Ellison Hall, UCSB Energy Use

Role of Computer Monitors in the Reduction of Building Energy Use and Carbon Dioxide Emissions.

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1. Introduction

Institutions of higher education and their associated buildings and infrastructure are responsible for massive energy and resource consumption, resulting in impacts on the social, economic, and environmental systems they are integrated with. It is up to these institutions to teach and practice methods of energy efficiency and resource conservation to ensure that future generations will have adequate access to these needs. The University of California is beginning to take the necessary steps to implement sustainability initiatives throughout the statewide system; such as mandating a green building policies, clean energy, and transportation policies. At the University of California, Santa Barbara, there many various groups are collaborating on these initiatives from a campus wide level to departmental. The Ellison Hall Sustainability Committee, a faction of the Geography Department, is one such group that is actively engaged in putting sustainability into practice. This group consists of faculty, staff and students that use the multi-departmental facilities of Ellison Hall. The committee is currently involved in creating a recycling program, vermaculture, and research and implementation of building energy efficiency practices.

A goal of the committee is to aid and assist in the process of becoming accredited as a green building through the Unites States Green Building Councils' Leadership in Energy and Environmental Design for Existing Buildings program (LEED EB). With increasing development, the building sector will increase its energy consumption in the United States dramatically unless there are strict building codes implemented that enforce energy efficiency and consumption through the overall design of the building and use of clean energy. As illustrated in Figure 1 and Figure 2,

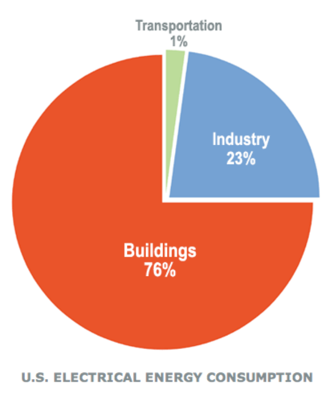


Figure 1

the building sector uses the majority of the U.S. Electrical Energy and is subsequently has the largest emissions in C02.

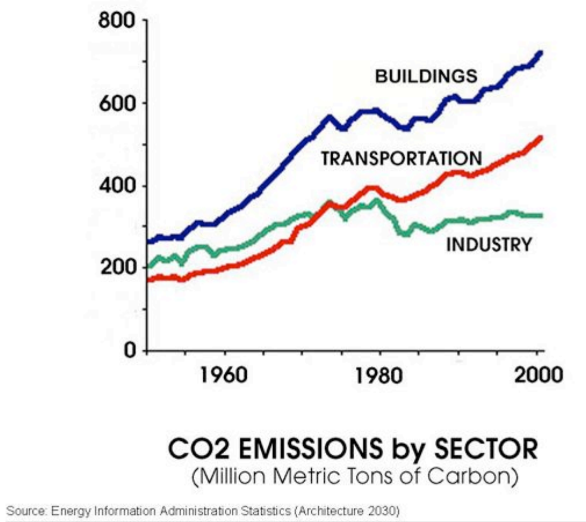


Figure 2

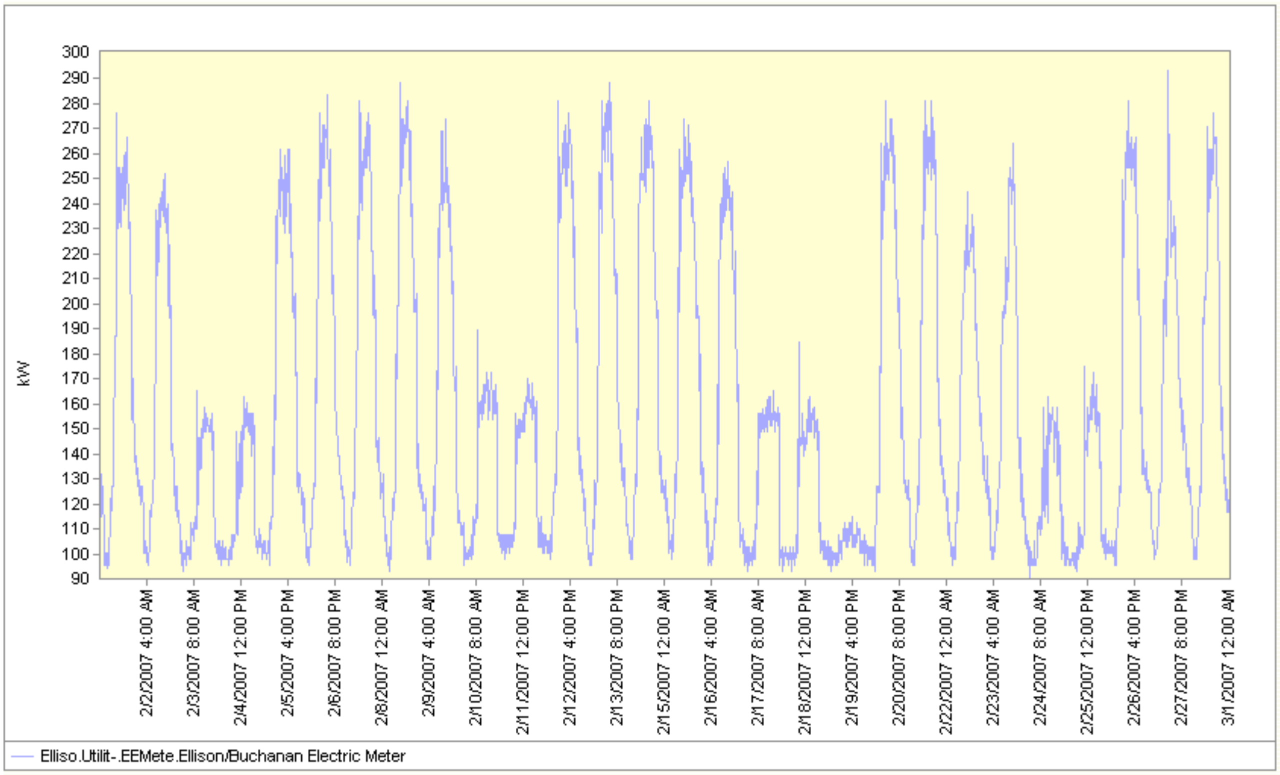
Guidelines such as the US Green Building councils will assist buildings to reduce their C02 emissions and energy consumption. LEED EB "maximizes operational efficiency while minimizing environmental impacts. It provides a recognized, performance-based benchmark for building owners and operators to measure operations, improvements and maintenance on a consistent scale. LEED for Existing Buildings is a road map for delivering economically profitable, environmentally responsible, healthy, productive places to live and work." To apply and receive the LEED EB status the building must show improvements in building cleaning and maintenance, reductions in chemical use, improved indoor air quality, energy efficiency, water efficiency, recycling programs and facilities, exterior maintenance, and upgrades in the buildings systems to meet performance standards in energy, water and lighting(www.usgbc.org). There are many aspects that must be addressed in the overall sustainability of a building, however they must all be individually addressed in order to reach the goal of a LEED EB rated building. Through my involvement with the Ellison Hall Sustainability Committee I have assisted in the development of the recycling program, and am pursuing the research and recommendations to improve the overall energy efficiency of Ellison Hall. Electrical energy use for a building can be subdivided into three categories; lighting, process and plug load. Lighting electrical use is the overall energy used for all of the installed lighting applications such as hallway, office, classroom, and outdoor lighting. Secondly, the process electrical consumption consists of the building systems such as ventilation, heating and cooling, water heating and other building electrical needs. The final, and most readily accessible place to make energy efficiency improvements, consists of the plug load. The plug load measures how much energy is drawn from personal, office, and laboratory outlets. Personal lights, computers, refrigerators, research tools, and other appliances are examples of electricity consuming aspects of buildings needs. Recording the measured electrical use for these facets requires sub meters for each category, and unfortunately many buildings such as Ellison Hall are not equipped with this technology. Sub meters allow for facilities operations to record and observe current energy trends in these facets, and make necessary energy efficiency improvements. Ellison Hall has one meter that the facilities department oversees which includes all three facets of building energy use as well as the same uses in the adjacent Buchanan Hall. Currently, in order to assess the energy use of the building energy and make necessary improvements, specific audits of energy use must be studied. To aid and assist in the ongoing assessment of energy use in Ellison Hall I performed in combination with members of the Ellison Hall Sustainability committee a study on the overall energy use of the building and specifically on the variables of energy used by computer monitors and the various energy settings that can be adjusted to make them more efficient.

2. Methods, Research, Results.

The goal of this study is to establish a baseline understanding for energy use in Ellison Hall, and develop energy efficiency recommendations. Research methods and tools that were used in this study consisted of access the UCSB facilities metering computer energy analysis program, use of the Kill-a-Watt energy meter for plug load studies, and random samples of computer monitor type and personal display settings. Through the analyses of patterns and trends of energy use at the larger scale using the facilities energy analyses tools, to comparing the energy consumption of CRT (Cathode Ray Tube) and LCD (Liquid Crystal Display), we were able to formulate and quantify the ability to decrease substantially the buildings energy uses and C02 emissions.

The facilities' energy analyst tool is a comprehensive research and computational program that they use to keep track of energy throughout the campus. After a meeting with Jim Dewey, Director of Facilities, I was able to obtain limited access to this research tool. My access consisted only of the Ellison Hall/Buchanan energy meter and a limited range of graphical comparison tools

To broaden my understanding of energy trends and patterns for the building of Ellison Hall, I created a view of monthly energy usage as illustrated below in Figure 3. The energy use at Ellison hall is variable with the user occupancy and work-week as can be seen in the high use trends during the weekdays, and lowered energy uses on the weekends and holidays.



Data summary

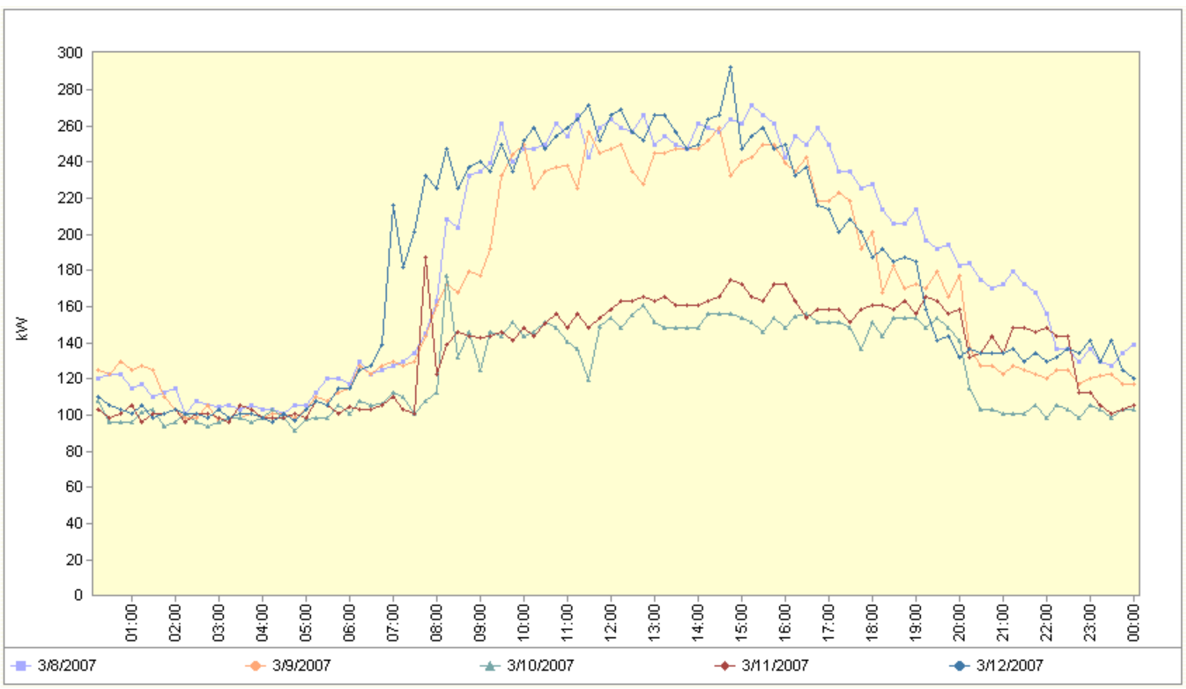
Point ID	Point name	Minimum	Minimum time stamp	Maximum	Maximum time stamp	Average	Units
165	Elliso.Utilit-.EEMete.Ellison/Buchanan Electric Meter	89.70	2/18/2007 6:15 AM	312.00	2/23/2007 1:00 PM	157.68	kW

Note: point data recorded at uneven timestamps have been fitted into even intervals for charting purposes.

Figure 3

Generally, after observing and comparing various months there is a decline in energy use towards the end of every week. This can be explained by the decrease in users of the buildings facilities at this time in the form of plug load and lighting. Many of the buildings process energy loads are automatically lowered and functions put on standby for weekend periods and holidays which explains some of the dramatic decreases in energy use at these times. The estimated average maximum energy use during the month is about 270 kilowatts (kw). This energy use trend falls during the peak hours of the work weekdays. The average minimum energy use is estimated at around 100 kw, which occurs during the middle of the night when facilities process systems are shut down, and there are minimal lighting and plug loads.

To further analyze the energy use trends of Ellison Hall, I then narrowed my study down to compare the energy use trends from Thursday through Monday. I chose these days as I assumed that the energy usages throughout this time period most accurately displayed the highest energy use of the weekdays with the lowest energy use of the weekends. In figure 4, the daily energy trends for these five days are displayed based upon their kw usage per day. This comparison shown gives a more detailed evaluation for the characteristics of daily energy use and patterns. Daily weekday trends show an overall decline and stabilization in energy at 100 kw at or around 2:00 a.m. and a sharp increase in energy at around 7:00 a.m. followed by a gradual increase until peak hours at around 12:00 p.m. reaching usages around 270 kw. At this time the energy use begins a gradual decline back to the baseline energy use of 100 kw from where the trends repeat themselves. The weekend trends show similar but less dramatic trends and have a peak energy use at around 160 kw.



Data summary

Elliso.Utilit-.EEMete.Ellison/Buchanan Electric Meter (Point ID: 165)					
Minimum	Minimum time stamp	Maximum	Maximum time stamp	Average	Units
91.20	3/10/2007 1:45 AM	297.60	3/9/2007 11:30 AM	158.81	kW

Figure 4

To understand more thoroughly where this energy is being used and distributed more accurate meters will have to be installed. To continue with a more narrowly focused energy assessment we focused our study on plug load, and more specifically the role of computer monitors. Initially, in the study of plug load of computers we intended to measure and evaluate the overall energy use of various computers including both the monitor and mainframe. The study and implementation of energy efficiency and usage of the mainframe computer system is temporarily on hold due to the overwhelming consensus that the computer systems must remain functional at all periods of time due to backup systems for hard drives and remote network access. Therefore, many obstacles are present when addressing energy savings in a research and computer dependant building such as Ellison Hall. For the purpose of this study to provide realistic energy savings analyses and options, we decided to focus specifically on the comparison of LCD and CRT computer monitors, and the display and energy efficiency settings. We have, by means of measuring energy use with the Kill-a-Watt meter, been able to compare and isolate various means of energy savings that are presented below in figure 5.

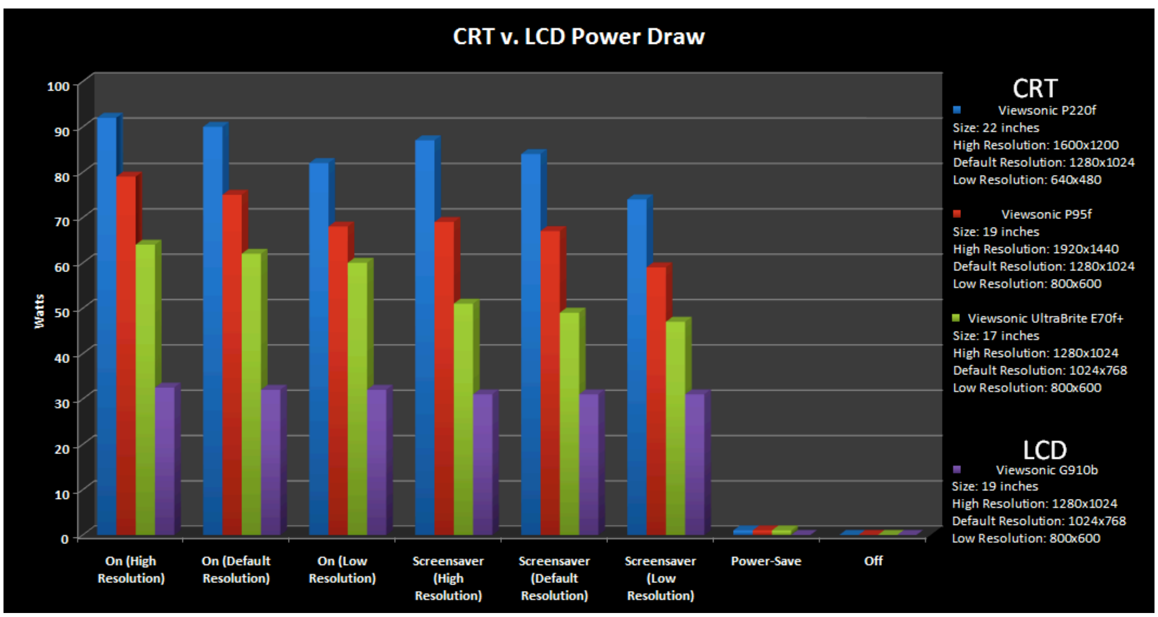


Figure 5

This chart displays the energy power draw of monitors using the various display settings and compares the energy used between three CRT monitors of different sizes and one LCD monitor. It is clearly deduced from this chart that larger CRT monitor sizes use more energy. Energy efficiency measures that show minimal deductions include lowering resolution, and using the screensaver. The best possible practice for energy efficiency is to use the power save display settings or turn the monitors off. LCD monitors show a stable energy use in all of the various display settings with energy conservation only taking place in the power save and off settings. The following graphs display this information in isolated comparisons of LCD vs. CRT monitor differences and screen resolution energy savings (Figures 6 and 7.)

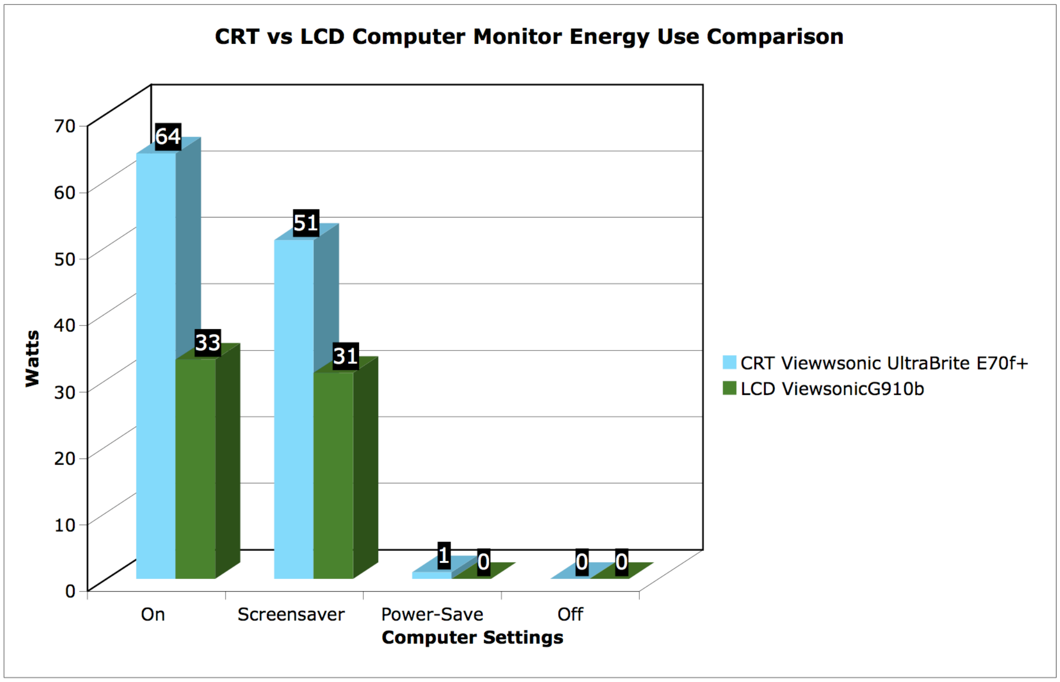


Figure 6

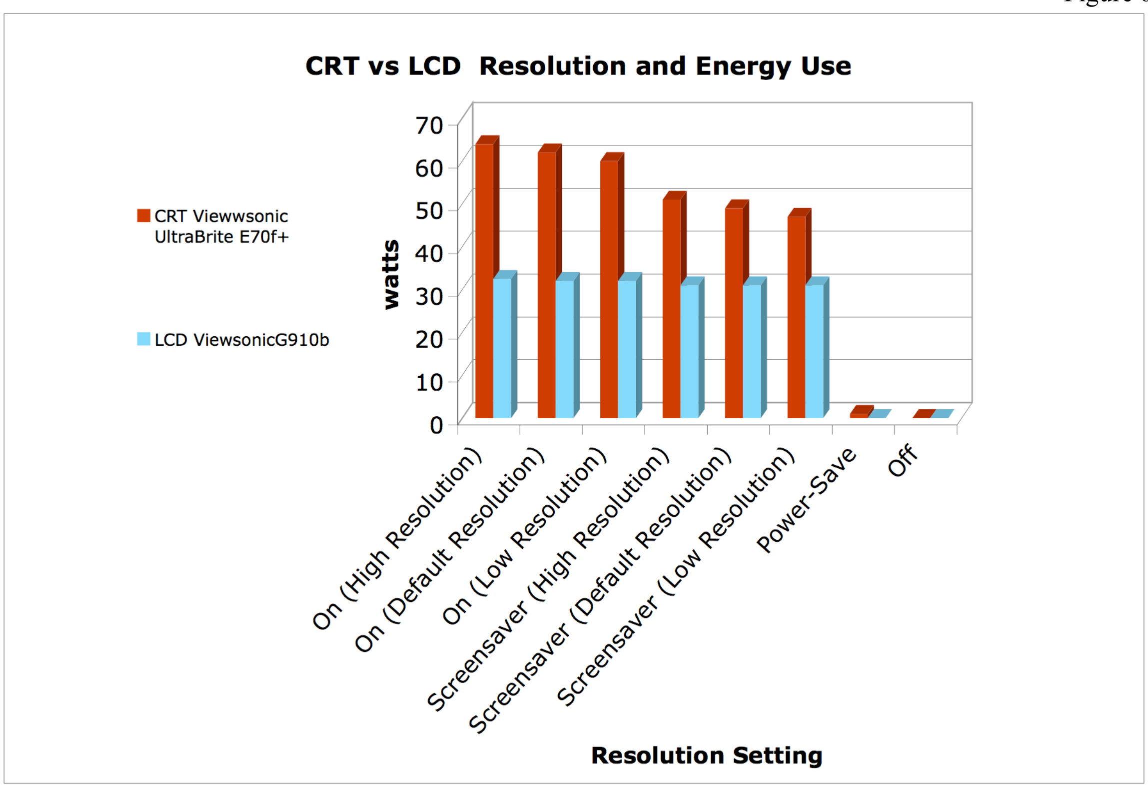


Figure 7

After assessing and metering the energy use and comparison of CRT vs. LCD we concluded that the use of LCD monitors for energy efficiency purposes was the most technological available and realistic energy efficiency alteration that could take place. Through initial observations of offices and labs, we decided to take a simple random sample of monitors in various rooms throughout Ellison Hall. By completing a study with a sample size of 89 monitors, we were able to develop a general sense for the distribution of CRT vs. LCD monitors in Ellison Hall (Figure 8.)

Figure 8

Monitor Type Distribution

Room #	# of Monitors	LCD	CRT
3610	6	0	6
3611	11	10	1
3616	3	2	1
3620	15	15	0
3625	21	9	12
3636	5	0	5
3715	1	1	0
3810	1	1	0
4718	2	2	0
4806	6	3	3
4808	1	1	0
4816	1	1	0
5710	1	1	0
5715	1	0	1
5814	1	1	0
6703	4	0	4
6704	2	1	1
6707	2	2	
6709	1	0	1
6714	3	1	2
6724	1	0	1
Total:	**89**	**51**	**38**

Through this assessment of monitor type distribution we noticed that LCD monitors are the majority being used (Figure 9) Lab technicians, departments, and individuals will be transitioning the remaining CRT monitors with new LCD as the need for replacing old monitors increases and as energy efficiency becomes more important with funds potentially becoming available.

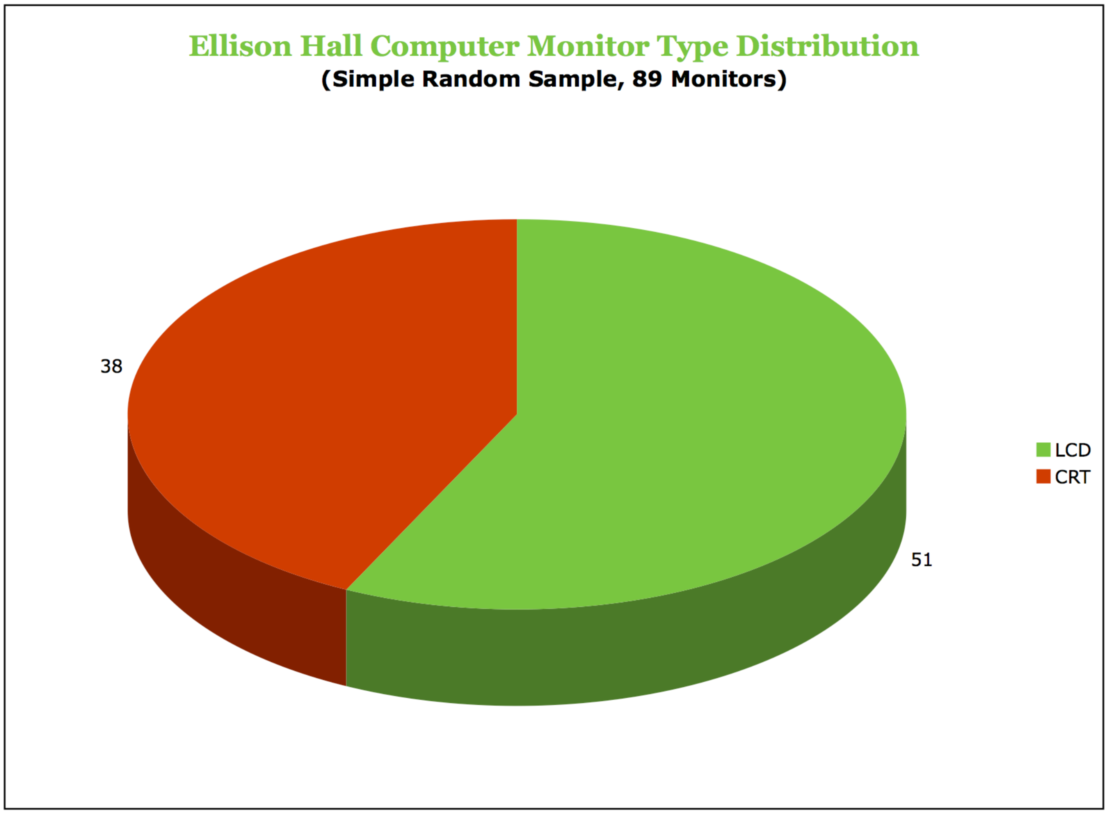


Figure 9

To quantify and compare the impacts of these monitors with regards to Carbon Dioxide emissions, I have calculated the energy used per monitor with the data collected using the simple random sample of monitor types and distributions. By comparing the amount of Kilowatt hours used per 8 hour weekday between the two monitors, and quantifying this amount to account for I full 5 day work week, I have calculated the amount of Carbon Dioxide emitted between the LCD monitor users and CRT monitor users as displayed in Figure 10. The amount of carbon tons per week that 51 LCD users produced was 54.19 whereas the lesser number of CRT users of 38 produced 78. 31. Per user, LCD monitors produce 1.06 carbon tons per week. CRT monitor users produce 2.06 carbon tons per week. By using LCD monitors the individual user reduces their carbon footprint by 1 carbon ton per week.

Energy Use of Sample of Monitors "On" in Ellison Hall/8hour Work Week

	# of Monitors	Energy Use (watts)	watt hours	kwh	Total Monitor Energy Use per Type (watts)	KWH/8 hours	Kwh/8hour/5days ton/work week	Carbon tons/week
LCD	51	33	264	0.264	1683	13.46	67.32	54.19
CRT	38	64	512	0.512	2432	19.46	97.28	78.31
						LCD vs CRT Carbon Savings		**24.12 Carbon tons/week**

Figure 10 www.infinitepower.org/calc_watts.htm

3. Conclusion

Energy use in Ellison Hall has the potential for being significantly reduced if small widespread energy efficiency policies and practices are implemented. The baseline of energy use and possible areas of efficiency is being established by gaining these broad perspectives of energy use through the study of UCSB metering to performing micro-metering of the individual energy use of computer monitors. It is imperative that old CRT monitors are urgently replaced with LCD screens and that energy efficiency measures are instituted in the meantime for all remaining CRT monitors. These measures include decreasing resolution, and setting the power settings to turn the monitor on power save or standby after a certain period of not being used. This setting also must be mandated for all new LCD monitors as well, as they also show a significant decrease in energy use when this measure is applied. Further sub metering is necessary to gain a more comprehensive understanding of energy use within Ellison Hall, and ways to decrease the consumption. Possible other suggestions for future research and implementation would include a network based power management system for the computer networks which would have settings that could simultaneously turn off computers at night after backups were completed as well as perform other network based power management applications. Lighting is a main source of energy use as well, and through the use of Hobo light meters, which measure light intensity and temperature, an extensive audit could be performed to measure the amount of energy being used by lighting systems throughout the buildings. Based upon the current trends of Global Warming and CO_2 emissions it is imperative that buildings take every step possible to reduce energy use through efficiency and conservation thus decreasing the overall impacts on the environment.