A Case Study on the Greening of Crossroads Dining Commons

Justin Yee

Abstract The Bay Area Green Business Program is designed to recognize businesses that voluntarily comply with environmentally friendly standards by issuing certification to those that demonstrate an annual reduction in garbage, water, gas, and electricity use. This study investigates whether the certification program for Crossroads Dining Commons (CDC), the largest student dining facility at U.C. Berkeley, is an effective tool to promote increased efficiency in resource use. Comparisons of monthly water, natural gas, and electric bills with two non-certified campus dining commons, Unit 3 and Foothill, were made. The averaged monthly differences before and after certification showed a 25 % decrease in water use differences, 3 % in electricity use differences, and a 500 % increase in natural gas use differences. Graphical analysis shows seasonal trends and an annual increase in amounts of resources used at CDC despite participation in the certification program, except for natural gas use, which decreased 67 % on average from before and after certification. Statistical analysis using the BACI model (Stewart-Oaten *et al.* 1986) showed significant differences in average water and natural gas consumption after certification. There were no statistically significant changes in electricity use after certification in either of the two comparisons. The results indicate that the certification program is a suitable investment to yield an increase in resource use efficiency for the remaining dining facilities at UC Berkeley. This conclusion has financial and environmental implications for businesses considering certification, and also for governments seeking to increase efficiency and resource conservation through legislation and policy.

Introduction

Becoming a "green business" has become a popular option available to businesses around the world. The term "green" refers to sustainability, and a green business is one that operates in a sustainable, environmentally friendly manner, leaving a low impact on current resources so that future generations can experience the same or better conditions (Nakashima 1998). On the global scale, it has been observed that the supply chain management business in China has seen economic benefits from applying green practices as a "win-win situation" (Zhu and Sarkis 2004). Thus, not only are there environmental, social, and cultural aspects, but there are financial incentives as well. Studies have shown correlation among environmental practices and customer satisfaction and business performance (Kassinia and Soteriou 2003). Yet with all the potential benefits, there must always be a trade off. Business managers need to consider the large initial investments in becoming green, and the proper timing for such investment. There is a "catch-22" for businesses to decide whether to "lead or lag" based on the potential costs and benefits (Walley and Whitehead 1994). These are reasons for why careful research is useful for businesses when considering participation in a "green" program.

On a local level, there is the Bay Area Green Business Program, which has been in operation since 1996. The program "recognizes and promotes businesses and government agencies that volunteer to operate in a more environmentally responsible way." More than 400 local businesses have been certified since the creation of the program. It is a result of collaboration between seven county governments - Alameda, Contra Costa, Marin, Napa, San Francisco, Santa Clara, and Sonoma - in the Association of Bay Area Governments (ABAG), along with organizations like the U.S. EPA, Cal EPA, Department of Toxic Substances Control, and the business community (Bay Area Green Business Program 2004).

In August of 2004, the CDC at U.C. Berkeley was recognized as a Bay Area Green Business by Alameda County officials (Situ 2004, pers comm.). A Bay Area Green Businesses needs to demonstrates at least minimal participation in water and energy conservation, pollution prevention, and solid waste reduction and recycling with requisite percentage reductions or diversions in the mentioned areas (Bay Area Green Business Program 2004). The certification indicates that CDC is considered a business that meets the efficiency requirements and has sustainable practices.

The CDC can host about 800 occupants, and serves up to 3,000 customers daily (Cal Dining 2005). There is much potential for conservation of resources and re-use. It is for this reason that

CDC was identified by the U.C.'s Residential and Student Service Programs (RSSP) as the first target for "greening" with future plans to apply the same certification process to the other three remaining dining commons by the year 2006 (Situ 2004, pers comm.). It is important that this process be handled with the utmost attention to environmentally beneficial standards and not done merely for environmentally inconsequential public image. Green certification can be a valuable asset for businesses and it should symbolize genuine concern and commitment to the community and the environment (Kassinia and Soteriou 2003). Standards for green certification should be upheld so that environmental stewardship is taken seriously and conducted thoroughly. This research looks into the results of CDC achieving a green certification.

This study will determine whether the Green Business Certification resulted in a significant increase in sustainability for CDC. There has not yet been any research regarding whether the changes after certification are significant indications that certification is effective. The recent declaration as a green business makes timing ideal for observing the changes made to accommodate sustainability in Cal Dining's largest facility, and possible certification applications for the other dining commons make the results of certification highly important (Cal Dining 2005). To find such results, there are two objectives for this study. First, we observe CDC's pre and post-certification energy, natural gas, and water use. Second, we calculate the differences in resource consumption between CDC and the other dining commons in order to establish whether there is a change before and after certification.

Once these objectives have been accomplished, the following questions should be answered: Did the efforts and resources employed to achieve certification result in an increase in the resource use efficiency of CDC? Have the Bay Area Green Business Program standards been developed to effectively mitigate wasteful practices and implement significant change? Is this a worthwhile goal to pursue for the three remaining dining commons?

My hypothesis is that there should be at least a minimal improvement in CDC resource management just to meet the percent reduction required to be certified by the Association of Bay Area Governments as a green business. However, the extent to which resource use efficiency is realized is another issue. As mentioned in the Walley and Whitehead paper, businesses have both costs and disadvantages to weigh when deciding to what extent to apply green management practices. We know there is a decrease in beginning resource use as compared to end use at certification, but these values are not adjusted to isolate the change as an impact due to certification. It is not possible to hypothesize whether there is a real difference in resource use

after certification. However, if there is, that would imply that participation in the certification program is worthwhile and effective in increasing resource conservation and consumption efficiency. Not only is this valuable information for UC Berkeley's RSSP, but it also provides government and regulatory agencies an effective tool to reduce waste via a simple, relatively low cost method.

Methods

The first objective requires observation of resource use before and after certification. The monthly water, natural gas, and electric bills were the required data source. Utility bills were deemed to be the most suitable means to quantify resource use. The required meters have already been installed by the service providers [EBMUD, SPURR Gas Services, APS Energy, and PG&E] thus no other equipment was needed. January 2003 to March 2005 was the monthly timeframe for data collected. This coincides with the opening of CDC, and incorporates certification, which was received on August 19, 2004.

To determine whether there were differences in resource use after certification, the BACI model (Stewart-Oaten *et al.* 1986) was applied. The Before-After aspect of the model was centered on certification as the turning point. Because certification occurred over a 12-month period, the data were broken into before, during, and after certification periods. The monthly data alone were affected by seasonality and the increasing student population (UC Office of Planning and Analysis 2005), so differences between the treatment site (CDC) and control sites (non-certified dining commons) were used to observe any impact resulting from participation in the certification program. I compared monthly water, electricity, and gas consumption differences between CDC and Unit 3 and between CDC and Foothill as the Control-Impact aspect of the BACI model. This allowed the extrapolation of two sets of data points, one before, and one after certification, avoiding pseudo-replication from the monthly, serial data. The t-test was used to find a p-value and indicate whether there were differences between the consumption before and after certification due to random chance, regardless of certification, or real difference resulting from participation in the certification program. Areas showing no difference towards reduced resource use after certification are those requiring higher, more effective resource efficiency standard by the Bay Area Green Business Program.

Graphical comparisons were made to observe quantities of resource use over time. In order to more accurately compare the different dining commons, proportioning values were applied to

all values for all dining commons compared. First, there were cases where the monthly resource quantities were billed for both the dining commons and their associated dormitory or office buildings due to shared utility meters. For Unit 3 data, the solution used by RSSP is to associate 30 % of the resource usage to the dining commons, and 70 % to the other buildings. For CDC, the proportion is 80 % for the dining commons, and 20 % for the offices. The Foothill dining common has its own meter, therefore no percent adjustment was required (Cokes 2004, pers. comm.). The percentages are the most accurate according to the building development staff that set them upon the buildings' openings (Black 2004, pers. comm.). Also, building size (in meters^2), average number of students served daily, and average daily hours of operation were measurements taken and divided into the respective dining commons' resource use amounts to smooth out the differences in size. It was determined that the majority of the gas is used for the water heater (Spivey and Lulu 2005, pers. comm.), therefore meters^2 was appropriate, rather than meters^3 in the case that gas is used more for heating the air. Adjusting each dining common by its respective measurements allowed direct comparison of all resource use quantities.

Results

Observing the data on the resource quantity used versus time after all the adjustments allows a qualitative understanding of the consumption pattern for each of the dining commons. All three show a median starting amount of water use in January 2003. As time proceeds, the usage generally rises, beginning in May, to the peak consumption level in October 2003. Water use then drops significantly in November and is at the lowest use level in December 2003. This general cycle repeats for the year 2004, and appears to do the same for 2005 so far. It can also be seen that the next annual cycle begins at a slightly higher use level in Unit 3 and Foothill, but not as much for CDC. Upon more observation CDC water use is initially about half that of the others from the beginning trend in January to April 2003 since those are its first months of operation. This initial period is about half that of the following year usage in the same period indicating that CDC use rose to the average water use levels after its first year of operation. One outlier is that for Unit 3 is that there is a spike in water use in April 2003 while the others have April at the same use level from the January to May 2003 (Fig. 1).

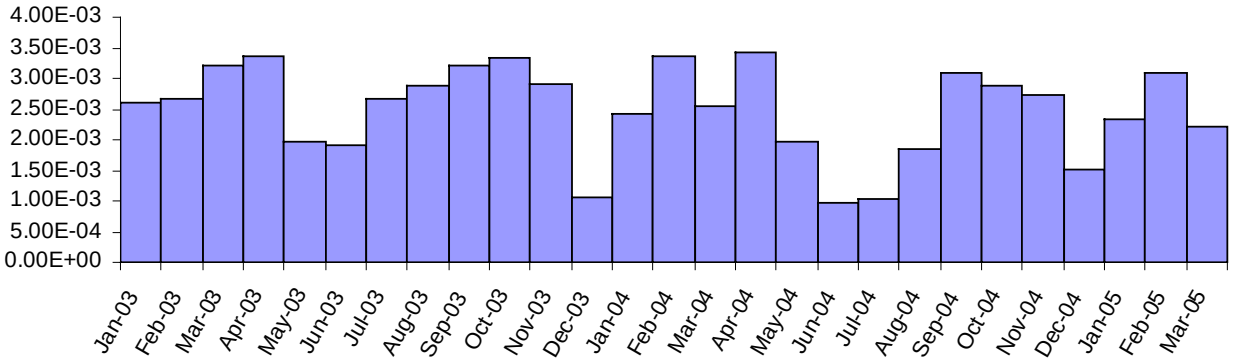

Figure 1. Unit 3 Monthly Water use adjusted to units of Gallons/(Day)(Person)(meter^2)(Hour of operation)

Electricity use similarly follows an annual pattern. From January to May 2003, electricity use is at the higher level of annual use in all three dining commons. Then the amounts all drop in June and July 2003, most significantly in Foothill, and least so in CDC. From August to October 2003, the electricity use levels steadily rise to a second peak, however, less than the May peak. November to December show a decline in use for all three dining commons and the cycle begins again. Peak electricity use is observed at the beginning of the semesters in February and May 2004 at Foothill and Unit 3 respectively. CDC peaks later in September 2004 (Fig. 2).

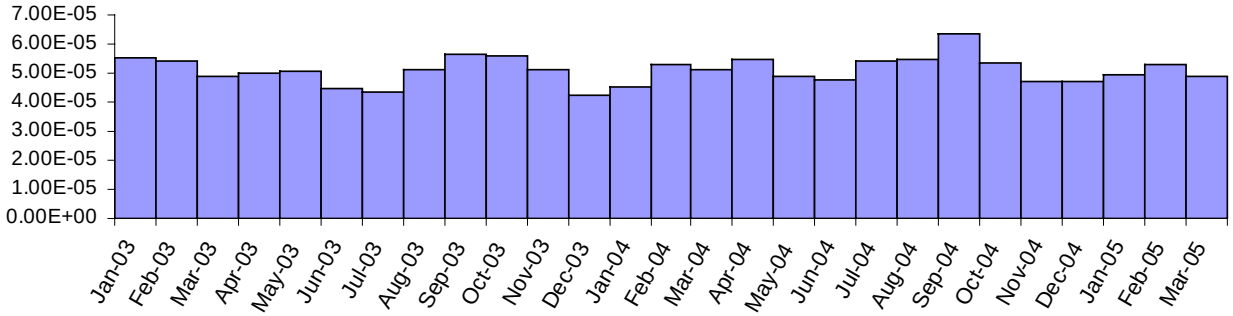

Figure 2. Crossroads Monthly Electricity use adjusted to units of Kilo-Watt Hours/(Day)(Person)(meter^2)(Hour of operation)

Natural Gas seems to have the most distinct usage pattern of the three utilities observed. There are easily observed peaks every February and November for all years observed. Use levels are otherwise fairly low, rising and falling around the peak natural gas use levels. The lowest use levels are unanimously observed in June through August before climbing to the November

peaks. February natural gas use is the highest of the peaks in all years for all dining commons, and the peak use level seems to rise each year. The use pattern for CDC shows peak levels in May through July 2003 and April 2004 while usage for every other month observed is near zero in comparison until May 2004 where levels are apparent non-zero, but still very low in comparison to the peaks. These low use levels follow the annual natural gas use pattern, though extremely dampened. The CDC Manager, Tete Lulu, explains this by the probability that there may have been other, less efficient gas appliances used temporarily when the CDC first opened. More strange is the fact that the overall average gas use for Foothill is about the same as both CDC and Unit 3 combined (Fig. 3).

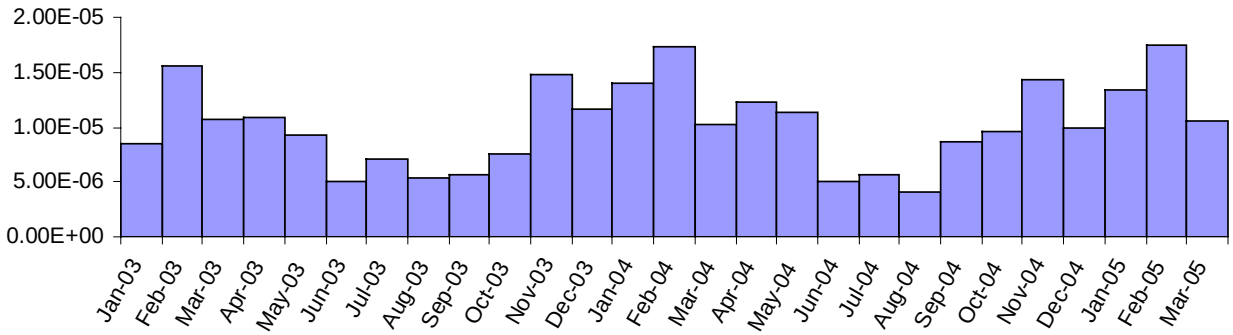

Figure 3. Foothill Monthly Natural Gas use adjusted to units of Therms/(Day)(Person)(meter^2)(Hour of operation)

These qualitative observations are useful for comparison, but only to an extent. They allow identification of the general patterns, the ability to see outliers, and to see the steady increases in use levels over the years. In order to complete the observations and have a more concrete comparison, observations of the differences between certified and non-certified utility use were made. The BACI model and t-tests yield a quantitative value, p-values, to indicate any relation between monthly resource use differences before and after certification. Specifically, the monthly data were broken into four different periods: before (b), during (d), after (a), and before and during (bd) certification. Significant p-values indicate a difference in CDC resource use after certification, however, not necessarily a reduction. A difference could also be towards an increase in resource use. The calculated values are displayed in Table 1.

Table 1. Calculated p-Values for differences for each utility (values above 0.15 are marked not significant, NS)

CDC compared to Unit3

	Water	Electric	Natural Gas
bd-a	NS	NS	NS
b-a	NS	NS	0.15
b-d	NS	NS	0.12
d-a	NS	NS	NS

CDC compared to Foothill

	Water	Electric	Natural Gas
bd-a	0.0034	NS	NS
b-a	0.0014	NS	NS
b-d	0.092	NS	0.14
d-a	0.028	NS	NS

For Unit 3, there is statistical difference in natural gas use in the comparisons between before and after, and between before and during. This indicates real difference that can be associated with participation in the certification program. This is more meaningful than the graphical analysis because using the differences eliminates the seasonal and student residency trends. Whether it supports the effectiveness of certification will be discussed below. In the CDC Foothill comparison, significant difference was found in all water comparisons, and among the before and during comparison for natural gas. Compared to Foothill, there is definitely a change associated with CDC participation in the certification program.

Discussion

The qualitative observations serve to show the general trend of increasing resource use every year. This is most likely due to increasing student populations mentioned earlier (UC Office of Planning and Analysis 2005). The annual patterns are obviously due to seasonal climate changes and the requirements of heating in the winter or cooling in the summer. Water use is not affected by climate as much as electricity and natural gas, however it still has annual trends most likely due to student occupation. The low water use levels correspond directly to winter, summer and spring break. The outlier for Unit 3 having a spike in water use for April 2003 has been confirmed to be the result of the Cal Student Orientation (CalSO) event, which was not held at Unit 3 after that year, explaining why the peak is only in April. The trend that CDC has the least change in electricity use over the typically low periods at the other dining commons is can be explained by the fact that they have more electric appliances, some of which replace natural gas consuming appliances found in the other two, older dining facilities. This is shown graphically when observing the averages in resource use for each dining common (Table 2).

Table 2. Averaged resource [extrapolated from figures 1-3]

Water*	# Months	CDC	Unit 3	Foothill
Before	7	8.26E-05	2.63E-03	2.65E-03
During	12	1.75E-04	2.43E-03	2.25E-03
After	8	1.62E-04	2.46E-03	1.67E-03

*Measured in Gallons/(Day)(Person)(m^2)(hour of operation)

Electricity*	# Months	CDC	Unit 3	Foothill
Before	7	4.96E-05	3.06E-04	7.45E-04
During	12	5.09E-05	2.90E-04	7.29E-04
After	8	5.21E-05	2.96E-04	7.41E-04

*Measured in KWHr/(Day)(Person)(m^2)(hour of operation)

Nat Gas*	# Months	CDC	Unit 3	Foothill
Before	7	8.86E-06	4.57E-06	9.60E-06
During	12	2.33E-06	4.80E-06	1.01E-05
After	8	2.88E-06	5.15E-06	1.10E-05

*Measured in Therms/(Day)(Person) (m^2)(hour of operation)

Given the examination and explanation of the qualitative trends, it is still difficult to determine whether certification was effective. The graphs of CDC utility use may show a slight increase given more students using the facility annually, but there is no way to know with certainty that the changes after the certification date are random or resulting from higher standards being adhered to as implemented by the Bay Area Green Business Program. The graphical results are inconclusive.

A more focused examination of the results involves using the same set of months observed in each of the three periods because the periods as is contain different months, and different periods of dining commons use. Specifically, the before period incorporates Summer break while the after period does not. January, February, and March are months that fall within each period, and are subject to identical factors affecting resource use, like seasonality and student occupation. The paired averages from the same months before, during, and after examine the trend in CDC resource use over the years (Table 3).

Table 3. Averaged resource use for January-March [from figures 1-3]

p.

Water*	J,F,M	CDC	Unit 3	Foothill
Before	J,F,M	5.88E-05	2.83E-03	2.06E-03
During	J,F,M	1.60E-04	2.77E-03	2.29E-03
After	J,F,M	1.54E-04	2.54E-03	1.56E-03

*Measured in Gallons/(Day)(Person)(m^2)(hour of operation)

Electricity*	J,F,M	CDC	Unit 3	Foothill
Before	J,F,M	7.65E-04	3.34E-04	7.65E-04
During	J,F,M	7.92E-04	3.18E-04	7.92E-04
After	3 J,F,M	7.53E-04	3.08E-04	7.53E-04

*Measured in KWHr/(Day)(Person)(m^2)(hour of operation)

Nat Gas*	J,F,M	CDC	Unit 3	Foothill
Before	J,F,M	1.05E-07	5.54E-06	1.16E-05
During	J,F,M	1.12E-08	6.58E-06	1.38E-05
After	J,F,M	3.64E-06	6.32E-06	1.38E-05

*Measured in Therms/(Day)(Person) (m^2)(hour of operation)

These comparisons indicate an increase in water and natural gas use, and a decrease in electricity use for CDC. Notice that Unit 3 and Foothill also show decreases in resource use in two utilities as well, meaning that the decreases seen for CDC may not be due to participation in the certification program. Again, the graphical data is inconclusive, despite the more robust analysis using comparison of paired months.

Next we have the statistical data. As mentioned before, there was significant difference apparent with CDC's participation in the certification program. However, it is difficult to see if the differences support or oppose the effectiveness of certification without more examination. First, it is acceptable to disregard the comparisons in which no difference was found. Then, examine a more focused sample of paired months of averaged monthly differences for the comparisons between CDC and the non-certified dining commons in the before, during, and after periods. These values are similar to the paired averages in the graphical comparison, but with the differences, we eliminate seasonal and student residency trends, *and* show the magnitude of difference in consumption. They are displayed in Table 4.

Table 4. Averaged monthly differences for January-March

Nat Gas*	J,F,M	Unit 3	Foothill
Before	J,F,M	5.43E-06	1.15E-05
During	J,F,M	6.57E-06	1.38E-05
After	J,F,M	2.68E-06	1.38E-05

*Measured in Therms/(Day)(Person) (m^2)(hour of operation)

Water*	J,F,M	Foothill
Before	J,F,M	1.40E-02
During	J,F,M	1.55E-02
After	J,F,M	1.10E-02

*Measured in Gallons/(Day)(Person)(m^2)(hour of operation)

As made evident, the paired average differences are decreasing in the CDC-Unit 3, b-a comparison with natural gas. Differences were calculated by subtracting CDC consumption values from the Foothill/Unit 3 values. The difference is decreasing due to either CDC being less efficient, or Foothill becoming more efficient. In the CDC-Unit 3, natural gas, b-d comparison, the differences increased, so the certification did cause increased efficiency, but just didn't last after certification was awarded. Next we observe the CDC-Foothill average differences in all comparisons for water use, and for natural gas use only in the before and during period comparison. For water bd-a, b-a, and d-a comparisons, there is, again, a decrease in differences. This also supports the potential decrease in CDC consumption efficiency, or increase in Foothill consumption efficiency. However, for the b-d comparison, there is an increase in difference similar to the CDC-Unit 3, b-d comparison. Finally, in the CDC-Foothill, natural gas, b-d comparison, there is another increase in differences, which further supports certification program effectiveness. This evidence unanimously supports that participation is effective in increasing resource use efficiency among the before and during periods. There simply needs to be better follow-up once certification is awarded to keep the differences in resource use between certified and non-certified dining commons increasing.

In conclusion, pursuing certification is a worthwhile goal to pursue for the other dining commons. Though there was not 100% effectiveness in reducing the resource use in all areas, the significant reduction in even one area, whether it be water, electricity, or natural gas consumption, brings U.C. Berkeley's dining facilities one step closer to functioning in a more sustainable manner, using resources efficiently and reducing the burden placed upon future generations. As a result of these findings, it is recommended that the Bay Area Green Business

Program adjust its certification standards specifically to be more effective in reducing electricity consumption. This is the area that did not show significant change overall for the differences in resource consumption in any periods, in either comparison, before and after certification. There is no selection bias in CDC's efforts to increase efficiency in the other utilities more because the goal, upon deciding to be certified in August 2003, was to increase efficiency for all three utilities (Situ 2005, pers comm.).

The findings of this research are in no way meant to discredit the Bay Area Green Business Program, but rather to encourage continuous improvement in achieving a more sustainable society where conservation and resource use efficiency are of high priority. Though the programs may have initial costs, the long-term benefits far outweigh these costs. Given the success in reducing at least one area of resource use consumption, it is worthwhile to invest the time and effort into developing increasingly effective programs to monitor and reduce businesses resource consumption.

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