



Integrating Energy Data into the Classroom

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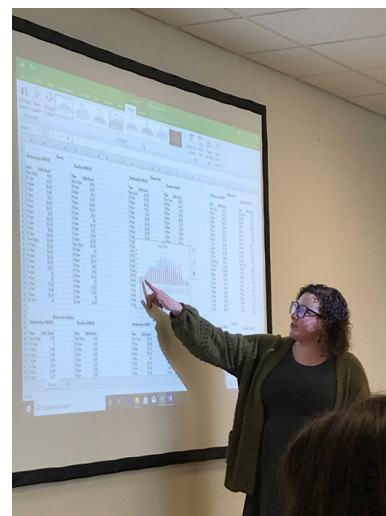
Department of Mathematics and CCG Energy Project Managers

Energy Conservation happens behind walls and in ceilings and therefore, it is often invisible and underappreciated. The purpose of this project was twofold: educate our students about energy conservation on campus and let them use their math skills to support what they have learned. Quantitative Reasoning (MAT 116) is a class many non-science majors take and it covers topics ranging from Algebra and Geometry to Probability and Statistics. The statistics section teaches them about calculating means, creating graphs, and analyzing data. They then use what they learn in their final project to help them understand energy use on campus. Many majors at Wingate also require Math 209, Inferential Statistics, and the capstone in this class showcases the students' abilities in graphing, construction of frequency distributions, calculation of means, technology use, and hypothesis testing – all to increase their awareness of energy efficiency and sustainability. Beyond honing their math skills, these projects encourage students to consider data analysis as an important way to enact change. As a result, students develop their citizenship by reflecting on Wingate University's desire to make itself a greener campus.

Math 116 Project:

The project has been completed in two semesters, Fall 2019 and Spring 2020. Both semesters, the students compared the energy use between two buildings on campus and then between 6 buildings on campus. In the fall semester, the students compared energy between the buildings on a Wednesday and a Sunday during the same week. In the spring semester, the students compared energy from March 9, 2020 and April 9, 2020, before and during Covid-19. The questions the students worked on for the project follow:

- You will need to pick two buildings. For each building, you will calculate the mean, range, and median energy usage for each day; create a graph for each building and each day; and compare the energy use for the two buildings. Some questions to consider: What information can you gather? Is the energy use consistent for each building? Or does the energy use vary? Why do you think this is happening? Looking at the individual

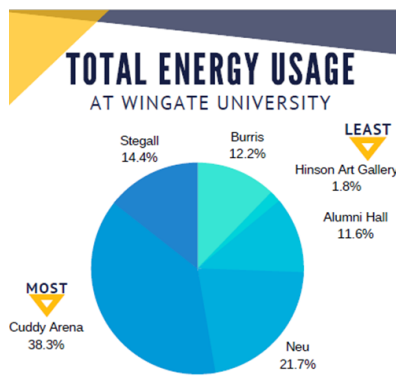
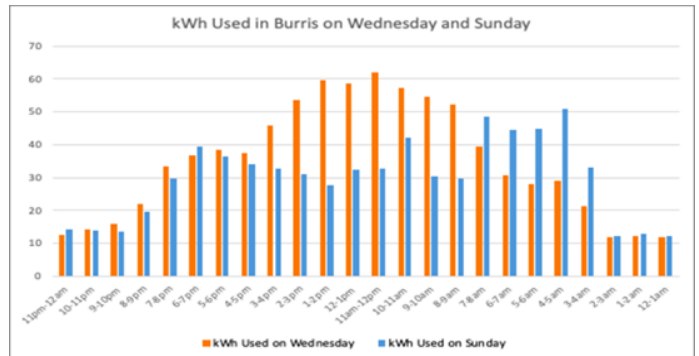
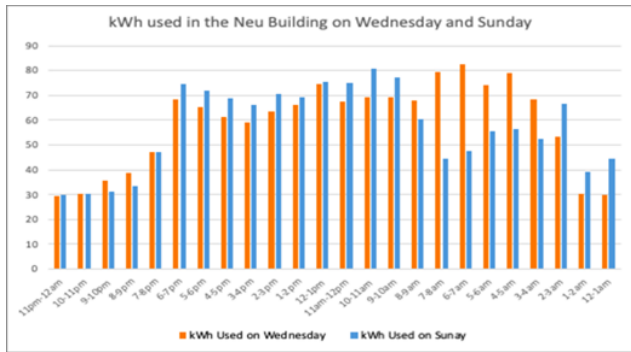


buildings, was there a difference between the energy use on Sunday vs Wednesday? Do you think there should be a difference? Why?

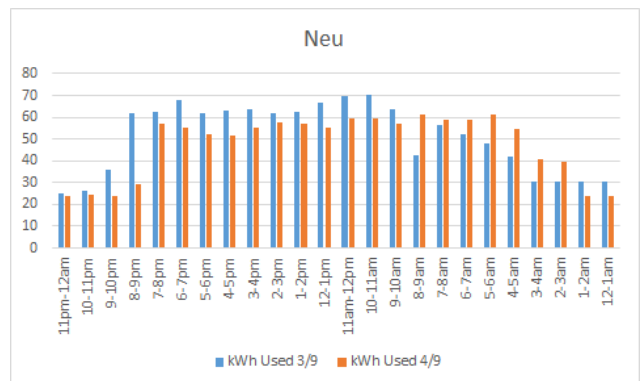
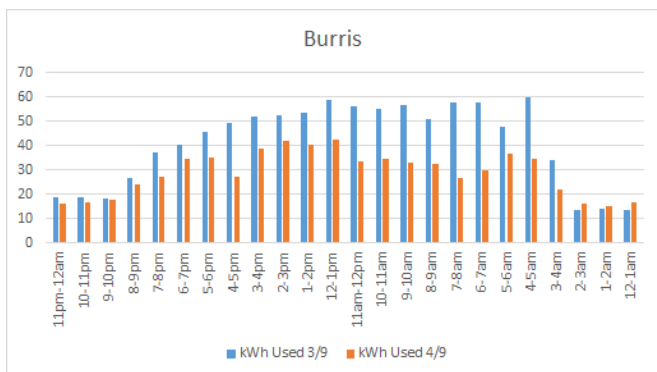
- Next, you will compare all the buildings. Add up the total amount of energy for all the buildings. With this information, write the percentage of the total energy use each building is using. Some questions to consider: Which building uses the most energy? Which uses the least energy? Why do you think this is true? Do you think any of the buildings are energy efficient?
- Do you feel that Wingate University is energy efficient? What could Wingate improve on? If you could change one thing about Wingate to improve its energy efficiency, what would your policy be? Why do you think I would assign this project? Do you think it's important to look at the campus energy use?
- Write a paragraph about what Dr. Cathy Wright discussed in the CCG video. Some questions to consider: How would you describe the Collaborative for the Common Good? How is this project a part of the CCG? What did you learn from this video?

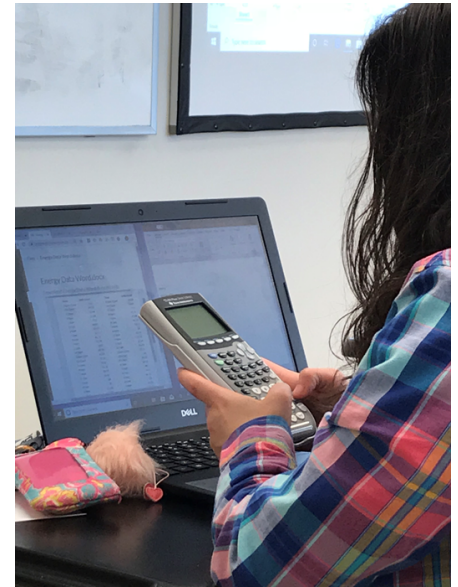
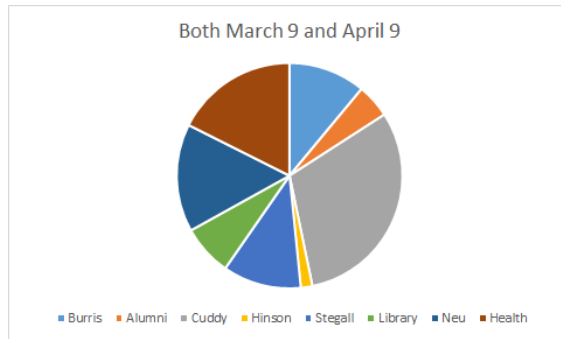
Student Results:

Fall 2019:



Spring 2020:





Both Semesters students discussed that Cuddy Arena used the most amount of energy whereas Hinson Art Gallery used the least amount of energy. When asked why they thought this was true, all the students stated it was because Cuddy is a very large building, a lot of sports are held there, and it costs a lot to control the temperature, and Hinson is a much smaller art gallery that isn't used very much.

In their final report of the project, the students were asked whether they felt that Wingate University was energy efficient and if they would change one thing about Wingate to improve its energy efficiency, what would their policy be. Overall, the students believe that Wingate University is not very energy efficient and could greatly improve. One student responded:

"I feel as though Wingate University is not very energy efficient. The reason I feel this way is because we are using the same amount of energy through the week as we are on the weekends. I feel like Wingate should send out emails reminding staff and students to turn off the lights once they are done using the classroom. Lastly, I think they could use a little less air conditioning or heat within certain months. This way it is not continuing to run all weekend. I feel like just by following those two steps, Wingate could save a lot of energy." (Fall 2019)



Another student stated:

"I think that Wingate University could likely do more to be energy efficient. The lack of efficiency is more evident in certain buildings. Some of the buildings did not show a significant reduction in energy use in April. This likely should not be the case as there were few to no people on campus at this time. Wingate should look into the ways that energy is being used on a daily basis and identify patterns of unnecessary use. One simple way to cut back the energy being used would be to install motion activated lights in areas with less use such as bathrooms so that they will automatically turn off when the lights are not needed." (Spring 2020)

Math 209 Project: Hypothesis Testing with Real-World Data on Energy Use

This project has also been completed in Fall of 2019 and Spring of 2020. Students used hypothesis testing to determine which of two campus buildings had the higher energy use in October of 2019 for the fall and March or April of 2020 for the spring. This project included the following:

1. A frequency distribution
2. A colorful graph
3. Statement of claim
4. Interpretation of the findings and any possible conclusions based on the data (use hypothesis testing)
5. Report on findings

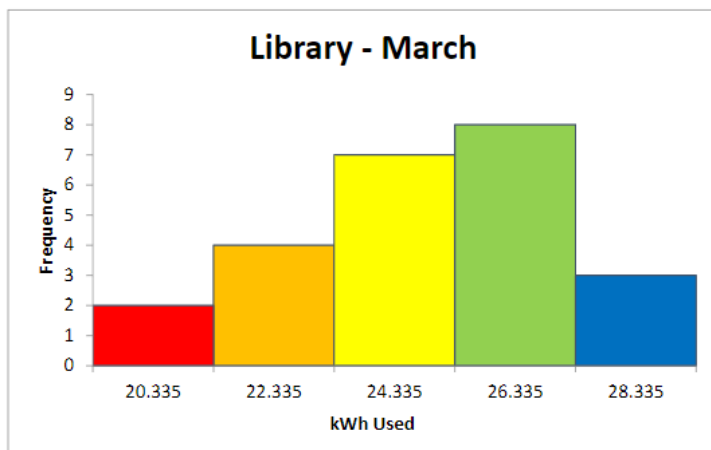


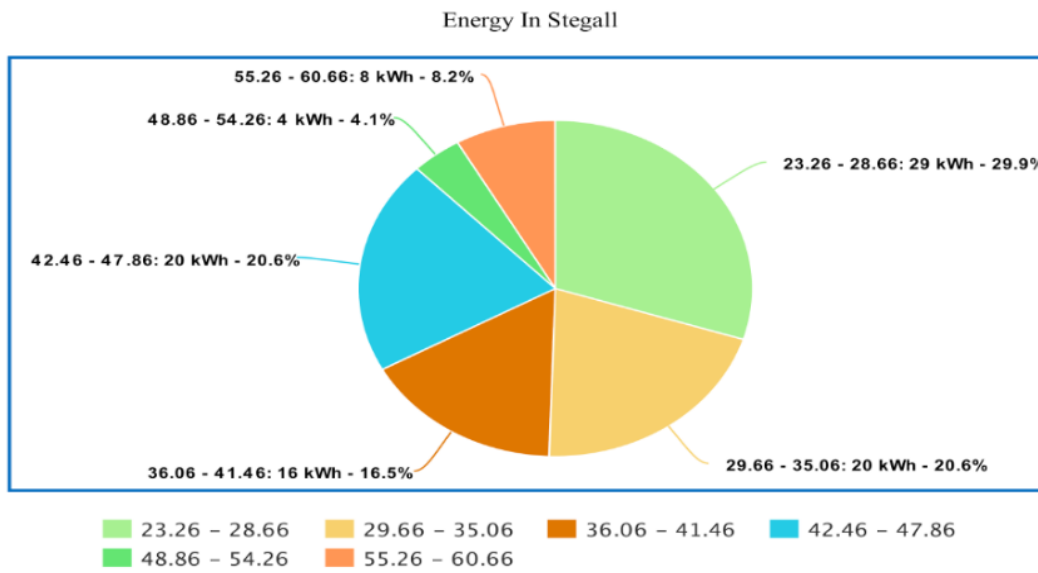
Student results:

Burriss

Class levels (kWh)	Bounds (kWh)	Frequencies	Relative Freq.	Cumulative Freq.
2.50-4.70	2.495-4.705	19	32.2%	19
4.71-6.91	4.705-6.915	12	20.3%	31
6.92-9.12	6.915-9.125	9	15.3%	40
9.13-11.33	9.125-11.335	10	16.9%	50
11.34- 13.54	11.335-13.545	5	8.5%	55
13.55-15.75	13.545-15.755	4	6.8%	59

Figure 3: A frequency distribution reflecting data obtained from the Burriss academic building regarding energy usage in kWh.





In their final report students included responses to the following:

- Describe your decisions and conclusions.
- Were there any surprises?
- Why is this data important to analyze?
- What impact might this analysis have on policies at Wingate?
- Include the original data and a description of this data in your report.

As a result of this project, students gained insight into the amount of energy used by Wingate University on an hourly basis. In addition, they were compelled to think about changes that would lead to a greener, more efficient campus. When asked “Why is this data important to analyze?”, one student stated,

“This energy data is important to analyze because the goal should be to reduce energy use as much as possible for a healthier carbon footprint that would benefit Wingate, its students, and the community around it.”

Another student replied,

“...this data is extremely important for us to analyze because it shows where we, as a Wingate family, can cut down on our energy use. This will not only help our environment, but it will also save the university a lot of money to be put towards other campus needs.”

This realization lends itself to thinking about how data analysis can affect policy on the Wingate University campus. When asked about this, one student responded

“...if we can determine where we are using too much energy, we can better implement energy efficiency. This will lower the energy used and save our University a lot of money, which will hopefully pour into our academics, student life, technology in classrooms, service projects, and co-curricular learning.”

Another student stated,

“analyzing this data allows those in charge to make educated and wise decisions as to how to make our campus more efficient and sustainable so that a better education and campus life can be provided; while also helping our community and environment.”