Reed College Climate Impact Assessment

Final Report of the Spring 2015 Environmental Studies Junior Seminar (ES 300) at Reed College

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Table of Contents

1.

actions that will help our school continue to be resourceful and appreciative of the landscape we inhabit.

1.2.Assessing electricity use as a sustainability goal

This report puts a strong emphasis on campuswide electricity use, investigating both where our energy comes from and how it is managed. Though the focus of this

outletsÓ In the mid 1950s, PGE started advertising all-electric homes. The company began participating in a national program, launched by the Edison Electric Institute. The program was designed to promote the use of electricity to builders and homeowners. ÒBy the end of the 1950s, the average PGE customer used three times the national average of electrical energy—

via panels on the roofs of the facilities warehouse. This essentially offsets the electricity use of the warehouse buildings.

Table 1. Sources of PGE electricity. An asterisk indicates a plant wholly owned by PGE; the remainder are jointl

The following pie charts, obtained from PGE, show that purchased power (Figure 1), as well as the power Reed chooses, can have substantial impact on the amount of environmental harm our power use incurs. The largest portion, 35% of the energy that PGE sells to Reed is purchased power (Figure 2). PGE owns major transmission rights to Pacific Intertie. This allows for power exchange between other utilities based on demand and production. It is possible for Reed to opt into Clean Wind, a billing option that adds an extra fee for new wind development, or Green Source which promises to offset all electricity usage with renewable energy. PGEÕs description of the Green Source mix (Figure 3) for 2015 states, ÒThis product will come from approximately 98 percent new wind, 1 percent new geothermal and 1 percent new solar energy.Ó By choosing Green Source an electric bill of $1,000,000 per year (about what Reed pays) would rise to $1,101,634.

Fig 1. 2013 power sources as a percent of retail load .

Fig 2

3. Ameresco Quantum Energy Assessment

In 2013 Reed signed a $5.4 million contract with Ameresco Quantum, an energy services company, to identify and execute changes to reduce energy use while maintaining building livability. Ameresco assessed energy use across the Reed campus and began various retrofits guaranteeing that the resulting savings would Òproduce over $250,000 annually in energy, water and maintenance related savings; equivalent to CO2 emissions reduction of 2,647,750 pound per year.Ó[10]

Ameresco reports that they have completed 95% of the projects at Reed totaling around $6 million. While we do not have exact completion dates for various buildings we have been able to use their guaranteed energy savings with the data we have for past electric use to project usage in individual buildings that have received upgrades. Figure 4 shows the projects savings estimated by Ameresco; this figure could be used to evaluate the effectiveness of these energy upgrades.

AmerescoÕs baseline Energy Use Analysis shows that between 2008 and 2010 ReedÕs aver

Fig 4. Projected energy savings per building based on Ameresco QuantumÕs guarantees.

4. Electricity Use at Reed

4.1.Individual Consumption

The nature and usage of electrical power on Reed campus is such that individuals have little control over total energy consumption. Academic buildings are illuminated and heated to standard amounts, and offices, support services, and Reed-owned buildings outside of campus, while contributing to total energy use, are outside the studentÕs sphere of direct influence. It is because of this lack of direct influence on

collective energy use that we must focus on individual energy use and how each person may directly reduce their energy consumption.

For individual energy use data collection we used the HOBO UX120 Plug Load Data Logger manufactured by onset¨. Figure 5 shows sample output data from the logger using the HOBO software, demonstrating the obtained time-series of wattage, amperage, and kWh energy usage of the plug load. This device, similar in size and shape to a brick, can connect to appliances and wall outlets to measure Amps (A), Watts (W), Volts (V), and Kilowatt Hours (kWh). Affectionately called ÒThe HOBOÓ, the class used this in conjunction with a power strip to measure the wattage (W) and power (kWh) of several appliances over time. This was useful in understanding the general use trends of several people involved in the project, but it was determined that measuring each appliance by itself would produce more coherent data. All of the data for individual energy use wascollected with this device. The HOBO is not only a powerful tool for quantifying power use, but also for qualifying trends in use. By connecting this device to your laptop, you can measure exactly how much energy is used when watching a movie versus editing a text document. The graphical output is a readyÐmade way of presenting information to the -0.3 (o) wat3 ( ) -214 ( ) -163is(t3 ( ) -)] TJ .4 onT Q q 0.2

Fig 5. Energy and Power Use for 13Ó Macbook Pro collected over 50 minutes [11]

Table 2: Power Use for Apple Products

Appliance !	Full u se, charging (W) !	RestE

labs all over

effectiveness by allowing one socket to control many others and having ÒpermanentlyÓ powered sockets for appliances which require continuous power.

4.2. Campus-wide Electricity Use

Assessing campuswide energy usage is a helpful mechanism to further our understanding of ReedÕs carbon footprint and its overall impact on the environment. Using energy data from 2009-2014, measured in kWh, it is evident that the 2012-2013 school year had the lowest recorded energy use by an average of 95,000 kWh. Potentially affecting this decrease in energy was the addition of the Performing Arts Building in 2013, which contains numerous windows and skylights to minimize the use of artificial light, along with bioswales and an eco-roof designed to minimize rainwater runoff. In terms of overall building energy use, h co

building uses significantly more energy than any other building on campus, with energy use an entire order of magnitude higher than that of other buildings. Additionally, residents in the Grove use three times as much energy as an average Reed resident student. Perhaps as a marker of perspective, the average Reed resident student uses less energy than the average American by a factor of five. These energy use distributions

the electricity use of the warehouse buildings on the western edge of the map goes to zero in 2013, after the installation of solar panels. There are some evident hotspots on campus where electricity use has remained consistently high, though these two figures display slight decreases in electricity consumption overall. It is important to note that there is some data not included in this map, including Commons and Anna Mann, but that this does not indicate zero energy use.

Lastly, Figure 9 depicts the electricity use of on-campus dorms, academic buildings, and faculty houses. The highest data point, shown in red, is the Educational Technology Center (ETC). This is not

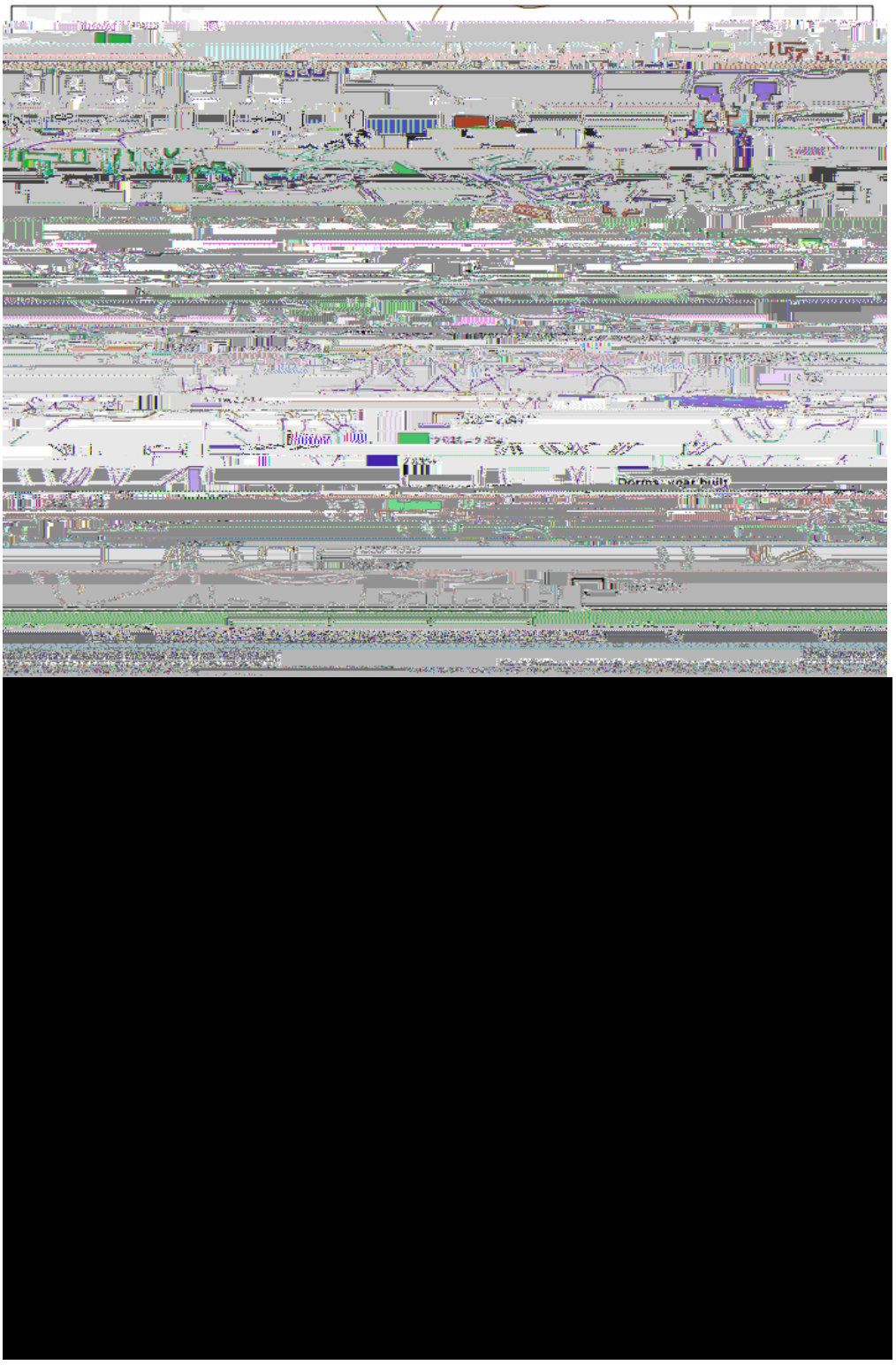

Figure 7. Annual Dorm Electricity Use Divided by Maximum Occupancy. Top panel: 2011-2012; Bottom panel: 2013-2014.

Figure 8. Annual Campus Building Electricity Use. Top panel: 2011-2012;

Fig 9. Annual Campus Building Electricity Use Divided by Square Footage

Figure 7 shows that dormitory energy use varies greatly, with the Grove using substantially more electricity than any other dorm. To investigate this in more detail, Figure 10 shows a typical annual cyclein energy use for three dorms, the Grove (newest dorm on campus), Old Dorm Block (ODB, the oldest on campus), and Naito (the newest dorm built prior to the Grove). It is notable that the GroveÕs winter electricity consumption is substantially more than its comparators, even in January when all three dorms have reduced occupancy

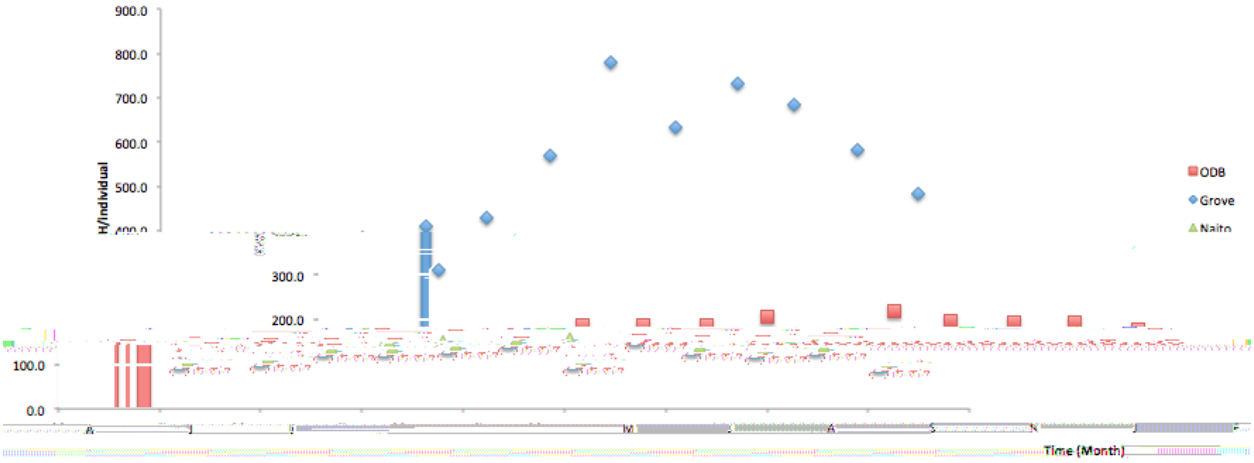

Figure 10. Monthly Average Per Occupant Electricit y Use from July 2010 - June 2011 for Three Representative Dormitories.

5. Behavior Change

As previously mentioned, energy use on campus is not the responsibility of facilities

- ¥ Negative, or shaming, campaigns either donÕt work or have limited success.
- ¥ Create pilot programs before doing full-scale implementation.
- ¥ Repeated reminders, interactions, and/or prompts boost success.
- ¥ Education and information dispersion is not sufficient for lasting change.
- ¥ Often, incentives work; particularly, financial incentives.
- ¥ Identify behaviors to target and change; tackle them specifically.
- ¥ Regular evaluation is a key to long-term success; third-party measurement is favored over self-evaluation.
- ¥ Coercion does not produce long-term success.
- ¥ Use active involvement and participantsÕ views of self as tools.

6. Next Steps

We recommend several next steps, the first of which is energy monitoring, including expansion to collecting data on individual building -level gas use for heating Data collection and continual monitoring is key to identifying opportunities for improvement, with regard to our energy-related carbon footprint. Such monitoring would better inform any further energy efft egyit(Su) -0.22 (r) 0.3(ie) -0.4 (t) -0.2 (,) 0.1 (ie) -0.4 (f) -

is a feasible candidate for solar panels, as its roof is well equipped for them, and it is a high energy use campus building.

If creating green power of our own proves too infrastructure-intensive in the short run, it is possible to achieve clean electricity through our current provider, PGE. It is possible for Reed to opt into Clean Wind, a billing option that adds an extra fee for new wind development or Green Source, which promises to offset all electricity usage with renewable energy. PGEÕs description of the Green Source mix for 2015 option states, ÒThis product will come from approximately 98 percent new wind, 1 percent new geothermal and 1 percent new solar energy.Ó By choosing Green Source an electric bill of $1,000,000 per year (about what Reed pays) would rise to $1,101,634.Though we recognize that a 10% increase in the CollegeÕs electricity billing is not insignificant, it puts carbon-neutral electricity sourcing within reach.

We also recommend further individual education, in the form of both behavior change campaigns and an expansion of the educational opportunities surrounding environmental issues. Reviving ÒThe Power Struggle,Ó an inter-dorm competition to reduce energy use for prizes would be an especially effective educational and behavior change tool if implemented during the winter months when electricity use is particularly high. Though past ÒPower StrugglesÓ have not produced energy-saving effects after the end of the competition, longevity could be better maintained with more long-term incentives. As shown in Figure 10, targeting dorms during the winter months, especially the Grove, would likely produce the largest effects.

Switching to clean power would make a powerful insa.3 (o) -0in1 ( ) -5.2 (p) -0.5.2 (c) -0.1 (l)

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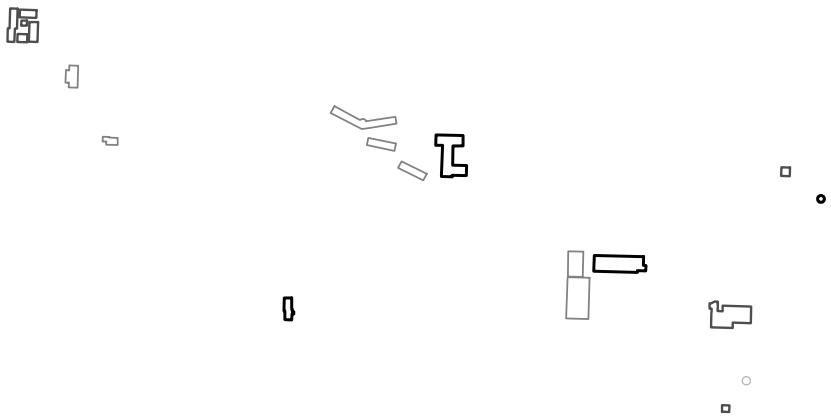

Figure A1. Annual Campus Building Electricity Use Divided by Square Footage. Top panel: 2011-2012; Bottom panel: 2013-2014.

Figure A2. Annual Reed-owned Faculty House Electricity Use. Left panel: 2011-2012; Right panel: 2013-2014. Circular objects indicate approximate locations of houses for which the footprint was unknown.