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The Biofuels Challenges Affecting the Mother Nature

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Abstract

Plant biomass currently accounts for 10 % of global primary energy and is generally predicted to supply a quarter of primary energy in influential low-carbon scenarios by 2050. Biomass produces as much energy as petroleum, natural gas and coal together in Shell's net-zero energy scenario, as well as potential for carbon reduction to be deployed on a broad scale in order to achieve more than a 50% chance of meeting the 2 ° C goal. Cellulose feedstock's are thought to have the greatest potential for climate change mitigation among different types of plant biomass and are widely available at a lower cost per unit energy than oil. Recent studies identify the vast number of jobs generated by green energy technology, including biofuels. Bioenergy is responsible, directly and indirectly, for almost 3 million workers worldwide about the same as solar energy and three times that of wind with liquid biofuels accounting for just over half of the total and solid biomass and biogas that make up the balance. Forecasts for specific liquid biofuel jobs in the United States range from 100,000 to 300,000, compared with approximately 370,000 direct workers in the U.S. solar industry and about 70,000 for coal mines. Sugarcane production in Brazil, nearly half of which is used for ethanol, is the country's main agricultural employer. Similar to other farm workers, cane workers have the highest presence in the formal economy and higher levels of employment. Towns with ethanol plants in Brazil have higher tax revenues than comparable cities that do not.

Bioenergy Feedstock

Bioenergy plants are broadly classified into two categories, (i) gymnosperms (soft woods like pine, spruce, fir, and cedar) and (ii) angiosperms [monocots: all perennial grasses (e.g., switchgrass, Miscanthus, Sorghum, sugarcane, and bamboo) and herbaceous species (e.g., corn, wheat, and rice); dicots: flowering plants (alfalfa, soybean tobacco), hardwoods (e.g., poplar, willow, and black locust). The cell wall components (cellulose, hemicellulose, lignin, and ash) vary for different species of plants. Most of the dicots and some monocots have cellulose microfibrils cross-linked with xyloglucans with little arabinoxylan linkages. On the other hand, most monocots consist of glucuronoarabinoxylans as the major cross-linked glycans that are hydrogen bonded to cellulose microfibrils. The lignin [aromatic polymer comprising of syringyl (S), guaiacyl (G), and p-hydroxyphenyl (H)] content and its composition significantly vary in different plant species. Gymnosperms have the highest lignin content and comprises of G and H units. Hard wood species mainly have G and S units and minor amounts of H-units. The monocot grasses have similar amounts of G and S units with significantly higher amounts of H-units than the hard or soft wood plant species. These compositional changes in plant cell wall and differences in ultrastructure greatly influence the pretreatment and the resultant pretreated biomass sugar conversion. For example, Ammonia Fiber Expansion (AFEX) pretreatment process is effective on monocot grasses and herbaceous plant biomass while not as effective on dicots such as poplar and black locust. Also, the same type of biomass harvested from the same field in different years will display changes in biomass composition (due to environmental conditions). This variance poses a challenge in adjusting the processing conditions and directly influences the biofuels yield.

Environmental Issues

It is well reported that biofuels offers several environmental benefits over fossil fuels. Biofuels from lignocellulose biomass have reduced emissions and fixed CO2, a greenhouse gas, among other things. In the near future when a new bio refinery is established, several technologies will be assembled based on their impact on the environment. Some of the examples are air pollution caused by particulate emission during biomass harvesting and grinding, noise pollution from explosive pretreatment processes, methods for producing pretreatment chemicals that produce GHG emissions, and release of pretreatment chemicals to the environment after processing. Life Cycle Analysis (LCA) is often used to assess the net environmental impact of these processing steps. The challenges are in carrying out accurate LCA analysis depending on the data that is collected from group of aligned processes that will be used in the bio refinery. Many companies are taking the LCA very seriously to assess the environment impact so that they could make decisions to adjust the process or areas that needed to be focused to reduce the emissions. Depending on the emissions estimated by LCA will influence the cost of establishing the bio refinery.

Coproduct Generation and Its Influence of Biofuel Production Cost

Coproduct generation is very essential for producing cost competitive biofuels. For example, the first generation corn ethanol industry consists of 67% dry mill based and 33% wet mill based operations. Coproducts generated depend on the mill type. Though the dry mill process produces more ethanol (2.8 gallon/bushels of corn) than the wet mill process (2.5 gallon/bushels of corn), the wet mill produces more coproducts, which results in more revenue. The corn dry mill industry produces Dry Distiller's Grains and Soluble (DDGS) and carbon dioxide as major coproducts reducing the biofuel cost by 35%. In the corn wet milling process, high capital and energy intensive processing is involved (fractionating grain into starch, fiber, gluten, and germ) to produce a larger number of coproducts that include carbon dioxide, corn oil, corn gluten meal, and corn gluten feed. For the second generation technology to be able to compete with the first generation technology, several coproducts should be generated that can be sold for a high market price and subsequently reducing the overall processing costs of biofuels. Some of the coproducts that could be generated from second generation bio refinery are discussed below.

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