

1. Introduction

1.1. PROBLEM STATEMENT

With an endless need for electricity growing, the efficient management of power grids is more important than ever. Power distribution networks are increasingly complex, integrating multiple energy sources, including distributed energy resources (DERs) such as solar and wind power. Unlike traditional power generation, these must be managed dynamically to account for the fluctuating energy inputs. Additionally, grid operators must handle multiple input streams, including real-time data from sensors, historical usage patterns, and AI-driven predictive analytics, making a well-designed user interface (UI) and front-end system essential for effective decision-making.

GridAI, a power grid management software, aims to provide an advanced solution for optimizing and managing grid performance. Currently, the backend of GridAI is fully developed, however, the application still requires development on its UI and front-end components. Our team has been tasked with improving existing front-end components and UI to ensure seamless user interactions and clear and efficient data visualizations.

1.2. INTENDED USERS

1.2.1. COMMERCIAL USERS

This group of users contains different facets of the power sector. Each is responsible for overseeing and managing large-scale power grids. These can be further broken down into the following:

DSOs:

DSOs or Distribution System Operators are primarily responsible for local energy distribution. They likely are in charge of maintaining local energy grids and connecting them to the end user. They need the following information:

- DERA operator
- Timeline of analyses
- Grid Impact Risk
- Grid location
- Bids under review
- Grid Capacity

ISOs:

ISOs or Independent System Operators manage wholesale electricity, ensure grid reliability, operate the energy market, and coordinate power flow. An ISO requires information similar to a DSO, with a few exceptions.

- More of an emphasis on bids
- Price of electricity and the market value
- The current status of the market

DERAs:

DERAs, or Distributed Energy Resource Aggregators, combine small energy resources, manage multiple virtual power plants, and optimize the DER portfolio. A DER again needs much of the same information, but some unique data is as follows.

- Full bid timelines
- The performance and utilization of different power grids
- Service plans offered
- Real-time execution data

These three user types represent the primary professional users of the Grid AI application, and we are committing to catering to the needs of these three users with features such as the Market Dashboard, which will be showcased later in the document. This will be where any information a commercial user requires will be available.

1.2.2. RESIDENTIAL USERS

This group of users represents an average homeowner or small business owner with little to a lot of knowledge of their residential grid and power consumption. They are interested in reducing their electricity costs, tracking the usage, and integrating their grid or solar panels.

User Needs:

- An application needs to be responsive
- Energy tracking tools for real-time data on statistics, power consumption, cost, etc
- Easy to navigate and professional UI
- Compare renewable energy (solar) vs grid energy utilization
- Clear visuals of the data, such as Map Box, where they can view the energy consumption relevant to their energy address or cluster

1.2.3. EDUCATIONAL USERS

This group of users represents users in the academic industry. They are academic researchers analyzing power grids and need a software tool to help them collect and analyze data. They will be dealing with multiple grid sources of varying sizes and collaborating with numerous other researchers. They are interested in utilizing GridAI to closely evaluate and organize large amounts of grid data from multiple input streams.

User Needs:

- Be able to handle and organize multiple input streams
- Data visualization tools to help easily understand
- Features to filter and organize datasets efficiently
- Features to collaborate and share data with other researchers
- Simple and clean navigation
- Generate automated reports based on grid simulations with data analysis

1.2.4. DEVELOPER USERS

This group of users represents the developers who could expand upon GridAI by creating their Widgets and using the platform to collaborate with other engineers working on the same project. They need an environment to work efficiently and work in team-friendly environments.

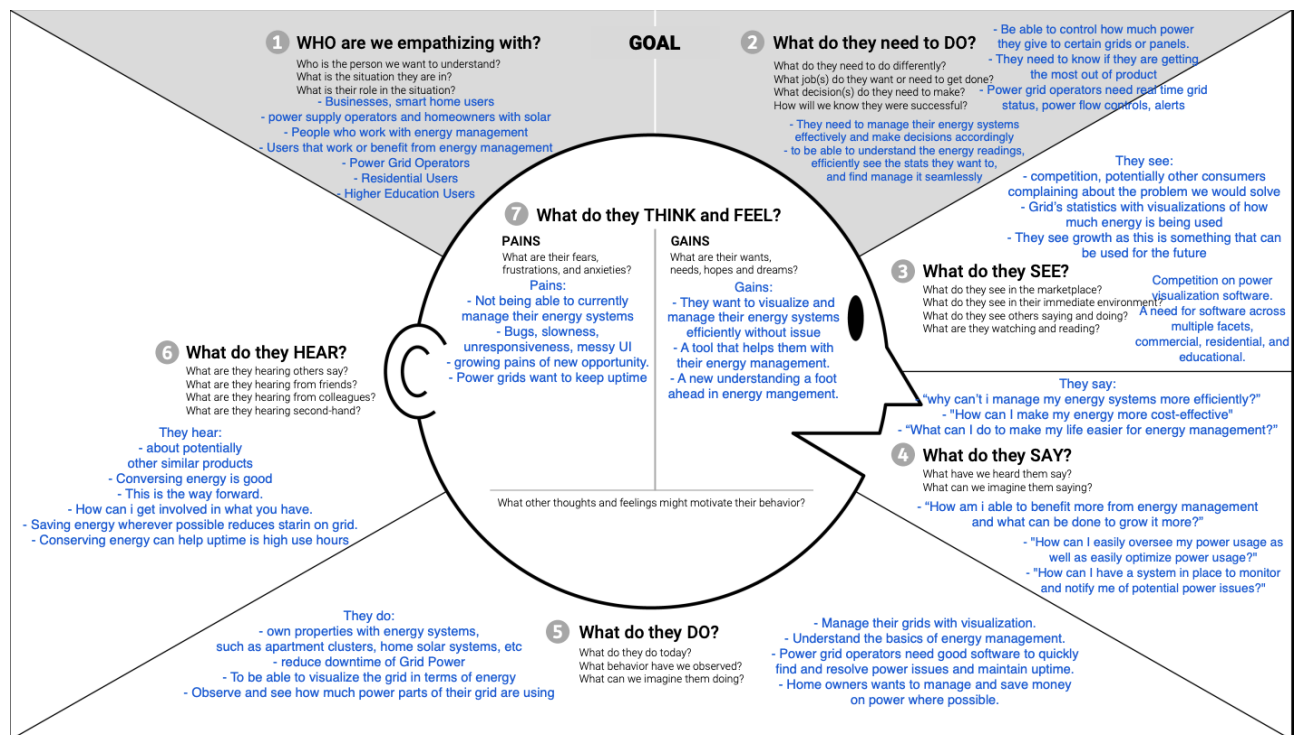
User Needs:

- Being able to deploy code and interface updates in a controlled environment for testing
- Effective communication between the team through Code Editor comments via Websockets
- Access to the codebase, system logs, backend APIs for RESTful connections for development
- User-friendly UI that feels natural for a developer
- Be able to view Map Box functionality without limitations and timeline segments for energy usage

1.3 APPENDICES

User Research and Empathy Map:

To better understand our intended users, we collaborated as a team to create an empathy map to help visualize user thoughts, feelings, behaviors, and challenges. This allowed us to design a solution that aligns with their needs.



1.4 CONCLUSION

This design document provides a structured approach to define GridAI's UI development goals. By focusing on user-driven design enhancements through research and thinking about what our users need, our team aims to create a highly interactive and scalable UI that empowers homeowners, researchers, developers and grid operators to make informed energy decisions like never before.