Multi-stage formulation of energy supply chain design and optimization

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Energy systems engineering problems are oftentimes complicated by factors like large amounts of uncertainties and multi-scale nature of decisions. This presentation will explore a particular aspect of energy systems engineering problems that gives rise to such complications: The coupling between long-term planning decisions like capital investment and policy and shorter-term decisions like production capacity operation and logistics. In these problems, periodic investment / policy decisions are to be made on a time-scale orders of magnitude slower than that of operating decisions. The problem of electrical energy supply chain design will be used as an illustrative example. In the particular problem we examine, annual acquisition of energy generation capacities of various types are coupled with hourly energy production and dispatch decisions. Numerical challenges that arise from the multi-scale nature and uncertainties are reviewed and some possible modeling and solution approaches are discussed. Approximate dynamic programming is proposed as a promising algorithmic strategy to handle such challenges.