RESOURCES *for the* FUTURE

Forest Bioenergy 102: Policy Approaches

An overview of the concerns about the impacts of bioenergy generation and the methods policymakers may use to measure these impacts.

Explainer by **David N. Wear** and **Ann Bartuska** — February 19, 2020

Forest bioenergy describes the energy generated from the combustion of wood and wood wastes or biofuels derived from wood. Forest bioenergy has been heralded by some as a promising renewable energy source and condemned by others as having negative effects on the environment. Most International Panel on Climate Change (IPCC) climate scenarios **anticipate** that bioenergy will play a critical role in reducing emissions from the energy sector. To learn some of the basics of forest bioenergy, read "**Forest Bioenergy 101**," which covers how bioenergy is generated, where it is used, how it affects greenhouse gas emissions, and how its emissions are measured and accounted for. This explainer discusses concerns about the impacts of bioenergy generation and the methods policymakers may use to measure these impacts.

Policy Considerations

Without policy intervention, forest bioenergy will not outcompete coal or natural gas on a cost-per-unit-energy basis. Forest bioenergy would only reach an industrial scale under policies that account for its lower carbon emissions profile. Such policies have emerged in the European Union (EU) and United Kingdom (UK) and have given rise to substantial demand for wood pellets. Nearly all wood pellet production in the United States serves the EU and UK markets. The future of wood energy use depends on the extent and design of energy and climate policies around the world. These policies are not without controversy.

Policy debate tends to focus on two sets of concerns: the measurement of emissions and climate benefits, and the impact of bioenergy on ecosystem services from forests. Emissions accounting is complicated, because emissions arise at fixed locations while regrowth occurs across a dispersed and varied landscape and over a long time period. In order to design effective policies, it is beneficial to incentivize both emissions reductions and forest carbon sequestration. Measuring environmental benefits is complicated by other drivers of change in forested landscapes, uncertain relationships between forest conditions and ecosystem service outputs, and geographic dependence.

The emissions benefits of forest bioenergy depend on the reforestation of harvested forestland. Economic theory and empirical work indicate that bioenergy markets provide strong incentives for increasing forest area and forest management inputs (i.e., reforestation, tree thinning, fertilization, prescribed fire, etc.), thereby accelerating forest carbon sequestration while reducing greenhouse gas concentrations over time. This link between markets and forest accumulation was demonstrated during the mid- to late 1900s in the Southeastern United States, where substantial increases in forest harvesting were accompanied by rapid accumulation of carbon through tree growth. However, if forest bioenergy is viewed only as a transient demand, it may work against forestland retention and expansion.

Harvesting forests for bioenergy at industrial scales could alter ecosystem services such as wildlife habitats, land-water dynamics, and recreation opportunities. The ecosystem services provided by forests depend on all of the dynamics that influence forest conditions, including harvesting for forest products other than energy and the pattern of current forest conditions including their species composition, age and arrangement. Currently, energy production **amounts to less than 5 percent** of US timber harvests, but some policy mechanisms could lead to a substantial increase in demand for domestic consumption. A rapid increase in forest bioenergy could increase the costs of other wood products and displace some production, especially in the paper sector. Ultimately, the question is whether policy-driven market changes will lead to significant scarcity of ecosystem services or market displacement. Both sets of concerns about policy impacts (emissions accounting and ecosystem services are defined by changes in forest conditions over time and suggest that forest bioenergy feedstocks and forest conditions should be monitored for potentially negative outcomes.

Monitoring the Effects of Forest Bioenergy Policies

Emissions accounting for wood bioenergy requires tracking both the emissions from the production and consumption, as well as the accumulation of forest carbon following harvest. Forest ecosystem service monitoring requires accounting for change in impacted services. In both cases, policymakers seek to accurately track policy benefits and to avoid unintended harm from policy design.

Policymakers have used two approaches to attempt to ensure that carbon emitted by bioenergy generation is being reabsorbed by regrowing forests. One approach is to track all feedstocks by type (e.g., harvest residues, harvested trees, etc.) and the carbon dynamics on harvested forestland. This carbon-debt or stand-level approach does not consider market effects. The alternative approach is to monitor changes in all forested landscapes from which feedstocks are sourced to assess overall changes in forest carbon dynamics. This landscape-level approach does consider market effects.

Carbon-Debt Approaches

The carbon-debt approach requires accounting for feedstocks by type and ensuring that harvested areas are regrown, so that the carbon emissions "debt" from burning biomass is recaptured by growing forests. If the amount of carbon stored in forests is stable or increasing, there is no carbon "debt" to be assigned to specific biomass used for energy production. The carbon-debt approach **requires** the bioenergy producer to certify their transactions with feedstock sellers (landowners and mill owners). The most direct approach to the carbon-debt accounting approach is to source timber from forestlands that are certified as sustainable (e.g., **Forest Stewardship Council**, **Sustainable Forestry Initiative**).

A carbon-debt approach could complicate the economics of the conversion of fossil energy generators to run on biomass. Before converting to biomass, the owner of a fossil energy facility will want to know the emissions reductions that would accrue to any investment needed to make the switch. They will need access to a long-term (10- to 20-year) supply of feedstock with known and predictable carbon emissions and regrowth characteristics. A feedstock-by-feedstock, site-by-site, post-harvest analysis of carbon debt adds costs and restrictions to the fuel supply, which could make an investment in bioenergy less attractive and effectively limit its use.

In addition to placing a bookkeeping cost burden on producers, a stand-level approach would also fail to account for the market-driven effects on timber growing. Increasing wood prices resulting from bioenergy demands would likely lead to expansion in forest area within the sourcing area and/or and increased in management activities—both of which are consistent with an expansion in the amount of carbon sequestered in forests. Neither of these two effects would be captured by a stand-level accounting strategy.

The only practical approach to guarantee reforestation of harvested land is purchasing wood from certified landowners; however, if this is necessary, there may be negative impacts. Wood bioenergy is a small portion of total timber harvesting (currently less than five percent of the harvest in the US South) and no other portion of the sector (paper or solid wood products) is subject to this kind of regulatory monitoring. The use of certified raw material in one sub sector could easily be offset by substitution of non-certified wood in other sub sectors (what has been termed "leakage" in the accounting system). Furthermore, certification tends to be viable only for large landowners, and a majority of timber harvest derives from small landowners.

Landscape Approaches

An alternative to the carbon-debt approach is to monitor the dynamics of forests across broader regional forest landscapes. Landscape-level approaches can be built from ongoing forest inventories (conducted in the United States by the US Forest Service Forest Inventory and Analysis **program**) and, perhaps, augmented with additional satellite-based data. These inventories include detailed assessments of forest carbon stocks, depletions and increases, and provide estimates of total forest carbon accumulation or losses across broader regions. These estimates are consistent with IPCC protocols and are subject to quality assurance standards. These landscape-level approaches address all changes in the forest system, including land use changes, forest morality, growth, and more, and can identify carbon dynamics associated with each element.

The landscape-level inventory approach provides estimates of overall forest carbon change over time and a means to estimate biomass and carbon regrowth in harvested forests. It does not directly provide an estimate of how bioenergy harvesting influences these dynamics. To estimate this type of effect requires a model of how the landscape would have changed without a market for bioenergy, which is commonly called a reference case (also referred to as a baseline or a counterfactual scenario). The difference between a reference case and the observed change can be used as an estimate of the impacts of bioenergy harvesting. Reference cases require an accounting of ongoing changes in forests, including growth and harvesting for all products and, additionally, other disturbance effects, including those of wildfire, wind, insects, diseases, and land use changes.

A full landscape approach therefore requires a combination of inventory data and reference case models to generate with- and without-bioenergy cases. By extending the scope to the entire landscape, these approaches can approximate second order effects of bioenergy policies on forest stocks, thereby providing a more complete accounting of effects. A landscape-level approach also allows for emissions monitoring across small, disparate landowners who are not likely to engage in certification.

Landscape approaches would likely be conducted by government entities using existing forest inventory programs. In the United States, the Forest Inventory and Analysis program monitors forest conditions across all ownership types using a sampling scheme that quantifies error estimates, measures forest carbon across all forest carbon pools consistent with IPCC protocols, and is subject to quality assurance monitoring. Inventories can be augmented with additional information to provide estimates for smaller subregions and more frequent reporting **intervals**. The cost burden of reporting would likely be borne by government institutions, avoiding a disincentive for market participation.

Critics of the landscape-level approach object to the reliance on a constructed reference case to assign impacts to the wood bioenergy sector. Proposed reference cases vary in their time dimensions and system **boundaries**. Specifying the appropriate reference case would therefore require consultation with experts and resolving differences across scientific disciplines and perspectives.

Summary

To design effective policies to reduce greenhouse gas emissions, it is necessary to have information regarding the net carbon emissions associated with bioenergy generation. In addition, because of the complexity of forest regrowth, forest management, and land use responses to a growing bioenergy sector, citizens need assurance that the bioenergy system is providing net benefits for climate goals and not generating harm to forested ecosystems and ecosystem service benefits.

Two types of assurance monitoring have been proposed. The carbon-debt/single-stand approach has the benefit of simplicity and tracks compliance to the individual facility. It establishes a closed-system accounting of carbon dynamics associated with harvested feedstocks to ensure reforestation following harvests, but it cannot account for market-driven changes in other forested areas and is subject to leakage issues. The monitoring cost burden falls on the sector's firms and which could diminish the efficacy of policies aimed at increasing use of this renewable energy alternative.

The landscape approach to monitoring relies on existing forest inventory systems to track changes in forest carbon over time. It tracks performance at the sector level and has the benefit of being comprehensive and can be used to estimate the total net emissions effects of the bioenergy sector. The latter depends on developing an accurate reference case and is challenged by a need to reconcile differences among experts. Reporting burden is carried by federal and/or state agencies and therefore avoids a disincentive to market participation. The inventory approach also provides a mechanism for monitoring effects on ecosystem services thereby addressing sustainability concerns beyond net emissions estimates and climate impacts.

Forestry in the United States is largely unregulated, relying on state-level best management practices to ensure environmental sustainability across a landscape of varied land uses and forest types. The future of forest bioenergy as a viable means to reducing greenhouse gas emissions rests on its technical performance and public acceptance. Performance or assurance monitoring will likely play an essential role in demonstrating net emissions parameters of a forest bioenergy system. Additional public sector policies, including traditional reforestation incentives may also play a role in minimizing risks of negative change.

David N. Wear is a Nonresident Senior Fellow at Resources for the Future.

Ann Bartuska is a Senior Advisor at Resources for the Future.