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Is Biopower Carbon Neutral?

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February 19, 2015

Congressional Research Service

7-5700

www.crs.gov

R41603

Summary

To promote energy diversity and improve energy security, Congress has expressed interest in biopower—electricity generated from biomass. Biopower, a baseload power source, can be produced from a large range of biomass feedstocks nationwide (e.g., urban, agricultural, and forestry wastes and residues). The two most common biopower processes are combustion (e.g., direct-fired or co-fired) and gasification, with the former being the most widely used. Proponents say biopower has the potential to strengthen rural economies, enhance energy security, and minimize the environmental impacts of energy production. Challenges to biopower production include the need for a sufficient feedstock supply, concerns about potential health impacts to nearby communities, and its higher generation costs relative to fossil fuel-based electricity. At present, biopower generally requires tax incentives to be competitive with conventional fossil fuel-fired electric generation.

The legislative record shows minimal debate about the carbon status of biopower. An energy production activity typically is classified as carbon neutral if it produces no net increase in greenhouse gas (GHG) emissions on a life-cycle basis. The argument that biopower is carbon neutral has come under scrutiny in debate on its potential to help meet U.S. energy demands and reduce U.S. GHG emissions. Whether biopower is considered carbon neutral depends on many factors, including the definition of carbon neutrality, feedstock type, technology used, and time frame examined. Carbon flux (emission and sequestration) varies at each phase of the biopower pathway, given site- and operation-specific factors. A life-cycle assessment (LCA) is a common technique to calculate the environmental footprint, including the carbon flux, of a particular biopower pathway. However, past legislation would not have required a standardized LCA for biopower.

The carbon-neutral status of biopower may be of concern to stakeholders, especially if Congress expands support for biopower. Questions such as where the feedstock supply for biopower originates, if it is managed in a sustainable manner, and whether the associated air-quality impacts from biopower generation are tolerable are part of the biopower carbon-neutrality debate. Congress may decide whether the current carbon-neutral designation for biopower is accurate or whether additional carbon accounting for biopower is warranted and what impact this accounting might have on renewable energy, agricultural, and environmental legislative goals.

Two recent actions by the executive branch—the U.S. Environmental Protection Agency’s (EPA’s) proposed standards for GHG emissions from existing fossil-fueled power plants (i.e., the Clean Power Plan) and EPA’s proposed framework to account for emissions of biogenic carbon dioxide (CO₂) from stationary sources—could focus attention on biopower’s carbon neutrality. The Clean Power Plan establishes state-specific CO₂ emission rate targets, measured in pounds of CO₂ per megawatt-hour of electricity. It uses four building blocks to establish the emission rate targets, which could include the use of biomass-derived fuels at affected electric generating units. In November 2014, EPA released its second biogenic accounting framework. The framework addresses some of the EPA Science Advisory Board’s recommendations from the first framework released in 2011, including the finding that “carbon neutrality cannot be assumed for all biomass energy a priori.” EPA acknowledges that the framework is an analytical methodology and that some stakeholders may consider it a precursor to how EPA may treat biogenic emissions in both the Clean Power Plan and the Prevention of Significant Deterioration program. However, EPA reports that it “has not yet determined how the framework might be applied in any particular regulatory or policy contexts or taken the steps needed for such implementation.”

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Introduction

Biomass energy, or bioenergy, may receive more attention from stakeholders as an alternative to fossil fuels because of its potential to minimize the environmental impacts of energy production, provide energy security, and promote economic development. Biomass is organic matter—woody biomass, agricultural biomass, animal wastes, and aquatic biomass—that can be converted to energy (e.g., heat, electricity, or liquid transportation fuels).¹ Thus far, the federal government has given legislative support for one form of bioenergy, biopower (electricity generated from biomass, such as paper mill residue used to generate power),² without considering its carbon status. As federal and state governments and others dedicate more resources to biopower, these same government agencies, along with environmentalists, biomass feedstock producers, and others are paying more attention to the biopower carbon-neutrality issue. The carbon-neutral designation typically is assigned to an energy-production activity that essentially produces no net increase in greenhouse gas (GHG) emissions on a life-cycle basis (or one that absorbs the amount of carbon dioxide emitted during the power-production cycle).³ Where biopower stands among the other renewable energy sources with respect to GHG emissions may affect the level of future legislative support granted to it.

Many views exist about whether biopower is carbon neutral and how its net carbon status is determined. Some biomass feedstock producers and biopower generators, among other stakeholders, contend that biopower is carbon neutral because the carbon released during bioenergy production comes from a carbon-neutral feedstock—biomass. Some environmentalists, among others, argue that biopower is not carbon neutral because the amount of GHG emissions released per unit of energy during simple biopower combustion may be higher for certain biomass fuels than for fossil fuels or because, even if the GHG emissions from certain biomass fuels are lower than those from fossil fuels, they are still not zero. Stakeholders often base their perspectives on differing assumptions, technologies, and time frames.

The debate concerning biopower's designation as carbon neutral may intensify, given possible congressional and Administration decisions. Congress may consider legislation involving biopower (e.g., under renewable energy and clean energy assistance, energy efficiency, and GHG emission reduction policy). Additionally, biopower production may receive increased attention due to executive branch actions, such as the U.S. Environmental Protection Agency's (EPA's) proposed standards for GHG emissions from existing fossil-fueled power plants (e.g., the Clean Power Plan)⁴ and EPA's proposed framework to account for emissions of biogenic carbon dioxide (CO₂) from stationary sources.

¹ For more information on biomass, see CRS Report R40529, *Biomass: Comparison of Definitions in Legislation*, by Kelsi Bracmort.

² Biopower is a baseload power source offering *firm* power without the need for power storage. Combustion—the burning of biomass in a power plant—is the dominant technology used to produce biopower.

³ The life cycle of a bioenergy pathway includes all stages of fuel and feedstock production and distribution, from feedstock generation or extraction through distribution, delivery, and use of the finished fuel by the ultimate consumer. The mass values for all greenhouse gases (GHGs) are adjusted to account for their relative global warming potential.

⁴ For more information, see CRS Report R43572, *EPA's Proposed Greenhouse Gas Regulations for Existing Power Plants: Frequently Asked Questions*.

This report discusses some factors taken into account when considering whether biopower is carbon neutral. It does not discuss carbon accounting for other bioenergy pathways.⁵

Biomass Carbon Cycle

The carbon cycle encompasses the many pathways through which carbon is exchanged between the atmosphere and the land and water.⁶ Human activities (also called *anthropogenic activities*) contribute to the carbon cycle by emitting CO₂. The human contribution of CO₂ to the carbon cycle is relatively small compared to other contributions, but CO₂ released to the atmosphere from human activities is taken up by soils, vegetation, and the ocean at a rate that is relatively slower than the rate at which human activities are emitting CO₂. If the excess carbon is not stored in land and ocean sinks, the atmospheric concentration of CO₂ increases, potentially impacting the Earth's climate.

One significant anthropogenic source of CO₂ in the carbon cycle is energy production. The net effect of an energy activity on the carbon cycle can be classified in one of three ways. A *carbon-positive* activity releases CO₂ into the atmosphere. A *carbon-negative* activity removes more CO₂ from the atmosphere than it emits. A *carbon-neutral* activity is one in which the CO₂ release and absorption are in balance. No commonly accepted definition for a carbon-neutral activity exists in the biopower arena. Those involved with bioenergy have put forth multiple assertions about carbon neutrality, including the following:⁷

- Biomass energy is carbon neutral because biomass is naturally carbon neutral. The premise is that if biomass is carbon neutral, then any product resulting from its use is also carbon neutral.
- Biomass energy is carbon neutral if growing the biomass removes as much CO₂ as is emitted into the atmosphere from its combustion.
- Biomass energy is carbon neutral only if the net life-cycle emissions are zero.⁸ Emissions include the emissions from the cultivation, harvest, and transportation of the biomass, as well as from its combustion.
- Biomass energy is carbon neutral if it achieves lower net increases in atmospheric GHGs when compared to alternative energy activities.

Each assertion raises issues. For instance, declaring that biomass energy is carbon neutral because biomass is naturally carbon neutral does not account for GHG emissions released due to management of crops grown for energy production (e.g., fertilizer). In addition, there may need to

⁵ Congress addressed carbon accounting for another major bioenergy pathway—liquid transportation biofuels—with a life-cycle emission analysis (a requirement within the Renewable Fuel Standard). For more information, see CRS Report R40460, *Calculation of Lifecycle Greenhouse Gas Emissions for the Renewable Fuel Standard (RFS)*, by Brent D. Yacobucci and Kelsi Bracmort.

⁶ Carbon is an elemental building block of molecules that make up all organisms on Earth. Carbon cycling is the process by which living things absorb carbon from the atmosphere, carbonate rocks and ocean deposits, dead organic matter in the soil, or food and return it to the atmosphere or soil by respiration, combustion, or decay.

⁷ R. Miner, “Biomass Carbon Neutrality in the Context of Forest-based Fuels and Products,” U.S. Department of Agriculture (USDA) Bioelectricity and GHG Workshop, Washington, DC, November 15, 2010. Some of the definitions are not mutually exclusive.

⁸ A life-cycle assessment (LCA) accounts for the GHG emissions from bioenergy production. The LCA is further discussed in “Greenhouse Gas Emission Accounting for Biopower Production,” below.

be additional plantings of certain biomass feedstocks to remove the CO₂ emitted from biomass cultivated for energy production.

The carbon cycles for a bioenergy system and a fossil fuel system differ in at least two ways: the carbon source (finite versus renewable) and the atmospheric carbon concentration (potentially stable versus additional; see **Figure 1**). Three main factors contribute to the amount of carbon emitted from biopower generation: feedstock production (cultivation and harvest), feedstock transport, and the biopower technology type. However, as noted by many sources, feedstock production also absorbs carbon during growth.

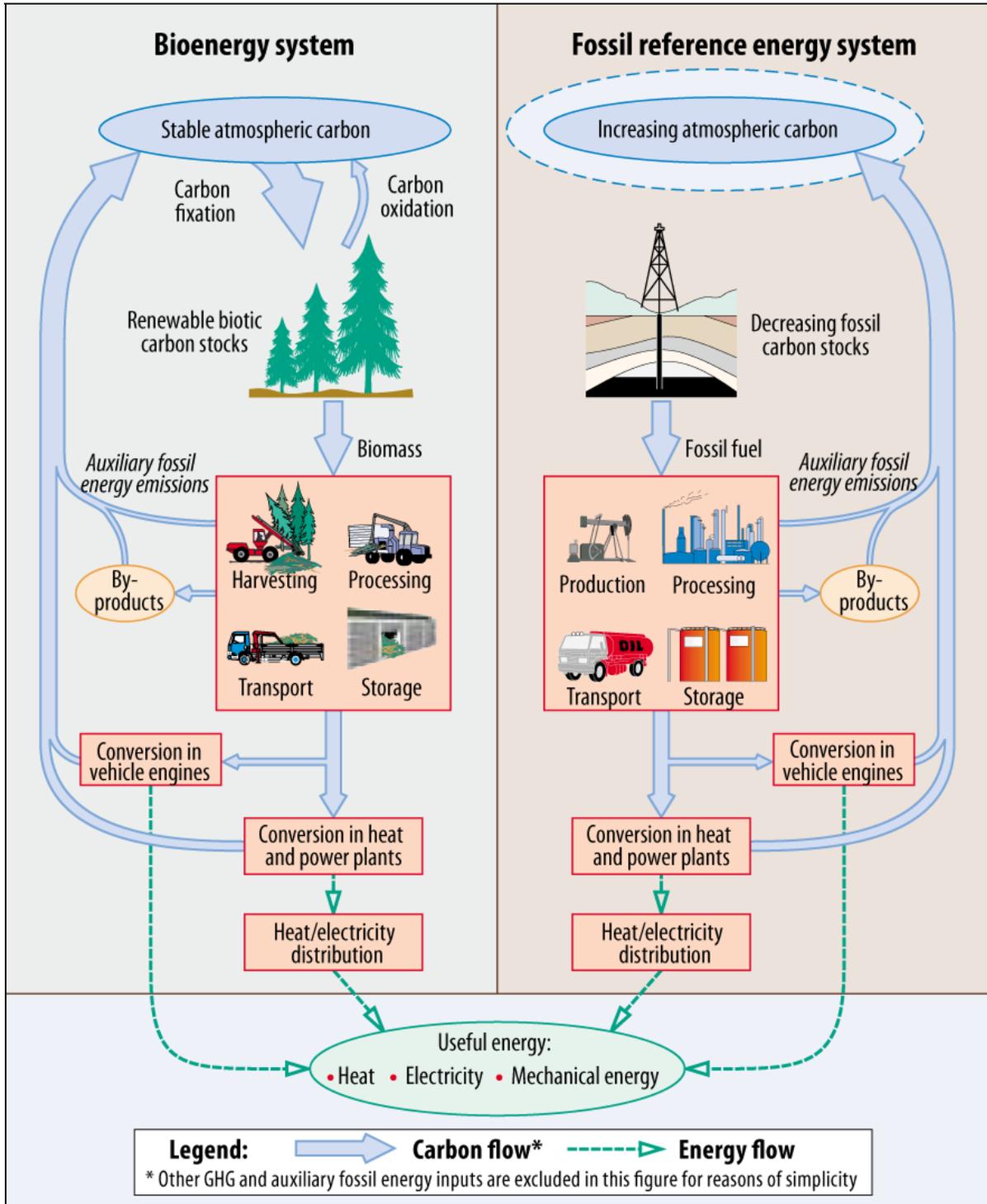
Greenhouse Gas Emission Accounting for Biopower Production

Whether and how to conduct GHG emission accounting for biopower are issues that have been under consideration for the last few years. GHG emission accounting can be used to compare the environmental footprint of a biopower operation with that of a conventional fossil fuel operation (e.g., electricity from coal or natural gas).⁹ A life-cycle assessment (LCA) is one method to calculate the environmental footprint. The LCA is an analytic method for identifying, evaluating, and comparing the environmental impacts of emissions and the resource depletion associated with a specific process.¹⁰ An LCA generally uses observed data and assumptions to model what GHGs are being released at each phase of the process. Ideally, an LCA would encompass economic and social factors for a more comprehensive assessment (e.g., job growth, poverty). However, most LCAs focus exclusively on emissions and fossil fuel consumption. An LCA can be one element used in assessing a preferred energy approach, along with cost and performance data. In some cases, even if LCA results favor a particular approach, an LCA alone might not be the deciding factor when choosing an energy process; financial objectives, policy goals, and other factors may influence which approach is selected.

⁹ For the purposes of this report, greenhouse gas emission accounting refers to methods used to compute the GHGs emitted from one or more stages of biopower production. Further carbon flux, or GHG flux, refers to the total greenhouse gas emitted or sequestered at particular stages of the biopower production process.

¹⁰ National Renewable Energy Laboratory, *Energy Analysis*, October 2010, at http://www.nrel.gov/analysis/tech_bio_analysis.html. For more information on life-cycle assessments, see U.S. Environmental Protection Agency (EPA), *Life Cycle Assessment: Principles and Practice*, EPA/600/R-06/060, Cincinnati, OH, May 2006.

Figure 1. Bioenergy CO₂ Balance vs. Fossil Fuel CO₂ Balance

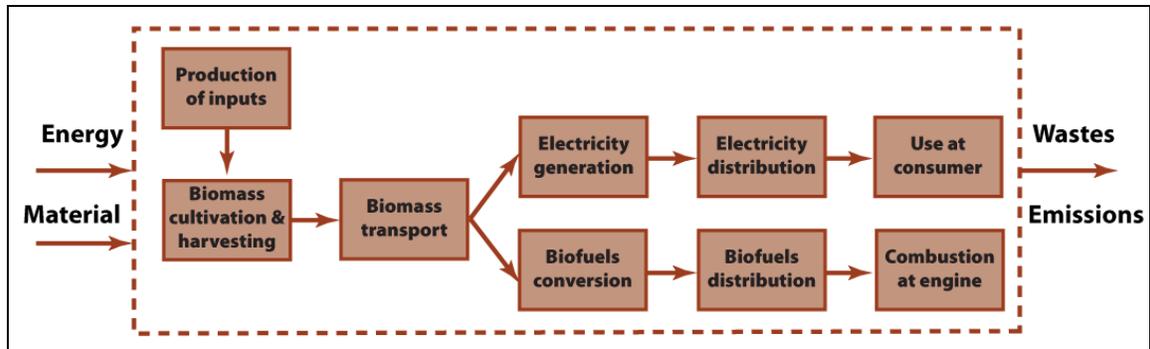


Source: International Energy Agency (IEA), IEA Bioenergy Task 38, *Greenhouse Gas Balances of Bioenergy and Bioenergy Systems*, 2002. Adapted by the Congressional Research Service (CRS).

Notes: The magnitude of the carbon flows, as indicated by the width of the arrows, is a significant part of the debate over the carbon neutrality of bioenergy.

GHG accounting with an LCA can be performed at each phase of the biopower pathway: biomass cultivation and harvest, biomass transport, electricity generation, electricity transmission and distribution, and electricity end use (see **Figure 2**). The first three phases of the biopower pathway (cultivation and harvest, transport, and electricity generation) are where the bulk of GHG emissions occur. GHG flux during the first three phases is site and operation specific and depends on many factors, including the biomass type, management strategies, and biopower generation technology.

Figure 2. Biopower and Biofuel Pathways



Source: Q. Zhang, K.R. Goldstein, and J.R. Mihelcic, "A Review of Life Cycle Assessment Renewable Energy Derived from Forest Resources," in *Renewable Energy from Forest Resources in the United States*, ed. B. D. Solomon, C. A. Luzadis (New York: Routledge, 2009). Adapted by CRS.

Published LCAs for biopower are limited and, as noted above, may not be applicable to specific cases.¹¹ The LCAs performed often are tailored to one feedstock and one biopower technology type, and LCA results vary depending on assumptions such as the time frame of the assessment.¹² The LCA time frame can be long (e.g., cradle to grave) or relatively short (e.g., cradle to gate).¹³ Different LCA time frames can lead to radically different, even contradictory, results. The majority of biopower LCAs were completed for two biopower technology types: combustion and gasification. Both technologies have strengths and weaknesses.¹⁴ The technology to co-fire (or combust) biomass with coal is available at commercial scale and is in use today. Gasification technology is in the development and demonstration phase.¹⁵

Although biopower LCAs are scarce compared to liquid transportation biofuel LCAs, certain trends appear in existing assessments. For instance, the National Renewable Energy Laboratory (NREL) reviewed and analyzed 57 biopower LCAs. The NREL review shows that biopower

¹¹ Most LCAs for bioenergy have focused on GHG emissions from biomass used for liquid transportation fuels and its impact on climate.

¹² For more information on biopower LCAs, see Electric Power Research Institute, *Literature Review and Sensitivity Analysis of Biopower Life-Cycle Assessments and Greenhouse Gas Emission*, January 2013.

¹³ A cradle-to-grave time frame generally includes all phases from feedstock production to energy end use. A cradle-to-gate time frame generally includes a fraction of the complete biopower pathway and may include feedstock production, feedstock cultivation, feedstock transport, and electricity generation.

¹⁴ D. Peterson and S. Haase, *Market Assessment of Biomass Gasification and Combustion Technology for Small- and Medium-Scale Applications*, U.S. Department of Energy National Renewable Energy Laboratory (NREL), NREL/TP-7A2-46190, July 2009, at <http://www.nrel.gov/docs/fy09osti/46190.pdf>.

¹⁵ Some gasification plants are starting to come on-line. For example, the PHG Energy waste-to-energy gasification plant in Tennessee began operating in 2013 and can process up to 12 tons of waste per day.

reduces GHG emissions when compared with fossil-based generation of electricity.¹⁶ Elsewhere, some members of the academic community reviewed more than 25 LCAs. They determined that biopower is in the top tier of bioenergy pathways that avoid the most GHG emissions and replace the largest amounts of fossil energy.¹⁷ Approximately 15 of the LCAs reviewed included electricity as an end product, of which at least 10 had an LCA time frame of when the feedstock was extracted to when the biopower was produced (e.g., cradle to gate).

There is an ongoing discussion about the foundation and underlying assumptions of LCAs, GHG modeling, and other methodologies used to evaluate the carbon impact of bioenergy.¹⁸ Some members of the academic community assert that the methodologies do not sufficiently address land use (e.g., land available to satisfy energy, food, and feed needs) and incorrectly account for biomass (e.g., double counting biomass). They contend that some biofuel systems and fossil fuel systems may not be compared easily using some of the methodologies that exist, among other concerns.¹⁹ Others maintain that some of these issues have been addressed, specifically that land-use concerns stem from multiple factors, not just bioenergy, that increased productivity (e.g., rising crop yields) must be considered when discussing global food and feed requirements, and that crops used for bioenergy have the ability to naturally re-sequester carbon.²⁰

Recent Developments Affecting Biopower Assessment

Certain actions have kept the biomass carbon-neutrality issue a concern for the bioenergy and environmental communities, among others. Most notable are EPA's proposed standards for greenhouse gas emissions from existing fossil-fueled power plants (e.g., the Clean Power Plan), EPA's 2014 framework for assessing biogenic CO₂ emissions from stationary sources, and EPA's permitting requirements under the Clean Air Act (CAA).²¹

¹⁶ The analysis did not consider land use change. NREL, *Biopower Greenhouse Gas Emissions in the LCA Literature*, October 5, 2011, at <http://lcacenter.org/lcaxi/final/446.pdf>.

¹⁷ Q. Zhang, K. R. Goldstein, and J. R. Miheleic, "A Review of Life Cycle Assessment Renewable Energy Derived from Forest Resources," in *Renewable Energy from Forest Resources in the United States*, ed. Barry D. Solomon, Calerie A. Luzadis (New York: Routledge, 2009). Information regarding the feedstocks, conversion processes, end products, system boundaries, allocation methods, and impact metrics for each LCA is available in Table 8.1.

¹⁸ Although the discussion has primarily centered on biomass used for liquid transportation fuels, these same concerns are applicable to biomass used for any type of energy production, including biopower.

¹⁹ John De Cicco, "The liquid carbon challenge: evolving views on transportation fuels and climate," *WIREs Energy and Environment*, vol. 4 (2015), pp. 98-114; World Resources Institute, *Avoiding Bioenergy Competition for Food Crops and Land*, January 2015.

²⁰ Renewable Fuels Association, "Debunking Searchinger's Doomsday Theories ... Again," press release, January 29, 2015; Global Renewable Fuels Alliance, "World Resources Institute Wrong About Biofuels Impact on Land Use and the Environment," press release, January 30, 2015.

²¹ Many scientists continue to contribute to the discussion by submitting letters to Members of Congress and the EPA. In 2014, more than 90 scientists submitted a letter to EPA urging the agency to base its regulations for stationary sources of biogenic emissions (e.g., biopower plants) on sound science "by putting in place a system that links emitter behavior directly to what's happening on the landscape and rigorously assesses the incremental carbon emissions impacts of bioenergy production." Cary Institute of Ecosystem Studies, "Scientists nationwide call on EPA to create scientifically strong pollution standards for biomass energy," press release, June 19, 2014.

Clean Power Plan Proposed Rule

In June 2013, President Obama issued a Climate Action Plan. As part of the plan, EPA was directed to propose standards for “carbon pollution” (i.e., CO₂, the principal GHG) from existing power plants by June 2014 and to finalize the standards by June 2015.²² In June 2014, EPA released the proposed rule, referred to as the Clean Power Plan (CPP).²³ The CPP establishes state-specific CO₂ emission rate targets, measured in pounds of CO₂ emissions per megawatt-hour of electricity.²⁴ Under the proposal, states have the flexibility to determine how to reduce their emission rates, which could include the use of biomass-derived fuels at electric generating units. EPA reports that it is working to “define a clear path” for states to include biomass. EPA asserts it will look to its accounting framework for assessing emissions from biogenic sources, once finalized, as a resource on how to do so.²⁵

EPA completed an evaluation of several GHG abatement measures to determine their national CO₂ reduction potential for the proposed rule, including an analysis for biomass co-firing.²⁶ EPA concluded that, given the parameters of its analysis, biomass co-firing may result in stack CO₂ emission increases and that biomass co-firing for CO₂ emission reductions can be relatively costly when compared with other measures. It is not clear what impact future federal and state policy and program decisions (e.g., biomass eligibility requirements, tax incentives, clean energy standards) would have on making biomass co-firing a more economically attractive option for GHG emission reduction using EPA’s evaluation method.

Framework for Assessing Biogenic CO₂ Emissions from Stationary Sources

EPA released two draft frameworks—the first in 2011 and the second in 2014—that establish a process to evaluate and account for GHGs associated with the use of biomass to produce energy at stationary sources (e.g., biopower).²⁷ The frameworks indicate how EPA may treat bioenergy for the programs and regulations within its domain. In addition to seeking public comment about the framework, EPA entrusts its Science Advisory Board (SAB) with conducting an independent review of each framework.

The 2014 framework addresses some of the SAB recommendations and stakeholder comments from the 2011 framework. The framework focuses on carbon flux corresponding to three stages of bioenergy production: (1) feedstock growth and harvest; (2) processing, transport, storage, and

²² Executive Office of the President, *The President’s Climate Action Plan*, June 2013. The President’s Climate Action Plan reiterates the Obama Administration’s focus on reducing carbon pollution from power plants, which has included and is likely to continue to involve biopower, among other renewable electricity-generation sources.

²³ EPA, “Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units,” Proposed Rule, 79 *Federal Register* 34830, June 18, 2014.

²⁴ For more information on the proposed rule, see CRS Report R43572, *EPA’s Proposed Greenhouse Gas Regulations for Existing Power Plants: Frequently Asked Questions*, by James E. McCarthy et al. and CRS Report R43652, *State CO₂ Emission Rate Goals in EPA’s Proposed Rule for Existing Power Plants*, by Jonathan L. Ramseur.

²⁵ The accounting framework is described in “Framework for Assessing Biogenic CO₂ Emissions from Stationary Sources.”

²⁶ EPA, *Clean Power Plan Proposed Rule: GHG Abatement Measures*, June 10, 2014.

²⁷ EPA, *Accounting Framework for Biogenic CO₂ Emissions from Stationary Sources*, September 2011; EPA, *Framework for Assessing Biogenic CO₂ Emissions from Stationary Sources*, November 2014.

use of a biogenic feedstock at the stationary source; and (3) the possible alternative fate of biogenic feedstock materials if not used for bioenergy. In preparing the 2014 framework, EPA reports that it considered information that “supports the finding that use of waste-derived feedstocks and certain forest-derived industrial byproducts are likely to have minimal or no net atmospheric contributions of biogenic CO₂ emissions, or even reduce such impacts, when compared with an alternate fate of disposal.”²⁸ EPA acknowledges that the 2014 framework is an analytical methodology and that some stakeholders may consider the framework a precursor to how EPA treats biogenic emissions for both the proposed standards for GHG emissions from existing fossil-fueled power plants and the Prevention of Significant Deterioration program (see “Prevention of Significant Deterioration/New Source Review Program and Title V Greenhouse Gas Permitting Requirements,” below).²⁹ However, EPA reports that it “has not yet determined how the framework might be applied in any particular regulatory or policy contexts or taken the steps needed for such implementation.”³⁰ EPA has requested that the SAB peer review the 2014 framework.³¹

For the 2011 framework, EPA charged the SAB with reviewing and commenting on (1) EPA’s characterization of the science and technical issues relevant to accounting for biogenic CO₂ emissions from stationary sources; (2) EPA’s framework, overall approach, and methodological choices for accounting for these emissions; and (3) options for improving upon the framework for accounting for biogenic CO₂ emissions, among other issues.³² The SAB conducted the independent review of the agency’s 2011 biogenic accounting framework and released its findings in September 2012. These findings included that “carbon neutrality cannot be assumed for all biomass energy a priori.”³³ The SAB acknowledged the “daunting task” of assessing the GHG implications of bioenergy and the “narrow regulatory boundaries” within EPA’s purview that limit the consideration of GHG flux at various points along the bioenergy pathway. The SAB identified multiple factors (e.g., time scale, spatial scale, leakage) that require further assessment by EPA and provided recommendations to revise the biogenic accounting framework. The SAB “found that quantification of most components of the framework has uncertainties, technical difficulties, data deficiencies and implementation challenges.” The SAB recommended an alternative biogenic accounting framework based on feedstock category, region, land management, and prior land use.

²⁸ Letter from EPA, Addressing Biogenic Carbon Dioxide Emissions from Stationary Sources, to Air Division Directors, November 19, 2014.

²⁹ For instance, more than 75 scientists submitted a letter to the EPA administrator expressing concerns about EPA’s proposed treatment of emissions from biomass used to produce energy. Cary Institute of Ecosystem Studies, February 9, 2015.

³⁰ EPA, *Framework for Assessing Biogenic CO₂ Emissions from Stationary Sources*, November 2014.

³¹ EPA reports that the specific elements of the 2014 framework that it wants the Science Advisory Board (SAB) to review are forthcoming. Letter from EPA, Request for Review of Additional Scientific Product, to Science Advisory Board Staff Office, November 19, 2014.

³² The agency’s charge for the SAB, review documents (including the accounting framework), and meeting materials are available at <http://yosemite.epa.gov/sab/sabproduct.nsf/0/2f9b572c712ac52e8525783100704886!OpenDocument&TableRow=2.2#2>.

³³ EPA, *SAB Review of EPA’s Accounting Framework for Biogenic CO₂ Emissions from Stationary Sources*, EPA-SAB-12-011, September 28, 2012.

Prevention of Significant Deterioration/New Source Review Program and Title V Greenhouse Gas Permitting Requirements

The CAA's Prevention of Significant Deterioration (PSD)/New Source Review program requires new or modified major stationary sources to undergo preconstruction review and permitting, including the installation of Best Available Control Technology (BACT) to limit emissions. Title V of the act requires all new and existing facilities that have the potential to emit a GHG pollutant in amounts of 100 tons per year or more to obtain permits.³⁴ In July 2011, EPA decided to defer for a period of three years the application of PSD and Title V permitting requirements for CO₂ emissions from bioenergy and other biogenic stationary sources.³⁵ EPA proposed using the three-year time period to conduct a detailed examination of the science associated with biogenic CO₂ emissions from stationary sources to determine how to treat emissions from biomass-fired and biogenic sources (i.e., charging its Science Advisory Board with reviewing EPA's approach to the assessment of CO₂ emissions from biogenic sources). In 2013, a DC circuit court decision vacated the deferral rule because the rule "cannot be justified under any of the administrative law doctrines [de minimis, one-step-at-a-time, administrative necessity, and absurd results] relied on by EPA."³⁶ Following the decision, the DC circuit court granted a series of motions to extend the deadline for petitioning for rehearing, the last grant extending the deadline to 30 days after the court issues its mandate in a related case now before the court.³⁷ These extensions, however, did not extend the original July 2014 expiration for the deferral period. The practical applications of the court changing its 2013 ruling at this point, well after the deferral period has expired, are unclear and beyond the scope of this report. The court's opinion on the deferral rule "leaves for another day the question whether the agency has authority under the Clean Air Act to permanently exempt biogenic carbon dioxide sources from the PSD permitting program."³⁸

Best Available Control Technologies

EPA noted in the PSD and Title V Permitting Guidance for Greenhouse Gases that it may consider certain types of biomass a *best available control technology* (BACT)³⁹ after taking into account environmental, energy, and economic considerations and state and federal policies that promote biomass for energy-independence and environmental reasons.⁴⁰ EPA provided specific

³⁴ For more information on the Prevention of Significant Deterioration and Title V permits, see CRS Report R41212, *EPA Regulation of Greenhouse Gases: Congressional Responses and Options*, by James E. McCarthy.

³⁵ EPA, "Deferral for CO₂ Emissions From Bioenergy and Other Biogenic Sources Under the Prevention of Significant Deterioration (PSD) and Title V Programs: Final Rule," 76 *Federal Register* 43490, July 20, 2011. Biogenic includes facilities that emit CO₂ from sources originating via biological processes, such as landfills.

³⁶ *Center for Biological Diversity v. Environmental Protection Agency*, 722 F. 3d 401, 412 (DC Cir. 2013).

³⁷ The last grant was on September 19, 2014. The related case now before the court is *Coalition for Responsible Regulation v. EPA*. This case was first decided by the DC circuit in 2012, 684 F.3d 102, then reversed in part by the Supreme Court in 2014 under the name *Utility Air Regulatory Group v. EPA*. The case is now back before the DC circuit, under the original case name, to decide the remaining issues.

³⁸ *Ibid.*

³⁹ A Best Available Control Technology (BACT) is a pollution control standard mandated by the Clean Air Act in PSD areas.

⁴⁰ EPA, *PSD and Title V Permitting Guidance for Greenhouse Gases*, EPA-457/B-11-001, March 2011. The Supreme Court's 2014 decision for the *Utility Air Regulatory Group v. EPA* case exempted biogenic CO₂ sources along with all other CO₂ sources, unless the source is covered by the PSD program due to its emissions of non-GHG emissions, otherwise known as *anyway sources*. The court decision significantly reduces the number of facilities applying for such permits and, thus, possibly in need of a BACT.

guidance on how to consider the unique GHG attributes of biomass as fuel in the BACT selection process.⁴¹ PSD permits require that facilities apply the BACT, but individual states, with EPA guidance, determine BACT on a case-by-case basis.

Considerations for the Regulation of Biogenic CO₂ Emissions

There are some key points to consider about the regulation of biogenic CO₂ sources. First, EPA is in the process of comprehensively assessing the GHG classification for biogenic CO₂ sources (which it is doing with the release of the second framework for assessing biogenic CO₂ emissions). Stakeholders likely will contest in the courts any decision the agency makes regarding these sources, although there is little to no precedent to follow. Second, EPA, thus far, has received no guidance from the courts (or the SAB) about how to proceed regarding whether to exempt biogenic CO₂ sources from PSD requirements or, if so, how to complete such an assessment. The court stopped current practices without offering alternatives. Third, the legal and regulatory struggles over biogenic CO₂ sources reflect a larger issue: Congress's bioenergy policy typically has not included carbon accounting for bioenergy, with an exception for the Renewable Fuel Standard. Thus, it is not clear if Congress would treat biopower differently from other types of power generated from conventional energy and renewable energy sources. Congress's approach thus far has tended at times to focus singularly on a particular bioenergy source (e.g., ethanol), biomass feedstock (e.g., cellulosic), or bioenergy conversion technology (e.g., anaerobic digestion), as opposed to an end result that is desired from a policy standpoint (e.g., the most efficient use of biomass for energy production with the least environmental effects). If EPA is to carry out the bioenergy legal requirements in a timely fashion, it may need better and more explicit direction from Congress. Such direction might include providing EPA with a predetermined amount of time—free of legal intrusions—to resolve issues with stakeholder and public input.

Is Biopower Carbon Neutral? It Depends

Carbon neutrality for biopower is calculated most accurately based on the carbon flux (GHG emission or sequestration) of several parameters over a specified time period. These parameters include at least the following: (1) the feedstock type; (2) the management and procurement of the energy source (in the case of biomass, how the feedstock is managed and harvested); (3) the feedstock transportation method; (4) the energy generation technology; and (5) the time frame to replenish the feedstock. Carbon flux attributed to the management and procurement of biomass feedstock deviates according to the type or mixture of feedstock used. For instance, agricultural biomass entails a different nutrient management plan than woody biomass. GHG emissions may be higher for agricultural biomass due to fertilizer treatments (e.g., nitrous oxide emissions from biofuel-dedicated crops).⁴² Carbon flux also will vary given how the biomass feedstock is harvested. For example, removal of woody biomass (e.g., thinnings) in large quantities may

⁴¹ EPA, *Guidance for Determining Best Available Control Technology for Reducing Carbon Dioxide Emissions from Bioenergy Production*, Washington, DC, March 2011, at <http://www.epa.gov/NSR/ghgdocs/bioenergyguidance.pdf>.

⁴² When agricultural waste is the biomass used for biopower production, some GHG emissions may be attributed to crop cultivation whereby the crop is used for other feed, fiber, and fuel purposes.

reduce carbon, and some methane, emissions on a CO₂-equivalent basis that would have been released if the woody biomass remained in the forest to decompose. Biomass-feedstock transport emits differing amounts of GHGs depending on how far one transports the feedstock and on fossil fuel usage.⁴³ The carbon flux of the biopower generation technology will depend on the type of technology and any emission capture or sequestration.⁴⁴ In addition, the time frame (e.g., 40 years, 100 years) assigned for biomass feedstock replenishment will determine CO₂ sequestration rates to balance out the GHGs emitted during biomass combustion, particularly for woody biomass, as growth periods (rotation ages for the trees) are often measured in decades.⁴⁵

It could be argued that only an LCA for each biopower operation can accurately determine whether biopower generation is carbon neutral. Such an LCA would measure carbon flux for each phase of the biopower pathway and incorporate biomass feedstock replenishment. A standard approach to perform a biopower LCA could ensure uniformity in GHG accounting across the biopower sector. However, multiple LCAs can be expensive and time-consuming to complete.

Biopower's carbon neutrality is a contentious aspect of the bioenergy debate. One reason the topic is so controversial is concern about unsustainable harvests of biomass feedstocks. Some environmentalists, among others, contend that if biopower proceeds with no carbon balance restrictions, it could lead to, for example, large amounts of woody biomass removal for energy production. Another reason for controversy is concern about the air quality of areas surrounding biopower plants. These two concerns—sustainability and air quality—can be, and in some cases already are, addressed through other avenues (e.g., sustainability requirements, air-quality regulations) at the federal and state levels.

Legislative Implications

Legislation with the goals of providing energy independence and security include biopower without considering its carbon status. Recent developments may prompt Congress to further analyze this premise. Carbon neutrality depends in part on the feedstock type, the technology, and the time frame for feedstock replenishment. Biopower can be produced using multiple biomass feedstocks and technologies. Each feedstock and technology has its own environmental footprint. The time frame to analyze carbon neutrality is relevant because it incorporates feedstock replenishment, and thus CO₂ removal rates, and considers technology developments.

To the extent carbon neutrality continues to be a legislative concern, Congress could examine whether the current carbon-neutral assumption for biopower is adequate. Congress may consider if additional carbon accounting for biopower is warranted and what impact this accounting might have on renewable energy, agricultural, and environmental legislative goals. A key contributor to this discussion may be whether decisions concerning biopower made by the executive branch contradict legislative goals set by Congress. A scientific assessment of whether a biopower plant

⁴³ Some stakeholders make the case that feedstock transportation could involve the use of fuels (e.g., ethanol) other than fossil fuels (e.g., diesel or gasoline).

⁴⁴ No commercial carbon capture and sequestration (CCS) projects currently operate. Therefore, CCS is not likely to impact carbon flux at the biopower generation stage in the near term.

⁴⁵ For more information on carbon sequestration in trees, see CRS Report R40562, *U.S. Tree Planting for Carbon Sequestration*, by Ross W. Gorte.

is carbon positive, carbon negative, or carbon neutral may require an analysis, such as an LCA. There are time and economic constraints in conducting an LCA for each biopower operation.

Congress could decide to use existing legislative authorities to address carbon accounting for biopower. Federal environmental regulatory controls exist for the three chief environmental concerns associated with a biopower plant—air quality, use of public land, and water discharges. GHG emissions may be accounted for with federal regulations regarding air quality. In addition, a biopower plant also has to meet state regulatory standards, which in some cases may be stricter than the federal regulatory controls.

A full carbon accounting for biopower could result in slowing the achievement of multiple renewable energy, agricultural, and environmental goals. Alternatively, the carbon-neutrality debate for biopower may lead to requests for carbon accounting of some or all energy ventures—renewable and conventional. Lastly, an ill-defined carbon accounting assessment for biopower may limit public and private investment, feedstock production, and more. Scientists, investors, biomass producers, and others may hesitate to expend time and money on expanding biopower efforts if they are not certain about the future contribution of biopower to U.S. energy and environmental goals.

If Congress chooses to address energy security and GHG emission increases, some stakeholders have argued that these goals could be met through the creation of a national renewable electricity standard (RES) or a clean electricity standard (CES). The mandate of a potential national RES or CES may require substantial quantities of baseload power, which some policymakers and others see as being achieved by using biopower. If biopower is a part of an RES or CES, the carbon-neutrality designation of biopower may need to be reconsidered in response to environmental and sustainability concerns.

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