Calvin Carbon Neutrality Date Project
Fall 2023
ENGR333AB
Calvin University
Prof. Heun

One of today's grand challenges is eliminating CO_2 emissions from energy consumption. Individuals, households, universities, corporations, nations, and other entities tackle the challenge in different ways and for differing reasons, according to their spheres of influence. Universities reduce their carbon emissions to reduce costs, to do right by the environment, and, in Calvin's case, to demonstrate care for creation in accordance with item 4 of our Statement on Sustainability. (See https://calvin.edu/offices-services/provost/files/sustainability-statement.pdf.)

To demonstrate Calvin University's commitment to reducing carbon emissions, then-president Michael Le Roy signed the President's Climate Commitment on 6 December 2017. (See https://calvin.edu/dotAsset/f294c564-3660-47fc-aa72-0b5baeea94c2.pdf and https://calvinchimes.org/2017/12/08/calvin-commits-to-carbon-neutrality-by-2057/.) In doing so, President Le Roy committed Calvin to carbon neutrality by 2057. Progress on the climate commitment has been mixed (https://calvinchimes.org/2021/12/05/calvins-progress-on-carbon-neutrality-sustainability-murky-during-pandemic/), with CO_2 emissions reductions likely caused by both improved energy efficiency (especially in lighting) and reduced enrollment.

Given what we now know (Figure 1 shows that humanity has already consumed about 83% of its carbon budget), 2057 looks increasingly like a dangerous and too-distant date. In fact, we have only about a decade of business as usual (i.e., ever-increasing carbon emissions) before the planet is committed to 1.5 °C warming.

Simultaneously, Calvin University is facing the need to upgrade its energy infrastructure, with many systems having several decades in service. The need to upgrade provides an unprecedented opportunity to replace CO_2-emitting technology with greener options. The question for this semester is

What earlier year should Calvin University choose for its carbon neutrality date?

There are many considerations to answering this question, including, but not limited to:
- How much investment should be made in energy efficiency?
- How much will it cost to replace CO_2-emitting energy technologies?
- Where can we raise money to install greener energy technologies? And at what speed?
- How can we eliminate fossil-fuel heating? Are new technologies ready?
- How can we eliminate fossil-fuel electricity consumption? Are new technologies ready?
- Should we wait for the electricity grid to decarbonize or invest in wind and solar?

You (the ENGR333 students) will pursue an answer to this question in groups of 4–5 students each, with each section developing an independent (and possibly different) answer. Your response to the question ("*What earlier year ...*") should take the form of two reports (one from each section) containing your section's answer to the question and comprehensive and accurate information from your analyses. A suggested outline for each section's report is a main technical memo followed by one appendix from each group. Each appendix should be its own technical memo. Each appendix must be thorough and provide your customer (see below) and others with enough
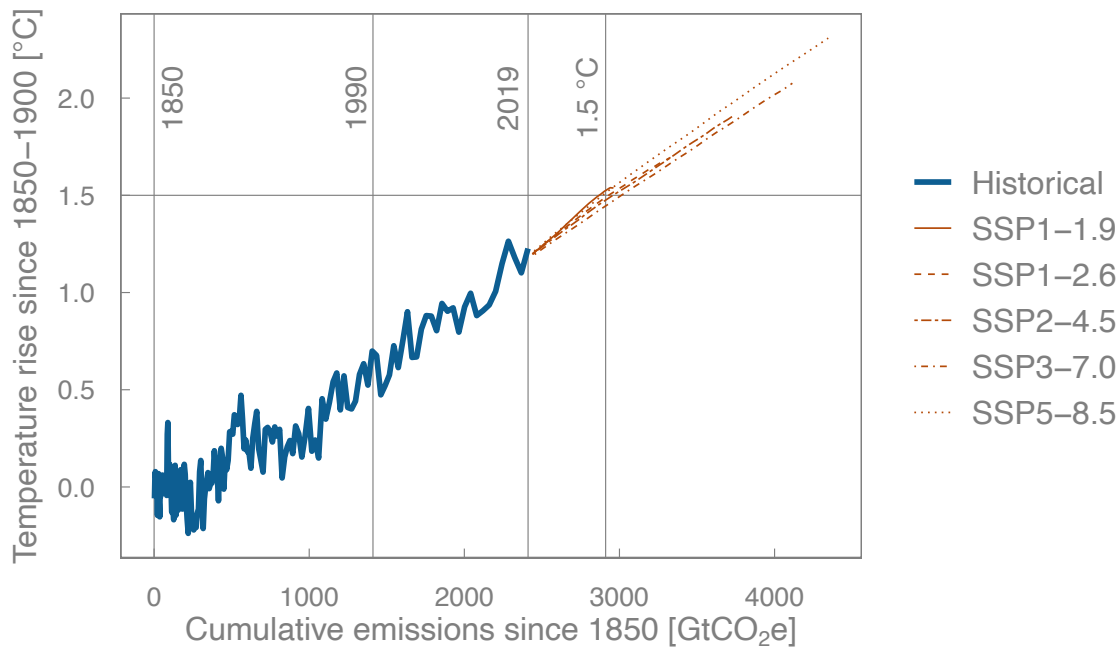
Figure 1. Global temperature rise vs. CO2 emissions. (Figure 2.6 in Van Antwerp and Heun, *A Framework for Sustainability Thinking: A Student's Introduction to Global Sustainability Challenges*, Springer, 2022. Used with permission.)

information to evaluate your answer and, ultimately, to make wise decisions about the design of future carbon-efficient energy systems for Calvin.

The customer for your work is Dr. Wiebe Boer, president of Calvin University, who desires to set an earlier carbon neutrality date.

Each group of 4–5 students must analyze a different aspect of the question, such as:
- Feasibility and development of public, private, and government funding options for pursuit of carbon neutrality
- Improving energy efficiency
- Eliminating fossil fuel electricity consumption
- Eliminating fossil fuel heating

Initially, groups will be organized around the four topics above.

The deliverables are:
(a) an Engineering department seminar on **Tuesday, 5 December 2023** at 4:00 PM in the **CFAC recital hall** (**** venue TBD ****) (both sections in one seminar).
(b) one poster per section to be presented at the Calvin University Sustainability Showcase at 3:30 PM on **Thursday, 7 December 2023** (**** venue TBD ****).
(c) two written final reports (one per section) that provide detailed descriptions of your work during the semester, due on the final day of classes (**4 PM, Thursday, 7 December 2023**).

Each ENGR333 student must attend either (a) the Engineering department seminar or (b) the Sustainability Showcase poster session.

Each final report will consist of:

(a) paper copies of your final technical memo with extensive appendices,

(b) an electronic copy of your final report (.pdf format, one file per section) to be posted at http://www.calvin.edu/~mkh2, and

(c) a flash drive or other means of conveyance containing electronic copies of all models, spreadsheets, posters, presentations, programs, and software analysis tools that you developed during the project.

You must submit copies of your final report (all three elements) to Prof. Heun.

Posters must be prepared from a template provided on Moodle. Posters must be submitted via email to slc@calvin.edu **one week** prior to the Sustainability Showcase poster session date (i.e., **Thursday, 30 November 2023**).

Each section must send notes of appreciation to each person who provided assistance during the semester.

Prior to the first class meeting each week (typically Monday), each student must submit a weekly timecard that includes

- hours worked on the project and
- a brief (1 paragraph) description of work accomplished.

Groups and sections are encouraged to share relevant information obtained from external sources and from your own research throughout the semester. To facilitate information sharing, each section should consider forming an executive team to coordinate the work of the groups in each section and, where applicable, across sections. Executive team members should mostly be relieved of their group's analysis responsibilities.

The professor will select students to form groups. To apply for one of the available groups, prepare a cover letter and resume and submit on Moodle by 8 PM on **Tuesday, 29 August 2023**. Your cover letter should indicate which group piques your interest and why you believe you are qualified to be included in that group. (You may supply first and second choices.) Group assignments will be announced via Moodle by the evening of **Thursday, 31 August 2023**.

An initial task for each group is to develop a schedule of your activities for the semester that includes all important dates and coordination among groups. Schedules must be discussed during oral progress reports (see below).

There will be three short, in-class progress reports in the form of oral presentations. A longer, in-class final presentation will summarize results of the project. Each student must give either (a) a progress report presentation or (b) part of the final presentation. The customer will be present at all presentations. The presentations must be professional quality, must concisely report your progress, and must provide sufficient technical detail for customer, professor, and peer review of your progress. Only 1 student from each team may participate in each oral progress report and 2 students (at most) from each team may participate in the final in-class report.

The in-class progress reports must follow this outline:
- Status relative to your schedule (and any re-planning that has occurred since your last report)
- Work accomplished since your last report (including technical and cost savings details)
- Issues or concerns (and plan for addressing them)
- Work planned for upcoming reporting period

The final in-class oral report should *not* follow the outline above. Rather it should summarize the final technical details of your work, how your technical work was used to estimate energy and carbon savings, and the conclusions of your group's work.

You must bring printed copies (6-up, double sided to save paper) of all in-class presentations for customer, professor, and resources.

The professor, in conjunction with the customer, will select an exemplary student from each section for a teamwork award at the end of the semester.

Despite the presence of an external customer for your work, the professor will assign final grades (in consultation with the customer). Students will be assessed on (a) the quality of their team's report, (b) peer evaluation, and (c) hours worked.

Supporting Resources:
- The customer: President Boer, wiebe.boer@calvin.edu, (616) 526-6100. Be aware that email messages are screened by the president's assistant. Please coordinate and aggregate questions before reaching out to President Boer.
- Calvin administrators:
    - Dirk Pruis, CFO, dirk.pruis@calvin.edu, (616) 526-6192.
    - Greg Elzinga, VP of Advancement, greg.elzinga@calvin.edu, (616) 526-6389.
    - Brett Hoogewind, Keystone, brett.hoogewind@calvin.edu, (616) 201-6793.
- External support:
    - Trent DeBoer, GMB Architects, trentd@gmb.com, (616) 796-0200.
    - Toby Della Santa, GMB Architects, tobyd@gmb.com, (616) 796-0200.

- Previous ENGR333 design projects available at http://www.calvin.edu/~mkh2/thermal-fluid_systems_desig/.
- Classroom learning on energy, exergy, economics, and thermal analysis
- Prior laboratory and lecture classes, especially business courses
- Independent research

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Note: Bold schedule items involve customer and resource participation, 13:05–15:00 in NH050.

Day	Date	Activity
Tue	**29 Aug**	**Project introduction, objectives, deliverables**
Thur	31 Aug	Resumes and cover letters due to Prof. Heun
Thur	31 Aug	Groups assigned via Moodle
Tue	5 Sep	Project work day (Meet in the classroom for group work) (Section A during session b; Section B during session a)
Tue	**12 Sep**	**In-class group presentations (5 minutes + 2 for questions) Use required outline.**
Tue	19 Sep	Project work day (Meet in the classroom for group work)
Tue	**26 Sep**	**In-class group presentations (5 minutes + 2 for questions) Use required outline.**
Tue	3 Oct	Project work day (Meet in the classroom for group work)
Tue	10 Oct	Project work day (Meet in the classroom for group work)
Thur	**19 Oct**	**In-class group presentations (5 minutes + 2 for questions) Use required outline. **** Thursday******
Tue	24 Oct	Project work day (Meet in the classroom for group work)
Tue	31 Oct	Project work day (Meet in the classroom for group work)
Tue	7 Nov	Project work day (Meet in the classroom for group work)
Tue	14 Nov	Project work day (Meet in the classroom for group work, both sessions)
Thur	16 Nov	Project work day (Meet in the classroom for group work, both sessions)
Tue	**21 Nov**	**Project final presentations (10 minutes + 4 for questions) Report on final results. Don't go home early for Thanksgiving break!**
Tue	**28 Nov**	**Project final presentations (10 minutes + 4 for questions) Report on final results.**
Thur	30 Nov	Peer and Project Assessment due
Tue	5 Dec	ENGR Department Seminar 4:00 PM (CFAC recital hall)
Thur	7 Dec	Sustainability Showcase poster session, 3:30 PM (Venue TBD)
Thur	7 Dec	Final report due

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Peer and Project Assessment
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Throughout this semester, you analyzed rebound and backfire for CO_2 emissions reductions. Now, your professor would like your feedback about the process in the form of a peer and project assessment. Part of your grade for the project will be determined by the quality of your peer and project assessment. Your response is and will remain confidential. Peer and project assessments are due at **3:30 PM** on **Thursday, 30 November 2023** in Prof. Heun's office.

1) Write one paragraph identifying one or two members of the class who performed exemplarily during this project. Provide examples of their supererogatory efforts.

2) Create a bullet-point list of 3 personal learnings (takeaways) from the project.

3) Create a bullet-point list of 3 suggestions for future ways to reduce Calvin's CO_2 emissions. In other words, what are your personal suggestions for Calvin moving forward?

4) Write one paragraph answering these questions: If you put this project on a resume, would you list it as "community service?" Does engineering (as a discipline) value volunteer work and community service? Why or why not?

5) Write one paragraph describing if or how your participation in this project caused you to alter your behavior this semester. Did you see any connections between your own personal behavior and CO_2 emissions reduction? If you didn't change your behavior at all, describe why not.

6) What nontechnical skills did you learn in the course of this project? Do you expect that these non-technical skills will be relevant to your future work as an engineer? If so, why? If not, why not?

7) Write three paragraphs addressing this question: what are the connections between (a) energy efficiency and (b) the twin challenges of (i) energy resource depletion and (ii) climate change caused by global warming?

8) Write one paragraph detailing your role and contributions to your small group team. Conclude the paragraph by assigning yourself a letter grade for your work on the project. Justify your grade.

9) Write one paragraph each detailing the roles and contributions of the three (or four) other team members. Conclude the paragraphs by assigning a letter grade for your teammates' work on the project. [Total of three (or four) paragraphs and three (or four) individual letter grades.]

10) Write one paragraph indicating any topics relevant to the content of ENGR333 that, in your opinion, would be interesting for future classes to study. Also provide any suggestions for improvements to the structure of this project in future years.

When writing paragraphs assessing yourself and your peers, you may wish to use the following rubric.

Did the individual:
- Research useful information for your group?
- Display punctuality in meeting deadlines?
- Thoroughly complete assigned duties?
- Share equally in work performed by the group?
- Perform work of high quality or did their work often require revision?
- Help direct the group in setting goals?
- Help direct the group in meeting goals?
- Encourage group members to share ideas?
- Display empathy during group discussions and work?
- Listen to ideas from other group members?
- Participate in helping the group work together better?