

# EST 694

## Energy and Buildings – Technology, Policy, and Behavior

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### Course Details:

**Semester:** Spring 2018

**Day and Time:** Tuesdays 12pm – 2:50pm

**Meeting Place:** Computer Science Seminar Room

### Contact Information:

Elizabeth Hewitt, PhD, LEED AP BD+C

elizabeth.hewitt@stonybrook.edu

Office location: Computer Science 1411

Office hours: Thursdays 12pm-3pm

### Course Overview:

Buildings consume vast amounts of energy and resources, and are one of the largest contributors to greenhouse gas emissions. Major advances in building design and technology over the past decade have given us tools to make buildings more energy efficient, but buildings lag far behind their potential. There are many avenues to green the built environment sector, including technological innovations, occupant behavior programs, retrofits of existing buildings, and innovative building codes. Ultimately, reducing energy consumption in the building stock will require an interdisciplinary approach and some combination of a range of program and policy types.

This course will introduce students to the many interdisciplinary issues surrounding energy use in buildings, with a particular focus on the intersection of policy with technology, economics, social science, and behavior. The course will combine lectures, student-led discussions, guest speaker(s) and field trip(s) to green buildings, depending on scheduling.

### Course Grading:

Mid-term exam (take home essay format): 30%

Final project and presentation (Suffolk County recommendations): 30%

Policy Briefings (2): 30%

Class Participation: 10%

### Assignments:

Grading for this course will be based on the following four assignments/exams:

- 1.) **Mid-term (30%):** The mid-term exam will be posted to Blackboard on **3/20/2018**. Class will be cancelled that day. You will have 24 hours to complete the exam and it will be open book (meaning you can use and refer to any of the readings from the course up that point). The exam will consist of three essay questions, of which **two** must be chosen and answered in the allotted class time. Each essay should be approximately 2 pages in length. More information, including the types of questions to expect, will be discussed in class a few weeks prior to the exam.
- 2.) **Final project (30%):** This semester will take a unique approach to the final project, since we have an opportunity to be involved in a real green building redevelopment project. Suffolk

County is developing plans to redesign the Suffolk County Farm Education and Visitors Center. When complete, this facility will promote the Suffolk County Farm and Cornell Cooperative Extension programs as well as Suffolk County's agricultural and related tourism. I am involved with the energy subcommittee, and over the next two months we will be working as a class with the head architect for Suffolk County, the Senior Energy Analyst, members of the Cornell Cooperative Extension, consultants, and other members of the project team, to develop and formulate ideas for both the energy features for the site as well as the educational displays to communicate the energy efficiency features to visitors. Over the course of the semester you will be working together in two small groups to formulate ideas and strategies, and will present these ideas to the Suffolk County group at the end of the semester. You will also prepare a final memo to Suffolk County to communicate your recommendations in writing. We will have *three* class dates to work together after the lecture in class on this project as well.

- 3.) **Policy Briefings (30%):** Students must sign up for *two* dates during the course of the semester to lead a discussion for that week on a current or recent policy development (locally, regionally, nationally, or internationally) pertaining to energy in the built environment (building materials, technology, behavior, rebates, incentives, education, etc). No written submission is expected or required, unless the student would like to prepare a handout for his/her classmates (not required). The discussion is informal – students should simply prepare ahead, present findings, and spur discussion amongst classmates on their chosen dates. What is the policy development? How does it impact the building industry? What will the impact on energy use be (if any)? Is it successful? (etc). Students should be prepared to share about 10-15 minutes worth of material, and have a 10-15-minute discussion/Q&A. Students will select two dates on the first day of class.
- 4.) **Class Participation (10%):** Students are expected to participate actively in class discussions about reading materials and during policy briefings by classmates. Active participation from all members of the class helps to make our time more interesting and dynamic, and helps students engage with the course materials.

### **Readings/Textbook:**

There is no **required** textbook for the course. Readings will be drawn from academic journals, book chapters, industry publications, and other sources, and will be posted on the Blackboard site for the course. Please note, readings may change as the semester progresses, and new articles and papers become available, but ample notice will be given, and the syllabus will be updated accordingly.

The following book may be interesting and helpful to students, but is *optional*:

Biggart, N. W. (2013). *Constructing Green: The Social Structures of Sustainability*. (R. L. Henn & A. J. Hoffman, Eds.). Cambridge, Massachusetts: The MIT Press.

### **Class Structure:**

Classes will be split into three parts: Lecture, reading discussion, and policy briefing/final project work. Each class meeting will begin with a lecture on that week's materials. Lecture length may vary, based on the topic. We will then discuss that week's readings as a group. Please be prepared to offer your thoughts and input, and ask questions about the readings. The last portion of class will consist of the policy briefing(s) led by the student volunteer(s) for the week or as collaborative work time to spend advancing ideas on the final project together.

**Course Schedule:**

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<b>WEEK</b>	<b>DATE</b>	<b>TOPIC</b>
<b>PART I: FRAMEWORK AND BACKGROUND FOR BUILDINGS AND ENERGY</b>		
1	1/23/18	Introduction and overview
<b>PART II: BEHAVIOR (MICRO SCALE – INDIVIDUALS, OCCUPANTS)</b>		
2	1/30/18	Human behavior and decision-making <i>Suffolk County introductory meeting</i>
3	2/6/18	Human behavior case studies and strategies
<b>PART III: TECHNOLOGY (MESO-SCALE – THE BUILDING)</b>		
4	2/13/18	Technology, innovation, and market transformation
5	2/20/18	Building operations and management
6	2/27/18	“Low-tech” building energy efficiency
7	3/6/18	<i>Suffolk County meeting (ON SITE AT FARM)</i>
8	3/13/18	<b>SPRING BREAK – NO CLASS</b>
9	3/20/18	<b>MID-TERM (take-home) – NO CLASS</b>
<b>PART IV: POLICY (Macro scale – Communities, Institutions, Organizations; National/Global)</b>		
10	3/27/18	<b>FIELD TRIP</b> – Advanced Energy Conference 2018
11	4/3/18	Data collection & analysis for building energy use
12	4/10/18	Building policy – regulations, incentives, building codes
13	4/17/18	Equality and social justice in energy efficient buildings
14	4/24/18	International examples – policies, buildings, technologies
15	5/1/18	<b>Final Presentations to Suffolk County / Last class</b>

## Lecture Descriptions and Readings:

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### PART I: FRAMEWORK AND BACKGROUND FOR BUILDINGS AND ENERGY

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#### Week 1: January 23, 2018

##### Introduction & Overview

Introduction to course; situating buildings within the larger climate challenge; framework for the importance of buildings; overview of topics for the semester; overview of grading and assignments; sign-up for policy discussion leadership dates

##### Readings:

- Introduction pp. 3-21 in Davis, H. (2000). *The Culture of Building*. Oxford University Press.
- Forward (pp. ix-xiv) and Introduction (pp. 1-10 only) in Biggart, N. W. (2013). *Constructing Green: The Social Structures of Sustainability*. (R. L. Henn & A. J. Hoffman, Eds.). Cambridge, Massachusetts: The MIT Press.

### PART II: BEHAVIOR

#### (Micro Scale – Individuals, Occupants)

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#### Week 2: January 30, 2018

##### Human behavior and decision-making

Framing the importance of the micro scale and the building occupant in energy consumption; understanding behavior in individuals and households; theories of behavioral outcomes; values, attitudes, and norms in energy consumption; major differences in energy consumption behavior in commercial properties vs residential properties; challenges that are unique to commercial buildings; behavior of occupants at work

##### Readings:

- (OPTIONAL) Andrews, C. J. (2000). Building a Micro Foundation for Industrial Ecology. *Journal of Industrial Ecology*, 4(3), 35–51. <http://doi.org/10.1162/108819800300106375>
- Kleindorfer, P. (1998). Understanding individuals' environmental decisions: A decision sciences approach. Chapter 2 in *Better Environmental Decisions- Strategies for Governments, Businesses & Communities* by Sexton, Ken. [1998] Paperback. Island.
- Lutzenhiser, L. (1992). A cultural model of household energy consumption. *Energy*, 17(1), 47–60. [http://doi.org/10.1016/0360-5442\(92\)90032-U](http://doi.org/10.1016/0360-5442(92)90032-U)
- Stern, P. C. (2000). Toward a Coherent Theory of Environmentally Significant Behavior. *Journal of Social Issues*, 56(3), 407–424.

#### **GUEST SPEAKER(s)—Suffolk County Farm redevelopment team/county officials**

Representatives from Suffolk County and the Cornell Cooperative will join us to introduce the Suffolk County Farm redevelopment project.

### **Week 3: February 6, 2018**

#### **Behavioral case studies and strategies**

A residential case study of the role of habits in occupant behavior in a NYC green building; a commercial case study of a portfolio of buildings in Philadelphia that studied the effects of load-shedding on occupant behavior and comfort; approaches to collecting data and researching occupant behavior; policy strategies to addressing behavior

#### Readings:

- Allcott, H. (2011). Social norms and energy conservation. *Journal of Public Economics*, 95(9–10), 1082–1095. <http://doi.org/10.1016/j.jpubeco.2011.03.003>
- (OPTIONAL) Hewitt, E., Andrews, C., Senick, J. Wener, R., Krogmann, U. and Sorensen Allacci, M. (2016). Distinguishing between green building occupants' reasoned and unplanned behaviors. *Building Research and Information*. doi: 10.1080/09613218.2015.1015854.
- (OPTIONAL) Malenchak, S., Sorensen Allacci, M., and Andrews, C.J. 2014. Preliminary experimental evaluations of occupant behavior during load shedding. Prepared by the Center for Green Building at Rutgers University for the Energy Efficient Buildings Hub, Philadelphia, PA.
- Lutzenhiser, L. (2002). Marketing Household Energy Conservation: The Message and the Reality. In *New Tools for Environmental Protection: Education, Information, and Voluntary Measures* (pp. 49–66). National Academies Press.
- Stern, P. (2002). Changing Behavior in Households and Communities: What Have We Learned? In *New Tools for Environmental Protection: Education, Information, and Voluntary Measures* (pp. 201–212). National Academies Press.

## **PART III: TECHNOLOGY (Meso-scale – The building)**

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### **Week 4: February 13, 2018**

#### **Technology, Innovation, and Market Transformation**

Transforming the building industry; new advances in building connectivity and integration with the grid (e.g. *smart buildings*); scaling up technologies and interventions; a brief framework of theories of innovation and how market transformation occurs; placing buildings within this larger framework; comparing & contrasting buildings to other transformative technologies (electric vehicles, biofuels, etc.)

#### Readings:

- “Issue Brief: Building Information Technology and Management.” (2011). Institute for Building Efficiency. (see Blackboard)
- Chapter 2 “Building expertise: Renovation as professional innovation” pp. 35-55 in Biggart, N. W. (2013). *Constructing Green: The Social Structures of Sustainability*. (R. L. Henn & A. J. Hoffman, Eds.). Cambridge, Massachusetts: The MIT Press.
- (OPTIONAL) Senick, J.S., Hewitt, E., and Andrews, C.J. (2014). Scaling up advanced energy retrofits within large portfolios of commercial buildings. Prepared by the Center for Green Building at Rutgers University for the Department of Energy, Energy Efficient Buildings Hub, Philadelphia, PA.
- “What is a Smart Building.” (2011). Institute for Building Efficiency. (see Blackboard)
- “Diffusion of Innovation Theory.” (from Boston University Medical College – see Blackboard)

**Week 5: February 20, 2018**

**Building Operations & Management**

The importance of operations and management in influencing overall building energy consumption; organizational drivers of effective building management; can managers “override” occupant behavior; new technology in building controls and automation

Readings:

- Galvin, R. and Terry, N. (2016). Selling energy savings in the UK: A case study of top-down pro-environmental behavior change in commercial office buildings. *Energy Research and Social Science*. 11: p. 155-163.
- Goulden and Spence. (2015). Caught in the middle: The role of the Facilities Manager in organizational energy use. *Energy Policy*. 85: p. 280-287.
- “Issue Brief: Fault Detection and Diagnostics.” (2013). Institute for Building Efficiency. (see Blackboard).

**Week 6: February 27, 2018**

**Low-tech energy efficiency**

Does it have to be “high-tech” to be green or energy efficient? An exploration of “low-tech” solutions to sustainable and energy efficient building practices; passive designs; historic buildings; building materials to increase insulation for heating and cooling; traditional and cultural building practices

Readings:

- Eisenberg, D. and Hammer, M. (2014). Straw bale construction and its evolution in building codes. *Building Safety Journal Online*. p. 25-29.
- Henderson, K. (2006). Ethics, Culture, and Structure in the Negotiation of Straw Bale Building Codes. *Science, Technology, & Human Values*, 31(3), pp.261-288.
- Lockwood, C. (2009). *The Green Quotient. Insights from Leading Experts on Sustainability*. Interview with Vivian Loftness. Pp. 74-79. Washington, D.C.: Urban Land Institute
- “Net Zero Energy Building: Passive heating, cooling, and ventilation.” (2011-2015). Autodesk Sustainability Workshop. (see Blackboard).

**Week 7: March 6, 2018**

**FIELD TRIP AND GUEST SPEAKER(s)—Suffolk County Farm redevelopment team**

We will visit the site of the Suffolk County Farm and will meet with representatives from Suffolk County and the Cornell Cooperative to discuss further aspects of the Farm redevelopment as the project has progressed. Students will be brought up to date on the latest developments and design plans, and have a chance to ask further questions and have a discussion about the county’s goals and desired outcomes from the project.

**Week 8: March 13, 2018**

SPRING BREAK – NO CLASS

**Week 9: March 20, 2018**

**MID-TERM** (take-home – essay format; see description on p.1 of syllabus) **NO CLASS**

**PART IV: POLICY**  
**(Macro scale – Communities, Institutions, Organizations; National/Global Issues)**

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**Week 10: March 27, 2018**

**FIELD TRIP – Advanced Energy Conference 2018, Marriott Marquis, New York, NY**

This year the Advanced Energy Center (AEC) is hosting the 2018 Advanced Energy Conference at the Marriott Marquis in New York City on March 26<sup>th</sup>, 27<sup>th</sup>, and 28<sup>th</sup>. I am sponsoring student attendance on the day of our class (3/27). The conference provides a number of educational sessions and has two tracks on buildings (Advanced Buildings I and Advanced Buildings II). Students should plan to attend on the 27<sup>th</sup>, but are free to attend more days if their schedule permits. We will meet *at the conference*. We will discuss in class if anyone needs help navigating public transportation to get to the event. Visit the conference website for more information on sessions: <http://aertc.org/aec2018/>.

**Week 11: April 3, 2018**

**Data Collection & Analysis for Building Energy Consumption**

What types of data exist for building energy researchers and practitioners; where is data found and made available online; different types of analysis for buildings; CBECS and RECS; Agent-based modeling; energy disclosure data

Readings:

- Andrews, C.J., Yi, D., Krogmann, U., Senick, J.A., and Wener, R.E. Designing Buildings for Real Occupants: An Agent-Based Approach. IEEE Transactions on Systems, Man, and Cybernetics--Part A: Systems and Humans November 2011, 41(6): 1077-1091.
- “Issue Brief: Building Energy Management – Using Data as a Tool.” (2012). Institute for Building Efficiency (see Blackboard).
- Please review (SKIM) the results of the EIA’s 2012 CBECS: <http://www.eia.gov/consumption/commercial/reports/2012/buildstock/index.cfm>
- (SKIM) U.S. Energy Information Administration. (2015). Drivers of U.S. Household Energy Consumption 1980-2009. (Results of the Residential Energy Consumption Survey (RECS)).

**Week 12: April 10, 2018**

**Green and energy efficient building policy: Regulations, Incentives, Building Codes**

Voluntary and mandated schemes, strategies, and policies to encourage more energy efficient building operations; LEED system and its international counterparts (BREAM, others); EnergyStar; prescriptive and performance based building codes; tax abatements, rebates, and other policies; effectiveness of policies and programs

Readings:

- Chapter 9 “Regulation” pp. 201-217 in Davis, H. (2006). The Culture of Building. Oxford University Press.
- Lee, W.L. and Yik, F.W.H. (2004). Regulatory and voluntary approaches for enhancing building energy efficiency. *Progress in Energy and Combustion Science*, (30) p. 477-499.
- Chapter 3 “LEED, collaborative rationality, and green building public policy” pp. 57-76 in Biggart, N. W. (2013). Constructing Green: The Social Structures of Sustainability. (R. L. Henn & A. J. Hoffman, Eds.). Cambridge, Massachusetts: The MIT Press.

### **Week 13: April 17, 2018**

#### **Equality & social justice in energy efficient buildings**

Exploring issues of equitable development and affordability in energy efficient and green buildings; green buildings as a “luxury” and potentially exclusionary product; benefits of energy efficiency to vulnerable populations; making energy efficient properties more accessible; examples and case studies

#### Readings:

- (READ INTRODUCTION ONLY – p. 13-23). New Ecology and the Green CDCs Initiative. (2006). “The Costs and Benefits of Green Affordable Housing.” (see Blackboard)
- Hernandez, D. and Phillips, D. (2015). Benefit or burden? Perceptions of energy efficiency efforts among low-income housing residents in New York City. *Energy Research and Social Science*, (8) p. 52-59.

### **Week 14: April 24, 2018**

#### **International Examples & Case Studies – Policies, Buildings, Technologies**

Differences in approaches to green and energy efficient building design and construction in other countries; examples and case studies; widespread technologies; unique international policies, mandates, and building codes; comparing performance across countries

#### Readings:

- Wheeler, S. & Beatley, T. (2004). “Part 6: Case Studies of Urban Sustainability” pp 293-306 in *The Sustainable Urban Development Reader*. New York: Routledge.
- American Council for an Energy Efficient Economy (ACEEE). (2016). “2016 International Energy Efficiency Scorecard.” Retrieved from: <http://aceee.org/sites/default/files/publications/researchreports/e1602.pdf>. (See Blackboard).

Read the following sections:

- “Executive Summary”
- “Buildings”
- SKIM any of the country summaries you are interested in

### **Week 15: May 1, 2018**

**FINAL PRESENTATIONS to SUFFOLK COUNTY and FINAL PAPERS DUE (submit one hard copy and send the file by email please)**

#### **Academic Integrity:**

Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty is required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty please refer to the academic judiciary website at:

[http://www.stonybrook.edu/commcms/academic\\_integrity/index.html](http://www.stonybrook.edu/commcms/academic_integrity/index.html)



### **Disability Support Services (DSS) Statement**

If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Disability Support Services, ECC(Educational Communications Center) Building, Room 128, (631)632-6748. They will determine with you what accommodations, if any, are necessary and appropriate. All information and documentation is confidential. Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and Disability Support Services. For procedures and information go to the following website:

<http://www.stonybrook.edu/ehs/fire/disabilities>.

### **Critical Incident Management**

Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of University Community Standards any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures. Further information about most academic matters can be found in the Undergraduate Bulletin, the Undergraduate Class Schedule, and the Faculty-Employee Handbook.