Chapter 1 Setting the Stage

1.0 Introduction

Woody biomass has the potential to help address some of the most urgent problems facing the United States today. Concerns about global climate change, forest health, energy security, and rural and economic development are spurring research and innovation to meet the nation's growing needs. Woody biomass may provide a short-or mid-term solution to these challenges while technology finds more long-lasting answers. Besides meeting energy needs, woody biomass may also have a more long-lasting role as a feedstock for a variety of other products like specialty chemicals and bioplastics.

So what is woody biomass? Biomass is any organic matter that is renewable over time. There are many sources of biomass, including corn stover (the leaves and stalks of corn); manure; wood residue (woody material left behind after a harvest); and landfill gas. (Chapter 2 describes these and other biomass sources in more detail.) Woody biomass is the accumulated mass, above and below ground, of the roots, wood, bark, and leaves of living and dead woody shrubs, vines, and trees. Woody biomass can be used to produce heat, power, electricity, transportation fuels, and a variety of biobased products, such as chemicals and adhesives. Its renewability, versatility, and local availability (in many places) make it an attractive option for various applications. While this guide will review all types of biomass, it will focus primarily on woody biomass.

Support for woody biomass utilization in mainstream energy, fuels, and bioproducts has increased dramatically within the past decade. The first major action was the creation of the Biomass Research and Development Act of 2000. The Healthy Forest Restoration Act (HFRA) of 2003 provided complementary support. As a result of the HFRA, the United States Departments of Energy, Interior and Agriculture announced an initiative to encourage the use of woody biomass as a strategy to reduce wildfire risk on public lands. The three departments signed a memorandum of understanding stating that each would support woody biomass utilization for energy and other products as a recommended option for reducing hazardous fuels. The utilization of woody biomass was encouraged in President George W. Bush's 2006 and 2007 State of the Union addresses; the Energy Policy Act of 2007; the Energy Title of the 2008 Farm Bill; numerous state, regional, national and international technical conferences; and the "25 x 25 - America's Working Lands: Powering the Future" initiative. (chapter 5 provides more information about federal, state, and local policies and incentives for woody biomass production and utilization.)

This chapter introduces the economic, environmental, and social issues surrounding woody biomass production and utilization. The U.S. is facing major challenges with regard to energy and climate. Fluctuating fossil fuel prices, volatile world politics, and overdependence on nonrenewable energy resources are creating serious concerns about national energy security and sustainability. While no one solution is likely to resolve all of these issues, woody biomass has the potential to work in conjunction with other options to help address some of these concerns.

Table 1: *Sulfur Dioxide, Nitrogen Oxide, and Carbon Dioxide Emissions Factors for Different Energy Sources.* (U.S. DOE, 2003).

Pollutant	Woody Biomass	Coal	Heavy Oil	Natural Gas
Sulfur dioxide	0.08 lbs/ton	39 lbs/ton	157 lbs/ton	0.6/10^6 cubic feet (cf)
Nitrogen dioxide	1.5 lbs/ton	21 lbs/ton	47 lbs/ton	170/10^6 cf
Carbon dioxide	0* lbs/million Btu (mBtu)	225 lbs/mBtu	174 lbs/mBtu	117 lbs/mBtu

* Assumes wood grown and harvested for this purpose.

1.1 Global Climate Change

During the past century, the Earth's average temperature has increased about 1 degree Fahrenheit (U.S. EPA, 2007). Scientists call this increase an indication of "global warming." Average temperature change, warmer or cooler, can lead to climate change, which is the long-term change in a particular region's weather patterns (e.g., temperature, precipitation, frequency and severity of storms). The burning of fossil fuels has considerably increased atmospheric carbon and other greenhouse gases since the beginning of the Industrial Revolution. When burned, fossil fuels release carbon dioxide and other gases into the Earth's atmosphere where they trap and reflect heat, resulting in global warming. Because this carbon came from fossilized storage (carbon that was produced and stored millions of years ago), it represents a net addition of carbon into the atmosphere and more than can be sequestered (stored) by today's plants, soils, and oceans.

Global climate change has the potential to impact the planet's ecosystems and every aspect of our society. Even slight changes in climate can influence human health, agricultural productivity, and biodiversity. Changes in climate, particularly temperature, can influence the range of infective parasites that spread disease. Extreme weather events such as droughts, hurricanes, floods, and fires, all of which can be exacerbated by climate change, can directly and indirectly cause loss of human life and infrastructure. Even more subtle changes such as fluctuations in rainfall and length of growing seasons may pose further challenges to farmers worldwide.

Finding sustainable ways to meet growing energy needs while reducing greenhouse gas emissions is one way to address the threat of climate change. While wind and solar power are increasing in popularity and prevalence, so is biomass. Versatile enough to provide heat, power, electricity, transportation fuels, and other products, biomass can be used to produce energy on a larger scale than solar and wind, in many cases. It is probable that a successful and sustainable short- and mid-term response to the threat of climate change will be comprised of a suite of renewable energy options that includes woody biomass. In terms of greenhouse gas emissions, woody biomass emits less than fossil fuels and if sources are replanted on a sustainable basis, the process of using woody biomass is essentially carbon-neutral. Table 1 illustrates uncontrolled air emissions from natural gas, oil, coal, and wood. In addition, for every British thermal unit (Btu) produced by cellulosic ethanol rather than gasoline, there is a total life cycle greenhouse gas reduction of 90.9 percent (Malmsheimer et al., 2008).

Loss of Forests

Because forests absorb large amounts of carbon, deforestation is directly connected to climate change and is a growing concern, both globally and nationally. Between 1850 and 1998, the conversion of forestland around the globe contributed approximately 136 billion tonnes of carbon to the atmosphere.

This represents 33 percent of the total emissions during that time span and the second largest amount of human induced emissions (energy production was the first) (Malmsheimer et al., 2008). In 2003, forestland in the U.S. sequestered 750 million tonnes of CO_2 equivalent (U.S. EPA, 2005).

One major threat to forest cover in the U.S. is development. Rising land prices are an enticement to forest landowners to sell land for development in some areas, leading to fragmented forests and the depletion of total forestland. For instance forestland in the southeastern U.S. was appraised at approximately $415 per acre when used for forestry and $36,216 per acre when sold for development (Malmsheimer et al., 2008). Likewise, forestland in the Pacific Northwest was valued at approximately $1000 per acre when used for forestry and $20,000 per acre when sold for development (Malmsheimer et al., 2008). These economic factors make the conservation of forestland a challenge.

Climate change can also affect forests. Forest composition, structure, and function are influenced by disturbances such as fire, drought, introduced species, insect and pathogen outbreaks, hurricanes, windstorms and ice storms. Climate change can alter the frequency, intensity, duration, and timing of such disturbances. Additionally, models have shown that warmer temperatures will likely lead to more productive U.S. forests. Increased growth combined with more intense, frequent, longer-lasting disturbances could lead to overcrowded stands, compromised forest health, and increased risk of wildfire. The U.S. may already be seeing some evidence of this. Throughout the last twenty years, the U.S. has experienced record drought in terms of temperature and duration, record wildfire

Figure 1: *Climate change may lead to prolonged droughts in susceptible forests.* Photo courtesy of Ogden Archive, U.S. Forest Service.

In the U.S., a ton is equal to 2,000 lbs. In Great Britain, a ton is equal to 2,240 lbs. To distinguish between the two tons, the U.S. ton is called a "short ton" because it is the smaller of the two; whereas, the British ton is called a "long ton" because it is the larger of the two. In addition, you may sometimes see a metric tonne, which is 1,000 kg or 2,205 lbs. The spelling "t-o-n-n-e" is what distinguishes this measurement from the others.

What's the difference between a clearcut and deforestation?

A **clearcut** is a silvicultural method used for regenerating an even-aged (trees of similar ages) community of trees, where the new seedlings become established in fully exposed areas following the removal of most or all mature trees (Nyland, 1996). **Deforestation** is the removal of most or all trees in an area with no plans for regenerating a forest or for the purpose of converting the forestland to some other use, for example agriculture or development.

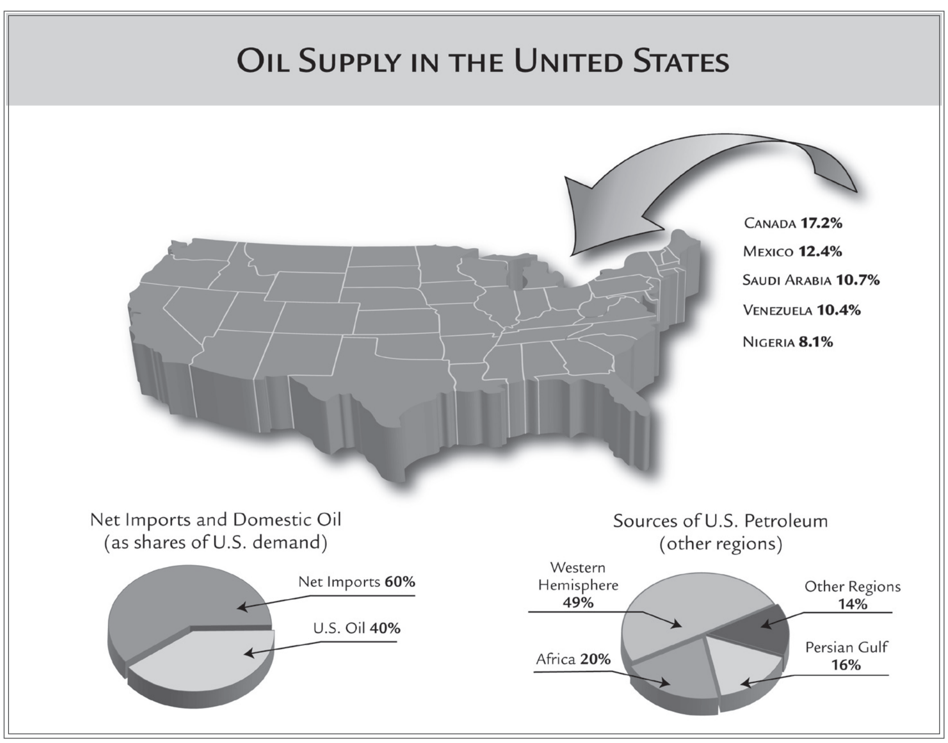
in terms of frequency and intensity, and record hurricanes in terms of frequency and intensity.

Woody biomass production and utilization create markets for wood and wood waste that may provide forest landowners with incentives to keep their land in forests. The more markets that can be developed and enhanced to help make working forests more profitable, the more likely forestland will be maintained. While some opponents of wood energy fear that increased biomass utilization will further deplete the nation's forests, the opposite may actually be true. If biomass projects involve sustainable management and harvesting of wood resources, they may help reduce or prevent the fragmentation and loss of forests.

1.2 Growing Energy Demands and Security

Another major concern facing the U.S. is energy security. While the annual per capita energy consumption has actually been decreasing in recent years, most likely due to new energy efficient technologies such as compact fluorescent light bulbs and more efficient technology, total demand is on the rise. The total annual energy consumption in the U.S. increased from about 89 quadrillion Btu in 1994 to 100 quadrillion Btu in 2004 (U.S.DOE, 2005). The current U.S. population is approximately 304 million and projected to reach 325 million by 2015. Some project that by 2030, consumption will have increased 15 percent and Americans will consume just over 118 quadrillion Btu annually (U.S. DOE, 2008). During the next twenty-five years, it is estimated that the U.S. will need to build at least 1,200 new 300-megawatt (MW) power plants to meet growing electricity demand (Malmsheimer et al., 2008).

Diagram 1: *Oil supply in the United States.* Adapted from EIA Petroleum Supply Annual (2002) vol.i.



Currently, about 85 percent of the total energy consumed nationally comes from fossil fuels, 7 percent from renewable energy sources, and 8 percent from nuclear power. Biomass provides approximately 3 percent of all energy consumed in the U.S. and is the country's single largest source of renewable energy (U.S. DOE, 2005). Woody biomass accounts for approximately 59 percent of all biomass energy consumed in the U.S. (U.S. DOE, 2008a).

So where does the U.S. get the majority of its energy? Nearly 60 percent of crude oil is imported from Canada, Mexico, Saudi Arabia, and Venezuela (Diagram 1). The U.S. depends on oil for everything from transportation of goods to running farming equipment. Because of this dependency, the U.S. is vulnerable to oil supply disruptions and price increases. While predictions vary, most estimates suggest that global peak oil production will occur sometime between now and twenty years from now, and as scarcity increases, it will drive up cost (Science Daily, 2007). In addition, the fact that much of the oil used in the U.S. today comes from politically unstable regions or those with contentious relations with the U.S. makes oil resources even less reliable.

The U.S. uses more than 1,100 million short tons of coal each year, the majority of which comes from Wyoming and West Virginia and is shipped all over the country by train (U.S. DOE, 2008b). Most natural gas comes from Texas, Wyoming, and federal offshore drilling (U.S. DOE, 2008c). While coal and natural gas are readily available domestically, the finite nature of fossil fuels means that eventually their supplies will dwindle and they cannot be counted on as a sustainable source of energy. Concerns about climate change are helping prompt a transition to renewable energy sooner than later.

In an effort to increase energy security, the U.S. is working to improve the efficiency, sustainability, and reliability of energy generation, distribution, and consumption. It has begun to harness local resources as a way to increase the security of the energy supply, reverse fossil fuel dependency, and improve the trade balance. With consumption increasing, a limited domestic supply of fossil fuels, and increased concerns about global warming and loss of forests, woody biomass may provide a viable alternative.

Figure 2: *Wildland-urban interface, the space where developed and forested lands meet, pose challenges to managing forest fuel loads.* Photo courtesy of Larry Korhnak.

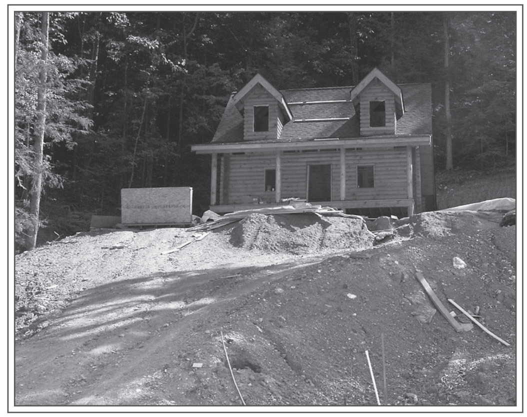


Figure 3: *Reducing fuel loads in forests lessens the severity of wildfires.* Photo courtesy of Arthur Allen, U.S. Fish and Wildlife Service.

1.3 Wildfire and Forest Health

Years of fire suppression have left many U.S. forestlands dangerously overstocked. With the rapid expansion of the wildland-urban interface in some regions, the need for fire hazard reduction has become increasingly important. Wildland-urban interface is defined as any area where increased human influence and land use conversion are changing natural resource goods, services, and management (Macie and Hermansen, 2002). In the interface, homes are often located in or adjacent to heavily forested areas that can be prone to wildfire. Wildfires are expensive to fight, cause billions of dollars each year in damage to both the natural and built environment, and can negatively affect wildlife habitat as well as air and water quality. Overstocked forests may also be more susceptible to insect infestation and disease.

Because of this, natural resource managers are faced with the enormous task of enhancing, restoring, and maintaining forest health on both public and private lands. This often involves the removal of small-diameter, low-quality woody material. If markets exist, it can be harvested for other uses. According to a recent study, about 8.4 billion dry tons of vegetation have been identified nationally for treatment, yet due to accessibility limitations, recovery limits, and the merchandising of some of this wood for higher value products, only 60 million dry tons of fuel from treatment thinnings can actually be removed annually (USDA and U.S.DOE, 2005). Approximately 80 percent of this material would be removed from private forestland and the remaining 20 percent from public forests. By creating new markets for wastewood and debris from thinning, woody biomass utilization may help public agencies and private landowners pay for management activities that can help reduce the risk of wildfire and increase forest health and resilience.

1.4 Changing Forest Economy

Another driver of overstocked and unhealthy forestland in the U.S. is changing forest markets. Globalization has made it easier for countries to compete for global resources. As a result, forest industry, in an effort to provide the highest return for shareholders, has largely sold off its forestland in the U.S. Plantations in the southern hemisphere, primarily New Zealand, Australia, Chile, and subtropical regions of southeastern Brazil, with climates that support high levels of wood fiber production on very short rotations, combined with low labor and other social costs, are much more productive and less expensive than North American forestlands and plantations (Franklin and Johnson, 2004). Plantations and mills have moved south. Pulp markets used to create demand for the small diameter timber removed during thinning operations. However, as demand decreases due to this shift south, scheduled thinnings are often delayed or forgone. This delay often leads to overcrowded stands, poor forest health, and susceptibility to catastrophic fire, insects, and disease.

As we move into a more globalized economy, heavily forested, rural, and wildland-urban interface areas face new challenges to provide jobs and income from forestry. Thinned trees and pine plantations support the pulp and paper industry, particularly in the southern U.S. Globalization is squeezing the industry and shifting markets in some areas. Once reliable forest products markets are less reliable or non-existent. U.S. pulpwood markets, for example, once thrived, with the South supplying more than 70 percent of the nation's pulp needs. Because pulp and other higher value forest products can be produced faster and cheaper in the southern hemisphere, in many cases, forest industry has largely divested their U.S. holdings (land and infrastructure) and moved to South America (Best, 2002; Franklin and Johnson, 2004). Some people are concerned about how increasing the use of wood for energy and biobased products might influence competition and thus prices for wood.

Fragmented, parcelized landscapes resulting from development are also changing the forest economy in the U.S. by making timber harvesting less profitable (Sampson and Decoster, 2000). Small individual tract sizes as well as small noncontiguous patches of forestland lead to diseconomies of scale not only in the harvesting operation but also in management, planning, and marketing of products. Small tracts frequently yield smaller volumes, which are often unable to offset the high costs associated with transportation, capital investment, and operation expenses (Shaffer, 1992). Markets for woody biomass may provide value to material previously thought to be non-merchantable. This additional value may make smaller tracts of forestland more profitable.

1.5 Summary and Conclusion

New markets for woody biomass could potentially strengthen the demand for small diameter timber, reduce wildfire risk, reduce the atmospheric carbon and other greenhouse gases released into the atmosphere, and promote domestic energy security. New opportunities are emerging for utilizing sustainably produced woody biomass from forest enhancement, restoration, and maintenance activities. Additionally, utilizing woody biomass for energy and other bioproducts can help promote management to enhance forest health, reduce the risk of wildfires, and mitigate the potential effects of climate change. While woody biomass has the potential to address some of the challenging issues facing the U.S., it remains important to carefully weigh the costs and benefits. See chapter 4, "Implications of Producing and Using Woody Biomass" for information on the advantages and disadvantages of using wood for energy and other bioproducts.

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Authors:

Sarah Ashton, Southern Regional Extension Forestry
Lauren McDonell, University of Florida
Kiley Barnes, Southern Regional Extension Forestry