



Introduction

With this study the researchers attempted to assess the student behaviors that result in the consumption of the most energy, and hoped to shed light on areas in which students may scale back their consumption without noticing differences in daily life. Through survey collection and energy audits of individual student rooms, the researchers monitored appliances in order to discover which ones are used the most and what effect they have on energy overconsumption.

The researchers hypothesized that

- 1) Total energy consumption would vary between gender, grade, and residence halls.
- 2) Ghost energy, or passive energy consumption, would contribute highly to total energy consumption

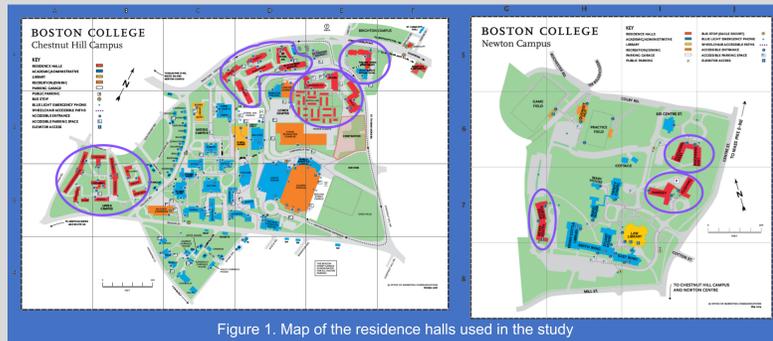


Figure 1. Map of the residence halls used in the study

Methods

The researchers utilized paper and online surveys to collect data on student appliance usage in the residence halls. Further, they tabled outside of Lower and MacElroy dining halls to distribute the paper surveys, and use facebook posts to distribute the online surveys.



Figure 3: Kill-A-Watt meter measuring the watt usage of a desk lamp in Stayer Hall.

Figure 2: Survey we used to gather data on average amount of time appliances are used and plugged per day

Gender: M F other
 Grade: Freshman Sophomore Junior Senior
 Res Hall: _____
 # people in room: _____

Do you have these appliances in your dorm?

| Appliance | How Many | Hours/minutes plugged in (per day) | Hours/minutes used per day |
|----------------------|----------|------------------------------------|----------------------------|
| Computer Charger | _____ | _____ | _____ |
| Phone Charger | _____ | _____ | _____ |
| Desk Lamp | _____ | _____ | _____ |
| Hairdryer | _____ | _____ | _____ |
| TV | _____ | _____ | _____ |
| Xbox/Playstation/Wii | _____ | _____ | _____ |
| Speakers | _____ | _____ | _____ |
| Keurig/Coffee Maker | _____ | _____ | _____ |
| Mini Fridge | _____ | _____ | _____ |
| Microwave | _____ | _____ | _____ |
| Blender | _____ | _____ | _____ |

Would you be willing to have us do an energy audit of your room? Yes No
 If yes, please provide your name & email: _____

To collect Kilowatt hours per appliance, the researchers used Kill-A-Watt handheld energy monitors, provided by John MacDonald, BC's Energy Manager, and recorded the watt usage of each appliance. The researchers then converted the data into KWH using the following equations:

$$\text{Eq. 1: Active Energy Consumption: } \frac{\text{Watts} \times \text{hours used}}{1000}$$

$$\text{Eq. 2: Ghost Energy Consumption: } \frac{\text{Watts} \times (\text{hours plugged in} - \text{hours used})}{1000}$$

Using SPSS, the researchers conducted statistical tests to determine correlation between grade, gender, or residence halls and amount of appliances owned, time used, time plugged in, or energy consumption.

Results

| Appliance | Average amount per individual | Hours Plugged in per day | Hours used per day |
|------------------|-------------------------------|--------------------------|--------------------|
| Computer charger | [1, 2] | [11.72, 15.18] | [4.25, 5.77] |
| Phone charger | [1, 2] | [18.46, 21.11] | [6.69, 8.69] |
| Desk Lamp | [1, 2] | [21.51, 23.63] | [3.75, 6.09] |
| Hair Dryer | [0, 1] | [41, 4.41] | [27, 2.43] |
| TV | [0, 1] | 24 | [2.38, 4.23] |
| Game system | [0, 1] | [18.99, 23.47] | [1.89, 3.37] |
| Speakers | [0, 1] | [11.19, 17.13] | [1.162, 3.58] |
| Coffee Maker | [0, 1] | [13.989, 21.09] | [1.59, .276] |
| Mini Fridge | [1, 2] | 24 | 24 |
| Microwave | [0, 1] | [23.54, 24] | [1.13, 1.70] |
| Blender | [0, 1] | [2.58, 11.99] | [.25, .57] |

Table 1: The average amount of appliances owned per individual, and 95% CIs for average time plugged in and average time used per appliance

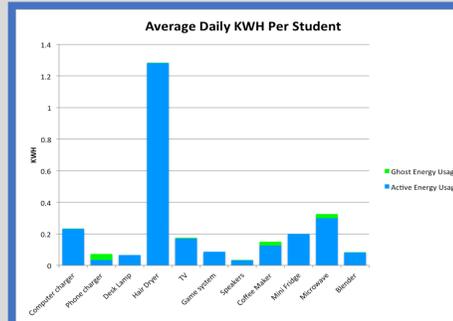


Chart 1: the average daily energy consumption per student, measured in Kilowatts Per Hour.

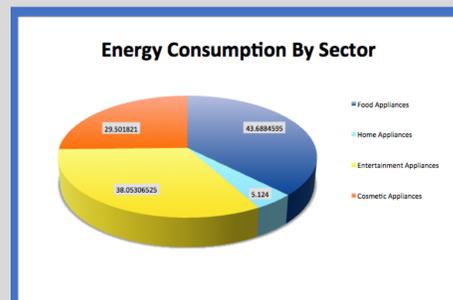


Figure 4: The pie chart pictured above represents the amount of energy drawn on average from the four sectors identified: Food (37.5%), Home (4.4%), Cosmetics (25.4%), and Entertainment (32.7%).

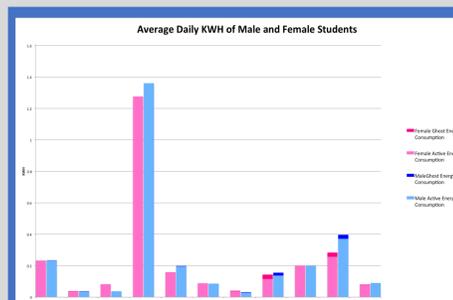
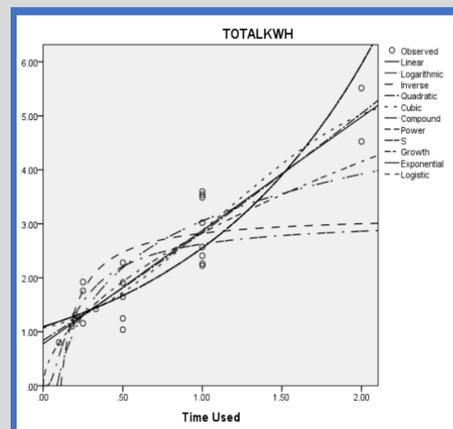
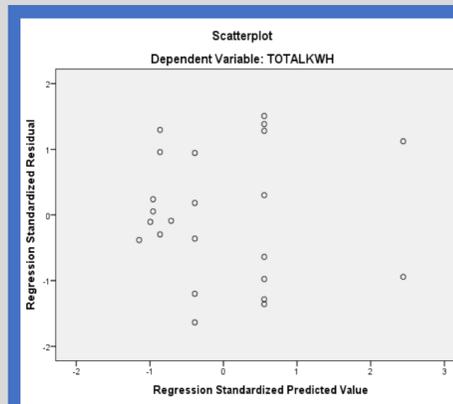


Chart 2: The average daily Kilowatts per hour of energy consumed grouped by male and female students.



Scatter Plot 1: The relationship between Total KWH and Time Used for hair dryers was significant at the .05 p level for linear, logarithmic, compound, and power regression models.



Scatter Plot 2: Using a linear regression model, the standardized residual and predicted values are shown beneath. The scatter shows that there is little cause for concern regarding heteroskedasticity, normality, or linearity.

Relevant Statistics and Trends

- Consumption By Gender:
 - ◆ Mean Total KWH For Females: 1.4299 (N=55, S=1.09)
 - ◆ Mean Total KWH For Males: 1.545 (N=34, S=.787)
- Appliance Ownership/Usage By Gender:
 - ◆ Difference In Means Between Men and Women Were Significant For the Following Variables:
 - # of Computer Chargers (F>M) **
 - # of Phone Chargers (F>M) **
 - # of Hair Dryers (F>M) **
 - # of TV's (M>F) **
 - # of Game Systems (M>F) *
 - # of Speakers (M>F) **
 - # of Hours Keurig Plugged In (F>M) *
 - # of Hours Blender Plugged In (F>M) **
 - ◆ (Differences In Means Were Calculated Using an Independent Samples T-Test)
- Appliance Ownership/Usage By Grade:
 - ◆ Freshman V. Sophomore:
 - # of Hours Phone Charger Used (F>Soph) **
 - ◆ Freshman V. Junior & Freshman V. Senior:
 - # of Hours Speaker Plugged In (Junior & Senior>F) *
 - ◆ Sophomore V. Senior:
 - # of Hours Microwave Used (Senior>Soph) **
 - # of Hours Blender Plugged In (Senior>Soph) *
 - # of Hours Blender Used (Senior>Soph) *
 - ◆ Junior V. Senior:
 - # of Hours Microwave Used (Senior>Junior) **
 - # of Hours Blender Plugged In (Senior>Junior) *
 - # of Hours Blender Used (Senior>Junior) **
- Active Energy Consumption Is a Better Predictor For Total Energy Consumption, Than Ghost Energy (ΔR^2 Active Energy > ΔR^2 Ghost Energy)

* = p<.1
** = p<.05

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** = p<.05

Discussion

Following the data collection, and statistical analysis phases, the researchers were able to reject the null hypothesis that there were no differences in energy consumption and appliance usage between gender, grade, and residence halls. However, the researchers were not able to reject the null hypothesis that ghost energy contributes highly to total energy consumption.

The researchers did find that the amount of time a hair dryer is used as well as the amount of time a microwave is used are independent significant predictors for total energy consumption. The researchers believe this is the case because hair dryers and microwaves use the most KWh of the appliances, even though they are used for the least amount of time.

The average BC student consumes 1.32 KWh of electricity per day

Based on the fuel mix and air emissions rates from electricity in New England (EPA, 2017), this is equivalent to:

Emitting 9.57 lb of CO₂ or CO₂ equivalent

OR



Driving 10.4 miles in an average 2 axle, 4 passenger car

The total resident student body, 7,266 students, emits 69,511 lbs of CO₂ or CO₂ equivalent per day, solely from their appliance usage. This is equivalent to driving 75,566 miles per day, or 27,581,590 miles per year.

Recommendations

- Cut back on hair dryers and microwaves, two of the most energy intensive appliances
- Use Energy_Star to check consumption rates, and identify energy efficient products (i.e. Drip coffee is more energy efficient than Keurig)
- Purchase energy efficient LED desk lamps (use approx 40 KW/hr less than other lamps), or contact The Office of Sustainability for one
- Boston College facilities should invest in energy smart appliances. By controlling the appliances allowed in dorms, Boston College may reduce energy consumption amongst students, through reduction of choice.

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