The Forest—Bioenergy—Carbon Connection

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Extended Abstract—Burning wood for energy is a back-to-the-future approach for solving modern problems. The burning of fossil fuels for energy and resultant carbon emissions are global concerns: "The world needs ever increasing energy supplies to sustain economic growth and development. But energy resources are under pressure and carbon dioxide (CO_2) emissions from today's energy use already threaten our climate. What options do we have for switching to a cleaner and more efficient energy future?" (IEA 2008). The basic choice is between action and delay, and forest management is among the set of options that have the capacity to provide "stabilization wedges" and solve the climate problem for the next half-century (Pacala & Socolow 2004).

Wood bioenergy is a proven, cost-effective technology for producing homegrown, reliable baseload energy (O'Laughlin, in press). In 2007 wood provided 1.8 percent of the energy consumed in the United States (EIA 2009). Wood bioenergy use is generally higher in states with extensive forest resources and a substantial forest products business sector, like Idaho, where 4.7 percent of the energy consumed is from wood (Idaho Legislature 2007). Forest products manufacturing mill residues are the low hanging fruit for wood bioenergy, as they have already been transported out of the woods, but almost all mill residues are already used to make energy (Nicholls and others 2008).

Forest health thinnings and logging residues are a potential source of feedstocks for wood bioenergy, whether for space heating with thermal energy, electric biopower, or liquid biofuels. The benefits of producing thermal energy and biopower from wood can be substantial; e.g., the University of Idaho (2008) saves on average $1.5 million per year burning wood residues from local sawmills instead of natural gas, and Fuels for Schools projects save $1.8 million per year in fuel costs. These thermal heating solutions are the most efficient use of wood bioenergy and widely used in some European countries (see Richter and others 2009).

Using forest residues (thinnings and logging slash) for bioenergy is an opportunity to restore forest health, wildfire resiliency, and wildlife habitat. Silvicultural operations to improve forest conditions can help revitalize rural economies while providing renewable energy feedstocks (Cloughesy & Lord 2006). In addition to this "triple win" (IFPC 2009; OFRI 2009), forests play a key role in the global carbon cycle by capturing, storing, and cycling carbon (EPA 2009a, see also California Forest Foundation 2009). Forests in the conterminous U.S. sequestered, on average, 162 million metric tons of carbon per year during 1990-2005 (Woodbury and others 2007). This is sufficient to offset at least 10 percent of all U.S. carbon dioxide emissions (data from EPA 2009b). However, from 2002-2006 wildfires in the conterminous U.S. emitted, on an annual average, 59 million metric tons of carbon as CO_2 and two million metric tons as particulate matter (Wiedinmyer & Neff 2007).

Considerations for safe storage of carbon on, in, or deep under the soil create roles for forestry (Read 2009). Five types of carbon reservoirs are preferable to storing carbon in the atmosphere, and only the last item does not have an obvious role for forestry: 1) new forestry plantations; 2) new timber structures and other durable wood products from harvested wood; 3) underground wood burial, perhaps in abandoned mines; 4) biochar storage in soil reservoirs with co-produced bio-oil; and 5) carbon capture and storage in deep geological strata or as bicarbonates in the ocean or insoluble carbonates on land in played-out coal mines. In addition, the

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existing fossil carbon reservoir is maintained *in situ* through technology chains that involve bioenergy and other renewable sources of energy that substitute for fossil fuel (Read 2009).

Silviculture designed to reduce stand-replacing wildfires is the most important forestry strategy for mitigating climate change, followed by keeping forest lands in forest cover, putting trees back on the land through afforestation and reforestation, using wood products instead of substitutes like concrete and steel, and modifying harvest rotation length (Cloughesy 2006). Beginning in the mid-1980s, the acreage burned by wildfires in the 11 western states began to increase considerably from levels of the previous 50 years. According to information provided to the U.S. Government Accountability Office by the U.S. Forest Service, "The most extensive and serious problems related to the health of national forests in the Interior West is the over-accumulation of vegetation, which has caused an increasing number of large, intense, uncontrollable, and catastrophically destructive wildfires" (GAO 1999).

Climate change concerns heighten the issue: "The overall importance of climate in wildfire activity underscores the urgency of ecological restoration and fuels management to reduce wildfire hazards to human communities and to mitigate ecological impacts of climate change" (Westerling and others 2006). According to the Intergovernmental Panel on Climate Change, "…a sustainable forest management strategy aimed at maintaining or increasing forest carbon stocks, while producing an annual sustained yield of timber fibre or energy from the forest, will generate the largest sustained mitigation benefit" (Nabuurs and others 2007). Two types of barriers impede implementing this strategy on federal lands.

One of the two primary challenges to utilization of wood biomass that could provide energy feedstocks are high harvesting and transportation costs (GAO 2005, 2006). Perhaps the best way to create more favorable economics that can make biomass removal projects feasible is harvesting higher value timber along with biomass removals (Evans 2008; Nicholls and others 2008). Furthermore, in dry forest types comprehensive restoration treatments are not only more effective at reducing hazard than thin-from-below approaches designed to remove smaller trees only, the economics are more favorable and in many situations can return more revenue than the treatment costs, whereas thin-from-below requires out-of-pocket expenditures (Fiedler and others 2004).

Besides harvesting high value timber along with biomass, the only other way to deal with unfavorable economics of biomass harvesting is through public subsidies (Nicholls and others 2008). A rationale for subsidizing fuel treatments is that the benefits to society from hazardous fuel treatments are worth more than the value of electricity produced by wood biopower plants. These include the uncompensated benefits of reduced costs of fire suppression costs and avoided costs of site rehabilitation as well as avoided costs of carbon emissions, calculated at a conservative estimate of $10 per metric ton (WGA 2006). Other researchers have also quantified the value of these silvicultural benefits (see Mason and others 2006). In part to support bioenergy, the Western Governors' Association "call[s] on the federal government to create a substantial, long-term national public investment on the scale of tens of billions of dollars annually, and encourage at least the same investment from the private sector, to support the kind of basic and applied research and deployment of clean energy technology and infrastructure" (WGA 2009).

The other primary challenge to using wood as an energy feedstock is the lack of a long-term reliable supply (GAO 2005, 2006). To deal with that, some have suggested public programs that create a demand for biomass material (e.g., Williams 2005). One such program is "Fuels for Schools and Beyond" (see Nicholls and others 2008). However, unless entrepreneurs can demonstrate that they have reliable feedstock supplies for 10 or 20 years they will have difficulty attracting capital to wood bioenergy projects. Whether demand will pull out supply or supply will push new demand is a chicken-and-egg argument; both are necessary.

Since the advent of the National Fire Plan in 2000 there has been much positive activity to reduce hazardous fuels, notes Doug Crandall (2006), currently the legislative liaison for the U.S. Forest Service. Referring to the relationship of forest growth, mortality, and removals he said, "Momentum has shifted from conflict and neglect to a recognition that there's actually a gorilla in the room." He opined that with 190 million acres of forests needing treatment, much more than the current level of four to five million acres per year nationwide needs to be accomplished (Crandall 2006). While serving as Chief of the U.S. Forest Service, Dale Bosworth described the situation as unsustainable: "We have some 73 million acres of national forest land at risk from wildland fires that could compromise human safety and ecosystem integrity. . . . The situation is simply not sustainable—not socially, not economically, not ecologically" (Bosworth 2003).

Idaho and Montana face forest health and wildfire risks from overstocked forests. Together the two states have 7 million acres of forests in the high-risk Fire Regime Condition Class (FRCC) 3 category and another 10.5 million acres in FRCC 2 (Schmidt and others 2002). Federal land managers are reducing fuels on an average of 250,000 acres per year (Healthy Forests and Rangelands 2009). At that rate it would take 28 years to treat just the FRCC 3 lands, at which time vegetation would have grown back and retreatment would be necessary to maintain fuel reduction benefits. Forest managers, stakeholders, and policy-makers need to consider whether passively waiting for the inevitable wildfire to burn is better that actively managing fuels, and whether piling and burning biomass onsite is preferable to moving it offsite and burning it in boilers that produce bioenergy. The State of Oregon subsidizes biomass removal for energy production at $10 per green ton (ODE 2007). A similar program failed to pass the Montana legislature in 2009 (O'Laughlin, in press).

In conclusion, wood bioenergy opportunities are substantial and sustainable. Many communities are interested in installing wood bioenergy facilities to reduce costs to heat public buildings and provide local jobs. In addition, the uncompensated social benefits of reduced wildfire suppression costs, plus the avoided costs of site rehabilitation and carbon emissions, exceed the value of bioenergy and create a rationale for subsidizing hazardous fuel treatments. The implementation question in the forestry sector is whether the subsidy should be in the form of timber from the forest or cash payments from the public treasury and taxpayers' pockets. In the short term hazardous fuel reduction provides a triple win: improved forest conditions, renewable energy feedstocks, and revitalized rural communities. The reduction of carbon emissions from burning wood in a boiler instead of in the woods is a substantial bonus. The long-term payoff from wood bioenergy will be enhanced energy security.

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