Consolidated Bioprocessing for Sustainable Fuel Production

Edited by Neha Srivastava

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Chapter 12

Cost Analysis of Consolidated Bioprocess Technology for Green Energy Production and Environmental Sustainability Impact

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Summary

Rising global energy demands and environmental concerns, such as climate change, fossil fuel depletion, and greenhouse gas emissions, are driving a critical shift toward renewable energy. Among the sustainable alternatives, bioenergy uniquely addresses both clean energy production and organic waste management. Central to this is the bioeconomy, which promotes the conversion of renewable biomass into fuels, chemicals, and materials. However, conventional biofuel production faces challenges, including high costs, complex processing, and reliance on expensive enzymes, especially for advanced biofuels derived from non-food biomass and algae. This chapter explores consolidated bioprocessing (CBP), a game-changing approach that integrates enzyme production, biomass hydrolysis, and fermentation into a single step. CBP aligns with green chemistry and circular bioeconomy goals by minimizing water and energy use as well as waste, while enabling the valorization of agro-industrial residues. This chapter also provides a comprehensive review of CBP's technical foundations, economic metrics (CAPEX, OPEX, ROI, and IRR), and sustainability benefits. Additionally, it highlights recent advances in synthetic biology and AI-driven optimization that are accelerating CBP's path to commercialization. Through critical analysis, this chapter positions CBP as a scalable and cost-effective solution for sustainable biofuel production, supporting a low-carbon energy transition in both developed and developing economies.

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