Course Syllabus
ISEN 403 Energy, Water, and Transportation System Economics
Fall 2020
MWF 10:20-11:10
Northwestern University

Instructors:  Mark Witte and Lynne Kiesling
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Office Hours:  After class, but also at other times by appointment
Class Room:  McCormick Technological Institute Lecture Room 2

Course Synopsis: This course will review the underlying economic theory driving core resource markets - including electricity, gas, water, and transportation. It will also include a discussion of issues that are unique to energy generation and environmental impact, as well as a deep dive by resource type.

Course Goals: This course will provide students with an understanding of consumer and supplier rationale for economic behavior in energy, water and transportation markets, as a basis for applying the tools of economic analysis to discrete decision-making.

- Build a basic understanding of the economics that govern energy, water and transportation systems
- Understand supply and demand in natural resource commodity markets
- Understand how market outcomes have many benefits but also some costs
- Understand the possible benefits and drawbacks of government regulation
- Understand varied ownership structures and economics for “utilities” (IOU, Muni, Co-op) and how this can influence decision making
- Develop analytical capabilities to compare and contrast substitutes (e.g. energy sources)
- Learn different rate structures and how they provide incentive or disincentive for investment and production
- Identify unrealized or non-market costs related to risk, environmental externalities, and climate
- Consider the short-term vs. long-term impacts of resource investment and production, and how different economic agents may be behave differently under the same conditions
- Be able to identify market characteristics that are unique to specific resources

This course is a prerequisite for ISEN 404 - Resource Markets Design, Regulation, and Reform.

Prerequisites: None
Grading/Assessment:

Grading will be based:

- **10% on class participation**
  - Class participation will include attendance, class participation that demonstrates ownership and mastery of discussion topics
- **30% on homework**
- **30% on written position assignments**
  - Position papers will be assigned weekly (10 in total); papers will be 2-3 pages long (each worth 5% of total grade), addressing a current events manifestation of the week’s topics.
- **30% on a final exam**

<table>
<thead>
<tr>
<th>Letter grade</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>A</td>
<td>93–100%</td>
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<tr>
<td>A−</td>
<td>90–92%</td>
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<tr>
<td>B+</td>
<td>87–89%</td>
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<td>B</td>
<td>83–86%</td>
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<td>B−</td>
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<td>C+</td>
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<td>C</td>
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<td>C−</td>
<td>70–72%</td>
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<td>D+</td>
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<td>D</td>
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<td>D−</td>
<td>60–62%</td>
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<tr>
<td>F</td>
<td>0–59%</td>
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All questions and problems regarding grades must be presented in writing within one week after the test, homework, or project has been returned. Grades will be assigned based on all the work you have completed during the semester following the traditional practice of A=90-100, B=80-89, C=70-79, D=60-69, F<60.

Course Readings: Please be aware that this is a living document and we may find materials that would be important additions. When that happens, we will add them and announce it clearly.

For students who have not completed an undergraduate course in Microeconomics, we recommend giving a careful read to the included chapters from *Principles of Microeconomics*, OpenStax. We will also be drawing on *Markets and the Environment*, 2nd edition, Nathaniel O. Keohane and Sheila M. Olmstead, Island Press, 2016 (Available on Canvas).
<table>
<thead>
<tr>
<th>Week 1 (Sept. 16-18): Microeconomics - Perfect Competition, Supply &amp; Demand, Welfare Analysis</th>
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<tbody>
<tr>
<td><strong>Description/Topics:</strong></td>
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<tr>
<td>• Microeconomics - Perfect competition, Supply &amp; Demand, Welfare analysis, Ceilings &amp; floors, Elasticity</td>
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<tr>
<td>• Basics of supply, demand, and price formation in natural monopoly vs. competitive markets – how they apply to natural resources and transportation; discussion of “perfect” markets</td>
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<tr>
<td>• Substitute goods and demand rebound</td>
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<tr>
<td><strong>Readings:</strong></td>
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<tr>
<td>• <a href="#">OpenStax Economics: Supply &amp; Demand</a></td>
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<tr>
<td>• <a href="#">OpenStax Economics: Elasticity</a></td>
</tr>
<tr>
<td>• <a href="#">OpenStax Economics: Cost &amp; Industry Structure</a></td>
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<tr>
<td>• <a href="#">OpenStax Economics: Perfect Competition</a></td>
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<td>• Max Auffhammer. “High Wintertime Energy Prices Kill People.”</td>
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<tr>
<td><strong>Writing Assignment #1</strong> – <em>(Sample topic)</em> Assess a current resource market in the news &amp; comment on how supply &amp; demand OR demand elasticity are impacting stakeholders</td>
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<tr>
<th>Week 2 (Sept. 21-25): Microeconomics - Imperfect Competition, Regulation</th>
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<tr>
<td><strong>Description/Topics:</strong></td>
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<tr>
<td>• Microeconomics - Imperfect competition, Fixed versus Variable Costs, Natural monopoly theory (cost subadditivity), increasing returns (networks), Peak-load pricing, Ramsey Pricing, Regulatory responses</td>
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<tr>
<td>• Commodity pricing and marginal supply cost for exhaustible vs. renewable resources</td>
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<tr>
<td><strong>Readings:</strong></td>
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<tr>
<td>• <a href="#">OpenStax Economics: Monopoly</a></td>
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<tr>
<td>• <a href="#">OpenStax Economics: Oligopoly</a></td>
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<tr>
<td>• <a href="#">OpenStax Economics: Anti-Trust</a></td>
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<td><strong>Writing Assignment #2</strong> – <em>(Sample topic)</em> Design a two-part tariff for pricing electric service using economic models presented in class, and use those arguments to support your distribution of the common costs across the residential, commercial, and industrial customers.</td>
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<th>Week 3 (Sept. 28-Oct. 2): Time Value of Money, Infrastructure Investment</th>
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<td><strong>Description/Topics:</strong></td>
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<tr>
<td>• Social and private discount rates</td>
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- Net Present Value (NPV) versus Internal Rate of Return (IRR)

Readings:
- Keohane & Olmstead pp. 30-33.
- OpenStax Economics: Present Discounted Value

Writing Assignment #3 – (Sample topic) Discuss the key influences on a unique approach to resource or energy pricing in today's market

Week 4 (Oct. 5-9): Environmental economics and non-market value

Description/Topics:
- Non-market values
- Cost-Benefit Analysis (CBA)
- Environmental, Social, & Governance (ESG)
- Environmental Kuznets Curve
- Climate Change
- Risk

Readings:
- Keohane & Olmstead pp. 35-68.
- OpenStax Economics: Environmental Protection & Negative Externalities
- “Study Finds Racial Gap Between Who Causes Air Pollution And Who Breathes It”
- Timothy Taylor. “Contingent Valuation and the Deepwater Horizon Spill”
- Timothy Taylor. “China and the Environmental Kuznets Curve”

Writing Assignment #4 – (Sample topic) Write an opinion paper on which externalities are most important for low income residents of the U.S. (urban or rural). Explain your position using the economic concepts covered in the course to date.

Week 5 (Oct. 12-16): Complexities of Electricity Pricing

Description/Topics:
- Duck curve
- Demand Response
- Feed-in tariff

Readings:
- David Roberts. “Utilities versus Rooftop Solar: What the fight is about.”
- David Roberts. “Utilities for Dummies: How they work and why that needs to change.”
**Writing Assignment #5**  *(Sample topic)*  Provide a pro-con analysis of one aspect of changing the structure of the electricity industry.

**Week 6 (Oct. 19-23):  Fossil Fuels**

**Description/Topics:**
- Green paradox
- Hotelling extraction
- Carbon pricing
- Stranded assets

**Readings:**
- Keohane & Olmstead pp. 99-113, 139-162.
- [Hans Rosling. Climate Change and Fossil Fuel Distribution](https://www.youtube.com/watch?v=5s5pZ5JQoFY) (2:00 Video)
- [David Roberts. “Americans are willing to pay $177 a year to avoid climate change”](https://www.theguardian.com/environment/2019/mar/07/americans-willing-to-pay-dollar-177-a-year-to-avoid-climate-change)

**Writing Assignment #6** *(Sample topic)*  What are the social implications of taxing pollution emissions versus capping the quantity and selling the use of the right to release some of those limited emissions?

**Week 7 (Oct. 26-30):  Energy technologies and technological change**

**Description/Topics:**
- How technologies compete with each other
- Economic history of energy technologies
- Technology cost curves, technology life cycle, S curves
- Case study: Hydraulic fracturing and natural gas

**Readings:**
- Keohane & Olmstead pp. 15-16.

**Writing Assignment #7** – *(Sample topic)* Policymakers often follow a “demand pull” theory of using policy to attempt to accelerate technology maturity. Choose an energy technology case and analyze the extent to which, and how, such a policy approach was successful or not.

**Week 8 (Nov. 2-6): Transportation**

**Description/Topics:**
- Pricing
- Demsetz Auctions
- Schelling Model of Congestion
- Free parking.
- Fuel Economy Standards
- Ethanol

**Readings:**
- OpenStax Economics: Positive Externalities & Public Goods

**Writing Assignment #8** - *(Sample topic)* Opinion paper – What is the greatest economic disruption coming in the US transportation market coming in the next 10-15 years and why?

**Week 9 (Nov. 9-13): Electricity markets and their evolution**

**Description/Topics:**
- Wholesale markets, market design -- load duration, CA, market monitoring, price caps, capacity mechanisms
- Retail markets, demand response, digitization, transactive energy
- Growth of renewables and DERs, LCOE, case study of TX wind, revisit duck curve question

**Readings:**
- Grist. “Report: These rarely used, dirty power plants could be cheaply replaced by batteries”

**Writing Assignment #9** - *(Sample topic)* Outline the impact of a market disruption from an economic point of view in gas or power markets (supply, demand, externalities other)
**Week 10 (Nov. 16-20): Electricity Regulation; Water**

**Description/Topics:**
- Rights
- Ownership
- Privatization
- Perceptions of Risk

**Readings:**
- Keohane pp. 214-217, 221-223
- Timothy Taylor, “Some Economics of the Clean Water Act”
- “Drought: 10 things to know about California water use” – Peterson, KPCC, April 15, 2015
- “Cape Town’s ‘Day Zero’ Water Crisis, A Year Later” – Alexander, CityLab, Apr 12, 2019

**Guest Speakers:**
- Carrie Zalewski, Chairman, Illinois Commerce Commission
- David Rankin, Executive Director, Great Lakes Protection Fund

**Writing Assignment #10:** (Sample topic) Assess the economics of the Colorado River from the perspective of one of the stakeholders (one of the 7 states that is part of the compact, EPA, environmental activists, investors)

**Week 11 (Nov. 23-25): Review & Final Exam**

**Supplemental readings that you may find interesting and useful**
- IEA World Energy Outlook 2018
- Small and Verhoef, “The Economics of Urban Transportation” (Routledge Press, 2007)
The following are questions that many of you will have about the class.

Q: Where should I look for posted Zoom recordings, slides, readings, and things like that?
A: The best place is on Canvas under “Pages.” We will try to put everything there in an organized way.

Q: What is the deal with these homeworks?
A: There will be a bunch of these over the course of the quarter and they will usually follow what we did in lecture, and have some predictive value for what will be on the exam. Your first homework will be to get you familiarized with the use of Piazza, so you will need to post an interesting article relating to energy in the “post_to_piazza_homework” on Piazza (in “Modules” in Canvas). When you post your article, don’t send it to the whole class but rather only to me, and be sure to put your last name in the header so I know it’s from you.

I will post questions and you will submit answers through Canvas. The computational problems will be graded by Canvas, and you will get three chances to get them right. You can collaborate with your peers on these and ask questions through Piazza (anonymously if you wish). Some of the homework may involve you submitting hand drawn graphs or hand written summaries of the lecture contents through Crowdmark. [Piazza is a discussion forum that allows anonymous posts. The story about its creation is pretty cool.]

Q: What are the basic work expectations for the class?
A: I hope that you will do about two hours of study for every hour of lecture, and that you will get the material assigned for the lecture before class (and catch up on the first lecture assigned reading too).

Q: What is your electronics communication policy?
A: (1) We expect you to have your preferred e-mail address entered into Canvas so that I can send messages to the class, and I expect you to check that e-mail on a daily basis. (2) Use Canvas’s Piazza discussion forum (found in Canvas’s “Modules”) to post questions that would be of general use to your classmates. (Yes: “What does MR stand for?” No: “Can’t I get more credit on the last assignment?”) When you post on Piazza about specific homework questions, it’s very helpful if you cut-and-paste the actual question into what you write in Piazza.

Q: What happens if I fall suddenly ill and am unable to do an assignment?
A: Just let me know in advance. (mwitte@northwestern.edu).

Q: Averaging my grades, I come out very close to a higher grade. How about if you give it to me?
A: No...unless you are deserving of special consideration.

Q: Am I deserving of special consideration?
A: That depends. I may feel you deserve a higher grade than you earn on the tests if I feel that your comments in class, Piazza, and office hours improve the education of your fellow students and show you are able to and have been thinking intelligently about the material.

Q: What is the most important thing?
A: Please be assured that I want students to learn and to receive the good grades they deserve. So please make an appointment with me should you have undue difficulty with your work in the course.
Any student with a documented disability needing accommodations is requested to speak directly to the Accessible NU (847-467-5530) and the instructor, as early as possible in the quarter (preferably within the first two weeks of class). All discussions will remain confidential. For resources on safety and mental and physical health, please visit the NUhelp website or phone app.