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Abstract

Premium fuel pellets are popular for home heating fuel and standard fuel pellets are finding increased use for electrical generation. In 2005, 41 percent of the fiber feed stock used to produce pellets in the Lake States was wood residue, 27 percent waste paper or agricultural residue, and 32 percent multiple or unspecified fiber feed stocks. Between 2005 and 2008, the number of wood pellet processing facilities in the region nearly doubled and this expansion required an additional 592 thousand dry tons of fiber feed stock. Currently, two facilities producing 67 thousand tons of pellets are under construction and four plants slated to produce an additional 600 thousand tons of product are in the planning stage. The primary product manufactured in these new or planned facilities will be commercial fuel pellets and the primary feed stock will be roundwood or harvest residues and paper and agriculture waste. The potential increase in the demand for lower quality roundwood by these new facilities could replace the declining demand for this material by the paper industry. However, if the fuel pellet industry continues to expand, it could bid roundwood away from the remaining pulp and paper mills.

Key Words: Fuel pellet, wood energy, roundwood consumption
Introduction

In the 19th century, an estimated 90-percent of Americans burned wood to heat their homes (USDE 2008). By 1970, the consumption of wood for fuel had steadily declined to approximately 1 percent (USDE 2008). In the fall of 1973, the oil producing Middle Eastern nations stopped the export of oil to the United States and other nations that supported Israel during the Yom Kippur War (Jordan et al. 1977). The resulting surge in oil prices caused interest in wood heating to reemerge primarily through increased use of wood stoves (USDE 2008). Another product that entered into the market during this period was the pellet stove (USDE 2008). These stoves burned pellets made from compressed dried wood or other biomass wastes. Pellet stoves are superior to many other sources of wood heat because their emissions are considerably less than other wood heat sources (EPA 2008). These stoves also were cleaner to operate and produced less creosote (USDE 2008).

As energy prices declined over the next several years, so did interest in pellet stoves. Many of the pellet manufacturers that survived produced pellets for animal sanitation applications. In 2005, a number of important market factors including Hurricane Katrina’s damage to Gulf Coast petroleum production and refining infrastructure reduced supplies and increased prices of fuel oil (Fig. 1). As a result, wood fuels were again a field of interest. Between the late 1970s and 2005, the residential pellet stove industry developed high efficiency, low emission stoves requiring premium quality pellets with low ash content. These stoves have a combustion efficiency rating of up to 85 percent (compared to 72 percent combustion efficiency of a catalytic wood stove) and can be vented through an outside wall versus a chimney (USDE 2008).

Pellet manufacturers are building new plants in the Lake States of Minnesota, Wisconsin, and Michigan. In 2005, this region contained nine plants that use wood, paper, and agricultural residue to manufacture pellets. The continued increase in energy prices between 2005 and 2008 (Fig. 1) fostered a 300-percent increase in fuel pellet production (Table 1). By the end of 2009, another 67 thousand tons of industrial fuel pellets will be manufactured by facilities under construction. Four plants currently seeking permits could produce an additional 600 thousand tons of pellets.

The objective of this paper is to examine the growth and changes in the fuel pellet industry in the Lake States, to estimate the current and potential volume of products manufactured by this industry, and to examine changes in the type of fiber feed stock used by this industry. We chose the Lake States because of the diverse sources of fiber feed stock and the growth of pellet manufacturing in this region. Before proceeding with the analysis, we will describe the properties of the various types of pellets and related products, enumerate the types of feed stock used to manufacture these products, and discuss the manufacturing process.
Figure 1 – Cost of electricity and fuel oil in Midwest urban areas in dollars per 100,000 BTU from 2000 to 2008.

Source: USDL 2008

Table 1- Changes in the number of Lake States pellet and briquette plants and production volume between 2005 and 2008 and projected future changes.

<table>
<thead>
<tr>
<th>Product</th>
<th>2005</th>
<th>2008</th>
<th>Under construction or planned</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Plants</td>
<td>Production</td>
<td>Plants</td>
</tr>
<tr>
<td></td>
<td>Number</td>
<td>(000 tons)</td>
<td>Number</td>
</tr>
<tr>
<td>Residential fuel</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Industrial fuel</td>
<td>5</td>
<td>109</td>
<td>7</td>
</tr>
<tr>
<td>Pet and animal products</td>
<td>3</td>
<td>28</td>
<td>2</td>
</tr>
<tr>
<td>Multiple products(^3)</td>
<td>4</td>
<td>56</td>
<td>9(^4)</td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td>193</td>
<td>23</td>
</tr>
</tbody>
</table>

\(^1\) Includes residential fuel pellet expansion of multiple product facilities.
\(^2\) Volume includes expansion of an existing plant.
\(^3\) These manufacturers produce multiple products including residential pellet, commercial/industrial pellets, pet and animal products, briquettes, wood flour, mulch, chips, and shavings.
\(^4\) Includes an existing plant that was idle in 2005.
Pellets and Related Products

As previously stated, pellets and related products fall into four broad categories: premium fuel pellets, standard fuel pellets, briquettes, and animal sanitation products. Super premium and premium fuel pellets are for use in high efficiency stoves with catalytic converters and account for 95 percent of residential pellet consumption (Pellet Fuel Institute 2008). Super premium pellets are defined by the Pellet Fuel Institute (PFI) as having an ash content of 0.5 percent or less and moisture content of 6 percent or lower; premium pellets have an ash and moisture content of 1.0 and 8.0 percent or less, respectively1. Low ash content reduces the potential of incombustible “clinkers” occurring in the fire pot. While there is no required value of range for heating value for pellets in the PFI specification, the BTU value of premium grade pellets tends to range from 7900 to 8500 per pound, depending on the manufacturer and fiber feed stock used.

Most standard fuel pellets produced in the Lake States are used in house or are sold as boiler fuel (primarily to electrical generation facilities). Although the PFI does have a specification for standard grade pellets, these pellets may be manufactured following the specifications of an individual. Fuel briquettes are primarily used for boiler fuel and less expensive to manufacture. Briquettes also can be manufactured for use in home fireplaces, but no Lake State facilities currently manufacture this product.

A broad array of wood-based pellets is made for animal sanitation purposes such as equine bedding and kitty litter. Pellets are an efficient way to control animal waste because the soiled areas are easy to identify and remove. These products may contain aromatic wood species such as pine or cedar, but aspen is the most preferred species for most applications (Peterson 2009). These manufacturers also can produce chips and other wood products such as hamster bedding or kitty litter. Pellets manufactured for animal and pet sanitary purposes are normally priced higher per ton than premium fuel pellets and are sometimes manufactured using proprietary processes and feed stock mixtures. These products also can contain bark because ash content is not a critical consideration. While the markets for animal products and fuel products are distinct, many manufacturers of animal sanitation products also produce premium fuel pellets.

Fiber Feed Stock and Manufacturing Process

Wood residues such as green or dried sawdust, wood chips, and shavings have been preferred in the production of super premium and premium fuel pellets. Standard pellets can be manufactured from wood residue, roundwood, logging residue, seed shells, corn stocks, waste paper, and nearly any other fibrous products that are dry or can be dried easily. In recent years, the production of wood-based pellet and related products in the Lake States has increased faster than the availability of wood residues in many areas of this region. This change has resulted in the

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1 Four types of fuel pellets are defined by the Pellet Fuel Institute (PFI). All pellets defined by the PFI are less than 1.5 inches in length and .25 to .285 inches in diameter but vary in density, durability, inorganic ash, and moisture content. The specification for standard fuel pellets produced by Lake State manufacturers can vary from these specifications.
direct consumption of roundwood or chips manufactured from roundwood. Therefore, many of the newly built or proposed pellet facilities employ or contract loggers.

The manufacturing of pellets and related products is affected by the feedstock source and the moisture content of this material. However, all processes involve high-pressure extrusion of a dried and ground feedstock material through a die. In the case of wood pellets, the extrusion process causes lignin within the wood to heat up and act as a binding agent. The resulting pellet is 100 percent wood or fiber based. Production of pellets from sawdust produced from kiln-dried lumber may require only high pressure extrusion while pellets produced from green sawmill waste or chips require drying and grinding steps before extrusion. The manufacturing process for briquettes differs from pellets in that briquettes are made by a compression, not an extrusion process.

**Data Development**

The data used for this study were collected from Lake States utilization foresters through documents associated with the environmental permitting process, conversations with pellet manufacturers, press releases, and home pages of these manufacturers. In this paper we will report only changes in the region to keep from disclosing information of individual firms. Information for one pet sanitation product firm could not be obtained and was estimated by the authors.

**Changes in the Lake States Pellet Industry**

At the beginning of 2005, there were 12 pellet plants operating in the Lake States and one plant that was idle (Table 1). The combined pellet production from these plants was estimated to be 193 thousand tons with at least 28 thousand tons of pet and animal products. While four plants manufactured premium residential fuel pellets, these plants also manufactured other products including pet products, wood flour, mulch, shavings, and chips. The combined pellet production for these multi-product facilities was 56 thousand tons in 2005. Although wood residue was the most commonly used feedstock in 2005 at 41 percent, nearly 27 percent of pellets were made from waste paper or agricultural residue and an additional 32 percent were manufactured from multiple or unspecified fiber feedstocks (Table 2).

On a volume basis, commercial industrial pellets were the most important product manufactured in the Lake States in 2005 (Table 1). All waste paper or agricultural residue used in pellet manufacturing was consumed by these facilities. Two of these manufacturing facilities used waste paper products generated in a manufacturing process or post consumer waste paper; the third consumed agricultural residue.

The steep increase in the price of fuel oil from 2000 to 2008 (Fig. 1) caused people to reexamine wood and wood pellet stoves. International demand for wood pellets for electricity production also provided an expanding market for standard grade pellets. The renewed interest in wood based fuels caused in some existing facilities to increase capacity, one idled facility to reopen, and 11 new plants to be constructed. As a result of these capital investments, pellet production increased by 300 percent between 2005 and 2008. Four of the new plants produced premium
fuel pellets from wood residue and a fifth plant produced standard fuel pellets for home use from agricultural waste.

Table 2- Changes in the volume of fiber feed stock consumed by the Lake States pellet and briquette industry between 2005 and 2008 and projected future changes in dry tons.

<table>
<thead>
<tr>
<th>Fiber feed stock</th>
<th>Building or planned (000 tons)</th>
</tr>
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<tbody>
<tr>
<td>Primarily wood residue</td>
<td>79</td>
</tr>
<tr>
<td>Primarily paper and/or ag residue</td>
<td>53</td>
</tr>
<tr>
<td>Primarily chips manufactured from roundwood</td>
<td>0</td>
</tr>
<tr>
<td>Primarily chips manufactured from roundwood and residue</td>
<td>0</td>
</tr>
<tr>
<td>Multiple or unspecified fiber feed stock</td>
<td>61</td>
</tr>
<tr>
<td>Total</td>
<td>193</td>
</tr>
</tbody>
</table>

Two new plants with a combined capacity of 107 tons were constructed to manufacture commercial/industrial fuel pellet and briquettes for power production. While one of these plants produces pellets from wood waste, the other plant manufactures briquettes using paper waste, agriculture residue, and potentially some wood residue. Five plants with a combined capacity of 265 thousand tons were constructed to produce multiple products. One small facility that produced animal sanitary products closed between 2005 and 2008, most likely because of increased production of these products at the facility manufacturing multiple products.

The construction of 11 new and expansion of several existing pellet and briquette facilities required an additional 592 thousand dry tons of fiber feed stock. Forty-three percent of the additional feed stocks were wood residue in the form of dust, chips, and shavings. An additional 25 percent were roundwood, chips made from roundwood, and wood residue. Facilities that used agricultural residue accounted for 18 percent of the new feed stock and multiple feed stock facilities accounted for 13 percent.

Perhaps the greatest change in the Lake States pellet industry is yet to come with one plant under construction, another adding capacity, and four other plants being planned. The combined production capacity that may result from these activities is 667 thousand (Table 1). Nearly 70 percent of the planned increased production is solely industrial fuel as increased emphasis on green energy sources is causing some traditional coal fired power plants to combine pellets or briquettes with coal. Although these plants could use wood residue, they are being designed to use softwood and hardwood roundwood, paper waste, agricultural residue, or unspecified biomass residue. Two of the four planned plants will produce multiple products including
premium fuel pellets. The other four plants are being built or designed to produce industrial pellets or briquettes for power production.

If all the plants that are under construction or planned go into operation, the combined capacity of all pellet and briquette plants in the Lake States will exceed 1.4 million tons per year. This would be a 1.3 million ton (650 percent) increase over the 2005 level. Although premium fuel pellets may be the most visible part of the Lake States pellet and briquette industry, industrial fuel is now the fastest growing part of this industry.

The 600 thousand ton increase in fiber feed stocks demand that could result after the construction of the four planned plants will primarily be supplied by roundwood or by combining several sources of fiber feed stock. It is unlikely that traditional primary and secondary wood residues will be a major source of fiber feed stock for these planned operations because of the existing demand for this material from existing operations that produce higher value premium, super premium, and animal sanitary pellets.

In the current market of 2009, many of the existing users of wood residue feed stock are finding it difficult to obtain because of the decline in primary and secondary timber and wood processing. This slowdown of activity also is causing pulp mills to close or reduce production. The potential increase in the demand for lower value roundwood by new pellet manufacturing facilities could replace the declining demand for this material from the paper industry. However, if the industry continues to expand, it could bid roundwood away from the remaining pulp and paper mills and other timber using industries.

**Conclusions**

Although the market for premium fuel pellets for use by residential customers has increased dramatically in the Lake States since 2005, this increase is dwarfed by the increases in combined production of commercial/industrial pellets and plants that produce numerous products but appear to specialize in fuel products. Furthermore, while premium fuel pellet manufacturers rely on sawdust and other clean wood waste for feed stock, the large plants producing briquettes and commercial/industrial pellets plan to obtain a major portion of the feed stock from low-grade roundwood and slash.

One factor that could influence the future of the pellet and briquette industry is whether costs of obtaining feed sock and producing and transporting pellets resulting from increased fuel prices will be offset by increased price for pellets. Given the divergence in prices shown in Figure 1, pellet manufacturers probably will be able to raise their prices as prices of other competing fuels increase. Producers of wood briquettes also may be able to raise prices if environmental regulations on coal fire generating facilities are expanded. Because the planned plants have not started construction, the long-term impact of increased production of fuel pellet and briquette products remains to be seen. The potential increase in the demand for low-value species often left in the woods could improve the quality of Lake States timber in the long term. However, if the pellet industry continues to expand and the pulp and paper industry increases production to previous levels, there could be local and regional shortages in timber supply.
**Literature Cited**


