The Carbon Footprint of Wood for Bioenergy

Biomass energy is expected to play a major role in the substitution of renewable energy sources for fossil fuels over the next several decades. The US Energy Information Administration forecasts that biomass will increase to 15 percent of US energy production by 2035, up from 8 percent in 2009. And although wood, grasses, plants, and other biogenic materials do release carbon when combusted, the general view has been that they are carbon neutral: the subsequent plant regrowth simply recaptures the carbon emitted earlier. But recently, this view has been challenged on two counts. First, a study released by the Manomet Center for Conservation Sciences in 2010 argues that the use of wood for bioenergy will result in a decrease in the forest stock and in an associated net reduction in sequestered carbon—meaning that the carbon in the forest will be transferred to the atmosphere, at least for a period of time. A second argument, advanced by Princeton University scholar Tim Searchinger and colleagues in a 2009 *Science* article, is that the use of biogenic material for bioenergy will lead to changes in land use associated with the release of large volumes of greenhouse gases. This occurs, the argument goes, because bioenergy use will raise demand, leading to increases in crop prices and providing incentives for natural land systems to be converted to crop production. This argument has been used particularly for biofuel production with respect to corn, corn prices, and ethanol.

A dispute has since ensued over the carbon neutrality of biomass energy and the nature of regulations that may be applied. Should biomass energy, particularly trees, which have a long regeneration period, be treated like a fossil fuel, the carbon emissions of which are viewed as irreversible and are regulated as such? Or, does the fact that biomass is renewable and hence, when regenerated, offsets its own emissions imply a different treatment for biomass emissions as suggested by the Intergovernmental Panel on Climate Change (IPCC)?

The general view that biomass energy is carbon neutral has been challenged on two counts.

A Two-Way Street

In reality, neither argument captures the dynamic nature of markets for renewable resources. The use of bioenergy is a two-way street, affecting supply as well as demand. Given an expectation of a significant increase in the use of biogenic energy, it is clear that bioenergy harvests from forests will reduce stored forest carbon and release carbon into the atmosphere. It is also clear, though, that an anticipation of higher levels of future demand for wood biomass will encourage increased investments in forests for biomass energy—think forest expansions, new plantings, and improved, faster-growing seedlings. To the extent that these investments need be undertaken in anticipation of future demand not yet realized, forest expansion will precede harvests, and carbon will be newly captured, thereby preceding its future release. The expansion of forests and harvests is additional to what would have been the "business-as-usual forest."

Most commercial forests in the United States are managed, and increasing percentages involve investments in tree planting. Forest management allows for increased forest intensity, as with the denser planting of tree seedlings and more frequent pre-commercial thinnings. These thinnings, which traditionally have not been undertaken or have simply been turned to waste, become economically important if they have value as biomass. Hence, market incentives will promote investments to increase forest stocks as part of traditional commercial forestry as well as through biofuel-dedicated forest plantings, often in anticipation of their use. A static analysis would not capture these anticipatory market adjustments. Indeed, an increasing demand for biomass for energy creates a self-generating incentive for markets to invest in its production. For wood, this means that higher biomass prices also create incentives for increased investment in forests and therefore increasing capacity for carbon sequestration.

The entire sector of commercial forestry, which must wait 20 to 50 years before a tree is ready to be harvested, is predicated on making investments today in anticipation of future, as-yet-unrealized demand. Over the last 40 years, for example, almost 50 million acres of commercial forest have been planted in the United States, and forest stocks rose even as harvests experienced their peak levels. Commercial forests, which provide the vast majority of industrial wood produced in the United States, involve investments based on a tree's expected future market value, as investors anticipate future wood markets. These forests are managed largely on a sustainable

basis and respond to market forces. Higher biomass prices can be expected to result in reductions in forest carbon through larger harvests and also to offset increases in forest carbon emissions as forest managers invest in biomass for the future to substitute for fossil fuels, through a combination of forestland expansion and increased forest management.

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A Dynamic Approach

Forest dynamic modeling studies have shown that earlier static analysis fails to incorporate supply responses as well as demand changes into their carbon neutrality analysis. Thus, static analysis ignores the self-regulating feature of markets for renewable resources and commercial forests and the associated carbon sequestration adjustments. In one study, Xiaohui Tian and I examine how an increase in the demand for wood as bioenergy affects investments in forestry and the volumes of carbon in the forest stock. Our dynamic model shows under what conditions that stock might increase or decline. Another paper—a dynamic approach of the entire multi-stand commercial, multiple-forest system by Adam Daigneault and colleagues—captures the interconnectedness of the forest system both spatially and over time. Decisions on a site are not independent of activities on other sites as market signals provide coordinating information. This analytical approach demonstrates conceptually what the tree growing experience of the late 20th century illustrated: that when responding to an anticipated substantial increase in future demand, the forest stock will rise as fast as or faster than harvest draw-downs. Again, this result reflects the response of managers to increase the area (and intensity) of forest production, thereby offsetting the carbon released in the harvest for feedstock for bioenergy production. This finding demonstrates that wood bioenergy production can be carbon neutral in a host of situations, and particularly when demand is anticipated to increase substantially into the future, as is the current case in the United States.

—Roger Sedjo

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FURTHER READING

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