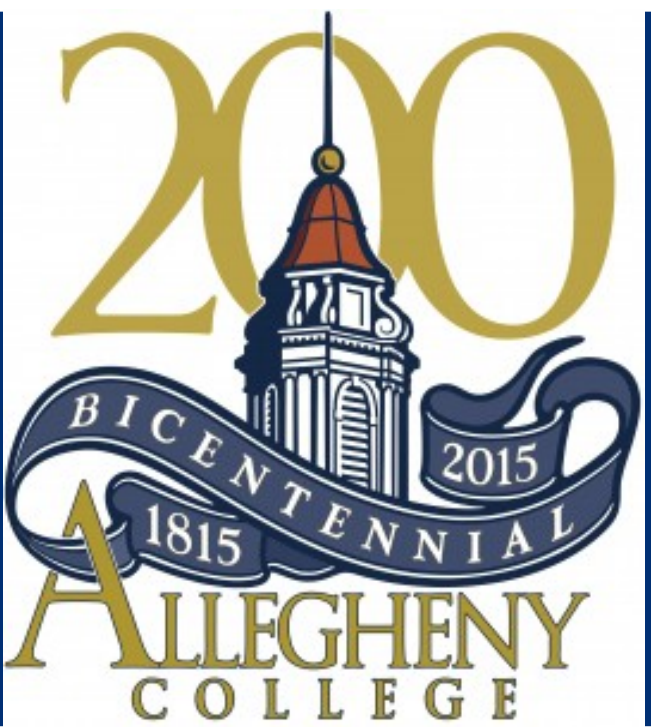


Reducing Campus Electricity Consumption through Cooperation and Fun

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Purpose - Approximately 700 colleges and universities have committed to climate neutrality, which will require significant reductions in energy consumption. This study explores the effectiveness of an Annual Energy Challenge in curtailing electricity use by changing consumption behaviors at one liberal arts college.

Design/Methodology/Approach - From 2010 - 2014 Allegheny College (Meadville, PA) ran four-week long energy challenges. Electricity consumption was measured and compared to a baseline year of 2008. An alternate baseline, more granular data for 20 sub-metered buildings, and historic utility bill consumption trends were further analyzed to identify any persisting change and understand the impact of behavior change separate from efficiency retrofits, changes in population, and normal seasonal shifts.

Findings - Electricity consumption during the challenge period dropped an average of 9% compared to the 2008 baseline and 6% compared to the baseline of the 4 weeks preceding each challenge. Consumption trends changed in the years during challenge implementation compared to the years before engaging the campus community. All analyses reinforce that the challenge reduces electricity consumption. However, results must be analyzed in multiple ways to isolate for behavior change.

Introduction: Allegheny’s Climate Action Plan calls for achieving climate neutrality by the year 2020 using a multipronged approach to reducing greenhouse gas emissions. Allegheny’s strategies include maximizing operational efficiency, responsible purchasing, investing in renewable energy, encouraging behavioral change to reduce impacts, and finally using carbon offsets and onsets to balance any remaining negative impacts of campus operations and purchases. After years of simultaneous efforts to reduce energy consumption via retrofitting existing structures and modifying behaviors throughout campus, the aim of this study is to identify how significant reductions in electricity are occurring as the result of the challenge and if there are lasting reductions across campus after the challenge has concluded.

Beginning in 2010, for four weeks per year (in October and November), Allegheny College has challenged the collective campus community to reduce its consumption of electricity by 10 percent from the baseline established in the same time-frame in 2008. Throughout the challenge, weekly usage was tracked through the use of sub-meter data for 24 buildings as well as manual meter readings for 5 other buildings and 57 campus owned apartments. All together the challenge monitored energy use for 81 percent of the residential population of the campus and 87 percent of Allegheny’s total square footage, excluding buildings only when data was inaccessible due to the lack of either a sub-meter or utility meter for each building.

A multifaceted approach was used to promote energy conservation. The college Sustainability Coordinator, in collaboration with student organizations and leaders, promoted the challenge and energy conservation behaviors beginning a few days before the four-week challenge. In addition, in every year, students in two sections of *Introduction to Environmental Science* (~80 students total) were assigned group projects to promote energy conservation. The Sustainability Coordinator, student organizers, and students in the *Introduction to Environmental Science* classes all worked on the principle that changes in behavior were only to be encouraged using engagement and positive reinforcement rather than guilt, lecturing, and competition, exploring the theory that building a positive culture of collective campus sustainability is the most effective means of encouraging more responsible behaviors that will persist after the challenge concludes. Typical Energy Challenge events emphasizing fun and engagement in low-energy activities are highlighted in the 2015 Schedule of Events (Figure 1).

After each annual four week long Energy Challenge, final results in total percent and kilowatt hours reduced as well as dollars saved compared to the baseline year of 2008, were posted and widely announced. The money saved was invested in additional energy saving measures like photovoltaic solar panels, a method popular with students who are skeptical of "saving the college money" without a tangible reward or result.

Results: Annual results were calculated as the total percent and kilowatt hours reduced and dollars saved compared to the same period in the baseline year of 2008 (Table 1). This measurement indicates that each year energy is reduced by at least 7% and more than \$35,000 in total have been saved and invested in sustainability projects of interest to students.

Table 1: Annual Allegheny College Energy Challenge results summary – 2008 baseline

Year	Percent Reduction	Energy Use Reduction (kWh)	Energy Cost Reduction (\$)	Method of Investment
2010	10.0%	95,654	5,739	combined with 2011 savings
2011	9.8%	100,863	7,060	1.68 kW solar array
2012	7.8%	84,791	7,143	2.24 kW solar array
2013	7.2%	78,040	6,574	3 kW solar array
2014	10.6%	101,870	8,745	filtered water refill stations



Figure 1: Comparison of annual results during and after the challenge for 20 sub-metered buildings using alternate baseline methods.

6th Annual

Energy Challenge

unplug 2015

10/9 – 11/6

10/16 Fri – Bike Share Pedal-Powered Free Smoothies
6-7pm just outside Grounds for Change, 2nd floor of Campus Center. Toss some fruit in our bike-mounted blender then pedal your way to a free smoothie...electricity free and free of cost! Stick around for the entertainment at GFC afterwards.

10/16 Fri – Grounds for Change Unplugged Open Mic
7-9pm at Grounds for Change, 2nd floor of Campus Center. Share your talent, listen to others, enjoy a free drink...all without electricity!

10/17 Sat – Students for Environmental Action and Edible Allegheny Food & Fire Gathering
6:30pm at Robertson pavilion. Bring a dish to share. Chili and s'mores provided.

10/22 Thu – Meditation Club Yoga in the Dark
9pm in Montgomery upper studio. All welcome, no experience required. Yoga mats provided. Jennifer Hellwarth will lead the practice.

10/23 Fri – Outing Club Night Hike
8pm. Meet at Brooks Circle to walk to Robertson to hike wooded trails and stargaze.

10/23 Fri – Dumbledore’s Army Glow in the Dark Quidditch
7-9:30pm at Gator Quad. Wear clothes and shoes you can run in and we'll explain the rest. Rain location is Wise Center blue court 4.

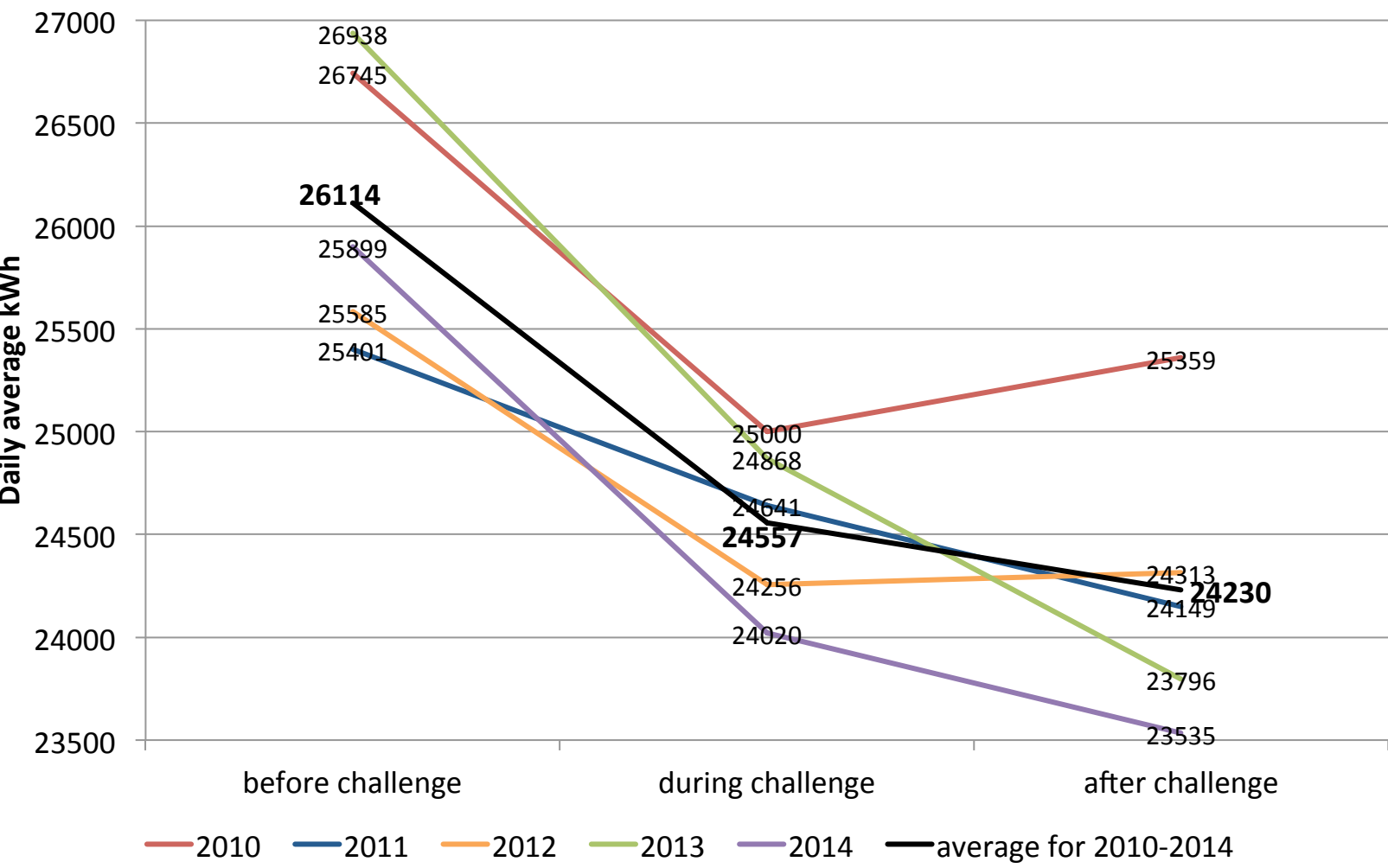
10/29 Thu – Students for Environmental Action and Green Living Cauldron Potluck
7pm at Green Living House, 296 Loomis. Bring a dish to share. Hot cider and fall treats will be provided.

11/3 Tue – ASG Meeting in the Dark
7pm in CC301/2.

11/3 Tue – Astronomy Club S'mores & Stargazing
9-11pm at Robertson Field Pavilion. Explore the constellations, background mythology and other cool space objects! Rain date is 11/4 Wed.

In addition to comparing data with the 2008 baseline, this study tested a baseline method using the weeks directly preceding the challenge as the baseline in order to isolate results due to changes in the behavior of the current population from building modifications, such as efficiency retrofits. When the annual results are recalculated using the alternate baseline of four weeks preceding the challenge, there is a reduction in energy use both during the challenge and continuing afterward (Figure 2). During 2011, 2013, and 2014, the amount of energy used by the college continues to decline after the challenge. In 2010 and 2012, although energy usage does not continue to decline, daily average kWh consumption remains less than the four weeks prior to the challenge.

Figure 2: Daily average kWh for each year (2010-2014) for 20 sub-metered buildings four weeks before, four weeks during, and the remainder of the academic year after the challenge. The black line and bold numbers are the average of the five years.



Analyzing the 20 sub-metered buildings for which daily data was available, electricity consumption during the challenge was compared to the 2008 baseline as well as to the baseline of the four weeks preceding each challenge to isolate for behavior change (Table 2). On average, in 2010-2014, electricity consumption during the challenge declined by 8.3% using the 2008 baseline but by only 6.0% percent using the baseline of the four weeks preceding each annual challenge. In all years except for 2013, using a baseline of the four weeks preceding the challenge yielded more moderate reductions.

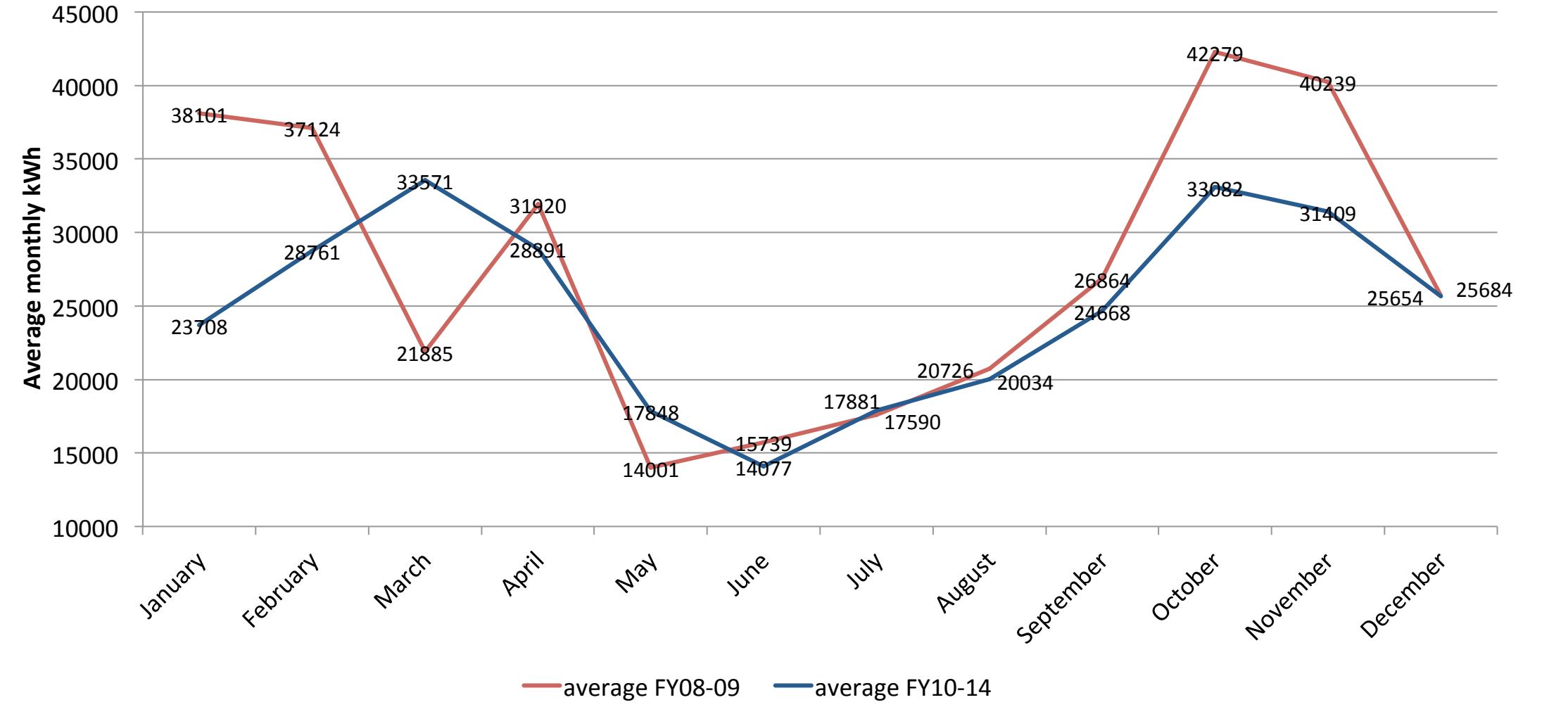
Table 2: Comparison of annual results during and after the challenge for 20 sub-metered buildings using alternate baseline methods.

	2008 baseline	Four weeks preceding baseline
Year	Reduction during challenge	Reduction during challenge
2010	8.0%	6.5%
2011	10.8%	3.0%
2012	7.2%	5.2%
2013	7.9%	7.7%
2014	7.6%	7.3%
Average	8.3%	6.0%

The campus has invested strategically in building envelope improvements, boiler and lighting retrofits, as well as other measures that have yielded quantitative results. Using the alternate baseline of the four weeks preceding the challenge reduces overall average annual challenge reduction results. This moderation of the results is likely due to isolation of behavior changes from efficiency measures implemented in campus buildings over the years.

While the alternate baseline of the four weeks preceding each annual challenge better isolates for reductions due to behavior change by accounting for gradual efficiency improvements across campus over the years, it introduces the question of what impact normal seasonal shifts and consumption trends have on Energy Challenge results. Challenge dates always fall in four weeks overlapping October and November, therefore the four weeks preceding the challenge fall in September and October. According to NOAA’s Monthly Weather Summary for Erie PA, a normal September (based on 1981-2010) has 106 heating degree days and 71 cooling degree days, October has 379 heating and 9 cooling degree days and November has 653 heating and 0 cooling degree days. With this shift in weather and therefore cooling and heating needs across campus, it’s likely that energy consumption shifts as well. In order to consider challenge results within the context of this seasonal shift, this study analyzed the relative trends of consumption in the years before the challenge was implemented compared to during challenge years. For a better understanding of student behavior specifically, this study completed an analysis of three dorms for which we have separate utility meters (Figure 3). Before the Energy Challenge was implemented in 2009, there was a 53.6% increase in dormitory electricity consumption from September to the average of October and November. During the years with the Energy Challenge, there was only a 30.7% increase in consumption during challenge years, reflecting a nearly 23% moderation of the seasonal upward trend. An increase is to be expected in dormitories in the fall as day length decreases, workload increases and therefore student use of lights and computers also increases. The Energy Challenge has meant, however, that the rate of increase is lower in the dorms than it would have been in the absence of the challenge.

Figure 3: Average monthly kilowatt hour consumption in Allegheny Hall, Ravine-Narvik Hall, South Highland Hall, in the years preceding (FY08-09) and the years during Energy Challenge implementation (FY 10-14).



Discussion:

All three analyses of the data, using the 2008 baseline, using the baseline of the four weeks preceding each challenge, and comparing seasonal consumption trends in the years before challenge implementation with the years during the challenges, suggest that the Energy Challenge reduces electricity consumption by influencing behavior on campus. However, this study also revealed that campus competitions and challenges, including Allegheny College’s, need to analyze data within multiple contexts to truly understand the impact of behavior change separate from efficiency retrofits, changes in population and weather, and normal seasonal shifts in consumption.

This study found shifting the baseline from a previous year to the weeks directly preceding each challenge moderates results to better reflect behavior change within the context of a particular population and level of building operational efficiency each year. However, this alternate baseline introduces impacts of seasonal shifts on consumption which may similarly obscure results due solely to behavior change.

The Energy Challenge consists of fun events, engaging education, collective action, and sill reminders aiming to raise awareness about the environmental impacts of everyday activities. The fact that this research observed a decrease in electricity use due to behavior change indicates an impression is made on students which may influence their actions as they move from college into society.

This poster is based on research and a paper authored by:
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Yo! Lights out!

Professor Pallant encourages you to steal this sign to hang in your dorm. Collect them all.

GATOR A GREEN Conservation Challenges 2014