

## Current Development in Energy Markets

FALL 2016

### Prof. Geoffrey Heal

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Office Hours: I operate an **open-door policy**: I am happy to talk with you whenever I am in my office. If I'm not there when you look for me, then send me an email and we will set an appointment.

TEACHING ASSISTANT: TBA

Class times 2.15pm to 3.45pm Mondays and Wednesdays in Uris 330.

### Classroom Culture is about the 3Ps

#### Present:

- On time and present for every session
- Attendance tracked (instructor's discretion on how graded)\*

#### Prepared:

- Complete pre-work needed, expect cold calling
- Bring nameplates and clickers (if relevant)\*

#### Participating:

- Constructive participation expected and part of grade
- **No electronic devices in class.**

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The energy industry is one of the largest in the U.S., and is absolutely central to the operation of the economy: without energy, the economy collapses. Currently the energy industry is undergoing rapid and possibly dramatic changes, with implications for the rest of the economy. (The energy industry includes oil and gas, coal, wind, solar, nuclear, utilities, pipelines, power distribution, and transportation.) This is an exciting time in energy markets. Changes are always business challenges and business opportunities, and there will be many opportunities and challenges in the energy business. These changes and the factors driving them and the opportunities they generate are the subject of this course.

The course starts with a review of the concept of energy – what is energy, how is it measured and how is it generated? We then talk about the regulatory and institutional framework within which energy is produced and traded in the U.S., and about the costing of energy – average versus marginal costs and the levelized cost of electricity.

Next the course moves to an analysis of the factors driving changes in energy markets – the movements in oil prices, geopolitical and energy security concerns, climate change and the need to decarbonize the economy, the development of shale oil and gas supplies in the U.S. and elsewhere and changes in the regulatory framework.

The next section of the course focuses on specific energy types and their economic and commercial characteristics. These will include coal, oil, gas (both conventional oil and gas and tight oil and gas as produced by fracking and the controversies over fracking), solar thermal, solar PV, biofuels of various types, geothermal, wind, nuclear, fuel cells and then energy storage and the use of energy in transportation (hybrid vehicles, hydrogen vehicles, electric vehicles). For each of these energy types we will talk about its general economic and technological characteristics and in some cases profile a company developing this energy type. In the context of renewable such as wind and solar, we will talk about the intermittency of their outputs, the impact of this on the management of the grid and the potential of energy storage technologies. In the context of fossil fuels we will review the potential of technologies that can capture and store the carbon dioxide emitted by power stations. We will also review energy efficiency and demand management as possible solutions to the energy problem. We will discuss the policies being adopted by the current administration and their implications for investments in the energy industry, and compare them with those of other countries.

Basic reading for the course will be posted in files on Canvas. In addition, good background reading on renewable energy technologies (but not their economics) can be found in the book “Renewable Energy – Without the Hot Air” by Professor David MacKay of the Cambridge Physics Department, which is available free online in HTML or pdf. formats at

<http://www.withouthotair.com> .

This is a very good non-technical introduction to the basic engineering of energy systems and renewable energy technologies. Another basic item for background reading is the June 2011 Special Report on Renewable Energy of the Intergovernmental Panel on Climate Change (IPCC): it is available on their web site at

<http://srren.ipcc-wg3.de/report>

That site – [www.ipcc.ch](http://www.ipcc.ch) - also has a short version of the report for policymakers. This report focuses on the economics of renewable energy, and it and the MacKay book provide good background reading.

The course is a mixture of lectures, discussions, and presentations by outside speakers who are experts in some aspect of the energy industry, many of whom are alumni of the School.

### **Course outline:**

Class Sequence – Current Development in Energy Markets – Fall 2016

1. Course Overview and “What is Energy?”
2. Costing energy sources – LCOE or Levelized Cost of Electricity
3. Energy policy – what are the issues and what are the instruments?
4. Energy policy (cont’d) and Energy Markets in the US

5. Climate change – science and policy
6. Climate change (continued)
7. Coal and carbon capture and storage (CCS)
8. Class discussion on climate change and its implications for energy markets
9. Fracking and the natural gas revolution
10. Oil prices and why they are volatile
11. Oil availability
12. Class discussion of fracking and of US oil/gas export policy
13. Wind
14. Solar Energy
15. Outside presentation on the state of oil and gas markets
16. Class discussion of unburnable carbon and fossil fuel divestment
17. Class discussion of prospects for wind and solar power
18. Geothermal power and Nuclear power
19. Nuclear continued
20. Class discussion of nuclear power
21. Biofuels
22. Energy in transportation
23. General Electric presentation on project evaluation for wind, solar gas and coal power stations
24. Course summary and overview

**Assessment.** Students have to participate in class discussion and complete three assignments. Before the end of the mid-term break you have to write a **short** (2 page maximum) briefing on one of the topics covered in the first half of the semester, the first 12 sessions, – oil, coal, gas, etc. In addition by the end of the semester you have to write an evaluation of a company in the energy area broadly defined and write a term paper on one of the energy topics covered in class (i.e. wind, solar PV, storage, energy in transportation, .....). This should be a **different** topic from the topic of the briefing. The firm whose profile you write can be in one of the industries covered in the briefing or the term paper.

**Short papers are to be written individually. Company evaluations and term papers are to be completed in teams of 4 or 5 students.** Allocation of grades will be based on the following formula:

1. Class participation 5%
2. Briefing 15%
3. Company review 35%
4. Term paper 45%

The firm evaluation and the term paper should not exceed 15 pages single-spaced. **Both are due by the end of the day on December 16.**

**Here is some more information about what is expected in the two papers:**

Both papers should be written as for investors who are thinking of becoming involved in the firm (firm review) or energy field (term paper).

The **firm review** should give a brief history of the company, and a summary of its financial position (earnings, assets, liabilities etc). Then an analysis of its competitive position in its market, its strengths and weaknesses, and its main competitors. I also want to see a discussion of what distinguishes this company – if anything – from its competitors, and what is its business plan. Finally, what do you think of the company? Would you invest? This last point is the main one – I want to see your reasoned evaluation of the company.

The term paper can take any topic – such as energy efficiency, or demand management, or electric vehicles, or LNG, or nuclear power, or solar PV, or off-grid solar, ..... . I want a short history of this area and how it got where it is, a review of what is happening now, and where you think it will be going. Finally, is it an area in which it is possible to invest, how would one invest, and would that be a smart thing to do?