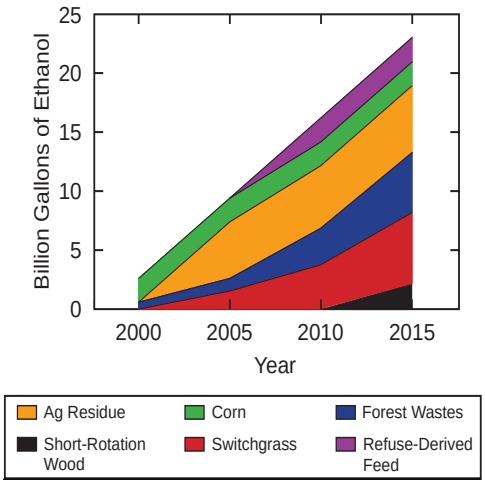
Predicting Growth in Ethanol Demand

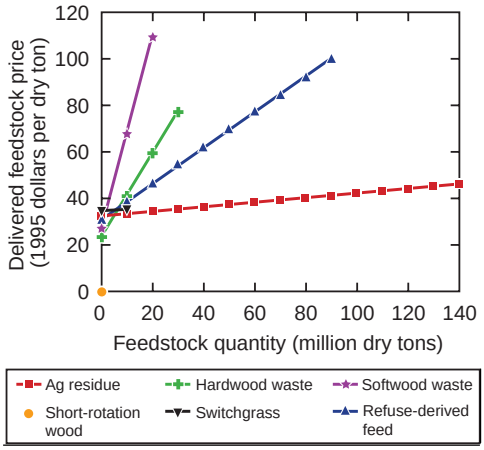
Successful commercialization of new fuels depends largely on their economic competitiveness, and ORNL is leading the way in evaluating the economic potential of biomass-derived ethanol.

Feedstock supply curves (below) have been estimated for the years 2000, 2005, 2010, and 2015 for biomass sources that include forest wastes (logging residues, tree thinnings), agricultural residues (corn stalks, wheat straw), dedicated energy crops (switchgrass, short-rotation hybrid poplar and willow crops), and refuse-derived feedstocks (from municipal solid waste). The feedstock supply curves, combined with information about the cost of converting various feedstocks to ethanol, have been used to create ethanol supply curves that relate quantities of ethanol produced to price.



Estimated biomass supply curves for the year 2000.

The supply curves have been used to estimate the least-cost combination of biomass feedstocks for any given quantity of ethanol under various scenarios (at right). ORNL has begun to derive ethanol demand curves using a refinery model (RYM) for ethanol blended with gasoline, and the "Transition to Alternative Fueled Vehicles" model for ethanol used as a neat fuel. By combining the ethanol supply curves with demand curves, it will be possible to estimate the potential size of the ethanol industry, the market price of ethanol, and the feedstock mix used to produce the ethanol. This modeling framework will provide DOE's Office of Transportation Technologies with economic information needed to evaluate constraints to commercialization, explore the impacts of policy on commercialization potential, and estimate the economic and environmental impacts of biomass-derived ethanol.



Least-cost combustion of feedstocks used to produce ethanol.

By Marie Walsh, 423-576-5607, zw7@ornl.gov
Sponsor: Office of Transportation Technologies, Office of Fuels Development

Growing a Biomass Power Supply

ORNL staff of the Bioenergy Feedstock Development Program have worked with DOE and many collaborators for 20 years to develop cropping technologies that could result in environmentally beneficial and low-cost, profitable crops for energy production. These concepts are now being tested in real-world conditions.

The first willow trees to be planted specifically for electricity generation were established in spring 1998 in New York on idle crop and pasture lands. The willow planting is one of three Biomass Power for Rural Development projects that are getting farmers involved in growing energy crops to supplement biomass resources. In the New York project, 25 organizations—including several utility companies, state agencies, university researchers, U.S. Department of Agriculture units, and local farmers—have formed a consortium to demonstrate the use of

Biomass (continued on page 10)

Willow trees to be used for generating electricity surround a power plant in New York state.

Biomass Productivity Puzzle in the Southeast

ORNL researchers, working under a CRADA with Union Camp, initiated a large irrigation/fertilization or "fertigation," experiment in 1995 to determine the factors that limit biomass productivity in the southeastern United States. Growth rate (productivity) is the single largest factor determining landowner profits, environmental impact, land-use changes, and overall return on investment in biomass-based renewable energy.

Productivity varies according to planting stock, cultural practices, and region. Other things held equal, productivity in the Southeast is below observed growth rates in other regions and below expectations based on environmentally based growth and yield models. The objective of the Union Camp experiment was to characterize carbon use efficiency in trees grown in the Southeast under optimal conditions; the assumption was that higher temperatures during the growing season in the Southeast limit productivity through respiratory loss of carbon.

Results to date show that growth through age three in cottonwood and sycamore is as high as in other regions (projected productivities of 5 to 7 dry tons per acre per year). During the fourth growing season, however, the leaf area index decreases, respiratory losses increase per unit of biomass, water use decreases, and growth slows. Increased water availability through irrigation and nitrogen fertilization does not appear to prevent these changes in cottonwood and sycamore growth. The amount of carbon fixed through photosynthesis apparently decreases with age, and the carbon that is fixed is lost to respiration. In short, carbon-use efficiency decreases after three years of growth.

Paul Hansen of ORNL checks soil respiration data for young sweetgums.

With this information, it may be possible to adjust growing conditions to maintain high leaf area indices, reduce respiratory losses, and maintain growth through a full rotation (i.e., 8 to 10 years) in the Southeast. In addition, information is now available to breeders that should allow them to select superior planting stock: they can select for improved crown architecture, increased leaf area per tree during crown closure, improved water use, and integratively increased productivity.

By Jerry Tuskan, 423-576-8141, gtk@ornl.gov
Sponsor: Office of Fuels Development

Biomass (continued from page 9)

willow trees as energy crops for power generation in the Northeast and upper Midwest.

Near-term project goals include demonstrating 30–40 MW of biomass power generation by co-firing a combination of willows and forest residues with coal, and by successfully producing willow on 1000 acres. Co-firing small amounts of forest residues is already under way, and co-firing the first willow biomass is anticipated to occur as early as the year 2000. A longer-term goal is to create a sufficient market for willow biomass at $2 per million Btu to encourage the establishment of several thousands of acres of willow on idle crop and pasture land.

ORNL is facilitating accomplishment of the goals of the New York Biomass Power for Rural Development project in several ways. ORNL staff participate on the DOE team that oversees and reviews the project. In addition, ORNL is working to facilitate the development of an effective farmers' willow cooperative by researching and sharing information on organizational modes of effective cooperatives. ORNL also provides funds for and collaborates with the State University of New York and the U.S. Forest Service to develop genetically improved willow varieties with the potential to bring a profit to farmers at the relatively low price of $2 per million Btu. Finally, ORNL researchers are using willows for basic research on the isolation of gender-determining genes. Although this research is not directly tied to the New York Biomass Power project, progress in the basic research could lead to higher-yield clones of willows that do not expend energy in producing flowers, and to mechanisms for ensuring the safe release of genetically transformed willow clones.

By Lynn Wright, 423-574-7378, lld@ornl.gov
Sponsor: Office of Solar Thermal, Biomass Power, and Hydrogen Technologies