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Biorefinery as Extension to Sugar Mills: Sustainability and Social Upliftment in the Green Economy

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Abstract : The sugar industry has to 're-invent' itself to ensure long-term economic survival and opportunities for job creation and enhanced community-level impacts, given increasing pressure from fluctuating and low global sugar prices, increasing energy prices and sustainability demands. We propose biorefineries for re-vitalisation of the sugar industry using low value lignocellulosic biomass (sugarcane bagasse, leaves, and tops) annexed to existing sugar mills, producing a spectrum of high value platform chemicals along with biofuel, bioenergy, and electricity. Opportunity is presented for greener products, to mitigate climate change and overcome economic challenges. Xylose from labile hemicellulose remains largely underutilized and the conversion to value-add products a major challenge. Insight is required on pretreatment and/or extraction to optimize production of cellulosic ethanol together with lactic acid, furfural or biopolymers from sugarcane bagasse, leaves, and tops. Experimental conditions for alkaline and pressurized hot water extraction dilute acid and steam explosion pretreatment of sugarcane bagasse and harvest residues were investigated to serve as a basis for developing various process scenarios under a sugarcane biorefinery scheme. Dilute acid and steam explosion pretreatment were optimized for maximum hemicellulose recovery, combined sugar yield and solids digestibility. An optimal range of conditions for alkaline and liquid hot water extraction of hemicellulosic biopolymers, as well as conditions for acceptable enzymatic digestibility of the solid residue, after such extraction was established. Using data from the above, a series of energy efficient biorefinery scenarios are under development and modeled using Aspen Plus® software, to simulate potential factories to better understand the biorefinery processes and estimate the CAPEX and OPEX, environmental impacts, and overall viability. Rigorous and detailed sustainability assessment methodology was formulated to address all pillars of sustainability. This work is ongoing and to date, models have been developed for some of the processes which can ultimately be combined into biorefinery scenarios. This will allow systematic comparison of a series of biorefinery scenarios to assess the potential to reduce negative impacts on and maximize the benefits of social, economic, and environmental factors on a lifecycle basis.

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