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CONVERTING URBAN TREE MAINTENANCE RESIDUE TO ENERGY

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Abstract. The feasibility of using residues from municipal tree maintenance and land clearing operations as fuel is examined in terms of dollars and net energy. This fuel chip market was developed as an alternative to landfilling this residue.

Landfilling has been a commonplace and relatively simple solution to the problem of disposing of material from urban tree maintenance such as powerline clearance. But, environmental and land cost factors are requiring alternative solutions. One such alternative is converting urban waste to energy. In light of the nation's current energy shortage, this particular alternative is attractive from two relevant points of view: contributing to the nation's energy pool, and disposing of the wood waste. The present paper reports on the results of the selection of this alternative by an urban tree maintenance firm in Houston, Texas.

Background

The Houston firm collects and needs to dispose of 30,000 tons of wood waste each year. This waste is comprised of chipped material, unchipped branches, and logs which are too large to be chipped by the mobile chippers. The firm had exhausted its landfill in the city and had located a new one 28 miles away. The cost for using this new landfill was estimated at $240,000 annually, not including labor and transportation for the wood waste. Due to the prohibitive cost, the feasibility of converting the wood waste to fuel was investigated.

The following three systems represented the wood waste alternatives from which the firm needed to choose. Figure 1 illustrates these alternatives while Table 1 presents their economic and energy trade-offs.

Using the new landfill represented the simplest alternative. The wood waste would be brought to a central concentration point. The existing city landfill was identified as the local choice of possible points. Next, the waste would be loaded into 15-ton trucks, hauled the 28 miles, and unloaded at the new, remote landfill.

The second alternative involved using the lighting and power company's lignite boilers to convert the wood waste to electricity. Again, the wood waste would be brought to the existing landfill. But, a large, permanent chipper would be installed to chip all material into sizes compatible with the firing systems of the boilers. The chipped material would then be loaded into 15-ton trucks and hauled to the power plant, where it would be stockpiled and fed into the boiler as needed. Eventually, a boiler would be located near the concentration yard reducing the hauling distance.

The final alternative consisted of hauling the wood waste to the concentration point, chipping the material, and then selling it to an outside firm to be used as boiler fuel by that company rather than the city's power and lighting company. This alternative had the advantage of utilizing the wood for fuel while not requiring that power company boiler adjustments and stockpiling arrangements be made at the same time as the large chipper was installed and started up.

As Table 1 indicates, delivering the wood waste to the concentration yard requires a substantial portion of the total energy input for each alternative. Therefore, the criterion for selecting an alternative involves examining the remaining costs. As shown, it is much cheaper to chip and haul the material to the power plant than it is to haul the material, unchipped, 28 miles distant. And, this smaller cost ignores any returns from the electricity gained from burning the waste. The alternative of selling the chipped material appears much more attractive than the power plant alternative, since a return is realized from the same amount as inputs. It should be noted that this last alternative includes miscellaneous transportation equivalent to hauling to the power plant.

Parameters used to estimate the costs in Table 1 needed to be measured, estimated from past data, or assumed. The following paragraphs presents a discussion of the assignment of values to some of these parameters.

The energy potential is assumed to be that of a green ton of chips at an average moisture content (Murphey & Cutter 1974) for hardwoods although the material includes softwoods and palms and their leaves and twigs. This material is delivered to the concentration yard requiring a round trip of twenty-five miles. Fuel consumption is assumed to be nine miles per gallon based on the firm's data. The energy content of the fuel is assumed to be 125,000 Btu/gallon. Felling and chipping fuel consumption average 0.41 gallons per ton of

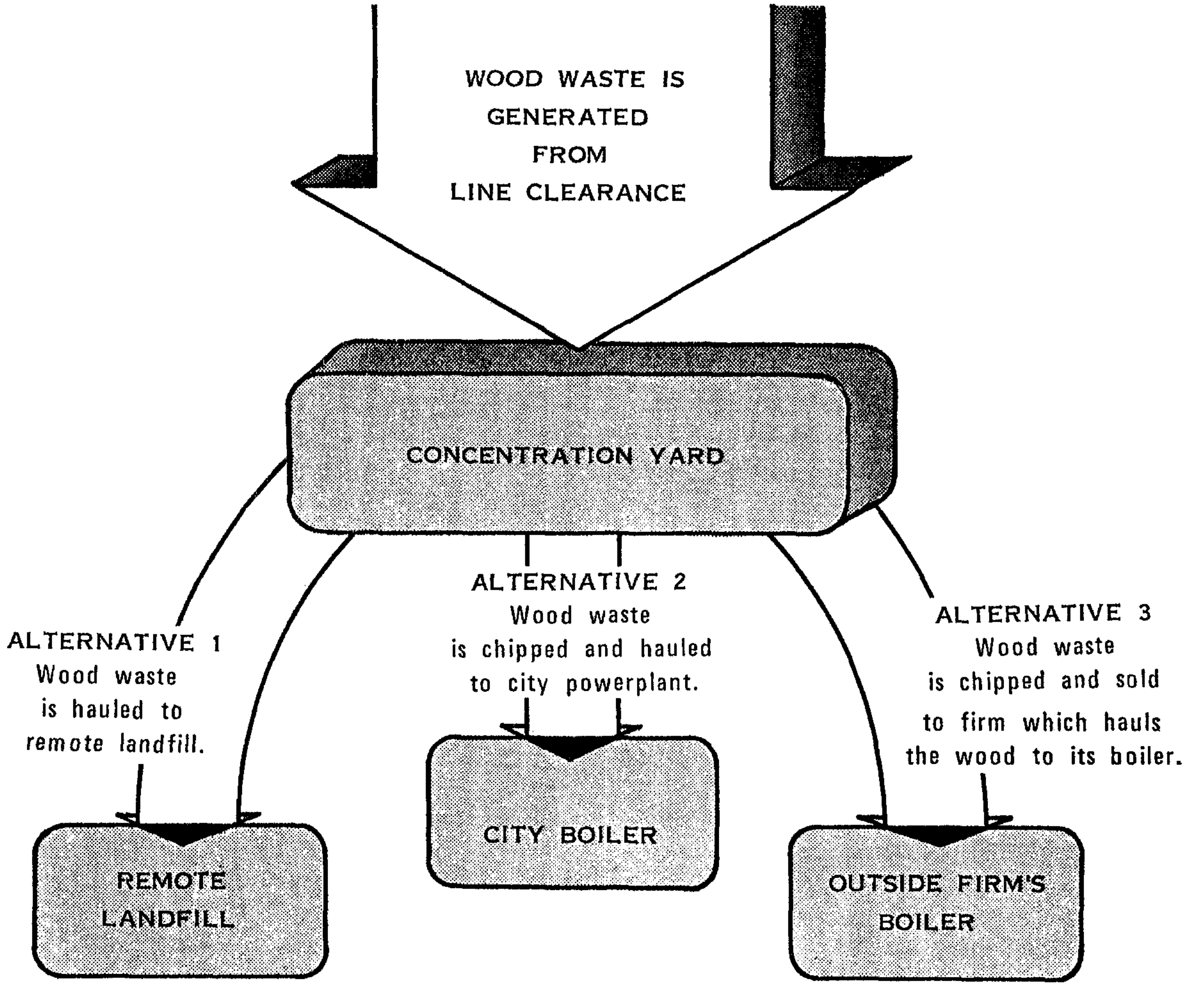

Figure 1. Three alternative systems for disposing of the wood residue.

green wood. Energy to manufacture the chain saws, chipper trucks and other equipment was estimated by obtaining the weight of these items from manufacturers data, determining the energy used in manufacture, and the projected life and production rate (Smith & Corcoran 1976).

The dollar values shown were developed on a per ton of residue basis. Equipment was amortized over experienced service life. The fuel includes both that used in transporting the residue and that used by the remote portable chipper and chain saws. Labor costs were direct costs obtained from a separate municipal operation. The zero value for residue assumes the job had been contracted to remove parts or all of the trees. The residue then was a result of another operation and has no cost. Therefore, it is assumed to be placed on the truck at no cost. Regardless of its negative

Table 1. The Economic and Energy Tradeoffs Associated with Three Alternatives for Utilizing Urban Wood Waste

Alternative	*Cost (Dollars/day)*	*Energy Cost (mm Btu/day)*
I. Haul to Remote Landfill		
1. Fuel, labor & equipment to concentration point	$12,064.00	15.386[a]
2. Fee, labor, handling and transport to the landfill	411.21	6.208[b]
Total Cost	$12,475.21	21.576
II. Chip and haul to power plant		
1. Fuel, labor, and equipment to concentration yard	$12,064.00	15.386[a]
2. Labor, handling, chipper operation	275.00	20.507[c]
3. Chipper depreciation	151.00[d]	
4. Energy gained from the waste	−2,265.00[e]	−904.000
Total Cost	$10,225.00	868.107
III. Sell to outside firm		
1. Fuel, labor, and equipment to concentration yard	$12,064.00	15.386
2. Labor, handling, and chipper operation	275.00	20.507
3. Chipper depreciation	151.00	
4. Revenue to firm for chips sold at $1.25/ton	−152.00	
Total Cost	$12,348.00	35.893

[a]Breakdown for this energy cost into its elements are (1) transportation, 69,450 Btu/ton, (2) chipping, 51.250 Btu/ton, (3) equipment, 15,800 Btu/ton, and (4) 113 tons processed per day for a 265-day year.

[b]Breakdown is as follows: (1) transport, 4.618 mm Btu/day and (2) handling, 1.590 mm Btu/day.

[c]Breakdown is as follows: (1) transport, 6.2 mm Btu/day, (2) chipping, 2.904 mm Btu/day, and (3) handling, 11.385 mm Btu/day

[d]Initial cost of chipper was $200,000. It is assumed that its value will decrease (straight line) to zero in five years.

[e]Energy value was calculated as follows: oil cost=$20/bbl, oil firing efficiency=82.5%, wood firing efficiency=62%, and oil energy content=6 mm Btu/bbl.

or zero value at this point, the residue developed a negative value as it was transported to the concentration point.

The energy produced by the fuel chips can be translated into dollars. A barrel of residual fuel oil contains 6.287 million Btu's and is fired at 82.5 percent efficiency versus a 72 percent firing efficiency for wood, the fuel value per day for the residue obtained in this case is equivalent to 122.6 barrels of oil. Similar coal values would be 31.6 short tons. Fuel costs for oil and coal paid by utility companies in 1980 are estimated to be $3.91 and $1.52 per million Btu's respectively (1). The daily residue then will be worth $2,792.31 and $1,135.96 when compared to these fossil fuels and is in addition to the lesser costs associated with the power plant option.

Conclusion

The Houston firm chose to chip its wood waste and sell the material to an outside firm at $1.25 per ton. A seven-year contract has been negotiated. Figures two and three show two photographs of the chipping operation now underway at the concentration point (the old city landfill).

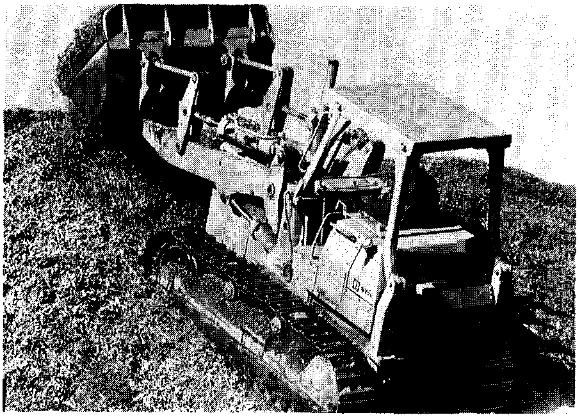

Figure 2. Stacking chips for sale in Houston, Texas.

From the economic analysis presented in Table 1, the alternative of generating electricity in the city itself appears attractive relative to this selected alternative. It is reasonable to assume that this more attractive alternative will be reviewed at the end of the seven year contract period.

The analysis of the Houston firm's alternatives and selection criteria indicate that it is feasible from both an economic and energy point of view to convert urban wood waste into energy. As the nation's energy needs become more intense we can assume that such an alternative will become even more attractive.

Figure 3. Examination of chips for uniformity.

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