

Electric Energy Markets

Professor Kory W. Hedman

Credits: 3

Required Textbook: None (Class Notes & Papers)

Useful References:

- Fundamentals of Power System Economics, Daniel Kirschen
 - On hold in Noble Library
- Power System Economics, Steven Stoft

Additional References:

- Power Generation, Operation, and Control, Wood & Wollenberg
- Intermediate Microeconomics, Hal R. Varian
- Introduction to Linear Optimization, Dimitris Bertsimas and John Tsitsiklis
- Linear and Nonlinear Programming, David Luenberger
- Market Operations in Electric Power Systems, Mohammad Shahidehpour
 - On hold in Noble Library
- Electricity Market Reform: An International Perspective, Fereidoon Sioshansi
 - On hold in Noble Library

Offered: Spring semester every year starting 2011

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.

Topical Coverage and Timeline:

- Review of Syllabus (week 1)
- Overview of the Electric Power Industry (week 1)
 - History of the Electric Power Industry
 - Deregulation Overview
 - Vertical Integration
 - Role of NERC & FERC

- Market Structure in the USA
- Overview of Economic Theory (weeks 2-3)
 - 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 (weeks 4-6)
 - Linear Programming
 - Convex sets
 - Primal and Dual
 - Proof of Optimality
 - Duality Theory
 - Duality Theory
 - Mixed Integer Linear Programming
 - Branch & Bound
- Dispatch (week 6-7)
 - Economic Dispatch
 - Direct Current Optimal Power Flow (DCOPF)
 - Unit Commitment
 - Analyzing MIP Unit Commitment Formulations (?)
- **MIDTERM EXAM 1: Monday, March 7th (week 8) (tentative date)**
 - Coverage of Material: until February 21st
- Pricing (weeks 8-10)
 - Uniform Market Clearing Prices (MCP) vs. Pay As Bid
 - Locational Marginal Pricing (LMPs)
- Objectives, Rents, Congestion (week 10-11)
 - Dual of the DCOPF
 - Load payment, Congestion Rent, Generation Rent
 - Congestion
- Non-convex markets (week 11-12)
 - Make-whole Payments / Uplift
 - Centralized Unit Commitment vs. Decentralized
- Financial Transmission Rights (week 13) (?)
 - Simultaneous Feasibility Test

- Revenue inadequacy
- SCE's Proposed Objective: Minimize Payment to Generators vs. Minimize Total Cost (week 13)
 - Overview
 - **Presentations**
- Extended-LMP (Convex Hull Pricing) (week 14)
 - Overview
 - **Presentations**
- **MIDTERM EXAM 2: Wednesday, April 20th (week 14) (tentative date)**
 - **Coverage of Material: Until April 11th**
- Presentation Days 1 & 2 (week 15)
- Last Day of Class: Monday, May 5th: Review for Final Exam
- **Final Exam: Wednesday, May 11th, 12:10pm – 2pm**
- Other Potential Topics:
 - Reliability Unit Commitment (?)
 - Ancillary Services (?)

Topics with a: (?) are tentative (time permitting)

Grading:

Homework: 20%

Midterm 1: 20%

Midterm 2: 20%

Final Exam: 20% (probably will be a take home exam)

Project: 20%

Projects:

Information on the projects will be posted on Blackboard.

Academic Integrity Policy at ASU:

Every student is expected to understand and know ASU's Academic Integrity Policy:

<http://provost.asu.edu/academicintegrity>

If at any time you are not sure about what is allowed/acceptable, ask your professor.

Late Assignments will not be accepted (unless there is a documented emergency).