Group 1-6: Energy Supply

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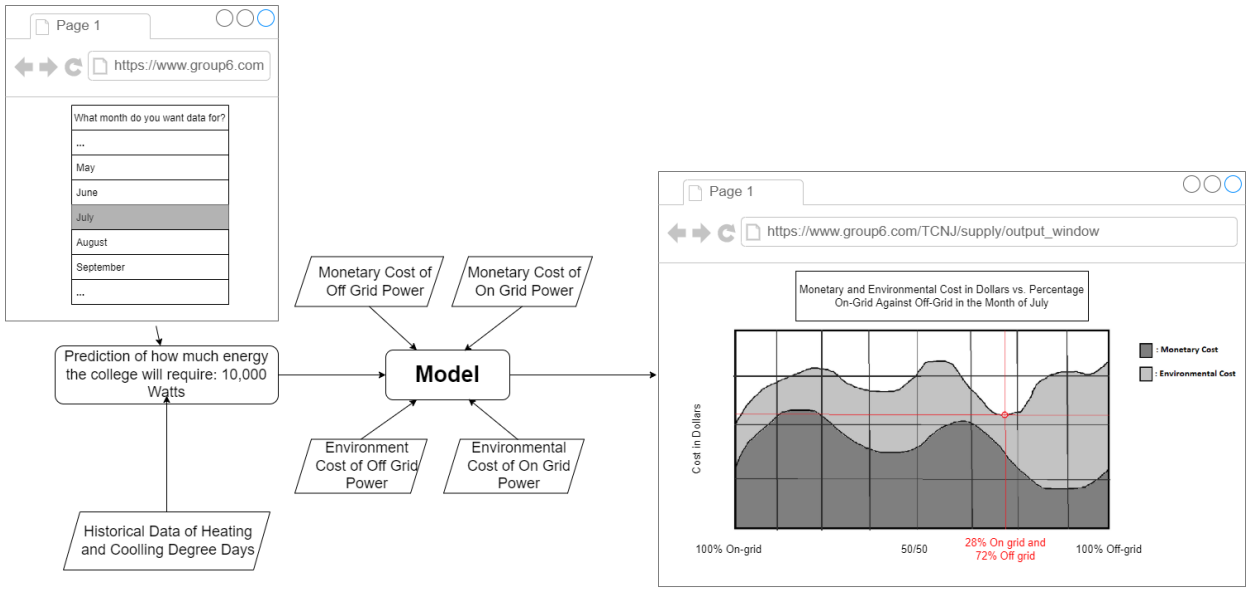
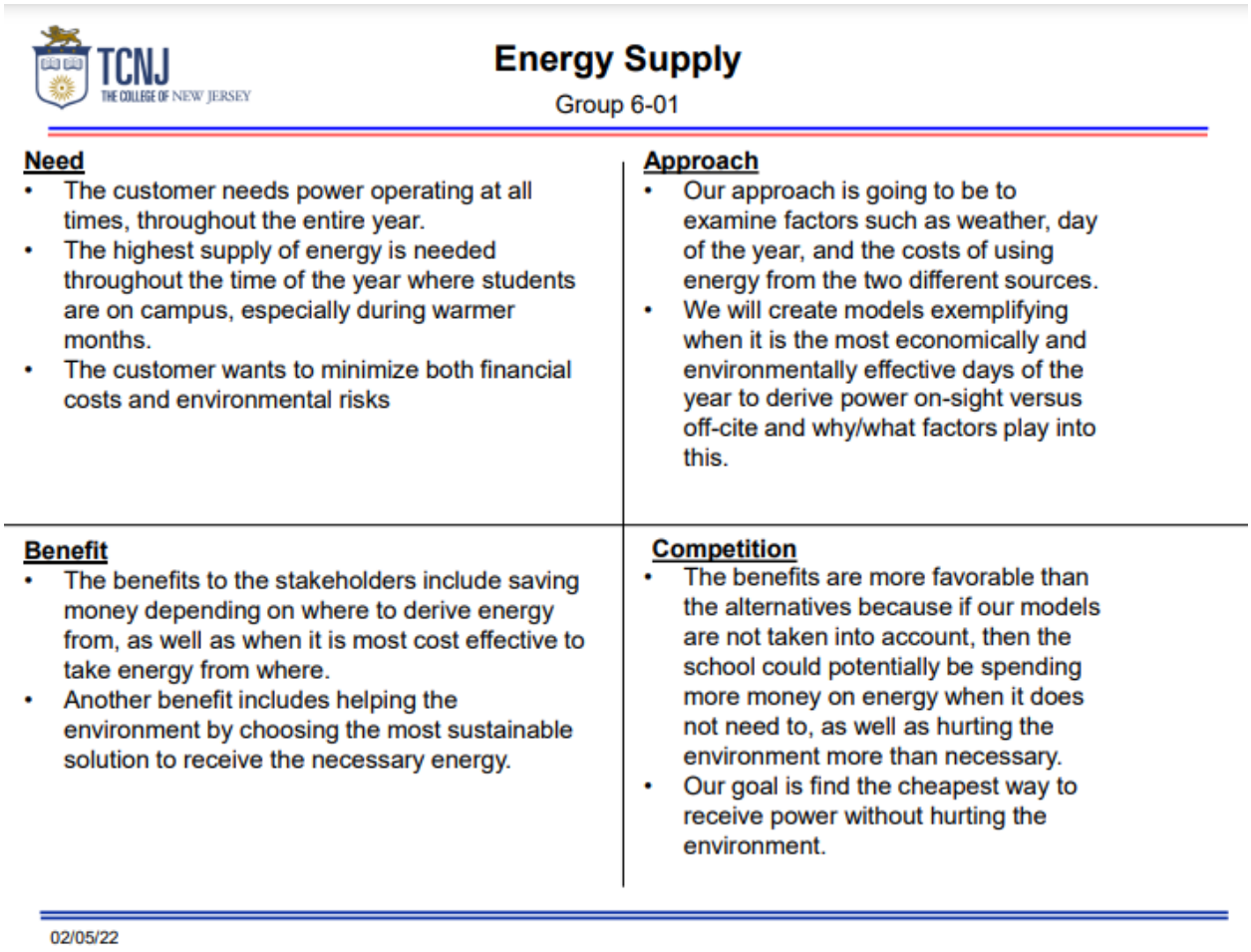
Use Case Diagram



Quad- Chart



Problem statement.

With approximately 7,400 students and almost 50 buildings, The College of New Jersey continuously utilizes a great deal of power. Because of all of the usage needed to operate all the buildings, and satisfy the needs of the students, TCNJ has different resources in which it can derive such power. These resources are both on-site at the college, and off-site from an electrical grid. Utilizing over 3,500,000 kWh of electricity at the campus' peak, the problem worth addressing is how to keep costs low while supplying adequate power. However, another problem that arises with keeping the physical costs low, is making sure that there is no significant environmental damage with the ways in which the college derives its power. By examining the costs of each way the school accesses its power, and the potential pollutants of each form, an answer can be found when both variables are at their lowest points. Factors such as the weather and the time of the year will also play a role in addressing this energy supply problem. Times of the year when class is in session and students are living on campus, the supply of energy going to the school will obviously be much higher than in the summer when most students are at home.

• Objective

We aim to resolve the problem regarding campus's energy by creating models that exhibit optimal methods of deriving energy, while taking into consideration the environmental and economical factors. Our objective is also tied into TCNJ's Sustainability Plan, which explains the college's commitment to becoming carbon neutral by the year 2040. The units of observation in our study will be cost and carbon footprint, ensuring that our plans are both cost effective and eco-friendly. The variables used in our models will be heating and cooling degree days. Our model will help us answer questions such as:

How much energy is necessary for the campus to operate at its peak times of the year?
Where should the college be deriving this energy from in order to minimize costs both financially and environmentally at peak usage?
When and why are good times to obtain power from an on-site or an off-site source?

EDIT: We will pull historical data of TCNJ power use type and cost, based on a per month basis. We will store in a database, data about any given historical month at TCNJ including the amount of on grid and off grid power used as well as well as the number of heating and cooling days. We will also store information about the different energy options available, including the monetary and environmental cost for each type. The user would be able to submit queries to the database using a web interface. Queries will include the ability to display historical data by month, display power usage in a graph format, display On-grid vs Off-grid Usage for a given month, and display associated environmental and monetary costs of a given energy type.

• Description of the desired end product, and the part you will develop for this class.

The end product will be a web application that can visualize the tradeoffs, monetary and environmentally, of on-grid vs. Off-grid power during different times of the year and during various levels of demand. We would, ideally, also create a model that has an equivalency between carbon footprint and monetary value in a way that can allow the end user to visualize the monetary cost it would take to offset a given carbon footprint.

• Description of the importance and need for the module, and how it addresses the problem.

The module we aim to create will make it much easier to visualize the amount of power the college is using, and where that power is coming from. By doing so, it will allow the college to make the most environmentally and financially safe choice when deciding how to supply the school with the amount of energy it needs. The importance of supplying enough power on days when the school needs it most will be a big emphasis while addressing the problem, especially because many TCNJ students live on campus for most of the year and rely on the college for their heating and cooling needs, electricity needs, and just about everything necessary for human survival. If this problem is not addressed, then the well-being of TCNJ students will be at risk. The reason for keeping an environmentally conscious mind when choosing how to power the school, is due to the fact that at such a high volume of power, it could be taken from sources that pollute the environment far greater than potential alternatives. Coinciding with the TCNJ Sustainability plan, the desire to minimize risk of excess polluting will also be of focus in

addressing the energy supply problem, as it should be for every topic regarding anything that could potentially pollute.

• Plan for how you will research the problem domain and obtain the data needed.

We will look at various documents to figure out how the power company charges us for power. We will also seek to understand the precise differences in pollution levels of the different energy sources available to us. In order to do this, we will have to have a general understanding of how the power TCNJ uses is generated, be it on grid or off grid.

• Other similar systems / approaches that exist, and how your module is different or will add to the existing system.

Similar systems and colleges have tried reducing energy consumption on their campuses:

- Bowdoin vs Colby. Both colleges decided to start a competition to try to reduce energy usage for three weeks.They ended up saving a total of 22,536 kWh. Colby lowered their usage by 7% below baseline data, while Bowdoin lowered theirs by 8.7% below baseline data.
- Yale now owns 3 power plants in order to better conserve energy and increase the usage of renewable energy technologies. By 2007, they had managed to reduce energy consumption within the dorms by 17.3% due to students' efforts which administrators hope will continue. In 2020, they were on track to meet their energy conservation goals.

As seen, many of these colleges depended on their students to lower their energy consumption and they had hoped that they would be able to keep it going. We want to analyze our data first, to figure out the optimal way for TCNJ to resolve the problem regarding campus's energy. We want to see when it would be most cost effective to go On-grid vs Off-grid. In other words, we want to figure out how to better our energy consumption starting off with what the college can consistently do first, to then be able to incorporate our students in our plan so we won't have to worry about any inconsistencies on their end.

• Possible other applications of the system (how it could be modified and reused.)

While this model and project is specific to supplying energy on campus at The College of New Jersey, there are other functions that it could have. The primary objective is to find the best method of powering The College of New Jersey by using a combination of on-grid and off-grid energy sources. However, there are other possible functions for this model that do not only pertain to TCNJ. For example, other colleges and universities could use this model to track their energy usage and decide which method is the most efficient in terms of cost and pollution. It also does not have to be just colleges and universities using this model, because it could be used for towns or cities. Any community large or small can use this system to find the optimal way of powering their buildings. Another task that this model could be used for is to find the energy demand of each building and what it takes to heat or cool them. The only additional data you would need would be the number of buildings and how large they are. This model could potentially answer a lot of questions regarding energy and the cost of using it. Therefore it has endless possibilities. This model could also be used with other models that are unrelated to

energy on campus. For example if it is clear that energy usage is down over Winter Break then the college could look into saving money in other aspects as well. If there is less energy being used then there are most likely less students on campus, meaning the college does not have to buy as much food. These are just some out of a long list of possibilities created from this model.

- Performance

Performance will not be much of a concern for us, as we are not dealing with big data.

- Backup And Recovery

The project is entirely stored on github, including code and relevant documents. Github allows us to keep track of changes via the usage of small atomic commits. These commits keep track of all changes made and allow us to recover previous implementations of the project if desired.

- Security

Only the admin has access to edit the data while the standard user can only input queries and view the output graphs

- Relevant Concepts and Technologies

In order to complete the project, we will need to learn Postgres, SQL, Flast, and Python. We plan on reading up on these as well as buying relevant tutorial material.

Project Preposal Slides:

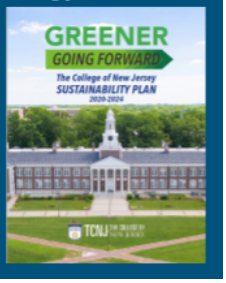
Energy Supply Proposal

Group 01-6

Problem Statement

The College of New Jersey continuously utilizes a great deal of power and has different resources in which it can derive such power.

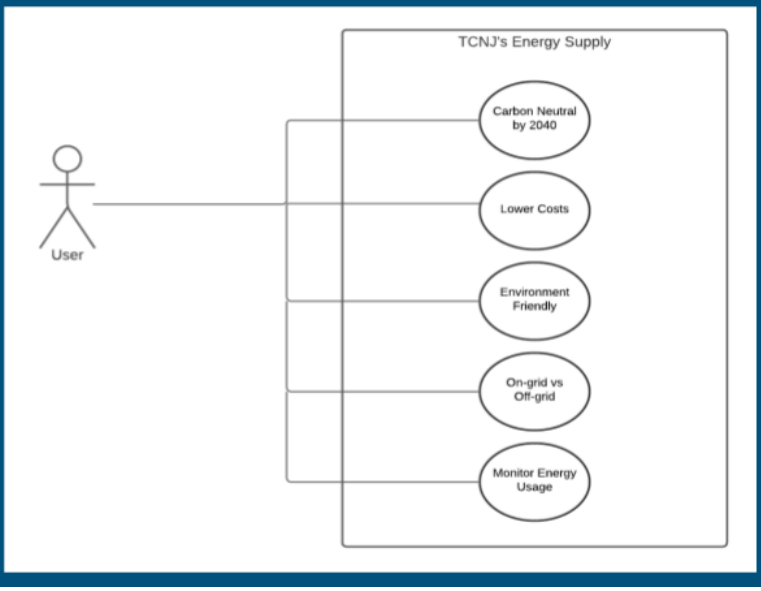
The factors in question regarding this problem include how the environment affects energy usage, and the costs involved to satisfy how much energy is needed for the school to operate.



Objective

- We aim to resolve the problem regarding energy supply by creating models that exhibit the optimal methods of deriving energy, considering the economic and environmental factors.

System Boundary Diagram



Description of the Desired End Product

- Web application that can graphs environmental and monetary costs again
  - Demand
- Make an equivalency between carbon footprint and monetary cost.

Description of the importance and need for the module, and how it addresses the problem

- Can help reduce energy costs and keep them at a minimum
- Can help reduce TCNJ's carbon footprint

Research and Data

- Look at various documents to figure out how the power company charges us for power
- Understand the difference in pollution levels of the different energy sources.
- Understand the process behind how the power is generated

Other similar systems / approaches that exist, and how your module is different or will add to the existing system

- Bowdoin VS. Colby.
  - Saved 22,546 kWh. Colby lowered their usage by 7%. Bowdoin by 8.7%
- Yale owns 3 power plants and they reduced energy consumption by 17.3% due to their students efforts.
- Low Emissions Analysis Platform (LEAP)
- We will be aiming on the college's consistency first by analyzing the data presented to us, spreading awareness, then incorporating our students into our plans.

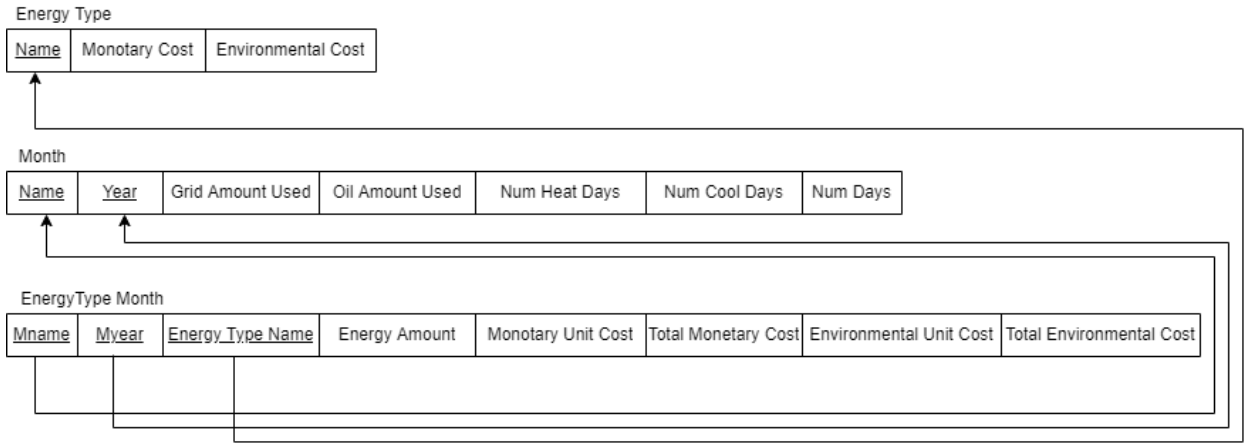
This criterion is linked to a Learning Outcome

Possible other applications of the system (how it could be modified and reused.)

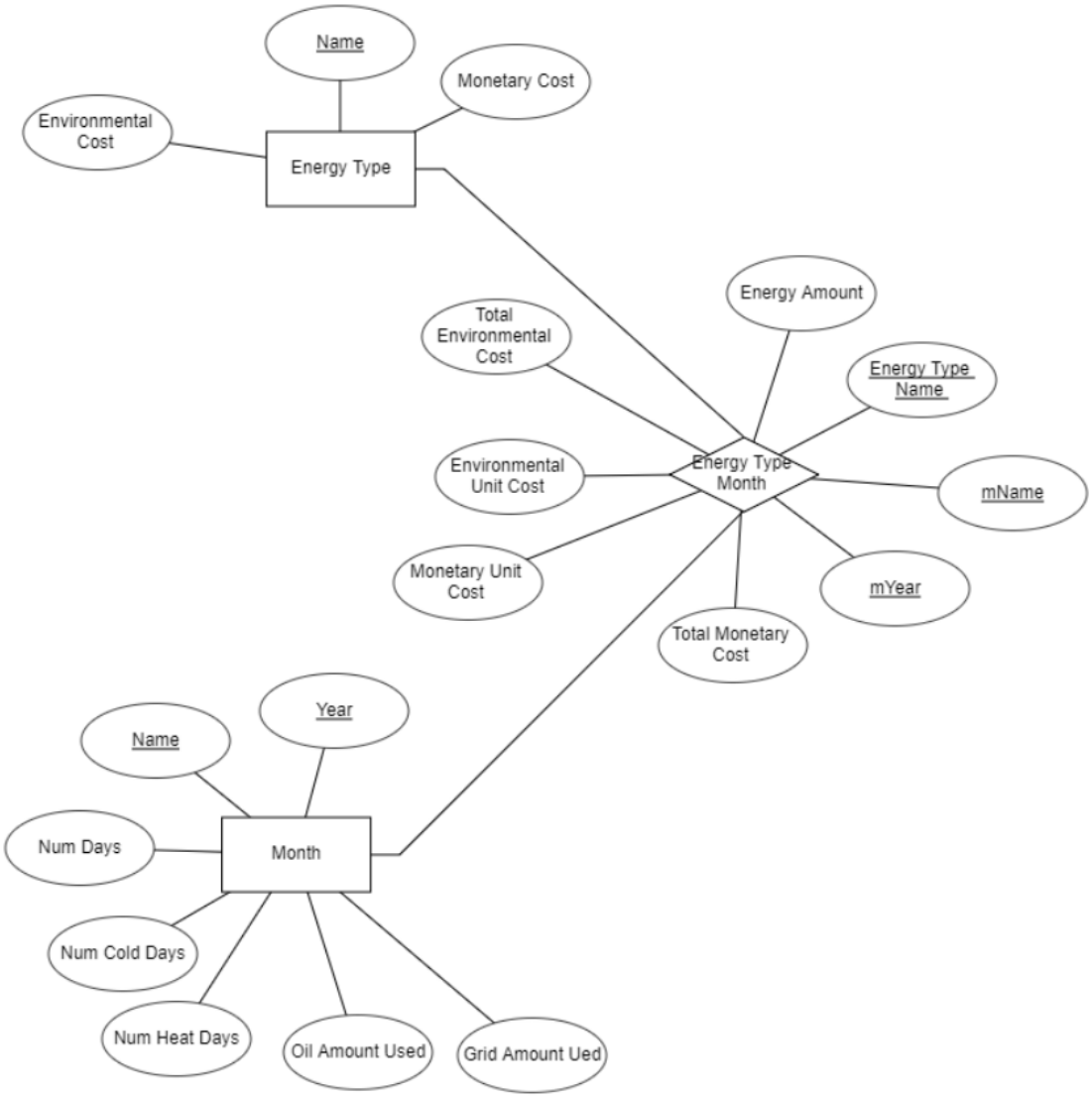
- Can be used by other colleges to track their energy usage
- Can track the demand each building on campus needs to function
- Find when it is optimal to heat or cool each building
- Use together with other models

Stage 3 Documents:

Relational Schema:


Energy Type
Name
Monotary Cost
Environmental Cost
Month
Name
Year
Grid Amount Used
Oil Amount Used
Num Heat Days
Num Cool Days
Num Days
EnergyType Month
Mname
Myear
Energy Type Name
Energy Amount
Monotary Unit Cost
Total Monetary Cost
Environmental Unit Cost
Total Environmental Cost

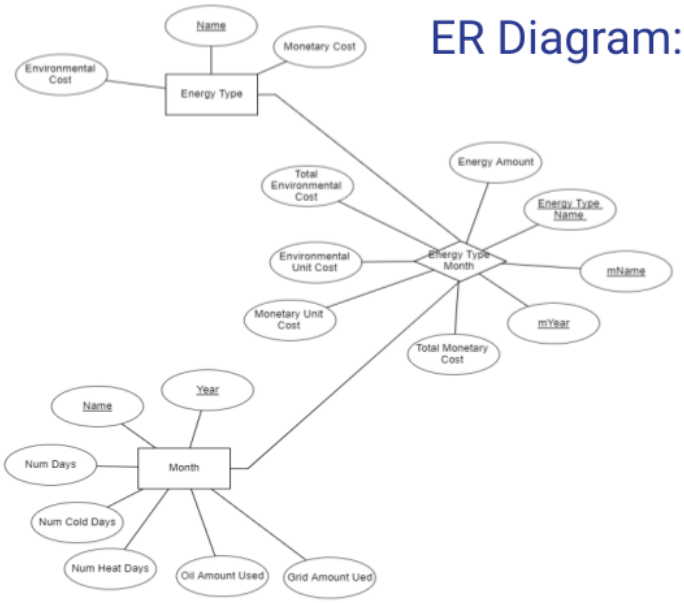
ER Diagram:


Name
Monetary Cost
Environmental Cost
Energy Type
Energy Amount
Total Environmental Cost
Energy Type Name
Environmental Unit Cost
Energy Type Month
mName
Monetary Unit Cost
mYear
Total Monetary Cost
Year
Name
Num Days
Month
Num Cold Days
Num Heat Days
Oil Amount Used
Grid Amount Ued

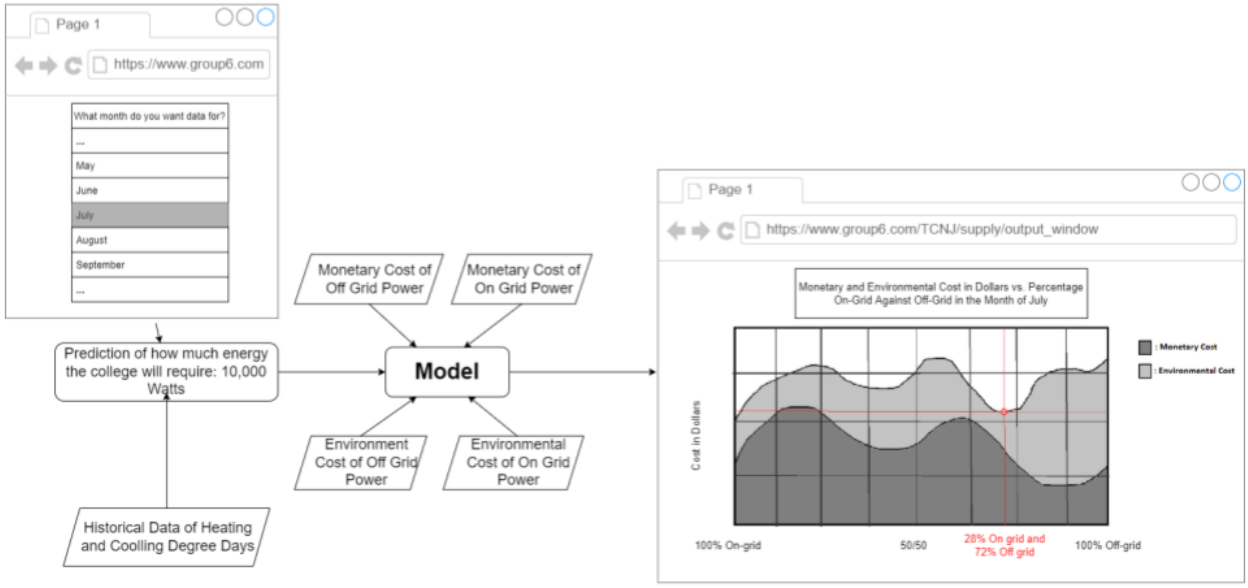
Mid-Semester Presentation

By Group 6

ER Diagram:



Use Case Diagram:



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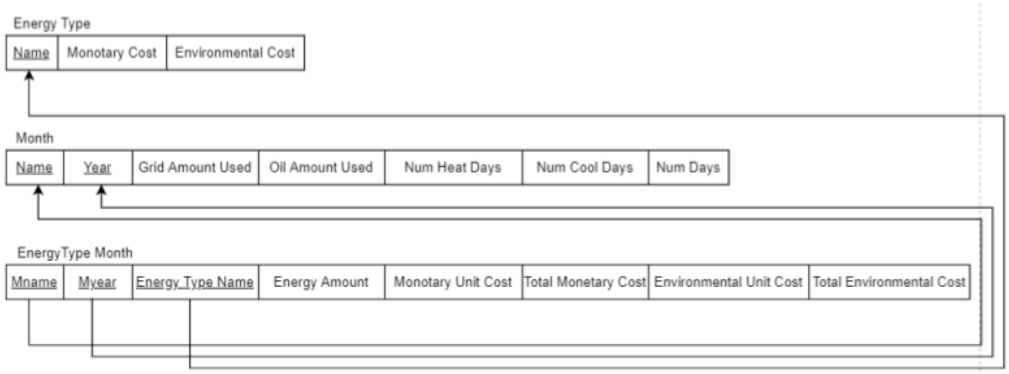

Possible Queries:

- Display historical data by month.
- Display power usage graphs.
- Display On-grid vs Off-grid Usage.
- Display Environmental costs.
- Display Monetary costs.