WOOD to ENERGY

Fact Sheet

Environmental Impacts

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When deciding how to meet increasing energy needs, communities often consider how power generation options will affect the environment. Energy production affects air quality, land-use options, forest health, and other natural resources in different ways and with different intensity levels. Energy from woody biomass offers several environmental benefits, but can have negative environmental impacts if appropriate practices are not used. Compared to many fuel sources, especially fossil fuels (such as coal and natural gas), proper production and use of woody biomass can have more positive impacts on air and water quality, reduce greenhouse gas emissions, and offer other environmental benefits.

Air Quality

When any substance is burned, emissions are produced. Conventional wood-fired power plants typically produce some of the same emissions as coal-fired power plants including carbon dioxide (CO_2) and carbon monoxide (CO). Wood-fired plants, however, produce very little sulfur and mercury and lower levels of nitrogen oxides (U.S. EPA 2006b). Although wood-fired power plants produce 90 percent less ash than coal-fired plants, some particulate matter (ash and soot) is produced. Particulate matter is the easiest emission to control and can be managed by using pollution-control devices (Power Scorecard 2000). The type of wood fuel, power plant, and emissions control technology used determine both the emissions produced and the overall impacts on air quality. Using woody biomass or co-firing (using wood in combination with coal or other fuels) has less of an impact on air quality than using coal alone. In addition, some sources of woody biomass, such as yard trimmings and debris from land clearing for development, are often burned in open fields without emission controls (Figure 1). Burning these wood resources in the controlled environment of a power plant should significantly reduce the air quality impacts created by burning debris and land clearing piles in wildland-urban areas. See the *Impacts on Air Quality* fact sheet for more information, at http://www.interfacesouth.org/woodybiomass.

Global Climate Change

All power plants that use combustion also produce CO_2, a greenhouse gas. Increasing levels of CO_2 in the atmosphere is considered a major contributor to global climate change. The carbon from burning fossil fuels, such as oil, natural gas, and coal comes from carbon deposits that were buried beneath the earth's surface for millions of years. Because the carbon emitted from burning wood was

Figure 1. *Woody debris that could be used to produce energy is often burned in open fields without emission controls.* Photo by Larry Korhnak.

derived from recently living plant matter, it does not contribute to the overall amount of carbon in the atmosphere; in other words, burning wood releases the same amount of carbon that the tree recently absorbed during growth. As new trees are planted to replace those harvested, they will also take in carbon as they grow. In this way an equal amount of carbon is cycling between trees and the atmosphere (Power Scorecard 2000). Fast-growing woody plants called *short rotation woody crops* can be planted and harvested more quickly than other tree species. This process may recycle CO_2 much quicker than using typical forests. From a global climate change perspective this gives wood energy a distinct advantage over fossil fuels. See the fact sheet, *Climate Change and Carbon*, for more information.

Currently, at some level all renewable energy sources such as solar, wind, water, and wood require the input of fossil fuels. Planting, harvesting, transporting, and processing woody biomass currently requires some fossil fuels. If the energy needed for these activities were to come from renewable sources such as cellulosic ethanol or biodiesel (both transportation fuels derived from plant material), the net contribution of CO_2 into the atmosphere would be minimized.

Forests

Wood for energy can come from many different sources. For instance, woody debris from yard trimmings, land clearing for development, or timber harvests can be used. The latter source may not be desirable for landowners interested in keeping piles of their post-harvest debris for wildlife habitat or soil amendments. Wood from forest thinning activities to improve forest health, enhance timber production, and reduce risk of wildfire can also be collected for fuel. In addition, wood can be grown specifically for energy production, just as it is grown for paper, lumber, and other products. Using wood for energy provides another economic market that encourages landowners to maintain their forests rather than sell their land for development. These working forests, managed to produce biomass for energy using either native or exotic species, may also provide environmental benefits such as soil protection, clean air and ground water, carbon sequestration and wildlife habitat although not generally to the same extent as natural forests or plantations managed less intensively. Plantations of exotic species may protect soil, air, and water, but will not likely provide wildlife habitat. Trees grown for energy, as in other plantation settings, are generally grown and harvested in staggered cycles, leaving some forested areas standing at all times. Like most business owners, timber growers are typically interested in sustaining their businesses and therefore are motivated to foster long-term forest health and productivity. If appropriate management practices are used for growing and harvesting forests, environmental impacts are minimized. Sustainable forest management programs such as the Sustainable Forestry Initiative, Forest Stewardship Council, Tree Farm, and Forest Stewardship Program provide timber growers with information and tools to implement sustainable practices and independently certify that landowners adhere to similar standards. See the *Sustainable Forest Management* fact sheet for more information.

Soil

Growing trees for energy can also enhance soil quality in comparison to agricultural food crops. Trees are typically grown for about twenty years before they are harvested. During this time, their roots and leaf litter help stabilize and enrich soil. Some tree species can sprout back from the stump after they are harvested. Using trees that can re-sprout reduces the need for tilling and planting, thereby reducing soil erosion.

Typically, harvesting woody biomass involves removing the tree trunks and large branches and leaving stumps, roots, and leaves. Since about one-third of a tree's nutrients are contained in its leaves or needles, ensuring that the leaf litter remains in the forest helps maintain soil quality (Moller 2000). Wood production generally places less intense demands on soil nutrients than agricultural production, illustrated in Figure 2. Annually, growing and harvesting corn (either grain or stalks) removes over 100 kilograms (kg) of nitrogen per hectare (ha), while growing and harvesting loblolly pines removes about 5 kg of nitrogen per ha. Furthermore, although the cost of trucking and spreading it might be a deterrent, ash from wood-fired power plants may provide sufficient nutrients to alleviate nutrient loss from harvest, depending on the soil type. Note that the ash from facilities that co-fire wood with coal cannot be used for soil improvement.

Soil quality can also be affected by physical disturbance and compaction. Roads and heavy machinery used during harvesting can lead to increased soil compaction, erosion, and water run-off. Run-off can contaminate nearby water bodies with soil, silt, and chemicals. These impacts can be reduced by minimizing the use of heavy machinery and scheduling a harvest when soils are dry or frozen. There are numerous well-established best management practices for harvesting that help protect soil. Again, proper management practices can help maintain soil quality and sustain forest productivity. Collecting residue (left-over woody debris) from forestry operations for fuel could reduce soil fertility, unless leaves and roots are left on site.

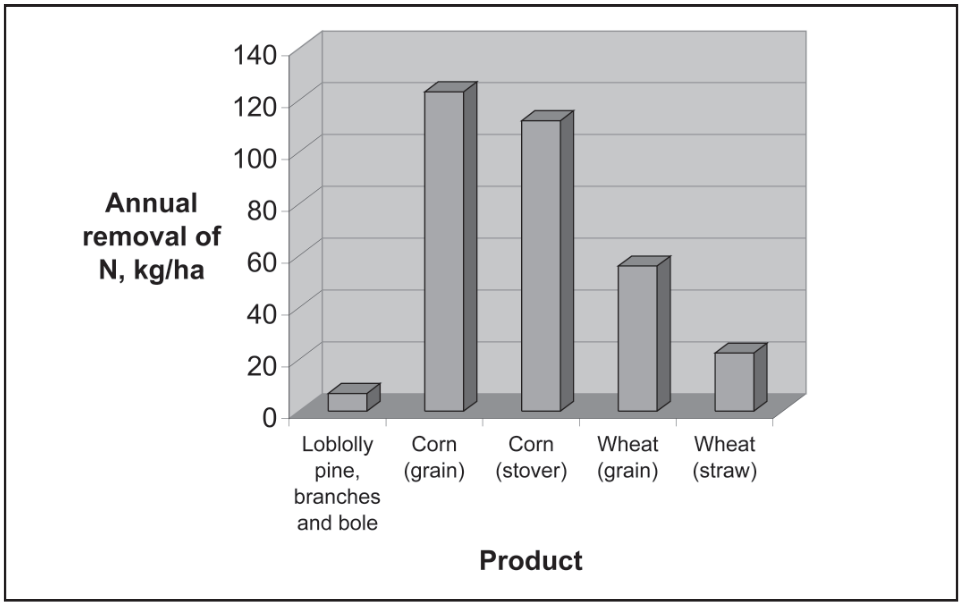

Figure 2. *Estimated annual removal of nitrogen (kg/ha) from forestry, corn production, and wheat production. The values for loblolly pine are divided by rotation age (twenty years) to calculate annual removals.* Gresham 2002.

Water

Methods used to obtain different types of fuel can impact water quality. Coal mining typically alters the shape of the land and changes the patterns of water flow in the area mined. Surface mining, deep mining, and even coal stored in piles can produce acid mine drainage, a flow of liquid that tends to be highly acidic and can contain high levels of potentially toxic metals (U.S. EPA 2006a).

As mentioned previously, harvesting wood for energy can lead to soil erosion and water run-off if proper management practices are not used. Growing trees requires less water, and fewer chemical fertilizers and pesticides than growing annual energy crops, such as corn. In addition, the root systems in forests help filter pollutants in surface waters.

Regardless of their fuel source, most power plants require water for steam production and cooling. Water can be conserved if power plants elect to reuse it, although for various reasons there is a limit to how many times it can be reused. The water used for cooling is much warmer after circulating through the system and has often been treated with chemicals to prevent equipment corrosion. If water is released untreated into lakes or rivers, it can negatively affect water quality. Power plants are usually required to obtain a permit to release water used in this way and water quality is monitored (Sustainable Northwest 2005).

Both thermal and chemical water pollution can harm aquatic animals and plants and potentially pollute drinking water. It is important for communities to consider the condition of local aquatic resources and how energy decisions will influence those resources.

In terms of growing wood for energy, different species and practices will have different impacts on water quality. For example, some short rotation woody species may need larger quantities of water than slower-growing tree species. People and communities exploring the possibility of growing wood for energy production should carefully consider the potential impacts of various alternatives.

Public Engagement

Citizens, leaders, and industries can work together to develop local policies and guidelines that address and alleviate specific concerns about their energy systems. For example, in Burlington, Vermont, where a 50 megawatt wood-fueled facility was proposed, concern from members of the local community about maintaining nearby forests led to local development of strict environmental standards regarding tree harvests. Today, the local utility purchases only wood that is harvested in compliance with these standards, and as a result it is able to obtain energy from wood resources while assuring forest health and sustainability. Addressing community perspectives and concerns about energy generation choices is an important step to developing a comprehensive and sustainable energy plan (Figure 3). See the *Power to the People* case study for more information about this example.

Summary

Figure 3. *Public engagement can play a crucial role in successfully developing and implementing plans for a wood-to-energy facility.* Photo by Larry Korhnak.

Trees can be grown and harvested for energy with minimal environmental impact if proven management techniques are used. In terms of environmental impacts, growing trees for energy is favorable to converting forest land to development, which contributes to forest fragmentation and deforestation. Growing trees for energy is also less resource-intensive than conventional agriculture. Purchasing local wood can also help stimulate the local economy. There are environmental and economic benefits to using wood as one component of a community's energy system. Of course, each opportunity for energy production is unique, and environmental impacts depend on many variables. The type of wood, practices for producing and harvesting wood, and the technology used to convert it to energy ultimately determine how the environment will be affected. One way communities might reduce environmental impacts from woody biomass production is for the wood users or utility to require that all wood harvested from planted or natural forests be certified by one of the four programs that promote sustainable forest management.

For more information about using wood to produce energy, visit http://www.interfacesouth.org/woodybiomass and read other fact sheets, community economic profiles, and case studies from this program, or http://www.forestbioenergy.net/ to access a number of other resources.

References

Gresham, C. A. 2002. Sustainability of intensive loblolly pine plantation management in the South Carolina Coastal Plain, USA. *Forest Ecology and Management* 155:69-80.

Moller, I. S. 2000. Calculation of biomass and nutrient removal for different harvesting intensities. *New Zealand Journal of Forestry Science* 30(1-2): 29-45.

Power scorecard: Rating the environmental impacts of electricity products. 2000. http://www.powerscorecard.org/tech_detail.cfm?resource_id=1 (accessed May 3, 2007).

Sustainable Northwest. 2005. Community-based forestry perspectives on woody biomass, briefing paper. http://www.sustainablenorthwest.org/pdf/policy/biomass/biobrief.pdf) (accessed May 3, 2007).

U.S. Environmental Protection Agency. 2006a. Coal mining. http://www.epa.gov/maia/html/coal-mining.html (accessed May 3, 2007).

U.S. Environmental Protection Agency. 2006b. Electricity from non-hydroelectric renewable energy sources. http://www.epa.gov/cleanrgy/renew.htm#biomass (accessed May 3, 2007).

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