P-graph Approach to Criticality Analysis in Bioenergy Parks under Uncertainty

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Abstract

A bioenergy park is an integrated network of biomass processing industries that optimally allocate products, by-products, wastes, and utilities in order to improve sustainability. However, such systems are also characterized as having inherent vulnerability to cascading disruptions due to the inoperability (i.e., capacity reduction) of one or more of its component plants. The inoperability of bioenergy plants can be caused by supply-side disruptions due to reductions in the available biomass feedstocks. It is therefore necessary to incorporate risk analysis when designing bioenergy parks. A previous study developed a risk-based criticality analysis in integrated bioenergy systems (IBS) based on P-graph methodology. This approach utilizes the algorithmic capabilities of the P-graph framework in order to identify critical facilities in an IBS. However, uncertainties in the demand for bioenergy products are not yet considered in the framework. This work thus proposes an extension to the P-graph based method for criticality analysis in bioenergy parks with demand perturbation scenarios. Results show that the criticality of bioenergy plants is greatly influenced by variations in the demand of products and the reduction in net output is higher than the baseline demand scenario. This method can then be used in long-term planning and developing robust IBS. A bioenergy park case study is presented to demonstrate the applicability of the proposed approach.