

have comparably high efficiencies; methanol production and use for fuel and heavy oil production and use for fuel have overall efficiencies of about 30 percent. Tillman shows that as a material for gasification wood, with an overall process efficiency of about 78 percent, is less desirable than coal at about 85 percent but better than manure at about 33 percent and municipal waste at about 66 percent. He also considers other factors, including the energy costs of extraction, transport, and conversion, and concludes that wood is a prime candidate for use in systems such as cogeneration that are aimed at high efficiency of energy recovery.

Tillman explains why fuel farms are unlikely sources of fuel wood and why increases in fuel wood will come from the residues generated by forest management, forest harvesting, and forest products manufacturing until the end of this century. He believes that such requirements for energy farms as a minimum size of 28,500 acres and intensive land management, including the extensive use of fertilizers, makes their use unrealistic prior to 2000. Tillman presents statistics to show that, if fuel farms become established, crops such as sugar cane that have high productivity and high yield rates are most promising. He also shows, through an energy trajectory analysis, that fuel farms have a trajectory efficiency of only 20.33 percent, compared to 52.8 percent for residue fuel wood use.

Because of the emphasis of the book on prospects for the future, there are numerous assumptions and conclusions that can be debated, but this is not because Tillman's work lacks documentation and rigor. He presents a detailed historical account of the use of wood and other fuels in this country, and he tries to back up his interpretation of statistical data with numerous chi-square contingency tests, coefficient-of-correlation determinations, and trajectory analyses.

Sometime he places too much emphasis on mathematical analysis, and the results appear forced and, in one case, meaningless. In that case he takes heating values for seven different species of wood as determined by different methods with different assumptions by four different authors, averages them, and compares the resulting mean heating value (8613 Btu per pound) with a mean value (8559 Btu per pound) obtained by another mathematical formula using average assumed lignin and holocellulose percentages for the same seven species and assumed heating values for lignin and holocellulose. Although the heating values for lignin and holocellulose are

applied to all species, they were actually derived for the lignin and holocellulose in Douglas fir. They are values for separated lignin and separated holocellulose, which are not necessarily the same as the values for the native wood constituents. Given the lack of precision in these data, the compared values are surprisingly close.

Unfortunately, the comparison of heating values for wood at different moisture content with other fuels is not readily understood, and much that has been written recently, instead of clarifying the subject, has created more confusion. Tillman's handling of the matter may add to the confusion. It would probably be better to base comparisons on high heating values rather than on inadequately defined net heating values as he has done.

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