CEE 107R/207R: E^3: Extreme Energy Efficiency
3–5 Units

Spring Quarter 2023
4/5/23 – 6/7/23

Class meetings: Wednesdays, 1:30PM - 4:20PM PT for all students
Discussion sections: Wednesdays, 5:30PM - 6:20PM PT for 4–5-unit options
Location: Y2E2, room 292A

Instructors:
Dr. Amory B. Lovins, https://rmi.org/people/amory-lovins/
and Dr. Joel N. Swisher PE, jswisher@stanford.edu swishej3@wwu.edu

Office hours:

Tuesdays 3:30–5:30 PM, Y2E2, room 393
Fridays 1:30–3:30 PM and by arrangement, remote via Zoom
Office hours signup link in "Course Information" module on Canvas

Faculty Support:

Dr. Diana Gragg, Managing Director, Explore Energy, moongdes@stanford.edu

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Course Description

This course will investigate integrative design, revealing and exploiting connections between parts of a system to achieve far more than the sum of their individual benefits. To achieve radical energy and resource efficiency, integrative design artfully chooses, combines, sequences, and times *fewer*, *simpler* technologies. This achieves far greater savings at lower cost, and creates *increasing* returns rather than *diminishing* returns. Integrative design's techniques, principles, and modes of thinking can offer levels of energy and resource efficiency far greater than generally expected or achieved in the mobility, buildings, industrial, and electricity sectors. Integrative design offers impressive advances in profitable climate protection, global equity and security, good livelihoods, and health.

The emphasis of the course will be on real-world implementation of these techniques and their diverse, often disruptive implications. Students will learn this innovative approach to design through a combination of lectures, workshops, problem-solving sessions, and presentations from Rocky Mountain Institute's cofounder Amory Lovins and his colleagues. They have developed a unique suite of design techniques and principles that apply whole-systems thinking to achieve extreme—even order-of-magnitude higher—energy and resource efficiency. This approach to optimizing the whole system for multiple benefits, rather than isolated components for single benefits, has yielded enormous energy savings, better performance, and lower capital cost across diverse engineering disciplines and applications.

This course includes a mix of live keynote lectures, guest lectures, interactive Puzzlers, and exercises synthesizing integrative design. Before each class on Wednesday, students are expected to complete the readings, watch the pre-recorded lecture (if applicable), and write their journal entry. Each class will begin with reflection and inquiry with Amory Lovins and Joel Swisher based on your journal entries. The remainder, and majority, of class time will be for interactive small-group Puzzlers and/or exercises followed by presentations and group discussions.

Prerequisite:

Completion of one of the following courses or their equivalent: CEE 107A/207A/, Earthsys 103, CEE 107S/ CEE 207S, CEE 176A, CEE 176B; or instructor permission. Stanford students from all disciplines and of all levels are eligible to participate. This topic requires imaginative, whole-systems thinking, and the class will benefit from the perspectives of students from all backgrounds and with a wide range of interests. In turn, the skills acquired will prove useful in diverse disciplines and applications, ranging across and far beyond engineering.

Description of RMI (Rocky Mountain Institute)

RMI (known until 2021 as Rocky Mountain Institute) is an independent, nonprofit, entrepreneurial think-do-and-scale tank that transforms the global energy system to secure a clean, prosperous, zero-carbon future for all. Amory Lovins cofounded RMI in 1982 and continues to collaborate in its unusual work concurrent with his half-time Stanford engagements. RMI engages businesses, communities, institutions, and entrepreneurs to speed the adoption of market-based solutions that cost-effectively shift from fossil fuels to efficiency and renewables. The organization's 600+ staff work in Basalt and Boulder, Colorado, New York City,Washington DC, Oakland CA, Beijing, Delhi, and other areas from East Asia to sub-Saharan Africa to the Caribbean.

RMI has a 40-year record of fundamental innovation in energy efficiency and renewables spanning all sectors and most applications. Its recent international accomplishments include co-leading *Reinventing Fire: China* (a roadmap for radical resource efficiency and economic growth that strongly informed China's 13th Five Year Plan) and *India Leaps Ahead* (an electric and IT-driven reframing of personal mobility for the Government of India), and helping Rwanda design a rise in electrification from 25% to 75% at $1 billion lower cost (saving $20 million a year immediately). In the U.S., RMI is scaling up major efficiency gains in buildings, testing new mobility models, slashing solar power costs, and helping create the next electricity industry. To learn more about RMI's wide-ranging work, please visit www.rmi.org, updated frequently to reflect the Institute's current projects and perspectives.

Course objectives for CEE 107R/207R are:

- ✓ To engage students with integrative design—the problem-solving design practice developed by RMI to deliver real-world examples of profitable resource efficiency
- ✓ To teach optimization of whole systems to capture multiple benefits and increasing returns from single expenditures
- ✓ To apply consistent methods and processes, cross-pollinated across many design disciplines, while moving briskly through a wide range of design challenges
- ✓ To develop critical thinking skills, cultivate "beginner's mind," and apply newly learned concepts in Hackathon-like workshops and small-group exercises with different topics each week, thus building practical skills in integrative design
- ✓ To promote networking and collaboration among Stanford students with shared interests across disciplines, and to connect them with the instructors and their networks
- ✓ To promote networking and collaboration among Stanford students with shared interests across different disciplines, and to connect them with the instructors and their networks

Upon completion of CEE 107R/207R, students should be able to:

- Innovatively think about and apply advanced energy efficiency
- Integrate integrative design approaches into projects across a variety of disciplines, in both future academic studies and career work
- Raise challenges and address opportunities at the nexus of engineering and economics
- Find ways to apply integrative design in developing countries or underserved communities
- Rethink tough problems not by shrinking their scope but by enlarging their boundaries, and less by applying prior knowledge than by igniting imagination and asking new questions
- Consider the role of integrative design and whole-system thinking in engineering and design classes taught at Stanford

The course is predicated on the assumption that many, if not all, important issues in efficiency require substantive understanding of diverse and multiple disciplines. Thus the concepts, readings, and class assignments in the course will examine and cover theories, models, and ideas from a variety of economic sectors and real-world applications. Please be ready to bring your own unique perspectives, insights, and experiences to class assignments and discussion.

Course Requirements

Each week, students are expected to:

- Complete required readings in advance of class
- Watch pre-recorded lecture(s) in advance of class
- Submit journal entry in preparation for class (described on page 7)
- Attend all class activities (see additional information on attendance, page 9)
- Actively participate in discussions and activities
- Complete in-class Puzzlers (described on page 8)

There will be no midterm or final for this class. Students will complete a midterm report onapplied integrative design (described on page 7).

Grading

A final letter grade for the class will be awarded for each student, based on :

Attendance/Participation	25%
Journal Entries	20%
Weekly Puzzlers	30%
Applied Integrative Design Report	25%

Please note that a substantial percentage of the final grade is attendance and participation. If you have difficulty speaking in class / group settings, please meet with one of the TAs as early in the course as possible to discuss your situation. Participation will be evaluated on an individual basis by the Teaching Staff and will value *quality* of contribution as much as (and in some cases more than) *quantity*. **If you have challenging circumstances that may affect attendance and/or participation because of COVID-19 (in another time zone, have become a caregiver for someone in your family, taking care of kids at home, etc.), please reach out to the teaching staff and we will be accommodating and flexible!**

Course Units

The following tentative topic list is subject to change.

Focus 1: Buildings

- Conventional vs. integrative design
- Passive thermal comfort in cold, hot, and humid climates
- Illumination
- Water heating
- Appliances and other loads
- Design, construction, commissioning, improvement, and adaptation
- Real-estate implications

Focus 2: Mobility

- Radical light-duty vehicle efficiency
- Vehicles and mobility demand
- Electric and alternative-fueled vehicles
- Shared mobility systems
- Connected mobility systems
- Autonomous vehicles
- Business strategy
- Heavy-vehicle efficiency and logistics

Focus 3: Industry

- Industrial systems and principles
- Purpose and design intent
- Fluid-handling and drivesystems
- Process heat
- Heavy-industry examples
- Technology-industry examples
- Industrial systems

Focus 4: Electricity

- Implications for demand and business model
- Comprehensive disruptions
- Grid and generation right-sizing
- The supply-side revolution
- Cost-effective, reliable, and resilient integration of variable renewables
- Transition paths

Focus 5: Disruptive Energy Futures

- Market adoption of energy efficiency, renewables, and integrative design
- Pace of disruption
- National-level strategies for rapid, cost-effective decarbonization and energy security
- Turning barriers into business opportunities
- Profitable climate protection through energy savings and natural-systems carbon removal

Focus 6: Implementation at Scale

- Implications for resilience, security, global development, and financial capital allocation
- Implementation through a wide range of techniques and stakeholders

Course Outline By Week

The following tentative topic list is subject to change.

1. Introduction

This class session will ground the course in this moment's opportunity for breakthroughs in many aspects of our relationship with the Earth and each other. Beginner's mind lets us start to imagine and achieve the vast energy and resource savings, and the reconception of the energy problem itself, that can help transform lives, for all, for ever.

2. Buildings

Buildings offer the most familiar and intuitive examples of how to make very large energy savings cost less than small or no savings: typically add less up-front cost for high efficiency than you subtract by shrinking or eliminating supply investments. The right steps in the right order, starting with delivered energy services and working back upstream, can often achieve astonishingly large savings at low, no, or negative extra cost, in buildings old and new, big and small, in any climate, style, and culture.

3. Mobility

Asking different design questions in a different order can optimize the basic physics and whole-vehicle design of autos, trucks, ships, and planes. This can raise their energy efficiency by several- to manyfold—often far more than conventionally supposed—yet with excellent economics and no compromise.

4. Industry context

Industry's complexity conceals underlying and often underused opportunities in frugally using energy-intensive materials, lean production, and rethinking production and use from the perspective of natural capitalism.

5. Industry equipment

Redesigning fluid-handling, drivepower, and other basic industrial systems can often achieve astonishing, even order-of-magnitude, energy savings at lower capital cost by systematically applying orthodox engineering logic in novel ways. Beyond that bonanza, the biomimetic design revolution beckons.

6. Industry processes

Actual cases illustrate integrative design's results in both classical and modern processes: hardrock mining, LNG liquefaction, crude-oil distillation, chip fabs, and data centers.

7. Electricity

Energy efficiency plus electrification can displace fossil fuels sooner and more profitably by harnessing synergies with renewable, distributed, and resilient electrical resources, and by understanding the transformation of business models and regulation.

8. Implications

Most of the world's energy is now wasted. Neither business nor climate models yet recognize how deeply energy savings—already the world's largest energy "source"—can further strand supply assets, speed capital flight, build resilience, protect climate, enhance security, and reshape almost everything we thought we knew about energy.

9. Implementation

Diverse societies can adapt and adopt advanced energy efficiency by diverse means—informed by social science, shaped by political economy, and often at many levels and with many actors in government, private enterprise, and civil society. Conventional tools have important new complements, especially in barrier-busting, making markets in saved resources, and novel ways to influence complex systems and creatively manage conflict.

10. Open session

This course is bound to raise so many interlinked and silo-spanning questions that we reserved the final class for a wide-ranging exploration of "wildcard" issues, new ideas, and next steps.

Activity and Assignment Descriptions

Applied Integrative Design Report

To be submitted on Canvas by ***Thursday, May 25, 11:59 pm PT***

Students will write a report on how integrative design could be applied to provide energy savings, better performance, and lower capital cost to a system on the Stanford campus or a larger world system. Students will apply the concepts of whole-systems thinking and integrate at least 3 of the 10 pillars of integrative design to explore how your chosen energy system can be improved (energy savings, lower costs, etc.). We expect reports that apply these concepts, rather than merely restating them. This report will be 1500 words minimum, 2500 words maximum. Graphs, charts, and tables are required. Please cite all sources used, including any sources used outside of the required and recommended readings. This assignment is intentionally flexible in order to allow students to explore integrative design through a practical lens. There is no "right" topic, though more complex systems do make for a more engaging assessment!

Journal Entries

To be submitted on Canvas ***every Tuesday by 5:30 pm PT***

Each student will submit weekly journal entries on Canvas. Each (900 words maximum) will compile reactions, insights, reflections, responses, questions, and implications from the previous week's class discussion, as well as incorporate forward-thinking thoughts, questions, and inquiries stemming from pre-lecture material for the next week's class. This assignment is intentionally flexible in order to serve as a forum for individual exploration of the concepts presented in the preceding class. The goal of this assignment is to encourage reflective and critical inquiry. The questions and inquiries raised about the upcoming material will be reviewed before each class to foster the starting discussion with Dr. Lovins and Dr. Swisher.

Possible questions to help frame lessons learned:

- How does what I learned connect with my background, interests, skills, and professional and personal aspirations?
- What are some personal "aha" moments? How can I best share these insights with others?
- What critical challenges would I raise to the material presented? What real-world, practical obstacles do I foresee? What are my suggestions for overcoming them?
- If I am doubtful about any of what I just learned, how could I test its validity?
- What are some critical (small or large) next steps?
- What are some direct and indirect implications for my and others' education?
- What should Stanford be doing to help address these issues? What should I be doing?

Students will be graded in the following manner:

- 0–10 points: Unacceptable. Missing, late, or very poor quality assignment. Poor quality indicated by meager summary of the topic and issue and insufficient style/grammar/formatting/etc.; lack of overall effort evident. Does not incorporate assigned readings/videos.
- 10–20 points: Acceptable. Descriptive, but little contribution beyond summarizing facts from lecture, session, and other sources. Some personal points of view/analysis. Average writing skills (grammar, form, flow, style). Some thought given to assigned readings/videos, but minimal reflection/inquiry.

- 20–30 points: Excellent. Went beyond re-stating facts by using critical analysis. Used insightful arguments and top-level writing skills (grammar, form, flow, style). Uses both learned material and assigned readings/videos for the next class to shape insights and inquiries. Poses forward-thinking questions to the material.

In-Class Puzzler (Group Activity)

Each workshop session is intended to be an exercise in small-group integrative problem-solving and out-of-the-box thinking (there is no box!), as well as insightful and time-efficient framing, estimating, and research. Problems are deliberately framed in unfamiliar territory to help cultivate beginner's mind. The ultimate aim is for students to gain first-hand experience applying RMI's problem-solving methods. Work must cite any online or other supporting material used.

In-Class Puzzler Write-Up

Each group will write up and turn in the main take-aways from the Puzzler, e.g. context, challenge, solution, and conclusions or implications. Write-up will be a document of no fewer than 300 words to be submitted via Canvas. Answers will be graded on: 1) Application of whole-system principles (50%), 2) creative analysis (20%), and 3) breadth and depth of response (30%).

Puzzler Presentations and Group Discussion

After the Puzzlers, each group will have a chance to present its solution and to raise issues, questions, or ideas encountered during the day's work. This will give students the benefit of seeing others' solutions, stimulating a lively whole-class or smaller-group discussions. We will also discuss next potential steps for the subject area.

Lectures

Each class will focus on a highly substantive topical lecture, recorded and pre-posted so you can view it carefully before the class. Posting will normally occur soon after each Wednesday class (though perhaps not in the first week, when the lecture is normally live). We will make every effort to post before the weekend.

We have moved these lectures from class time to a view-ahead so you can schedule viewing at your own convenience, take such breaks as you wish, and go back and review anything that wasn't clear the first time. To support your thorough understanding of the content, we will post with each lecture's video an additional PDF file of the slide deck including Presenter's Notes. In those Notes, "*" marks each transition, build, or animation—none of which will show in the PDF; "/" marks a paragraph break; and [bracketed small type] contains extra or explanatory text not spoken.

The lectures contain rather extensive content at relatively high density, so we encourage you to view them when you have time and mental space to focus. Since you can go back and view them at any time, you needn't be distracted by taking notes. Leave extra time for lectures #2 (Buildings), #3 (Mobility), and #7 (Electricity), as they're particularly long. Before Class 2 (Buildings, April 12), you'll also have a second lecture to preview—a 55-minute video tour of a passive-solar banana farm high in the Rocky Mountains. We recommend you view it *after* the Buildings lecture, to help you bridge from theory to practice to the in-class Puzzler.

Additional Assignments for Students Registered for 4 or 5 credits

Students can earn an additional unit of academic credit by completing *either one* of the following, or *two credits by completing both:*

- Participating in an additional one-hour discussion section, starting an hour after each Wednesday's E^3 class (i.e., 5:30–6:20 pm), and completing assigned readings to prepare and frame questions for section meetings.
- Writing an additional integrative design paper, building on one or more topics addressed in the main course content or in the additional meetings for this section, to provide an opportunity to deepen the E^3 class experience (due June 12th).

Attendance / Course Policies

- Attendance is mandatory at all scheduled class activities. If you have special needs, or are required to miss an event or scheduled activity, please let your TAs know as soon as possible. Because we understand that conflicts do occur, you are allowed one excused absence with completion of a make-up assignment during the quarter for a valid conflict (to a single scheduled activity) without consequence to your grade. An additional absence (over the one allowable) will result in a 5% reduction to your grade with a maximum of a 20% reduction. In addition, failure to attend regularly will result in grade losses for participation, journal entries, and Puzzlers. In other words, attend the seminar sessions! **If you have challenging circumstances that may affect attendance and/or participation because of COVID-19, please reach out to the teaching staff and we will be accommodating and flexible!**
- Students are reminded that they are expected to comply with the Stanford Honor Code and Fundamental Standard at all times. Information on these policies is available at https://communitystandards.stanford.edu/student-conduct-process/honor-code-and-fundamental-standard.
- The Puzzlers can be intellectually demanding. Especially in the first few weeks as their techniques are becoming more familiar, they may sometimes feel intensive or even stressful. This is normal, like muscles' hurting with unfamiliar exercise. We therefore recommend coming to class rested and undistracted, and therefore not waiting until the night before to preview that week's lecture. We are also confident that you will find this classwork worthwhile, and that as you gain comfort and facility with the techniques of integrative design—especially the hardest part, which is letting go of old ideas—any initial stress will turn to the exhilaration of mastery.
- A course of this density and breadth requires your full attention. Distracting and extraneous activities (Internet surfing, non-emergency messaging and emailing, etc.) during lectures and class are strongly discouraged and are discourteous. Come prepared to be fully present. **Please stay as focused as you can—the more students we have participating and engaging, the more camaraderie and community we will all feel and share, especially during these strange and not-yet-over pandemic times.**

Access and Accommodations

Stanford is committed to providing equal educational opportunities for disabled students. Disabled students are a valued and essential part of the Stanford community. We welcome you to our class.

If you experience disability, please register with the Office of Accessible Education (OAE). Professional staff will evaluate your needs, support appropriate and reasonable accommodations, and prepare an Academic Accommodation Letter for faculty. To get started, or to re-initiate services, please visit oae.stanford.edu.

If you already have an Academic Accommodation Letter, we invite you to share your letter with us. Academic Accommodation Letters should be shared at the earliest possible opportunity so we may partner with you and OAE to identify any barriers to access and inclusion that might be encountered in your experience of this course.

Readings

Below is a selected list of publications by Amory Lovins and others that are the most appropriate background readings for the course. Recommended readings will be helpful in completing the Puzzlers and other assignments. This is a reference reading list and will be trickled throughout the quarter depending on weekly topic, and updates will be posted in Canvas.

Text:

Reinventing Fire, Amory Lovins and Rocky Mountain Institute, 2011. Published by Chelsea Green (White River Jct, VT). Specific sections are assigned below. Summary chapters and details included at https://www.rmi.org/insights/reinventing-fire/. The entire book will be helpful, in hard copy or the Google Books version (better than the Kindle version), and it is *on reserve in Terman Engineering Library*.

Links to all other readings are posted on Canvas, and some are listed below too.

Week 1:

Required: Lovins, A.B., 1976. "Energy Strategy: The Road Not Taken?" *ForeignAffairs* ***55(1)***.
Required: Lovins, A.B., 2018. "How big is the energy efficiency resource?" *Envtl Res Ltrs* **13**(9):1–17, https://doi.org/10.1088/1748-9326/aad965
Required: Lovins, A.B., 2021. "Creating The Next Energy Revolution: Integrative Design for Radical Energy Efficiency" (the "10 Pillars," download from Canvas)

Week 2:

Required: *Reinventing Fire,* chapter 3, pages 76–98.
Recommended: Randolph, J., and G. Masters *Energy for Sustainability,* 2nd edition, chapter 6.

Week 3:

Required: *Reinventing Fire,* chapter 2, pages 14–35 and 49–62.
Required: Lovins, A.B., 2020. "Reframing Automotive Fuel Efficiency," Soc. Autom. Engineers.
Recommended: Lovins, A.B., 2010. "DOD's Energy Challenge as Strategic Opportunity," *Joint Force Quarterly,* 57:33–42.
Recommended: *Ross, M., 1997. "Fuel Efficiency and the Physics of Automobiles," Con. Physics*

Week 4:
Required: Lovins, A. B., Lovins, L. H., & Hawken, P., 1999. "A road map for natural capitalism." https://rmi.org/insight/roadmap-for-natural-capitalism/
Required: Lovins, A.B. "Profitably Decarbonizing Heavy Transport and Industrial Heat," RMI, 14 July 2021, https://www.rmi.org/profitable-decarb/.
Required: Lovins, A.B., "Decarbonizing Our Toughest Sectors—Profitably," *MIT Sloan Mgt Rev*, 4 Aug 2021, free at https://sloanreview.mit.edu/offers-free-download-sustainable-business/
Required: *Natural Capitalism: Creating the Next Industrial Revolution*, P. Hawken, A.B. and L.H. Lovins, Little Brown (NY) and Earthscan (London), 1999, 415 pp., posted free as tediously downloadable-chapter-by-chapter PDFs at www.natcap.org. **Read chapter 7.**

Week 5:
Required: *Reinventing Fire,* chapter 4, pages 122–144.
Recommended: Senge and Carstedt, "Innovating Our Way to the Next Industrial Revolution" *MIT Sloan Management Review*, vol. 42, no. 2, 2001.

Week 6:
Required: *Natural Capitalism,* **chapter 4**.
Required: *Natural Capitalism,* **chapter 6**.
Required: Lovins, A.B., 2005. *"*End-Use Energy Efficiency," commissioned for Transitions to Sustainable Energy Use, InterAcademy Council.
Required Video: Autodesk Sustainability Workshop. "Whole Systems Design: Introduction to Life CycleThinking." https://www.youtube.com/watch?v=7mC9xaJC2dQ

Week 7:
Required: *Reinventing Fire,* chapter 5, pages 164-202.
Required: Lovins, A.B., & A. Faruqui, 2020. "The coming transformation of the electricity sector: A conversation with Amory Lovins," *The Electricity Journal* **33**(7).
Recommended: Lovins A. and L.H. Lovins. 1983. "The fragility of domestic energy," *Atlantic*.
Recommended: Lovins A.B. and M.V. Ramana, 2021. "Three Myths About Renewable Energy and the Grid, Debunked," *Yale E360*, https://e360.yale.edu/features/three-myths-about-renewable-energy-and-the-grid-debunked
Recommended: Victoria, M. et al., 2021. "Solar photovoltaics is ready to power a sustainable future," *Joule* 5:1041–1056, https://www.cell.com/joule/pdfExtended/S2542-4351(21)00100-8.
Recommended: *Lazar, J., 2016. Electricity Regulation in the US: A Guide*, Second Edition, Regulatory Assistance Project. Chapters 1, 15 and 17.
Recommended: Swisher, J., G. Jannuzzi and R. Redlinger, 1997. *Tools and Methods for Integrated Resource Planning*, UN Environment Programme, sections, 1C, 1D, 2C, 2E.

Week 8:
Required: Lovins, A.B., 2019. "Recalibrating climate prospects," *Environ. Res. Ltrs.* **14**(12).
Required: Lovins, A.B., 2012. "A farewell to fossil fuels: Answering the energy challenge." *ForeignAffairs*. http://www.rmi.org/Knowledge-Center/Library/2012-01_FarewellToFossilFuels
Required: Lovins A.B., 2019, "Does Nuclear Power Slow Or Speed Climate Change?" *Forbes*.
Recommended: R. Way et al., "Empirically grounded technology forecasts and the energy transition," https://www.cell.com/joule/pdf/S2542-4351(22)00410-X.pdf.

Recommended: Harvey, C. and K. House, 2022. "Every Dollar Spent on This Climate Technology Is a Waste," *New York Times*, 22 August.

Week 9:
Required: Lovins, A. B., 1993. "Energy-Efficient Buildings: Institutional Barriers and Opportunities," E source.
Required: Meadows, D. H., 1997. "Places to intervene in a system." *Whole Earth*, **2**(91). https://www.bfi.org/sites/default/files/attachments/pages/PlacesInterveneSystem-Meadows.pdf
Required: Gold, R., 2022. "The Texas Electric Grid Failure Was a Warm-up," *Texas Monthly.*
Required: Reed, S. and M. Eddy, 2023. "Europe Has Weathered an Energy Crisis, for Now," *New York Times*, 24 February 2023.

Week 10:
Required: Lovins, A.B., 2019. "Applied Hope," Commencement remarks to Olin College.
Required: Cavanagh, R., 2021. "A Tale of Two Grids: Texas and California, NRDC Blog, https://www.nrdc.org/experts/ralph-cavanagh/tale-two-grids-texas-and-california