Mid-Semester Project Report

The College of New Jersey

Group 01-1
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Elaboration: Project Proposal and Specifications

I. Problem Statement

The electrical grid is a complex, interconnected system of power generating plants, transformers, substations, and power lines through which electricity is supplied from producers to consumers, with the three main components of the electricity supply chain consisting of generation, transmission and distribution. During the generation phase, energy from primary resources such as coal, natural gas, oil, and nuclear energy (nonrenewable sources), as well as wind, solar, geothermal, and hydropower (renewable sources) is converted into electricity, both a secondary source and energy carrier. There are two types of generation—centralized and decentralized—with the former referring to the common, widespread power production manufactured far away from consumption, and the latter occurring significantly closer to consumer demand. In order for centralized electricity to reach end users, power lines and transformers (used to “step up” or “step down” electrical voltages during different stages to increase efficiency, minimize loss, and ensure consumer safety) are relied upon in what is known as the next process: transmission. Finally, substations, smaller transformers, and distributor lines are used to complete the third component of the electricity value chain: distribution.

From the ability to operate appliances to the advancement in technological and medical services provided, electricity is an indispensable staple of modern life, with innumerable uses people may or may not take for granted. Electricity is a necessity, and the electrical grid remains a leading power source for hundreds of millions of residential, industrial, and commercial consumers. According to statista, in 2018, the world’s electricity consumption amounted to approximately 23,398 billion kilowatt hours, or 23,398 terawatt hours; U.S. consumption, alone, totaled approximately 4,194 terawatt, making it the second-largest electricity consumer after China. Electricity, however, is also a perishable commodity, with not only depleting effects of nonrenewable natural reserves, but far-encompassing negative implications and externalities to the environment, public health, and economy. While electricity, in and of itself, is a “clean and relatively safe form of energy when it is used,” the perils lie in the generation and transmission of the energy supply. When fossil fuels and other nonrenewable resources are used to generate electricity, a number of harmful pollutants, such as carbon dioxide and sulfur dioxide, are emitted into the air and water systems, contributing to climate change and global warming.

Today, a number of businesses and facilities are working progressively to reduce their carbon footprint. For that reason, we ask this question, “when is it most economical and least polluting for The College of New Jersey campus to produce its own power as opposed to using an electrical grid on both a site and source basis?

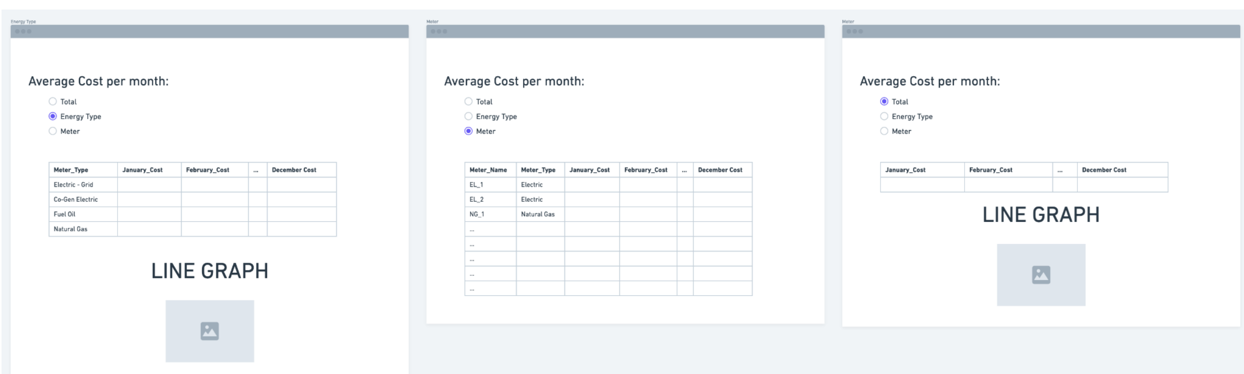
II. Objective

The objective of our module is to create a web application that provides a user important interpretations of data regarding TCNJ's energy supply. This will be done by displaying the results of useful, complex and efficient queries from our database and constructing data models based on important data points. We will use those spreadsheets provided for us to use in Canvas that are keyed in on energy supply.

III. End Product Description

Our end product will be a web application created using python and flask. This application will use a Postgres database containing data about TCNJ's energy supply to provide the user with useful information. We expect to see a best scenario end result by the research we gather from both data provided and outside research done regarding the relevant information and variables. We hope to see which option least impacts stakeholders and TCNJ as a whole.

UI Mockup and Use Cases



IV. Module Importance

Our module is important for the school because it provides needed information to the user about TCNJ's energy supply. Sustainability is very important and it is crucial that TCNJ is equipped with the necessary information to make decisions about how they will address this topic in the future. Our application will help TCNJ move forward in a way that is both economical and environment-friendly.

V. Research Plan

Our research plan is to calculate and find important values such as the average monthly cost, how this cost changes between months, the average monthly cost per type of meter, and the energy production. The majority of the data that we need to focus on has been given to us by our client, so we can focus our research on studying data rather than obtaining it. We will be analyzing the given data to find the most important data points and relationships that exist between different values. Also, the number of machine hours used. The costs to install and operate components represent additional operational expenses. The increase of usage is a major factor increasing energy supply because the more it is used through a community, the more supply of energy is increased that then increases the cost. Maily demand and supply are the easiest terms to put it. Manufacturing, installment, usage, maintenance. After completing our analysis, we can create meaningful queries and implement our database.

VI. Comparison to Other Systems

Our application is similar to other applications such as Energy Star Portfolio Manager or AASHE STARS, however our application is much more catered to TCNJ's demands to satisfy the sustainability plan set for 2020-2024.

VII. Other Applications

This application can be modified to allow for projections of energy costs in the future given TCNJ's sustainability commitment. In addition, the application can be further modified to allow for cost predictions of different energy sources that may be developed and considered for adoption at TCNJ in the future.

VIII. Performance

Since our web application is relatively small, with our database likely only containing a few thousand instances, application performance should be very efficient.

IX. Security

Github classroom provides security so security should not be a concern for our project. Once the application is live, we will allow two different types of users. One type, an administrator, will be able to add or change data. The other, a regular user, will only be able to view the data. This will prevent unauthorized users from making changes to the application. Once the project departs Github, only authorized users will be able to access and manipulate the data to prevent any misrepresentation of TCNJ's energy supply to the client, which can be implemented with Flask's user authentication functionality.

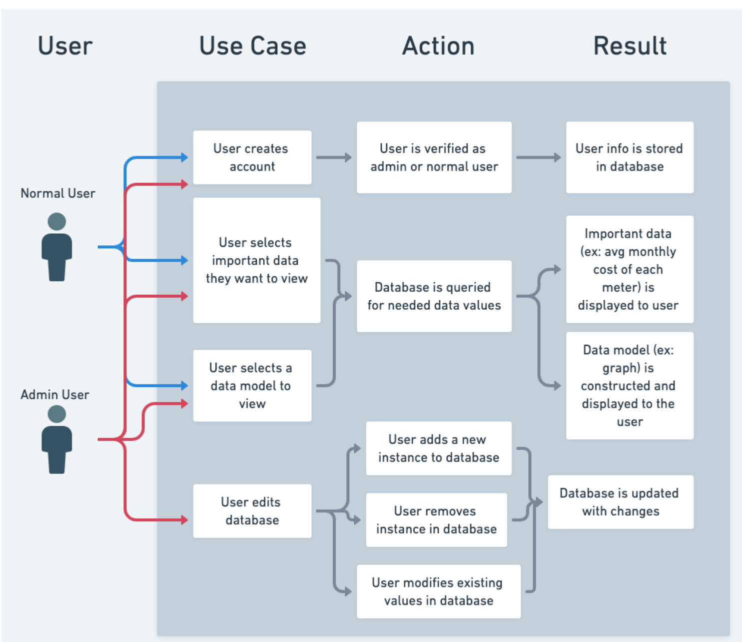
X. Backup and Recovery

Github provides our project a proven backup and recovery system for our project, so we will be leveraging it for this purpose. Once launched and delivered to TCNJ facilities, the project will be backed up on the TCNJ Cloud for simpler recovery. In case of TCNJ facility failure, together Flask and SQL have functionality for both local and remote server backups.

XI. Technological and Database Concepts

We are going to be implementing a relational database using Postgres on a dynamic web application created using python and flask. Understanding these technologies will be crucial to completing this project.

XII. System Boundaries Diagram



XIII. Quad Chart

TCNJ THE COLLEGE OF NEW JERSEY

Energy Supply

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Need

- Our customer would like to find out when is it most economical and least polluting for the campus to produce its own power as opposed to using an electrical grid on both a site and source basis?
- Electricity is a perishable commodity, finding the best systems to produce electricity efficiently is imperative for sustained success in the future with the increasing demand.
- Finding the least polluting sources of supply is critical as more stringent laws and regulations may pass in the future, requiring supply systems with cleaner energy.
- With the depletion of natural resources, new sources of clean and renewable energy is required for the future

Approach

- Our group plans to provide the user with a web application that provides useful interpretations of data regarding TCNJ's energy supply by displaying useful data models and useful, complex and efficient queries.
- Our web application will be created using python and flask. This application will use a Postgres database containing data about TCNJ's energy supply to provide the user with the needed information.
- Our plan is to calculate and find the average monthly cost, how this cost changes between months, the average monthly cost per type of meter, and the energy production of the Tri-Gen.
- We will be researching the energy supply of the buildings on campus. After, we will import that information and organize it into a database.

Benefit

- The benefits of the application allow for projections of energy costs in the future given TCNJ's sustainability commitment.
- The application can be further modified to allow for cost predictions of different energy sources that may be developed and considered for adoption at TCNJ in the future.
- The stakeholders will be given a database with the requisite information, calculations, and graphs that can assist with getting a better understanding of the models.
- The environment would benefit as this data can assist with the energy supply and further research into new supply resources
- Rather than getting outside electrical supply from a grid, TCNJ can generate their own energy at a lower rate and independent from any other sources

Competition

- The benefits of TCNJ creating their own supply independently from the grid allow for a better application of excess energy. In the summer TCNJ is able to cool their water with the excess steam energy created by the Tri-Gen generation. In the winter, the campus can heat their buildings with the excess energy.
- Limiting the amount of wasted electricity can save TCNJ money and allow the college to recycle the energy for their own benefit.
- Electrical grids also require TCNJ to get supply from other vendors which forces them to rely on that supplier. If there is an energy grid failure or issues on the other end, then TCNJ is affected. By creating their own electricity, TCNJ can maintain their own facilities to their own standards, allowing the college to be more self-sufficient.

02/05/2022

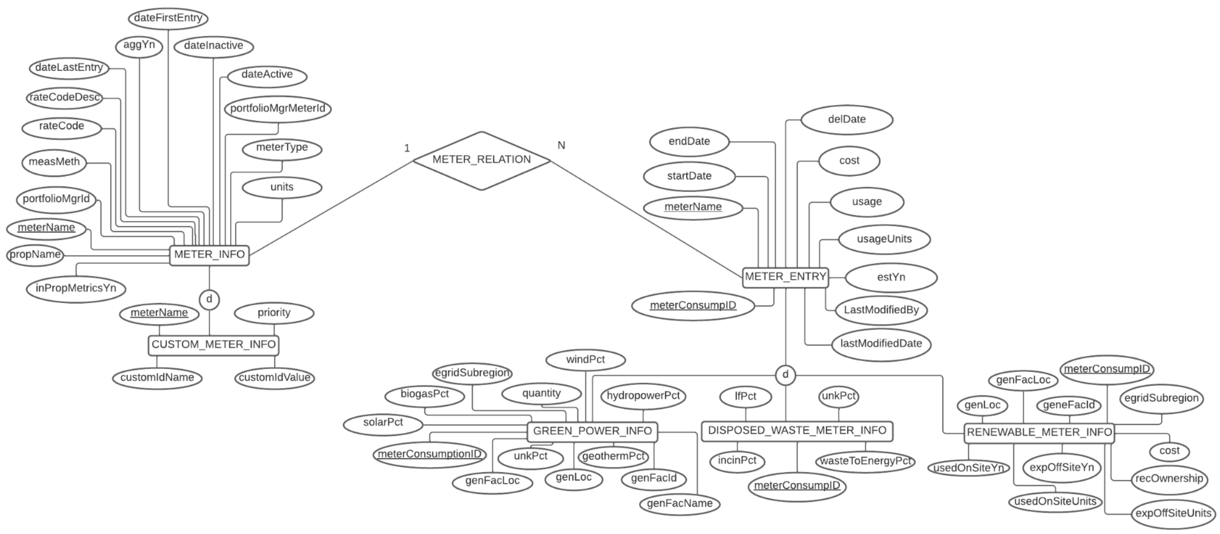
Elaboration: Design

I. Estimations

There are about 1,430 meter entries in the data given. Since this is the bulk of our data, we can assume that the rest of our records will add up to substantially less than this number. In total, we expect between 1,500 and 2,000 records,

We expect to need about 5-10 searches in our web application. The majority of these searches will access data in the METER_ENTRY table since this is where the most important data is. Many of these searches will use aggregate functions to obtain meaningful values such as average costs.

II. ER Diagram



III. Relational Schema