Energy Supply Project Analysis (ESPA)

CSC 315/ACC 311-02 Group 1

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Inception: “Executive Summary”

- **Need**: The college needs to understand when it is most economical for The College of New Jersey to produce its own power and when it is best for the environment for The College of New Jersey to produce its own power.
- **Approach**: To answer this question the group had utilized GitHub to create a database of all the historical data for The College of New Jerseys energy usage. It provided the ability to create queries within the database to understand trends within the data.
- **Benefits**: When compared to other databases, this is a cost effective solution as GitHub is free to college students providing a cheap way to understand this data and gain understanding. The interface is clean, user friendly, and provides clear insights into the data.
- **Cost**: The goal of this project is to create a new way for The College of New Jersey to synthesize the energy that The College of New Jersey is producing and provide insights into that data. Moving forward, the cost would be maintaining the database, conducting PAR (periodic access review) to verify all users / editors of the database. This is within reason for the organization to maintain moving forward. Another cost to be considered for the application is the data needed to run the program. Because of the implementation of the fifteen minute intervals, the data needs to be formatted in a certain way. Some scripts were developed some of this process, but the script does not fully work for the part of the data that handles the fifteen minute intervals. The initial setup of this application would need to take this into account which means it should be preformatted to have a meter consumption id be broken down into the corresponding fifteen minute intervals.

Elaboration: Project Proposal and Specifications

• 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.

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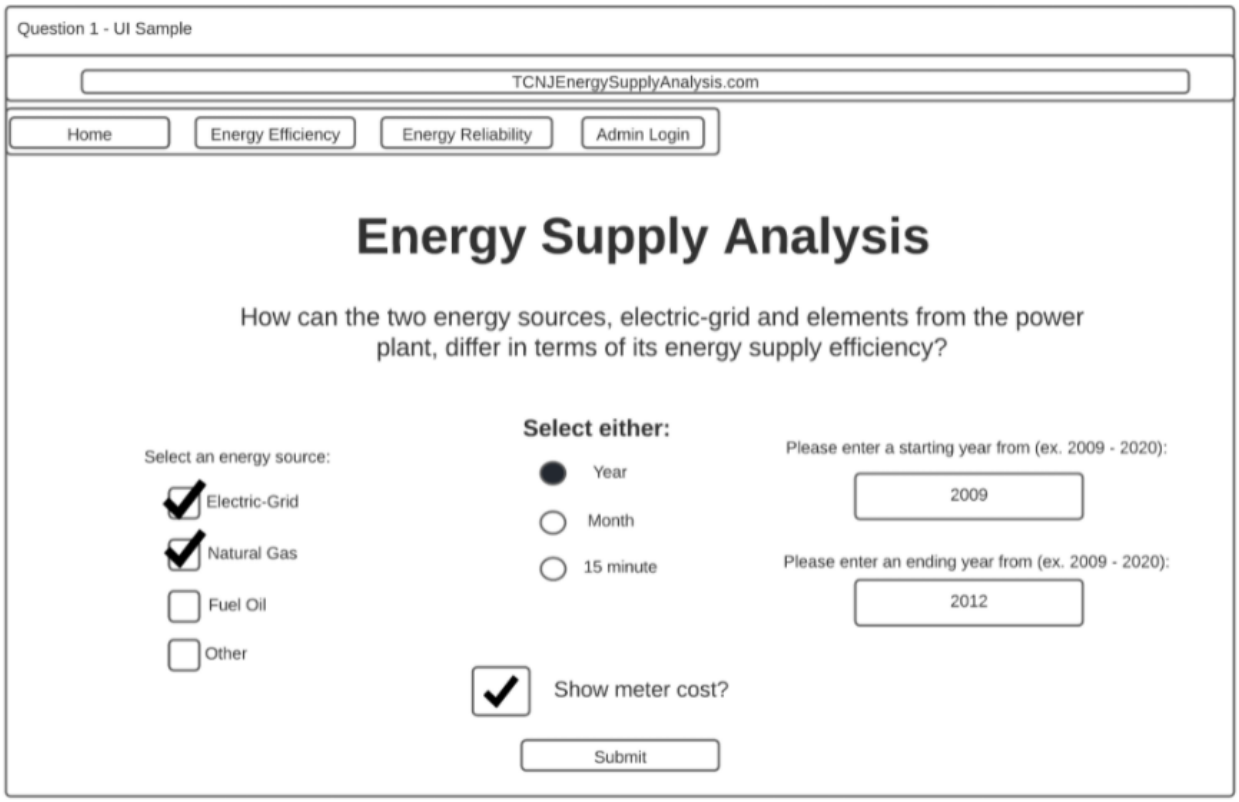

Database Interaction
(Use Case)

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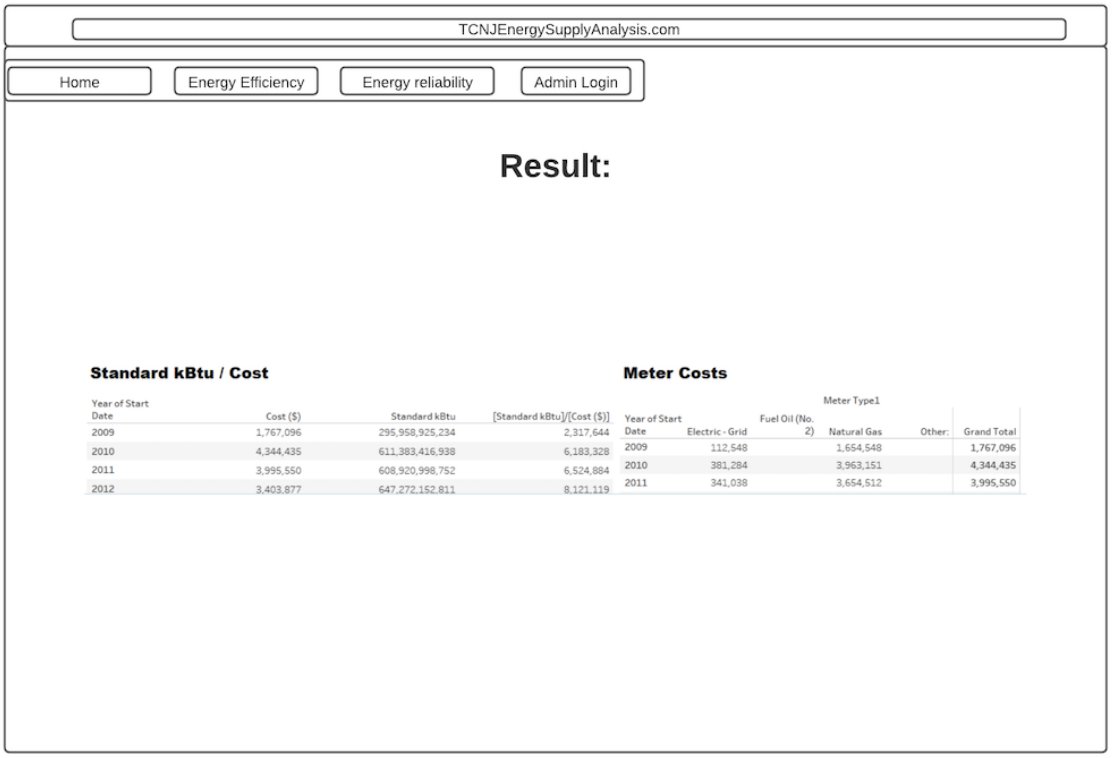

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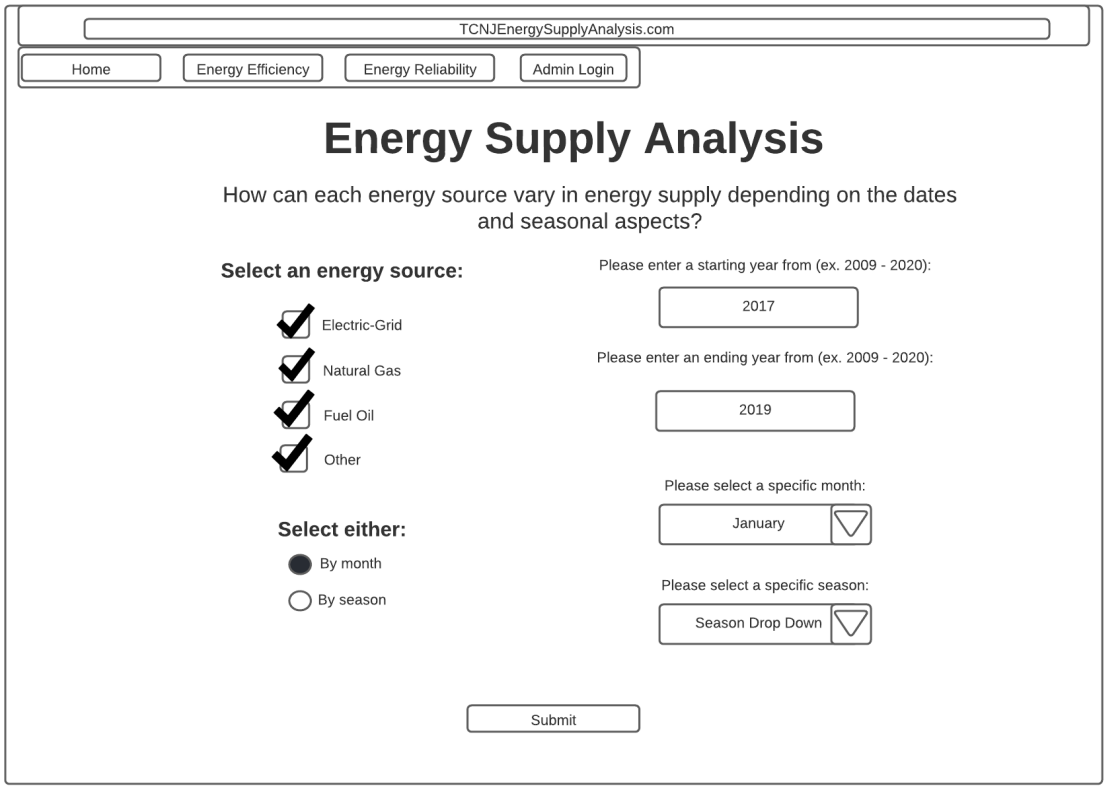

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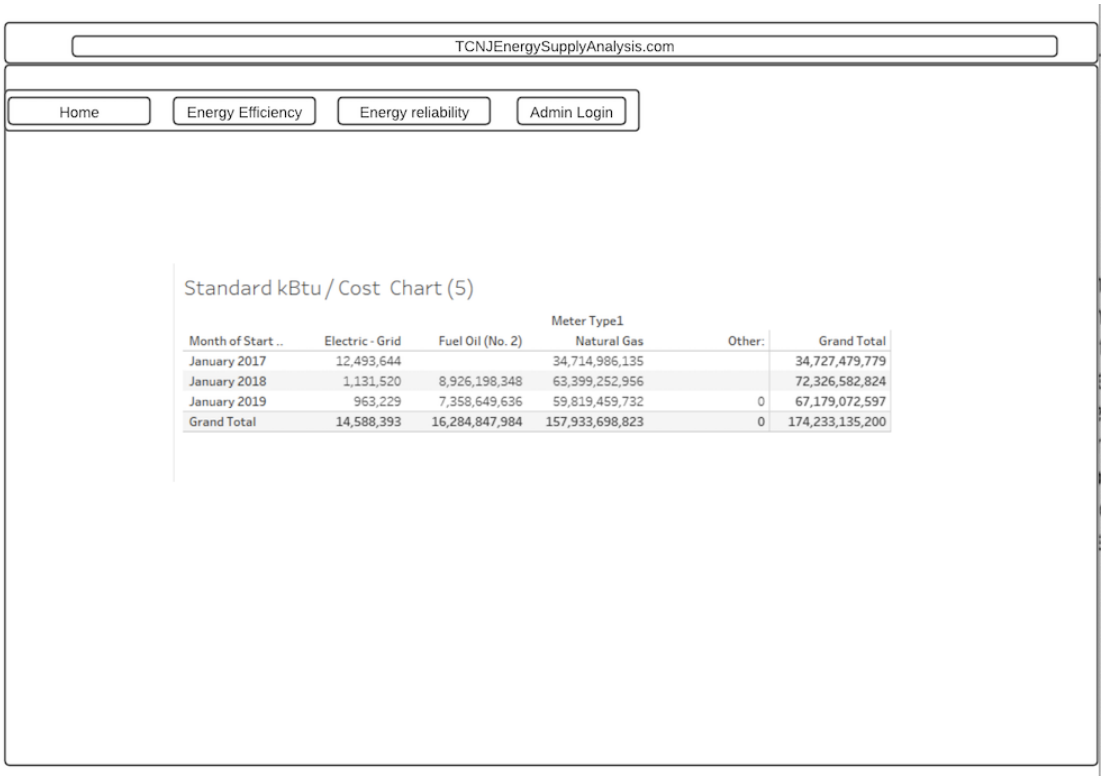

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• Description of the importance and need for the module, and how it addresses the problem.

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.

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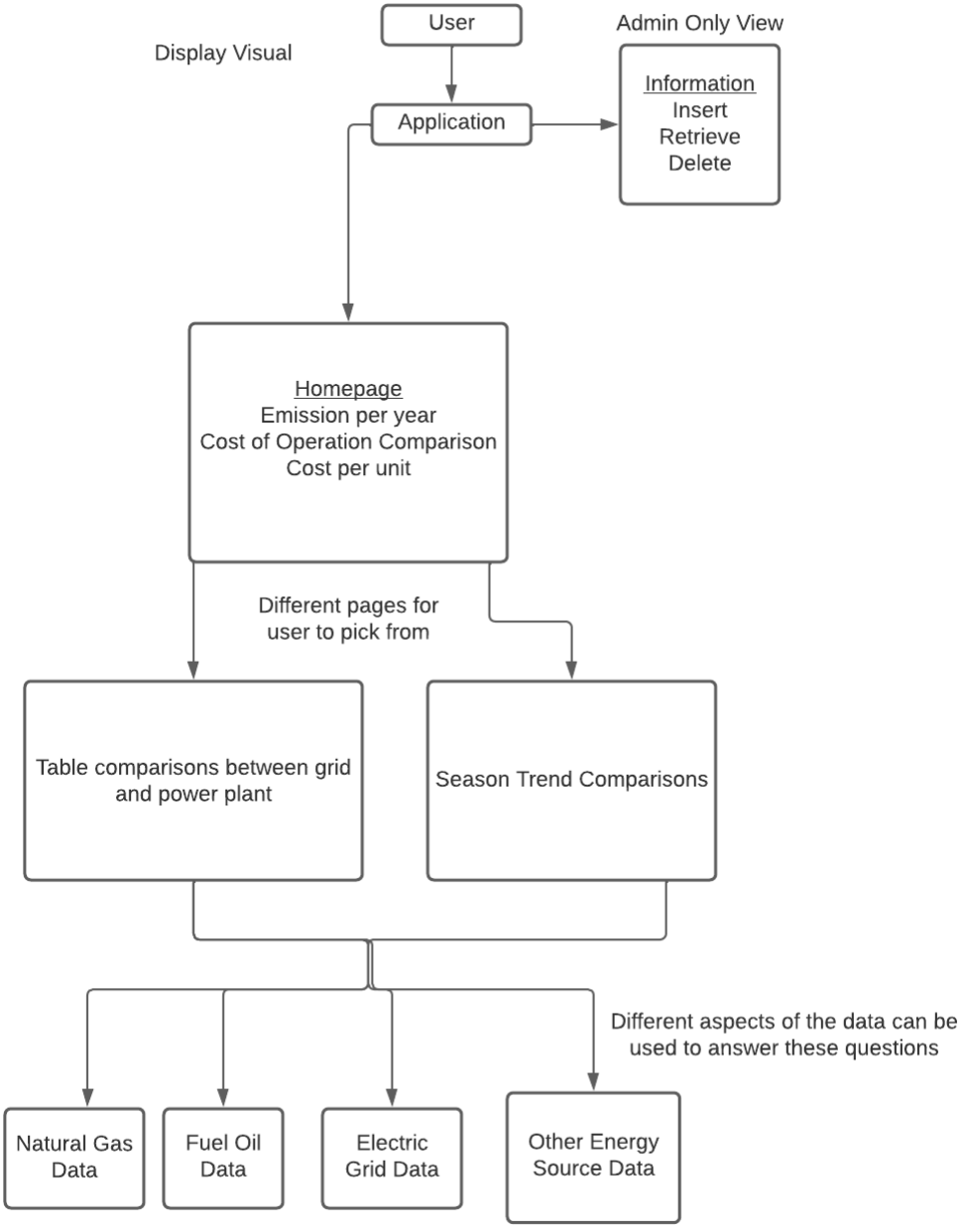

REVISION: The diagrammatic representation has been revised to have an ‘other energy source data’ option in the data area.

• **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

Energy Supply Database Project Pitch

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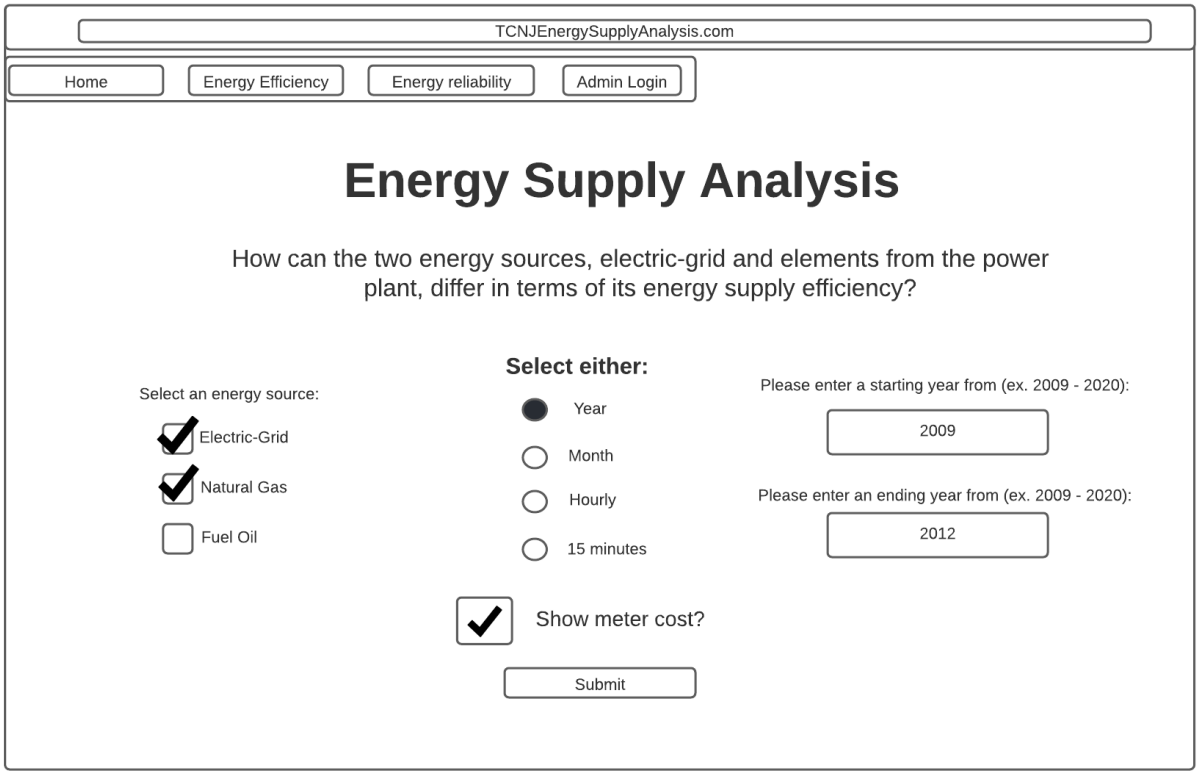
Question 1 - UI Sample



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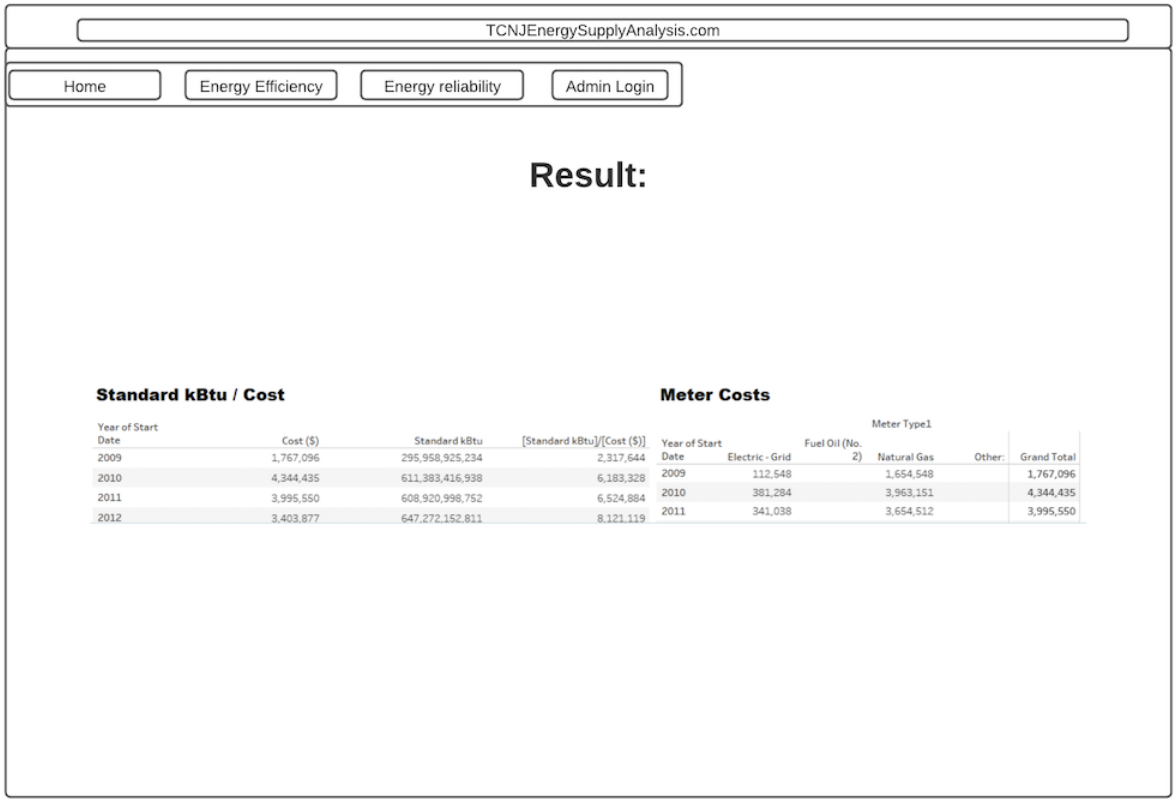

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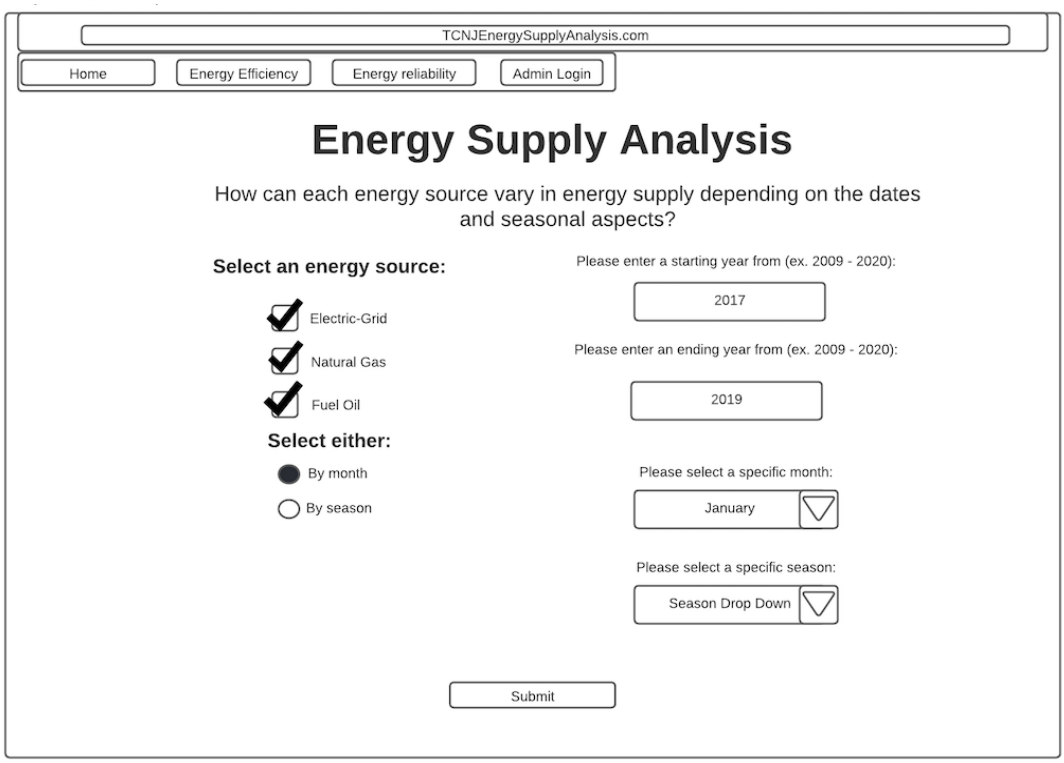

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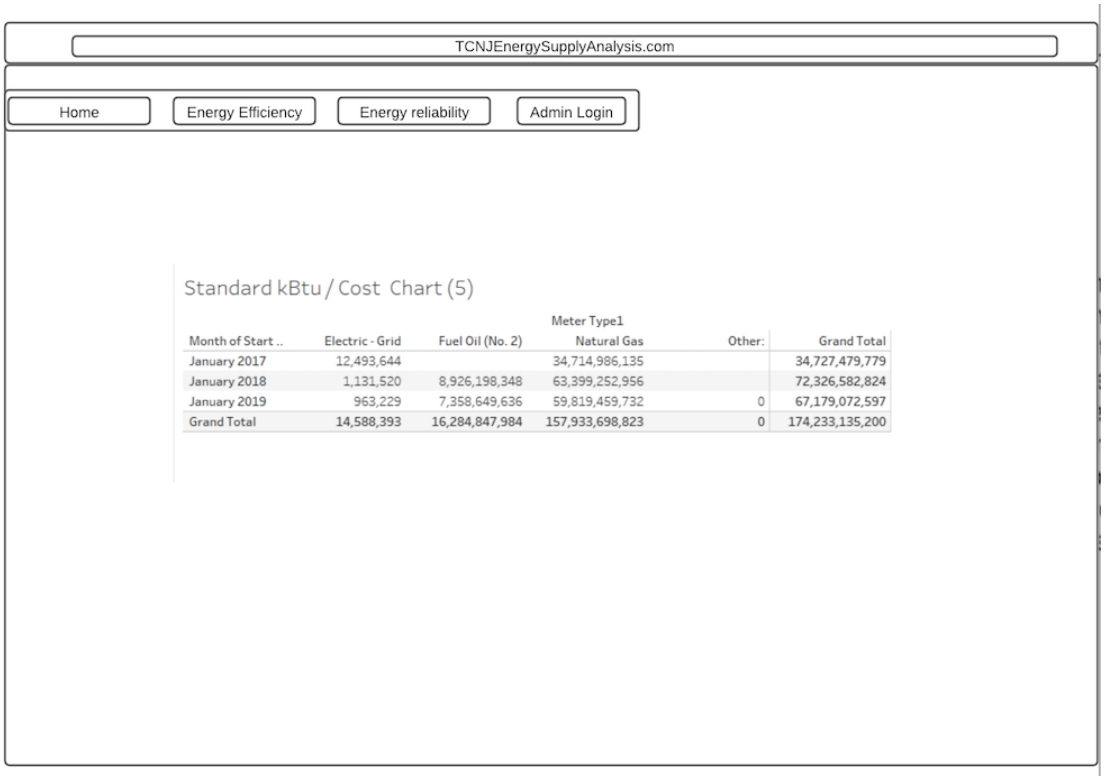

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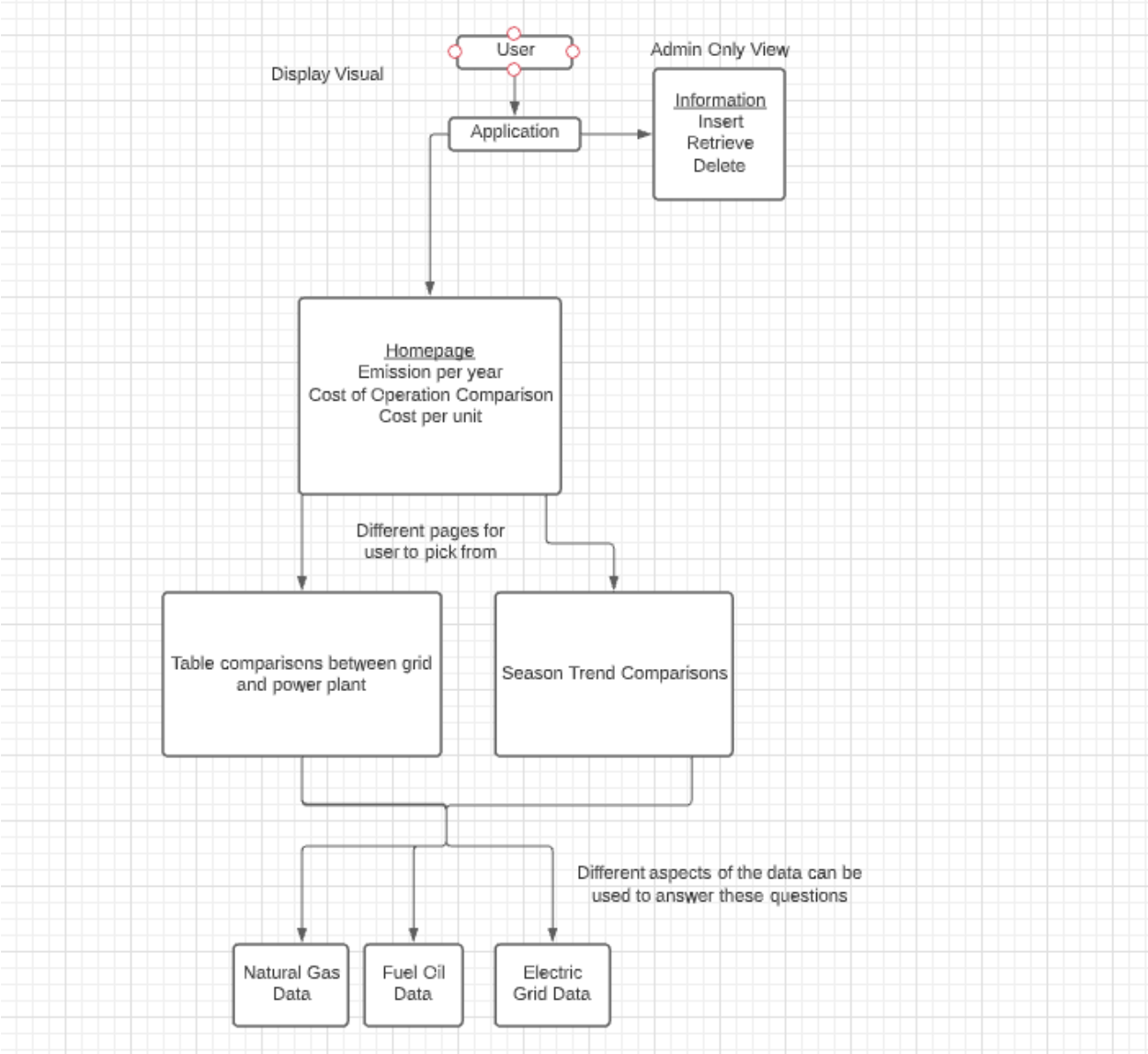

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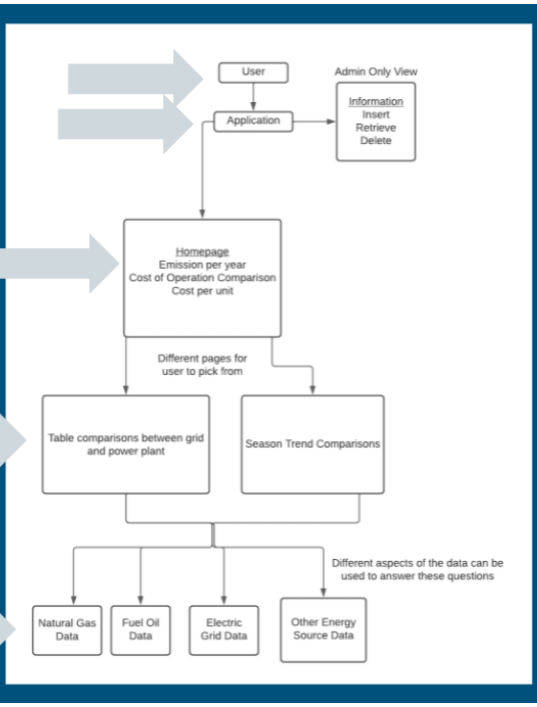
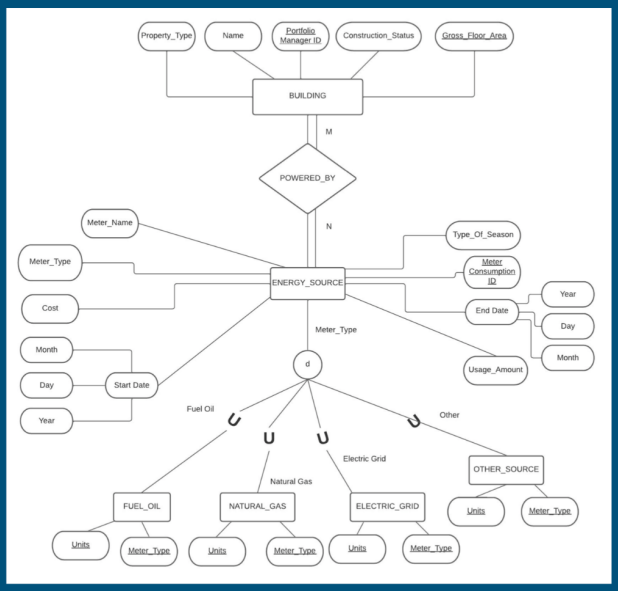
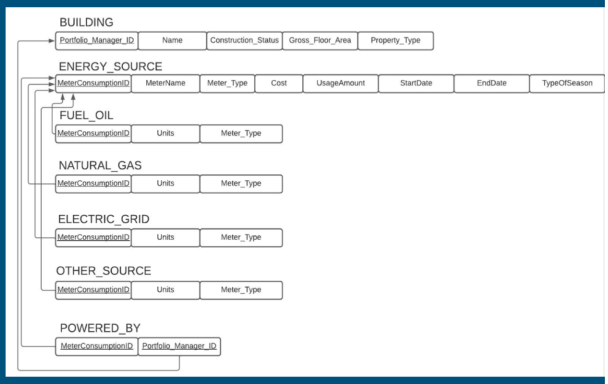
Mid-Semester Project Presentation

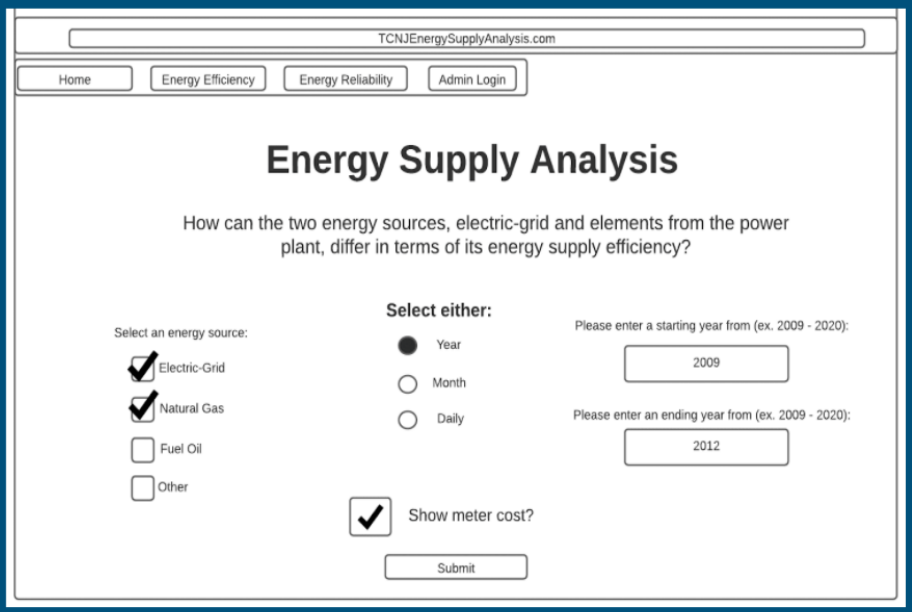
Information about Database

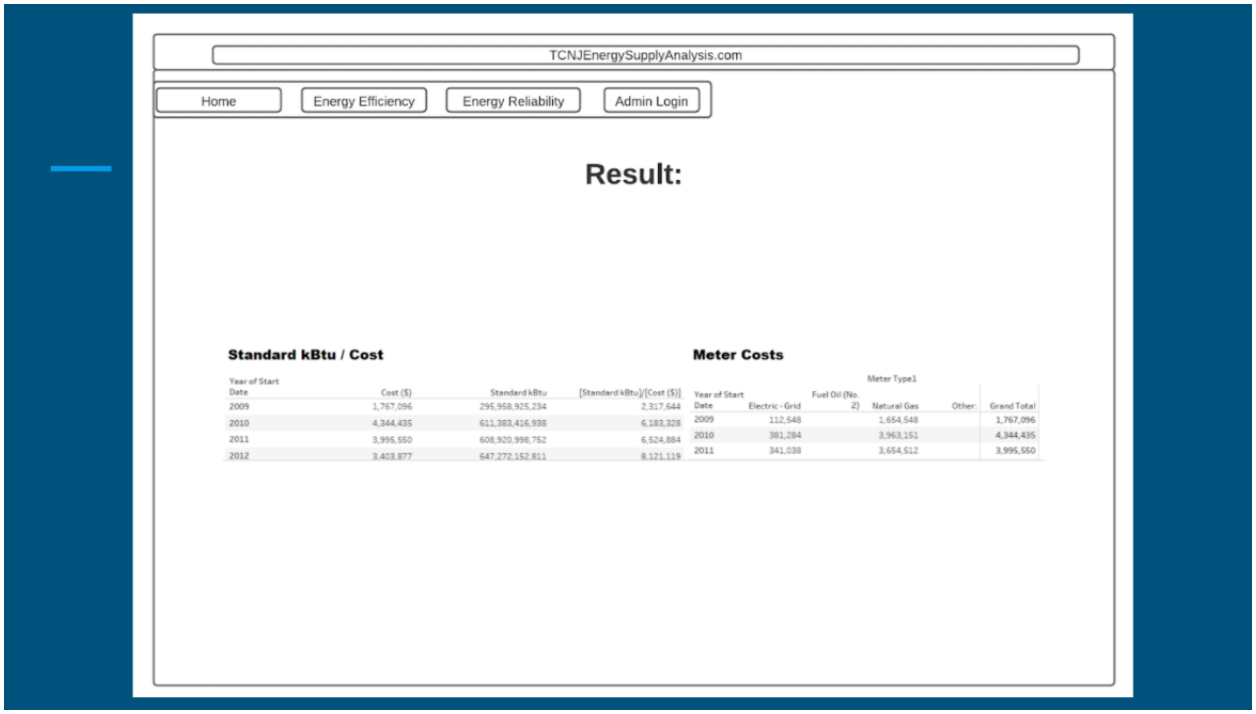
- 1430 rows of records within data set
  - Est. 4.1 million rows of records to display 15 minute fluctuations
- Type of searches
  - Select an energy source
  - Enter starting / ending year
  - Show meter costs
  - Select year, month, daily
  - Select by seasons
- Average number of searches
  - 2-4 per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

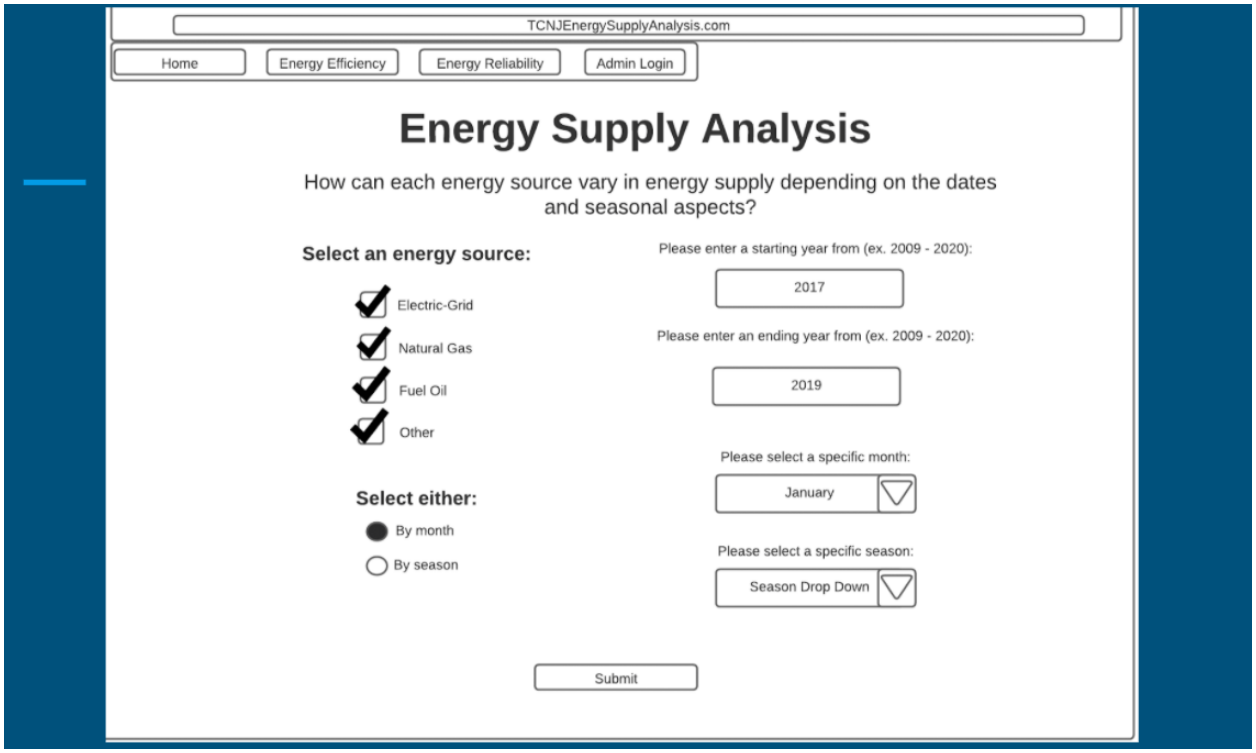


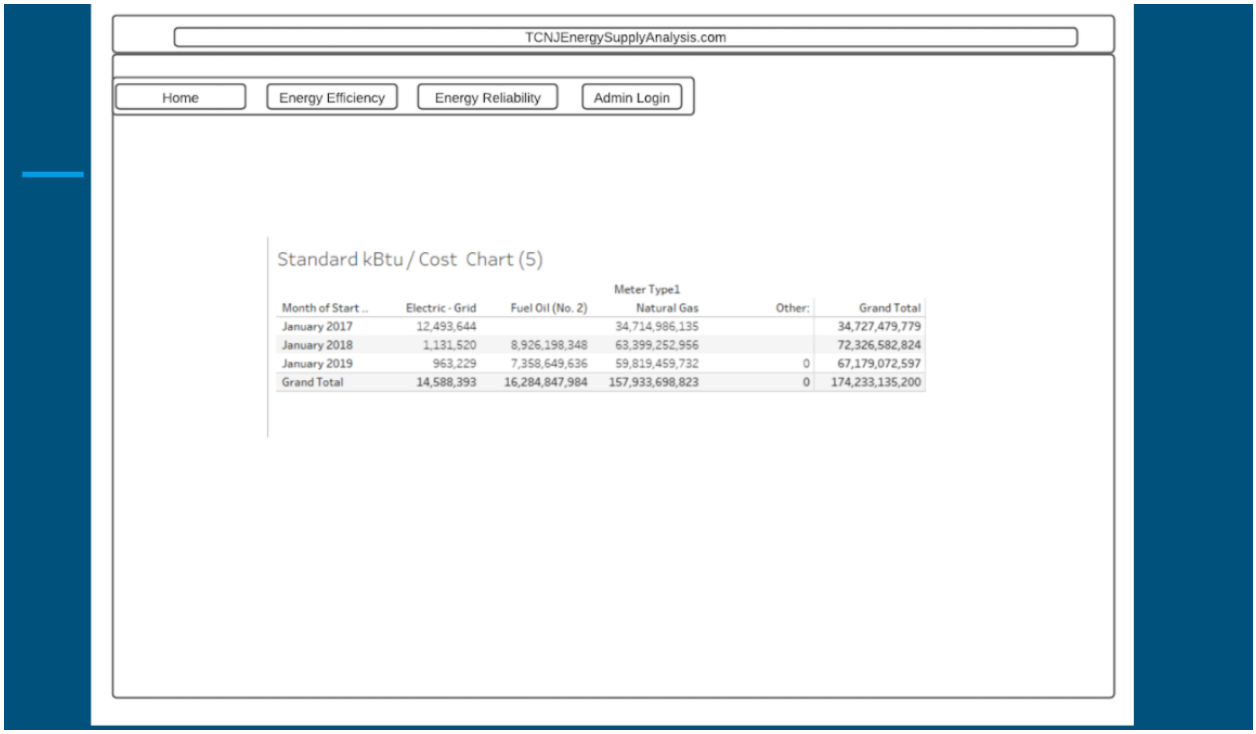

Property_Type
Name
Portfolio Manager ID
Construction_Status
Gross_Floor_Area
BUILDING
M
POWERED_BY
N
Meter_Name
Meter_Type
Cost
Month
Day
Year
Start Date
ENERGY_SOURCE
Type_Of_Season
Meter Consumption ID
Year
End Date
Day
Month
Usage_Amount
Meter_Type
d
Fuel Oil
Other
Electric Grid
Natural Gas
FUEL_OIL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


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


TCNJEnergySupplyAnalysis.com
Home
Energy Efficiency
Energy Reliability
Admin Login
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

Construction: Tables, Queries, and User Interface

- **Tables:**

CREATE TABLE DATE_INTERVAL (Meter_Consumption_ID varchar(20) UNIQUE PRIMARY KEY, StartDate date, TypeOfSeason varchar(7) , StartTimestamp time);

CREATE TABLE BUILDING (Name varchar(50) UNIQUE, Portfolio_Manager_ID varchar(30) UNIQUE, Construction_Status varchar(50), Gross_Floor_Area int, PRIMARY KEY (Portfolio_Manager_ID, Name));

CREATE TABLE ENERGY_SOURCE (Portfolio_Manager_Meter_ID varchar(30) UNIQUE, MeterName varchar(30) UNIQUE, Meter_Type varchar(30), PRIMARY KEY (Portfolio_Manager_Meter_ID, MeterName));

CREATE TABLE BUILDING_TYPE (Name varchar(50) PRIMARY KEY references BUILDING(Name), Property_Type varchar(30));

CREATE TABLE ENERGY_SOURCE_COST (Portfolio_Manager_Meter_ID varchar(30) REFERENCES ENERGY_SOURCE(Portfolio_Manager_Meter_ID) PRIMARY KEY, cost float, Usage_Amount float);

CREATE TABLE FUEL_OIL (Portfolio_Manager_Meter_ID varchar(30) REFERENCES ENERGY_SOURCE(Portfolio_Manager_Meter_ID), MeterType varchar(30), Units varchar(26));

CREATE TABLE NATURAL_GAS (Portfolio_Manager_Meter_ID varchar(30) REFERENCES ENERGY_SOURCE(Portfolio_Manager_Meter_ID), MeterType varchar(30), Units varchar(26));

CREATE TABLE ELECTRIC_GRID (Portfolio_Manager_Meter_ID varchar(30) REFERENCES ENERGY_SOURCE(Portfolio_Manager_Meter_ID), MeterType varchar(30), Units varchar(26));

CREATE TABLE OTHER_SOURCE (Portfolio_Manager_Meter_ID varchar(30) REFERENCES ENERGY_SOURCE(Portfolio_Manager_Meter_ID), MeterType varchar(30), Units varchar(26));

CREATE TABLE MAPS_TO (Portfolio_Manager_Meter_ID varchar(30) REFERENCES ENERGY_SOURCE(Portfolio_Manager_Meter_ID), Meter_Consumption_ID varchar(20)

```
REFERENCES DATE_INTERVAL(Meter_Consumption_ID), PRIMARY KEY
(Portfolio_Manager_Meter_ID, Meter_Consumption_ID));

CREATE TABLE POWERED_BY (Portfolio_Manager_ID varchar(30) REFERENCES
BUILDING(Portfolio_Manager_ID), Portfolio_Manager_Meter_ID varchar(30) REFERENCES
ENERGY_SOURCE(Portfolio_Manager_Meter_ID), PRIMARY KEY (Portfolio_Manager_ID,
Portfolio_Manager_Meter_ID));

CREATE VIEW YEAR_ENERGY_SOURCE_KBTU_COST AS
SELECT cast(EXTRACT(YEAR FROM StartDate) as int) AS Year, Cost, Usage_Amount,
Usage_Amount/cast(SUM(Cost) as float) AS kbtuPerCost, Meter_Type
FROM DATE_INTERVAL NATURAL JOIN MAPS_TO NATURAL JOIN
ENERGY_SOURCE_COST NATURAL JOIN ENERGY_SOURCE
GROUP BY Year, Cost, Usage_Amount, Meter_Type;

CREATE VIEW YEAR_SOURCE AS
SELECT Year, SUM(Cost) AS Cost, SUM(Usage_Amount) AS
Usage_Amount,(SUM(Usage_Amount)/cast(SUM(Cost) as float)) AS kbtuPerCost
FROM YEAR_ENERGY_SOURCE_KBTU_COST
GROUP BY Year;

CREATE VIEW MONTH_ENERGY_SOURCE_KBTU_COST AS
SELECT cast(EXTRACT(YEAR FROM StartDate) as int) AS Year, cast(EXTRACT(MONTH
FROM StartDate) as int) AS Month, Cost, Usage_Amount, Usage_Amount/cast(SUM(Cost) as
float) AS kbtuPerCost, Meter_Type
FROM DATE_INTERVAL NATURAL JOIN MAPS_TO NATURAL JOIN
ENERGY_SOURCE_COST NATURAL JOIN ENERGY_SOURCE
GROUP BY Year, Month, Cost, Usage_Amount, Meter_Type;

CREATE VIEW MONTH_SOURCE AS
SELECT Year, Month, SUM(Cost) AS Cost, SUM(Usage_Amount) AS Usage_Amount,
(SUM(Usage_Amount)/cast(SUM(Cost) as float)) AS kbtuPerCost
FROM MONTH_ENERGY_SOURCE_KBTU_COST
GROUP BY Year, Month;

CREATE VIEW MINUTE_ENERGY_SOURCE_KBTU_COST AS
SELECT StartDate, StartTimestamp, cast(Cost as float)/(30 * 24 * 4) AS cost,
cast(Usage_Amount as float)/ (30*24*4) AS Usage_Amt, (Usage_Amount/(cast(Cost as float)) /
(30 * 24 * 4)) AS kbtuPerCost, Meter_Type
```

```
FROM DATE_INTERVAL NATURAL JOIN MAPS_TO NATURAL JOIN
ENERGY_SOURCE_COST NATURAL JOIN ENERGY_SOURCE
GROUP BY StartDate, StartTimestamp, Usage_Amount, Cost, Meter_Type
ORDER BY StartDate ASC;

CREATE VIEW MINUTE_SOURCE AS
SELECT StartDate, StartTimestamp, SUM(cost) AS Cost, SUM(Usage_Amt) AS Usage_Amt,
(SUM(Usage_Amt)/cast(SUM(Cost) as float)) AS kbtuPerCost
FROM MINUTE_ENERGY_SOURCE_KBTU_COST
GROUP BY StartDate, StartTimestamp;

CREATE VIEW YEAR_METER_COST AS
SELECT cast(EXTRACT(YEAR FROM StartDate) as int) AS Year, Meter_Type, Cost
FROM DATE_INTERVAL NATURAL JOIN MAPS_TO NATURAL JOIN
ENERGY_SOURCE_COST NATURAL JOIN ENERGY_SOURCE
GROUP BY Year, Meter_Type, Cost;

CREATE VIEW YEAR_METER_COST_SOURCE AS
SELECT YEAR, Meter_Type, SUM(Cost) AS Cost
FROM YEAR_METER_COST
GROUP BY YEAR, Meter_Type;

CREATE VIEW MONTH_METER_COST AS
SELECT cast(EXTRACT(YEAR FROM StartDate) as int) AS Year, cast(EXTRACT(MONTH
FROM StartDate) as int) AS Month, Meter_Type, Cost
FROM DATE_INTERVAL NATURAL JOIN MAPS_TO NATURAL JOIN
ENERGY_SOURCE_COST NATURAL JOIN ENERGY_SOURCE
GROUP BY Year, Month, Meter_Type, Cost;

CREATE VIEW MINUTE_METER_COST AS
SELECT StartDate, StartTimestamp, Meter_Type, cast(Cost as float)/ (30*24*4) AS Cost
FROM DATE_INTERVAL NATURAL JOIN MAPS_TO NATURAL JOIN
ENERGY_SOURCE_COST NATURAL JOIN ENERGY_SOURCE
GROUP BY StartDate, StartTimestamp, Meter_Type, Cost
ORDER BY StartDate ASC;

CREATE VIEW MONTH_USAGE AS
SELECT cast(EXTRACT(YEAR FROM StartDate) as int) AS Year, cast(EXTRACT(MONTH
FROM StartDate) as int) AS Month, Meter_Type, Usage_Amount
```

```
FROM DATE_INTERVAL NATURAL JOIN MAPS_TO NATURAL JOIN
ENERGY_SOURCE_COST NATURAL JOIN ENERGY_SOURCE
GROUP BY Year, Month, Usage_Amount, Meter_Type;

CREATE VIEW MONTH_USAGE_SOURCE AS
SELECT Year, Month, SUM(Usage_Amount) AS Usage, Meter_Type
FROM MONTH_USAGE
GROUP BY Year, Month, Meter_Type
ORDER BY Year, Month;

CREATE VIEW SEASON_USAGE AS
SELECT cast(EXTRACT(YEAR FROM StartDate) as int) AS Year, cast(EXTRACT(MONTH
FROM StartDate) as int) AS Month, TypeOfSeason, Usage_Amount, Meter_Type
FROM DATE_INTERVAL NATURAL JOIN MAPS_TO NATURAL JOIN
ENERGY_SOURCE_COST NATURAL JOIN ENERGY_SOURCE
GROUP BY Year, Month, TypeOfSeason, Usage_Amount, Meter_Type;

CREATE VIEW SEASON_USAGE_SOURCE AS
SELECT Year, SUM(Usage_Amount) AS Usage, TypeOfSeason, Meter_Type
FROM SEASON_USAGE
GROUP BY Year, TypeOfSeason, Meter_Type
ORDER BY Year;
```

- **Queries:**

Selecting Year Option:

```
SELECT year, cost, usage_amount, kbtupercost
FROM YEAR_SOURCE WHERE CAST(year AS int) BETWEEN <yearSel_startyear> AND
<yearSel_endyear>
ORDER BY year;
```

Selecting Show Meter Cost for Year:

```
SELECT year, meter_type, cost
FROM YEAR_METER_COST_SOURCE
WHERE meter_type IN {List of Meter Types} AND CAST(year AS int) BETWEEN
<yearSel_startyear> AND <yearSel_endyear>
ORDER BY year;
```

Selecting Month Option:

```
SELECT year, month, cost, usage_amount, kbtupercost
FROM MONTH_SOURCE
```

WHERE CAST(year AS int) = <monthSel_year> AND CAST(month AS int) BETWEEN <monthSel_startmonth> AND <monthSel_endmonth>
ORDER BY year, month ASC;

Selecting Show Meter Cost for Month:
SELECT year, month, meter_type, cost
FROM MONTH_METER_COST
WHERE meter_type IN {List of Meter Types} AND CAST(month AS int) BETWEEN <monthSel_startmonth> AND <monthSel_endmonth> AND CAST(year as int) = <monthSel_year>
ORDER BY year, month ASC;

Selecting 15 Minute Option
SELECT StartDate, StartTimestamp, cost, usage_amt, kbtupercost
FROM MINUTE_SOURCE
WHERE StartDate = <minSel_date> AND starttimestamp BETWEEN <minSel_starttime> AND <minSel_endtime>
ORDER BY StartTimestamp;

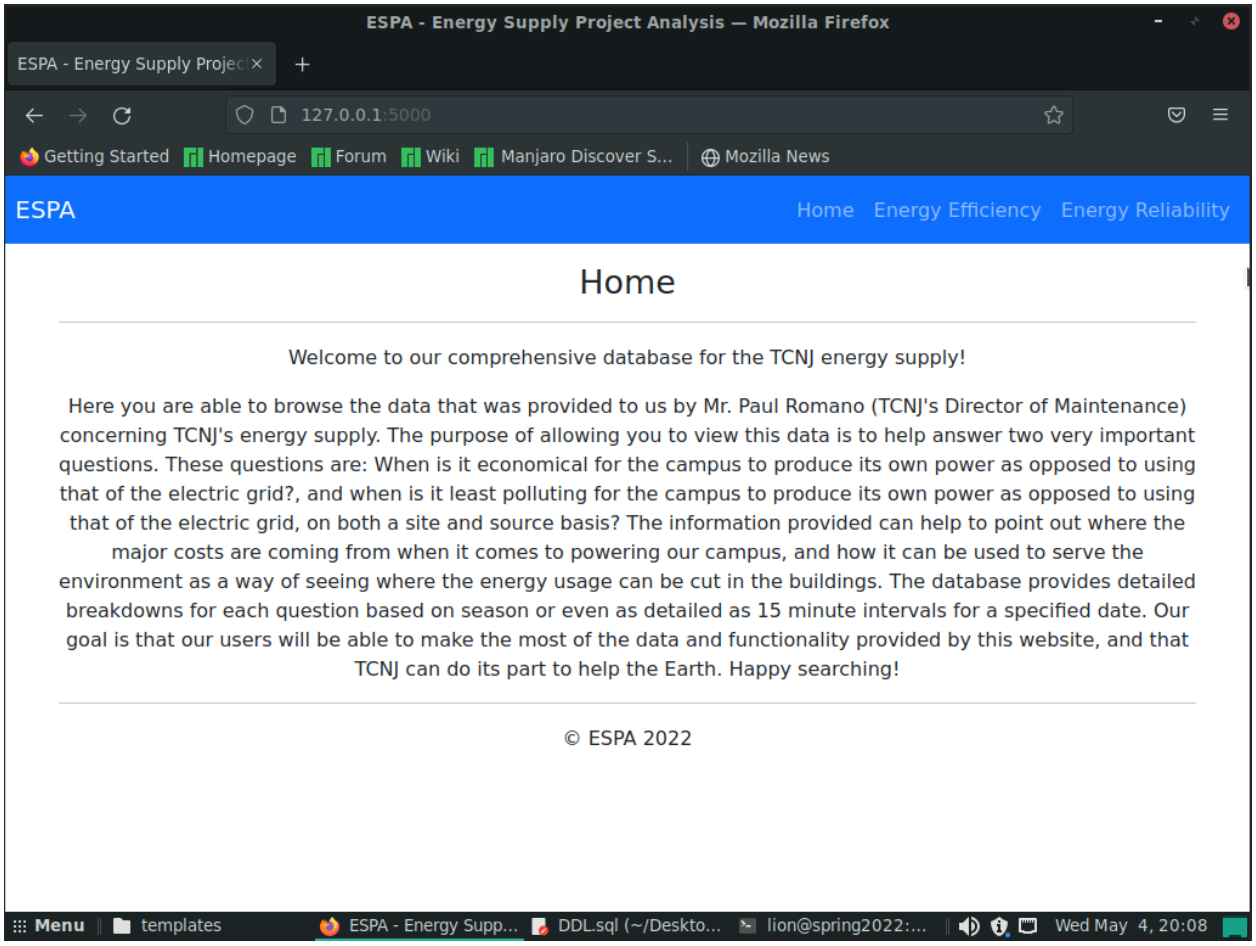
Selecting Show Meter Cost for 15 Minute Option
SELECT StartDate, starttimestamp, meter_type, cost
FROM MINUTE_METER_COST
WHERE meter_type IN {List of Meter Types} AND starttimestamp BETWEEN <start_time> AND <end_time> AND StartDate = <minSel_date>
ORDER BY StartTimestamp;

Selecting Specific Month Option
SELECT Year, Month, Meter_Type, Usage
FROM MONTH_USAGE_SOURCE
WHERE meter_type IN {List of Meter Types} AND Cast(Year AS int) BETWEEN <start_year> AND <end_year> AND Cast(Month AS int) = <q2monthSel>;

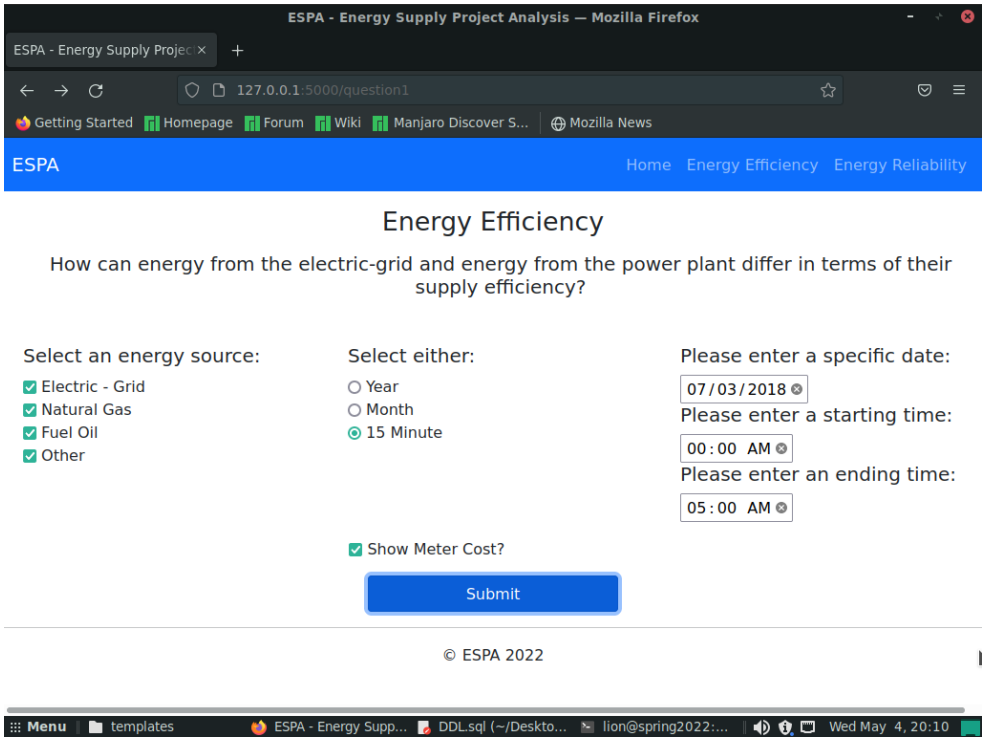
Selecting Specific Season Option
SELECT Year, Meter_Type, Usage, TypeOfSeason
FROM SEASON_USAGE_SOURCE
WHERE meter_type IN {List of Meter Types} AND Cast(Year AS int) BETWEEN <start_year> AND <end_year> AND TypeOfSeason = <q2seasonSel>;

- **User Interface:**

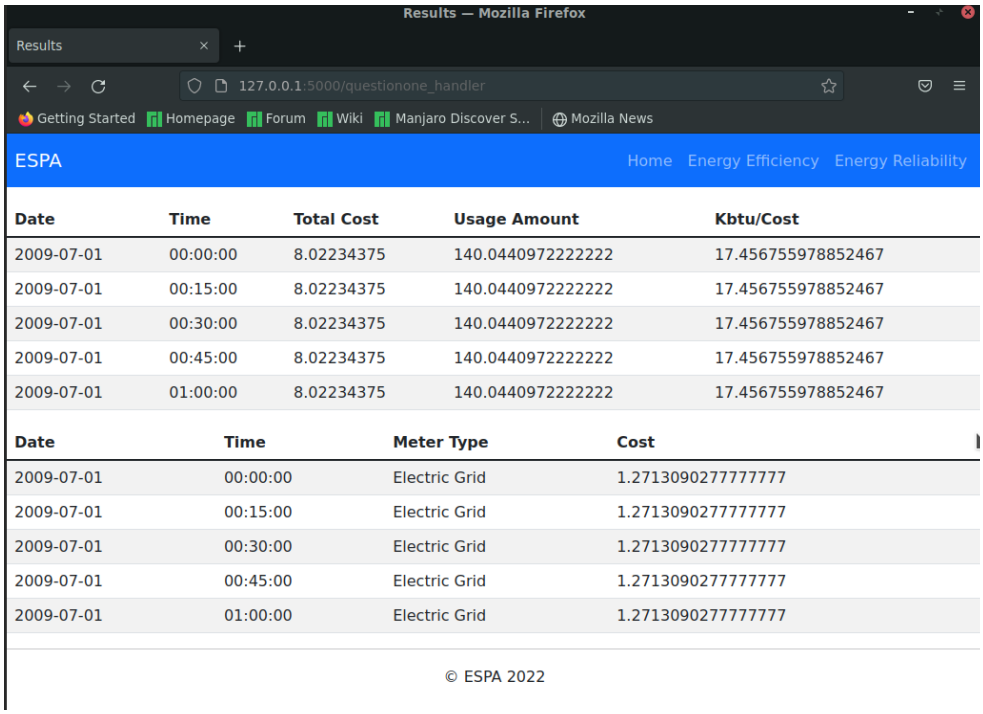
Home Page



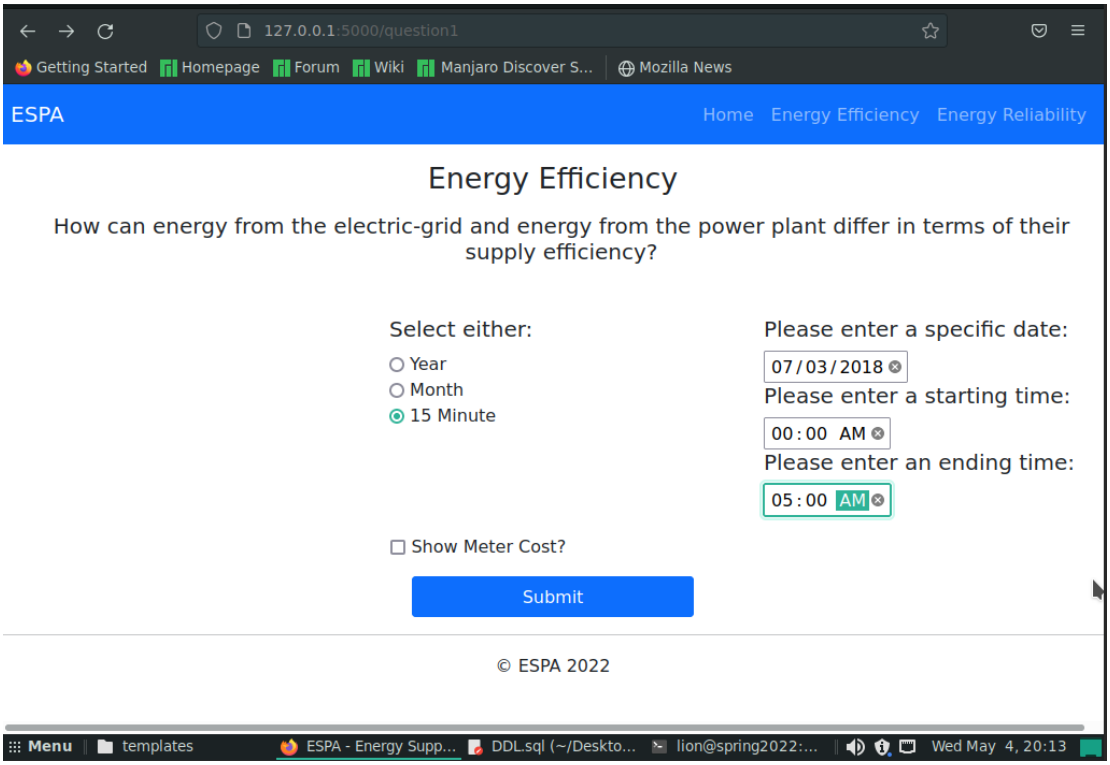
15 Minute Interval with Meter Cost Query



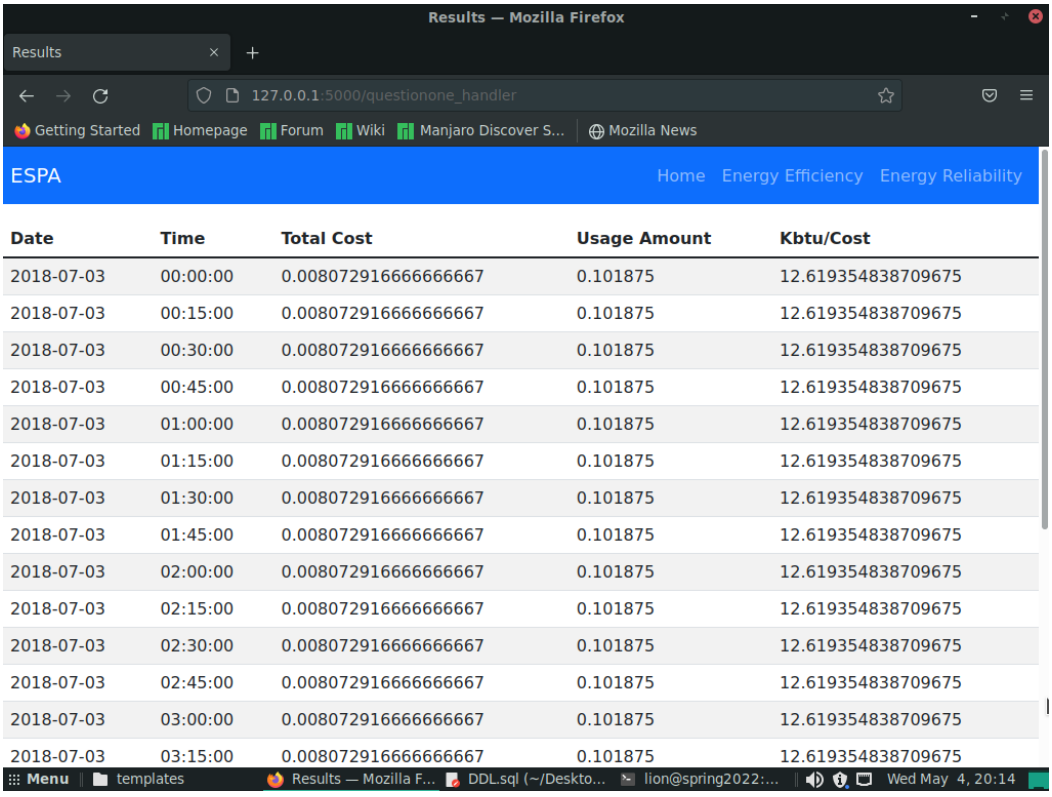
15 Minute Interval with Meter Cost Result



15 Minute Interval without Meter Cost Query

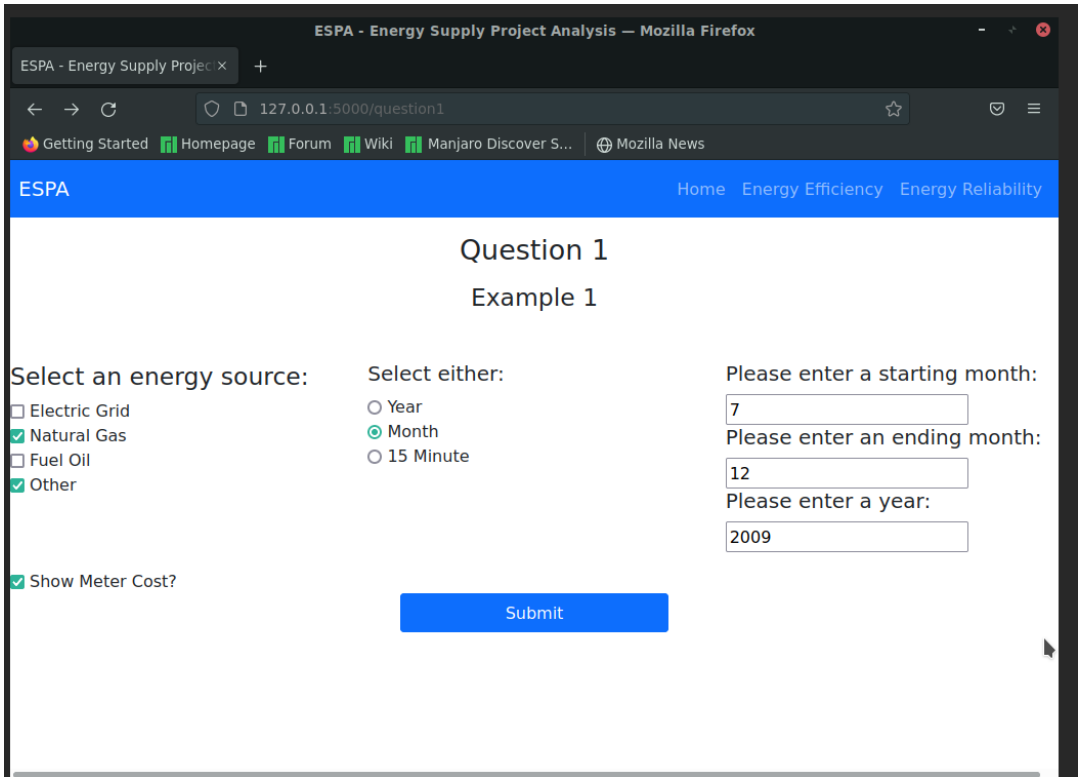


15 Minute Interval without Meter Cost Result

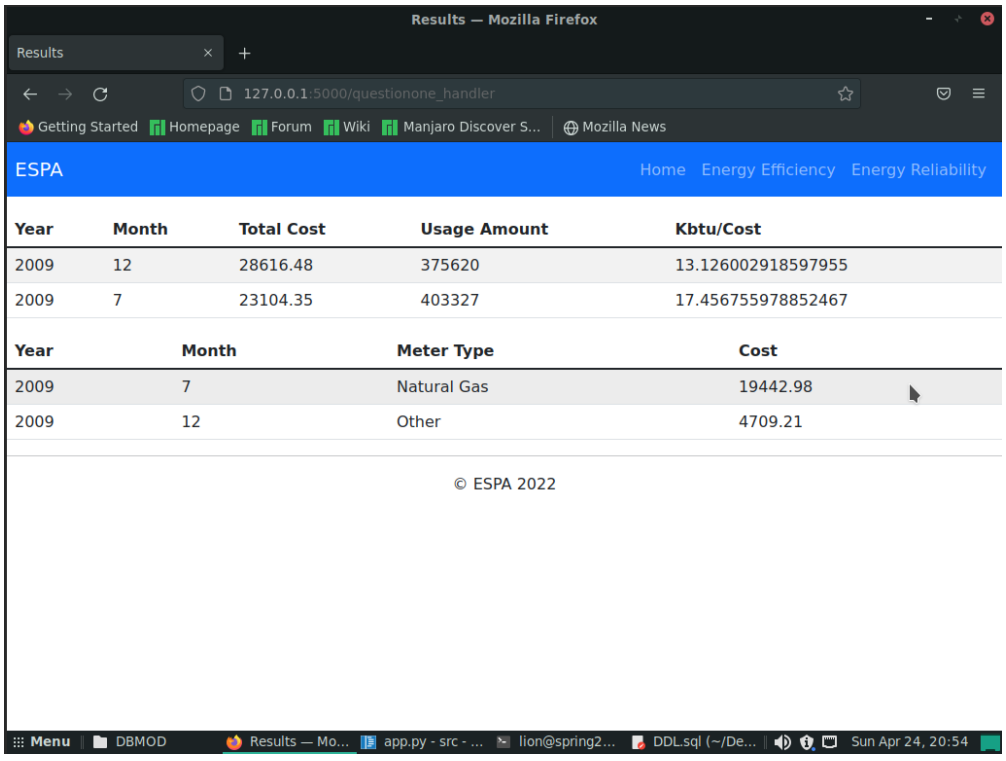


Date	Time	Total Cost	Usage Amount	Kbtu/Cost
2018-07-03	00:00:00	0.008072916666666667	0.101875	12.619354838709675
2018-07-03	00:15:00	0.008072916666666667	0.101875	12.619354838709675
2018-07-03	00:30:00	0.008072916666666667	0.101875	12.619354838709675
2018-07-03	00:45:00	0.008072916666666667	0.101875	12.619354838709675
2018-07-03	01:00:00	0.008072916666666667	0.101875	12.619354838709675
2018-07-03	01:15:00	0.008072916666666667	0.101875	12.619354838709675
2018-07-03	01:30:00	0.008072916666666667	0.101875	12.619354838709675
2018-07-03	01:45:00	0.008072916666666667	0.101875	12.619354838709675
2018-07-03	02:00:00	0.008072916666666667	0.101875	12.619354838709675
2018-07-03	02:15:00	0.008072916666666667	0.101875	12.619354838709675
2018-07-03	02:30:00	0.008072916666666667	0.101875	12.619354838709675
2018-07-03	02:45:00	0.008072916666666667	0.101875	12.619354838709675
2018-07-03	03:00:00	0.008072916666666667	0.101875	12.619354838709675
2018-07-03	03:15:00	0.008072916666666667	0.101875	12.619354838709675

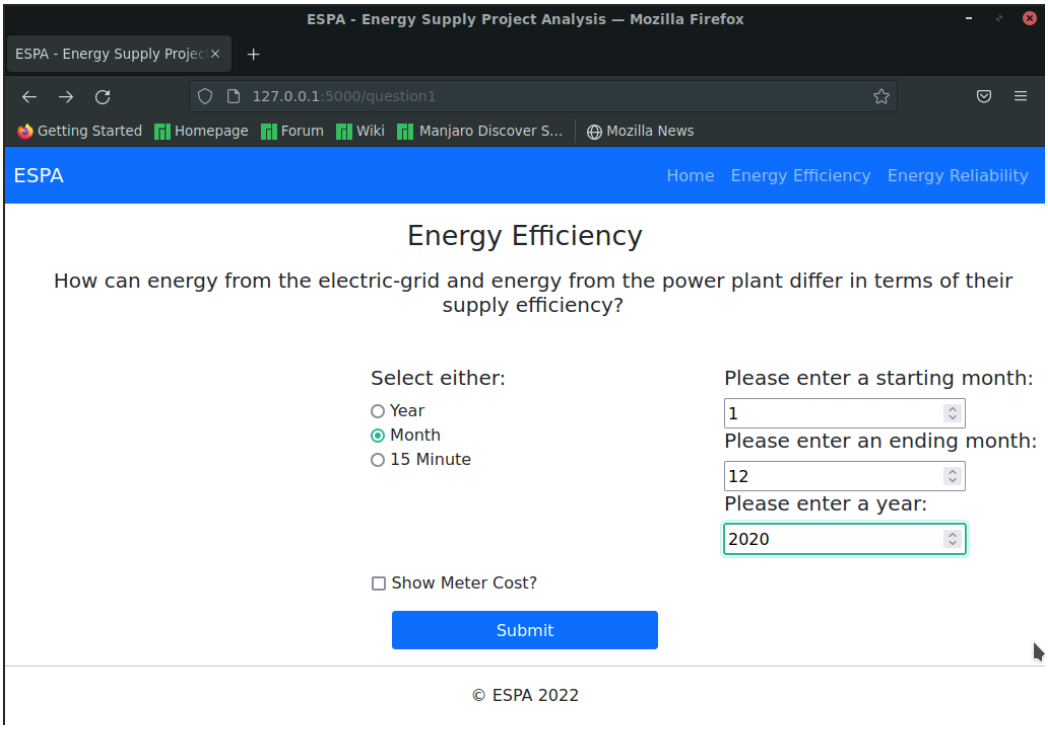
Month with Meter Cost Query



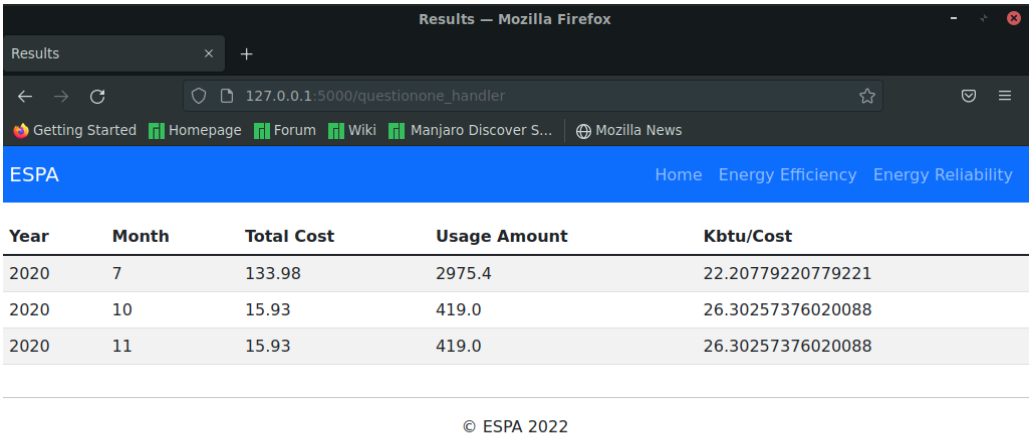
Month with Meter Cost Result



Month without Meter Cost Query

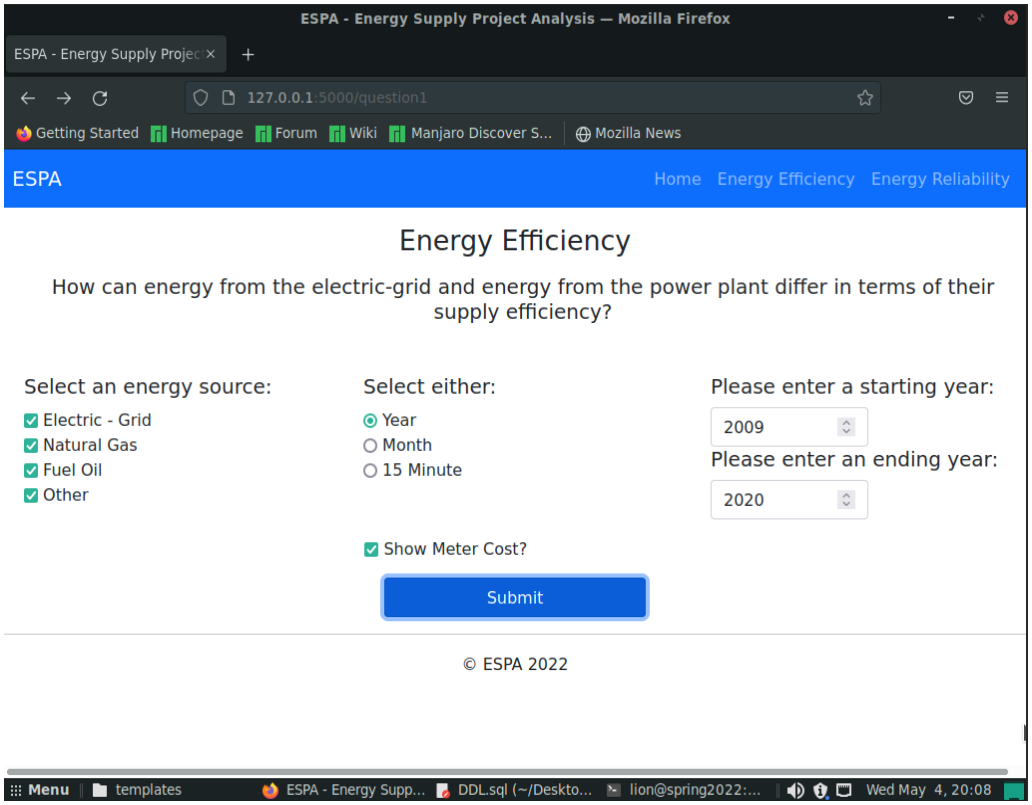


Month without Meter Cost Query Result

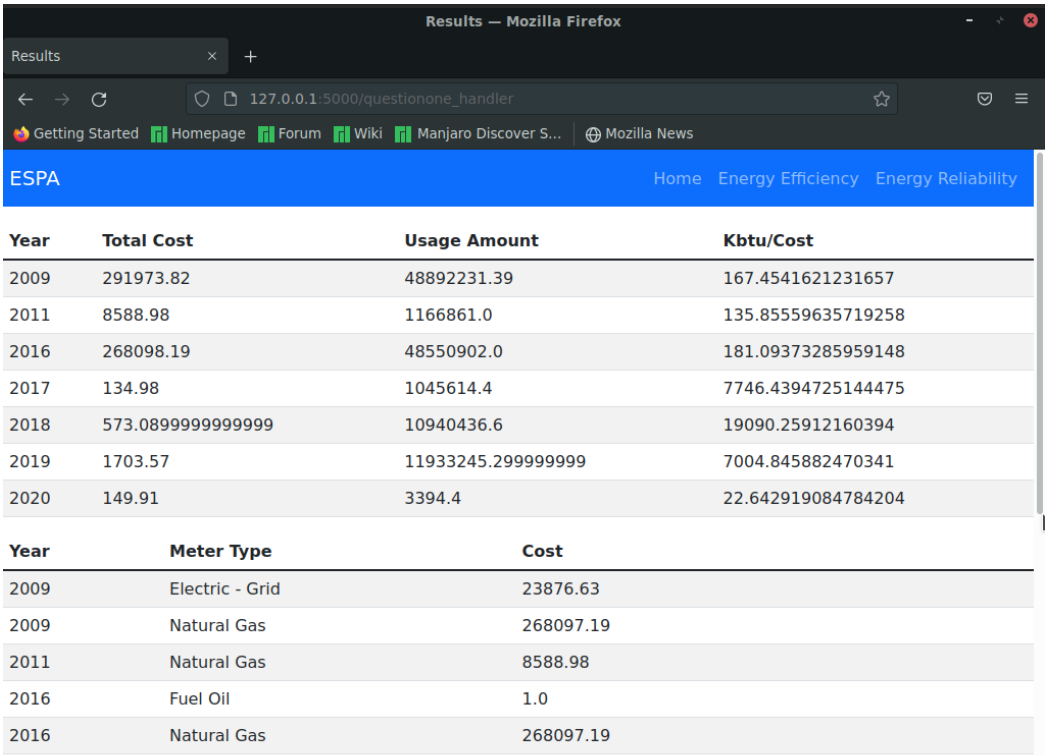


Year	Month	Total Cost	Usage Amount	Kbtu/Cost
2020	7	133.98	2975.4	22.20779220779221
2020	10	15.93	419.0	26.30257376020088
2020	11	15.93	419.0	26.30257376020088

Yearly with Meter Cost



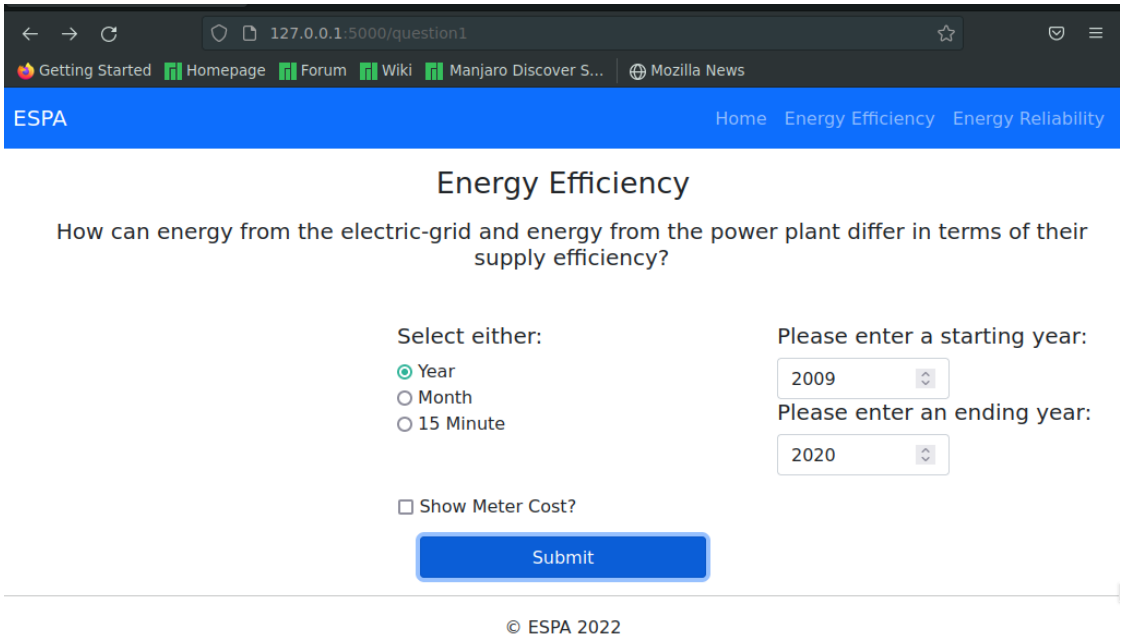
Yearly with Meter Cost Result

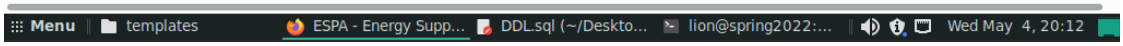


Year	Total Cost	Usage Amount	Kbtu/Cost
2009	291973.82	48892231.39	167.4541621231657
2011	8588.98	1166861.0	135.85559635719258
2016	268098.19	48550902.0	181.09373285959148
2017	134.98	1045614.4	7746.4394725144475
2018	573.0899999999999	10940436.6	19090.25912160394
2019	1703.57	11933245.299999999	7004.845882470341
2020	149.91	3394.4	22.642919084784204

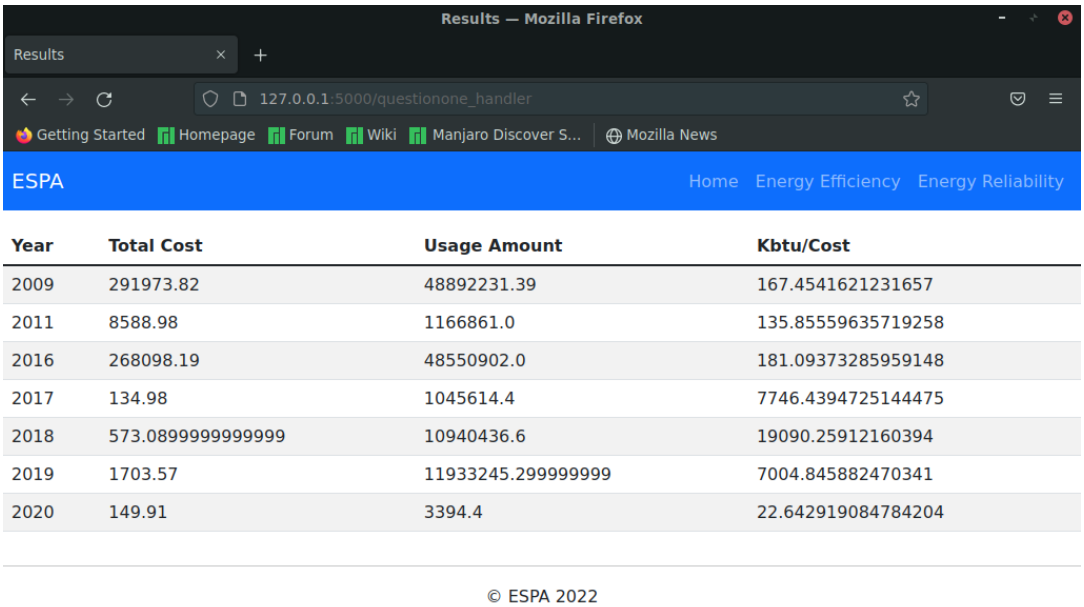
Year	Meter Type	Cost
2009	Electric - Grid	23876.63
2009	Natural Gas	268097.19
2011	Natural Gas	8588.98
2016	Fuel Oil	1.0
2016	Natural Gas	268097.19

Year Without Meter Cost Query



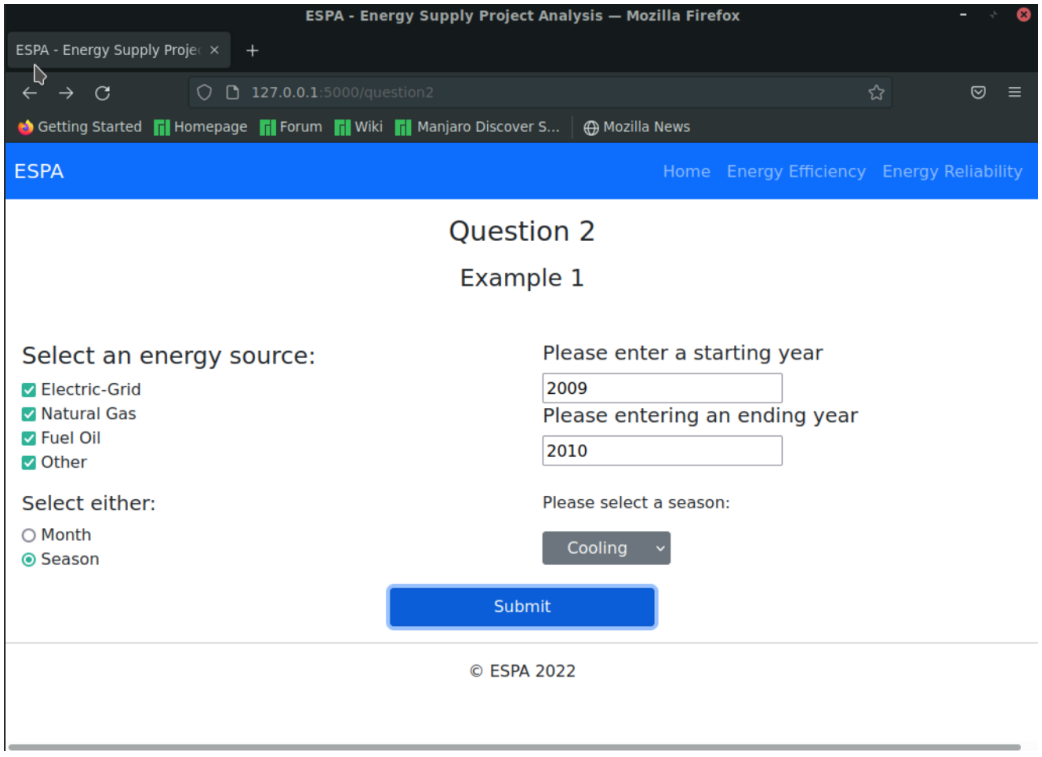


Year Without Meter Cost Query Result:

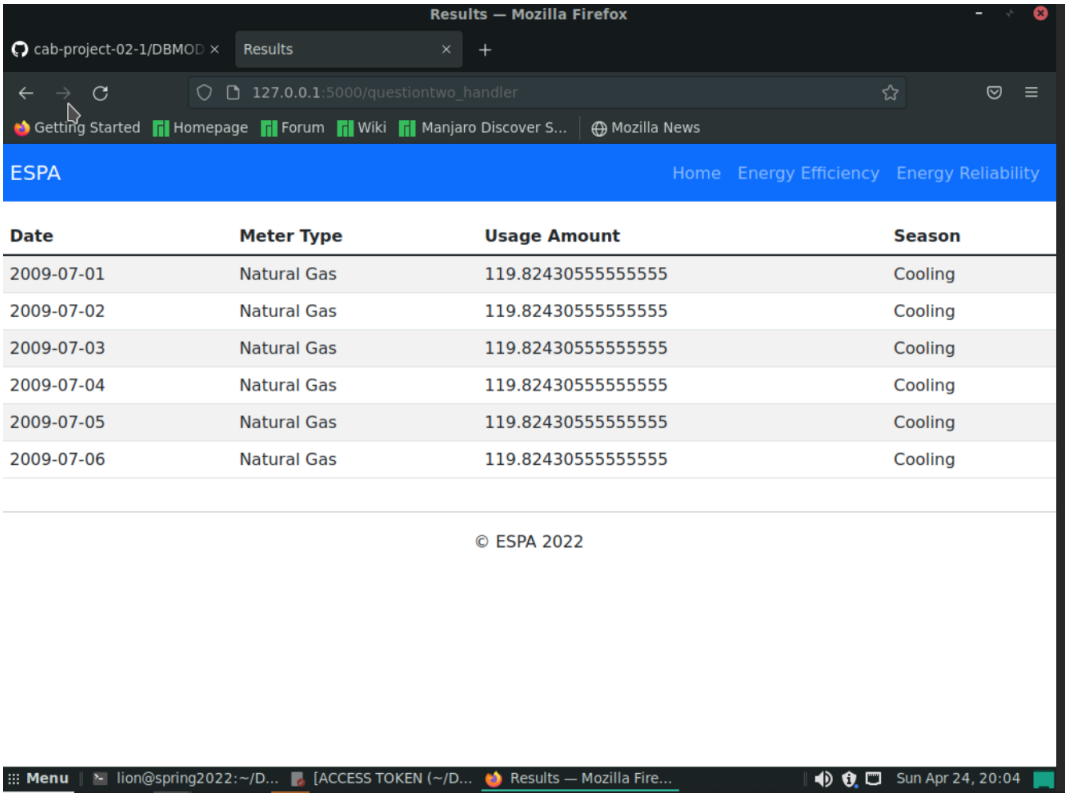


Year	Total Cost	Usage Amount	Kbtu/Cost
2009	291973.82	48892231.39	167.4541621231657
2011	8588.98	1166861.0	135.85559635719258
2016	268098.19	48550902.0	181.09373285959148
2017	134.98	1045614.4	7746.4394725144475
2018	573.0899999999999	10940436.6	19090.25912160394
2019	1703.57	11933245.299999999	7004.845882470341
2020	149.91	3394.4	22.642919084784204

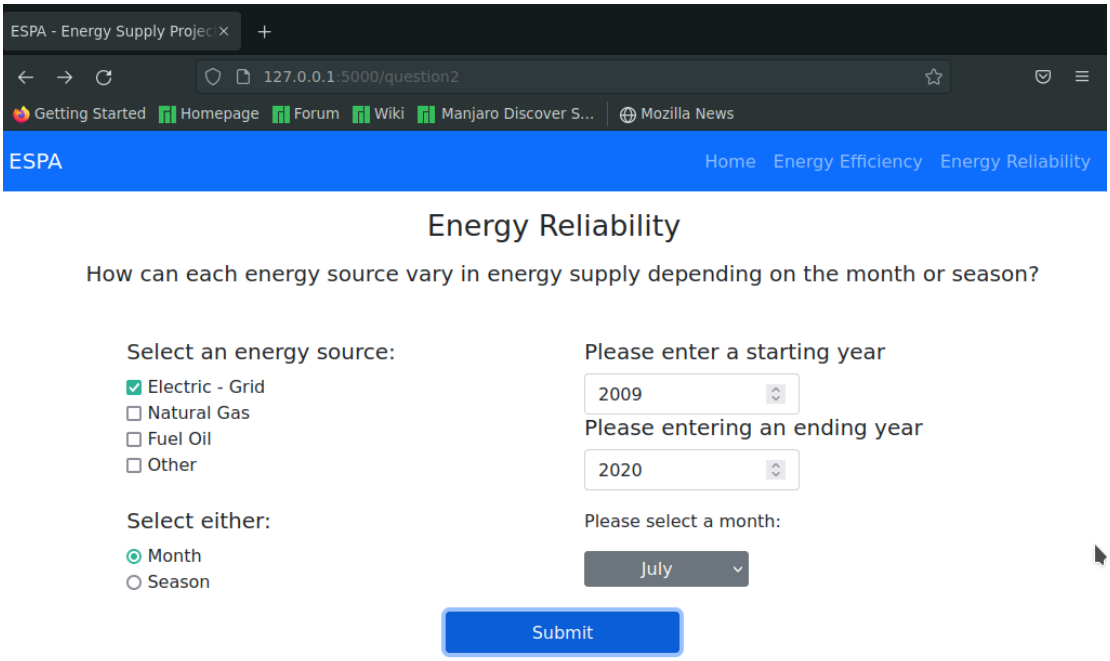
Specific Season Query



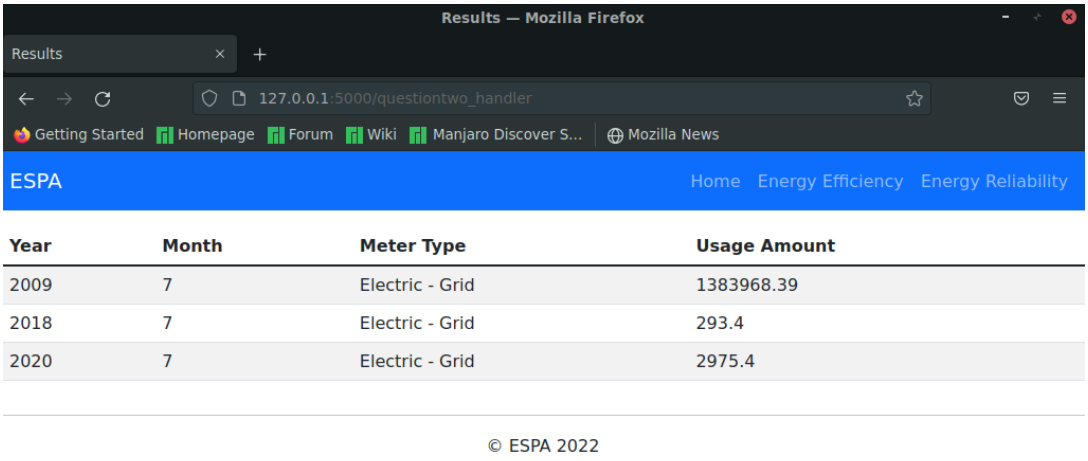
Specific Season Query Result



Specific Month Query



Specific Month Query Result



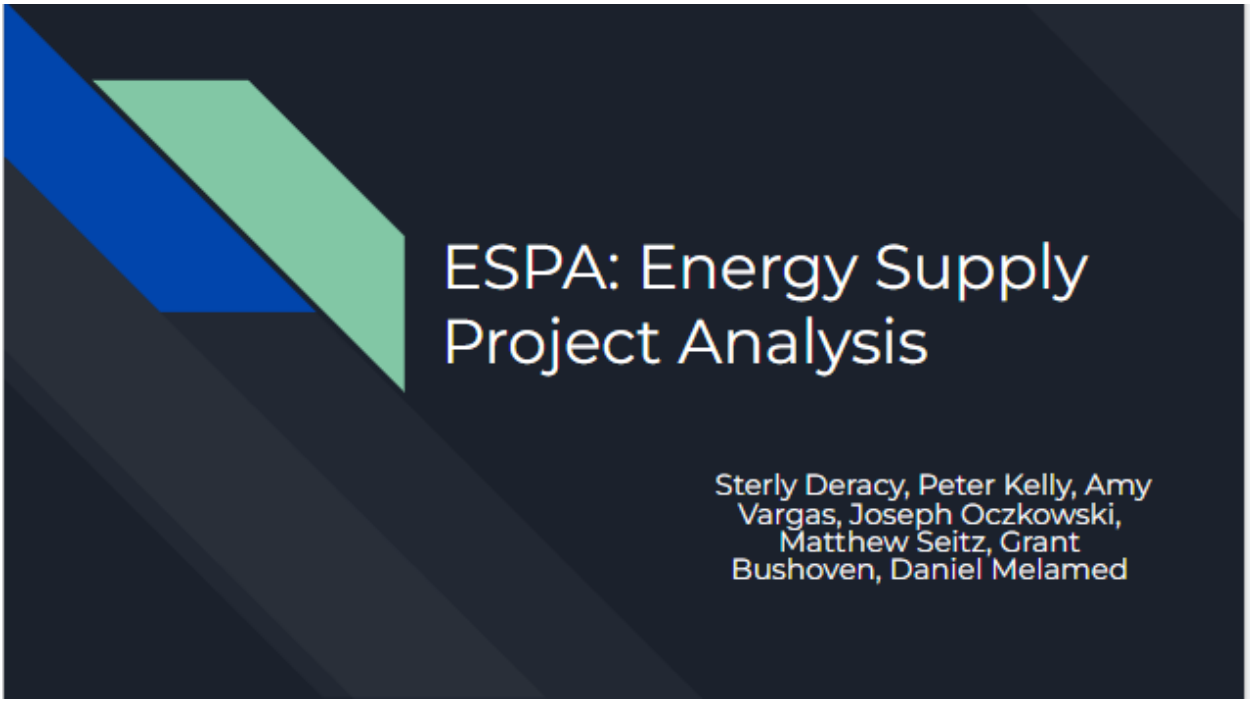
Transition: Maintenance

Private Github Project URL:

- https://github.com/TCNJ-degoodj/cab-project-02-1

Final Project Demonstration

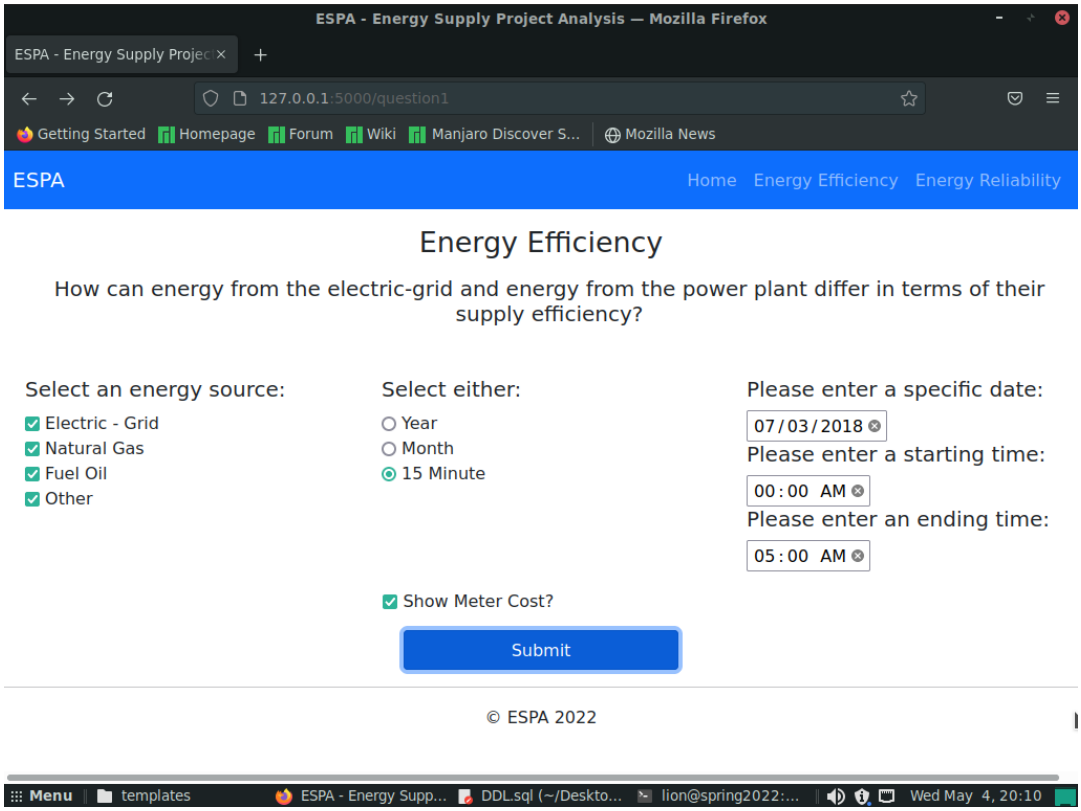
Slides:



ESPA's Impact

- Benefits
  - Specialized
  - Detailed 15 minute breakdowns
  - Robust room for expansion
  - Front end error checking
  - Straightforward and practical design
- Costs:
  - Data predefined in 15 minute intervals
  - Sizable memory space
  - Brand new website

User Interface Screenshot:



Transition: Product Hand Over

Sterly's URL: https://github.com/sderacy/csc315cab
Amy's URL: https://github.com/A-Vargas-GP/cab-project-02-1
Peter's URL: https://github.com/kellyp11/cab-project-02-1