

# Renewable Energy Generation Projects

Fall 2018  
ENGR333ab  
Calvin College  
Prof. Heun

Calvin faces continuing budget constraints, requiring cost cutting in most areas of the college. Because Calvin spends nearly \$3M/year on energy (both natural gas and electricity), Physical Plant is under pressure to reduce utility expenditures. We are not alone. Businesses and educational institutions alike face reduced budgets, and stewardship of financial resources can be achieved by reducing energy costs. As far back as 2003's *The Energy Smart Guide to Campus Cost Savings* (<http://www.nrel.gov/docs/fy03osti/34291.pdf>), the National Renewable Energy Lab was highlighting the importance of energy management to reduce costs on college and university campuses.

In December 2017, President Le Roy signed the President's Carbon Commitment (<https://secondnature.org/wp-content/uploads/Carbon-Commitment-2017-Second-Nature.pdf>) which calls on Calvin to reduce greenhouse gas emissions and achieve carbon neutrality as soon as possible. One way to reduce emissions is to utilize as much renewable energy as possible. Renewable energy sources such as wind, solar, geothermal, and biomass emit or cause to be emitted very little CO<sub>2</sub> or other greenhouse gasses in the process of creating usable useful energy (heat or mechanical work). (The fabrication of renewable energy machines requires energy and causes greenhouse gasses to be emitted if the energy to make renewable energy machines is not, itself, carbon-free.) Implementation of renewable energy systems for Calvin may require up-front investment.

Both budgetary pressures and Calvin's participation in the Carbon Commitment exist in the context of a new capital campaign for Calvin. We are already in the silent phase, and a public phase is soon to begin. Some of the resources raised by the capital campaign will be reserved for new campus infrastructure. And some of the infrastructure funds (up to several million dollars) could be set aside for renewable energy generating equipment that can save annual energy costs. Your question for this semester is:

*What is the largest possible reduction in Calvin's annual energy costs from a \$5M investment in renewable energy?*

You will pursue this question in groups of 4–5 students, with each section developing an independent (and possibly different) answer to the question. Your response to the question (“*What is the largest possible reduction ...*”) should take the form of two reports (one from each section) containing comprehensive and accurate information on your approach to obtaining the specified energy cost savings. A suggested outline for each 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 Physical Plant and the Calvin administration with enough information to understand your renewable energy plan and, ultimately, to make wise decisions about future energy infrastructure on campus.

The deliverables are:

- (a) two written final reports (one per section) that provide detailed descriptions of your work during the semester,

- (b) an Engineering department seminar on **Wednesday, 5 December 2018** at 3:30 PM in SB010 (both sections in one seminar).
- (c) one poster per section to be presented at the Calvin Environmental Assessment Program (CEAP) conference at 3:30 PM on **Thursday, 6 December 2018** (date is an estimate, venue TBD).

Each ENGR333 student must attend either (a) the Engineering department seminar or (b) the CEAP 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 containing electronic copies of all models, spreadsheets, posters, presentations, programs, and software analysis tools that you developed during the project.

You must distribute copies of your final report (all three elements) to Physical Plant and your professor. Final reports are due at the end of the final exam time (**Noon, Tuesday 18 December 2018**). Each section must send notes of appreciation to each person who provided assistance during the semester.

Posters must be prepared with the CEAP template found at <https://calvin.edu/dotAsset/3b6542cc-fe22-45df-9e07-e89fbc1fbbc4>.

Unless instructed otherwise, posters must be submitted to Instructional Graphics via email to [posters@calvin.edu](mailto:posters@calvin.edu). Attach both a .ppt and .pdf version of your poster. Include BOTH a student last name and the class (ENGR333) in the filenames of the posters. Indicate that printing costs should be charged to the ENGR department AV account: 1-1-01110-50305. The professor will submit a Job Request Form at <http://www.calvin.edu/admin/igs/request/>. Posters must be submitted **three weeks** prior to the CEAP poster session date (i.e., **Thursday, 15 November 2018**).

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

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

It is likely that information from Physical Plant will be helpful to groups throughout the semester. All requests for such information requests must first be sent via email to the professor who will forward well-formed requests to physical plant and return responses to students.

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

Each section may choose to divide the work as it deems appropriate. An initial work breakdown structure is:

Section-Group	Responsibilities	Section-Group	Responsibilities
A-1	Finances & CO <sub>2</sub>	B-1	Finances & CO <sub>2</sub>

A-2	Geothermal	B-2	Geothermal
A-3	Biomass	B-3	Biomass
A-4	Wind	B-4	Wind
A-5	Solar	B-5	Solar

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The professor will select students to fill the initial groups. To apply for one of the available groups, prepare a cover letter and resume and deliver a paper copy to your professor on **Wednesday, 5 September 2018** prior to lecture. Your cover letter should indicate the group in which you are interested and why you are qualified for that position. Group assignments will be announced via Moodle in the evening of **Thursday, 6 September 2018**.

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). Mandatory early tasks include brainstorming and documenting as many successful projects of your type at other college or university campuses.

There will be three short, in-class progress reports in the form of oral presentations. There will be a longer in-class final presentation that summarizes the results of the project. Each student must give either (a) a progress report presentation or (b) part of the final presentation. 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 may participate in each oral progress reports and 2 students (at most) 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 cost savings for your section, 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 and professor.

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: Russell Bray, Director of Physical Plant  
(616) 526-6481, [rtb4@calvin.edu](mailto:rtb4@calvin.edu)
- Previous ENGR333 design projects available at  
[http://www.calvin.edu/~mkh2/thermal-fluid\\_systems\\_desig/](http://www.calvin.edu/~mkh2/thermal-fluid_systems_desig/)
- Classroom learning on energy, exergy, economics, and thermal analysis
- Prior laboratory and lecture classes (especially the thermal-fluids sequence and ENGR382)

- Independent research

# ENGR333

## Renewable Energy Projects

### Fall 2018

**Note: bold schedule items indicate customer participation.**

Day	Date	Activity
<b>Tue</b>	<b>4 Sep</b>	<b>Project introduction, objectives, deliverables</b>
Wed	5 Sep	Resumes and cover letters due to Prof. Heun at class.
Tue	11 Sep	Project work day (Meet in the classroom for group work)
<b>Tue</b>	<b>18 Sep</b>	<b>In-class group presentations (5 minutes + 2 for questions) Use required outline.</b>
Tue	25 Sep	Project work day (Meet in the classroom for group work)
<b>Tue</b>	<b>2 Oct</b>	<b>In-class group presentations (5 minutes + 2 for questions) Use required outline.</b>
Tue	9 Oct	Project work day (Meet in the classroom for group work)
Tue	16 Oct	Project work day (Meet in the classroom for group work)
<b>Mon</b>	<b>22 Oct</b>	<b>In-class group presentations (5 minutes + 2 for questions) **Monday** Use required outline.</b>
Tue	30 Oct	Project work day
Tue	6 Nov	Project work day (Meet in the classroom for group work)
Wed	14 Nov	Project work day (Meet in the classroom for group work)
Fri	16 Nov	Project work day (Meet in the classroom for group work)
Mon	19 Nov	Project work day (Meet in the classroom for group work)
Tue	20 Nov	Project work day (Meet in the classroom for group work)
<b>Mon</b>	<b>26 Nov</b>	<b>Project final presentations (10 minutes + 4 for questions) Report on final results.</b>
<b>Tue</b>	<b>27 Nov</b>	<b>Project final presentations (10 minutes + 4 for questions) Report on final results.</b>
Mon	3 Dec	Peer and Project Assessment due (3:30 PM)
Wed	5 Dec	ENGR Department Seminar 3:30 PM (SB010)
Thur	6 Dec	CEAP Poster Session, 3:30 PM (Venue TBD)
Tue	18 Dec	Final reports due at Noon

# Renewable Energy Projects

## Peer and Project Assessment

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Throughout this semester, you developed a detailed assessment of ways for Calvin to save money on energy-related costs. Now, your professor would like your feedback about the process. Part of your grade for the Energy Savings Projects will be determined by the quality of your submission. Your response is and will remain confidential. Peer and project assessments are due at **3:30 PM on Monday 3 December 2018** 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) 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?
- 3) 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 energy efficiency? If you didn't change your behavior at all, describe why not.
- 4) 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?
- 5) 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?
- 6) 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.
- 7) 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.]
- 8) 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?