substituting bioenergy for fossil energy results in greater CO_2 emissions. However, regrowing forests "pay down" this carbon debt over time, eventually resulting in a reduction in cumulative CO_2 emissions. Therefore, whether and when such projects achieve "carbon neutrality" depends critically on the analytic time horizon used for evaluation. As the authors note, "a key question for policymakers is the appropriate societal weighting of the short term costs and the longer term benefits of biomass combustion."

Although it focuses on the time profile of emissions and sequestration, by focusing on "carbon debt" rather than "warming debt", the authors actually understate the magnitude of the problem. Had they considered time required to offset the warming caused by the additional CO_2 resulting from bioenergy use until it is re-absorbed by growing biomass, the payback periods would be even longer.

Another key point of this study is that in a properly framed study, considering the landscape scale does not change the results seen at the stand level, since the business-as-usual growth of forest biomass cancels out of the comparison.

4. Carbon Accounting Summary

Between Walker et al. 2010, Anderson-Teixeira and Delucia 2010, Morris 2008, and the various papers on the GORCAM model by Schlamadinger and Marland, we can summarize the necessary elements in accounting for the climate effects of forest bioenergy projects:

1. Growth rate
2. Harvest rate
3. Alternative fate of biomass, including
    a. Disturbances due to wildfire, pests, disease, or other natural or human impacts
    b. Decomposition of biomass, which may release CH_4 rather than CO_2, for example
    c. Forgone sequestration or stabilization of carbon, as would have occurred in long-lived uses of timber, in a dry landfill, or the loss of SOC when residues are harvested
    d. Energy production, such as diverting MSW previously used to generate electricity to liquid fuel production
4. GHG emissions displaced by bioenergy, which in turn depends on:
    a. Carbon emission rate per unit energy for bioenergy and assumed displaced system
    b. Efficiency of energy conversion for each system
    c. Anticipated changes in these parameters over the analytical time horizon
5. Other life cycle emissions, including those from
    a. Production of agrichemicals
    b. Tillage, agrichemical application, irrigation, harvesting and other field operations
    c. Transportation of feedstock to energy conversion facilities
    d. Transportation of final biofuel to point of use (where appropriate)
    e. Market-mediated effects such as ILUC and the petroleum rebound effect
6. Timing of all flows (sinks and sources) of GHGs, and the decay of atmospheric GHGs over time

When viewed with broad system boundaries, neither the climate neutrality nor the carbon neutrality of a bioenergy project are guaranteed. Ignoring the direct CO_2 emissions from combustion of biogenic carbon is typically justified by the assumption that carbon uptake equals carbon release, but this assumption can be incorrect under a variety of conditions.

5. Key Themes in Bioenergy Accounting Literature

Three conclusions should be drawn from this review:

1. For many bioenergy projects, carbon neutrality is achieved only after years or decades. This raises questions about tradeoffs between short-term and longer-term mitigation.
2. Whether bioenergy is carbon neutral depends entirely on the system boundaries and accounting methods employed.

3. Carbon neutrality does not imply climate neutrality, since biogenic CO_2 contributes to warming between combustion and uptake in new biomass.

The final point is best illustrated by analogy. Say a company uses an industrial process that emits dioxins in a populated region, but also employs another process that scrubs the emitted dioxins from the environment over the course of 20 years. You could say the company is "dioxin-neutral" since at the end of 20 years, the net dioxin release is zero. However, for 20 years, some (decreasing) amount of additional dioxin remains in the environment, causing cancer in the region*. Persistent emissions may reach arithmetic "neutrality" over time, but this does not imply that they cause no harm. The* harm is indeed lower than it would be if the emissions were not eventually neutralized, but to say that it has a zero emissions is a poor and clearly biased estimate of the effect.

Bioenergy systems behave in a similar manner, especially in the case of long-lived perennials. The additional CO_2 released (relative to fossil energy systems) when biomass is combusted is removed from the atmosphere by regrowth over years or decades in some cases. During this time, that additional CO_2 contributes to climate change, causing the very harm CO_2 regulation is intended to reduce. Perceived carbon "neutrality" is therefore an inadequate rationale for exempting bioenergy from regulation. The deployment of some bioenergy systems results in an increase in GHG concentrations, in some cases for decades, and in other cases indefinitely. Assuming carbon neutrality eliminates incentives to ensure that bioenergy delivers benefits rather than costs.

An alternative would be to regulate all CO_2 emissions equally, while providing credit (i.e., agricultural offsets) for documented net sequestration. The bioenergy facility and the biomass farmer would then have to work out suitable financial arrangements. This approach recognizes that while the CO_2 emissions are easily measured and quite certain, the compensating CO_2 removals are subject to delay and reversibility which can undermine their effectiveness. Ignoring these factors provides no incentive to ensure that bioenergy helps mitigate climate change. It is important to note that this approach still does not guarantee that bioenergy systems deliver net climate change mitigation benefits: to ensure this would require a comprehensive life cycle accounting approach, including leakage. However, in the context of regulating direct emissions, the approach recommended here avoids the most critical potential error of treating a net loss of biotic carbon sequestration as a climate change mitigating activity.

Another approach would be to award "carbon neutral" status to sustainably-grown and -harvested biomass. However, this approach would fail to distinguish between bioenergy systems that re-absorb most of the emitted CO_2 very quickly, and those that take decades. In both cases, the emission of CO_2 is instantaneous. Accounting for the different climate effects of these systems requires consideration of the time profile of plant growth and harvest. If we account for the CO_2 emissions and sequestration when and where they occur, the incentives work out appropriately.

i. Life Cycle Versus Direct Emissions

To avoid creating biases, a GHG regulation should consistently count either life cycle or direct emissions across all regulated facilities, fuels or activities. Counting expected future absorption of CO_2 for bioenergy systems brings one element of the bioenergy life cycle into the regulation, while all other processes are regulated on the basis of direct emissions only. Including only one element of the bioenergy life cycle—especially without recognition of the effect of the timing of emissions and uptake—fails to address the larger question of whether incentivizing bioenergy helps or hinders climate change mitigation efforts.

Expanding the use of LCA-based GHG regulations faces at least one practical problem: some regulated processes produce inputs consumed by other regulated processes. For example, the life cycle of most industrial processes includes some amount of grid electricity and petroleum-based transport fuels. If electricity and petroleum refining were regulated on a life cycle basis, the electricity and transport portions of the life cycles of downstream processes (e.g., cement manufacturing and biofuel production) should exclude the already-regulated upstream processes to avoid double-penalizing those upstream processes. As more processes are regulated on a life cycle basis, more overlap will occur: construction uses cement and steel, which use electricity and petroleum. Sorting this out to avoid multiple penalties would be fairly complicated.

Regulating only direct emissions is far simpler, but without fairly complete regulatory coverage substantial leakage can occur. Regulating *committed* direct emissions (i.e., taxing both fossil and biogenic carbon at the point in the production chain when they are committed to combustion) would substantially reduce the number of regulated parties and thus somewhat simplify regulation. This approach would also ensure that all emissions are regulated (e.g., taxed) only once. But without universal coverage, this approach fails to account for emissions that are pushed outside the regulatory jurisdiction. Notably, this problem also exists for national GHG inventories under the UNFCCC (Weber and Matthews 2007; Andersen, Gössling et al. 2010).

As set forth above, a question for the tailoring rule is whether EPA has a legal basis under the Clean Air Act to consider life cycle emissions of GHGs, since harm is caused regardless of the location of the emitter. If consideration of international emissions is deemed outside the scope of the regulation, then the LCA would be incomplete for some processes, and regulating on a direct basis would be the only reasonable option.

B. The IPCC Method of Accounting for Biogenic CO2 Emissions Is Incomplete and Legally Irrelevant to EPA's Duty to Regulate GHG Emissions Under the Clean Air Act[45]

EPA requests comment on the accounting mechanism provided for in the IPCC guidelines for biogenic CO_2 emissions, specifically on two points:

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[45] The analysis of the IPCC accounting method was provided by Timothy D. Searchinger.

- To what extent does this approach suggest that biomass consumption for energy is ''neutral'' with respect to net fluxes of CO_2?; and

- To what extent is the accounting procedure in the IPCC Guidelines applicable or sufficient for assessing net emissions from specific biogenic sources, facilities, fuels, or practices?

The short answer is that the accounting system set forth in the IPCC guidelines is intended for a very different context and does not accurately count emissions in the context of regulations that apply to emissions from stationary installations.

1. The IPCC guidelines only work for accounting systems that are worldwide, and address both land use emissions and energy combustion emissions.

The Call for Information asks whether IPCC national inventory accounting guidelines could serve as a basis for accounting under the EPA's regulatory programs for stationary installations. The short answer is no because the IPCC guidelines were developed for a very different context and do not work for these kinds of regulations.

EPA's Call for Information accurately represents the rationale behind the IPCC guidelines for bioenergy, which is to avoid double-counting. In effect, the guidelines recognize that if a tree is harvested for bioenergy, it generates greenhouse gas emissions but those emissions can be counted either in the land use account or the energy account. Because the guidelines assign those emissions to the land use account and in effect treat the cutting down of the tree as an emission, they do not need to count the emissions again when they literally occur up a smokestack.

Exempting energy emissions from biomass only works if those emissions are counted elsewhere. The IPCC guidelines work for three reasons: most importantly, land use emissions fully and equally "count." Therefore the real physical emissions from biomass energy consumption, minus any effective offset for net additional carbon uptake by land, are reported as emissions from land use and land use change. It is also important that the IPCC accounting applies worldwide, as nearly all countries signed the UNFCCC. In this way, biomass imported into a country and burned for energy, while not counted in the importing country, is reflected in the emissions of the exporting country. In addition, indirect land use change that occurs if one country diverts into energy its otherwise used biomass, whether for food or timber products, the land use implications of replacing those products again show up in land use accounts wherever they occur. These limitations are set forth in Searchinger et al. 2009.

The regulatory program of the EPA under the Clean Air Act does not share these features. It applies only to energy emissions (and only to some of them), not land use and land use change. And it does not apply worldwide. Nor do other countries have equivalent regulations that apply worldwide. The exemption of bioenergy emissions therefore not only fails to account for real emissions but also creates a perverse incentive to transfer carbon now sequestered in plants into the atmosphere for energy use based on a false accounting that doing so reduces greenhouse gases.

For a system equivalent to the IPCC national inventory accounting system to work for regulatory purposes, it must have the effect of applying equal controls on land use emissions as on energy emissions. Only in that hypothetical case, would the cost of causing land use emissions equal the cost of reducing energy emissions, which would then provide the right incentive to energy emitters to use biomass only to the extent it does reduce energy emissions.

It is important to emphasize, however, that regulating energy emissions for what they are is not a form of land use regulation. The physical emissions occur in the energy sector. When these emissions are fully counted, it is only because the method of generating biomass has not, in effect, captured additional carbon and provided an offset for these energy emissions. Regulating bioenergy emissions simply means that this kind of land-based offset cannot automatically be assumed.

In summary, the IPCC approach does not apply to the EPA regulations because they were never intended to apply in this context. Attempting to capture bioenergy emissions through the land use accounting cannot apply in the context of EPA air regulations that do not have a land use component. Misapplying the IPCC guidelines would not prevent double-counting but instead would mean that emissions associated with bioenergy are never counted at all regardless of the source of the biomass.

III. Quantitative Data and Qualitative Information About the Biomass Energy Sector[46]

In the Call for Information, EPA requests quantitative data and qualitative information about: (1) the number of facilities that generate or are expected to generate GHG emissions from bioenergy and other biogenic sources; (2) the types of processes that generate or are expected to generate such emissions; (3) current and projected utilization of biomass feedstocks for energy; and (4) current and projected levels of GHG emissions from bioenergy and other biogenic sources.

A. The Number and Type of Facilities that Generate or Are Expected to Generate Emissions from Bioenergy and Other Biogenic Sources

1. Types of Biomass Currently Used for Power Generation

The EIA defines two categories for biomass in its "existing generation by state" database:[47]

WOOD AND WOOD DERIVED FUELS

- includes paper pellets, railroad ties, utility poles, wood chips, bark, red liquor, sludge wood, spent sulfite liquor, and black liquor, with other wood waste solids and wood-based liquids.

"OTHER" BIOMASS

- includes biogenic municipal solid waste, landfill gas, sludge waste, agricultural byproducts, other biomass solids, other biomass liquids, and other biomass gases (including digester gases and methane).

2. Constitution of the Current Biomass Industry

EIA's "existing generating units"[48] database for 2008 indicates this is an industry that has been relatively static in recent years.

- There are 347 plants, total, with a combined capacity of 7,173 MW
- Unit status is "operating" for 303 plants
- Oldest operating plants were built in 1929
- Median age of operating plants is 29 years old (commenced operation in 1981)
- Average size is about 24 MW (nameplate capacity)

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[46] The discussion of qualitative and quantitative information related to the bioenergy sector was largely prepard by Mary Booth, Ph.D.

[47] Energy Information Administration. Net generation by state, 2008. Washington, DC. Jan. 21, 2010, *available at* www.**eia**.doe.gov/cneaf/electricity/epa/**generation_state**.xls.

[48] The EIA database only includes information about electricity-generating plants, so data for thermal-only facilities are not included.

- 194 operating plants are 15 MW or larger
- 42 plants are 45 MW or larger
- 152 plants, with a combined capacity of 4,263 MW, use wood liquors as a primary fuel; about half of these use some kind of fossil fuel, including coal, as a secondary fuel; about half use wood solids as fuel
- 151 plants, with a combined capacity of 2,910 MW, use wood solids as a primary fuel. The average capacity of these plants is 19 MW.
- Wood use at all 347 plants is probably around 30 million tons per year (see below for how this estimate was made).

3. The Total Number of Facilities Burning Biomass Is Expected to Increase Significantly

Biomass power is eligible for renewable energy credits and is considered a qualifying technology for renewable energy portfolios in all states that mandate increased generation of renewable power. Projections of biomass development, such as those conducted by the Energy Information Administration to model development of renewable power under the Stimulus Bill and the American Clean Energy and Security Act, predict large increases in biomass power capacity. Presumably, this would not have been the case were the assumption of carbon neutrality of biomass widely questioned or substantively shown not to true, but until recently, the unquestioned acceptance of this concept has led to widespread promotion of biomass power. In response to legislative mandates to increase renewable power generation, federal production tax incentives, and the exemption of biomass power facilities from buying emission allowances in states operating under a carbon trading program, there has been a recent surge in proposals to build biomass plants and to co-fire biomass in coal plants. While it seems unlikely that all or even most of these proposals will go forward, if only because fuel supplies will be limiting, there is no question that the industry is undergoing both a qualitative and a quantitative change. EPA is asking for information on the amount of biomass power proposed, but EPA's own future actions and how it regulates biogenic emissions will determine the financial viability for many of these proposals.

i. New Direct-Fired Biomass Facilities

- According to an industry database,[49] updated as of June 2010, there are 106 new or proposed direct-fired plants that would use wood as fuel. (The majority of these plants have not yet been built).
- Average size of these plants is 39 MW. There are 37 plants that are 45 MW or larger. The biggest plants are 100, 110, and 200 MW.

ii. Proposals to Co-Fire Biomass at Coal Plants

[49] RISI Wood Products Industry Information database (http://www.risiinfo.com/pages/product/wood/).

- There are at least 25 proposals to co-fire biomass at coal plants or completely re-fire coal plants with biomass. (This estimate has been compiled from news reports – proposals of this type are not included in the industry database – and is therefore less certain.)
- The combined capacity of these proposals is about 2,290 MW, but some of the proposals have to be estimated (it is assumed that 10% of the total generation will be produced with biomass when the biomass capacity is not stated).
- The largest re-firing proposal is the Burger Coal Plant in Ohio, which plans to refire 80% of 312 MW with biomass.

iii. Small Thermal and Combined Heat and Power Facilities

There is an increasing push at the state level to convert formerly fossil-fuel fired boilers at schools, hospitals, and municipal buildings to biomass. Vermont has been promoting the "fuels for schools" program for a number of years, and as of the 2007 heating season had 32 facilities that were using about 18,000 tons of wood.[50] In Pennsylvania, a state-sponsored initiative to promote small-scale biomass is underway; at least 11 facilities exist or are proposed currently. Since pollutant emission rates from small facilities tend to be high, many operate better by using "cleaner burning" pelletized wood. This increases the total wood harvesting required to generate fuel, relative to use of whole tree chips, because pellet facilities tend to use only white, interior trunkwood as feedstock to produce premium pellets. All of these facilities increase the total demand for wood and increase pressure on forests.

B. Current and Projected Utilization of Biomass Feedstocks for Energy

1. The Total Amount of Wood Required is Likely to Increase Dramatically

Considering biomass power capacity that could be brought online to be built in the next five years, wood requirements for biomass fuel are likely to increase substantially. Further, pellet production and overseas wood exports are also increasing significantly. The current practice of considering biomass energy to be carbon neutral has thus created incentives that result in a real threat to forests.

i. Current Wood Use

For 2008, EIA states[51] that "wood and wood derived fuels" delivered 37,299,853 MWh in the United States (this includes all sectors, including industrial end-use generators). "Wood derived fuels" refers to pulping liquors. An unknown amount of thermal energy was also generated from wood. To estimate the amount of wood consumed

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[50] Vermont Fuels for Schools wood fuel survey results for 2006-2007 heating season.
[51] Energy Information Administration. Net generation by state,2008. Washington, DC. Jan. 21, 2010.

at existing biomass electricity generating facilities, it is assumed that only 41% [52] of power generated at biomass facilities is generated from wood – this is the proportion of total nameplate capacity that is represented by plants that say wood solids are their primary fuel. Average plant efficiency is assumed to be 20%,[53] since the majority of existing plants are relatively small. Considering only the wood used as fuel at existing plants, this translates to 261 MMBtu of wood that is needed to generate 15.3 GWh. Using the lower heating value of wood, as ORNL recommends,[54] and assuming the average wood moisture content of mill residues is 40%,[55] this translates to about 28 million tons of wood a year, presumably much of that from mill residues (however, see below – many existing plants are using forestry wood as fuel, including whole tree chips, rather than mill products like sawdust, etc). [56]

US Forest Service Inventory data state that 37 million dry tons of mill residues are used for fuel each year.[57] Assuming a moisture content of 40%, this translates to about 61 million "green" tons. Thus, the approach used here for estimating usage may have produced a low estimate; however, this estimate is for power generation, only, whereas the USFS data probably also takes into account use at heat-only facilities.

ii. Wood Required by New Biomass Generation Coming Online

EIA assumes in its National Energy System modeling for a federal RES[58] that new biomass plants are online (operating) about 73% of the time by 2015. Assuming this to be the case, and assuming a weighted average of 28% efficiency for new generation (which

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52 According to EIA data, about half of existing plants use black liquors as their primary fuel, with about half of those plants using wood solids as a secondary fuel. However, very few plants that use wood solids as their primary fuel then use wood liquors as their secondary fuel. (Source: EIA: Existing generating units in the United States by energy source, 2008).

53 Council of Industrial Boiler Owners. Energy efficiency and industrial boiler efficiency – an industry perspective. March, 2003 (available at http://cibo.org/pubs/whitepaper1.pdf). The estimate of 20% efficiency is the midpoint of the 15% - 25% efficiency range presented for biomass boilers.

54 Wright, Lynn, et al. 2009. Biomass Energy Data Book: Edition 2. ORNL/TM-2009/098. Oak Ridge National Laboratory, Oak Ridge, TN.

55 Mill residues tend to be somewhat drier than forest residues alone.

56 Another way to estimate the amount of wood used to calculate the proportion of the time that existing plants were operating, by calculating that the 37.3 million MWh of biomass power generated is about 60% of the power that would be generated if the existing fleet of biomass boilers were operating full-time. Assuming that the primary fuel at a plant is burned at least 75% of the time, taking into consideration actual operating time of the industry, and assuming average boiler efficiency of 20%, wood use would be approximately 28.1 million green tons a year. Since EIA's data only tracks electricity-generating plants, wood use by thermal-only plants is not included in this estimate.

57 Table 42 from Smith, W.B., et al. 2007. Forest Resources of the United States, 2007. United States Forest Service, Gen.Tech Report WO-78. December, 2008.

58 Energy Information Administration, National Energy Modeling System run HR2454CAP.D072909A

takes into account the relative proportion of direct-fired plants, assumed to operate at 24% efficiency, and co-firing at coal plants, which are assumed to operate at 33% efficiency), cumulative wood demand rises each year. Table 1 estimates future wood demand, including wood use by the existing fleet of biomass plants, as calculated above.

TABLE 1: YEARLY WOOD DEMAND FOR BIOMASS FUEL, GREEN TONS, IF PROPOSED BIOMASS CAPACITY IS BUILT

year	2010	2011	2012	2013	2014	2015
Cumulative tons	32,777,647	38,431,961	51,129,539	68,328,896	78,879,017	91,379,581

iii. Pellet Wood Demand by 2015

The current pellet industry relies to some extent on clean wood residues and waste sawdust produced at mills. It is difficult to quantify this use but it appears that with growth in the pellet industry, more of these “clean” materials go for pellets and less are directly combusted as feedstocks to fuel power at end-user electricity generation facilities. This means that existing biomass energy plants are looking beyond mill residues for fuel, and are burning forestry wood (see below).

An industry database estimates that total wood demand from *new* pellet production plants proposed or in permitting[59] (current pellet production is not counted) will be about 60,362,000 green tons per year by 2015.[60] Some of this production could go to meeting developing biomass fuel needs at utility-scale plants, though currently, pellets are being sold for small-scale thermal facilities and domestic use.

There is also an expanding overseas market for pelletized biomass from the United States. Some plants, like Green Circle Energy in Cottondale, FL, ship exclusively overseas. Their current production capacity is 560,000 tons, which requires more than 1.12 million tons of green wood to produce. It is estimated that the size of the western European pellet/biomass market will be 72 million green tons by 2014.[61] Much of this is expected to be met with exports from North America.

2. Forest Residue, Whole Tree Chipping, and Dedicated Energy Crops as Sources of Biomass Fuel

As noted above, the current pellet industry relies to some extent on clean wood residues and waste sawdust produced at mills. Further, it is difficult to quantify this use but it appears that with growth in the pellet industry, more of these “clean” materials go for pellets and less are directly combusted as feedstocks to fuel power at end-user electricity generation facilities. This means that existing biomass energy plants are looking beyond mill residues for fuel, and are burning forestry wood (see below).

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59 RISI wood products database, June 2010 update
60 RISI wood products database, June 2010 update.
61 RISI wood products newsletter, April, 2010.

In addition, as explained above, an industry database estimates that total wood demand from *new* pellet production plants proposed or in permitting[62] (current pellet production is not counted) will be about 60,362,000 green tons per year by 2015.[63] Some of this production could go to meeting developing biomass fuel needs at utility-scale plants, though currently, pellets are being sold for small-scale thermal facilities and domestic use.

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i. Utilities Will Demand Whole Tree Biomass

According to the US Forest Service, there are about 102 million green tons of logging residues[65] generated each year in the continental US. These are diffuse, hard to collect, dirty, and green. Coal plant operators do not want to use these materials for co-firing, because they don't burn cleanly and they foul emissions equipment.[66]

As stated at the beginning of this document, the Manomet Study concluded that because cutting trees for biomass fuel involves foregoing much of the carbon sequestration that occurs under the "business as usual" scenario where forests are cut solely for commercial timber, net emissions from biomass can be greater than net emissions from fossil fuels, even over a period of several decades. The EPA should thus carefully scrutinize claims that biomass fuels are derived from "forest residues", since it is clear that not only is the definition of "residues" expanding to include more whole-tree harvesting, but that the carbon dioxide emissions of such increased harvesting can actually exceed emissions from simply continuing to use fossil fuels, particularly if biomass replaces natural gas.

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62 RISI wood products database, June 2010 update

63 RISI wood products database, June 2010 update.

64 RISI wood products newsletter, April, 2010.

65 Smith, W.B., et al. 2007. Forest Resources of the United States, 2007. United States Forest Service, Gen.Tech Report WO-78. December, 2008. The report states there are about 56 million dry tons; assuming 45% moisture, the industry standard, this converts to about 102 million green tons.

66 Notes from an Ohio Biomass Work Group meeting, provided by Cheryl Johncox of the Buckeye Forest Council to Mary Booth. According to Johncox's notes, Dave Frederick, an official from the First Energy Burger plant, indicated that the Burger plant can't run on 100% agricultural products because agricultural products are hard on the burners and because the burners will not meet emissions requirements when burning agricultural products. Frederick further indicated that the Burger plant will need to burn only wood products initially and then phase in agriculture residue over time. Frederick defined wood products to mean no limbs, no bark, no leaves – that is, only "white wood" would be used in order to meet applicable emissions requirements.

Proposals in Massachusetts to build three large-scale biomass electricity plants with a combined capacity of about 135 MW[67] drew the attention of citizens and scientists when it become apparent that forestry residues could only provide a small amount of fuel compared to the total demand. Data from a 2007 state-commissioned report on biomass availability in Massachusetts[68] stated that there was only about 109,000 green tons of residues produced, or enough material to generate about 9 MW of power, or 4.5 MW of power if 50% of residues were left onsite in the forests.[69] In response to the concerns raised by citizens, the State of Massachusetts commissioned a biomass sustainability study that was ultimately completed by the Manomet Center for Conservation Sciences, with the assistance of other groups from the forestry and biomass industries. Manomet examined the question of fuel availability and also came to the conclusion that logging residues could only supply a small proportion of fuel needs, and that logging would have to be increased to provide fuel if biomass electric generation facilities were built.

Some utilities also contend that forest residues are inadequate to meet their co-firing fuel needs. For example, Duke Energy Carolinas submitted testimony to the North Carolina Utilities Commission stating that "a limiting interpretation of the definition of "biomass resource" would impact the company's REPS compliance strategy and resource investment plans as follows:

> Duke Energy Carolinas would be forced to significantly alter its [Renewable Energy and Efficiency Portfolio Standards (REPS)] compliance strategy if the definition of 'biomass resource' was interpreted as a matter of law to exclude all other wood fuel sources except "wood waste". . . [T]here is already limited 'wood waste' supply in the marketplace, and such a limiting interpretation would create an artificial premium for that supply. . . Also as the supply of 'wood waste' will be geographically dispersed, risks and limitation related to economical transport of fuel will further constrain actual supply. . . Depending upon the transport distances in relation to the generation facility sites, there may simply not be enough "wood waste" fuel available to support the relative needs at Company-owned or third party sites. [70]
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> In December 2009, the Company issued a Request for Information for Biomass Fuel Supplies and received 26 responses for a variety of biomass

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[67] About 30 MW would be fueled with construction and demolition debris, therefore about 105 MW were to be fueled with forest wood.

[68] Innovative Natural Resource Solutions, 2007. Biomass availability analysis – five counties of Western Massachusetts. Report prepared for the Massachusetts Division of Energy Resources and the Massachusetts Department of Conservation and Recreation.

[69] Residues should be left onsite to retain soil fertility, build soil carbon, protect against erosion, and maintain wildlife habitat.

[70] Duke Energy Carolinas, LLC's Pre-Hearing Brief, *In re. the Registration Statements of Buck and Lee Steam Stations as Renewable Energy Facilities Pursuant to Rule R8-66* (N.C. Utilities Commission, Docket Nos. E-7, SUB 939 and E-7, SUB 940 (May 24, 2010)) (Test. of Owen A. Smith at 9-10)).

resources. The predominant biomass fuel that was offered was from whole tree chips.[71]

[I]n today's marketplace, only approximately 6% of forest residues are collected within our service area. Most are left at the harvest site because they are considered uneconomic to transport and have low quality for utilization due to size, dirt, and bark content.[72]

[T]the Company estimates that limiting eligible wood fuel to "wood wastes" would result in more than a projected 80% reduction in RECs produced by Company-owned "brownfield" assets. This result is based upon a Company estimate of 275,000 tons of material available to Duke assuming maximum residue collection rate of 50%, and the assumption that approximately 25% of residues would be available to Duke Energy Carolinas.[73]

ii. Some Estimates of Forestry Residues Already Include Whole Tree Harvesting

Some estimates of biomass availability, such as that used by the Energy Information Administration to define biomass stocks used as inputs to the National Energy Modeling System, [74] exhibit "definition creep" by including increased whole tree harvesting under the definition of forestry "residues". As defined by the U.S. Forest Service, forest residues include branches, tops, and unmarketable "cull" trees that are removed at current harvesting levels.[75] However, in the dataset used by EIA, the forest residues category includes part of the national inventory of standing cull trees, as well as standing inventories of "excess small pole trees."[76] Because the Forest Service inventory includes standing cull trees on potentially harvestable forest land, whether or not this land is likely to be logged, the estimated supply of potentially harvestable cull and pole trees greatly exceeds the amount of true logging residues that are actually generated each year. [77] Increasing whole-tree harvesting for fuel significantly increases carbon payback periods for biomass energy.

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[71] Duke Energy Carolinas, LLC's Pre-Hearing Brief, *In re. the Registration Statements of Buck and Lee Steam Stations as Renewable Energy Facilities Pursuant to Rule R8-66* (N.C. Utilities Commission, Docket Nos. E-7, SUB 939 and E-7, SUB 940 (May 24, 2010)) (Test. of Tracy Beer at 5).

[72] Duke Energy Carolinas, LLC's Pre-Hearing Brief, *In re. the Registration Statements of Buck and Lee Steam Stations as Renewable Energy Facilities Pursuant to Rule R8-66* (N.C. Utilities Commission, Docket Nos. E-7, SUB 939 and E-7, SUB 940 (May 24, 2010)) (Test. of Tracy Beer at 7-8).

[73] Duke Energy Carolinas, LLC's Pre-Hearing Brief, *In re. the Registration Statements of Buck and Lee Steam Stations as Renewable Energy Facilities Pursuant to Rule R8-66* (N.C. Utilities Commission, Docket Nos. E-7, SUB 939 and E-7, SUB 940 (May 24, 2010)) (Test. of Tracy Beer at 8).

[74] Walsh, M., et al. 2000. Biomass feedstock availability in the United States: 1999 state level analysis. Prepared for EIA; available at http://bioenergy.ornl.gov/resourcedata/index.html

[75] Smith et al, 2007.

[76] The term "excess small pole trees" does not occur in the glossary of terms included with the Forest Service forest inventory dataset but presumably refers to some portion of the standing stock of poletimber, which is defined as "Live trees at least 5.0 inches in d.b.h but smaller than sawtimber trees".

[77] Documentation for the ACESA scenarios, available at

iii. Many Exisiting Biomass Plants Already Use Whole Tree Chips for Fuel

Increasing use of whole tree chippers that can process both entire trees and low-diameter material left over after bolewood harvesting has led to increasing vagueness of what is meant by the term "logging residues". Increasingly the term is used to describe a mixture of materials, some of which may be derived from logging residues as the term is traditionally understood, and some of which may represent trees that would not have been cut, except for a need for biomass fuel. The term "whole tree chips" is increasingly used to describe this mixture of materials. As demonstrated by the following quotes taken from materials developed by biomass power companies, many existing companies are currently using whole tree chips as fuel.[78]

1. MA: "The Fitchburg Power Station is a 17 MW waste wood and landfill gas fired power facility. The facility burns whole tree chips"[79]
2. NH: "Tamworth Power Station is a 22.5 MW waste wood power facility … The facility uses wood from trees unsuitable for lumber or pulp"[80]
3. NH: "The Bethlehem Power Station burns low quality wood, which is continuously replenished through the natural forest cycles. The facility uses approximately 675 tons (per day) of whole tree chips"[81]
4. NH: Schiller Station: "Currently, PSNH's Schiller Station in Portsmouth operates three 50 megawatt coal-fired steam boilers built in the 1950s. PSNH will replace one of these coal boilers with a new fluidized-bed boiler. This state-of-the-art boiler will

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http://www.eia.doe.gov/oiaf/aeo/assumption/renewable.html, makes it clear that new logging will be required to provide biomass fuel: "Fuel supply schedules are a composite of four fuel types: forestry materials, wood residues, agricultural residues and energy crops. Energy crop data are presented in yearly schedules from 2010 to 2030 in combination with the other material types for each region. The forestry materials component is made up of logging residues, rough rotten salvageable dead wood, and excess small pole trees. The wood residue component consists of primary mill residues, silvicultural trimmings and urban wood such as pallets, construction waste, and demolition debris that are not otherwise used. Agricultural residues are wheat straw, corn stover and a number of other major agricultural crops. Energy crop data are for hybrid poplar, willow, and switchgrass grown on crop land, pasture land, or on Conservation Reserve Program lands."

[78] These examples are taken from a blog post authored by Booth at the Environmental Working Group "AgMag" site, available at http://www.ewg.org/agmag/2010/06/did-they-really-say-that-see-for-yourself/.

Copies of the company statements are available from Dr. Booth.

[79] http://www.suezenergyna.com/utilities/documents/Fitchburg.pdf

[80] http://www.suezenergyna.com/utilities/documents/Tamworth.pdf

[81] http://www.suezenergyna.com/utilities/documents/Bethlehem.pdf

burn whole-tree wood chips and other clean low-grade wood materials to generate electricity."[82]

5. VT: "The Ryegate Power Station burns 250,000 tons of whole tree chips per year"[83]
6. VT: McNeil Station (Burlington Electric): "Seventy percent of the wood chips that fuel the McNeil Station are called whole-tree chips and come from low quality trees and harvest residues. The trees, a majority of which are on privately owned woodlands, are cut and chipped in the forest. Clearcutting of woodlands is limited to areas that need to establish a new crop of trees. It may also be used in some instances to improve wildlife habitat. In these cases, the size of the area cleared is limited to a maximum of 25 acres. To run McNeil at full load, approximately 76 tons of whole-tree chips are consumed per hour. That amounts to about 30 cords per hour (there are about 2.5 tons of chips per cord of green wood)"[84]

iv. Many New Facilities and Coal-Plants Co-Firing Biomass Will Utilize Whole Tree Chips

- NH: Laidlaw Energy: "The Berlin biomass-energy project (the "Berlin Project") will be one of the largest biomass-energy facilities in the United States… and will utilize in excess of 700,000 tons of clean whole tree wood chips per year in order to generate approximately 65 megawatts of electricity, thus generating substantial local economic activity for loggers, truckers and other local businesses. The fuel source for the Berlin Project will be whole tree wood chips and other low-grade wood."[85]
- OH: The Beckjord coal plant seeks to refire with biomass. In their response to interrogatories before the Public Utilities Commission of Ohio, they state that "the most likely initial fuel will be woody biomass produced by whole tree chipping" and will "likely be local within a 50 mile radius of the coal landing terminal"[86]
- OH: The 312 MW Burger coal plant has recently been approved by the Ohio Public Utilities Commission to refire 80% of its capacity with biomass. The plant has solicited proposals for fuel supply that specify "whole tree chips" as a fuel category,

[82] http://www.psnh.com/Energy/ENERGYPROJECT/NWPP/print-faqs.html
[83] http://www.suezenergyna.com/utilities/documents/Ryegate.pdf
[84] https://www.burlingtonelectric.com/page.php?pid=75&name=mcneil
[85] http://www.laidlawenergy.com/berlin-nh-project.html
[86] Beckjord Response to Interrogatories, Case No. 09-10230EL-REN; filing with the Public Utilities Commission of Ohio. (http://dis.puc.state.oh.us/DocumentRecord.aspx?DocID=352a4eb8-ffd8-452b-a1ab-74ea7f409f33)

but is also interested in "engineered" wood fuel products which drying and processing wood.[87]

v. Energy Crops Are Not a Currently Viable Source of Biomass Fuel

Energy crops are not a viable source of biomass fuel at this point, and may not become so, given the expense of producing them, and existing mandated targets for biofuel production that are likely to utilize the majority of crops grown for a considerable period of time. The lack of energy crops is one more factor that puts pressure on forests to supply biomass fuel. For instance, Duke Energy is straightforward about the unfeasibility of supplying biomass fuel from existing energy crops. When asked: "Can the company use "energy crops" to meet the wood fuel needs to support its biomass implementation plans?" Duke representatives answered, "No at least not at the present time. Energy crops, which are plants, trees, and other crops planted specifically for use as energy fuel, are simply not presently available in the marketplace in quantities to sustainably support any type of biomass operations within Duke Energy Carolinas service territory."[88]

C. GHG Emissions from Bioenergy and Other Biogenic Sources

EPA will need to employ a carbon accounting framework, perhaps along the lines of the approach used by the Manomet Center, to evaluate the net emissions from combustion of all kinds of biomass, whether it be derived from annual grasses or trees. A minimum benchmark for performance could be emissions from fossil fuel generation, similar to how emissions from biofuels are evaluated. However, from a policy perspective, benchmarking against fossil fuels, instead of other renewable energy technologies, could be seen as a step backwards, particularly since biomass power is eligible for many of the same financial incentives as renewable energy technologies that have no stack emissions.

1. Treatment of Indirect Land Use Change from Biomass Harvest

As EPA develops a carbon accounting framework for biomass energy, there are a number of areas where special care should be taken to assure that the approach is robust. This is perhaps nowhere more important than in the consideration of emissions from indirect land use change, a topic that has proved contentious in biofuels carbon accounting. For instance, a recent study of greenhouse gas accounting for how Southeastern biomass could be used in co-firing at coal plants provides an example of how failing to include indirect land use change effects can produce an unrealistically favorable assessment of net

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[87] First Energy Solutions, Request for proposal for supply of solid biomass fuel, January 28, 2010. Akron, OH.

[88] Duke Energy Carolinas, LLC's Pre-Hearing Brief, *In re. the Registration Statements of Buck and Lee Steam Stations as Renewable Energy Facilities Pursuant to Rule R8-66* (N.C. Utilities Commission, Docket Nos. E-7, SUB 939 and E-7, SUB 940 (May 24, 2010)) (Test. of Tracy Beer at 5-6).

carbon emissions from biomass.[89] The study considers that using material normally harvested for pulpwood as biomass fuel would entail no emissions, ignoring the probable displacement of pulpwood harvesting into new areas. By making this assumption, the study generates a huge source of "carbon-free" biomass when, in fact, emissions under such a scenario could increase dramatically.

2. Soil Carbon Losses from Biomass Harvesting

Forest harvesting can produce collateral emissions aside from direct removal of carbon stocks. A recent review[90] that summarizes soil carbon flux following forestry activities found that significant amounts of carbon can be lost following soil disturbance. Soil carbon represents the largest carbon stock in temperate forests, is slow to accumulate and easy to lose. As well as representing a direct threat to forest sustainability, soil carbon losses from harvest activities likely represent a far greater source of greenhouse gases than negligible trace gas fluxes from decomposing material on the forest floor. Any carbon accounting system set up by EPA should take potential impacts on soil carbon stocks into account.

3. Treatment of Emissions from Biomass "Waste"

The question of how to treat greenhouse gas emissions from so-called "waste" wood and other materials will be contentious but is extremely important for EPA to settle in a scientifically sound way. Waste wood can represent material that would decompose in any case, thus it is often argued that burning this material results in no greater net emission of carbon than would occur if it were allowed to decompose. However, treating waste wood as if it has no net greenhouse gas emissions when burned creates an incentive to define more and more material as "waste", leading to an expanding definition of "forestry residues" that can include large amounts of whole tree harvesting. Further, the emphasis on the hypothetical alternative emissions from waste wood, should it be left to decompose, has increasingly lead to invocation of the "methane myth" (explained below) as justification for burning materials to avoid methane emissions that can occur during decomposition. These trends can be nipped in the bud if EPA uses a rigorous standard to actually quantify GHG emissions from burning waste wood. In particular, EPA should keep in mind that critical thresholds ensconced in state laws, such as the Massachusetts Global Warming Solutions Act, require actual reductions in emissions within very short time-frames, such as ten or twenty years. Achieving the transition from carbon debt to carbon dividend within such short timeframes is difficult, even for waste materials that "would decompose anyway", particularly since carbon emissions per unit energy from burning wood in low-efficiency biomass boilers can be dramatically higher than carbon emissions from fossil fuels.

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[89] Abt, R.C, et al. 2010. The near-term market and greenhouse gas implications of forest biomass utilization in the Southeastern United States. Duke University, Durham, NC.

[90] Nave, L.E.; Vance, E.D.; Swanston, C.W.; Curtis, P.S. 2010. Harvest impacts on soil carbon storage in temperate forests. Forest Ecology and Management. 259: 857-866.

4. Use of Land-Clearing Wood and Construction Demolition Wood as Biomass Fuel

The premise behind most arguments that biomass is a low-carbon technology is that since biomass materials grow back and resequester carbon, their combustion is net carbon neutral over some timeframe. The Manomet study concluded that even actively growing forests take decades to regrow the carbon removed by harvest. Burning "waste" wood – that is, wood from land-clearing, and construction and demolition debris – cannot also be carbon neutral. Credible life-cycle analysis may not be possible for such wood, and in fact, its use as biomass fuel may displace other uses, ultimately causing "leakage" effects. For instance, to the extent that land-clearing wood was being used for firewood, its use as fuel at biomass facilities may cause firewood harvesting to increase elsewhere.

5. Methane Emissions

i. Methane from Decomposition of Forest Wood

The biomass industry often argues that using waste wood as fuel actually emits less greenhouse gases than leaving it decompose, because decomposition emits methane, a greenhouse gas with a higher global warming potential than the carbon dioxide produced during burning. This argument is flawed, however. First, the methane cycle is mediated not only by methanogens (bacteria that produce methane) but also methanotrophs (bacteria that consume methane). The net flux of methane is a product of these competing processes, and the flux is not large in most soils. While wetlands can be significant methane sources due to their anaerobic conditions, there is no evidence that decomposing tops and branches from forestry activities, which are primarily cut in upland areas, are a significant source of methane production. Bacterial methane production in upland environments is not even considered important enough to be included in EPA's listing of methane sources, (http://epa.gov/methane/sources.html), which focuses on methane production in wetlands.

Arguments that burning wood that would otherwise be landfilled prevents significant methane evolution also appear to be largely overstated. A review[91] of several studies on methane production from landfilled wood found wide agreement that methane emission rates were relatively low; the study estimated that maximally only 30% of the carbon from paper and 0 – 3% of the carbon from wood are ever emitted as landfill gas, concluding that "US landfills serve as a tremendous carbon sink, effectively preventing major quantities of carbon from being released back into the atmosphere." EPA's own data from the national greenhouse gas inventory supports this general conclusion (Table 2), estimating that solid waste disposal sites (SWDS) represent a greater annual carbon sink than do harvested wood products. Claims that burning waste wood avoids methane emissions therefore need rigorous scrutiny by EPA.

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[91] Micales, J.A. and Skog, K.E. 1997. The decomposition of forest products in landfills. International Biodeterioration and Biodegradation 39:145-158.

TABLE 2: ESTIMATED CARBON FLUX FOR FOREST AND HARVESTED WOOD PRODUCTS, FROM EPA'S INVENTORY OF GREENHOUSE GAS EMISSIONS AND SINKS, 1990 – 2008 (EPA 430-R-10-006).

Table 7-7. Net Annual Changes in C Stocks (Tg C/yr) in Forest and Harvested Wood Pools

Carbon Pool	1990	1995	2000	2005	2006	2007	2008
Forest	**(163.1)**	**(156.6)**	**(96.8)**	**(191.2)**	**(192.0)**	**(192.0)**	**(192.0)**
Aboveground Biomass	(103.0)	(108.6)	(84.4)	(108.3)	(108.3)	(108.3)	(108.3)
Belowground Biomass	(20.3)	(21.6)	(16.8)	(21.5)	(21.5)	(21.5)	(21.5)
Dead Wood	(8.0)	(8.5)	(4.3)	(6.4)	(7.1)	(7.1)	(7.1)
Litter	(12.7)	(7.7)	0.9	(15.2)	(15.2)	(15.2)	(15.2)
Soil Organic C	(19.1)	(10.1)	7.8	(39.8)	(39.8)	(39.8)	(39.8)
Harvested Wood	**(35.9)**	**(32.3)**	**(30.8)**	**(28.7)**	**(29.6)**	**(28.1)**	**(24.0)**
Products in Use	(17.7)	(15.1)	(12.8)	(12.4)	(12.3)	(10.7)	(6.7)
SWDS	(18.3)	(17.2)	(18.0)	(16.3)	(17.3)	(17.4)	(17.3)
Total Net Flux	**(199.0)**	**(188.9)**	**(127.6)**	**(220.0)**	**(221.6)**	**(220.1)**	**(216.0)**

Note: Forest C stocks do not include forest stocks in U.S. territories, Hawaii, a portion of managed lands in Alaska, or trees on non-forest land (e.g., urban trees, agroforestry systems). Parentheses indicate net C sequestration (i.e., a net removal of C from the atmosphere). Total net flux is an estimate of the actual net flux between the total forest C pool and the atmosphere. Harvested wood estimates are based on results from annual surveys and models. Totals may not sum due to independent rounding.

ii. Methane from Wood Chip Piles

Despite proponents of biomass power sometimes claiming that decomposing wood represents a source of methane, and that burning waste wood actually represents mitigation of methane emissions, the actual risk of methane emissions – from decomposition of wood in massive fuel chip piles that can reach over 70 feet in height – has not been examined. Studies have found significantly greater rates of decomposition and mass loss for whole-tree chips than clean, debarked chips, and that piles of whole-tree chips are more prone to spontaneous combustion than clean, debarked chips.[92] Oceanic transport of pellets, which are processed and dried and thus present less risk of fermentation than green chips, has been found nonetheless to sometimes result in dangerously high buildups of toxic gasses during transport. One study found average methane concentrations of 605 ppm in the hold areas of vessels transporting wood pellets.[93] EPA should assess net methane production from chip piles as part of an assessment of net greenhouse gas production from biomass power.

[92] Springer, E. 1980. Should whole-tree chips be dried before storage? USDA Forest Products Laboratory Research Note FPL-0241.

[93] Svedberg, U., et al. 2008. Hazardous off-gassing of carbon monoxide and oxygen depletion during ocean transportation of wood pellets. Annals of Occupational Hygiene, 52:259-266.

IV. Conclusion

We are pleased to provide these comments to EPA. We appreciate EPA's recognition that regulating the emissions of CO_2 from bioenergy feedstocks requires consideration of complex issues and its effort to gather the most up-to-date, scientifically accurate assessments of the CO_2 emissions associated with bioenergy. We look forward to continuing to work with EPA on the development and implementation of bioenergy policies that truly benefit the environment and result in much-needed CO_2 emissions reductions in the near future.

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APPENDIX 1

References for Section II.A., "Bioenergy Accounting: Review of Relevant Research"

Andersen, O., S. Gössling, M. Simonsen, H. J. Walnum, P. Peeters and C. Neiberger (2010). "CO2 emissions from the transport of China's exported goods." Energy Policy **38**(10): 5790-5798.

Anderson-Teixeira, K. J. and E. H. Delucia (2010). "The greenhouse gas value of ecosystems." Global Change Biology **9999**(9999).

Bergsma, G., J. Vroonhof and V. Dornburg (2007). A greenhouse gas calculation methodology for biomass-based electricity, heat and fuels - The view of the Cramer Commission, CE Delft and the University of Utrecht**:** 44. http://www.senternovem.nl/mmfiles/methodologiegreenhousecalculethod_tcm24-239731.pdf.

Christensen, T. H., E. Gentil, A. Boldrin, A. Larsen, B. Weidema and M. Hauschild (2009). "C balance, carbon dioxide emissions and global warming potentials." Waste Management & Research: 0734242X08096304.

Courchesne, A., V. Bécaert, R. K. Rosenbaum, L. Deschênes and R. Samson (2010). "Using the Lashof Accounting Methodology to Assess Carbon Mitigation Projects With Life Cycle Assessment." Journal of Industrial Ecology **14**(2): 309-321.

Delucchi, M. A. (2010). "Impacts of biofuels on climate change, water use, and land use." Annals of the New York Academy of Sciences **1195**: 28-45.

Gentil, E., T. H. Christensen and E. Aoustin (2009). "Greenhouse gas accounting and waste management." Waste Management & Research **27**(8): 696-706.

Guinée, J., R. Heijungs and E. van der Voet (2009). "A greenhouse gas indicator for bioenergy: some theoretical issues with practical implications." The International Journal of Life Cycle Assessment.

Gustavsson, L., T. Karjalainen, G. Marland, I. Savolainen, B. Schlamadinger and M. Apps (2000). "Project-based greenhouse-gas accounting: guiding principles with a focus on baselines and additionality." Energy Policy **28**(13): 935-946.

Hertel, T. W., A. Golub, A. D. Jones, M. O'Hare, R. J. Plevin and D. M. Kammen (2010). "Global Land Use and Greenhouse Gas Emissions Impacts of U.S. Maize Ethanol: Estimating Market-Mediated Responses." BioScience **60**(3): 223-231.

Jacobson, M. Z. (2004). "The Short-Term Cooling but Long-Term Global Warming Due to Biomass Burning." Journal of Climate **17**(15): 2909-2926.

Levasseur, A., P. Lesage, M. Margni, L. Deschénes and R. Samson (2010). "Considering Time in LCA: Dynamic LCA and Its Application to Global Warming Impact Assessments." Environmental Science & Technology.

Luo, L., E. van der Voet, G. Huppes and H. Udo de Haes (2009). "Allocation issues in LCA methodology: a case study of corn stover-based fuel ethanol." The International Journal of Life Cycle Assessment **14**(6): 529-539.

Luyssaert, S., E. D. Schulze, A. Borner, A. Knohl, D. Hessenmoller, B. E. Law, P. Ciais and J. Grace (2008). "Old-growth forests as global carbon sinks." Nature **455**(7210): 213-215.

Marland, G. and B. Schlamadinger (1995). "Biomass fuels and forest-management strategies: How do we calculate the greenhouse-gas emissions benefits?" Energy **20**(11): 1131-1140.

Marland, G. and B. Schlamadinger (1997). "Forests for carbon sequestration or fossil fuel substitution? A sensitivity analysis." Biomass and Bioenergy **13**(6): 389-397.

O'Hare, M., R. J. Plevin, J. I. Martin, A. D. Jones, A. Kendall and E. Hopson (2009). "Proper accounting for time increases crop-based biofuels' greenhouse gas deficit versus petroleum." Environmental Research Letters **4**(2): 024001.

Rabl, A., A. Benoist, D. Dron, B. Peuportier, J. Spadaro and A. Zoughaib (2007). "How to account for CO2 emissions from biomass in an LCA." The International Journal of Life Cycle Assessment **12**(5): 281-281.

Schlamadinger, B., M. Apps, F. Bohlin, L. Gustavsson, G. Jungmeier, G. Marland, K. Pingoud and I. Savolainen (1997). "Towards a standard methodology for greenhouse gas balances of bioenergy systems in comparison with fossil energy systems." Biomass and Bioenergy **13**(6): 359-375.

Schlamadinger, B., N. Bird, T. Johns, S. Brown, J. Canadell, L. Ciccarese, M. Dutschke, J. Fiedler, A. Fischlin, P. Fearnside, C. Forner, A. Freibauer, P. Frumhoff, N. Hoehne, M. U. F. Kirschbaum, A. Labat, G. Marland, A. Michaelowa, L. Montanarella, P. Moutinho, D. Murdiyarso, N. Pena, K. Pingoud, Z. Rakonczay, E.

Rametsteiner, J. Rock, M. J. Sanz, U. A. Schneider, A. Shvidenko, M. Skutsch, P. Smith, Z. Somogyi, E. Trines, M. Ward and Y. Yamagata (2007). "A synopsis of land use, land-use change and forestry (LULUCF) under the Kyoto Protocol and Marrakech Accords." Environmental Science & Policy **10**(4): 271-282.

Schlamadinger, B. and G. Marland (1996). "The role of forest and bioenergy strategies in the global carbon cycle." Biomass and Bioenergy **10**(5-6): 275-300.

Schlamadinger, B. and G. Marland (1999). "Net effect of forest harvest on CO2 emissions to the atmosphere: a sensitivity analysis on the influence of time." Tellus B **51**(2): 314-325.

Searchinger, T., R. Heimlich, R. A. Houghton, F. Dong, A. Elobeid, J. Fabiosa, S. Tokgoz, D. Hayes and T.-H. Yu (2008). "Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land Use Change." Science **319**(5867): 1238-1240.

Searchinger, T. D., S. P. Hamburg, J. Melillo, W. Chameides, P. Havlik, D. M. Kammen, G. E. Likens, R. N. Lubowski, M. Obersteiner, M. Oppenheimer, G. Philip Robertson, W. H. Schlesinger and G. David Tilman (2009). "Fixing a Critical Climate Accounting Error." Science **326**(5952): 527-528.

Stoft, S. (2010). Renewable fuel and the global rebound effect. Berkeley, Global Energy Policy Center**:** 19. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1636911.

van der Voet, E., R. J. Lifset and L. Luo (2010). "Life-cycle assessment of biofuels, convergence and divergence." Biofuels **1**: 435-449.

Walker, T., P. Cardellichio, A. Colnes, J. Gunn, B. Kittler, B. Perschel, C. Recchia and D. Saah (2010). Biomass sustainability and carbon policy study. Brunswick, Maine, Manomet Center for Conservation Sciences**:** 182.

Weber, C. L. and H. S. Matthews (2007). "Embodied Environmental Emissions in U.S. International Trade, 1997-2004." Environmental Science & Technology **41**(14): 4875-4881.