Classifying biomass as carbon neutral increases greenhouse gas and air pollution emissions under the Clean Power Plan

A summary of Energy Information Administration projections

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Summary

The Senate energy bill (S. 2012) now pending in Congress includes a provision that requires the Environmental Protection Agency (EPA) to ignore carbon pollution from burning forest biomass by classifying it as "carbon neutral." This measure would render bioenergy effectively equivalent to zero-emissions wind and solar energy as a replacement for coal under the Clean Power Plan (CPP). Similar provisions are included in the pending House and Senate Interior Appropriations bills.

Energy Information Administration modeling of Clean Power Plan (CPP) impacts on renewable energy generation and carbon pollution includes a reference case with no implementation of the CPP, and two CPP scenarios – one where biomass energy is classified as carbon neutral, and one where carbon pollution from bioenergy is counted. Because burning biomass in power plants increases smokestack emissions of carbon dioxide per megawatt-hour of electricity (Figure 1), theses differing assumptions affect EIA's modeled projections for bioenergy generation.

We examined EIA's analyses and calculated the additional emissions from bioenergy in EIA's scenarios where the model treats bioenergy as carbon neutral. Our analysis of EIA's scenarios came to the following conclusions.

- Biomass power plant capacity (new standalone plants or coal plants that are re-fired to burn wood) increases by 87 percent when bioenergy is classified as carbon neutral, compared to the reference case and the biomass carbon counts scenario (Figure 2).
- Cumulative bioenergy generation 2017 – 2030 is 498 billion kWh under the carbon neutral scenario, 2.9 percent of coal use; and 175 billion kWh if biomass carbon counts, 1 percent of coal use (Figures 3 and 4).
- The electric power sector emits 830 million metric tonnes (mmt) more carbon pollution between 2017 and 2030 when biomass is classified as carbon neutral, a 3.5 percent increase over the scenario where bioenergy carbon pollution counts (Figure 6). The average annual increase in emissions, 64 mmt, is equivalent to carbon pollution from wildfires in the continental US in 2013.
- The increase in bioenergy does not displace coal use, which is slightly higher under the biomass carbon neutral scenario than the scenario where biomass carbon counts.
- Bioenergy suppresses deployment of solar energy. Solar photovoltaic deployment is 21 percent higher under the biomass carbon counts scenario than the carbon neutral scenario (Figure 5).

- Biomass demand under the carbon neutral scenario would require additional fuel equivalent to clear cutting 6 - 8 million acres of forests.
- Classifying biomass generation as carbon neutral increases power sector soot, smog, and acid rain pollution (Table 1).
- Industrial bioenergy use at paper mills and sawmills is projected hold steady under all scenarios – it is not affected by how biomass carbon is classified (Figure 7).

Biomass power plants emit more carbon pollution per MWh than fossil-fueled plants

While bioenergy advocates promote the idea that biomass is carbon neutral, burning biomass actually increases carbon pollution at the smokestack. Environmental Protection Agency data on power sector carbon emissions[1] show that wood and other biomass-burning power plants typically emit more than 3,000 lb CO_2 per megawatt-hour, 40 – 60 percent more than modern coal plants and 290 percent more than combined cycle natural gas plants.[2] Figure 1 shows representative rates from power plants burning different fuels.

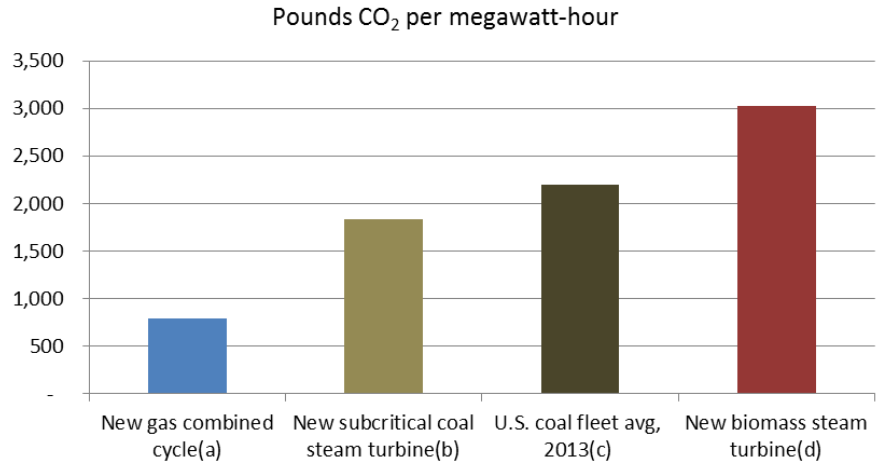

Figure 1 (Multiple sources[3]). Typical CO_2 emission rates from power plants burning fossil fuels and biomass. See footnote 1 for link to EPA data on actual CO_2 emissions at biomass and fossil-fueled power plants.

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[1] EPA data on actual CO_2 emissions at power plants burning biomass, coal, and gas are downloadable at http://www.pfpi.net/wp-content/uploads/2016/09/EPAs-non-cogen-eGRID-data-for-2012.xlsx

[2] Large biomass power plants burning undried wood chips typically operate at around 24% efficiency. The average efficiency of the US coal fleet is about 33%, meaning that per megawatt-hour, biomass plant emissions exceed coal emissions. The discrepancy between biomass plants and the most efficient "supercritical" coal plants can approach 65%.

[3] References and assumptions for Figure 1, "Typical CO_2 emission rates from power plants":

CO_2 emissions per MMBtu heat input:

a, b, c : from EIA at http://www.eia.gov/environment/emissions/co2_vol_mass.cfm. Value for coal is for "all types." Different types of coal emit slightly more or less.

d: Assumes HHV of 8,600 MMBtu/lb for bone dry wood (Biomass Energy Data Book v. 4; Oak Ridge National Laboratory, 2011) and that wood is 50% carbon.

As EPA notes, co-firing biomass in a coal plant can decrease overall facility efficiency,[4] and "*Replacing some coal with low levels of biomass co-firing may result in stack CO_2 increases*."[5]

Some bioenergy advocates assert that biomass can be carbon neutral because plants and trees harvested and burned for energy can eventually grow back, re-sequestering an equivalent amount of carbon as was released by burning the fuel. However, burning fuels produces pollution instantaneously, while offsetting those emissions though regrowth can take several decades, well beyond the CPP's 2030 target date for emissions reductions.[6] Similarly, when "waste" wood is burned as fuel, its eventual decomposition would add carbon to the atmosphere, thus burning this material for energy is not considered to increase net emissions. Again, however, burning is instantaneous, while decomposition takes years to decades. This is a critical point because scientists warn that we must promptly reduce emissions now.

The Energy Information Administration (EIA) used the National Energy Modeling System (NEMS) to examine energy use, renewable energy development, and carbon emissions under the Clean Power Plan. The goal of NEMS is to identify power sector development scenarios that will reduce carbon emissions in a cost-effective way. EIA's modeling included a CPP scenario in which biomass emissions were classified as carbon neutral (labeled in the graphs below as the "CPP Biomass Carbon Neutral" scenario) and a CPP scenario in which the model counts biomass carbon pollution (labeled "CPP

Efficiency of power plants:

a: DOE National Energy Technology Laboratory: Natural Gas Combined Cycle Plant F-Class (http://www.netl.doe.gov/KMD/cds/disk50/NGCC%20Plant%20Case_FClass_051607.pdf)

b: International Energy Agency. Power Generation from Coal: Measuring and Reporting Efficiency Performance and CO_2 Emissions. https://www.iea.org/ciab/papers/power_generation_from_coal.pdf

c. EIA data show the averaged efficiency for the U.S. coal fleet in 2013 was 32.6% (http://www.eia.gov/electricity/annual/html/epa_08_01.html)

d: The Biomass Energy Data Book from Oak Ridge National Laboratory (http://cta.ornl.gov/bedb; page 83) states that actual efficiencies for biomass steam turbines are "in the low 20's"; PFPI's review of a number of air permits for recently proposed biopower plants reveals a common assumption of 24% efficiency.

[4] U.S. Environmental Protection Agency. Documentation for EPA Base Case v.5.13 Using the Integrated Planning Model. Page 5-9. http://www.epa.gov/powersectormodeling/docs/v513/Documentation.pdf

[5] U.S. Environmental Protection Agency. Technical Support Document for Carbon Pollution Guidelines for Existing Power Plants. GHG Abatement Measures, page 6-16. http://www2.epa.gov/carbon-pollution-standards/clean-power-plan-proposed-rule-ghg-abatement-measures

[6] Some references on carbon accounting for bioenergy include:

Walker, T., et al. 2012. Carbon accounting for woody biomass from Massachusetts (USA) managed forests: a framework for determining the temporal impacts of wood biomass energy on atmospheric greenhouse gas levels. Journal of Sustainable Forestry, 32:1-2, 130 – 158; 2010;

Colnes, A., et al. 2012. Biomass supply and carbon accounting for Southeastern Forests. Biomass Energy Resource Center, Montpelier, VT;

Mitchell, S., et al. 2012. Carbon debt and carbon sequestration parity in forest bioenergy production. GCB Bioenergy (2012) doi:10.1111/j.1757-1707.2012.01173.x.

McKechnie et al, 2010. Forest Bioenergy or Forest Carbon? Assessing Trade-Offs in Greenhouse Gas Mitigation with Wood-Based Fuels. Environ. Sci. Technol., 2011, 45 (2), pp 789–795

Domke et al, 2011. Carbon emissions associated with the procurement and utilization of forest harvest residues for energy, northern Minnesota, USA. Biomass and Bioenergy, 36, 141-150.

Biomass Carbon Counted"). We present results from these scenarios, along with EIA's Reference ("No CPP") case, a business-as-usual scenario where the Clean Power Plan is not implemented and biomass is classified as carbon neutral.

The following graphs from EIA data and PFPI's analyses compare the two CPP scenarios and the no CPP scenario. All graphs refer to the electric generation sector,[7] which is the sector regulated under the Clean Power Plan, except for Figure 7, which refers to the "end-use" sector. The end-use sector includes industrial users like paper mills and sawmills that generate on-site heat and power. Such facilities will generally not be regulated under the Clean Power Plan.

Findings

Classifying biomass as carbon neutral under the Clean Power Plan leads to a near-doubling in biomass power plant capacity

EIA projects an 87 percent increase in electric sector biomass power plant capacity under the CPP if biomass is classified as carbon neutral (Figure 2). However, bioenergy buildout under the carbon counts scenario is effectively indistinguishable from the no CPP scenario in the years before 2030.

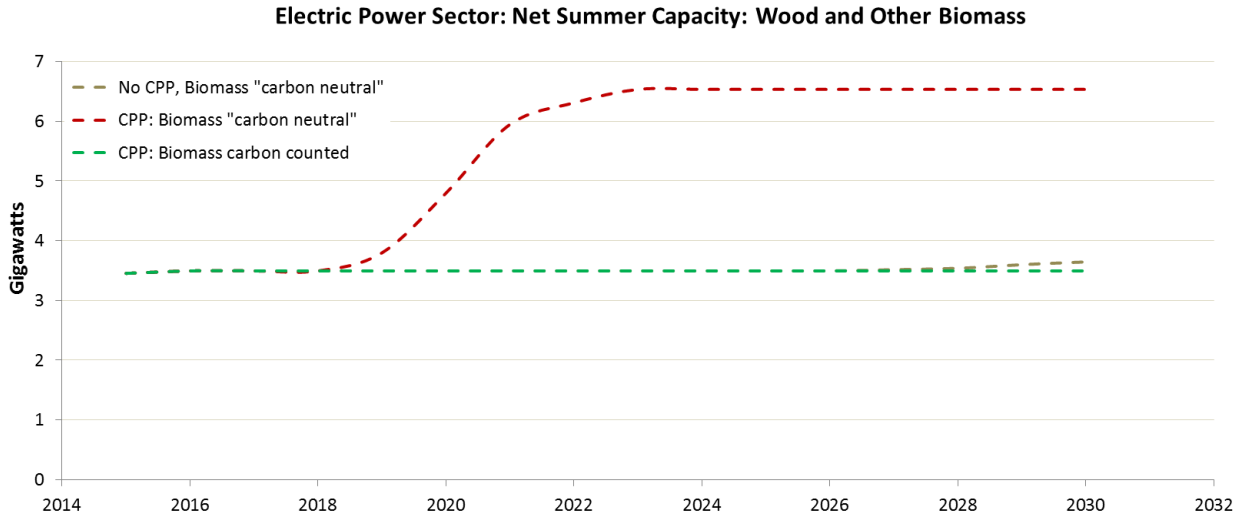

Figure 2 (http://bit.ly/2chcNLu). Biomass capacity significantly increases under the CPP carbon neutral scenario.

This surge in biomass capacity in the power sector consists of "dedicated" wood-burning plants that are generally not associated with manufacturing or other industrial facilities (see Figure 7 for data on the "end use" sector). It could include new biomass power plants and coal plants that are completely re-fired to burn only biomass.

[7] Generally, fossil-fueled power plants of more than 25 MW that produce electricity for sale

Classifying biomass as carbon neutral causes a large increase in electric sector bioenergy generation

Increased bioenergy capacity leads to increased generation at "dedicated" plants (Figure 3). Generation from biomass co-firing at coal plants also increases, but the story is more complicated (Figure 4).

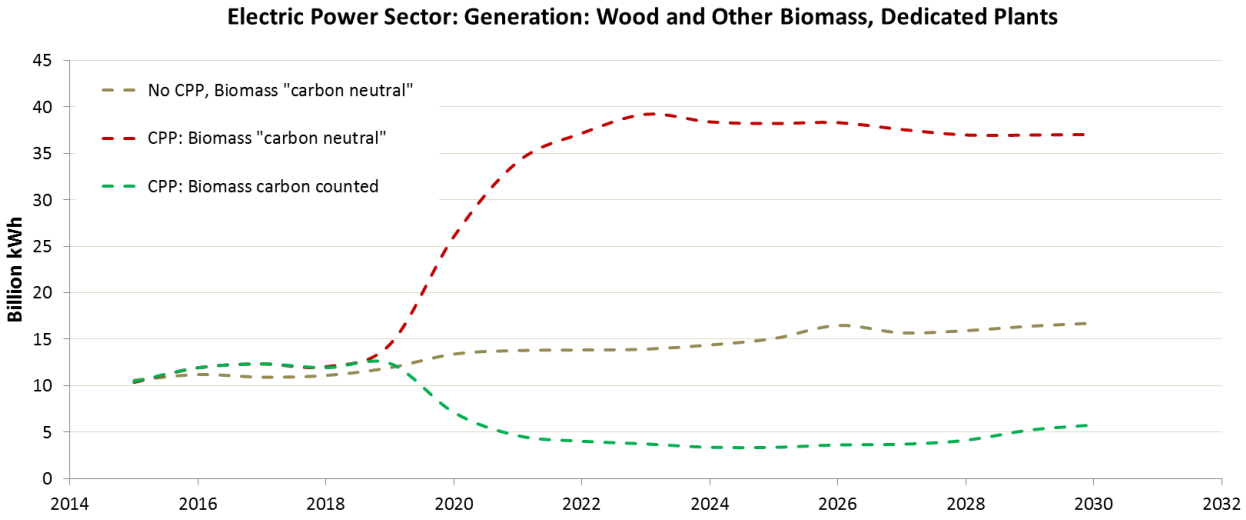

Figure 3 (http://bit.ly/2df5u79**).** Electric sector biomass energy generation at dedicated plants increases significantly under the CPP if biomass is classified as carbon neutral.

Biomass co-firing increases under both CPP scenarios, but less than in the no CPP scenario

While classifying bioenergy as carbon neutral causes bioenergy capacity and generation to increase, biomass co-firing with coal does not increase as steeply as generation at dedicated biomass facilities (Figure 4). Lower projected co-firing under both CPP scenarios compared to the no CPP scenario is a somewhat counter-intuitive result of EIA's modeling. It is likely explained by the relative cost of co-firing compared to other means of reducing emissions from coal combustion. In technical documents released with the Clean Power Plan, EPA provides a detailed treatment of the costs and logistics of biomass co-firing at coal plants, finding

> "*Replacing some coal with low levels of biomass co-firing may result in stack CO_2 increases. Even if biogenic CO_2 emissions are not counted as part of stack emissions, biomass co-firing is a relatively costly approach to CO_2 reductions at existing coal steam boilers when compared to other measures such as heat rate improvements and re-dispatch of generation supply to other existing capacity with lower CO_2 emissions rates*."[8]

[8] U.S. Environmental Protection Agency. Technical Support Document for Carbon Pollution Guidelines for Existing Power Plants. GHG Abatement Measures, page 6-16. http://www2.epa.gov/carbon-pollution-standards/clean-power-plan-proposed-rule-ghg-abatement-measures.

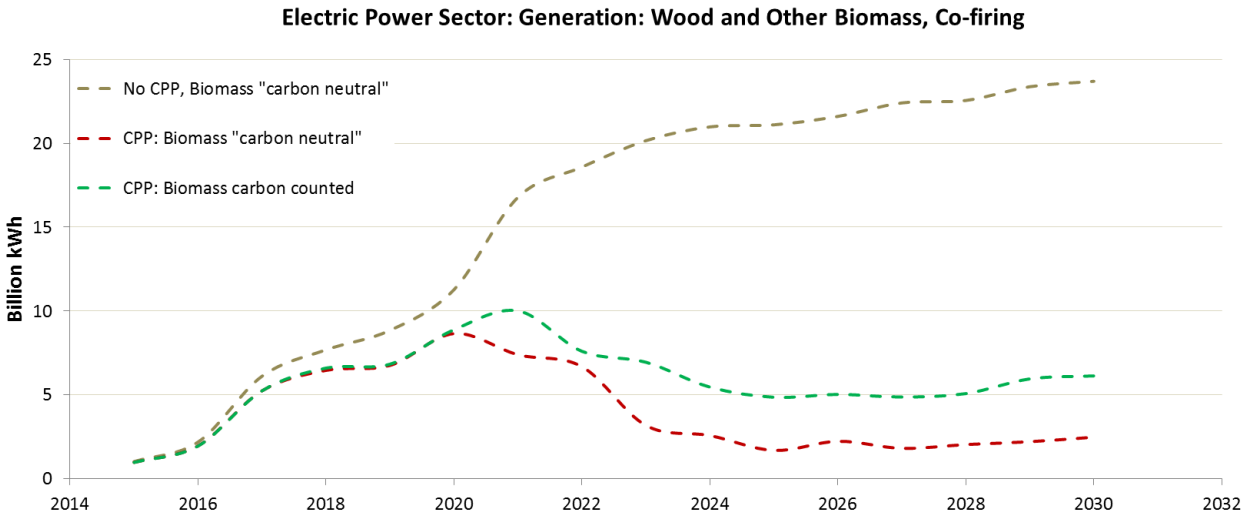

Figure 4 (http://bit.ly/2c5DEdK). Electric sector biomass co-firing increases after 2017 under both CPP scenarios, but the increase is lower than under the reference scenario. Competition for fuel from dedicated biomass plants suppresses biomass co-firing in the CPP scenario where biomass is carbon neutral.

It also seems counter-intuitive that co-firing levels are higher when biomass carbon is counted than when it is not. EIA's response to a query about this was as follows:

> "*When biomass is allowed to count as 'zero emission,' the availability of dedicated biomass as a compliance option creates competition for biomass supplies that would otherwise be used in co-firing operations (although the CPP reduces the number of host plants available for co-firing). However, even when biomass emissions are counted against the CPP emission limits, there is some amount of co-firing that is seen as economic, and doesn't have to compete (as much) with dedicated biomass operations*."[9]

Under the CPP carbon neutral scenario, cumulative biomass generation (billion kWh, 2017 - 2030) from dedicated plants and co-firing in the electric power sector is equivalent is 498 billion kWh, 2.9 percent of cumulative generation from coal over the same period. Under the biomass carbon counts scenario, cumulative generation is 175 billion kWh, 1 percent of coal generation.

Classifying biomass as carbon neutral significantly reduces solar photovoltaic deployment under the Clean Power Plan

Bioenergy is often assumed to displace coal use. However, ignoring carbon pollution from bioenergy in NEMS makes bioenergy functionally equivalent to solar and wind as a compliance option under the

[9] Email from Chris Namovicz, Team Leader for Renewable Electricity Analysis, U.S. Energy Information Administration. September 15, 2016.

CPP, which displaces solar energy, not coal. Counting biomass carbon and building less bioenergy capacity boosts zero-emissions solar photovoltaic capacity by about 21 percent (Figure 5).

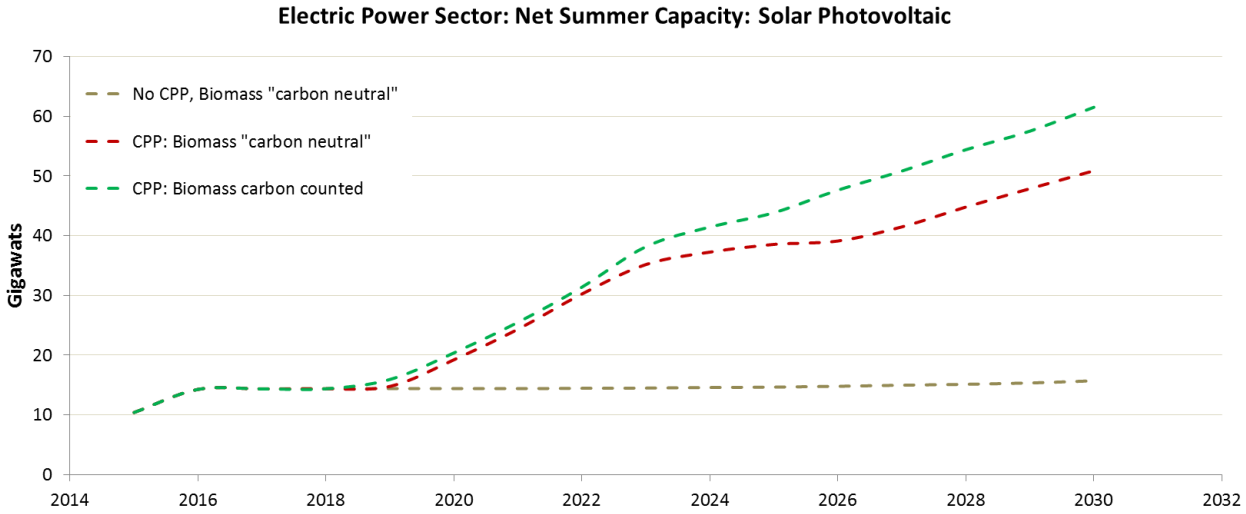

Figure 5 (http://bit.ly/2d4osO9**).** EIA projects an additional 21 percent solar photovoltaic capacity by 2030 in the electric sector when biomass carbon pollution counts.

Total power sector carbon pollution increases when biomass is classified as carbon neutral

EIA may classify bioenergy as having zero emissions, but how much additional carbon pollution actually goes into the atmosphere from the greater amount of biomass that is burned under this scenario? Annual carbon emissions would be approximately 5 percent higher in 2023 and 2024 under the CPP carbon neutral scenario compared to the scenario that counts biomass carbon pollution, and cumulative carbon pollution from 2017 to 2030 is 830 mmt higher, a 3.5 percent increase over the scenario where biomass carbon counts (Figure 6).

We calculate that wood demand for power sector electricity generation from 2017 to 2030 is about 450 mmt greater in the biomass carbon neutral scenario than the biomass carbon counts scenario. Burning one tonne of green wood emits just over one tonne of CO_2,[10] thus stack emissions from higher levels of biomass burning account for 55 percent of the additional 830 mmt of CO_2 emitted under the biomass carbon neutral scenario. The rest of the increase comes from higher coal use, lower deployment of solar photovoltaic, and other cascading effects estimated by the model.

[10] At 45 percent moisture content, a common industry assumption, and assuming wood is 50 percent carbon, burning one tonne of wood emits 1.008 tonnes of CO_2.

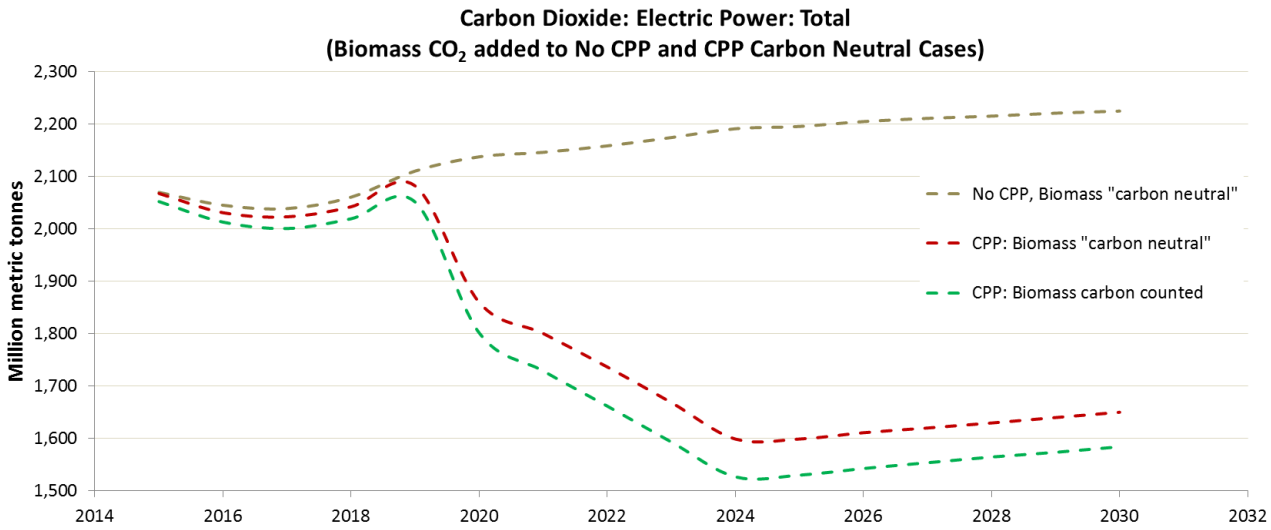

Figure 6 (derived from EIA data and PFPI calculations[11]). Power sector CO_2 emissions, with biomass emissions added to EIA's "reference" (no CPP) and CPP "carbon neutral" scenarios (biomass emissions are included by EIA in the "biomass carbon counted" scenario).

New bioenergy capacity will likely be fueled by wood, with a net increase carbon pollution

Observation of existing trends indicates that wood – and not other forms of biomass – will fuel most new bioenergy capacity. Industrial sources of biomass, such as sawdust and black liquor produced at sawmills and paper mills, are already allocated for energy generation at existing plants or other uses. Agricultural sources of biomass, such as corn stalks and energy crops, are utilized primarily as feedstock for liquid biofuels manufacture, and have not been widely adopted by the biopower sector due to logistical and cost challenges. Of the new biomass power plants that have been proposed and built in recent years, virtually all burn wood as fuel.[12] Some facilities claim to burn forestry "residues," but this term generally includes any wood deemed economic for bioenergy harvesting, including whole trees. Some facilities may burn whole tree chips for a majority of their fuel – for instance, the air permit for Laidlaw Berlin BioPower, a 70 MW plant in New Hampshire, states that the facility burns 113

[11] We estimated biomass CO_2 emissions based on power generation at dedicated biomass power plants and via biomass co-firing with coal, first estimating the amount of wood needed as fuel under EIA's scenarios, then calculating CO_2 emissions based on wood use. When estimating fuel use, we assume that biomass power plants operate at about 24% efficiency, and that coal plants co-firing biomass operate at 33% efficiency (the average of the US coal fleet, which does not take into account the efficiency penalty at coal plants that co-fire biomass and thus may underestimate carbon emissions). Burning one ton of undried wood chips emits just over one ton of CO_2. To estimate actual total power sector emissions for the reference case (no CCP) and CCP carbon neutral scenarios where EIA's modeling ignores biomass emissions, we added our calculated bioenergy emissions to EIA's values for emissions from fossil fuel burning in the power sector. Adding the bioenergy emissions to the rest of power sector emissions permits an apples-to-apples comparison with the EIA scenario that includes bioenergy carbon emissions.

[12] Booth, M.S. Trees, Trash, and Toxics: How Biomass Energy Has Become the New Coal. Partnership for Policy Integrity, April, 2014. http://www.pfpi.net/wp-content/uploads/2014/04/PFPI-Biomass-is-the-New-Coal-April-2-2014.pdf

tons of clean wood chips per hour (more than the standing biomass of an acre of New Hampshire's forest) and that it chips "whole logs" on site.[13]

Meeting the additional 450 mmt tonnes of wood demand under the carbon neutral scenario with forest wood would require the equivalent of clearcutting 6 to 8 million acres of forest; if less wood were cut per acre, the number of acres affected would increase commensurately. This estimate of wood demand actually represents a "floor" because it assumes that all new bioenergy in the U.S. would be provided by burning wood chips. If treatment of biomass as carbon neutral increased the cost-effectiveness of burning manufactured wood pellets, then the amount of wood required, and the concomitant carbon emitted, would increase significantly. It requires about 2.2 tons of green roundwood to make one ton of wood pellets,[14] and manufacturing high-quality pellets requires large-diameter forestry residues and whole trees that can be de-limbed and de-barked.[15] Pellet manufacturing additionally requires fuel-burning and electricity to dry and process the feedstock, processes that emit carbon pollution.[16]

Also not reflected in EIA's projections are *net* atmospheric carbon impacts from burning forest wood as fuel. To the extent that bioenergy demand drives an increase in forest harvesting, this not only increases emissions at the *source*, but also degrades the forest carbon *sink*, increasing the amount of carbon that the atmosphere "sees."

Additional carbon pollution from biomass use will undermine U.S. climate goals

Forest growth and expansion is the only significant carbon sink reported in EPA's annual greenhouse gas accounting, sequestering 742.6 mmt CO_2-equivalent in 2014,[17] or about 11 percent of total U.S. emissions that year.[18] Additional forest harvesting for energy and cascading effects of utilizing bioenergy, including displacement of solar capacity, could undermine the United States' ability to meet its GHG reduction targets under the Paris Climate Accord. The cumulative 830 mmt of additional CO_2 emitted from the power sector 2017 – 2030 under the biomass carbon neutral scenario is on average 64 mmt per year, approximately 9 percent of the annual carbon sequestration provided by forests in 2014. That number is also significant in the context of wildfire emissions. The EPA's 2016 GHG inventory reports wildfire emissions in the contiguous 48 states at 64.7 mmt in 2013[19] – nearly

[13] Air permit issued by the NH Department of Environmental Resources, Air Resources Division, to Laidlaw Berlin BioPower. July 26, 2010. http://www.pfpi.net/wp-content/uploads/2011/06/100726air_permit.pdf

[14] Forisk Wood Bioenergy US report, June/July/August 2014. Vol 6, Issue 3. Page 2.

[15] Booth, M.S. Carbon Emissions and Climate Change Disclosure by the Wood Pellet Industry – A Report to the SEC on Enviva Partners LP. Partnership for Policy Integrity and the Dogwood Alliance, March, 2014. http://www.pfpi.net/wp-content/uploads/2016/03/Report-to-SEC-on-Enviva-March-14-2016.pdf

[16] Ibid.

[17] United States Environmental Protection Agency. 2016. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2014. EPA 430-R-16-002. April 15, 2016. Table ES-5. (Total for "forest land remaining forest land," and "land converted to forest land").

[18] Ibid, Table ES-2.

[19] Ibid, Table 6-13.

identical to the average yearly increase in power sector emissions for 2017 – 2030 under the biomass carbon neutral scenario.

Paris Accord targets of reduced net carbon emissions for the U.S. rely on relatively high rates of carbon sequestration in forests, but there is uncertainty concerning how much carbon is actually sequestered by plants and soils each year. Current accounting may overestimate CO_2 uptake by forests and other terrestrial carbon sinks by up to 300 mmt per year.[20] Additional biomass harvesting for new domestic demand and the millions of tons of dried wood pellets that are shipped internationally contribute to this uncertainty. Forest carbon losses from biomass harvesting are not tracked explicitly under U.S. carbon accounting, nor is carbon pollution from biomass combustion counted in energy sector emissions reporting. Instead, successive forest inventories simply track the difference in forest carbon stocks through time with repeat sampling at permanent sampling plots. An analogy is attempting to evaluate how the amounts of water flowing into and out of a tub are changing by simply observing the depth of the water in the tub at successive points in time. The 2016 GHG inventory shows that forest carbon uptake has decreased somewhat since 2010,[21] and forests in some areas are in decline due to drought, insects, and fire. Increased forest harvesting for biomass reduces the magnitude of the forest carbon sink, but these losses, along with other impacts on forests, can be difficult to track given the imprecision of forest inventory data.

The United States needs carbon pollution reductions beyond existing reduction plans to meet its Paris goals. A recent analysis from the Department of Energy's Lawrence Berkley Laboratory found a yearly gap of 330 mmt between the emission reductions required for the U.S. carbon reduction goals and the cuts already planned.[22] Additionally, experts warn that some planned pollution reductions may not occur. For instance, a recent report estimates that a 500 mmt increase of carbon pollution due to increased truck sales may negate emissions benefits from new vehicle efficiency rules and undermine emission reductions.[23] The 64 mmt of annual additional carbon pollution from uncounted bioenergy carbon pollution from 2017 – 2030 would make reducing actual emissions even more difficult.

Neither CPP scenario affects industrial biomass use

EIA projects that bioenergy generation is effectively the same whether bioenergy carbon is counted or not, and even whether the CPP is enacted or not (Figure 7). Under the CPP, renewable energy generators built prior to 2013 are not eligible to serve as compliance, whether they be wind facilities, biomass burners, or solar arrays. EIA's modeling indicates it is unlikely that new paper mill or sawmill construction is influenced by whether bioenergy carbon is counted, or ignored.

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[20] U.S. Department of State. 2016. Second biennial report of the United States of America under the United Nations Framework Convention on Climate Change. Figure 6. http://unfccc.int/national_reports/biennial_reports_and_iar/submitted_biennial_reports/items/7550.php

[21] U.S. EPA, 2016. Table 6-10.

[22] Greenblatt, J.B, and Wei, M. 2016. Assessment of the climate commitments and additional mitigation policies of the United States. Nature Climate Change, doi:10.1038/nclimate3125. http://www.nature.com/nclimate/journal/vaop/ncurrent/full/nclimate3125.html

[23] "Paris 'Gap,' TAR Findings Could Aid Efforts To Bolster Vehicle GHG Rules." InsideEPA/Climate, July 26, 2016.

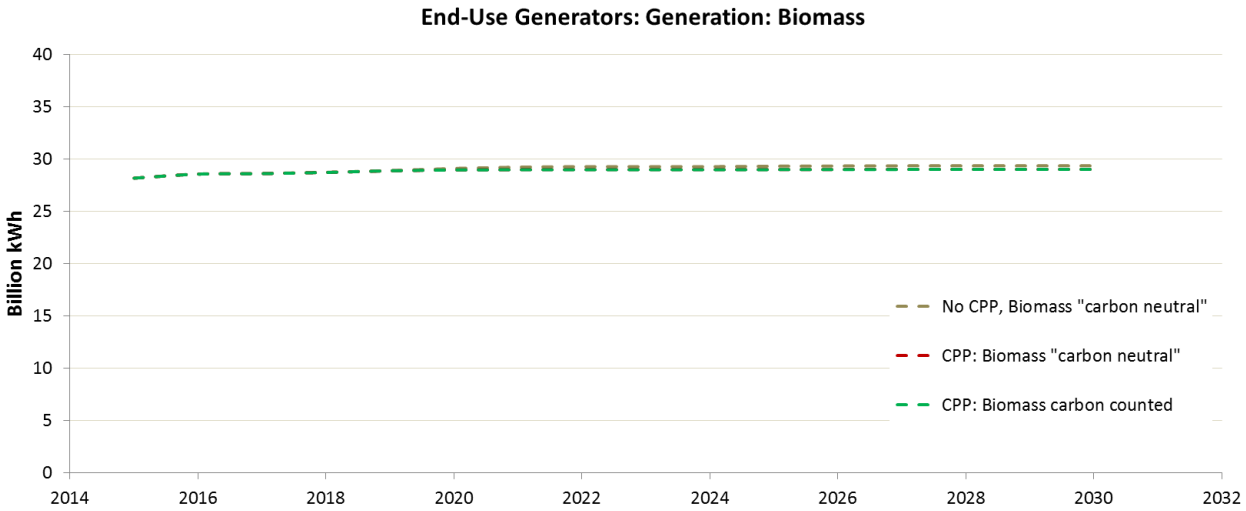

Figure 7 (http://bit.ly/2cNWcRb). End-use generators (e.g., paper mills that burn mill waste to generate power on-site) are unaffected by the Clean Power Plan, and unaffected by classification of biomass carbon.

Classifying biomass as carbon neutral increases particulate matter and nitrogen oxide emissions from bioenergy facilities

EIA data indicates that bioenergy generation will increase if biomass is classified as carbon neutral. Biomass combustion produces pollutants that threaten public health, including particulate matter (soot) and nitrogen oxides, which are important smog precursors. Both pollutants can increase or exacerbate respiratory ailments, and even lead to premature death. We estimate[24] that for 2017 – 2030, biomass burning at dedicated plants under the carbon neutral scenario would emit an additional 75,432 tons of particulates and 326,873 tons of nitrogen oxides above emissions in the carbon counts scenario (Table 1).

Bioenergy emissions of these and other pollutants have led the American Lung Association and allied public health organizations to oppose proposals that would classify biomass combustion as carbon neutral:

> *"Among the most dangerous of these emissions is particulate matter, also known as soot. These particles are so small that they can enter and lodge deep in the lungs, triggering asthma attacks, cardiovascular disease, and even death. Particulate matter can also cause lung cancer. Biomass combustion also creates nitrogen oxide emissions,*

[24] To calculate PM and NOx emissions, we estimated MMBtu heat input to plants (from EIA data on kwh generated and assuming dedicated biomass power plants operate at 24% efficiency). We assumed average rates of PM_{10} emissions at 0.03 lb/MMBtu and NOx emissions at 0.13 lb/MMBtu, based on a survey of 88 air permits for new standalone biomass plants (at http://www.pfpi.net/wp-content/uploads/2014/04/PFPI-Biomass-is-the-New-Coal-April-2-2014.pdf).

which are harmful in their own right and also contribute to the formation of ozone smog and particulate matter downwind. Ground-level ozone pollution can trigger asthma attacks and cause premature death, and newer research shows possible links to reproductive and central nervous system harm."[25]

Particulate matter and Nitrogen Oxide Pollution From Dedicated Biomass Plants in the Electric Power Sector, 2017 - 2030	**PM10 (tons)**	**NOx (tons)**
No CPP reference (biomass C neutral)	42,603	184,612
Clean Power Plan (biomass C neutral)	93,652	405,827
Clean Power Plan (biomass C counted)	18,220	78,954
Additional pollution under CPP biomass "carbon neutral" scenario	75,432	326,873

Table 1 (derived from EIA data). Cumulative particulate matter and nitrogen oxide emissions from dedicated biomass power plants, 2017 – 2030.

Treating biomass as carbon neutral increases emissions of sulfur dioxide and mercury from the power sector as a whole

The highest sulfur dioxide emissions in the bioenergy sector come from pulp and paper mills burning black liquor, a manufacturing residue, and other industrial wastes. However, this analysis focuses on pollution from additional bioenergy generation in the electric power sector, not the end-use sector. We used EIA's NEMS projections of SOx emissions for the power sector *as a whole* to compare emissions from the three scenarios.[26] Although wood-burning power plants generally emit less SOx per megawatt-hour than coal plants, EIA projects that SOx emissions from 2017 to 2030 would increase by 262,100 tons under the CPP scenario that classifies biomass combustion as carbon neutral. This is partly because coal combustion is slightly greater under the biomass carbon neutral scenario (http://bit.ly/2cbTEb0), which is itself due in part to somewhat fewer coal plant retirements (http://bit.ly/2cL8Ihy). Greater coal combustion also contributes to an additional 2,277 pounds of mercury emissions 2017 – 2030 under the biomass carbon neutral scenario.

[25] Available at http://www.pfpi.net/wp-content/uploads/2016/09/health-organizations-letter-biomass-Sept-2016.pdf.

[26] http://bit.ly/2cKigu7

Conclusions

The electric power sector is the largest unregulated source of carbon pollution in the United States in 2014 (last year of data), contributing about 30 percent of total U.S. emissions.[27] EIA's projections for the Clean Power Plan show that the CPP is intended to reduce annual power sector emissions by about 22 percent by 2030. EIA's projections show both scenarios as equally effective in achieving this goal, but this is simply because EIA's projections do not include the substantial carbon pollution emitted by bioenergy under the "carbon neutral" scenario. In reality, bioenergy emissions are not zero. Adding actual bioenergy emissions back in to EIA's "carbon neutral" estimate increases cumulative emissions by 830 mmt, or about 3.5 percent, compared to the scenario where EIA counts bioenergy pollution. A policy that declares that biomass energy is carbon neutral regardless of the science and data would thus partly reverse the pollution reductions anticipated under the Clean Power Plan.

In addition to an increase in carbon and other air pollution, the carbon neutral scenario would give biomass energy an advantage compared to solar energy, leading to a significant reduction in anticipated deployment. Many believe that vast, prompt deployment of solar photovoltaic is essential to reduce carbon pollution and slow the impacts of climate change.

Climate change is already impacting the United States. The past two years, 2014 and 2015, each set a high temperature record. This year will likely break it. Scientists have warned that droughts, floods, and wildfires will occur with greater frequency and ferocity as the climate changes. These impacts are evident in California, in the Mississippi River watershed, western forests and elsewhere.

We must do all we can to reduce the carbon pollution responsible for climate change, and there's no time to wait. This analysis of EIA projections clearly indicates that classifying biomass energy production as carbon neutral would undermine efforts to slow climate change and increase our vulnerability to climate change impacts. Americans cannot afford to pretend that burning biomass has no climate consequences.

[27] "Sources of Greenhouse Gas Emissions," Environmental Protection Agency, accessed September 29, 2016. https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions