

GREEN LABS

UNIVERSITY OF WASHINGTON

AUTUMN 2012 SUSTAINABILITY STUDIO

COURSE OBJECTIVES

The course cultivates a quarter-long investigation of research laboratory systems with a special attention to the new Green Labs program launched by the UW Environmental Stewardship and Sustainability (ESS) Office. Many laboratory systems and research practices aim to ensure repeatable and accurate scientific results. Laboratory success often comes at the cost of resource efficiency of inputs and waste byproducts. In response to this challenge ENVIR 480 students engaged in hands-on, project-based work to support the Green Labs program through student-designed and led pilot-projects. We evaluated specific lab characteristics, researcher behaviors, existing incentive programs, and best practices for future sustainable laboratory systems on UW Campus.

STUDENT MEMORANDUM

BY MOMOKA NAKAMURA

To: University of Washington President Michael Young
From: Momoka Nakamura, UW Program on the Environment Undergraduate
Re: Green Laboratories at the University of Washington
Date: October 20, 2012
Cc: UW Environmental Stewardship and Sustainability Office

EXECUTIVE SUMMARY

Various sustainable practices across the University of Washington campus have been expanding, but there is little to no focus on improving sustainability in laboratories. This memo will provide background on sustainable practices in laboratories, waste generation and energy consumption in laboratories, and proposals for improving laboratory practices to leave minimum impact on the environment and future generation, as well as to improve campus sustainability.

UW GREEN LABORATORIES AND LAB PRACTICES

Laboratories across the United States require 4-6 times more energy than an office space per square foot. Furthermore, there are more than 1,100 square miles of non-recycled plastic waste from laboratories across the nation that enters our waste streams. If all laboratories in the United States reduce energy consumption by 30%, the country could save 84 trillion Btu, which would be a significant step towards national sustainability. There are many reasons why laboratories conduct wasteful

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practices, ranging from concerns for maintaining safety of human health, to protection of research processes and results. Nonetheless, the recent movement towards sustainability has been transforming ways of building construction, transportation, and daily lives, and it would be an opportunity missed if the science realm does not follow.

The University of Washington campus consists of many laboratory spaces, primarily for research purposes but also for student education. It is estimated that Environmental Health and Safety collect about 200,000 kg of hazardous waste each year, which half is incinerated and half is reused, recycled, or treated. In addition the entire campus consumes between 70,000,000 kWh and 80,000,000 kWh each quarter as seen in **figure 1**. While the electric consumption in the laboratories is currently not specified, it is estimated to be responsible for a large component of the campus consumption.

Similar to how the University of Washington campus committed to sustainable practices through switching to energy efficient electronics and low-flow showerheads, and decreasing waste by increasing compostables, it is possible to improve laboratory environments without impacting research and education. When waste generation and electricity consumption are examined, there are practices ranging from behavioral to systematic that can be easily altered to have less impact on the environment.

LABORATORY IMPROVEMENT PROPOSAL

There are small adjustments and changes that could potentially have a significant effect in reducing electricity consumption and waste generation. Behavioral change by individuals such as choosing to recycle rather than trashing paper, to unplugging appliances not in use can add up to become large savings for the University. Collaborative system changes among laboratories such as switching room and heat lamp light bulbs to fluorescent light bulbs, reducing the freezer temperature by 10 degrees Celsius, and purchasing energy efficient equipment when necessary would also contribute to a significant decrease in energy consumption as proved by the Green Labs Programs at the Colorado University. Finally, systematic adjustment such as partnering with Seattle City Lights for rebate opportunities, to regulation on equipment purchasing, reusing, recycling, and repurposing; and strategic construction would have a great impact on campus sustainability.

RECOMMENDATION

While the above changes in laboratories on campus would all contribute to improve campus sustainability, implementing behavioral changes may have the greatest impact with the shortest amount of time. Through proper education on how to practice energy efficiency and minimizing waste, researchers and students in laboratories will have better knowledge about sustainability. With collaboration with other programs on campus, incentives to have green laboratories may build and expand, which would make it a rewarding opportunity to minimize the impact on the

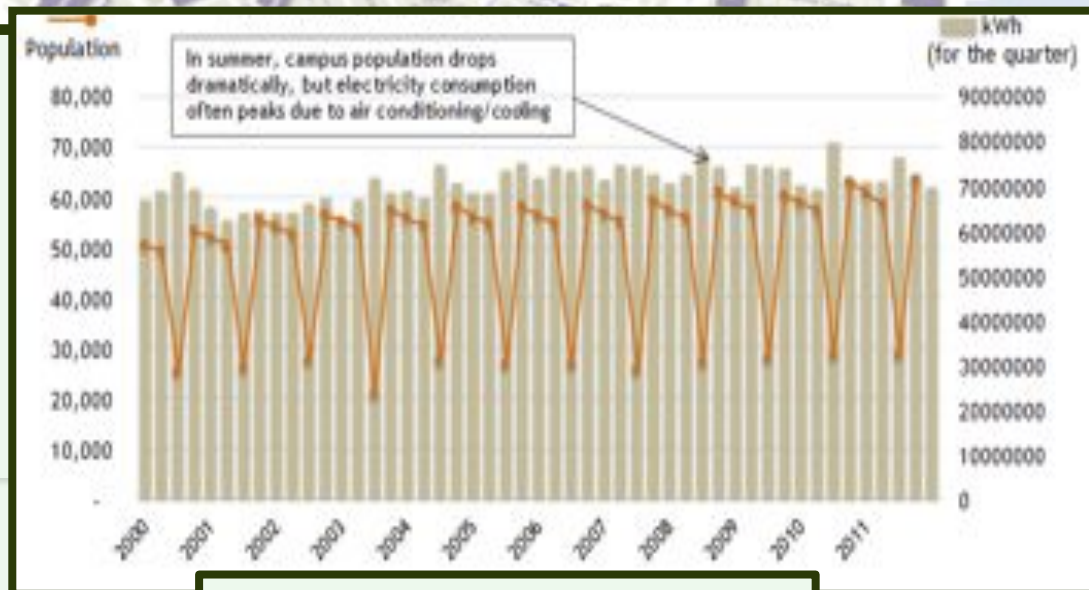


Figure 1: Electricity Consumption and Campus Size

environment. The University should put full effort into improving sustainability in laboratories for there are countless factors that could be adjusted. By involving the campus completely, the University of Washington will maintain its reputation of 'green' campus among various rankings, improve the environment, and benefit us all.

UW GREEN LABS: LED GROWTH CHAMBERS AND SINK AERATORS PILOT PROJECT

BY KATE STEVENSON & SYLVIA HOWARD

INTRODUCTION

As we all know, reducing our consumption of water and electricity plays a key role in improving lab sustainability. Our group decided to focus on energy and water use on one floor of the Marine Sciences Building.

While there are many appliances and lab procedures that inherently require certain quantities of water and energy, we chose to investigate two simple tactics aimed to reduce waste. Namely, our project will look at the viability of implementing sink aerators and LED lights in growth chambers. The goal of our research is to provide resources and information regarding these possibilities.

LED GROWTH CHAMBERS

Our first goal is to investigate the possibility of replacing current growth chamber lights with an LED alternative. Growth chambers are rooms where samples can be isolated from the outside environment and research can be done in regulated conditions. These are basically walk-in cold rooms with shelves where samples are exposed to growth lights.

In the particular labs we are working with, the lights operate on a schedule of sixteen hours on and eight hours

off. The current fixtures use Philips T5 bulbs, which are 32-watt fluorescent tubes, which we hope to replace with more energy-efficient, longer lasting LED lights. Our study will provide information that can be used by campus organizations (i.e. Environmental Stewardship and Sustainability Office, individual labs, etc.) to evaluate the viability of using LED growth lights in their own facilities.

There are marked energy-saving benefits to LED technology. According to the U.S. Department of Energy, "Quality LED products can last 25 times longer than an incandescent bulb and use 75% less energy," and due to their design they focus "light in ways that are useful in homes and commercial settings."¹ Although this data is promising, there is limited research regarding LED grow lights in lab/growth chamber settings.

One study from the UW Department of Botany examines the efficacy of LED grow lights on basil and lettuce samples. In the case of lettuce, these bulbs improved plant productivity by 39.7%. However, basil samples fared slightly better under T5 fluorescent lights.¹ While this data is useful to some labs, the array of samples in the growth chambers we are working with have different spectral/intensity requirements.

There has been some research conducted at NASA focusing on whether LED growth lights could be used to reduce energy usage allowing cultivation of crops on space missions. NASA has been interested in this technology since the 1980s, as LED lights are not only energy efficient but also durable and long lasting. While this research attests to the benefits of LED technology, like most LED research, it focuses on growing crops rather than microbial samples.

SINK AERATORS

Due to the simplicity of this feature, the second goal of this project is to install sink aerators throughout one floor of the Marine Sciences Building and monitor the reduction of water usage in the facility. This study aims to encourage



other departments to install faucet aerators as well. This information could be used to update building codes for all buildings on campus. Since there is at least one sink in almost every lab on campus, water consumption is a major focus in lab sustainability efforts.

According to the Environmental Sustainability & Stewardship's Sustainability Dashboard, in 2011

UW was successful in reducing water consumption beyond the targeted 1,176,000 gallons per day.¹ While this is a great achievement, campus water consumption could be reduced even further. Installing sink aerators is one of the simplest ways to effectively reduce water consumption. In labs, this means removing any tubing and barb attachments from faucets, screwing in a sink aerator, and replacing the tubing (used to fill containers and eliminate splash), and securing it with a clamp. The equipment required costs less than five dollars, installation can be completed in five minutes, and the result is up to 50% reduction in water usage. You watch a video explaining how to install a sink aerator [here](#).

One of the best features of faucet aerators is their price! Generally, a faucet aerator costs only \$2.50-\$8.00 before shipping. Considering the lifespan of this product and the cost of water, this simple device could lead to a significant reduction in your water bill.

CHALLENGES

Although there were few challenges regarding the sink aerator portion of our project, we have had trouble identifying an LED bulb that provides the proper spectrum and intensity for growth chambers. It is possible that this is simply a technological limitation, as growth lights require strong intensity that LED lights may not yet provide in the warm white (4100K) color temperature. While we continue to search for the "perfect LED light", this project may not be viable until a suitable product comes out.

GREEN PURCHASING

BY JUNE SONGTANTARUK & TERRA MILLER-CASSMAN

INTRODUCTION

What if you could make one decision that would reduce the environmental impact of your laboratory, without actually changing your daily routine? You can, just purchase green! While there are many other changes anyone can make to be environmentally responsible, purchasing is an upstream activity that affects other areas down the line, such as energy use, waste, and water consumption. We wanted to make information on green purchasing readily available, so that more of our labs on campus would consider trying out a green product alternative. We created a list of green lab products that could be widely used and communicated by labs across



campus. We realize it can be tricky to change the purchasing habits of labs that rely heavily on affordable lab equipment that does not risk tampering results. Often, purchasers resort to the cheapest products that are familiar and are available immediately. However, by making our page clear, easy to use, and recommending products that have been tested for performance and usability, we hope to increase the popularity of green products in labs.

WHAT WE DID

1. Survey: We started by distributing a survey to UW laboratories. The survey asked questions about their purchasing habits- such as what products they purchase, how often, from which vendors, and if they would be willing to purchase green alternatives if available. We received seven completed surveys, and

used this information to direct our product research. The survey allowed us to narrow our focus to products that are compatible with UW laboratories purchasing needs and habits. Our survey revealed that paper products (such as Paper towels, Kimwipes, and bench absorption pads) and gloves are the most commonly purchased products. We also discovered that many labs do not use resources available on campus for their lab supplies. USWAP, UW Surplus, the Biochemistry store, and MyChem supply labs with products, supplies, and/or chemicals that may have been over-ordered, can be re-used, or lent to labs.

Want to view the survey? Check it out at <http://depts.washington.edu/poeweb/students/fyi.html>

2. Research: We pursued other Universities' green lab purchasing practices and vendor information on green products. After we had a familiarity with green lab purchasing best practices and resources, we scouted out green products. We wanted to find green alternatives for the products purchased most often by UW labs, which vendors carry those products, the costs, environmental



benefits, and feasibility of use for lab duties.

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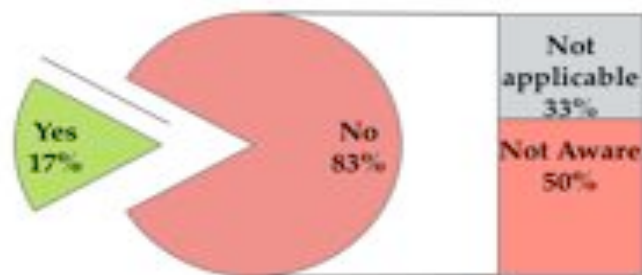
3. Communication: Throughout the quarter, we kept constant communication with Claudia Christensen from E-procurement and vendors such as Life Technologies, Mt. Baker Bio, and VWR Scientific. E-procurement is UW's central product purchasing site, and this communication helped us to understand the purchasing process and the potential for including the Green Products list on the website for ease of access and promotion of the list. We also spoke to vendors to receive information of the green products they sell, as well as to persuade these vendors to include a green "hotlist" on their websites so purchasers can easily locate green alternatives offered by their preferred vendor.

WHAT WE FOUND

This project has highlighted some important realities about greening laboratories.

1. Vendor take-back and recycling programs can save labs money and are available from most

Do you use vendor take-back programs?



vendors. However, from our survey, we found that most UW labs do not use these programs. Most of the labs said they do not use these programs because they are not aware of them. This is why we have included on our Green Products list some take-back and recycling programs

Paper Products



Gloves



Plastic Products



Hazardous Materials



Glass Products



that are available for labs to recycle used products.

2. There is a lack of green products currently available for laboratories. Of the most popular vendors, the green products that they do offer are difficult to locate on the website. This makes seeking green alternatives for labs time consuming, and most labs will not waste time searching for green products.
3. There is an emerging market for green lab products. Universities such as Harvard, Massachusetts Institute of Technology (MIT), and now University of Washington have begun Green Lab Programs to decrease the environmental impact of their campus laboratories. Because of the increased interest in this field, specialized vendors have begun to crop up which focus on green products for labs.

WHAT'S NEXT?

Right now you can view the Green Products list at [\[redacted\]](#). We hope that our Green Product list will become available to labs through E-Procurement, and that labs will go to this list for green alternatives prior to searching through vendors for needed products. However, the most important success of this project has been communicating to labs and vendors the importance and availability of quality green lab products.

ASSESSMENT OF SOLID WASTE STREAMS IN LABS

BY JARON CRAMER, MATTHEW CALANTAS & ANGELA HERR

INTRODUCTION

Our main goal was to try to tackle issues related to solid waste streams in labs on campus. We felt there were opportunities to reduce waste, increase recycling and compost, and educate lab users about practices that support the UW's goal of sustainability. While some labs might have already sought out such opportunities, we discovered there was very little communication between labs about these practices. We made our project to try to address these issues. We met with several labs to photograph waste, recycling, and compost bins and to talk about the lab's solid waste stream and disposal practices. We also went through a draft of the ESS Office's Green Laboratory Certification Program Survey (GLCPS) with someone in each lab. We took what we learned

from our meetings with labs and made eye-catching signage that might be used to help inspire lab users to make good decisions regarding waste.

PARTNERS

Matthew Smith (Baker Lab), Claire Levy (FSH 334 Lab), Wendi Ruef (OSB 540 Lab), Shelly Carpenter (MSB Lab), Emily Newcomer from UW Recycling, Jill Tepe from Green Lab Alliance, Aubrey Batchelor from UW ESS Office

WHAT WE DID

SOLID WASTE STREAM AUDIT*

We met with four labs on campus to discuss each lab's solid waste stream and take pictures of waste, recycling, and compost bins. This discussion was guided by a simple audit sheet that we generated and included questions such as "What is already being done to divert waste towards recycling?" and "What are the most common items put in the trash?" When possible, questions similar to those on the GLCPS were asked to try to determine what might be an effective way to reduce waste in each lab.

*Our original plan for our audits was to be much more thorough and assign metrics to each category of solid waste over two weeks. This would have required us to be in the lab seven days a week and examine each lab's garbage before it is emptied. Given our lack of proper training, and our time constraints, we found this to be unrealistic and revised our audits to be far less invasive. We decided to use a simpler audit sheet to give us an idea of the waste practices in each lab.

GLCPS FIELD-TESTING

We went through the GLCPS draft with a few labs to get a better idea of what gets thrown away or recycled and how waste is handled in the lab. This also gave us a chance to discuss any changes that could be made to the draft and see how the labs would score if they were to take the survey for certification. We timed the survey to get an idea of how much of a commitment would be necessary for a lab to get certified. Going through the draft was also another way to share best practices with the labs.

LAB SIGNAGE

Once our visits with labs were complete, we made signage based on what we learned. We directed our sign making towards engaging lab



managers and users with an interesting design, while getting across useful information about recycling methods.

What We Found

**SOLID WASTE
STREAM AUDIT**

1. Most lab users recycle and compost when they have easy access to proper bins. UW Recycling offers a wide range of recycling programs for lab-related materials, such as



Styrofoam, plastic film, and hard-rigid plastics, which labs can easily utilize. This simple solution just requires some sort of communication to get the proper bin put in the lab and in the loading dock of the building.

2. There were some recyclable items being put in the trash. We found large quantities of hard-rigid plastics thrown out, usually in the form of sample

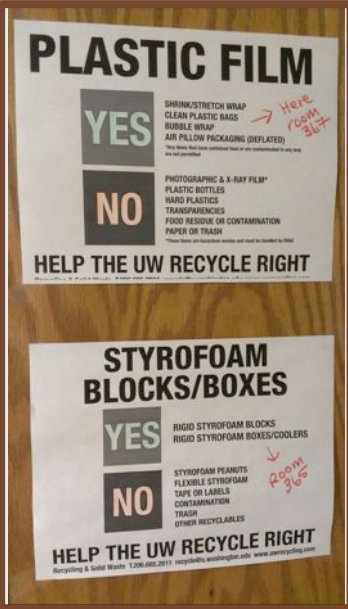
containers or pipette tip boxes. Styrofoam was another common item in the lab waste streams.

3. Some common items in the trash could be reused or composted. Every lab we met with had a significant amount of latex or nitrile gloves and

paper towels in the trash. Labs could consider reusing or purchasing washable gloves and using some sort of compost bin for paper towels.

GLCPS Field-Testing

- Found possible areas for revision in draft
- Eliminated or reworded repetitive or confusing questions



-Survey took around 15 minutes and could be taken by one person in lab

-Positive response from survey takers about its content

LAB SIGNAGE

-Green Labs logo developed

-“Did you know” signs made for Styrofoam, plastic film, and hard-rigid plastic recycling programs

-Stylish green design used to be eye-catching and relate to sustainability

TIPS FOR LAB MANAGERS

-Use audit sheet to guide waste reduction

-Get certified by the Green Labs Certification

-Communicate with UW Recycling to utilize existing recycling programs

-Use signage when and where possible to inform lab users on proper disposal practices

ELECTRICITY USAGE ACROSS LABORATORIES

BY RILEY SMITH, MOMOKA NAKAMURA, WES GREENBERG & MIKE MENEGHINI

INTRODUCTION

One of the main concerns when addressing sustainability in laboratories on the University of Washington campus is energy usage. Labs disproportionately consume energy and contain a unique assortment of equipment with varying levels of energy demand. Currently, laboratory operators are mindful of turning equipment off when it is not in use. However, there are no measurement systems available to individual labs to identify sources of energy waste. The purpose of our project was to examine energy usage in campus laboratories to provide equipment usage information, efficiency recommendations, and lab-specific incentive opportunities. With these results we hoped to better understand current trends in UW labs in order to identify possible areas to minimize energy consumption and waste. There are underutilized incentives and rebates offered by local utility providers to make simple yet effective energy efficiency improvements. By coupling these with sustainability programs like Green Labs, massive energy gains can be achieved.

WHAT WE DID

EQUIPMENT INVENTORY

We first identified potential campus laboratories encompassing a diverse selection of departments with specific research fields. We chose to conduct a case study of energy usage across three UW laboratory spaces, including the Kerr Laboratory, the Simpson Laboratory, and the Klavins Laboratory. Throughout the quarter we conducted equipment inventories of relevant electrical equipment in each lab, recording equipment manufacturer specifications; including manufacturer name, model number, serial number, volts and amps. We estimated weekly equipment usage hours via in-lab observations and researcher surveying.

Using the equipment wattage and the estimated weekly usage we calculated kWh over specified durations.

RESEARCHER USAGE TIMESHEETS

In each lab we posted a timesheet for lab researchers to sign in and out. This voluntary survey allowed us to map the peak usage patterns for each lab in order to estimate lighting energy consumption and assess the possibility of sensor technology within the lighting system. Installed on 11/8.

ENERGYHUB METERS

Next, electricity meters will be used to monitor energy consumption for specific equipment. The information that we collect from the energy meters will be used to identify the energy demand of appliances. Each meter can monitor six appliances and provides real time information through an energy consumption graph and table. EnergyHubs were installed on 11/19 and metered until 12/4.



UW ENERGY DASHBOARD (CLICK [HERE](#))

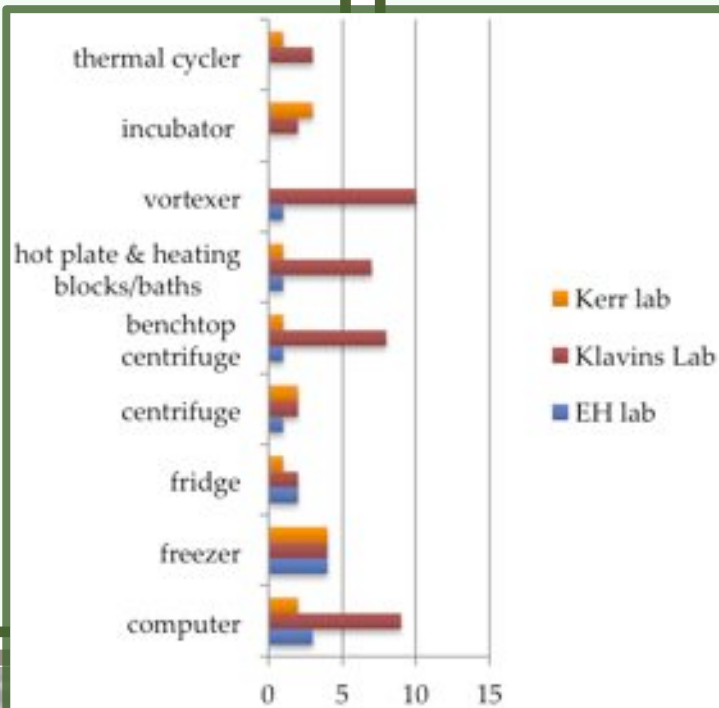
Also, the University's Energy Dashboard monitoring data provided raw metering data for the buildings housing our three lab spaces, including: the F-Wing of the Health Sciences Building, the Computer Sciences Engineering Building and the Physics and Astronomy Building. The dashboard, as part of the "smart grid" program, provided benchmark energy consumption for both the relevant laboratory buildings and other buildings on campus.

WHAT WE FOUND

INVENTORY ESTIMATES & DASHBOARD

The Simpson Lab (1950) had an estimated weekly energy use of 2,199.64 kWh, the lowest of the three labs examined. The lab equipment/lighting comprised 4.6% of the total F-Wing annual energy usage. The appliances that showed high-energy consumption rates were the fume hood and the freezers/refrigerators, comprising 51% and 16% of the lab's estimated energy consumption, respectively. Room lighting also showed to have a high consumption rate of 98.56 kWh per week.

The Kerr Lab (1994) had an estimated weekly

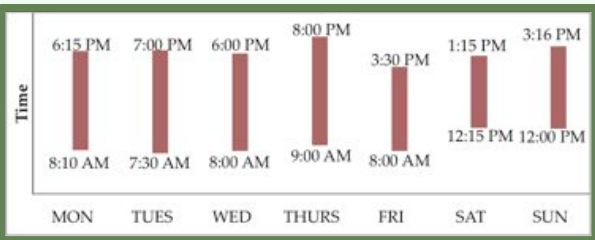


energy use of 3,017.88 kWh, the second lowest of the three labs examined. Appliances using a considerable amount of included the freezers/refrigerators, fume hood and isotemp oven. The freezers/refrigerators comprised 40% of the lab's estimated energy consumption.

The Klavins Lab (1998) had an overall energy consumption rate of 5,650.47 kWh per week, the highest of the three labs. The appliances using the highest amount of energy included the fume hood, the lighting, the isotemp incubator and the freezers/refrigerators. There are a total of 132 fluorescent lights in the lab using 591.36 kWh per week. The incubator used 394.97 kWh per week. The freezers/refrigerators comprised 27% of the lab's estimated energy consumption.

TIMESHEETS

Researcher participation in the usage timesheets was derived

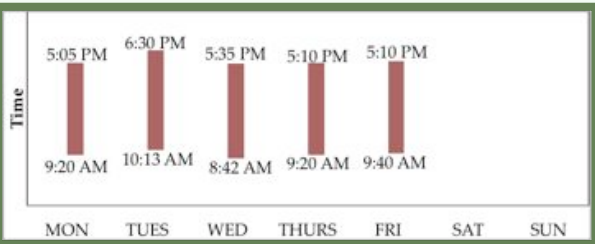


distinct occupancy patterns in the Kerr and Simpson labs.

The Kerr Lab's researcher-usage is concentrated from 7:30 to 8:00 from

Monday to Thursday, tailing off as the weekend approaches. The weekend usage is very limited to early afternoon.

The Simpson Lab's research-usage is even more tailored to weekdays, with no occupancy recorded on Saturday or Sunday.



The weekday occupancy is concentrated between 8:42 and 6:30, showing considerably shorter intervals than the Kerr Lab.

ENERGYHUB METERS

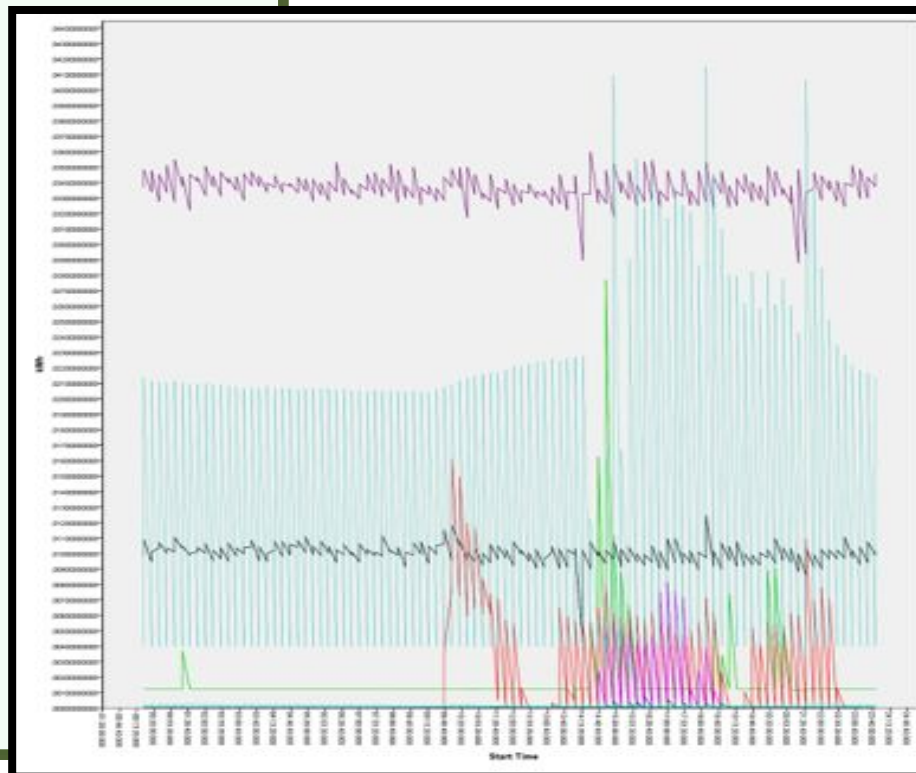
The meters highlighted the equipment categorizations within each lab. We were able to select common equipment and show average energy usage across a two-week duration. The data, displayed for the Klavins Lab to the right, shows disproportionate energy usage between the refrigerators (top) and the tabletop appliances (bottom) across all labs.

RECOMMENDATIONS

Our estimated annual costs of energy (\$5,810.60, \$7,972.03, \$14,926.28) directly related to the newness of our selected labs (1950, 1994, 1998). As more high-energy modern lab spaces are constructed on campus there becomes a need for accountability within

- laboratory resource consumption.
- Fake energy bills for individual labs.
- Incentive-based with rebates for savings (Seattle City Light).
- There needs to be a standardized norm for energy consumption across labs based on specifications.
- Researcher usage patterns must foster timed lighting management.
- Occupancy sensors to reduce energy usage during vacancy.
- Purchasing must consider energy efficiency when allocating grant funding for lab equipment.

In order to achieve these goals widespread laboratory-based energy metering must integrate fully into University campus. Only then can there be a reference point to reduce energy inefficiencies and adjust behavioral practices to ensure sustainability.



CLASS CONCLUSIONS

- Opportunity for growth in labs
- Lack of quantitative research within waste streams & energy usage
- No accountability, tragedy of the commons
- Lack of systematic approach to changing behavior
- Need for definition of sustainable within labs
- Need for standardized resource-use expectations
- Lack of communication and awareness
- Recycling programs
- Take-back programs
- Buyer Incentive & Rebate programs

IN THE FUTURE

- Green Lab Programs
- Improving Vendor Relationships
- Capstone Projects
- Research Students
- Follow-up studies

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