Process Resilience and Energy Systems Design

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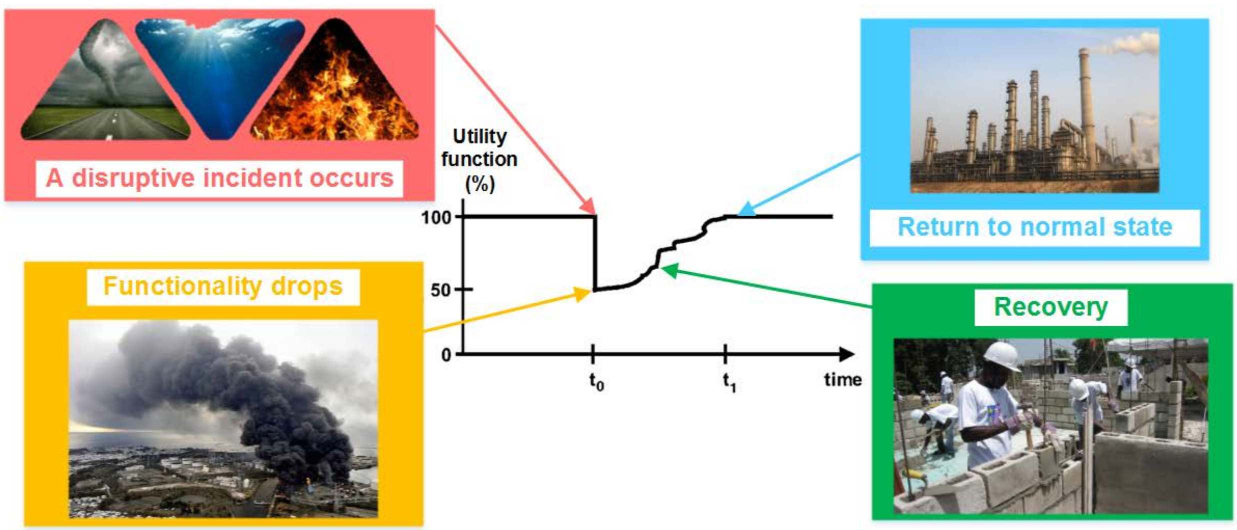
Resilience was first proposed in ecology and it was concerned with the persistence of systems regarding unexpected change and disturbance. Later resilience was introduced and actively studied in various infrastructure systems, such as electric power systems, transportation systems, water delivery systems, health care systems, supply chains, among others. An energy system is considered resilient if it demonstrates more reliability, lower consequences, and faster recovery in the face of destructive incidents. Although resilience is clearly defined as the ability to recover quickly from disruptions, it is rarely considered in process design and synthesis of energy systems, and there remains a research gap to develop a general framework for designing resilient energy systems.



In this project, we will first investigate what aspects of resilience to be considered in our framework and how they can be modeled mathematically. In order to evaluate resilience, a utility function of a system should be identified or established. Additionally, we will further develop a restoration model that describe how the system returns to its normal state of operation. With the above-mentioned functions and settings, an optimization model will be developed to account for decisions in technology selection, redundancy unit arrangement, recover sequencing, and utility function evaluation. We will also develop tailored solution methods to enhance the computational efficiency. The proposed framework will be demonstrated on energy systems for algal biofuel production and for shale gas processing.