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International bioenergy synthesis—Lessons learned and opportunities for the western United States

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ABSTRACT

This synthesis examines international opportunities for utilizing biomass for energy at several different scales, with an emphasis on larger scale electrical power generation at stand-alone facilities as well as smaller scale thermal heating applications such as those at governmental, educational, or other institutional facilities. It identifies barriers that can inhibit bioenergy applications, and considers international cases of successful bioenergy production with a focus on Europe and Brazil. Based on the review of international bioenergy applications, important ecosystem service issues having relevance to western U.S. forests are discussed, including hazardous fuel reduction, community development, and sustainability of the wood products industry.

1. Introduction—environmental benefits of bioenergy and its potential as an ecosystem service

For the purposes of this paper the term "biomass" is used as shorthand for "woody biomass" and refers to organic material from woody plants, especially trees, that is not otherwise utilized in conventional wood products. Biomass thus includes small stems, branches, twigs, and residues of harvesting and wood processing that could potentially be made available for conversion into energy products. This definition is consistent with usage in the Woody Biomass Utilization Strategy recently published by the U.S. Forest Service (Patton-Mallory, 2008). In addition, biomass can be obtained from non-forest sources such as urban waste, which often includes recycled wood, garden trimmings, and other types of biomass.

Although a plentiful supply of such biomass is available in western U.S. forests (Rummer et al., 2003), challenges remain to find economically viable uses given the high removal costs and relatively limited markets for this material. Because the cost of harvesting and transporting biomass is often several times the final value of products obtained, a key challenge for natural resource managers is to find markets and products that will offset at least part of these costs while providing other benefits such as reducing wildfire risk. Important ecosystem services (defined later) are also provided through removal of biomass having little commercial value for lumber or other wood products.

Global carbon dioxide (CO_2) levels and temperatures have increased dramatically during recent years, with CO_2 levels now approaching 380 parts per million (ppm) vs. pre-industrial levels of about 280 ppm (Intergovernmental Panel on Climate Change, 2007). Most of the observed global warming over recent decades appears to have resulted from increased greenhouse gas concentrations in the atmosphere. Although the combustion of biomass, either as biofuels or during conversion into bioenergy, results in a range of combustion products and gases, as does combustion of coal and other fossil fuels, biomass can be regrown to sequester the CO_2 produced through combustion. Thus, forest biomass sources have the potential to be carbon-neutral (Wahlund et al., 2004).

World-wide, forests serve as an important carbon sink, absorbing about 25 percent of CO_2 emissions (Nabuurs et al., 2000). Other estimates indicate that forest and land management decisions could effectively reduce net carbon emissions by 10–20 percent through the year 2050, and that the greatest potential for sequestering carbon is in tropical and sub-tropical forests (Union of Concerned Scientists, 2007). In Europe, boreal forests are estimated to have relatively little carbon sequestration ability while Mediterranean forests have a greater ability to sequester carbon (Nabuurs et al., 2000). Use of forest fuels for bioenergy can potentially negate the effects of carbon sequestration by quickly releasing CO_2 upon combustion, although the newly released CO_2 can be sequestered by trees in forests or plantations established for that purpose. In addition, incorporation of carbon into durable

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