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Bio-Hub Ecosystems: Investment Risk Analysis Using Monte Carlo Techno-Economic Analysis

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Abstract : In order to attract new types of investors into the emerging Bio-Economy, new methodologies to analyze investment risk are needed. The Bio-Hub Ecosystem model was developed to address a critical area of concern within the global energy market regarding the use of biomass as a feedstock for power plants. This study looked at repurposing existing biomass-energy plants into Circular Zero-Waste Bio-Hub Ecosystems. A Bio-Hub model that first targets a 'whole-tree' approach and then looks at the circular economics of co-hosting diverse industries (wood processing, aquaculture, agriculture) in the vicinity of the Biomass Power Plants facilities. This study modeled the economics and risk strategies of cradle-to-cradle linkages to incorporate the value-chain effects on capital/operational expenditures and investment risk reductions using a proprietary techno-economic model that incorporates investment risk scenarios utilizing the Monte Carlo methodology. The study calculated the sequential increases in profitability for each additional co-host on an operating forestry-based biomass energy plant in West Enfield, Maine. Phase I starts with the base-line of forestry biomass to electricity only and was built up in stages to include co-hosts of a greenhouse and a land-based shrimp farm. Phase I incorporates CO2 and heat waste streams from the operating power plant in an analysis of lowering and stabilizing the operating costs of the agriculture and aquaculture co-hosts. Phase II analysis incorporated a jet-fuel biorefinery and its secondary slip-stream of biochar which would be developed into two additional bio-products: 1) A soil amendment compost for agriculture and 2) A biochar effluent filter for the aquaculture. The second part of the study applied the Monte Carlo risk methodology to illustrate how co-location derisks investment in an integrated Bio-Hub versus individual investments in stand-alone projects of energy, agriculture or aquaculture. The analyzed scenarios compared reductions in both Capital and Operating Expenditures, which stabilizes profits and reduces the investment risk associated with projects in energy, agriculture, and aquaculture. The major findings of this techno-economic modeling using the Monte Carlo technique resulted in the masterplan for the first Bio-Hub to be built in West Enfield, Maine. In 2018, the site was designated as an economic opportunity zone as part of a Federal Program, which allows for Capital Gains tax benefits for investments on the site. Bioenergy facilities are currently at a critical juncture where they have an opportunity to be repurposed into efficient, profitable and socially responsible investments, or be idled and scrapped. The Bio-hub Ecosystems techno-economic analysis model is a critical model to expedite new standards for investments in circular zero-waste projects. Profitable projects will expedite adoption and advance the critical transition from the current 'take-make-dispose' paradigm inherent in the energy, forestry and food industries to a more sustainable Bio-Economy paradigm that supports local and rural communities.

Keywords : bio-economy, investment risk, circular design, economic modelling
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