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Abstract

A biomass energy system (BES) consists of highly integrated process units within a network. Via process integration, such system able to achieve higher thermodynamic efficiency levels and economic performance as compared to conventional stand-alone system. However, such benefits may not be realised if an energy system is not equipped to cope with failure of its component process units. A failure event can cause “ripple effects” to propagate throughout the BES and disrupt its overall performance. To address this, designers often allocate additional or redundant process units for the entire BES. However, this approach requires high capital investment. In case where designers are constrained by tight capital budgets, redundancy allocation for the entire BES would not be possible. Therefore, an appropriate resolution for this issue would be to identify the most critical process unit in the BES prior to allocating equipment redundancy. In this respect, this work presents a two-stage decision making framework for designing BES by addressing criticality of process units via redundancy allocation. The first stage consists of criticality analysis approach using input-output (I-O) analysis. The criticality analysis can identify the most crucial process unit by quantifying the effect of a component’s disruption within the BES. After identifying the bottleneck process unit, the second stage of the framework allows designers to systematically allocate equipment redundancy based on their budget restrictions via $k$-out-$m$ system modelling or process intensification. To demonstrate the proposed framework, a palm-based BES case study is solved.