UNH Building Energy Benchmarking

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Abstract

The University of New Haven has, over the past several years, been striving to reduce campus energy usage. The purpose of this project was to evaluate the various energy inputs of each of the buildings on campus in order to develop a conservation plan. This project utilized EPA's Portfolio Manager® to energy benchmark nine of the campus buildings at UNH. An energy baseline for fiscal year 2013 was created. The baseline represented electrical, gas, and propane usage, as well as important building characteristics such as square footage, number of occupants, number of computers, etc. An expansion of this project to include more buildings is planned for academic year 2013-2014.

Introduction

Founded in 1920, the University of New Haven (UNH) is a small private institution of higher education in West Haven, Connecticut. UNH offers 75 degree programs for approximately 4,600 undergraduate and 1,800 graduate students. With a main campus comprised of 35 buildings, eight of which are residence halls and others, which are mixed-use academic buildings, it is important to review and monitor the energy usage of the thriving campus.

Energy benchmarking is defined as the ongoing review of energy performance for a building in comparison to previous years, in comparison to other buildings within the portfolio, and in comparison to similar buildings nationwide. Benchmarking is usually performed using a software tool. In this case, the Environmental Protection Agency's (EPA) Portfolio Manager was used. Portfolio Manager® is an online tool created by the EPA that allows users to measure and track energy and water consumption, as well as greenhouse gas emissions. This software was chosen because it is widely used and allows national comparisons, and has also been used for other benchmarking projects by UNH faculty and students. Buildings in the portfolio can be ranked by performance against standard benchmarks or similar buildings across the nation, as well as have yearly progress recorded to show the successes of energy and water conservation strategies and improvements.

This project was preceded by two similar studies. Adam Sipperly, a senior in System Engineering, worked with Dr. Amy Thompson and United Illuminating to energy benchmark municipal buildings in Connecticut. The methods and processes performed in this project were applied to the current study. Celtic Energy provided an energy audit and report to UNH for 19 on campus buildings, from which the initial buildings to benchmark were selected. Information and conclusions from the Celtic Energy report were considered during the analysis portion of this research.

The results of this report will aid the University in creating a strategic energy plan for addressing the use of and expenditures for energy on campus. EPA Portfolio Manager will also allow the facilities department to easily upload the data from each energy bill so that they can monitor the progress of current and future energy projects. We will also be able to generate a comparison of our energy use to that of other campuses across the country.

Literature Review

Several journal articles and energy reports were researched to provide background for the actual project. For example, a report created for UNH prepared by Celtic Energy was used to determine which buildings would be evaluated first; the recommendations for energy conservation in potential problem areas were considered as well. The Celtic Energy Master Plan provides an overview of the building data already collected. The purpose of this evaluation was to develop an energy use baseline for selected buildings and to perform an American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Level 1 energy audit. They surveyed 18 buildings on campus: Marvin K. Peterson library, Echlin Hall, Charger Gym, Harugari Hall, Buckman Hall, Dodds, Kaplan Hall, Bethel, Dunham, Sheffield, Winchester, Maxcy Hall, Bartels Hall, South Campus, Soundview, Gate House, and German Club.

Sipperly's final report for the energy benchmarking of buildings in Woodbridge was also used as a guide as to what data needed to be collected, and their importance. It was also useful to become familiar with Portfolio Manager, as the report defined many of the program functionalities and provided sample tables and graphs. The process flow utilized for the research poster was also derived from this report.

The report created by Fahim and Wang focused on developing methods to track and reduce energy usage. The project followed the ASHRAE process of first performing site visits and collecting data, then creating a baseline energy model and running a computer simulation program. This report was helpful in providing a similar approach to that used in Sipperly's report, which provided further guidance for research. The report also cited the lack of a building management system as a project limitation, which is something that Celtic Energy has also mentioned to UNH.

The review of energy benchmarking methodologies prepared by Kolokota and Stavrakakis was useful in accessing our chosen process. To phrase the purpose of benchmarking simply, it is to develop a way to use less energy for heating, cooling, and lighting without affecting the health or comfort of the occupants. The report also cited the four most significant factors of energy usage to be

building age, operating hours, the floor area, number of consumers, and building behavior and maintenance. These will be verified upon completion of the portfolio.

Methodology

The benchmarking process began with gathering data for this project with the help of the UNH Facilities staff. Utility bills from United Illuminating, TransCanada, Southern Connecticut Gas, Hess Corporation, Regional Water Authority, and Suburban Propane in the form of Excel spreadsheets were collected from the facilities office and compiled into a master spreadsheet that included all of the other input data for each of the buildings. The EPA Portfolio Manager software requires a full 12 months of data to perform an accurate analysis, so it was vital that adequate data was gathered. This was followed by an analysis of the data still needed to generate reports, at which point further requests for data were submitted. The original plan for the order in which to benchmark the buildings was to use the 19 buildings reviewed in the Celtic Energy report. However, due to the varied availability of data, 9 of the buildings will have a report generated at this time. Data to be collected for this project was based upon the Woodbridge report prepared by Sipperly, and included the operating hours for a building and percentage of the building heated and cooled.

For all office spaces, it was assumed that the building was occupied from 8:30am - 4:30pm, Monday through Friday. Academic buildings were expected to have peak operation hours from 7:00am – 9:00pm, every day of the week. Residence halls are operational at all times. The staff and faculty for all buildings were accounted for; however, for the residence halls a default value was and will be used until this can be replaced with accurate numbers. Due to the lack of availability of heating and cooling data, the default values for each space were used. The floor plans for most of the buildings were also reviewed in order to verify the attributes of space types as well as the presence of the heating and cooling units. The heating and cooling energy costs and types of units will be implemented to the portfolio at a later date. Although a total of 10 buildings were examined, only nine are reported because the Bartels Student Activity Center and the Marvin K. Peterson library share meters. Thus, the energy used cannot be accurately divided out. In the future it is recommended that the buildings be separated.

Definition of Analytics

A baseline is the first 12 full months of complete utility data. For this project it is the 2013 fiscal year, although we hope to go back further, pending the availability of data. A target is the goal for a property's energy usage. These can be either in terms of an ENERGY STAR rating or a percentage improvement over the baseline or median. Portfolio Manager requires a space type categorization for the general use of space in a building. Although there are many options, only 12 of the space types available can earn an ENERGY STAR rating. Because of this limitation, any buildings classified as mixed use academic were ineligible. However, all buildings that are either residence halls or comprised primarily of office space are eligible. An ENERGY STAR score is a measure of how well the property is performing relative to others. Buildings with a score over 75 on a scale of 1-100 are eligible for an ENERGY STAR certification, based upon a third-party official verification. Figure 1 shows some of the building characteristics and some of the energy benchmarking results.

Building	Space Type	Year Built	Property Floor Area (ft²)	Site Energy Usage (kBtu)	Site EUI (kBtu/ft²)	Source EUI (kBtu/ft²)	Weather Normalized Source EUI (kBtu/ft²)	National Median Site EUI (kBtu/ft²)	National Median Source EUI (kBtu/ft²)	Percent Better than National Median Source EUI
Bayer	Office	1993	5,999	988,226	165	321	323	108	210	-53
Bethel	Residence Hall	1965	36,740	11,203,925	305	511	520	121	203	-151
Buckman	College/University	1964	63,728	7,939,339	125	198	201	165	263	25
Echlin	Office	1920	30,000	2,843,008	95	224	226	85	202	-11
Gate House	Office	1910	8,167	865,787	106	144	149	125	169	15
Library/BSAC	Library	1975, 1970	45,853	4,595,050	100	218	219	109	236	8
Maxcy	College/University	1910	98,000	6,494,880	66	118	121	69	123	4
Rec Center	Fitness Center	2007	56,500	3,631,623	64	158	157	39	97	-64
Soundview	Residence Hall	2009	127,000	5,843,477	46	128	128	70	196	34

Figure 1. Excerpt from data input spreadsheet for basic building analysis.

Results & Discussion

Upon completion of the project, a benchmarking portfolio was created for the University of New Haven. This portfolio established a baseline for current energy usage for the benchmark academic year 2012-2013. Nine buildings were completed of the 30+ on campus. The EPA also launched a new version of Portfolio Manager mid-project, which overall produced much cleaner reports. There are plans to organize training sessions in the near future, which would be taught by those who worked with the program this summer.

Five of the buildings monitored received an ENERGY STAR score; only Soundview is eligible for ENERGY STAR certification with a score of 80. Figure 2 shows the kBtu used by each building per month. This figure shows the seasonal trends of energy usage, mainly for air conditioning in the summer and heating in the winter. It is interesting to note that some buildings stay fairly constant, such as Bayer. Other buildings such as Soundview and the Rec Center show a clear fluctuation in energy usage. Figure 3 shows the comparison of energy usage in kBtu among the nine buildings. Bethel has an abnormally high usage, which indicates either that the building is enormously inefficient or that the data sampled contained a great deal of error. The other values for energy usage seem to be appropriate for the building characteristics and usage. The residence halls appear to on average to use more energy than other campus buildings, likely due to their long-term occupancy. However, this trend should be further evaluated as more buildings are analyzed in the portfolio. It is recommended that the university separate any buildings that share a meter, so that we can individually interpret energy usage for buildings such as the library and student activity center. Please note that a full evaluation of the energy usage by building will be available upon completion of the portfolio.

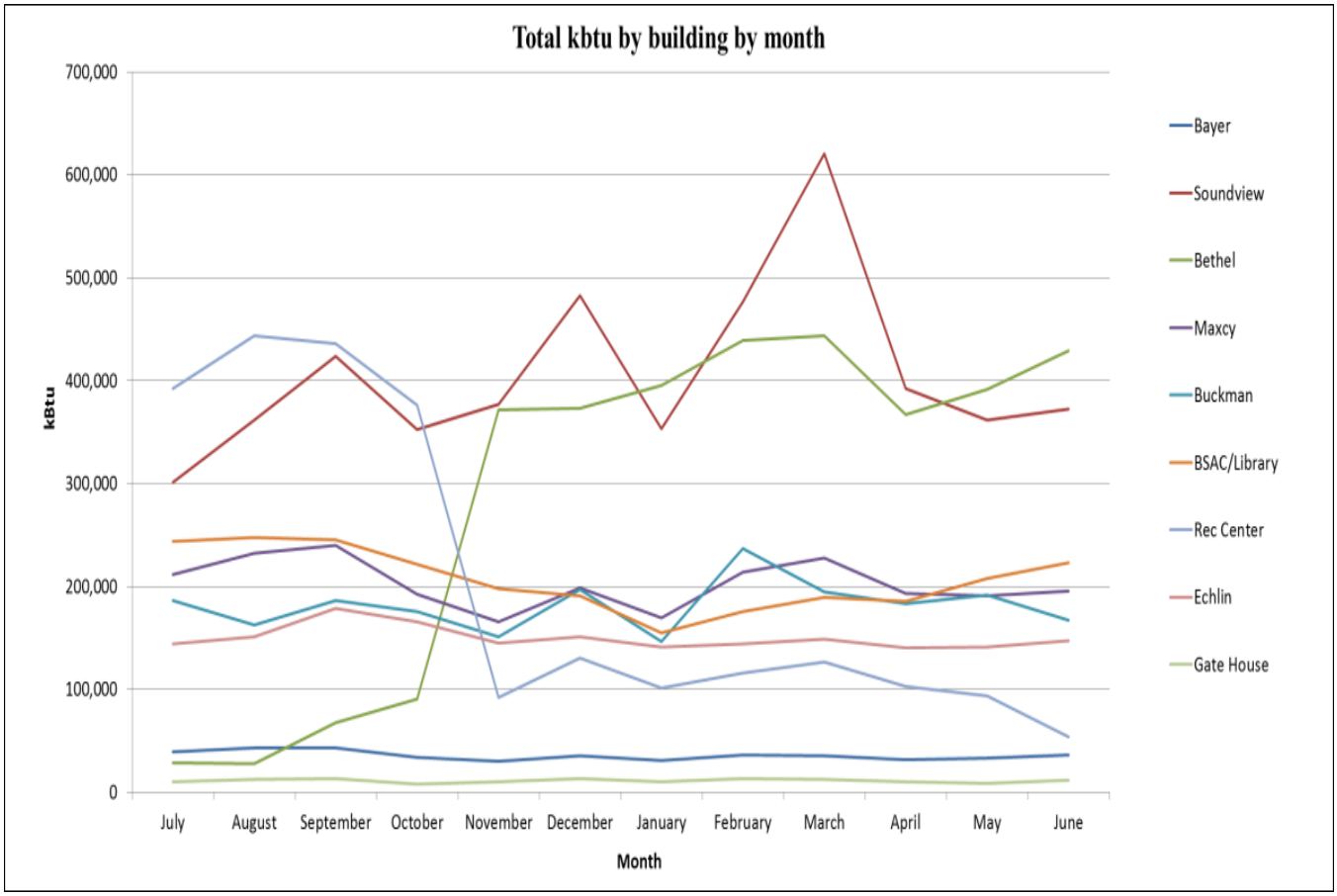

Figure 2. Total kBtu by month.

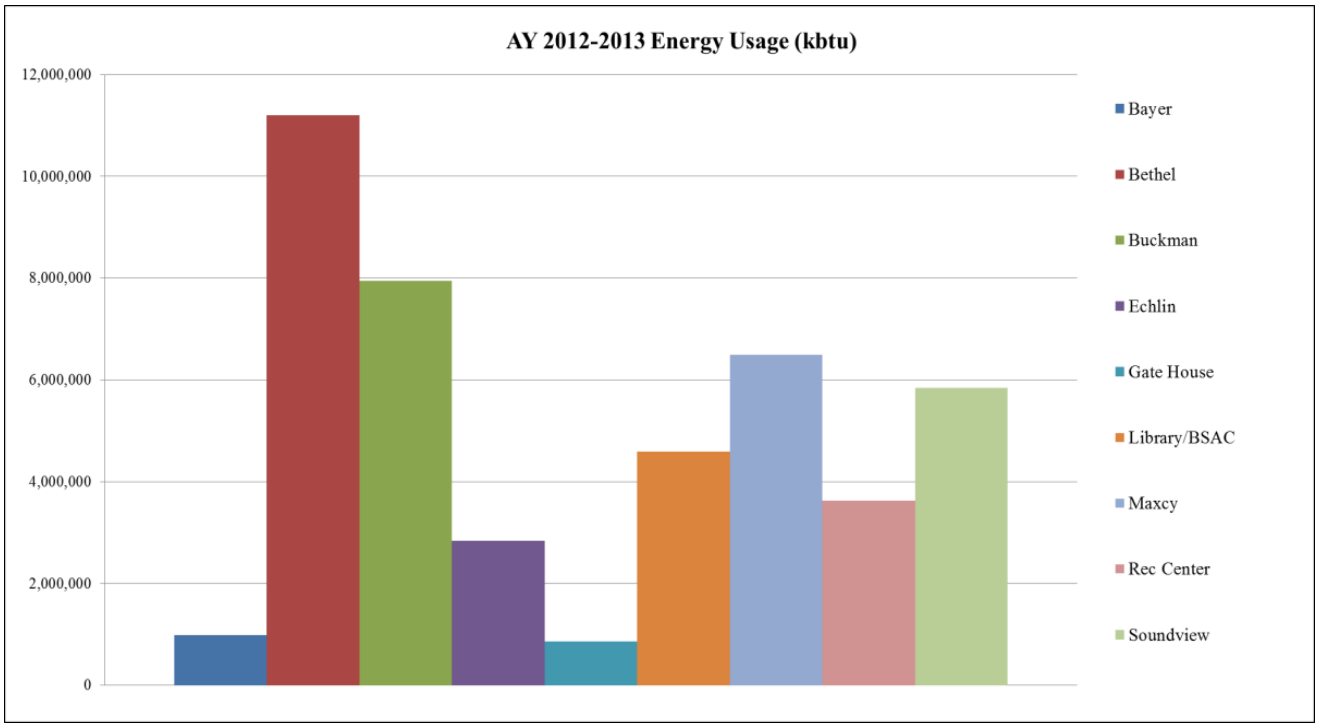

Figure 3. Fiscal Year 2013 Energy Usage in kBtu.

Continued benchmarking has been made possible through a business Sustainability Challenge grant from United Illuminating. Different features will be added to the project, including customized meter names and two additional energy reports analyzing water and emissions. The long term goal is to have the UNH Facilities Department take over the portfolio to continue monitoring and improving the energy usage on campus.

Literature Cited

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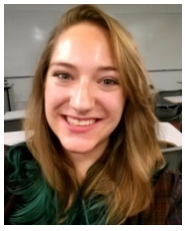
Biography

Robin Willick is a sophomore studying System Engineering with a minor in Sustainability Studies at UNH. She plans to pursue graduate studies and hopes to eventually become a teacher.



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