Energy Supply Project Analysis (ESPA)

CSC 315/ACC 311-02 Group 1

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Energy Supply Database Project Pitch

• Problem statement.

As of recently, TCNJ is attempting to determine if their current sustainability and economical efforts are sufficient. The college has information regarding each of their buildings such as the type of meters used and the cost, but it is not maintained using a database or a user-friendly application or system. Moreover, the majority of the information is not easily understandable at first glance, and it is difficult to search for specific details such as the cost of energy or the amount of energy usage. Overall, the issue is determining which energy source contributes the most towards a possible economic or pollution problem.

• Objective of the module.

The objective of the project is to create and supply an easy to use application and database that is meant to highlight the general categories of energy supply as well as amount of energy cost with its respectable types of energy, which include fuel oil and natural gas and electric-grid. Furthermore, the project plans to address a way for users to see the relationship between the costs for sustainability and the environmental impact the sources have.

Our module will address the following questions:

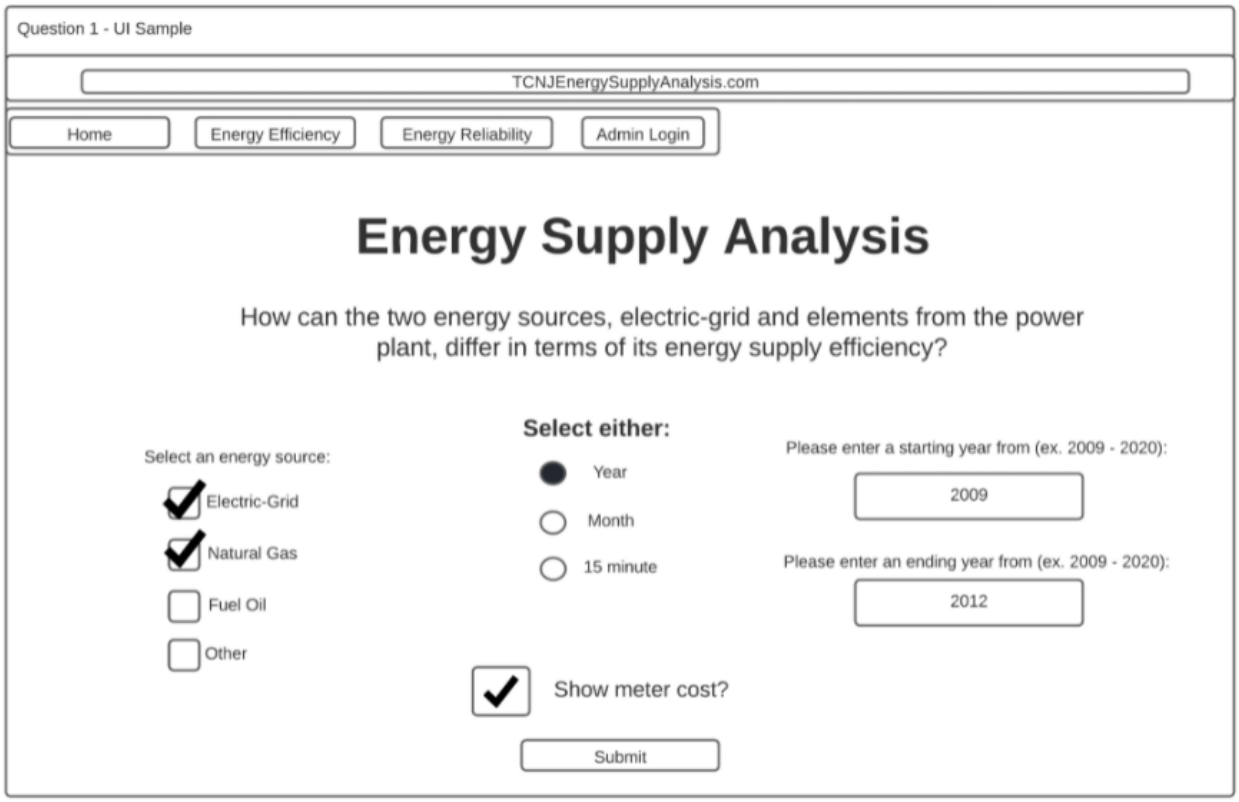
- How can the two energy sources, electric-grid and elements from the power plant, differ in terms of their energy supply efficiency?
- How can each energy source vary in energy supply depending on the dates and seasonal aspects?

The end goal is to provide the college with a product that will allow them to discern the best routes of action to become more efficient and cost-effective.

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

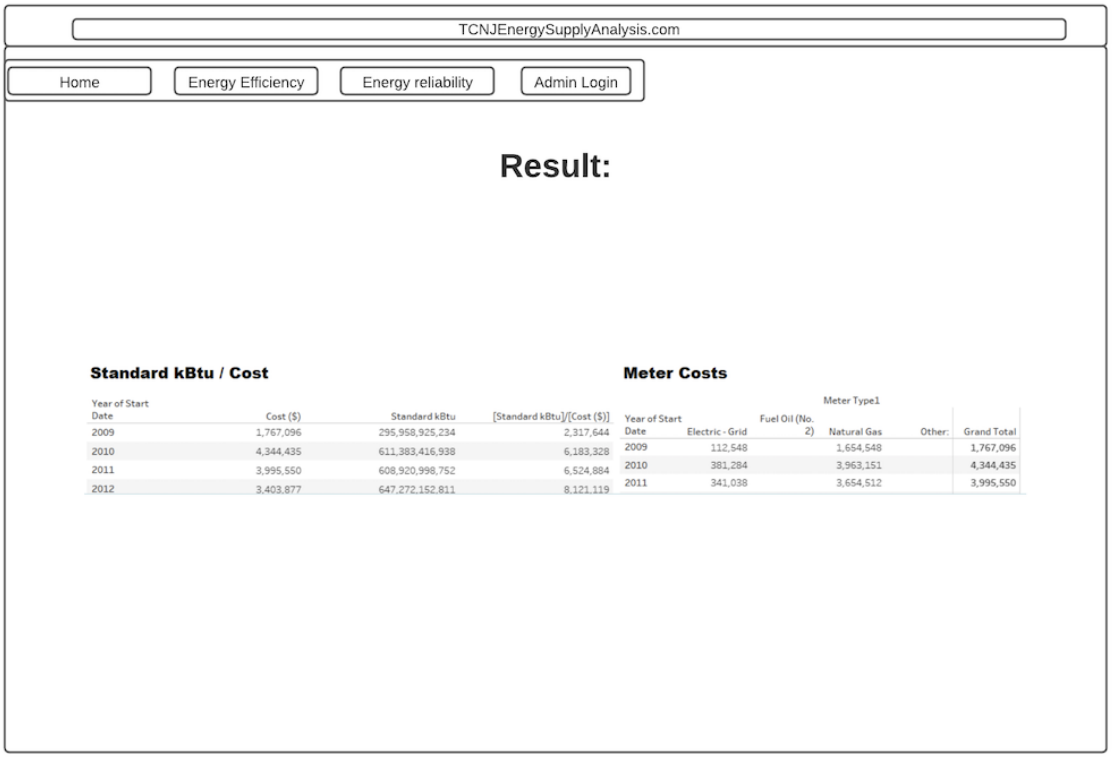
The desired end product that will be developed includes a finalized database and application where the user is able to retrieve their respective piece of information. For instance, the product will utilize a table that will allow the user to compare the energy supply for each energy source using the same unit of measurement and cost per unit. It will feature another table that shows the costs per year for each energy source. All of this information will be categorized by year. Check boxes will be added to allow the user to select which energy source they would like to look at, and text boxes will be used to have the user input what years they would like to see. Another checkbox will be inserted if the user would like to see the meter cost for each individual energy source.

REVISION: The user interface sample has been revised to insert radio buttons that offer a year, month, or 15 minute option. Additionally, an ‘other’ option using a checkbox has been added to the ‘Select an energy source’ area.



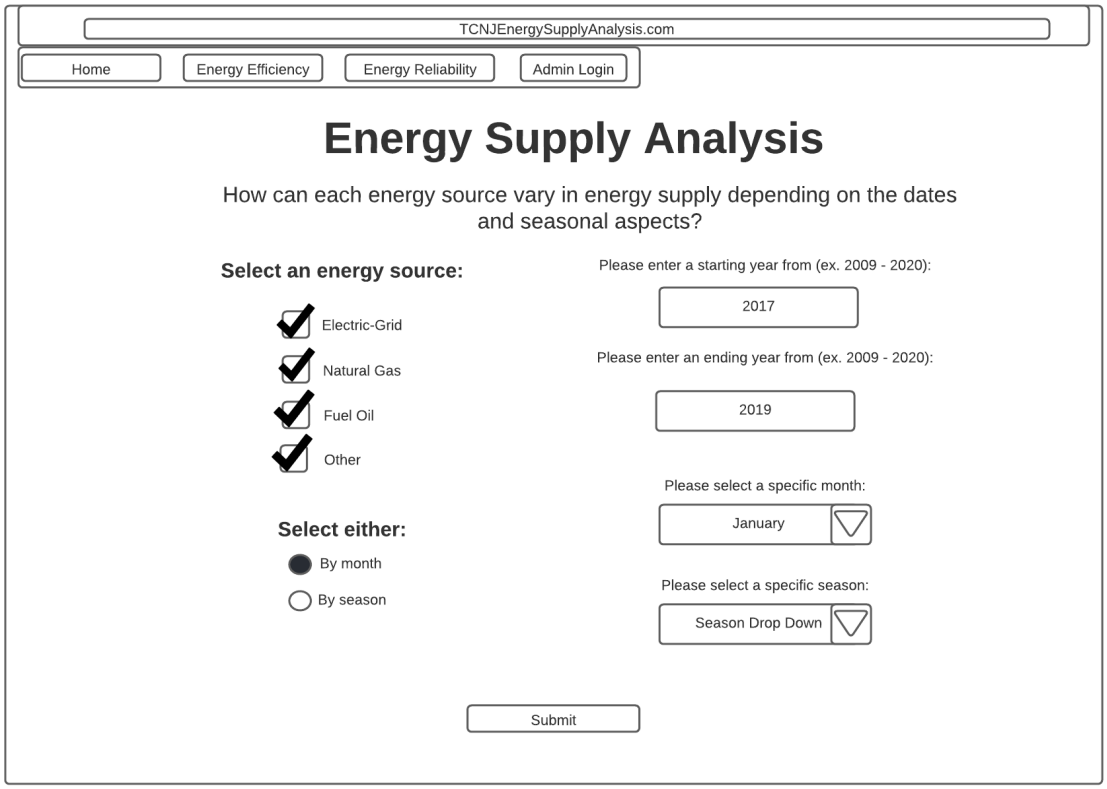
Database Interaction
(Use Case)

Using the input, we would take the type of energy sources selected and the starting/ending year, and we would search and display that data on a table. In this sample case, the user is looking for the cost of all the energy from the years ranging from 2009 to 2012. We would also convert each energy source's unit to kBtu and show the cost per year. Moreover, we would create an average that reflects kBtu/cost for each year. We will be using the SELECT and PROJECT operations to grab specific years along with the specific energy sources chosen by the user. Additionally, we will have a separate table that shows the separate meter costs per year for each energy source. Filters would be used to isolate the years and energy sources in the table. Furthermore, the JOIN operation will be used to have data from the selected energy sources into one table based on the years chosen.



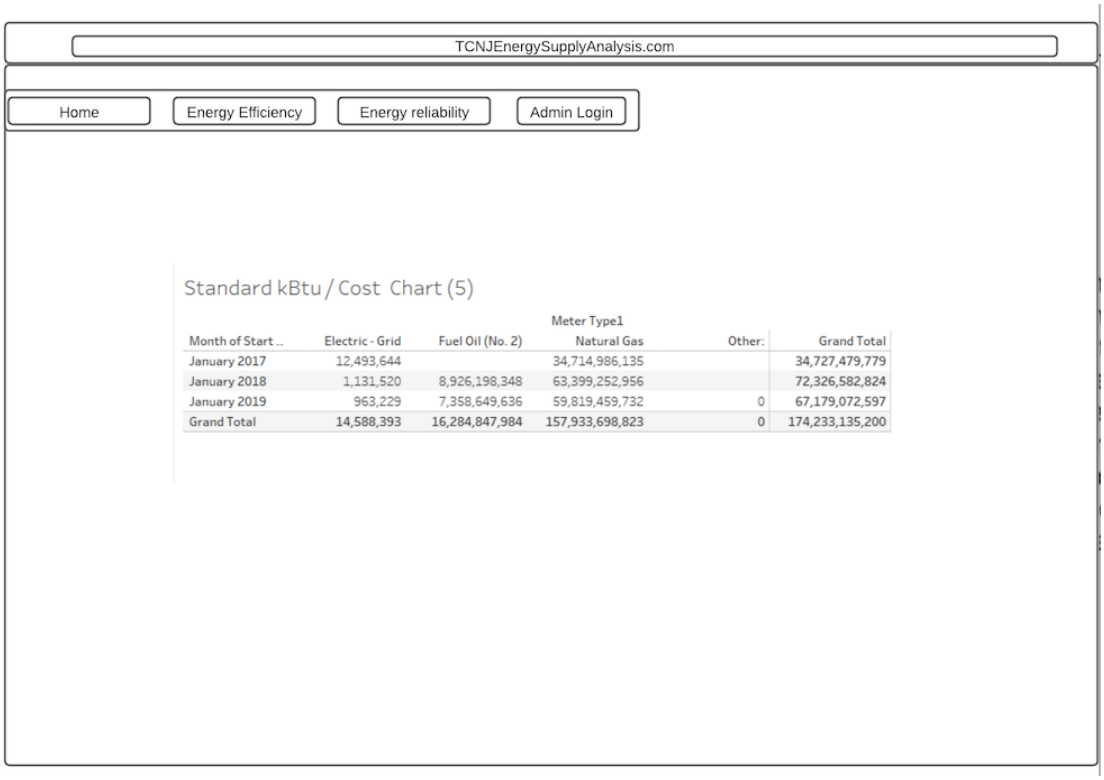
In addition, the product will feature a table that allows users to view the supply for each energy source based on individual months and seasons depending on a range of years. Check boxes will be utilized so the user can select which energy source they would like to look at, and radio buttons will be added so the user can select if they would like to look at the energy supply by months or by seasons. Text boxes will be used to have the user input what years they would like to see, and a drop-down menu will be utilized so the user can select what starting month they would like to see.

REVISION: The user interface sample has been revised to have an ‘other’ option using a checkbox to the ‘Select an energy source’ area.



Database Interaction (Use Case)

Using the input, we would take the type of energy sources selected, selecting the option by year and then further specifying whether it would be a season or specific month basis. There is also another option for the user to see only the picked month for each year that is specified by the user. The algorithm for this operation would perform the SELECT operation on the relevant tuples according to the time frame selected according to the energy sources, in conjunction with PROJECT to form a table that is readable to the user with the relevant columns. The RENAME operation would have to be used when converting the energy units of each source measured, as the algorithm necessitates that kbtu is the universal unit of measurement for this data analysis. Filters would be used to isolate the year, month chosen by the user or to isolate certain months depending on the season. Additionally, the JOIN operation will be used to have data from the selected energy sources into one table based on the years chosen or the seasons selected.



To be able to adjust information, certain users, most likely someone with admin privileges, will be able to insert or delete data on an additional page once they select an energy source and a specific year. The other users will be able to see the cost and emission breakdowns per building, but will be able to do the other actions aforementioned.

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

The database and application is essential to the project since TCNJ's current method of maintaining data also lacks easily accessible and readable information regarding energy usage. It will search for areas to reduce costs, and reduce pollution. It will present a way to be greener since users can look to see how they can be more economical and produce less environmental pollution by using their own power. The way the module will do this is by organizing all of the data presented in the excel spreadsheet and presenting it in a fashion that is easy to read. Seeing a breakdown of the costs and emissions by building will also help those who are interested in knowing this information determine which areas to start with first if there happens to be any buildings in particular that are creating a lot of pollution or consuming large amounts of money. The end results of the product will map TCNJ's goal to promote environmental sustainability and incorporate sustainability within its recreational and residential operations. The product will also assist in the college's energy plan to commit to renewable energy.

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

In order to fully understand the problem domain, our group plans on performing an analysis on the historical data to understand the trends within TCNJ energy usage. We will also look into the college's current method of power and determine areas that would be a possible alternative depending on the sustainability and cost of the energy source. To obtain additional data, we will reach out to the CSC315/ACC311 professors and Paul Romano if there is other data we will need.

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

Other systems that function similarly to our planned product include the *Energy Star Portfolio Manager*, AASHE's *Sustainability Tracking Assessment and Ratings* System, and the *Environmental, Social, and Governance Investing* system. Our planned product is different in that the end user will be able to make an informed decision as to where environmental and economic factors may need to be improved in certain areas. Furthermore, our system is able to differentiate the cost and usage for each energy source, and it utilizes an easy-to-understand map that will show the trends of TCNJ's energy consumption as well as other information. Additionally, our system will be created with the needs of what TCNJ requires to determine the status of their sustainability and economic efforts in mind.

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

Based on historical data, we could create an expected budgeted amount of money and energy needed, and then if current actual data is provided, add a window within our dashboard to show the budgeted vs. actual. This method of analyzing data could be repurposed for other colleges or different aspects of the college like vehicle supply, food supply, water supply, etc.. The data can also be purposed for examining economic and environmental impact with differing times of year. Additionally, the database will be able to be modified to include new years, thus allowing a possibility that new trends can be introduced as the college operates throughout different periods.

Some of the assumptions we're making is that we'll have access to the data Romano possesses in regards to the energy usage from the power plant as well as the energy TCNJ uses with the grid. We also expect this data to be very close to what the energy supply distribution is like at TCNJ, which is how we're so confident that the data we present will be accurate to the user.

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

We would like the database to run smoothly without any lag or crashes. One thing that would help with this is by not using any NULL attributes when establishing our data, which would use less performance overhead. Additionally, we will try to keep the amount of complex attributes to near zero since that would also limit performance due to the large amount of nesting

needed to implement. Furthermore, we will attempt to implement solely binary relationships and avoid n-ary relationships.

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

We will not have a lot of security features to start. Github will probably be useful because of its own security features, such as the personal access token and general authentication. We'll also make sure to make our code private where it can be made private. Privileged users or administrators will be able to directly modify data per building, while the vast majority of the users will be treated as guests that will be able to see different levels of data in relation to the privilege levels that they have. As a result of this security, this will ensure that the more sensitive aspects of the financial information regarding operating costs with the college will not be leaked to the public.

Once our project departs Github and is delivered to TCNJ facilities, we will still reinforce security in other ways. One way to do this is with our multi-level user access. We'll set up the data in a way where the confidential data the client does not want to be seen by general users within the application will be forbidden whereas users such as admins will be able to view this data and modify it as well.

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

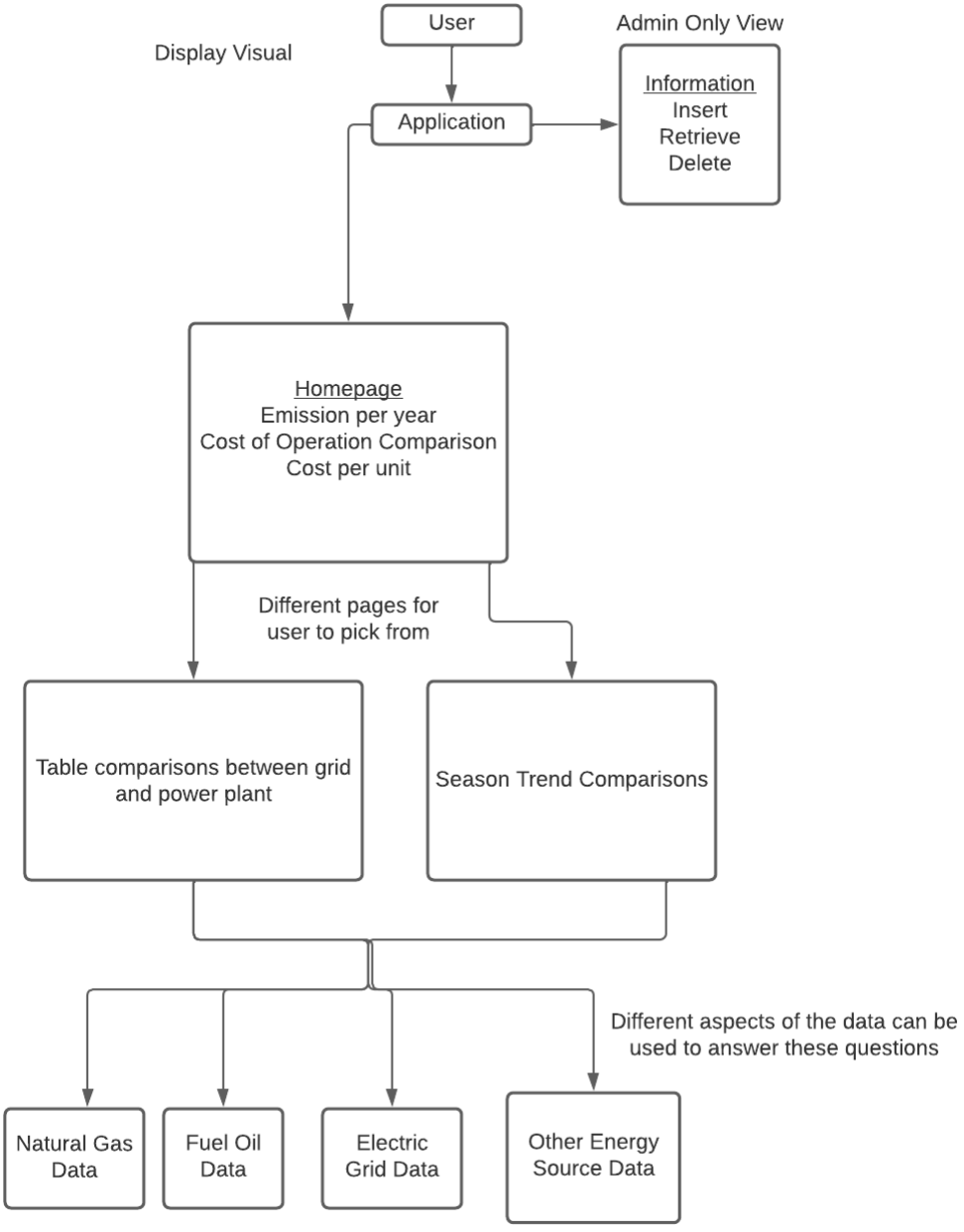
We will probably not need to use a backup and recovery system because Github most likely has redundancies and copies of the code. We most likely will not need anything else for backup.

Once the project departs Github and is delivered to TCNJ facilities, we will do a bi-weekly or monthly export of our data to ensure that the database ever goes down. This will allow us to have some data to restore the database back to in the worst case scenario. In terms of recovery, we will be sure to keep documentation of setting up the database initially so that we will be able to do it much faster should anything ever happen to the backend of our application.

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

Some technologies and database concepts that the group will need to learn include Python, Flask, and PostgreSQL. In order to learn more about these languages, we will be utilizing LinkedIn Learning on our own time. We plan to use these languages in order to create our interactive application. For the mathematical calculations and to organize any essential data, we will utilize tools from Microsoft Excel.

• A diagrammatic representation of the system boundary that specifies what data you will model and which queries you will implement.



REVISION: The diagrammatic representation has been revised to have an ‘other energy source data’ option in the data area.

• **1-page quad chart:**

TCNJ THE COLLEGE OF NEW JERSEY

Energy Supply Database

Peter Kelly, Sterly Deracy, Amy Vargas, Joseph Oczkowski, Grant Bushoven, Matthew Seitz, Daniel Melamed

Need

- Efficient and easy to understand database and application regarding energy consumption and pollution
- Cost effective analysis to decide where and when to use power from campus or sustainable energy
- Determine which energy source is causing the most pollution

Approach

- To separate the four types of meters and analyze historical trends (cost and usage)
- Find a common measurement to compare usage rate to cost
- Analyze the results to come up with efficient and environmental friendly solution.

Benefit

- High performance and secure database access to energy use on campus
- Clear analysis on which energy sources should be used to save the most money and reduce pollution
- Comfort knowing that TCNJ will have the greenest and economically efficient solution for powering campus

Competition

- Includes ability to differentiate cost and usage between the four types of meters.
- Utilizes a visually appealing and easy to understand tables illustrating trends of TCNJ's energy usage.
- Tailored to the needs of what TCNJ requires to determine the status of their sustainability and economical efforts.

02/06/22

Proposal Pitch Slides

Problem Statement

- TCNJ is determining if their current sustainability and economical efforts are sufficient.
- Data is currently not placed using a database or a user-friendly application.
  - Difficult to understand and search for information
- Main issue is to determine which energy source contributes the most towards a possible economic or pollution problem.

Objective

- To resolve this issue, our group will plan on creating:
  - An efficient database that highlights general categories including cost and energy usage
    - Focus on C.T.O and emissions of Tri-Gen/Boilers/Chiller
    - Emissions at Site/Source
  - Separate subcategories that differentiate by energy type
  - Visualization of the environmental impact and cost relationship present for further analysis

Desired End Product Description

- Easily understandable map with information breakdown by building
- Include a map that displays:
  - Costs of each energy source
  - Total emissions of each energy source
  - Total emissions at a site/source basis
- User will be able to retrieve pertinent information, filter data to an extent

Why Model is Important

- TCNJ currently lacks an easily accessible/readable information application regarding energy use
- Find optimal areas to reduce energy costs and pollution via visual
- Users can see biggest contributors to cost and pollution
- End result will map to TCNJ's goal for environmental sustainability
- Also offer insight to plan for renewable energy

Method of Research

In order to fully understand the problem domain, our group plans on:

- Performing analysis on historical data to understand trends within TCNJ energy usage
- Look into the college's current strategy for energy supply
- Determine areas that would be a possible alternative depending on:
  - Sustainability
  - Energy cost
  - Energy consumption

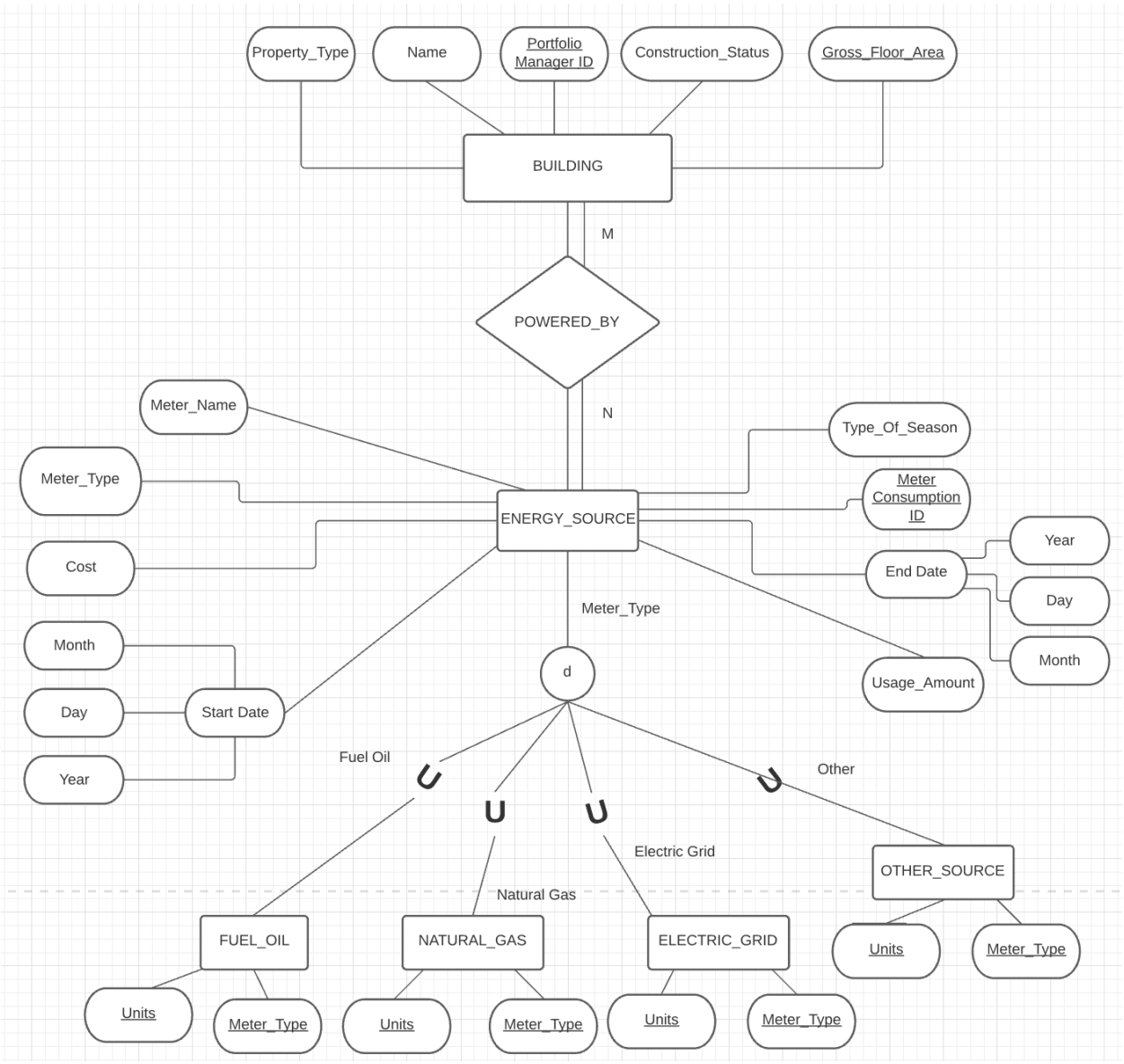
Similar Approaches

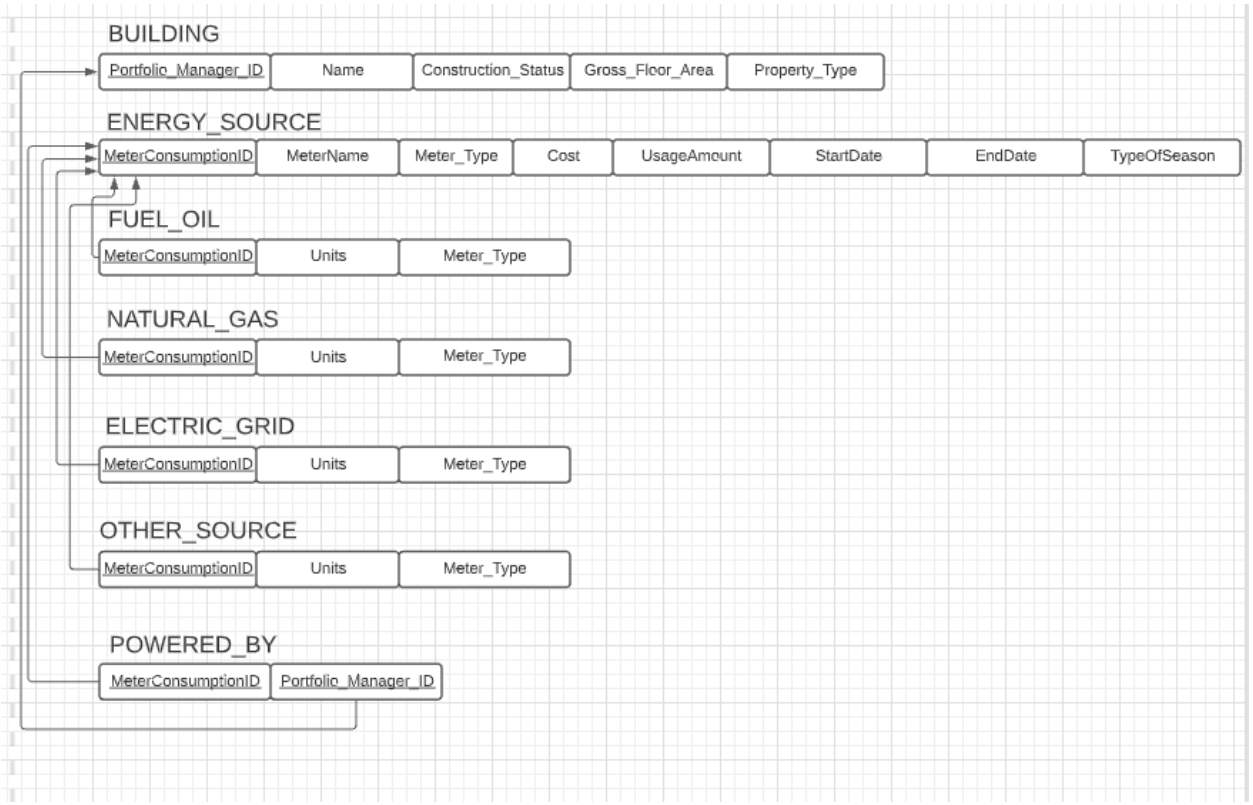
- Energy Star Manager
- AASHE's STAR
- Scoring Analytic
    - Rating of energy source's cost and pollution

Possible Alternate Applications

- Create expected budgets based on available funds and energy needed
- Examine economic and environmental impact by season
- Re-use application to examine trends:
    - That may arise as time goes on
    - Different areas of college:
        - Vehicle supply
        - Food supply
        - Water supply

Elaboration: Design



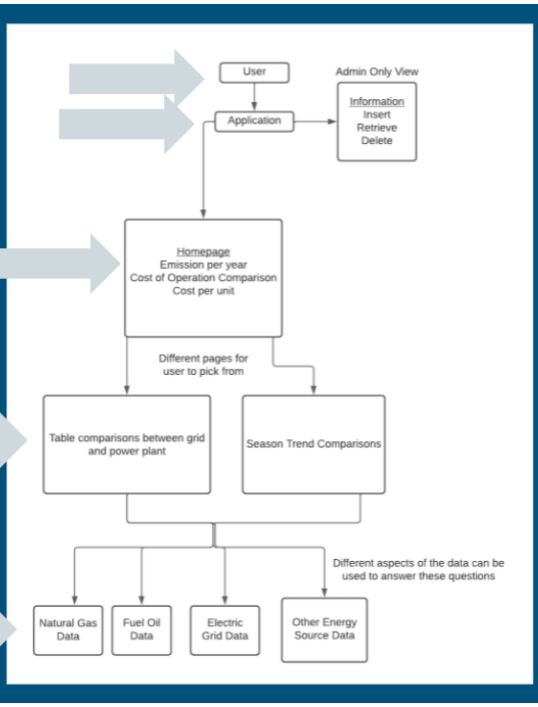


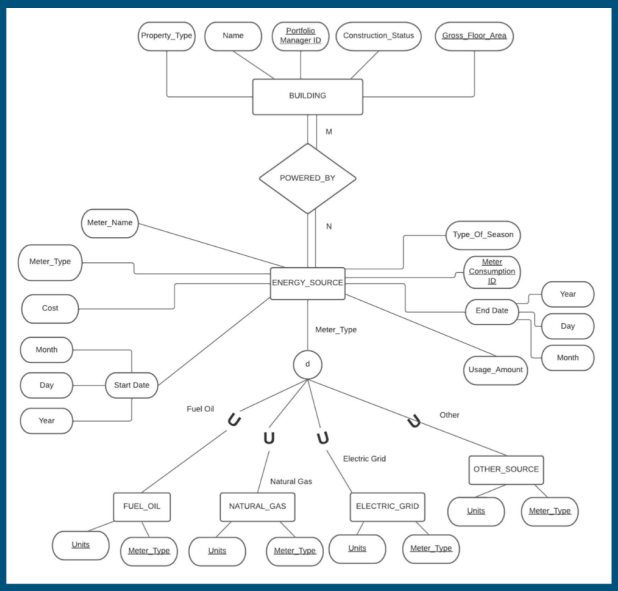
Based on our research and understanding of the project requirements and scope, we estimate that the initial database size, specifically the approximate number of records, includes 4.1 million rows of records within the data set. The average number of searches include roughly 2-4 per user. The types of searches we expect users to take include selecting an energy source, entering a starting and ending year, showing meter costs, selecting either yearly, monthly, or daily, and selecting a specific season. In regards to specific operations, we expect to use SELECT operations with JOIN operations to combine ENERGY_SOURCE with the energy types.

Mid-Semester Project Presentation

Information about Database

- 1430 rows of records within data set
  - Est. 4.1 million rows of records to display 15 minute fluctuations
- Type of searches
  - Select an energy source
  - Enter starting / ending year
  - Show meter costs
  - Select year, month, daily
  - Select by seasons
- Average number of searches
  - 2-4 per user




Property_Type
Name
Portfolio Manager ID
Construction_Status
Gross_Floor_Area
BUILDING
M
POWERED_BY
N
Meter_Name
Meter_Type
Cost
Month
Day
Year
Start Date
ENERGY_SOURCE
Type_Of_Season
Meter Consumption ID
Year
End Date
Day
Month
Usage_Amount
Meter_Type
d
Fuel Oil
Other
Electric Grid
Natural Gas
FUEL_OIL
NATURAL_GAS
ELECTRIC_GRID
OTHER_SOURCE
Units
Meter_Type
Units
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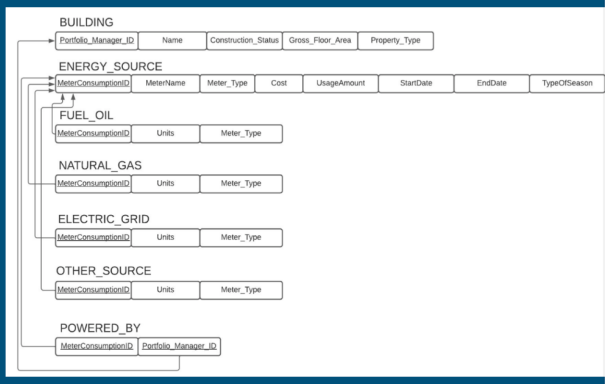
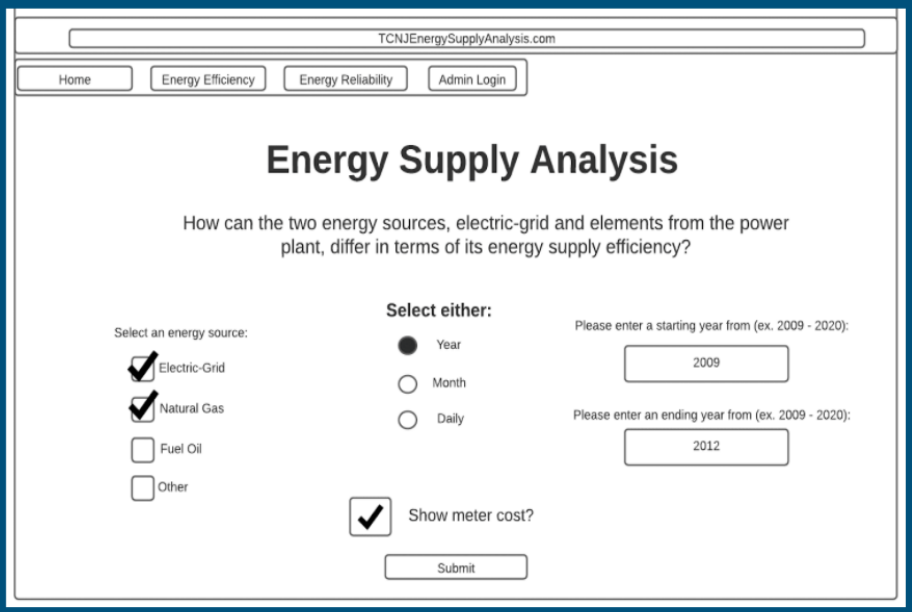
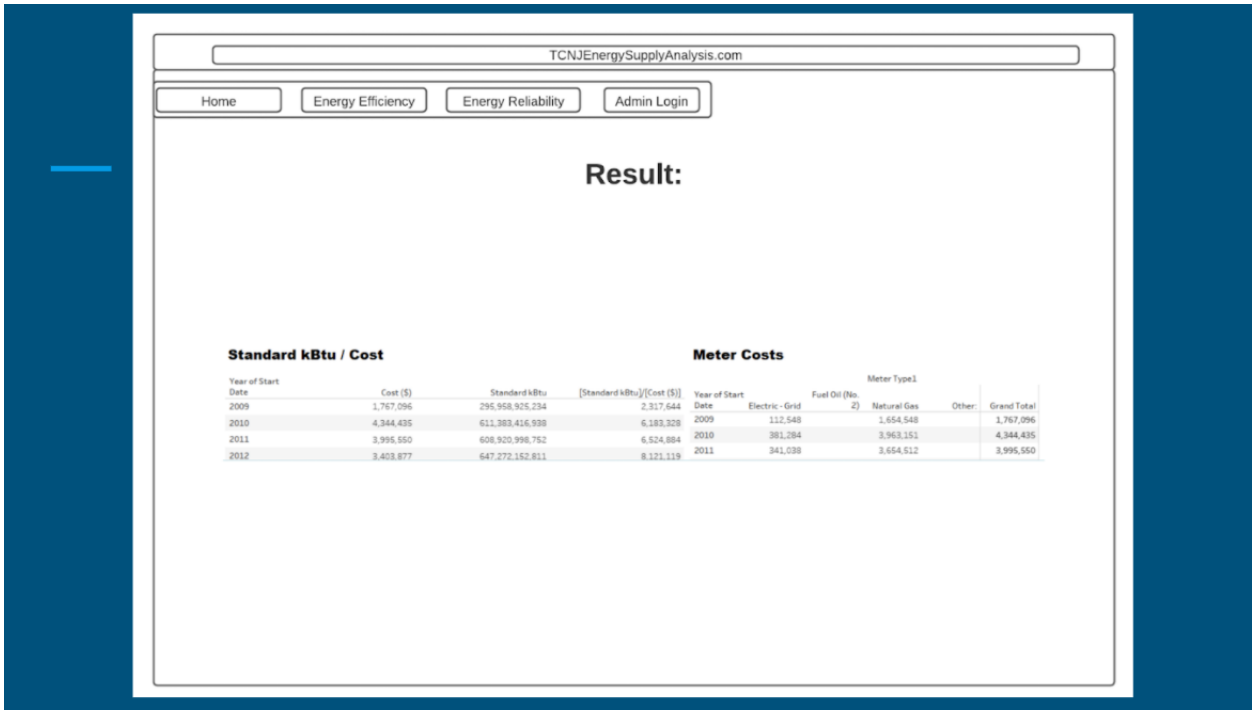
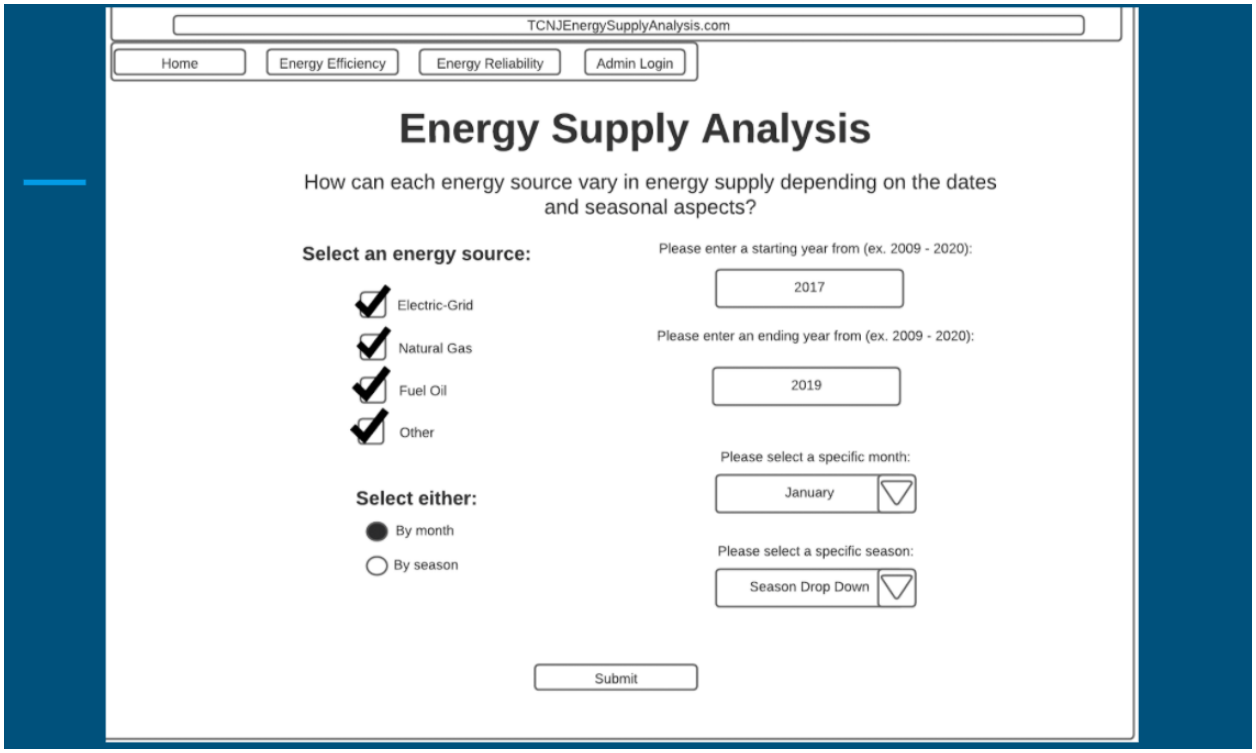

BUILDING
Portfolio_Manager_ID
Name
Construction_Status
Gross_Floor_Area
Property_Type
ENERGY_SOURCE
MeterConsumptionID
MeterName
Meter_Type
Cost
UsageAmount
StartDate
EndDate
TypeOfSeason
1
1
FUEL_OIL
MeterConsumptionID
Units
Meter_Type
NATURAL_GAS
MeterConsumptionID
Units
Meter_Type
ELECTRIC_GRID
MeterConsumptionID
Units
Meter_Type
OTHER_SOURCE
MeterConsumptionID
Units
Meter_Type
POWERED_BY
MeterConsumptionID
Portfolio_Manager_ID


TCNJEnergySupplyAnalysis.com
Home
Energy Efficiency
Energy Reliability
Admin Login
Energy Supply Analysis
How can the two energy sources, electric-grid and elements from the power plant, differ in terms of its energy supply efficiency?
Select an energy source:
Electric-Grid
Natural Gas
Fuel Oil
Other
Select either:
Year
Month
Daily
Please enter a starting year from (ex. 2009 - 2020):
2009
Please enter an ending year from (ex. 2009 - 2020):
2012
Show meter cost?
Submit


TCNJEnergySupplyAnalysis.com
Home
Energy Efficiency
Energy Reliability
Admin Login
Result:
Standard kBtu / Cost
Year of Start Date
Cost ($)
Standard kBtu
[Standard kBtu]/[Cost ($)]
2009
1,767,096
295,958,925,234
2,317,644
2010
4,344,435
611,383,416,938
6,183,328
2011
3,995,550
608,920,998,752
6,524,884
2012
3,403,877
647,272,162,811
8,121,119
Meter Costs
Meter Type1
Year of Start Date
Electric - Grid
Fuel Oil (No. 2)
Natural Gas
Other
Grand Total
2009
112,548
1,654,548
1,767,096
2010
381,284
3,963,151
4,344,435
2011
341,038
3,654,512
3,995,550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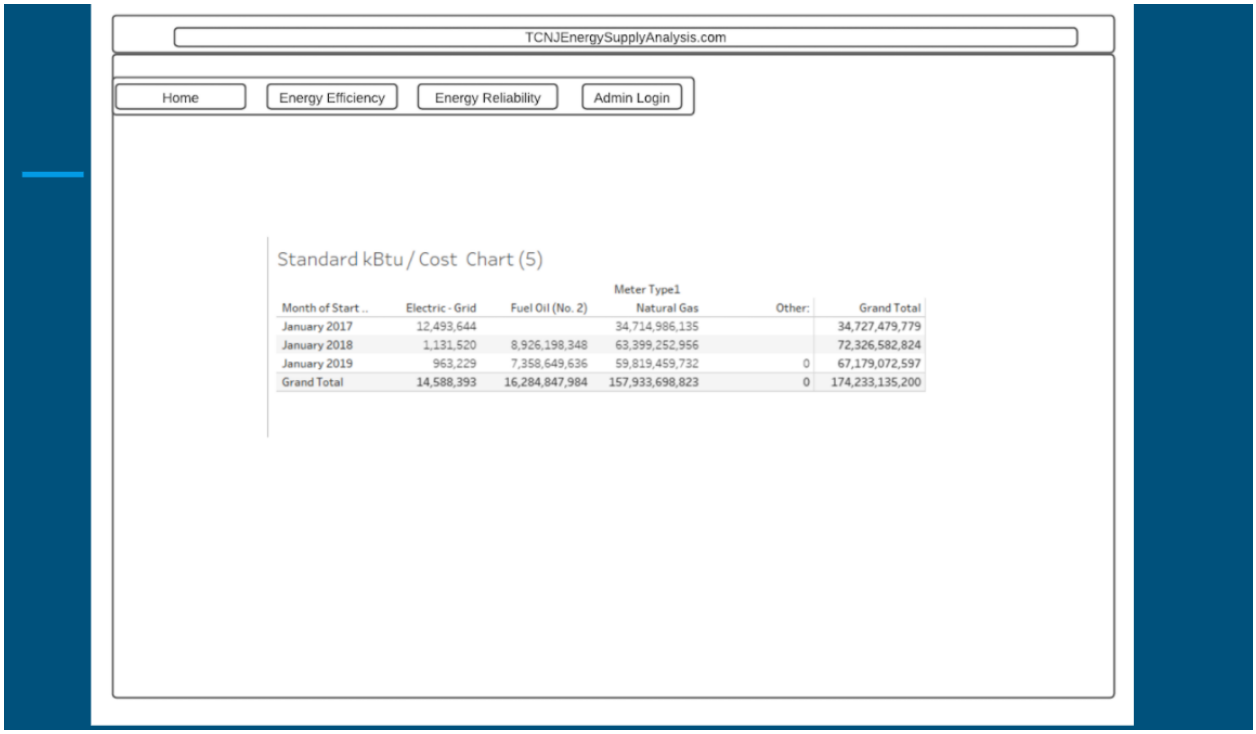
Energy Supply Analysis
How can each energy source vary in energy supply depending on the dates and seasonal aspects?
Select an energy source:
Electric-Grid
Natural Gas
Fuel Oil
Other
Select either:
By month
By season
Please enter a starting year from (ex. 2009 - 2020):
2017
Please enter an ending year from (ex. 2009 - 2020):
2019
Please select a specific month:
January
Please select a specific season:
Season Drop Down
Submit



	Meter Type1				
Month of Start ..	Electric - Grid	Fuel Oil (No. 2)	Natural Gas	Other:	Grand Total
January 2017	12,493,644		34,714,986,135		34,727,479,779
January 2018	1,131,520	8,926,198,348	63,399,252,956		72,326,582,824
January 2019	963,229	7,358,649,636	59,819,459,732	0	67,179,072,597
Grand Total	14,588,393	16,284,847,984	157,933,698,823	0	174,233,135,200