# Electric Vehicles Trends in Washington State

*Dhruv Jain — Purva Badve — Tam Huynh — Manyam Soumith Reddy — Varun Jaiswal*

***Abstract***

In 2011, the United States sold just over 16,000 battery and plug-in hybrid electric vehicles. That number had increased by a factor of a hundred by December 2020, to approximately 1.7 million automobiles. By the middle of 2021, total sales of plug-in electric vehicles had topped 2 million. We have narrowed down particularly to the state of Washington's EV sales data from 2017 to 2021. The aim of our investigation firstly is to analyze the sales trend over the years, company and model wise sales distribution and secondly we are looking into factors like reduction in cost of renewable energy source which have either led to or affected the rise in EV sales, thus drawing a correlation between them and concluding based on the analysis.

## I. Introduction

Between 2010 and 2020, the electric car market in the United States grew from a few thousand vehicles to over 315,000 vehicles sold yearly. Electric vehicles accounted for about 2.4 percent of new car sales in 2020, up from nearly 2 percent in 2019.

States with ZEV legislation had a combined new electric car share of 5% and at least 13 more electric models available than states without such regulations, which had a 1.3 percent average electric vehicle share. ZEV-required states accounted for around two-thirds of electric vehicle sales in 2020, but less than one-third of overall light-duty vehicle sales.

The growth of renewable energy will have a significant impact on electric vehicle sales. In 2021, $105 billion in additional private capital will be invested in the US energy transition, an increase of 11% year over year and 70% over the previous five years. Clean energy received $47 billion (45 percent), electrified transportation received $35 billion (34 percent), and hydrogen investments doubled to $200 million in 2021. Furthermore, the US grid installed nearly 4.2 GW of battery capacity in 2021, more than in the previous five years combined. This was due to the increased demand for batteries brought on by the rise of renewable energy, particularly solar.

EVs currently account for about 2 to 3% of the annual new-vehicle market, despite their exponential rise. Passenger car fleets typically last 20 years, whereas truck fleets last 25 years. Even under the most hopeful scenarios, the shift to electric vehicles will be gradual. By 2025, new electric vehicle sales will have a minor impact on overall emissions, but they will become increasingly essential in the decades ahead. During this long-term transition, continued gains in gasoline vehicle fuel efficiency are crucial to reducing GHG emissions. Vehicle cost—especially for bigger vehicles—and public charging technology and availability are significant impediments to more broad adoption of EVs. Government initiatives and ongoing innovation will be critical in accelerating the transition to electric vehicles.

## II. Innovation

Despite having a transactional dataset we were able to produce a dataset for analytical processes. This helped us understand that no data is bad data and every data is useful when adequate time is spent on understanding it. Also, we used Socrata Open Data API to pull additional information from the US government website which gave us the geo-location for the vehicles. Combining data from different sources improves the analytical processes and provides more insights.The correlation between the sales of electric vehicles and factors affecting its sales was done in two different Data Warehouse, Sales dataset was loaded onto AWS redshift whereas dataset with factors affecting it's sales was loaded onto MariaDB so in this process we had the experience of working on two different RDBMS and get to know the differences in the working of Redshift and MariaDB

## III. Significance to the real world

"Our reliance on petroleum makes us vulnerable to price spikes and supply interruptions," according to Energy.gov. Because practically all electricity in the United States is generated domestically, including coal, nuclear, natural gas, and renewable sources, EVs help to mitigate this threat. The elimination of dangerous exhaust emissions such as particles (soot), volatile organic compounds, hydrocarbons, carbon monoxide, ozone, lead, and different oxides of nitrogen is one of the many environmental advantages of electric vehicles over conventional gas-powered vehicles. The average electric vehicle in the United States presently emits the same amount of pollution as a gasoline car that gets 100 miles per gallon or more, and emissions are only reducing as renewable energy is added to the electric grid. Driving an electric vehicle decreases your own carbon footprint and contributes to global climate change goals and the 1.5°C lifestyle, which is consistent with the Paris Agreement targets. Electric vehicles will become even more environmentally friendly. Fresh Energy will be present throughout the process, shaping and driving innovative policy for a just, carbon-free future that benefits everyone. With this project we want to shed light on how EV sales have increased over the past given the above reasons. This report will be beneficial for organizations or people who want to understand the relation between renewable energy sources and electric vehicle sales.

## IV. Literature Review

In the United States, Transportation accounts for over 28% of total energy consumption and 26% of carbon relation emissions in the atmosphere. The number is quite high and in the long run harmful for the environment and the people. Battery electric and Hybrid electric vehicles are the most promising opinions to decarbonize transportation.

Electric vehicles promise increased energy security by reducing reliance on foreign fuels, lowering greenhouse gas (GHG) emissions, boosting economic growth through the development of new technologies and industries, and improving public health by improving local air quality.

Vehicle costs, decreased driving ranges, long charging periods, and the requirement for charging infrastructure are all significant technological, social, and economic impediments to broad adoption of electric automobiles. Furthermore, people who are unfamiliar with electric vehicles are unsure of their costs and benefits, and they have a variety of needs that current electric vehicles may not be able to meet.

These factors have made a shift from natural gas to electric vehicles slow-paced in most of the countries. However, improvement in technologies and awareness of the disasters that are being caused by natural fuels are creating conditions that favor alternate transportation fuels. Also, the currently available climate models are predicting a near-surface warming trend due to a rise in the levels of greenhouse gasses. Over one-sixth of the earth's population relies on glaciers for water supply, the climate changes can have an adverse effect on these water bodies.

These studies have piqued the interest for us to dig further and find out the rate of adoption of electric vehicles. This project can be extended further to help us find out how external factors influence the adoption of electric vehicles.

## V. Project Development Methodology

- The project structure and timeline was discussed during in-person meetings and accordingly set up on ConceptBoard. We followed fibonacci's agile methodology.

- The tasks created in Conceptboard were assigned to team members on Jira board and after each sprint we had project update meetings. ( 1 sprint = 2 weeks )

- Github was used for version control and source code management.

- We used python libraries like Pandas for data cleaning and processing

- Data modeling and ER diagrams were modeled on draw.io.

- Data visualization is done by using Tableau.

- The use of pair programming has enhanced the project's time management for development and testing.

- Using this strategy, fostering teamwork among the team was also quite simple. We can state that adopting a pair programming approach alongside development has had a very favorable impact on the project outcome.

## VI. Database Structure

In this project, we have used a data warehouse and a relational database. The data warehouse consists of the data related to electric vehicles and their sales. Whereas, the relational database consists of yearly data for several factors that may have influenced the growth of electric vehicles.

The **AWS Redshift data warehouse** consists of the tables namely **Vehicle**, **Company**, **Sale**, **Location,** and **Geo-Location**.

### A. Vehicle

- **DOL_Vehicle_ID**: It is a unique number given to each vehicle by the government with the intention to identify the vehicles.
- **Company_ID**: A serially allocated number to identify the company of the vehicle.
- **Model**: The model of the electric vehicle of a certain company.
- **Model_Year**: The year in which the model was created.
- **Clean_Alternative_Fuel_Vehicle_Type**: This identifies whether the type of vehicle is an electric or plug-in hybrid.
- **CAFV_Eligibilty**: Based on the fuel requirement and electric-only range requirement of the House Bill 2042, passed in the legislative session of 2019, it categorizes the vehicle.
- **Primary_Use**: Describes the primary purpose of the vehicle
- **Electric_Range**: Determines how much distance a vehicle can travel on a single electric charge.

### B. Company

- **Company_Id**: A serially allocated number to identify the company of the vehicle.
- **Make**: The name of the company which manufactured the vehicle

### C. Sales

- **Sale_ID**: A serially allocated number to identify a sale of a vehicle.
- **DOL_Vehicle_ID**: It is a unique number given to each vehicle by the government with the intention to identify the vehicles.
- **Sale_Price**: The price at which the vehicle was sold (in dollars).
- **Sale_Date**: The date on which the ownership of the vehicle changed.
- **New_Used_Vehicle**: Determines if the vehicle being sold is new or used.

### D. Location

- **DOL_Vehicle_ID**: It is a unique number given to each vehicle by the government with the intention to identify the vehicles.
- **State**: The state in which the owner of the vehicle resides.

- **County**: The county in which the owner of the vehicle resides.
- **City**: The city in which the owner of the vehicle resides.
- **Zip_Code**: The zip code of the owner of the vehicle resides.

E. **Geo-Location**

- **Latitude**: Geographic coordinates of the center of the Zipcode.
- **Longitude**: Geographic coordinates of the center of the Zipcode.

The **MariaDB database** consists of three tables namely **Factor Year**, **Factor Indicator** and **Factor Values**.

F. **Factor Year**

- **Year_ID**: A serially allocated number to identify the year.
- **Year**: The year in which a value for an indicator was recorded.

G. **Factor Indicator**

- **Indicator_ID**: A serially allocated number to identify an indicator.
- **Indicator**: A factor that could have influenced the growth of electric vehicles.
- **Metric**: The unit of measurement for an indicator.

H. **Factor Values**

- **Year_ID**: A serially allocated number to identify the year.
- **Indicator_ID**: A serially allocated number to identify an indicator.

**Value**: The recorded data for a particular indicator in a particular year.

## VII. Entity-Relationship Diagram

An **entity-relationship diagram** illustrates the relationship between a multitude of data points. In an entity-relationship representation, there are two components - entity and relationships. An **entity** is an object about which the data will be stored or captured in the form of properties. A **relationship** is a connection between the entities stored.

Since we have a data warehouse and a database, we had to create separate entity-relationship diagrams before creating and storing the data in their respective tables. The entity-relationship representation helps us understand which data belongs to which table and how they will be connected to the other tables using **keys**.

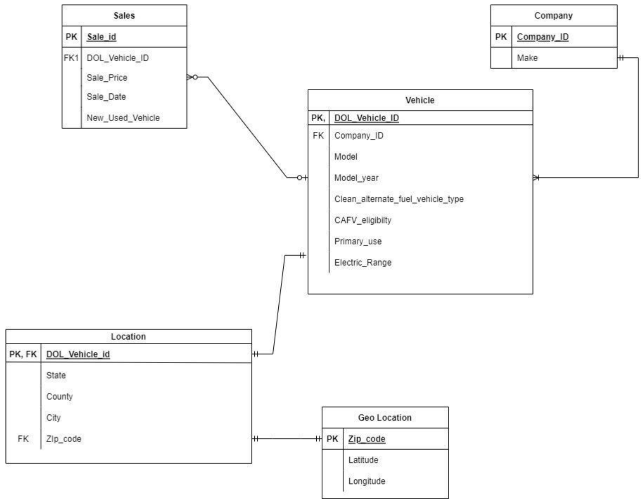



Fig No. (1) Entity Relationship Diagram for Data Warehouse

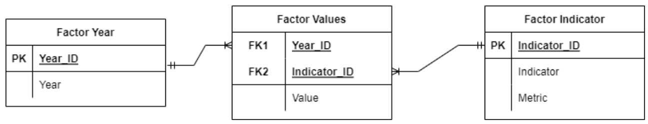



Fig No. (2) Entity Relationship Diagram for Database

## VIII. Analysis and Business Decision

- We inspect the dataset of 89,158 electric vehicles being distributed over 642 zip codes in Washington state from 2017 to 2021.

- The total sales went from 0.49 Billions (in 2017) to 1.43 Billions (in 2021), which is as much as three times.

- Among EV companies in the market, Tesla is the leading brand with total sales of 2,255 Millions (which is half of total sales of all companies from 2017 to 2021).

- The average mileage range of all EVs is about 107miles (with Hybrid vehicles being brought to the picture). Some companies have vehicles above average mileage are Tesla (up to 238miles), Chevrolet (up to 213miles).

- CO2 emissions from transportations, petroleum, and gasoline have been raising up to 13% from 1990 to 2021.

- Dollar per kWh of usable lithium-ion batteries has been decreasing significantly from 2008 to 2011 (-87%).

- Costs to produce other renewable energies have also been reduced up to 85% (Solar photovoltaic).
- From the analysis, we can see that the demand of EVs has been rising in the last few years and tends to continue increasing in the future, with Tesla being the dominant of the EV market.

- Other companies might want to think about doing partnerships with Tesla to further grow their business. Another way is to think about focusing on product development (increasing mileage ranges, moderating model designs, ensuring mechanic securities).

- There are many reasons for the rise of EVs, which include factors that we have analyzed such as costs of renewable energy reduction, lower batteries cost, and the increasing of CO2 emissions.

## IX. Design steps and tools used

| No | Task | Tools Used |
|---|---|---|
| 1 | Project Scope | Team meeting on Google meets, Brainstorming |
| 2 | Project Proposal | Google doc, Team meeting on Google Meet |
| 3 | EV Dataset | Kaggle,... |
| 4 | Project Planning | Concept Board |
| 5 | Bug and Status Tracking | Jira Board |
| 6 | Data Model | MySQL Workbench, Draw.io |
| 7 | Physical Schema | Redshift |
| 8 | Raw Data Storage | CSV File, Amazon Simple Storage Services(S3) |
| 9 | Cleaning/ETL | Python Pandas, AWS Glue, Jupyter Notebook |
| 10 | Loading Data(CSV) on Tables | Using Aws Glue Job, MariaDb |
| 11 | Data Analysis | Amazon redshift database, Jupyter Notebook (Python libraries) |
| 12 | Data Visualization | Tableau, Python seaborn Library, Matplotlib, Pandas |
| 13 | Code integration and testing | Python, Amazon Redshift |
| 14 | Project Report | Google Doc, Excel Sheet, Latex |
| 15 | Project PPT | Google Slides, Prezi, Canva |
| 16 | Version Control | Github Repository |

## X. Technical Difficulties

**- With Python:**

- Our Kaggle dataset consisted of **transactional data** relating to the title activity (transactions of changes in ownership) and registration activity (transactions authorizing vehicles that can be used on the roads of Washington), which then had to be converted into **vehicle population data**. We solved this problem by selecting data that had **Transaction Type as Original Title** which gave us unique vehicle rows.

- The column **Geo location** had the latitude and longitude as a **dictionary** for each row. We used the **from_dict** function in pandas and manipulated the column to get separate columns for both latitude and longitude.

- Since we had vehicle transactions such as sales and we did not want to lose data that are not unique but yet have some value, we decided to create **separate data frames** for **sales** and **vehicle population**. Here the vehicle population will consist of unique vehicle information and sales would contain all the sales transactions of those vehicles.

**- With AWS**

- While Connecting redshift to tableau we faced issues in **permission configuration** and we were able to resolve it by making our **cluster public** for users with the endpoint URL, modifying subnet settings and using the endpoint URL instead of JDBC URL.

- While running Glue job we faced an error in execution, we resolved it by checking the security groups attached with the glue job and editing the inbound rules as at least one security group must open all ingress ports

**- With Tableau**

- When creating worksheets, we encountered problems with creating **global filters** to make connections among other worksheets. This is then solved by applying parameters, sets, and creating calculated fields.

## XI. Data Visualization

- After finishing data wrangling steps, we bring our database closer to stakeholders and people with interests by doing visualization. This is a way to bring patterns, trends that derive messages, insights so stakeholders can make good decisions.

- The tool that we picked for our visualization is Tableau. We used Tableau Desktop, which is a visualization software to connect with our database, and created charts, diagrams to show concise and clean information.

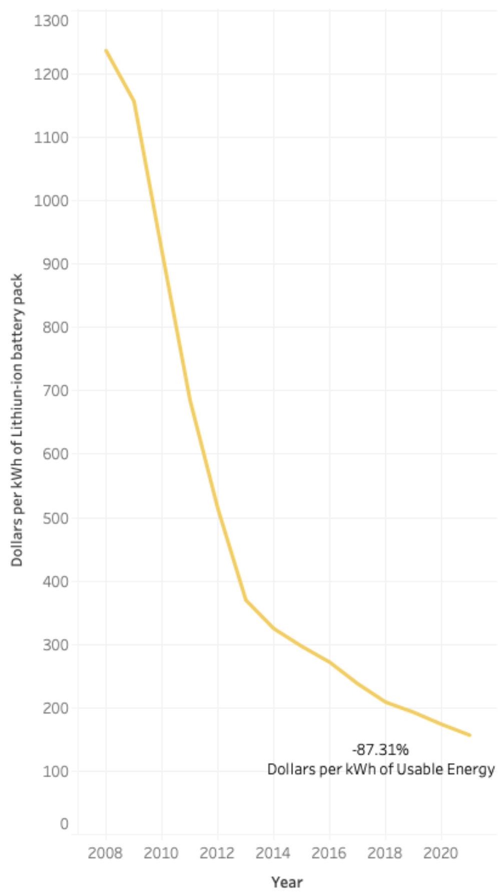



Fig No. (3) Cost to produce lithium-ion batteries

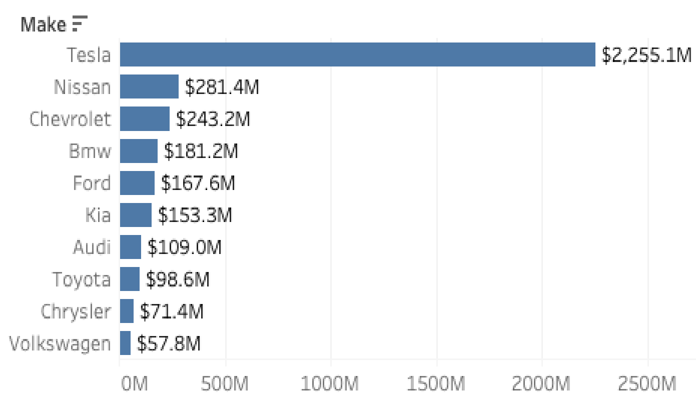



Fig No. (4) Top 10 companies with highest sales

## XII. AWS Implementation

We loaded the data into S3 buckets in AWS, created a VPC Endpoint, and then moved the data from S3 to Glue Catalog, where we used Glue jobs to load the data from S3 to Redshift, and then connected this RDBMS database to tableau to perform required visualizations.

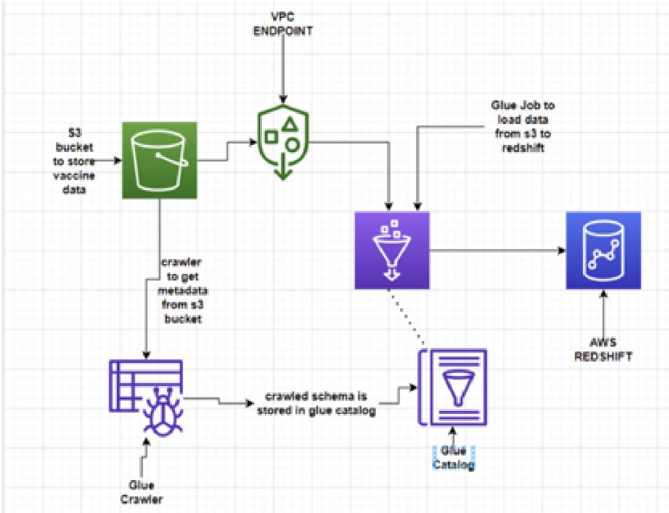



Fig No. (5) AWS implementation steps

## XIII. Lessons Learnt

- We learned the importance of data cleaning and realized how it is one of the most time consuming parts of the project.
- Data Modeling is a crucial step and best practices must be used while doing it as it helps in reducing the query processing and also works well with Tableau (BI Tool)
- We learned the usage of RDBMS MariaDb and connecting with tableau.
- We leveraged the AWS platform and used S3, redshift, and glue to load the clean dataset and perform exploratory analysis.
- We created global filters and created interactive tableau dashboard representing comprehensive information

## XIV. Version control

We uploaded our work to a created git repository and public the codes. In this way, we can keep track of our progress and we can show code walkthroughs during the presentation.
Link: https://github.com/slushi7/ElectricVehicle_Analysis_DATA225

## XV. Essential Outcomes

- Sales Trend of Electric vehicles in USA
    - Top 10 company sales distribution over the years from 2017 to 2021
    - County wise sales of electric vehicles
    - Top 10 companies with average electric range.
    - Total sale value distribution of electric vehicles from 2017 to 2021
    - Distribution of total sales as new and used vehicle
    - Battery Electric Vehicle Vs Plug-In Hybrid Electric Vehicle sales comparison from 2017 to 2021
    - Count of vehicles by make (company).
- Factors affecting sales of Electric vehicles
    - Continuous decrease in price of renewable energy sources including solar energy, thermal energy, wind energy.
- Effects of increase in sales of Electric vehicles
    - Year on year there has been an increase in CO2 emissions but over the past years as sales of Electric vehicles have been on rise we observed constant emission values instead of rise.
- Direct factor which can lead to more production of electric vehicles
    - We have observed a continuous and steep decrease in the price of

production of lithium ion battery which is a major boost for EV companies to manufacture more EVS

## XVI. Future Work

- In the future, we can use the same data warehouse to store similar data for the other states in the United States of America to see the trend of electric vehicles throughout the country.

- The factors that affect the adoption of electric vehicles are not limited to the indicators that we have captured. We can further research those factors and visualize if they are correlated with the adoption of electric vehicles. A few of such factors could be the charging rate of electric vehicles and improvements in battery technology.

- As the volume of data keeps increasing we can implement a star or a snowflake schema for our data warehouse to increase performance.

## XVII. Conclusion

Electric vehicles (EVs) have yet to achieve widespread adoption at scale, despite gaining widespread awareness in a short period of time. Cost is one of the most significant barriers to mainstream EV adoption. The cost of purchasing an electric vehicle is the main worry for 67 percent of consumers. These fears are well-founded: an EV can cost anywhere from 10% to over 40% more than a comparable gasoline-only car. However, early adopters, on the other hand, have reacted positively to the many advantages of electric vehicles, including lower lifetime costs, better performance, and a less carbon footprint. Lower operating expenses, along with lower up-front expenditures, make EVs more appealing to a wider range of customers, particularly low-income drivers. Currently, transportation expenditures form a substantial part of overall household expenses, and with this more inexpensive, accessible choice, low-income households will most benefit from these reductions.

## XVIII. Term Project Rubric

| Criteria | Comments | Pts |
|---|---|---|
| Presentation skills<br>Include time management | [Evaluated by professor and classmates during presentation] | 5 pts |
| Code Walkthrough | Source code is in the Git repository with the link provided. Code walkthrough will be presented in class | 3 pts |
| Discussion / Q&A | [Asked and evaluated by professor and classmates during presentation; Answers by our group] | 4 pts |
| Demo | https://public.tableau.com/app/profile/varun.jaiswal/viz/ElectricVehicleTrendAnalysisForWashingtonWiththeReasonforEVBoom/Story1 | 5 pts |
| Version Control<br>Use of Git / GitHub or equivalent; must be publicly accessible | https://github.com/slushi7/ElectricVehicle_Analysis_DATA225 | 3 pts |
| Significance to the real world | Included in report | 5 pts |
| Lessons learned<br>Included in the report and presentation? How substantial and unique are they? | Included in report | 5 pts |
| Innovation | Included in report | 5 pts |
| Teamwork | Using Conceptboard to divide work to everyone, then we practiced pair programming, and applied Agile approach. | 5 pts |
| Technical difficulty | Included in report | 4 pts |
| Practiced pair programming? | Pair programming is done once every week (to help anyone with difficulties in implementation) and once after a sprint is due (to keep track of the plan) | 2 pts |

| | | |
|---|---|---|
| Practiced agile / scrum (1-week sprints)?<br>Submit evidence on Canvas - meeting minutes, other artifacts | Shown in Concept board and Jira<br>Proof of history meeting link:<br>https://docs.google.com/document/d/1QYNZco08uYoZ88Prx1saONdjLRyuiqi1xYvBnI4E0S0/edit?usp=sharing | 3 pts |
| Used Grammarly / other tools for language?<br>Grammarly free version is sufficient; can use other tools as well. Submit report screenshot on Canvas. | We used Grammarly to check for sentence structure, grammar, and word spell. | 2 pts |
| Slides | Shown in presentation slides | 5 pts |
| Report<br>Format, completeness, language, plagiarism, whether turnItIn could process it (no unnecessary screenshots), etc | Every requirement has been put in the report itself with plagiarism being checked. The report is graded and evaluated by the professor. | 5 pts |
| Used unique tools for writing report | Latex (proof link:<br>https://drive.google.com/drive/folders/1DUdBgzfxUo1vTL5UfAaW1BlfBYrhDowY?usp=sharing),<br>google docs | 5 pts |
| Performed substantial analysis using database techniques<br>Project must include an analytics component | Analysis was done by Amazon Redshift, Jupyter notebook, and Tableau visualization tool. | 3 pts |
| Used a new database or data warehouse tool not covered in the HW or class | We used Amazon Redshift for data warehousing, and MariaDB to store dimension and fact tables. | 3 pts |
| Used appropriate data modeling techniques | draw.io | 5 pts |
| Used ETL tool | AWS Glue, Python library Pandas | 3 pts |
| Demonstrated how Analytics support business decisions | Included in report | 3 pts |
| Used RDBMS<br>Idea is to exercise as many topics from the course as possible | Used MariaDB | 2 pts |
| Used Data Warehouse<br>Idea is to exercise as many topics from the course as possible | We used Amazon Redshift data warehousing | 3 pts |
| Includes DB Connectivity / API calls<br>Possibly using Python | We used API calls to get EVs sales data from data.gov | 3 pts |

## XIX. Credit taxonomy

| Terms | Who |
|---|---|
| Conceptualization | Everyone |
| Data curation | Dhruv, Tam, Purva |
| Formal Analysis | Tam, Dhruv, Varun |
| Funding acquisition | Everyone |
| Investigation | Everyone |
| Methodology | Everyone |
| Project administration | Dhruv, Soumith, Varun |
| Resources | Purva, Tam, Soumith |
| Software | Everyone |
| Supervision | Varun, Dhruv |
| Validation | Everyone |
| Visualization | Dhruv, Tam, Varun |
| Writing - original draft | Purva, Soumith |
| Writing - review & editing | Everyone |

## XX. References


[1] Electric Vehicle population in Washington state https://data.wa.gov/Transportation/Electric-Vehicle-Population-Data/f6w7-q2d2

[2] Electric vehicle titles and registrations in Washington state https://www.kaggle.com/datasets/konradb/electric-vehicle-title-and-registration-activity

[3] Renewable energy data https://www.eia.gov/renewable/

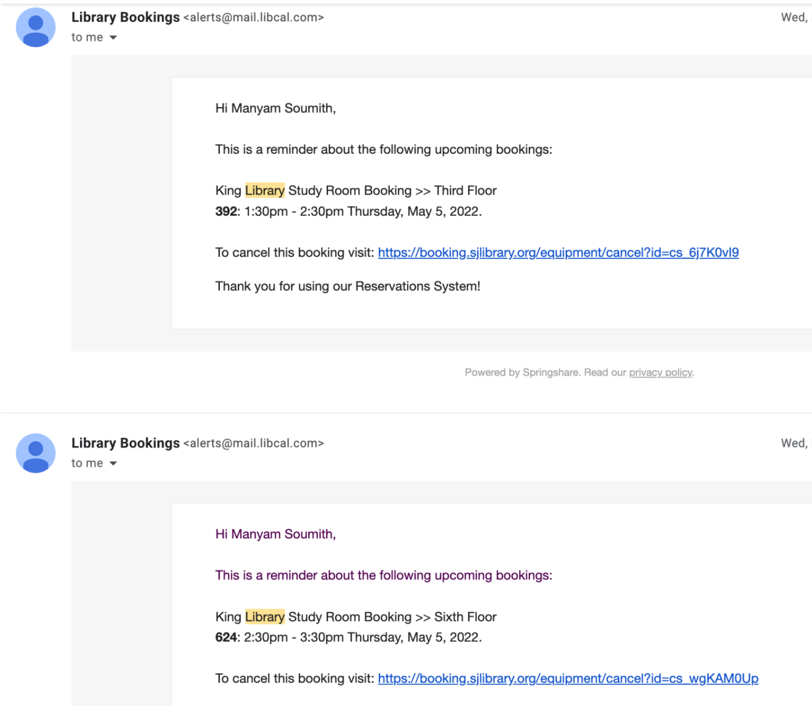
[4] Gasoline and Diesel retail prices https://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_nus_w.htm

[5] Lithium-ion batteries pack cost https://www.energy.gov/eere/vehicles/articles/fotw-1206-oct-4-2021-doe-estimates-electric-vehicle-battery-pack-costs-2021

# XXI. Appendix

## Screenshots of various components:

Meetings and pair programming:
Followed Master and Observer programming where one person codes and other reviews.



**Library Bookings** <alerts@mail.libcal.com> Wed,
to me

Hi Manyam Soumith,

This is a reminder about the following upcoming bookings:

King Library Study Room Booking >> Third Floor
**392**: 1:30pm - 2:30pm Thursday, May 5, 2022.

To cancel this booking visit: https://booking.sjlibrary.org/equipment/cancel?id=cs_6j7K0vl9

Thank you for using our Reservations System!

Powered by Springshare. Read our privacy policy.

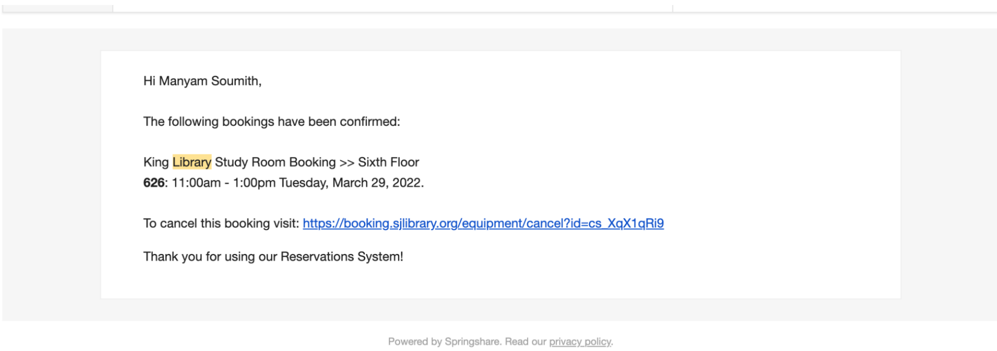
**Library Bookings** <alerts@mail.libcal.com> Wed,
to me

Hi Manyam Soumith,

This is a reminder about the following upcoming bookings:

King Library Study Room Booking >> Sixth Floor
**624**: 2:30pm - 3:30pm Thursday, May 5, 2022.

To cancel this booking visit: https://booking.sjlibrary.org/equipment/cancel?id=cs_wgKAM0Up



Hi Manyam Soumith,

The following bookings have been confirmed:

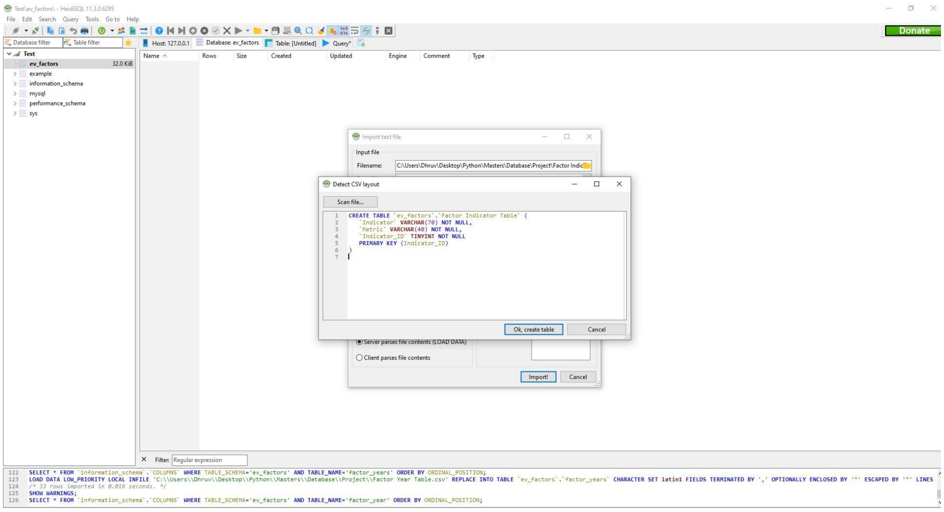
King Library Study Room Booking >> Sixth Floor
**626**: 11:00am - 1:00pm Tuesday, March 29, 2022.

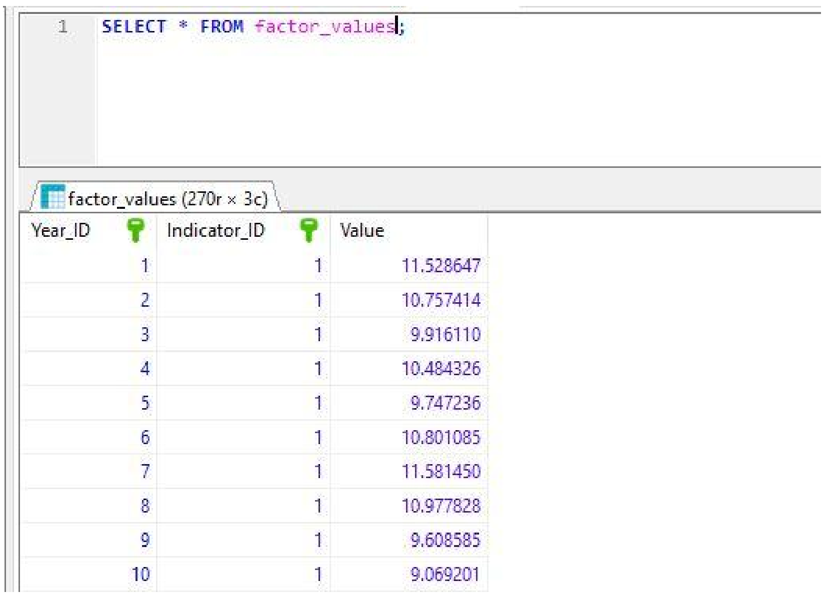
To cancel this booking visit: https://booking.sjlibrary.org/equipment/cancel?id=cs_XqX1qRi9

Thank you for using our Reservations System!

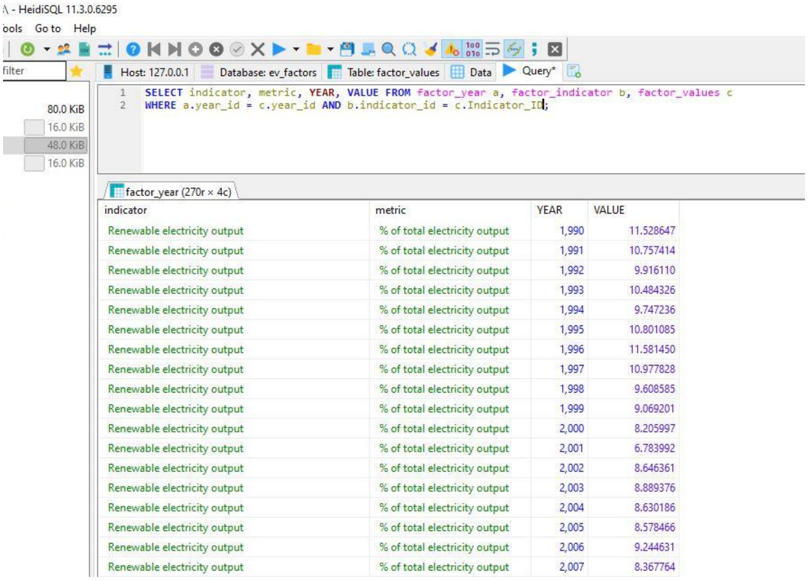
Powered by Springshare. Read our privacy policy.

MariaDB:

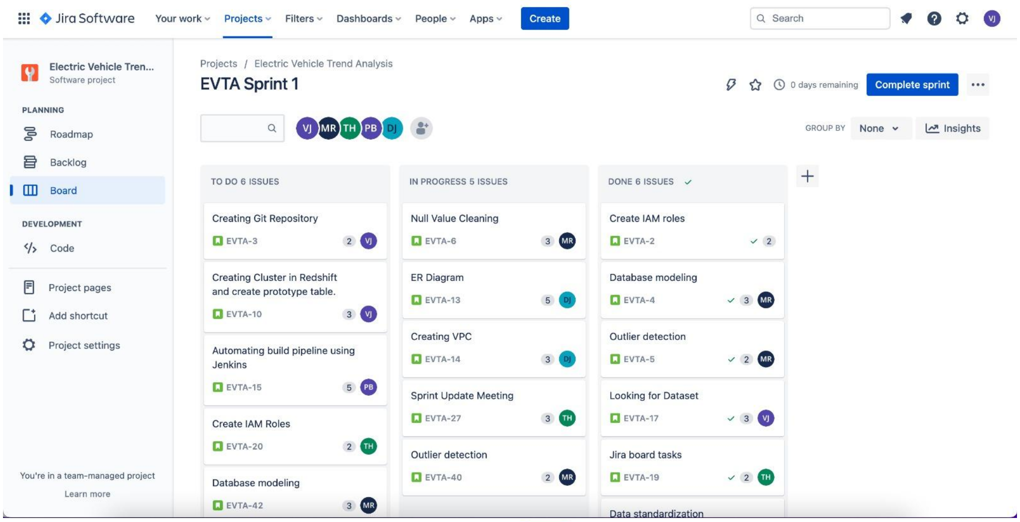


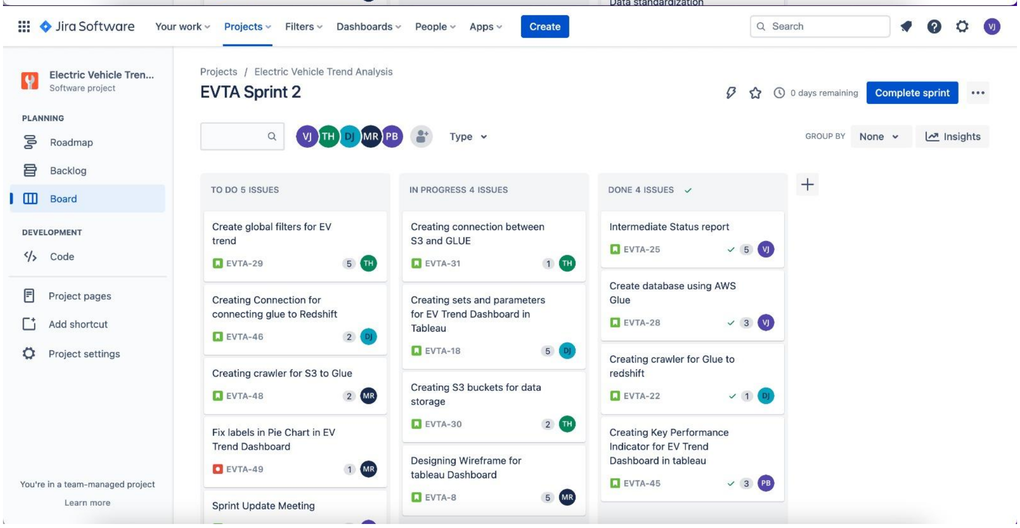



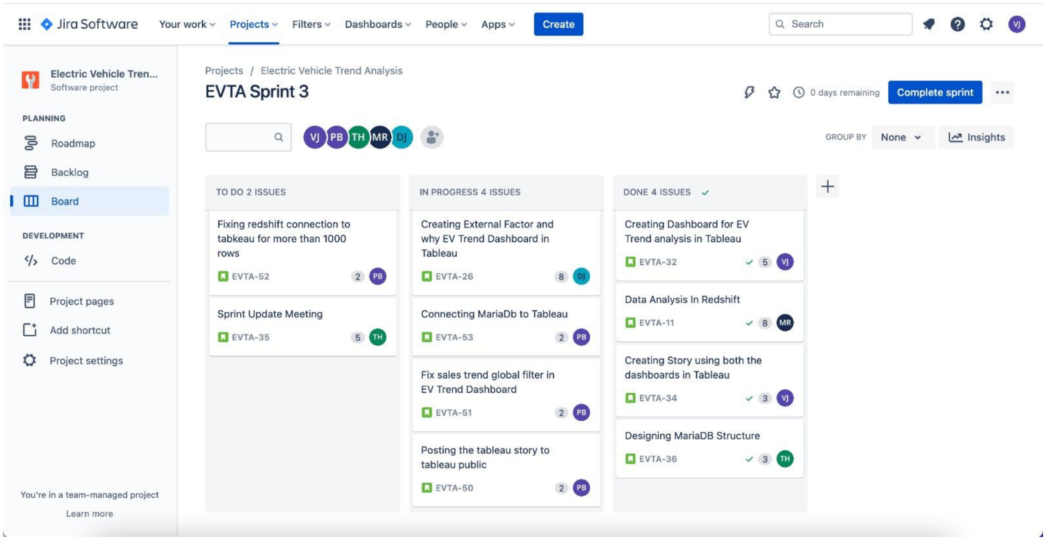

| Year_ID | Indicator_ID | Value |
|---|---|---|
| 1 | 1 | 11.528647 |
| 2 | 1 | 10.757414 |
| 3 | 1 | 9.916110 |
| 4 | 1 | 10.484326 |
| 5 | 1 | 9.747236 |
| 6 | 1 | 10.801085 |
| 7 | 1 | 11.581450 |
| 8 | 1 | 10.977828 |
| 9 | 1 | 9.608585 |
| 10 | 1 | 9.069201 |

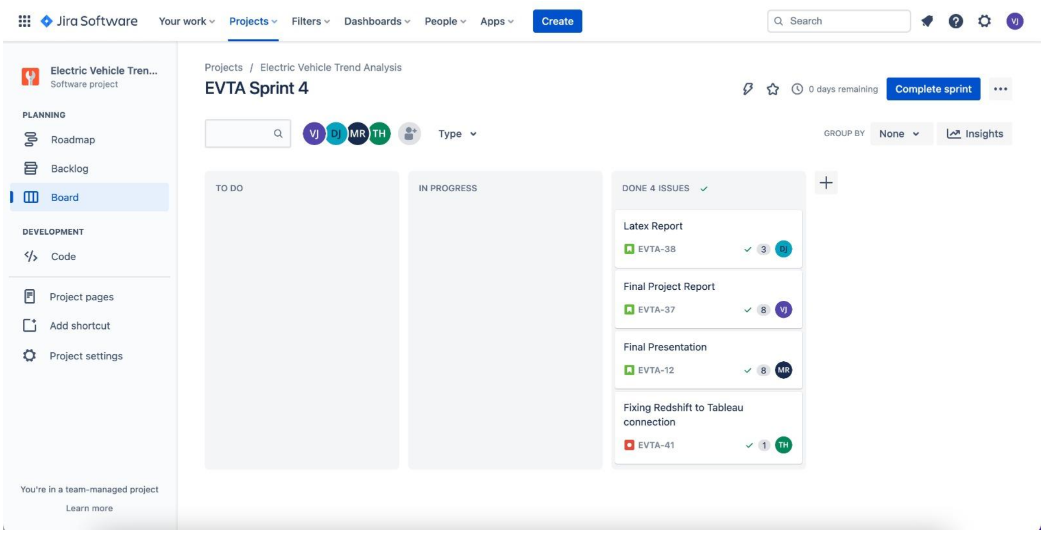

HeidiSQL 11.3.0.6295
Host: 127.0.0.1
Database: ev_factors
Table: factor_values
Data
Query*
SELECT indicator, metric, YEAR, VALUE FROM factor_year a, factor_indicator b, factor_values c
WHERE a.year_id = c.year_id AND b.indicator_id = c.Indicator_ID;
factor_year (270r × 4c)
indicator | metric | YEAR | VALUE
Renewable electricity output | % of total electricity output | 1,990 | 11.528647
Renewable electricity output | % of total electricity output | 1,991 | 10.757414
Renewable electricity output | % of total electricity output | 1,992 | 9.916110
Renewable electricity output | % of total electricity output | 1,993 | 10.484326
Renewable electricity output | % of total electricity output | 1,994 | 9.747236
Renewable electricity output | % of total electricity output | 1,995 | 10.801085
Renewable electricity output | % of total electricity output | 1,996 | 11.581450
Renewable electricity output | % of total electricity output | 1,997 | 10.977828
Renewable electricity output | % of total electricity output | 1,998 | 9.608585
Renewable electricity output | % of total electricity output | 1,999 | 9.069201
Renewable electricity output | % of total electricity output | 2,000 | 8.205997
Renewable electricity output | % of total electricity output | 2,001 | 6.783992
Renewable electricity output | % of total electricity output | 2,002 | 8.646361
Renewable electricity output | % of total electricity output | 2,003 | 8.889376
Renewable electricity output | % of total electricity output | 2,004 | 8.630186
Renewable electricity output | % of total electricity output | 2,005 | 8.578466
Renewable electricity output | % of total electricity output | 2,006 | 9.244631
Renewable electricity output | % of total electricity output | 2,007 | 8.367764

Jira:

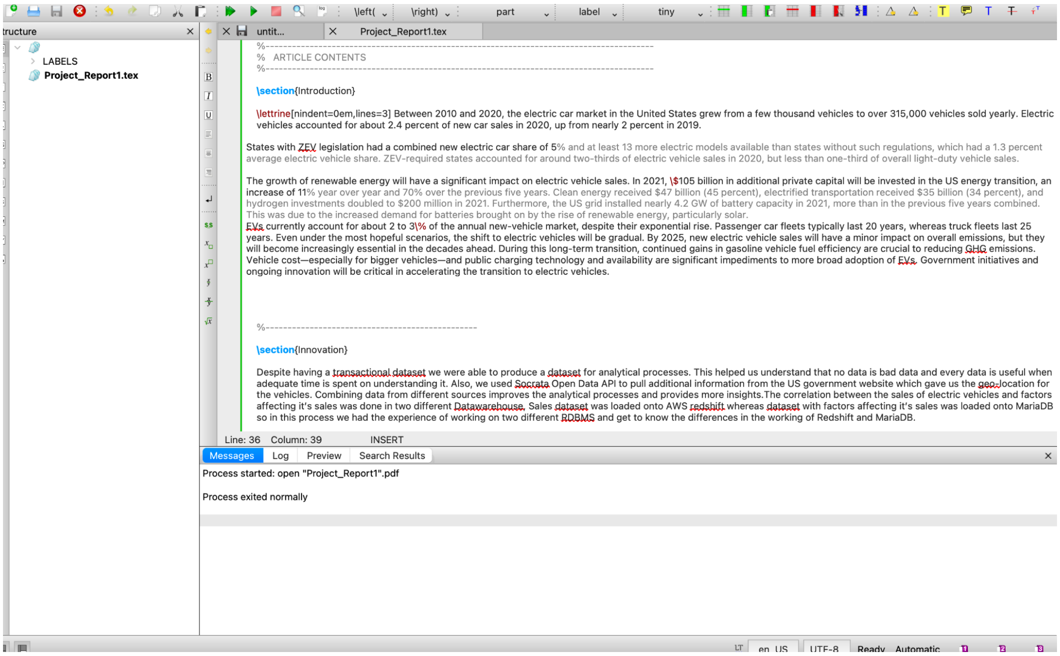

Jira Software
Projects / Electric Vehicle Trend Analysis
EVTA Sprint 1
0 days remaining
Complete sprint
TO DO 6 ISSUES
Creating Git Repository EVTA-3
Creating Cluster in Redshift and create prototype table. EVTA-10
Automating build pipeline using Jenkins EVTA-15
Create IAM Roles EVTA-20
Database modeling EVTA-42
IN PROGRESS 5 ISSUES
Null Value Cleaning EVTA-6
ER Diagram EVTA-13
Creating VPC EVTA-14
Sprint Update Meeting EVTA-27
Outlier detection EVTA-40
DONE 6 ISSUES
Create IAM roles EVTA-2
Database modeling EVTA-4
Outlier detection EVTA-5
Looking for Dataset EVTA-17
Jira board tasks EVTA-19
Data standardization


Jira Software
Projects / Electric Vehicle Trend Analysis
EVTA Sprint 2
0 days remaining
Complete sprint
TO DO 5 ISSUES
Create global filters for EV trend EVTA-29
Creating Connection for connecting glue to Redshift EVTA-46
Creating crawler for S3 to Glue EVTA-48
Fix labels in Pie Chart in EV Trend Dashboard EVTA-49
Sprint Update Meeting
IN PROGRESS 4 ISSUES
Creating connection between S3 and GLUE EVTA-31
Creating sets and parameters for EV Trend Dashboard in Tableau EVTA-18
Creating S3 buckets for data storage EVTA-30
Designing Wireframe for tableau Dashboard EVTA-8
DONE 4 ISSUES
Intermediate Status report EVTA-25
Create database using AWS Glue EVTA-28
Creating crawler for Glue to redshift EVTA-22
Creating Key Performance Indicator for EV Trend Dashboard in tableau EVTA-45

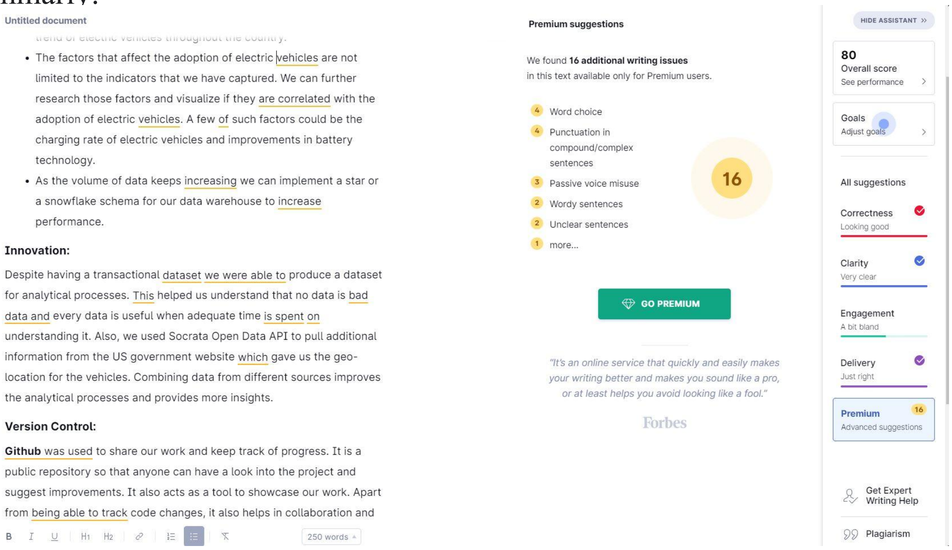

Jira Software
Your work
Projects
Filters
Dashboards
People
Apps
Create
Search
Electric Vehicle Tren...
Software project
PLANNING
Roadmap
Backlog
Board
DEVELOPMENT
Code
Project pages
Add shortcut
Project settings
You're in a team-managed project
Learn more
Projects / Electric Vehicle Trend Analysis
EVTA Sprint 3
0 days remaining
Complete sprint
GROUP BY
None
Insights
TO DO 2 ISSUES
Fixing redshift connection to tabkeau for more than 1000 rows
EVTA-52
Sprint Update Meeting
EVTA-35
IN PROGRESS 4 ISSUES
Creating External Factor and why EV Trend Dashboard in Tableau
EVTA-26
Connecting MariaDb to Tableau
EVTA-53
Fix sales trend global filter in EV Trend Dashboard
EVTA-51
Posting the tableau story to tableau public
EVTA-50
DONE 4 ISSUES
Creating Dashboard for EV Trend analysis in Tableau
EVTA-32
Data Analysis In Redshift
EVTA-11
Creating Story using both the dashboards in Tableau
EVTA-34
Designing MariaDB Structure
EVTA-36


Jira Software
Your work
Projects
Filters
Dashboards
People
Apps
Create
Search
Electric Vehicle Tren...
Software project
PLANNING
Roadmap
Backlog
Board
DEVELOPMENT
Code
Project pages
Add shortcut
Project settings
You're in a team-managed project
Learn more
Projects / Electric Vehicle Trend Analysis
EVTA Sprint 4
0 days remaining
Complete sprint
Type
GROUP BY
None
Insights
TO DO
IN PROGRESS
DONE 4 ISSUES
Latex Report
EVTA-38
Final Project Report
EVTA-37
Final Presentation
EVTA-12
Fixing Redshift to Tableau connection
EVTA-41

Latex:


Project_Report1.tex
LABELS
% ARTICLE CONTENTS
\section{Introduction}
\lettrine[nindent=0em,lines=3] Between 2010 and 2020, the electric car market in the United States grew from a few thousand vehicles to over 315,000 vehicles sold yearly. Electric vehicles accounted for about 2.4 percent of new car sales in 2020, up from nearly 2 percent in 2019.
States with ZEV legislation had a combined new electric car share of 5% and at least 13 more electric models available than states without such regulations, which had a 1.3 percent average electric vehicle share. ZEV-required states accounted for around two-thirds of electric vehicle sales in 2020, but less than one-third of overall light-duty vehicle sales.
The growth of renewable energy will have a significant impact on electric vehicle sales. In 2021, \$105 billion in additional private capital will be invested in the US energy transition, an increase of 11% year over year and 70% over the previous five years. Clean energy received $47 billion (45 percent), electrified transportation received $35 billion (34 percent), and hydrogen investments doubled to $200 million in 2021. Furthermore, the US grid installed nearly 4.2 GW of battery capacity in 2021, more than in the previous five years combined. This was due to the increased demand for batteries brought on by the rise of renewable energy, particularly solar.
EVs currently account for about 2 to 3\% of the annual new-vehicle market, despite their exponential rise. Passenger car fleets typically last 20 years, whereas truck fleets last 25 years. Even under the most hopeful scenarios, the shift to electric vehicles will be gradual. By 2025, new electric vehicle sales will have a minor impact on overall emissions, but they will become increasingly essential in the decades ahead. During this long-term transition, continued gains in gasoline vehicle fuel efficiency are crucial to reducing GHG emissions. Vehicle cost—especially for bigger vehicles—and public charging technology and availability are significant impediments to more broad adoption of EVs. Government initiatives and ongoing innovation will be critical in accelerating the transition to electric vehicles.
\section{Innovation}
Despite having a transactional dataset we were able to produce a dataset for analytical processes. This helped us understand that no data is bad data and every data is useful when adequate time is spent on understanding it. Also, we used Socrata Open Data API to pull additional information from the US government website which gave us the geo-location for the vehicles. Combining data from different sources improves the analytical processes and provides more insights.The correlation between the sales of electric vehicles and factors affecting it's sales was done in two different Datawarehouse. Sales dataset was loaded onto AWS redshift whereas dataset with factors affecting it's sales was loaded onto MariaDB so in this process we had the experience of working on two different RDBMS and get to know the differences in the working of Redshift and MariaDB.
Line: 36 Column: 39 INSERT
Messages Log Preview Search Results
Process started: open "Project_Report1".pdf
Process exited normally
en_US UTF-8 Ready Automatic

# Grammarly:


Untitled document
The factors that affect the adoption of electric vehicles are not limited to the indicators that we have captured. We can further research those factors and visualize if they are correlated with the adoption of electric vehicles. A few of such factors could be the charging rate of electric vehicles and improvements in battery technology.
As the volume of data keeps increasing we can implement a star or a snowflake schema for our data warehouse to increase performance.
Innovation:
Despite having a transactional dataset we were able to produce a dataset for analytical processes. This helped us understand that no data is bad data and every data is useful when adequate time is spent on understanding it. Also, we used Socrata Open Data API to pull additional information from the US government website which gave us the geo-location for the vehicles. Combining data from different sources improves the analytical processes and provides more insights.
Version Control:
Github was used to share our work and keep track of progress. It is a public repository so that anyone can have a look into the project and suggest improvements. It also acts as a tool to showcase our work. Apart from being able to track code changes, it also helps in collaboration and
250 words
Premium suggestions
We found 16 additional writing issues
in this text available only for Premium users.
4 Word choice
4 Punctuation in compound/complex sentences
3 Passive voice misuse
2 Wordy sentences
2 Unclear sentences
1 more...
16
GO PREMIUM
"It's an online service that quickly and easily makes your writing better and makes you sound like a pro, or at least helps you avoid looking like a fool."
Forbes
HIDE ASSISTANT
80
Overall score
See performance
Goals
Adjust goals
All suggestions
Correctness
Looking good
Clarity
Very clear
Engagement
A bit bland
Delivery
Just right
Premium
16
Advanced suggestions
Get Expert Writing Help
Plagiarism