

# Energy Markets

**EMGT 5962/MBAD 6962 (also cross-listed as SEGR 4962, ECGR 4172, ECGR 5172)**

**Classroom: Fretwell 126**

**Time: Tuesdays 5:30 – 8:15 pm**

**Instructors:** Prof. Badrul H Chowdhury  
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**Hours: M: 1 – 2 pm; W: 11 am – 12 pm**

**Hours: T 10-11 am, 1-2 pm**

and by appointment

**Course Description:** Energy and power systems in regulated and competitive environments and implications on business decisions for firms in these industries. Topics include: mechanism of energy markets; comparative market systems; determination of prices under different market structures; gas, oil, coal, and electricity market architecture; electricity market design; dispatch and new build decisions; smart grid and renewable energy in electricity markets; risk and risk management in energy including demand and price volatility and use of financial derivatives; and the impact of financial market trends and current and proposed policies on the energy industry.

**Special Reminder:** *This is a cross-disciplinary course that spans two colleges at UNC Charlotte: The Belk College of Business and the Lee College of Engineering. Prof. Schwarz represents the Belk College and Prof. Chowdhury represents the Lee College. As obvious from the course title and the cross-listings, this course will include concepts from both Economics and Engineering. The course was designed for a specific type of student – one who values both economics and engineering. It is not meant for a student only interested in economics, nor for a student only interested in engineering principles of energy markets.*

**Prerequisite:** Basic math (including elementary Calculus, and economics (including Principles of Microeconomics) or consent of instructor(s)). SEGR 4961/EMGT 5961 Introduction to Energy Systems or ECON 5181 Energy and Environmental Economics.

**Corequisite:** If students have not completed ECGR 4171/SEGR 4961/EMGT 5961 Introduction to Energy Systems or ECON 4181/5181 Energy and Environmental Economics, they should enroll in one of these courses concurrently with this one; or permission of instructor(s).

**Required Textbook:** *Fundamentals of Power System Economics*, Daniel S. Kirschen and Goran Strbac, 2<sup>nd</sup> Edition, John Wiley & Sons, Ltd., 2019, Hoboken, NJ.

ISBN 9781119309888 (pdf) | ISBN 9781119213253 (epub) | ISBN 9781119213246 (cloth)

## Reference Textbooks:

1. *Fundamentals of Power System Economics* (1<sup>st</sup> Ed), D. Kirschen, G. Strbac, John Wiley & Sons, Ltd., 2004 (1<sup>st</sup> Edition), ISBN: 978-0-470-84572-1  
<https://librarylink.uncc.edu/login?url=http://onlinelibrary.wiley.com/book/10.1002/0470020598>.
2. *Power System Economics: Designing Markets for Electricity*, Steven Stoft, May 2002, Wiley-IEEE Press, ISBN: 978-0-471-15040-4

3. *Energy Markets: Price Risk Management and Trading* (Wiley Finance), Tom James, December, 2007, Wiley; ISBN-13: 978-0-470-82225-8
4. *Power Markets and Economics: Energy Costs, Trading, Emissions*, Barrie Murray, March 2009, ISBN: 978-0-470-77966-8
5. *Operation of Restructured Power Systems*, Bhattacharya, Bollen, Daalder. Kluwer Academic Press, 2001
6. *Electricity Economics: Regulation and Deregulation*, Geoffrey Rothwell and Tomas Gomez, 2003, ISBN 0-471-23437-0 (printed on demand)
7. *International Energy Markets: Understanding Pricing, Policies and Profits, 2e*, Carol A. Dahl, Pennwell Corp , 2015, ISBN: 978-1593702915
8. *Understanding Today's Electricity Business*, John Ferrare and Bob Shively, Enerdynamics, San Francisco, 2008
9. *Investing in Energy*, Gianna Bern, Bloomberg Press, 2011
10. *Power System Operations and Electricity Markets*, Fred Denny and David Dismukes, CEC, 2002, ISBN: 9780849308130
11. *Electricity Markets and Power System Economics*, Deqiang Gan, Donghan Feng, and Jun Xie, CEC, 2013, ISBN: 9781466501690
12. *Evolution of Global Electricity Markets*, Fereidoon Sioshansi, Elsevier, 2013, ISBN: 9780123978912
13. *The Economics of Electricity Markets*, Darryl Biggar and Mohammad Reza Hesamzadeh, IEEE Press/Wiley, 2014, ISBN: 9781118775752
14. *Electricity Restructuring in the United States: Markets and Policy from the 1978 Energy Act to the Present*, Steve Isser, Cambridge, ISBN9781107100787
15. *Energy Economics*, Peter M. Schwarz, Routledge, 2018, ISBN-13: 978-0415676786
16. *Electricity Markets: Theories and Applications (IEEE Series on Power Engineering)*, Jeremy Lin and Fernando Magnano, Wiley, 2018, ISBN-13: 978-1119179351

**Supplementary Materials:** Lecture notes and non-textbook readings (from among the listed readings below) will be provided through the course website on Canvas.

### **Learning Objectives:**

After completing the course, the students will be able to

1. Have a working knowledge of the mechanisms of energy markets
2. Understand supply and demand dynamics
3. Understand marginal cost
4. Understand regulated and restructured electricity markets
5. Understand electricity market economics and the constitution of locational marginal price
6. Understand the impact of transmission congestion on pricing
7. Understand risk management policies.
8. Communicate effectively in an area related to energy markets

**Course Requirements:**

1. Regular, on-time attendance, including arriving on time, staying until the end of class, and not leaving class except during breaks, is a requirement for on-campus students.

A student whose religion requires that (s)he miss class for a religious observance must fill out a "Request for Religious Observances" form and submit it prior to the census date for that semester to receive an excused absence for that event.

2. There will be two quizzes, a midterm and a final examination. The two quizzes will be in class for 30 minutes each. The midterm exam will be an in-class exam for 90 minutes. The final exam will be in class for 2.5 hours.

For the in-class quizzes and exams, you are allowed to use the following items:

- One single-sided 8.5 in x 11 in. sheet of notes in student's own handwriting to be attached when the quiz or exam is turned in.
- Calculator (mobile phone, laptop, tablet and other forms of PDA are not allowed).
- Writing utensils.

3. During the last class of the semester, undergraduate students will be required to present a ten-minute team presentation. The presentation should include both economic and engineering aspects of an energy-related business practice of your employer. If you are not currently working, you may choose to focus on any organization with operations in NC or SC, or with permission of the instructors, a company outside the Carolinas. The goal of your presentation should be to educate us about a practice that needs improvement and possible solutions or an energy markets practice at your organization or another organization about which you think others would benefit from learning. Depending on class size, these may be team presentations of up to three students. You are also required to produce a one-page executive summary of your findings. You are asked to discuss the topic (either face-to-face or via email) with the instructors before making the final decision on your topic. This discussion will comprise 10% of the project grade.

Graduate students will do one team project with up to three students per team. Teams will be required to submit a written version of the project and do a presentation on April 30. Detailed instructions will be distributed separately.

4. Graduate and undergraduate sections will be taught jointly, but obtaining graduate credit will require the inclusion of more advanced assignments on the homework, project, and exams.

**Grading:**

Quiz I	10%
Midterm	25%
Quiz II	10%
Final Exam	30%
Homework	15%
Presentation/Project	10%

The grading scale is as follows:

A = 90 -100	B = 80 - 89.99	C = 70 - 79.99	D = 60 - 69.99
F = < 60	Graduate students	U = < 70	

**Canvas Environment:**

This course includes a significant and required use of the Canvas online environment. You must be able to access course materials and announcements on-line. You can login to Canvas here: <https://uncc.instructure.com/courses/46923> (update once we have created combined course)

We determine your grade according to the syllabus. Use Canvas for information on individual grades, but not for totals or averages. Canvas uses a single formula to calculate averages and totals, which we are unable to alter to reflect different point totals for undergraduate and graduate homeworks and exams.

**Email:**

You *must* be reachable via your UNC Charlotte email account. All course communication will be directed to you at your UNC Charlotte email address via Canvas. If you primarily use a different email account, then you should forward your email to your primary account.

**Course Outline and Reading Schedule: (C = Prof. Chowdhury; S = Prof. Schwarz)****A. Introduction to Energy Markets****I. Week 1 Jan. 15 Course Overview: Syllabus and Energy and Electricity Markets (C and S)**

- Reading:

1. J. Harris and B. Roach, Energy: The Great Transition

*Martin Luther King Holiday Monday Jan. 21*

**II. Week 2 Jan. 22 Review of Microeconomics (S)**

- Reading:

1. Text Ch. 2

**III. Week 3 Jan. 29 Energy Markets: Oil (S)**

- Reading:

1. S. Blumsack, Lesson 1: Global Markets for Crude and Lesson 2: Markets for Refined Petroleum Products

**B. Overview of Electricity Markets****IV. Week 4 Feb. 5 Introduction to Electricity Markets (S)**

**Quiz 1 (S):** (30 minutes) Covers Weeks 1 and 2: Energy: The Great Transition (Harris and Roach document) and Review of Microeconomics (Text Ch. 2)

- Reading:

1. J. Griffin and S. Fuller: A Primer on Electricity and the Economics of Deregulation  
or S. Blumsack: Lessons 5 and 6)

**V. Week 5 Feb. 12 Markets for Electrical Energy (C)**

- Readings:
  1. Kirschen Ch 1, 3
  2. Selected reading material from US electricity markets

**VI. Week 6 Feb. 19 Markets for Electrical Energy (cont.) (C)**

- Readings:
  1. Kirschen Ch 4
  2. Selected reading material from US electricity markets

**VII. Week 7 Feb. 26 Regulation (S)**

- Reading:
  1. J. Lazar, Regulatory Assistance Project (RAP 2016), Electricity Regulation in the US: A Guide (Second Edition), Selected topics or Regulatory Assistance Project (RAP 2017), Electricity Regulation in the US: A (Brief) Guide and/or S. Blumsack Lecture 5.

***Midterm (90 minutes)***

- Covers Weeks 1-5: Intro, Oil, Intro to Electricity and Text Chapters 1-3.

***Spring Recess March 4-9*****C. Additional Energy Markets****VIII. Week 8 Mar. 12 Natural Gas (S)**

- Reading:
  1. Natural Gas: Energy Information Administration document or Blumsack Ch's 3 and 4.

**IX. Week 9 Mar. 19 Renewable Energy (S)**

- Midterm returned on or before this date.
- Readings:
  1. Timmons, et al. The Economics of Renewable Energy or Joskow: Intermittent vs. Dispatchable Technologies and/or Blumsack Lecture 7 (and possibly Lesson 12)

***Tuesday, Mar. 19 11:59 pm Last day to withdraw from course with a 'W' grade***

**D. Additional Electricity Markets****X. Week 10 Mar. 26 Transmission Networks and Electricity Markets (C)**

- Readings:
  1. Kirschen Ch. 5
  2. Selected reading material from US electricity markets

**XI. Week 11 Apr. 2 Power System Operations (C)**

- Readings:
  1. Kirschen Ch. 6
  2. Selected reading material from US electricity markets

**XII. Week 12 Apr. 9 Power System Operations (cont.) (C)**

- Reading:
  1. Selected reading material from US electricity markets**Quiz 2 (C):** Covers weeks 9, 10: Text Chapters 4, 5

**XIII. Week 13 Apr. 16 Investing in Generation and Transmission (C)**

- Reading:
  1. Kirschen Ch. 7

*Apr. 19-20, Spring Weekend*

**XIV. Week 14 Apr. 23 Investing in Generation and Transmission (cont.) (C)**

- Reading:
  1. Kirschen Ch. 8

**XV. Week 15 Apr. 30 Undergraduate and graduate student presentations**

Reading Day: May 1 (Wednesday)

***Final Exam May 7 (Tuesday), 5-7:30 pm. Covers Weeks 6-14:  
Regulation, Natural Gas, Renewable Energy, and Text Chapters 4-8.***

### Citations

- Griffin, J. M. & Puller, S. L. (2005). A Primer on Electricity and the Economics of Deregulation. In J. M. Griffin & S. L. Puller (Eds.), *Electricity Deregulation: Choices and Challenges* (pp. 1-28): Bush School Series in the Economics of Public Policy, vol. 4, last retrieved December 4, 2017.  
[https://books.google.com/books/about/Electricity\\_Deregulation.html?id=9n29ItGH-24C&printsec=frontcover&source=kp\\_read\\_button#v=onepage&q&f=false](https://books.google.com/books/about/Electricity_Deregulation.html?id=9n29ItGH-24C&printsec=frontcover&source=kp_read_button#v=onepage&q&f=false)
- Lazar, J. (2016). *Electricity Regulation in the US: A Guide*. Second Edition. Montpelier, VT: The Regulatory Assistance Project. Retrieved from  
<http://www.raponline.org/knowledge-center/electricityregulation-in-the-us-a-guide-2>
- Joskow, P. L. (2011). Comparing the Costs of Intermittent and Dispatchable Electricity Generating Technologies. *American Economic Review*, 101(3), 238-241. Short version: doi:  
<http://www.aeaweb.org/aer/>  
 Full length version: <https://economics.mit.edu/files/6317>

Timmons, D., Harris, J.M. and Roach, B. (2014). *The Economics of Renewable Energy*. *Global Development and Environmental Institute*, Tufts University.  
[http://www.ase.tufts.edu/gdae/education\\_materials/modules/RenewableEnergyEcon.pdf](http://www.ase.tufts.edu/gdae/education_materials/modules/RenewableEnergyEcon.pdf)

Harris and Roach (2017), *Environmental and Natural Resource Economics: A Contemporary Approach*, 4e Chapter 11: Energy – The Great Transition,  
[http://www.ase.tufts.edu/gdae/Pubs/te/ENRE/4/Ch11\\_Energy\\_4E.pdf](http://www.ase.tufts.edu/gdae/Pubs/te/ENRE/4/Ch11_Energy_4E.pdf) Last retrieved January 3, 2019

Blumsack, S. (2019) *Energy Markets, Policy, and Regulation*  
<https://www.e-education.psu.edu/eme801/> Last retrieved January 3, 2019

Global Natural Gas Markets Overview (August 2014). *A Report Prepared by Leidos, Inc., Under Contract to EIA*  
Last retrieved January 3, 2019, from  
[https://www.eia.gov/workingpapers/pdf/global\\_gas.pdf](https://www.eia.gov/workingpapers/pdf/global_gas.pdf)

### **Diversity:**

The Belk College of Business and the William States Lee College of Engineering strive to create an inclusive academic climate in which the dignity of all individuals is respected and maintained. Therefore, we celebrate diversity that includes, but is not limited to ability/disability, age, culture, ethnicity, gender, language, race, religion, sexual orientation, and socio-economic status.

### **Academic Integrity:**

You are required to complete 100% of your own work in this class including making a full contribution to the team project and not communicating with other students on exams or homework assignments. It is of the utmost importance that there be no communication among students in completing the take-home exams. It is our utmost desire that students will read and adhere to every aspect of the UNC Charlotte Honor Code and that there will be no incidents. Violations represent cheating and will be pursued through the Academic Integrity Code. We have had to pursue violations in past semesters, so if you have any questions about what is allowed, ask if you have any doubts. It is in all of our best interests to not have any violations.

Cheating violates the UNC Charlotte Code of Academic Integrity and may result in a 0 on a homework assignment or an exam, course failure, suspension, and/or expulsion. For more information see the following:

<https://legal.uncc.edu/policies/up-407>

### **Disability and Impairment Accommodation:**

If you require course adaptations or accommodations because of a disability, or if you have emergency medical information about which we should be informed, please speak with us as soon as possible. Students who require such accommodations must work with the Office of Disability Services (704-687-0040).

**ALL PARTS OF THIS SYLLABUS ARE SUBJECT TO REVISION  
ANY REVISIONS WILL BE ANNOUNCED IN CLASS OR VIA CANVAS**