WOOD to ENERGY

Community Economic Profile

Kentucky: Laurel and Trimble Counties

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In the southern United States, communities with increasing populations and nearby forests may be able to consider using woody biomass to generate energy. A variety of other factors must also be considered, such as the price of existing energy sources, competing markets for wood, community acceptance, and the economic availability of wood resources. Many counties in Kentucky have forests in close proximity to growing populations. To gain a better understanding of the range of possibilities for economic availability and the local economic impacts of using wood for energy, Laurel and Trimble counties were selected for analysis in this community economic profile. In addition, an economic analysis for Clark County is included in this profile since it is the home of a large coal-powered facility managed by Eastern Kentucky Power Cooperative (EKPC), who is a large energy provider and a potential end user for woody biomass produced in this region.

Kentucky's forested landscape and other natural areas provide the state with a variety of benefits, including wildlife habitat, timber resources, recreational opportunities, and cleaner water and air. The Daniel Boone National Forest stretches across the Appalachian region in the eastern part of the state, and large rivers, the Ohio, Cumberland, and Kentucky, traverse the landscape. About half, 47 percent, of the state is covered with hardwood forests, consisting mostly of the oak-hickory forest ecosystem. Private landowners dominate forest ownership, accounting for three-quarters of forested land, while the remaining land is either owned publicly or by corporations (Thomas et al. 2007).

The forest industry plays an important role in the state's economy. Over 37,500 people are employed through forestry-related jobs, and almost all, 93 percent, of the counties in the state are home to at least one wood-based company (Thomas et al. 2007). The industry in Kentucky is adept at using its own wood wastes, including bark and sawdust, to produce mulch, fuel for energy, composite wood, and charcoal. While the number of trees being grown in Kentucky has consistently been more than the number harvested, the acreage of forested land has been declining due to forest conversion for development (Thomas et al. 2007).

Kentucky's forests significantly contribute to the state's character and to the residents' way of life. Like rural areas throughout the nation, development continually pressures forested areas within Laurel and Trimble counties, located in the central and eastern portions of the state. According to the U.S. Census Bureau (2007), each of these counties is experiencing population growth, which brings an increased demand for goods and services, including shopping centers, neighborhoods, schools, and additional energy and water supply (Table 1).

Trimble County is located northeast of Louisville on the Ohio River. The county, which is being urbanized as Louisville grows, is rich in agricultural land and has 25 to 50 percent forest cover (USDA 2004). Just east of the city of Lexington, Clark County is a fertile region containing many farms and less than 25 percent forest cover (USDA 2004). Winchester is the largest city in the county and takes pride in promoting community greenspace in the downtown area. In addition, the town is distinguished as a Tree City USA by the National Arbor Day Foundation. One of the campuses for Bluegrass Community Technical College is located in Winchester and another campus is under construction. Similarly, in Laurel County, south

Table 1. *Population Data for Selected Kentucky Counties*

County	2000	2006	Population Growth from 2000 to 2006
Clark	33,144	35,275	6.4%
Laurel	52,715	56,979	8.1%
Trimble	8,125	9,074	11.7%

of Lexington, several technical centers and community college campuses are expanding. Laurel County is a fast-growing county that values its proximity to the Daniel Boone National Forest. The county has 50 to 75 percent forest cover, and the forest industry has a large presence in the local economy (USDA 2004).

The combination of increasing populations and forested areas may enable each of these counties to consider using wood to produce energy, whether for a large utility or a smaller facility, such as a school, hospital, or industry. Wood residues are already used by local forest industries to produce their own energy, and these facilities can serve as examples to others who also want to utilize wood for energy. See the case studies, *Waste-to-Energy Program* and *Burning Sawdust for Heat and Power* for more information. All of our materials are available at http://www.interfacesouth.org/woodybiomass.

Currently, most of the energy in Kentucky is produced from coal, which is a relatively cheap and locally abundant source of fuel. However, for communities that want to use renewable sources of energy and where wood is economically available, wood may be a reasonable option. EKPC, like many other energy providers, is supplementing its use of coal with renewable fuels. The company has constructed four facilities that produce almost 13 megawatts (MW) of energy from landfill gas, one of which is located in Laurel County. EKPC included woody biomass in its recent evaluation of available fuel sources.

Woody biomass from urban wood waste, logging residues, and forest thinnings, for example, can be used to generate energy. Using wood to generate electricity provides many potential benefits such as reduced greenhouse gas emissions, healthier forests, and local jobs and other economic impacts. For more information on these topics see the *Climate Change and Carbon*, *Sustainable Forest Management*, and *Environmental Impacts* fact sheets.

To estimate the amount of wood that could be available in a community, we include three sources: urban wood waste, logging residues, and pulpwood. While other woody biomass resources exist and could be added to the resource assessments, we include only these resources, for which cost and supply data are available. Urban wood waste is generated from tree and yard trimmings, the commercial tree care industry, utility line clearings, and greenspace maintenance. Logging residue is composed of the leftovers from forest harvesting, such as tree tops and limbs, and poorly formed trees. Pulpwood refers to small diameter trees (3.6 to 6.5 inches diameter at breast height) that are harvested for manufacturing paper, purified cellulose products (including absorbents, filters, rayon, and acetate), and oleoresin products (including pine oils, fragrances, cosmetics, and thinners). This profile excludes secondary woody waste from sawmills and furniture makers, which is available but may already be used within the industry to produce energy. See the fact sheet, *Sources and Supply*, for more information.

Economic factors, including fuel costs and the creation of local jobs, are major determinants of the feasibility of bioenergy projects. Assessing the economic availability of biomass requires learning about the delivered cost of wood, the quantity of available wood, and its geographic distribution. This information is then used to create biomass resource supply curves, which express price per unit of biomass at a range of potential quantities of consumption. The following summary uses these methods to assess the economic availability of wood resources for Trimble, Clark, and Laurel counties in Kentucky. More information about the development of this supply curve can be found on the Web site in *Assessing the Economic Availability of Wood*.

Cost Calculations

The delivered cost of woody biomass to a facility is the sum of the amount paid to buy the wood from the original owner (procurement), the harvest cost, and the transportation cost. Although rail transportation could be used in some cases, woody biomass is typically transported by truck. The cost of transportation depends on the time it takes a truck to travel from the harvest site to the facility. Haul times to the central delivery point in each county are calculated using a software program called ArcGIS Network Analyst Extension (Figure 1).

Assuming that haulers drive the speed limit on the quickest route available to them, we calculate total transportation times for the forested areas around the delivery point, and then increase haul times (and thus costs) by 25 percent to account for delays, such as traffic and stops. These haul-time areas delineate potential “woodsheds” or areas that can provide wood for a specific community or biomass user. If demand is established in more than one area in proximity, woodsheds can overlap, causing competing demand for biomass.

The total delivered cost is derived from the sum of the procurement, harvest, and transportation for urban wood waste, logging residues, and pulpwood. This is calculated at 15-minute increments up to one hour from each delivery point. Delivered costs allow us to see the progression of the most- to least-expensive woody

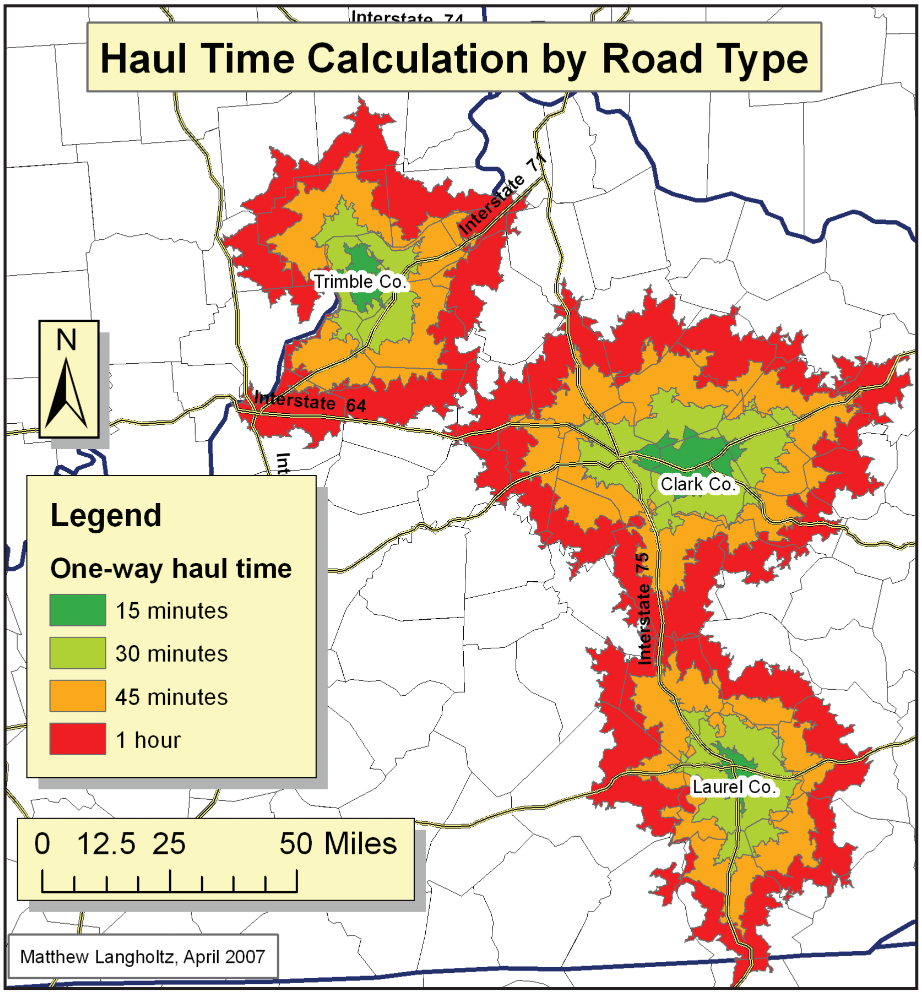

Figure 1. *Wood harvested within each colored band can be transported to the center of each county in 15-minute increments.*

biomass resources. For example, if urban waste wood were delivered within the one-hour limit, the total delivered cost would be $19.46 per dry ton, or $1.25 per million British thermal units (MMBtu). However, if pulpwood were delivered from the same distance, the delivered cost would increase to $49.14 per dry ton, or $3.04 per MMBtu, primarily because pulpwood is more expensive than urban wood waste.

Physical Availability

In addition to the delivered cost of wood, knowing how much of each type of woody biomass is available is necessary to construct supply curves. Annually harvested pulpwood and annually available urban wood waste and logging residues within the three Kentucky counties are shown in Table 2.

For urban wood waste, it is assumed that 0.203 green tons (40 percent moisture content) of urban wood waste is generated per person per year (Wiltsee 1998). This includes municipal solid waste wood from yard waste and tree trimming but excludes industrial wood (e.g., cabinet and pallet production) and construction and demolition debris. This average yield was multiplied by county population estimates and reduced by 40 percent to estimate total annual county yield of urban wood waste. For example, in Clark County, this results in 4,200 green tons of urban wood waste per year.

The amount of logging residue and pulpwood for all counties in Kentucky was obtained from the USDA Forest Service (2003) Timber Product Output Reports. This database provides forest inventory and harvest information, including annual yields of forest residues and pulpwood. We reduced the figure for logging residues by 30 percent to exclude stumps. For example, in Laurel County, there are 97,300 green tons (37 percent moisture) of logging residues available annually from existing forestry operations. There are also 116,700 green tons (50 percent moisture) of pulpwood harvested annually. Because the pulpwood harvest is currently used to produce pulp and paper products, not all of this resource is economically available for

Moisture content refers to the amount of moisture remaining in wood and is an important consideration in the quality of biomass resources. Moisture content is 0 percent in oven-dried biomass, about 20 percent for air-dried biomass, and about 50 percent for fresh or "green" biomass. As the moisture content of wood increases, the energy content per unit mass of wood decreases. Thus, wood with low moisture content will combust more efficiently than wood with high moisture content. Moisture content referred to in this document is reported on a green-weight basis.

Table 2. *Three Sources of Available Wood*

County	Available urban wood waste	Available logging residues	Harvested pulpwood
Clark	4,200	1,800	None
Laurel	6,900	97,300	116,700
Trimble	1,100	2,000	None

bioenergy. However, additional biomass is available from forest thinning, particularly those conducted for ecosystem restoration, which is not included in this assessment (Condon and Putz 2007).

Supply Curve Construction

Given information regarding cost, quantity, and distribution of all three types of woody biomass, supply curves can be generated for the three Kentucky counties. Figure 2 shows the price of wood at different quantities needed. The y-axis represents price per MMBtu of energy and the x-axis represents the total amount of wood available in 15-minute increments. Several scales are provided to translate the quantity of wood into tons, energy content, and houses electrified. Biomass sources include urban wood waste, logging residues, and pulpwood within a one-hour haul radius of each county center.

Supply Analysis Results

Energy resources and costs for each resource-haul time category for the three counties are shown in Table 3 (resources are ranked from cheapest to most expensive based on delivered cost of energy). These values were used to construct the supply curves shown in Figure 2. The supply curves suggest that anywhere from 1 trillion Btu in the Trimble County woodshed to 2.6 trillion Btu in the Laurel County woodshed, or 8 to 22 MW of electricity, enough to power 3,400 to 8,900 households in the South (Bellemar 2003), are available for less than $2.60 per MMBtu, which is competitive with current costs of

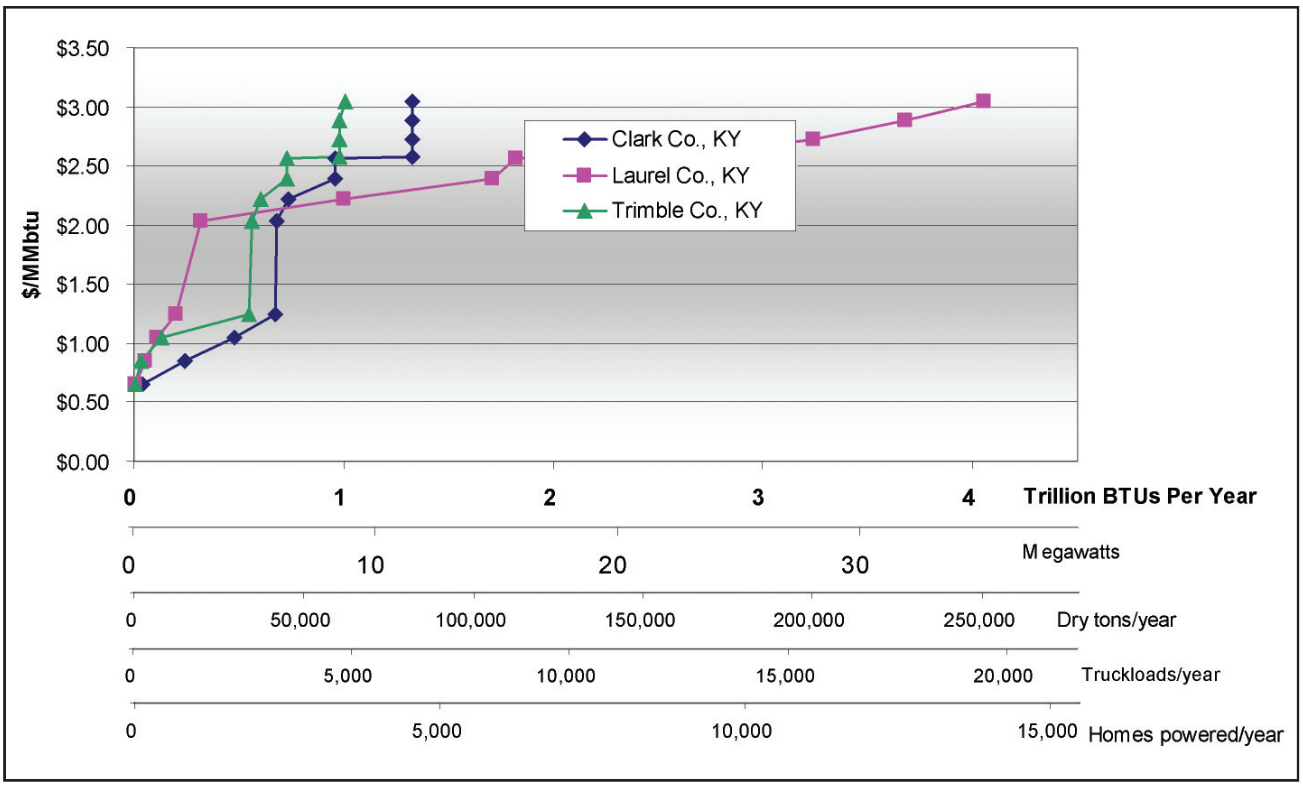

Figure 2. *Supply curves for woody biomass indicate the cost and quantity of wood at 15-minute hauling intervals.*

Table 3. *Delivered Cost of Available Wood*

		Trillion Btu available per year within a one-hour haul radius		
Delivered cost ($/MMBtu)	Resource/Haul time category	Clark County	Laurel County	Trimble County
$0.65	Urban wood: 0-15 minutes	0.04	0.01	0.00
$0.85	Urban wood:15-30 minutes	0.20	0.05	0.03
$1.05	Urban wood: 30-45 minutes	0.23	0.06	0.10
$1.25	Urban wood: 45-60 minutes	0.20	0.09	0.42
$2.03	Logging residues: 0-15 minutes	0.01	0.12	0.01
$2.21	Logging residues: 15-30 minutes	0.05	0.68	0.05
$2.39	Logging residues: 30-45 minutes	0.22	0.70	0.12
$2.56	Pulpwood: 0-15 minutes	0.00	0.12	0.00
$2.57	Logging residues: 45-60 minutes	0.37	0.78	0.25
$2.72	Pulpwood: 15-30 minutes	0.00	0.64	0.00
$2.88	Pulpwood: 30-45 minutes	0.00	0.44	0.00
$3.04	Pulpwood: 45-60 minutes	0.00	0.38	0.03

coal. Within a one-hour haul radius, up to 0.2 to 0.7 trillion Btu can be provided from urban wood waste alone. With the addition of logging residues, 1.0 to 2.5 trillion Btu can be produced. Other types of wood may be available from thinnings to improve forest health, although estimates of this wood are not available. As the cost of oil increases, all price estimates increase (with petroleum inputs for harvesting and transportation), but so do the costs of coal and natural gas. In other words, as fossil fuels become more expensive, the delivered cost of wood will increase but will become increasingly competitive with nonrenewable fuels.

Economic Impact Analysis

The potential economic impacts of developing a wood-fueled power plant are an important consideration for both public and private interests in a community. In this economic analysis, two sizes of power plant were considered: 20 or 40 MW. The construction of the plant would be a one-time impact event that is assumed to occur within a year, while the impacts of plant operations continue annually over the life of the plant, for 20 years or more. Wood fuel costs were calculated from the regional supply curves discussed previously in this report. Economic impacts were estimated using IMPLAN software and databases for each county. These estimates included not only the direct impacts of plant construction and operation but also the indirect impacts from local purchases and local spending by employee households. Further information on the methods of analysis and interpretation of economic impact results is available in the fact sheet, *Economic Impacts of Generating Electricity*.

Wood fuel typically represented the largest operating cost for a wood-fired power plant. Fuel costs averaged $3.9 and $9.7 million annually for the 20 or 40 MW plants, respectively, however, these costs ranged from $8.8 to $10.5 million for the 40 MW plant, due to differences in availability of forest and wood waste resources, as well as transportation infrastructure in these counties (Table 4). Trimble County had the lowest wood fuel cost while Laurel County had the highest.

The economic impacts of plant construction and operations varied widely among Clark, Laurel, and Trimble counties due to differences in the specific makeup of the local economy. The total annual operating impacts (first year) for a 20 MW plant ranged from $2.8 to $12.3 million in output (revenue), 27 to 240 jobs, and $1.7 to $7.0 million in value added (income). Total operating impacts for a 40 MW plant ranged from $4.6 to $25.2 million in output, 43 to 519 jobs, and $2.8 to $14.3 million in value added. The first year impacts for plant operations are representative of the ongoing annual impacts; however, future impacts could change due to prices of inputs such as fuel, unexpected maintenance activities, and general economic inflation.

Table 4. *Economic Impacts of 20 and 40 MW Power Plants*

Kentucky County	Wood Fuel Cost ($Mn)	Annual Operations Impacts (first year)			Plant Construction Impacts		
		Output ($Mn)	Employment (Jobs)	Value Added ($Mn)	Output ($Mn)	Employment (Jobs)	Value Added ($Mn)
20 MW							
Clark	3.77	5.00	54	2.98	4.54	54	2.61
Laurel	4.48	12.33	240	7.02	4.48	54	2.59
Trimble	3.57	2.83	27	1.71	2.83	36	1.54
Average	**3.94**	**6.73**	**107**	**3.91**	**3.95**	**48**	**2.25**
40 MW							
Clark	9.85	7.91	85	4.67	5.47	64	3.10
Laurel	10.52	25.23	519	14.34	5.40	64	3.06
Trimble	8.79	4.57	43	2.75	3.37	43	1.77
Average	**9.72**	**12.57**	**215**	**7.25**	**4.75**	**57**	**2.64**

Total construction costs were valued at $48.7 million for the 20 MW plant and $86.8 million for the 40 MW plant, including land, site work, construction, plant equipment, and engineering fees. Local construction impacts for a 20 MW plant ranged from $2.8 to $4.5 million in output, 36 to 54 jobs, and $1.5 to $2.6 million in value added. Construction impacts for the 40 MW plant ranged from $3.4 to $5.5 million in output, 43 to 64 jobs, and $1.8 to $3.1 million in value added. Again, the large range of values for construction impacts in these counties reflects differences in the makeup of the local economies.

Often it is helpful to predict the distribution of economic impacts across various sectors of the local economy. More than 60 percent of all job impacts for operations would occur in the agriculture and forestry sector, which supplies wood fuel to these facilities. However, there would also be significant employment impacts in the sectors for professional services, retail trade, and government, reflecting the indirect effects on the local economy associated with purchased supplies and employee household spending.

Conclusions

Economic concerns are important to discussions of using wood for energy in the South. For many communities, the conversation begins with the recognition that there might be enough wood at an affordable cost. Our supply analysis suggests that, indeed, enough wood at a reasonable cost is available in Clark, Laurel, and Trimble counties to make a continued conversation possible. Up to 1.0 to 2.6 trillion Btu (i.e., 8 to 22 MW or energy to power 3,400 to 8,900 homes annually) of woody biomass are available at less than $2.60 per MMBtu in these three Kentucky counties. These general estimates could be improved with more site-specific analysis and information.

Additional assessments of local conditions, population density, distribution of wood, competition from pulp mills, restoration activities, and other factors would improve the accuracy of these biomass resource assessments. The following caveats should be considered when interpreting the results presented in this profile:

- The supply considered in this profile includes only urban wood waste, logging residues, and pulpwood. It excludes stumps and waste from wood industries.
- Because only county-level data were available, homogeneous distribution of resources within counties is assumed. Resource distribution within counties and location of bioenergy generating facilities will influence the actual economic availability of woody biomass suitable for energy generation. More detailed local analysis might consider the distribution of biomass resources within counties, especially for site selection of bioenergy facilities.
- The inclusion of other resources such as mill wastes or thinnings for forest management and habitat restoration would increase available resources.

- This analysis is not intended to be a definitive resource assessment but is rather meant to provide a starting point for discussions about the feasibility of using wood for energy. Resources can be excluded or added as more information becomes available, and prices can be modified to reflect local conditions.
- A rise in the price of oil would increase the cost of the resources shown here, as well as costs of conventional energy sources like coal.
- Some assumptions made in this analysis are subject to change. For example, large-scale bioenergy development in the area could increase competing demand for wood resources.
- Rail transportation was not considered in this analysis, which could reduce transportation costs and make biomass resources from other areas more available.
- Construction and operation of wood-fueled power plants may have significant local economic impacts. These impacts vary widely among selected counties, depending upon the makeup of the local economy.
- Wood fuel represents one of the largest expenditures for a power plant, and gives rise to large impacts in the local forestry and forestry services sectors. Other sectors of the local economy are also impacted through the indirect effects associated with purchased supplies and employee household spending.
- Economic impacts of a 40 MW power plant are greater than for a 20 MW plant, although not in proportion to the power output, due to economies of scale.

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.

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