



Net Zero Energy Module

Can we get to Zero?

Context: In response to calls for corporations and universities to decarbonize their operations, teams will develop plans for a Net Zero Energy Building. These types of buildings are optimally efficient, and over the course of a year, generates energy onsite in a quantity equal to or greater than the total amount of energy consumed onsite.

Teams will need to outline three innovative options for retrofitting a building we all spend time inside of and are familiar with. Building chosen for this assignment is the Business School. Baseline information on the buildings performance and utility data, along with emissions information is provided within this project-based assignment. Each team will have a \$20M budget constraint to create an proposal for renovation projects that can be tracked by the system. Each energy management plan must have a benefits summary for the renovation based on a business case for the proposed changes to the Business School, including a reduction in this building's ecological footprint, and potential improvements in stakeholder productivity.

*Given the nature of ongoing renovation efforts on campus and with the Business School, do not approach contractors or companies under the auspices of this "assignment" being something they can come to the University to bid on or solicit services.

Objectives:

- Net Zero Energy plan development among teams to outline the vision of the building as a system, a sustainability plan, and three proposed high-level ROI projects. Teams can use information from invited speakers, course resources, and public-domain research.
- Teams are encouraged to be innovative and use green building products and materials, the most efficient systems, mechanicals, fixtures, and passive and active approaches to building and system investments.
- Proposed design features that capture *the business case* resulting from implementing the system and three suggested investment projects. The business case should include environmental and social returns on investments, be based on peer-reviewed journal articles and trade journal research studies, and have impacts on ecological footprint and stakeholder productivity.
- Summarize total costs and savings using ROI, and NPV calculations while including the social cost of CO₂
- Compare and contrast the building's current and future Energy Use Intensity (EUI)
- Answer the question: what does it take to get this building to Net Zero energy?



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Building/Systems Information:

- HVAC system resides on the roof above the 10th floor. Heating and cooling are provided from on-campus cogeneration and ice storage facilities.
- Electricity is provided roughly 85% by on campus cogeneration facility, 15% from the local grid. The University buys Renewable Energy Certificates to offset the 15% of electricity coming off of the grid (how can offsets play a role in getting to Net Zero?).
- Floor Information: The 1st floor thru the 10th floor is the same (11,514 sq ft) with the exception of the 6th fl (12,738 w/ pedestrian bridge). Using the Eaton electricity meter readings, our estimated electric consumption, at a rate of 10 cents per kWhr is a daily consumption of ~ 4,333 kwh or \$433.30, monthly ~ 130,000 kwh or \$13,000; and annual consumption of ~ 1,560,000 kwh and \$156,000.
- Building total gross sq. feet is 165,065, not including the 6th floor pedestrian bridge.
- Water information: Annual consumption is 1,076,000 gallons at a total cost of \$9,378.00 with an average monthly cost between the range of \$.00836 and \$.00898.
- Flooring/Ceilings: carpeting, with drop tile ceilings throughout.
- Interior finish is concrete and rock slab over metal structural framework.

- Structural composition of core: steel and concrete, masonry block around elevators
- Number of windows can be determined for each floor. Elevation and size to be determined is needed. Size can be estimated from inside or outside the building.
- Utilize the building's historical energy and water data
- Stay within the proposed budget while demonstrating integrated bottom-line returns

Student Resources

- Consider: LEED, Passive House, Energy Star; WELL Buildings; resources within Course Website; professional networks; and web-based research.
- EPA electric grid data for [conversion factors](#) for the state of Pennsylvania (PA), USA. Output emission rates for PA electric grid mix is 860 lb/MWh (there are 1000 kWh in 1 MWh)
- Converting pounds to metric tons (1 lb = .000453592 metric tons)
- The CO₂ equivalent in pounds per kWh is 860/1000 = .86
- Then the CO₂ equivalent metric ton per kWh is 0.00390089 This number can be used to tell you how many metric tons of CO₂ your Business School projects would help avoid emissions from per kWh saved and can be used for the Social Cost of CO₂.
- Social Cost of CO₂ = \$51/ton
- Keep in mind a US short ton is 2000 pounds and a metric ton is 2204.62 pounds. Apply the SSC to metric tons of CO₂ ([Website fo the Social Cost of CO₂](#)).



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Student Deliverables

(Evaluated using the course written deliverables guidelines with 100 points possible)

Report (Max 5 pages, not including appendices). The report outline should include an explicit use of the sustainability frameworks and planning as outlined below report checklist portion of this document (executive summary, situation analysis, conclusions, research and analysis, indicated actions with suggestions to monitor and control, including proposed methods for educating occupants about energy and CO₂ emissions). The report should highlight the team's vision of a Net Zero energy building, cost estimates that include the impacts of using a SCC, sources for project materials, and realistic cost estimates, along with works cited from academic and trade journals.

The report evaluation criteria include communication, content, development of coherent analysis, application of relevant sustainability models, and strategic business frameworks and models.

Presentation (20 minutes with 10 minutes Q&A) with the following outline:

- Problem/Opportunity Statement: scope of the Net Zero energy plan
- Situation analysis: energy retrofit vision and measures of success to get to Net Zero
- Alternatives evaluation: strategic alignment of success criteria
- Propose three investment projects: business case including ROI, NPV and Payback (20 yr, using 3% discount rate), discuss impacts of using the SCC.
 - Review the sustainability attributes of the proposed design and application of cross-functional frameworks or models from across MBA courses.
- Suggest metrics to monitor and control, including proposed methods for educating occupants about energy and water usage.



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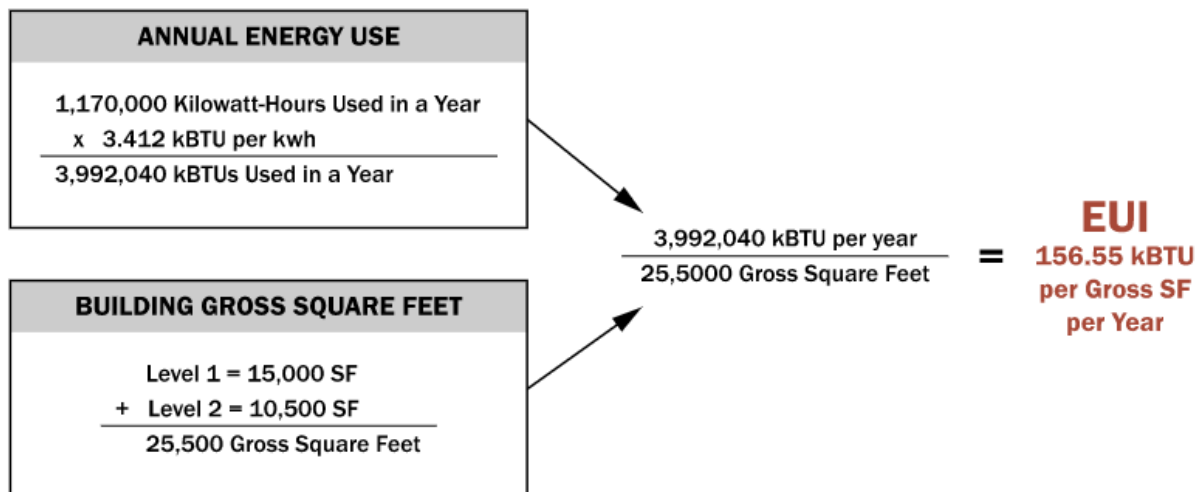
Instructor Checklist and Resources

*Note: Most of this information can come from internal sources, University Facilities personnel.

- ✓ Business School Building floor plan diagrams and/or sqft information by floor to get to the total square footage of the building.
- ✓ The structural composition of the building, i.e., brick, cement, steel, timber etc.
- ✓ Utility data and cost data, for electricity
- ✓ Description of any recent building retrofits or new HVAC equipment installed.

Information gathered from external sources

- ✓ Net Zero Energy Buildings Basics, National Renewable Energy Laboratory ([NREL](#))
- ✓ Calculate Energy Use Intensity
 - [What is EUI?](#) EUI is expressed as energy per square foot or meter per year. EUI is calculated by dividing the total energy consumed by the building in one year by the total gross floor area of the building. This is measured in kBtu/sqft
 - Generally, a low EUI signifies good energy performance. However, certain property types will always use more energy than others. For example, a school uses relatively little energy compared to a hospital. See the building example below.



- ✓ Convert electricity into CO₂ emissions using [eGRID data](#) specific to your location, i.e., State if in the USA. <https://www.epa.gov/egrid>
- ✓ Social Cost of Carbon dioxide (SCC) price suggested by the US Federal Government is \$51/ton.
 - <https://www.rff.org/publications/explainers/social-cost-carbon-101/>

Optional

- ✓ Invite internal and external judges from university facilities, faculty, or industry.



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Judging Panel Criteria (optional):

(Presentations evaluated by judges, each category is worth a possible total of 100 points)

Instruction to Judges: complete the following evaluation by assigning between 0 and 100 points for each of the five criteria.

1. Feasibility of getting to Net Zero energy and change in EUI.
2. Demonstrates the highest possible ROI and payback, emphasizing projects that will lower occupancy costs, including utilities and maintenance.
3. Realistic cost estimates and assumptions with financial modeling.
4. Thoughtful methods for educating occupants about energy usage.
5. Shows evidence of input gathered from academic and trade journals from a variety of disciplines.

The Report and Presentation can be equally weighted and combined when tallying each team's final performance evaluation point total. The deliverables and judging criteria parallel the US Green Building Council Natural Talent Design competition but have been modified to fit our needs.

Judges can, and have included: Project Managers and Budget Analysts from University Facilities; Program Directors; Executive Director of Education; the Director of Entrepreneurship; University Business School Faculty; Executive Director of BOMA; President, Construction Companies, Engineers, Architects; and area NGOs involved in Green Buildings.

Related Pedagogical References Supporting Module:

Sroufe, R., Hart, S. L., & Lovins, H. (2021). [Transforming Business Education](#): 21 st Century Sustainable MBA Programs. *Journal of Management for Global Sustainability*, 9(1).

Sroufe, R. (2020). [Business schools as living labs](#): Advancing sustainability in management education. *Journal of Management Education*, 44(6), 726-765.

Sroufe., R., Stevenson, C., and Eckenrode, B., (2019). [The Power of Existing Buildings](#): Save Money, Improve Health, and Reduce Environmental Impacts, Island Press.

Sroufe, R. (2018). [Integrated Management](#): How Sustainability Creates Value for Any Business, Emerald Perss.

Laszlo, C., Waddock, S., & Sroufe, R. (2017). [Torn Between Two Paradigms](#): A Struggle for the Soul of Business Schools. *AI Practitioner*, 19(2).

Sroufe, R., and Ramos D., (2015). "[Leveraging Collaborative, Thematic Problem-based Learning](#) to Integrate Curricula," *Decision Sciences Journal of Innovative Education*, 13.2



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Net Zero Energy Plan Report -- Outline and Checklist

NOTE: Final document should be no more than 5 pages without appendices.

<i>Section</i>	<i>Elements</i>	<i>Description</i>	<i>Length</i>
Prefatory	1. Cover Page	Plan title, students' names, date, ethics statement.	1 page
	2. Executive Summary	Condense the entire report into a "mini" version for those who will <i>not</i> read the body of the report. Write this last; include a recap of analysis, alternatives, conclusions, and action plan.	½ page
Text (<i>Body</i>)	3. Situation Analysis and Purpose	<p>Preface the purpose, scope and limitation of the energy management plan:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Describe the "System" current state, industry, drivers, competition and operational issues. <input type="checkbox"/> Identify the problem statement, goals and key operational and supply chain issues. <input type="checkbox"/> Provide any needed background or rationale on the process examined. <input type="checkbox"/> Define "Success" and how it will be measured (metrics). 	¾ page
	4. Conclusion(s)	Succinctly state conclusions and implications of research and analysis.	¼ page
	5. Research & Analysis	<p>This section should be a fact-based analysis of the "Strategic" alignment of recommendations, including subsections such as those listed below, but detail and data should be in the appendix:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Significant findings from literature search and benchmarking <input type="checkbox"/> Documentation of "current state" of the building's EUI, identification of "ideal state" <input type="checkbox"/> Apply a stage of implementation assessment, available "Tools" <input type="checkbox"/> Identify places to intervene and a planning process <input type="checkbox"/> Identify the business case for the organization, apply SWOT and other relevant models <input type="checkbox"/> Long-term strategy, including three suggested time frames for actions (see below) <input type="checkbox"/> Suggest a framework and net zero vision for the building <input type="checkbox"/> Impact assessment dashboard, what should be measured, and why <input type="checkbox"/> Implementation plan of actions including forecasted impact on cost-benefit categories <input type="checkbox"/> Results of any statistical and financial analyses <input type="checkbox"/> Environmental impacts of the building, "current state" and "ideal state" <input type="checkbox"/> Recommend communication of benefits and opportunities for stakeholders 	2-3 pages
Supplementary	6. Indicated Action	Outline your recommendations to achieve the goals of the plan. Include short and long-term action steps, a timetable, and a budget (overall costs and benefits), and identify enabling sustainability assessment alternatives and " Actions ".	1 page
	7. Bibliography	Works cited and consulted.	Variable
	8. Appendix	Exhibits; assessment tools, including sustainability models, frameworks, UN SDGs. Summary Table of the three options total costs, EUI, NPV, ROI, and SCC impacts.	Variable