

## MESQUITE AS AN ENERGY RESOURCE: POTENTIAL AND ENVIRONMENTAL CONSIDERATIONS

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### ABSTRACT

Recently, increased attention has been paid towards using alternative sources of energy. However, of the available alternatives little consideration has been given to the biomass potential of mesquite trees. This paper examines the feasibility, problems and prospects of using mesquite trees as a renewable energy resource in Southwestern states such as Texas. Lignite is also an energy resource which is expected in future years to provide a greater proportion of electric generating capacity in Texas. To put in perspective any estimates of mesquite potential as an alternative energy resource, a comparison is made between mesquite and lignite. The advantages and disadvantages of each are pointed out.

In the coming decades, a major shift is expected to take place in the United States away from an oil based economy. To some, coal or oil shale presents the logical alternative. To others, while coal is relatively abundant, the use of coal or oil shale is unacceptable because of related environmental and water resource problems. The nuclear option is currently in disfavor for a variety of economic, environmental, social and political reasons. The role of nuclear energy in supplying energy needs may well decrease as plants under construction are not completed, and those in the planning stage are not built. The debate surrounding solar continues, and its ultimate contribution may depend upon social and political as well as technological constraints. Conservation faces similar constraints.

In the continuing controversy about which directions to take, biomass has received only nominal attention as a potential alternative energy source.

However, as fossil fuels become depleted the conversion of plant biomass offers potential as a renewable energy resource [1, 2]. Indeed, it has been argued that in theory biomass could provide more than enough of the world's energy needs. Ultimately, trees may be the preferred form of energy [3]. The use of biomass as an alternative energy source will become more and more attractive as other energy prices rise. Biomass might not have received any serious consideration if during the last decade petroleum prices had not risen sharply. As prices continue to rise, the use of biomass would allow for satisfying a portion of the enduse demand with a renewable resource while conserving fossil fuel use [2].

Studies of the feasibility of biomass as an energy resource generally concentrate on agriculturally grown products such as corn, or on the utilization of wood products. Under the silviculture option there is one potential source within the Southwestern part of the United States which has been largely ignored. In two recent publications dealing exclusively with biomass potential, there is no mention of the potential use of mesquite trees (*Prosopis glandulosa*) for biomass energy [4, 5]. This paper presents an examination of the problems and prospects of using mesquite as a renewable energy resource. The particular focus is on mesquite in Texas. The intent is not to present a definitive analysis, but rather to consider the feasibility of the mesquite option.

## BIOGEOGRAPHY OF MESQUITE

A brief description of the biogeography of the mesquite tree will give a better appreciation of how it spread and came to dominate formerly valuable rangeland in Texas. The honey mesquite is an excellent example of a desert angiosperm. This hardy legume has invaded overgrazed areas of the southwestern United States. Traditionally, mesquite's niche was relegated to desert washes and stream beds. However, over the past century and a half, while mesquite's niche has increased into upland areas, its range has not changed. The range of honey mesquite in Texas has not changed since the 1800's, only its concentration has changed. Mesquite's niche has expanded from desert washes and streambeds to heavily trampled and overgrazed lands.

The increased densities of honey mesquite is attributed largely to a major increase in the number of grazing animals on the range. Between 1830 and 1900, the number of grazing animals in Texas increased from half a million to over nine million head [6].

Mesquite's pods are rich in protein and sweetly flavored, and for this reason, cattle browse mesquite pods quite heavily. The pods, which enclose the seeds are digested by cattle, but the seeds are passed unaffected through the cow's digestive system. In the process of consumption of mesquite pods, a cow will remove the seed cover and destroy the parasitic bruchid larvae which would otherwise consume the seed [7]. The seeds are then deposited in a fertile medium of cow dung after the grass has been removed by previous grazing. Grazing thereby provides a near-perfect niche for mesquite infestation.

There is, however, more to mesquite's success than the opportunity afforded by heavy grazing pressures. Several characteristics of mesquite's meristem and root system allow it to survive both drought and the wrath of ranchers. Mesquite seedlings concentrate on tap root growth. Young seedlings grow tap roots twenty-five feet deep. As the mesquite trees mature, their root system spread some seventy-five feet. This vast and deep root system allows them to tap the sparse water supplies of the southwest [8]. The problem will be compounded in the future as water becomes scarcer in areas such as West Texas where water availability may be the major factor in limiting growth. Mesquite has been cast in the villain's role since it can consume nine acre feet per year of water. One 15,000 acre ranch heavily infested with mesquite may consume as much water as a small Texas town. However, when water is scarce, mesquite can survive by abstaining and lowering its water needs [9].

The mesquite tree's auxiliary growth buds can also play an important role in the infestation of rangeland. If the tree is chopped down, a network of subterranean growth nodes take over the growth function. Consequently, chopping down a single-stemmed mesquite tree leads to the growth of a multi-stemmed tree. As a legacy of this strong adaptation, vast stands of multi-stemmed mesquite trees cover the landscape of Texas rangeland, the end result of efforts by Texas ranchers to clear mesquite off the land.

The Southwest is now dealing with a mesquite invasion, both as a result of overgrazing and mesquite's amazing ability to secure water and resist cutting. Previously valuable rangeland is now infested by mesquite. This not only hurts the range industries, but also depletes limited and increasingly valuable water resources.

Understandably, the mesquite tree is called the "water robber" and is viewed with contempt by Texas' ranchers, appearing to be roughly as unpopular as the coyote. "Insidious thieves steal more water from southwestern rangelands than used by all the towns, factories and irrigators." [9]

The United States Department of Agriculture recognized that mesquite would be a major problem as early as 1923. "Its invasion of grazing lands, especially in Texas, may be compared to the in-roads of the boll weevil into the cotton belt." [10] The mesquite is a problem because the tree is so well adapted to the niche which has opened because of heavy grazing pressures. Grazing cattle provide a near-perfect opportunity for the spread of mesquite. There is an apparent correlation between grazing and the increased in mesquite infestation. With the appearance of cattle and ranching came the spread of mesquite. Unfortunately, in recent years as grazing has diminished, there has not been a concurrent decrease in mesquite infestation.

## MESQUITE BIOMASS AS AN ENERGY RESOURCE

Does mesquite have potential as an alternative energy source? To put any estimates in perspective, a comparison is made with lignite. Figure 1 shows the

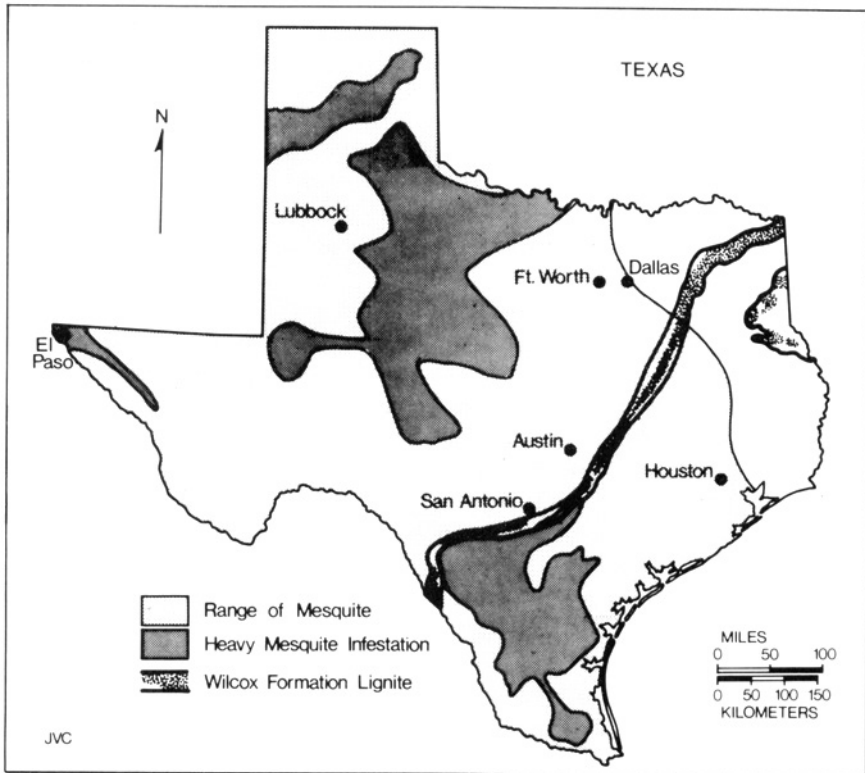


Figure 1. Mesquite and lignite in Texas.

ranges of mesquite trees in Texas. It has been estimated that over thirty-four million acres are heavily infested with mesquite trees [11]. Texas also has, as shown in Figure 1, a significant amount of lignite contained in what is known as the Wilcox formation. Lignite is a low grade of coal which has a lower heating value than eastern bituminous or western sub-bituminous coal. While in 1971, lignite contributed only 1 per cent of the electrical generating capacity in the state, this is expected to increase to 27 per cent by 1985. In 1970, only 2.25 million tons of lignite were extracted, whereas by 1985, 55 million tons are expected to be strip mined [12, 13].

How does mesquite compare with lignite? On the basis of thermal value per pound, it compares quite favorably. Mesquite has a thermal value of approximately 8,100 Btu per pound [14]. The thermal value of Texas lignite is only 6,330 Btu per pound [15]. Heavily infested lands should provide an average yield of 8.75 dry tons of mesquite per acre [11]. Wiley and Maniviller have estimated that in productive terms, biomass resulting from cutting and pelletizing all mesquite trees in a densely infested three mile radius would product enough energy to completely fuel a medium sized industrial plant for

ten years [14]. Using the estimate of 8.75 dry tons per acre, if all of Texas' moderately to heavily infested rangelands were harvested this could produce roughly 4.3 quadrillion Btu.

In 1976 the United States gross energy inputs totalled seventy-four quadrillion Btu [16]. Consequently, just Texas mesquite alone could theoretically provide about 6 per cent of the United States' gross energy inputs. Moreover, these are very tentative and conservatively biased estimates. They could be off by as much as a factor of four since much work remains to be done in simply inventorying the amount of available mesquite energy.

While mesquite is readily available, it does, in comparison to coal, have some obvious disadvantages. It is less concentrated and must be collected in bulky form from large areas, and has relatively higher labor and transportation costs. However, because of its tendency to self ignite, lignite is limited to a transport distance of about thirty miles from extraction to consumption in a power plant. Nevertheless, more area is required to extract a given amount of energy from mesquite than lignite. From an environmental standpoint, mesquite does have a definitive advantage over lignite extraction. Recent surveys indicate the importance of environmental considerations in energy-environmental tradeoffs [17, 18]. The use of lignite presents a host of environmental problems in the form of external or environmental costs, such as the associated reclamation, air and water pollution and waste disposal problems.

The air pollution comparison with lignite is particularly telling. The use of biomass would reduce carbon dioxide and sulfur dioxide pollution because the total amount of fuel burned would be less, and the sulfur content of plant residues would be lower [19]. The sulfur content is estimated to be 19 per cent for lignite and only 0.1 per cent for mesquite [15, 20]. The lower pollution levels are important because of their implications on the siting of power plants. The Prevent Significant Deterioration (PSD) restrictions of the Clean Air Act require that in clean air areas power plants not be located too closely together. In rapidly growing regions such as the Southwest, the PSD requirements could put a constraint on the amount of growth allowed in an area. In the clean air areas, power plants burning mesquite could be more closely spaced than lignite plants, and more importantly would use up less of the PSD increments.

The cleaner burning mesquite can be used in a variety of forms. With only minor modifications it can be pelletized and burned in standard coal-fired generators [21]. It could be used more efficiently through direct combustion for heat. It can also be converted into charcoal for cooking and heating purposes. Its greatest potential use, however, may be on the horizon. Mesquite pellets could be used as a backup system for solar photovoltaic arrays in small-scale utilities. Utilizing a scaled-down fluidized-bed combustion system, mesquite could be used to generate energy during periods of low insolation to replace intermittent solar energy.

In any comparison of mesquite with lignite the socioeconomic impacts of each alternative should be weighed carefully. Lignite development can create

considerable opposition in the impacted communities. Studies of communities in the Western and Southwestern part of the United States cite a litany of strains on local public services, as well as social impacts such as rising crime rates [22-24]. In Texas, proposed strip mining of Federal lands has resulted in considerable opposition from the local residents [25].

One of the reasons for the opposition to the mining of lignite is its incompatibility with other land uses. Land which is mined cannot be used for farming or grazing, at least not in the short term. If one use of the land precludes another, this forces people, as in the case of Montana or Wyoming ranchers, to choose between opposing options. As recent studies attest, conflict necessarily follows when some choose one way, and others another [26, 27]. Mesquite harvesting may avoid such conflicts since it is compatible with other land uses such as grazing and farming. If the need for biomass energy decreased, the land allocated to such use could relatively easily be returned to other uses such as grazing or farming. However, the problem of eradicating the mesquite would still remain.

Mesquite, in contrast to lignite is a renewable resource. If properly managed, its production can be sustained. Mesquite harvesting thus creates greater long-term employment possibilities. Moreover, mesquite harvesting is a more labor intensive operation than lignite mining which is largely capital intensive. In predominately rural areas employment considerations may not be a small factor in the degree of acceptability of any proposed project. The use of mesquite would also spread employment out, rather than concentrating it spatially. There may be advantages to keeping the power plants small and dispersed.

Some impacts from using mesquite may or may not be considered advantageous. The harvesting of mesquite may require projects of considerable size in acreage. Consequently, considerable changes in the ownership of land may take place. The type of economic base that communities have may change affecting the underlying tax structure. Mesquite farming could become largely a corporate venture, or it could offer to rural farmers and ranchers opportunities which they presently don't have.

Farmers in regions such as West Texas face a serious water shortage problem in the future. There are clear indications that irrigation schemes will be too expensive in the future. Growing crops, or other types of trees may demand more water than is available. Mesquite farming, however, faces less constraints since mesquite can adapt by lowering its water requirement.

Mesquite has some additional advantages over the other biomass options. Other trees often considered in the biomass alternative are on public lands. The extent to which these trees could be used for energy production may be limited by opposition from environmentalists and other groups. Mesquite by contrast is located largely on private lands. Other agricultural and wood product sources also have supply constraints. There may be a higher use value to these agricultural and wood products, and their residuals. As the price of these

alternative uses goes up, it decreases the supply available for energy use. Such supply constraints may make public utilities uncertain as to the reliability of their long term supply [14]. No such problem currently exists with mesquite, since mesquite is not perceived as a resource. Instead, vast sums of money are spent trying to eradicate it. The least expensive means of controlling mesquite is by the application of 2,4,5-T (Dioxin). The cost of control is approximately \$3.25 per acre (1973 dollars). However, use of this herbicide was banned by the U.S. Environmental Protection Agency in 1979 [11]. Mesquite control in Texas using 2,4,5-T costs an estimated \$1.1 billion. Although no good estimates are available, this figure is now considerably higher. The \$1.1 billion figure is a conservative estimate of the amount saved if and when mesquite becomes a resource.

## CONCLUSION

Many questions still need to be resolved in consideration of the use of mesquite as an energy resource. These include the comparative economics of using photogrammetric techniques to more accurately measure the amount of mesquite available; the associated environmental and social costs; and the implications of harvesting mesquite, most of which is on private lands.

The potential inherent in mesquite as an energy resource needs to be more carefully studied. Mesquite is an attractive alternative because it is a renewable energy source. Mesquite harvesting may be another step towards a society based on renewable energy resources. As non-renewable energy supplies decrease, and energy prices rise, alternative energy sources become both more feasible and attractive. Mesquite may well become another example of Zimmerman's famous adage "resources are not, they become." [28]

## ACKNOWLEDGEMENT

We would like to thank Larry Patrick for his comments on an earlier draft of this paper.

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