ENVS/ENGR 119: Energy & the Environment - Spring 2025

Instructor: Dustin Mulvaney, Ph.D., Environmental Studies Department, San José State University

Office hours/location: Monday/Wednesday 11:00–11:50am, 115 WSQ or zoom – sign up here.

Email: via canvas messaging or dustin.mulvaney@sjsu.edu

Class meeting days / time / room: Monday/Wednesday 12–1:15 pm, 226B DMH

Attributes: General Education Area R: Earth, Environment, and Sustainability

Prerequisites: Passage of the Writing Skills Test or ENGL 100A / LLD 100A with a C or better (C- not accepted), completion of Core General Education and upper division standing are prerequisites to all SJSU studies courses. Completion of, or co-registration in, 100W is strongly recommended.
MYSJSU Messaging and Canvas: Course materials such as the syllabus, assignments, readings, and handouts are posted to canvas. You are responsible for regularly checking with the messaging system through MySJSU https://one.sjsu.edu/ and canvas https://sjsu.instructure.com

Course Description: Introduces students to the sources of energy that fuel industrial civilization and the environmental impacts of energy extraction, distribution, and consumption. Explores a range of approaches to moving society toward a more sustainable energy future. This course introduces students to patterns of energy use, and the social, technical, and environmental challenges to providing sustainable energy supplies. Students learn physical principles underlying power generation, conventional forms of energy and their social and environmental impacts, sources of renewable energy, and means to transition to more sustainable energy sources. The political, economic, cultural, historical, and policy dimensions of energy procurement, generation, and consumption show how energy issues are entangled in deeper social and environmental contexts.

Course Goals and Student Learning Objectives

- Understand the nexus of energy challenges and relevant economic, social, and environmental issues.
- Apply the physical principles related to the energy, heat, power, and work to explore relationships between humans and the natural environment.
- Complete basic calculations / conversions in energy, heat, power, and work.
- Describe the scientific properties and spatial distribution of conventional and renewable energy sources.
- Analyze relative energy use in U.S. to other nations, and shift in the mix of energy sources over time.
- Understand basic principles to improve efficiency and design of energy delivery, recognize opportunities to reduce energy consumption, and promote sustainability.
- Assess basic economic, government policy, and social equity dimensions of energy options
- Utilize tools to evaluate an energy option and assess alternatives.

Diversity, Equity, and Inclusivity Statement

San José State University is committed to supporting a diverse community guided by core values of ethical conduct and inclusion and respect for each individual. In accordance with San José State University's Policies, the Student Code of Conduct, and applicable state and federal laws, discrimination based on gender, gender identity, gender expression, race, nationality, ethnicity, religion, sexual orientation, or disability is prohibited in any form. This course also incorporates issues of diversity, equity, and inclusion throughout the semester by addressing how the development and use of energy impacts diverse peoples and the environment, as well as how interactions between humans, societies, peoples, cultures, and other organisms impact and are impacted by socio-ecological systems tied to energy.

Land acknowledgement

Mákkin Mak Muwekma, 'Akkoy Mak-Warep, Manne Mak Hiswi!
We Are Muwekma Ohlone, Welcome To Our Ancestral Homeland!
San Jose State University and Surrounding Region Thámien Ancestral Muwekma Ohlone Territory

The San Jose State University community recognizes that the present-day Muwekma Ohlone Tribe, with an enrolled Bureau of Indian Affairs documented membership of over 550, is comprised of all of the known surviving American Indian lineages aboriginal to the San Francisco Bay region who trace their ancestry through the Missions Santa Clara, San Jose, and Dolores, during the advent of the Hispano-European empire into Alta California; and who are the successors and living members of the sovereign, historic, previously Federally Recognized Verona Band of Alameda County. Furthermore, the San Jose State University community recognizes that the university is established within the Thámien Ohlone-speaking tribal ethnohistoric territory, which based upon the unratified federal treaties of 1851-1852, includes the unceded ancestral lands of the Muwekma Ohlone Tribe of the San Francisco Bay Area. Some of the enrolled Muwekma lineages are descended from direct ancestors from the Thámien Ohlone tribal territory whose ancestors had affiliation with Mission Santa Clara. The San Jose State University community also recognizes the importance of this land to the indigenous Muwekma Ohlone people of this region, and consistent with our principles of community and diversity strives to be good stewards on behalf of the Muwekma Ohlone Tribe whose land we occupy.

Required Books

Richard Rhodes, 2018. *Energy: A Human History.* Simon and Schuster. https://archive.org/details/energy-a-human-history-by-richard-rhodes-z-lib.org/page/1850/mode/2up

J. Mijin Cha, 2024. *A Just Transition For All: Workers and Communities for a Carbon-Free Future*. MIT Press. https://doi.org/10.7551/mitpress/15174.001.0001

Sandeep Vaheesan, 2024. Democracy in Power: A history of Electrification in the United States. University of Chicago Press.

Jonathan Koomey and Ian Monroe. 2022. Solving Climate Change. https://www.solveclimate.org/

Environmental Studies Library Liaison: Peggy Cabrera, peggy.cabrera@sjsu.edu
website: https://libguides.sjsu.edu/environmental_studies

Interdisciplinary Engineering Senior Assistant Librarian: Annina Wyss-Lockner, annina.wyss-lockner@sjsu.edu website: https://libguides.sjsu.edu/sb.php?subject_id=181283

Classroom Protocol: You are expected to attend every class on time. Important announcements are made at the start of class. Don't miss them! Classroom participation will be reflected in your final grade.

Dropping and Adding: Students are responsible for understanding the policies and procedures about add/drop, grade forgiveness, etc. Add/drop deadlines can be found on the current academic calendar. Students should read the Late Drop Policy and be aware of the current deadlines and penalties for dropping classes.

Credit-hour statement: SJSU classes are designed such that in order to be successful, it is expected that students will spend a minimum of forty-five hours for each unit of credit (three hours per unit per week or two hours outside of class for every hour in class), including preparing for class, participating in course activities, completing assignments, and so on. This three-unit course requires a minimum of 9 hours per week to complete class-related readings and assignments (roughly 2.5 hours in class and 6.5 hours outside class per week.) Careful time management will help you keep up with readings and assignments and enable you to succeed. More details about student workload can be found in University Policy S12-3.

Grading

20% Participation. It is expected that you will participate in class discussions and activities. Come to class having completed all of the assigned readings and something important from the reading in your notebooks. Also make sure to bring the assigned readings each class. Every article we read should be summarizes or noted upon in this notebook. Share your thoughts about the readings when prompted, ask questions about lectures, answer discussion prompts. Keeping good notes about the main points or views taken by authors of course readings is a good means a facilitating a sustained discussion. You will also be asked to work in small groups at times in class, and you will be expected to be a contributing member to your group. ***Current events in energy*** Bring a news story to the classes' attention **twice** over the semester by (1) posting it to the canvas website in the discussion section with a short description; prepare a few remarks as we'll want to know more than just the headline, (2) describing the story at the start of class.

50% Assignments: As part of the activities in this class, you will complete four graded assignments.

Assignment 1 – Unit conversions, power energy, energy/GHGs (ALO 1 & 2)
Assignment 2 – Energy and GHG accounting problem sets (ALO 1 & 2)
Assignment 3 – Carbon footprint calculator & 500-word essay (ALO 3 & 4)
Assignment 4 – Social resistance to natural gas development, 1,000 words (ALO 3 & 4)
Assignment 5 – Sustainability and justice in planning energy systems, 500 words (ALO 3 & 4)

30% Final Research Paper (ALO 3 & 4): Students will individually write a 2,000-word research paper related to renewable or conventional energy technologies and how it shapes communities, landscapes, air and waters, and or other species.

General Education Area R. Earth, Environment, and Sustainability

Earth, Environment, and Sustainability (Upper Division B) Area R courses apply the scientific method and quantitative reasoning to engage in ethical, civic minded inquiry around sustaining the earth, its environments and its inhabitants.

General Education Area Learning Outcomes (ALOs)

ALO 1: Apply scientific principles and the scientific method to answer questions about earth, the environment, and sustainability while recognizing the limits of both the method and principles and is assessed in assignments 1, 2, & 4, and the midterm & final exam.

ALO 2: Apply mathematical or quantitative reasoning concepts to the analysis and generation of solutions to issues of earth, the environment, and sustainability and is assessed in assignments 1 & 2, and the midterm & final exam.

ALO 3: Communicate a scientific finding, assertion, or theory to a general audience with the integrity and rigor of the underlying science and is assessed in the final research paper and assignments 3 & 4, and the final paper.

ALO 4: Explain ethical, social, and civic dimensions of scientific inquiry and is assessed in assignments 3 & 4, and the final research paper.

Area Learning Objectives mapped to assignments

ASSIGNMENT	Grade %	Word count	ALO 1	ALO 2	ALO 3	ALO 4
Assignment 1 – Unit conversions, power energy, energy/GHGs	10%		X	X		
Assignment 2 – Energy and GHG accounting problem sets	10%		X	X		
Assignment 3 – Carbon footprint calculators	10%	500			X	X
Assignment 4 – Social resistance to natural gas development	10%	800–1,000			X	X
Assignment 5 – Sustainability and justice in planning energy systems	10%	500			X	X
Final Research Paper	30%	2,000			X	X

General Education Course Content (CC) Requirements

1. A focus on issues or present perspectives from different academic disciplines and including an integrative assignment appropriate to the course content (CC-1).
2. Application of basic skills (reading, writing, speaking, critical thinking, research, and mathematics/quantitative reasoning) gained in Core General Education courses (CC-2).
3. Assignments that utilize library research and written communication skills (CC-3).
4. Promotion of reflective processes and critical analysis of the civic relevance and ethical dimensions of course topics. (CC-4).
5. Materials that include primary sources appropriate to the disciplinary approaches used in the course (CC-5).

Course Content mapping to assignments

ASSIGNMENT	CC1	CC-2	CC-3	CC-4	CC-5
Assignment 1 – Unit conversions, power energy, energy/GHGs		X			
Assignment 2 – Energy and GHG accounting problem sets		X			
Assignment 3 – Carbon footprint calculator		X		X	
Assignment 4 – social resistance to natural gas development	X		X	X	X
Assignment 5 – Sustainability and justice in planning energy systems		X			
Final Research Paper	X		X	X	X

Course Grading: The course grade will be determined based on a total 100 possible points. The grade scale below determines your semester grade.

A+ 97–100	A 92–96	A- 89–91	B+ 86–88	B 81–85	B- 79–80	C+ 76–78
C 72–76	C- 69–71	D+ 67–68	D 64–66	D- 60–64	F < 60	

University policy on academic integrity is strictly enforced. Your commitment as a student to learning is evidenced by your enrollment at San Jose State University. Student Conduct and Ethical Development promotes academic integrity through enforcing the Academic Integrity Policy [pdf] (University Policy F15-7). Faculty members are required to report all infractions to the office of Student Conduct and Ethical Development. **Instances of academic dishonesty will not be tolerated.** Cheating on exams or plagiarism (presenting the work of another as your own, or the use of another person's ideas without giving proper credit) will result in a failing grade and sanctions by the University. If you would like to include your assignment or any material you have submitted, or plan to submit for another class, please note that SJSU's Academic Policy S07-2 requires approval of instructors.

Campus policy in compliance with the American Disabilities Act

If you need course adaptations or accommodations because of a disability, or if you need to make special arrangements in case the building must be evacuated, please make an appointment or communicate this in some way with me as soon as possible. Presidential Directive 97-03 requires that students with disabilities requesting accommodations must register with the Accessible Education Center to establish a record of their disability.

Other Campus Resources

- Computers are available for check out at Clark Hall. Computers are also available in the Martin Luther King Library in student computing resources. A wide variety of audio-visual equipment is available for student checkout from Media Services located in IRC 112.
- **Peer Connections** is provides free tutoring, mentoring, supplemental instruction, learning assistants, and strengths coaching for students at SJSU. It is designed to assist students in the development of their full academic potential and to inspire them to become independent learners. Peer Connections tutors provide content-based tutoring in many lower division courses (some upper division) as well as writing and study skills assistance. Small group, individual, and drop-in tutoring are available.
- The **SJSU Writing Center** is staffed by professional instructors and upper-division/graduate-level writing specialists that are trained to assist all students at all levels within all disciplines to become better writers.
- Student Wellness Center, **Counseling & Psychological Services.**

Energy and the Environment

1 - Energy, Society, Environment

Introduction, challenges and dilemmas in energy and the environment. Course and syllabus overview, logistics.
Read: Koomey and Monroe, Solving Climate Change, Chapters 1 & 2.
Read: Rhodes, Energy: A Human History. Chapter 1 & 2.
Questions: *What are the key shifts in the evolution of energy use? What changed with the shift from biomass to fossil fuels? Why is energy important to human well-being? How do energy choices impact the environment?*

Keywords & concepts: Energy use in historical/evolutionary perspective, Environmental impacts of energy choices. GHGs quotas to avoid dangerous climate change, mass and energy flows through ecosystems, energy v. power, stationary and mobile prime movers, energy conversions/conversion efficiencies, primary energy supplies, final energy, useful energy, energy services, energy types (mechanical, thermal, chemical, solar, nuclear, electrical).

Check this out! Global Energy Use.

2 - Energy Science Fundamentals - Assignment 1 due

Review of underlying physical processes to make and generate energy for human civilization.
Read: Rhodes, Chapter 3–5.
Read: Richard Wolfson. 2012. Energy, Environment, and Climate. WW Norton. Chapter 3.
Read: How do batteries work? https://www.saveonenergy.com/how-batteries-work/
Review: Mulvaney, 2020. *Sustainable Energy Transitions*, Chapter 2
Questions: *What are the differences between forces and energy, power? What are the key forms of energy? How is electricity made? What happens to energy as it is transformed? What units do we use to measure power and energy? How are basic unit conversions calculated?*

Keywords & concepts: Energy Density, Entropy, Stocks and Flows, Intergenerational Equity, thermodynamic laws; Energy units; efficiency; Energy use in transportation, Kinetic and Gravitational Potential Energy, Forces, Electricity, Electro-magnetic induction

Listen: [Episode #119] – Energy Basics Parts 1–3

Listen: [Episode #126] – Energy Basics Parts 4–6 – Electricity, Generation and Grid Management.

Check this out! Today in Energy, US EIA.

3 – Coal

Overview of the types of coal, geographies, global supply chains, and environmental impacts. How does coal fit into modern energy systems and what are its prospects globally?
Read: International Energy Agency, 2024. Global coal demand saw another all-time high in 2023. https://www.iea.org/reports/coal-mid-year-update-july-2024/demand
Read: Rhodes, Chapter 6–7.
Read: Curley, A. (2019). T'áá hwó ají t'éego and the Moral Economy of Navajo Coal Workers. *Annals of the American Association of Geographers*, *109*(1), 71-86. https://doi.org/10.1080/24694452.2018.1488576
Read: U.S. Energy Information Agency, More than 100 coal-fired plants have been replaced or converted to natural gas since 2011.
Read: What is cap and trade and why do some people hate it?
Read: Carbon Pricing, Explained With Chickens

Questions: *Why is coal such a problem for the climate? What are the main types of pollution from coal? What are the challenges to getting off coal? What state and more specifically coal reserve, is considered the Saudi Arabia of coal? What portion of coal supply does it provide to the USA?*

Keywords & concepts: Coal: China, export terminals, coal-to-liquids, syngas, clean coal, CCS, regions, uses, sources, formation, Carboniferous period, labor hazards, noxious gases, mountain top removal, coal surface mining.

Listen to podcast - Energy Transition Show [Episode #92] – Financing Coal Plant Retirements

Check this out! Electricity carbon intensity map

4 - Natural Gas

Overview of the types, uses, and sources of natural gas, geographies, global supply chains, and environmental impacts, with an emphasis on impacts to water resources; history of electrification.
Read: Rhodes, Chapter 8 & 9.
Read: S. Vaheesan, Democracy in Power.
Read executive summary/introduction: EPA's Study of Hydraulic Fracturing for Oil and Gas and Its Potential Impact on Drinking Water Resources
Read: EIA Natural Gas
Watch: Gasland (also for assignment 2)

Questions: *How do you calculate the heat and carbon emissions from combustion of methane? What are the key scientific debates around fracking? What do we know and not know? What can we conclude about the public health risks from fracking according to the EPA?*

Keywords & concepts: natural gas production, horizontal slant drilling, hydraulic fracturing, shale, water impacts, risks to drinking water, heating value, chemical energy, heat of combustion, politics of reserve estimates, Marcellus Shale, impacts to water, natural has and energy security.

Check this out! Global Gas Flaring Data.

5 – Petroleum - Assignment 2 Due

The worlds transportation runs on petroleum, a look at its history, uses, major oil spills and pollution.
Read: Kai Bosworth, 2023, The Dakota Access Pipeline Struggle Vulnerability, Security, and Settler Colonialism in the Oil Assemblage. In *Settling The Boom.* University of Minnesota Press.
Read: Faces of Fracking, California's getting Fracked
Read: Rhodes, Chapter 10
Read: Jeremy Miller, 2011. The Colonization of Kern County: A story of oil and water. Orion Magazine. January/February. https://orionmagazine.org/article/the-colonization-of-kern-county/
Questions: *What is going on in Kern County and the oil industry? What are the largest oil fields in California? What is an oil boom and bust and what are the consequences? What is the dark side of the boom?*

Watch: Air Pollution 101

Watch: Exxon, in the wake of disaster, New York Times.

Keywords & concepts: Oil & petroleum consumption & production trends, oil impacts, ANWR, unit: tons of oil equivalent, air pollution & photochemical smog from combustion; tar sands, Synfuels, Bitumen, dilbit, Keystone XL pipeline Carbon intensity, emissions factors

Check this out! Gulf Spill Map; Mapping Global Air Pollution Down to the Neighborhood Level

6 - Bioenergy

Overview of sources and supply chains for bioenergy and impacts.
Read: Rhodes, Chapter 12.
Read: Mulvaney, 2020. *Sustainable Energy Transitions*, Chapter 5
Read: M. Dupuis and D. Mulvaney, 2024. Opening the Black Box: Carbon-Footprint Calculators, Meat Consumption, and the "Wicked Problem" of Metric Governance. *Sustainability: Science, Practice, and Policy.* 20(1): 2390232. https://doi.org/10.1080/15487733.2024.2390232
Read: Oregon's Largest Natural Gas Company Said It Was Going Green. It Sells as Much Fossil Fuel as Before. https://www.propublica.org/article/nw-natural-gas-oregon-fossil-fuel

Questions. *Where do sustainability issues and biofuels production intersect? Why are sustainability criteria important?*
Keywords & concepts: Bioenergy, First Generation Crops, GHG balances for biofuels, conversion efficiency, direct/indirect land use change, eutrophication, sustainable biofuels criteria.
Check this out! California fossil fuel and bioenergy ; U.S. ethanol production and consumption over time.

7 – Electric Vehicles & Hydrogen - Assignment 3 Due

Overview of transportation and mobility challenges and solutions.
Read: Perry Gottesfeld, 2025. Super-sized electric vehicles (EVs) will not solve the climate crisis. *PLOS Sustainability and Transformation*, *4*(1), e0000159. https://doi.org/10.1371/journal.pstr.0000159
Read: BNEF, Electric Vehicle Outlook 2024. https://about.bnef.com/electric-vehicle-outlook/
Read: Battle of Thacker Pass. https://grist.org/climate/the-west-has-a-new-front-in-the-war-over-electric-cars/

Questions: *What are the primary obstacles to widespread EV adoption? Depending on the feedstock for making hydrogen fuel, it could have substantial benefits or very limited benefits if at all. What are the primary challenges to making hydrogen fuel sustainable?*
Keywords & concepts: Sustainable transportation, hydrogen, battery energy density, obstacles to EVs
Check this out! Hydrogen Hubs maps.

8 - Hydropower

Focus on the large hydroelectric power infrastructures, role in development, displacement/ecological impacts.
Read: Rhodes, Chapter 13
Read: S. Vaheesan, Democracy in Power.
Read: Marc Reisner, 1993. Chapter 4. An American Nile. *Cadillac Desert: The American West and its Disappearing Water*. Penguin, New York.
Listen: Undammed: The Klamath Story. https://www.americanrivers.org/2024/09/the-klamath-dam-removals-a-story-of-people-and-possibility

Questions: *How do you estimate the power output of a hydro-electric system? What are the different kinds of hydro-electric power systems? What were some of the challenges encountered at Boulder Canyon?*

Keywords & concepts: Hydro-electric power, dams and displacement, different kinds of dams.

Check this out! Dams Out.

9 - Nuclear Power

History and uses of nuclear power, impacts of fuel supply chains, role in decarbonization pathways
Read: Rhodes, Chapter 14

Read: Fegadel, A. R. (2023). Uranium mining, environmental inequality, and Native American health. In *Handbook on Inequality and the Environment* (pp. 556-573). Edward Elgar Publishing.
Read: Charles Perrow. 2013. Nuclear Denial: From Hiroshima to Fukushima. *Bulletin of the Atomic Scientists*. 65(5). https://sociology.yale.edu/publications/nuclear-denial-hiroshima-fukushima
Read: David Chandler. 2011. Explained: rad, rem, sieverts, becquerels: A guide to terminology about radiation exposure MIT News. http://web.mit.edu/newsoffice/2011/explained-radioactivity-0328.html

Questions: *What is being denied with nuclear denial? Is Nuclear a Green, Sustainable, or Renewable Energy? How is radiation measured and characterized?*
Keywords & concepts: Uranium mining, nuclear waste, low level radiation, yellow cake, Uranium 235 versus U238, Yucca Mountain, passive design, Chernobyl, Three Mile Island, Diablo Canyon.

Check this out! Nuclear Reactor map.

10 – Wind, Tidal, and Wave Power - Assignment 4 due

Overview of onshore and offshore wind power, coastal and ocean energy resource, environmental impacts.
Read: Fast Facts about California Wind, Cal Wind Energy Association https://www.calwea.org/fast-facts
Read: California Energy Commission, Wind Energy in California.
Read: Pacific Northwest National Laboratory - Blue Economy - Marine Energy
Read: Rhodes, Chapter 16.

Questions: *How is the potential wind power output calculated for a specific site and turbine? What are California's prospects for onshore and offshore wind? Does Tidal or Wave Power have a future?*

Keywords & concepts: Wind Power Basics, Power potential, siting challenges, ecological compatibility, the social gap in renewable energy

Check this out! USGS wind turbine map https://energy.usgs.gov/uswtdb/

11 – Solar

Overview of solar technologies, role in decarbonization, designs, environmental impacts.
Read: Hernandez, Rebecca, Alona Armstrong, Jennifer Burney, Greer Ryan, Kara Moore, Ibrahima Diedhiou, Steven M. Grodsky, Leslie Saul-Gershenz, Davis R., Jordan Macknick, Dustin Mulvaney, Garvin A. Heath, Shane B. Easter, Brenda Beatty, Michael F. Allen, and Daniel M. Kammen.(2019). Techno-ecological synergies of solar energy produce outcomes to mitigate global environmental change. *Nature - Sustainability*. 2(7): 560–568. https://doi.org/10.1038/s41893-019-0309-z
Read: Rhodes, Chapter 17.

Questions: *How do photovoltaics generate electricity?*

Keywords & concepts: Sources of solar thermal and photovoltaic energy, types of technologies, design considerations for sustainable energy landscapes.

Check this out! California Solar Statistics and USGS solar database

12 – Geothermal

Introduction to geothermal resources for energy including electricity, heat, district heat, and industry.
Read: Geothermal power plants, Nearly half of U.S. geothermal power capacity came online in the 1980s, Geothermal Electricity Production Basics.

Read: Between Hot Rocks and Dry Places: The Status of the Dixie Valley Toad. Western North American Naturalist, 77(2):162-175 (2017). https://doi.org/10.3398/064.077.0204

Read: Rhodes, Chapter 18–20.

Questions: *What are the key challenges to California's geothermal energy industry and the emerging trends?*

Keywords & concepts: Geothermal energy, enhanced geothermal, distric heating, geothermal heat pumps

Check this out! NREL geothermal resource data, tools, and maps.

13 – Energy Efficiency, Conservation, Energy Justice - Assignment 5 Due

Reviews key concepts in energy efficiency and conservation with an emphasis on the energy justice, dimensions of an equitable access and quality of energy.
Read: Brockway, A. M., Conde, J., & Callaway, D. (2021). Inequitable access to distributed energy resources due to grid infrastructure limits in California. *Nature Energy*, *6*(9), 892-903.
Read: Gillingham, K., Rapson, D., & Wagner, G. (2016). The rebound effect and energy efficiency policy. *Review of Environmental Economics and Policy*.

Questions: *What motivates people to conserve energy?*

Keywords & concepts: Energy use & conservation, inequities in access to energy, electrification, heat pumps.

Check this out! **https://ejmap.org/justice/**

14 – Critical Minerals and Circular Economy

Overview of the materials needed for future civilizations and to close the loop and move from take-make-waste.
Read: Thea Riofrancos, 2023. The security–sustainability nexus: Lithium onshoring in the Global North. *Global Environmental Politics*, 23(1), 20–41. https://doi.org/10.1162/glep_a_00668

Read: Mulvaney, D., Richards, R. M., Bazilian, M. D., Hensley, E., Clough, G., & Sridhar, S. (2021). Progress towards a circular economy in materials to decarbonize electricity and mobility. *Renewable and Sustainable Energy Reviews*, *137*, 110604. https://doi.org/10.1016/j.rser.2020.110604

Listen: Critical Minerals and China, With Morgan Bazilian.

Questions: *Why are critical minerals in the news? Why is there an interest in mining in the United States?*

Keywords & concepts: Critical minerals, transition minerals, offshoring, reshoring, mining, recycling.

Check this out! **Critical Minerals.**

15 – Just Transitions

Highlights key areas of focus in mobilizations and efforts to elevate percepts of just transitions.
Read: J. Mijin Cha, A Just Transition for All: Workers and Communities for a Carbon-Free Future. MIT Press. https://doi.org/10.7551/mitpress/15174.001.0001

Questions: *What is a just transition?*

Keywords & concepts: Just transition, restoration, reparation, critical environmental justice.

Check this out! EJ Atlas https://ejatlas.org

Final Research Paper Due