

# GRIDED

The Center for Grid Engineering Education

## Electricity Markets

### Course Description

The course, developed by Case Western Reserve University (CWRU) and the Electric Power Research Institute (EPRI), teaches the fundamental principles which govern electricity market operation and pricing dynamics. Course participants will learn about the electrical power system infrastructure and reliability operation, and the locational marginal cost based pricing mechanism underlying the wholesale electricity market design. Additional topics include market settlement, the capacity and Financial Transmission Right (FTR) markets, and management of generation portfolios by the load serving entities. Impacts from integrating intermittent renewable generation, energy storage and demand-side resources will also be discussed. Further, the CWRU has developed an online electricity market simulator that allows course participants to play realistic market clearing scenarios while acting as market participants. As a key component of the course, the interactive market simulation exercises supplement the course lectures with hands-on learning experience. Course participants will retain online access to the market simulator tool for six months after the course.

### Who Should Attend

This course is intended for students and professionals who seek fundamental understanding of the wholesale electricity market design and operation. Course materials will be quantitative. Basic knowledge in electric circuit and microeconomics will be helpful but not a prerequisite. The course serves learning needs in academic institutions, business organizations and regulatory offices where a tangible knowledge about the electricity market is an essential part of study, business operation or policy decision making. In addition, this is a good way to get 16 hours toward your professional license - continuing education requirements.

### Registration Information

Registration at: <http://grided.epri.com/courses.html>

Dates: Monday, November 13th  
Tuesday, November 14th  
Day 1: 8:00-5:00  
Day 2: 8:00-12:00

Location: Electric Power Training Center  
19-1667 Cole Blvd. #152  
Golden, CO 80401

PDH Available: 12 hours

Registration Fee:

- \$1,200 per person
- 20% discount for organizations with three or more attendees
- 25% discount for government employees (non-utility)
- 25% discount for university professors\*
- 75% discount for graduate students\*

\*University IDs required to qualify for professor or graduate student discounts.

*Students need to bring: laptops or tablets to access online resources and to follow class notes. Wi-Fi access is provided. Lecture slides will be provided electronically in PDF format.*

### For More Information

Amy Feser, [afeser@epri.com](mailto:afeser@epri.com), (865) 218-5909

### Course Instructors

Mingguo Hong, [mxh543@case.edu](mailto:mxh543@case.edu)

Vincenzo Liberatore, [vliberatore@epri.com](mailto:vliberatore@epri.com)

Erik Ela, [eela@epri.com](mailto:eela@epri.com)

## Meet the Instructors



**Mingguo Hong**, Associate Professor, Electrical Engineering and Computer Science, Dr. Hong received his Bachelor of Science degree in Electrical Engineering from Tsinghua University of China, Master of Science degree in Mathematics from the University of Minnesota, and Ph.D. degree in Electrical Engineering from the University of Washington. He worked in both the distribution and transmission sectors of the electric power industry for 14 years before joining the Case Western Reserve University (CWRU) as a faculty member. At the Mid-continent Independent System Operator (MISO), he was a key contributor to the award-winning Energy and Ancillary Services Market design and implementation. At CWRU, Dr. Hong also has developed and taught both power engineering and operation research courses. His research interests are in smart distribution systems, microgrids, and electricity markets.



**Vincenzo Liberatore**, Associate Professor, Electrical Engineering and Computer Science, Dr. Liberatore holds a Laurea degree in Electrical Engineering from the University of Rome "La Sapienza" and a Ph.D. in Computer Science from Rutgers University. His previous appointments include a visiting position at Bell Labs, a research associate position at the University of Maryland, College Park, and senior software engineer position at Tokutek (now Percona). Prof. Liberatore has extensive publications in networking, theoretical computer science, and compilers. His current research interests are in the area of networked control systems and their applications to Internet robotics and to distributed simulations. Prof. Liberatore served on the program committees of the Workshop on Factory Communication Systems (WFCS), and the International Conference on Mobile Data Management (MDM).



**Erik Ela**, Senior Technical Leader, Grid Operations and Planning, Dr. Ela received a B.S. Degree in Electrical Engineering from Binghamton University in Binghamton, NY, a M.S. Degree in Electrical Engineering from the Illinois Institute of Technology in Chicago, IL, and Ph.D Degree in Electrical Engineering from the University College Dublin in Dublin, Ireland. He worked previously as a Senior Engineer for the National Renewable Energy Laboratory leading research in power system operations with emerging technologies, and before that for the New York Independent System Operator, leading work on energy and ancillary service market designs, energy management systems, and operations. He has led innovative research in the economic management of variable energy resources for congestion management purposes, the importance of negative LMPs, wind integration studies, evolution of dynamic operating reserve requirements, multi-timescale integrated power system simulation, primary frequency response ancillary service markets, and ramp capability market designs. He has spoken on topics of electricity markets and integration of renewables and emerging technologies into power system operations and planning to over 80 venues around the world. He leads EPRI's research in electricity market designs, including facilitating the collaboration of North America's ISOs and RTOs on technical market design research initiatives, and also is a technical lead on steady-state operations and renewable integration. Dr. Ela is an associate editor for the IEEE Transactions on Power Systems, and is a member of several committees and working groups within IEEE's Power and Energy Society and CIGRE.

## Course Outline

### Day 1

- Introduction to Course Outline
- The electric power system infrastructure and operation
- Restructuring of the electric power industry
- Introduction to the Electricity Market Stimulator
- Locational Marginal Pricing based electricity market design and lab
- The two market settlement system and lab I
- Management of generation portfolio and lab

### Day 2

- Market scenario simulation lab and bidding strategies
- Market settlement and uplift payment
- Ancillary service markets
- Financial Transmission Rights and capacity markets
- Introduction to Emerging Electricity Market Topics (e.g., integrating renewable, energy storage and demand-side resources)
- Course review and conclusions

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### Electric Power Research Institute

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