ESLP

Education for Sustainable Living Program

Team Energy

Final Report

Spring 2015

Sam Geldin #1

Elizabeth Mazmanian #2

Angela Kim #1

Lawrence Kumar #2

Sayros Yadgar

Energy Engineer/Facilities Management

UCLA

Institute of the Environment and Sustainability

Table of Contents

Acknowledgements:

The Energy Team would like to thank our stakeholder Sayros Yadgar, who devoted countless time and effort to advise the technical considerations of the energy audit and leveraged the resources of Facilities Management to ensure that we could collect quality data. We would like to thank Sandra Rhee, who despite illness, led the Energy Team during Winter 2015 and the beginning of Spring 2015, in addition to providing the idea and inspiration for our solar charger pilot project. Lastly, we would like to thank building manager Craig Reaves for overseeing data logger placement in the Physics and Astronomy Building, as well as Facilities Electrical Supervisor Jeff Beaver, who provided technical estimates of light retrofits.

I. Executive Summary

Now more than ever, alternative energy and energy-wise practices increasingly factor into the UC system's plans to attain carbon neutrality by 2025. With this broad and ambitious vision in mind, the 2015 Energy Action Research Team formed two major project initiatives to reduce wasted energy on campus and promote everyday student use of renewable energy: a building energy audit and a campaign to pilot solar-powered phone chargers to be sold in the ASUCLA student store. First, the team used data loggers to collect light emissivity records in five rooms of the Physics and Astronomy Building. Then, based on observed light patterns and the material and replacement costs of automatic sensor retrofits, the team calculated that the energy and cost savings for each room (separately and altogether) would not pay off in less than five years. However, more efficient LED replacements and campaigns encouraging students and maintenance crews to turn off lights in unoccupied rooms, particularly in restrooms with manual lights, show promise as cost-effective short-term solutions to reduce wasted electricity.

Additionally, the team made clean energy more visible and accessible by conducting a pilot program for students to test solar-powered phone chargers. 100 general interest surveys and pre- and post-surveys from 30 pilot project participants revealed that while interest in purchasing solar chargers remained high (96%), a majority of students would only pay around $15. Therefore, the UCLA student store has reason to explore selling solar chargers and other renewable products, but should purchase them from a quality (relatively cheap) merchant. While different in scope, these two projects, offer considerable prospects for lasting change in UCLA's energy sector.

II. Background

First explored by the ART Program in 2009, energy has become an increasingly important aspect of sustainability at UCLA, as the University of California strives to attain carbon neutrality. Attainment of climate neutrality was already one of three climate change goals outlined in the 2007 UC Sustainable Practices Policy, when energy usage alone was responsible for more than 80% of CO_2 emissions (UCLA Climate Action Plan, 2008). By developing energy efficiency and usage reduction campaigns, the Energy Action Research Team can thus have a significant impact on one of the campus' climate change priorities. Past teams have developed and implemented energy conservation and awareness campaigns through display monitors, stickers, and information booths to educate the campus community and promote behavioral changes. Using a more quantitative approach, some teams also conducted energy audits in the dorms, on campus, and at Ecochella to reduce energy usage (ART Final Reports).

The Energy Team's projects this year also had both quantitative and qualitative measures. At the request of Facilities Management, in need of data monitoring and observations to press for change, the team audited the Physics and Astronomy Building and made recommendations to reduce energy use. If community-based awareness initiatives accompanied the team's recommendations for improvement, Facilities could report a potential decrease in energy usage by as much as 20%, a considerable source of optimism motivating this project choice (EEA).

The team's second project decided to gauge student interest in eco-friendly products, particularly solar chargers. The initial motivation for popularizing solar-powered phone chargers arose from the observation that the student-owned Ackerman

Union Store lacked an adequate amount of green products for sale. Interested in learning about the steps UCLA has taken as an institution towards more environmentally preferable purchasing (as elaborated in their Sustainable Practices Policy), the ART Energy Team decided to observe student interest of a product directly promoting sustainable energy practices and then test its financial success (St. Clair). By presenting the results from our surveys and pilot project feedback to the ASUCLA Student Government, the team hoped to initiate UCLA procurement of green products similar to the Green Purchasing model conducted at UCSC (University of California, Santa Cruz).

III. Project Goals

The overall vision of the energy audit has not changed since the outset, though the team had to forgo original plans of testing the effect of different types of energy-saving campaigns and interventions due to time constraints and technical setbacks. The team was interested from the start in the use of data loggers to provide experimental proof of wasted energy through UCLA's lighting systems, since our stakeholder in Facilities Management voiced a strong need for a campus energy audit to provide unavailable monitoring data. Through the energy audit, we hoped to gain substantial evidence of inefficient lighting systems in the Physics and Astronomy Building and quantitatively persuade Facilities Management to install more efficient automatic sensors. By submitting a proposal of our energy savings calculations and recommendations to Facilities Management, we hoped to inform future light retrofit decisions in the building and catalyze similar monitoring in other dated campus buildings.

While the team's preliminary goal of gauging student interest on green goods has not changed, our methods and approach to disseminating the product did change. The team originally envisioned studying student interest by analyzing sales of solar-powered phone chargers. However, we realized giving away chargers for free in return for survey data would allow us to apply for university funding and would prove much easier than selling a product (with many on-campus restrictions) and then identifying and justifying a purpose to put the profits toward. We hoped to stage trial tests of the chargers and collect user satisfaction data in order to understand student opinions of renewable energy, sustainable personal devices, and green purchasing at UCLA. With the goal of increasing the visibility and accessibility of renewable energy use in daily activities, we planned to report our results to UCLA's Undergraduate Student Association and ultimately persuade the Ackerman Union Student Store to sell more sustainable products.

IV. Research Methodology

Energy Audit

The team coordinated an energy audit divided into three stages (instrumental preparation and site selection, data collection, and data analysis), in order to assess the cost effectiveness of solutions promoting energy conservation in campus buildings. First, the team had to acquire the necessary instruments to assess energy patterns, data loggers with timestamps that could record patterns of light emissivity or motion-detected occupancy. Southern California Edison, the electric utility representing much of Southern California, loaned the team five HOBO data loggers (which detect when a light source is on or off) free of charge (Figure 1) for our project. Our stakeholder Sayros Yadgar furnished us with an additional three Watt-Stopper Intellitimer-200 data loggers, providing us with an initial total of eight monitoring devices.

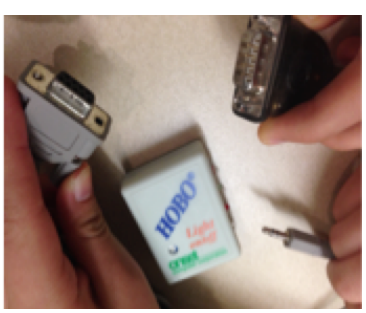


Figure 1 Light on/off data logger, loaned by Southern California Edison, with auxiliary devices to monitor settings via computer.

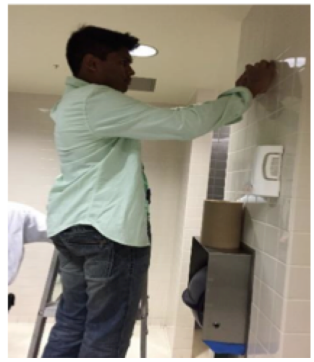


Figure 2A and 2B Team members Lawrence Kumar and Angela Kim mounting data loggers in a restroom and a classroom, respectively, within the Physics and Astronomy Building.

Figure 3 Energy Team distributing general interest surveys at UCLA's 2015 Earth Day Fair.

Since we had a limited number of instruments, we decided to put all eight data loggers in one relatively small building for a greater overall impact. After surveying eight different buildings on campus (between 9PM and 11PM) that we suspected had unneeded lights turned on for most of the night, the team decided our best choice would be the Physics and Astronomy Building. This building offered a diverse collection of lecture halls, discussion classrooms, restrooms, and public workspaces. Since this building also did not have any automatic light sensors, we could analyze the cost effectiveness of making significant lighting retrofits, feasible if the building did in fact waste electricity overnight. To represent all types of rooms that students could potentially turn lights off when unoccupied, the team decided to put two data loggers in the restrooms, one in the public study lounge, and the rest of the loggers in classrooms. On Week 7 of Winter Quarter, a week of normal anticipated classroom and afterschool student organization light use, the team used mounting pads to place the data loggers on walls with the assistance of a UCLA Facilities electrician and the building manager Craig Reaves (Figure 2A and 2B).

During the data collection phase, the team spent several weeks becoming familiarized with the ITT Pro Software, which launches the data loggers and presents the results in tabular and graphic form. While the Southern California Edison-loaned data loggers only detected light emissivity in real time, our stakeholder's loggers recorded emissivity and motion-detected occupancy, but only according to preset periodic intervals. The team chose fifteen minute intervals for the loggers to update occupancy data, but ultimately after many tests, the occupancy sensor proved too unreliable. On the other hand, our stakeholder's data logger emissivity updated every minute or so and merely had to be positioned in a well-lit portion of a wall to accurately record whether the light remained on or off. Upon collecting a week of complete light emissivity data, the team could analyze the records.

To calculate potential energy savings, the team documented the types and number of light fixtures in each room, the total wattage, the total cost (using a fixed standard LADWP rate of $.15/kWh) and the number of hours lights could have unconditionally been turned off (between the hours of 1AM-6AM, identified by our stakeholder as a period without any expected room occupation). However, due to time constraints, the team excluded light fixtures small in size and number, used the known wattage of 4-inch fluorescent bulbs to estimate the likely wattage for all non-fluorescent fixtures (based on relative size and brightness), and merely assumed more efficient LED models use half the amount of energy, all lofty assumptions (see Appendix for floor plan with light fixture counts) ("Compare: LED Lights"). Based on the data collected and difference between projected hours of wasted light and baseline hours of light use, the team calculated the energy and cost savings as well as the payback period of installing automatic light sensors in place of manual switches (see Facilities proposal in Appendix for details). In addition to calculating the payback period of replacing existing lights with more efficient LED versions, the team also factored into consideration the replacement cost of labor and time to change to LED bulbs.

It should be noted that the team's original methodology had to be further revised because of time constraints and technical limitations. Because three of Southern California Edison's data loggers did not function upon arrival, two of the remaining loaned data loggers did not accurately record observed light conditions, and one of Facilities Management's data loggers fell off the wall during the final week of baseline data collection, the team could only obtain limited usable data. In addition, the motion-detected occupancy sensor did not accurately reflect observed conditions despite troubleshoot efforts. Since the team observed during late night and early morning that the lecture hall had lights left on about half the days we checked, while the discussion room had lights on left less than half the days we checked, the team estimated that these rooms wasted electricity 50% and 25% of normal weeknights, respectively, to calculate energy savings. The team also assumed the same number of hours of wasted electricity in both restrooms, since observations taken while mounting data loggers suggested the same lighting pattern.

Solar Charger Pilot Project

The team's solar-powered phone charger marketing plan and three surveys sought to achieve two main overlapping objectives: increasing public awareness about renewable energy and increasing access to sustainable products. To gauge student interest in purchasing solar chargers and inform ASUCLA about how to cost effectively sell these eco-products, we distributed 30 XTG solar chargers to students willing to test the devices. We applied to and acquired funding from TGIF to pay an Amazon-based merchant $20 per device. After receiving the chargers, we gave at least half of the devices to students in the ESLP Program and Institute of the Environment, while raffling the remaining chargers to visitors at the Ecochella Fair. We chose this audience because we merely wanted to determine if a target audience existed on campus and what kind of feedback students would provide upon testing the quality of the charger themselves. We also felt more confident in obtaining responses from interested and more environmentally conscious students than from only marginally interested randomly selected participants.

Participants filled out an anonymous survey asking them about their interest in sustainable products, how much they were willing to pay for a charger, and if they wanted to see more sustainable products available for purchase at the student union (see pre-survey in Appendix). We asked for the participant's email address, phone number, student identification number, and contract signature, agreeing to review the product with the team by phone or email after 7-14 days of use. Our anonymous post surveys determined what difficulties participants experienced with the chargers and assessed whether participant attitudes towards the product or expected price changed (see post-survey in Appendix). Additionally, to better estimate interest in sustainable products and energy awareness (our charger trial remained limited by a small sample size), the team also distributed a general survey to 100 visitors at the UCLA Earth Day Fair (see Figure 3 and general interest survey in Appendix). This gave us more data and information to back up our claims before the ASUCLA product board.

V. Results

Energy Audit

Based on light emissivity records, the men's (and assumedly women's) restroom had manual lights left on routinely every night for an entire week (See Figure 4). Most days, the restroom lights turned off around 1 AM and turned on after 7AM. In comparison, the tutor lounge, with a conspicuously placed manual light switch near the door, only had two days of the week that the lights never turned off, one of them notably over the weekend (See Figure 5).

From our calculations, we found switching 111 light fixtures to more efficient LEDs in all five rooms and installing automatic sensors would save $1,622.12 per year, but the total cost of retrofits, labor, and electricity would add up to $12,573.64 and thus a payback period of approximately 7.75 years (see audit spread sheet in Appendix). Switching to LED lights and installing automatic sensors in just the lecture hall of interest would result in a relatively comparable 9.23 year payback period, but the same solution in all the rooms except the lecture hall would take more than 20 years to pay back. Switching to LED lights in all five rooms (without installing automatic sensors) possesses a considerably shorter payback period of roughly one month because LEDs assumedly use half the wattage of traditional light bulbs ("Compare: LED Lights").

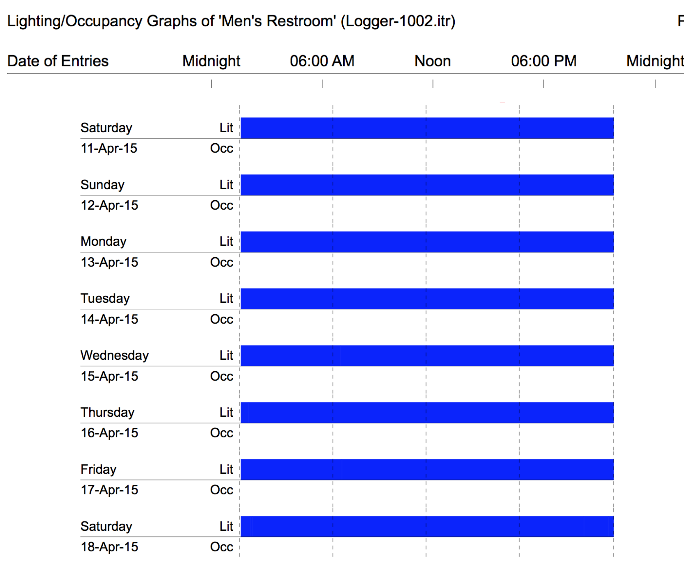


Figure 4 Men's restroom light emissivity data. Note light (indicated in blue) consistently turned on.

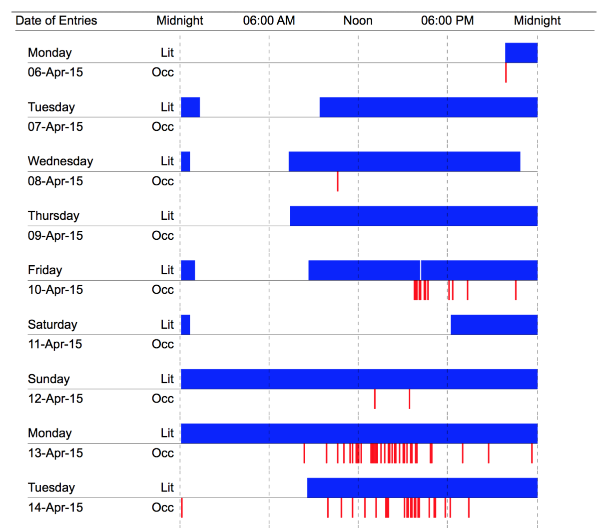


Figure 5 Tutor lounge light emissivity data (red indicates occupancy, inaccurate because of faulty occupancy sensor). Note lights typically off between 1AM and 7AM.

Solar Charger Pilot Project

According to our general interest survey, 96% of respondents at the 2015 Earth Day Fair indicated that they would purchase a solar charger. Nearly half of those stated that they would purchase a charger between $10 and $15, while more than one-third of participants both before and after the pilot project stated they would pay $15 for a solar charger, indicating a relatively constant consumer price range (See Figure 6, 7, and 8).

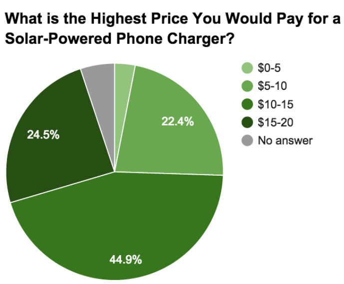


Figure 6 General survey results

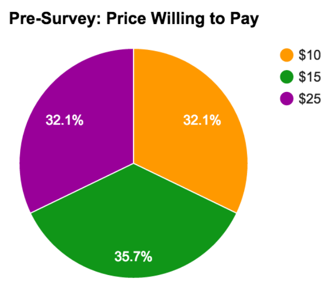


Figure 7 Pre-Survey results

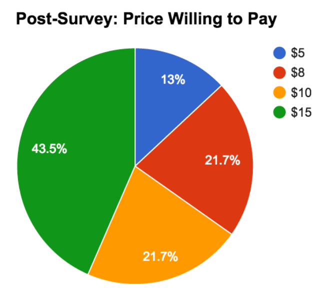


Figure 8 Post-Survey results

Furthermore, our general interest survey concluded that two-thirds of respondents believed UCLA should act as a leader in sustainability, two-thirds were familiar with the "Do It in the Dark Competition" in the dorms (and thus more likely to buy a solar charger), and the majority of respondents engage in at least one or two energy-saving practices already (See Figure 9).

Mark any energy-saving practices you currently engage in:	
use energy efficient appliances	54
turn off lights when not in a room	97
unplug devices when not in use	77
raise thermostat setting when using air conditioning	31
air-dry clothes instead of using a dryer	35
purposely using energy-demanding devices at off-peak hours	17
other	0
none / no answer	2

Figure 9 Excerpt from General Interest Survey

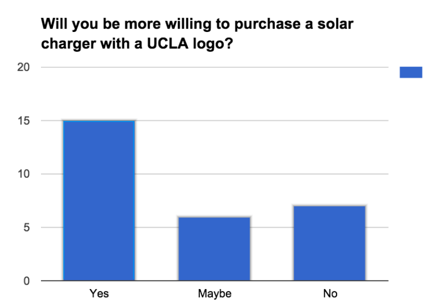


Figure 10 Graph from General Survey Data

In terms of post-survey feedback from the charger pilot project, three-quarters participants stated that this particular XTG model never worked or charged very slowly. However, at least half of students would still recommend the product to friends, depending on the price, and would buy a solar charger with a UCLA logo on it (Figure 10). This data strongly supported our position to make ASUCLA consider selling the chargers.

VI. Discussion

Energy Audit

Based on our long list of assumptions, our energy saving calculations for the men's restroom and tutor lounge, as well as estimated calculations for the three other rooms of interest, Facilities' option of installing automatic light sensors for all rooms remains highly impractical as a short-term energy conservation solution (with a payback period of less than five years) due to the high building-specific retrofit cost ($12,411.14 total). However, installing automatic sensors in just the lecture hall would result in the most profitable payback period for an individual room (9.23 years), because of the large number of light fixtures and moderate levels of wasted electricity. Despite the restrooms wasting the most hours of electricity, they had a relatively smaller impact compared to the lecture hall because they had few light fixtures. While calculations did not account for the cost of purchasing the actual light bulbs, switching to LED lights in any or all of the rooms would definitely pay off in the short term and could be implemented immediately.

Solar Charger Pilot Project

Interest among solar charger trial participants suggests ASUCLA should explore selling the clean energy devices; though preferably use a higher quality model than the one in our pilot project. The students involved were certainly more environmentally conscious than the average student due to the location of our general survey distribution, which was at the Earth Day Fair, and the solar charger giveaway, which was at Ecochella. Yet regardless, a large target audience for environmentally friendly products exists. According to our survey results, we recommend pricing the chargers at least $15, since most students surveyed were willing to pay that price, even though most were disappointed with the charger model we distributed. Unfortunately, since the charger could only use the sun to reach 50% charge (not clearly advertised by the company), the device frequently needed to be plugged in by USB to a traditional power source. The charger also was very slow to charge the phone itself, and in some cases would not fully charge the phone at all.

From the post-survey, students were frustrated with the chargers' inability and slowness to fully charge. Yet many students still stated their interest in owning and using a solar charger, which makes this product satisfaction data valuable for ASUCLA. Students recommended incorporating the UCLA logo onto the chargers, purchasing a product that would allow them to clip the product onto their backpacks, and providing more helpful instructions and information about the energy being saved by using the product. The participants also recommended using solar chargers with higher voltage capacity in order to charge larger smartphones. After meeting with Roy Champawat, Director of the UCLA Student Union, and informing him about the team's and participant's recommendations, Champawat agreed to have us pitch the product and the research at the ASUCLA board meeting in July. He expressed a lot of enthusiasm with the product and wondered why the student union had not yet considered selling them.

VII. Recommendations

For any future teams that attempt to do a test run of a product, we recommend starting extremely early. In our initial plan we had another cheaper solar charger in mind that came in different colors and clipped onto backpacks. Unfortunately, by the time we contacted the right people, secured funding, and purchased the chargers, the shipment would have arrived 2 weeks after the end of the quarter. Besides starting early, we recommend heavily researching your product pre-purchase. For example, we should have taken into consideration the fact that the majority of students at UCLA have very large smartphones that take a lot of energy to charge. In addition to conducting outreach on campus at the Earth Day Fair and Ecochella, we recommend making sure pre- and post-survey questions are consistent, such as including the same price ranges, in order to more effective analysis.

Lastly, since our XTG solar charger model was not ideal, we recommend using a different product. For similar quality as the XTG model but at half the price, the well-reviewed (but low voltage) HAPPYCOCO Solar Panel 5000mah Portable Backup Power Bank Pack sells at about $11. While some Amazon bestsellers like the $20 Poweradd™ Apollo 7200mAh Solar Panel Charger Portable Charger Power Bank may not fully charge smartphones, we recommend ASUCLA purchase the $20 Universal 10000mAh Portable Dual USB External Solar Power Bank / Backup Battery Charger, which has good reviews and double the voltage capacity of the $11 charger. By contacting the manufacturer with a large order, we may be able to get discount bulk pricing and sell the product for a reasonable $15, while still providing a quality product.

With regards to the energy audit, teams should preferably have some technical proficiency and be willing to devote extra time to learning analytical data software. With one less team member, technical challenges that took weeks to resolve (such as accessing software, and collecting usable data, and determining that Edison's data loggers in fact didn't work) limited the effective time available for us to carry out our envisioned project. However, being able to flexibly revise project expectations made us successful in completing both projects. At first, the team hoped to collect baseline light and occupancy data, test the effect of signage encouraging students to turn off lights when leaving, and test the effectiveness of different technological solutions in at least eight rooms of the building to provide comprehensive energy and cost savings recommendations. We also planned to distribute more solar chargers using random selection. However, in the interest of time constraints and technical challenges, our team made do with fewer and more expensive chargers distributed to a targeted audience, as well as only one week of complete light data in just two rooms of the Physics and Astronomy Building. Ultimately though, we still collected enough preliminary data to support the following recommendations to Facilities: switching all lights in the Physics and Astronomy Building with more efficient LEDs, encouraging awareness campaigns to turn off lights, and if willing to invest in automatic sensors with a long payback period, implementing retrofits in all rooms for the greatest savings and impact.

VIII. Conclusion

The Energy Team of 2015 had quite a few obstacles to overcome, but with perseverance and teamwork, we managed to complete two projects with meaningful results. The three surveys and solar charger pilot project not only led to more solar awareness amongst undergraduates, but proved that students do want more eco-friendly products in Ackerman Union. After pitching the idea of selling solar powered phone chargers to the director of the student union, we now plan to present price and model recommendations to the ASUCLA board in July.

Despite collecting less light emissivity data than expected, our energy audit of the Physics and Astronomy Building provided the data to back our suspicion that restroom lights remained on virtually all the time. Though the high cost of installing automatic light sensors in the building likely precludes Facilities Management from making near-term retrofit plans, our calculations suggest Facilities Management prioritize more efficient LED light replacements in all rooms before installing automatic sensors throughout the building. The team likewise recommends exploring cheaper alternatives to turning lights off when leaving, such as awareness campaigns and signage near manual switches, as well as enforced protocol amongst maintenance crews. In sum, the prospects for increasing energy savings and public awareness don't remain immediately high for the Physics and Astronomy Building and XTG solar chargers, but provide invaluable information for conducting energy retrofits in other campus buildings and for ensuring customer satisfaction and interest for higher quality solar chargers.

IX References

"Green Purchasing." *Blueprint for a Sustainable Campus*. University of California, Santa Cruz, n.d. Web.13 Mar. 2015. <http://www.blueprint.enviroslug.org/green-purchasing.html#/>.

Mok, Harry. "UC Takes Sustainability to the next Level." University of California. Office of the President, 24 Sept. 2014. Web. 13 Mar. 2015.

StClair, Matthew, ed. *Sustainable Practice*s. Rep. University of California, 1 July 2004. Web. 9 Mar. 2015. <http://policy.ucop.edu/doc/3100155/Sustainable%20Practices>.

"Action Research Team Final Reports." Education for Sustainable Living Program. <http://www.eslp.environment.ucla.edu/archives/>

Dudman, Tracy and Renee Fortier, David Johnson, David Karwaski, Nurit Katz, Tova Lelah, J. Cully Nordby, Jack Powazek, Robert Striff. *UCLA Climate Action Plan*. Los Angeles: UCLA, 2008.

European Environment Agency, *Achieving energy efficiency through behaviour change: what does it take?* Luxembourg: Publications Office of the European Union, 2013.

"Compare: LED Lights vs CFL vs Incandescent Lighting Chart." *Compare: LED Lights vs CFL vs Incandescent Lighting Chart*. N.p., n.d. Web. 05 June 2015. < http://www.designrecycleinc.com/led%20comp%20chart.html>

X Appendices

Solar Charger Pre-Survey

1. What sustainable products do you currently use? Check all that apply.

__Reusable water canteen
__Reusable tote bag
__Notebooks with recycled paper
Other__________________

2. In the last two weeks, what items have you purchased from the UCLA Store?
[If you haven't visited the store in the last two weeks, do not circle.]

Clothes Books School Supplies Food

3. While a student at UCLA, what sustainable products have you purchased from the UCLA Store? If none, do not check.

__Reusable water canteen
__Reusable tote bag (not the bag the store offers to carry a purchase!)
__Notebooks with recycled paper
Other__________________

4. What is the maximum price you are willing to pay for a solar-powered phone charger?

$5 $8 $10 $15 $25

5. Would you be more willing to purchase a solar-powered phone charger with a UCLA logo?

Yes Maybe No

Solar Charger Post Survey

How would you rate the quality of this product?

1 2 3 4 5

Never worked Charged too slowly Always worked

How often did you use the charger in the last two weeks?

1-2 times total 2-3 times a week Once a day Several times a day

How often did you still need to use a traditional wall outlet to charge your device?

Always Sometimes Never

In what locations did you find the solar charger useful? Check all that apply.

__Inside libraries (Powell, YRL)

__Outdoor patios (Ackerman, Kerckhoff, North Campus, Lu Valle, Bombshelter)

__Outdoors on the Hill (outside)

__Bedroom (inside)

__Any other campus location: _________________

Would you recommend others to purchase the product if it was sold at the UCLA Store?

Yes No Depends on price

On a scale of 1-5 (5 being the highest), how much did your trial period with this charger increase your appreciation for sustainable products?

1 2 3 4 5

Are there any other recommendations you would offer to the solar charger company or UCLA Store if they chose to sell the product?

____

____

General Interest Survey for Solar-Powered Phone Chargers in the UCLA Store

1. Would you want to purchase a solar-powered phone charger?

Yes No

If no, skip #2.

2. What is the most you are willing to pay for a solar powered cell phone charger?

$0-5 $5-10 $10-15 $15-20

3. Are you aware of any energy-saving campaigns at UCLA? Circle all that apply.

Power Save Do it in the Dark Grand Challenge Other__________

4. Should UCLA install more solar panels on campus buildings?

Yes No

Choose ONE reason why.

If yes:
__They will save money
__They will increase the percentage of locally sourced clean renewable energy
__UCLA should be a leader in sustainable actions

If no:
__They're too expensive; not cost-effective
__I don't like how they look
__Building designs don't support panels

Other:_______________________

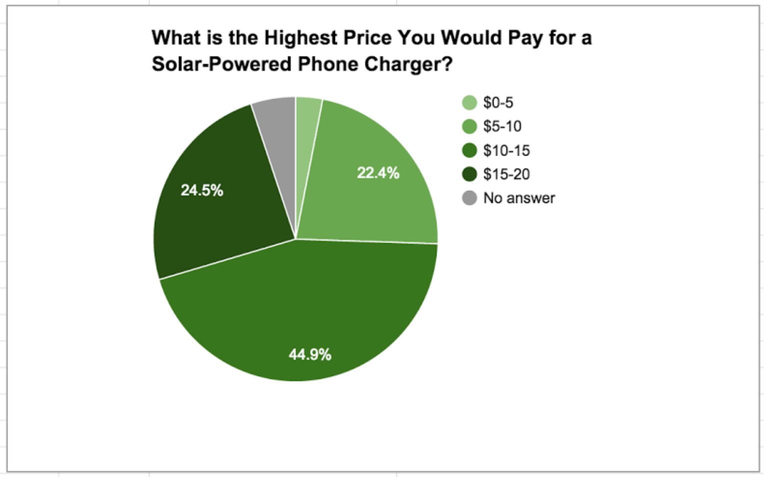
5. Mark any energy-saving practice you currently engage in.

__use energy efficient appliances
__turn off lights when not in a room
__unplug devices when not in use
__raise thermostat setting when using air conditioning
__air-dry clothes instead of using a dryer
__purposely use energy-demanding devices at off-peak hours (late morning, early afternoon, late night)

Other:____

general energy survey results

	A	B	C	D
1	**QUESTIONS**	**#**	**%**	total surveys
2	**Would you want to purchase solar-powered phone charger?**			100
3	yes -	96		
4	no -	4		
5	**What is the most you are willing to pay for a solar powered cell phone charger?**			
6	$0-5	3		
7	$5-10	22		
8	$10-15	44		
9	$15-20	24		
10	No answer	5		
11	**Are you aware of any energy-saving campaigns at UCLA? Circle all that apply.**			
12	Power Save	16		
13	Do it in the Dark	64		
14	Grand Challenges	35		
15	No answer	19		
16	**Should UCLA install more solar panels on campus buildings?**			
17	Yes			
18	They will save money	54		
19	They will increase the percentage of locally sourced clean renewable energy	66		
20	UCLA should be a leader in sustainable actions	68		
21	No			
22	They're too expensive; not cost-effective	3		
23	**Mark any energy-saving practices you currently engage in:**			
24	use energy efficient appliances	54		
25	turn off lights when not in a room	97		
26	unplug devices when not in use	77		
27	raise thermostat setting when using air conditioning	31		
28	air-dry clothes instead of using a dryer	35		



Solar Powered Phone Charger Post Survey (Responses)

File Edit View Insert Format Data Tools Form Add-ons Help

fx Timestamp

	A	B	C	D	E	F	G	H
1	Timestamp	How would you rate the q	How often did you use the	How often did you still ne	In what locations did you	Would you recommend o	At what price would you p	On a scale of 1-5 (5 bein
2	5/20/2015 10:17:15	2 Charged Very Slowly	2-3 times a week	Always	Dorm room/apartment	Depends on price	$8	3
3	5/20/2015 10:49:55	3 Charged Slowly	1-2 times total	Always	Dorm room/apartment	Yes	$15	5
4	5/20/2015 16:56:26	5 Always worked	1-2 times total	Sometimes	Dorm room/apartment	Depends on price	$10	3
5	5/21/2015 13:38:03	3 Charged Slowly	2-3 times a week	Always	Inside libraries (Powell, Y	Depends on price	$15	5
6	5/21/2015 13:46:42	2 Charged Very Slowly	1-2 times total	Always	Dorm room/apartment	Depends on price	$8	3
7	5/21/2015 14:47:28	4 Worked most of the tim	1-2 times total	Always	Outdoor patios (Ackerma	Yes	$15	4
8	5/21/2015 15:16:25	3 Charged Slowly	1-2 times total	Always	Outdoor patios (Ackerma	Yes	$15	3
9	5/21/2015 15:16:51	3 Charged Slowly	1-2 times total	Always	Outdoor patios (Ackerma	Yes	$15	3
10	5/21/2015 15:58:16	3 Charged Slowly	1-2 times total	Always	Dorm room/apartment	Depends on price	$15	3
11	5/21/2015 16:12:02	2 Charged Very Slowly	1-2 times total	Sometimes	Dorm room/apartment	Depends on price	$5	3
12	5/21/2015 16:29:20	2 Charged Very Slowly	1-2 times total	Always	Dorm room/apartment	No	$15	2
13	5/21/2015 18:15:11	4 Worked most of the tim	1-2 times total	Sometimes	Dorm room/apartment	Depends on price	$15	3
14	5/22/2015 0:01:01	5 Always worked	2-3 times a week	Always	Inside libraries (Powell, Y	Depends on price	$10	3
15	5/22/2015 1:04:41	2 Charged Very Slowly	1-2 times total	Always	Outdoor patios (Ackerma	Depends on price	$8	4
16	5/22/2015 6:55:35	2 Charged Very Slowly	1-2 times total	Always	Outdoor patios (Ackerma	No	$10	2
17	5/22/2015 15:43:27	5 Always worked	1-2 times total	Always	Outdoor patios (Ackerma	Yes	$15	4
18	5/24/2015 11:11:29	2 Charged Very Slowly	1-2 times total	Always	Outdoor patios (Ackerma	Depends on price	$8	3
19	5/24/2015 18:22:05	3 Charged Slowly	2-3 times a week	Always	Outdoor patios (Ackerma	No	$5	4
20	5/26/2015 15:33:04	3 Charged Slowly	1-2 times total	Always	Outdoor patios (Ackerma	Depends on price	$5	4
21	5/26/2015 16:28:02	3 Charged Slowly	1-2 times total	Sometimes	Outdoor patios (Ackerma	Depends on price	$8	3
22	5/26/2015 17:39:40	2 Charged Very Slowly	2-3 times a week	Sometimes	Outdoor patios (Ackerma	Depends on price	$10	5
23	5/26/2015 20:51:45	2 Charged Very Slowly	1-2 times total	Always	Outdoor patios (Ackerma	Depends on price	$10	5
24	5/26/2015 21:04:34	3 Charged Slowly	2-3 times a week	Always	Inside libraries (Powell, Y	Yes	$15	5
25	5/28/2015 6:23:15	1 Never Worked	1-2 times total	Always	Inside libraries (Powell, Y	No	$15	2
26	5/28/2015 16:32:32	3 Charged Slowly	1-2 times total	Always	Inside libraries (Powell, Y	No	$10	3
27								

Pre-Survey Solar Charger results

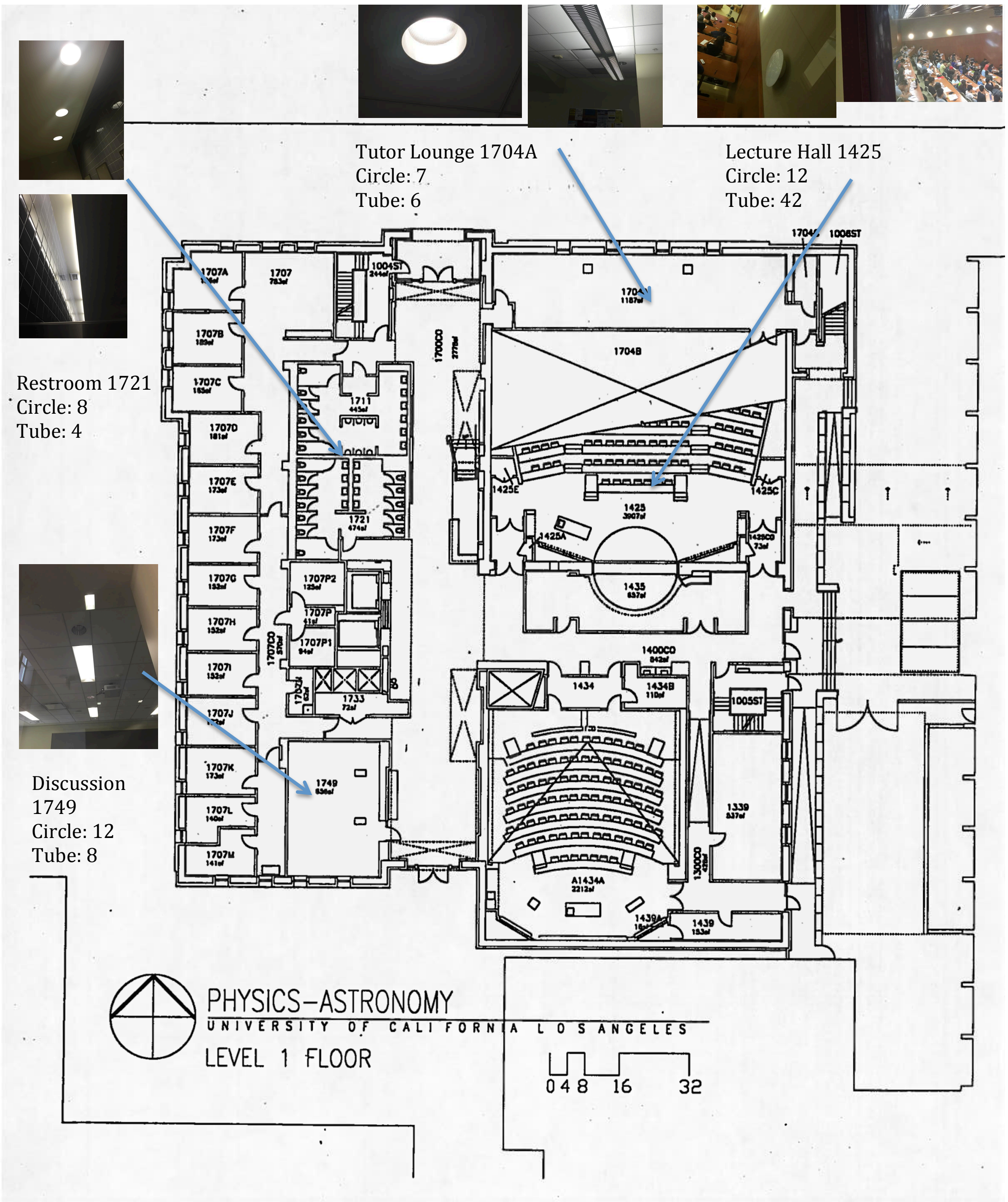
File Edit View Insert Format Data Too

$ % .0 .00 123 Aria

fx Question 1

	A	B	C
1	Question 1		
2	Reusable water l	28	
3	Reusable tote ba	28	
4	notebook with re	19	
5			
6	Question 2		
7	Clothes	2	
8	Books	5	
9	School Supplies	10	
10	Food	6	
11			
12	Question 3		
13	Reusable water l	5	
14	Reusable tote ba	1	
15	notebook with re	9	
16			
17	Question 4		
18	$5	0	
19	$8	0	
20	$10	9	
21	$15	10	
22	$25	9	
23			
24	Question 5		
25	Yes	15	
26	Maybe	6	
27	No	7	

Physics and Astronomy Building Floor Plan Level 1 with Light Fixtures



Base line calculations for PAB:

	A	B	C	D	E	F	G	H
1	**Base line: data from 4/7 to 4/14**							
2	room number	light type	light number	wattage per bulb (W)	total wattage (W)	total on (hrs/week)	kwh / week	15 cents / kwh ($/week)
3	1704A (tutor)	circle	7	20	140	134	18.76	2.814
4		tube	6	28	168	134	22.512	3.3768
5	1711 (restroom)	circle	8	20	160	168	26.88	4.032
6		tube	4	28	112	168	18.816	2.8224
7	1721 (restroom)	circle	8	20	160	168	26.88	4.032
8		tube	4	28	112	168	18.816	2.8224
9	1749 (lecture)	circle	12	20	240	130	31.2	4.68
10		tube	42	28	1176	130	152.88	22.932
11	total		91	192	2268	1200	316.744	47.5116
12	note: number of lightbulbs are low estimates, especially in the big lecture hall (there are more light bulbs than accounted for in calculations)							
13	assumptions:							
14	1) wattage of circle bulbs estimated from wattage of tubes							
15	2) total hours on estimated from graph data							
16	3) cost of 15 cents/kwh from Sam							

Base line calculations for PAB:

	A	I	J	K	L	M	N	O	P
1	**Intervention 2: LED + sensors**								
2	room number	new wattage with LED	new total wattage	new kwh/week	new cost/week	$saved / week	estimated hours of work	estimated cost of labor	simple payback period (weeks)
3	1704A (tutor)	10	70	9.38	1.407	1.407	0.5	12.5	
4		14	84	11.256	1.6884	1.6884	0.5	12.5	
5	1711 (restroom)	10	80	13.44	2.016	2.016	0.5	12.5	
6		14	56	9.408	1.4112	1.4112	0.5	12.5	
7	1721 (restroom)	10	80	13.44	2.016	2.016	0.5	12.5	
8		14	56	9.408	1.4112	1.4112	0.5	12.5	
9	1749 (lecture)	10	120	15.6	2.34	2.34	1	25	
10		14	588	76.44	11.466	11.466	1	25	
11	total	96	1134	158.372	23.7558	23.7558	5	125	5.26187289
12	note: number of lightbulbs are low estimates, especially in the big lecture hall (there are more light bulbs than accounted for in calculations)								
13	assumptions:								
14	1) wattage of circle bulbs estimated from wattage of tubes								
15	2) total hours on estimated from graph data								
16	3) cost of 15 cents/kwh from Sam								
17	4) LEDs use half the wattage - http://www.designrecycleinc.com/led%20comp%20chart.html								
18	5) adding sensors would decrease use by about 6 hours a day (-42 hrs/week)								
19	6) cost of installing sensors								

adjusted hours with sensors	adjusted kwh/week	adjusted cost/week	$ saved / week	cost of installing sensors	total cost (LED+sensors)	simple payback (years)
92	6.44	0.966	1.848			
92	7.728	1.1592	2.2176			
126	10.08	1.512	2.52			
126	7.056	1.0584	1.764			
126	10.08	1.512	2.52			
126	7.056	1.0584	1.764			
88	10.56	1.584	3.096			
88	51.744	7.7616	15.1704			
864	110.744	16.6116	30.9	$12,411.14	$12,536.14	7.8019293

Energy-Saving Proposal for the UCLA Physics and Astronomy Building

The 2015 ESLP Energy Team drafted the attached spreadsheet of calculations and following proposal to UCLA Facilities Management with the aim of improving the sustainable and cost-effective operations of campus lighting. While the Energy Team faced many data limitations, these recommendations to conserve energy in the Physics and Astronomy Building still remain useful and can inform other building operations. The spreadsheet results will also automatically calculate changes the client makes to value estimates. For more details regarding instrumental light emissivity collection using data loggers, see the publicly available *2015 ESLP Energy Team Report*.

The team calculated energy and cost savings using the following assumptions:

- Light fixtures small in number and size were excluded from consideration. Facilities staff should confirm the number of light fixtures per room that this proposal reports.
- The unknown wattages of circular light fixtures were estimated from the known wattage of the tubular light fixtures. Facilities staff should confirm the wattage of each light fixture.
- The total hours of electricity use were estimated from light emissivity data and observations, since there no accurate occupancy data could be obtained. Facilities staff should collect occupancy readings to support estimates of daily hours of light.
- Based on observations, lecture hall lights were on all night 50% of the time. Occupancy readings should ideally support observations.
- Based on observations, discussion room lights were on all night 25% of the time. Occupancy readings should ideally support observations.
- Men's and women's restroom light emissivity data followed the same patterns. Actual emissivity and occupancy records should ideally confirm estimates.
- A fixed and not variable cost of LADWP electricity at 15 cents/kwh. A more comprehensive study would study a variable rate.
- Without clearly identified light fixture types and wattages, LED wattage was estimated to use half the wattage of traditional lights source. Facilities staff should identify specific LED bulbs to replace various light fixture types and compare the actual LED wattage with the wattage of traditional bulbs.
- Installing automatic sensors would decrease wasted electricity by 6 hours a day (between 1AM-6AM or 42 hours/week), the frame of time no occupants should be expected to be present. Facilities staff should use occupancy readings and observations to confirm the actual number of hours of electricity wasted in unoccupied rooms.
- Cost of light bulbs not included. Facilities staff should include these values for more comprehensive recommendations.
- Hours of labor required to switch bulbs to LED not confirmed by UCLA staff. Ideally, staff should report how long light bulb installations take.
- Cost of paying electrician for labor costs estimated at $25/hour. Ideally, staff should report their salary.

Results

From our calculations, we found switching 111 light fixtures to more efficient LEDs in all five rooms and installing automatic sensors would save $1,622.12 per year, but the total cost of retrofits, labor, and electricity would add up to $12,573.64 and thus a payback period of approximately 7.75 years. Switching to LED lights and installing automatic sensors in just the lecture hall of interest would result in a relatively comparable 9.23 year payback period, but the same solution in all the rooms except the lecture hall would take more than 20 years to pay back. Switching to LED lights in all five rooms (without installing automatic sensors) possesses a considerably shorter payback period of roughly one month because LEDs assumedly use half the wattage of traditional light bulbs.

Recommendations

The restroom lights may have been consistently left on during most nights, but they have too few lights to make an automatic sensor retrofit cost-effective. Changing the lights in the lecture hall would have the biggest impact, and the team recommends implementing LEDs in all rooms before retrofitting for automatic sensors. Yet Facilities should also explore other cost effective methods for reducing energy use, such as creating awareness campaigns to turn off lights throughout the Physics and Astronomy Building.