

Electric Energy Markets

Prerequisites / co-requisites: graduate standing and a background in power engineering

Course Description: This course focuses on the market structures that exist within the electric energy industry. The course will provide a background on basic economic theory that is necessary to understand operational objectives, pricing and incentives, market power, etc. We will discuss the history of the electric power industry, regulation, and deregulation. We will discuss dispatch optimization problems that exist in the electric industry, approaches to solving these problems, and the corresponding markets. We will discuss different pricing methods, non-convex markets, uplift payments, etc. The final part of this class will deal with a discussion on current research problems in this field, including the Extended-LMP proposal, changing the ISO's objective from minimizing total system bid cost to minimizing the payment to suppliers, as well as other research topics.

Course Topics

- Overview of the Electric Power Industry
 - History of the Electric Power Industry
 - Deregulation Overview
 - Vertical Integration
 - Role of NERC & FERC
 - Market Structure in the USA
- Overview of Economic Theory
 - Microeconomics
 - Supply & Demand
 - Consumer Surplus & Producer Surplus
 - Price Taking
 - Profit Maximization
 - Monopoly
 - Game Theory
 - Equilibrium Models
 - Market Power
 - Hockey Stick Bidding
 - Deck Game
 - Measurements of market power
 - Auctions
 - Theory of Second Best
 - Transmission Expansion
 - Carbon Tax
- Optimization
 - Linear Programming
 - Convex sets
 - Primal and Dual
 - Proof of Optimality
 - Duality Theory
 - Duality Theory
 - Mixed Integer Linear Programming
 - Branch & Bound
- Dispatch
 - Economic Dispatch
 - Direct Current Optimal Power Flow (DCOPF)
 - Unit Commitment
 - Analyzing MIP Unit Commitment Formulations

- Pricing
 - Uniform Market Clearing Prices (MCP) vs. Pay As Bid
 - Locational Marginal Pricing (LMPs)
- Objectives, Rents, Congestion
 - Dual of the DCOPF
 - Load payment, Congestion Rent, Generation Rent
 - Congestion
- Non-convex markets
 - Make-whole Payments / Uplift
 - Centralized Unit Commitment vs. Decentralized
- Financial Transmission Rights
 - Simultaneous Feasibility Test
 - Revenue inadequacy
- SCE's Proposed Objective: Minimize Payment to Generators vs. Minimize Total Cost
- Extended-LMP (Convex Hull Pricing)
- Other Potential Topics:
 - Reliability Unit Commitment
 - Ancillary Services