Emissions Tracking Dashboard

DESIGN DOCUMENT

Team 15
Client: MISO
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Executive Summary

Development Standards & Practices Used

- IEEE Std 1063, Standard for Software User Documentation. Minimum requirements for the structure, information content, and format of user documentation.
- IEEE Std 1220-2005, Standard for Application and Management of the Systems Engineering Process. Describes the systems engineering activities and processes required throughout a system's life cycle to develop systems meeting customer needs, requirements and constraints.
- IEEE 16326:2019 This standard gives content specifications for project management plans that cover software projects and describes applying sets of common project processes to software and system life cycle.
- IEEE 23026-2015. This standard describes the system engineering and management requirements for the life cycle of websites, including the strategy, design, engineering, and testing and validation and management for the Intranet and Extranet environments.

Summary of Requirements

- Graphical User Interface
- Software program design
- Assumption development
- Information access and availability
- Program documentation

Applicable Courses from Iowa State University Curriculum

SE 319: Construction of user interfaces, SE 329: Software project management, SE 309: Software development practices, EE 303: Power systems, CprE 339: Software architecture, CprE 416: Software evolution

New Skills/Knowledge acquired that was not taught in courses

Javascript and Python programming, Highcharts design, data analysis, User experience analysis and development.

Table of Contents

List of figures/tables/symbols/definitions

MISO: Midcontinent MISO (Midcontinent Independent System Operator) is an independent, not-for-profit, member-based organization responsible for operating the power grid across 15 U.S. states and the Canadian province of Manitoba.

EIA: The U.S. Energy Information Administration (EIA) is a principal agency of the U.S. Federal Statistical System responsible for collecting, analyzing, and disseminating energy information to promote sound policymaking, efficient markets, and public understanding of energy and its interaction with the economy and the environment

1 Team

1.1 Team Members

1) ____Dylan Christensen_____________ 2) _______ John DiBasilio __________

3) ____Sean Fleming ________________ 4) _______ Manbir Guron ___________

5) ____Tyler Maglaya________________ 6) _______Damandeep Riat__________

7) ____ Jack Riley____________________

1.2 Required Skill Sets for Your Project

- Python
- HTML
- Data Visualization (Tableau)
- Pandas
- Web Parsing
- Organization and Scheduling

1.3 Skill Sets covered by the Team

- Python - Manbir, Dylan, Jack, Sean, Tyler, Damandeep
- Data Visualization – John
- Analyze Data – John
- HTML – Jack, Manbir, Dylan
- Pandas - Jack Riley
- Organization and Scheduling - John, Jack

1.4 Project Management Style Adopted by the team

Agile project management

1.5 Initial Project Management Roles

1. Product owner: John DiBasilio
2. Development team members:
    a. Sean Flemming
    b. Dylan Christensen

c. Tyler Maglaya

d. Damandeep Riat

3. Scrum master: Jack Riley

4. Agile mentor: Manbir Guron

2 Introduction

2.1 Problem Statement

Team 15 is tasked with developing an emissions dashboard for MISO (Midcontinent Independent System Operations). MISO stakeholders lack a fast and efficient way to analyze public emissions data generated by MISO. Currently, the data can be found in numerous different places, which can be cryptic to many consumers. The emissions dashboard is intended to solve this problem and provide stakeholders and MISO an opportunity to interact with public emissions data through a series of user-friendly visualizations. This dashboard should allow users to understand the emissions impact of their energy generation or consumption, and create a rich context behind this data to make complex trends in electricity generation emissions simple to view and understand.

2.2 Requirements & Constraints

The main goal for this project is to produce a dashboard where users can view a variety of emissions data for either the entire MISO territory or individual MISO regions. Below are the detailed requirements and constraints.

1) **Graphic interface**

a) Daily Emission Chart

i) Line Chart showing Emissions of MISO / MISO regions up to current hour starting from 00:00

b) Interactable by public website user

i) Filters by region on emission output

ii) Allow user to download recent data (Data up to that hour of the day starting from 00:00)

iii) Allow graph to be "popped out" to a larger standalone display

iv) Include description of chart and data being used to make it

(1) Example: current MISO real time charts have a (i) which when clicked on give info

v) Includes area, generation type, possibly fuel type filters

c) Similarity to Current MISO website graphs

i) Hours X axis, Emission Y axis

ii) Use MISO colors

2) **Software program design**

a) Python is widely used in MISO for automation and data analysis.

b) Currently working with internal MISO software team to find more technical requirements in this specific department and what preferred language should be used for website

3) **Assumption development**

a) Maintain documentation of assumptions made, and any sources / discussion notes leading to those assumptions

i) Any formulas or derivations made to reach emissions calculations need to be fully described and maintained in a list of formulas used

ii) Maintain cited source list of all sources of information for any calculations which assist in the emission derivation effort

4) **Information access and availability**

a) All information used must be publicly accessible information, which could create a degree of approximation in deriving the exact real time emissions data from any source (Constraint).

5) **Program documentation**

a) At conclusion of project, a write up of the overall project will be created with the intent to inform others of the work done and share knowledge to allow expansion upon the foundation created by the project

2.3 Engineering Standards

- IEEE Std 1063, Standard for Software User Documentation. Minimum requirements for the structure, information content, and format of user documentation, including both printed and electronic documents used in the work environment by users of systems containing software, are provided in this standard.
- IEEE Std 1220-2005, Standard for Application and Management of the Systems Engineering Process. This standard describes the systems engineering activities and processes required throughout a system's life cycle to develop systems meeting customer needs, requirements and constraints.

- IEEE 16326:2019 This standard gives content specifications for project management plans that cover software projects and describes applying sets of common project processes to software and system life cycle.
- IEEE 23026-2015. This standard describes the system engineering and management requirements for the life cycle of websites, including the strategy, design, engineering, and testing and validation and management for the Intranet and Extranet environments. Project will be a website hosted dashboard so it will be useful in some of the information it provides.

2.4 Intended Users and Uses

The intended consumers of the emissions dashboard will be MISO, its stakeholders, and the public at large. All parties benefit with the creation of the emission dashboard, whether they are generation facilities, utility companies, or electrical consumers. Users can easily access emissions data that is historical and in real time that can be used for projects and other business decisions for electric utilities and their customers. They will be able to take the data provided in the dashboard and use it however it applies to their situation.

Researchers employed by MISO area utilities and outside institutions can see how various trends impact emissions of the MISO region, allowing them to study new generation projects and technologies to effectively meet emissions targets set by MISO customers and all levels of government.

Customers of MISO utilities, including utility companies and individual end users, can view this dashboard to see the emissions impacts of their regular activities, and look to see how they can decrease the impact of their energy usage by shifting the time of day, season, or physical location of their energy usage.

With the implementation of interactable charts, maps, and graphs that represent the emissions data from the various MISO regions, large amounts of data can be expressed in a user-friendly way so that the parties above can easily access it in a quick and efficient manner.

3 Project Plan

3.1 Project Management/Tracking Procedures

Which of agile, waterfall or waterfall+agile project management style are you adopting?

We will be using an agile project management style. This is because of the fact that our sponsor wants a dashboard that could include a variety of data sources, views, and elements of user experience. This requires an interactive design process with small tasks designed to build layers of functionality on top of each other.

What will your group use to track progress throughout the course of this and the next semester. ?

Our team will use Git to manage any code written for our dashboard, and to track issues and major changes, and we will use our Teams chat and associated integrations to manage smaller discussions with less time sensitivity.

3.2 Task Decomposition

1. **Construct model to find all plants in MISO system, categorize them into *Regional Generation Source Data (RGSD)***
    a. Select data sources from MISO and EIA databases
    b. Determine the methods to use to extract and store data
    c. Extract and store relevant plant metadata
2. **Construct module to import historical emissions data from all plants, Plant Historical Emissions Data (PHED)**
    a. Determine relevant data sources and necessary conversions/calculations
    b. Extract and operate on relevant data, link this new data to RGSD
    c. Perform necessary calculations and estimations, preserve raw data for user download
    d. Construct exception handling mechanisms to support gaps in historical data
    e. Prepare data for final export to dashboard
3. **Construct module to import real time data from all plants, Plant Instantaneous Emission System (PIES)**
    a. Subtasks follow task 2, with real time sources instead of historical data sources

4. **Construct dashboard to visualize regional emissions data**
    a. Determine initial user requirements for dashboard views, interactivity, UX/UI
    b. Incorporate RGSD, PHED, and PIES datasets into base dashboard
    c. Optimize dashboard interaction and performance
    d. Test dashboard interaction
5. **Construct dashboard view to visualize MISO total emissions data**
    a. Add together the three regional dashboards into a single dashboard, using the same processes for optimization
    b. Test dashboard interaction
6. **Host dashboard and code on MISO server**
    a. Determine technical requirements for MISO web server compatibility
    b. Interact with MISO to host dashboard on their servers
7. **Write report analyzing emissions trends**
    a. Use the completed dashboard to analyze trends in emissions data
    b. Create necessary figures, charts, etc to communicate trends in a variety of settings
    c. Create any other communication tools like posters, web pages, etc

3.3 Project Proposed Milestones, Metrics, and Evaluation Criteria

What are some key milestones in your proposed project?I

1.Construct model to find all plants in MISO system, categorize them into regions to create the *Regional Generation Source Data (RGSD)*

A. Determine required input sources to achieve desired model output.

a. Determine and select available data sources relevant plant location and region. *(Metric:MISO/team discretion)*

b. Determine the methods to be used to extract and store data from relevant sources into the project's dataset. *(Metric: Data is able to be extracted and usable during subsequent steps)*

c. Write code to extract and organize relevant data from selected sources into the project dataset. *(Metric(s): Extracted data matches source data, code is well organized, code runs in an efficient manner (efficiency metric TBD))*

2. Construct module to import historical emissions data from all plants Plant Historical Emissions Data (PHED)

A. Determine relevant data sources and what calculations or estimations need to be performed. *(Metric: MISO acceptance)*

B. Write code to extract source data and link it to RGSD from (1) *(Metric: Verify data by "fact checking" samples with an external, existing data source.)*

C. Write code to perform required calculations or estimations on source data and to preserve source data for potential user output. *(Metric: Code output matches expected calculations)*

D. Write code to incorporate data error handling (possible missing information, down servers, etc.). *(Metric: Code runs without errors/properly handles external errors)*
E. Write code that prepares data for output to dashboard: Perform any variable type conversions, organizational changes, etc. to make dataset easily incorporated by dashboard code. *(Metric: Data is organized such that it is easy to incorporate and manipulate using the dashboard (team/subteam discretion)*

3. Construct module to import real time data from all plants Plant Instantaneous Emission System (PIES)

The task/subtask goals for (3) are the same as for (2)

4. Construct the dashboard to visualize regional emissions data.

A. Develop and code initial dashboard visualization template. *(Metric: MISO acceptance)*
   a. (Possible goal): Create a static, team-defined dataset (and test server?) for testing purposes which will give a known output.
   b. Determine and code required filters and user interaction tools. *(Metric(s):User can view data as specified by MISO proposal, filters function properly without error, output is as expected)*
   c. Write the code to incorporate MISO map(s) into the dashboard *(Metric: Regional views change with respect to dashboard filters, visualizations update when filters are applied)*
   d. Write code for user data download. *(Metric: Data is able to be downloaded in a format similar to other MISO dashboards (csv or other formats as required)*

B. Write code to incorporate RGSD (1) and PHED (2) data into the dashboard. *(Metric: Dashboard shows accurate visualizations from source data)*

C. Test dashboard interaction. *(Metric: Dashboard operates (proper filtering, updating, allows repeated filters)*

   a. (Possible goal): Test dashboard on the "test dataset" to verify information is displayed properly for all user filters and outputs correctly.

   b. Test dashboard using real dataset.

D. Perform run-time optimization *(Metric: Dashboard response is equivalent to other MISO dashboards)*

   a. Write code to optimize efficiency of user interaction. Add branching, optimization of functions for certain tasks, etc. to lower user wait time below threshold value (TBD based on existing MISO dashboards)

E. Submit dashboard model to MISO for approval; revise dashboard as requested. *(Metric: MISO approval)*

5. Construct dashboard view to visualize MISO total emissions data

The task/subtask goals for (5) are essentially the same as for (4).

6. Host dashboard and code on MISO serverFormat all code to MISO standards.

(Metric: Code meets MISO code standards)

A. Perform all required steps to host code on MISO servers. *(Metric: MISO approval??)*

B. Interact with MISO to submit, review, and edit code as necessary. *(MISO final approval to host code)*

C. Goal: MISO accepts code to host on server.

D. Goal: Code operates as expected on MISO server.

7. Write report analyzing emissions trends

A. Rough outline of report. (Metric: Meets general report standards)

B. Incorporation of dashboard figures, tables, and other useful information into the report relating to textual references.

C. Refine report following (TBD) reporting standard guidelines. (Metric: MLA, APA, etc. formatting)

3.4 Project Timeline/Schedule

Below is the official gantt chart for the first section of this project, covering systems architecture, assumption development, preliminary design and interpretation.

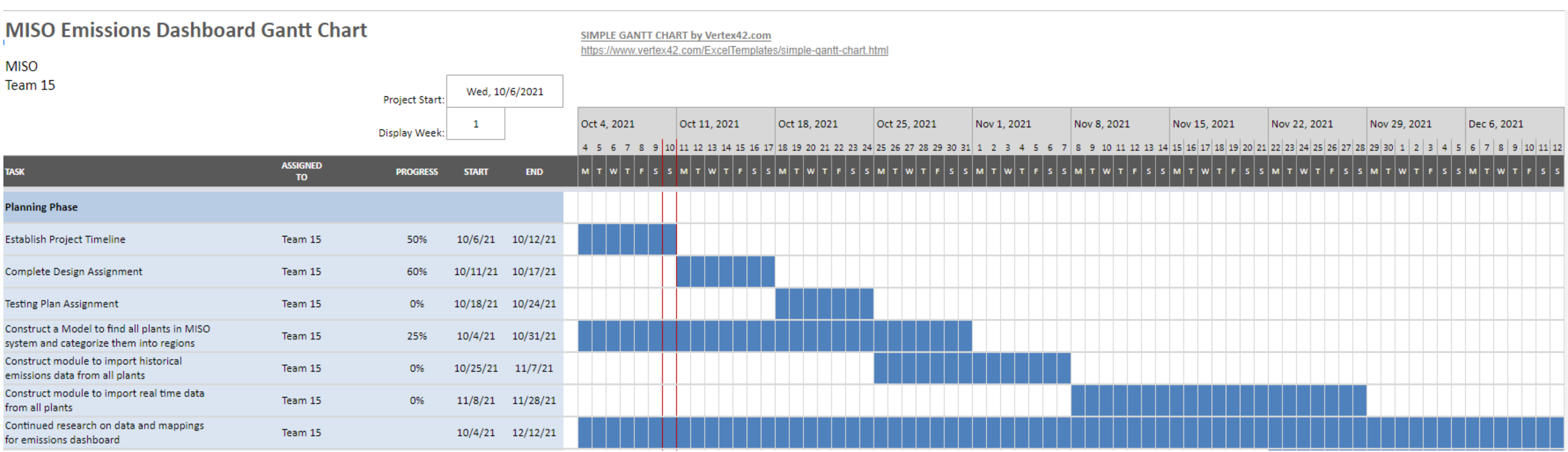

Figure 1. Gantt chart

3.5 Risks And Risk Management/Mitigation

Consider for each task what risks exist (certain performance target may not be met; certain tool may not work as expected) and assign an educated guess of probability for that risk.

1. **Construct model to find all plants in MISO system, categorize them into *Regional Generation Source Data (RGSD)***
    a. Select data sources from MISO and EIA databases
        i. *These data sources may not include all the information we need.*

           Mitigation: We have to estimate our data based on the information we are allowed to use. (HIGH RISK)
        ii. *The data source location could change and become unavailable to our project.*

            Mitigation: We will need to (i) find other sources for the data or (ii) handle these errors appropriately by making the data sources used in our code easy to understand and update as required. (HIGH RISK)
    b. Determine the methods to use to extract and store data
        i. The methods we use to extract and store data could become deprecated or removed from public use. (LOW RISK)

           Mitigation: Use established, open source applications throughout the project.
    c. Extract and store relevant plant metadata
        i. Relevant data is provided by internal and external sources with respect to MISO.
            1. Internal source problems. (LOW RISK)

               Mitigation: Communicate concerns with MISO to build redundancy.
            2. External source problem. (MEDIUM RISK)

               Mitigation: Incorporate multiple paths to source data?

2. **Construct module to import historical emissions data from all plants, Plant Historical Emissions Data (PHED)**

   Low risk - if data is properly sourced the collection of data should be straightforward

   Mitigation: Build in multiple paths to access data/easily configure code for future changes to source data.

3. **Construct module to import real time data from all plants, Plant Instantaneous Emission System (PIES)**

   Same as task #2

4. **Construct dashboard to visualize regional emissions data**
   a. Determine initial user requirements for dashboard views, interactivity, UX/UI
      Mitigation: Communicate with MISO to be sure of user requirements and update as required.
   b. Incorporate RGSD, PHED, and PIES datasets into base dashboard
      i. (Medium Risk): different data formats and other incompatibilities may create difficulty here
      ii. **Mitigation:** Care will need to be taken to make sure data formats are synchronized during tasks 2 and 3
   c. Optimize dashboard interaction and performance
      i. Data analysis required excess computation time. (MEDIUM RISK)
         Mitigation: Optimize code as much as possible to remove latency. Verify load time is acceptable range for MISO.
   d. Test dashboard interaction

i. Dashboard does not fall in line with current MISO dashboard latency.

Mitigation: Verify MISO requirements on latency, attempt to optimize code for speed.

5. **Construct dashboard view to visualize MISO total emissions data**
    a. Add together the three regional dashboards into a single dashboard, using the same processes for optimization
        i. Dashboard information does not correlate with the combined dashboard information.

        Mitigation: Review and refine data fed to the combined dashboard.
    b. Test dashboard interaction
        i. Dashboard interaction does not meet requirements.

        Mitigation: Refine code to reduce latency and match user requirements.
6. **Host dashboard and code on MISO server**
    a. Determine technical requirements for MISO web server compatibility
        i. (Low/No Risk): Relies on communicating technical standards
    b. Interact with MISO to host dashboard on their servers
        i. (Medium Risk): MISO website may be difficult to interface with for external entities
        ii. **Mitigation**: The group can host the dashboard in a third party site that can be easily linked to or embedded in the MISO site
7. **Write report analyzing emissions trends**
        i. (Low Risk): if the dashboard works, constructing an analysis and report should be straightforward
        ii. **Mitigation**: If the dashboard is not operable, the team may need to manually sort through data to construct our analysis

3.6 Personnel Effort Requirements

Include a detailed estimate in the form of a table accompanied by a textual reference and explanation. This estimate shall be done on a task-by-task basis and should be the projected effort in the total number of person-hours required to perform the task.

Task	Number of person-hours
Project Plan Assignment	11
Project Plan Lightning Talk	7
Design Assignment	11
Testing Plan Assignment	11
Construct a Model to find all plants in MISO system and categorize them into regions	21
Construct module to import historical emissions data from all plants	14
Construct module to import real time data from all plants	28

Table 1. Personnel Effort Requirements

- 11 number of person-hours refers to having seven people on our team, and each person working about one and a half hours on the assignment.
- All assignments presented in this table come from the Gantt chart listed in section 2.4

3.7 Other Resource Requirements

Identify the other resources aside from financial (such as parts and materials) required to complete the project.

- Tableau - will be used for data visualization and data management around the dashboard.
- Any Python IDE - Python will be used for the creation of any sort of algorithms needed to sort through or filter the emissions data that is provided on MISO's website.

4 Design

4.1 Design Context

4.1.1 Broader Context

Describe the broader context in which your design problem is situated. What communities are you designing for? What communities are affected by your design? What societal needs does your project address?

List relevant considerations related to your project in each of the following areas:

Area	Description	Examples
Public health, safety, and welfare	How does your project affect the general well-being of various stakeholder groups? These groups may be direct users or may be indirectly affected (e.g., solution is implemented in their communities)	This project will give stakeholders an understanding of the existing and historical health effects of electricity generation. This will allow for more educated decision

		making in regards to how to improve the electricity grid to reduce the harmful effects of pollution.
Global, cultural, and social	How well does your project reflect the values, practices, and aims of the cultural groups it affects? Groups may include but are not limited to specific communities, nations, professions, workplaces, and ethnic cultures.	This project advances the social responsibility and transparency of MISO and their planning engineers. By using open data and displaying it in an accessible format for the general public, electricity consumers are better educated on the effects of their behavior. This project promotes the values of transparency and environmental consciousness.
Environmental	What environmental impact might your project have? This can include indirect effects, such as deforestation or unsustainable practices related to materials manufacture or procurement.	Our project will allow MISO customers to better understand the environmental impacts of their electricity usage. This allows for more educated decision making on environmental grounds.
Economic	What economic impact might your project have? This can include the financial viability of your product within your team or company, cost to	Product has minimal costs in implementation, but awareness of the data presented could distort electricity demand depending on

	consumers, or broader economic effects on communities, markets, nations, and other groups.	the time of day, etc. This potential distortion of the market while seeking lower emissions could adversely impact consumers in states with more liberalized electricity pricing models via demand fluctuations. Additionally, the clear data presented in this project could drive decision making in future network planning, in a manner that could financially benefit the producers of clean energy.

Table 2. Design Context

4.1.2 User Needs

List each of your user groups. For each user group, list a needs statement in the form of:

User group needs (a way to) do something (i.e., a task to accomplish, a practice to implement, a way to be) because of some insight or detail about the user group.

MISO customers (Utilities) need a way to see the emissions profile of the entire MISO network to better understand where and how to introduce more clean energy into their networks.

Electricity ratepayers and concerned citizens need to understand the emissions profile of their electricity usage in order to find ways to alter their behavior to reduce their environmental impacts.

MISO wants to collate a large amount of data about generation emissions as customers, regulators, and similar groups will demand more detailed information about generation emissions in the future.

4.1.3 Prior Work/Solutions

California ISO has produced a dashboard[1] showing the historical, real time, and source of CO_2 emissions in the electricity generation occurring in their footprint. This dashboard contains a variety of time scales, sources, and contexts that help explain the trends in CO_2 emissions in a clear manner. Another advantage of the dashboard is the hyperlinking of official government sources that give more context to the data and the statutory regime that necessitates and produces the data. Additionally, the dashboard is consistent with the rest of the ISO's website in terms of visual standards and visual appeal. One shortcoming of the database is the lack of information on the exact sources of the CO_2 emissions beyond the fuel used in generation. Ideally, a customer would have some information about the region where the electricity is being produced, and some more insight into pollutants besides CO_2.

Other ISO's such as New York ISO[2], ISO-New England[3], and Southwest Power Pool[4] have produced dashboards that visualize the mix of fuels used in generation of electricity in their regions. These dashboards succeed in communicating the fuel mix, but lack detailed context on the emissions impacts of this mix. The dashboards are all clear and simple to understand, and many contain the option to interact with the data or download the source data. This interactivity is very important and allows for stakeholders to engage with our project in an intimate fashion and should be integrated as a feature in our design.

“Todays Emissions,” *California iso - emissions, today's outlook*. [Online]. Available: https://www.caiso.com/TodaysOutlook/Pages/emissions.html. [Accessed: 14-Oct-2021].

“Real Time Dashboard,” *NYISO*. [Online]. Available: https://www.nyiso.com/real-time-dashboard. [Accessed: 14-Oct-2021].

“Real-time maps and charts,” *ISO New England - Real-Time Maps and Charts*. [Online]. Available: https://www.iso-ne.com/isoexpress/web/charts. [Accessed: 14-Oct-2021].

Southwest Power Pool, “Generation Mix,” *Generation mix*. [Online]. Available: https://marketplace.spp.org/pages/generation-mix. [Accessed: 14-Oct-2021].

4.1.4 Technical Complexity

Provide evidence that your project is of sufficient technical complexity. Use the following metric or argue for one of your own. Justify your statements (e.g., list the components/subsystems and describe the applicable scientific, mathematical, or engineering principles)

1. The design consists of multiple components/subsystems that each utilize distinct scientific, mathematical, or engineering principles –AND–
2. The problem scope contains multiple challenging requirements that match or exceed current solutions or industry standards.

Our design will integrate distinct systems to import and display information about the MISO generation network, the historical and real time emissions of the MISO network, and the regional breakdowns of this data. This includes databasing the included sources for future use and recording for stakeholders and displaying information to the user using integrated code to display this data.

This will use various data science principles to extract data from the source and manipulate it for easy display.

4.2 Design Exploration

4.2.1 Design Decisions

List key design decisions (at least three) that you have made or will need to make in relation to your proposed solution. These can include, but are not limited to, materials, subsystems, physical components, sensors/chips/devices, physical layout, features, etc.

Our design will need to have at a minimum, a Graphical User Interface (GUI), information access and availability for the general public, and software for real time updating of the GUI. The GUI will encompass the emissions dashboard and the intractability by a public user. The software will have to poll data from data sources to update the emissions chart daily at a minimum, with a stretch goal of possibly by five minute intervals. The accessibility for the general public will mean that the data sourced will have to be obtained from public sources so the regular user doesn't need additional policies to allow them to access information.

4.2.2 Ideation

For one design decision, describe how you ideated or identified potential options (e.g., lotus blossom technique). List at least five options that you considered.

For our GUI design decisions, we had to think about how we could make our GUI best display the data we had in a way to make it as user friendly as possible. For our lotus blossom of GUI design, we had the word GUI surrounded by Interactibility, Colored Overlays, Legends, Download Ability, and Live Updating. We were able to ideate these decisions based on thinking upon what our stakeholders desired most from the input they had given to us as well as some of the features we observed on similar projects that had been already developed.

4.2.3 Decision-Making and Trade-Off

Demonstrate the process you used to identify the pros and cons or trade-offs between each of your ideated options. You may wish you include a weighted decision matrix or other relevant tool. Describe the option you chose and why you chose it.

To understand the pros and cons of our design decisions, we did basic pro/cons of each of our decisions. For example, when we looked at the decision to make our GUI Interactable, we came up with the following pro/con arguments. For the pro's of making the GUI intractable, we had increased usability to focus on singular trends, better aesthetics, and screen space reduction. For the negatives of this decision we found increased development time, more edge case coding, able to handle varied data sets, and limited by existing tableau options. We chose this method of decision making because it's the most simple and useful way to analyze costs and benefits.

4.3 Proposed Design

The proposed design consists of an emissions dashboard similar to what California ISO has on their website, with how they have their CO2 resources charted in trends and charts, with included historical data. Research is being conducted still on how to implement this data into a website interface user using High Chart, a JavaScript library. Data will be polled from external sources such as Energy Information Administration and MISO's websites.

4.3.1 Design Visual and Description

Include a visual depiction of your current design. Different visual types may be relevant to different types of projects. You may include: a block diagram of individual components or subsystems and their interconnections, a circuit diagram, a sketch of physical components and their operation, etc.

Describe your current design, referencing the visual. This design description should be in sufficient detail that another team of engineers can look through it and implement it.

The design on the dashboard will cover the emissions data from the North, Central, and South regions of MISO's area of operations. The user will be able to independently access each region, meaning emissions data from other MISO regions will be filtered out in order for easy access to the needed information and trends. There will be various charts, graphs, and tables that will display which regions are hitting their emissions targets, trends of emission data, and show a historical outlook of how a region's emissions are affected by different variables. The visual of the screen will be shown below:

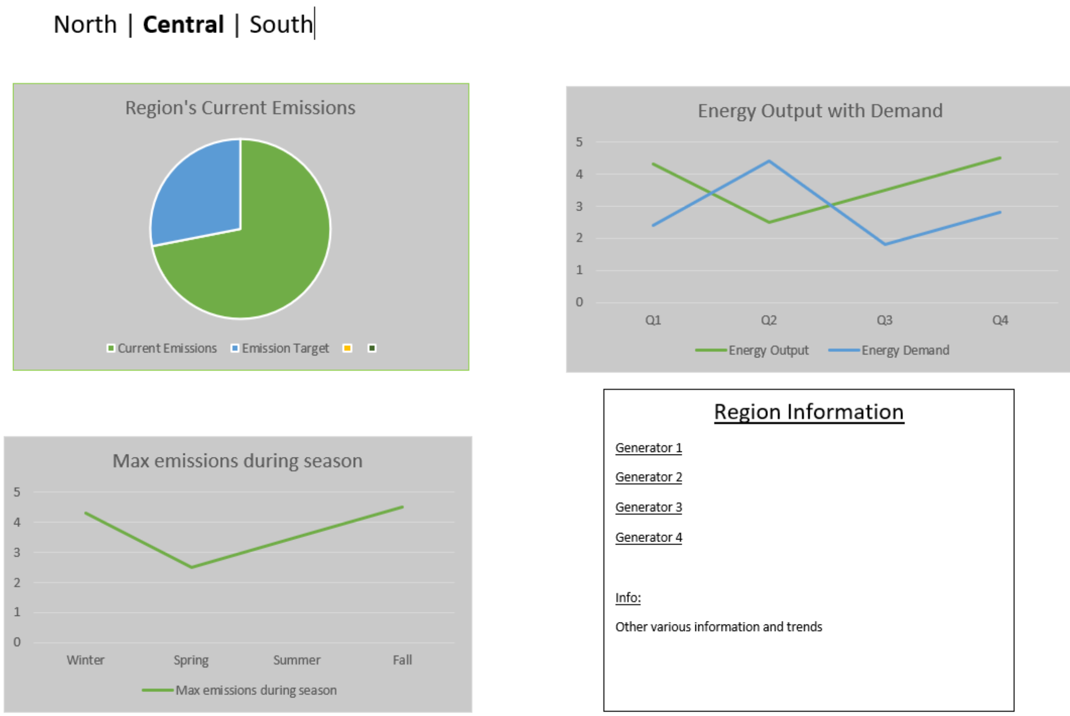

Figure 2. Sample Dashboard layouts

4.3.2 Functionality

Users will be able to publicly access this dashboard on MISO's website. We will implement interactable maps and data for easy UI traversal for the user and for quick data gathering. The goal of this dashboard is to allow MISO to see how various trends impact emissions of each MISO region, and customers of MISO can see how their activities impact their emissions data so they can more easily regulate their activities in order to hit set emission targets.

Currently, all functional and non-functional requirements are satisfied due to the many conversations about the design and implementation of features with MISO. Javascript along with its Highchart library will be used to cover these requirements.

4.3.3 Areas of Concern and Development

Based on your current design, what are your primary concerns for delivering a product/system that addresses requirements and meets user and client needs?

What are your immediate plans for developing the solution to address those concerns? What questions do you have for clients, TAs, and faculty advisers?

Primary concerns:

1. Data sources moving or links breaking.
2. Dashboard layout and/or functionality do not meet customer's (MISO) vision of product.
3. Estimated emission information is not accurate or detailed enough for customer requirements.
4. User experience interacting with the dashboard is less than desired.
5. Project is successful but is not able to be maintained or updated by the customer.
6. Data sources moving or links breaking.
    a. Properly document code and design for the possibility of data sources moving. For example, create a SOP for updating any broken data sources, have the code look and notify that "DATASOURCE_X" is missing, etc.
7. Dashboard layout and/or functionality does not meet customer's (MISO) vision of product.
    a. Ensure that the customer specifications (listed in MISO provided document "Project Requirements" (PR) Section 2) are implemented early in the development.
    b. Early prototyping of the dashboard to share with the customer.
    c. Maintain open communication with the customer throughout the development process.

8. Estimated emission information is not accurate or detailed enough for customer requirements.
    a. Develop a clear plan for data collection, manipulation, and calculations required and share this plan with the faculty adviser and MISO before major programming tasks begin.
    b. Record clear documentation of all data sources accessed, assumptions made, data calculations or manipulations performed, etc. to ease any modifications requested by the customer during the development process.
9. User experience interacting with the dashboard is less than desired.
    a. Create a test server to host the dashboard during development.
    b. Perform various tests and performance evaluations as the dashboard evolves.
    c. With each successive iteration of the dashboard, obtain input from the customer or ask fellow students to test out UI to locate potential problems or improvements.
10. Project is successful but is not able to be maintained or updated by the customer.
    a. Create proper documentation on how to use the dashboard, how to perform critical maintenance such as changing data sources, adding data views, etc.
    b. Properly format and document all code so that it is easy to understand and edit.

4.4 Technology Considerations

Our design produces an expandable dashboard that allows for a great degree of flexibility in implementation, but this flexibility in the graphing framework can create a large degree of uncertainty in implementation. If our group used a higher level graphing framework like Tableau, we may be able to produce a dashboard in less time with a higher degree of technical reliability. The main caveat to using a tool other than Highcharts is that further expansions of our dashboard will be difficult as MISO is looking to exclusively use Highcharts for similar activities.

Additionally, the decision to use both Python for and Javascript for different portions of the project creates a situation where packaging the project for further storage may require a bespoke or inelegant solution. If the group used one programming language natively packaged into one application, overall interaction with the whole program would be easier, but implementation of basic functionality could be more difficult than the baseline solution.

4.5 Design Analysis

The previously iterated design plan is effective as it has effectively isolated major functional delivery requirements and creates discrete functional components for project implementation. After further work on the project after the initial creation of the design plan, greater emphasis on systems integration and software reusability could create a more robust final project. The previously created design plan is largely based on initial functional requirements, and pays less attention to the final user experience requirements. By adding more focus on the target product experience, the design may be more cohesive and professional in nature. Overall, the design plan iterated in section 3.3 of this document is effective but could be improved with a multifaceted approach towards understanding project requirements.

4.6 Design Plan

Describe a design plan with respect to use-cases within the context of requirements, modules in your design (dependency/concurrency of modules through a module diagram, interfaces, architectural overview), module constraints tied to requirements.

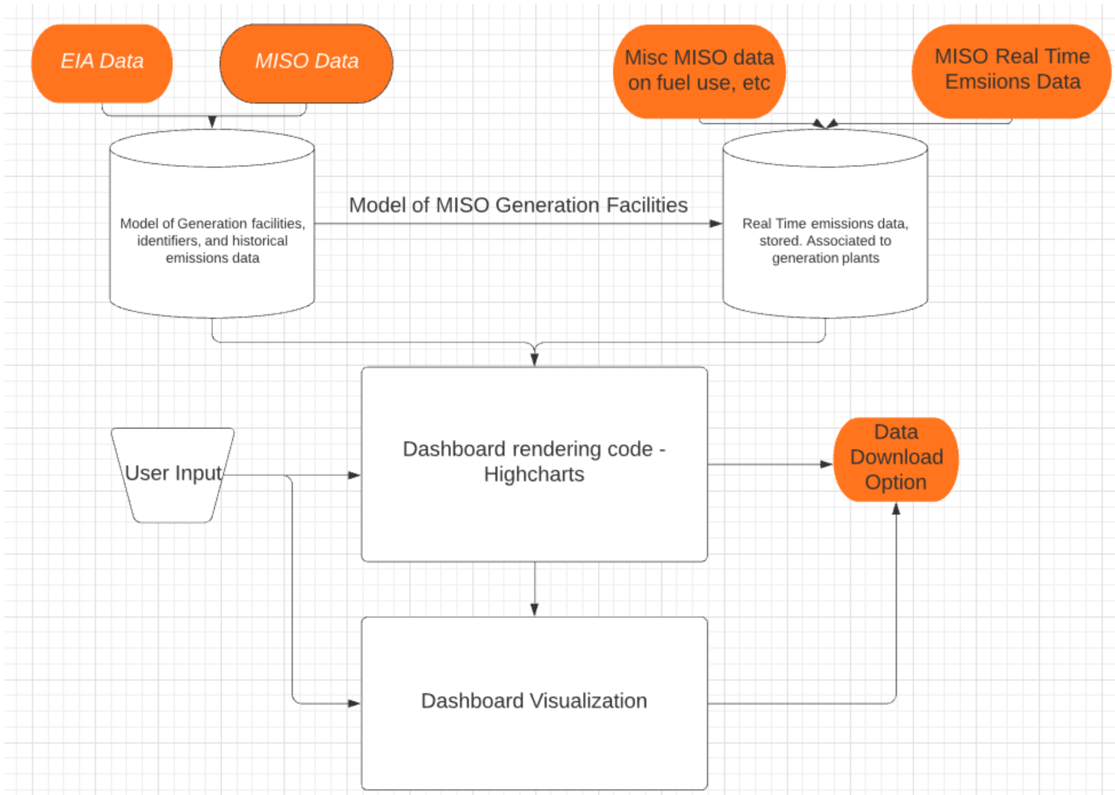

Figure 3. Mid-High Level Design Plan

1.Construct model to find all plants in MISO system, categorize them into regions to create the *Regional Generation Source Data (RGSD)*

This design stage will require interfacing with emissions data provided by government agencies like EIA (Energy Information Administration) and internal MISO data. With data links established, a model of all generation plants in the MISO footprint will be created.

2. Construct module to import historical emissions data from all plants Plant Historical Emissions Data (PHED)

Similar to task one, this stage of our design will rely on data importing from MISO, EIA, and state regulatory agencies. Expanding on task one, data associated to each generation plant will be imported into .csv files for long term data storage.

3. Construct module to import real time data from all plants Plant Instantaneous Emission System (PIES)

The task/subtask goals for (3) are the same as for (2)

4. Construct the dashboard to visualize regional emissions data.

Using the collated emissions data, the Highcharts graphing library will be used to display the emissions for the MISO network and the three regions within.

5. Construct dashboard view to visualize MISO total emissions data

The task/subtask goals for (5) are essentially the same as for (4).

6. Host dashboard and code on MISO server. Format all code to MISO standards.

This task will primarily focus on systems integration with existing MISO sites and standards for data visualization in order to present a cohesive user experience and allow for MISO data analysts and programmers to modify our dashboard.

7. Write report analyzing emissions trends

Using the dashboard and the associated data model, a report will be created that analyzes emissions trends across the MISO network and within the regions of the MISO network. This report will highlight the utility of the dashboard, and create discussion for future data analysis activities.

5 Testing

5.1 Unit Testing

What units are being tested? How? Tools?

Each data importing module will need to be tested separately. This will be done by comparing the imported data to the data source. Because the imported data is simply extracted from larger datasets with more information, our imported data should exactly match a subsection of the source data. To verify our operations were performed correctly, unit testing will be performed by comparing a section of imported data to the corresponding section of the data source.

All data visualization subsystems need to be tested to verify their correct operation characteristics. To accomplish this, test data will be fed into our visualizations to verify correct visual behavior and interactivity. Using test data allows the team to construct test cases reflective of the diversity of data contained within the existing MISO and EIA datasets without spending time running all of the imported data through our visualizations.

5.2 Interface Testing

What are the interfaces in your design? Discuss how the composition of two or more units (interfaces) are being tested. Tools?

In our data importing modules, the interfaces between modules will be the EIA plant identifier and applicable MISO unique identifiers for each generation plant. To maintain interface integrity, we will need to test for timely handoffs of plant identifiers, the preservation of plant identifiers between interfaces will also need to be verified. To test for this, the team will compare the plant identifiers passed on at each step to the original plant identifiers associated with a plant from the source data, verifying that our code is not distorting plant identifiers.

Additionally, our dashboard library, Highcharts, will need to be verified. This is an important interface between our web environment and the input data. To verify that this interface is performing correctly, test data can be input into our Highcharts code to verify the use of the correct parts of the library vis-a-vis our specifications and the input data.

5.3 Integration Testing

What are the critical integration paths in your design? Justification for criticality may come from your requirements. How will they be tested? Tools?

1) Design Requirements

- a. Graphic interface
    - i. Daily Emission Chart
        1. Line Chart showing Emissions of MISO / MISO regions up to current hour starting from 00:00
    - ii. Interactable by public website user

1. Filters by region on emission output

2. Allow user to download recent data (Data up to that hour of the day starting from 00:00)

3. Allow graph to be “popped out” to a larger standalone display

4. Include description of chart and data being used to make it

a. Example: current MISO real time charts have a (i) which when clicked on give info

5. Includes area, generation type, possibly fuel type filters

iii. Similarity to Current MISO website graphs

1. Hours X axis, Emission Y axis

2. Use MISO colors

b. Software program design

i. Python is widely used in MISO for automation and data analysis. Students can utilize python for any data manipulation or automation needed

ii. Utilize JavaScript (https://www.javascript.com/) as the code base for project graphical implementation.

1. Scripts must be able to be utilized to create widgets to be plugged into a website

2. Highcharts (https://www.highcharts.com/) is the preferred javascript library to utilize for chart creation

a. Library is able to be readily downloaded here for free: https://www.highcharts.com/download/

c. Assumption development

i. Maintain documentation of assumptions made, and any sources / discussion notes leading to those assumptions

ii. Any formulas or derivations made to reach emissions calculations need to be fully described and maintained in a list of formulas used

iii. Maintain cited source list of all sources of information for any calculations which assist in the emission derivation effort

d. Information access and availability

i. All information used must be publicly accessible information

e. Program documentation

i. At conclusion of project, a write up of the overall project will be created with the intent to inform others of the work done and share knowledge to allow expansion upon the foundation created by the project

Critical Integration Path in our design

6 Assumption Development - While discussing with MISO employees we decided on some assumptions that will go into our data sources. One example is, if a generator in the MISO region also feeds power into a different ISO, we will assume it is only feeding the MISO region.

7 Gathering information - Next, we are going to pull together public information using MISO public data and EIA (Energy Information Administration) data based on our assumptions.

8 Next we will start developing the interface using Python, JavaScript, and HighCharts. Some requirements of the interface include having a visible line chart, filtering by region, and allowing the user to download recent data. HighCharts will be used mainly for the graphics.

9 The final step will be checking to see if all visual aspects are implemented and write a report documenting any conclusions we came to.

5.4 System Testing

For the systems level testing strategy we can break our system down into 3 steps. Firstly we have the data pull, then our data processing, and finally we have our data visualization. In order to make sure that we have a complete system we'll primarily be looking at the inputs and the outputs of each of these system level functions. For the inputs to the data pull, there will likely be few as it should be pulling data from a static number of sources. In terms of outputs however it will pull the most recent set of data for any number of categories we desire. In our second step of the data processing, our inputs will be the data we pulled from the previous step. While the outputs would be data that is processed and cleaned up for easier consumption by the user. Finally at the visualization level we will have a higher number of inputs consisting of the processed data alongside user input from the web page itself determining the output of the desired graphs and trend lines. Our key strategy to test this whole process will be linking these steps together and changing any variable inputs at each stage to observe outputs at all stages.

5.5 Regression Testing

How are you ensuring that any new additions do not break the old functionality? What implemented critical features do you need to ensure they do not break? Is it driven by requirements? Tools?

For our emissions dashboard, some critical components that must not break are the capability of data to be sourced to the emissions dashboard for daily updating of interface and Intractability with the user including publicly sourced information. To ensure that these two components do not break when adding in new code to add more features, proper documentation of the information will be a necessity and organization of this information will make adding new features easier and less likely to break these critical functions. These critical components are driven by requirements from MISO documentation of the project.

5.6 Acceptance Testing

How will you demonstrate that the design requirements, both functional and non-functional are being met? How would you involve your client in the acceptance testing?

Following the more technical testing frameworks comes the "user" acceptance testing. The word user is very important in this context as it implies that the MISO dashboard users(stakeholders) will be involved in this testing step. In order for the MISO dashboard to most efficiently and effectively benefit the end users and stakeholders, our team must ensure that the dashboard is operating within the pre-specified business requirements. The end-product will be moved to a "UAT"(User-Acceptance Testing) environment where the main stakeholders can analyze the dashboard and ensure each business requirement has been satisfied. If any discrepancies arise, the team will fix the issues in the UAT environment and re-engage in the acceptance testing process until all business requirements have been met. The client will be involved in this process by actively testing each aspect of the business requirements until each one has been successfully implemented.

5.7 Results

What are the results of your testing? How do they ensure compliance with the requirements? Include figures and tables to explain your testing process better. A summary narrative concluding that your design is as intended is useful.

From our testing, we want to ensure data identifiers are preserved between operations, the correct data is being graphed, and that the dashboard output matches our initial specifications. This process will ensure compliance with our project requirements by ensuring that our underlying data is maintained with a high degree of fidelity, and that the functional requirements of our project are met. Our overall design needs to maintain the desired interactivity and user experience defined by our project sponsor, and our testing plan for the dashboard components needs to be focused on specific functional requirements to ensure that our sponsor's needs are being met in an expeditious fashion.

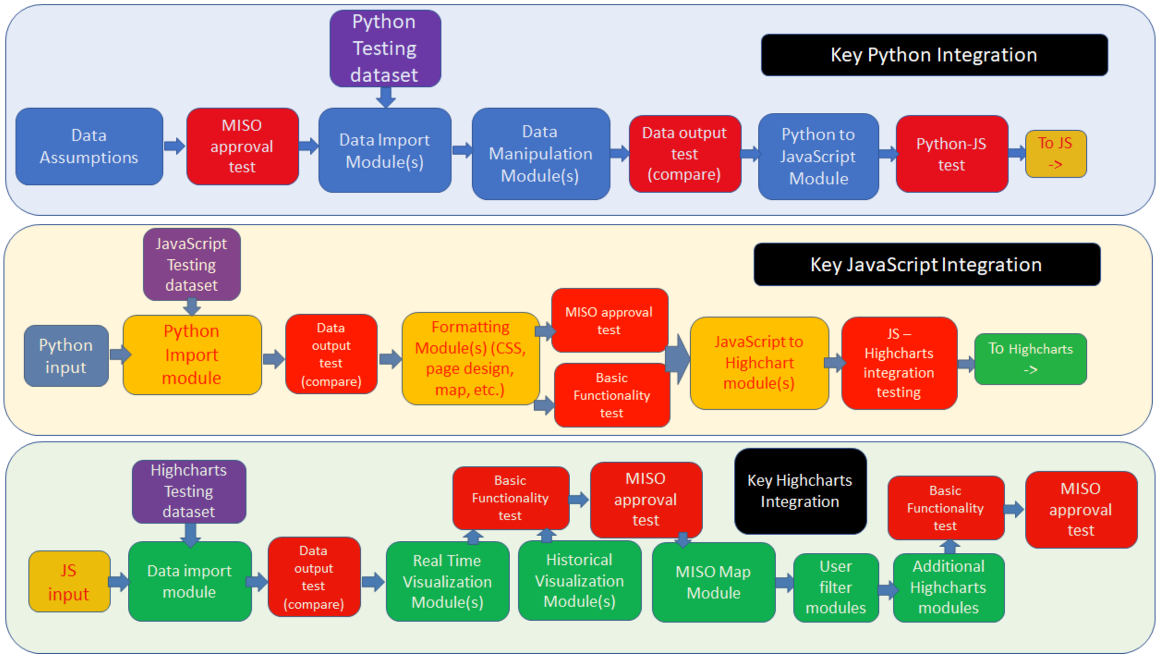

Figure 4. Testing Plan

6 Implementation

This current semester, we already have preliminary implementation/testing for graphics to include on the website, such as line graphs that will help to characterize data over certain time periods, as well as data scraping tools to help grab this data from online sources.

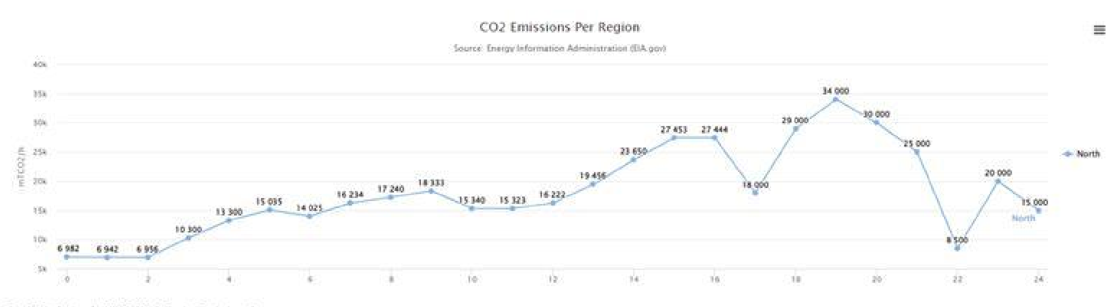

Figure 5. Test Highcharts graph

Next semester, including over winter break, we plan to integrate both of these ideas together so that the graphics can now represent data gathered from these sources and to fine tune the scraping tools and include more detailed graphics to give more information on emission data. We hav

7 Professionalism

This discussion is with respect to the paper titled "Contextualizing Professionalism in Capstone Projects Using the IDEALS Professional Responsibility Assessment", *International Journal of Engineering Education* Vol. 28, No. 2, pp. 416–424, 2012

7.1 Areas of Responsibility

Pick one of IEEE, ACM, or SE code of ethics. Add a column to Table 1 from the paper corresponding to the society-specific code of ethics selected above. State how it addresses each of the areas of seven professional responsibilities in the table. Briefly describe each entry added to the table in your own words. How does the IEEE, ACM, or SE code of ethics differ from the NSPE version for each area?

Area of Responsibility	**Definition**	**NSPE Canon**	**ACM Code of Ethics**	**Difference from NSPE**
Work Competence	Perform work of high quality, integrity, timeliness,	Perform services only in areas of their competence;	Achieve high quality work and keep the bar set high to ensure	ACM focuses on keeping the general standards set

	and professional competence.	Avoid deceptive acts.	efficient competence. Acknowledge the existing rules pertaining to professional work. Only perform work in areas of competence.	high to allow hig quality work. It also places an emphasis on knowing preexisting rules and regulations in the areas of industry to ensure that no rules are broken during execution.
Financial Responsibility	Deliver products and services of realizable value and at reasonable costs.	Act for each employer or client as faithful agents or trustees.	Manage personnel and other project resources to ensure high quality of life for all project stakeholders.	ACM focuses on improving the quality of life for all stakeholders through the management of personnel and resources, while NSPE focuses on only the employers and clients and

				excludes information about resource management.
Communication Honesty	Report work truthfully, without deception, and understandable to stakeholders.	Issue public statements only in an objective and truthful manner; Avoid deceptive acts.	Accept any feedback generated from professional review and access required computing and communication resources ONLY when authorized	ACM focuses more on using peer reviews and critiques to improve work performance. It is similar to the NSPE by avoiding deceptive acts and only accessing resources as required.
Health, Safety, and Well-Being	Minimize risks to safety, health, and well-being of stakeholders.	Hold paramount the safety, health, and welfare of the public.	Contribute to society and human well-being.	The ACM focuses on analyzing each stakeholder to a specific project and ensuring that the

				project does not harm any of these stakeholders. This differs from NSPE because it takes time to encourage analysis of the stakeholders rather than group them into the general public.
Property Ownership	Respect property, ideas, and information of clients and others.	Act for each employer or client as faithful agents or trustees.	Honor the property rights of stakeholders or team members including tangible and intangible property.	ACM focuses on giving the proper credit for intangible resources and intelligence appropriately, while NSPE focuses more heavily on acting respectful and

				trustworthy.
Sustainability	Protect environment and natural resources locally and globally.	N/A	Contribute to society and human well-being. It is vital to understand each stakeholder to a project.	NSPE did not have any section that highlighted sustainability.
Social Responsibility	Produce products and services that benefit society and communities.	Conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession.	Articulate to all members and stakeholders of an organization the social responsibilities of a certain project and ensure all members accept those responsibilities.	ACM focuses more on ensuring all other members of the organization's team understand their social responsibilities, while the NSPE focuses on just one individual's social responsibility.

Table 3. Areas of Responsibility

7.2 Project Specific Professional Responsibility Areas

For each of the professional responsibility areas in Table 1, discuss whether it applies in your project's professional context.

Area of Responsibility	Does it apply to the project?	How well is the team performing?
Work Competence	Yes - For the emissions dashboard, getting information readily available for the customer is important as they would like updates in a timely manner. The work that we produce must also be high quality since this is their product that we are developing	Medium
Financial Responsibility	Yes - The cost of the project is relatively minimal, but making sure that the customers time is not wasted in meetings is important	High
Communication Honesty	Yes - Making sure that the work we are doing is	High

	communicated effectively without deception in meetings and also in deliverables	
Health, Safety, and Well-Being	No - No one is at risk in our project, since all the data is publicly sourced and it is a website hosted project, no stakeholders safety is at risk in this project.	
Property Ownership	Yes - Respecting the information that MISO holds with respect for the power industry and the information that they are providing is a must in this project.	High
Sustainability	Yes - This project consists of looking at the emissions data throughout their floor plan, which directly correlates with sustainability of power in those areas of interest	High
Social Responsibility	Yes - This product will be publicly available for MISO's stakeholders to view and to be	High

	able to update their own floor plan based on emissions data they would like to see	

Table 4. Project Specific Responsibility Areas

7.3 Most Applicable Professional Responsibility Area

Sustainability is the driving force behind our project. Due to the need to meet global warming targets under 2 degrees,, a mass mobilization of data and expertise is needed in the electricity generation sector. By collecting a large amount of data on the emissions profile of the MISO network, utilities, MISO, regulators/politicians, and concerned citizens will be able to see where and when new clean electricity sources are needed. Our project will allow these stakeholders to find the existing gaps in the generation network where new clean generation installations are needed most. Our team has demonstrated the need for sustainability in our industry by evaluating a variety of data sources, other competing and similar data visualizations. We have analyzed these implementations and data sources to ascertain which inputs and target outputs will best deliver clarity on the areas where clean electricity generation is most needed.

8 Closing Material

8.1 Discussion

Our Emissions tracking dashboard will provide a critical solution to allow electric customers, regulators, and researchers to understand the dynamics of emissions from electric generation in and across the MISO region. We have successfully created a system architecture that ensures that users can view historical and real time emissions data. This system will allow for a broader understanding of electric grid emissions dynamics to meet broad environmental targets among a variety of stakeholders. By unifying a variety of datasets, our solution will unlock new opportunities and insights for MISO and associated stakeholders.

8.2 Conclusion

We have created a full system architecture and data model to synthesize a diversity of data sources in one source. Additionally, we have started to provisionally implement some of the major pieces of this architecture and data storage model, including historical data importing, basic graphing capabilities, and data storage. In order to produce a functional dashboard our group will need to expand on our existing progress in implementation by focusing on systems integration and testing of major components. This will require use of our existing test plan, and regular consultation with MISO as not only a project sponsor but also a chief partner in systems integration activities.

8.3 References

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8.4 Appendices

8.4.1 Team Contract

Team Members:

1) ____Dylan Christensen____________ 2) _______ John DiBasilio __________

3) ____Sean Fleming _______________ 4) _______ Manbir Guron ___________

5) ____Tyler Maglaya_______________ 6) _______Damandeep Riat__________

7) ____ Jack Riley__________________

Team Procedures

1. Day, time, and location (face-to-face or virtual) for regular team meetings:

   Monday, 1pm to 3pm, Virtual meeting via Webex

2. Preferred method of communication updates, reminders, issues, and scheduling (e.g., e-mail, phone, app, face-to-face):

   Email the group for critical communication updates (changes in meeting times, schedule conflicts, etc.). Microsoft Teams app for less critical communications.

3. Decision-making policy (e.g., consensus, majority vote):

   Majority vote

4. Procedures for record keeping (i.e., who will keep meeting minutes, how will minutes be shared/archived):

   Record keeping will be done by team members rotating through the task and sent via email to the other members in case of scheduling conflicts and to facilitate clear communication.

Participation Expectations

1. Expected individual attendance, punctuality, and participation at all team meetings:

   Team members should attempt to attend all team meetings and should notify all other team members in the event that a significant portion of any meeting will be missed.

2. Expected level of responsibility for fulfilling team assignments, timelines, and deadlines:

   Team members are expected to fulfill obligations on time and to communicate any obstacles that arise in completing any of those assignments on time.

3. Expected level of communication with other team members:
   Team members are expected to communicate any problems that arise in a timely manner.

4. Expected level of commitment to team decisions and tasks:

Team members are expected to communicate concerns he or she may have about any upcoming team decisions or assigned tasks early in order to properly address them. Once the team has accepted a decision all team members are expected to follow the decision.

Leadership

1. Leadership roles for each team member (e.g., team organization, client interaction, individual component design, testing, etc.):

   Client interaction - John

   PanDas + misc python data science, Team Organization - Jack

   Agile master, web scraping - Manbir

   Testing and Client Interaction - Daman

   Front End Development, Client Interaction - Sean Fleming

2. Strategies for supporting and guiding the work of all team members:

   Using regular meeting times to go over recent projects and take input on how to solve problems faced by team members. Additionally, team members will take time to give input to other team members.

3. Strategies for recognizing the contributions of all team members:

   Team members will be aware of other's contributions due to regular updates on project status. Contributions will also be recognized when project status advances and team members reach out to gain further experience on past project elements.

Collaboration and Inclusion

1. Describe the skills, expertise, and unique perspectives each team member brings to the team.

Sean Fleming - Can bring a perspective in Python programming as well as a positive attitude to help drive the team. I've worked with stakeholders of MISO and can relate to their experience with MISO.

John DiBasilio - I have worked with MISO in the past via a summer internship, so I can bring some extra experience with the company to the project. I will also be familiar with MISO's expectations for the final product.

Dylan Christensen - I have had some experience in manufacturing quality inspection data collection and visualization in my current job and have an interest in learning more about using Python to perform data analysis.

Jack Riley - I've had several years of experience working doing python data science and visualization scripting for Micron. Furthermore, I have a decent amount of experience in leadership roles and running and organizing events and meetings.

Manbir Guron - I have developed a web parser and have experience in creating data visualizations and data analysis tools. Additionally, I have experience in python development and python API development.

Tyler Maglaya - I have many years of experience in UI development in Java and API development. I have never worked with Python and I am excited to learn more about it and how it works. I love working with groups and am willing to help out with any aspect of the project.

Damandeep Riat- I have worked with Python and have experience with creating efficient and effective dashboards during my internships. I am also an MBA student so I can add a business- oriented perspective to our project as well as strong communication and interpersonal skills when working with stakeholders.

2. Strategies for encouraging and support contributions and ideas from all team members:

   To support the contributions of individual members, the team will allot time to each team member at regular intervals to discuss the requirements and features of the project that they are working on in order to invite collaboration and input on possible solutions.

3. Procedures for identifying and resolving collaboration or inclusion issues (e.g., how will a team member inform the team that the team environment is obstructing their opportunity or ability to contribute?)

   If a team member is not actively contributing to the project, he will be given a warning to contribute. If this continues we will talk to the 491 instructors.

Goal-Setting, Planning, and Execution

1. Team goals for this semester:

   Develop full scope for the project

   Identify all sources of data

   Understand stakeholder needs for the project data

   Create rough proof of concept implementation of initial dashboard

2. Strategies for planning and assigning individual and team work:

   Create strong deadlines based on stakeholder needs to create firm dates to base planning around, and then start internal work around these deadlines. Additionally, the team will set aside time for regular project planning and larger systems level analysis of the project to turn requirements into functional tasks.

3. Strategies for keeping on task:

   Team members will take care to make the team aware of their schedules and any changes to them. Individual tasks will be apportioned based on schedule availability and be linked to larger functional goals with dates associated. Team members will also take care to use the assigned meeting and working times to accomplish their work, and take care to find alternate times if their regular schedule is impacted.

Consequences for Not Adhering to Team Contract

1. How will you handle infractions of any of the obligations of this team contract?

   We will talk to the team member and try to resolve the issue on our own.

2. What will your team do if the infractions continue?

   We will talk to the 491 professors and our advisor to try to resolve this issue,

****

a) *I participated in formulating the standards, roles, and procedures as stated in this contract.*

b) *I understand that I am obligated to abide by these terms and conditions.*

c) *I understand that if I do not abide by these terms and conditions, I will suffer the consequences as stated in this contract.*

1) Manbir Guron_____________________________ DATE 9/16/2021___________________

2) Jack Riley_____________________________________ DATE 9/16/2021___________________

3) Dylan Christensen_____________________________ DATE _9/16/21___________________

4) Sean Francis Fleming_________________________ _ DATE _9/16/21___________________

5) John DiBasilio______________________________ DATE __9/16/21_______________

6) Tyler Maglaya______________________________ DATE __9/19/2021________________

7) Damandeep Riat__________________________ DATE _09/19/2021_____________