



NEEA's Product Council

**I've Got the Power: Empowered Occupants Save Energy
through a University Tenant Engagement Program**

February 14, 2023

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Presentation Agenda

- Introduction:
 - Staff intro
 - ID+CL project examples
 - History
- Energy and Comfort at WSU context
- Smart Power Strips (SPS) Project Outcomes, Challenges + Next Steps
- Pulling it all together
- Conclusions and final questions



Washington State University's ID+CL

The Integrated Design + Construction Laboratory



Meet the ID+CL Team (2023)



Julia Day



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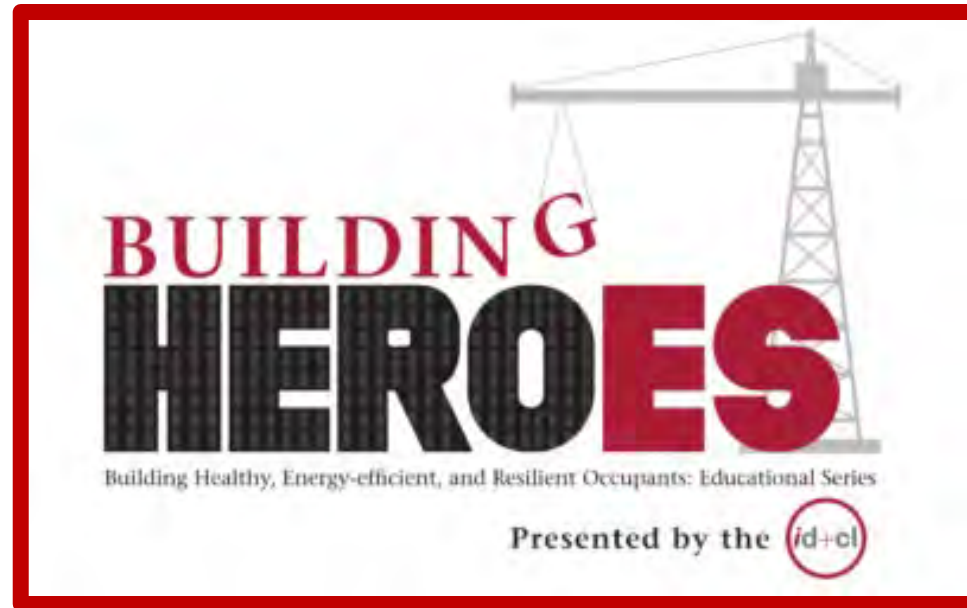
About the ID+CL

At the ID+CL, we aim to transform design, construction and building operational practices to advance high-performance buildings that are more comfortable for people, require less carbon and energy to construct and maintain, and enhance the health and productivity of occupants.

Research topics include but are not limited to occupant comfort (thermal and visual), adaptive behaviors, energy efficiency, high-performance buildings, human-building interfaces and controls, and management of occupant satisfaction and behaviors.



ID+CL Project Examples



Background and History

Occupant's behaviors, actions, and misuse of a building can significantly reduce (or nullify) potential building energy savings if they do not understand how to operate their building in an energy-efficient manner.

It may be necessary to educate occupants.



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Understanding high performance buildings: The link between occupant knowledge of passive design systems, corresponding behaviors, occupant comfort and environmental satisfaction



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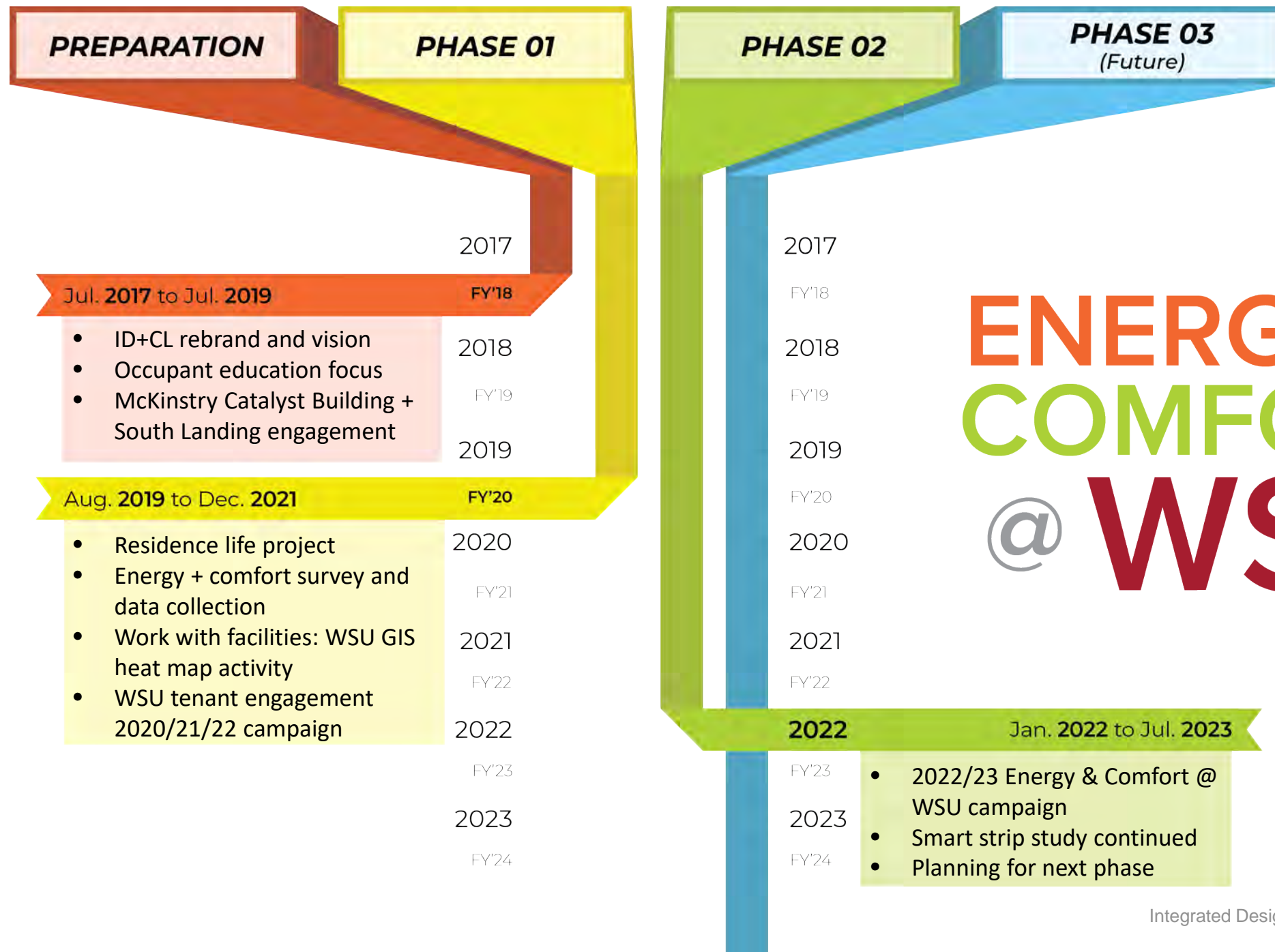
Keywords:

Occupant behaviors
High performance buildings
Passive design strategies
Environmental satisfaction
Thermal/visual comfort
Occupant training

ABSTRACT

In the past twenty years, more stringent energy codes and environmental standards have led to many higher performance building designs that use less energy. Oftentimes, high performance buildings that incorporate passive building strategies require active occupant engagement [Brown et al. (2009) [1]] but the people who work in these buildings on a daily basis may not comprehend how their actions (*negatively or positively*) affect the building's energy use [Janda (2009) [2]]. Additionally, minimal research exists surrounding educational strategies for how to best educate building occupants. The purpose of this study was to investigate existing occupant training in high performance buildings to provide recommendations for future occupant education efforts.

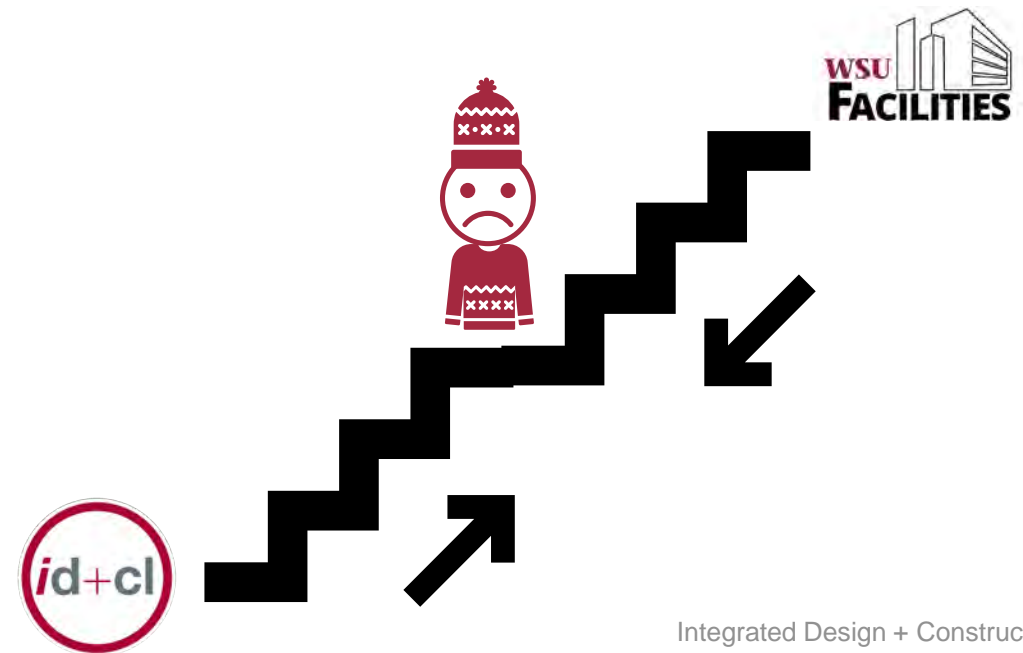
A sequential mixed methods study was conducted to better understand the relationships between occupant behaviors, reported environmental satisfaction, and learning in high performance buildings. First, expert interviews were conducted ($n = 3$) to determine the study population. Second, a survey was sent to ten high performance buildings in the United States ($n = 118$), and third, follow-up occupant interviews ($n = 41$) were conducted to better understand the survey responses. It was hypothesized that participants who had received effective training for high performance building features would be more satisfied with their environment than those who had not received training. Results indicated a significant difference between the two groups (those who had received effective training and those who did not), and individuals who reported *effective* training were significantly more likely to be satisfied with their office environment. Follow-up interviews provided additional insight into occupant satisfaction and behaviors.



Introduction



With support from WSU's Revolving Energy Fund (REF) and NEEA's BetterBricks Program, the ID+CL is in the second phase of implementing a tenant engagement program designed to help building occupants on the WSU Pullman campus manage their personal comfort while learning strategies to save energy while on campus.



Context + Project Background



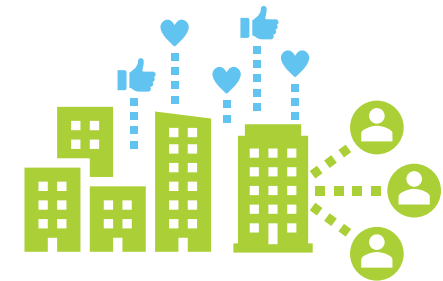
House bill 1257
→
Clean Buildings
Standard



WSU Facilities
Services
Relationships and
Resources



ID+CL was hired by
Mckinstry's PowerEd
team to develop a TE
program for Catalyst



System wide WSU
survey and targeted
interviews to measure
population

Campaign approach and design



Communicate



Relate



Educate



Interpret



Disseminate



Advocate

Energy and Comfort at WSU Pillars

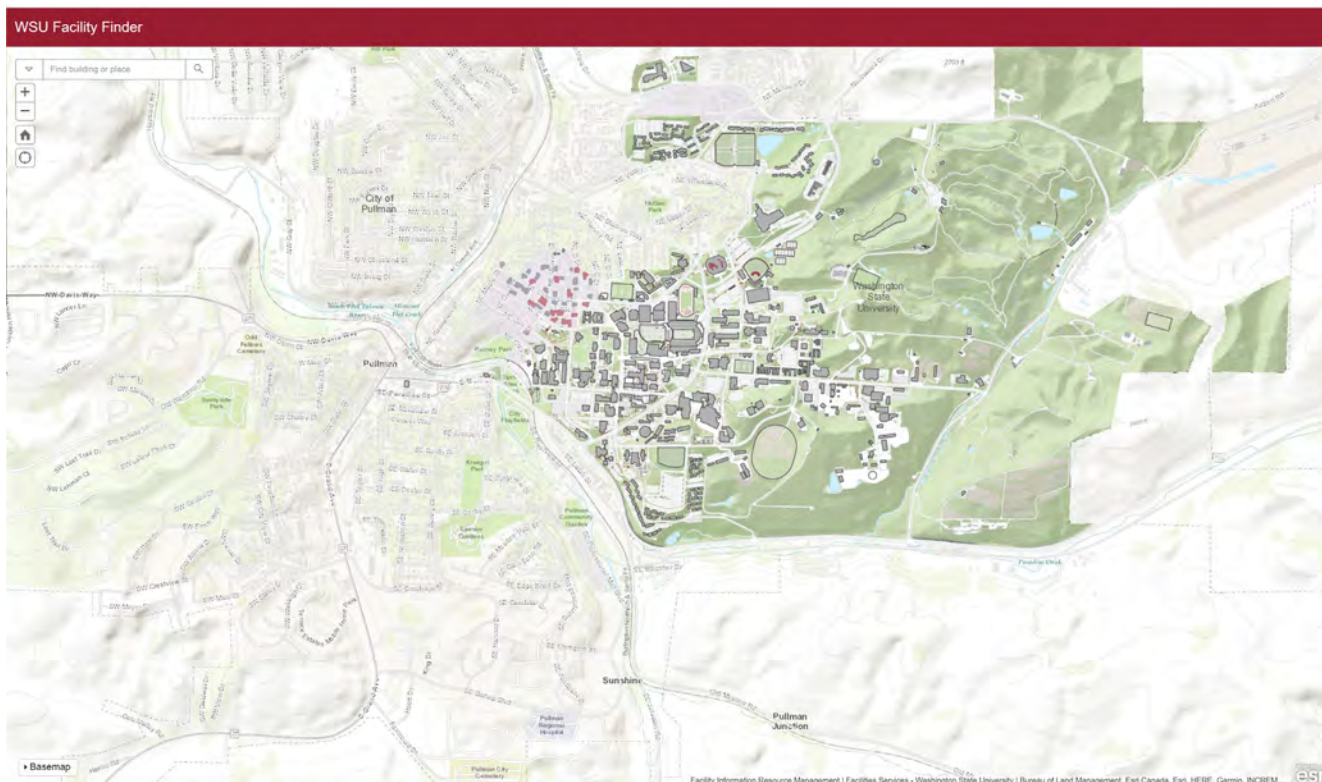
1. **Reduce energy use and costs at WSU:** *inform, educate, and empower occupants to help reduce their personal energy use and encourage their peers to be more conscious of wasted energy on campus.*
2. **Sustainable Community at WSU:** *foster the development of a social and active building culture that inspires community sustainability in meaningful ways.*
3. **Health and Well-being of WSU building occupants:** *empower occupants to take control of their physical and mental health, comfort, and well-being.*



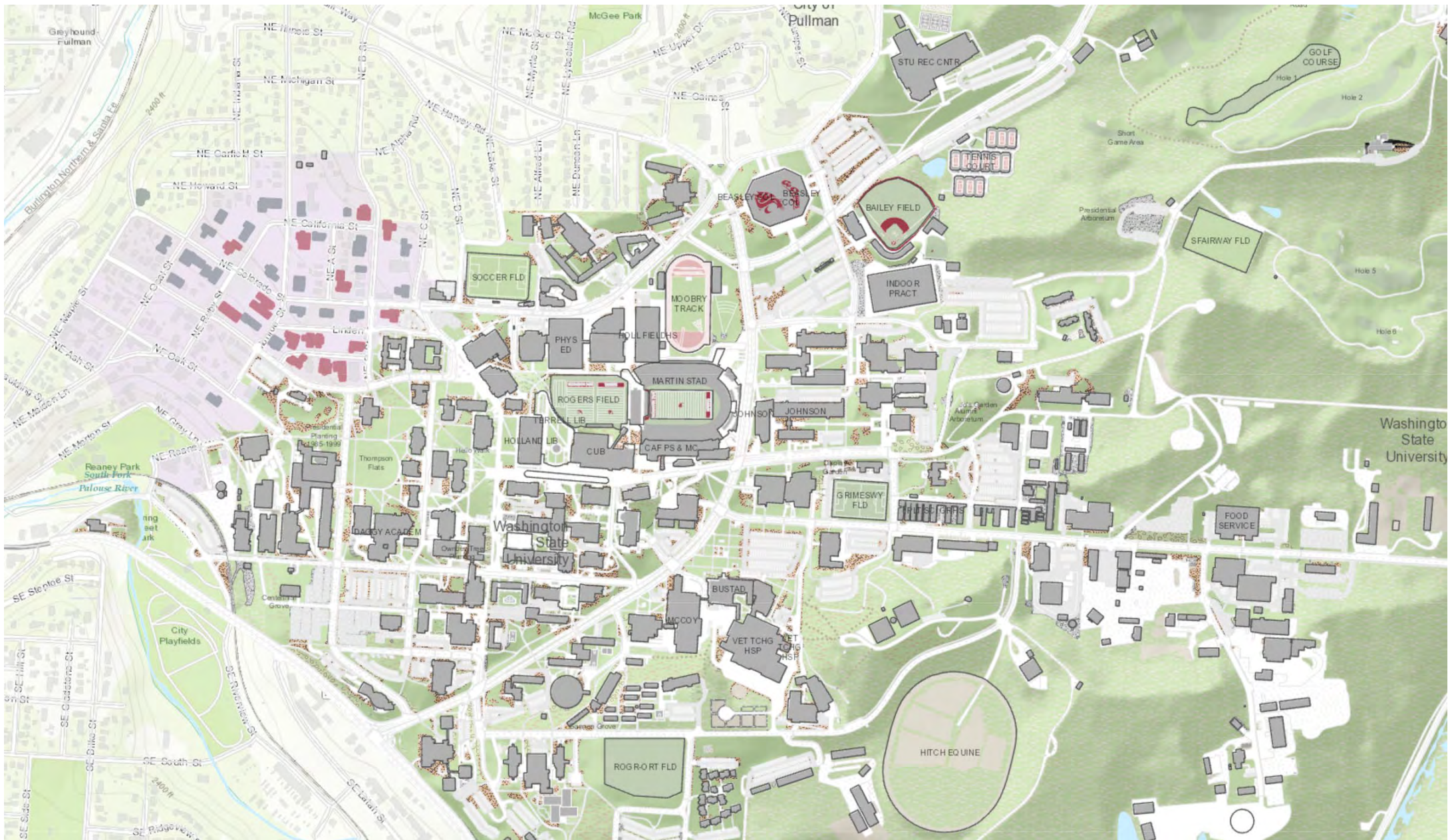
Any questions before we move on?



ENERGY & COMFORT @WSU



Impact

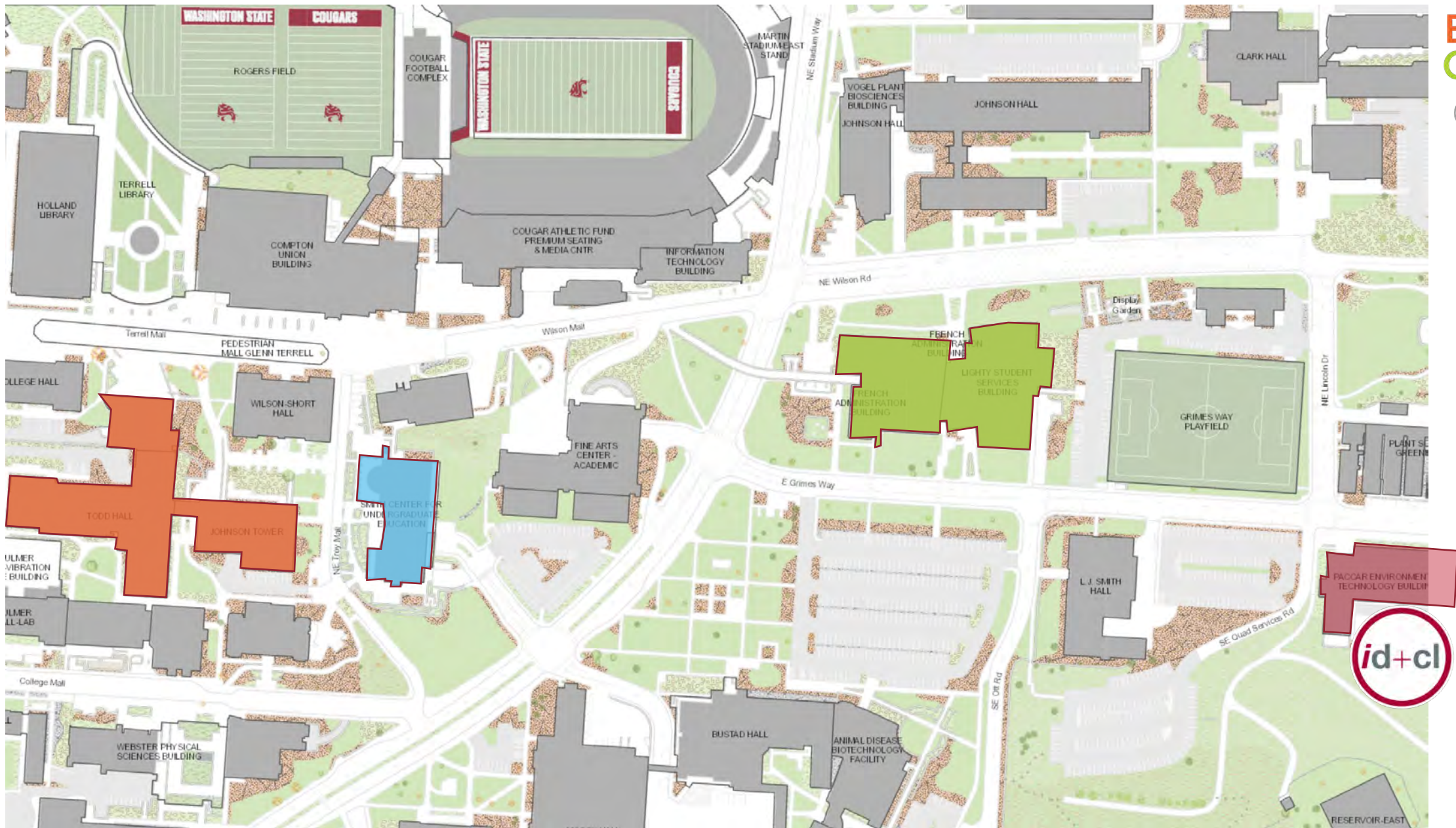


WSU Pullman Campus





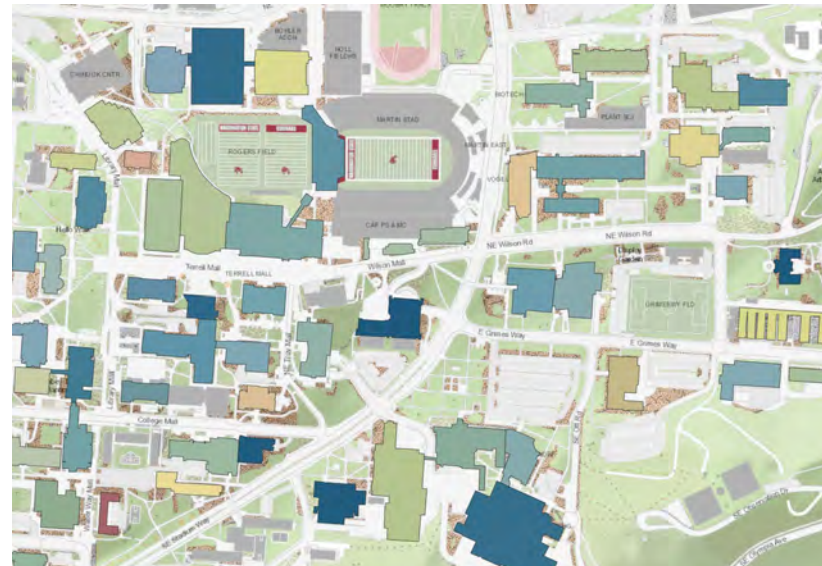
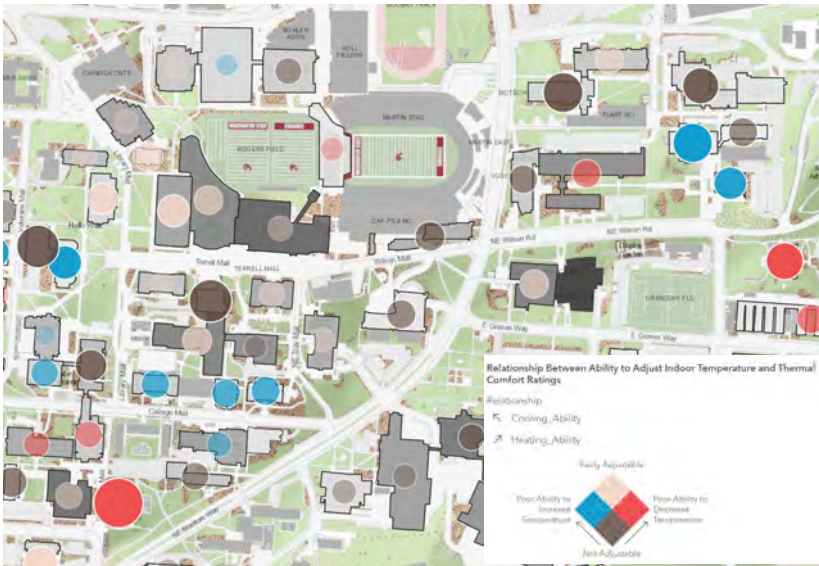
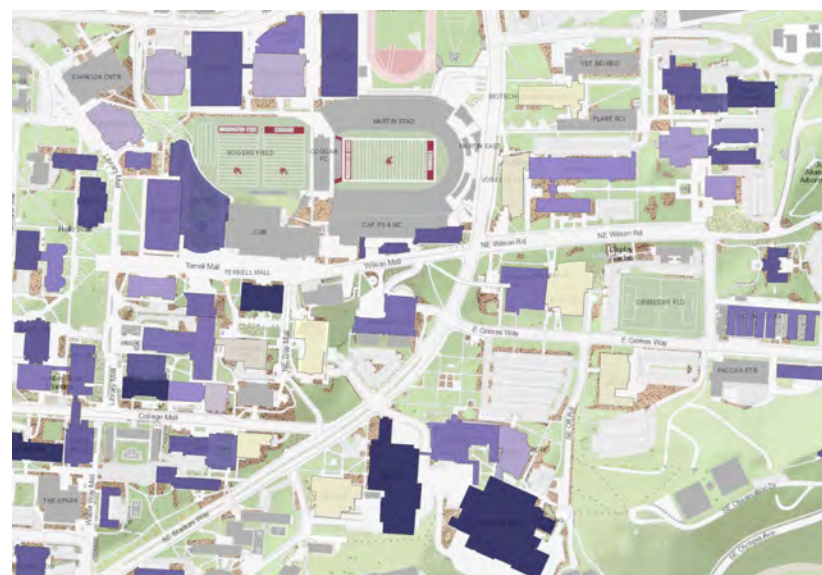
PHASE I



PHASE II

Decisions on targeted interventions

- Facilities data
- Utility metrics
- Occupancy
- Survey feedback
- Interviews feedback
- Overlapped relationships between:
 - Visual, thermal, olfactory comfort
 - Satisfaction/dissatisfaction (PPD)
 - Ability to adjust environmental conditions
 - Desire and knowledge to conserve



Heat Maps project

Building Selection was based on...

- Overall comfort ratings (from surveys/interviews)
- Occupant experiences in buildings
- Severity of deferred maintenance
- Importance of departments to university function
- Overall energy performance of buildings
- CBS compliance (first priority) + ASHRAE 2
- High occupancy spaces
- Primarily office workers



Any questions before we move on to smart strips?

ENERGY & COMFORT @ WSU



Why smart power strips?

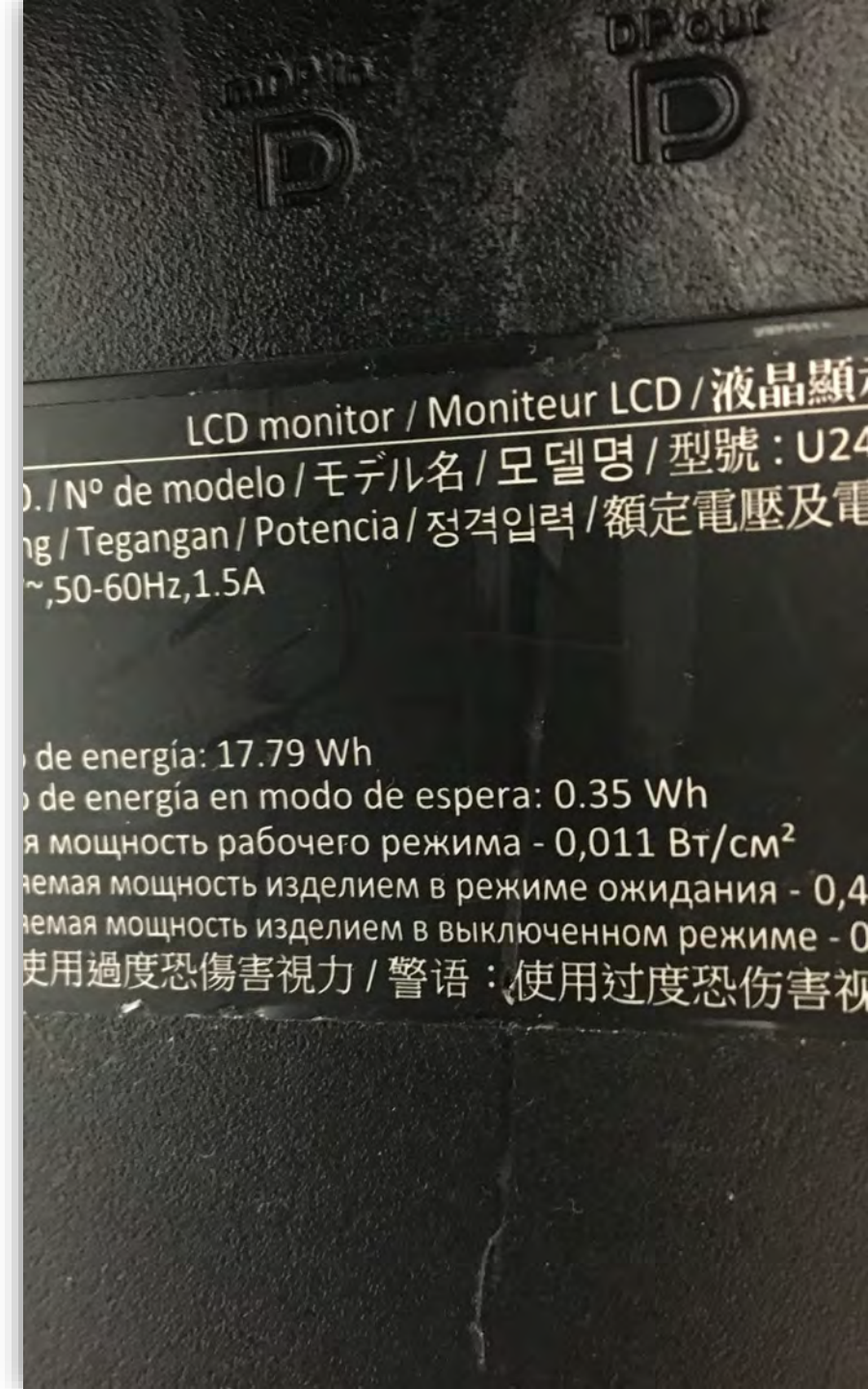
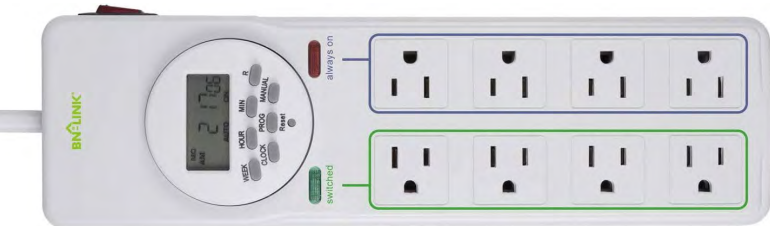
We know occupants were not consistently turning *anything* off.

Savings from plug and process loads have shown to be significant – timed reductions can remove phantom use in non-working hours

IT in targeted building departments helped with the product selection, keeping in mind WSU tech limitations.

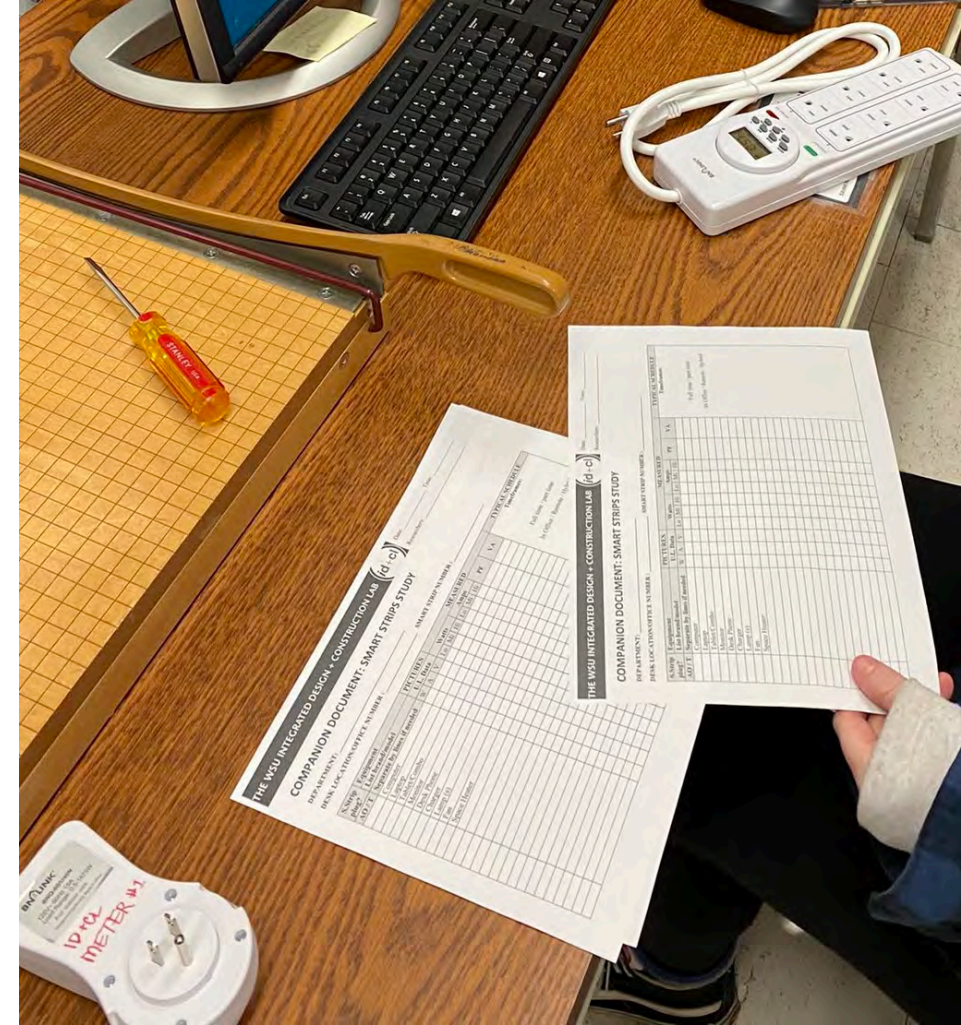
Methodology

- Energy consumption data was collected from devices in an office, then data were entered into excel, where calculations were done to estimate energy savings based on measured data, expected pre-intervention energy use, assumed savings from timed-programming, and additional research.
- Pre-install document, photos from install, and energy companion document stored for frequent reference and updating.
- **So far, 188 smart strips have been installed. We plan to install up to 100 more in the next implementation phase (Jan 2023-June 2023).**






Data Collection

- Collected device energy use through plug meters including varying activity levels of watts, amps, PF, VA, to calculate expected pre-intervention consumption
- Calculations were adjusted based on each participants' expected daily/weekly schedule, their device use patterns, and the performance of their electronics themselves. Users are given a small window of time before and after their scheduled times.
- Filled in device consumption based on manufacturer resources and other research as needed and ran the numbers for timed controlled energy management.



SS ID	Always vs Timed	[EQUIPMENT INFORMATION]				[MEASURED DATA]												Daily AO (pre-SPS)	Daily ON	Standard Weekly ON	ALWAYS ON Pre-SPS Install		TIMED SETTINGS				
Strip #	AO=Always On T=Timed	Type	Manufacturer	Model	UL Label <i>(from pictures)</i>		Watts				Amps				Time ON	Time OFF	Hours ON	Hours OFF				Daily AO kWh	Daily AO \$	Daily ON kWh	Daily ON Hrs. \$	Weekly ON kWh	Weekly ON \$
																		(Watt-Hrs)	(Watt-Hrs)	(Watt-Hrs)	596.06	\$46.64	336.114	\$26.30	2352.795	\$184.11	
27	TO	Printer (BLK + WHT)		HP/BOISB09020	583-673 V 5.3 A	110-127 V	182	233	650	355.00	0.02	0.24	2.4	0.886667	7:00	6:00	11	13									
SS-27		6								717.84				5.96					6402.64	4036.64	23784.48	14.92	\$1.17	7.942	\$0.62	43.309	\$3.39
28	AO	Computer	Dell	D09M	500-1200 5A	100-240 V	65.7	-	76	70.85	-	0.6	-	0.6			24	0	1659.20	1659.20	11614.40	1.66	\$0.13	1.659	\$0.13	11.614	\$0.91
28	AO	Laptop			160-384 V 1.6A	100-240 V	5.5	-	6.3	5.90	-	0.6	-	0.6			24	0	141.60	141.60	991.20	0.14	\$0.01	0.142	\$0.01	0.991	\$0.08
28	AO	Monitor 1	Dell	U2419H	160-384 V 1.6A	100-240 V	0.31	11.2	13.02	8.18	0.02	0.16	0.17	0.116667			24	0	109.12	109.12	763.84	0.11	\$0.01	0.109	\$0.01	0.764	\$0.06
28	AO	Monitor 2	Dell	U2419H	160-384 V 1.6A	100-240 V	0.31	11.2	13.02	8.18	0.02	0.16	0.17	0.116667			24	0	109.12	109.12	545.60	0.11	\$0.01	0.109	\$0.01	0.546	\$0.04
28	TO	Speaker					-	2.6	-	2.60	-	0.04	-	0.04	7:00	7:00	12	12	62.40	31.20	156.00	0.06	\$0.00	0.031	\$0.00	0.156	\$0.01
28	TO	Printer	HP	BOISB090200	583-673 V 5.3 A	110-127 V	1.6	65.5	266	111.03	-	1.17	-	1.17	7:00	7:00	12	12	170.60	151.40	757.00	0.17	\$0.01	0.151	\$0.01	0.757	\$0.06
28	TO	Calculator	Sharp	VX-2652H	15.12 W .126 A	120 V	-	2.5	-	2.50	-	0.03	-	0.03	7:00	7:00	12	12	60.00	30.00	150.00	0.06	\$0.00	0.030	\$0.00	0.150	\$0.01

ONLINE PRE-INSTALLATION SURVEY



WSU Integrated Design
+ Construction
Laboratory

WSU Tenant
Engagement

Overview

Tenant Engagement
Tips & Tricks

**ID+CL SMART STRIP
STUDY**

LLLC Curriculum

ID + CL Research

Newsletters & Posters





Energy Champions

Energy Efficiency &
Comfort Training

About Us

Building Healthy,
Energy-efficient, and
Resilient Occupants
Podcast

ID+CL News



myWSU ACCESS POLICIES

SMART STRIP SIGNUP

PRE-INSTALLATION SURVEY

Please complete this questionnaire to help us program the Smart Power Strip (SPS) prior to the installation, which minimizes any unnecessary disruption to your workday. The additional questions related to energy use and thermal preferences are to provide us with a greater understanding of occupant behavior and perceived thermal comfort:

Would you like a free Smart Power Strip or to update the schedule for your existing strip? <i>(Required)</i>	REASON FOR SERVICE (IF APPLICABLE)
<input checked="" type="radio"/> I need a new Smart Power Strip <input type="radio"/> I need to update my existing strip	<input type="text"/>
Name <i>(Required)</i>	
<input type="text"/> First	<input type="text"/> Last
EMAIL <i>(REQUIRED)</i>	
<input type="text"/>	
DEPARTMENT <i>(REQUIRED)</i>	BUILDING & OFFICE NUMBER <i>(REQUIRED)</i>
<input type="text"/>	<input type="text"/>

FAQs about Smart Strips answered on our website.....

Q: Are the Smart Strips free?

Q: Who can get one?

Q: What is the difference between the 'Always On' and 'Switched' portions of the Smart Power Strip?

Q: Will Daylight Saving Time be an issue?

Q: Can I use my devices outside of the scheduled time?

Q: Can I have more than one SPS in my office?

Q: Can I have one for my home office?

See more on our website!! idcl.wsu.edu

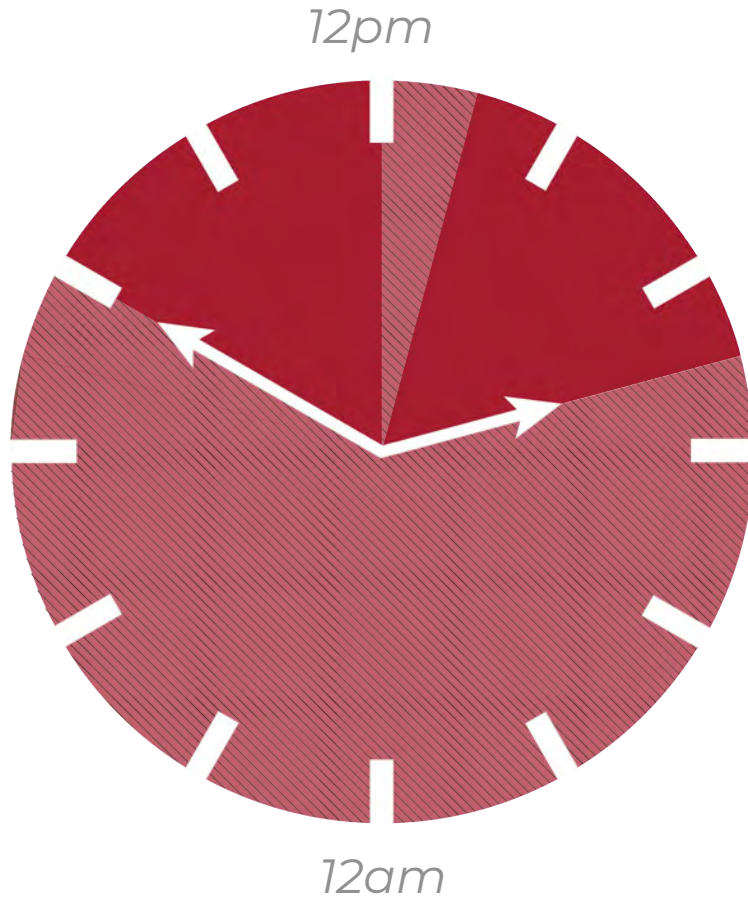
Updated Method

IN RESPONSE TO CHALLENGES

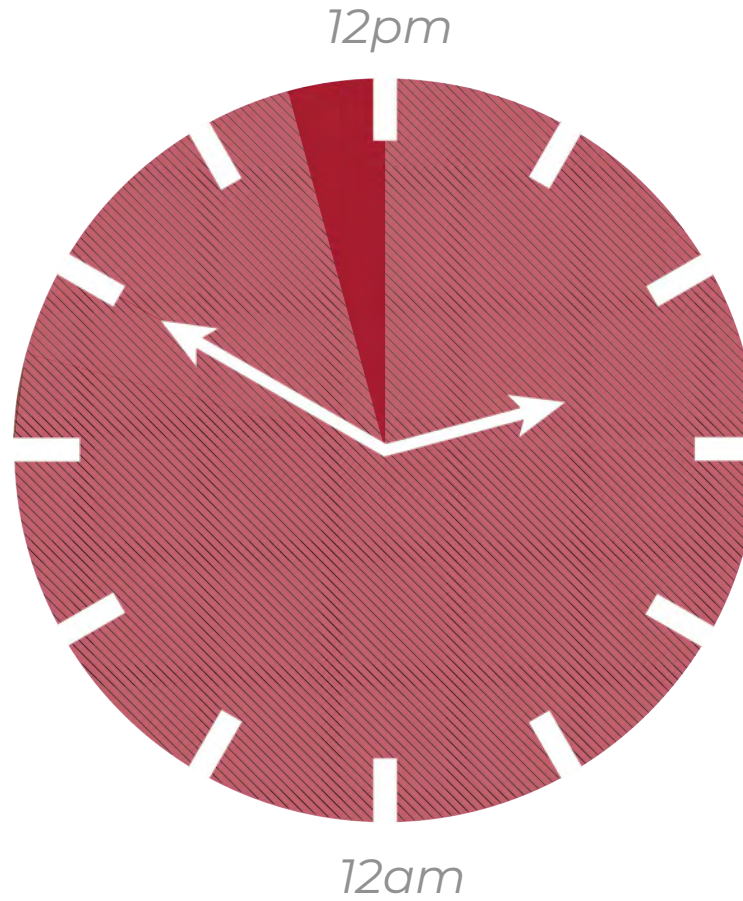
- **Conversations with departmental IT support** to install the SPSs with their concerns in mind.
- Ongoing **conversations with users** to ensure their comfort and productivity is being maintained.
- Critically thinking about the installation to establish and improve procedures for efficiency.
 - Installed **91 strips** in the first 9 months: installed **93 strips** in the last two months



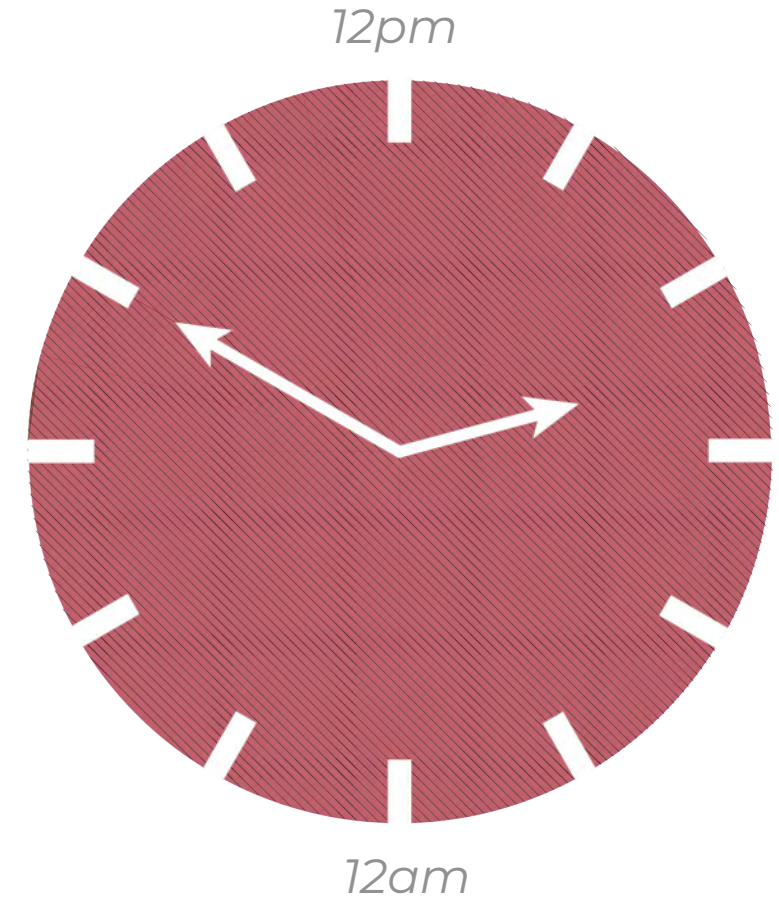
Fulltime Schedule



Hybrid Schedule



Weekend/off-day



Fulltime Schedule

- **'Always ON'** = 5 days (8hr ($W_{avg.}$) + 16hr (W_{low}))

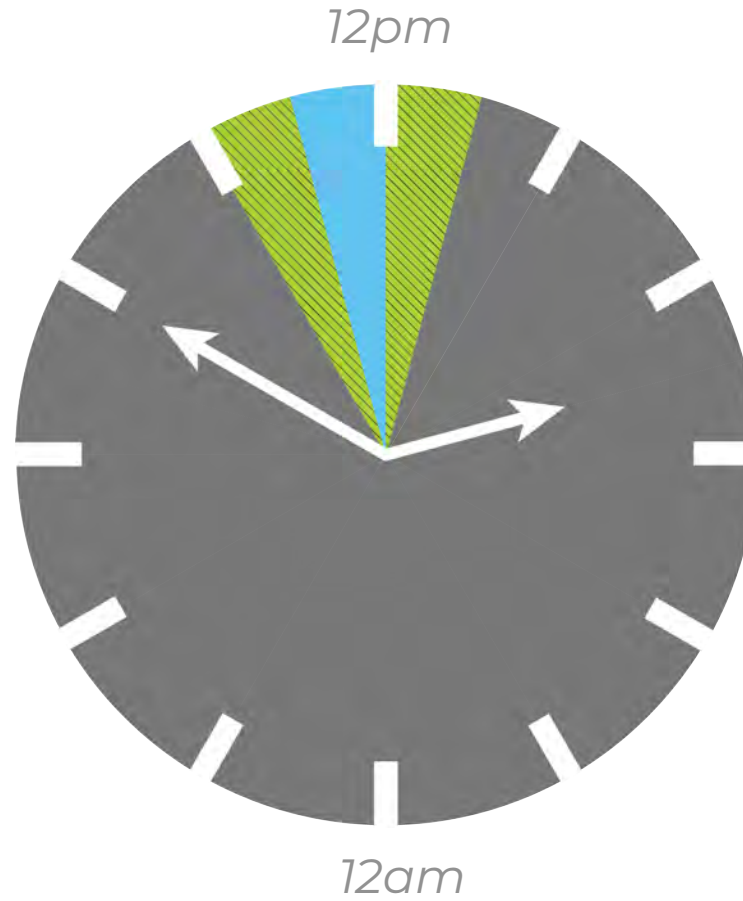
Active Hours

Idle Hours

Fulltime Schedule



Hybrid Schedule



Weekend/off-day



- *Fulltime Schedule**
- **'Timed'** = 5 days (8hr ($W_{avg.}$) + 3hr (W_{low}) + 13hr (W_{OFF}))

SMART STRIPS STUDY

Results

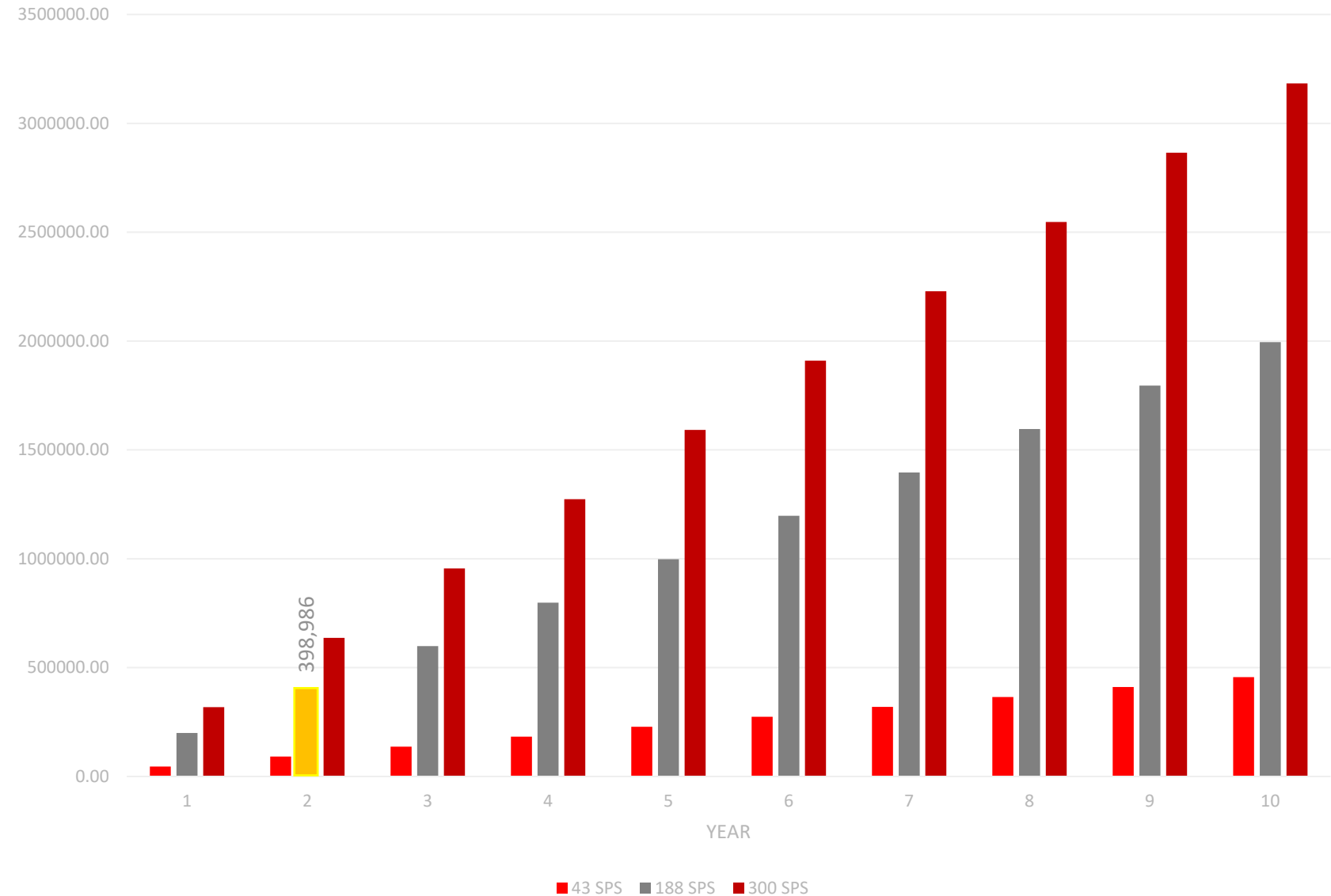
FY23 REF ESTIMATED SAVINGS -

Estimated annual dollar savings - \$24,576.00

Cumulative energy savings – \$245,758.00

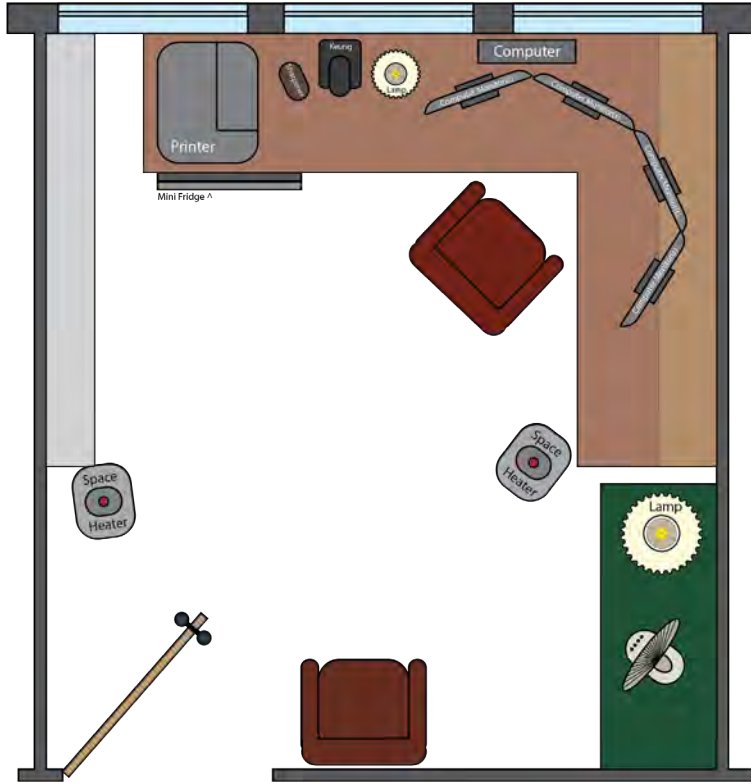
Estimated electricity savings – 318,340 kWh

kWh Savings Over Time



For this one office...

- Daily Costs: \$7.55
- Daily Energy Use: 96.5 kWh



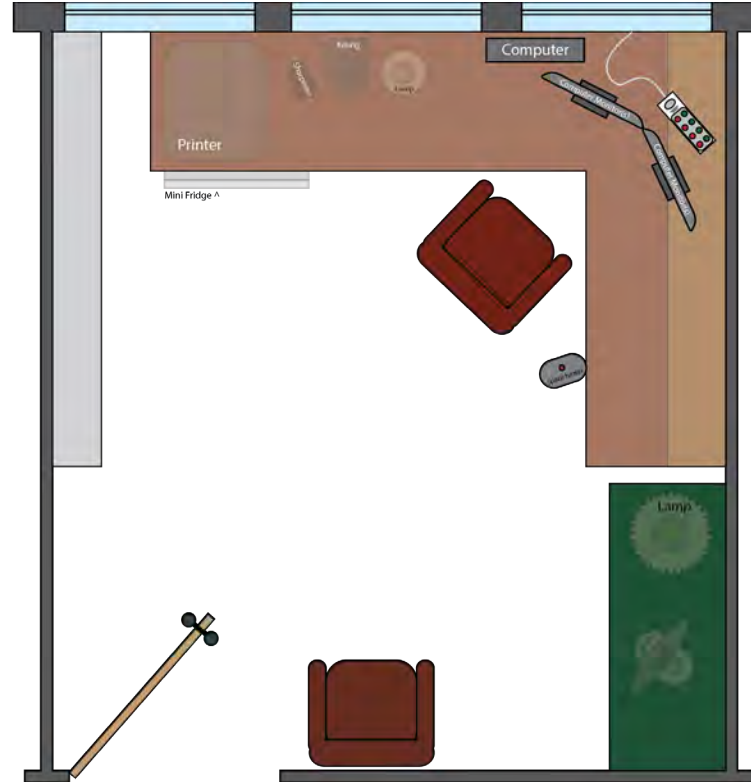
Existing Condition

"WORST CASE SCENARIO"

Before any tenant engagement
and smart strip install

For this one office...

- Daily Costs: \$0.49
- Daily Energy Use: 6.03 kWh



Intervention C

"BEST CASE SCENARIO"

Interventions A + B + Removal of
printer, 2 monitors, and replacement (or removal)
of high wattage space heater.

SMART STRIPS STUDY

Examples

Mr. 4 Monitors

- Office was cold – left his space heaters running 24/7/365, trapped in cooling loop
- Simple conversations and removal/replacement of equipment resulted in higher comfort and lower energy use outcomes
- (despite going back to having 4)

Engagement communications



"Does [broadening temperature setpoints] really save energy if everyone is cranking up space heaters?"

*"My office was freezing cold for several weeks **this summer**. I came into my office on a Monday and the temperature was 65 degrees. It remained this temperature for two weeks."*

*"**There are several using a space heater this summer**. It's an issue in other suites on the 4th floor as well."*

**PEOPLE REACH OUT TO US WHEN
THEY ARE NOT COMFORTABLE
AND THEY HAVE QUESTIONS**

COMMENTS FROM WSU STAFF REGARDING NEW MANDATORY CHANGES

*"There are people that are definitely layering on the clothes. **This discomfort then turns into disgruntle**, which leads to less working hours and/or poor attitudes, which turns into an entirely different issue."*

"I'm sure there are plenty of wonderful comments heading towards facilities 😊 I feel bad for them this time of year!"

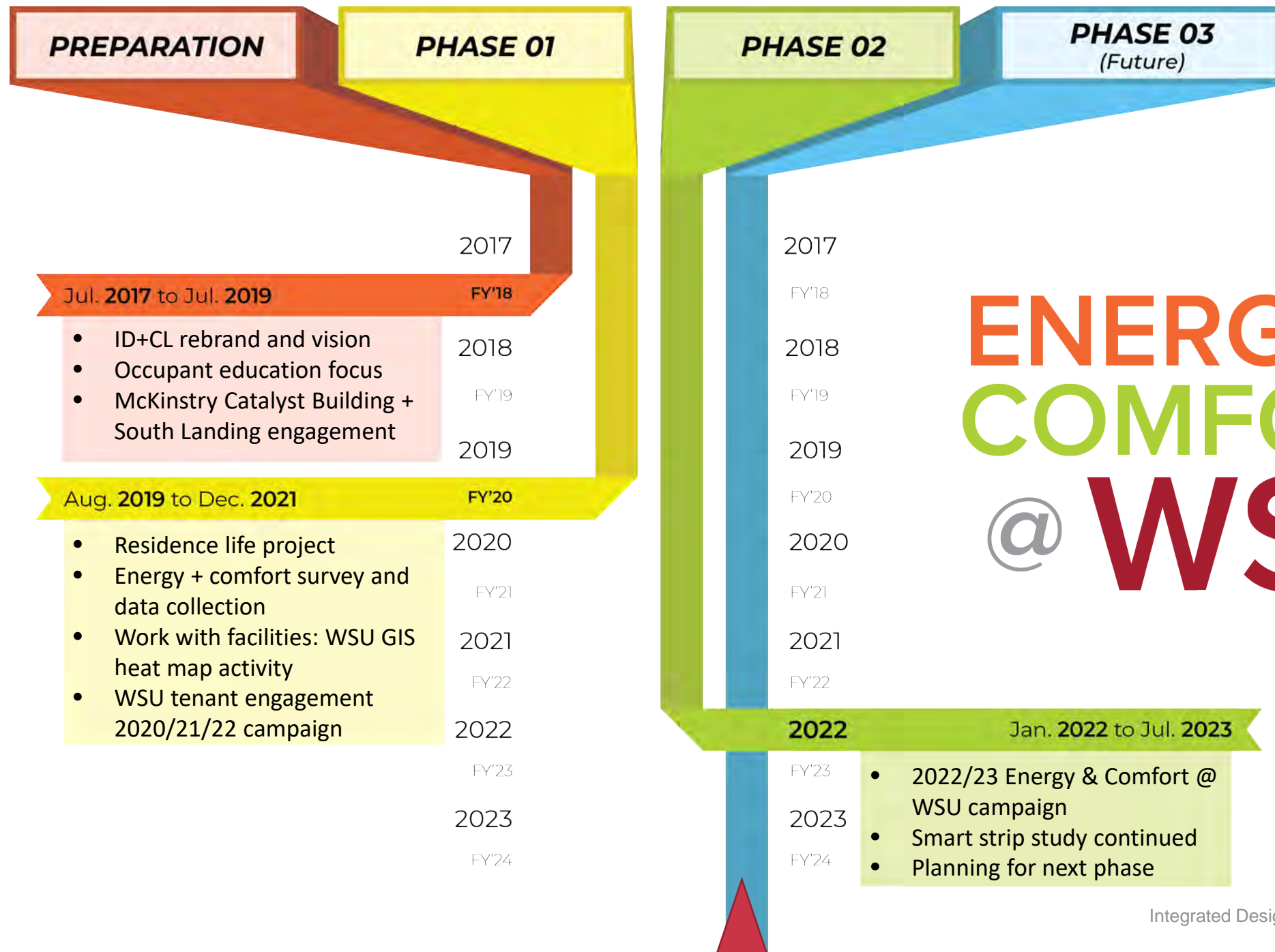
Limitations

- Only hear about problems when they reach critical mass, from the most vocal
- Not very 'Smart' Smart strips due to IT limitations:
 - Security concerns
 - Estimates based on initial collection
- Balance of convenience vs. efficiency
 - Accommodating people's schedules, different backgrounds, level of interest, tolerance for disruption
- Negotiated utility rates and cumulative cost savings
- Getting meaningful feedback from participants, surveys, interviews, we are all busy!



Any questions before we move on?







Energy + Comfort @ WSU

What comes next?

Moving into the next phase of engagement:

- Next steps and plans for implementation in the spring of 2023, connecting with IT within new target locations, more smart strip installations, and recruiting new energy champions in these new buildings while maintaining current ones.
- More *encouragement* from energy champions, departmental IT, and enforcement of departmental adoption and implementation.
- Revamping of data analysis approach and documentation (chronological limitations and getting closer estimates)
- Selection of new buildings and opportunities for 2023 SOW
- Proposals in the works: NEH Climate Smart Humanities Grant, WSUxUW proposal to tackle impacts of the Washington State Clean Buildings Performance Standard and the Climate Commitment Act.



The ID+CL Approach

Our lab takes a human-centric and people-focused approach. We enjoy talking to people and find that this mixed methods approach of implementing both qualitative and quantitative methods helps us understand energy-related issues more holistically. We are excited to do this work. Thanks to NEEA and BetterBricks for your support.

If you'd like to contact us, please reach out to Julia + Shelby!
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Thanks for your time!



Facilities Services
WASHINGTON STATE UNIVERSITY



Thank you to WSU Facilities Services and NEEA!
Questions?

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Scan to learn more about
Energy and Comfort at WSU

