Abstract

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ADVANCED BIOREFINERIES

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The term “biorefinery” has been coined to describe future processing complexes that will use renewable agricultural residues, plant-based starch and lignocellulosic materials as feedstocks to produce a wide range of chemicals, fuels and bio-based materials. Predecessors to the new complexes, which can be considered first generation biorefineries, include existing pulp and paper manufacturing plants, corn wet and dry mills, soy processing facilities, and sugar-ethanol mills. Advanced biorefineries are envisioned to serve as the foundation of a new bioindustry. By exploiting new chemical, biological and mechanical technologies, they offer the promise of greatly expanding the use of renewable plant-based materials, as well as a means of transitioning to a more energy efficient and environmentally sustainable chemical and energy economy.

There are numerous technical and infrastructure challenges associated with commercializing lignocellulosic biomass as an expanded source of feedstocks for biorefineries. While large quantities of various crop wastes go unused throughout the world, these lignocellulosic materials are difficult to efficiently convert into chemical products due to their complex polymeric structures. A multi-disciplinary approach that couples biotechnology and chemistry with process engineering is necessary in order to achieve efficient commercial processes.In addition to the technical challenges of commercializing advanced biorefineries, there are also large infrastructure barriers. These barriers are associated with the development of new agricultural infrastructure for the collection and storage of crop wastes. An integrated feedstock supply system must be developed that can supply the feedstock needs in a sustainable fashion at a reasonable cost. Infrastructure issues could be as significant as the technical issues when considering overall production costs.

In this report, PEP presents process designs and associated cost estimates for two biorefinery configurations, a lignocelulose biorefinery with lactic acid as the primary product and a whole crop biorefinery with 1,3-propanediol as the primary product. Technology development is in the semi-commercial stage with government supported R&D from the Department of Energy and the Department of Agriculture. Process economics are also estimated for corn dry milling, an important first generation biorefinery technology. The general conclusions are summarized below:

- Advanced biorefineries are capital intensive due to the complex process technologies required. Sections of the process which are most capital intensive are lignocellulose pretreatment and recovery and purification of polymer grade product.
- Production of a variety of coproducts provides economic synergy primarily due to shared infrastructure such as utilities and waste treatment. The biorefinery also benefits from a diversified set of products which reduces the risk of a single commodity market.

Economic benefits could be further enhanced through development of higher value applications for lignin-based products.

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