Executive Summary

The primary objective of this study was to design and implement a comprehensive relational database system tailored to the management and optimization of electric vehicle (EV) charging stations. This system addresses critical challenges, including station compatibility with various EV models, compliance with regulations, accessibility, operational efficiency, and environmental impact. By centralizing and structuring diverse data points, the database enhances decision-making and supports the expansion of sustainable EV infrastructure.

The dataset used for this project is sourced from the Alternative Fueling Station Locations, provided by the U.S. federal government. This dataset focuses on EV charging stations across the United States, offering detailed information about their locations, capabilities, and availability. The data was cleaned and prepared using Python in the Jupyter Notebook. Data preprocessing included handling missing values, standardizing geographical and station-specific details, and filtering out incomplete records. These steps ensure data quality and reliability, enabling meaningful analyses such as pricing effects on user behavior, energy consumption, CO2 reduction from EV usage, and optimal station locations for infrastructure development.

The database design involved the creation of Enhanced Entity-Relationship (EER) and Unified Modeling Language (UML) diagrams to conceptualize the system, which was subsequently implemented in MySQL. Selected relationships were also prototyped in MongoDB to demonstrate adaptability in a NoSQL environment.

Future improvements include implementing robust data governance measures and expanding the database to integrate nationwide EV infrastructure. By leveraging the capabilities of this relational database, the project supports the development of a cleaner, more efficient EV charging network, promoting sustainable energy usage and reducing carbon emissions across the United States.

Introduction

The rise in electric vehicle (EV) adoption worldwide has significantly increased the demand for EV charging infrastructure. In the United States, particularly in states like Washington, where environmental sustainability is a priority, the establishment of EV charging stations is a critical step toward achieving clean energy goals. However, managing and optimizing this infrastructure requires a comprehensive database system to address key challenges such as accessibility, compatibility, compliance, and operational efficiency.

This project aims to develop a relational database system to address these challenges by consolidating all critical aspects of EV charging station management. The database will include schemas for stations, station owners, station employees, station addresses, suppliers of EV stations, accessibility of stations, compatibility of stations, electric consumption, EV charging station compliance, EV networks, fuel types, and payment methods at stations. Each schema is designed to eliminate data redundancy, streamline information management, and facilitate data-driven decision-making.

With this centralized database, station operators can efficiently manage their facilities, monitor energy consumption, and ensure compatibility with evolving EV standards. Suppliers can track compliance and support station operations, while users benefit from better accessibility and a seamless charging experience. By integrating real-time data from multiple entities, the database will also enable predictive analytics, such as forecasting energy demand and optimizing station deployment based on usage patterns.