



An Analysis of Palo Alto High School's Idle Energy Consumption

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RESEARCH QUESTION

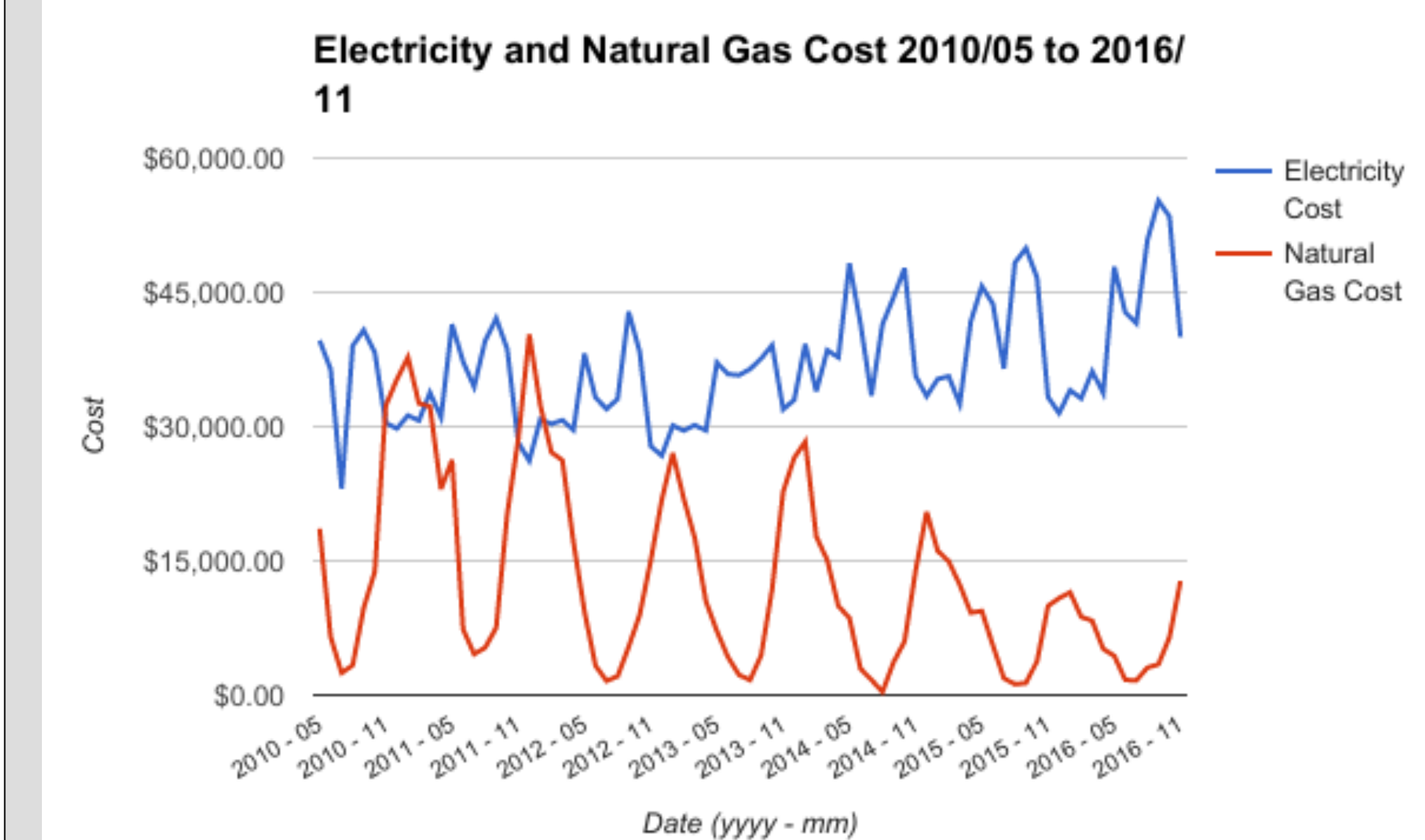
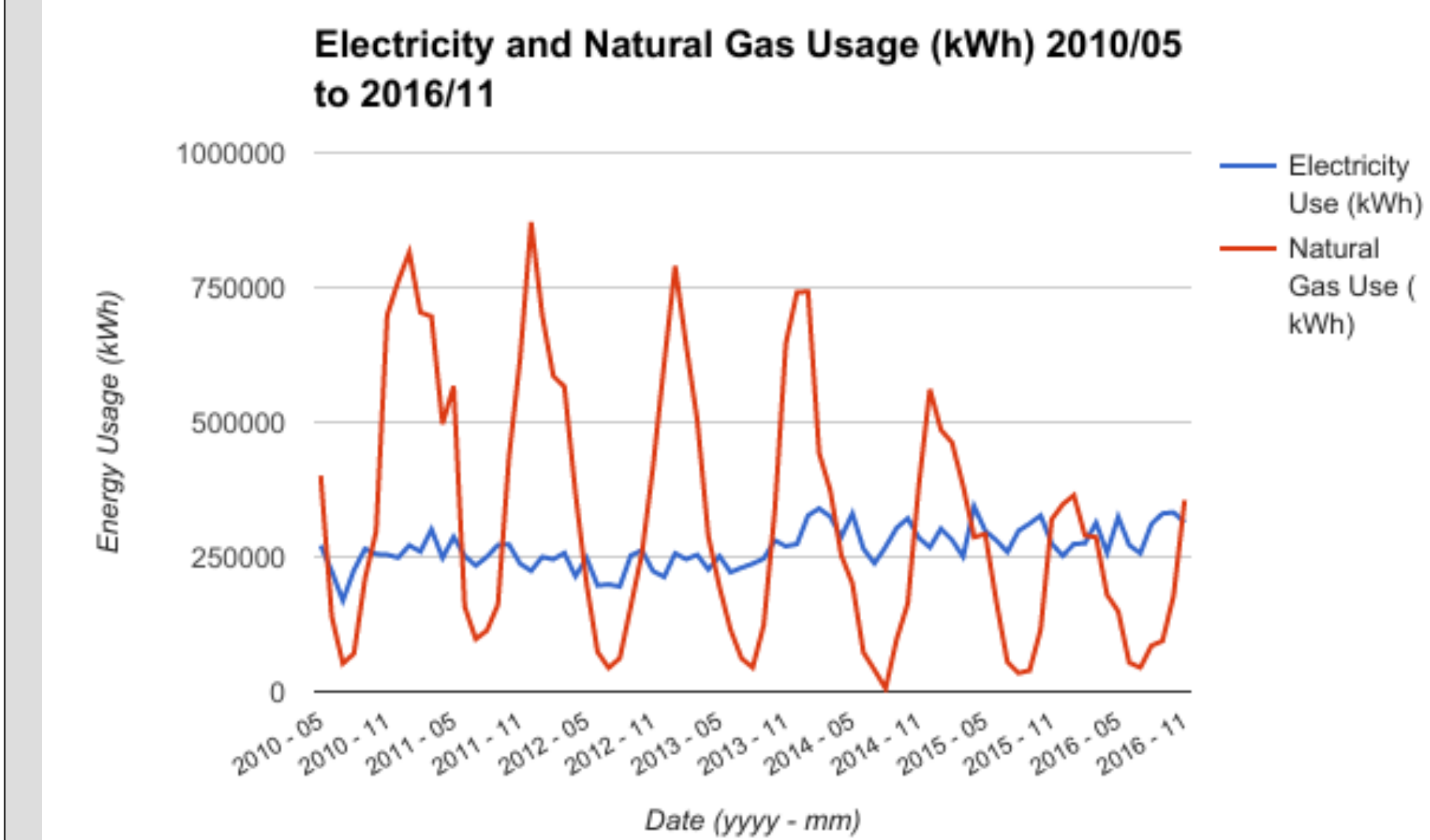
How can Palo Alto Unified School District (PAUSD) effectively reduce the amount of idle energy load, or the amount of energy consumed after school hours, on the Palo Alto High School (PALY) campus through behavioral changes, policy, and education?

ABSTRACT

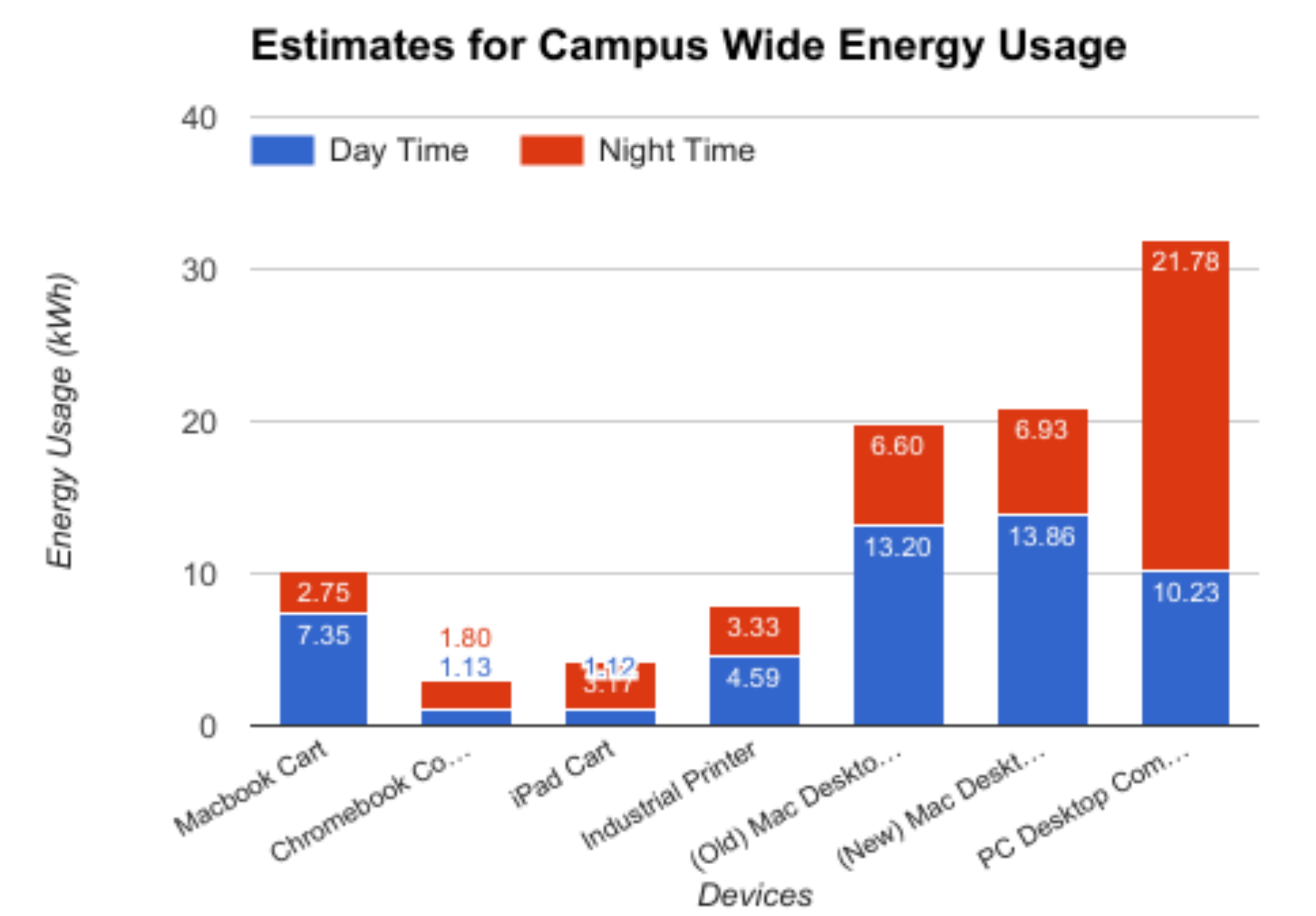
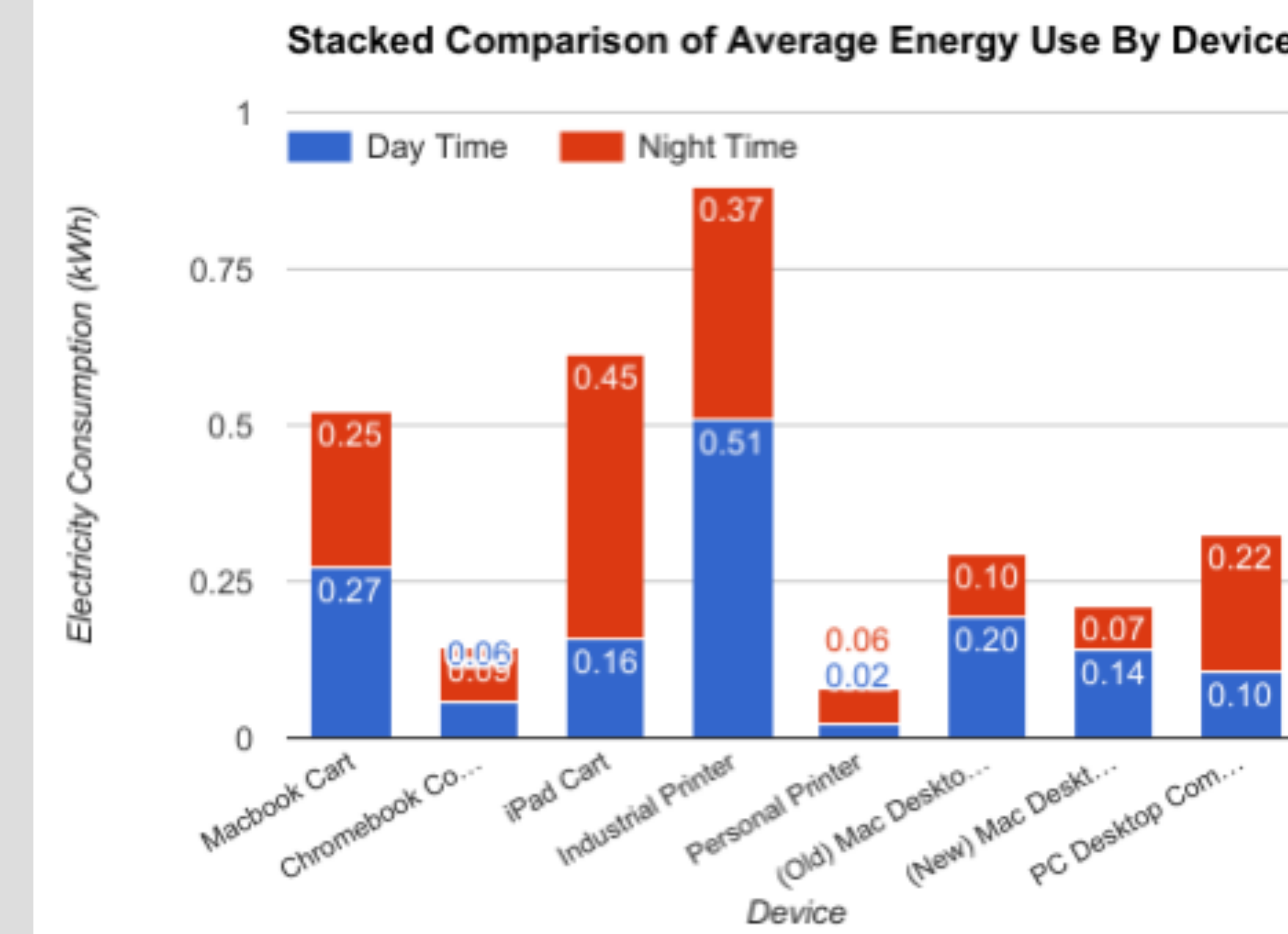
The central purpose of this study will be to collect data, both quantitative and qualitative, analyze these data, and propose a formal suggestion to PALY and the PAUSD as to how they can reduce energy wasted after school hours, or decrease classroom idle energy load, by way of behavioral changes, policy, and education. In summary, the study will include surveys, interviews, personal collection of quantitative data at PALY, and analysis of data (primarily retrieved from studies, databases, and the PAUSD utilities department).

BACKGROUND & SIGNIFICANCE

Every movement has a certain level of popularity driving it, something that appeals to the community's emotions. While some may argue that farms hundreds of miles away are the leading depleting sources of our water, we must remember that we can see, hold, and touch water. On the other hand, energy consumption—both natural gas and electricity usage—is one of the most abstract resources that we consume on a daily basis, and therefore, it is a resource that we often don't give much thought to. While our energy sources may be becoming increasingly reliant upon renewables, reducing the amount of energy we consume and waste is equally important. Energy sources are changed by policy, but, similarly to water, the energy demanded or the amount of energy we consume is the aspect of the resource over which we have control. This abstraction only makes conserving energy more important.



DATA ANALYSIS AND RESULTS



FINDINGS: AVERAGE ENERGY USAGE (COLLECTED)

- Computer labs (old Mac, new Mac, and PC desktops), no matter the type of computer, consume a fairly average and consistent amount of energy compared to computer carts (MacBook, Chromebook, iPad), where energy usage varies greatly.
- iPad carts relatively consume the largest amount of energy during the night, or have the largest idle load. Of the three types of computer carts monitored (MacBook, Chromebook, iPad), iPad carts are the least efficient when it comes overall energy usage as well.
- Industrial printers consume the largest amount of energy, during the day and in total, on average.
- Personal printers use the least amount of energy overall and when monitoring string lights, which are often used by English teachers, the meters were not able to detect any energy usage whatsoever.

FINDINGS: ESTIMATES FOR CAMPUS USAGE (CALCULATED)

- Computer labs (old Mac, new Mac, and PC desktops) consume the greatest amount of energy on campus.
- Of the three types of computer carts monitored (MacBook, Chromebook, iPad), MacBook carts use the greatest amount of energy collectively. However, iPads are the least efficient when it comes to idle load usage.
- Industrial printers consume a fair amount of energy; however, there are only nine on campus. Therefore, changing that number would not mean getting rid of the, but rather turning them off at night.
- String lights and personal printers, both of which are only used occasionally by teachers, have negligible energy consumption.

Energy Usage of Typical Classroom Electronic Devices compared to Total Electricity Usage

Average Cost/Unit (\$/kWh)	Typical Classroom Devices			Total Campus		% of Overall Cost
	Usage Per Day (kWh)	Usage Per Year (kWh)	Cost Per Year	Electricity Usage Per Year	Cost Per Year	
\$0.14	93.18	16772.4	\$2,348	105278.28	\$14,571	16.11%

Potential Savings from Idle Load (Nighttime Energy Usage)

Average Cost/Unit (\$/kWh)	Typical Classroom Devices			Total Campus		% of Overall Cost
	Nighttime Usage Per Day (kWh)	Nighttime Usage Per Year (kWh)	Cost Per Year	Electricity Usage Per Year	Cost Per Year	
\$0.14	46.36	8345.4	\$1,168	105278.28	\$14,571	8.02%

FINDINGS: OVERALL

In general, common classroom electronic devices tend to exhibit large idle loads—most devices continue to draw significant amounts of energy during the night (2/4 PM to 8 AM) when they are not being used. While electrical outlet timers are easy solutions to reduce idle load for computer carts and printers. Student groups and staff who stay late generally continue to use desktops; therefore, automatically switching them off at a given time, is not ideal.

ERROR ANALYSIS

- Daytime data collected for iPad carts may be skewed as the monitored cart is known to be unplugged and moved around during the school day.
- Mac Air carts and Chromebook towers were not monitored. These may have been potentially significant in contributing to overall energy usage.

METHODOLOGIES

Surveys

- Surveys were conducted at an early stage in the study in order to gain a general understanding of how students, teachers, and administration feel towards energy consumption.
- These surveys looked at many components: subject's opinions on their own energy consumption, common devices that they feel consume a great amount of energy, and stances on what should be done to reduce PALY's energy consumption.

Interviews

- Interviews had the aim of collecting information from teachers and staff in departments where machinery or electronic devices consuming large amounts of energy may be more relevant.
- These were conducted with the IT staff to obtain estimates of the number of computer carts and computer labs, the auto shop and robotics teacher in order to learn of the high power equipment they may use.

Metering on Campus

- A second goal for this energy monitoring is to determine whether or not classroom electronic devices create a negligible amount of wasted energy, because if this proves to be true, then behavioral changes will be unable to create significant cuts in energy consumption and alternative options must be explored
- "Kill a Watt" meters were used to monitor a variety of common classroom electronic devices.

Retrieved Data

- Quantitative data on PALY's energy consumption will be retrieved from the Palo Alto Unified School District by way of Ms. Navarro.
- These data will be analyzed in order to gauge how much electricity and natural gas, PALY consumes overall, and to create a sense of perspective to accompany metering on PALY's campus.

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