University of Washington Green Labs Proposal

A partnership between the University of Washington Sustainability Office and ENVIR 480: Sustainability Consulting Practicum

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UNIVERSITY of WASHINGTON

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Executive Summary

The UW Office of Sustainability has partnered with the UW Student Sustainability team (i.e. course ENVIR 480: Sustainable Consulting Practicum), to develop a proposal for UW to create a new Green Labs Program. As a premier R1 public research institution, and continued commitment to improving sustainability across campuses, the University of Washington is overdue for reinstating its Green Labs program, which has been paused since 2020. The context and first steps for revitalizing this program are outlined in this proposal.

Our team assessed 28 peer institutions (see Appendix A for institutions), conducted interviews with leaders of Green Lab Programs across the country, analyzed data on current protocols and waste initiatives at the university, and developed a set of recommendations outlining why and how the Green Labs Program should be implemented in the near future. Our team developed recommended lab initiatives, identified incentives, and reviewed insights for the implementation of the program.

Why UW Should Start a Green Labs Program

UW has approximately 730 labs on the Seattle campus, 25 labs on the Bothell campus, and 20 labs on the Tacoma campus. Research shows that higher education laboratory spaces use approximately 5-10 times more energy than a typical workspace, and high process load or special use laboratories can use up to 100 times more energy depending on the nature of research. A Green Labs program can dramatically reduce energy and resource usage, and can provide countless other opportunities for the university.

- **Leadership:** Out of 28 peer institutions, the University of Washington is one of the few institutions that does not have a current Green Labs Program. As a leading R1 institution known for its innovative research, UW should also be a leader in conducting that research sustainably.
- **Cost Savings:** Implementing a comprehensive Green Labs program has the potential to yield major cost savings across many different categories. From energy-saving initiatives that have saved up to $1 million dollars at peer institutions to waste reduction initiatives that eliminate approximately $10,000 in landfill tipping fees, this program will draw attention to key areas where the university is paying avoidable fines and excess utility bills.
- **Safety:** The Green Labs program has major potential to partner with the UW Environmental Health and Safety Office, promoting initiatives like ACT Environmental Impact labels that increase transparency of safety hazards in labs. Additionally, Green Chemistry is a major part of the program that promotes responsible disposal of hazardous waste, keeping faculty, staff, and students safe across campuses.

- **Environmental Conservation:** Aligning with UW's Commitments to Sustainability, the program will provide resources for labs to reduce energy usage and waste, including campaigns like Shut the Sash that drastically reduce energy use from equipment while not in use, and replace unnecessarily energy-intensive lab resources (ie: ultra low-temperature freezers) where they are not needed. This will result in a massive reduction in water and energy usage, as well as the reuse and recycling of equipment instead of wrongful landfill disposal.
- **Equity and Social Justice:** In addition to encouraging sustainable practices and safety measures, the Green Labs program is an opportunity to focus attention on equitable practices in labs. Comprehensive initiatives include responsible procurement policies that avoid forced labor and eliminate harmful impacts to marginalized communities, and space optimization techniques that ensure all researchers have equal access and opportunity to equipment and lab spaces on campus.

Key Green Lab Focus Areas

The following lab initiative focus areas are recommended for UW's new Green Labs program:

- Energy and Water
- Waste Reduction
- Reuse and Recycling
- Green Chemistry and Safety
- Procurement and Consumables
- Social Justice and Equity Initiatives

While this list may include many aspects of different types of labs on campus, a majority of these guidelines can be implemented from the top down at a procurement level, and will be in the best interest of staff, faculty, and students by increasing safety measures in lab buildings. This program will rely on collaboration with on-campus stakeholders like EHS, procurement, waste management, researchers, and many other groups.

Proposed **Energy and Water** initiatives include the implementation of the Shut the Sash campaign to reduce energy consumption from fume hoods in labs, which could help reduce energy usage by up to 80%. At peer institutions, this campaign has yielded savings of up to $1,000,000 dollars a year; a significant cost savings from UW's annual cost of $3.7 million dollars a year spent on the cost of running fume hoods. Additionally, decreasing temperatures of Ultra Low Temperature Freezers would reduce energy consumption and yield more efficient use of freezers; an initiative successfully implemented at UVA that created $15,700 in cost savings annually. Lastly, the use of benchtop timers to reduce equipment use and proper detection of autoclave failures has the potential for a significant reduction in energy consumption and subsequent cost savings.

Proposed **Waste Reduction** initiatives include increasing the borrowing and sharing of systems and equipment between labs, bolstering composting initiatives and signage, and implementing sustainable purchasing guidelines and package reduction at a procurement level. These waste diversion initiatives would decrease solid waste going to landfills and could yield over $10,000 dollars annually in cost savings from landfill tipping fees.

Proposed **Reuse and Recycling** initiatives include promoting the sharing and reuse of lab materials over single-use, reducing lab recycling contamination through increased education, and pursuing vendor recycling programs outside of UW. While cost savings from reuse initiatives may be hard to quantify before the program is implemented, it is more straightforward to recognize the cost savings opportunities by reducing lab recycling contamination. This contamination caused almost a 70% increase (around $3,700 dollars) in recycling fees, so the reduction of this contamination could drastically reduce, or even eliminate this fine.

The main proposed **Green Chemistry and Safety** initiative includes the implementation of ACT Environmental Impact Labels, which would promote transparency and awareness of environmental impact as well as safety hazards in chemicals used by labs. Working with UW EH&S, the Green Labs Program could use the intersection of safety and sustainability to ensure labs are as safe as possible for staff, faculty, and students, while also reducing environmental footprint.

Proposed **Procurement and Consumables** initiatives include maximizing reusable labware over single-use materials, participating in reuse networks (i.e. Rheaply, Warp-it, and/or USwap), buying in bulk to avoid individual packaging, utilizing recycling programs for otherwise landfilled-products, replacing older equipment with energy-efficient models, and overall conforming to environmentally preferred purchasing practices, as listed on UW Sustainability's website.

Proposed **Social Justice and Equity** initiatives include promoting space optimization and identifying equity issues from consumables at a procurement and waste level. By devoting more research into procurement policies surrounding supply chains and labor practices, the Green Labs Program can support the University of Washington's commitment to making campus a safe and equitable space for all. Similarly, by focusing efforts on space optimization and shared equipment, the program can increase lab space availability for researchers who come from historically underrepresented and marginalized groups, ensuring all researchers have equal opportunity to utilize labs on campus.

Staffing and Implementation

The UW Green Labs Program should be led by at least one full-time employee to lead the program, perform outreach on campus, and lead certifications for specific labs. This person will have leadership experience in facilitating connections between stakeholders, strong background

knowledge of sustainability, and preferably some prior experience working in a lab setting or with scientific researchers. A prime example of this position comes from the University of Virginia, where the Sustainable Labs Project Associate oversees a highly involved certification process for labs on campus, and completes a majority of the community outreach and communications from the program. In a preliminary research interview, the current Sustainable Labs Project Associate, Fiona Hogan Bradford emphasized the need for at least one FTE position, explaining that the needs of a successful Green Labs program exceed the capacity of the existing positions at a typical university sustainability office. Prior to the implementation of this program and the creation of the position, we recommend that there be a working group created to support the development of the program and represent different perspectives from key stakeholders on campus.

The best practices and cross-collaboration outlined in this report will not only increase efficiency, safety, and sustainability in labs on campus but will yield massive cost savings across multiple focus areas and on-campus programs. Most importantly, this program will align with UW's commitment to Sustainability, representing the interests of faculty, staff, and students, as well as re-establishing the University of Washington as a national leader in sustainable and equitable lab practices among public research institutions.

Introduction and Background

The University of Washington receives more federal research dollars than any other U.S. public university and is ranked the No. 1 most innovative public university in the world by Reuters. Additionally, the University of Washington is already regarded as a leader in hazardous waste management among peer institutions. With our cutting-edge research, excellence in hazardous waste management, and commitment to sustainability, as outlined in the UW Sustainability Action Plan (2021-2025), it is time for the University of Washington to reinstate the Green Labs Certification Program.

Formed in 2012, the original Green Labs Program worked to minimize the environmental impact of laboratories at the university by engaging stakeholders and providing resources for on-campus labs to become certified green labs. The program had a fully fledged certification process and was managed by the Green Laboratory Certification Committee. The program was put on hold after the pandemic in 2020 and certifications have not been up and running since.

With the university's 2024 update to the Sustainability Action Plan, now is the perfect time to reinstate this program and uphold the University of Washington's commitment to sustainability on campus. This certification program will contribute to actions outlined in the plan, including 15% less energy usage intensity, 10% less solid waste, and a 45% reduction of greenhouse gas emissions by 2025. Additionally, this program will work to double student, staff, and faculty sustainability engagement by providing incentives for sustainable policies and engaging in community outreach and education surrounding green lab policies.

This report presents an overview of Green Labs programs at top national and peer institutions, as well as reviewing the International Institute for Sustainable Laboratories (I2SL), a leader in designing and implementing green lab programs all over the world. Next, we provide recommended initiatives for the proposed green lab program, including Energy and Water initiatives, Waste Reduction initiatives, Reuse and Recycling initiatives, Green Chemistry and Safety initiatives, Procurement and Consumables initiatives, and Equity and Social Justice initiatives. We then explore potential incentives for implementing the program, providing details on potential funding sources and FTE opportunities. This is followed by an overview of the key findings in this report, as well as insights and recommendations for the successful implementation of the green labs program at the University of Washington.

This report is the culmination of the combined efforts of Lisa Dulude, Director of the UW Sustainability Team, and UW Student Sustainability Team, developed by the Sustainable Consulting Practicum (ENVIR 480 A) and overseen by Professor Fred Pursell.

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Peer and Aspirational Green Labs Programs

Top National Institutions

The Green Labs Programs at the University of Virginia and the University of Georgia stand out as national leaders in green lab establishment and certifications. Both of these institutions are recognized as peer institutions and have comprehensive green lab programs that the University of Washington's program would seek to emulate.

The University of Virginia's green lab certification program has a comprehensive approach that focuses on five areas: cold storage, chemicals and reagents, materials and refuse, electronics and appliances, and engagement. This program utilizes a preliminary self-assessment followed by a consultation, a final assessment, and mandatory training in sustainable lab practices. Upon completion, the participating organization receives certification, a plaque, and a written feature on the UVA website.

The University of Georgia utilizes four areas of focus for sustainable lab practices: energy saving, procurement, waste diversion, and water saving. This institution uses a holistic approach and has been recognized for its practices, earning multiple awards including the 2022 Emerging Leader Award from the International Institute for Sustainable Laboratories (I2SL). Additionally, the University of Georgia is regarded as a leader in incorporating social justice and equity initiatives into its green labs program, making it a model institution for a comprehensive approach to sustainability.

Peer Institutions

The University of Washington currently uses the U.S. News Top-25 Public Research Institutions as its primary peer comparison group. At the recommendation of Davina Spencer, Director of Institutional Reporting in the UW Office of Finance, Planning & Budgeting, we've included three additional institutions in the peer comparison group to account for year-to-year changes (see Appendix A for list of institutions).

Out of the 28 peer institutions on the list, 19 of these leading public research institutions have up-to-date green lab or sustainable lab certification programs. Like the University of Washington, 5 of these institutions have green lab programs that are on pause or are currently being developed. 4 institutions do not have any type of green lab program.

The University of Washington has the opportunity to rejoin its peers in reinstating its green lab certification program, becoming a leader with one of the most efficient and engaging green lab programs among top public research institutions across the nation.

International Institute for Sustainable Laboratories (I2SL)

The International Institute for Sustainable Laboratories or I2SL is a resource for engaging all stakeholders in advancing the safety and sustainability of laboratories around the world. This highly developed institute serves as a major resource for high-tech facilities including the University of Georgia.

This organization provides abundant resources for its users including education services, certifications, memberships, and highly organized toolkits. The I2SL Labs2Zero project is a program in development specifically created for decarbonizing lab spaces around the world and is comprised of a variety of tools and information that addresses the complexity of laboratories as well as the need to make them greener. Some of the resources listed on their website included in the Labs2Zero program include “Lab Energy Score”, “Emissions Scorecard for Labs”, “Actionable Insights and Measures (AIM) Report”, “Embodied Carbon Benchmarking Tool”, “Design2Zero”, “Lab Emissions Performance Certification”, and “Training and Accreditation Program”. These tools in development are created specifically to assist large-scale organizations like the University of Washington in learning about our current environmental impacts from our laboratories as well as tools on how to address said impacts. I2SL also offers the “Smart Labs Toolkit” which is a completely free, online resource with a guide to assist lab owners as well as users with implementing their own Smart Labs programming. The toolkit addresses four main phases to help to support sustainability, safety, and efficiency in laboratories and is a more economical and personal way for large organizations to participate in this movement for green labs.

The University of Washington has the ability to participate in I2SL’s program whether that is through membership, use of their free resources and education tools, as well as their developing Labs2Zero program. I2SL could serve as a means for UW to set roots in the Green Lab Program and receive guidance from a globally recognized program.

Recommended Green Labs Initiatives

The new and improved UW Green Labs Program will be built upon the existing, dormant program, as well as lab safety requirements and environmental compliance regulations. The proposed initiatives that follow include the topic areas of Energy and Water, Waste Reduction, Reuse and Recycling, Green Chemistry and Safety, Procurement and Consumables, and Equity and Social Justice. While these focus areas cover a myriad of topics, this list of initiatives is not all-encompassing but rather focuses on viable, straightforward solutions with significant environmental, safety, and economic benefits.

Energy and Water Initiatives

The UW Sustainability Action Plan calls for a 15% energy usage intensity by 2025 and a commitment to monitoring methods to reduce water consumption for construction maintenance and irrigation.[b] Of the greenhouse gas emissions generated by UW, 93% originate from fossil fuels burned to generate heat for the campus. There are currently plans in progress to change this heating source to electricity, but the switch is constrained by the amount of electricity that is possible to flow at a given time. If UW is able to limit its existing energy use, it will be possible to decrease the burden of this added demand and avoid power shut-offs in times of high use. The University of Washington paid $4 million dollars in fines in 2023 for exceeding the limits set by the recently passed Climate Commitment Act and is set to pay an additional $15 million in 2029 if no changes are made.

Laboratory spaces use 5-10 times more energy per square foot than office spaces, mostly due to high energy use equipment, ventilation needs, and cold storage. High process load and special use laboratories can use as much as 100 times more energy.[c] Equipment and materials commonly used in labs can waste large amounts of water if not properly maintained or used.

Fume Hoods

There are about 1,700 fume hoods on the University of Washington campus.[c] Fume hoods themselves are extremely energy intensive, each using more daily energy than 3.5 American Households and accounting for 60% of the energy use of a laboratory.[a] This is largely due to the 825 cubic feet of conditioned air pulled up per minute that must be replaced by the ventilation system and fans. From a conservative estimate, at UW this adds to $3.7 million dollars a year in electricity costs, although this number is likely to be much higher based on the age of the building, the efficiency of the ventilation, and the model of the fume hood. (see appendix for calculation)

Shut the Sash Campaign

However, a significant portion of this energy use can be avoided by minimizing the air pulled up by the fume hoods when not in use. Buildings that contain Variable Air Volume (VAV) systems will lose less air when fume hood sashes are lowered when not in use. “Shutting the Sash” has been shown to reduce energy use by 80%.[d] Closed sashes are also safer for laboratory workers, and much more likely to contain any hazardous chemicals or fumes inside.

Despite this, fume hoods in universities across the country are commonly left open when not in use. To combat this, the UW Green Labs program would aim to launch an educational “Shut the Sash” campaign, including educational resources and fume hood stickers that would be able to encourage students and researchers to reduce sash height when active, and to close fume hoods completely on nights, weekends, and between tasks.

While not all fume hoods are in VAV systems, they still provide an important and easily implemented opportunity to save energy and increase safety. VAV systems are commonly used in large mixed-use buildings, like many lab spaces on campus. While energy savings for Shut the Sash campaigns are based on voluntary action and outreach, they have led to significant savings for peer institutions. MIT reported an annual energy savings of $190,000 (105 hoods) and UC Berkeley reported an annual energy savings of $1,000,000 (600 hoods).[e]

Ultra Low Temperature (ULT) Freezers

Ultra Low-Temperature freezers are often used as storage for research samples and tissue. Traditionally, these freezers are set to -80*C. However, emerging research has shown that many samples are able to be stored at -70*C and warmer with no negative impacts.[f] When the Center for Disease Control (CDC) tested this theory using 60 ULT Freezers in 2012, it was found that a 10-degree increase in temperature led to an average 37% reduction in energy use for both standard and energy-efficient ULT freezers.[g] These energy savings can be further increased by encouraging labs to clear out old samples and consolidating and sharing freezer space. While the energy efficiency has been improving, the average ULT freezer uses an average of 20 kWh a day.[h] Assuming a 37% reduction in energy use, this would save approximately $565 per ULT freezer annually. This savings would be much higher for older and less efficient freezer models. Research has also shown that increasing the temperature of ULT freezers decreases the strain on their systems, increasing their product lifespan. The importance of this is expanded upon further in the Procurement and Consumables section of this document.

UW Green Labs would include freezer use as a parameter of evaluation for certification. Labs would be encouraged to increase the temperatures of their ULT freezers when possible, based on the samples listed here. It would also be encouraged to use freezer space efficiently, removing unused samples and consolidating whenever possible. As a motivator, UW would also participate in the annual Freezer Challenge put on by I2SL and My Green Labs, which puts universities and laboratories around the world in a competition to reduce energy consumption from ULT freezers.

The 2023 round of this challenge led to ~23 million kWh in energy savings and included over 2,000 laboratories from around the world including John Hopkins, University of Illinois Urbana-Champaign and the University of Michigan. [i] The University of Virginia had 25 labs participate in the 2022 freezer challenge and saved approximately 441 kWh of energy a day, equalling $15,700 in savings a year. [j]

Equipment Use

It remains to be mentioned that a large portion of laboratory energy consumption comes from the use of laboratory equipment. Equipment such as hot water baths, drying ovens and incubators that take time to start are often run overnight and on weekends to minimize prep time. For example, the average drying oven uses 13,140 kWh of energy annually.[k] At UW, this energy use is likely much higher considering many labs still use older, less energy efficient, models.

This can be easily avoided by using benchtop timers to automatically power down smaller items at the end of the day and to give equipment time to start in the morning. Similar to ULT Freezers, larger equipment can operate under reduced temperatures to additionally minimize energy use, or simply be manually turned off over breaks and weekends.

The UW Green Labs program would aim to provide a limited amount of benchtop timers for UW Labs, as well as offer resources for labs to determine whether their equipment had the right wattage for benchtop timers, or was applicable for temperature reduction. Labs that added their own benchtop timers to equipment or chose to power down equipment when not in use would be further recognized in the certification process.

Autoclaves

Autoclaves on the UW main campus are typically heated with steam from the central steam plant, and many units employ a water-cooled jacket to rapidly cool the steam vessel and its contents at the end of the sterilization cycle. Autoclaves operate using solenoid valves. These valves control the flow of water in autoclaves, and occasionally wear and fail from use. A broken valve on an autoclave can waste thousands of dollars of potable water if left unnoticed. A single broken valve left unnoticed for 6 months would waste 1.3 million gallons of water, resulting in $23,000 in water and sewer charges.[l] Despite this, few people know how to properly identify broken autoclaves, so errors often go unnoticed. Autoclaves are often shared between labs, and are used at inconsistent intervals. Because of this, training individuals would be difficult to maintain, especially because of high turnover rates from students and staff.

The UW Green Labs program would train the individuals working with the program to be able to detect common autoclave failures and report them to the UW Facilities Department immediately. Labs that were willing to train on common signs of autoclave equipment failure and set up a

recurring inspection of their autoclaves would be credited as part of the certification process. The existence of a FTE would be key in this effort, as they would be the one best positioned to identify possible autoclave faults and are not as susceptible to the high turnover rate customary to research and laboratory spaces.

Waste Reduction Initiatives

UW landfilled 39.7%, or 3,458 tons, of its total waste in FY21 according to the UW Recycling Annual Report, costing $570,570. UW Sustainability Action Plan (SAP) has aimed to reduce solid waste production by 10% by 2025, which is a goal less than two years away. Currently, waste diversion efforts are focused on expanding composting across campus buildings. In 2018, a waste characterization study was conducted on the UW Seattle campus, identifying 590 tons of waste produced by campus laboratories, with 275 tons (46.6%) attributable to landfills. Of this, 63% (173.25 tons) of landfilled items could be recovered. These waste diversion savings could amount to over $10,000, with the University of Georgia estimating that their efforts would save $12,600 in landfill tipping fees. With UW's strong existing waste infrastructure, the revitalized Green Labs Program will assist in achieving this goal through waste reduction initiatives including, but not limited to composting, sharing, reuse, and recycling.

Borrowing and Sharing Systems

Much of the waste produced in labs can be stopped at the source through borrowing and sharing systems between labs on and across campuses. Limiting the number of purchases inevitably decreases waste from packaging, transport, and excess materials, which requires a system for borrowing and sharing with other labs. There is currently a system of materials sharing through UW Research, which requires a Material Transfer Agreement (MTA). UW Research also provides information on services, facilities, and equipment available to researchers. With these opportunities, labs need to be made keenly aware of how to aim to reduce resource consumption before making new purchases. For more information on this topic, see Green Chemistry and Safety Initiatives.

Composting

According to the 2018 Waste Characterization Study, composting materials properly is a key area of opportunity for waste reduction. Compostable material was identified as the largest category of recoverable waste in the landfill stream at 38%, and only 48% of compostable materials were composted. 29% of paper and 19% of organics ended up in landfills, which demonstrates a need for better education or signage on what can and cannot be composted in lab environments. Due to the focus on composting in the SAP and UW's recommendation to expand composting bins across campus buildings, laboratories have an opportunity to greatly reduce their waste footprint through more comprehensive composting practices. A recent composting initiative that has become ubiquitous across campus is the use of compostable paper towels for handwashing. This

initiative can greatly reduce the amount of paper being sent to landfills, which has been identified as a pain point.

Composting materials is currently the cheapest option for UW at $69.50 per ton. Seattle campus laboratories composted 110 tons of waste in 2018, costing an estimated $7,645 at the time. 8.14 tons of compost made its way into the recycling stream, and 104.5 tons made its way into the landfill. This made recycling in 2018 $948.72 more expensive, and landfill tipping fees $17,242 more costly. Diverting the compostable lab materials that were sent to recycling and landfill would only cost an additional $7,828.48 compared to the cost of over $18,000 from wrongly disposed of compost, saving over $10,000.

Sustainable Purchasing and Packaging Reduction

Through sustainable purchasing practices, labs across campuses can reduce waste by limiting the amount of packaging that comes with lab orders. UW Surplus provides materials without packaging, which is a waste-free and cost-effective solution for purchasing. Ordering in bulk or in combination with other labs can also help reduce packaging. Additionally, consciously choosing vendors to purchase from can reduce environmental impact and packaging use. By contacting vendors personally, labs can assess ways to receive goods without packaging, return packaging after use, or recycle packaging properly.

Due to the limited standardization of lab purchasing across campuses, to best align with UW purchasing commitments, the university must ensure lab procurers are equipped with the necessary training to engage in socially equitable and sustainable purchasing practices. As UW is still trying to integrate sustainability into procurement, labs may struggle to decrease solid waste through the process of buying goods and services. Providing labs with catalogs of sustainable lab goods, such as socially responsible nitrile gloves, reuse systems and services, and more can help aid this transition. For more information on this topic, see Procurement and Consumables Initiatives.

Reuse and Recycling Initiatives

Reuse

While reusable alternatives may not be the most viable option for all lab settings, there are methods of reuse that can help achieve waste reduction in lab spaces. Aforementioned, borrowing and sharing systems, such as transferring chemicals between labs and utilizing used lab equipment from UW Surplus can allow for lab materials to be involved in a circular system of use, rather than the traditional single-use nature of laboratories. Moreover, a variety of goods and vendor services exist to help labs divert waste through the process of reuse. Pipette tips, a common disposable item, can be reused through the Grenova or IonField Systems services.

While these technologies may be costly upfront, long-term savings will begin to show with fewer, less frequent orders of disposables. There are also many reusable pipette tip boxes that can be purchased to begin implementing reuse strategies in labs. In addition, nitrile gloves are convenient, but their disposable nature contributes to a lot of waste, whereas a reusable alternative like butyl gloves can be sanitized and reused. Glass alternatives to common lab disposables, like test tubes and petri dishes, can usually be reused when sterilized properly, which offers opportunities for vendor engagement and reuse. For materials that can be reused but are often not, such as lab notebooks and protective wear, labs should consider the viability of reusing these items, when safety is not compromised, to practice and promote reuse. Innovative tactics implemented by labs during the last UW Green Labs Program can stand as an example of successful reuse of materials, such as Baker Laboratory's system for reusing SPE cartridges and disposable syringes.

Recycling

The 2018 Waste Characterization Study identified that 30% of lab recycling was contaminated, which is 22.2 tons of waste wrongly sorted into recycling bins. Most of this contamination was non-recoverable, compostable, or separated recyclable materials, to which better education and signage about what materials can be recycled would be beneficial. Due to lab recycling contamination being higher than 15%, the fee to recycle bumped up from $116.55 per ton to $166.55 per ton, costing $12,324.7 instead of $8,624.7, or an almost 70% cost increase. As UW Recycling can take all unsoiled paper products, separate bins with lab-specific signage are essential to mitigate the costs of contamination. UW Recycling offers recycling for materials that can contaminate paper recycling such as hard plastics, styrofoam, polystyrene, ink cartridges, e-media, and plastic film which requires labs to coordinate with UW Recycling. All of these resources are dispersed on various UW web pages which can make recycling lab materials challenging and lead to higher landfill rates.

Outside of UW, services exist to help recycle other materials that UW Recycling does not take. UW Recycling no longer accepts pipette tip boxes, which is an opportunity for vendor recycling programs to be utilized, such as the Gimme 5 program, Polycarbin, and Terracycle recycling, or even transition to reusable alternatives. UW Recycling does not accept used chemical containers, which is another opportunity to contract with vendors who recycle hazardous waste, or reuse the container safely as proposed by EH&S. Another vendor, who produces Envetec GENERATIONS technology, can convert biohazardous waste into recyclable material.

Green Chemistry and Safety Initiatives

As a standard set by the American Chemical Society, programs with an ACS certification must ensure that students have a working knowledge of Green Chemistry.[a] Green Chemistry refers to

the reduction of hazardous waste, and chemical use, and a focus on using more environmentally friendly alternatives. Green Chemistry is inherently connected to safety due to its aim to reduce the unnecessary use of strong and hazardous chemicals. Less chemicals reduce unnecessary exposure and incidents for researchers and students. While chemical use and procurement is largely dependent on individual laboratory purchasing practices, the UW Green Labs program can increase awareness and offer resources for laboratories to identify key processes and alternatives to practice Green Chemistry. The initiatives in this section would make sustainable decision-making accessible to students and staff both when purchasing chemicals, planning reactions, and choosing reagents in the lab.

Because of its robust laboratory program, UW generates large amounts of hazardous waste. In 2023, there were 112,600 kilograms of hazardous waste disposed of by Environmental Health and Safety (EHS). This represents an ample opportunity to reduce chemical waste and hazardous waste generation. This also combines with the reported major safety incidents. The last publicly available incident report from UW shows that in 2016, 63% of lab-related incidents occurred due to improper chemical use - incidents that could be avoided by switching out highly toxic chemicals with safer alternatives.[b]

The main initiative through Green Chemistry would be the use of ACT Environmental Impact Labels in participating laboratories. These labels are part of a database designed by My Green Labs to display the Environmental Impact of commonly used chemicals, solvents and reagents. Use of these labels in labs would encourage researchers to be consciously aware of the chemicals they are using, as well as promoting personal responsibility when choosing reagents and solvents for reactions. This would aim to reduce both waste generation and promote the use of more environmentally friendly chemicals in daily laboratory use. While it is not always possible to substitute chemicals in chemistry, it is important to provide students and staff with the ability to make educated decisions whenever possible.

The ACS has an abundance of resources on Green Chemistry, including the 12 Key steps for Green Chemistry, which are a helpful beginners guide, and the Solvent Selection Tool and Solvent Selection Guide which helps to show solvents with similar properties, but lower environmental impact. When this Solvent Guide was implemented in Pfizer, they achieved a 50% reduction in chlorinated solvent use, the reduction of undesirable ether usage by 97%, and shifted the use of heptane over a longer period of time.[c]

Sigma Aldrich has the DOZN tool, which shows different chemical synthesis and processes, and helps to show which have the lowest environmental impact.

UW already has a successful online inventory database and chemical exchange through MyChem and the UW Chemical Exchange. These are important as they allow labs to keep track of existing

chemical inventories and share chemicals across laboratories. Shared resources reduce the need to buy unnecessary chemicals for individual lab groups, and allow laboratories to buy in bulk when needed. However, despite these resources available, 30% of waste is unused chemicals. The UW Green Labs program would support the continued use of these resources by encouraging active lab participation in Chemical Exchange and awarding points to participants who were able to share chemicals with other labs rather than buying individually. If possible, the UW Green Labs staff would also work to include ACT labels as a part of MyChem, so that environmental impact chemical information was easily available to all labs. Any reduction in chemical use and environmentally friendly substitutions also serves to protect students and staff from hazardous waste and unnecessarily strong/toxic chemicals.

Procurement and Consumables Initiatives

Labs independently source and dispose of their materials, making specific data about utilized material unavailable. However, as per the University of Washington's 2018 Waste Characterization study, campus labs' overall waste stream consisted of 47% paper and 14% plastics. Sourcing reusable materials, such as glassware over plastics, can drastically reduce the single-use culture, and thus waste accumulation of UW labs. Research proves that this transition does not increase toxin carryover or contamination (Kilcoyne, 2022). This can look like replacing disposable paper liners with reusable chemical-resistant trays or plastic containers with compostable counterparts. If these products cannot be autoclaved, soaking in a 10% fresh bleach solution, followed by a distilled water rinse and air dry should be adequate for decontamination (University of Massachusetts Lowell, n.d.). Brands such as Thermo-Fisher Scientific produce reusable plastic labware designed to uphold through intensive lab work. Further waste reduction can take the form of services, such as Rheaply and Warp-it Reuse Network, that provide spaces for the sharing and trading of lab resources. UW also has the potential to redesign their USwap program, which follows similar parameters, but more locally.

Although it is unclear how much pipette-specific waste UW produces, a 2019 audit of MIT's clean plastic waste found 80% to be contributed to empty pipette tip boxes and conical tube racks (MIT, 2023). By implementing stackable racks and bagged pipette tips into the lab, much of this waste would be diverted. These would both remove the need for individual plastic casings and reduce pipette tip racks and boxes. Additionally, pipettes themselves can be entirely reusable and autoclavable when made from certain materials, such as borosilicate glass; these can be purchased from known brands like Fisher Scientific and DWK Life Sciences.

Many consumables, such as personal protective equipment, nitrile gloves, safety glasses, masks, and chemical wipes are not accepted into standard recycling streams. That said, over three-fifths of garbage collected at UW campus labs is recoverable (UW Waste Characterization, 2018). Kimberly Clark SmartCycle provides the service of recycling these materials properly after use. Specifically, Kimberly-Clark Professional™ KIMTECH PURE™ G3 Sterile Sterling™ Nitrile

Gloves are made of stronger material and provided in efficient packaging to reduce excess waste production by one ton per year. However, it should be noted that there are considerations of expenses for shipping and equity issues regarding nitrile gloves, among other lab plastics. This service should function as a last-case alternative. For more information on sustainably sourcing lab materials, view UW Sustainability's "Green Laboratory Products" or https://sustainability.uw.edu/files/green_lab/purchasing_guide.xlsx

The above listed aligns with the University of Washington's Green Purchasing Program. With additional employment of environmentally preferred purchasing (EEP), sustainability requirements are already listed under Procurement Service's policy and guidelines. Enforcing listed initiatives to reduce paper through e-Procurement and use energy-efficient equipment will both save money by minimizing purchases and contribute to UW's sustainability commitments. Currently, Seattle City Light is offering rebates of up to $600 for each purchase of a Stirling Ultra Low Temperature (ULT) Freezer. With vacuum-insulated panels, insulated interior doors, and improved cascaded refrigeration system design, these freezers save up to 5,250 kWh/year/unit. This equates to over 65% energy savings, significantly sizable compared to other ULT freezer models. As for lab-grade freezers and chromatography refrigerators, these can usually be avoided and replaced by standard residential units. To learn more about sustainable procurement of lab equipment, visit the My Green Lab database (ACT Database). Older equipment can be given to UW Surplus for rehoming or recycling. *Refer to Appendix B for a more in-depth discussion of the proposed initiatives.

Equity and Social Justice Initiatives

The reinstatement of the Green Labs Program at the University of Washington is not only an opportunity to maintain the institution's commitment to sustainability but also equity and inclusion. Sustainability and equity are deeply interconnected and can be addressed through policy and initiatives at the institutional and individual levels. The university can foster a more equitable and safe environment for lab participants by reevaluating and enforcing procurement policies for labs on campus and reconsidering the use of laboratory spaces and equipment.

To ensure equitable material sourcing, the Green Lab Program must work closely with the University of Washington's Procurement Office as their Green Purchasing Program certifies that sweatshop labor may not be utilized. UW's Green Lab will have to enforce top-down equitable resource allocation through an assessment of current sourcing practices in the lab space.

Injustice is also revealed in space optimization issues meaning that people of minority identities often do not have equal access to lab space. This is a result of systematic oppression and must also be addressed to ensure equity in the Green Lab Program. UW can combat this injustice by educating lab managers of this inequity as well as creating concrete space for minority identities in the lab environment.

Including social justice and equity in the University of Washington Green Lab program can be incredibly impactful as UW laboratories produce essential research and study not just for the UW but the nation as a whole. Making research equitable will support UW's commitment to diversity and inclusion while making important contributions to informing our world with a more equitable foundation.

Incentives

Potential Funding Sources (fee to service, central funding, etc.)

The University of Washington remains the largest recipient of federal funding across the nation, with $1.87 billion in grants and contracts in 2023. Many other R1 institutions have employed incentive programs in funding their Green Labs, specifically in regard to compensation for energy-efficient equipment (see Procurement and Consumables Initiatives for more information). Grants already offered to UW labs can be altered, to achieve the same ends but through more sustainable measures. This can be accomplished through BETR grants, an initiative by I2SL, in which specific language is utilized in grant proposals to promote efficiency in lab spaces. Considering 21% of UW's funding is sourced from grants and contracts, the redirection of these funds toward more sustainable goals would be beneficial for the labs themselves, the sponsors of said funds, and the University as a whole. However, even as this advances toward the objectives of a Green Labs program, it does not directly contribute to its funding.

Nevertheless, the Consolidated Endowment Fund distributed $167 million to campus unit holders in 2023, with 6% allotted to research activities and 20% for academic support/programs; this investment pool is allotted based on the specific requests of donors. Seeing as the Green Lab program necessitates funding for its long-term implementation, this source has the potential to either directly fund the program or support further research into lab specific measures. This would be useful in establishing trackable standards needed for the projection of campus-oriented initiatives. The Green Seed Grant, a sustainable research grant, is an alternative to the latter.

Overall, money saved through the above listed recommendations can be applied to funding of the Green Labs program. Although initially higher costs, compensated installation of ULT freezers will reduce this expense, as well as save on electricity costs. Other procurement costs further reduce expenses, such as the purchase of pipette tips in bags as opposed to boxes, saving $16.05 for more product (as per USA Scientific).

As inspired by the University of Virginia and the strongest candidate for funding, these savings should take on the form of rotating funds. Sustainable investments have the potential to double in size, due to extensive energy and waste reduction savings; remaining funds will always be

reinvested into the program. This ensures the continual funding of Green Labs and at least partial accommodation for an FTE salary. This sourcing is most feasible with an onset budget; advancement coordinates “development, alumni and stakeholder engagement, marketing and communications, and operations” to campaign for targeted topics, in this case Green Labs. Integrating this method of donor funding with a rotating fund would permit these monetary contributions to keep providing year after year. Another option is a ‘donation section’ available on the Green Labs website, which constructs a more grassroots approach to accumulating funds. To clarify, whatever money is directed towards updating the efficiency of production is a fixed cost. Because these updates operate at optimal efficiency, the investments will pay off themselves. Thus, they will continue to generate money beyond the initial investment, which can go directly back into the Green Labs program.

From a joint Smart and Green Labs perspective (as discussed in Recommendations), customer buildings’ utility bills would remain stagnant as improvements were being made. Following this work, the money is recovered 125%, creating 25% profit for the program itself, with the rest returning to the customer. The profited 25% would generate overhead, i.e. accumulate over time. This follows the same logic as above, however under the guise of a more involved program; this might be a stronger position to take after the proposed Green Labs program becomes fully established.

FTE Opportunities

It is recommended that UW employ a full-time staff member, if not more as the program progresses, to oversee and manage the Green Labs program. As UW Sustainability has spearheaded the re-establishment of this program, the position would be housed within the UW Sustainability Office, with support from EH&S, as well as the Capital Projects Office and Finance and Facilities. Since program participation is voluntary, this role is necessary in fostering connections and trust among lab members, to encourage their allegiance. Lack of success among previous Green Lab efforts can be partially attributed to the minimal outreach and understanding among lab faculty.

Candidates should have experience with leadership and guidance of varying stakeholders. Although background in a lab setting would be ideal, hands-on interaction with Principal Investigators (PIs) should both fulfill this required knowledge, as well as provide opportunity for individualization of lab needs. In other words, this is largely a management position, with collaboration across disciplines supplementing niche expertise and fostering personal input of labs. The salary for this position can either be sourced from sustainability initiative savings or a rotating fund’s overhead accumulation.

As covered in Green Chemistry and Safety Initiatives, safety procedures through the certification process can be enforced through an FTE position. This entails, following the self-assessment, a mandatory training of staff to ensure their proper interaction and operation of the new sustainable equipment or tools. The position is also crucial due to the unavoidable turnover rate; it would be unsustainable to expend resources on training all current staff, who will leave as soon as their contract or degree is completed. Especially if this program flourishes and involves a plethora of stakeholders, a supervisor position is essential in providing direction and oversight.

An additional aid to the FTE position would be a working group- this involves any interested students or faculty who would like to be involved in sustainable measures for the lab spaces. This group would optimistically meet monthly to discuss future developments and foster active deliberation between various departments about best practices. Because the supervisor/ FTE position represents a faculty-led project, it is our hope that the working group would be student-led. This presents a wonderful working experience for dedicated students and incentive for broader engagement. Further, it would permit the group to qualify for the Campus Sustainability Fund, at least initially.

Insights and Recommendations

Key Findings

Seeing as the Green Labs program has already been in effect, much of the foundation has already been laid for its reestablishment. That said, this previous framework needs to be updated and improved. Many initiatives to reduce the unnecessary output of labs, such as waste, energy and water, can be accomplished through simple behavioral shifts or small technological implementations (i.e. benchtop timers). Already widely accepted actions in labs include the ‘Shut the Sash Campaign’ and ‘Freezer Challenge’ (refer to Energy and Water Initiatives for more information). Dissemination of knowledge regarding aspects such as proper equipment use is also critical in making sustainability a community effort; in this, signage should play a key role. Additionally, outreach is necessary to engage labs in this opportunity and encourage sustainability across all UW labs.

The value for the University of Washington in supporting a Green Labs program remains expansive- ranking as a top research institution nationally, there is not only plenty of opportunity, but much expectation, that UW carries that title with honor. Consideringly, the University’s position in the Puget Sound and marketing as an environmentally-conscious school, requires nothing less than its contribution to this program. In this sense, UW would both live up to its own standards and receive positive publicity on a national, and potentially international, scale. Furthermore, the approaches taken to improve sustainability would decrease costs of waste

disposal and energy usage, thus saving the University money annually. (See Potential Funding Sources and Appendix B).

Insights

Our research has shown that UW lacks clear metrics on lab specific information; aspects include the amount of equipment in each lab, general water usage, money spent on lab materials, etc. Thus, there is a need for standards to quantify these areas, enabling the program to track their progress upon implementation. Moreover, this unknown information has proven challenging in calculating highly-specialized initiatives for the most immediate, effective outcomes or related savings. Therefore, closing these gaps in knowledge would be beneficial, not only for the initial integration of this program, but in creating the strongest opportunity for its long-term survival.

Labs should be incentivized to participate in sustainable behaviors, as ultimately they too will save money and contribute to a healthier environment. Green Labs is also a promising platform for collaboration among labs and for elevated voices; working groups as spoken about in FTE Opportunities furthers this end. Due to the highly occupied nature of lab work, recognition is a crucial factor in encouraging voluntary involvement. This can take the form of plaques for display and highlighting their work in The Daily (or other school newspapers). A sustainable product show is another example of increasing awareness and enthusiasm for the program. Generally, student interest in sustainability is high at the University of Washington. If this can be generated through funding or communication with lab members, lab recruitment should not serve as an obstacle.

Recommendations

Based on our study, there are several specific areas of improvement the University of Washington should consider in restructuring its Green Labs program. To begin with, the websites regarding Green Labs material should be updated with relevant links and materials, so as to properly inform those interested in engaging. For each unique initiative, such as purchasing and waste management, labs should be provided with a comprehensive overview of the topic and information on how to take part accordingly. With straight-forward initiatives like compostable paper towels or “Shutting the Sash”, all labs should be encouraged to implement these immediately, with help from an FTE. Procurement should be flexible depending on the needs of the individual lab; as stated in Appendix B, the aforementioned are guidelines on a need-basis.

Seeing as the previous Green Lab certification process has been on pause since Covid, it is recommended that this process be restructured and updated to current University standards. Steps toward a fully integrated Green Labs program include receiving the approval to reimplement, creating a comprehensive webpage, distributing signage and overall increasing outreach, and

perhaps most importantly, hiring an FTE position. These will nicely pave the way for a smooth transition towards sustainability.

Through conversations with peer institutions, primarily UVA, it has come to our attention that combining the Green Labs program with a Smart Labs aspect, i.e. DEF, would be valuable for the longevity of the program. Partnerships with engineers for retro-commissioning projects would effectively make buildings on campus more environmentally friendly, thus saving money without having to expend more on outsourcing labor. It would also prove helpful to consider shifting the funding model of the University to individual building metering. This allows each building to be responsible for its own usage and emissions, and ultimately avoids UW's projected payment in 2029 of $15 million. This approach would encompass top-down and bottom-up initiatives, enhancing the stability of the program; Green Labs tackle the individual labs compared to the building-wide attention of Smart Labs. While this involves greater membership, the two complement each other so as to solve communication and funding issues.

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Appendix A

1. List of 28 Peer Institutions from the University of Washington Office of Finance, Planning and Budgeting:
    a. Clemson University
    b. Florida State University
    c. Georgia Institute of Tech
    d. Ohio State University
    e. Purdue University
    f. Rutgers University
    g. Texas A&M University
    h. University of California, Berkeley
    i. University of California, Davis
    j. University of California, Irvine
    k. University of California, Santa Barbara
    l. University of California, San Diego

m. University of California, Los Angeles
n. University of Connecticut
o. University of Florida
p. University of Georgia
q. University of Illinois Urbana-Champaign
r. University of Maryland
s. University of Massachusetts-Amherst
t. University of Michigan Ann Arbor
u. University of Minnesota
v. University of North Carolina, Chapel Hill
w. University of Pittsburgh
x. University of Texas, Austin
y. University of Virginia
z. University of Washington
aa. University of Wisconsin, Madison
bb. Virginia Tech

Appendix B

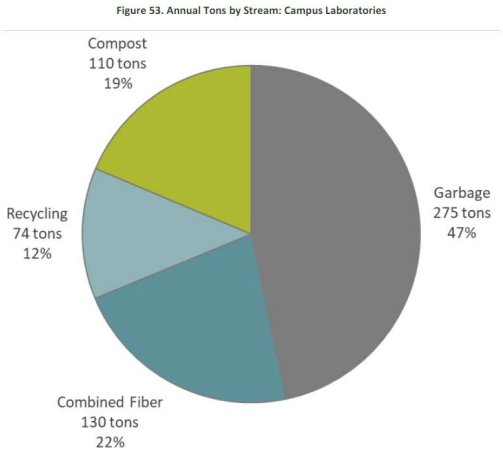
Reusable Plastic Labware

Thermo-Fisher's reusable labware is made of materials (polypropylene and polyethylene) that can be recycled in certain areas at the end-of-life. However, this is not applicable to all recycling systems. It might be necessary for labs to establish their own systems to recycle these items, to further reduce the amount of recoverable waste in landfill.

Waste Cost Calculations

Waste diversion cost and savings calculations came from the following information:

Landfill tipping fee: $165/ton
Recycling fee: $116.55/ton ($166.55/ton if more than 15% contaminated)
Composting fee: $69.50/ton



(2018 UW Waste Characterization)

Sharing Networks for Procurement

USwap was a program on campus established under the previous Green Labs program that has since fallen out of use. It “allow[ed] users to request items they need[ed] AND post and sell items they [were] trying to get rid of,” (UW Sustainability). This space would require more than a behavioral shift, as there needs to be awareness and participation in order for it to effectively reuse campus resources. The aforementioned Rheaply and Warp-it Network are larger scale examples of this initiative, which can be used as inspiration during the redevelopment of USwap. Since the program would be specific to UW, it would enhance collaboration between labs and directly serve the goal of waste reduction on campus. It would also be simpler to navigate, as the parameters of the project are specific to the UW campus.

Pipettes and Pipette-specific Material

Pipettes, along with racks and tips, are one of the largest perpetrators of single-use waste in labs. Because of this, our proposal offers several solutions to this problem, despite their potential contradictions. The point is not to suggest all be implemented, but rather that any of the above be chosen depending on the goals and abilities of each lab.

ULT Freezers

The U.S. Department of Energy did a study on high-efficiency ULT laboratory freezers, in which it was found that certain implementation technologies would save significant amounts of energy. Most of these were found in the Stirling cooler model demo. Users of said demo observed about 66% energy savings and a reduction of over five MWh annually. Although these models have a higher initial cost, the “favorable payback periods” suggest a quick recovery of these savings. If individual researchers are responsible for equipment purchase, the University should establish incentive programs proportional to their energy savings, such as ‘paying forward’ the operating

cost savings in the form of rebates, as exemplified by CU Boulder. If UW funds purchase equipment, then the aforementioned rebates through Seattle City Light should support a quicker recovery of any expended funds, which can then be used for further sustainable improvements (funding is further explained in Potential Funding Sources).

Table 6: Significant Energy Consuming Equipment in Chemistry and Life Science Laboratories (in descending order with most significant at the top of the list)

Chemistry	Life Science
Heaters/Stirrers	Freezer (-20)
Mass Spectrometry	Environmental Chamber
Gas Chromatography	Water bath
Rotary Evaporators	Incubator
NMR	Freezer (-80)
Ovens (Chemical)	Oven
Fridges	Ice maker
Diaphragm Pumps	Hybridiser
Vacuum Pumps	Incubator-shaker
Water Baths (Large)	Thermal Cycler (PCR)

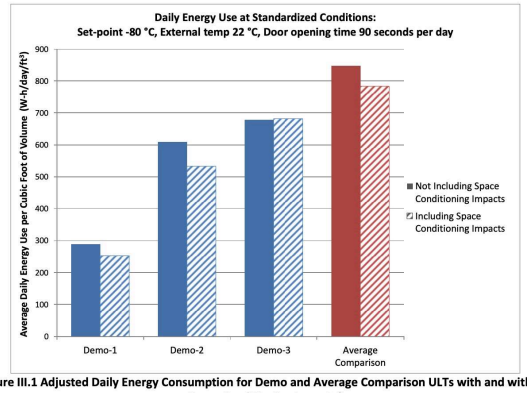


Figure III.1 Adjusted Daily Energy Consumption for Demo and Average Comparison ULTs with and without Space Conditioning Impacts*

Pricing of Procurement

Any purchase of reusable over single-use equipment will save the University money, as few materials need to be purchased less frequently. This is the case with butyl gloves in Reuse and Recycling Initiatives or reusable plastic and glass labware in Procurement and Consumables Initiatives. For example, the bulk bags of pipette tips are more economical, seeing as they have more tips in less packaging. Per USA Scientific, the purchase of 10 uL, natural graduated, non-sterile tips sold in bags cost $23.45 for 1000 tips. Meanwhile, 10 uL, natural graduated, non-sterile tips in racks cost $39.50 for 960 tips. This relationship holds true for many sustainable lab products.

Funding of Peer Institutions

Florida State University has received a grant from the National Science Foundation to “promote participation in energy efficiency programs aimed at reducing high utility costs,” (Florida State University). They are additionally funded by the U.S. Department of Energy, The Solar Foundation, Lincoln Institute for Land Policy, and the American Institute for Economic Research. The University of Maryland Baltimore offers participation incentives for completing steps in the certification process, with credit for their biomedical research supply core. The University of Georgia provides links to several grant/scholarship opportunities, of which their ‘Living Lab’ projects qualify. The University of California Riverside distributes funds to cover initial costs of new and efficient equipment. The University of California Berkeley has ‘The Green Initiative Fund’ for all sustainability projects, fueled by student fees.

Fume Hood Calculations

The average American household uses 10,791 kWh annually. The Average fume hood uses 37,768.5 kWh annually. At an electricity price for the City of Seattle of 0.0577 per kWh used, this amounts to $2,179 in electricity used per fume hood. With 1,700 fume hoods, this amounts to an energy cost of $3.7 million dollars.

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