Carnegie Mellon University

Energy Demand and Utilization

CIT 39-611
Tuesday & Thursday 9:30AM – 11:20AM
Wean Hall 5421
Spring 2019

Professor: Costa Samaras
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Office Hours: Tuesdays and Thursdays after class and by appointment

Summary:

Energy Demand & Utilization examines how human demands for energy have evolved over time and how they differ across nations. The course evaluates of present demand and synthesis of future projections. The course focuses on the technologies used in the different sectors: housing, commerce, food, industry and transportation. Students successfully completing this course will be able to demonstrate an understanding of a variety of tools for energy analysis and measurement, including some fundamentals of economic analysis, energy efficiency, and demand response. We will also analyze strategies for inducing the adoption of efficient technologies and consumption.

Learning Objectives

Upon successful completion of the course, students should be able to:

- Describe how energy demand has evolved over time across various sectors
- Analyze trends and forecast energy consumption for different sectors: housing, commerce, food, industry and transportation
- Collect and use open data to analyze energy efficiency and demand response problems and quantify solutions
- Work in small teams to succinctly communicate their technical recommendations on efficient technologies and energy consumption

Readings and Lecture Material

The course will utilize multiple academic and popular press articles as readings throughout the course. All required readings will be available on Canvas, with students expected to review required readings before each class. There will also be several suggested readings and links for specific topic areas available on Canvas.

As course background material, there are several suggested books. You don't need to buy the books below, but these are good sources to learn more about energy demand and forecasts across various sectors. The library should have copies of these and you can always obtain books from Carnegie Mellon Library's Interlibrary Loan Program.

1. L. D. D. Harvey, Energy and the New Reality 1: Energy Efficiency and the Demand for Energy Services. Earthscan/Routledge Publications Ltd., 2010.

2. F. Vanek and L. Albright, Energy Systems Engineering: Evaluation and Implementation, 1st ed. McGraw-Hill Professional, 2008.

3. McKary, D. Sustainable Energy Without the Hot Air. 2009. https://www.withouthotair.com/ (this book has a free PDF download)

As stated above, you do not need to purchase these books for the class. All of the reading material to achieve the course learning objectives will be provided by the instructor.

Assessments and Grading Rubric

Technical Quizzes: 40%
In-Class Exercises and Participation: 20%
Mid-Term State Energy Brief 15%
Final Project Group Briefing Report: 10%
Final Project Group Poster: 10%
Final Project Group Presentation: 5%

Technical Quizzes (40%): Four mini-quizzes will be assigned, occurring after approximately every three or four classes. Quizzes will be quantitative and qualitative assessments, will include multiple choice questions, short answer questions requiring judgment and technical writing, and quantitative problems. Quizzes will be completed electronically on Canvas, out-of-class and on your own. You may use your course notes and other data, but complete the quiz individually and not discuss the questions and answers with anyone other than the instructor.

Class Participation, Attendance, and Practice (20%): Good discussion makes an important contribution to everyone's experience in this class. You are expected to prepare for class and review all required readings, attend class, ask questions, and be an active participant in the discussion.

In the beginning of each class, I will ask for volunteers to briefly summarize something in recent energy demand news, preferably something that addresses the current class topic. A good source of this news is E&E News, which you have a subscription to at CMU. If you're on campus (or tethered via VPN), you have access to the stories at http://www.eenews.net/. Check EnergyWire, ClimateWire, GreenWire, etc on there. You can get the headlines emailed to you. Always come to class with at least one story on here read and be able to describe it in 2-5 min. **This will count toward your participation grade.**

During some classes, we will have individual or group exercises that will result in a written product turned in to the instructor with each person's name on it. Completion of these will count toward the class participation grade. Students will sometimes have to miss class for various reasons, and you may miss one in-class exercise without affecting your participation grade.

Before some classes, I will assign short online assignments based on the readings, to be completed before class. These will be assessed and counted toward participation as well.

Mid-Term State Energy Brief (15%)
You will individually produce a brief about energy use and indicators in one U.S. state, and it will be no more than 8 pages, 1.5 spacing, no smaller than 10-point font, including all charts and references (references can be 8 or 10 point font). At the end of the brief, you will include a section titled, "Near-Term Outlook", and you will provide your analytical opinion of the range of future conditions in this state through 2025. The brief **will have a summary page** (included in the 8 pages) with the main charts and a bulleted highlights section. You will use EIA's State Energy Profiles and other EIA data as a starting point. I will assign you a state after the first day of class. You will find external credible data for state GDP, population and other indicators that you will use to present, normalize, and project state energy demand indicators. Using the prices for electricity and fuels from EIA, provide some informed commentary on why you think electricity generation and emissions have changed in this state. You will name your file (ANDREW ID_State Energy Brief). You can include an appendix with additional charts and calculations, but this is not required.

Final Group Project: Presentation (5%), Final Paper (10%), Final Poster (10%)
25% of the grades for the course will be based on a group project, which consists of a written report and a presentation. The main objective of this project is to elaborate a formal proposal for a solution that can have the potential of reducing and/or controlling the energy demand (and/or GHG emissions) in a chosen sector. The solution will need to be described in detail, and accompanied by theoretical evaluations of the potential savings, costs of implementation, ease of deployment, etc.

The final project of this class consists of evaluating or proposing a solution to help reduce or better manage the energy demand of one sector. You will need to estimate and forecast the energy and emissions saved with this solution.

You will prepare a group report, group presentation, and a group poster

Here are some general guidelines to help you out prepare your final report and presentation.

1. You should imagine that you will be presenting a formal evaluation or proposal to a client (the mayor of a city, a large company, the government, etc.).
2. You will evaluate or propose one solution for the sector you are given. This solution can be an emerging product or service, a technological improvement, a new policy, etc.
3. You will quantify the feasibility of the solution: economic viability, environmental benefits, etc. These should be demonstrated both quantitatively and qualitatively. Use the tools we have learned in class to tackle this.
4. You will use your own template for the slides, and will write the final report in no more than 8 pages, **1.5 spacing**. Again, imagine you are presenting to a formal client. The presentation should be compelling, and the written proposal should contain all the necessary details for the client to evaluate and make a decision on his own.

5. Your solution should contain technical details on how to implement it and what the expected outcomes are. No client will buy into your solution if you don't persuade them on why it is a good idea.
6. Your presentation should be no longer than 15 minutes. There will be 5 minutes for questions from the audience. Even though you should divide the presentation so that each member of the group has the opportunity to present, the questions will be addressed to any member and it is expected that all members will know about the entire work.
7. The organization of the written report is flexible. However, it will be taken into account when evaluating your document. In general, you want to include the following sections into your report or proposal:
   a. **Executive Summary**
   b. Introduction, which may include: motivation, context, background information, related work
   c. Proposal, where you describe the idea and provide the technical content
   d. Evaluation, where you present the results of your evaluation (economic feasibility, environmental impact, potential benefits, etc.
   e. Sensitivity analysis
   f. Limitations

These same sections should be included in your oral presentation. You will turn in your slides and your report in Canvas under assignments.

Slides and PDF of poster are Due by 9:30AM February 26th
Report is Due by 12:00PM March 7th

Course Procedures and Protocols

- Class begins promptly at 9:30 AM. Late arrivals will be reflected on your participation grade.

- Assignments are due before class via Canvas' assignment page on the designated date and time. Assignments should not be submitted via email. To submit an assignment, select assignments in the tool bar, and then select view/complete assignment under the heading of the assignment you wish to complete. Online quizzes will not be accepted late due to extenuating circumstances without discussion with the professor at least 48 hours prior to the due date. Assignments submitted late will incur a penalty of 20% of total points per day late.

- Collaboration is working together to come to frame a problem and work through a solution, discussing results, and analyzing the process. All members of the group contribute, understand the process (sometimes by being taught by other members of the group), and are prepared to complete a similar problem by themselves afterward. Collaboration is encouraged on homework assignments. However, for individual assignments, individual submissions are required. While you may have

worked with another in solving the problem the work you hand in must be your own.

- Academic integrity is a core value at Carnegie Mellon. Cheating, including copying someone else's work and handing it in as your own work is unacceptable and actionable. It is equally unacceptable to allow others to use your work.

- Plagiarism is using someone else's published work and not giving them credit. Several web sources or the library have guidelines for referencing work from published journals, books, or newspapers, and from websites. (See "Citations and References" section, below.) Occurrences of cheating or plagiarism will be handled according to the university policy on Academic Integrity, http://www.cmu.edu/policies/documents/Academic%20Integrity.htm. Students are expected to have read this policy and conform to the highest standards of academic integrity. For incidents of academic misconduct, the University Academic Disciplinary Actions Policy, found at http://www.cmu.edu/policies/documents/AcadRegs.html , will be followed. You should read these two policies now. ***If you are unsure if a specific action or activity constitutes unacceptable collaboration or cheating, ASK FIRST.***

- **Policy on Recording of Class Sessions:** No recording or taping of any classroom activity is permitted without the expressed written consent of the Professor. Any student who needs to record or tape classroom activities because of a disability should contact the Carnegie Mellon Office of Equal Opportunity Services to request an appropriate accommodation.

- **Policy on Web Posting of Course Materials:** Uploading course materials to web sites is not an authorized use of the course material. Posting and using these materials is defined as Cheating per the University Policy on Cheating and Plagiarism under "1. Theft of or unauthorized access to an exam, answer key or other graded work from previous course offerings." Both the poster and the user are in violation of the university policy.

- **Regrading Policy:** Regrades are possible within a one-week timeframe after the assignments are returned. After that time, no regrades will be considered (except for simple addition errors). To submit a regrade, you should attach a sheet of paper detailing your concerns about the score given and argue your point. Regrade requests should be handed to the professor in class.

- **Class Decorum:** The classroom should be viewed as a professional workplace, and students should view themselves as members in a peer community. Disrespectful behavior is not acceptable in a professional workplace and will not be tolerated in the classroom. Cell phones should be **off** during class; if you have a personal issue that requires an active communication channel during class (e.g., children in daycare; on-call for facility management or health emergency), please discuss this with the professor at the start of term. Laptops can be used during

group exercises and for learning activities. You are responsible to respecting your classmates and the instructor by not using laptops for non-class activity.

- **Accommodation for Students with Disabilities**: If you have a disability and have an accommodations letter from the Disability Resources office, I encourage you to discuss your accommodations and needs with me as early in the semester as possible. I will work with you to ensure that accommodations are provided as appropriate. If you suspect that you may have a disability and would benefit from accommodations but are not yet registered with the Office of Disability Resources, I encourage you to contact them at access@andrew.cmu.edu. Disability Resources, 102 Whitfield Hall 412.268.2013.

- **Take care of yourself:** Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress. All of us benefit from support during times of struggle. You deserve to be here and are not alone. There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is often helpful. If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support. Counseling and Psychological Services (CaPS) is here to help: call 412-268-2922 and visit their website at http://www.cmu.edu/counseling/. Consider reaching out to a friend, faculty or family member you trust for help getting connected to the support that can help. If you or someone you know is feeling suicidal or in danger of self-harm, call someone immediately, day or night:
    - CaPS: 412-268-2922
    - Re:solve Crisis Network: 888-796-8226
    - If the situation is life threatening, call the police:
        - On campus: CMU Police: 412-268-2323
        - Off campus: 911

Citations and References

In order to put together a professional report and to avoid plagiarism, it is imperative to become familiar with the proper procedures and styles for citing sources. There are several different styles and many online guides on proper citing. For this class, the specific style used (APA, MLA, etc.) is up to you, so as long as it is consistent and properly done. Below are some resources that outline citation styles.

1) Duke University reference for citations:

http://www.lib.duke.edu/libguide/cite/works_cited.htm

A good online reference, where you can easily find how to cite several different types of works.

2) CMU Reference for citations:

https://libwebspace.library.cmu.edu:4430/Genref/citing.html

3) University of California Berkeley reference for citations and definitions of plagiarism:

http://www.lib.berkeley.edu/instruct/guides/citations.html

Course Topics

Date	No.	Topic	Assessment
Tues, Jan. 15	1.	Introduction to Energy Demand Modeling	
Thur, Jan. 17	2.	Understanding Current Demand (EIA MER, RECS)	
Tues, Jan. 22	3.	Modeling Future Demand Sources (EIA AEO, STEO, IEO, IEA, others)	Mini Quiz 1 Out
Thur, Jan. 24	4.	Projecting Demand and Uncertainty	Mini Quiz 1 on Classes 1-3 Due
Tues, Jan. 29	5.	Energy Project Finance and Electricity Demand	Project Topics Defined and Emailed
Thur, Jan. 31	6.	Energy and the Rebound Effect	Mini Quiz 2 on Classes 4-6 Out
Tues, Feb. 5	7.	Transportation – Personal	Mini Quiz 2 on Classes 4-6 Due
Thur, Feb. 7	8.	Transportation – Freight	
Tues, Feb. 12	9.	Industrial Energy	Mid-term State Brief Due Mini Quiz 3 on Classes 7-9 Out

Thur, Feb. 14	10.	Residential Energy	Mini Quiz 3 on Classes 7-9 Due
Tues, Feb. 19	11.	Commercial Energy	
Thur, Feb. 21	12.	Food Production and Consumption	Mini Quiz 4 on Classes 10-12 Out
Tues, Feb. 26	13.	Final Presentations	All Final Presentation Slides Due
Thur, Mar. 28	14.	Final Presentations	
Mon., Mar. 4			Mini Quiz 4 on Classes 10-12 Due
Thur., Mar. 7			Final Report Due