

**Course Syllabus**

**Spring 2021**

**ISEN 406 – Energy Efficiency & Sustainability Opportunities: Engineering, Design & Adoption  
Northwestern University**

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**Profile:** TBD

**Office Hours:** Tuesdays, 12:30 – 1:30 pm. Alternate days/times may be scheduled for Zoom.

**NU Faculty Sponsor:**

Prof. Brad Sageman, Earth and Planetary Sciences, Weinberg College of Arts & Sciences

**Class Room:** Most Tuesdays: On-campus, Tech LR2 ([map](#))

Most Thursdays: Online, Zoom. See the Class Outline, below, for details and exceptions.

**Canvas:** <https://canvas.northwestern.edu>

Canvas will be used to share course materials (including some required readings), submit assignments (mini-quizzes, case studies, and the final paper), and post grades.

**Zoom:** Zoom will be available in Canvas.

**Class Schedule:**

Tuesdays & Thursdays, 11 am – 12:30 pm, April 1 – June 3 (10 weeks)

The first class (online) is Thursday, April 1. The last class (on-campus) is Thursday, June 3.

**Course Synopsis:** This course will explore key concepts critical to the realization of energy efficiency (EE) within the built environment in the United States. Key themes include the roles of energy engineers and engineering tools in delivering EE; the characteristics of effective utility and corporate EE program design; and, the challenges and opportunities that influence EE adoption rates. Course content will provide broad exposure to a variety of topics critical to understanding EE in buildings. These topics include energy bills, energy usage and demand, energy audits, energy conservation measures (ECMs), local and state laws/codes, state and federal policies, utility incentives, consumer behavior, financial considerations, standards and certifications, and emerging trends/models. Although the course will

emphasize EE for commercial and industrial (C&I) buildings, it will introduce EE for residential buildings as well. Two field visits are planned to provide direct experience at an energy audit site and direct communication with local energy regulators.

**Course Goals:** Students will develop a broad foundation in the following:

- **Understanding Efficiency Opportunities and ECMs:** This course will outline key tools used to assess energy efficiency (EE) opportunities, such as energy audits and thermodynamic tools/methodology. In addition, students will become familiar with key energy conservation measures (ECMs) and technological solutions for EE. Students will learn how measures vary for residential or commercial and industrial (C&I) projects.
- **Learning Energy Efficiency Policies, Programs, and Laws:** Students will get an overview of the codes and standards, utility regulatory frameworks and government incentive programs that are important to improving energy efficiency. Content will include an overview of utility efficiency programs as well as independent standards and certifications relevant for driving energy efficiency.
- **Adoption of Efficiency & Managing Costs:** The class will learn how to interpret an energy bill and will understand the role of load shaping. The students will be exposed to program designs and critical steps to drive behavior and adoption of efficiency solutions. Codes, rate structures, and other tools used to drive uptake will be discussed.

**Prerequisites:**

This course will require students to apply general technical and quantitative competency, but there are no prerequisites.

**Required Readings:**

Readings outside of class are an integral part of this course. Students will be given both required and optional readings for each week. These readings are listed in the course outline further below. To prepare for and participate in each class, students are expected to complete the required readings in advance. Almost all readings are available freely online (hyperlinks are provided below) or will be provided by the instructor and available for download via Canvas. In addition to the readings freely available online, students will be expected to read several chapters from the following textbook: Martinez, Daniel M., et al. *Energy Efficiency: Concepts and Calculations*. Cambridge, MA: Elsevier, 2019.

**Guest Lectures:**

This course will include a series of guest lectures by professionals and stakeholders in the energy efficiency and sustainability industry. The dates of these guest lectures are indicated in the course outline further below. Guest lecturers provide fresh perspectives on class topics and additional examples of real-world experience.

**Field Visit:**

One field visit is planned and currently in development. More details about date, time, and location will be announced when they are available—likely the first day of class.

**Grading/Assessment Policy:**

Any questions regarding grades must be presented in writing within one week after the quiz, case study assignment, or final paper has been returned. The grading scale is fixed. Students concerned about the direction of their grade should not wait until the end of the quarter to address it. Grades will be assigned using the following scale:

<b>A</b>	93.333 to 100	<b>C</b>	73.333 to 76.666
<b>A-</b>	90.000 to 93.333	<b>C-</b>	70.000 to 73.333
<b>B+</b>	86.666 to 90.000	<b>D+</b>	66.666 to 70.000
<b>B</b>	83.333 to 86.666	<b>D</b>	63.333 to 66.666
<b>B-</b>	80.000 to 83.333	<b>D-</b>	60.000 to 63.333
<b>C+</b>	76.666 to 80.000	<b>F</b>	< 60.000

All work submitted for this course is expected to be the original work of the student submitting it. All suspected violations will be reported to the McCormick College of Engineering’s Dean’s Office in accordance with the NU Academic Integrity Policy.

In the event of extenuating circumstances, assignments may be accepted late. However, students must request and receive approval for the extension from the instructor prior to the original due date.

**Grading/Assessment Rubric:**

Grading will be based on the following rubric:

<b>Component</b>	<b>Weight</b>	<b>Description</b>	<b>Due Date</b>
Quizzes	10% (collectively)	Students will be given multiple quizzes based on content delivered during class and/or drawn from required readings. The quizzes may involve multiple choice questions, free response questions, and/or short essay questions. The dates of all quizzes are to be determined but will be announced in advance (i.e., there will be no pop quizzes).	Quiz 1 released after class April 15, due at 5 p.m. on April 19  Quiz 2 released after class May 6, due 5 p.m. on May 10
Case Study Assignments	40% (20% each)	Students will be given two case studies and asked to write responses. These assignments will require students to perform limited online research in addition to applying knowledge acquired in class and from readings. After analyzing the available data, students will answer specific questions when crafting their responses.  Each case study response should be 1,000 to 1,500 words in length,	Case Study 1 due before class Tuesday, May 4 (Week 6)  Case Study 2

		excluding tables, graphs, and figures. Additional instructions will be included with the case study assignments.  Case study responses will be graded on the basis of: 1) depth of insight; 2) accuracy and attention to detail; 3) application of acquired knowledge.	due before class Tuesday, June 1 (Week 10)
Final Paper	40% (10% for abstract, 30% for paper)	Students will be assigned a hypothetical building scenario and asked to develop energy efficiency recommendations. This assignment may require students to perform limited online research in addition to applying knowledge acquired in class and from readings.  The paper should be 2,500 to 3,000 words in length, excluding tables, graphs, and figures. Additional instructions will be included with the final paper assignment.  The final paper will be graded on the basis of: 1) the extent to which it demonstrates the understanding and application of diverse course concepts; 2) the quality and completeness of the proposed recommendations.	Abstract due before class Tuesday, May 18 (Week 8)  Paper due before class Thursday, June 3 (Week 10)
Effort and Attendance	10%	The instructor will assess each student's overall preparation for class, and participation in class, throughout the 10-week session. Students are encouraged to attend every class, engage during class, and complete readings outside of class.	Ongoing

**Class Outline:**

The course will adhere as much as possible to the following class schedule:

Week/Topic	Description	Assignments & Readings
<b>WEEK 1</b>  <b>Overview of Energy Efficiency and Current State of the Market</b>  <b>Thursday, April 1</b> Online	<ul style="list-style-type: none"> <li>Course introduction</li> <li>History of EE in the U.S.</li> <li>Current state of EE in the U.S.</li> <li>Scale of the domestic opportunity</li> <li>Efficiency vs. conservation</li> <li>Existing buildings vs. new construction</li> <li>EE marketplace stakeholders</li> </ul>	<b>Required Readings:</b> U.S. DOE. <i>Quadrennial Technology Review 2015</i> . <b>ONLY Chapter 1 (Energy Challenges)</b> . Report. <a href="#">Link</a> .  Electric Power Research Institute (EPRI). <i>U.S. Energy Efficiency Potential Through 2040: Summary Report</i> . December 2018. Report. <a href="#">Link</a> .  Lovins, Amory. "How Big is the Energy Efficiency Resource?" <i>Environmental Research Letters</i> , Volume 13, Number 9, 2018. Article. <a href="#">Link</a> .  <b>Optional Readings:</b> U.S. DOE. "U.S. Energy Efficiency Potential Maps." Website. <a href="#">Link</a> .  Granholm, Jennifer. "Secretary Granholm's Message to America." February 2021. Video. <a href="#">Link</a> .  Lovins, Amory. <i>Soft Energy Paths: Towards a Durable Peace</i> . New York: Harper & Row, 1979.
<b>WEEK 2</b>  <b>Understanding the</b>	<ul style="list-style-type: none"> <li>Overview of U.S. electricity grid</li> <li>Independent system</li> </ul>	<b>CASE STUDY 1:</b> Introduced during class on Tuesday, April 6.  <b>Required Readings:</b> U.S. EIA. "How Electricity is Delivered to Consumers." October



Week/Topic	Description	Assignments & Readings
<p><b>Power Grid, Utility Rate Structures, and Energy Bills</b></p> <p><b>Tuesday, April 6</b> On-Campus</p> <p><b>Thursday, April 8</b> Online</p> <p><b>Guest Lecturer:</b> Energy Management Consultant</p>	<p>operators (ISOs)</p> <ul style="list-style-type: none"> <li>• Regional transmission organizations (RTOs)</li> <li>• Federal Energy Regulatory Commission (FERC)</li> <li>• North American Electric Reliability Corporation (NERC)</li> <li>• Investor-owned utilities (IOUs)</li> <li>• Publicly-owned utilities (POUs)</li> <li>• Electric cooperatives (coops)</li> <li>• Deregulated energy markets</li> <li>• Utility rate classes and common rate structures</li> <li>• Introduction to utility tariffs</li> <li>• Introduction to energy bills</li> <li>• Peak demand</li> <li>• Power factor</li> <li>• Time-of-use (TOU) pricing</li> <li>• Net metering</li> </ul>	<p>2020. Website. <a href="#">Link</a>.</p> <p>U.S. EIA. "Investor-Owned Utilities Served 72% of U.S. Electricity Customers in 2017." August 2019. Website. <a href="#">Link</a>.</p> <p>National Rural Electric Cooperative Association (NRECA). "America's Electric Cooperatives Facts and Figures." January 2021. <a href="#">Link</a>.</p> <p>PJM. "PJM At A Glance" Factsheet. <a href="#">Link</a>.</p> <p>NRDC. Sustainable FERC Project. "Navigating PJM." Article. <a href="#">Link</a>.</p> <p>ComEd. "Current Rates and Tariffs." <b>Students do not need to read all pages or docs linked here, but they should read the rate and rider titles, and perhaps open and skim a few examples.</b> Website. <a href="#">Link</a>.</p> <p>NREL. U.S. Utility Rate Database. <b>Students should spend a few minutes experimenting with this database to become familiar with it.</b> Website. <a href="#">Link</a>.</p> <p><b>Optional Readings:</b></p> <p>U.S. EIA. "About 60% of the U.S. Electric Power Supply is Managed by RTOs." April 2011. Website. <a href="#">Link</a>.</p> <p>Edison Electric Institute (EEI). "America's Electric Companies Are #Committed2Clean: Electric Power Industry Outlook." February 2021. Presentation. <a href="#">Link</a>.</p> <p>National Rural Electric Cooperative Association (NRECA). "Electric Cooperatives Light Up America." Map Visualization. <a href="#">Link</a>.</p> <p>Edison Electric Institute (EEI). "EEI U.S. Member Company Service Territories." February 2021. Map. <a href="#">Link</a>.</p> <p>Cardwell, Diane. "Cities Weigh Taking Over from Private Utilities." <i>The New York Times</i>, March 13, 2013. Article. <a href="#">Link</a>.</p> <p>Fox-Penner, Peter. <i>Power after Carbon: Building a Clean, Resilient Grid</i>. Cambridge, MA: Harvard University Press, 2020.</p>
<p><b>WEEK 3</b></p> <p><b>Energy Benchmarking, Energy Audits, and Other Engineering Tools</b></p> <p><b>Tuesday, April 13</b> On-Campus</p>	<ul style="list-style-type: none"> <li>• Energy benchmarking (ENERGY STAR, various SaaS)</li> <li>• Introduction to energy audits</li> <li>• Commercial energy auditor accreditations (CEA - AEE, BEAP - ASHRAE, EMP - EMA, CEM - AEE)</li> <li>• Residential energy auditor accreditations (HEP EA - BPI, HEA Provider - RESNET)</li> <li>• Examples of commercial</li> </ul>	<p><b>CASE STUDY 2:</b> Introduced during class on Tuesday, April 13.</p> <p><b>Required Readings:</b></p> <p>U.S. DOE. "Building Energy Use Benchmarking." Website. <a href="#">Link</a>.</p> <p>U.S. DOE and U.S. EPA. "ENERGY STAR Portfolio Manager." <b>Students should skim the home page and major pages linked from the menu at the left side.</b> Website. <a href="#">Link</a>.</p> <p>PNNL. <i>A Guide to Energy Audits</i>. September 2011. Report. <a href="#">Link</a>.</p> <p>U.S. DOE. Energy Saver. "Professional Home Energy Audits."</p>



Week/Topic	Description	Assignments & Readings
<p><b>Thursday, April 15</b> Online TA Lecture: Amir Haghighat</p>	<p>energy audit protocols (IEA-EBC, ASHRAE)</p> <ul style="list-style-type: none"> <li>• Evolution in sale and execution of energy audits</li> <li>• Building systems targeted for EE (envelope, lighting, HVAC, controls, plug loads, etc.)</li> <li>• Building envelope basics</li> <li>• R-value and U-value</li> <li>• Lighting watts and lumens</li> <li>• Evolution of lighting from incandescent to CFL to LED</li> <li>• Commercial HVAC system basics</li> <li>• Controls or building automation system (BAS) basics</li> <li>• Blower door tests</li> <li>• Infrared thermography</li> <li>• Technological advancements in performing audits (AI, apps, tablets, etc.)</li> </ul>	<p>Website. <a href="#">Link</a>.</p> <p>Lucchi, Elena. "Applications of the Infrared Thermography in the Energy Audit of Buildings: A Review." <i>Renewable and Sustainable Energy Reviews</i>, Volume 82, Part 3, February 2018. Article. <a href="#">Link</a>.</p> <p><b>Optional Readings:</b> Association of Energy Engineers (AEE). "Certified Energy Auditor (CEA)." Factsheet. <a href="#">Link</a>.</p> <p>ASHRAE. "Building Energy Assessment Professional (BEAP)." Website. <a href="#">Link</a>.</p> <p>Energy Management Association (EMA). "Energy Management Professional (EMP)." Website. <a href="#">Link</a>.</p> <p>Association of Energy Engineers (AEE). "Certified Energy Manager (CEM)." Factsheet. <a href="#">Link</a>.</p> <p>Building Performance Institute (BPI). "Home Energy Professional Energy Auditor (HEP EA)." Website. <a href="#">Link</a>.</p> <p>Residential Energy Services Network (RESNET). "Home Energy Audit Providers." Website. <a href="#">Link</a>.</p>
<p><b>WEEK 4</b></p> <p><b>Introduction to Energy Efficiency Approaches and Solutions</b></p> <p><b>Tuesday, April 20</b> On-Campus</p> <p><b>Thursday, April 22</b> On-Campus TA Lecture: Amir Haghighat</p>	<ul style="list-style-type: none"> <li>• Retro-commissioning (RCx)</li> <li>• Data analytics (roles of big data and real-time data)</li> <li>• Monitoring-based commissioning (MBCx)</li> <li>• Differences between RCx/MBCx and traditional audits</li> <li>• Introduction to ASHRAE Level I, II, and III audit classifications</li> <li>• Introduction to energy conservation measures (ECMs)</li> <li>• Low-cost ECMs vs. cap-ex ECMs</li> <li>• Financial impact of ECMs (rate design, fuel cost, equipment life, labor, etc.)</li> <li>• Environmental impact of ECMs (decarbonization, resource intensity, indoor air quality, etc.)</li> <li>• Elements of a high-quality energy audit report</li> </ul>	<p><b>FINAL PAPER:</b> Introduced during class on Tuesday, April 20.</p> <p><b>Required Readings:</b> U.S. DOE and U.S. EPA. <i>ENERGY STAR Building Upgrade Manual</i>. <b>ONLY Chapter 5 (Retrocommissioning)</b>. <a href="#">Link</a>.</p> <p>LBNL. "Monitoring-Based Commissioning Plan Template." June 2017. <a href="#">Link</a>.</p> <p>Martinez, Daniel M., et al. <i>Energy Efficiency: Concepts and Calculations</i>. <b>ONLY Chapter 8 (Residential and Commercial Sector Energy Efficiency)</b>. Cambridge, MA: Elsevier, 2019.</p> <p>American Council for an Energy-Efficient Economy (ACEEE). <i>Halfway There: Energy Efficiency Can Cut Energy Use and Greenhouse Gas Emissions in Half by 2050</i>. September 2019. <a href="#">Link</a>. (Note: Name and Email Required for Download)</p> <p><b>Optional Readings:</b> U.S. DOE. <i>Quadrennial Technology Review 2015</i>. <b>ONLY Chapter 5 (Increasing Efficiency of Building Systems and Technologies)</b>. Report. <a href="#">Link</a>.</p> <p>U.S. DOE. Energy Saver. "Do-It-Yourself Home Energy Audits." Website. <a href="#">Link</a>.</p>
<p><b>WEEK 5</b></p>	<ul style="list-style-type: none"> <li>• Opportunities in residential EE</li> </ul>	<p><b>Required Readings:</b></p>



Week/Topic	Description	Assignments & Readings
<p><b>Exploring Residential EE and Common ECMs</b></p> <p><b>Tuesday, April 27</b> On-Campus</p> <p><b>Thursday, April 29</b> Online</p> <p><b>Guest Lecturer:</b> Residential EE Consultant</p>	<ul style="list-style-type: none"> <li>• Common residential ECMs (weatherization, sealing, insulation, roofs, light bulbs, refrigerator/freezer, air conditioner, furnace)</li> <li>• Overview of residential EE costs and benefits</li> <li>• Utility residential incentive programs</li> <li>• Government rebates, subsidies, and programs for homes</li> <li>• ENERGY STAR for homes</li> </ul>	<p>U.S. EIA. "Energy Use in Homes." August 2020. Website. <a href="#">Link</a>.</p> <p>U.S. DOE and U.S. EPA. "Energy Savings at Home." <b>Students should skim the home page and click some of the links to become familiar with this resource.</b> Website. <a href="#">Link</a>.</p> <p>Building Performance Institute (BPI). "Top 10 Questions to Compare Home Performance Contractors." Checklist. <a href="#">Link</a>.</p> <p>Ask This Old House. "How to Perform a Whole-House Energy Audit." Video. <a href="#">Link</a>.</p> <p>ComEd. "Ways to Save: For Your Home." <b>Students do not need to read all pages or docs linked here, but they should skim the contents.</b> Website. <a href="#">Link</a>.</p> <p>U.S. DOE. "Challenges and Opportunities to Achieve 50% Energy Savings in Homes." <b>ONLY Executive Summary.</b> July 2011. <a href="#">Link</a>.</p> <p><b>Optional Readings:</b> Building Performance Institute (BPI). "Homeowners Site." <b>Students should skim the main pages linked from the menu at the top of this page.</b> Website. <a href="#">Link</a>.</p> <p>Residential Energy Services Network (RESNET). "Home Energy Audit Program Guidelines." August 2020. <a href="#">Link</a>.</p>
<p><b>WEEK 6</b></p> <p><b>Exploring Commercial and Industrial EE and Common ECMs</b></p> <p><b>Tuesday, May 4</b> On-Campus</p> <p><b>Thursday, May 6</b> Online</p> <p><b>Guest Lecturer:</b> Corporate Energy Manager</p>	<ul style="list-style-type: none"> <li>• Opportunities in C&amp;I EE</li> <li>• Common C&amp;I ECMs (high-efficiency HVAC, variable speed drives, LED lighting, BAS upgrades, controls optimization)</li> <li>• Whole-building retrofits (deep retrofits)</li> <li>• Overview of C&amp;I EE costs and benefits</li> <li>• Replacement vs. retrofit and deferred maintenance</li> <li>• Utility C&amp;I incentive programs</li> <li>• Government rebates, subsidies, and programs for C&amp;I buildings</li> <li>• ENERGY STAR for C&amp;I buildings</li> </ul>	<p><b>CASE STUDY 1:</b> Due before class on Tuesday, May 4.</p> <p><b>Required Readings:</b> U.S. EIA. "Energy Use in Commercial Buildings." September 2018. Website. <a href="#">Link</a>.</p> <p>ASHRAE. "Standard for Commercial Building Energy Audits: ANSI/ASHRAE/ACCA Standard 211-2018." Industry Standard. 2018. <b>PDF will be available for download through Canvas.</b></p> <p>ComEd. "Ways to Save: For Your Business." <b>Students do not need to read all pages or docs linked here, but they should skim the contents.</b> Website. <a href="#">Link</a>.</p>
<p><b>WEEK 7</b></p> <p><b>Designing EE Solutions: Consumer Behavior and ECM</b></p>	<ul style="list-style-type: none"> <li>• Challenges engaging residential customers in EE</li> <li>• Challenges engaging C&amp;I customers in EE</li> <li>• Non-financial factors affecting adoption of ECMs</li> </ul>	<p><b>Required Readings:</b> Boston Consulting Group. "The Energy Efficiency Opportunity." May 2014. Article. <a href="#">Link</a>.</p> <p>Grueneich, Dian M. "The Next Level of Energy Efficiency: The Five Challenges Ahead." <i>The Electricity Journal</i>, Volume 28,</p>

Week/Topic	Description	Assignments & Readings
<p><b>Adoption</b></p> <p><b>Tuesday, May 11</b> On-campus</p> <p><b>Thursday, May 13</b> Online</p> <p><b>Guest Lecturer:</b> Corporate Energy Manager</p>	<ul style="list-style-type: none"> <li>• Load shaping, load shifting, and demand response (behavioral, automated)</li> <li>• Responses to benchmarking and disclosure laws</li> </ul>	<p>Issue 7, 2015. Article. <a href="#">Link</a>.</p> <p>Palmer, Karen, et al. Resources for the Future (RFF). "Can Benchmarking and Disclosure Laws Provide Incentives for Energy Efficiency Improvements in Buildings?" March 2015. Discussion Paper. <a href="#">Link</a>.</p> <p><b>Optional Readings:</b> American Council for an Energy-Efficient Economy (ACEEE). "Engaging Small and Medium Sized Businesses in Behavior Change through a Multifaceted Marketing Campaign." 2016. Article. <a href="#">Link</a>.</p>
<p><b>WEEK 8</b></p> <p><b>Designing EE Solutions: Prioritization Principles</b></p> <p><b>Tuesday, May 18</b> On-campus</p> <p><b>Thursday, May 20</b> Online</p>	<ul style="list-style-type: none"> <li>• Decarbonization</li> <li>• Resource intensity</li> <li>• Fuel costs and options</li> <li>• Utility rate structures</li> <li>• Operating &amp; maintenance costs</li> <li>• Equipment useful life</li> <li>• Landlord-tenant split incentives</li> </ul>	<p><b>FINAL PAPER ABSTRACT:</b> Due before class on Tuesday, May 18.</p> <p><b>Required Readings:</b> Martinez, Daniel M., et al. <i>Energy Efficiency: Concepts and Calculations</i>. <b>ONLY Chapter 9, Sections 9.1-9.5 and 9.8 (Policy Instruments to Foster Energy Efficiency)</b>. Cambridge, MA: Elsevier, 2019.</p> <p>Better Buildings. U.S. DOE. "Benchmarking and Transparency: Resources for State and Local Leaders." January 2019. Report. <a href="#">Link</a>.</p> <p>LBNL. "Evaluation of U.S. Building Energy Benchmarking and Transparency Programs." April 2017. <b>Students do not need to read all pages or sections but should skim the contents.</b> Report. <a href="#">Link</a>.</p> <p>NC Clean Energy Technology Center. DSIRE: Database of State Incentives for Renewables &amp; Efficiency. <b>Students should spend a few minutes experimenting with this database to become familiar with it.</b> Website. <a href="#">Link</a>.</p>
<p><b>WEEK 9</b></p> <p><b>Local, State, and Federal EE Policy Considerations</b></p> <p><b>Tuesday, May 25</b> On-campus</p> <p><b>Thursday, May 27</b> Online</p> <p><b>Guest Lecturer:</b> Public Policy Specialist</p>	<ul style="list-style-type: none"> <li>• Examples of local policies</li> <li>• Examples of state policies</li> <li>• Federal policies</li> <li>• ENERGY STAR certification</li> <li>• LEED certification</li> <li>• Chicago's building energy benchmarking ordinance</li> </ul>	<p><b>Required Readings:</b> American Council for an Energy-Efficient Economy (ACEEE). "2020 State Energy Efficiency Scorecard." <b>ONLY Executive Summary, Chapter 1 (Introduction, Methodology, and Results), and Chapter 4 (Building Energy Efficiency Policies)</b>. Report. <a href="#">Link</a>. (Note: Name and Email Required for Download)</p> <p>American Council for an Energy-Efficient Economy (ACEEE). "2020 City Clean Energy Scorecard." <b>ONLY Executive Summary, Chapter 4 (Buildings Policies), and Chapter 5 (Energy and Water Utilities)</b>. Report. <a href="#">Link</a>. (Note: Name and Email Required for Download)</p> <p>U.S. DOE. "About the Federal Energy Management Program." Website. <a href="#">Link</a>.</p> <p>U.S. DOE. "Facility Energy Efficiency: Federal Laws and Requirements Search." Website. <a href="#">Link</a>.</p> <p>U.S. EPA and U.S. DOE. "Ten Reasons to Pursue ENERGY STAR</p>



Week/Topic	Description	Assignments & Readings
		<p>Certification.” Website. <a href="#">Link</a>.</p> <p>City of Chicago. <i>Chicago Energy Benchmarking Report</i>. 2018. <b>Students do not need to read this entire report, but they should skim the contents.</b> <a href="#">Link</a>.</p> <p>City of Chicago. “Chicago Energy Rating System.” 2020. Website. <a href="#">Link</a>.</p> <p><b>Optional Readings:</b>            U.S. EPA and U.S. DOE. “ENERGY STAR Certification for Your Building.” Website. <a href="#">Link</a>.</p> <p>U.S. Green Building Council. “LEED Certification for Existing Buildings and Spaces.” Website. <a href="#">Link</a>.</p> <p>U.S. Green Building Council. LEED v4.1 O&amp;M Beta Guide. <b>ONLY Page 4 (Welcome), Pages 5-6 (Scorecard), and Pages 36-50 (EA Prerequisites and Credits).</b> Industry Standard. <a href="#">Link</a>.</p> <p>U.S. EIA. “Many States Have Adopted Policies to Encourage Energy Efficiency.” August 2017. <a href="#">Link</a>.</p> <p>American Council for an Energy-Efficient Economy (ACEEE). State and Local Policy Database. <b>Students should spend a few minutes experimenting with this database to become familiar with it.</b> <a href="#">Link</a>.</p>
<p><b>WEEK 10</b></p> <p><b>Innovation in the Marketplace and the Future of EE</b></p> <p><b>Tuesday, June 1</b> On-campus</p> <p><b>Thursday, June 3</b> On-campus</p>	<ul style="list-style-type: none"> <li>• Net-zero buildings</li> <li>• Smart, intelligent, or grid-interactive efficient buildings</li> <li>• Integration with electric vehicles (EVs) and distributed energy resources (DER)</li> <li>• Emerging “Utility of the Future” paradigm</li> <li>• Financing innovations (e.g., public-private partnerships, PACE model)</li> <li>• Program design, marketing, and delivery innovations</li> </ul>	<p><b>CASE STUDY 2:</b> Due before class on Tuesday, June 1.</p> <p><b>FINAL PAPER:</b> Due before class on Thursday, June 3.</p> <p><b>Required Readings:</b>            U.S. DOE. “Zero Energy Buildings.” Website. <a href="#">Link</a>.</p> <p>California Public Utilities Commission. “It All Adds up to Zero: California’s Zero Net Energy Future.” October 2017. Presentation. <b>PDF will be available for download through Canvas.</b></p> <p>U.S. DOE. “Grid-Interactive Efficient Buildings.” April 2019. Factsheet. <a href="#">Link</a>.</p> <p>Rocky Mountain Institute (RMI) and New Buildings Institute (NBI). “The Value of Grid-Interactive Buildings to Building Owners.” Workshop Summary. November 2019. <a href="#">Link</a>.</p> <p>MIT Energy Initiative. <i>The Utility of the Future</i>. <b>ONLY Executive Summary</b>. 2016. Report. <a href="#">Link</a>.</p> <p>U.S. DOE. “Property Assessed Clean Energy Programs.” Website. <a href="#">Link</a>.</p> <p><b>Optional Readings:</b>            Langevin, Jared. LBNL. “Grid-Interactive Efficient Buildings.” ASHRAE Virtual Conference, 2020. Video. <a href="#">Link</a>.</p> <p>Schneider Electric. “The Power of Public-Private Partnerships</p>



Week/Topic	Description	Assignments & Readings
		for Energy & Infrastructure.” Blog Post and Video. <a href="#">Link</a> .

**Statement on Winter 2021 COVID-19 Classroom Requirements:**

Students, faculty, and staff must comply with University expectations regarding appropriate classroom behavior, including those outlined below and in the [COVID-19 Code of Conduct](#). With respect to classroom procedures, this includes:

- Students, faculty, and staff are required to wear a face covering in all public and shared environments on campus, including during class sessions when others are present.
  - *Disposable face masks will be available at identified building entrances in all campus buildings.*
  - *Clear face coverings may be worn to improve ability to read lips; if an accommodation is needed, please contact [Accessible NU](#) (students) or [Office of Equity](#) (faculty).*
  - *Face shields are no longer allowed as an alternative to a face mask, per guidance from the CDC and Northwestern Medicine. This includes instructional spaces regardless of social distancing.*
- Students, faculty, and staff are expected to observe the rules of social distancing, which require that you are no closer than six feet from other individuals.
- No food is allowed inside classrooms. Drinks are permitted, but please keep your face covering on and use a straw.
- Chairs and tables in classrooms are set to maintain a six-foot distance between individuals. Do not move chairs from their place in the room.
- There will be assigned seating in every class. Instructors may be asked to provide seating information to aid in contact tracing if a student tests positive for COVID-19.
- Class dismissals will start with the seat/row closest to the exit door and be managed by the instructor so as to minimize congestion near the exit.
- Students and faculty will allow those occupying rooms to fully exit before they enter the room.
- Faculty, students, staff and visitors are expected to use the daily symptom check web app for daily health monitoring on days they come to campus.
- As noted below, ALL graduate students must receive a negative test during Wildcat Wellness and before starting in-person classes on January 19. Throughout the semester we expect MSES students to be tested weekly or bi-weekly. Please abide by the email reminders you receive from the testing center.
- The University will again hold a Wildcat Wellness period from Jan 4 through January 17. During this time ALL graduate students must be tested for COVID-19 and ALL classes will be held remotely.

In the event that a student fails to comply with the [COVID-19 Code of Conduct](#) or other University expectations related to COVID-19, the instructor may ask the student to leave the class. The instructor is asked to report the incident to the Office of Community Standards for additional follow-up.

It is also the policy of the MSES Program that all lectures will be recorded and offered in a synchronous, hybrid format. In Winter Quarter 2021 this means that students are expected to attend class in-person on Mondays and Tuesdays and that class will be held completely remote on Wednesdays and Thursdays. On in-person days there will always be a synchronous Zoom option for any students that feel ill or are uncomfortable coming to class. If the professor needs to alter this schedule, they will aim to announce the changes at least 24 hours in advance.

**Class Recording:**

This class or portions of this class will be recorded by the instructor for educational purpose and available to the class during the quarter. Your instructor will communicate how you can access the recordings. Portions of the course that contain images, questions or commentary/discussion by students will be edited out of any recordings that are saved beyond the current term.

Unauthorized student recording of classroom or other academic activities (including advising sessions or office hours) is prohibited. Unauthorized recording is unethical and may also be a violation of University policy and state law. Students requesting the use of assistive technology as an accommodation should contact [AccessibleNU](#). Unauthorized use of classroom recordings – including distributing or posting them – is also prohibited. Under the University’s [Copyright Policy](#), faculty own the copyright to instructional materials – including those resources created specifically for the purposes of instruction, such as syllabi, lectures and lecture notes, and presentations. Students cannot copy, reproduce, display, or distribute these materials. Students who engage in unauthorized recording, unauthorized use of a recording, or unauthorized distribution of instructional materials will be referred to the appropriate University office for follow-up.

**Expectations for Class Participation:**

Being prepared for class is about more than just showing up, it’s also about making sure you’ve completed the readings, homework, etc. so that you are able to make thoughtful contributions during class. Sitting silently and/or being unprepared can damage your participation grade. When in a virtual class, we expect students to keep their camera and mute on as much as possible. When in the classroom, we expect students to keep their phones off and put away.

**Academic Integrity:**

Academic integrity is taken very seriously at Northwestern. Students are responsible for reading and understanding Northwestern’s Academic Integrity policies. All suspected violations will be reported to the McCormick College of Engineering’s Dean’s Office. These include cheating, plagiarism, fabrication, unfair advantage, unauthorized collaboration, and aiding and abetting of academic dishonesty. Students found in violation of academic integrity may receive a zero on the assignment or a failing grade for the course and may be suspended or permanently expelled from the University. See [Academic Integrity: A Basic Guide](#) for more information.

**Accessibility Statement:**

Northwestern University is committed to providing the most accessible learning environment as possible for students with disabilities. Should you anticipate or experience disability-related barriers in the academic setting, please contact AccessibleNU to move forward with the university’s established accommodation process (e: [accessiblenu@northwestern.edu](mailto:accessiblenu@northwestern.edu); p: 847-467-5530). If you already have established accommodations with AccessibleNU, please let me know as soon as possible, preferably

within the first two weeks of the term, so we can work together to implement your disability accommodations. Disability information, including academic accommodations, is confidential under the Family Educational Rights and Privacy Act.

**Illness and Medical Leave of Absence:**

Review the University's [policy](#) on missing academic work due to illness. Your instructor cannot waive an assignment missed due to illness unless the illness can be verified (e.g., by University Health Services or other licensed health professionals).

**Discrimination and Sexual Harassment:**

Northwestern's Policies on Discrimination, Harassment, and Sexual Harassment apply to all members of the University community, including students, staff, faculty, and third parties. Any student, staff, faculty member, or third party who believes that they have been discriminated against or harassed on the basis of their race, color, religion, national origin, sex, sexual orientation, gender identity, gender expression, pregnancy, parental status, marital status, age, disability, citizenship, veteran status, genetic information or any other classification protected by law, should contact the Office of Equity at (847) 467- 6571. Additional information about the University's discrimination and harassment policies, including the campus resources available to assist individuals with discrimination or harassment concerns, is available online on the [Office of Equity Website](#). Students, staff, and faculty who report harassment, discrimination, or sexual misconduct are also protected under the [University's Policy on Non-Retaliation](#).

**Sexual Misconduct and Reporting:**

Northwestern University is committed to fostering an environment where students are safe and free from sexual misconduct. [Confidential resources](#) are available to those who have experienced sexual misconduct. Faculty and instructors are not confidential resources and are required to report incidents of sexual misconduct, whether discussed in your assignments or in person, to the Office of Equity, which can provide information about resources and options. We encourage students who have experienced sexual misconduct to talk with someone to get support. For more information, including how to request interim protective measures and academic accommodations or file a complaint, see the [Get Help page](#).

**Other Resources:**

Students can find useful resources for safety and security, academic support, and mental and physical health and well-being at the [NUhelp website](#).