

Energy and Climate (CE478 / CE578)

Fall 2024, 3 credit hours

Department of Civil, Construction & Environmental Engineering
North Carolina State University

Instructors:

Dr. Aditya Sinha, email: asinha2@ncsu.edu

Teaching Assistant:

Ms. Qoriatul Fitriyah, email: qfitriy@ncsu.edu

Mr. Jingwei Qian, email: jqian4@ncsu.edu

Class Time and Location: Tu/Th, 10:15am-11:30am, Engineering Building 3, Room 2124

Office Hours:

Dr. Sinha: Make an appointment at <https://go.ncsu.edu/sinhazoom>, times available: Tue 12:00 pm-1:00 pm; Wed 7:30 pm – 8:30 pm

Ms. Fitriyah: Thu 12:00 pm – 2:00 pm

Mr. Qian: Mon 11:30 am – 12:30 pm (all students); 5:30 pm – 6:30 pm (EOL only)

Course Purpose

This course provides an overview of the global energy system, relates fossil fuel consumption to anthropogenic climate change, and outlines alternatives that promote long term environmental sustainability. Topics include basic climate science, energetics of natural and human systems, energy in fossil-fueled civilization, the impact of anthropogenic CO₂ emissions on climate, and technology and public policy options for addressing the climate challenge. While the course is highly interdisciplinary, the approach is quantitative with a strong focus on science and engineering.

Course Objectives

By the end of the course, students will be able to (1) apply concepts drawn from ecology, physics, economics, and engineering to analyze energy resources and technologies, (2) explain how human activity affects climate, (3) outline the pros and cons of various low carbon energy technologies using quantitative methods, (4) build and apply impulse-response function models of climate change to relate emissions to atmospheric concentrations and impacts, and (5) describe public policy and adaptation options for dealing with climate change.

Suggestions for Textbooks/Reports (no required purchase for course):

- Intergovernmental Panel on Climate Change (2022). *Sixth Assessment Report, Impacts, Adaptation and Vulnerability*. <https://www.ipcc.ch/report/ar6/wg2/>
- Intergovernmental Panel on Climate Change (2022). *Sixth Assessment Report, Mitigation of*

Climate Change. <https://www.ipcc.ch/report/ar6/wg3/>

- Tester, J. *et al.* (2012). *Sustainable Energy (Second Edition)*. MIT Press, Cambridge, MA.
- Wolfson, R. (2008). *Energy, Environment, and Climate*. W.W. Norton & Company, New York, New York.

Prerequisite: CE478 - Senior standing; CE578 – Graduate standing

Course Delivery

Lectures will be delivered in-person. To provide added flexibility and improve access to course materials, recorded lectures will be posted. You do not need permission nor prior approval to view the lectures in this format. The lectures will be recorded automatically and posted to Moodle several hours after each class. All other course materials, including readings, homework assignments, and exams will be administered via the course Moodle page.

Topics Covered

- Energy (physical principles, biosphere energetics, and technology assessment)
- Climate (radiative balance, perturbations, impacts)
- Policy (national and international efforts, adaptation options)

Grading Weights

- Reflective Journal: 10%
- Homework: 20%
- Midterm: 15%
- Project: 30%
- Final: 25%

Grading Scale

A+	97 to 100%	A	93 to 97%	A-	90 to 93%
B+	87 to 90%	B	83 to 87%	B-	80 to 83%
C+	77 to 80%	C	73 to 77%	C-	70 to 73%
D+	67 to 70%	D	63 to 67%	D-	60 to 63%
F	<60%				

Attendance and Reflection Diary

Attendance will not be taken. **Nonetheless, it is expected you to attend class in-person or keep up-to-date with the recorded lectures if your absence is unavoidable.**

In lieu of attendance, we will be asking you to regularly reflect on a particular issue or topic discussed in the lecture or reading. There will be one reflection assigned per week. Reflections will

be scored according to the rubric below:

- 0 – No Submission/Invalid Submission (0%)
- 1 – Does Not Meet Expectations (50%)
- 2 – Meets Expectations (80%)
- 3 – Exceeds Expectations (100%)

Reflections will be due on Thursdays (unless otherwise specified) at 10:15am (i.e., before class). We will not accept late submissions for reflections, but we will give every student one “free pass,” intended to cover any professional or personal absences. You do not need to notify me of any absences to receive this free pass. If you submit all reflections, we will drop the lowest grade.

Guided Notes Packet

Guided notes will be used for this course. The lecture notes are posted on Moodle as a pdf. For class, we recommend you bring a device that you can use to mark up the slides electronically. **The posted slides will be incomplete and require note taking.**

Homework

Homework assignments will be handled through Moodle. Homework solutions will be uploaded on Moodle. Your solutions, whether typed or handwritten must be uploaded for grading.

- For handwritten responses, we recommend using a phone app that can scan documents into a PDF. A good choice that works for both iOS and Android devices is Adobe Scan.
- Homework will be assigned approximately bi-weekly.
- Homework assignments will generally consist of 6-10 word problems; some questions will require use of a spreadsheet or a programming language or your choice. In such cases, you may be asked to upload relevant files via Moodle.
- You are allowed to work in groups; however, we expect you to write up your own solutions. Do not copy someone else’s work.
- Please be neat and show all your work. Partial credit will be given.
- Problems may be chosen at random for grading.
- Homework will always be due at the end of day on Fridays. This deadline is firm, and no late assignments will be accepted.
- **The lowest homework grade will be dropped (including a score of 0).** This is intended to cover illnesses, personal/professional conflicts, technical problems, etc. that interfere with the timely submission of your work.

Project (more details as we approach Fall break)

- Conduct an in-depth analysis of an energy technology, including technical, economic, environmental, and social considerations.
- Choose a set of energy technologies and perform quantitative analysis to show how they may

affect global emissions and climate over time.

- In order to maximize your available time to work on your project, the final project will be due during the last week of class.

Exams

- The exams will be accessible via Moodle, and will be open notes and book.
- All exams must be completed in-person during the designated time slots.
- The final exam will take place on Thursday, December 5th from 8:30-11:00am.
- The final exam will be comprehensive.
- If you miss the midterm without a certified medical excuse or prior instructor approval, you will need to take a makeup test at a designated time during the last week of the semester.
- Makeup final exams will only be given in the event of a documented emergency.

A Note on Grading

Student re-grade requests will be considered up to one week following the return of the assignment. For all other re-grade requests, students must send the TA an email explaining why their problem should be re-graded. We will regrade the entire assignment, which could result in a higher or lower grade. Requests without an explanation will not be considered.

Health and Participation in Class

We are most concerned about your health and the health of your classmates. If you test positive for COVID-19, or are told by a healthcare provider that you are presumed positive for the virus, please take advantage of the built-in flexibility of this course to participate remotely. If you feel sick, please stay home to protect the health of others in your classroom or workplace.

Use of Artificial Intelligence Tools

Artificial intelligence tools (e.g., ChatGPT) should only be used to enhance learning, not replace effort. Permitted uses include: brainstorming ideas, finding preliminary information on a topic, drafting an outline to organize your ideas, and checking grammar. Non-permitted uses include: writing a draft of a writing assignment, writing entire sentences to complete class assignments, and completing your contribution to group assignments. Because A.I. tools are advancing rapidly, we are still grappling with the boundaries of acceptable use. If you are not sure if an application is acceptable, please ask the instructors. You are responsible for anything that you submit based on an A.I. query (e.g., misinformation) and your use of AI tools must be disclosed in your assignment submission and properly documented. Any assignment that is found to have used generative A.I. tools in unauthorized ways will result in a zero for the assignment, at a minimum.

Even when using these tools to support your learning, be very careful! While some capabilities are impressive, responses tend to be error prone for even simple questions (see below).

How many "R"s are in the word "strawberry" ?

The word "strawberry" contains two "R"s.

Are you sure about this? My grades depend on this!

Yes, I'm sure. The word "strawberry" has two "R"s in it. You can count them yourself: s-t-r-a-w-b-e-r-r-y.



Message ChatGPT



ChatGPT can make mistakes. Check important info.

Schedule of Lectures (Subject to Change)

Date	Topic
Introduction	
8/20	Overview of syllabus; intro to units
8/22	Summary of the energy/climate challenge we face
8/27	Earth's radiation balance; effect of Sun-Earth orientation on seasons and long-term climate
Energy Demand	
8/29	Energy flow through biosphere; energetics of human metabolism and food; pre-industrial energy
9/3	Industrial energy patterns; IPAT identity
Fossil-Fueled Civilization	
9/5	Fossil fuel resources
9/10	Thermodynamics: 1st and 2nd law, introduction to heat engines
9/12	Thermodynamics: Otto, Diesel, Brayton, & Rankine cycles; gas turbines & coal plants
9/17	<i>Wellness Day</i>
9/19	Physics of electricity generation and transmission
9/24	Basic engineering-economics
Anthropogenic Climate Change	
9/26	Emissions, concentration, radiative forcing from greenhouse gases
10/1	The climate record; examination of arguments by skeptics
10/3	Climate modeling
10/8	Climate impacts
10/10	Midterm
Energy in a Carbon-Constrained World	
10/17	Energy Efficiency
10/22	Carbon capture and sequestration
10/24	Nuclear power
10/29	Nuclear power 2
10/31	Biomass
11/5	Solar
11/7	Wind
11/12	Geothermal
11/14	Hydro/tidal
11/19	Geoengineering and Adaptation
11/21	Exotic Options
11/26	{Dedicated project time – no lecture}
12/3	Climate policies (project due date)
12/5	Final Exam (8:30am – 11:00am)

Academic Integrity Statement

Students are expected to adhere to the guidelines for academic integrity as outlined in the Code of Student Conduct ([NCSU POL11.35.01](#)). All assignments and exams must be completed in accordance with the Pack Pledge: “I have neither given nor received unauthorized aid on this test or assignment.”

Violations of academic integrity will be handled in accordance with the Student Discipline Procedures ([NCSU REG 11.35.02](#)). In particular, please familiarize yourself with Sections 8 and 9. At a minimum, cheating and plagiarism will result in loss of credit for the exam or assignment in question.

Students with Disabilities

Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with the Disability Resource Office at Holmes Hall, Suite 304, 2751 Cates Avenue, Campus Box 7509, 919-515-7653. For more information on NC State’s policy on working with students with disabilities, please see the Academic Accommodations for Students with Disabilities Regulation (NCSU [REG 02.20.01](#)). For more information, please see: <https://dro.dasa.ncsu.edu/>

Students registered for courses on Centennial campus have two location options:

1. schedule at the DRO following the “Main Campus Courses” process on their website; or
2. if preferred, schedule at DELTA Testing Services by completing the [DELTA Accommodation Request Form](#) at least 72 hours prior to the exam date.

Supporting Fellow Students in Distress

As members of the NC State Wolfpack community, we each share a personal responsibility to express concern for one another and to ensure that this classroom and the campus as a whole remains a healthy and safe environment for learning. Occasionally, you may come across a fellow classmate whose personal behavior concerns or worries you, either for the classmate’s well-being or yours. When this is the case, I would encourage you to report this behavior via the NC State’s Students of Concern website:

https://cm.maxient.com/reportingform.php?NCStateUniv&layout_id=2 . Although you can report anonymously, it is preferred that you share your contact information so they can follow-up with you personally.

Health and Well-Being Resources

These are difficult times, and academic and personal stress is a natural result. Everyone is encouraged to take care of themselves and their peers. If you need additional support, there are resources on campus to help you:

- Counseling Center (<https://counseling.dasa.ncsu.edu/>)

- Health Center (<https://healthypack.dasa.ncsu.edu/>)
- If you or someone you know are experiencing food, housing or financial insecurity, please see the Pack Essentials Program (<https://dasa.ncsu.edu/pack-essentials>).

Other Important Resources

- Keep Learning: <https://dasa.ncsu.edu/students/keep-learning/>
- Protect the Pack FAQs: <https://www.ncsu.edu/coronavirus/frequently-asked-questions/>
- NC State Protect the Pack Resources for Students: <https://www.ncsu.edu/coronavirus/reactivating-campus/resources-for-students/>
- NC State Keep Learning, tips for students opting to take courses remotely: <https://dasa.ncsu.edu/students/keep-learning/>
- Introduction to Zoom for students: <https://youtu.be/5LbPzzPbYEW>
- Learning with Moodle, a student's guide to using Moodle: <https://moodle-projects.wolfware.ncsu.edu/course/view.php?id=226>

Other University Policies

- Note that in-class video and audio recordings may record students attending in-person sessions.
- Students may be required to disclose personally identifiable information to other students in the course, via digital tools, such as email or web-postings, where relevant to the course. Examples include online discussions of class topics, and posting of student coursework. All students are expected to respect the privacy of each other by not sharing or using such information outside the course.
- Students are responsible for reviewing the NC State University Policies, Rules, and Regulations (PRRs) which pertain to their course rights and responsibilities, including those referenced both below and above in this syllabus:
 - Equal Opportunity and Non-Discrimination Policy Statement <https://policies.ncsu.edu/policy/pol-04-25-05> with additional references at <https://oied.ncsu.edu/divweb/policies/>
 - Code of Student Conduct <https://policies.ncsu.edu/policy/pol-11-35-01>.