

HANDOUT 1 Electricity Production: Comparing Wood and Fossil Fuel Feedstocks

Woody biomass is a substantial renewable resource that can be used as a fuel to produce energy. This wood can come from a wide variety of sources, including land clearing for development, silvicultural activities (managing forests for timber production), urban tree and landscaping debris, and waste wood (bark, sawdust, wood chips, and wood scrap) (U.S. DOE, 2006a).

Energy can be produced from woody biomass in various ways. Wood-fueled power plants are capable of producing significant amounts of electricity and can be cleaner, renewable alternatives to many current power facilities that currently use fossil fuels (Northeast Sustainable Energy Association, 2001). In addition, woody biomass can be used to produce heat and power at facilities, such as hospitals and schools. Biomass has been the largest nonhydro renewable energy source for electricity in the United States since 2000 and offers some promising incentives for continued development and research of its use (Energy Information Administration, 2006). As technology improves, biomass is becoming a more attractive alternative to fossil fuels because it produces fewer emissions, contributes to local economies, mitigates global climate change, and can increase national security.

Cost

Cost is an important factor to consider when comparing fuel sources. Table 1 shows a comparison of the price of fuels measured in British thermal units (Btu). Depending on the type and proximity of the source and local supply and demand conditions, wood prices can be competitive with most fossil fuels.

The cost of using wood to generate energy can vary significantly depending on the technology used, the size of the facility, the wood transportation distance, and the cost of wood (Power Scorecard, 2007). For instance, if a wood-fueled facility is situated near the source of wood, fuel transportation costs will be lower, making the final fuel cost lower. Currently, the most inexpensive method of using woody biomass is co-firing, which involves burning two or more types of fuel together, such as coal and wood. Modifying an existing coal power plant to use wood is much less expensive than building a new, exclusively wood-fueled facility. The addition of wood and reduction of coal reduces overall air emissions and cuts down on emission control costs (Power Scorecard, 2007).

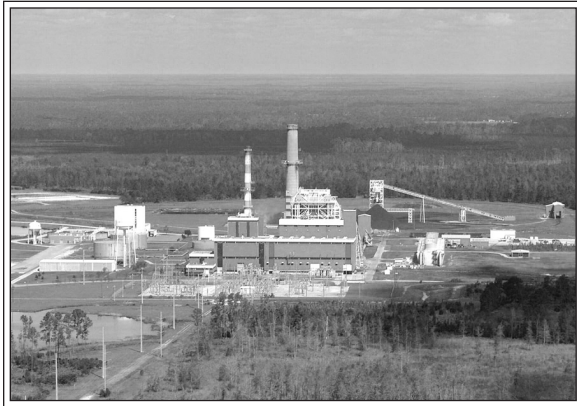
While coal has historically been significantly cheaper than wood, the price of coal has nearly tripled since November 2007 (Energy Information Administration, 2008). The full cost of coal is not included in the figures in Table 1. Because coal produces numerous toxic air emissions such as carbon dioxide, sulfur dioxide, nitrogen oxides, and carbon monoxide, which contribute to climate change, acid rain, water pollution, and health risks, its use comes with significant environmental and social costs that are not reflected in the price alone (U.S. EPA, 2007b). Communities may want to consider such indirect costs when deciding how to meet future energy needs (Figure 1).

Table 1: Approximate Price of Residential Heating Fuels in 2008
(ENERGY INFORMATION ADMINISTRATION 2008A).

Fuel Type	Dollars per million Btu
Oil (residential)	\$22.42
Wood*	\$9.09
Natural Gas	\$12.40
Coal	\$8.03

*The price of wood for fuel can vary depending on several factors, including the type of tree species. Energy Information Administration 2008a.

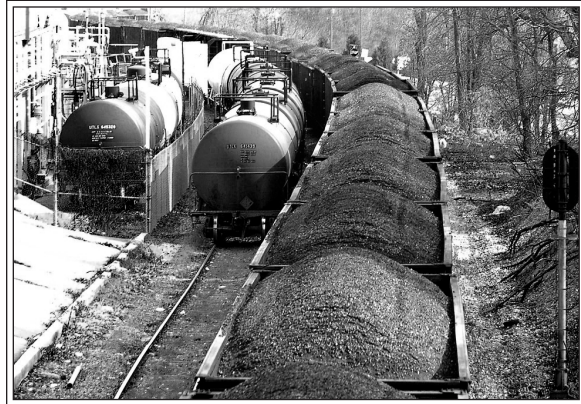
Figure 1: Fossil fuels, such as coal, may have non-economic costs associated with them. PHOTO BY LARRY KORHNAK, UNIVERSITY OF FLORIDA.



Environmental Impacts

Coal accounts for more than 57 percent of electrical generation in the United States. It is a popular fuel because of its abundance and low cost. However, the type of coal that has been used traditionally is also responsible for 93 percent of sulfur dioxide, 80 percent of nitrogen oxide, and 73 percent of carbon dioxide emissions that come from the electricity industry. Proper emission controls and new technologies can reduce the environmental impacts of using coal; yet, even with these improvements, emissions from burning coal can contribute to acid rain, urban smog, health problems, water pollution, and global climate change. Coal plants can also contaminate air and water with mercury, a toxin linked to a variety of neurological disorders. The environment is also impacted by the mining, processing, and transporting of coal (Figure 2). Surface mining heavily disturbs the land and contaminates the soils with heavy metals, threatening nearby water quality (U.S. DOE, 2006b). In some cases, coal is obtained through mountaintop

Figure 2: The mining, processing, and transporting of coal can negatively impact the environment. PHOTO BY LARRY KORHNAK, UNIVERSITY OF FLORIDA.



removal using explosives. This practice may detract from the safety, aesthetics, and quality of life for local communities (U.S. EPA, 2007a).

Natural gas creates fewer environmental impacts than coal, producing about half the amount of carbon dioxide, less particulate matter and nitrogen oxides, and negligible amounts of sulfur dioxide or mercury emissions. However, natural gas produces methane, a greenhouse gas that is twenty times more effective than carbon dioxide at trapping heat in the atmosphere, thereby contributing to climate change. Other environmental impacts associated with the drilling and natural gas explorations are erosion, landslides, and flooding (U.S. DOE, 2006b).

Biomass emissions can vary depending on the type of wood and technology that is used. If wood is the primary source for energy generation, very little sulfur dioxide is emitted. Nitrogen oxide and carbon monoxide are produced; however, emission levels of these vary greatly depending on the combustion facilities. The combustion of wood releases carbon dioxide into the atmosphere, but through the cycle of growing trees, using the wood, and replanting more trees, the carbon dioxide is recycled from the atmosphere. As long as trees are replanted at the same rate they are harvested and used, they take in approximately the same amount of carbon dioxide as is released during combustion. Therefore, using wood for energy does not contribute to climate change by adding more carbon dioxide to the atmosphere. Using wood as a fuel source can also help reduce release of methane by diverting waste wood from landfills.

Possible negative effects of managing forests for energy production are the change in wildlife habitat from periodic harvests and the decreased soil quality requiring the use of fertilizers (U.S. DOE, 2006b).

These effects can be addressed with proper forest management. For example, in order to ensure sustainable forest management, some communities have hired professional foresters to monitor the operations that provide wood for a wood-fueled facility. In many cases, the use of wood for energy can provide the economic basis for maintaining land in forests. If landowners cannot afford to maintain forestlands, they are frequently sold for housing developments and the many benefits of forestlands are lost forever.

Jobs

The current lack of employment opportunities in the rural United States is putting a burden on local economies, infrastructure, and the tax base. Using wood for energy can provide important economic benefits, such as local job creation, strengthening of forestry markets, and reduction of the national trade deficit (when the value of what we import is greater than the value of what we export) (Energy Information Administration, 2007b). Through construction, operation, maintenance, and support for bioenergy facilities, rural communities have the opportunity for more domestic jobs and increased local economic activity.

A study by the Renewable Energy Policy Project shows that co-firing biomass in existing coal facilities tends to offer more employment than coal-only operations. Furthermore, coal mining jobs are decreasing as the industry becomes more automated (U.S. DOE, 2005).

According to the National Renewable Energy Laboratory, by 2020, more than 30,000 megawatts of biomass power could be used nationwide. Approximately 60 percent of the fuel would come from energy crops and 40 percent would be supplied from woody biomass. This increase in biomass facilities could support more than 150,000 U.S. jobs that could contribute to the revitalization of rural economies (Singh and Fehrs, 2001).

National Security

Fossil fuel energy sources are nonrenewable and may not ensure a secure energy future for the United States. More than half of our daily needs of oil and petroleum products are imported each day. Increasing demand and dependency on foreign energy sources could affect the nation's economy by contributing substantially to the trade deficit. Furthermore, national security could be affected because most of the oil imported to the United States comes from politically unstable regions.

Facilities that use renewable sources of energy (e.g., biomass power plants) are typically small and geographically dispersed. They promote energy independence and provide an infrastructure that is not easily disrupted. Biomass resources can be derived from any location that can support agricultural or silvicultural production. Thus, biomass resources and facilities can be located almost anywhere in the country, broadening our resource availability and increasing energy security (National Renewable Energy Laboratory, 2000).

Summary and Conclusion

Both wood and fossil fuels offer certain advantages as fuels for energy production. While some fossil fuels under certain circumstances may be less expensive and utilize traditional and familiar practices, wood tends to be a more environmentally sound option. In addition, using wood can help foster national security, introduce new markets for forestry, and create local jobs. Because there is not enough wood to provide all of our energy needs, we need to look at a variety of sources and continued use of fossil fuels in the near future. While wood may not be a feasible or sensible option for every community, it may help support efforts to promote more sustainable and locally generated sources of energy. In deciding how to meet growing energy demands, each community will need to carefully evaluate the advantages and disadvantages of a variety of energy options.

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Monroe, M. C., L. W. McDonell, and A. Oxarart. 2007. Wood to energy outreach program: Biomass ambassador guide. Gainesville, FL: Florida Cooperative Extension Service, Circa 1526, University of Florida.

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HANDOUT **2** Woody Biomass Basics

In 2006, 7 percent of the energy consumed in the United States came from renewable resources. Roughly half of that amount, 3 percent total, was producing using some form of biomass (U.S. EIA, 2008). Biomass is organic plant or animal material that is available on a renewable basis (U.S. EIA, 2008). Biomass energy resources include food crops, grassy and woody plants, agricultural and forestry residues, municipal and industrial solid wastes, and landfill gas (NREL, 2008). These resources are renewable because, although individual trees and plants are consumed, additional trees and plants can be cultivated and grown relatively quickly, and municipal and industrial solid wastes are continually produced.

Plants grow by harnessing the sun's energy through photosynthesis. During photosynthesis, plants use the sunlight, carbon dioxide, and water to produce oxygen and glucose. The glucose (or sugar) is a form of chemical energy that is stored in the cells of plants or trees (U.S. EIA, 2008). This energy is released when the plants are eaten, decomposed, or burned. Whether burned or converted through a chemical process, biomass fuels release energy that can be used to produce heat, power, electricity, and transportation fuels.

Woody Biomass

Woody biomass is plant material from trees and shrubs that can include roots, bark, leaves, branches, limbs, trunks, and vines. Woody biomass can come from many sources, including forestry operation residues, wood product residues, urban waste wood, trees grown specifically for energy, fuelwood, and forest thinnings that reduce damage from fires and pests.

Forest Operation Residues Residues are branches, tree tops, stumps, and other woody debris left behind after trees are harvested for timber. Removing

and selling these residues for energy production can provide landowners with additional income and improve forest health by reducing susceptibility to wild-fire, insects, and disease.

Figure 1: Forest operation residues. PHOTO COURTESY OF DIOMY ZAMORA, UNIVERSITY OF MINNESOTA.



Wood Products Residues Sawdust, scraps, and other wood waste from industries that make products from wood, such as cabinet and furniture companies, can also be used to produce energy. Many wood product facilities use their own wood waste to produce heat, steam, or electricity for their operation. This reduces costs and utilizes a waste product. In some cases, industries can even sell surplus energy to local power companies.

Urban Waste Wood and Yard Waste Each time utility workers clear trees from power lines or homeowners trim their hedges, woody biomass is piled up and removed. This biomass is often mulched, taken to a landfill, or burned without emission controls. Waste wood resulting from storms and land clearing also produce woody debris, but these sources are not consistent or sustainable over the long term. Woody biomass from urban waste wood and yard waste can also be used to produce energy. People generally have to pay to dispose of urban waste wood; however, if

a local wood energy market existed, this wood might represent a reasonable source of inexpensive energy.

Figure 2: Woody biomass from urban waste wood and yard waste can be used to produce energy. PHOTO COURTESY OF RANDY CYR, GREENTREE TECHNOLOGIES.



Energy Plantations Just as trees can be grown for lumber, they can be produced in forestry plantations for energy. Just as we grow fields of wheat for food, we can grow fields of trees to produce energy. Some species of trees or woody crops, known as short-rotation woody crops, grow quickly and also resprout after they are trimmed. Examples of short-rotation woody crops are hybrid poplar and willow. These crops produce a lot of biomass in a short time and can be harvested repeatedly before they have to be replanted. Though this form of energy wood tends to be more expensive than some wood waste, it could be a reasonable option in some places, especially on degraded lands that cannot support healthy, natural forests or be used for growing food crops.

Forest Restoration and Health Improving forest health and restoring certain ecosystems to the naturally occurring forest type typically involves removing unwanted trees and other vegetation to reduce crowding and promote healthy tree growth. Small diameter trees may need to be removed in a process called thinning, to reduce the risk of wildfire and insect pest or disease outbreaks. If the removed biomass can be sold for energy, it might help landowners pay for removal efforts.

Fuelwood In addition to residues, waste, and dedicated energy crops, pulp wood and commercial grade timber can be used as an energy or bioproducts feedstock. When used this way, the fiber is called “fuelwood.” In 2005, approximately 35 million dry tons of fuelwood was used in the residential and commercial sectors where it was harvested and burned for space and process heat (U.S.DOE and USDA 2005). Harvesting fuelwood may become more feasible in

areas where the forest products industry is not buying or paying competitive market prices for pulp and commercial grade wood due to mill closures, market shifts, or other reasons.

Figure 3: Short rotation woody crop grow very quickly. For example, the hybrid poplar trees pictured above are only six years old. PHOTO COURTESY OF DIOMY ZAMORA, UNIVERSITY OF MINNESOTA.



Summary and Conclusion

Woody biomass can provide a locally available, renewable source of energy that can be combined with other energy options to help meet growing energy needs. A combination of energy conservation, using multiple renewable energy sources, and managing population growth, is the most likely recipe for success when it comes to meeting energy needs in an environmentally, socially, and economically sustainable way.

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HANDOUT 3 Agricultural Biomass

Agricultural biomass is a relatively broad category of biomass that includes: the food-based portion of crops (such as corn, sugarcane, and beets), the nonfood-based portion of crops (such as corn stover [the leaves, stalks, and cobs], orchard trimmings, and rice husks), perennial grasses, and animal waste. Traditionally, there have been high costs associated with recovering most agricultural residues, and therefore, they have not yet been widely used for energy purposes. However, they can offer a sizeable biomass resource if technology and infrastructure are developed to economically recover and deliver this type of biomass to processing facilities.

Food-based Portion of Crops (oil and simple carbohydrates)

The food-based portion of crops is the part of the plant that is either oil or simple sugars. Rapeseed, sunflower, soybeans, corn, sugarcane, and sugar beets are all examples of this type of agricultural biomass. The sugar from corn, sugar beets, and sugar cane are commonly fermented to produce ethanol. Oilseed crops such as rapeseed, sunflower, and soybeans can be refined into biodiesel.

Nonfood Based Portion of Crops (complex carbohydrates)

The nonfood based portion of crops is the part of the plant that is commonly discarded during processing for food production. This category includes materials such as corn stover; wheat, barley, and oat straw; and nutshells. Stover and straw are fermented into ethanol. Nutshells are typically refined into biodiesel or combusted for heat. Due to the important function of crop residues in erosion protection and overall soil quality, care must be taken on a site-by-site basis to ensure sustainability.

Figure 1: Corn is one example of the food-based portion of a crop. It is primarily fermented into ethanol. PHOTO COURTESY OF WARREN GRETZ, NATIONAL RENEWABLE ENERGY LABORATORY.



Figure 2: The nonfood based portion of crops is commonly discarded but can be used to make bioproducts. PHOTO COURTESY OF WARREN GRETZ, NATIONAL RENEWABLE ENERGY LABORATORY.



Perennial Grasses

Perennial grasses are grasses that have a life cycle of several years. Some examples include big bluestem and switchgrass. The advantage of perennial grasses is that they have a low nutrient demand, a large geographical growing range, and high net energy yields (Downing et al., 1995). Perennial grasses are pre-treated to break down cellulose and then fermented into biofuels such as cellulosic ethanol.

Figure 3: *Switchgrass*. PHOTO COURTESY OF ART WISELOHEL, NATIONAL RENEWABLE ENERGY LABORATORY.



Animal Waste

Beef cattle, dairy cattle, hogs and poultry produce manure, which can be used to produce energy. Manure is typically categorized as a liquid, slurry (a mix of liquid and solids), or solid. In its solid state, manure can be burned for heating and cooking or to produce a gas for energy production. As a slurry, manure releases methane (CH_4), which can be captured to produce heat, power, electricity, and biofuels.

Figure 4: *Feedlot operations result in large quantities of manure which can then be used to produce energy.* PHOTO COURTESY OF BRIAN PRECHTEL, AGRICULTURAL RESEARCH SERVICE.



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HANDOUT **4** Implications of Using Woody Biomass for Energy and Other Products

Like with many natural resource-related issues, the production and utilization of woody biomass for heat, power, electricity, transportation fuels, and industrial-scale bioproducts can be controversial. Like all feedstocks, woody biomass has benefits and costs that must be carefully considered.

Advantages

Some potential advantages of producing and utilizing woody biomass for bioenergy, biofuels, and bioproducts are:

Wildfire Mitigation and Healthy Forests Landowners have the opportunity to market materials for biomass that are removed during forest management activities, such as those that help reduce wildfire risk and prevent insect infestations and disease.

Economic Development Markets are key components of the woody biomass value chain. Viable, local biomass markets provide financial opportunities for bolstering rural communities, providing additional income to forest landowners, insuring local flow of money, and diversifying local economies. Woody biomass production and use can also create new jobs, further stimulating local economies.

Increased Energy Security The United States is vulnerable to oil supply disruptions and price increases because it imports much of its oil from politically unstable countries. Woody biomass offers an opportunity to lessen the dependence on foreign supplies of fossil fuels by providing an alternative, “homegrown,” renewable source of energy.

Environmental Benefits Wood offers many environmental benefits including improved air and water quality, incentives for better forest management, and reductions in greenhouse gases. When burned, trees do not add more carbon dioxide into the atmosphere than they removed while growing. As long as trees are replanted, wood is an essentially carbon-neutral energy source. Fossil fuels, on the other hand, release carbon that was sequestered thousands of years ago.

Disadvantages

Some potential disadvantages of producing and utilizing woody biomass for bioenergy, biofuels, and bioproducts are:

Size of Facility Power plants that strictly use wood cannot typically be built to produce as much power as their traditional coal-fueled counterparts. While a large wood plant may produce up to 50 megawatts of power, coal plants can be built to produce thousands of megawatts.

Sustainable Supply of Wood Needed Communities need an ample, sustainable supply of wood in order for a woody biomass facility to be successful. For example, urban areas surrounded by expansive suburbs do not lend themselves to wood supply accessibility. Wood must be plentiful and relatively easy to access and transport.

Loss of Soil Fertility and Habitat Change Removing debris that would otherwise become organic matter under natural conditions may have long-term negative effects on soil fertility and wildlife habitat. Woody

biomass utilization must incorporate management standards based on sustainability and facilitating a healthy forest ecosystem, including the health of the soil and wildlife habitat.

Wood May Not Be Cost Competitive The cost of woody biomass varies depending on location, availability, type and quality; environmental regulations; and transportation and processing options. In some communities and at some scales, wood may be more expensive than traditional fossil fuels, such as coal.

Is There Enough Wood to Meet Our Needs? Concerns exist about whether or not there are sufficient amounts of wood for wood-based needs: paper and timber, energy, green landscapes, recreation, wildlife habitat, and watershed protection. The emergence of new and growing markets for bioenergy and biobased products will likely place an even greater burden on already heavily used forest resources, further supporting the need for sustainable forest management and effective land-use and energy policies

Summary and Conclusion

Like all feedstocks, the production and utilization of woody biomass has advantages and disadvantages that should be weighed carefully as individuals, industries, and communities decide whether or not to choose wood. While no energy source or raw material is perfect, wood may be a viable option in some cases.

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HANDOUT 5 State and Local Policies and Incentives to Produce and Use Woody Biomass

Several policies related to renewable energy, including woody biomass, have been established in the U.S., including generation disclosure rules, renewable portfolio standards, interconnection, construction and design standards, and green power purchase. These regulations can be implemented at the state or local level or by regional utilities.

State and Local Policies

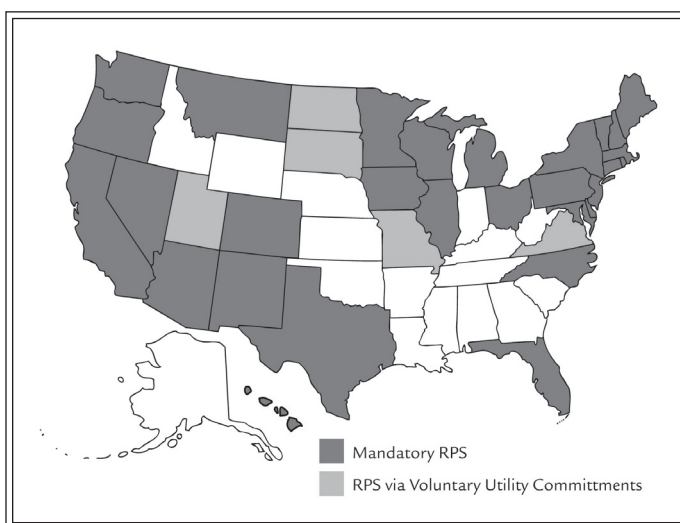
Generation Disclosure Rules require utility companies to provide information regarding the energy they supply to their customers, which may include fuel mix percentages and emission statistics (North Carolina State University, 2007).

Renewable Portfolio Standards/Set Aside require that utility companies generate a certain amount of their energy from renewable resources, such as wood, wind, and solar by a determined year. The term “set aside” refers to similar regulations that require new utility installations to have a certain amount of generating capacity from renewable resources (North Carolina State University, 2007).

Interconnection or Line Extension Analysis exists in many states. When power lines are extended to customers outside of the existing power grid, the customers are charged distance-based fees. In some of these cases, it may be more economical for customers to generate their own energy on-site using renewable energy systems rather than pay the extra fees associated with distance (North Carolina State University, 2007).

Construction and Design Standards may require an evaluation of the costs and benefits of using renewable energy technologies for new state construction projects, such as schools, office buildings, and other new facilities. In addition, green building guidelines are being developed in many cities to either encourage or require design and construction projects to consider renewable energy technologies. Local energy codes are another type of standard that can be implemented to increase energy efficiency by requiring building construction or renovation to exceed the state requirements for resource conservation. Builders or renovators can meet this requirement by incorporating renewable energy technologies (North Carolina State University, 2007).

Figure 1: Several states have implemented Renewable Portfolio Standards. PEW CENTER ON GLOBAL CLIMATE CHANGE 2008.



Green Power Purchasing/Aggregation Policies allow state and local governments, businesses, and other nonresidential customers to serve as role models to the rest of the community by purchasing electricity from renewable resources, through a practice commonly called green power purchasing. Some states even require that state government buildings use a certain amount of renewable energy. The process by which local governments combine electric loads from the whole community, or in cooperation with other communities, to form a green power purchasing block is called “community aggregation” or sometimes “community choice” (North Carolina State University, 2007).

Green Pricing Programs offer customers the option to pay an additional fee beyond their regular electric bills to support the utility’s effort to provide power from renewable sources. Customers who participate in these types of programs do not receive “green energy” directly, but rather help enhance the utility’s ability to generate or purchase more of its power from renewable sources (Pew Center for Global Climate Change, 2008). In 2006, there were 484 electric utilities in 44 states now offering green power to their customers (U.S. DOE, 2008). Some states have mandatory green pricing programs, where utilities are required to offer customers the option to purchase power from renewable energy sources, while in other states it is voluntary for utilities.

Figure 2: *The majority of states offer green pricing programs.*
PEW CENTER ON GLOBAL CLIMATE CHANGE 2008.

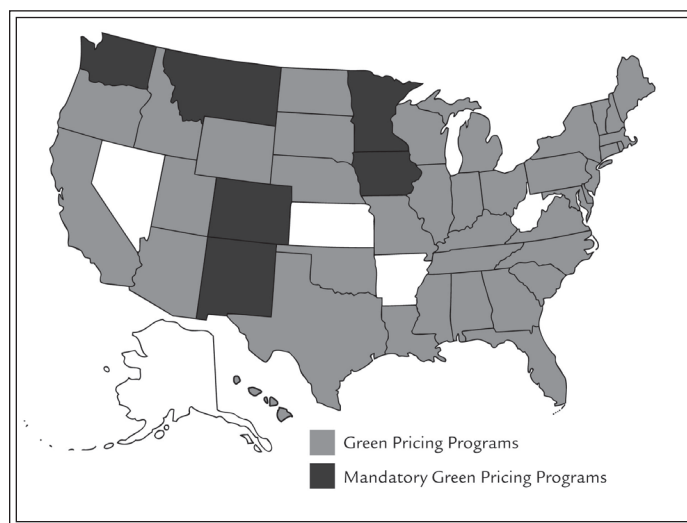
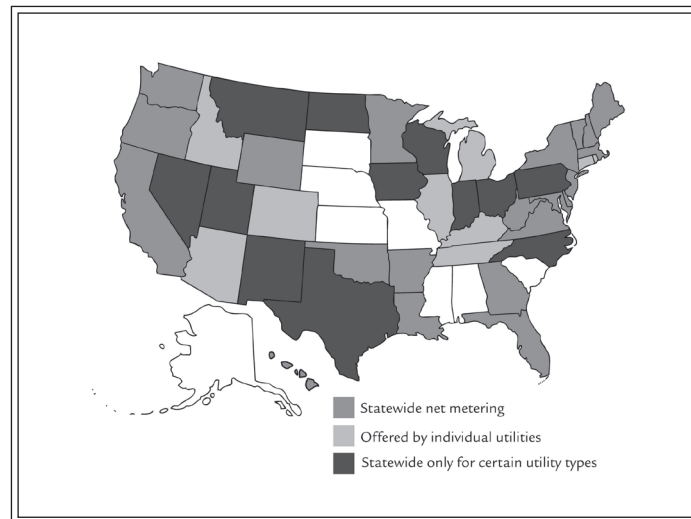


Figure 3: *More than 20 states have statewide net metering statutes.* PEW CENTER ON GLOBAL CLIMATE CHANGE 2008.



State and Local Incentives

Net Metering is a system for customers who have their own electricity generating units. When customers generate more electricity than their demand, the excess electricity is provided to the local power grid. The customers’ electric meter keeps track of the excess electricity as credit toward future power purchases (North Carolina State University, 2007). Twenty-one states and the District of Columbia had statewide net metering statutes in 2008 (Pew Center for Climate Change, 2008).

Public Benefit Funds (PBF) are used to support efforts such as energy efficiency, renewable energy projects, and programs for low-income households. The money for these support funds is commonly acquired by charging customers an added fee based on their electricity consumption. For example, the customer may be charged 0.2 cents for each kilowatt hour used. These funds can be used for rebates on renewable energy systems, funding for renewable energy research and development (R&D), and development of renewable energy education programs.

Various state and local incentives also exist for generating energy from renewable resources, including woody biomass. Incentives are usually expressed in state and local policies in the form of tax credits, rebates, grant and loan programs, or industrial and production incentives (Werner, 2004). For example, in Florida, a comprehensive four-year plan, the Florida Renewable Energy,

Technology & Energy Efficiency Act of 2006 provides rebates, grants, and tax incentives in order to increase the state's investments in renewable energy resources such as solar, hydrogen, and biofuels (Florida Energy Office, 2006).

As renewable and local sources of energy become more valuable, a variety of policies and incentive programs may make it easier for communities, industries, and forest landowners to develop woody biomass systems.

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Rahmani, M.; A. W. Hodges, and M. C. Monroe. 2007. *Federal Policies and Incentives*, Wood to Energy Outreach Program. Florida Cooperative Extension Service, Circ 1526. University of Florida, Gainesville, FL,

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HANDOUT **6** Financing a Bioenergy Project

There are many federal, state, private, and foundation-based funding opportunities for research and training activities in bioenergy production, utilization, and commercialization. This handout primarily focuses on funding opportunities for the commercialization of woody biomass. Commercialization of any new energy source using new technology is considered new product development until a commercial-sized energy facility is successfully operated for an extended period of time on a consistent basis. For some communities and industries considering wood-to-energy facilities, it may be possible to tap financial resources that are typically reserved for the commercialization of new technology.

The financial services sector, be it a Wall Street venture capital group or a “Main Street” bank, possesses an institutional fear of anything new and unproven. Though woody biomass has been used in small-scale projects for years, bioenergy companies may have trouble raising equity because many woody biomass-related projects and entrepreneurs are rural-based businesses that have yet to demonstrate the viability of the technology and the ability to penetrate the marketplace. They may also lack the proven managerial and marketing expertise needed in order to be successful. For some venture capitalists located almost exclusively in the nation’s cities, a rural start-up business commercializing an agricultural-based product is unfamiliar. Others, however, may be looking for those unusual and risky but potentially highly rewarding opportunities that lie outside the mainstream.

Despite these challenges, various sources of funding are available if entrepreneurs and companies know where to look. These sources not only provide funding but alleviate the worries and trepidation on the part of the borrowing and lending communities.

In addition to owner equity, which is, of course, essential, a project may obtain grants, tax credits, state

and local incentives, bonds, appropriated dollars, loans, guarantee loans, and other financial resources to make the project commercially viable. Therefore when beginning a project, planners should seek out experts who can identify funding, open doors, find private and public lending resources, and arrange for these multiple funding sources. Doing so can greatly reduce the time and expense incurred during the commercialization phase and can also reduce the amount of private capital needed for a successful venture.

Start-up ventures are the most difficult to finance and may require the most steps and financial resources. One of the best sources of funds especially for start-ups can come from the very group with the most to gain from commercialization—the growers or producers who supply the biomass feedstock. By contributing cash or even a supply of raw materials, forest landowners can receive equity and a return on their investment if the company’s commercialization efforts are successful. Also, in some cases, the raw material can be counted as an asset that can be used to attract debt financing.

Federal, state, and local government assistance may be available in certain cases. This assistance can come in the form of direct appropriations, tax abatements, tax increment financing for infrastructure financing, and even grants for job training and other assistance. Also, federal tax credits may be available, which can be used by the investors or, in some cases, sold and converted to cash and used to attract debt financing. All of these sources can be difficult to obtain without the assistance of someone familiar with the appropriate public entities, funding sources, and governmental officials.

Other sources available to those new ventures fortunate enough to find them are known as “angels.” Angels are investors who are bullish enough on the new venture to provide the early stage investment

necessary to get it off the ground. Angel investors are usually more patient investors than venture capital firms and may not require the substantial return on investment normally sought by venture capital firms, or they may accept delayed repayment.

Companies already in business manufacturing and selling value-added products have some attractive sources of financing unavailable to start-up companies, because lenders prefer companies with a track record. Even more attractive terms and rates may be available under certain circumstances. Existing companies can form special subsidiaries or nonprofit entities for the purpose of developing new sources of energy.

The following sections describe some of the many resources available and the governmental sources that provide them. Note: specific terms and dollar amounts will change with time. It is always advisable to research specific, up-to-date information when planning project financing.

U.S. Department of Agriculture

Business & Industry (B&I) Guarantee Loan Program The B&I Guarantee Loan Program provides up to a 90 percent loan guarantee to banks for businesses located in areas with 50,000 in population or less. The primary objective of the program is creation or preservation of jobs in rural areas. Loan proceeds may be used for working capital (seven-year amortization), machinery and equipment (fifteen-year amortization), buildings and real estate (up to thirty-year amortization), and certain types of debt refinancing. The maximum loan amount is \$40 million, and loans can include a fixed interest rate. Personal guarantees are required along with a minimum of 25 percent tangible equity for companies that produce energy from renewable sources. Obtaining the guarantee is a complicated process but is well worth it. It is especially helpful in small communities with small lenders that have limited lending capacity. A 70 to 90 percent loan guarantee can permit these small banks to make loans that otherwise would be considered too risky or do not meet established lending guidelines.

Rural Utilities Service (RUS) Approximately \$200 million in direct loans is available through USDA's Rural Utility Service for electricity produced from biomass energy that is generated for sale to rural utilities and power companies with a significant "rural customer load." Loan interest rates are tied to municipal bond rates and the rate is a fixed rate that is amor-

tized for 25 years. This loan requires cooperative arrangement with local rural electric cooperatives or other power companies with a significant rural customer load. The technology must be "proven" and "renewable," however, the equity requirement for the borrower is flexible.

Renewable Energy Grant and Loan Program The USDA Rural Business Service offers entrepreneurs a grant and guarantee loan program. Commercial entities and agricultural and forestry producers are eligible. This program has \$11.4 million available for grants and \$176 million in guarantee loan authority available for projects that produce energy from renewable sources. Grants can cover 25 percent of eligible project costs and guarantee loans can be for up to 50 percent of project costs. Loan terms are similar to B&I loan terms and conditions. Companies must demonstrate financial need in order to qualify.

Value-Added Agricultural Product Market Development Grants The Rural Business-Cooperative Service now offers grants to help independent producers, such as forest owners, enter into value-added activities. The primary objective of this grant program is to help eligible applicants develop business plans and strategies for viable marketing opportunities. Grants of up to \$500,000 are available. All applicants must be producers of agricultural commodities or products, including aquaculture and wood lot enterprises. Grants are available for planning and working capital.

Biomass Research and Development Initiative (BRDI) The USDA and U.S.DOE jointly administer the BRDI to provide assistance for research, development, and demonstration of biomass-based products, bioenergy, and biofuels. The intent is to promote greater innovation and development related to biomass. Technical topic areas include feedstock development and production, biobased product development, environmental and economic performance, integrated resource management and biomass use, and incentive analysis for commercialization. Approximately \$15 million is available for grants in each fiscal year. The maximum grant amount is \$2 million and requires a 20 percent match by the applicant. Pre-applications are due in February and the full applications are typically due in April.

Cooperative Services For cooperative-owned businesses, there are special programs by USDA that may include grants for projects that support the use of renewable fuels. This may involve a partnership with

a nonprofit or university if further research and development is involved. These programs are typically for energy projects involving farmer or producer-owned entities. However, even a utility can access these programs if an alliance with producers is established to provide the necessary feedstock to produce energy.

Economic Action Program The U.S. Forest Service has in recent years offered funding for projects utilizing woody biomass for value-added purposes. The Economic Action Program is designed to assist projects meeting the following objectives.

- **RURAL DEVELOPMENT:** Encourages rural communities through education and seed money to develop natural resource-based opportunities. Emphasis is on addressing community-identified needs and working with businesses.
- **ECONOMIC RECOVERY:** Assists rural communities experiencing acute economic problems associated with changes in natural resource management to diversify and expand their economic potential.
- **WOOD IN TRANSPORTATION:** Provides cost saving options to rural communities to rebuild or replace their transportation and recreation infrastructure while stimulating diverse markets for local wood products.

It is uncertain if this program, which historically has been funded at levels of approximately \$25 million, will be funded each fiscal year.

In addition to these USDA programs there are other economic development programs that can be accessed to provide grants, equity, and favorable rates and terms for debt financing. Following is a description of some of these programs.

U.S.DOE Tribal Energy Program Grant

This federal grant program administered by U.S.DOE's Office of Energy Efficiency and Renewable Energy (EERE) provides financial and technical assistance to Native American tribes for feasibility studies and shares the cost of implementing sustainable installations that use renewable energy sources on tribal lands. Eligible technologies include the use of passive-solar space heat, solar water heat, photovoltaics, wind, biomass, hydroelectric, geothermal, electric, and geothermal heat pumps. Eligible applicants are tribal governments. The program provides approximately \$2.7 million in funding, with \$1 million going

to the Council of Energy Resource Tribes (CERT) and \$1.7 million available for other applicants.

New Market Tax Credits

Congress created the New Market Tax Credit program to encourage \$15 billion in investments in low-income communities. Qualified Community Development Entities (CDEs) are eligible for allocations of credits and must apply to the Community Development Financial Institutions (CDFI) Fund for an award of New Market Tax Credits. The CDE then seeks taxpayers to make qualifying equity investments in the CDE. Equity investments or loans are then used to make Qualified Low-Income Community investments in Qualified Active Low-Income Businesses in low-income areas. The investors are eligible to claim a tax credit equal to 39 percent of the total investment in the CDE.

Revenue Ruling 63-20 Bonds

These tax exempt bonds can be used to provide long-term fixed rate loans for projects with a purpose that is "public in nature." Bonds are issued by local governments on behalf of a nonprofit entity. The political subdivision issuing the bonds must have a beneficial interest in the nonprofit entity while the indebtedness remains outstanding. The political subdivision must obtain full legal title to the property upon debt retirement.

Tax Increment Financing (TIF)

These bonds are issued by local governments for infrastructure improvements in an area predetermined to be part of a "tax increment financing district." Bond proceeds are used to entice businesses to bring revenue-producing properties to an area. Bonds are retired by the property and/or sales taxes generated by businesses locating in the tax increment district. These bonds are an excellent way to offset the costs of infrastructure associated with a project that produces energy from renewable sources.

General Obligation and Revenue Bonds

General Obligation/Revenue Bonds issued by the state, county, or municipality provide long-term, fixed rate financing at tax exempt bond rates. With these bonds the government is obligated for repayment of debt that is issued as a means to attract new industry and economic development to an area.

State and Local Government Incentive Programs

Perhaps the best source of funding may be found right at home through your own state's economic development agency. These agencies are in business to attract and create jobs and offer many incentives that can complement private and other governmental programs. Types of assistance available may be in the form of grants, direct loans and loan guarantees, infrastructure financing, tax credits and abatements, and even job training programs for workers.

Food, Conservation, and Energy Act of 2008

Formerly known as the 2008 Farm Bill, the Food Conservation and Energy Act of 2008 reauthorized 2002 Farm Bill programs. It provides grants for investment in renewable technologies, financial incentives to use agricultural and forestry crops for bioenergy, and establishes a biobased markets program. The Food, Conservation, and Energy Act of 2008 includes several new provisions that address biomass and bioenergy. It allots \$1 billion for programs designed to encourage investment in renewable energy and technology. The Act also creates the Rural Energy for America Program (REAP), which assists agricultural producers and rural small businesses in planning and preparing feasibility studies for renewable energy projects. The Bioenergy Program receives \$300 million in funding to provide incentives for using agricultural and forestry crops and waste to produce bioenergy and provides for multi-year contracts for crop and forest producers to grow dedicated energy crops. In addition, the Act establishes the Biobased Markets Program, designed to provide a USDA certification system for qualifying biobased products. This provision also establishes a federal procurement preference for biobased products.

Summary and Conclusion

This is a brief review of the types of financing that are available to support woody biomass energy. Of course, other programs and funding sources may exist, and potential biomass program developers should explore all options prior to beginning any new venture. In addition, organizations should also seek enough funding to make it through the lean times that always occur during the early stages of new ventures. And funds should be sought and set aside for marketing, ongoing product research and development, and other business contingencies.

The lending community's appetite for the use of renewable energy sources has never been greater. However, due to the lack of understanding and the anxiety associated with funding "out-of-the-box" ventures, it is imperative that the entrepreneur use any and all means necessary to buy down the size of the funding needed with tax credits, grants, and other governmental assistance and seek loan guarantees, third party feasibility studies, and other means to mitigate the risk exposure for lenders.

This handout was adapted from the following source and used with permission.

Crain, B., A. W. Hodges and M. C. Monroe. 2007. Financing woody biomass facilities. In *Wood to energy outreach program: Biomass ambassador guide*, eds. M. C. Monroe, L. W. McDonell, and A. Oxarart. Gainesville, FL: Florida Cooperative Extension Service, Circa 1526, University of Florida.



HANDOUT **7** Common Concerns

As a community considers whether or not to use wood for energy and other biobased products, residents and leaders must weigh various factors, such as existing energy sources, existing facility permits, air quality, available supplies of wood, the environment, and economics. This handout explores common questions about biomass utilization technology to help individuals and communities with this decision.

Question 1: Will a wood-to-energy facility produce a lot of air pollution?

Many people worry that burning wood or wood-based fuels will affect air quality. They might associate burning wood with burning coal, believing that both sources of energy produce more emissions than natural gas. Indeed, the American Lung Association reports that burning wood in fireplaces, wood stoves, and campfires is the largest source of particulate matter emissions generated by residences, and the U.S. Environmental Protection Agency has linked particulate matter emissions to respiratory illnesses, such as asthma (American Lung Association, 2000).

However, unlike the process of combustion of wood in a fireplace or campfire, which is uncontrolled and sends unfiltered smoke directly into the air, a modern power plant that uses wood controls the combustion temperature, the moisture level, and the size of the wood particles, all of which reduce air pollutants. Air emission control devices can also capture and filter pollution. These processes greatly reduce the amount of pollution produced by the wood-burning facilities.

Question 2: Will burning cellulosic ethanol (ethanol made from wood) in vehicles produce a lot of air pollution?

When cellulosic ethanol is burned in a vehicle, there are significantly fewer greenhouse gas (GHG) emissions than when gasoline is used. In fact cellulosic

ethanol has the potential to lower GHG emission by up to 86 percent (Department of Energy, 2008). The higher the amount of ethanol blended with gasoline the lower the resulting GHG emissions.

Question 3: If we use wood for electricity and other bioproducts, will we lose all our forests?

Unlike fossil fuels, wood is a renewable resource and with proper management local forests can produce wood for centuries. In some communities, waste wood from utility line trimmings or from forest operations can be used to supply wood-to-energy facilities so that additional trees are not harvested. Our Cost and Supply Profiles include estimates of wood supplies based on current forest harvesting practices and urban waste resources from selected communities. Residents would not notice any loss of nearby forests if extracting these amounts of wood.

Some people are concerned that if wood is such a good solution to providing energy or other products, everyone will start harvesting and using wood. Indeed, competition for wood within a region is an important factor when considering a wood-using facility. From an economic perspective, however, an increase in competition should drive the price of wood higher, which could encourage more forest landowners to plant trees for future feedstock needs. This could also eventually make it uneconomical to burn wood. No facility wants to use up its fuel source faster than fuel can be provided, so it is not likely to propose a risky endeavor. Still, there can be differences of opinion about how much harvesting will negatively impact soil, water, and wildlife resources.

Moreover, woody biomass utilization facilities may in some situations help maintain forests by increasing their economic value. As a result of increased competition from international wood suppliers and increased land values here at home, the markets for

small-diameter, low quality wood have been declining in some parts of the country over the last decade. Providing a new market for wood and increasing the price of wood could allow forest landowners to make a living from their land and resist offers to sell their property to developers. Their working forests, if sustainably harvested, can provide a green landscape for both aesthetic and conservation purposes, which may be for many communities a preferable alternative to the addition of more subdivisions and shopping plazas.

Question 4: If we use the waste wood from logging operations for fuel, will we deplete the forest of all its nutrients?

Whenever trees are harvested, the branches, leaves and stumps unsuitable for pulp or lumber are left behind as waste. While leaves and stumps are generally not removed, the wood from branches and other residue can be collected and used as feedstock for biomass utilization facilities.

It is possible to reduce soil nutrients over time through intensive agriculture if nutrients are removed faster than they are replaced. In these agricultural systems, nutrient-rich plants are harvested annually. Harvesting corn, for example removes 120 kilograms per hectare (kg/ha) of nitrogen every year, which is typically restored by adding fertilizer.

Nutrient removal from harvesting trees, however, is low in comparison (5 kg/ha per year for loblolly pine trees) because most of a tree's nutrients are contained in the leaves, not the wood. Leaves fall off branches and are difficult to collect. By minimizing the removal of leaves when harvesting wood, nutrient loss can be kept very low.

Question 5: Will the cost of energy from a wood-to-energy facility be too high?

If a new facility is needed, the cost of construction is likely to be significant, as it would be for any energy generating complex. The annual operating cost associated with facilities that use wood depends largely upon the size of the facility, fuel sources, and proximity of fuel wood available. By using waste wood, sizing the facility to match available resources, and choosing a site that minimizes transportation costs, a wood-to-energy plant can be an attractive alternative to one that burns fossil fuels. Vast fluctuations in the cost of fossil fuels coupled with large increases in cost have also made alternative fuel sources, such as wood, economically attractive.

There are additional costs and benefits of a woody biomass energy facility that are not often included in an economic analysis that, nonetheless, make a big difference in quality of life. For example, the enjoyment one might get from viewing a forest on the way to work, the satisfaction that one's electricity is stimulating the local economy and not contributing to climate change, and the security of having a locally produced fuel source are all advantages not easily calculated in an economic analysis.

Question 6: Has wood-to-energy technology been tested? Should we wait until we know more?

There are already facilities in the country that use wood waste to run machinery and produce electricity. Sawmills and paper mills frequently use their own bark and wood debris to power their equipment, and have been doing so for decades. Other facilities purchase wood or accept waste wood and generate power (see the Chapter 8: Case Studies). The generation of this type of power is not a new concept; the technology is readily available and trustworthy. Additional technologies have not yet been tested on large scales or over a long time but are rapidly emerging, such as converting wood to gas, ethanol, and oil.

Question 7: Are we better off using other alternative energy sources, like solar and wind?

Many people consider solar or wind energy preferable because these sources are continuous and do not involve combustion. Indeed, both solar and wind energy represent promising approaches to meet current and future energy needs. On a national level, shifting to sustainable sources of energy will involve a combination of solar, wind, and biomass. However, neither solar nor wind energy currently represents a viable option for large-scale power production in the most parts of the country. With current technology, solar energy is best suited to supplying individual homes with hot water, heat, and electricity. It is currently too expensive to produce energy in a utility plant. Wind is a less consistent energy source in some parts of the country than in others for large-scale facilities. Both solar energy and wind are available during limited times and therefore require energy storage systems. Wood is essentially a form of stored solar energy that is convenient to use.

Question 8: How does wood compare to coal and natural gas?

Coal and natural gas are fossil fuels widely used to generate electricity. Coal-fired power plants require air pollution control devices to keep sulfur and mercury out of the air. The combustion of natural gas and wood does not emit much sulfur and mercury, and tends to have smaller amounts of nitrogen oxides and carbon monoxide than coal. The combustion of wood from fast-grown trees, however, may emit some metals, but far less than coal.

Cost comparisons among the resources show that the cost of wood is dependent upon the source and distance from the facility (see the Massachusetts Supply Profile found in appendix F of this program) and other factors. Coal is relatively available and cheap (between \$5 and \$6 per million Btu), and the price of natural gas fluctuates considerably but has been high enough to cause utility operators to consider other fuels. Because wood is locally available, the money that is spent to buy the wood stays in the local economy, supporting local jobs. If your community does not produce coal or natural gas, spending money to buy these fuels takes money out of your local economy.

Using local wood for energy is one step toward becoming more self-sufficient and sustainable. Using a locally available energy supply may help increase awareness and knowledge of how we produce, use, and conserve energy. Finally, wood also differs from fossil fuels in terms of carbon and climate, which is explained in the answer to question 9.

Question 9: Doesn't wood put carbon in the air, just like fossil fuels?

Wood, coal, and natural gas are made of carbon-based compounds. Burning them releases carbon, which becomes carbon dioxide in the atmosphere. Decomposing wood releases the same amount of carbon, which eventually goes into the atmosphere or the soil. The big difference between wood and fossil fuels is that the carbon released by burning or decomposing wood has been recently circulating through the atmosphere. Growing plants and animals absorb and release carbon every day, and cycling this amount of carbon is a benefit that our ecosystems provide to us. Burning coal and natural gas releases fossilized carbon that has been out of the system for millions of years. This newly released carbon, when added to the atmosphere, is thought to be responsible for a significant amount of the changing global climate. In

addition, the newly planted trees that replace those harvested for energy will absorb the same amount of carbon during their lifetime.

Summary and Conclusion

Many of the concerns about using wood for energy are based on elements of truth. Across the country, variations in topography, industrial forests, energy availability, harvesting practices, road networks, and population density affect projections about the possibility of using wood for energy and other products. It is important to investigate local assumptions and factors in order to create a strategy that is best for your area.

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Monroe, M. C. and R. Plate. 2007. Common concerns. In *Wood to energy outreach program: Biomass ambassador guide*, eds. M. C. Monroe, L. W. McDonell, and A. Oxarart. Gainesville, FL: Florida Cooperative Extension Service, Circa 1526, University of Florida.

