Co-Firing Wood Biomass With Coal at the Cañon City Power Plant

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Abstract—Green full tree chips produced from small diameter trees can be co-fired with coal. This paper reports some of the challenges and benefits at a Cañon City power plant. Tree chips include the main stem, branches, tops, needles, and bark. If a sufficient supply of low-cost wood is available, the power plant will continue to burn it. Collaboration among agencies and private companies is crucial for continued success.

Introduction

Past fire management and suppression practices have created conditions favorable for catastrophic fire throughout wildland/urban interface zones of the Intermountain West. These past practices are responsible for greater standing fuel loads that potentially threaten public safety, watershed productivity, and forest health. The National Interagency Fire Center (2002) reported that over 8.4 million acres of forest land burned nationwide during the 2000 fire season, which compares to a 10-year average (1990-1999) of about 3.8 million acres per year. Unfortunately, unless efforts to reduce standing fuel loads are implemented, it appears that conditions will continue to be favorable for large wildfires in future years.

In response to the 2000 fire season, the National Fire Plan (Department of the Interior 2001) was developed. One objective of the National Fire Plan is to implement strategies that mitigate the severe fire conditions existing on forest land throughout the Intermountain West. These strategies revolve primarily around forest restoration (fire mitigation) thinning, prescribed burning, or a combination of both (usually mechanical removal or thinning followed by prescribed burning). Because of inherent risks associated with prescribed burns in the absence of prior fuel reduction, forest restoration thinning is now being utilized throughout the Intermountain West to mitigate fire conditions.

Forest restoration thinning involves removing primarily small diameter trees, which are found abundantly in the Intermountain West. In Colorado, small diameter trees are considered to be less than 12 inches in diameter at breast height (dbh). However, the majority of trees removed during thinning projects are usually considerably less than 12 inches dbh and often less than 5 inches dbh. In addition to being small, these trees tend to have many limbs and correspondingly their wood has many knots usually considered to be defects in solid wood products. Small diameter trees also have disproportionately high quantities of juvenile and reaction wood that further reduce wood quality. As a result, many of these trees are currently unmerchantable.

Therefore, the question has arisen, how can these small trees be utilized? The potential for producing composite products, such as oriented strand board (OSB) or particleboard, and pulp and paper products is limited in Colorado.

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by the lack of infrastructure. This is also true for other products such as pelletized fuel. Because of the high capital investment required to build plants for producing these products, it is doubtful that a private company would risk building such a plant unless guaranteed a wood supply. No such guarantees currently exist. Because small trees have little or no value, much of this material is left in the forest lopped and scattered or chipped and blown back onto the forest floor. In addition to being wasteful, the impacts of doing this on soil and ground water are unclear and currently being studied.

Utilizing green wood chips produced from small diameter trees to generate electric power is one alternative. There are currently numerous plants throughout the country that utilize wood biomass as a source of fuel for generating electricity (Bain and Overend 2002). Although there are plants that use only biomass, many also co-fire wood with other fuels such as coal or natural gas. Co-firing is not a “new” technology and many power plants that operate on coal do not even have to modify their handling and boiler systems to utilize some wood. Therefore, these plants can burn wood with little or no capital investment.

Background

The W. N. Clark power plant located in Cañon City, Colorado, is capable of co-firing wood with coal. The plant is an older facility and has experimented with co-firing in the past. Prior efforts were discontinued because of inconsistent wood supply and quality issues with the size of wood particles provided. Wood residues procured from a local sawmill were not of uniform size, which caused handling problems. Also, fine wood particles and dust in the residues had a tendency to become airborne and were considered a potential explosion risk. Nonetheless, the plant expressed interest in co-firing if a sufficient economical wood supply of acceptable quality and size could be procured.

This research was conducted to demonstrate that the W. N. Clark power plant could utilize green full tree chips produced from small diameter trees. Full tree chips included the main stem, branches, tops, needles, and bark of the tree. A resource assessment is also in progress to identify potential sources of low cost wood and to determine the best scenario for wood delivery, processing, and storage. This project was a collaborative effort of Aquila (W. N. Clark power plant), Colorado State Forest Service, Department of Forest Sciences at Colorado State University, City of Cañon City, Fremont County, and Sangre de Cristo Resource Conservation & Development.

Discussion

The W. N. Clark power plant is currently permitted to burn up to 5 percent wood by weight with coal. To demonstrate that the plant could burn green full tree chips for an extended period of time, ponderosa pine chips were supplied from forest restoration thinning projects in the region. The Colorado State Forest Service subsidized the transportation of chips to the plant. Chip deliveries began in September 2001 and the plant began co-firing immediately. Initially a mix of less than 1 percent green wood chips by weight or 1 to 2 tons of wood per day was used. Over 200 tons of green wood chips have been co-fired with coal since September.

Chip moisture content ranged from 20 to 70 percent. The moisture in the chips did not present any significant problems for plant systems except for
reducing the amount of recoverable heat. Because of the impact on recoverable heat, wood chips used in this research would have had to be considerably drier (20 percent moisture content or less) to significantly increase the amount used. The plant is currently evaluating ways to increase the percentage of wood burned and there is potential to burn up to 25 tons per day.

Several sources of wood for the plant are being investigated. These include continued supply of small diameter trees from forest restoration thinning projects in the region, local primary and secondary wood processors, and arborists and municipalities in the area.

As part of the National Fire Plan, 38,400 acres are to be treated in Colorado during 2002 (Department of the Interior 2001). Based on an analysis by Lynch (2000) of forest restoration thinning work done at Cheesman Reservoir in Colorado, treating these acres could conservatively yield from 9 to 15 green tons of green biomass per acre. Therefore, 345,000-576,000 tons of green biomass could potentially be available. The primary constraint on availability is the distance that this biomass would need to be transported. Transportation of green wood chips to the W. N. Clark power plant is currently being subsidized and even though the plant can pay for wood, in the absence of the subsidy, it is not likely that chip transport would be economical. Transportation data is currently being collected and maximum haul distances are not yet known, but they are considerably less than 100 miles (more likely in the range of 20 to 30 miles). In addition to acres that are to be treated under the National Fire Plan, more wood biomass could be available through road construction, defensible space efforts, and other logging activities not considered as part of the National Fire Plan.

Primary and secondary wood processors could also be a significant supplier of wood chips. In spring 2001, Ward (2000) surveyed 173 primary and secondary wood manufacturers operating in Colorado. The 75 companies that responded generated 380 tons of residues per week on average. About 83 percent were willing to consider alternatives to current wood biomass disposal practices. More importantly, two sawmills in the immediate area said they would be interested in supplying residue to the plant. However, handling and dust problems that occurred when the W. N. Clark power plant attempted to use sawmill residues in the past would likely reoccur.

Another possible supply of green wood chips could be urban wood residues. This would include residues from work done by local arborists and municipalities, as well as construction and demolition debris going into the local landfill. An advantage of this wood material is that it can often be procured at little or no cost. Results from a survey of local arborists conducted by Prokupets (2002) revealed that they conservatively generate an estimated 2000 tons of wood debris annually, which is currently enough to supply the W. N. Clark power plant. However, a preliminary test burn conducted with wood residues (chips) supplied by a local arborist was not successful. As with wood processing residues, wood particle size was inconsistent and oversized (long, stringy) particles clogged the fuel handling system at the plant. As a result, future research will include evaluating wood processing equipment (chippers and grinders) to determine the most cost effective way of producing a wood chip suitable for use at the plant.

Conclusion

Research to date has demonstrated that green full tree chips can be co-fired with coal at the W. N. Clark power plant. The plant has indicated that it will
continue to burn wood if a sufficient supply of adequate low cost wood is available. Although it appears that there is a sufficient supply of low cost wood available to the plant, further research is necessary to determine how best to collect and process the wood biomass into a useful size and form.

Generally, project success depends on overcoming several major challenges. The costs associated with procuring and co-firing wood chips with coal must be economical. The logistics of wood delivery, chipping, and storage must be evaluated to determine the most cost effective methods. Transportation is a major cost of getting wood from forest restoration thinning projects to the plant. Haul distances will likely have to be considerably less than 100 miles and government subsidies may be necessary to cover all transportation costs. Perhaps most crucial to the success of this project is the collaboration of the various agencies, private companies, and individuals who will be involved.

**Literature Cited**


