Duke | NICHOLAS SCHOOL of the ENVIRONMENT

Building Energy on Campus

ENVIRON/ENERGY 830—Fall 2025

Wednesdays, 1:25 to 3:55
Grainger Hall 2102

Instructors

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Course Description and Objectives

Buildings use more than 40% of the energy consumed in the US and are a natural focus of energy efficiency and conservation measures. The rise of building rating systems such as LEED, WELL, and the Living Building Challenge; the increasing prominence of demand-side energy management programs; and municipal-level energy and greenhouse gas emission reduction efforts are focusing public attention on the connection between energy use and the built environment. While new construction draws much attention, a significant part of the built environment in 2050 will consist of structures existing today. Building owners and facility managers, policy makers, and electric utility planners are therefore interested in identifying

means of reducing energy consumption in the current building stock and taking advantage of the embodied energy already sunk in its construction. Such efficiency and conservation measures range from lighting and HVAC (heating, ventilation, and air conditioning) system upgrades, to plug load reductions, building envelope retrofits, building-scale renewable integration, and occupant behavior changes. Aiding this process is the increasing availability of data from utility sources, as well as from sensors and building energy management systems, used in conjunction with building energy models to evaluate energy efficiency alternatives.

This course is designed to increase students' understanding of the linkage between building design and energy consumption *plus* institutional decision-making regarding energy and sustainability priorities. The class provides hands-on experience evaluating energy use in existing campus buildings, as well as a grounding in related building science concepts and exposure to the work of building industry professionals. Most of Duke's buildings are tied into a larger campus utility system, and we will therefore focus on those aspects of building energy consumption that can be isolated and addressed through building-specific recommendations.

After taking this class, students will be able to:

- Explain trends in building energy use, the forces motivating building energy efficiency improvements, and best practices for green design
- Collect and analyze energy utility data, read architectural and related technical drawings, conduct basic energy audits, evaluate energy reduction measures, and present audit findings and recommendations to an actual client
- Apply building science fundamentals to predict energy needs and develop energy savings recommendations
- Explain how an institution like Duke manages energy supply and use and prioritizes energy conservation measures in its decision making
- Communicate with a variety of building industry professionals and appreciate how they approach problems related to their work

This course will take advantage of a unique opportunity. Duke is in the rare position of having a Facilities Management Department (FMD) that sees education as part of its mission. The campus will therefore provide a laboratory for student learning. Casey Collins, Director of Duke University's Utility and Energy Services, and Tyler Ellsworth, an engineer with FMD, have helped organize the class and will lead occasional class discussions, conduct "back of the house" campus tours, facilitate access to campus buildings and energy data, and serve as clients for student project work.

Course Format

The course will consist of discussions of the day's topics and material presented in class, campus building tours, and talks by invited industry speakers.

Prerequisites

This course does not have formal prerequisites. All students interested in the connection between energy use and the built environment are welcome.

Coursework and Grading

Your grade will be based on the following:

Assignments	40% (7 assignments)
Group Project	50%
Class Participation	10%

Assignments will consist of quantitative problem solving and short-answer questions. **You must complete each assignment individually; though you may discuss assignment questions with your colleagues, the work you submit must be your own (per the Duke Honor Code).** All assignments are due on a Thursday by 11:59 pm (except Assignment 1, which has a Tuesday deadline). Due dates follow, though note that *these submission deadlines are subject to change*.

Assignment	Due Date
1	02 Sep
2	11 Sep
3	18 Sep
4	25 Sep
5	09 Oct
6	23 Oct
7	30 Oct

The ***Group Project*** will provide an opportunity to apply everything you learn this semester in an evaluation of measures to reduce energy use in an existing campus building. The project will involve data collection and analysis, energy auditing, spreadsheet-based energy modeling, consideration of occupant behavior, identification of alternative measures, calculation of financial savings, and presentation of final recommendations (written and oral) to Duke's Facilities Management Division. See the project handout on Canvas for details.

Your ***class participation*** score will depend on attendance, contribution to class discussions, and evidence of having prepared for class. The more interactive the class is, the more we will all get out of it.

I will use the following rubric to translate your cumulative weighted score (percentage) into a final grade (e.g., a final score between 90.00 and 92.99 corresponds to an A-):

[99 to 100]	A+	[80 to 83)	B-
[93 to 99)	A	[77 to 80)	C+
[90 to 93)	A-	[73 to 77)	C
[87 to 90)	B+	[70 to 73)	C-
[83 to 87)	B	Below 70	F

Policy on Late Assignments

All assignments must be uploaded to Canvas by the posted deadline. Assignments handed in after the posted deadline will incur a 25-point penalty for each 24-hour period they are late. **Assignments submitted more than 3 days (72 hours) after the posted due date and time will not receive credit**. Please do not ask for exceptions for reasons other than serious illnesses and personal emergencies.

Readings

Readings are available on Canvas with each week's lesson, and we will not use a separate textbook. The schedule below also lists reading assignments, which you must complete prior to each day's class. I may also assign additional readings based on your interest in related topics. Your job is to read critically and use the factual basis we develop in class to reach your own conclusions about the issues we discuss.

Canvas

You will have complete access to our Canvas website if you are registered for the class. All course materials, including this syllabus, readings, materials from class, and assignments are available on Canvas.

Use of Generative AI

All work you submit for this class must be your own. The world of generative artificial intelligence (AI), however, has complicated what "your own" involves. Just as use of a calculator to solve math problems is not only acceptable but expected, AI is quickly finding its way into everyday use. The line between acceptable and unacceptable use is therefore blurry. At minimum, copying results from an AI session verbatim into an assignment is plagiarism and a violation of the Duke Community Standard and Nicholas School Honor Code that is subject to punishment for academic misconduct. Use of AI as a starting point (i.e., the equivalent of a Google search) on assignments is fine, though your submitted work must reflect significant original thought, problem solving, and effort on your part. Think of AI as one of your classmates: any use of a peer on an assignment that is improper (e.g., copying from another's work, having a buddy complete assignment questions for you) is also an improper use of AI.

Classroom Etiquette

Please arrive on time and refrain from checking email and social media, texting, and web browsing while we are together. These activities are more obvious than you might think, and I will not hesitate to cold call anyone who appears to be using their device for anything other than notetaking or researching the occasional discussion question. I will ask everyone to turn off and store all phones, laptops, and other devices during class if I feel that electronic media are becoming too much of a distraction.

My Expectations of You

This is your course. At minimum, I expect you to attend class and be an active participant, which, in turn, requires that you prepare for each class in advance and arrive having completed the readings. I also expect you to have an open mind, think critically, and use what we learn to make your own judgments.

In addition, if you have suggestions on how to improve the course, please let me know. Feedback received midstream is often more useful to you and me than end-of-term evaluations, and I am happy to make reasonable changes if a majority concurs.

What You Can Expect from Me

I am here to help you learn. I will do my best to understand and appreciate the diversity in your backgrounds, interests, and analytical strengths, and I have tried to design the course to accommodate these differences while providing opportunities to help you develop in new areas. Again, I appreciate feedback. I am available during my office hours if you have questions about the class (or life in general) and am happy to find mutually agreeable times outside of these windows to meet. Just let me know what works best for you.

Respect for Personal Views and Honest Analysis

Building energy supply and use are inseparable from our daily lives and lifestyle choices. Hence, some of the topics we will cover have a political and even personal subtext, and some of you may arrive with strong opinions about the past, present, and future of energy and all that it affects. My goal is to help you reason through the complexities of how we might balance conflicting societal goals that require more than technical problem solving or idealistic visions of how cultural change occurs. While I will respect the individual conclusions you reach, I ask that you *lead with evidence and analysis rather than opinion* and I will try to model this behavior in class. In short, let's strive to be honest brokers and respect differences in personal and cultural preferences. The fact that we come from many different places and backgrounds is an asset and I will draw on your experiences as a valued resource.

Beyond that, **I teach because I like spending time with students and helping them develop in their careers**. If you all looked, felt, and thought like me it wouldn't be nearly as much fun, and

I wouldn't learn nearly as much as I continue to do after many years in the classroom. I enjoy getting to know you as individuals and will do whatever I can to create a comfortable environment in which we can all be challenged and learn together.

Nicholas School Honor Code and the Duke Community Standard

All activities of Nicholas School students, including those of you in this course, are governed by the Duke Community Standard (https://students.duke.edu/get-assistance/community-standard/), which states:

"Duke University is a community dedicated to scholarship, leadership, and service and to the principles of honesty, fairness, respect, and accountability. Members of this community commit to reflect upon and uphold these principles in all academic and nonacademic endeavors, and to protect and promote a culture of integrity.

To uphold the Duke Community Standard:

- I will not lie, cheat, or steal in my academic endeavors;
- I will conduct myself honorably in all my endeavors; and
- I will act if the Standard is compromised."

You will need to attest to the Duke Community Standard with each assignment submission.

The Nicholas School Honor Code (https://nicholas.duke.edu/about/policies/nicholas-school-honor-code) describes implementation of the Duke Community Standard and its terms govern violations related to this class.

Zoom

This is an in-person class. That said, colds, the flu, Covid, and other illnesses will likely make the rounds. I will open a Zoom link only for those who are genuinely ill and cannot attend class in person. If you are sick, please let me know as soon as you can, and I will send you meeting information. Unfortunately, our classroom is not configured for hybrid class sessions, and you will be able to see whoever is standing in front of the classroom and view slides online but will not be able to see or hear others in the room. Note that some of our guest speakers may not consent to a live Zoom session or a recording of their presentations.

Schedule

This schedule below is subject to change, and I may modify it as we go along if extra time is needed (or desired!) for particular topics. I'll provide updates to the schedule in class and via email. The bibliography below provides full reading citations.

Week	Date	First Half (1:25 to 2:35)	Second Half (2:45 to 3:55)	Readings
1	27-Aug	Introduction to the class and energy supply and use at Duke	Building tour: Duke Chilled Water Plant #2	2019 Duke University Climate Action Plan Update (pages 1 to 32) Duke University Sustainability Strategic Plan *Optional if you are new to energy*: Net Zero Energy Design, Chapter 4 ("Energy")
2	3-Sep	Trends in building energy efficiency, design, and policy; Assignment 1 presentations	Building science fundamentals: Energy codes and standards, green building standards and rating systems	How to Decarbonize Every Building Everywhere — Just Not All at Once ASHRAE GreenGuide, Chapter 2 ("Green Rating Systems") Green Building Certification *Optional if you want an international perspective*: Global Status Report for Buildings and Construction 2024/2025, Chapter 3 ("Sustainable Buildings and Construction Policies")
3	10-Sep	Introduction to energy data management and building drawings	Building tour: Project building	Unlocking Energy Savings

Week	Date	First Half (1:25 to 2:35)	Second Half (2:45 to 3:55)	Readings
4	17-Sep	Building science fundamentals: Lighting	Building energy audits	Energy Audits and Improvements for Commercial Buildings, Chapter 5 ("Lighting") Daylight and Electric Illumination Updated Procedures for Commercial Building Energy Audits
5	24-Sep	Building science fundamentals: Thermal comfort	Building science fundamentals: Building enclosure (envelope) design	Thermal Comfort The Building Enclosure High Performance Glass
6	1-Oct	Building science fundamentals: Heating and cooling load calculations	Building science fundamentals: Humidity control	Thermal Control in Buildings Energy for Sustainability, Chapter 6 ("Energy Efficiency for Buildings") and Chapter 7 ("Solar Energy for Buildings Approach") Relative Humidity
7	8-Oct	Building science fundamentals: Active and passive systems	Guest speaker: Green building from an engineer's perspective	Passive House How Heat Pumps of the 1800s are Becoming the Technology of the Future

Week	Date	First Half (1:25 to 2:35)	Second Half (2:45 to 3:55)	Readings
8	15-Oct	Building science fundamentals: Energy modeling class exercise; Financial analysis	Guest speaker: Green building from a building commissioner's perspective	An Architect's Guide to Integrating Energy Modeling in the Design Process (especially pages 39 to 41 and Section 5) Building Commissioning *Optional if you are new to financial analysis*: Energy Audit of Building Systems, Chapter 3 ("Economic Analysis")
9	22-Oct	Energy at Duke: Energy lookback analysis; heating electrification; renewables on campus	Building tour: Project building onsite Q&A	*No reading*
10	29-Oct	Guest speaker: Green building from an architect's perspective	Assorted topics and discussion: Mass timber construction, embodied energy, water use	View Duda | Paine project portfolio at https://www.dudapaine.com/ Net Zero Energy Design, Chapter 3 ("Integrated Process") Sustainable Building Movement Embraces the Use of Mass Timber Construction Carbon Crackdown
11	5-Nov	Duke University Energy Conference (no class)	Duke University Energy Conference (no class)	*No reading*

Week	Date	First Half (1:25 to 2:35)	Second Half (2:45 to 3:55)	Readings
12	12-Nov	Master planning on campus: Guest speaker Adem Gusa, Director of Planning and Design, Duke FMD	Building tour: Campus architecture and infrastructure	Duke Illustrative Plan Update 2022 Duke Master Planning Principles Duke University Architectural Design Guidelines 2018
13	19-Nov	Project presentations	Project presentations; Course wrap-up	*No reading*

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