Name _____ **Lab Day/Time** _____

GEOS 130: Chico State Building Energy Use

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California State University Chico is recognized as a leader in sustainability. As you've learned throughout this course, one way to be more sustainable is to reduce your ecological or carbon footprint. Chico State has committed to sustainable policies and practices that reduce the ecological footprint of the entire campus. In fact, Chico State was one of the first campuses in the US to sign a commitment to reduce greenhouse gas emissions and become "carbon neutral" by 2030. Also known as *net zero carbon footprint*, this means that the amount of carbon that is released across campus is balanced by an equivalent amount sequestered or offset.

How does a campus become carbon neutral? List some actions (some of which Chico State may already be doing across campus!).

One important step in the process of becoming carbon neutral is to know exactly how much carbon the campus is producing. Energy use is large source of carbon emissions across campus, and buildings have meters that record how much energy is being used at any particular time, down to every fifteen minutes. In this lab, you will utilize recent data on energy use of some of the buildings on campus.

Objectives of this lab:

- Summarize data with Excel, using graphs and tables
- Scale energy use up to a building level
- Discuss ideas for sustainability and reducing energy use
- Calculate carbon off setting metrics

Terms to know

Carbon offsetting:

Carbon neutral:

Sustainability:

Your TA will give you an Excel dataset from one of six buildings on campus. Each Excel spreadsheet has two tabs (on the bottom). One tab is for daily data – kilowatt hours (kWh) per day for the entire month of March 2016. The other tab is for hourly data – kilowatt hours (kWh) used from midnight through 11:00pm on March 7, 2016 (a Tuesday) and March 5, 2016 (a Saturday). There are three different types of

buildings represented in the dataset: buildings used primarily for instruction; buildings used as residential dorms; and a dining hall.

You can (and are encouraged to) do all your calculations in the Excel spreadsheet. You will also create graphs to display your data. Your TA will go through an example to show you how this is done.

Each group will summarize the data for the class.

Table 1: Building information

Building Name	**Type**	**Area/Size**	**Roof**
O'Connell Technology Building	Instructional	74,566 sq ft	18,641 sq ft
Physical Sciences	Instructional	82,882 sq ft	27,627 sq ft
Lassen	Dorm	39,310 sq ft	13,103 sq ft
Tehama	Instructional	90,157 sq ft	30,052 sq ft
Shasta	Dorm	39,310 sq ft	13,103 sq ft
Sutter – dorms	Dorm	64,000 sq ft	16,000 sq ft
Sutter – dining	Dining	16,000 sq ft	16,000 sq ft

Building Name _____

Daily Data

1. What is the total energy use and the total energy use per sq foot (use Table 1 to determine the square footage of the building)? (HINT: to calculate the total energy use, use the =SUM() function in Excel and highlight the column of data that you want to get the sum of).

2. What is the total amount of CO_2 emissions coming from this building in March? Remember from the Kill-A-Watt lab that in CA 1 kWh of energy is equivalent to 0.4688 lbs CO_2/kWh.

3. What day in March had the highest energy use? What day had the lowest?

4. Create a graph in Excel and describe the overall energy use trends you see. Make sure to show your TA your graph! Sketch your graph on a whiteboard. Is there a period in March when there is lower energy use? If so, what might account for this?

Hourly Data – Tuesday March 7, 2016

5. What is the average energy use on typical school day (in this case, March 7, 2016)? (HINT: you can use the =AVERAGE() function in Excel, and highlight the column of data you are interested in).

6. When is the energy use the highest? When is it the lowest? What do you think accounts for these?

7. Create a graph in Excel and describe the overall energy use trends you see. Make sure to show your TA your graph! Sketch your graph on a whiteboard.

Hourly Data – Saturday March 5, 2016

8. What is the average energy use on a typical weekend day (in this case, March 5, 2016)?

9. When is the energy use the highest? When is it the lowest? What do you think accounts for these?

10. Create a graph in Excel and describe the overall energy use trends you see. Make sure to show your TA your graph! Sketch your graph on a whiteboard.

11. Now compare Tuesday March 7 with Saturday March 5. How did the energy use differ? Is this difference more or less than what you expected?

All groups should write their findings on the board, and everyone should record the data in Table 2.

Table 2: Building Energy Use Summary

Building Name	Type	Total Energy Use (March) kWh	Energy use per sq ft (March) kWh	Total CO_2 emitted (lbs)	Time of highest energy use - Tuesday	Time of highest energy use - Saturday
O'Connell Technology Building	Instructional					
Physical Sciences	Instructional					
Lassen	Dorm					
Tehama	Instructional					
Shasta	Dorm					
Sutter – dorms	Dorm					
Sutter – dining	Dining					

12. Which type of building (Instructional, Dorm or Dining) had the highest energy use per square foot? Remembering back to the Kill-A-Watt lab, why do you suspect this is the case?

Now that you've calculated how much energy some of the buildings use, let's start thinking about how Chico State can achieve the goal of carbon neutrality by 2030. One possible way to do this is for Chico State to produce it's own energy, rather than rely on PG&E to supply energy to campus. Remember from lecture, after installation, using solar panels to produce energy has zero carbon emissions.

Currently, the only solar panels generating energy on campus are 1,212, 3ft x 4ft solar panels on the roofs of Yolo Hall and Acker Gym.

13. How many total sq feet of solar panels is this? _____ sq ft

These solar panels produce 464,345 kW hours of energy each year.

14. How much (on average) does each sq ft of solar panel produce?

_____ kW/sq ft

Let's assume that energy use in March is a good representation of an average month of the year. Use this one month of energy use to extrapolate to energy use over the entire year. Use the building you have been analyzing this lab. If your building is Sutter, you have to add both dorm and dining, as these are in the same building.

15. _____ kWh

Now let's assume that 75% of the total roof area can be covered in solar panels.

16. This means that _____ sq ft of solar panels can be put on the roof.

17. If each sq ft of solar panels produces the amount of energy that you calculated in question 13, what is the total amount of energy that can be produced by the solar panels?

18. Are there enough solar panels on the roof to offset the yearly energy use of the building?

19. Compare your answers with other groups in the class who calculated the solar energy production for different buildings. Could any of the buildings produce enough energy with solar on their rooftops? If yes, which ones?

Energy Reduction

20. Let's imagine there are two computer labs housing a total of 50 desktop computers. Calculate the amount of energy used PER DAY and PER ACADEMIC YEAR (210 days) if all 50 desktop computers were left on 24 hours a day. The run load is 50W. (Remember, first you have to convert W to kW, then you need to multiply by the hours per day and days per year to calculate the respective values)

21. What is the energy use PER DAY and PER ACADEMIC YEAR (210 days) if the computers were put into sleep mode for 8 hours when they weren't in use? Sleep mode uses 1.1 W. (Hint, sleep mode is for 8 hours a day and the rest of the day the computer is on run mode).

22. If the computers were simply shut down for 8 hours a day, instead of putting on sleep mode, what would be the energy saved? The phantom load is 0 W. What is the reduction in CO_2 emissions PER DAY and PER ACADEMIC YEAR (210 days)?

Carbon offsetting

Chico State may not find it feasible to put solar panels on all the buildings. Likely they will employ a combination of energy reduction, energy production and carbon offsetting techniques to obtain carbon neutrality. Carbon offsetting is defined as the counteracting of carbon dioxide emissions with an equivalent reduction of carbon dioxide in the atmosphere. We have looked at one way this could be done: by having trees capture some of the CO_2 that is emitted. A complete survey of all campus trees could be done to determine how many pounds of CO_2 they capture each year. A Master's student in Geography measured all the city owned trees in Chico (these are trees growing alongside the streets) and calculated that <u>every year</u> they capture 2,387,078 pounds of CO_2.

23. Just examining the buildings we looked at in this lab, how many total pounds of CO_2 would the trees need to capture in order to offset the carbon emissions?

24. If one tree in Chico can capture 78lbs of CO_2 per year, how many trees would need to be planted to offset all of the building emissions?

25. What would you recommend to facilities management at Chico State to help the campus attain carbon neutrality?