Optimal Hybrid Storage Management for Stochastic Dual-Commodity Energy System

Ece Karakoyun
Erasmus School of Economics, Erasmus University Rotterdam

We study a stochastic resource allocation problem in which an intermittent direct carrier serves current demand while also supporting an alternative carrier with a terminal contractual requirement. The system contains two dedicated storage assets and lossy cross-carrier conversion, creating a dynamic trade-off between mitigating current shortages and preserving or building inventory for future obligations. We formulate the problem as a finite-horizon Markov decision process and characterize the optimal policy. The analysis yields rules for charging, discharging, and cross-carrier transfer, and identifies when reserve and transfer decisions arise. We show that conversion losses endogenously shape the relationship between the two storages: they act as substitutes in shortage mitigation, but as complements when transfer is used to build contractual reserves.