

2014-2015 LONG SIGNATURE SHEET



UNC CHARLOTTE

Proposal Number: ECGR 1-12-15

Proposal Title: Proposal for new course ECGR 5172 Energy Markets

Originating Department: Electrical and Computer Engineering

TYPE OF PROPOSAL: UNDERGRADUATE _____ GRADUATE UNDERGRADUATE & GRADUATE
 (Separate proposals sent to UCCC and Grad. Council)

DATE RECEIVED	DATE CONSIDERED	DATE FORWARDED	ACTION	SIGNATURES
			Approved	<u>DEPARTMENT CHAIR</u> [print name here:] <u>ASIS NASIPURI</u>
			Approved	<u>COLLEGE CURRICULUM COMMITTEE CHAIR</u> [print name here:] <u>TAO HONG</u>
			Approved	<u>COLLEGE FACULTY CHAIR (if applicable)</u> [print name here:] <u>Bruce Cedric</u>
	9/21/15		Approved	<u>COLLEGE DEAN</u> [print name here:]
			Approved	<u>GENERAL EDUCATION</u> (if applicable; for General Education courses) [print name here:]
			Approved	<u>HONORS COLLEGE</u> (if applicable; for Honors courses & programs) [print name here:]
			Approved	<u>UNDERGRADUATE COURSE & CURRICULUM COMMITTEE CHAIR (for undergraduate content)</u>
9/28/15	11/3/15	2/2/16	Approved	<u>GRADUATE COUNCIL CHAIR</u> (for graduate content) [print name here:] <u>Dennis Lwesay</u>
				<u>FACULTY GOVERNANCE ASSISTANT</u> (Faculty Council approval on Consent Calendar)
				<u>FACULTY EXECUTIVE COMMITTEE</u> (if decision is appealed)



UNC CHARLOTTE

I. LONG FORM II. COURSE AND CURRICULUM PROPOSAL

*To: Chair of the Graduate Council

From: Badrul H. Chowdhury, ECE

Date: January 12, 2015

Re: Proposal for new course ECGR 5172 Energy Markets

The Long Form is used for major curriculum changes. Examples of major changes can include:

Undergraduate: Major changes include new undergraduate degrees, minors, concentrations, certificates, and changes to more than 50% of an existing program (Note: changing the name of an academic department does not automatically change the name(s) of the degree(s). The requests must be approved separately by the Board of Governors.)

Graduate: Major changes include new graduate courses, major changes to an existing graduate course or major changes to an existing graduate program

Submission of this Long Form indicates review and assessment of the proposed curriculum changes at the department and collegiate level either separately or as part of ongoing assessment efforts.

*Proposals for undergraduate courses and programs should be sent to the Undergraduate Course and Curriculum Committee Chair. Proposals related to both undergraduate and graduate courses,

(e.g., courses co-listed at both levels) must be sent to both the Undergraduate Course and Curriculum Committee and the Graduate Council.

ECGR 1-12-15

I. HEADING AND PROPOSAL NUMBER

University of North Carolina at Charlotte

Proposal for New Graduate Course

Course and Curriculum Proposal from: Department of Electrical and Computer Engineering

Title: *Proposal for new course ECGR 5172 Energy Markets*

II. CONTENT OF PROPOSALS

A. PROPOSAL SUMMARY AND CATALOG COPY

1. **SUMMARY:** The Electrical and Computer Engineering Department proposes to add a new elective course to the graduate curriculum:
 - ECGR 5172 Energy Markets

2. **PROPOSED CATALOG COPY:**

ECGR 5172. Energy Markets. (3) Pre- or co-requisite: ECGR 4171 or equivalent: MATH 1241; ECON 2101; or permission of the department. 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. Credit will not be given for ECGR 5172 where credit has been given for ECGR 4172 (*Spring*).

B. JUSTIFICATION

1. Identify the need addressed by the proposal and explain how the proposed action meets the need: Energy markets, such as the oil, natural gas and coal markets thrive on supply and demand dynamics. Although the same paradigm does not always apply to electricity markets, the latter still depends, to a large part, on the availability of fossil fuels. Therefore, energy value chains, costing, levelized cost of energy, risk management, etc. become critically important. There is a growing concern, though, on the impact of fossil fuels, particularly on the environment, and as such, there is now a tremendous interest in renewable forms of energy, such as solar and wind energy for electricity generation. However, there are many operational and regulatory issues that generally accompany such types of generation in competitive markets. This course will attempt to fill this need.

Specific goals are for the students are to:

- Have a working knowledge of the mechanisms of energy markets
 - Understand supply and demand dynamics
 - Understand marginal cost
 - Understand electricity market economics and the constitution of locational marginal price
 - Understand the impact of transmission congestion on pricing
 - Understand risk management policies.
2. Discuss prerequisites/corequisites for course(s) including class-standing:
Pre- or co-requisite: [ECGR 4171 or equivalent](#); MATH 1241; ECON 2101; or permission of the department.
 3. Demonstrate that course numbering is consistent with the level of academic advancement of students for whom it is intended: The course numbering ECGR 5172 is consistent with the level of academic advancement of graduate students, for whom these courses are intended.
 4. In general, how will this proposal improve the scope, quality and/or efficiency of programs and/or instruction: This course is suitable for graduate students irrespective of their area of concentration in the ECE Department at UNCC since the goal is to provide a background on energy markets.
 5. If course(s) has been offered previously under special topics numbers, give details of experience including number of times taught and enrollment figures.
 - ECGR 5090 Special Topics: Energy Markets
 - Spring 2014, Enrollment: 13 (5 BS; 2 M.S.; 6 PhD)
 - Spring 2015, Enrollment: 12 (0 BS; 8 M.S.; 4 PhD)

C. IMPACT

1. What group(s) of students will be served by this proposal? This course will serve all graduate students in electrical and computer engineering irrespective of whether they are enrolled in the power area. This course will be especially useful though for students taking the concentration in power systems.
2. What effect will this proposal have on existing courses and curricula? The proposed course will complement the existing courses in power and energy systems in the ECE Department.
 - a. When and how often will added course(s) be taught? According to the current demand and scheduling of courses, ECGR 5172 will be taught each Spring.
 - b. How will the content and/or frequency of offering of other courses be affected? None expected.
 - c. What is the anticipated enrollment in course(s) added (for credit and auditors)? Typical enrollment is expected to be 8-15 ECE graduate students. This is consistent with current offerings of the equivalent special topics course.
 - d. How will enrollment in other courses be affected? None to minimal expected. How did you determine this? This course has been offered twice times already as a special topics course and none of the other elective courses in the power area were impacted. It is clear that this course fills a niche requirement.
 - e. Identify other areas of catalog copy that would be affected, e.g., curriculum outlines, requirements for the degree, etc. Cross-listing ECGR 5172 with ECGR 4172. Also cross-listed with EMGT 5962, SEGR 4962, MBAD 6962.

III. RESOURCES REQUIRED TO SUPPORT PROPOSAL

A. Personnel

- a. Specify requirements for new faculty, part-time teaching, student assistant and/or increased load on present faculty: None. The course sequence will be taught by one faculty member at no required increased teaching load and with no teaching assistant.
- b. List by name qualified faculty members interested in teaching the course(s): Dr. Badrul Chowdhury only has taught this course before as a special topics course,

B. Physical Facility: None

C. Equipment and Supplies: None

D. Computer: None

E. Audio-Visual: None

F. Other Resources: None

G. Source of Funding. Indicate source(s) of funding for new/additional resources required to support this proposal: None required

IV. CONSULTATION WITH THE LIBRARY AND OTHER DEPARTMENTS OR UNITS

A. Library Consultation

Indicate written consultation with the Library Reference Staff at the departmental level to insure that library holdings are adequate to support the proposal prior to its leaving the department. (*Attach copy of Consultation on Library Holdings*).

B. Consultation with other departments or units

The Systems Engineering and Engineering Management Department already has two course numbers for this course. They are EMGT 5962 and SEGR 4962.

The College of Business also has the course listed as MBAD 6962.

C. Honors Council Consultation. In the case of Honors courses or Honors programs indicate written consultation with the Honors Council (if applicable).

V. INITIATION AND CONSIDERATION OF THE PROPOSAL

A. Originating Unit

Approved per attached signatures

B. Other Considering Units

SEEM

Belk College of Business

C. CREDIT HOUR. (Mandatory if new and/or revised course in proposal): 3

Review statement and check box once completed:

- The appropriate faculty committee has reviewed the course outline/syllabus and has determined that the assignments are sufficient to meet the University definition of a [credit hour](#).

D. ATTACHMENTS.

1. CONSULTATION: Attach relevant documentation of consultations with other units.
2. COURSE OUTLINE/SYLLABUS: For undergraduate courses attach course outline(s) including basic topics to be covered and suggested textbooks and reference materials with dates of publication. For Graduate Courses attach a course syllabus. Please see [Boiler Plate for Syllabi for New/Revised Graduate Courses](#).
3. PROPOSED CATALOG COPY: Copy should be provided for all courses in the proposal. Include current subject prefixes and course numbers, full titles, credit hours, prerequisites and/or corequisites, concise descriptions, and an indication of when the courses are to be offered as to semesters and day/evening/weekend. Copy and paste the [current catalog copy](#) and use the Microsoft Word "track changes" feature (or use ~~red text with "striketrough"~~ formatting for text to be deleted, and adding [blue text with "underline"](#) formatting for text to be added).
 - a. For a new course or revisions to an existing course, check all the statements that apply:
 - This course will be cross listed with another course.
 - There are prerequisites for this course.
 - There are corequisites for this course.
 - This course is repeatable for credit.
 - This course will increase/decrease the number of credits hours currently offered by its program.
 - This proposal results in the deletion of an existing course(s) from the degree program and/or catalog.For all items checked above, applicable statements and content must be reflected in the proposed catalog copy.
 - b. If overall proposal is for a new degree program that requires approval from General Administration, please contact the facultygovernance@uncc.edu for consultation on catalog copy.
4. ACADEMIC PLAN OF STUDY (UNDERGRADUATE ONLY): Does the proposed change impact an [existing Academic Plan of Study](#)?

- Yes. If yes, please provide updated Academic Plan of Study in template format.
- No.
5. STUDENT LEARNING OUTCOMES (UNDERGRADUATE & GRADUATE): Does this course or curricular change require a change in Student Learning Outcomes (SLOs) or assessment for the degree program?
- Yes. If yes, please provide updated SLOs in template format.
- No.
6. TEXTBOOK COSTS: It is the policy of the Board of Governors to reduce textbook costs for students whenever possible. Have electronic textbooks, textbook rentals, or the buyback program been considered and adopted?
- Yes. Briefly explain below.
- No. Briefly explain below.
- The electronic version of the textbook is available through Atkins Library.*

IMPORTANT NOTE: A Microsoft Word version of the final course and curriculum proposal should be sent to facultygovernance@uncc.edu upon approval by the Undergraduate Course and Curriculum Committee and/or Graduate Council chair.

ECGR 4172/ECGR 5172 - Energy Markets

Syllabus

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Spring 2015

Instructors: Prof. Badrul H Chowdhury Prof. Peter M. Schwarz
Phone: (704) 687-1960 **Fax:** (704) 687-5588 **Phone:** (704) 687-7614 **Fax:** 7-1384
E-mail: b.chowdhury@uncc.edu **E-mail:** pschwarz@uncc.edu
Office: EPIC 1162 **Office:** FRI 223A
Hours: M & T: 11:00 am – 12:00 pm **Hours:** T Th 11-12 am, 1-1:30 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. Credit will not be given for ECGR 5172 where credit has been given for ECGR 4172

Pre- or co-requisite: : ECGR 4171 or equivalent; MATH 1241; ECON 2101, or permission of the department.

Required Textbook: *Fundamentals of Power System Economics*, D. Kirschen, G. Strbac, John Wiley & Sons, Ltd., 2004 (printed on demand), ISBN: 978-0-470-84572-1, last reprinting March 2010.

This text can be viewed online at no charge via a new limited free service offered by the UNC Charlotte library.

URL:

<https://librarylink.uncc.edu/login?url=http://onlinelibrary.wiley.com/book/10.1002/0470020598>.

Students who follow the link from a non-UNCC IP address will be prompted to log in with their NinerNet username and password before they are connected to the publisher's site.

Reference Textbooks:

1. *Power System Economics: Designing Markets for Electricity*, Steven Stoft, May 2002, Wiley-IEEE Press, ISBN: 978-0-471-15040-4
2. *Energy Markets: Price Risk Management and Trading* (Wiley Finance), Tom James, December, 2007, Wiley; ISBN-13: 978-0-470-82225-8

3. *Power Markets and Economics: Energy Costs, Trading, Emissions*, Barrie Murray, March 2009, ISBN: 978-0-470-77966-8
4. *Operation of Restructured Power Systems*, Bhattacharya, Bollen, Daalder. Kluwer Academic Press, 2001.
5. *Electricity Economics: Regulation and Deregulation*, Geoffrey Rothwell and Tomas Gomez, 2003, ISBN 0-471-23437-0 (printed on demand)
6. *International Energy Markets: Understanding Pricing, Policies and Profits*, Carol A. Dahl, Pennwell Corp , March 2004, ISBN: 978-0878147991
7. *Understanding Today's Electricity Business*, John Ferrare and Bob Shively, Enerdyanics, San Francisco, 2008
8. *Investing in Energy*, Gianna Bern, Bloomberg Press, 2011
9. *Power System Operations and Electricity Markets*, Fred Denny and David Dismukes, CEC, 2002, ISBN: 9780849308130
10. *Electricity Markets and Power System Economics*, Deqiang Gan, Donghan Feng, Jun Xie, CEC, 2013, ISBN: 9781466501690
11. *Evolution of Global Electricity Markets*, Fereidoon Sioshansi, Elsevier, 2013, ISBN: 9780123978912

Supplementary Materials: Lecture notes and non-textbook readings (from among the listed readings below) will be provided through the course website on Moodle2. We anticipate using clickers, which can be purchased (new or used) or rented at the University Bookstore. You will need a clicker for class participation.

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 electricity market economics and the constitution of locational marginal price
5. Understand the impact of transmission congestion on pricing
6. Understand risk management policies.

Course Requirements:

- (1) This class is offered as both an on-campus face-to-face delivery and an online version. Online students don't have to be present in class to take this course if they sign up for the online section. Each lecture will be recorded using Panopto software. The software is maintained by Classroom Support. All students (both on-campus and on-line) will be able to watch the recording on Moodle shortly after the lecture ends.
- (2) 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. There will be a participation grade each week based on attendance, being on time and staying until the end of class, and answering questions during class on that day's material.

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. The University's inclement weather number is 704-786-2877.

For online students, it is expected that they will watch the lecture on the day the lecture is recorded. However, if that's not possible, they should finish watching the lecture before the next lecture. There will not be a participation grade for online students. Instead, each of the three exams will count 25% for online students.

- (3) There will be two in-course examinations and a final examination. Details will be distributed.
- (4) During the semester undergraduate students will be required to present a ten-minute presentation (no more than 5 slides) on some aspect of energy markets at your employer. If you are not currently working you may choose to focus on any organization with operations in NC or SC. The goal of your presentation should be to educate us about a practice that needs improvement and possible solutions or about a model energy markets practice at your organization that you think others would benefit from learning about. Depending on class size, these may be team presentations.

On-campus graduate students will do one team project. Teams will be required to submit a written version of the project and present their project to class on the last day of class. Online graduate students will do a solo project (not team), and will not present it in class. Detailed instructions will be distributed separately.

- (5) Special requirements for on-line students for exams, homework, and projects.
For on-line students, the exams and homework submission are handled via Moodle. The exams are emailed to all distance students at a pre-set time of the exam day. We anticipate all exams will be take-home exams, in which case online students will have the same amount of time as the on-campus students to take the exam. Moodle will not accept submissions past a specific time. Homework submissions work in a similar fashion - students have to upload their scanned homework to Moodle by the submission deadline. You must name your file as 'HW#_Lastname_Firstname' or 'Exam#_Lastname_Firstname' where # is replaced by the assignment number, Lastname and Firstname are your last and first names. You must also scan into a pdf document before uploading the assignment. Online students will turn in a solo term project, but will not present it in class.

- (6) Graduate section (ECGR 5172) and undergraduate sections (ECGR 4172) will be taught jointly, but obtaining graduate credit in the graduate section will require the inclusion of more advanced assignments on the homework, project, and exams. In general, graduate students will be responsible for 25% more points in their homework and exams; besides, some of the additional questions for graduate students will have a higher difficulty level and will be of the essay type. Graduate students will also be doing a team project.

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Grading:

Exam I	20% (25% for on-line students)
Exam II	20% (25% for on-line students)
Final Exam	25%
Homework	15%
Presentation/Project	10% (<u>Project is for grad students</u>)
Participation Grade	10% (0% for on-line students)

The grading scale is as follows:

A = 90 -100 B = 80 - 89.99 C = 70 - 79.99 U = < 70

Moodle Environment:

This course includes a significant and required use of the Moodle on-line environment. You must be able to access course materials and announcements on-line. You can login to Moodle here: <https://moodle2.uncc.edu/login/index.php>

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. If you primarily use a different email account, then you should forward your email to your primary account.

Diversity:

The Belk College of Business and the William Lee States 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 Honesty:

You are required to complete 100% of your own work in this class (including making a full contribution to the team project). Cheating violates the UNC Charlotte Code of Academic Integrity and may result in course failure, suspension, and/or expulsion. For more information see the following: <http://integrity.uncc.edu/>

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 (704-687-4355).

Course Outline and Reading Schedule:

A. Overview of Energy markets

I. Week 1 Course Overview: Syllabus and Energy and Electricity Markets

- Reading:
 1. U of TX document, Chapter 1: International Energy Marketsⁱ

II. Week 2 Review of Microeconomics

- Reading:
 1. Text Ch. 2

Weeks 3, 4 Energy Markets: Fuel Markets and Value Chains

- Readings:
 1. Schwarz provisional text: Ch's on NG, Nu, Alt. Fuels (Moodle)
 2. Oil and Natural Gas: U of TX materials: Section 2, Ch's 2-4ⁱⁱ.
 3. Uranium: Uranium Development Partnership, Ch. 1ⁱⁱⁱ.
 4. Pricing coal and natural gas: Energy Charter Secretariat
 - a. chapters 3 and 4^{iv}.

Exam 1

B. Overview of Electricity Markets

III. Week 5, 6 Introduction to Electricity Markets

- Readings:
 1. Kirschen Ch. 1, Material on Regulation (to be posted on Moodle)
 2. Selected reading material from US electricity markets

IV. Week 7, 8 Markets for Electrical Energy

- Readings:
 1. Kirschen Ch's 3, 4
 2. Selected reading material from US electricity markets
 3. J Griffin and S Fuller: A Primer on Electricity and the Economics of Deregulation^v
 4. Joskow: Intermittent vs. Dispatchable Technologies^{vi}.

Exam 2

V. Week 9 Ancillary Services

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

VI. Week 10, 11 Transmission Networks

- Readings:

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

VII. Week 12, 13 Investing in Generation and Transmission

- Readings:
 1. Kirschen Ch. 7, 8

VIII. Week 14 Investing in Energy and Summing Up

IX. Week 15 Graduate student presentations

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

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.

Joskow, P. L. (2011). Comparing the Costs of Intermittent and Dispatchable Electricity Generating Technologies. *American Economic Review*, 101(3), 238-241. doi: <http://www.aeaweb.org/aer/>

Capturing the Full Potential of the Uranium Value Chain in Saskatchewan. (n.d.). *Uranium Development Partnership*. Retrieved November 11, 2013, from <http://www.gov.sk.ca/adx/asp/adxGetMedia.aspx?mediaId=767&PN=Shared>

Economics of the Energy Industries. (n.d.). *Center for Energy Economics*. Retrieved November 11, 2013, from <http://www.beg.utexas.edu/energyecon/Economics%20of%20Energy%20Industries.pdf>

Putting a Price on Energy. (n.d.). *Energy Charter Secretariat*. Retrieved November 11, 2013, from http://www.encharter.org/fileadmin/user_upload/document/Oil_and_Gas_Pricing_2007_ENG.pdf

ⁱ <http://www.beg.utexas.edu/energyecon/Economics%20of%20Energy%20Industries.pdf>

ⁱⁱ <http://www.beg.utexas.edu/energyecon/Economics%20of%20Energy%20Industries.pdf>

ⁱⁱⁱ <http://www.gov.sk.ca/adx/asp/adxGetMedia.aspx?mediaId=767&PN=Shared>

^{iv} http://www.encharter.org/fileadmin/user_upload/document/Oil_and_Gas_Pricing_2007_ENG.pdf

^v <http://econweb.tamu.edu/puller/AcadDocs/primer.pdf>

^{vi} <http://economics.mit.edu/files/6317>. (See Moodle2 for AER 2011 version).