

# Bunker Interpretive Center Energy Efficiency Project

Fall 2011  
ENGR333a  
Professor Heun



The Bunker Interpretive Center (BIC) opened in 2004 and earned its LEED Gold certification in 2005. Because the LEED standards have focused only on building *design*, they say nothing about building energy consumption. In contrast, the U.S. Environmental Protection Agency (U.S. EPA) has established the Energy Star<sup>®</sup> rating for buildings. (See [http://www.energystar.gov/index.cfm?c=business.bus\\_index](http://www.energystar.gov/index.cfm?c=business.bus_index) for details.) Much like the appliance ratings we are accustomed to seeing, an Energy Star<sup>®</sup> rating recognizes a building for being in the top 25% for building energy efficiency nationally. While LEED addresses the *design* of a building, Energy Star<sup>®</sup> addresses the *operation* of the building.

According to the New York Times (<http://www.nytimes.com/2009/08/31/science/earth/31leed.html?scp=1&sq=leed%20buildings%20energy&st=cse>), over the past several years 53% of LEED<sup>®</sup> buildings did not qualify for the Energy Star<sup>®</sup> label, and 15% of LEED<sup>®</sup> buildings score in the bottom 30% of buildings for energy efficiency. The challenge for you (as a class) this semester is to answer the following question:

*What would it take for Calvin College to obtain an Energy Star<sup>®</sup> rating for the Bunker Interpretive Center? Or, if the BIC already qualifies for an Energy Star<sup>®</sup> rating, what would it take to improve the energy efficiency of the BIC (as measured by Energy Star<sup>®</sup> metrics) by 15%, thereby ensuring Energy Star<sup>®</sup> performance of the building into the future.*

There are several challenges that must be overcome in the process of answering this question.

## The BIC Doesn't Fit

The Energy Star® program certifies buildings in the following categories:

Commercial Buildings	Manufacturing Plants
Bank branches	Auto assembly plants
Courthouses	Cement plants
Data centers	Container glass manufacturing
Dormitories	Cookie and cracker baking plants
Financial centers	Flat glass manufacturing
Hospitals	Frozen fried potato processing plants
Hotels	Juice processing
House of worship	Petroleum refineries
K-12 schools	Pharmaceutical manufacturing plants
Medical offices	Pulp and paper plants
Offices	Wet corn mills
Retailers	
Senior Care	
Supermarkets	
Warehouses	

Unfortunately, the BIC doesn't fit one of the existing categories. This means that you will need to define a new category of building, *Tertiary Academic: Mixed Use*. You must apply the EPA's method for establishing Energy Star® thresholds to develop the Energy Use Intensity (EUI) target score for the new category.

An overview of the EPA process is as follows:

- The U.S. Energy Information Administration (U.S. EIA) conducts its Commercial Buildings Energy Consumption Survey (CBECS) approximately every 4 years.
- For each category, the EPA selects a subset of buildings from the CBECS.
- From the data available in that subset, the EPA develops the Energy Star® statistics for that category.
- From the statistics, and accounting for many factors, including size, site, and occupancy for each building, the EPA defines the Energy Star® Energy Use Intensity (EUI) threshold for buildings of that type.

Resources:

CBECS: <http://www.eia.gov/emeu/cbecs/contents.html>

How the Energy Star® rating system works:

[http://www.energystar.gov/index.cfm?c=evaluate\\_performance.pt\\_neprs\\_learn](http://www.energystar.gov/index.cfm?c=evaluate_performance.pt_neprs_learn)

Understanding the Energy Performance Scale:

[http://www.energystar.gov/ia/business/evaluate\\_performance/The\\_ENERGY\\_STAR\\_Energy\\_Performance\\_Scale\\_3.28.11\\_abbrev.pdf](http://www.energystar.gov/ia/business/evaluate_performance/The_ENERGY_STAR_Energy_Performance_Scale_3.28.11_abbrev.pdf)

How the rating levels are calculated (for existing Energy Star® building categories):

[http://www.energystar.gov/index.cfm?c=evaluate\\_performance.bus\\_portfoliomanager\\_model\\_tech\\_desc](http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager_model_tech_desc)

### *Obtaining and Assessing Energy Consumption Data*

In the Spring 2011 semester, the ENGR382 classes designed a building monitoring system that collects energy consumption data for the BIC. You will use that monitoring system to monitor building energy usage and develop EUIs and an Energy Cost Intensity (ECI) for the BIC.

Resources:

Paul Pennock: Physical Plant, (616) 262-9230 (mobile), [ppennock@calvin.edu](mailto:ppennock@calvin.edu)

### *Understanding the Impact of Renewable Energy Sources*

The BIC has a building-integrated PV system that supplies electricity to the building. This renewable energy generation capability provides an offset to fossil fuel energy consumption at the BIC, and it should be accounted when developing the electricity EUI for the building.

Resources:

On-site Renewable Energy:

[http://www.energystar.gov/index.cfm?c=healthcare.bus\\_healthcare\\_onsite\\_energy](http://www.energystar.gov/index.cfm?c=healthcare.bus_healthcare_onsite_energy)

Chuck Holwerda: Electronics Shop Technician, (616) 526-6438 (office), (616) 802-4903 (mobile)  
[holwerda@calvin.edu](mailto:holwerda@calvin.edu)

### *Evaluating the BIC*

You can use the Portfolio Manager tool at the Energy Star<sup>®</sup> website to analyze the performance of the BIC.

Resources:

Portfolio Manager:

[http://www.energystar.gov/index.cfm?c=evaluate\\_performance.bus\\_portfoliomanager](http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager)

Eric DeVries of Midwest Energy Group: 616-299-9463 (cell), [edevries@midwestenergygroup](mailto:edevries@midwestenergygroup)

### *Improving Energy Efficiency*

If necessary, you need to make suggestions for improving the energy of the building. Calvin has instituted the *Calvin Energy Recovery Fund (CERF)* to assist with these issues. 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. There may be opportunities to apply for CERF funding to implement an energy efficiency idea. The CERF intern is a potential resource-person for energy efficiency ideas.

Resources:

Mike Troupos: CERF intern ([mtt2@students.calvin.edu](mailto:mtt2@students.calvin.edu))

CERF website: <http://www.calvin.edu/admin/development/cerf.html>

Previous CERF reports and presentations:

[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)

[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)

CERF policies: available from CERF intern

Your response to the question (“*What would it take ...*”) should take the form of a single report containing comprehensive and accurate analysis of the BIC’s energy usage relative to your new Energy Star® category and suggestions for how Calvin College could either obtain the Energy Star® rating in the new *Tertiary Academic: Mixed Use* category or improve the energy efficiency of the BIC by 15%.

Your deliverables are:

- (a) a final report that provides a detailed description of your work during the semester,
- (b) two posters to be presented at the Calvin Environmental Assessment Program (CEAP) conference at 3:30 PM on Thursday 1 December 2011 (location TBD)
- (c) an Engineering seminar on Tuesday 6 December 2011 (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 one 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 (from Calvin College administration and Midwest Energy Group), and your professor. The final report is due on **Thursday, 15 December 2011** before Noon. As a class, you must also send a note of appreciation to each resource for their assistance during the semester.

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

- Total Building EUI (BTU/ft<sup>2</sup>-yr): This group develops statistical analyses on the total building Energy Use Index for the *Tertiary Academic: Mixed Use* category. They calculate the BIC's total building EUI and compare to other buildings in the new category.
- Electricity EUI (kwh/ft<sup>2</sup>-yr): This group develops statistical analyses on the Electricity Energy Use Index for the *Tertiary Academic: Mixed Use* category. They calculate the BIC's Electricity EUI and compare to other buildings in the new category.
- Natural Gas EUI (Ccf/ft<sup>2</sup>-yr): This group develops statistical analyses on the Natural Gas Energy Use Index for the *Tertiary Academic: Mixed Use* category. They calculate the BIC's Natural Gas EUI and compare to other buildings in the new category.
- Total Building ECI (\$/ft<sup>2</sup>-yr): This group develops statistical analyses on the total building Energy Cost Index for the *Tertiary Academic: Mixed Use* category. They calculate the BIC's total building ECI and compare to other buildings in the new category.
- Renewable Energy and External Comparisons: This group reviews how renewable technologies affect building energy balance and figures out how to apply renewable energy production to the total EUI for the building. They also are responsible for identifying similar buildings in the U.S. and assessing the BIC relative to those other buildings. This group also researches other comparisons between LEED and Energy Star<sup>®</sup>. This group is responsible for performing adjustments to the EUI levels based on external factors including siting, weather, and occupancy.

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 all activities among the groups, planning the final report, and 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 7 September 2011 before 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 Wednesday 7 December 2011.

As a class, you may find it necessary to adjust the topics being addressed by each group or redistribute the workforce among the groups as the semester progresses. You may simply make the change yourselves provided that you inform the professor and supply justification.

An initial task for each group is to develop a schedule of your activities for the semester that coordinates with the schedules 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 renovation 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. Please have only 1 student participating in oral progress report and 2 students (at most) participating in the final in-class report.

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 conclusions for the BIC project, 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, your professor will assign final grades (in consultation with the resources for the project). Students will be assessed 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)
- Dan Slager, Physical Plant: Calvin College energy purchasing  
(616) 526-6267, [slagda@calvin.edu](mailto:slagda@calvin.edu)
- Dr. Randy Van Dragt: Ecosystem Preserve Director, (616) 526-6497, [vdra@calvin.edu](mailto:vdra@calvin.edu)
- Jeanette Henderson: Ecosystem Preserve Manager, (616) 526-7601, [jmh46@calvin.edu](mailto:jmh46@calvin.edu)
- Previous ENGR333 design projects available from  
[http://www.calvin.edu/~mkh2/thermal-fluid\\_systems\\_desig/](http://www.calvin.edu/~mkh2/thermal-fluid_systems_desig/)
- Classroom learning on exergy, energy, economics, and thermal analysis
- Prior laboratory and lecture classes
- Independent research
- Other resources listed in sections above

Next year, consider requiring weekly 0.5-page updates from each student.

# ENGR333 Bunker Interpretive Center Energy Efficiency Project Fall 2011

Full-class project meetings are held Tuesdays 10:30–11:20 in NH050

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

Day	Date	Activity
<b>Tue</b>	<b>6 Sep</b>	<b>Project introduction, objectives, deliverables, intro. to resources (11:00)</b>
Wed	7 Sep	Cover letters and resumes due to Prof. Heun at class. Groups assigned.
Tue	13 Sep	Project work day (Meet in the classroom for group work)
<b>Tue</b>	<b>20 Sep</b>	<b>In-class group presentations (7 minutes + 2 for questions) Use required outline.</b>
Tue	27 Sep	Project work day (Meet in the classroom for group work)
<b>Tue</b>	<b>4 Oct</b>	<b>In-class group presentations (7 minutes + 2 for questions) Use required outline.</b>
Tue	11 Oct	Project work day (Meet in the classroom for group work)
Tue	18 Oct	Project work day (Meet in the classroom for group work)
Tue	25 Oct	Project work day (Academic Advising)
<b>Tue</b>	<b>1 Nov</b>	<b>In-class group presentations (7 minutes + 2 for questions) Use required outline.</b>
Tue	8 Nov	Project work day (Meet in the classroom for group work)
Tue	15 Nov	Project work day (Meet in the classroom for group work)
Wed	16 Nov	Project work day (Meet in the classroom for group work)
Fri	18 Nov	Project work day (Meet in the classroom for group work)
Mon	21 Nov	Project work day (Meet in the classroom for group work)
Tue	22 Nov	Project work day (Meet in the classroom for group work)
<b>Wed</b>	<b>23 Nov</b>	<b>Project final presentations (13 minutes + 2 for questions)</b>
<b>Mon</b>	<b>28 Nov</b>	<b>Project final presentations (13 minutes + 2 for questions) Report on final results.</b>
Thur	1 Dec	CEAP Poster Session, 3:30 PM (Location TBD)
Tue	6 Dec	ENGR Department Seminar 3:30 PM (Location TBD)
Thur	15 Dec	Final report due at Noon