Energize TCNJ

2-05

Adriana Barroqueiro, Robert Fenton, Rebecca Goldberg,
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Executive Summary

EnergizeTCNJ is a web application that interfaces with a PostgreSQL database to allow users to view not only the direct, financial costs of TCNJ's energy supply but also the environmental costs thereof. These features were developed to meet the needs of our stakeholder, the TCNJ Department of Facilities and Administrative Services, as well as other potential users, such as accountants and energy supply strategists. The motivation for creating this application with these specific features was the lack of an analogous application that could be used to view the college's energy supply measures. The applications that come closest to this task may measure the energy usage of specific buildings, but do not keep track of energy supply for all meters on a campus such as our own, and may not provide emissions estimates.

Our approach to implementing these features was to create a PostgreSQL database that stores the energy supply data provided to our group, and to create a simple, but robust web interface that allows this data to be viewed by the user. Specifically, our web interface allows the user to view the average and total emissions per source, as well as the cost of energy on a per meter basis. This application allows the user to collect information on the cost of TCNJ's energy supply from a financial and emissions standpoint. There are multiple ways to select which data is displayed to the user: when viewing total emissions, for example, the user can either search by specific meter names, or look at each meter which reports energy of a certain unit.

This application allows users to have a convenient and informative look at TCNJ's energy supply figures in terms of their financial and environmental costs. Without this application, the user would be left looking at the raw data, i.e. a number of excel files with energy supply data, which presents obvious difficulties for the user. We hope that this application will make the work of the stakeholder more efficient and productive when analyzing TCNJ's energy supply.

This web application is available as an entirely new service, without extending or replacing an existing one. Due to the fact that the entire system requires relatively little computational resources, the database server should be able to be run on most personal computers, and the web application can be accessed by any individual with a desktop browser. We do not expect that our stakeholders will feel the need to replace any existing systems due to the fact that this web application seems to be the first to provide a way to view the cost and environmental impact of the campus's energy supply.

It is important to note that our web application is highly amenable to the addition of further features, which requires a developer to manipulate the app.py file and the relevant HTML template files, as well as potentially the SQL code. Nonetheless, even a relatively experienced developer should be able to add a variety of features to the application as they may need due to the relatively simplicity of the application.

Specifications - Stage IIb

Problem statement

TCNJ is committed to providing a reliable but cost-efficient energy supply to the TCNJ campus. There is currently no application that lets users access and visualize the use and costs of locally produced and grid energy with environmental considerations for the entire TCNJ campus. Users would benefit from a single module that provides visualizations and tables concerning the costs and environmental impacts of the various energy supply methods. This would allow for the campus to create a well-informed decision for a future plan to reduce emissions at a fair price.

Objective of the Module

Our objective is to develop a module that allows for a user to simultaneously minimize both energy consumption costs and environmental impact with the current TCNJ data.

Desired end product, and the part you will develop for this class

We would like to create a webpage application that provides visualizations of the costs associated with power supply for the TCNJ campus, which specifically will allow a user to come to an informed conclusion about how economical and environmentally friendly different energy sources are. Another feature of the module would be the ability to predict future costs and energy expenditure. The end product would compare the cost of creating energy on campus in comparison to taking energy from the grid. Additionally, the module will weigh the environmental impacts thereof. We hope to create a comprehensive database using PostgreSQL to store the existing energy supply data, provide projections on future energy usage and costs, all within an efficient, secure, and informative user interface.

Importance and need for the module, and how it addresses the problem

By aggregating and displaying data, this module will allow a user to come to an informed decision regarding the most cost-effective and environmentally friendly way to supply the TCNJ campus with power. We plan to provide visual representations in the form of graphs and charts to help the user understand trends in their data. We believe that an intuitive user interface is crucial to achieving our goal of informing our users. With the expansion of TCNJ power sources to solar panels and wind turbines, the college requires a comprehensive database to store and visualize the data in real-time. Providing graphs may not be feasible due to the experience of the team.

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

To complete our task, we will need information from many sources. Namely, data on the unit cost of power when produced locally vs. taken from the grid. Important sets of data include the carbon emissions of each energy supply method, price, and energy expenditure in kWh, all in relationship to time. Some research on our part would include obtaining available data on energy

supply from solar power and wind turbines in a similar-sized institution. This would allow us to create a better model for TCNJ power supply and cost calculations. Finding data from other institutions of the same size proved to be difficult. Data will be collected from national averages posted on government websites.

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

A similar system to our proposed project is that of Energy star. Their portfolio manager application displays data on energy consumption and efficiency per building. Our module will display campus-wide data on the costs of energy supply. We plan to include both locally produced power and energy from the grid, as well as the environmental consequences of producing versus outsourcing energy supply. The advantage of our module is that all the data will be stored together, the user will be able to compare energy consumption from different suppliers for the entire campus.

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

This module will be useful in visualizing data from the past and current day, as well as providing projections into the future. A possible modification can be to create multiple projection plans and compare them using live data. This means that a user could view historical trends in power supply in former years. It can also be used to build various plans for years in the future. As TCNJ expands, the module can be used to support data for different energy sources. As more and more data is collected, future projections will become more accurate.

Performance – specify how and to what extent you will address this.

We hope to create an efficient application and database that can manage all the data gathered by TCNJ for energy expenditures and create visualizations based on the data. By using Python and PostgreSQL we believe that it would be possible to create a module of this size. For security purposes, we will implement access control to allow only authorized users to access the database and sensitive information. There will be a home page

Security – specify how and to what extent you will provide security features.

Before creating the full-scale database, we hope to learn more about database security in class and implement these practices in our project. We will use GitHub and its repositories to store the data and source code. We can improve the security of our modules by following certain best practices, such as those outlined by IBM. Specifically, we will make sure that all software we use is patched and up to date, implement a password-secure administrator profile, and record database logins and uses. Registering for an administrator account will be limited to staff and faculty who present a pressing need to alter or configure certain parts of the database itself; normal users themselves will not be permitted to alter the database.

Technologies and database concepts the group will need to learn, and a plan for learning these.

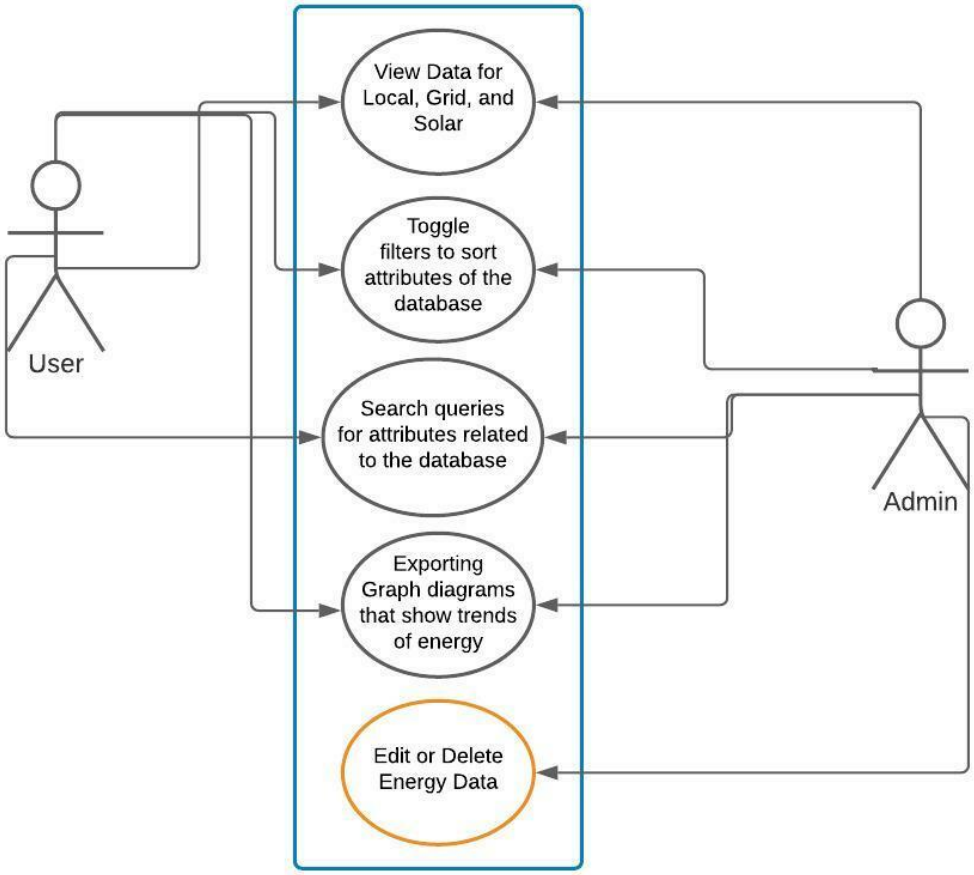
We will need to learn how to use Python to create a secure connection to PostgreSQL, as well as learn how to use PostgreSQL in order to efficiently store our data. As students, we will learn the basics of how to use these tools in class and then will look for reference material on the execution of specific tasks that we may not be familiar with doing. Each member in our group has different experience levels with tasks that we will be responsible for, but this allows for us to learn as a group while having an "expert" on various topics.

Backup and recovery – specify how and to what extent you will implement this. and which queries you will implement.

GitHub offers easy recovery and version control solutions, and seems to be the best resource to achieve this goal. Github not only can serve as a repository for our source code, but also as a way to store our starting data sets, and information crucial to our project. However, this requires our team to properly use branches and commits to ensure that we keep our final production code segregated from our in-progress code and materials.

The ability to backup our database itself is critical, and as such we plan to back it up consistently. Specifically, since the database will likely see minimal (if any) use outside of working hours, we plan to back up our database late at night or in the early morning. There are a number of services which provide the ability to back up a SQL database, such as Microsoft SQL Server. Since our database is relatively small, we plan to back up the entire database, as well as log files, as opposed to a partial backup. As we move forward, we will refer to Microsoft's guidelines as the details of our project become more granular.

Diagrammatic Representation



Quad Chart

Need: TCNJ, as well as other customers in the market, are looking for a cost-effective, yet environmentally conscious way to balance energy supply costs.	**Approach**: Create a web-based module that allows for easy visualization of the costs of various supplies of power for TCNJ's campus.
Balance: Balance in energy cost and environmental sustainability Benefits for future use of buildings and energy sources	**Competition:** No direct competition; energy star provides a somewhat similar service on a per building basis.

Project Proposal - Energy Supply

02-05

Rebecca Goldberg, Robert Helck, Adriana Barroqueiro, Robert Fenton, Jeffrey Liu, Alexis Gualario

Problem Statement

"The Mission of the office of Energy and Central Utilities is to deliver highly reliable electricity, chilled water, steam, and utilities at the lowest cost to the campus."(TCNJ Energy and Central Utilities)

TCNJ is committed to providing a reliable but cost-efficient energy supply to the TCNJ campus. There is currently no application that lets users access and visualize the use and costs of locally produced versus grid energy with environmental considerations for the entire TCNJ campus.

Users would benefit from a single module that provides visualizations, displays, and comparisons of the costs and environmental impacts of the various energy supply methods.

Objective of Module

To create a comprehensive application that allows the institution to balance environmental concerns with their spending budget and energy costs. The goal of the module is to assist the college in creating a budget friendly plan for shifting to a greener source of energy.

End product and importance

By aggregating and displaying data, this module will allow a user to come to an informed decision regarding the most cost-effective and environmentally friendly way to supply the TCNJ campus with power.

We plan to provide visual representations in the form of graphs and charts to help the user understand trends in their data. We believe that an intuitive user interface is crucial to achieving our goal of informing our users.

Data and Research

- Data on the unit cost of power
  - when produced locally vs. taken from the grid.
- Emissions and environmental impact for each energy supply method
- Seasonal fluctuations in price
- Potential costs associated with generating power on the TCNJ campus

Research would include obtaining available data on energy supply from similar institutions that have taken a “greener energy” initiative.

Difference in our System

Energy star Portfolio manager application

- displays data on energy consumption and efficiency per building.

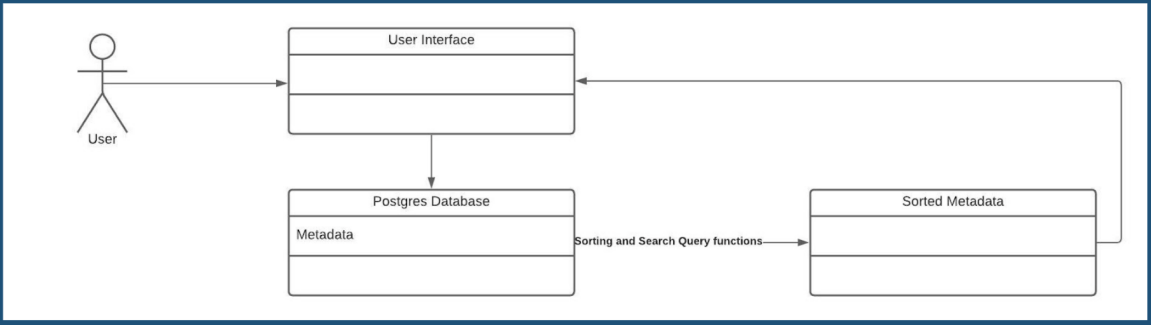
Our module will display campus-wide data on the costs of energy supply. We plan to include both locally produced power and energy from the grid, as well as the environmental consequences of producing versus outsourcing energy supply.

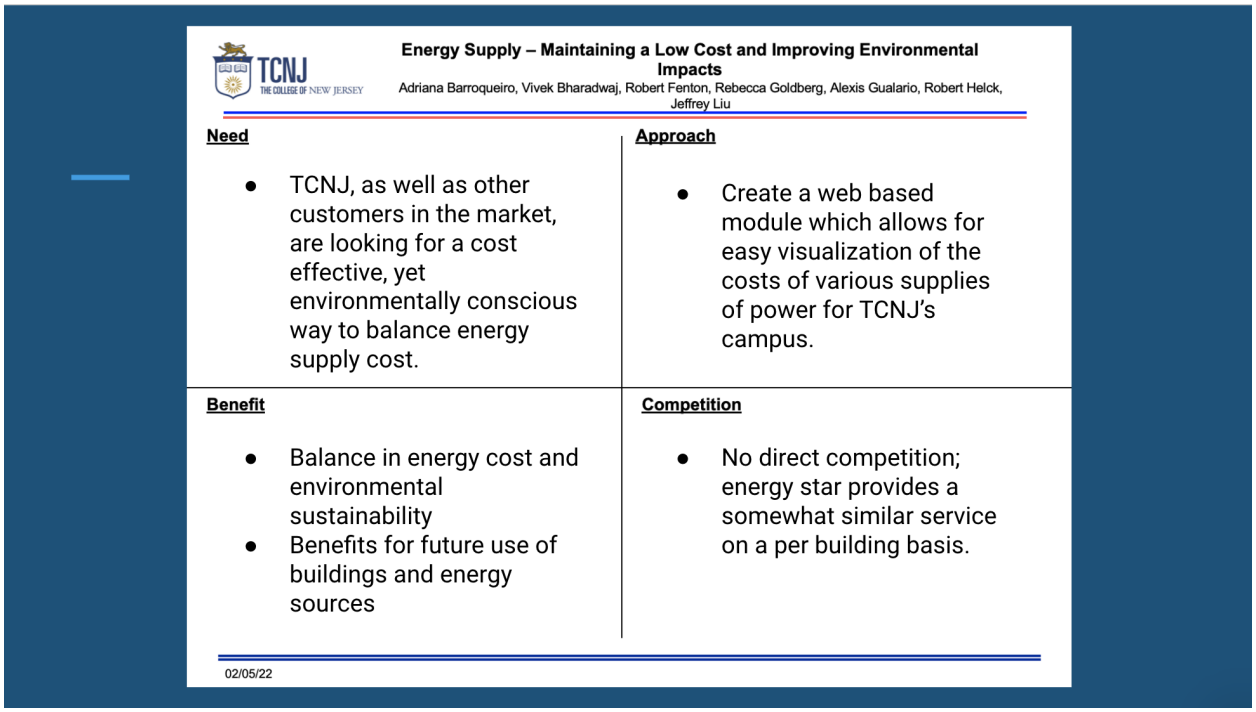
Other Uses of Module

This module will be useful in visualizing data from the past and current day, as well as providing projections into the future.

A possible modification can be to create multiple projection plans and compare them using live data. This means that a user could view historical trends in power supply in former years. It can also be used to build various plans for years in the future.

Diagrammatic representation of the system boundary





Specifications - Stage III

Desired end product, and the part you will develop for this class

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Importance and need for the module, and how it addresses the problem

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

To complete our task, we will need information from many sources. Namely, data on the unit cost of power when produced locally vs. taken from the grid. Important sets of data include the carbon emissions of each energy supply method, price, and energy expenditure in kWh, all in relationship to time. Some research on our part would include obtaining available data on energy supply from solar power and wind turbines in a similar-sized institution. This would allow us to create a better model for TCNJ power supply and cost calculations.

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database logins and uses. Registering for an administrator account will be limited to staff and faculty who present a pressing need to alter or configure certain parts of the database itself; normal users themselves will not be permitted to alter the database. We were not able to implement admin logins for the web application due to time constraints.

Technologies and database concepts the group will need to learn, and a plan for learning these.

We will need to learn how to use Python to create a secure connection to PostgreSQL, as well as learn how to use PostgreSQL in order to efficiently store our data. As students, we will learn the basics of how to use these tools in class and then will look for reference material on the execution of specific tasks that we may not be familiar with doing. Each member in our group has different experience levels with tasks that we will be responsible for, but this allows for us to learn as a group while having an "expert" on various topics.

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Mid Semester Project Report: Energize TCNJ

Adriana Barroqueiro, Robert Fenton, Rebecca Goldberg, Alexis Gualario, Robert Helck, Jeffrey Liu, and Vivek Bharadwaj

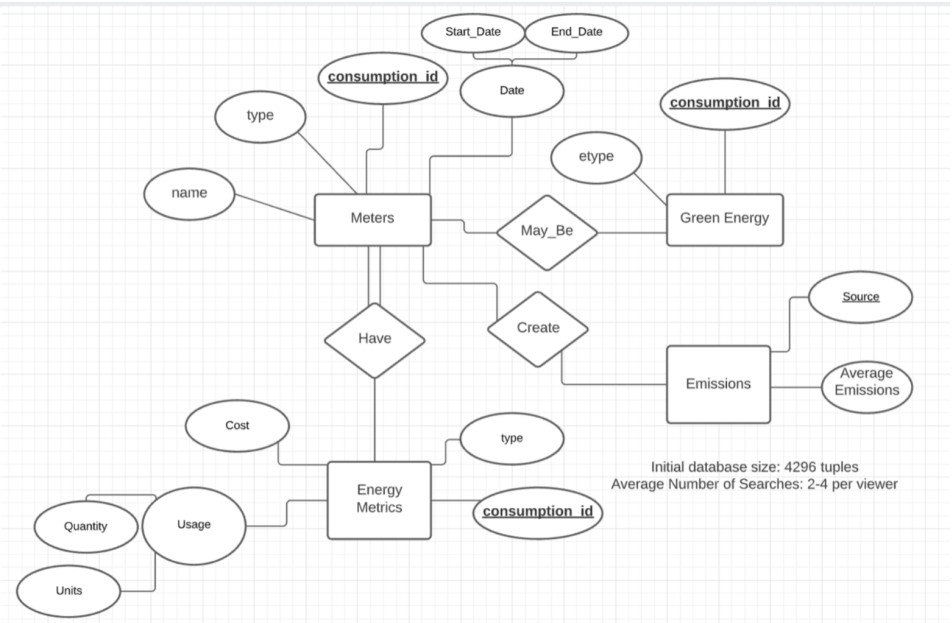
Overview

- To create a comprehensive application that allows the institution to balance environmental concerns with their spending budget and energy costs.

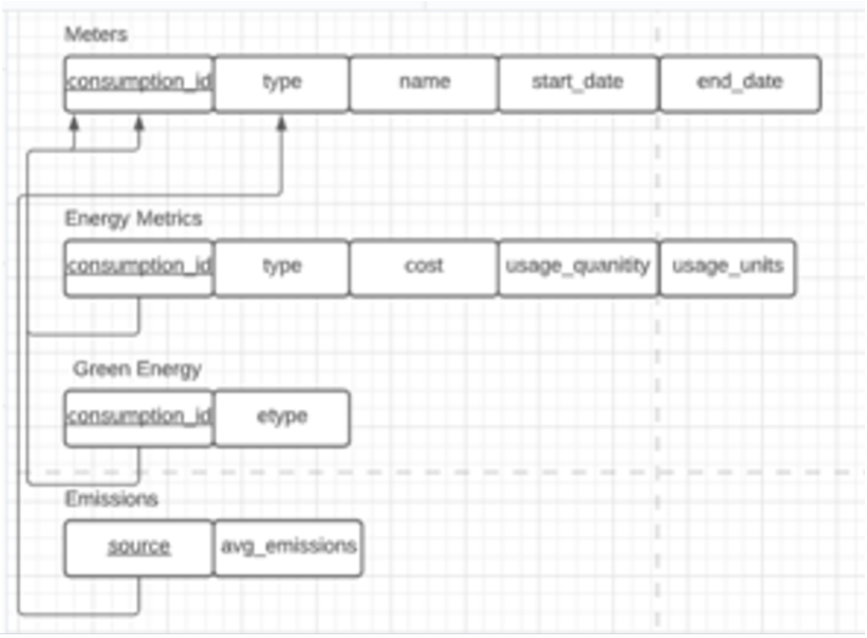
Stage III

- went into detail about database model
- completed an ER diagram
- created a relational schema

ER Diagram



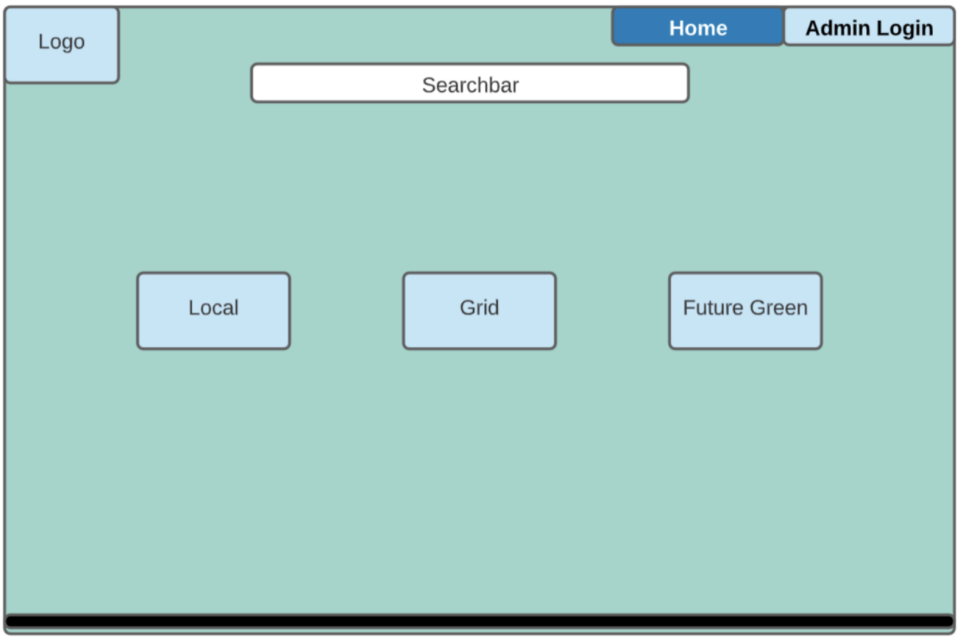
Relational Schema



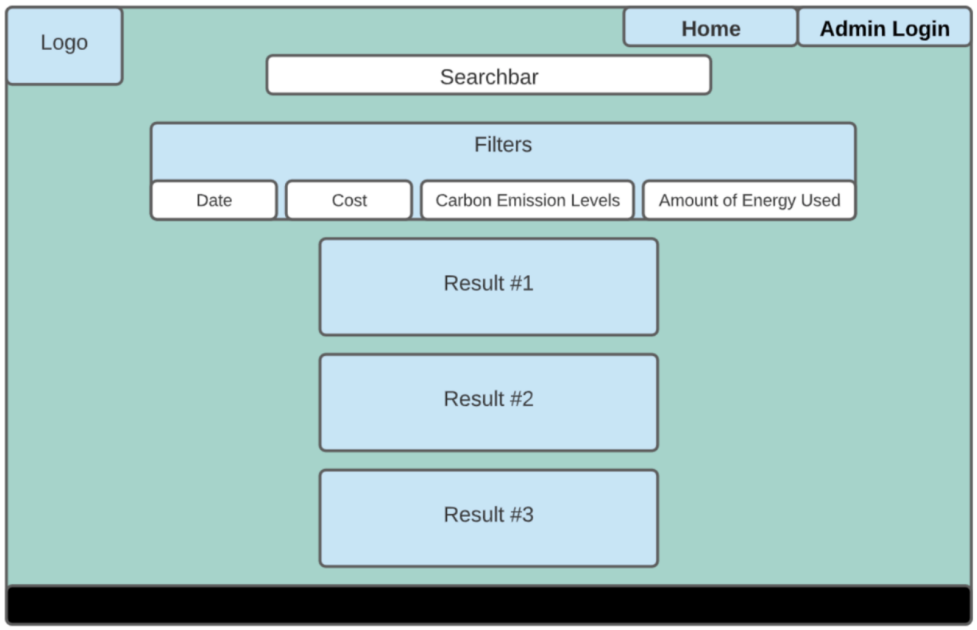
Supported User Queries

- Search for values to find data related within the database
- Generate graphical representations for current data or future projections of energy usage, cost, etc.
- Provide filters to sort tables by their attributes
    - Ex. Date -> 2009-10-09 to 2022-03-08

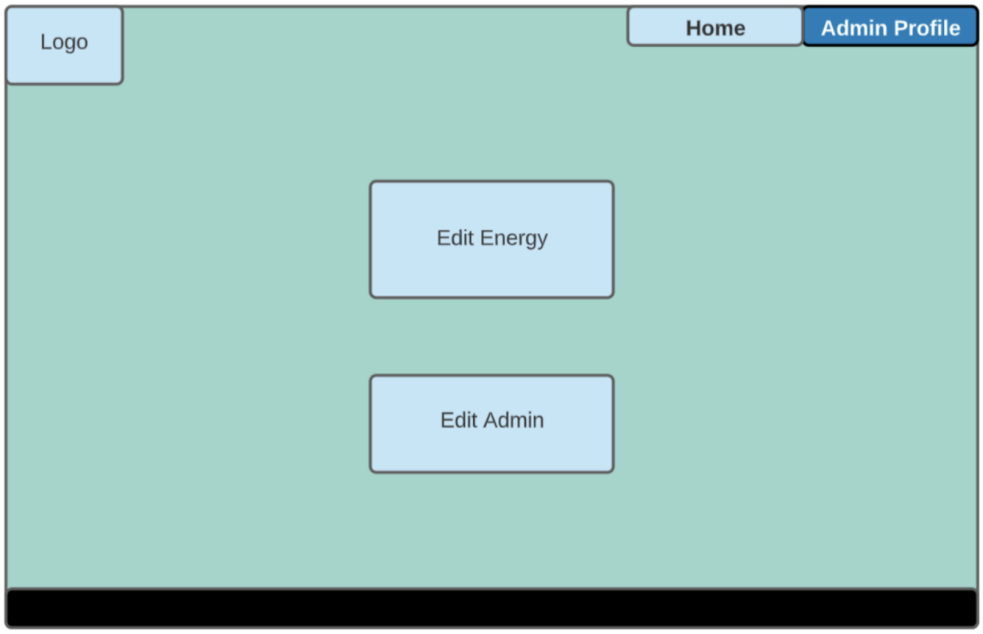
Home Page

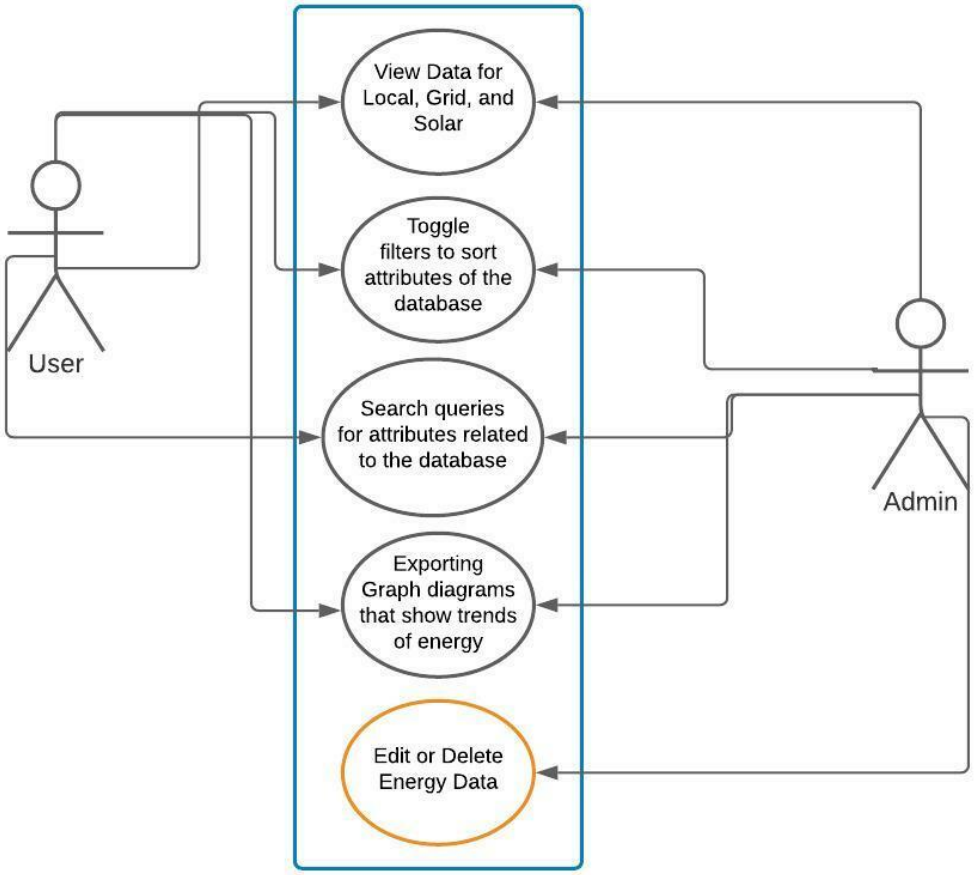


Results Page

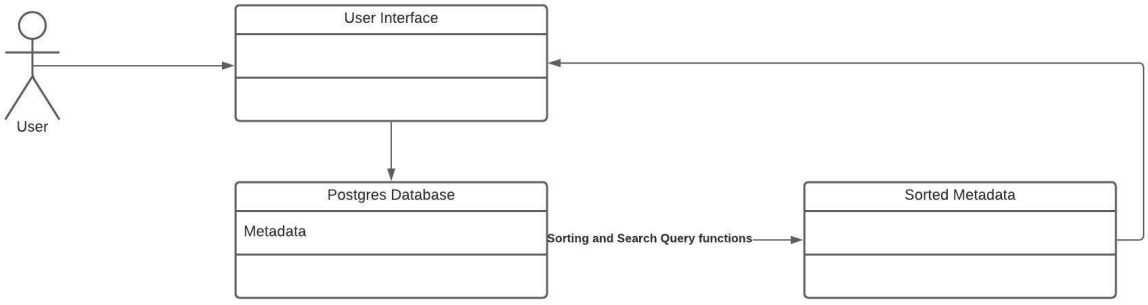


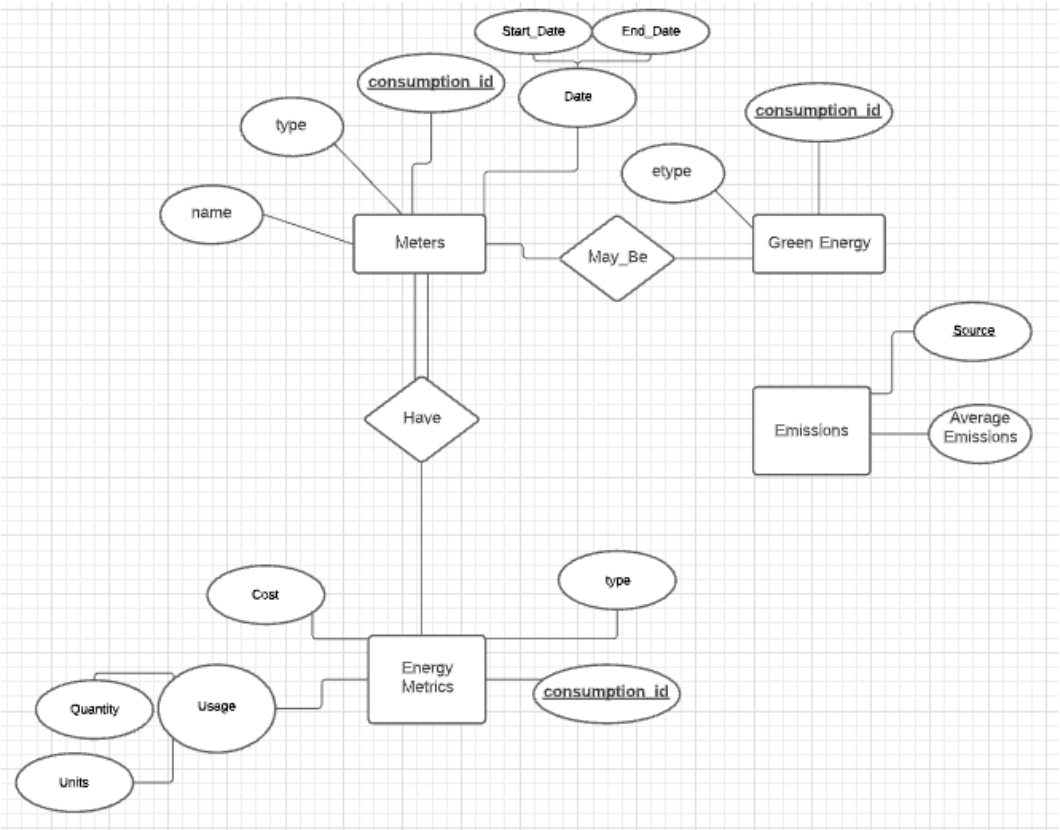
Admin Profile Page



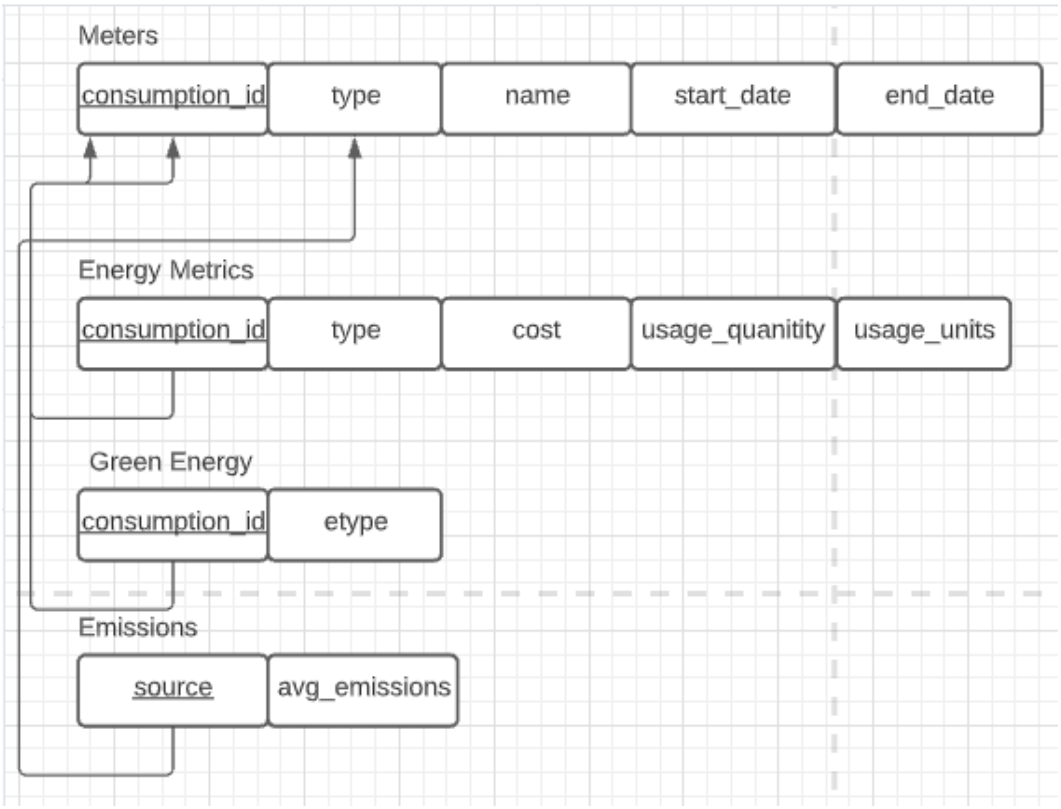


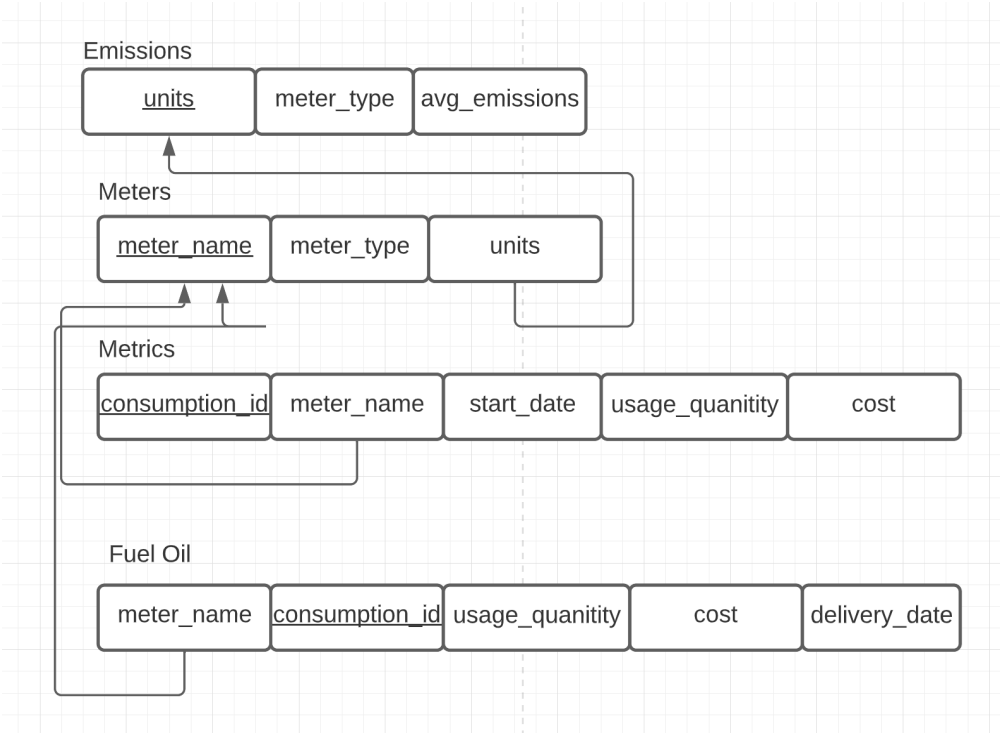
Diagrammatic Representation





Initial database size: 4296 tuples
Average Number of Searches: 2-4 per viewer





Updated Relational Schema for the module. The proposed schema was not fully normalized and created errors when scripted into the database.

GitHub Link:
https://github.com/TCNJ-degoodj/cab-project-02-5