



Energy, Environment and Society (5.92)

Student Project Results

Disclaimer

The following document was created by undergraduate students at the Massachusetts Institute of Technology as part of a Spring 2007 class “Energy, Environment and Society”. The report, which includes data that were collected and analyzed by students as part of an intensive educational experience, is not intended to be comprehensive or conclusive. The conclusions of this student report should not be interpreted as being endorsed by MIT or any parties involved in this study. All data and analyses should be confirmed prior to use in the implementation of any energy installation. No licensed engineers or architects participated in the creation of this analysis.

Executive Summary

In response to the growing concern of global climate change, the City of Cambridge, Massachusetts has set a target to reduce its greenhouse gas emissions to 20% of the 1990 level by 2010 (Climate 2). To achieve this goal, the City has outlined numerous strategies. One of the targets is to increase the energy efficiency of Cambridge's buildings. In accordance with this target, Cambridge Rindge and Latin High School (CRLS) is planning to reconstruct the roof of one of its buildings, and would therefore be an attractive site for a renewable energy system. HMFH Architects has been contracted to update the roof, and is considering implementing renewable options. The goal of Team CRLS was to work with the school's facilities and with the HMFH Architects to assess which technology would most benefit the school both economically and environmentally. The Team then developed a plan to integrate these alternative energy technologies into the design of the new roof.

Two different roof sites were analyzed for this project, but the majority of the team's analysis focused on the War Memorial roof because this is what will undergo the retrofit. Team CRLS then determined which alternative energy options would be feasible at this location. They considered multi-crystalline silicon solar photovoltaic cells and solar thermal units, as well as AeroVironment and Skystream wind turbines. The feasibility study for these systems was based on environmental factors—such as space availability, incident sunlight, and weather patterns—as well as cost. The relevant information was gathered through a number of avenues. Two OnSet weather stations were installed on the CRLS roof for a period of five weeks in order to get data on wind speed and direction, as well as solar insolation. Wind data was then correlated with data acquired by the MIT wind study, as well as seasonal averages from other locations. The solar data was compared to data from the MIT student center as well as data from NASA. This comparison allowed the team to compute long-term averages in order to insure that the data they were analyzing was correct and that their analysis would be sustainable over the next ten or twenty years.

After the data was acquired and correlated, it was imperative to evaluate the cost of implementing these systems and compare it to the benefits that the system would provide. The systems were compared by considering annual energy savings, the amount of carbon equivalent emissions offset, the payback periods and net present values, and the lifecycle analyses. In the end, the stakeholders should be able to see exactly how their initial investment will correspond with a reduction in greenhouse gas emissions and energy expenditures.

Overall, Team CRLS would recommend to the architect, the city, and the school to incorporate solar thermal into the roof redesign. They also feel that it would be in the school's best interest to pursue the solar photovoltaic option only if they are granted funding from Massachusetts Technology Collaborative, and to forget about the wind turbine, as wind is not a viable resource on the War Memorial.