

**U.S. Department of Energy - Energy Efficiency and Renewable Energy
Alternative Fuels and Advanced Vehicles Data Center - Ethanol**

Cellulosic Ethanol Feedstocks

Plants contain the cellulosic materials cellulose and hemicellulose. These complex polymers form the structure of plant stalks, leaves, trunks, branches, and husks. They are also in products made from plants, such as paper. Cellulosic feedstocks contain sugars within their cellulose and hemicellulose, but they are more difficult to biochemically convert into ethanol than starch- and sugar-based feedstocks. Cellulose resists being broken down into its component sugars. Hemicellulose is easier to break down, but the resulting sugars are difficult to ferment. The plant compound lignin also resists biochemical conversion.

Developing processes to break down these components of biomass economically has been the focus of research by the U.S. Department of Energy (DOE) and other government and industry groups. Significant progress has resulted in biochemical conversion processes to break down cellulose and hemicellulose and thermochemical conversion processes to break down lignin. Together, these processes could unlock the potential of cellulosic feedstocks for [ethanol production](#). They are being demonstrated in [six DOE-supported commercial biorefineries](#).



Cellulosic feedstocks suited to ethanol production include the following:

- Agricultural residue—crop residues such as wheat straw and corn stalks, leaves, and husks
- Forestry residue—logging and mill residues such as wood chips, sawdust, and pulping liquor
- Grasses—hardy, fast-growing grasses such as switchgrass grown specifically for ethanol production
- Municipal and other wastes—plant-derived wastes such as household garbage, paper products, paper pulp, and food-processing waste
- Trees—fast-growing trees such as poplar and willow grown specifically for ethanol production

These feedstocks have many advantages over [starch- and sugar-based feedstocks](#). They are much more [abundant](#) and thus can be used to produce more substantial amounts of ethanol to meet U.S. fuel demand. They are waste products or, in the case of trees and grasses grown specifically for ethanol production, can be grown on marginal lands not suitable for other crops. Less fossil fuel energy is required to grow/collect them and convert them to ethanol (see [Energy Balance of Ethanol](#)), and they are not human food products. To learn more, see the DOE Biomass Program's [Bioethanol Feedstocks](#) page.

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