

# Metering Labs for the Integration of the iCAP Goals into Laboratory Practices

Brinn McDowell  
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## Overview:

The need for greener laboratory practices is becoming increasingly clear. As Paul Foote said, “Many of Illinois’ peer institutions and the founding institutions started the sustainable lab initiative and programs over a decade ago (2008-2010), they range from small one person director led programs to programs that provide a sustainable lab coordinator in every college on campus. The basic sustainable lab practices such as shut the sash, inventory management, energy efficiency, plug load management, green chemistry, chemical & equipment sharing, space management, recycling programs etc... are old hat. They are now innovating new solutions and tasking researchers with creating breakthrough practices that put them at the forefront of sustainable leadership. It is past time for the University of Illinois to capitalize on the expertise available all over campus and bring our labs to the forefront of sustainable practices and environmental stewardship.” According to My Green Labs, academic research labs typically consume 5x more energy than academic office buildings, and use around 50% of the energy on a university campus (My Green Labs, n.d.). A committee would aim to minimize the use of energy, water, material goods and hazardous chemicals and promote the efficient use of research equipment and laboratory spaces at the University of Illinois Urbana Champaign. Metering would be one of the responsibilities that is given to a committee formed to integrate the Illinois Climate Action Plan (iCAP) goals into laboratories, and ultimately be the first step in the consultation process for the implementation of sustainable laboratory practices.

The purpose of this study was to:

- Determine the feasibility of metering laboratories around the University of Illinois Urbana Champaign campus.
- Share the impacts lab practices “as is” have financially and environmentally.
- Provide reasoning why integrating greener energy practices into laboratories on campus is essential to reaching the iCAP energy goals.

In FY19, Illinois received the most funding from NSF, and much of that research is related to the global challenge of climate change and long-term sustainability. The University of Illinois has a responsibility to personify our espoused ideals. The University of Illinois prides itself on being one of the most innovative Universities in the world, yet is far behind colleagues in regard to sustainable practices in the lab. Being aware of the iCAP goals will help promote researchers to be actively engaged in their work, and help them to continue to make impactful change into the future.

## Scope:

Over the past 3 months, laboratory instruments were measured amongst four chemistry laboratory rooms in the Engineering Sciences Building. Five P3 P4400 Kill A Watt Electricity Usage Monitors were purchased through a micro grant from the Student Sustainability Committee for metering equipment. The main categories of equipment measured were fume hoods, hot plates, glove boxes, freezers, ovens, centrifuges, scale, computers, and lights (specific names are included in the attached excel spreadsheet). There were a few limitations when it came to metering the energy usage of instruments in lab:

### *COVID-19.*

Access to lab space usage has been greatly affected over the past year due to the restrictions in place for COVID-19 safety protocols. In years past, many more collaborators and group members would have access to the laboratory space at the same time. This would have greatly increased the use of the equipment being metered.

### *Academically Advanced Laboratory Group*

The laboratory group whose instruments were metered are all advanced in their academic careers. Newer graduate students typically use lab spaces more frequently, whereas older students tend to be writing papers and doing literature reviews. This also greatly decreased the use of lab instruments, and therefore the output of energy.

### *Inability to Measure All Equipment*

Due to the type of meter purchased, not all instrumentation could be metered. This could be attributed to the size of the plug prongs, and instrument plugs themselves. Some equipment that was specifically affected were the double glove box, and chromatography machine. Glove boxes and lights were also unable to be measured because they are wired directly into the wall. Numbers for energy usage of fume hoods were assumed to be the same as the data collected by My Green Labs, and light usage was calculated using Phillips website. However, the commonly accepted price of a fume hood at Illinois is around \$5200 per hood per year. The other instruments that couldn't be measured were left as zero. This further decreased the actual amount of energy consumed that was reported.

To neutralize the limitations, the data collected was adjusted for estimates of typical laboratory usage made by a postdoctoral mentor (Table 2). The time of usage for each equipment was based on an average lab group of 5 graduate students. Certain instruments are on 24 hours a day despite the amount of people in a lab (see values below). These assumptions were made, so that other laboratory groups could compare their usage to this base-line. If they use equipment more frequently than they could assume their utilities bill would be higher and vice versa.

Fume hood, Glove Box, Freezer, Oven, Scale, Computer: 24 hours a day

Hot plate: 10 hours a day

Centrifuge: 1 hours a day

Lights: 11 hours a day

## Data:

This table (Table 1) demonstrates if the numbers collected were true and consistent for 24 hours a day 365 days a year. In a normal laboratory scenario, not all of the instruments are on or used this frequently. The total money spent on the metered equipment under this criteria adds up to be \$33,825.48 and the energy used equals 430349.58 kWh.

	kWh/day	kWh/year	Money Spent/ year
<b>Fume Hood/ Bio hood/ Vacuum Pumps</b>	1132.32	413295.58	\$32,485.03
<b>Hot Plate</b>	2.58	941.7	\$74.02
<b>Glove Box</b>	8.62	3146.3	\$247.30
<b>Freezer</b>	1.18	430.7	\$33.85
<b>Oven</b>	10.42	3803.91	\$298.99
<b>Centrifuge</b>	0.07	25.55	\$2.01
<b>Scale</b>	0.108	39.42	\$3.10
<b>Computer</b>	6.37	2325.05	\$182.75
<b>Light</b>	17.37	6341.364	\$498.43
		<b>Total Money Spent:</b>	\$33,825.48
		<b>Total Energy Used:</b>	430349.58 kWh

Table 1. Based on if equipment was used for 24 hours a day 365 days a year. All prices were calculated based on the University of Illinois Utility Rates FY 2019.

This table (Table 2) displays if the numbers measured through metering were adjusted for estimates of time each instrument was actually used in the laboratory. The numbers that were collected on a 24 hour a day, 365 day a year scale (Table 1) were mathematically fixed based on time per day and days per year that my mentor/ postdoctoral researcher helped to estimate. The total money spent on the metered equipment under this criteria adds up to be \$33,387.07 and the energy used equals 424771.8367 kWh.

	kWh/day	kWh/year	Money Spent/ year
<b>Fume Hood/ Bio hood/ Vacuum Pumps</b>	1132.32	413295.58	\$32,485.03
<b>Hot Plate</b>	1.075	322.5	\$25.35

<b>Glove Box</b>	8.62	2586	\$203.26
<b>Freezer</b>	1.18	430.7	\$33.85
<b>Oven</b>	10.42	3803.91	\$298.99
<b>Centrifuge</b>	0.0029	0.875	\$0.07
<b>Scale</b>	0.108	32.4	\$2.55
<b>Computer</b>	6.37	1911	\$150.20
<b>Light</b>	7.96	2388.87	\$187.77
		<b>Total Money Spent:</b>	\$33,387.07
		<b>Total Energy Used:</b>	424771.8367 kWh

Table 2. Based on estimates of how often lab equipment is used a day in a five person lab group. All prices were calculated based on the University of Illinois Utility Rates FY 2019.

## Analysis:

Despite the metered numbers being conservative due to the limitations of data collection, the amount of energy and money spent are still very significant. Based on the adjusted numbers (Table 2) the energy used for just one lab group reached 424771.8367 kWh. This measurement also did not include offices or hallways, which would have only increased that number. The fact that these numbers are so large even as conservative estimates validates the need for energy conservation at the laboratory level. Metering in a lab is one of the ways that areas of improvement can be identified and monitored.

When looking at the data collected one of the main takeaways that can be made is that the use of energy in a laboratory can be greatly decreased by simply changing the social norms revolving around energy consumption. A few main sources of energy and money spent are the ovens, glove boxes, fume hoods and lights. When walking around the laboratory there are almost always lights on during the day whether or not researchers are in the laboratory space. This is due to the fact that people forget to turn off the lights when they walk out of the room. Furthermore, fume hoods are almost always left open even when they are not being used on a daily basis. According to My Green Labs, “the energy savings from lowering the sash in a VAV fume hood can be upwards of 40%” (My Green Labs, n.d). Cutting down \$32,485.03 in spending from fume hoods by 40% would cause a significant savings in money and energy. Ovens not in use could be unplugged, or put on an outlet timer to help conserve energy. A committee focused on sustainable lab practices would be able to strengthen social norms by imposing social sanctions on researchers that do not turn off lights or shut fume hood sashes, encourage competition amongst lab groups by providing incentives as prizes, and encourage compliance by “starting at the top” and having practices incorporated into University protocols.

Currently, there are no enforcement mechanisms in place to ensure that laboratories are following guidelines set in place. A person or mechanism put in place to ensure participation would be essential in providing this service. There also would need to be an incentive for departments to want to show continuous support for the program. The change in the billing practices of utilities from the University as a whole to a department by department basis offers the foundation to offer incentives for departments to continue to make the world a more sustainable and safer space. For example, part of the money saved by decreasing energy usage could be given back to the researchers. Metering would allow monitoring of energy consumption changes, and make it easier to celebrate researchers trying to cut back on energy usage. Finally, people only will make these changes if top researchers, and faculty members are emphasizing the importance of sustainable lab practices. Having a committee designated to being environmental stewards in laboratories would help to demonstrate the support from the University and bring more attention globally to the importance of this cause.

## Conclusion:

After this past semester, I believe that metering would be a feasible task to undertake. Whether it is a designated researcher within a laboratory group or interested students and staff, the time needed to collect data is easy to incorporate. I spent around 30 minutes everyday collecting data and moving the five meters to different instruments. During this feasibility study I had multiple professors display interest and offer to have their laboratory instruments measured, which demonstrates great support from researchers at the University. I also had other students reach out to me specifically asking how to get involved. This further emphasizes the interest in implementation of sustainable lab practices, especially in regards to energy usage.

Energy metering is just one way the University of Illinois should be looking to reduce their footprint. A committee designated to sustainable lab practices will help to ensure the promise the University made in the iCAP goals to reduce energy consumption. Sustainable lab practices are already being implemented around campus and a committee would offer a way to combine efforts together to make a more impactful change.

Some other ideas for committee responsibility would be:

- Creation of a laboratory instrument inventory
- Adding a training module of sustainable lab practices while on boarding
- Metering and consultation of energy usage in labs
- Developing a money incentive program
- Continuing and adding challenges/ competitions such as the “Freezer Challenge”
- Increasing lab recycling efforts
- Increasing training in green chemistry practices and knowledge
- Promoting better usage of laboratory space



# Appendix:

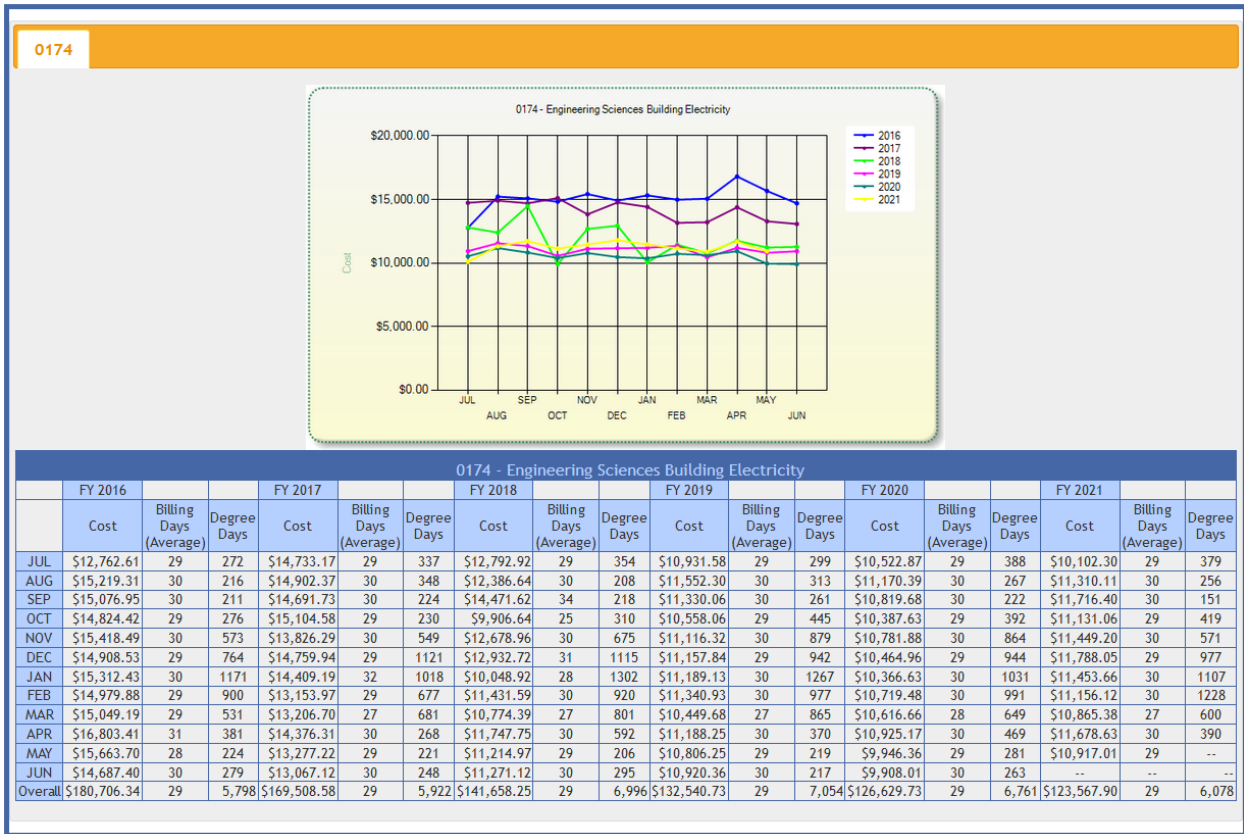


Image 1. This is a chart of the Engineering Sciences Building Electricity Billing. During Pre-Covid time, the spending aligns with what the lab usage estimates were calculated to be.

## Sources:

“Energy.” My Green Lab, [www.mygreenlab.org/energy.html](http://www.mygreenlab.org/energy.html).