Urban Energy Systems & Policy
11.165J(UG), 11.477J(G) / 3-0-9 / Fall 2019
DRAFT. Version last updated: August 28, 2019

Key Information
Instructor: Associate Professor David Hsu, office 9-434, ydh@mit.edu
Time & Place: Tuesdays and Thursdays, 11 am - 12:30 pm, room 9-450
Computer Policy: Please consider your laptop and cellphone use in class.
Direct Contact: E-mail is best; you can expect a reply in 1-2 business days.
Office Hours: Make appointments at DUSP CRON website or by e-mail.
Web Resources: We will decide in the first class whether to use e-mail or Slack for
communication, and whether Dropbox or Google Drive for documents.
Fulfills: GIR (HASS-S); Energy Minor “Technology in Context” requirement.
Joint Listing: 1.286J.

Learning Objectives
• Learn what cities can do and how to meet their 100% renewable energy goals,
• Develop understanding of energy systems, infrastructure, and technology in cities,
• Develop ability to do simple back-of-the-envelope calculations,
• Identify key points or issues for future management, intervention, or revolution,
• Work together with a diverse group of people and disciplines, and
• Develop a highly-detailed understanding for a group of cities together as a class.

Introduction
This class is about figuring out together what cities can do to reduce their energy use and carbon
emissions, and how to put that knowledge into action in your future careers. This course is designed
for any students interested in learning how to intervene in the energy use of cities using policy,
technology, economics, and urban planning. This is a fast-moving topic, since:

• New physical and digital technologies have many profound implications for networked infra-
structure and the built environment.
• The developing world has often been characterized as lacking existing infrastructure, but now
can either build the same systems or leapfrog existing technologies.
• Many developed countries now face issues of legacy infrastructure or the need to replace large
systems that are often a century old.
• Climate change.

Finally, the following rationales for this course may appeal to any or all of you:

• For planners, there are many opportunities for employment in this area and to shape how we
use energy in the future. Perhaps unlike other planning classes on energy, this class will give
you basic calculation skills to figure out what area to focus your policy skills on.
• For engineers: 54% of all people now live in cities that generate 70% of world carbon emis-
sions and 80% of world GDP; by 2050, 66% of the world’s population is expected to be urban.
Cities, however, are different than the overall energy system, since they already have legacy
infrastructure; are densely and diversely populated; and have limited and local powers. Unlike many other energy classes at MIT, this class will focus on urban energy use, efficiency, jurisdiction, institutions, and governance.

- For climate change: given the uncertain prospects of national and international efforts, efforts in cities may be the fastest and most pragmatic solution.

Class structure

This class is divided into two halves:

- in the first segment (September 5 to October 10) you are learning which basic calculations to perform in order to analyze one or two cities (more on that later), and we will learn about key technical aspects of energy systems in all cities.
- in the second segment (October 22 to December 10), we will examine the politics and institutions governing urban energy systems, with a particular focus on regulation and markets of the electricity sector in the U.S..

Putting the two halves together will help you decide where and how to intervene in urban energy systems.

Assignments

In the very first two classes, we will build a composite picture of our class, using our personal experiences and visions for the future to energy systems that you are familiar with. Please calculate the current carbon emissions for yourself and/or an average resident for where (a) you lived before MIT and (b) where you think you will live in 2050, using the CoolClimate calculator.

In the first half of the semester, before each class, doing the reading and a basic calculation exercise will help build up your understanding of what numbers matter, as well as your background knowledge of a particular city. We will reinforce the knowledge with an exam, but if you do the calculation/homework each week, I expect that the exam should be fairly easy.

In the second half of the semester, before each class, researching, writing up a few notes, submitting questions, and getting feedback will help you build up the base of knowledge and material that you need to write your paper.

We will have group discussions in the last three classes to share knowledge from our papers. This is also a good chance to prepare for your final paper.

The final paper assignment will synthesize what you lean over the semester by considering the prospects for a technological or policy innovation in a city of your choosing (I recommend your home or future city). Undergraduates will be expected to write a short paper of approximately 10 pages or 4,000 words (whichever is greater). Graduate students will write a paper of approximately (15 pages and 6,000 words), with the additional task of analyzing their chosen city in terms of its expected future demographic changes.

Readings

There is only one required book for the class:

- MacKay, D.J., 2009. *Sustainable Energy - Without the Hot Air*, 1st ed., UIT Cambridge Ltd. Available in paperback from your local or global bookseller for $27-50, and/or can be downloaded legally as a PDF or read in webpage format at withouthotair.com. I find it pretty useful to have a copy handy and flip through it for reading and calculations, so the cheapest way to get a hardcopy is to print it out at CRON and have it bound at MIT Copytech.
Other papers assigned for each class and which will be available on the class folder on the cloud. I may occasionally modify the weekly readings and will notify you in advance.

**Schedule & topics**

All readings can be found in the bibliography, class drive, and/or on the web. Readings are denoted by (links), with a dash to indicate chapter numbers and/or appendix letters. psets = problem sets; sendq = send questions in.

<table>
<thead>
<tr>
<th>Date</th>
<th>No.</th>
<th>Topic</th>
<th>Preparation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-Sep</td>
<td>1</td>
<td>Introduce class, focus, your interests</td>
<td>(25)-1,2, pset0</td>
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<tr>
<td>10-Sep</td>
<td>2</td>
<td>Energy use, climate change, cities</td>
<td>(9), (10), (26), pset1</td>
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<tr>
<td>12-Sep</td>
<td>3</td>
<td>Personal transport: cars, bicycles, etc.</td>
<td>(25)-5,20,A, (22), (11), pset2</td>
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<tr>
<td>17-Sep</td>
<td>4</td>
<td>Transportation systems: transit, planes, etc.</td>
<td>(25)-5,C, (4), pset3</td>
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<tr>
<td>19-Sep</td>
<td>5</td>
<td>Buildings: heating, cooling, lighting</td>
<td>(25)-7,9,11,E, pset4</td>
</tr>
<tr>
<td>24-Sep</td>
<td>6</td>
<td>Renewables: solar, wind</td>
<td>(25)-4,6,8,B,D, (23), (24), pset5</td>
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<tr>
<td>26-Sep</td>
<td>7</td>
<td>Renewables: hydro, geothermal, biomass</td>
<td>(25)-10,16,18, (33), pset6</td>
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<tr>
<td>1-Oct</td>
<td>8</td>
<td>Food, stuff, materials and industry</td>
<td>(25)-13,15,H, (31), (3), pset7</td>
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<tr>
<td>3-Oct</td>
<td>9</td>
<td>Energy efficiency</td>
<td>(25)-19,21,22, (36)-6, (1), pset8</td>
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<tr>
<td>8-Oct</td>
<td>10</td>
<td>Fossil fuels, direct air capture, and nuclear</td>
<td>(25)-23,24, (30), (35), pset9</td>
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<tr>
<td>10-Oct</td>
<td>11</td>
<td>Grids, storage, microgrids &amp; districts</td>
<td>(25)-25,26,27, (42), (6), pset10</td>
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<tr>
<td>15-Oct</td>
<td>12</td>
<td>NO CLASS (student holiday)</td>
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<tr>
<td>17-Oct</td>
<td>12</td>
<td>Exam, review, paper planning</td>
<td>Short paper proposal due (1 pg.)</td>
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<tr>
<td>22-Oct</td>
<td>13</td>
<td>‘The grid” system</td>
<td>(14)-1,3,5,6, sendq</td>
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<tr>
<td>24-Oct</td>
<td>14</td>
<td>State public utility commissions, regulators</td>
<td>(28), (39)-1, (15)-2, (20)-3, sendq</td>
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<tr>
<td>29-Oct</td>
<td>15</td>
<td>Investor-owned utilities</td>
<td>(17), (12), (40), sendq</td>
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<tr>
<td>31-Oct</td>
<td>16</td>
<td>Municipally-owned utilities and coops</td>
<td>(16), (38), (37), (21), sendq</td>
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<tr>
<td>5-Nov</td>
<td>17</td>
<td>Community solar</td>
<td>(13), (19), (34), (27), sendq</td>
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<tr>
<td>7-Nov</td>
<td>18</td>
<td>Individual choices, behind-the-meter &amp; retail</td>
<td>(41), (32), (5), sendq</td>
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<tr>
<td>12-Nov</td>
<td>19</td>
<td>Aggregation by local governments</td>
<td>Hsu CCA chapter, (29), sendq</td>
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<tr>
<td>14-Nov</td>
<td>20</td>
<td>Local government powers</td>
<td>(18), (2), sendq</td>
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<tr>
<td>19-Nov</td>
<td>21</td>
<td>Sustainability and 0x50 plans</td>
<td>(7), (8), sendq</td>
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<tr>
<td>21-Nov</td>
<td>22</td>
<td>Guest: David Musselman, City of Boston and DUSP MCP’17 graduate.</td>
<td>Review Boston plans TBD, sendq</td>
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<tr>
<td>26-Nov</td>
<td>23</td>
<td>Guest lecture 2</td>
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<tr>
<td>28-Nov</td>
<td></td>
<td>NO CLASS (Bioenergy storage holiday)</td>
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<tr>
<td>3-Dec</td>
<td>24</td>
<td>Group discussion 1, order TBD</td>
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<tr>
<td>5-Dec</td>
<td>25</td>
<td>Group discussion 2</td>
<td></td>
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<tr>
<td>10-Dec</td>
<td>26</td>
<td>Group discussion 3 &amp; wrap-up as needed</td>
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Grading

Learning expectations / norms

- Do reading and submit your problem sets or questions at least two hours before class
- Ask questions and contribute insights for everyone’s learning
- Focus on class discussion and lecture
- Use technology effectively and only as needed

Grading breakdown

The details marked TBD (to be determined) will depend on the number of students in the class and number of topics that we want to cover.

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Before class prep: problem sets and reading</td>
<td>25%</td>
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<tr>
<td>questions</td>
<td></td>
</tr>
<tr>
<td>Exam</td>
<td>20%</td>
</tr>
<tr>
<td>Short presentation in group discussion</td>
<td>5%</td>
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<tr>
<td>Class discussion / participation</td>
<td>10%</td>
</tr>
<tr>
<td>Final paper</td>
<td>35%</td>
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<tr>
<td></td>
<td>100%</td>
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</table>

Please make an effort to be on time for class, and please let me know in advance if you will miss class. Missing more than two classes will affect your participation / discussion grade.

Assignments and due dates

- Calculations are due by 9 am before class for the first 11 classes.
- Exam will follow a similar format as the calculations.
- Short presentation: schedule TBD based on student interests (and numbers). One slide maximum, 16 point font minimum, must be circulated to your classmates and me in PDF format one full day beforehand.
- Final paper: this will describe a strategic plan to meet the energy challenge for a chosen city. This paper will include a description of your plan and/or intervention, with an assessment of its prospects for success (strengths, weaknesses, other contributing factors necessary), an assessment of the capability of proposed or existing institutions to carry out the plan, and an analysis of its likely environmental, economic, and social effects. You should also turn in basic calculations as needed (not included in the paper page limit), which shows how you derived the key calculations that are the foundation of your paper analysis. Due the day after last class, December 11.

Paper criteria

In general, papers will be evaluated based on the degree to which they present a clear and coherent argument, introduce appropriate supporting evidence, and develop the argument to a logical conclusion. You should develop your writing and thoughts through multiple written drafts. Other considerations:

- Format: Avoid overly fancy graphic layouts for your paper. Please use black text, white paper, 1.5 or double-spacing, a font with serifs, minimum font size 11.
• Bibliographies: You should include a full bibliography in a common citation format (for example, University of Chicago). This will not count towards the total pages of the paper.
• Tables & graphics: You are encouraged to use any tools that you need to communicate, such as maps, figures, or tables, but these exhibits may not exceed 20% of the pages. Captions and references help to integrate graphics and text. These exhibits will also be graded for clarity, cogency, and the degree to which they support, inform, or extend the argument presented in the text.

Extensions

Each person is allowed 5 days of extensions total, to be used on the psets, reading questions, and paper assignments, which you can allocate as you choose. I will assume that you used your extension days if you hand in the assignments late according to the time of posting; assignments that are otherwise handed in after you have used your extensions up will be penalized accordingly. If there are extreme physical or emotional circumstances, any further extensions should be requested from the Office of the Dean of Graduate Education (http://odge.mit.edu); if they decide that an extension is warranted, they will then send me a generic note, which preserves your privacy.

ADA accommodations

Any student who, because of a disability, may require special arrangements in order to meet course requirements should contact me as soon as possible to make necessary arrangements with MIT’s Student Disabilities Services: http://web.mit.edu/uaap/sds/index.html.

Academic integrity

Plagiarism, unauthorized collaboration, cheating, and facilitating academic dishonesty are academic crimes. It is your responsibility as students and scholars to understand the definition of any such activities, and to avoid and discourage them. Engaging in these activities either knowingly or unknowingly may result in severe academic sanctions, and you are therefore expected to familiarize yourself with MIT’s policies: https://integrity.mit.edu.

Issues TBD on first day

1. Introduction to one another
2. Your names, backgrounds
3. Where are you from? Where are you going?

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References


