

Energy Savings Projects

Fall 2017

ENGR333ab

Calvin College

Prof. Heun

Last year, Calvin College spent about \$2.8M on electricity and natural gas, and with today's financial challenges, Physical Plant is under pressure to reduce these costs. We are not alone. Businesses and educational institutions alike face reduced budgets, and stewardship of financial resources can be achieved by reducing utility expenses. 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 expenses.

Higher education executives today work in a climate as tough as that of any Fortune 500 company. The bear market took a heavy toll on many university portfolios. Budget shortfalls are a reality on many campuses. There continues to be a pressing need for new approaches to the oldest dilemma in education—how to do more with less, while not shortchanging students or demoralizing staff. In this high-stakes environment, business officers and facility managers play an increasingly important role, as they seek new technologies and methodologies for saving money. Energy management has emerged as a key area for these professionals.

There are two ways that energy managers work to reduce costs: demand-side efficiencies and production-side efficiencies. Demand-side cost reductions involve efficient use of heat and electricity at the point of demand via additional insulation, better windows, efficient light fixtures, etc. Production-side cost reductions can be achieved at the point of production with high-efficiency boilers or by producing electricity inexpensively with on-site co-generation plants.

Here at Calvin, the February 2017 report from external consultant Sightlines indicated that if Calvin were as efficient as some other colleges, natural gas cost savings in excess of \$100k could be realized. Furthermore, Calvin's decades-old, on-site co-generation plant is no longer operational, thus we cannot obtain cost savings by converting low-cost natural gas to electricity in the basement of the Commons.

Given this environment, your questions for this semester are:

Section A (10:30): What would it take for Calvin to save \$75k/year on natural gas costs?

Section B (11:30): What would it take for Calvin to save \$150k/year on energy costs (mostly electricity) using a new on-site co-gen plant?

You will pursue these questions in groups of 4–5 students. Your response to the question (“*What would it take ...*”) 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 cost savings plan and, ultimately, to make wise decisions about future energy cost savings 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, 6 December 2017** 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, 7 December 2017** (venue TBD).

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

Each final report for the project 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 single file) 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 19 December 2017**). 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 <http://www.calvin.edu/admin/igs/research%20poster%20templates/>.

Posters must be submitted to Instructional Graphics via email to 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., **Thur 16 November 2017**).

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 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	B-1	Finances
A-2	Boilers	B-2	Engine selection
A-3	Dorms & dining halls	B-3	Interconnections
A-4	Academic buildings	B-4	Natural gas savings
A-5	PE complex	B-5	CO ₂ savings (PCC*)

*President's Carbon Commitment

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, 6 September 2017** 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, 7 September 2017**.

An initial task for each group is to develop a schedule of your activities for the semester that includes all important dates and coordination between groups. Schedules must be discussed during oral progress reports (see below). Mandatory early tasks include brainstorming and documenting as many energy saving ideas as possible (section A) and detailed research into co-gen machines (section B).

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 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:

- Phil Beezhold, Director of Physical Plant: the customer
(616) 526-6481, pdb2@calvin.edu
- 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 the thermal-fluids sequence and ENGR382)
- Independent research

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Note: bold schedule items indicate customer participation.

Day	Date	Activity
Tue	5 Sep	Project introduction, objectives, deliverables
Wed	6 Sep	Resumes and cover letters due to Prof. Heun at class.
Tue	12 Sep	Project work day (Meet in the classroom for group work)
Tue	19 Sep	In-class group presentations (5 minutes + 2 for questions) Use required outline.
Tue	26 Sep	Project work day (Meet in the classroom for group work)
Tue	3 Oct	In-class group presentations (5 minutes + 2 for questions) Use required outline.
Tue	10 Oct	Project work day (Meet in the classroom for group work)
Tue	17 Oct	Project work day (Meet in the classroom for group work)
Mon	23 Oct	In-class group presentations (5 minutes + 2 for questions) **Monday** Use required outline.
Tue	31 Oct	Project work day
Tue	7 Nov	Project work day (Meet in the classroom for group work)
Wed	15 Nov	Project work day (Meet in the classroom for group work)
Fri	17 Nov	Project work day (Meet in the classroom for group work)
Mon	20 Nov	Project work day (Meet in the classroom for group work)
Tue	21 Nov	Project work day (Meet in the classroom for group work)
Mon	27 Nov	Project final presentations (10 minutes + 4 for questions) Report on final results.
Tue	28 Nov	Project final presentations (10 minutes + 4 for questions) Report on final results.
Mon	4 Dec	Peer and Project Assessment due (3:30 PM)
Wed	6 Dec	ENGR Department Seminar 3:30 PM (SB010)
Thur	7 Dec	CEAP Poster Session, 3:30 PM (Venue TBD)
Tue	19 Dec	Final reports due at Noon

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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 4 December 2017** 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?