02-2
Energy Demand

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I) Proposal: Energy Demand Project Specifications:

1. Problem Statement:
    a. Determine the estimated energy demanded and corresponding energy cost of each of the buildings on TCNJ campus.
2. Objective of the Module:
    a. What is the energy demanded for each building per square foot?
    b. Do hot or cold months require more energy for a specific building, if so how by how much?
    c. What are the most significant characteristics that correspond to the energy demand of each building on the TCNJ campus (example: year built, use details, building operational hours)?
    d. How much carbon-equivalent emissions are produced by a specific building due to the amount of energy consumed?
3. Description of the Desired End Product:
    a. **Use Case Name:** Get General Statistics
        i. **Actors:** Paul Romano & Sustainability Staff
        ii. **Flow of Events:**
            1. The Staff member navigates to energysavers website.
            2. The Staff member selects from the dropdown menus the desired buildings (Bliss Hall, STEM Building, Social Sciences Building, etc.).
            3. The Staff member selects the “General Statistics” option from the options menu on the page.

4. The Staff member selects the “Submit” button.
5. The database processes the Staff member’s request and returns the attributes for the selected buildings.
6. The Staff member views the returned results in a table format and eases the process of completing subsequent analysis.
7. The Staff member clicks the exit button at the top-right of the window to leave the website.

b. Use Case Name: Get Energy Demand

i. Actors: Paul Romano & Sustainability Staff

ii. Flow of Events:

1. The Staff member navitages to the energysavers website.
2. Staff member selects from the dropdown menus the desired buildings (Bliss Hall, STEM Building, Social Sciences Building, etc.).
3. The Staff member selects the “Energy Demand” option from the options menu on the page.
4. The Staff member selects the “Submit” button.
5. The database processes the Staff member’s request and returns a table for the estimated energy consumption per square foot for days, months, and years.
6. The Staff member views the returned table and completes their analysis.

7. The Staff member clicks the exit button on the top-right of the window to leave the website.

c. **Use Case Name:** Get Energy Consumption by Season

   i. **Actors:** Paul Romano & Sustainability Staff

   ii. **Flow of Events:**

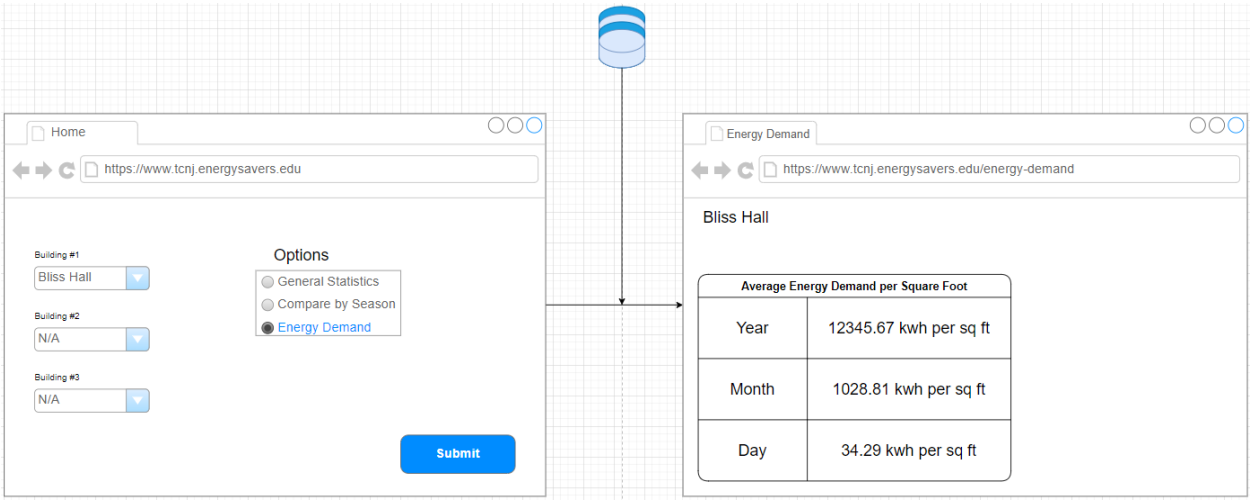
      1. The Staff member navigates to the energysaver website.
      2. The Staff member selects from the dropdown menus the desired buildings (Bliss Hall, STEM Building, Social Sciences Building, etc.).
      3. The Staff member selects the "Compare by Season" option from the options menu on the page.
      4. The Staff member selects the "Submit" button.
      5. The database processes the Staff member's request and returns the table for the energy consumption by seasonality.
      6. The Staff member views the returned table and completes their analysis.
      7. The Staff member clicks the exit button the top-right side of the window, leaving the website.

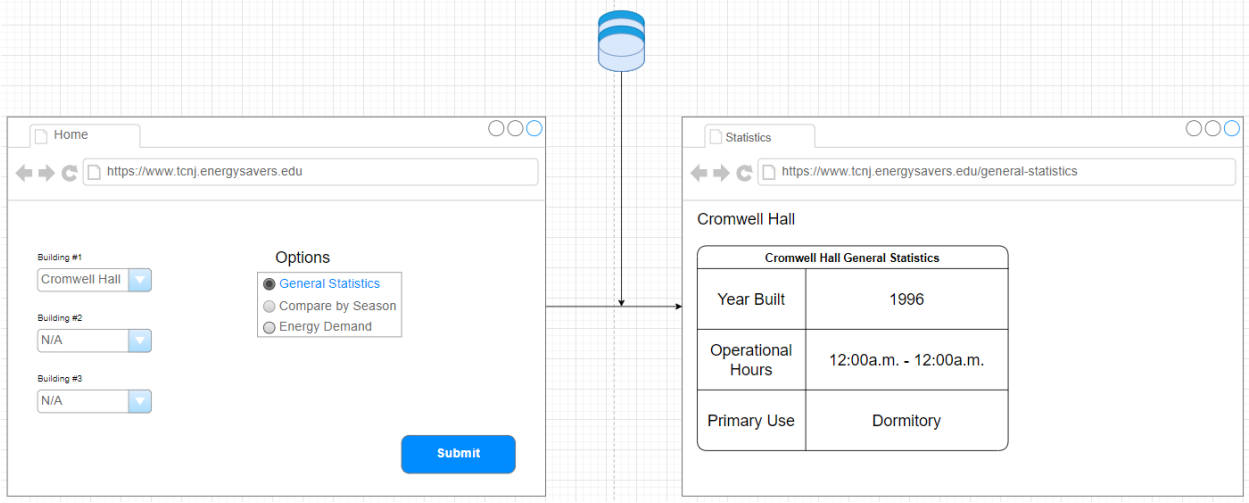
d. Provide database access to the TCNJ sustainability Staff and Paul Romano.

e. Create a home page that displays a description of the website and provides easy navigation.

f. Implement users with privileged (can modify the data) and non-privileged (can not modify the data) access.

g. Allow users to input desired information about specific buildings (based on questions from the objective of the module) and provide them corresponding tables.





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

   a. Personalized database architecture offers the desired energy demand data to allow the TCNJ sustainability team to access and analyze a large amount of data easily.

b. The data provided with the Excel sheet is cumbersome to read and understand for the average user, so we intend on clarifying certain data entries for the average user.

5. Plan for how you will research the problem domain and obtain the data needed:
    a. To be able to compare the building's energy consumption on cold versus hot months, we will find weather data on temperature averages of the corresponding months.
    b. We will use the building's area and use details to estimate the energy consumption of that building.
    c. We will research conversion factors between the energy consumed for each building and the corresponding carbon-equivalent emissions. By using equivalent units, we can provide the client with a benchmark for CO_2 emissions categorized by building.
6. Other similar systems / approaches that exist, and how your module is different or will add to the existing system:
    a. Our module is personalized for The College of New Jersey. Similar systems like Energy Star can be overwhelming for the average user. Our interface is simple and provides comprehensible chunks of data based on the query instead of all the data at once.
7. Possible other applications of the system (how it could be modified and reused):
    a. While the database will be built on the goal of providing Paul Romano and his team an easy way to analyze TCNJ buildings' energy consumption, the data could be extended to other sectors of TCNJ. For example, TCNJ workers who analyze

the college's budget can use the database to determine how much money is being used for energy in specific buildings.

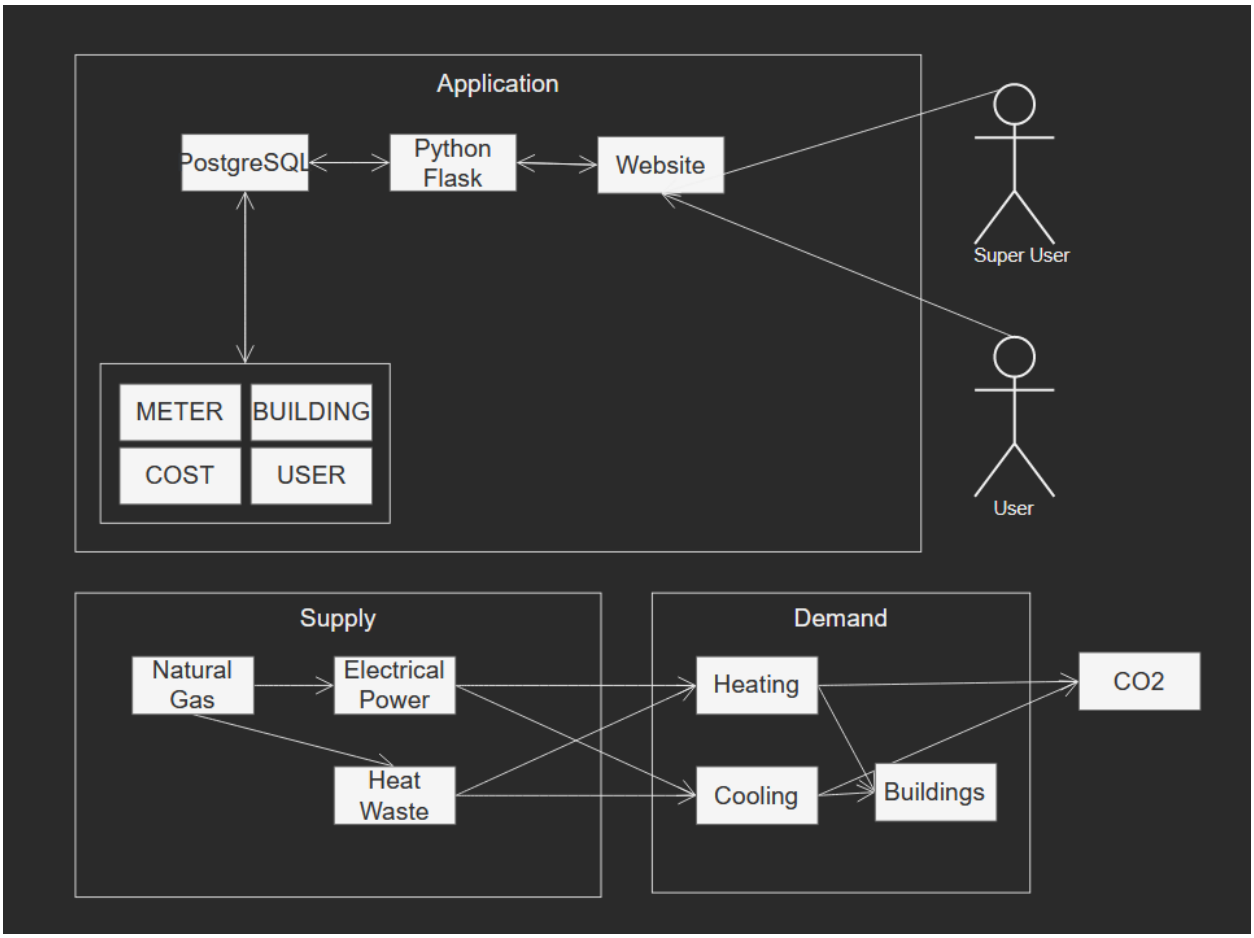
8. Performance:
    a. The data is not at a large enough scale to significantly reduce performance. Thus, no extra measures are needed to address this.
9. Security:
    a. TCNJ server cluster and GitHub provides the authentication services for security.
    b. Access to the database will be provided by user authentication via login page.
    c. Access to the data is exclusive only to members of the TCNJ sustainability team and other authorized users.
    d. Security can be provided by a login page for sustained use off of Github.
10. Backup and recovery:
    a. The database will be hosted on the GitHub distributed servers therefore there is inherent redundancy. The TCNJ server cluster utilizes backup images thereby providing recovery for our application or database.
    b. After the database departs from GitHub, we plan to backup the database weekly to an external drive. Furthermore, redundancy will be provided by hosting the database on a multitude of database servers.

11. Technology and Database Concepts To Learn
    a. Develop an understanding of relational databases and how to efficiently and securely query the databases.

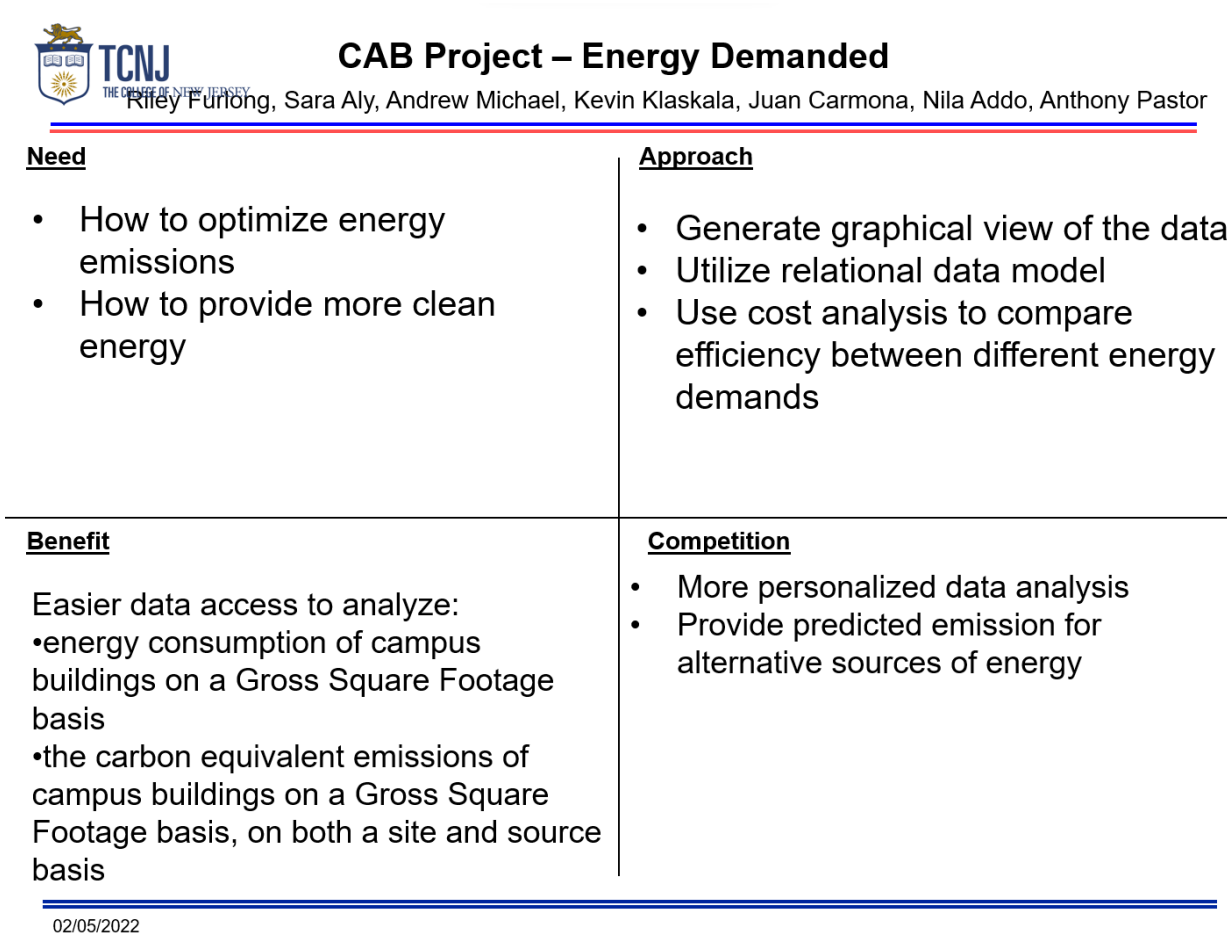
b. Learn how to utilize data sanitation for protecting against SQL injection and other forms of malicious use.

c. Learn how to create effective ER diagrams and identify keys to develop a comprehensive schema.

12. Diagrammatic Representation of the System Boundary



13. 1-Page Energy Demanded Quad Chart:



CAB Project – Energy Demanded

Riley Furlong, Sara Aly, Andrew Michael, Kevin Klaskala, Juan Carmona, Nila Addo, Anthony Pastor

Need

- How to optimize energy emissions
- How to provide more clean energy

Approach

- Generate graphical view of the data
- Utilize relational data model
- Use cost analysis to compare efficiency between different energy demands

Benefit

Easier data access to analyze:
•energy consumption of campus buildings on a Gross Square Footage basis
•the carbon equivalent emissions of campus buildings on a Gross Square Footage basis, on both a site and source basis

Competition

- More personalized data analysis
- Provide predicted emission for alternative sources of energy

02/05/2022

II) Project Pitch

Problem Statement

How can we determine the efficiency of the energy consumption and cost benefit of alternative energy resources in buildings across the TCNJ campus? With in depth analysis, we can offer a more personalized approach to potential distinct energy solutions.

Objective of the Module

- Can we view the data in a more comprehensible manner?
  - User-friendly web interface
- How do we analyze financial impact of energy demand?
- What options exist for green energy usage?

Desired End Product

- Built upon a relational database
- Centralized access point
- Authentication provided through login page
- Implementation of homepage for ease of navigation
- Graphical representation for ease of viewing of the data

Importance and Need of the Module

- This module is essential to understanding the energy demand of TCNJ buildings and how to maintain an energy and cost efficient campus-wide protocol.
- There is a need for this module in order to truly identify the best energy sources for specific areas of the campus and understand the financial impact each will have.
- Our graphical representation will provide stakeholders with a more comprehensive understanding of energy consumption and carbon emission.

Researching the Problem Domain/Obtaining the Data

- By using accounting principles involving cost analysis, we can analyze TCNJ's individual buildings' energy efficiency, in order to get the economic data and resulting monetary effect of the current energy consumption across campus
- Consumption wise, we will utilize equivalent units in order to benchmark current actual CO2 emissions against alternative energy forms (including green energy) and the amount of predicted CO2 it would emit if that alternative energy source was utilized

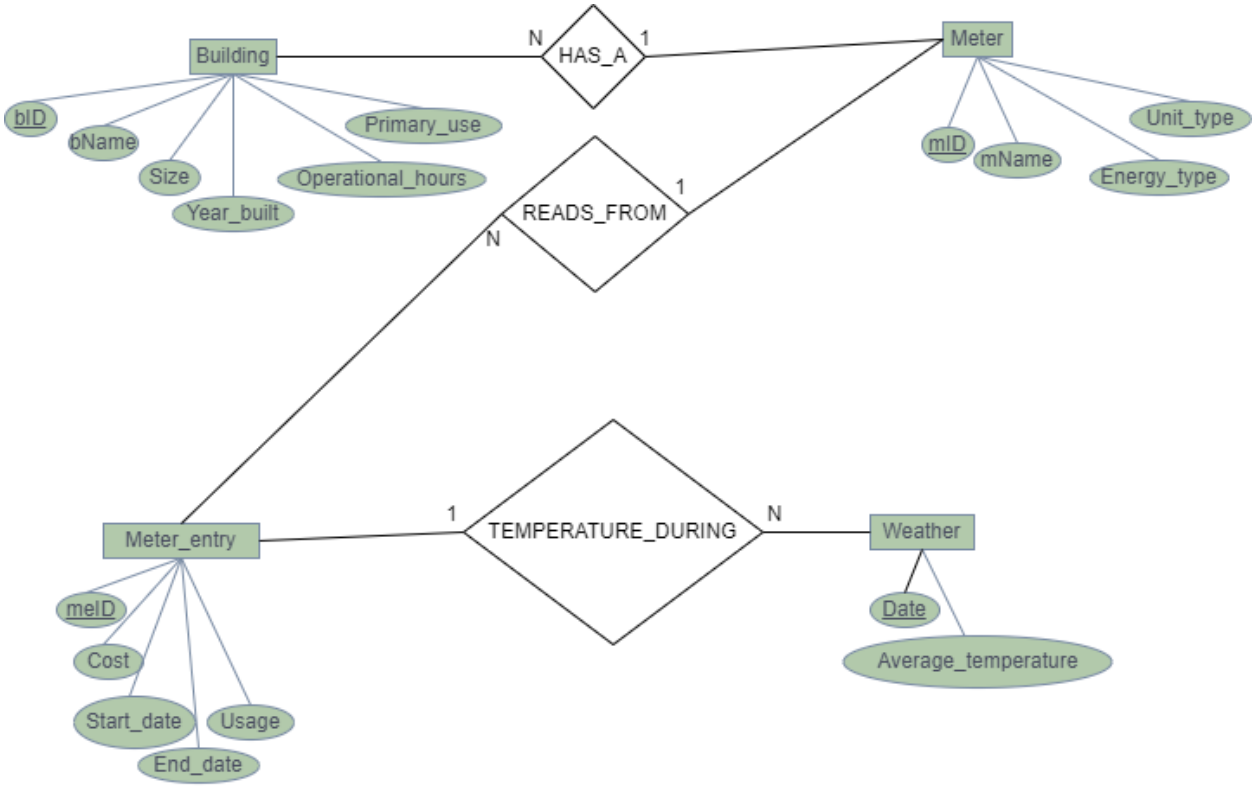
How Our Model is Different

- Our module differs where we will provide both the energy efficiency and cost efficiency of used energy for a certain building/entity in user friendly format
- as well as providing users with green solutions that show the expected economic and energy efficiency effects of switching to green energy to help them make decisions

Possible other applications of the system

- Our database is made for Paul Romano and his sustainability team
- However, other sectors such as TCNJ Budget team can use the database
    - Example: analyzing costs of energy in dorm buildings when factoring in room and board costs

III) Database Model (ER and Relational Schema) Stage III



Building

bID	Name	Size	Year_built	Operational_hours	Primary_use

Meter

mID	mName	Unit_type	Energy_type

Meter_entry

meID	Cost	Start_date	End_date	Usage

Weather

Date	Average_temperature

IV) Mid-Semester Project Presentation

Energy Demanded

By Andrew Michael, Sara Aly, Juan Carmona, Anthony Pastor, Nila Addo, Kevin Klaskala, Riley Furlong

Update

At this point we have reconsidered our project given the data. We have created new objectives that correspond more to Energy Demand, instead of Supply.

Our presentation will consist of

- Updated Objective Modules
- Cost Analysis
- Web Diagram
- Entity Relation Diagram
- Relational Schema

Objective of the Module

1) What is the energy demanded for each building per square foot?

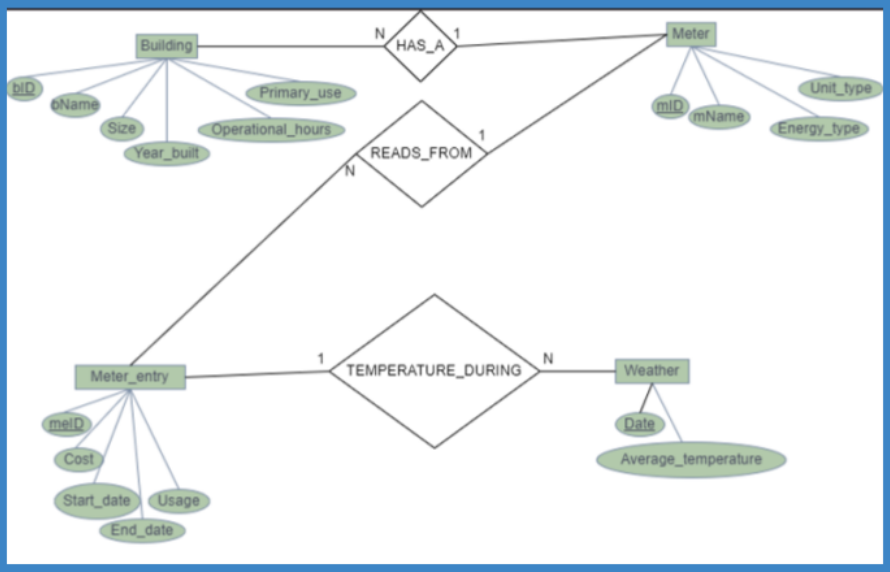
2) Do hot or cold months require more energy for a specific building. If so, by how much?

3) What are the most significant characteristics that correspond to the energy demanded of each building on the TCNJ campus (example: year built, use details, building operational hours)?

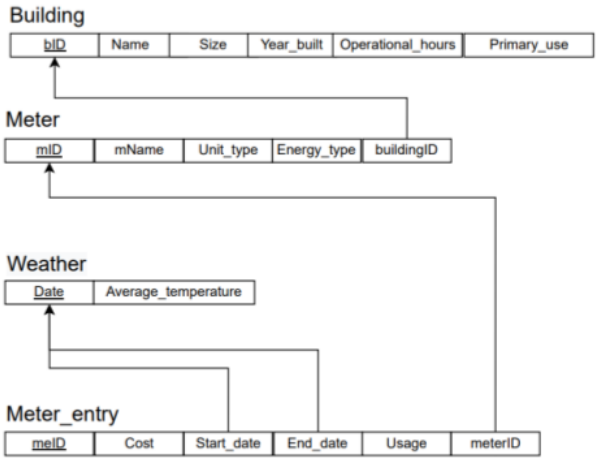
Cost Analysis

Initially one of our objectives is to determine the efficiency of buildings across campus. However, we could not determine such factors with the data given. As an alternative we have chosen to focus on an analysis of daily cost of running a building including during different seasonal weather patterns. We will use the cost per kilowatt hour of energy demand to determine the cost of buildings per day using operational hours as a metric for each building.

Entity Relationship Diagram



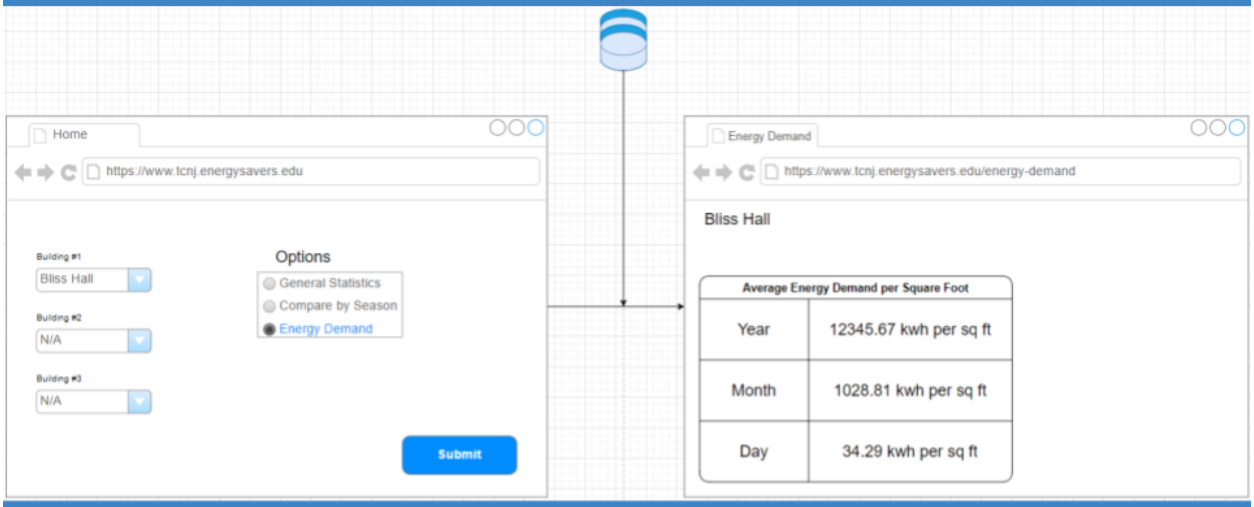
Relational Schema



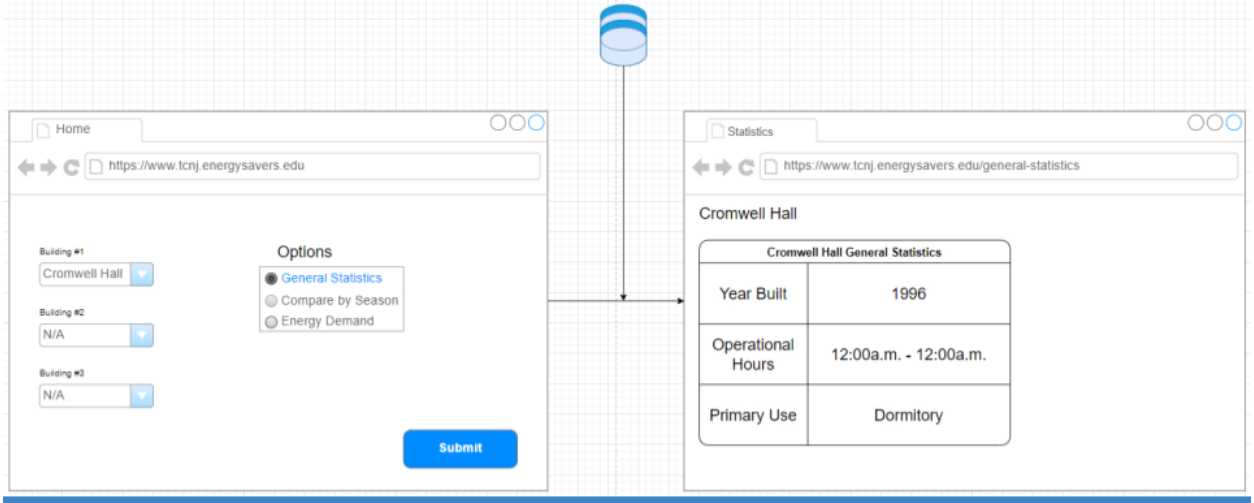
Database Information:

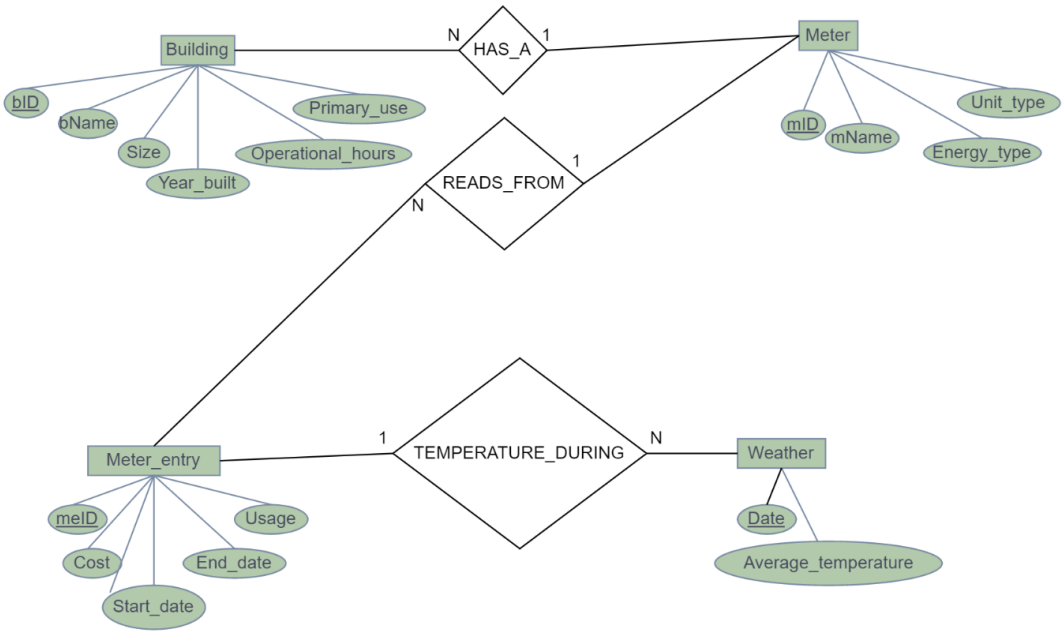
- Database size: **5000** (Degree days, buildings, meter entries, meters)
- Most popular type of search: **Energy Demand**
- Average number of searches per year: **40**

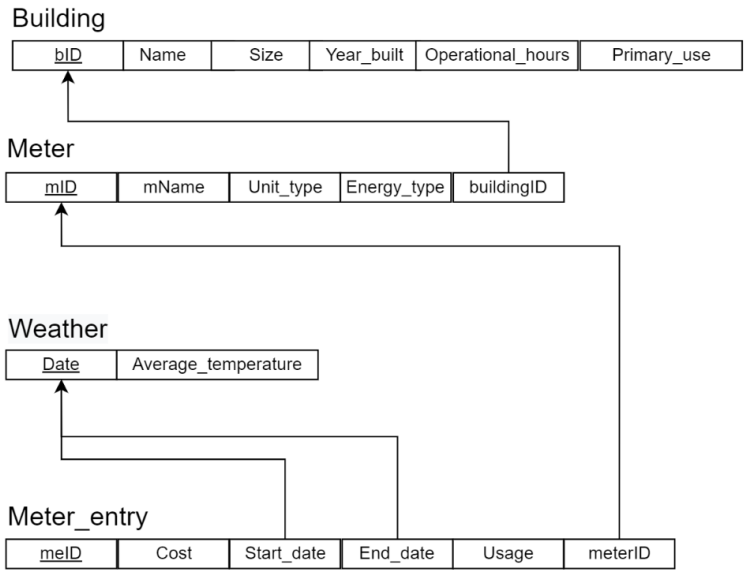
Energy Demand View Diagram



General Statistics View




Building
HAS_A
Meter
N
1
bID
bName
Size
Year_built
Primary_use
Operational_hours
mID
mName
Energy_type
Unit_type
READS_FROM
1
N
Meter_entry
1
TEMPERATURE_DURING
N
Weather
meID
Cost
Start_date
End_date
Usage
Date
Average_temperature


Building
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