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Shut the Sash
Energy Conservation in the Chemistry Building

Contents

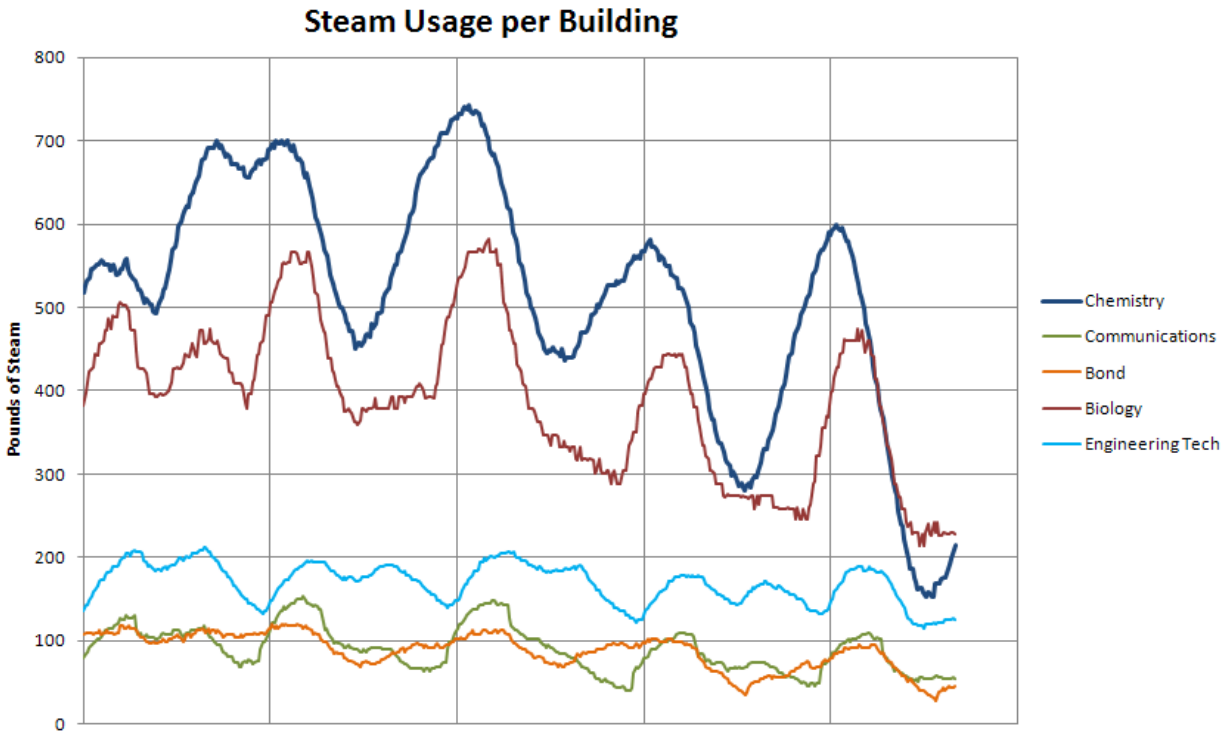
1. Introduction

1.1 Purpose

Washington State safety regulations require that negative air pressure be maintained at all times in WWU's chemistry building. To maintain this pressure, the building is constantly expelling air, and the HVAC system must constantly reheat the building. For that reason, the chemistry building uses three times more energy per square foot than any other building on campus. Laboratory fume hoods exacerbate the problem by increasing airflow throughout the building and therefore increasing the burden on the HVAC system. For example, Figure 1 shows steam usage among several buildings on campus of the course of a week. Most buildings consume about 100 pounds of steam per hour. Even the engineering technology building, with all its machinery and shop equipment, uses less than 200 lbs/hr. The chemistry building on the other hand consumes between 150 and 750 lbs/hr. The only building that comes close is biology, and that is because it also has several fume hoods. We

are encouraging students and staff to develop a better habit of closing the fume hoods. It is apparent that keeping the fume hoods closed more often, and reducing airflow, will save the university much energy and money.

Figure 1



1.2 What are fume hoods?

Fume hoods allow students to safely handle chemicals. It limits exposure to hazardous fumes and vapors by drawing air into an exhaust duct. At the same time, much air from the room goes with it. When fume hoods are no longer in use, a door called a sash can be closed to restrict airflow. However, students and faculty often forget to close the sashes, and the fume hoods continue to waste the building's conditioned air. Fume hoods at Western typically circulate air at rates between 400 and 1,800 cubic feet per minute (CFM). As air leaves through the fume hood, fresh unconditioned air is drawn in to replace it. The energy it takes to filter, move, cool or heat, and clean the air is the majority of energy used in the lab buildings (Chen). It's basically like leaving every door and window of your home open during the winter. All this effort is to keep the lab at constant, comfortable 70 degrees, and to ensure dangerous fumes leave the building. Generally, if chemical fume hoods were closed when not in use, it could reduce the amount of energy wasted by 60% at that hood (ThinkOne).

1.3 Significance to Western Washington University

Because the chemistry building consumes so much more energy than any other building on campus, Western stands to save a lot of money from energy conservation. Western has been a leader in campus sustainability for decades. By encouraging students to develop better energy-saving habits and reminding them to shut the sash, this will increase the university's leadership standing and encourage more student-led sustainability projects on campus. Additionally, the university is currently facing the most drastic budget cuts ever seen. We care about saving the university money in energy costs to help alleviate pressure on other campus costs. Encouraging energy saving habits will have a positive effect on the campus culture as a whole.

2. Case Studies

2.1 Harvard University

In 2005, Harvard initiated a fume hood campaign called "Shut the Sash." Their goals were to increase awareness of energy use and to encourage the development better habits in the lab. Harvard used a variety of visual aids, from posters to electronic meters, to remind students and faculty to keep the fume hoods closed. Professors also selected a volunteer to "police" their labs for open fume hoods. Harvard started a competition among their lab buildings to see who could do the best. As an incentive, the most effective lab would receive a wine and cheese party. Throughout the period of the campaign, the average sash height of all fume hoods decreased from 12 inches to just 2. In the end, Harvard's campaign saved the university $100,000 on energy costs each year. It has also increased the student's awareness of their habits of remembering to close the fume hood when not in use. After the success of the first campaign, Harvard now has an ongoing effort to train new students in difficult art of closing the sash.

2.2 Berkeley

At Berkeley, California, the university created a new fume hood technology that is one of two being tested in the United States. This technology uses a fan on the top and bottom of the fume hood, which creates a divider of air in front of the user, keeping harmful fumes away from their face. This type of fume hood reduces the airflow by 70% compared to a typical fume hood. This results in a reduction of energy consumption by 50% or more. Because it is still being tested, this is not a likely solution for Western at the moment, but could be a great solution for the future. Since these fume hoods use substantially less air than others, HVAC systems could also be built smaller saving universities money when building new laboratory buildings.

2.3 MIT

A few years ago, a student at MIT did a research project on fume hoods on campus. He found that many of these were left open which was wasting huge amounts of energy. His research led others on campus to continue the work that he started and began bringing awareness of the issue to students and faculty on campus. One graduate student took the initiative to make sure people were aware of shutting their sashes by sending out e-mails, putting up posters, and spreading the word around. They have seen that once students become aware and get reminded, they make the effort to shut the sash when they are no longer using the fume hood. MIT has found that by students participating in closing their fume hoods, they could potentially save the university one million dollars each year from fume hoods alone.

3. Methodology

3.1 Research

Early in the project we met with Ron Bailey and Migo Biciunas from Facilities Management to discuss our project goals. We learned that the chemistry building had many energy-wasting problems, but we decided to just tackle fume hoods for now. Initially we thought we track energy consumption by just looking at the energy bill for the building, but that proved to be too complex and unreliable. The chemistry building's electricity meter is hooked up to several external electrical loads that would affect our readings. For example, the track lights at the football field were tied into the building. When the lights turn on in the evening, it appears that the chemistry building is using the energy.

In search of a better solution, Mark Harrison showed us that we could track the airflow through each individual fume hood in real time. Additionally, Ron Bailey had given us access to the building's steam usage logs. If we knew how much steam the chemistry building was using to heat its air, and if we knew how much of that air was leaving through fume hoods, then we could determine how much energy consumption was due to those fume hoods. This system is better because it allows us to ignore external energy loads. We can also see which fume hoods are behaving abnormally and adjust our statistics accordingly.

3.2 Program Development

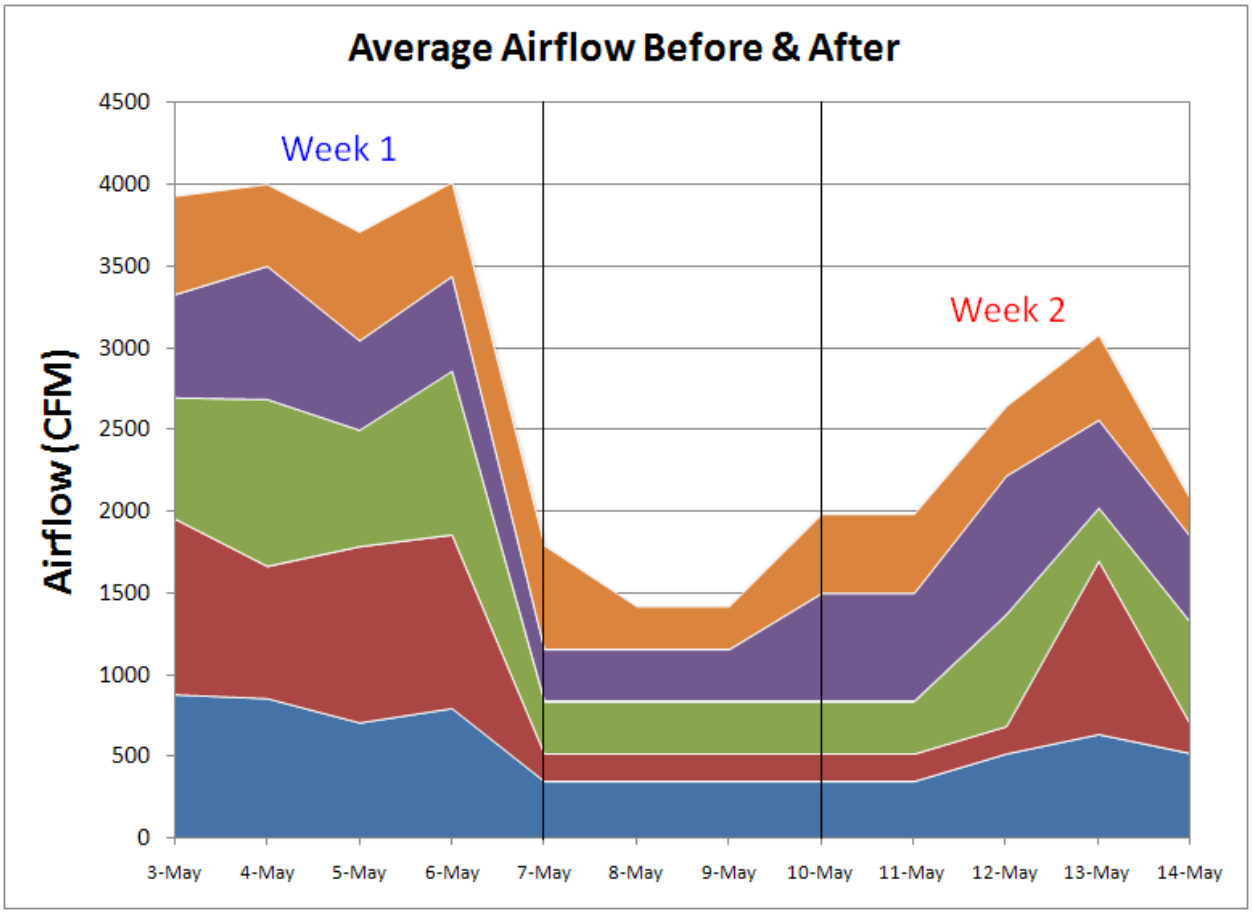
Inspired by Harvard's "Shut the Sash" campaign, ours would run for just one week. During that time we would track airflow and steam usage. We would then compare the numbers to the week before the campaign and determine if a significant change occurred. Through email and faculty meetings, we asked chemistry faculty, professors and instructors, to help remind their students to keep their fume hoods closed during the week of our experiment.

4. Analysis

4.1 Findings

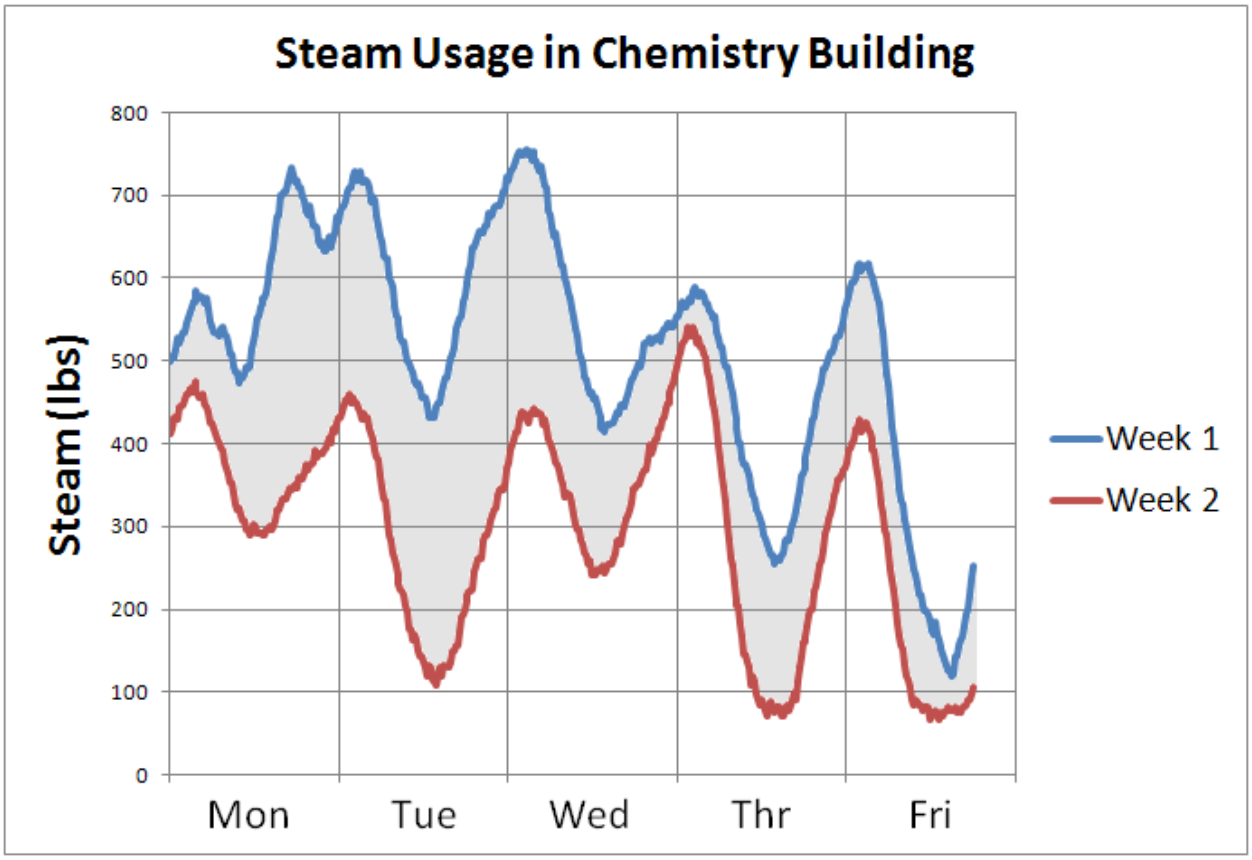
During the week of the experiment, average airflow of each fume hood was reduced by about 20 to 50 percent compared to the week before (Figure 2). Airflow is only reduced when the sashes are closed. This suggests that students and staff were closing the sashes more often.

Figure 2



Steam usage for the building also decreased. Figure 3 shows steam usage per hour of the chemistry building before and during the experiment. After the experiment, the building saved about 41 percent in steam costs. This translates to about $2180 in savings. It is important to note that this experiment occurred in May. We estimate that energy savings will be even more profound during the colder winter months. During the summer, when the HVAC system works to *cool* incoming air, energy savings may be greater as well.

Figure 3



4.2 Conclusions

We believe our experiment was effective in reducing energy consumption in the chemistry building. In only one week, the university saved nearly $2200 due to better fume hood habits. Unlike Harvard, we did not use as many visual reminders such as flyers, posters, or magnets. Additionally, we did not personally audit the lab rooms. Based on the success of Harvard University's campaign and our experiment, we propose that a long-term campaign take place at Western. The cost of encouraging better habits is almost nothing when compared to the potential savings in energy. Visual reminders are very cost effective. To make it more fun, the university should also consider making the campaign a competition among different lab rooms, buildings, or majors and offering a reward.

5. Future Works

5.1 Visual Reminders

For better results, we recommend that Western produce posters, magnetic signs, stickers, or handouts to remind students to shut the sash. It may be helpful to publish energy usage statistics so students know how much energy they are using on a regular basis. The production of these materials may become projects for future classes or students in other majors. The chemistry department will also have to provide funding for these materials.

5.2 Ongoing Campaign

Because new students use the labs every quarter, it is important to teach these new recruits the importance of energy conservation. Professors and lab instructors should remind each new class about energy-saving fume hood habits. An ongoing campaign will require someone to monitor the energy usage in each building and produce usable statistics. This could be a project for future CSPS students, or a work-study position in the chemistry department.

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