Forecasting Energy Usage in Appliances and Lights

Jessica Parks

Background

Now more than ever there is companies are having conversations about creating more sustainable products. We see this in many arenas of business. Clothing is being advertised as made with sustainable materials[1]. The automotive industry is increasing investments into the research and development of electric cars to reduce fossil fuel emissions[2]. More infrastructure is being built to achieve LEED certification[3]. Not only is this good for our environment and communities, but from a marketing stand point, it is good advertisement for businesses too. It is one thing for a company to highlight it's recent sustainability achievements but it is another to show how they have maintained this effort and improved upon it. As we all know, some companies talk the talk and others truly walk the walk. This has become such an important issue that a term has even been created for this, "greenwashing". This is not the reputation a business wants to have. In this case, it is important that companies make a collective effort for their business model and their consumer to reduce their environmental impact.

How can a business prove to their competitors and their consumers they are working toward reducing their carbon footprint? By showing the improvements they have made in their past, along with the trajectory they are on for their future. Even if a business' current trajectory is not the direction they want to be on, they can show interventions they are currently making to mitigate their impact. This is something everyone can feel good about. Their employees will feel good about their efforts being made for the environment and future generations, along with the consumers who know they are purchasing a product that was consciously made to minimize their energy usage and, ultimately, the cost of using it.

Research Goal

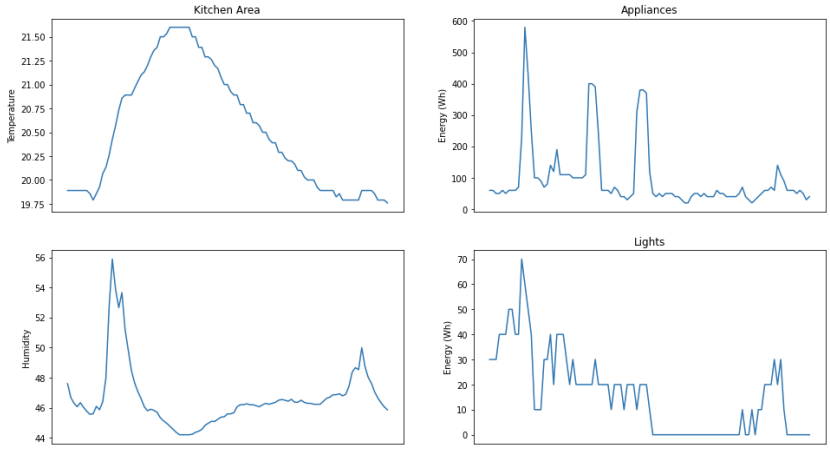
There are many models used to predict energy usage depending on the business sector and products. Our model will specifically be focusing on appliances and their energy usage. It will show the past total energy consumption in a household along with the projected amount.

Additionally, it will show how some environmental factors, temperature and relative humidity, can impact energy consumption. As we know, energy usage of an appliance is not a once size fits all. For example, if a room is especially warm, it will require more energy to maintain the internal temperature of a refrigerator[4]. Our model will show the impact these environmental factors have on the energy usage.

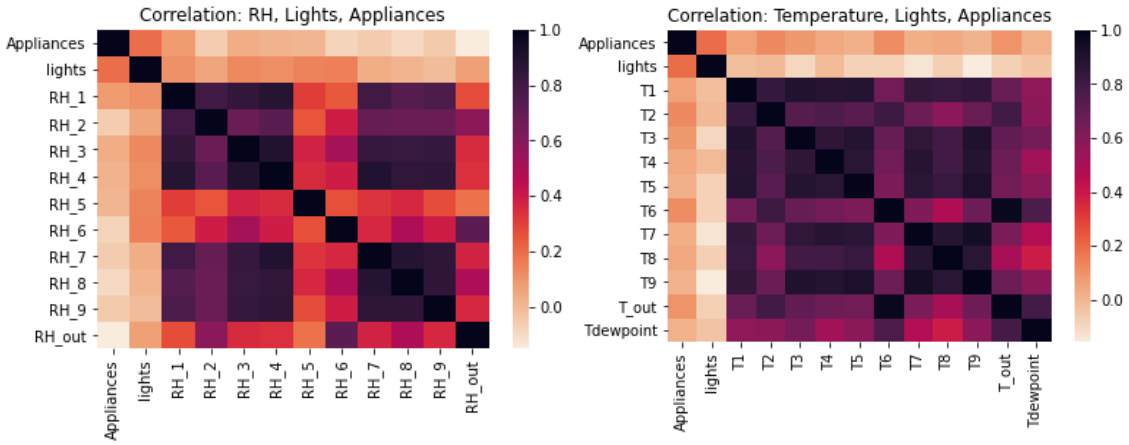
Exploratory Data and Initial Observations

There are some basic relationships our model would look more into. One that was mentioned above was the environmental factors, temperature and relative humidity, and if they relate to the energy output of appliances. For example, in the graphs below we can see the trends of energy usage by appliances and lights in the right hand column. In the left column, we can see the temperature and

relative humidity of the kitchen (chosen since many appliances are in this one room). Based on the graphs, we can see there is an overall spike and decline in the graphs. Look more closely though, and we see these spikes and declines are not all the same. The graphs of the appliances and lights have a greater amount of spikes and variations. Our model would investigate how the temperature and relative humidity would affect the shape of the appliances and lights graphs since we see some similarities and discrepancies between them.



While this is helpful to see that there is potentially a relationship between these variables, this is not enough for a business. Our model aims to quantify how much the appliances and lights are correlated with the relative humidity and temperature. In order for us to forecast their energy consumptions into the future, we need to know how much each of these variables will impact our model. This is shown below in our correlation plots. On the left, we see the correlation between relative humidity, appliances and lights; on the right is the correlation between temperature, appliances, and lights. Each number next to T and RH_ represents the assigned number to each room of the house (I.e. T1 and RH_1 are the temperature and the relative humidity of the kitchen.

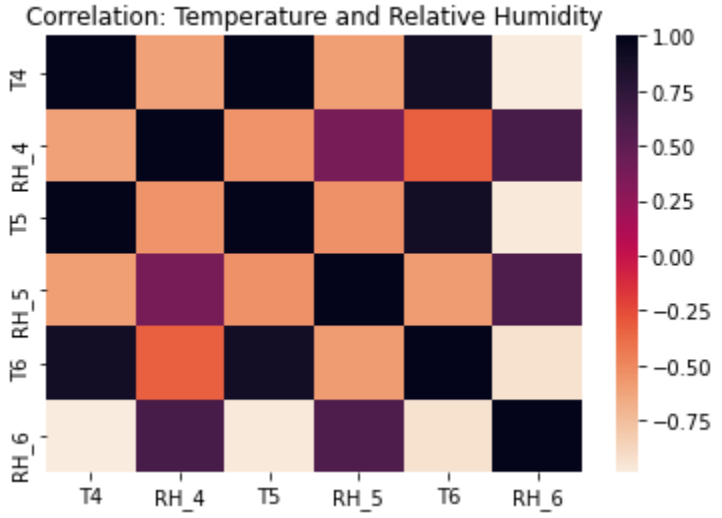


Upon first glance, these correlation plots reveal a few interesting things. It appears there is not as much of a correlation between temperature and the appliance and lights as there is for relative humidity and appliances and lights. Just from these two plots, we hypothesize that relative humidity has a stronger impact on the energy usage of lights rather than appliances. On the flipside, we hypothesize temperature has a stronger impact on the energy usage of appliances than lights.

This is an interesting but essential point to investigate. From a business standpoint, this can help engineers focus on where to delegate their resources and time into researching. If relative humidity impacts the light energy usage more, then they may want to look more closely at sealants that can minimize the amount moisture that enters the lightbulb. Not only does this help engineers produce a better product, but consumers can purchase a lightbulb that is longer lasting and requires less energy to output the same amount of lumens (measurement of light output).

A similar approach can be taken when considering the improvements upon appliances based on temperature. As we know, different materials are better at conducting and insulating heat. Knowing what variables have the greatest affect on energy usage of an appliance allows engineers to get the biggest rate of return on their research time.

As described above, we are trying to measure the impact that relative humidity has on both lights and appliances, and also, the impact the impact that relative humidity has on both lights and appliances. This leaves out one relationship that is also important to understand: the relationship between temperature and relative humidity. Living in Michigan, we experience this relationship each year. As the winter approaches and temperatures cool, our skin dries out due to less moisture being held in the air. In our summers though, we experience the humidity with the warm temperatures when we start to perspire the moment we step out our front door. Below is a small snapshot of the correlation between temperature and relative humidity between certain rooms.



Conclusion

Understanding what relationships exist between appliances and lights and environmental factors is important. Knowing how to quantify these relationships and make predictions with this information is essential.

Companies that are producing appliances and lights need to know how temperature and relative humidity affects the energy output of these before they can move forward with research and design.

In addition, researchers are testing different materials and chemicals, they may not be able to collect years worth of data on it before pushing it into production. That is why forecasting is very helpful to scientists. They are able to make predictions on the success of their designs. By predicting how much energy usage will be affected by these changes, they can also weigh the costs and time of production to see if what is achieved in the long run is outweighed by other costs. This can help business' save time and funds.

When researchers are using forecasting during their studies, it also benefits the consumers. As described above, by producing a better product, they can also boost their advertisement and potentially sales by showing customers their product uses less energy which in turn, can save the consumer money and reduce their carbon footprint.

In conclusion, forecasting the energy usage of appliances and lights helps businesses, consumers and our environment. A win, win, win.

Bibliography

1. Bringé, Alison. “Council Post: The State of Sustainability in the Fashion Industry (and What It Means for Brands).” *Forbes*, Forbes Magazine, 3 Jan. 2023, https://www.forbes.com/sites/forbescommunicationscouncil/2023/01/02/the-state-of-sustainability-in-the-fashion-industry-and-what-it-means-for-brands/?sh=220767a31c82.

2. Bullard, Nathaniel. “Automakers Are Investing Billions of Dollars in EVS.” *Bloomberg.com*, Bloomberg, 5 Aug. 2021, https://www.bloomberg.com/news/articles/2021-08-05/automakers-are-investing-billions-of-dollars-in-evs?leadSource=uverify+wall.

3. Benjamin, Heather. “LEED-Certified Office Buildings Found to Bring High Sale Premiums.” *U.S. Green Building Council*, U.S. Green Building Council, 27 Jan. 2022, https://www.usgbc.org/articles/leed-certified-office-buildings-found-bring-high-sale-premiums.

4. Energized by Edison. “9 Ways to Make Your Refrigerator More Efficient.” *Energized by Edison*, Edison International, 6 Sept. 2016, https://energized.edison.com/stories/9-ways-to-make-your-refrigerator-more-efficient#:~:text=Regulate%20Room%20Temperature&text=This%20means%20your%20refrigerator%20could,near%20an%20oven%20or%20dishwasher.