

# Calvin Redundant Data Center Design Project

Spring 2010  
ENGR333a  
Professor Heun

Calvin is developing plans for a new data center to provide business continuity and quick recovery in the event of a disaster. The new data center will not replace the existing data center; rather, it will provide redundancy for the operations of the campus.

Because of the energy demands of data centers, there is a worldwide push for energy efficiency. So-called “green data centers” provide the same functionality as a normal data center with reduced energy usage and reduced energy costs. Calvin, like most organizations, must weigh the long-term economic benefits of energy efficiency projects against higher initial costs for such projects. Often, these tradeoffs lead to decision-making that focuses on short-term issues and favors lower initial costs, even when higher initial costs would lead to long-term savings as well as environmental and social benefits.

Calvin has instituted the *Calvin Energy Recovery Fund* (CERF) to assist with these issues. (See [http://www.calvin.edu/~mkh2/thermal-fluid\\_systems\\_desig/2008\\_ceef\\_final\\_report.pdf](http://www.calvin.edu/~mkh2/thermal-fluid_systems_desig/2008_ceef_final_report.pdf) and [http://www.calvin.edu/~mkh2/thermal-fluid\\_systems\\_desig/2008\\_ceef\\_seminar.pdf](http://www.calvin.edu/~mkh2/thermal-fluid_systems_desig/2008_ceef_seminar.pdf) for details.) Money from CERF can be used to implement energy efficiency projects on campus. Verified cost savings from those projects (relative to a baseline) are routed back into the fund for a period of 5 years after the project is paid off, thereby growing the size of the fund. Increasingly large energy efficiency projects can then be undertaken with the fund.

The question for you this semester is “*What would it take to build a redundant data center at Calvin that is 30% more energy efficient than the existing data center?*” Corollary questions include:

- What is the baseline performance of the existing data center?
- What should be considered the baseline design for the new data center?
- What design options will improve the energy efficiency of the redundant data center relative to its baseline design and relative to the existing data center?
- Are there opportunities for increased energy efficiency that could be funded by CERF?
- Can we take advantage of existing overcapacity of the HVAC infrastructure on campus in the design of the new data center?
- How can we assess the energy performance of the data center?

Your answer to these questions should take the form of a comprehensive and realistic design for the new data center. Elements of your proposed design should include:

- Options for differential energy efficiency interventions that could be designed into the data center
- An energetic and economic evaluation of the energy efficiency options
- Recommendations for which design options should be undertaken for the new data center
- A list of which design options you reject and the reasons why you reject them

Your deliverables are:

- (a) a final report that provides a detailed description of your design,
- (b) an Engineering seminar on Friday 30 April 2010 at 3:30 PM (location TBD), and

- (c) two posters to be presented at the Calvin Environmental Assessment Program (CEAP) conference at 3:30 PM on Thursday 6 May 2010 (location TBD).

Each student must attend either (a) the CEAP Poster Session or (b) the Engineering Seminar.

Your final report will consist of:

- (a) a paper copy of your final technical memo with extensive appendices (the tech memo must be a single report for the entire class),
- (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 CD or DVD containing electronic copies of all posters, presentations, programs, and analysis tools that you developed during the project.

The ultimate customer for your final report is Calvin's Vice-President for Finance, Henry DeVries. The final written report should follow the technical memo format, including a two-page summary with conclusions followed by extensive appendices. Each group (see below) must provide a detailed appendix (in technical memo format, of course) to the overall technical memo that describes the analyses performed by and the contributions from each group.

You must distribute copies of your final report (all three elements) to the VP for Finance, your supporting resources (see below), and your professor. The final report is due on Monday, 17 May 2010 before Noon. As a class, you must also send a note of appreciation to each resource for their assistance during the semester.

To develop the required design, you must first brainstorm (as an entire class) several energy efficiency design options to be evaluated. You must develop ideas on your own *and* in consultation with your resources. You must present your list of ideas during your first progress presentations.

You will pursue this project in small groups of approximately 5 students each. The groups will address the following topics:

- HVAC system design (including whether to integrate with existing campus loops)
- Envelope (design of walls, ceiling, and floor)
- Power/energy supply (design how energy will be supplied, including UPS, etc.)
- Instrumentation (design how to measure and assess performance)
- Finance/CERF (evaluate design options from a financial perspective and assess whether CERF can be utilized for incremental design improvements)

You should consider forming an executive council consisting of representatives from each of the five groups discussed above. The executive council could be responsible for coordinating and planning the final report and for writing the introductory two pages of the report, among other things.

The professor will select students to fill the groups. To apply for one of the available groups, prepare a cover letter and resume and deliver it to your professor on Wednesday 3 February 2010 at class. 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 Knightvision in the evening of Wednesday 3 February 2010.

As a class, you may find it necessary to adjust the topics being addressed by each group as the semester progresses. For example, if none of the topics assigned to a group appear technically or financially

feasible, you may need to re-distribute the topics and analyses among the groups. Or, new ideas may emerge that require study. Those may be pursued as required.

All groups must arrange a tour of Calvin's existing data center facilities with Sam Anema (see *Supporting Resources* below). All groups must arrange a meeting with Bob Myers to brainstorm energy savings ideas related to your topic for the data center.

The first task for each group will be to develop a schedule of your activities for the semester that coordinates with the timelines of other groups. The schedule must show milestones corresponding to points of interaction with other groups. Schedules must be presented during the first oral progress reports (see below).

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 data center project. Each student must give either (a) part of the progress report presentations 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.

The in-class progress reports must follow the following 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 details)
- Issues or concerns (and plan for addressing them)
- Work planned for upcoming reporting period

The final in-class oral report need not follow the outline above. Rather it should summarize the final technical details of your work, how your work was used in the final design for the data center, and the conclusions for your group.

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

Although the customer for this report is the VP for Finance, final grades will be assigned by your professor. Students will be graded on (a) the quality of their team's contribution to the overall effort of the class and (b) peer evaluation. The professor, in conjunction with our external resource persons, will select an exemplary student for a teamwork award at the end of the semester.

Supporting Resources:

- Dr. Henry DeVries, VP for Finance: the ultimate customer  
(616) 526-6148, [hdevries@calvin.edu](mailto:hdevries@calvin.edu)
- Sam Anema, CIT: contact for information about existing and new data center designs  
(616) 526-6780, [sane@calvin.edu](mailto:sane@calvin.edu)
- Bob Myers, CIT: contact for information about CIT and usage of the new data center  
(616) 526-6620, [rmyers@calvin.edu](mailto:rmyers@calvin.edu)
- Paul Pennock, Physical Plant: contact for information about the existing campus HVAC systems  
(616) 262-9230 (mobile), [ppennock@calvin.edu](mailto:ppennock@calvin.edu) (email)
- Classroom learning on exergy, energy, economics, and thermal analysis
- Prior laboratory and lecture classes
- Independent research

# ENGR 333 Data Center Project Schedule (2010)

Full-group project meetings are held Tuesdays 1:30–2:20 in SB101

**Note: bold schedule items will include participation of the customer and resources**

| <b>Day</b> | <b>Date</b>   | <b>Activity</b>                                                                                |
|------------|---------------|------------------------------------------------------------------------------------------------|
| <b>Mon</b> | <b>1 Feb</b>  | <b>Project introduction, objectives, deliverables, introduction to resources</b>               |
| Wed        | 3 Feb         | Cover letters and resumes due to Prof. Heun at class. Groups assigned.                         |
| Tue        | 9 Feb         | Project work day (Meet in the classroom for group work)                                        |
| <b>Tue</b> | <b>16 Feb</b> | <b>In-class group presentations (7 minutes + 2 for questions)<br/>Use required outline.</b>    |
| Tue        | 23 Feb        | Project work day (Meet in the classroom for group work)                                        |
| <b>Tue</b> | <b>2 Mar</b>  | <b>In-class group presentations (7 minutes + 2 for questions)<br/>Use required outline.</b>    |
| Tue        | 9 Mar         | Project work day (Meet in the classroom for group work)                                        |
| Tue        | 16 Mar        | Project work day (Meet in the classroom for group work)                                        |
| Tue        | 30 Mar        | Project work day (Academic Advising)                                                           |
| <b>Tue</b> | <b>6 Apr</b>  | <b>In-class group presentations (7 minutes + 2 for questions)<br/>Use required outline.</b>    |
| Tue        | 13 Apr        | Project work day (Meet in the classroom for group work)                                        |
| Fri        | 16 Apr        | Project work day (Meet in the classroom for group work)                                        |
| Mon        | 19 Apr        | Project work day (Meet in the classroom for group work)                                        |
| Tue        | 20 Apr        | Project work day (Meet in the classroom for group work)                                        |
| Wed        | 21 Apr        | Project work day (Meet in the classroom for group work)                                        |
| <b>Fri</b> | <b>23 Apr</b> | <b>Project final presentations (13 minutes + 2 for questions)</b>                              |
| <b>Mon</b> | <b>26 Apr</b> | <b>Project final presentations (13 minutes + 2 for questions)<br/>Report on final results.</b> |
| Fri        | 30 Apr        | ENGR Department Seminar 3:30 PM. Location TBD.                                                 |
| Thur       | 6 May         | CEAP Poster Session, 3:30 PM                                                                   |
| Mon        | 17 May        | Final report due at Noon                                                                       |