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Inside the ’62 Center for Theatre and Dance

Introduction

The Williams College ’62 Center for Theatre and Dance is the fourth largest electricity consumer on campus.[1] Built and renovated in 2005 the 126,00 ft^2 building houses the Williams Theatre and Dance departments, student organizations, visiting performers and lecturers, and the summer Theatre festival. In terms of electricity usage per square foot the building is not a humongous consumer. However, the size of the complex and its intricate uses bump it up in the rankings to science building status. The ’62 Center (Figure 1) is an important part of Williamstown; both as an architectural building, part of the college and for the income it brings to the town during the summer season.

Figure 1. The ’62 Center for Theatre and Dance. View of front entrance from Main St.

One of the issues that comes up with the Center for Theatre and Dance (CTD) is the ratio of students using the building in comparison to the amount of electricity consumed. The building has a handful of offices and a few classrooms but most of the building is performance

[1] This data is the result of a query of all campus buildings from April 2009 – April 2010. If an earlier date range is used, the ’62 Center will fall at a different point in the campus rankings.

space, which is not used during the day. These spaces are used for rehearsals and performances. The capacity of the building greatly increases during performances as 100+ audience members come to see each performance. However, the amount of energy used in the building is not completely dependent on how many people are in the building. The building maintains a high baseline due to the equipment and size of the building. During this project I strove to figure out more about how the electricity usage in the ’62 Center for Theatre and Dance relates to the amount of people using the building at a given time.

Setting

The Center for Theatre and Dance has a variety of occupants throughout the calendar year. During the school year the Williams College Theatre Department and Dance Department occupy the building, in conjunction with student groups such as Cap and Bells. The performance spaces (Main Stage, Center Stage, and Adams Memorial Theatre) are divided amongst the groups for performances throughout the year. The dance department occupies the 2 large dance studios on the second floor along with a set of offices. On the main floor there are the theatre offices, two classrooms and scene shop. The basement has a small studio space, the costume shop, dressing rooms and storage spaces. All of the spaces are used to varying degrees and at various times.

During the summer, the Williamstown Theatre Festival (WTF) takes over most of the building. The main performance spaces they use are the Main Stage and Adams Memorial Theatre (AMT) in addition to the scene shop and various other rooms in the building. They use about 46% of the CTDs square footage. The Williams College Theatre Department uses what is

remaining of the building for their summer program. In the summer, WTF dictates the use of the building. They are a needy and demanding tenant who gets what they want. This results in higher than average consumption of all electrical aspects related to the building, especially cooling.

Heating and Cooling

Due to the complexity of the electrical use within the Center for Theatre and Dance, I elected not to spend much time on the heating and cooling load of the building and primarily focus on the electricity. Despite this I was able to learn a little about the heating and cooling load of the building. One of the most interesting things about the building is that it must be cooled year round. This is a result of both the large amount of heat given off by the stage lights and the body temperature of audience members.

While the thought of having to cool the building during the winter would seem to require a great amount of electricity; it does not. From September 28, 2009 through May 7, 2009, the college "free cooled" the building. This free cooling is done by circulating fluid thorough pipes buried in the ground. Since the weather in Williamstown is cold enough to keep the ground cool, the fluid is brought down to ground temperature. The fluid is then brought back into the building and into the air handlers providing the coolant for air conditioning. Since the infrastructure of these pipes is already present for the summer cooling, no additional initial costs were needed.

During the summer months (this year starting May 7th) the building is cooled via the central chiller, which is located in the Greylock quad parking garage. The chiller functions in a similar way to the free cooling except that rather than using the ground as a coolant, the water is chilled via compression coils and then piped into the buildings. The campus central chiller runs

at 86-89% efficiency when under full production. It chills the major buildings on campus: Chapin Hall, Griffin Hall, Sawyer Library, Hopkins Hall, Pare sky Center, Hollander Hall, Schapiro Hall, Greylock Dining Hall and the Center for Theatre and Dance. During the summer of 2009 the ’62 Center used 39% of the cooling load put out by the central chiller. This amounted to about a $20,000 air conditioning bill for the building for the brief Williamstown summer.

Due to its large size, the CTD is a large consumer of both steam for heat and chilled water for cooling. While both loads are needed throughout the year they luckily do not overlap. The free cooling is a sustainable way to achieve a necessary but unusual request. All of the temperature needs in the building are controlled automatically and monitored through a computer system. This system controls the Heating Ventilating Air Conditioning (HVAC) units within the building, which are major electricity consumers.

Methods

The analysis of electricity use within the building was done primarily with “historical” data from the Williams College sustainability website. The data was downloaded and then analyzed for trends and mean and total use during specified time periods. The data was then analyzed in respect to the master calendar of the building. The large performance spaces, day of the week, time of day and time in relation to the opening of the show were the main aspects taken into account during analysis.

Thanks to the odd and demanding schedule of Williams students, I was able to perform test runs to establish certain values. These test runs included a time when Adam Stoner remained as the only one in the building from 3-7:30 am. During this time he used the scene

shop. On this same night, Ben Kaplan was in the directing studio working on a lighting design project from 12-3am. From midnight onward Adam and Ben were the only ones in the building until the custodians arrived in the morning.

Another trial run I was able to run was to turn on 24 lights at full power for 20 minutes on the Main Stage to see how much power they used in relation to their stated wattage. However, this test did not work out correctly as during my test run the elevator returned to its dormant floor, the fluorescent work lights in another part of the building turned on and the HVAC system may have turned itself on. The HVAC had previously been turned off for a recording session. Despite this issue, the change in data is visible. However, one of the rogue peaks is present during the trial run.

Results

Peaks

In my analysis of the electrical data from the sustainability website I noticed what I have called “rogue peaks.” These peaks appear at random times, from what I can determine. During the 10 min reading they raise the kilowatt consumption from an average of 130 kilowatts to over 400 kilowatts. Occasionally, the peaks will rise about 600 kilowatts. At random times two peaks will occur next to each other of the exact same value.

The peaks create an average increase of about 500 kilowatt-hours per day. I determined this value by removing all the peaks and replacing it by averaging the kilowatt values during the ten minutes either side of the peak. Over the course of a week the kilowatt-hours per day consumed by the peak is bout 3,500 kWh. As the presences of these peaks are apparently random, this average value will vary from day to day and weak to weak.

Lifetime Analysis

Since the ’62 Center opened in September 2005, four full years of electricity use have passed. During these years the kilowatt-hours consumed by the Center for Theatre and Dance has varied greatly. Initially, the building started out with a lower than average electricity consumption. However, in its second year of operation, the kilowatt-hours consumed increased by 150%. In the two following years, the building has been on a downward trend in electricity consumption (Figure 2).

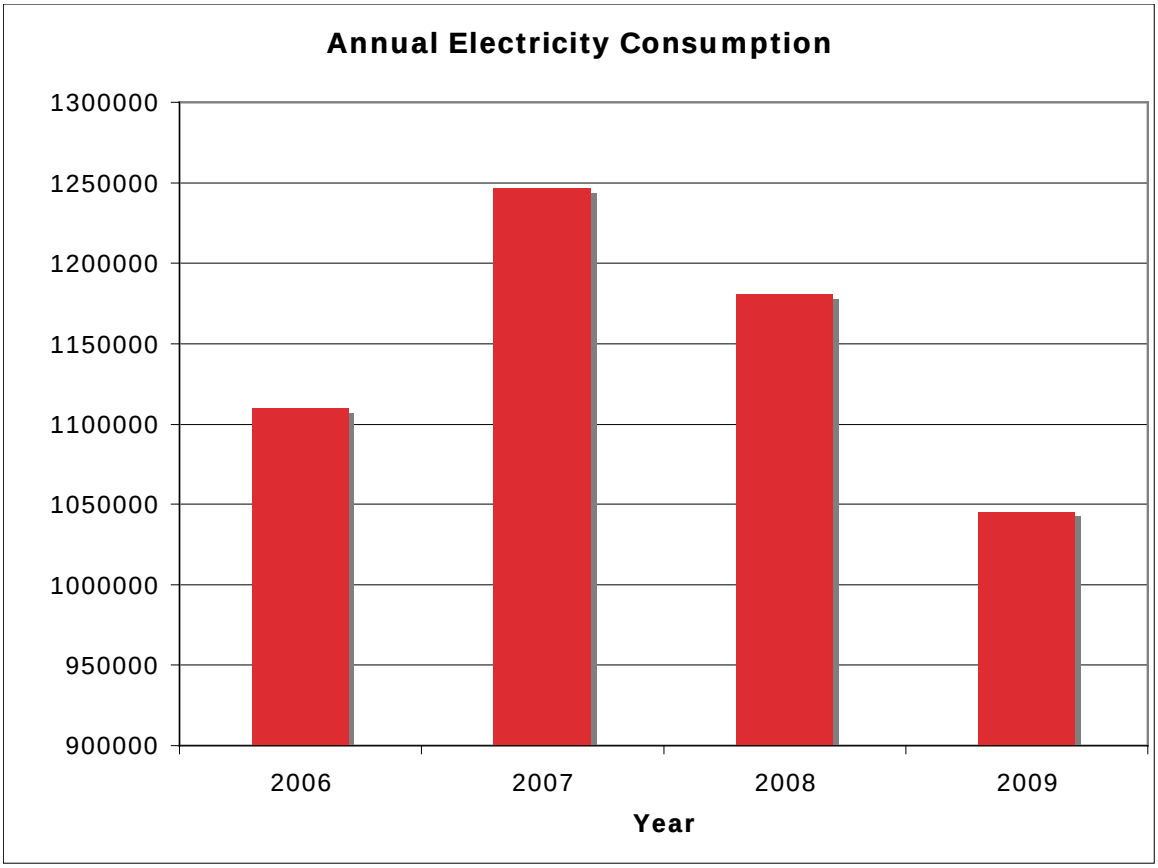

Figure 2. Annual Electricity Consumption in the CTD in terms of kWh by calendar year.

The monthly readings of electricity use in the CTD have a much more up and down nature than the annual values. However, once a linear trendline is applied to the data, a clear downward trend over the buildings lifetime is visible (Figure 3). Over the course of the 56 months the building has been open it has reduced the electricity consumed monthly by about 4000 kilowatt-hours.

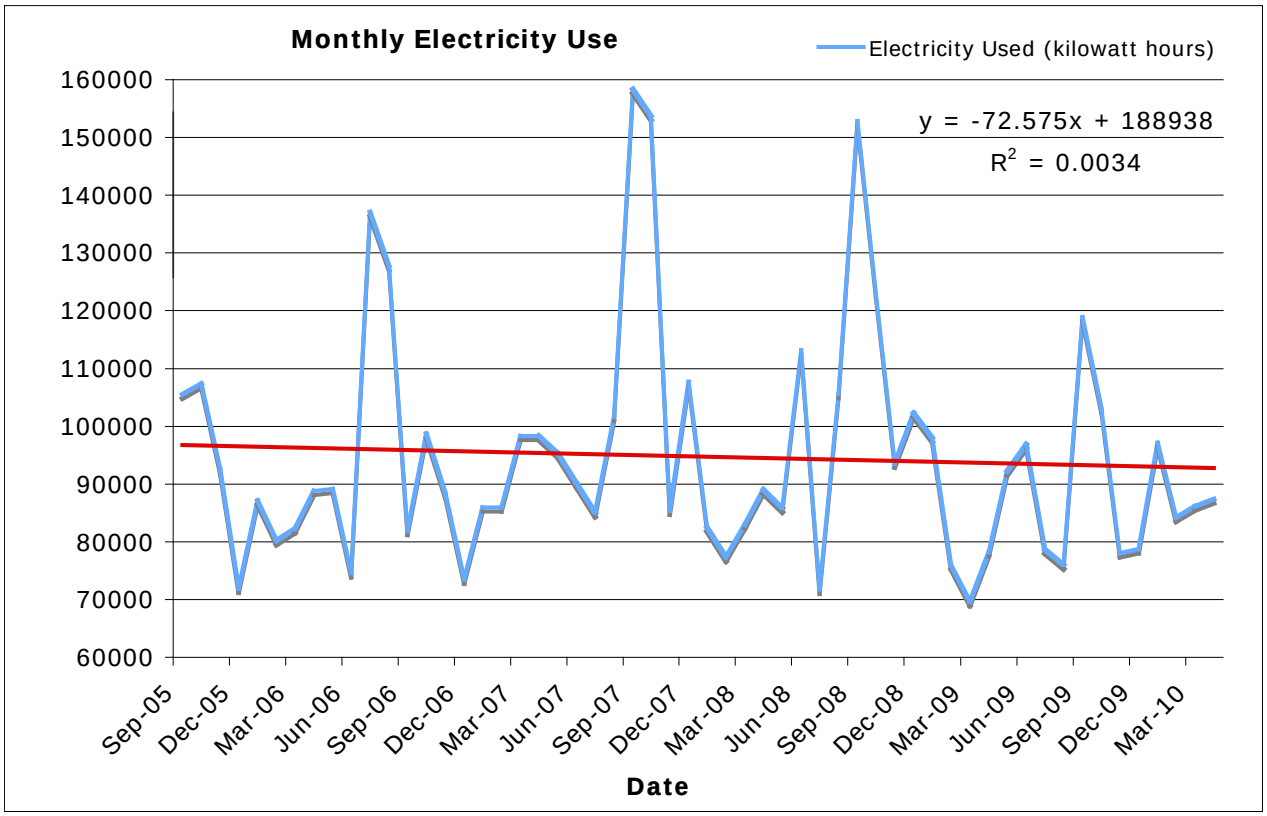

Figure 3. Total monthly electricity use in the CTD. Data is from the opening month to present.

Seasonal Analysis

As a result of both its various occupants and the climate conditions in Williamstown the summer and winter seasons have differing electricity consumption. For the purposes of this project summer is defined as June, July, and August (the months Williams College is not the main occupant of the building). The average electricity consumed by the CTD is 2,000 kilowatt-hours greater during the summer than the winter months (Figure 4). This calculation does not take into account the amount of electricity used by the central chiller to cool the building during

the summer or the central heating plant to heat the building during the winter. The lowest month recorded was March 2009, consuming 69,747 kWh (Figure 4). The month with the highest consumption was September 2007, with 158,452 kWh (Figure 4).

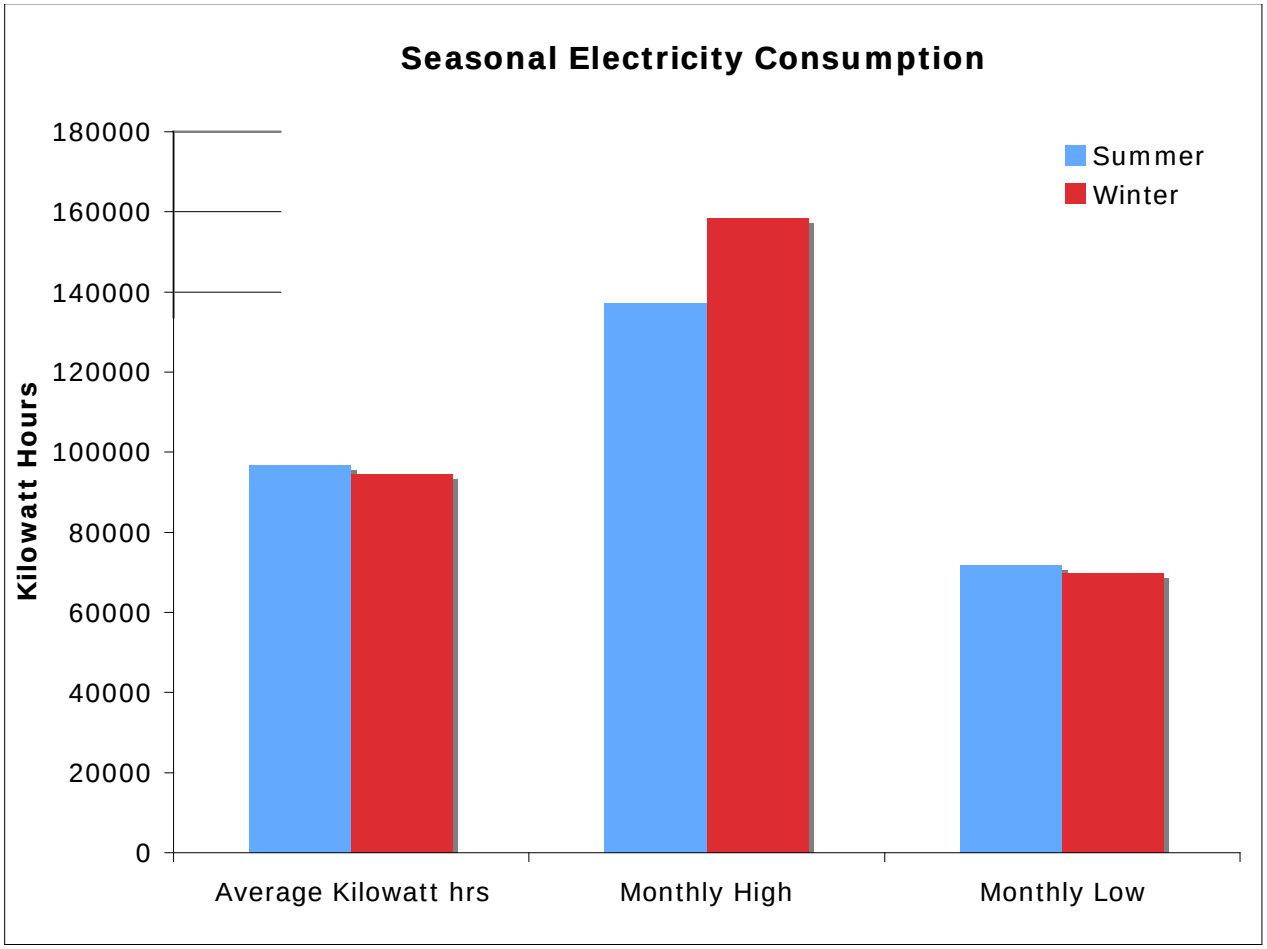

Figure 4. A comparison of seasonal electricity consumption in the CTD. Average, Highs, and Lows per month graphed against each other.

In the monthly data over the buildings lifetime there is a consistent trend of a very large increase in electricity consumption of about 150% during the start of each new school year (September and October). The peaks created by these months (Figure 3) have a similar downward trend to the annual analysis (Figure 2). Due to the height of these peaks they are bound to have a large influence on the annual sums. However, without these peaks the general consumption trend of the building is still one of a decreasing nature over time.

Weeklong Analysis

The Center for Theatre and Dance has two baselines. A baseline of about 40 kilowatt-hours per hour was achieved during the 2009 Winter Shutdown. This differs from the daily nighttime baseline during the full operating season of about 50 kilowatt-hours per hour. The latter baseline is only achieved for a few hours during the night. Each night the building is "powered down" as the exterior doors turn to swipe access. During this time the main HVAC system is turned off and lights in the building automatically shutoff. When the HVAC system and lights go off a step decline in the electricity coming into the building can be seen (Figure 5) However, people remaining in the building can turn these lights back on at any point.

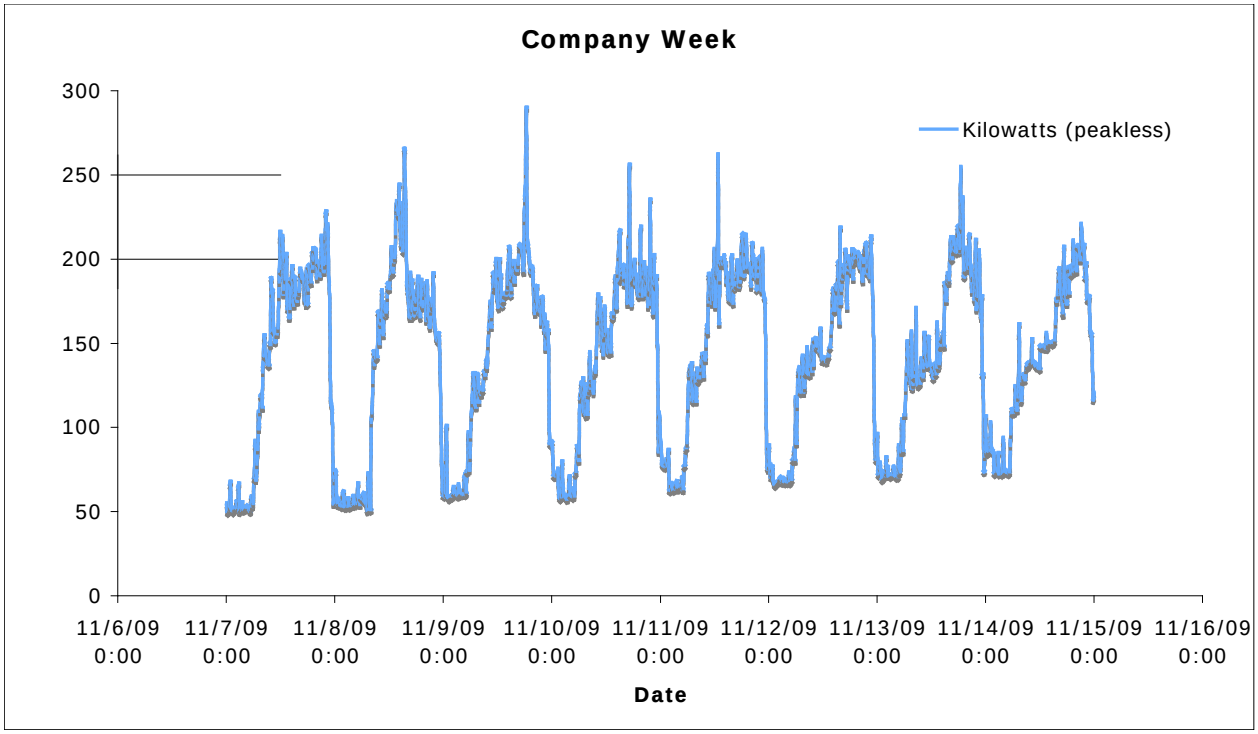

Figure 5. The production week and show nights of Company. At the end of each evening a steep decline can be seen when everything is turned off. The consumption begins to increase when the janitors arrive in the morning.

The HVAC systems in each performance space are individually controlled and turned on only for rehearsals and performances. Because the audience is in the building for such a short

amount of time they will not increase the fan loads. However, the fans must be turned on both for them and to control the heat given off by the stage lights.

Over the course of a production week the electricity pulled into the building varies greatly. As the week progresses the consumption decreases. The largest consumption is the weekend before (when rehearsals run for 10 hours and the stage lights are on constantly). After this the dress rehearsals decrease in electricity use. The final dress (Thursday), opening (Friday) and closing (Saturday) nights use even less energy (Figure 6). Here the low point of electricity on Saturday can in part be attributed to the fact that the building is not used as much during daylight on the weekend as during the week.

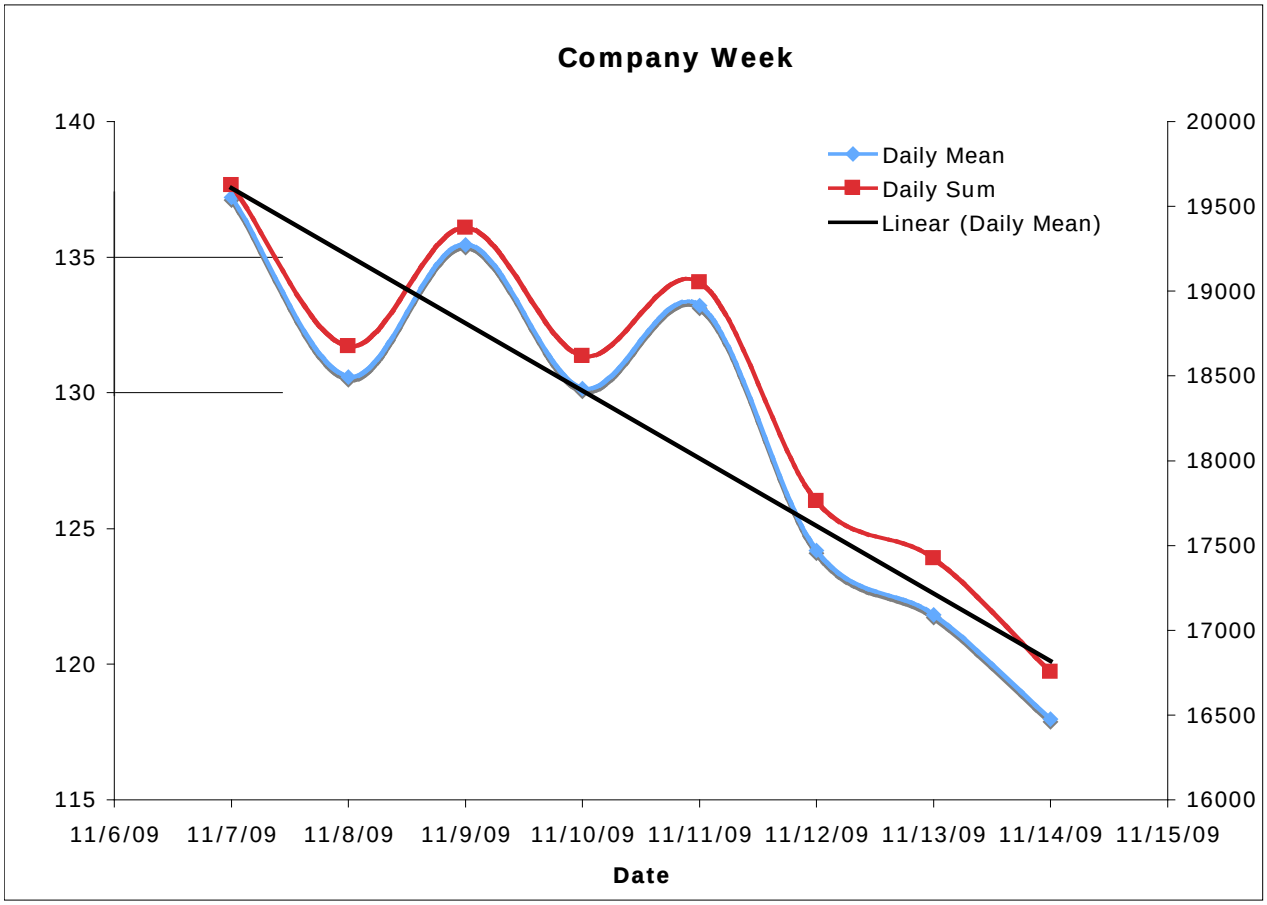

Figure 6. Daily mean and total electricity use for Saturday to Saturday of a production week.

Trial Runs

The scene shop of the CTD uses about 10 kilowatt-hours per hour during nighttime use. This value was discovered with the help of my friend who checked for times when he was the only one in the building and working in the scene shop. After comparing these times against the nighttime use for the previous and following nights the 10 kilowatt-hour difference was concluded. During this span the lights in the scene shop were the main energy consumer with the occasional power tool or fan being used.

An abnormal use of the directing studio, a small rehearsal space, allowed me to determine how much energy a few lights use. Although I was not able to know exactly how many lights were turned on in the 3 hours Ben Kaplan was in the studio, I do know that he could only turn on a maximum of 24 stage lights. For most of the time, only two or three lights were on at a time. Over the course of Ben's rehearsal he was able to bring the electrical use in the building up 5 kilowatts. As the only person in the building, one student is responsible for 15 kilowatt-hours of use.

Discussion

The fact that electricity consumption in the '62 Center has been on a downward trend since 2007 is an impressive feat and a movement towards sustainability. The explanation for the trend is most likely due to the fact the operators of the building are beginning to understand how it functions and operate it more efficiently. The fact that the HVAC and lighting systems are turned off nightly or only used when necessary are having a large contribution to the buildings decline. The automated nature of the systems has influenced and helped to reduce consumption.

The rogue peaks in the data have no apparent direct cause in the building. They are most likely errors in the metering system or data stream.

In terms of the September and October annual spikes there are two possible explanations. The first is that the monthly data on the website is mislabeled by 2 months. If these peaks were bumped up to July and August, when Williamstown Theatre Festival occupies the building, their positioning would make a lot more sense. With the current dates applied the summer usage is on average with the annual average. However, these values being equal is contrary to the expected building usage. Normally, the Williamstown Theatre Festival uses a far greater amount of energy than the Williams College Theatre Department since WTF runs shows constantly with a very quick turnover. They also run the HVAC systems at a much higher rate. Another explanation for these peaks is the building is adjusting to new occupants at the beginning of the new school year. This second explanation does not seem worthy enough to warrant a 150% increase over 2 months. However, after querying the data multiple times, I received the same monthly breakdown each time. The current monthly readings also are the same as a summation of daily readings, indicating that the time scale is not off, but the data is correct and the peaks are a result of building usage.

As a show gets closer to closing night its electricity consumption begins to decrease. This is a result of shorter rehearsal times and a more complete show. During the initial weekend rehearsals the lights are on for the entire rehearsal, which last an average of 10 hours. Once the week starts and full run-throughs begin the rehearsals only last slightly longer than the show. Once the show opens, the lights are only running for the length of the show. During all these times the HVAC system in the performance space is running at the same intensity. Downstairs

in the dressing rooms the individual HVAC systems are run on occupancy sensors. These will not change over the course of the production week.

In respects to the electrical load consumed during a show the lighting takes up the greatest amount of energy followed by the HVAC system. This is evident by the up and down nature of the energy graph due to lighting changes while the HVAC is running at a fairly constant speed. In the building a surprising amount of energy is used by “non-performance” events. The increase of energy during a rehearsal or performance is very significant but it is increasing from an already high point.

Although the ’62 Center for Theatre and Dance is such a large building, it is run very efficiently. Many measures are taken to reduce its energy use. However, these measures never come at the expense of a performance or the students using the building on a regular basis. While a performance does consume a lot of energy over the course of its development, it is usually worthwhile for the two hours in which audience members get to enjoy it.

Future Research

Due to the timing of this project I unfortunately was not able to test certain aspects of the CTD. Future possibilities include isolating HVAC units and measuring how much electricity they consume. Also being able to isolate and analyze parts of the building to determine how much energy the dance department uses in comparison to the theatre department would be an interesting study. Further research into the electrical consumption differences of the three Theatres would also be an interesting direction. Finally, including steam metering and data would give a much more complete picture of the building than is given here.

Acknowledgements

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